X-6933

GMC TRUCK SERVICE MANUAL

SERIES 4000 thru 6500

GMC TRUCK & COACH DIVISION GENERAL MOTORS CORPORATION

X-6933

SERVICE MANUAL

GMC
TRUCKS

SERIES 4000 THRU 6500

This manual includes procedures for maintenance and adjustments, minor service operations and replacement of components

GMC TRUCK & COACH DIVISION
GENERAL MOTORS CORPORATION
PONTIAC, MICHIGAN

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SECTION INDEX

INTRODUCTION

This manual contains on-the-vehicle maintenance, light repair information, and unit replacement on all truck series listed on page v. Overhaul procedures for major units will be published in separate "Unit Overhaul" manuals. Important information on the arrangement and use of this manual will be found on page iv. Operation of the vehicles from the standpoint of the driver is contained in a separate Owner's and Driver's manual which is furnished with every new GMC Truck.

Every effort has been made to include timely and adequate information on the various units and systems used on GMC Trucks. The general maintenance and light repair procedures in the various manual sections are the result of extensive service experience. This information should serve not only as a reference for the experienced mechanical force, but also as a comprehensive text for training purposes.

In some cases, considerable space is devoted to describing the operation of a unit or system. The use of this space is justified by the presumption that in order for a mechanic to maintain a unit or system in a serviceable condition, he must first understand how the unit or system should function.

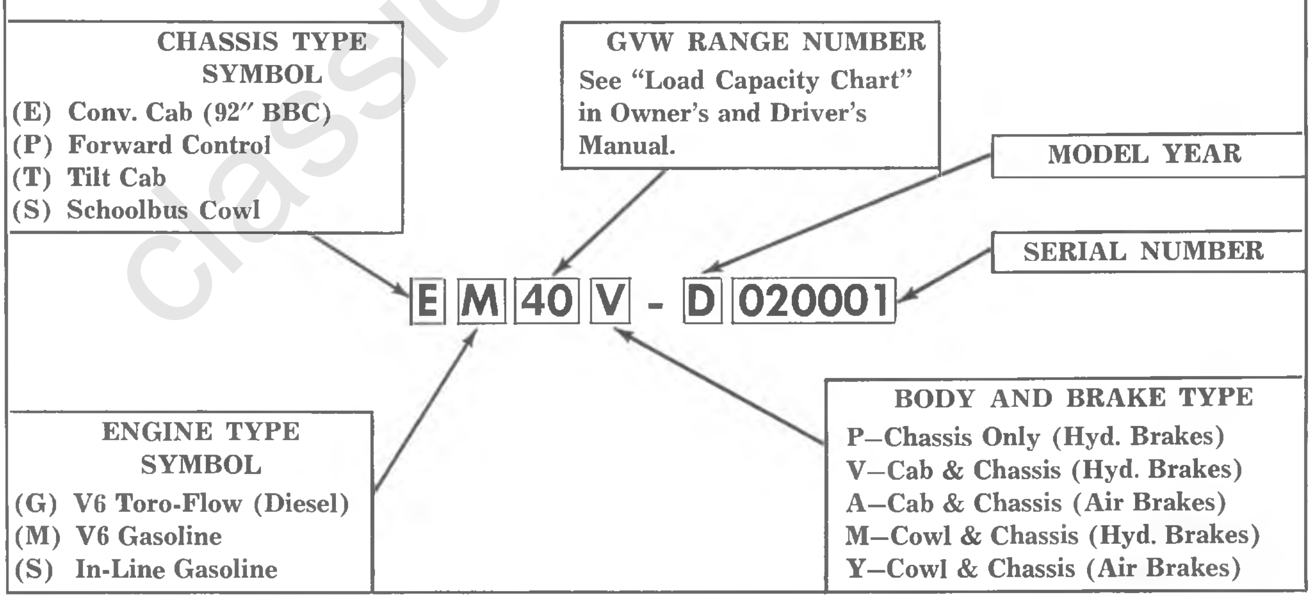
All information contained in this manual is based on the latest product information available at the time of publication approval. GMC Truck and Coach Division reserves the right to make changes in design or add improvements at any time without incurring any obligation to install same on vehicles previously purchased.

TRUCK MODEL DESIGNATION

("L" SERIES 4000)

(L) Tilt Cab (V) Hydraulic Brakes (A) Air Brakes

(ALL OTHER SERIES)



GENERAL INFORMATION

IMPORTANT—READ THIS PAGE

TRUCK MODELS COVERED

This manual contains "on-the-vehicle" maintenance and light repair information on GMC Truck Models listed on page v. Since many truck models with various combinations of equipment are covered in this manual, the reader must necessarily refer to truck model applications and methods of distinguishing design differences in each manual section.

All standard equipment and the most commonly used regular production options are included in this manual. Many special equipment and accessory items are available on these GMC Trucks, however, these items are too numerous to permit their coverage in this manual.

MANUAL ARRANGEMENT

This manual is divided into major sections in the sequence shown on the margin of the title page. A black tab bearing the major section number is placed on the first page of each major section which indexes with the tab on the title page. Many of the major sections are divided into sub-sections, each sub-section containing important and specific information on related units or components. A section index is also included on the first page of each major section, when the major section is divided into sub-sections.

PAGE AND ILLUSTRATION NUMBERS

The manual pages are numbered consecutively throughout the manual. Illustrations are numbered consecutively within each section, or within each sub-section when the major section is so divided.

SPECIFICATIONS

Service data, fits, and tolerances are listed at end of each section or sub-section under the heading "Specifications." In some cases reference must also be made to these "Specifications." for model application and methods of distinguishing the various design and construction differences.

Manufacturers model or part numbers are used in many instances in the "Specifications" tabulations. These numbers are provided primarily for unit identification or truck model application reference, and should be referred to when ordering parts. All detail service part numbers must be obtained from the applicable Parts Book.

SPECIAL TOOLS

Special tools and equipment are mentioned, and in many instances illustrated, throughout the text. These tools are specially designed to accomplish certain operations efficiently and readily. Such tools are mentioned in the text by tool vendor's numbers. These tools are not offered for sale by GMC Truck and Coach Division. Information regarding availability of these tools can be obtained from your Zone Office or directly from the Technical Publication Department at the Factory.

SERVICE BULLETINS

Service bulletins are issued, when required, supplementing or in some cases superseding information in this manual. Information in these bulletins should be noted in the text of the applicable manual section and the bulletin filed for ready reference.

OPERATION

Operating instructions from the standpoint of the driver are included in a booklet entitled "Owner's and Driver's Manual" which is placed in the cab of every new GMC Truck.

ALPHABETICAL INDEX

Important subjects, with manual page number references, are alphabetically listed in the index in the back of this manual.

MODEL DATA

TRUCK SERIES	GMC ENGINE		CLUTCH		FRONT AXLE		REAR AXLE		TRANSMISSION	
	STD.	OPT	STD.	OPT.	STD.	OPT.	STD.	OPT.	STD.	OPT.
LA, LV-4000	305C	351C	12	13	F070	—	H150	G161, 16121, T150, G361, 16221	435GL	435GD, 540GD, 540GL
DLA, DLV-4000	DH478	—	12	13	F070	—	H150	G161, 16121, T150, G361, 16221	435GL	435GD, 540GD, 540GL
EM-4500	305E	—	11	12	F055	—	H110	H135, H150, T150	435GL	435GD
ES-4500	250	292	11	12	F055	—	H110	H135, H150, T150	435GL	435GD
PS-4500	250	292	11	12	F050	—	H110	H135	SM465	—
EG-5500V	DH478	—	12	13	F055	F070	H150	G161, 16121, T150, G361, 16221	435GL	435GD, 540GD, 540GL
EG-5500A	DH478	—	12	13	F070	—	G161	16121, G361, 16221	435GL	435GD, 540GD, 540GL
EM-5500	305C	351C	12	13	F055	F070	H150	G161, 16121, T150, G361, 16221	435GL	435GD, 540GD, 540GL
EM-5500 A & Y	305C	351C	12	13	F070	—	G161	16121, G361, 16221	435GL	435GD, 540GD, 540GL
ES-5500 V & M	292	—	12	—	F055	F070	H150	G161, 16121, T150, G361, 16221	435GL	435GD, 540GD, 540GL
SG-5500M	DH478	—	12	13	F055	F070	H150	G161, 16121, T150, G361, 16221	435GL	435GD, 540GD, 540GL
SG-5500Y	DH478	—	12	13	F070	—	G161	16121, G361, 16221	435GL	435GD, 540GD, 540GL
SM-5500M	305C	351C	12	13	F055	F070	H150	G161, 16121, T150, G361, 16221	435GL	435GD, 540GD, 540GL
SM-5500Y	305C	351C	12	13	F070	—	G161	16121, G361, 16221	435GL	435GD, 540GD, 540GL
SS-5500	292	—	12	—	F055	F070	H150	G161, 16121, T150, G361, 16221	435GL	435GD, 540GD, 540GL
EG-6500	DH478	—	12	13	F070	—	16121	17121, 16221, 17221	435GL	435GD, 540GD, 540GL
EM-6500	305C	351C	12	13	F070	—	16121	17121, 16221, 17221	435GL	435GD, 540GD, 540GL
SM-6500 M & Y	351M	—	13	—	F070	—	16121	17121, 16221, 17221	435GL	435GD, 540GD, 540GL

VEHICLE MODEL IDENTIFICATION AND WEIGHT RATING PLATE

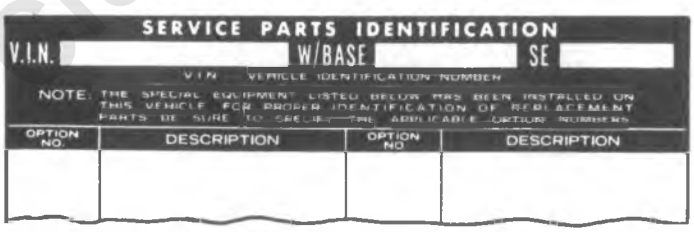
The vehicle identification and weight rating plate is located on the cab left door pillar of all models except "P" and cowl models. Plate location on "P" and cowl models is determined by the body manufacturer.

ENGINE SERIAL NUMBERS

The engine serial number on "V" engines is stamped on top of the cylinder block ahead of the right-bank cylinder head as shown below. Engine serial numbers are not used on in-line engines; numbers appearing on crankcase boss at rear of distributor are manufacturing location and building date codes.

SERVICE PARTS IDENTIFICATION

The "Service Parts Identification" label is located on inside of glove compartment door of steel tilt and conventional cab models. Location of label on "P" and cowl models is determined by the body manufacturer. This label lists all special equipment installed on the vehicle. This information is imprinted on the label at the factory and represents only the special equipment on the vehicle when it was shipped from the factory. Always refer to this information when ordering parts.



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SECTION O

Lubrication

INDEX

GENERAL INFORMATION

Lubrication charts on following pages will locate each lubrication point on the series shown under each chart. Each point is numbered on the charts, and each number is keyed to explanatory text on same or opposite page.

Each item shown on charts requiring lubrication is covered with a lubricant symbol. Explanations of symbols start on page following charts. Explanations include type of lubricant recommended, and detailed instructions regarding its application. The charts show recommended intervals when various items should be lubricated. The intervals are recommended for normal use; however, operating conditions may require more frequent intervals. Recommended intervals should be followed until operating experience indicates other periods.

No particular brand of lubricant is recommended as many reputable oil dealers can furnish the right lubricants when advised of the correct specifications or descriptions. The lubricant manufacturer must be responsible for the quality and satisfactory performance of his product. His reputation is your best indication of quality.

LUBRICANT SYMBOLS

Symbol	Explanation	Page No.
"E"	Engine Oil	7
"MP"	Multi-Purpose Gear Lubricant	12
"C"	Chassis Lubricant	13
"SG"	Steering Gear Lubricant	14
"S-2"	High Temperature Grease	14
"S-3"	Petroleum Jelly	14
"S-4"	Waterproof Grease	15
"S-12"	Hydraulic Brake Fluid	15
"S-16"	Soft, Smooth Cup Grease	15
"S-17"	Special Grease	15
"S-19"	Automatic Transmission Fluid	16
"S-28"	High Temperature Grease (Special)	16

LUBRICATION

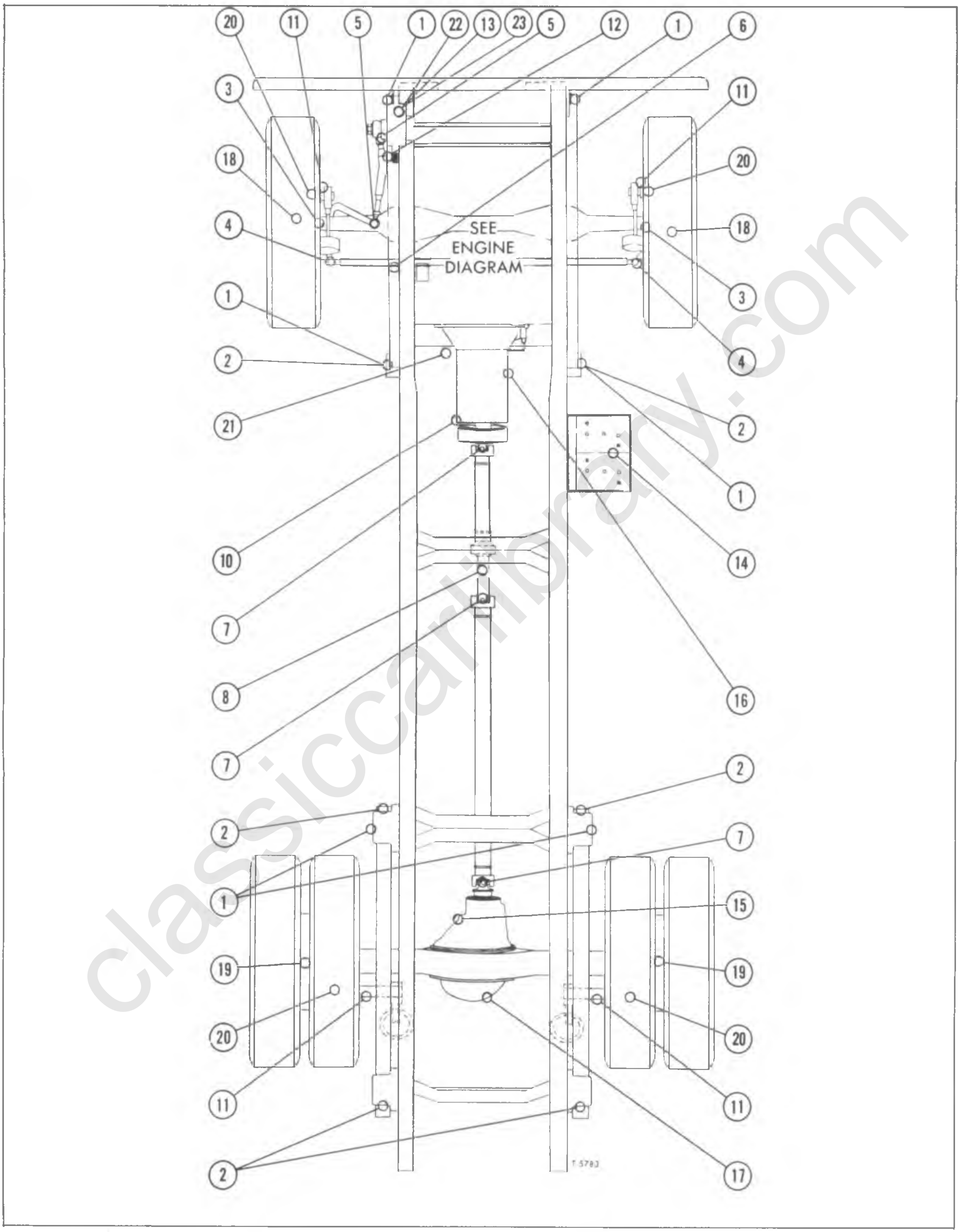


Figure 1—Lubrication Chart (Except Steel Tilt Cab Models)

LUBRICATION DATA
(CHART ON OPPOSITE PAGE)

Item No.	Item	Remarks	Sym.	Miles ‡
1	Spring Shackles and Brackets (1)	2 fittings each shackle	C	6,000
		1 fitting each bracket	C	6,000
2	Spring Slip Pads (1)	Apply each end	C	6,000
3	Steering Knuckles	2 fittings each side	C	6,000
4	Steering Tie Rod Ends	1 fitting each end	C	6,000
5	Steering Drag Link	1 fitting each end	C	6,000
6	Power Steering Cylinder Ends (1)	2 fittings	C	6,000
7	Prop. Shaft U-Joints	1 fitting each joint	GO	6,000
8	Prop. Shaft Slip Joint	1 fitting each joint	C	6,000
10	Speedometer Adapter	1 fitting	C	6,000
11	Brake Camshaft (2)	1 fitting ea. (apply sparingly)	C	6,000
12	Brake Master Cylinder (3)	Fill - 1/2" below opening	S12	6,000
13	Steering Gear Housing	To level of filler plug	SG	6,000
14	Battery Terminals	Keep coated	S3	6,000
15	Electric Shift Unit (2-Spd.)	To level of filler plug	S7	12,000
16	Transmission	To level of filler plug	MP	6,000
		Drain and refill	MP	12,000
17	Rear Axle	To level of filler plug	MP	6,000
		Drain and refill	MP	24,000#
18	Front Wheel Bearings	Hand pack or use lubricator	S2	20,000*
19	Rear Wheel Bearings	Hand pack or use lubricator Series 4500 & 5500 H110, H135, T150, H150, G161, G361	S16	20,000*
		All Others	S2	20,000*
20	Brake Cam Roller Pins (2)	Apply	E	20,000
21	Brake and Axle Cyl. Air Cleaner (1)	Clean and reinstall	-	6,000
22	Steering Column U-Joints	1 fitting each joint	C	6,000
23	Steering Column Slip Joints	1 fitting	C	6,000

* Or once a year, whichever occurs first.
\# Or every 6 months, whichever occurs first.
‡ When "C" Chassis Lubricant is specified, lubricate every 6,000 miles or 60 days, whichever occurs first.
(1) Some Models.
(2) Air Brake only.
(3) Hydraulic Brakes only.

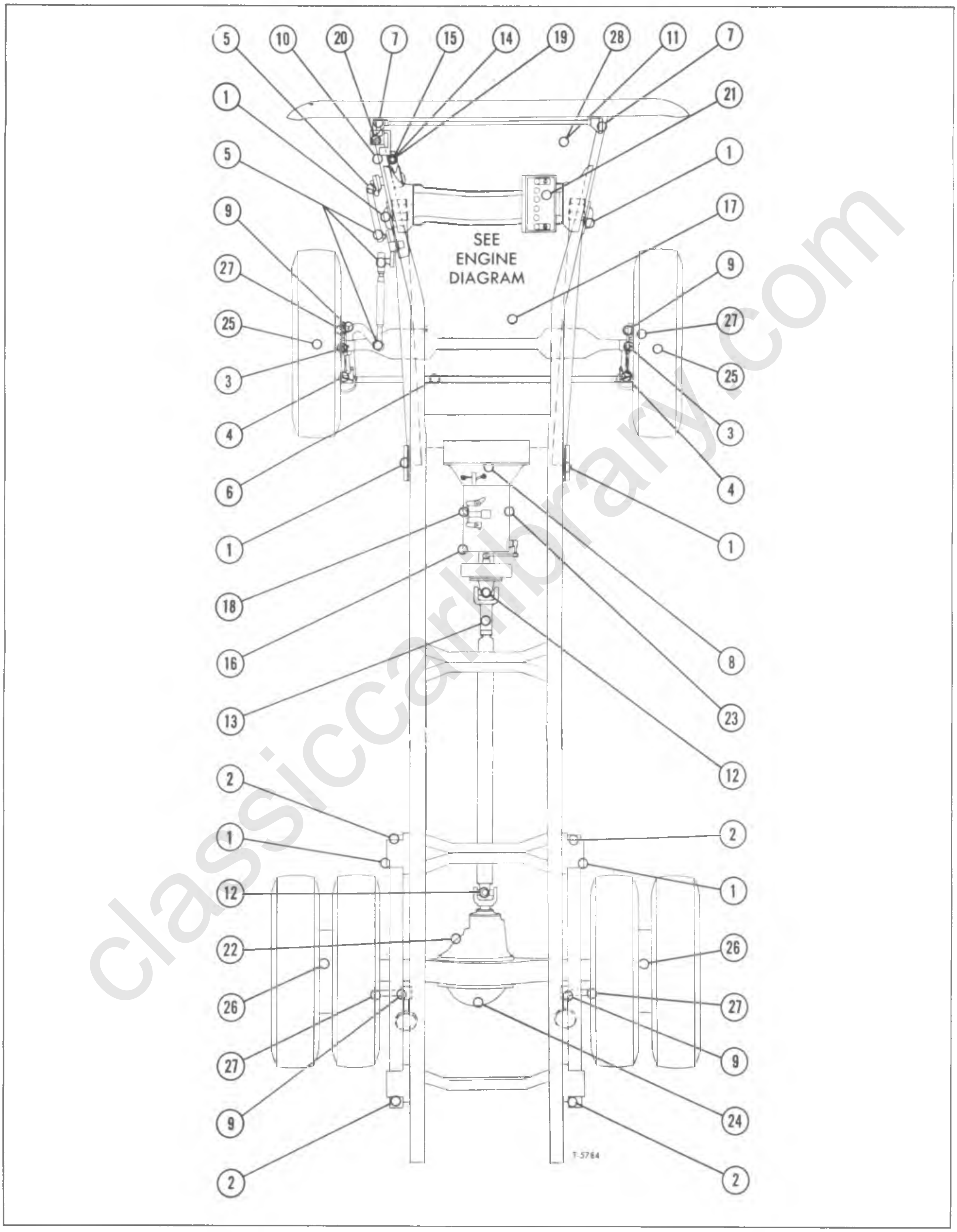


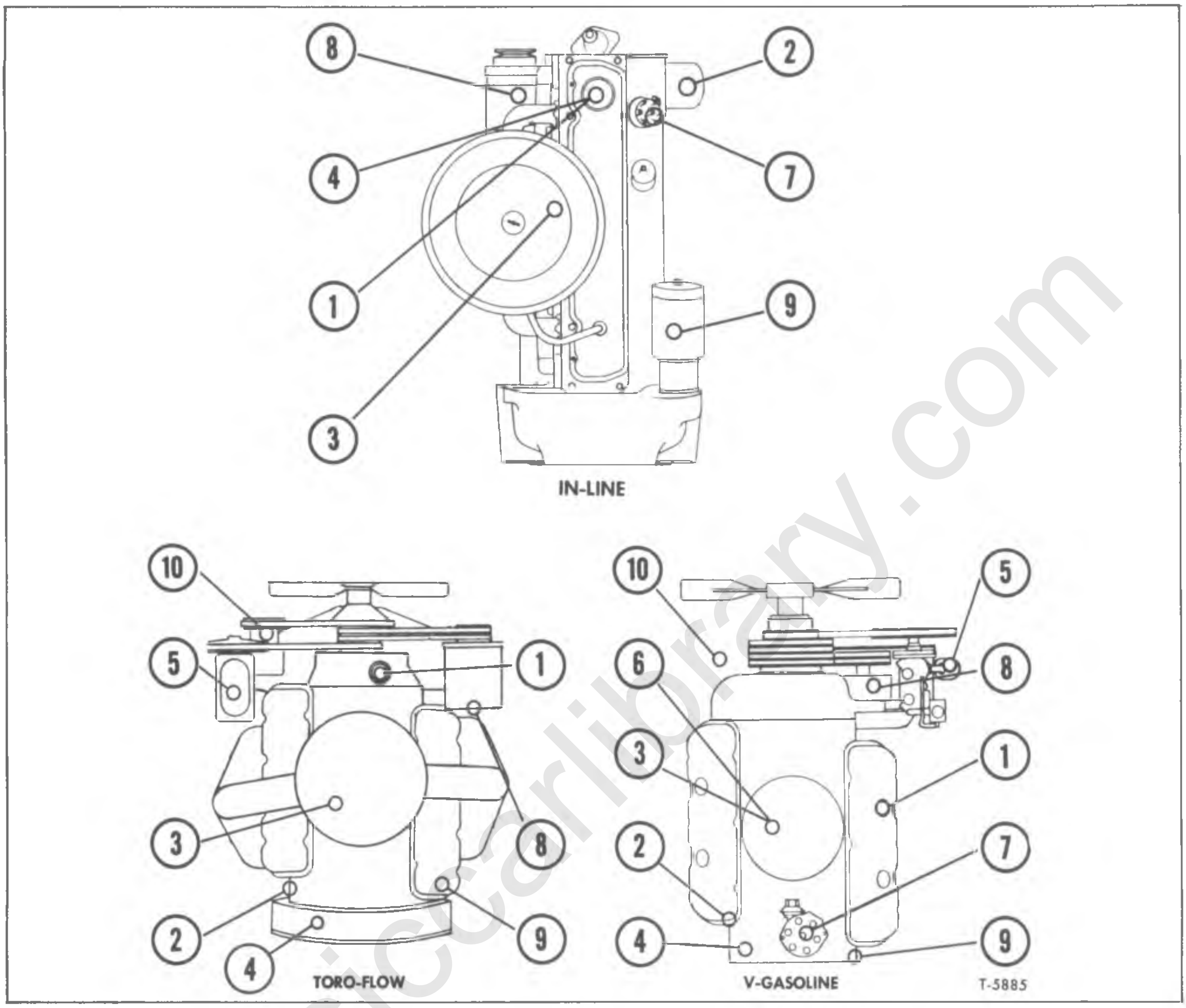
Figure 2—Lubrication Chart (Steel Tilt Cab Models)

LUBRICATION DATA
(CHART ON OPPOSITE PAGE)

Item No.	Item	Remarks	Sym.	Miles ‡
1	Spring Shackles and Brackets	2 fittings each shackle	C	6,000
		1 fitting each bracket	C	6,000
2	Spring Slip Pads - Rear	Apply each end	C	6,000
3	Steering Knuckles	2 fittings each side	C	6,000
4	Steering Tie Rod Ends	1 fitting each end	C	6,000
5	Steering Drag Links	1 fitting each end	C	6,000
6	Power Steering Cylinder Ends (1)	2 fittings	C	6,000
7	Cab Hinges	1 fitting each side	C	6,000
8	Cab Hold-Down Latch	1 fitting	C	6,000
9	Brake Camshafts (2)	1 fitting each	C	6,000
10	Clutch and Brake Pedals	2 fittings	C	6,000
11	Air-Hydraulic Cylinder (3)	To level of plug	S6	12,000
12	Prop. Shaft U-Joints	1 fitting each joint	GO	6,000
13	Prop. Shaft Slip Joints	1 fitting each joint	C	6,000
14	Steering Column U-Joints	1 fitting each joint	GO	6,000
15	Steering Column Slip Joint	1 fitting	C	6,000
16	Speedometer Adapter	1 fitting	C	6,000
17	Transmission Shift Levers	2 fittings	C	6,000
18	Transmission Shift Linkage (NP 540)	1 fitting	C	6,000
19	Steering Gear Housing	To level of filler plug	SG	6,000
20	Brake Master Cylinder (3)	Fill - 1/2" below opening	S12	6,000
21	Battery Terminals	Keep coated	S3	6,000
22	Electric Shift Unit (2-Spd.)	To level of filler plug	S7	12,000
23	Transmission	To level of filler plug	MP	6,000
		Drain and refill	MP	12,000
24	Rear Axle	To level of filler plug	MP	6,000
		Drain and refill	MP	24,000#
25	Front Wheel Bearings	Hand pack or use lubricator	S2	20,000*
26	Rear Wheel Bearings	Hand pack or use lubricator		
		H110, H135, T150, H150, G161, G361	S16	20,000*
		All Others	S2	20,000*
27	Brake Cam Roller Pins (2)	Apply	E	20,000
28	Brake Power and Axle Cylinder Air Cleaner (1)	Clean and reinstall	-	6,000

* Or once a year, whichever occurs first.
# Or every 6 months, whichever occurs first.
‡ When "C" Chassis Lubricant is specified, lubricate every 6,000 miles or 60 days, whichever occurs first.
(1) Some Models.
(2) Air Brakes only.
(3) Air-Hydraulic Brakes only.

LUBRICATION



Item No.	Item	Remarks	Sym.	Miles
1	Engine	Keep to "FULL" mark	E	Daily
2	Engine Oil Filter	See instructions	-	---
3	Engine Air Cleaner	Clean and refill	E	3,000
4	Crankcase Breather (1)	See instructions	-	--
5	Air Compressor Air Strainer (1)	Clean and install	-	6,000
6	Governor Air Filter (2)	Clean and install	-	6,000
7	Distributor (2)	1/2 turn of cam lubricator	-	12,000#
		Breaker pivot - 1 drop	E	6,000
		Rotor felt - 4 drops	E	6,000
8	Generator	No lubrication required	-	--
9	Starter	See instructions	E	--
10	Power Steering Reservoir (1)	To "OIL LEVEL" mark	S19	6,000

(1) Some Models.
(2) Gas Engine Only.
Replace lubricator at 24,000 mile intervals.

Figure 3—Engine Lubrication Charts

CAPACITIES

CRANKCASE CAPACITIES

ENGINE MODEL	LESS FILTER QTS.* U.S.	LESS FILTER QTS.* IMP.	WITH FILTER QTS.* U.S.	WITH FILTER QTS.* IMP.
250	4	3-1/4	5	4-1/4
292* - 305E	5	4-1/4	6	5
305C* - 351C*	8	6-3/4	9	7-1/2
351M	8	6-3/4	10	8-1/2
DH478**	11	9-1/4	13	10¾

* Add one quart when 2-qt. filter is used.
** Add one quart when oil cooler is drained.

Crankcase capacities are for normal refill. Add oil as indicated when oil filter is drained and element changed. Capacities given may be approximate - keep level as close as possible to "FULL" mark without over-filling. Do not operate with level below "ADD" mark.

TRANSMISSION CAPACITIES

	PINTS U.S.	PINTS IMPERIAL
SM465	8	6-3/4
NP435	7	5-3/4
NP540	10	8-1/4

REAR AXLE CAPACITIES

BEVEL	PINTS U.S.	PINTS IMPERIAL
H110	14	11-3/4
H135	20	16-3/4
H150	20	16-3/4
G161	21	17-1/2
E16121	24	20
E17121	29	24-1/4
TWO-SPEED		
T150	18	15
G361	21	17-1/2
E16221	24	20
E17221	29	24-1/4

ENGINE OIL
(SYMBOL "E" ON CHARTS)

RECOMMENDATIONS

The oil industry markets various types of engine oil under certain service designations and specification numbers.

The selection of a reliable supplier, with close attention to his oil and filter element change recommendations can provide satisfactory lubrication and longer life for engine.

DIESEL ENGINE

Use Only High Quality Oils Which Are:

(1) MIL-L-2104B engine oils (see Note).
- or -
(2) Oils which pass the vehicle manufacturers tests (including General Motors Standard GM 6042M).

NOTE: Supplement 1 engine oils (based upon now obsoleted MIL-L-2104A) have been superseded by MIL-L-2104B engine oils, so these Supplement 1 oils are therefore becoming unavailable. However, where a history of satisfactory performance with Supplement 1 oils has been established, they can still be used.

The use of proper engine oils and oil change intervals are your best assurance of continued reliability and performance of engine.

IMPORTANT: Non-detergent and other lower quality engine oils are specifically not recommended in diesel engines.

GASOLINE ENGINE

Use Only High Quality Oils Which Are:

(1) Intended for Service Designations "MS" and "DM" (see Note).
- or -
(2) Products passing vehicle manufacturers tests (including General Motors Standard GM 6042M).

NOTE: Supplement 1 engine oils based upon now obsoleted MIL-L-2104A) have been superseded by MIL-L-2104B engine oils. However, Supplement 1 engine oils (MS - DM) with a history of satisfactory performance are available and may be used.

The use of proper engine oils and oil change intervals are your best assurance of continued reliability and performance of engine.

LUBRICATION

IMPORTANT: Non-detergent and other lower quality engine oils are specifically not recommended.

BREAK-IN OILS AND ADDITIVES

The use of proprietary blends of supplementary additives or concentrates such as engine oil supplements, break-in oils, tune-up compounds, friction reducing compounds, etc., is not recommended in lubricating oils of the diesel engines in GMC Truck and Coach vehicles. For gasoline engines, if greater stability or detergency is desired to reduce varnish and sludge formations, and minimize wear, a thoroughly tested and approved concentrate is available from GMC Dealers.

VISCOSITIES

Atmospheric temperatures and severity of service determine the viscosity grade of engine oil to use. Viscosity numbers constitute a classification of lubricants in terms of viscosity or fluidity, but with no reference to any other characteristics or properties.

GASOLINE ENGINES

As a guide to the selection of the proper grade or viscosity of oil to be used in gasoline engines at various atmospheric temperatures, refer to "Viscosity Chart" (fig. 4).

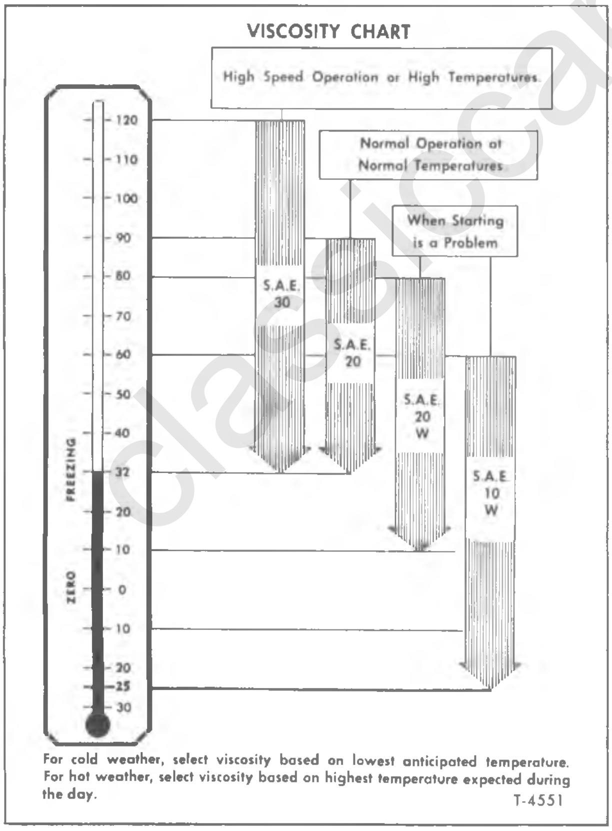


Figure 4—Gasoline Engine Oil Viscosity Chart

DIESEL ENGINES

S.A.E. 30 engine oil is recommended for year around use. Where cold weather starting is a problem, it is suggested that other starting aids, oil and coolant system heaters, as well as proper fuel selection will be helpful. For further assistance, consult your authorized GMC Dealer.

Lower S.A.E. engine oil grades (S.A.E. 20, S.A.E. 10, etc.), and the multi-viscosity oils (10W-30, etc.), are not recommended, except as a last resort. If used, they should be replaced with S.A.E. 30 as soon as possible.

MULTI-VISCOSITY TYPE ENGINE OILS

Multi-Viscosity lubricating oils, as a group, are not normally recommended. However, some may be effectively used to facilitate starting when prolonged exposure of the engine to temperatures below freezing is unavoidable. Consult your supplier regarding the performance characteristics of this type of oil and obtain his assurance of adequate lubrication before subjecting the engine to heavy-duty service.

OIL CHANGE INTERVALS

It is recommended that new engines should have the first oil change at 3,000 miles.

The drain interval may then be increased or decreased, depending upon experience with specific oils or the recommendations and used oil analyses as furnished by the supplier. Such a procedure would be helpful in establishing the most practical oil change period for the particular service.

CHECKING ENGINE OIL LEVEL

Daily, or oftener if necessary, check oil level. Make the check perferably after a day's run and after engine has been stopped for a few minutes. Remove dipstick, wipe clean with cloth, reinsert and remove again. The upper mark on dipstick is "FULL," the lower "ADD." Keep level as close as possible to "FULL" mark without overfilling. Do not operate with level below "ADD" mark.

On gasoline and diesel engines dipstick is on right side and engine can be filled at right filler on valve rocker cover after removing filler cap (fig. 5).

On steel cab models, accessibility is through door behind passenger seat. On other models, dipstick and oil filler are accessible when hood is raised.

ENGINE OIL FILTER

Oil filter element changing periods are closely related to crankcase oil changing periods, the quality of oil used, or the severity of the trucks service.

It is recommended that element be changed initially at first oil change and thereafter at intervals indicated under "Engine Oil Recommendations."

Location of oil filter is at left rear on gasoline and diesel models (fig. 6).

ELEMENT TYPE

1. Remove plug in filter shell to drain oil from filter.
2. Back out center stud and withdraw shell, element, and stud as an assembly.
3. Remove and discard element.
4. Clean filter shell of old oil or other deposits.
5. Replace old filter shell gasket in groove of filter base.
6. Position new filter element in shell, THEN FILL SHELL WITH OIL.
7. Install shell and element assembly on filter base, then tighten center stud being careful that gaskets are not damaged. Torque to 40 to 50 foot-pounds.
8. Start engine and operate at idle speed for a few minutes until oil pressure builds up to normal.
9. Check filter for leaks, then check dipstick level. Add oil to bring level up to (not above) dipstick mark.

DISPOSABLE TYPE

1. Turn filter from mounting on engine, then discard assembly.
2. Thoroughly clean mounting at gasket area.
3. Apply lubricant to filter gasket. Fill element shell with engine oil, then thread filter onto mounting stud until gasket touches mounting, then tighten filter two-thirds more, which should provide the required torque of 10 to 15 foot-pounds.
4. Whenever new element is installed, the engine should be run and the filter inspected for signs of an oil leak. The engine should then be stopped, and the oil level brought up to the "FULL" mark on the oil level dipstick.

AIR CLEANERS

Air cleaners must be serviced a minimum of every 3,000 miles, or whenever dirt becomes visible in the element or oil. Under extreme dirty conditions inspection may be required daily. Air cleaners on vehicles operating in dust storm areas should be cleaned immediately after such storms occur.

Several types of air cleaners are used. Depending upon the vehicle model, each type cleaner is serviced and mounted in a different manner.

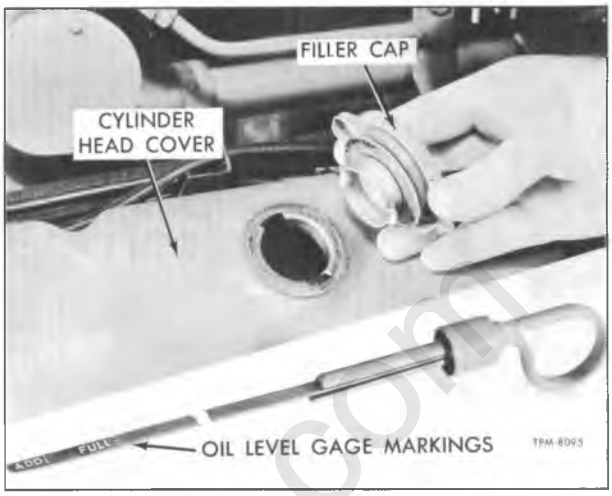


Figure 5—Oil Filler and Dipstick (Gasoline and Toro-Flow)

> **WARNING—DIESEL ENGINE**
>
> USE EXTREME CAUTION TO BE SURE THAT ALL VOLATILE CLEANING FLUID (GASOLINE, KEROSENE, ETC.) IS REMOVED FROM AIR CLEANER AT TIME OF CLEANING, UNCONTROLLED FUEL ENTERING THE COMBUSTION CHAMBER IN THIS MANNER CAN CAUSE THE ENGINE TO "RUN-AWAY" AND POSSIBLY DESTROY ITSELF AND CAUSE INJURY TO PERSONNEL.

OIL BATH TYPE (Figs. 7 and 9)

Oil bath type air cleaners are mounted directly to the engine or on cab dash. Loosen thumb screw on top, then separate cover and element from reservoir.

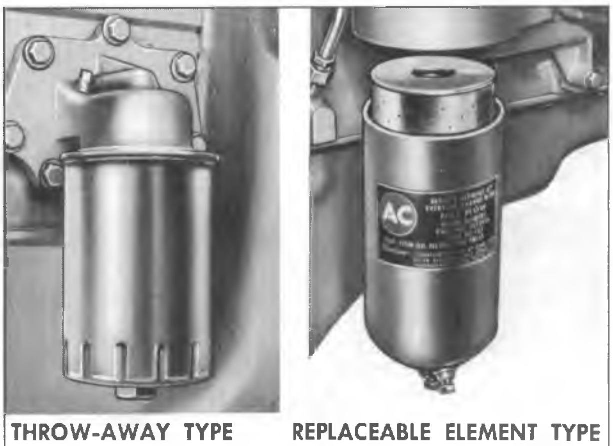


Figure 6—Engine Oil Filters

LUBRICATION

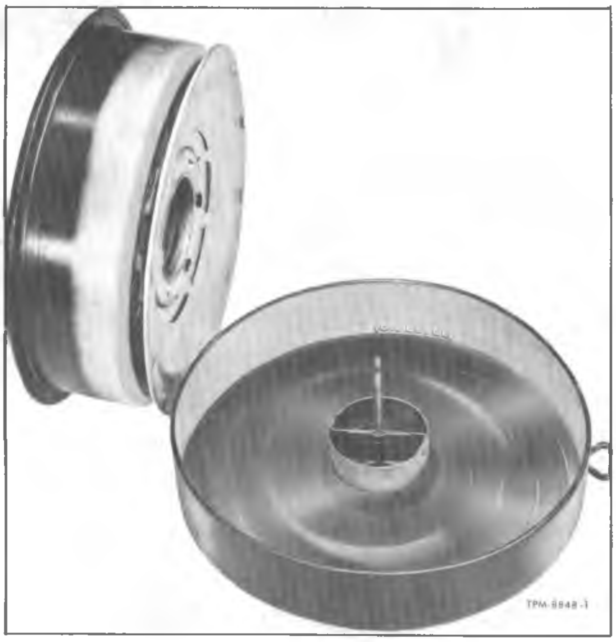


Figure 7—Air Cleaner—Oil Bath (Typical)

Remove reservoir and drain oil. Immerse all parts in cleaning solution until all dirt or other foreign matter is removed. Do NOT use compressed air on element. Be sure all volatile fluid is removed.

Fill reservoir to "OIL LEVEL" mark, using same grade oil used in engine. Assemble and reinstall reservoir and element in reverse order of removal and disassembly.

PAPER ELEMENT TYPE
- DRY OR PAPER WETTED (Fig. 8)

Remove wing nut from stud at top of air cleaner, then lift cover and element from base.

To determine if an air filter element requires cleaning or replacement, use air filter viewer, A.C. Part Number 6484631, which has a special lens for this purpose. A dirt-clogged element prevents the light from being visible from outside. The paper-wetted type has been impregnated with oil and cannot be cleaned. When dirt clogged, or when light as described above is not visible, the element must be replaced.

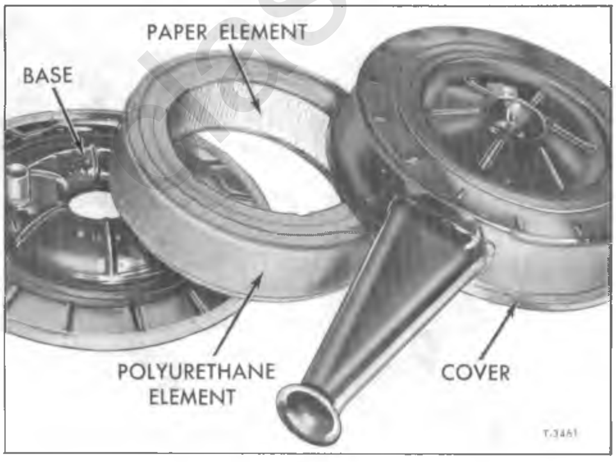


Figure 8—Air Cleaner—Paper Element with Polyurethane (Typical)

Some dry elements are washable; refer to decal for instructions.

Clean element by shaking out accumulated dirt, or clean by washing with water and detergent only. Rinse until water runs clean. Shake off excess water and dry. DO NOT OIL ELEMENT.

NOTE: Install a new element after five (5) cleaning. Some elements also have a band of synthetic material (polyurethane) which is cleanable in kerosene or mineral spirits.

Install assembly in reverse order of "Removal" and "Disassembly" procedure.

BRAKE POWER AND AXLE
CYLINDER AIR CLEANER

Several types of cleaners are used for this purpose. Two types - one disposable and the other

Figure 9—Air Cleaner (Toro-Flow Engine)

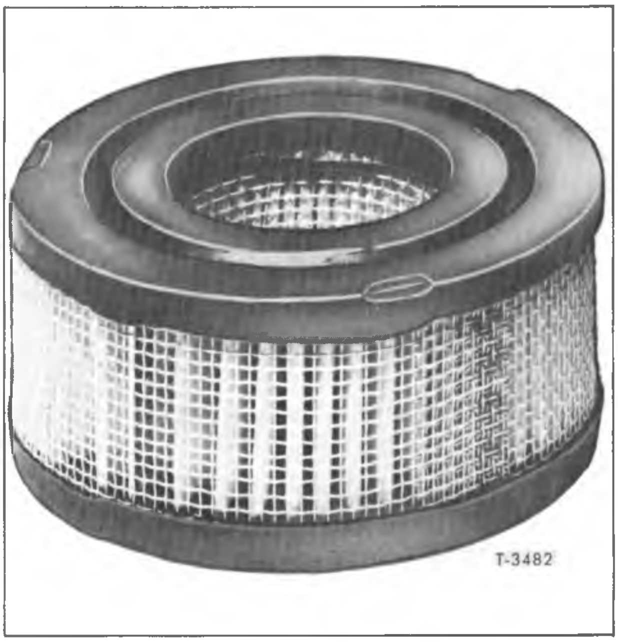


Figure 10—Air Compressor Air Strainer

cleanable - is located on inside of cab at left rear corner. Another type is made of polyurethane and is installed in brake booster cylinder.

Cleanable Type
Lift element assembly from tube. Wash element thoroughly in cleaning solvent until all accumulated dirt is removed. Dry thoroughly, then reinstall. Do not oil element.

Disposable Type
Remove retaining bolt, then lift assembly from tube. When inspection indicates the assembly is dirty it should be discarded and a new assembly installed.

Polyurethane Type
This cleaning element is removable for inspection and cleaning as instructed in BRAKES (SEC. 5). Element is cleaned by immersing and squeezing in kerosene or mineral spirits.

IMPORTANT

Regardless of where an air cleaner is used, it is extremely important that element be cleaned as directed to assure extended life of applicable unit.

AIR COMPRESSOR AIR STRAINER
(Refer to Fig. 10)
The air compressor air strainer should be replaced regularly.

Figure 11—Crankcase Breather (V6 Gasoline Engine)

Paper element type air compressor cleaner is used on all models and should be replaced when element shows visible evidence of damage or a dirt clogged condition or is oil saturated.

OTHER ENGINE OIL USES

DISTRIBUTOR
Breaker Pivot. Remove distributor cap and apply one drop of S.A.E. 10 engine oil to breaker arm pivot. Do not apply excessive lubricant.

Rotor Felt. A felt is used under rotor of some distributors. Apply 3 or 4 drops of S.A.E. 20 engine oil.

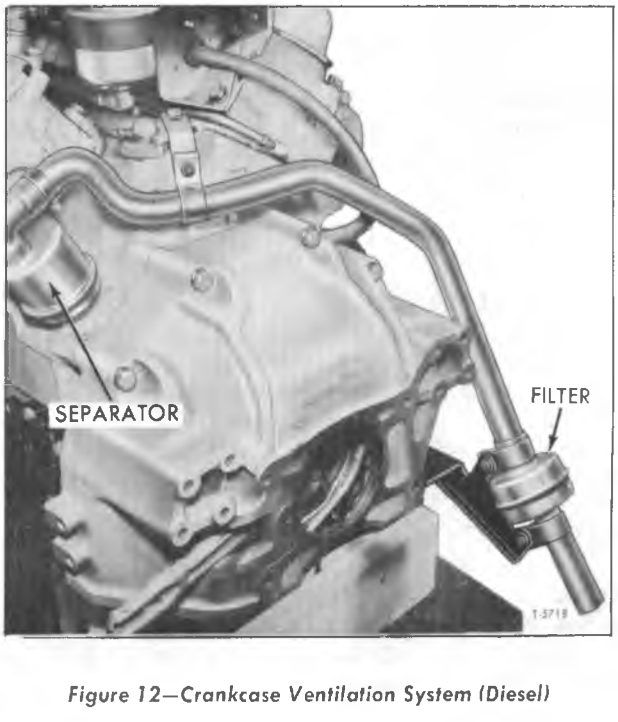


Figure 12—Crankcase Ventilation System (Diesel)

LUBRICATION

STARTER

Some starters are equipped with oiler or plug at drive end, plug at commutator end, and plug at middle bearing. At the time of installation, apply S.A.E. 20 at plugs or oilers.

LINKAGE

Engine oil is used also to lubricate clevis pins, linkage, clevises, etc. Application should be made by brush or spray.

AXLE SHIFT UNIT

Remove plug in cover and fill to level of opening with S.A.E. 10 engine oil.

CRANKCASE VENTILATION

GASOLINE ENGINES

The closed positive crankcase ventilation system makes an important contribution to the reduction of air pollution by recycling fuel fumes, which enter the crankcase, back to the combustion chamber to be burned, and achieves nearly one-hundred percent elimination of crankcase emissions - one-third of total hydrocarbon emissions from vehicle.

Ventilation valves on "V" engines are threaded into cylinder heads, while valve on In-line engines is installed in rocker arm cover. At first engine oil change ventilation valve(s) should be checked for proper operation as described in GASOLINE ENGINES (SEC. 6A) under "Crankcase Ventilation System." Every 12 months or 12,000 miles, whichever occurs first, the valve(s) MUST be replaced. Also, all hoses and fittings (including flame arrester on In-line engine) should be inspected, cleaned, and replaced if necessary.

On V6 engines, a crankcase breather (fig. 11) is installed at valve rocker arm cover and should be removed and cleaned at each oil change interval.

DIESEL ENGINE

Oil separator, breather tube and filter assembly (fig. 12) are installed at opening in rear of crankcase on diesel engines. A mesh filter element is contained in a retainer which should be removed every 30,000 miles and cleaned of accumulations by immersing repeatedly in fuel oil or cleaning solvent, until all deposits are removed.

MULTI-PURPOSE GEAR LUBRICANT (SYMBOL "MP" ON CHARTS)

Multi-Purpose Gear Lubricant, meeting U.S. Army Ord. Specification MIL-L-2105B and indicated by the symbol "MP" on charts, must satisfactorily lubricate heavy duty truck hypoid or bevel axles, and transmissions, under maximum torque and speed conditions. It must provide necessary and suitable load-carrying characteristics to prevent scoring and wear, good stability in storage and service, and give good resistance to corrosion. Suppliers should assure these characteristics, and be responsible for the quality and satisfactory performance of their products.

VISCOSITIES

ROCKWELL AXLES

In Rockwell axles, S.A.E. 140 should be used the year around except in cases of extremely low temperatures. If trucks are parked in temperaatures below +20^{O}F., or operated in temperatures consistently below 0^{O}F., it is advisable to use S.A.E. 90.

OTHER UNITS

S.A.E. 90 may be used the year around. If truck is operated in temperatures consistently below 0^{O}F., use S.A.E. 80. If the truck is operated in consistently high temperatures (over 100^{O}F.), S.A.E. 140 may be used.

REAR AXLE

CHECKING LEVEL

Remove filler plug and if necessary, add sufficient lubricant to bring the level up to filler plug level. Install and tighten plug. On the forward rear axle with torque divider, be sure that vehicle has stood for at least 5 minutes before checking level; then check level AT REAR FILLER HOLE.

DRAINING AND FILLING

When axle is new, or after overhaul, it is recommended that lubricant be drained after the first 3,000 miles of operation, and thereafter at recommended intervals. Draining at an early mileage removes fine particles of metal or other foreign material.

At specified intervals remove plug at bottom of axle housing, also at bottom of torque divider or inter-axle differential housing on tandem bevel axles. Drain when unit is hot, preferably immediately after operation. Reinstall drain plugs.

Fill axle to level of filler plug opening. On tandem axles with torque divider, add specified quantity through filler plug on side of case or add two pints of lubricant at top of inter-axle differential housing.

SPECIAL AXLE LUBRICATION

Special lubrication is required on all axles as follows: (1) when axle has not been operated for a long period (2) has been out of normal position or (3) after overhaul.

Add one pint of lubricant through plug opening in top of pinion cage or differential carrier. Recheck lubricant level at filler plug.

TRANSMISSION

CHECKING LEVEL (Fig. 13)
At specified intervals remove filler plug at side of case and, if necessary, add sufficient recommended lubricant to bring lubricant level up to level of opening. Install and tighten filler plug.

DRAINING AND FILLING (Fig. 13)
When transmission is new, or after overhaul, it is recommended that lubricant be drained after the first 3,000 miles of operation, and thereafter at recommended intervals. Draining at early mileage removes fine metal or other foreign material.

At specified intervals, preferably immediately after operation while unit is hot, remove plug to drain lubricant. Clean drain plug, then reinstall and tighten securely. Refill to level of filler plug opening as directed above. Use S.A.E. 90 the year around in transmissions.

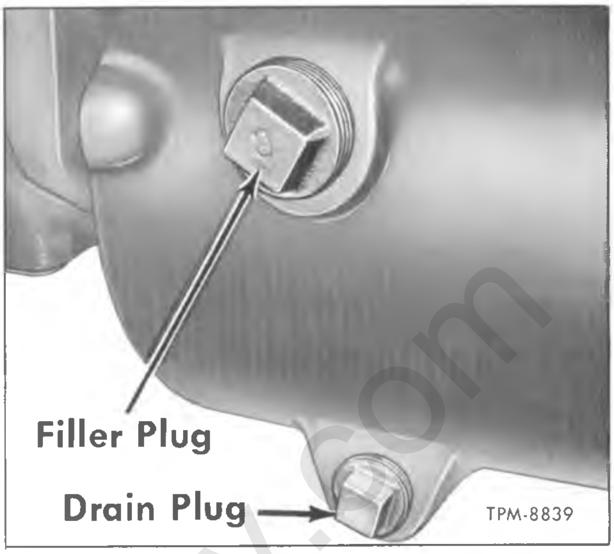


Figure 13—Transmission Drain and Level Plug (Typical)

CHASSIS LUBRICANT (SYMBOL "C" ON CHARTS)

The lubricant indicated by symbol "C" on charts should be a high grade pressure gun lubricant.

Good quality lithium soap multi-purpose grease is recommended, especially for extreme operating conditions - water, heat, etc.

UNIVERSAL JOINTS
At specified intervals, use pressure gun to apply lubricant through fitting in universal joint trunnion. Apply until lubricant is forced out around all four trunnion seals (fig. 14). Good quality Lithium soap multi-purpose grease is recommended.

APPLYING CHASSIS LUBRICANT
All lubrication fittings must be clean before applying lubricant. Always be sure equipment used in applying lubricant is clean. Every precaution should be taken to prevent entry of dirt, grit, lint, or other foreign matter into lubricant containers.

Fittings that have become broken or damaged should be replaced with new part, and can be removed with a wrench or suitable extracting tool.

COLD WEATHER PREPARATION
When hard steering is encountered as a result of cold weather, the steering system should be lubricated as follows:

Use steering gear lubricant (Symbol "SG") or Multi-Purpose Grease (N.L.G.I. #0) to lubricate all steering linkage such as steering knuckles, tie rod ends, and (if used) power steering booster cylinder ends. In warmer weather, relubricate linkage with chassis grease previously recommended.

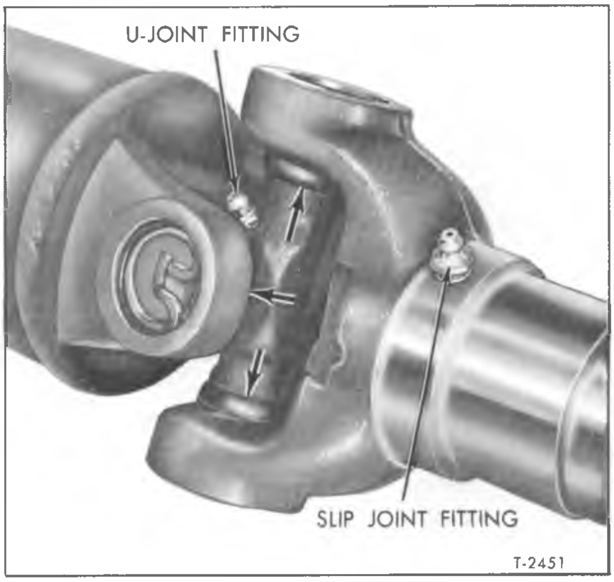


Figure 14—Universal and Slip Joint Lubrication

STEERING GEAR LUBRICANT (SYMBOL "SG" ON CHARTS)

The lubricant indicated by the symbol "SG" is a special steering gear lubricant. No. 0 grade with low cold test characteristics and extreme pressure properties. This type of lubricant is marketed by many oil companies.

Multi-Purpose gear lubricant "MP" previously described, may be used to replenish steering gear housing when additional lubricant is required; however, lubricant as described previously must be used as initial fill after overhaul, or in a new gear.

At specified intervals, remove filler plug in housing and add lubricant to bring level up to filler plug opening. Do not overfill housing.

HIGH TEMPERATURE GREASE (SYMBOL "S2" ON CHARTS)

The type of lubricant indicated by the symbol "S2" on charts should be a short fiber, non-fluid, sodium soap grease having a high melting point (350°F., min.). Good quality lithium soap grease is also highly recommended, especially where corrosion is evident due to moisture. Use No. 2 grade in each case.

WHEEL BEARINGS

CLEANING

With a stiff bristle brush and cleaning solvent, thoroughly clean bearings and hubs, making sure that all old lubricant and dirt is removed. Check bearings and cups and replace damaged parts.

PACKING

Some wheel bearings are lubricated from axle differential after the initial lubrication. However, whenever wheel hub is removed, bearings should be cleaned, inspected, and re-lubricated. Some rear wheel bearings require cleaning, inspection, and lubrication at regular intervals as specified on lubrication charts.

When packing by hand, be sure that lubricant is kneaded between rollers and races. A mechanical lubricator can be used; however, bearings must be thoroughly lubricated.

DO NOT FILL HUB. Coat inside hub and axle spindle with thin coat (1/8" thick) of grease to retard rusting. Allow some excess grease at inner side of bearings and around adjusting nut. DO NOT PACK HUB WITH GREASE. The lubricant applied to bearings is sufficient to provide lubrication until next service period. Readjust bearings as described in "FRONT HUBS AND BEARINGS" (SEC. 3D) or "REAR HUBS AND BEARINGS" (SEC. 4D) of this manual.

OTHER HIGH TEMPERATURE GREASE USES

The following points require use of high temperature grease at assembly. Methods of applying grease to these points are covered in applicable sections of this manual.

Clutch Pilot Bearing
Clutch Release Bearing Collar
Clutch Shift Fork Ball Stud
Steering Column Upper Bearing

PETROLEUM JELLY (SYMBOL "S3" ON CHARTS)

The type lubricant indicated by the symbol "S3" is petroleum jelly or petrolatum.

BATTERY TERMINALS

To prevent corrosion, remove cables, clean terminals on cable and battery, and reinstall cables to battery terminals. Tighten cables securely, then apply petroleum jelly.

DISTRIBUTOR BREAKER CAM

At recommended intervals, apply a small amount of petroleum jelly on distributor breaker cam. Do not use an excessive amount.

WATERPROOF GREASE (SYMBOL "S4" ON CHARTS)

This type of lubricant should be waterproof grease containing 20% to 35% calcium soap. On models equipped with propeller shaft center bearings, both sides of the shield should be packed with this lubricant at the time of assembly. This lubricant excludes water and dirt from bearing. Refer to "PROPELLER SHAFTS" (SEC. 4D) of this manual for procedure.

HYDRAULIC BRAKE FLUID (SYMBOL "S12" ON CHARTS)

The fluid indicated by the symbol "S12" must be genuine heavy duty brake fluid meeting the heavy duty standards of S.A.E. 70R3.

CLUTCH AND BRAKE MASTER CYLINDER

Check master cylinder fluid level at intervals indicated on charts. Remove dirt from around the plug or cover, then remove.

Fill with fluid until level is within 1/2" of opening. Inspect to be sure vent hole is clean, then install and tighten filler plug or cover (refer to figure 15).

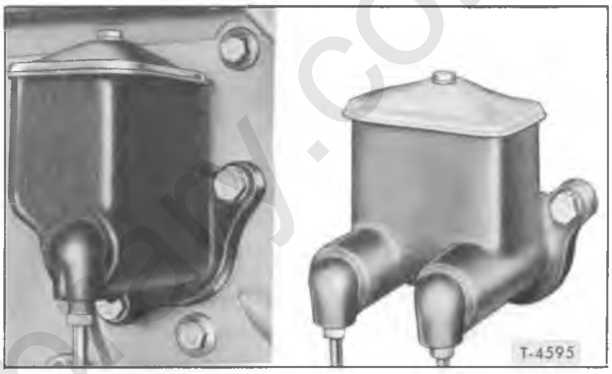


Figure 15—Clutch and Brake Master Cylinder (Typical)

SOFT, SMOOTH CUP GREASE (SYMBOL "S16" ON CHARTS)

Lubricant indicated by the symbol "S16" on charts should be No. 2½ soft, smooth cup grease. Fibrous types of lubricant are not recommended for spherangular (barrel) type roller bearings. High quality lithium soap grease is also highly recommended, especially where corrosion is evident due to moisture.

REAR WHEEL BEARINGS

At regular intervals as specified on Lubrication Charts, or whenever wheel hub is removed, bearings should be cleaned, inspected, and relubricated as previously described under "Symbol S2."

SPECIAL GREASE (SYMBOL "S17" ON CHARTS)

A semi-fluid grease having extreme pressure properties and containing zinc oxide.

At regular lubrication intervals, or whenever accessible during repairs or overhaul, apply lubricant sparingly to the following items and areas:

Door Striker Plates
Door Checks and Trunnions
Door Hinge Pins
Door Lock Remote Control Link
Cowl Ventilator Linkage
Seat Adjuster Slides
Door Lock Mechanism
Door Dove Tails
Window Regulator Channels
Window Regulators
Hood Hinges
Tilt Cab Guide Pin

In addition to items just mentioned, which are lubricated periodically, many other units use this lubricant at time of assembly after overhaul, as indicated in various sections of this manual.

AUTOMATIC TRANSMISSION FLUID (SYMBOL "S19" ON CHARTS)

The fluid indicated by the symbol "S19" must be an "Automatic Transmission Fluid," which has been tested and approved and qualified to bear GM trademark "DEXRON." DO NOT USE ANY OTHER FLUID.

POWER STEERING SYSTEM

Power steering system reservoir is located on power steering hydraulic pump (fig. 16). Reservoir is marked with an "OIL LEVEL" mark. Use only "Automatic Transmission Fluid GM DEXRON." DO NOT USE HYDRAULIC BRAKE FLUID, SHOCK ABSORBER FLUID, OR SIMILAR OIL.

Fluid level should be kept at "OIL LEVEL" mark on reservoir. After cleaning reservoir and cover, loosen cover bolt and remove. Using a clean receptacle, pour fluid through a 200-mesh screen - NOT A CLOTH STRAINER. Keep fluid clean and free from water.

For cold weather preparation on steering linkage refer to information under "Chassis Lubricant" (Symbol "C") in this section.

Figure 16—Power Steering Fluid System Reservoir (Typical)

BLEEDING SYSTEM

Whenever a line is disconnected or a pump is replaced, the air that has entered the hydraulic system must be bled out, otherwise noisy and unsatisfactory operation will result.

ALLISON AUTOMATIC TRANSMISSION

Allison Automatic Transmission is filled with GM DEXRON Automatic Transmission Fluid at the factory. DO NOT MIX TYPES OF FLUID.

CHECKING FLUID LEVEL

Dipstick and filler tube are located at right side.

1. Apply PARKING BRAKE FIRMLY AND BLOCK WHEELS. Start engine and warm fluid to operating temperature.

IMPORTANT: Do not operate retarder while warming fluid. Move selector lever through all speed ranges.

2. Run engine at "IDLE" speed with lever in "N" (Neutral).
3. Clean dipstick and adjacent area, then remove dipstick, clean, re-insert, again remove and note fluid level.
4. Add one quart of fluid when level reaches "ADD" mark.

DRAINING AND FILLING

When new, or after overhaul, drain fluid and change filter element after 3,000 miles, thereafter at recommended intervals. Drain while fluid is at operating temperature.

1. Loosen acorn nut which secures filter cover to oil pan.
2. When drainage is complete, remove acorn nut, washer, cover, gasket, retainer, and filter element.
3. Install new element in reverse order of removal. Tighten nut to 8 to 10 foot-pounds torque.
4. Pour eight quarts of fluid into transmission using clean container and spout, or funnel.
5. Start engine and check fluid level. Add fluid as necessary to bring level up to mark on dipstick. DO NOT OVERFILL.

HIGH TEMPERATURE GREASE (SPECIAL) (SYMBOL "S28" ON CHARTS)

The lubricant indicated by the symbol "S28" must be a water-proof, non-soap, smooth fibre grease having a #1 N.L.G.I. stable consistency, and must withstand extended high temperatures.

STOPMASTER BRAKE UNIT

At time of assembly after overhaul apply above lubricant to areas indicated in "AIR BRAKES" (SEC. 5B) of this manual.

SECTION 1

Cabs and Air Conditioning

Maintenance information on subjects common to all cabs, such as painting, checking for water and dust leaks, cab alignment, windshield wipers, and replacement of windshield glass is covered in the "GENERAL MAINTENANCE" section following. For all other information, refer to respective cab section as listed in Index below:

General Body Maintenance

This section includes general maintenance information on subjects common to all cabs. Subjects are listed in Index below:

GENERAL

All cab assemblies for models covered by this manual are of welded steel construction. Heavy box-type cab framing is used to form a stress-resistant foundation to fortify cab against twisting and flexing.

Principle steel panels are lap-jointed and welded for maximum sealing and structural strength Further rigidity is achieved by strategically located reinforcement braces and brackets. Sturdy steel door frames serve as upright structural members for rigid cab side support to assure proper door fit. Heavy-duty hinges assure sag-resistant doors while doors are of double-panel construction for extra strength. Primary sheet metal panels have stamped depressions to minimize cab drumming and vibration. Sheet metal components receive several protective finishes to provide ample resistance to rust and corrosion.

Flexible mounts cushion cab assembly against shock and protect cab panels from stress and strain. Periodic inspections are recommended to ensure that all cab mounting bolts and sheet metal screws are properly tightened.

Refer to LUBRICATION (SEC. 0) for information regarding lubrication of cab components such as door hinges and seat adjuster slides. Information on sheet metal components used with conventional cab is described in SHEET METAL (SEC. 11) of this manual.

KEY INFORMATION

All models have lock cylinders incorporating coded keyways and keys. The code letter is located on key shank and the code number is stamped on the knock-out portion of the key head. These numbers identify the locks in which the keys are used and are required when ordering or making new keys.

Notch depth information on current production keys will be provided upon request through the manufacturer of your key cutting equipment or his locksmith association. Also, he will be able to furnish a conversion package for your cutter, if required, for grinding new keys.

EXTERIOR MAINTENANCE

Entire vehicle should be regularly inspected for condition of paint and for corrosion damage, with particular attention given to chrome. Inspection should be made more frequently in freezing weather due to the corrosive effect of road deicing materials (salt, calcium chloride, etc.) on metal. If inspection discloses any evidences of corrosion, paint failure, or bare metal, corrective measures as outlined under "Painting" (later in this section) should be immediately employed.

Body painted surfaces and chrome plating should be protected by a coating of wax, applied at regular intervals. Periods between applications should be sufficiently short to assure continuous protection of the finish; 30 days after delivery, and at least once a year thereafter. Any good body wax can be used for both painted and chrome surfaces. Wax should be applied immediately after vehicle has been cleaned.

NOTE: Calcium chloride and other salts, road tar, excretion from insects ("tree sap"), chemicals from factory chimneys and other foreign matter may permanently damage paint and chrome. Frequent, regular washing and a thorough cleaning after exposure is recommended to prevent damage by these substances.

INTERIOR MAINTENANCE

Care of the upholstery is a relatively simple but important matter. Accumulation of dirt on the surface eventually turns into a hard, gritty, substance which cuts into the surface of the upholstery.

VINYL COATED CLOTH

To clean the seats, use lukewarm, not hot or cold water, and any mild soap or liquid household detergent. Work up thin suds on a piece of cheesecloth and rub upholstery briskly. Remove suds with a damp cheesecloth, using no soap, and finish by wiping lightly with a dry soft cloth. Do not use furniture polishes, oils, varnishes, or ammonia. As required, stubborn stains may be removed with common foaming-type upholstery cleaner prepared for use on vinyl cloth.

WOVEN NYLON FABRIC

Soap and water, regardless of the basic type of soap, is not recommended for cleaning flat cloths, particularly broadcloths.

1. Carefully brush all loose particles of dirt and soil.

2. Immerse small cloth in volatile type cleaning solution, wring out thoroughly, open cloth and allow medium evaporation.

IMPORTANT: Use only volatile cleaning solutions prepared specifically for use on nylon fabrics. DO NOT USE bleaches, reducing agents, acetone, lacquer thinners, enamel reducers, nail polish remover, gasoline, or cleaning solvents which contain dyes or caustic agents. Use of these solvents tends to weaken and change color of fabric.

3. Place cloth on soiled spot and blot area gently - DO NOT RUB. This will pick up particles which are too embedded to be removed in the brushing operation. This operation should be repeated several times - in each instance using a clean area of cloth.

IMPORTANT: DO NOT use too much cleaning fluid; some interior trim assemblies are padded with rubber and volatile cleaners are generally solvents for rubber. The application of too much cleaner may destroy these rubber pads or cause the rubber itself to penetrate the upholstery fabric and spoil appearance.

4. Immerse second cloth, wring out, and allow evaporation until barely damp, then apply to both the soiled and the area surrounding same, using a light swabbing motion.

5. Repeat brushing operation.

6. If a cleaning ring should form, the entire area of the assembly which is being cleaned should be thoroughly brushed and gone over lightly with the solvent.

FLOOR AND SIDE PANELS

Floor should be cleared of debris by sweeping or vacuuming. Using mild soap and water sparingly, sponge clean side panels and floor. Repeat cleaning operation with clean damp sponge or towel to remove soap film and allow to dry thoroughly.

Pressure spray cleaning and use of strong solvents are not recommended since damage to interior finishes and upholstery could result.

DUST AND WATER LEAKS

Test windshield, windows, and cab underflooring for leaks by spraying water under pressure against cab while assistant inside cab marks points of leakage, if any exist.

If location of leak has been determined to be around glass, dry surface and apply rubber cement. Apply cement to outside, both between glass and weatherstrip and between weatherstrip and body.

To determine the exact location of leak at flooring or cowl, remove floor mat and dash panel pad. Water which shows up at a certain place inside cab may actually be entering at a point other than where water is found. Back-track path of water to point of entry. Apply body sealing compound over all leak points.

If leakage occurs at door opening, check weatherstrip. Seal with rubber cement or replace if necessary. If door does not firmly contact weatherstrip, align door as described in applicable cab section.

CAB ALIGNMENT

Since cab is an integrally welded structure, repair should be attempted only by competent craftsman using proper tools and equipment. For best results, only genuine factory parts should be used for replacement. As work progresses, cross-checking with an adjustable tram bar is recommended for obtaining proper alignment.

STRAIGHTENING

Before attempting repair of a damaged cab, the chassis frame must be checked and aligned as described in FRAME (SEC. 2). To straighten frame, it may be necessary to remove cab.

Never attempt to straighten cab unless cab is firmly attached to chassis. The inner paneling of cab should be straightened first. Use of a push-pull hydraulic jack, together with extension and adapters is recommended for this type of repair.

After straightening, it is important that strains set up in cab framing be relieved or "normalized." Normalizing consists of heating areas of greatest stress with a torch. Holding torch nozzle about 2 inches from metal, move torch over an area of 3 to 4 inches until the metal barely begins to turn red. Cooling must be slow to avoid changing characteristics of the metal. Apply slight heat with torch, if necessary, to retard cooling.

DINGING AND FINISHING

Paint is quickly scuffed off sharp dents leaving metal exposed to rusting and corrosion; therefore, damaged panels should be repaired as soon as possible. Proper metal finishing is required to assure a smooth surface. Application of hammer directly to panel tends to stretch the metal and cause a great deal of unnecessary work. Whenever possible, a spoon should be used under the hammer when bumping a panel. Repair damaged panels by forcing outward in direction opposite to force which caused damage. In this way metal strains, set up when damage occurred, are relieved.

PAINTING

REPAINTING

1. Thorough cleaning is essential. All corrosion products, grease, and other foreign matter must be removed. Use of phosphoric base metal conditioners, such as "Metalprep" (Neilson Chemical Co.) or "Dioxidine" (American Chemical Paint Co.) or equivalent is recommended in preparing steel for painting. These materials vary in method of application and use, and should be employed only as directed by the manufacturer. Solvent cleaning, pressure steam cleaning, wire brushing, and hand sanding methods are recommended.

2. Completely remove old paint by use of organic or alkaline solvents. However, if alkaline removers are used, all traces of alkali must be washed off before primer is applied. If old primer is very difficult to remove, and if there is no evidence of metal corrosion, old primer may be left on, but all loose paint must be removed.

3. Apply primer, preferably by spraying, and allow to dry. Use a good oxide primer obtained from a reputable manufacturer.

4. Apply finish coats:

a. For understructure or other parts not requiring color, apply two coats of a good air-drying black or other automotive lacquer.

b. To exposed body parts, apply surfacer and paint in accordance with standard practice.

PAINTING NEW PARTS

New replacement parts should be thoroughly cleaned and painted, as outlined previously under "Repainting," after installation in vehicle. In addition, hidden surfaces of panels should be cleaned and coated with one heavy coat of sheet metal deadener.

WINDSHIELD GLASS REPLACEMENT

Windshield glass is retained in cab opening by a molded rubber weatherstrip with an insert-type rubber seal as illustrated in figure 1. A single windshield glass is used in the conventional cab models whereas two glass sections are used on steel tilt and "P" models.

When replacing a cracked windshield glass, it is very important that the cause of the glass breakage be determined and the condition corrected before a new glass is installed. Otherwise, it is highly possible that a small obstruction or high spot somewhere around the windshield opening will continue to crack or break the newly installed windshield; especially when the strain on the glass caused by the obstruction is increased by such conditions as wind pressures, extremes of temperature, motion of the vehicle, etc.

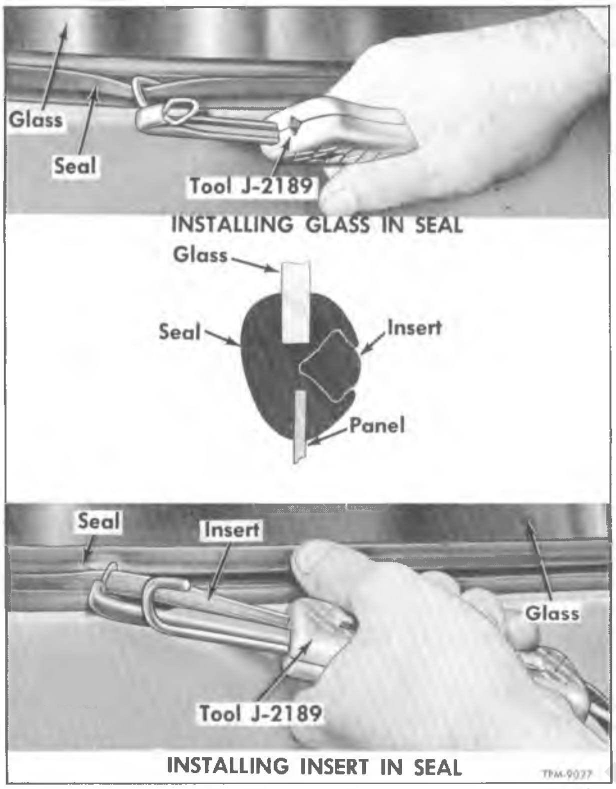


Figure 1—Installing Insert-Retained Glass

REMOVAL (Fig. 1)

If cracks in glass extend to outer edge of glass, mark cab or cowl with chalk at these points so that weatherstrip flange in cab opening can be examined later for possible distortion.

Protect the interior paint finish by placing a protective covering over steering wheel and dash panel. Mask around the windshield opening and lay a suitable cover over hood and fenders.

> **CAUTION**
>
> ALWAYS WEAR HEAVY GLOVES TO PREVENT POSSIBLE INJURY WHEN HANDLING GLASS.

1. Pry end of insert out of rubber seal with a pointed tool; pull insert completely out of seal.
2. With aid of an assistant to hold glass outside cab, push glass forward from inside cab.

INSPECTION

Due to the expanse and contour of the windshield, it is imperative in the event of a strain break that the windshield opening be thoroughly checked before installing a replacement windshield.

1. Check for the following conditions at the previous marked point of fracture:

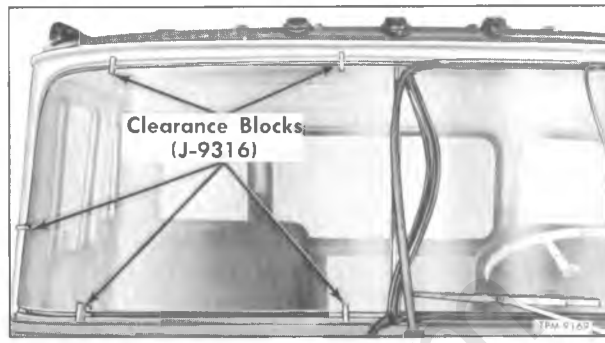


Figure 2—Checking Glass Clearances (Tilt Cab)

a. Chipped edges on glass.
b. Irregularities in body opening.
c. Irregularities in rubber channel weatherstrip.

2. Remove all sealer from flange and body around windshield opening.
3. Check flange area for solder, weld high spots, or hardened spot-weld sealer. Remove all high spots.

GLASS-TO-OPENING CLEARANCE CHECK (TILT CAB)

Before installing new glass, check glass opening for proper clearance, using five special spacer blocks (J-9316) as shown in figure 2. With the aid of an assistant, place blocks around perimeter of new glass, two at bottom and top and one at outer side of opening. A 5/16 to 3/8 inch clearance should exist between glass and opening flange. Insert blocks into gap, then rotate blocks perpendicular to flange surfaces. If all blocks cannot be installed, rework metal flange or grind off edge of glass at the side where block or blocks could not be installed.

> **CAUTION: DO NOT strike glass against body metal. Chipped edges on the glass can lead to future breaks.**

If glass clearance is too small and glass is to be ground off, place a strip of tape on a line where glass is to be removed. Grind up to edge of tape.

If glass clearance is found too large, braze a continuous piece of 1/8 inch diameter wire to edge of cab windshield glass opening flange. This will provide a closer glass and seal fit.

NOTE: Add build-up to flange where necessary. Usually the building up to only one side and one-half way around one corner will provide proper glass and seal fit. Taper off ends of build-up to conform to edge of glass, otherwise glass breakage may occur, originating at a point adjacent to the end of flange build-up.

INSTALLATION (Fig. 1)

NOTE: If desired, sealing cement can be applied between lip of seal and glass and seal lip at cab opening flange.

1. Reposition rubber seal on cab opening flange. Raise new glass to outside of seal; then with hook end of installer tool (J-2189) in glass groove of seal as shown in figure 1, move tool around glass to force outer lip of seal over edge of glass.
2. Thread end of rubber insert through handle and loop of installer tool (fig. 1). Push tool loop and end of insert into groove of seal. Feed in rubber insert, while proceeding around window. Use a hitching movement of tool to avoid elongating insert. If new insert is being used, cut off insert allowing sufficient overlap for a tight joint; then butt into groove.
3. Install insert in center vertical seal (2-piece windshield) in same manner previously described in Step 2.

REAR WINDOW GLASS REPLACEMENT (ALL CABS)

Rear window glass is retained by means of rubber seal and seal insert (fig. 1). No sealing compound or cement is used.

If body prevents access to rear window, glass can be installed from inside cab by reversing seal so that insert is located inside cab.

1. Pry end of seal insert out of seal with a pointed tool; then remove rubber insert completely. Push glass from inside cab. Pull seal from opening.
2. If necessary, straighten any irregularities of seal flange in cab opening which may have caused breakage of glass.
3. Install new rubber seal over panel flange, pushing it completely into corners. Avoid stretching seal during installation. Cut seal to allow sufficient overlap for a tight joint, then butt ends.
4. Position glass to seal and insert hook end of installer tool (fig. 1) into seal groove. Move tool around glass to force outer lip of seal over glass.
5. Thread end of rubber insert through handle and loop of installer (fig. 1). Push tool loop and end of insert into groove at bottom center of window. Feed in the rubber insert while proceeding around window. Use a hitching movement to avoid elongation of insert.
6. Cut off end of insert, allowing sufficient overlap for a tight joint; then butt into groove.

WINDSHIELD WIPERS

GENERAL DESCRIPTION

Conventional cab and steel tilt models have two-speed electric E-type windshield wipers with washers as standard equipment. The wiper assembly used on cowl, "P," and school bus models is determined by the body manufacturer.

A single wiper motor, mounted on engine side of cowl, powers both wiper blades on conventional cab models. Two separate motors are used with tilt cab models where each wiper motor is bracket-mounted to rear side of cowl under dash.

Tilt cab models employ separate wiper motor control switches; the left switch incorporates a push-type control for operation of windshield washers.

WIPER ARM ADJUSTMENT

To adjust sweep of blades to provide maximum visibility, turn on wipers, then note sweep of arms.

> CAUTION: DO NOT ATTEMPT TO MANUALLY MOVE WIPER ARMS AS DAMAGE TO LINKAGE OR MOTOR MAY OCCUR.

If necessary, remove arms as follows:

CONVENTIONAL CAB MODELS

1. Pull outer end of arm away from glass which will trip lock spring at base of arm and release spring from undercut of pivot shaft.
2. While holding arm in this position, pull outward on cap section at base of arm to remove the arm.

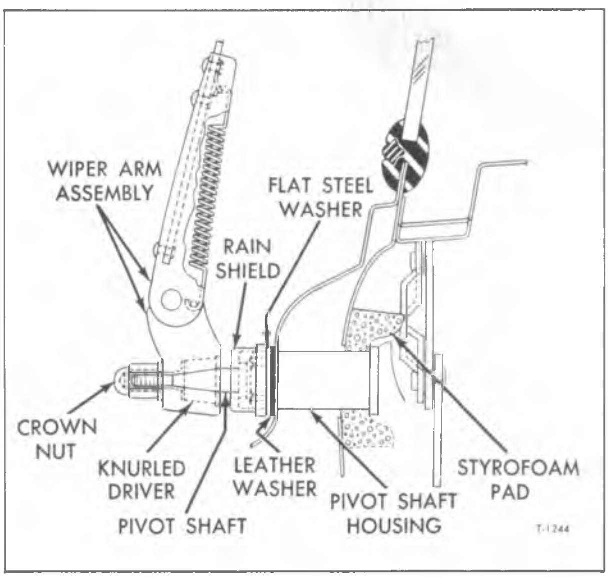


Figure 3—Wiper Arm Installed (Tilt Cab)

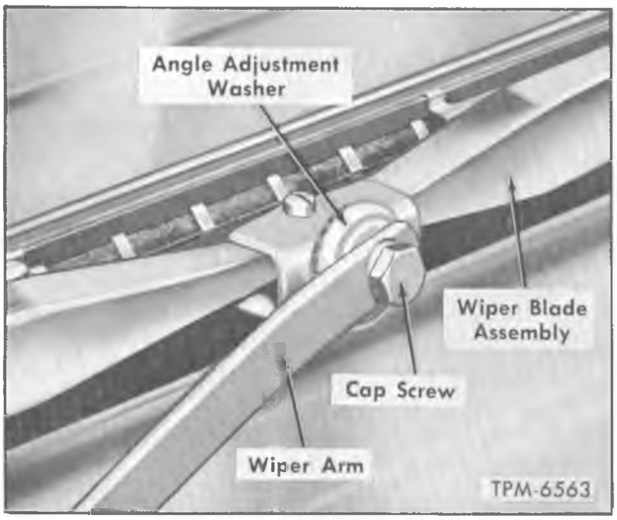


Figure 4—Blade Angle Adjustment (Tilt Cab)

3. Arm can be reinstalled in any one of several positions due to serrations on pivot shaft and in arm cap.

TILT CAB MODELS

Wiper Arm Adjustment (Fig. 3)

Wiper arm can be repositioned on pivot shaft to provide proper sweep as follows:

1. Remove hex crown nut and washer which attach wiper arm to knurled driver and pivot shaft.
2. Relocate arm on driver to desired position.
3. Install washer and hex crown nut.

Blade Angle Adjustment (Fig. 4)

To change angle of wiper blade on arm, loosen cap screw which attaches blade to arm. Rotate blade to new position against adjustment washer on arm, then tighten cap screw firmly. When wiper motor is in "PARK" position, blade should be approximately parallel to the horizontal windshield seal.

WIPER ARM TRANSMISSION AND LINKAGE REPLACEMENT (CONV. CAB MODELS)

REMOVAL (Fig. 5)

NOTE: Both right and left wiper transmission units with connecting link rod and motor link rod are replaced as an assembly.

1. Remove both right and left wiper arms from transmissions. Pull arms outward to disengage arm retaining clip.
2. Remove special retaining nut, steel washer, and seal washer from each transmission at front of windshield.
3. Underneath the dash, remove defroster air outlet tubing if necessary, and any other items to allow access to transmission linkage.
4. At motor crank arm under dash, remove the two nut assemblies which secure link rod to arm. Disengage end of rod from arm.

NOTE: Alternate methods of obtaining access to these two nuts are to move the wiper motor forward from the cowl opening or to remove the ash tray panel.

5. Using a short cross-recess type screwdriver, remove two screws and washer assemblies which attach each transmission unit to underside of cowl. Remove the transmissions with linkage as an assembly.

INSTALLATION (Figs. 5 and 7)

Perform the installation procedures in the reverse of the "Removal" procedures. Make sure the seal washers located below the transmission units at front of windshield are new or in good condition before installing; otherwise leakage may occur later at these two points.

IMPORTANT: Before locating the wiper arms on transmission shafts, make sure wiper motor was stopped in the "PARK" position (fig. 7). Operate motor, then turn switch off and allow it to stop in "PARK" position. If motor is not in "PARK" position and arms are installed, the arm travel

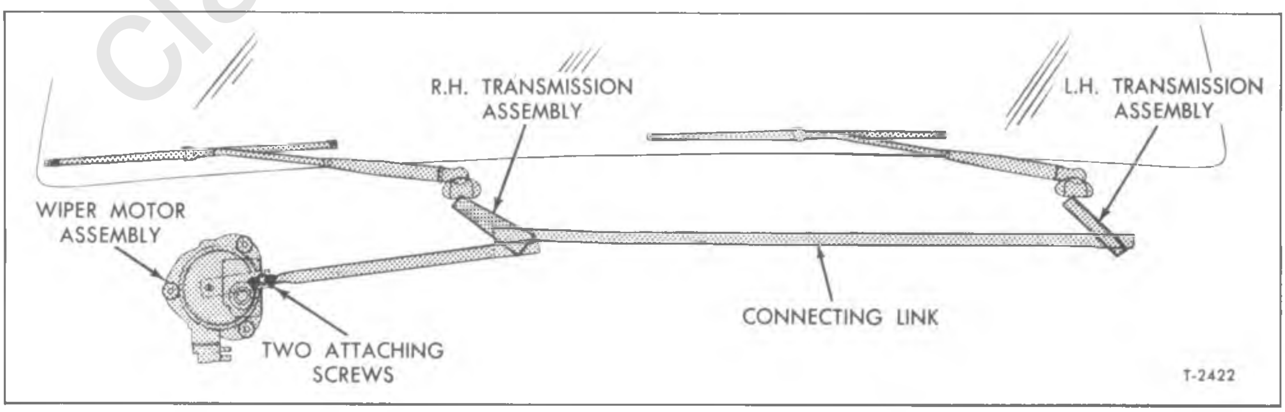


Figure 5—Wiper Motor and Linkage (Conventional Cab)

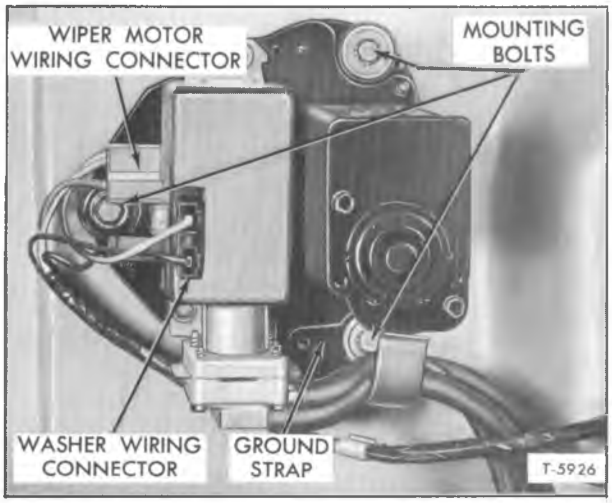


Figure 6—Wiper Motor Installed (Conventional Cab)

may be restricted when motor is started, resulting in a blown fuse. In any case when motor is first started, be prepared to turn wiper switch off in the event wiper arms were installed out of proper sweep position. Reposition arms if necessary.

WIPER MOTOR REPLACEMENT (CONV. CAB MODELS)

REMOVAL (Fig. 6)

1. Disconnect wiring harness at motor.
2. If windshield washers are used, disconnect washer lines at pump.
3. Remove three screw assemblies which attach motor assembly to front of cab cowl.
4. Pull motor forward from opening, then through the opening, remove two nuts from arm-to-link rod ball clamp to separate motor from link rod. Remove motor assembly.

INSTALLATION (Figs. 6 and 7)

Before installing motor, scrape any of the old sealing compound from around cowl opening, then apply a bead of new compound around the opening.

Perform the installation procedures in the reverse of "Removal" procedures.

IMPORTANT: Make sure motor ground strap is free of paint before installing motor mounting screws; otherwise motor will not operate. Also, be sure that wiper motor crank arm is in "PARK" position before attaching linkage and wiring harness.

WIPER MOTOR REPLACEMENT (TILT CAB MODELS)

REMOVAL (Figs. 3 and 8)

1. Remove hex crown nut and lock washer which attaches wiper arm to knurled driver and

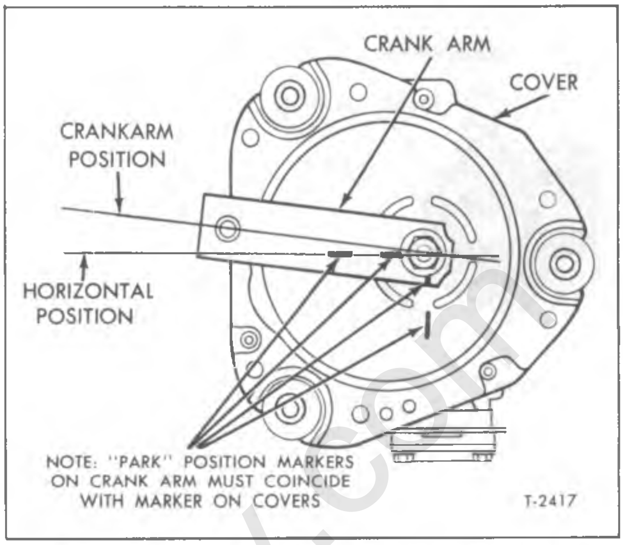


Figure 7—Crank Arm in "Park" Position (Typical)

pivot shaft. Remove arm and driver.

2. Remove rubber rainshield, hex nut, flat steel washer, and leather washer from pivot shaft housing.
3. Inside of cab, disconnect electrical wiring at connector on motor drive unit. If equipped with washers, disconnect hoses.
4. Remove four cap screws which attach motor and drive unit to cab panel.

INSTALLATION (Figs. 3 and 8)

1. Position styrofoam pad on pivot shaft housing, then locate motor and drive unit to cab panel. Attach unit mounting bracket to panel with four cap screws and washers.

IMPORTANT: Be sure a good metal-to-metal contact is made between panel and mounting bracket so as to provide an electrical ground for motor.

2. Connect electrical wiring to terminals on drive unit. If equipped with washers, connect hoses.
3. Install leather washer, flat steel washer, hex nut, and rubber shield on pivot shaft housing. Position arm driver on pivot shaft.
4. Before installing wiper arms, operate wiper motor momentarily, then turn it off which should rotate pivot shaft to "PARK" position (fig. 7).
5. Install arm on driver of shaft so that it is located in the "PARK" position. Wet windshield, then again operate wiper and check arm sweep. Reposition arm on shaft driver if necessary. Secure arm on shaft with crown nut.

WIPER TRANSMISSION LINKAGE AND MOUNTING BRACKET REPLACEMENT (TILT CAB MODELS)

REMOVAL (Fig. 8)

1. Remove small retaining ring near end of

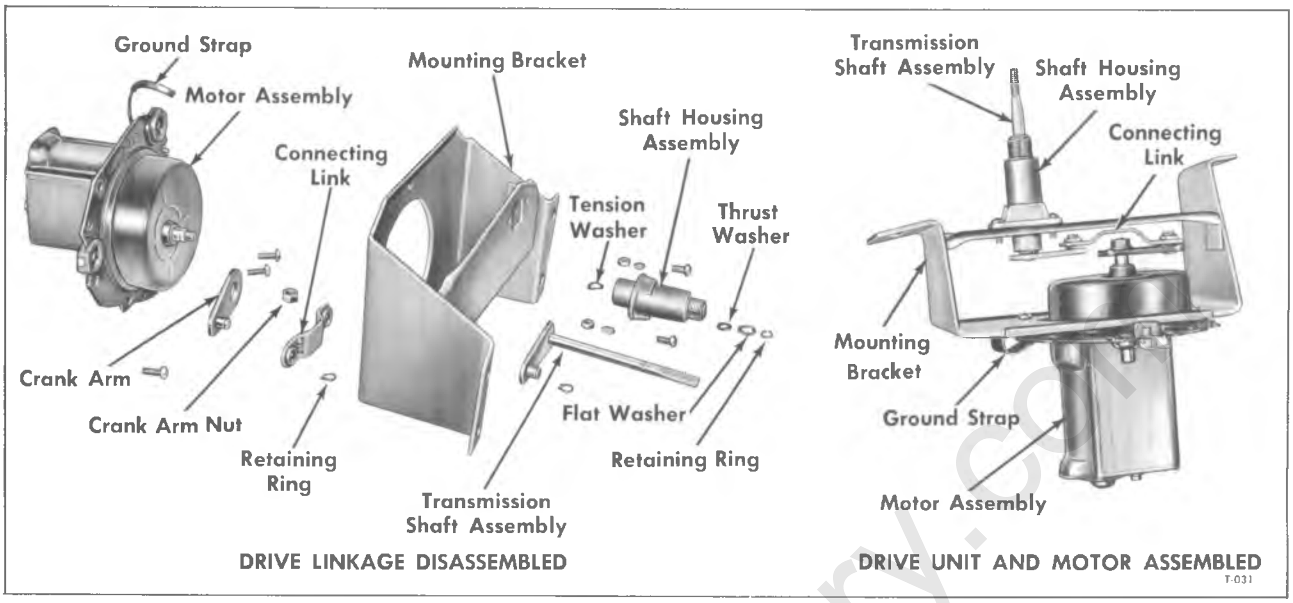


Figure 8—Wiper Motor and Bracket Components (Tilt Cab)

transmission shaft, then slide the flat washer and thrust washer from end of shaft.

2. Remove the three small screws which attach motor mounting bracket to motor. Move motor with attached linkage from mounting bracket sufficiently to allow access to connecting link retaining rings.

3. Remove connecting link retaining rings, then remove link. Separate motor from mounting bracket.

4. The transmission shaft can be removed only after the shaft housing is separated from mounting bracket. Housing is attached with two screws, nuts, and washers.

INSTALLATION (Fig. 8)

1. If transmission shaft was separated from housing, locate small tension washer on shaft before inserting shaft into housing.

2. Locate shaft and housing assembly to mounting bracket and attach housing to bracket with two screws, nuts, and washers.

3. Locate motor into mounting bracket, then install connecting link.

IMPORTANT: Make sure end of link marked "Crank End" is connected to motor crank arm. Install link retaining rings.

4. Attach motor to mounting bracket with three screws. Make sure motor ground strap is sandwiched between motor and bracket.

5. At outer end of wiper transmission shaft, install bronze thrust washer, flat steel washer, and the shaft retaining ring.

WIPER OPERATION

DESCRIPTION

The type "E" two-speed electric windshield wiper assembly incorporates a non-depressed type (blades park approximately 2 inches above windshield molding) motor and gear train. The rectangular, 12 volt, compound wound motor is coupled to a train consisting of a helical drive gear at the end of the motor armature shaft, an intermediate gear and pinion assembly, and an output gear and shaft assembly. The crank arm is attached to the output gear shaft.

Two switches, a control switch on dash and a parking switch within wiper unit, control the starting and stopping of wiper. Parking switch contacts, located on a terminal board at bottom of drive unit are actually connected across the dash switch and act as a set of holding contacts when the dash switch is turned off. This keeps the wiper circuit closed so wiper can keep operating until the blades reach their predetermined "PARK" position.

When the wipers are turned on, current flows from battery through the circuit breaker or fuse through the motor field and armature to the dash switch and on to ground, starting the wiper.

NOTE: Refer to "Windshield Washer" later in this section for operation of washers.

TWO-SPEED OPERATION (Figs. 9 and 10)

Low Speed Operation

When the dash switch is placed in "LOW" speed position, current from the battery flows

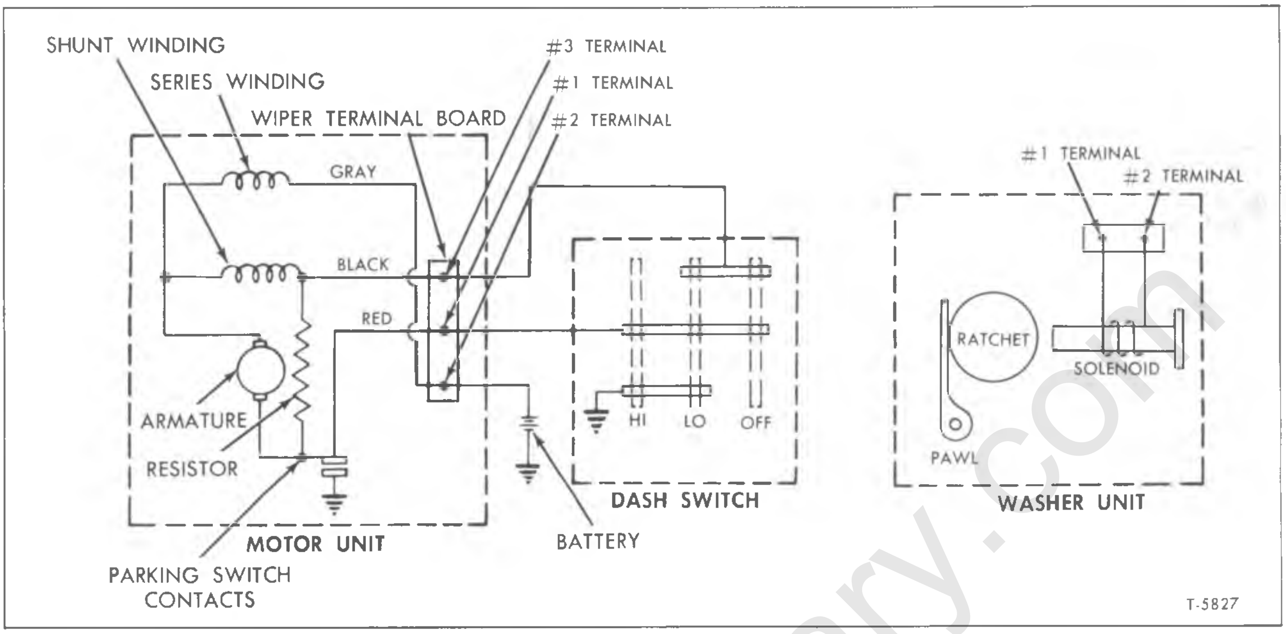


Figure 9—Wiper Motor and Washer Wiring Diagram

through the series field coil and divides; part passing through the shunt field coil to ground at the dash switch, the remaining part passing through the armature to ground at the dash switch.

High Speed Operation

Moving the dash switch to "HIGH" speed position opens the shunt field circuit to ground at dash switch and keeps the armature circuit closed to ground. The shunt field current must then pass through a resistor located on the wiper terminal board, and then through the same lead that connects the armature circuit to ground through the dash switch.

Parking Circuit

When wiper is turned off, circuit is broken at the dash switch. However, current from battery continues to flow through motor, through the parking switch contacts to ground. When wiper blades reach "PARK" position at the inboard end of wiper pattern, the parking switch contacts open, stopping the motor.

TROUBLESHOOTING WIPER MOTOR

Refer to figures 9, 10, and 11 when troubleshooting two-speed wiper.

TYPICAL TROUBLE CONDITIONS

1. Wiper will not shut off.
2. Wiper inoperative.
3. Wiper has one speed (HIGH).
4. Wiper has one speed (LOW) and shuts off with dash switch in "HIGH" position.
5. Blades do not return to "PARK" position when wiper is turned "OFF."
6. Wiper speed normal in "LOW" speed position but too fast in "HIGH" speed position.
7. Wiper operates intermittently.

CHECKING INSTALLED WIPER

Wiper Will Not Shut Off

1. Determine if wiper operates in both "HIGH" and "LOW" speeds, "LOW" speed only, or "HIGH" speed only.

IMPORTANT: Wiper must operate in "LOW" speed during parking cycle.

2. Disconnect the wiring harness from wiper motor and try operating wiper independently of the dash switch as shown in figure 11. If wiper operates correctly independently of the dash switch (shuts off correctly with crank arm in "PARK" position) refer to possible causes below:

a. If wiper operates in both speeds, lead between wiper terminal No. 1 and dash switch is grounded, or the dash switch is defective.

b. If wiper operates in "LOW" speed only, the lead between wiper terminal No. 3 and dash switch is grounded, or the dash switch is defective.

c. If wiper operates in "HIGH" speed only, the lead between wiper terminal and dash switch is open, or the dash switch is defective.

3. If wiper still fails to operate correctly, remove it from cab, then remove covering from over drive gears and check parking switch contacts which may be broken or stuck in closed position; check for a grounded lead at No. 1 or 3 terminals (fig. 11), or for a grounded shunt field.

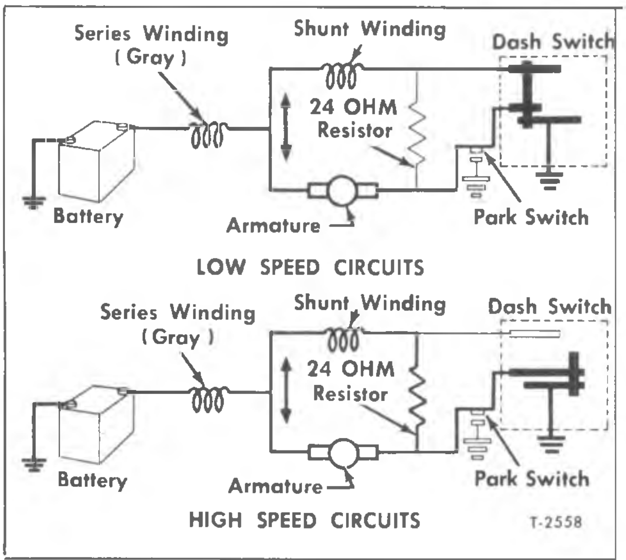


Figure 10—High-Low Speed Circuits

Wiper Inoperative

1. Check wiring harness connections at motor and at dash switch.
2. Check fuse (if used) or circuit breaker.
3. See if wiper motor ground strap is secure.
4. Check for loosely mounted dash switch.
5. If wiper still fails to operate, disconnect wiring from motor, and check for 12 volts at motor No. 2 terminal (fig. 11). No voltage indicates defective wiring.
6. With harness disconnected from motor, try operating motor as shown in figure 11. If wiper fails to operate, remove wiper transmission linkage and recheck wiper operation. If wiper operates, linkage is at fault. If wiper does not operate, remove unit from vehicle for disassembly.

Wiper Has One Speed - Fast

Check for a defective dash switch or open lead between motor No. 3 terminal and dash switch.

Wiper Has One Speed (LOW) and Shuts Off With Dash Switch in "HIGH" Speed Position

Reverse harness leads that connect to motor terminals Nos. 1 and 3.

Blades Do Not Return to "PARK" Position When Wiper is Turned Off

1. Check wiper motor ground connection to the cab.
2. Remove wiper motor from cab and check for dirty, bent or broken "PARK" switch contacts.

Wiper Speed Normal in "LOW" But Too Fast in "HIGH"

Remove wiper motor from cab and check for an open motor resistor.

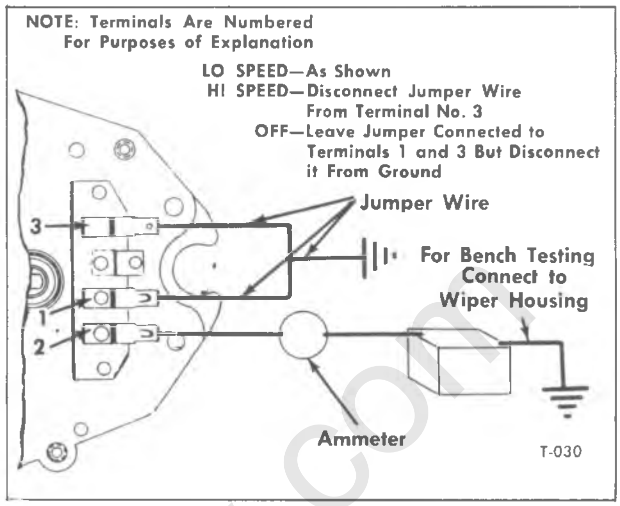


Figure 11—Troubleshooting Wiper Motor Circuit

Intermittent Operation

Check for loose wiper ground connection and/or loose dash switch mounting.

WIPER MOTOR AND GEAR BOX DISASSEMBLY AND ASSEMBLY

DISASSEMBLY (Fig. 12)

Gear Box

1. Remove washer pump mounting screws and lift pump from motor.
2. Remove washer pump drive cam (fig. 16). Cam is pressed on shaft but may be removed by carefully wedging two screwdrivers between cam and plate.
3. Lightly clamp crank arm in a vise and remove crank arm retaining nut. Separate arm from shaft.

NOTE: Failure to clamp crank arm may result in stripping of drive gears when retaining nut is removed.

4. Remove seal cap, retaining ring, and end-play washers.
5. Drill out gear box cover attaching rivets and remove cover from motor assembly.

NOTE: Necessary parts for reassembly of gear box cover to motor is contained in service repair package.

6. Remove output gear and shaft assembly, then slide intermediate gear and pinion assembly off shaft. Note position of wave washers.
7. If necessary, remove terminal board and "PARK" switch by marking wires and unsoldering at terminal lugs. Drill out terminal board attaching rivets and remove board.

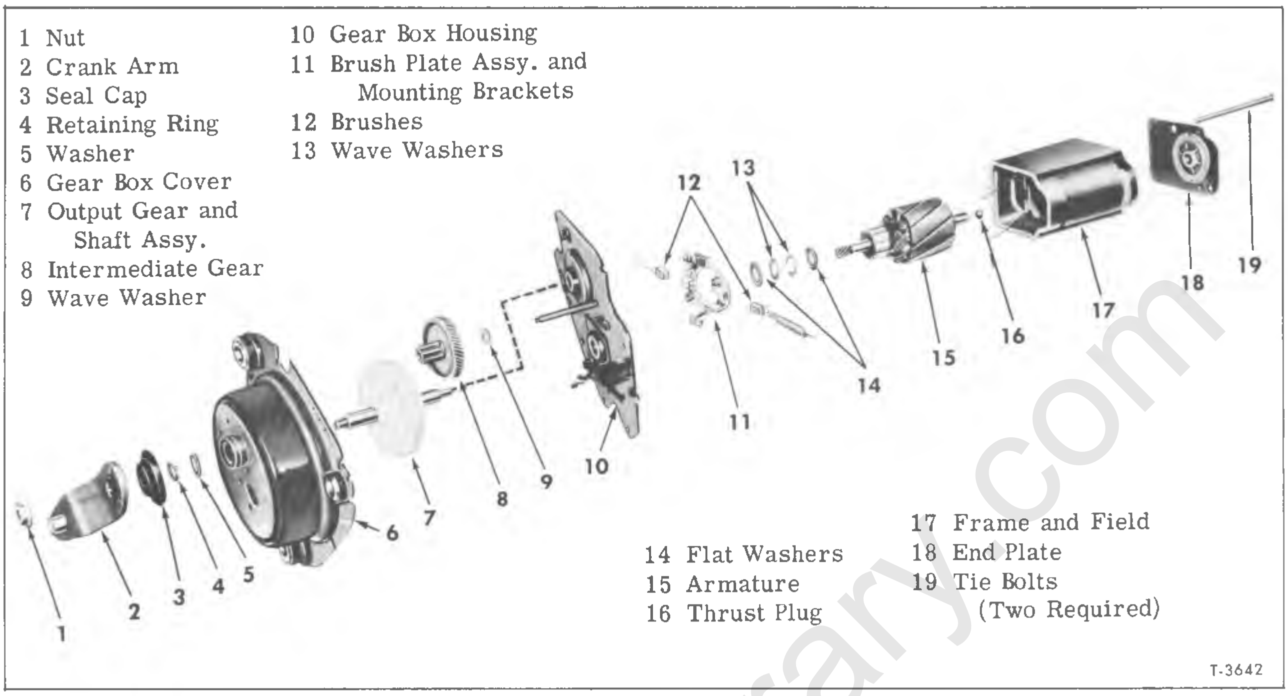


Figure 12—Wiper Motor and Gear Box Assembly (Typical)

Motor

8. Remove motor through bolts, tap motor frame lightly, and separate motor assembly from gear box housing.

9. Remove brush tension by placing brush spring in holder groove as shown in figure 13.

10. Slide armature and end plate from motor frame and field. Note arrangement of wave washers (fig. 14) on gear end of armature shaft before removing to assure proper installation upon motor assembly.

11. Pull end plate from armature. Note thrust plug between tip of armature shaft and end plate.

INSPECTION

Check armature shaft, gears, and supporting bushings for wear. Inspect commutator for evidence of arcing or loose solder joints to armature windings. Check "PARK" contacts for dirt or oxidation. Inspect for worn brushes, weak springs, and binding in holders.

In general, inspect all parts for serviceability and replace as required. All parts can be replaced individually except motor frame and field which is serviced as an assembly. Service kits provide all necessary attaching parts for installation of gear cover and terminal board.

ASSEMBLY (Fig. 12)

Motor

Reassemble motor using reverse order of "Disassembly" procedures.

NOTE: Be sure wave washers on armature shaft are installed properly as shown in figure 14. Lightly lubricate armature shaft bushings with light machine oil. Be sure brushes are properly positioned in holders before armature commutator protrudes between brushes.

Gear Box

1. Assemble gear box in reverse order of "Disassembly" procedures.

NOTE: Lubricate gear teeth with Delco Cam and Ball Bearing Lubricant or equivalent. Be sure cover is properly located over dowel pins and that

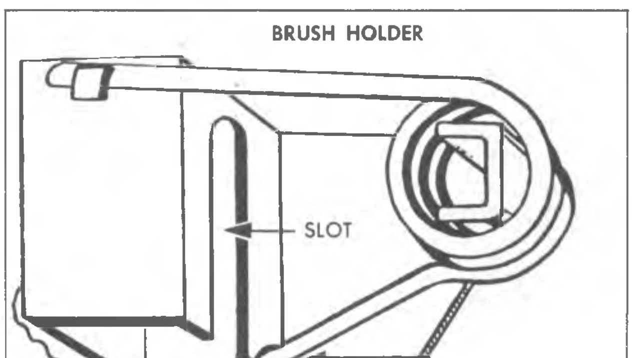


Figure 13—Releasing Brush Spring Tension

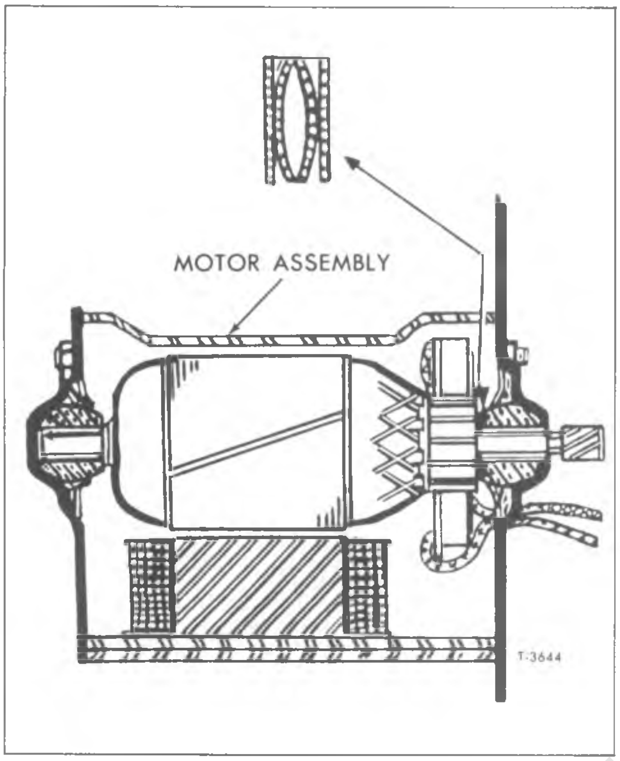


Figure 14—End Play Wave Washer Installation

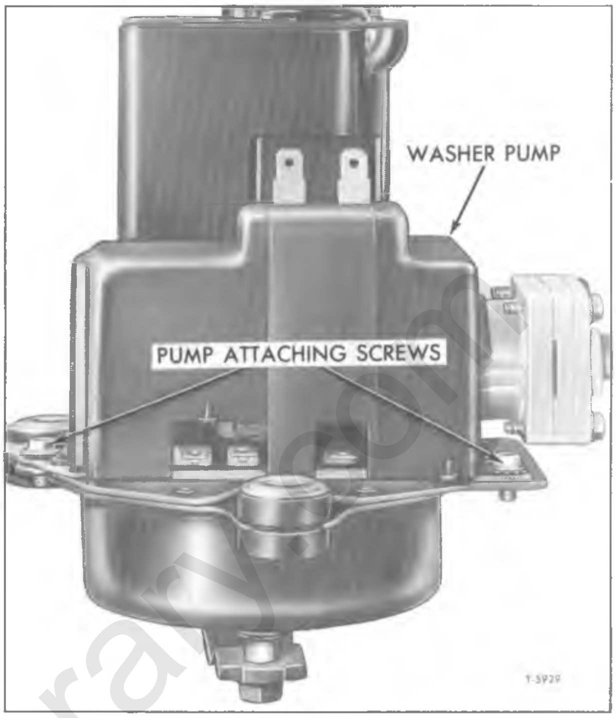


Figure 15—Washer Pump Attaching Screws

ground strap is properly positioned before securing cover.

Seal cap (fig. 12) should be cleaned and repacked with water-proof grease before reassembly.

2. Install crank arm on output shaft so that alignment marks line up with those on cover when wiper motor is in "PARK" position (fig. 7). Replace and tighten retaining nut after placing crank arm in vise.

3. Check operation by connecting assembled motor to battery as shown in figure 11.

WINDSHIELD WASHER PUMP

GENERAL INFORMATION

The "E" type washer pump used on the "E" type rectangular non-depressed park wiper motors resembles previous models somewhat in physical appearance but it has been changed considerably internally. Refer to figure 15 for view of pump mounted on wiper motor assembly. Past model pumps used a bellows system for the pumping mechanism whereas the new design incorporates a piston enclosed in a plastic cylinder housing. The piston type pump provides higher pressures and increased volume (fig. 18).

The basic principle of operation is very similar to past model pumps of this type. The pumping mechanism is powered by a four-lobe cam which is pressed on wiper motor output shaft. This cam rotates whenever the wiper motor is running. Programming is accomplished electrically and mechanically through use of a pump solenoid circuit and ratchet wheel arrangement.

OPERATION

Conventional Cab Models (Single Wiper Motor)

Pushing in on the wiper switch knob causes the washer to activate and also causes wipers to activate in "LOW" speed. If operator wishes high speed wiper action he must manually switch to "HIGH" speed. At the end of washer cycle, washer will automatically shut off; wiper must be shut off manually, regardless of high or low speed.

Tilt Cab Models (Two Wiper Motors)

Pushing in switch knob of left-hand wiper switch causes washer to activate, and also causes left-hand wiper to activate in "LOW" speed. If operator wishes "HIGH" speed and/or right-hand wiper action also, he must manually control both. At the end of washer cycle, washer will automatically shut off; wiper(s) must be shut off manually regardless of speed (both left- and right-hand).

PUMP REMOVAL (Figs. 15 and 16)

1. Disconnect water hoses to washer pump making certain they are properly marked to assure correct installation.

2. Disconnect electric wiring from washer terminals.

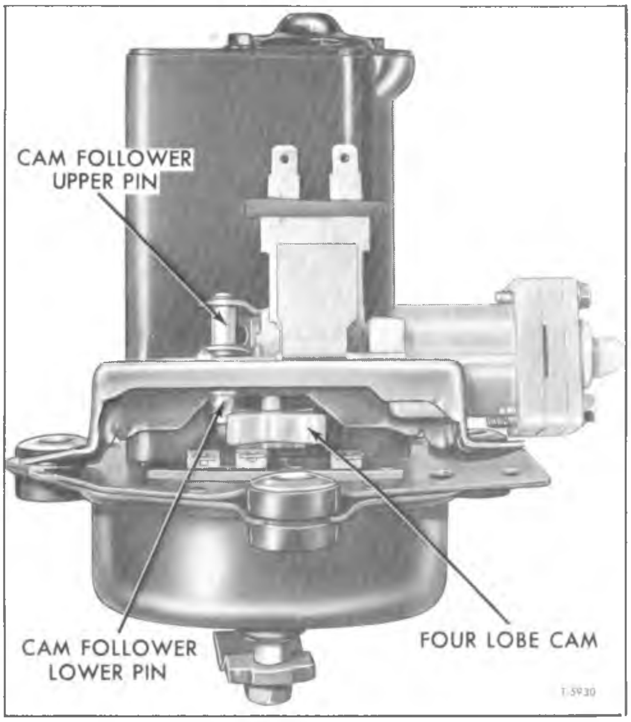


Figure 16—Separating Pump from Motor

3. Remove washer pump attaching screws, then lift pump off wiper motor.

PUMP INSTALLATION (Figs. 15 and 16)

1. Place washer pump in position on wiper motor making sure lever arm pin properly engages four-lobe cam.
2. Secure pump to motor with two mounting screws.
3. Reconnect electric wiring.
4. Reconnect water hoses.

TROUBLESHOOTING WASHER PUMP
(Refer to Fig. 17)

On-Vehicle Check

1. If washer pumps continuously when wiper is on, disconnect wiring from washer pump.
   a. If pump shuts off, trouble is located in wiring harness or dash switch.
   b. If pump fails to shut off in Step a, remove pump assembly from vehicle for further checking.

2. Check the following items if pump is inoperative:
   a. Reservoir contains water solution.
   b. Hoses are not damaged and hose connections are tight.
   c. Screen at end of jar cover hose is not plugged.
   d. Electrical connections to washer pump and dash switch are secure.
   e. Nozzles are not plugged.

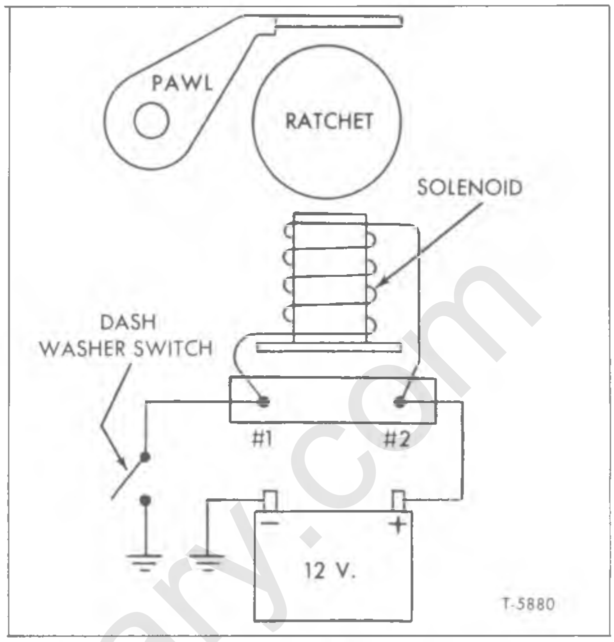


Figure 17—Checking Washer Solenoid

3. If all items in Step 2 check out, start wiper motor only, then push washer button and listen for "click" as washer solenoid pulls in. If no "click" is heard, check for 12 volts at terminal No. 2 (fig. 17). No voltage indicates defective wiring. If "click" is heard, proceed to Step 5.

4. If correct voltage was found in Step No. 3, connect a jumper wire from washer terminal No. 1 to ground (fig. 17) and operate wiper. If washer relay "click" is heard and pump functions correctly, a defective dash switch or an open circuit between washer pump and dash switch is indicated - "No Click" indicates an open pump solenoid.

5. If relay "click" is heard in Step 3, listen for the soft clicking as the pump ratchet wheel is rotated.
   a. If soft clicking is not heard, the pump mechanism is faulty and should be removed from the wiper motor and checked.
   b. If soft clicking is heard but no pumping action occurs, replace the valve assembly and recheck pump.

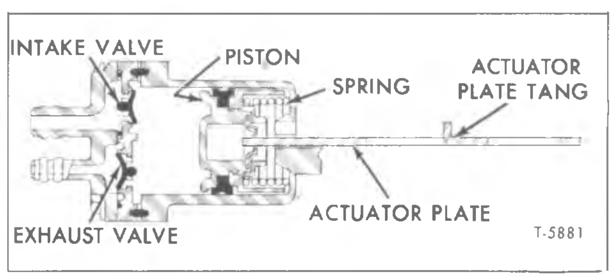
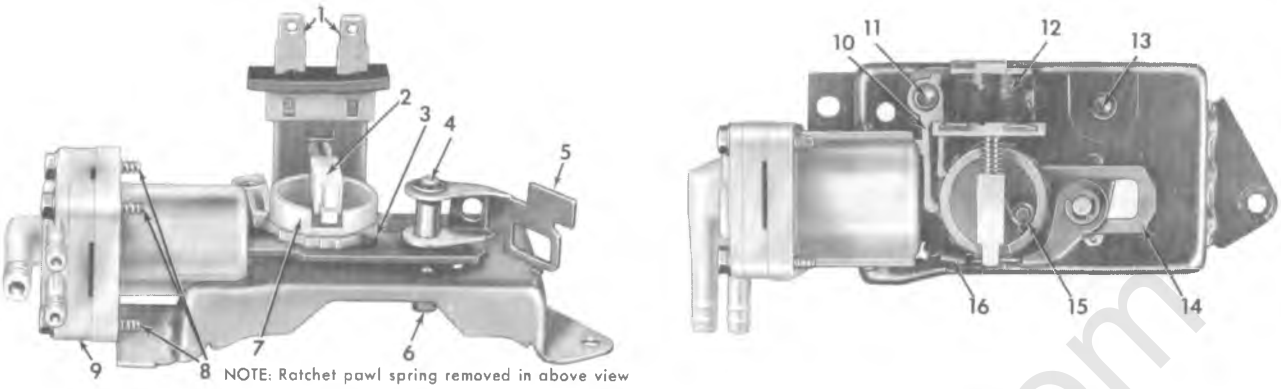


Figure 18—Washer Pump Piston and Valve Assembly



1 Coil Terminals	7 Ratchet Wheel	12 Solenoid Coil Assembly
2 Solenoid Plunger	8 Valve Assy. Mtg. Screws	13 Pivot Pin
3 Actuator Plate Tang	9 Valve Assembly	14 Piston Actuator Plate
4 Cam Follower Upper Pin	10 Ratchet Dog	15 Ratchet Wheel Spring
5 Ratchet Pawl	11 Dog Retaining Screw	16 Ratchet Pawl Spring
6 Cam Follower Lower Pin		

Figure 19—Washer Pump Mechanism

Bench Check

1. Manually actuate the solenoid plunger and check for binding condition.

2. Check relay coil as follows: Connect 12 volt supply to washer terminals (fig. 17). Observe if solenoid plunger pulls in. Failure of solenoid plunger to pull in indicates an open solenoid coil or poor solder connections.

3. If solenoid plunger pulls in correctly, manually actuate the cam follower lower pin and observe if pump piston and actuator plate operate freely. Locate and correct cause if binding occurs.

4. Attach a hose to the large or intake pipe. You should be able to blow, but not draw, through intake pipe (fig. 18).

5. Attach a hose individually to each of the small exhaust pipes. You should be able to draw, but not blow, through them. If any of the valves allow air to pass in both directions, the valve assembly is defective and must be replaced.

PUMP DISASSEMBLY AND ASSEMBLY
(Refer to Fig. 19)

1. Remove washer pump cover.

2. Remove ratchet dog retaining screw. Hold spring loaded solenoid plunger in position and carefully lift the solenoid assembly and ratchet dog off the frame of the pump.

3. Disconnect ratchet pawl spring. Remove ratchet pawl retaining ring and slide ratchet pawl off cam follower shaft.

4. Move ratchet wheel spring out of shaft groove and slide ratchet wheel off shaft.

5. Pull pump housing away from frame until housing grooves clear frame. Remove actuator plate from ratchet wheel and cam follower shafts.

6. Remove screws that attach valve assembly to pump housing. Separate valve assembly from pump housing.

NOTE: Observe direction of pipes before removing pipe assembly from pump housing.

7. To assemble, reverse "Removal" procedure

NOTE: During reassembly, be sure gasket between housing and valve plate is properly positioned in the housing and valve plate grooves. Also, be sure triple O-ring is properly installed between valve body and pipe assembly. Hose connections on pipe assembly should be pointed in same direction as original position.

Conventional Cab

Contents of this section are listed in Index below:

NOTE: Maintenance information on painting, windshield glass, and windshield wipers which is common to all types of cabs is explained at beginning of this group in "GENERAL MAINTENANCE" section.

Information on sheet metal components is covered in SHEET METAL (SEC. 11) of this manual.

CAB DESCRIPTION

The basic conventional cab is of all steel welded construction (fig. 1). Cab side construction consists of a one-piece body door opening frame which assures more positive sealing around the door when closed.

The one-piece roof panel has longitudinal ribbing to stiffen and reinforce the roof. The floor panel, also of one-piece construction eliminates joints, pockets and seams which normally act as moisture traps. In most cases, all paneling pieces are lap-jointed and welded for maximum in sealing and structural strength.

Front outside air intake is located at top center of cowl. Opening and closing of intake is controlled by push-pull lever at top of dash panel. Outside air for the heating system enters through a separate louvered opening at right side of cowl.

Doors are of double-wall construction. Lower inner panel of door has a cut-out allowing access to door control mechanism for adjustment and parts replacement. Horizontal slots in door hinge assembly provides for adjustment of door in cab opening. Door vent window is of friction-type with positive theft-resistant latch.

The windshield used on all conventional cab models covered in this manual is of the one-piece type.

CAB MOUNTINGS

Four point type cab mountings are used on these vehicles. The front mount consists of an upper and lower cushion assembly as shown in figure 2. Cab rear mounts are of the compression type (fig. 3), utilizing rubber biscuit cushions. This compression-type mounting is readily replaced by removing one mounting bolt.

At regular intervals, all cab mountings should be checked for loose attaching parts and for deteriorated or collapsed rubber cushions.

Any one cab mounting can be readily replaced after removing the weight of cab at that particular mounting.

IMPORTANT: Raise cab only to height necessary to replace mounting components. If cab is raised too high, damage to vehicle operating controls, wiring and lines may occur. Before lowering cab, be sure cushion is properly centered between frame and cab.

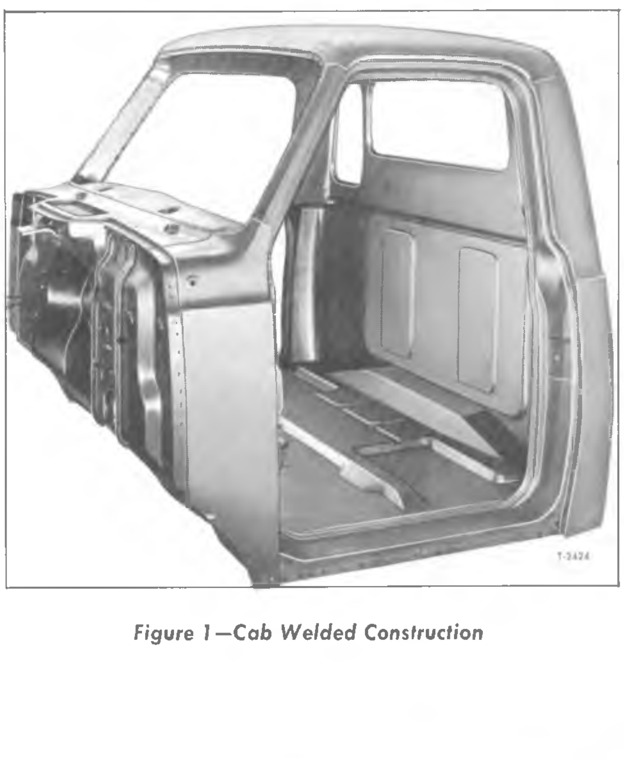


Figure 1—Cab Welded Construction

CONVENTIONAL CAB

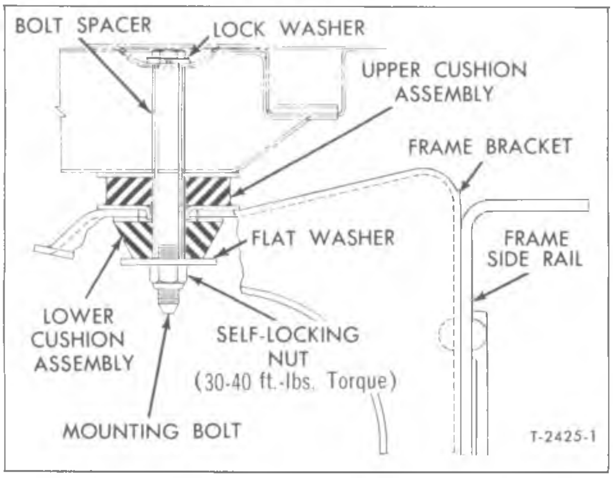


Figure 2—Cab Front Mounting

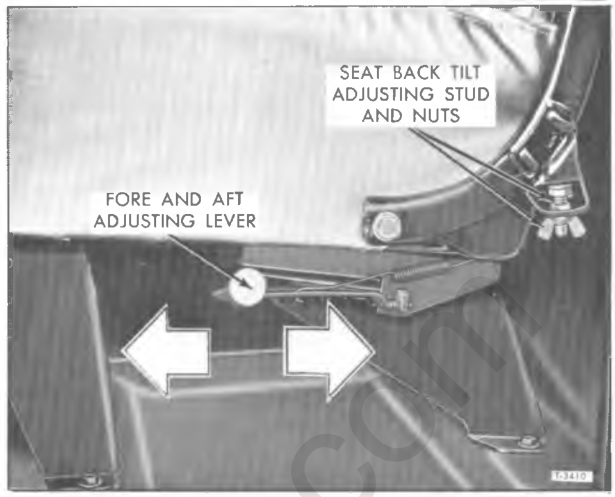


Figure 4—Full Width Seat Back Adjustment

SEATS

SEAT ADJUSTMENT

If right- and left-hand seat adjusters do not release simultaneously, lengthen or shorten adjuster lock rod underneath the seat assembly.

A stud adjustment nut and wing nut at ends of seat-back frame (fig. 4) provide a means of changing tilt of seat-back. To change tilt of seat-back, loosen each wing nut and turn adjustment nuts above seat-back frame brackets an equal amount to raise or lower seat-back. Tighten wing nuts to secure desired position.

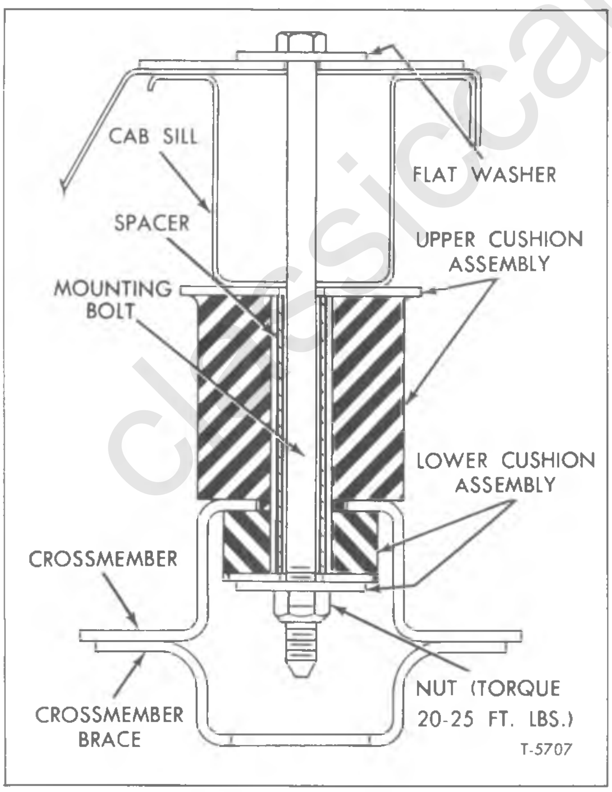


Figure 3—Cab Rear Mounting

SEAT TRACK REPLACEMENT

NOTE: The seat track assemblies are more readily replaced after seat assembly is removed from cab.

1. Remove four screws which attach each track assembly to seat cushion. Lift seat assembly from cab.

2. If only one track assembly is to be removed, disconnect lock rod between tracks, then remove four bolts which attach each track to cab floor panel. Remove track assembly.

3. Reverse the above procedure to install track assembly.

DOORS

Component sub-assemblies of cab doors, such as window regulator, door lock, remote control, and vent window can be replaced without necessity of removing door from cab. Doors can be replaced without prior removal of above components.

Replacement of door glass is explained later in this section.

Instructions for replacing door assembly are as follows:

REMOVAL (Fig. 5)

1. Using small punch, drive spring pin up from door check strap at cab bracket.

2. With aid of an assistant to support weight of door, remove three cap screws which attach each hinge strap to door. Remove door and hinge shims (if used).

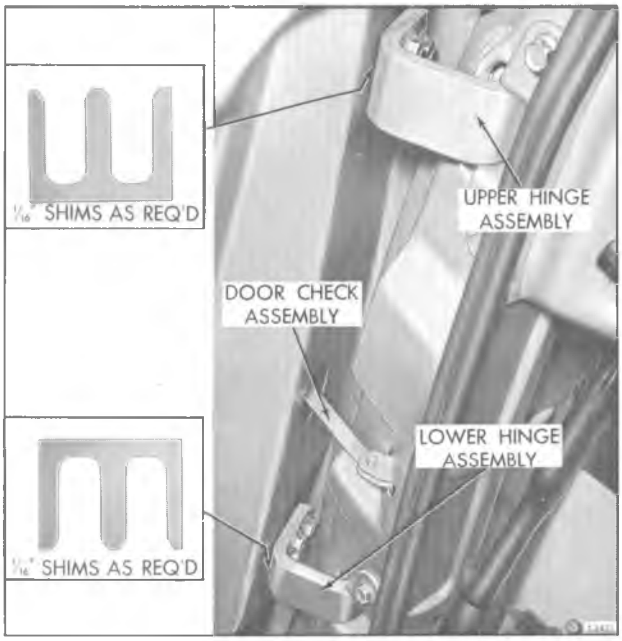


Figure 5—Cab Door Hinges and Check Link

INSTALLATION (Fig. 5)

1. Position door to hinge straps and install attaching cap screws loosely. Insert shims (if used) between hinge and door. Note direction of slots in upper and lower hinge shims as illustrated in figure 5.
2. Adjust door-to-cab opening as explained later under "Door Adjustments."
3. Connect door check strap to cab pillar bracket by driving spring pin down from the top.

NOTE: It is not recommended that the access panel be removed from door inner panel for purpose of storing heavy tools in door compartment.

DOOR ADJUSTMENTS

Doors can be adjusted for alignment or clearance in the cab door opening (fig. 6), and for proper latching. The door, when properly located in door opening, will have equal clearance around its perimeter.

Door alignment adjustments are made at the striker bolt and door hinges. Rubber seal around door should be lubricated with silicone lubricant and door vent window should be open before opening and closing door while making door adjustment. Before adjusting hinges, remove the striker bolt from the cab pillar.

DOOR "FORE" AND "AFT" POSITIONING

The fore and aft adjustment of door is provided by the removal or installation of shims inserted between door and hinge strap (fig. 5). At only one hinge at a time, loosen three cap screws which attach hinge strap to door. Add shim to increase clearance at door leading edge or remove shim (if used) to decrease clearance. Repeat adjustment at other hinge, as required.

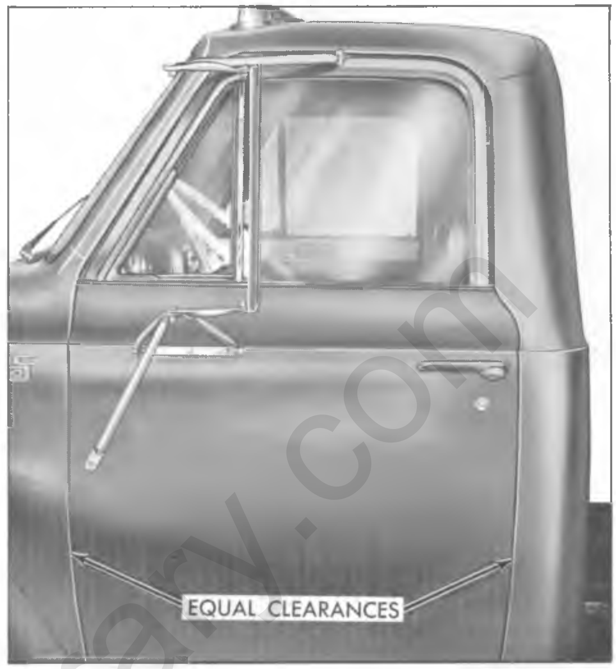


Figure 6—Door Clearances

Door should have equal clearances at both front and rear (fig. 6). After making adjustment, tighten hinge screws firmly.

DOOR "IN" OR "OUT" POSITIONING

Horizontal slotted cap screw holes in door half of hinge provide the "in" and "out" adjustment of door (fig. 5). Loosen three cap screws which attach each hinge strap to door. Reposition door on hinge straps so that door outer surface is flush with cowl surface.

Perform clearance adjustment at rear of door as directed later under "Door Striker."

DOOR STRIKER PLATE

The door striker consists of a special bolt and washer assembly which is threaded into a tapped, floating cage plate located behind the cab lock pillar as shown in figure 7. The door is secured in closed position when the lock cam in door engages and snaps-over the striker bolt. Striker bolt can be replaced or adjusted as directed under applicable headings.

STRIKER BOLT REPLACEMENT

Removal (Fig. 7)

1. Mark position of striker bolt spacer or

CONVENTIONAL CAB

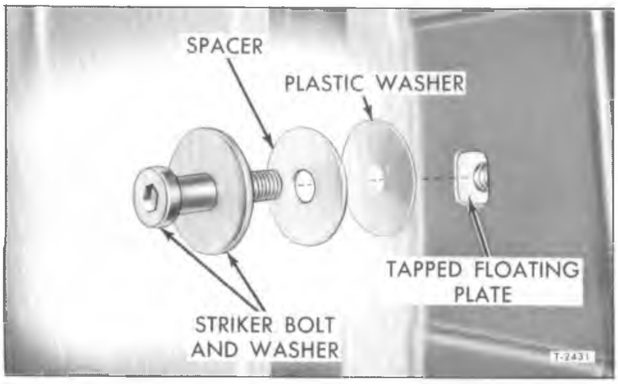


Figure 7—Door Striker Bolt and Washers

washer on door pillar using pencil or crayon.

2. Insert a 5/16-inch hex wrench into head of striker bolt, then turn bolt counterclockwise from plate in cab pillar.

Installation (Fig. 7)

1. To install, reverse "Removal" procedure.

NOTE: Make sure the thin plastic washer is positioned against the painted door opening pillar and center the bolt washer within marks on pillar.

2. If door has been removed and then installed or aligned in opening, the door should not be closed completely until a visual check is made to determine if lock cam in door will engage the striker bolt correctly. Center of striker bolt should be in direct alignment with "V" slot in door. See figure 8. If necessary, reposition striker bolt as directed below under "Striker Bolt Adjustment."

STRIKER BOLT ADJUSTMENT

IMPORTANT: This adjustment should be checked and if necessary adjusted after door is aligned properly in cab opening.

Striker bolt on cab pillar is adjustable vertically and transversely after loosening the bolt with a 5/16-inch hex wrench. The bolt fore and aft adjustment is obtained by use of shim spacers located between the bolt washer and the cab pillar. Figure 7 illustrates location of bolt, washers, and spacer.

Striker Bolt "Fore" and "Aft" Adjustment

1. To check striker bolt for proper fore and aft adjustment, smear grease or paint to contact side of bolt as shown in figure 9.

2. Slowly close door until lock cam of door just contacts the side of striker bolt and makes an impression in the grease or paint.

3. Measure distance between head of bolt and the cam impression in grease. Distance should measure 1/8-inch as shown in right view of figure 9. This dimension is necessary to assure that the head of striker bolt will ride at center of nylon

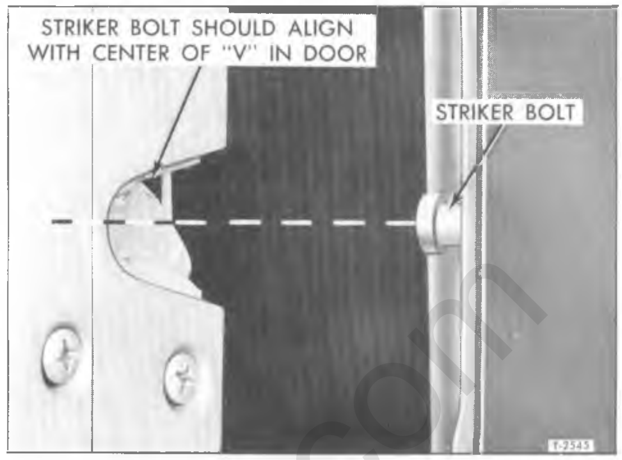


Figure 8—Sight Checking Striker Bolt Alignment

shoe which is located just in back of the lock cam.

To obtain this dimension, remove the striker bolt and install or remove shim spacers. Spacers are available in two thicknesses: 5/64-inch and 5/32-inch. Make sure the thin plastic washer is located next to cab pillar.

After obtaining proper fore and aft adjustment, tighten bolt snug only at this time and then proceed with the "Striker Bolt Height Adjustment."

Striker Bolt Height Adjustment

This adjustment is important to assure that the right proportion of door's weight will rest on striker bolt when door is closed. If bolt is positioned too high on pillar, rapid wear will occur to the lock cam; if too low, an extra load will be placed on door hinges as well as pull door downward and out of alignment.

Generally the striker bolt height adjustment can be checked quite accurately by just sighting the center of "V" slot on door with the center of striker bolt as illustrated in figure 8. However, to make a more positive check, perform the following:

1. Mark a horizontal line through center of "V" slot and on door lock cam as shown in figure 9.

2. Smear some grease or paint on contact edge of lock cam as shown in figure 9.

3. Slowly close door until cam barely contacts the striker bolt to leave an impression in grease. Open door and check contact mark on edge of cam. Mark should be located approximately 1/16-inch below the horizontal mark if properly aligned.

4. If necessary, raise or lower the loosened striker bolt up or down by tapping on the washer or spacer at base of striker bolt. DO NOT TAP ON HEAD OF BOLT.

NOTE: If striker bolt reaches end of adjustment travel it will then be necessary to add or remove shims at the door hinges.

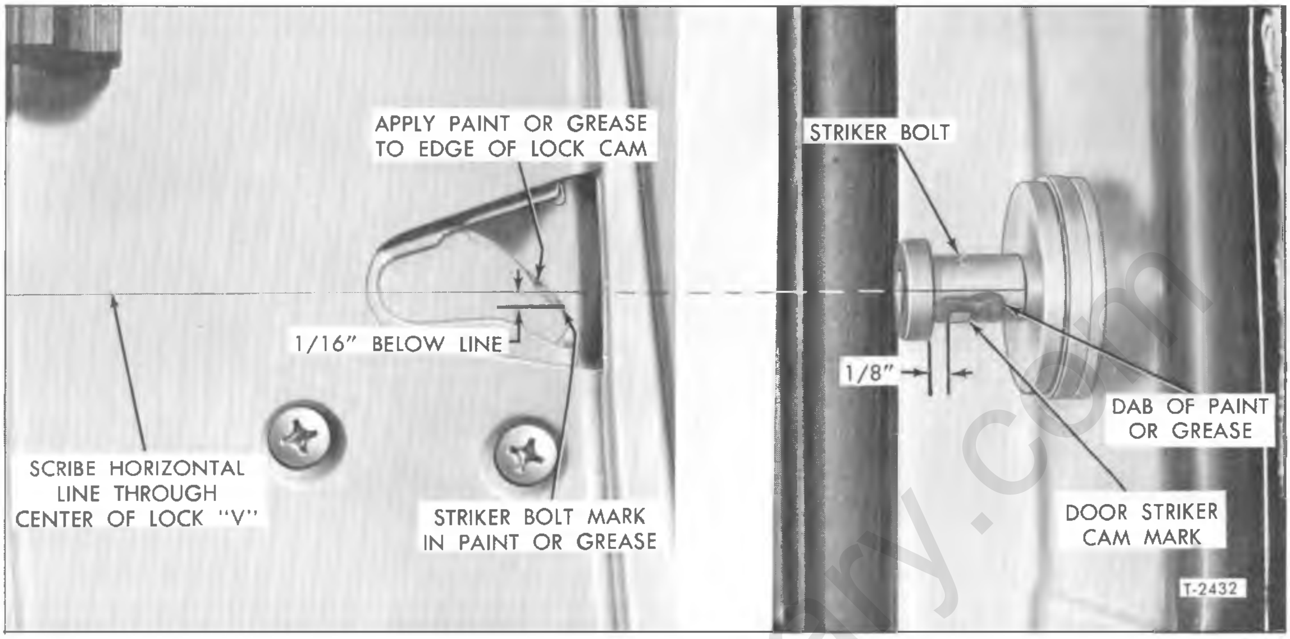


Figure 9—Striker Bolt Alignment Points

After obtaining proper height adjustment, proceed to make "Door Rear Edge "In" or "Out" Adjustment."

Door Rear Edge "In" or "Out" Adjustment

This adjustment is for purpose of aligning the rear surface of door flush with adjustment surfaces of cab. If surfaces are not flush, proceed as follows:

1. Mark a horizontal line on cab pillar at top of striker bolt base washer or spacer.

2. Loosen striker bolt slightly, then tap against bolt base washer, to move bolt "in" or "out" as necessary to locate door surface flush with cab surface when door is closed. Before tightening the striker bolt make sure top of bolt base washer is contacting the horizontal mark on cab pillar. Final tighten striker bolt.

Two rubber bumper blocks are inserted into door rear edge panel to absorb closing shock and to limit the "in" adjustment. If bumper blocks are deteriorated or damaged otherwise, they should be replaced. Pull blocks from door to remove. A flat-bladed tool, such as a putty knife, can be used for installing blocks in manner shown in figure 10.

DOOR CHECK REPLACEMENT

IMPORTANT: Do not allow door to swing beyond the normal full-open position when the check strap is disconnected.

1. Using a small punch, drive spring pin up from bottom of strap bracket (fig. 11).

2. Remove the two screw and washer assemblies which attach the check strap catch to door. Remove check assembly.

3. Attach check assembly to door, then connect check strap to cab bracket with spring pin, which must be installed from top side.

DOOR WEATHERSTRIP REPLACEMENT

Door weatherstrip is retained to cab opening with adhesive cement. Weatherstrip at bottom of door opening is retained by the sill plate shown in figure 12.

1. Remove weatherstrip, then scrape all old cement from cab flange.

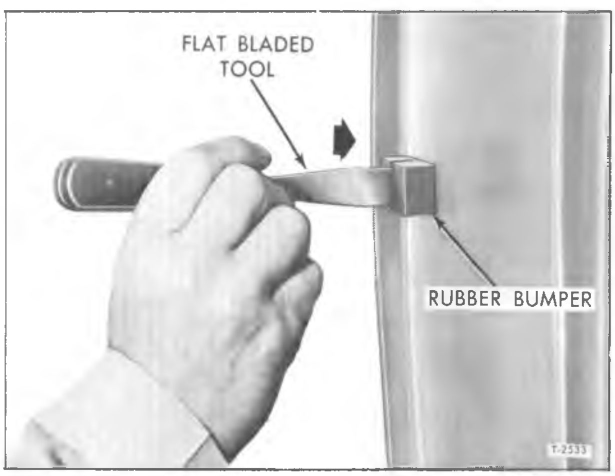


Figure 10—Installing Rubber Bumper in Door

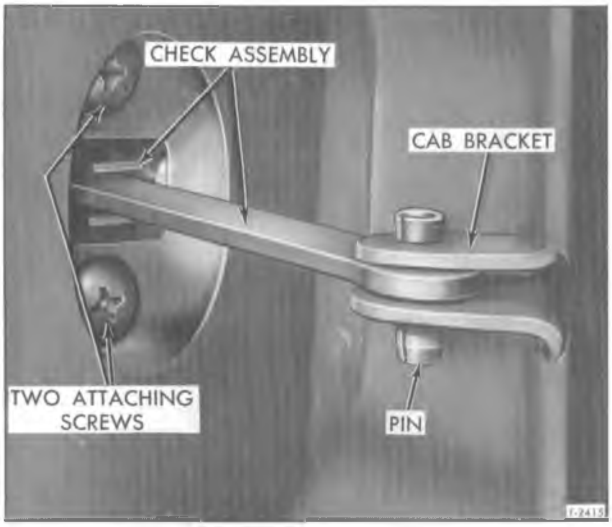


Figure 11—Door Check Installed

2. Apply cement to cab flange surfaces, then position seal to cab. Referring to figure 12, note the installed position of seal ends of the door weatherstrip. Also note the position of the cut ends of weatherstrip in cab opening.

3. After installing weatherstrip in cab opening, install sill plate.

NOTE: An application of silicone lubricant or equivalent to weatherstrip and adjacent contact

Figure 12—Door Weatherstrip Installed

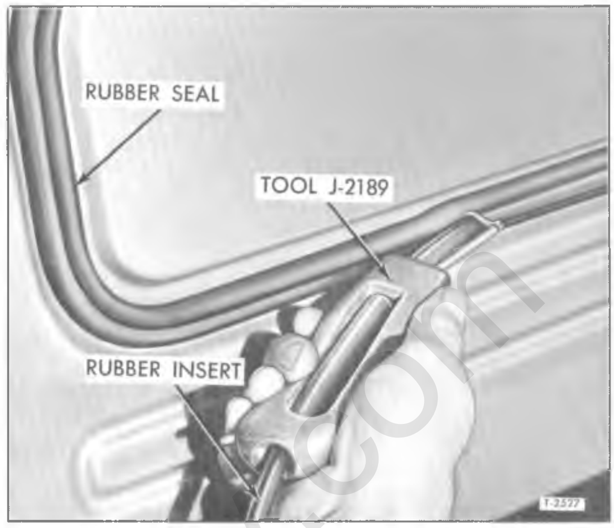


Figure 13—Installing Access Panel Insert

areas will prevent weatherstrip from sticking or freezing between cab and door.

DOOR ACCESS PANEL REPLACEMENT

REMOVAL (Fig. 13)

1. Pry end of small rubber insert out of retainer seal groove with a pointed tool, then pull insert completely out of seal.

2. Engage hook end of tool (J-2189) under edge of access panel, then run hook along panel to force panel out of rubber seal.

3. Pull seal from door.

IMPORTANT: Inside edge of opening may be sharp. Do not attempt to perform operations through opening unless sharp edge is removed or covered with tape.

INSTALLATION (Fig. 13)

1. Position rubber seal around opening in door.

2. Place access panel to seal, then with hook end of tool in panel groove of seal, move tool around panel to force outer lip of seal over edge of panel.

3. Thread end of small rubber insert through handle and loop of installer tool (fig. 13). Push tool loop and end of insert into groove of seal. Feed in rubber insert, while proceeding around panel. Use a hitching movement of tool to avoid elongation of insert. If new insert strip is being used, cut off insert allowing sufficient overlap for a tight joint, then butt into seal groove.

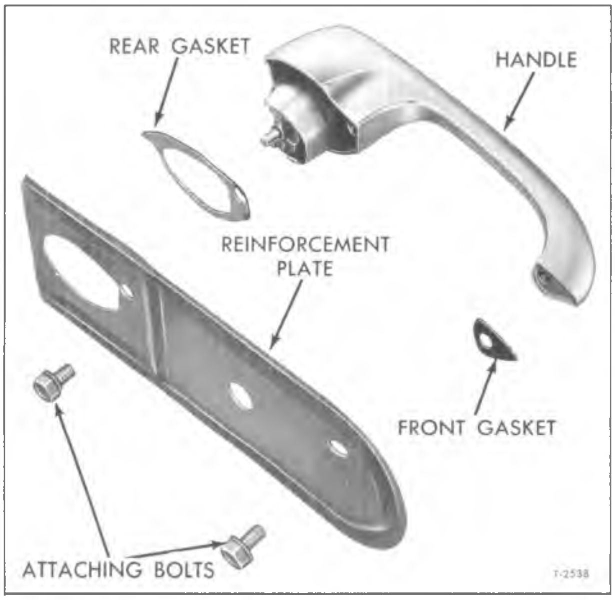


Figure 14—Door Handle Installation

DOOR OUTSIDE HANDLE REPLACEMENT

REPLACEMENT (Fig. 14)

1. Remove the access panel from lower portion of door as directed previously under "Door Access Panel Replacement."
2. Roll window to top of door, then using a 7/16-inch wrench, reach up through access opening and remove two lock-type screw and washer assemblies which attach handle to door. Remove handle and handle gaskets.
3. Install door handle, using procedures in reverse of handle removal. Make sure the handle reinforcement plate is in position, inside of door at handle mounting.

DOOR HANDLE PUSH BUTTON AND SHAFT REPLACEMENT

DISASSEMBLY (Fig. 15)

1. Remove handle from door as directed previously under "Door Outside Handle Replacement."
2. Remove the button shaft retainer by first depressing, then rotating retainer as shown in figure 16. Remove shaft spring and button assembly with O-ring seal from handle.

ASSEMBLY

1. Place button assembly with installed O-ring seal in handle.
2. Locate spring over button shaft, then install spring retainer (fig. 16).

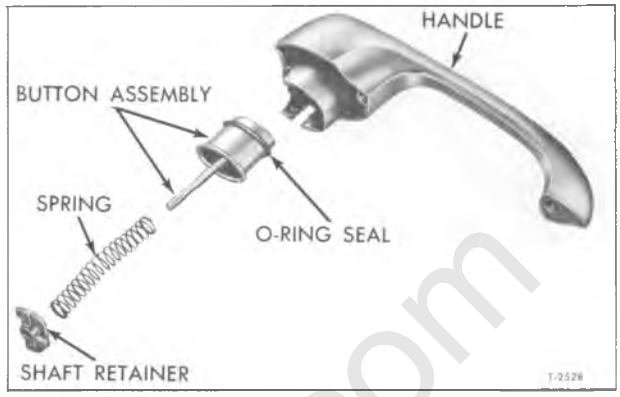


Figure 15—Door Handle Disassembly

DOOR LOCK CYLINDER REPLACEMENT

REMOVAL (Fig. 17)

1. Using flat blade screwdriver, pry retainer from edge of door.

CAUTION: HOLD ON TO RETAINER WHEN REMOVING AS RETAINER MAY FLY FROM POSITION.

2. Remove the lock cylinder from door. Cylinder must be rotated and tilted slightly to permit cylinder lug to disengage from lock mechanism stud. Remove lock cylinder gasket.

INSTALLATION (Fig. 17)

1. With gasket in position on lock cylinder, insert cylinder into door to engage cylinder lug over lock mechanism stud within door.
2. While holding cylinder in door, force the

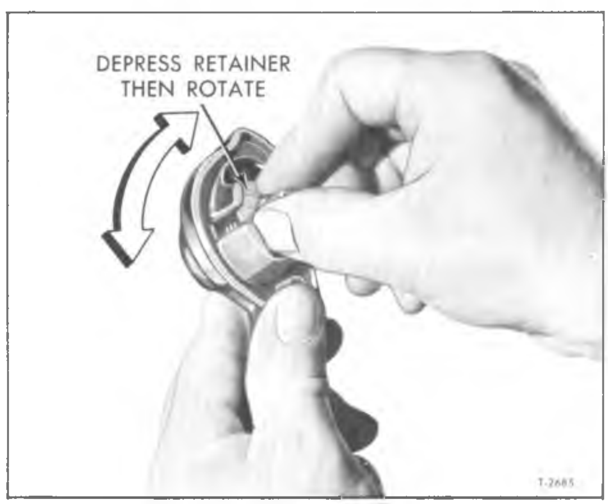
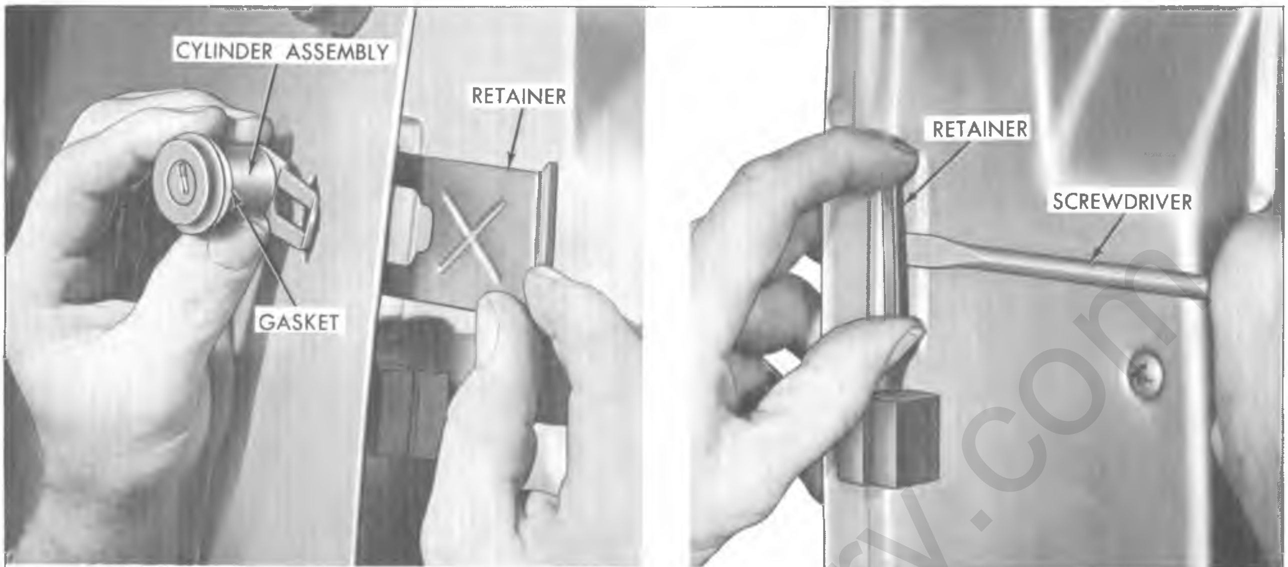


Figure 16—Disengaging Handle Spring Retainer

CONVENTIONAL CAB



INSTALLING CYLINDER REMOVING RETAINER T-2529

Figure 17—Door Lock Assembly Replacement

cylinder retainer through slot at edge of door to engage grooves at side of cylinder body. It may be necessary to drive the retainer into final engagement with a light hammer. Make sure both legs of retainer are engaged in grooves of lock cylinder. If one of the retainer legs is not engaged, the retainer flange will not be vertical in door slot.

DOOR INSIDE HANDLES REPLACEMENT

If removing door inside handle, the handle position should be marked in relation to door panel to assure that handle is installed later at the same operating angle. See figure 18 which shows proper handle position.

REMOVAL

1. Insert tool (J-9886) between handle flange and escutcheon plate as shown in figure 18.

2. Force lock spring from grooves in base of door handle. DO NOT LOSE SPRING. Remove handle and escutcheon plate.

NOTE: The lower view in figure 18 shows how the tool engages the clip at underside of handle when removing.

INSTALLATION

1. Insert lock spring in handle grooves from direction shown in figure 18.

2. Place the escutcheon plate on handle spindle.

3. If installing door lock release handle, make sure handle is in position previously marked on door inner panel. To install either handle, force handle with installed lock spring over spindle until lock spring becomes fully engaged.

DOOR LOCK AND REMOTE CONTROL MECHANISM REPLACEMENT

REMOVAL (Fig. 19)

1. Remove the door inside lock knob which is threaded on lock rod.

2. Remove the access panel from door inner panel as directed previously under "Door Access Panel Replacement."

3. Remove the door lock inside handle as directed previously under "Door Inside Handles Replacement."

4. Remove three screws which attach the remote control to door inner panel. Lower the control to door access opening, then disengage fastener at pull-rod. Separate rod from control.

5. Remove the lock cylinder assembly from outer side of door as directed previously under "Door Lock Cylinder Replacement."

6. At rear edge of door, remove three special locking-type screws which attach lock mechanism to door frame. Lower the lock and attached two rods out through access opening in door.

INSTALLATION

Install lock mechanism with rods and remote control in reverse of the "Removal" procedures.

IMPORTANT: Be sure to use the three special locking-type screws which attach lock mechanism to door frame. Check for proper operation of installed lock assembly before attaching access panel to door.

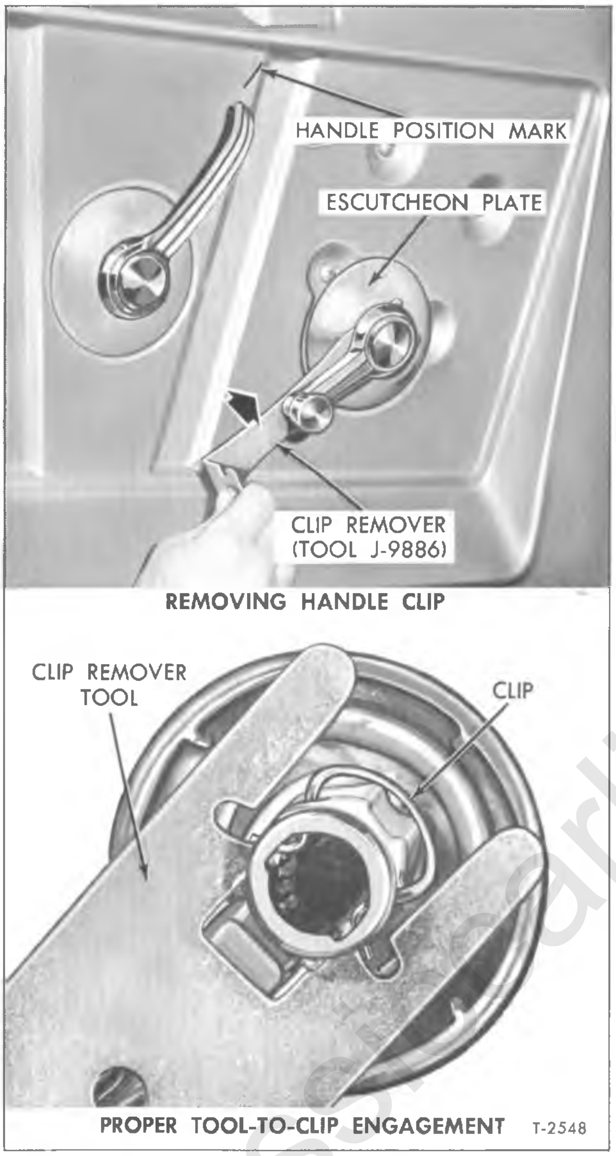


Figure 18—Door Inside Handle Replacement

DOOR VENT GLASS REPLACEMENT

1. Squirt gasoline on rubber filler all around glass frame to soften old filler. When seal softens sufficiently, pull glass and old filler from glass channel.
2. Thoroughly clean the inside of the glass channel with sandpaper to remove all rust and foreign matter.

NOTE: Ventilator glass rubber filler is supplied in two thicknesses - 0.067" and 0.080" for select fit between glass and channel.

3. Cut new piece of glass channel rubber filler two inches longer than required. Position filler (soapstoned side away from glass) over that part of glass which will be inserted in frame. Punch together projecting length of filler at each end to retain filler in place during installation.

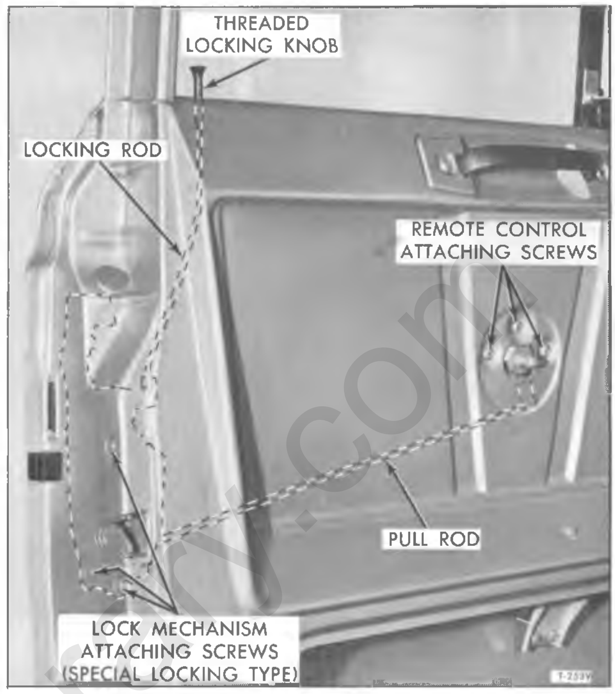


Figure 19—Door Lock Mechanism and Rods

4. Brush inner channel of glass frame with soap solution. Press glass and filler into frame until firmly seated. Purpose of soap solution is to facilitate assembly. DO NOT USE GREASE OR OIL.
5. Trim off excess filler material around frame and at end of frame.

DOOR VENT WINDOW TENSION REPLACEMENT

Vent windows are of friction type having a theft-resistant latch. Friction mechanism consists primarily of a coil spring mounted on vent window lower pivot, which exerts frictional force against mounting lower support.

If friction mechanism is adjusted too tight, it will be difficult to open or close vent. Too loose an adjustment will result in a fluttering vent or one having a tendency to close with wind pressure.

If necessary to change vent friction, perform procedures as follows:

1. Remove access panel from door inner panel as directed previously under "Door Access Panel Replacement." Panel is retained to door with rubber insert-type retainer.
2. Reaching up through access opening in door,

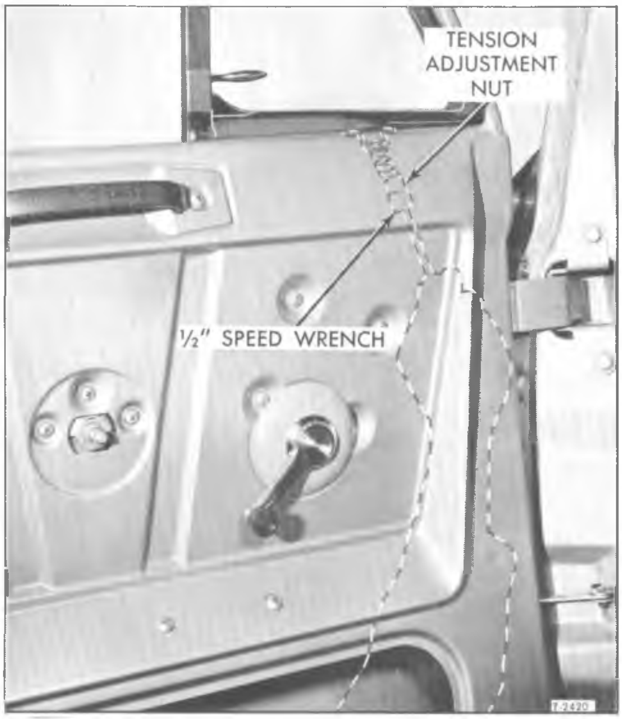


Figure 20—Adjusting Vent Window Tension

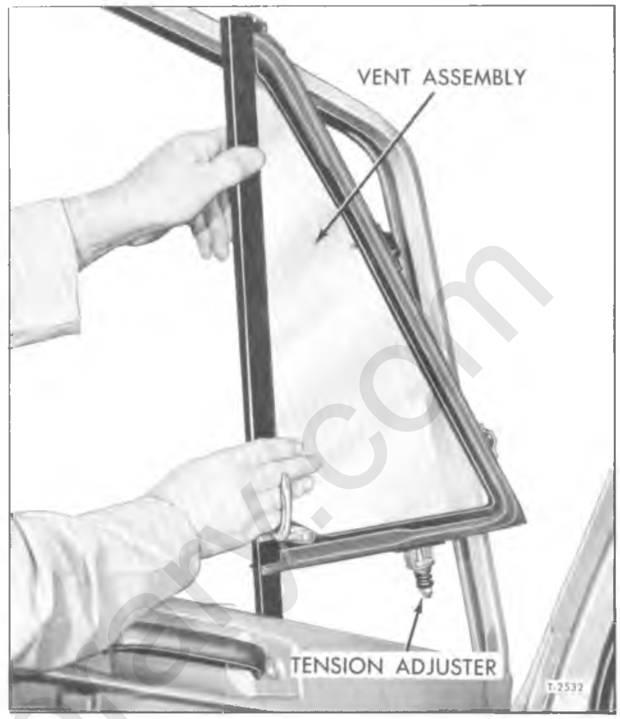


Figure 22—Replacing Vent Window

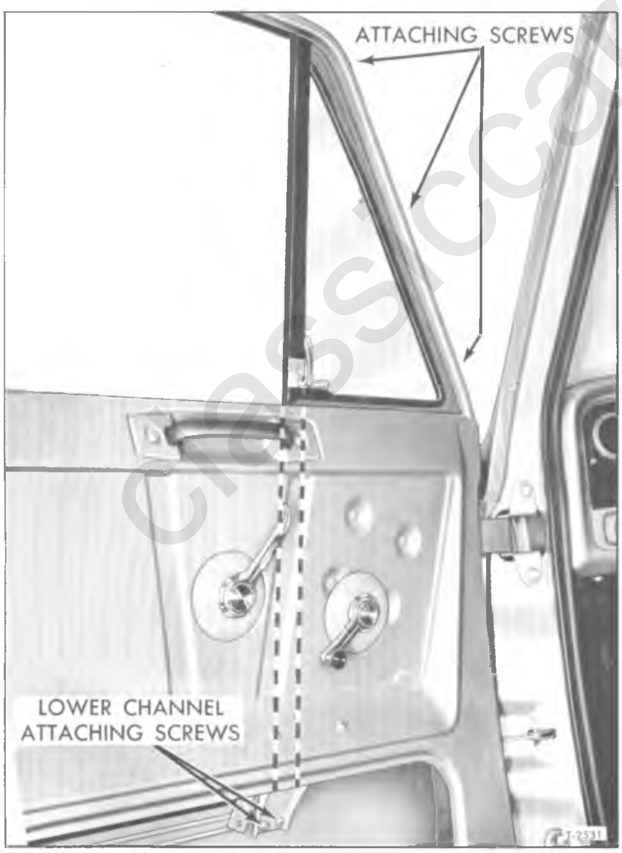


Figure 21—Vent Window Attachment

as shown in figure 20, turn adjustment nut with a ½-inch speed wrench to obtain five to seven pounds torque, while moving vent window from a ten-degree open position to a full-open position. Use either a push or pull type spring scale, positioned at rear edge of vent glass. Turning adjustment nut clockwise increases operating tension.

3. Install door access panel.

DOOR VENT WINDOW ASSEMBLY REPLACEMENT

REMOVAL

The channel between the door window glass and the door vent is part of, and is removed with, the vent window assembly.

1. Regulate the window to the full down position.
2. Remove the access panel from door inner panel as directed previously under "Door Access Panel Replacement."
3. Remove lower two channel retaining screws from door inner panel bracket (fig. 21).
4. Remove three screws which attach vent framing to door (fig. 21).
5. Rotate the vent window assembly and carefully lift it up and out of door (fig. 22).

INSTALLATION

1. With window glass down, lower the glass channel portion of vent assembly down into the

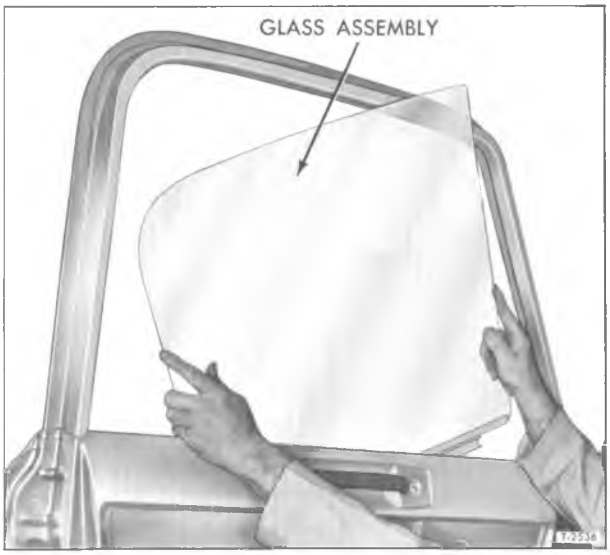


Figure 23—Replacing Door Window Glass Assembly

door and rotate it to locate in position (fig. 22).

2. Make sure that the rubber lip around forward portion of vent is properly mated over door vent opening contours.

3. Install two screws attaching lower channel portion of vent assembly to door inner panel bracket (fig. 21).

4. Referring to figure 21, install three screws to attach vent frame to door structure.

5. Adjust the vent opening and closing tension as directed previously under "Door Vent Window Tension Adjustment."

6. Install door access panel.

DOOR WINDOW GLASS REPLACEMENT

REMOVAL

1. Remove the vent window assembly as directed previously under "Door Vent Window Assembly Replacement."

2. Regulate window to two-thirds closed position.

3. Disengage the glass from the regulator guide by positioning the roller at the guide openings and then lifting out the window (fig. 23).

4. If desired, the horizontal seal strips can be replaced using a flat-bladed tool to pry strips from door as shown in figure 27.

5. Also if desired, the door glass run channel assembly can be removed at this time. Pull run channel from door.

6. To replace the glass in glass channel perform the following:

a. Squirt gasoline along glass filler on both sides of glass to soften seal. Remove glass from

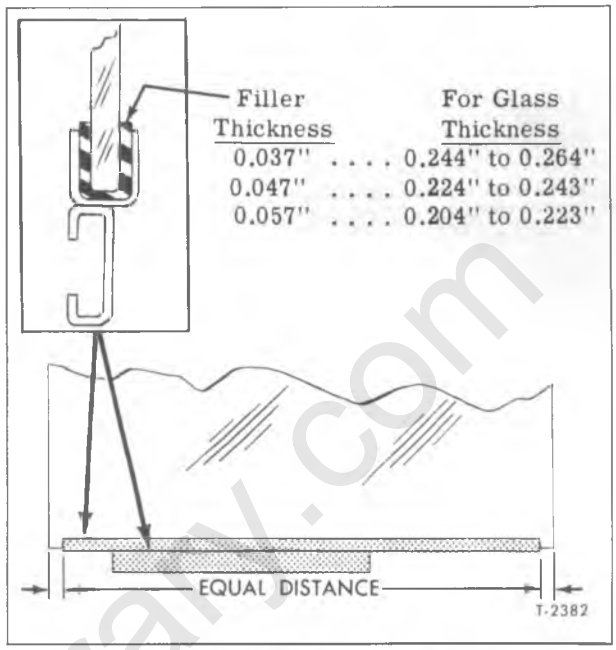


Figure 24—Door Window Glass Assembly

channel when filler is sufficiently soft. Pull rubber filler from channel.

b. Thoroughly clean inside of glass channel, removing all rust and foreign matter.

c. Window glass rubber filler is supplied in three thicknesses - 0.037", 0.047", and 0.057" for select fit between glass and channel.

d. Cut new piece of channel filler slightly longer than channel. Position filler (soapstone side away from glass) around glass.

e. Brush inside of channel with a light application of liquid soap solution to facilitate installation. DO NOT USE GREASE OR OIL.

f. Press channel on filler and glass until firmly seated.

IMPORTANT: Make sure channel ends are equal distance from edge of glass (fig. 24) and that regulator arm slot in channel, is facing the right direction in respect to rounded and squared corners at upper edge of glass. Trim off excess filler material along channel and at ends.

INSTALLATION

1. If glass run channel was removed from door framing, install channel by pressing run channel into place around door frame.

2. If the glass horizontal seal strips were removed from door, press new seal strips into position making sure all strip attaching clips are fully engaged.

3. Lower the door window assembly into door (fig. 23).

4. Engage glass channel on the roller of regulator arm. NOTE: Regulator arm should be in

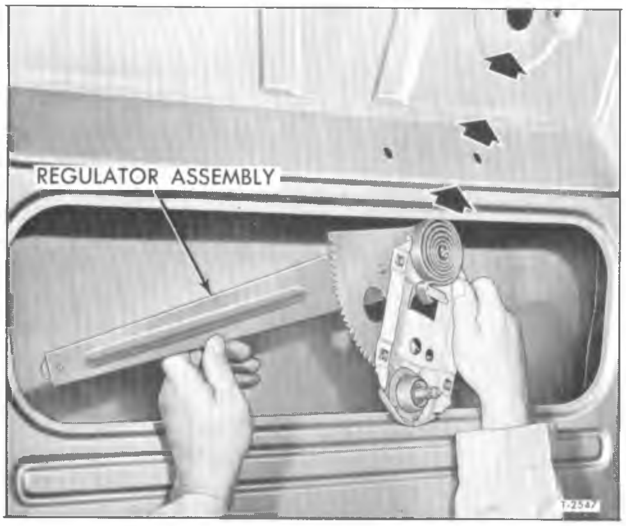


Figure 25—Replacing Door Window Glass Regulator

the window two-thirds closed position.

5. Install vent assembly as directed under "Door Vent Window Assembly Replacement."

6. Check operation of vent assembly and window raising and lowering action for possible binding.

DOOR WINDOW REGULATOR REPLACEMENT

To replace regulator, it is first necessary to remove the door window assembly and the vent window assembly as directed previously under "Door Window Glass Replacement."

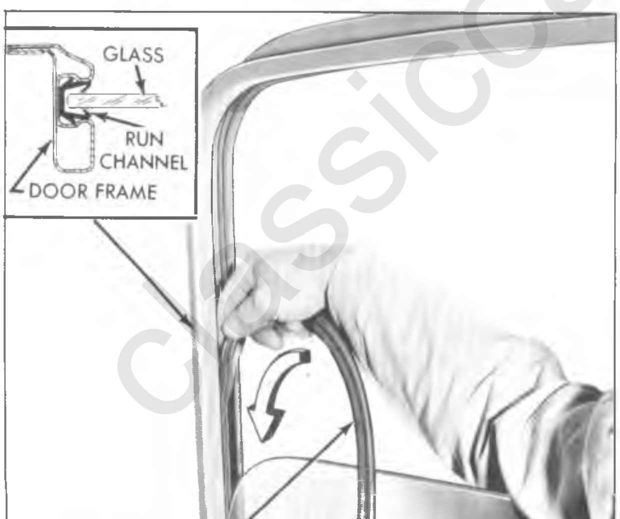


Figure 26—Installing Window Glass Channel Run

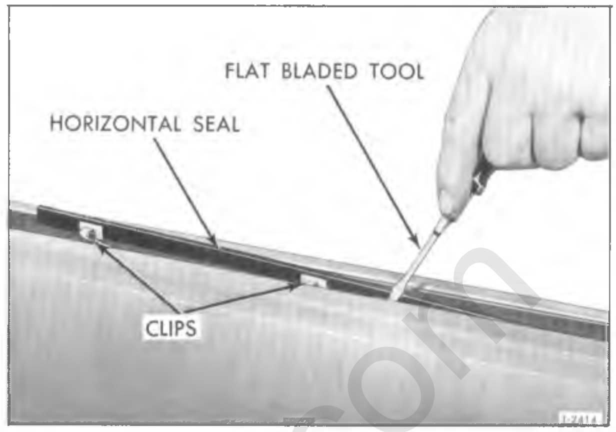


Figure 27—Removing Glass Horizontal Seals

1. Remove regulator handle.
2. Remove four screws which attach regulator to door inner panel.
3. Referring to figure 25, remove regulator.
4. To install regulator, perform the "Removal" procedures in reverse sequence.

DOOR GLASS RUN CHANNEL REPLACEMENT

REMOVAL (Fig. 26)

1. Roll window to bottom of door.
2. At upper end of channel, next to vent window frame, pry end of channel from door using a small flat-bladed instrument.
3. Continue to pull channel downward from top of door, then upward to remove from side frame of door.

INSTALLATION (Fig. 26)

1. Apply thin coat of silicone type lubricant to back and sides of run channel.
2. Start end of run channel into door side frame, then force it downward in manner shown in figure 26. By engaging length of channel required to butt against vent window frame, the amount of channel to be inserted downward can be determined. Use thumbs to press channel into position.

NOTE: The run channel can be inserted downward more readily if the window is rolled up and down during the process. If run channel cannot be installed as instructed, it will then be necessary to remove the door window glass.

Referring to inset of figure 26, be sure to properly position run channel so that channel lips lock behind grooves of window frame.

DOOR WINDOW GLASS HORIZONTAL SEAL REPLACEMENT

1. Remove the vent window and door window as directed previously under applicable headings.
2. Using a thin flat-bladed instrument, pry seals from door panel in manner shown in figure 27. Pry a small amount at each fastener to prevent seal channel distortion.
3. To install, press seal assembly evenly into door panel.
4. Install door glass.

CAB REPLACEMENT

REMOVAL

NOTE: Necessary equipment for efficient and safe replacement of cab consists of a chain hoist (3/4-ton minimum capacity), a sling having padded hangers, and two or more support blocks to rest cab on once the cab is removed from chassis.

1. Disconnect the battery.
2. Remove the hood panels.
3. Drain cooling system if equipped with heater and disconnect heater hoses at cab cowl.
4. If equipped with air brakes, exhaust the pressure from air system.
5. Disconnect all necessary wiring harnesses and cables from cab or chassis.
6. If air conditioned, refer to "AIR CONDITIONING" section and open system and cap lines observing precautions found in above references.
7. Detach and/or disconnect all lines between cab and chassis.

NOTE: Do not attempt to salvage clutch or brake hydraulic fluid.

8. Disconnect accelerator linkage at cab cowl.
9. Disconnect mechanical parking brake.
10. Remove closure panel from cab floor at transmission shift lever.
11. Disconnect speedometer cable at transmission or at the dash unit.
12. Mark for alignment purposes later, the steering shaft joint flange-to-steering gear shaft, then remove the flange clamp bolt. When cab is raised later, this connection will separate.
13. Remove the cab mounting bolts.
14. With a hoist sling device having padded hangers, open doors and engage hangers to cab door openings. DO NOT ATTACH HANGERS TO DOORS.

NOTE: If sling device of type described above is not available, a solid hardwood 4 x 4, 7½ feet long, positioned through the cab with hoist chain attached securely to each end, can be used. Place padding at points where beam contacts cab.

15. Raise cab and remove from chassis.

INSTALLATION

1. Place cab mounting components in position on chassis frame brackets. If desired, masking tape can be applied to retain loose parts temporarily in position.
2. Carefully lower the cab to chassis and at same time engage the steering shaft to gear shaft using marks made prior to removal for alignment. Tighten shaft clamp bolt (when used) to 35 to 40 foot-pounds torque or clamp bolt nut (when used) to 40 to 50 foot-pounds torque.
3. Install balance of cab mounting components.
4. Connect speedometer cable.
5. Connect hand brake if mechanical.
6. Connect accelerator linkage.
7. Connect all control and gauge lines.
8. Connect fuel line if previously disconnected.
9. Connect heater hoses (if used), then fill cooling system.
10. Service the hydraulic brake system, if used.
11. Service the clutch hydraulic system. Use new fluid.
12. Connect all electrical wiring.
13. Refer to "AIR CONDITIONING" later in this section, for service of the air conditioning system, if used.
14. Connect battery cables.
15. Install hood panels and align, if necessary. Refer to SHEET METAL (SEC. 11) of this manual.
16. Recheck all connections of wiring, lines, and control linkage.
17. With wheels blocked as a safety measure, start engine, then final check all connections and linkage.

CAB HEATING AND VENTILATION

HEATERS

Two types of heaters may be used in these conventional cabs, the standard duty air-flow type (fig. 28), and the heavy duty air-flow type (fig. 29). All the heater components are located within cab, under the dash.

Description, operation, and maintenance information for each type heater is explained under applicable headings. Service diagnosis information,

CONVENTIONAL CAB

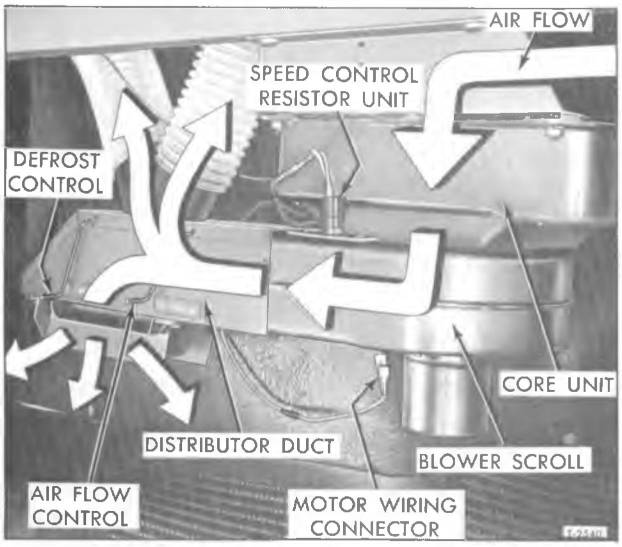


Figure 28—Standard Duty Air-Flow Heater

covering both types of heaters, is explained later at end of the "Heaters" section in this group.

STANDARD AIR-FLOW HEATER

The standard air-flow heater provides heated outside air for heating and defrosting requirements. Outside air is drawn through the air inlet grille at right side of cab cowl and through the heater by the blower motor. The degree of heated air to be expelled by heater is determined by the position of "OFF-AIR-ON" lever at side of the air distributor.

IMPORTANT: Avoid operating blower motor with this control lever in "OFF" position.

The control marked "ON-DEFROST-OFF" regulates the flow of heated air to either the windshield defroster outlets or onto floor, or to both.

The blower motor speed is regulated by the dash switch and a resistor unit. Resistor unit is attached to top of blower shroud with two screws. If resistor should become defective the result will be high speed blower motor operation in both the "MEDIUM" and "LOW" speed switch positions.

HEATER CORE, BLOWER AND DISTRIBUTOR DUCT REPLACEMENT (STANDARD AIR-FLOW HEATER)

Both the distributor duct and the blower assembly can be readily replaced separately without having to remove the heater core unit from cab. The replacement procedure following describes the method for replacing the heater air distributor, the blower and motor assembly, and the heater core unit which are all shown in figure 28.

REMOVAL (Fig. 28)

1. Drain the cooling system to just below level of heater core fittings.
2. Mark the heater hoses and piping at front of cowl for identification purposes later at installation, then disconnect hoses.
3. Separate the defroster air duct tubes from air distributor.
4. Disconnect electrical wiring from heater speed control resistor and from blower motor. Resistor is located at top of blower scroll.
5. Remove screws which attach the air distributor to cowl and to blower scroll. Remove air distributor.
6. To remove the heater core and blower unit as an assembly, remove the screws which attach the heater core housing to the outside air inlet duct. Carefully lower heater unit and remove from compartment.
7. To remove the outside air inlet duct, remove screws which attach duct to fire wall and instrument panel, then remove duct and seal gasket.
8. Remove screws which attach heater core in housing. Remove core.
9. Remove screws which attach blower motor to scroll. Remove motor and blower fan assembly.

NOTE: The heater core can be repaired by a competent radiator core repairman.

INSTALLATION (Fig. 28)

Assemble and install the heater components in reverse of "Removal" procedures using new gaskets and seals where necessary.

IMPORTANT: When connecting heater hoses to core piping make sure the 5/8 inch I.D. hose is connected to small core pipe and that 3/4 inch I.D. hose is connected to larger pipe.

If hoses are not installed as directed, poor heat output and/or a ruptured heater core may result. The core, internally, is designed to accept the higher pressure at the inlet (5/8 inch I.D. pipe) side of core only.

HEAVY DUTY AIR-FLOW HEATER

The heavy duty air-flow heater operates on full outside air and has a three lever control panel and a blower motor control switch on dash (fig. 29).

Temperature control is by means of the air-mix method; mixing heated outside air which has passed through the heater core and outside air which has by-passed the core in proportions necessary to provide the desired temperature. The control on dash for this purpose is marked "TEMP." With lever to the left, all the incoming air bypasses the heater core. With lever to the far right, all outside air must pass through the core, thus providing maximum heat. When lever is positioned

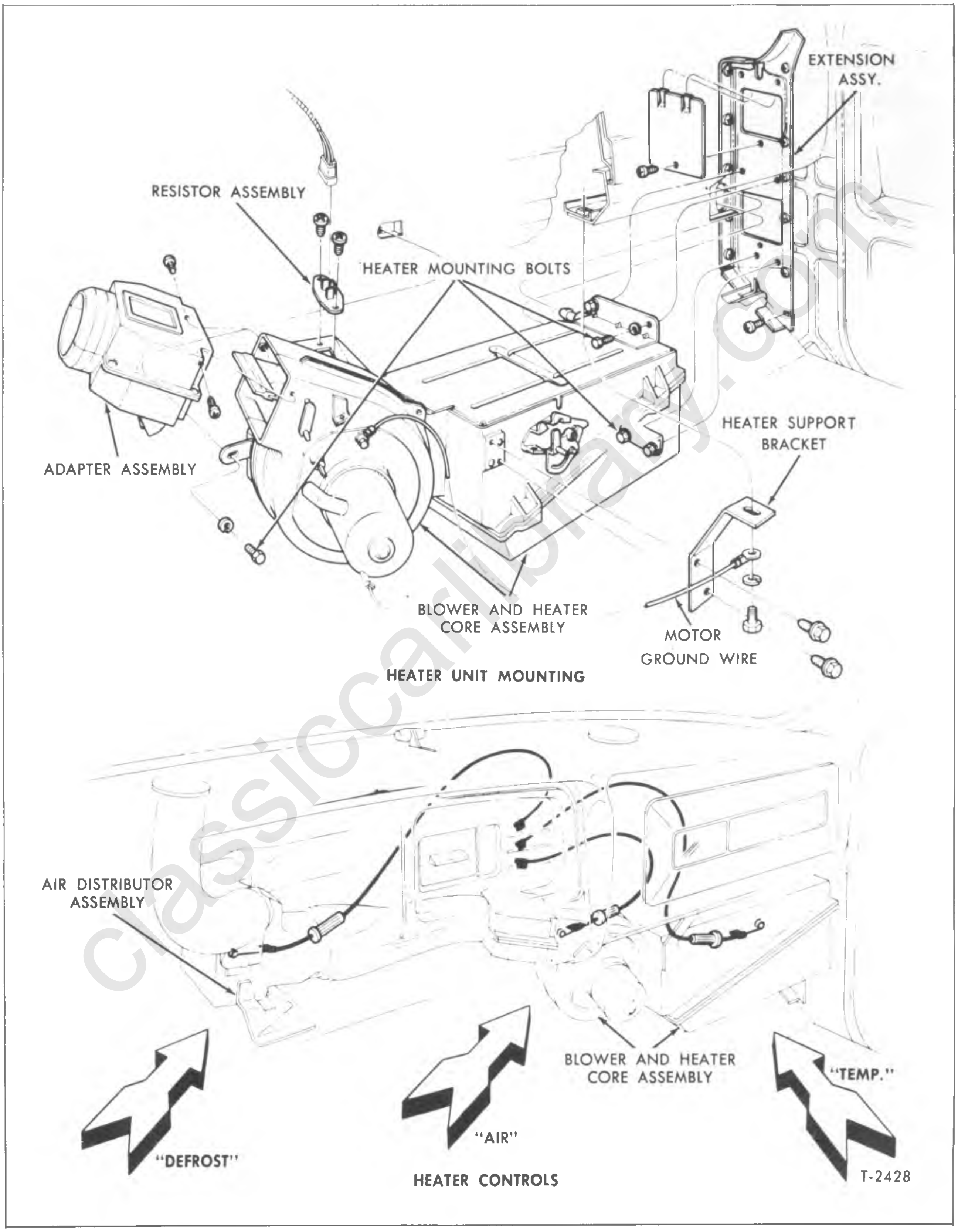


Figure 29—Heavy Duty Air-Flow Heater

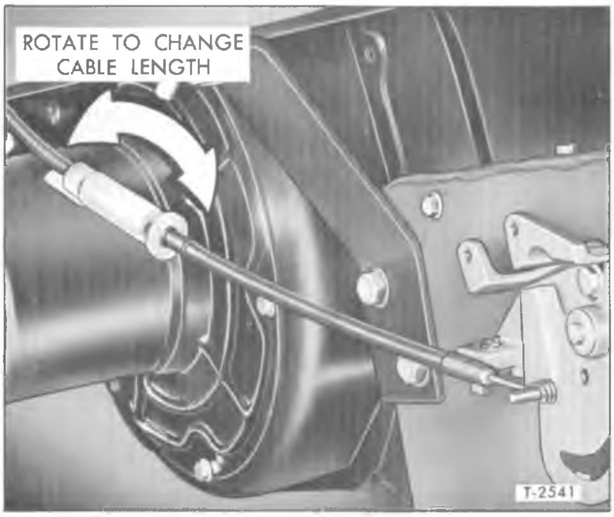


Figure 30—Heater Control Cable Adjustment Sleeve

part way, part tempered and part untempered air passes through the heater.

The control on dash marked "AIR" regulates the flow of outside air which passes through heater and into cab. This control must be positioned all the way towards the right in order to obtain heat.

IMPORTANT: DO NOT operate the blower motor when "AIR" control lever is in the full left position. The heater fan speed is controlled by moving blower switch lever from left to right positions "OFF-LOW-SPEED," "MEDIUM SPEED," and "HIGH SPEED."

The "DEFROST" lever controls flow of air to the windshield defroster ducts. With knob all the way to the right, entire heater output is diverted to the defroster ducts for defrosting.

For warm weather ventilation, place "DEFROST" and "TEMP." control knobs in extreme left positions, move "AIR" knob to extreme right, then place fan switch lever to desired fan speed position. The fan speed control resistor unit is attached to the blower shroud with two screws. If resistor should become defective, the result will be high speed blower motor operation with blower switch lever in both the "LOW" and "MEDIUM" speed positions.

HEATER UNIT REPLACEMENT (HEAVY DUTY AIR-FLOW TYPE)

REMOVAL (Fig. 29)

1. Drain cooling system to just below level of heater core.
2. Mark hoses for identification, then disconnect hoses at heater core fittings.
3. At front side of cowl, remove single bolt which attaches the heater blower bracket to cowl.
4. At front side of heater core housing, remove protective shield and the small spring-type retaining washer from "TEMP" control lever, then remove the control wire clamp screw. Pull wire from lever.
5. At top of blower motor, disconnect the "AIR" control wire in same manner.
6. Disconnect the blower adapter-to-air distributor hose.
7. At top of blower housing, near the cowl, separate the wiring connection at the blower speed control resistor.
8. Separate wiring connector at rear of blower motor. Pull outward on connection.
9. Underneath the dash, at right side of core, remove four bolts which attach heater unit to cowl extension.
10. Remove single bolt which attaches heater support bracket to bottom of dash panel. This same bolt attaches the blower motor ground wire.
11. Using care not to damage heater unit, work the unit rearward and down from compartment.
12. If desired, the unit can be readily disassembled for inspection or replacement of the blower, motor, core, etc.

INSTALLATION

1. Make sure the cellular dust pad is located over heater core water inlet and outlet pipes.
2. Place the heater core and blower assembly into position, then install all attaching bolts.

IMPORTANT: Make sure blower motor ground wire is sandwiched under head of heater support bracket attaching bolt at dash panel.

3. Connect wiring at blower speed control resistor unit and also at the blower motor. Make sure connections are secure.
4. Connect the blower air outlet tube.
5. Connect the "AIR" and "TEMP." controls to heater assembly. Lower view in figure 29 shows connections.
6. Referring to identification marks made on heater hoses prior to disconnecting, connect the hoses to respective heater core piping.

IMPORTANT: Make sure the 5/8-inch I.D. hose is connected to small core pipe and that the 3/4 inch I.D. hose is attached to the larger pipe. If hoses are not installed as directed, poor heat output and/or a ruptured heater core will result. The core internally is designed to accept the higher pressure at the inlet (5/8 inch I.D. pipe) side of core only.

7. Replenish cooant in system then start and operate engine until normal operating temperature is obtained.
8. Check for possible leakage and check the operation of heater and controls.

AIR DISTRIBUTOR REPLACEMENT (HEAVY DUTY AIR-FLOW HEATER)

The air distributor can be readily replaced after disconnecting the attaching air hoses and the "DEFROST" control wire, then removing the three screws which attach distributor to dash and cowl (fig. 29).

HEATER CONTROL CABLE ADJUSTMENT

Each control wire conduit is equipped with a threaded-sleeve (fig. 30) which can be turned to obtain full opening and closing of air doors and to even up the heater knobs on control panel. Make adjustment to control wire conduit if desired.

SERVICE DIAGNOSIS

The following applies to both the Standard and Heavy Duty Air-Flow Heater systems:

POOR OR NO HEATING

1. Heater hoses are kinked, deteriorated, or switched around at the core piping.
2. Heater core plugged.
3. Poor blower motor ground connection.
4. Blower malfunctioning.
5. Low coolant temperature.

BLOWER INOPERATIVE

1. Check dash switch and blower motor connections.
2. If blower operates at high speed with switch in either "MED." or "SLOW" position, the speed control resistor at top of blower shroud is defective and should be replaced.

NOTE: Resistor is attached to the blower motor scroll by two screws. Only one-half of resistor winding may be defective; if so, replace the resistor assembly.

3. Check the blower motor.

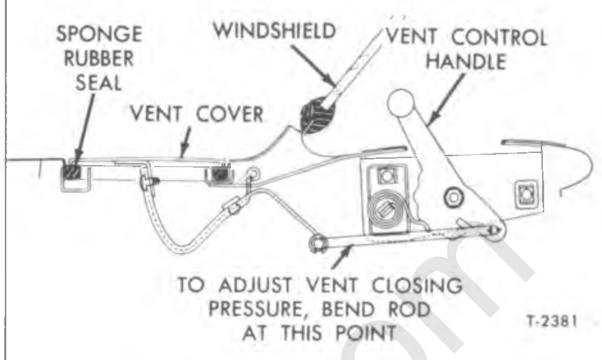


Figure 31—Cab Outside Air Vent

VENTILATION

A single vent intake at front center of cab cowl (fig. 31) permits outside air to enter cab under dash panel. The vent is controlled by "VENT" control handle located at top center of dash panel. Pulling "VENT" handle rearward opens the vent. Vent closes when handle is pushed forward.

Sponge rubber seal under vent cover should be replaced if deteriorated or damaged. Before installing new seal, remove all the old seal and adhesive from seal channel.

Figure 31 illustrates the vent control mechanism shown in closed position. If vent cover fails to close firmly against seal, the link rod under dash can be bent slightly as required to increase the closing pressure.

NOTE: Do not bend rod excessively as the control handle will fail to remain in closed detent position.

NOTE

For all "Air Conditioning" information, refer to separate "AIR CONDITIONING" sub-section at end of this section.

Tilt Cab

Maintenance information on windshield wipers, windshield and rear window glass replacement, and cab painting is explained in "GENERAL MAINTENANCE" section at beginning of this group. Refer to LUBRICATION (SEC. 0) for cab lubrication information. Contents of this section are listed in Index below:

CAB DESCRIPTION

The "L" Model is a tilt cab type of all-steel welded construction (fig. 1). Cab fully surrounds engine and can be tilted 55 degrees to expose engine for servicing. The cab tilting mechanism is integral with cab front mountings and tilting is accomplished by means of a torsion bar extending across cab front hinge mountings. One end of torsion bar is anchored to cab, whereas opposite end is anchored to chassis. Cab is retained in lowered (operating) position by positive locking mechanism located at rear of cab.

Access for minor engine servicing, such as oil and engine coolant, is accomplished without tilting cab through access doors in panel at rear of passenger seat and at top of seat back riser. A concealed step is constructed in floor of each door opening. Also, a central island shifting area that is not disturbed with the cab tilted, is located between the seats. Island contains transmission shift lever, hand brake lever and ignition or control switch.

Two-piece windshield is retained in cab openings with a one-piece rubber seal expanded into position by a small rubber insert. No sealing compound or cement is used. Rear window glass and rear side glass is retained in same manner as windshield glass.

Doors are on swing-out type hinges with the upper hinge incorporating a spring-loaded door check for holding door open. Door is retained at the rear by a striker bolt on cab pillar. Outside handles are stationary-type screw retained to door and have a push button-type latch control.

Vent window in forward portion of door is of friction-type having a positive theft-resistant latch. Friction mechanism consists of a nylon bushing on lower pivot of vent which exerts frictional force against tension clamp mounted to door paneling.

Outside air enters cab through a vent directly in front of driver and through the outside air heating system. Air entry from outside of cab is made through a louvered, removable panel, located in front center of cab just above radiator grille opening. Air flows through plenum chamber between

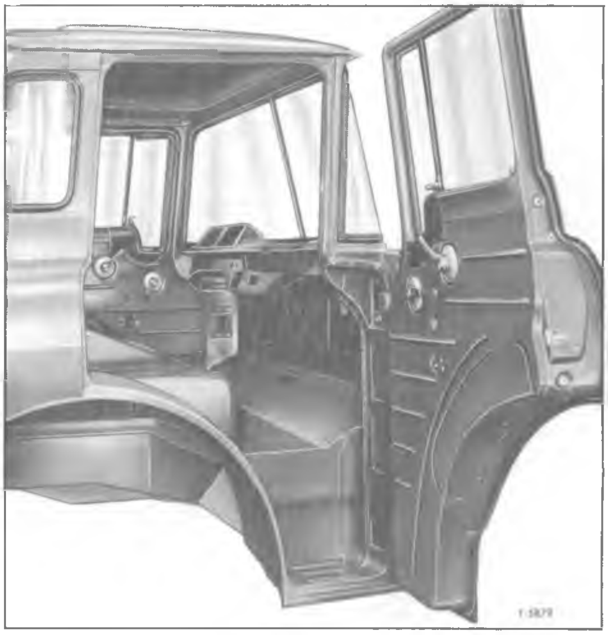


Figure 1—Tilt Cab Interior Construction

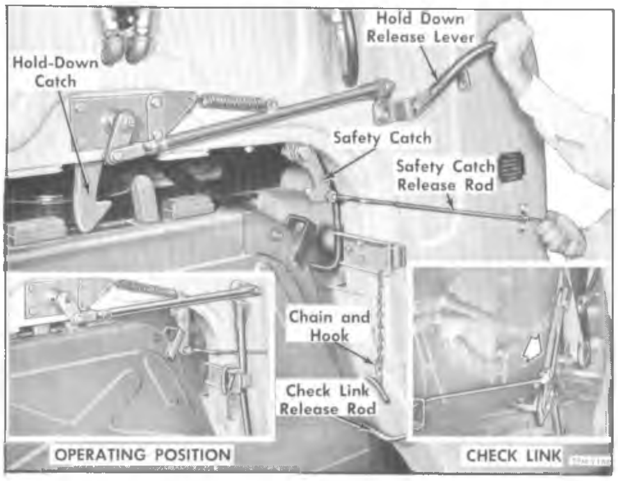


Figure 2—Releasing Cab Hold-Down Mechanism

outer and inner cab paneling and is dispersed to heater and vent outlet.

Cab is three-point mounted to chassis. Weight of cab at front is supported on cab right and left tilt hinges and a support bracket having rubber cushions, supports cab at rear center. Cab tilt hold-down mechanism locks cab firmly on cushions.

The underside of cab is completely insulated to deaden sound and prevent corrosion. A rubber weatherstrip around perimeter of door is used for sealing door to cab opening.

CAB TILTING INSTRUCTIONS

TO RAISE CAB (Fig. 2)

IMPORTANT: Before tilting cab forward, remove loose articles in cab; also place transmission shift lever in neutral and apply hand brake.

1. Close both doors of cab.
2. At right rear of cab remove safety chain hook.
3. While holding safety catch release rod to the right, pull hold-down release lever out and upward until hold-down catch becomes disengaged and rear of cab raises from mount (fig. 2). Tilt the cab completely forward until check link at right front mounting locks cab safely in full-tilt position.

IMPORTANT: Make sure check link is properly engaged with frame anchor pin.

TO LOWER CAB (Fig. 2)

IMPORTANT: Before lowering the cab to operating position, make sure transmission shift lever is in neutral position and that hand brake lever is in the applied position.

1. Release check link at right front mounting (see inset, fig. 2) by pulling rearward on link release rod, then pull cab back to operating position.
2. Safety catch at rear of cab will automatically become engaged. Pull downward on hold-down release lever and engage lower end of lever in lever spring catch, bracket-mounted to rear of cab.
3. Engage safety hook through matching holes in clip bracket and lug on lever by inserting the chain hook from underside.

NOTE: The raising and lowering effort of cab can be adjusted as desired by means of relocating torsion bar anchor lever at left frame bracket. If required, make adjustment as directed later under "Torsion Bar Tension Adjustment."

CAB MOUNTINGS

Cab is three-point mounted with two pivot-type mountings at front and twin cushion-type mountings at rear. Refer to figure 3 for typical views of mountings.

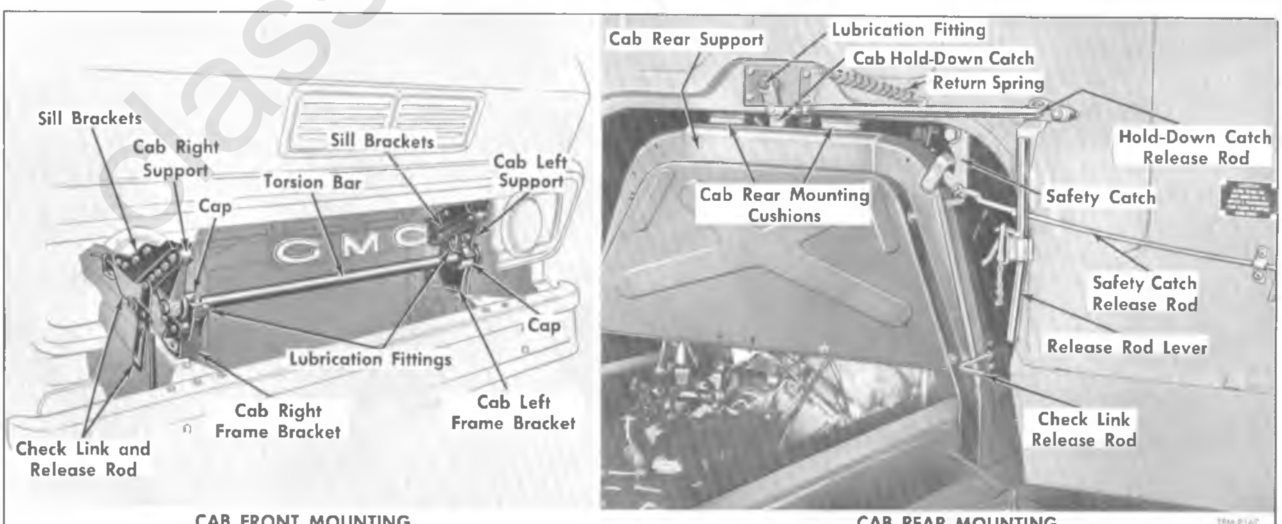


Figure 3—Cab Mountings

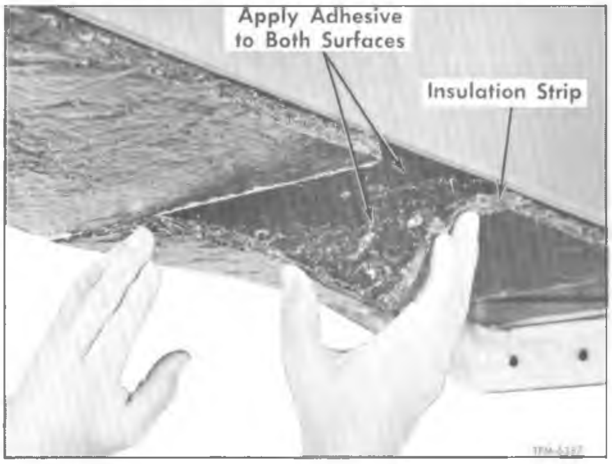


Figure 4—Applying Insulation

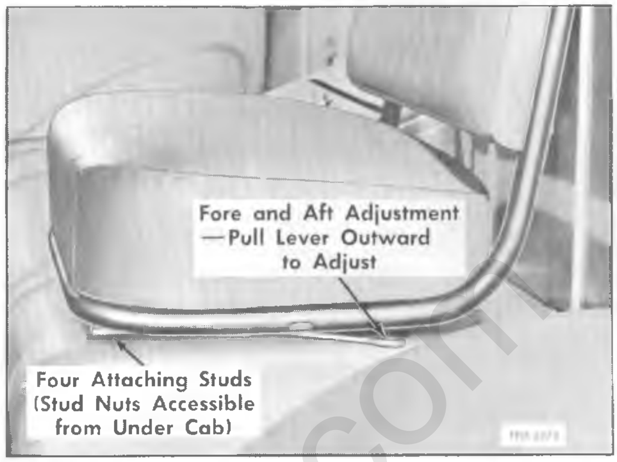


Figure 5—Driver's Seat Mounting and Adjustment

Interconnected with the cab front mountings is a torsion bar (fig. 3) which is under load when cab is in either the operating or full-tilted position. Right end of bar is anchored to cab bracket and left end is anchored by lever to frame bracket as shown in figure 3. Bar is unloaded when cab is tilted approximately 45 degrees, therefore, torsion bar assists operator in both the raising and lowering of cab.

CAUTION: UNDER NO CIRCUMSTANCES SHOULD THE BOLTS WHICH ATTACH TORSION BAR RIGHT ANCHOR BRACKET TO CAB AND THE TORSION BAR LEFT ANCHOR LEVER TO FRAME BE LOOSENED OR REMOVED WHEN CAB IS IN OPERATING OR FULL TILT POSITIONS WHICH IS WHEN BAR IS LOADED. AN INJURY COULD RESULT WHEN ANCHOR BRACKET AND TORSION BAR IS ALLOWED TO RELEASE.

Attaching bolts can be removed safely when bar is unloaded, cab tilted part way (approx. 45 degrees). Normally it should never be necessary to remove bolts. Whenever torsion bar is inoperative, cab must be supported safely.

Attaching bolts at front pivot mountings should be checked at regular intervals for tightness. Loose mountings will allow shifting of cab and eventual failure of other items connecting cab to chassis. Front pivot mountings have fittings for lubrication purposes. Lubricate as directed under LUBRICATION (SEC. 0) of this manual.

Rear mounting has positive locking mechanism to retain cab in normal operating position in relation to chassis frame. The rear mounting also includes an additional safety catch. Tightness of cab hold-down lock can be adjusted by shortening or lengthening catch release rod. After adjusting rod, tighten end yoke lock nut. Cab hold-down catch shaft is equipped with a lubrication fitting.

A check link is provided near the right front mounting (see inset, fig. 2) which limits the distance cab can be tilted forward and automatically locks the cab in the full-tilt position. Check link must be released before cab can be returned to normal operating position.

INSULATION

Insulation, applied to cab understructure directly over engine, is highly resistant to abrasion and corrosion and is designed to give maximum sound deadening and insulation.

In the event a repair such as welding is required to that part of cab covered with insulation, it is first necessary to remove the insulation from that area. After completing repair, insulation sections can be cut to size and cemented over the repaired area (fig. 4). Be sure to clean area thoroughly before installing new section of insulation.

SEATS

SEAT ADJUSTMENT (Fig. 5)

Driver's seat is provided with "fore" and "aft" adjustment only. Pull out on lever at left side of seat to disengage seat position lock.

SEAT TRACK REPLACEMENT (Fig. 5)

1. Tilt cab forward, then remove four nuts and washers from studs which attach seat tracks to seat riser of cab.
2. Lower cab to operating position, then lift seat assembly from cab.
3. Remove four nuts which attach each track assembly to seat assembly and remove track.
4. Reverse the above procedure to install track assembly.

Figure 6—Door Clearances

DOORS

Component sub-assemblies of cab doors, such as window regulator, door lock, remote control, vent window, and door window can be replaced without necessity of removing door from cab. Doors can be removed, however, without prior removal of above components. Removal and installation of door window glass is described later in this section.

DOOR REPLACEMENT

REMOVAL

1. With the aid of an assistant to support weight of door, remove the screws which attach hinge straps to door. Access to one cap screw at door upper hinge is gained by removing plug from door inner panel.
2. Carefully remove door assembly from cab.

INSTALLATION

Attach door to hinge straps with six cap screws. Adjust door in cab opening as instructed later under "Door Adjustments."

DOOR ADJUSTMENTS

Doors can be adjusted for alignment or clearance in the cab door opening (fig. 6), and for proper latching. Door alignment adjustments are made at the striker bolt, and at door hinges. The door, when properly located in door opening, will have equal clearance around its perimeter.

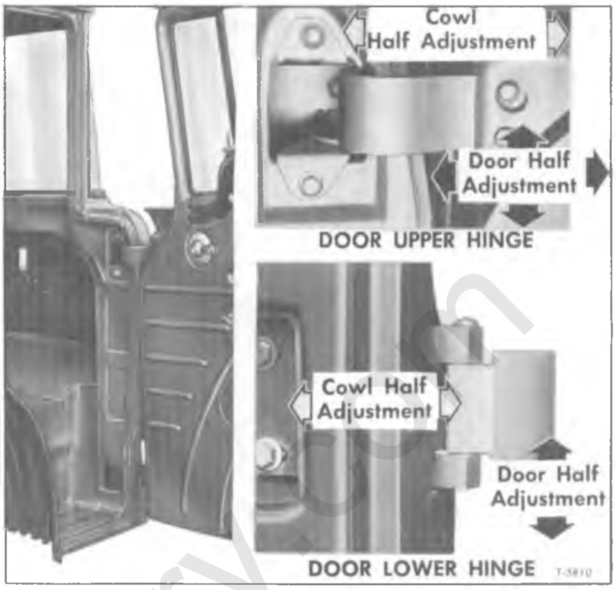


Figure 7—Door Hinges

If door has been replaced, adjustments should be made in sequence described in the following paragraphs:

REPOSITION DOOR "UP" OR "DOWN" (Fig. 7)

Door "up" and "down" adjustment in cab opening is provided by means of floating hinge cap screw tapping plates within door framing. Horizontal slotted cap screw holes in cab half of hinge assembly provide the "in" or "out" adjustment of door.

1. Remove striker bolt from cab pillar.
2. Loosen hinge-to-door cap screws slightly. Reposition door on hinges to provide equal clearance around perimeter of door in cab opening.

NOTE: Access to one cap screw at door upper hinge is gained after removing plug from door inner panel.

3. After satisfactory adjustment has been obtained, tighten hinge cap screws firmly. Open and close door to check operation. If necessary, repeat adjustment. Install hinge cap screw access plug in door inner paneling after making final adjustment.
4. Install striker bolt and adjust as directed later under "Striker Bolt Adjustment."

REPOSITION DOOR "FORE" OR "AFT" (Fig. 7)

Only the upper portion of door can be adjusted "fore" or "aft." This adjustment is made at the upper hinge. No means for this adjustment exists at the lower hinge.

1. Remove striker bolt from cab pillar.
2. Loosen upper hinge-to-door cap screws slightly. Access to one cap screw at door upper hinge is gained after removing plug from door inner panel.

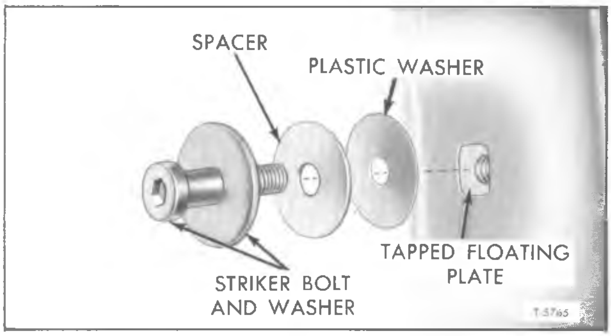


Figure 8—Door Striker Bolt and Washers

3. Lift upward or pull downward at rear of door to tilt upper portion of door "fore" or "aft" as desired.

4. Tighten hinge cap screws firmly after making adjustment. Open and close door to check operation. Repeat adjustment if necessary. Install cap screw access plug in door inner paneling.

5. Install striker bolt and adjust as directed later under "Striker Bolt Adjustment."

REPOSITION DOOR "IN" OR "OUT" (Fig. 7)

Horizontal cap screw slots exist in cab half of hinge assembly to permit this adjustment.

The outer surface of door, when properly installed, should be flush with adjacent surfaces of cab. If necessary, reposition door as follows:

1. Loosen slightly all cap screws which attach hinge half to cab pillar.

2. If door is to be brought outward from cab opening, apply pressure at door hinge area from inside cab. If door is to be moved inward, apply pressure on door outer panel at hinge area. Be careful not to damage door paneling by applying excessive pressure.

3. After adjustment has been made, tighten hinge cap screws firmly. Open and close door to check operation. Readjust if necessary.

NOTE: It may be necessary to reposition striker on pillar after making above adjustment. See "Striker Bolt Adjustment."

DOOR STRIKER

The door striker consists of a special bolt and washer assembly which is threaded into a tapped, floating cage plate located behind the cab lock pillar as shown in figure 8. The door is secured in closed position when the lock cam in door engages and snaps-over the striker bolt. Striker bolt can be replaced or adjusted as directed under applicable headings.

STRIKER BOLT REPLACEMENT (Fig. 8)

1. Mark position of striker bolt spacer or washer on door pillar using pencil or crayon.

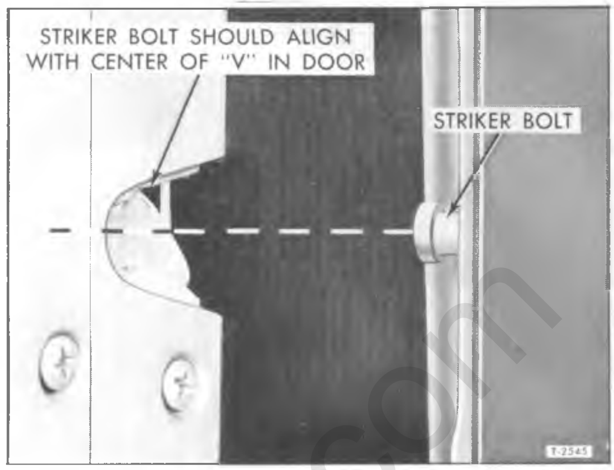


Figure 9—Sight Checking Striker Bolt Alignment

2. Insert a 5/16-inch hex wrench into head of striker bolt, then turn bolt counterclockwise from plate in cab pillar.

3. Reverse above procedure to install striker bolt. Make sure the thin plastic washer is positioned against the painted door opening pillar and center the bolt washer within marks on pillar.

4. If door has been removed and then installed or aligned in opening, the door should not be closed completely until a visual check is made to determine if lock cam in door will engage the striker bolt correctly. Center of striker bolt should be in direct alignment with "V" slot in door. See figure 9. If necessary, reposition striker bolt as directed below under "Striker Bolt Adjustment."

STRIKER BOLT ADJUSTMENT (Fig. 10)

Striker bolt on cab pillar is adjustable vertically and transversely after loosening the bolt with a 5/16-inch hex wrench. The bolt fore and aft adjustment is obtained by use of shim spacers located between the bolt washer and the cab pillar. Figure 8 illustrates location of bolt, washers, and spacer.

Striker Bolt Fore and Aft Adjustment

1. To check striker bolt for proper fore and aft adjustment, smear grease or paint to contact side of bolt as shown in figure 10.

2. Slowly close door until lock cam of door just contacts the side of striker bolt and makes an impression in the grease or paint.

3. Measure distance between head of bolt and the cam impression in grease. Distance should measure 1/8-inch as shown in right view of figure 10. This dimension is necessary to assure that the head of striker bolt will ride at center of nylon shoe which is located just in back of the lock cam.

To obtain this dimension, remove the striker bolt and install or remove shim spacers. Spacers

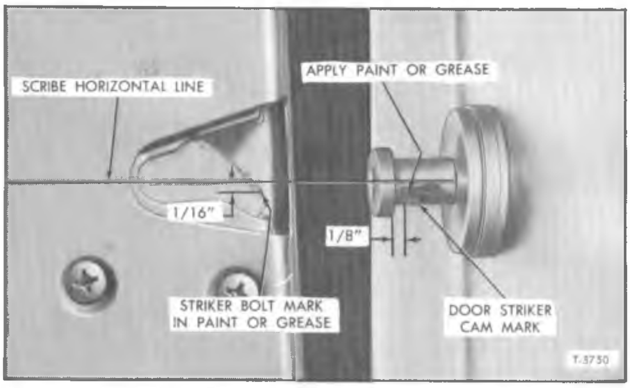


Figure 10—Striker Bolt Alignment

are available in two thicknesses: 5/64-inch and 5/32-inch. Make sure the thin plastic washer is located next to cab pillar.

After obtaining proper fore and aft adjustment, tighten bolt snug only at this time and then proceed with the "Striker Bolt Height Adjustment."

Striker Bolt Height Adjustment

This adjustment is important to assure that the right proportion of door's weight will rest on striker bolt when door is closed. If bolt is positioned too high on pillar, rapid wear will occur to the lock cam: if too low, an extra load will be placed on door hinges as well as pull door downward and out of alignment.

Generally the striker bolt height adjustment can be checked quite accurately by just sighting the center of "V" slot on door with the center of striker bolt as illustrated in figure 9. However,

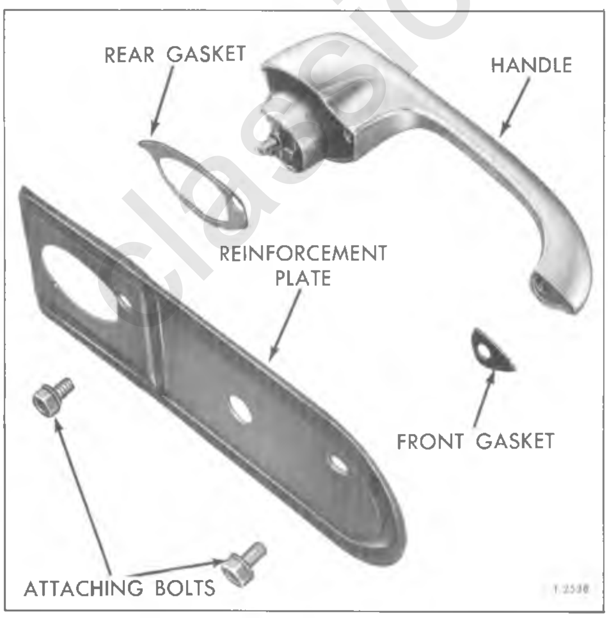


Figure 11—Door Handle Installation

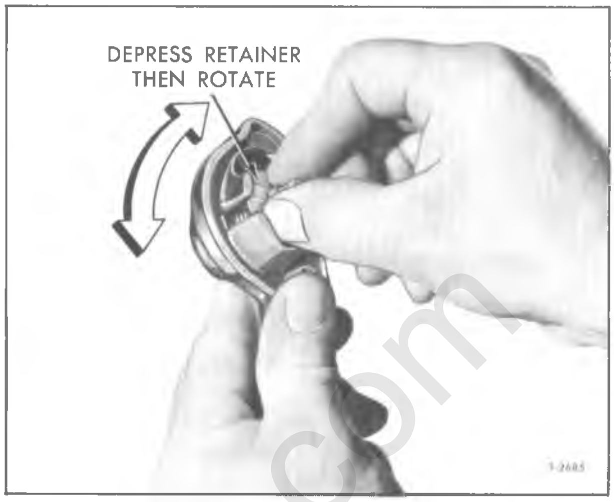


Figure 12—Disengaging Handle Spring Retainer

to make a more positive check, perform the following:

1. Mark a horizontal line through center of "V" slot and on door lock cam as shown in left view of figure 10.

2. Smear some grease or paint on contact edge of lock cam as shown in same view.

3. Slowly close door until cam barely contacts the striker bolt to leave an impression in grease. Open door and check contact mark on edge of cam. Mark should be located approximately 1/16-inch below the horizontal mark if properly aligned.

4. If necessary, raise or lower the loosened striker bolt up or down by tapping on the washer or spacer at base of striker bolt. DO NOT TAP ON HEAD OF BOLT.

Door Rear Edge "In" or "Out" Adjustment

This adjustment is for purpose of aligning the rear surface of door flush with adjacent surfaces of cab. If surfaces are not flush, proceed as follows:

1. Mark a horizontal line on cab pillar at top of striker bolt base washer or spacer.

2. Loosen striker bolt slightly, then tap against bolt base washer, to move bolt "in" or "out" as necessary to locate door surface flush with cab surface when door is closed. Before tightening the striker bolt make sure top bolt base washer is contacting the horizontal mark on cab pillar. Final tighten striker bolt.

DOOR OUTSIDE HANDLE REPLACEMENT

REMOVAL

1. Remove eight screws which attach access panel to lower portion of door. Remove access panel.

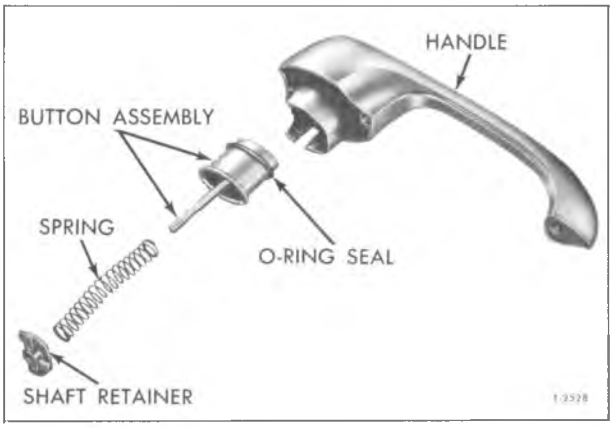


Figure 13—Door Handle Components

2. Roll door glass to top, then through access opening, using a 7/16" wrench, remove two bolts which attach door handle to door outer panel. Remove handle and handle gaskets (fig. 11).

NOTE: Reinforcement plate is spot-welded to inside of door outer panel.

3. Remove the button shaft retainer by first depressing, then rotating retainer as shown in figure 12. Remove shaft spring and button assembly with O-ring seal from handle (fig. 13).

INSTALLATION

1. Place button assembly with installed O-ring seal in handle.
2. Locate spring over button shaft, then install spring retainer (fig. 12).
3. Position door handle with gaskets to door outer panel, then through access opening at bottom of door, install two attaching bolts.
4. Install access panel to bottom of door.

DOOR LOCK CYLINDER REPLACEMENT

REMOVAL (Fig. 14)

1. Remove access panel at bottom of door.

2. Through access panel opening, pull lock cylinder retainer from beneath the lock cylinder grooves by grasping retainer lip with pliers.

3. Tilt lock assembly to permit cylinder lug to disengage from lock mechanism lever. Remove lock cylinder and gasket from door.

INSTALLATION (Fig. 14)

1. With gasket in position on lock cylinder, insert cylinder in door and engage lug over lock mechanism lever.
2. While holding cylinder, insert legs of retainer into grooves of lock cylinder body. Be certain legs of retainer are fully engaged. It may be necessary to drive retainer into final engagement with a light hammer.
3. Insert key and check operation of lock. If lock operates freely, install lower access panel to door.

Figure 14—Door Lock Cylinder Replacement

DOOR INSIDE HANDLE REPLACEMENT

Window regulator crank handle and door lock handle are retained on shafts by lock springs. If

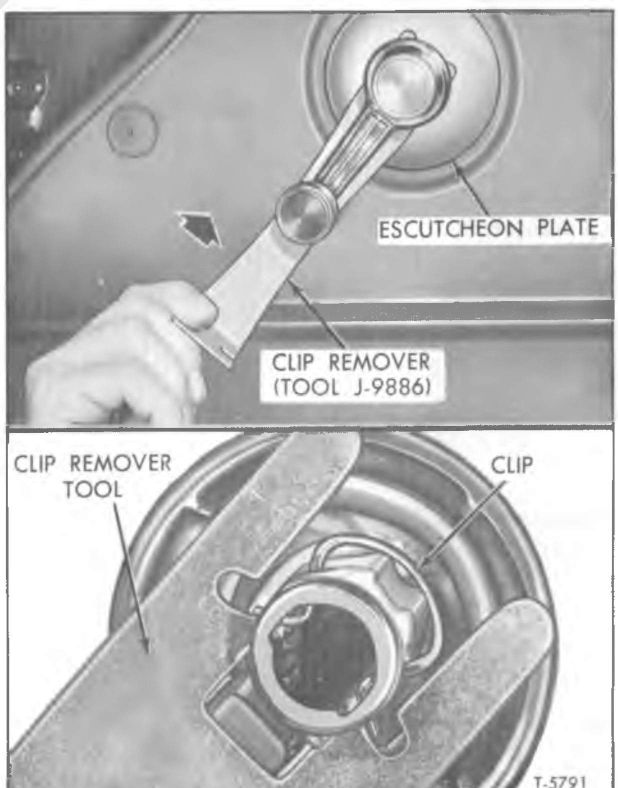
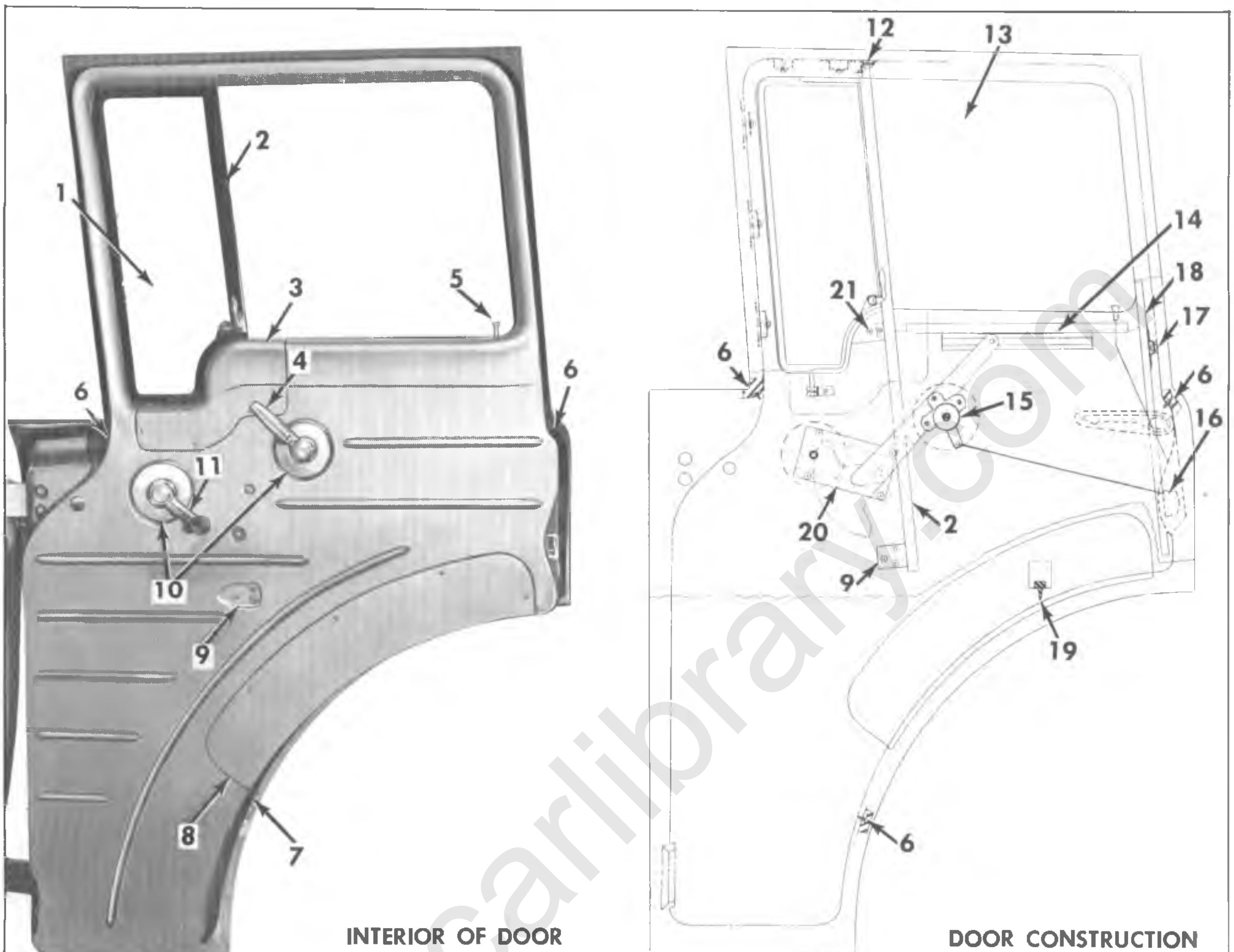


Figure 15—Disengaging Door Inside Handle



1 Vent Window Glass
2 Division Channel
3 Access Panel
4 Remote Control Handle
5 Inside Lock Knob
6 Weatherstrip Seal Clip and Screw
7 Weatherstrip Seal
8 Access Panel
9 Division Channel Lower Attaching Screws
10 Escutcheon Plates
11 Regulator Handle
12 Division Channel Upper Attaching Screws
13 Door Window
14 Sash Channel
15 Door Lock Remote Control Assembly
16 Door Lock Mechanism
17 Run Channel Retainer Screw
18 Run Channel Retainer
19 Door Window Stop Bumper
20 Window Regulator Assy.
21 Division Channel Center Attaching Screw

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Figure 16—Door Construction

removing door lock inside handle, the handle position should be marked in relation to door panel to assure that handle is installed later at the same operating angle.

REMOVAL (Fig. 15)

1. Insert tool (J-9886) between handle flange and escutcheon plate.
2. Force lock spring from grooves in base of handle. DO NOT LOSE SPRING. Remove handle and escutcheon plate.

NOTE: The lower view in figure 15 shows how the tool engages the clip at underside of handle when removing. Clip may be installed in opposite direction than shown.

INSTALLATION

1. Insert lock spring in handle grooves.
2. Place the escutcheon plate on handle spindle.
3. If installing door lock handle, make sure handle is in position previously marked on door inner panel. To install either handle, force handle with installed lock spring over spindle until lock spring becomes fully engaged.

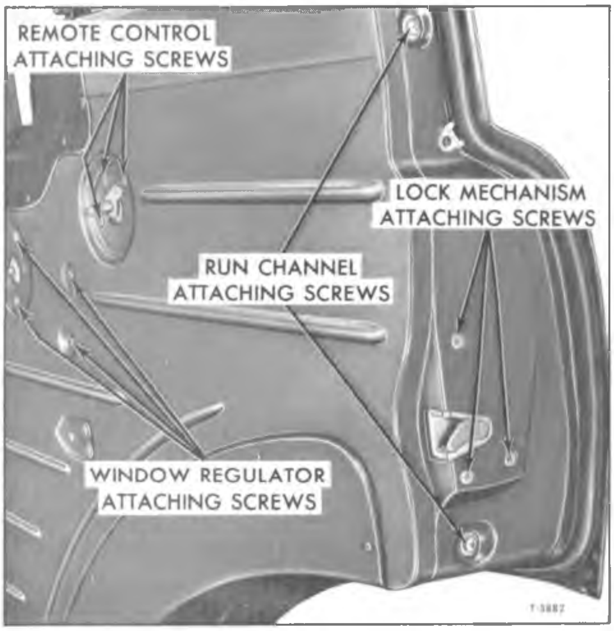


Figure 17—Door Lock Attaching Screws

DOOR LOCK AND REMOTE CONTROL MECHANISM REPLACEMENT

NOTE: Figure 16 illustrates the position of the lock and remote control mechanism components.

REMOVAL (Fig. 17)

1. Remove the door inside lock knob which is threaded on lock rod.
2. Remove the lower access panel from door inner panel as directed previously.
3. Raise window and then remove the door inside handle as directed previously.
4. Remove three screws which attach remote control to door inner panel. Lower control to door access opening, then disengage fastener at pull-rod. Separate rod and remove control from door.
5. Remove the lock cylinder assembly from outer side of door as directed previously.
6. At rear edge of door, remove two run channel retainer screws to provide clearance for removal of lock mechanism.
7. At rear edge of door, remove three special locking-type screws which attach lock mechanism to door frame. Lower the lock and attached two rods out through access opening in door.
8. Separate rods from lock mechanism by disengaging fasteners.

INSTALLATION (Figs. 16 and 17)

Install lock mechanism with rods and remote control in reverse of the "Removal" procedures.

IMPORTANT: Make sure to use the three special locking-type screws which attach lock mechanism to door frame. Check operation of door lock and remote control mechanism after installation. As required, remote control unit may be shifted slightly on door inner panel to obtain satisfactory lock operation.

Figure 18—Removing Regulator Arm from Track

DOOR WINDOW REGULATOR REPLACEMENT

REMOVAL

1. Remove access panel from lower portion of door.
2. Lower window and remove window regulator handle and escutcheon plate.

Figure 19—Lowering Regulator from Door

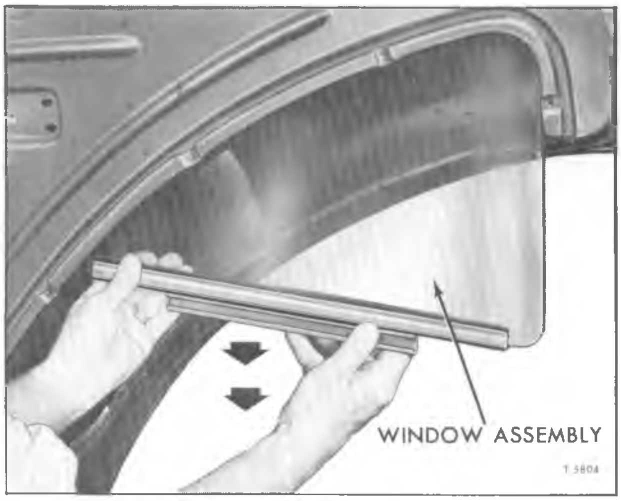


Figure 20—Removing Door Window Glass

3. While holding regulator assembly through opening in door, remove four screws (figs. 16 and 17) which attach regulator assembly to door inner panel.

4. Guide regulator arm to remove roller from window channel track (fig. 18). Carefully lower regulator assembly from door (fig. 19).

INSTALLATION

Install door window regulator in reverse order of "Removal" procedures. Before installing access door, operate window regulator to be sure roller is not binding in window channel track. If binding occurs, bend window regulator arm slightly until roller turns freely in channel. Also, check division and run channels for alignment.

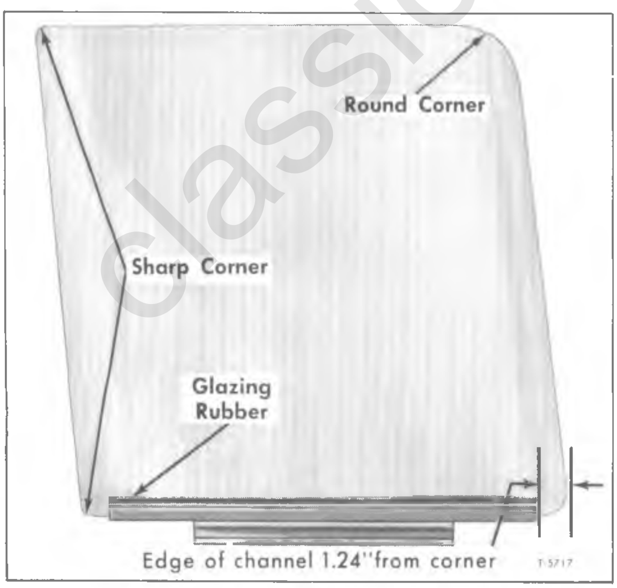


Figure 21—Door Glass Assembly (Right Side Shown)

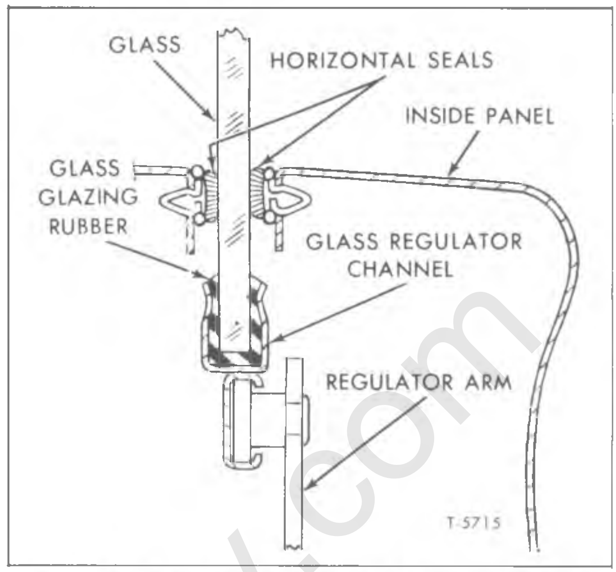


Figure 22—Cross Section of Window Regulator Channel

DOOR WINDOW GLASS REPLACEMENT

REMOVAL

1. Remove access panel from door inner panel below vent window.

2. Unlatch vent window and swing outward.

3. Remove five screws which attach access trim panel to door just below vent window.

4. Remove frame to door screw and frame to divisional channel screw (fig. 16).

5. Remove three division channel lower attaching screws (fig. 16).

6. Remove division channel screws at top of door (fig. 16).

7. Remove two screws at edge of door which attach run channel to door (figs. 16 and 17).

8. Lower window and remove window regulator assembly as described previously (figs. 18 and 19).

9. Tilt and lower glass assembly through lower access opening (fig. 20).

INSTALLATION

1. Squirt gasoline along glass filler on both sides of glass to soften seal. Remove glass from channel when filler is sufficiently soft.

2. Thoroughly clean inside of glass channel by removing all rust and old glazing rubber filler.

3. Cut new piece of glazing rubber filler to length of glass regulator channel.

4. Position glazing rubber filler (soapstone side away from glass) on bottom edge of glass 1.24-inch from lower corner as shown in figure 21.

5. Carefully position edge of glass regulator channel 1.24-inch from lower right corner (fig. 21) and then press channel over glass and glazing

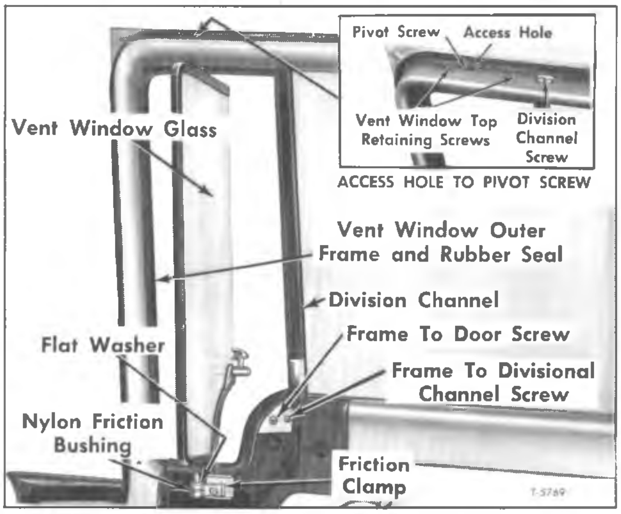


Figure 23—Door Vent Window Installed

rubber filler. Lightly tap channel with rubber hammer to firmly seat channel over glass and filler.

6. Install assembled window into door in reverse order of "Removal" procedures.

NOTE: When inserting glass assembly into door run channels, be careful not scratch or place undue stress on glass. After installation, raise and lower window to check for binding. If binding occurs, adjust appropriate run channels by loosening applicable channel attaching screws.

DOOR WINDOW GLASS HORIZONTAL SEALS REPLACEMENT

1. Remove access panel from bottom of door. This will remove window stop attached to access panel and allow top of window to be lowered to a point below horizontal weatherstrips.
2. Using a flat-blade screwdriver, pry weatherstrips from door (fig. 22).
3. Install weatherstrips to door, making sure retaining clips are fully engaged.
4. Raise window, then install access panel to bottom of door.

DOOR WINDOW RUN CHANNEL REPLACEMENT

1. Remove door window as explained previously under "Door Window Glass Replacement."
2. Remove applicable screws which attach either division channel or run channel to door framing (fig. 16) and lower channel(s) through access opening at bottom of door.
3. Install channel(s) in reverse order of removal procedures.

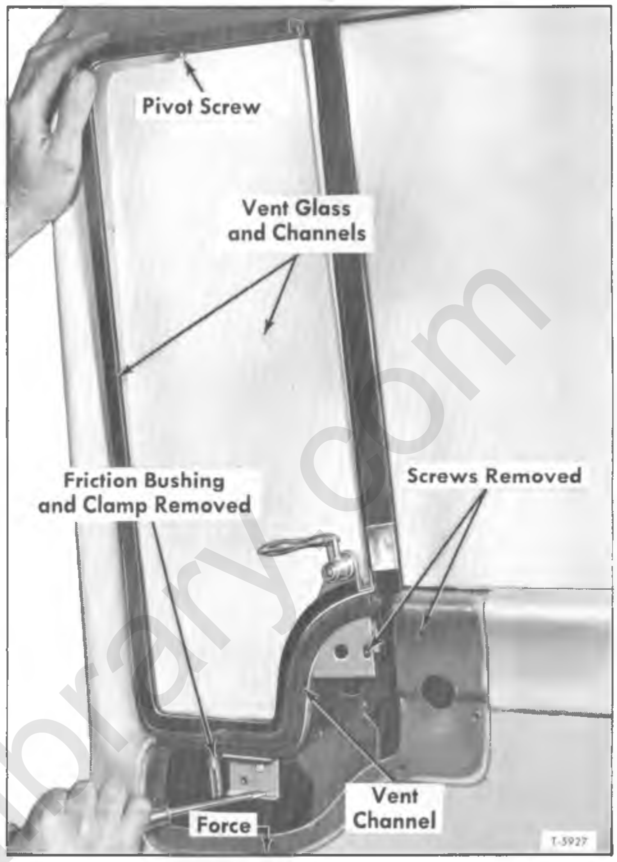


Figure 24—Removing Vent Window

4. Install and adjust window glass as explained previously under "Door Window Glass Replacement."

DOOR VENT WINDOW TENSION ADJUSTMENT

Cab vent windows are of friction type having a positive theft-resistant latch. Friction mechanism consists of a bushing attached at lower end of vent shaft which rotates in a stationary friction clamp.

If friction mechanism is adjusted too tight, it will be difficult to open or close vent. Too loose an adjustment will result in a fluttering vent or one having a tendency to close with wind pressure.

If necessary to change vent friction, perform procedures as follows:

1. Remove access trim panel attached to door just below vent window with five screws. Figure 23 shows access opening to friction components.
2. Using screwdriver, turn clamp screw (fig. 23) to obtain two to four pounds torque while moving vent window from a ten-degree open position to a full-open position. Use either a push or pull-type spring scale positioned at rear edge of glass.

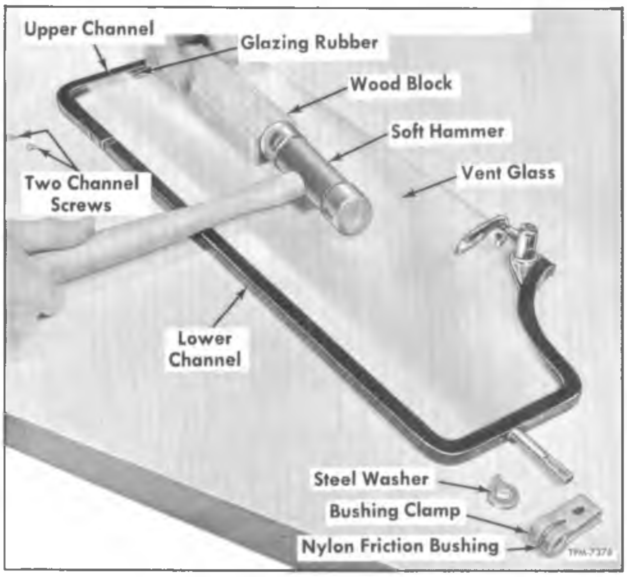


Figure 25—Vent Window Disassembled

3. After obtaining proper tension, install access trim panel.

DOOR VENT GLASS REPLACEMENT

REMOVAL

1. Remove small access panel from inner side of door below vent window.

2. At bottom of vent glass (fig. 23), place hand to catch vent friction components, then remove screw from friction clamp. Slide clamp, friction bushing, and flat steel washer from vent shaft.

3. At top of door through small access opening (see inset, fig. 23), turn vent upper pivot screw from vent frame.

NOTE: Screw need not be removed completely, just enough to become disengaged from vent glass channel.

4. Remove three screws which attach division channel to vent channel just below vent latch. Using a screwdriver, pry down on vent channel as shown in figure 24, which will cause upper part of channel to become disengaged from pivot screw. Rotate glass channel lower pivot shaft up out of vent channel.

5. Remove two screws which attach glass upper channel to glass lower channel (fig. 25).

6. Apply gasoline on vent glazing rubber to soften old rubber. When rubber softens sufficiently, separate upper and lower glass channels, then remove old glass.

INSTALLATION

1. Thoroughly clean inside of glass channels to remove old glazing rubber, rust, or other foreign matter.

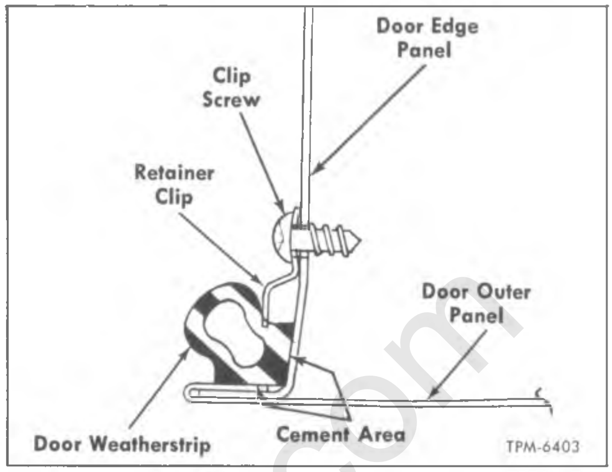


Figure 26—Door Weatherstrip Installed

2. Position new glazing rubber (soapstone side away from glass) around edge of glass. Press glass with glazing rubber into lower channel, then press upper channel over top of glass. Make sure channels are firmly seated, then install two small screws which attach channels together (fig. 25).

3. If necessary, trim glazing rubber at ends of channels and along sides of channel each side of glass. As required, seal cracks at latch bracket.

4. Insert pivot stud of vent lower channel into hole of vent frame as shown in figure 24. Through small access hole at top of door, install vent upper pivot screw. Install three screws which attach bracket of vent channel to glass division channel just below vent latch.

5. Install special flat washer, nylon friction bushing, and friction clamp on vent lower channel pivot shaft, positioned as shown in figure 23.

NOTE: Make sure that tab on special flat washer is positioned properly to act as a stop of vent when it is in full open position. Attach friction clamp to vent lower frame with screw. Tighten screw to obtain two to four pounds torque while moving vent window from a ten-degree to a full-open position. Use either a push or pull type spring scale positioned at rear edge of glass.

6. Install access panel to inner side of door.

DOOR WEATHERSTRIP REPLACEMENT

1. Remove screw-retained clips from weatherstrip around perimeter of door. Figure 26 shows view of weatherstrip installed at retainer.

2. Pull weatherstrip from door, then scrape any rubber or adhesive material which may have become bonded to door surface.

3. Apply coat of weatherstrip adhesive to seal and seal surfaces of door as directed by manufacturer of adhesive. Directions for application are usually found on adhesive container.

4. Position seal around perimeter of door, making sure corners of seal engage respective corners of door.

5. Install screw-retained clips (fig. 26) to door and weatherstrip. Tighten clip screws firmly but be careful not to tear weatherstrip.

CAB VENTILATION AND HEATING

VENTILATION

A single grilled intake at front center of cab (fig. 26) permits outside air to enter plenum chamber located between the cab outer and inner panels. From the plenum chamber, outside air can be directed into cab interior through opening at front of driver and through opening at front of passenger. When heater is used, the outside air enters heating system through the right side opening.

The outlet located ahead of driver is opened and closed manually by control knob on dash. The control knob pushed inward closes outlet door and pulling out on knob opens outlet door. A spring-loaded door prop retains door snug in either the fully opened or closed positions. A rubber seal around perimeter of outlet door provides positive sealing of outlet. Seal, which is glued to door, can be readily replaced if necessary.

Figure 27—Outside Air Intake

CONTROL ADJUSTMENT (DRIVER"S SIDE)

NOTE: Refer to inset of figure 27.

When control knob on dash is pushed completely in, the air outlet door should close snug to outlet opening.

If door is not seated completely with control knob in this position, loosen screw at control conduit clamp above door which will allow compression spring within door telescopic prop to force door tight to opening. Retighten clamp screw after making adjustment.

HEATING

The heater is of the water valve temperature control type (fig. 28) and is serviced in same manner as "Air-Flow Heater" described previously under "Conventional Model Cabs."

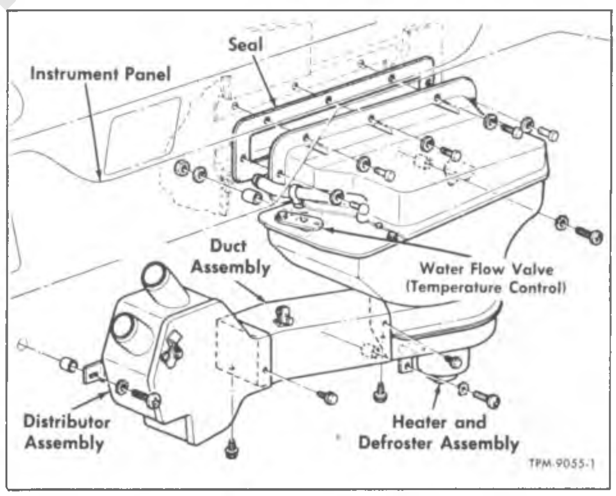


Figure 28—Heater Installation

CAB REPLACEMENT

Necessary equipment for efficient and safe replacement of cab consists of a chain hoist (1-ton minimum capacity), a sling having padded hangers, and two or more support blocks to rest cab on when it is removed from chassis.

NOTE: A wood 4 x 4, 7½ feet long positioned through cab door openings with a hoist chain attached securely to each end can be used. However, means of protecting top of cab from chain must be provided. Also, be sure to provide padding at points where beam contacts cab openings and carefully position beam to assure proper cab support.

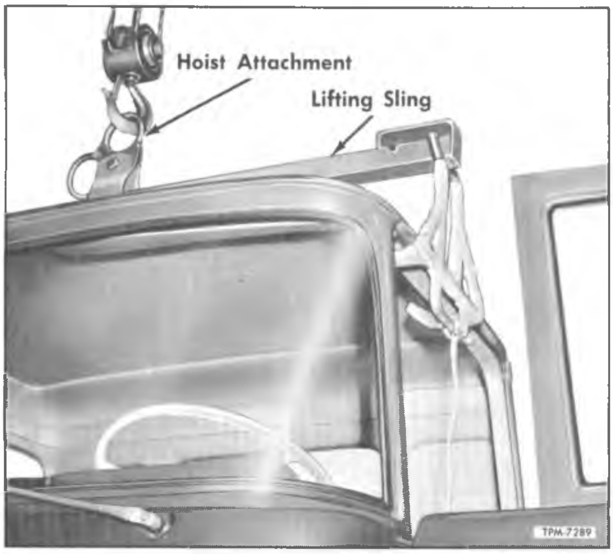


Figure 29—Lifting Sling Attached to Cab

CAB REMOVAL

1. Disconnect battery ground strap.
2. On vehicles with air brakes, exhaust air supply from air tank at drain fitting. Remove bumper (with attached air tank, if used).
3. Open heater temperature control on dash to full open position, and drain radiator. Disconnect heater hoses at cab connections.
4. Disconnect accelerator linkage and steering flexible coupling, marking for later alignment. Disconnect brake lines and clutch line.
5. Disconnect speedometer cable and all electric connectors that junction cab with the chassis. Remove cab-to-chassis ground straps.

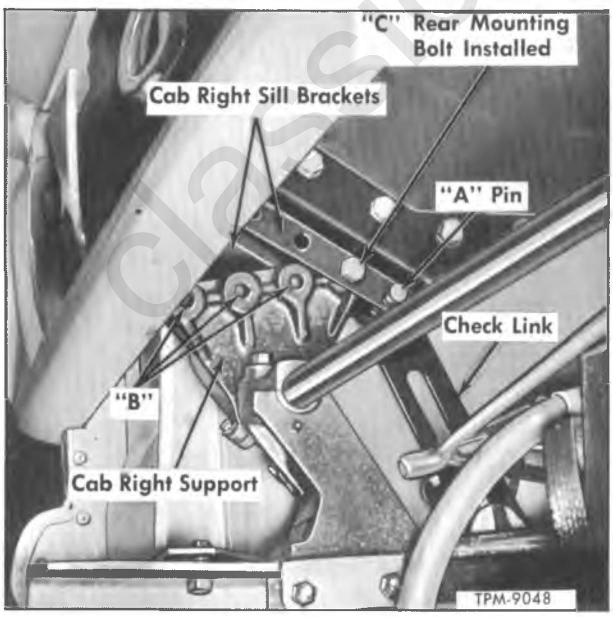


Figure 30—Mounting at Cab Rear Support

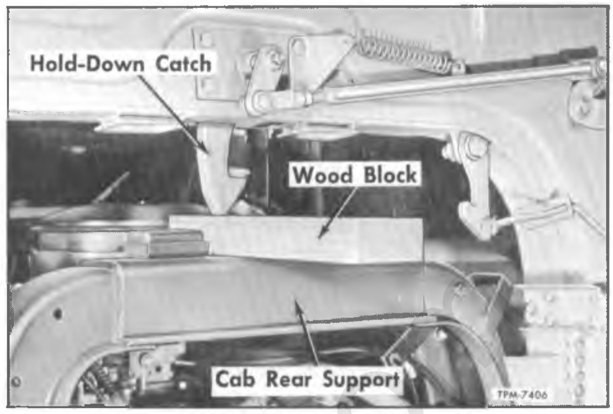


Figure 31—Rear Hold-Down Catch on Wood Block

NOTE: REMOVE OR SECURE ALL LOOSE ITEMS IN CAB BEFORE TILTING. PLACE SHIFT LEVER IN NEUTRAL AND THE HAND BRAKE IN FULL-APPLIED POSITION.

6. Attach a suitable padded lifting sling (fig. 29) to cab with doors partly open (lifting cab with doors closed will disturb door alignment later).
7. Using aid of assistant and hoist, tilt cab approximately 45^{O} to the unloaded position of cab mounting torsion bar (refer to preceding caution) and suspend safely there. While cab is in this position, insert a pry bar in between cab right support and cab sill. Remove three forward bolts, lock washers and nuts from cab right support to sill brackets (B, fig. 30). Use pry bar to assist in removing bolts. Disconnect check link at right side of cab.
8. Place a short piece of wood 2" x 4" over catch hole in cab rear support (fig. 31), then with aid of assistant, lower cab until catch at bottom of cab rests on block. This will prevent engagement of cab hold-down catch. Remove two retaining bolts from torsion bar at cab left support and remove support cap. Raise cab slightly, and remove rear mounting bolt (C, fig. 30) attaching right support to sill brackets.
9. Raise cab slightly to clear cab lift mechanism, then forward and up to clear shift control panel. Figure 32 shows cab and chassis disconnect points.
10. Lower cab onto suitable blocks, then remove chainfall and lifting sling.

NOTE: Left support can be removed from cab, if desired.

CAB INSTALLATION

1. Install lifting sling and chainfall to cab with doors slightly open (fig. 29).

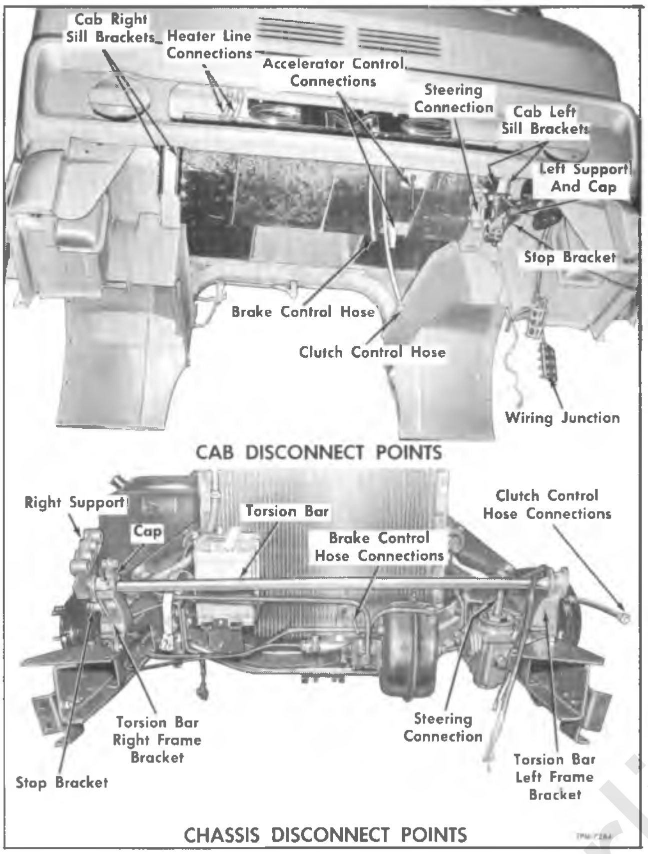


Figure 32—Cab and Chassis Disconnect Points (Typical)

2. Raise cab and install support (if previously removed) loosely to cab left sill brackets.

NOTE: Cab tilt torsion bar, check link, and right cab to sill support should be in position on chassis as shown in lower view of figure 32.

3. Raise cab over chassis and lower into position, forward slightly to clear shift control panel, then back and down until steering gear coupling can be engaged using marks made previously for proper alignment.

4. Finish lowering cab until left support rests on torsion bar. Install support cap with two bolts, torque bolts to 50-60 foot-pounds.

5. Install check link retaining clevis pin with cotter pin (A, fig. 30). Install bolt (C, fig. 30) into rear hole of cab right sill brackets and support.

6. Insert a pry bar in between cab right support and cab sill.

7. With two assistants, one holding pry bar and the other helping to tilt cab forward (approximately 45 degrees), install the three remaining bolts, lock washers, and nuts (B, fig. 30) in the right cab support and sill brackets. Use pry bar to align bolt holes. Torque bolt nuts to 40-50 foot-pounds.

8. Tighten steering coupling clamp bolt to 40-50 foot-pounds torque. Connect speedometer cable

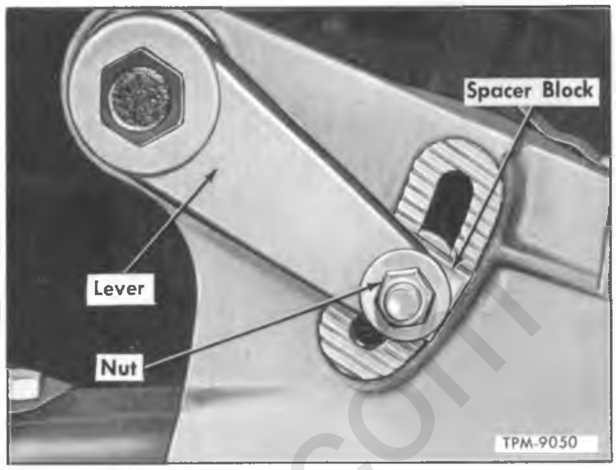


Figure 33—Torsion Bar Tension Adjustment Lever Installed

and all electric connectors that junction with the cab-to-chassis.

9. Connect accelerator linkage and adjust as outlined under ENGINE FUEL SYSTEM (SEC. 6M). Connect all ground straps.

10. Connect brake lines and hoses. Bleed the brakes as outlined under "HYDRAULIC BRAKES" (SEC. 5A) if equipped with hydraulic brakes.

11. Connect clutch flexible line and bleed as outlined under "CLUTCH CONTROLS" (SEC. 7D).

12. Connect heater hoses and fill radiator.

13. Install bumper to front of frame. If vehicle is equipped with air brakes, connect air lines.

14. Check cab tilting and lock action.

TILT CAB TORSION BAR REPLACEMENT

A chain hoist and a lifting sling are required to properly replace cab torsion bar as the weight of cab must be removed from bar. Also, the aid of one or more assistants is recommended.

REMOVAL

Instructions below pertain to cab replacement procedures when cab is tilted (approximately 45 degrees) and suspended safely with weight of cab removed from chassis. A chain from hoist hook, down over rear center of cab and attached to cab rear hold-down catch will assist in maintaining cab safely at a 45-degree angle.

IMPORTANT: Protect top of cab from damage by hoist equipment.

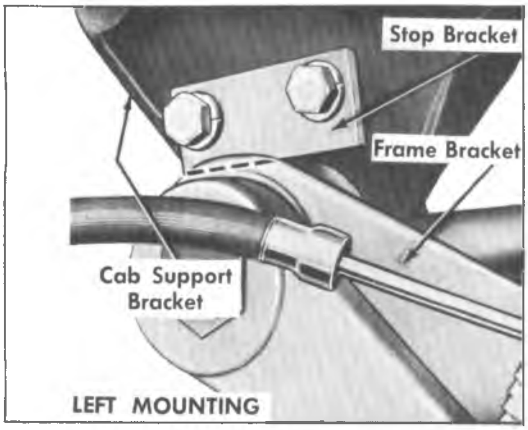
1. Secure hoist sling at rear of door openings.

2. Remove weight of cab from chassis.

3. Remove two retaining bolts from mounting cap at torsion bar right frame bracket and from support cap left support.

4. Remove bolt, nut, and washers which attach torsion bar anchor lever to cab mounting left

TILT CAB



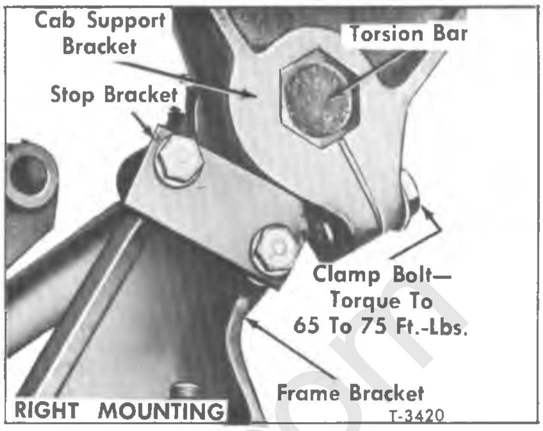


Figure 34—Cab Torsion Bar Stop Brackets Installed

frame bracket. Remove arm from bar and bracket.

5. Loosen cap screw which clamps cab right mounting bracket to right end of torsion bar.

6. Slide torsion bar from cab right frame bracket, then slide bar in opposite direction from cab left support.

CAUTION: DO NOT hammer on end of bar.

INSTALLATION

1. Before replacement of torsion bar, inspect frame brackets (castings) and cab supports (castings) for cracks. DO NOT WELD OR BRAZE BRACKETS. If cracked, replace.

2. Prelubricate left frame bracket opening and right frame bracket. Slide hex end of torsion bar into left frame bracket, then insert opposite end into cab right support.

3. Install torsion bar anchor lever over end of bar and into frame bracket.

NOTE: Lever should be located on bar so that opposite end of anchor lever is located near center of serrations on cab bracket (fig. 33).

4. Install cab stop brackets (if previously removed) to torsion bar cab and frame brackets as shown in figure 34. Torque attaching bolts to 35 to 50 foot-pounds. Make sure stop brackets are installed as shown.

5. Install torsion bar right frame bracket cap and cab left support cap with two bolts and washers. Torque bolts to 50-60 foot-pounds.

6. Tighten bolt which clamps cab right mounting bracket to end of torsion bar (fig. 34) to 65-75 foot-pounds.

7. Lubricate all cab tilt lubrication fittings with lubricant specified in LUBRICATION (SEC. 0).

8. Raise and lower cab to check operation. If cab rises too fast from operating position or if considerable effort is required to raise cab, make torsion bar tension adjustment as directed under "Torsion Bar Tension Adjustment."

TORSION BAR TENSION ADJUSTMENT

1. Tilt cab forward to an angle whereby the torsional load is removed from torsion bar. Usually the bar will become unloaded when cab is tilted 45 to 50 degrees. This unloaded angle position may vary slightly on different vehicles.

IMPORTANT: Before continuing, check tightness of screw which clamps cab right mounting bracket to torsion bar. Tighten screw firmly ONLY when torsion bar is unloaded - cab tilted part way. If screw is loose, cab bracket may fracture when torsion bar is loaded.

2. SAFELY support cab at angle at which torsion bar becomes unloaded. An overhead hoist is recommended for supporting cab in this position as it will allow cab to tilt slightly fore or aft to facilitate alignment of torsion bar anchor lever to cab frame bracket.

3. Loosen nut on bolt which attaches the anchor lever and serrated spacer block to the cab frame bracket (fig. 33). Loosen nut only enough for spacer to clear serrations.

4. By tilting cab slightly fore and aft, the small serrated spacer block can be relocated to new related serrations on cab frame bracket as desired.

5. Tighten anchor bolt nut to 80-90 foot-pounds.

6. Check cab tilting action. If necessary, reposition anchor point of torsion bar anchor lever as directed above.

NOTE: If adjustment is such that cab rises rapidly to full-tilt position, damage to cab check link could occur and also upon lowering of the cab to operating position, considerable effort may be required.

IMPORTANT: Final check tightness of anchor lever bolt nut.

Body Mountings

PLATFORM BODY MOUNTINGS

Before any body mounting is attempted, this section should be studied carefully and the recommendations followed as closely as possible.

When mounting bodies, certain important procedures should be followed. Unless such practices are followed, strains of load and chassis weave may not be distributed correctly, causing damage to body or frame.

IMPORTANT: Avoid drilling additional holes in frame for mounting bolts. Use existing holes if possible; if additional holes are necessary, close unused holes by welding.

LONGITUDINAL SILL MOUNTING

If body is equipped with longitudinal sills, observe following standard practices.

1. Wooden longitudinal sill should rest directly on top flange of chassis frame side rail. If projecting rivet heads prevent a solid bearing, countersink longitudinal sills just enough to clear rivet heads.

IMPORTANT: Do not use spacers to raise sills above rivet heads. If body longitudinal sill is of metal, it will be necessary to use a one-piece full length hardwood strip, with holes to clear rivet heads between body sill and frame rail. Wood strip should be firmly fastened to body sill.

2. Sill should extend as close as possible to back of cab without interfering with mounting or movement of cab.

3. Make sure height of sill is sufficient to prevent body from striking tires, or other parts of chassis, with maximum spring deflection. Take into consideration full load operation over extremely rough terrain.

4. Sill must rest squarely on frame flange and not overhang outside of frame. If sill width does not cover entire width of frame, install a spacer block as shown in figures 1 and 2. Blocks should

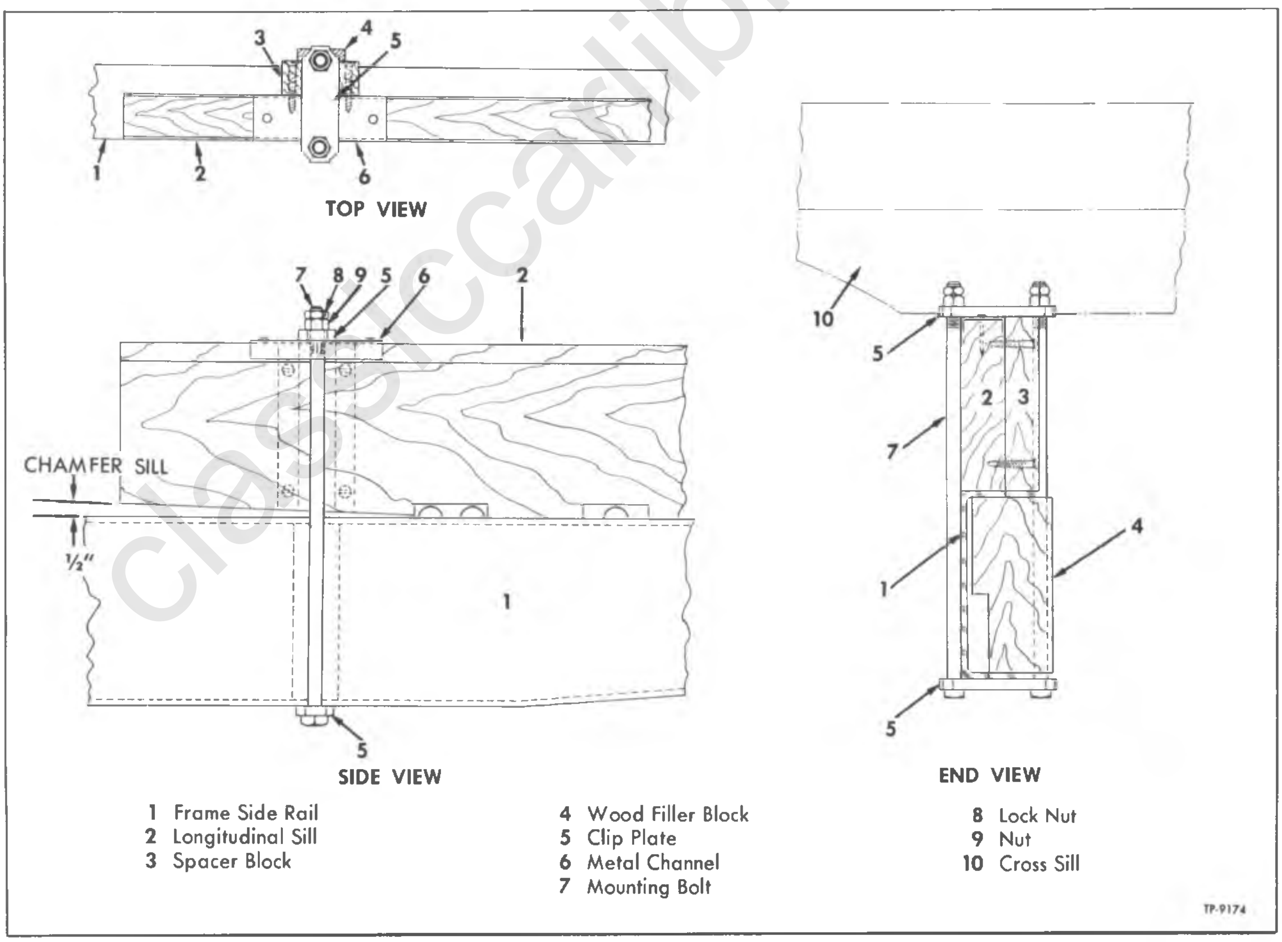


Figure 1—Typical Body Mountings

BODY MOUNTINGS

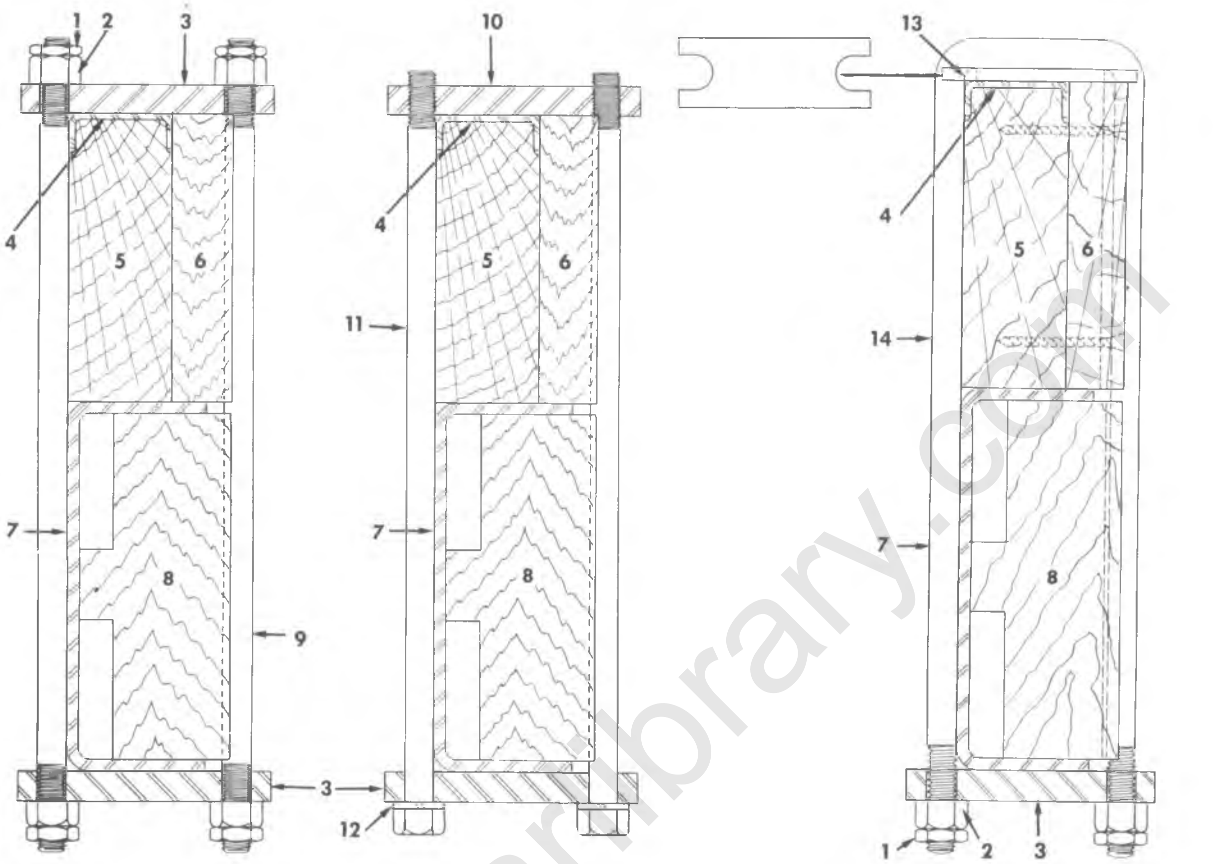


Figure 2—Recommended Methods of Mounting Body

extend beyond width of frame flanges to permit grooving blocks to maintain position of mounting bolts. If desired, block can be attached to sill with screws as shown in figure 2.

Wood grain of block should be perpendicular (up and down) to grain of sill.

5. Wood sills must be chamfered 1/2" at the front end, tapering to meet the frame 12 to 18 inches from end of sill (fig. 1). Tapered front of sill is required for all Van or torsionally rigid bodies. Notch or spot drill sill to clear the rivet heads.

6. To prevent mounting clip plate becoming embedded in longitudinal sill, install a sheet metal channel on top of sill at each mounting point (figs. 1, 2, and 3). Rabbet grooves along each side of top edges of longitudinal sills to permit flush mounting of sill channels.

MOUNTING BOLTS

1. Install one mounting near front end of sill, one near rear end of sill, and space others as nearly equal as possible between front and rear mountings. It may be necessary to vary distances to clear chassis brackets, etc., but approximately equal spacing should be maintained.

2. Use two bolts or studs of proper length with a diameter of at least 7/16" and preferably 1/2" for each mounting. Use a clip plate, of same thickness as diameter of bolts, at upper and lower end of bolts. Use at least three, and preferably four mountings on each side.

3. Hex head bolts are preferred for body mountings; however, carriage bolts, U-bolts, and threaded rods (studs) can also be successfully employed. If design of body does not permit use

of nuts at top of sill, tapped plate, as shown in figure 2 can be used.

4. Insert a block of hard, dry wood (with grain running up and down) in channel of frame at each mounting. Block must be of sufficient length to extend well under clip plates. Thickness of block should extend beyond width of frame flanges to permit grooving the blocks. Inner mounting bolt will fit into groove and hold block firmly in place (fig. 1 or 2).

5. If shoulder on bolt head is square, as on carriage bolts, the holes in upper clip plates should also be square. Shoulder of bolts should be driven into holes to prevent bolts turning. If U-bolts are used, bolt must be of "flatted" type as shown in figure 2. A clip or spreader must be used on each U-bolt, and bolt must not be used in reverse of position shown in figure 2.

6. Use two nuts on threaded end of each bolt. Tighten inner nut firmly, then tighten outer (lock) nut firmly against inner nut. DO NOT USE SINGLE NUT AND LOCK WASHER. However, lock washer should be used with tapped plate type of mounting.

CROSS SILL MOUNTING

If body is not equipped with longitudinal sills, attach sills, if possible, as shown in figure 3, since mounting on cross sills (bolsters) is not recommended. Longitudinal sills can be easily made of dry hardwood and attached to either wood or metal cross sills by means of angle irons and bolts. General practice of body mounting is on longitudinal sills; however, where the conditions necessitate mounting directly on cross sills, the following practices should be observed:

1. Sills must rest squarely on frame top flange. Countersink sill, if necessary, to clear rivet heads -- do not use spacer.

2. Use same type of mounting bolts and clip plates as described in "Mounting Bolts." The number of clips to use is of course dependent upon load, body style, etc. Carriage or step bolts are useful in this type mounting, since bolt heads project above floor.

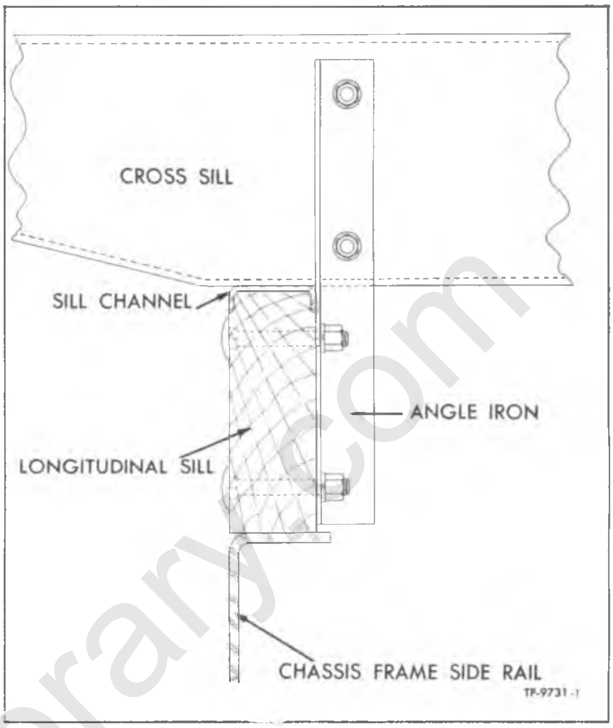


Figure 3—Method of Attaching Longitudinal Sills to Body

3. Use wood blocks in frame channel whenever mountings are used on frame. Mount clip plates diagonally across frame rail -- with one bolt forward of cross sill and inside frame rail and other bolt to rear of cross sill and outside frame rail.

4. U-bolts cannot be used with this type of mounting since mounting bolts, of necessity, project through floor or platform of body. Make sure that heads of bolts are well supported at body floor with plates or washers.

IMPORTANT

DO NOT drill additional holes in frame.

Refer to FRAME (SEC. 2) for additional cautions.

Air Conditioning

(CONVENTIONAL CAB MODELS)

This sub-section contains service information on the following:

GENERAL INFORMATION

The optional air conditioning system used on conventional cab models operates in conjunction with the heating system to cool and dehumidify the incoming air, the recirculated inside air, or a mixture of both as required for optimum driver comfort. Briefly, the air conditioning system is comprised of the following basic systems:

CONDENSING SYSTEM

This system is composed of three major units which are located behind the radiator shell sheet metal assembly. Units are described as follows:

1. The six-cylinder double-action piston-type compressor, which is belt-driven by the engine crankshaft through an electromagnetic clutch-pulley assembly. The compressor pumps refrigerant through the system as required and operates when the compressor clutch coil is energized. The compressor is equipped with an automatic high pressure relief valve to reduce excessive refrigerant pressure.

The complete compressor-clutch assembly is serviceable. The compressor, which may be removed for repairs, is mounted towards front of engine parallel to the engine crankshaft.

2. Tne condenser is a fin and tube-type core designed to change entering refrigerant vapor to a liquid by the removal of heat. The condenser is mounted in front of engine cooling radiator where it receives a high volume of air from movement of the vehicle and the engine fan.

3. The receiver and dehydrator unit, usually mounted to right side of radiator shell, is designed to store liquid refrigerant and to remove small traces of moisture that may be in system after purging and evacuating. A sight glass at the top of this component is used to observe flow of liquid refrigerant in system.

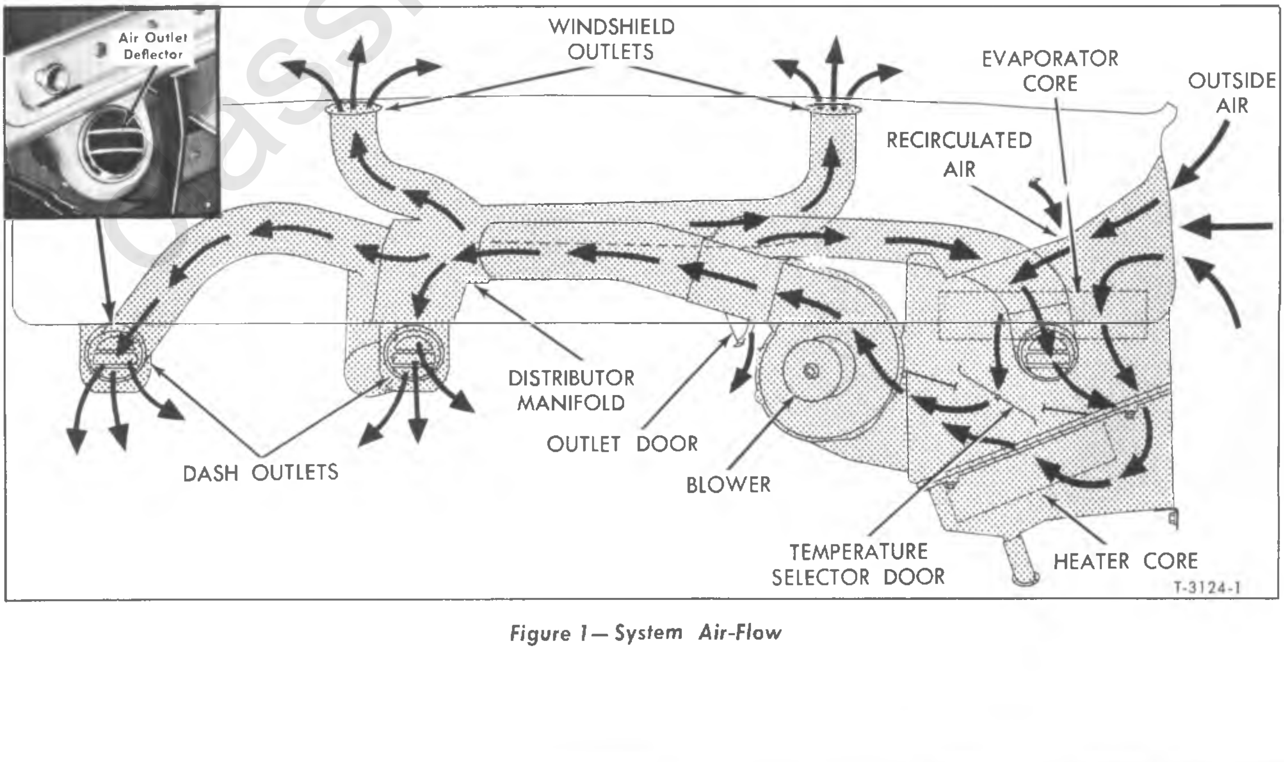


Figure 1— System Air-Flow

AIR CONDITIONING

COOLING SYSTEM

This system consists of three major components located at the cowl and dash assembly. These components are described as follows:

1. The evaporator, located under right side of dash in an enclosed housing assembly, is designed to cool, dry, and clean the air that enters the cab. Refrigerant enters the evaporator as a low-pressure mixture of liquid and vapor. The liquid vaporizes at this low pressure, absorbing large quantities of heat from air that is forced through the evaporator core fins. Thus, air directed into the cab from the evaporator will be cooled (fig. 1). Also, moisture in air that passes through the evaporator condenses on fins and is drained off carrying away dust and pollen.

2. The refrigerant expansion valve, located below evaporator core in enclosed dash housing assembly, regulates the flow of liquid refrigerant into the evaporator automatically in accordance with requirements of evaporator.

3. The suction throttling valve (S.T.V.) is designed to maintain the evaporator pressure sufficiently high to avoid freezing of moisture on evaporator core and at the same time, provide maximum cooling efficiency.

The suction throttling valve is mounted at top of enclosed dash housing assembly and is accessible after opening the dash compartment door.

AIR CIRCULATION SYSTEM

The air flow forced through the evaporator core and heater core results from the use of a multi-speed blower and motor assembly mounted at side of dash unit (fig. 1). Motor speed is controlled by a fan switch located on instrument panel (fig. 2).

NOTE: A thorough technical description of all air conditioning components is given later in this section.

OPERATING INSTRUCTIONS

DESCRIPTION OF CONTROLS (Figs. 1 and 2)

1. The "AIR CONDITION" lever, when moved to the extreme right "ON" position, energizes the compressor circuit for refrigerant flow in system. This results in cooling of air directed through evaporator core.

2. The "DEFROST" lever controls air flow to the windshield defroster ducts. When the lever is moved to the extreme right "ON" position, maximum air flow is diverted to the windshield defroster ducts.

3. The "TEMP" lever directs air flow through either the heater core, the evaporator core, or through both. Lever may be set at any position between "COOL" and "HOT" to control temperature of air circulated through cab.

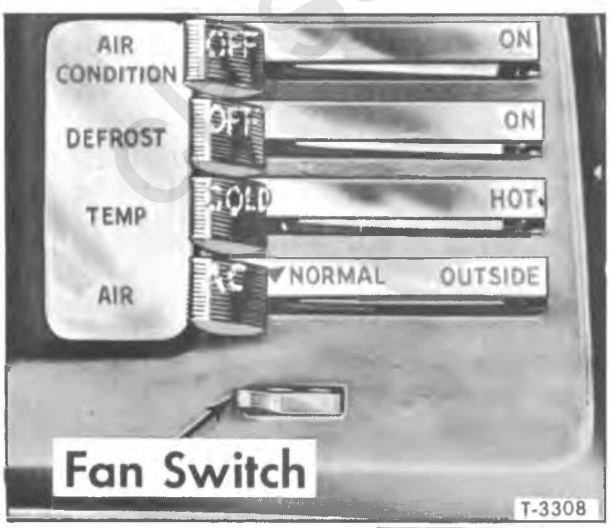


Figure 2—Air Conditioning Control Switches

4. The "AIR" lever controls amount of recirculated and outside air through system. With lever in extreme left position, system operates entirely on recirculated air. Intermediate positions of lever will result in proportional amounts of outside and recirculated air flow through system.

5. The "FAN SWITCH" controls the three-speed blower motor. Switch has four positions: Off, Low Speed, Medium Speed, and High Speed.

6. Direction of air flow from dash outlets (fig. 1) can be controlled by positioning of outlet inner deflector. The inner deflector can also be oscillated to completely close the outlet if desired. To close off any one of the outlets will increase the flow from remaining open outlets. The small outlet door at base of distributor duct can be opened if desired by pulling downward on door tab.

OPERATING AIR CONDITIONING SYSTEM

IMPORTANT: Be sure "AIR CONDITION" lever is in the "OFF" position to reduce electrical load on battery when starting engine.

1. With engine running, move "AIR CONDITION" control lever to "ON" position. Blower motor will automatically operate at low speed.

2. Move "TEMP" and "DEFROST" levers to extreme left position.

3. Move "AIR" control lever to "A/C" and then select desired blower speed.

For increased cooling, place blower control switch to high speed position and open windows for a few minutes to expel warm air from cab.

When cab begins to cool, close windows tightly and move "AIR" lever to "NORMAL" position to provide desired mixture of both recirculated air and outside air. As required, "TEMP" lever can be moved towards "HOT" position to allow mixing of hot and cool conditioned air as required for comfortable system outlet temperatures.

OPERATING HEATING SYSTEM ONLY

For heating only, move "AIR CONDITION" lever to "OFF" and "AIR" lever to "OUTSIDE." Position "TEMP" lever as required for desired temperature of incoming air. Should defogging of windshield be required, open door ventilator window slightly, place "DEFROST" lever to extreme right "ON" position, and operate blower motor at high speed.

For warm weather ventilation less air conditioning, place "AIR CONDITION," "DEFROST," and "TEMP" levers in extreme left positions, move "AIR" lever to extreme right position, then place fan switch lever to desired speed position. Air flow will be directed through heater outlets and not "A/C" outlets.

VENTILATION

WARNING - CARBON MONOXIDE

Keep cowl vent air intakes closed when operating in congested traffic to prevent deadly exhaust gases from entering cab.

Exhaust gases may have strong odors which normally should give warning of their presence. However, the exhaust gases from some vehicles may not be so noticeable under certain conditions and the senses of people react differently. Exhaust gases contain a percentage of carbon monoxide which is poisonous gas that, by itself, is tasteless, colorless, and odorless.

AIR CONDITIONING

SYSTEM OPERATION

Contents of This Sub-Section are as Follows:

GENERAL OPERATION

Some controls and units used with the air conditioning system are common to the heating system. These controls and units are: Control switches, heater core, air intake and distribution ducts.

The heating and cooling systems operate independently of each other, except under certain conditions of cooling system operation when there is an overlapping operation of both systems as explained previously under "Operating Instructions."

NOTE

Refer to applicable Wiring Diagram Manual for schematics of air conditioning electrical circuits.

REFRIGERANT-12
PRESSURE-TEMPERATURE RELATIONSHIP

The table below indicates the pressure of Refrigerant-12 at various temperatures. For instance, a drum of Refrigerant at a temperature of 80°F. will have a pressure of 84.1 psi. If it is heated to 125°F. the pressure will increase to 167.5 psi. It also can be used conversely to determine the temperature at which Refrigerant-12 boils under various pressures. For example, at a pressure of 30.1 psi, Refrigerant boils at 32°F.

TEMP. (°F.)	PRESSURE (PSIG)	TEMP. (°F.)	PRESSURE (PSIG)
-21.7	0 (atmospheric pressure)	55	52.0
		60	57.7
-20	2.4	65	63.7
-10	4.5	70	70.1
- 5	6.8	75	76.9
0	9.2	80	84.1
5	11.8	85	91.7
10	14.7	90	99.6
15	17.7	95	108.1
20	21.1	100	116.9
25	24.6	105	126.2
30	28.5	110	136.0
32	30.1	115	146.5
35	32.6	120	157.1
40	37.0	125	167.5
45	41.7	130	179.0
50	46.7	140	204.5

Figure 3—Pressure-Temperature Chart

FUNDAMENTAL PRINCIPLES OF REFRIGERATION

The principle of operation of the refrigeration system is based on a few simple laws of physics which are stated informally as follows:

1. Temperature is a measurement of the intensity of heat.

2. Heat is a form of energy. When heat is added to a substance, it usually is noticed by an increase in temperature. For example, in order to raise the temperature of water from 35°F. to 100°F., it is necessary to add a certain amount of heat.

3. When an object cools, it does not absorb cold, but rather it loses heat to a colder object or substance nearby. When a bottle containing warm liquid is placed on a cake of ice, the ice will melt and the bottle and its contents will become cool. Heat from the bottle and its contents is lost to the ice.

4. When a liquid boils, turning to vapor, it absorbs a great amount of heat. For instance, water boiling on a stove is absorbing a great amount of heat from the burner as it is changing to the vapor commonly called steam. Boiling is a rapid form of evaporation.

When a liquid boils, it absorbs heat without changing temperature. For example, when heat is added to water at sea level, as when heating on a stove, the temperature of the water will rise until it reaches 212°F. If the water remains on the hot stove, it will boil, but the temperature will remain at 212°F. The heat being absorbed by the water is changing it to steam rather than raising the temperature.

Refrigerant-12 used in air conditioning system boils at 21.7°F., below zero. Thus, if it were exposed to the air at normal room temperature, it would absorb heat from surrounding air and boil, immediately changing to a vapor.

5. When heat is removed from water vapor, it will condense back into a liquid. For example, the steam caused by boiling water on a stove will condense into water on the underside of the cover.

This is due to the fact that the cover is not as hot as the steam. The cover, therefore, takes heat from the steam, condensing it back to water.

6. The temperature at which substances will boil or condense is affected by pressure. Refer to "Pressure Temperature Chart" (fig. 5). If the pressure is increased, the liquid will not boil until a higher temperature is reached. Thus, we can prevent refrigerant from boiling if it is kept under high pressure. If this high pressure is suddenly released, refrigerant will immediately boil. This has been demonstrated on modern vehicles with pressure cooling systems.

When the pressure of a vapor is increased, the temperature at which it will condense is also raised. Steam condenses below 212°F., if heat is removed from it, but it can be made to condense at higher temperature by increasing the pressure.

7. Compressing a vapor increases its temperature. For example, when pumping air into a tire with hand pump, the pump will become warm due to the heating of the air as it is compressed.

8. When a liquid is heated until it is converted to a gas, then this gas is heated additionally without changing pressure, the gas is said to be superheated. For instance, in the evaporator, refrigerant absorbs heat and boils at a constant temperature and pressure until it has been completely vaporized, and it continues to absorb heat from the warm air passing over the evaporator without any increase in pressure. Since this heat is no longer being used to convert the refrigerant from a liquid to a gas, it will now cause the temperature of the refrigerant to rise. The refrigerant is then superheated.

REFRIGERANT

The refrigerants used are commonly known by their trade name of Freon-12, Ucon-12, or Genetron-12. Regardless of brand, refrigerant-12 must be used. The chemical name of refrigerant-12 is dichlorodifluoromethane (CCL_2F_2).

REFRIGERANT CHARACTERISTICS

Refrigerant exists as a gas at atmospheric pressure and must be held under pressure to remain liquid. At ordinary temperatures, it will exist as a liquid under a pressure of about 75 pounds per square inch.

Refrigerant has very little odor, but in large concentrations a distinct odor may be detected. It is colorless in both its liquid and gaseous states.

Refrigerant is nonpoisonous, nonflammable, and nonexplosive. It is noncorrosive to any of the ordinary metals.

Goggles should be worn whenever there is the slightest possibility of refrigerant coming in contact with the face or eyes, because refrigerant evaporates and cools so rapidly it will cause an injury similar to frostbite.

PROCUREMENT

Refrigerant is generally shipped and stored in 25-lb. drums and 15-oz. cans.

It will be impossible to draw all the refrigerant out of the drum. The use of warm water when charging the system will assure the extraction of a maximum amount of refrigerant from the drum. Be sure to follow the instructions under "Charging The System" explained later.

NOTE: Approximately 3-1/4 pounds of refrigerant is required in system.

PRECAUTIONS IN HANDLING REFRIGERANT

1. Do not leave container of refrigerant uncapped.
2. Do not subject container to high temperature.
3. Do not weld or steam clean on or near system.
4. Do not fill drum (when used) completely.
5. Do not discharge vapor into area where flame is exposed.
6. Do not expose eyes to liquid.

All refrigerant drums are shipped with a heavy metal screw cap. The purpose of the cap is to protect the valve and safety plug from damage. It is good practice to replace the cap after each use of the drum for the same reason. If the drum is exposed to the radiant heat from the sun, the resultant increase in pressure may cause the safety plug to release or the drum to burst.

For the same reason, the refrigerant container should never be subjected to excessive temperature when charging a system. The refrigerant drum (when used) should be heated for charging purposes by placing in 125°F., water. Never heat above 125°F., or use blowtorch, radiator, or stove to heat the drum.

Welding or steam cleaning on or near any of the refrigerant lines or components of the air conditioning system could build up dangerous and damaging pressures in the system.

If a small drum is ever filled from a large one, never fill the drum completely. Space should always be allowed above the liquid for expansion. Weighing drums before and during the transfer will determine fullness of drums.

Discharging large quantities of refrigerant into a room can usually be done safely as the vapor would produce no ill effects. However, this should not be done if the area contains a flame-producing device such as a gas heater. While refrigerant normally is nonpoisonous, heavy concentrations of it in contact with a live flame will produce a

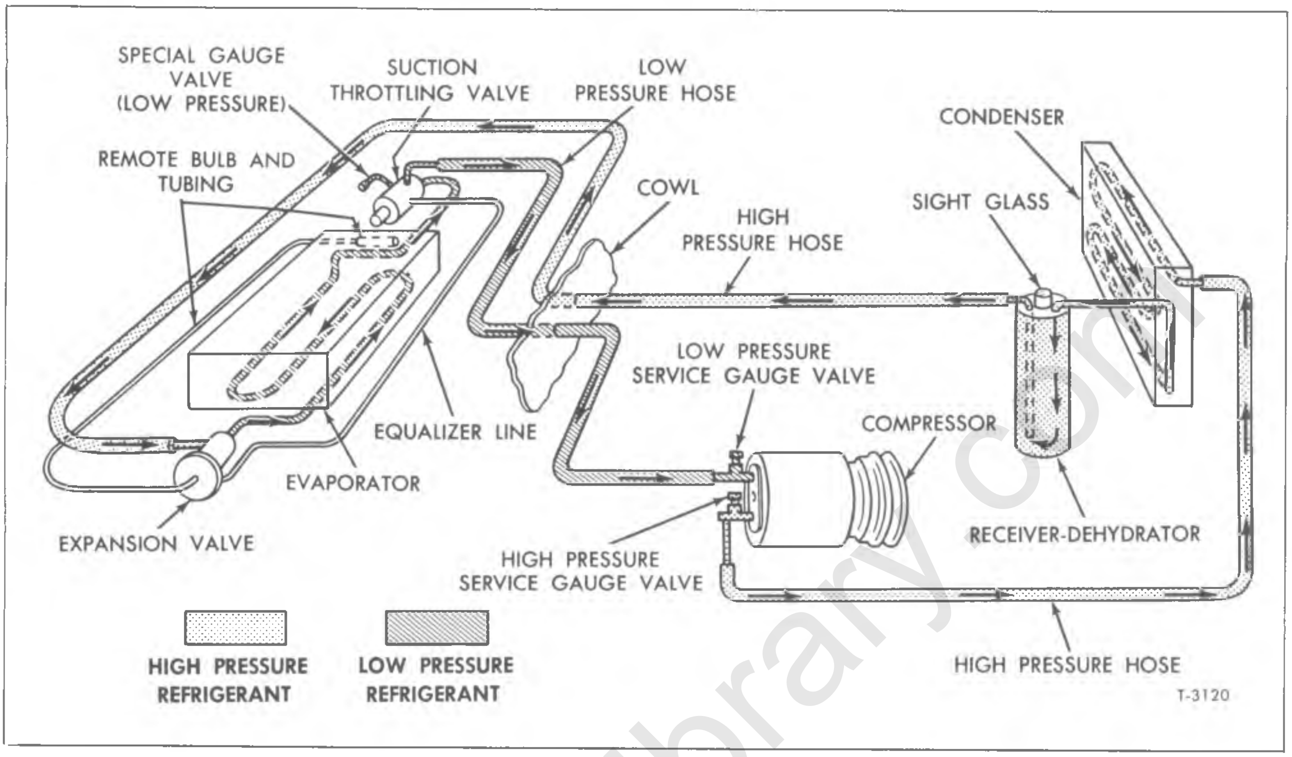


Figure 4—Schematic of Refrigerant Cycle

poisonous gas. The same gas will attack all bright metal surfaces.

DO NOT EXPOSE EYES TO REFRIGERANT

One of the most important precautions is protection of the eyes when handling refrigerant. Any liquid refrigerant which may accidentally escape is approximately 21.7°F., below zero. If any refrigerant comes in contact with the eyes, serious injury could result. Always wear goggles to protect the eyes when handling refrigerant.

If refrigerant should come in contact with the eyes:

1. DO NOT rub the eyes. Splash the eyes with cold water to gradually get the temperature above the freezing point.
2. Apply a protective film of an antiseptic oil over the eye-ball to reduce the possibility of infection.
3. Consult a doctor or an eye specialist immediately.

Should liquid refrigerant come in contact with the skin, the injury should be treated the same as though the skin had been frostbitten or frozen.

REFRIGERANT CIRCULATION

Refrigerant control units and piping is illustrated in figures 1 and 4. A complete cycle of the refrigerating system is as follows:

1. Refrigerant in its gaseous state is drawn into the compressor where it is compressed and discharged into the condenser.

2. As the heated gas circulates through the condenser coils, it is cooled by air being forced through the condenser by an engine cooling fan. The combined effects of the decreased temperature and increasing pressure cause the gas to condense (liquify).

3. The liquid refrigerant is then forced from condenser into the liquid receiver.

4. By its own pressure, liquid refrigerant is forced from liquid receiver-dehydrator through the expansion valve and into the evaporator.

5. In the evaporator, where the pressure is reduced, the liquid refrigerant evaporates, or changes into its gaseous state. As the liquid evaporates, heat is absorbed from the air passing through the evaporator coils, thus the air is cooled.

6. Flow of refrigerant into the evaporator is regulated by the expansion valve. The expansion valve is actually a pressure reducing valve which serves two purposes:

a. It maintains pressure on the liquid line.

b. It admits only the required amount of liquid refrigerant into the evaporator, this requirement being determined by the temperature of the gaseous refrigerant at the evaporator outlet.

7. The low pressure refrigerant gas passes

from the evaporator through the suction throttling valve, then back through the suction line to compressor thus completing the cycle.

AIR CIRCULATION

Air circulation is common to both the heating and air conditioning systems. For detailed description of air circulation in vehicle, refer to "Operating Instructions" explained previously.

OPERATION OF INDIVIDUAL UNITS

Figures 1 and 4 illustrate the location of the Air Conditioning (and Heating) System units. Each of the units in the air conditioning system is described following:

AIR OUTLETS

Refrigerated air enters the interior of the cab through four outlets below the instrument panel (fig. 1).

Air outlets can be individually controlled to provide a comfortable air flow in any direction desired by the occupants.

EXPANSION VALVE

The expansion valve (fig. 5) consists of a capillary bulb and tube which is connected to an operating diaphragm (which is sealed within the valve itself) and an equalizer line which connects the valve and the low pressure return line.

The purpose of the expansion valve is to regulate the flow of liquid refrigerant into the evaporator automatically in accordance to the requirements of the evaporator.

The valve is the dividing point in the system between high pressure liquid refrigerant supplied from the receiver-dehydrator and relatively low pressure liquid and gaseous refrigerant in the evaporator. It is so designed that the temperature of the refrigerant at the evaporator outlet must have 10.6°F., of super heat before more refrigerant is allowed to enter the evaporator. Superheat is an increase in temperature of the gaseous refrigerant above the temperature at which the refrigerant vaporizes.

A capillary tube filled with carbon dioxide and the equalizer line provide the temperature regulation of the expansion valve. This capillary tube is fastened to the low pressure refrigerant pipe coming out of the evaporator so that it communicates the temperature of the refrigerant at this point to the expansion valve. If the superheat at the outlet decreases below 10.6°F., the expansion valve will automatically reduce the amount of refrigerant entering the evaporator, thus reducing the amount of cooling. If the superheat increases, the expansion valve will automatically allow more refrigerant to enter the evaporator, thus increasing the cooling.

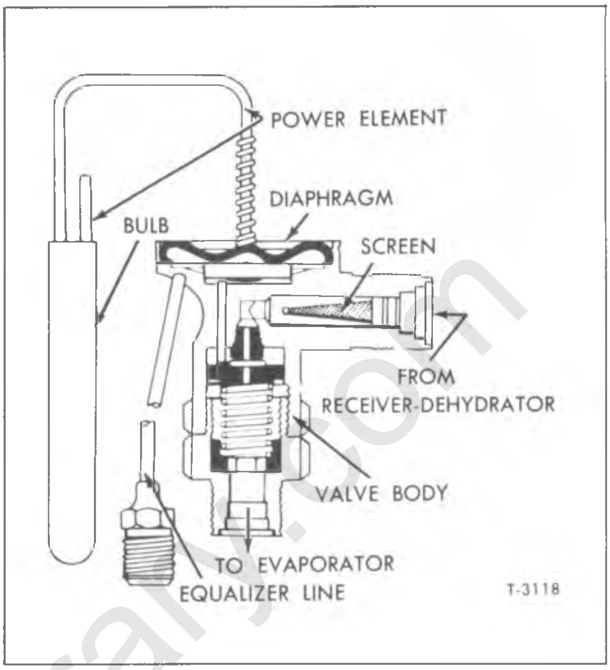


Figure 5—Expansion Valve

The equalizer line joining the suction throttling valve with the area behind the operating diaphragm acts with the capillary to measure superheat.

It is the temperature of the air passing over the evaporator core that determines the amount of refrigerant that will enter and pass through the evaporator. When the air is very warm, the heat transfer from the air to the refrigerant is great and a greater quantity of refrigerant is required to cool the air and to achieve the proper superheat on the refrigerant gas leaving the evaporator. When the air passing over the evaporator is cool, the heat transfer is small and a lesser quantity of refrigerant is required to cool the air and to achieve the proper superheat on the refrigerant gas leaving the evaporator.

Since the evaporator outlet pressure is proportionate to the amount of heat (superheat) picked up by the refrigerant gas in passing through the evaporator, it can be seen that adjusting spring tension which works against capillary pressure and equalizer line pressure controls the volume of refrigerant entering the evaporator as signaled by the temperature and pressure in the evaporator outlet pipe.

When the air conditioning system has not been operating, all pressures within the expansion valve assembly will have equalized at the ambient (surrounding air) temperature, thus the pressure above and below the operating diaphragm and at the inlet and outlet side of the valve will be equal (fig. 5).

(Pressure under the diaphragm is evaporator pressure. It reaches this area by means of clearance around the operating pins in the valve body which connects the area under the diaphragm with the evaporator pressure area.) While pressures in the expansion valve are almost equal, the addition of the valve adjusting spring pressure behind the valve will hold the valve over to close the valve orifice.

When the air conditioning system first begins to operate, the compressor will immediately begin to draw refrigerant from the evaporator, lowering the pressure in the evaporator and in the area under the operating diaphragm. As the pressure in this area decreases, the pressure above the diaphragm exerted by the carbon dioxide in the capillary tube will overcome spring pressure and push the diaphragm against the operating pins, which in turn will force the needle valve off its seat.

Refrigerant will then pass through the expansion valve into the evaporator where it will boil at a temperature corresponding to the pressure in the evaporator. This will begin cooling the air passing over the evaporator, and, also it will begin to cool the evaporator outlet pipe.

As the evaporator outlet pipe cools, the pressure of the carbon dioxide in the capillary tube (contacting this outlet pipe) decreases, exerting less force on the operating diaphragm.

The valve adjusting spring is calibrated so that the pressure of the refrigerant in the evaporator, plus the spring force, will equal the force above the operating diaphragm when the temperature of the refrigerant in the evaporator outlet is 10.6°F., above the temperature of the refrigerant entering the evaporator. In other words, the refrigerant should remain in the evaporator long enough to

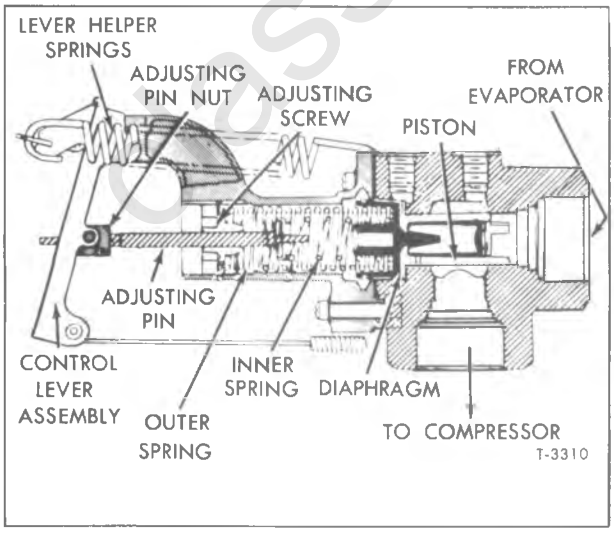


Figure 6—Suction Throttling Valve

completely vaporize and then warm (superheat) 10.6°F.

If the temperature differential begins to go below 10.6°F. (outlet pipe becomes too cold), carbon dioxide pressure in the capillary tube and area above the diaphragm decreases, allowing the valve adjusting spring to move the needle valve toward its seat, closing off the flow of refrigerant past the needle valve.

If the temperature differential begins to go above 10.6°F. (outlet pipe too warm), the pressure in the capillary tube and area above the operating diaphragm will increase, pushing this diaphragm against the operating pins to open the needle valve further, admitting more refrigerant to the evaporator.

EVAPORATOR

The evaporator is actually the device which cools and dehumidifies the air before it enters the cab. High pressure liquid refrigerant flows through the valve orifice in the expansion valve into the low pressure area of the evaporator. This regulated flow of refrigerant boils immediately. Heat from the core surface is lost to the boiling and vaporizing refrigerant, which is cooler than the core, thereby cooling the core. The heat in the air passing over the evaporator loses its heat to the cooler surface of the core, thereby cooling the air. As the process of heat loss from the air to the evaporator core surface is taking place, any moisture (humidity) in the air condenses on the outside surface of the evaporator core and is drained off as water.

Since Refrigerant-12 will boil at 21.7°F., below zero at atmospheric pressure and water freezes at 32°F., it becomes obvious that the temperature in the evaporator must be controlled so that the water collecting on the core surface will not freeze in the fins of the core and block off the air passages. In order to control the temperature, it is necessary to control pressure inside the evaporator and this is done by the suction throttling valve.

To obtain maximum cooling the refrigerant must remain in the core long enough to completely vaporize and then superheat a minimum of 10.6°F. If too much or too little refrigerant is present in the core, then maximum cooling efficiency is lost. An expansion valve in conjunction with the suction throttling valve is used to provide this necessary refrigerant and pressure control.

SUCTION THROTTLING VALVE

The main function of the Suction Throttling Valve (fig. 6) is to maintain the evaporator pressure at a pressure sufficiently high to avoid freezing of moisture on the evaporator core and at the same time provide maximum cooling efficiency.

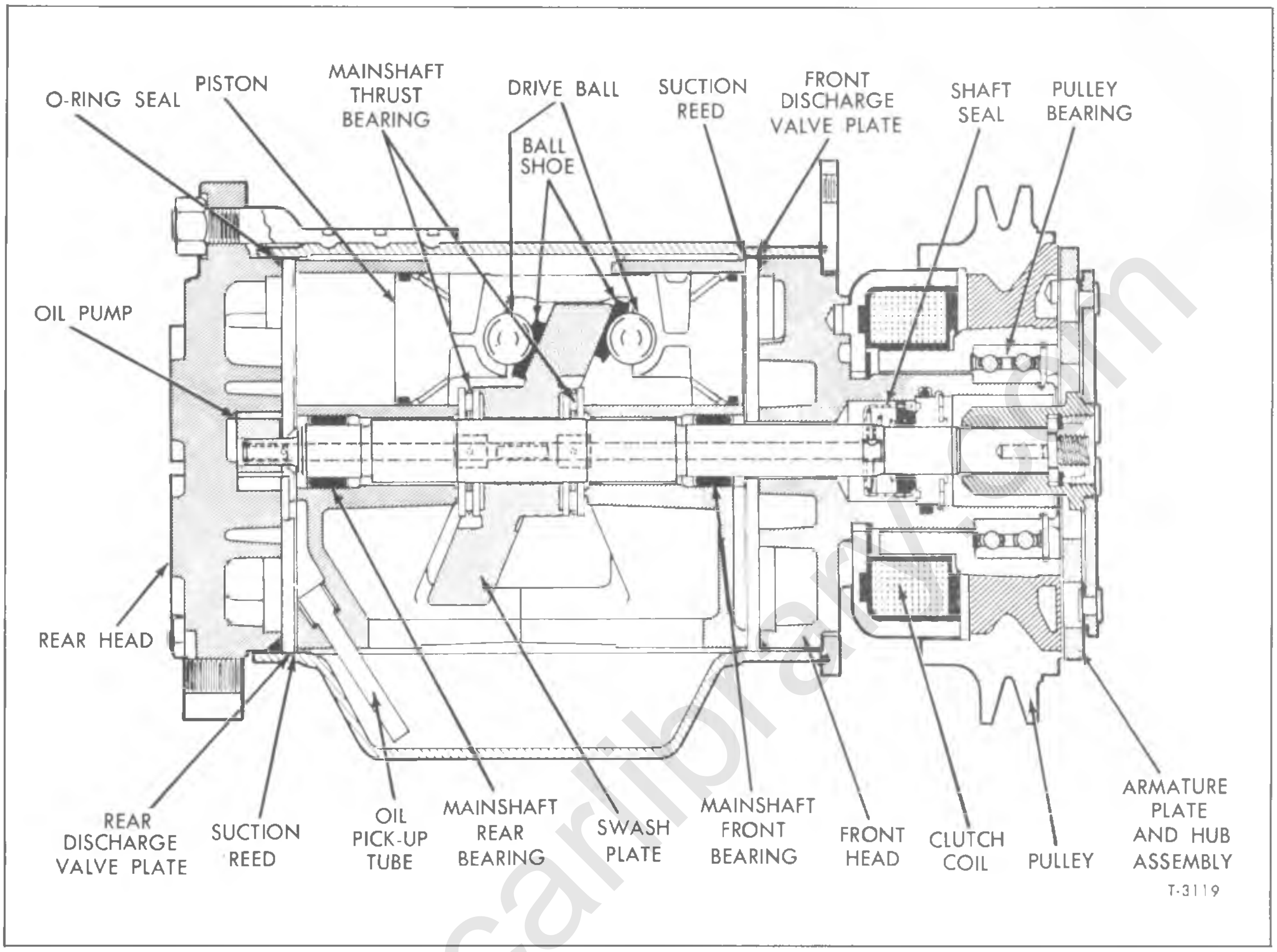


Figure 7—Refrigerant Compressor

The opposing forces, spring pressure and atmospheric pressure on the one side of the valve diaphragm and evaporator pressure on the opposite side of the diaphragm constitute a balanced valve and control its operation.

When the evaporator pressure rises above the manual spring setting, this increase in evaporator pressure is exerted against the valve piston and through the bleed holes in the piston to the underside of the diaphragm. The pressures under the diaphragm overcome the spring pressure causing the valve piston to move in an opening direction. As the piston opens, it reaches a balanced position and the evaporator pressure returns to its original setting (23-24 p.s.i.g.).

When the evaporator pressure drops below the predetermined setting, the spring pressure overcomes the opposing evaporator pressure and forces the piston in a closing direction until the predetermined pressure setting is maintained (23-24 p.s.i.g.). The minimum operating pressure of the suction throttling valve is pre-set by an adjustment screw. Maximum operating pressure may be obtained by means of a cable operated from the instrument panel to the lever arm on the valve. When reduced load conditions require elevated control pressures, the lever arm actuates the inner spring assembly causing the piston to throttle in a closing direction. This results in a higher evaporation pressure and the desired increase in discharge air temperature.

COMPRESSOR

The compressor is of basic double-action piston design. Three horizontal double acting pistons make up a six-cylinder compressor, and are mounted axially around the compressor shaft to operate in a front and rear cylinder assembly. These pistons operate in a 1-1/2" bore, have a 1-3/16" stroke and are actuated by a swash plate pressed on the compressor crankshaft (see fig. 7).

Reed-type suction and discharge valves are mounted in valve plates between the cylinder assembly and the head at each end of the compressor. The heads are connected with each other by gas-tight passage ways which direct refrigerant gas to a common output.

AIR CONDITIONING

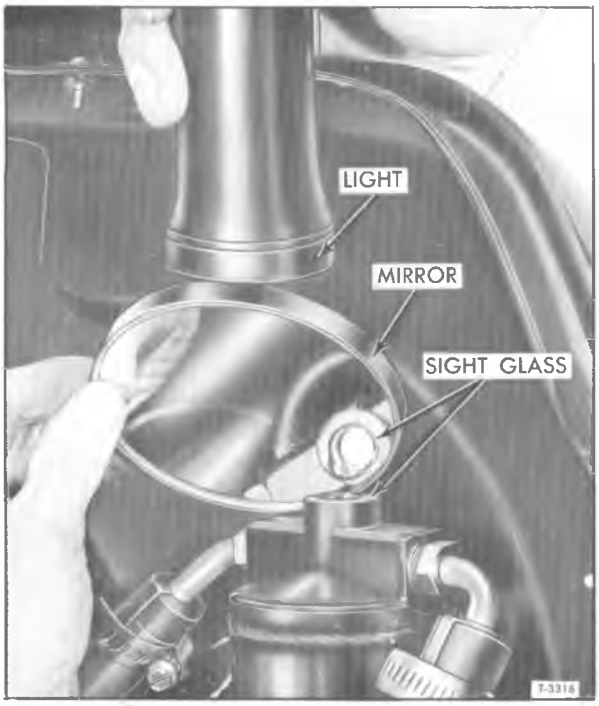


Figure 8—Receiver-Dehydrator

The compressor mainshaft is driven by the pulley when the clutch coil is energized. It extends through the compressor front head, to the compressor rear head and drives the oil pump in the rear head pump cavities.

The compressor is fitted with a high pressure relief valve. If the discharge pressure ever exceeds approximately 440 psi, the relief valve opens automatically to relieve the pressure and closes again when the pressure recedes.

The pulley assembly contains an electrically controlled magnetic clutch, permitting the compressor to operate only when air conditioning is desired.

The clutch actuating coil is molded into the coil housing with a potted epoxy resin; therefore, the coil and housing are replaceable only as a complete assembly. The coil has 3.85 ohms resistance at 80°F. (surrounding temperature) and should not demand more than 3.2 amperes of 12 V.D.C.

Compressor Operation

When the "AIR COND." lever is placed in "ON," the electrical circuit to the compressor clutch closes.

Current flowing through the coil creates a magnetic force which flows through the pulley to draw the armature plate (forward of the pulley assembly) rearward toward the pulley. As the armature plate moves toward the pulley, it contacts the pulley shaft face (which rotates freely about the compressor shaft).

When the "AIR COND." knob is placed to "OFF," the electrical circuit to the compressor clutch is opened and the magnetic pull on the clutch no longer exists. The armature plate to driven ring actuating springs will then pull the armature plate away from the pulley and the plate loses contact with the pulley.

A gauge fitting containing a Schrader valve is located in both the discharge and suction passage to permit pressure gauge readings.

CONDENSER

The condenser is similar to the ordinary radiator but is designed to withstand much higher pressures. It is made up of tubes which carry the refrigerant and cooling fins which provide rapid transfer of heat.

The condenser is located in front of the engine cooling system radiator so that it receives a high volume of air from the movement of the vehicle and from the engine fan. Air passing over the condenser cools the hot high pressure refrigerant gas, causing it to condense into high pressure liquid refrigerant.

RECEIVER-DEHYDRATOR ASSEMBLY

The receiver-dehydrator assembly is mounted vertically along the right rear side of the radiator support.

The purpose of the receiver part of this system is to insure a solid column of liquid refrigerant to the expansion valve at all times, provided the system is properly charged.

The liquid indicator (many times referred to as a sight glass) is in the refrigeration system as an aid to diagnosis (see fig. 8). The appearance of bubbles or foam beneath the sight glass (liquid indicator) above 70°F., ambient indicates air or a partial discharge of refrigerant in the system. A solid liquid column as seen in the sight glass is difficult to tell from one that has no refrigerant in the system at all. Two ways to establish whether the system is properly charged or empty are to feel the suction pipe in the suction throttling valve or to disconnect the compressor clutch while observing the sight glass. If the system has the proper refrigerant charge, the suction line at the suction throttling valve will be cool. Also, the refrigerant column in the sight glass will be seen to collapse soon after the clutch has been disconnected. Foam may be noted in the sight glass below 70°F., even when the system is free of air and properly charged. Details of these conditions are in the "Insufficient Cooling Diagnosis Chart."

Liquid refrigerant from the condenser enters the receiver to flow into the upper portion of the receiver which contains desiccant confined in a white felt bag that is not attached to anything but merely rests on the baffle in the lower portion of the receiver. As the refrigerant flows through an opening in the lower portion of the receiver, it is also filtered through a 100 mesh screen attached to a baffle at the bottom of the receiver.

The desiccant in this assembly is to absorb any moisture that might be present in the system after assembly. The screens trap any foreign material which may enter the system during assembly. These features of the assembly prevent obstruction to the valves or damage to the compressor.

NOTE: Markings on top of the receiver show the proper inlet and outlet fitting connections.

ON-VEHICLE SERVICE

Contents of this Sub-Section are as follows:

PERIODIC SERVICE

(60 Days or 6000 Miles whichever occurs first)

1. Check front of condenser for an accumulation of dirt, such as leaves, bugs, dirt, etc. Also check to see that the space between the condenser and radiador is also free of this material.

2. Inspect compressor drive belt. Check and adjust tension to 100 to 105 lbs. on belt tension gauge. Adjust new belt tension to 120 to 130 lbs.

3. Operate system and check for correct operation in all control positions.

4. Check for refrigerant leaks and observe refrigerant passing through the sight glass with system operating to see if there is any evidence of bubbles (above 70^{O}F. ambient).

PRECAUTIONARY SERVICE MEASURES

Before any service is attempted which requires the opening of refrigeration pipes or units, the person doing the work should be thoroughly familiar with "General Information" on refrigeration service.

The major reasons behind these measures are for safety and to prevent dirt and moisture from getting into the system. Dirt contaminant is apt to cause leaky valves or wear in the compressor, and moisture will freeze into ice at the expansion valve and freeze the valve stem.

PRE-ASSEMBLY

1. All sub-assemblies are shipped, sealed and dehydrated. They are to remain sealed until just prior to making connections.

2. All sub-assemblies should be at room temperature before uncapping. (This prevents condensation of moisture from the air that enters into the system.)

3. If, for any reason the caps are removed, but the connections are not made, then the tubes and other parts should not remain unsealed for more than 15 minutes. Reseal connections if period is to be longer. This applies particularly to partially built-up systems that will be left overnight.

4. Compressors are shipped with 10 - 11 oz. of Frigidaire-525 Viscosity Oil and charged with a mixture of Refrigerant-12 and dry nitrogen to

TEST READINGS										
Ambient Air in Degrees F. (In Auxiliary Fan Air Blast 2" Ahead of Condenser).	70		80		90		100		110	
Air Quality	Arid	Humid	Arid	Humid	Arid	Humid	Arid	Humid	Arid	Humid
Average Compressor Head Pressure—PSI	125/155	150/180	160/190	180/210	197/227	213/243	225/255	250/280	270/300	290/320
Average Suction Throttling Valve Pressure—PSI	20/23	21/24	20/23	22/25	21/24	25/28	24/27	29/32	28/31	36/39
Center Outlet Temperature Degree F.	41/44	48/52	44/48	53/57	48/52	58/62	52/57	62/68	58/65	68/75

Shown in the above table are the average readings expected in arid or dry air, and in humid or moist air with maximum allowable tolerance shown.

Humid air is considered 20—90% R.H. Nozzle
Arid air is considered 5—20% R.H. Nozzle

Figure 9—Operational Test Data Chart

provide an internal pressure at slightly above atmospheric pressure.

ASSEMBLY

1. All precautions should be taken to prevent damage to fittings or connections. Even minute damage to a connection could cause it to leak.

2. Any fittings getting grease or dirt on them should be wiped clean with a cloth dampened with alcohol. Do not use chlorinated solvents such as trichloroethylene for a cleaning agent, as they are contaminants. If dirt, grease or moisture gets inside the hoses and cannot be removed, the hose should be replaced.

3. Sealing caps should be removed from subassemblies just prior to making connections for final assembly.

4. Use a small amount of clean refrigeration oil (525 or 1000 viscosity) on all tube and hose joints, and dip the O-ring gasket (when used) in this oil before assembling the joint, as this oil will help in making a leak-proof joint.

5. Do not connect the receiver-dehydrator assembly until all other sealed sub-assemblies have been connected. This is necessary to insure optimum dehydration and maximum moisture protection of the refrigeration system.

CAUTION - LIQUID INDICATOR (SIGHT GLASS)

Under normal conditions, the receiver-dehydrator will show clear with about 3 pounds of refrigerant in the system. However, the air conditioner will not produce its best performance until 3-1/4 pounds of refrigerant are in the system. Do not overcharge with refrigerant, as this will result in extremely high head pressures and the compressor safety valve will "blow."

PERFORMANCE TESTING

In order to determine if an air conditioning system is operating properly and efficiently, it must be performance tested. The first step to diagnosing a system that has been malfunctioning should be a complete performance test (see fig. 9).

Correct pressures indicate that the required charge of refrigerant is in the system and that it is functioning properly.

Testing to determine if the discharge air temperature, suction pressure, and discharge pressure meet the specifications at a particular ambient condition is called a "Performance Test."

The suction throttling valve is pre-set at the factory to maintain the minimum and maximum evaporator core pressure and generally should never require resetting. If a malfunction in the refrigerant system due to above or below normal evaporator core pressures is suspected, check the following:

1. Restrictions in evaporator core, hoses, tubes, etc.
2. Refrigerant leaks.
3. Compressor clutch slippage.
4. Improper drive belt tension.
5. Capillary tube broken or not tight to evaporator tube.
6. Expansion valve inoperative.
7. Suction throttling valve stuck.

The purpose of performing an operational test is to prove that the air conditioning electrical system, air system, and refrigeration system are operating properly and efficiently. Results of the test are as follows:

a. Operation of the air conditioner blower at all speeds and engagement of the compressor clutch would indicate that the electrical circuits are functioning properly.

b. A clear sight glass would indicate a properly charged refrigeration system.

c. Proper evaporator pressure, as controlled by the Suction Throttling Valve would provide proper "freeze protection" for the evaporator.

d. Proper nozzle temperatures would indicate a system free from warm air leaks.

Check and correct all air and refrigerant leaks in the air conditioning system as well as operation of cable-operated air doors.

Check for proper compressor oil level during the repair of refrigerant leaks, before conducting an operational test.

PRELIMINARY CHECKS

1. Check compressor belt for proper tension; if below 100 lbs. (used belt) adjust to 100-105 lbs. using belt tension gauge.
2. Check all refrigeration lines for leaks, kinks, or other restrictions.
3. Check outer surfaces of radiator and condenser cores to be sure they are not plugged with dirt, leaves or other foreign material. Be sure to check between the condenser and radiator as well as the outer surfaces.
4. Connect engine tachometer.
5. Start engine and operate at 2000 rpm with "AIR" lever on "OUTSIDE" and "TEMP" lever set for maximum cooling, and blower on high. After at least five minutes of engine operation, observe for

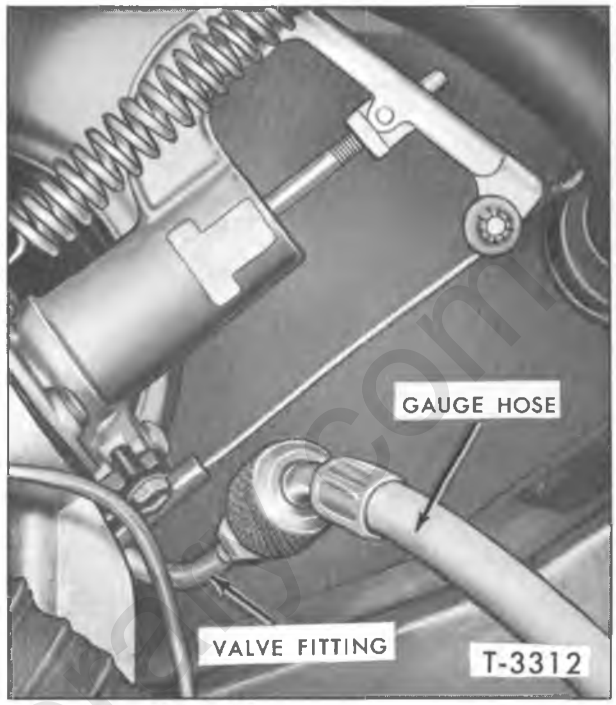


Figure 10—Gauge Hose Connection at Suction Throttling Valve

bubbling at the sight glass (above 70^{O}F. ambient). If the system is low on refrigerant, add refrigerant until liquid indicator just shows clear and add an additional 1/2-pound of refrigerant.

6. Under the same conditions as in step 5 above, move "AIR COND" lever to "OFF." This should disengage the compressor clutch. If clutch does not disengage, check the clutch control switch adjustment.
7. Move "AIR COND" lever to "ON" again and observe clutch engagement action which should be without slip. If clutch slips, check clutch for proper adjustment, short in clutch coil, or leaking compressor shaft seal.
8. Change blower speed to medium, and to low, and observe for decreases in air flow.

FUNCTIONAL TEST

NOTE: This test should not be performed in direct rays of sun.

1. Connect gauge set high pressure hose to outer gauge fitting at rear of compressor and connect 30-inch vacuum, 60-psi compound test gauge hose to refrigerant fitting at suction throttling valve (fig. 10).
2. Locate auxiliary fan (at least 20" in diameter) in front of condenser. Leave hood open.
3. Open both cab doors.
4. Place a calibrated thermometer in front of condenser in auxiliary fan air stream.
5. Place a second calibrated thermometer in

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auxiliary fan air stream to measure wet bulb temperature.

6. Connect engine tachometer.
7. Open all air outlets below dash.
8. Locate a calibrated thermometer in center outlet. Sensing bulb must not touch metal.
9. Place transmission lever in "Neutral," with parking brake on.
10. Start engine and set "AIR" lever at "OUTSIDE," "TEMP" lever full left for maximum cooling and blower switch at high blower speed.
11. Set engine speed at 2000 rpm.

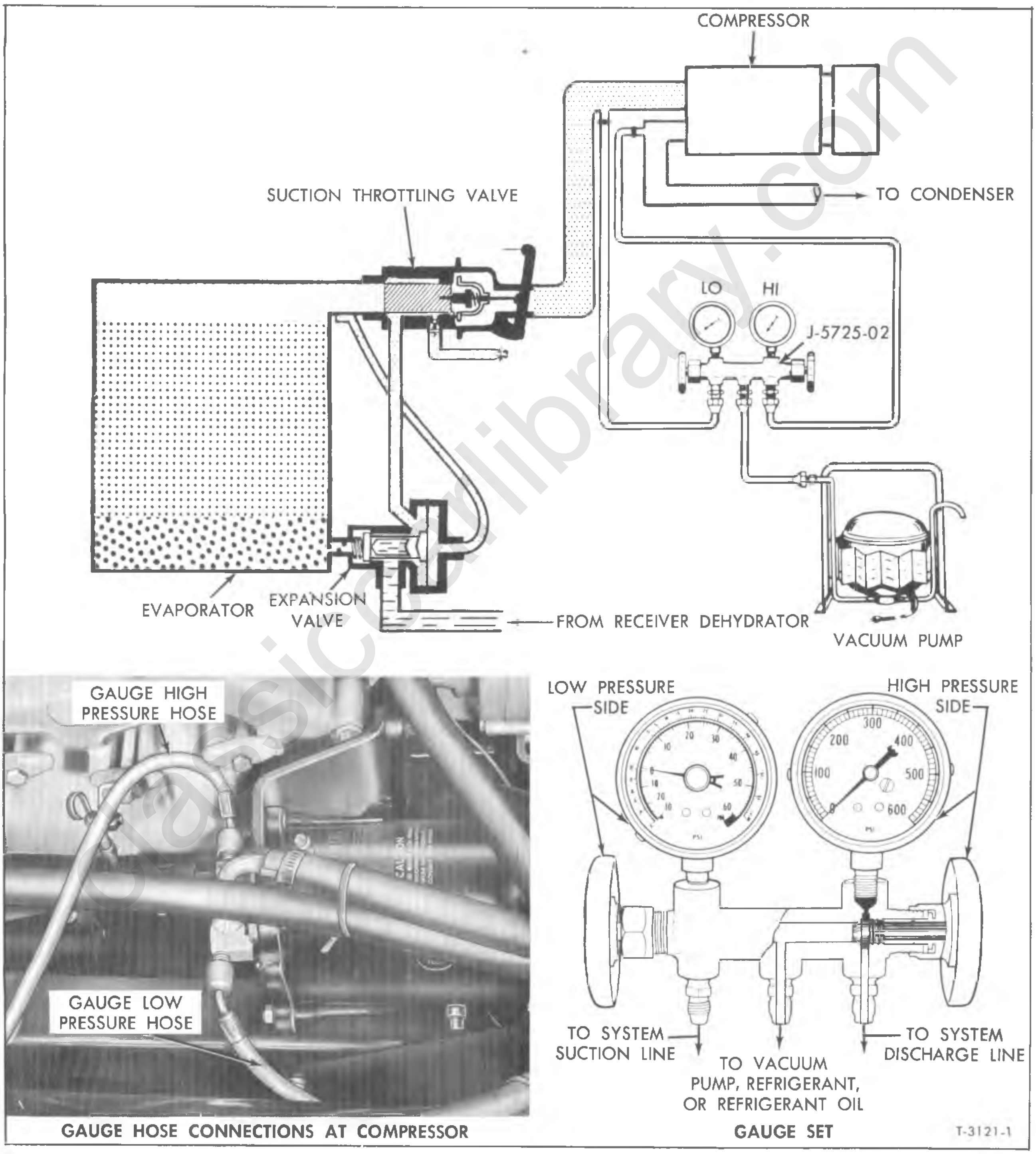


Figure 11—Hook-Up of Gauges and Evacuating Pump

12. Allow engine to run for 10 minutes, or until stabilized.

NOTE: If at any time during test,compressor head pressure exceeds 375 psi, discontinue test and check the following:

a. Engine cooling system.

b. Restricted receiver and liquid indicator assembly.

c. Air in refrigeration system or overcharge of refrigerant.

d. Insufficient auxiliary fan air on radiator and condenser.

13. At the end of this time record the following:

a. Ambient air at condenser.

b. Wet bulb temperature in auxiliary fan air stream.

c. Compressor head pressure.

d. Refrigerant test fitting gauge pressure.

e. Center outlet temperature.

Compare above with system pressures and temperature shown on "Operational Test Data Chart" (fig. 9). If not within the limits shown, refer to the "Insufficient Cooling Diagnosis Chart" for possible cause of sub-standard performance. Reference should be made in the order listed with head pressure first, if not within "Operational Test Data Chart" limits, then check suction throttling valve inlet pressure and finally center outlet temperature.

NOTE: For altitude levels at or near sea level, set the suction throttling valve as specified (23 psig). For higher levels, set valve 1/2 lb. per sq. in. higher for each 1,000 feet of elevation.

14. Remove charging manifold gauge set, test fitting gauge, and install the fitting caps.

DEPRESSURIZING THE SYSTEM

Any time the system is to be opened, it must first be depressurized. Depressurize the system as follows:

NOTE: Install gauge set to compressor gauge fittings (fig. 11).

1. Remove caps from gauge fittings at compressor.

2. With both valves on the manifold gauge set J-5725-04 closed (clockwise), attach manifold hoses to compressor fittings, using J-5420 Schrader valve adapter at the suction gauge fitting and J-9459 Schrader valve adapter at the discharge gauge fitting.

3. Crack open the high pressure valve on manifold gauge set to allow slow escape of refrigerant from the system through the manifold gauge set and out the center fitting and hose. (Place end of hose in clean container.) If oil drips from the hose into the container, refrigerant is escaping too rapidly.

4. When hissing ceases (indicating all refrigerant has escaped) close valves on manifold gauge set by turning valve clockwise.

EVACUATING THE SYSTEM

When the refrigeration system is depressurized and opened for service, some air will enter the lines regardless of how quickly the openings are capped. In order to remove this air and as much as possible of the moisture it contains, the complete system must be "evacuated." Evacuating is merely the process of removing all air from the system, thereby creating a vacuum in the system.

> CAUTION: Under no circumstances should alcohol be used in the system in an attempt to remove moisture, regardless of the successful use of alcohol in other refrigeration systems.

PREPARATION FOR EVACUATING COMPLETE SYSTEM

1. Check the low pressure gauge for proper calibration, with the gauge disconnected from the refrigeration system. Be sure that the pointer on the gauge indicates to the center of "O." Tap the gauge a few times lightly to be sure pointer is not sticking. If necessary, calibrate as follows:

a. Remove the cover from the gauge.

b. Holding gauge pointer adjusting screw firmly with one hand, carefully force pointer in the proper direction in the proper amount to position the pointer through the center of the "O" position. Tap gauge a few times to be sure pointer on gauge is not sticking. Replace gauge cover.

2. If gauge set is not already connected to compressor fittings, connect as follows (refer to fig. 11):

a. Close hand shut-off valves on gauge set by turning clockwise.

b. Remove caps from gauge fittings at compressor.

NOTE: To shorten evacuating and charging time, the valve core in each compressor gauge fitting can be unseated using Tool J-22132-01. The gauge lines are then connected to the tool fittings. Turn tool knobs counterclockwise to unseat cores.

c. Attach Schrader valve adapter J-5420 to end of hose from suction valve low pressure gauge and connect this adapter fitted hose to the compressor suction gauge fitting or to Tool J-22132-01 (if used).

d. Attach Schrader valve adapter J-9459 to end of hose from compressor gauge and connect this adapter fitted hose to the discharge gauge fitting or Tool J-22132-01 (if used).

3. Attach a flexible gauge hose to the center fitting of the gauge set and attach the other end of this hose to the vacuum pump J-5428-03 (fig. 11).

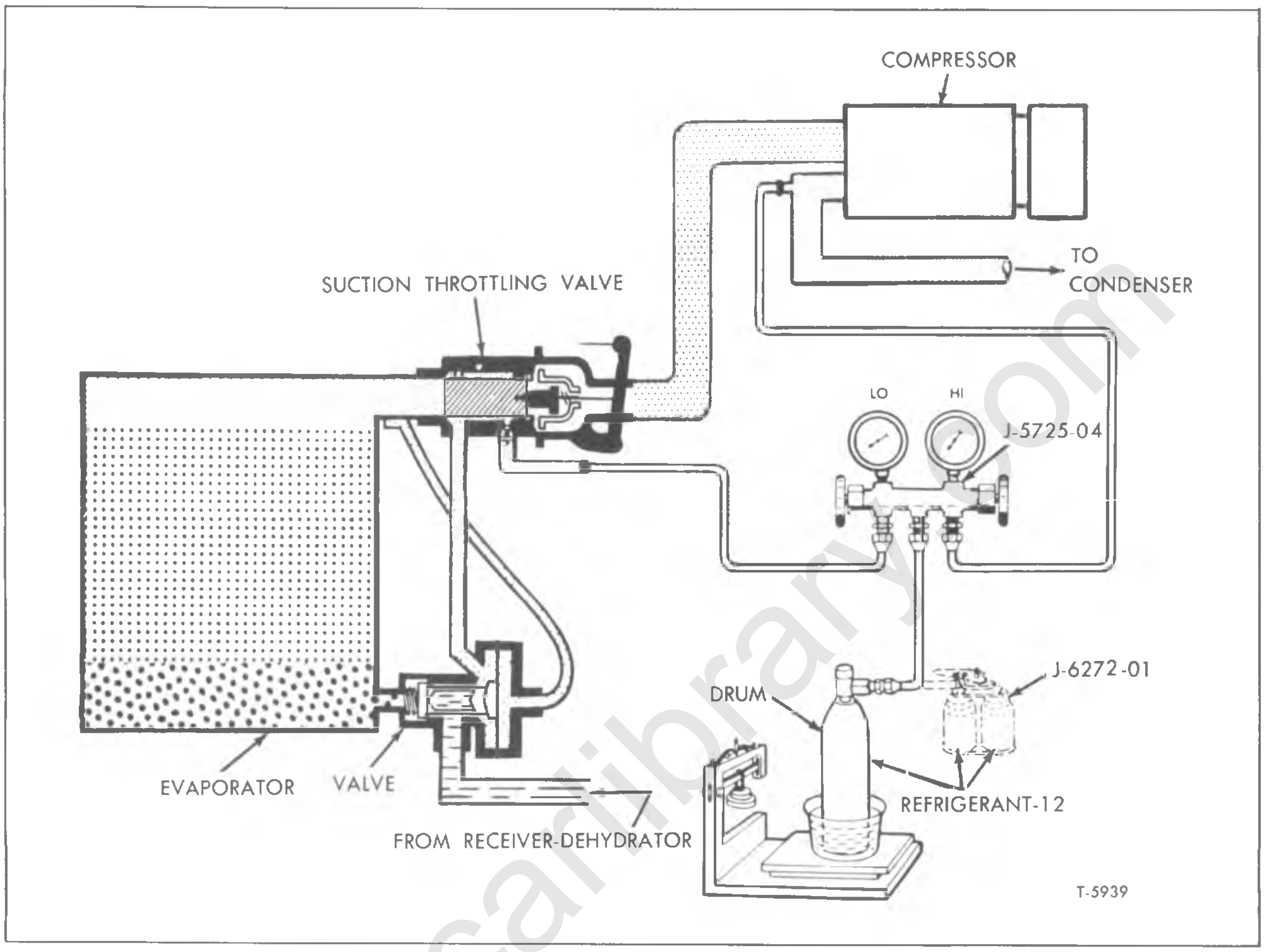


Figure 12—Hook-Up of Gauges and Charging Equipment

4. The system can now be evacuated.

EVACUATING COMPLETE SYSTEM

1. Turn hand shut-off valve on low pressure gauge of gauge set to the full clockwise (closed) position.
2. Slowly turn valve on high pressure gauge counterclockwise from the full clockwise position, letting any pressure build-up escape completely. Close high pressure valve.
3. Check oil level in vacuum pump (J-5428-03) and add Frigidaire-150 viscosity oil or equivalent, if necessary, to bring to proper level. Make sure dust cap on discharge side of vacuum pump has been removed.
4. Start the vacuum pump and slowly open the low and high pressure sides of the manifold gauge set to avoid forcing oil out of the refrigeration system and the pump. Pressure is now being reduced on both sides of the refrigeration system.

NOTE: If oil is blown from the vacuum pump, it should be refilled to the proper level with Frigidaire-150 viscosity oil or equivalent.

5. Observe low pressure gauge and operate vacuum pump until gauge shows 26-28" vacuum. Continue to run pump for ten additional minutes.

NOTE: In all evacuating procedures the specification of 26-28 inches of vacuum is used. This evacuation can only be attained at or near sea level. For each 1000 feet above sea level where this operation is being performed, the specification should be lowered by one inch of mercury vacuum. For example: at 5000 feet elevation only 21 to 23 inches of vacuum can normally be obtained.

If vacuum cannot be pulled to the minimum specification for the respective altitude, it indicates a leak in the system, gauge connections or a defective vacuum pump. In this case, it will be necessary to check for leaks as outlined later, after a small amount of Refrigerant-12 has been added to the low side of the system.

a. Turn the hand shut-off valves at the low and high pressure gauge of the gauge set to the full clockwise position with the vacuum pump operating, then stop pump.

b. Connect flexible line from center fitting of the gauge set to refrigerant container (container should be at room temperature).

NOTE: It may be necessary to use reducer fitting J-8695-18 if attaching flexible hose to drum-type refrigerant container.

c. Open shut-off valve on container and loosen flexible line fitting at center fitting at gauge set so that refrigerant will purge all air from line. Tighten flexible fitting when certain all air has been purged from line.

d. Open suction valve on gauge set. This will allow refrigerant to pass from the container into the system. When pressure stops rising, close suction valve on gauge set and valve at refrigerant container (as refrigerant container is at room temperature, only a small refrigerant charge will enter the system).

e. Using leak detector J-6084, check all fittings in the system, compressor shaft seal and on the gauge set for evidence of leakage. When general area of leak has been found with the test torch, a liquid leak detector may be helpful in locating the exact point of leakage. After leak has been corrected, evacuate the system again for 15 to 20 minutes.

6. Turn the hand shut-off valves at the low and high pressure gauge of the gauge set to the full clockwise position with the vacuum pump operating, then stop pump. Carefully check low pressure gauge to see that vacuum remains constant. If vacuum reduces, it indicates a leak in the system or gauge connections. See "NOTE" in step 5 previously for method of locating leak.

CHARGING THE SYSTEM

The system should be charged only after being evacuated as outlined in "Evacuating The System."

REFRIGERANT DRUM METHOD

1. Connect center flexible line of gauge set to refrigerant drum.

NOTE: It may be necessary to use adapter J-8695-18 to attach flexible line to refrigerant drum.

2. Place refrigerant drum in a pail of water which has been heated to a maximum of 125^{O}F.

> CAUTION: Do not allow temperature of water to exceed 125^{O}F. High temperature will cause excessive pressure and possible softening of the fusible safety plugs in the refrigerant drum. It may not be necessary to use hot water if a large drum is used (over approximately 100 pounds).

3. Place refrigerant drum (in pail of water) on scales (bathroom or commercial, preferably commercial) (fig. 12).

4. If line at center gauge fitting has not been purged of air, loosen line at center fitting on gauge set and "crack" valve on refrigerant drum to blow air from line. Retighten line at center fitting and record exact weight of refrigerant tank in water on the scales.

> CAUTION: When purging a line by cracking a fitting, wrap a cloth around connection to prevent injury due to release of pressurized refrigerant. Also, be sure to wear eye protection.

5. Open valve on refrigerant drum and both valves on gauge set to allow refrigerant to flow into the system. Continue charging until the scales show that 3-1/4 pounds of refrigerant have been transferred from refrigerant drum to the system.

NOTE: If full charge cannot be attained, close both valves on gauge set, start engine, place "AIR COND" lever to "ON," the "AIR" lever to "OUTSIDE," and then place "TEMP" lever to full cold position. Open low pressure valve on gauge set slowly and leave open until full charge of 3-1/4 pounds of Refrigerant-12 is taken in.

> CAUTION: Observe high pressure gauge while charging with compressor running. Shut off engine if pressure exceeds 375 psi. A large fan placed in front of the vehicle will help reduce excessively high head pressure.

6. Close both valves on gauge set (high pressure valve will already be closed if charging was completed by running compressor) and close valve on refrigerant drum.

NOTE: If the engine was used to complete the Refrigerant-12 charge into the system, close valve on refrigerant drum to permit compressor to draw any refrigerant left in the line from the drum to the center fitting of the gauge set, then close the low pressure valve on the gauge set.

7. Operate engine at 2000 rpm with "TEMP" control knob at full cold position and blower control for high speed with "AIR" lever to "OUTSIDE." After ten minutes of operation observe appearance of refrigerant in receiver-dehydrator. If bubbles are observed, open low pressure gauge valve and valve on refrigerant drum to allow more refrigerant to enter system. Close valve when receiver-dehydrator clears up.

NOTE: If air inlet temperature is below 70^{O}F., when this check is made, bubbles may appear even though the proper amount of refrigerant is in the system. Air inlet temperature must be 70°F., or above to make an accurate check. In no case should the system be charged with more than 3-1/4 lbs. of refrigerant.

8. When refrigerant has been injected, continue to operate system and test for proper operation as outlined under "Performance Testing."

9. When satisfied that air conditioning system is operating properly, stop engine, remove gauge set and replace protective caps on compressor fittings.

> CAUTION: A considerable amount of refrigerant will collect in the high pressure line, since some of this refrigerant will have condensed into liquid refrigerant. Wrap the high pressure gauge fitting at the compressor with a shop cloth before disconnecting the Schrader valve from the gauge fitting, to prevent injury to personnel.

10. Using leak detector J-6084, check complete system for leaks, as explained later under "Checking For Leaks."

REFRIGERANT-12 DISPOSABLE CAN METHOD

After having depressurized, repaired (if necessary), and evacuating the refrigerant system, the system may be charged as follows when using Refrigerant-12 disposable cans:

1. Obtain five "one" pound cans of Refrigerant-12.

2. Mount four cans in J-6272-01 No. 4 Multi-opener or attach J-6271 Fits-All valve (single can opener valve) on one can.

> CAUTION: Make sure outlet valve on opener is closed (clockwise) before installing opener.

a. If the J-6272-01 No. 4 Multi-opener is used, raise locking lever, position four cans of refrigerant and force the locking lever down to secure cans and at the same time puncture the top of the can to make it ready for charging.

b. If the J-6271 Fits-All valve is used, back off the valve from the can top retainer, slip the valve on to the can and turn the valve into the retainer until tight. DO NOT open outlet valve during this operation as turning the valve into the retainer punctures the top of the can to make it ready for charging.

3. Connect center flexible line of gauge set to the fitting on a can opener valve.

NOTE: If line at center gauge fitting has not been purged of air, loosen line at center fitting on gauge set and "crack" valve at can opener (for a second or two) to force air from the line. Retighten line at center fitting.

4. Open valve on No. 4 Multi-opener (or on single can) and also low pressure and high pressure valves on manifold gauge set. Leave can valve open until all refrigerant has entered the refrigeration system. Close valve on can.

a. If the system is charged using single cans and the J-6271 valve, disconnect valve from can, leaving valve closed to flexible line to the center fitting of the manifold gauge set. Install valve on a new and full disposable can of Refrigerant-12, and repeat until three and one quarter "one-pound" cans of refrigerant have been used to charge the system. The system requires 3-1/4 pounds of refrigerant to have a proper charge. (Actually the net weight of refrigerant is 15 ozs. per can, therefore it will be necessary to use 3-1/2 to 4 cans. In no case should the system be charged with more than 3-1/4 pounds of refrigerant.)

If the J-6271 Fits-All valve for single cans is available, complete charging as explained in 4a previously.

5. Close valves on manifold gauge set.

6. Operate engine at 2000 rpm with "TEMP" control knob at full cold position and blower control for high speed with "AIR" knob in "OUTSIDE" position.

NOTE: If air inlet temperature at the condenser is below 70°F., when this check is made, bubbles may appear even though the proper amount of refrigerant is in the system. Air inlet temperature must be 70°F., or above to make an accurate check. In no case should the system be charged with more than 3-1/4 pounds of refrigerant.

7. When refrigerant has been installed, continue to operate system and test for proper operation as outlined previously under "Performance Testing."

8. When satisfied that air conditioning system is operating properly, stop engine, remove gauge set and replace protective caps on suction and discharge fittings.

> CAUTION: A considerable amount of refrigerant will collect in the high pressure line, since some of this refrigerant will have condensed into liquid refrigerant. Wrap the high pressure fitting at the compressor with a shop cloth before disconnecting the Schrader valve from the gauge fitting to prevent damage or injury to personnel.

9. Using leak detector J-6084, check complete system for leaks as explained later under "Checking For Leaks."

SERVICE STATION METHOD

The J-8393 Deluxe Portable Air Conditioner Service Station supplies all evacuating and charging equipment assembled into a compact portable unit.

1. Be certain compressor hand shut-off valves are closed to gauge fittings (counterclockwise).

2. Be certain all valves on charging station are closed.

3. Connect high pressure gauge line (with J-9459 attached) to compressor high pressure gauge fitting or to core remover Tool J-22132-01 (if used).

4. Turn high pressure hand shut-off valve one turn clockwise, and high pressure control (2) one turn counterclockwise (open). Crack open low pressure control (1) and allow refrigerant gas to hiss from low pressure gauge line for three seconds, then connect low pressure gauge line to low pressure gauge fitting on compressor. Place J-5420 adapter on hose, then attach adapter to gauge fitting or fitting core remover tool.

Filling Charging Cylinder

1. Open control valve on refrigerant container.

2. Open valve on bottom of charging cylinder allowing refrigerant to enter cylinder.

3. Bleed charging cylinder to valve (behind control panel) only as required to allow refrigerant to enter cylinder. When refrigerant reaches desired charge level (3-1/4 lbs.), close valve at bottom of charging cylinder and be certain cylinder bleed valve is closed securely.

NOTE: While filling the cylinder, it will be necessary to close the bleed valve periodically to allow boiling to subside so that refrigerant level in the charging cylinder can be accurately read.

Charging The System
Using Service Station J-8393

1. With charging station installed as previously described, remove low pressure gauge line at compressor.

2. Crack open high (No. 2) and low (No. 1) pressure control valves on station, and allow refrigerant gas to purge from system. Purge slowly enough so that oil does not escape from system along with refrigerant.

3. When refrigerant flow nearly stops, connect low pressure gauge line to compressor.

4. Turn on vacuum pump and open vacuum control valve (No. 3).

5. With system purged as directed previously, run pump until 26-28 inches of vacuum is obtained. Continue to run pump for 15 minutes after the system reaches 26-28 inches vacuum.

NOTE: In all evacuating procedures, the specification of 26-28 inches of mercury vacuum is used. These figures are only attainable at or near sea level. For each 1000 feet above sea level where this operation is being performed, the specifications should be lowered by 1 inch. Example: At 5000 ft. elevation, only 21 to 23 inches vacuum can normally be obtained.

6. If 26-28 inches vacuum (corrected to sea level) cannot be obtained, close vacuum control valve (No. 3) and shut off vacuum pump. Open refrigerant control valve (No. 4) and allow some refrigerant to enter system. Locate and repair all leaks.

7. After evacuating for 15 minutes, add 1/2 pound of refrigerant to system as described in step 6 previously. Purge this 1/2 pound and re-evacuate for 15 to 30 minutes. This second evacuation is to be certain that as much contamination is removed from the system as possible.

8. Only after evacuating as directed previously system is ready for charging. Note reading on sight glass of charging cylinder. If it does not contain a sufficient amount for a full charge, fill to the proper level.

9. Close low pressure valve on charging station. Fully open station refrigerant control valve (No. 4) and allow all liquid refrigerant to enter system. When full charge of refrigerant has entered system (3-1/4 lbs.), turn off refrigerant control valve (No. 4) and close both hand shut-off valves.

10. If full charge of refrigerant will not enter system, close high pressure control and refrigerant control valves. Start engine and run at slow idle with compressor operating. Crack refrigerant control valve (No. 4) and low pressure control on station. Watch low side gauge and keep gauge below 50 psi by regulating refrigerant control valve. Closing valve will lower pressure. This is to prevent liquid refrigerant from reaching the compressor while the compressor is operating. When required charge has entered system, close refrigerant control valve and close low pressure control.

11. System is now charged and should be performance tested before removing gauges.

ADDING REFRIGERANT
(SMALL AMOUNT)

The following procedure should be used in adding small amounts of refrigerant that may have been lost by leaks, or while opening system for servicing the compressor. Before adding refrigerant to replace that lost by leaks, check compressor oil level and add oil if necessary. See "Adding Oil" later. NOTE: This procedure will only apply if the air inlet temperature is above 70°F., at the condenser.

1. Remove caps from compressor gauge fittings. Attach gauge set to gauge fittings, making sure Schrader adapter is between low pressure gauge hose and suction gauge fitting, and between high pressure gauge hose and discharge gauge fitting.

AIR CONDITIONING

2. Start engine, turn air conditioning temperature control to full cold position, blower control for high speed, and also move "AIR" lever to "OUTSIDE." Operate for ten minutes at 2000 rpm to stabilize system.

3. Observe the refrigerant through the sight glass of the receiver-dehydrator with the system operating, to see if there are any bubbles evident.

a. If no bubbles are evident, then bleed system slowly through the discharge valve until bubbles appear in the receiver-dehydrator right glass. Add one pound of refrigerant as explained under "Charging The System."

b. If bubbles are visible in the receiver-dehydrator sight glass with the "TEMP" control knob at the full cold position and the blower at high speed, it indicates partial or complete plug in a line, or a shortage of refrigerant, or both. Correct condition. Add refrigerant as explained below until the sight glass clears, then add another one pound of refrigerant.

4. Attach flexible hose from center fitting of gauge set loosely to refrigerant drum or on disposable can valves. Open high and low pressure valves on the gauge set slightly to purge pressure gauge lines of air. Tighten fitting of refrigerant drum or can, when satisfied that all air has been removed from gauge lines. Close (clockwise) both hand shut-off valves of gauge set.

5. Partially charge system.

a. Refrigerant-12 Drum Method.

(1) Place pail containing hot water that does not have a temperature exceeding 125°F., on scales, place refrigerant drum in pan containing water, note weight, and only open low pressure valve on gauge set.

(2) Start engine, move "Temp" control knob to full cold position, and place blower control for high speed. Operate engine for ten minutes at 2000 rpm to stabilize system.

(3) With compressor operating, slowly open valve on refrigerant drum and allow refrigerant to flow into system (through manifold gauge set) until liquid indicator clears up and immediately shut off valve at gauge set or on refrigerant drum. Check weight of refrigerant drum and pail of water. Then slowly open valve on gauge set (or refrigerant drum) and add one more pound of refrigerant. Note total amount of refrigerant added.

b. Refrigerant-12 Disposable Can Method (15 oz. per can).

(1) Make sure the outlet valve on the J-6271 Fits-All valve is fully clockwise and attach the J-6271 to a "one pound" can of refrigerant as follows: Back off the valve from the top of the retainer, slip the valve onto the can and turn the valve into the retainer until tight. DO NOT accidentally open outlet valve during this operation as turning the valve into the retainer punctures the top of the can to make it ready for charging.

(2) Connect center flexible line of gauge set to the fitting on the valve.

(3) Start engine, place "TEMP" control knob to full cold position and blower control for high speed with "AIR" knob in "OUTSIDE" position. Operate engine for ten minutes at 2000 rpm to stabilize system.

(4) With compressor operating, slowly open valve on refrigerant can and allow refrigerant to flow into system (through manifold gauge set) until liquid indicator clears up and immediately shut off valve at gauge set and on refrigerant can. Check weight of can and valve assembly and record.

(5) Add an additional one pound of refrigerant by adding refrigerant from the can just weighed until can is empty. Attach another can and add refrigerant until can and valve assembly weigh the same as recorded.

6. Close valves at refrigerant drum or can.

7. Test for leaks and make operational check of system as outlined under "Performance Testing."

CHECKING COMPRESSOR OIL LEVEL AND ADDING OIL

The refrigeration system with the six-cylinder axial compressor requires 11 fluid ozs. of 525 viscosity oil. After the system has been operated, oil circulates throughout the system with the refrigerant. Hence, while the system is running, oil is leaving the compressor with the high pressure gas and is returning to the compressor with the suction gas.

NOTE: The oil level in the compressor should not be checked as a matter of course, such as is done to the truck engine crankcase.

In general, the compressor oil level should be questioned only in cases where there is evidence of a major loss of system oil such as:

1. Broken hose or severe hose fitting leak.
2. Oil sprayed in copious amounts under the hood due to a badly leaking compressor seal(s).
3. Collision damage to refrigeration system components.

REPLACING REFRIGERATION SYSTEM COMPONENTS OTHER THAN COMPRESSOR

When refrigerant system components other than the compressor are replaced, the compressor must also be removed and oil drained from the compressor. The amount of oil to put back into the compressor is found as follows: DO NOT add any more oil than is necessary or maximum cooling will be reduced.

1. Remove the compressor and place in a horizontal position with the compressor drain plug downward, drain compressor in an empty graduated bottle, measure the amount of oil and discard this oil.

2. If the quantity of oil measured is more than 4 fluid ozs., replace into the compressor the same amount of clean oil as the oil drained, plus the following amount for the refrigeration system component being changed.

a. Evaporator - 3 fluid ozs.

b. Condenser - 1 fluid oz.

c. Receiver-dehydrator assembly - 1 fluid oz.

Neglect any fluid oil coating loss in case of line change.

3. If the oil quantity drained from the compressor is less than 4 ozs., replace into the compressor 6 fluid ozs. of clean oil, plus the amount shown previously for the respective component replacements.

4. Replace compressor and system components.

5. Evacuate, charge and perform operational test.

CHECKING FOR LEAKS

Leak detector J-6084 as used for checking for leaks in system, is a gas-operated torch-type leak detector using a replaceable cylinder.

ASSEMBLING AND LIGHTING THE UNIT

1. Remove dust cap from cylinder.

2. Close valve knob on detector unit.

3. Thread detector unit onto top of fuel cylinder. Tighten finger tight.

4. Attach search hose assembly to detector unit (fig. 13).

5. Open control valve until slight hiss of gas is heard, then light gas at opening in chimney.

> CAUTION: Do not use lighted detector in any place where combustible or explosive gases, dusts or vapors may be present.

6. Adjust the flame until the desired volume is obtained. A pale blue flame approximately 3/8" above the reaction plate is best for detecting leaks.

NOTE: The reaction plate will be heated to a cherry red.

CORRECTION FOR YELLOW FLAME

If the flame is yellow, insufficient air is being inspirated or the reaction plate is dirty. Insufficient air may be caused by:

1. Obstructed or partially collapsed suction tube.

2. Dirt or foreign substance in burner tube.

3. Dirty or partially clogged orifice.

Blowing air through the suction tube and back through the detector will usually clear dirt or foreign matter. If a yellow flame is caused by dirty reaction plate, allow the flame to burn for several minutes. This will usually burn the plate clean. If an oxide film appears on the reaction plate from continued use, it will reduce the sensitivity of the detector. This may be remedied by removing the plate and scraping the surface gently with a knife.

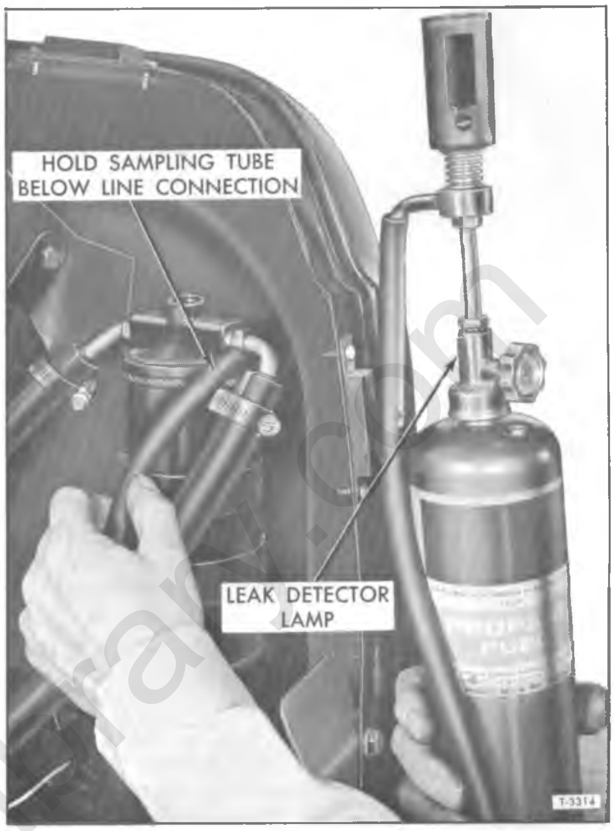


Figure 13—Checking for Refrigerant Leak

TO CLEAN ORIFICE

1. Never attempt to clean orifice by passing anything through the hole.

2. Unthread burner head assembly from burner tube. This will expose orifice block which is inserted into the end of the tube.

3. Remove orifice block from tube.

4. Reverse orifice block and replace against burner tube; thread burner head onto burner tube

(hand tight), then open valve quickly, admitting several short blasts.

5. To reassemble: Unthread burner head, insert orifice block into burner tube, and thread burner head onto burner tube with a wrench to form a gas-tight joint.

Replacement parts can be obtained from Kent-Moore Corp., Detroit, Michigan.

CHECKING FOR REFRIGERANT LEAKS

After the leak detector flame is adjusted, check for refrigerant leaks in an area having a minimum amount of air flow in the following manner (see fig. 13):

Explore for leaks by moving end of sampling tube around all connections and points where a leak may be. Check around bottom of connections, since Refrigerant-12 is heavier than air and will, therefore, be more apparent at bottom of fitting.

The color of the flame will turn to a yellow-green when a small leak is detected. Large leaks will be indicated by a change in color to brilliant blue or purple. When the suction hose is moved away from the leak the flame will clear to an almost colorless pale blue again.

> CAUTION: Do not breathe the fumes and black smoke that are produced if the leak is a big one. They are poisonous! Any time an open flame is used near a vehicle there is a certain amount of danger. Although the torch flame is small and well protected, it is recommended that fire extinguisher be close at hand for any emergency that might arise.

LIQUID-TYPE LEAK DETECTORS

There are a number of fittings and places throughout the air conditioning unit where a liquid leak detector solution may be used to pinpoint leaks. By merely applying solution to the area with the swab that is usually attached to the bottle cap, bubbles will form within seconds if there is a leak.

For confined areas, such as sections of the evaporator and condenser, the torch-type detector is the only practical kind which should be used for determining leaks.

ELECTRONIC LEAK DETECTOR

An electronic leak detector for detecting refrigerant leaks is also available. Instructions for operation of this type detector are supplied with the unit.

REPLACING COMPRESSOR

The compressor removed must be closed immediately. See lower View of figure 14 which shows a closure plate which can be improvised and installed as shown.

If the system has been or can be operated for more than two minutes, circulation of oil from the compressor to other components of the system will require adjustment of the oil charge in the new compressor as explained previously, under "Replacing Components Other Than Compressor."

After draining and measuring the oil from the crankcase, the amount that has migrated to other parts of the system can be determined by subtracting the amount drained from the original oil charge of 11 fluid ozs. The amount of oil equal to this loss shall be drained from the new compressor assembly before it is installed.

REPLACING AN OPERABLE COMPRESSOR

After idling compressor (on vehicle) to be replaced for 10 minutes at 1500-2000 engine rpm, at maximum refrigeration and blower at high speed: DO NOT add any more oil to the compressor than is necessary or maximum cooling will be reduced.

1. Compressor replaced with service compressor assembly.

a. Remove compressor and place in a horizontal position with drain plug downward, drain compressor, measure quantity of oil drained and then discard it.

b. Drain oil from replacement compressor and save it.

c. (1) If amount of oil drained in "a" previously is more than 4 ozs., place into the new compressor the same amount of oil drained from the replaced compressor.

(2) If amount of oil drained in "a" previously is less than 4 ozs., place 6 ozs. of oil in the replacement compressor.

d. Install compressor.

2. Compressor replaced with a field repaired (overhauled) compressor.

a. Proceed as in step 1 previously, and then add one extra oz. of oil. (More oil is retained in a drained compressor than one that has been rebuilt.)

REPLACING AN INOPERATIVE COMPRESSOR

In the case when it is not possible to idle the compressor to be replaced to effect oil return to it the following will apply. DO NOT add any more oil than is necessary as maximum cooling will be reduced.

1. Remove compressor from vehicle, drain and measure the oil.

2. If amount drained in step 1 above is more than 1-1/2 fluid ozs., subtract this amount drained from the original oil charge of 11 ozs., to obtain "oil loss." Take the new compressor assembly and drain from it the amount of "oil loss" above; provided the refrigeration system shows no evi-

dence of a major leak, indicating that little or no oil has been lost from the system. (Minor leak indicating very slow leakage.)

3. If oil drained in step 1 previously contains any foreign material such as chips, or there is evidence of moisture in the system, replace the receiver-dehydrator assembly and flush all component parts, or replace if necessary. After flushing refrigeration system in this manner, the full oil charge should be left in the new service compressor or 11 ozs., installed in an overhauled or repaired compressor.

COMPRESSOR REMOVAL

1. Connect the high and low pressure gauge lines from the gauge set to the respective connections on the old compressor on the vehicle. Be sure valves on gauge set are fully clockwise to close gauge set to center fitting, and that a J-5420 or J-9459 Schrader adapter is between low pressure hose and suction gauge fitting, and also at the discharge gauge fitting.

2. Remove the flare nut from center connection on gauge manifold or the plug in the gauge line attached to the center connection. Wrap the line at the outlet with a cloth to protect persons and vehicle surfaces from oil or refrigerant.

3. Slowly depressurize refrigeration system as instructed previously under "Depressurizing The System."

4. While system is depressurizing, remove (if desired) clutch assembly and coil from old compressor. If parts are not oil soaked and are in good condition, lay them aside on a clean surface as they may be installed on the new compressor.

5. After the system is completely depressurized, very slowly loosen screw which retains compressor fittings assembly to compressor (see fig. 14). As screw is being loosened, work fittings assembly back and forth to break seal and carefully bleed off any remaining pressure.

> CAUTION: High pressure may still exist at the discharge fitting. If this pressure is released too rapidly there will be a considerable discharge of refrigerant and oil.

6. When all pressure has been relieved, remove fittings assembly and O-ring seals.

7. Immediately cover compressor openings. A simple way is with a plate (similar to the one on new compressor) which can be attached with fittings assembly screw, using the O-rings to provide a seal. See lower portion of figure 14.

8. Disconnect compressor clutch coil wire and remove compressor mounting plates to bracket bolts, front and rear.

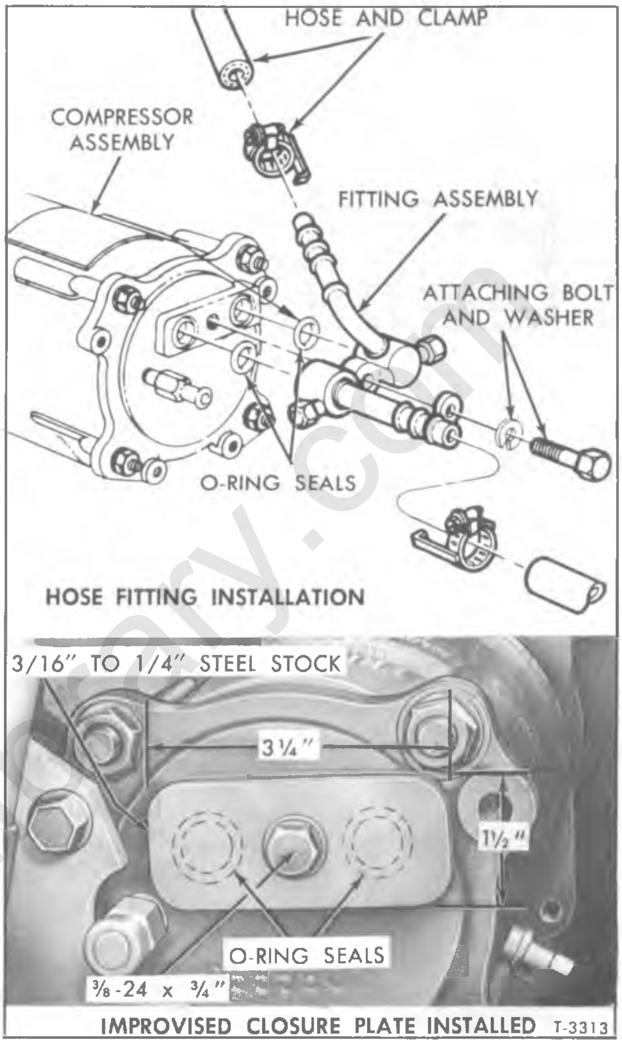


Figure 14—Compressor Fittings Installation

9. If there is any possibility that broken parts from the compressor got into the discharge line or the condenser, all refrigeration system parts should be cleaned and a new receiver-dehydrator assembly should be installed.

10. Drain all oil from compressor just removed in a clean dry container and replace compressor drain plug screw. Measure amount of oil drained. See "Checking Compressor Oil Level and Adding Oil" previously.

COMPRESSOR INSTALLATION

NOTE: Before installing a new compressor, rotate compressor shaft four or five times. This permits proper lubrication of compressor seal over all its surface. Before compressor clutch is mounted to the new compressor, wipe the front face of the compressor thoroughly with a clean dry cloth and, if necessary, clean front of compressor with a solvent to remove any excess oil. Cleaning compressor in this manner will prevent any oil

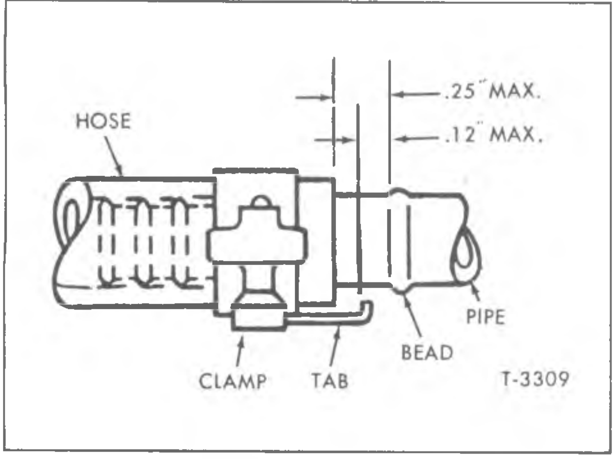


Figure 15—Hose and Clamp Properly Installed

from being thrown onto the clutch surfaces which would cause slippage and eventual clutch failure.

1. Stamp refrigerant charge of the refrigerant system on new compressor in space on plate provided for this information.

NOTE: Follow procedure for replacing oil in new compressor explained previously under "Removing Malfunctioning Compressor and Installing New Compressor."

2. Install new compressor to engine, leaving compressor fittings opening cover plate on the compressor.
3. Remove cover plate over compressor openings very slowly to bleed off pressure.

> CAUTION: New compressors are charged with a mixture of nitrogen and Refrigerant-12 and 11 fluid ozs. of Frigidaire-525 viscosity oil. If the cover is removed too rapidly, the oil will be blown out violently with the sudden release of pressure.

4. Install coil and clutch parts if not already installed.
5. Evacuate, charge and make a test of system as explained previously under "Performance Testing."

SERVICING LEAKING SEALS AND HOSES

When refrigeration system components other than the compressor are replaced, the compressor must also be removed and oil drained from the compressor if oil was sprayed in copious amounts due to severe leaks or broken lines. DO NOT add any more oil than is necessary or maximum cooling will be reduced. See "Checking Compressor Oil Level and Adding Oil" previously.

1. Replace leaking seal, hose, or line. See figure 15 for proper positioning of hose and hose clamp.

NOTE: The initial clamp screw torque is 25 to 32 inch-pounds. After short period of time, torque may drop off as low as 10 inch-pounds. Final torque the clamp screw to 20-25 inch-pounds.

2. Evacuate, charge and make performance test.

CONDENSER ASSEMBLY REPLACEMENT

NOTE: When refrigeration system components other than the compressor are replaced, compressor must also be removed and oil drained from compressor if oil was sprayed in copious amounts. See "Checking Compressor Oil Level and Adding Oil" explained previously.

1. Depressurize the refrigeration system.
2. Remove radiator grille.
3. Remove compressor discharge hose clamp at condenser inlet.
4. Remove hose from condenser inlet. Plug openings.
5. Disconnect hex nut connection at condenser outlet, then plug openings.
6. Remove four condenser assembly retaining bolts and remove condenser.
7. Replace by reversing the above procedures, using a new rubber O-ring seal well lubricated with clean compressor oil at line connection.
8. Evacuate and charge system.
9. Make a performance test.

RECEIVER-DEHYDRATOR ASSEMBLY REPLACEMENT

NOTE: When refrigeration system components other than compressor are replaced, the compressor must also be removed and oil drained from compressor if oil was sprayed in copious amounts due to leaks or collision damage to receiver-dehydrator. See "Checking Compressor Oil Level and Adding Oil" explained previously.

1. Depressurize the system.
2. Disconnect inlet and outlet connections of receiver at receiver-dehydrator assembly and plug openings.
3. Loosen the receiver-dehydrator assembly clamp screws and remove assembly.
4. Replace the receiver-dehydrator assembly by reversing the previous procedures, using new rubber O-ring seal, well lubricated with clean compressor oil, at line connection.
5. Evacuate complete system.
6. Charge complete system.
7. Make performance test.

EXPANSION VALVE REPLACEMENT

NOTE: When refrigeration system components other than the compressor are replaced, the compressor must also be removed and oil drained from the compressor if oil was sprayed in copious amounts due to leaks or collision damage to valve. See "Checking Compressor Oil Level and Adding Oil" explained previously.

1. Depressurize the system.
2. Drain the cooling system.
3. Remove the evaporator and heater core unit from under dash as directed later under "Evaporator, Heater Core and Blower Replacement."
4. Remove the heater core from unit after removing unit lower cover.
5. Disconnect expansion valve capillary tube bulb at evaporator outlet pipe.
6. Disconnect expansion valve equalizer line at suction throttling valve.
7. Disconnect thermostatic expansion valve inlet and outlet connections carefully, as some pressure may still exist, and plug openings.
8. Separate unit upper cover, then lift out the coil assembly. Remove expansion valve, noting amount of oil that drains from fittings, and plug openings.
9. Replace by reversing the previous procedure, using new rubber O-ring seals, well lubricated with clean compressor oil, at each fitting connection.
10. Evacuate and charge system.
11. Make a performance test.

SUCTION THROTTLING VALVE REPLACEMENT

NOTE: When refrigeration system components other than the compressor are replaced, the compressor must also be removed and oil drained from the compressor if oil was sprayed in copious amounts due to leaks or collision damage to core. See "Checking Compressor Oil Level and Adding Oil" explained previously.

1. Depressurize the refrigeration system.
2. Disconnect expansion valve equalizer line at the suction throttling valve plug openings.
3. Disconnect suction valve to compressor hose elbow.
4. Disconnect suction valve from evaporator outlet. Remove two bracket attaching cap screws, then remove valve.
5. Replace the suction throttling valve by reversing the above procedures, using new rubber O-ring seals, well lubricated with compressor oil, at each connection.
6. Evacuate complete system.
7. Charge complete system.
8. Make a performance test.

EVAPORATOR HEATER CORE ASSEMBLY REPLACEMENT

NOTE: When refrigeration system components other than the compressor are replaced, the compressor must also be removed and oil drained from the compressor if oil was sprayed in copious amounts due to leaks or collision damage to valve. See "Checking Compressor Oil Level and Adding Oil" explained previously.

1. Depressurize the system.
2. Drain coolant.
3. Disconnect heater hoses at cowl.
4. Disconnect air distributor tube from blower.
5. Disconnect all heating and cooling control cables. Also, disconnect blower motor ground wire at dash.
6. Disconnect refrigerant hoses from unit.
7. At base of unit, pull the drain tube from floor opening.
8. Remove four screws which attach unit to right side cowl. There are two at the top and bottom of unit.
9. At front of cowl remove single attaching bolt. Carefully remove unit from cab.
10. Replace evaporator unit and blower motor duct assembly by reversing previous procedures.
11. Evacuate and charge system.
12. Make a performance test.

COLLISION SERVICE

The severity and circumstances of the collision will determine the extent of repair required. Good judgment must be used in deciding what steps are necessary to put the system back into operation.

Each part of the system must be carefully inspected. No attempt should be made to straighten kinked tubes or repair any bent or broken units. Check especially for cracks at soldered connections.

REFRIGERATION SYSTEM OPEN TO ATMOSPHERE

Broken tubes or units will allow air, moisture and dirt to enter. These parts should be sealed as soon as possible until such time as they are replaced.

If the system is open for more than 15 or 20 minutes (depending on humidity), the receiver-dehydrator assembly will absorb an excessive amount of moisture and should be replaced, and each component of the system should be cleaned with dry nitrogen and flushed with liquid refrigerant to remove dirt and moisture.

FLUSHING SYSTEM

Flushing can be accomplished by connecting a refrigerant drum to the unit to be flushed and then turning the drum upside down and opening the drum

Figure 16—Blower Motor Wiring Connection

shut-off valve to force refrigerant through the unit. The unit should be supported so that the refrigerant passing through it will be directed into an area where -21.7°F., will do no damage.

> CAUTION: Remember that when liquid refrigerant is released from the drum into an area where atmospheric pressure exists, its temperature will immediately drop to -21.7°F.

In order to keep the expansion valve open when flushing the evaporator, the expansion valve bulb must be detached from the evaporator outlet tube.

INSPECTING COMPRESSOR

If there is no visible evidence of damage, rotate compressor shaft to test for normal reaction. A quick check for broken reed valves is to turn compressor shaft (using box end wrench on compressor shaft nut) and check for resistance when turning the shaft. An irregular resistance force will be felt as each of the pistons goes over top center for each revolution of the crankshaft. If this pattern is not felt, it indicates one or more broken compressor reed valves and the compressor must be repaired.

Inspect oil for foreign material which would indicate internal damage to the compressor. If no foreign matter is found in oil, compressor can be used. Flush entire refrigeration system with refrigerant, drain oil from compressor and pour in 11 oz. of new Frigidaire 525 viscosity oil.

BLOWER MOTOR REPLACEMENT

1. Disconnect motor ground wire from dash panel flange.
2. Pull motor switch lead at quick-disconnect terminal (fig. 16).
3. For access to blower mounting screws, pull back the cellular insulating material at motor hose plate. Remove screws, then pull motor assembly from shroud. Rotate hose plate so that cutoff is at the top before removing.
4. Install the motor unit by reversing the previous procedures.

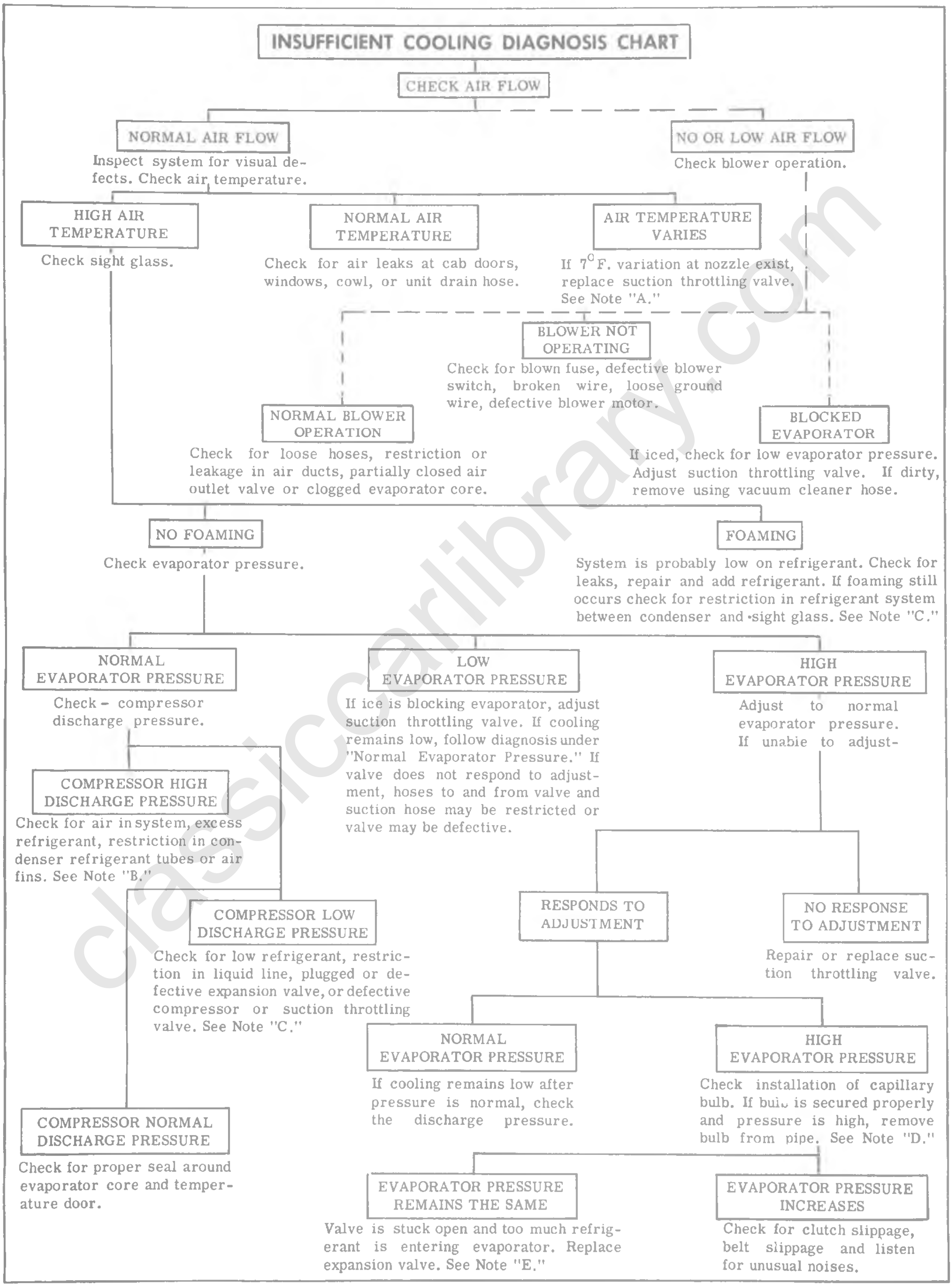
NOTE: After installing attaching screws, seal down the insulating material using a light coat of rubber cement.

SPECIFICATIONS

Refrigerant Capacity	3 lbs. 4 oz.
Refrigerant Oil Capacity (entire system)	11 oz.
Compressor Clutch Coil	
Current (maximum demand)	3.2 Amps. at 12v.
Resistance	3.85 Ohms. at 80°F.
Compressor Belt Tension (Using Tension Gauge)	
New	130 to 140 lbs.
Used	100 to 105 lbs.
Circuit Breaker	30 Amp.
Heater and AC Blower Fuse	15 Amp.
Evacuation Period (@ 26 to 28 in. of vac.)	15 to 30 min.

Refer to "Insufficient Cooling Diagnosis Chart" on following two pages.

AIR CONDITIONING



INSUFFICIENT COOLING DIAGNOSIS CHART NOTES

(Used in Conjunction With Chart on Opposite Page)

NOTE "A"

Suction throttling valve piston sticking; if stuck closed, no cooling due to lack of flow of refrigerant through the evaporator core; if stuck open no controlled cooling and cab may get too cold - evaporator may freeze. Replace valve.

NOTE "B"

System with excess discharge pressure should be slowly depressurized at the receiver-dehydrator inlet connection, observing the behavior of the high pressure gauge indicator.

1. If discharge pressure drops rapidly, it indicates air (with the possibility of moisture) in the system. When pressure drop levels but still indicates in excess of specifications shown in the OPERATIONAL TEST DATA CHART, slowly bleed system until bubbles appear in the sight glass and stop. Add refrigerant until bubbles clear, then add one (1) pound of refrigerant. Recheck operational pressures. If discharge pressure still remains above specifications and the suction pressure is slightly above normal, then a restriction exists in the high pressure side of the system.

2. If discharge pressure drops slowly, it indicates excessive refrigerant. If pressure drops to specifications and sight glass remains clear, stop depressurizing and recheck operational pressures. If pressures are satisfactory, depressurize until bubbles appear in the sight glass, stop depressurizing, then add one (1) pound of refrigerant. Recheck operational pressures.

3. If discharge pressure remains high after depressurizing the system, continue depressurizing until bubbles appear in the sight glass. If suction pressures also remain high, then the suction throttling valve may require adjustment, as well as a possibility of a restriction in the high pressure side of the refrigeration system. The system will have high pressure control more frequently under this condition.

Install gauge set and bleed off refrigerant from compressor suction and discharge side for 20 seconds. After 20 seconds close valves and recheck operating pressures. Repeat until discharge pressure is normal. Check sight glass; if bubbles appear it indicates that air was in system. Charge with refrigerant as follows: 2000 engine rpm, "OUTSIDE" air, "HI" blower and maximum cooling. Add refrigerant until sight glass clears, then add 1 pound additional.

NOTE "C"

Check for presence of bubbles or foam. If bubbles or foam is noted, charge with refrigerant as follows: 2000 engine rpm, "OUTSIDE" air, "HI" blower and Maximum Cooling. Add refrigerant until sight glass clears, then add an additional 1 pound.

NOTE: It is not unusual for bubbling to occur on minimum cooling and "LO" blower in mild weather even with a fully charged system.

NOTE "D"

Remove insulation and inspect for clearance between tube and bulb. If gap exists, move bulb to establish contact, reclamp and reinsulate.

NOTE "E"

Remove expansion valve and inspect internal screen for foreign objects. If present, there is a possibility seat is being held open. Install new expansion valve; if condition is corrected, discard the valve removed.

Refer to "Refrigerant Line Connections Torque Specifications" chart on following page.

REFRIGERANT LINE CONNECTIONS
TORQUE SPECIFICATIONS

OUTSIDE DIAMETER OF METAL TUBING (INCHES)	TORQUE FT.-LBS. (STEEL)	TORQUE FT.-LBS. ALUMINUM OR COPPER
1/4	10 - 15	5 - 7
3/8	30 - 35	11 - 13
1/2	30 - 35	15 - 20
5/8	30 - 35	21 - 27
3/4	30 - 35	28 - 33

NOTE: Steel torques to be used only when tube is mated steel-to-steel. If steel connection is made to aluminum or copper tube fittings, use appropriate "ALUMINUM OR COPPER" torque specifications.

SECTION 2
Frame

2

GENERAL

This section includes general instructions for checking frame alignment and recommendations for frame repair and reinforcement. It must be pointed out that the information is provided to assist in the repair or reinforcement of frames, using the most desirable practices. This section was prepared to aid competent personnel in the repair or reinforcement of frames.

Channel-type frame (fig. 1) construction with riveted crossmembers is used on all models. Frame side rails are usually of S.A.E. 1023 steel. Figure 1 illustrates typical arrangement of frame mounted suspension and body attaching brackets.

In the event the vehicle is damaged in a collision, carefully check for proper frame alignment in addition to steering geometry and axle alignment.

FRAME ALIGNMENT CHECK

The most convenient way to check frame alignment, particularly when the cab or body is on the chassis, is to select various corresponding points of measurement on the outside of each side rail and then, by use of a plumb bob, transfer these points to a layout on a level floor. (NOTE: Flange width may vary ± 3/16".) The selection of these points is an arbitrary matter; however, it is an important factor to remember that for each point selected on the left side rail, a corresponding point must be used on the right rail. The illustration (fig. 1) is used merely to serve as a guide in the selection of checking points "M."

In order to obtain reliable results, checking must be done thoroughly and accurately. After all corresponding points have been carefully transferred from the vehicle frame to the floor layout, move the vehicle away from the layout and proceed as directed in the following steps:

NOTE: Key letters in the following text refer to figure 1.

1. Check the frame width at front and rear ends using the corresponding marks on the floor. If widths correspond to specifications (refer to "Specifications"), draw centerline full length of vehicle layout bisecting points indicating front width (WF) and rear width (WR). If frame widths are not correct, layout centerline as directed in Step 4.

2. With centerline properly laid out, measure the distance perpendicular from the centerline to corresponding points on each side over the entire length of the chassis. If the frame is in proper alignment, measurement should not vary more than an 1/8" at any corresponding point.

3. Where improper alignment is encountered, the point at which the frame is sprung may be located by measuring pairs of corresponding diagonals marked "A" or "B." If the length of each pair of diagonals ("A" or "B") are within 1/8" and the intersection point of the diagonal pairs is within 1/8" of the centerline, the portion of the frame

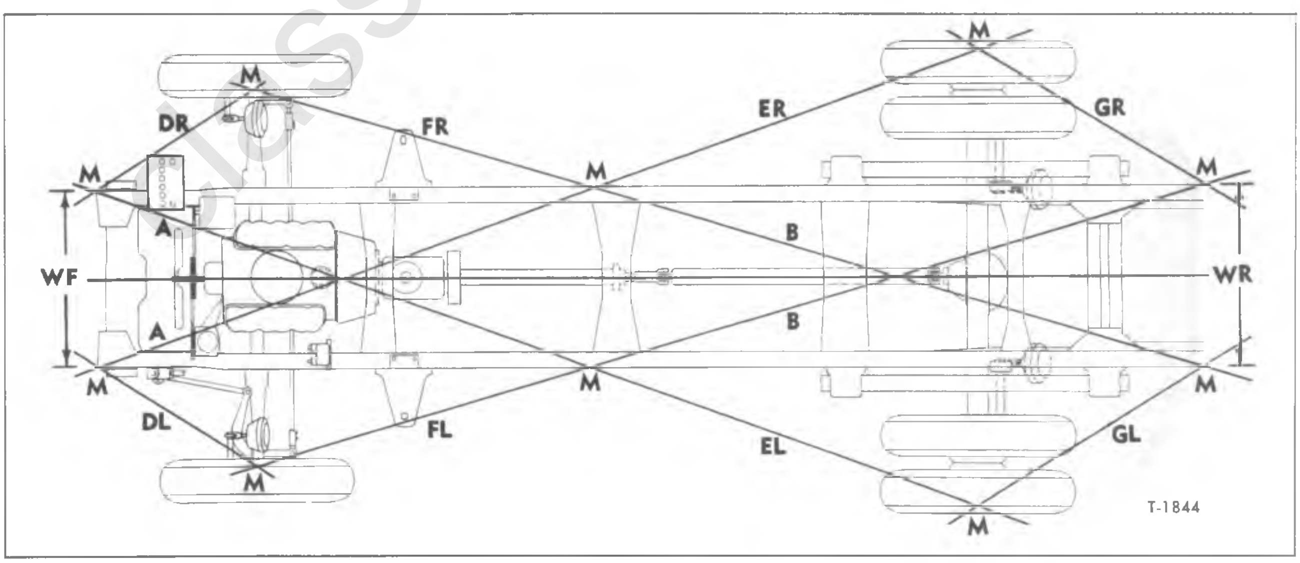


Figure 1—Typical Frame Alignment Points

included between the points of measurement may be considered to be in proper alignment. Variation of more than a 1/8" indicates misalignment.

4. If the frame centerline cannot be determined by method indicated in Step 1, the centerline may be established by drawing a line through the intersection points of equal pairs of diagonals or from the intersection of equal diagonals through the midpoint of either correctly established front or rear frame widths. This method is usually required when front or rear end damage is incurred as the result of a collision.

5. After it has been determined that the frame is properly aligned, axle alignment with respect to the frame can be checked as directed below: (See fig. 1.)

a. Front axle alignment with respect to the frame is correct if "FR" equals "FL" and "DR" equals "DL." This can be concluded if both front and rear frame ends have been established as properly aligned (Step 3).

b. Rear axle alignment with respect to the frame is correct if "ER" equals "EL" and "GR" equals "GL." NOTE: Alignment may appear to be off if rear ends of frame rails are not cut-off evenly when reducing cab to end of frame (CE) for specific operations.

Straightening Frames

The practice of straightening frames should not be attempted by inexperienced personnel, as more damage can result from improper methods. Internal stresses can be introduced into the material by improper frame straightening. For this reason the following restrictions should be adhered to completely:

1. Frame straightening should be attempted only by experienced personnel.

2. Heat may be applied to S.A.E. 1023 steel only by competent personnel. The material temperature should not exceed 1200^{O} (dull red glow). It must be strongly pointed out that excessive heat will damage the material structure characteristics of the frame rail.

3. Frame members which are bent or buckled sufficiently to show strains or cracks after straightening should be replaced.

IDENTIFICATION OF MATERIAL

The importance of properly identifying the base rail before attempting to straighten or repair cannot be overemphasized. The results of incorrect welding or straightening methods may cause more damage to the frame than was originally experienced. Frame stress concentrations resulting from improper welding methods are a major cause of future frame failures.

The standard models as quoted in the GMC Data Book describe the physical dimension of the frame rail and specify the type of material used. However, due to the number of RPO's and Special Quotations available on most models, the Data Book inspection is not always a valid identification.

The material can be identified by the type of cut-out in the frame side rail at the front axle center line.

Any reinforcements added must be of the same or better material than the base frame rail. This would permit the use of S.A.E. 950 reinforcements on S.A.E. 1023 base rails.

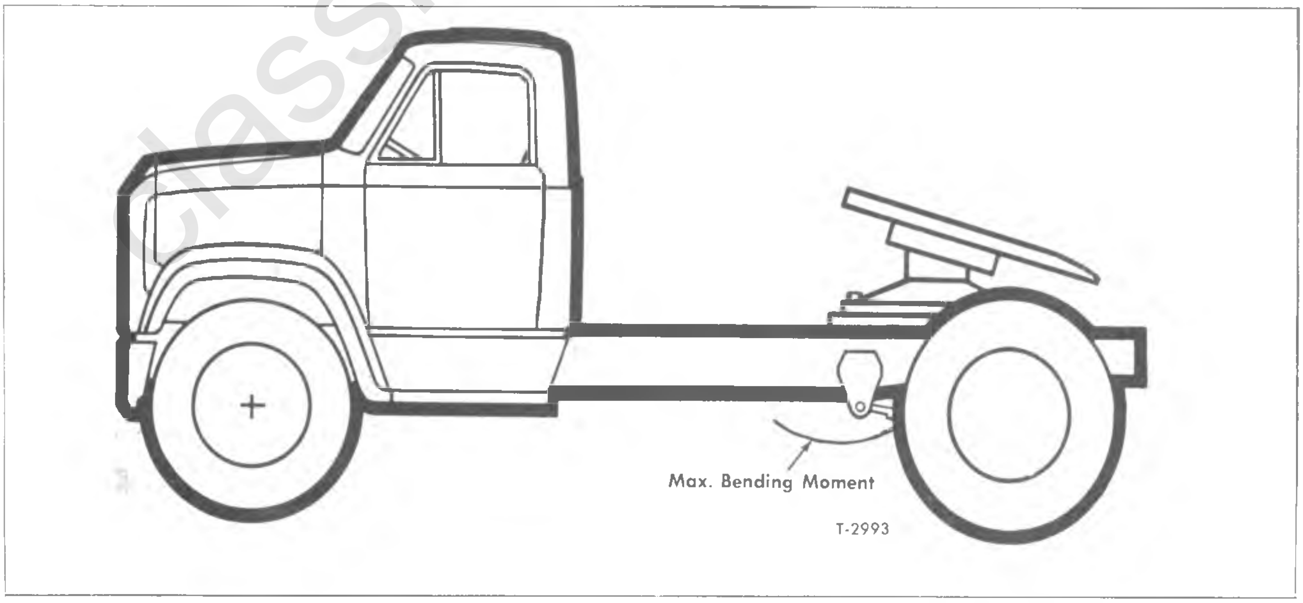


Figure 2—Frame Bending Moment (Typical Tractor)

Listed under "Specifications" at the end of this section are selected sizes of welding electrodes for use in repairing frame side rails. Recommended current ranges for various electrodes are given when performing either flat or overhead welding. When welding SAE-1023 steel, type E-7011 electrodes are recommended with type E-7016 suggested as an alternate. To ensure permanent frame repairs, correct material identification, proper electrode selection, and professional welding techniques are required.

ANALYZING FAILURE CAUSES

This analysis is not intended to cover the causes of all possible frame problems; however, it should be of valuable assistance in preparing complete, concise reports.

The purpose of this discussion is to emphasize the fact that frame failure don't just happen, there must be a cause or reason. An example of this would be a vehicle involved in a collision. The reason for failure in this case is apparent; however, other failures can be encountered where the reasons are not so apparent.

Frame failures can be classified by three types:
(1) Collisions
(2) Excessive bending moment
(3) Localized stress concentration

Failures caused by collision should be repaired, using proper methods and reinforcements, where necessary.

Excessive bending moment failures are caused by overload, improper weight distribution, or misapplication of the vehicle. Excessive bending moment failure will occur at different areas on various types of vehicles; therefore, for easier understanding, the effects of excessive bending moments will be discussed by type of vehicle.

TRACTORS

The maximum bending moment of vehicles used in tractor service is in the area of the leading edge of fifth wheel (fig. 2). Failures may be caused by overload, excessive fifth wheel setting, excessive fifth wheel heights, poor fifth wheel installations, severe operating conditions and severe braking operations (inertia of certain loads), which induce excessive bending moments in the frame. These failures will start at edge of lower flanges and progress across the frame flange and up the web section of the frame rail. Instances may occur where upper or lower frame flanges buckle.

STRAIGHT TRUCKS

The maximum bending moment occurs in the area near the rear of the cab on vehicles having van or platform bodies (fig. 3). Failures may be caused by overload or can occur when loads are dispersed in diminishing quantities allowing the balance of a load to remain in the extreme front of the body.

In both tractor and straight truck operation the highest tensile stress is applied to the bottom side of the lower frame flange. However, it must

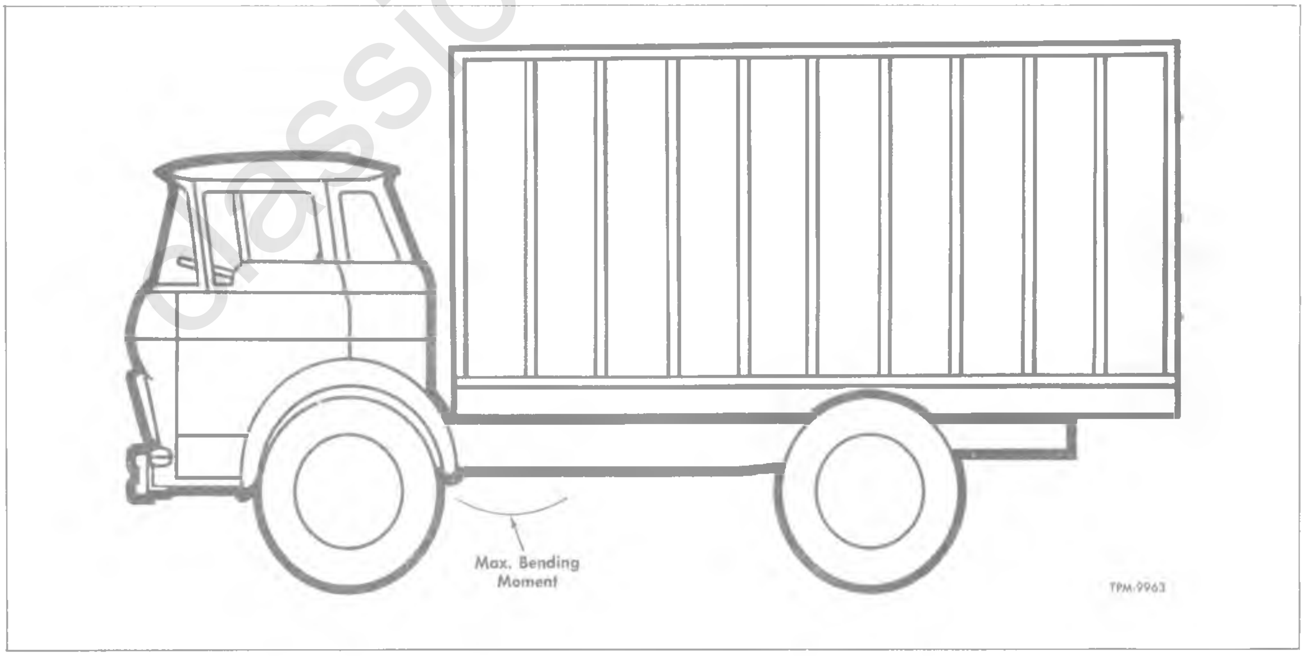


Figure 3—Frame Bending Moment (Typical Straight Truck)

be pointed out that dump trucks, as an example, when operated with the box in a raised position causes the center of gravity of the load to move behind the rear axle centerline resulting in a change of maximum tensile stress location from the bottom of the lower flanges to the top of the upper flanges (fig. 4). This information can be very useful when examining cracks on vehicles used in dump service, as it would appear that the vehicle has been operated at excessive speed over rough terrain while spreading with the dump box in the raised position or with too long a dump box for wheelbase selected.

Localized stress concentration failures may be the result of bending moment stresses; however, it must be pointed out that the stress levels would not be high enough to cause any difficulty without localized stress concentration points. These localized stress concentration points may be caused by poor body or fifth wheel mountings, special equipment or accessory installation, improper welding or welding methods, improper reinforcements, loose bolts or rivets and defective material. They may also occur as a result of high bending loads, coupled with severe torsional loads as may be found in off-road service.

The proper installation of fifth wheels or bodies is covered in the "Body Builder's Book"; however, it should be re-emphasized that the use of U-bolts for attachment of fifth wheels or bodies is not an approved installation as high stress concentration may develop. The desired fifth wheel or body mounting is attached to the frame rail web section, not through flanges. Heat-treated rails must not have attachments welded to the frame. Wood sills should be used between main rails and sub-frame on body installations to insure good load distribution.

Special equipment or accessory installation can cause high stress concentrations due to the method of attachment or the weight of the equipment. Holes should never be drilled through the flanges and rapid changes of section modulus should be avoided. These section modulus changes usually occur when large mounting plates are added for supporting special equipment. Heavy equipment mounted across the flanges or on the web of a side rail may cause enough stress concentration to cause failures at the nearest crossmember, bracket, or other frame stiffener or through a nearby hole in the frame flange.

IMPORTANT

Improper welding or welding methods are a major cause of stress concentration points, which may ultimately result in frame failure. (Refer to "General Welding Instructions.")

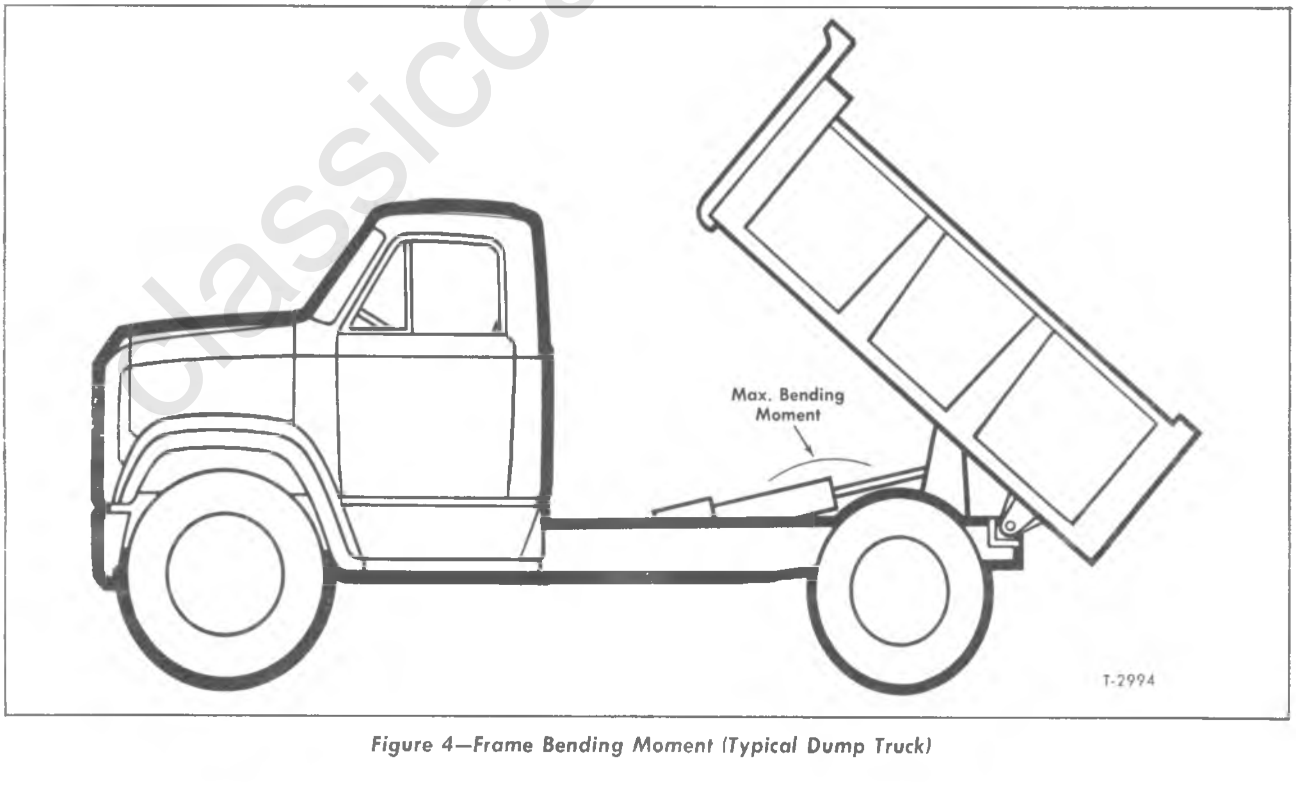


Figure 4—Frame Bending Moment (Typical Dump Truck)

Improper reinforcement or attachment of reinforcement may cause more difficulty than the original problem as the creation of localized stress concentrations may reduce the frame load carrying capacity below the original frame before adding reinforcements. The use of rivets for attaching reinforcement during field modification is generally not recommended due to the lack of proper riveting equipment in most service locations. For this reason it is recommended that most reinforcements be attached with 300-M bolts and that hardened washers be placed on both ends of the bolt to provide a good torquing surface and to maintain tight bolts.

GENERAL WELDING INSTRUCTIONS

Good welding is a very favorable method of attachment or repair; however, improper welding or welding procedure may result in further frame damage. Additives of reinforcements may be necessary in the repair area to prevent reoccurrence.

WARNING: Before welding, disconnect one or both battery cables.

WELDING EQUIPMENT

CAUTION

NEVER USE OXYACETYLENE FOR WELDING FRAME RAILS!!

There are several types of welding machines that are used for welding on frame rails. Listed below are the three most commonly used machines and their advantages:

1. DC (Rectifier Type) - This machine requires very little service as there are no moving parts, also reduces chance of arc blows.
2. DC (Motor-Generator Type) - The principle advantage is the power supply may be self-contained; thereby, this machine is readily portable and has very good voltage variation control and versatility with all types of electrodes.
3. AC - This is the least expensive and reduces possibility of arc blows; however, some difficulty may be encountered in striking an arc when using small diameter electrodes.

It is recommended that for all-purpose welding, the minimum capacity of any machine should be 350 amperes. There are four basic types of welding used in the repair or reinforcing of frame rails. All of these can be used with any type of material except heat-treated material which requires electrodes E12016 or E11018. Following are the descriptions of the types of welds:

a. Continuous Fillet Weld - This is used to weld a continuous bead along a reinforcement placed on the web section of the frame rail or for adding gussets or plates to crossmembers. Continuous fillet welds should never be made across frame flanges or along inside edges of frame flanges. When welding in the flat position use high range of electrode current and voltage chart. When welding overhead or in difficult areas, use low range of the electrode chart.

b. Groove Welding - This is a basic repair weld which is applied after the surface has been vee ground for good penetration. Particular care should be taken when welding cracks which cross either the upper or lower flanges. Weld completely then grind off the excess weld to eliminate the possibility of notches or weld build-ups on the flange edge. Use medium range of electrode chart.

c. Plug Welding - This is a good method of attaching reinforcements as it eliminates the possibility of loose fitting bolts; however, care must be exercised in locating plug welds in different types of reinforcements. E-6011 electrode is highly recommended for plug welding because of its good penetration and light coating. Use high range of electrode chart for flat or vertical plug welds. Overhead plug welding is very difficult and should not be used unless other approaches are not practical, then use high range for first pass and complete plug at medium range. Refer to plug weld table for size of hole to use for variations of material thickness.

d. Stitch (Intermittant Fillet) Welding - This type is not generally used on frames as continuous fillet welding provides better attachment; however, where warpage and heat control is critical, use stitch welding at medium range of electrode chart.

Other recommendations for all types of welding include:

1. Connect welding machine ground cables as close to working area as possible.
2. Where possible, use smaller diameter electrode and make several passes rather than large diameter electrode and single pass.

FRAME RAIL REPAIR

It is very important that repairs be correctly applied, as inadequate repairs will create additional localized stress concentration which may result in repeat failures. There are two basic types of cracks which may be encountered in frame difficulties (fig. 5). The straight crack or the multiple sunburst cracks which will radiate from a hole in the web section.

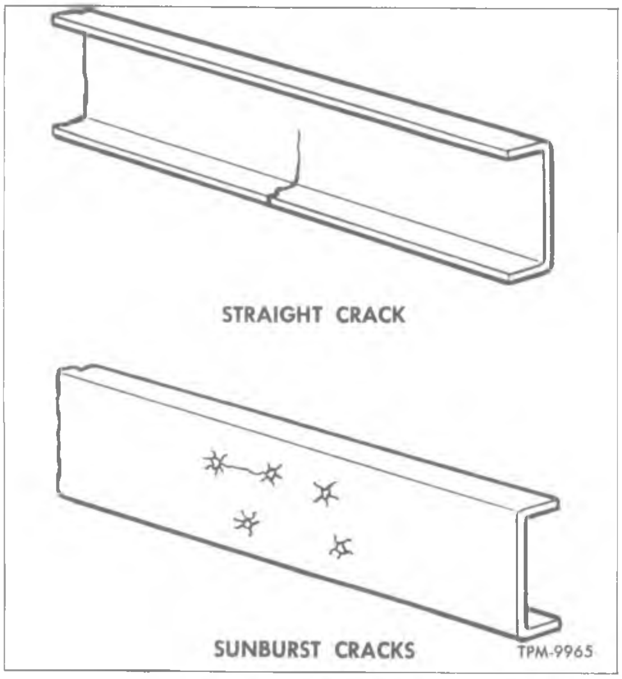


Figure 5—Types of Cracks

The straight crack will normally start from the edge of a flange and progress across the flange and then travel through the web section toward the opposite flange of the same rail. This may be caused either by localized stress concentration, excessive bending moment, or torsional loading. The sunburst type cracks are caused by high loads applied locally at the mounting bracket or crossmember whose attachment is not sufficiently adequate or is not securely fastened to the side rail.

In either case both types of cracks may be repaired using similar methods. The procedure for repairing frame rail cracks is as follows:

1. Remove any equipment that will interfere with workable access to the failure.
2. Locate the extreme end of the crack and drill a quarter inch hole. (NOTE: It may be necessary to align the frame and level the rails before repairing the frame.)
3. Vee grind the entire length of the crack from the starting point to the quarter inch hole at the extreme end. Using a hack-saw blade, the crack should be opened (1/16") to allow complete penetration of the weld.
4. Weld with proper electrode corresponding to the material of the basic rail.
5. Grind the weld smooth on both inside and outside of rail or reinforcement, being extremely careful to eliminate weld build-up or notches on the flange edges. (NOTE: Care should be taken when grinding not to reduce thickness of base rail.)
6. Quality and neatness of workmanship cannot be overemphasized. After the repair is completed, the repaired area should be painted and should not be readily discernible from the unrepaired area of side rail. Use a copper spacer between the flanges of cracked base rail flanges and reinforcement flanges and repair each flange separately as the flanges must react independently to prevent localized stress concentration.

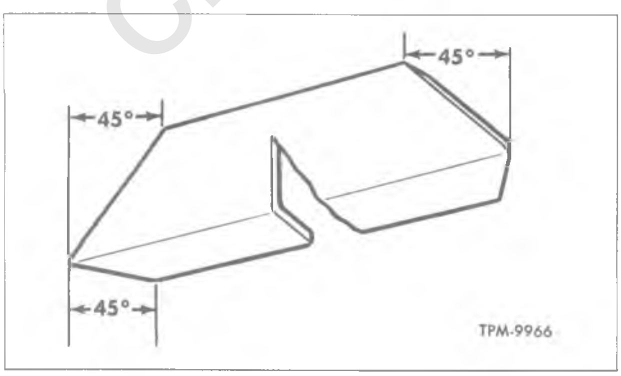


Figure 6—Scarfed (Tapered) Ends of Reinforcement

Buckled frame flanges should be straightened using proper alignment procedures, then an adequate reinforcement should be used (see frame reinforcement) or offending equipment remounted to obtain an improved transition of loaded to non-loaded areas. DO NOT USE OXYACETYLENE FOR WELDING FRAME RAILS.

Crossmember and Brackets

The repair of crossmembers may be accomplished if the damage is not extensive. Crossmember mounting flange cracks may be repaired in the same manner as side rail cracks; however, the weld bead should be built up to provide a good smooth radius. If extensive damage is incurred to a crossmember, the crossmember should be replaced, using bolts rather than rivets. All cast mounting brackets that are damaged should be replaced as it is not practical to weld a cast bracket. In the event that a frame crack appears in the area of cast bracket, the bracket must be removed while repair is made. Under no circumstances should a cast bracket be welded to the frame side rail.

REINFORCEMENTS

Review the discussion on analyzing causes of failures before applying reinforcement. A common misconception in the past was to patch a cracked frame. This is incorrect; reinforce the failed area. A reinforcement must be large enough (approx. 30 inches) to provide adequate stress relief from rapid changes in section modulus. For this reason it is extremely important that all reinforcement ends be scarfed to change section modulus as gradually as possible with the longest section installed (fig. 6) in the area of highest loads.

There are five basic types of reinforcements that may be used on truck frames. However, it must be pointed out that the material used for the reinforcement must be similar to that of the base rail. Base rails of S.A.E. 1023 material could use reinforcements of S.A.E. 950 material. S.A.E. 1023 rails may be reinforced with S.A.E. 1023 steel, but under no circumstances should strength of reinforcement be less than base rail. Figures 7 and 8 illustrate the five basic reinforcements.

1. Upright "L" Reinforcement - May be placed on either the inside or outside of the frame side rail. It should be used where maximum stress occurs at the bottom of the lower flange and buckling of the upper flange is not a problem. This reinforcement is quite versatile as it may be used in full length or in a short localized reinforcement. The configuration of the frame or spring hanger brackets may limit the use of the upright "L" reinforcement.

2. Inverted "L" Reinforcement - This may be used on the inside or outside of the frame rail. It is recommended where the maximum stress area is transferred to the upper flange; for example, dump trucks with the box in the raised position. This is also readily adapted where frame and hanger bracket design restricts using an upright "L" reinforcement or where frame upper flange buckling has been noted.

3. Channel Reinforcement - This may also be installed on the inside or outside of the frame side rail and can be full length or a localized reinforcement. The principle disadvantage of the channel is additional weight and hours of labor required to make an installation. Additional difficulty may arise when attempting to place the channel inside or over the existing rail due to manufacturing tolerances, cross members or mounting brackets.

4. Strap Reinforcements - This type of reinforcement may also be used to increase the section modulus of a frame if previous damage and repair has resulted in a loss of frame strength which would require additional modulus to return the frame strength to original design. These reinforcements are plug welded at 6 to 8 inch intervals. Do not weld across the end or along the flange edges. Ends should be cut at an angle and edges of plug welds must not be closer than 3/4" to the edge of a frame flange.

5. Inverted "J" Reinforcement - This is a rather new type of frame reinforcement that is designed to increase the flange strength to prevent flange buckling due to high torsional inputs or shock loading during tractor hook-up operations. The inverted "J" reinforcement is attached to the web section only with a spaced bolt pattern. This

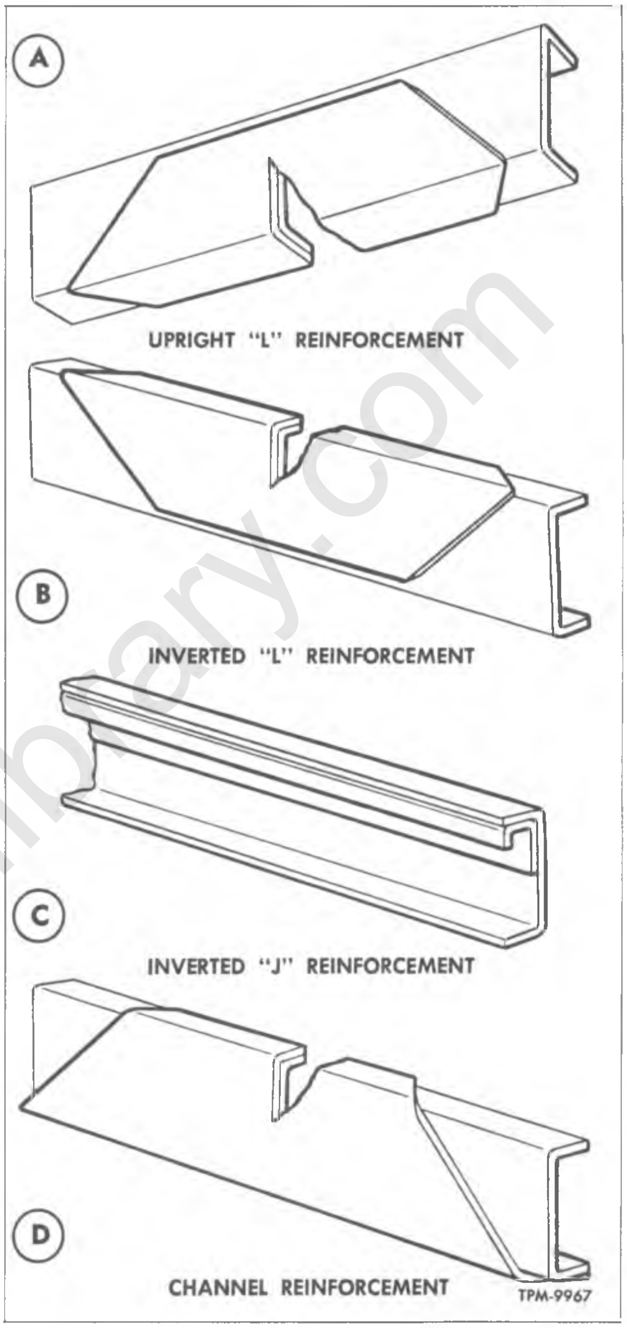


Figure 7—Frame Reinforcements

reinforcement has been released in six-foot lengths through the Factory Warehouse under GMC Part Number 2446489.

The attachment of reinforcement to the basic rail may vary somewhat with materials. The following general rules apply:

1. Do not use rivets. Proper riveting equipment is not generally available in most field service outlets; therefore, the use of 300M bolts and hardened flat washers are recommended.

2. Reinforcements, with the exception of strap

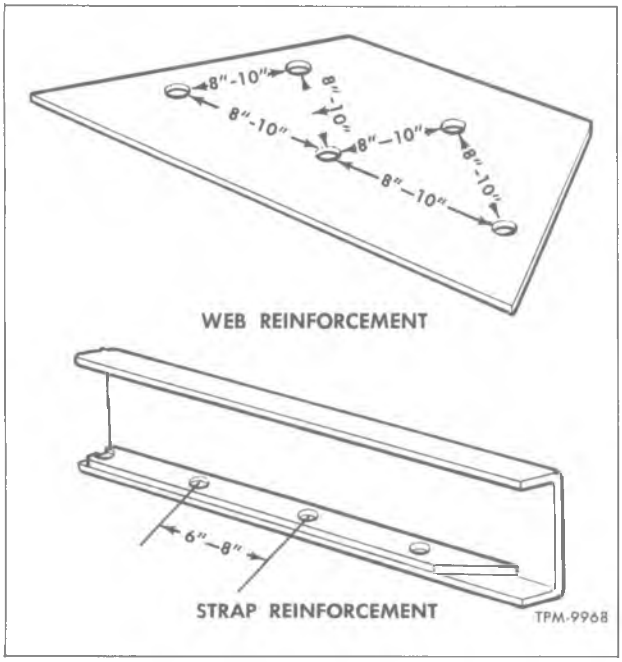


Figure 8—Plug Patterns of Strap Reinforcements

type, should not be attached to the flanges except in the case where a mounting bracket or crossmember holes are already through the frame flange.

3. Plug welds may be used in a staggered 8 to 10 inch pattern when attaching reinforcements to the web section (fig. 8).

4. Strap reinforcements may be plug welded at 6 to 8 inch intervals to the flanges in some cases; however, as pointed out, this is for section modulus increase and should only be attempted by highly qualified specialists.

The termination of reinforcements is very important. Reinforcement ends must be scarfed or stress relieved to prevent localized stress concentration. This scarfing should not be greater than 45° (fig. 6). It should also be strongly emphasized that in cases where several reinforcements are used, the ends of the reinforcements must overlap and be staggered so that the reinforcement ends overlap by eight to ten inches.

— CAUTION —
GENERAL RULES

Listed below are general rules which apply to frame repair and reinforcements. Most of these rules are discussed earlier in this section; however, the importance of adhering to them cannot be overemphasized.

1. Always identify the material of base rail.

2. Frame straightening or repair must be attempted only by highly qualified specialists.

3. Always attempt to identify the cause of failure.

4. Fifth wheel, body, and accessory mountings should not be made through frame flanges. (See "Body Builder's Book".)

5. Do not drill holes in the lower flanges.

6. Use only proper electrodes as specified for base rail material when welding is necessary.

7. Do not use oxyacetylene welding equipment on frames.

8. Do not weld reinforcements across the frame flanges.

9. Do not weld within 3/4 inch of the edge of a frame flange.

10. Remove all notches or weld build-ups from flange edge when repairing a broken frame.

11. Do not weld cast brackets to frame.

12. Do not weld the flanges of cracked reinforcements and base rails together.

13. Do not patch cracks. Reinforce the area.

14. Reinforcement should be of the same or better material than base rail.

15. Always scarf reinforcement ends to provide adequate stress relief.

16. Always stagger ends of reinforcements by a minimum of eight inches apart.

17. Before welding, disconnect negative battery cable to prevent possible electrical damage to generating system.

FRAME SPECIFICATIONS

ELECTRODE CHARTS

E-7011

Available Sizes	Flat Welding Current Range	Arc Voltage
3/32" X 12"	45—80	21—23
1/8" X 14"	80—115	21—23
5/32" X 14"	125—165	22—24
3/16" X 14"	160—200	22—24
7/32" X 18"	200—250	23—25
1/4" X 18"	250—320	23—25
5/16" X 18"	325—400	24—28
	Overhead Welding	
5/32" X 12"	45—75	20—22
1/8" X 14"	80—110	20—22
5/32" X 14"	125—150	21—23
3/16" X 14"	150—175	21—23

E-7160

	Flat Welding	
5/64" X 9"	30—60	20—22
3/32" X 12"	50—80	20—22
1/8" X 14"	90—125	22—24
5/32" X 14"	120—190	22—24
3/16" X 14"	175—240	22—24

PLUG WELD CHART

Thickness of Material	Diameter of Plug	Depth of Plug
1/4	3/4	1/4
3/8	1	3/8
1/2	1 1/8	7/16
5/8	1 1/4	1/2
3/4	1 3/8	9/16
1	1 1/2	9/16

FRAME WIDTHS

Model	Front Width*	Rear Width*
Cowl and Cab (E4500/5500)	34"	34"
Cowl and Cab (all others)	34 1/8"	34 1/8"
Tilt Cab	53 3/8"	34 1/16"

*Outside Dimension of Base Rails

ELECTRODE USAGE WITH FRAME MATERIAL

Material	SAE-1023
Type of Electrode	E-7011
Alternate Electrode	E-7016

Side Rail Material Identification
(Location—Centerline of Front Axle)

SAE1023

Frame repairs should be undertaken only by competent mechanics, and only the recommended materials should be used.

SECTION 3
Front Suspension

This group is divided into four sub-sections as shown in index below:

3

SECTION 3A
Front End Alignment

Proper alignment of front wheels must be maintained to insure efficient steering and satisfactory tire life. The most important factors of front end alignment are wheel toe-in, wheel camber, and axle caster. Front end alignment should be checked at regular intervals, and particularly after front axle has been subjected to heavy impacts such as a collision or a hard curb bump. Before checking alignment, wheel bearings must be properly adjusted since loose wheel bearings will affect instrument readings when checking wheel toe-in, wheel camber, and axle caster.

When checking alignment, instructions outlined in this section should be followed carefully, as well as instructions covering related units such as brakes, springs, steering gear, hubs and bearings, and wheels and tires, which are given in other sections of this manual. Front End Alignment Chart (fig. 1) indicates points at which alignment dimensions are taken.

The caster, camber, and toe-in dimensions are for vehicle at design load (with frame level). If frame is not level on alignment equipment, the frame angle must be considered. This is especially important when making caster check for the frame angle must be added to the caster angle to obtain a true setting. All alignment checking should be done with precision equipment and instruments. Refer to "Alignment Specifications" at end of this section.

DEFINITION OF TERMS

WHEEL TOE-IN

Distance front wheels are closer together at front than at rear of axle (see "E" and "F," fig. 1).

WHEEL CAMBER

Amount wheels are inclined from vertical plane (see "C," fig. 1).

FRONT AXLE CASTER

Inclination of king pin from the vertical in the fore and aft direction of the vehicle (see "G," fig. 1).

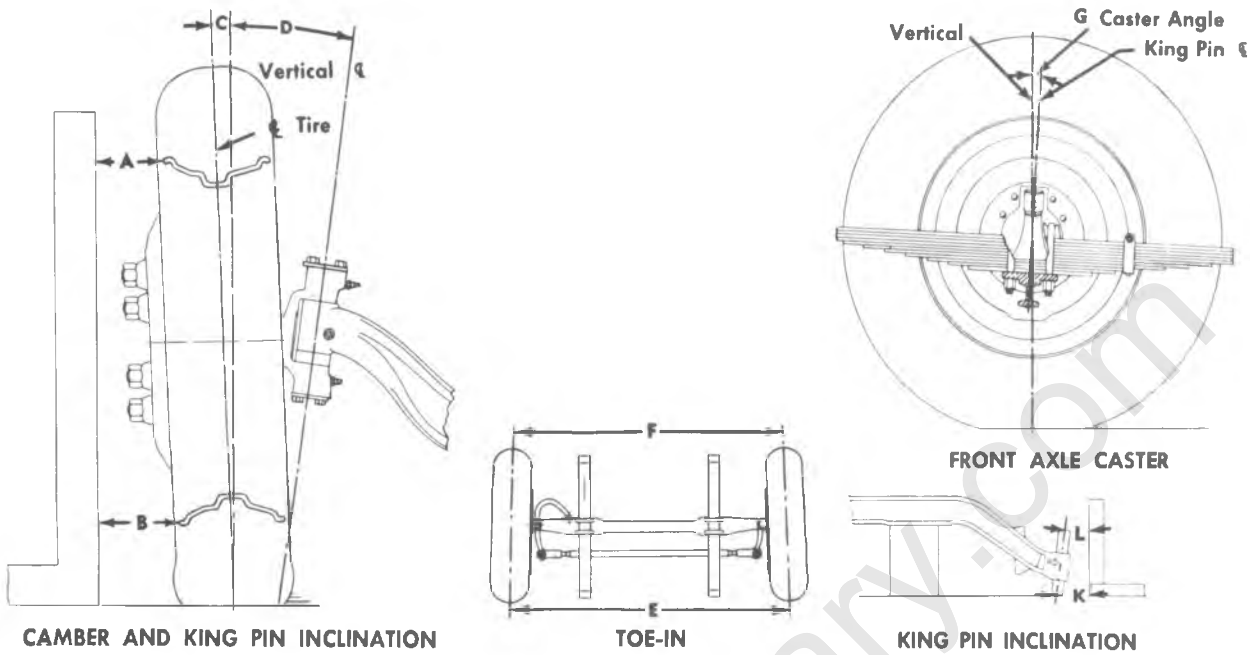
KING PIN INCLINATION

The slant of the king pin toward the center of the vehicle at the top and outward at the bottom (see "D," fig. 1).

SERVICE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Noisy Front End	1. Loose tie rod ends.	1. Replace ends.
	2. Lack of proper lubrication.	2. Refer to LUBRICATION (SEC. 0).
	3. Broken spring leaf.	3. Replace spring leaf.
	4. Loose U-bolts or spring clips.	4. Tighten
Wheel Bounce	1. Unbalanced wheels or tires.	1. Refer to "Balancing" (SEC. 10).
	2. Unequal tire pressure.	2. See "Load and Inflation Table" (SEC. 10).
	3. Weak or broken front spring.	3. Replace.
	4. Excessive wheel or tire runout.	4. Refer to WHEELS AND TIRES (SEC. 10).
Excessive Tire Wear	1. Incorrect wheel alignment.	1. Align wheels (SEC. 3A).
	2. Failure to rotate tires.	2. Refer to WHEELS AND TIRES (SEC. 10).
	3. Improper tire inflation.	3. Refer to "Load and Inflation Table"(SEC.10)
	4. Overloaded or improperly loaded.	4. Avoid overloading vehicle.

FRONT END ALIGNMENT



B MINUS A . . . . Camber (Inches)
C . . . . Camber (Degrees Positive)
D . . . . King Pin Inclination (Degrees)
E MINUS F . . . . Toe-in (Inches)
G . . . . Caster (Degrees Positive)
K MINUS L . . . . King Pin Inclination (Inches)

Refer to "Specifications" for correct dimensions.

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Figure 1—Front End Alignment Chart

FRONT END INSPECTION

Before checking front end alignment, the following front end inspection should always be made:

1. Check tires for proper inflation. NOTE: Rim-to-floor dimension should be the same at each wheel.
2. Check wheel installation and run-out.
3. Check wheel bearing adjustment.
4. Check steering tie rod and drag link ends for looseness.
5. Check king pins for looseness.

CHECKING AND CORRECTING FRONT WHEEL TOE-IN

Incorrect toe-in results in excessive tire wear caused by side slippage and also unstable steering with a tendency to wander. Toe-in may be measured from center of tire treads or from inside of tires. Measurements at both front and rear of axle (see "E" and "F," fig. 1).

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 when in operation. 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 operating position. Neutralizing the front suspension is extremely important, especially if the vehicle has been jacked up in order to scribe the tires, otherwise the front wheels will not return to the normal operating position due to the tires gripping the floor surface when the vehicle is lowered on the jack.

IMPORTANT

"TOE-IN" MEASUREMENTS MUST BE MADE AT THE HORIZONTAL AXIS OF THE WHEEL.

"Toe-in" is corrected by loosening clamp bolt at tie rod ends, then turning tie rod with pipe wrench until wheels have proper toe-in. On some vehicles with power steering, loosen the power cylinder to tie rod "U" bolt nuts. With both tie rod ends in same plane, tighten clamp bolts securely. Refer to "Specifications" for correct toe-in.

On some vehicles with power steering, tighten power cylinder to tie rod bracket "U" bolt nuts. Adjust power cylinder as directed in "POWER STEERING" (SEC. 9B) of this manual.

NOTE: Tie rod clamps must be lined up with slots in tie rod tube or difficulty in tightening clamps securely will be experienced.

FRONT WHEEL CAMBER

Camber is the amount in inches or degrees that front wheels are tilted outward at top from vertical position (see "C," fig. 1). Camber offsets wheel deflection, due to wear of front axle parts, and prevents a reverse or negative camber condition. A reverse or negative camber is an inward inclination of wheels at the top.

If camber is extreme or unequal between wheels, improper steering and excessive tire wear will result. Camber variations may be caused by wear at wheel bearings and steering knuckle bushings, or by a bent steering knuckle or axle center.

Specifications are listed at end of this section.

CHECKING AND CORRECTING CAMBER

Before checking camber, check wear at king pins as follows:

Jack up front of vehicle, pull bottom of wheel outward and take a camber reading; then pull top of wheel outward and take a camber reading. If readings vary more than $1/4^{\circ}$, make following adjustments:

1. Adjust wheel bearings as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D), then take camber readings as shown on Front End Alignment Chart (fig. 1). If readings still vary over $1/4^{\circ}$, replace steering knuckle bushings and king pins as instructed in "FRONT AXLE" (SEC. 3B).
2. Check the wheel run-out as instructed in WHEELS AND TIRES (SEC. 10). If run-out is excessive, straighten or replace wheel.
3. Place vehicle on level surface, with normal weight of vehicle on wheels, then take final camber reading. If camber gauge is not available, readings can be taken as shown on Front End Alignment Chart in figure 1. Place square as shown and measure distances "A" and "B." "B" SHOULD EXCEED "A" by amount specified. Camber dimensions of right wheel should not vary over 3/32" from camber dimensions of left wheel. If final camber reading is incorrect, either steering knuckle or axle center is bent.
4. To determine which part is bent, check king pin inclination ("D," fig. 1). Camber plus king pin inclination is the "included angle" of steering knuckle. If "included angle" of knuckle varies more than $1/2^{\circ}$ from value specified in "Specifications," knuckle is bent and should be replaced. Excessive positive camber results in irregular wear of tires at outer shoulder. Negative or reverse camber causes wear at inner shoulder. Ease of steering is affected by any deviation from specified camber.

AXLE CASTER

Positive caster is the rearward tilt from the vertical of the king pin. Negative or reverse caster is the forward tilt from the vertical of the king pin.

Incorrect caster may result from sagging springs, bent axle, twisted axle, or uneven tightening of spring U-bolt nuts. Tighten all U-bolt nuts equally. Refer to "FRONT SPRINGS" (SEC 3C) for U-bolt torque specifications. Generally, if the axle is twisted, the caster will be unequal for right and left side.

CHECKING AND CORRECTING CASTER

IMPORTANT: Caster, camber, and toe-in dimensions are for vehicle carrying its design load whereby the frame in most instances would be level. If alignment check is to be made with frame NOT LEVEL the frame angle (fig. 2) must be determined and added to the caster angle to obtain a true caster reading.

1. Position vehicle on a smooth level surface.
2. Using a bubble protractor, measure the frame angle (FA). See figure 2. Frame angle is the degree of tilt in the frame from the level position. Negative frame angle is when the frame is high (above level) in the rear. Positive frame angle is when the frame is low (below level) in the rear.
3. Determine the caster angle for the left wheel using the alignment equipment.
4. Add the frame angle (FA) found in step 2 to the left wheel caster reading found in step 3 to determine the "corrected caster" for left wheel.

To determine "corrected caster" with various frame and caster readings the following rules apply:

(a) - Negative frame angle must be added to positive caster reading.

(b) - Positive frame angle must be subtracted from positive caster reading.

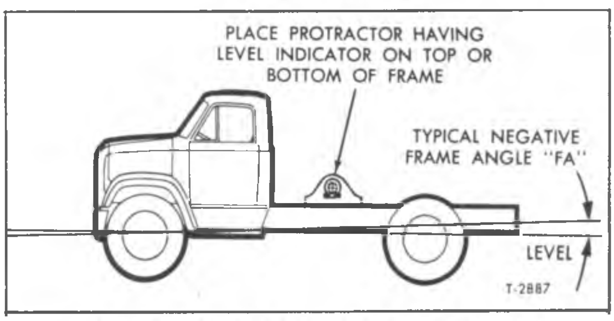


Figure 2—Method of Checking Frame Angle

(c) - Negative frame angle must be subtracted from negative caster reading.
(d) - Positive frame angle must be added to negative caster reading.

Example: L-4000 with power steering has a left wheel caster reading of 2° positive, but the frame angle is negative (high in the rear) 1/2°; therefore 1/2° negative frame angle plus 2° positive caster gives 2½° positive as the "corrected caster" for that wheel. Referring to "Specifications," we find that 2½° positive caster is ¾° over maximum specified setting.

5. Repeat steps 2 through 4 for the right wheel.
6. If the caster is not within specifications, caster can be corrected by adding or removing caster shims between the axle and spring.

KING PIN INCLINATION

King pin inclination is the amount that top of king pin is inclined toward center of vehicle. King pins are inclined (D, fig. 1), to decrease friction between tires and road when turning. Precision instruments must be used to check king pin inclination when axle is installed in vehicle. When axle is removed, check can be made on bench as follows:

Place two uniform blocks on level surface, rest spring seats on blocks. Using a square, measure "K" and "L" (fig. 1). "K" minus "L" equals king pin inclination in inches. If axle is bent or twisted, refer to "FRONT AXLE" (SEC. 3B) in this manual for corrective information. Straightening axle center to correct king pin inclination will also change camber. Recheck camber after correcting king pin inclination.

IMPORTANT: Caster, camber, and toe-in dimensions are for vehicle carrying its design load whereby the frame in most instances would be level. If alignment check is to be made with frame NOT LEVEL the frame angle (fig. 2) must be determined and added to the caster angle to obtain a true caster reading.

FRONT END ALIGNMENT SPECIFICATIONS

NOTE: Use in Conjunction with Alignment Chart, Figure 1, page 110.

TRUCK MODELS	EG/EM/ES-PS 4500 EG/EM/ES/ SM/SG/SS5500	ALL 4000	EG/EM/ES/ SM/SG/SS/ 5500 EM/EG/ES/ SM6500
AXLE MODELS	F050 F055	F-070	F-070
B—Minus—A Camber (Inches)	33/64	33/64	33/64
C—Camber (Degrees Positive)*	1½° ± ½°	1½° ± ½°	1½° ± ½°
D—King Pin Inclination (Degrees)	7-1/6	7-1/6	7-1/6
E—Minus F—Toe-In (Inches)	⅛ — ¼	⅛ — ¼	⅛ — ¼
Caster (Degrees Positive)*	2¾ ± ½	1¼ ± ½	2¾ ± ½
K—Minus L—King Pin (Inches)	51/64	63/64	63/64

(*) Note: When Power Steering is used, Standard or Optional Caster is the same as called out.

SECTION 3B
Front Axle

Axle steering knuckles are constructed as shown in figure 2. Wheel bearings, springs, steering, and brake parts which are mounted on front axle are described in their respective section in this manual. Front axle specifications are given at end of this section.

MAINTENANCE ON VEHICLE

Following maintenance operations should be performed at intervals determined by severity of service:

1. Inspect spring U-bolts for tightness. If loose, tighten as directed in "FRONT SPRINGS" (SEC. 3C).
2. Inspect and tighten all ball stud nuts.
3. Examine steering knuckle bearing caps for tightness and evidence of lubricant leakage. Tighten or replace parts as required.
4. Inspect and tighten king pin draw key nuts. Loose draw keys will permit king pin to turn in axle center, thus enlarging king pin hole. If hole becomes too greatly enlarged, replacement of axle center may be necessary. If draw key holes become enlarged beyond use of new key, replace axle center. IT IS NOT SAFE TO REAM AND BUSH DRAW KEY HOLES.
5. Check vertical movement of knuckle on king pin as directed under "Axle Overhaul" later.

STOP SCREWS

Stop screws shown in figure 1 for F-040, F-050 and F-055 axles are installed on steering arms and stop against axle center. Stop screws for F-070 axles are installed in the steering knuckles and stop against the axle center. If stop screws are set in too far, road shock may impose excessive load on steering gear, and worm shaft nut may bottom on housing end cover before stop screws contact axle center.

Place each wheel on wheel alignment instrument and adjust stop screws as shown in figure 1.

When oversize tires are installed, the turning clearance should be checked. A minimum clearance of 5/8" should be maintained between chassis and tires. If specified clearance does not exist, readjust knuckle stop screws to obtain the proper clearance.

FRONT AXLE REPLACEMENT

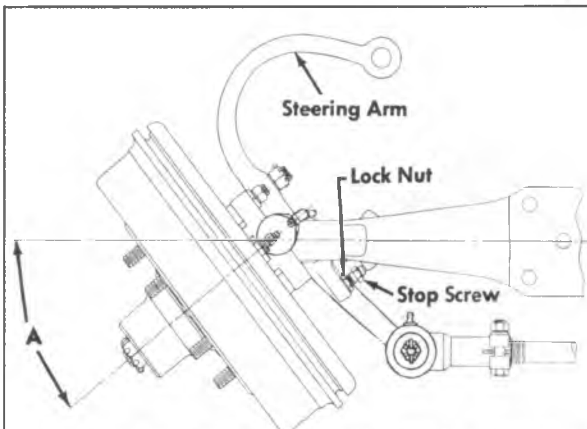
All component parts of the front axle assembly except axle center can be replaced without removing assembly from vehicle if necessary. Minor straightening with suitable equipment can be accomplished with assembly in vehicle. When the front axle requires a complete overhaul, the assembly can be replaced as described in following procedures:

REMOVAL

1. Jack up and support vehicle frame to relieve load from front springs.
2. Remove wheels and hubs. Disconnect brake lines to axle. Disconnect drag link from steering arm.
3. While supporting axle center with suitable jack, remove spring U-bolts. Lower assembly and remove from under vehicle.

INSTALLATION

1. Place assembly on dolly and roll into position under vehicle. Raise axle up against springs, making sure spring center bolts enter alignment holes in spring seats. Be sure caster axle shims, if used, are in place between spring and axle with thick edge of caster spacer facing proper direction as indicated in figures 2 and 3 of "FRONT SPRINGS" (SEC. 3C) of this manual. Attach axle to springs, tightening the U-bolts as described in "FRONT SPRINGS" (SEC. 3C) of this manual.
2. Install hubs and bearings as described in "FRONT HUBS AND BEARINGS" (SEC. 3D). Connect drag link as directed in STEERING SYSTEM (SEC. 9). Connect brake lines. If hydraulic brakes are used, bleed as described in "HYDRAULIC



A — Dimension Varies with Different Size Tires. Set Stop Screws to Provide ⅝" Clearance Between Tires and Chassis at Extreme Turn Positions. T-1500

Figure 1—Typical Stop Screw Adjustment

BRAKES" (SEC. 5A) of this manual.

3. Check stop screws and adjust as previously described. Check front end alignment factors and adjust as necessary.

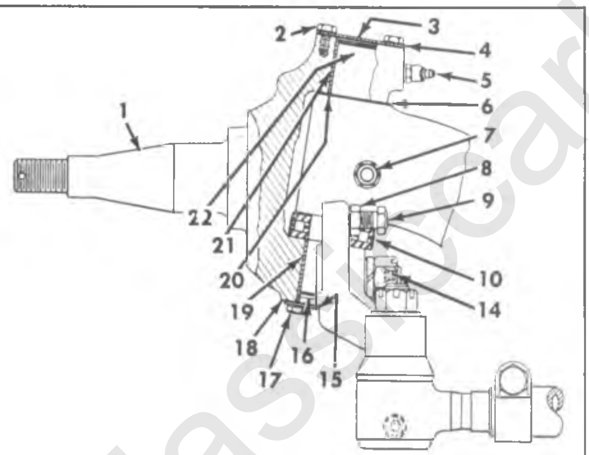
FRONT AXLE OVERHAUL

Steering knuckles, king pins, and bushings or thrust washers and thrust bearings can be replaced without removing front axle from vehicle. Minor axle straightening can also be accomplished without removing assembly from vehicle. Preliminary inspection can be made while axle is still mounted. These inspections should aid in determining the amount of repair necessary. Check front end alignment as directed previously under "FRONT END ALIGNMENT" (SEC. 3A). Inability to correctly align wheels indicates that axle center or steering knuckle is distorted, tie rod bent, or knuckle bushings are worn beyond limits.

STEERING KNUCKLE

DESCRIPTION

The king pin is held in place with a tapered draw key, installed as shown in figure 2. The draw key is retained in place by a lock washer and nut.



1 Steering Knuckle
2 Cap Screw
3 Upper King Pin Bearing Cap
4 King Pin Bearing Cap Gasket
5 Lubrication Fitting
6 Shim
7 Draw Key
8 Stop Screw Lock Nut
9 Stop Screw
10 Thrust Bearing
14 Lubrication Fitting
15 Lower King Pin Bearing Cap
16 Spacer - Steering Knuckle Bushing (Some Models)
17 Cap Screw
18 King Pin Bearing Cap Gasket
19 Lower Bushing
20 O-ring Seal
21 Upper Bushing
22 King Pin

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Figure 2—Typical Steering Knuckle Construction

Steering knuckles are equipped with bushings of polycarbonate construction and they can be washed in conventional solvents without damage.

Upper and lower ends of knuckles are sealed with king pin bearing caps and gaskets and an O-ring seal at the bottom of upper bushings, to prevent lubricant leakage and to exclude dirt and moisture. Some models are equipped with steering knuckle bushing spacer (fig. 2). The vertical thrust loads are carried by thrust bearing or thrust washer installed between lower face of axle center and steering knuckle lower yoke.

REMOVAL

1. Jack up axle and remove hubs and bearings as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D). Remove brake backing plate from steering knuckle. Remove tie-rod as directed in STEERING SYSTEM (SEC. 9) of this manual.
2. Remove steering arm from steering knuckle.
3. Remove king pin draw key nut and washer. Thread nut on draw key far enough to protect threads. Strike nut with hammer to loosen draw key. Remove nut, then drive pin out with brass drift and hammer.
4. Remove cap screws attaching upper and lower king pin bearing caps and gaskets to steering knuckle, then remove caps and gaskets.
5. Using brass drift and hammer drive king pin out of axle.

NOTE: On some models, bushing spacer will be removed at same time as king pin.

6. Remove steering knuckle thrust bearing or thrust washers, shims, and O-ring.
7. Refer to "Inspection and Repair" later in this section for inspection and repair procedure.

INSPECTION AND REPAIR

Wash all parts in cleaning solution. Cap gaskets should be discarded and replaced with new parts. Soak thrust washers and bearings in cleaner to dissolve lubricant; then brush with soft brush to remove grit if necessary.

> CAUTION: Avoid turning bearings in races when bearing assemblies are dirty, since small particles of grit will damage bearings. "Specifications" at end of this section itemize the various fits and tolerances which apply to all front axles covered by this manual. It is recommended that all parts which do not meet these specifications be replaced.

King pin repair kits are available. The kits include parts which normally require replacement at overhaul.

THRUST WASHERS OR BEARINGS

Examine thrust washers or bearings for excessive wear or damage. If thrust washer dust caps are damaged, replace. Replace all parts which show excessive wear.

STEERING KNUCKLE BUSHINGS

Replace steering knuckle bushings if wear is indicated, or if results given previously under "Front Wheel Camber" indicate replacement is necessary.

BUSHING REPLACEMENT

Removal

Bushings are split, and of Polycarbonate construction, and are hand push fit in knuckle. To remove, slide bushings out of bore in knuckle yoke.

Installation

Before installing bushings, remove nicks and burrs in knuckle yokes and polish with medium grit abrasive paper or cloth. Apply lubricant specified in LUBRICATION (SEC. 0) of this manual, to all parts. Push bushings into knuckle bores with split in bushings aligned with lubrication fitting.

KING PIN INSPECTION

Check diameter of king pin. Also check for minute cracks or other damage. If inspection reveals excessive wear, replace king pin.

AXLE CENTER

There are two conditions which, if either exists, will necessitate replacement of axle center:

1. If king pin holes in axle center ends are worn to such an extent that a new oversize king pin fits loosely, axle center must be replaced.
2. If axle center has been twisted or bent more than 5 degrees from original shape, center should be replaced. As a general rule, when an extreme bent condition exists, minute fractures which may be invisible will occur, and failure under ordinary operating conditions will result. Check axle center for twist with alignment instruments, or on a bench as illustrated in "FRONT END ALIGNMENT" (SEC. 3A) in figure 3. If equipment is available, use Magna-Flux method to check axle center for minute fractures.

NOTE: AXLE CENTERS SHOULD ALWAYS BE STRAIGHTENED COLD. UNDER NO CIRCUMSTANCES SHOULD HEAT BE APPLIED.

STEERING KNUCKLES

After steering knuckles have been thoroughly cleaned, examine knuckles for distortion, cracks, or fractures. If Magna-Flux equipment is available, use this method to inspect knuckles for fractures which otherwise would not be visible. Replace steering knuckles if inspection reveals defects which would affect serviceability.

INSTALLATION

1. Before assembly, thoroughly clean all parts; then coat king pin with light coat of engine oil.
2. Position steering knuckle on axle, then slide thrust bearing into place.

NOTE: On models shown in inset of figure 2 place steel washer between bronze washers, with lubricating grooves facing steel washer. Always place larger dust shield over top of washers.

3. Install a new O-ring seal at bottom of upper bushing.
4. Align king pin holes in steering knuckle yoke, axle end, thrust bearing or thrust washer, then partially install king pin through top.
5. With axle center held firmly, place a jack under steering knuckle; then raise until all clearance between knuckle lower yoke, thrust bearing or thrust washer and axle center is taken up. Check clearance between top of axle center and knuckle upper yoke. If clearance exceeds 0.005", place a shim between axle center and knuckle upper yoke.
6. Install king pin, with milled slot in side of pin registering with draw key hole in axle center. Install king pin from top, inserting through steering knuckle yoke, shim, thrust bearing or thrust washer and axle center end. Press pin down until milled slot in pin lines up with draw key hole.
7. Insert draw key into axle center, registering with king pin, then install lock washer and nut. Tighten nut firmly. If nut bottoms on knuckle before king pin is secure, replace draw key or use a draw key with more taper.
8. On models using steering knuckle bushing spacer, install spacer at lower end of king pin.
9. Install new gaskets, then install upper and lower king pin bearing caps with cap screws. Tighten cap screws to torque listed in "Specifications."
10. Lubricate king pins thoroughly through lubrication fittings as directed in LUBRICATION (SEC. 0). Try action of steering knuckle for binding condition.
11. Install steering arms to knuckles. Install tie-rod as directed in STEERING SYSTEM (SEC. 9) of this manual. Install brake backing plate assembly. Install hubs and bearings as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D) of this manual.
12. Check front end alignment and stop screw adjustment as previously directed.

SPECIFICATIONS

FRONT AXLE SPECIFICATIONS

AXLE MODEL		F050 F055	F070
King Pin—Length		$6\frac{23}{64}$″	$7\frac{57}{64}$
Diameter at Bushings		1.1090″	1.2492″
		1.1094″	1.2496″
Steering Knuckle Bushings—Length		$1\frac{11}{32}$″	$1\frac{7}{8}$″
I.D.		1.1094″	1.2496″
		1.1124″	1.2526″
Thrust Washers—Bronze (thickness)		—	—
Steel (thickness)		—	—
Steering Knuckle Thrust—Maximum		0.005″	0.005″
Shims Available		0.005″	0.005″
Torque Specifications			
King Pin Nut	—	—	—
King Pin Bearing Cap Cap—Screw	20-30 in.-lbs.	50-70 in.-lbs.	60-70 in.-lbs.

SECTION 3C
Front Springs

DESCRIPTION

Front springs on all series are vari-rate leaf type. Springs are attached to front axle center with U-bolts and secured at frame side rails as shown in figure 1. U-bolts may also secure shock absorbers and tow eyes (when used). Spring eyes on all series are equipped with replaceable bushings. The front spring rear hangers on some vehicles have a floating cushion. The cushion is held in place by the front spring rear hanger rebound bolt, and can be reversed to extend wear life of spring end-to-cushion metal contact area. Refer to figure 1. Front springs which employ rubber-mounted bushings with solid eye bolt, require no lubrication at bushing.

GENERAL SPRING MAINTENANCE

LUBRICATION

Spring leaves are lubricated at time of assembly and require no further lubrication unless spring is disassembled.

TIGHTENING

IMPORTANT: U-bolt nuts must be retightened to initial torque listed in "Specifications" at end of this section, after 500 miles. Thereafter, U-bolts should be checked at regular intervals. U-bolts must be kept TIGHT at all times to hold axle in place at springs. Otherwise, axle may shift, causing misalignment; also, spring leaf failure in the vicinity of the spring center bolt could result.

The center bolt serves only to hold the spring together while in shipment and during installation, and as a locating point when assembling spring to axle. After assembly, it is strictly the function of the U-bolts to hold the spring and axle in alignment, and the importance of keeping the U-bolts tight, cannot be overemphasized.

Check, and tighten if necessary, all spring bracket bolt nuts and bracket pin clamp bolts. Rebound clips should be tightened just enough to hold spring leaves in alignment without restricting free movement of leaves.

REPAIR OPERATIONS

FRONT SPRING REMOVAL (Refer to Fig. 1)

1. Raise vehicle frame to take weight off the spring. Make sure vehicle is supported safely.
2. Support axle on floor jack.
3. Remove spring shackle U-bolt nuts, then lower axle.
4. At front of vehicle, remove spring eye bolt, nut, and washer; withdraw eye bolt from bracket and spring eye.
5. On all L-4000 Series, remove bolt, bolt retainer, and rebound pin at rear hanger. On all "E," "S," and "PS" Series, remove nut, lock washer, rebound bolt, and spacer at rear hanger.
6. Remove shock absorber bracket (if used) (figs. 2 and 3), spring caster spacer, tow eye (if used) and dowel pins (when used). Also, front spring rear hanger cushion (when used). Remove spring.

NOTE: Refer to figures 2 and 3 for correct position of caster spacer at time of installation.

INSPECTION

1. Thoroughly clean spring eye bushings, bolts, and pins.
2. Insert bolts or pins into bushings in spring eyes, and check for looseness. If excessive looseness is evident, bolt pin or bushing must be replaced.

SERVICE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Spring Noise	1. Loose U-bolts. 2. Loose or worn shackle bushings. 3. Lack of lubrication. 4. Defective shock absorber.	1. Tighten to recommended torque. 2. Replace shackle bushings. 3. Lubricate as required. 4. Replace shock absorber.
Spring Sag or Bottom	1. Inoperative shock absorbers. 2. Broken spring leaf. 3. Severe operation or overloading.	1. Replace shock absorbers. 2. Replace leaf or spring assy. 3. Check load capacity rating.
Spring Breakage	1. Loose U-bolts. 2. Normal fatigue. 3. Overloading.	1. Tighten to recommended torque. 2. Replace spring. 3. Check load capacity rating.

FRONT SPRINGS

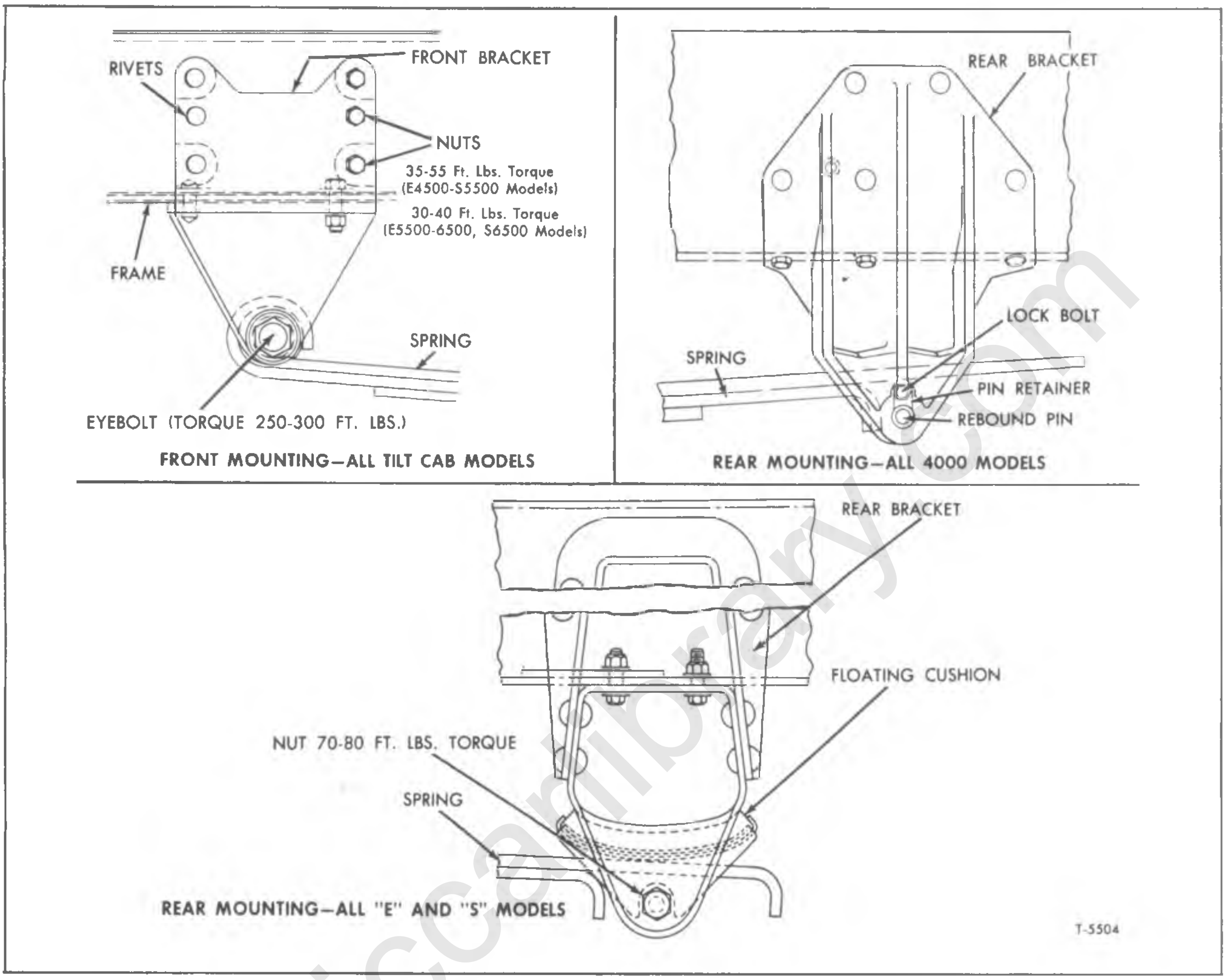


Figure 1—Front Spring Mountings

3. Inspect spring assembly for broken or fractured leaves. Number 1 and 2 leaves can be replaced, however if other leaves are broken, replace complete spring assembly. Replace broken leaves as directed later in this section.

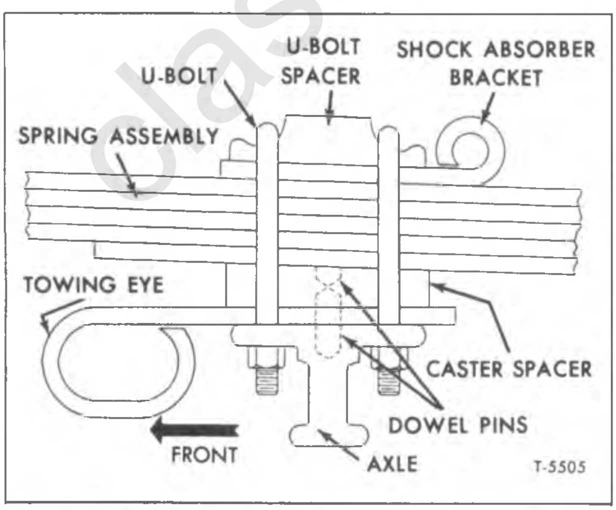


Figure 2—Front Spring Caster Spacer ("E" and "S" Models)

4. Inspect spring for loose or broken rebound clips. Rebound clips should be tight enough to hold spring leaves in alignment, but not tight enough to restrict free movement of leaves.

5. Check for broken, loose, or sprung spring center bolt. Replace or tighten as necessary.

BUSHING REPLACEMENT

<u>Rubber-Type Eye Bushing (With Spring Off Vehicle) All Series Except PS-4500</u>

Remove and replace front eye bushing using bushing remover, and installer tool set J-21058 as shown in figures 5 and 6.

<u>Series PS-4500 (With Spring on Vehicle) Removal</u>

1. Raise vehicle to take weight off spring and remove spring eye nut and bolt.

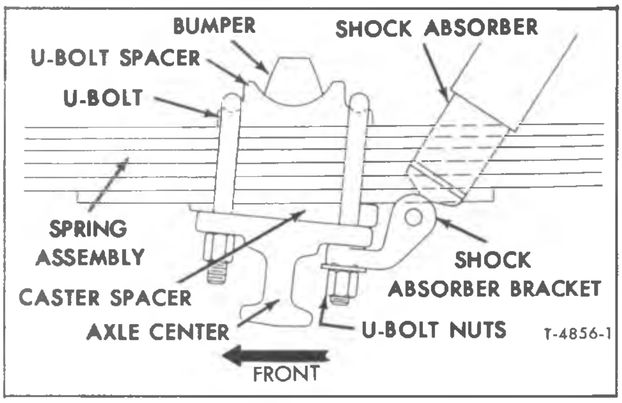


Figure 3—Front Spring Center Mounting (All 4000—PS4500 Models)

2. Continue to raise vehicle until spring eye clears hanger.

3. Using J-21978-1 remover adapter J-21058 nut and screw and J-21830-4, -7 receiver and bridge, remove bushing from spring eye (fig. 7).

Installation

1. Using installer adapter J-21978-2 and tools called out in Step 3 of "Removal" procedure, install bushing (fig. 7) with offset of bushing at top of spring eye as shown in figure 9.

2. Lower vehicle to position spring eye in hanger.

3. Install spring eye bolt and nut. Tighten nut to 320-420 foot-pounds torque, then lower vehicle.

Series PS-4500 (With Spring Off Vehicle)

If bushing is replaced with spring off vehicle, use a press and adapters J-21978-2 to remove and install bushing.

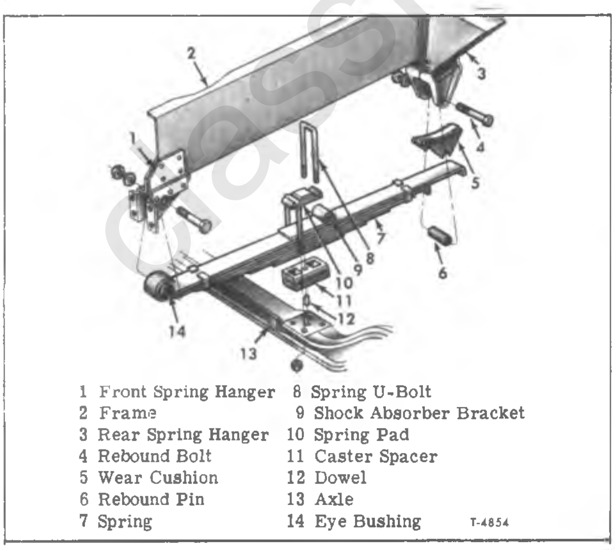


Figure 4—Front Spring Installation ("E" and "S" Models 4500-6500 Series)

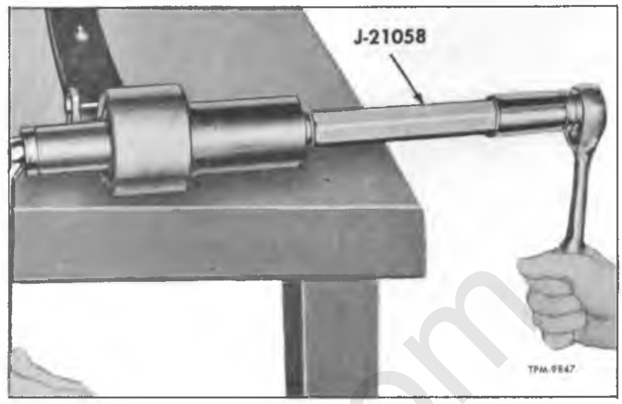


Figure 5—Removing Rubber Type Eye Bushing (All Series Except PS4500)

SPRING LEAF REPLACEMENT

1. Mark down one side of springs to assure original position of leaves, then place spring assembly in a vise or arbor press near center bolt.

2. When bolted type is used, remove rebound clip, nuts, bolts, and spacers.

3. File off peened end of center bolt, then remove nut and bolt.

4. Release vise or arbor press slowly to avoid possible injury. Separate spring leaves and clean thoroughly, using a wire brush if necessary.

5. Replace any broken rebound clips by cutting old rivet, and riveting new clip to spring leaf.

6. Replace broken leaf and stack leaves in correct order, applying a thin film of graphite grease to each leaf. Align center bolt holes in spring leaves with long drift, then compress spring leaves in vise or arbor press.

7. Install center bolt and nut and tighten firmly. Peen end of bolt to prevent nut loosening.

8. Remove spring from vise or arbor press. Align spring leaves by tapping with hammer. Install rebound clip, spacers, bolts, and nuts; tighten

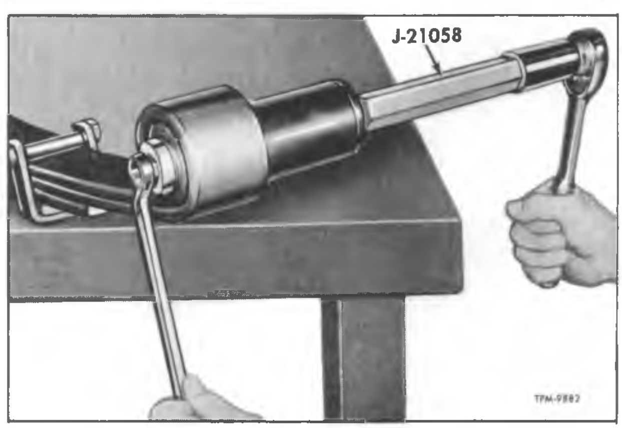


Figure 6—Installing Rubber Type Eye Bushing (All Series Except PS4500)

FRONT SPRINGS

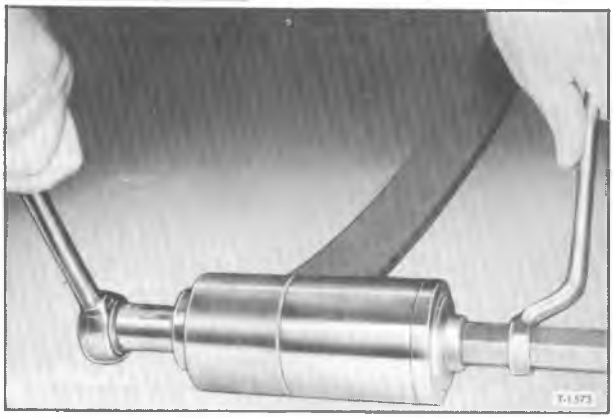


Figure 7—Removing Rubber Type Eye Bushing (PS4500)

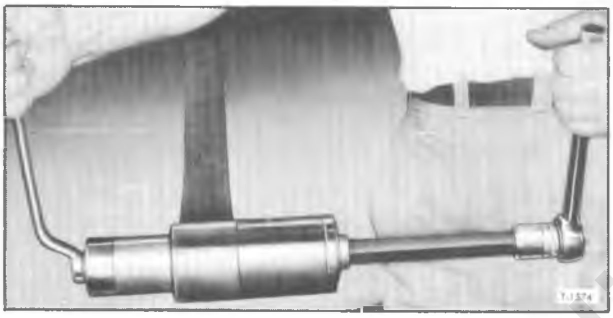


Figure 8—Installing Rubber Eye Bushing (PS4500)

enough to hold spring leaves in alignment, but not enough to restrict free movement of leaves.

FRONT SPRING INSTALLATION
(Refer to Fig. 1)

1. On all series, place rear end of spring in rear hanger, then install rebound pin, pin retainer, and pin retainer bolt, or rebound bolt spacer, spacer bolt, lock washer and nut.
2. Raise front end of spring into frame forward hanger brackets; then install eye bolt, eye bolt washer, and nut.
3. With dowel pins (when used) tow eye (when

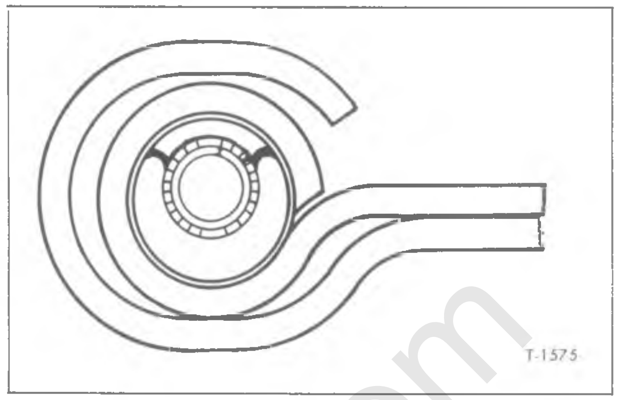


Figure 9—Installed Position of Offset Bushing (PS4500)

used) and caster spacer (when used) on axle pad, raise axle to spring, making sure spring center bolt or dowel pin engages hole in axle pad.

NOTE: Install caster spacers with thick edge facing proper direction as shown in figures 2 and 3. If caster spacer is incorrectly installed it will result in hard steering.

4. Install shock absorber bracket, at spring, U-bolt spacer, U-bolt and shock absorber (when used). Install U-bolts and nuts.
5. Tighten front spring eye bolt nut, bracket pin nuts, U-bolt nuts, rebound pin or bolt nuts, to torque listed in "Specifications" at end of this section.
6. Lubricate as instructed in LUBRICATION (SEC. 0) of this manual.
7. Lower vehicle to floor.

SHOCK ABSORBERS

Shock absorbers are non-adjustable and non-repairable. Maintenance requirements involve replacement of the rubber mounting grommets, and tightening all shock absorber pin nuts at regular intervals. If a shock absorber becomes inoperative, the complete unit must be replaced.

CAUTION: When replacing shock absorbers, check the model number stamped on the unit to make sure it is the same model as the one removed.

Refer to next page for "Specifications."

SPECIFICATIONS

TORQUE SPECIFICATIONS

	FT. LBS.
U-BOLT NUTS	
All 4000 Series	135-150
PS4500	105-130
E-5500-6500 Series, S6500 Series	90-110 Lube Before Ass.
E-4500, S5500 Series	90-100 Lube Before Ass.
FRONT EYEBOLT-TO-BRACKET NUT	
All 4000 Series	300-400
E4500, S5500 Series	250-300
E5500-6500 Series, S6500 Series	250-300
PS4500	320-420
REAR BRACKET-TO-FRAME BOLT NUTS	
All 4000 Series	35-55
E4500, S5500 Series	35-55
E5500-6500 Series, S6500 Series	30-40
FRONT BRACKET-TO-FRAME BOLTS	
All 4000 Series	35-55
E4500, S5500 Series	35-55
E5500-6500 Series, S6500 Series	30-40
FRONT SPRING REAR REBOUND BOLT NUT	
E4500, S5500 Series	70-80
E5500-6500 Series, S6500 Series	70-80
PS4500	75-95
SHOCK ABSORBER BRACKET-TO-FRAME	
All 4000 Series	40-50

IMPORTANT

U-bolts must be retightened to initial torque listed in "Specifications" after 500 miles.

SECTION 3D

Front Hubs and Bearings

DESCRIPTION

Front hubs are mounted on steering knuckle spindle on opposed tapered roller bearing as illustrated in figure 1. Refer to "Service Parts Identification" decal on dash compartment door to determine type of axle used on a specific vehicle. Mounting parts (mainly bearings, spindle nuts, and seals) shown in figure 1, are of primary importance. Brake drum mounting bolts, studs, and nuts differ in type and method of installation on various series vehicles.

BEARING MAINTENANCE

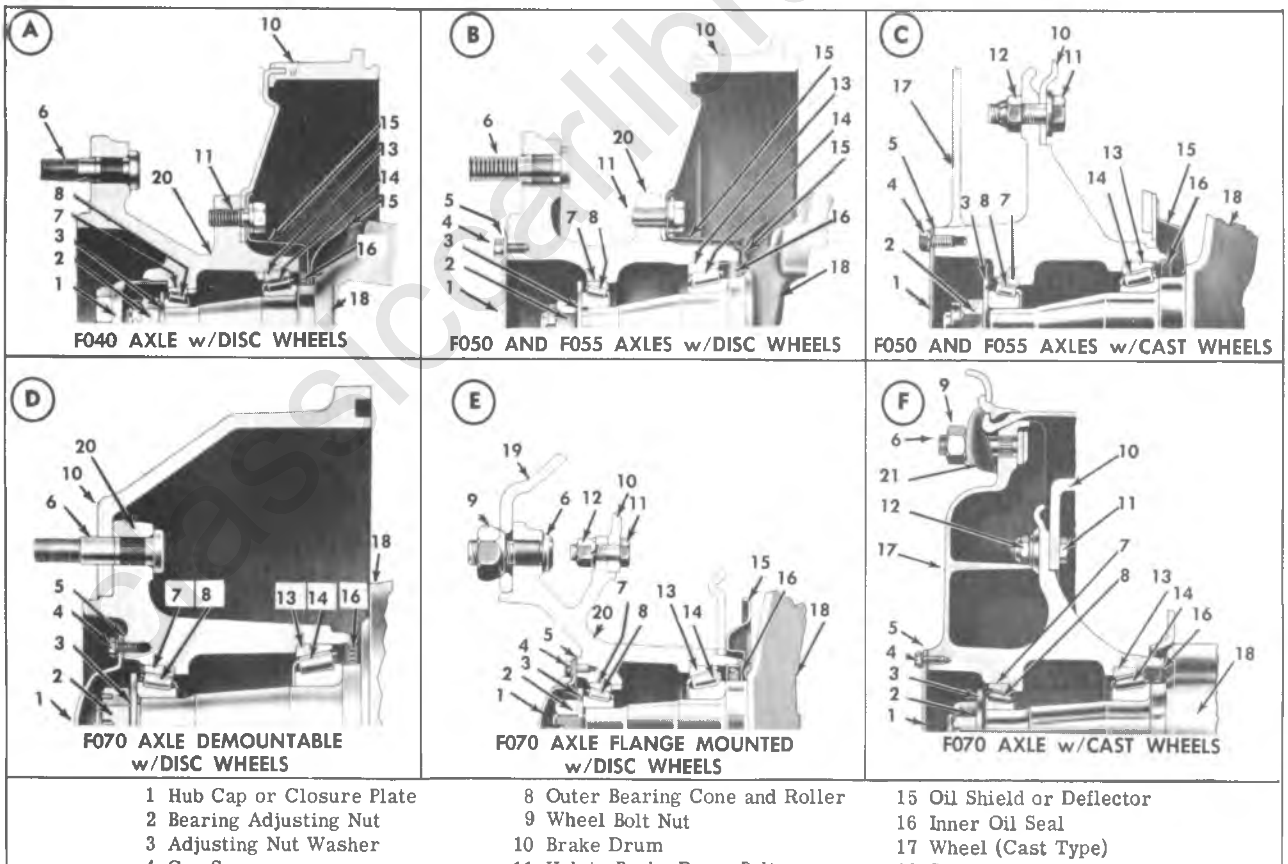
All wheel bearings are adjustable for wear. Satisfactory operation and long life of bearings depend upon proper adjustment and correct lubrication. If bearings are adjusted too tight, they will overheat and wear rapidly. Loose adjustment will cause pounding and will also contribute to steering difficulties, uneven tire wear, and inefficient brakes. Bearing adjustment should be checked at regular inspection periods.

Front hubs and bearings should be cleaned, inspected, and lubricated whenever hubs are removed, or at intervals indicated in LUBRICATION (SEC. 0) of this manual.

New hub oil seals should be installed when servicing bearings if there is the slightest indication of wear or damage. An imperfect seal may permit bearing lubricant to reach brake linings, resulting in faulty brake operation and necessitating premature replacement of linings.

BEARING ADJUSTMENT CHECK

Before checking wheel bearing adjustment make sure brakes are fully released. Jack up the



1 Hub Cap or Closure Plate
2 Bearing Adjusting Nut
3 Adjusting Nut Washer
4 Cap Screw
5 Gasket
6 Wheel Bolt
7 Outer Bearing Cup
8 Outer Bearing Cone and Roller
9 Wheel Bolt Nut
10 Brake Drum
11 Hub to Brake Drum Bolt
12 Lock Nut
13 Inner Bearing Cup
14 Inner Bearing Cone and Rollers
15 Oil Shield or Deflector
16 Inner Oil Seal
17 Wheel (Cast Type)
18 Steering Knuckle
19 Wheel (Budd Type)
20 Hub
21 Wheel Clamp

T-3115-1

Figure 1—Front Hubs and Bearings

front axle until wheels clear floor.

Check bearing play, by grasping tire at top and pulling back and forth, or by using a pry bar under tire. If bearings are properly adjusted, movement of brake drum in relation to backing plate will be barely noticeable and wheel will turn freely. If movement is excessive, adjust as follows:

FRONT WHEEL BEARING ADJUSTMENT

1. With the wheel raised and axle safely supported, remove hub cap, or hub cap closure plate and gasket.
2. Remove cotter pin securing adjusting nut to spindle.
3. Back off the adjusting nut, then using a torque wrench, tighten adjusting nut to 40 foot-pounds on F-040, F-050, and F-055 axles, and 60 foot-pounds on F-070 axle, at the same time turn wheel in both directions to be sure all bearing surfaces are in contact.
4. Back off adjusting nut ¼ to 1/3 turn, or to the nearest cotter pin hole in spindle, or sufficiently to allow the wheel to rotate freely within limits of 0.001" to 0.007" end play.
5. Install new cotter pin and make sure that wheel or hub turns freely.
6. Install hub cap or hub closure plate with new gasket, and tighten cap screws firmly.
7. Lower wheel to floor and remove jack.

FRONT HUB AND BEARING REPLACEMENT

REMOVAL (Fig. 1)

1. Jack up front wheel and remove tire and rim assembly if cast wheels are used. Remove tire and wheel assembly if ventilated disc or Budd type wheels are used.
2. On some trucks remove the hub cap.

NOTE: On F-040 axle hub cap is threaded into outer end of hub. On other vehicles remove cap screws, lock washers, hub closure plate, and gasket. Discard gasket.

3. Remove cotter pin, bearing adjusting nut, and adjusting nut washer.
4. Pull hub and drum assembly straight off steering knuckle spindle, using care to prevent outer bearing from dropping on floor. Remove outer bearing cone and roller assembly from hub.
5. Pull inner oil seal out of hub; then remove inner bearing from hub.
6. Clean, inspect, and repair parts as necessary, as directed later in this section under "Cleaning, Inspection, and Repair."

INSTALLATION (Fig. 1)

1. Lubricate bearings, spindle, and inside of hub as directed in LUBRICATION (SEC. 0) of this manual. If seal is leather, soak in oil before installing. On all other type oil seals, coat lip of seal with wheel bearing grease or equivalent before installing.
2. Place inner bearing in hub. Coat oil seal bore in hub with a thin layer of non-hardening sealing compound, then press seal in until seal case seats against shoulder in hub or against inner bearing cup. On types having spring-loaded lip-type oil seal, seal must be installed with lip pointing inward.
3. On trucks so equipped, make sure the oil deflector and oil shield are in place on spindle.
4. Carefully install hub assembly on spindle, being careful not to damage inner oil seal.
5. Place outer bearing cone and roller assembly on spindle, pressing firmly into hub with fingers. Install adjusting nut washer and adjusting nut.
6. Install tire and rim or tire and wheel assembly.
7. Adjust bearings and complete the installation as previously directed under "Front Bearing Adjustment." Adjust brakes as directed in BRAKES (SEC. 5) of this manual.

CLEANING, INSPECTION, AND REPAIR

CLEANING

1. Immerse bearing assemblies in suitable cleaning solvent. Clean with stiff brush if necessary to remove old lubricant. Blow bearings dry with compressed air, directing air stream across bearings. Do not spin bearings while blowing them dry.
2. Thoroughly clean all lubricant out of inside of hub and wipe dry. Make sure all particles of gasket are removed from outer end of hub, and that all sealing compound is cleaned out of oil seal bore in inner end of hub.
3. Clean lubricant off steering knuckle spindle, wash bearing adjusting nut and washer in cleaning solvent and wipe dry.

INSPECTION

1. Inspect bearings for excessive wear, chipped edges, and other damage. Slowly roll rollers around cone to detect any flat or rough spots. Replace damaged parts. If either the cone and roller assembly or the cup of the roller bearings are damaged, the complete bearing assembly must be replaced.
2. Examine bearing cups which are still installed in hub. If cups are pitted or cracked, they must be replaced as directed later under "Repair."
3. Examine brake drums for scoring or other

FRONT HUBS AND BEARINGS

damage. Non-demountable brake drums can be refinished while mounted on hubs. (NOTE: Refer to "HYDRAULIC BRAKES" (SEC. 5A) under "Brake Drums.") If necessary to replace demountable brake drum refer to "Repair" later in this section.

4. Examine wheel studs or rim clamp studs for damaged threads and replace, if necessary, as directed later under "Repair."

5. Discard old oil seals and obtain new oil seals to be used at assembly.

REPAIR

Bearing Cup Replacement

1. Bearing cups are removed by using a mild steel rod through opposite end of hub and driving against inner edge of bearing cup. Alternately drive on opposite sides of cup to avoid cocking cup and damaging inside of hub.

2. To install new cups, position cup in hub and drive into place, using a suitable driver or by using a mild steel rod against outer edge of cup. If drift is used, alternately drive against opposite sides to assure driving cup in squarely. Cups must seat against shoulder in hub.

Brake Drum Replacement

1. Demountable Type. The demountable type drum may be separated from the hub and removed from the vehicle without disturbing the hub. The drum is held to the hub by countersunk, slotted screws, which are easily removed with a screwdriver.

2. Non-Demountable Type. Non-demountable type hub and drum assembly is such that replacement cannot be accomplished with the hub assembly installed on the vehicle.

a. Separate the drums and hub by removing the drum-to-hub retaining bolts, hub stud nuts, or by pressing out the wheel studs, as applicable.

b. Position brake drum to hub assembly, making certain that all drain holes are in alignment.

c. Apply a light, even coating of sealing compound to the hub oil deflector contact surface, and position deflector to drum.

d. Install drum-to-hub retaining bolts, hub stud nuts, or press wheel studs into drum.

Wheel Bolt Replacement

Wheel bolts are serrated and may also be swaged in place; however, replacement procedure remains the same for both types of installation. Press bolts out of hub flange, using suitable press, then press new bolts into place, making sure bolts are a tight fit. If all bolts were removed, be sure that hub oil deflector is in position under bolt heads.

IMPORTANT: If any one wheel experiences a single stud failure caused by a loose running wheel, all studs should be replaced.

A loose running wheel may cause only one stud to break, but several more studs may become fatigued to the point of failure, but not actually breaking. Replacing only the one broken stud and remounting wheel will then set the stage for a second and possibly more serious failure. If holes in wheel have become elongated, or enlarged, replace wheel.

Hub Stud Replacement

Hub studs can be removed and replaced by using a conventional stud remover and replacer. Make sure that studs are firmly bottomed in holes and that threads are not damaged during installation.

SECTION 4
Rear Suspension

This section is divided into three sub-sections as shown in index below:

SECTION 4A
Rear Axle and Controls

DESCRIPTION

Rear axles used on all vehicles covered by this publication are full floating type, using Hotchkiss or leaf spring drive.

Rear axles are Hypoid or spiral bevel pinion gear type. Pinion is straddle mounted between roller bearing and two adjustable tapered roller bearings. Differential is supported by adjustable tapered roller bearings in differential carrier.

Housing is either banjo or bowl type, with spring seats and brackets, also brake mounting brackets welded to housing. This type construction provides exact alignment and location of the axle assembly at time of assembly and installation.

Axle shafts are full-floating type. Inner end of shaft is splined and engages similar splines in differential side gear. Outer end of shaft is flanged and is attached to the wheel hub by studs, tapered dowels, and nuts.

REAR AXLE CONTROLS

Paragraphs following are intended to provide information relative to several systems used to shift 2-speed axles into high or low speeds.

ELECTRIC SHIFT

The electric shift control system consists of a control switch, speedometer adapter, shift units, and interconnecting wiring harness.

CONTROL SWITCH

The control switch, mounted on transmission shift lever consists of a shift button which is positioned by the driver to operate a shift unit at axle. The driver selects the axle ratio by moving control button (fig. 1) to select "Low" and "High" axle range. Movement of control button completes circuit to one field of shift unit motor when in "High" and to opposite field when in "Low." Refer to applicable "Wiring Diagrams" booklet.

SHIFT UNIT

The shift unit and automatic switch assembly is mounted on differential carrier (fig. 2). This unit, controlled by the control switch, shifts the axle into "Low" or "High" range.

When the control switch button is in "Hi" range, wiring carries current to one field of the unit motor. The armature and drive screw turn in a clockwise direction and move the nut down (fig.3).

When the nut has traveled a sufficient distance to wind the torsion spring, a contact bumper on the nut breaks an electrical connection on the auto-

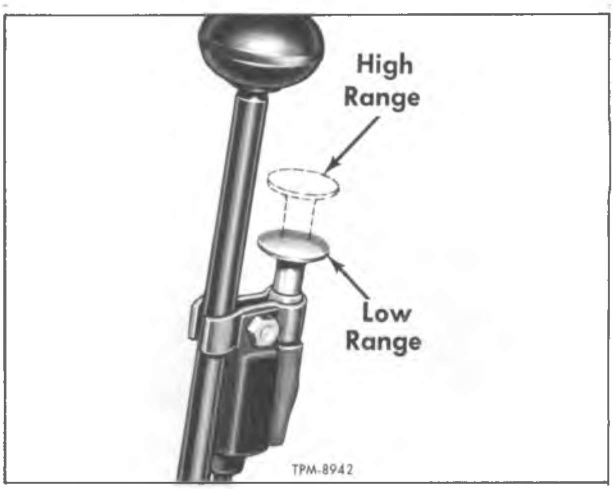


Figure 1—Two-Speed Axle Shift Control

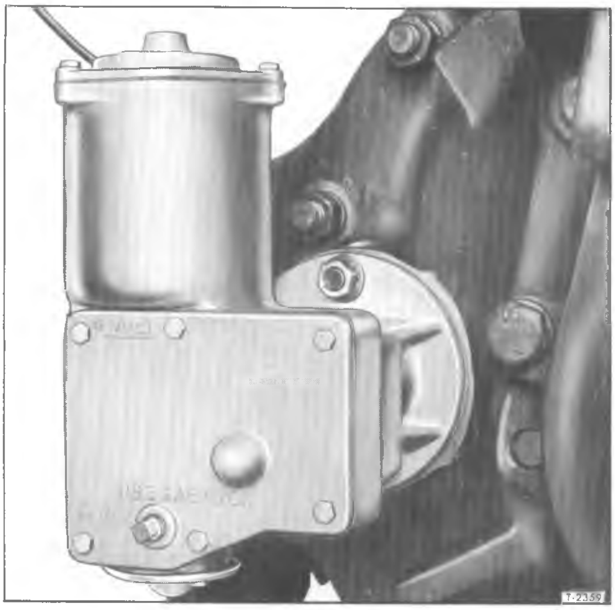


Figure 2—Two-Speed Electric Shift Unit Installed (Eaton Axle Shown)

matic switch so that motor is no longer energized and the armature stops rotating. To make sure that the nut cannot travel back on the screw due to vibration, a ball screw detent spring, holds the nut at the end of its travel on the screw.

The nut moves the spring winding lever down pivoting on winding and actuating lever shaft, winds the torsion spring for high. Thus an increased load is put on the spring, and in this position the axle is ready to snap into high speed ratio as soon as the load on the axle gears is relieved.

The torsion spring is assembled in the unit so that it is under approximately 50 to 90 pounds pressure, depending upon the size of the axle. When the spring winding lever is moved so that the spring is wound, the pressure of the spring is raised to approximately 90 to 140 pounds, depending upon size of axle.

The additional pressure is used to shift the axle. When the shift is completed, the ends of the spring come together leaving the original tension on the spring. Thus pre-load tension holds the axle in either selected gear.

When the shift button is in "Lo" range, the motor is energized so that the motor armature and drive screw rotate to drive nut in opposite direction for shift into "Low" range, in the same manner as previously described for "High" range operation.

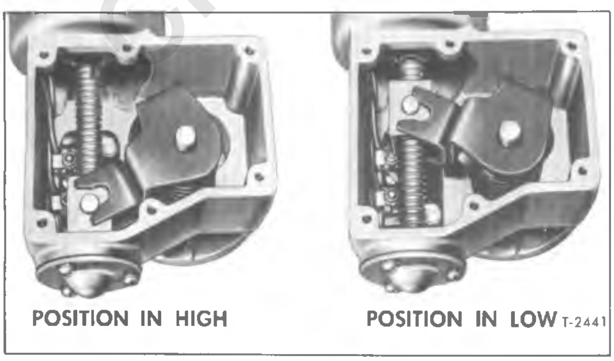


Figure 3—Position of Drive Screw in High and Low Range

SPEEDOMETER ADAPTER

The speedometer adapter is mounted to back of speedometer and is electrically connected to control switch. When the control switch button is placed into "Lo" range position, an electro-magnet shifts the adapter mechanism to compensate for the difference in gear reduction between "High" and "Low" range in the axle. When shift button is in "Hi" range position, current is released from electro-magnet, and a spring holds the adapter mechanism in "High" range position.

Speedometer adapters used on these vehicles are 12 volt type. Voltage of the unit is stamped on the housing below the wire terminal. Care should be used to select unit of same voltage as vehicle.

WIRING SYSTEM

Reference should be made to optional equipment wiring diagrams in "Wiring Diagrams" booklet. The ignition switch must be on before electric shift mechanism will operate.

A separate circuit breaker in the circuit protects the shift circuit in the event of a short. Refer to applicable "Wiring Diagrams" booklet for circuit breaker connections.

VACUUM SHIFT

Vacuum operated power shift system is used on some vehicles equipped with 2-speed rear axle. A typical system arrangement is shown in figure 4.

Vacuum power shift system utilizes engine intake manifold vacuum and atmospheric pressure for its operation. Units used in vacuum power shift system are: Control Button, located on gearshift lever; Control Valve, mounted on frame side rail at left-hand side; Vacuum Check Valve, installed in vacuum line at dash junction; Speedometer Adapter and Adapter Shift Diaphragm, mounted at speedometer head under instrument panel; Rear Axle Power Shift Chamber, mounted on differential carrier; and interconnecting vacuum lines and fittings.

SYSTEM OPERATION

LOW SPEED

With shift control button in "Lo" position, control valve opens one side of shift chamber at

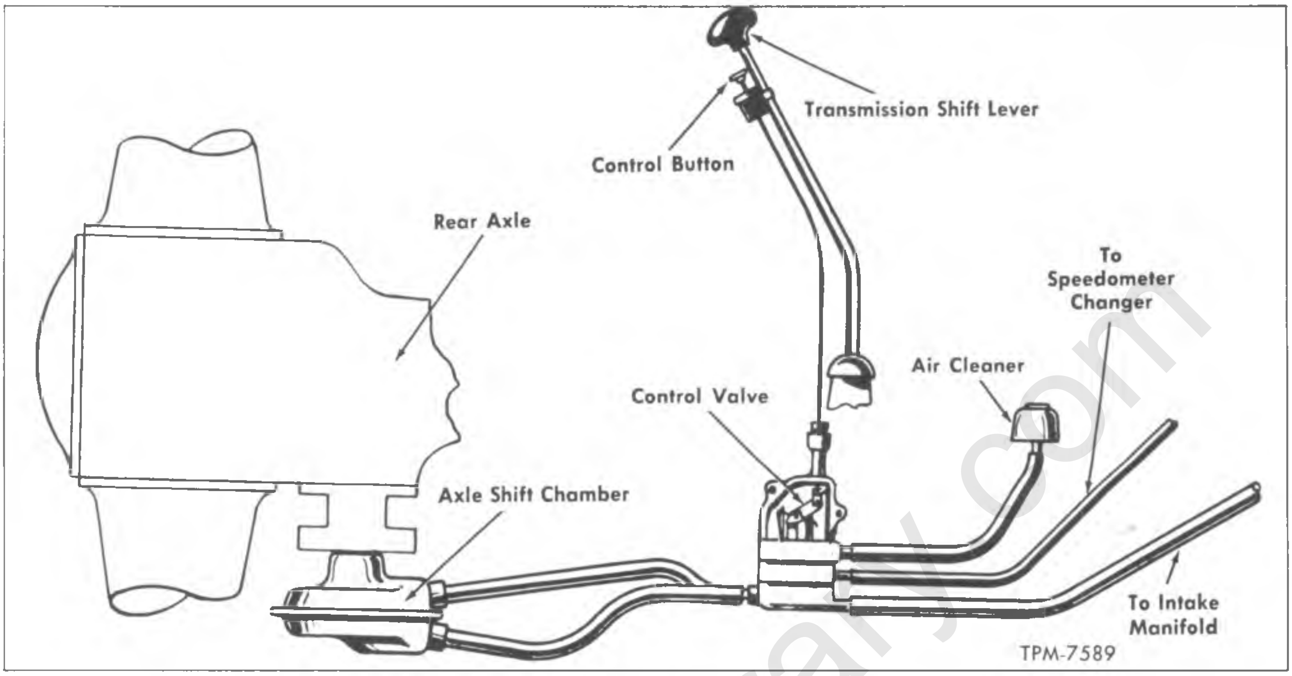
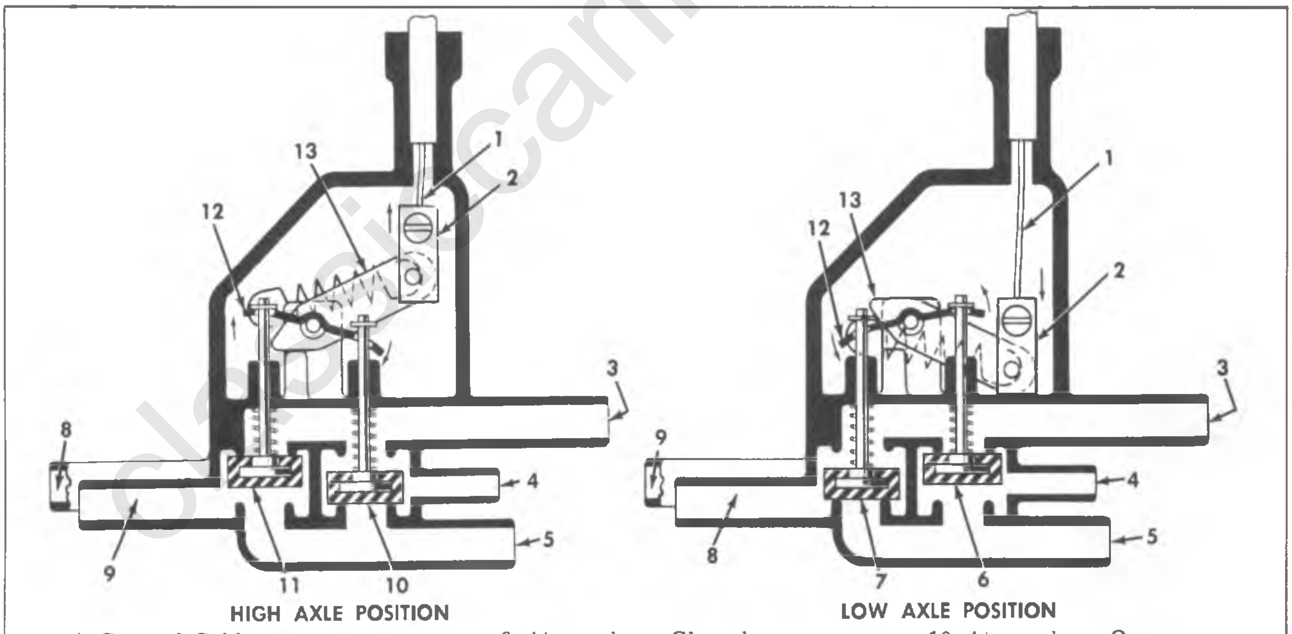


Figure 4—Typical Arrangement of Two-Speed Axle Vacuum Control Units

rear axle to vacuum and opposite side to atmosphere. In "Lo" speed position, vacuum is supplied to speedometer adapter causing rod to move inward shifting speedometer into low ratio.



1 Control Cable
2 Cable Trunnion
3 Atmosphere Port
4 Speedometer Shift Port
5 Vacuum Port
6 Atmosphere Closed - Vacuum Open
7 Atmosphere Open - Vacuum Closed
8 Atmosphere Open to Axle
9 Vacuum Open to Axle
10 Atmosphere Open - Vacuum Closed
11 Atmosphere Closed - Vacuum Open
12 Poppet Lever
13 Operating Lever

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Figure 5—Operating Positions of Vacuum Shift Control Valve

HIGH SPEED

With shift control button on gearshift lever up, in "Hi" position, rear axle power shift chamber is subjected to vacuum through the control valve. With vacuum present on one side of the shift chamber diaphragm, the atmospheric pressure on the opposite side of the diaphragm forces the diaphragm to move toward the vacuum side. Movement of the diaphragm is transmitted to the rear axle sliding clutch shift fork through the shift rod, and the axle gears are shifted into high speed. At the same time, vacuum is removed from the speedometer adapter causing the spring to move the diaphragm and rod, shifting speedometer into high speed.

SHIFTING

When shifting from "Lo" to "Hi" the operator pulls on control button, which is attached to valve through a cable. This raises the cable trunnion and operating lever up as shown in figure 5. The tension springs are therefore moved "over center" causing poppet lever to rotate, lifting one poppet valve and lowering the opposite valve.

When shifting from "Hi" to "Lo" the operator presses on control button. This moves the cable trunnion and operating lever downward as shown in figure 5. The tension springs are therefore moved "over center" causing poppet lever to rotate, lifting one poppet valve and lowering the opposite valve.

MAINTENANCE ON VEHICLES

At regular intervals, the following lubrication, inspection, and maintenance procedures should be accomplished and corrective measures taken whenever necessary.

LUBRICATION

Lubrication intervals, method of filling and draining, also type of lubricant and capacities for all axles are covered in LUBRICATION (SEC. 0).

Examine housing cover, pinion oil seal retainers, and axle shaft flanges for lubricant leaks. Tighten bolts or nuts, or replace gaskets and seals as necessary to correct leaks.

MOUNTING

Check for axle misalignment. Select a point at one side of vehicle and a corresponding point at opposite side. Measure distances between points selected and identical points at each end of axle assembly. If distances are not equal, axle misalignment is indicated and rear spring should be checked for correct installation.

Refer to "REAR SPRINGS" (SEC. 4B) for spring U-bolt tightening instructions, also for torque rod inspection and maintenance.

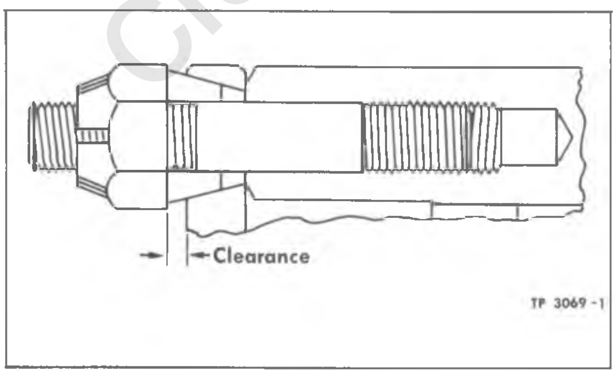

Figure 6—Clearance Between Axle Shaft Flange and Stud Nut

AXLE SHAFT FLANGE MOUNTING

Axle shaft flanges are retained to hubs by hub caps or stud nuts and dowels.

1. Check tightness of stud nuts at regular intervals. Tighten 1/2" nuts to 50-60 foot-pounds torque, or 5/8" nuts to 90-110 foot-pounds torque.
2. The studs must be straight and dowels of correct taper must be used. There should always be a slight clearance between nuts and driving flange when nuts are drawn up (fig. 6). No clearance at this point indicates excessive wear at studs, dowels, or holes in flange. Replacement of worn parts is the only remedy.
3. If stud nuts are not tightened to torque specified, play between flange and studs will cause bent or broken studs, also worn tapered holes in flange of axle shaft.

BENT HOUSING CHECK

A check for bent axle housing can be made with unit in vehicle in following manner; however, conventional alignment instruments can be used if available.

1. Raise rear axle with a jack until wheels clear floor. Block up axle under each spring seat.
2. Check wheel bearing adjustment and adjust if necessary, then check wheels for looseness and tighten wheel nuts if necessary. Refer to "REAR HUBS AND BEARINGS" (SEC. 4C).
3. Place a chalk mark on outer side wall of tires at bottom. Measure across tires at chalk marks with a toe-in gauge.
4. Turn wheels half-way around so that chalk marks are positioned at top of wheel. Measure across tires again. If measurement at top is 1/8" or more smaller than previous measurement noted at bottom of wheels, axle housing has sagged and is bent. If measurement at top exceeds bottom dimension by 1/8", axle housing is bent at ends.

5. Turn chalk marks on both wheels so that marks are level with axle and toward rear of vehicle. Take measurement with toe-in gauge at chalk marks; then turn both chalk marks to front and level with axle and take another measurement. If measurement at front exceeds rear dimension by 1/8" or more, axle is bent to the rear. If the measurement condition is the reverse, the axle is bent forward.

ELECTRIC SHIFT MAINTENANCE AND DIAGNOSIS

The only general maintenance necessary on the shift control system is periodic lubrication of unit as described in LUBRICATION (SEC. 0). The wiring connectors should be kept tight, and wires to the various units should be kept in good condition.

DIAGNOSING TROUBLE

If the electric shift fails to operate properly, the system should be tested and the trouble diagnosed as described in following paragraphs. A test light consisting of a 12-volt bulb with two wires a few feet long with small battery clips on the ends. Refer to Wiring Diagram and test in following sequence:

1. Disconnect two wires from shift unit at rear axle. Place engine control or ignition switch in "ON" position, also place axle shift switch at shift lever in "Hi" position.
2. Connect one lead of test light to ribbed wire and opposite lead to ground. One of the following conditions should exist.
   a. Should light come on and stay on, the circuit is satisfactory and any trouble will probably be found in the shift unit. Repeat check for "Lo" position as directed in step 3 following.
   b. If the light fails to come on, this indicates that the circuit is open between the control switch and the shift unit and further tests will be required.
   c. If the light comes on but cycles, this indicates that there is a short between the control or ignition switch and shift unit, and further tests will be required.
3. Remove test light lead from ribbed wire and connect to smooth wire, also place axle shift switch in "Lo" position. Observe conditions as outlined in sub-paragraphs above.
4. Connect one lead of test light to control switch side of circuit breaker and opposite lead to ground. Should light come on, and stay on, the circuit is satisfactory. However, if the light fails to come on the circuit between the control switch and circuit breaker is either open or shorted.
5. Connect one test lead to load side of circuit breaker and opposite lead to ground. Should light come on, and stay on, the circuit breaker is satisfactory. However, if the light fails to come on the circuit breaker is faulty.
6. At chassis junction, remove both wires, then test circuit through red wire with white stripe. Reconnect both wires to terminal.
7. At chassis junction, remove wire from terminal. Place axle shift lever switch in "Lo" position and test circuit.
8. At chassis junction, remove wire from terminal. Place axle shift lever switch in "Hi" position and test circuit.

The preceding tests should readily localize any trouble within the system. When checking the wiring harness for shorts or open circuits, examine for broken insulation.

The control or ignition switch can be best tested by substituting a new unit.

If the vehicle shifts normally, but the speedometer adapter fails to operate, make the test to determine whether the adapter is getting current in "Lo" range. If current is present, replace the adapter. When the trouble is traced to the shift unit, it should be replaced.

VACUUM SYSTEM MAINTENANCE

All lines and units in vacuum power shift system must be kept free of vacuum leaks. When vacuum leaks exist, rear axle shift mechanism will operate sluggish and in some instances may not shift axle. If this condition exists make tests to determine location of leaks.

VACUUM LEAKAGE TEST

1. Disconnect flexible lines one at a time, at axle shift chamber and insert a vacuum gauge in line, using a "Tee" fitting.
2. Start engine and place axle shift button in "Hi" or "Lo" depending upon location of vacuum gauge. Run engine long enough to obtain maximum vacuum, then stop engine and note rate of vacuum drop on gauge. If drop exceeds 1 inch to 10 minutes, leakage is excessive.
3. If leakage is indicated, coat all vacuum

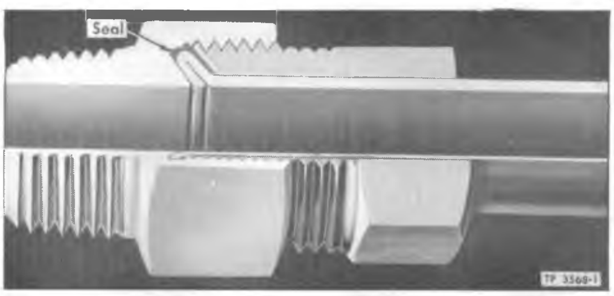

Figure 7—Vacuum Tubing Connection Seal

line connections with hydraulic brake fluid. If leak exists, fluid will be drawn into connection with engine idling and control lever in "LOCK" position.

4. Remove line having leaking connection. Slide tube nut back on tube and remove all particles of seal ring from tube and from inside of nut. Slip new seal ring over tube end. Insert tube into fitting and seat solidly. Slide seal ring (do not roll) into fitting (fig. 7). Thread tube nut into fitting and tighten slowly and firmly.

5. Repeat above test on opposite vacuum line, being sure to change shift button.

6. If vacuum drop is still excessive after all connections have been checked, leakage in one of the units is indicated. Remove each unit and overhaul or replace as required.

AIR CLEANER

Air cleaner removes dirt particles from atmosphere which passes into the control valve and other units. Air cleaner should be removed and cleaned at regular intervals.

REAR AXLE SERVICE DIAGNOSIS

SYMPTOM	PROBABLE REMEDY
NOISE ON DRIVE	
Excessive Pinion Gear Backlash	Adjust
Worn Pinion and Bevel Gear	Replace
Worn Pinion Bearings	Replace
Loose Pinion Bearings	Adjust
Excessive Pinion End Play	Adjust
Worn Differential Bearings	Replace
Loose Differential Bearings	Adjust
Excessive Bevel Gear Run-Out	Replace
Low Lubricant Level	Replenish
Wrong or Poor Grade Lubricant	Replace
Bent Axle Housing	Straighten or Replace
NOISY ON COAST	
Axle noises heard on drive will usually be heard also on coasting; although not as loud	Adjust or Replace
Pinion and bevel gear too tight (audible when decelerating & disappears when driving)	Adjust
INTERMITTENT NOISE	
Warped Bevel Gear	Replace
Loose Differential Case Bolts	Tighten

SYMPTOM	PROBABLE REMEDY
CONSTANT NOISE	
Flat Spot on Pinion or Bevel Gear Teeth	Replace
Flat Spot on Bearings	Replace
Worn Pinion Splines	Replace
Worn Axle Shaft Dowel Holes	Replace
Worn Hub Studs	Replace
Bent Axle Shaft	Replace
NOISY ON TURNS	
Worn Differential Side Gears and Pinions	Replace
Worn Differential Spider	Replace
Worn Differential Thrust Washers	Replace
Worn Axle Shaft Splines	Replace
FAILS TO SHIFT INTO HIGH OR LOW	
Defective Electrical Circuit	Correct
Defective Shift Unit	Replace
Lack of Air Pressure	Correct
Low Vacuum	Correct

REPLACEMENT AND OVERHAUL

AXLE REPLACEMENT

REMOVAL

1. Jack up rear of vehicle until load is removed from springs, then place blocks under frame to prevent accidental dropping of vehicle.

2. Disconnect hydraulic or air brake lines, whichever is used. Refer to BRAKES (SEC. 5).

3. Disconnect electric wiring or line from shift chamber if vehicle is equipped with a 2-speed axle.

4. Disconnect propeller shafts as directed in "PROPELLER SHAFTS" (SEC. 4D).

5. Disconnect torque or radius rods, if used, as directed in "REAR SPRINGS" (SEC. 4B).

6. Disconnect spring U-bolts as directed in "REAR SPRINGS" (SEC. 4B).

7. Roll axle out from under vehicle, then remove wheels, hubs, and bearings as directed in "REAR HUBS AND BEARINGS" (SEC. 4C).

8. Whenever another axle is to be installed instead of the one removed, it may be necessary to remove two speed shift unit, and brake chambers. Refer to respective sub-sections for instructions.

INSTALLATION

1. If brake chambers or two-speed shift unit has been removed, they should be reinstalled as directed in respective sections.

2. Install hubs, wheels and tires as directed

in "REAR HUBS AND BEARINGS" (SEC. 4C). Roll axle into position under vehicle.

3. Connect springs to axle as directed in "REAR SPRINGS" (SEC. 4B).

4. Reconnect the torque rods as directed in "REAR SPRINGS" (SEC. 4B). On some vehicles torque rods are adjustable to secure proper axle alignment.

5. Reconnect propeller shafts as directed in "PROPELLER SHAFTS" (SEC. 4D).

6. Reconnect electric wiring or line at shift chamber if vehicle is equipped with a 2-speed axle.

7. Reconnect air brake lines as directed in BRAKES (SEC. 5).

8. Check lubricant level and fill with type and grade of lubricant in the manner instructed in LUBRICATION (SEC. 0). Some types of axles require additional lubricant at pinion cage when filled initially or after overhaul.

9. Remove blocks and lower vehicle to the ground. Retighten spring U-bolts as instructed in "REAR SPRINGS" (SEC. 4B).

10. After all installation procedures have been completed, check air or vacuum lines for leaks, also test brakes for proper application.

DIFFERENTIAL CARRIER REPLACEMENT

In some instances it may be desirable to remove the differential carrier assembly from the axle housing, while the housing remains installed under the vehicle.

To assist in handling the differential carrier assembly, a roller jack should be available; also, a pan for draining lubricant.

Inspect axle housing for lubricant leaks before cleaning, then steam clean thoroughly to remove all dirt or other foreign matter.

REMOVAL

1. Remove plug at bottom of housing to drain lubricant.

2. Remove axle shafts as directed under heading "Axle Shaft Replacement" in this section.

3. On 2-speed axles disconnect lines from shift chamber or wiring from shift electric unit.

4. Disconnect propeller shaft from yoke as directed in "PROPELLER SHAFTS" (SEC. 4D).

5. Remove cap screws or stud nuts, and lock washers, except two near top. Loosen two at top and leave installed to prevent carrier falling.

6. Support carrier on roller jack, remove top stud nuts or cap screws, then work carrier free of housing. A small pinch bar may be used to keep carrier straight in housing bore, while carrier is withdrawn. End of bar must be rounded to prevent damage to carrier flange.

INSTALLATION

1. Install new differential carrier to housing gasket over studs or align bolt holes in gasket with holes in housing. On axles using cap screws, install four temporary studs which will simplify locating carrier and gasket and assist in drawing carrier into place.

2. Roll carrier into place using roller jack. Start carrier over studs and into housing, using flat washers under four equally spaced stud nuts.

3. Tighten all nuts evenly and alternately until carrier is in position. Replace temporary flat washers. Install lock washers, then tighten all nuts to specified torque.

4. Connect propeller shaft to rear axle yoke as directed in "PROPELLER SHAFTS" (SEC. 4D).

5. On 2-speed axles connect wiring to electric shift unit or line to shift chamber.

6. Install axle shafts as directed under heading "Axle Shaft Replacement" in this section.

7. Fill to level of filler plug opening with lubricant recommended in LUBRICATION (SEC. 0) of this manual.

AXLE SHAFT REPLACEMENT

REMOVAL

Procedure for removal of axle shafts is the same with axle assembly removed or installed in the vehicle.

1. Remove nuts from studs attaching axle shaft flange to wheel hub.

2. Strike center of flange with a lead hammer to loosen flange and split tapered dowels from studs.

3. Remove split tapered dowels from studs. In some instances it may be necessary to spread dowels, while being removed.

4. Grasp axle shaft flange and pull outward to remove. Remove and discard gasket.

INSTALLATION

1. Install new gasket over hub studs and against hub.

2. Dip splined end of shaft in axle lubricant, and insert shaft through hub.

3. Turn shaft as necessary to index shaft splines with differential side gear splines.

4. As shaft is pushed inward, rotate as necessary to align flange holes with hub studs, then press shaft inward until flange is against hub.

5. Install split tapered dowel over each stud. Install and tighten 5/8" nuts to 90-110 foot-pounds torque or 1/2" nuts to 50-60 foot-pounds torque.

6. Observe that clearance exists between nut and flange (fig. 6). If no clearance exists, this indicates excessive wear at studs, dowels, or flange holes. Replace worn parts if necessary.

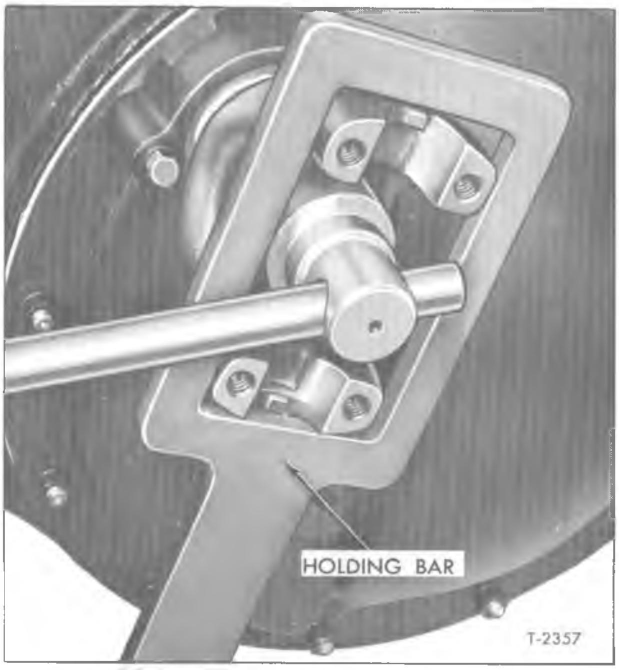

Figure 8—Propeller Shaft Yoke Holding Bar

PINION OIL SEAL REPLACEMENT

Several types of oil seal installation are used on axles covered by this publication. One type has the seal assembly installed directly into differential carrier, while another has the seal installed in a retainer which is attached to carrier.

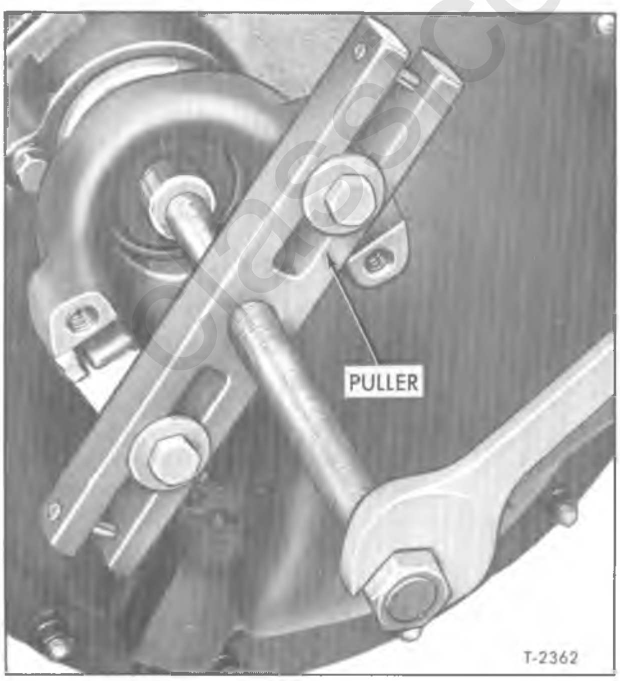

Figure 9—Propeller Shaft Yoke Puller (Typical)

REMOVAL

1. Remove propeller shaft from yoke at axle as directed in "PROPELLER SHAFTS" (SEC. 4D).
2. Hold propeller shaft yoke with holding bar (fig. 8) while removing yoke retaining nut and washer.
3. Use suitable puller in manner typically illustrated in figure 9 to remove propeller shaft yoke.
4. On axle where seal and retainer is pressed into carrier, use available removing tool such as punch or pry bar. Remove flat washer from counterbore in carrier.
5. On axles where seal and retainer assembly are attached to carrier by cap screws, remove screws and washers, then lift assembly from carrier. NOTE: Some axles also have a cork seal installed in a groove in pinion cage, which should be replaced.

INSTALLATION

1. Before installing new seal, be sure that differential carrier is cleaned of all deposits, such as oil, dirt, etc.
2. On axles where seal and retainer is pressed into carrier, install flat washer in carrier, then install strip sealer around carrier counterbore and against washer.
3. Coat outer surface of seal retainer with sealing compound, then position assembly in carrier. Use suitable available tool to press or drive retainer into carrier until seated against flat washer.
4. On axles where seal and retainer assembly is attached to carrier by cap screws, install cork seal in groove or gasket on pinion cage.

NOTE: Be sure that gasket does not cover any oil passage holes in pinion cage.

5. Install oil seal and retainer assembly over pinion and against pinion cage. Secure with cap

Figure 10—Electric Shift Unit Seal Markings

screws and lock washers, tightened securely.

6. Coat lip of oil seal with axle lubricant, then install propeller shaft yoke, washer, and nut. Hold yoke with holding bar (fig. 8) while tightening nut to recommended torque.

ELECTRIC SHIFT UNIT REPLACEMENT

REMOVAL

1. Remove two shift housing to carrier stud nuts and lock washers (fig. 2).
2. Remove shift unit assembly.
3. Remove lock nuts and the two wires from shift housing. Note that the long or black ribbed wire is attached to the bottom terminal.

INSTALLATION

1. Check condition of rubber seal between shift unit and carrier. Seal must be in good condition to prevent lubricant leaking into shift unit.

NOTE: Seal bears lettering "BOTTOM - FORWARD TANDEM" and "BOTTOM - SINGLE AND REAR TANDEM," as indicated in insert of figure 10. Be sure seal is properly installed.

1 Motor Cover to Housing Screw (with Washer)
2 Motor to Cover Nut
3 Motor Cover Cable Clip
4 Motor Cover
5 Motor Cover Gasket
6 Electric Motor
7 Motor Grommet
8 Shift Unit Housing
9 Switch Terminal Nut (outside)
10 Switch Terminal Washer (outside)
11 Switch Terminal Bushing
12 Bearing (with snap ring)
13 Bearing Lock Nut
14 Bearing Cover Gasket
15 Bearing Cover
16 Bearing Cover to Housing Screw (With Washer)
17 Automatic Switch Assembly
18 Switch to Housing Screw (inside)
19 Switch Terminal Nut (inside)
20 Drive Screw Assembly
21 Winding and Actuating Lever Shaft
22 Shift Fork Actuating Lever Assembly
23 Torsion Spring
24 Spring Winding Lever Assembly
25 Shift Housing Cover Gasket
26 Shift Housing Cover and Detent Spring
27 Lubricant Plug
28 Housing Cover to Housing Screw (with Washer)

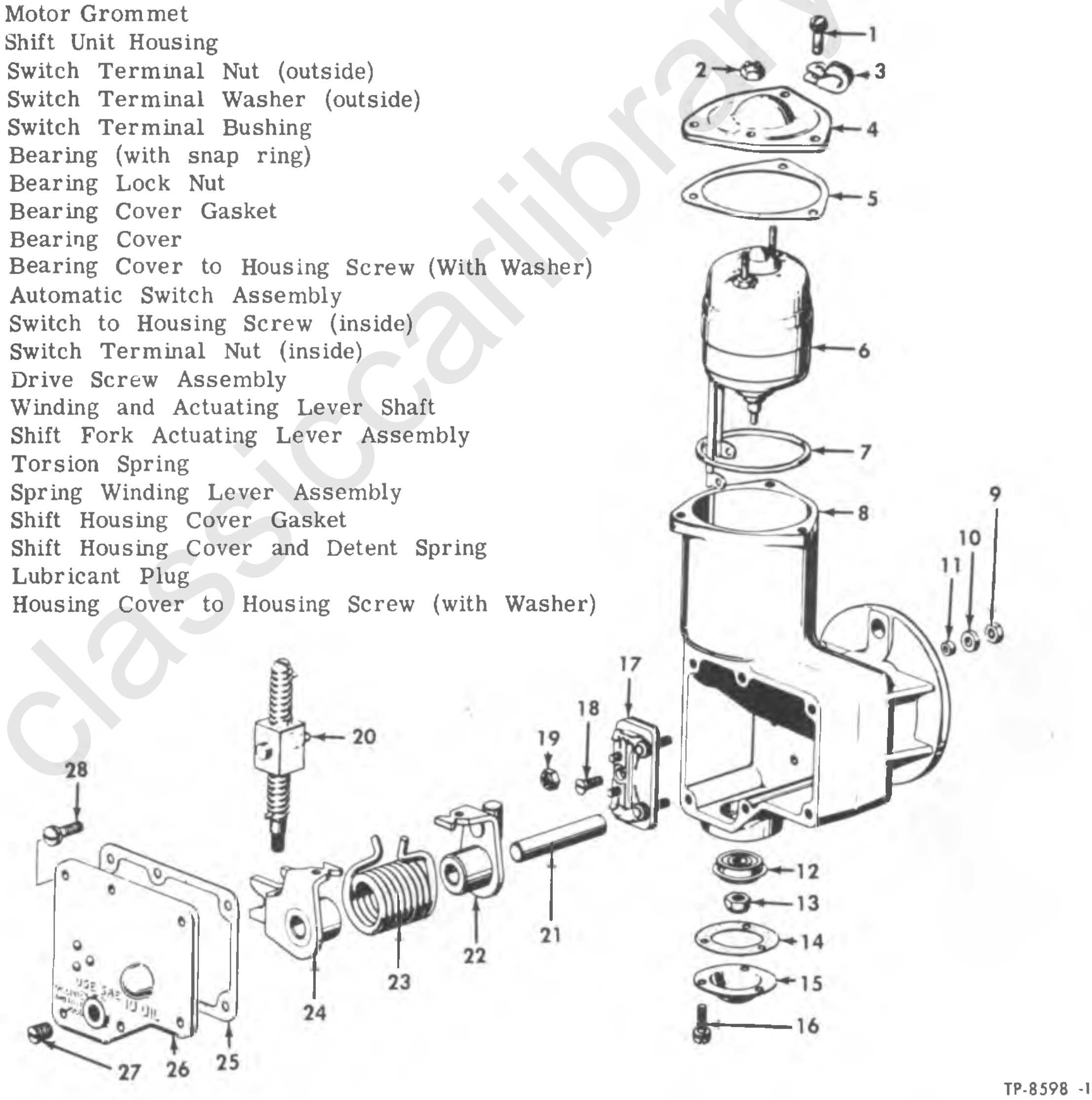

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Figure 11—Electric Shift Unit Components (Eaton and Corporation)

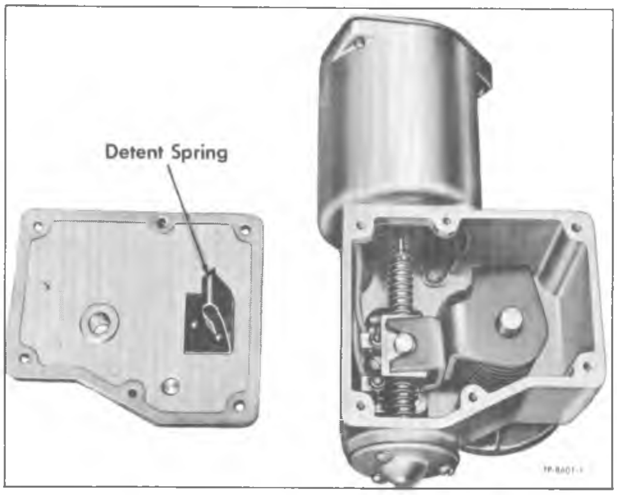


Figure 12—Position of Drive Nut When Disassembling

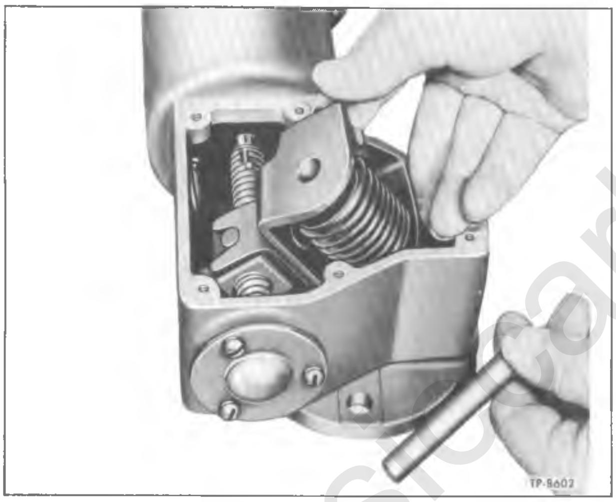


Figure 13—Removing Shaft, Actuating Lever, and Spring

2. Install wires to outside terminals. The long black ribbed wire is attached to bottom terminal. Harness is clipped to cable clip on housing.

3. With seal between carrier and shift unit in place, install shift unit over carrier studs. Make certain that the swivel block of the shift fork actuating lever fits into the slot in carrier shift fork. Tighten stud nuts firmly.

4. Check installation by making a "Lo" and "Hi" range shift. Ignition or control switch must be turned on before check can be made.

NOTE: The shift unit motor is designed to be reversible and runs equally well in either direction. If the terminal wires are reversed, the unit will shift to "Low" when the control switch button is in "Hi" position, and will shift to "High" when the button is in "Lo" position.

REMOVAL OF ROCKWELL SHIFT UNIT

It is necessary to partially disassemble the Rockwell electric two-speed unit to remove it from axle housing. This may be accomplished in the following manner:

1. Remove five screws from shift unit housing cover (25) (refer to fig. 18), then remove cover. This also drains the lubricant. After cover is removed, note that drive screw nut is either at top or bottom (fig. 3) depending on whether axle is in "HIGH" or "LOW" range position.

2. Loosen shift unit-to-differential carrier stud nuts (fig. 16) to remove preload from shift unit spring.

3. Turn drive screw by hand to run nut to midway position on drive screw, similar to figure 12. This is necessary to prevent damage to drive nut contact bumper.

4. Pull out lever shaft (fig. 16). Disconnect torsion spring from push rod, then remove spring and spring winding lever.

5. Remove shift unit-to-differential housing

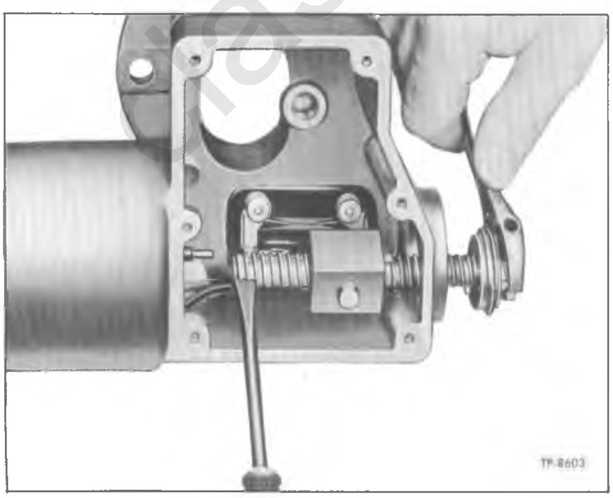


Figure 14—Removing Drive Screw Bearing

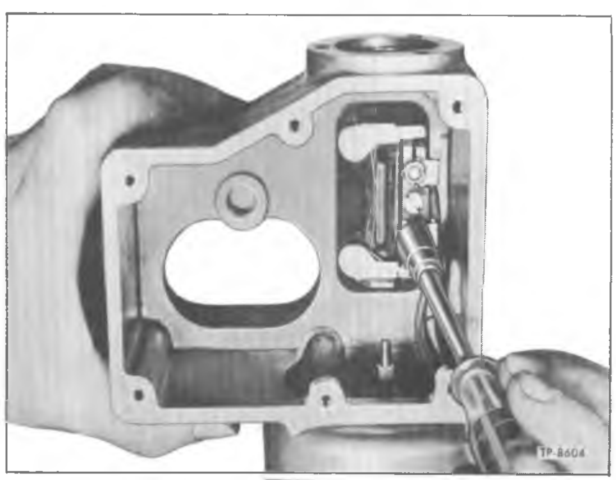


Figure 15—Removing Motor Wires

stud nuts, then remove shift unit from axle.

6. Remove wire cable clip from shift unit cover. Note to which terminal each wire is attached, then disconnect the two wires from shift unit terminals.

ELECTRIC SHIFT UNIT OVERHAUL

The following information is provided on the assumption that shift unit has been tested and removed as previously instructed.

DISASSEMBLY (EATON AND CORP.)

Key numbers in text refer to figure 11.

1. Remove six screws (28) and lock washers which attach cover (26) to shift motor housing (8). Drain lubricant from housing. Remove gasket (25).

2. After removing cover (26), the drive screw (20) nut will be at either top or bottom depending upon the position in which the control switch was last left.

3. By turning drive screw, run nut from top or bottom to the center of the screw (fig. 12).

IMPORTANT: The previous step is essential to prevent damage to drive nut contact bumper, and is also necessary in assembly.

4. Remove shift fork actuating lever (22), torsion spring (23), and spring winding lever (24) as an assembly by pulling shaft (21) up. Swing the assembly away from the drive nut and lift out of the housing (fig. 13).

5. Remove three screws and lock washers (16) which attach bearing cover (15). Remove cover and gasket (14).

6. Push down on drive screw assembly (20) until bearing assembly (12) is free of housing.

7. Insert screwdriver in drive slot of screw (fig. 14), then remove bearing lock nut (13) and bearing with snap ring (12). Drive screw assembly (20) can then be lifted out of housing.

8. Remove the two lock nuts (19) from switch terminals (17). Pull off motor wires (fig. 15).

9. Remove three screws and lock washers (1) which attach motor cover (4) to housing. Pull out motor (6) with cover (4) attached to motor with two cover nuts (2). Remove grommet (7).

10. Remove two jam nuts (9) and fiber washers (10) from outside of housing. On inside remove switch center screw (18). Pull out automatic switch (17) as shown in figure 17.

11. Do not disassemble the shift fork actuating lever (22), torsion spring (23), and spring winding lever (24) unless necessary to replace one of the parts. If necessary to disassemble, mount assembly in vise as shown in figure 18. Turn spring winding lever (24) clockwise and pull to separate.

DISASSEMBLY (ROCKWELL) (Refer to Fig. 18)

1. Remove three screws and lock washers (16) which attach bearing cover (15) to bottom of shift

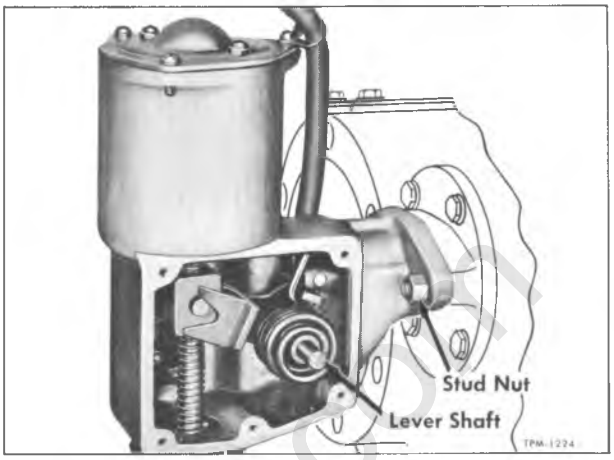


Figure 16—Shift Unit Cover Removed(Rockwell Axles)

unit housing. Remove cover and gasket (14).

2. Push down on drive screw assembly (20) until bearing assembly (12) is free of housing.

3. Insert screwdriver in drive slot of screw (fig. 14); then remove bearing lock nut (13) and bearing with snap ring (12). Drive screw assembly (20) can then be lifted out housing.

4. Remove the two lock nuts (19) from switch terminals (17). Pull off motor wires (fig. 15).

5. Remove three screws and lock washers (1) which attach motor cover (4) to housing. Pull out motor (6) with cover (4) attached to motor, with two cover nuts (2). Grommet (7) can then be removed.

6. Remove two jam nuts (9) and fiber washers (10) from outside of housing. On inside remove switch to housing screws (18). Remove automatic switch.

7. Do not disassemble torsion spring (23), and spring winding lever (22) unless necessary to replace one of the parts. If necessary to disassemble,

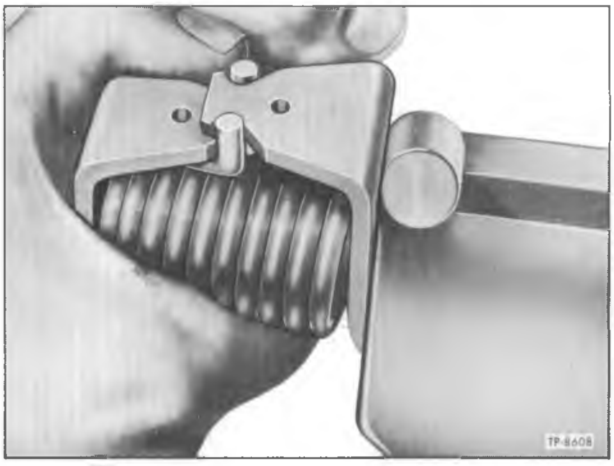


Figure 17—Disassembling Torsion Spring from Lever

mount assembly in vise as shown in figure 19. Place a short piece of rod in hub of spring winding lever as a safety factor to prevent injury should torsion spring slip out of control. Next, place two lengths of tubing over ends of spring, pull spring ends apart, then raise spring above spring winding lever (fig. 20). To assemble, reverse above procedure.

CLEANING AND INSPECTION

Clean all parts except motor in cleaning solvent. Inspect as follows:

Automatic Switch

The switch assembly is serviced only as an assembly. The switch should have clean free moving points which close firmly under spring tension.

1 Motor Cover to Housing Screw (with Washer)
2 Motor to Cover Nut
3 Motor Cover Cable Clip
4 Motor Cover
5 Motor Cover Gasket
6 Electric Motor
7 Motor Grommet
8 Shift Unit Housing
9 Switch Terminal Nut (outside)
10 Switch Terminal Washer (outside)
11 Switch Terminal Bushing
12 Bearing (with Snap Ring)
13 Bearing Lock Nut
14 Bearing Cover Gasket
15 Bearing Cover
16 Bearing Cover to Housing Screw (with Washer)
17 Automatic Switch Assembly
18 Switch to Housing Screw (inside)
19 Switch Terminal Nut (inside)
20 Drive Screw Assembly
21 Winding and Actuating Lever Shaft
22 Spring Winding Lever
23 Torsion Spring
24 Shift Housing Cover Gasket
25 Shift Housing Cover and Detent Spring
26 Lubricant Plug
27 Housing Cover to Housing Screw (with Washer)
28 Housing to Carrier Seal

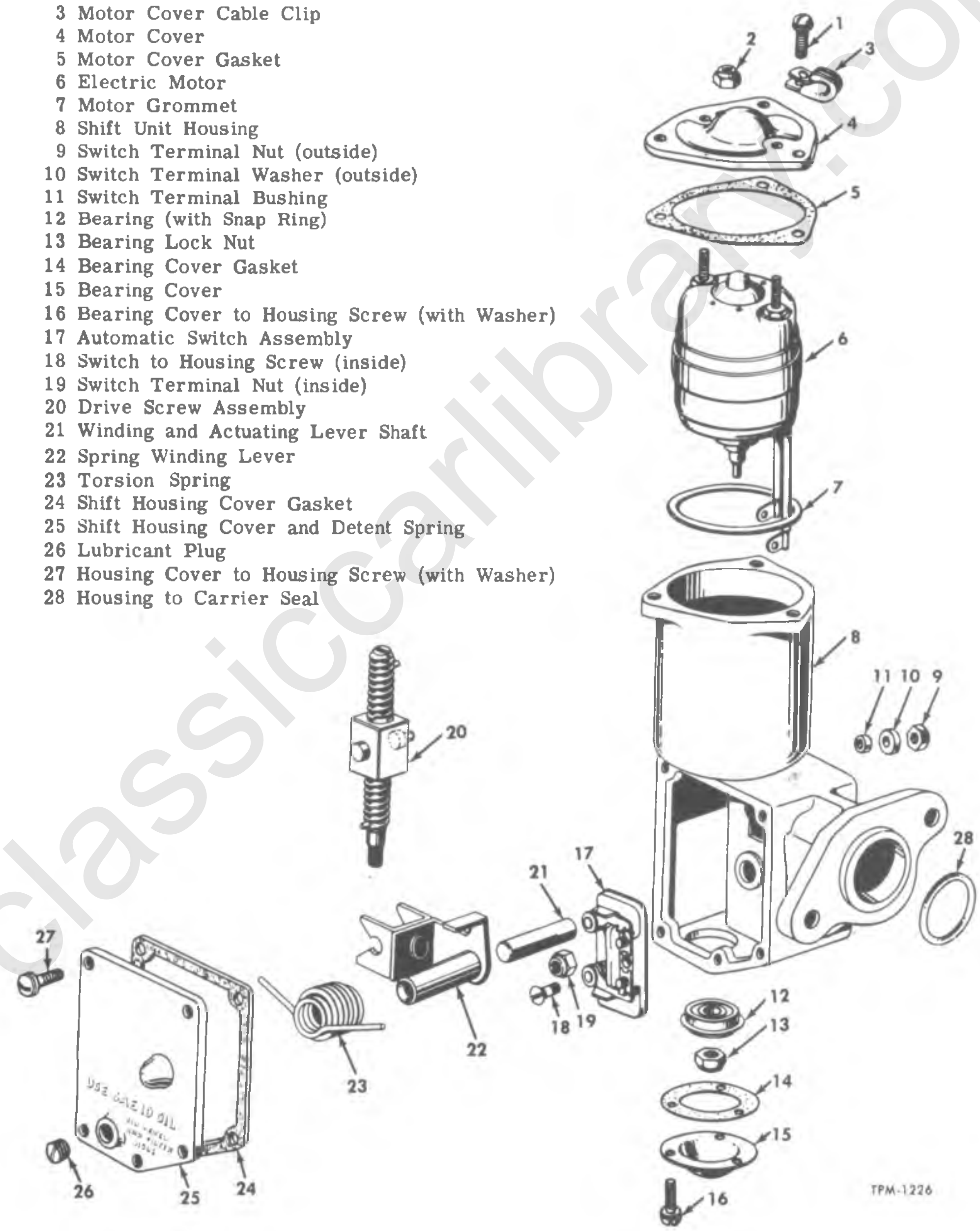


Figure 18—Electric Shift Unit Components (Rockwell)

Drive Screw

The drive screw assembly is serviced only as an assembly. While holding the nut, rotate the screw from one end to the other. It should rotate freely. When the nut gets to either end of the screw, the screw should continue to turn, but the nut should not jam or run off the ends.

Electric Motor

The motor (serviced only as an assembly) is reversible. With the motor housing connected to one battery terminal, and either one of the two motor wires connected to the other battery terminal the motor will run in one direction. With the other motor wire connected to the battery, motor will run in the opposite direction.

The motor has a stall torque of approximately 6 inch-pounds. Clamp a small crescent wrench on the rectangular drive on the armature shaft. Place motor in vise, and grasp wrench handle with one hand. Connect one motor wire to a battery terminal and connect motor housing to the other battery terminal. The wrench should tend to turn with a torque of about 6 inch-pounds. Allow wrench to turn VERY SLOWLY, making sure that this pull or torque is present the FULL 360 degrees turn of the wrench. If one armature is burned out, the torque will disappear for a small part of the 360 degrees. Do not overheat the motor while making test. Motor must be replaced as an assembly, and is lubricated for life of motor. The motor used is 12-volt type which is the same as truck electrical system. When installing a new motor use care to select motor of proper voltage. Voltage is stamped on motor housing and on side cover of shift unit.

Miscellaneous Parts

Gaskets should be replaced at assembly.

Inspect bearing. If balls are rough or chipped, replace with new bearing and snap ring assembly. Pack bearing assembly with clean grease (Chassis Grease) - Symbol "C" in LUBRICATION (SEC. 0).

Inspect torsion spring (23, fig. 11 and 18) for breaks or wear at lever contact points. Make certain that correct replacement spring is used.

ASSEMBLY (EATON AND CORP.)

Key numbers in text refer to figure 11.

1. Install automatic switch assembly (17) into housing. Use flat head screw (18) to attach switch to housing. On outside of housing, install two bushings (11), fiber washers (10), and jam nuts (9) over switch terminal screws. Tighten nuts firmly.

2. Install motor assembly grommet (7), then install gasket (5) on housing. Install motor (6) and cover (4) into housing. Install three screws and lock washers (1) and two stop nuts (2). Install motor cover cable clip (3) under outer screw. Tighten screws and nuts firmly.

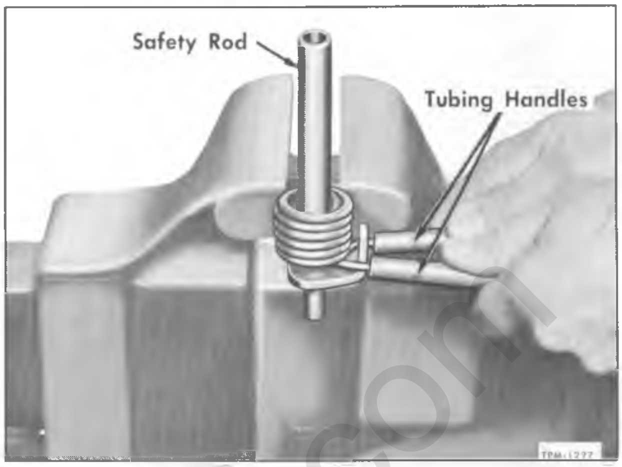


Figure 19—Removing Torsion Spring (Rockwell)

3. Attach motor wires to switch terminals. The red or longer wire attaches to bottom terminal. Tighten inside terminal nuts (19) firmly.

4. With a screwdriver inserted into slot of drive screw (20), install bearing (12) on end of screw with shielded side of bearing toward inside. Retain bearing with bearing lock nut (13).

5. Run nut to center of screw, then insert slotted end of screw into housing, meshing slotted end with armature shaft.

NOTE: Fiber bumper contacts on drive nut must be toward switch.

6. Install gasket (14) and cover (15) with three screws and lock washers (16). Tighten screws firmly.

7. If the assembly consisting of shift fork actuating lever (22), torsion spring (23), and spring winding lever (24) has been separated, reassemble. With shift fork actuating lever (22) in vise, assemble parts as shown in figure 21. Turn the spring

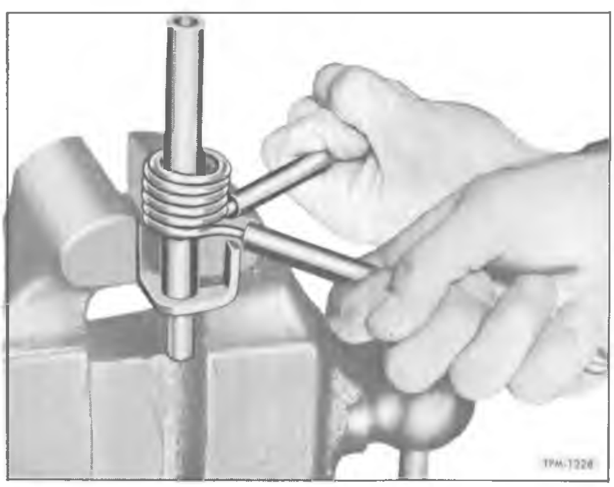


Figure 20—Removing Torsion Spring (Rockwell)

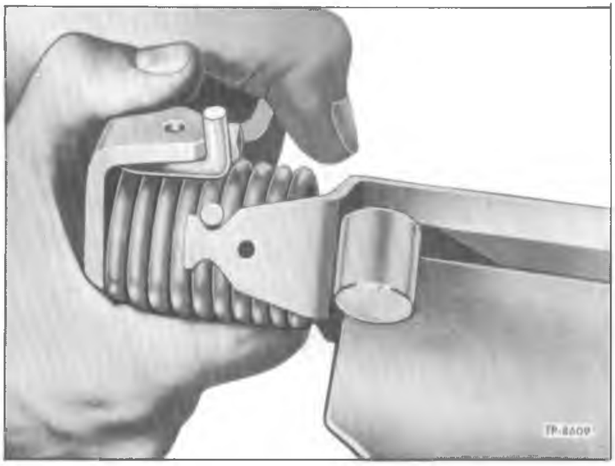


Figure 21—Assembling Torsion Spring and Levers (Eaton)

winding lever (24) with one end of spring, in clockwise direction until end of spring is past shift fork actuating lever; then push in on assembly until positioned as shown in figure 17.

8. Dip above assembly in lubricant. With drive nut on drive screw assembly in center of screw, and fiber contact bumper down toward switch, position the slots of winding lever over the drive nut. Install the shaft (21) through center of the assembly into depression in housing.

9. Install new gasket (25) on housing. Install cover (26) with spring detent against drive nut. Retain cover with screws and lock washers (28).

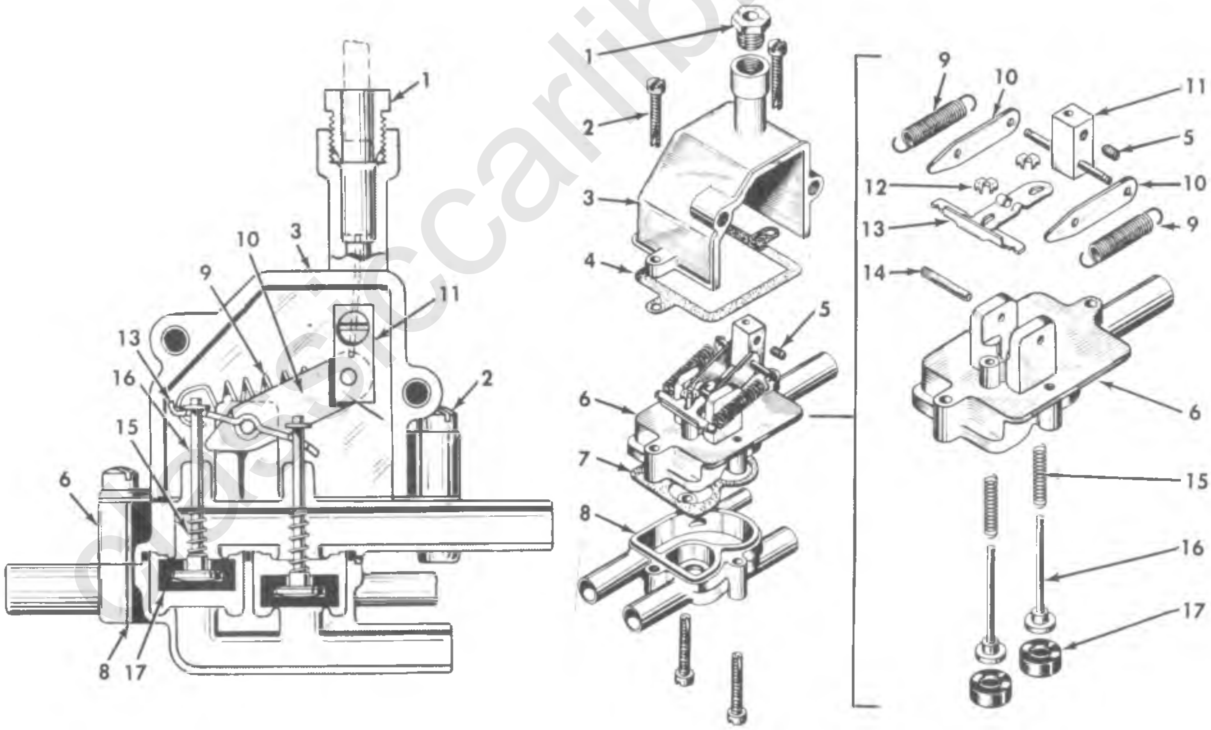
10. Remove oil plug (27). With unit standing with motor up, lubricate in accordance with instructions given in LUBRICATION (SEC. 0). Reinstall plug and tighten firmly.

ASSEMBLY (ROCKWELL)

Key numbers in text refer to figure 18.

1. Install automatic switch assembly (17) into housing. Use flat head screw (18) to attach switch to housing. On outside of housing, install two bushings (11), fiber washers (10), and jam nuts (9) over switch terminal screws. Tighten nuts firmly.

2. Install motor assembly grommet (7), then install gasket (5) on housing. Install motor (6) and cover (4) into housing. Install three screws and lock washers (1) and two stop nuts (2). Install motor cover cable clip (3) under outer screw. Tighten screws and nuts firmly.



1 Compression Nut	7 Body Gasket	13 Poppet Lever
2 Screw	8 Lower Valve Body	14 Pivot Pins
3 Valve Cover	9 Tension Spring	15 Poppet Spring
4 Cover Gasket	10 Operating Lever	16 Poppet Stem
5 Trunnion Screw	11 Trunnion	17 Poppet (Valve)
6 Valve Body	12 Retaining Washer	

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Figure 22—Sectional and Disassembled Views of Control Valve

3. Attach motor wires to switch terminals. The red or longer wire attaches to bottom terminal. Tighten inside terminal nuts (19) firmly.

4. With a screwdriver inserted into slot of drive screw (20), install bearing (12) on end of screw with shielded side of bearing toward inside. Retain bearing with bearing lock nut (13).

5. Run nut to center of screw, then insert slotted end of screw into housing, meshing slotted end with armature shaft.

NOTE: Fiber bumper contact on drive nut must be toward switch.

6. Install gasket (14) and cover (15) with three screws and lock washers (16). Tighten screws firmly.

NOTE: Remainder of assembly of shift unit used on Rockwell axles must be completed when unit is installed on housing as described previously in the section under "Two-Speed Shift Unit Replacement."

VACUUM CONTROL VALVE

Control valve (fig. 22) requires very little maintenance, unless cleaning of air cleaner has been neglected and valve has become contaminated as a result of neglect. However, should tests indicate that valve is faulty it should be repaired or replaced.

REMOVAL

1. Remove manifold to valve vacuum line, air cleaner line, and speedometer shift line from respective valve ports.

2. Remove two axle shift chamber lines from valve ports.

3. Loosen cable clamp nut at top of valve.

4. Remove two mounting screws, separate valve from mounting surface, and loosen cable trunnion screw.

5. Remove valve from control cable.

DISASSEMBLY (Fig. 22)

1. Remove four screws, and separate cover, cover gasket, valve body assembly, body gasket, and lower body.

2. Remove two tension springs from ends of poppet lever and trunnion pin.

3. Remove two retaining washers, poppet springs and poppet valve assemblies from valve body. Remove discs from valve stems.

INSPECTION

1. Check poppet valve seats in valve body and lower valve body for evidence of nicks or scratches which may cause vacuum leak.

2. Inspect poppet levers, springs, operating levers, trunnion pin, and pivot pin for wear or other damage.

3. Inspect poppet discs and replace if not in new condition, since these items are included in a repair kit.

ASSEMBLY (Fig. 22)

During assembly operations apply a light film of Lubriplate, or equivalent, to all friction surfaces.

1. Place rounded end of operating levers over ends of pin in cable trunnion.

2. Align poppet lever between holes at pointed end of operating levers, and align to valve body.

NOTE: Be sure parts are assembled with trunnion pin off-center toward operating levers. Install pivot pins, driving pin in until ends are flush with valve body.

3. Install new poppet discs to ends of poppet stems. Install poppet springs.

4. Install poppet valve stems through holes in body and through elongated holes in poppet lever. Install new retaining washers.

5. Install tension springs. One end of spring attaches to trunnion pin and opposite end to notch in poppet lever arm.

NOTE: Test operation of valve by moving trunnion up and down several times by hand, while noting if "over center" action of the tension springs cause poppets to operate freely and without binding.

6. Install new gasket to lower valve body and align body with valve body.

7. Hold these two parts in place while positioning new gasket and valve cover to top of valve body. Install and tighten four screws.

BENCH TEST

The following test will determine if the valve has been correctly assembled and is operating properly without serious vacuum leakage.

1. Attach vacuum source to vacuum port and install a shut-off valve in line.

2. Attach a vacuum line to each of the valve ports leading to axle shift chamber. Each line should have a vacuum gauge.

3. Supply 20 inches of mercury vacuum to valve with valve trunnion in "up" position. One gauge should read 20 inches of mercury and opposite gauge should read zero.

4. Push valve trunnion down and close speedometer adapter outlet port. Reading on vacuum gauges will now be opposite to previous reading.

5. Check "snap over" position of cable trunnion, which should occur when trunnion is not less than 1/8" from valve body in each direction.

6. Whenever tests outlined in previous paragraphs indicate that leakage is greater than 1 inch in 15 seconds, the valve must be inspected for faulty seats.

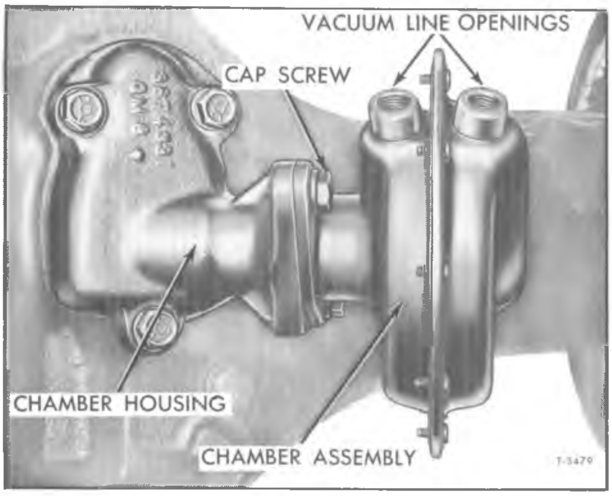


Figure 23—Two-Speed Axle Vacuum Shift Chamber Installed (Corporation Axle)

INSTALLATION

1. At cable button clamping bracket, loosen cable jacket clamp nut allowing cable to turn freely.
2. Insert cable into hole at top of valve cover and insert cable into hole in cable trunnion. Install and tighten cable securely, using trunnion screw.
3. Mount valve in the original location using mounting screws. Tighten cover tube nut.
4. Attach intake manifold, air cleaner, speedometer shifter changer, and shift chamber lines to valve in their original location.
5. With cable button pushed down, position operating button bracket to shift lever so that clearance exists between bottom of button and bracket.

SHIFT CHAMBER (CORP. AXLE)

REMOVAL (Fig. 23)

1. Remove hose clamps, then remove vacuum hose from cylinder. Tag each hose so that it will be replaced in proper position.
2. Remove three bolts and lock washers attaching cylinder to differential carrier, then remove cylinder and housing assembly.

DISASSEMBLY (Fig. 24)

1. Remove screws attaching two halves of cylinder to each other, then separate two halves.
2. Using two wrenches, remove outer push rod nut, then separate push rod from diaphragm.
3. Push piston rod in to relieve spring load, then remove snap ring from inside of piston rod. Pull push rod and spring assembly from piston rod.
4. Should inspection indicate necessity, oil seal can be driven from housing at this time.

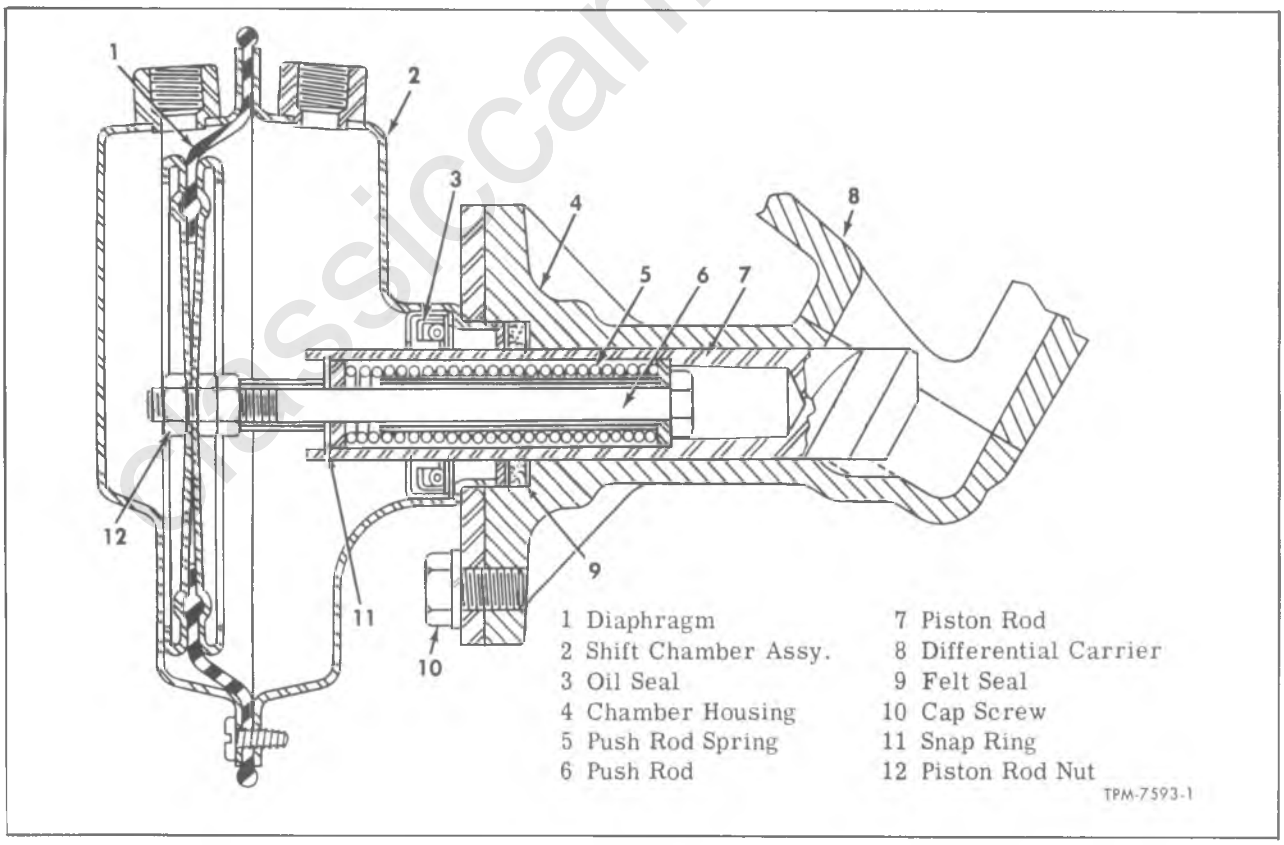


Figure 24—Sectional View of Two-Speed Axle Vacuum Shift Chamber (Corporation Axle)

ASSEMBLY (Fig. 24)

1. Install washer, long spacer, spring, washer, short spacer, and nut on push rod.
2. Tighten adjusting nut until dimension over washers at each end is 2-27/32" (fig. 25). Install and tighten lock nut, being careful not to change dimension.
3. Lubricate inside of piston rod then install push rod and spring assembly.
4. Compress push rod spring and install snap ring.
5. Install push rod assembly in housing.
6. Install new diaphragm and plates to push rod and tighten nut securely.

NOTE: Apply sealing compound around push rod hole in diaphragm plates.

7. Install outer half of cylinder to inner half and secure with screws tightened securely.
8. Attach assembly to differential carrier, using new gasket. Tighten cap screws securely.
9. Attach hoses to cylinder, being sure connections are tight.

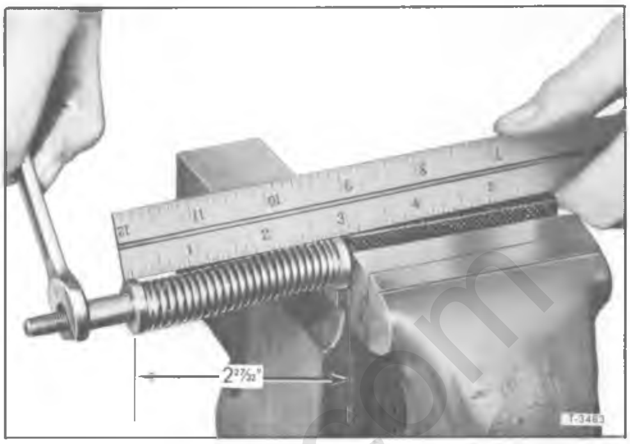
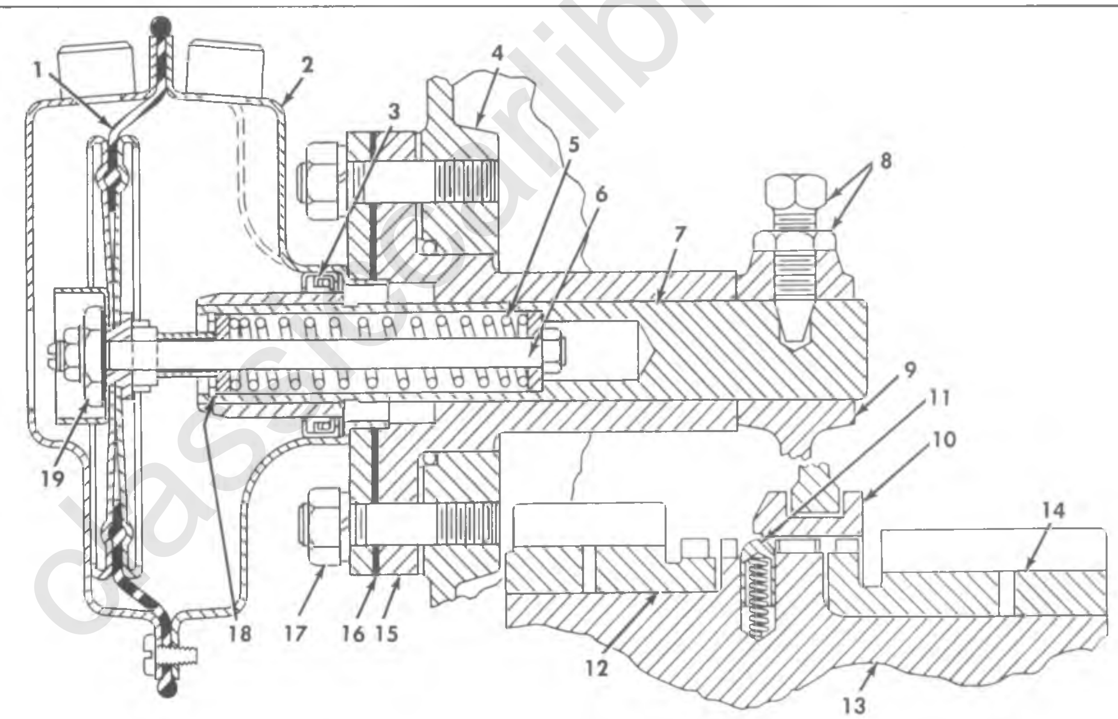


Figure 25—Adjusting Push Rod (Corporation)

SHIFT CHAMBER (ROCKWELL AXLE)

REMOVAL AND DISASSEMBLY (Fig. 26)

1. Remove hose clamps, then remove vacuum hose from chamber. Tag each hose so that it can be identified and installed in proper position.



1 Diaphragm
2 Shift Chamber Assembly
3 Oil Seal
4 Differential Carrier
5 Push Rod Spring
6 Push Rod
7 Piston Rod
8 Lock Screw and Nut
9 Shift Fork
10 Sliding Clutch
11 Clutch Poppet
12 High Speed Gear
13 Cross Shaft
14 Low Speed Gear
15 Mounting Sleeve
16 Adjusting Shims
17 Stud and Nut
18 Snap Ring
19 Nut

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Figure 26—Sectional View of Two-Speed Axle Shift Chamber Installation (Rockwell)

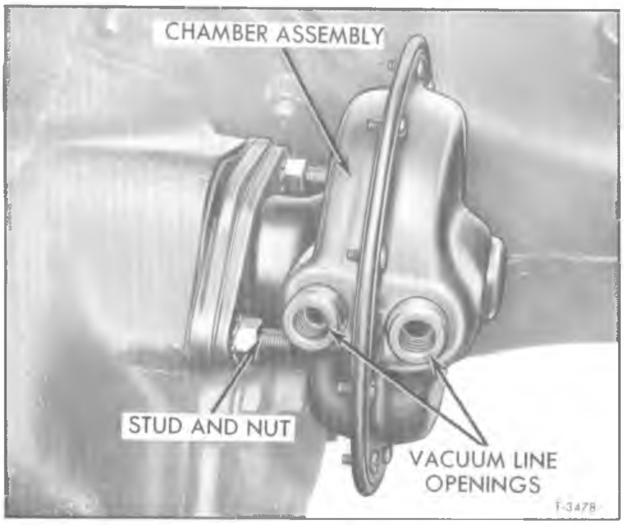


Figure 27—Two-Speed Axle Vacuum Shift Chamber Installed (Rockwell)

2. Remove ten screws attaching cover to chamber, then remove cover from body of chamber.

3. Remove nut from end of push rod, then remove diaphragm and plates assembly from push rod.

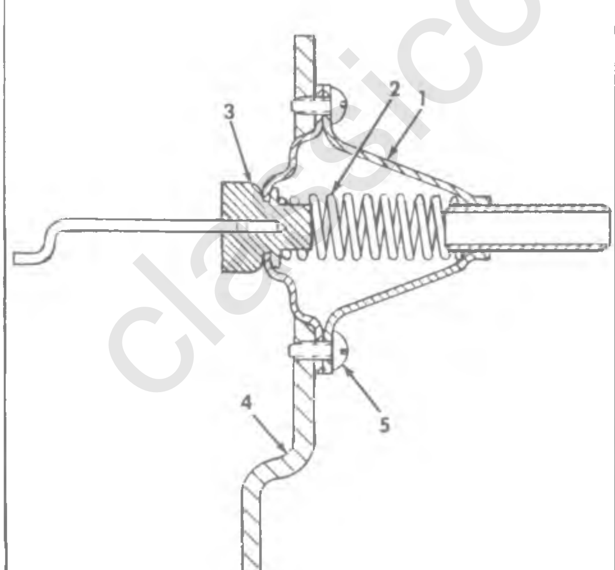


Figure 28—Speedometer Adapter Shift Diaphragm

4. Remove two nuts and lock washers from studs (fig. 27) attaching chamber mounting flange to mounting sleeve and carrier. Remove chamber assembly.

5. Force push rod in to relieve spring load, then remove snap ring (18) from inside of piston rod. Pull push rod and spring assembly from piston rod.

6. Piston rod and shift fork cannot be removed unless carrier assembly is removed from housing. Refer to respective axle section for procedure.

ASSEMBLY AND INSTALLATION (Fig. 26)

1. If disassembled, assemble push rod by installing parts in following order: washer, spring, washer, spacer, and nut. Stake nut securely to prevent loosening.

2. Position push rod and spring assembly into piston rod. Compress spring sufficiently to install snap ring (18).

3. Apply sealing compound on the diaphragm plates around holes. Position diaphragm between two plates with diaphragm bead in grooves of plates.

4. Secure plates together with bolt, locking plate, and nut (19). Make sure that diaphragm is properly located, then tighten nut just enough to form a vacuum-tight seal.

5. Install chamber inner shell with flange over studs (fig. 27). Install lock washers and nuts, tighten nuts securely.

6. Position diaphragm assembly over push rod, then install nut. Tighten nut securely.

7. Install cylinder outer shell to inner shell with diaphragm between shells. Install and tighten screws firmly.

8. Attach hose in their original location, using hose clamps.

CHECK VALVE

Check valve, in intake manifold line, is used to prevent vacuum loss or drop when engine is accelerated or is pulling under heavy load. Check valve also effectively retards loss of vacuum when engine is stopped. Refer to "HYDRAULIC BRAKES" (SEC. 5A) of this manual for service maintenance information.

AIR CLEANER

An air cleaner is used at atmospheric inlet line to filter air entering control valve and shift units.

MAINTENANCE

At regular intervals remove air cleaner and immerse in cleaning solvent to remove all accumulated dirt or other foreign material. Drain cleaning solvent from element. Reinstall dry.

SPEEDOMETER ADAPTER SHIFT DIAPHRAGM

When shift control lever is moved to "HI" position, cavity behind speedometer adapter shift diaphragm (fig. 28) is subjected to atmosphere through the shift control valve. Spring movement of diaphragm is transmitted to the speedometer adapter lever by the diaphragm rod, shifting the speedometer adapter gears into high ratio. When the control lever is moved to "LO" position, the control valve admits vacuum to the cavity behind the diaphragm and forces diaphragm and rod inward, shifting the speedometer adapter gears into low ratio.

REMOVAL AND DISASSEMBLY

1. Disconnect vacuum line from the shift diaphragm body.

2. Remove two screws attaching diaphragm bracket to speedometer adapter. Lift diaphragm and bracket to unhook diaphragm rod from adapter lever and remove diaphragm and bracket assembly.

3. Remove four screws attaching body to bracket. Remove body, spring, and diaphragm and rod assembly from bracket.

INSPECTION

1. Examine diaphragm for cracks or other damage. Replace assembly if diaphragm is damaged.

2. Check condition and tension of diaphragm spring. If spring is corroded or if tension is not sufficient to return diaphragm to release position, replace assembly.

ASSEMBLY AND INSTALLATION

1. Position the diaphragm and rod assembly, spring, and body on diaphragm bracket and attach with four screws. Screws must be tightened sufficiently to make the assembly air-tight with two pounds of air pressure.

2. Position diaphragm and bracket assembly at speedometer adapter, hooking diaphragm rod into adapter lever. Attach diaphragm bracket to adapter with two screws and washers.

3. Connect vacuum line to diaphragm body. Tighten connection firmly.

See next page for Torque Specifications.

REAR AXLE TORQUE SPECIFICATIONS

ITEM	TORQUE (FT. LB.)
DRIVE PINION YOKE NUT	
Eaton	
1⅛″-18	325-450
1¼″-12	400-600
1½″-18	500-700
Rockwell	
1″-20	300-400
1¼″-18	700-900
1½″-18	800-1100
Corporation	
1⅛″-18	160-280
DIFFERENTIAL CARRIER TO HOUSING	
Eaton	
½″-13 Cap Screw	75-85
⅝″-11 Cap Screw	160-175
⅝″-18 Stud Nut	220-240
Rockwell	
½″-20 Stud Nut	80-105
⅝″-18 Stud Nut	160-205
Corporation	
7/16″-20 Cap Screw	75-90
9/16″-18	130-170
OIL SEAL RETAINER & PINION CAGE	
Eaton	
9/16″-12	115-125
Rockwell	
7/16″-14	55-70
½″-13	80-105
9/16″-12	115-150
Corporation	
½″-13 (H135)	160-170
½″-13 (H150)	80-105
½″-13 (T150)	80-105
⅝″-11 (H110)	160-170
SHIFT CHAMBER	
Stud Nut—⅜″-24	30-35
AXLE SHAFT FLANGE	
Stud Nut—½″	50-60
Stud Nut—⅝″	90-110
Cap Screw—5/16″-24	11-18

SECTION 4B
Rear Springs and Suspension

Progressive type, two-stage rear springs, as used on all 4000 and PS4500 Series (fig. 1), have a straight-ended main leaf which rests against the cam surface of the front and rear hangers, thereby allowing the springs a full fore and aft float to effect spring length changes. The second or third leaf has hooked ends which contact rebound pins in the spring hangers to prevent excessive fore and aft travel in event of radius leaf rod failure.

The radius leaf rods maintain axle alignment and transmit driving and braking forces to the frame. A spacer is used at bottom of each spring pile to separate the last leaf from the radius leaf which is half-leaf formed with an eye and bushed for attachment to the front hanger.

Two slanted U-bolts attach the spring pile and radius leaf to the axle housing. Vari-rate type rear springs shown in figure 2 are used on all "E," and "S" Series vehicles. The spring eye is bushed and bolted to a bracket at front and is cam-supported at rear. Cam action of the spring leaf produces a variable deflection rate as contact point changes under varying load.

NOTE: Refer to "Service Diagnosis Chart" in "FRONT SPRINGS" (SEC. 3C) of this manual.

GENERAL SPRING MAINTENANCE

LUBRICATION

Spring leaves are lubricated at time of assembly and require no further lubrication unless spring is disassembled. Spring eye or radius leaf bushings that are rubber-mounted do not require lubrication.

TIGHTENING

At regular intervals, spring U-bolts should be checked and tightened if necessary to torque listed in "Specifications" at end of this section.

IMPORTANT: U-bolts must be kept TIGHT at all times to hold axle in place at springs. Otherwise, axle may shift, causing misalignment; also, spring leaf failure in the vicinity of the spring center bolt could result.

CAUTION

U-bolts must be retightened to initial torque listed in "Specifications" after 500 miles when new, or when spring repairs are made.

NOTE: The center bolt serves only to hold the spring together while in shipment and during installation, and as a locating point when assembling spring to axle. After assembly, it is strictly the function of the U-bolts to hold the spring and axle in alignment, and the importance of keeping the U-bolts tight cannot be overemphasized.

REPAIR OPERATIONS

REAR SPRING REMOVAL (Figs. 1, 2, and 3)

1. Raise vehicle frame to take weight off the spring. Make sure vehicle is supported safely.

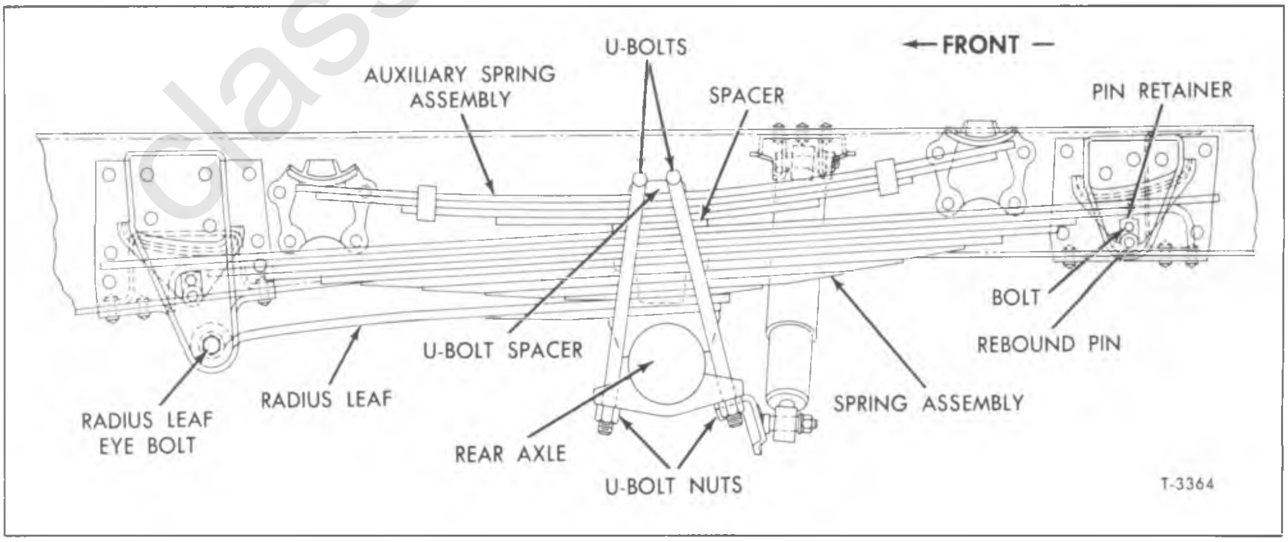


Figure 1—Rear Springs Installed (Series 4000 and PS4500) (Typical)

REAR SPRINGS AND SUSPENSION

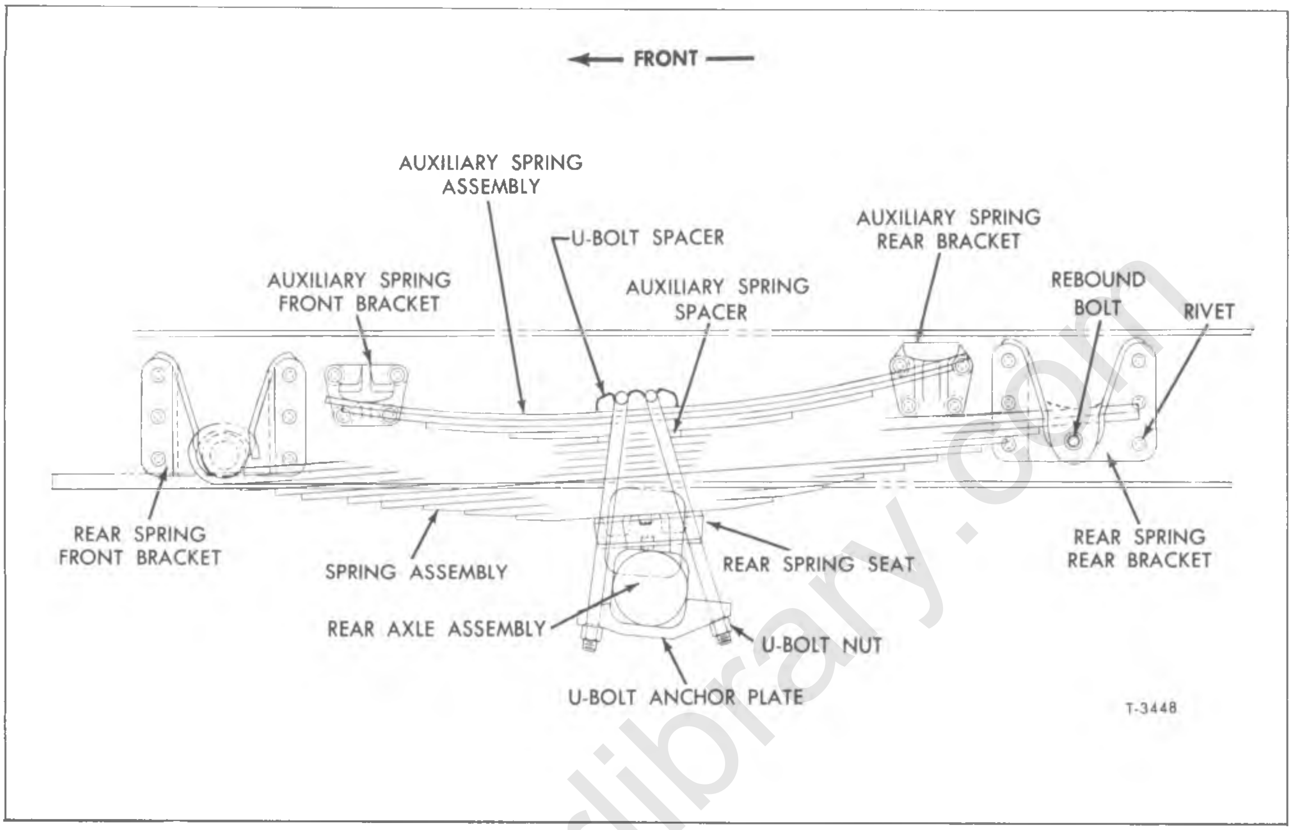


Figure 2—Rear Springs Installed (Typical for "E" and "S" Models)

Remove rear wheels to provide access to spring assembly.

2. Safely support axle on floor jack.

3. Install a C-clamp on radius leaf as shown in figure 3, to relieve load on radius leaf eye bolt on 4000 and PS4500 Series vehicles.

4. On 4000 and PS4500 Series (fig. 1), at front and rear hanger, remove rebound pin retainer bolt, then remove retainer. Install suitable puller into tapped hole at end of rebound pin, then remove pin.

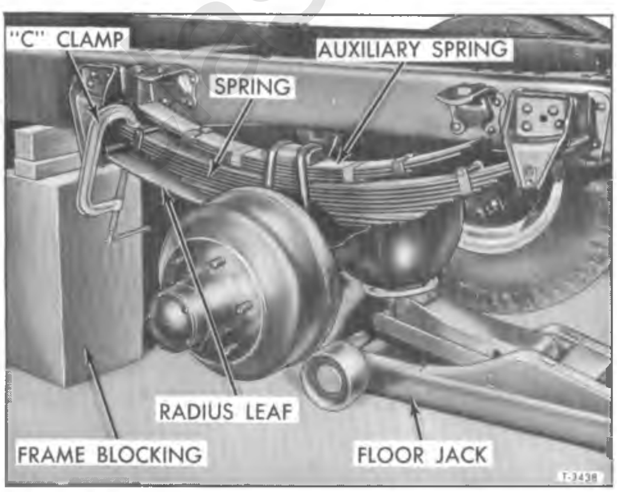


Figure 3—Using C-Clamp at Radius Leaf

5. On "E," and "S" Series, remove rebound bolt nut and washer, then remove rebound bolt (fig. 2).

6. Remove spring U-bolt nuts, shock absorber bracket (when used) U-bolt anchor plate and U-bolts and U-bolt spacer, then lower axle slightly.

7. Remove spring eye or radius bolt nut and washer, then remove spring eye bolt from spring eye or radius leaf.

NOTE: When tapered shim is used, the position of shim thin and thick edge should be noted so that shim can be installed properly at assembly.

8. Inspect spring. Replace bushing, repair or replace spring unit as outlined later in this section.

SPRING LEAF REPLACEMENT

NOTE: Auxiliary springs should be disassembled in an arbor press. When assembling springs, make sure spacer is installed between the auxiliary and main spring.

1. Mark one side of spring assembly to assure original position of springs when assembling.

2. Place spring in a vise and remove spring clip, bolt, nut, and spacer.

3. File peened end of center bolt and remove center bolt nut.

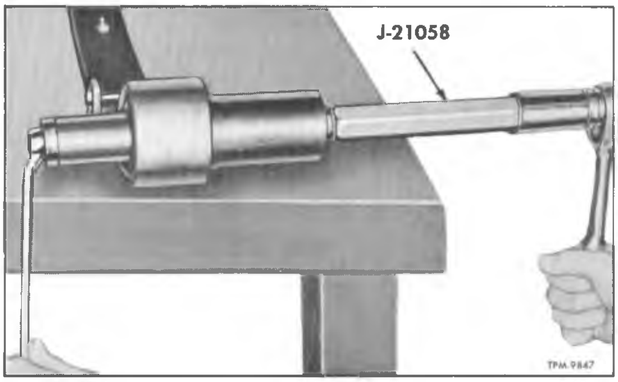


Figure 4—Removing Rubber-Type Eye Bushing

4. Open vise slowly and carefully to let spring assembly expand. Wire brush and clean spring leaves.

5. Replace weak or broken spring leaf.

6. Align center bolt holes in spring leaves using a long drift.

7. Compress spring leaves in a vise, then remove drift and install a new center bolt.

8. Install nut on center bolt and tighten securely. Peen end of bolt to prevent nut from loosening.

9. Align springs by tapping with a hammer. Install spring clip, bolts, spacers, and nuts.

SPRING EYE OR RADIUS LEAF BUSHING REPLACEMENT (WITH SPRINGS REMOVED)

Steel Backed Rubber Bushings

Remove and replace radius leaf eye bushing using bushing remover and installer (J-21058 Tool Set) as shown in figures 3 and 4.

REAR SPRING INSTALLATION
(Refer to Figs. 1, 2, and 3)

1. Set spring assembly and tapered shim or spacer (if used) at axle pad.

IMPORTANT: Tapered shim must be installed on axle in same position that was noted at removal.

NOTE: If auxiliary springs are used, place spring assembly and spacer in position.

2. Install U-bolt spacer over center bolt.

3. Seat U-bolts in spacer grooves, then secure spring to axle by installing anchor plates, shock absorber bracket (when used) and nuts on U-bolts. Tighten nuts to torque listed in "Specifications" at end of this section.

4. On "E," and "S" Series, lower frame until spring enters hanger with spring eye and hanger hole aligned at front and spring touches cam surface of hanger at rear.

5. On 4000 and PS4500 Series, lower frame until ends of spring enter the hanger and touch the cam surface of hanger. Compress radius leaf with a C-clamp (fig. 3) until radius leaf eye and hanger holes are aligned.

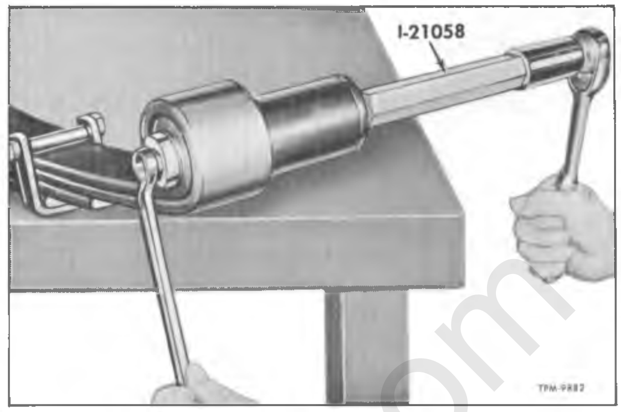


Figure 5—Installing Rubber-Type Eye Bushing

6. On 4000 and PS4500, torque nut to torque listed in "Specifications." On "E," and "S" Series, torque the eye bolt to torque listed in "Specifications."

7. On 4000, and PS4500 Series, remove C-clamp from radius leaf.

8. On 4000, and PS4500 Series, install rebound pin at front and rear hangers. Install rebound pin retainer and secure with retainer bolt.

9. On "E," and "S" Series, install rebound bolt, washer and nut at rear hanger. Tighten rebound bolt nut to torque listed in "Specifications."

10. Install wheels.

11. Remove blocking and lower frame to place weight on springs. Check U-bolt nuts for proper torque. Refer to "Specifications."

> **CAUTION**
>
> U-bolts must be retightened to initial torque listed in "Specifications" after 500 miles when new, or if spring repairs are made.

AUXILIARY SPRINGS

Some vehicles have auxiliary rear springs which are necessary for certain types of operation. When used, the auxiliary spring leaves or leaf (Single Leaf Auxiliary) are installed above the regular rear spring assembly and are held in place by long U-bolts. Brackets are installed on frame and are contacted by the auxiliary spring to provide added stability required for these unusual conditions.

SHOCK ABSORBERS

Shock absorbers (when used) are non-adjustable and non-repairable. Maintenance operations

REAR SPRINGS AND SUSPENSION

are limited to replacement of rubber mounting grommets and periodically tightening all mountings. If a shock absorber becomes inoperative, the complete unit must be replaced.

CAUTION: When replacing a shock absorber, check the model number stamped on the unit to make sure it is the same model as the one removed.

SPECIFICATIONS

REAR SUSPENSION SPECIFICATIONS

SPRING EYE BUSHING—(4000 and PS4500) (Steel Backed Rubber Type)	(Width) 3.270"-3.300" (O.D.) 1.750"-1.755" (I.D.) 0.940"-0.950"
RADIUS LEAF BUSHING—(All 4000—PS-4500) (Steel Backed Rubber Type)	(Width) 2.725"-2.750" (.OD.) 1.375"-1.380" (I.D.) 0.625"-0.632"

TORQUE SPECIFICATIONS

	FT. LBS.	TORQUE
SPRING U-BOLT NUTS		
All 4000 Series	220	320
(All E and S Models)	300	320
PS-4500 Models	300	320
REAR SPRING REBOUND BOLT NUT		
(All E and S Models)	30	40
SHOCK ABSORBER NUTS		
(Upper Nut All 4000 Series)	85	95
(Lower Nut All 4000 Series)	70	80
REAR SPRING EYE TO		
Front Hanger Bolt Nut (All 4000 Series)	175	225
(All E and S Series) Radius Leaf Bolt Nut	450	500
REBOUND PIN RETAINER BOLT		
(4000 and PS 4500 Series)	5	10

SECTION 4C

Rear Hubs and Bearings

DESCRIPTION

Rear hubs on all series trucks are mounted to axle housing tube on opposed tapered roller bearings as shown in figure 2. Hubs, bearings, and oil seals are identified with the type of rear axle. Refer to "Service Parts Identification Decal" to determine type of axle used on a specific vehicle.

Mounting parts (mainly bearings, seals, and sleeves) are of primary importance. Brake drum mounting bolts, studs, and nuts differ in type and their method of installation on the various series vehicles will vary.

BEARING MAINTENANCE

All wheel bearings are adjustable for wear. Satisfactory operation and long life of bearings depend upon proper adjustment and correct lubrication. If bearings are adjusted too tight, they will overheat and wear rapidly. Loose adjustment will cause pounding and will also contribute to steering difficulties, uneven tire wear, and inefficient brakes. Bearing adjustment should be checked at regular inspection periods.

Hubs and bearings should be cleaned, inspected, and lubricated whenever hubs are removed, or at intervals indicated in LUBRICATION (SEC. 0) of this manual.

New hub oil seals should be installed when servicing bearings if there is the slightest indication of wear or damage. An imperfect seal may permit bearing lubricant to reach brake linings, resulting in faulty brake operation and necessitating premature replacement of linings.

BEARING ADJUSTMENT

BEARING ADJUSTMENT CHECK

Before checking wheel bearing adjustment, make sure brakes are fully released and do not drag. Jack up axle until tires clear the floor. Remove axle shafts as directed in "REAR AXLES" (SEC. 4A) of this manual.

Check bearing play by grasping tire at top and pulling back and forth, or by using a pry bar under tire. If bearings are properly adjusted, movement of brake drum in relation to backing plate or brake spider will be barely noticeable and wheel will turn freely. If movement is excessive, adjust as follows:

ADJUSTMENT

1. Jack up axle and remove axle shaft as directed in "REAR AXLES" (SEC. 4A) of this manual.
2. Remove bearing lock nut and nut lock.
3. With a wrench, tighten adjusting nut to torque listed in "Specifications," while the wheel is being rotated in both directions to correctly position the bearings.
4. Back off the adjusting nut 1/8 to 1/4 turn.
5. Install bearing adjusting nut lock, referring to figure 1.
   a. If vehicle is equipped with type shown in View A, figure 1, align nearest slot in adjusting nut with short tang on nut lock and bend tang into slot on nut. Install lock nut with slots outward and tighten to torque listed in "Specifications." Then bend tangs of nut lock into slots in lock nut and adjusting nut.
   b. If vehicle is equipped with type shown in View B, figure 1, align flat on adjusting nut with nearest lip of nut lock. Make sure wheel turns freely; then install nut lock and lock nut. Tighten lock nut to torque listed in "Specifications." Bend one lip of nut lock over one flat on each nut.
6. After completing bearing adjustment, recheck adjustment to make sure wheel turns freely. Final bearing adjustment should be within 0.001" to 0.007" end play.

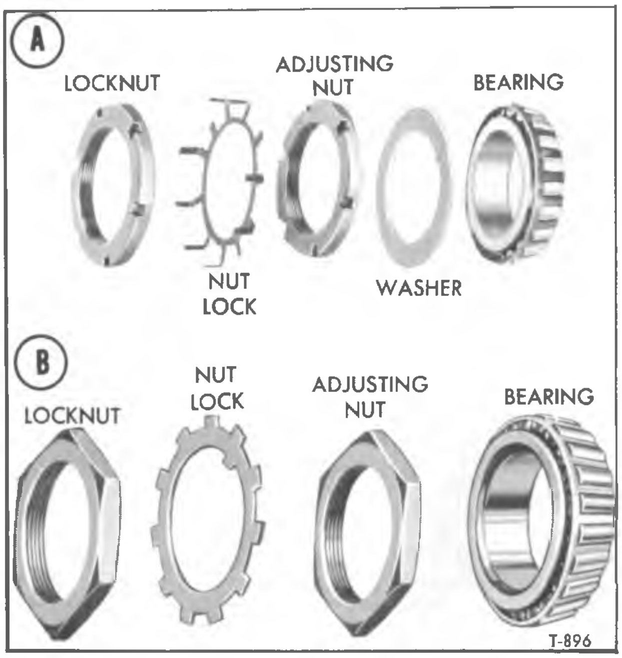
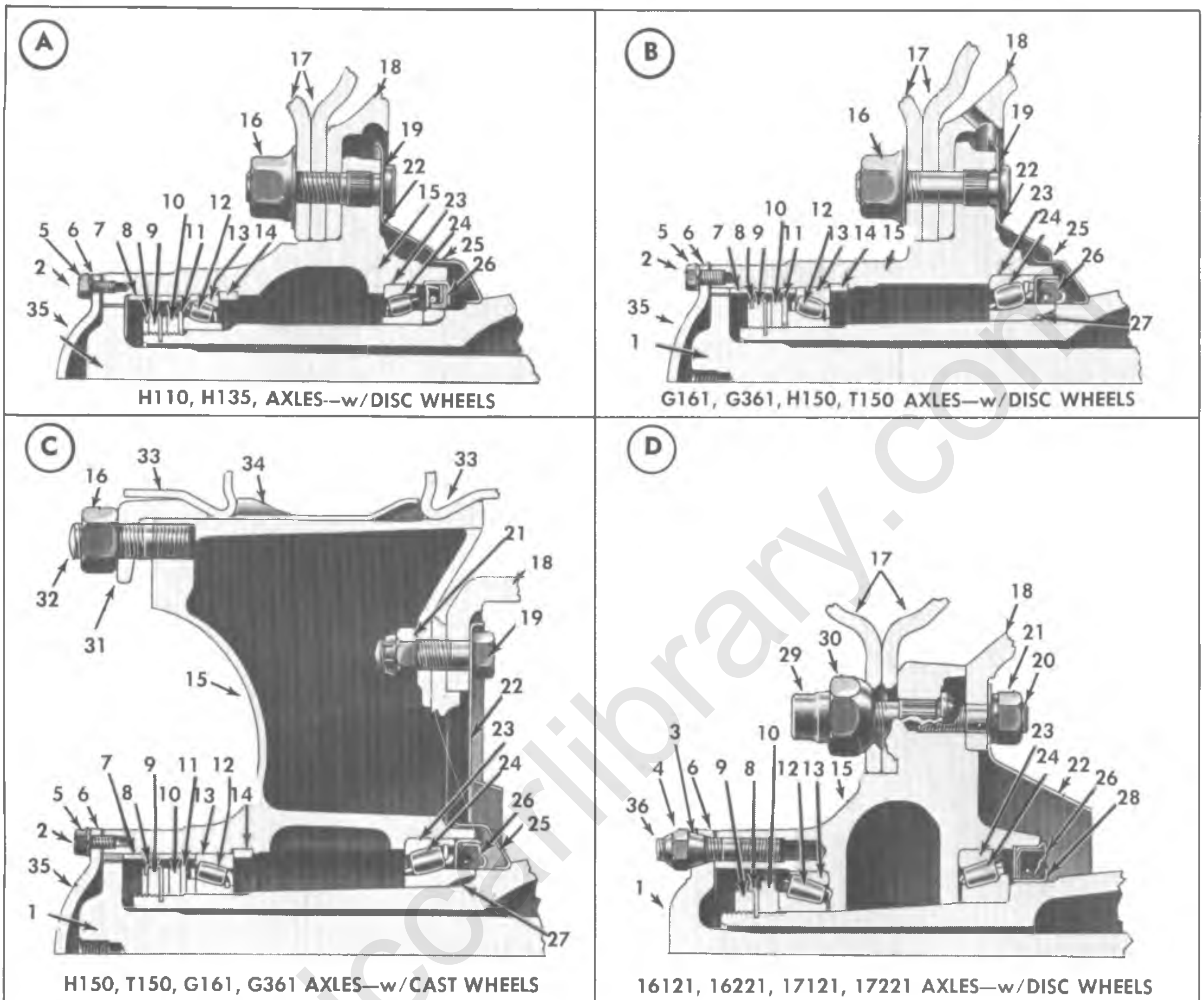
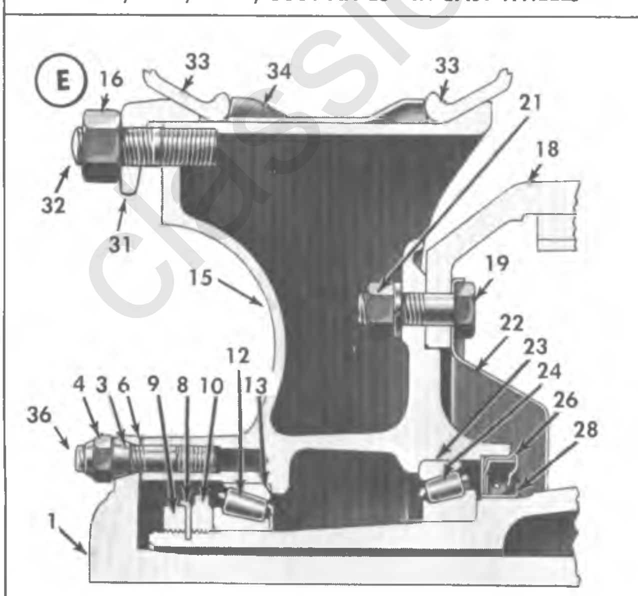


Figure 1—Rear Wheel Bearing Adjusting Nuts

REAR HUBS AND BEARINGS





1 Axle Shaft
2 Cap Screw
3 Dowel
4 Lock Nut
5 Washer
6 Gasket
7 Axle Shaft Spacer
8 Nut Lock
9 Lock Nut
10 Adjusting Nut
11 Adjusting Nut Washer
12 Outer Bearing Cone and Rollers
13 Outer Bearing Cup
14 Snap Ring
15 Hub
16 Wheel Nuts
17 Wheels
18 Brake Drum
19 Bolt
20 Stud
21 Lock Nut
22 Oil Shield
23 Inner Bearing Cup
24 Inner Bearing Cone and Rollers
25 Oil Deflector
26 Inner Oil Seal
27 Seal Ring
28 Oil Seal Sleeve
29 Inner Nut
30 Outer Nut
31 Wheel Rim Clamp
32 Wheel Rim Clamp Stud
33 Wheel Rim
34 Wheel Rim Spacer
35 Hub Cap
36 Axle Shaft Flange Stud

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Figure 2—Rear Hubs, Bearings, and Oil Seals

7. Install axle shaft as directed in "REAR AXLES" (SEC. 4A) of this manual.

REAR HUB AND BEARING REMOVAL

(Refer to Figure 2)

1. Jack up rear axle and remove tire and rim assembly on vehicles having cast wheels. Remove tire and wheel assembly from trucks having ventilated disc or Budd type wheels.
2. If brake drum is demountable type, remove brake drum.
3. Remove axle shaft as directed in "REAR AXLES" (SEC. 4A) of this manual.

TYPES D AND E

1. Remove lock nut, nut lock, and adjusting nut from axle housing tube.
2. On Type E in figure 2, lift wheel (hub) and drum assembly straight off axle housing, using care to prevent outer cone and roller assembly from dropping out of hub. Remove outer bearing cone and roller from hub.
3. On Type D figure 2, carefully pull hub assembly straight off axle housing, using care to prevent outer cone and roller assembly from dropping out of hub. Remove outer bearing cone and roller from hub.
4. Pull inner oil seal out of hub, then lift out inner bearing cone and roller assembly. Discard oil seal.
5. Clean, inspect, and repair parts as directed later under "Cleaning, Inspection, and Repair."

TYPES A, B AND C

1. Raise tang of nut lock out of slot in lock nut; then using wheel bearing nut wrench listed in SPECIAL TOOLS at end of this manual, remove lock nut.
2. Remove nut lock, bearing adjusting nut, and washer from axle housing.
3. Carefully pull wheel (hub) and drum assembly or hub off axle housing.
4. Using a mild steel rod through outer end of hub, drive against inner bearing cup to drive inner cone and roller assembly and oil seal out of hub. Drive alternately on opposite sides of cup to prevent cocking of cup in hub. Discard oil seal.
5. Using a mild steel rod through inner end of hub, tap outer bearing cup outward away from the snap ring just enough to remove tension on snap ring.
6. Remove the snap ring, using Tru-arc or snap ring pliers through inner end of hub.
7. Using a mild steel rod against outer end of axle shaft spacer, drive outer bearing out of hub. Care must be taken to engage edge of spacer with punch and not damage bearing seat in hub. Alternately drive on opposite sides of spacer to avoid cocking bearing cup in hub.
8. Clean, inspect, and repair parts as follows:

CLEANING, INSPECTION, AND REPAIR

CLEANING

1. Immerse bearing assemblies in suitable cleaning solvent. Clean with stiff brush if necessary to remove old lubricant. Blow bearings dry with compressed air, directing air stream across bearings. Do not spin bearings while blowing them dry.
2. Thoroughly clean all lubricant out of inside of hub and wipe dry. Make sure all particles of gasket are removed from outer end of hub, and that all sealing compound is cleaned out of oil seal bore in inner end of hub.
3. Clean lubricant off axle housing tube.
4. Wash small parts such as nuts, spacers, and nut locks in cleaning solvent and wipe dry.

INSPECTION

1. Inspect bearings for excessive wear, chipped edges, or other damage. Slowly roll the rollers around cone to detect any flat or rough spots. Replace damaged parts. If either the cone and roller assembly or the cup of the roller bearings are damaged, the complete bearing assembly must be replaced.
2. Examine bearing cups which are still installed in hub. If cups are pitted or cracked, they must be replaced as directed later under "Repair."
3. Examine oil seal sleeve (when used) on which the hub inner oil seal lip wipes for evidence of wear or roughness. If any damage is evident, sleeve must be replaced. Oil seal sleeves are replaced as directed later under "Repair."
4. Examine axle shaft flange studs (Views D and E, figure 2) for damaged threads or bent studs. Clean up threads or replace studs as necessary. On Views A, B and C, figure 2, check for damaged threads in tapped holes in outer end of hub. If threads are damaged, holes can be filled, drilled, and tapped, otherwise hub must be replaced. On hubs having internal splines, check condition of splines in outer end of hub. If any damage is evident, replace hub.
5. Examine brake drums for scoring or other damage. Non-demountable brake drums can be refinished while mounted on hubs. If necessary to replace brake drum refer to "Repair" later in this section.
6. Examine wheel studs or rim clamp studs for damaged threads and replace, if necessary, as directed later under "Repair."
7. Discard old oil seals and obtain new oil seals to be used at assembly.

REAR HUBS AND BEARINGS

REPAIR

Bearing Cup Replacement

1. Bearing cups are removed by using a mild steel rod through opposite end of hub and driving against inner edge of bearing cup. Alternately drive on opposite sides of cup to avoid cocking cup and damaging inside of hub.

2. To install new cups, position cup in hub and drive into place, using a suitable driver or by using a mild steel rod against outer edge of cup. If drift is used, alternately drive against opposite sides to assure driving cup in squarely. Cups must seat firmly against shoulder in hub.

Inner Oil Seal Sleeve Replacement

1. To remove oil seal sleeve (when used) tap sleeve around entire circumference with hammer to stretch the metal; then use a blunt chisel to cut into the sleeve inner flange. This will loosen the sleeve sufficiently to permit removal.

IMPORTANT: Do not damage axle housing tube when chiseling on sleeve.

2. Slide new sleeve over axle housing tube; then using axle oil seal sleeve driver set J-3822-02, drive sleeve into place. Use care not to damage surface on sleeve which will be contacted by the inner oil seal.

Brake Drum Replacement

1. Demountable Type. The demountable type drum may be separated from the hub and removed from the vehicle without disturbing the axle shaft and hub. The drum is held to the hub by countersunk, slotted screws, which are easily removed with a screwdriver.

2. Non-Demountable Type. Construction of the non-demountable type hub and drum assembly is such that replacement cannot be accomplished with the hub assembly installed on the vehicle.

a. Separate the drums and hub by removing the drum-to-hub retaining bolts, hub stud nuts, or by pressing out the wheel studs, as applicable.

b. Position brake drum to hub assembly, making certain that all drain holes are in alignment.

c. Apply a light, even coating of sealing compound to the hub oil deflector contact surface, and position deflector to drum.

d. Install drum-to-hub retaining bolts, hub stud nuts, or press wheel studs into drum, as applicable.

Wheel Bolt Replacement

Wheel bolts are serrated and may also be swaged in place; however, replacement procedure remains the same for both types of installation. Press bolts out of hub flange, using suitable press, then press new bolts into place, making sure bolts are a tight fit. If all bolts were removed, be sure that hub oil deflector is in position under bolt heads.

IMPORTANT: If any wheel experiences a single stud failure, caused by a loose running wheel, all wheel studs should be replaced.

A loose running wheel may cause only one stud to break, but several more studs may become fatigued to the point of failure, but not actually breaking. Replacing only the one broken stud and remounting wheel will then set the stage for a second and possibly more serious failure. If holes in wheel have become elongated or enlarged, replace wheel.

Hub Stud Replacement

Hub studs can be removed and replaced by using a conventional stud remover and replacer. Make sure that studs are firmly bottomed in holes and that threads are not damaged during installation.

REAR HUB AND BEARING INSTALLATION

(Refer to Figure 2)

After completing cleaning, inspection, and repair operations, lubricate bearings, axle housing tube, and inside of hub as directed in LUBRICATION (SEC. 0) of this manual. Coat lip of oil seal and surface contacted by seal lip with wheel bearing grease or equivalent.

TYPE D AND E (Fig. 2)

1. Position inner bearing cone and roller in hub or wheel (hub) and drum assembly. Coat oil seal case with a thin layer of non-hardening sealing compound; then press seal in hub until seal lip seats against hub. Seal lip must point inward and driving tool used must exert force on outer edge of oil seal.

2. Make sure oil seal sleeve is in place on axle housing. Place wheel (hub) and drum assembly or hub on axle housing tube using care not to damage the inner oil seal.

3. Place outer bearing cone and roller assembly on axle housing tube and press firmly into place. Install bearing adjusting nut, nut lock, and lock nut on axle housing tube.

4. Install tire and rim assemblies or tire and wheel assemblies. Adjust wheel bearings as previously described under "Bearing Adjustment."

5. Install axle shafts as directed in "REAR AXLES" (SEC. 4A). Adjust brakes as directed in BRAKES (SEC. 5) of this manual.

TYPES A, B AND C (Fig. 2)

1. From inner end of hub place axle shaft spacer in hub, install outer bearing cone and roller

assembly; then install outer bearing cup with thin edge of cup toward outer end of hub until it clears the snap ring groove, using a suitable sleeve. Install the snap ring in groove in hub.

2. Using a punch, drive axle shaft spacer to force outer bearing cup back against the snap ring.

IMPORTANT: This procedure must be followed to assure a wheel bearing adjustment that will not work loose.

3. Place inner bearing cup in hub with wide side of cup toward inside of hub. Press cup into hub until it seats against shoulder in hub, using a suitable sleeve.

4. Press new oil seal into hub flush or until it seats against bearing cup, on types shown in Views B, and C in figure 2, make sure seal ring is in place in axle housing.

5. Carefully install wheel (hub) and drum assembly or hub.

6. Install adjusting nut washer, adjusting nut, nut lock, and lock nut on axle housing tube. Install brake drum if previously removed.

7. Install tire and rim assemblies or tire and wheel assemblies. Adjust wheel bearings as previously described under "Bearing Adjustment."

8. Install axle shafts as directed in "REAR AXLES" (SEC. 4A). Adjust brakes as directed in BRAKES (SEC. 5) of this manual.

SPECIFICATIONS

TORQUE SPECIFICATIONS

	FT. LBS.
ADJUSTING NUT	
All Axles Except Corp. H-110	50
Corp. H-110	75-100
LOCK NUT	
W/Rockwell and Eaton	100-150
W/Corp. T, H-150	135
W/Corp. H-110	250

IMPORTANT

At installation, always coat the oil seal bore in hub with a thin layer of non-hardening sealing compound and always be sure that the oil seals are properly seated.

SECTION 4D
Propeller Shafts

DESCRIPTION

Power is transmitted from transmission to rear axle through one or more propeller shaft and universal joint assemblies (fig. 1). The number of propeller shafts and universal joint assemblies vary with vehicle wheelbases and combination of transmission and rear axle equipment.

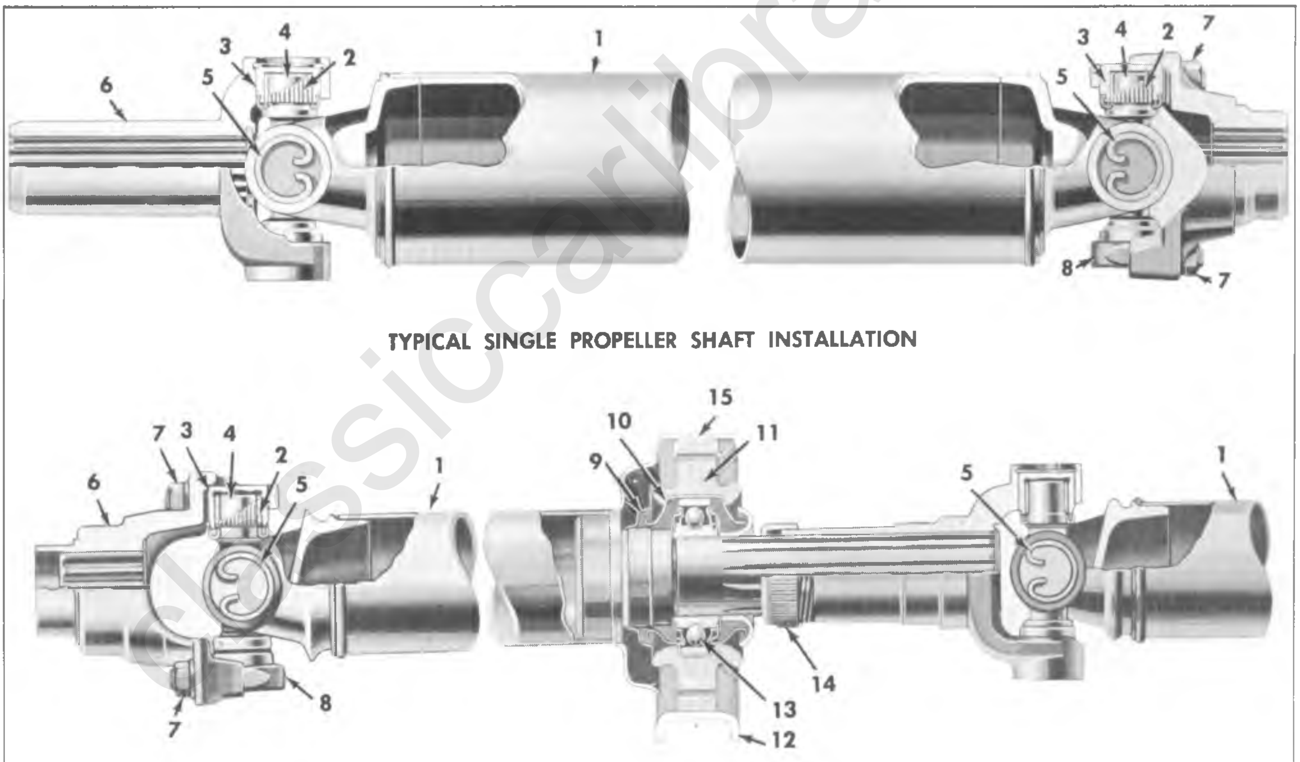
PROPELLER SHAFTS (Fig. 1)

All propeller shafts are tubular type. A splined slip joint is provided in each drive line. If a single propeller shaft is used, slip joint is at transmission end of shaft; if two or more shafts are used, slip joint is at forward end of rear shaft. End of slip yoke is sealed by a cork washer, held in place by a steel washer and a dust cap which threads onto end of yoke. Fixed yoke may be either welded to propeller shaft tube or it may be splined to a stub shaft and secured with a nut and cotter pin as shown in figure 2. It is recommended that a scribe mark be made on slip yoke and shaft to provide for alignment of yokes later at assembly.

UNIVERSAL JOINTS (Fig. 1)

Two types of universal joint assemblies are used on vehicles covered by this manual. Refer to "Specifications" at end of this section for type of joint used on any vehicle with standard equipment. Refer to applicable Parts Book for universal joint application with optional transmission and axles. Universal joints are described as follows:

Joint bearing cages are retained in yoke flanges on propeller shaft by snap rings. Bearings



1 Tube Assembly
2 Bearing Rollers
3 Bearing
4 Universal Joint Journal
5 Snap Ring
6 Yoke
7 "U" Bolt Nut
8 "U" Bolt
9 Grease Retainer Guard
10 Grease Retainer
11 Rubber Cushion
12 Center Bearing Support
13 Center Bearing
14 Dust Cap
15 Cushion Retainer

TPM-3603-2

Figure 1—Typical Propeller Shaft and Universal Joints

SERVICE DIAGNOSIS CHART		
CONDITION	POSSIBLE CAUSE	CORRECTION
Propeller Shaft Vibration	1. Propeller Shaft Out of Balance.	1. Check for Foreign Material on Propeller Shaft.
	2. Parking Brake Drum Out of Balance.	2. Replace Drum.
	3. Distorted or Damaged Yokes.	3. Install New Yokes.
	4. Yokes Out of Parallel to Each Other.	4. Change Propeller Shaft.
Universal Joint Noise	1. Center Bearing Worn.	1. Replace Center Bearing.
	2. Worn Universal Joint Bearings.	2. Replace Bearings.
	3. Improper Lubrication.	3. Lubricate as Directed.
	4. Loose Flange Bolts.	4. Tighten to Specifications.

at opposite end of propeller shaft are attached to journal cross with snap rings and U-bolts, lock washers and nuts. A visual inspection must be made of vehicle to determine at which end of propeller shaft U-bolts and lock rings are used and at which end of propeller shaft lock rings only are used. Needle rollers are installed in bearing cages and oil seals are installed on inner ends of cages.

Repair Kits

Universal joint repair kits are available for all types of universal joints. Each kit contains a journal, bearings and seals, and retaining components which should always be replaced when overhauling a universal joint.

CENTER BEARING (Fig. 2)

Center bearings are used to support center portion of drive line when two or more propeller shafts are used. Bearing is ball type, mounted in a rubber cushion which is attached to frame crossmember by the center bearing support. The two center bearings shown in cross section in figure 2 are of the same construction except for shape and location of dust slinger. View B illustrates center bearing used at shaft end with slip yoke; View A illustrates center bearing used at shaft end with fixed yoke. Bearing is prelubricated and permanently sealed. Cavities in grease retainers on both sides of bearing are packed with waterproof grease to exclude dirt and water.

LUBRICATION

Journals of universal joints are drilled and provided with lubrication fittings through which lubricant travels to all four oil reservoirs, then through a small hole in side of each reservoir, direct to needle bearings. Bearings are protected against lubricant leakage and entrance of foreign matter by seals. Splines of slip joint are lubricated through lubrication fitting installed in slip yoke.

NOTE: Universal joints and slip yoke splines should be lubricated periodically as specified in LUBRICATION (SEC. 0) of this manual.

PROPELLER SHAFT REMOVAL

Disconnecting propeller shaft permits removal of transmission or rear axle without disturbing unit at opposite end of shaft. On some vehicles, propeller shaft may be removed at any flange joint by removing nuts from bolts holding flanges. On other vehicles, propeller shafts must be disconnected at universal joints as described later in this section. Propeller shaft should be supported before removing to prevent damage by dropping. To remove complete drive line, on models in which center bearings are used, it is necessary to disconnect center bearing bracket from hanger and remove propeller shaft guards (when used) from supports. Refer to figure 3.

DISASSEMBLY OPERATIONS

SLIP JOINT DISASSEMBLY

With propeller shaft removed, scribe a mark on slip yoke and shaft to insure assembly is in exactly same relative position. When clearly marked, unscrew dust cap and withdraw shaft. Remove cork washer, steel washer, and dust cap from shaft.

UNIVERSAL JOINT DISASSEMBLY

1. On universal joints using snap rings to retain bearings on journal cross, remove snap rings (fig. 1).

2. On universal joints using U-bolts to retain bearings on journal cross, remove nuts and washers from U-bolts, then remove U-bolts (fig. 1).

3. Strike one side of yoke with hammer to force one bearing out of yoke. Strike opposite side of yoke to force opposite bearing out.

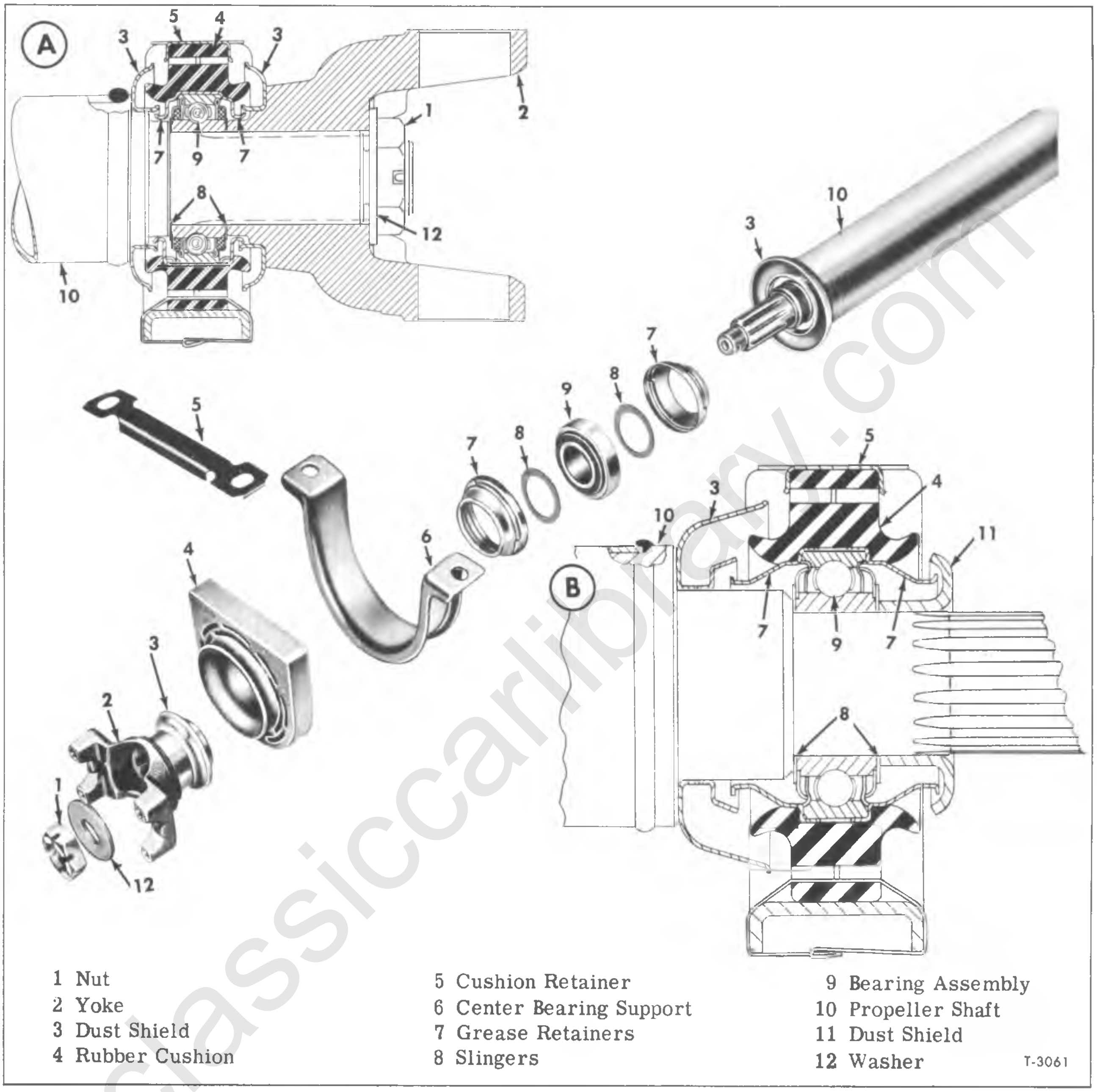


Figure 2—Typical Propeller Shaft Center Bearings

CAUTION: Use care not to permit bearings to drop on floor, or irreparable damage may result.

4. Journal can now be tilted to permit removal of yoke from journal.

5. Remove the other two bearings in same manner to permit removing journal from opposite yoke.

CENTER BEARING DISASSEMBLY

The following procedure covers disassembly of center bearing with propeller shaft removed from vehicle. Key numbers in text refer to figure 2.

1. Remove retainer (5) from support (6), then remove support from cushion (4).

2. On type shown in View A, figure 2, remove cotter pin and nut securing yoke (2) on shaft, then pull yoke off shaft. On type shown in View B, remove dust shield (11) from shaft.

3. Remove rubber cushion (4) from bearing (9), then pull bearing assembly from shaft.

4. Remove grease retainers (7) from bearing, and remove slingers (8).

IMPORTANT: Do not attempt to disassemble

PROPELLER SHAFTS

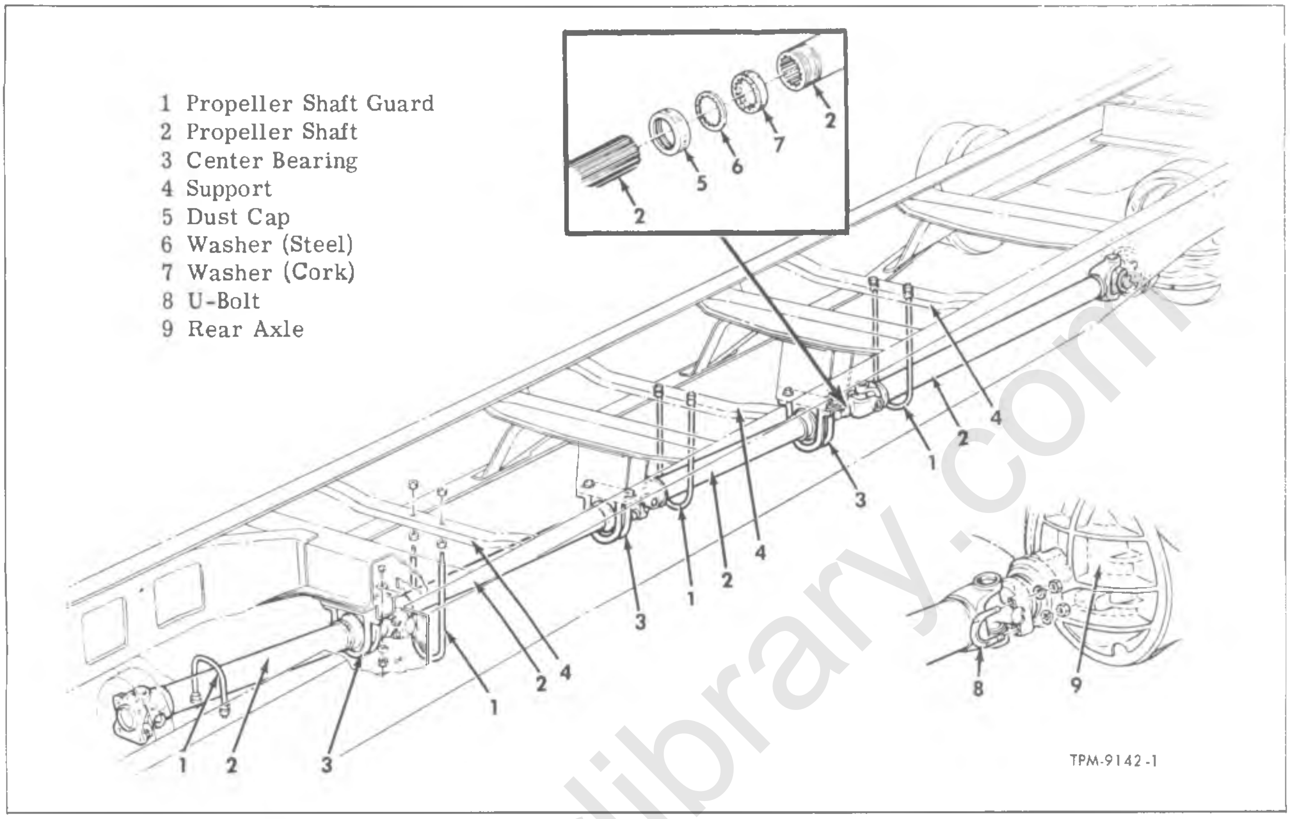


Figure 3—Propeller Shaft Guards Installed ("S" Series Shown)

ball bearing. This is a sealed bearing and cannot be disassembled without being destroyed.

5. If dust shields (3) are damaged, use a chisel to break welds and remove shields.

CLEANING AND INSPECTION

PROPELLER SHAFT

Thoroughly clean old grease and dirt from shaft splines, then check splines for wear, warpage, and cracks. If shaft is worn, warped, or cracked, replace with new shaft. Welding of broken shaft is not recommended, since this operation requires special balancing facilities.

UNIVERSAL JOINT

Wash all parts in cleaning fluid. Make sure lubricant passages in journal cross are clean. Soak needle bearings and cages in cleaning fluid to soften particles of hardened grease, then wash in cleaning fluid, using a stiff brush if necessary to remove all old lubricant. Check each bearing for missing rollers. Refer to "Specifications" at end of this section for correct number of rollers. After needle bearing assemblies are thoroughly clean, apply clean lubricant to rollers and turn on trunnion of journal to check wear. Refer to LUBRICATION (SEC. 0) for type of lubricant.

If excessive clearance is noted, discard journal and bearings and replace with new parts contained in universal joint repair kit.

SLIP JOINT

Using a suitable cleaning fluid, clean all dirt and old grease from slip yoke, slip yoke splines, and shaft splines. Carefully inspect slip yoke splines for wear or evidence of twisting. Check clearance between slip yoke splines and shaft splines. If backlash is excessive, replace parts.

CENTER BEARING

Wash all parts except ball bearing and rubber cushion in suitable cleaning fluid.

DO NOT IMMERSE SEALED BEARING IN CLEANING FLUID.

Wipe bearing and cushion clean with a cloth dampened with cleaning fluid.

Check the bearing for wear or rough action by rotating inner race while holding outer race. If wear or roughness is evident, replace with new bearing.

Examine rubber cushion for evidence of hardening, cracking, or deterioraton. Replace with new part if damaged in any way.

Grease retainers and slingers are serviced only as a part of the bearing assembly.

ASSEMBLY OPERATIONS

CENTER BEARING ASSEMBLY

Key numbers in text refer to figure 2.

1. If removed, install new dust shields (3) on shaft or yoke. Tack weld or stake shields in place.

2. Press a grease retainer (7) over each side of bearing outer race. Pack cavities in retainers with waterproof grease recommended in LUBRICATION (SEC. 0) of this manual.

3. Install one slinger (8) over end of shaft. Start bearing and retainer assembly straight on shaft, then using a suitable sleeve to exert force on bearing inner race, press bearing and slinger against shoulder on shaft. Install the other slinger (8) over shaft and position against bearing.

4. Install rubber cushion (4) over bearing assembly, making sure bearing is centered in hole in cushion.

5. Position support (6) around cushion and install cushion retainer (5).

6. On type shown in View B, figure 2, press dust shield (11) onto shaft against slinger (8). On type shown in View A, install yoke (2) on shaft.

IMPORTANT: Centerline through yoke flanges must be aligned with centerline of yoke flanges on other end of shaft. Install nut (1), tighten firmly, and secure with cotter pin.

SLIP JOINT ASSEMBLY (Fig. 1)

1. Position dust cap on shaft, then install steel washer and new cork or felt washer on shaft. Coat shaft splines with lubricant specified in LUBRICATION (SEC. 0) of this manual.

2. Align arrows or markings on splined shaft and slip yoke and insert shaft into slip yoke. Make certain yokes on both joints are exactly aligned.

IMPORTANT: Journal crosses must be in same plane, otherwise serious vibration will occur, with resultant damage to both shaft and connected units.

3. Thread dust cap onto end of slip yoke. Tighten dust cap by hand only; use of wrench will damage cork or felt washer.

4. Install lubrication fitting in slip yoke.

UNIVERSAL JOINT ASSEMBLY

NOTE: Make sure seals are in place on inner end of bearing cages. Apply lubricant recommended in LUBRICATION (SEC. 0) to needle rollers in each bearing to provide initial lubrication.

1. Install lubrication fitting in journal.

2. Install journal in yoke, then install bearing assemblies in yoke over journal trunnions. Use a plastic or rawhide hammer to tap bearings into place.

3. On universal joints using snap rings to retain bearings, press bearings in far enough to clear snap ring grooves, then install snap rings. Hold journal and lightly tap yoke to seat bearings outward against snap rings.

4. On universal joints using U-bolts, install U-bolts, washers, and nuts on journal bearing assembly and tighten nuts to torque listed in "Specifications."

PROPELLER SHAFT INSTALLATION

If propeller shaft has been removed at flange joint, position propeller shaft at joint, and install bolts, washers, and nuts. If propeller shaft has been removed at universal joints, assemble universal as previously described under "Universal Joint Assembly." Where complete drive line has been removed on models having center bearing, connect center bearing support to crossmember. On "S" models, install propeller shaft guards to frame supports. Refer to figure 3 for typical propeller shaft installation on "S" models. A visual inspection must be made of vehicle to determine the number of propeller shaft guards and center bearings used.

See following page for "Specifications."

SPECIFICATIONS

UNIVERSAL JOINT APPLICATION

The following tabulation lists universal joints used with standard equipment only. Refer to parts book for universal joints used with optional equipment.

TRUCK SERIES	UNIVERSAL JOINT
LV 4000	1410
LA 4000	1410
DLV 4000	1480
DLA 4000	1480
EM 4500	1350
ES 4500	1350
PS 4500	1350
EG 5500	1480
EM 5500	1410
ES 5500	1410
SG 5500	1480
SM 5500	1410
SS 5500	1410
EG 6500	1480
EM 6500	1410
SM 6500	1410

UNIVERSAL JOINT SPECIFICATIONS

JOINT SERIES	JOURNAL DIAMETER	NEEDLES PER BEARING	DIAMETER OF NEEDLES	LENGTH OF NEEDLES
1350	0.7730"-0.7735"	34	0.0783"-0.0785"	0.625"
1410	0.7730"-0.7735"	34	0.0783"-0.0785"	0.625"
1480	0.8942 0.8947"	33	0.0936 0.0938"	0.765"

TORQUE SPECIFICATIONS

UNIVERSAL JOINT U-BOLT NUT	
⅜" x 24 Nut 1350 . 1410	20-24 ft. lbs.
7/16"-20 Nut 1480	32-37 ft.-lbs.
PROPELLER SHAFT TO HANGER ATTACHING PARTS	
7/16" x 20 Nut	25-30 ft. lbs.
ATTACHING PARTS TO REAR AXLE OR TRANS.	
7/16" x 20 Nut. 1350 1410	50-60 ft. lbs.
½" x 20 Nut. 1480	60-70 ft.-lbs.
Propshaft Support to Frame	40-50 ft. lbs.

SECTION 5

Brakes

This group is divided into three sections as shown in Index below:

BRAKE SYSTEM EQUIPMENT

There are four different brake systems used on vehicles covered by this manual.

1. Straight Hydraulic brakes are used as standard equipment on all 4500 Series trucks.

2. Vacuum Assisted Hydraulic brakes are used as standard and/or optional equipment on trucks covered by this manual as follows:

a. Dash mounted master cylinder with remote mounted vacuum booster:

Standard - L4000, DL4000, S5500, and S6500 Series.

Optional - P4500 Model and L4000, DL4000 Series (Heavy Duty).

b. Dash mounted vacuum booster (with integral master cylinder):

Standard - E5500, 6500 Series.

Optional - E4500, E5500, 6500 Series (Heavy Duty).

3. Air Assisted Hydraulic brakes are used as standard equipment on LA and DLA 4000 Models.

4. Full Air brakes are available on all models covered by this manual when specified on the sales order or as optional equipment, except:

4500 Series and ES, SS5500 Models.

5. Optional Equipment is available in both systems. Such items as vacuum reserve tank, heavy duty boosters, vacuum gauges, trailer brake connections, air parking brake, moisture ejector, etc., are factory installed options.

IMPORTANT: The following brake maintenance schedules, adjustments, procedures, and replacement techniques are required and are applicable to normal vehicle usage. Unusual or severe operations require greater attention to the normal maintenance approach commensurate with the usage severity.

SECTION 5A

Hydraulic Brakes

Contents of this section are listed in Index below:

GENERAL

The vacuum power assisted system used on vehicles covered by this manual is described as a "one to one" system; that is the volume of hydraulic fluid output of the vacuum booster is the same as the input volume. This type system eliminates the need for compensating lines and also the need for "pumping" the brake pedal in the event of loss of vacuum power assist.

The vacuum system on these vehicles contains a check valve which maintains enough vacuum in the booster chamber to permit at least one power assisted brake application after loss of vacuum occurs.

The various components of the brake system, such as shoe and lining assemblies, pedal and linkage, power boosters, master cylinders, wheel cyl-

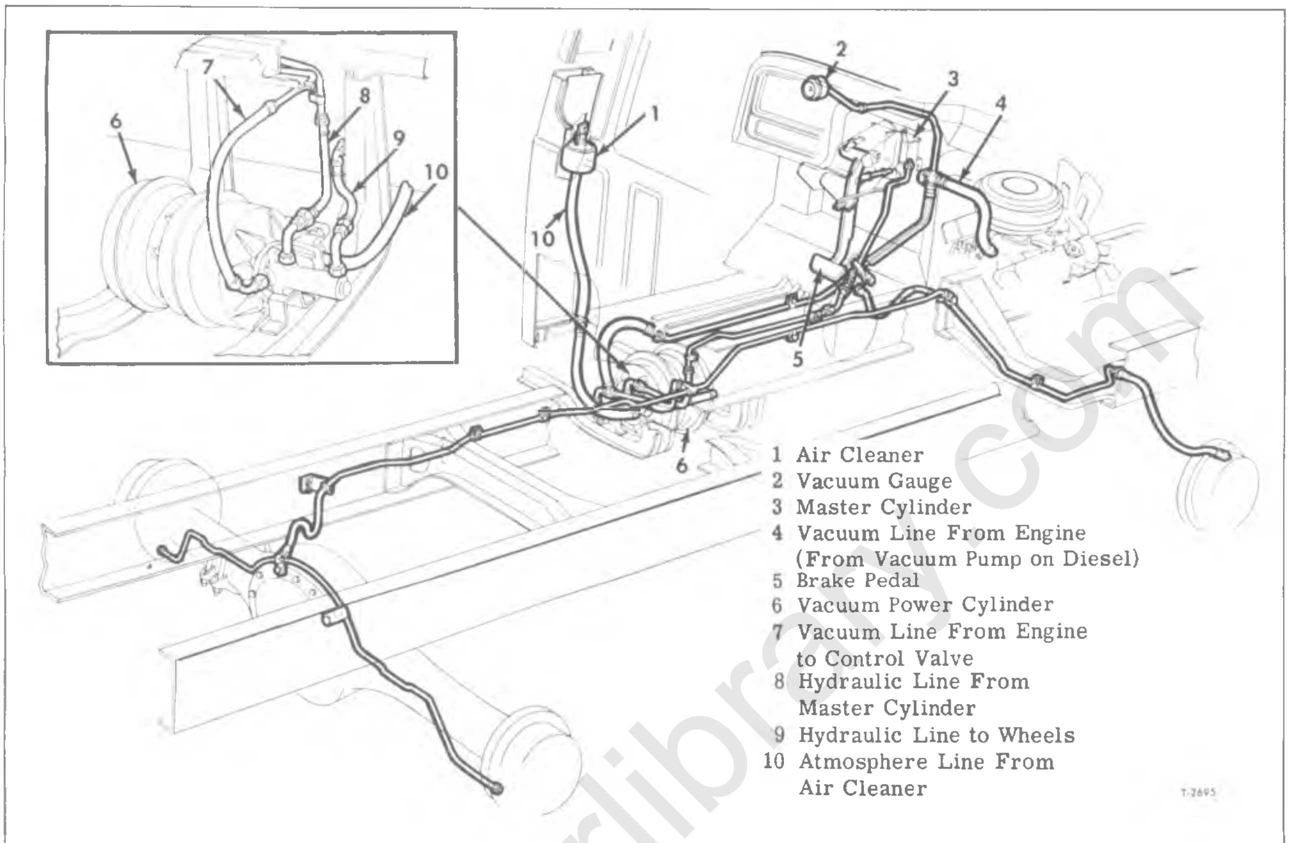


Figure 1—Typical Vacuum and Hydraulic Lines Installed (Remote Mounted Booster)

inders, lines, gauges, reserve tanks, etc., are covered under respective headings in this section.

For illustration of typical system installation see figure 1.

BRAKE SYSTEM MAINTENANCE

1. Maintain proper level of hydraulic brake fluid in master cylinder. Refer to LUBRICATION (SEC. 0) for recommended fluid and checking intervals. At least once a year, drain and flush entire brake system and refill with new fluid.
2. Adjust brake shoes at regular intervals. After two or three adjustments, check brake linings for wear. Reline brakes before lining is worn sufficiently to permit lining rivets to damage brake drums.
3. Keep brake pedal and linkage well lubricated to assure free movement and rapid release of brakes.
4. Inspect entire brake system regularly for fluid leakage. Leakage must be corrected immediately.
5. Make sure brake shoes are free on their mountings, that shoe return springs are not weak or broken, and that backing plates are not sprung or loose on axle or steering knuckle.
6. Service remote mounted vacuum power cylinder air cleaner, referring to LUBRICATION (SEC. 0) for recommended intervals and for service instructions. Air cleaners on dash mounted booster and master cylinder assembly are integral part of complete assembly and can be serviced only when assembly is removed from the vehicle as part of unit overhaul.
7. Tighten all vacuum and atmosphere line fittings and connections.
8. Perform "Power Brake System Tests" as directed later under "Power Cylinders." These tests may reveal sub-standard performance before the condition becomes bad enough to cause driver complaints or brake failure on the road.

BRAKE ADJUSTMENTS

There are six different type brakes used on these vehicles:

1. Type "F" manual adjusting - FRONT.
2. Type "FA" automatic adjusting - FRONT.
3. Type "FR-3" manual adjusting - REAR.
4. Type "FR-3A" automatic adjusting - REAR.
5. Duo-Servo automatic adjusting - FRONT.
6. Twin-Action automatic adjusting - REAR.

BRAKE ADJUSTMENT MODEL CHART

FRONT BRAKES

Type "F" (Manual)	Type "FA" (Automatic)	Duo-Servo (Automatic)
L4000 Series	S6500	4500 Series
6500 Series (exc. "S")		5500 Series

REAR BRAKES

Type "FR-3" (Manual)	Type "FR-3A" (Automatic)	Twin-Action (Automatic)
6500 Series (exc. "S")	S6500	L4000 Series
		4500 Series
		5500 Series

MANUAL ADJUSTMENT

All manual brake adjustments to compensate for normal lining wear can be made without removing wheels and brake drums. Adjustment points are accessible through openings in brake backing plate or are external type.

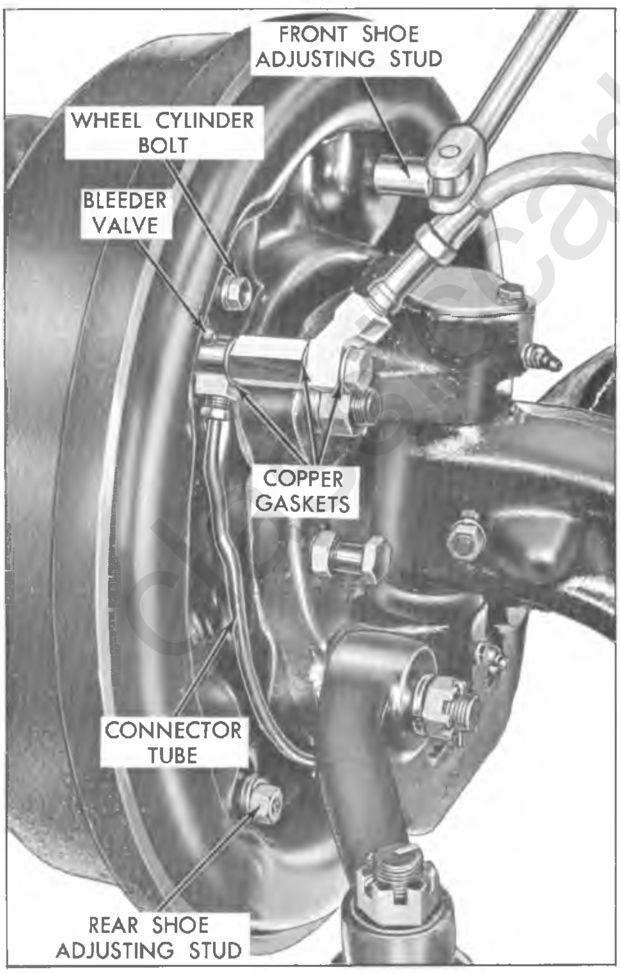


Figure 2—Type "F" Brake Adjustment

NOTE: Wheel bearings must be properly adjusted before attempting to adjust brake shoes. Refer to "HUBS AND BEARINGS" (SEC. 3D for FRONT and SEC. 4C for REAR).

Brake shoe adjustment points for front brakes (Type "F") are illustrated in figure 2. Adjustment points for rear brakes (Type "FR-3") are shown in figure 3.

Type "F" (Fig. 2)

1. Jack up front end of vehicle until wheels clear floor. Place wrench on one adjusting cam stud to adjust one shoe. Rotate wrench in direction of forward wheel rotation to decrease lining-to-drum clearance. Reduce clearance until brake drag is felt as wheel is turned in forward direction by hand.

2. Move wrench slightly in opposite direction until brake drag is relieved, then move wrench an additional 7 to 10 degrees to provide running clearance. (7 to 10 degrees is equal to 1 to 1½ inches of travel at end of an 8-inch wrench.)

3. Place wrench on opposite adjusting cam stud and adjust second shoe by repeating Steps 1 and 2.

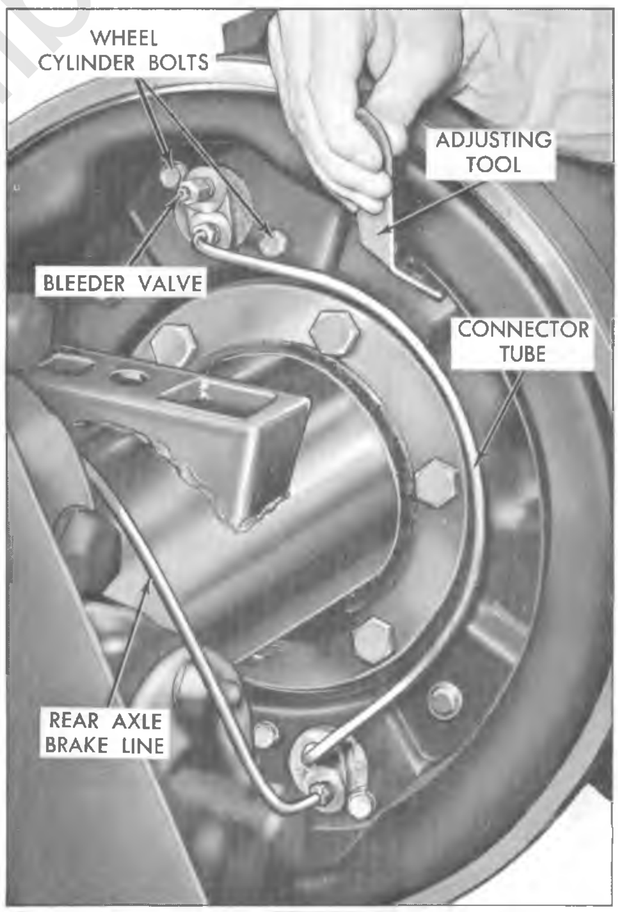


Figure 3—Type "FR-3" Brake Adjustment

Type "FR-3" (Fig. 3)

1. Jack up vehicle until wheels are clear of floor. Remove adjusting hole covers from backing plate.

2. At one adjusting slot, insert adjusting tool (J-4707) or similar tool through slot and engage adjusting wheel and decrease lining clearance until lining drags on drum.

3. Relieve drag by rotating adjusting wheel in opposite direction. Back off adjustment as follows:

For worn lining - 3 notches (clicks).

For new lining - 5 notches (clicks).

4. At other adjusting slot, repeat Steps 2 and 3 to adjust other shoe.

5. Install hole covers in backing plate.

AUTOMATIC ADJUSTMENT

Duo-Servo

As the brakes are applied, when vehicle is traveling in reverse, the shoes contact the drum and revolve with the wheel until the web of the primary shoe contacts the anchor pin. This motion causes the secondary shoe to move away from the anchor pin, thus increasing the distance between the actuating lever pivot point and the anchor pin. Since the actuating link maintains a constant length, the actuating lever assembly pivots on the secondary shoe hold-down pin location and the pawl end of the lever rocks down against the adjusting screw star wheel. If the lining is worn enough to allow sufficient movement of the secondary shoe, the pawl will advance the star wheel one or two teeth. If the brake linings are not worn enough to require an adjustment, the restricted movement of the secondary shoe prohibits over-adjustment.

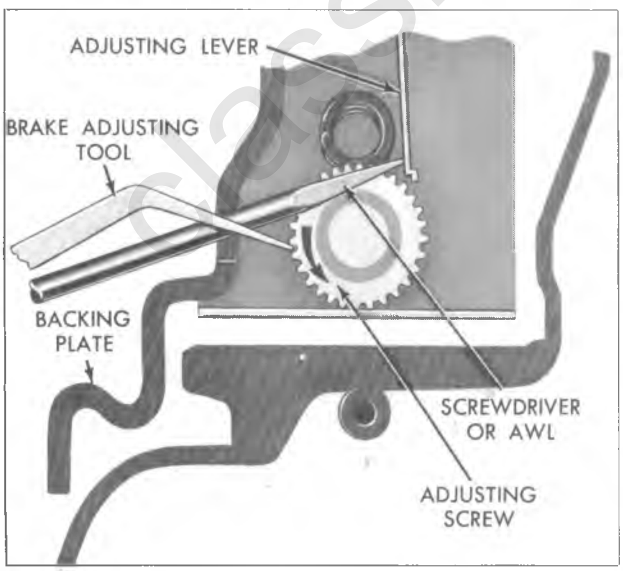


Figure 4—Backing Off Adjusting Screw (Cross-Section View)

When the brakes are released, the pull-back springs return the shoes to the rest position. At the same time, the actuating lever return spring moves the linkage to the rest position. The contour of the actuating lever pawl allows the lever to ratchet back to the rest position and in effect "take a new bite" on the star wheel. As a result of this action, the linkage is in position to make the next adjustment as it is needed.

Under normal operating conditions it is not necessary to make any manual adjustment to this type brake. However, when it is necessary to remove a brake drum it may also be necessary to "back-off" the adjustment in order to pull edge of drum past linings. In such cases, insert a screwdriver or awl through hole in backing plate and hold adjusting lever or pawl away from adjusting screw. Then turn screw with proper brake tool to loosen adjustment. See figures 4 and 5.

Twin-Action

Brake shoe adjustment takes place when brakes are applied with a firm pedal effort while the vehicle is backing up. Applying the brakes moves adjusting levers which turn the star wheels and rotate the adjusting screws outward from the anchor brackets. This action adjusts the shoe until clearance between the lining and drum is within proper limits.

Should low pedal heights be encountered, it is recommended that numerous forward and reverse stops be performed with a firm pedal effort until a satisfactory pedal height results.

Access holes are located in the flange plate. These holes are for service purposes in the event retracting of the brake shoes is required to remove the drum. In order to back off the adjusting screws,

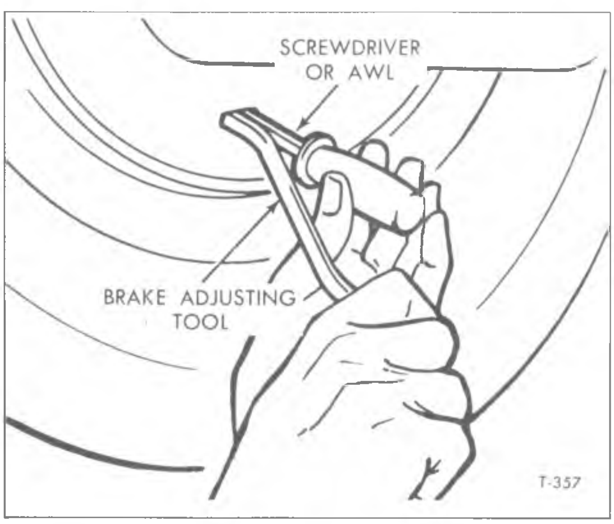


Figure 5—Backing Off Adjusting Screw (Outside View)

remove the cover from the access hole and insert a screwdriver. Place a corner of the screwdriver blade in the hole in the adjusting lever and push the lever away from the star wheel. Using a brake adjusting tool, back off the star wheel. See figures 4 and 5.

BLEEDING BRAKES

Use only Hydraulic Brake Fluid recommended in LUBRICATION (SEC. 0). When other than recommended fluid has been used, drain and flush the entire hydraulic system, using clean alcohol or a hydraulic brake system cleaning fluid. Disassemble, clean, and inspect hydraulic units. Replace all rubber parts. Refill system with recommended fluid.

The need for bleeding air from system is generally indicated by a springy, spongy pedal action. The presence of air in system is a result of low fluid level in master cylinder, or of some part of the system having been disconnected. Bleeder valves are provided on the power cylinder (some models), master cylinder (some models) and at wheel cylinders. Type "F" and type "FA" front brakes have two cylinders per wheel and each has a bleeder valve. Type "FR-3" and type "FR-3A" rear brakes have two cylinders per wheel with a bleeder screw at the top cylinder only. Duo-Servo front brakes have one cylinder per wheel and each has a bleeder screw. Twin-Action rear brakes have two cylinders per wheel with a bleeder screw at the top cylinder only. Refer to figure 7 for bleeding sequence by truck model.

Master cylinder is accessible under the hood on conventional models, through access door in seat riser on tilt cab models and through access door in floor on "P" model. Bleeder valves at wheel cylinders are accessible at inner sides of the backing plates.

It is recommended that brake system is bled in a definite sequence to obtain best result. Figure 7 illustrates various combinations of brake equipment used, with bleeder valves numbered in the recommended sequence in which they should be bled.

IMPORTANT: Note that neither master cylinder nor power cylinder on some models is equipped with a bleeder valve. If bleeding at the wheels only does not produce satisfactory results, it will be necessary to disconnect line from master cylinder and bleed it through output port. Then reconnect line and disconnect power cylinder output line and bleed. Reconnect line and check operation of brakes. If still not satisfactory, rebleed wheel cylinders in sequence shown.

There are two methods of bleeding hydraulic brake systems used on these vehicles; pressure bleeding and manual bleeding. Both are acceptable and adequate (except on split systems) but pressure bleeding is recommended, if equipment is available.

CAUTION: Before starting pressure bleeding operations, stop engine and destroy vacuum in system before opening any bleeder valve.

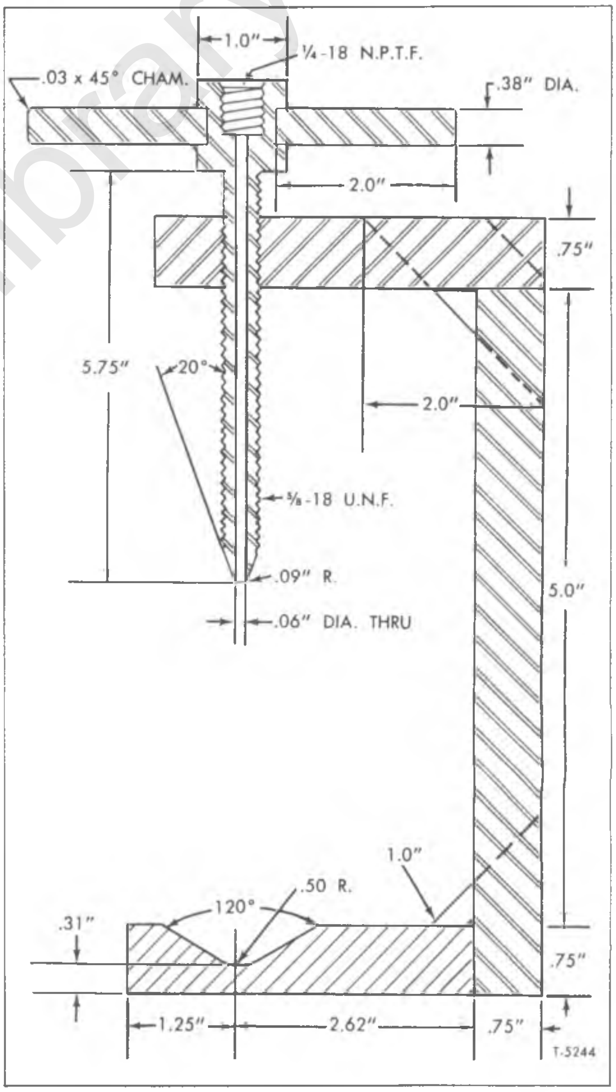


Figure 6—Brake Bleeding Tool for Split System Master Cylinder

HYDRAULIC BRAKES

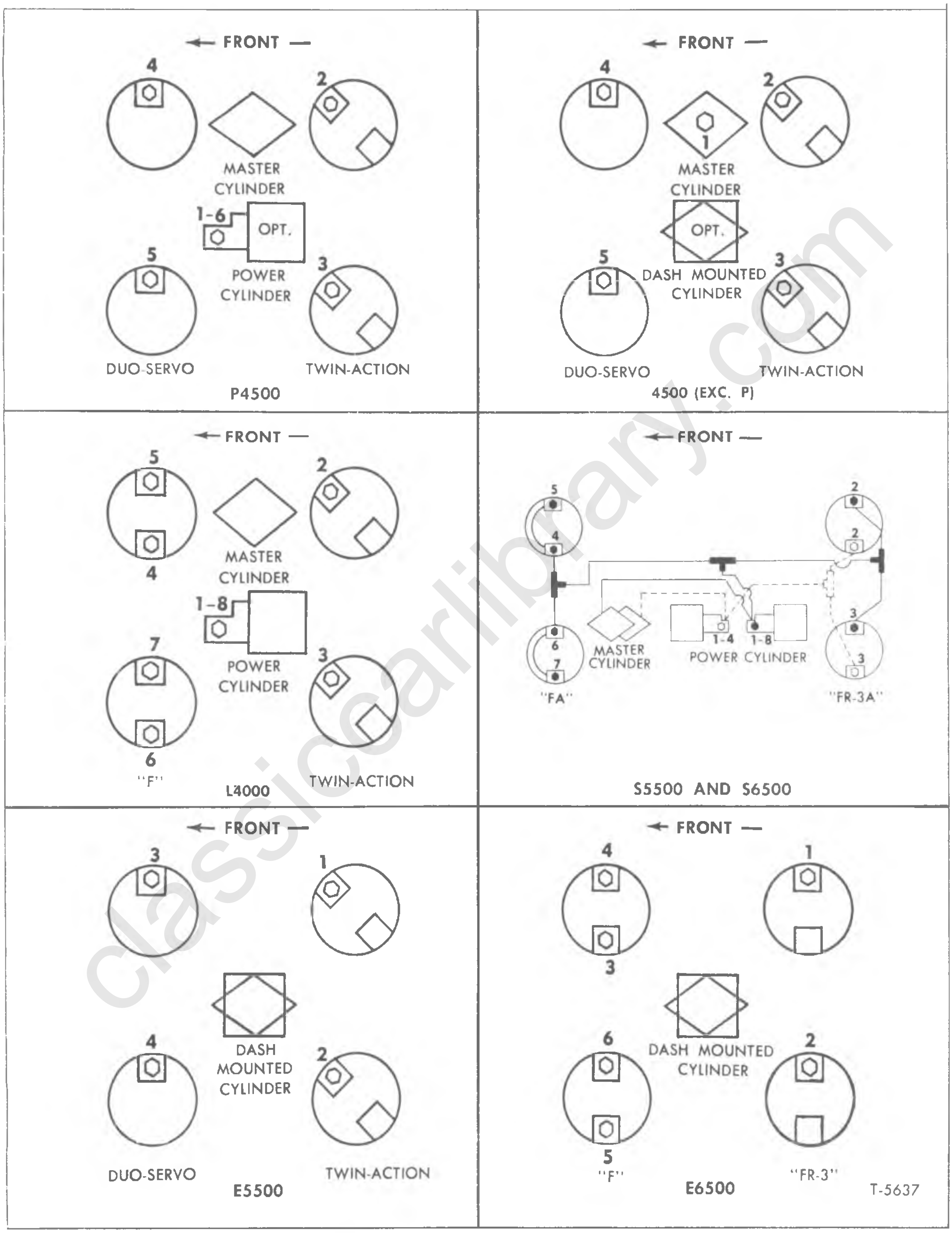


Figure 7—Hydraulic Brake Bleeding Sequence Chart

SPLIT SYSTEM ("S" MODELS)

The split system on "S" Models consists of two separate brake systems split as follows:

1. Main System - front wheel brakes plus one cylinder on each rear wheel brake.
2. Secondary System - one cylinder on each rear wheel brake.

The system on both models consists of a dash mounted master cylinder and two frame mounted power cylinders.

It does not matter which system (main or secondary) is bled first, however, each must be bled separately. Because the two systems have a common push rod and act simultaneously, THE SPLIT BRAKE SYSTEM CANNOT BE BLED MANUALLY. THE PRESSURE BLEEDING METHOD MUST BE USED.

Figure 6 illustrates a tool which can be made locally for use in pressure bleeding the split brake system (both standard and optional).

Tool (J-23339) may also be used for this purpose. It is a special adapter designed to fit the master cylinder used on the "S" Models. This tool is not illustrated.

PRESSURE BLEEDING

Refer to figure 7 for bleeding sequence.

1. Make sure fluid level in pressure tank is up to petcock above outlet and that tank is charged with 40 to 50 psi air pressure.
2. Clean dirt from around master cylinder filler cap or cover. Remove standard cover and install special cover required to fit the model cylinder used. Connect pressure tank hose to filler cap or cover opening. Bleed air from hose before tightening connection. Open valves at both ends of hose.
3. First bleed master cylinder valve on models where used. Slip end of bleeder hose over bleeder valve No. 1 and place other end in a glass jar containing enough hydraulic fluid to cover end of hose. Open bleeder valve with wrench and observe flow of fluid from hose. Close bleeder valve as soon as bubbles stop and fluid flows in a solid stream.
4. Bleed valve No. 2 (on power cylinder where used), then bleed wheel cylinders in sequence shown in figure 7. After bleeding wheel cylinders, repeat bleeding operations at power cylinder (where used).
5. If, after bleeding, the pedal "feel" is not satisfactory, it is recommended that the residual check valve in the master cylinder or the check valve in the power cylinder piston be inspected (on those models which have check valves). Improper operation of either or both of these valves will result in the same pedal "feel" as air in the system. Refer to applicable procedures for repair. If these valves are operating properly, or if "feel" is not satisfactory on models not using check valves, then air is still present in system and bleeding again will be necessary.

MANUAL BLEEDING

Manual bleeding is the same as pressure bleeding, except that the brake fluid is forced through the lines by pumping the brake pedal instead of by air pressure. Fluid in master cylinder must be replenished after bleeding at each valve. Brake pedal should be pumped up and down slowly. and should be on downstroke as valve is closed.

BRAKE PEDAL AND LINKAGE

There are three basic types of brake pedal and linkage installations used on vehicles covered by this manual. They are illustrated in figures 8, 9, and 10.

Figure 8 illustrates the type installation used with a dash mounted master cylinder and a remote booster cylinder (P4500 and 5500 Models).

Figure 9 illustrates the type installation used with a dash mounted combination master and booster cylinder (4500 Series except "P," 5500 Series, and 6500 Series).

Figure 10 illustrates the type installation used with the master cylinder mounted under the cab and a push through brake pedal (all tilt cab models).

BRAKE PEDAL REPLACEMENT (ALL EXCEPT TILT CAB)

These models have a suspended type brake

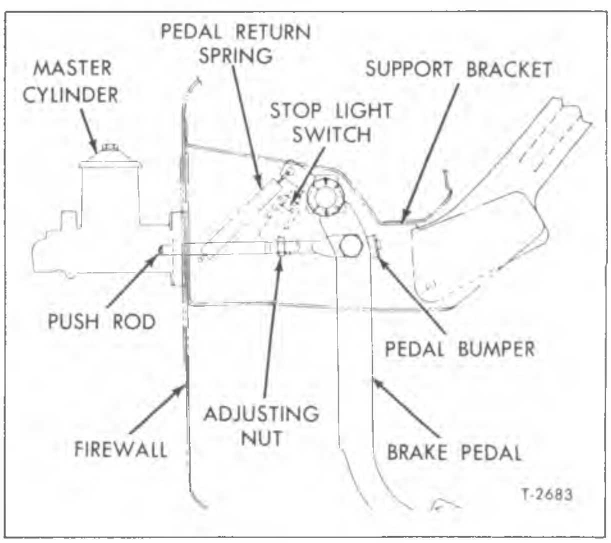


Figure 8—Brake Pedal and Master Cylinder Installation (P4500 and 5500 Models)

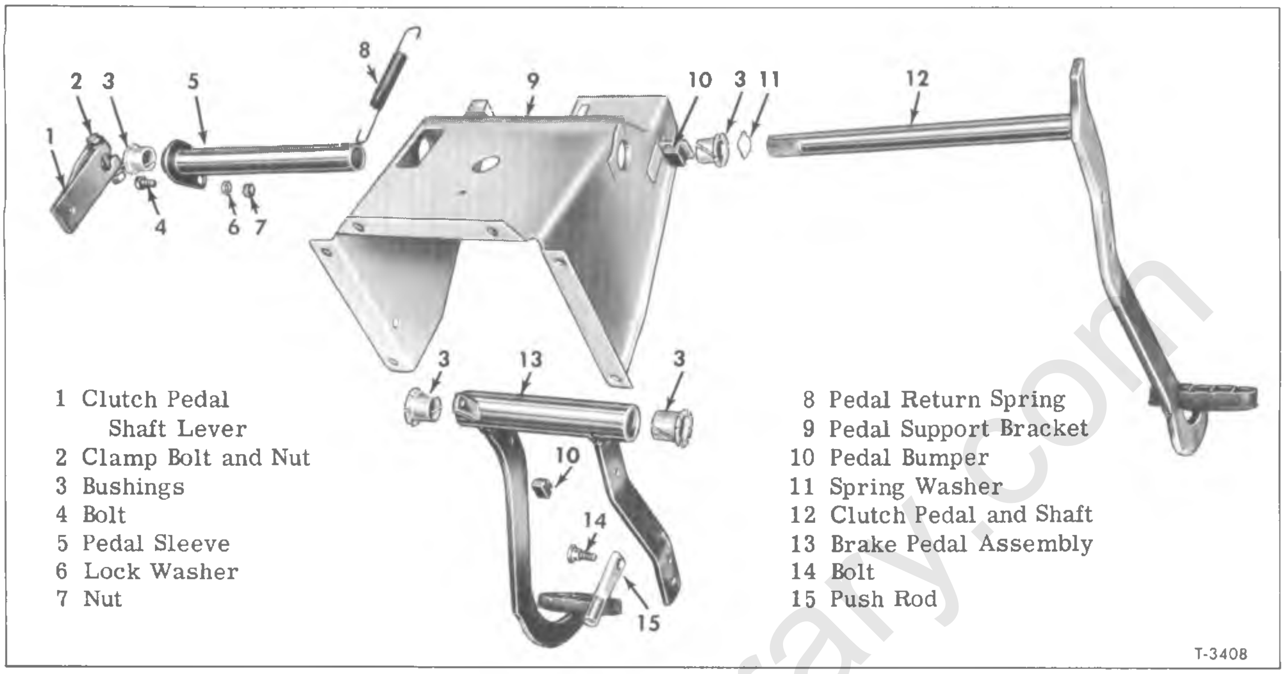


Figure 9—Clutch and Brake Pedal Installation (E4500, 5500, 6500 and S5500, 6500)

pedal mounted in a bracket which is secured on the underside of the instrument panel.

As indicated on figures 8 and 9, the brake pedal pivots on the outside of sleeve, and clutch pedal shaft extends through inside of sleeve. Nylon bushings are installed in each end of brake pedal tube, forming the contact between pedal tube and pedal sleeve. Clutch pedal shaft is carried in nylon bushings installed in each end of sleeve. The brake master cylinder is mounted on the engine side of the dash (double barrel on some models, single barrel on others). Adjustable push rods, extending through dash into master cylinder bores, are attached by special bolts to brake pedal lever and to clutch pedal shaft lever (on models with hydraulic clutch controls).

In released position, each pedal is held against a rubber bumper by pedal return springs. The following pedal replacement procedures cover both clutch and brake pedals.

PEDAL REMOVAL (Figs. 8 and 9)

In order to remove the brake pedal, the clutch pedal must also be removed.

1. Remove bolts attaching brake and clutch master cylinder push rods to pedal levers.
2. Unhook pedal return springs.
3. Loosen clamp bolt securing clutch pedal shaft lever on end of clutch pedal shaft and remove lever from shaft. Remove spring washer, bushings, and clutch pedal and shaft from sleeve.
4. Remove bolt attaching pedal sleeve to panel-to-dash brace. Remove sleeve from brace, at the same time removing brake pedal and bushings.

PEDAL INSTALLATION

Before installing pedals, check bushings in brake pedal and in pedal sleeve for evidence of wear or deterioration. Bushings are split type and can easily be removed and replaced.

1. Install bushings in pedal tube. Position brake pedal at underside of instrument panel-to-dash brace. Insert pedal sleeve through brace and pedal and attach sleeve to brace with bolt and nut.
2. Install bushings in sleeve. Insert clutch pedal shaft through sleeve and install spring washer and pedal shaft lever on end of shaft. Tighten lever clamp bolt firmly.
3. Connect pedal return springs.
4. Connect master cylinder push rods to brake and clutch pedals, using special shoulder bolts, lock washers, and nuts. Tighten nuts to 25-30 foot-pounds torque.
5. Adjust push rod to provide rod to piston clearance as directed under "Push Rod Adjustment."

BRAKE PEDAL REPLACEMENT (TILT CAB)

(Refer to Figure 10)

REMOVAL

In order to remove the brake pedal on tilt cab models, it is necessary to first remove the clutch

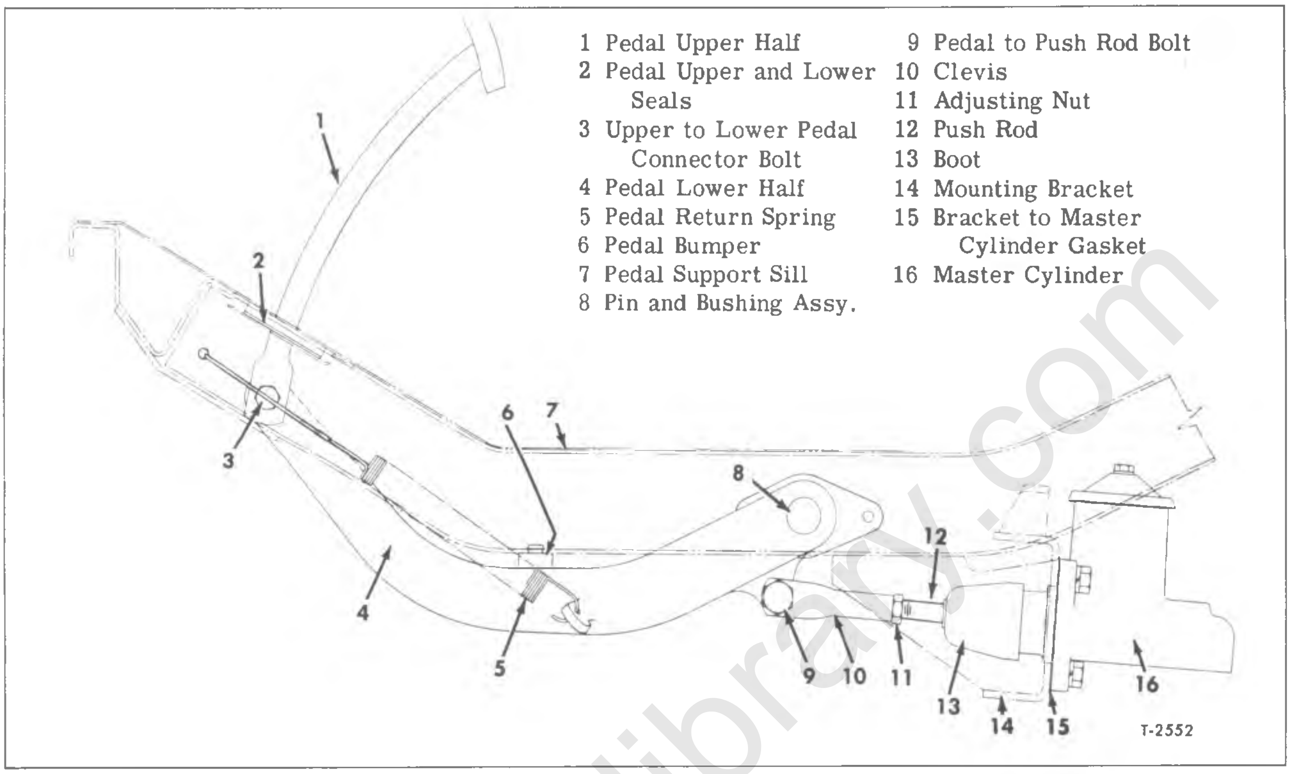


Figure 10—Brake Pedal and Master Cylinder Installation (Tilt Cab Models)

pedal assembly to obtain enough clearance to remove brake pedal.

1. Remove clutch pedal (for details see "Clutch Pedal and Bushing Replacement" in "CLUTCH CONTROLS" (SEC. 7D) of this manual.
2. Remove upper to lower pedal connector bolt. Remove pedal upper half.
3. Remove pedal return spring.
4. Remove pedal to push rod bolt.
5. Remove lock ring and washer from outside end of pin and bushing assembly.
6. Remove grease fitting from bushing.
7. Remove bolts which fasten bushing assembly to cab sill.
8. Simultaneously slide pedal assembly and bushing assembly out of cab sill in opposite directions, twisting each as necessary to clear sill and other obstructions.

INSTALLATION

1. Simultaneously insert bushing assembly from outer side of cab sill and brake pedal assembly from inner side of cab sill, twisting each as necessary to allow pedal pin to slide completely through bushing and bushing assembly to slide completely through cab sill.
2. Install bolts which fasten bushing assembly to cab sill. Tighten securely.
3. Install grease fitting.
4. Install washer and lock ring on outside end of pin and bushing assembly.
5. Install pedal to push rod bolt.
6. Install pedal return spring.
7. Insert pedal upper half through seals and fasten upper and lower pedal halves with bolt.
8. Install clutch pedal (for details see "Clutch Pedal and Bushing Replacement" in "CLUTCH CONTROLS" (SEC. 7D) of this manual).

PUSH ROD ADJUSTMENT

Instructions covering push rod adjustment varies according to model. The amount of free play and the location for measuring free play differs, dependent on vehicle model and type of equipment used.

Push rod adjustment is very important on all models and tolerances given should be adhered to. If the push rod is too long, brakes will not release completely. If the push rod is too short excessive pedal travel will be required to apply the brakes.

IMPORTANT: If any doubt exists relative to push rod adjustment, always remember it is better to have push rod adjusted too short than for it to be too long.

TILT CAB MODELS (Refer to Fig. 10)

1. Set emergency brake or block wheels.
2. Tilt cab (see instructions in Section 1).

3. Pull back boot on push rod. Visually check to see if piston is seated firmly against piston snap ring in cylinder bore. If piston is NOT against snap ring, push rod is too long and should be shortened.

4. To adjust, loosen lock nut and turn rod in or out of rod end as necessary. Adjust so that a slight movement of brake pedal at pad is necessary before end of push rod contacts piston.

5. Tighten lock nut.

6. Check operation of brakes.

P4500 (Refer to Fig. 8)

1. Loosen lock nut on push rod.

2. Turn push rod in or out of push rod end as necessary so that free pedal travel measured at center of pedal pad is between 0.060" and 0.250".

3. Tighten lock nut.

4. Check operation of brakes.

ALL MODELS WITH DASH MOUNTED POWER CYLINDER (STD. OR OPT.)
(Refer to Fig. 20)

1. Loosen lock nut on push rod.

2. Turn push rod in or out of push rod end as necessary to obtain free play of 0.250" before push rod causes movement of power cylinder hub.

NOTE: The free play is "at push rod" NOT at pedal pad. The push rod is part of the power cylinder assembly and the free play is related to the power cylinder not the brake pedal.

3. Tighten lock nut.

4. Check operation of brakes.

MASTER CYLINDERS

DESCRIPTION

There are four different type brake master cylinders used on these vehicles; single barrel (models with mechanical clutch controls), double barrel (models with hydraulic clutch controls), split system, and those which have a master cylinder integral with the dash mounted type vacuum power booster.

On conventional cab models, all types are mounted on the engine side of the fire wall. The single barrel cylinder is fastened by two bolts; the double barrel cylinder uses three bolts. The booster type cylinder has four studs as part of the vacuum chamber. These studs pass through the fire wall and the assembly is fastened with four nuts on these studs, inside the cab. The master cylinder is fastened to the booster assembly on two studs with nuts.

On tilt cab models the double-barrel cylinder is mounted under the cab on a bracket with three bolts.

On "P" Models the double-barrel cylinder is mounted on a dash panel with three bolts.

On "S" Models the split system type master cylinder is used. It is mounted on engine side of the fire wall and is fastened by four bolts.

Some master cylinders have bleeder screws and others do not (refer to brake bleeding sequence chart, figure 6).

FILLER CAPS

Filler cap on single and double barrel cylinders is rectangular and incorporates a combination seal and diaphragm made of rubber. The purpose of this is to prevent dirt from entering the reservoir, to prevent brake fluid from leaking out and to allow for expansion and contraction of fluid level as the result of changes in temperature as well as changes in fluid level as the result of normal brake operation. These caps are fastened to the top of the master cylinder by a single bolt down through the center which fits in a threaded hole in the master cylinder body (see fig. 12).

Filler caps used on those cylinders which are integral with a dash mounted vacuum booster are identical to caps used on regular master cylinders except that they are round instead of rectangular.

Filler cap used on split system is a single cap covering both reservoirs and is fastened by a single bolt in the center as shown in figure 13.

Brake fluid level in all master cylinders should be checked periodically by removing filler cap and making visual inspection. On conventional models the master cylinder is accessible by lifting the hood to the engine compartment on the left side of vehicle. On tilt cab models the master cylinder is accessible by removing the metal plate on the riser panel below the front of the driver's seat. On "P" Models the master cylinder is accessible by removing a metal cover from outside the vehicle at the front, or from inside the vehicle, on the dash, between windshield and instrument panel. Location differs with body manufacturer. On "S" Models the master cylinder is accessible by lifting the hood to the engine compartment on the left side of the vehicle.

MAINTENANCE (ALL TYPES)

Filler caps on all master cylinders are designed to vent the fluid reservoir without permitting loss of fluid. By-pass port between cylinder bore and reservoir and vent hole in filler cap must be kept open to assure proper operation. An obstructed by-pass port will prevent return of fluid to reservoir, preventing full release of brakes.

By-pass ports may be obstructed by one of the following causes:

1. Clogged with dirt -- remove master cylinder and disassemble and clean all parts.
2. Swollen primary cup due to the use of wrong fluid -- overhaul master cylinder, drain and flush entire brake system, and refill with proper fluid.
3. Pedal binding on shaft, preventing full return of piston -- free up and lubricate pedal.
4. Improper push rod adjustment -- adjust push rod.

MASTER CYLINDER REPLACEMENT

TILT CAB MODELS

Removal

1. Tilt cab forward and place a suitable container under master cylinder to catch fluid when hydraulic lines are disconnected. DO NOT RE-USE THIS FLUID.
2. Disconnect hydraulic lines from outlets of brake and clutch cylinders.
3. Pull push rod boots off master cylinder. Boots will remain on push rods when master cylinder is removed.
4. Remove three bolts attaching master cylinder to support bracket and remove master cylinder assembly.

Installation

1. Position master cylinder assembly at support bracket and guide push rods into pistons. Attach cylinder with three bolts. Tighten bolts firmly.
2. Connect hydraulic lines to brake and clutch cylinder outlets.
3. Place push rod boots over ends of master cylinder brackets.
4. Adjust push rods as directed under "Brake Pedal and Linkage."
5. Fill master cylinder reservoir and bleed brake system as directed under "Bleeding Brakes."

CONVENTIONAL MODELS
(SEPARATE MASTER CYLINDER)

Removal

1. Place a suitable container under master cylinder to catch fluid when hydraulic lines are disconnected. DO NOT RE-USE THIS FLUID.
2. Disconnect hydraulic lines from outlet of brake cylinder (also clutch lines on dual cylinders).
3. Pull push rod boot off master cylinder tube which extends through dash. Boot will remain on push rod when master cylinder is removed.
4. Remove three bolts and lock washers (two on single barrel cylinders) attaching master cylinder to dash (nuts are welded to inner side of dash) and remove master cylinder assembly.

Installation

1. Place gasket over each cylinder tube. Position master cylinder assembly at dash, while an assistant inside cab guides push rod into piston. Attach cylinder to dash with three bolts and lock washers (two on single barrel cylinders).
2. Connect hydraulic line to brake (and clutch on dual) cylinder outlet.
3. Inside cab, place push rod boot over end of cylinder tube.
4. Adjust push rod as directed under "Brake Pedal and Linkage."
5. Fill master cylinder reservoir and bleed brake system as directed under "Bleeding Brakes."

CONVENTIONAL MODELS
(WITH DASH MOUNTED BOOSTER)

Removal

1. Place a suitable container under master cylinder to catch fluid when hydraulic line is disconnected. DO NOT RE-USE THIS FLUID.
2. Remove two nuts from studs on booster chamber and pull master cylinder off studs.
3. If complete booster assembly is to be removed, omit Step 2. Instead, remove nut and bolt which fastens push rod to brake pedal inside cab.
4. Remove four bolts which fasten booster and support bracket assembly to cab fire wall.
5. Pull booster assembly (with master cylinder and support bracket attached) away from fire wall and remove from engine compartment.

Installation

1. Place booster assembly (with master cylinder and support bracket attached) in position on fire wall from engine compartment side.

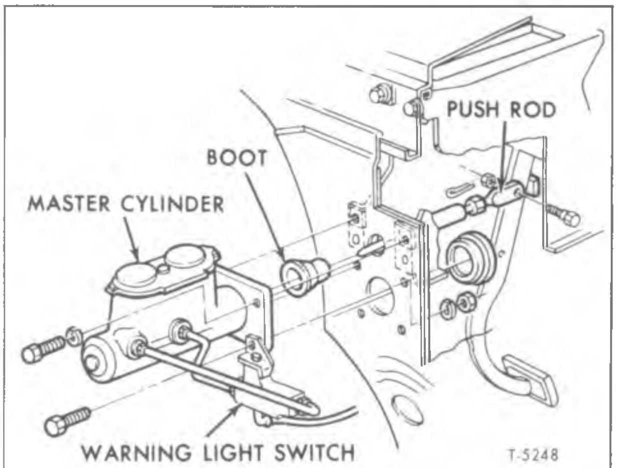


Figure 11—Split System Master Cylinder Installed

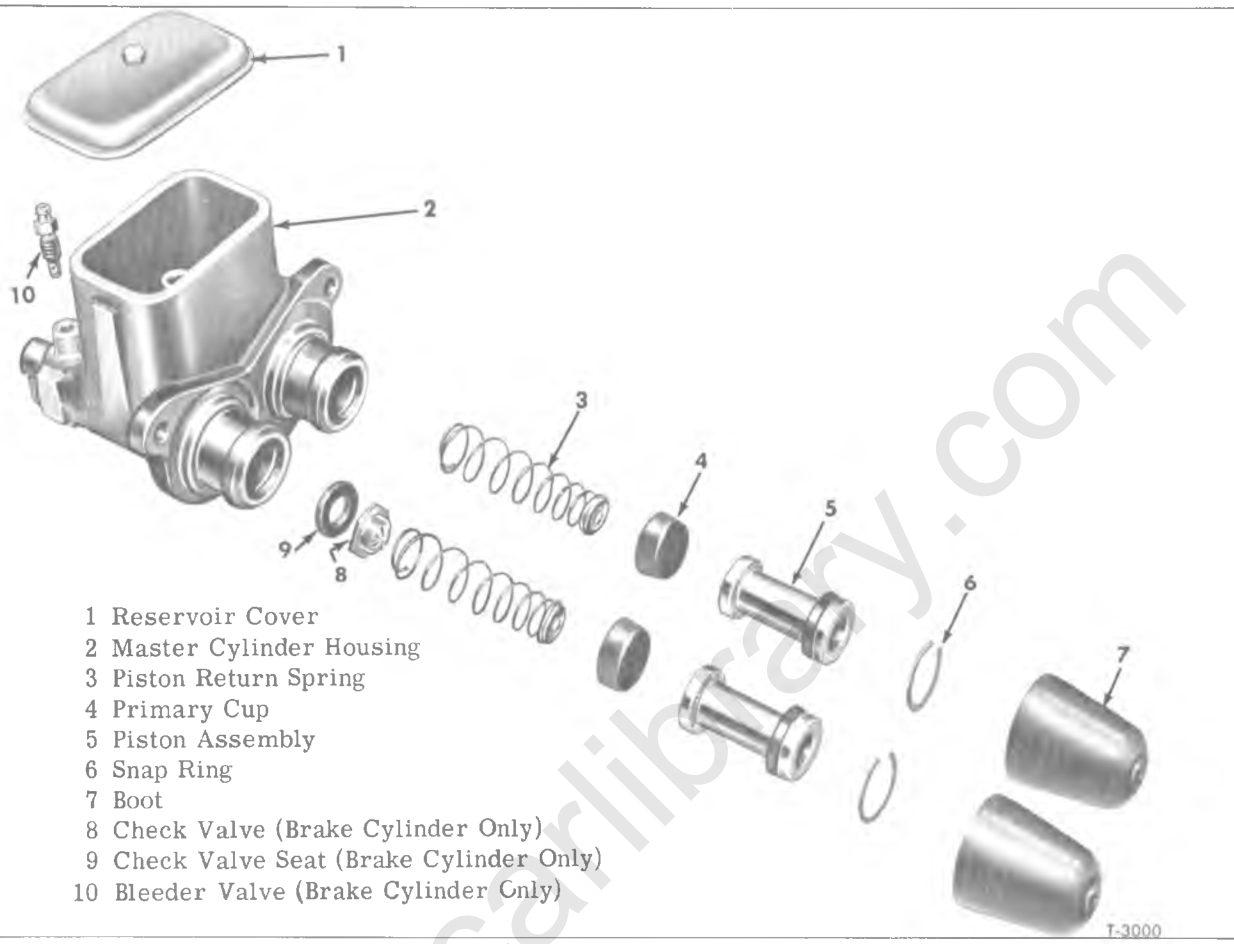


Figure 12—Double Barrel Master Cylinder Components

2. Fasten booster support bracket to fire wall with four bolts.

3. Attach push rod to brake pedal.

4. If master cylinder only is to be installed omit Steps 1, 2, and 3. Instead, place master cylinder in position on studs on booster chamber and fasten with two nuts.

5. Connect hydraulic brake line to master cylinder.

6. Fill master cylinder reservoir with proper fluid and bleed brake system as directed under "Bleeding Brakes."

7. Adjust brake pedal push rod as necessary.

"S" MODELS
(SPLIT MASTER CYLINDER)

Removal (Refer to Fig. 11)

1. Wipe master cylinder and lines clean with a clean cloth. Place dry cloths below master cylinder to absorb any fluid spillage.

2. Disconnect hydraulic lines at master cylinder. Cover line ends with clean, lint-free material to prevent foreign matter from entering system.

3. Disconnect battery ground strap or stop light wires and brake warning switch wire.

4. Remove nuts, bolts, and washers which fasten master cylinder to dash. Pull master cylinder straight off push rod and remove from engine compartment.

5. Remove and discard master cylinder push rod boot.

6. Remove master cylinder cover and pour out fluid from reservoirs. Pump the remaining fluid out by depressing piston.

Installation (Refer to Fig. 11)

1. Assemble new boot on brake pedal push rod.

2. Place master cylinder in position in engine compartment. Make certain that push rod and boot are in proper position.

3. Fasten master cylinder to dash with nuts, bolts, and washers.

4. Connect brake lines to master cylinder.

5. Fill the reservoirs with recommended brake fluid.

6. Follow instructions in this manual under heading of "Bleeding Brakes."

7. If necessary, adjust the brake pedal free-play as directed.

8. Connect battery ground strap or stop light wires and brake warning switch wire (whichever was disconnected at removal).

9. Test brakes and make any necessary adjustments if operation is not satisfactory.

MASTER CYLINDER OVERHAUL

The following procedures cover disassembly, cleaning, inspection and repair, and assembly of components used in both the brake and clutch cylinder bores on double barrel master cylinders and on brake cylinder bores on single barrel cylinders. The master cylinder assembly used with dash mounted power booster is integral with the booster and has a different internal construction. They can be removed and installed on the vehicle as described in "Master Cylinder Replacement." Overhaul of this type master cylinder is covered in the unit overhaul manual as part of the complete assembly overhaul.

OVERHAUL (EXCEPT SPLIT-TYPE)

(Refer to Figure 12)

1. Clean all dirt from outside of unit, using a non-petroleum solvent.
2. Remove snap ring from groove in both cylinder bores.
3. Remove piston assembly, primary cup, return spring and retainer assembly, check valve and check valve seat from brake cylinder bore.
4. Remove piston assembly, primary cup, and return spring and retainer assembly from clutch cylinder bore.
5. Remove cover from cylinder housing.
6. Remove bleeder screw (if used).

Cleaning

Immerse all parts in denatured alcohol and wash thoroughly. Wipe small parts dry and blow out inside of reservoir and cylinder bores. Make sure intake and by-pass ports in cylinder housing and bleeder holes in piston are clean.

> **CAUTION: DO NOT use kerosene or gasoline for cleaning master cylinder components.**

Inspection and Repair

Master cylinder repair kits are available which contain all the parts ordinarily required when overhauling master cylinders. Refer to applicable Parts Book for part number of repair kit. In addition to replacement of parts contained in repair kit, master cylinder should be inspected and repaired, if necessary, as follows:

1. Examine cylinder bores. If scored or rusted, recondition by honing. Be sure to use proper size hone. (Refer to "Specifications" for nominal diameter of cylinder bores.) Do not hone more than necessary to remove scores and smooth up cylinder. Remove burrs caused by honing from around by-pass and intake ports.
2. Check piston fit in cylinder bore. Clearance between piston and cylinder wall should be within 0.001" to 0.005" when checked with feeler gauge.

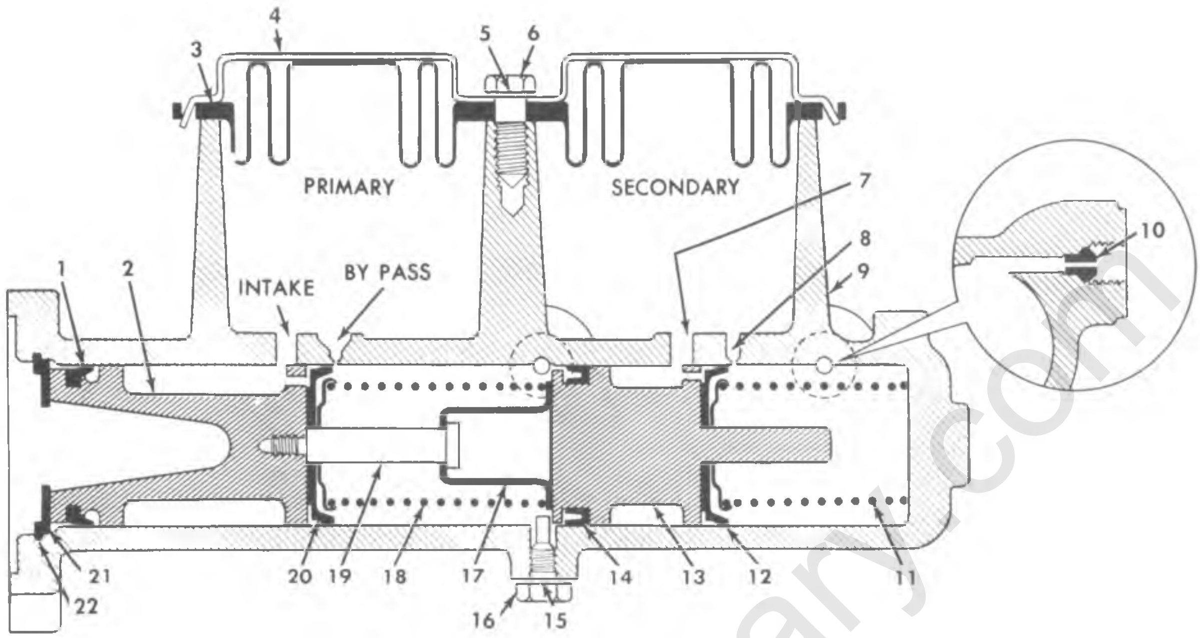
Assembly (Fig. 12)

1. Before assembling, coat inside of cylinder bores and dip all internal parts in hydraulic brake fluid.
2. Install components in brake cylinder bore of double barrel cylinders as follows:
   a. Install check valve seat in cylinder bore, then position check valve on seat.
   b. Install return spring (shortest of the two) in bore with large diameter end of spring over check valve.
   c. Install primary cup in cylinder bore with lip of cup toward outlet end. Make sure end of return spring seats inside the cup.
   d. Insert piston and secondary cup assembly into cylinder bore, with open end of piston toward open end of cylinder.
   e. Press piston into cylinder bore, compressing spring, and install snap ring in groove in bore. Make sure snap ring is fully seated in groove.
3. Install components in clutch cylinder bore as follows:
   a. Install return spring (longest of the two) in cylinder bore, large diameter end first.
   b. Install primary cup in cylinder bore with lip of cup toward outlet end. Make sure end of spring seats inside the cup.
   c. Insert piston and secondary cup into cylinder bore, with open end of piston toward open end of cylinder.
   d. Press piston into cylinder bore, compressing spring, and install snap ring in groove in bore. Make sure snap ring is fully seated in groove.
4. Install cover on cylinder reservoir.
5. Install bleeder screw (if used).

OVERHAUL (SPLIT-TYPE)

Disassembly (Refer to Fig. 13)

1. Remove cylinder cover bolt and gasket.
2. Lift off reservoir cover and cover seal. Pour out any excess fluid and stroke piston to force fluid through outlet ports.
3. Remove piston stop bolt and gasket from bottom of reservoir housing.
4. Use snap ring pliers and remove retainer ring from groove in end of cylinder bore.



1 Primary Piston Seal Cup
2 Primary Piston
3 Cover Seal
4 Reservoir Cover
5 Gasket
6 Cover Bolt
7 Intake Port
8 By-Pass Port
9 Reservoir Housing
10 Tube Seat
11 Secondary Piston Return Spring
12 Secondary Piston Pressure Cup
13 Floating Secondary Piston
14 Secondary Piston Seal Cup
15 Gasket
16 Stop Bolt
17 Primary Return Spring Retainer
18 Primary Return Spring
19 Primary Piston Stop Pin
20 Primary Piston Pressure Cup
21 Stop Plate
22 Retainer Ring

T-5245

Figure 13—Split System Master Cylinder (S5500 - S6500)

5. Remove stop plate.

6. All internal parts should slide easily out of cylinder bore. If they do not, apply compressed air carefully at front outlet port. If parts do not remove easily, examine bore carefully for extensive damage which may eliminate the possibility of reconditioning the master cylinder.

Cleaning and Inspection

Clean all parts in denatured alcohol or brake fluid. If reservoir housing is degreased, finish clean to remove all trace of other solvents. Inspect cylinder bore for scratches or corrosion. Minor blemishes can be removed with crocus cloth or a clean-up hone. DO NOT OVERSIZE CYLINDER MORE THAN 0.007-INCH OVER NOMINAL INSIDE DIAMETER.

Check by-pass ports in both reservoirs to make sure they are open and free of burrs. Probe parts with soft copper wire 0.020-inch in diameter, or smaller. Do not use steel wire to check parts. This may scratch bore of master cylinder or cause burrs in port.

Remove and discard all rubber parts. All rubber parts are included in repair kit which is available from regular service parts sources.

Assembly (Refer to Fig. 13)

1. Coat all parts with a liberal amount of brake fluid.

2. Install rubber seal cup on secondary piston with cup lip facing rear (open end of cylinder).

NOTE: All other cup lips face opposite direction (closed end of cylinder).

3. Stack and install secondary piston spring, pressure cup and piston in cylinder bore.

4. Install piston stop bolt and gasket, making sure screw enters cylinder bore behind rear of piston.

5. Assemble and install primary piston parts in cylinder bore.

6. Install stop plate in cylinder bore.

7. Compress all parts in cylinder bore and install retainer ring in groove.

8. Install reservoir cover and seal.

BRAKE PIPE DISTRIBUTION AND SWITCH ASSEMBLY

All models with split brake system are equipped with a brake pipe distribution and switch assembly (refer to fig. 11). The hydraulic brake lines are routed from the master cylinder, through the switch assembly, to the front and rear brakes. The switch is wired electrically to the brake alarm indicator light on the instrument panel. In the event of fluid loss in either the main or secondary brake system, the indicator light will come on when the brakes are applied. If this light comes on during vehicle operation, it is an indication that there is a failure somewhere in the brake system. The truck should be removed from service as soon as possible and the trouble corrected.

This light also comes on when the ignition key is held in the "START" position. As soon as the key is released to the "ON" position, the light goes out. The purpose of this is to assure the driver that the warning light is not burned out.

BRAKE PIPE DISTRIBUTION AND SWITCH ASSEMBLY REPLACEMENT

(Refer to Figure 11)

REMOVAL

1. Disconnect battery cable.
2. Disconnect electrical lead from pressure differential switch.
3. Place dry rags below the switch to absorb any fluid spilled during removal of switch.
4. Disconnect four hydraulic lines from connections at switch. If necessary, loosen line connections at main cylinder. Cover open line ends with clean, lint-free material to prevent foreign matter from entering the system.
5. Remove mounting screw and remove switch from vehicle.

INSTALLATION

1. Make sure new switch is clean and free of dust and lint. If any doubt exists, wash switch in suitable solvent, and dry with air.
2. Place switch in position and secure to bracket with mounting screw.
3. Remove protective material from open hydraulic brake lines and connect lines to switch. If necessary, tighten brake line connections at main cylinder.
4. Connect switch electrical lead.
5. Connect battery cable.
6. Bleed the brake systems as outlined in this manual.

TESTING DISTRIBUTION AND SWITCH ASSEMBLY

1. Determine if bulb is functioning by turning key in ignition switch to "START" position.
2. Check main cylinder to make sure both reservoirs have enough fluid. Add if necessary.
3. Turn key in ignition switch to "ON" position.
4. Open wheel cylinder bleed screw at one rear wheel.
5. Depress brake pedal and hold down. The brake warning light should come on due to pressure difference between front and rear systems. Approximately 200-250 psi differential is needed to operate brake light switch.
6. Close bleed screw, then release brake pedal. Refill rear reservoir, if needed.

NOTE: Caution should be taken to prevent air from entering hydraulic system during checks on switch.

7. The recommended interval for checking switch is 24 months, or 24,000 miles, any time major brake work is done, or any time brake operation is abnormal.

WHEEL CYLINDERS

There are four different type wheel cylinders used on vehicles covered by this manual. Front brakes are either Type "F," "FA," or Duo-Servo. Rear brakes are either Type "FR-3," "FR-3A," or Twin-Action.

Since wheel cylinders can be disassembled and repaired without removing them from the vehicle the procedures are covered in this manual along with "Replacement" procedures.

WHEEL CYLINDER REPLACEMENT

TYPES "F" AND "FA"

Removal

1. Jack up axle and remove brake shoes as directed under "Brake Shoe Removal."
2. Disconnect axle brake tube from inlet connector at upper cylinder. Remove inlet connector attaching connecting tube fitting to upper cylinder,

and remove bolt attaching connecting tube fitting to lower cylinder. Remove connecting tube and fitting assembly.

3. Remove one large and two small bolts attaching each cylinder to backing plate, then remove cylinders from backing plate.

Installation

NOTE: The two wheel cylinders mounted on each brake are identical; however, cylinders on right- and left-hand brakes have opposite cylinder castings. Clean mating surfaces of cylinders and backing plate to insure proper alignment.

1. Place each cylinder on backing plate and attach with one large and two small bolts and lock washers.

2. Position wheel cylinder connecting tube and fittings assembly and attach fitting to lower opening in upper cylinder with inlet connector, using new copper gasket on both sides of fitting. Attach fitting to lower opening in lower cylinder with special bolt, using new copper gasket on both sides of fitting. Tighten inlet connector and special bolt firmly.

3. Install bleeder valve in upper opening in each cylinder.

4. Install brake shoes as directed under "Brake Shoe Installation." Bleed brake system as directed under "Bleeding Brakes."

DUO-SERVO

Removal

1. Jack up axle and remove wheel, brake drum, and brake shoes as directed later under "Brake Shoe Removal."

2. Disconnect metal brake tube from flexible hose at frame, disconnect hose from frame, then unscrew hose fitting from wheel cylinder housing.

3. Remove cap screws and washers attaching wheel cylinder to backing plate and remove cylinder assembly.

Installation

1. Position wheel cylinder on backing plate and attach with cap screws and lock washers.

2. Thread brake hose fitting into wheel cylinder housing using a new copper gasket on hose fitting. Insert fitting at other end of hose through frame and secure with toothed lock washer and nut or with spring lock, depending upon type used. Connect metal brake tube to hose fitting inside frame side rail.

3. Install brake shoes as directed under "Brake Shoe Installation." Bleed brake system as directed under "Bleeding Brakes."

TYPE "FR-3" AND "FR-3A"

Removal

1. Jack up axle and remove brake shoes as directed under "Brake Shoe Removal."

2. Disconnect axle brake tube from upper cylinder at inner side of backing plate. Remove wheel cylinder connecting tube at inner side of backing plate.

3. Remove two bolts and lock washers attaching each wheel cylinder to backing plate. Remove wheel cylinders and heat shields, then remove heat shields from cylinders.

Installation

NOTE: Upper and lower wheel cylinders on both right- and left-hand brakes are interchangeable. Cylinders must be positioned on backing plate so that the long stroke end of the cylinder faces the shoe toe (adjustment end of shoe) or the adjusting slot in backing plate. Make sure mating surfaces of cylinders, heat shields, and backing plate are clean to assure proper alignment.

1. Position heat shield on each wheel cylinder and install on backing plate, and attach each cylinder with two bolts and lock washers.

2. Attach connecting tube to upper opening in lower cylinder and to lower opening in upper cylinder. Connect axle brake tube to lower opening in lower cylinder, and install bleeder valve in upper opening in upper cylinder.

3. Install brake shoes as directed under "Brake Shoe Installation." Bleed brake system as directed under "Bleeding Brakes."

TWIN-ACTION

Removal

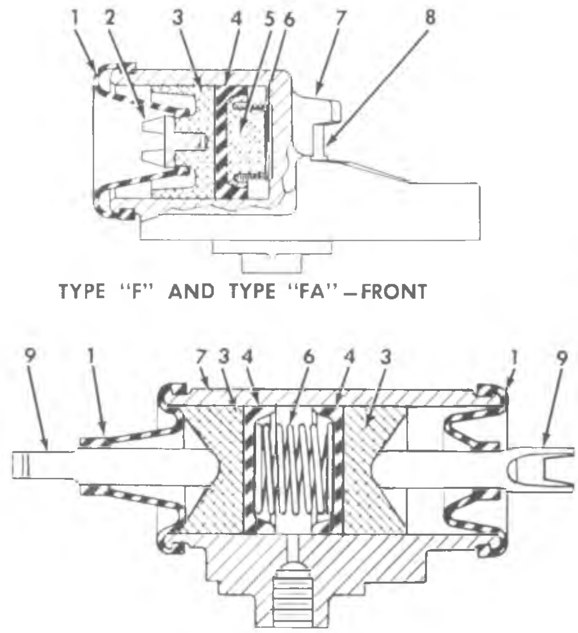
1. Jack up axle and remove brake shoes as directed later under "Brake Shoe Removal."

2. Disconnect brake tube from rear wheel cylinder connector at inner side of backing plate. Remove brake tube connecting wheel cylinders at outer side of backing plate. Remove dust shield from upper end of each cylinder.

3. Remove cap screws and lock washers attaching wheel cylinders to backing plate, then remove wheel cylinders and heat shield. Remove brake line connectors from cylinder housings.

Installation

NOTE: Forward and rearward wheel cylinders are not interchangeable. Rearward cylinder has threaded inlet opening near center of cylinder bore. Forward cylinder has threaded bleeder valve opening at extreme outer edge of cylinder bore. Cylinders must be positioned with connecting tube openings toward each other.



1 Boot	6 Piston Spring
2 Brake Shoe Guide	7 Cylinder
3 Piston	8 Brake Shoe Anchor Slot
4 Piston Cup	9 Push Rod
5 Cup Filler	

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Figure 14—Wheel Cylinders Used with Type "F", "FA", "FR-3", and "FR-3A" Brakes

1. Position heat shields on cylinders, place wheel cylinders on backing plate, and attach with cap screws and lock washers. Tighten cap screws firmly. Install dust shield on upper end of each cylinder.

2. Install connecting tube between the two cylinders and tighten connections firmly. Connect brake tube to inlet opening in rearward cylinder at inner side of backing plate. Install bleeder valve in threaded opening in forward cylinder.

3. Install brake shoes as directed under "Brake Shoe Installation." Bleed brake system as directed under "Bleeding Brakes."

WHEEL CYLINDER REPAIR

TYPES "F" AND "FA" (Fig. 14)

Disassembly

Pull boot off end of cylinder, then remove boot and piston. Pull boot off piston. Brake shoe guide is pressed into piston and cannot be removed. Remove piston cup, cup filler, and spring from cylinder. Remove bleeder valve from cylinder.

Inspection and Repair

1. Repair kits are available which contain the parts to be replaced when overhauling wheel cylinders. Refer to Parts Book for repair kit part numbers.

Figure 15—Checking Fit of Piston in Wheel Cylinder

2. Inspect cylinder bore for scores, scratches, or corrosion. Light scratches or slightly corroded spots may be polished out with crocus cloth. Never use emery cloth or sandpaper. If scratches or corrosion are too deep to be polished out, replace cylinder.

3. Check fit of new pistons in cylinder bore, using a feeler gauge (fig. 15). Clearance should be within 0.0025" to 0.0065" on "F" and "FA" type cylinders. Replace cylinder if clearance exceeds the maximum.

Assembly

Before assembling wheel cylinder, be sure each part has been cleaned in denatured alcohol.

CAUTION: DO NOT use kerosene or gasoline for cleaning wheel cylinder parts. Dip each internal part in hydraulic brake fluid before assembling.

1. Insert piston spring, cup filler, and cup into cylinder bore. Cup filler bumper and cup lip must face closed end of cylinder.

2. Assemble boot on piston, making sure the boot snaps over the brake shoe guide.

3. Install piston and boot, inserting piston into cylinder and engaging boot lip in groove in edge of cylinder. Position brake shoe guide so slot in guide is parallel with flat mounting surface of cylinder.

DUO-SERVO (Fig. 16)

Disassembly

Pull boots off ends of cylinder and remove push rods from boots. Push pistons, cups, and spring out of cylinder. Remove bleeder valve from cylinder.

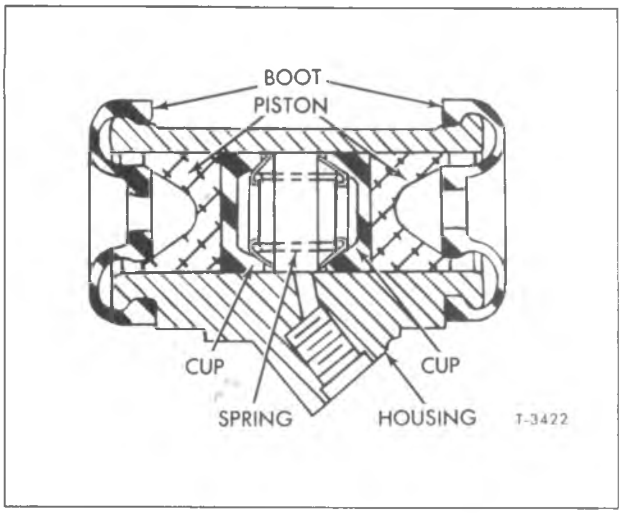


Figure 16—Duo-Servo Wheel Cylinder

Inspection and Repair

1. Repair kits are available which contain the parts to be replaced when overhauling wheel cylinders. Refer to Parts Book for repair kit part numbers.

2. Inspect cylinder bore for scores, scratches, or corrosion. Light scratches or slightly corroded spots may be polished out with crocus cloth. Never use emery cloth or sandpaper. If scratches or corrosion are too deep to be polished out, replace cylinder.

3. Check fit of new pistons in cylinder bore, using a feeler gauge. Clearance should be within 0.002" to 0.004". Replace cylinder if clearance exceeds 0.004". Refer to figure 15.

Assembly

Before assembling wheel cylinder, be sure each part has been cleaned in denatured alcohol.

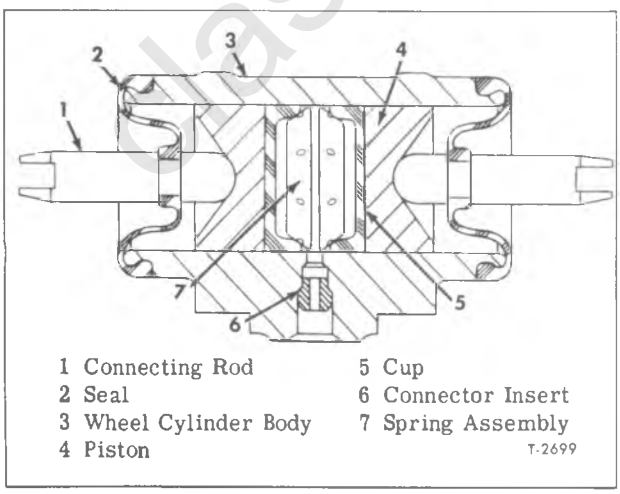


Figure 17—Twin-Action Wheel Cylinder

CAUTION: DO NOT use kerosene or gasoline for cleaning wheel cylinder parts. Dip each internal part in hydraulic brake fluid before assembling.

Insert pistons, cups, and spring into cylinder bore. Assemble push rods in boots and install boots over ends of cylinder. Install bleeder valve.

TYPES "FR-3" AND "FR-3A" (Fig. 14)

Disassembly

Pull boots off ends of cylinders and remove push rods from boots. Push pistons, cups, and spring out of cylinder. Remove bleeder valve from upper cylinder.

Inspection and Repair

1. Repair kits are available which contain the parts to be replaced when overhauling wheel cylinders.

IMPORTANT: Only genuine GMC parts should be used. Non-genuine parts may deteriorate and swell in a short time, resulting in faulty brake operation.

2. Inspect cylinder bore for scores, scratches, or corrosion. Light scratches or slightly corroded spots may be polished out with crocus cloth. Never use emery cloth or sandpaper. If scratches or corrosion are too deep to be polished out, replace cylinder.

3. Check fit of new pistons in cylinder bore, using a feeler gauge as shown in figure 15. Clearance should be within 0.001" to 0.005" on "FR-3" type. Replace cylinder if clearance exceeds the maximum.

Assembly

Before assembling wheel cylinder, be sure each part has been cleaned in denatured alcohol.

CAUTION: DO NOT use kerosene or gasoline for cleaning wheel cylinder parts. Dip each internal part in hydraulic brake fluid before assembling.

1. Install pistons, piston cups, and spring, with cup lips toward inside of cylinder.
2. Assemble push rods and boots, then install on cylinder. Seat boots evenly in cylinder grooves. Align push rod slots as shown in figure 14.
3. Install bleeder valve in upper cylinder.

TWIN-ACTION (Fig. 17)

Disassembly

Pull boots off ends of cylinder and remove push rods from boots. Push pistons, cups, and spring out of cylinder. Remove cups from pistons. Remove bleeder valve from upper cylinder.

Inspection and Repair

1. Repair kits are available which contain the parts to be replaced when overhauling wheel cylinders. Refer to Parts Book for repair kit part numbers.

2. Inspect cylinder bore for scores, scratches, or corrosion. Light scratches or slightly corroded spots may be polished out with crocus cloth. Never use emery cloth or sandpaper. If scratches or corrosion are too deep to be polished out, replace cylinder.

3. Check fit of new pistons in cylinder bore, using a feeler gauge. Clearance should be within 0.002" to 0.004". Replace cylinder if clearance exceeds 0.004". Refer to figure 15.

Assembly

Before assembling wheel cylinder, be sure each part has been cleaned in denatured alcohol.

CAUTION: DO NOT use kerosene or gasoline for cleaning wheel cylinder parts. Dip each internal part in hydraulic brake fluid before assembling.

Figure 18—Using Special Tool (J-4705) for Installing Wheel Cylinder Cup (Twin-Action Only)

1. Install new cup on each piston so open end of cup will be toward flat end of piston. Use special tool (J-4705) to guide cup over piston (fig. 18). This applies to old style assemblies only.

2. Assemble boots on push rods, being sure bead on boot engages groove in push rod. Install boots and push rods on cylinders, engaging bead on outer edges of cylinder housing.

HYDRAULIC LINES

Hydraulic brake system units are interconnected by flexible hose and special metal tubing. Flexible hose is used between master cylinder (on cab) and frame connection, between frame and front wheel cylinders, and between frame and rear axle brake line. Whenever hydraulic lines have been disconnected for any reason, brake system must be bled, after connecting lines, as directed under "Bleeding Brakes."

FLEXIBLE HOSE

At front wheels on type "F" and type "FA," hose fitting is threaded into wheel cylinder connector, with a copper gasket used between shoulder on hose fitting and connector. On Duo-Servo a connector is not used. Fitting at other end of hose is inserted through hole in frame and secured by a toothed lock washer and nut or by a spring lock. Brake tube connector or tee fitting threads into end of hose fitting.

At rear axle, fitting at one end of hose is threaded into axle tee, with a copper gasket used to seal the connection. Other end of hose is inserted through frame bracket and secured by a toothed lock washer and nut or by a spring lock. Brake tube connector or tee fitting threads into end of hose fitting.

To remove hose, disconnect end at frame or frame bracket, then unscrew hose fitting from wheel cylinder or rear axle tee. When installing hose, always use a new copper gasket at wheel cylinder and rear axle tee. When frame end of hose is secured by a nut, always hold hose fitting with a wrench while tightening nut to prevent twisting hose.

METAL TUBING

When necessary to replace metal brake tubing, always use special metal tubing which is designed to withstand high pressure and to resist corrosion. Ordinary copper tubing is not satisfactory for use as hydraulic brake lines. When replacing tubing, always use the same size as that removed.

TUBE FLARING

In order to insure a proper flare, a special flaring tool must be used. When using tool, instructions furnished by the tool manufacturer should be followed. Always inspect newly formed flares for cracks or malformations which might cause leaks.

VACUUM POWER CYLINDERS

Vacuum power cylinders are used as standard equipment or are available as optional equipment on all vehicles with hydraulic brakes covered by this manual.

All the power cylinders used on these vehicles, both remote mounted and dash mounted (integral with master cylinder) are the type used in the "one to one" hydraulic system. That is, the hydraulic fluid volume output is equal to input.

The power cylinder is a combined vacuum-hydraulic power unit, utilizing vacuum and atmospheric pressure for its operation.

The vacuum source on gasoline engine models is the engine intake manifold. The vacuum source on Toro-Flow Diesel Models is the vacuum pump.

The combination of vacuum in front of the diaphragm and atmospheric pressure behind the diaphragm results in the power application of the brakes.

VACUUM POWER BRAKE SYSTEM TESTS

VACUUM TEST

With engine stopped, hand brake applied and transmission in neutral, apply brakes several times to destroy all vacuum in system.

Depress brake pedal, and while holding foot pressure on pedal, start engine. If vacuum system is operating, pedal will tend to fall away under foot pressure when engine starts, and less pressure will be required to hold pedal in applied position. If no action is felt, vacuum system is not functioning.

Inspect vacuum lines for leakage, and for restriction caused by bent or kinked tube or hose. If no fault is found in lines, trouble is in power cylinder control valve, necessitating overhaul of power cylinder.

HYDRAULIC TEST

Stop engine and again destroy all vacuum in system. Depress brake pedal and hold foot pressure on pedal. If brake pedal gradually falls away under foot pressure hydraulic system is leaking, either internally or externally.

Inspect all hydraulic line connections for leakage and make the necessary repairs. If no external leaks are evident, inspect master cylinder and wheel cylinders and replace parts as necessary. If the condition still exists, an internal leak in power cylinder is indicated, necessitating overhaul of power cylinder.

POWER CYLINDER REPLACEMENT

The installed location of vacuum power cylinders varies by model.

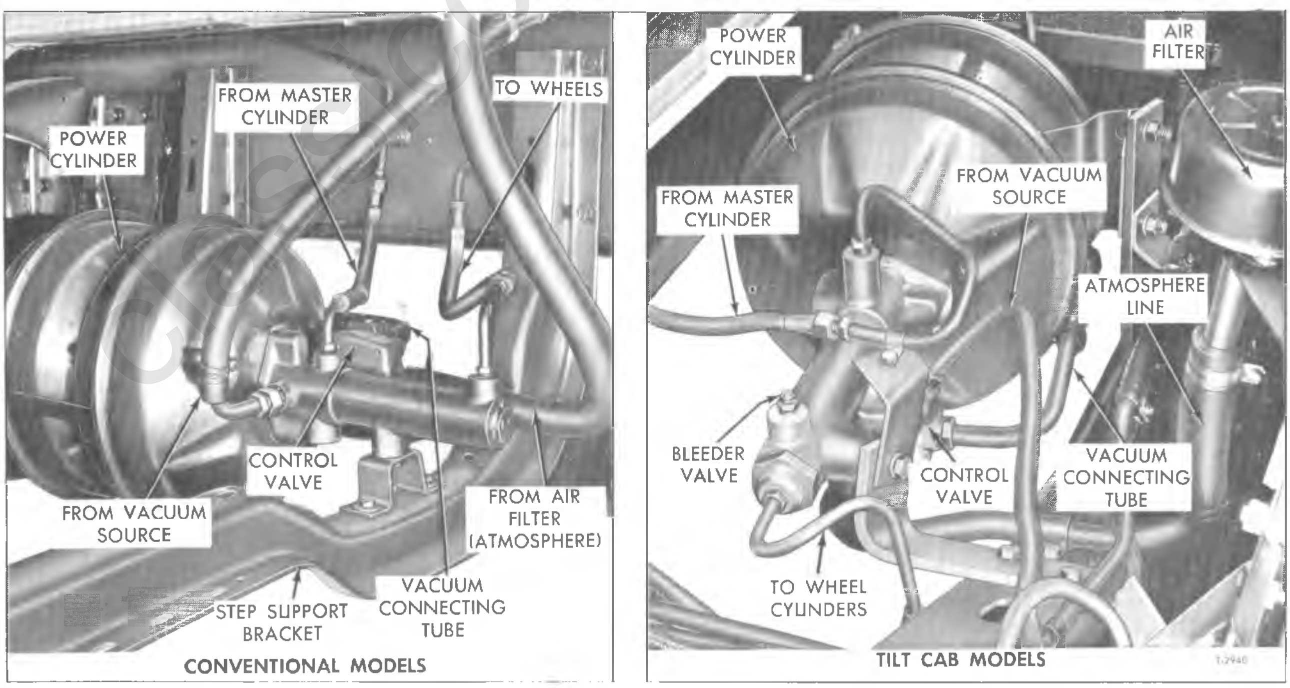


Figure 19—Power Cylinder Installed

Conventional - behind cab step, immediately below left-hand door. Vacuum reserve tank is located in this same area, when used. See figure 19.

Tilt Cab - between frame side rails in front of the radiator and behind the front bumper. See figure 19.

P4500 - on the outside of the left-hand frame side rail just ahead of the second frame crossmember.

"S" Models - on the outside of the left-hand frame side rail.

Some Models (both standard and optional) - use the combined master-booster cylinder type which is mounted on the dash panel in the engine compartment. See figure 20.

REMOVAL (REMOTE MOUNTED)

1. For easier accessibility, it is recommended that cab step be removed on conventional models and that cab be tilted forward on tilt cab models.
2. Clean away as much road dirt and grease as possible to prevent contamination of vacuum or hydraulic systems.
3. Have suitable container available to catch hydraulic brake fluid which will flow from system. DO NOT RE-USE THIS FLUID.
4. Disconnect all hydraulic, vacuum, and atmospheric lines and hoses from power cylinder.
5. Remove bolts and nuts which fasten cylinder to vehicle frame and support brackets. Remove power cylinder.

INSTALLATION (REMOTE MOUNTED)

1. Place power cylinder in position and fasten with nuts and bolts to vehicle frame and support brackets.
2. Connect all hydraulic, vacuum, and atmospheric lines and hoses to power cylinder.
3. Bleed master cylinder and vacuum power cylinder as directed under "Bleeding Brakes" in this manual. If ONLY the power cylinder has been removed, it should not be necessary to bleed the wheel cylinders IF the master cylinder and power cylinders are bled first AND lines to wheel cylinder have not been disturbed.
4. Start engine and test operation of brake system as directed. Refer to "Trouble-Shooting" chart in this manual if operation is not satisfactory.

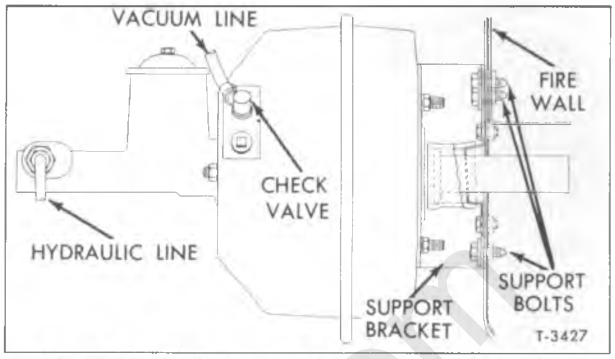


Figure 20—Dash-Mounted Power Cylinder Installed

REMOVAL (DASH MOUNTED)

1. Clean away as much road dirt and grease as possible to prevent contamination of vacuum or hydraulic systems.
2. Have suitable container available to catch hydraulic brake fluid which will flow from system. DO NOT RE-USE THIS FLUID.
3. Disconnect hydraulic line from master cylinder outlet.
4. Disconnect vacuum hose from vacuum check valve in booster chamber.
5. Inside cab, disconnect push rod from brake pedal.
6. Remove four bolts which fasten booster and support bracket to fire wall and remove booster and master cylinder assembly with support bracket from engine compartment.

INSTALLATION (DASH-MOUNTED)

1. Place power cylinder booster (with master cylinder and support bracket attached) in position on fire wall in engine compartment.
2. Install four bolts which fasten support bracket to fire wall in engine compartment.
3. Connect vacuum line to check valve in booster chamber.
4. Connect hydraulic line to master cylinder.
5. Inside cab, connect push rod to brake pedal.
6. Fill master cylinder with proper fluid. If ONLY power cylinder has been removed it should not be necessary to bleed wheel cylinders. Bleed master cylinder as directed under "Bleeding Brakes."
7. Adjust brake pedal as directed.
8. Start engine and check operation of brake system as directed. Refer to "Troubleshooting" chart in this manual if operation is not satisfactory.

VACUUM POWER CYLINDER AIR CLEANER

There are three different types of air cleaners used on vehicles with vacuum assisted hydraulic brakes.

SERVICING AIR CLEANERS

The air cleaner used on P4500, S5500, and S6500 Models is the metal cup type which uses a hog's hair type element. This cup is a friction fit on the air intake pipe and can be removed by pulling straight off. It can be cleaned and reused. Refer to LUBRICATION (SEC. 0) in this manual for service intervals and cleaning instructions. If

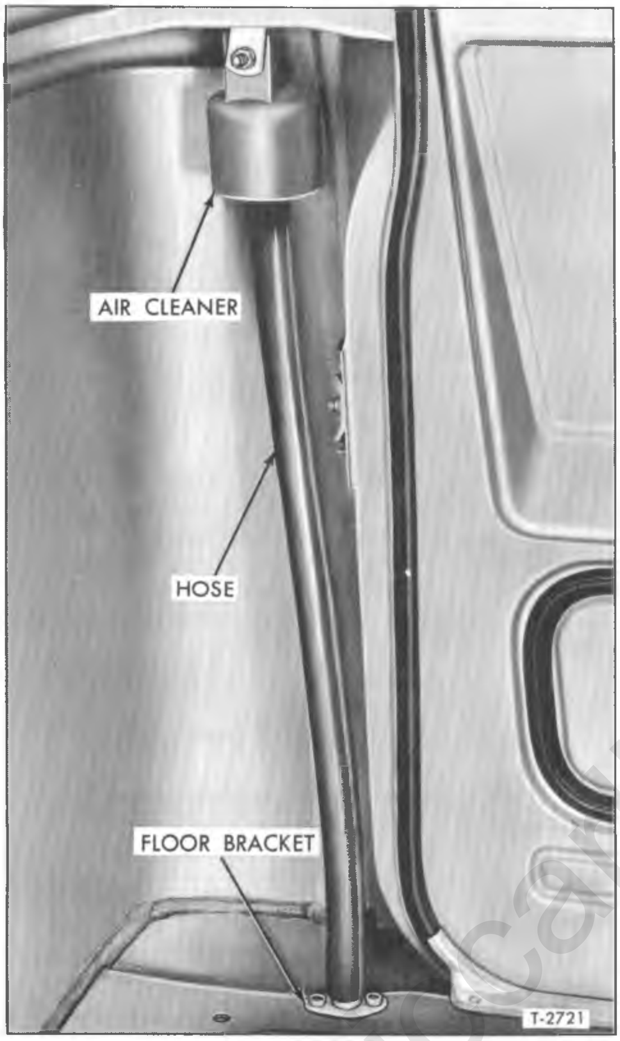


Figure 21—Power Cylinder Air Cleaner Installed (Conv.)

cleaner has become so laden with an accumulation of dirt, that satisfactory cleaning cannot be done, replace it with a new cleaner.

The air cleaner used on the conventional and all Tilt-Cab Models is a plastic encased, synthetic element type filter and cleaning is NOT recommended. When cleaner becomes so laden with dirt, that tapping it against some solid surface (such as a work bench) will not remove foreign matter, then a new cleaner should be installed.

The air cleaner used with dash mounted power cylinders is an integral part of the assembly. This air cleaner is a cylindrical piece of polyurethane foam which is fastened on the power cylinder push rod. This air cleaner can be removed from the assembly, cleaned, and replaced.

LOCATION OF AIR CLEANERS

The air cleaner on the P4500 Model vehicles is located on the dash panel in front of the driver's seat and is readily accessible.

The air cleaner on "S" Models is located on the fire wall under the dash on the driver's side.

The air cleaner on the conventional models is located in the left rear corner of the cab, directly behind the driver's seat. The air cleaner on the Tilt-Cab models is located in front of the radiator near the vacuum power cylinder and is accessible by tilting cab forward. To remove cleaner from conventional or tilt cab, unfasten nut and bolt holding cleaner to bracket and pull cleaner off air hose (see fig. 21).

The air cleaner on models equipped with dash mounted boosters is located in the booster hub on the push rod. To remove this air cleaner it is necessary to disconnect push rod from brake pedal and remove push rod from booster assembly. This requires approximately 225 lbs. pulling force and therefore some sort of leverage is needed. This can be done without removing booster from the vehicle. It must be done from inside the cab or body. The nylon push rod retainer will be broken upon removal, therefore a new retainer should be available before removing push rod. Remove filter from push rod, clean as directed in LUBRICATION (SEC. 0) in this manual, and replace on push rod. Reinstall push rod and connect to brake pedal. Refer to figure 22 for illustration of this type of filter.

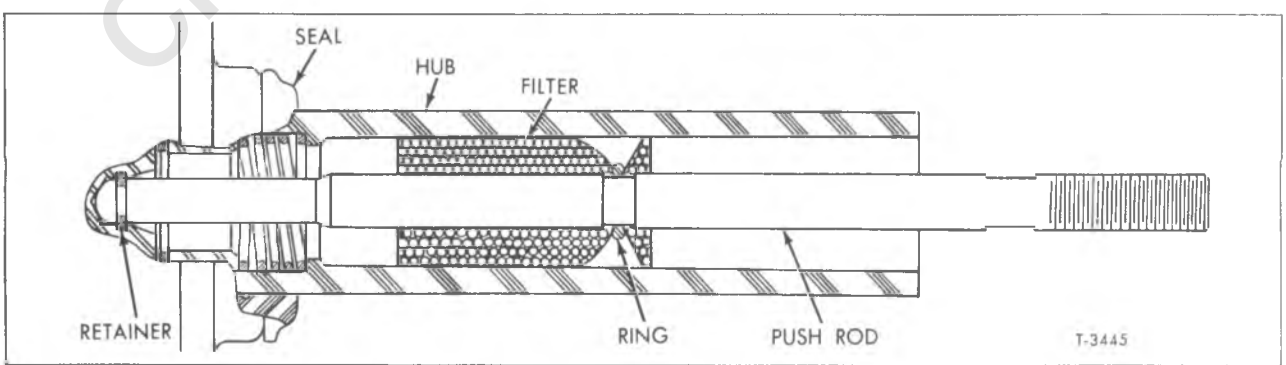


Figure 22—Power Cylinder Air Cleaner (Dash-Mounted Booster)

VACUUM CHECK VALVE

On all vehicles with vacuum power assisted hydraulic brakes a check valve is used somewhere in the vacuum line between the engine intake manifold (gasoline) or the vacuum pump (Diesel) and the vacuum power cylinder (see fig. 23).

Purpose of check valve is to seal vacuum in power cylinder (and in vacuum reserve tank, when used), assuring sufficient vacuum for at least one power brake application in case the engine stalls.

Check valve can be tested for leakage by disconnecting power cylinder vacuum line from valve fitting and connecting a vacuum gauge, using a length of hose between gauge and check valve. Start engine, run at idle for a few seconds, and note reading on gauge. Stop engine and observe rate of vacuum drop. If drop exceeds 1 inch in 15 seconds, leakage must be considered excessive, and check valve must be repaired or replaced.

There are three basically different type vacuum check valves used. One is repairable and two are not. The repairable type has a cast metal body and is used on Tilt Cab and P4500 Model trucks. The non-repairable types have a sealed plastic body and are used on all other models.

Check valves (plastic, non-repairable type) used with dash mounted boosters are integral with vacuum chamber assembly. Check valves used on "S" Models and some conventional Models are mounted separate from booster cylinders.

Removal and installation of valves on P4500, "S" Models, conventional, and Tilt Cab Models is the same. Disconnect all lines and hoses and remove bolts or screws which fasten valve to vehicle. Discard malfunctioning valves removed from conventional and "S" Models and replace with new valve. These are non-repairable. Valves removed from Tilt Cab and P4500 Models can be repaired.

To remove check valve from dash mounted power cylinders disconnect vacuum supply hose from check valve manifold assembly and pull manifold assembly out of grommet in vacuum booster chamber. Discard malfunctioning valves since this type cannot be repaired. When installing this type valve always use a new rubber grommet. Coat grommet lightly with grease prior to installation.

Valve on the P4500 Model is mounted on dash panel below master cylinder assembly and on opposite side of panel.

Valve on the tilt cab model is at the front of the engine and is mounted on a bracket attached to the frame crossmember on diesel models. On gasoline models, the valve is fastened to a bracket which is bolted on cab rear support, inside the channel on left-hand side (see fig. 23).

Valve on conventional and "S" Models is located in the engine compartment and is fastened to a bracket attached to the fire wall (see fig. 23).

As previously stated, check valve on models using dash mounted booster is part of vacuum chamber assembly.

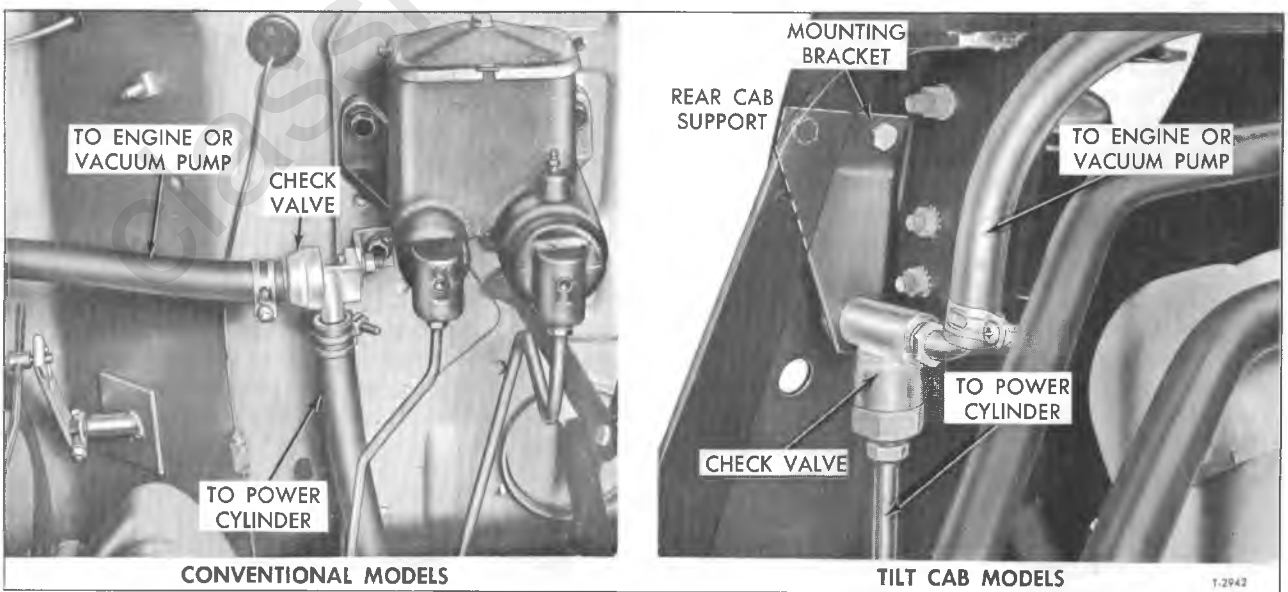


Figure 23—Vacuum Check Valves Installed

HYDRAULIC BRAKES

VACUUM RESERVE TANK

A vacuum reserve tank is used as standard equipment on "S" 5500 and 6500 Models and as optional equipment on all other models using vacuum assisted hydraulic brakes. This tank has a minimum capacity of 1,000 cubic inches and is installed in the vacuum line between the vacuum check valve and the power cylinder.

On conventional cab models, the tank is installed immediately below the left-hand door, behind the cab step.

On tilt cab models, the tank is installed behind the engine, in front of the rear axle, and between frame side rails.

On "S" models the tank is installed on the outside of the left-hand side rail just to the rear of the batteries.

To replace tank, disconnect lines and brackets connecting tank to vehicle.

VACUUM GAUGE

The vacuum gauges used on vehicles covered by this manual all operate on the same principle and are factory set and sealed units which are not adjustable or repairable. If a gauge fails to operate or operates improperly, it must be replaced. All vacuum gauges are located in the instrument panel.

A vacuum gauge is standard equipment on some models and optional on others.

If a vacuum gauge is suspected of operating improperly, it may be checked by comparing readings with a test gauge which is known to be accurate. Observe readings on vehicle gauge at engine idle speed and at various, specific engine rpm up to maximum. Install test gauge in convenient location in vacuum line and observe readings on test gauge at same, specific engine rpm. The manufacturer's specifications permit a variation of - 1-inch of mercury at 5 inches and - 2 inches of mercury at 20 inches. Any variation beyond these limits is an indication that the vehicle vacuum gauge should be replaced. Before condemning a gauge which does not register, or registers improperly, make certain that all vacuum lines in the system are free of dirt and/or kinks and that all connections are tight. System leakage can result in registration on gauge which is not normal. Also, on models with diesel engine, make certain that vacuum pump is properly installed and operating.

VACUUM PUMP

GENERAL DESCRIPTION

The vacuum pump is a rotary, sliding vane type pump in which the rotor is eccentrically located with respect to the housing. The pump is dependent upon oil as a means for lubrication of the bearings and also for providing a seal.

The vacuum pump is operated directly by a belt and pulley drive from the engine and operates at all times while the engine is running. The lubrication of the pump is accomplished by connection with the oil pressure system of the engine.

DISCHARGE OF OIL AND AIR

The oil plus the air which enters through the vacuum port, is discharged through the housing just below the point of minimum rotor to housing clearance. The oil and air leaves the pump through the opening on the pump base which is connected to the engine crankcase by a discharging hose.

DRIVE PULLEY

Maximum pump speed, for good life expectancy, is 4,000 rpm. If it is necessary to replace the drive pulley, be certain that correct pulley is used. If pulley diameter is too large the pump capacity will be decreased; if the pulley is too small pump speed will exceed maximum recommended and premature pump failure will result. Refer to Parts Catalogue for proper replacement pulley.

SYSTEM TESTS

The following tests or checks can be made on the vacuum pump while it is operating.

LUBRICATION

After the pump has been running for a few minutes, check the oil and air discharge line near the pump discharge port. If the line is not warming up, stop the pump and check for restrictions in the oil supply line.

VACUUM

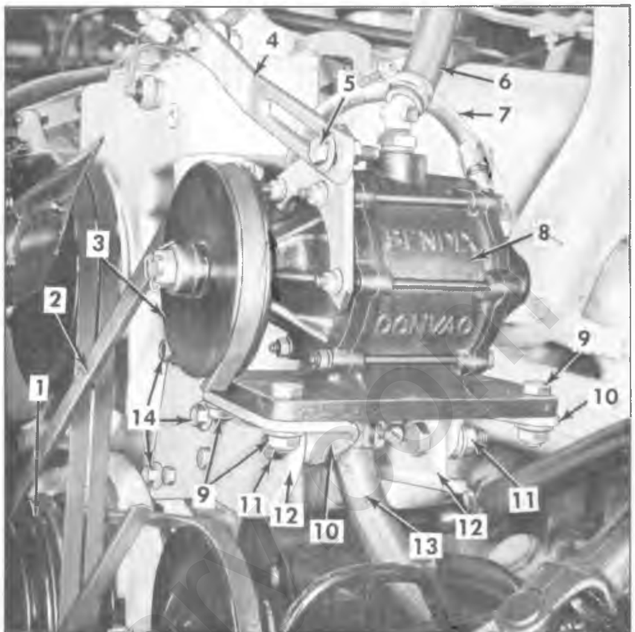
Let the pump and engine operate at their normal operating speed for several minutes so as to warm the oil circulating through the pump. Check the vacuum gauge. The pump should maintain at least 26 inches of mercury vacuum. Let the engine idle. The pump should maintain at least 20 inches of mercury vacuum with the engine idling. If the pump does not maintain the vacuum values given above, inspect the pump for belt slippage or lack of lubrication. Also inspect the vacuum lines and fittings for leaks. If vehicle is not equipped with vacuum gauge, temporarily connect one in intake line.

BINDING IN THE PUMP

After the pump has been running for several minutes, stop the pump, loosen the belt adjusting device and remove the belt. With the vacuum port of the pump open to atmosphere, rotate the pump in the direction indicated on the front end plate, and check for points at which the pump tends to be binding. If binding occurs, the pump should be removed from the installation, disassembled, and inspected for faulty parts.

OIL LEAKS

After the pump has been operating for several minutes, inspect between the housing and the end plates for signs of oil leakage. This check should be made both with the vacuum port open and closed to atmosphere.



1 Crankshaft Pulley
2 Drive Belt
3 Drive Pulley
4 Adjusting Arm
5 Adjusting Bolt
6 Air Intake
7 Oil Inlet Line
8 Pump Body
9 Body to Base Bolt
10 Mounting Base
11 Base to Bracket Bolt
12 Mounting Bracket
13 Air and Oil Discharge Hose
14 Bracket to Engine Bolt

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Figure 24—Vacuum Pump Installed (Typical)

VACUUM PUMP REPLACEMENT

(Refer to Figure 24)

REMOVAL

1. Loosen adjusting arm bolt and nut.
2. Loosen tension on drive belt and remove belt from drive pulley.
3. Disconnect air intake hose.
4. Disconnect oil inlet hose.
5. Disconnect oil and air discharge hose.
6. Remove four bolts which secure vacuum pump to support base.
7. Remove pump and discard gasket.

INSTALLATION

1. Position new gasket on pump base.
2. Position pump on base and secure with four bolts.
3. Connect oil and air discharge hose.
4. Connect oil inlet hose.
5. Connect air intake hose.
6. Install belt on drive pulley and pull to proper tension (120-130 pounds (new belt) or 80-90 pounds (used belt)) using a strand tension gauge placed at the center of the greatest belt span.
7. Tighten adjusting bolt and nut.

AIR POWER CYLINDERS

Air power assisted hydraulic brakes are standard equipment on models LA4000 and DLA-4000. These models use an air power cylinder to activate the standard type hydraulic brake. A regular air compressor is used as the air supply source.

NOTE: Full air brakes are also available on these same models, as optional equipment. Refer to "AIR BRAKES" (SEC. 5B) of this manual.

AIR POWER BRAKE SYSTEM OPERATION

An air-operated power unit is used on LA and DLA-4000 models in place of a vacuum-assisted power unit. With the air power unit, the hydraulic brake system remains unchanged.

The air power unit consists of three basic elements:

1. An air cylinder which includes a cylinder,

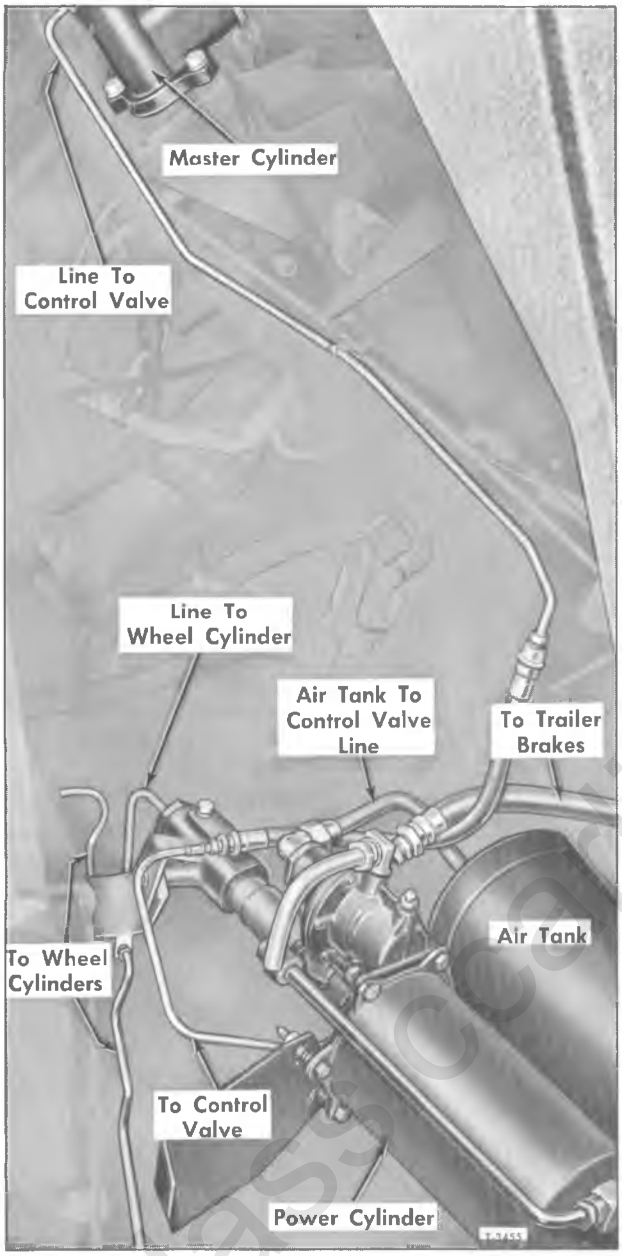


Figure 25—Typical Installation for Air-Assisted Hydraulic Brakes on Tilt Cab Models

a piston, and a push rod that connects the power piston to the hydraulic piston.

2. A hydraulic cylinder which includes a hydraulic piston with built-in check valve and a residual pressure check valve.

3. An air pressure control valve which controls the power output of the air pressure cylinder in accordance with the hydraulic pressure developed within the brake master cylinder.

The compressed air supply line is attached to the control valve. Air is exhausted from the exhaust port in the control valve through an exhaust tube directed downward to prevent the entrance of dirt or water into the power cylinder.

The hydraulic input line from the master cylinder is attached to the fluid inlet port located in the control valve. The outlet port, located in the end cap, is connected to the wheel cylinders of the vehicle brakes.

When the brake pedal is depressed, hydraulic fluid is transmitted from the master cylinder to the control valve. The force on the control valve piston moves the valve diaphragm assembly, which closes the atmospheric port and opens the compressed air port. The compressed air admitted to the air cylinder moves the air piston and push rod to displace fluid to the wheel cylinders and apply the brakes.

When pressure on brake pedal is removed, the force of the brake shoe return springs, the air piston return spring and the brake pedal return spring cause movement in the opposite direction of all components and the brakes are released. Opening of the atmospheric port in the control valve allows compressed air to vent to atmosphere.

LUBRICATION

Refer to LUBRICATION (SEC. 0) for type of lubricant, recommended periods of application, and method of applying.

AIR POWER BRAKE SYSTEM TESTS

OPERATING TEST

1. Build up air pressure in system to normal operating pressure. If vehicle is equipped with trailer brake controls, trailer line shut-off cocks must be closed while making tests.

2. Apply brakes, then listen for sound of exhausting air pressure as brakes are released. Rapid release of air pressure indicates that power unit is operating.

3. Depress brake pedal and hold foot pressure on pedal. If pedal gradually falls away, leakage in hydraulic system is indicated. Make further test as directed under "Hydraulic Pressure Test."

AIR PRESSURE TESTS

1. Remove lubrication pipe plug from rear end of cylinder shell and connect an air pressure test gauge at this point. Build up air pressure in system to maximum limit.

2. Coat all air line connections with soap suds to check for leakage. Leakage can sometimes be corrected by tightening the connection. If this fails to correct leakage, new fittings, metal tubing, or flexible hose must be used.

3. Hold a jar of water up under exhaust tube so that end of tube is immersed in water. Watch for bubbles to appear in water. The appearance of

bubbles indicates a leaking control valve poppet air inlet seal.

4. Make a brake application and hold foot pressure on pedal, and observe action of air pressure gauge at rear of power unit. Power unit should hold maximum pressure registered on gauge without perceptible loss until the brake pedal is released. Loss of air pressure indicates a leaking control valve poppet exhaust seal, or leakage past the power cylinder piston.

5. Depress and momentarily hold brake pedal to several positions between fully released and fully applied positions. Pressures registered on gauge at rear of power unit should vary according to degree brake pedal is depressed.

6. Make a full brake application, then observe action of air pressure gauge when brakes are released. If gauge does not return to zero or is slow in returning, a sticking control valve hydraulic piston is indicated.

HYDRAULIC PRESSURE TEST

1. Connect a hydraulic pressure gauge capable of registering at least 1200 pounds pressure to bleeder valve opening at one of the wheel cylinders. Do NOT remove air pressure gauge installed at rear of power cylinder.

2. Apply brakes until approximately 60 pounds is registered on air gauge at rear of power cylinder. Observe reading on hydraulic pressure gauge. Pressure should be 950 to 1100 pounds with 60 pounds air pressure applied to power cylinder. If air system pressure is higher or lower than 60 pounds, hydraulic pressure will be proportionately higher or lower. Hold brakes applied for at least one minute, observing action of pressure gauge.

3. A low pressure reading or a drop in hydraulic pressure indicates leakage in hydraulic lines, wheel cylinders, or power cylinder. Inspect hydraulic lines and wheel cylinders; repair or replace damaged parts.

4. After repairs have been made (if necessary), repeat test described in paragraph 2 above. If pressure is still too low or if pressure drops, an internal leak in the power unit slave cylinder is indicated. This necessitates removing and overhauling the power cylinder.

AIR POWER CYLINDER REPLACEMENT

REMOVAL (Refer to Fig. 25)

1. Tilt cab forward.
2. Clean away as much road dirt and grease as possible to prevent contamination.
3. Having suitable containers, catch hydraulic fluid which drains from system when hydraulic lines are disconnected. Disconnect lines. DO NOT RE-USE THIS FLUID.
4. Disconnect air lines.
5. Remove bolts which attach air power cylinder to mounting brackets and remove cylinder from vehicle.

INSTALLATION

1. Place air power cylinder in position and fasten to mounting brackets with bolts.
2. Connect air lines.
3. Connect hydraulic lines.
4. Check master cylinder and add fluid if necessary.
5. Bleed hydraulic system as necessary.
6. Start engine, build up air pressure and check operation of brakes.

AIR POWER CYLINDER AIR CLEANER

Air cleaners used with air assisted power hydraulic brakes are part of the air compressor system and are covered in LUBRICATION (SEC. 0) of this manual.

BRAKE SHOES AND LININGS

TYPE "F" FRONT BRAKE

(Refer to Figure 26)

Two identical brake shoes are arranged on backing plate so that their toes are diagonally opposite. Two single-end wheel cylinders are arranged so that each cylinder is mounted between the toe of one shoe and the heel of the other. The two wheel cylinder pistons apply an equal amount of force to the toe of each shoe. Each cylinder casting is shaped to provide an anchor block for the brake shoe heel.

Each shoe is adjusted by means of an eccentric cam which contacts a pin pressed into brake shoe web. Each cam is attached to the backing plate by a cam and shoe guide stud which protrudes through a slot in the shoe web and in conjunction with flat washers and C-washers, also serves as a shoe hold-down. Two return springs are connected between the shoes, one at each toe and heel.

With vehicle moving forward, both shoes are forward acting (primary shoes), self-energizing in forward direction of drum rotation. With vehicle in reverse, both shoes are reverse acting since neither is self-energized in the reverse direction of drum rotation.

HYDRAULIC BRAKES

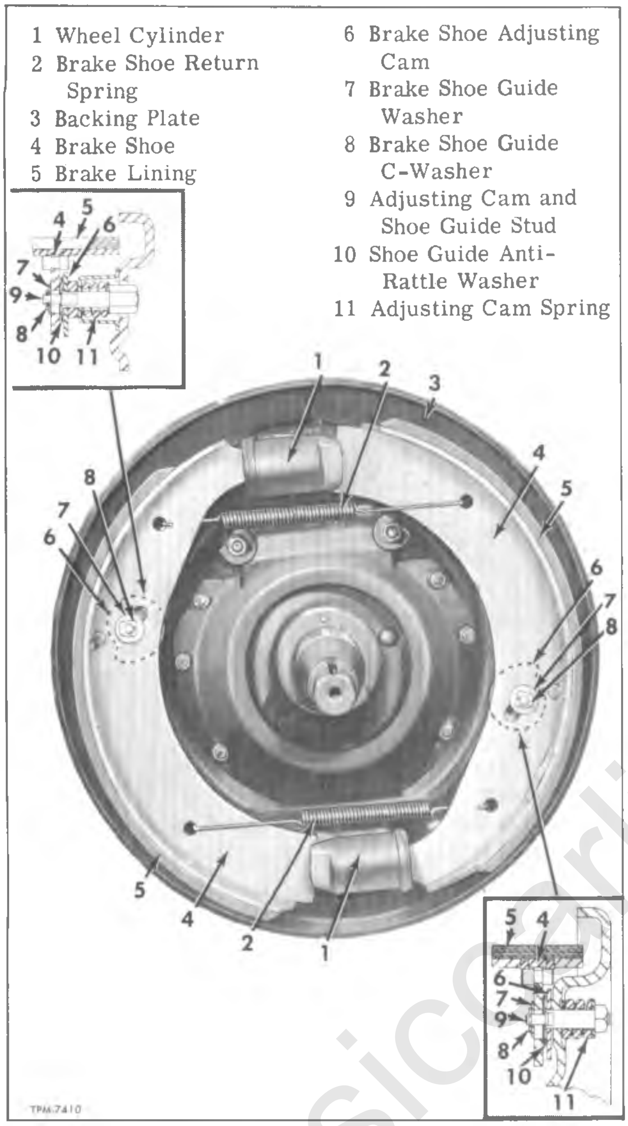


Figure 26—Type "F" Front Brake Assembly

BRAKE SHOE REMOVAL (Fig. 26)

1. Jack up axle and remove hub and brake drum assembly as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D) of this manual.
2. Remove both brake shoe return springs, using brake spring pliers.
3. Remove C-washers and flat washer from each adjusting cam and hold-down stud. Lift shoes off backing plate.

CLEANING AND INSPECTION

1. Clean all dirt out of brake drum. Inspect drum for roughness, scoring, or out-of-round. Replace or recondition brake drum as necessary. Refer to "Brake Drums" later in this section.
2. Inspect wheel bearings and oil seals as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D) of this manual.
3. Check backing plate attaching bolts to make sure they are tight. Clean all dirt off backing plate.
4. Inspect brake shoe return springs. If broken, cracked, or weakened, replace with new springs.
5. Check cam and shoe guide stud and friction spring on backing plate for corrosion or binding. Cam stud should turn easily with an 8-inch wrench, but should not be loose. If frozen, lubricate with kerosene or penetrating oil and work free.
6. Examine brake shoe linings for wear. Linings should be replaced if worn down close to rivet heads. Refer to "Brake Shoe Relining" in this section.

BRAKE SHOE INSTALLATION

1. Install anti-rattle spring washer on each cam and shoe guide stud, pronged side facing adjusting cam.
2. Place shoe assembly on backing plate with cam and shoe guide stud inserted through hole in shoe web; locate shoe toe in wheel cylinder piston shoe guide and position shoe heel in slot in anchor block.
3. Install flat washer and C-washer on cam and shoe guide stud. Crimp ends of C-washer together.
4. After installing both shoes, install brake shoe return spring. To install each spring, place spring end with short hook in toe of shoe, then using brake spring pliers, stretch spring and secure long hook end in heel of opposite shoe.
5. Install hub and brake drum assembly as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D) of this manual.
6. Adjust brake as previously directed under "Brake Adjustments."

DUO-SERVO FRONT BRAKE

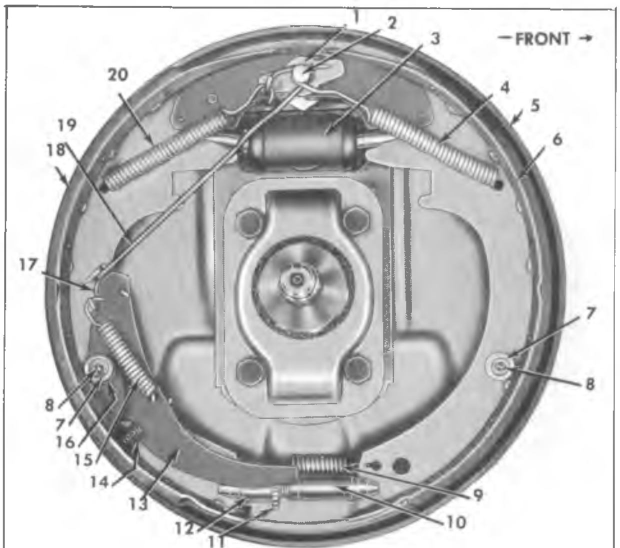
(Refer to Figure 27)

The Duo-Servo front brakes used on these vehicles are self-adjusting. Primary linings (shoe toward front of vehicle) are shorter than secondary linings (shoe toward rear of vehicle).

Self-adjusting actuating levers are attached to the secondary (rear) shoes on all models and operate when the brakes are applied while the vehicle is traveling in reverse.

BRAKE SHOE REMOVAL

1. Jack up vehicle and remove wheel.
2. If drum cannot be removed readily, back off adjustment as described under heading of "Brake Adjustments."
3. Block up brake pedal so it will not be depressed while drums are removed. Wheel cylinder boots are recessed in grooves on cylinders, eliminating need for clamps.



1 Shoe Guide Plate
2 Anchor Pin
3 Wheel Cylinder
4 Primary Shoe Return Spring
5 Brake Backing Plate
6 Primary Brake Shoe and Lining
7 Hold-Down Washer
8 Hold-Down Pin
9 Connecting Spring
10 Adjusting Nut
11 Adjusting Screw
12 Adjusting Socket
13 Actuating Lever
14 Lever Return Spring
15 Lever Override Spring
16 Hold-Down Spring
17 Adjusting Lever Pivot
18 Secondary Brake Shoe and Lining
19 Actuating Link
20 Secondary Shoe Return Spring

Figure 27—Duo-Servo Front Brake (Automatic Adjuster)

4. Unhook primary shoe return spring first from anchor pin and secondary shoe return spring from actuating link. Refer to figure 28.
5. Remove actuating lever return spring.
6. Disengage actuating link end first from anchor pin, then from adjusting lever pivot.
7. Remove hold-down pins and springs. Refer to figure 29.
8. Remove the actuating lever assembly.

NOTE: The actuating lever, adjusting lever pivot and lever override spring are removed as an assembly. It is not recommended that they be disassembled for service purpose unless one or more of the components is damaged. It is much easier to assemble and disassemble the brakes by leaving this assembly intact.

9. Remove brake shoe guide plate.
10. Pull top of shoes away from anchor pin and wheel cylinder push rods and remove shoes from backing plate.
11. Move top of brake shoes toward one another crossing them until adjusting screw assembly and spring fall off, permitting shoes to separate.

CLEANING AND INSPECTION

1. Clean all dirt out of brake drum. Inspect

Figure 28—Unhooking Brake Shoe Return Spring

drum for roughness, scoring, or out-of-round. Replace or recondition drum as necessary. Refer to "Brake Drums" in this section.

2. Carefully pull lower edge of wheel cylinder boots away from cylinders and note whether interior is excessively wet with brake fluid. Excessive fluid indicates leakage past piston cups, requiring overhaul of wheel cylinder.

NOTE: A slight amount of fluid is nearly always present and acts as lubricant for pistons.

3. Check all backing plate attaching bolts to make sure bolts are tight. Clean all rust and dirt

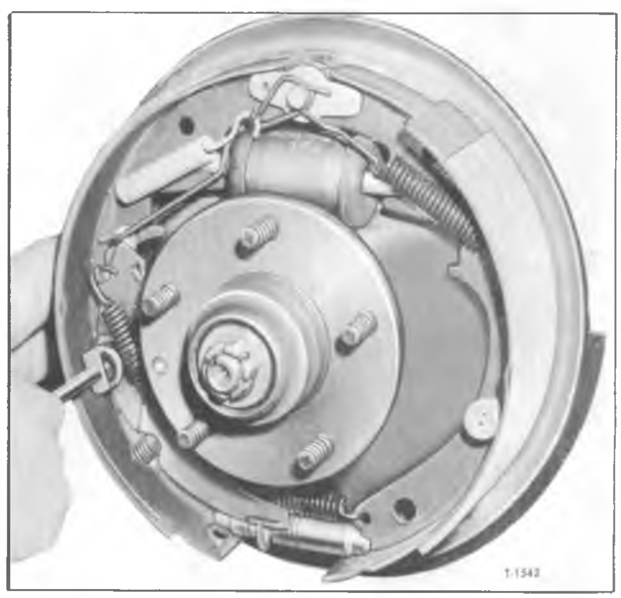


Figure 29—Removing Hold Down Springs and Pins

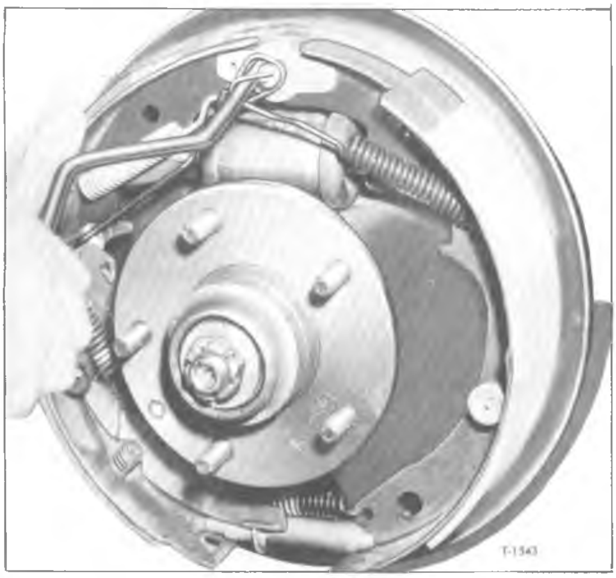


Figure 30—Installing Primary Shoe Return Spring

from brake shoe contact surfaces on backing plate using fine emery cloth.

4. Inspect brake shoe return springs. If broken, cracked, or weakened, replace springs.

5. If lining is worn to the extent that replacement is necessary, replace lining as directed under "Brake Shoe Relining."

BRAKE SHOE INSTALLATION

1. Inspect new brake shoe and lining assemblies and make sure there are no nicks or burrs on edges of shoes which contact backing plate.

NOTE: Keep hand clean while handling brake

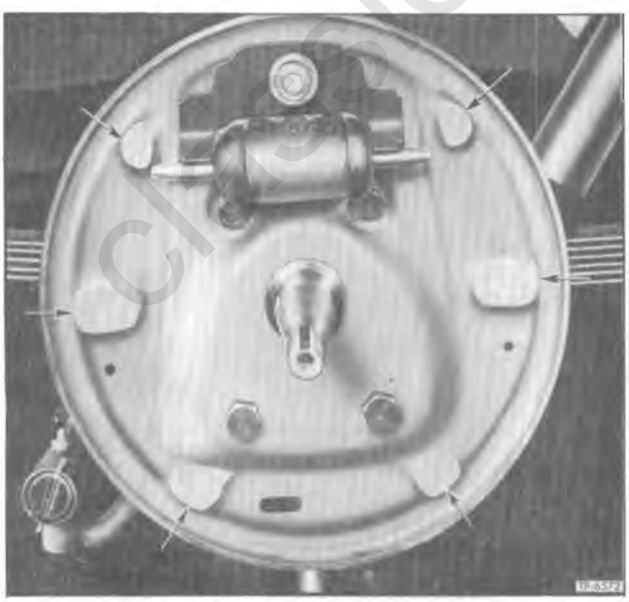


Figure 31—Brake Shoe Contact Surfaces and Backing Plate

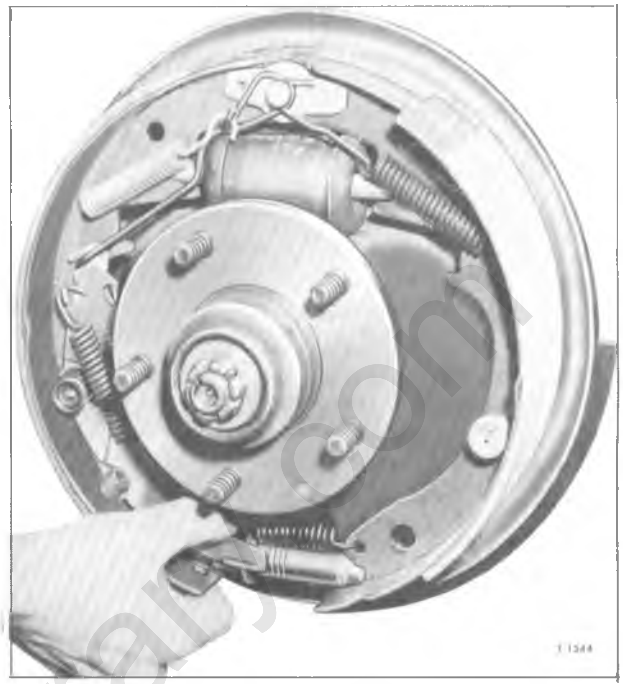


Figure 32—Checking Operation of Actuating Lever

shoes. Do not permit oil or grease to come in contact with linings.

2. Connect brake shoes together with connecting spring and place adjusting screw assembly in position.

> **CAUTION: Make sure the proper adjusting screw assembly is used (left- or right-hand). The adjusting screw assembly must be installed with the star wheel (adjusting screw) nearest to the secondary shoe. The connecting spring must be installed with the long end hooked on the secondary shoe, so that the spring coils will not interfere with movement of star wheel.**

3. Spread brake shoes apart at top and place against backing plate so that primary shoe (short lining) is toward front of vehicle. Secondary shoe (long lining) is toward rear of vehicle.

4. Insert brake shoe webs into slots in wheel cylinder rods.

5. Secure primary shoe to backing plate with hold-down pin, spring and washers.

6. Place the actuating lever assembly (including pivot and override spring) in position on secondary shoe and attach both shoe and actuating lever assembly to backing plate with hold-down pin, spring, and washers.

7. Install guide plate over anchor pin.

8. Install actuating link.

> CAUTION: DO NOT hook the actuating link over the anchor pin with a regular spring hook tool. This may damage the wheel cylinder boot. Place the actuating link over the anchor pin first and then fasten link to actuating lever assembly by holding this assembly in the full "DOWN" position.

9. Install primary shoe return spring in shoe and pull over anchor pin. Refer to figure 30.
IMPORTANT: Return spring for primary shoe is always installed AFTER actuating link, regardless of right or left, so that it will be in the OUTSIDE position on the anchor pin.
10. Install secondary shoe return spring in shoe and pull over actuating link.
11. Pry shoes away from backing plate and lubricate shoe contact surfaces with special lubricant (S-17). Be careful to keep lubricant off linings. Refer to figure 31.
12. Check operation of self-adjusting mechanism by hand operating. If there is any binding, locate trouble and correct. Refer to figure 32.
13. Expand adjustment as far as possible to still permit brake drums to clear linings. Install brake drums.
14. Install wheels, lower vehicle to ground and finish adjustment by applying brakes as many times as required, while vehicle is traveling in reverse, until proper pedal height is attained.

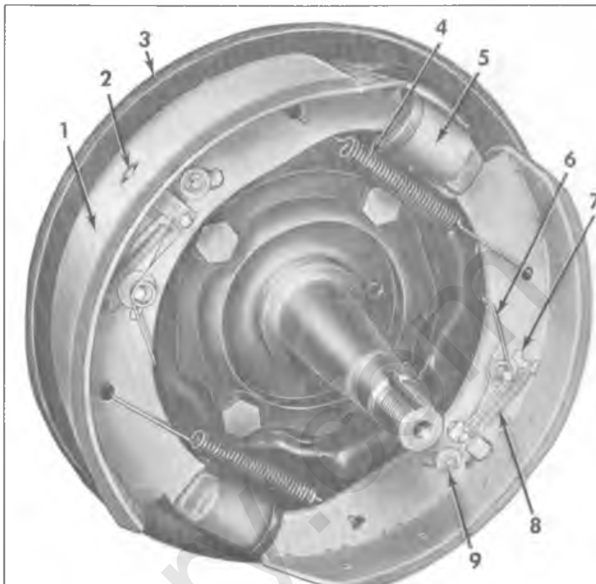
TYPE "FA" FRONT BRAKE

(Refer to Figure 33)

The type "FA" front brake is the same as the type "F" brake except for method of adjustment. The type "FA" brake has an automatic adjusting mechanism.

An automatic adjuster lever is pivot-pinned on the inner side of shoe web and rests against the manual adjuster cam. A drum contact plug is mounted on the pivot pin on the outside of the shoe web and is centered in the shoe table and lining. A spring loaded, serrated wedge slides on the pivot pin and under the drum contact plug between the plug pin and a wedge guide which is also pinned on the shoe web. A torsion spring is hooked over the contact plug pin, the lever pivot pin, and the edge of the shoe web. This torsion spring holds the assembly stable and keeps the plug surface flush with the lining surface.

As the lining wears, the brake drum depresses the contact plug and it moves the adjuster lever away from the shoe table. In this gradual action, the spring loaded wedge moves to keep the gap between the plug pin and the wedge guide closed.



1 Brake Shoe and Lining Assembly
2 Contact Plug
3 Backing Plate
4 Brake Shoe Return Spring
5 Wheel Cylinder
6 Torsion Spring
7 Wedge
8 Wedge Spring
9 Flat Washer, Spring Washer, and "C" Washer

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Figure 33—Type "FA" Front Brake Installed

This holds the lever (and the brake shoe) in the adjusted position.

At the point of maximum lining wear, the plug pin bottoms on the inner side of its oversized hole in the shoe web, stopping automatic adjustment.

BRAKE SHOE REMOVAL
(Refer to Figure 34)

1. Jack up axle and remove hub and brake drum assembly as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D) in this manual.
2. Remove both brake shoe return springs, using brake spring pliers.
3. Remove C-washer, flat washer, anti-rattle washer and another flat washer from each pin and remove shoes from backing plate.

DISASSEMBLE AUTOMATIC ADJUSTER
(Refer to Figure 34)

1. Unhook wedge spring from wedge and remove spring.
2. Unhook torsion spring from shoe web, work spring coil off lever pivot pin and slide end of torsion spring off contact plug pin.
3. Pull adjuster lever from opposite side of shoe web.
4. Pull contact plug through shoe table.
5. Lift off retainer washer, wedge, and guide.

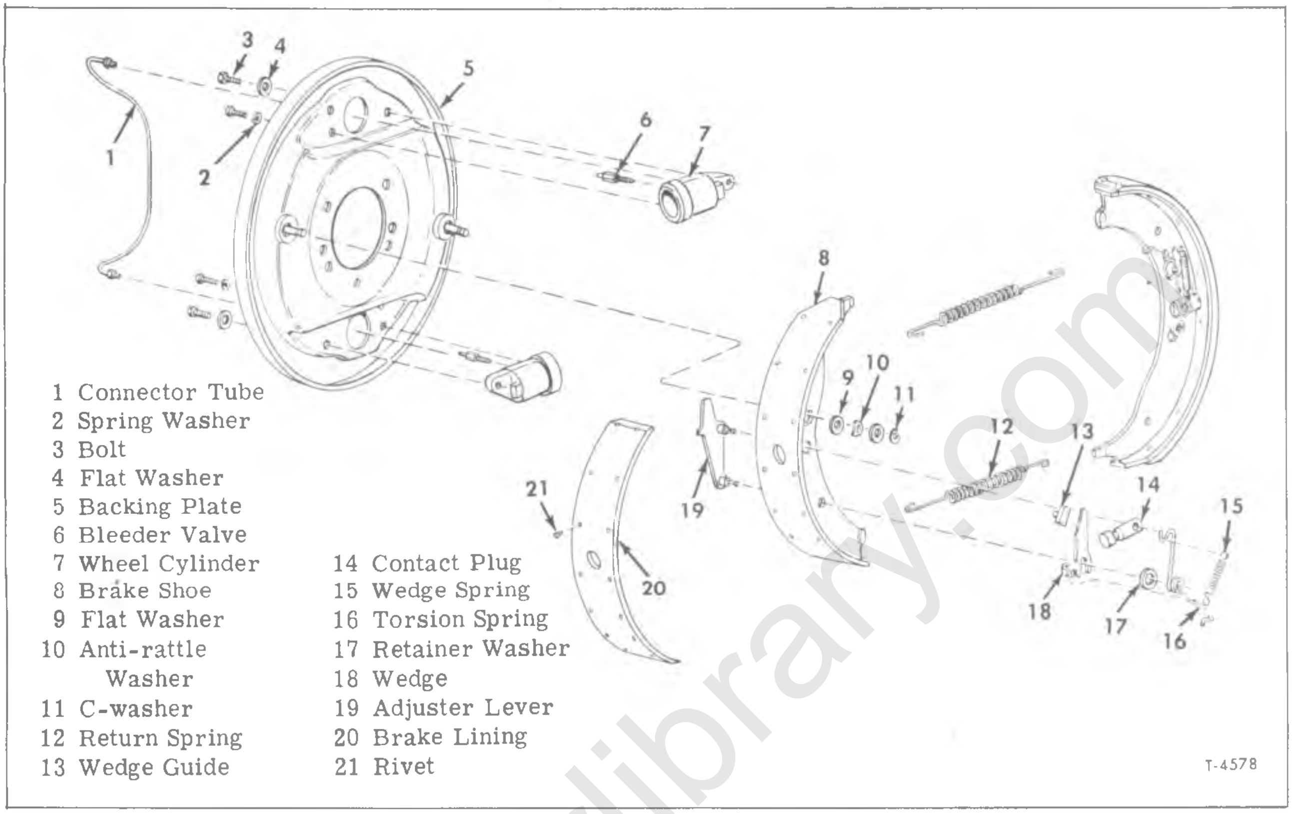


Figure 34—Type "FA" Front Brake Components

CLEANING AND INSPECTION

1. Clean all dirt out of brake drum. Inspect drum for roughness, scoring, or out-of-round. Replace or recondition brake drum as necessary. Refer to "Brake Drums" in this section.

2. Inspect bearings and oil seals as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D) in this manual.

3. Check backing plate attaching bolts to make sure they are tight. Clean all dirt off backing plate.

4. Inspect brake shoe return springs. If broken, cracked, or weakened, replace with new springs.

5. Check cam and shoe guide stud and friction spring on backing plate for corrosion or binding. Cam stud should turn easily with an 8-inch wrench, but should not be loose. If frozen, lubricate with kerosene or penetrating oil and work free.

6. Check all automatic adjuster components and replace any which are worn or damaged. Replace springs if broken, cracked, or weakened.

7. Check wheel cylinders as instructed under "Wheel Cylinder Repair" in this section. Replace with new cylinders if necessary.

8. Examine brake shoe linings for wear. Linings should be replaced if worn down close to rivet heads. Refer to "Brake Shoe Relining" in this section.

ASSEMBLE AUTOMATIC ADJUSTER
(Refer to Figure 34)

1. Place the wedge guide on the shoe web (side away from mounting plate) with the serrations facing away from the shoe table.

2. Lay the wedge on the shoe with the serrations against matching serrations on the wedge guide. Align wedge slot with pivot pin hole.

3. Insert contact plug from drum side of shoe, guiding its shank through the hole in the shoe table and over the wedge guide and wedge.

4. Place adjuster lever on opposite side of shoe web and insert pins through holes in shoe web and mating hole in contact plug shank.

5. Place retainer washer over wedge pivot pin.

6. Slide "U" hook of torsion spring on pin over contact plug shank. Attach end of wedge spring to this hook, then install coil of torsion spring over the pivot pin and pull the spring hook over the edge of shoe web.

7. Connect wedge spring on raised hook on the wedge "fork."

8. Fully retract the wedge against the lever pivot pin, pressing on the contact plug to permit this movement. If the plug now protrudes more than 0.005" above lining, clamp shoe in vise jaws bear against the adjuster lever and dress down the

plug. This can be done with a file, taking care to not create a "flat spot" on the lining. (An alternate method is to block adjuster lever in extended position and grind plug with lining.) If fully extended plug is more than 0.005" BELOW lining surface, replace with new plug.

BRAKE SHOE INSTALLATION

1. Place brake shoes over hold-down pins on backing place and install a flat washer, an anti-rattle washer, a flat washer, and a C-washer (in that order) on each pin. Note that each shoe has a "heel" and "toe." The "heel" fits in the anchor slot of wheel cylinder, the "toe" fits in the piston end of wheel cylinder.

2. After installing both shoes on backing plate, install return springs. To install each spring, place spring end with short hook in "toe" of shoe, then using brake spring pliers, stretch spring and secure long hook end in "heel" of opposite shoe.

3. Center each shoe, before installing drum, by sliding shoe up or down in its anchor slot until the leading and trailing edges of the lining are equidistant from the inner curl of the brake mounting plate.

4. Back off manual adjustment cam.

5. Install hub and brake drum as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D) in this manual.

INITIAL MANUAL LINING ADJUSTMENT

1. Rotate adjuster cam stud in the direction of forward drum rotation. Tighten adjustment until the lining drags on the brake drum.

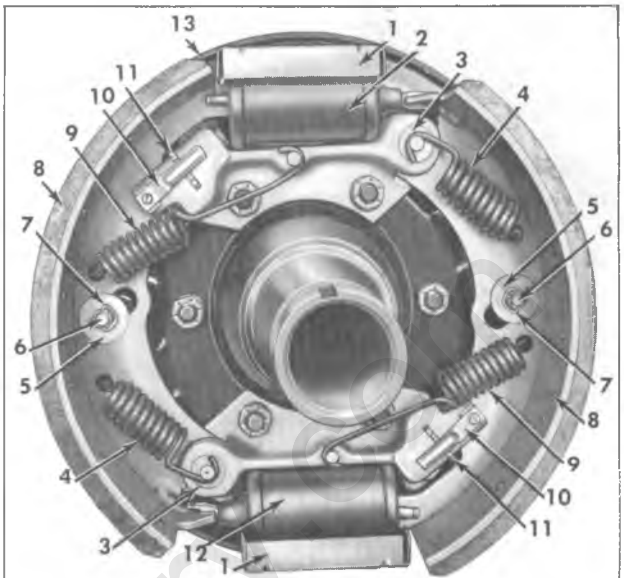
2. Back off the adjuster cam stud while rotating drum forward, until drag is just relieved.

3. Adjust the second manual shoe adjuster cam stud in the same manner, forward to tighten and reverse to relieve drag, and permit automatic adjustment to take over.

TYPE "FR-3" REAR BRAKE

(Refer to Figure 35)

Each brake is equipped with two double-end wheel cylinders which apply hydraulic pressure to both the toe and the heel of two identical, self-centering shoes. The shoes anchor at either toe or heel, depending upon the direction of drum rotation. Brake anchor supports and backing plate are bolted to the axle housing flange. The supports have removable slotted anchor pins at the shoe heels, and adjusting screws at the shoe toes. Adjusting screws act as anchors in the reverse direction of rotation. Each adjusting screw is threaded into or out of its support by means of an adjusting wheel. Adjusting wheels are accessible through adjusting slots in the backing plate.



1 Wheel Cylinder Heat Shield
2 Upper Wheel Cylinder
3 Anchor Pin
4 Return Spring (Short)
5 Guide Washer
6 Guide Bolt
7 Guide Bolt Nut Lock Wire
8 Brake Shoe and Lining Assembly
9 Return Spring (Long)
10 Adjusting Wheel Lock Spring
11 Adjusting Wheel
12 Lower Wheel Cylinder
13 Backing Plate

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Figure 35—Type "FR-3" Rear Brake Assembly

BRAKE SHOE REMOVAL

1. Jack up axle and remove hub and brake drum assembly as directed in "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual.

2. Install wheel cylinder clamps to hold piston in cylinders.

3. Using special brake spring tool (J-8049), remove brake shoe return springs.

4. Remove lock wires, nuts, and washers from brake shoe guide bolts, then remove brake shoe assemblies.

5. Remove screws attaching adjusting wheel lock springs to anchor supports. Thread each adjusting screw from the shoe side of its anchor support by turning adjusting wheels, then lift adjusting wheels out of slots in anchor supports.

CLEANING AND INSPECTION

1. Clean all dirt out of brake drum. Inspect drum for roughness, scoring, or out-of-round. Recondition or replace drum as necessary. Refer to "Brake Drums" in this section.

2. Clean all dirt out of anchor pin holes and adjusting screw openings in anchor supports.

3. Inspect wheel bearings and oil seals as directed in "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual.

4. Inspect brake shoe return springs. If broken,

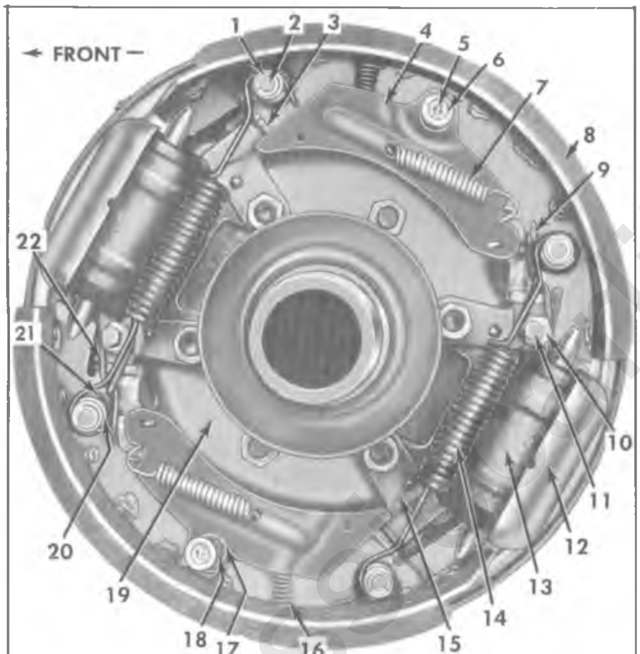
cracked, or weakened, replace with new springs.

5. Inspect threads on adjusting screws and in adjusting wheels for wear or damage. Replace as necessary.

6. Examine brake shoe linings for wear. Linings should be replaced if worn down close to rivet heads. Refer to "Brake Shoe Relining" in this section.

BRAKE SHOE INSTALLATION

1. Install adjusting screws and wheels in anchor supports dry; use no lubricant. Insert each adjusting wheel in slot in anchor support, insert threaded end of adjusting screw in anchor support, then turn adjusting wheel to thread adjusting screw into anchor support. Insert anchor pins into holes in anchor supports, with slots in pins facing slots in supports.



1 Hold-Down Pin Spring Lock
2 Hold-Down Pin
3 Adjusting Screw
4 Adjusting Lever
5 Adjusting Lever Pin
6 Hold-Down Spring Cup
7 Lever Override Spring
8 Brake Shoe and Lining
9 Adjusting Lever Pivot
10 Adjusting Lever Cam
11 Adjusting Lever Bolt
12 Wheel Cylinder Shield
13 Wheel Cylinder
14 Brake Shoe Return Spring
15 Brake Shoe Anchor
16 Lever Return Spring
17 Adjusting Lever Pin Sleeve
18 Hold-Down Spring
19 Brake Backing Plate
20 Hold-Down Pin Retainer
21 Hold-Down Pin Spring
22 Adjusting Lever Link

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Figure 36—Twin-Action Rear Brake Assembly (Automatic Adjuster)

2. Install brake shoes with cut-away end of shoe web next to adjusting screw and with ends of shoes engaging slots in wheel cylinder push rods and anchor pins. Install flat washer and nut on each brake shoe guide bolt. Tighten nuts finger-tight, then back off nuts only far enough to allow movement of shoes without binding.

3. Install brake shoe return springs, hooking one end of each spring in brake shoe web, then hook other end over anchor pins with special brake spring tool (J-8049).

4. Remove wheel cylinder clamps.

5. Install hub and brake drum assembly as directed in "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual.

6. Adjust brakes as directed under "Brake Adjustments."

TWIN-ACTION TYPE REAR BRAKE

(Refer to Figure 36)

BRAKE SHOE REMOVAL

1. Raise the vehicle and place on jack stands.

2. Remove brake drums.

NOTE: If brake drums are worn severely, it may be necessary to retract the adjusting screws.

3. Using Tool (J-22348), remove the brake shoe pull-back springs (fig. 37).

NOTE: Since wheel cylinder piston stops are incorporated in the anchor brackets, it is not necessary to install wheel cylinder clamps when the brake shoes are removed. However, the brake pedal must not be depressed while the drums are removed.

4. Loosen the adjusting lever cam cap screw and while holding the star wheel end of the adjusting lever past the star wheel, remove the cap screw and cam.

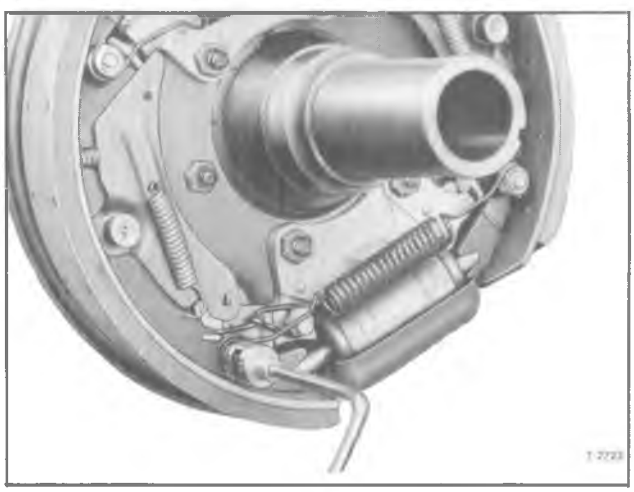


Figure 37—Removing Pull Back Springs

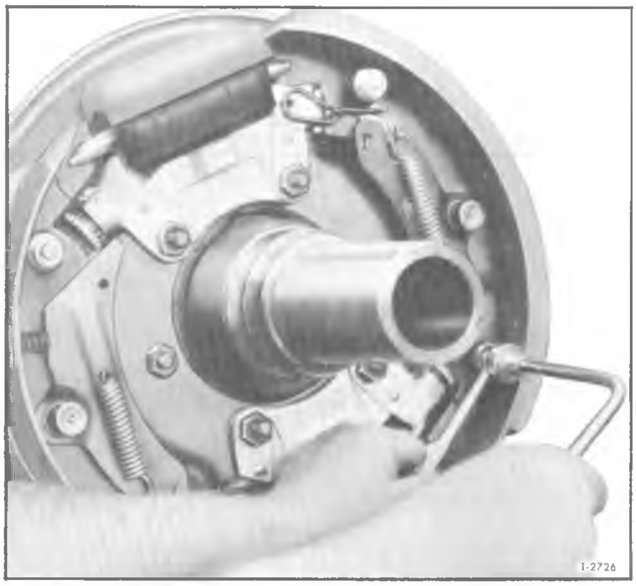


Figure 38—Removing Brake Shoe Hold Down Pins

5. Remove the brake shoe hold-down springs and pins by compressing the spring with Tool (J-22348) and, at the same time, pushing the pin back through the flange plate toward the tool. Then, keeping the spring compressed, remove the lock (C-washer) from the pin with a magnet (fig. 38).

6. Lift off the brake shoe and self-adjuster lever as an assembly.

7. The self-adjuster lever can now be removed from the brake shoe by removing the hold-down spring and pin. Remove lever return spring also.

NOTE: The adjusting lever, override spring and pivot are an assembly. It is not recommended that they be disassembled for service purposes unless they are broken. It is much easier to assemble and disassemble the brake leaving them intact.

8. Thread the adjusting screw out of the brake shoe anchor and remove and discard the friction spring (not shown in figure 36).

9. Clean all dirt out of brake drum. Inspect drums for roughness, scoring or out-of-round. Replace or recondition drums as necessary.

10. Carefully pull lower edges of wheel cylinder boots away from cylinders. If brake fluid flows out, overhaul of the wheel cylinders is necessary.

NOTE: A slight amount of fluid is nearly always present and acts as a lubricant for the piston.

11. Inspect flange plate for oil leakage past axle shaft oil seals. Install seals if necessary.

12. Check all flange plate attaching bolts to make sure they are tight. Clean all dirt and rust from shoe contact faces on flange plate using emery cloth.

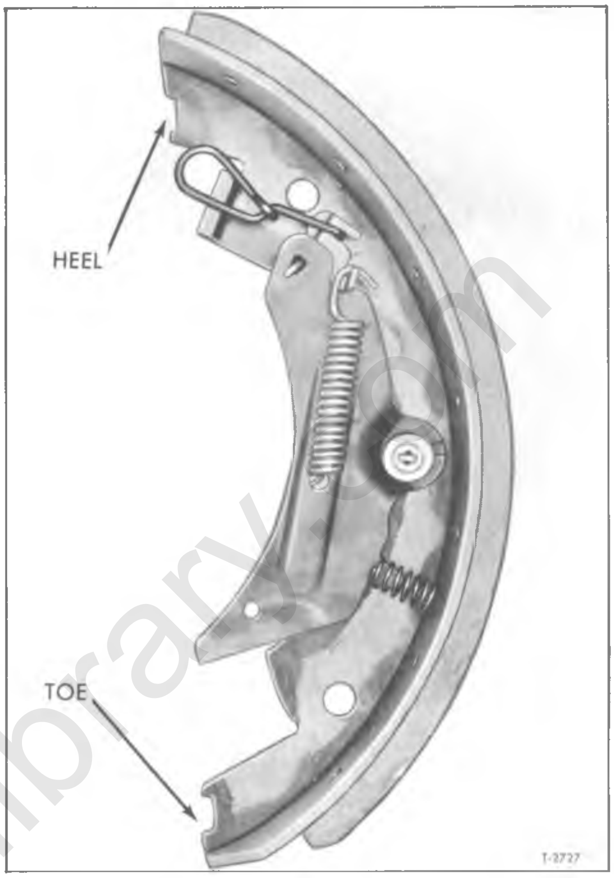


Figure 39—Brake Shoe and Automatic Adjuster Assembly

13. Thoroughly clean adjusting screws and threads in the anchors.

BRAKE SHOE INSTALLATION

1. Put a light film of lubricant on shoe bearing surfaces of brake flange plate and on threads of adjusting screw.

2. Thread adjusting screw completely into anchor without friction spring to be sure threads are clean and screw turns easily. Then remove screws, position a new friction spring on screw and reinstall in anchor.

3. Assemble self-adjuster assembly and lever return spring to brake shoe and position adjusting lever link on adjusting lever pivot.

4. Position hold-down pins in flange plate.

5. Install brake shoe and self-adjuster assemblies onto hold-down pins. Insert ends of shoes in wheel cylinder push rods and legs of friction springs.

NOTE: Make sure the toe of the shoe is against the adjusting screw (fig. 39).

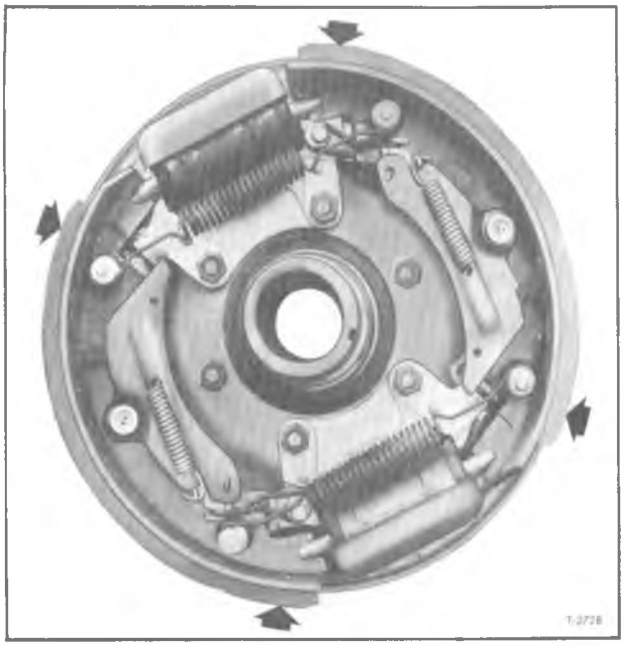


Figure 40—Measuring Points for Brake Shoe Centering

6. Install cup, spring, and retainer on end of hold-down pin. Using Tool (J-22348) compress the spring. With spring compressed, push the hold-down pin back through the flange plate toward the tool and install the lock on the pin.

7. Using Tool (J-22348) install brake shoe return springs.

8. Holding the star wheel end of the adjusting lever as far as possible past the star wheel, position the adjusting lever cam into the adjusting lever link and assemble with cap screw.

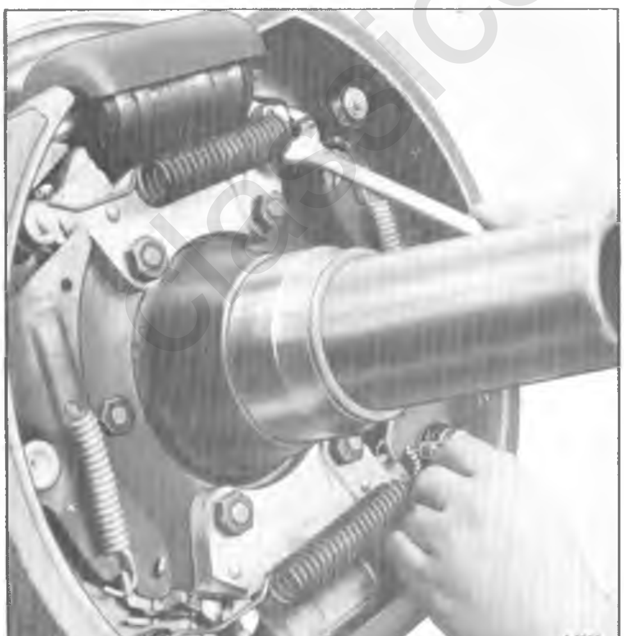


Figure 41—Positioning Adjusting Lever

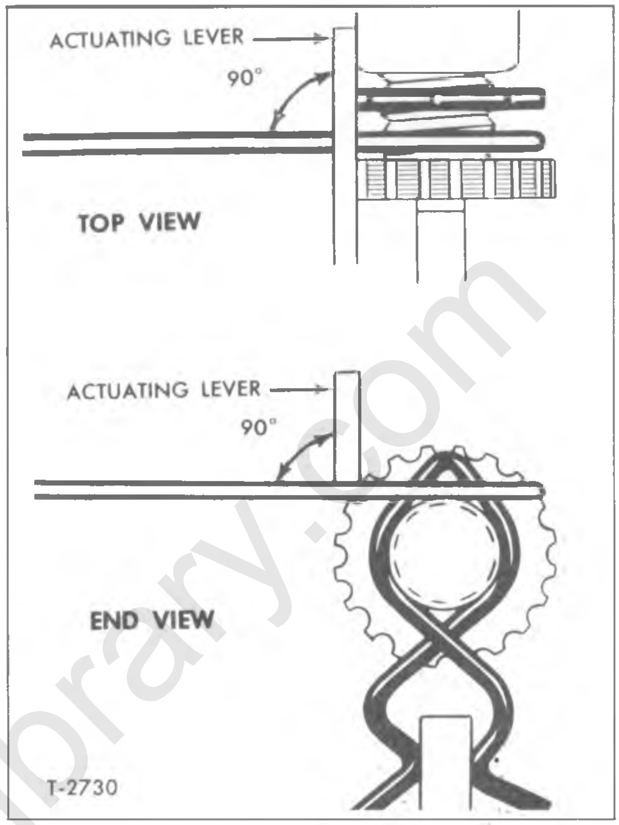


Figure 42—Wire Gauge Position for Correct Adjusting Lever Adjustment

9. Check the brake shoes for being centered by measuring the distance from the lining surface to the edge of the flange plate at the points shown in figure 40. To center the shoes, tap the upper or lower end of the shoes with a plastic mallet until the distances at each end become equal.

10. Locate the adjusting lever 0.020" to 0.039" above the outside diameter of the adjusting screw thread by loosening the cap screw and turning the adjusting cam.

NOTE: To determine 0.020" to 0.039", turn the adjusting screw 2 full turns out from the fully retracted position. Hold a 0.060" wire gauge at a 90° angle with the star wheel edge of the adjusting lever. Turn the adjusting cam until the adjusting lever and threaded area on the adjusting screw just touch the wire (figs. 41 and 42).

11. Secure the adjusting cam cap screw and retract the adjusting screw.

12. Install brake drums and wheels.

13. Adjust the brakes by making several forward and reverse stops until a satisfactory brake pedal height results.

TYPE "FR-3A" REAR BRAKE

The type "FR-3A" rear brake is the same as the type "FR-3" brake except for method of adjustment. The type "FR-3A" brake has an automatic adjusting mechanism. Refer to figure 43.

Brake shoe adjustment takes place when the brakes are applied with firm pedal effort while vehicle is backing up. When brakes are applied (backing up) the heel of the brake shoe moves away from the forward-acting anchor, an action which places a cocking motion in the link-crank system. An adjustable eccentric on the shoe web provides a hinge for a short link which carries this motion to an adjuster crank fastened on the forward acting anchor pin by a C-washer. From the adjuster crank, motion transfers through the long link to the star wheel crank assembly mounted on the opposite anchor bracket so that a pawl on the crank meshes with the star wheel. The motion pivots (cocks) the crank back, the force overcoming the adjuster spring connected between a finger of the crank and the brake shoe return spring pin. If the lining clearance permits sufficient movement, the crank pawl picks up the next tooth on the star wheel.

Unintentional back-off of the star wheel is prevented by a friction ring located on the star wheel screw. This ring applies sufficient drag to prevent an automatic back-off, but not enough to prevent manual adjustments at the star wheel.

Automatic adjustment is completed upon brake release, as the adjuster spring returns the star wheel crank, advancing the star wheel one tooth. Completion may be delayed by anchoring pressure against the star wheel screw; in this case, it is completed as the anchor pressure is relieved by the next forward brake application.

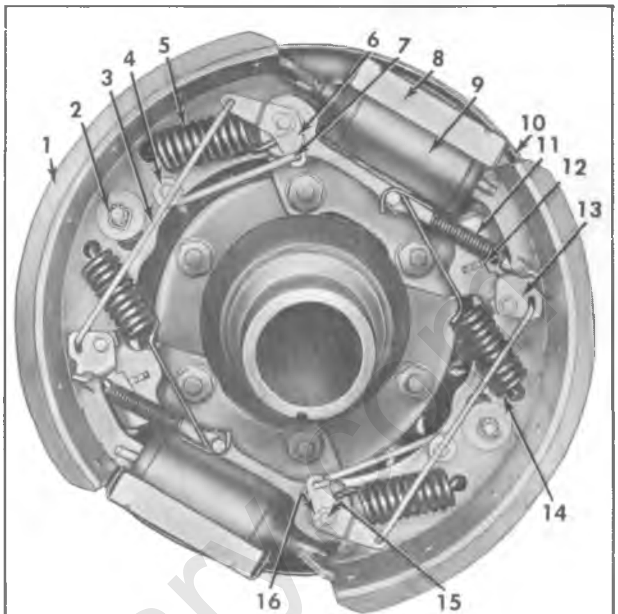
BRAKE SHOE REMOVAL
(Refer to Figure 44)

1. Jack up axle and remove hub and brake drum assembly as directed in "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual. It may be necessary to back off adjuster star wheels slightly to free grooved drums.

> CAUTION: DO NOT back off adjustment so much that star wheel is jammed against the friction ring on the star wheel screw; this may damage the friction ring.

2. Unhook the two automatic adjuster springs.

3. Remove the two long crank links by pivoting back the star wheel cranks until their slots align with the link "U" hooks. Lift out links, then slide their "S" hooks from the adjuster cranks.



1 Brake Shoe and Lining Assembly
2 Hold-down Bolt, Washer, Nut, and Lock Wire
3 Crank Link (Long)
4 Eccentric and Screw
5 Shoe Return Spring (Short)
6 Adjuster Crank
7 Crank Link (Short)
8 Wheel Cylinder Cover
9 Wheel Cylinder
10 Backing Plate
11 Adjuster Spring
12 Starwheel
13 Starwheel Crank
14 Shoe Return Spring (Long)
15 Anchor Pin
16 "C" Washer

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Figure 43—Type "FR-3A" Rear Brake Installed

4. Remove short crank links by rotating adjuster cranks until link "U" hooks clear the eccentrics on shoe webs, then remove the smaller "U" hooks from the adjuster cranks.

5. Spread adjuster crank C-washers and lift off cranks.

6. Remove bolt which fastens star wheel crank to anchor support and remove crank.

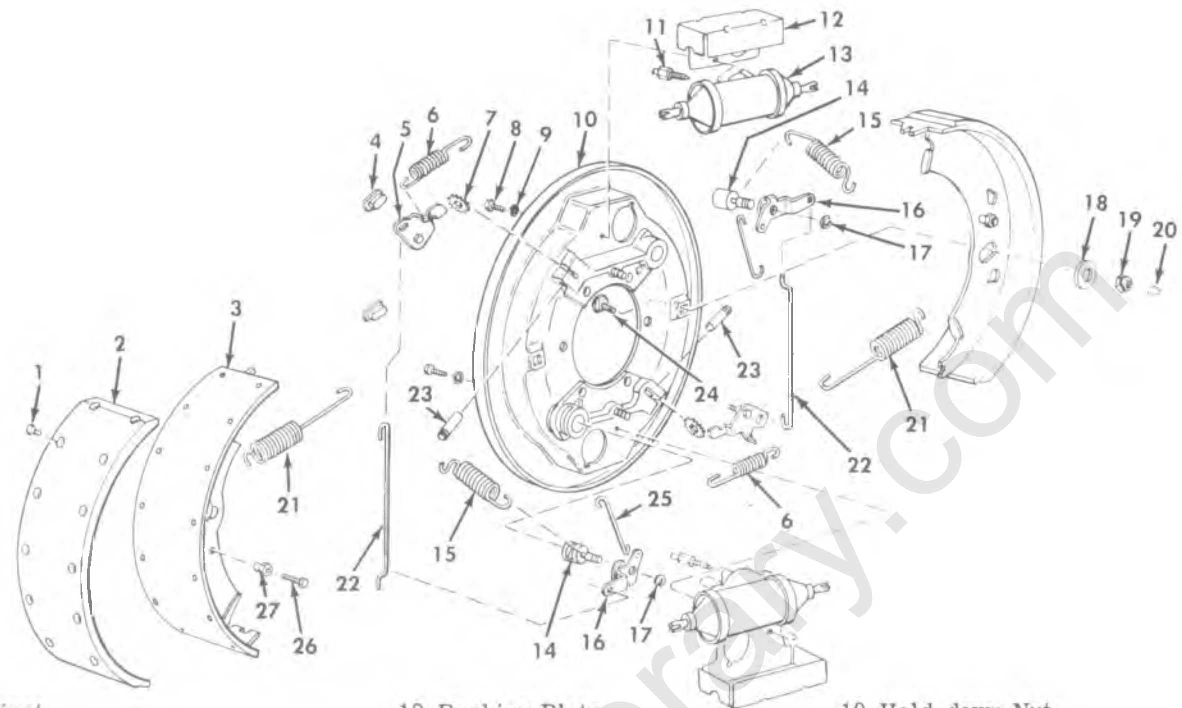
7. Remove adjuster eccentric screw and eccentric from brake shoe.

8. Remove two long shoe return springs and two short return springs by sliding looped ends off pins.

9. Remove lock wires, hold-down nuts, and washers from hold-down bolts and lift off brake shoes.

10. Thread each star wheel screw out of anchor support from shoe side of support. Lift star wheels from support slots.

NOTE: DO NOT attempt to remove a friction ring from a star wheel screw; if necessary, replace with a new screw and friction ring assembly.



1 Rivet	10 Backing Plate	19 Hold-down Nut
2 Brake Lining	11 Bleeder Valve	20 Lock Wire
3 Brake Shoe	12 Wheel Cylinder Cover	21 Shoe Return Spring (Long)
4 Hole Cover	13 Wheel Cylinder	22 Crank Link (Long)
5 Starwheel Crank	14 Anchor Pin	23 Starwheel Screw
6 Adjuster Spring	15 Shoe Return Spring (Short)	24 Hold-down Bolt
7 Starwheel	16 Adjuster Crank	25 Crank Link (Short)
8 Bolt	17 C-washer	26 Eccentric Screw
9 Spring Washer	18 Hold-down Washer	27 Eccentric

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Figure 44—Type "FR-3A" Rear Brake Components

CLEANING AND INSPECTION

1. Clean all dirt out of brake drum. Inspect drum for roughness, scoring, or out-of-round. Recondition or replace drum as necessary. Refer to "Brake Drums" in this section.

2. Clean all dirt out of anchor pin holes and adjusting screw openings in anchor supports.

3. Inspect wheel bearings and oil seals as directed in "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual.

4. Inspect brake shoe return springs. If they are broken, cracked, or weakened, replace with new springs.

5. Inspect threads on adjusting screws and in adjusting wheels for wear or damage. Replace as necessary.

6. Check all automatic adjuster components and replace any which are worn or damaged. Replace springs if broken, cracked, or weakened.

7. Check wheel cylinders as instructed under "Wheel Cylinder Repair" in this section. Replace with new cylinders if necessary.

8. Examine brake shoe linings for wear. Linings should be replaced if worn down close to rivet heads. Refer to "Brake Shoe Relining" in this section.

BRAKE SHOE INSTALLATION

1. Insert star wheels in anchor support slots and thread in star wheel screw from the shoe side. friction ring end toward the shoe. For new linings, back off screws, taking care to not jam star wheels.

NOTE: DO NOT LUBRICATE STAR WHEEL SCREWS.

2. Position one brake shoe with its "toe" (cut-away portion of web) located in the adjuster slot and the "heel" in the anchor pin slot of anchor supports.

3. Install brake shoe hold-down bolt, hold-down washer and hold-down nut. Tighten nut finger-tight and then back off nut one turn and insert nut lock wire.

4. Install the other brake shoe in same manner as described in paragraphs 2 and 3.

5. Install long brake shoe return springs in shoe web, longest shank at adjuster, and hook springs over pins.

6. Install short brake shoe return springs in shoe web and hook springs over pins at anchor end.

7. Place adjuster eccentrics on shoe webs and fasten with self-tapping screw. Tighten screw only finger-tight to permit final adjustment later.

8. Place adjuster cranks on anchor pins, their long arms toward shoes, bushing toward backing plate, so that they rotate freely while resting against return spring hooks.

9. Install and crimp adjuster crank C-washer.

10. Place star wheel crank on anchor support and fasten with crank bolt.

11. At each adjuster crank assemble the short link small hook into the short arm of the crank from the lower side and hook the other end of link around the eccentric on the shoe web.

12. Assemble long link "S" hook to long arm of adjuster crank from upper side, rotate star wheel crank so that slot lines up with link "U" hook. Insert "U" hook and rotate star wheel crank back to approximate adjusting position.

13. Install adjuster spring with short hook on star wheel crank finger so that its long shank hook assembles on the outer groove of the pin from the wheel cylinder side.

INITIAL MANUAL LINING ADJUSTMENT

1. If shoes have been relined, back off star wheel adjustments.

2. Center each shoe; insert a pry tool against backing plate curl and shoe (do not mar lining). Slide shoe up or down in anchor slots until leading and trailing edges of the lining are equidistant from the inner curl of the brake backing plate.

3. On each shoe web, rotate hex eccentric, as required, until linkage aligns star wheel crankpawl with center line of star wheel screw. A SMALL DRILL POINT RECESS ON THE ANCHOR SUPPORT IS THE ALIGNING MARK.

4. When aligned, lock eccentrics by tightening self-tapping screws to 19 foot-pounds torque.

5. Install hub and drum as described in "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual.

6. Remove both adjustment slot covers from back of backing plate.

7. Insert adjusting tool and turn each star wheel until lining drags on drum while drum is rotated. To tighten adjustment, move tool handle toward axle while using inner side of adjuster slot as fulcrum for the tool, rotating the star wheel teeth away from the axle.

8. Back off star wheels while rotating drum forward, until drag is just relieved. Provide additional running clearance by backing off 8 to 10 more notches and replace slot covers. Automatic adjustment now takes over.

BRAKE SHOE RELINING

Brake linings on these models are riveted to the brake shoes and may be replaced. These linings may be purchased in replacement sets of four linings and sufficient rivets of correct specifications. Refer to Parts Book for lining replacement kits. When replacing linings, make sure that shoes are clean and that linings are installed in a manner that will prevent gaps between lining and shoe.

Conventional lining replacement equipment should be used. Make sure lining fits firmly against shoe, and that rivets are properly upset.

BRAKE DRUMS

Brake drum installations are illustrated in "FRONT HUBS AND BEARINGS" (SEC. 3D) and "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual. Procedures for replacing brake drums are also included in the above mentioned sections.

Whenever brake drums are removed for servicing brakes, inspect drums. If found to be scored, rough, or out-of-round, drums should be machined.

Machining or grinding of brake drums increases the inside diameter of the drum and changes the lining to drum fit. When machining drums, it is recommended that the following maximum oversizes not be exceeded:

(a) Drums with standard diameter up to 14" can be machined up to 0.060" oversize.
(b) Drums with standard diameter over 14" can be machined up to 0.080" oversize.

When it is found that machining to these maximum limits does not provide a suitable braking surface, discard the worn drum and replace with a new standard drum.

DO NOT EXCEED THESE LIMITS. THIS IS A SAFETY PRECAUTION.

TROUBLESHOOTING CHART

LOW PEDAL OR PEDAL GOES TO TOE BOARD

PROBABLE CAUSE	REMEDY
1. Excessive clearance between linings and drum.	1. Adjust brakes.
2. Automatic adjusters not working.	2. Make forward and reverse stops; if pedal stays low, repair faulty adjusters.
3. Weak brake hose.	3. Replace with new hose.
4. Leaking conduits.	4. Repair or replace faulty parts.
5. Leaking wheel cylinder.	5. Clean and rebuild.
6. Leaking master cylinder.	6. Clean and rebuild.
7. Leaking master cylinder check valve.	7. Install new check valve.
8. Air in system.	8. Bleed system.
9. Plugged master cylinder filler cap.	9. Clean filler cap vent holes; bleed system.
10. Improper brake fluid.	10. Flush system and refill with recommended brake fluid.
11. Low fluid level.	11. Fill reservoir with brake fluid; bleed system.

SPRINGY, SPONGY PEDAL

PROBABLE CAUSE	REMEDY
1. Air trapped in hydraulic system.	1. Remove air by bleeding.
2. Improper brake fluid.	2. Flush, refill and bleed system. Use recommended brake fluid.
3. Improper lining thickness or location.	3. Install specified lining or replace shoe and lining.
4. Drums worn too thin.	4. Replace drums.
5. Master cylinder filler vent clogged.	5. Clean vent or replace cap; bleed brakes.
6. Weak hose.	6. Install new hose.

EXCESSIVE PEDAL PRESSURE REQUIRED TO STOP

PROBABLE CAUSE	REMEDY
1. Brake adjustment not correct.	1. Adjust the brakes.
2. Incorrect lining.	2. Install specified linings.
3. Grease or fluid soaked lining.	3. Repair grease seal or wheel cylinder. Install new linings.
4. Lining not in full contact.	4. Grind lining to proper radius.
5. Improper fluid.	5. Flush out system; fill with recommended fluid; bleed.
6. Frozen master or wheel cylinder pistons.	6. Recondition or replace all cylinders.
7. Brake pedal binding on shaft.	7. Lubricate.
8. Linings installed on wrong shoes.	8. Install primary and secondary linings correctly.
9. Glazed linings.	9. Sand surface of linings.
10. Bellmouthed, barrel-shaped or scored drums.	10. Replace or resurface drums in R.H. and L.H. pairs.

LIGHT PEDAL PRESSURE -- BRAKES TOO SEVERE

PROBABLE CAUSE	REMEDY
1. Brake adjustment not correct.	1. Adjust the brakes.
2. Loose backing plate on front axle.	2. Tighten plates.
3. A small amount of grease or fluid on linings.	3. Replace the linings.
4. Charred linings.	4. Sand the surfaces of the linings.
5. Incorrect lining.	5. Install factory specified linings.
6. Wheel bearings loose.	6. Adjust wheel bearings.
7. Lining loose on shoe.	7. Replace lining or shoe and lining.
8. Excessive dust and dirt in drums.	8. Clean and sand drums and linings.
9. Bad drum.	9. Turn drums in pairs or replace.

BRAKE PEDAL TRAVEL DECREASING

PROBABLE CAUSE	REMEDY
1. Master cylinder compensating port plugged.	1. Open, use air or .015 wire. Remove any burr in bore.
2. Swollen cup in master cylinder.	2. Replace rubber parts flush system. Refill with recommended fluid.
3. Master cylinder piston not returning.	3. Rebuild master cylinder.
4. Weak shoe retracting springs.	4. Replace springs.
5. Wheel cylinder pistons sticking.	5. Clean cylinder bores and parts. Replace bad parts.

PULSATING BRAKE PEDAL

PROBABLE CAUSE	REMEDY
1. Drums out-of-round.	1. Refinish drums.
2. Loose brake drums on hub.	2. Tighten.
3. Worn or loose wheel bearings.	3. Replace or adjust.
4. Bent rear axle.	4. Replace axle.

BRAKES FADE

PROBABLE CAUSE	REMEDY
1. Incorrect lining.	1. Replace lining with lining recommended.
2. Poor lining contact.	2. Grind lining to proper radius; adjust.
3. Thin drum.	3. Replace drum.
4. Dragging brakes.	4. Adjust.

ALL BRAKES DRAG WHEN ADJUSTMENT IS KNOWN TO BE CORRECT

PROBABLE CAUSE	REMEDY
1. Pedal does not return to stop.	1. Lubricate the pedal.

HYDRAULIC BRAKES

ALL BRAKES DRAG WHEN ADJUSTMENT IS KNOWN TO BE CORRECT (Cont'd.)

PROBABLE CAUSE	REMEDY
2. Improper fluid.	2. Replace rubber parts and fill with recommended brake fluid.
3. Compensating or bypass port of master cylinder closed.	3. Open by air or .015 wire. Remove any burr in bore.
4. Use of inferior rubber parts.	4. Install proper parts.

ONE WHEEL DRAGS

PROBABLE CAUSE	REMEDY
1. Weak or broken shoe retracting springs.	1. Replace the defective brake shoe springs and lubricate the brake shoe ledges.
2. Brake shoe to drum clearance too small.	2. Adjust.
3. Loose wheel bearings.	3. Adjust wheel bearings.
4. Wheel cylinder piston cups swollen and distorted or the piston stuck.	4. Rebuild cylinders.
5. Pistons sticking in wheel cylinder.	5. Clean or replace pistons; clean cylinder bore.
6. Drum out-of-round.	6. Grind or turn both front or rear drums.
7. Obstruction in line.	7. Clean out or replace.
8. Distorted shoe.	8. Replace.
9. Defective lining.	9. Replace with specified lining.

PULLS TO ONE SIDE

PROBABLE CAUSE	REMEDY
1. Grease or fluid soaked lining.	1. Replace with new linings.
2. Loose wheel bearings, loose packing plate on rear axle or front axle or loose spring bolts.	2. Adjust the wheel bearing, tighten the backing plate on the rear and front axles and tighten spring bolts.
3. Linings not of specified kind or primary and secondary shoes reversed.	3. Install specified linings. Install shoes correctly.
4. Tires not properly inflated or unequal wear of tread. Different tread non-skid design.	4. Inflate the tires to recommended pressures. Rearrange the tires so that a pair of non-skid tread surfaces of similar design and equal wear will be installed on the front wheels, and another pair with like tread will be installed on the rear wheels.
5. Linings charred.	5. Sand the surfaces of the lining.
6. Water, mud, etc., in brakes.	6. Remove any foreign material from all of the brake parts and inside of the drums. Lubricate the shoe ledges and rear brake cable ramps.
7. Wheel cylinder sticking.	7. Repair or replace wheel cylinder.
8. Weak or broken retracting springs.	8. Check springs -- replace bent, open-coiled or cracked springs.
9. Out-of-round drums.	9. Resurface or replace drums in left- and right-hand pairs (both front and both rear).

PULLS TO ONE SIDE (Cont'd.)	
PROBABLE CAUSE	REMEDY
10. Brake dragging.	10. Check for loose lining. Adjust.
11. Weak chassis springs, loose U-bolts, loose steering gear, etc.	11. Replace spring, tighten U-bolts, adjust steering gear, etc.
12. Loose steering.	12. Repair and adjust.
13. Unequal camber.	13. Adjust to "Specifications."
14. Clogged or crimped hydraulic line.	14. Repair or replace line.
15. Wheel cylinder size different on opposite sides.	15. Replace with correct cylinders.
16. Loose king pin.	16. Replace king pins or bushings.
17. Bad drum.	17. Refinish drums in pairs.

ONE WHEEL LOCKS	
PROBABLE CAUSE	REMEDY
1. Gummy lining.	1. Reline.
2. Tire tread slick.	2. Match up tire treads from side to side.

WET WEATHER: BRAKES GRAB OR WON'T HOLD	
PROBABLE CAUSE	REMEDY
1. Linings too sensitive to water.	1. Reline.
2. Dirty brakes.	2. Clean out.
3. Bent backing plate -- opening.	3. Straighten.
4. Scored drums.	4. Grind or turn in pairs.

BRAKES SQUEAK	
PROBABLE CAUSE	REMEDY
1. Backing plate bent or shoes twisted.	1. Straighten or replace damaged parts.
2. Metallic particles or dust imbedded in lining.	2. Sand the surfaces of the linings and drums. Remove all particles of metal that may be found in the surfaces of the linings.
3. Lining rivets loose or lining not held tightly against the shoe at the ends.	3. Replace rivets and/or tighten lining by reriveting.
4. Drums not square or distorted.	4. Turn or grind or replace drums.
5. Incorrect lining.	5. Replace lining.
6. Shoes scraping on backing plate ledges.	6. Apply brake lube to ledges. Replace with new shoe and linings, if distorted.
7. Weak or broken hold down springs.	7. Replace defective parts.
8. Loose wheel bearings.	8. Tighten to proper setting.
9. Loose backing plate, anchor, drum, wheel cylinder.	9. Tighten.
10. Linings located wrong on shoes.	10. Install linings correctly.

HYDRAULIC BRAKES

BRAKES CHATTER

PROBABLE CAUSE	REMEDY
1. Incorrect lining to drum clearance.	1. Readjust to recommended clearances.
2. Loose backing plate.	2. Tighten securely.
3. Grease, fluid, road dust on lining.	3. Clean or reline.
4. Weak or broken retractor spring.	4. Replace.
5. Loose wheel bearings.	5. Readjust.
6. Drums out-of-round.	6. Grind or turn drums in pairs.
7. Cocked or distorted shoes.	7. Straighten or replace.
8. Tapered or barrel-shaped drums.	8. Grind or turn in pairs.

SHOE CLICK

PROBABLE CAUSE	REMEDY
1. Shoes lift off backing plate and snap back.	1. Change drums side to side or grind drums (in pairs).
2. Hold down springs weak.	2. Replace springs.
3. Shoe bent.	3. Straighten.
4. Grooves in backing plate pads.	4. Grind and lubricate.

TROUBLE SHOOTING POWER HYDRAULIC BRAKES (Vacuum Assist Units)

NOTE: The same types of brake troubles are encountered with power brakes as with standard brakes. Before checking the power brake system for source of trouble, refer to trouble diagnosis of standard hydraulic brakes. After these possible causes have been eliminated, check for cause as outlined below.

NOTE: Make the following test before checking hard pedal for the cause. With the engine stopped, depress the brake pedal several times to eliminate all vacuum from the system. Apply the brakes, and while holding the foot pressure on the brake pedal, start the engine. If the unit is operating correctly, the brake pedal will move forward when the engine vacuum power is added to the pedal pressure. If this test shows that the power unit is not operating, the trouble may be one of the following:

BRAKE SYSTEM LOSES FLUID

PROBABLE CAUSE	REMEDY
1. External Leak: Leaking-pipe connections, hose, wheel cylinders, master cylinder head nut, etc.	1. Clean parts. Tighten. Replace defective parts.
2. Internal Leaks: Past secondary seals into power unit. Check vacuum hose for fluid.	2. Rebuild master cylinder.

NO BOOST -- HARD PEDAL

PROBABLE CAUSE	REMEDY
1. Bent, broken obstructed tube. Collapsed hose.	1. Replace defective parts.
2. Stuck check valve.	2. Replace valve.
3. Air inlet blocked.	3. Replace filter. Open passages.
4. Air valve stuck.	4. Disassemble unit -- clean -- replace defective parts.
5. Faulty diaphragm.	5. Replace diaphragm.
6. Faulty piston seal.	6. Replace seal.
7. Leaks internally.	7. Rebuild.
8. Leaking vacuum tank.	8. Repair tank.

SLOW BRAKE PEDAL RETURN

PROBABLE CAUSE	REMEDY
1. Excessive seal friction in power unit.	1. Rebuild unit.
2. Faulty valve action.	2. Rebuild unit.
3. Broken return spring.	3. Replace spring.

BRAKES GRABBY

PROBABLE CAUSE	REMEDY
1. Broken valve spring.	1. Rebuild unit.
2. Sticking vacuum valve.	2. Clean and lubricate.
3. Reaction diaphragm leakage.	3. Rebuild unit.

SPECIFICATIONS

FRONT BRAKES

TRUCK SERIES	4500 5500	L4000 E6500	S6500
Type	Duo-Servo	"F"	"FA"
Adjustment	Automatic	Manual	Automatic
Size	14 x 2½	15 x 3	15 x 3
Lining Width	2½"	3"	3"
Lining Thickness	9/32"	5/16	.31"
Lining Area—Sq. In. per axle	136.1	199.0	199.0

REAR BRAKES

TRUCK SERIES	All Except 6500	E6500	S6500
Type	Twin-Action	"FR-3"	"FR-3A"
Adjustment	Automatic	Manual	Automatic
Size	15 x 4	15 x 6	15 x 6
Lining Width	4"	6"	6"
Lining Thickness	½"	½"	½"
Lining Area—Sq. In. per axle	249.0	379.6	379.6

BRAKE CONTROLS

TRUCK SERIES	Wheel Cylinder Bore Front	Wheel Cylinder Bore Rear	Master Cyl. Bore
LV4000	1⅛"	1½"	1¼"
LA4000	1⅛"	1½"	1½"
4500	⅞"	1½"	1¼"
E5500	⅞"	1½"	*
S5500	⅞"	1½"	1¾"
E6500	1⅛"	1⅝"	*
S6500	1¼"	1⅝"	1¾"

*Master cylinder is part of dash mounted booster

POWER CYLINDERS

MODEL NO.	STANDARD OR OPTIONAL	TRUCK SERIES	TYPE OF MOUNT	OVERALL DIAMETER	CYLINDER BORE	POWER DIAPHRAGM STROKE	HYDRAULIC PISTON STROKE
C-4055	Std.	LV4000	Remote	11.7"	.84"	3.00"	—
	Opt.	P4500					
C-4056	Opt.	LV4000	Remote	11.7"	.84"	4.40"	—
C-4074-A	Opt.	E4500 (Conv.)	Dash	11.7"	.91"	4.75"	4.50"
	Std.	E5500 (Conv.)					
	Std.	E6500					
C-4074-B	Opt.	E5500	Dash	11.7"	.97"	4.75"	4.50"
	Opt.	E6500					
C-4074-C	Std.	E5500 (Cowl)	Dash	11.7"	.91"	4.75"	4.50"
	Opt.	E4500 (Cowl)					
C-4090	Std.	S5500	Remote	13.0"	.97"	4.45"	—
	Std.	S6500					
2504183	Std.	LA4000	Remote	4.625"	1.125"	3.90"	3.75"
(Air operated)	Std.	DLA4000					

SPECIFICATIONS (CONT.)

VACUUM PUMP SPECIFICATIONS

Model (exc. DLV4000)	4GA
Model (DLV4000)	4GB
Rotation	Clockwise
Drive	Belt & Pulley
Front Bearing (Ball)	
I.D.	0.7872"-0.7874"
O.D.	1.8501"-1.8504"
Rear Bushing (Not Serviced Separately)	
I.D.	0.7500"-0.7505"
Front End Plate	
Recess for Baffle Plate—Dia.	2.250"-2.251"
Recess for Ball Bearing—Dia.	1.8495"-1.8505"
Recess for Oil Seal—Dia.	1.498"-1.500"
Recess for Felt Washer—Dia.	1.240"-1.260"
Shaft Hole—Dia.	0.826"-0.831"
Rotor Vane	
Quantity	3
Length	3.179"-3.181"
Width	1.050"-1.070"
Thickness	0.246"-0.249"
Baffle Plate	
Outside Diameter	2.251"-2.253"
Shaft Hole Diameter	0.790"-0.800"
Oil Seal	
Outside Dia.	1.501"-1.505"
I.D. to fit Shaft Dia. of	0.781"
Thickness	0.703"-0.734"
Type	Double Lip
Housing	
Inside Diameter	3.5715"-3.5725"
Length (between machined ends)	3.310"-3.315"
Rotor	
Length	3.181"-3.182"
Material	Aluminum
Rotor Shaft	
Length	9"
Diam. at Rear Bushing	0.7485"-0.7495"
Diam. at Ball Bearing	0.7867"-0.7872"

SECTION 5B

Air Brakes

INDEX

BRAKE SYSTEM EQUIPMENT

The air brake system comprises a group of devices, some of which maintain a supply of compressed air, some of which direct and control the flow of the compressed air, and others which transform the energy of compressed air into the mechanical force and motion necessary to apply the brakes. Refer to figure 1 for typical schematic diagram.

Information in this section covers all standard air brake equipment, as well as other units which are used as optional equipment on some models.

There are two basically different types of air actuated brakes used on vehicles covered by this manual. One type is the cam-type brake which is energized by an air chamber and slack adjuster arrangement. The other is called Stopmaster, which is a complete assembly consisting of two air chambers connected to two brake shoes through tubes containing push-rod-and plunger assemblies. All information relative to Stopmaster brakes is found under the heading of "Stopmaster Brakes" in this section. Unless otherwise specified, all pedals, valves, controls, etc., covered in this manual apply to both cam-type and Stopmaster type brake systems.

Refer to AIR COMPRESSOR AND GOVERNOR (SEC. 6T) for information relative to air compressors and governors.

BRAKE SYSTEM MAINTENANCE

Normal operation of braking system necessitates periodic tests, inspection, and adjustments to assure safe, efficient operation. Test, inspection and adjustment procedures for each air brake control unit are described under individual headings in this section. Since the vehicles covered by this Maintenance Manual will be used in a wide variety of operation types, it is impossible to fix maintenance intervals (either time or mileage) which will satisfactorily suit all conditions. Therefore, any such intervals stated in these maintenance procedures must be related to the type of usage to which a particular vehicle is put. Obviously, a truck used in city "stop and start" driving will require different service operations and intervals than one hauling "over the road" for long distance. With this in mind, all service intervals should be related to a specific vehicle.

Compression and subsequent cooling of air causes the moisture in the air to condense. This moisture collects in air tank and should be drained daily. Drain cocks are provided at bottom of air tanks for this purpose. Satisfactory draining is accomplished only by leaving the drain cocks open after compressed air has escaped and until all drainage stops.

Some vehicles are equipped with a moisture ejector valve (optional), which eliminates the need for daily drainage of air tanks. For description of

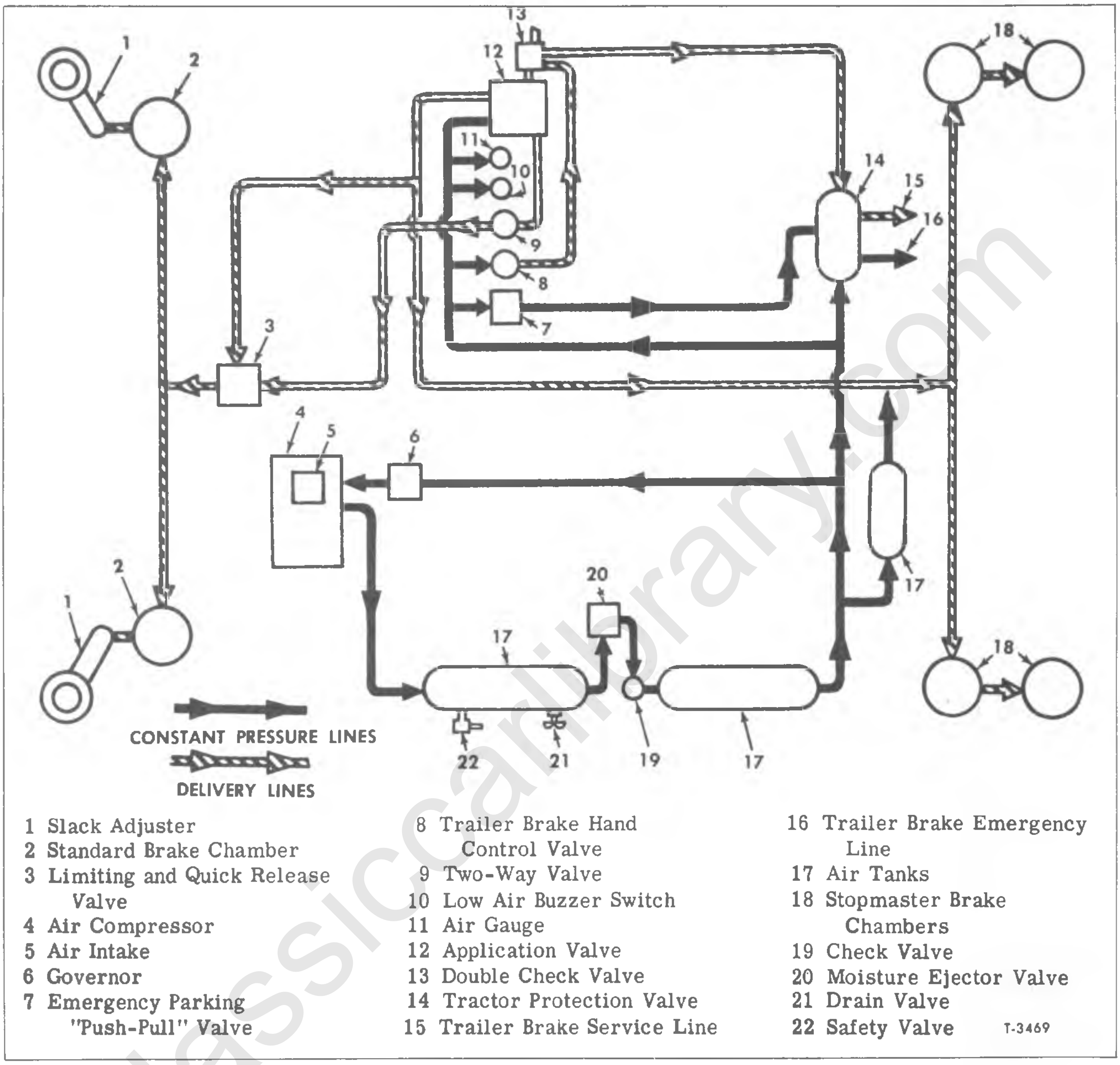


Figure 1—Schematic Diagram of Typical Air Brake System

how this valve works, refer to procedures under heading of "Moisture Ejector Valve."

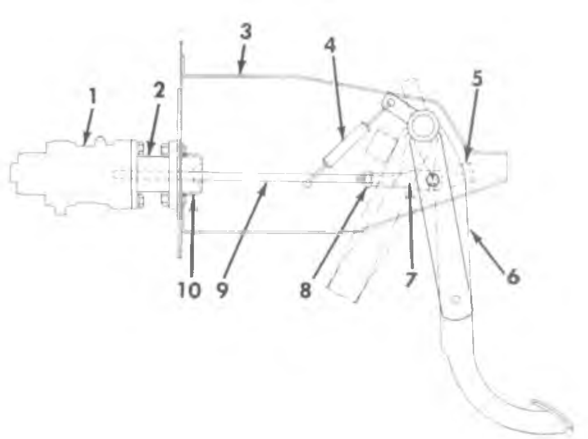
The complete air system should be checked for leakage at regular intervals. Build up air pressure in system to governor cut-out point, then with engine stopped and brakes released, observe rate of air pressure drop registered by the dash air pressure gauge. The rate of drop should not exceed two pounds per minute. With engine stopped and brakes fully applied, observe rate of air pressure drop registered by the dash gauge. Rate of drop should not exceed three pounds per minute. If leakage is excessive, leakage test should be made at air line connections and at all air brake control units as directed under individual headings later in this section.

In cold weather, particular attention should be given to draining of moisture from air system.

BRAKE ADJUSTMENTS

Brake adjustments to compensate for normal lining wear are made at slack adjuster at each wheel. Adjustment must be made before the brake chamber push rod travel reaches the maximum working stroke listed in "Specifications" at end of this section.

On 5500 and 6500 "cowl" models, an adjustable



1 Application Valve
2 Valve Mounting Bracket
3 Pedal Support Bracket
4 Pedal Return Spring
5 Pedal Stop Bumper
6 Brake Pedal
7 Push Rod End
8 Adjusting Nut
9 Push Rod
10 Boot T-3468

Figure 2—Brake Pedal and Linkage (Cowl Models)

push rod is used between the brake pedal and the brake application valve. On "L" models, an adjustable stop screw is provided to control the pedal push rod to application valve relationship. These adjustments are not normally required except when the application valve, pedal, or push rod have been removed and reinstalled.

On E6500 Models the brake pedal is part of the application valve assembly and adjustment is by means of a stop screw (Midland-Ross valve) or a stop button (Bendix-Westinghouse valve).

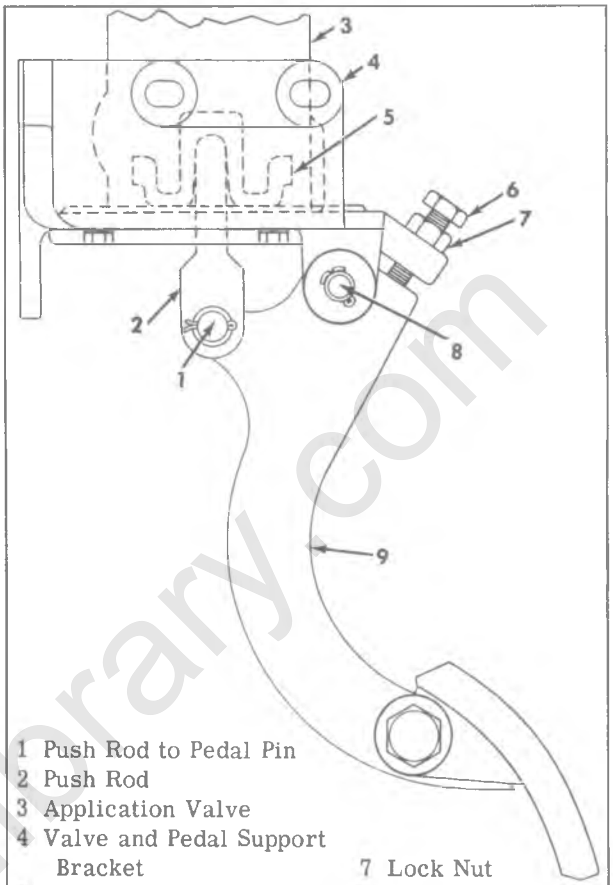
PUSH ROD ADJUSTMENT
(5500, 6500 COWL MODELS) (Fig. 2)

Push rod adjustment controls the exhaust opening between the hollow end of the application valve piston and the exhaust valve, and the pedal travel before brake application begins. If push rod is too long, it will prevent the piston from leaving the exhaust valve and brakes will not release, or if it does not open far enough it can result in slow brake release. If push rod is too short, excessive pedal travel will be required to start brake application, and full brake application may not be obtained. With push rod installed (fig. 2), adjust as follows:

1. Loosen lock nut on push rod.

2. Using a pair of pliers, grasp and turn rod into rod end until pedal does not contact the pedal stop bumper with push rod bottomed in piston cup.

3. Place a .040" shim between the brake pedal and the pedal stop bumper, then adjust the push rod until it just contacts the piston cup.



1 Push Rod to Pedal Pin
2 Push Rod
3 Application Valve
4 Valve and Pedal Support Bracket
5 Application Valve Piston Cup
6 Pedal Stop Screw
7 Lock Nut
8 Pedal to Bracket Pin
9 Pedal T-1563

Figure 3—Brake Pedal and Linkage (Tilt Cab Models)

4. Hold push rod while firmly tightening lock nut.

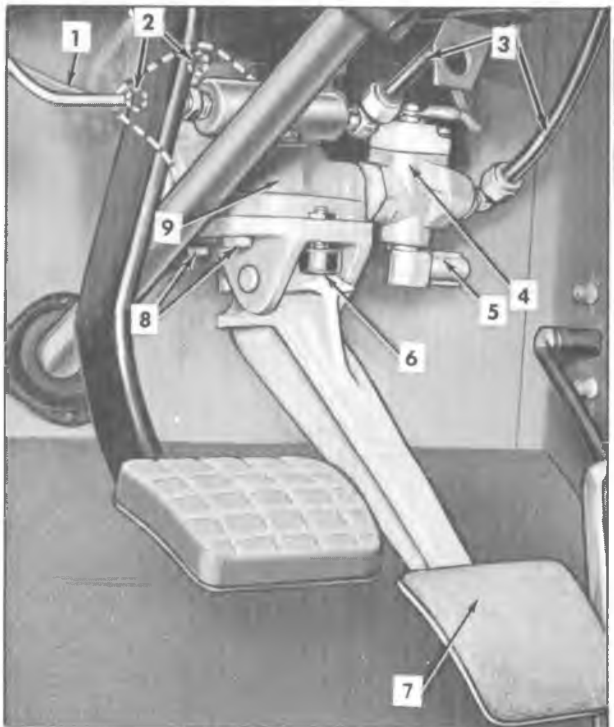
5. Check brake operation for full application and release.

PEDAL STOP SCREW ADJUSTMENT
(TILT CAB MODELS - Fig. 3)

Pedal stop screw adjustment controls the exhaust opening between the hollow end of the application valve piston and the exhaust valve. It also controls the pedal travel before brake application begins. If stop screw is turned down too far, it will prevent the piston from leaving the exhaust valve and brakes will not release. If it does not open far enough it can result in slow brake release. If stop screw is not turned down far enough, excessive pedal travel will be required to start the brake application, and full application may not be obtained. Adjust stop screw as follows:

1. Loosen lock nut on pedal stop screw.

2. Back stop screw out until there is free play between the push rod and the application valve piston cup.



1 Line to Air Gauge
2 Valve Mounting Bolt and Nut (in Engine Compartment)
3 Lines to Trailer Brakes Hand Control Valve
4 Double Check Valve and Stop Light Switch
5 Line to Tractor Protection Valve
6 Pedal Stop Button
7 Pedal Assembly
8 Pedal to Valve Bolts
9 Application Valve Assembly T-2126

Figure 4—Brake Pedal and Application Valve Installed(Conv. Cab) (Typical)

3. Turn stop screw down until all free play is removed; then back screw out ½ turn and lock.
4. Hold stop screw while tightening lock nut.
5. Check brake operation for full application and release.

PEDAL STOP SCREW ADJUSTMENT
(CONVENTIONAL MODELS - Fig. 4)

On all conventional models, both Midland-Ross and Bendix-Westinghouse application valves (pedal assembly included) are used. Midland-Ross has a stop screw and Bendix-Westinghouse has a stop button as part of the assembly. This stop screw, or button, is used to adjust pedal to provide proper pedal travel. If travel is too great, application will be too slow and full application may not be obtained. If travel is not great enough, brakes may not release completely. Adjust stop screw (button) as follows:

1. Loosen lock nut.
2. Turn stop screw (M-R) into pedal bracket until pedal roller does not touch exposed end of valve piston; or (B-W) until plunger does not touch valve piston.
3. Turn stop screw (M-R) out of pedal bracket until roller JUST TOUCHES exposed end of valve piston; or (B-W) until plunger JUST TOUCHES valve piston. In other words, there should be NO FREE PLAY between pedal and valve piston.
4. Tighten lock nut without moving stop screw (or button).
5. Check brake operation for full application and release.

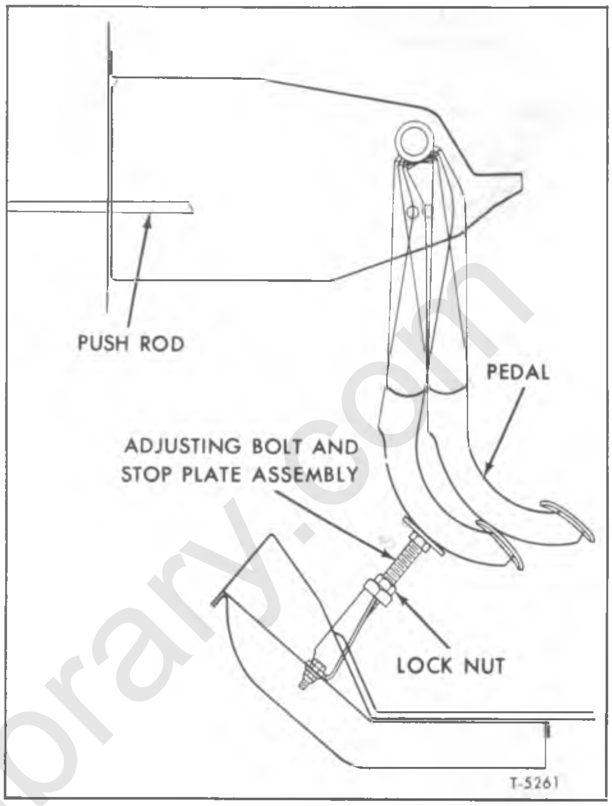


Figure 5—Brake Pedal Stop Installed ("S" Models)

BRAKE PEDAL STOP ADJUSTMENT
(Refer to Figure 5)

A pedal "stop" is provided on all school bus models with air brakes to prevent driver from bending or breaking push rod as the result of exerting more pressure than necessary on the brake pedal. It is important that this "stop" be properly adjusted whenever service procedures have been performed which might change the pedal-to-valve relation. Adjust as follows:

1. Set emergency brake or block wheels.
2. Exhaust air from brake system.
3. Loosen lock nut and turn adjusting bolt and stop plate assembly down as far as possible away from brake pedal.

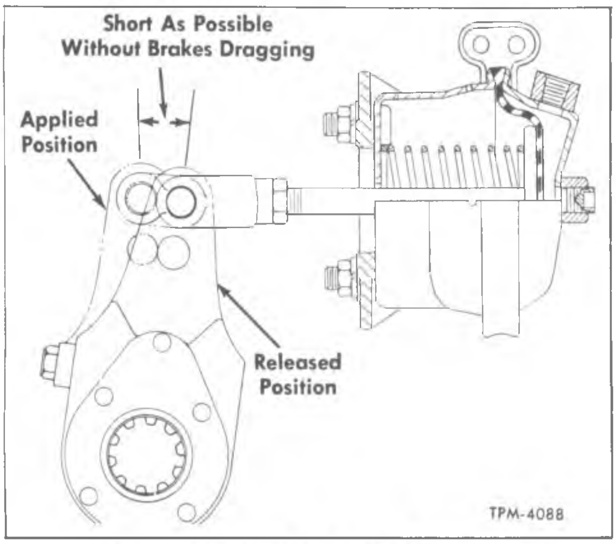


Figure 6—Typical Air Brake Adjustment

4. Depress and hold brake pedal in full-down position.
5. Turn adjusting bolt and stop plate assembly up until plate contacts brake pedal, with pedal in full-down position.
6. Release brake pedal and turn adjusting bolt and stop plate assembly up (toward brake pedal) three full turns.
7. Hold adjusting bolt and stop plate assembly and tighten lock nut.
8. Start engine and build up air pressure in system.
9. Check operation of brake pedal. Make sure pedal contacts stop plate before piston bottoms in application valve.

BRAKE LINING WEAR ADJUSTMENT
(Refer to Fig. 6)

NOTE: On vehicles equipped with "Stopmaster" brakes, brake shoe adjustment is covered under "Stopmaster Brakes" near end of this section.

Slack adjusters function as adjustable levers and provide a quick and easy method of adjusting the brakes to compensate for normal lining wear. Positive-locking type slack adjusters are used on all vehicles. Internal construction of all slack adjusters is as shown in figure 7; however, lever arm (body) may be offset to suit installation requirements. Refer to "Air Brake Specifications" at end of this section to determine slack adjuster type used.

The most efficient brake action with "S" cam brakes, will be obtained when the arm travel of the slack adjuster is held to a minimum so that the full length of the lever is utilized during brake application. Minor adjustment to compensate for normal lining wear should be confined to the slack adjusters.

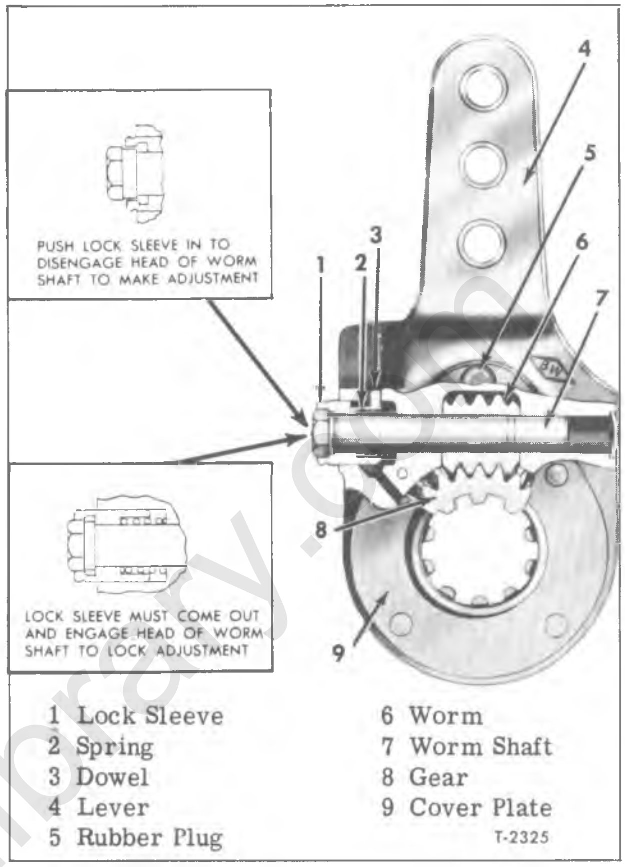


Figure 7—Slack Adjuster

Push rod travel should be maintained as short as possible without brakes dragging (refer to fig. 6). Push rod travel should be checked after every 2,000 miles of operation to determine whether adjustment is necessary. Brake linings should be replaced before wear exposes rivet heads and causes drum damage.

1. With wheel jacked up, turn slack adjuster worm shaft until brake drags, then back off until wheel turns freely.

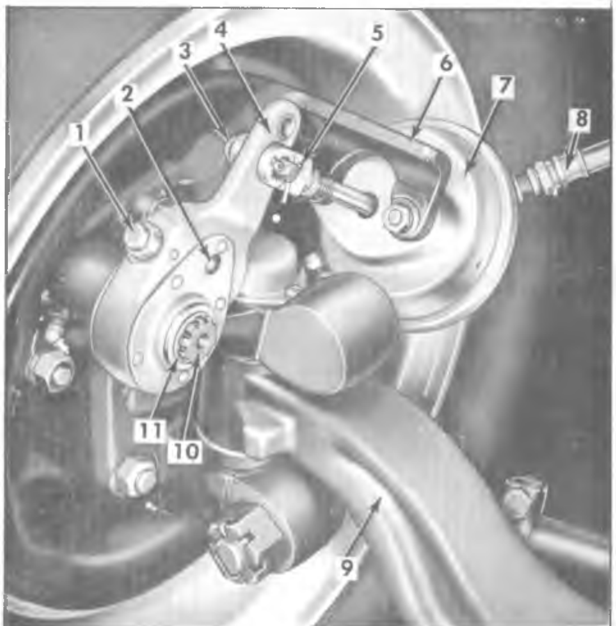
NOTE: Lock sleeve must be pushed in before worm shaft can be turned (fig. 7). Make sure sleeve is pushed in far enough to clear hex end of worm shaft before turning shaft.

2. Be sure wheel turns freely with brakes fully released. After completing adjustment, make sure lock sleeve comes out and engages hex end of worm shaft (fig. 7). Pry sleeve out with screwdriver if necessary. Coat lock sleeve and end of worm shaft with wheel bearing grease to keep out dirt and moisture to assure free movement of sleeve at next adjustment.

SLACK ADJUSTERS

SLACK ADJUSTER OPERATING TEST

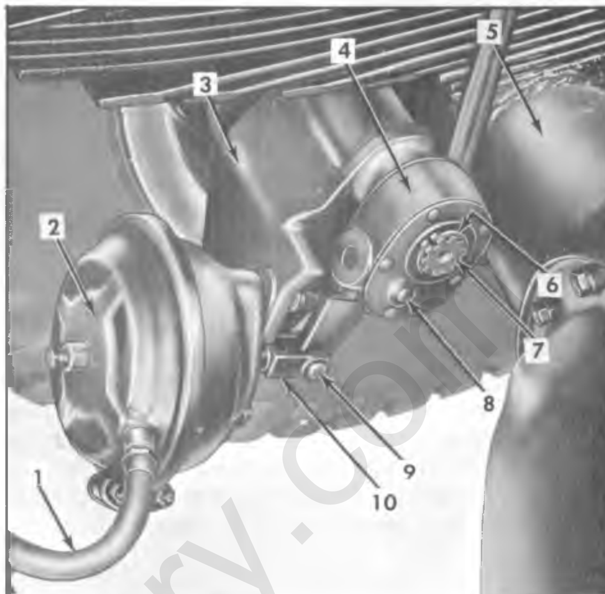
Apply brakes and make sure all slack adjusters rotate freely and without binding. Release



1 Adjusting Worm Shaft	7 Brake Chamber
2 Lubrication Hole Plug	8 Air Brake Hose
3 Clevis Pin	9 Front Axle
4 Slack Adjuster	10 Brake Camshaft
5 Adjusting Clevis	11 Snap Ring
6 Mounting Bracket	

T-3197

Figure 8—Brake Chamber and Slack Adjuster Installed (Front)



1 Air Brake Hose	6 Snap Ring
2 Brake Chamber	7 Brake Camshaft
3 Mounting Bracket	8 Lubrication Hole Plug
4 Slack Adjuster	9 Clevis pin
5 Rear Axle	10 Adjusting Clevis

T-2196

Figure 9—Brake Chamber and Slack Adjuster Installed (Rear)

brakes and make sure all slack adjusters return to released position freely without binding.

With brakes released, make sure the angle formed by slack adjuster arm and brake chamber push rod is greater than 90 degrees. All slack adjusters should be set at the same angle. With brakes applied, make sure the angle formed by the slack adjuster arm and brake chamber push rod is still slightly greater than 90 degrees and that all are at the same angle. If angle is less than 90 degrees with brakes applied, slack adjuster is going "over center." Adjust brakes as previously described under "Brake Adjustments."

SLACK ADJUSTER REPLACEMENT
(Refer to Figs. 8 and 9)

Removal

1. Remove clevis pin attaching brake chamber push rod yoke to slack adjuster.

2. Remove lock ring or cotter pin and spacer securing slack adjuster on camshaft. Slide slack adjuster off end of shaft.

Installation

1. If a new slack adjuster is being installed, make sure it is the same size and type as that removed. Make sure spacing washer is in place on camshaft. Slide slack adjuster onto camshaft and attach with spacer and lock ring or cotter pin.

2. Connect brake chamber push rod yoke to slack adjuster with clevis pin and cotter pin. Refer to "Brake Chamber Installation" for adjustment of brake chamber push rod.

3. Adjust brakes as directed under "Brake Adjustments."

BRAKE CHAMBERS (STANDARD)

All service information in the following paragraphs refers only to standard chambers. Chambers used on rear brakes only on 6500 Series are covered under the separate heading of "Stopmaster Brakes." "Stopmaster" and "Fail-Safe" brakes are also available on all Series 5500 as optional equipment. Chambers used as optional equipment for air operated emergency and parking brakes are covered under separate headings of "DD3 Brake Actuator System" or "Anchorlok Brake Chambers." Standard chambers on rear brakes of Series 4000 tilt cab models, all Series 5500 models, and for front brakes are covered here.

An air brake chamber is used at each wheel to convert the energy of compressed air into the mechanical force and motion required to apply the brakes. The yoke on the brake chamber push rod connects to a slack adjuster which is mounted on the brake camshaft. Push rod opening and four equally spaced holes near clamping flange in non-pressure plate provide for breathing and drainage. For illustration of brake chambers installed see figure 8 (at front axle) and figure 9 (at rear axle).

Brake chambers have two different type clamp rings; (1) a two-piece ring with two bolts and (2) a one-piece clamp ring with two bolts at the clamp ring joint.

BRAKE CHAMBER OPERATION

As air pressure enters the brake chamber behind the diaphragm, the diaphragm forces push rod outward, thus applying force to the slack adjuster which rotates brake camshaft, applying brakes. When air pressure is released from the brake chamber, the brake shoe return springs and the push rod spring return brake shoes, camshaft, slack adjuster, push rod, and diaphragm to released position.

BRAKE CHAMBER
SERVICEABILITY TESTS

1. Operating Test

Apply brakes and see that the brake chamber push rods move out promptly without binding. Release brakes and see that they return to released position without binding.

2. Leakage Test

a. While full brake pressure is being delivered apply soap suds to clamp ring holding the diaphragm in place between the pressure plate and non-pressure plate. No leakage is permissible. If leakage is evident, tighten clamp ring bolts.

b. With the brakes fully applied, check for leakage through the diaphragm by coating the push rod hole and drain holes in non-pressure plate with soap suds. No leakage is permissible. If leakage is evident, replace the diaphragm.

BRAKE CHAMBER REPLACEMENT

1. Removal

Disconnect the air line from brake chamber. Disconnect push rod yoke from slack adjuster. Remove nuts from brake chamber mounting studs, then remove brake chamber assembly.

2. Installation

Install the brake chamber on mounting bracket and secure with stud nuts and lock washers. Connect push rod yoke to slack adjuster. Adjust the brakes as previously directed under "Brake Adjustments." Apply brakes and make sure push rod is correct length. Angle formed by push rod and slack adjuster should be greater than 90 degrees with brakes released, and with brakes applied after being adjusted, this angle should still be greater than 90 degrees; in other words, the slack adjuster should not go "over center" during brake application. If necessary, adjust yoke on push rod to obtain this condition. Push rod must not extend through yoke far enough to interfere with slack adjuster. Test brake chamber as directed under "Serviceability Tests."

MAINTENANCE

It is recommended that all brake chambers be removed, disassembled, inspected and thoroughly cleaned at the time that brakes are relined or at one year periods, whichever occurs first (also dependent upon the type of operation and operator experience). Any parts worn, cracked, or deteriorated should be replaced.

AIR TANKS

The number of air tanks used and their mounting locations vary from model to model. On tilt cab models one tank is mounted crossways between frame side rails behind front bumper and in front of first frame crossmember. On conventional cab models the tanks are mounted along the outside of the left frame rail, under the cab in the step area. On "cowl" models the air tank is mounted on the outside of the left-hand frame side rail near the front of the vehicle. Standard air tank on all models except tilt cab is a divided tank which incorporates a wet tank and a dry tank in the same assembly, divided by a check valve which is built into the tank.

The purpose of the air tanks is to provide a place to store compressed air so there will always be an ample supply available for immediate operation of the brakes. Tanks provide storage for sufficient compressed air for several brake applications with engine stopped.

Another purpose of the air tanks is to provide a place where the air, heated during compression, can cool and the water vapor can condense. Most of this condensation takes place in the "wet" tank; this is the tank into which the compressed air is first discharged from the compressor. Condensation should be drained from all air tanks daily. To drain tanks properly, leave drain cocks open until all air escapes and draining stops. Daily draining is not necessary on those models which have the optional moisture ejector valve.

All pressure for operation of the brakes and air compressor governor is taken from the dry tank. A one-way check valve at inlet to second tank prevents loss of air pressure from the second tank in the event of leakage in the first tank or air compressor discharge line.

Air tank U-bolts and support brackets to frame bolts should be checked for looseness at regular intervals and tightened if necessary. Air tank may be cleaned inside using steam or hot water. If corrosion or other damage has weakened the tank, it must be replaced.

AIR PRESSURE CHECK VALVE

There are several different kinds of check valves used on vehicles covered by this manual. Check valves located as separate units in the air lines (single check valve, double check valve, and double check valve with stop light switch) are to be serviced and repaired as covered in the Air Brake Control Units Overhaul Manual X-5B-01.

Check valve prevents loss of air pressure from second air tank in the event of leakage in the first tank or in the air compressor discharge line. Arrow on valve body indicates direction of air flow through valve.

The rubber valve seat should be replaced if there is any evidence of deterioration or hardening Valve spring should be replaced if weakened by rust or corrosion. Valve disc should be perfectly smooth and free of rust or corrosion. When installing check valve, make sure it is installed to permit air flow from first tank into second tank as indicated by the arrow on valve body.

A fourth type check valve, which is an integral part of the divided air tank assembly, is to be serviced and repaired as detailed in the following procedures (refer to fig. 10). This valve is built into the tank at the point where the "wet" tank portion is divided from the "dry" tank portion (refer to fig. 11).

All check valves, regardless of type, should be removed, disassembled, and cleaned or replaced every six months, 50,000 miles, or 1800 hours (whichever occurs first).

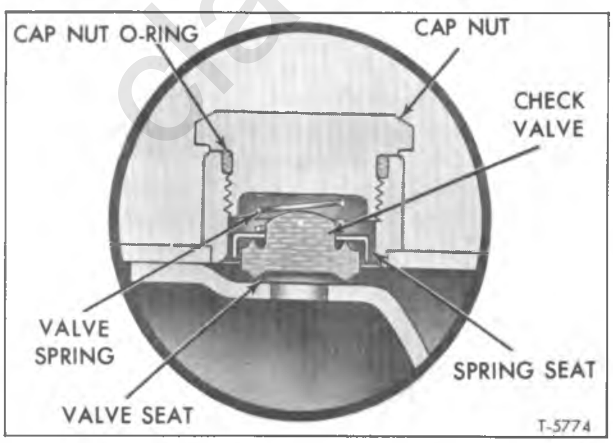


Figure 10—Air Tank Check Valve

DIVIDED TANK CHECK VALVE SERVICE (Refer to Fig. 10)

1. Drain air from all reservoirs.
2. Remove cap nut carefully. Nut compresses both valve spring and valve seat spring and parts will "fly off" if not removed carefully.
3. Remove springs, valve, and valve seat.
4. Inspect all parts for cracking, deterioration, or swollen condition. Discard any bad parts.
5. Clean valve seat area.
6. Reassemble, using new parts as necessary. Install seat and O-ring assembly, valve, and springs.
7. Compress springs by pushing down on cap nut and thread cap nut into tank. Tighten cap nut.
8. Build up air pressure in system and determine effectiveness of check valve by opening drain cock on "wet" portion of tank and note pressure retention in "dry" portion of tank.

SAFETY VALVE

A safety valve is installed in air tank to eliminate the possibility of air pressure building up in the system beyond a safe maximum in the event of failure of the air compressor governor.

OPERATION

When pressure in the air tank is built up to exceed 145 to 155 psi, air pressure forces ball valve off seat, permitting air to escape through exhaust port to atmosphere. After pressure bleeds down, spring forces ball back onto the seat.

MAINTENANCE

Check safety valve periodically for leakage, using soap suds at exhaust port, with 90 pounds pressure in tank. Leakage should not exceed a 3-inch bubble in 3 seconds. Once a year, safety valve should be disassembled, cleaned with kerosene, and reset to blow off at 145 to 155 psi.

ADJUSTMENT (Fig. 12)

1. Loosen lock nut.
2. Adjust pressure by turning adjusting screw. Turn clockwise to increase pressure or counterclockwise to decrease pressure.
3. Tighten lock nut.

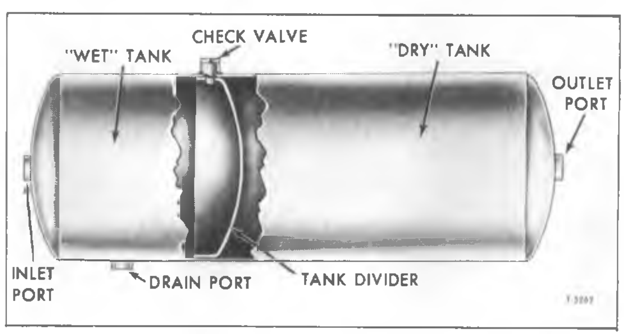
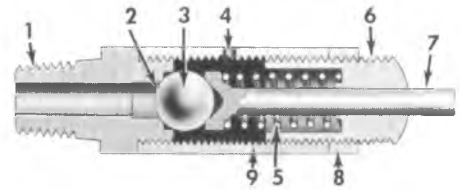


Figure 11—Divided Air Tank

AIR BRAKES



1 Body
2 Ball Seat
3 Ball Valve
4 Exhaust Port
5 Spring
6 Adjusting Screw
7 Stem
8 Lock Nut
9 Spring Cage

T-953

Figure 12—Safety Valve

PRESSURE PROTECTION VALVE

The pressure protection valve is used on some models. It is mounted in a delivery port of the application valve. On some series trucks it may be used with optional equipment (air shift, differential lock, etc.). In the optional application, it is located in the outlet air line of air tank between air tank and optional equipment.

The function of the valve is to close the air lines to horns, wipers, transmission shift, differential lock, etc., when the pressure in the main air system falls below 65 psi (± 5 lbs.). Thus, in the event of pressure loss to 65 psi, there still will be sufficient pressure left to apply service or emergency brakes and stop the vehicle.

REPLACEMENT

Removal

1. Block vehicle wheels.
2. Exhaust air pressure from system.
3. Disconnect air lines to valve.
4. Remove valve from port of application valve (or air tank line).

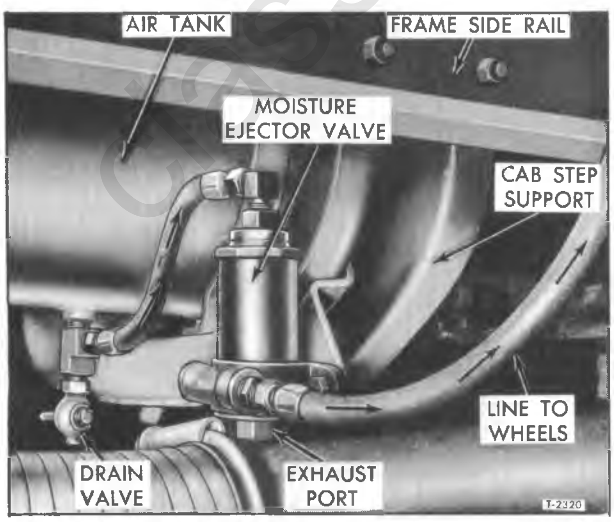


Figure 13—Moisture Ejector Valve Installed (Typical)

Installation

1. Install valve in delivery port of application valve (or air tank line).
2. Connect air lines to valve.
3. Build up air pressure in system and check for leaks.
4. Drain air pressure in system below 65 psi and check to determine if valve has shut off supply to applicable units.

QUICK RELEASE VALVE

Quick release valve is used as standard equipment at both the front and rear brakes on some models, and at front brakes only on other models. The purpose of the quick release valve is to reduce the time required to release the brakes by hastening the exhaust of air pressure from the brake chambers. The valve consists of a body cover and diaphragm so arranged as to permit air pressure to flow through the valve in one direction. When application pressure is reduced, the air pressure which has passed through the valve is permitted to escape through the exhaust port.

SERVICEABILITY TESTS

1. Operating Test

Apply brakes and observe that when brakes are released, air pressure is exhausted freely through the exhaust port of the valve. Be sure the exhaust port is not restricted in any way.

2. Leakage Test

With brakes applied, coat the exhaust port with soap suds to check leakage. Leakage is caused either by dirt on exhaust seat, by a worn diaphragm, or by a damaged exhaust seat on valve cover.

QUICK RELEASE VALVE REPLACEMENT

Removal

Disconnect air lines from valve. Remove two bolts attaching valve to crossmember or axle bracket and remove valve assembly.

Installation

Mount valve on crossmember or axle bracket and tighten mounting bolts firmly. Connect air lines to valve, referring to "Air Lines" section for torque specifications for air line fittings. Build up air pressure in system, then test valve as directed under "Serviceability Tests."

MOISTURE EJECTOR VALVE

DESCRIPTION AND OPERATION

The moisture ejector valve is mounted on a bracket attached to the cab step support close to the wet air tank. Moisture is ejected each time the brakes are released. Air pressure lifts actuator which lifts plunger, moving inlet valve off seat. This permits flow of air from wet tank into column section of valve. When brakes are released, air pressure snaps actuator back in place, allowing air and moisture in column to escape past plunger seat through exhaust port of lower body to atmosphere. Spring then returns inlet seat and plunger seat to "OFF" position. This action takes place each time brakes are applied and released, thereby operating a continuous process of moisture ejection from brake air system.

The moisture ejector valve is NOT standard equipment. It is offered as optional equipment only on all 5500 and 6500 Series.

REPLACEMENT (Refer to Fig. 13)

Removal

1. Exhaust air from system.
2. Disconnect air lines at valve.
3. Remove bolts which fasten valve to bracket on cab step support and remove valve.

Installation

1. Position valve on bracket on cab step support and secure with attaching bolts.
2. Connect air lines at valve.
3. Build up air pressure in system. Check operation of valve while applying and releasing brakes. Check for leaks.

BRAKE APPLICATION VALVES

GENERAL

The brake application valves used on models covered by this manual all operate on the same basic principle. The physical shape of the valves and the methods of mounting differ according to model. There are three mounting types; tilt cab models, conventional cab models, and "cowl" models.

TILT CAB MODELS

The application valve is mounted on a support bracket in an inverted position inside the cab. The actuating push rod from the brake pedal extends up through the bracket into the valve piston cup as shown in figure 3. A breather tube is installed in the exhaust opening in place of filter screens and a hose connected to the tube carries the exhaust air down below the cab floor.

CONVENTIONAL CAB MODELS

The application valve on these models is fastened to the cowl (fig. 4). The valve has two studs as part of the assembly and one threaded bolt hole. The valve is mounted inside the cab and studs extend through holes in cowl. Nuts and lock washers are installed on studs on engine compartment side along with one bolt to fasten valve securely to cowl. A pedal bracket and pedal assembly is fastened to the bottom of the application valve by three bolts. Pedal assembly contacts valve piston with an upward movement. The exhaust port is on the back side of the valve and exhaust air escapes into engine compartment.

"COWL" MODELS

On these models, brake application valve is mounted in a horizontal position on engine side of dash. Valve assembly is attached to a mounting bracket which is bolted to the dash panel. Brake pedal is mounted inside the cab, with the actuating push rod extending through the dash panel into the valve piston cup as shown in figure 2.

APPLICATION VALVE REPLACEMENT

On all conventional cab models both Midland-Ross and Bendix-Westinghouse application valves are interchangeable as complete assemblies (including pedal). The component parts are not interchangeable. All valve ports, mounting holes and brackets are located in the same relative places to permit replacement of assemblies regardless of manufacturer. The following procedures covering removal and installation, apply to both Bendix-Westinghouse and Midland-Ross valves.

TILT CAB MODELS

Removal

1. To remove pedal only, remove cotter pin and drive out pedal to bracket pin.
2. To remove pedal, valve and bracket as an assembly or valve only, block vehicle wheels or hold by some means other than air brakes.
3. Drain air pressure from brake system.
4. Disconnect air lines from valve.
5. Disconnect exhaust hose from valve exhaust port.
6. Remove bolts which attach support bracket to cab and remove complete assembly or:
7. If valve only is to be removed, remove bolts which attach valve to support bracket and remove valve.

Installation

1. To install valve only, place valve in position on support bracket and attach with bolts or:

2. To install pedal, valve and support bracket as an assembly, position in cab and attach assembly to cab with bolts.
3. Connect exhaust hose to valve exhaust port.
4. Connect air lines to valve.
5. Start engine and build up air pressure in brake system.
6. Check for leaks.
7. Test operation of brakes.

NOTE: Various items of special or optional equipment are often assembled in outlet ports of the valve, such as low air pressure switch, double check valve, stop light switch, etc. These items may be removed separately from the valve by disconnecting proper air lines, without the necessity of removing the valve from the vehicle. They may also be taken out WITH the valve as an assembly, if desired.

CONVENTIONAL CAB MODELS

Removal

1. To remove pedal only, remove cotter pin and drive out pedal to bracket pin.
2. To remove pedal and valve as an assembly block vehicle wheels or hold by some means other than air brakes.
3. Drain air pressure from brake system.
4. Disconnect air lines from valve both in cab and in engine compartment.
5. From engine side of cowl, remove one bolt and two stud nuts which fasten valve to cowl.
6. Remove pedal and valve assembly from inside cab.

Installation

1. Place pedal and valve assembly in position on cowl inside cab.
2. From engine compartment side of cowl, install one bolt and two stud nuts to fasten valve to cowl.
3. Connect air lines to valve, both in cab and in engine compartment.
4. Start engine and build up air pressure to operating level.
5. Check for leaks.
6. Test operation of brakes.

NOTE: Various items of special or optional equipment are often assembled in outlet ports of the valve, such as low air pressure switch, double check valve, stop light switch, etc. These items may be removed separately from the valve by disconnecting proper air lines, without the necessity of removing the valve from the vehicle. They may also be taken out with the valve as an assembly, if desired.

"COWL" MODELS

Removal

1. To remove pedal only, it is also necessary to remove the clutch pedal. Refer to "HYDRAULIC BRAKES" (SEC. 5A) under heading of "Brake Pedal Replacement (All Except Tilt Cab)" for instructions.
2. To remove valve only, block vehicle wheels or hold by some means other than air brakes.
3. Drain air pressure from brake system.
4. Disconnect air lines from valve.
5. Remove three bolts from valve and remove valve from mounting bracket, or remove two bolts from mounting bracket and remove valve, bracket and boot from firewall as an assembly.

Installation

1. Place valve (or valve, mounting bracket and boot) in position and secure with bolts.
2. Connect air lines to valve.
3. Start engine and build up air pressure in brake system.
4. Check for leaks.
5. Test operation of brakes.

NOTE: Various items of special or optional equipment are often assembled in outlet ports of the valve, such as low air pressure switch, double check valve, stop light switch, etc. These items may be removed separately from the valve by disconnecting proper air lines, without the necessity of removing the valve from the vehicle. They may also be taken out WITH the valve as an assembly, if desired.

APPLICATION VALVE SERVICEABILITY TESTS

OPERATION TESTS

Check the delivery pressure of the brake valve using an accurate test gauge connected into one of the air lines leading to the brake chambers. Depress the pedal to several positions between the fully released and fully applied positions and check the delivered pressure on the test gauge to see that it varies proportionately with the movement of the pedal. When the pedal is fully applied, the reading on the test gauge should be approximately that of full reservoir pressure. The reading on the test gauge should fall off to zero when application is released. Also, check pressures registered on the dash gauge. These should agree with test gauge readings within 5 pounds.

LEAKAGE TESTS

With the valve fully released, check the exhaust port or end of exhaust tube for leakage. No leakage is permissible. Leakage evidenced by this test is probably caused by worn or deteriorated inlet valve seal or by binding or corrosion between the exhaust valve disc and the valve cage, preventing the inlet valve from fully closing.

Make and hold a high pressure application. Coat the exhaust port and the top of the valve with soap suds. No leakage is permissible.

Leakage evidenced by these tests may be due to worn or deteriorated exhaust valve or leaking piston seals.

PREVENTIVE MAINTENANCE

BRAKE PEDAL

No regular, periodic maintenance is required. At the time of each chassis lubrication it is well to check pedal operation.

1. Tilt Cab Models. If the pedal does not move "free and easy," lubricate the pedal to bracket pin and the push rod to pedal pin with engine oil. Use oil sparingly. Do not drip oil on pedal pad.

2. Conventional Cab Models. Lubricate hinge pin and roller pin with engine oil. Use oil sparingly. Do not drip oil on pedal pad.

3. Cowl Models. Lubricate nylon bushings on clutch and brake pedal shaft and sleeve sparingly with engine oil. Also oil push rod to pedal bolt. Do not drip oil on pedal pad.

BRAKE APPLICATION VALVE

It is recommended that every year, or after 50,000 miles, whichever occurs first (and also dependent upon the type of operation and operator experience) that the application valve be removed from the vehicle, disassembled and various components inspected for wear or deterioration. Install new parts where they are found to be worn or damaged. This applies to all valves on all models.

AIR LINES

Metal tubing and flexible hose are used to connect the various units in the air brake system. Service instructions for both types follow:

METAL TUBING

Metal lines are of annealed copper tubing with three-piece compression type fittings. Flared type fittings should never be used in air brake systems. Connections should be tested at least every 5,000 miles and tightened or replaced, if necessary. When replacing metal tubing, tubing must be free of burrs, copper cuttings, and dirt. Blow tubing out with compressed air. Any of the above mentioned particles will destroy sealing seats in air control units. New tubing must be of the same size as the old tubing.

Always use a new sleeve when replacing tubing. When tightening tube connector nuts, tighten to torque listed below to assure an airtight connection. Overtightening will cause leakage. Apply S.A.E. #10 lube oil to ball sleeves, tubes, and male threads, then torque to minimum value and check for leaks. If leaking, back off tube nut approximately ¼ turn and retorque to higher than minimum value.

Tubing Size	Torque Inch-Pounds
1/4 Inch	30 to 50
3/8 Inch	30 to 50
1/2 Inch	90 to 115
5/8 Inch	100 to 125

FLEXIBLE HOSE

Flexible hose is used at each brake chamber, between cab and frame, and at trailer connections where it is impossible to use metal tubing due to constant flexing during vehicle operation. Hose connections should be tested at least every 5,000 miles and tightened or replaced if necessary. Any hose which is chafed, worn, or kinked should be replaced.

SERVICEABILITY TESTS

1. Operating Test

If any trouble symptoms, such as slow brake application or release, indicates a restricted or clogged air line, disconnect the suspected tube or hose at both ends and blow through it to make sure the passage is clear. Inspect tubing and hose for partial restriction such as would be caused by dents or kinks. If such condition is found, tubing or hose should be replaced.

2. Leakage Test

With air system fully charged and brake applied, coat all tubing and hose connections with soap suds to check for leakage. No leakage is permissible. Leakage is sometimes corrected by tightening the connection. If this fails to correct leakage, new fittings, metal tubing, or flexible hose must be installed.

TRAILER CONNECTIONS

On vehicles equipped with trailer connections, two air lines are used to connect the truck brake system to the trailer brake system. One of these lines is the "Service" line and the other is the "Emergency" line. The emergency line delivers constant air pressure to the trailer air tank and operating valve, while the service line delivers air pressure to trailer brakes only while the trailer brakes are being operated, either by means of the

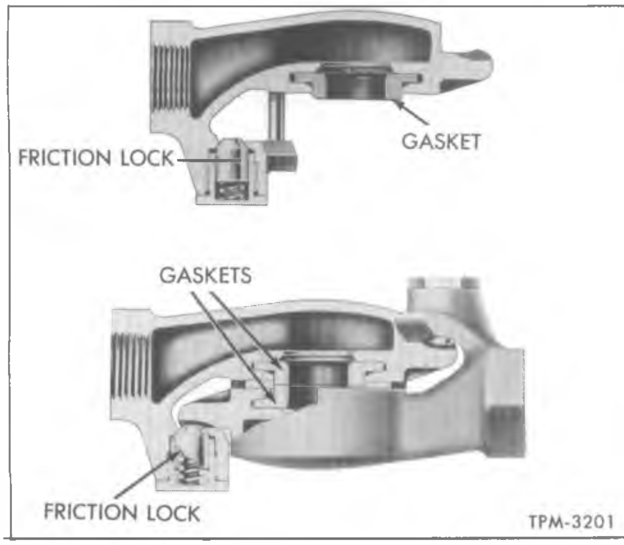


Figure 14—Trailer Hose Coupling

foot brake system or by the trailer brake hand control valve. Flexible hoses are used to make the connection between the truck and the trailer. Each hose is equipped with couplings for convenience in connecting and disconnecting the truck and trailer brake systems (fig. 14).

The emergency line is at the right side and is tagged "Emergency." The service line is at the left side and is tagged "Service." When coupling tractor and trailer make sure that air lines are properly connected. Couplings on trailer are also tagged "Service" and "Emergency." See figure 15 for illustration of trailer connections mounted on the back of a conventional cab model.

1. Couplings

Figure 14 shows a sectional view of a single hose coupling, and a view of the two couplings connected. The design of the coupling is such that when the two are connected together, pressure is placed on two rubber gaskets, making an airtight seal. The rubber gaskets should be replaced every six months, or more often under severe operating conditions.

2. Dummy Couplings

Dummy couplings are mounted on rear of cab and serve as hangers for the trailer hose when they are disconnected from the trailer. Both hoses should always be connected to the dummy couplings when not connected to the trailer.

3. Cut-out Cocks (When Used)

Cut-out cocks are used in the trailer brake lines on vehicles not equipped with trailer breakaway valve. Purpose of cut-out cocks is to provide a means of closing off these lines when they are not being used. The cut-out cock is open when the handle is at a 90-degree angle to the body, and is closed when the handle is parallel with the body. Stops are provided so the handle cannot be turned beyond its normal open and closed positions.

Cut-out cocks should be tested periodically for leakage. Connect cut-out cock to source of air pressure, build up 90 pounds pressure against it, and cover opening with soap suds. If leakage exceeds a 1-inch bubble in 3 seconds, cock should be repaired or replaced. In some instances, leakage may be caused by dirt on the key. This condition can be remedied by cleaning the key and seat with gasoline, then grinding the key to its seat with grade 400 grinding compound. Thoroughly wash off all grinding compound and coat key lightly with a good grade of cup grease before assembling. If the key or body is badly scored, the complete cut-out cock should be replaced.

1 Trailer Hose Couplings
2 Dummy Couplings
3 Brake and Electrical Lines
4 Hose Support Springs
5 Electrical Connections
6 Tractor Protection Valve

T-2346

Figure 15—Trailer Brake Connections

AIR PRESSURE GAUGE

The air pressure gauge in the instrument panel provides the driver with a means of checking system air pressure. The vehicle should never be put in motion until pressure reaches 65 pounds. If pressure reading drops to less than 65 pounds while vehicle is in motion, vehicle should be stopped and the cause of air loss corrected. Dash gauge should be checked regularly with an accurate test gauge. If pressure reading varies 4 pounds or more, replace gauge with a recalibrated unit.

LOW AIR PRESSURE SWITCH

Low air pressure switch is used with a buzzer as a low air alarm. Buzzer is also used as a part of engine alarm system. The switch is installed in a delivery port of the application valve or in a fitting which is installed in a delivery port of the application valve. Switch is adjusted and sealed by the manufacturer and is not reparable. Switch has only one wire terminal, being internally grounded.

The low air pressure switch is an air-controlled switch in an electrical circuit, automatically controlling a buzzer in the cab. A tell-tale light is also used. Refer to applicable "Wiring Diagram" in Manual X-6905 for electrical circuits.

The switch has a nominal pressure setting of 58 to 65 psi. If switch fails, it must be replaced. When installing switch, do not use sealing compound on threads, since the switch is grounded through its mounting and sealing compound will act as insulation.

TRAILER BRAKE CONTROLS

INDEPENDENT TRAILER BRAKE APPLICATION

On vehicles equipped with trailer brake hand control valve, trailer brakes may be applied without applying the truck brakes. When hand control valve lever is moved to applying position, air pressure passes through the hand control valve and double check valve into trailer brake service line, applying the trailer brakes. When hand control valve lever is returned to released position, air pressure in the trailer brake service line is exhausted from exhaust port of the control valve, releasing the trailer brakes. Any desired degree of trailer brake application is obtained by regulating the position of the hand control valve lever.

I.C.C. BRAKE SYSTEM EQUIPMENT

Some vehicles are equipped with special I.C.C. (Interstate Commerce Commision) brake system equipment in conjunction with the trailer brake controls. These controls are a tractor protection (breakaway) valve and a trailer emergency air supply control valve. These controls are provided for the following purposes:

1. They protect the tractor air system from complete loss of air pressure in the event of a trailer breakaway or loss of air pressure in the trailer air system.
2. They automatically actuate the trailer brake emergency relay valve (on trailer) in case the tractor air system pressure falls below 45 psi.
3. They provide the driver with a manual means of actuating the trailer brake emergency relay valve (on trailer).

TRAILER BRAKE HAND CONTROL VALVES

Three different trailer brake hand control valves are used on these models. Midland-Ross valve Model N-3973-H is used on all tilt cab models. The other two hand control valves are used optionally on conventional cab models. Bendix-Westinghouse (Model TC-2) and Midland-Ross (Model N-30060) are completely interchangeable.

All three valves are mounted on the steering column with the operating handle on the right-hand side (fig. 16). The valve graduates the delivered air pressure in proportion to the degree the operating handle is moved. That is the farther the handle is moved from "OFF" to "ON," the greater the air pressure delivered to the trailer brakes. If, at any time during such an application a service brake application is also made with the foot-controlled valve, whichever valve releases the greater air pressure will control the brakes.

On Midland-Ross valve Model N-30060 it is necessary to hold the handle in the desired position in order to apply trailer brakes. When handle is released, it automatically returns to the "OFF" position. The Bendix-Westinghouse valve (Model TC-2) and the Midland-Ross valve on tilt cab Models (N-3973-H) will remain in the placed position until manually moved. Other than this operation of all three valves is identical.

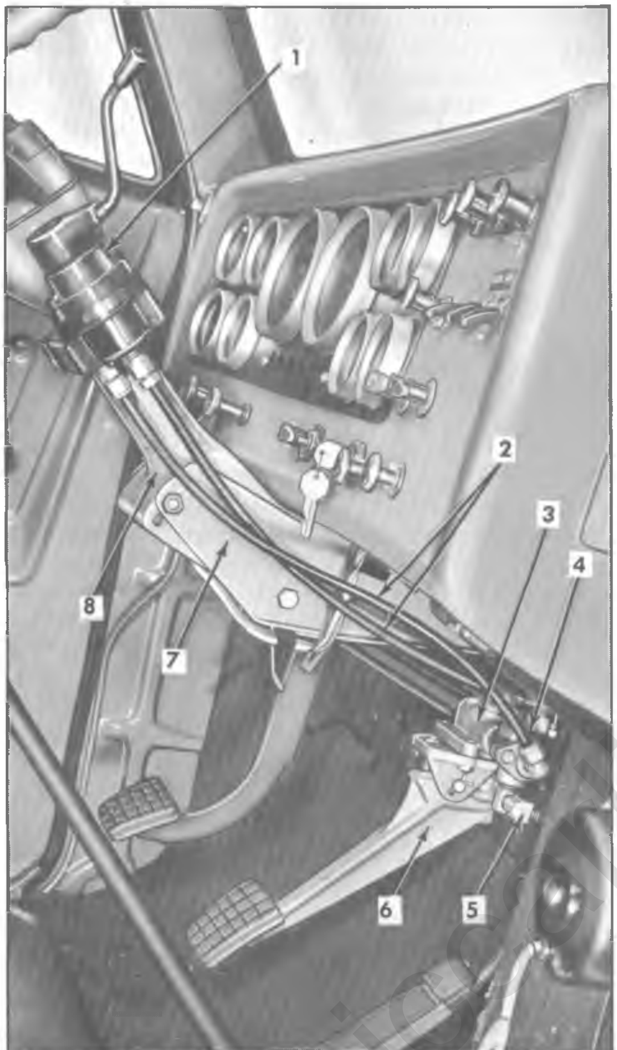
HAND CONTROL VALVE REPLACEMENT

Removal

1. Block vehicle wheels.
2. Drain air from brake system.
3. Disconnect air lines from valve.
4. Remove bolts attaching mounting bracket and valve to steering column.
5. Remove valve and bracket.

Installation

1. Position valve and mounting bracket on steering column. Fasten with bolts.
2. Connect air lines to valve.
3. Start engine and build up air pressure.
4. Check for leaks and operation of brakes.



1 Trailer Brake Hand Control Valve	5 Line to Tractor Protection Valve
2 Air Lines to Application Valve	6 Brake Pedal
3 Application Valve	7 Steering Column Bracket
4 Stop Light Switch and Double Check Valve	8 Steering Column

T-2195

Figure 16—Trailer Brake Hand Control Valve Installed—Conventional Models

TRAILER EMERGENCY AIR SUPPLY CONTROL VALVES

The trailer emergency supply control valve, working in conjunction with the tractor protection (breakaway) valve, controls the operation of the trailer brakes in EMERGENCY situations.

NOTE: THIS SYSTEM IS NOT DESIGNED TO BE USED AS A PARKING BRAKE UNDER ANY CIRCUMSTANCES.

T-2970

Figure 17—Emergency Control Valve Decal

There are two different model control valves used on these vehicles but both operate on the same principle. They are spring-loaded valves which will automatically act when pressure in the truck brake system falls below 45 psi.

Whenever the emergency air valve is actuated, either manually or automatically, truck air system pressure must be built up above 45 psi and valve knob must be manually held in to charge the trailer emergency line and release the trailer brakes.

This same type valve is also used with the DD3 brake system which is optional equipment available on tilt cab models. For information relative to the function of this valve with the DD3 system, see procedures given under that heading in this section. If a truck has BOTH the DD3 system and trailer brake controls, there will be TWO control valves and each will be properly identified.

There are two different valves used on conventional cab models, one Bendix-Westinghouse and one Midland-Ross. These two valves are interchangeable on conventional cab models as complete assemblies. However on any given vehicle, it is necessary to use a breakaway valve of the same manufacturer with each control valve; you can NOT use a B-W control valve with an M-R break-away valve, and vice versa.

On conventional models this valve is located in the engine compartment on the firewall and is connected to the knob by a push rod. The knob is located in the instrument panel in the first hole on the left side and is identified by a decal on the panel which is illustrated in figure 17.

EMERGENCY CONTROL VALVE REPLACEMENT

Removal

1. Drain air pressure from brake system.
2. Disconnect air lines.
3. Steel Tilt Cab - Remove screws from plate which holds the valve to bracket at left of steering column. Remove valve.

Conventional Cab - Disconnect knob and push rod assembly from piston stem. Remove screws which fasten valve to cowl. Remove valve from engine compartment side of cowl.

Installation

1. Position valve at mounting bracket (tilt cab) or cowl (conventional) and attach air lines.
2. Secure valve with screws. Install plate where used.
3. On conventional cab models connect knob and push rod to valve stem.
4. Start engine and build up air pressure to operating level.
5. Check for air leaks.
6. Check the operation of trailer emergency brakes.

TRACTOR PROTECTION (BREAKAWAY) VALVE

The tractor protection valve, used in conjunction with the trailer emergency air supply control valve, controls operation of the trailer brakes in EMERGENCY situations.

This valve is located on the inner side of the cab back panel on tilt cab models and on the outside of the cab back panel on conventional cab models (fig. 15).

Both service and emergency trailer brake lines are routed through this valve, and its basic function is to protect the tractor air brake system from loss of pressure in the event of pressure loss in the trailer system.

There are two optional valves used on conventional cab models, one Bendix-Westinghouse and one Midland-Ross. They are interchangeable as complete assemblies but each must be used with a control valve made by the same Manufacturer. You can NOT use a B-W breakaway valve with an M-R control valve, and vice versa. The Bendix-Westinghouse valve has two mounting bolt holes, while the Midland-Ross valve has three mounting bolt holes.

BREAKAWAY VALVE REPLACEMENT

Removal

1. Block vehicle wheels.
2. Drain air pressure from brake system.
3. Disconnect air lines.
4. Remove mounting bolts and valve.

Installation

1. Position valve on back of cab and install mounting bolts.
2. Connect air lines.
3. Start engine and build up air pressure to operating level.
4. Check for leaks.
5. Check operation of brakes.

SERVICEABILITY TESTS

Operating Tests

1. Pull out emergency air valve knob to exhaust air pressure from breakaway valve control line. Disconnect trailer emergency line from emergency outlet port at breakaway valve and connect an air pressure test gauge to emergency outlet port.
2. Start engine and build up air pressure in system. Low air pressure buzzer should stop operating at 58 to 65 psi. With air pressure in operating range, push emergency air valve knob in. Test gauge should show full air system pressure. Then pull knob out; test gauge should drop to zero.
3. Again build up air pressure in system to operating range, then stop engine. Push emergency air valve knob in. Make a series of brake applications until low air buzzer sounds. Slightly open drain cock in the dry air tank to obtain a slow (approx. 10 psi per min.) pressure drop in the tractor brake system. When truck air system drops to 45 psi (approx.), the emergency air valve knob should automatically come out and pressure on test gauge should rapidly drop to zero.

Leakage Tests

1. Build up air pressure in truck brake system to operating range. Push in emergency air valve knob to charge trailer brake system. Use soap suds to coat exhaust ports of emergency air valve and breakaway valve.
2. When emergency air valve leaks excessively, install new piston O-rings. When breakaway valve leaks excessively, install new O-rings and plunger seal.

DOUBLE CHECK VALVE AND STOP LIGHT SWITCH

A combination double check valve and stop light switch is used in brake systems on all conventional models equipped with trailer brake controls. Check valve is used to connect both the foot brake application valve and the trailer brake hand control valve to the trailer brake service line. Check valve is installed in delivery port in brake application valve. Air line from trailer brake hand control valve connects to other end of check valve. Trailer brake service line and truck stop light switch are connected to the two side outlet ports.

CHECK VALVE OPERATION

When brake application is made by the foot brake valve, air pressure from the foot brake valve forces the shuttle valve over against the inlet from the hand control valve and flows out the holes in the valve guide into the trailer brake service line. When foot brakes are released and trailer brakes are applied by means of the hand control valve, air pressure from the hand control valve forces the shuttle valve over against the inlet from the foot brake valve and flows out through the holes in the valve guide into the trailer brake service line.

CHECK VALVE SERVICEABILITY TESTS

1. Operating Tests

a. Apply truck brakes and note that brakes apply promptly on both the truck and the trailer. Release truck brakes and note that brakes on truck and trailer both release promptly.

b. Move hand control valve lever to applied position and note that brakes apply only on the trailer. Move control valve lever to released position and note that trailer brakes release promptly.

2. Leakage Tests

a. Apply truck brakes and check for leakage at hand control valve exhaust port, using soap suds.

b. Apply trailer brakes only with hand control valve and check for leakage at truck brake application valve exhaust port, using soap suds.

c. No leakage is permissible in either of these tests. If there is any leakage, replace the shuttle valve.

CHECK VALVE REPLACEMENT

Removal

1. Block vehicle wheels.
2. Drain air pressure from brake system.
3. Disconnect air lines from valve.
4. Screw valve out of brake application valve.

Installation

1. Screw valve into brake application valve.
2. Connect air lines.
3. Start engine and build up air pressure to operating level.
4. Check for leaks.
5. Check operation of brakes and stop lights.

FRONT BRAKE LIMITING VALVE AND TWO-WAY CONTROL VALVE

A combination limiting and quick release valve and a two-way control valve are used in combination on some vehicles as shown in figure 18. This combination permits full brake valve delivery pressure to the front brakes when on dry roads, or at the option of the driver, limits the pressure to the front brakes to 50 percent of the brake valve delivery pressure when on slippery roads.

The two-way control valve (handle or knob) is mounted on instrument panel within easy reach of the driver. On tilt cab models, a plate showing "DRY ROAD" and "SLIPPERY ROAD" positions is mounted on the dash panel and a flip-type lever is used to select the desired position. On all other models, there is a knob on the dash panel marked "FRT. BRAKE LIMIT." When pushed in the valve is in "DRY ROAD" position. Pull knob out for "SLIPPERY ROAD" position. On conventional cab models the valve is located inside the cab. On "cowl" models the valve is inside the engine compartment. In both cases, the valve is mounted on a bracket fastened to the firewall with two bolts.

The limiting quick release valve is mounted on frame crossmember near the front brake chambers. One air line from brake application valve is connected to the inlet port of the two-way valve and another connects to the brake valve port at top of limiting quick release valve (fig. 18). Another air line connects the side delivery port of the two-way valve to the port opposite the mounting pad of the limiting quick release valve. The two other side ports of the limiting quick release valve are connected to the front brake chambers.

The limiting quick release valve, besides providing for a 50 percent reduction of front wheel brake pressure, also serves as a quick release valve when brakes are released.

SERVICEABILITY TESTS

1. Operating Tests

a. Connect an air pressure test gauge into the air line leading to the rear brake quick release or relay valve; disconnect air line at valve and connect gauge to line if no other convenient connecting point is available. Disconnect one front brake chamber line from port at side of limiting quick release valve and connect another test gauge to this port.

b. Place the handle or knob of the two-way valve in the "DRY ROAD" position and apply the truck brakes. Both test gauges should read the same. Place the handle of the two-way valve in the "SLIPPERY ROAD" position and apply the truck brakes. The test gauge at the limiting quick release valve should read approximately one-half the amount shown on the test gauge connected to the rear axle air line.

2. Leakage Tests

a. Place the handle or knob of the two-way valve in "DRY ROAD" position and with the truck

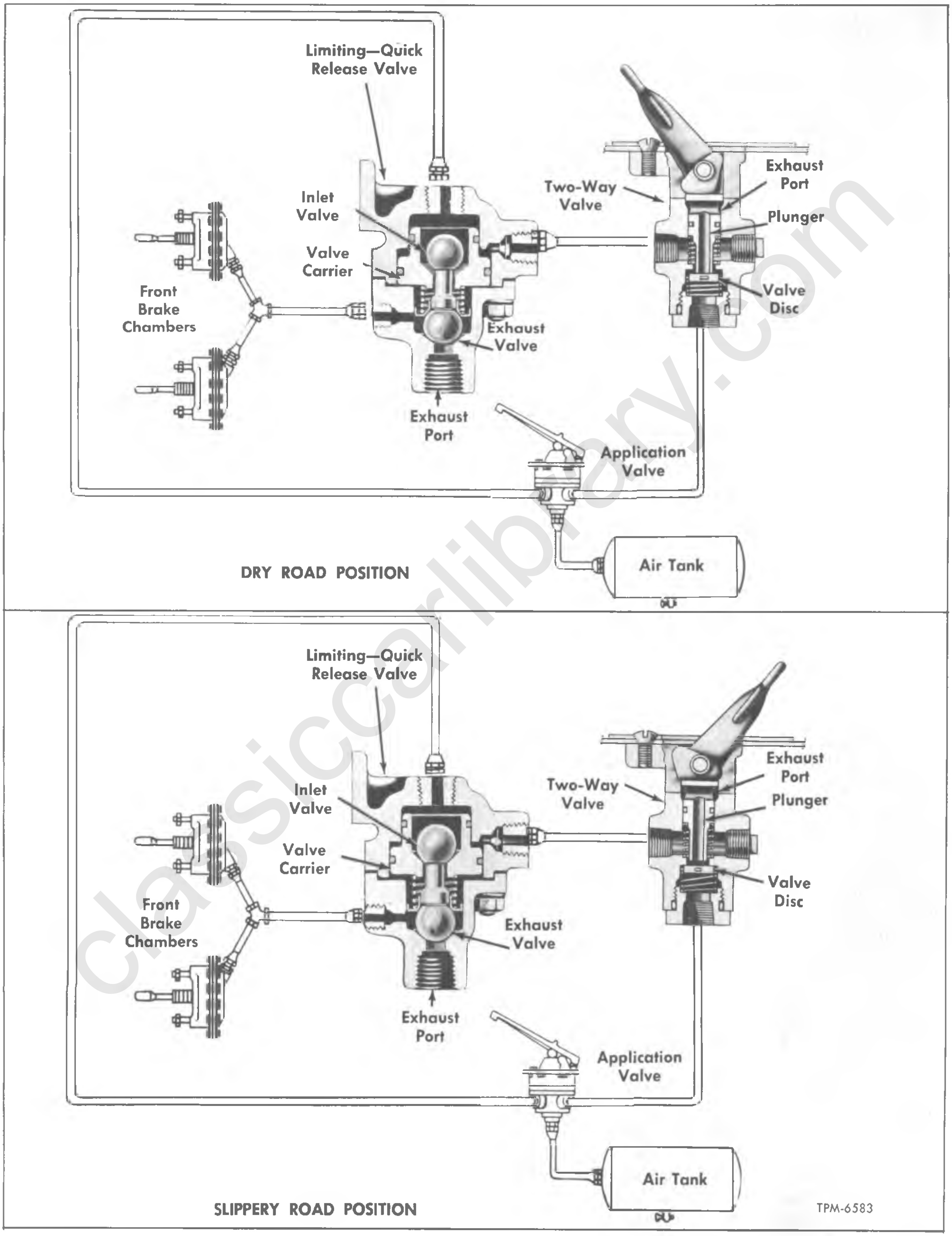


Figure 18—Front Brake Limiting and Two-Way Control Valve Operation

brakes applied, coat the exhaust ports of the two-way valve and limiting quick release valve with soap suds. If leakage is excessive, replace valve.

b. Place handle of two-way valve in "SLIPPERY ROAD" position and with truck brakes applied, coat exhaust port of two-way valve with soap suds. If leakage is excessive, replace valve.

TWO-WAY VALVE REPLACEMENT

IMPORTANT: Before disconnecting air lines, either scribe a line or put a daub of paint on one air line and corresponding port on valve. It is possible to connect the air lines to this valve in the opposite position, with the result that the brake application pressures would be opposite to that intended; that is, with valve knob in "SLIPPERY ROAD" position, brake application would be for "DRY ROAD" conditions and vice versa.

Removal

1. Block vehicle wheels.
2. Drain air pressure from brake system.
3. Disconnect air lines.
4. On tilt cab models remove screws and remove plate and valve from instrument panel.
5. On other models, disconnect rod from lever and remove bolts and valve from bracket.

Installation

1. Position valve in instrument panel or on fire wall and connect air lines.
2. On tilt cab models fasten valve and plate to instrument panel with screws.
3. On other models, fasten valve and bracket to fire wall.
4. Start engine and build up air pressure.
5. Check for leaks.
6. Check operation of brakes.

LIMITING VALVE REPLACEMENT

Removal

1. Block vehicle wheels.
2. Drain air from brake system.
3. Disconnect air lines.
4. Remove bolts which fasten valve to vehicle. Remove valve.

Installation

1. Connect air lines.
2. Position valve and fasten with bolts.
3. Start engine and build up air pressure.
4. Check for leaks.
5. Check operation of brakes.

DD3 BRAKE ACTUATOR SYSTEM

DESCRIPTION

The DD3 brake actuator system consists of three major units connected by air lines. These are, the brake actuator (chamber), a push-pull control valve (for manual parking and emergency application), and an inversion valve (to direct the flow of air pressure to either parking or locking chambers). Of these three units the actuator is used by either the service or parking systems, while the other units are used wholly by the parking system to operate the foundation brake. These three units are used in conjunction with a standard foot control valve and a slack adjuster connection to standard cam-operated wheel brakes.

Since this DD3 system serves both parking and service brake systems, information on mechanical parking brake in sub-section for "PARKING BRAKE" applies to those vehicles which do not have DD3 parking brake.

The name of the system is derived from the description of the actuator (chamber). "DD" denotes the double diaphragm and the suffix "3" denotes the triple action for service, parking and emergency braking. The actuator functions normally as a service brake chamber but in addition has a means of mechanically locking a brake application so it can be used for parking. The DD3 brake actuator is used only at the rear wheels. Standard air-operated chambers are used at the front wheels.

SERVICE BRAKE OPERATION

Figure 19 shows schematically how the system works. With the handle of the push-pull control valve pushed in, air pressure from the parking reservoir is delivered through the push-pull control valve to the control port of the inversion valve. From there it is routed to the lock port of the DD3 brake actuator. Air pressure, acting on the actuator piston moves it forward to contact the rollers which roll up the ramp of the piston holding them away from the push plate shaft. This allows the push plate and shaft to move freely in both directions for normal service brake application and release.

PARKING OPERATION

To park, the handle of the push-pull control valve is pulled out. This action closes the inlet valve, closing off any further air supply to the push-pull valve control port (and from there through the inversion valve to the DD3 brake actuator lock port). At the same time, this "pulling out" action opens the exhaust valve of the push-pull control valve, which allows the lock port of the DD3 brake actuator to vent through the control port of the inversion valve and then through the push-pull

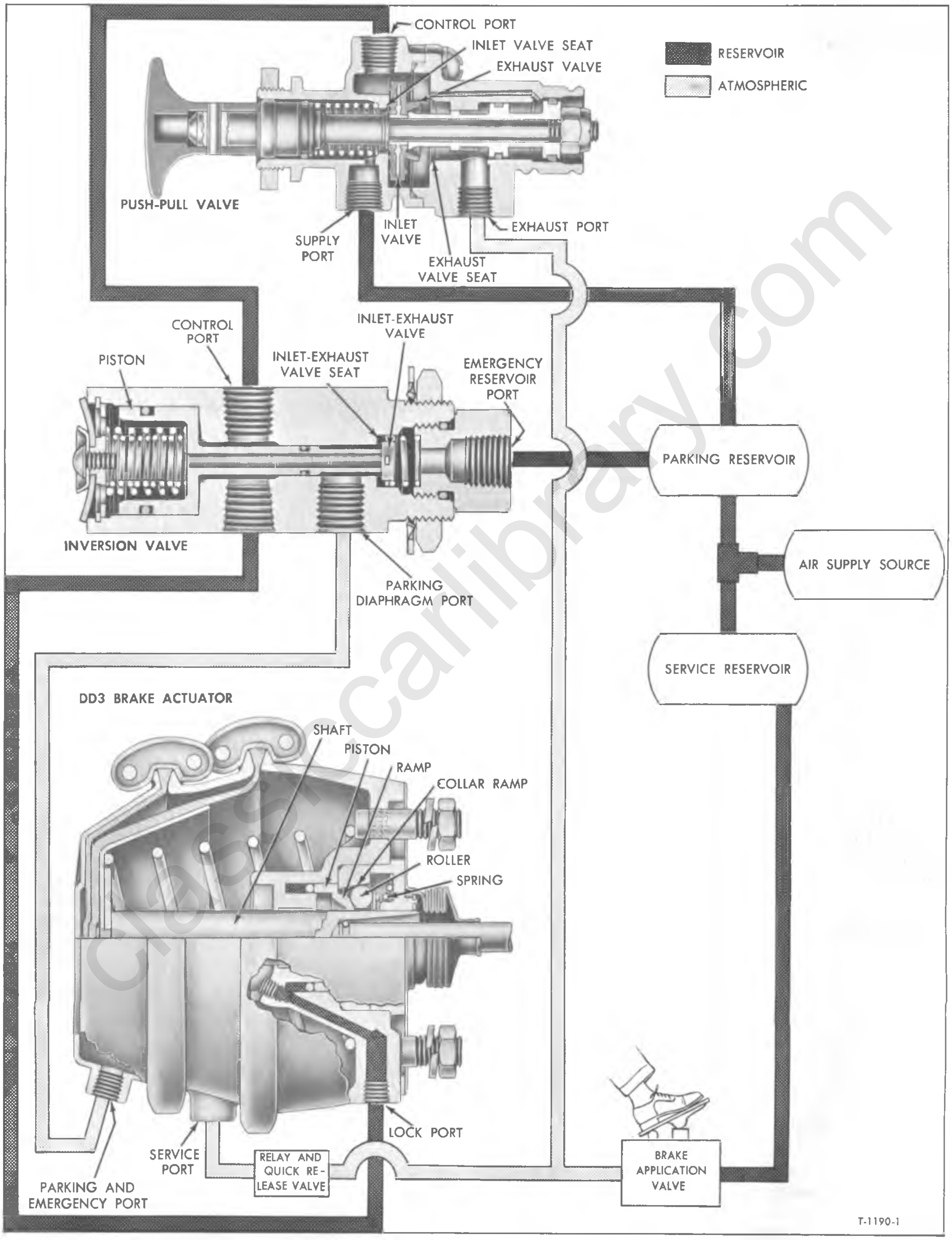


Figure 19—Schematic Diagram of DD3 Brake Actuator System

control valve and the open exhaust port of the foot control valve.

When the DD3 brake actuator lock port is vented the roller spring forces the rollers against the ramp on the collar to engage them with the push plate shaft.

When the control port of the inversion valve is vented, the inversion valve piston moves forward and opens the inlet exhaust valve. This opens the line from the parking reservoir and allows air pressure to flow into the parking port of the DD3 brake actuator. Full parking reservoir pressure is delivered and a parking brake application results. With the rollers against the shaft, the shaft can move forward but is locked so that it cannot return for release. To release parking brake application it is necessary to have full pressure in the air system, "push in" on push-pull control valve (make sure it stays "in") and make a full 100 psi service brake application.

EMERGENCY OPERATION

The vehicle is equipped with an air pressure gauge (in the instrument cluster) and (as optional equipment) a low air pressure buzzer. When the operator is aware of a loss of air pressure as indicated by the gauge or the buzzer, and the service brakes will not stop the vehicle, a manual emergency application of the parking brake should be made by pulling out the handle of the push-pull control valve. Brakes then operate as described under the heading of "Parking Operation."

In the event the operator does not respond to the warning system or if the system fails to function, or if the loss of air pressure is too sudden for action, and if the air pressure in the parking reservoir falls below 40 psi, the push-pull control valve will automatically "pop" out, causing pressure in the DD3 actuator lock port to exhaust, which will result in an automatic parking (emergency) brake application.

DD3 BRAKE ACTUATOR OPERATION

(Refer to Figure 19)

NORMAL RUNNING

Through the push-pull control valve and an inversion valve, air enters the actuator locking port and exerts pressure on the locking piston grommet. The resultant force moves the locking piston forward against the rollers and roller spring. The beveled, or ramp, end of the piston will pick up and hold the rollers away from the shaft. As long as air pressure remains against the locking piston grommet and the rollers are not in contact with the shaft, normal service brake applications will permit the shaft to move freely, back and forth, past the locking mechanism. When a normal service brake application is made, air enters the actuator service port and applies pressure against the service diaphragm. The diaphragm moves the push plate and shaft out, applying the brakes. Upon the release of the service application, the brakes are released.

PARKING

To park, air is exhausted from the locking port and air is applied against the parking diaphragm through the parking diaphragm port. When air is exhausted from the lock piston, the roller spring forces the rollers against the collar and shaft. Air entering the parking port exerts force on the parking diaphragm. The diaphragm moves the push plate and shaft out, applying the brakes. With no air on the lock piston, the shaft becomes mechanically locked in the applied position as the rollers wedge between the shaft and collar.

NOTE: While in a parked position, when there is a loss of air pressure on the parking diaphragm, the output force on the shaft is reduced. However, the shaft will not retract since its output force is transferred to the mechanical lock mechanism.

RELEASE OF PARKING APPLICATION

To release a parking application of the DD3 brake actuator, it is necessary to re-apply air pressure to equal a shaft force approximately the same as was used in making the parking application. This is necessary to release the locking rollers so they can be moved away from the shaft when air is re-applied to the locking piston. This can be accomplished by making a 100 psi service application after the push-pull control valve is "in" to release the parking application.

To release a parking application, air enters the locking piston and the air on the parking diaphragm is exhausted. A full 100 psi service brake application will be necessary to force the shaft forward sufficiently to allow the locking rollers to disengage and unlock the shaft. Upon release of the service application, the return spring will return the shaft to the release position.

In the event of a loss of air from the service system and it becomes necessary to move the vehicle before service air can be restored, the brakes may be manually released as follows:

IMPORTANT: BLOCK WHEELS OF VEHICLE BEFORE RELEASING BRAKES.

Exhaust any air pressure remaining in the parking reservoir by opening drain cock, then back off the slack adjuster at each rear brake chamber. If necessary, disconnect slack adjuster from chamber push rod clevis.

PREVENTIVE MAINTENANCE DD3 BRAKE ACTUATOR

Depending on experience and type of operation, the drain slot in the actuator non-pressure plate should be checked and cleared periodically.

Brakes should be adjusted as is customary with any brake chambers. Push rod travel should be as short as possible without brakes dragging. Excessive travel not only shortens the normal service life of diaphragms but gives slow braking response, wastes air, and decreases brake torque output.

Push rod to slack adjuster alignment should be checked in both the applied and released positions, the rod should move out and return properly without binding. Also, check the angle formed by the slack adjuster arm and push rod. It should be 90° or greater in any position, after adjustment.

It is recommended that every year, or after 50,000 miles whichever occurs first (and also dependent upon type of operation, and operator experience) that brake actuators be removed from vehicle and disassembled.

Disassemble DD3 brake actuator, clean all parts and lubricate locking mechanism. A special barium base grease (or its equivalent) is recommended as a lubricant.

When diaphragms or return spring or both are replaced, like parts in the corresponding brake actuator on the same axle should also be replaced.

OPERATING AND LEAKAGE CHECKS DD3 BRAKE ACTUATOR

OPERATING

With the brake actuator in the released position, make several service brake applications and note that actuators apply and release properly. Operate parking push-pull control valve and observe that actuators apply. While actuators are in a parking position, drain air supply to parking diaphragm and note that actuators remain applied.

Replenish air supply to auxiliary diaphragm. Operate push-pull control valve to release parking application, then make a 100 psi service application to complete release of actuators. The magnitude of the service brake application to release the brakes may vary on different vehicles due to compressor governor setting. A service application of approximately 100 psi will release the brakes.

LEAKAGE

With air system at maximum governor pressure and DD3 brake actuators in the released position, check drain slot and around the push rod boot with a soapy solution to detect possible leakage past the locking piston grommet.

Make and hold a service brake application and again check the actuator drain slot for service diaphragm leakage. Continue to hold the service application and coat around the service and parking diaphragm clamping rings with the soapy solution to detect seal leakage.

Operate the actuator control valve to a parking position and check the exhaust port of a service brake application to detect parking diaphragm leakage. This parking diaphragm leakage detection point could be the exhaust port of the foot brake valve, quick release valve or relay valve. While still in a parking position, the parking diaphragm clamping ring should be coated with the soap solution to detect seal leakage.

Should leakage be detected at the clamping rings in either of the above tests, the clamping ring nuts should be tightened evenly but only enough to stop leakage.

If the DD3 brake actuator does not function as described, or leakage is excessive, it is recommended that it be repaired or replaced.

DD3 BRAKE ACTUATOR REPLACEMENT

(Refer to Figure 20)

REMOVAL

1. Block and hold vehicle by some means other than air brakes.

2. With the brake actuators in the released position, disconnect or completely remove air brake hoses from parking and service ports of the actuator.

3. At this point, exhaust air from parking reservoir. This may be done by opening the drain cock in the reservoir tank or by pulling out the push-pull control valve button.

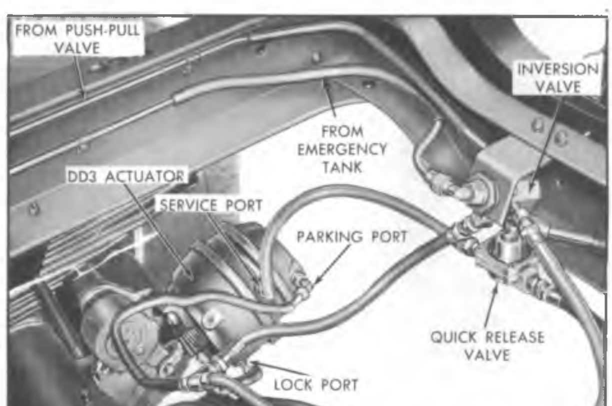


Figure 20—DD3 Brake Actuator System Installed at Rear Axle

> NOTE OF CAUTION: Air will be exhausted out the line that was connected to the parking port, if the push-pull control valve is operated. If this line is not removed, it should be disconnected in such a way that it will not whip and cause damage as the air exhausts.

4. As a safety precaution, the service system should also be drained.
5. Disconnect air brake hose at actuator lock port.
6. Remove yoke pin cotter pin and knock out yoke pin.
7. Remove mounting nuts, then actuator.

INSTALLATION

IMPORTANT: DD3 brake actuators must be installed with the drain slot pointing down and towards the center line of the vehicle.

1. Mount actuator to mounting bracket and tighten securely.
2. Fasten actuator push rod yoke to slack adjuster with yoke pin. Lock yoke pin with cotter pin. The angle formed by the push rod and slack adjuster arm should be greater than 90°.
3. Connect air brake hoses to actuator taking precautions that the proper hose is installed in the correct port, and hoses are positioned for proper movement during coach operation.
4. Adjust brakes.
5. Build up air pressure in system and test operation of brakes.
6. Test for leaks.

INVERSION VALVE DESCRIPTION

The inversion valve is used in combination with the DD3 brake actuators and push-pull control valve in a parking and/or emergency system. When the push-pull control valve is operated, the inversion valve operates permitting air in the parking reservoir to apply the brakes. The inversion valve also operates automatically when air pressure drops to a predetermined pressure (40 psi).

The inversion valve employs a 1-1/4" diameter hole mounting. The valve serves as a manifold having a total of six (6) 1/4" pipe ports: three (3) control ports, two (2) delivery ports and one (1) supply port. These ports are identified. The control ports are marked "C," supply "S" and the delivery ports are marked "D." The exhaust port is protected by a diaphragm.

INVERSION VALVE OPERATION

With no air pressure in the system, the inversion valve inlet valve is open and its exhaust is closed. On initial build-up, as air enters the parking reservoir to which the inversion valve supply port is connected, it will pass by the open inlet and out the delivery ports. When system air pressure reaches between 50 and 60 psi and the push-pull control valve is pushed in, air will pass into the inversion valve from the push-pull control valve. This air flows in one control port and exerts a force on the inversion valve piston. At a pressure between 60 and 70 psi, the piston moves against the resistance of the two (2) piston springs. The piston exhaust seat moves away from the inlet and exhaust valve, opening the exhaust passage. The inlet valve spring and supply air in the inlet valve will cause it to seat. Air at the inversion valve delivery will now exhaust from the valve exhaust port.

PARKING OR EMERGENCY

The air at the inversion valve control ports is exhausted through the push-pull control valve exhaust when it is operated. The piston springs will then cause the piston to move and seat on the inlet and exhaust valve closing the exhaust passage. The inlet valve is moved off its seat by the piston, so that supply air from the parking reservoir will pass by the open inlet and out delivery ports.

When the application is released by pushing in on the push-pull control valve, air passes into the inversion valve control port. The piston moves away from the inlet and exhaust valve, opening the exhaust passage through the piston. The inlet valve closes and air in the delivery ports will exhaust through the center of the piston stem and out the inversion valve exhaust port.

PREVENTIVE MAINTENANCE

The manufacturer recommends that every year or after 50,000 miles the inversion valve be disassembled, cleaned and lubricated. Lubricate with a barium base grease (or equivalent).

Rubber parts should be replaced and any other parts which show signs of wear or damage should also be replaced.

INVERSION VALVE OPERATING AND LEAKAGE CHECKS

OPERATING

With the air brake system built up to governor cut-out pressure and the brakes released, operate by pulling out the push-pull control valve button to apply the brakes. Note that the brakes apply.

Operate by pushing in the push-pull control valve to release the brake application and note that the delivered air from the inversion valve is exhausted out its exhaust port. The operation of the push-pull control valve will not necessarily complete the release of the brakes. A full 100 psi service brake application after the push-pull control valve is pushed in should complete the release.

LEAKAGE

Start leakage checks with system pressure up to governor cut-out and brakes released. Check the inversion valve exhaust port for possible leakage at (1) the large piston grommet; (2) the piston stem grommet or; (3) the inlet valve or its seat. Slight leakage is permissible. While the inversion valve is still in this position, the cap nut should be checked for leakage by the seal ring.

Actuate push-pull control valve by pulling out on the button to apply the brakes, then check the inversion valve exhaust port for exhaust valve or seat leakage.

If the inversion valve does not function as described or leakage is excessive, it is recommended that it be repaired or replaced.

INVERSION VALVE REPLACEMENT

(Refer to Figure 20)

REMOVAL

1. Block and hold vehicle by means other than air brakes.
2. Drain service and parking reservoir air supply.
3. Disconnect air lines and air brake hoses from inversion valve.
4. Loosen mounting nut and remove valve.

INSTALLATION

1. Check and clean air lines to valve.
2. Mount valve securely with mounting nut and lock washer.
3. Connect air lines and air brake hoses.
4. Check for proper operation and leaks.

PUSH-PULL CONTROL VALVE DESCRIPTION

The push-pull control valve is located in the dash panel. It is to the right of the steering column. The valve has a black knob which moves in and out ("push-pull") for operation. The lettering on the knob is illustrated in figure 21. A red colored ring on the knob, when exposed, indicates that parking brake is on. The valve has four ports; two delivery, one supply and one for connection to the service brake foot control valve. The push-pull valve directs the flow of air to the DD3 brake actuator through the inversion valve. The direction of flow is controlled within the valve by a combination inlet and exhaust valve in conjunction with the position of the knob ("push" for service, - "pull" for parking).

Figure 21—DD3 Control Valve Knob

CONTROL VALVE OPERATION

For operation of the push-pull control valve, refer to figure 19 and the description given previously under "Service Brake Operation," "Parking Operation" and "Emergency Operation."

CONTROL VALVE REPLACEMENT

REMOVAL

1. Secure vehicle by some means other than air brakes.
2. Exhaust air from parking brake system. It is unnecessary to exhaust service air.
3. Disconnect air lines from push-pull control valve. Mark lines to assure installation in correct valve ports when replacing valve.
4. Drive spirol pin out of button and remove button.
5. Remove mounting nut from valve body and remove valve from dash panel.

INSTALLATION

1. Position valve on dash panel and secure with mounting nut.
2. Place button on plunger shaft, line up hole in button with hole in plunger shaft and drive in spirol pin.
3. Connect air lines to push-pull control valve ports making sure lines are connected to correct ports.
4. Build up vehicle air pressure system, and check valve for operation and leaks.

SYNCHRO VALVE

The purpose of the Synchro valve is to activate the trailer emergency brakes when tractor emergency push-pull control valve is pulled. It joins the trailer emergency brake system to the tractor parking and emergency brake system. It is used only on vehicles which have trailer brake connections and air operated emergency brakes (L4000 only).

AIR BRAKES

On tractors which have an air operated emergency brake system (such as DD3), as opposed to those having a mechanically applied emergency brake, this valve is used to apply both tractor and trailer emergency systems simultaneously. The basic purpose of this type application is to prevent trailer "jack-knife" conditions, which can result from applying only tractor brakes while vehicle is in motion.

The Synchro valve is mounted in the air line system controlling the trailer emergency valve. It is installed in the lines at the cab front cross sill, in or near the junction block in the sill. It is accessible with cab tilted, or from underneath with cab in normal position. The supply of air from the Synchro valve is connected to the control port of the tractor protection valve.

SERVICEABILITY TESTS

1. Operating Test. Pull knob of push-pull control valve (tractor emergency brake) and note that trailer emergency brakes also apply. Push knob of push-pull control valve and note that trailer emergency brakes release. A 100 psi foot valve brake application will be necessary to complete release of tractor brakes.

2. Leakage Test. Using soap suds, check for leakage both with brakes applied and released. If any leakage is evident, remove valve from vehicle and repair or replace.

REPLACEMENT

Removal

1. Block vehicle wheels or make a parking brake application (with DD3 system, parking brake is effective after air is exhausted).
2. Exhaust air from brake system.
3. Disconnect air lines from synchro valve and remove valve.

Installation

1. Place valve in position and connect air lines.
2. Start engine and build up air pressure to at least 100 psi.
3. Push "in" on control valve knob and make a service brake application. This will release the parking brake application.
4. Test as directed in applicable procedure.

ANCHORLOK BRAKE CHAMBERS

"Anchorlok" brake chambers are used as optional equipment on all 5500 and 6500 Series trucks. Refer to figure 22.

The "Anchorlok" chamber is used as a service brake chamber, an emergency brake in case of air pressure loss and a spring-applied parking brake. It consists of two separate air chambers, each having its own diaphragm and push rod. In the front chamber, air pressure enters behind the diaphragm when brake pedal is pushed, causing a service brake application, just as in any standard chamber. The rear chamber is subject to constant air pressure in front of the diaphragm, compressing the emergency parking spring. In the event of loss of air pressure in the rear chamber, or intentional exhausting of pressure by the driver, the spring will apply the brakes. Application will begin when pressure drops to approximately 45 psi and will be complete when pressure reaches approximately 25 psi.

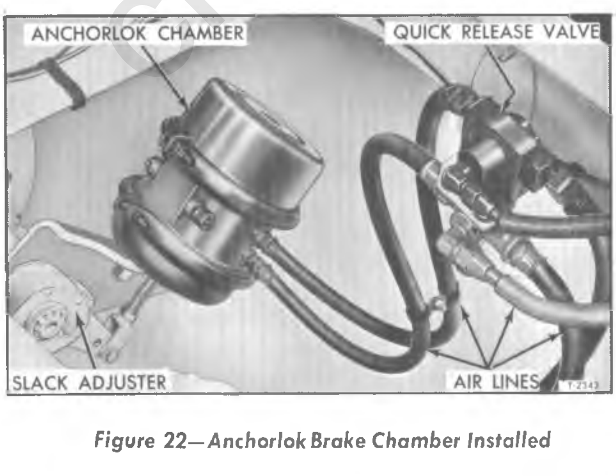


Figure 22—Anchorlok Brake Chamber Installed

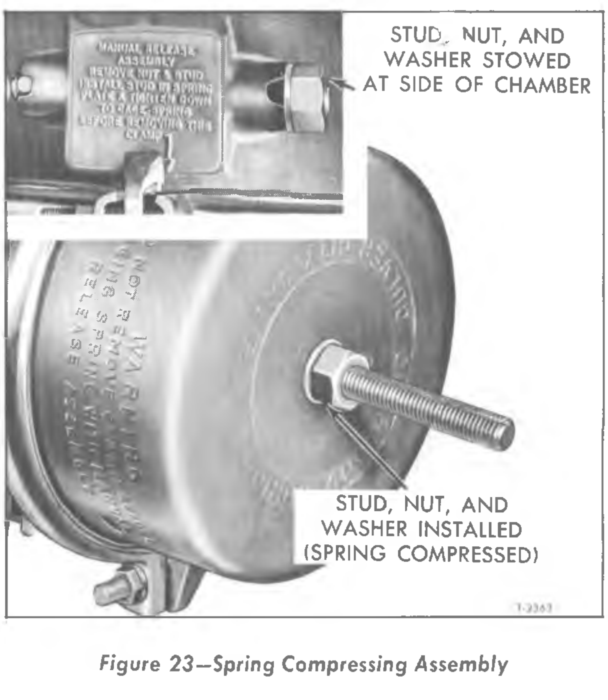


Figure 23—Spring Compressing Assembly

In the event of an automatic emergency application (loss of air pressure) and it is necessary to move the vehicle before air pressure can be restored, the emergency parking spring can be compressed mechanically to release brake. A spring"caging" tool is part of the chamber assembly. Remove nut and release stud from its storage place on chamber body. Remove spring housing rubber cap and insert stud in hole. Secure stud in place (1/4 turn) and "cage" spring by tightening nut with wrench. Directions are also given for this operation on the body of the chamber (see fig. 23). This same procedure is followed if the chamber is to be removed from the vehicle for service.

A manual emergency application (or parking application) may be made by the driver by pulling out the knob on the instrument panel which controls manual application. Release of a parking or emergency application can be made by pushing in this same knob, provided there is at least 45 pounds pressure in the air brake system.

BRAKE CHAMBER REPLACEMENT

REMOVAL

1. Block vehicle wheels.

2. With brakes released, remove "spring-caging" tool from its storage place. Remove spring housing rubber cap, insert stud in hole and turn 1/4 turn. Run nut down on stud until finger tight, then use wrench to turn nut at least three turns. Spring is now "caged."

NOTE: If both chambers are to be removed, perform step 2 on each BEFORE proceeding further.

3. Open air tank drain valves and exhaust pressure from brake system.

4. Disconnect air lines at chamber.

NOTE: If only the emergency parking chamber needs to be removed, this may be done at this point by removing rear clamp ring and lifting rear chamber assembly off front (service) chamber.

5. Disconnect push rod clevis from slack adjuster.

6. Remove nuts and lock washers from mounting studs.

7. Remove "Anchorlok" brake chamber from mounting bracket.

INSTALLATION

1. Place "Anchorlok" chamber in position on mounting bracket.

2. Install lock washers and nuts on studs.

3. Connect push rod clevis to slack adjuster.

4. Connect air lines at chamber.

5. Start engine and build up air pressure to operating level. Make sure knob is pushed in on emergency parking brake valve on instrument panel.

6. Back off nut from "caging" stud in end of chamber. Remove stud and replace in storage pocket on chamber housing. Install rubber cap over release stud hole.

7. Check operation of brakes.

8. Check for leaks.

FRONT BRAKE SHOES AND ANCHOR PINS

BRAKE SHOES

(Refer to Figure 24)

One-piece molded lining is riveted to each shoe. Lining should be replaced before it becomes worn to the extent that the rivets will damage the brake drum. Make sure new lining fits firmly against shoe and that all rivets are properly upset. When brake drums have been machined oversize, shims should be used between lining and shoe or oversize lining used to maintain proper lining-to-drum contact. Refer to "Brake Drums" in this section. Maximum braking efficiency can be obtained immediately if linings are trued-up with a conventional lining grinder so they are properly centralized in relation to center of hub.

Whenever any part of the brake assembly has been removed and replaced, adjust brakes as directed under "Brake Adjustments."

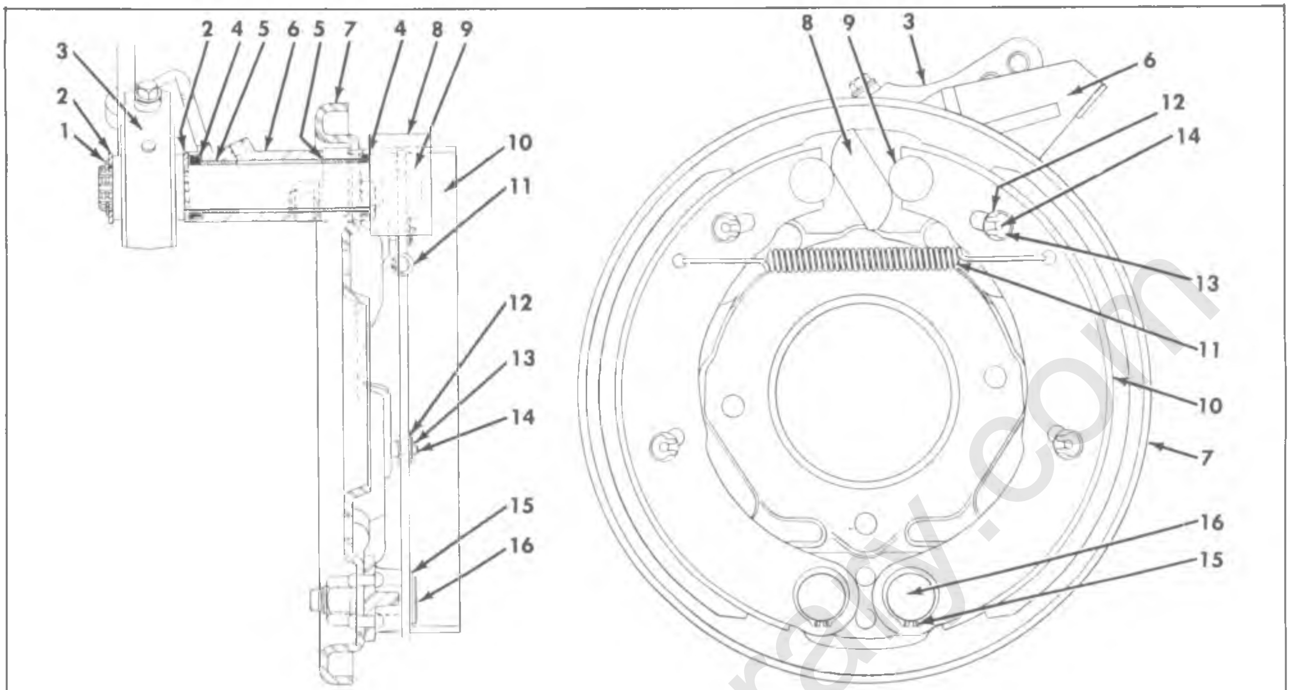
ANCHOR PINS

Anchor pin ends of shoes are secured on the anchor pins by lock rings. Shoe ends are not equipped with bushings; if shoes or anchor pins become worn, parts must be replaced. Contact between cam ends of shoes and cam is made through rollers. No lubricant should be applied at rollers or cam head; anchor pin ends should be coated with S-17 Special Lubricant or equivalent at assembly. Guide pins, two for each shoe, hold shoes in alignment on backing plate.

CAMSHAFTS

Front brake camshafts have constant lift type cams forged integral with shaft. Camshafts are mounted in camshaft and brake chamber brackets which are bolted to backing plate (fig. 24). Each

AIR BRAKES



1 Lock Ring	6 Camshaft and Brake Chamber Bracket	11 Brake Shoe Return Spring
2 Spacer	7 Backing Plate	12 Guide Pin Washer
3 Slack Adjuster	8 Cam (integral with shaft)	13 Guide Pin "C" Washer
4 Camshaft Seal	9 Cam Roller	14 Guide Pin
5 Camshaft Bushing	10 Brake Shoe	15 Lock Ring
		16 Anchor Pin

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Figure 24—Front Brake Assembly

bracket is equipped with two bushings and a lubrication fitting. Space between bushings acts as a lubricant reservoir. Lubricant should be applied sparingly at intervals specified in LUBRICATION (SEC. 0) in this manual.

CAUTION: Do not overlubricate camshaft, as excess lubricant will be forced into brake drums.

Slack adjuster, mounted on splined end of camshaft, is held in place by a lock ring. A spacer is used on each side of slack adjuster. Whenever camshaft has been removed, coat bushing surfaces with S-17 Special Lubricant or equivalent before installing. After installation, apply lubricant as directed in LUBRICATION (SEC. 0), and adjust brake as directed under "Brake Adjustments."

Refer to "Front Suspension" under "FRONT HUBS AND BEARINGS" (SEC. 3D) for removal of wheels, hubs, and brake drums for access to brake shoes.

"S" CAM REAR BRAKES

"S" cam brake assemblies are used on rear axle of all tilt cab models and all 5500 Series models. All 6500 Series models use "Stopmaster" brakes at rear axle. Brake assembly can be removed as a complete assembly; however, the various components must be replaced individually.

The brake assembly is mounted on the brake spider, which is bolted to flange on axle housing.

Brake assembly shown in figure 25 is a typical Wagner brake assembly.

BRAKE SHOES AND ANCHOR PINS

(Refer to Figure 25)

Refer to "Rear Suspension" under "REAR HUBS AND BEARINGS" (SEC. 4C) for removal of wheels, hubs, and brake drums for access to brake shoes.

Each brake shoe consists of a shoe table with two shoe webs welded in place. At anchor end, shoe webs straddle the mounting flange on brake spider and pivot on anchor pins. Anchor pins are

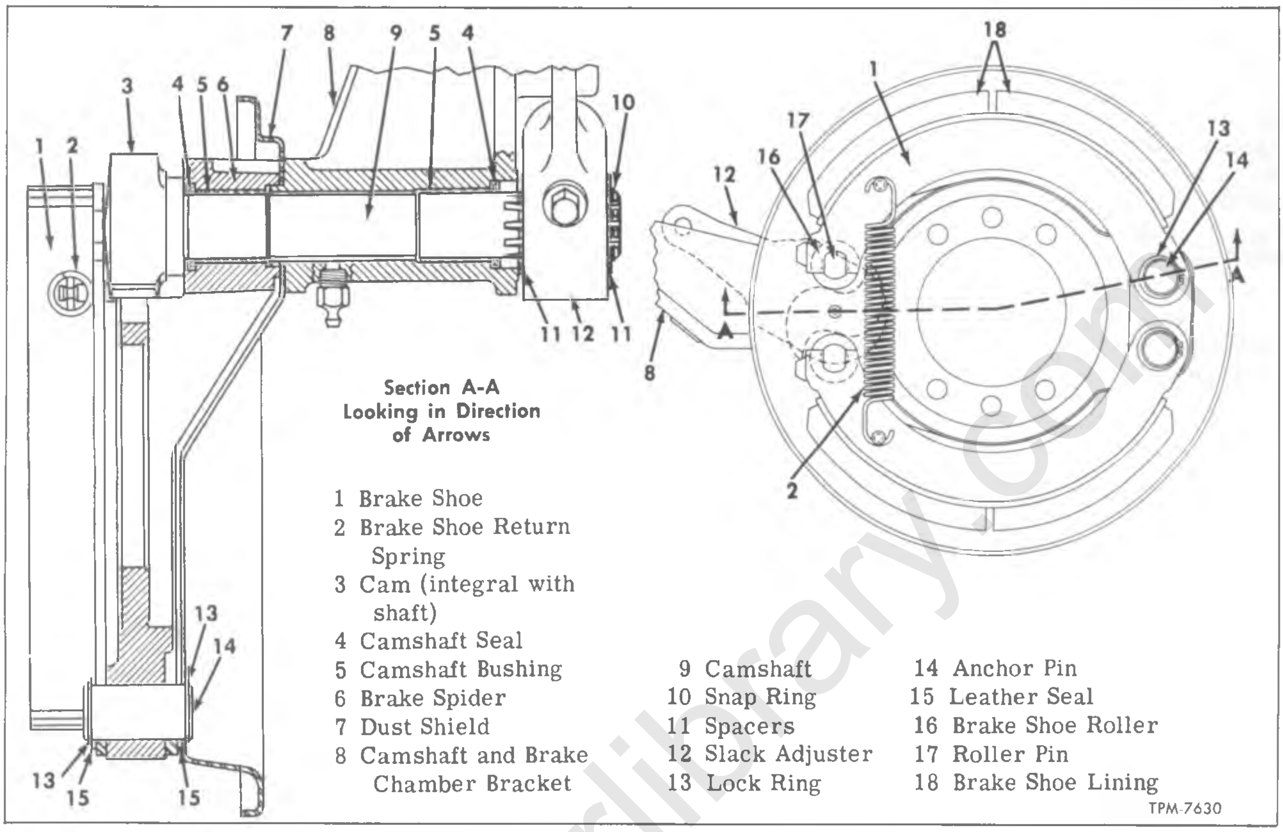


Figure 25—Rear Brake Assembly

held in place by a lock ring at each end. A leather seal is used between lock ring and shoe web at outer end and between dust shield and shoe web at inner end to retain lubricant and exclude dirt. Shoe ends are not equipped with bushings; if shoes or anchor pins become worn, parts must be replaced. Refer to figure 26 for cross-sectional view.

At cam end of each shoe, a roller installed between shoe webs on a roller pin makes the contact between shoes and cam. Flats on end of roller pin fit into notches in shoe webs. Tension of brake shoe return spring holds shoe rollers firmly against cam. Return spring pins are staked in 8 places so that they will not slide out of shoe webs. No lubrication is required at rollers or roller pins; parts should be assembled clean and dry. Anchor pin ends should be coated with S-17 Special Lubricant or equivalent during installation.

A two-piece molded lining is riveted to each shoe. Linings should be replaced before wear exposes the rivet heads and causes damage to brake drums. Both linings on each shoe are identical and can be installed at either end. New linings must be securely riveted to shoe with correct size rivets, and rivets must be properly upset. Maximum braking efficiency can be obtained immediately if linings are trued-up with lining grinder so they are properly centralized in relation to center of hub.

Whenever any part of the brake assembly has been removed and replaced, adjust brakes as directed under "Brake Adjustments."

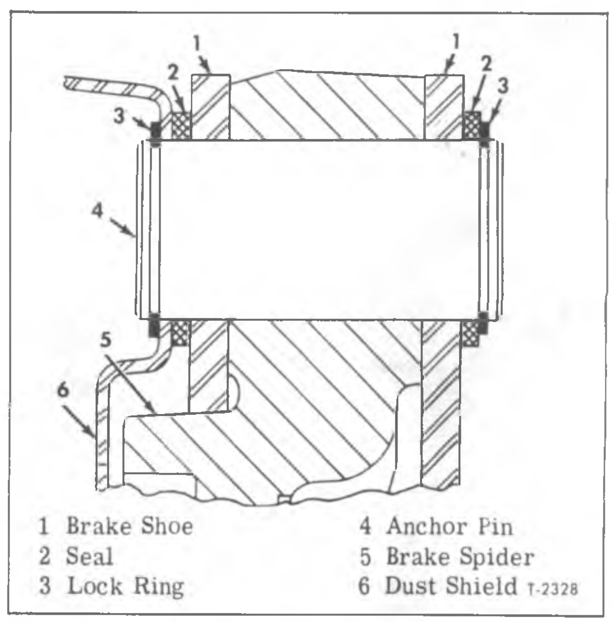


Figure 26—Rear Brake Shoe Anchor Pin Installation

CAMSHAFT

Rear brake camshafts have constant lift, S-type cams forged integral with shaft. Camshaft is carried in a bushing in brake spider at outer end, and in a bushing in camshaft and brake chamber bracket at inner end. Camshaft and brake chamber bracket is bolted to brake spider in conjunction with the brake dust shield. Lubrication fitting in bracket provides a means of lubricating both bushings; space between bushings serve as a lubricant reservoir. Seals, in outer end of camshaft bore in brake spider and in inner end of bracket, retain lubricant and exclude dirt. Apply lubricant at intervals indicated in LUBRICATION (SEC. 0).

CAUTION: Do not overlubricate camshaft, as excess lubricant may be forced by the seals into the brake drums.

Slack adjuster, mounted on splined end of camshaft, is held in place by a lock ring. A spacer is used on each side of slack adjuster. On the brake assembly shown in figure 25, the two spacers (11) are the same; on some models equipped with offset slack adjusters, the inner spacer is thicker than the outer spacer. Whenever camshaft has been removed, coat bushing surfaces with S-17 Special Lubricant or equivalent before installing. After installation, apply lubricant as directed in LUBRICATION (SEC. 0), and adjust brakes as directed under "Brake Adjustments."

BRAKE DRUMS

Brake drum installations are illustrated in "Rear Suspension" in "REAR HUBS AND BEARINGS" (SEC. 4C), and in "Front Suspension" under "FRONT HUBS AND BEARINGS" (SEC. 3D). By referring to the illustrations in the above sections, methods of replacing brake drums are readily discernible.

Whenever brake drums are removed for servicing brakes, inspect drums. If found to be scored, rough, or out-of-round, drums should be machined.

Machining or grinding of brake drums increases the inside diameter of the drum and changes the lining to drum fit. When machining drums, it is recommended that the following maximum oversizes not be exceeded:

(a) Drums with standard diameter up to 14" can be machined up to .060" oversize.
(b) Drums with standard diameter over 14" can be machined up to .080" oversize.

When it is found that machining to these maximum limits does not provide a suitable braking surface, discard the worn drum and replace with a new standard drum.

DO NOT EXCEED THESE LIMITS. THIS IS SAFETY PRECAUTION.

STOPMASTER BRAKES

The Stopmaster type brake differs from the conventional "S" cam type brake in several respects. The air chamber push rod is connected to the brake shoes through a series of wedges, rollers, and plungers rather than through a slack adjuster and camshaft. Stopmaster brakes are used at the rear wheels only. Stopmaster brakes employ two different type air chambers; (1) a standard air chamber which is operated by air pressure and (2) a "Fail-Safe" air chamber which can be operated either by air pressure or by spring pressure. There are three basic variations of Stopmaster brakes shown in figure 27; standard, single axle "Fail-Safe," and tandem axle "Fail-Safe."

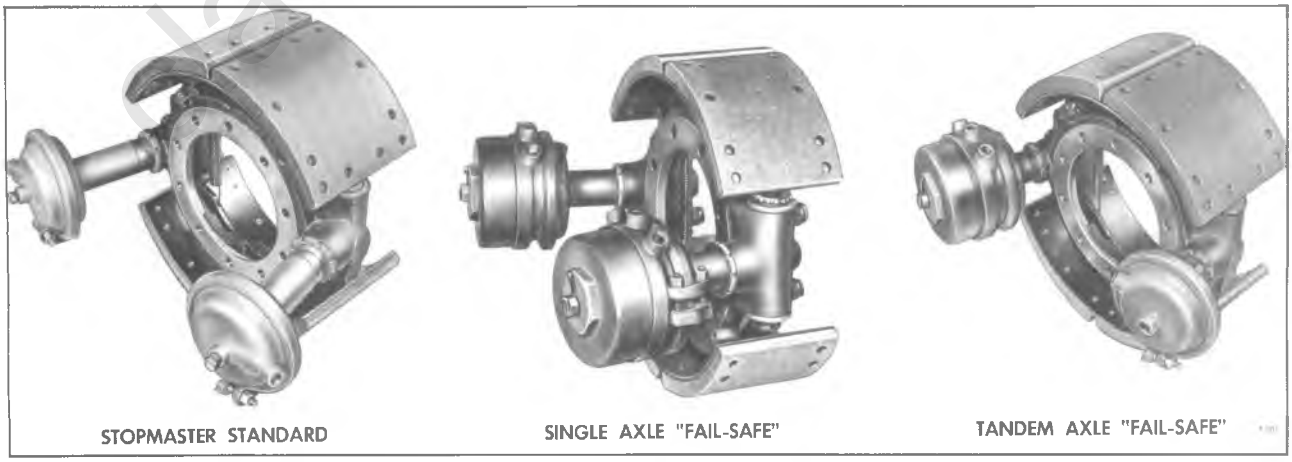


Figure 27—Stopmaster Brake Assemblies

AUTOMATIC ADJUSTER

All Stopmaster brakes have automatic adjuster mechanisms. The basic part of the adjuster (refer to fig. 28) is a plunger assembly which is made up of the adjusting plunger, the actuator, and the adjusting bolt. The actuator is threaded internally to receive adjusting bolt. On the external surface, there are buttress type teeth. The plunger guide is free to slide in a drilled hole in the spider housing and has teeth to match those on the exterior surface of the actuator. A spring, gasket, and bolt are used to hold the guide in contact with the actuator.

Figure 29 is an illustration of an automatic

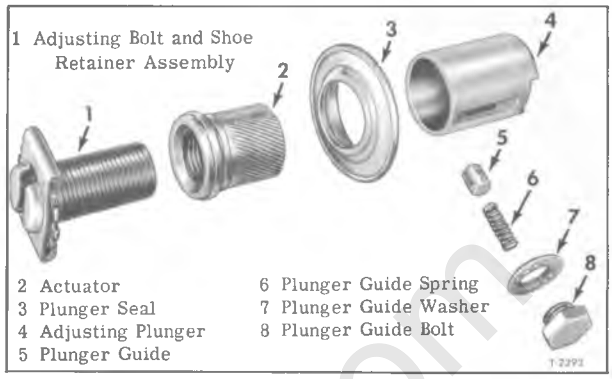
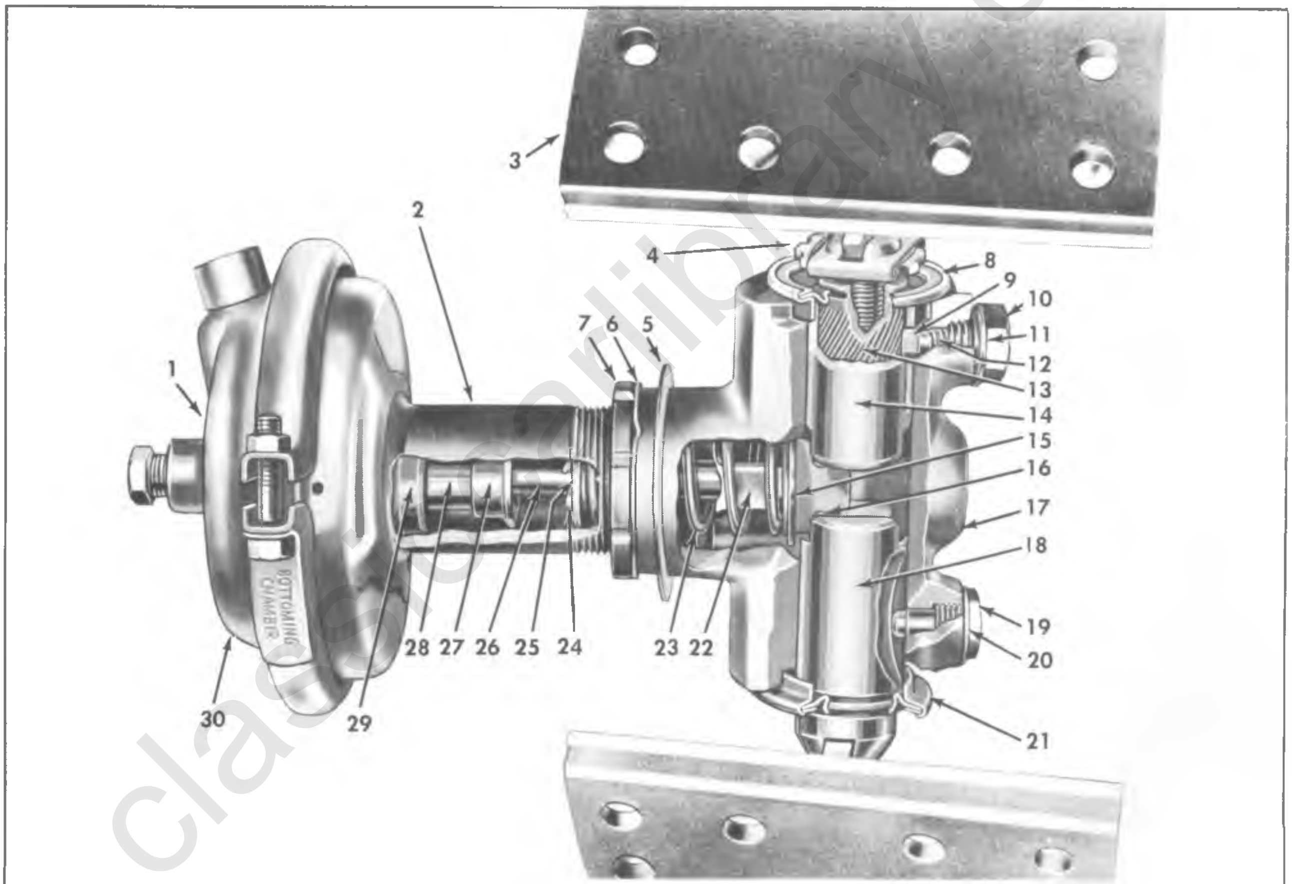


Figure 28—Automatic Adjuster Components



1 Brake Air Chamber Assembly	11 Gasket	21 Plunger Seal and Retainer
2 Non-Pressure Half	12 Spring	22 Roller Retaining Cage
3 Brake Shoe Assembly	13 Adjusting Sleeve (Actuator)	23 Wedge Spring
4 Adjusting Bolt Assembly	14 Adjusting Plunger	24 Cotter Key
5 Identification Ring	15 Wedge Spring Retainer	25 Washer
6 Spanner Nut Retainer	16 Roller	26 Wedge Shaft
7 Spanner Nut	17 Plunger Housing	27 Wedge Guide
8 Plunger Seal and Retainer	18 Anchor Plunger (Solid)	28 Diaphragm Plate (Push Rod)
9 Adjusting Pawl (Plunger Guide)	19 Guide Screw	29 Rubber Boot
10 Hollow Cap Screw	20 Gasket	30 Pressure Half

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Figure 29—Automatic Adjuster Assembled

adjuster assembly installed. When the plunger assembly is moved outward to apply the shoe against the drum, the plunger guide will slide across the sloping sides of the teeth on the actuator. If the plunger assembly moves outward and exceeds the pitch distance, the teeth on the guide will engage the next teeth on the actuator. When the plunger returns, the actuator must rotate in order to allow the assembly to return to the "in" position. This rotation is caused by the angle of the teeth. As the actuator rotates, it screws the adjusting bolt. The distance for the plunger to move before adjusting is controlled either by the angle of the teeth, and/or the number of teeth. This travel establishes the lining-drum clearance.

The plunger guide has two flat sides, which are a slip fit in a slot in the adjusting plunger. This performs two functions: (1) it prevents the guide from turning, and (2) it prevents the adjusting plunger from turning in the housing.

In order to function properly the adjusting bolt must not turn. If it rotates with the actuator, no adjustment would occur.

The combination of the number of teeth on the outside of the actuator and the number of threads per inch on the adjusting bolt establishes the actual linear advance or rate of adjustment.

Figure 30—Installing Adjusting Bolt

Procedures covering the removal and installation of automatic adjuster components are given in the following paragraphs.

Any time the adjuster assemblies are removed for service they should be lubricated as directed in the following procedures.

The adjuster system should be disassembled whenever brake shoes are relined and inspected for the general condition of all moving parts. It is advisable to use new plunger seals and plunger guide gaskets when removing and installing these parts.

REMOVAL (Refer to Fig. 28)

1. Remove brake shoes and brake chambers as detailed under applicable procedures.
2. Remove bolt and plunger guide gasket from housing.
3. Remove spring and plunger guide.
4. Unscrew adjusting bolt from actuator.
5. Using a screwdriver, pry plunger seal out of spider housing.
6. Remove actuator and adjusting plunger.

INSTALLATION (Refer to Fig. 28)

NOTE: Make sure that adjusting mechanism is installed at proper end of spider so that brake shoe ends are mounted in proper position. Also make certain that all parts are properly lubricated. All threads on all components should be coated with lubricant to assure smooth, free operation. The tip of the plunger guide and the entire plunger should also be coated. See LUBRICATION (SEC. 0) for type of lubricant to be used.

1. Install new seal on adjusting plunger and actuator.
2. Install adjusting plunger and actuator in spider housing.
3. Tap plunger seal into place in spider housing. See figure 36.
4. Screw adjusting bolt into actuator to the full length of threads, then back off 1/4 turn so that screw will not jam and fail to adjust when assembly is complete. See figure 30.
5. Install plunger guide in spider housing. The end of the guide with teeth is installed first and the flat sides of the guide must fit into the slot in the adjusting plunger to mesh with the outer teeth of the actuator.

CAUTION: The chamfered notch on the back end of the guide must be toward the plunger seal end of the housing, otherwise the automatic adjustment feature will not functiom. When properly assembled, if adjusting bolt is turned in one direction, the brake will adjust and if turned in opposite direction a ratcheting effect will result. When assembled wrong, a ratcheting effect will result

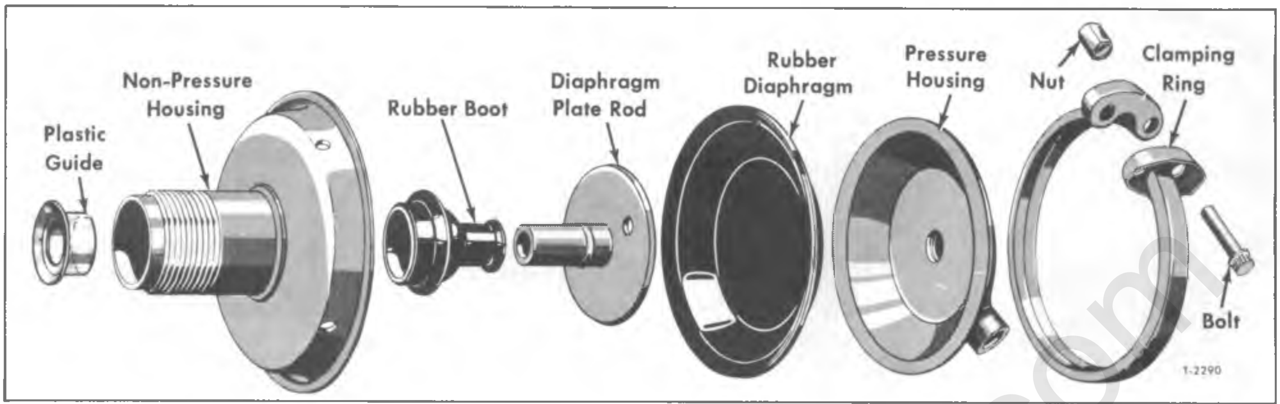


Figure 31—Standard Stopmaster Air Chamber Components

regardless of which direction adjusting bolt is turned.

6. Install spring, gasket and bolt.
7. Install anchor plunger components as described under "Brake Actuation Components."
8. Install brake shoes and brake chamber as detailed under applicable procedures.

INITIAL ADJUSTMENT

If a new installation has just been made as described above, start engine and build up required amount of air pressure in system. Then pump the brake pedal until the automatic adjuster system adjusts enough to provide sufficient brake for safe driving. Final adjustment is made with the vehicle in motion, by pumping the pedal.

SERVICING STANDARD STOPMASTER BRAKE CHAMBERS

It is recommended that all brake chambers be removed, disassembled, inspected and thoroughly cleaned at the time that brakes are relined or at one year periods, whichever occurs first (also dependent upon type of operation and operator experience). Thorough cleaning, proper lubrication and replacement of any worn parts on a preventive maintenance basis will assure proper operation of the system at all times.

Instructions covering the removal and service of standard chambers follows (refer to fig. 31):

REMOVAL AND DISASSEMBLY

1. Disconnect air lines from chambers.
2. Using a punch, drive lock washer protrusions from notches in spanner nut and spider housing.
3. Using a spanner wrench or a punch and hammer, loosen spanner nut which secures air chamber to brake spider housing.
4. Remove air chamber assembly from brake spider housing.
5. Remove bolt and nut which secure clamping ring.
6. Scribe a mark across the pressure housing and the non-pressure housing to assure proper reassembly.
7. Remove diaphragm, rod, boot and guide from housings.

CLEANING AND INSPECTION

1. Clean all metal parts thoroughly, using a suitable cleaning fluid. Blow dry with air or wipe dry with cloth. (Do not use solvent on diaphragm.)
2. Examine diaphragm and replace with new part if any signs of wear or deterioration are evident.
3. Inspect pressure housing for scratches, scores, or excessive wear. Examine all parts for obstructions and remove any foreign matter.
4. Examine diaphragm plate rod boot for deterioration or cracks. If deterioration or other damage is evident, replace. In order to replace boot it is necessary to remove the plastic guide from the end of the rod. If the guide is damaged or worn, it too should be replaced. Apply a liberal amount of rubber cement to boot flange and mating surface on non-pressure housing.

BRAKE CHAMBER ASSEMBLY AND INSTALLATION

1. Install boot, rod, guide and diaphragm in non-pressure housing.
2. Position pressure housing on non-pressure housing so that scribe marks made at disassembly are aligned.
3. Install clamping ring on assembly and secure with bolt and nut.
4. Install air chamber in brake spider housing until it "bottoms" in spider. Then back off not more than one full turn to position chamber ports in line with air tubes. The plastic guide will assure proper positioning of the wedge. At this point lock the air chamber in position by tightening the

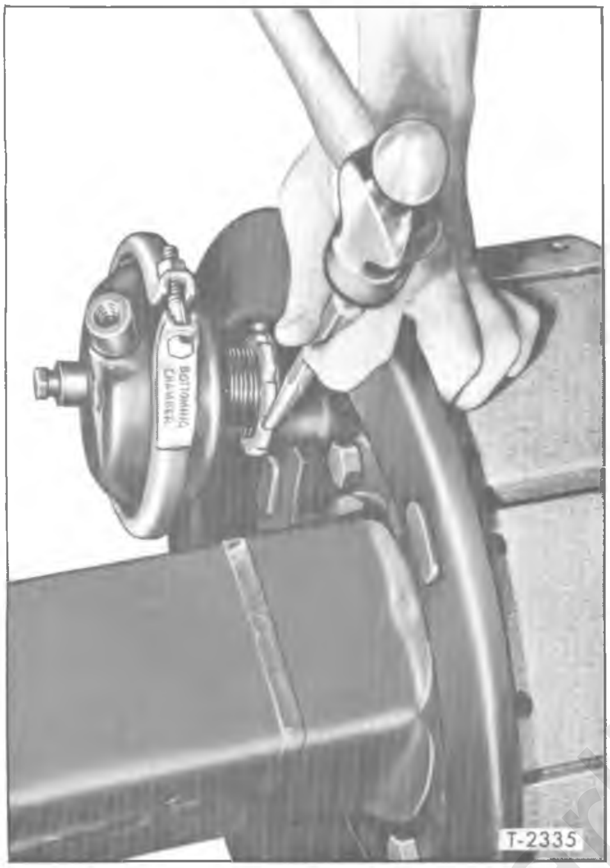


Figure 32—Staking Air Chamber Lockwasher

spanner nut against lock washer and the spider housing. Using a punch, drive edge of lock washer into notches provided in spider housing and spanner nut (see fig. 32).

BRAKE SHOE AND LININGS

BRAKE SHOE REMOVAL (Refer to Fig. 33)

1. Jack up rear of vehicle and remove wheels.
2. Remove hub and brake drum assembly. Refer to "Rear Suspension" under "REAR HUBS AND BEARINGS" (Sec. 4C) of this manual.
3. Remove brake shoe return springs.
4. Lift brake shoe web out of shoe hold-down clip and out of notches in anchor and adjusting plungers. NOTE: Mark adjusting end of brake shoes to insure correct reassembly.

SHOE RELINING

Each brake shoe consists of a shoe table with a single web welded in place. A two-piece molded lining is riveted to each shoe. Lining should be replaced before wear exposes the rivet heads and causes damage to brake drums. Both linings on each shoe are identical and can be installed at either end. New linings must be securely riveted to shoe with correct size rivets, and rivets must be properly upset. Maximum braking efficiency can be obtained immediately if linings are trued-up with a lining grinder so they are properly centralized in relation to center of hub.

BRAKE SHOE INSTALLATION
(Refer to Fig. 33)

1. Position brake shoe webs inside hold-down clips with ends engaging slotted end of anchor plungers and slotted end of adjusting bolt.

NOTE: Brake shoes are constructed with a 4-inch radius on the adjusting end and a 3-inch radius on the anchor end. When installing shoes on brake assembly, make certain the end marked as suggested in "NOTE" of step 4 of "Removal" is mounted in adjusting plunger.

2. Install brake shoe return springs. Make certain hold-down clip applies pressure to shoe web to avoid cocked shoes.

BRAKE ACTUATION COMPONENTS

Actuation components can be serviced without removing spider from axle. Trouble diagnosis might indicate faulty internal parts which would not necessitate brake chamber disassembly or new brake lining. Actuation components should be inspected for faulty or unacceptable conditions.

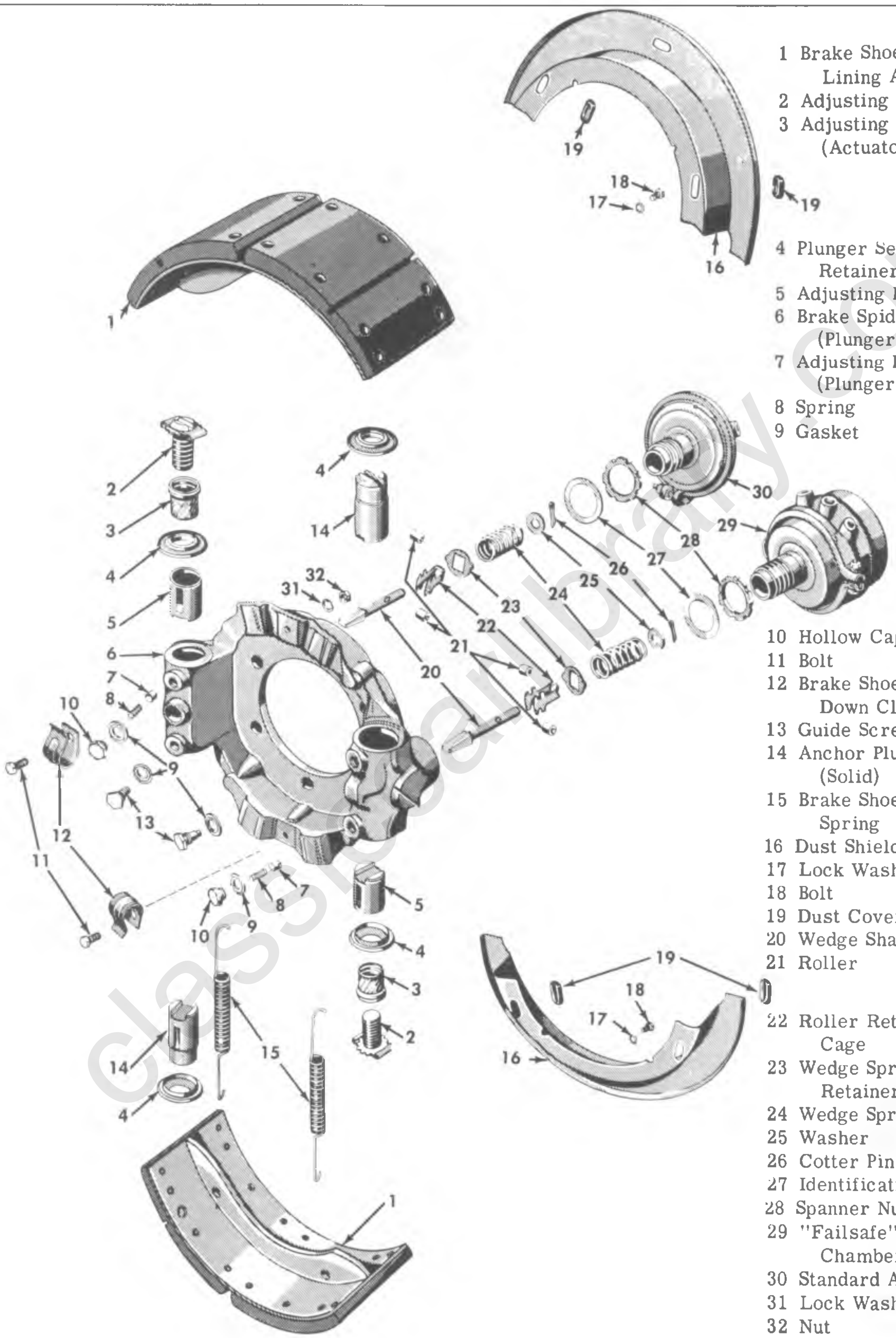
For service of automatic adjuster components see procedures under that subject on a previous page of this section. The following procedures cover the anchor end components and other actuation components.

REMOVAL (Refer to Fig. 33)

1. Remove brake chambers. Refer to procedures covering standard and/or "Fail-Safe" chamber service.
2. Loosen spanner nut, then unscrew non-pressure housing from brake spider. This leaves wedge, roller and spring assembly exposed.
3. Remove wedge, roller and spring assembly from actuation housing by pulling straight out.
4. Remove brake shoes. Refer to procedure covering this operation.
5. Remove plunger guides and washers.
6. Pry plunger seal from spider housing.
7. Remove anchor plunger.
8. Remove automatic adjuster components as described in applicable procedures.

DISASSEMBLY OF WEDGE ASSEMBLY
(Refer to Figs. 33 and 34)

1. Remove cotter pin and wedge return spring washer from wedge assembly.
2. Slide wedge spring off wedge.
3. Remove wedge retainer washer and rollers from roller retaining cage.



1 Brake Shoe and Lining Assembly
2 Adjusting Bolt Assy.
3 Adjusting Sleeve (Actuator)
4 Plunger Seal and Retainer
5 Adjusting Plunger
6 Brake Spider (Plunger Housing)
7 Adjusting Pawl (Plunger Guide)
8 Spring
9 Gasket
10 Hollow Cap Screw
11 Bolt
12 Brake Shoe Hold-Down Clip
13 Guide Screw
14 Anchor Plunger (Solid)
15 Brake Shoe Return Spring
16 Dust Shield
17 Lock Washer
18 Bolt
19 Dust Cover
20 Wedge Shaft
21 Roller
22 Roller Retaining Cage
23 Wedge Spring Retainer
24 Wedge Spring
25 Washer
26 Cotter Pin
27 Identification Ring
28 Spanner Nut
29 "Failsafe" Air Chamber
30 Standard Air Chamber
31 Lock Washer
32 Nut

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Figure 33—Stopmaster Brake Components (Automatic Adjuster with "Fail-Safe")

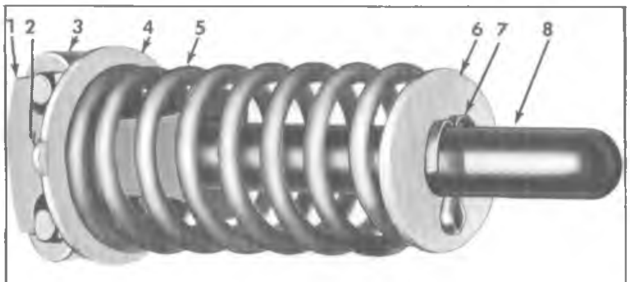


Figure 34—Wedge and Roller Assembly

CLEANING AND INSPECTION

All components should be thoroughly cleaned prior to inspection and reassembly.

1. Inspect wedge for bent or distorted condition. Examine bearing surfaces for scoring or wear. Replace wedge if there is evidence of wear or distortion.
2. Examine rollers for any wear or out-of-round condition. No scratches or scoring is permissible.
3. Examine wedge spring for fatigue or corrosion. Replace spring if necessary.
4. Inspect actuation housing cylinder bores for scores, scratches, or corrosion. Light scratches or slightly corroded spots may be polished out with crocus cloth. Never use emery cloth or sandpaper. If scratches or corrosion are too deep to be polished out, spider must be replaced.

Inspect plungers for scoring, scratches, or corrosion. Light scratches may be polished out with crocus cloth. If scratches or corrosion are too deep to be polished out, plunger must be replaced.

6. Inspect plunger seal for any cracking or deterioration. Any deterioration is unacceptable and seal should be replaced.

ASSEMBLY OF WEDGE ASSEMBLY
(Refers to Figs. 33 and 34)

1. Install rollers in retaining cage.
2. Place washer in position on retaining cage.
3. Install wedge in retaining cage.
4. Position spring on wedge against washer and compress enough to install return spring washer and cotter pin.

INSTALLATION (Refer to Fig. 33)

1. Install new seals on anchor plungers as shown in figure 35.
2. Install plungers and seals in housing as shown in figure 36.

NOTE: Installation tool shown in figure 33 can

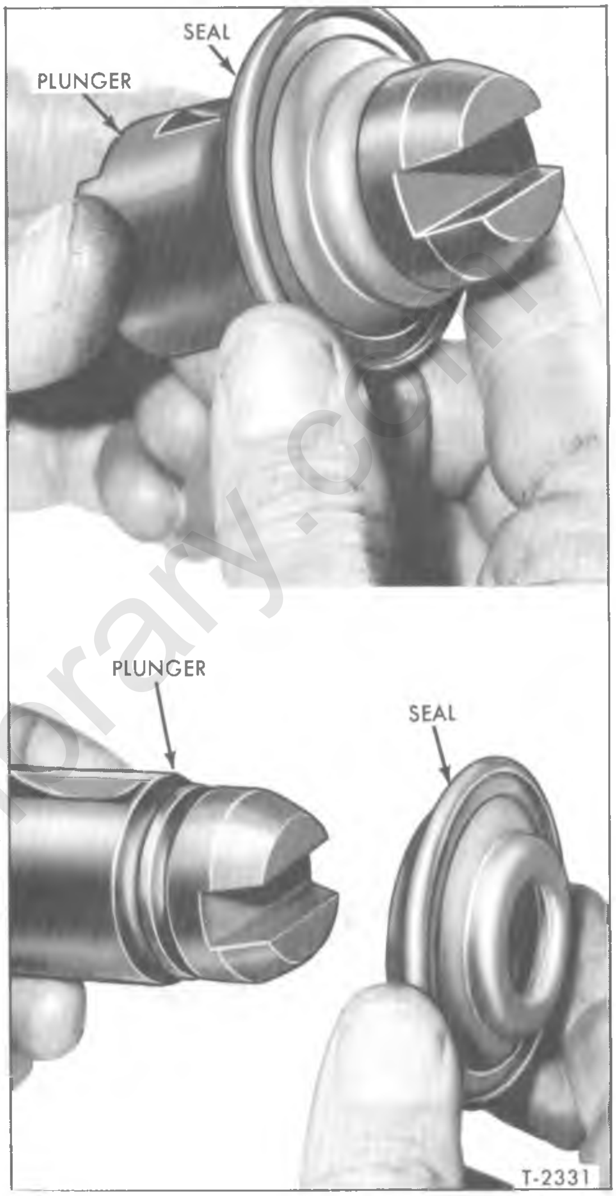


Figure 35—Installing Seal on Anchor Plunger

be made locally according to dimensions shown in figure 37.

3. Insert plunger guide with new washer inside slots in anchor plungers.
4. Install automatic adjuster components as detailed in applicable procedure.
5. Install wedge assembly in actuation housing (refer to fig. 38). Be sure rollers are seated correctly in retainer cage and make good contact with plungers.

NOTE: Spring retainer washer has "ears" on each side to be used as guides to assure correct installation (see fig. 34). Housing has "slots" to match "ears" on washer (see fig. 39).

6. Install brake shoes as previously described

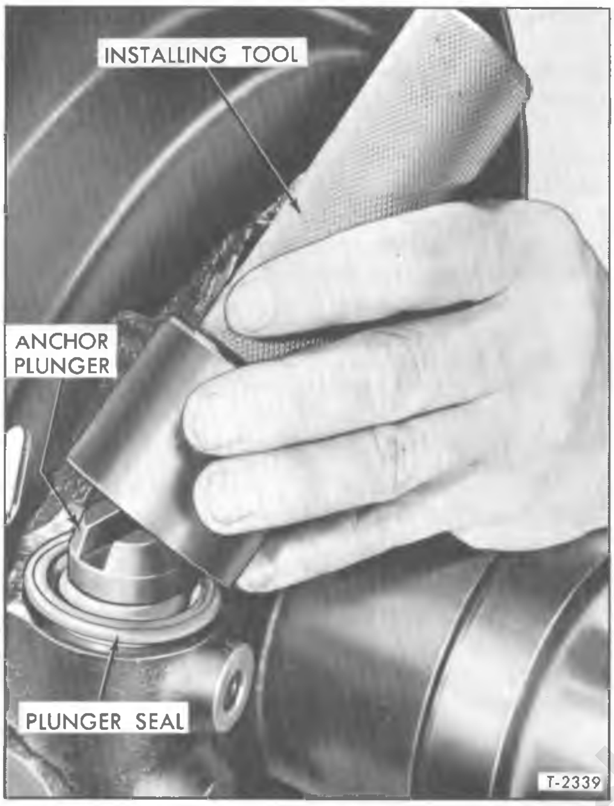


Figure 36—Installing Anchor Plunger and Seal

under "Brake Shoe Installation" in this section.

7. Install brake chambers as described previously.

8. Connect all air lines into both chambers.

9. Build up air pressure in system and push parking brake knob in to admit air into outer chambers (with "Fail-Safe" only).

10. With air in outer chambers, turn release bolt at each chamber (if "Fail-Safe") counterclockwise as far as it will go (approximately 18 turns - see fig. 42). Brakes are now in operating condition, either for service brakes or parking.

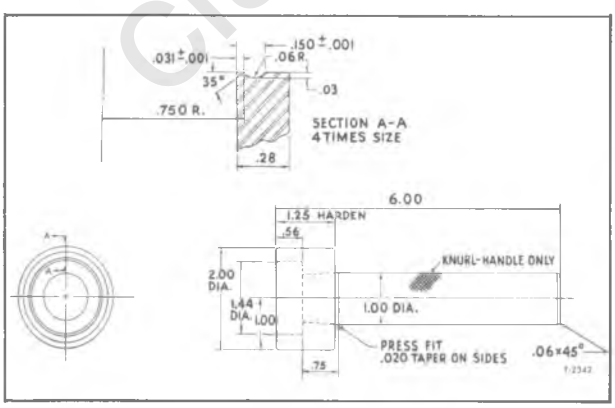


Figure 37—Plunger Seal Installing Tool Dimensions

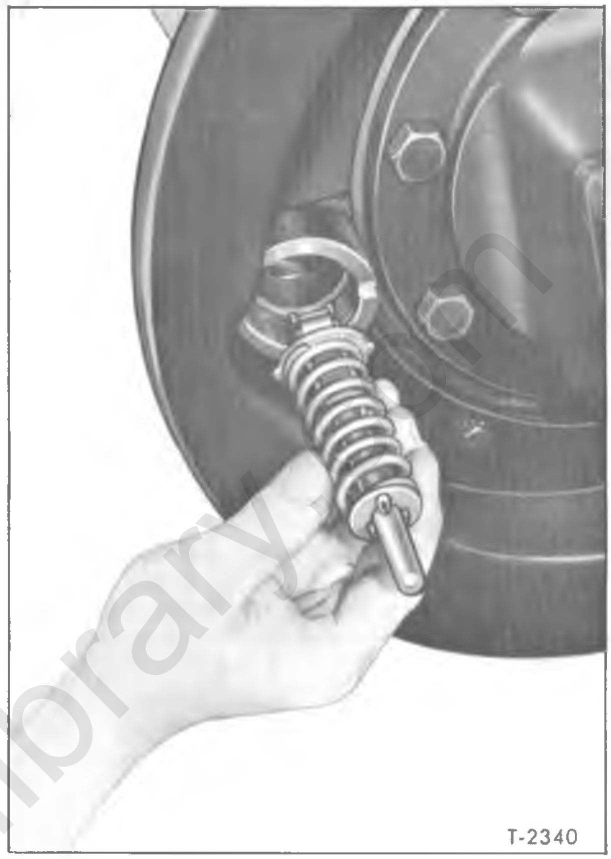


Figure 38—Installing Wedge Assembly

11. After brakes are in operating condition, adjust brakes and repeat operating and leakage tests as previously described.

Figure 39—Wedge Cavity in Housing ("Slots" Shown)

"FAIL-SAFE" BRAKES

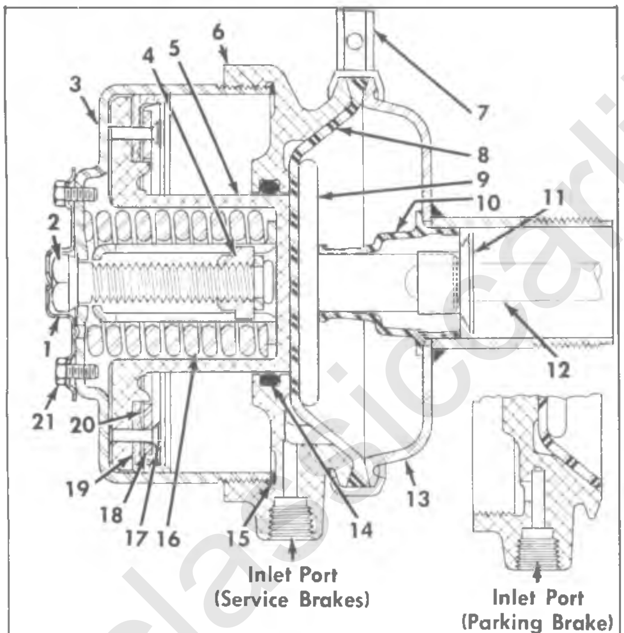
GENERAL

The Stopmaster "Fail-Safe" is a mechanical actuation feature for power brakes and is two-fold in purpose. It is used as an air-released, spring-applied parking brake, as well as a safety feature in the event of air brake failure.

DESCRIPTION AND OPERATION

BRAKE CHAMBERS (Fig. 40)

Two brake chamber assemblies are used at each wheel. Type used differs by model as shown in figure 27. The "Fail-Safe" brake chamber assembly consists of an inner and outer chamber. The inner chamber, containing a diaphragm and diaphragm plate rod, serves as the service brake chamber and operates in the same manner as a conventional brake chamber. Movement of diaphragm plate rod is transmitted to the brake shoes through the mechanical actuating components as described later.



1 Spring Lock
2 Release Bolt
3 Spring and Cap Assembly
4 Release Bolt Nut
5 Piston
6 Pressure Housing
7 Clamping Ring
8 Rubber Diaphragm
9 Diaphragm Plate Rod
10 Rubber Boot
11 Wedge Rod Guide
12 Wedge Rod (Part of Wedge Assembly)
13 Non-Pressure Housing
14 O-Ring
15 Rubber Washer
16 Spring
17 Rivet
18 Retainer Plate
19 Piston Seal
20 Expander
21 Spring Lock Capscrew

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Figure 40—"Fail-Safe" Brake Chamber Assembly

The outer chamber contains a spring-loaded piston which acts against the service brake chamber diaphragm plate rod. During normal operation, constant air pressure is applied to the outer chamber, this pressure, acting on the piston, holds the spring compressed. When air pressure is released from the outer chamber by pulling out the knob on the parking brake control valve, spring pressure forces the piston toward the service brake chamber; piston movement is transmitted through the service brake diaphragm plate rod to the brake actuating mechanism, applying the brakes.

This same action will take place in the event air pressure is lost from the system.

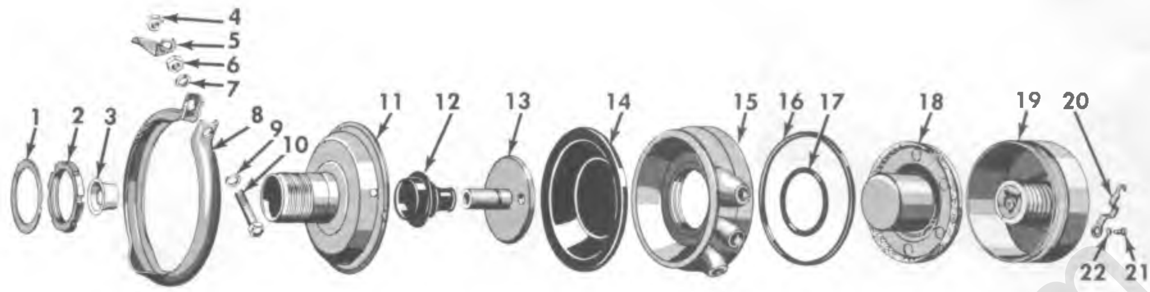
NOTE: The air tank supplying air pressure to the parking brake chambers is protected from the main air system by a one-way check valve; this tank will contain enough pressure for at least one parking brake release in case pressure is lost from the main air system.

In case of complete pressure loss, and pressure in the protected tank is depleted, brakes will remain applied until air pressure is restored. If necessary to move the vehicle before air pressure can be restored, brakes can be released by turning the release bolts clockwise as far as possible (approximately 18 turns) to compress the springs, as shown in figure 42. (This must be done at all "Fail-Safe" chambers at each wheel.) After air pressure has been restored, service brakes will be operative immediately; however, the parking brake will remain inoperative until the spring release bolts are backed out (counterclockwise) as far as possible to release the springs. Push parking brake valve knob in to released position to admit air pressure into the parking brake chambers to hold springs compressed while turning the release bolts.

CAUTION: Under no circumstances should any service operations be attempted on the brake chambers without first compressing the springs by means of the release bolts. Applying air pressure (at least 60 psi) to the parking brake chambers, either from the vehicle air system or from shop air supply, will hold springs compressed and facilitate turning bolts.

MECHANICAL ACTUATING COMPONENTS (Refer to Fig. 33)

When pressure is applied to the brake chamber diaphragm plate rod, either by air pressure during a service brake application or by spring pressure from the parking brake chamber, move-



1 Spanner Nut Retaining Washer
2 Spanner Nut
3 Wedge Rod Guide
4 Tag Nut
5 Caution Tag
6 Nut
7 Lock Washer
8 Clamping Ring
9 Washer
10 Bolt
11 Non-Pressure Housing
12 Push Rod Boot
13 Diaphragm Plate Rod
14 Rubber Diaphragm
15 "Fail-Safe" Pressure Housing
16 Housing to Cap Rubber Washer
17 Housing to Plunger "O" Ring
18 Air Chamber Piston Plunger Assembly
19 Air Chamber Cap Assembly
20 Release Bolt Spring Lock
21 Capscrew
22 Lock Washer

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Figure 41—"Fail-Safe" Air Chamber Components

ment is transmitted to both ends of each brake shoe through wedges, rollers, and plungers which are installed in the actuating housing in the brake spider. One plunger for each shoe incorporates an adjusting wheel to provide a means of adjusting the brakes to compensate for normal lining wear. All Stopmaster brakes have automatic adjuster mechanisms.

SERVICEABILITY TESTS

OPERATING TEST

1. Service Brakes

Make a brake application and check expansion of brake shoes against drum. Shoes should move freely and instantly when brake treadle is depressed. Release treadle. Shoes should contract and release the brakes without any lag. Visually inspect entire lining area to see if lining is bearing properly on both sides.

2. Parking Brakes

Apply parking brakes by pulling knob of control valve to release air from chamber. Brakes should apply promptly and should hold on any grade on which vehicle is expected to operate. Release the brakes by pushing knob in. The brakes should release instantly and wheels turn freely.

LEAKAGE TEST

1. Service Brakes

With brakes applied, check air chambers for leakage at clamping ring by covering ring with soap suds. Also apply suds to drain holes on bottom of chamber. Any small air leaks should be evident. No leakage is permissible at either location. If leakage occurs at clamping ring, tighten clamping ring. If leakage still persists, diaphragm may be deteriorated or not fitting properly between pressure and non-pressure housings (see figs. 40 and 41).

If air is escaping from drain holes only, it is an indication that diaphragm is faulty and should be replaced.

2. Parking Brakes (Fig. 40)

a. With parking brake released by air pressure, apply soap suds on cap around release bolt. Any leakage that is evident indicates a faulty piston seal. Seal should be replaced and suds applied again to be sure leakage has been corrected.

b. Soap suds should be applied at cap to pressure housing joint. If leakage is evident, fault could be due to distorted cap caused by careless handling or deteriorated rubber washer between cap and housing.

c. Coat service brake relay valve exhaust port with soap suds. Leakage at this point indicates leakage past O-ring seal in the pressure housing. If leakage occurs, replace O-ring with new part.

SERVICING "FAIL-SAFE" BRAKE CHAMBERS

Brake chamber components can be removed from the vehicle for inspection and replacement of parts without removing the non-pressure housing and without disturbing the mechanical actuating mechanism.

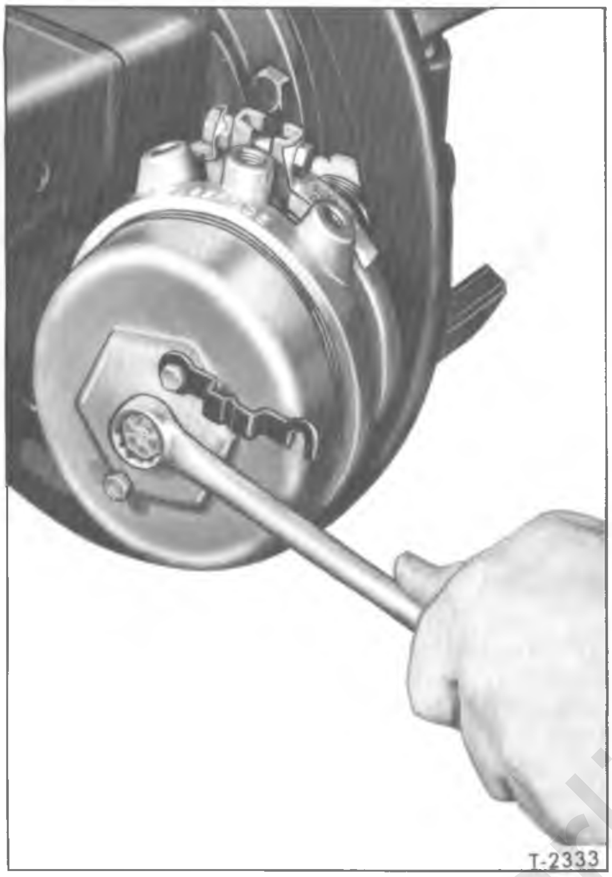


Figure 42—Compressing "Fail-Safe" Power Spring

REMOVAL AND DISASSEMBLY
Refer to figure 40 (also refer to figure 41 for components).

CAUTION: BEFORE ATTEMPTING BRAKE CHAMBER REMOVAL, BLOCK WHEELS SECURELY, SINCE PARKING BRAKE WILL NOT BE APPLIED.

1. With air pressure in parking brake chamber (brake released), loosen release bolt spring lock and swing to one side; then turn release bolt clockwise as far as it will go (approx. 18 turns) to compress the power spring. Refer to figure 42.
2. Exhaust air pressure from parking brake chamber by pulling parking brake knob out.
3. Disconnect air lines from both chambers.
4. Mark pressure housing and non-pressure housing so that parts can be reassembled in the same relative position. Loosen clamping ring by unscrewing bolt. Hang clamping ring on non-pressure plate tube.
5. Remove entire cap and spring assembly, pressure housing, and rubber diaphragm (see fig. 43). Diaphragm plate rod and boot will remain in the non-pressure housing.
6. Mount pressure housing in vise.

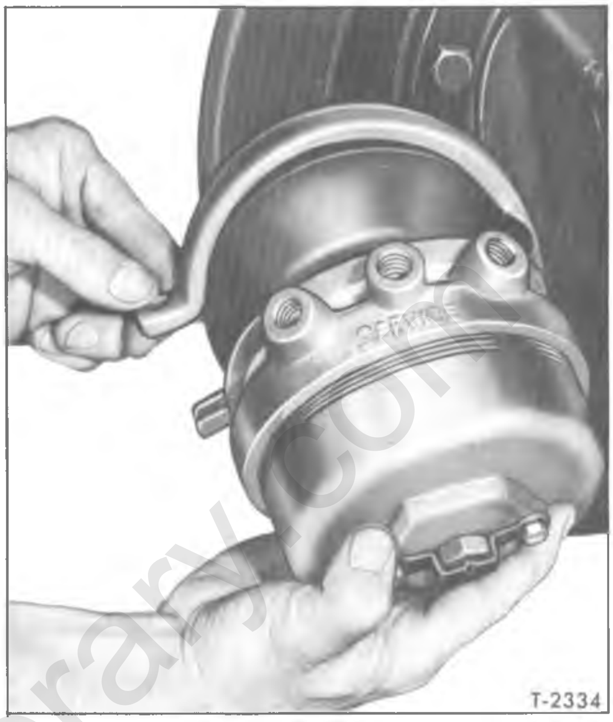


Figure 43—Removing "Fail-Safe" Assembly

NOTE: Do not tighten vise jaws enough to distort pressure from cap assembly. See figures 44 and 45 for illustration of this operation and dimensions to make a "strap" wrench.

7. Remove washer and O-ring from pressure housing.
8. Remove piston assembly from cap by pulling straight out. At times the spring, when fully compressed, cocks slightly. It is then necessary to loosen the release bolt a few turns so that the piston can be withdrawn easily.
9. The piston, retainer plate, seal and expander are held together by rivets. If any part of this assembly is defective the complete assembly must be replaced. Details are not serviced separately.
10. Cap and spring assembly is serviced as a unit. If any of the parts become damaged or need replacing, it is necessary to replace the complete cap and spring assembly.

CAUTION: Do not attempt to disassemble the cap and spring assembly. In the event any part of this assembly is defective, the complete assembly must be replaced. The component parts are not serviced separately.

CLEANING AND INSPECTION
(Refer to Figs. 40 and 41)
1. It is recommended that all brake chambers be removed, disassembled, inspected and thoroughly cleaned at the time brakes are relined or at one

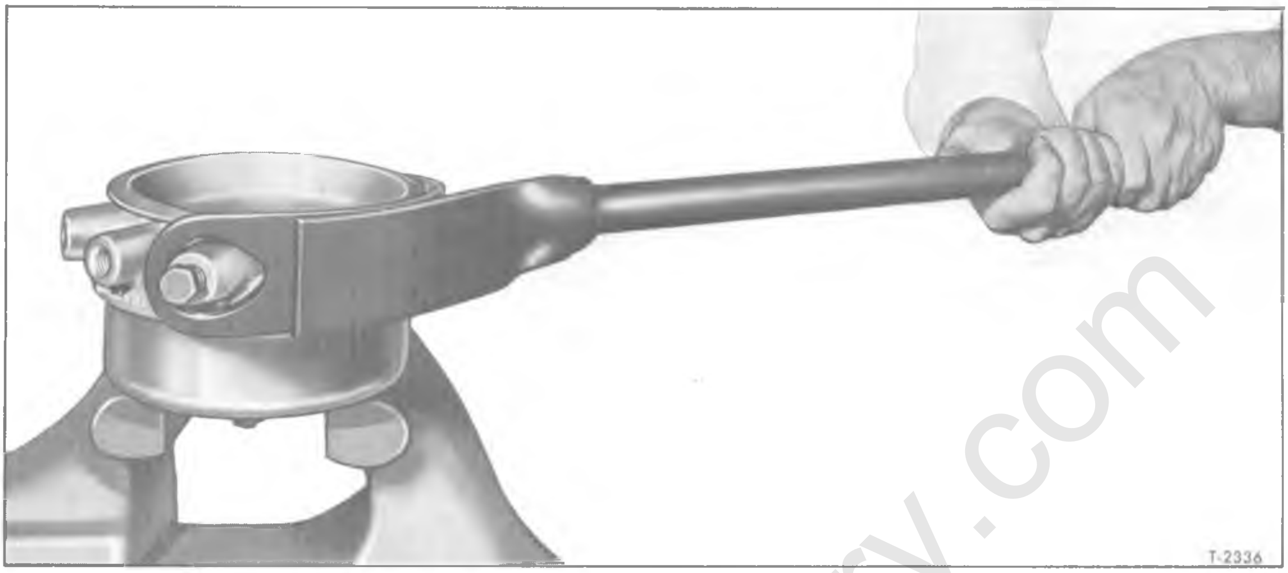


Figure 44—Removing Pressure Housing with "Strap" Wrench

year periods, whichever occurs first (also dependent upon type of operation and operators experience).

2. Clean all metal parts thoroughly, using a suitable cleaning fluid. Blow dry with air or wipe dry with cloth.

3. Inspect piston cap for signs of damage or excessive wear. Piston should slide freely inside cap assembly. Replace piston if badly worn or damaged.

4. Inspect inside walls of cap assembly for scratches, scores, or excessive wear. Slightly worn spots may be removed with crocus cloth. Inspect external threads on cap for rust or corrosion.

5. Inspect piston seal for cracking or deterioration. Inspect expander and expander retaining plate for deterioration. Replace piston assembly, if necessary.

6. Inspect pressure housing for scratches, scores, or excessive wear. Examine all parts for obstructions and remove any foreign matter.

7. Examine spring in cap for deterioration or rust. Inspect release bolt for signs of rust on the threaded portion. Unless spring or bolt is in very bad condition, replacement should not be necessary. See "Caution" in Step 10 of "Removal and Disassembly."

8. Discard O-ring and rubber washer. Replace with new parts.

9. Examine diaphragm plate rod boot (in non-pressure housing) for deterioration or cracks. If deterioration or other damage is evident, replace as follows:

a. Pull diaphragm plate rod, wedge rod guide and boot out of wedge rod and mounting tube respectively.

b. Remove guide and boot from diaphragm plate rod and install new boot on plate rod. Replace wedge rod guide.

c. Apply a liberal amount of rubber cement to boot flange and mating surface on non-pressure housing.

d. Position plate rod on wedge rod and hold rubber boot flange tightly against housing surface. Flange should seal tight to keep any moisture or foreign matter from falling into actuation components.

NOTE: Be careful not to disturb wedge and roller mechanism inside actuation housing when repositioning plate rod on wedge rod.

BRAKE CHAMBER ASSEMBLY
AND INSTALLATION

Refer to figure 40 (also refer to figure 41 for components).

1. Install O-ring in groove in pressure housing.

2. Install piston assembly in cap assembly.

3. Position rubber washer in pressure housing at bottom of internal threads. Thread cap and spring assembly into pressure housing and tighten firmly against rubber washer. This may be done with "strap" type wrench (see figures 44 and 45)

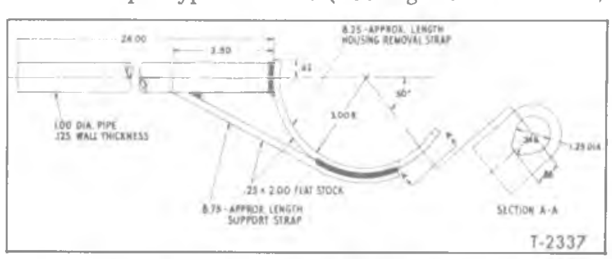


Figure 45—"Strap" Type Wrench Dimensions

AIR BRAKES

or by putting pressure housing in vise and using a wrench on hex end of cap.

4. Position diaphragm over plate rod, then install pressure housing and cap assembly.

NOTE: Diaphragm should fit evenly between pressure housing and non-pressure housing. Align marks made on housings at disassembly to insure proper air port location.

5. Pull clamping ring over flange of pressure and non-pressure housings. Install clamp bolt and nut and tighten firmly.

6. Connect all air lines and build up air pressure in system to normal operating pressure. Push parking brake knob in to admit air to outer brake chamber.

7. Turn release bolt counterclockwise as far as possible (approx. 18 turns) to release spring (see fig. 42). This will leave the parking brake chamber in operating condition.

NOTE: It is best to have at least 60 psi of air in chamber to hold spring tension off nut so a better "feel" is obtained when the nut does bottom.

SPECIFICATIONS

FRONT BRAKES

FRONT AXLE MODEL	*F070
Brake Size	15 x 3
Brake Shoe Lining	
Width	3″
Thickness	7/16″
Area (sq. in. per axle)	190
Brake Chamber	
Type	12
Diameter	5 23/32″
Adjust Travel to	Short as possible w/o brakes dragging
Slack Adjuster	
Type	PL-18
Length Between Hole Centers	4½″-5½″

*Air brakes are optional equipment on LA, DLA4000. Standard brakes are Air-Assisted Hydraulic.

REAR BRAKES (EXCEPT STOPMASTER)

TRUCK SERIES	L, DL4000(*)	ALL MODELS(†)
Brake Size	15 x 6	15 x 5
Brake Shoe Lining		
Width	6″	5″
Thickness	¾″	¾″
Area (sq. in. per axle)		316.8
Brake Chamber		
Type	24	24
Diameter	7¼″	7¼″
Adjust Travel to	Short as possible w/o brakes dragging	
Slack Adjuster		
Type	PL-24	PL-20
Length Between Hole Centers	5½″	6″

(*) With Eaton 16121 or 16221 opt. axle.
(†) Includes L, DL4000 with Timken G161 or G361 opt. axle.

STOPMASTER BRAKE SPECIFICATIONS

TRUCK SERIES	5500—OPT 6500—STD
Brake Size	15 x 5
Brake Shoe Lining	
Width	5″
Thickness	¾″ Crescent
Area (sq. in. per axle)	315
Brake Chamber	
Standard	
Diameter (at clamp band)	5.66″
"Fail-Safe"	
Diameter (at chamber body)	5.264″*

* "Fail-Safe" chambers are optional on all 5500-6500.

GENERAL TROUBLESHOOTING CHART

NO BRAKES

PROBABLE CAUSE	REMEDY
1. No air pressure	1. Check for leaks, broken lines, etc. Repair or replace as necessary
2. Restricted tubing or hose	2. Replace defective parts.
3. Defective brake valve	3. Repair or replace

INSUFFICIENT BRAKES

PROBABLE CAUSE	REMEDY
1. Low brake line pressure	1. Check for leaks, etc. and repair
2. Too much push rod travel	2. Adjust
3. Worn linings or drums	3. Replace as necessary
4. Leaking chamber diaphragm	4. Replace diaphragm
5. Slack adjusters out of adjustment	5. Adjust
6. Wrong size brake chambers	6. Replace according to "Specifications"

SLOW BRAKE APPLICATION

PROBABLE CAUSE	REMEDY
1. Low brake line pressure	1. Check for leaks, etc. and repair
2. Linkage binding	2. Lubricate linkage
3. Too much push rod travel	3. Adjust
4. Restriction in line	4. Remove restriction or replace line
5. Leaking brake valve	5. Repair or replace
6. Worn linings or drums	6. Replace as necessary
7. Leaking chamber diaphragm	7. Replace diaphragm
8. Brake shoe anchor pins frozen	8. Free up, replace or lubricate as necessary
9. Foot control valve linkage improperly adjusted	9. Adjust
10. Camshaft bushings binding or worn	10. Lubricate or replace

AIR BRAKES

SLOW BRAKE RELEASE

PROBABLE CAUSE	REMEDY
1. Linkage binding	1. Lubricate linkage
2. Restriction in line	2. Remove restriction or replace line.
3. Too much push rod travel	3. Adjust
4. Improper seating of valves in application valve.	4. Repair or replace
5. Binding cam or camshafts	5. Lubricate if possible; replace if not effective.
6. Weak shoe return springs	6. Replace springs

GRABBING BRAKES

PROBABLE CAUSE	REMEDY
1. Grease or dirt on lining	1. Clean or reline.
2. Brake drum out-of-round	2. Turn or replace
3. Defective application valve	3. Repair or replace

UNEVEN BRAKES

PROBABLE CAUSE	REMEDY
1. Uneven slack adjuster settings	1. Adjust properly
2. Linkage binding at one or more wheels	2. Lubricate as necessary
3. Linings worn uneven	3. Adjust or replace
4. Brake shoe return spring weak or broken	4. Replace
5. Defective brake chamber	5. Repair or replace
6. Defective brake drum	6. Repair or replace
7. Unequal springs in brake chambers or between brake shoes	7. Replace in pairs.

SLOW PRESSURE BUILDUP IN RESERVOIRS

PROBABLE CAUSE	REMEDY
1. Clogged air cleaner	1. Clean or replace
2. Air leak	2. Find and repair
3. Faulty compressor	3. Repair (see "Air Compressor" section in this manual)
4. Open or leaking reservoir drain cocks.	4. Close, repair or replace.
5. Defective compressor governor	5. Repair or replace

AIR PRESSURE ABOVE NORMAL

PROBABLE CAUSE	REMEDY
1. Defective air gauge	1. Replace
2. Governor out of adjustment or defective	2. Adjust, repair or replace
3. Restricted line between governor and compressor	3. Clear line or replace
4. Compressor unloader inoperative	4. Repair or replace

QUICK LOSS OF PRESSURE WHEN ENGINE IS STOPPED (BRAKES NOT APPLIED)

PROBABLE CAUSE	REMEDY
1. Leaking lines or connections	1. Repair or replace
2. Worn or leaking compressor exhaust valve or one-way check valve.	2. Repair or replace
3. Leaking governor	3. Repair or replace
4. Leaking application valve	4. Repair or replace
5. Open or leaking reservoir drain cock	5. Close, repair or replace

(BRAKES FULLY APPLIED)

PROBABLE CAUSE	REMEDY
1. Leaking brake chamber	1. Repair or replace
2. Leaking application valve	2. Repair or replace
3. Leaking service line	3. Repair or replace
4. Leaking chamber hoses	4. Repair or replace
5. Dirt in two-way check valve. (If equipped with hand control valve and brakes are applied by the foot valve, dirt in the two-way check valve could cause a pressure leak at the hand valve exhaust port.)	5. Clean or replace
6. Defective quick release valve	6. Clean or replace diaphragm.

SAFETY VALVE "BLOWS OFF"

PROBABLE CAUSE	REMEDY
1. Safety valve out of adjustment	1. Adjust
2. Pressure in system above normal	2. See chart on "Air pressure above normal"
3. Governor out of adjustment	3. Adjust

STOPMASTER TROUBLESHOOTING CHART

"FAIL-SAFE" PARKING BRAKE WILL NOT RELEASE

PROBABLE CAUSE	REMEDY
1. Air leak in "Fail-Safe" lines	1. Check air system and correct leaks
2. Loose clamp ring or cap	2. Tighten and check for air leaks
3. Leakage at release bolt	3. Replace piston and seal assembly
4. Faulty piston O-ring seal	4. Replace piston O-ring seal
5. Foreign material in "Fail-Safe" chamber	5. Clean with solvent and lubricate
6. Improper wedge adjustment	6. Make wedge adjustment
7. Corroded "Fail-Safe" spring	7. Replace cap and spring assembly

"FAIL-SAFE" PARKING BRAKE WILL NOT APPLY

PROBABLE CAUSE	REMEDY
1. "Fail-Safe" spring not fully released	1. Turn release bolt counterclockwise
2. Inoperative parking brake control valve or quick release valve	2. Check operation of valves as outlined in Maintenance Manual and replace if necessary
3. Foreign material in chambers or piston stuck in cap	3. Disassemble and clean with solvent; lubricate piston and cap
4. "Fail-Safe" spring failure	4. Replace cap and spring assembly
5. Rollers not aligned with plungers or wedge not mated with diaphragm plate rod	5. Remove non-pressure housing and check installation of wedge
6. Brakes out of adjustment	6. Adjust brakes; check operation of automatic adjusters

AUTOMATIC ADJUSTERS INOPERATIVE

PROBABLE CAUSE	REMEDY
1. Guide installed backwards	1. Remove plunger guide components and reassemble
2. Guide spring missing or weak	2. Replace guide spring
3. Plunger seal failure	3. Replace seal; clean and lubricate actuation parts
4. Adjusting bolt threaded into actuator too tight	4. Back off bolt 1/4 turn
5. Plunger guide washer omitted	5. Replace washer

SERVICE BRAKES INOPERATIVE	
PROBABLE CAUSE	REMEDY
1. Low air pressure	1. Check system for leaks
2. Faulty brake chamber diaphragm	2. Replace diaphragm
3. Improper brake shoe adjustment	3. Adjust brake shoes
4. Improper wedge adjustment	4. Make wedge adjustment
5. Plunger seal failure	5. Replace seal and clean and lubricate actuation parts
6. Grease on linings	6. Reline brakes and check seals

SECTION 5C
Parking Brakes
EXTERNAL CONTRACTING BAND TYPE BRAKE

External contracting band type parking brake is mounted at rear of transmission (fig. 1).

Brake drum is attached to the transmission output shaft flange in conjunction with the propeller shaft universal joint flange. The band and lining assembly is supported around the drum by a bracket on the adjustment side and an anchor bar on the stationary side. Both supports are attached to the transmission case. The band contracts around the drum when brake is applied.

Linkage connecting parking brake lever to brake operating cams varies on different models, however, adjustment is made at brake assembly in same manner.

BAND TYPE ADJUSTMENT (Fig. 1)

1. Place hand lever in fully released position. Disconnect brake rod or cable from operating cams by removing cotter pin and clevis pin.
2. Remove lock wire from anchor adjusting screw and turn anchor screw as necessary to obtain 0.010" to 0.015" between lining and drum. Install lock wire in anchor screw.
3. Loosen lock nut on locating bolt and tighten adjusting nut on locating bolt until there is a clearance of 0.020" between lower end of lining and drum. Measure clearance about 1-1/2 inch from end of lining. When correct clearance is obtained, tighten lock nut on locating bolt.
4. Loosen lock nut on adjusting bolt and tighten adjusting nut on adjusting bolt to obtain clearance of 0.020" between upper end of lining and drum. Measure clearance about 1-1/2 inch from end of lining. Tighten lock nut on adjusting bolt.
5. Adjust end on brake rod so that clevis pin may be freely inserted through operating cams and rod end. Install clevis pin and cotter pin, then tighten lock nut on rod end.

BRAKE BAND REMOVAL (Fig. 1)

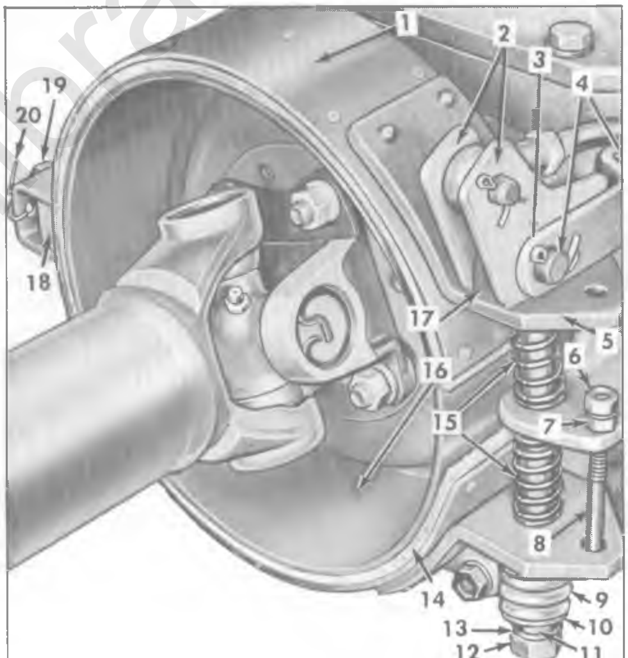
1. Disconnect brake rod or cable from operating cams. Remove clevis pin and operating cams from upper end of adjusting bolt.
2. Remove nuts, washers, and tension spring from lower end of adjusting bolt. Lift adjusting bolt straight up out of brake band brackets and support, stripping release springs and cam shoe from bolt as bolt is removed.
3. Remove nuts from locating bolt, then remove bolt.
4. Remove lock wire from anchor screw, then back screw out until clear of anchor bar.
5. Slide band and lining assembly straight to rear off brake drum and anchor bar (fig. 1), removing band and lining assembly off over propeller shaft.

INSPECTION

1. Examine braking surface of drum for roughness or scoring. If drum is worn or damaged, it must be replaced.
2. Inspect brake lining. If worn down close to rivet heads, new lining must be installed.
3. Examine tension and release springs; replace if weak or broken.

BRAKE BAND INSTALLATION (Fig. 1)

1. Place band and lining assembly over propeller shaft. Place anchor screw spring in depression of anchor bar, and compress spring as band



1 Brake Band	11 Adjusting Nut
2 Cams	12 Lock Nut
3 Links	13 Lock Washer
4 Clevis Pins	14 Brake Lining
5 Cam Shoe	15 Release Springs
6 Lock Nut	16 Brake Drum
7 Adjusting Nut	17 Adjusting Bolt
8 Locating Bolt	18 Anchor Bar
9 Tension Spring	19 Anchor Screw
10 Washer	20 Lock Wire

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Figure 1—Contracting Band (External) Parking Brake (Typical)

anchor bracket is placed over anchor bar.

2. Install anchor screw through bracket and spring into anchor bar. Insert locating bolt up through band lower bracket and hole in support and install nuts temporarily.

3. Place operating cams between links and install new clevis pin and cotter pin.

4. Insert threaded end of adjusting bolt down between operating cams with hook toward rear of vehicle. As bolt is lowered into place it must pass through cam shoe, band upper bracket, upper release spring, brake support, lower release spring, and band lower bracket. Install tension spring, flat washer, adjusting nut, lock washer (if used), and lock nut on adjusting bolt.

5. Adjust lining to drum clearance and connect brake rod as directed under "Band Type Adjustment."

BRAKE DRUM REMOVAL

1. Remove brake band and lining assembly.

2. Remove nuts and lock washers from bolts attaching propeller shaft U-joint flange and brake drum to transmission output shaft flange. Telescope propeller shaft at slip joint and lower end of propeller shaft to floor. Remove if necessary, nuts, lock washers, and bolts attaching propeller shaft center bearing hanger bracket to crossmember.

3. On some vehicles, brake drum is mounted on forward side of transmission mainshaft companion flange, and on other vehicles it is mounted on rear side of flange. If mounted on rear side of flange, drum may be removed without removing flange; if mounted on forward side of flange, remove retaining nut and flange from output shaft. Press serrated bolts from flange to remove drum.

BRAKE DRUM INSTALLATION

1. Wipe mating surfaces of brake drum and output shaft flange clean. Position brake drum on flange and press serrated bolts into place. Replace drum assembly and retaining nut on output shaft. Refer to "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" for nut torque on various transmission models.

2. Position propeller shaft flange against brake drum (or output shaft flange). If removed, attach propeller shaft center bearing hanger bracket to crossmember. Replace all lock washers and nuts and tighten securely.

3. Install brake band and lining assembly and adjust brake.

TWO-SHOE (DUO-GRIP) PARKING BRAKE

The two-shoe duo-grip type brake consists of two brake shoes operating on a brake drum attached to transmission mainshaft flange in conjunction with the propelller shaft (fig. 2).

Linkage connecting parking brake lever to operating lever at brake varies on different models, however, adjustment is made at brake assembly on all models in same manner.

BRAKE ADJUSTMENT (Fig. 2)

1. Place parking brake lever in fully released position.

2. Loosen lock nut (12) and adjust bolt (13) as necessary to obtain 0.010" to 0.015" clearance between outer shoe lining and brake drum at a point directly above adjusting bolt (13). Hold bolt and tighten lock nut securely.

3. Loosen lock nut (6) and adjust nut (11) as necessary to obtain 0.010" to 0.015" clearance between inner shoe lining and drum. Hold nut (11) and tighten lock nut (6).

4. Recheck lining to drum clearance. Final clearance between both linings and drum must be 0.010" to 0.015".

BRAKE SHOE REMOVAL (Fig. 2)

1. Remove adjusting nut (11) and disengage link from operating lever.

2. Loosen adjusting bolt lock nut (12) and back off adjusting bolt (13) until it clears the brake shoe web. Unhook return spring from outer shoe.

3. Remove lock from outer shoe upper pivot pin and slide shoe and operating lever assembly off pivot pin and brake drum.

4. Place shoe and operating lever assembly on bench. Remove lock rings securing brake shoes on operating lever pins and remove shoes from pins.

LINING REPLACEMENT

1. Remove linings from shoes, using deliner punch in a brake relining machine.

2. Clean all dirt and corrosion from shoes, using a wire brush if necessary.

3. Install new linings on shoes, installing rivets in center holes first. A 0.010" feeler must not enter between lining and shoe at any point.

BRAKE SHOE INSTALLATION (Fig. 2)

1. Install brake shoes on operating lever pins and secure with lock rings.

2. Install shoe and operating lever assembly on brake drum, with upper end of outer lever in place on pivot pin. Install lock on pivot pin.

3. Insert link through operating lever, with washer and spring in place on top of lever. Install adjusting nut (11) on link. Connect return spring to outer shoe.

PARKING BRAKES

4. Adjust lining to drum clearance as previously directed under "Brake Adjustment."

BRAKE DRUM REMOVAL

1. Remove brake shoes as previously directed under "Brake Shoe Removal."

2. Disconnect propeller shaft at transmission. Remove bolts attaching center bearing bracket to crossmember, then lower center bearing and front propeller shaft to floor.

3. Remove brake drum from bolts in transmission mainshaft flange. Remove four nuts, lock washers, and bolts attaching oil deflector to inner side of brake drum.

BRAKE DRUM INSTALLATION

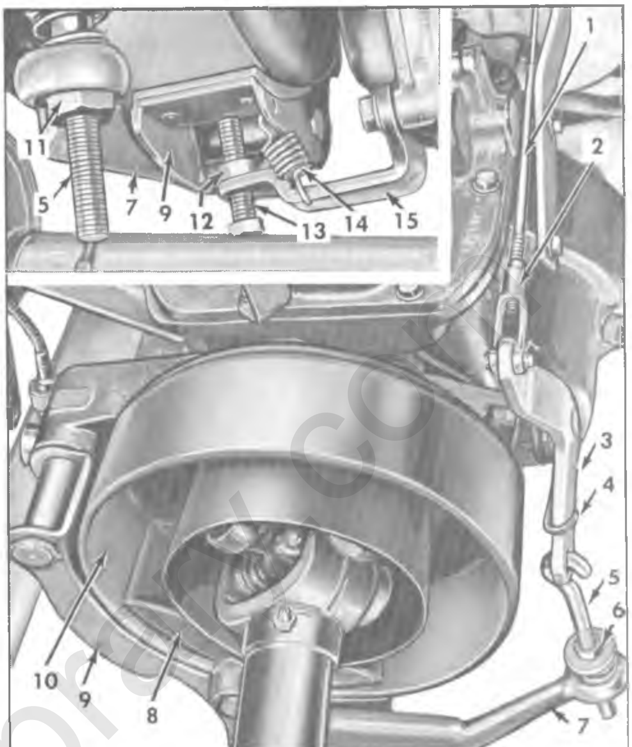
1. Position oil deflector in brake drum and attach with four bolts, lock washers, and nuts. Tighten nuts to 5-8 foot-pounds torque.

2. Install brake drum on bolts in transmission mainshaft flange. Connect propeller shaft at transmission and attach center bearing bracket to frame crossmember. Refer to "PROPELLER SHAFTS" (SEC. 4D) of this manual for universal joint construction.

3. Install brake shoes as previously directed under "Brake Shoe Installation."

IMPORTANT

Any time that brake shoes have been removed or disturbed for any service operation it is advisable to adjust the brake as directed under "Brake Adjustment."



1 Brake Cable
2 Adjustable Clevis
3 Connecting Lever
4 Return Spring
5 Link
6 Lock Nut
7 Operating Lever
8 Inner Shoe
9 Outer Shoe
10 Brake Drum
11 Adjusting Nut
12 Lock Nut
13 Adjusting Bolt
14 Return Spring
15 Adjuster Bracket

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Figure 2—Two Shoe (Duo-Grip) Parking Brake

INTERNAL-EXPANDING TYPE BRAKE

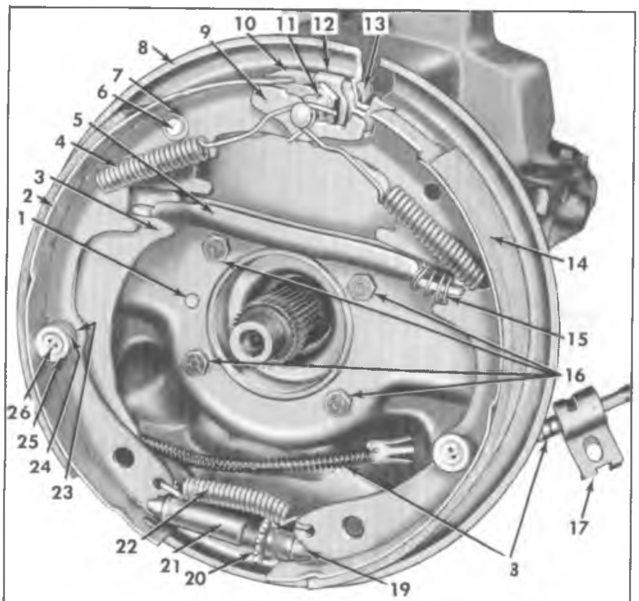
Figure 3 illustrates the internal-expanding type parking brake used on the PS-4500 Models. In order to remove components of this brake, it is necessary to disconnect the propeller shaft from the transmission at the front universal joint. This can be done as instructed in "PROPELLER SHAFTS" (SEC. 4D) in this Manual. Then remove four nuts from transmission output flange and remove propeller shaft yoke and brake drum from flange.

NOTE: It may be necessary to back off the shoe adjustment before removing drum.

Brake components are now exposed.

REMOVAL

1. Remove two pull-back springs.
2. Remove guide plate from anchor pin.
3. Remove shoe holddown cups, springs, and washers from hold-down pins. Remove pins from backing plate.
4. Pull brake shoe and lining assemblies away from anchor pin and remove lever strut and strut spring.
5. Lift brake shoe and lining assemblies with adjusting nut and bolt and connecting spring off backing plate.
6. Move tops of shoes toward one another until adjusting nut and bolt assembly and connecting spring drop off.
7. Remove clip from pin and remove pin, lever, and washer from primary shoe and lining assembly (the primary shoe is the shoe with the short lining).
8. Compress spring on cable and remove cable from lever.
9. If necessary to remove anchor pin, straighten bent over tangs of washer from pin hex and



1 Plate Locating Pin
2 Primary Shoe and Lining
3 Brake Lever
4 Return Spring
5 Lever Strut
6 Pin
7 Clip
8 Backing Plate
9 Guide Plate
10 Reinforcement
11 Anchor Pin
12 Lock Washer
13 Anchor Pin Nut
14 Secondary Shoe and Lining
15 Strut Spring
16 Backing Plate Bolts
17 Cable Bracket
18 Cable Assembly
19 Socket
20 Adjusting Screw
21 Nut
22 Connecting Spring
23 Washer
24 Spring
25 Cup
26 Hold-Down Pin

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Figure 3—Internal-Expanding Parking Brake

from reinforcement. Remove pin from backing plate by threading it from nut. Remove reinforcement and washer with anchor pin.

10. If necessary to remove cable, compress tangs on cable lock and pull assembly out of hole in backing plate.

11. If necessary to remove backing plate, remove transmission flange nut and transmission output flange. Remove bolts which fasten backing plate to bearing retainer and remove backing plate.

INSTALLATION

1. Place backing plate in position on rear bearing retainer and fasten with four bolts. Torque bolts to 20-26 foot-pounds.

2. Install transmission output flange on spline of mainshaft and fasten with flange nut. Torque nut to 80-120 foot-pounds.

3. Install cable assembly from back of backing plate. Push retainer through hole in backing plate until tangs securely grip inner side of plate.

4. Place washer and reinforcement over the threaded end of anchor pin. Hold anchor pin nut (flat side against flange on backing plate) in position behind backing plate and insert threaded end of anchor pin from front side. Thread anchor pin into nut and tighten securely. Bend tang of washer over reinforcement and side of washer over hex of anchor pin.

5. Install lever on cable by compressing spring and inserting cable in channel of lever. Release spring.

6. Install primary shoe (the one with the short lining) to lever as follows: Place pin in lever with head of pin toward backing plate. Place washer on pin and push pin through hole provided in primary shoe. Fasten parts together by installing clip in groove of pin.

7. Fasten two brake shoe and lining assemblies together by installing adjusting screw and nut assembly and connecting spring. Lubricate adjusting screw sparingly before assembly with S-17 Special Lubricant.

8. Lubricate the six bearing surfaces on the backing plate with a heavy grade of S-17 Special Lubricant.

9. Place brake shoe and lining assemblies in position on backing plate.

NOTE: When facing the brake assembly the shoe with the short lining (primary) should be to the left with the lever assembled to it.

10. Pull brake shoes apart and install lever strut and strut spring between the secondary shoe and the lever. The loop on the strut spring should be in the "up" position.

11. Hold shoe and lining assemblies in position and fasten to backing plate by inserting pin through back side of plate. Then, install washer, hold-down spring, and cup (in that order) on hold-down pin.

12. Place guide plate on anchor pin.

13. Install the two pull-back springs.

14. Before installing brake drum, remove the two "knock-out" plugs and replace with rubber plugs as used on standard service brakes with screw-type adjustment. This will provide holes for adjustment without the necessity of removing drum. Install brake drum and propeller shaft yoke.

15. Connect propeller shaft as instructed in "PROPELLER SHAFTS" (SEC. 4D) in this Manual.

OPTIONAL AIR-OPERATED PARKING BRAKES

Models in this manual using air brake systems may have installed, as optional equipment, one of the following three parking-emergency brake systems: "DD-3," "Anchorlok," or Stopmaster "Fail-Safe." For information concerning these features refer to "AIR BRAKES" (SEC. 5B) of this manual under appropriate heading.

SPECIFICATIONS

BRAKE TYPE	BAND	DUO-GRIP TWO-SHOE	INTERNAL EXPANDING
Brake Size	9½ x 2½	10 x 2¼	11 x 2
Brake Drum Diameter			
Outside	9½"	10"	—
Inside	—	9½"	11"
Lining Length (approx.)	27⅝"	—	—
Internal	—	7 29/64"	—
External	—	8⅜"	—
Lining Width	2½"	2¼"	2"
Lining Thickness	5/16"	¼"	¼"
Total Lining Area (Sq. In.)	67.5	35.6	41.75

SECTION 6A

Gasoline Engines

Contents of this section are listed in Index below:

6A

ENGINE APPLICATION CHART

TRUCK SERIES	GMC ENGINE STANDARD	GMC ENGINE OPT.
LA, LV4000	305C	351C
EM4500	305E	--
ES4500	250	292
PS4500	250	292
EM5500	305C	351C

TRUCK SERIES	GMC ENGINE STANDARD	GMC ENGINE OPT.
SM5500	305C	351C
ES5500	292	--
SS5500	292	--
EM6500	305C	351C
SM6500	351M	--

GENERAL INFORMATION

A definite, systematic maintenance program is required to assure satisfactory economical performance of engine. Included in maintenance program must be the servicing of related units and systems as well as regular tune-up of engine.

Frequency of tune-up is dependent upon the type of service in which the vehicle is used.

This section of manual provides instructions for servicing the various items and tuning the engine. Unless otherwise stated, the procedures are applicable to all gasoline engines used in vehicles covered by this manual. To adequately accomplish a satisfactory tune-up, reliable test equipment in the hands of trained personnel is necessary.

ENGINE LUBRICATION

IN-LINE ENGINES

Lubrication system for In-line engines is shown in figure 1. After passing through full-flow oil filter, oil is supplied under pressure to main oil gallery where it is distributed to main bearings, and crankshaft drillings. Hydraulic valve lifters receive oil from main gallery. Oil metered from valve lifters passes through hollow push rods to lubricate individually-mounted rocker arms.

V6 ENGINES

Lubrication of V6 engines is typically illustrated in diagram shown in figure 2.

High capacity type oil pump (9, fig. 2) delivers oil to main oil gallery in cylinder block after oil

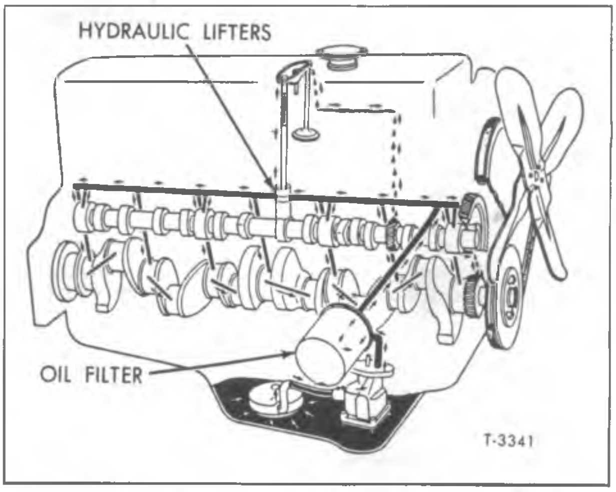
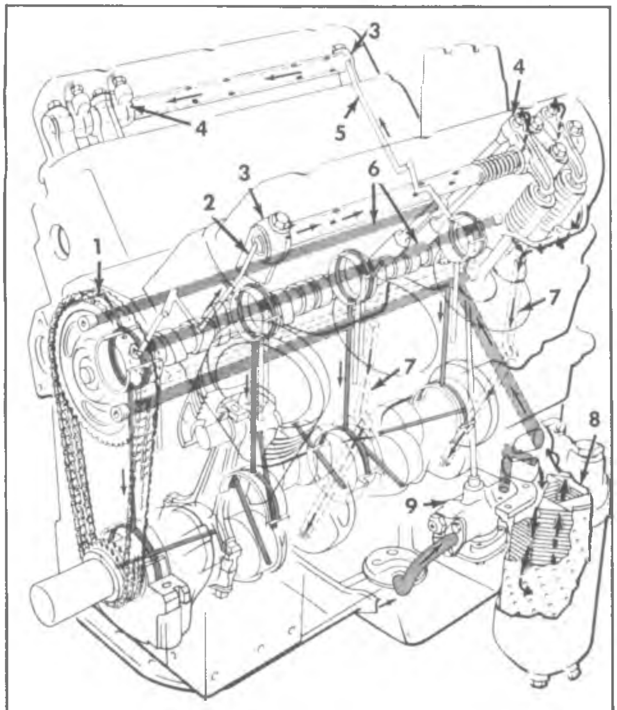


Figure 1—Engine Lubrication Diagram for In-Line Engine



1 To Timing Chain and Sprocket
2 Oil From Camshaft Front Bearing
3 Rocker Arm Shaft Bracket
4 Rocker Arms
5 Oil From Camshaft Rear Bearing
6 Oil Galleries
7 Oil Drain-Back Holes
8 Oil Filter
9 Engine Oil Pump

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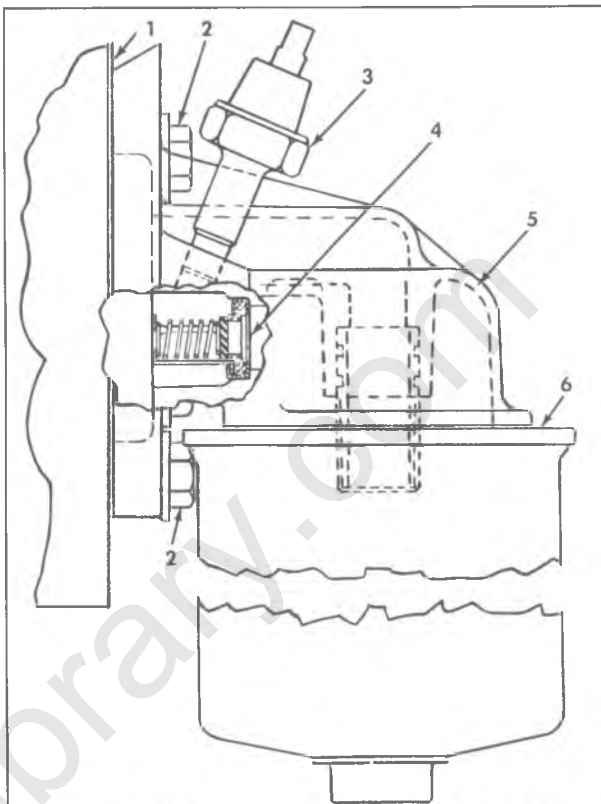
Figure 2—Engine Lubrication Diagram for V6 Engine



1 Housing Gasket
2 Housing-to-Block Bolts
3 Oil Pressure Sending Unit
4 Pressure Relief Valve
5 Oil Filter Housing
6 Oil Filter Element

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Figure 3—Oil Filter with Throw-Away Type Element

passes through oil filter. Oil passages carry oil under pressure to all crankshaft, camshaft, and connecting rod bearings. Oil for lubrication of valve rocker arms is supplied through passages drilled in block, cylinder heads, and one rocker arm shaft bracket on each head. From the bracket, the oil passes into hollow rocker arm shaft and out through an oil hole to each rocker arm.

Engine Maintenance and Tune-Up

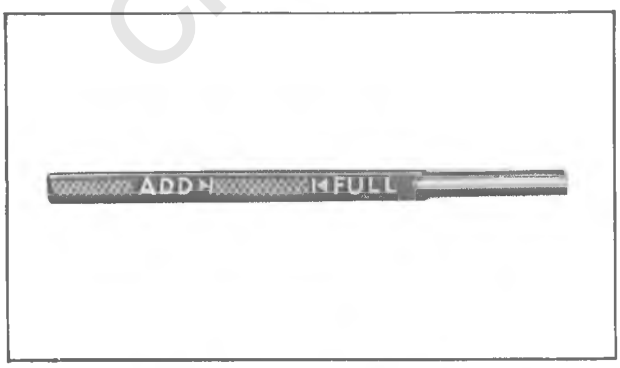


Figure 4—Typical Oil Level Dipstick

ENGINE MAINTENANCE

SERVICING AIR CLEANERS

Carburetor air cleaners on all vehicles require occasional servicing. For type and location of air cleaners, recommended element servicing intervals, and servicing procedures, refer to LUBRICATION (SEC. 0) of this manual.

CHECKING AND MAINTAINING CRANKCASE OIL LEVEL

Daily, or oftener if necessary, check oil level. Check when at operating temperature, and after engine has been stopped for at least five minutes. Remove dipstick, wipe clean, reinsert and remove again. The upper mark on dipstick is "FULL," the lower "ADD" or "ADD OIL." Keep level as close as possible to "FULL" mark without over-filling. Do not operate with level below "ADD" or "ADD OIL" mark. Dipstick is at the right side of engines. When replenishing oil supply in crankcase, add oil of same brand and quality as is used when changing oil.

Refer to LUBRICATION (SEC. 0) earlier in this manual for recommendations pertaining to oil change intervals and oil filter replacement intervals.

CHECKING DRIVE BELTS

1. Inspect drive belts for excessive wear and damage. If no defects are found, check belts for proper tension.

2. When installing new drive belts or adjusting old belts, use tension gauge to provide correct tension.

CAUTION: Adjusting drive belts too tightly will impose too great a load on bearings in the driven units. Slipping will occur if drive belts are not adjusted tight enough. Belt life will be shortened if belts are not properly tightened.

ENGINE OIL FILTERS

Engine oil filters are either standard or optional equipment, and are either of two types. Filters shown in figures 1 and 3 are throw-away type. Replaceable element type oil filters (figs. 2 and 5) are used instead of throw-away filters on some engines.

REPLACING OIL FILTER
(THROW-AWAY TYPE)

1. Use filter wrench to screw the oil filter off stud on mounting bracket. Discard the filter assembly.

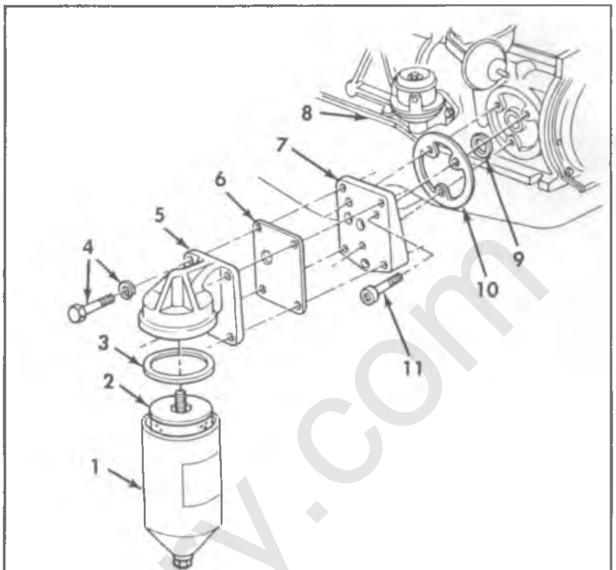
2. Thoroughly clean gasket area on filter bracket.

3. Apply engine oil on filter gasket (gasket is bonded to filter assembly), then thread filter onto stud until gasket contacts bracket. Tighten filter ½ turn after gasket has contacted mating surface on filter bracket.

4. Start engine and inspect for leaks at oil filter. Check crankcase oil level at dipstick. Add oil if required to raise level to "FULL" mark.

REPLACING OIL FILTER ELEMENT
(REPLACEABLE ELEMENT TYPE FILTER)

1. If filter housing has drain plug, remove plug and allow oil to drain from housing. Use wrench to loosen filter housing bolt, then remove bolt, housing, and filter element as an assembly. Remove housing gasket.



1 Filter Shell
2 Filter Element
3 Shell Gasket
4 Housing and Adapter Bolt & Lock Washer
5 Housing
6 Housing Gasket
7 Adapter
8 Engine
9 Adapter-to-Block Seal
10 Adapter Gasket
11 Adapter-to-Block Bolt

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Figure 5—Oil Filter and Bracket Components (Opt. 2 qt. Type on 292 Engine)

2. Remove element from housing and discard element. Clean housing thoroughly. Also clean filter bracket.

3. Install new element in housing, fill housing with new oil, place housing gasket at filter bracket, and install housing and element assembly. Tighten housing retaining bolt.

4. Start engine and inspect for oil leaks. If necessary, add oil to raise oil level to "FULL" mark on dipstick. Refer to figure 4.

OPTIONAL OIL FILTER AND ADAPTER

Key numbers in text refer to figure 5.

When In-line engine is equipped with optional 2-quart filter, an adapter is bolted to block with special socket-head bolts.

When replacing adapter (7), use new seal and gasket (9 and 10) between adapter and cylinder block. Tighten adapter bolts (11) to 35 foot-pounds. When installing housing (5), tighten bolts (4) to 30 foot-pounds torque.

FILTER BY-PASS VALVE
REPLACEMENT (Some Engines)

The oil filter bracket on which the throw-away type filter is mounted has a by-pass valve assembly as shown in figure 3.

GASOLINE ENGINES

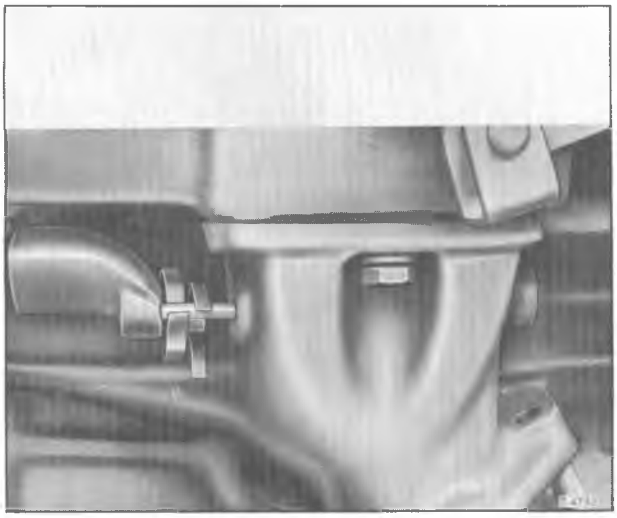


Figure 6—Manifold Heat Control Valve (250 In-Line Engine)

1. To replace the by-pass valve assembly, remove the housing to cylinder block bolts, then remove the housing assembly.

2. Remove the filter element from the housing, then with suitable drift, drive the valve assembly out of housing as shown in figure 4.

3. Set new by-pass valve in place at recess in housing, then with suitable sleeve type installer (fig. 4) drive valve solidly into recess in housing.

4. Install housing on block using new gasket. Use plain washers on attaching bolts and tighten bolts uniformly. Install filter element, and pressure switch (if removed). Start engine and check filter and housing for leaks. Fill engine crankcase as necessary to raise oil level to "FULL" mark on dipstick.

MANIFOLD HEAT CONTROL VALVE
(250 IN-LINE ENGINES)

Referring to figure 6, check for movement of weight on heat control valve shaft. Shaft should rotate freely in bushings. If binding is noticed, lubricate shaft with graphite in alcohol. When engine is cold, the spring should cause valve to move to closed position. Replace spring if defective.

TUNE-UP, CHECKS, AND ADJUSTMENTS

TUNE-UP SEQUENCE INDEX

INTRODUCTION

Engine tune-up consists of diagnosis, and the required preventive maintenance performed at regular intervals to provide maximum performance and economy.

A systematic procedure must be followed when tuning an engine. The operations should be performed in sequence suggested by "Tune-up Sequence Index" above.

NOTE: When performing work where electrical terminals could be accidentally grounded, disconnect the battery cables so no damage to circuits will result.

ENGINE TUNE-UP

SPARK PLUG REMOVAL

1. Clean all foreign matter away from around spark plugs and wiring using compressed air. Disconnect spark plug wires, and loosen each spark plug one turn.

2. Reconnect plug wires, start engine and accelerate to approximately 1,000 rpm. This is done to blow away loose dirt particles and carbon. Failure to do this increases the possibility of foreign material lodging under valves, with resultant false readings and possible valve damage.

3. Stop engine, disconnect plug wires and remove spark plugs and gaskets.

CYLINDER COMPRESSION TEST

1. With carburetor choke and throttle in wide-open position, operate starter with remote control switch.

CAUTION: When using remote switch to operate starter, the primary wire must be disconnected from coil negative terminal and ignition switch must be turned on. Failure to do this will result in damaged grounding circuit in ignition switch.

2. Starting with compression gauge at zero, crank engine through at least four compression strokes to obtain highest possible reading.

3. Make compression check at each cylinder and record each reading.

4. If some cylinders have low compression, inject about one tablespoon of engine oil into combustion chamber through spark plug hole. Crank engine to spread oil on cylinder walls, then recheck compression with gauge.

a. If compression is higher but does not necessarily reach normal pressure, worn piston rings are indicated.

b. If compression is not improved by adding oil to cylinder, it is probable that valves are not properly seating possibly due to sticking in guides, or burned valves or seats.

c. If two adjacent cylinders have lower than normal compression, and injecting oil into cylinders does not increase compression, the cause may be a head gasket leak between the cylinders. This condition could be cause of coolant leaking into cylinders.

NOTE: An engine with low or uneven compression cannot be tuned to give peak performance; therefore, it is important to make necessary corrections before proceeding with tune-up operations.

SERVICE AND INSTALL SPARK PLUGS

1. Inspect all spark plugs carefully. Look for glazed, broken, or blistered porcelains and burned electrodes. Refer to ENGINE ELECTRICAL (SEC. 6Y) in this manual for correct type of spark plugs for various engines.

2. If spark plugs are serviceable, use an abrasive type cleaner such as sand blaster to thoroughly clean spark plugs. File end of center electrode flat.

3. Adjust spark plug gaps to specifications.

4. Test spark plugs with spark plug tester.

5. Install spark plugs using new gasket. Use torque wrench and special spark plug socket wrench. Correct torque for spark plug installation

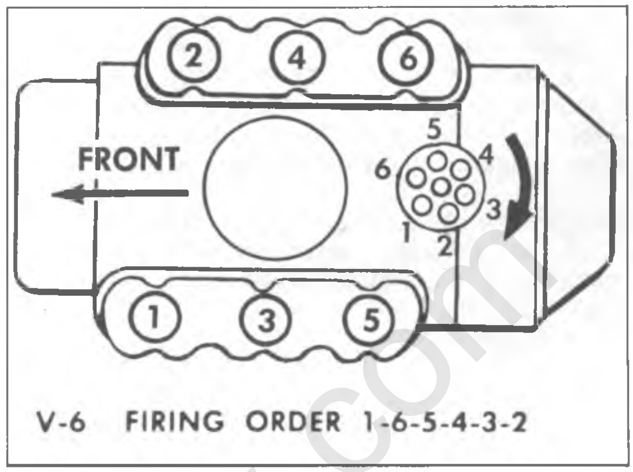


Figure 7—Cylinder Numbers and Spark Plug Wire Locations on V6 Engine

is shown in respective engine tune-up specifications later in this section.

IGNITION SYSTEM SERVICE

1. Remove equipment as required to provide access to ignition distributor, spark plug wires and coil.

2. Check condition of wiring. If any wires are brittle, cracked, or otherwise damaged, replace as necessary.

3. Inspect distributor cap for burned wire sockets, cracks, and for erosion at terminals inside cap. Replace the distributor cap if it is not in good condition. When installing spark plug wires, refer to figure 7 which shows cylinder numbering, firing order and distributor cap wire socket numbering on V6 engines.

On In-line, 6-cylinder engines the cylinders

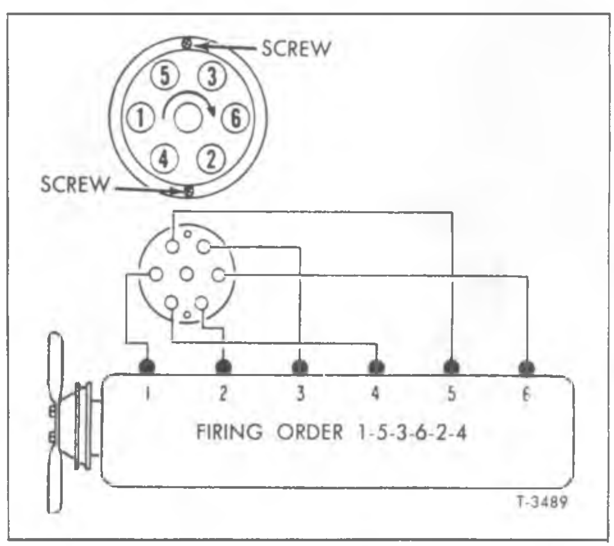


Figure 8—Cylinder Numbers and Spark Plug Wire Locations on In-Line Engine

are numbered consecutively from front to rear and firing order is 1-5-3-6-2-4 (fig. 8).

4. Refer to ENGINE ELECTRICAL (SEC. 6Y) of this manual and inspect ignition distributor points, rotor, and advance mechanism. Make necessary parts replacement and/or adjustments.

BATTERY AND BATTERY CABLE SERVICE

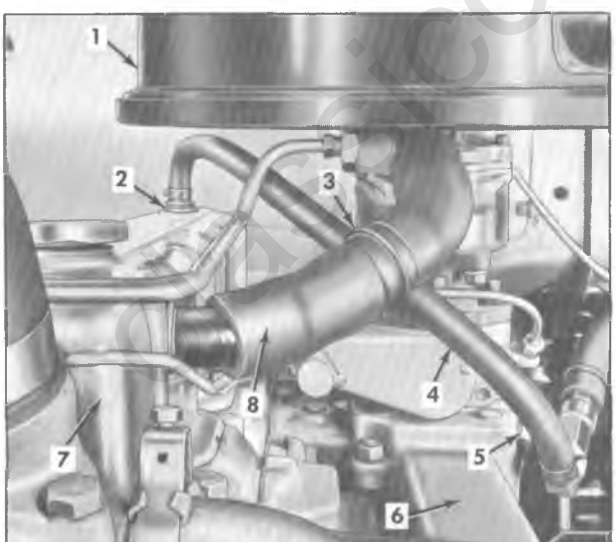
1. Using battery hydrometer check specific gravity of storage battery electrolyte in each cell. Gravity reading below 1.230 (corrected to 80^{O}F.) indicates insufficient charge.

2. Use a voltmeter to check cranking voltage. Disconnect coil primary lead from negative terminal on coil to prevent engine from firing during test.

3. With voltmeter connected between coil positive terminal and ground, operate starter. Voltage of 9 volts or more when starter is cranking engine indicates that battery, and ignition circuit to coil are satisfactory. If voltage reading is less tan 9 volts when engine is being cranked, or if cranking speed is low; a weak battery, defective starter switch, or excessive resistance in ignition circuit exists.

NOTE: If, when making check of cranking voltage, it is noted that cranking speed is uneven, this is an indication of uneven cylinder compression, defective starter or starter drive.

4. In cases where loose, corroded, or otherwise defective battery cables and/or wiring are found, the defects must be corrected to ensure



1 Air Cleaner
2 Ventilation Valve
3 Flame Arrestor
4 Vacuum Line
5 Manifold Fitting
6 Intake Manifold
7 Rocker Arm Cover
8 Hose

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Figure 9—Closed Positive Type Crankcase Ventilation System on In-Line Engine

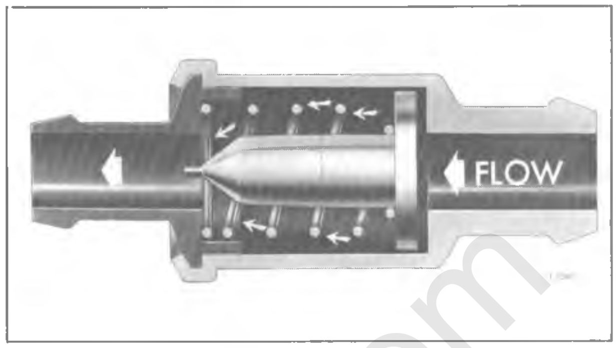


Figure 10—Typical Crankcase Ventilation Valve for In-Line Engine

good engine performance.

5. If battery is weak or shows other evidence of being defective, refer to appropriate coverage in ENGINE ELECTRICAL (SEC. 6Y) in this manual for method of diagnosing battery deficiencies.

CHARGING CIRCUIT AND WIRING INSPECTION

Refer to ENGINE ELECTRICAL (SEC. 6Y) in this manual for procedure required to check performance of charging circuit units.

COOLING SYSTEM INSPECTION

Refer to ENGINE COOLING SYSTEM (SEC. 6K) in this manual for arrangement of cooling system units and for inspection and required maintenance procedures.

CARBURETOR THROTTLE AND CHOKE LINKAGE

On most vehicles it will be necessary to remove air cleaner or air intake hose adapter at carburetor to observe choke operation and action of throttle linkage. All linkage must be maintained in free working condition and should be checked as part of tune-up procedure. Oil linkage pivot points if any binding is evident. Complete information on throttle linkage is given in ENGINE FUEL SYSTEM (SEC. 6M) in this manual.

INSTRUMENT CHECK-OUT

1. Hook up test equipment for use in making final adjustments. Equipment required consists of dwell meter, tachometer, vacuum gauge and timing light.

2. With engine running at idle speed, check dwell angle and readjust if necessary.

3. With vacuum line to distributor disconnected and plugged, run engine at idle speed and check ignition timing with timing light. Loosen distributor clamp and rotate distributor body to change timing as required. Tighten distributor clamp and connect the vacuum line after checking timing.

4. While observing vacuum gauge and tachometer, set engine idle speed and adjust carburetor idle mixture screws to provide steady running engine.

NOTE: If difficulty is experienced in obtaining satisfactory engine idle performance, the cause may be due to malfunction of crankcase ventilation valve(s). Inspection and service of ventilation valves are covered later under appropriate headings.

5. Refer to ENGINE ELECTRICAL (SEC. 6Y) of this manual for instructions for checking voltage regulator settings, generator output, and specifications on various electrical equipment units.

CRANKCASE VENTILATION SYSTEM (IN-LINE 6 CYLINDER ENGINE)

INSPECTION, SERVICE AND UNIT REPLACEMENT

Figure 9 shows typical closed type crankcase ventilation on In-line engine. The ventilation valve (2) is inserted in hole in rocker arm cover and flame arrester (3) is used in air hose (8) connecting air cleaner to rocker arm cover.

TESTING CRANKCASE VENTILATION VALVE

Key number in text refer to figure 9.

1. Connect tachometer and vacuum gauge as when setting idle speed and mixture.
2. Start engine and adjust idle mixture and idle speed.
3. Remove ventilation valve (2) with hose (4) attached. Block the inlet opening in ventilation valve and note change in engine rpm.
4. If blocking the valve opening causes a change of less than 50 rpm, a clogged, or partially restricted ventilation valve is indicated.
5. Install new valve assembly; or if valve (fig. 10) is operative, reinstall in rocker arm cover.

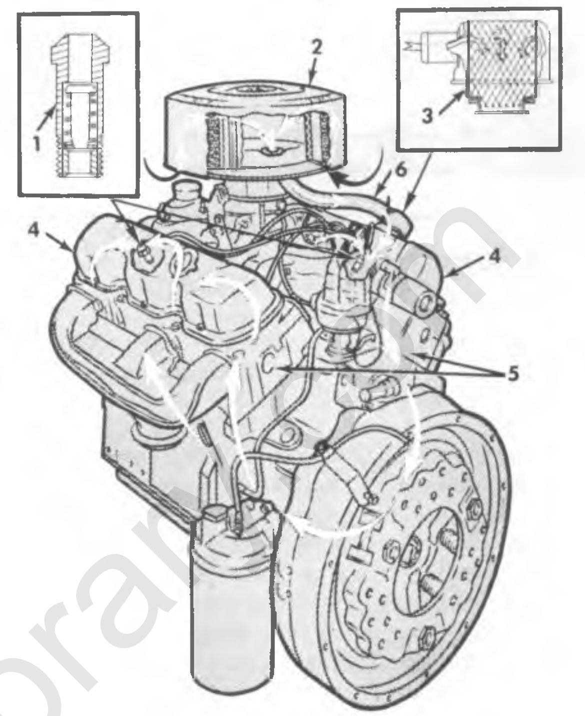
IMPORTANT: At 12-month or 12,000 mile intervals (whichever occurs first) the crankcase ventilation valves must be replaced.

CRANKCASE VENTILATION SYSTEM (V6 ENGINE)

INSPECTION, SERVICE, AND UNIT REPLACEMENT

All V6 gasoline engines have two crankcase ventilation valves, one valve is installed in cylinder head under each rocker arm cover (fig. 11). Each valve assembly is screwed into a threaded passage which leads into intake port in cylinder head.

Ventilation valves (fig. 12) cannot be disassembled but can be removed for inspection. A crankcase ventilation valve which is not functioning properly can affect engine idle and the inadequate ventilation of crankcase may contribute to engine oil contamination and sludge formation.



1 Crankcase Ventilation Valve Assembly
2 Carburetor Air Cleaner
3 Breather Cap
4 Rocker Arm Cover
5 Cylinder Heads
6 Ventilation Hose

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Figure 11—Schematic View of Crankcase Ventilation System on V6 Engine

TESTING CRANKCASE VENTILATION VALVE OPERATION

1. Remove rocker arm cover from each cylinder head.

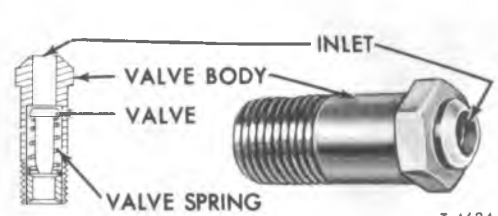


Figure 12—Crankcase Ventilation Valve Used in V6 Engine Cylinder Heads

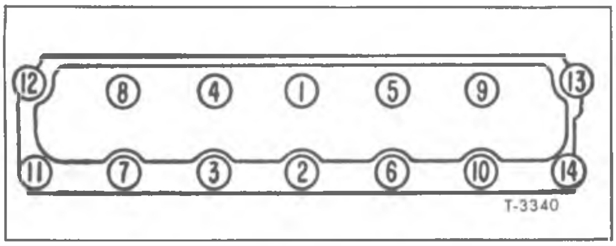


Figure 13—Cylinder Head Bolt Tightening Sequence for In-Line Engine

2. Visually inspect ventilation valves for accumulation of sludge or other matter at inlet opening (fig. 12).

3. If valves appear to be in good condition, start engine and allow to run at idle speed. Connect tachometer if engine is not so equipped.

4. With engine running, note tachometer reading; then cap the inlet openings in valves and compare tachometer reading with reading previously noted before capping openings in ventilation valves. If there is a change of less than 50 rpm when the valve openings are closed, a malfunction of one or both of the valves is indicated.

VENTILATION VALVE REPLACEMENT

1. Use socket wrench to remove valves from engine.

2. If valves have been in use less than 12 months or less than 12,000 miles, solvent may be used to clean the valves.

IMPORTANT NOTE: Crankcase ventilation valves (P.C.V.) MUST be replaced every 12 months, or at 12,000-mile intervals, whichever occurs first. Also, replace ventilation hoses and/or clamps if not in good condition.

3. Install valves in threaded ports in cylinder heads, then install rocker arm covers.

4. At service intervals the breather cap and

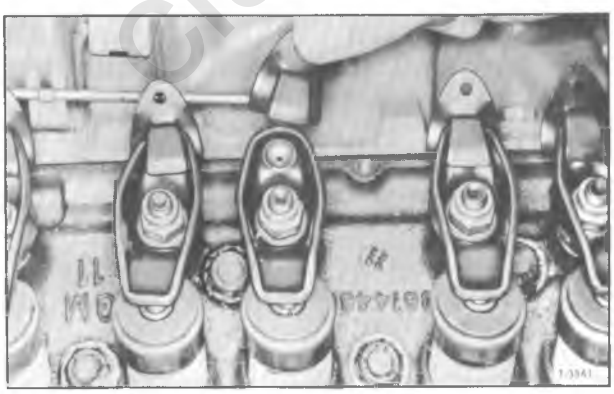


Figure 14—Use of Oil Deflector Clips on In-Line Engine ((Typical)

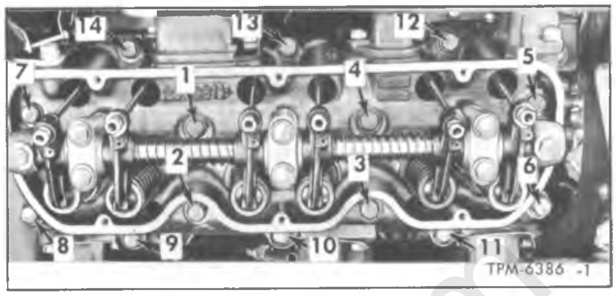


Figure 15—Cylinder Head Bolt Tightening Sequence on V6 Engine

hose must be inspected, cleaned, and reassembled, to ensure free flow of air from air cleaner into valve rocker arm cover.

CYLINDER HEAD BOLT TORQUE AND VALVE LASH ADJUSTMENT (IN-LINE 6 CYLINDER ENGINE)

Checking cylinder head bolt torque is not required unless a leak is suspected, or in case head gasket has been replaced. Valve lifters which are hydraulic type should be reset to place lifter plunger near center of travel, after cylinder head bolts have been retorqued.

1. Tighten cylinder head bolts in sequence indicated in figure 13. Correct torque is 95 foot-pounds.

2. Start engine and run until normal operating temperature is reached. Oil deflector clips (fig. 14) may be installed on rocker arms to prevent oil spatter while adjusting valve lifters.

3. With engine running at idle speed, back off rocker arm stud nut at one rocker arm until it begins to clatter, then turn stud nut back down slowly until the clatter just stops. This is zero lash position.

4. Turn nut down ¼ turn and pause 10 seconds until engine runs smoothly. Repeat additional ¼ turns and 10-second pauses until stud nut has been turned down 1 full turn from zero lash position.

NOTE: The gradual turning down of rocker arm stud nut is necessary to allow lifter to adjust itself and allow valve to completely close each time. If valve is held open, the top of piston may strike valve and cause internal damage and/or bent push rod. Noisy valve lifters should be replaced.

4. Adjust rest of valve lifters in same manner.

5. Remove deflector clips and install rocker arm cover using new gasket.

CYLINDER HEAD BOLT TORQUE AND VALVE LASH ADJUSTMENT (V6 ENGINE)

A check of cylinder head bolt torque should be made at regular tune-up intervals on V6 engines, and should be followed by valve lash adjustment. Follow procedure given below to tighten cylinder head bolts and adjust valve lash.

1. Run engine until normal operating temperature is reached, then stop engine and remove rocker arm covers.
2. Using torque wrench, loosen, then tighten cylinder head bolts in sequence shown in figure 15. Correct head bolt torque is 60 to 65 foot-pounds.

NOTE: Adapter (J-8514) may be used to torque cylinder head bolts under the rocker arm shaft.

3. Using feeler gauge and box end wrench (fig. 16), set exhaust valve clearance at 0.018-inch and intake valve clearance at 0.012-inch.
4. While performing above operations, observe the oil supply to valve rocker arms. If there appears to be insufficient lubrication, make necessary corrections to provide adequate oil supply.

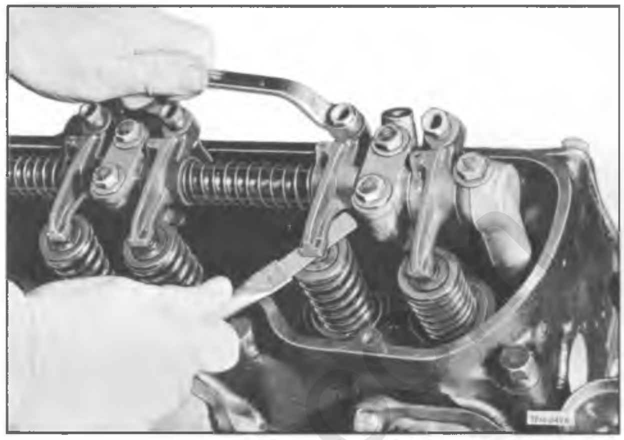


Figure 16—Adjusting Valve Clearance

ENGINE MODELS		250 - 292	305E - 305C	351C - 351M
IDLE* RPM	Without Exhaust Emission Control	525	550	550
	With Exhaust Emission Control	700	550	550
IGNITION TIMING**	Without Exhaust Emission Control	4°	7½°	10°
	With Exhaust Emission Control	0°	7½°	10°

* With air condition turned on (when used).
** With vacuum advance line disconnected and plugged.
Note: Above timing settings apply when average Nation-Wide regular fuel is used.

Figure 17—Engine Idle Speed RPM and Timing Data Chart

Refer to Next Page For "Engine Tune-Up Specifications."

SPECIFICATIONS

IN-LINE ENGINE TUNE-UP CHART

Except as otherwise indicated, the following specifications apply to both engine models.

ENGINE TYPE AND NUMBER OF CYLINDERS	In-Line, 6-Cyl.
COMPRESSION RATIO	
250 Engine	8.5:1
292 Engine	8.0:1
CYLINDER COMPRESSION (PSI)	
At Cranking Speed	130
Max. Variation Between Cylinders	20
SPARK PLUG MAKE AND NUMBER	
250 Engine	AC-R46N
292 Engine	AC-CR44N
Spark Plug Gap (All)	0.035"
Plug Tightening Torque (Ft.-Lbs.)	25
IGNITION DISTRIBUTOR	
Dwell Angle (Degrees)	31-34
Point Gap (New)	0.019"
Point Gap (Used)	0.016"
Contact Lever Spring Tension (Oz.)	19-23
FIRING ORDER	1-5-3-6-2-4
IGNITION TIMING*	Refer to Chart (Fig. 17)
VALVE LASH	Zero
ENGINE IDLE SPEED (RPM)	Refer to Chart (Fig. 17)
FUEL PUMP PRESSURE (PSI)	3½-4½
CYLINDER HEAD BOLT TORQUE (FT.-LBS.)	95

NOTE: Valve lifters are hydraulic type. Refer to "Cylinder Head Bolt Torque and Valve Lash Adjustment" in this section for instructions.

*At engine idling speed, with vacuum advance line disconnected and plugged.

V-6 ENGINE TUNE-UP CHART

Specifications apply to all engines listed above unless otherwise indicated.

TYPE AND NUMBER OF CYLINDERS	60°, V-6
COMPRESSION RATIO	
305E, 305C Engines	7.75:1
351C, 351M Engines	7.50:1
CYLINDER COMPRESSION (PSI)	
At Cranking Speed	125
Max. Variation Between Cyl.	30
SPARK PLUGS	
Make	AC
Type and Gap	
305C	CR 44 NS, 0.040"
305E	CR 45 NS, 0.035"
351C & 351M	CR 43 N, 0.035"
Tightening Torque (Ft.-Lbs.)	32
IGNITION DISTRIBUTOR	
Dwell Angle (Degrees)	31-34
Point Gap (New)	0.019"
Point Gap (Used)	0.016"
Contact Lever Spring Tension (Oz.)	19-23
FIRING ORDER	1-6-5-4-3-2
IGNITION TIMING*	Refer to Chart (Fig. 17)
VALVE LASH	
Intake	0.012"
Exhaust	0.018"
ENGINE GOVERNOR SETTING (Full Load RPM)**	
305E & 305C	3400
351C	3600
351M	3400
ENGINE IDLING SPEED (RPM)	Refer to Chart (Fig. 17)
FUEL PUMP PRESSURE (PSI)	5-6
CYLINDER HEAD BOLT TORQUE (FT.-LBS.)	60-65

*At idling speed, with vacuum advance line disconnected and plugged.
**No-Load settings are approximately 200 rpm more than full-load settings.

Engine Replacement

GENERAL

Two types of engines, namely "In-line" and "V6" are mounted in different manner, hence, the procedures required to remove and install each type of engine will differ. Also, the operations required to replace engines will vary between models, i.e., conventional, tilt-cab, and "P" models.

IN-LINE ENGINES IN CONVENTIONAL AND SCHOOL BUS MODELS

ENGINE REMOVAL

1. Drain radiator.
2. Disconnect battery.
3. Remove hood attaching parts and remove hood.
4. Remove braces which support grille and radiator assembly.
5. Remove radiator hoses and heater hoses.
6. Remove radiator and grille assembly. Refer to SHEET METAL (SEC. 11) of this manual for necessary information when removing grille and radiator assembly.
7. Disconnect fuel line at fuel pump.
8. Remove air cleaner and cover carburetor air inlet opening to prevent entrance of dirt.
9. Disconnect choke control and accelerator linkage.
10. Disconnect exhaust pipe from manifold.
11. Disconnect wiring harness and battery cable.
12. Remove floor mat and transmission cover from cab floor, then remove hand brake lever and gearshift lever from transmission.
13. Disconnect propeller shaft from transmission flange.
14. Attach lifting equipment to take weight of power plant off mountings, then remove mounting bolts and remove rear crossmember which is bolted in place.
15. Lift engine and transmission out of chassis as an assembly.
16. Refer to TRANSMISSIONS AND CLUTCHES (SEC. 7) for necessary information to remove transmission and clutch from engine.

ENGINE INSTALLATION

1. Refer to TRANSMISSIONS AND CLUTCHES (SEC. 7) for information necessary to install clutch and transmission on engine.
2. Attach lifting equipment and lift power plant into place in chassis. Install support crossmember and install engine mountings. Refer to ENGINE MOUNTINGS (SEC. 6D) of this manual for required information regarding engine mountings.
3. Connect propeller shaft and hand brake.
4. Install hand brake lever and gearshift lever, then install cover in cab above transmission.
5. Connect exhaust pipes to manifolds, make electrical wiring connections, and connect carburetor control linkage.
6. Install front end sheet metal and hood, referring to SHEET METAL (SEC. 11) for necessary information for fitting hood.
7. Install air cleaner, connect fuel line, and fill cooling system.
8. Fill crankcase with oil to proper level on dipstick, referring to LUBRICATION (SEC. 0) in this manual for recommended type and viscosity.
9. Install battery and check operation of electrical equipment.
10. Start engine and check for coolant leaks and oil leaks.

ENGINE REPLACEMENT (IN-LINE ENGINE IN PS4500 MODEL)

REMOVAL

1. Remove engine cover and disconnect cables from battery.
2. Remove driver's seat and remove floor panel between step wells.
3. Remove seal plates around steering shaft and pedals.
4. Remove air cleaner and disconnect throttle and choke controls. Disconnect wiring and fuel supply line.
5. Disconnect exhaust pipe from manifold.
6. Disconnect radiator hose and heater hose from engine. Remove radiator, radiator support and shroud, referring to RADIATOR AND SURGE TANK (SEC. 13) of this manual for necessary information.
7. Remove fan blade assembly to prevent damage when removing engine. Disconnect clutch control linkage.
8. Disconnect crankcase ventilation hoses and remove rocker arm cover.
9. Attach crane-type hoist to engine.
10. Support power plant on hoist and remove transmission assembly.
11. Remove engine mounting bolts, then lift engine and remove from vehicle.

INSTALLATION

1. Use crane-type hoist to move engine into position in chassis.

2. Assemble mountings and bolts, referring to ENGINE MOUNTINGS (SEC. 6D) for required information.

3. Install transmission and fan. Install radiator and shroud, and connect radiator hose and heater hose, install rocker arm cover and connect crankcase ventilation hose.

4. Connect exhaust pipe.

5. Reconnect all wiring and controls and install items which were removed or disconnected during engine removal.

6. Fill crankcase to "FULL" mark on oil level dipstick. Fill cooling system. Recommendations regarding engine oil type and viscosity are included in LUBRICATION (SEC. 0) in this manual.

7. Start engine and check for oil leaks and leaks in cooling system.

V6 ENGINE REPLACEMENT FOR CONVENTIONAL CAB MODELS

ENGINE REMOVAL

1. Drain radiator.

2. Disconnect battery.

3. Remove hood attaching parts and remove hood.

4. Remove grille and radiator braces.

5. Remove radiator and heater hoses.

6. Disconnect oil cooler lines from radiator. (Some engines do not have oil cooler.)

7. Remove grille and radiator. Also, remove front bumper.

8. Disconnect fuel supply line.

9. On vehicles with air compressor, disconnect air lines.

10. Disconnect engine ground strap.

11. Disconnect exhaust pipes from exhaust manifolds.

12. Disconnect accelerator and choke controls from carburetor.

13. Disconnect tachometer drive (when used). Also disconnect oil gauge pressure line (when used).

14. If vehicle is equipped with power steering, the power steering pump may be removed from engine and fluid lines may remain connected during engine removal.

15. The hydraulic clutch release cylinder line (when used) should remain attached to cylinder, the cylinder mounting bolts removed to permit engine removal without draining fluid from clutch release system.

16. Attach lifting sling to overhead hoist and take weight off front mounting.

17. Remove clutch housing-to-flywheel housing bolts, then carefully work engine forward to disengage transmission drive gear from clutch driven member splines. When free from transmission, raise engine and remove from vehicle.

ENGINE INSTALLATION

Engine installation is accomplished by reversing "Removal" procedure, meanwhile taking necessary precautions to maintain cleanliness and to avoid damaging components.

After engine is installed, check operation of control linkage. Fill cooling system and check for leaks.

Fill crankcase with engine oil of recommended grade and viscosity, referring to LUBRICATION (SEC. 0) in this manual.

Start engine, make adjustments at carburetor, set ignition timing, and adjust valve lash.

NOTE: If engine has been run in on test stand, the foregoing adjustments will have been made previously and need not be repeated.

V6 ENGINE REPLACEMENT FOR TILT CAB MODELS

GENERAL

The steps required to replace an engine in tilt-cab models with V6 gasoline engine will vary with the model and optional equipment involved. Procedure which follows will serve as a guide for use when engine replacement is necessary. In most instances the transmission and engine should be removed as an assembly.

REMOVAL

1. Drain radiator and disconnect battery.

2. Disconnect oil cooler lines (when used). Cooler lines are attached to fittings at bottom tank on radiator. Oil will drain from lines and cooler when lines are disconnected.

3. Disconnect electrical wiring and cables at starter; also, disconnect engine ground strap.

4. Disconnect throttle and choke controls.

5. Disconnect transmission control rods, detach hoses from surge tank. Remove air cleaners and inlet hoses as necessary to permit removal of control island assembly.

6. Remove control island, and cab rear support.

7. Disconnect exhaust pipes from manifolds.

8. Disconnect clutch control cylinder from release lever and flywheel housing. The fluid line may remain attached to cylinder to prevent fluid from draining from clutch control system while engine is removed.

9. Disconnect parking brake control (except when air-operated brake is used) and speedometer drive at rear of transmission.

10. Disconnect cooling system and heater hoses.

11. Disconnect propeller shaft from transmission.

12. If air compressor is used, disconnect air lines from compressor. In some cases the air compressor mounting bracket may be detached from engine and compressor may remain with chassis when engine is removed.

13. If power steering is used, the power steering pump may be detached from engine and lines may remain connected to prevent fluid loss when removing engine.

14. Attach overhead hoist securely to engine sling, then raise power plant slightly to remove weight from engine mountings. Remove mounting bolts from front and rear mountings, then raise power plant and remove from chassis.

15. Refer to applicable procedures in TRANSMISSIONS AND CLUTCHES (SEC. 7) for instructions, and remove transmission and clutch from engine.

INSTALLATION

Assemble clutch components and transmission to engine referring to applicable instructions in TRANSMISSIONS AND CLUTCHES (SEC. 7) in this manual.

Install power plant by reversing order of "Removal" procedure taking necessary precautions to maintain cleanliness and to avoid damage to the engine components.

After engine is installed, check operation of control linkage, fill cooling system and check for leaks.

Fill crankcase with engine oil of recommended grade and viscosity. Refer to LUBRICATION (SEC. 0) in this manual.

Start engine, make adjustments at carburetor, set ignition timing and adjust valve lash.

NOTE: If engine has been run in on test stand, the foregoing adjustments will have been made previously and need not be repeated.

In-Vehicle Service Operations

IN-LINE ENGINE IN-VEHICLE SERVICE OPERATIONS

MANIFOLD REPLACEMENT

REMOVAL

1. Remove air cleaner.
2. Disconnect both throttle rods at bellcrank and remove throttle return spring.
3. Disconnect fuel and vacuum lines and choke cable at carburetor.
4. Disconnect crankcase ventilation hose at rocker arm cover.
5. Disconnect exhaust pipe at manifold flange and discard packing.
6. On engines with sheet metal heat stove, remove the attaching screws, and remove stove parts (fig. 18) from exhaust manifold.
7. Remove manifold attaching bolts and clamps then remove manifold assembly and discard gaskets.
8. Check for cracks in manifold castings.
9. If necessary to replace either the intake or exhaust manifold, separate them by removing one bolt and two nuts at center of assembly. Reassemble manifolds using a new gasket. Tighten finger-tight and torque to "Specifications" after assembly to cylinder head. Transfer all necessary parts.

INSTALLATION

1. Clean gasket surfaces on cylinder head and manifolds. On engines with heat stove, assemble stove bracket at manifold attaching parts.
2. Position new gasket over manifold end studs on head and carefully install the manifold in position making sure the gaskets are in place.
3. Install bolts and clamps while holding manifold in place with hand.
4. Torque bolts to specifications.

NOTE: Center bolt and end bolt torque differ.

5. Connect exhaust pipe to manifold using a new packing.
6. Connect crankcase ventilation hose at rocker arm cover.
7. Connect fuel and vacuum lines at carburetor.

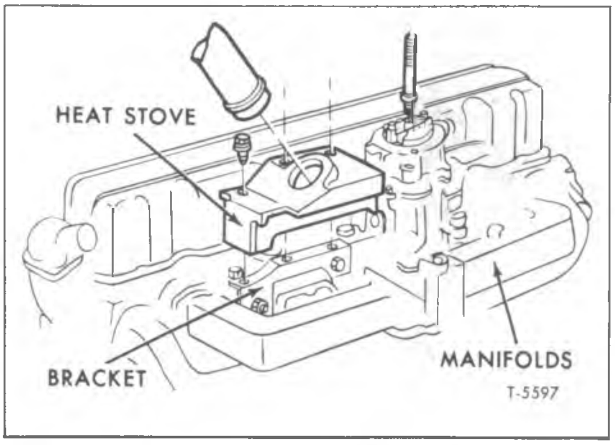


Figure 18—Manifold Heat Stove Installation (In-Line Engine)

Figure 19—Valve Adjustment on In-Line Engine

8. Connect choke cable and adjust as directed in ENGINE FUEL SYSTEM (SEC. 6M) of this manual.
9. Connect throttle rods at bellcrank and install throttle return spring.
10. Install air cleaner, start engine, check for leaks and adjust carburetor idle speed and mixture.

ROCKER ARM COVER REPLACEMENT

REMOVAL

1. Disconnect crankcase ventilation hose at rocker arm cover.
2. Remove air cleaner.
3. Disconnect temperature wire from rocker arm cover clips.
4. Remove cover attaching screws, then remove cover.

> **CAUTION: DO NOT pry rocker arm cover loose. Gaskets adhering to cylinder head and rocker arm cover may be loosened by bumping end of rocker arm cover rearward with palm of hand, or a rubber mallet.**

INSTALLATION

1. Clean gasket surfaces on cylinder head and rocker arm cover with degreaser, then using a new gasket, install rocker arm cover and torque screws to specifications.
2. Connect temperature wire at rocker arm cover clips.
3. Install air cleaner.
4. Connect crankcase ventilation hose.

VALVE MECHANISM REPLACEMENT

REMOVAL

1. Remove rocker arm cover as previously directed.
2. Remove rocker arm nuts, rocker arm balls, rocker arms and push rods.

NOTE: Place rocker arms, rocker arm balls and push rods in a rack so they may be reinstalled in the same location.

INSTALLATION AND ADJUSTMENT

NOTE: Whenever new rocker arms and/or rocker arm balls are being installed, coat bearing surfaces of rocker arms and rocker arm balls with Molykote or its equivalent.

1. Install push rods. Be sure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts. Tighten rocker arm nuts until all lash is eliminated.
3. Adjust valves when lifter is on base circle of camshaft lobe as follows:

a. Mark distributor housing, with chalk, at each cylinder position (plug wire), then disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly (if not previously done).

b. Crank engine until distributor rotor points to No. 1 cylinder position and breaker points are open. Both valves on No. 1 cylinder may now be adjusted.

c. Back out adjusting nut until lash is felt at the push rod, then turn in adjusting nut until all lash is removed. This can be determined by checking push rod side play while turning adjusting nut (fig. 19). When play has been removed, turn adjusting nut one full additional turn (to center the lifter plunger).

d. Adjust the remaining valves, one cylinder at a time, in the same manner.

4. Install distributor cap and spark plug wire assembly.
5. Install rocker arm cover as previously instructed.
6. Adjust carburetor idle speed and mixture as directed in ENGINE FUEL SYSTEM (SEC. 6M) of this manual.

VALVE LIFTERS

Hydraulic valve lifters seldom require attention. The lifters are simple in design, readjustments are not necessary, and servicing of the lifters requires only that care and cleanliness be exercised in the handling of parts.

LOCATING NOISY LIFTERS

Locate a noisy valve lifter by using a piece of garden hose approximately four feet in length. Place one end of the hose near the end of each intake and exhaust valve with the other end of the hose to the ear. In this manner, the sound is localized making it easy to determine which lifter is at fault.

Another method is to place a finger on the face of the valve spring retainer. If the lifter is not functioning properly, a distinct shock will be felt when the valve returns to its seat.

The general types of valve lifter noise are as follows:

1. Hard Rapping Noise - Usually caused by the plunger becoming tight in the bore of the lifter body to such an extent that the return spring can no longer push the plunger back up to working position. Probable causes are:

a. Excessive varnish or carbon deposit causing abnormal stickiness.

b. Galling or "pickup" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedging between plunger and lifter body.

2. Moderate Rapping Noise - Probable causes are:

a. Excessively high leakdown rate.

b. Leaky check valve seat.

c. Improper adjustment.

3. General Noise Throughout the Valve Train - This will, in almost all cases, be a definite indication of insufficient oil supply, or improper adjustment.

4. Intermittent Clicking - Probable causes are:

a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.

b. In rare cases, the ball itself may be out-of-round or have a flat spot.

c. Improper adjustment.

In most cases, where noise exists in one or more lifters all lifter units should be removed, disassembled, cleaned in a solvent, reassembled, and reinstalled in the engine.

REMOVAL

1. Remove valve mechanism as previously directed.

2. Mark distributor housing, with chalk, at each cylinder position (plug wire), then disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly.

3. Crank engine until distributor rotor points to number one position, then disconnect distributor primary lead at coil and remove distributor.

4. Remove push rod covers (discard gaskets).

5. Remove valve lifters.

NOTE: Place valve lifters in a rack so they may be reinstalled in the original locations.

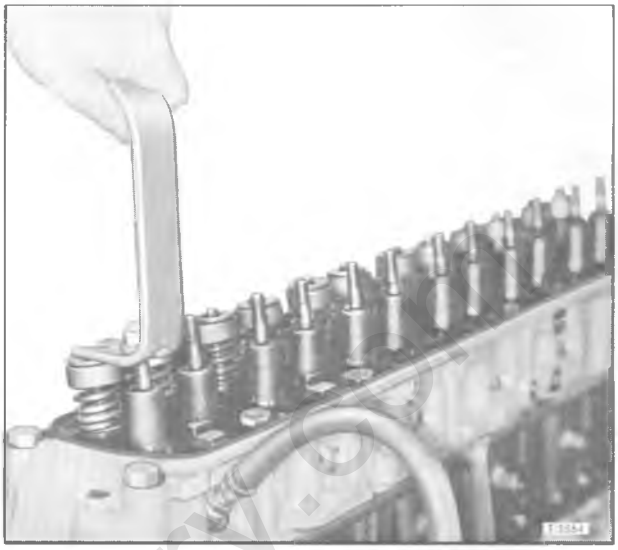


Figure 20—Using Special Tool and Compressed Air to Remove Valve Spring

INSTALLATION

1. Install valve lifters.

NOTE: Whenever new valve lifters are being installed, coat foot of valve lifters with Molykote or its equivalent.

2. Install push rod covers, using new gaskets, and torque screws to "Specifications."

3. Install distributor, positioning rotor to number one cylinder position, then connect primary lead at coil.

4. Install and adjust valve mechanism.

5. Adjust ignition timing and carburetor idle speed and mixture.

VALVE STEM OIL SEAL AND/OR VALVE SPRING REPLACEMENT

1. Remove rocker arm cover as previously directed.

2. Remove spark plug, rocker arm, and push rod on the cylinder(s) to be serviced.

3. Apply compressed air to the spark plug hole to hold the valves in place.

NOTE: An adapter (J-21546) for use in connecting air supply to spark plug hole now is available to facilitate the valve spring replacement.

4. Using Tool (J-5892) (fig. 20) to compress the valve spring, remove the valve locks, valve cap (or rotator), valve shield and valve spring and damper.

5. Remove the valve stem oil seal.

6. To replace, set the valve spring and damper, valve shield and valve cap (or rotator) in place. The close coiled end of the spring is installed against the cylinder head. Compress the spring with Tool (J-5892) and install oil seal in the lower

groove of the stem, making sure the seal is flat and not twisted.

NOTE: A light coat of oil on the seal will help prevent twisting.

7. Install the valve locks and release the compressor tool, making sure the locks seat properly in the upper groove of the valve stem.

NOTE: Grease may be used to hold the locks in place while releasing the compressor tool.

CYLINDER HEAD ASSEMBLY REPLACEMENT

REMOVAL

1. Remove manifold assembly.
2. Remove valve mechanism.
3. Drain cooling system.
4. Remove fuel and vacuum line from retaining clip at water outlet, then disconnect wires from temperature sending units.
5. Disconnect upper radiator hose at water outlet housing and battery ground strap at cylinder head.
6. Remove coil.
7. Remove cylinder head bolts, cylinder head and gasket. Place cylinder head on two blocks of wood to prevent damage.

INSTALLATION

> **CAUTION: Gasket surfaces on both the head and the block must be clean of any foreign matter and free of nicks or heavy scratches. Cylinder head bolt threads in the block and threads on cylinder head bolt must be cleaned. (Dirt will affect bolt torque.) Do NOT use gasket sealer on composition steel-asbestos gaskets.**

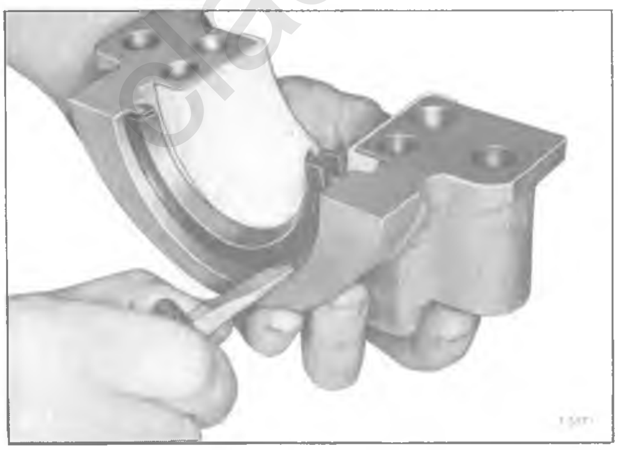


Figure 21—Removing Oil Seal from Bearing Cap Groove (Typical)

1. Place the gasket in position over the dowel pins with the bead up.
2. Carefully guide cylinder head into place over dowel pins and gasket.
3. Coat threads of cylinder head bolts with sealing compound and install finger tight.
4. Tighten cylinder head bolts a little at a time in the sequence shown in figure 13, until the specified torque is reached (95 foot-pounds).
5. Install coil (if removed).
6. Connect upper radiator hose and engine ground strap.
7. Connect temperature sending unit wires and install fuel and vacuum lines in clip at water outlet.
8. Fill cooling system.
9. Install manifold assembly.
10. Install and adjust valve mechanism as previously instructed.

NOTE: Do NOT install rocker arm cover.

11. Start engine and allow to warm up, retorque cylinder head and readjust valves.

NOTE: Use of commercially available oil deflector clips (14) on rocker arms will prevent oil spatter during warm-up.

12. After making foregoing adjustment install rocker arm cover using new gasket. Install air cleaner and connect manifold heat stove pipe.

OIL PAN REPLACEMENT

OIL PAN REMOVAL

1. Clean all dirt and accumulated material from oil pan attaching bolts and drain plug.
2. Drain oil out of crankcase.
3. Remove oil pan bolts, then remove oil pan. Scrape off any portions of gaskets which adhere to oil pan flange or bolting flange on engine block and front cover. Gasket at front cover is neoprene type. Remove seal at crankshaft rear bearing cap.

INSTALLATION

1. Install seal at rear bearing cap.
2. Install front seal on timing gear cover, pressing tips into holes in cover.
3. Use grease or cement to hold side gaskets in place on cylinder block. Side gasket tabs must index with front seal on timing gear cover.
4. Install oil pan.

OIL PUMP REPLACEMENT

REMOVAL

1. Remove oil pan as previously directed under appropriate heading.
2. Remove bolt attaching oil suction pipe. Remove two bolts holding pump flange to engine, then remove pump and screen as an assembly.

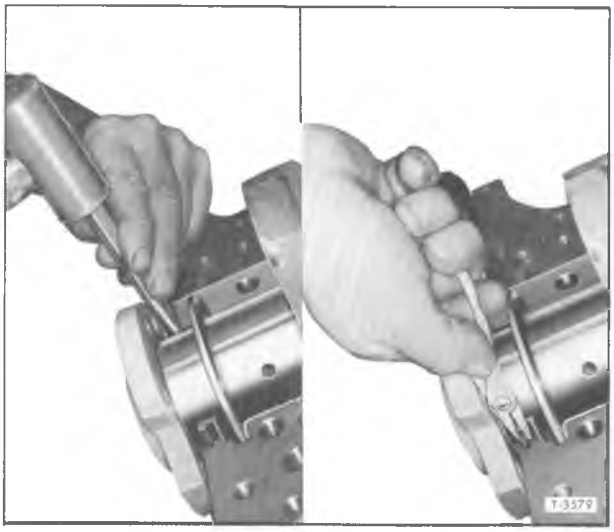


Figure 22—Removing Oil Seal Upper Half (Typical)

INSTALLATION

1. Align oil pump drive shaft to match with distributor tang, then install oil pump to block, positioning flange over distributor lower bushing. Use no gasket. Attach suction pipe support with bolt.

NOTE: Oil pump should slide easily into place, if it does not, remove and reposition shaft slot to align with distributor tang.

2. Install oil pan as instructed previously.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

REMOVAL

The rear main bearing oil seal can be replaced (both halves) without removal of the crankshaft.

NOTE: Always replace the upper and lower seal as a unit. Install with the lip facing toward the front of the engine.

1. With the oil pan and oil pump removed, remove the rear main bearing cap.
2. Remove oil seal from the groove by prying from the bottom with a small screwdriver (fig. 21).
3. Use light hammer and small brass pin punch in manner shown in figure 22 to start seal upper half out of block. When end of seal protrudes far enough to be grasped with pliers, pull upper half out of block.

INSTALLATION

1. Wipe crankshaft surface with clean cloth. Apply engine oil on seal lip, but keep oil off parting line surface as this surface is treated with glue. Press seal into place in bearing cap with fingers.
2. Position seal upper half on crankshaft so it can be installed in block by holding seal firmly

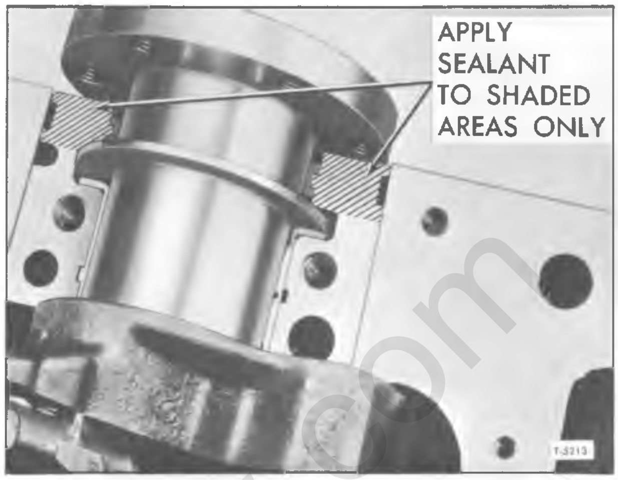


Figure 23—Sealer on Bearing Cap Area on Cylinder Block

with hammer handle while crankshaft is turned, similar to method used to install bearing.

3. Referring to figure 23, apply light coat of brush-on type oil sealing compound to block and mating surface on bearing cap. Do not apply sealer on treated ends of oil seals.
4. Install bearing cap and install cap bolts with 10 to 12 foot-pounds initial torque, then use lead hammer to tap crankshaft first rearward, then forward. This will line up rear main bearing thrust faces. Finally, tighten bearing cap bolts to 115 foot-pounds torque.
5. Install oil pump and oil pan.

CRANKSHAFT DAMPER REPLACEMENT

REMOVAL

1. Drain radiator and disconnect radiator hoses at radiator.
2. Remove radiator core, as outlined in RADIATOR AND SURGE TANK (SEC. 13) of this manual.
3. Remove fan belt and (if so equipped) accessory drive pulley and belt. If so equipped, remove retaining bolt.
4. Install Tool (J-6978-04) on damper and turn puller screw to remove damper (fig. 24). Remove tool from damper.

INSTALLATION

CAUTION: The inertia weight section of the damper is assembled to the hub with a rubber-type material. The installation procedures (with proper tool) must be followed or movement of the inertia weight section on the hub will destroy the tuning of the damper.

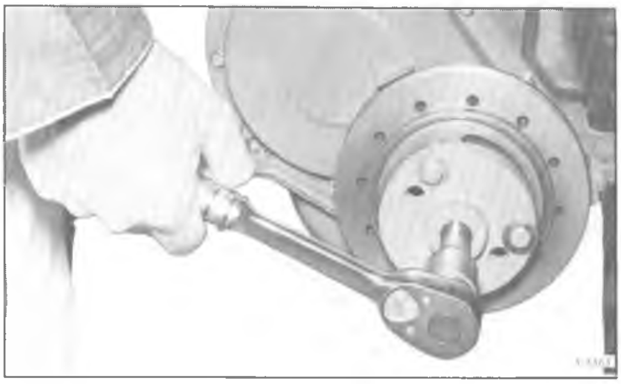


Figure 24—Removing Crankshaft Damper

1. Coat front seal contact area (on damper hub) with engine oil.

2. Install damper as follows:

a. DRIVE ON TYPE (Without Retaining Bolt).

(1) Attach damper installer Tool (J-22197) to damper. Tighten fingers of tool to prevent inertia weight from moving (fig. 25).

(2) Position damper on crankshaft and drive into position until it bottoms against crankshaft gear (fig. 25). Remove installer tool.

b. PULL ON TYPE (With Retaining Bolt).

(1) Use a 7/16"-20 x 4" bolt, nut, and washer or special installer (J-21058) (fig. 26) to pull torsional damper onto crankshaft. If tool is used, hold bolt with wrench, then turn threaded sleeve to force hub onto crankshaft.

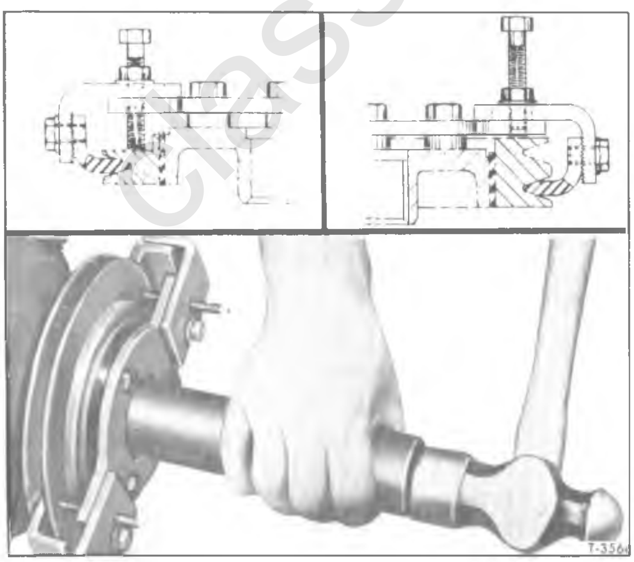


Figure 25—Installing Drive-On Type Crankshaft Damper

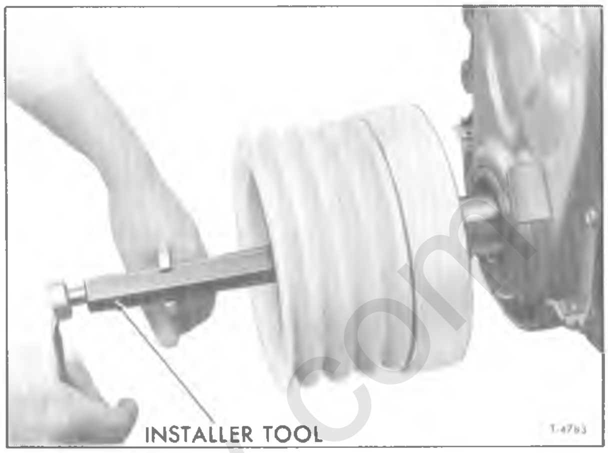


Figure 26—Installing Pull-On Type Crankshaft Damper

CAUTION: Install bolt in crankshaft with sufficient thread engagement (min. ½").

(2) Remove bolt, nut, and washer or tool, then install retaining bolt and torque to "Specifications."

3. Install fan belt and adjust using strand tension gauge.

4. If so equipped, install accessory drive pulley and belt.

5. Install radiator core as directed in RADIATOR AND SURGE TANK (SEC. 13) of this manual.

6. Connect radiator hoses.

7. Fill cooling system and check for leaks.

CRANKCASE FRONT COVER AND OIL SEAL

REMOVAL

1. Remove oil pan.

2. Remove crankshaft pulley and hub or damper as directed previously.

3. Remove crankshaft front cover attaching screws, remove cover and gasket.

INSTALLATION

1. Clean gasket surfaces on block and crankcase front cover. If oil seal requires replacing, follow instructions given later under appropriate heading.

2. Install centering Tool (J-0966) or centering Tool (J-21742) in crankcase front cover seal (fig. 27).

3. Cement cover gasket in place on block. Attach new oil pan seal at cover lower flange.

NOTE: It is important that centering tool be used to align front cover so that crankshaft hub or

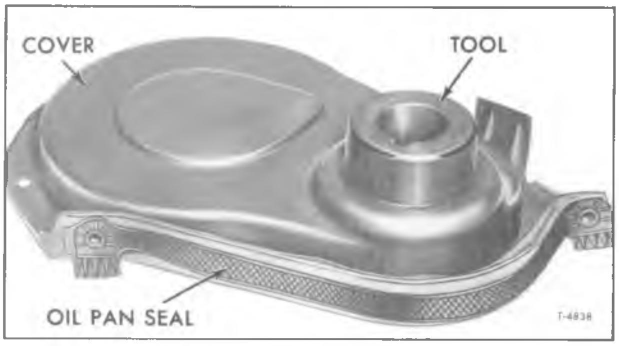


Figure 27—Centering Tool in Engine Cover

damper installation will not damage seal and to position seal to seat evenly around the damper or hub surface.

4. With centering Tool (J-0966) in place (fig. 27), position cover on front of cylinder block, install attaching bolts, and tighten firmly (6½ foot-pounds torque). Install two oil pan bolts, then remove centering tool.

5. Install crankshaft damper and pulley, referring to instructions given previously.

OIL SEAL REPLACEMENT

Removal

If front cover is installed, remove crankshaft damper as previously instructed, then use suitable tool to pry the seal out of cover.

If cover is removed from engine, drive oil seal out of cover with suitable tool, then clean the seal recess.

Installation

If cover is installed on engine, Tool (J-8340) may be used as shown in figure 28 to drive new oil seal into cover. The seal lip must be toward inner side of cover.

When installing oil seal with cover removed,

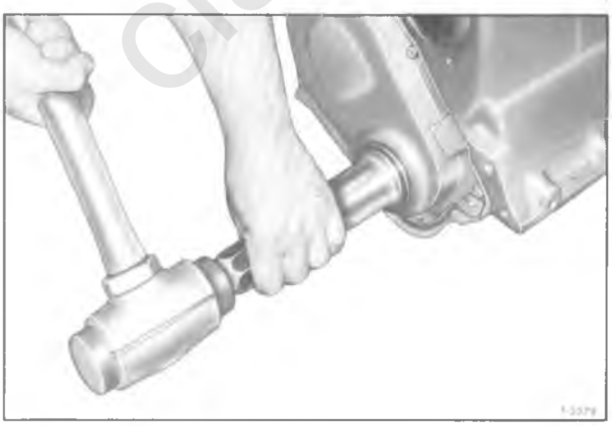


Figure 28—Installing Front Cover Oil Seal (Cover Installed)

Figure 29—Installing Front Cover Oil Seal

support inner side of cover with Tool (J-971), position seal with lip toward inner side of cover, then use Tool (J-995) to drive new oil seal squarely into cover as shown in figure 29.

FLYWHEEL REPLACEMENT
(All Except 292 Engines)

1. Remove transmission and clutch parts (as necessary), then remove the flywheel bolts, and remove flywheel from crankshaft.

2. Clean mating surfaces on flywheel and crankshaft, then place flywheel at crankshaft and install bolts. Tighten bolts to 60 foot-pounds. Figure 30 shows flywheel installation views. Install clutch parts (if used) and install transmission.

FLYWHEEL REPLACEMENT (292 Engines)

1. Remove transmission and clutch mechanism from engine. Remove engine oil pan and rear main bearing cap, then use hammer and drift to drive

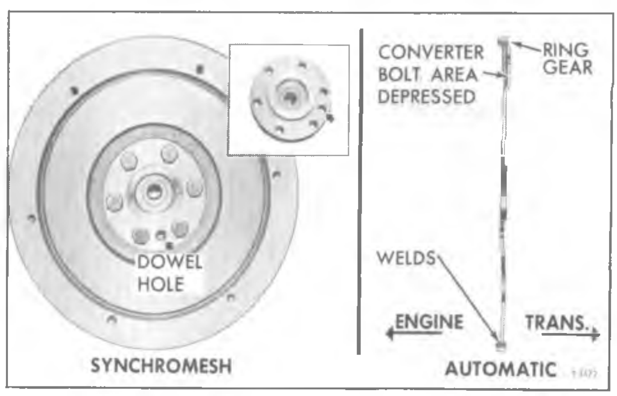


Figure 30—Flywheel Installation (Typical)

out and remove the three flywheel-to-crankshaft dowel pins. Crankshaft must be turned each time a dowel pin is removed, so next pin can be driven out without contacting cylinder block. After removing dowel pins, remove flywheel-to-crankshaft bolts, then remove flywheel.

2. Clean mating surfaces on crankshaft flange and flywheel and remove any existing burrs. Position flywheel at crankshaft flange with dowel pins aligned.

NOTE: If new flywheel is being installed it is necessary to ream the dowel pin holes to assure correct hole alignment and dowel pin fit. Dowel pins must be driven into place as they are interference fit.

3. With flywheel bolts installed and tightened to 110 foot-pounds torque, use reamer (J-22808) to size and line ream the dowel pin holes. Finish ream the holes with reamer (J-22808-1). Drive oversize dowel pins flush with flywheel rear surface. Install bearing cap and oil pan referring to instructions previously given in this section. Assemble clutch mechanism, then install transmission on engine.

CHECKING ENGINE VALVE TIMING

When it becomes necessary to make a check of valve timing, the procedure following may be used:

1. Remove valve rocker arm cover and push rod front cover.
2. Loosen nut at #1 intake valve rocker arm, swing rocker arm away from push rod, then remove push rod and hydraulic valve lifter.
3. Temporarily install a flat face mechanical lifter in place of the hydraulic lifter.
4. Turn crankshaft until #2 exhaust valve opens and notch on pulley or damper is aligned with "O" mark on timing pointer.
5. Position dial indicator to measure lifter movement and set indicator at zero. Turn crankshaft 360 degrees and read indicator. On correctly timed engines the indicator will read as follows:

On 250 Engines .... 0.010 to 0.018 inch
On 292 Engines .... 0.012 to 0.020 inch

If reading is not as shown, reset indicator at zero and turn crankshaft 360 degrees, then read indicator again. If reading is now in accord with specifications, the engine is timed properly.

NOTE: Chart following shows indicator readings with gears properly indexed for each engine and the indicator readings resulting from improperly indexed gears:

Engine (Cu.In.)	Camshaft Part No. & Valve Lift	Gears Properly Indexed	One Tooth Adv.	One Tooth Ret.
250	3864896-.388	.014" - .004"	.0351"	.0055"
292	3848000-.405	.016" - .004"	.0379"	.0068"

6. If foregoing check indicates an out-of-time condition, remove engine front cover and check for proper indexing of timing marks on gears.

IN-VEHICLE SERVICE OPERATIONS (V6 ENGINE)

VALVE ROCKER ARM COVER REPLACEMENT

REMOVAL

Remove valve rocker arm cover screws, then remove rocker arm cover. On tilt cab models it will be necessary to remove transmission shift rods in order to remove cover from left-hand cylinder head.

NOTE: If cover is stuck in place, loosen by striking with palm of hand or a rubber mallet. Do not pry on cover flange since the flange may be distorted.

INSTALLATION

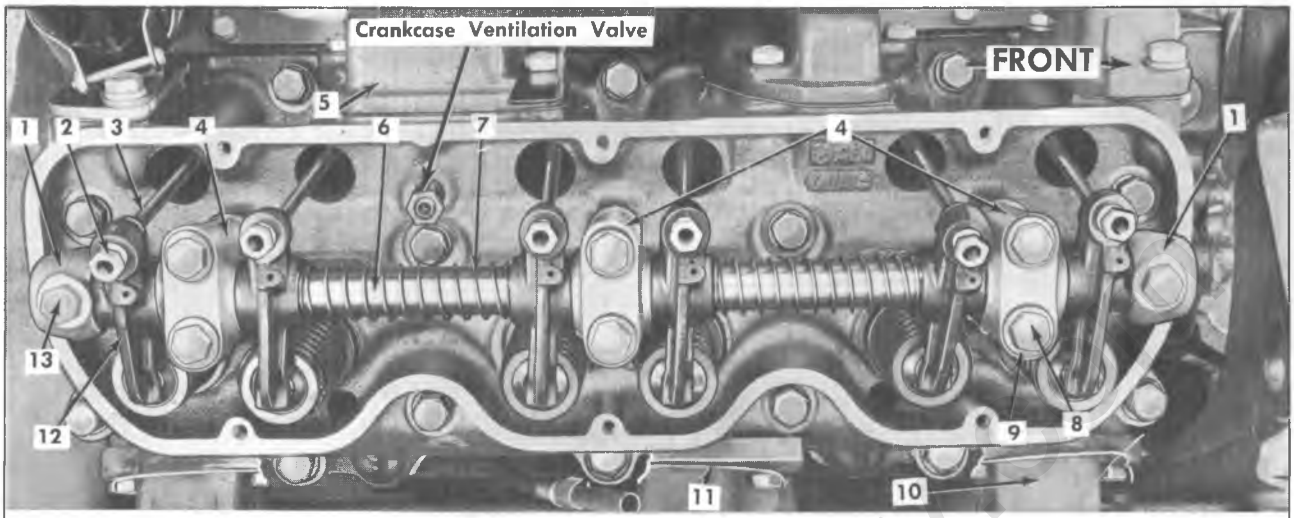
Using new cover gasket, install rocker arm cover and tighten cover screws uniformly.

VALVE ROCKER ARMS, SHAFT, AND PUSH ROD REPLACEMENT

Same instructions apply to either the right-hand or left-hand cylinder head.

REMOVAL

1. Remove rocker arm covers referring to instructions previously given.
2. Loosen rocker arm shaft bracket bolts gradually until spring pressure is fully relieved at rocker arms. Lift off the rocker arm shaft and brackets, with attaching bolts, as an assembly.
3. Remove push rods and identify in some manner so they can be returned to original position at assembly.
4. On all 305 engines and 351C engine, if the



1 End Bracket
2 Adjusting Screw
3 Push Rod
4 Rocker Arm Shaft Bracket
5 Intake Manifold
6 Rocker Arm Shaft
7 Spring
8 Bracket Bolt
9 Flat Washer
10 Exhaust Manifold
11 Exhaust Manifold Bolt Lock
12 Rocker Arm
13 Special Bolt

T-5602

Figure 31—Valve Rocker Arms and Shaft Installed

removal of valve lifters is desired, a special tool is available to remove lifters without removing cylinder head. Insert tool through push rod holes in cylinder head and into lifter. Turn knob at upper end of tool to lock the tool into lifter, then pull lifter out of bore.

NOTE: Valve lifters should be installed in bores from which they were removed.

INSTALLATION

1. If valve lifters have been removed from 305 or 351C engines lubricate lifters with special break-in compound, and use special tool to insert lifters into respective bores.
2. Place push rods in original positions, then place rocker arm shaft and bracket assembly (fig. 31) on cylinder head, being careful to engage rocker arm screws with sockets in push rods. Tighten bracket bolts to 20 to 25 foot-pounds torque.
3. Check clearance between rocker arm end brackets and adjacent rocker arm. If a clearance of approximately 0.030 inch does not exist, loosen end bracket bolts and relocate brackets as allowed by clearance in bracket hole, then tighten bolts to specified torque.
4. Make initial adjustment to provide clearance of 0.014 inch at intake valves, and 0.022 inch at exhaust valves.
5. Lubricate rocker arms with engine oil.
6. Install rocker arm covers temporarily while engine is run to warm up to operating temperature. With engine idling and temperature at 160 degrees, adjust intake valves to 0.012 inch and exhaust valves to 0.018 inch.

NOTE: Inspect crankcase ventilation valve (fig. 31) and clean or replace as necessary.

7. Install rocker arm cover using new cover gasket.

VALVE SPRING REPLACEMENT (CYLINDER HEAD INSTALLED)

In most vehicles it is possible to replace a broken valve spring without removing cylinder head by following the procedure outlined below:

When it is necessary to replace a valve spring and/or seals on valve stems, the special tools shown in figure 32 may be used to facilitate the operation without removing the cylinder head. Proceed in following manner to replace valve spring and retaining parts:

1. Remove valve rocker arm cover.
2. Remove spark plug from cylinder on which work is to be done. Use spark plug gasket and install adapter (J-21546) in spark plug hole.
3. Remove rocker arm shaft and bracket assembly from cylinder head. Install a 3/8-16 stud in bracket bolt hole adjacent to the valve spring to be removed. Stud must have sufficient threads to permit screwing stud nut down one-half inch after compressor contacts valve spring cap.
4. Turn engine crankshaft to place piston at

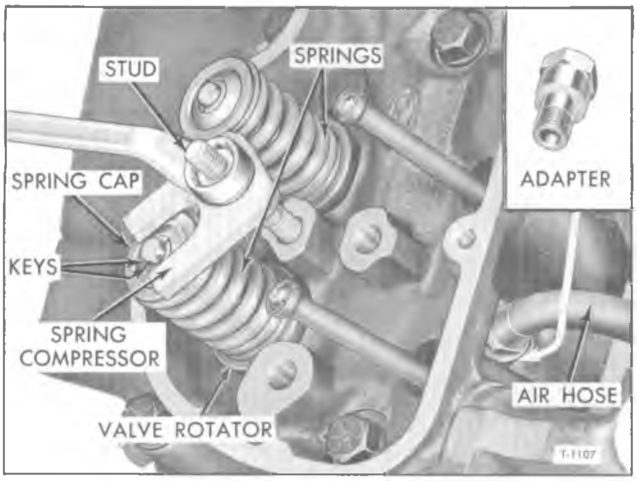


Figure 32—Use of Special Equipment for Replacing Valve Spring (V6 Engine)

BOTTOM of stroke. Attach compressed air supply line to adapter and turn on air supply. Air pressure in cylinder will hold valves against seats while spring and retaining parts are removed.

5. Assemble valve spring compressor (J-21544) and nut on stud as shown in figure 32, then with wrench, turn nut to force compressor down

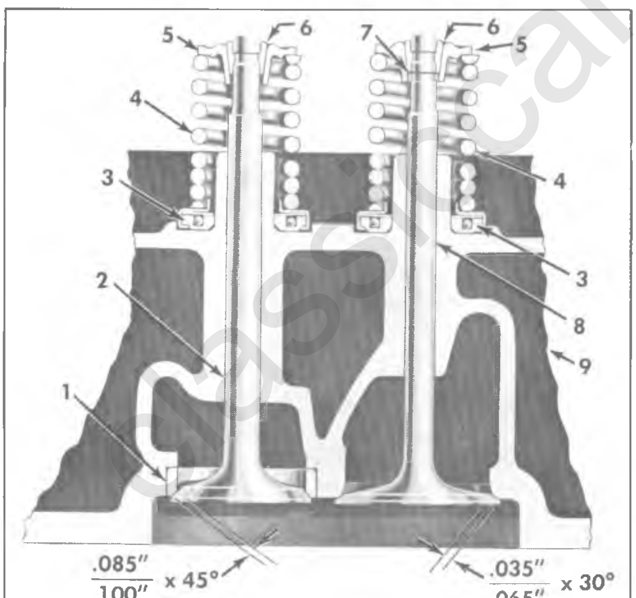


Figure 33—Sectional View of V6 Engine Cylinder Head (Rotators Optional on 305E Engine)

against valve spring cap meanwhile striking spring cap lightly with hammer to unseat the valve locking keys. Continue to turn the stud nut until spring is compressed sufficiently to permit removal of the two valve keys. Remove keys, then turn stud nut counterclockwise to release the valve spring. Swing the compressor away from valve, and remove the spring and seat. Remove oil seal whenever spring is removed from intake valve. Refer to figure 33 for valve spring and retaining parts installation.

CAUTION: DO NOT turn off the air supply while spring and retaining parts are removed from valve, as the valve may fall out of guide and drop into cylinder.

6. If valve rotator is replaced, be sure to position rotator on cylinder head with spring pilot on top. Set valve spring on rotator with close-wound coils toward cylinder head. Place spring cap on spring and use compressor in same manner as shown in figure 32 to compress valve spring. On intake valves, install new oil seal in lower groove in valve stem. Insert two keys in valve stem grooves, then back off stud nut to release pressure on valve spring. Be sure keys engage groove in valve stem. Remove compressor, stud and nut from cylinder head.

7. Turn off air supply, and disconnect air line from adapter. Remove adapter and install spark plug and gasket. Tighten spark plug to 32 foot-pounds torque.

8. Install rocker arm shaft and bracket assembly and tighten bracket bolts evenly to 20 to 25 foot-pounds torque.

NOTE: Refer to "Valve Operating Mechanism Replacement" for additional information regarding rocker arm shaft and bracket installation.

9. Start engine and when normal operating temperature is reached, check valve lash. Clearance should be 0.012 inch at intake valves and 0.018 inch at exhaust valves.

10. Install valve rocker arm cover and gasket.

CYLINDER HEAD REPLACEMENT

Cylinder head can be replaced on most truck models with V6 gasoline engines by following the instructions outlined in following paragraphs. Be sure to install new head gasket and manifold gaskets when replacing cylinder heads. It will facilitate the procedure on Tilt-Cab Models if the engine shield on cab rear support is removed.

CYLINDER HEAD REMOVAL

NOTE: When left-hand head is to be removed from tilt cab model, the transmission control rods must first be removed.

1. Drain cooling system.
2. Disconnect exhaust pipe from exhaust manifold, then remove exhaust manifold and gasket.
3. Remove valve cover, rocker arms and push rods. Identify push rods so they can be returned to original positions when installed. Procedures for replacing valve rocker arms and rocker arm covers are given previously under respective headings.
4. Disengage spark plug wires from plugs and from plug wire supports.
5. Remove bolts which attach water outlet manifold and intake manifold to cylinder head.

NOTE: If only one cylinder head is to be removed, the intake manifold and water outlet manifold may remain in place on opposite head, in which case carburetor controls and fuel line need not be disconnected. However, it will be necessary to loosen the manifold attaching parts to permit cylinder head to rise off locating dowels.

6. Remove cylinder head bolts.
7. Lift cylinder head off cylinder block, then remove head gasket, and clean carbon deposits from cylinder head, pistons, and cylinder block. If lifters are removed ALWAYS install them in the bores from which they were removed.

CYLINDER HEAD INSTALLATION

NOTE: If valve lifters have been removed, lubricate lifters with special break-in compound and install in respective bores.

1. Place cylinder head gasket on top of cylinder block with word "TOP" facing upwards (fig. 34). Dowels will locate gasket.
2. Set cylinder head in place on gasket with dowels in block engaged with mating holes in cylinder head. Install cylinder head bolts and draw head down gradually. Finally, tighten cylinder head bolts in sequence shown in figure 15. Use final torque of 60 to 65 foot-pounds in tightening cylinder head bolts. A crankcase ventilation valve (fig. 31) must be in place in each cylinder head.
3. Install exhaust manifolds using new gaskets and bolt locks. Tighten exhaust manifold bolts to 15 to 20 foot-pounds torque. Connect exhaust pipes to manifolds.
4. Use new intake manifold gaskets between intake manifold and cylinder heads, and bolt intake manifold and water outlet manifold in place, tightening manifold bolts evenly to seat parts squarely at gaskets. Correct intake manifold torque is 30 to 35 foot-pounds torque.
5. Lubricate push rods, and position at valve lifters in original locations. Set valve rocker arm assembly (fig. 31) on cylinder head and bolt in place following instructions previously given under "Valve Rocker Arms, Shaft, and Push Rod Replacement."

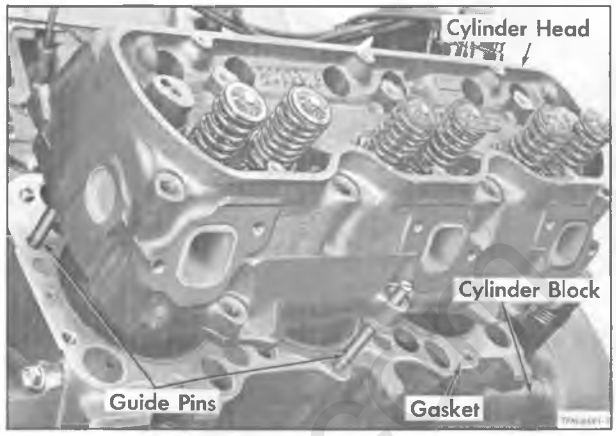


Figure 34—Installing Cylinder Head (Typical)

6. Install valve rocker arm cover, using new gasket.

CRANKSHAFT PULLEY REPLACEMENT

On some models the crankshaft pulley is not readily accessible unless the radiator core is first removed. The special tool typically illustrated in figure 35 must be used to start the pulley off the crankshaft when a retaining cone is used.

REMOVAL

1. Remove radiator if necessary, to provide access to crankshaft pulley.

2. Use impact wrench, or hold engine flywheel and use conventional wrench to remove pulley retaining bolt.

3. Assemble puller and center plug in manner shown in figure 35, then turn puller screw to remove pulley from crankshaft.

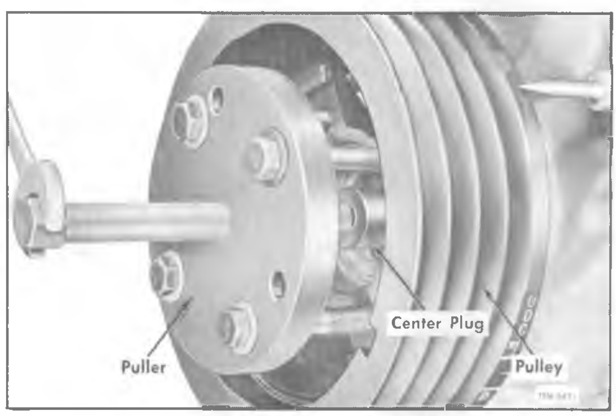


Figure 35—Removing Crankshaft Pulley or Hub with Special Puller

GASOLINE ENGINES

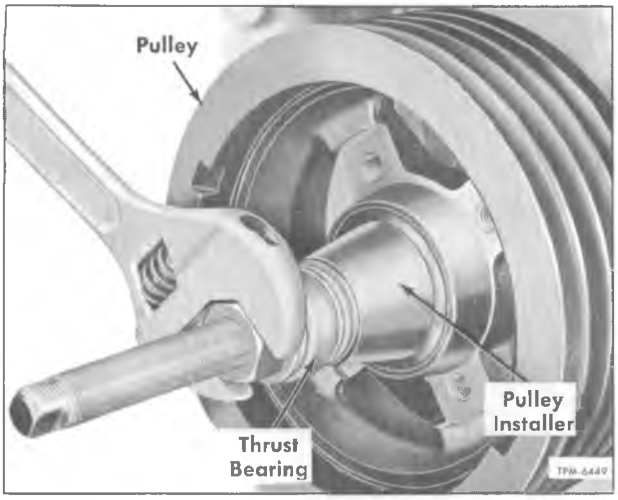


Figure 36—Tool Application for Crankshaft Pulley or Hub Installation

INSTALLATION

1. Clean seal area on crankshaft pulley or hub thoroughly and apply engine oil on surface contacted by oil seal.
2. Align keyway in pulley or hub with key in crankshaft, then start pulley or hub onto front end of crankshaft. Assemble special installer shown in figure 36, and turn nut with wrench to force pulley firmly into place on crankshaft.
3. Remove installer, then referring to figure 37, locate cone (when used) at hub, and install retaining washer and bolt. Tighten retaining bolt with torque wrench to 95 to 105 foot-pounds torque on engines without cone-type retainer. If cone is used the correct torque is 180 to 200 foot-pounds.

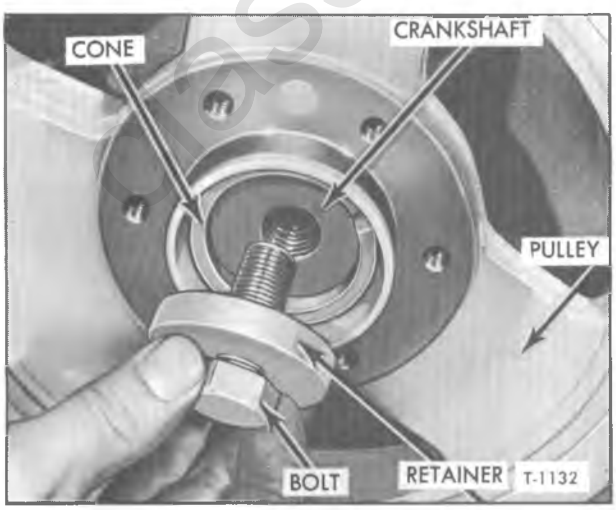


Figure 37—Crankshaft Pulley Retaining Parts (Engine with Cone Retainer Shown)

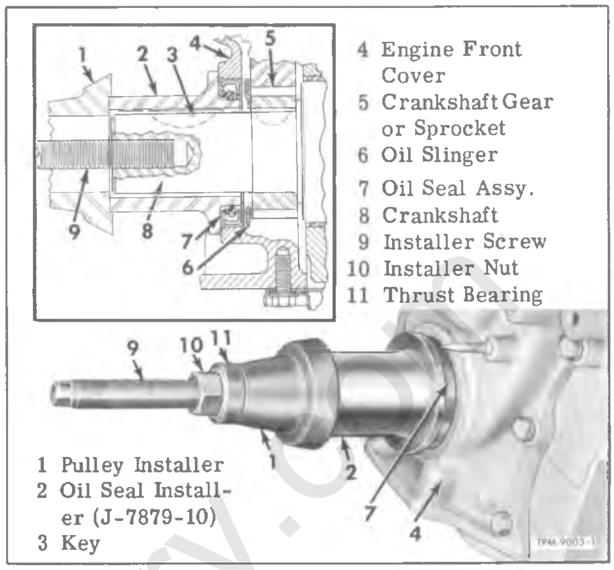


Figure 38—Front Cover Oil Seal Installation (with Cover Installed on Engine)

CRANKSHAFT FRONT COVER OIL SEAL REPLACEMENT

REMOVAL

1. Remove crankshaft pulley or hub as previously instructed under "Crankshaft Pulley Replacement."
2. Use suitable tool to pry oil seal out of front cover.

INSTALLATION

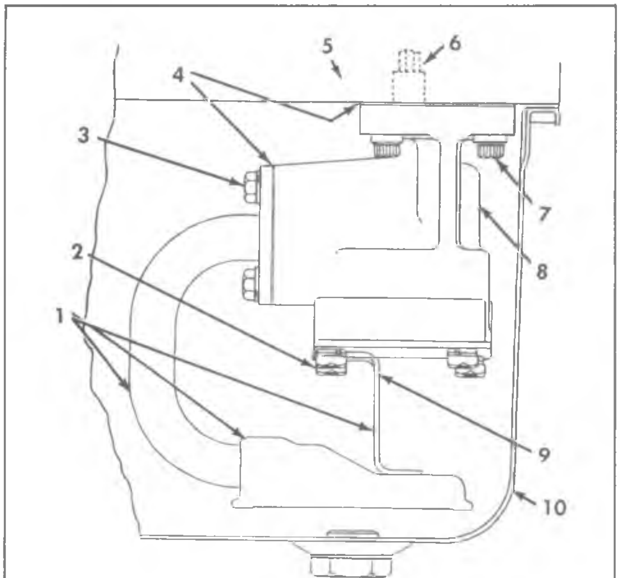
A special Tool (J-7879-01) is available for installing crankshaft front oil seal assembly without removing front cover.

1. Lubricate oil seal lip with engine oil, then turn engine crankshaft so key (3, fig. 38) is at top as shown.
2. Locate new seal assembly at bore in front cover with seal lip pointing inward, then assemble special tool components in manner shown in figure 38.
3. Tighten nut against thrust bearing to force seal squarely into cover bore.
4. Inspect surface on pulley hub, with magnifying glass if necessary, to locate any nicks, burrs, or scratches which could cause rapid wear at oil seal. When inspection shows surface to be in poor condition, install a new pulley or hub.
5. Install crankshaft pulley or hub following instructions previously given under "Crankshaft Pulley Replacement."

OIL PAN REPLACEMENT

OIL PAN REMOVAL

1. Clean all dirt and accumulated material



1 Suction Tube and Screen Assy.
2 Bracket Bolt (20-25 ft.-lbs.)
3 Flange Bolts and Lock Washers
4 Gaskets
5 Cylinder Block
6 Pump Drive Shaft
7 Pump to Block Bolts (30-35 ft.-lbs.)
8 Oil Pump
9 Bracket
10 Oil Pan

T-2460-2

Figure 39—Oil Pump Installation on Engine without Hydraulic Governor

from oil pan attaching bolts and drain plug.

2. Drain oil from oil pan.

3. Remove oil pan bolts and stud nut, then remove oil pan. Scrape off any portions of gasket which adhere to oil pan flange or to bolting flange on cylinder block and engine front cover.

OIL PAN INSTALLATION

1. Use gasket cement to hold new oil pan gasket in place at cylinder block and front cover.

2. Position oil pan at engine and install attaching bolts and stud nut.

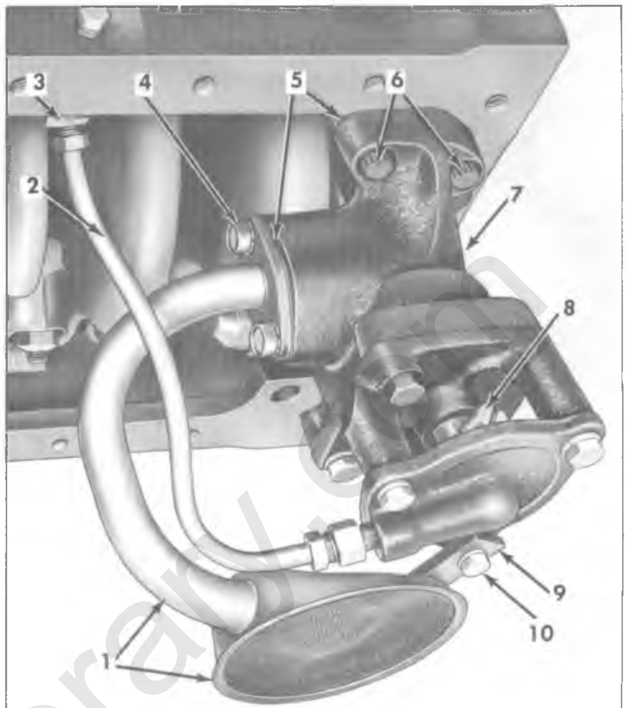
NOTE: Three of the oil pan bolts are longer than the others; and these must be installed at rear of oil pan at reinforcement. These bolts may be readily identified by internal-external type lock washers. Other pan bolts are shorter.

3. Install drain plug with new gasket, then fill crankcase with engine oil to "FULL" mark on dip stick.

OIL PUMP REPLACEMENT

REMOVAL

1. Remove engine oil pan as previously directed under "Engine Oil Pan Replacement."



1 Oil Inlet Tube and Screen
2 Governor Oil Line Assembly
3 Elbow
4 Flange Bolts
5 Gaskets
6 Pump Mounting Bolts
7 Oil Pump Assembly
8 Governor Spinner Valve
9 Bracket (Welded to Item 1)
10 Spinner Cover Bolt and Lock Washer

T-2343

Figure 40—Oil Pump Installation on Engine with Hydraulic Type Governor

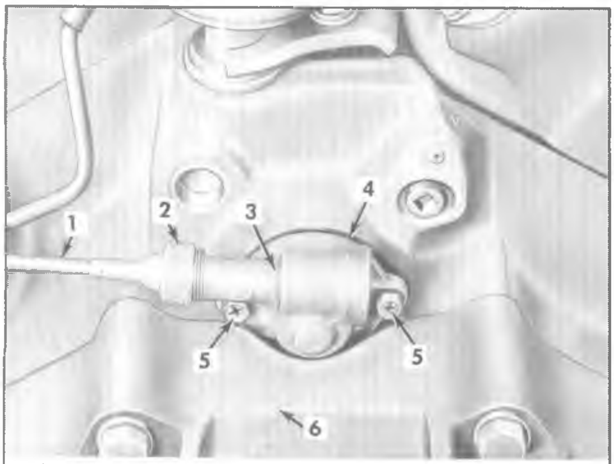
2. On engines (351M) with hydraulic type governor (fig. 40), remove governor oil line assembly.

3. Remove two special pump mounting bolts, then remove engine oil pump with oil inlet tube and screen assembly attached. Oil pump drive shaft will usually remain in socket in oil pump shaft.

INSPECTION AND REPLACEMENT OF SUCTION TUBE AND SCREEN

Inspect screen and tube for damage. If screen is clogged, the assembly should be removed from pump and thoroughly cleaned; or a new suction tube and screen assembly installed.

When installing tube and screen assembly on oil pump, use new gasket between tube flange and pump body. Install all attaching bolts loosely, then tighten bracket bolt first. Correct torque is 20 to 25 foot-pounds. Finally, tighten tube flange bolts. Figure 39 shows engine oil pump without hydraulic governor spinner valve.



1 Drive Housing
2 Housing Nut
3 Tachometer Adapter
4 Gasket
5 Adapter Mounting Bolt
6 Flywheel Housing

T-4389

Figure 41—Tachometer Drive Assembly

INSTALLATION

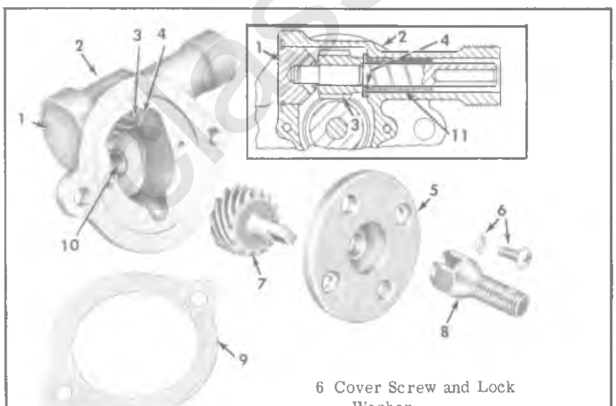
1. Place new pump-to-block gasket on oil pump flange, and insert pump drive shaft in drive socket in pump shaft.

2. Set oil pump assembly in position at cylinder block and turn pump as necessary to engage the pump drive shaft with drive socket at upper end.

3. On engines (351M) with hydraulic type governor, position oil line (2, fig. 40) at fittings on cylinder block and oil pump and start oil line nuts.

4. Install oil pump-to-cylinder block bolts and tighten to 30 to 35 foot-pounds torque. Tighten oil line nuts on engine with hydraulic governor.

5. Install engine oil pan, following instructions previously given in "Oil Pan Replacement."



1 Bearing
2 Housing
3 Gear and Shaft Assy.
4 Thrust Washer
5 Cover and Bushing Assy.
6 Cover Screw and Lock Washer
7 Drive Gear
8 Drive Bolt (In Camshaft)
9 Gasket
10 Bushing (In Housing)
11 Gear Shaft Bushing

Figure 42—Tachometer Mechanical Drive Components

TACHOMETER DRIVE ADAPTER REPLACEMENT

REMOVAL (Fig. 41)

1. Remove floor pan from cab on conventional cab models, or remove shield from cab rear support on tilt cab models.

2. Disconnect tachometer drive shaft housing (1) from adapter (3).

3. Remove two bolts and lock washers (4) attaching adapter (3) to cylinder block.

4. Remove adapter assembly and gasket from cylinder block.

NOTE: If there is insufficient clearance for adapter removal, try turning engine crankshaft to position drive bolt (8, fig. 42) in camshaft so drive slot is in vertical position. In some cases it may be necessary to use small pencil type grinder to remove necessary amount of stock from flywheel housing to permit disengagement of tongue on gear shaft from drive slot in bolt (8, fig. 42).

5. Referring to figure 42, remove cover (5) and inspect teeth on gears (3 and 7). Clean oil holes in cover.

INSTALLATION

1. Lubricate adapter parts with clean engine oil and attach cover to housing with screws and lock washers (6, fig. 42).

2. Check drive bolt (8, fig. 42) to make sure it is firmly tightened into threads in camshaft. If necessary, turn engine crankshaft to position drive bolt slot in vertical position.

3. Align tongue on adapter shaft with drive bolt slot, then place new gasket at cylinder block and install adapter assembly. Connect flexible drive shaft housing to adapter (fig. 41).

4. Check tachometer drive cable and housing routing. There must be no sharp bends or kinks in the assembly. Lubricate tachometer drive cable with correct lubricant (Type ST-640) or equivalent.

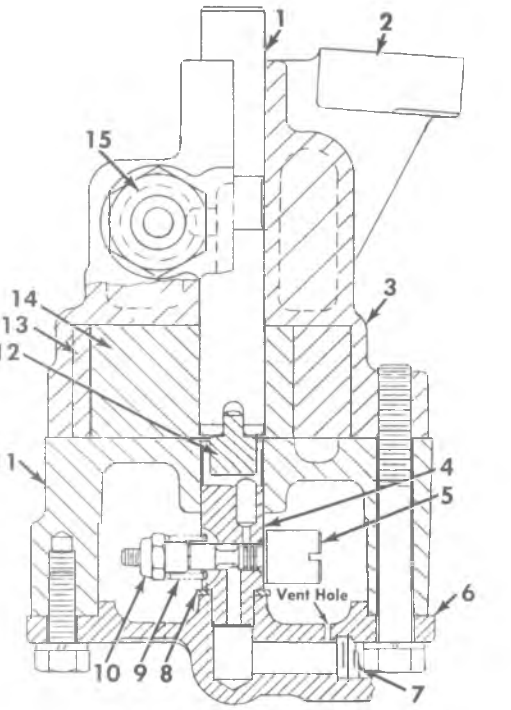
GOVERNOR SPINNER VALVE ADJUSTMENT

If governed speed on engines equipped with hydraulic type governor is not as specified in applicable "Gasoline V6 Engine Tune-up Chart" the speed can be changed by adjusting spinner valve spring tension.

To change the engine governed speed proceed as follows:

1. Drain oil from oil pan and remove oil pan from engine.

2. Turn engine crankshaft as necessary to position the spinner valve weight and adjusting nut so wrench and screwdriver can be used to make adjustment.



1 Shaft and Inner Rotor Assembly	8 Shaft Thrust Washer
2 Pump Outlet	9 Valve Spring
3 Pump Body	10 Valve Adjusting Nut
4 Governor Spinner Shaft	11 Rotor Cover and Spinner Housing
5 Governor Spinner Valve	12 Drive Coupling
6 Governor Spinner Cover	13 Outer Rotor
7 Governor Pressure Outlet	14 Inner Rotor
	15 Oil Pump Pressure Relief Valve Spring Cap

TPM-7787-1

Figure 43—Engine Oil Pump with Hydraulic Governor

3. To change engine rpm, hold weight with screwdriver while turning nut (10, fig. 43). Tightening nut 1/8 turn increases engine speed approximately 100 rpm. Loosening nut 1/8 turn lowers engine governed speed approximately 100 rpm.

4. After adjusting the governor, install oil pan with enough screws to hold pan in place while rechecking governed speed. Be sure to add engine oil to mark on dipstick. With oil warmed up, recheck no-load speed.

5. When governor performance is satisfactory, install balance of oil pan screws and tighten evenly and firmly.

HYDRAULIC GOVERNOR TROUBLESHOOTING

With engine warmed up to 180°F., install pressure gauge and tee in governor line at carburetor.

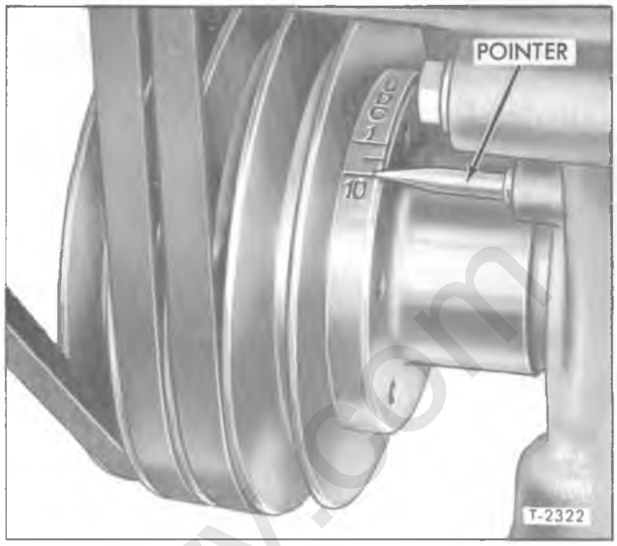


Figure 44—Timing Marks on V6 Engine (Typical)

Run engine at full throttle (no-load) momentarily and check engine speed on tachometer and note pressure on gauge in line. Properly functioning governor will provide 3400 rpm with 8-10 psi on gauge (351M engine). Procedure for adjusting governor spinner is given previously.

CHECKING ENGINE VALVE TIMING

When a check of valve timing is necessary, the following procedure may be used referring to markings at crankshaft pulley hub or pulley for determining upper-dead-center on No. 1 cylinder:

1. Remove left-hand rocker cover from cylinder head to provide access to rocker arms at No. 1 cylinder.

2. Turn engine clockwise (viewed from front of engine) to UDC #1 mark at crankshaft pulley (fig. 44) on compression stroke. Both the intake and the exhaust valve on No. 1 cylinder will then be closed.

3. On all V6 engines adjust clearance to exactly 0.099 inch at No. 1 exhaust valve (front valve).

4. Turn engine clockwise until No. 1 exhaust valve opens and begins to close, then with fingers, try turning push rod of No. 1 exhaust valve as engine is cranked slowly. When push rod rotates with finger pressure, the 5-degree (BUDC) mark on pulley should be at pointer. This will be about one revolution from starting point. If push rod can be rotated at any point between 10 degree mark and UDC #1 mark, the valve timing is correct. Be sure to adjust exhaust valve clearance to 0.018 inch after performing the foregoing check.

NOTE: When making check of valve timing, if timing chain is improperly installed, there will be 15-degree out-of-time condition for each mismatched tooth on sprocket.

GASOLINE ENGINES

TORQUE WRENCH SPECIFICATIONS (IN-LINE ENGINES)

Item		Ft. Lbs.
Cylinder Head Bolts		95
Manifold Clamps (Outer)		20
Manifold Clamps (Except Outer)		30
Oil Filter (Throw-Away Type)	(10-15)	See Text
Oil Filter Stud (If Used)		45
Spark Plugs		25
Oil Pan Drain Plug		20
Main Bearing Cap		65
Oil Pump Bolts		9½
Flywheel Bolts		
250 Engines		60
292 Engines		110
Crankshaft Damper		60
Main Bearing Cap Bolts		65

TORQUE WRENCH SPECIFICATIONS (V6 ENGINE)

Torque wrench specifications listed below apply to clean dry threads except as otherwise indicated:

Item	Ft. Lbs.
Cylinder Head Bolts	60 - 65*
Intake Manifold Bolts	30 - 35
Exhaust Manifold Bolts	15 - 20
Oil Filter Stud (If Used)	40 - 50
Spark Plugs	32
Rocker Arm Shaft Bracket Bolts	20 - 25
Damper or Hub-to-Crankshaft Bolt (Without Cone)	95 - 105
Damper or Hub-to-Crankshaft Bolt (With Cone)	180 - 200
Oil Pan Drain Plug	20 - 25

*Oiled with S.A.E. No. 10 Engine Oil.

USE ENGINE OIL AS SPECIFIED IN LUBRICATION (SEC. 0) AND SERVICE CRANKCASE VENTILATION UNITS AND OIL FILTERS REGULARLY.

Trouble Diagnosis Chart

HARD STARTING

SYMPTOM A - SLOW CRANKING

POSSIBLE CAUSES	REMEDY
1. Heavy engine oil.	1. Change to lighter oil.
2. Partially discharged battery.	2. Charge battery.
3. Faulty or undercapacity battery.	3. Replace battery.
4. Poor battery connections.	4. Clean and tighten or replace connections.
5. Faulty starter solenoid.	5. Replace or repair solenoid.
6. Faulty starting motor or drive.	6. Overhaul starting motor.

SYMPTOM B - LOW CYLINDER COMPRESSION

POSSIBLE CAUSES	REMEDY
1. Burned or warped valves.	1. Overhaul cylinder head.
2. Improper valve lash.	2. Adjust to proper clearance.
3. Worn or broken piston rings.	3. Overhaul engine.
4. Defective cylinder head gasket.	4. Replace gasket.

SYMPTOM C - LACK OF FUEL

POSSIBLE CAUSES	REMEDY
1. Fuel lines clogged.	1. Clean fuel lines.
2. Low fuel supply.	2. Check amount of fuel in tank, fill if supply is low.
3. Clogged vent in fuel tank cap.	3. Clean or replace cap.
4. Break in fuel supply line allowing air to be drawn into fuel line.	4. Replace or repair lines.
5. Clogged fuel filter.	5. Service filter as recommended in applicable portion of ENGINE FUEL SYSTEM (SEC. 6M).
6. Water or ice in fuel system.	6. Thaw if frozen, and drain water out of tank and filters.
7. Defective fuel pump.	7. Make pressure test at pump outlet.
8. Dirty carburetor.	8. Clean carburetor.
9. Carburetor choke inoperative, or not properly adjusted.	9. Check choke operation and adjust as necessary.

SYMPTOM D - IGNITION TROUBLES

POSSIBLE CAUSES	REMEDY
1. Distributor points burned or corroded.	1. Clean or replace points.
2. Distributor points out of adjustment.	2. Adjust point gap.
3. Faulty spark plugs.	3. Clean or replace and adjust spark plug gap.
4. Defective wiring.	4. Inspect wiring and correct as required.
5. Ignition out of time.	5. Set ignition timing.

GASOLINE ENGINES

HARD STARTING (CONT.)

SYMPTOM D - IGNITION TROUBLES (Cont'd.)

POSSIBLE CAUSES	REMEDY
6. Defective ignition coil or condenser.	6. Test coil and condenser; replace if necessary.
7. Cracked distributor cap.	7. Install new cap.

LACK OF POWER

SYMPTOM A - POOR COMPRESSION

POSSIBLE CAUSES	REMEDY
1. Incorrect valve lash.	1. Adjust to correct clearance.
2. Leaky valves.	2. Remove cylinder head and grind valves.
3. Valves or lifters sticking.	3. Free up or replace.
4. Weak or broken valve springs.	4. Replace defective springs.
5. Valve timing incorrect.	5. Correct the valve timing.
6. Blown cylinder head gasket.	6. Replace gasket.
7. Broken or stuck piston rings.	7. Free up or replace piston rings.
8. Worn pistons, ring, and/or cylinder bores.	8. Overhaul engine.

SYMPTOM B - IGNITION SYSTEM MALFUNCTION

POSSIBLE CAUSES	REMEDY
1. Ignition out of time.	1. Set ignition timing.
2. Defective spark plugs.	2. Clean or replace spark plugs.
3. Distributor points worn or out of adjustment.	3. Clean and adjust points or replace.

SYMPTOM C - LACK OF FUEL

POSSIBLE CAUSES	REMEDY
1. Dirt or water in carburetor.	1. Clean carburetor.
2. Gas lines partly clogged.	2. Clean gas lines.
3. Dirt in gas tank.	3. Clean gas tank.
4. Air leaks in gas line.	4. Tighten and check gas lines.
5. Fuel pump not functioning properly.	5. Replace or repair fuel pump.
6. Governor malfunction.	6. Repair or replace governor.

SYMPTOM D - EXCESSIVE FUEL (FLOODING)

POSSIBLE CAUSES	REMEDY
1. Choke not fully open.	1. Check choke and adjust control.
2. Air cleaner restricted.	2. Service air cleaner.
3. Carburetor float valve not seating.	3. Clean float valve and set float level.
4. Rich mixture at idle speed.	4. Adjust carburetor idle mixture.

LACK OF POWER (CONT.)

SYMPTOM D - FAULTY ACCELERATION

POSSIBLE CAUSES	REMEDY
1. Defective carburetor (accelerator pump - clogged jets).	1. Repair or replace carburetor.
2. Defective governor.	2. Repair or replace governor.
3. Air leak at intake manifold.	3. Replace gaskets and/or manifold.
4. Faulty ignition wiring.	4. Inspect for excessive resistance and defective insulation.
5. Misfiring spark plugs.	5. Clean and/or replace spark plugs.
6. Lack of cylinder compression, due to worn piston rings, burned valves, or defective head gasket.	6. Replace defective parts or overhaul engine.
7. Exhaust back pressure too high.	7. Replace or repair defective exhaust system components.

OVERHEATING

POSSIBLE CAUSES	REMEDY
1. Loose or defective fan belt.	1. Adjust or replace belt.
2. Thermostat not opening.	2. Replace thermostat.
3. Coolant loss.	3. Check for leaks and repair as necessary.
4. Partially clogged radiator.	4. Clean radiator core internal passages, and air passages.
5. Defective water pump.	5. Repair or replace pump.
6. Incorrect ignition or valve timing.	6. Retime engine.
7. Dragging brakes.	7. Adjust or repair brakes.
8. Restricted exhaust system.	8. Clean or replace exhaust system components.
9. Improper valve clearances.	9. Adjust valve clearance.
10. Ignition distributor advance inoperative.	10. Repair distributor to correct malfunction.
11. Overloaded vehicle.	11. Reduce load per vehicle rating.

NOTE: When operating vehicle in hot climate or at high altitudes, it may be necessary to check pressure cap and/or use cap with higher opening pressure to prevent boiling.

ROUGH IDLE AND/OR STALLING

SYMPTOM A - ERRATIC RUNNING OR SURGING

POSSIBLE CAUSES	REMEDY
1. Idle mixture too rich.	1. Adjust idle mixture screws.
2. Improper ignition timing.	2. Set timing.
3. Vacuum leak (air entering intake manifold).	3. Replace gasket, or tighten manifold bolts. Check and/or replace vacuum brake hose (when used).

GASOLINE ENGINES

ROUGH IDLE AND/OR STALLING (CONT.)

SYMPTOM A - ERRATIC RUNNING OR SURGING (Cont'd.)

POSSIBLE CAUSES	REMEDY
4. Inoperative crankcase ventilation valves.	4. Clean or replace valves.
5. Cylinder head gaskets leaking, or cylinder head cracked.	5. Replace cylinder head or gasket.
6. Worn valve guides.	6. Overhaul cylinder head.

SYMPTOM B - STALLING

POSSIBLE CAUSES	REMEDY
1. Engine idle speed set too slow.	1. Adjust idle speed to specifications.
2. Engine running too cool.	2. Install proper thermostat.
3. Exhaust restricted.	3. Repair exhaust system to eliminate excessive back pressure.
4. Carburetor flooding.	4. Replace defective float valve, set carburetor float level. Check fuel pump for excessive pressure.
5. Defective fuel pump.	5. Replace pump.

DETONATION (SPARK KNOCK OR PING ON ACCELERATION)

POSSIBLE CAUSES	REMEDY
1. Ignition advance too far for fuel being used.	1. Retard ignition timing.
2. Wrong type (heat range) spark plug.	2. Install correct spark plug.
3. Excessive build-up of deposits in combustion chambers.	3. Clean combustion chambers.
4. Restricted coolant passages in cylinder head causing "hot spots" in combustion chamber.	4. Remove cylinder head and clean passages.
5. Overheated engine.	5. Make corrections to lower the engine operating temperature. (Refer to "Causes" and "Remedies" previously covered under "Overheating.")
6. Lugging engine.	6. Use lower transmission gear to prevent overloading engine.

HIGH LUBRICATING OIL CONSUMPTION

POSSIBLE CAUSES	REMEDY
1. Oil lines or connections leaking.	1. Tighten or replace defective parts.
2. Leaking gaskets.	2. Replace gaskets as necessary.
3. Crankcase oil level too high.	3. Drain crankcase and refill to correct level.
4. Crankshaft oil seals worn.	4. Replace oil seals.
5. Pistons and/or rings worn, or pistons damaged; cylinder bores scored or worn.	5. Overhaul engine.

LOW ENGINE OIL PRESSURE

(When checked with engine at normal operating temperature)

POSSIBLE CAUSES	REMEDY
1. Defective oil gauge or sending unit.	1. Check pressure with master gauge. Replace oil gauge or sending unit if defective.
2. Oil viscosity too low.	2. Fill crankcase with correct oil.
3. Oil diluted with gasoline.	3. Check for indications of choke malfunction or carburetor flooding allowing gasoline to enter crankcase. Make necessary correction.
4. Suction loss.	4. Check for loose intake pipe and screen in oil pan. Also check for partially clogged inlet screen.
5. Weak or broken relief valve spring in oil pump.	5. Inspect spring and replace if necessary.

ENGINE NOISE

SYMPTOM A - VALVE MECHANISM NOISE

POSSIBLE CAUSES	REMEDY
1. Sticking valves.	1. Clean and lubricate valve stems.
2. Incorrect valve lash.	2. Adjust valve lash.
3. Bent push rod(s).	3. Determine and correct cause of push rod bending. Install new push rod.
4. Worn rocker arms and/or shaft.	4. Replace worn parts and make sure oil is reaching valve rocker arms.
5. Broken valve spring.	5. Replace spring.
6. Damaged valve lifter and/or camshaft.	6. Replace lifter and/or camshaft.

SYMPTOM B - BEARING NOISE

POSSIBLE CAUSES	REMEDY
1. Insufficient oil supply.	1. Check oil level and add oil as required.
2. Low oil pump pressure.	2. Remove and inspect oil pump and inlet screen. Make necessary corrections.
3. Thin or diluted oil.	3. Change oil. Use oil with proper viscosity.
4. Excessive bearing clearance.	4. Remove oil pan and make bearing replacement or repairs.
5. Piston pins loose fit in connecting rod or piston.	5. Install new piston pins (oversize pins if req'd.).
6. Piston to cylinder bore clearance excessive (piston slap).	6. Overhaul engine.

NOTE: When diagnosing engine noise problems, be careful that noises caused by accessories such as air compressor and power take-off are not mistaken for engine noises. Removal of accessory drive belts will eliminate any noises caused by these units.

Inspect engine front and rear mountings as part of regular engine maintenance program. Be sure all bracket attaching bolts are kept tight. Refer to ENGINE MOUNTINGS (SEC. 6D) for engine mounting information.

USE ENGINE OIL AS SPECIFIED IN LUBRICATION (SEC. 0) AND SERVICE CRANKCASE VENTILATION UNITS AND OIL FILTERS REGULARLY.

SECTION 6B

Toro-Flow Diesel Engine

Contents of this section are listed in Index below:

TORO-FLOW DIESEL ENGINE APPLICATION CHART

TRUCK SERIES	GMC ENGINE
DLV. DLA 4000	DH478
EG5500	DH478
SG5500	DH478
EG6500	DH478

GENERAL INFORMATION

General engine maintenance includes servicing engine accessories and components to assure satisfactory, economical performance at all times. Since the equipment used with various truck models is somewhat varied, reference must be made to applicable maintenance paragraphs in this manual for service instructions for servicing air cleaners, fuel filters, and crankcase ventilation system. In addition to service described, the engine should be precisely tuned at regular intervals, following the procedure given later under "Engine Tune-up Operations."

To analyze problems related to fuel system, make reference to "Fuel System Trouble Diagnosis Chart" in "FUEL INJECTION SYSTEM" (SEC. 6M) in this manual for symptoms, causes, and remedies for various problems.

Engine Maintenance and Tune-Up

ENGINE MAINTENANCE

SERVICING AIR CLEANERS

Engine air cleaners are oil bath type. Follow the procedure given in applicable "Owner's and Driver's Manual" and to applicable portion of ENGINE FUEL SYSTEM (SEC. 6M) to maintain air cleaners in serviceable condition.

The air filter (fig. 1) in ventilation tube should be inspected and cleaned periodically.

> **WARNING**
>
> USE EXTREME CAUTION TO BE SURE THAT ALL VOLATILE CLEANING FLUID (GASOLINE, KEROSENE, ETC.) IS REMOVED FROM AIR CLEANER AT TIME OF CLEANING. UNCONTROLLED FUEL ENTERING THE COMBUSTION CHAMBER IN THIS MANNER CAN CAUSE THE ENGINE TO "RUN AWAY" AND POSSIBLY DESTROY ITSELF AND ALSO CAUSE INJURY TO PERSONNEL.

ENGINE OIL FILTER ELEMENT

Oil filter element changing periods are related to crankcase oil changing periods, the quality of oil used and severity of service. Element is replaceable paper type. To replace element, proceed as follows:

1. Remove drain plug and loosen bolt which holds filter shell on base. Allow oil to drain out of filter.

2. Remove shell and element as an assembly by removing bolt which is screwed into filter base.

3. Withdraw element from shell and discard element. Clean shell assembly and remove gasket from base at engine.

4. Install new element in filter shell, then fill shell with new engine oil and install the shell and element assembly on engine using new gasket. This procedure assures lubrication to engine as soon as engine is started. Tighten filter bolt to 45 foot-pounds and check drain plug for tightness.

5. Check crankcase oil level and add oil if necessary.

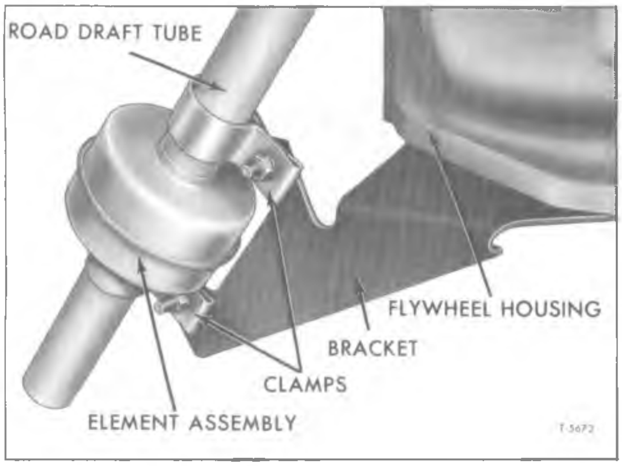


Figure 1—Air Filter in Ventilation Tube

6. Start engine and check for oil leaks at shell gasket and retaining bolt.

7. Stop engine, allow a few minutes for oil to drain into oil pan; recheck oil level on dipstick. If necessary, add oil to raise level to "FULL" mark.

NOTE: Recommendations for oil change periods, oil specifications, and viscosity are contained in LUBRICATION (SEC. 0) of this manual.

CRANKCASE OIL LEVEL AND VISCOSITY OBSERVATION

A bayonet-type oil level gauge at right side of engine is provided for checking crankcase oil level. This gauge is marked "ADD" and "FULL."

Daily, or oftener if necessary, check crankcase oil level. Make oil level check preferably after a day's run and after engine has been stopped for at least five minutes. Remove dipstick, wipe clean with cloth, reinsert dipstick, then remove again. Oil level should be maintained between "ADD" and "FULL" marks without overfilling. Do not operate with level below "ADD" mark. Add oil whenever the oil level reaches or falls below the "ADD" mark.

When checking engine oil level, make note of oil viscosity. If there is evidence of crankcase oil dilution as indicated by oil appearing too "thin" or by level above the "FULL" mark on dipstick, make necessary investigation to determine cause of dilution and make necessary corrections.

DRIVE BELTS

Inspect all drive belts for evidence of worn or frayed condition as well as for other damage. Replace belts if worn.

NOTE: Belts used in pairs must be replaced as a matched pair. Follow instructions given in ENGINE COOLING SYSTEM (SEC. 6K) of this manual for replacing and/or adjusting drive belts.

FUEL SYSTEM

Make periodic inspection of fuel filters, lines, and injection units for evidence of leaks and damage. Repair as necessary.

Refer to applicable portion of ENGINE FUEL SYSTEM (SEC. 6M) for detailed information on fuel filters, injection pump assembly, control mechanism and servicing fuel injection nozzles. Recommendations pertaining to fuel system service intervals are contained in applicable "Owner's and Driver's Manual."

NOTE: In case of complaints of hard starting in cold weather, refer to suggested remedies in "Trouble Diagnosis" under "Hard Starting."

CRANKCASE VENTILATION SYSTEM

Road draft type crankcase ventilation system is employed on Toro-Flow engines. The opening for escape of blow-by gases is through a baffled oil separator installed in cylinder block at rear of left-hand bank of cylinders.

A filter element assembly (fig. 1) is installed in road draft tube near lower end.

A periodical inspection of road draft tube and filter element should be made to assure free flow of gases. To clean filter element remove from engine, wash in solvent and reinstall.

CHECKS PRIOR TO TUNE-UP

Before performing other tune-up procedure, check battery electrolyte specific gravity at each cell to be sure battery is fully charged. Add water and charge battery as necessary.

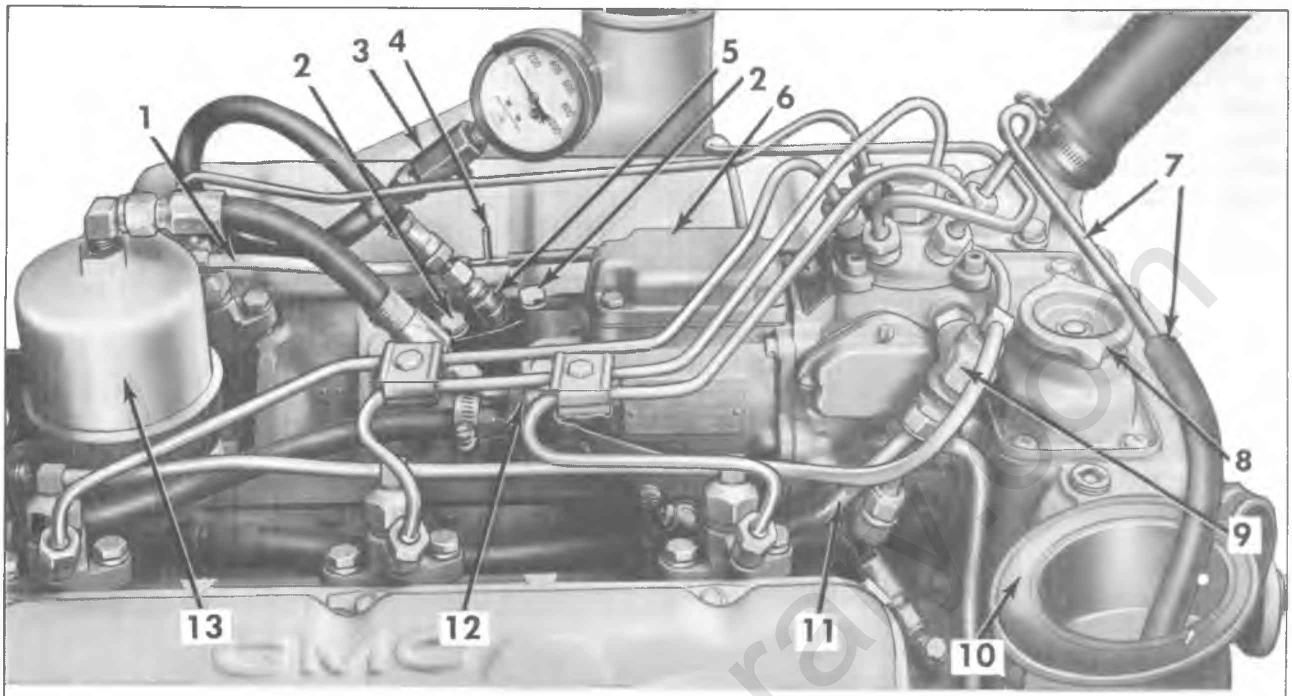
PRELIMINARY TEST OF CYLINDER COMPRESSION

In case there is evidence of low compression on one or more cylinders, the following test should be made to determine which cylinders may be at fault:

1. Start engine and run until normal operating temperature is reached.

2. Stop engine and remove high pressure line clamps. Remove the high pressure line between injection pump and nozzle holder at cylinder to be checked. Use care not to bend the high pressure line when removing. Remove the nut at each end from the threads at pump and nozzle holder and lift the line away from both units without bending.

3. Disconnect leak-off hoses from tee or elbow on injection nozzle holder. Remove nozzle holder retaining bolts and pull the holder assembly out of well in cylinder head. Clean nozzle holder cavity and gasket seat in cylinder head, then turn engine



1 Fuel Leak-off Hose
2 Injection Nozzle Bolts and Lock Washers
3 Compression Gauge and Hose
4 Leak-off Hose Connector
5 Adapter
6 Fuel Injection Pump Assembly
7 Adapter and Hose
8 Oil Filler Cap
9 Overflow Valve
10 Fuel Receptacle
11 Fuel Return Line
12 Fuel Supply Pump
13 Fuel Secondary Filter

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Figure 2—Gauge and Adapter for Checking Cylinder Compression

over with starter to blow loose carbon out of combustion chamber and nozzle holder cavity. Use a nozzle holder copper gasket at bottom of well and install the compression gauge adapter (J-21735-02) in place of nozzle holder as shown in figure 2, using the nozzle holder bolts to hold the adapter in place. Connect gauge to the adapter. Be sure all connections are tight.

4. If a rear cylinder is being checked, insert plug in the disconnected leak-off hose. When other cylinders are being checked, join the disconnected leak-off hoses with a two-way connector, if required. Plug and connectors are furnished as part of compression gauge kit.

5. Install adapter and hose (7, fig. 2) in outlet port in hydraulic head on injection pump and place hose in receptacle to catch fuel oil while running the engine.

CAUTION: Under no condition should the high pressure outlet port on the injection pump be plugged to prevent the escape of fuel. The resulting hydrostatic lock would severely damage the injection pump mechanism when engine was started.

6. Start the engine and allow engine to idle at 625 rpm. Observe and record the compression pressure shown on compression gauge.

NOTE: Do not attempt to obtain compression pressure by cranking engine with starter.

7. Perform this operation on each cylinder.

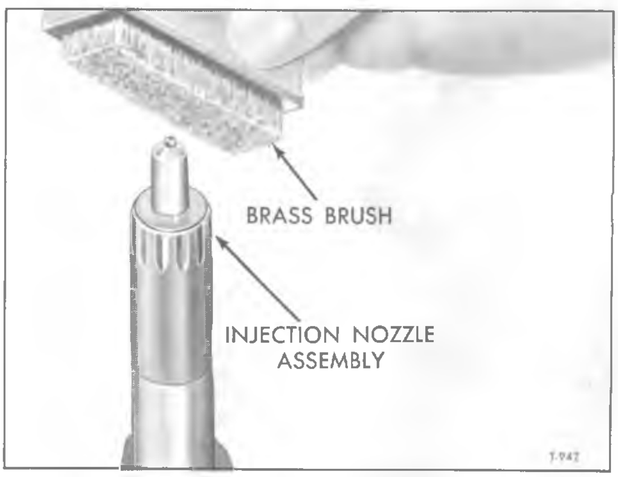


Figure 3—Cleaning Fuel Injection Nozzle with Brass Brush

Before installing a fuel injection nozzle, use fine brass-bristled brush (fig. 3) to clean nozzle tip. The compression pressure in any one cylinder should be not less than 500 psi at 625 rpm. In addition, the variation in compression pressures between cylinders of the engine must not exceed 30 psi at 625 rpm.

8. Low cylinder pressures may result from any one of several causes:

a. Piston rings may be worn, stuck, or broken.

b. Compression may be escaping past valves, or cylinder head gasket may be defective.

ENGINE TUNE-UP

BATTERY AND BATTERY CABLE SERVICE

1. Using battery hydrometer, check specific gravity of storage battery electrolyte in each cell. Gravity reading below 1.230 (corrected to 80°F.) indicates insufficient charge.

2. Use a voltmeter to check cranking voltage. Be sure to place engine control in stop position to prevent engine from starting during test.

3. With voltmeter connected between solenoid terminal and ground, operate starter. Voltage of 9 volts or more when starter is cranking engine indicates that battery, and circuit to solenoid is satisfactory. If voltage reading is less than 9 volts when engine is being cranked, or if cranking speed is low; a weak battery, defective starter switch, or excessive resistance in starting circuit exists.

NOTE: If, when making check of cranking voltage, it is noted that cranking speed is uneven; this is an indication of uneven cylinder compression, defective starter or starter drive.

Figure 4—Adjusting Engine Idling Speed

4. In cases where loose, corroded, or otherwise defective battery cables and/or wiring are found, the defects must be corrected to insure good engine performance.

5. If battery is weak or shows other evidence of being defective, refer to appropriate coverage in ENGINE ELECTRICAL (SEC. 6Y) of this manual for method of diagnosing battery deficiencies.

Refer to ENGINE ELECTRICAL (SEC. 6Y) in this manual for procedure required to check performance of charging circuit units.

DRIVE BELT ADJUSTMENT

When installing new drive belts or adjusting old belts, use tension gauge to provide correct tension.

> **CAUTION: Adjusting drive belts too tightly will impose too great a load on bearings in the driven units. Slipping will occur if drive belts are not adjusted tight enough. Belt life will be shortened if belts are not properly tightened.**

COOLING SYSTEM INSPECTION

Refer to ENGINE COOLING SYSTEM (SEC. 6K) in this manual for arrangement of cooling system units and for inspection and required maintenance procedures.

CYLINDER HEAD BOLTS

Normally the cylinder head bolts should not require retightening at tune-up intervals. When necessary to tighten cylinder head bolts, refer to "Cylinder Head Replacement" covered later in this section, for bolt tightening sequence.

MANIFOLD BOLTS

At tune-up intervals, check all manifold bolts for proper torque and be sure end bolts have washers installed as shown in figure 8.

VALVE CLEARANCE

1. Run engine until operating temperature of approximately 160° is reached, then remove rocker arm covers.

2. Using feeler gauges and box-end wrench, set exhaust valves to 0.018-inch clearance, and set intake valve clearance to 0.010-inch.

3. Reinstall rocker arm covers with new cover gaskets and tighten cover screws firmly (3 to 5 foot-pounds).

FUEL SYSTEM INSPECTION

1. Inspect all fuel lines, both the supply line and return line between engine and fuel tank, for evidence of leakage.

2. Referring to ENGINE FUEL SYSTEM (SEC. 6M) in this manual, service air cleaners and fuel filters. Also, check operation of accelerator control linkage for free movement. Check operation of engine stop mechanism which must function perfectly.

3. Check engine idle speed which should be 625 rpm. The hex head, self-sealing, adjusting screw at rear of fuel injection pump is provided for setting slow idle speed. Adjustment is made by turning the screw in with wrench (fig. 4) to increase idle speed. Turn screw out (counterclockwise) to reduce idle speed.

NOTE: If after the foregoing procedures have been completed, the engine performance is not satisfactory, it may be necessary to remove the fuel injection nozzles and check the nozzle opening pressure and spray pattern. Instructions for servicing injection nozzles are covered later in ENGINE FUEL SYSTEM (SEC. 6M) of this manual.

FUEL INJECTION PUMP TIMING

A check of fuel injection pump timing is not normally required as part of engine tune-up procedure; however, in cases when it is necessary to check the timing in diagnosing trouble, refer to "Checking Injection Timing," covered later in ENGINE FUEL SYSTEM (SEC. 6M) for information on making the timing check.

CHECKING ENGINE VALVE TIMING

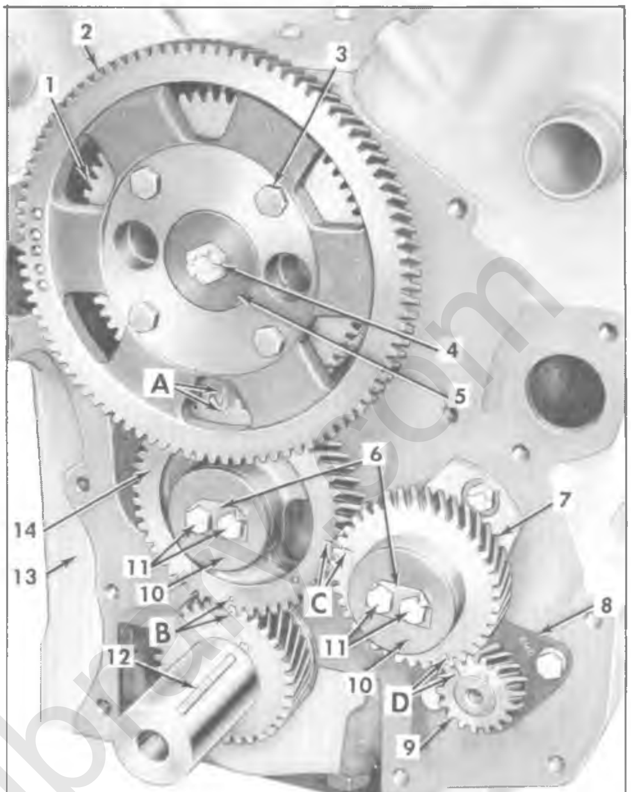
Valves must open and close in correct relationship to upper and lower-dead-center of crankshaft as indicated in valve timing as indicated in "Tune-up Specifications" later in this manual. When a check of valve timing is necessary, following procedure may be used referring to markings at crankshaft damper for determining top-dead-center on No. 1 cylinder.

1. Remove left-hand rocker arm cover from cylinder head to provide access to rocker arms at No. 1 cylinder.

2. Turn engine clockwise (viewed from front of engine) to "UDC" mark at crankshaft damper on compression stroke. Both the intake and the exhaust valve on No. 1 cylinder will then be closed.

3. Adjust valve lash on No. 1 exhaust valve (front valve) to exactly 0.054 inch.

4. Turn engine clockwise until No. 1 exhaust valve opens and begins to close, then with fingers try turning push rod of No. 1 exhaust valve as engine is cranked slowly. When push rod rotates with finger pressure, the "UDC" mark on damper should be at pointer. This will be about 1 revolution from starting point. If push rod starts to rotate at any point within one-quarter inch either side of "UDC"



1 Camshaft Gear	8 Balance Shaft Thrust Plate
2 Injection Pump Drive Gear	9 Balance Shaft Gear
3 Drive Gear Bolts	10 Gear Retainer Plate
4 Self Locking Bolt	11 Plate Retaining Bolts
5 Camshaft Gear Retainer	12 Crankshaft Balancer Key
6 Lock Plates	13 Cylinder Block
7 Balance Shaft Idler Gear	14 Camshaft Idler Gear

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Figure 5—Gear Train and Timing Marks (Engine Front Cover Removed)

mark, the valve timing is correct. Be sure to adjust exhaust valve clearance to 0.018 inch after performing the foregoing check.

5. If when checking valve timing, the push rod starts to rotate at a point more than three-quarters inch either side of the "UDC" mark, the camshaft can be considered "out-of-time."

To correct the timing, the fuel injection pump, and engine front cover assembly must be removed; then the timing gear teeth must be meshed according to marks (A, B, C, and D, fig. 5) on gears.

If a change in valve timing is necessary, refer to ENGINE FUEL SYSTEM (SEC. 6M) for instructions when removing, installing and timing the fuel injection pump assembly.

Refer to following page for "Engine Tune-Up Chart."

DH478 TORO-FLOW DIESEL ENGINE TUNE-UP CHART

ENGINE MODEL DH478
CYLINDER COMPRESSION (PSI) . . . 500 (Min.)*
FIRING ORDER 1-6-5-4-3-2

VALVE LASH
Intake . . . . 0.010"
Exhaust . . . . 0.018"

GOVERNED SPEED (RPM)**
DH478 2800

IDLE SPEED SETTING (RPM) 625-675

FUEL INJECTION
TIMING . . . . "INJ" Mark on Damper
INJECTION NOZZLE VALVE
OPENING PRESSURE (PSI) 3000
FUEL SUPPLY PUMP OUTPUT
MAXIMUM PRESSURE (PSI) 65
CYLINDER HEAD BOLT TORQUE
(FT.-LBS.) 130-135
FUEL OVERFLOW VALVE REGULATING
PRESSURE (PSI AT IDLE) 18-28

* With engine running at 625 rpm maximum variation between cylinders must not exceed 30 psi.
** Full load setting. (No load speed is approximately 200 rpm higher than full load speed.)

Engine Replacement

CONVENTIONAL MODELS WITH TORO-FLOW DIESEL ENGINE

REMOVAL

1. Drain cooling system.
2. Disconnect battery.
3. If vehicle is equipped with air conditioning, it is necessary to disconnect refrigerant lines from condenser assembly which is mounted in front of radiator.

> CAUTION: Only personnel familiar with air conditioning service procedures should attempt removal and/or installation of air conditioning units.

4. Disconnect oil cooler lines from fittings at radiator lower tank. Also disconnect radiator hoses and heater hoses.
5. Remove front end sheet metal, referring to SHEET METAL (SEC. 11) for necessary information.
6. Disconnect battery cable and wiring from starter, remove engine ground strap, and disconnect wiring harness connections at generator, temperature sending unit, etc.
7. Remove air cleaner and air inlet hoses. Disconnect tachometer drive from engine and the engine oil gauge pressure line. Disconnect engine stop control and accelerator control linkage.
8. Disconnect air compressor discharge line; and when vehicle is equipped with power steering, disconnect the power steering lines or remove pump assembly from engine and allow pump and lines to remain on chassis.
9. Disconnect exhaust pipes from manifold. Disconnect fuel supply and return lines.
10. Remove cover inside cab above transmission, then remove hand brake lever and transmission gearshift lever.
11. Disconnect clutch control rods and remove control cross shaft.
12. Disconnect propeller shaft from rear of transmission. Also, remove road draft tube and filter from rear of engine.
13. Attach lifting equipment, then remove engine mounting bolts. Remove engine from chassis with transmission attached.
14. Referring to the TRANSMISSIONS AND CLUTCHES (SEC. 7) of this manual, remove transmission and clutch from engine.

INSTALLATION

1. Assemble clutch and transmission to engine.
2. Hoist power plant into position in chassis and install mountings referring to ENGINE MOUNTINGS (SEC. 6D) in this manual.
3. At transmission, connect propeller shaft, speedometer cable, install hand brake control linkage, and gearshift lever. Install transmission cover and floor mat in cab.
4. Connect and adjust clutch control. Also, install road draft tube and filter (fig. 1) at rear of engine.
5. Connect tachometer drive (when used), and connect throttle and engine stop control.
6. Connect fuel supply and return lines.
7. Connect exhaust pipes to manifolds.
8. Connect electrical wiring and starter cables including engine ground strap.
9. Install air cleaner and hoses to intake manifolds.
10. Install accessories and adjust drive belts.
11. Install front end sheet metal and radiator. Connect oil cooler lines.

12. Fill cooling system and connect battery cables.

13. Start engine and inspect for cooling system and oil leaks.

TILT CAB MODELS WITH TORO-FLOW DIESEL ENGINE

REMOVAL

1. Tilt the cab forward and drain cooling system.
2. Disconnect cables from battery.
3. Disconnect equipment and wiring as necessary to allow removal of control island.
4. Remove attaching bolts, then remove control island and cab rear support.
5. Disconnect exhaust pipes at exhaust manifolds.
6. Disconnect radiator hoses and heater hoses.
7. Disconnect all starter cables, ground straps and other wiring connected to engine electrical equipment.
8. Disconnect power steering lines (when used).
9. Disconnect engine oil cooler lines.
10. Disconnect fuel supply and return lines.
11. Disconnect propeller shaft and speedometer drive at rear of transmission.
12. Disconnect clutch release linkage. Also, remove road draft tube and filter from rear of engine.
13. Disconnect air discharge line and lubrication lines from air compressor. If vehicle is equipped with vacuum brakes, disconnect lines from vacuum pump.
14. Attach overhead lifting equipment and raise until power plant is partially supported; then remove front and rear mounting bolts.
15. Lift power plant out of chassis, using care to prevent fouling of lines and wiring.
16. Remove transmission and clutch from engine, making reference to appropriate sections of manual for additional information required to properly separate the components.

INSTALLATION

Refer to applicable portion of TRANSMISSIONS AND CLUTCHES (SEC. 7) of this manual for information required to properly assemble clutch parts and transmission to engine.

1. Attach overhead hoist in manner to provide balance as engine is lifted into position.
2. With mounting brackets in place on engine, lift power plant into place. Locate engine front and rear mountings and install mounting bolts. Refer to ENGINE MOUNTINGS (SEC. 6D) for necessary information regarding engine mountings.
3. Connect air lines (or vacuum lines if vacuum pump is used), lubricating oil lines, electrical wiring, and radiator and heater hoses. Connect oil cooler lines.
4. Connect propeller shaft and speedometer drive. Also, connect tachometer drive (when used).
5. Connect clutch control linkage. Also, install road draft tube and filter (fig. 1) at rear of engine.
6. Install control island and connect all wiring and transmission control rods.
7. Fill cooling system and check for leaks.
8. Make certain engine crankcase is filled to proper level with engine oil.
9. Connect battery cables, prime fuel system, and start engine. Adjust controls and inspect for oil leaks.

In-Vehicle Component Replacement

VALVE SPRING REPLACEMENT (CYLINDER HEAD INSTALLED)

In most vehicles it is possible to replace a broken valve spring without removing cylinder head from engines by following procedure below:

When it is necessary to replace a valve spring and/or seals on valve stems, the tool (J-21544) also used for changing valve springs on V6 gasoline engine, is used to facilitate the operation. Proceed in following manner to replace valve spring and retaining parts:

1. Remove rocker arm cover.
2. Turn engine crankshaft until piston is at upper-dead-center on cylinder at which work is to be performed.

NOTE: The mark on crankshaft damper may be used as reference point - while observing valve action - to locate dead-center on #1 and #4 cylinders. When piston is at upper center on compression stroke there will be no rocker arm movement at cylinder in which firing is to occur.

3. Remove rocker arm and shaft assembly from cylinder head, then use tool to compress valve spring and release valve keys.
4. Remove valve keys, then release spring compressor tool and remove spring seat, inner spring, and outer spring. At intake valve, remove valve stem oil seal from groove in stem. Valve rotator may also be removed if necessary.

CAUTION: DO NOT turn engine crankshaft while springs are removed from valve, since valve may fall out of guide and into cylinder as piston reaches bottom of stroke.

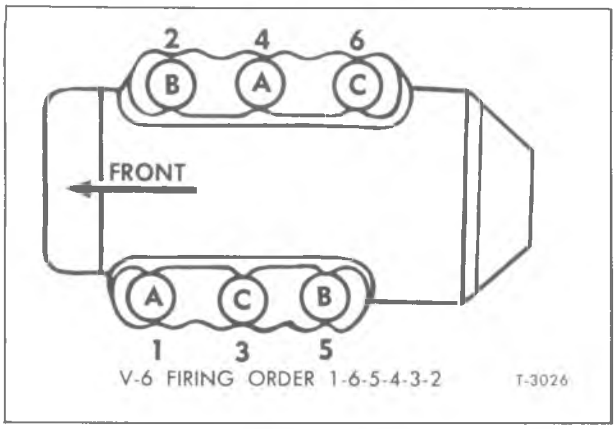
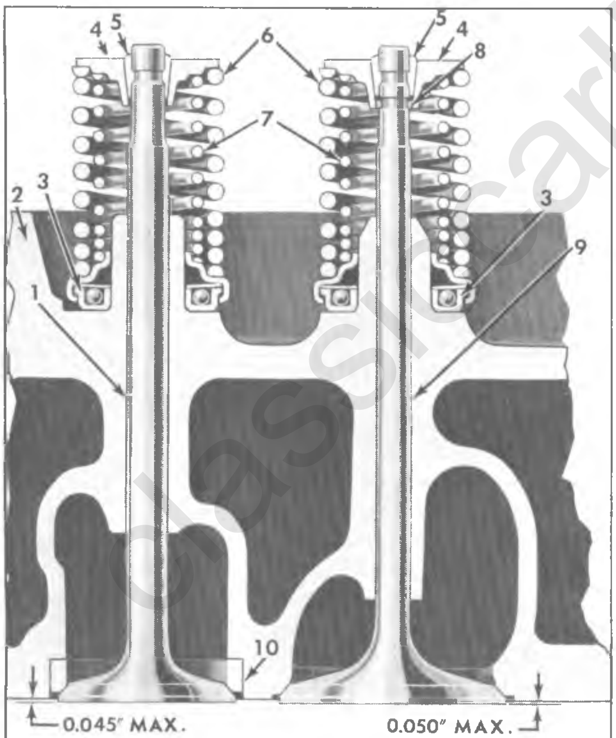


Figure 6—Firing Order and Mated Cylinders for Diesel Engine

NOTE: Figure 6 shows firing order for 6-cylinder engines and also indicates pairs of cylinders in which pistons reach top-dead-center at same time. Valve springs at any two cylinders having same letter identification in figure 6 may be changed without turning crankshaft.



1 Exhaust Valve
2 Cylinder Head
3 Valve Rotator
4 Spring Cap
5 Valve Keys
6 Outer Springs
7 Inner Springs
8 Intake Valve Oil Seal
9 Intake Valve
10 Exhaust Valve Seat Insert

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Figure 7—Cross Sectional View of Cylinder Head

5. Referring to figure 7 assemble rotator (if removed), inner and outer springs, and spring cap, then use compressor tool to force springs and cap down far enough to permit installation of valve keys.

6. On intake valve install oil seal (8, fig. 7). Place valve keys (5, fig. 7) in valve stem groove, then remove spring compressor.

7. Install rocker arm and shaft assembly following instructions given later under "Valve Operating Mechanism Replacement."

8. Install rocker arm cover; start engine and operate until warmed up to normal operating temperature. Check and adjust valve lash if necessary.

MANIFOLD REPLACEMENT

The intake and exhaust manifolds (fig. 8) are attached to cylinder heads by same clamps and bolts. A continuous strip type gasket is installed between cylinder head and manifolds.

REMOVAL

1. Remove from cab access covers (when used) and other equipment which may interfere with manifold removal. On tilt cab models, tilt the cab for access.

2. Disconnect air intake hoses from intake manifolds.

3. Disconnect exhaust pipes from exhaust manifolds.

4. Remove clamp bolts and clamps. Remove end bolts and washers, then remove manifolds and gaskets.

INSTALLATION

1. Clean the gasket surfaces on manifolds and mating surfaces on cylinder heads.

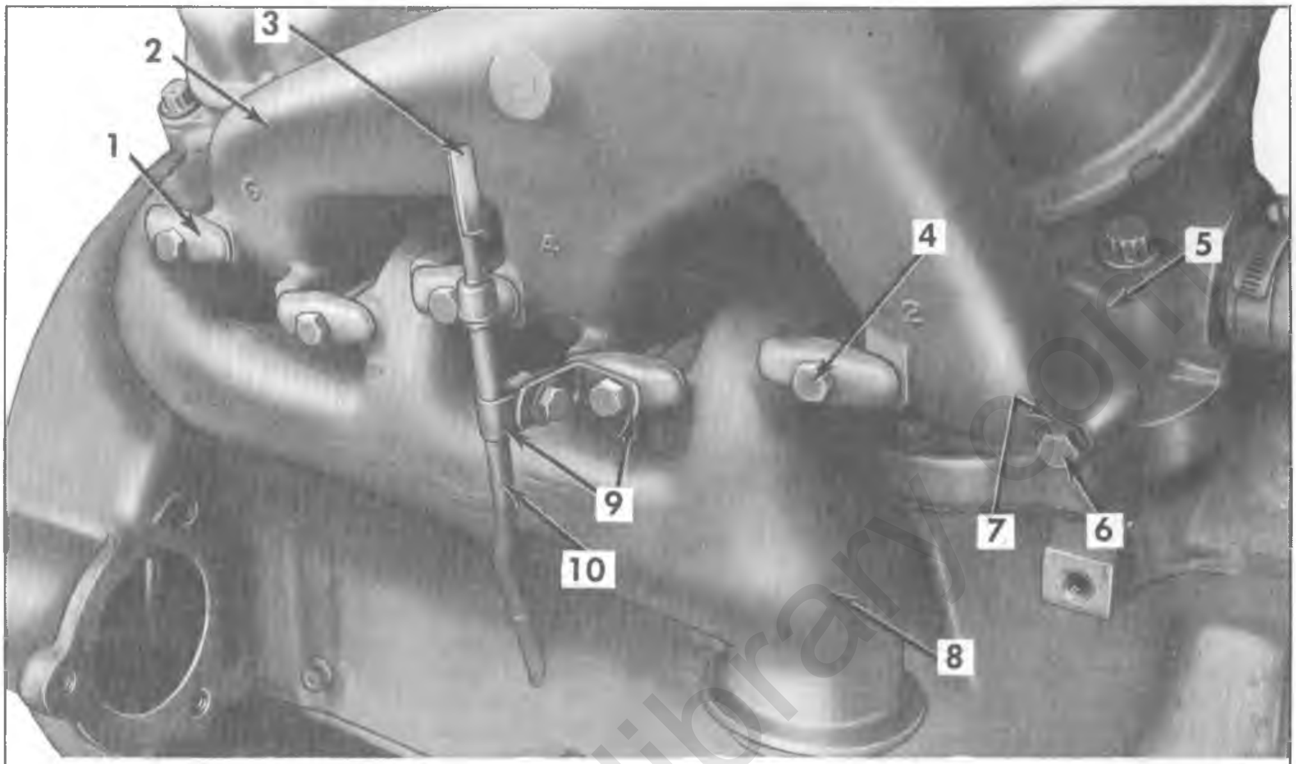
2. Locate manifolds and new gaskets and install end bolts with washers. Do not tighten end bolts until clamps and clamp bolts have been started. Tighten all bolts to apply even pressure at gaskets. Correct torque for intake manifold end bolt is 20 foot-pounds, exhaust manifold end bolt 20 foot-pounds, and all manifold clamp bolts 20 to 25 foot-pounds.

ROCKER ARM COVER REPLACEMENT

REMOVAL

NOTE: On some tilt cab models, it is necessary to remove transmission shift rods to permit left-hand rocker arm cover removal.

1. Remove crankcase ventilation hoses (when used) from covers.



1 Manifold Clamp
2 Intake Manifold
3 Oil Level Dipstick
4 Clamp Bolt
5 Cylinder Head
6 Manifold End Bolt
7 Plain Washer and Lock Washer
8 Exhaust Manifold
9 Tube Clamp and Bracket
10 Dipstick Tube

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Figure 8—Manifolds Installed (Right Hand Side)

2. Remove cover-to-cylinder head screws, then lift off covers and gaskets.

NOTE: Do not pry on cover flanges if gasket is stuck, since prying will bend cover flanges. Strike cover with rubber mallet if necessary to loosen stuck covers.

INSTALLATION

1. Press new cover gaskets into place at cover flanges.

2. Locate covers at cylinder heads and install attaching screws.

VALVE OPERATING MECHANISM REPLACEMENT

REMOVAL

1. Remove rocker arm covers referring to instructions given previously.

2. Remove bolts which hold rocker arm brackets to cylinder heads, then remove rocker arm shaft and bracket assemblies.

3. Remove push rods and identify so they may be reinstalled in original locations.

INSTALLATION

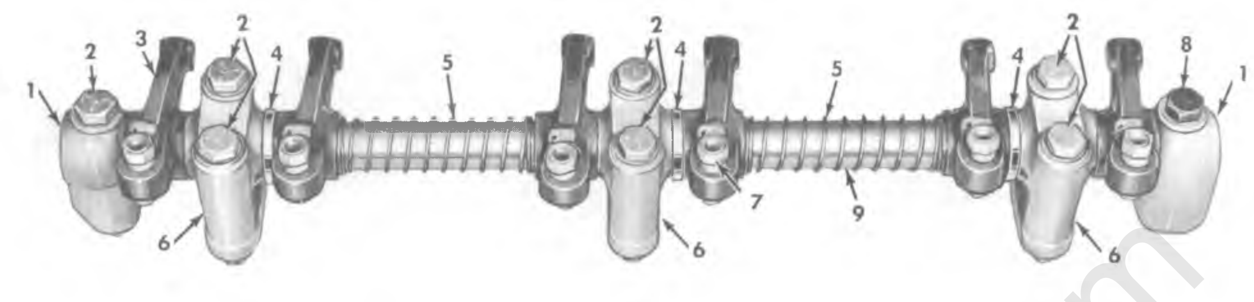
1. Place all push rods in original locations, then referring to figure 9, bolt rocker arm shaft brackets in place, meanwhile being careful to engage rocker arm screws with sockets in push rods. Tighten bracket bolts 20 to 25 foot-pounds torque.

2. Check clearance between rocker arm shaft end brackets and adjacent rocker arm. If a clearance of approximately 0.030-inch does not exist, loosen bracket bolts, and relocate brackets as allowed by clearance in bracket holes, then tighten bolts to specified torque.

3. Make initial adjustment to provide clearance of 0.012-inch at intake valves, and 0.022-inch at exhaust valves.

NOTE: The foregoing valve clearances (lash) are initial "cold" settings. Final adjustment must be made with engine warmed up to normal operating temperature. Correct valve lash with engine warmed up and running is 0.010-inch at intake valves and 0.018-inch at exhaust valves.

4. Install valve rocker arm covers, referring to instructions given previously.



1 End Bracket	4 Spacer	7 Adjusting Screw
2 Bracket Bolt and Plain Washer	5 Spring	8 Special Bolt
3 Rocker Arm	6 Rocker Arm Shaft Bracket	9 Shaft

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Figure 9—Rocker Arms, Shaft, and Brackets

CYLINDER HEAD REPLACEMENT

Unless otherwise stated in text, the replacement procedure which follows applies to replacing either the right-hand or left-hand cylinder head.

REMOVAL

1. Drain cooling system.

2. On tilt cab models, control island must be removed to provide access to injection pump lines, outlet manifold and head bolts. Disconnect and remove air intake system. If right-hand head is to be removed, remove air cleaner assembly, disconnect fuel supply line, and remove fuel secondary filter.

3. Remove rocker arm cover, and rocker arm and shaft assembly. Remove push rods and tag each one so rods may be installed in original position.

4. Disconnect exhaust pipe from manifold.

5. Remove clamps from fuel high pressure lines, then loosen nuts attaching fuel lines to hydraulic head and fuel injection nozzles. Disconnect and remove fuel high pressure lines, using care to avoid bending lines. Cap all openings in hydraulic head and nozzles to prevent entrance of dirt.

6. Remove fuel leak-off lines, then remove injection nozzles from cylinder head. See applicable portion of ENGINE FUEL SYSTEM (SEC. 6M) of this manual for illustrations on arrangement of

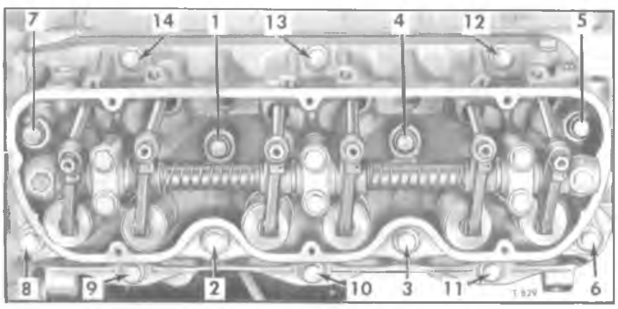


Figure 10—Cylinder Head Bolt Tightening Sequence

fuel system items.

7. Remove manifold attaching clamp bolts, then remove bolts, manifolds, and gaskets.

8. Remove water outlet hose clamps at front of cylinder head, and loosen hose.

9. Remove cylinder head bolts, then lift cylinder head off dowel pins and remove from engine.

10. Remove cylinder head gasket. Clean carbon deposits from cylinder head, pistons, and cylinder block. Do not scratch or gouge surfaces.

INSTALLATION

1. Use fine emery cloth and oil, to polish sealing surface on block and head. Be certain that no scratches are present on this surface.

2. Clean all head bolt holes in block with a 9/16-12 bottom tap and remove all cuttings from holes. When holes are properly cleaned, a 4-inch head bolt will project not more than 2-31/32-inch when screwed into any bolt hole.

3. Discard any head bolts which have heavily pitted shank.

4. Use pilot pins in two head bolt holes and locate head gasket on cylinder block.

IMPORTANT: The seal at hollow dowel is interference fit and must be pushed onto dowel with fingers. If any of seals or rings are dislodged reposition them carefully.

5. Lower cylinder head onto engine, using care not to dislocate any of seals.

6. Oil head bolt threads and area under bolt heads and start bolts into block.

a. Following sequence in figure 10, tighten all head bolts gradually to 90 foot-pounds torque.

b. Further tighten all head bolts in proper sequence to 130 to 135 foot-pounds.

c. Beginning at No. 1 bolt loosen one bolt at a time ¼ turn and immediately retighten to 130 to 135 foot-pounds. Be sure to retighten each bolt before loosening next one.

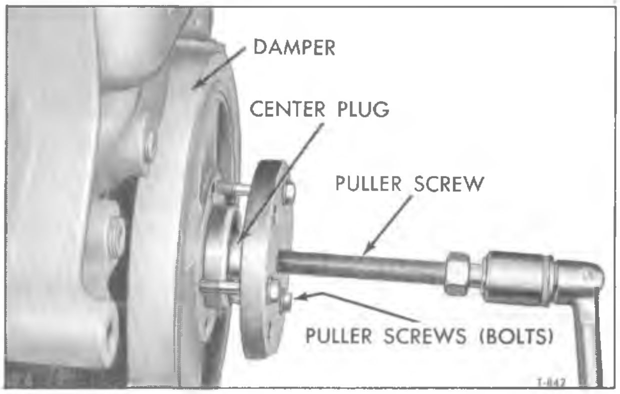


Figure 11—Tool Application for Removing Crankshaft Damper

d. Finally, check all bolts in proper sequence to assure a minimum torque of 130 foot-pounds. DO NOT LOOSEN ANY BOLT A SECOND TIME.

NOTE: No retorquing of head bolts is required after engine warm-up.

7. Position water outlet hose at front of head and install hose clamps.

8. Using new manifold gasket, install intake and exhaust manifold on cylinder head. Tighten manifold end bolts with washers (fig. 8) to 20 foot-pounds. Tighten clamp bolts to 20 to 25 foot-pounds.

NOTE: Intake manifold openings should be plugged or covered while installing on engine or performing other work to prevent foreign objects from falling into manifold openings.

9. Install push rods and assemble rocker arm and shaft assembly to cylinder head, refer to rocker arm replacement procedure given previously under "In-Vehicle Component Replacement" for instructions on installing rocker arms and shaft, and rocker arm cover.

10. Referring to ENGINE FUEL SYSTEM (SEC. 6M) of this manual, install fuel injection nozzles, leak-off lines, fuel high pressure lines, and fuel injection pump controls. Instructions and illustrations for installing fuel lines are included in appropriate portion of ENGINE FUEL SYSTEM (SEC. 6M) of this manual.

11. Connect exhaust pipe to manifold.

12. After installing right-hand cylinder head, mount fuel secondary filter assembly and connect fuel supply line.

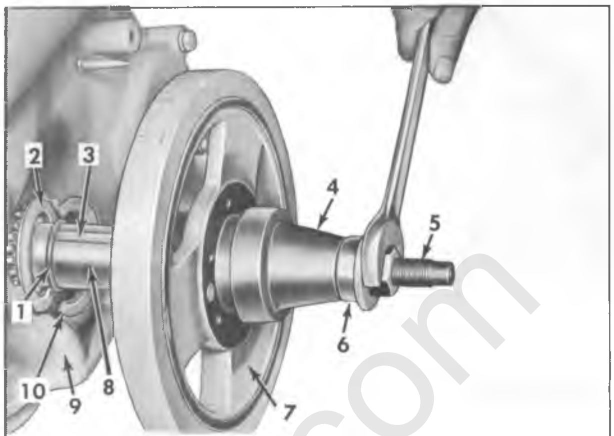
13. Assemble air intake hoses and air cleaner.

14. On tilt cab models, install control island.

15. Fill cooling system and check for leaks. Run engine until normal operating temperature is reached, then recheck and adjust valve lash.

CRANKSHAFT DAMPER REPLACEMENT

On some models, it may be necessary to remove radiator core to provide sufficient space for access to and removal of damper.



1 Seal "O" Ring	6 Thrust Bearing
2 Slinger	7 Crankshaft Damper
3 Key	8 Crankshaft
4 Installer	9 Engine Front Cover
5 Installer Screw	10 Oil Seal

T-2172-2

Figure 12—Installing Crankshaft Damper

REMOVAL

NOTE: On some engines fan is mounted on hub at front end of crankshaft. Remove hub mounting bolts and remove fan mounting hub; then proceed to remove pulley and damper as directed below:

1. Remove pulley which is bolted to damper hub.

2. Remove bolt and retainer washer which secures damper hub to crankshaft.

3. Assemble puller (J-7879-01) in manner shown in figure 11 and remove damper from crankshaft. A center plug is used at end of crankshaft to serve as bearing for puller screw.

4. Remove O-ring seal, found either at counterbore in damper hub, or on crankshaft behind key.

INSTALLATION

Key numbers in text refer to figure 12.

1. Place new seal O-ring (1) on crankshaft and position squarely at inner end of damper key (3) as shown in figure 12. DO NOT PLACE SEAL RING (1) AGAINST SLINGER (2). The seal ring must roll into hub counterbore when damper is *installed.*

2. Apply engine oil on damper hub at surface contacted by oil seal (10). Start damper onto crankshaft with keyway aligned with key (3). If damper does not slide onto crankshaft easily, installer screw (5) may be threaded into end of crankshaft and installer (4) and thrust bearing (6) may be used to install damper.

3. Referring to figure 13, install cone, retainer washer, and bolt as shown. Tighten damper retainer bolt to torque shown on page 302.

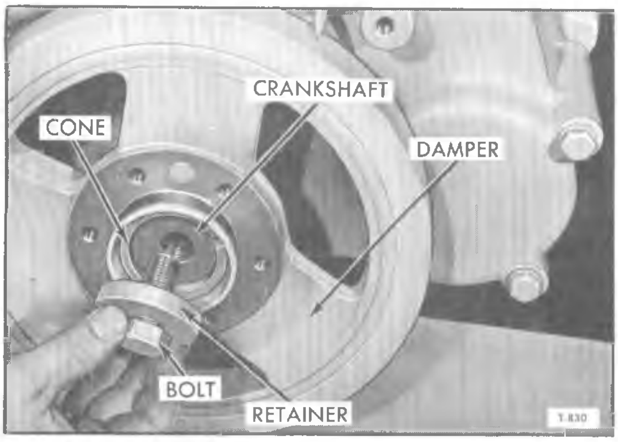
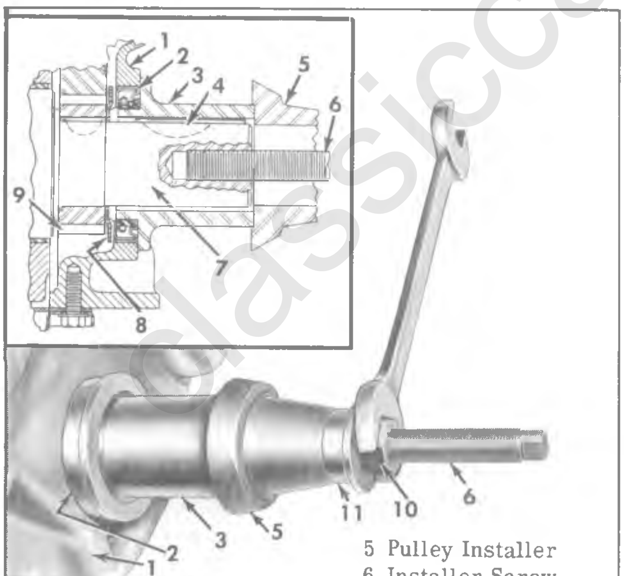


Figure 13—Crankshaft Damper Retainer Parts

4. Install pulley on damper hub, and install drive belts.
5. If vehicle is type with fan installed at front end of crankshaft, install fan hub assembly and fan.

CRANKSHAFT FRONT COVER OIL SEAL REPLACEMENT

In event of oil leak at crankshaft front oil seal it is possible to replace the oil seal (located in engine front cover without removing cover assembly from engine. Replace the seal as follows:



1 Engine Front Cover
2 Oil Seal Assembly
3 Oil Seal Installer (J-7879-10)
4 Key
5 Pulley Installer
6 Installer Screw
7 Crankshaft
8 Oil Slinger
9 Crankshaft Gear
10 Installer Nut
11 Thrust Bearing

Figure 14—Front Cover Oil Seal Installation

1. Remove crankshaft damper following the procedure previously given under "Crankshaft Damper Replacement."
2. Pry oil seal out of front cover assembly.
3. Use special installer (J-7879-10) in manner shown in figure 14, and press new oil seal into bore in cover. Seal lip must point inward toward crankshaft oil slinger (8, fig. 14). When using installer, turn crankshaft so key is on top. This centers the tool properly so pressure is applied uniformly over outer diameter of seal.
4. Inspect surface on damper hub, with magnifying glass if necessary, to locate any nicks, burrs, or scratches which could cause rapid wear at oil seal. When inspection shows surface to be in poor condition, install a new damper assembly.
5. Install damper assembly as previously instructed under "Crankshaft Damper Replacement."

ENGINE OIL PAN REPLACEMENT

OIL PAN REMOVAL

1. Clean all dirt and accumulated material from oil pan attaching bolts and drain plug.
2. Drain oil from oil pan.
3. Remove oil pan bolts and stud nut, then remove oil pan. Scrape off any portions of gasket which adhere to oil pan flange or to bolting flange on cylinder block and engine front cover.

OIL PAN INSTALLATION

1. Use gasket cement to hold new oil pan gasket in place at cylinder block and front cover.
2. Position oil pan at engine and install attaching bolts and stud nut.

NOTE: Three of the oil pan bolts are longer than the others; and these must be installed at rear of oil pan at reinforcement. These bolts may be readily identified by internal-external type lock washers. Other longer (9/16-inch) bolts have spring type lock washers.

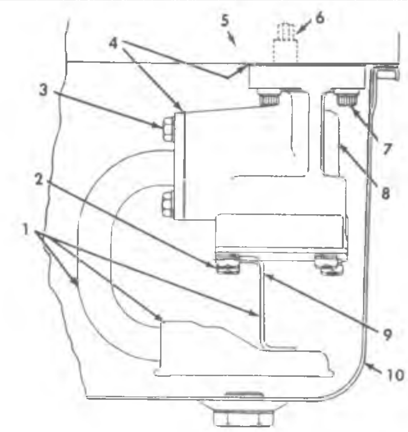
3. Install drain plug with new gasket, then fill crankcase with engine oil to "FULL" mark on dip stick.

ENGINE OIL PUMP REPLACEMENT

(Key Numbers Refer to Figure 15)

REMOVAL

1. Remove engine oil pan as previously directed under "Engine Oil Pan Replacement."
2. Remove two special bolts (7) which attach oil pump body to cylinder block, then remove oil pump and the suction tube and screen assembly as a unit. Oil pump drive shaft (6) will usually disengage from socket in tachometer drive and will remain with oil pump as it is removed.
3. Remove gasket; clean gasket contact areas on pump mounting flange and on cylinder block.



1 Suction Tube and Screen Assy.
2 Bracket Bolt (20-25 ft.-lbs.)
3 Flange Bolts and Lock Washers
4 Gaskets
5 Cylinder Block
6 Pump Drive Shaft
7 Pump to Block Bolts (30-35 ft.-lbs.)
8 Oil Pump
9 Bracket
10 Oil Pan

T-2460-2

Figure 15—Engine Oil Pump and Suction Screen Assembly

INSPECTION AND REPLACEMENT OF SUCTION SCREEN AND TUBE

Inspect screen and tube for damage. If screen is clogged, the assembly should be removed from pump and thoroughly cleaned; or a new suction tube and screen assembly installed.

When installing tube and screen assembly on oil pump, use new gasket between tube flange and pump body. Install all attaching bolts loosely, then tighten bracket bolt (2, fig. 15) first. Correct torque is 20 to 25 foot-pounds. Finally, tighten tube flange bolts (3, fig. 15).

INSTALLATION (Fig. 15)

1. Place new pump-to-block gasket on oil pump flange, and insert pump drive shaft in drive socket in pump shaft.
2. Set oil pump assembly in position at cylinder block and turn pump as necessary to engage the pump drive shaft with drive socket at upper end.
3. Align mounting bolt holes in pump flange with holes in block and install pump to block bolts (7, fig. 15).
4. Install engine oil pan as previously instructed under "Engine Oil Pan Replacement" in this section.

CRANKSHAFT REAR BEARING OIL SEAL

The lip-type seal used at crankshaft rear bearing can be replaced without removing crankshaft or bearings.

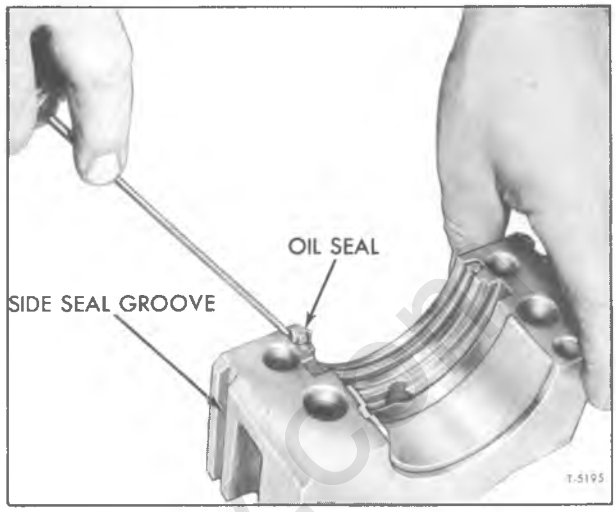


Figure 16—Removing Seal Lower Half from Bearing Cap

SEAL REMOVAL

1. With oil pan and oil pump removed from engine, remove the rear main bearing cap.
2. Remove lower half of seal from bearing cap using screwdriver as shown in figure 16.
3. Use a drift of soft metal (aluminum, copper or brass) to start the seal upper half out of cylinder block (fig. 17).

SEAL INSTALLATION

1. Wipe crankshaft with clean cloth. Apply engine oil on seal lip, then position oil seal upper half on crankshaft with seal lip toward front of engine.
2. While pressing on seal with hammer handle or suitable blunt tool, turn crankshaft and seal together until seal is rolled into position in block in same manner as for installing bearing insert. Both

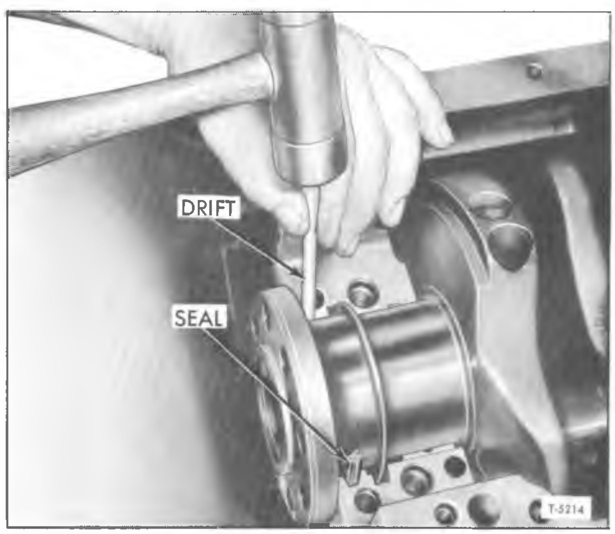


Figure 17—Removing Seal Upper Half from Block

TORO-FLOW DIESEL ENGINE

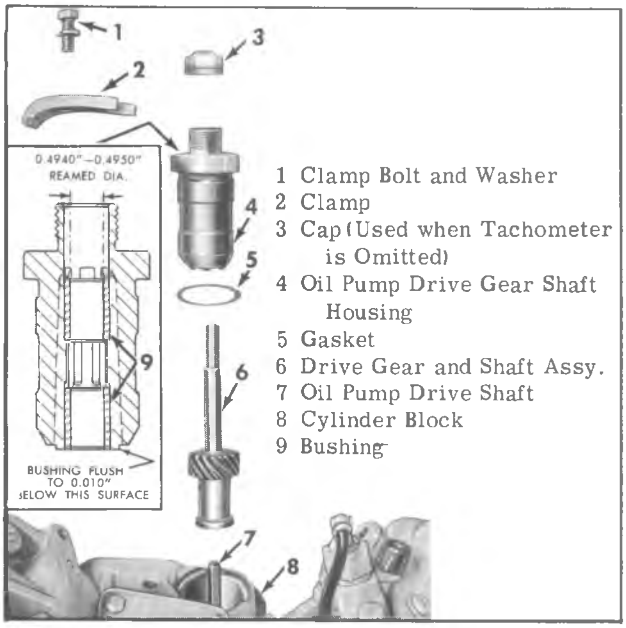


Figure 18—Tachometer and Oil Pump Drive Parts

ends of seal should be flush with block surface.

3. Using fingers, press seal lower half into place in bearing cap with seal lip forward to mate with lip on seal upper half.

4. Apply sealer at block, then bolt bearing cap in place. Dip new bearing cap side seals in diesel fuel and insert in bearing cap grooves.

5. Install oil pump and oil pan using new pan gasket. Refer to appropriate instructions given previously to install oil pump and oil pan.

TACHOMETER AND OIL PUMP DRIVE REPLACEMENT

GENERAL

Tachometer (when used) and engine oil pump are driven from gear teeth machined on camshaft. The shaft, gear, and housing assembly (fig. 18) are installed in cylinder block at location normally occupied by ignition distributor on gasoline engine. Oil pump is driven by shaft which engages socket in lower end of drive gear. When tachometer is used, the tachometer drive engages slot in upper end of gear and shaft assembly (6, fig. 18).

Key numbers in text refer to figure 18.

REMOVAL

1. Disconnect tachometer drive shaft, or if tachometer is not used, remove cap (3) from drive housing.

2. Remove clamp bolt, washer, and clamp (2) which secure shaft housing to cylinder block.

3. Lift the shaft and housing out of cylinder block, then use long nose pliers to reach into cylinder block cavity and remove oil pump drive shaft from oil pump.

4. Remove housing gasket (5).

INSTALLATION

1. Lubricate gear and shaft assembly with engine oil, then insert shaft into housing (4).

2. If oil pump drive shaft was removed from engine, insert shaft (7) into socket in oil pump.

3. Place new gasket (5) at housing flange, then install shaft and housing assembly in block. If the housing flange cannot be pushed down into contact with block, it may be necessary to turn crankshaft sufficiently to rotate drive gear so socket will engage pump drive shaft (7).

4. Push shaft housing down firmly so the flange seats on gasket, then install clamp (2) and secure bolt and lock washer (1).

5. Install cap (3) and gasket, or connect tachometer drive.

TORQUE WRENCH SPECIFICATIONS

Recommended specifications for proper torque to apply at points throughout the engine are as given below. Figures shown are foot-pounds of torque with threads clean and dry except as otherwise indicated.

Item	Ft.-Lbs.
Cylinder Head Bolts	130-135*
Flywheel to Crankshaft Bolts	100-110
Intake Manifold End Bolts	20-25
Exhaust Manifold End Bolts	15-20
Manifold Clamp Bolts	20-25
Rocker Arm Shaft Bracket Bolts	20-25

Item	Ft.-Lbs.
Damper to Crankshaft Bolt	240-260
Oil Filter Center Stud	40-50
Oil Pan Drain Plug	25-35
Oil Pan to Cylinder Block Bolts	10-15
Oil Pump to Cylinder Block Bolts	30-35

*Oiled with S.A.E. No. 10 Engine Oil.

Trouble Diagnosis Chart

HARD STARTING

SYMPTOM A - LOW STARTING RPM

POSSIBLE CAUSES	REMEDY
1. Improper oil viscosity.	1. Drain crankcase and refill with recommended grade of oil (Refer to LUBRICATION (SEC. 0) in this manual for Viscosity vs Temperature Chart). Also change oil at recommended intervals.
2. Low battery output.	2. Check for: a. Undercharged or defective battery. Replace battery if necessary. b. High resistance in starting circuit. Clean and/or tighten all connections.
3. Low temperature.	3. Use a starting aid.
4. Defective starter or solenoid.	4. Replace defective parts.

SYMPTOM B - LOW CYLINDER COMPRESSION

POSSIBLE CAUSES	REMEDY
1. Burned or warped valves.	1. Overhaul cylinder head.
2. Improper valve lash.	2. Adjust to proper clearance.
3. Worn or broken piston rings.	3. Overhaul engine.
4. Defective cylinder head gasket.	4. Replace gasket.

SYMPTOM C - LACK OF FUEL

POSSIBLE CAUSES	REMEDY
1. Fuel line shut-off valve closed.	1. Open shut-off valve.
2. Engine stop mechanism not released.	2. Check and as necessary, correct operation of mechanism. Stop button must be pushed in completely.
3. Accelerator linkage not operating properly.	3. Check linkage operation and adjust or repair as required.
4. Low fuel supply.	4. Check amount of fuel in tank, fill if supply is low.
5. Clogged vent in fuel tank cap.	5. Clean or replace cap.
6. Break in fuel supply line allowing air to be drawn into system.	6. Replace or repair lines.
7. Clogged fuel filters.	7. Service filters.
8. Air trapped in system.	8. Bleed air from system.
9. Water or ice in fuel system.	9. Thaw if frozen, and drain water out of tank and filters.
10. Defective fuel supply pump.	10. Make pressure test at secondary filter.
11. Overflow valve leaking or stuck open.	11. Clean and inspect overflow valve.
12. Low fuel delivery.	12. Check excess fuel starting device to determine if sticking.

HARD STARTING (CONT'D)

SYMPTOM D - WRONG TYPE OF FUEL

POSSIBLE CAUSE	REMEDY
1. Improper grade or type of fuel in tank.	1. Fill tank with proper fuel referring to current GMC Diesel Fuel Oil Bulletin.

ABNORMAL ENGINE OPERATION

SYMPTOM A - UNEVEN RUNNING OR FREQUENT STALLING

POSSIBLE CAUSES	REMEDY
1. Idle speed set too slow.	1. Adjust idle speed to 625 to 650 rpm.
2. Cylinder misfiring.	2. Check for misfiring cylinder, replace or overhaul fuel injection nozzle assembly.
3. Burned or sticking valves.	3. Inspect valve operating mechanism and check cylinder compression. Overhaul cylinder head if necessary.
4. Engine temperature too hot or too cold.	4. Check thermostats, fan belt tension, and coolant level. Correct as necessary.
5. Fuel system deficiencies.	5. Refer to items 4 through 10 under "Hard Starting" Symptom C.

SYMPTOM B - DETONATION

POSSIBLE CAUSES	REMEDY
1. Improper injection timing.	1. Check and, if necessary, set injection timing properly.
2. Defective injection nozzles.	2. Remove nozzles and check on test stand.

SYMPTOM C - LACK OF POWER

POSSIBLE CAUSES	REMEDY
1. Improper valve lash.	1. Set to specified valve clearance.
2. Insufficient fuel.	2. Check for drop in fuel pressure, using gauges at secondary fuel filter.
3. Insufficient air.	3. Check for damaged or clogged air cleaners and intake passages. Service air cleaners or repair as required.
4. Excessive exhaust back-pressure.	4. Inspect exhaust system components, replace damaged or clogged units.
5. Improper engine operating temperature.	5. Inspect and correct cooling system.
6. Low cylinder compression.	6. See Symptom B under "Hard Starting" diagnosis.

EXHAUST ANALYSIS

(NOTE: Make checks with engine at normal operating temperature.)

SYMPTOM A - EXCESSIVE BLACK OR GRAY SMOKE

POSSIBLE CAUSES	REMEDY
1. Insufficient combustion air.	1. Service air cleaners and check for other restrictions.
2. Exhaust pipe or muffler clogged or pinched.	2. Repair or replace parts as necessary.

EXHAUST ANALYSIS (CONT'D)

POSSIBLE CAUSES	REMEDY
3. Injection pump not properly timed to engine.	3. Correct injection timing.
4. Incorrect engine valve timing.	4. Check and correct as necessary.
5. Injection nozzles leaking (worn), or improper opening pressure.	5. Remove nozzle assemblies, test, replace or repair as necessary.
6. Wrong grade or type of fuel.	6. Fill tank with correct fuel. (Refer to current GMC Diesel Fuel Oil Bulletin.)
7. Engine overheating.	7. Correct cooling system malfunction.
8. Poor cylinder compression.	8. Check and correct as required.
9. Damaged or worn pistons, and/or piston rings.	9. Overhaul engine.
10. Cylinder overfueled.	10. Have injection pump recalibrated. Check for excess fuel device sticking.

SYMPTOM B - EXCESSIVE WHITE OR BLUE SMOKE

POSSIBLE CAUSES	REMEDY
1. Oil level in air cleaner too high.	1. Service air cleaner.
2. Injection pump not properly timed to engine.	2. Retime correctly.
3. Engine crankcase oil level too high.	3. Drain crankcase and refill to correct level.
4. Engine running too cool.	4. Correct cooling system malfunction.
5. Poor cylinder compression.	5. Check and correct as required.
6. Damaged or worn pistons and/or piston rings.	6. Overhaul engine.
7. Wrong grade or type of fuel.	7. Fill tank with correct fuel. (Refer to current GMC Diesel Fuel Oil Bulletin.)

HIGH LUBRICATING OIL CONSUMPTION

POSSIBLE CAUSES	REMEDY
1. Oil lines or connections leaking.	1. Tighten or replace defective parts.
2. Leaking gaskets.	2. Replace gaskets as necessary.
3. Crankcase oil level too high.	3. Drain crankcase and refill to correct level.
4. Pistons and/or rings worn, or pistons damaged.	4. Overhaul engine.

LOW ENGINE OIL PRESSURE

(When checked with engine at normal operating temperature)

POSSIBLE CAUSES	REMEDY
1. Defective oil gauge or sending unit.	1. Check pressure with master gauge. Replace oil gauge or sending unit if defective.
2. Oil viscosity too low.	2. Fill crankcase with correct oil.
3. Oil diluted with fuel oil.	3. Check for indications of fuel oil entering crankcase and make necessary correction.
4. Suction loss.	4. Check for loose intake pipe and screen in oil pan. Also check for partially clogged inlet screen.
5. Weak or broken relief valve spring in oil pump.	5. Inspect spring and replace if necessary.

LOW ENGINE OIL PRESSURE (CONT'D)

POSSIBLE CAUSES	REMEDY
6. Worn oil pump assembly.	6. Overhaul or replace engine oil pump assembly.
7. Excessive clearance at crankshaft, camshaft or balance shaft bearings.	7. Disassemble engine and replace bearings as required.

NOTE: In case of no oil pressure, the oil pump drive shaft or drive gear teeth could be worn to point where oil pump is not driven. Inspection can be made by removing the oil pump and tachometer drive housing and gear at rear of engine.

ABNORMAL ENGINE COOLANT TEMPERATURES

SYMPTOM A - ENGINE OVERHEATS

POSSIBLE CAUSES	REMEDY
1. Scale deposits in cooling system.	1. Clean and flush cooling system.
2. Air flow thru radiator restricted or clogged.	2. Clean outside of radiator core.
3. Loose fan drive belt (if used).	3. Adjust belt to proper tension.
4. Low coolant level.	4. Fill system to proper level. Inspect cooling system for leaks.
5. Hoses collapsed.	5. Replace defective hoses.
6. Defective thermostats.	6. Remove thermostats, inspect, test, and replace as necessary.
7. Combustion gases in cooling water.	7. Determine point at which gases enter system. Disassemble and inspect cylinder head and gaskets. Replace gaskets, and if head is cracked, replace head.
8. Incorrect injection pump to engine timing.	8. Set timing correctly.

SYMPTOM B - ENGINE RUNS TOO COOL

POSSIBLE CAUSES	REMEDY
1. Defective thermostat.	1. Inspect thermostat and replace defective unit.
2. Wrong thermostats installed.	2. Install thermostats having correct opening temperature.

SECTION 6D

Engine Mountings

DESCRIPTION

Cushion-type mountings are used at all engine mounting points. A single front mount is used with all V6 engines; whereas, dual front mounts are used with all In-line engines.

The various types of mountings are illustrated in figures 1 through 4.

GENERAL MAINTENANCE

Engine mountings should be inspected periodically and replaced if found damaged or deteriorated.

IMPORTANT: Broken or deteriorated mounts can cause misalignment and eventual destruction of certain drive train components. Also, when a single mounting failure occurs, the remaining mounts are subjected to abnormally high stresses.

When inspecting engine mounts, check all attaching bolts and nuts for tightness. Refer to Torque Chart shown below:

MOUNTING CUSHION REPLACEMENT

IMPORTANT: When supporting engine to replace a mount, raise engine only to height required to replace the mount. If raised beyond this height, possible damage to wiring, lines and control linkage could occur.

When replacing either rear mount it is necessary to raise only that particular side of engine.

1. Before lowering engine onto new mounting cushion, make sure cushion, bolts and bolt spacers (if used) are positioned properly. Refer to applicable illustration.

NOTE: If an alignment dowel is used at mounting make certain that it engages the locating hole in mating part.

6D

ENGINE MOUNTING TORQUE CHART

BOLT TORQUES (FT.-LB.) GIVEN UNLESS OTHERWISE SPECIFIED

ENGINE FRONT MOUNTINGS			ENGINE REAR MOUNTINGS		
Models	Mounting Bracket To Engine Bolts	Mounting Bolts	Mounting Bracket To Engine Bolts	Mounting Bolts	Mounting Bracket To Frame Bolts
LV, LA-4000	60 - 70	50 - 60	-	55 - 75	*40 - 50
PS-4500	40 - 50	55 - 75	-	55 - 75	*40 - 50
DLV, DLA-4000	60 - 70	50 - 60	45 - 55	120 - 130	-
EG, EM, SG, SM-5500; EG, SM-6500	60 - 70	95 - 105	55 - 65	130 - 140	*40 - 50
EM-4500; EM-6500	60 - 70	95 - 105	-	55 - 65	*40 - 50
ES-4500; ES, SS-5500;	25 - 30	40 - 50	-	55 - 75	*45 - 55

*Nut Torque.

ENGINE MOUNTINGS

2. With cushion components in place, lower engine just enough to allow starting of all attaching bolts.

3. After bolts are started, lower engine to mount, then with all components in position, tighten the attaching bolts and nuts to torque specified in Torque Chart on previous page.

IMPORTANT: If a lock strap is used at mounting bolts or nuts, install the same to secure the mounting.

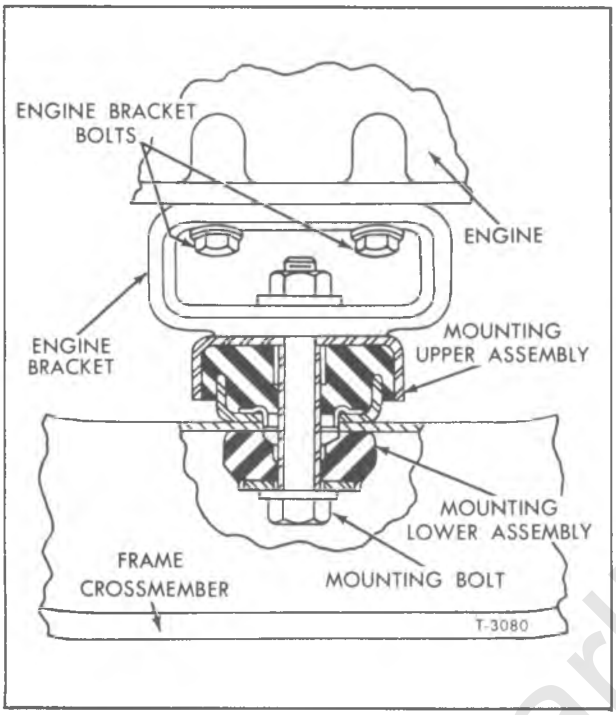


Figure 1—Engine Front Mounting For V6 Engine (Typical)

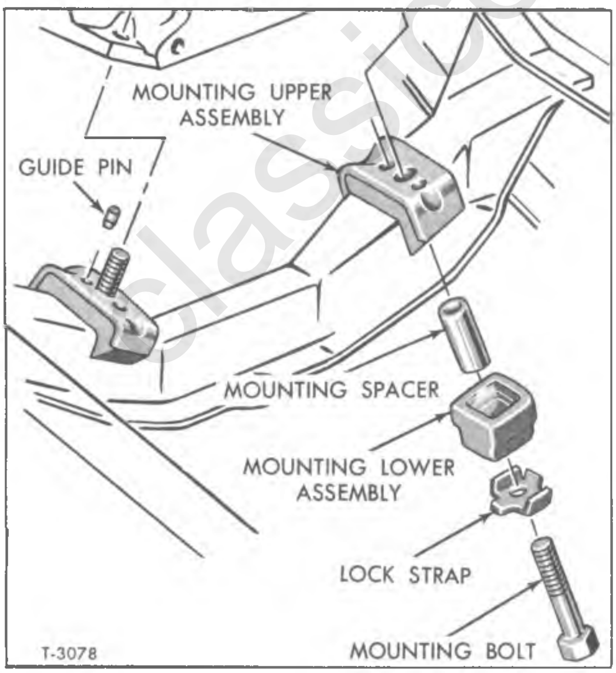


Figure 2—Engine Rear Mounting on Crossmember

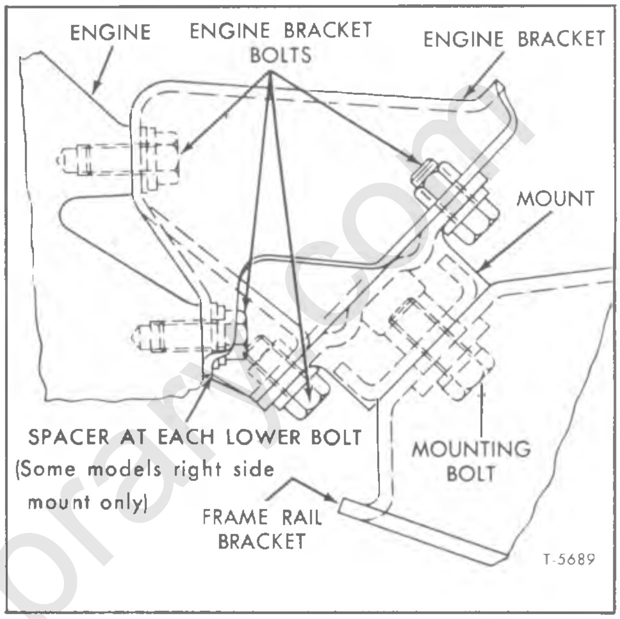


Figure 3—Engine Front Mounting For In-Line Engine (Typical)

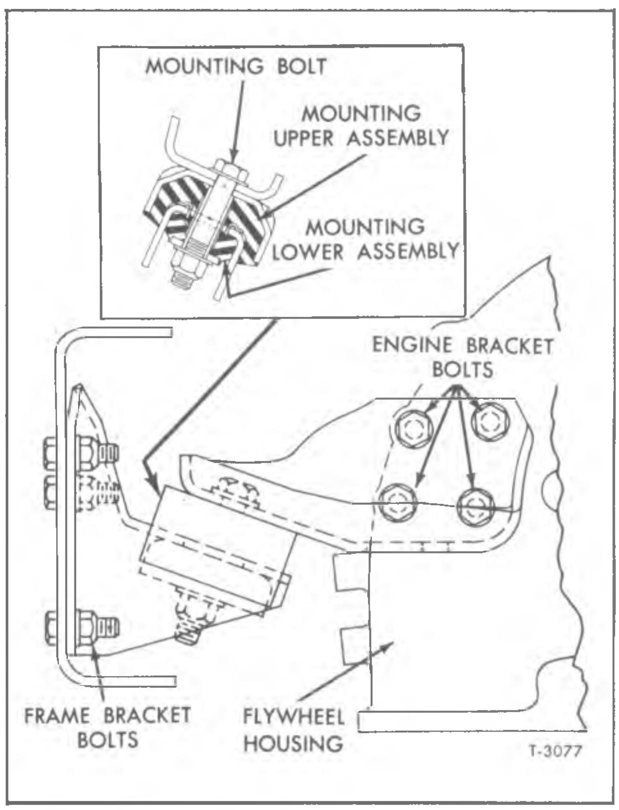


Figure 4—Engine Rear Mounting at Frame Bracket

SECTION 6K

Engine Cooling System

COOLANT CIRCULATION

IN-LINE GASOLINE ENGINES

The water pump, belt-driven from engine crankshaft pulley, circulates coolant through the cooling system. Coolant from the radiator is forced through engine water jacket, around cylinder walls, upward into cylinder head through the thermostat, and then back to the radiator.

During engine warm-up and while thermostat is closed, coolant is recirculated within the engine until thermostat opening temperature is reached.

V6 GASOLINE ENGINES

The water pump, belt-driven from the engine crankshaft pulley, circulates the coolant through the cooling system. The coolant from radiator (and surge tank - when used) is forced into front of each cylinder bank (fig. 1) where it traverses around the cylinders to rear of bank. From here it flows upward through transfer holes and into rear of cylinder heads, then back to front of heads. At this point a portion of coolant flows up and out of the engine water manifold and back to radiator. The remaining portion of coolant is recirculated back into water pump and engine.

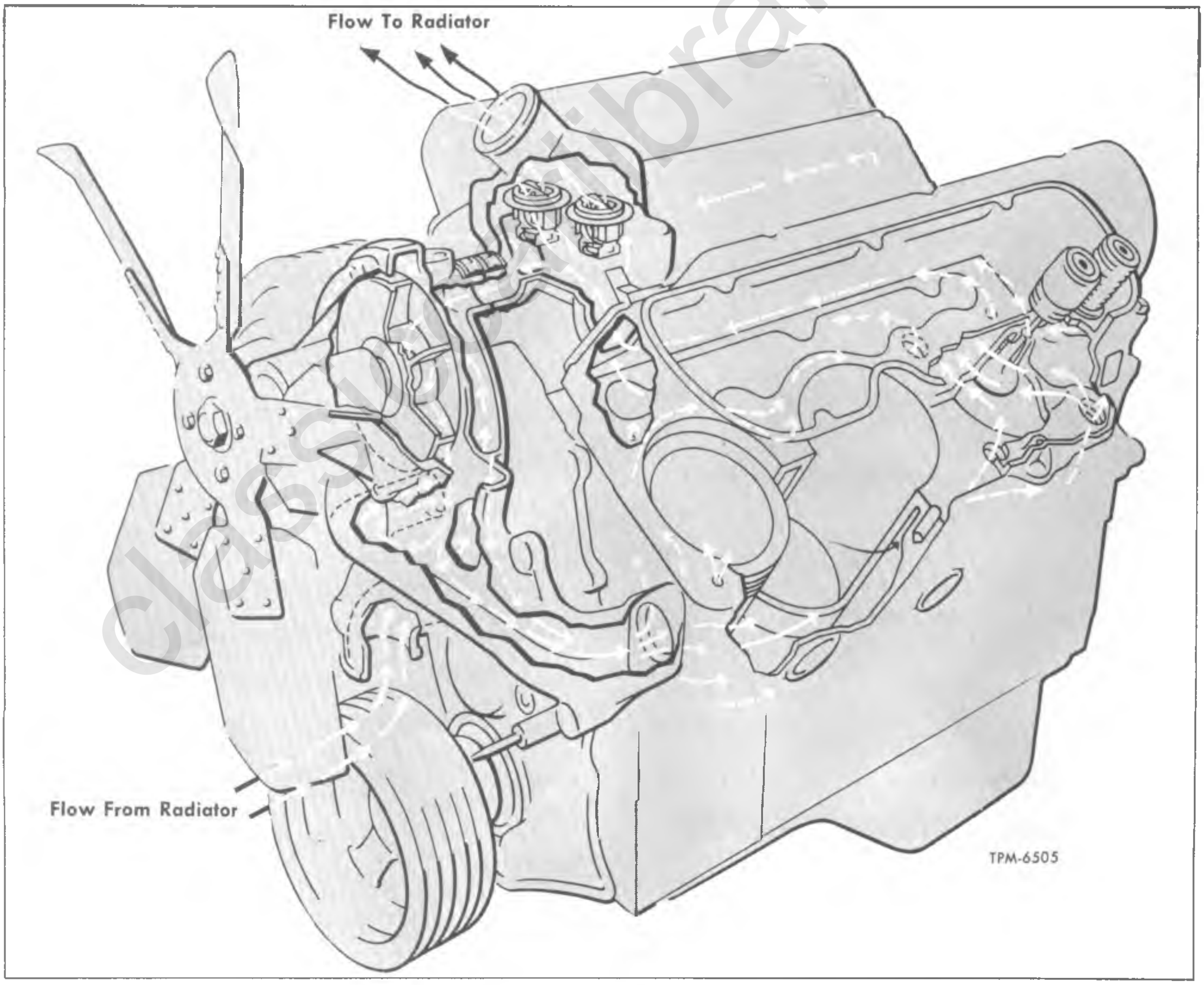


Figure 1—Coolant Circulation (V6 Engine) (Typical)

ENGINE COOLING SYSTEM

All thermostats are located in the top of engine water manifold. One thermostat is used on EM, SM 5500M-V and EM6500V when equipped with a 305C engine. In addition, EM4500 with the 305E engine uses one thermostat. All other gasoline engine equipped models, covered by this manual, have two thermostats.

Engine Warm-Up Period

During engine warm-up period, the thermostat valve(s) is closed and shuts off circulation to the radiator. As engine warms up the valve(s) slowly opens, allowing a gradually increasing amount of liquid to flow through cooling system, until engine reaches normal operating temperature.

During engine warm-up, coolant is recirculated through by-pass at side of water manifold.

As engine water temperature reaches normal, the thermostat valve(s) becomes fully open. The valve(s) then may move frequently to regulate flow of coolant into radiator. Thus an efficient operating temperature is maintained. A temperature gauge on dash is connected to a thermal unit in engine cylinder head water outlet manifold.

DIESEL ENGINES

The cooling system on the diesel engine functions the same as the V6 gasoline engine, as described previously. The thermostat is located in top of engine front cover at the outlet to the radiator.

INSPECTION OF SYSTEM

Although action of the cooling system controls the operating temperature of the engine, improper ignition timing (gasoline engines) or improper or insufficient lubricating oil in the engine crankcase may cause the engine to overheat, even though the cooling system is functioning properly. These items should also be checked for cause of improper cooling.

Cooling systems must be kept air-tight. As the pressure in the system raises the boiling point of the coolant, any air leak would lower boiling point and result in loss of coolant. Check radiator cap seal and all radiator connections. Entire cooling system can be checked for leaks in castings, connection hoses, gaskets, and filler cap using a conventional cooling system testing kit which can usually be obtained locally.

DRAINING COOLING SYSTEM

1. On Tilt Cab model, move heater control "TEMP" knob to "ON."
2. Remove radiator filler cap.
3. Remove plug or open drain cock at bottom of radiator core.
4. Open drain cock or remove plug at each side of cylinder block on V-type engines. On In-line engines, remove plug or open drain plug at left rear side of cylinder block.
5. Remove drain plug from bottom of cooling system filter assembly (if equipped).

FILLING COOLING SYSTEM

When cold water is poured into the radiator the thermostats will close even though the engine is warm. This action may trap air in cylinder block and head passages. The trapped air will leak through the thermostat vents thereby lowering the water level.

NOTE: Before filling, flush out system with plain water.

1. On tilt cab models, move heater control "TEMP" knob to "ON."
2. With all drains closed, add coolant until visible in filler neck.

NOTE: The coolant level should be approximately 1-inch below bottom of the filler neck when engine is hot. If the engine is cold, the coolant level should be two to three inches below bottom of filler neck.

3. Run engine to expel air; then add coolant as necessary.
4. Do not overfill if anti-freeze solution is used.

CAUTION: DO NOT POUR COLD WATER IN RADIATOR WHILE ENGINE IS HOT. Wait until boiling ceases, then add water slowly while engine is idling. Install radiator cap firmly.

CLEANING COOLING SYSTEM

Unless water in cooling system is treated with a corrosion preventive, rust and scale may eventually clog water passages in radiator and water jackets. This condition is aggravated in some localities by the formation of insoluble salts from water used.

Cleaning solutions, commercially available, will successfully clean cooling systems of rust, scale, sludge, and grease when used as directed by the manufacturers. However, if radiator is clogged with insoluble scale formations, reliable radiator service stations in the various localities are best equipped to remove such formations.

GMC Cooling System Cleaner or other commercial cleaning solutions are especially effective in removing rust, scale, and corrosion from the radiator and engine water passages. Use cleaner only as directed on label. Particularly at winter check-up, preferably before and after using anti-freeze solutions, entire system should be cleaned with a recommended cleaning solution as follows:

CLEANING

1. Drain system, then close cocks and install drain plugs.

2. Fill system with cleaning solution. Always follow manufacturer's directions.

3. With radiator covered and radiator cap on tight, run engine 15 to 20 minutes at fast idle speed. Drain system completely.

4. If cleaning solution used requires a neutralizer, use as directed by manufacturer.

FLUSHING

Remove thermostats before pressure flushing system. Avoid excessive pressure. When pressure flushing, apply air gradually, as radiator will stand only a limited pressure.

CORROSION PREVENTION

Use of water containing lime, alkali, and other impurities is a major cause of rust and scale formation in cooling system. Air or exhaust gas leaking into the system can also be cause of rust and corrosion. A rust preventive, inhibitor, or water filter should be used continuously. WHENEVER WATER FILTER IS USED IN SYSTEM NO INHIBITOR OR RUST PREVENTIVE IS REQUIRED AS FILTER CONDITIONS THE COOLING SYSTEM.

Drain and flush cooling system every 24 months and add new anti-freeze solution.

INHIBITORS AND SEALERS

In general, inhibitors are not cleaners and will not remove scale and rust already formed. GM Cooling System Inhibitor and Sealer will retard rust and scale formation and is compatible with aluminum components. Inhibitor and sealer should be used immediately after new anti-freeze solution has been added to system and every fall thereafter.

It is important not to use too much inhibitor or to use two different types at the same time.

USE INHIBITOR AND SEALER ONLY AS INSTRUCTED ON LABEL.

AIR SUCTION TEST

Air may be drawn into system due to low liquid level in the radiator or surge tank, leaky water pump, or loose hose connections. This action will also cause corrosion.

1. Replace radiator cap having integral pressure relief valve with a plain filler cap less the relief valve.

2. Make sure radiator cap seal is in good condition and will make an airtight seal. Adjust level of cooling liquid in radiator, allowing ample room for expansion to avoid any overflow loss during test.

3. Attach a length of rubber tube to lower end of overflow tube. This connection must be air-tight. Run engine with transmission in neutral at ¼ throttle speed until temperature gauge stops rising and remains stationary.

4. Without changing engine speed, put end of rubber tube in a bottle of water, avoiding kinks and sharp bends that might block flow of air. Watch for bubbles in bottle of water. The continuous appearance of bubbles indicates that air is being sucked into the cooling system.

5. Correct condition by tightening hose clamps and fitting connections. Also examine all hoses carefully and if cracked, swollen, or deteriorated in any way, replace with new hose.

EXHAUST GAS LEAKAGE TEST

Exhaust gas may be blown into the cooling system past cylinder head gasket or through cracks in the cylinder head and block. This action will also cause corrosion and possible damage to engine combustion chamber components.

1. Start test with engine cold. Remove drive belt to prevent water pump operation.

2. Partially drain cooling system until cooling liquid level is at top of thermostat well. Remove thermostat(s) and insure that coolant level is at top of thermostat well.

3. With transmission in neutral, start engine and accelerate it several times.

4. Watch for bubbles in water or smoke at surface of coolant while accelerating engine. Also watch when engine speed drops back to idle. The appearance of bubbles or a sudden rise of cooling liquid indicates exhaust gas leakage into cooling system. Make test quickly before boiling starts as steam bubbles will give misleading results.

5. If exhaust gas leakage is evident, replace cylinder head gasket or gaskets, then test again. Tighten cylinder head bolts to torque specified in ENGINES (SEC. 6A or 6B) of this manual. If leaks are still evident, cylinder head or block may be cracked. Correct cause of leakage, then install thermostats and adjust drive belt. Fill cooling system.

COLD WEATHER OPERATION

Water, with an inhibitor, can be safely used as a cooling medium in climates where temperatures do not reach below 32°F. In lower temperatures, anti-freeze solutions must be used. Before installing anti-freeze solution, cooling system should be inspected and serviced for cold weather operation, as previously described under "Cleaning System" in this section.

Cylinder head bolts should be checked for tightness and gasket replaced if necessary, to avoid possibility of anti-freeze solution leaking

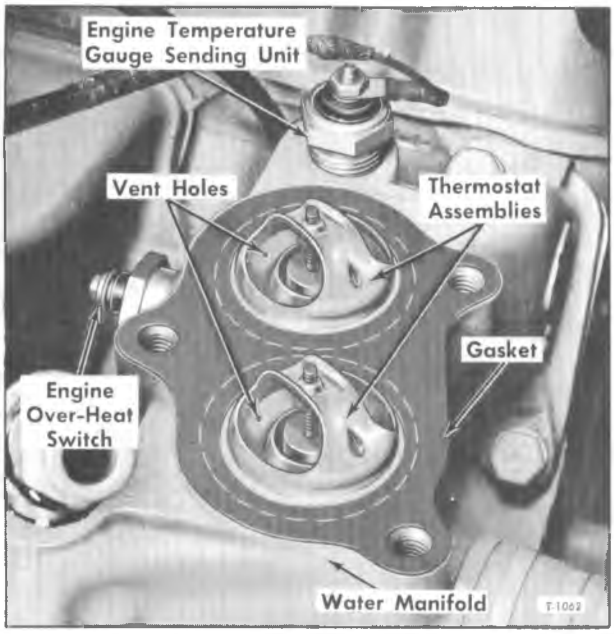


Figure 2—Engine Units for Overheat Switch and Temperature Gauge (V6 Gasoline Engine)

into engine, and exhaust gases entering cooling system. If Ethylene Glycol anti-freeze is to be used on vehicles having a water filter, the water filter must be serviced at regular intervals as directed later in this section under "Water Filter." After anti-freeze solution has been installed, entire system should be inspected regularly for leaks.

THAWING COOLING SYSTEM

If cooling medium in system becomes frozen solid, place vehicle in warm place until ice is completely thawed out. UNDER NO CIRCUMSTANCES SHOULD ENGINE BE RUN WHEN COOLING SYSTEM IS FROZEN SOLID.

The inhibited year-around (permanent-type) engine coolant, used to fill the cooling system at the factory is a high quality solution that meets General Motors Specification 1899-M. This factory-fill coolant solution is formulated to withstand two full calendar years of normal operation without draining or adding inhibitors, and provides freezing protection to -20°F.

It is the owner's responsibility to keep the freeze protection at a level commensurate with the area in which the vehicle will be operated. Regardless of climate, system protection should be maintained at least to 0°F., to provide adequate corrosion protection. When adding solution due to loss of coolant for any reason or in areas where temperatures lower than -20°F., may occur, a sufficient amount of an ethylene glycol base coolant that meets GM Specification 1899-M should be used.

Every two years the cooling system should be serviced by flushing with plain water, then completely refilling with a fresh solution of water and a high-quality, inhibited (permanent type) glycol base coolant meeting GM Specification 1899-M, and providing freezing protection at least to read 0°F. At this time, also add GM Cooling System Inhibitor and Sealer or equivalent. In addition, Cooling System Inhibitor and Sealer should be added every fall thereafter. GM Cooling System Inhibitor retards the formation of rust or scale and is compatible with aluminum components.

IMPORTANT: Alcohol or methanol base coolants or plain water are not recommended for your truck at any time. DO NOT use glycol ether (methoxy propanal type) base permanent type anti-freeze coolants in diesel engines - damage to head gaskets will occur.

WATER TEMPERATURE INDICATOR

Electric type temperature gauge system consists of an engine thermal plug electrically connected with registering gauge mounted on instrument panel. Refer to applicable wiring diagram in "Wiring Diagram" booklet. System is activated when ignition is turned on.

In-line engines have sending unit installed either in the thermostat housing or at the front left side of cylinder head. Unit is installed in engine water manifold on V6 gasoline engines (fig. 2) and in engine front cover on diesel engines (fig. 3).

CIRCUIT TEST

1. Disconnect wire at engine unit.
2. Connect a test light consisting of a 12-volt, 2-candlepower bulb and a pair of test leads in circuit by clipping one lead to battery positive terminal and other lead to body of engine gauge unit. If bulb lights, unit is properly grounded. If bulb does not light, check for presence of sealing compound around threads of unit. Remove compound and repeat test. Make sure unit is properly grounded before proceeding with next test.
3. Remove test lead from body of unit and connect lead to terminal of the unit. If bulb lights, engine unit is internally short-circuited and should be replaced.
4. Remove test light and reinstall wire on unit.
5. If engine unit tests satisfactorily under the above conditions, check following items according to nature of difficulty.

a. If gauge does not register when ignition is turned on: This may be caused by a break in the circuit between the gauge and the ignition switch or a short between this lead and ground.

b. If gauge shows high temperature under all conditions, wire leading from gauge to engine unit is shorted to ground.

c. If gauge registers a low temperature under all conditions, wire between gauge and engine unit is broken.

Do not attempt to repair either the engine unit or the gauge. When installing new engine unit, do not use thread compound on unit threads, as this will increase electrical resistance of unit and cause faulty reading on gauge.

ENGINE OVERHEAT ALARM

Overheat alarm switch is located near the water temperature indicator, engine unit. Refer to figure 2 or 3 for location of engine overheat alarm.

NOTE: Electrical wire end of overheat switch is retained by screw, whereas, wire end for temperature indicator is retained by a nut.

The alarm system is interconnected to a telltale light and, on some vehicles, to a buzzer. The purpose of this system is to signal the driver when engine temperature exceeds a safe range. Refer to current wiring diagram in "Wiring Diagrams" booklet for alarm system circuit.

Overheat temperature switch is not repairable and must be replaced as an assembly or unit.

TESTING ENGINE UNIT AND CIRCUIT

NOTE: Before testing overheat switch, make the following circuit tests:

Circuit Tests

1. Disconnect wire at engine unit.
2. Connect a test light consisting of a 2-candlepower 12-volt bulb and a pair of test leads in circuit by clipping one lead to a hot terminal and other lead to body of engine unit. If bulb does not light, check for presence of sealing compound, oil or paint around threads of unit. Remove insulating substance and repeat test. Make sure unit is properly grounded before proceeding with tests.
3. Remove test lead from body of engine unit and connect lead to terminal of unit. Then providing engine water temperature is not exceeding switch setting, and the bulb lights, engine unit is internally short-circuited and should be replaced. Refer to "Specifications" for switch setting.
4. Remove test light and reinstall wire on engine unit.
5. If alarm buzzer sounds and/or tell-tale lights under all conditions with engine control switch in "ON" position; wire leading from buzzer or light to engine unit is shorted to ground.
6. With engine control switch in "ON" position, and light does not come on when terminal at temperature switch is shorted to ground, a break or short in wire between engine unit and engine control switch is indicated.
7. When installing engine unit, do not use thread compound on unit threads, as this will increase electrical resistance and cause faulty reaction.

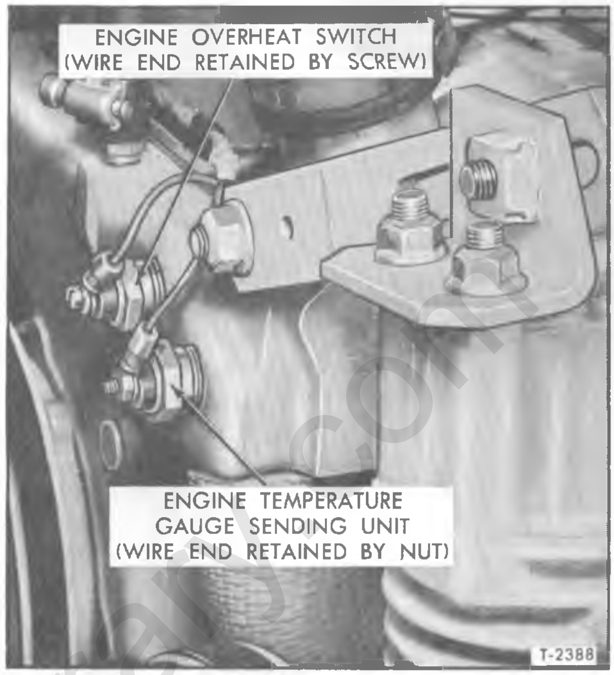


Figure 3—Engine Units for Overheat Switch Temperature Gauge—Toro-Flow Diesel Engine (Typical)

Testing Switch Contacts

NOTE: Switch unit must be removed from engine manifold in order to make this test. Before testing unit, be sure that entire unit is pre-heated to approximately normal engine temperature.

Insert unit tube and lower half of body threads in hydraulic oil, heated to a temperature 15° F. to 20°F., higher than unit point contact setting listed in "Specifications." Agitate oil thoroughly (and gently tap unit). If points contact readily, correct working of instrument is indicated.

ENGINE THERMOSTATS

Thermostats are installed in engine water outlet manifold on all gasoline engines. The thermostat on diesel engines is installed in top of the engine front cover at the outlet to the radiator.

Thermostats consist of a restriction valve controlled by a thermostatic element. Restriction valve cracks or just starts to open at predetermined temperature and continues to open as engine coolant temperature increases. Refer to "Coolant Circulation" earlier in this section for operation of engine thermostats.

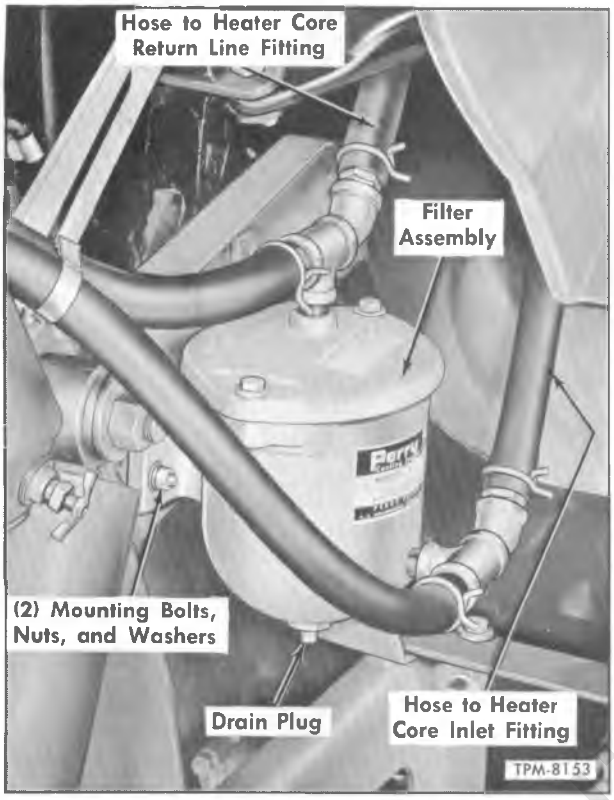


Figure 4—Cooling System Water Filter Installed (Typical)

NOTE: To assure proper cooling and engine warm-up it is very important that the correct thermostat is used. Refer to "Specifications" at end of this section for thermostat application.

THERMOSTAT CHECK

If it is suspected that thermostat is not functioning properly, remove thermostat assembly. If the thermostat appears to be in good condition, the following test should be conducted.

Suspend thermostat and thermometer in water with thermometer located close to thermostat. Thermostat must be completely submerged and water thoroughly agitated while heating. Apply heat to the water and record both the temperature at which the thermostat begins to open and the temperature at which the thermostat is fully open.

Compare temperature readings taken in the test with those given under "Thermostats" in "Specifications" at end of this section.

Do not attempt to repair thermostat. If thermostat does not function properly, replace with new unit which has been checked as directed previously.

Use new gasket when installing thermostat. Fill cooling system then run engine until normal operating temperature is reached. Check for coolant leakage at thermostat cover gasket.

WATER FILTER

Water filter (fig. 4) as installed on some vehicles is used to filter and condition water in cooling system On a new engine, the filter element should be initially changed after 2,500 to 3,000 miles. After initial change, the filter should be serviced periodically 7,500 to 10,000 miles or 300 to 500 hours depending upon engine workload, conditions, etc.

Except when anti-freeze is used, color of water in system should be a golden yellow. No rust preventive or inhibitor should be used in system when water filter is used.

IMPORTANT: Some permanent-type anti-freeze solutions may contain inhibitor which will produce a green residue or precipitation. If this is noted more frequent element change periods will be necessary and if this fails to correct condition, the filter element should be removed, or disconnected.

ELEMENT REPLACEMENT

NOTE: Key numbers in text refer to figure 5.

1. For convenience in changing element, close off filter supply and return hose by clamping vise-grip pliers to each hose if if equipped with shut-off cocks, close cocks. Otherwise drain system.
2. Remove two bolts (1) which attach cover (2) to filter. Remove cover and cover gasket (3).
3. Remove drain plug (9) from bottom of filter.
4. Remove upper plate (4), element (5), lower plate (6), and spring (7) from filter body (8). Flush out filter body.
5. Discard filter element and cover gasket, then clean all parts. Examine element lower plate for excessive corrosion.

NOTE: Deep pits in plate do not warrant replacement. Clean plate by wire brushing. This plate generates current for the electro-chemical action of the filter element. If excessively corroded, replace.

6. Referring to illustration, position spring (7), lower plate (6), new element (5), and upper plate (4) in filter body. Install cover (2) using new gasket (3). Tighten cover attaching bolts evenly and firmly.
7. Remove vise grips from filter hoses. Start and operate engine until water in cooling system is warm. Check for air lock in filter. If cover of filter becomes warm, no air-lock condition exists in system. If cover remains cool, vent system same as for a hot water heater system.
8. Refill system to proper level.
9. Make sure that filter body is grounded back to cylinder block, otherwise electro-chemical action of filter element will be affected.

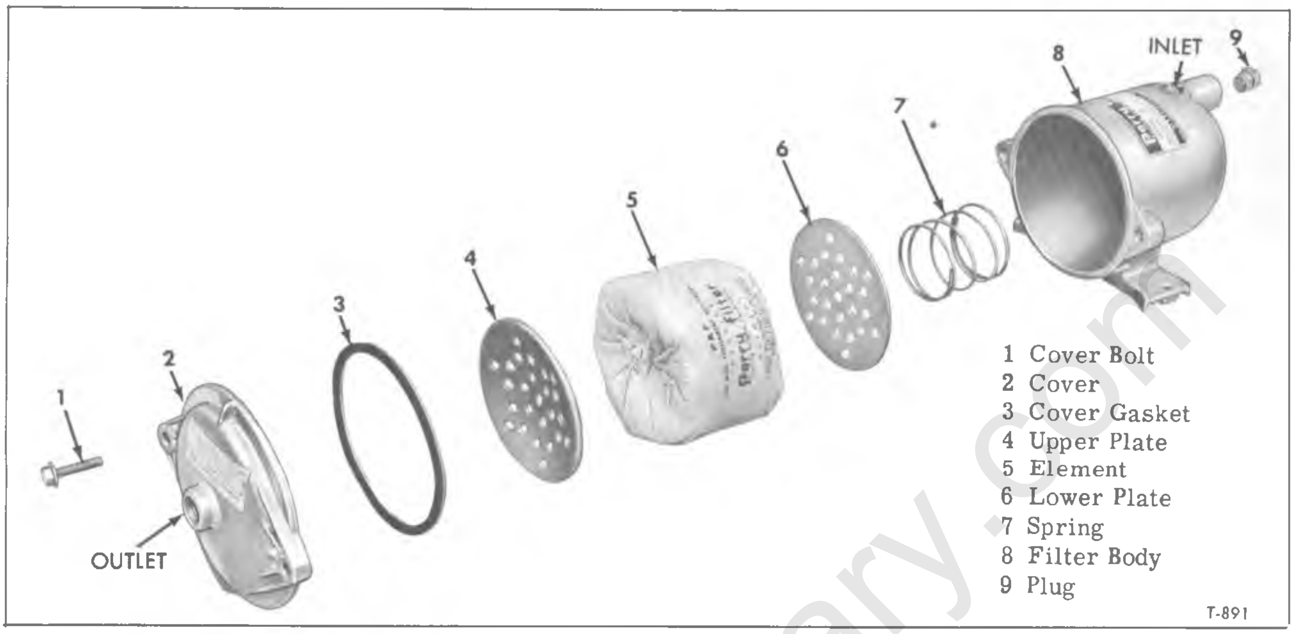


Figure 5—Water Filter Assembly (Typical)

ENGINE OIL COOLER

Models with an oil cooler use type of oil cooling system shown in figure 6. Oil is filtered, circulated through oil cooler, and returned to engine.

If engine difficulties are encountered and there is suspicion that foreign matter has entered the oil cooler, the oil cooler and connecting lines must be flushed before engine is put back into operation.

Oil cooler, located at bottom of radiator core, should be flushed in the following manner:

1. Disconnect oil cooler lines at oil filter.
2. Back-flush oil cooler and lines using clean solvent and compressed air. DO NOT EXCEED 100 PSI AIR PRESSURE.
3. Remove all remaining cleaning solvent from the system with compressed air.
4. Flush system again with the same type of oil normally circulated through the cooler.
5. Test flow of oil through cooler. If flow is not restricted, reconnect oil cooler lines. If flow is restricted, have oil cooler element replaced by a radiator specialist.

FAN AND DRIVE BELTS

FAN BLADE

Fan blade assembly is bolted directly to water pump pulley on all models except tilt cab models. Fan blade on tilt cab models is bolted to engine crankshaft pulley hub.

DRIVE BELT TENSION ADJUSTMENT

Drive belts must be kept at proper tension. A loose or broken drive belt will affect operation of driven accessory. A drive belt that is too tight will place excessive stress on bearings within accessory.

Belt tension adjustments should be made with an accurate belt tension dial gauge.

Fan and generator drive belts for all models are adjusted to 120 to 130 pounds tension for new belts and 80 to 90 pounds tension for used belts. New belts are adjusted to a higher tension to allow for stretch in the belt. As stretch occurs, tension should decrease to 80 to 90 pounds.

NOTE: On a new vehicle or after having installed new belts, check tension of belts twice in first 200 miles of operation.

When making adjustment, examine belts. Replace if frayed or worn.

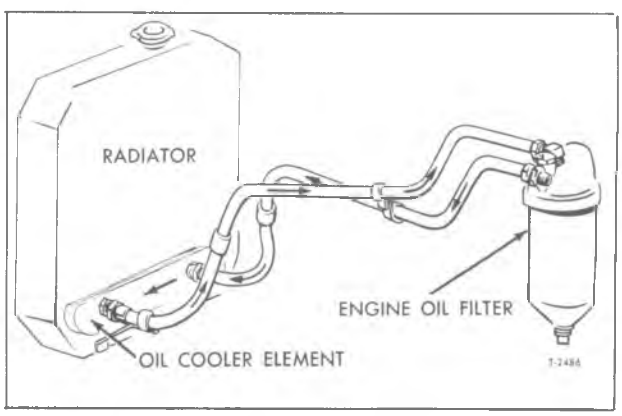


Figure 6—Oil Cooler Circuit

ENGINE COOLING SYSTEM

DRIVE BELT REPLACEMENT

On some vehicles, several accessories may be driven from multiple groove crankshaft pulley, and the replacement of any one inside drive belt will make it necessary to remove all the outside belts first.

NOTE: Instructions for replacing power steering drive belt are given in "POWER STEERING" (SEC. 9B) of this manual. Refer to AIR COMPRESSOR AND GOVERNOR (SEC. 6T) for adjustment and replacement instructions for air compressor drive belts.

IMPORTANT: When replacing dual or triple drive belts, it is essential that entire set be replaced at same time. Belts are available in matched sets only.

SPECIFICATIONS

The cooling system capacities listed in "Anti-Freeze Chart" and Model Capacity Chart" below apply to vehicles with standard equipment only. Because of some optional equipment which may be used, such as engine oil cooler, air conditioning, larger engine, water filter, increased cooling, etc., the capacity of cooling system will vary. For the purpose of obtaining an accurate cooling system capacity before adding anti-freeze to an optional equipped vehicle, it is recommended that the cooling system be first replenished until visible in filler opening and then drained into a graduated container of which the contents can be measured.

Refer to "Anti-Freeze Solutions" under "Cold Weather Operation" in this section.

QUARTS OF PERMANENT (ETHYLENE GLYCOL) ANTI-FREEZE REQUIRED AT INDICATED TEMPERATURE

TEMPERATURE (°F.) CAPACITY (QTS.)	+10	0	−10	−20	−30
43.5	11.0	14.5	16.5	19.0	20.5
36.0	9.0	12.0	14.0	15.5	17.0
35.0	9.0	11.5	13.5	15.5	16.5
34.0	8.5	11.5	13.0	15.0	16.0
31.5	8.0	10.5	12.0	14.0	15.0
29.0	7.5	10.0	11.0	12.5	14.0
16.0	4.0	5.5	6.5	7.0	7.5
15.0	4.0	5.0	6.0	6.5	7.5
13.0	3.5	4.5	5.0	6.0	6.5

COOLING SYSTEM CAPACITIES (QTS) INCLUDING HEATER

TRUCK SERIES	QTS.
LV, LA4000	43.5
DLV, DLA4000; SM5500	35.0
EM4500	31.5
ES4500; ES5500	16.0
PS4500	13.0
EG, SG5500; EG6500	29.0
SS5500	15.0
EM5500; EM6500	36.0
SM6500	34.0

ENGINE THERMOSTATS

ENGINE	NUMBER USED	MEAN TEMP. (°F.)	STARTS TO OPEN (°F.)	FULLY OPEN (°F.)
V-6 Engines	1*	180	177-183	202
In-Line Engines	1	195	192-198	217

*Two thermostats used on 305C engine with air brakes, and all 351C and 351M engines.

ENGINE OVERHEAT SWITCH

SWITCH CONTACTS CLOSE AT:

Gasoline Engines .... 225°F.

Diesel Engines .... 215°F.

SECTION 6M

Engine Fuel System

Contents of this section are listed in Index below:

6M

Gasoline Engines

ACCELERATOR AND THROTTLE LINKAGE ADJUSTMENT

Adjustment of accelerator linkage is accomplished by adjusting length and travel of the accelerator rods. The carburetor throttle plate should be in fully-open (full throttle) position when pedal is held completely down in contact with floor mat or pedal stop.

IMPORTANT: Accelerator pedal should contact floor or pedal stop at same time throttle shaft lever contacts the lever stop. DO NOT FORCE THROTTLE LEVER BEYOND LIMITS OF NORMAL TRAVEL.

When accelerator linkage is properly adjusted, the carburetor throttle plate will completely close carburetor throat passage when linkage is in idle position and the carburetor idle speed screw is turned out beyond point of contacting throttle stop.

Linkage adjustment procedure for specified engines or models are as follows:

MODEL PS4500

(Refer to Figure 1)

1. Disconnect pull-back spring from throttle lever.
2. Disconnect relay rod at bell crank.
3. Block accelerator pedal down against pedal stop.
4. Hold carburetor throttle lever in full throttle position, then adjust length of swivel until relay rod fits freely into bell crank. Lock swivel in place with clip.
5. Release accelerator pedal and connect pull-back spring to throttle lever.

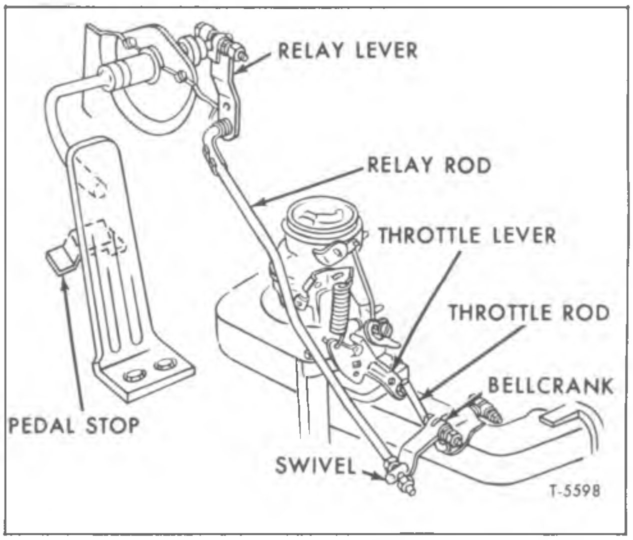


Figure 1—Accelerator Linkage (PS4500)

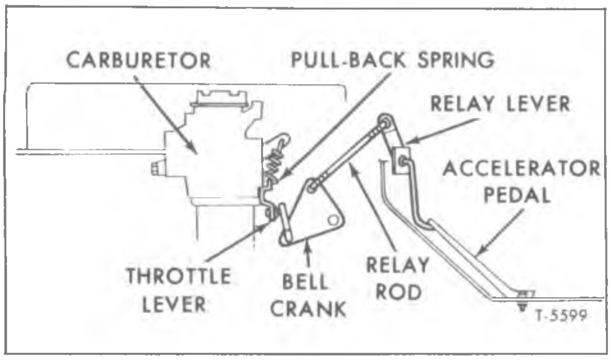


Figure 2—Accelerator Linkage ("E" and "S" Models with In-Line Engine)

"E" AND "S" MODELS WITH IN-LINE ENGINE

(Refer to Figure 2)

1. Disconnect pull-back spring from throttle lever, then disconnect relay rod from relay lever.
2. Block accelerator pedal down against floor mat or pedal stop, hold bell crank in full throttle position and adjust swivel until relay rod fits freely into relay lever.
3. Release accelerator pedal and connect pull-back spring to throttle lever.

CONVENTIONAL CAB MODELS WITH V6 ENGINE

(Refer to Figure 3)

1. Disconnect pull-back spring from carburetor.
2. Loosen jam nut on relay rod and disconnect relay rod from throttle lever.

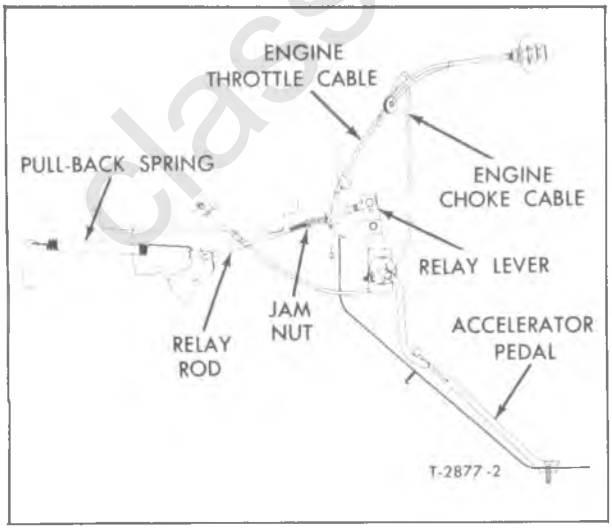


Figure 3—Accelerator Linkage (Models Equipped with V6 Engines)

3. Block accelerator pedal down firmly against floor mat; then hold carburetor throttle lever in full throttle position and turn relay rod until end of rod fits freely into relay lever. Tighten jam nut on relay rod firmly.
4. Release accelerator pedal and connect pull-back spring to carburetor.

TILT CAB MODELS

(Refer to Figure 4)

1. Tilt cab forward and disconnect accelerator linkage pull-back spring.
2. Return cab to normal operating position. Place a .54" spacer between accelerator pedal and floor mat.
3. When accelerator linkage is adjusted properly, the accelerator pedal will just contact the spacer when pedal is held down tightly by hand.
4. If pedal does not contact spacer, it will be necessary to shorten telescopic linkage at relay lever. If pedal can be held closer to floor when spacer is removed, it will be necessary to lengthen telescopic linkage at relay lever.
5. To adjust linkage at relay lever, tilt cab forward and remove trunnion on telescopic rod at relay lever. Loosen trunnion jam nuts, adjust trunnion; then tighten jam nuts and install trunnion on relay lever.
6. Connect the accelerator linkage pull-back spring, then lock cab down in normal operating position. Remove spacer from under accelerator pedal and check operation of accelerator linkage.

MANUAL CHOKE CONTROL

Adjust manual choke control so choke valve is fully open (vertical) when choke control knob is pushed in. Choke setting can be changed as follows:

1. Loosen choke wire screw at carburetor.
2. Position choke control knob 1/8-inch from instrument panel, then move choke lever to fully open position and tighten screw which secures choke wire to lever on carburetor.
3. Check operation of choke to make sure choke valve closes completely as knob is pulled out. Reposition choke housing in clamp if there is interference before choke valve is completely closed.

NOTE: Adjustment of fast idle mechanism is covered in this section.

HAND THROTTLE ADJUSTMENT

1. Check accelerator linkage for free movement and to be sure pull-back spring returns accelerator linkage to idle position.
2. Check to see that hand throttle wire housing is clamped securely at bracket.

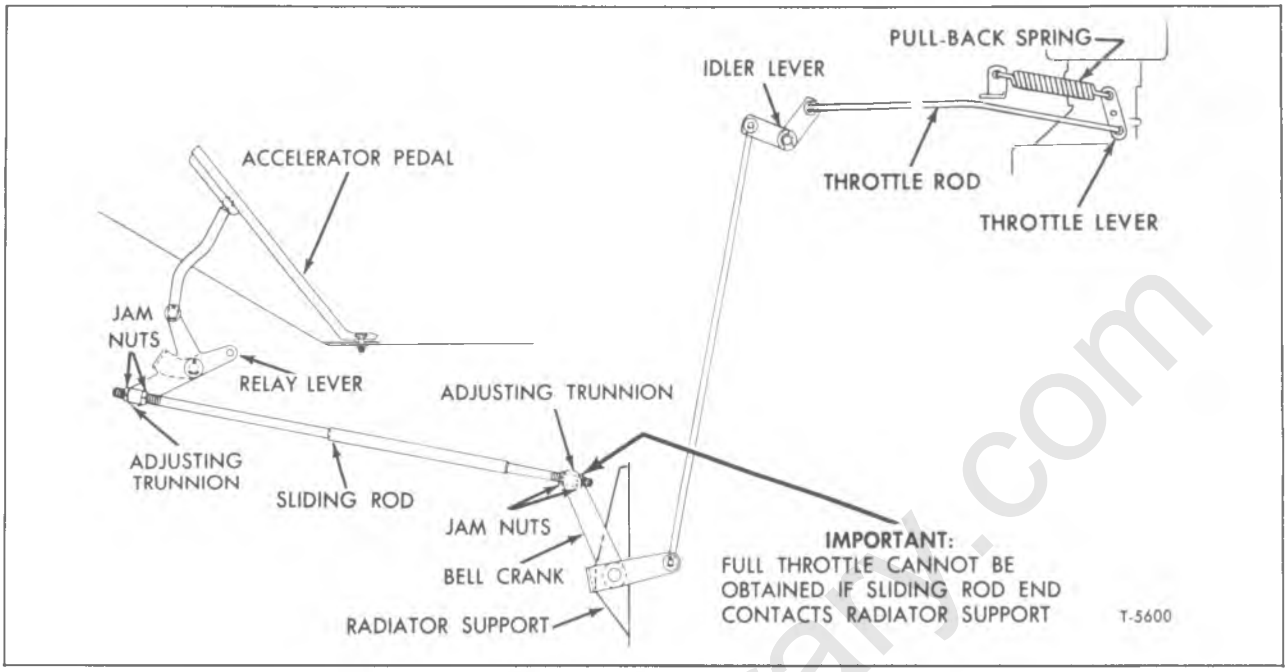


Figure 4—Accelerator Linkage (Tilt Cab Models)

3. Push hand throttle completely in, then loosen trunnion screw and move wire trunnion to make light contact with hand throttle lever. Tighten trunnion screw, then check operation of hand throttle. If properly adjusted, initial movement of hand throttle control handle will cause increase in engine speed; and when handle is pushed in, engine will return to idle speed.

AIR CLEANERS

Air cleaners used on models covered by this manual are equipped with one of the following types of air cleaner elements:

1. Oil Bath
2. Oil Wetted Paper
3. Dry Type - Paper

Air cleaners must be serviced at regular intervals as specified in LUBRICATION (SEC. 0) in this manual, or more frequently for extensive operations in dusty areas.

All clamps and connections between air cleaner and carburetor must be kept tight at all times to prevent unfiltered air from entering the carburetor.

If air cleaner is allowed to become clogged with dirt or sludge, the flow of air to carburetor will become restricted causing increased fuel consumption, loss of power, and possible damage to engine. Air cleaner on vehicles operating in dust storm areas should be cleaned immediately after such storms occur.

A heat stove (fig. 5) is used on all models equipped with In-line engine. The heat stove is mounted at the exhaust manifold and allows preheated air (heated by the manifold) to be drawn through the heat stove to the air cleaner where it is mixed with cold air drawn into the air cleaner opening. This warm air mixture is then drawn into the engine.

FUEL FILTERS

On In-line engines, a pleated paper-type filter is used at carburetor as illustrated in figure 6. The filter element should be replaced after first 500 miles of service and at periodic intervals thereafter, depending on cleanliness of fuel.

On V-6 engines, a disposable line-type filter is used. This filter is located between the fuel pump and carburetor and should be replaced at 12,000 mile intervals.

An optional frame-mounted fuel filter may be used on models covered by this manual. This filter uses a disposable paper-element which should be replaced at 12,000 mile intervals.

FUEL SYSTEM—GASOLINE ENGINES

FUEL PUMP

Fuel pumps (fig. 7) used on vehicles covered by this manual cannot be overhauled. In the event of failure the entire pump must be replaced.

Pumps are diaphragm type, operated from an eccentric on the engine camshaft. The diaphragm is made from a single layer of fabric treated to make it impervious to gasoline and engine oil.

FUEL PUMP OPERATION

In operation, the diaphragm is pulled against pressure of spring as rocker arm is moved by engine camshaft. The partial vacuum caused in pump chamber draws fuel from tank into pump chamber through inlet valve. As camshaft rotates, pressure on rocker arm is relieved and diaphragm spring acts on diaphragm which in turn forces fuel out of pump chamber through outlet valve and through fuel line to carburetor. Each revolution of camshaft repeats this cycle, drawing fuel from tank and discharging it through line to carburetor.

When float rises in carburetor bowl and closes valve so no more fuel can enter carburetor, fuel cannot escape from fuel chamber in pump and diaphragm spring is held in compressed position. Rocker arm then idles on camshaft eccentric and diaphragm moves only a few thousandths of an inch to replace fuel which enters carburetor between pump strokes. Thus a constant pressure proportional to force of diaphragm spring is maintained on fuel in line to carburetor.

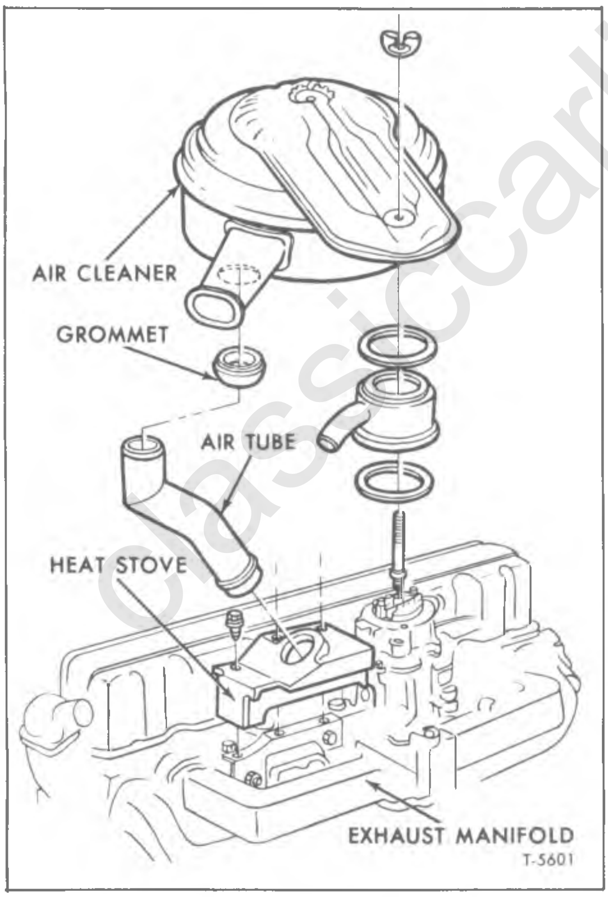


Figure 5—Heat Stove (Used on Models Equipped with In-Line Engines)

TESTING FUEL PUMP

Always check fuel pump while it is mounted on the engine and be sure there is gasoline in the tank.

The line from tank to pump is the suction side of system. The line from pump to carburetor is the pressure side of system. A leak on the pressure side of the system would be visible because of dripping fuel. A leak on the suction side would not be apparent except for its effect of reducing the volume of fuel on the pressure side.

Tighten any loose line connections and look for bends or kinks in lines which could reduce flow of fuel.

PRESSURE TESTING

To make the pressure test, disconnect fuel line at the carburetor inlet and attach a pressure gauge between the carburetor inlet and the disconnected fuel line. Take the pressure reading with

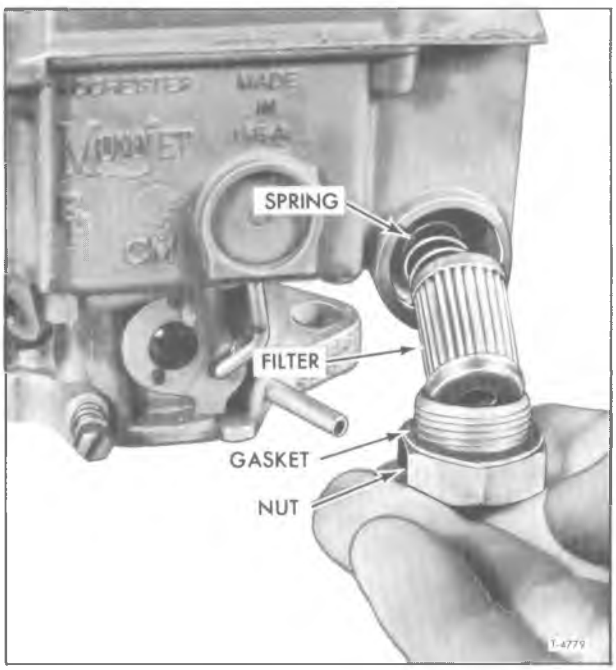


Figure 6—Pleated Paper-Type Fuel Filter

the engine running. The pressure should be within the limits given in "Specifications" for the particular engine. The pressure should remain constant and return to zero when the engine is stopped.

CAPACITY TEST

To make the capacity test, connect a hose to the disconnected fuel line at the carburetor inlet. Place the hose in a pint measure held at carburetor level. Run the engine at 1200 rpm's and note the time it takes to fill the pint measure. Refer to "Specifications" for time required for type engine used.

FUEL PUMP REPLACEMENT

REMOVAL

NOTE: On trucks equipped with a shut-off valve in fuel line, close valve before removing fuel pump. Remove any accessories and piping which would interfere with fuel pump removal.

1. Disconnect fuel lines at fuel pump.

NOTE: If tank line continues to siphon, remove filler cap from fuel tank, then apply air pressure into line to force fuel back into tank. Make sure filler cap is reinstalled.

2. Remove pump mounting bolts, then move pump away from engine and remove gasket.

INSTALLATION

Before installing fuel pump, be sure mounting pad on engine is clean and that any gasket cement or portions of old gaskets have been removed.

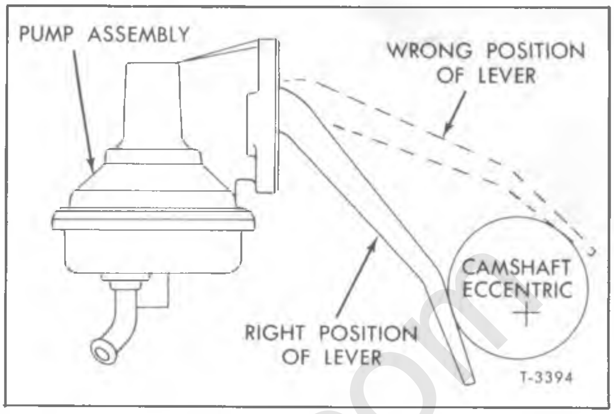


Figure 7—Positioning Fuel Pump for Installation (Typical)

NOTE: To facilitate installation, crank engine so eccentric on camshaft applies least tension on pump arm.

1. Place new fuel pump gasket at mounting pad on engine, then set pump in place and install mounting bolts.

IMPORTANT: When installing fuel pump, be sure pump lever is positioned as shown in figure 7. On vehicles equipped with the V-6 engine, pump arm must be on bottom of camshaft eccentric otherwise pump arm will be broken when engine is started.

2. Connect fuel lines to pump, then open fuel shut-off valve (if used).

3. Install all accessories or piping removed to gain access for removing fuel pump.

4. Start engine and check line connections for evidence of leakage. Check pump for static pressure as explained previously.

GOVERNORS

VELOCITY TYPE GOVERNOR

Velocity type governors are of two types and designated as single-throat type and dual-throat type (fig. 8). Single-throat type governor, having a single throttle valve is used on In-line engines, and the dual-throat type governor having two throttle valves is used on V-6 engines.

Governor is mounted between carburetor and intake manifold and operates on combination of vacuum and the velocity pressure of in-going gases. Speed adjustment is by means of sealed adjusting screw.

Governor is adjusted for correct maximum engine speed and sealed at the factory.

Refer to "Governor Specifications" located at rear of this section before servicing governor.

GOVERNOR OPERATION

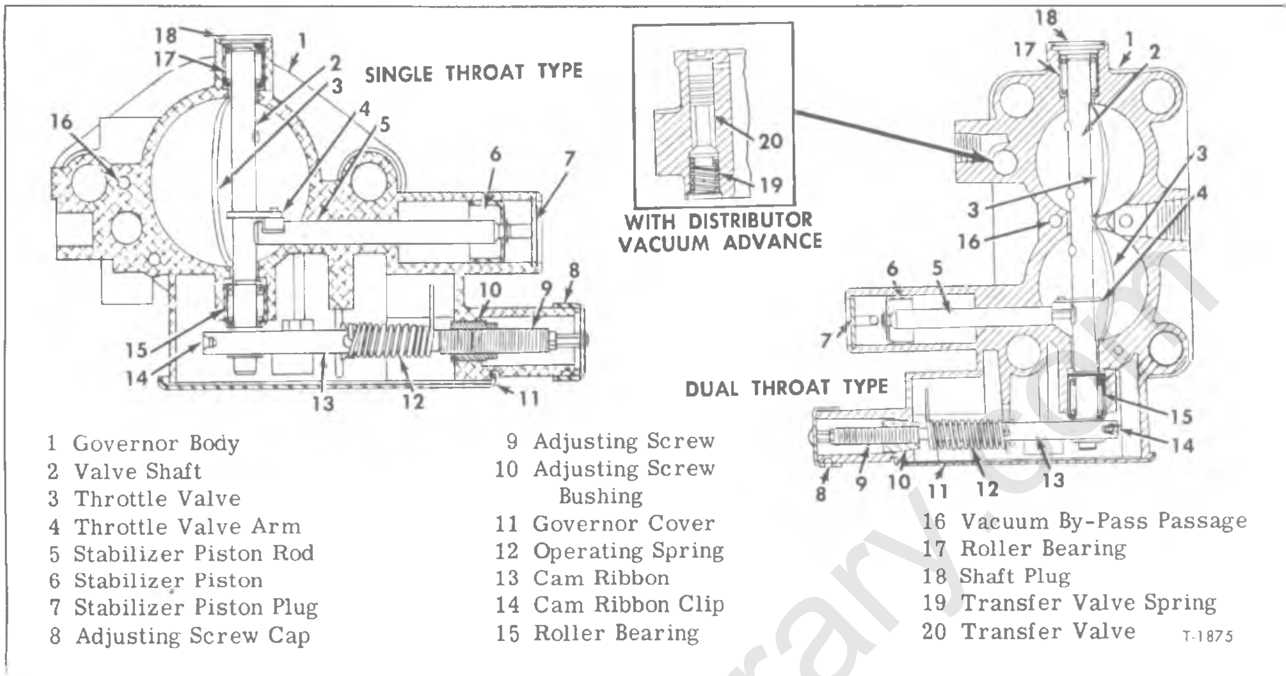
Three force systems, set up within governor, control its operation. These are shown graphically in figure 9 and are explained as follows:

Closing Force (Fig. 9)

A strong velocity pressure of air-fuel mixture against approximately 75% of the area of governor throttle valve tends to push plate into closed position. This action occurs by having the throttle shaft off-center as shown in figure 9.

Opening Force (Fig. 9)

To maintain constant control after top engine speed is reached, it is necessary to have an ever-increasing "opening force" opposing the "closing force." This is accomplished, as shown in figure 9, by the anchored coil spring, connecting ribbon and cam attached to throttle shaft. The ever-increasing spring tension plus the progressively



1 Governor Body
2 Valve Shaft
3 Throttle Valve
4 Throttle Valve Arm
5 Stabilizer Piston Rod
6 Stabilizer Piston
7 Stabilizer Piston Plug
8 Adjusting Screw Cap
9 Adjusting Screw
10 Adjusting Screw Bushing
11 Governor Cover
12 Operating Spring
13 Cam Ribbon
14 Cam Ribbon Clip
15 Roller Bearing
16 Vacuum By-Pass Passage
17 Roller Bearing
18 Shaft Plug
19 Transfer Valve Spring
20 Transfer Valve

Figure 8—Velocity Type Governor

increasing radius of the cam builds up an "opening force" to oppose and balance the "closing force" on the throttle valve. Actually, under operating conditions, throttle valve does not close but assumes a position between point "A" and "B" to give proper amount of air-fuel mixture to limit speed of engine to governor setting.

Stabilizing Force (Fig. 9)

A sudden manipulation of the throttle will often result in the opening of governor throttle valve and permit engine to exceed governed speed. To counteract this condition, a stabilizing force is set up as shown in figure 9.

Stabilizing piston is open on inside to vacuum above governor throttle valve, and is open on outside to atmospheric pressure through a felt air filter. Piston linked to throttle valve acts to close valve when a vacuum draws piston toward governor throat, thus offsetting any tendency of the increased vacuum, due to carburetor throttle valve manipulation, to open the governor valve. This action controls smoothness of governor action.

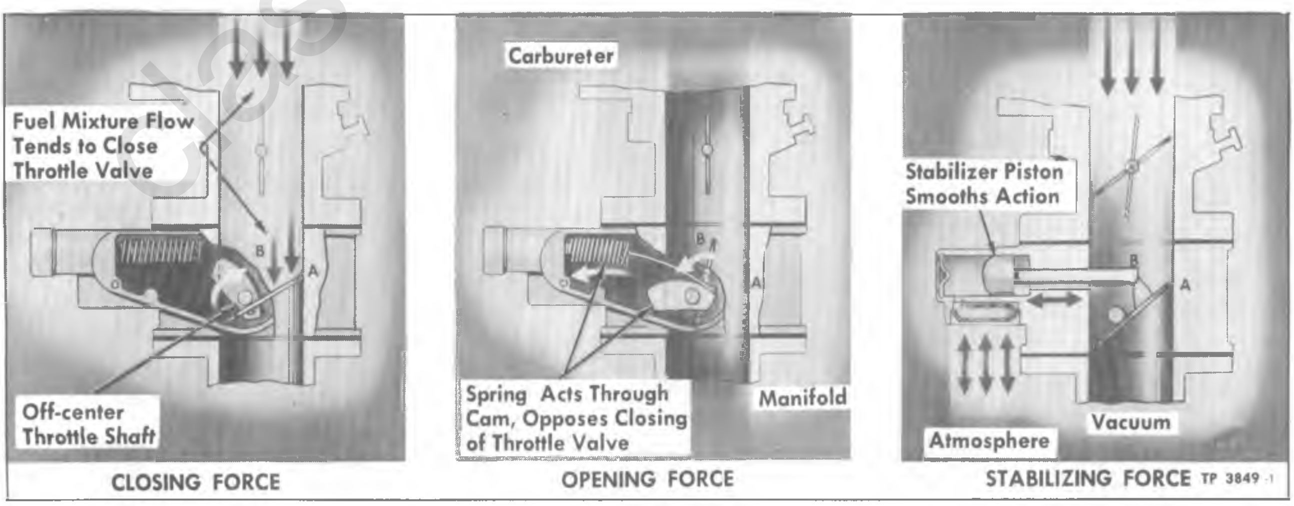


Figure 9—Major Controlling Forces of Governor Operation

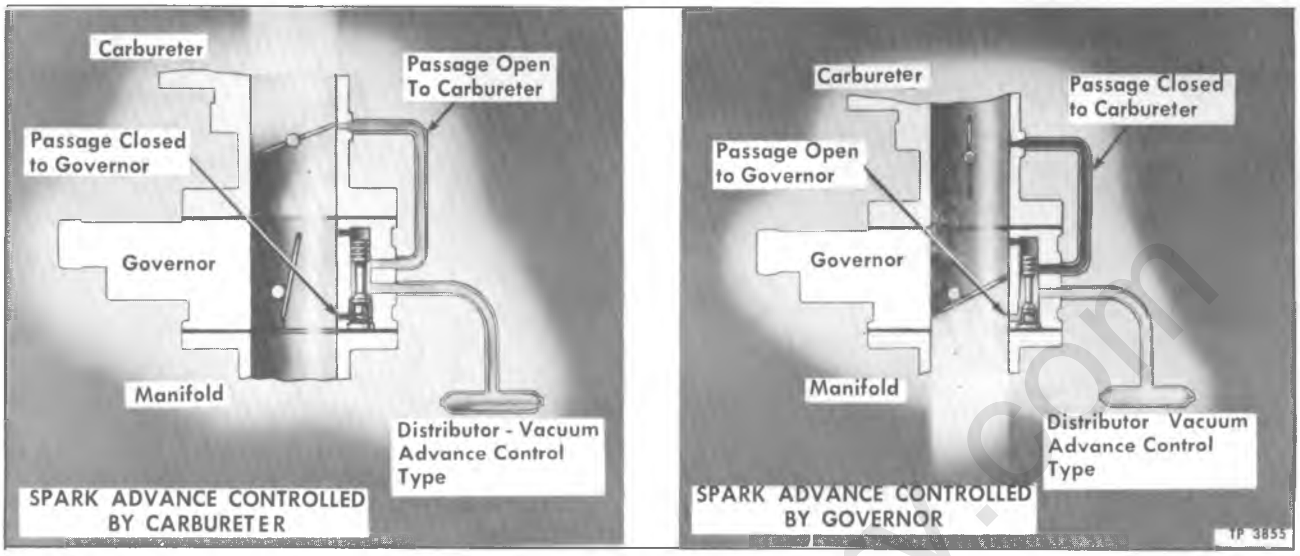


Figure 10—Vacuum Valve Operation (Typical)

Automatic Spark Control

An automatic spark transfer valve is incorporated in all velocity type governors.

Vacuum valve (20) and valve spring (19) shown on insert of figure 8 assist in regulating the ignition timing and do not in any way control the governed speed of engine.

When vacuum transfer valve is used, the function is as follows:

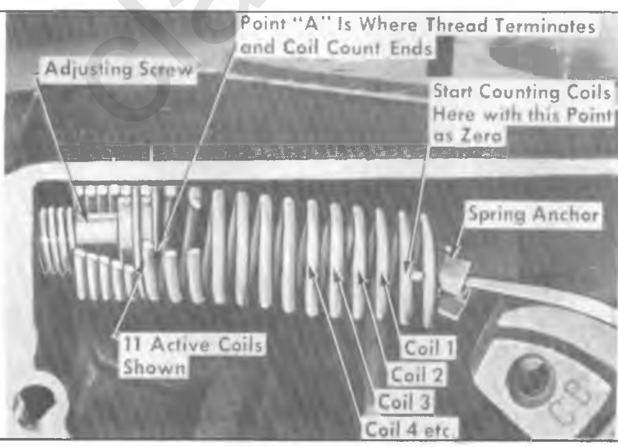
As long as the carburetor throttle valve controls the engine speed, the orifice in the carburetor throat opening controls the spark advance and the engine functions the same as if it were not governor equipped. This is illustrated in left-hand view in figure 10. When the governor controls engine speed, spark control is obtained as shown in right-hand view in figure 10. Here the vacuum produced below the governor throttle valve pulls the vacuum transfer valve downward, providing an opening from below the governor throttle valve to the spark control diaphragm. At same time, the upper part of valve closes off the opening from the carburetor orifice.

When governor is equipped with this transfer valve, the automatic spark advance continues to function in a proper manner, controlling distributor advance in relation to throttle opening.

GOVERNOR MAINTENANCE

Governor requires no lubrication, adjustment or other servicing, except when engine performance indicates trouble in governor. Before attempting a diagnosis of governor difficulties, be sure engine is properly tuned and that all fuel system units are functioning properly.

The checks discussed following can be made to determine if governor requires servicing.



Active coils of spring begin at point "zero" (spring anchor) and end at point "A" (where spring enters adjusting screw pilot threads).
To obtain any number of full active coils point "A" must be parallel with point "zero" as shown.
Each turn of adjusting screw adds or subtracts one coil.
To obtain fractional coils turn adjusting screw as required. Each complete turn counter-clockwise, looking at adjusting screw end of governor, adds one coil. Each complete turn clockwise subtracts one coil. For example: To set $10\frac{1}{4}$ coils turn adjusting screw until 10 active coils are included between "zero" point and point "A", to add $\frac{1}{4}$ coil turn adjusting screw counter-clockwise $\frac{1}{4}$ turn.

Figure 11—Operating Spring Installation and Calibration (Typical)

FUEL SYSTEM—GASOLINE ENGINES

Figure 12—Operating Spring Coils

Figure 13—Calibrating Governor

Figure 14—Spreading Filter Cover

CHECKING GOVERNOR OPERATION

With engine idling, open throttle quickly and observe engine response. If engine is slow or sluggish, basic setting of operating spring may be wrong or governor may be dirty. If engine reaches top speed quickly, then surges erratically between high and low speed, improper spring setting or faulty stabilizer action may be the cause. In either case, cleaning and adjusting of governor is necessary.

When erratic governor action occurs, clean air filter felt. Replace filter felt if necessary.

GOVERNOR ADJUSTMENTS

NOTE: Make sure engine is at normal operating temperature and tuned properly. Illustrations are of the single throat-type governor, but they are also applicable to the dual throat-type governors.

Governor Calibration

To obtain proper calibration, governor should be adjusted in following manner:

1. Remove governor as directed under "Governor Removal."

2. Remove cover from governor and rotate throttle valve to separate coils of spring (fig. 11); then count active coils of operating spring in manner shown in figure 12. Active coils begin at cam ribbon anchor and end at beginning of adjusting screw pilot thread (fig. 11).

3. Remove governor seal and seal cap. Using 1/8" socket head setscrew wrench turn adjusting screw until number of coils remaining in spring are as shown in "Specifications" at end of this section for this particular governor.

4. Install governor cover with slotted screw and drive screw. Use an oversize drive screw if necessary to hold cover securely. Refer to "Governor Installation," and install governor.

5. After engine has reached normal operating temperature and tuned perfectly, install a tachometer to determine actual engine rpm.

6. Assemble hollow wrench (King-Seeley No. 27941) to adjusting screw bushing, and socket head setscrew wrench in adjusting screw (fig. 13). Accelerate engine and run at wide-open throttle.

7. Taking care not to change number of active coils, hold socket head setscrew wrench in one hand, and rotate hollow wrench to change tension on spring assembly with the other hand.

8. Turning hollow wrench to right will increase governor speed. Turning it left will decrease this speed. Turn hollow wrench to produce a speed 25 to 50 rpm above speed shown in "Specifications," with throttle still wide open.

9. Remove socket head setscrew wrench and tap lightly on hollow wrench until specified speed is obtained. This operation is to seat adjusting screw bushing in governor body. Remove hollow wrench and install adjusting screw cap.

10. Seal governor by passing sealing wire through hole in cover screw, adjusting screw cap, and female half of seal. Twist ends of wire together securely inside female half and insert male half. Also seal carburetor forward mounting bolt in same manner.

Special Adjustment

In certain cases when vehicle goes into service or has been in service for a short period of time, operator may for purposes of policy, or as a result of experience, desire a setting on governor other than that originally established. This may be accomplished exclusively with use of regular governor adjusting screw cap (8, fig. 8) as follows:

1. Remove seal from adjusting screw cap. Check governor setting against tachometer and turn adjusting screw cap clockwise to decrease speed or counterclockwise to increase speed.

2. Under no circumstances should governor be set faster than settings shown in "Specifications."

If "Governor Calibration" results in a surging or sluggish condition, correct as instructed under "Correction For Surge" or "Correction For Slow Opening" following:

Correction For Surge

Adjustment for surge must be made only to point of removing surge. Over-adjustment will result in slow governor opening. Method for removing surge is as follows:

1. Break seal and remove adjusting cap. Insert hollow wrench into adjusting screw housing. Insert 1/8" socket head setscrew wrench into adjusting screw.
2. Turn socket head setscrew wrench clockwise, one-half turn, then holding it firmly, turn hollow wrench clockwise until desired no-load speed is reached. Repeat in one-half turn increments until surge is eliminated.

NOTE: Do not set governor to permit engine rpm to exceed limits listed in "Specifications."

3. Road test vehicle for elimination of surge. When satisfactory adjustment has been made, reseal governor.

Correction For Slow Opening

Correction is made in same manner as correction for surge; except turn socket head setscrew counterclockwise and hollow wrench counterclockwise. Make adjustment for slow governor opening very carefully as over-adjustment will cause surge.

Dirty Governor

When sluggish action gradually causes vehicle speed variations which grow exceedingly worse, a dirty governor is indicated. Only remedy is to remove governor so that faulty unit can be disassembled, cleaned, reassembled, and calibrated as previously directed. If governor is adjusted when dirt is cause of unsatisfactory operations, engine may be overspeeded under some conditions, causing serious damage.

Cleaning Air Filter

Occasional cleaning of governor air filter is necessary. This element is assembled in governor body beneath a perforated cover. Clean as follows:

1. Pry out metal cover carefully with a sharp punch. Do not damage projections in governor body. Lift out filter felt and inner cover. Wash felt in cleaning solvent (gasoline, dry-cleaning solution); then allow to dry.
2. Blow out stabilizer cylinder and piston by directing air in sudden bursts through atmospheric hole in governor air cleaner chamber.
3. Install inner cover; then install felt in governor body. Install outer cover. It may be necessary to bend cover to install; if so, flatten by tapping with hammer (fig. 14).

NOTE: Felt is to be installed dry; do not oil.

GOVERNOR REMOVAL

IMPORTANT: Before removing governor and associated parts, note position of governor spacers, and also note number of gaskets used. This will assure installation of parts in their original position later.

Remove air cleaner; then disconnect lines and controls from carburetor and remove carburetor and governor.

GOVERNOR INSTALLATION

1. Care should be taken to see that governor is not installed upside down. Governor is marked with an arrow indicating carburetor side.
2. A by-pass screw is installed in power jet vacuum passage in some carburetors and under no circumstances should this screw be left out when installing governor.
3. On some vehicles the gasket between carburetor and governor is slotted to allow vacuum to by-pass through governor for operation of power jet piston. Make sure that this gasket is in good condition and installed so that vacuum openings are not obstructed.
4. Road test vehicle to make sure that governor is operating correctly. When this is determined seal governor as directed.

HYDRAULIC TYPE GOVERNOR

The hydraulic type governor system consists of shaded items in figure 15. The hydraulic type governor is used as standard equipment on 351-M engines.

NOTE: Key numbers in text refer to figure 16.

The hydraulic control mechanism is incorporated into the engine oil pump in engine crankcase. The spinner valve is coupled to the engine oil pump drive shaft and turns at same speed as the oil pump (½ engine crankshaft speed). At one end of the valve is a weight and at other end is a spring. The spring holds the valve assembly in closed position until such time as centrifugal force acting on valve weight begins to move the valve toward the open position. Governor valve calibration is present to provide governor action at proper speed. Engine speed control is achieved by permitting pressure from oil pump to be applied at diaphragm (5) in slave unit (fig. 16).

When accelerator pedal is depressed to wide-open position, the tension spring (3) in slave unit causes the throttle plates (10) to move to wide-open position. Diaphragm spring (4) holds diaphragm(5) in its outer position and telescopic link (7) is shortened as lever (8) on throttle shaft (9)

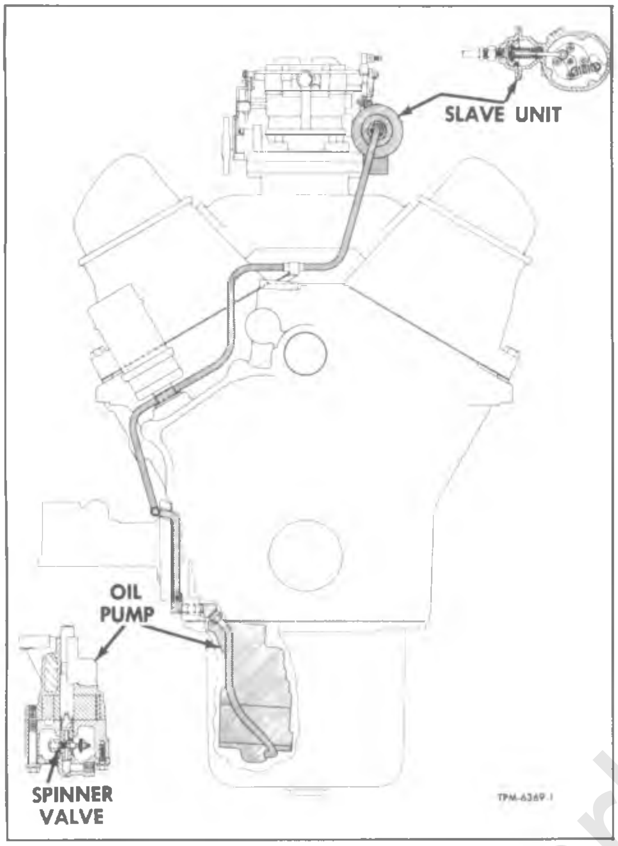
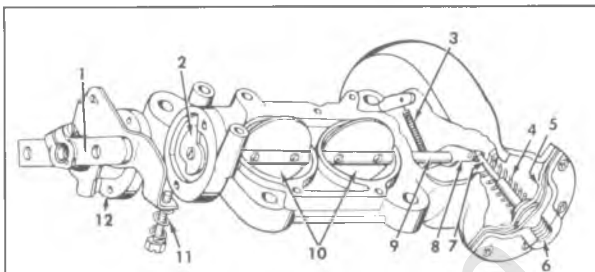


Figure 15—Hydraulic Governor System (Typical)

moves and forces link into engagement with diaphragm assembly. As engine approaches governed speed the spinner valve begins to open and hydraulic pressure is applied to diaphragm (5) in slave unit. As pressure moves diaphragm, force is transmitted through link (7) to the lever (8) on throttle shaft (9) and throttle plates (10) are moved toward closed position, thereby governing the en-



1 Accelerator Lever
2 Throttle Shaft Driver
3 Governor Tension Spring
4 Diaphragm Spring
5 Diaphragm Assembly
6 Hydraulic Line Connection (From Spinner Valve)
7 Telescopic Link
8 Lever
9 Throttle Shaft
10 Throttle Plates
11 Fast Idle Screw
12 Throttle Driver Assembly

Figure 16—Governor and Throttle Operation (Typical)

gine speed.

If engine speed falls below governed speed, the spring at spinner valve (fig. 15) closes valve and cuts off hydraulic pressure to governor line. With valve closed, line pressure is relieved through slot in side of spinner valve. Bleed hole in valve housing provides correct pressure regulation at diaphragm in slave units. Springs (3 and 4) force diaphragm back to outer position and tension spring (3) returns throttle plates to open position.

When accelerator pedal is released, the throttle driver assembly (12) engages throttle shaft driver (2) and moves throttle plates (10) to closed position.

The internal passage, between governor slave unit and air horn, insures clean air in governor housing as breathing occurs during diaphragm action. Vent also prevents any suction build-up due to vacuum transmitted through carburetor bodies.

Engine speed at which governor system begins to close throttle plates is controlled by tension of spinner valve spring.

ROCHESTER CARBURETOR

The Rochester M Carburetor (fig. 17) is used on all vehicles equipped with In-line engines covered by this manual. This is a single-barrel downdraft carburetor with a triple venturi in conjunction with a plain tube nozzle. The fuel flow in the main metering system is controlled by mechanical and vacuum means. A manual choke is used with cable control.

A conventional idle system is used in conjunction with the main metering system. A separate hot idle compensator unit is available with air conditioning, to maintain smooth engine idle during periods of extreme hot engine operation.

IMPORTANT: For description of carburetor operation and internal adjusting procedures refer to Unit Overhaul Manual X-6M-04.

The carburetor has an identification part number stamped on the float bowl as shown in figure 17. Before attempting to repair the carburetor, refer to identification number and secure the correct repair kit.

TROUBLE DIAGNOSIS

NOTE: The following information is included to serve as a guide in servicing carburetor. Many times a carburetor has been overhauled and replaced, yet the adverse condition still existed. Use this information which may assist in isolating the precise problem.

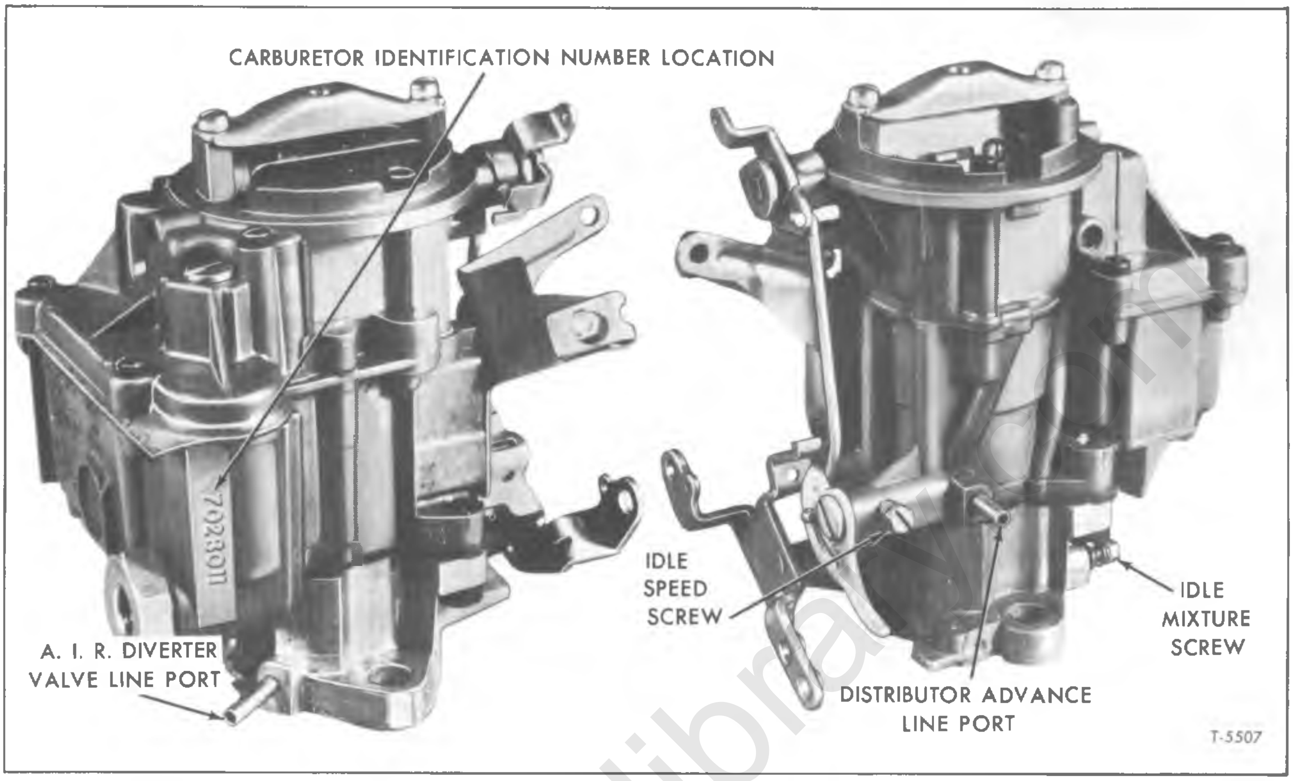


Figure 17—Rochester Carburetor (Model "M")

Before condemning the carburetor as the source of the engine running problem, always FIRST check the following:

1. Ignition System - Are the points, condenser, wires, spark plugs, and distributor operating to specifications.
2. Valve lash and spark plug gap.
3. Engine compression.
4. Crankcase ventilation and Exhaust Emission Control System (if used).
5. Fuel pump flow and pressure.
6. Intake manifold - cracks or gasket leakage.
7. Contaminated fuel.
8. Spark and valve timing.
9. Contaminated fuel filter.
10. Manifold heat control valve.

When the carburetor is isolated to be the source of the problem (above items all checked and are to specifications), select one of the ten complaints (shown in "Troubleshooting Chart" on next page) that best describes the problem, then proceed with the action outlined.

CARBURETOR CHECKS

It is very seldom necessary to replace a complete carburetor. They can generally be repaired at a lower cost than the price of a new assembly. Repair kits are readily available.

Although there may be exceptions, carburetors should not be replaced for the following reasons:

1. Flooding - In practically all cases, flooding is caused by a dirty or sticking float needle and seat. This item is easily repaired and is not a valid reason for replacing a carburetor.

2. Carburetor Spitback - Carburetors are not to be replaced as a cure for "carburetor spitback." This condition, in most cases, is not the fault of the carburetor but results from inoperative positive crankcase ventilation, incorrect valve lash, or incorrect spark plug application and/or gap setting.

Spitback on acceleration may be caused by the accelerator pump inlet ball check valve not properly seating. However, in no case should the carburetor be replaced to cure spitback.

3. Leaking - If leaking is due to a faulty carburetor, such as one with a porous casting, the leak will show up at very early mileage (0 - 5,000 miles). Low mileage leaking due to a porous housing is a valid reason for carburetor replacement or repair, whichever is less costly. However, higher mileage leaking (over 5,000 miles) in most cases is not caused by defective material in the carburetor.

ROCHESTER CARBURETOR TROUBLESHOOTING CHART (MODEL "M")

Locate the complaint by reading across the top of the complaint columns, then find Step 1. If Step 1 does not remedy the complaint, move to Step 2 in that column. Take Steps 3, 4, 5, etc., in order until you have located the trouble.

★ Indicates other possible trouble points.

COMPLAINT: Flooding	Rough Idle	Economy	Hesitation	Acceleration Flatness	Surge	Low Top Speed or Power	Cold Operation	Stalling	Hard Hot Starting	CHECK POINTS	WHAT TO LOOK FOR
	1	★		★			★	1	★	IDLE ADJUSTMENT	Correct speed and mixture
2		3		★	2	3		4	★	FLOAT ADJUSTMENT	Use correct gauge
			1	★			★			PUMP ADJUSTMENT	Use correct dimension, throttle valves closed
	★	★							★	IDLE VENT ADJUSTMENT	Dirt, wear, sticking open; must be closed except at idle
		★					1	★	1	CHOKE ADJUSTMENT	Set to latest specification
							2	★		CHOKE ROD ADJUSTMENT	Use correct gauge, fast idle screw on 2nd step of cam, next to high step
							3		2	UNLOADER ADJUSTMENT (4MV)	Use correct gauge, throttle valves wide open; check to see that throttle linkage allows wide open position on vehicle
							4	★		FAST IDLE ADJUSTMENT	Set with warm engine, use tachometer, set to information specification
							5	★		SECONDARY LOCKOUT ADJ.	Proper clearance so cam is free to move with throttle valves closed
							6	2		THROTTLE RETURN CHECK	Proper clearance with throttle lever, vacuum leaks
		2a		1	3	1	★			POWER PISTON	Dirty, distorted, sticking, incorrect part
		2b		2	4	2	★			METERING ROD	Dirty, sticking, incorrect part
		4		3	1	4	★			METERING JETS	Loose, plugged, incorrect part
1	★	★						3	3	NEEDLE & SEAT	Worn, damaged, dirty, incorrect part
3		★			★			★	★	FLOAT	Bent, leaky
	3							★		IDLE NEEDLES	Worn, damaged
	4		★	★		★	★	★		THROTTLE VALVES	Sticking open or closed, damaged, not aligned properly
4	★	★	★	★	★	★	★	★	★	GASKETS	Improper seal, hard or brittle material, loose screws
	2							★	★	IDLE PASSAGES	Dirty or plugged
	★	★					7		★	CHOKE VACUUM PASSAGE	Plugged or vacuum leaks
			2				★			PUMP PLUNGER	Hard or worn seal, distorted spring, stuck vent ball check
			3				★			PUMP INLET CHECK BALL	Out-of-round, damaged seat, stuck
	★		★				★	★	★	PUMP DISCHARGE CHECK	Out-of-round, damaged seat, stuck, distorted spring
		★		★			8	★	★	CHOKE VALVE	Dirty, damaged, sticking
		1					9		4	DRIVER	Driving habits, correct procedures
	1								1	HOT IDLE COMPENSATOR	Dirty, damaged, sticking

NOTE: Fuel seepage at the bowl to air horn mating surface is normal. This usually shows up as a discolored carburetor and is caused by wicking of the gasket in the area. Correction involves a periodic tightening of the bowl to air horn assembly screws.

4. Lack of Power - Lack of engine power that is isolated to the carburetor can usually be corrected by proper carburetor calibration and adjustment. Carburetors should be repaired rather than replaced when a lack of power complaint is encountered.

ROCHESTER CARBURETOR ADJUSTMENTS

Correct adjustment of idle speed, ignition timing, and fuel mixture are extremely important to ensure proper operation of the system and for maximum engine performance. A tachometer is necessary for making the settings as a specific engine rpm is necessary to obtain correct adjustments.

Refer to "Engine Tune-Up Specifications" in GASOLINE ENGINES (SEC. 6A) of this manual for complete tune-up specifications.

PRELIMINARY CHECKS

1. Thoroughly warm up the engine. If the engine is cold, allow to run for at least 15 minutes.
2. Be sure the carburetor is properly secured to the intake manifold, which will exclude the possibility of air leaks.
3. Inspect the manifold heat control valve (if used) for freedom of action and correct spring tension.

IDLE AND MIXTURE ADJUSTMENT

Idle and mixture adjustments should be performed with the engine at operating temperature, choke open, and air cleaner installed.

Air conditioning (when used) must be turned on during the carburetor adjustments. Also, when equipped with automatic transmission, apply parking brake and place transmission in "DRIVE" and air conditioning in "ON" while making carburetor idle adjustment.

1. Check the dwell reading.

NOTE: For all engines used on vehicles covered by this publication, the dwell reading should be 31 to 34 degrees.

2. Set ignition timing, as indicated by "Engine Data Chart," page 335.
3. Set the idle speed adjustment screw to the proper engine rpm, as indicated by "Engine Data Chart," page 335.

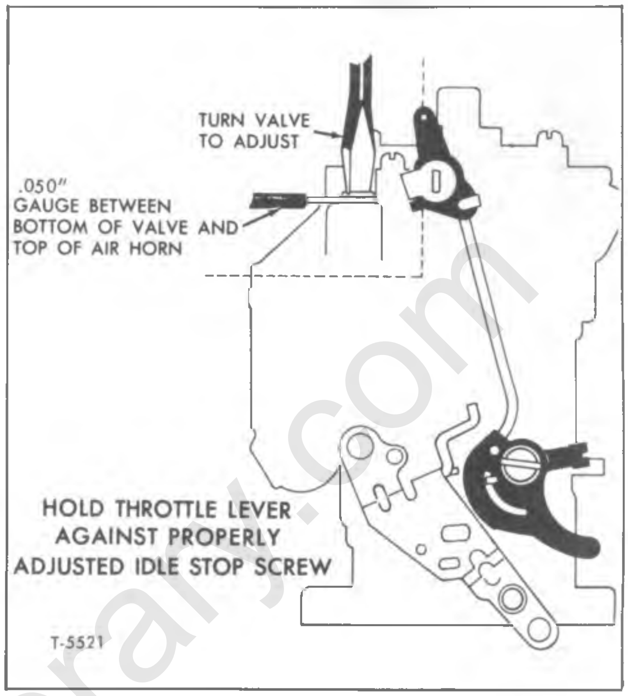


Figure 18—Idle Vent Adjustment

4. Adjust the mixture screw for maximum steady idle speed.
5. Adjust the carburetor mixture screw in to obtain a 20 rpm drop (lean roll).
6. Adjust mixture screw out ¼ turn.
7. Check idle speed and re-adjust to the proper idle rpm, as indicated in "Engine Data Chart," page 335.

IDLE VENT ADJUSTMENT (Fig. 18)

1. Hold throttle lever against idle stop screw.
2. Measure clearance between top of air horn casting and bottom surface of vent valve with plug gauge. Clearance should be 0.050".
3. To adjust, turn slotted vent valve head with screwdriver clockwise (inward) to decrease clearance and counterclockwise (outward) to increase clearance.

FLOAT LEVEL ADJUSTMENT (Figs. 17 and 19)

1. Remove carburetor air cleaner.
2. Disconnect choke wire from connector on choke lever.
3. Remove fast idle cam retaining screw from main body.
4. Remove choke rod from slot in fast idle cam by rotating rod. Remove choke rod from choke lever. Note position of rod in relation to levers for ease in reassembly.
5. Remove six air horn to float bowl attaching screws. There are three long and three short screws.

FUEL SYSTEM—GASOLINE ENGINES

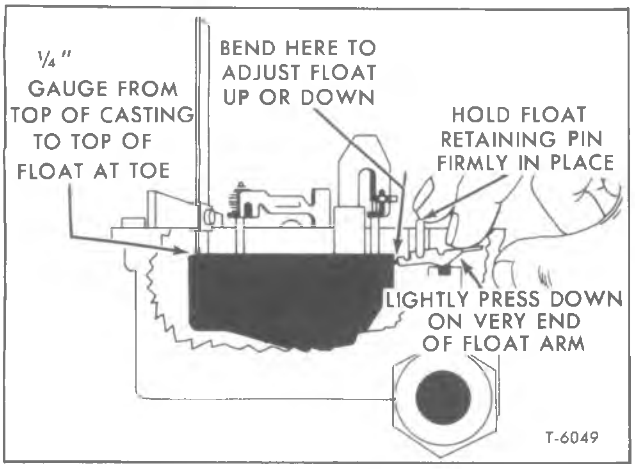


Figure 19—Float Level Adjustment

6. Remove air horn by lifting straight up. Invert air horn and place on a clean bench. Remove air horn to bowl gasket.

7. Hold float bowl retaining pin firmly in place and lightly press down on very end of float arm as shown in figure 19.

8. With adjustable T-scale, measure distance from top of float at toe to float bowl gasket surface (gasket removed). Measurement should be made at point 1/16-inch from end of flat surface at float toe (not on radius). Float level should be ¼-inch.

9. Bend float pontoon up or down to adjust.

10. Install air horn gasket on float bowl by carefully sliding slit portion of gasket over metering rod holder. Then align gasket with dowels provided on top of bowl casting and press firmly in place.

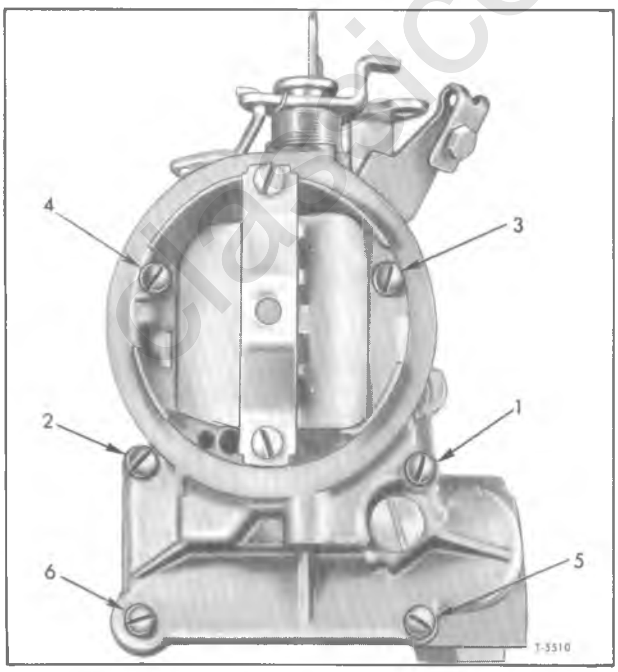


Figure 20—Tightening Sequence (Air Horn)

NOTE: Before installing air horn, check operation of metering rod and accelerator pump to ensure free operation from closed to wide open throttle.

11. Install air horn to float bowl by lowering gently on to float bowl until seated. Install three long and three short air horn to float bowl attaching screws. Tighten screws securely using correct tightening sequence as shown in figure 20.

12. Assemble choke rod to choke shaft lever. End of rod points away from air horn casting when installed properly. (Lower end of rod has 45-degree bend.)

13. Install lower end of choke rod into curved slot in fast idle cam. Part number on cam should face outward.

14. Install fast idle cam to main body and tighten retaining screw securely.

15. Connect manual choke wire to choke lever.

16. Install carburetor air cleaner.

CARBURETOR REPLACEMENT

CARBURETOR REMOVAL

Flooding, stumble on acceleration and other performing complaints are, in many instances, caused by the presence of dirt, water, or other foreign matter in the carburetor. To aid in diagnosing the cause of the complaint, the carburetor should be removed from the engine without draining the fuel from the bowl. The contents of the fuel bowl may then be examined for contamination as the carburetor is disassembled.

1. Remove air cleaner and gasket.
2. Disconnect fuel and vacuum lines from carburetor.
3. Disconnect choke cable.
4. Disconnect accelerator linkage.
5. Remove carburetor attaching nuts and remove carburetor.

TEST BEFORE INSTALLATION

It is good shop practice to fill the carburetor bowl before installing the carburetor. This reduces the strain on the starting motor and battery and reduces the possibility of backfiring while attempting to start the engine. A fuel pump clamped to the bench, a small supply of fuel and the necessary fittings enable the carburetor to be filled and the operation of the float and intake needle and seat to be checked. Operate the throttle several times and check the discharge from the pump jets before installing the carburetor.

CARBURETOR INSTALLATION

1. Be certain throttle body and intake manifold sealing surfaces are clean.

2. Install new carburetor to manifold flange gasket (if required).

3. Install carburetor over manifold studs.

4. Start vacuum and fuel lines at carburetor.
5. Install attaching nuts and tighten securely.
6. Tighten fuel and vacuum lines.
7. Connect and adjust accelerator linkage.
8. Connect choke tube or choke rod.
9. Make carburetor adjustments as outlined previously under "Carburetor Adjustment."

BENDIX-STROMBERG CARBURETORS

Carburetors described in this section are used on vehicles equipped with V-6 engines. The Bendix-Stromberg (WW) carburetor (fig. 21) is used on 305C, 305E, and 351C engines. The Bendix-Stromberg (WWC) carburetor (fig. 22) is used on the 351M engine.

Both carburetors are of the down-draft double barrel type. Each barrel of the carburetor has its own idle system, main metering system and throttle valve. The idle and main metering systems are supplemented by the float system, the accelerating system, and the power system.

The WW and WWC carburetors are equipped with manual choke control. The choke lever is connected to the throttle linkage to provide fast idle speed position during the choke period.

IMPORTANT: For description of carburetor operation and internal adjusting procedures refer to Unit Overhaul Manual X-6M-03.

IDENTIFICATION

Each carburetor has an identification part number tag on the air horn cover, next to the fuel inlet, as shown in figure 21 and 22. Before attempting to repair a carburetor, refer to the identification number and secure the correct repair kit.

TROUBLE DIAGNOSIS

NOTE: The following information is included to serve as a guide in servicing carburetor. Many times a carburetor has been overhauled and replaced, yet the adverse condition still existed. Use this information which may assist in isolating the precise problem.

Before condemning the carburetor as the source of the engine running problem, always FIRST check the following:

1. Ignition System - Are the points, condenser, wires, spark plugs, and distributor operating to specifications.
2. Valve lash and spark plug gap.
3. Engine compression.
4. Crankcase ventilation and Exhaust Emission Control System (if used).
5. Fuel pump flow and pressure.
6. Intake manifold - cracks or gasket leakage.
7. Contaminate fuel.
8. Spark and valve timing.
9. Contaminated fuel filter.

When the carburetor is isolated to be the source of the problem (above items all checked and are to specifications), Select one of the ten complaints shown in "Troubleshooting Chart" that best describes the problem, then proceed with the action outlined.

CARBURETOR CHECKS

It is very seldom necessary to replace a complete carburetor. They can generally be repaired at a lower cost than the price of a new assembly. Repair kits are readily available.

Although there may be exceptions, carburetors should not be replaced for the following reasons:

1. Flooding - In practically all cases, flooding is caused by a dirty or sticking float needle and seat. This item is easily repaired and is not a valid reason for replacing a carburetor.

2. Carburetor Spitback - Carburetors are not to be replaced as a cure for "carburetor spitback." This condition, in most cases, is not the fault of the carburetor but results from inoperative positive crankcase ventilation, incorrect valve lash, or incorrect spark plug application and/or gap setting.

Spitback on acceleration may be caused by the accelerator pump inlet ball check valve not properly seating. However, in no case should the carburetor be replaced to cure spitback.

3. Leaking - If leaking is due to a faulty carburetor, such as one with a porous casting, the leak will show up at very early mileage (0-5,000 miles). Low mileage leaking due to a porous housing is a valid reason for carburetor replacement or repair, whichever is less costly. However, higher mileage leaking (over 5,000 miles) in most cases is not caused by defective material in the carburetor.

NOTE: Fuel seepage at the bowl to air horn mating surface is normal. This usually shows up as a discolored carburetor and is caused by wicking of the gasket in the area. Correction involves a periodic tightening of the bowl to air horn assembly screws.

BENDIX-STROMBERG CARBURETOR TROUBLESHOOTING CHART

Locate the complaint by reading across the top of the complaint columns, then find Step 1. If Step 1 does not remedy the complaint, move to Step 2 in that column. Take Steps 3, 4, 5, etc., in order until you have located the trouble.

★ Indicate other possible trouble points.

COMPLAINT											
Flooding	Rough Idle	Economy	Hesitation	Acceleration Flatness	Surge	Low Top Speed or Power	Cold Operation	Stalling	Hard Hot Starting	CHECK POINTS	WHAT TO LOOK FOR
	1	★		★			★	1	★	Idle Adjustment	Correct speed and mixture
3		3		★	2	3		3	2	Float Adjustment	Use gauge and set to specifications
			1	★			★			Pump Adjustment	Use correct dimension, throttle valves closed
	★	★							1	Idle Vent Adjustment	Dirt, wear, sticking open; must be closed except at idle
							1	★		Choke Adjustment	Use correct gauge, fast idle screw on 2nd step of cam, next to high step
							2	★		Fast Idle Adjustment	Set with warm engine, use tachometer, set to information specification
								2		Throttle Return Check	Proper clearance with throttle lever,
		1		1	5	2				Power Piston	Bent or sticking, distorted spring
		2		2	4	1	★			Power Valve	Dirty, sticking, loose, incorrect part
		4		3	1	4	★			Metering Jets	Loose, plugged, incorrect part
1	★	★				5		5	3	Needle and Seat	Worn, damaged, dirty, loose or incorrect part
	★	★	5	4	3	★				Venturi Cluster	Dirty, loose screws, incorrect part
2		★			★			★	★	Float	Bent, leaky, distorted float arms
	3							★		Idle Needles	Worn, damaged
	4		★	★		★	★	★		Throttle Valves	Sticking open or closed, damaged, not aligned properly
4	★	★	★	★	★	★	★	4	★	Gaskets	Improper seal, hard or brittle material, loose screws
	2							★	★	Idle Passages	Dirty or Plugged
	★	★				★	★			Power Piston Vac. Pas.	Plugged or vacuum leaks
	★	★								Pump Shaft Seal	Crack or loose fit on plunger shaft
			2				★			Pump Plunger	Hard or worn leather, distorted spring, stuck vent ball check
			3				★			Pump Inlet Check Ball	Out-of-round, damaged seat, stuck
	★		4				★	★	★	Pump Discharge Check	Out-of-round, damaged seat, stuck, distorted spring
		★		★			3	★	★	Choke Valve	Dirty, damaged, sticking

NOTE: If the above complaints are persistent, check the governor diaphragm assembly for possible engine oil leakage. Engine oil could travel through the carburetor governor and throttle body and contaminate the air-fuel mixture. Depletion of engine oil supply may occur if the diaphragm is punctured.

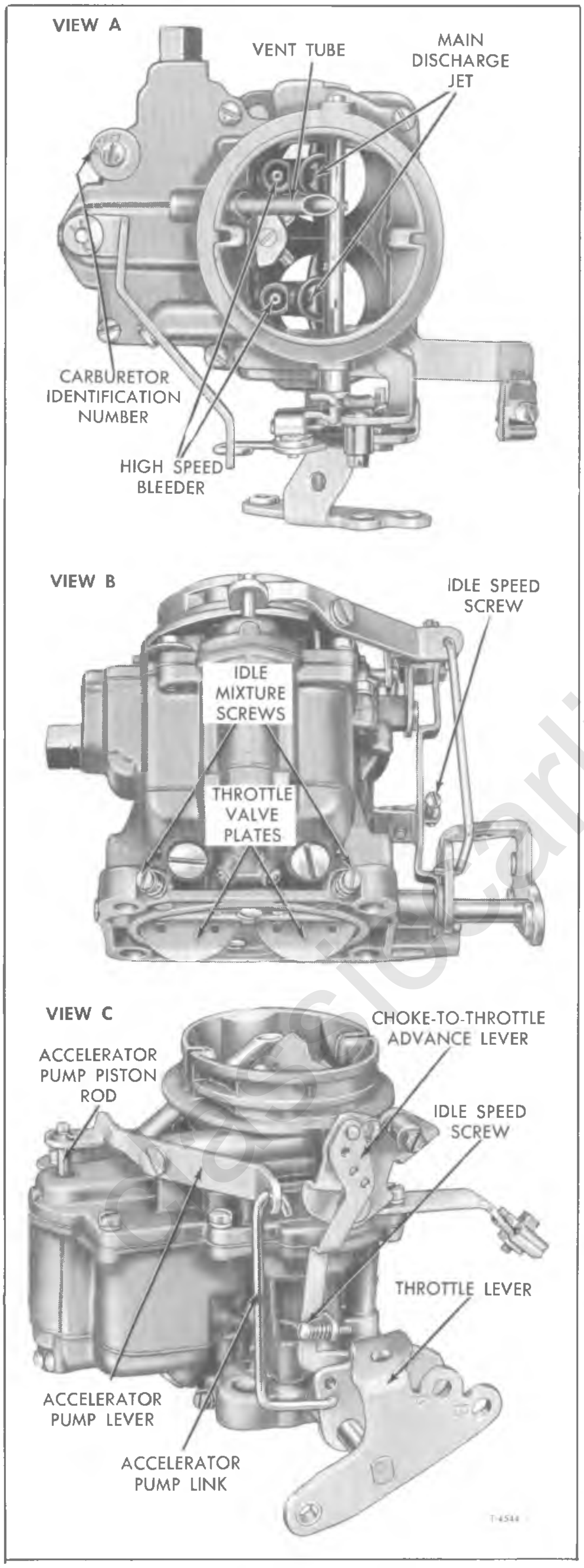


Figure 21—Bendix-Stromberg Carburetor (WW Series)

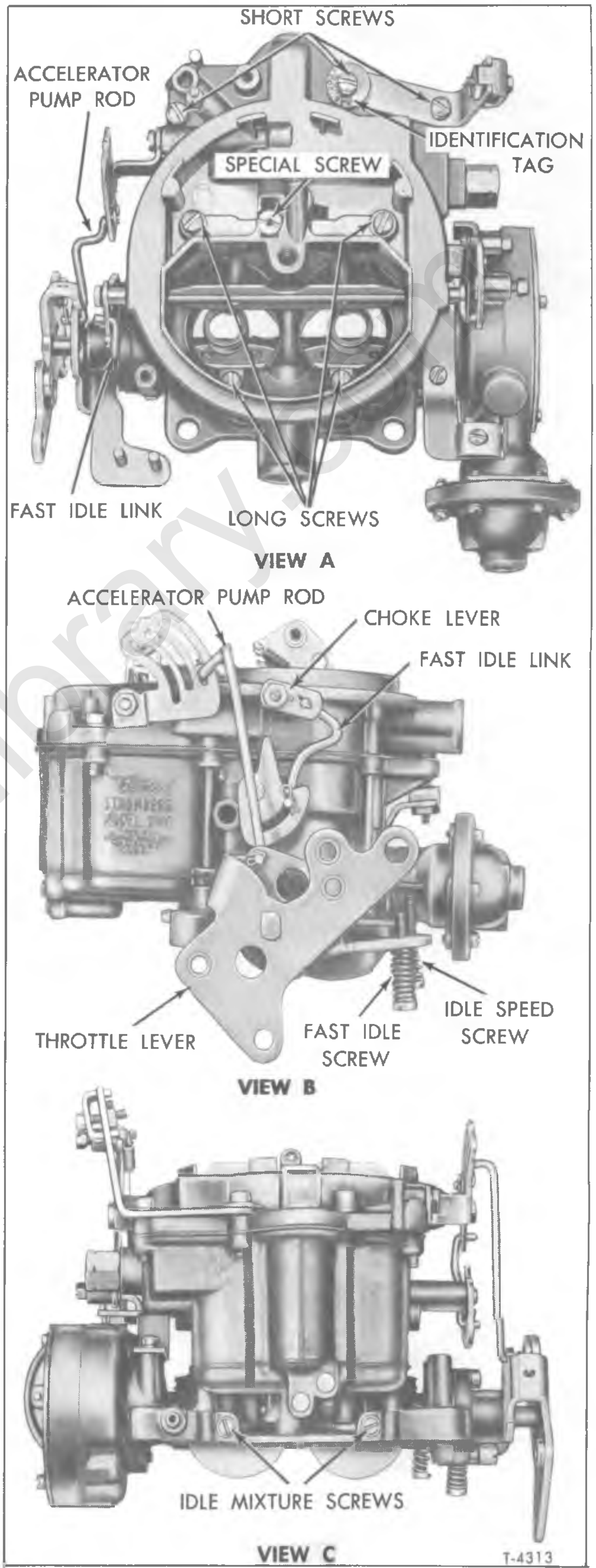


Figure 22—Bendix-Stromberg Carburetor (WWC Series)

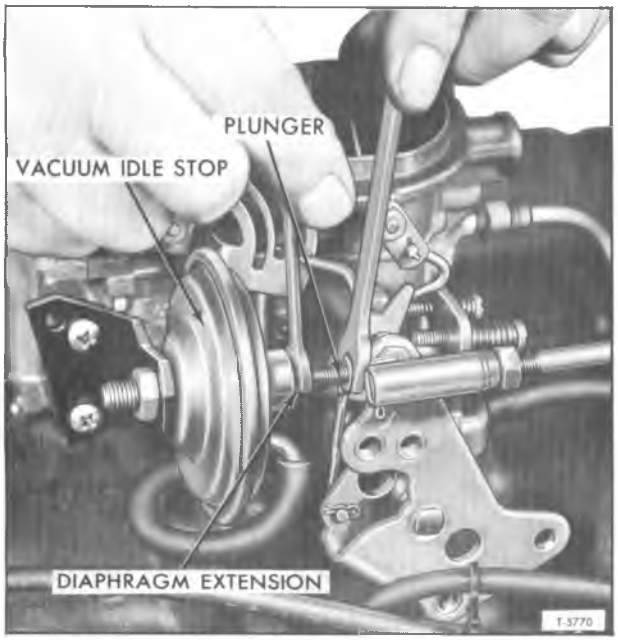


Figure 23—Adjusting Vacuum Idle Stop

4. Lack of Power - Lack of engine power that is isolated to the carburetor can usually be corrected by proper carburetor calibration and adjustment. Carburetors should be repaired rather than replaced when a lack of power complaint is encountered.

BENDIX-STROMBERG CARBURETOR ADJUSTMENTS

Correct adjustment of idle speed, ignition timing, and fuel mixture are extremely important to ensure proper operation of the system and for maximum engine performance. A tachometer is necessary for making the settings as a specific engine rpm is necessary to obtain correct adjustments.

Refer to "Engine Tune-up Specifications" in GASOLINE ENGINES (SEC. 6A) of this manual for complete tune-up specifications.

PRELIMINARY CHECKS

1. Thoroughly warm-up the engine. If the engine is cold, allow to run for at least 15 minutes.
2. Be sure the carburetor is properly secured to the intake manifold, which will exclude the possibility of air leaks.
3. Inspect the manifold heat control valve (if used) for freedom of action and correct spring tension.

IDLE AND MIXTURE ADJUSTMENT

The idle and mixture adjustments should be performed with the engine at operating temperature, and choke open.

Air conditioning (when used) must be turned on during the carburetor adjustments.

Engines Not Equipped With Controlled Combustion System - Modified (C.C.S.-M.)

1. Check the dwell reading. The dwell reading for all V6 engines should be 31 to 34 degrees.
2. Set the ignition timing as indicated by the "Engine Data Chart," then reconnect vacuum advance line.
3. Set the engine to run at 550 rpm by adjusting the idle speed screw (figs. 21 and 22).

NOTE: On 351M engine, if necessary, back out the fast idle screw to allow idle speed screw to contact its stop.

4. Adjust the idle mixture screws (figs. 21 and 22). With engine running and idling speed set, turn each idle mixture screw in until engine begins to slow down or run unevenly, then back out screws until engine runs smoothly with highest vacuum gauge reading.

NOTE: If vacuum gauge is not available, adjust idle mixture screws to give highest idle speed. Turning idle mixture screws "in" gives leaner mixture; while turning screws "out" gives richer mixture. DO NOT turn screws in tight against seats since screws or seats will be damaged.

5. Check idle speed and re-adjust if necessary to 550 rpm.

Engines Equipped With Controlled Combustion System - Modified (C.C.S.-M.)

NOTE: All V6 gasoline engines sold in the State of California, covered by this manual, are equipped with C.C.C.-M.

1. Check the dwell reading. The dwell reading on all V6 engines should be 31 to 34 degrees.
2. Set the ignition timing as indicated by the "Engine Data Chart," then reconnect vacuum advance line.
3. Disconnect and plug vacuum line to vacuum idle stop (figs. 30 and 31).

NOTE: Detailed explanation of vacuum idle stop is given later in this section under "Controlled Combustion System."

4. With engine running, vacuum idle stop disconnected, check reduced engine rpm. The reduced engine speed should be 350 rpm. If necessary, readjust the idle speed screw (figs. 21 ans 22) to obtain 350 rpm.
5. Connect vacuum line from carburetor to vacuum idle stop. With engine running, vacuum idle stop connected, engine idle speed should be 550 rpm. If necessary to readjust idle speed perform the following:

a. Referring to figure 23, place a ¼-inch open end wrench on diaphragm extension of vacuum idle stop to prevent its rotation while adjusting plunger.

ENGINE DATA CHART

ENGINE MODELS		250 - 292	305E - 305C	351C - 351M
IDLE* RPM	Without Exhaust Emission Control	525	550	550
	With Exhaust Emission Control	700	550	550
IGNITION TIMING**	Without Exhaust Emission Control	4°	$7\frac{1}{2}^{\circ}$	10°
	With Exhaust Emission Control	0°	$7\frac{1}{2}^{\circ}$	10°

* With air condition turned on (when used).
** With vacuum advance line disconnected and plugged.
Note: Above timing settings apply when average Nation-Wide regular fuel is used.

CAUTION: UNDER NO CONDITIONS SHOULD THE DIAPHRAGM EXTENSION BE ALLOWED TO ROTATE OR INTERNAL DAMAGE WILL RESULT TO VACUUM IDLE STOP UNIT.

b. Adjust the plunger with a 3/8-inch open end wrench until the face of the plunger hex contacting the carburetor throttle lever results in an idle speed of 550 rpm.

6. Adjust the idle mixture screws (figs. 21 and 22). With engine running and idling speed set, turn each mixture screw "in" until engine begins to slow down or run unevenly, then back out screws until engine runs smoothly with highest vacuum gauge reading.

NOTE: If vacuum gauge is not available adjust idle mixture screws to give highest idle speed. Turning idle mixture screws "in" gives leaner mixture; while turning screws "out" gives richer mixture. DO NOT turn screws in tight against seats since screws or seats will be damaged.

7. Reset the engine idle speed to 575 rpm, by adjusting plunger on vacuum idle stop as previously described.

8. Turn "in" idle mixture screws (lean mixture) equally to reduce idle speed to 550 rpm.

Fast Idle Adjustment - 351M Engine

The fast idle mechanism is used to provide increased engine speed when choke valve is not fully open. Fast idle screw is shown in figure 31. The link installed between choke valve lever and fast idle cam operates cam when choke valve is closed.

Check the position of cam with choke valve fully open. Fast idle screw must clear cam when throttle is at idle position. If there is interference, bend link to allow fast idle cam to drop below fast idle screw with throttle plate closed and choke open. To adjust fast idle properly, locate end of fast idle screw flush with inner surface of lever, then turn screw "in" 7½ turns, as shown in figure 24.

FLOAT LEVEL ADJUSTMENTS

351M Engine

Remove air cleaner and disconnect choke wire from choke lever. Disconnect fast idle link and accelerating pump rod. Remove three short screws attaching air horn to main body, then remove one long screw at forward side of air horn and one long screw next to fuel body. Replace these screws with two of the short screws to hold main body flange to throttle body. Tighten securely. Remove balance of air horn to main body screws, then remove air horn.

Use float gauge (J-8824) to check relationship

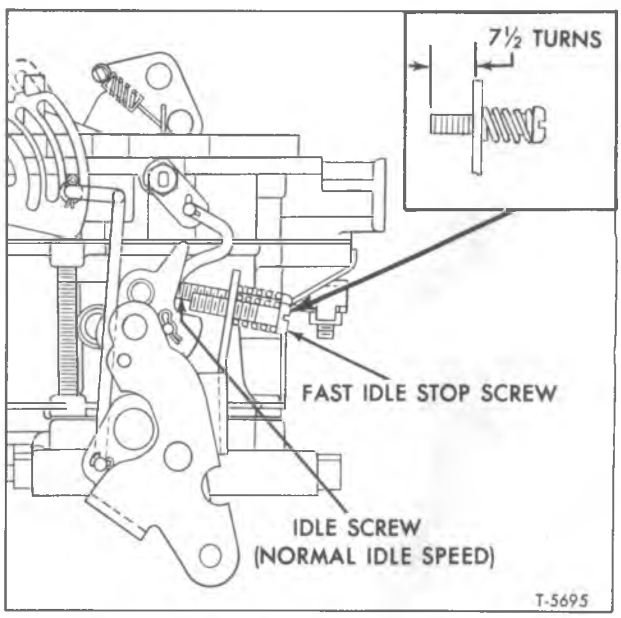


Figure 24—Fast Idle Adjustment (351M Engine)

FUEL SYSTEM—GASOLINE ENGINES

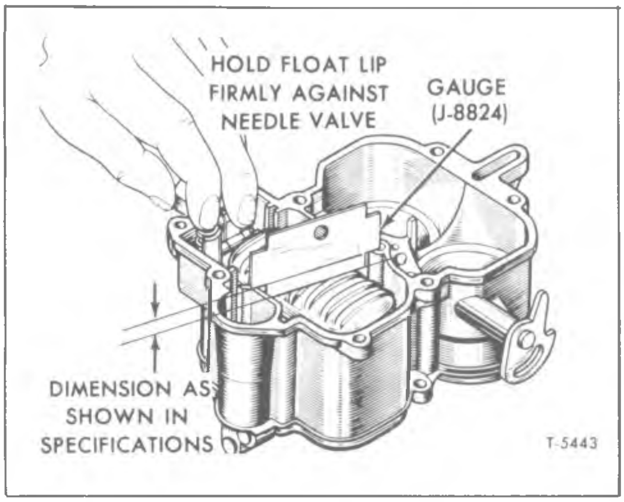


Figure 25—Checking Float Level (351M Engine)

of the float to the top of the fuel bowl as typically shown in figure 25. The gauge has several steps for use with various carburetors. Refer to "Specifications" for the proper float level adjustment dimension. Hold the tab on the float firmly against needle valve when using the gauge. Setting is correct when the edge of the gauge touches top of the rib on the float. Use tool (J-4395) to bend float lever next to float to change the float setting. Use bending tool as illustrated in figure 26.

After checking the float level, install air horn and a new gasket. Locate screws, choke control bracket, and identification tag in original positions. Connect fast idle link, accelerating pump rod, and choke wire. Install air cleaner.

305E, 305C, and 351C Engines

Float level on carburetors used on these engines can be checked with gauge (J-8824) or by

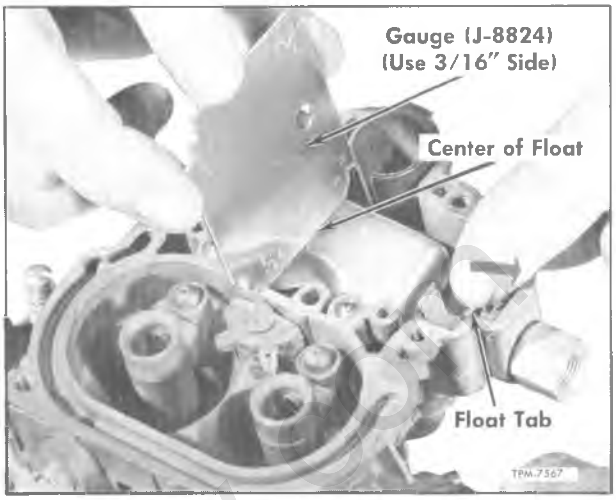


Figure 27—Checking Float Level (305C, 305E, and 351C Engines)

measuring with scale. Air horn assembly must be removed to check float level.

Use side of gauge as shown in figure 27, and be sure the gasket is removed. Check float level as follows:

While holding tab of float firmly against needle valve, measure from top center of float to top flange of the main body as shown. Measurement should be as indicated in "Specifications."

To reset float level, bend float lever next to float using bending tool (J-4395) as shown in figure 26.

ACCELERATOR PUMP TRAVEL ADJUSTMENT

351M Engines

Measure the total distance from the point at top of pump lever travel when throttle lever is

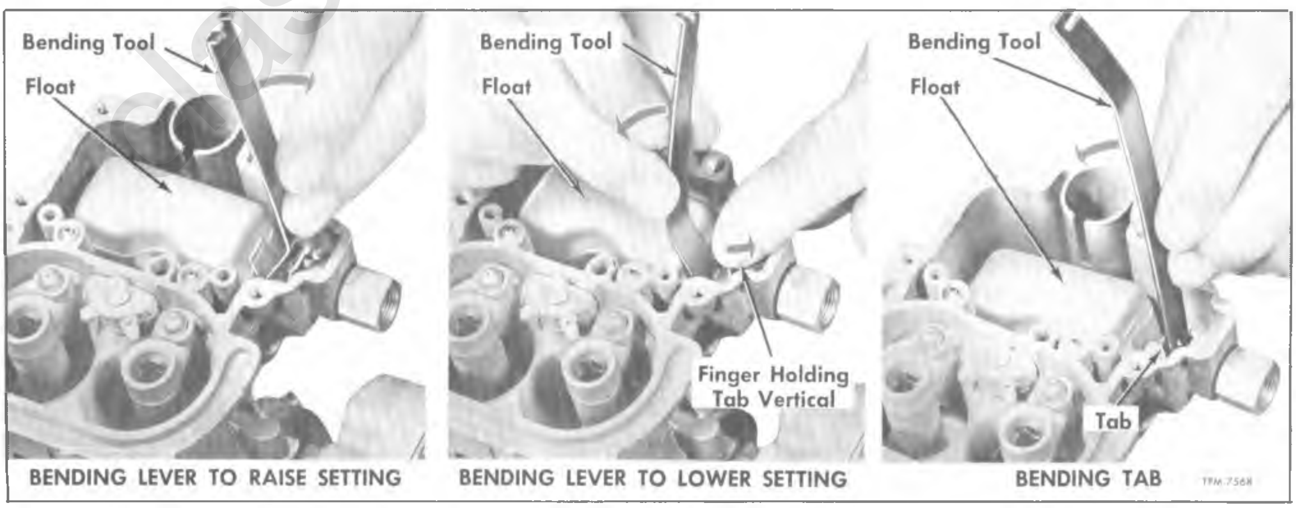


Figure 26—Typical Use of Bending Tool to Set Float Level

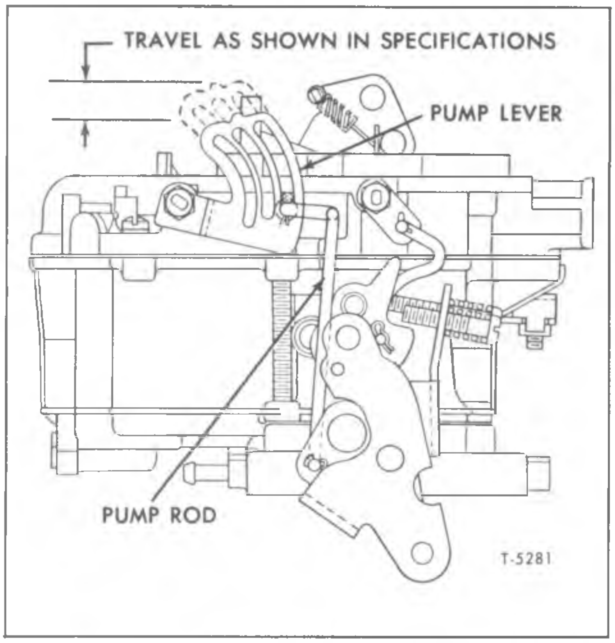


Figure 28—Accelerator Pump Adjustment (351M Engine)

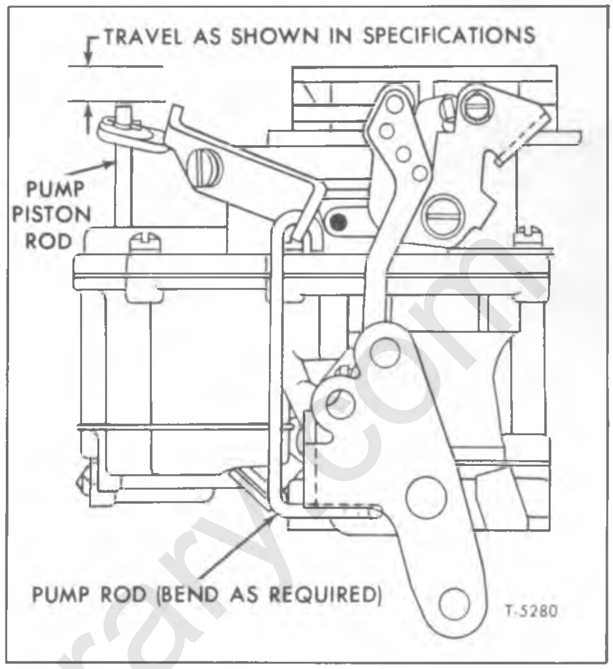


Figure 29—Accelerator Pump Adjustment (305C, 305E, and 351C Engines)

moved from closed to wide open position as shown in figure 28. The pump travel is as indicated in "Specifications." When necessary to adjust the lever travel, bend the pump rod at the upper end.

305E, 305C, and 351C Engines

Operate accelerator pump to properly seat checkball, then with throttle fully closed (idle speed screw backed out), place a straight-edge across the air horn and measure distance from straight-edge to top of pump piston rod. Open throttle valve and measure distance from straight-edge to top of pump piston rod.

Subtract the measurement taken with throttle valve fully closed from measurement taken with the throttle valve fully open to determine the pump rod travel. Adjust the pump rod travel by bending the pump rod at point shown in figure 29.

EXHAUST EMISSION CONTROL SYSTEMS

GENERAL INFORMATION

Since products of combustion in gasoline engines contain contaminants which cause atmospheric pollution, a means to reduce harmful emissions must be employed. Devices used for this purpose fall into one or more of the following catagories:

1. Positive Crankcase Ventilation System (P.C.V.).
2. Controlled Combustion System - Modified (C.C.S.-M.).
3. Air Injector Reactor System (A.I.R.).

The first system serves to prevent air pollution by re-cycling fumes from the crankcase (used on all engines). The other systems are used for control of air pollution from exhaust system emissions on vehicles sold in California.

IMPORTANT: All gasoline engines, covered by this manual, sold in the state of Californis are equipped with C.C.S.-M. (V6 engines) and A.I.R. (In-Line Engines).

POSITIVE CRANKCASE VENTILATION SYSTEMS

For detailed information on Crankcase Ventilation Systems, refer to GASOLINE ENGINES (SEC. 6A) of this manual.

CONTROLLED COMBUSTION SYSTEM—MODIFIED (C.C.S.-M.)

NOTE: The C.C.S.-M. system is found only on V6 engines, covered by this manual, sold in the State of California.

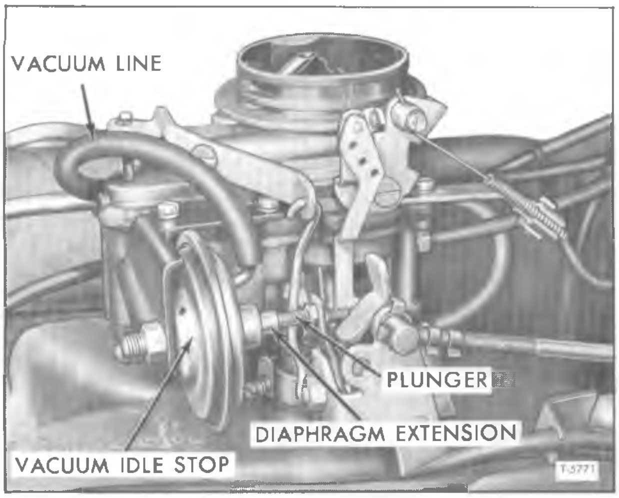


Figure 30—Vacuum Idle Stop—Bendix-Stromberg Carburetor (WW Series)

The C.C.S.-M. system is that system which increases combustion efficiency, and combustion efficiency reduces the hydrocarbon and carbon monoxide emissions. The complete effectiveness of this system, as well as full power and performance, is dependent upon the correct idle speed, ignition timing, and idle fuel mixture.

IMPORTANT: The C.C.S.-M. system consists of no additional components, other than a specially calibrated carburetor and a vacuum idle stop.

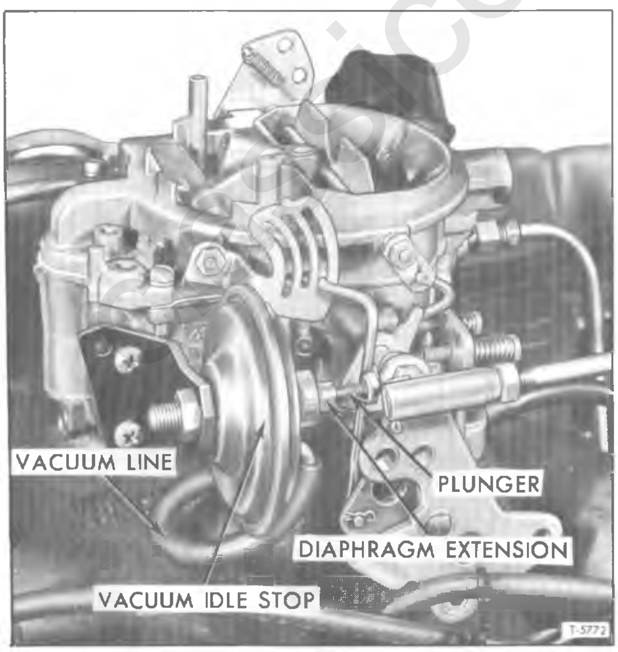


Figure 31—Vacuum Idle Stop—Bendix-Stromberg Carburetor (WWC Series)

CARBURETOR

The carburetor used on C.C.S.-M. equipped vehicles functions and operates the same as all other Bendix-Stromberg carburetors used on V6 engines. But under no circumstances should they be interchanged with, or replaced by another type carburetor.

NOTE: For carburetor adjustments on C.C.S.-M. engines, refer to "Idle and Mixture Adjustments" previously covered in this section.

VACUUM IDLE STOP
(Refer to Figs. 30 and 31)

A vacuum idle stop unit is used on all C.C.S.-M. equipped engines to prevent engine "dieseling" (engine operation after ignition switch is turned off).

The idle stop unit is mounted to the carburetor with a bracket and acts upon the throttle plates of the carburetor in the same manner as an idle setscrew. When the engine is started, engine vacuum acts upon the diaphragm in the idle stop unit and the plunger is pushed to its full extended position. The plunger acts upon the throttle lever and sets the throttle plates in a position to achieve the specified idle rpm. When the ignition switch is turned "OFF," engine vacuum is reduced and the plunger retracts into the idle stop unit. The result is the throttle plate closes to a lower position which is controlled by the idle speed screw. At this point, the throttle plate is open only enough to allow the engine to run well below normal idle rpm.

NOTE: For adjustment of the vacuum idle stop, refer to "Idle and Mixture Adjustment" previously covered in this section.

AIR INJECTION REACTOR SYSTEM (A.I.R.)

NOTE: The A.I.R. system (figs. 32 and 33) is found only on In-line engines, covered by this manual, sold in the state of California.

The A.I.R. system consists of: The air injection pump (with necessary brackets and drive attachments), air injection tube, diverter valve, check valve, and air manifold assembly, tubes and hoses necessary to connect the various components.

OPERATION

The air injection pump (fig. 34) with an integral filter, compresses the air and injects it through the air manifolds, hoses, and injection tubes into the exhaust system in the area of the exhaust valves. The fresh air ignites and burns the unburned portion of the exhaust gases in the exhaust system, thus minimizing exhaust contaminations.

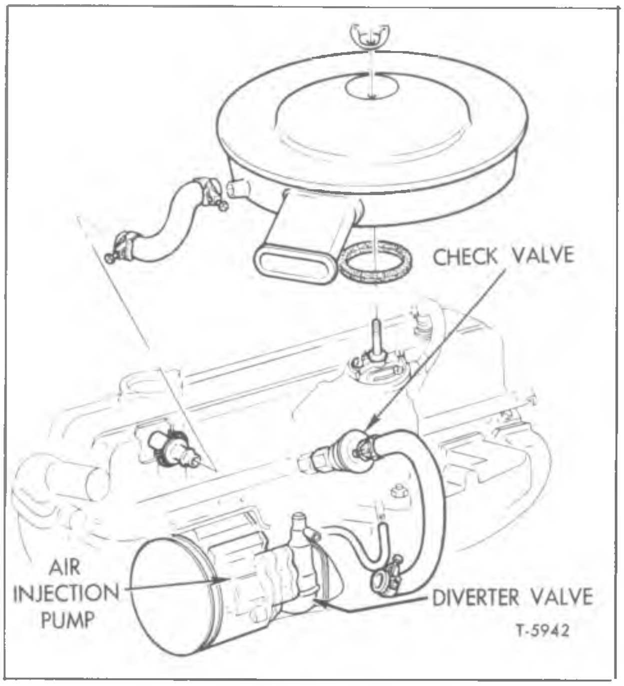


Figure 32—Air Injection Reactor System

The diverter valve (fig. 35) when triggered by a sharp increase in manifold vacuum, shuts off the injected air to the exhaust port areas and prevents backfiring during this richer period.

On engine overrun the total air supply is dumped through the muffler on the diverter valve. At

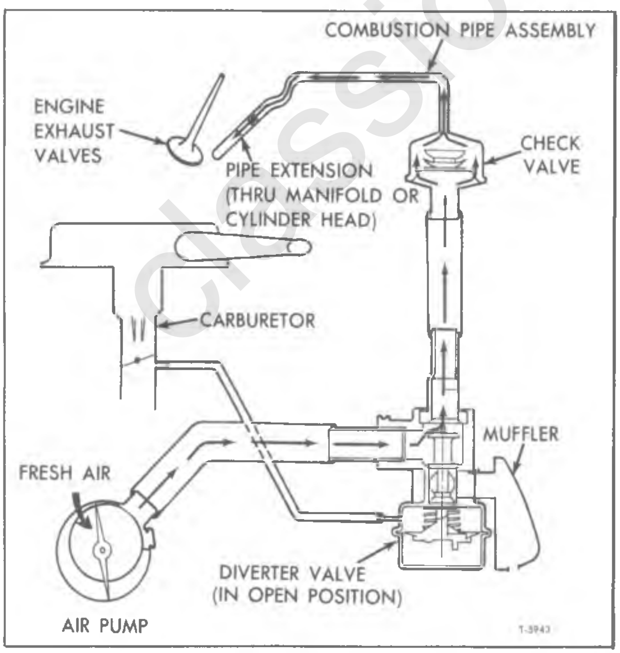


Figure 33—Schematic of A.I.R. System

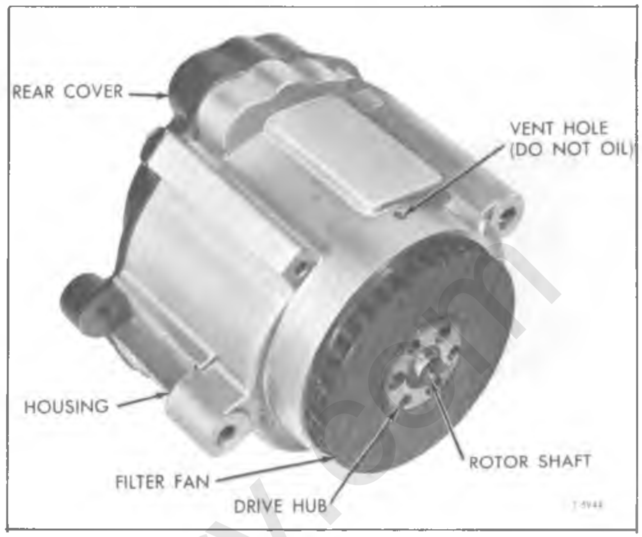


Figure 34—Air Injection Pump

high engine speeds the excess air is dumped through the pressure relief valve which is part of the air pump.

The check valve prevents exhaust gases from entering and damaging the air injection pump, as back-flow can occur even under normal operating conditions.

When properly installed and maintained, the A.I.R. System will effectively reduce exhaust emissions. However, if any A.I.R. component or any engine component that operates in conjunction with

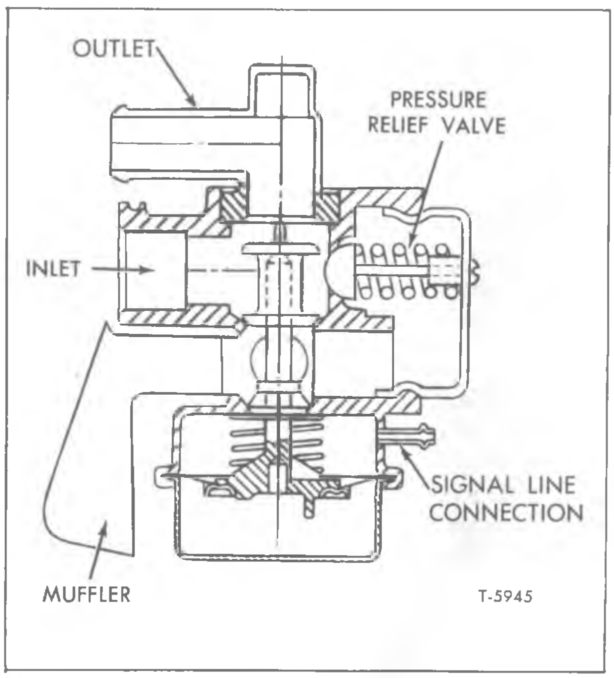


Figure 35—Diverter Valve

Figure 36—Installing Centrifugal Filter

the A.I.R. System should malfunction, the exhaust emissions might be increased.

Because of the relationship between "Engine Tune-Up" and "Unburned Exhaust Gases," functioning of the engine fuel system should be checked whenever the A.I.R. System seems to be malfunctioning. Particular care should be taken in checking items that affect fuel - air ratio such as the crankcase ventilation system, the carburetor and the carburetor air cleaner.

A.I.R. Trouble Diagnosis information is found at the end of this section.

MAINTENANCE PROCEDURES

DRIVE BELT

Inspection

1. Inspect drive belt for wear, cracks, or deterioration and replace if required.
2. Inspect belt tension and adjust if below 50 pounds using a strand tension gauge.

Adjustment

1. Loosen pump mounting bolt and pump adjustment bracket bolt.
2. Move pump until belt is tight (55 ± 5 lbs. used belt, or 75 ± 5 lbs. new belt) using a strand tension gauge, then tighten adjustment bracket bolt and mounting bolt.

> CAUTION: DO NOT PRY ON THE PUMP HOUSING. DISTORTION OF THE HOUSING WILL RESULT IN EXTENSIVE DAMAGE TO THE AIR INJECTION PUMP.

Replacement

1. Loosen pump mounting bolt and pump adjustment bracket bolt, then swing pump until drive belt may be removed.
2. Install a new drive belt and adjust as outlined previously.

DRIVE PULLEY

Replacement

1. Remove drive belt as outlined above, then replace drive pulley.
2. Install and adjust drive belt as instructed previously.

PUMP PULLEY

Replacement

1. Hold pump pulley from turning by compressing drive belt, then loosen pump pulley bolts.
2. Remove drive belt as instructed above, then remove pump pulley.
3. Install pump pulley with retaining bolts hand tight.
4. Install and adjust drive belt as directed previously.
5. Hold pump pulley from turning by compressing drive belt, then torque pump pulley bolts to 25 foot-pounds.
6. Recheck drive belt tension and adjust, if required.

PUMP FILTER

Replacement

1. Remove drive belt and pump pulley as described previously.
2. Pry loose outer disc of filter fan.
3. Pull remaining portion of filter off with pliers.

NOTE: Care should be taken to prevent fragments from entering the air intake hole.

4. Install the new filter by drawing it on with the pulley and pulley bolts (fig. 36).

> CAUTION: DO NOT attempt to install a filter by hammering it on or pressing it on.

5. Draw the filter down evenly by alternately tightening the bolts. Make certain that the outer edge of the filter slips into the housing. The slight amount of interference with the housing bore is normal.

NOTE: A new filter may squeal upon initial operation until its O.D. (outside diameter) sealing lip has worn in.

AIR MANIFOLD, HOSE, AND TUBE

Inspection (Refer to Fig. 32)

1. Inspect all hoses for deterioration or holes.
2. Inspect all tubes for cracks or holes.
3. Check all hose and tube connections.
4. Check all tube and hose routing. Interference may cause wear.
5. If leak is suspected on the pressure side of the system or any tubes and/or hoses have been disconnected on the pressure side, the connections should be checked for leaks with a soapy water solution. With the pump running, bubbles will form if a leak exists.

Replacement

1. To replace any hose and/or tube, note routing, then remove hose(s) and/or tube(s) as required.

CAUTION: The ¼" pipe thread at the cylinder head (In-line) is a straight pipe thread. Do not use a ¼" tapered pipe tap. The hoses of the A.I.R. System are a special material to withstand high temperature. No other type hose should be substituted.

2. Install new hose and/or tube(s), routing them as when removed.
3. Tighten all connections.

NOTE: Use anti-seize compound on threads of the air manifold to exhaust manifold or cylinder head connections.

CHECK VALVE

Inspection

1. The check valve should be inspected whenever the hose is disconnected from the check valve or whenever check valve failure is suspected. (A pump that had become inoperative and had shown indications of having exhaust gases in the pump would indicate check valve failure.)
2. Orally blow through the check valve (toward air manifold), then slowly attempt to suck back through check valve. Flow should only be in one direction (toward the air manifold).

Replacement

Disconnect pump outlet hose at check valve. Remove check valve from air manifold, being careful not to bend or twist air manifold.

DIVERTER VALVE

Inspection

1. Check condition and routing of all lines especially the signal line. All lines must be secure, without crimps and not leaking.

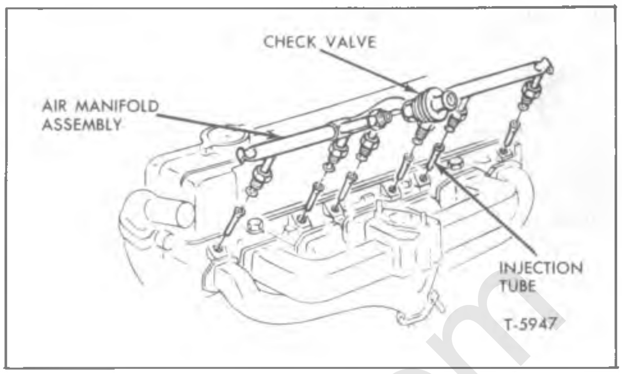


Figure 37—Air Injection Tubes

2. Disconnect signal line at valve. A vacuum signal must be available with engine running.
3. With engine stabilized at idle speed, no air should be escaping through the muffler. Manually open and quickly close the throttle, a momentary blast of air should discharge through muffler for at least one second.
4. Defective valves should be replaced.

CAUTION: Diverter valves although sometimes similar in appearance are designed to meet particular requirements of various engines, therefore, be sure to install the correct valve.

Replacement

1. Disconnect vacuum signal line. Disconnect valve exhaust hose(s).
2. Remove diverter valve from pump.
3. Install diverter valve to pump or bracket with new gasket. Torque valve attaching screws to 85 inch-pounds.
4. Install outlet and vacuum signal lines and check system for leaks.

AIR INJECTION TUBE

Inspection (Refer to Fig. 37)

1. There is no periodic service or inspection for the air injection tubes, yet on In-line engines whenever the cylinder head is removed, inspect the air injection tubes for carbon build-up and warped or burnt tubes.
2. Remove any carbon build-up with a wire brush.
3. Warped or burnt tubes must be replaced.

Replacement

1. On In-line engines, remove carbon from tubes and using penetrating oil, work tubes out of cylinder head.
2. Install new tubes in cylinder head.

AIR INJECTION PUMP

Inspection

Accelerate engine to approximately 1500 rpm and observe air flow from hose(s). If air flow increases as engine is accelerated, pump is operating satisfactorily. If air flow does not increase or is not present, proceed as follows:

1. Check for proper drive belt tension.
2. Check for a leaky pressure relief valve. Air may be heard leaking with the pump running.

NOTE: The A.I.R. System is not completely noiseless. Under normal conditions noise rises in pitch as engine speed increases. To determine if excessive noise is the fault of the Air Injection Reactor System, operate the engine with the pump drive belt removed. If excessive noise does not exist with the belt removed, proceed as follows:

3. Check for a seized air injection pump.
4. Check hoses, tubes, air manifolds and all connections for leaks and proper routing.
5. Check air injection pump for proper mounting.
6. If none of the above conditions exist, and the air injection pump has excessive noise, remove and replace pump kit.

Pump Replacement

1. Disconnect the hoses at the pump.
2. Remove the pump pulley as described previously.
3. Remove pump mounting bolts and remove pump.
4. Install pump with mounting bolts loose.
5. Install pump pulley as described previously.
6. Install and adjust belt as described previously.
7. Connect the hoses at the pump.
8. Tighten mounting bolts securely.

PRESSURE RELIEF VALVE

The pressure relief valve is incorporated in the diverter valve (see fig. 35). The complete unit must be replaced to correct a malfunction of the relief valve.

NOTE: Air Injection Reactor (A.I.R.) Trouble Diagnosis information and Gasoline Engine Specifications are found on the following pages.

AIR INJECTION REACTOR (A.I.R.) TROUBLE DIAGNOSIS

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOISY	Before trying to isolate the cause, it should be noted that the A.I.R. system is not completely noiseless. Under normal conditions, noise rises in amplitude as engine speed increases. Air pump noise can be confused with other engine noises.	
	Hose disconnected or leaking.	Re-connect or replace.
	Belt loose.	Retighten.
	Faulty relief valve (if mounted in pump).	Replace valve.
	A "chirping" noise may be prevalent on new pump.	Allow break-in time.
	A continuous "knocking" noise is indicative of rear bearing failure.	Replace pump.
	Improper belt tension.	Readjust.
	Seized or binding pump.	Replace.
	Incorrect or missing pressure setting plug (if relief valve is mounted on pump).	Replace plug.
	Bent or misaligned pulleys.	Inspect belt alignment—Replace pulleys.
BACKFIRE IN EXHAUST SYSTEM	Rich Fuel Mixture Caused By:	
	Inoperative choke—misadjusted or sticking closed.	Inspect choke operation—correct as necessary.
	Inoperative vacuum break.	Replace vacuum break.
	Use of manual choke; generally overchoking.	Closer control of choking period.
	Air cleaner element restricted.	Replace element.
	Improper crankcase vent maintenance.	Inspect system. Replace PCV valve. Check fitting at carburetor—may be plugged with crankcase deposits. Check PCV filter. Replace if dirty.
	High fuel level.	Adjust float level.
	Diverter valve stuck in open position.	Check valve—replace if defective.
	Diverter valve and distributor timing vacuum lines switched.	Correct hose routing.
BACKFIRE OR POPPING IN INLET MANIFOLD	Leaking inlet manifold.	Check manifold bolts for tightness.
	Incorrect ignition timing.	Check timing and set to specs.

AIR INJECTION REACTOR (A.I.R.) TROUBLE DIAGNOSIS (Cont'd)

TROUBLE	PROBABLE CAUSE	REMEDY
OFF IDLE HESITATION & ROUGH IDLE (HOT)	Appears in acceleration period from a standing start to approximately 900 R.P.M. resulting from the following:	
	Vacuum Leak—More noticeable on hot engine. Results from unconnected, split or oversized hoses, in addition to the hot idle compensator not closing or opening prematurely. Can also be caused by a leaking carburetor or intake manifold gasket.	Inspect hoses, gaskets and fittings for leaks. Plug off carb. hot idle compensator port in air horn. If this corrects condition, overhaul hot idle compensator.
	Insufficient fuel shot from carb. accelerator pump of fuel leaking past seal during pump travel. (This does not apply to diaphragm type accelerator pumps.)	Check accelerator pump adjustment. If rubber seal is hard or falls into cavity by its own weight (with return spring removed) it should be replaced. There should be slight interference between cup and wall.
	Carburetor float level low.	Adjust as required.
	Initial timing out of specification.	Check initial setting to specification.
ROUGH IDLE OR SURGE	Improper carburetor adjustment, idle speed, idle fuel mixture, choke, etc.	Check carburetion and adjust as necessary.
	Improper ignition timing.	Set timing to specs.
	Vacuum leak at signal line to diverter valve or distributor. Vacuum leak at carburetor or intake manifold.	Inspect and correct lines and connections. Check for leaks at carburetor and intake manifold gasket.
ENGINE IDLE SPEED HIGH	Throttle linkage sticking or obstructed by hoses.	Inspect linkage and eliminate points of interference.
	Idle speed set incorrectly.	Reset idle speed to specs.
ENGINE "DIESELS"—AFTER IGNITION IS TURNED OFF	Idle speed too high.	Reset idle to specs.
	Low octane fuel.	Use higher octane fuel or premium.
OVERHEATED EXHAUST SYSTEM	Ignition timing retarded—excessive burning in exhaust system.	Reset timing to specs.
	Incorrect or missing pressure relief valve plug in air pump.	Check for correct plug. Install if missing.
CHARRED, DETERIORATED SUPPLY HOSE	Defective check valves.	Replace check valve.
CONSTANT AIR NOISE	Broken Hose.	Replace Hose.
	Diverter valve stuck closed.	Replace diverter valve.

Caution—Because the A.I.R. pump air filter provides a direct path into the pump, cover the filter whenever the engine is cleaned.

GASOLINE ENGINE SPECIFICATIONS

BENDIX-STROMBERG CARBURETOR MODEL APPLICATION

(EXCLUDING CALIFORNIA VEHICLES)

TRUCK SERIES	ENGINE	GM PART NO.	VENDOR NO.	CODE NO.
LV/LA-4000	305-C	8877962	381207	23-203
SM-6500	351-M	2483900	381167	23-184C
EM-4500	305-E	8867230	381185	23-195A
EM/SM-5500; EM-6500	305-C	8867230	381185	23-195A
OPTIONAL				
LA/LV-4000	351-C	8878012	381208	23-204
EM/-SM-5500; EM-6500	351-C	8869152	381204	23-200A

BENDIX-STROMBERG CARBURETOR MODEL APPLICATION

(CALIFORNIA VEHICLES ONLY)

TRUCK SERIES	ENGINE	GM PART NO.	VENDOR NO.	CODE NO.
LV/LA-4000	305-C	657910	381261	23-221
SM-6500	351-M	655923	381257	23-217
EM-4500	305-E	657910	381261	23-221
EM/SM-5500; EM-6500	305-C	657910	381261	23-221
OPTIONAL				
LA/LV-4000; EM/SM-5500; EM-6500	351-C	657910	381261	23-221

BENDIX-STROMBERG CARBURETOR SPECIFICATIONS

CAREBURETOR NUMBER	8877962 8867230	8869152	657910	2483900	655923
VENTURI SIZE	1 3/16″	1 3/16″	1 3/16″	1 5/16″	1 5/16″
MAIN DISCHARGE JET NO.	28-36	28-36	28-36	—	—
MAIN METERING JET SIZE	0.055	0.056	0.058	0.066	0.067
HIGH SPEED BLEEDER	NO. 70	NO. 70	NO. 70	NO. 68	NO. 68
POWER BY-PASS JET	2 NO. 65	2 NO. 62	2 NO. 65	NO. 53	NO. 54
ACCELERATOR PUMP DISCHARGE JET NO.	NO. 70	NO. 68	NO. 70	NO. 70	NO. 70
GOVERNOR DIAPHRAGM SPRING NO.	—	—	—	389702	389702
GOVERNOR THROTTLE SPRING NO.	—	—	—	389703	389703
THROTTLE SPRING ANCHOR POSITION	—	—	—	NO. 3	NO. 3
FLOAT LEVEL	0.190	0.190	0.190	0.160	0.160

FUEL PUMP SPECIFICATIONS

ENGINE	PUMP MODEL	P.S.I. PRESSURE*	VOLUME
V6	6440050	5-6½	1 pint in 20-25 seconds
IN-LINE	6440616	4½-5	1 pint in 35-40 seconds

*At 16″ above outlet.

FUEL SYSTEM—GASOLINE ENGINES

GASOLINE ENGINE SPECIFICATIONS (Cont'd)

ROCHESTER-CARBURETOR MODEL APPLICATION

TRUCK SERIES	ENGINE	PART NO.
ES-4500	250	7029011
PS-4500	250	7029011
ES/SS-5500	292	7029012
OPTIONAL		
ES-4500	292	7029012
PS-4500	292	7029012

ROCHESTER-CARBURETOR SPECIFICATIONS

ENGINE	L-292	L-250
MODEL	M	M
MODEL NO.	7029012	7029011
FLOAT LEVEL	¼″	¼″

VELOCITY TYPE GOVERNOR SPECIFICATIONS

KING-SEELEY MODEL (STAMPED)	GMC NO. (STAMPED)	ENGINE MODEL	MAX. GOVERNED SPEED (RPM)* NO LOAD
901-623	2440843	305-C	3700
		305-E	3700
901-685	2472969	351-C	3900
651-735	3929621	250	2400
601-734	3929623	250	3900
651-739	3929625	292	2400
601-738	3929627	292	3900

*With Engine broken-in. Full load is approximately 300 RPM less than No Load RPM and will vary from engine to engine.

HYDRAULIC TYPE GOVERNOR

SPINNER VALVE
- Location .... At Engine Oil Pump
- Type .... Centrifugal, Pre-Set

SLAVE UNIT
- Location .... Carburetor Throttle Body

ENGINE GOVERNED SPEED
- Full Load
  - 351-M Engine .... 3400 RPM

Diesel Engine Fuel System

ACCELERATOR AND THROTTLE LINKAGE ADJUSTMENT

NOTE: For adjustment of accelerator linkage on vehicles equipped with Allison Automatic Transmission, refer to "TRANSMISSION CONTROL LINKAGE" (SEC. 7A) of this manual.

IMPORTANT

Before making accelerator and throttle linkage adjustment, engine idle should be set to "Specifications" as indicated in TORO-FLOW DIESEL ENGINES (SEC. 6B).

CONVENTIONAL CAB MODELS

Refer to figure 1.

1. Disconnect pull-back spring. Disconnect accelerator rod from the injection pump throttle lever.
2. Loosen the jam nut on the accelerator rod.
3. Depress the accelerator pedal to 3/8-inch from the toe pan.

NOTE: The thickness of floor mat must be considered.

4. Hold the injection pump throttle lever in full throttle position, then turn the accelerator rod until the end of the accelerator rod fits freely into injection pump throttle lever.
5. Tighten jam nut on the accelerator rod.
6. Connect the accelerator rod to the injection pump throttle lever, then release the accelerator pedal. Connect the pull-back spring.

COWL MODELS

Accelerator and throttle linkage adjustment information is the same as previously specified for the Conventional Cab Models with exception of Step 3, which should read:

3. Depress the accelerator pedal against the floor stop instead of toe pan.

STEEL TILT CAB MODELS

NOTE· Key numbers in text refer to figure 2.

1. Tilt cab forward.
2. Using ruler measure return spring dimension at points shown. Dimension should be 7 inches. If necessary, disengage rod assembly (17) from upper lever and shaft assembly (14). Loosen rod adjusting nut, then turn end link as required to obtain dimension. Tighten lock nut and engage rod (17) to bracket assembly (14).
3. Lower cab to operating position.

NOTE: Accelerator pedal linkage is proerly adjusted when accelerator pedal is contacting floor mat and the fuel injection pump lever is in full throttle position.

4. If necessary to adjust, loosen lock nut at clevis (6) and turn relay lever to idler lever rod (7) in or out of clevis (6) to obtain full throttle at fuel injection pump when throttle pedal (4) is depressed to floor mat. Tighten clevis lock nut when correct adjustment is made.

HAND THROTTLE ADJUSTMENT

Adjust hand throttle as instructed previously under "Hand Throttle Adjustment" in GASOLINE ENGINES (SEC. 6A) of this manual.

ENGINE STOP CONTROL

1. With engine stopped, loosen screw which secures control wire to swivel, then push engine stop handle completely in.
2. Move stop lever on injection pump as far as possible toward end of control wire, then tighten screw to secure control wire to swivel. Be sure lever clamp bolt is tight.
3. Start engine and check operation of stop control.

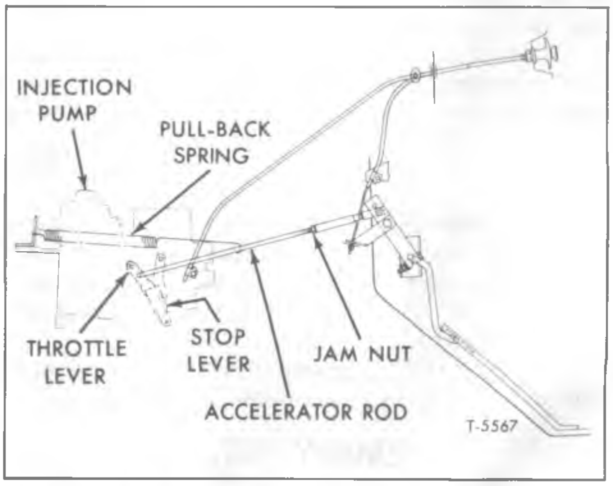


Figure 1—Conv. Cab Accelerator Linkage (Typical)

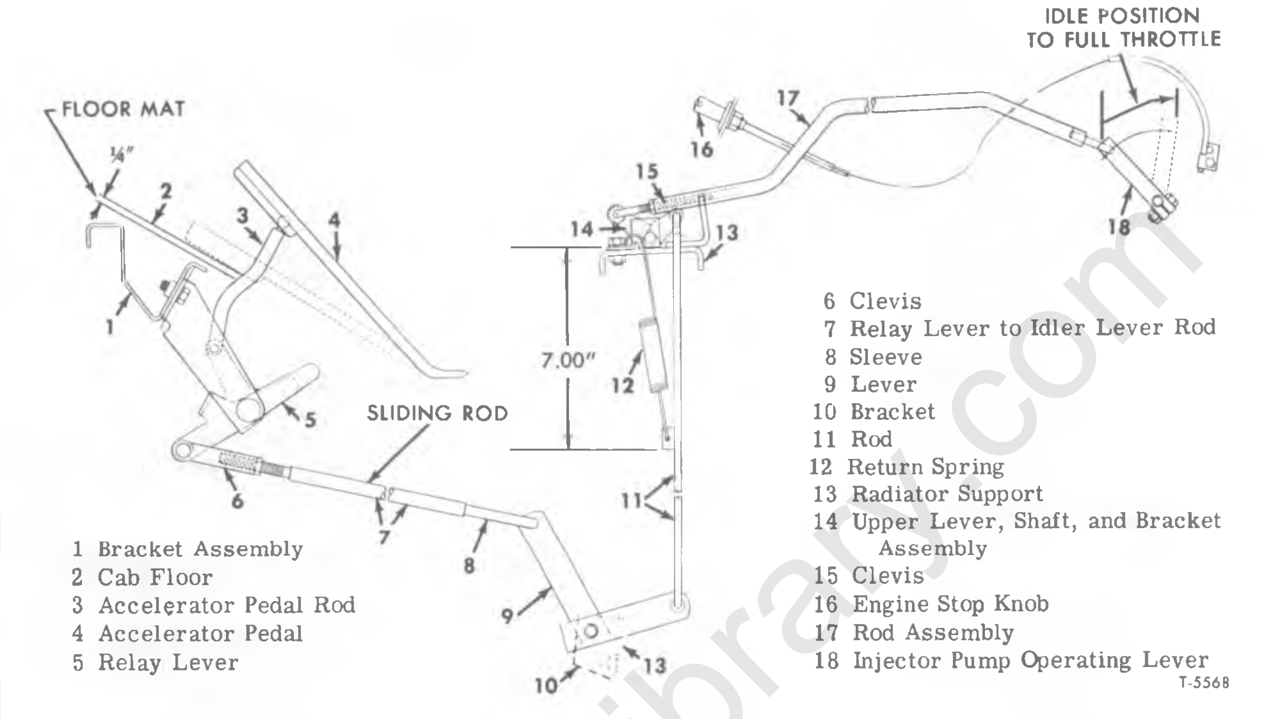


Figure 2—Steel Tilt Cab Accelerator Linkage for Toro-Flow Diesel (Typical)

AIR CLEANERS

WARNING: BE SURE ALL COMBUSTIBLE CLEANING FLUID (GASOLINE, SOLVENT, KEROSENE, ETC.) IS REMOVED FROM AIR CLEANER AT TIME OF CLEANING. UNCONTROLLED FUEL ENTERING THE COMBUSTION CHAMBER OF A DIESEL ENGINE CAN CAUSE THE ENGINE TO "RUN-AWAY" AND POSSIBLY DESTROY ITSELF AND/OR CAUSE INJURY TO PERSONNEL.

All clamps and connections between air cleaner and intake manifold must be kept tight to prevent unfiltered air from entering the engine.

If air cleaner becomes clogged, restricted air flow will cause increased fuel consumption, power loss, and possible engine damage. If air cleaner is operated in a dust storm area, it should be cleaned immediately after such storms occur.

Air cleaner must be serviced at regular intervals as specified in LUBRICATION (SEC. 0) in this manual or more frequently for extensive operation under severe conditions.

FUEL FILTERS

Fuel filter elements on Toro-Flow engines should be replaced at intervals specified later under each type of filter. Element replacement intervals are dependent upon cleanliness of the fuel and storage facilities.

IMPORTANT: Neglect of filters can lead to eventual damage to certain fuel components.

PRIMARY FILTER

Primary filter is disposable element type and is bracket-mounted on engine as typically illustrated in figure 3.

At regular intervals, depending upon operating experience, drain a small amount of fuel from filter and observe for presence of water or other foreign matter. Element should be replaced at 5,000 to 10,000 mile intervals.

ELEMENT REPLACEMENT

1. Remove drain plug or open drain cock to drain the filter.

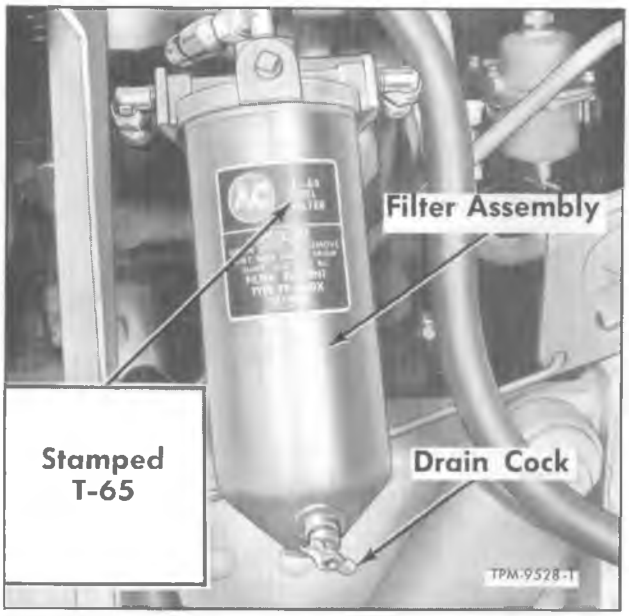
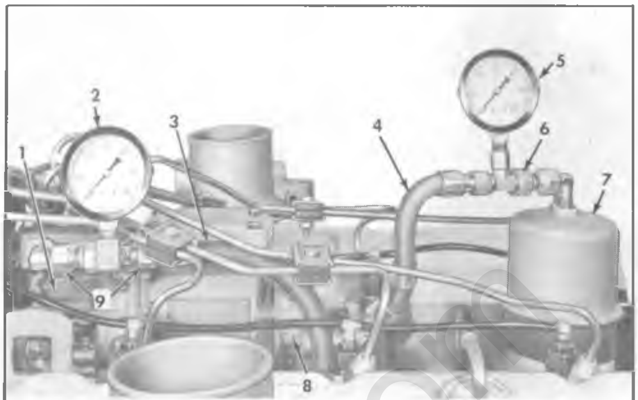


Figure 3—Primary Fuel Filter (Typical)



1 Fuel Injection Pump	5 Pressure Gauge
2 Pressure Gauge	6 Gauge Adapter Fittings
3 Secondary Filter Outlet Line	7 Secondary Filter
4 Secondary Filter Inlet Line	8 Fuel Pump
	9 Gauge Adapter Fittings

Figure 4—Testing Secondary Filter

2. Loosen bolt at top of filter until shell and element can be removed.
3. Lift element from shell and discard.
4. Wash all parts with solvent to remove all accumulated matter.
5. Install new element in shell then position element and shell assembly to base using gaskets furnished with new element. Fill shell with fuel.
6. Tighten cap screw securing shell in place. Check filter connections and fuel lines for leaks and tighten if necessary.

SECONDARY FILTER

Frequency of changing the secondary filter must be established by experience gained in actual operation of vehicle. Filter is illustrated in figure 4, Item 7.

Regular filter replacement intervals should not exceed 10,000 miles. Under the most severe conditions filter should be replaced every 6,000 miles. Filters should also be replaced whenever a pressure drop across the filter reaches 15 psi before the 10,000 mile replacement.

Secondary filter can be checked as follows:

1. Clean all accumulated particles of dirt from fittings and lines at top of secondary filter and fuel line junction at left side of fuel injection pump housing.

IMPORTANT: Every precaution must be taken to prevent dirt from entering fuel passages as fuel lines are disconnected and test equipment is installed.

2. Disconnect fuel flexible line from fitting at top of secondary filter and install pressure gauge which is part of testing set (J-21731) (fig. 4).
3. At fuel injection pump supply line fitting, disconnect fuel line, and assemble adapter fitting (9, fig. 4) and pressure gauge (also part of set mentioned in previous step 2).

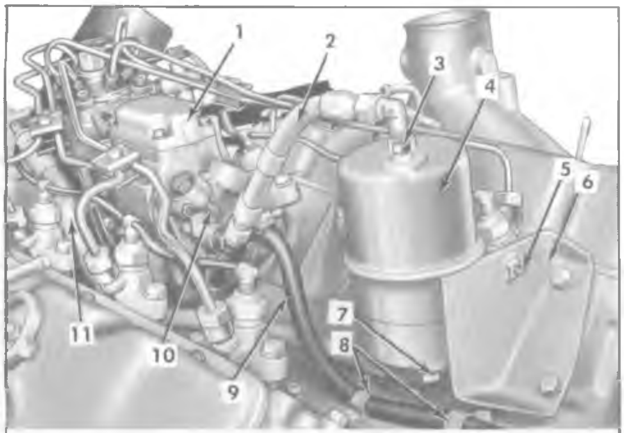
Refer to figure 4 for view of test gauges assembled in lines.

4. Allow adapter fittings (6 and 9, fig. 4) to remain loose enough to bleed out any air, and allow engine to idle until fuel begins to flow, then tighten the fittings.
5. With engine running, observe pressures on the two gauges (fig. 4). Normal pressure on gauge (5) in filter inlet line should be 40 to 50 psi. If secondary filter is in satisfactory operating condition, the reading on gauge (2) will show approximately 5 psi lower reading than that shown on gauge (5). If the pressure drop (differential) is greater than 15 psi between the two gauges, a partially clogged filter is indicated and the secondary filter assembly should be replaced.
6. After completing pressure checks, remove gauges and adapter fittings and connect fuel lines in original position, bleed out any air which may have been trapped in lines, and inspect line connections for leaks. If test has indicated need for secondary filter replacement, follow the instructions given below to install new filter assembly.

REPLACING SECONDARY FUEL FILTER ASSEMBLY

Key numbers in following text refer to figure 5.

1. Clean accumulated dirt from fittings at top



1 Fuel Injection Pump Assembly
2 Pump Discharge Line
3 Bleeder Plug
4 Secondary Filter
5 Filter Clamp Bolt
6 Filter Mounting Bracket
7 Filter Drain Plug
8 Clips
9 Fuel Suction Line (To Pump)
10 Fuel Pump Assembly
11 Fuel Supply Line (To Injection Pump)

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Figure 5—Secondary Fuel Filter and Connecting Lines

of filter assembly.

2. Loosen nut connecting line (2) to elbow on filter, then loosen filter clamp bolt (5). Raise filter (4) in the bracket to provide access to drain plug (7) and nut connecting line (11) to elbow at bottom of filter.

3. Remove bleeder plug (3), then remove drain plug (7) and drain filter into receptacle.

CAUTION: Use care to prevent dirt from entering fuel lines when replacing filter.

4. Clean fittings at bottom of filter of dirt, then disconnect line (11) at elbow. Disconnect line (2) from filter elbow, then remove filter assembly from bracket (6). Remove inlet and outlet elbows from filter assembly.

5. Install inlet and outlet elbows in new filter. Position new filter assembly at bracket (6) with word "TOP" upward. Connect line (11) to elbow at bottom of filter, and connect line (2) to elbow at top of filter.

6. Tighten fuel line nuts, check drain plug (7) for tightness, then position filter in clamp and tighten filter clamp bolt (5). Remove vent (bleeder) plug from top of fuel filter and fill filter with CLEAN fuel. Install plug loosely, start engine, and run at idle. Watch for fuel to flow at plug (3). When bubbles cease to appear and fuel flows steadily, tighten plug (3) securely.

If filter becomes excessively restricted, it will result in loss of engine power and could result in expensive fuel injection pump repair. Therefore, it is important to service fuel filters at specified intervals.

Fuel Injection System
(V6 TORO-FLOW ENGINE)

DESCRIPTION

FUEL INJECTION PUMP ASSEMBLY

The fuel injection pump assembly is of the PSJ Series manufactured by American Bosch Arma Corporation. See figure 1 for schematic of pump system.

Injection pump assembly is mounted on machined rear face of engine front cover assembly. Pump assembly is held in place by studs and nuts.

The high pressure pump is the single plunger type, which distributes equal amounts of fuel to the fuel injection nozzles, at the cylinders, in the proper firing sequence.

Injection pump is gear driven from a pump drive gear bolted to front face of engine camshaft gear. Pump input shaft, on which the pump driven gear is mounted, rotates at engine crankshaft speed.

The pump plunger is operated by a rotating camshaft having three lobes. Thus, fuel is injected for firing three cylinders during each crankshaft revolution.

Included in the fuel injection pump assembly are the following units or devices:

1. Fuel supply pump.
2. Hydraulic head assembly.
3. Timing advance mechanism.
4. Governor and fuel control unit.
5. Excess fuel device for starting.

An overflow valve assembly is installed on the hydraulic head housing and incorporates a valve assembly which maintains proper fuel pressure within the fuel chamber to assure an adequate supply of fuel to the pump plunger at all times.

Fuel Supply Pump

The fuel supply pump is bolted to rear face of the governor housing and is equipped with inlet and outlet fittings. The fuel supply pump is of the positive displacement gear type, and pump incorporates a relief valve assembly to insure against excessively high pressure.

Supply pump drive is from rear end of governor drive shaft assembly.

Hydraulic Head Assembly

The hydraulic head assembly which pumps fuel under high pressure to the fuel injection nozzles, is mounted in upper front portion of the injection pump assembly, directly above the pump camshaft lobes.

The hydraulic head bore is fitted with a pump plunger, the lower end of which seats in the tappet roller guide. Precision drilled fuel passages in the head carry fuel from the plunger distributing annulus to the outlet ports in upper surface of head block.

The plunger pumping action is provided by the tappet roller which is held in contact with the rotating camshaft lobes by a plunger return spring.

Rotary motion of pump plunger is supplied by a "face gear" below the hydraulic head. Face gear is engaged with a set of gear teeth on governor drive gear. Two revolutions of the governor drive gear cause one rotation of the face gear and pump plunger.

Pump plunger has a passage drilled from upper end down to the metering sleeve area. A hole drilled radially in the plunger intersects the vertical drilling. The drilling or "spill" port is located in the area of fuel metering sleeve which is installed on plunger and located by pin in the control unit assembly.

Installed at top of hydraulic head assembly is a fuel delivery valve assembly, through which the metered quantities of fuel must pass. Fuel discharged through the delivery valve passes through a duct in hydraulic head to the distributing annulus in plunger. Refer to figure 1 for view of hydraulic head and related mechanism.

Timing Advance Mechanism

The fuel injection timing is automatically advanced by means of the device shown in figure 2, which is assembled in a cavity provided in the injection pump drive shaft.

The advance mechanism provides the means for varying the point at which the fuel injections into cylinders occur.

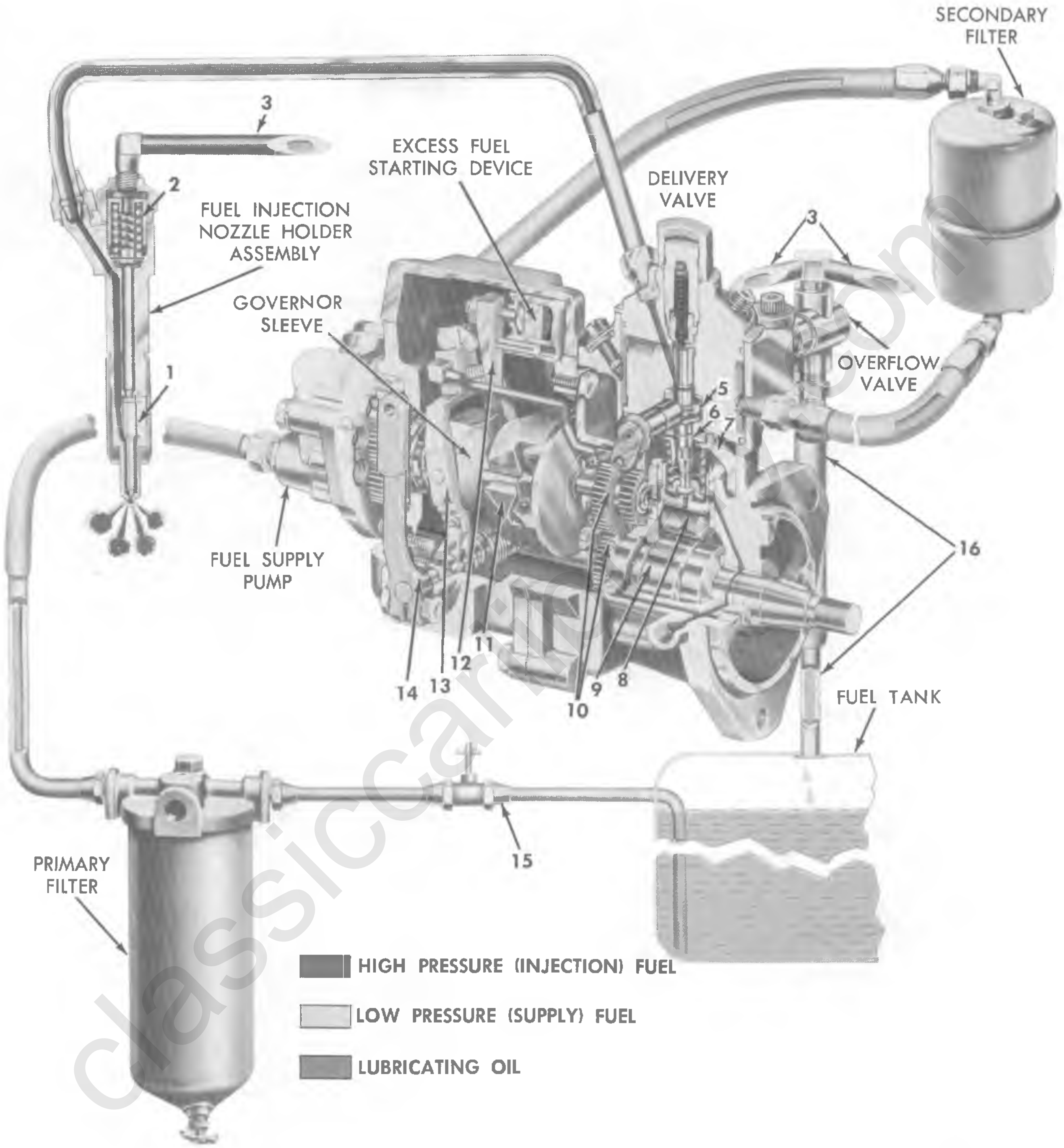
Advance in timing is accomplished by slightly rotating the cam in relation to the pump drive shaft.

As the splined sleeve is moved in longitudinal direction, the spiral splines cause a repositioning of cam in relation to the pump drive shaft. Splines on sleeve are engaged with mating splines on drive shaft and in cam.

Governor and Fuel Control Unit

The gear teeth at rear end of pump drive shaft are meshed with the governor drive gear teeth. Governor gear drives the governor shaft on which

FUEL INJECTION SYSTEM—TORO-FLOW ENGINE



1 Nozzle Valve and Body
2 Nozzle Valve Spring
3 Leak-off Lines
4 Hydraulic Head Assembly
5 Fuel Metering Sleeve
6 Pump Plunger
7 Face Gear
8 Tappet and Roller
9 Cam
10 Governor Gears
11 Governor Weights
12 Governor Stop Plate
13 Fulcrum Lever
14 Stop Lever
15 Shut-off (when used)
16 Fuel Return Line

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Figure 1—Schematic Arrangement of Fuel System Units (Typical)

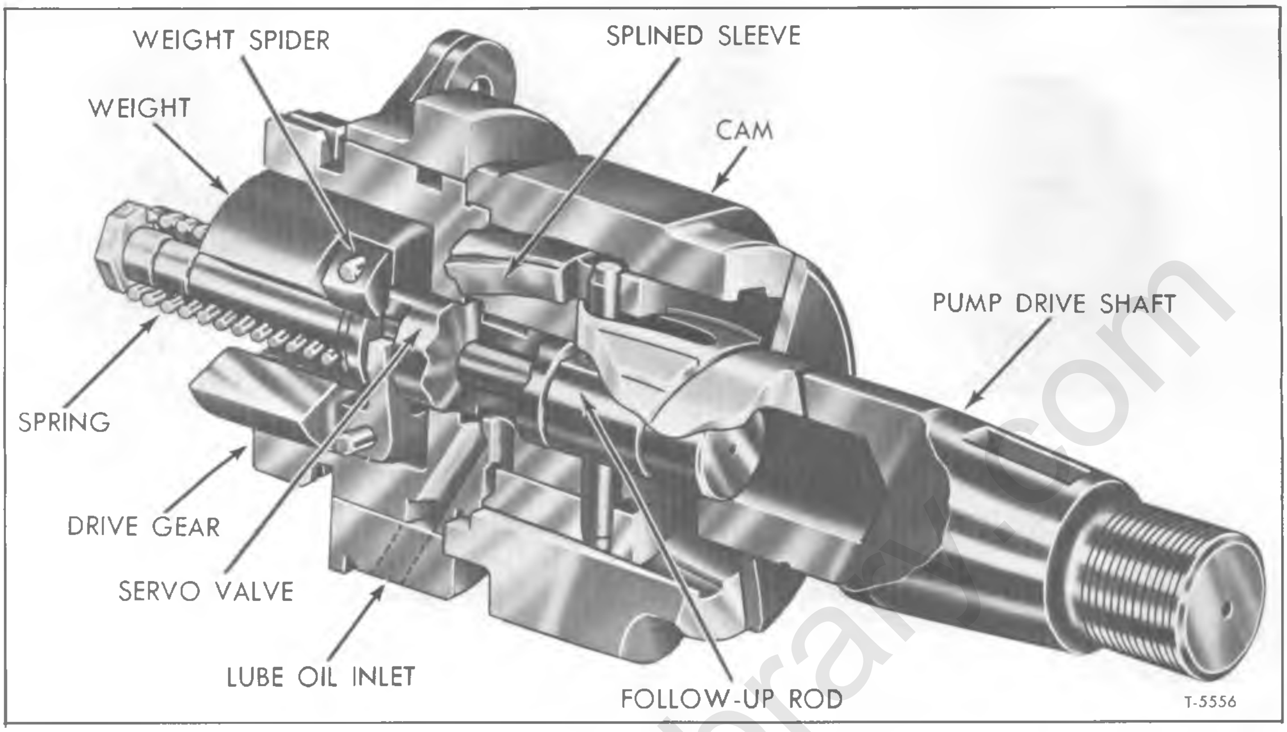


Figure 2—Timing Advance Mechanism

are installed the governor weights, governor sleeve, and inner and outer governor springs. The governor fulcrum lever assembly is assembled with pivot pins engaging slots in either side of governor sliding sleeve. Lower end of fulcrum lever is linked to an operating shaft internal lever at lower end, and to control unit rod at upper end. Outer lever attached to the operating shaft is connected to engine throttle control linkage. When an increase in engine speed is desired and accelerator is depressed, internal linkage below the governor sleeve moves the lower end of fulcrum lever rearward, fulcrum lever pivots on pins at sliding sleeve and upper end of fulcrum lever is moved forward; thus movement is transmitted through control rod to the control unit which raises the metering sleeve on injection pump plunger. Raising the metering sleeve causes an increase in the quantity of fuel injected with each stroke of pump plunger.

With accelerator held in the maximum speed position, engine speed will increase until the governor weights acting on the sliding sleeve force the fulcrum lever rearward. This governor action causes the metering sleeve position to be lowered, thereby reducing the quantity of fuel injected with each plunger stroke and causes reduction in engine speed. Thus, the governor limits the engine speed to the rpm for which the mechanism has been set. In a similar manner, the governor responds automatically to increase or decrease the amount of fuel injected to maintain torque output with varying load conditions. The idle speed adjusting screw is used to stop the internal lever in a position to provide desired idle speed.

Excess Fuel Starting Device

To provide an increased quantity of fuel for starting purposes, the injection pump assembly incorporates a device which automatically changes the position of the governor stop plate assembly.

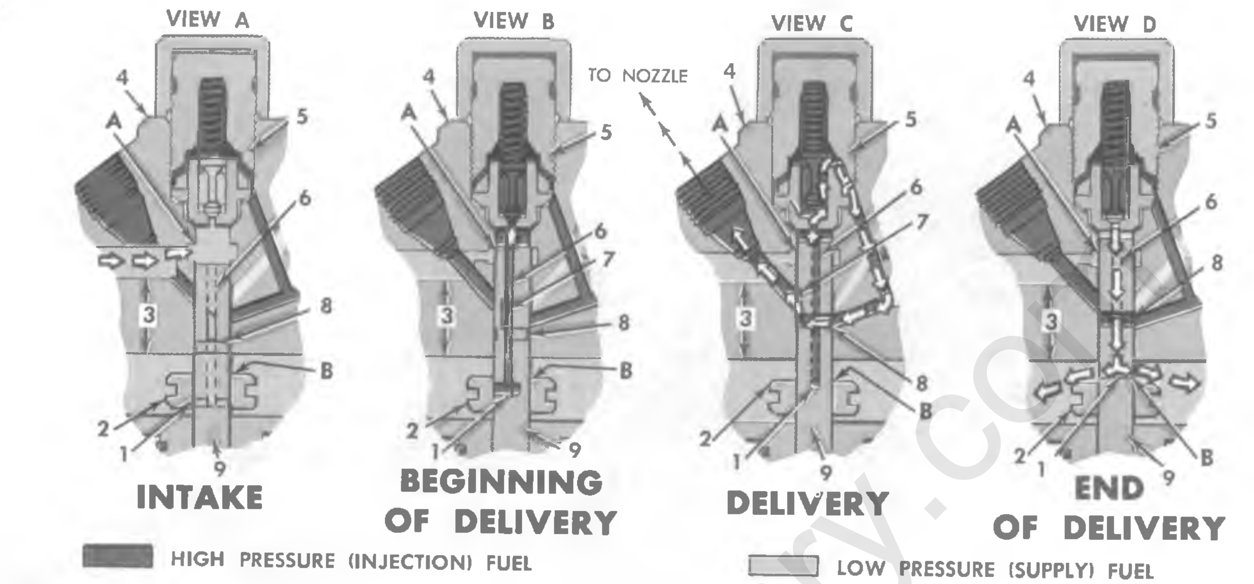
Under normal operating conditions, engine lubricating oil pressure is applied to the starting device piston to hold the governor stop plate in its normal run position (toward the smoke limit cam on upper end of fulcrum lever).

When engine is stopped, no engine oil pressure exists, and the governor stop plate moves forward to a position which permits the fuel metering sleeve on pump plunger to be raised above its normal position, thereby allowing a greater quantity of fuel to be injected into cylinders for easier starting. As soon as engine is started and oil pressure begins to build up, the starting device piston is forced back to end of bore and governor stop plate assembly is returned to normal run location.

FUEL INJECTION PUMPING PRINCIPLE

The various stages in the fuel injection pumping cycle are illustrated in figure 3. The pumping

FUEL INJECTION SYSTEM—TORO-FLOW ENGINE



1 Spill Port
2 Metering Sleeve
3 Low Pressure Fuel Chamber
4 Hydraulic Head Assembly
5 Fuel Delivery Valve
6 Fuel Passage in Plunger
7 Distributing Slot in Plunger
8 Plunger Annulus
9 Plunger

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Figure 3—Fuel Pumping Principle

action is described in the following paragraphs:

NOTE: Key numbers in text refer to figure 3.

FUEL INTAKE (VIEW A, Fig. 3)

When plunger (9) is at the bottom of the stroke, having been brought to that position by the plunger return spring and tappet which is contacting the base circle of the cam profile, the fuel flows from the fuel chamber (3) through a series of inlet ducts in the hydraulic head and fills that portion of the plunger bore cavity above point "A" between the top of the plunger and the bottom of the delivery valve (5). The delivery valve (5) is closed due to the tension of the delivery valve spring.

BEGINNING OF DELIVERY (VIEW B, Fig. 3)

As the rotating plunger (9) moves upward in its stroke under cam action it closes the head groove and inlet ports, thus trapping the admitted fuel and building up pressure until the spring loaded delivery valve (5) is lifted and opened.

DELIVERY (VIEW C, Fig. 3)

As the plunger (9) continues its upward stroke the fuel passes through the delivery valve bore and is conveyed through the communicating ducts to the annulus (8) in the plunger which connects to the vertical distributing slot (7) on the plunger. This vertical distributing slot registers, on successive pumping strokes, with each of the high pressure outlets in the head so that this portion of the plunger serves as a distributor as it is rotated continually by its drive gear. The rotating and reciprocating motions of plunger (9) are so phased in relation to the outlet ducts that the vertical distributing slot (7) overlaps only one outlet duct during each effective portion of each stroke.

END OF DELIVERY (VIEW D, Fig. 3)

After sufficient upward movement of the plunger (9), the spill port (1) passes upper edge (Point "B") of the metering sleeve (2) and the fuel under pressure escapes down the fuel passage (6) in the center of the plunger, then into the chamber surrounding the metering sleeve (2). The fuel pressure then drops to equal the supply pressure. With the drop in fuel pressure, the delivery valve (5) closes during which action the piston portion of the delivery valve (5) blocks the passage before the valve reaches its seat and thus performs its function of reducing the residual pressure in the discharge system. This is the end of the pumping cycle.

FUEL METERING PRINCIPLE

Key numbers in following text refer to figure 4, except as otherwise indicated. Figure 4 shows three positions of the fuel metering sleeve on the injection pump plunger.

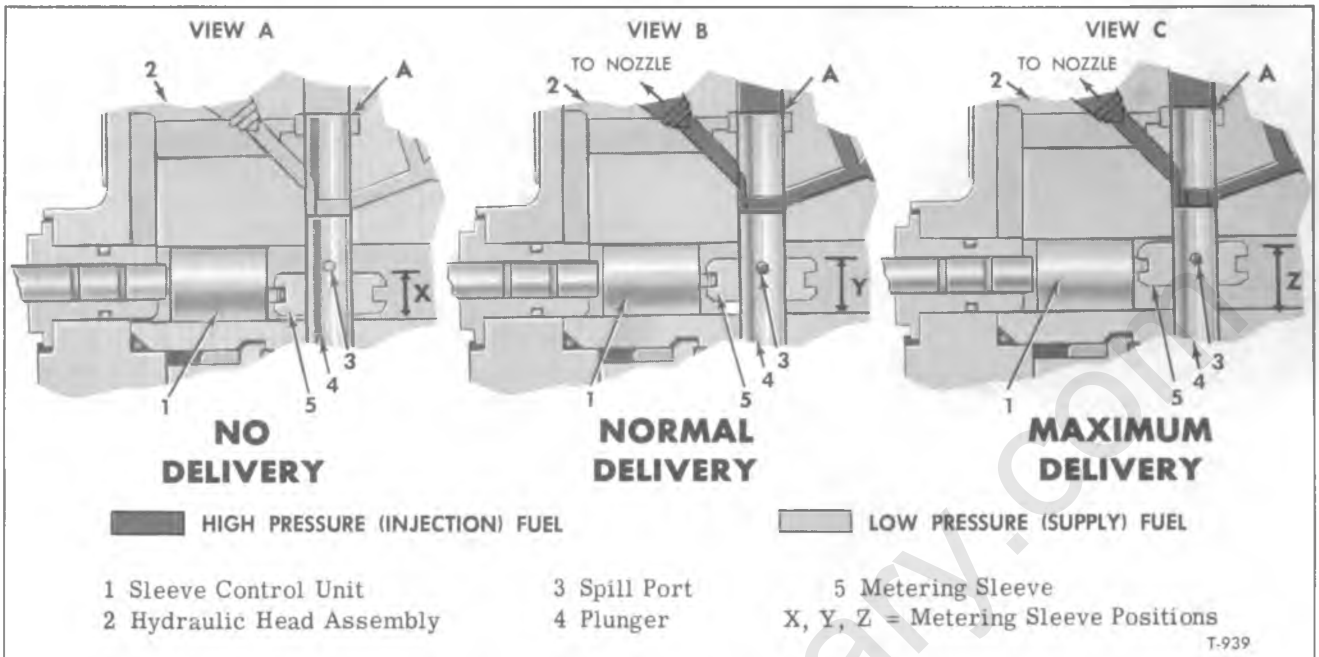


Figure 4—Fuel Metering Principle

Quantity of fuel delivered per stroke is governed by variation of the position of the metering sleeve (5) in relation to the fixed port closing position (Point "A" at which the top of the plunger covers the intake ports), for as the spill port (3) on the plunger (4) breaks over the top edge of the metering sleeve (5), pumping pressure is relieved down through the center hole of the plunger out into the sump surrounding the metering sleeve; and fuel delivery terminates despite the continued upward movement of the plunger (4).

NO DELIVERY (VIEW A, Fig. 4)

This view shows "no delivery" position. When the metering sleeve (5) is lowered to its extreme position "X," the spill port (3) on plunger (4) is uncovered at the top edge of the sleeve (5) before the upper end of the plunger can cover the intake ports. Under this condition no pressure can be built up even after the ports are closed, hence no fuel can be delivered. This is also the shut-off position. Therefore, the upward movement of metering sleeve (5) increases the quantity of fuel pumped per stroke and downward movement decreases the quantity of fuel pumped per stroke, until the point of zero delivery is reached.

NORMAL DELIVERY (VIEW B, Fig. 4)

As the metering sleeve (5) is moved upwards to point "Y," Spill port (3) on plunger (4) emerges above the sleeve slightly later in the plunger stroke, hence the effective stroke of the plunger is sufficient to deliver fuel per engine requirement.

MAXIMUM DELIVERY (VIEW C, Fig. 4)

If the position of metering sleeve (5) is raised toward position "Z," the spill port on plunger (4) remains covered by the sleeve until relatively late in the plunger stroke, hence the effective stroke of the plunger is longer and more fuel is delivered. Maximum fuel delivery occurs when metering sleeve (5) is raised to position "Z" to provide excess fuel for starting.

FUEL INJECTION PUMP LUBRICATION

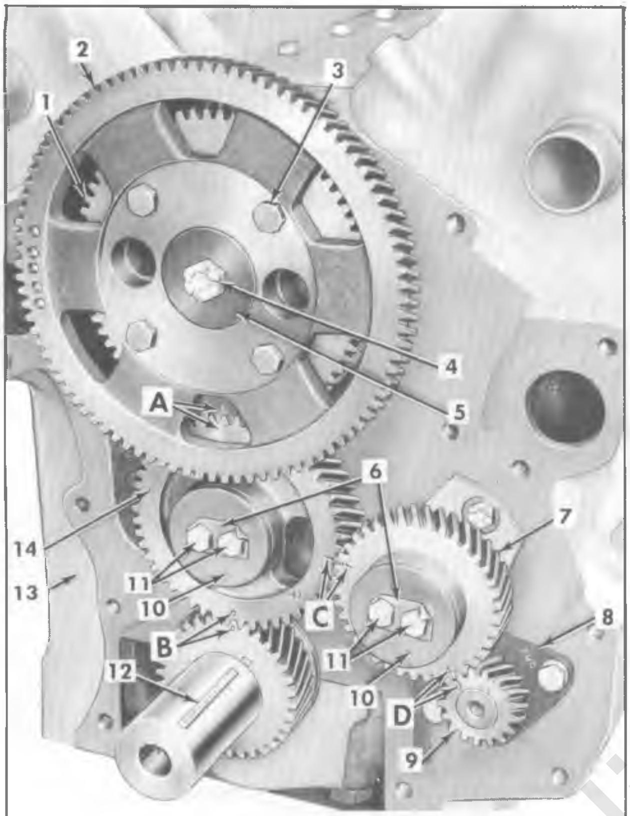
The fuel injection pump assembly is lubricated by engine lubricating oil supplied by engine oiling system to a fitting on side of pump housing.

After passing through various passages to lubricate gears, bearings, tappet roller, and other moving parts, the oil flows by gravity out of the pump housing and into engine front cover where it returns to engine crankcase.

FUEL INJECTION PUMP DRIVE

The fuel injection pump assembly is gear driven through gear train enclosed in the engine front cover assembly. Refer to figure 5 for view of gear train and timing marks. An inspection cover on top of the engine front end cover is provided for access to injection pump driven gear on all engines. This cover provides view of pointer and pump drive hub timing mark for use in timing the injection pump to the engine.

FUEL INJECTION SYSTEM—TORO-FLOW ENGINE



1 Camshaft Gear	8 Balance Shaft Thrust Plate
2 Injection Pump Drive Gear	9 Balance Shaft Gear
3 Drive Gear Bolts	10 Gear Retainer Plate
4 Self Locking Bolt	11 Plate Retaining Bolts
5 Camshaft Gear Retainer	12 Crankshaft Balancer Key
6 Lock Plates	13 Cylinder Block
7 Balance Shaft Idler Gear	14 Camshaft Idler Gear

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Figure 5—Gear Train and Timing Marks

Refer to figure 1 for schematic arrangement of injection pump internal mechanism.

FUEL INJECTION NOZZLES

Fuel under pressure is fed from the rotary single plunger injection pump to the appropriate nozzle via the high pressure pipe line and finds its way through the ducts in the nozzle holder and valve body to the lower end of valve.

When the fuel pressure reaches 3,000 psi, the valve will lift, and fuel is injected through holes in nozzle tip and into combustion chamber. Nozzle valve closes again when the line pressure drops. Any leak-back through the leak-off line fitting is passed back to the junction fitting on injection pump overflow valve.

FUEL INJECTION NOZZLE HOLDER ASSEMBLIES

The fuel injection nozzle and holder assemblies are utilized to carry the high pressure fuel (red color in fig. 1) through the cylinder head to nozzle tip and deliver it to the combustion chamber in the form of a finely atomized spray through the precision-drilled spray holes in the tip.

The nozzle holder consists of a forged body which houses the spindle and spring, and has a high pressure fuel duct. The spindle bore and spring chamber are utilized as a passage for leak-off fuel which seeps past and lubricates the nozzle valve.

The nozzle valve and body are a closely matched pair of parts which must always be used together as a unit. VALVES AND VALVE BODIES ARE NOT INTERCHANGEABLE; however, matched nozzle and valve assemblies are available for service replacement. Refer to "Nozzle and Holder Assembly Maintenance" covered later in this section under "Fuel Injection Nozzles." Nozzle and valve assembly is located on nozzle holder by dowel pins and the assembly is firmly seated at lapped mating surfaces on body and nozzle holder by the nozzle cap nut. A high pressure duct in nozzle valve body registers with the corresponding duct in nozzle holder to carry high pressure fuel to the valve seat area. Pressure spring at upper part of holder seats at a flange on spindle, and spring is retained by the pressure adjusting nut. Spring pressure is transferred through the spindle to the nozzle valve. Spring holds the valve on its seat in nozzle body.

A perfect seal is necessary at valve seat to prevent fuel dribble as well as to prevent any of the combustion gases in cylinder from entering the spray nozzle interior chamber.

The cap nut at upper end of nozzle holder assembly serves to lock the spring adjusting nut and is threaded to accept a leak-off tee or elbow to which is attached the leak-off hose.

A high pressure fuel line from outlet port in injection pump hydraulic head is connected to threaded portion on nozzle body forging.

The fuel injection nozzle holder assemblies are held in place in cylinder heads by two bolts; and a copper gasket is used at bottom of each nozzle well in head.

FUEL LINES

FUEL SUPPLY AND RETURN LINES

Rigid supply lines carry fuel from fuel tank and primary filter along vehicle frame to a point near the rear end of engine. A similar return line carries fuel from engine to fuel tank. Flexible hoses are employed to connect supply line to inlet fitting at fuel supply pump, and to connect the outlet fitting on overflow valve (at injection pump) to the rigid return line at frame rail. Clips are used to secure the fuel lines.

Flexible high pressure line assemblies are used to transfer fuel from supply pump to secondary filter, and from filter to the fuel injection pump.

LEAK-OFF HOSES

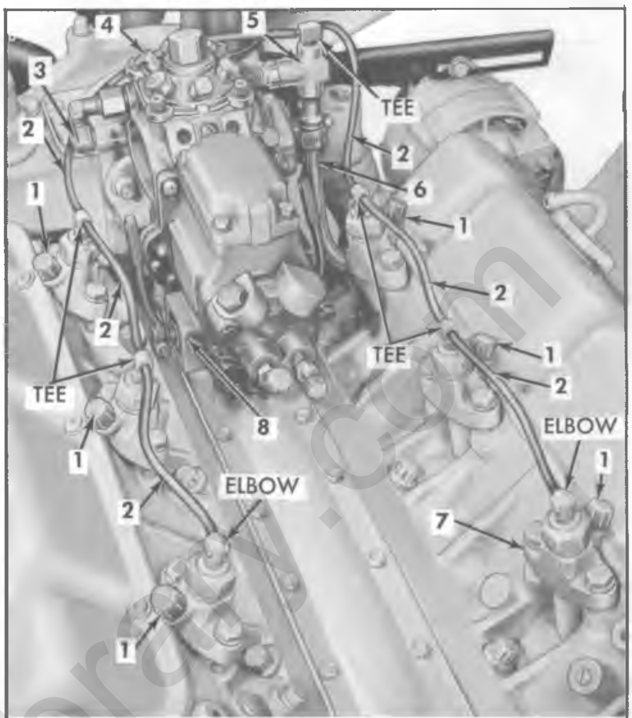
Leak-off lines are used to interconnect the fittings on the fuel nozzle holders to the overflow valve assembly. Leak-off line installation is shown in figure 6.

HIGH PRESSURE LINES

The high pressure lines, which carry high pressure fuel from injection pump hydraulic head to the injection nozzle holder assemblies, are of special thick-wall tubing. High pressure lines are carefully preformed to assure a good fit at respective locations without bending or stressing. The fuel line duct is the same length in all lines on any one engine.

Each line must be used in the location for which it is designed, and none of the high pressure lines are interchangeable. Refer to figure 27 for fuel lines routing at engine.

The high pressure line clamps dampen vibrations which would tend to cause fatigue and breakage of lines.



1 Dust Cap on Nozzle Holder Fitting
2 Leak-off Line
3 Dust Cap on Injection Pump Fitting
4 Plastic Plugs in Hydraulic Head
5 Overflow Valve Assembly
6 Fuel Return Line
7 Nozzle Assembly (6 Used)
8 Injection Pump Assembly
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Figure 6—Leak-Off Lines and Overflow Valve (Typical)

COLD WEATHER OPERATION

1. Fuel oil must conform to Factory recommended specifications. Your GMC Dealer can supply you with these specifications.

2. Neglect of fuel filter service can be one of the major contributing factors to hard starting. If water is permitted to accumulate in the primary filter it will freeze and make starting the engine impossible.

3. Adding one pint of alcohol to each tank of fuel oil during freezing weather is an excellent safeguard against water freezing in fuel tank, lines, and filter.

4. Make sure vent in fuel tank cap is open.

5. Always refuel at the end of a run to help keep out moisture. Moisture may condense in a nearly empty tank, therefore, tank should be filled before leaving vehicle standing for an extended period.

FUEL INJECTION SYSTEM TROUBLE DIAGNOSIS

When trouble with engine starting or performance is experienced, it is important to follow a definite procedure in checking possible causes of trouble. The "Fuel System Trouble Diagnosis Chart" provided on the following page should be used as a guide in analyzing symptoms and correcting difficulties which may occur in fuel injection system.

CHECKING FOR AIR LEAKS IN FUEL SUPPLY (SUCTION) LINE

If, when diagnosing fuel system problems, it is suspected that trouble may be caused by air leaks in line or fittings between the fuel supply pump and the fuel tank, the following means may be used to check for air in system.

CAUTION: Exercise necessary care to prevent any dirt from entering the fuel system when fuel lines are disconnected in making following tests:

1. Disconnect outlet line from fuel supply pump and install sight glass, or plastic line so that fuel may be observed while engine is running.

2. Start engine, then look for air bubbles in the pump discharge line. If bubbles are present, air is being drawn into system, either through defective lines, primary filter, or fittings, or possibly through supply pump oil seal or gasket.

FUEL SYSTEM TROUBLE DIAGNOSIS CHART

PROBABLE CAUSES	Low Power	Poor Performance, Surge, Erratic Governor Action	Rough Idle Vibrating Engine	Excessive Exhaust Smoke (Black)	Excessive Exhaust Smoke (White-Blue)	High Fuel Consumption	Engine Overspeeds	Hard Starting	Engine Overheating	No Start	RECOMMENDED REMEDY
1. Engine Stop Mechanism Out of Adjustment or Not Functioning	X	X	X					X		X	Refer to "Diesel Engines" in this section for control linkage adjustments.
2. Accelerator Linkage A. Out of Adjustment	X	X	X					X		X	Make necessary adjustments or repairs to Accelerator Linkage as instructed in "Diesel Engines" in this section.
B. Binding or Broken.	X	X	X								
3. Inadequate Fuel Supply A. Fuel Filters Clogged	X	X	X					X		X	Service or replace the fuel filters as previously directed under "Diesel Engines" in this section.
B. Defective Fuel Supply Pump	X	X	X					X		X	Overhaul or replace fuel supply pump.
C. Overflow Valve or Spring Defective	X	X	X					X		X	Remove and disassemble overflow valve. Replace parts as necessary.
D. Fuel Tank Vent Plugged	X		X					X			Clean vent or replace cup.
E. Air Entering System	X	X	X					X		X	Make necessary repairs to eliminate air leaks.
4. Fuel Injection Nozzles A. Nozzles Defective, Leaking, or Worn	X	X	X	X		X		X			Overhaul and/or adjust injection nozzles. Procedure for servicing nozzles is given later in this section.
B. Incorrect Nozzle Opening Pressure	X		X	X		X		X			Remove nozzle, test and adjust as necessary.
C. Incorrect Torque on Nozzle Holder Bolts		X				X					Use torque wrench and check nozzle bolt torque.
D. Nozzle Valve Sticking	X										Overhaul nozzle assembly.
E. Nozzle Seat Leaking, Dirty	X			X							Clean nozzle seat and install new gasket.
5. Adjusting Screws A. Idle Screw Out of Adjustment		X	X								Adjust as instructed under "Engine Tune-up."
B. High Speed Screw Out of Adjustment	X						X				Adjust as instructed under "Engine Tune-up."
6. Governor Springs A. Outer Spring		X	X								Check and adjust governor springs referring to procedure given in this section.
B. Inner Spring		X					X				
7. Defective Delivery Valve	X	X	X			X		X		X	Replace delivery valve assembly as directed under "Fuel Delivery Valve Replacement" in "Service Operations."
8. Damaged or Defective Hydraulic Head	X	X	X					X		X	Replace fuel injection pump with properly calibrated pump assembly. Refer to pump replacement instructions given in this section.
9. Fuel Injection Pump Out of Time with Engine	X	X	X	X	X	X		X	X	X	Refer to applicable instructions for timing the injection pump given in this section under "Injection Timing."

3. If a leak is apparent in the suction lines, filter or fittings, a sight glass or section of plastic line may be installed at inlet fitting on supply pump to determine if air is reaching pump through suction side of system. If no bubbles are observed at inlet connection, but continue to be present at outlet line, a defective supply pump is indicated. Refer to applicable procedure under "Checking for Crankcase Dilution" for method of checking and repairing fuel supply pump assembly.

NOTE: Be sure the fuel filter between fuel tank and pump is not clogged, and that filter gaskets are in good condition.

CHECKING FOR INADEQUATE FUEL PUMP DELIVERY AND/OR OVERFLOW VALVE MALFUNCTION

If it becomes necessary to check for defective fuel supply pump and/or overflow valve, proceed as follows:

1. Make necessary inspection to determine that fuel filters are not clogged.

2. Remove, clean, and inspect the supply pump relief valve assembly and spring (9 and 8, fig. 7). Valve and spring are available for service replacement. Install relief valve (9), valve spring (8), and retainer cap (7).

3. Disconnect lines from overflow valve and remove the valve assembly from the fuel injection pump. Disassemble the overflow valve, inspect parts (fig. 34). Install overflow valve or parts as required.

4. Check supply pump pressure as follows:

a. Install pressure gauge in line between supply pump outlet and secondary filter.

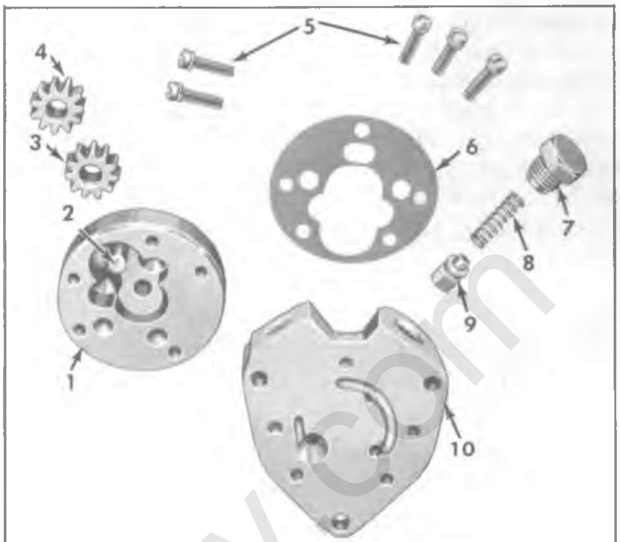
b. Gain access to the fuel return line from the overflow valve to fuel tank. Install a fuel shut-off valve at fuel tank or return fuel line in order to restrict fuel flow momentarily.

c. Open the shut-off valve and then start the engine. While running the engine at 2400 rpm, momentarily close the fuel shut-off valve. The pressure gauge should show between 60 and 65 psi.

CAUTION: Keeping the shut-off valve closed for any period of time can cause the injection pump plunger to overheat and seize.

d. If pressures are appreciably lower than specified in Step c. previously, the supply pump should be overhauled or the unit should be replaced with a new supply pump assembly. Procedure for removal, overhaul, and installation of fuel supply pump is explained later in this section of this manual.

e. Remove shut-off valve and pressure gauge.



1 Insert Assembly	6 Gasket
2 Pin (Pressed into Item 1)	7 Valve Spring Retainer Cap
3 Drive Gear	8 Valve Spring
4 Idler Gear	9 Relief Valve Assembly
5 Screws with Lock Washers	10 Pump Cover

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Figure 7—Fuel Supply Pump Components

CHECKING FOR CRANKCASE DILUTION BY FUEL

In cases when there are indications of engine lubricating oil dilution by fuel as evidenced by abnormally high oil level on dip stick, lowered engine oil viscosity (thinning) or strong fuel odor, the procedure following may be useful to find where the fuel is entering. In each case, a procedure is given to remedy the condition causing the trouble:

1. Remove fuel injection pump side cover. Start engine and observe the control unit to determine if fuel is leaking at that point. If fuel leakage is occurring, refer to procedure previously given under "Control Unit Assembly Replacement" and replace the control unit O-ring seal.

2. If, in preceding Step 1, there was no evidence of fuel leakage, refer to "Fuel Supply Pump Replacement" covered later in this section and remove the fuel supply pump.

a. Plug the outlet opening in supply pump assembly and install a compressed air hose connector in inlet port.

b. Insert special tool (J-22457) or spare governor shaft through the oil seal (9, fig. 35) to seal this opening. Use clamp or other means to hold tool or shaft during test (step c. following).

c. With pressure regulator in air supply line, apply 40 psi of air at pump inlet port, then submerge the pump assembly in fuel. Look for air bubbles rising to surface of oil. Bubbles indicate points where fuel leaks will occur during normal operation of supply pump.

d. If supply pump leaks are discovered, the defective seal, gasket, or other component must be replaced, or the supply pump overhauled or replaced by a serviceable unit. Supply pump overhaul procedure is given under appropriate headings previously in this section.

3. If no evidence of fuel leakage has been found in procedure described under Steps 1 and 2 previously, refer to "Replacing Hydraulic Head" covered later in this section. Follow applicable instructions to remove the hydraulic head assembly from fuel injection pump housing and replace head lower O-ring seal in housing (fig. 37).

SERVICE OPERATIONS

WARNING

Do not attempt to work on the fuel injection pump, nozzles, or high pressure lines in a dusty area. Extreme precautions must be taken to prevent any dust particles from entering the fuel passages in lines and nozzles. Any dirt or abrasive material permitted to enter the fuel supply port on fuel injection pump could quickly cause extensive damage to, or possibly ruin the pump hydraulic head mechanism. Figure 8 is a cut-away view of the injection pump hydraulic head which will aid in understanding the fuel system.

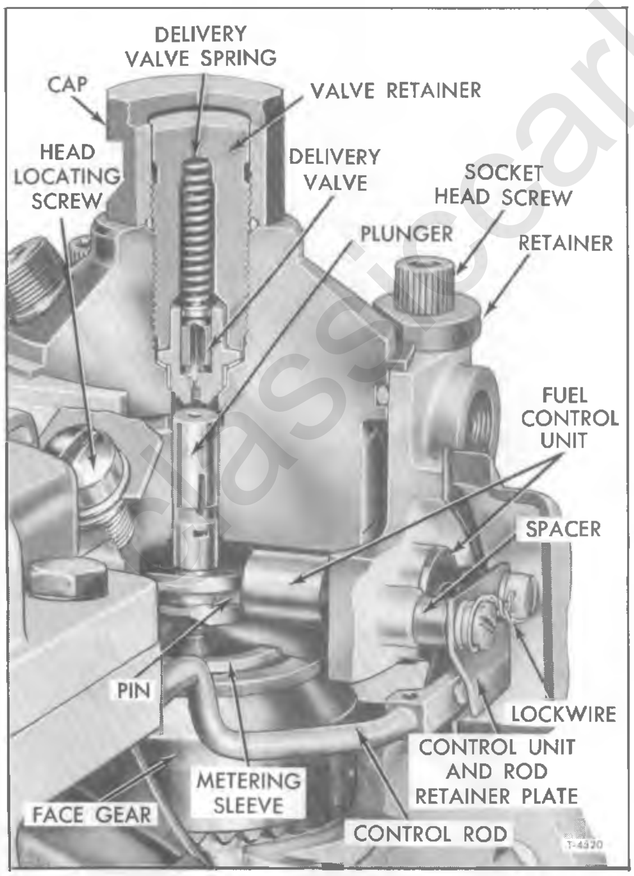


Figure 8—Hydraulic Head Showing Internal Components

PRIMING DIESEL FUEL SYSTEM

In the event fuel supply is exhausted from fuel tank, and in cases when the fuel filters, fuel injection pump and/or nozzles, or fuel lines, have been replaced it may be necessary to prime the system by use of one of the methods explained following:

ALL AIR MUST BE PURGED FROM SYSTEM BEFORE ENGINE WILL RUN PROPERLY.

METHOD A - USING MECHANICAL PUMP

A small hand operated pump which is available through the Parts Department can be installed in the fuel supply line between the fuel tank and primary filter as a temporary or permanent installation. It is suggested that a pump used as a temporary installation be equipped with flexible inlet and outlet hoses having the necessary fittings to connect into the system. Complete installation instructions are furnished with the priming pump. After installing the pump, prime the system as follows:

1. Remove plug from top of primary filter, then operate hand pump to purge all air from the primary filter back to fuel tank. Reinstall plug.

2. Remove the small hex bleed plug at the top of the secondary fuel filter (3, fig. 9) located on the engine.

3. Pump the hand primer until a clear stream of fluid flows from air bleed plug hole on the secondary filter. The bleed plug can be installed as soon as all air bubbles disappear.

NOTE: Once fuel is noticed at the secondary filter, it may take one or two minutes more before clear fluid will flow, depending upon the condition of all filters.

4. Loosen fuel inlet line fitting at left side of pump hydraulic head (11, fig. 9). Pump hand primer and purge all air from line from secondary filter to hydraulic head. Tighten line nut.

5. Disconnect the fuel return line at fuel injection pump overflow valve. Remove leak-off lines, then loosen overflow valve.

6. Again pump the hand primer until a solid stream of fuel flows from the overflow valve at the injection pump. Once clear fuel starts to flow, tighten overflow valve and the system is primed.

7. Connect fuel return lines to overflow valve.

NOTE: It will be necessary to crank the engine until fuel is supplied to the nozzles before engine will start.

IMPORTANT: Do not crank engine for more than ten (10) seconds at a time. Wait for intervals of ten (10) to fifteen (15) seconds when prolonged cranking is required. Excessive cranking may cause damage to starter windings. In addition, oil pressure will be high enough at the fuel injection pump excess fuel device to cause it to reduce fuel delivery for starting. Waiting 10 to 15 seconds will allow oil pressure to drop off and again allow excess fuel device to return to excess fuel position.

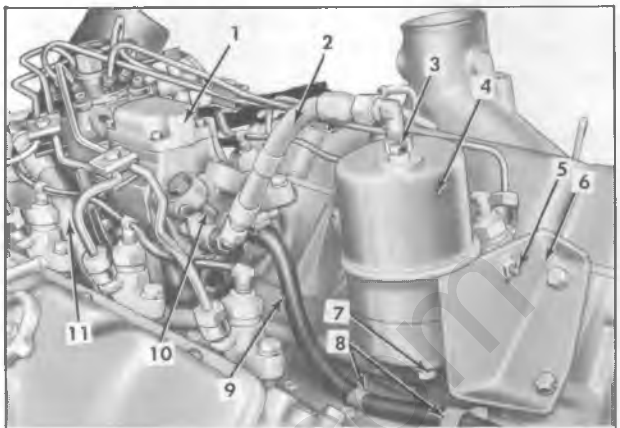
8. After engine starts, set hand throttle for 1,000 engine rpm, then loosen bleeder plug at secondary filter (3, fig. 9) and allow any air in fuel lines to purge. Tighten bleeder plug.

9. With engine still operating at 1,000 rpm, loosen fuel line nut at each fuel injector nozzle allowing any air in hydraulic head and each high pressure line to purge. As each line is purged, it is normal for engine speed to drop approximately 300 rpm. (Refer to "Fuel Injection Nozzles" later in this section for locating a misfiring cylinder.) Torque each fuel line nut to 20 to 25 foot-pounds.

METHOD B - USING PRESSURIZED SUPPLY TANK

A pressurized fuel supply tank can be used to prime the fuel system in place of the hand primer pump mentioned previously. A pressure tank can be improvised locally by using a brake system air tank or similar container equipped with a threaded type filler cap, an air pressure gauge, a fuel outlet fitting and a shut-off valve.

With the pressurized supply tank outlet valve closed, fill the tank ¾ full of clean fuel. Install the filler cap securely and apply 35 to 45 pounds air pressure to the tank. Follow the same procedure for priming the system as shown previously under "Method A - Using Mechanical Pump." The pressurized tank should be connected into the system in place of the hand pump.



1 Fuel Injection Pump Assembly
2 Pump Discharge Line
3 Bleeder Plug
4 Secondary Filter
5 Filter Clamp Bolt
6 Filter Mounting Bracket
7 Filter Drain Plug
8 Clips
9 Fuel Suction Line (To Pump)
10 Fuel Pump Assembly
11 Fuel Supply Line (To Injection Pump)

Figure 9—Fuel Secondary Filter and Connecting Lines

NOTE: The difference between the hand pump priming method and the pressurized tank priming method, is that with the former method fuel is pumped from the vehicle fuel tank through the system and not supplied from an external source.

DO NOT ALLOW FUEL SUPPLY IN PRESSURIZED TANK TO BE DEPLETED AS UNWANTED AIR WILL ENTER SYSTEM.

CAUTION

When priming the diesel engine, DO NOT prime the system with pressure exceeding 35 to 45 psi; it could cause a rupture of the element in secondary filter.

METHOD C - USING AN ORDINARY FUEL CONTAINER

NOTE: This method should be used only when priming equipment, as mentioned in the previous priming methods, is not available:

1. Procure a clean container having a small pour spout, or one with a drain tube which incorporates a shut-off. A large hand operated oil-can may also be used.

2. Remove necessary clips, bolts and nuts which will allow the secondary filter, with lines attached, to be raised and supported at an elevation slightly above the fuel injection pump. Support the filter assembly so that it remains in the raised position.

3. Disconnect lines leading to overflow valve at the fuel injection pump and loosen the valve.

4. Remove the small hex bleeder plug (3, fig. 9) from the top of the secondary filter which has been suspended.

5. Pour clean fuel into the filter through the plug hole opening and observe the overflow valve at the injection pump for presence of fuel.

NOTE: If fuel does not flow from the overflow valve threads, and the secondary filter is full of fuel, loosen the overflow valve several more turns.

6. When a clear stream of fuel flows from around the overflow valve threads at the injection pump, tighten the valve and connect the lines which were removed.

7. Continue to pour fuel into the secondary filter until full, then install hex bleed plug in filter.

NOTE: DO NOT ATTEMPT TO REMOUNT FILTER AT THIS TIME.

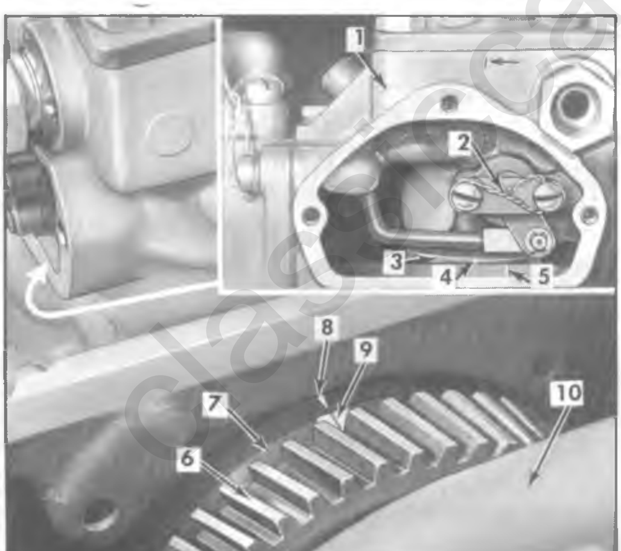
8. Remove bowl from primary filter and fill completely with clean fuel. Reinstall bowl to filter.

9. Disconnect line at top of secondary filter and slowly fill the line with fuel. When the line is full, reconnect it to the filter.

10. Start and operate engine for a few minutes, then shut it off and try to restart.

NOTE: If engine still will not start, repeat foregoing steps 1 through 9.

11. After starting the engine, lower the secondary filter into position at engine. Secure all items which were detached.



1 Injection Pump Assy.	6 Pump Driven Gear
2 Lock Wire	7 Pump Drive Hub
3 Face Gear	8 Pointer (In Pump Body)
4 Mark on Face Gear	9 Mark on Drive Hub
5 Mark on Ledge	10 Engine Front Cover

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Figure 10—Timing Marks at Face Gear and at Injection Pump Gear Flange

INJECTION TIMING

The fuel injection pump assembly is timed to the engine when pump assembly is installed, and should not require any subsequent alteration if the installation is done properly. Refer to "Fuel Injection Pump Replacement" later in this section for pump installation instructions.

In the event there is reason to suspect that fuel injection is not properly timed, the following procedure is necessary to check the timing.

CHECKING INJECTION TIMING
(WITH ALL FUEL UNITS INSTALLED)

1. Remove the cover and gasket from right side of fuel injection pump to expose the alignment marks in the opening below the control unit lever (4 and 5, fig. 10).

2. Remove the access cover and gasket from top of engine front cover assembly to expose pointer (8, fig. 10) and mark on injection pump hub (9, fig. 10).

SUGGESTION: To prevent accidental dropping of bolts, washers, etc., into engine front cover and out of reach, put clean shop cloth into cavity below the gear attaching bolts. DO NOT CRANK ENGINE UNTIL THE CLOTH HAS BEEN REMOVED.

3. Remove rocker arm cover from left-hand cylinder head, then crank engine to place No. 1 piston on compression stroke - (both valves will then be closed and push rods can be turned with fingers). Slowly crank the engine until the "INJ"

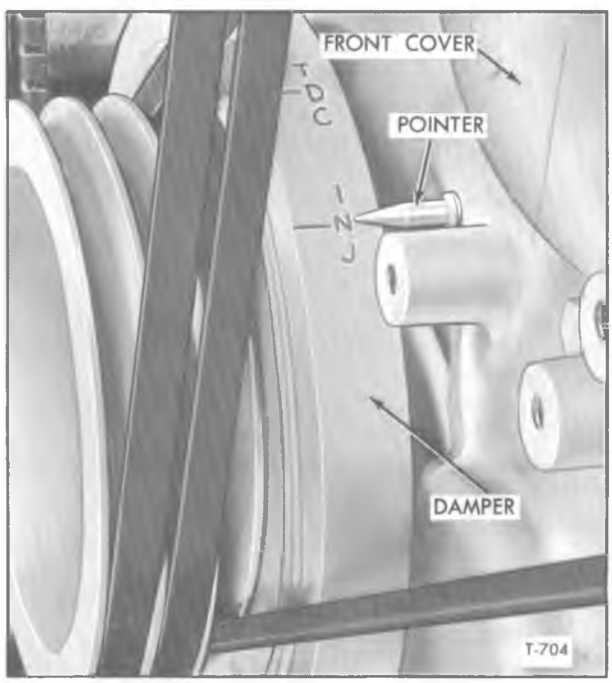


Figure 11—Timing Marks at Crankshaft Damper

mark on crankshaft damper is aligned with pointer in engine front cover (fig. 11). At this point pump should be injecting fuel into No. 1 cylinder, which will be the case if alignment marks are aligned as explained in following Step 4.

4. If engine is correctly timed, the mark and pointer (9 and 8, fig. 10) will be indexed and mark (4, fig. 10) on face gear viewed through cover opening in pump housing will be in the position shown in the inset in figure 10.

5. If the mark on pump drive hub is not indexed with pointer, or if the mark on face gear is not visible in opening, the injection timing is not correct. Before proceeding to reset the injection timing be sure No. 1 piston is on compression stroke and "INJ" mark on damper is aligned with pointer (fig. 11).

SETTING INJECTION TIMING

The elongated holes in injection pump driven gear (fig. 12) make possible the setting of injection timing when installing the fuel injection pump assembly as well as for making correction of timing when necessary.

1. With engine crankshaft positioned for firing on No. 1 cylinder (refer to Steps 3 and 4, under "Checking Injection Timing" previously) use a 7/8-inch wrench and 9/16-inch box end wrench as shown in figure 13 to loosen three driven gear mounting bolts (6, fig. 13).

SUGGESTION: With engine in time, two bolts at the top can be loosened with 9/16-inch box end wrench and third bolt at the bottom can be loosened with 9/16-inch open-end wrench.

2. With bolts (6, fig. 13) loose, and engine in time, as in Step 1 previously, use 7/8-inch wrench to turn injection pump shaft and hub as necessary to align mark on hub with pointer (3, fig. 13). Hold the shaft with wrench and tighten driven gear mounting bolts.

NOTE: Proper torque for driven gear mounting bolts is 35 to 40 foot-pounds with oiled threads.

3. After fuel injection pump gear mounting bolts are tightened, turn engine over slowly to bring timing marks into alignment as previously explained. Recheck indexing of marks.

GOVERNOR SPRING ADJUSTMENT

In cases where symptoms indicate defective, broken, or improperly adjusted governor springs, the following procedures are required to inspect and/or adjust the governor inner and outer spring. One (first) procedure can be used in case the specially designed gauge is not available; however, the second procedure using the gauge designed for this purpose is preferable for adjustment. Symptoms which are indications of governor spring malfunction are included under appropriate headings in "Fuel System Trouble Diagnosis" at end of section.

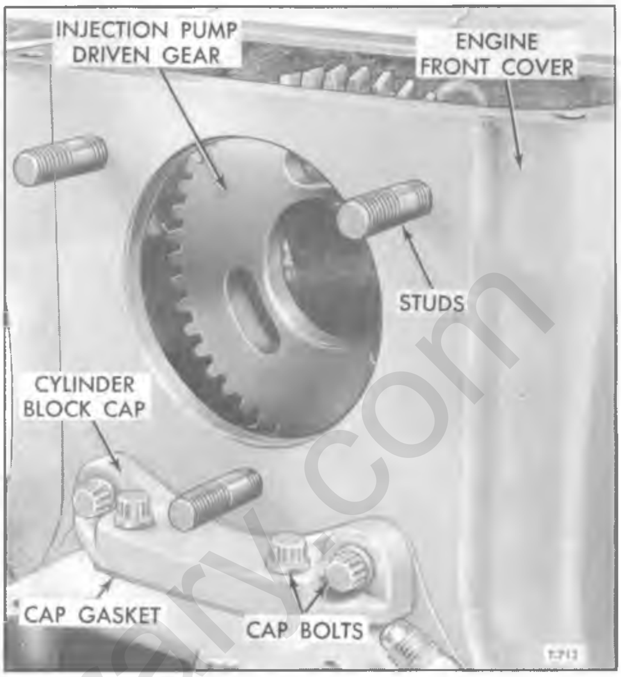


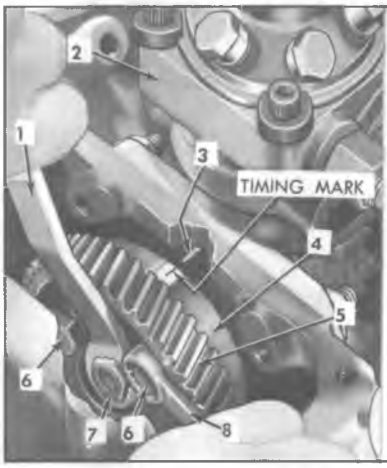
Figure 12—Injection Pump Driven Gear and Pump Mounting Studs

IMPORTANT: The normal idle and maximum speeds depend almost entirely on the characteristics of the governor springs, hence the speeds can only be varied to a limited degree by the adjusting screws at rear of governor housing (fig. 14).

NOTE: Remove air cleaner and necessary equipment to gain access to fuel injection pump.

INTERNAL GOVERNOR SPRING PACK ADJUSTMENT (WITHOUT SPECIAL TOOL)

1. Remove the four bolts attaching the governor cover to top of governor housing, then remove cover and gasket.



1 Holding Pump Shaft With 7/8" Box Wrench
2 Fuel Injection Pump Assembly
3 Pointer
4 Driven Gear Mounting Hub
5 Injection Pump Driven Gear
6 Driven Gear Mounting Bolts
7 Hub Retaining Nut
8 Tightening Driven Gear Bolt With 9/16" Box Wrench

T-5559

Figure 13—Using Wrench to Hold Pump Shaft While Tightening Drive Gear Bolts

FUEL INJECTION SYSTEM—TORO-FLOW ENGINE

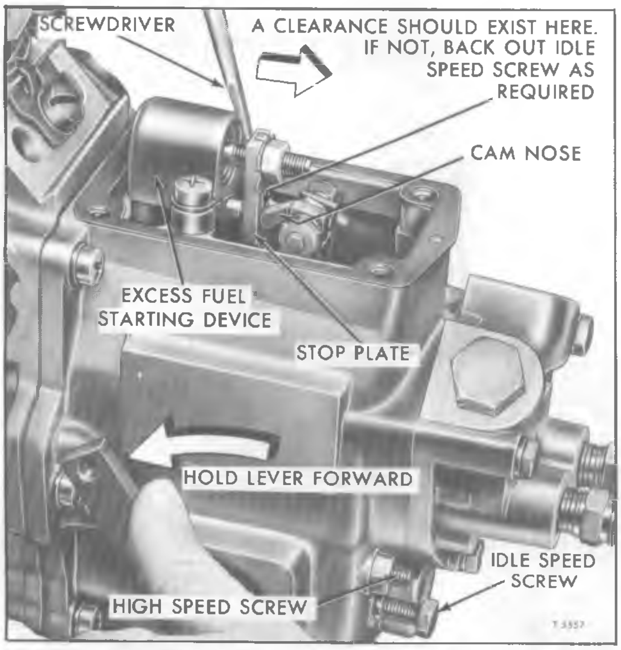
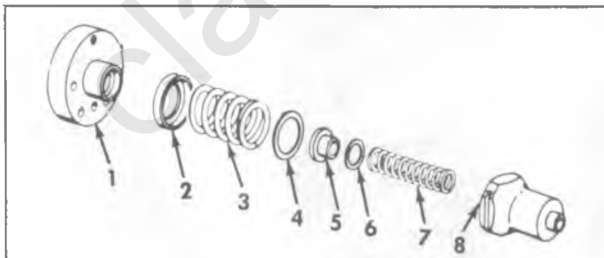


Figure 14—Checking for Clearance Between Cam Nose and Stop Plate

NOTE: If the two screws attaching the excess fuel starting device are loosened, or the excess fuel starting device is removed or replaced, the injection pump will be out of calibration. It will then be necessary to remove pump for recalibration.

2. While holding operating lever (fig. 14) in "IDLE" position, and stop plate (fig. 14) to rear of engine against spring tension of excess fuel starting device, check to see if there is clearance between cam nose and stop plate. If there is no clearance, back out idle adjusting screw (fig. 14) just to obtain clearance before making spring pack adjustment.



1 Supply Pump
2 Outer Spring Guide
3 Outer Spring
4 Outer Spring Spacer
5 Inner Spring Guide
6 Inner Spring Spacer
7 Inner Spring
8 Governor Sleeve

T-2375

Figure 15—Governor Spring and Spacer Arrangement

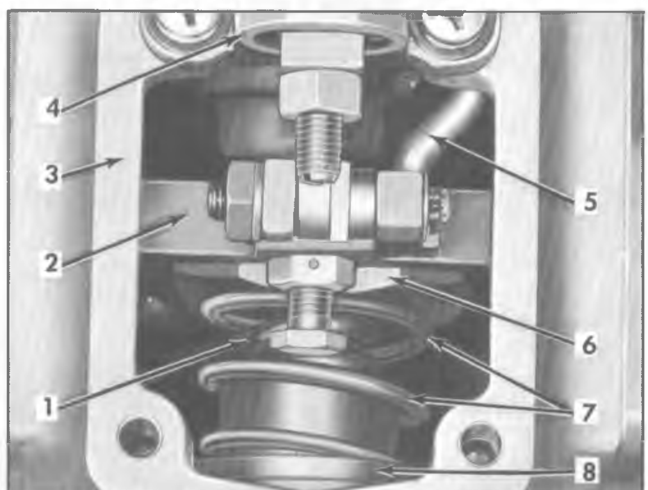
NOTE: It is possible in Step 2 previously, where engine idle is set to "Specifications," engine running and the cam nose touches the stop plate that a malfunction exists in the hydraulic head assembly.

3. Disconnect inlet and outlet fuel lines from rear of fuel pump and plug or cap the line openings to prevent dirt from entering.

4. Remove fuel supply pump as explained later under "Fuel Supply Pump Repair and Replacement" (fig. 35). Remove inner and outer governor springs and adjusting spacers (noting the position of spacers and spring guides). Figure 15 shows spacer and guide locations. The inner spring (7, fig. 15) is the high speed spring and must have a gap. The outer spring (3, fig. 15) is the low speed spring and must be precompressed. Determine the proper shim pack behind the governor springs with supply pump gasket in place as follows:

IMPORTANT: The flat (2, fig. 35) on the fuel pump drive shaft must engage with the gear in the supply pump. Exercise care with seal (9, fig. 35).

5. Position governor sleeve assembly in forward position as shown in figure 16. Then, place a quantity of adjusting spacers (6, fig. 15) between inner spring and the spring guide (5, fig. 15), so that when supply pump with gasket is held in installed position (flush with governor housing), inner spring can be turned but has no end play. This can be checked with a finger through governor cover opening (fig. 16). When this condition exists, remove supply pump and remove adjusting spacers to obtain proper gap of 0.089 to 0.108 inch.



1 Inner (High Speed) Spring
2 Fulcrum Lever Assy.
3 Governor Housing
4 Excess Fuel Starting Device
5 Control Rod
6 Governor Sleeve
7 Outer (Low Speed) Spring
8 Outer Spring Guide

T-2183

Figure 16—View of Governor Mechanism Through Cover Opening

6. Place a quantity of adjusting spacers (4, fig. 15) between governor sleeve (8, fig. 15) and outer spring (3, fig. 15), so that when supply pump with gasket is held in installed position, the outer spring can be turned but has no end play. Then, remove supply pump and add adjusting spacers with total thickness of 0.059 to 0.079 inch to give proper pre-compression on outer spring.

NOTE: Do not install outer spring (3, fig. 15) when checking spacer pack for inner spring (7, fig. 15) or install inner spring when checking spacer pack for outer spring.

7. Reinstall the inner and outer governor springs with their respective spacers as previously determined.

8. Reinstall the fuel supply pump and new gasket, taking care that the inner and outer spring guides (1 and 11, fig. 35) do not fall off the supply pump insert. The flat (2, fig. 35) on the fuel pump drive shaft must engage with the gear in the supply pump. Exercise care so that seal (9, fig. 35) is not damaged. Tighten supply pump mounting bolts to 5 to 6 foot-pounds torque.

9. Reinstall governor cover using new gasket and the four bolts. Connect inlet and outlet fuel lines and controls.

10. Start engine and adjust idle speed to 625-675 rpm with full accessory load. Set high speed to correct No-Load Rpm as specified, if necessary.

NOTE: Range of idle screw adjustment is limited. Too high adjustment may allow droop screw (fig. 32) to rest against excess fuel piston stop plate and cause erratic idle.

11. Check the operation of the fuel injection pump governor throughout the speed range. Be sure control rod movement is not restricted by governor cover right front cap screw.

12. Make sure that full travel of the accelerator lever and stop linkage can be obtained.

INTERNAL GOVERNOR SPRING PACK ADJUSTMENT (USING SPECIAL TOOL)

A special tool (J-22452) is available for use to accurately select injection pump governor spring spacers. The tool serves in determining the required spacers, both for the inner (high speed) and the outer (low speed) spring. Refer to figure 15 for location of spacers. Whenever occasion arises for checking either of the governor springs, the other spring should also be checked. Tool may be used without removing the injection pump assembly from engine.

IMPORTANT: If other tools are used to select spring spacers, it may be necessary to use feeler gauge to measure space. Also, the available tool may be graduated in millimeters rather than in inches. For conversion purposes 1 MM. is equal to approximately 0.040 inch.

NOTE: When using the tool to make spacer selection, do not use the supply pump gasket between tool and housing.

1. Perform Steps 1 through 4 under "Internal Governor Spring Pack Adjustment (Without Special Tool)" previously in this section.

NOTE: Refer to figure 15 for key numbers used in following text, unless otherwise specified.

2. Place inner spring guide (5) and spacers (6), which were removed in disassembly procedure, in the cavity provided in tool, then place tool in position with spring guide (5) inserted in spring and tool body seated against governor housing as shown in figure 17. Use short supply pump mounting bolt to temporarily secure tool flange to the pump housing.

3. Check engine stop mechanism to be sure stop lever is in the "STOP" position (fig. 16), then while holding governor sleeve forward, read the inner spring graduated scale to determine if spring spacers should be added or removed, and in what thickness (fig. 17). The inner spring can be turned but has no end play.

4. Add or remove inner spring spacers (6) so the tool scale is indexed with line when the parts are held in firm contact without compressing the inner spring. Spacers (6) are available in seven different thicknesses and may be selected in varying combinations to provide proper adjustment of inner spring. Tool scale will indicate a gap of 0.089 to 0.108 inch with proper spacers in place.

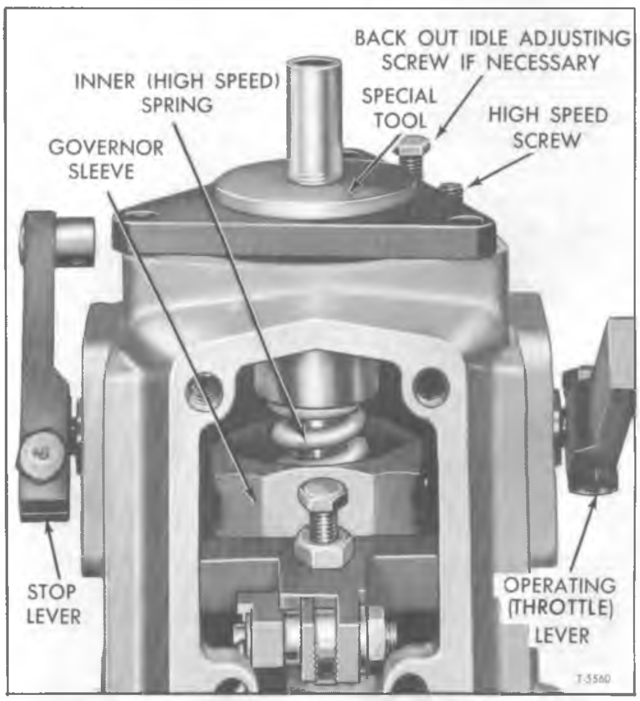


Figure 17—Special Tool Application for Selecting Inner (High Speed) Spring Spacer

FUEL INJECTION SYSTEM—TORO-FLOW ENGINE

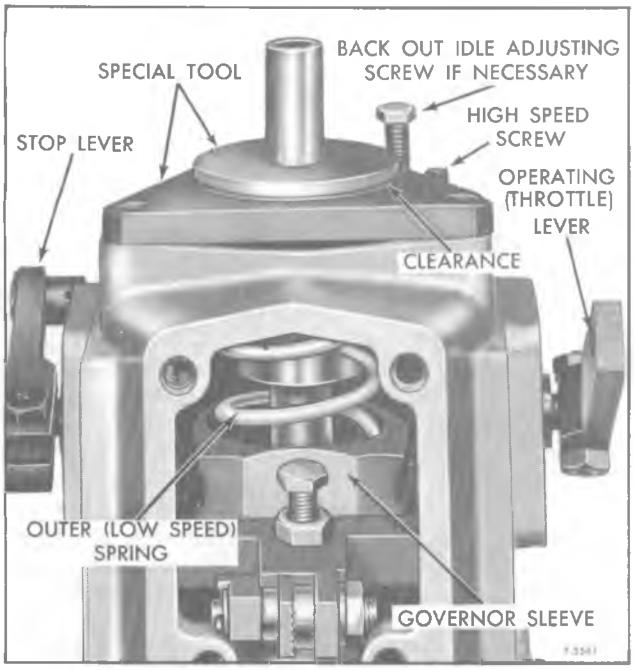


Figure 18—Special Tool Application for Selecting Outer (Low Speed) Spring Spacer

5. Remove inner spring, guide, and spacers (7, 5, and 6) from the governor shaft, keeping these parts together so they can be reinstalled after outer spring spacer selection has been made.

6. Assemble outer spring spacers (4), removed at disassembly, and the outer spring (3) at recess in center of the governor sleeve (8).

7. Place outer spring guide (2) over pilot on special tool (fig. 18), then place tool assembly at governor housing with pilot entered into outer spring. Governor sleeve (8) must be held forward as far as possible (fig. 16).

8. Observe outer spring clearance with feeler gauge on tool to determine if spacers are to be removed or added and in what thickness (fig. 18). The outer spring can be turned but has no end play.

9. Remove the outer spring (3), guide (2) and the tool components which are removable from tool mounting flange.

10. Add or remove spacers (4) as necessary to position the tool clearance to proper outer spring adjustment. Tool clearance will indicate outer spring compression of 0.059 to 0.069 inch when proper spacers are in place (fig. 18).

NOTE: When spring spacer selection has been completed, remove the tool assembly using care to take note of spacers selected so same pack can be reinstalled.

11. Perform Steps 7 through 12 previously under "Internal Governor Spring Pack Adjustment (Without Special Tool)" in this section.

FUEL INJECTION NOZZLES

LOCATING A MISFIRING CYLINDER

The procedure which follows may be used to locate a misfiring cylinder which may result from defective injection nozzle assembly.

This procedure will not serve to detect a nozzle with incorrect popping pressure within a moderate range. Such a malfunction can only be determined by removal of nozzle assembly from engine and checking on test stand (fig. 22).

1. Connect an accurate tachometer at the tachometer drive fitting on engine.

2. With engine running at 1,000 rpm, observe the tachometer reading as high pressure line nut is loosened at injection nozzle holders. When a high pressure line nut is loosened, the pressure build-up will not be great enough to cause the nozzle to deliver fuel to the cylinder being tested and no power will result. If, when the line nut is loosened, the engine rpm drops approximately 300 rpm, it can be assumed that the cylinder is functioning normally. On the other hand, if there is little or no drop in engine rpm when the line nut is loosened, the nozzle may be at fault and it should be removed for cleaning and inspection. Tighten line nut to 20 to 25 foot-pounds torque.

NOTE: When nut is loosened, fuel will spill from the loosened nut with each discharge from injection pump port. A shop towel around the nut will absorb spillage. Also, when nut is loosened to break seal at line connector it may be necessary to tap lightly only with plastic hammer on fuel lines.

NOZZLE AND HOLDER ASSEMBLY MAINTENANCE

Normally, unless engine performance, or other trouble diagnosis symptoms indicate a malfunction of fuel injection nozzles, the nozzle and holder assemblies should not be removed from engine.

When it becomes necessary to remove nozzle and holder assemblies use injection nozzle service tool set (J-2176-01). Follow the procedures given below:

REMOVING NOZZLE AND HOLDER ASSEMBLIES

1. Disconnect the high pressure line nut at the fuel injection nozzle holder and at fuel injection pump hydraulic head.

2. Remove the clamp assembly (fig. 27) from line being removed, then remove the high pressure line, using care not to bend line.

IMPORTANT: High pressure line must be disconnected at both ends and clamp must be removed so line can be removed without bending. Install dust caps when line is removed.

NOTE: To break seal at line connectors it may be necessary to tap lightly only with plastic hammer on fuel lines.

3. Clean all dirt from around injection nozzle holder depression in cylinder head. Use screwdriver blade to force leak-off hose off fitting in top of nozzle holder. Remove the two nozzle holder bolts amd lock washers, then pull nozzle holder assembly out of cylinder head, meanwhile using air hose to blow away any dirt particles which may be loosened as the nozzle holder is lifted out.

4. If necessary, use a suitable hook to remove copper gasket from bottom of cavity in cylinder head. Plug the opening cylinder head.

INSPECTION BEFORE DISASSEMBLY

NOTE: Test each nozzle assembly for leakage, valve opening pressure and spray pattern before disassembly. If nozzle assembly is in good condition, it should not be disassembled, but should only be cleaned externally. If holes in nozzle tip are clogged as indicated by unsatisfactory spray pattern, the components should be disassembled before attempting to clean holes.

REFER TO "SETTING INJECTION NOZZLE VALVE OPENING PRESSURE" FOR NOZZLE TEST PROCEDURE.

DISASSEMBLY (Fig. 19)

1. Extreme care must be exercised in handling nozzles and components. Do not allow nozzle tip to strike against other parts or tools as holes in tip may be damaged or tip may be deformed or broken.

2. With nozzle holder mounted on fixture or held in vise, loosen cap nut (4) and remove nut and gasket from spring pressure adjusting nut (3).

3. With Allen wrench, remove spring pressure adjusting nut from nozzle holder (7). Remove spring (1) and spindle (6).

IMPORTANT: DO NOT PROCEED WITH STEP 4 UNLESS ADJUSTING NUT (3) HAS BEEN LOOSENED TO RELIEVE THE SPRING PRESSURE.

4. Invert nozzle holder and remove the nozzle cap nut (10) from nozzle holder (7), then separate valve body (8 and 9) from the nozzle holder.

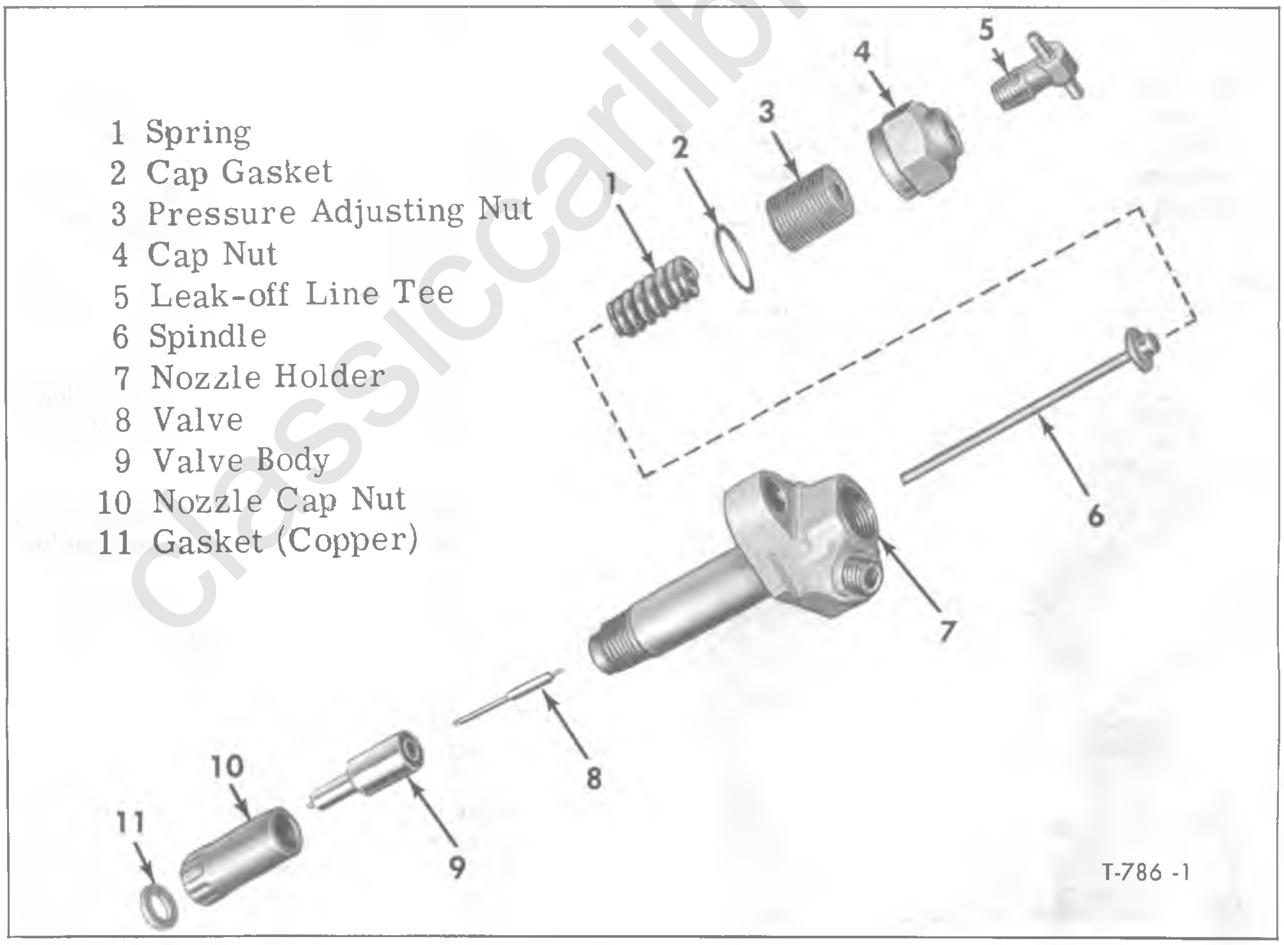


Figure 19—Nozzle Holder and Valve Assembly Components

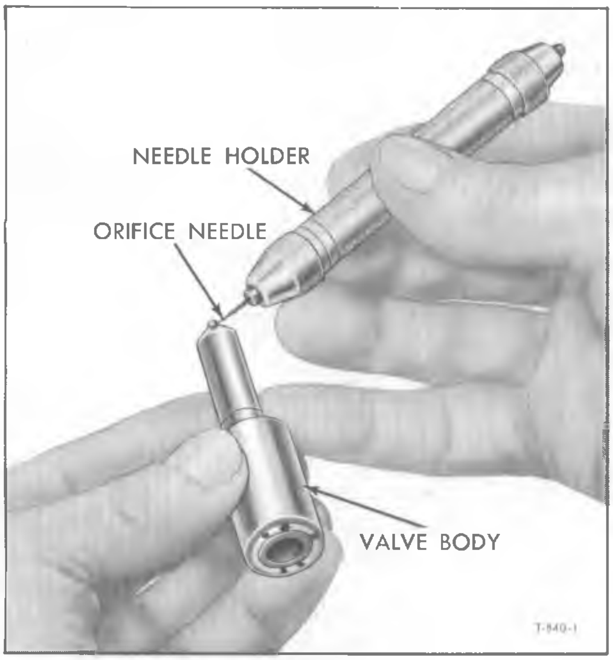


Figure 20—Cleaning Spray Holes in Nozzle

> **CAUTION: Valve (8) and valve body (9) constitute a matched pair which must be used as such. When handling injection nozzle valve, do not touch valve finished surfaces with fingers. Wash parts in clean fuel oil and polish with clean tissue paper.**

CLEANING AND INSPECTION

Clean nozzle tip with a brass wire brush before disassembling the valve body from nozzle

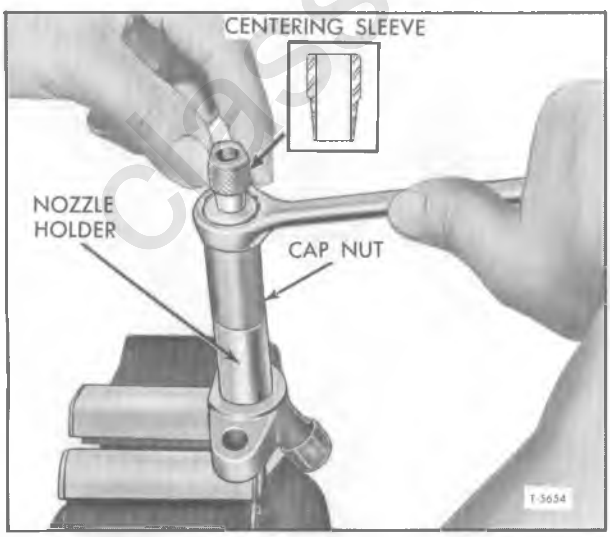
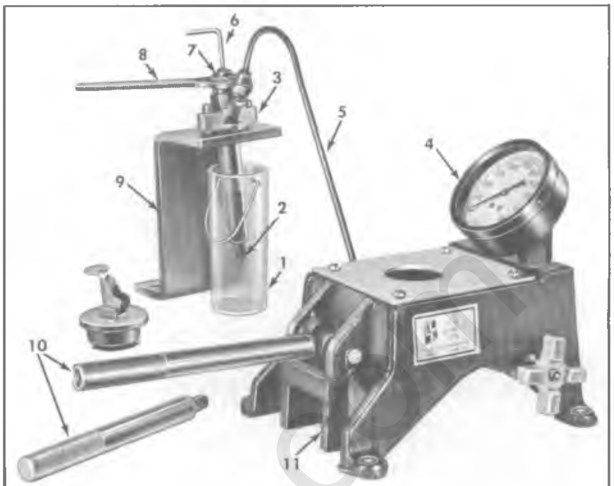


Figure 21—Use of Centering Sleeve to Locate Valve Body While Tightening Cap Nut



1 Cup	6 Allen Wrench
2 Spray Tip	7 Cap Nut
3 Nozzle Holder Assy	8 Box End Wrench
4 Pressure Gauge	9 Fixture
5 Fuel High Pressure Line	10 Pump Handle
	11 Test Stand

Figure 22—Test Stand for Checking Injection Nozzle Operation

holder. Clean the nozzle tip orifices using orifice needle (part of kit J-21761-01) (fig. 20). Care must be used when cleaning orifices to avoid breaking orifice needle in hole, as it is difficult or impossible to remove broken pieces. After disassembly, all parts should be carefully cleaned. If lapped surfaces on holder and mating surface on valve body are scratched, remove dowel pins from nozzle holder and polish the surface on lapping block using special fine lapping compound. Also, polish the mating surface on valve body. Install new dowel pins after nozzle holder surface has been lapped.

ASSEMBLY

Key numbers in text refer to figure 19.

1. Dip valve and body (8 and 9) in clean fuel and insert valve in body.

NOTE: The valve must be free in the body. By lifting the valve about one-third of its length out of the body, the valve should slide back to its seat without aid when the assembly is held at a 45-degree angle. If necessary, work valve into the body with clean mutton tallow.

2. Mount nozzle holder (7) in holding fixture, then set valve body in place on nozzle holder dowel pins and screw nozzle cap nut (10) onto nozzle holder. Before tightening cap nut (10), use centering sleeve (part of kit J-21761-01) (fig. 21) over nozzle tip to locate the nozzle valve body in center of opening in cap nut. After nut has been tightened sufficiently to seat parts, remove centering sleeve

and tighten cap nut (10) to 50 to 55 foot-pounds with torque wrench.

3. Set nozzle holder upright in holding fixture or vise and insert spindle (6) into holder. Place spring (1) on spindle, then thread spring pressure adjusting nut (3) into threads in nozzle holder. Place cap nut gasket (2) over nut (3), then install cap nut (4) on threads on adjusting nut (3).

4. Check nozzle on test fixture for spray pattern and valve opening pressure, as explained later under "Setting Injection Nozzle Valve Opening Pressure." Spray pattern should be equally spaced cones having no stringy ends or solid streamers. Note also if any leaking or dripping is evident after injection is completed. If valve does not open at 3,000 psi adjust valve spring pressure.

NOTE: There are four holes in valve body (9). Two point down and two at right angle in order to give proper spray pattern.

SETTING INJECTION NOZZLE VALVE OPENING PRESSURE

Using test pump (J-21770) connected as shown in figure 22, proceed as instructed to set the valve opening pressure and test for leaks. Key numbers in text refer to figure 22.

WARNING

Fuel spray from injection nozzle in operation has sufficient power to puncture the skin. Keep hands away from nozzle tip when testing. Fuel which enters blood stream may cause serious infection.

1. With nozzle holder assembly connected to tester, actuate the test stand handle (10) rapidly (about 25 strokes per minute) to expel air from nozzle and holder and to "settle" the spring and nozzle loading column.

2. Depress operating handle (10) slowly to raise pressure. Continue to depress handle and note the gauge pressure at which the nozzle valve opens. If opening pressure is not 3000 psi, remove the leak-off tee and loosen cap nut (7) so Allen wrench (6) can be used to adjust spring pressure.

3. Use Allen wrench (6) as shown in figure 22, to turn pressure adjusting nut and change spring pressure. Turning nut clockwise increases pressure. Repeat valve opening pressure test each time adjusting nut is changed until correct opening pressure is obtained.

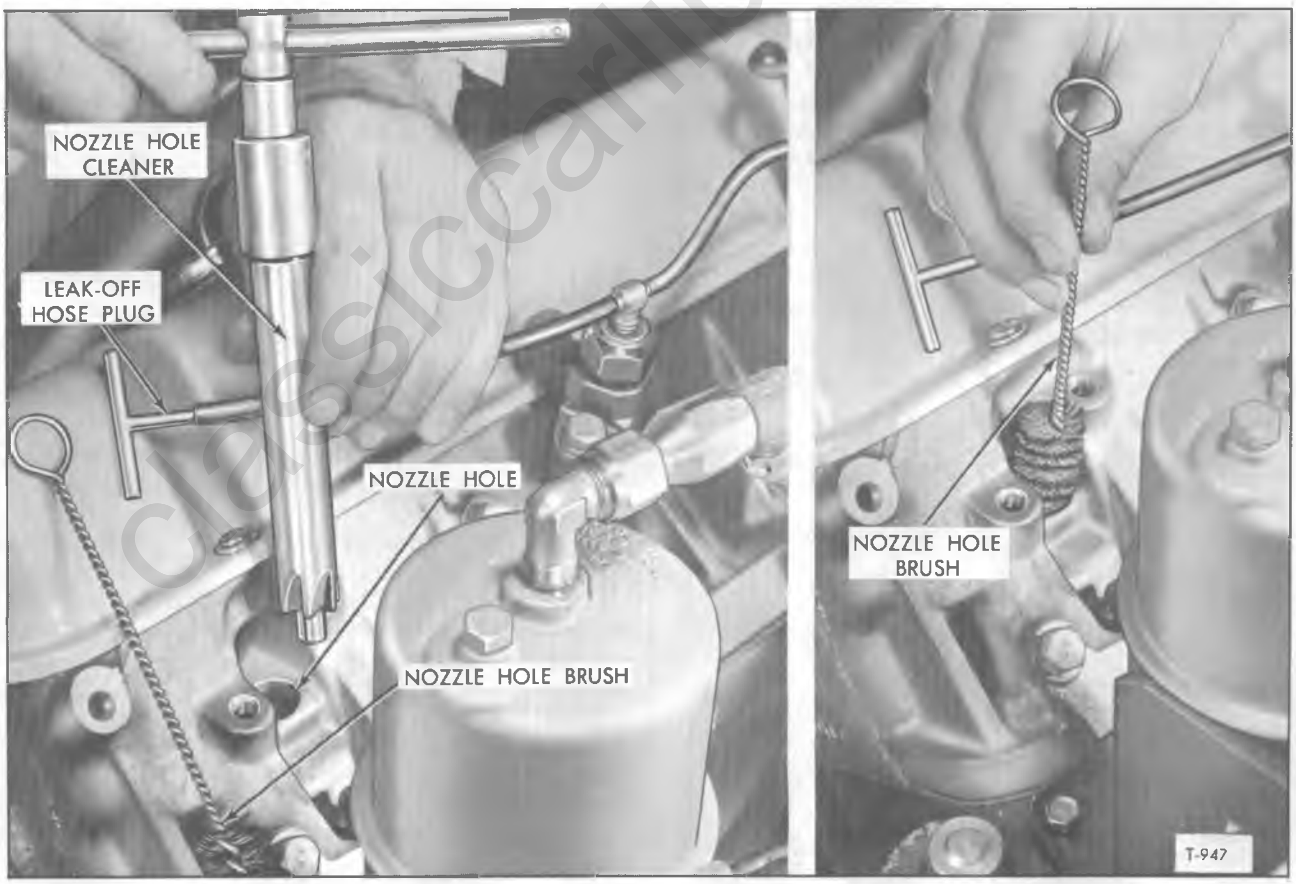


Figure 23—Cylinder Head Nozzle Well Cleaning Equipment

FUEL INJECTION SYSTEM—TORO-FLOW ENGINE

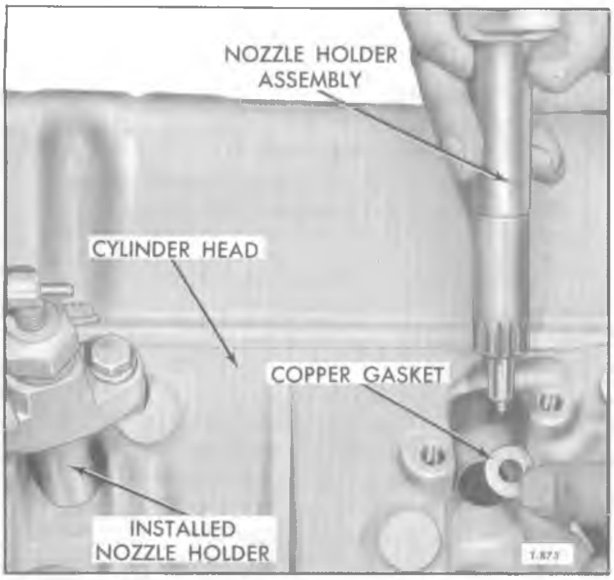


Figure 24—Installing Fuel Injection Nozzle Assembly

NOTE: When new pressure adjusting spring is installed, adjust the opening pressure 10% higher than specification to allow for spring set.

4. After correct valve opening pressure is obtained, tighten cap nut (4, fig. 19) firmly to lock the adjustment. Recheck for valve opening pressure after cap nut is tightened.

5. Operate test pump handle with several fast sharp strokes, meanwhile observing spray pattern. Spray should be in the nature of finely atomized sprays indicating that all holes are open. Nozzle tips have only four orifices.

6. Stroke pump slowly (approx. 3 seconds). Some degree of "chatter" should occur, indicating that nozzle valve is free and component parts are correctly assembled.

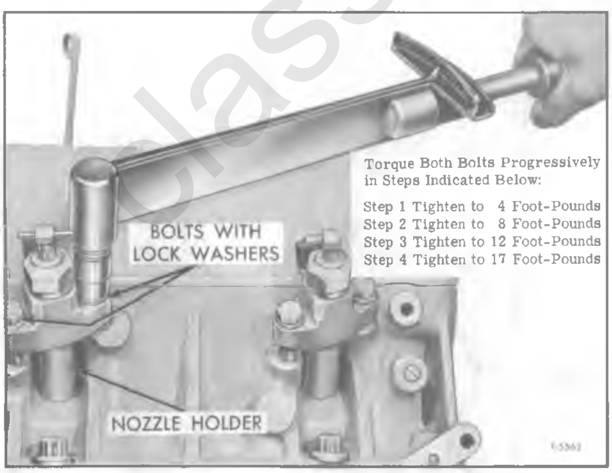


Figure 25—Tightening Nozzle Holder Bolts with Torque Wrench

7. Depress the pump handle slowly with a 10-second stroke and hold the pressure slightly (approx. 100 lbs.) below nozzle valve opening pressure to check for valve seat leakage. No fuel droplets should appear. Occasionally a slight wetting of the tip (2, fig. 22) may be noticed. This is permissible since it is caused from hydraulically balancing the spring and nozzle valve.

8. Remove the nozzle holder assembly (3, fig. 22) from test stand (11, fig. 22) and close the high pressure threaded connection with plastic cap to prevent entrance of dirt. If nozzle holder is not to be installed immediately, it should be wrapped in clean paper.

NOTE: If nozzle does not function properly when tested, a new valve and body should be installed in holder; or a new or rebuilt nozzle holder assembly should be installed when assembling engine.

NOZZLE HOLDER ASSEMBLY INSTALLATION

Before a nozzle holder assembly is installed in cylinder head, the cavity or well in cylinder head must be clean. A nozzle seat cleaner (J-21762) and hole brush (J-8152) should be used to remove all deposits from nozzle holder well. Use seat cleaner and wrench handle (fig. 23) first to clean seat, and the bore in cylinder head through which the injection nozzle valve body extends, then use brush to finish cleaning the well cavity.

1. Use new copper gasket at lower end of injection nozzle assembly and insert the nozzle holder assembly into place in cylinder head (fig. 24).

2. Install two bolts with lock washers (one long bolt and one short bolt is used at each nozzle) into tapped holes in cylinder head assembly. Use torque wrench (fig. 25) and gradually tighten nozzle holder bolts alternately to avoid any tendency to bend the holder assembly.

NOTE: Final tension on two nozzle holder bolts should be equal to seat assembly squarely on copper gasket. This can best be accomplished by torquing bolts in four steps. Torque each bolt first to four foot-pounds, then to eight foot-pounds, twelve foot-pounds and then seventeen foot-pounds (fig. 25).

3. Install leak-off lines (fig. 6) between injection nozzles and at fuel overflow valve on injection pump. To facilitate installation, the ends of leak-off lines may be warmed in hot water. Ends of plastic tubing should be pushed onto fittings so that ends seat at shoulder.

4. Install fuel lines as explained later under "High Pressure Fuel Line Installation."

HIGH PRESSURE FUEL LINE INSTALLATION

NOTE: Whenever it is necessary to replace high pressure fuel lines, it is important to use only

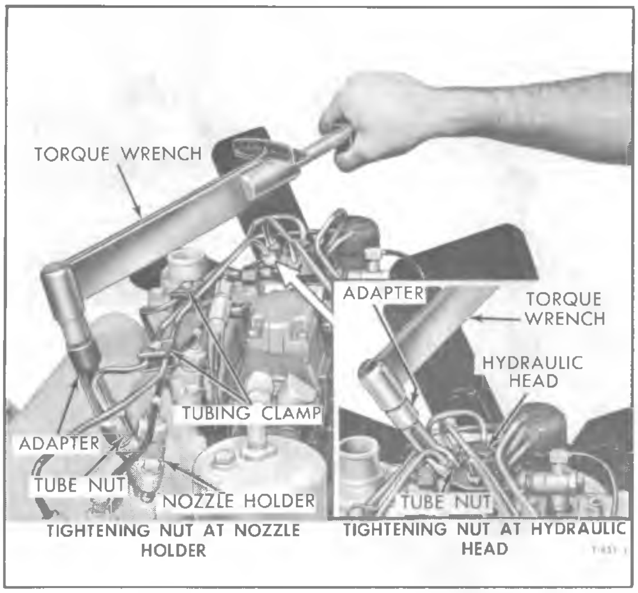


Figure 26—Torque Wrench Adapter for Tightening Nuts on High Pressure Lines (Typical)

preformed tubing of the original material. All lines must be of equal overall length. Tubing inside diameter must be 0.084-inch, and wall thickness must be 0.083-inch. The torque wrench adapter (J-22975) shown in figure 26 must be used to assure correct torque at all tube nuts. Torque nuts to 20 to 25 foot-pounds. NUTS MUST NOT BE OVER-TIGHTENED since this may compress the tubing and result in reduced inside diameter.

IMPORTANT: Refer to figure 27 for arrangement of fuel high pressure lines. As lines are selected and placed in respective positions, dip each end of line in fuel oil and start tube nuts at pump and injection nozzles with fingers. Each nut should be turned a minimum of four full turns before using wrenches. LINES MUST NOT BE FORCED OR BENT INTO POSITION.

1. Remove dust cap from threaded connections at injection nozzle and at outlet port in injection pump, then place the high pressure line in place so that fittings on both ends line up squarely with

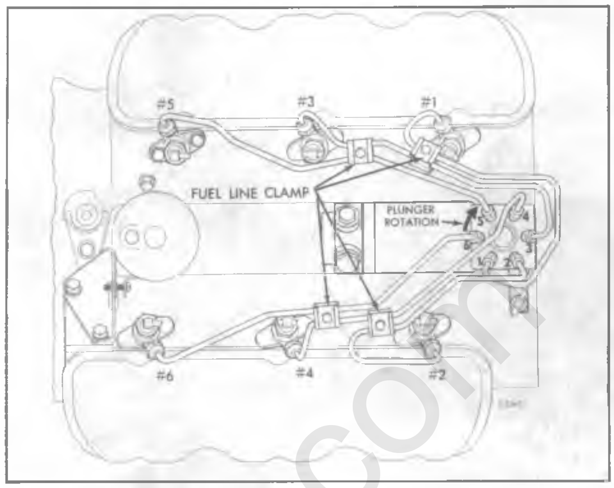


Figure 27—Fuel High Pressure Line and Clamp Installation

respective threads at both the injection pump and the nozzle holder. Start tube nuts at both ends, then when lines are seated use torque wrench and adapter (J-22975) (fig. 26), to tighten nut at hydraulic head to 20 to 25 foot-pounds torque. Tighten nuts at nozzles 20 to 25 foot-pounds torque.

2. Assemble rubber line clamps and metal backing plates with the rolled edges of backing plates crosswise of lines. Refer to figure 27.

3. Finally, tighten the line clamp bolts to firmly support lines and prevent vibration. When clamp bolts are properly tightened, the metal parts of clamp plates must not touch fuel lines. At least 0.060 inch clearance must exist between edge of clamp and surface of each line.

FUEL DELIVERY VALVE REPLACEMENT

IMPORTANT: Before disassembly of fuel delivery valve, make sure cap gasket and valve seat gaskets are available for replacement.

REMOVAL (Fig. 28)

1. Remove equipment as necessary to provide access to the hydraulic head assembly. Use solvent

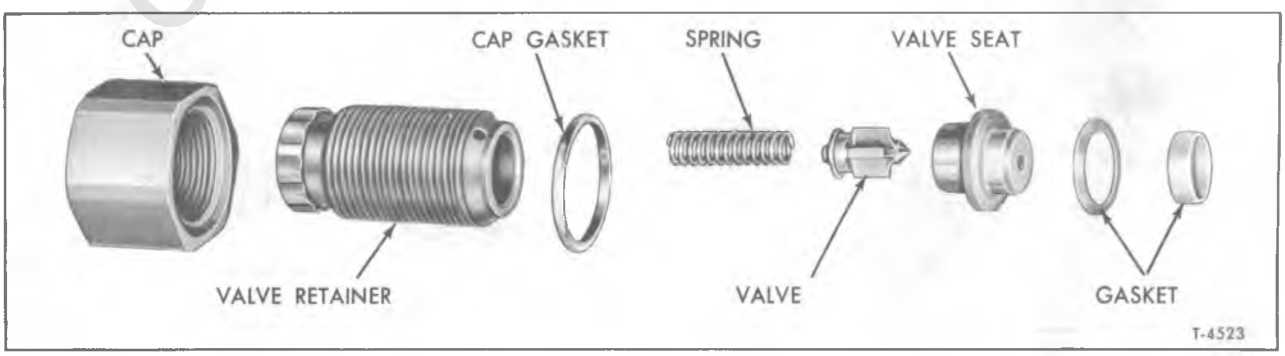


Figure 28—Delivery Valve and Retaining Parts

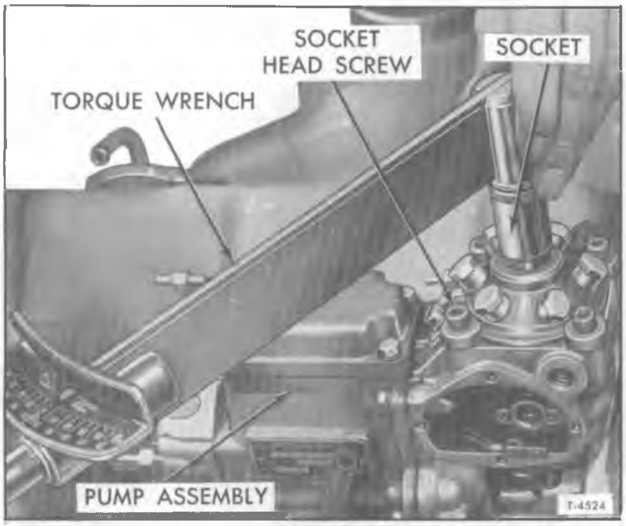


Figure 29—Installing Fuel Delivery Valve Retainer with Torque Wrench

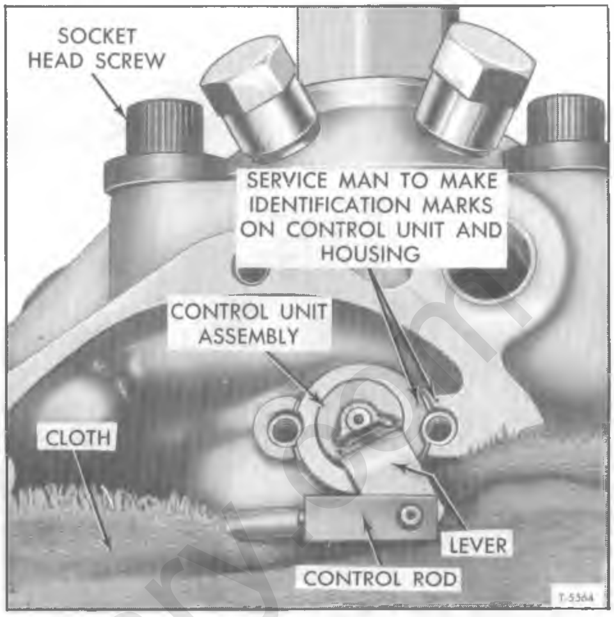


Figure 31—Control Unit Retaining Parts Removed Showing Alignment Marks

and a brush to remove any accumulated dirt from top of the injection pump assembly. Wash off top of head assembly and blow dry with compressed air.

2. Remove delivery valve cap and gasket, then use a 12-point socket to remove the delivery valve retainer from the head assembly.

3. Remove the delivery valve spring, then use needle-nose pliers or tweezers to remove the valve assembly and gaskets.

INSPECTION (Fig. 28)

1. Inspect spring for breakage at tips and replace if necessary.

2. Inspect valve and valve seat for pitting, corrosion, and scoring. Replace if damaged.

3. Replace all gaskets and damaged parts.

INSTALLATION (Fig. 28)

IMPORTANT: The delivery valve and retaining parts must be kept absolutely clean during installation. Any particles of dirt entering the delivery valve cavity in the hydraulic head will be carried by fuel to plunger area and to fuel injection nozzles. Extensive damage to pump and/or nozzles can result from presence of foreign particles in fuel.

1. Place fuel delivery valve assembly and gaskets in position in hydraulic head cavity (fig. 32), then position the delivery valve spring over pilot on the delivery valve.

2. Install the delivery valve retainer and use a torque wrench to tighten valve retainer to 65 to 70 foot-pounds torque.

3. Position the cap nut gasket on the delivery valve retainer, then install the delivery valve cap nut and tighten to 55 to 60 foot-pounds torque.

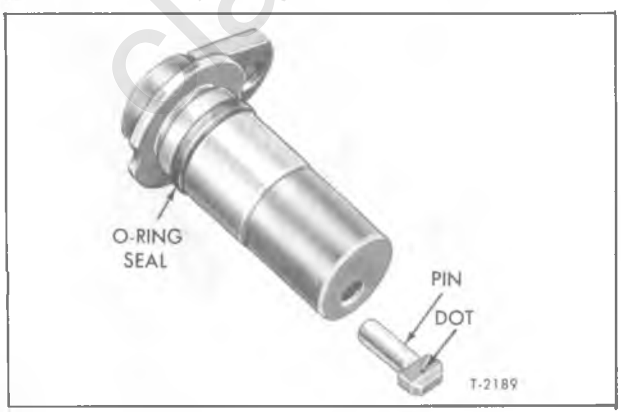


Figure 30—Fuel Control Unit Assembly

CONTROL UNIT ASSEMBLY REPLACEMENT

In case it becomes necessary to replace O-ring seal (fig. 30), the procedure given below must be followed to remove and install the fuel control unit assembly.

REMOVAL

1. Remove any equipment necessary to gain access to control unit cover at right side of the fuel injection pump.

2. Remove the four control unit cover attaching screws, then remove cover and gasket.

3. Place a clean lint-free cloth in opening as shown in figure 31, so parts cannot fall into pump interior as they are removed.

NOTE: Control unit and rod are held in place by a retainer plate which is attached by two screws equipped with lock wire. Control unit and rod retainer plate is shown in figure 32.

4. Remove lock wire from plate screws. Remove screws, plate, and the spacers which retain the control unit, then disengage the control rod from lever.

5. Use metal dye or paint to place index marks on control unit flange and on pump body (fig. 31).

NOTE: MARKING THE PARTS IS NECESSARY SO THE CONTROL UNIT CAN BE INSTALLED IN ORIGINAL LOCATION AND AVOID CHANGING THE PUMP CALIBRATION.

6. Carefully withdraw the control unit assembly from bore in housing, using two thin screwdrivers diagonally across from each other to start the unit out of bore.

IMPORTANT: The dot on the pin must be up, otherwise pump will be out of calibration (fig. 30).

7. Remove O-ring seal from control unit.

INSTALLATION

1. Using a clean screwdriver, carefully insert it through the control unit opening in the pump housing and carefully move the metering sleeve (fig. 36) downward to its lowest position on plunger.

2. Lubricate the control unit O-ring with petroleum jelly and assemble it to the control unit.

3. Holding the control unit, pin, and O-ring assembly as shown in figure 33, with the control unit arm horizontal and pointing toward the rear of the pump and with the pin horizontal and the identification dot (fig. 30) up, insert the assembly into the pump housing.

4. Rotate the control unit arm 360 degrees after installation to determine if the pin is properly positioned in the metering sleeve slot. If it is not, the control unit arm cannot be rotated 360 degrees.

5. Rotate the control unit bushing, which was marked in Step 5 under "Removal," so the screw scallops in the control unit bushing are aligned with the holes for the retainer plate attaching screws and the control unit bushing flange in the

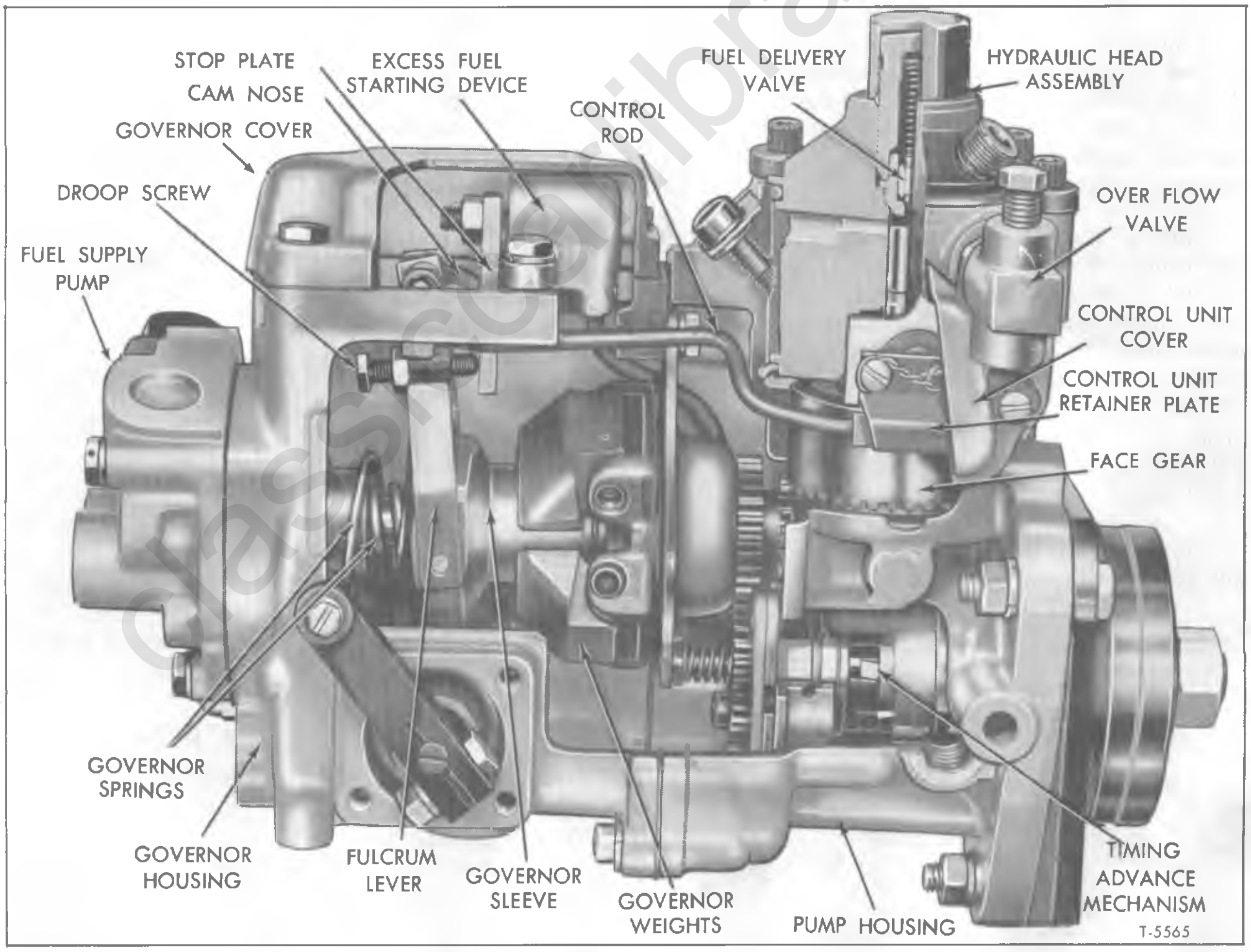


Figure 32—Cut-Away View of Fuel Injection Pump

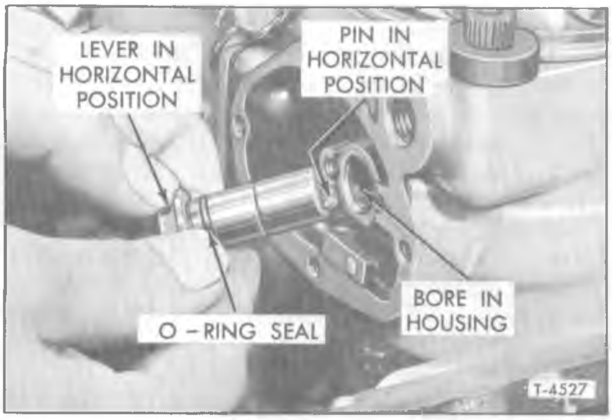


Figure 33—Control Unit Installation

same position as before removal, as marked with dye or paint (fig. 31).

6. Use lint-free cloth to prevent accidental loss of parts into pump cavity (fig. 31). Dropping parts into pump cavity may necessitate pump disassembly.

7. Assemble the control unit retaining plate, screws (with lock washers), and spacers (fig. 32), then install parts to retain the control unit. Tighten screws to 18 to 33 inch-pounds. Install lock wire through screw heads as shown in figure 32. The retaining plate (fig. 32) retains the control unit and also prevents control rod from becoming disengaged from lever.

NOTE: Control unit plates are available with differences in offset. After plate screws are installed, it is important to check for clearance between inner side of plate and the control rod pin while using screwdriver to hold the control unit lever outward as far as possible. If there is any contact of pin with lever or if clearance is in excess of 0.017 inch, a different plate should be selected to provide correct clearance (0.001 to 0.017 inch).

8. Using new gasket, install control unit cover and secure with screws and lock washers.

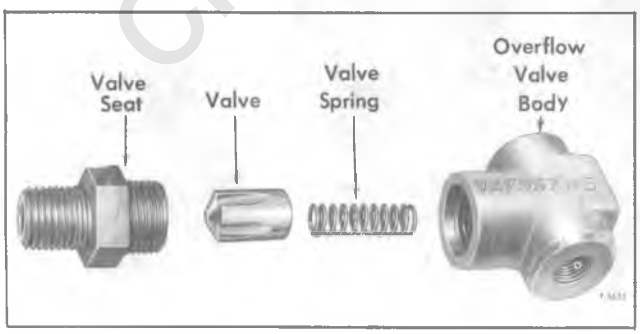


Figure 34—Overflow Valve Components

OVERFLOW VALVE ASSEMBLY

The overflow valve assembly components of which are shown in figure 34, is installed as shown in figure 6, item 5. Valve assembly is screwed into threads provided in injection pump housing.

The overflow valve assembly incorporates a spring-loaded valve which serves to regulate the fuel pressure within the fuel chamber surrounding the hydraulic head assembly, and also bleeds off any air bubbles which may be present in fuel supplied by the supply pump. Excess fuel passing through overflow valve tends to cool the hydraulic head assembly. The overflow valve body provides a junction for leak-off lines (fig. 6). Fuel flowing from the lines, as well as the pump supply fuel which is forced past the overflow valve, is returned to the fuel tank through fuel return line (6, fig. 6).

REMOVAL

1. Disconnect leak-off lines from fitting at valve and disconnect fuel return line.

2. Using wrench on hex-shaped portion of valve assembly remove the assembly from injection pump body.

DISASSEMBLY

Grip the overflow valve body in vise fitted with soft jaws, then use suitable wrench to remove the valve seat from the valve body. Remove the valve and spring.

INSPECTION

Inspect valve and seat for damage or corrosion. Inspect spring for damage or breakage.

ASSEMBLY

Place spring and valve in valve body; then after positioning the valve seat over valve, thread the valve seat into body. Use a wrench to tighten valve seat securely into body.

INSTALLATION

1. Use pipe thread sealant, and screw the overflow valve assembly into threaded port in injection pump body, using wrench on the hex-shaped portion of valve.

2. Install fittings and connect return line and leak-off lines to overflow valve body.

FUEL SUPPLY PUMP REPAIR AND REPLACEMENT

REMOVAL (Fig. 35)

1. Disconnect the fuel lines and remove fittings from supply pump.

2. Remove the three supply pump attaching bolts and lock washers, then remove the supply pump and gasket.

CAUTION: As supply pump is removed the governor inner spring guide (1, fig. 35) and spring spacers are free to fall out of place. Exercise necessary care to prevent loss of these parts. Plug the fuel line openings to prevent dirt from entering.

OIL SEAL REPLACEMENT

If the fuel supply pump is in satisfactory operating condition and does not require disassembling for other repairs, the oil seal (9, fig. 35) may be replaced without disassembling the pump. Pry out old seal assembly and press new seal into bore with the seal lip pointed toward the pump gear. Use sealer sparingly at outer circumference of seal to prevent leakage.

If the pump has been disassembled, a suitable punch may be inserted through bore in insert to drive the seal assembly out of the insert.

FUEL SUPPLY PUMP DISASSEMBLY

Key numbers in text refer to figure 35, unless otherwise indicated.

1. Remove governor outer spring guide (11) from pump assembly.
2. Remove the five screws and lock washers (6) which attach cover to insert (4). Tap the insert lightly with plastic hammer to separate insert from cover. Remove gears from insert.
3. Remove relief valve retainer screw (7) and remove spring and relief valve assembly (8 and 9, fig. 31).

SUPPLY PUMP COMPONENT INSPECTION

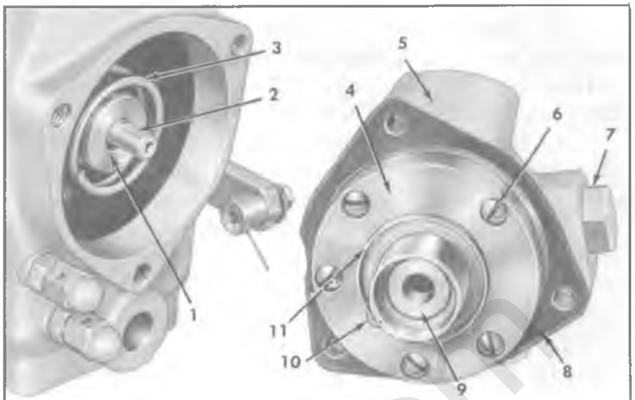
Key numbers in text refer to figure 7.

1. Inspect for wear in gear cavities in pump insert (1). Also look for evidence of worn surface or scoring on cover (10) area at which contact is made with gears.
2. Note condition of the oil seal in pump insert. New oil seals are available for service use.
3. Examine relief valve parts. Use new parts when assembling pump if any of the components are defective. Relief valve (9) should pass fuel through center in only one direction.
4. Inspect idler gear shaft pin (2) which is a press fit in bore in insert. If pin is worn, scored, or loose in bore, obtain a new insert and pin assembly.

INSTALLATION

Key numbers in text refer to figure 35.

1. Check governor, inner and outer springs to make certain the inner spring guide (1) and original spacers are in place. Outer spring guide (11) must be in place at pump insert (4).
2. Place gasket (8) on cover flange with bolt holes aligned.



1 Governor Inner (High Speed) Spring Guide
2 Flat on Pump Drive Shaft
3 Governor Outer (Low Speed) Spring
4 Pump Insert
5 Pump Cover
6 Insert to Cover Screws and Lock Washers
7 Relief Valve Retainer Screw
8 Gasket
9 Oil Seal
10 Pump Idler Gear Pin
11 Outer (Low Speed) Spring Guide

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Figure 35—Fuel Supply Pump Removed from Injection Pump Assembly

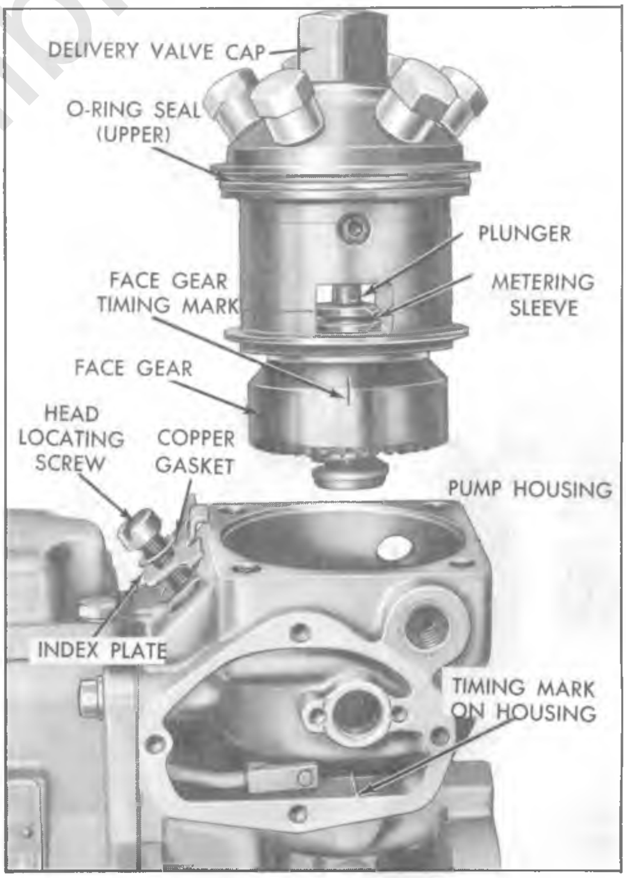


Figure 36—Fuel Injection Pump Hydraulic Head Assembly Replacement

3. Observe through opening in oil seal the position of flat in pump gear bore. A clean screwdriver may be used to turn the gear so as to align the gear with flat (2) on shaft.

4. Move supply pump assembly into position at injection pump housing using care to engage drive gear with flat on shaft. Install and tighten supply pump attaching bolts on which lock washers must be used. Tighten bolts to 5 to 6 foot-pounds torque.

5. Connect fuel lines to fittings at supply pump, remove vent plug from top of secondary fuel filter and bleed air from pump and lines.

REPLACING HYDRAULIC HEAD ASSEMBLY

Refer to figure 36 for identification of various items involved in hydraulic head replacement.

NOTE: The hydraulic head assembly which is shown in figure 36 is available for service use and is complete with face gear and plunger. If a new hydraulic head assembly is required, it will be necessary to remove the fuel injection pump assembly from the engine assembly; and the pump assembly MUST be recalibrated on equipment designed for this purpose after the service head is installed. In cases where the hydraulic head is in satisfactory operating condition, but it becomes necessary to remove the head assembly to replace the O-ring seals or other parts of the pump, it is possible to remove and install the hydraulic head without removing the pump assembly from the engine. Recalibrating is not required if the head replacement procedure is followed exactly as explained under "Removal" and "Installation."

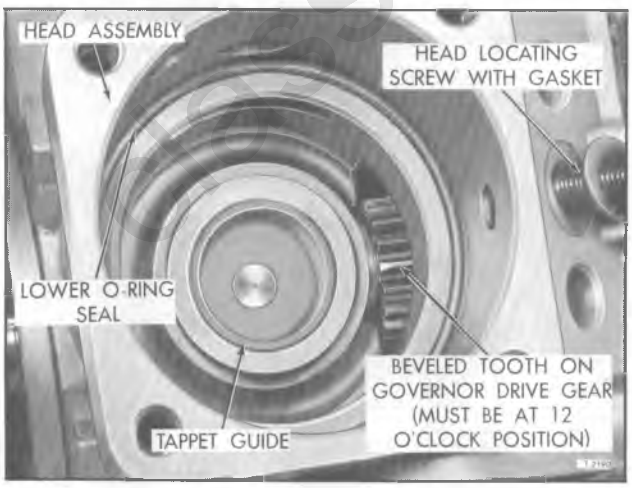


Figure 37—Fuel Injection Pump Cavity with Hydraulic Head Removed (Typical)

REMOVAL

1. Remove equipment as necessary to provide access to fuel injection pump assembly and fuel lines. Use solvent and brush to loosen and remove any accumulated dirt from pump assembly and fuel lines and fittings. Clean thoroughly to prevent dirt from entering fuel system.

2. Disconnect and remove fuel high pressure lines, then plug or cap the openings in the hydraulic head and nozzles.

NOTE: A service kit, containing all plugs and caps for closing the openings in pump and lines is available for use when working on the pump and/or lines.

3. Refer to the instructions given previously under "Control Unit Assembly Replacement" and remove injection pump control unit assembly.

4. Turn engine crankshaft to place No. 1 piston in firing position with the marking on crankshaft damper aligned with pointer (fig. 11), and the mark on face gear (visible in inspection window in pump housing) indexed with mark on housing (fig. 10). Make sure the No. 1 piston is on compression stroke.

IMPORTANT: Mark on face gear should be indexed with housing mark, even though damper mark may not be exactly registered with pointer (fig. 10).

a. Remove the head locating screw, gasket, and indexing plate. Remove four socket head screws and retainers which attach the hydraulic head to the pump housing (fig. 36).

b. Tap the hydraulic head assembly lightly with a plastic or lead hammer or slightly rotate the assembly with a wrench on the delivery valve cap to loosen it in housing bore. Raise the hydraulic head assembly up out of the pump housing. Remove upper seal ring (fig. 36) from groove in head assembly. Remove the head lower seal ring (fig. 37) from bottom of bore in pump housing. DO NOT TURN ENGINE CRANKSHAFT WHILE HYDRAULIC HEAD IS REMOVED FROM PUMP.

INSTALLATION

CAUTION: If the original hydraulic head assembly is not reinstalled, it will be necessary to remove the fuel injection pump assembly from the engine and to recalibrate the pump to "Specifications," using equipment designed for this purpose in the hands of specially trained personnel.

1. Lubricate the hydraulic head O-ring seals with petroleum jelly, then place lower ring in position at bottom of bore in pump body as shown in figure 37.

2. Place upper O-ring seal in groove in hydraulic head (fig. 36).

3. Position the hydraulic head assembly so the locating slot in head block is aligned with head locating screw; and turn face gear so that timing mark on gear is aligned with mark on housing (fig. 36). Carefully insert head assembly into housing bore. Observe face gear through the pump housing opening as head is pushed down into place. Teeth on face gear must mesh with drive gear teeth.

4. Install head locating screw with copper gasket and index plate (fig. 36), and if necessary, rotate head assembly so the locating screw can be turned freely - indicating no interference. Tighten locating screw to 10 to 11 foot-pounds torque.

5. Place a hydraulic head retainer and a socket head screw in diagonally opposite corners of the housing. Gradually tighten the retainer screws until head is properly seated, then install remaining two retainers and socket head screws. Use a torque wrench and adapter to tighten all socket head screws to 13 to 15 foot-pounds torque.

6. Refer to applicable instructions given previously under "Control Unit Assembly Replacement" and install the control unit assembly.

7. Referring to "High Pressure Fuel Line Installation" covered previously in this section install the fuel lines between hydraulic head outlet ports and fuel injection nozzles.

8. Prime the fuel system using one of the methods described under "Priming Fuel System."

9. Install equipment which may have been removed to gain access to the injection pump assembly. After engine is started, inspect for fuel leakage, particularly at hydraulic head and high pressure fuel lines.

FUEL INJECTION PUMP ASSEMBLY

NOTE: The fuel injection pump assembly is available for service replacement as a complete assembly; however, before pump replacement, it is important that a complete diagnosis of problem be made, and remedial measures taken, as previously explained under "Fuel Injection System Trouble Diagnosis." In most instances the required repairs may be made without removing the injection pump assembly from the engine.

FUEL INJECTION PUMP REPLACEMENT

The paragraphs following include directions for replacement of the fuel injection pump assembly, but replacement should only be made in case the symptoms described in "Fuel System Trouble Diagnosis Chart" in this section definitely indicate that the fuel injection pump assembly is at fault and is not repairable without removing the unit from the engine:

Before beginning the removal of fuel injection pump, either for overhaul of other engine components or for installation of a replacement pump assembly, the following equipment should be on hand:

1. Dust caps and plugs, which are available in a kit, for closing the openings at injection nozzles and ports in hydraulic head after high pressure lines are removed.

2. Gaskets for use when installing the fuel injection pump assembly.

3. Clean shop cloths.

4. Tachometer for use when adjusting engine idle speed and for checking governed speed.

CAUTION

DO NOT attempt to work on the fuel injection pump, nozzles, or high pressure lines in a dusty area. Extreme precautions must be taken to prevent any dust particles from entering the fuel passages in lines and nozzles. Any dirt or abrasive material permitted to enter the fuel supply port on fuel injection pump could quickly cause extensive damage to, or possibly ruin the pump hydraulic head mechanism.

REMOVAL

Depending on type of vehicle and accessory equipment, remove the necessary equipment to provide access to fuel injection pump assembly, high pressure fuel lines and engine controls. Carefully observe the arrangement of accelerator control linkage, and the engine stop mechanism, so the linkage can be properly installed.

NOTE: Clean any accumulated dirt from the entire area around fuel injection pump assembly, upper part of engine front cover, and all fuel line fittings.

1. Remove the cover and gasket from right side of fuel injection pump to expose the alignment mark in the opening below the control unit lever (fig. 10).

2. Remove the access cover and gasket from top of engine front cover assembly to expose pointer (8, fig. 10) and mark on injection pump hub.

SUGGESTION: To prevent accidental dropping of bolt washers into engine front cover and out of reach, pack clean shop cloths into cavity below the gear attaching bolts. Do not crank engine until the cloths have been removed.

3. Remove rocker arm cover from left-hand cylinder head, then crank engine to place No. 1 piston on compression stroke - (both valves will then be closed and push rods can be turned with fingers). Slowly crank the engine until the "INJ"

FUEL INJECTION SYSTEM—TORO-FLOW ENGINE

mark on crankshaft damper is aligned with pointer in engine front cover (fig. 11). At this point pump should be injecting fuel into No. 1 cylinder, which will be the case if alignment marks are aligned as explained in following Steps 4 and 5.

4. If engine is correctly timed, the mark and pointer (9 and 8, fig. 10) will be indexed and mark (4, fig. 10) on face gear viewed through cover opening in pump housing will be in the position shown in the inset in figure 10.

5. If the mark on pump drive hub is not indexed with pointer, or if the mark on face gear is not visible in opening, the injection timing is not correct. Before proceeding to reset the injection timing be sure No. 1 piston is on compression stroke and "INJ" mark on damper is aligned with pointer (fig. 11).

6. Remove tubing clamps which are shown in figure 27. Use the adapter shown in figure 26 and loosen high pressure tubing nuts at fuel injection nozzles and at pump hydraulic head. Use air hose to blow away any loose dirt particles at hydraulic head and at nozzles. With fingers complete tubing nut removal at both ends of each line, then if necessary, to break seal tap fuel line lightly with plastic hammer. Remove the high pressure tubing, using care not to bend tubing. When tubing nuts are disengaged from threads each line may be readily removed. Tape ends of each line to keep dirt out.

NOTE: To facilitate installation, each line may be tagged with identification number corresponding with cylinder numbers (fig. 27).

7. Plug pump ports and cap fittings at injection nozzles as soon as lines are removed. Figure 6 shows caps at injection nozzles and plugs in hydraulic head ports.

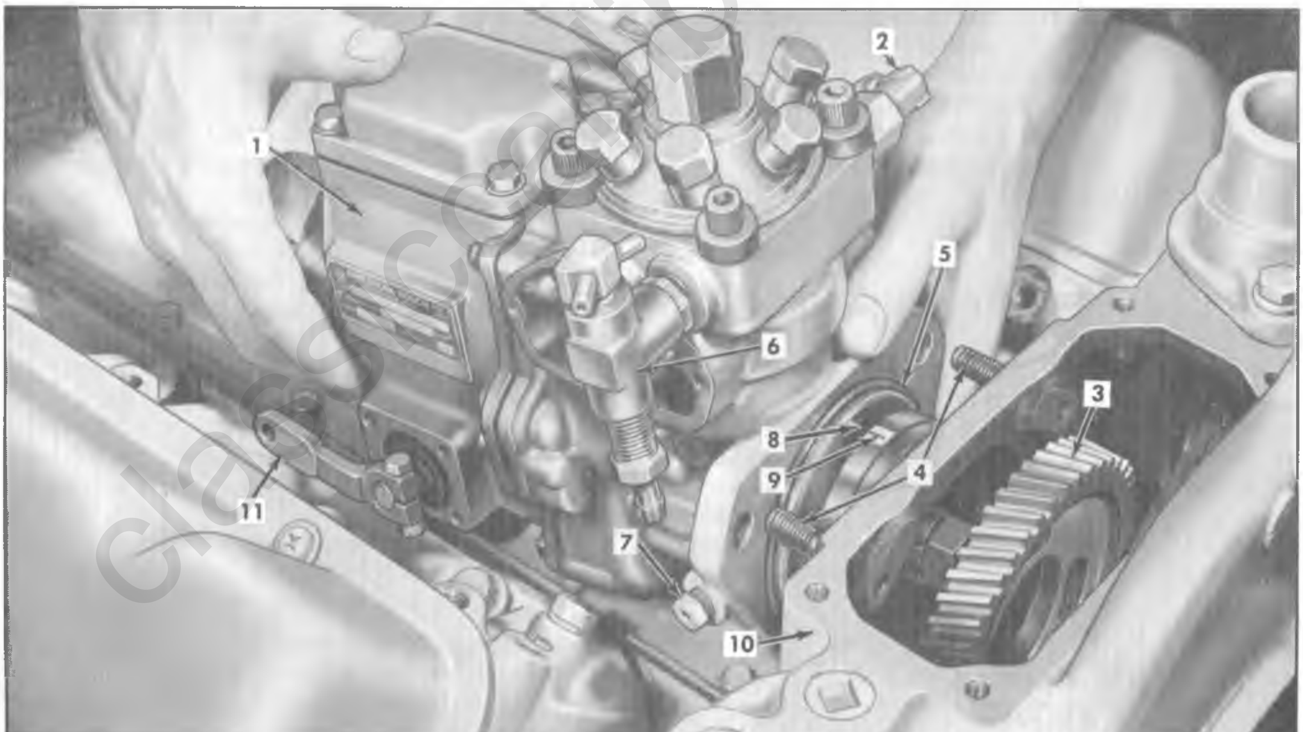
NOTE: THE IMPORTANCE OF CLEANLINESS CANNOT BE OVER-EMPHASIZED.

8. Disconnect fuel leak-off lines from overflow valve.

9. Disconnect stop control cable and disconnect accelerator linkage from lever at left side of injection pump assembly.

10. Disconnect fuel lines from fittings on supply pump at rear end of injection pump assembly. Also, disconnect the fuel line at left side of injection pump housing. Cap or plug all openings to prevent entrance of dust.

11. At right side of pump assembly, disconnect lubricating oil line and the fuel return line at the overflow valve assembly.



1 Injection Pump Assembly	5 Seal Ring	8 Pointer
2 Fuel Supply Line Fitting	6 Overflow Valve	9 Mark on Adapter Hub
3 Drive Gear	7 Lubricating Oil Fitting	10 Engine Front Cover
4 Mounting Studs		11 Stop Lever

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Figure 38—Installing or Removing Fuel Injection Pump Assembly

NOTE: The driven gear must be removed from hub on pump shaft before the injection pump assembly can be removed from engine, by removing three special bolts and washers.

12. Loosen and remove two driven gear-to-hub bolts and special washers. (These are near top position if engine is on No. 1 cylinder firing position.) Use clean shop towel to prevent bolts and washers falling in in gear train.

13. Remove shop towel and turn crankshaft counterclockwise until third or bottom bolt and washer is at the top and can be removed. Then move crankshaft clockwise until pointer is again at the "INJ." mark. Engine is now back in time.

14. Remove lower stud nut and washers attaching pump to engine front cover.

15. Remove upper stud nuts and washers attaching pump to front cover. Remove fuel injection pump assembly (fig. 38).

NOTE: If engine is properly timed, it is not always necessary to observe position of mark on face gear (fig. 10) before removing pump. Position of mark can be observed after pump removal; however, pump must be installed with face gear timing mark in same position as when removed. Observe position of timing mark immediately after pump removal. If marks are positioned as in figure 10, injection is beginning on #1 cylinder. If mark (4, fig. 10) is not visible as in figure 10, injection is beginning on No. 4 cylinder.

INSTALLATION

If a new fuel injection pump assembly is being installed, it will be necessary to transfer the fuel line and oil line fittings from the removed pump assembly to the new pump. Observe the position of each fitting as it is removed, and install it in same position on new pump assembly.

> **CAUTION: Carefully clean any accumulated dirt from fittings before installing in replacement pump assembly and install dust caps to exclude any foreign material when the fittings are installed.**

Inspect gear teeth on injection pump drive gear and driven gear before installing pump. Be sure the mounting surface on pump flange and the mating surface at engine front cover are clean.

Remove the cover from right-hand side of injection pump so alignment marks on face gear and ledge can be seen.

1. Set fuel injection pump driven gear in place through access opening in top of engine front cover. Driven gear teeth must engage teeth on pump drive gear and flat side of gear must be toward rear as shown in figure 12.

2. Check position of rocker arms at No. 1 cylinder to be sure No. 1 piston is on compression stroke. Observe "INJ." mark on crankshaft damper assembly (fig. 11) which must be indexed with the pointer on front cover as shown.

3. Through opening in right-hand side of fuel injection pump assembly, look for mark on edge of face gear. If mark is not visible, turn the pump shaft until mark comes into view, then set the mark on hub in alignment with pointer in pump housing. Mark and pointer are shown in figure 10 (Items 8 and 9).

4. Referring to figure 38, install seal ring (5) on pilot at forward side of pump mounting flange, then lift the injection pump assembly into position on mounting studs (4).

5. Install plain washer, lock washer, and nut on each of the three pump mounting studs and tighten the nuts evenly to seat pump flange firmly on cover.

6. Check the position of threaded hole in pump hub in relation to elongated slot in driven gear (fig. 12). If necessary, change the position of gear so threaded hole in hub is approximately centered in slot in gear. The gear teeth can be lifted out of mesh with drive gear to change gear position. Referring to the "Suggestion" under Step 2 of "Removal" procedure, take precautions to prevent accidental dropping of bolts and washers into engine cavity.

7. Start two of the driven gear mounting bolts (6, fig. 13) with special washer through driven gear slot and into mounting hub, and tighten with fingers.

8. Move crankshaft counterclockwise until the third bolt and washer can be installed with fingers. Then move crankshaft clockwise until pointer lines with "INJ." mark. Using a 7/8-inch wrench (fig. 13) hold pump hub timing mark in alignment with pointer and tighten gear mounting bolts 35 to 40 foot-pounds torque.

NOTE: Refer to "Setting Injection Timing" earlier in this section.

SUGGESTION: Before the gear access cover is installed on engine front cover assembly, it is suggested that engine crankshaft be turned counterclockwise a few degrees, and then turned back until the "INJ." mark on damper (fig. 10) is aligned with pointer. This will assure tooth contact on drive side of all gears. Make final check to be sure No. 1 cylinder is on compression stroke, then referring to figure 10, check for indexing of timing mark (9) with pointer (8), and also view face gear (3) through opening in pump housing. Mark (4) on face gear will be in the position shown, to left of mark (5), if the pump is properly timed to the engine.

9. Install side cover on pump housing using new gasket. Also use new gasket and install gear access cover on top of engine front cover assembly. Install rocker arm cover.

10. Connect lubrication oil supply line to fitting on injection pump housing. Connect fuel return

FUEL INJECTION SYSTEM—TORO-FLOW ENGINE

line to the overflow valve assembly.

11. Thoroughly clean and inspect the fuel lines to be used in connecting secondary fuel filter. Mount a new secondary filter on filter bracket and connect fuel lines. Refer to "Secondary Filter Replacement" for any necessary instructions for fuel line connections.

12. Connect accelerator control linkage and engine stop mechanism.

CAUTION: The fuel injection nozzles should be inspected and repaired as necessary, or replaced with new nozzles whenever a new or rebuilt fuel injection pump is installed on engine. Attempting to start an engine having defective injection nozzles can damage or ruin a fuel injection pump assembly.

13. Install high pressure fuel lines referring to "High Pressure Fuel Line Installation" covered previously in this section.

14. Prime the fuel system, before attempting to start engine. Recommended procedure for priming is given previously under "Priming Fuel System." During priming procedure, the supply line should remain disconnected from fitting on left side of pump assembly until all air has been purged from filters, supply pump, and lines; then continue to flush fuel through open end of line to avoid the possibility of any loose particles entering the fuel chamber surrounding the hydraulic head assembly.

15. Start engine and inspect all fuel line and lubricating oil line connections for leakage.

16. Check and adjust engine idle speed if required.

SPECIFICATIONS

FUEL INJECTION PUMP ASSEMBLY

Make	American Bosch Arma Corporation
Type	PSJ (Single Plunger, with Built-in Governor)
Drive	Gear Train from Crankshaft
Timing Advance	Fully Automatic

ENGINE GOVERNED SPEED (RPM)

	FULL LOAD	NO LOAD
DH-478	2800	3050

Engine Idle Speed .... 625-675 rpm

Note: Identification plate on pump housing carries GM Part No. and Mfgr's Number.

OVERFLOW VALVE ASSEMBLY

Regulating Pressure (psi) (at idle)	18-28
Regulating Pressure (psi) (Gov. speed)	40-50
Spring Free Length	1.000″
Spring Pressure @ 0.840″	4½ to 5 lbs.

FUEL INJECTION NOZZLE & HOLDER ASSEMBLY

Number and Size of Orifice	
DH-478	(4) 0.0138″
Valve Opening Pressure	*3000 psi

HIGH PRESSURE LINES

Wall Thickness	0.083″
Inside Diameter	0.084″

FUEL SUPPLY PUMP

Type	Positive Displacement
Location	Rear of Injection Pump Housing
Drive	From Internal Governor Shaft
Pump Output Pressure (Max.)	65 psi

*With new spring set to 3300 psi.

TORQUE WRENCH SPECIFICATIONS

INJECTION NOZZLE & HOLDER ASSEMBLY

Injection Nozzle Cap Nut	50-55 ft.-lbs.
High Pressure Fuel Line Nuts (at Pump & Nozzles)	20-25 ft.-lbs.
Injection Nozzle Bolts	17-20 ft.-lbs.

OVERFLOW VALVE ASSEMBLY

Valve to Body	20-25 ft.-lbs.

FUEL INJECTION PUMP ASSEMBLY

Delivery Valve Retainer	65-70 ft.-lbs.
Delivery Valve Cap Nut	55-60 ft.-lbs.

FUEL INJECTION PUMP ASSEMBLY (Cont.)

Hydraulic Head Fastening Screws	13-15 ft.-lbs.
Governor Cover Bolts	5-6 ft.-lbs.
Control Unit Cover Screws	2-2½ ft.-lbs.
Control Unit Plate Screws	1½-2 ft.-lbs.
Supply Pump Relief Valve Screw	35-40 ft.-lbs.
Fuel Supply Pump Mounting Bolts	5-6 ft.-lbs.
Fuel Supply Pump Insert-to-Cover Screws	2-2½ ft.-lbs.
Injection Pump Mounting Stud Nuts	25-30 ft.-lbs.

SECTION 6T

Air Compressors and Governors

GENERAL INFORMATION

Midland-Ross and Bendix-Westinghouse air compressors are interchangeable as complete assemblies on all models covered by his manual. Since both Midland-Ross and Bendix-Westinghouse compressors are used in regular production on all vehicles, the mechanic must determine which is used on each specific vehicle before proceeding with adjustment or repair of any compressor. Removal and installation procedures are applicable to both Midland-Ross and Bendix-Westinghouse compressors without exception.

DESCRIPTION

The air compressors covered in this manual are two-cylinder, piston type compressors. The rated capacity of an air compressor is its piston displacement in cubic feet per minute when operating at 1250 rpm. The air compressors used on these models are rated at 7¼ cubic feet per minute. The compressor Model Number is shown on a name plate which is attached to the cylinder block.

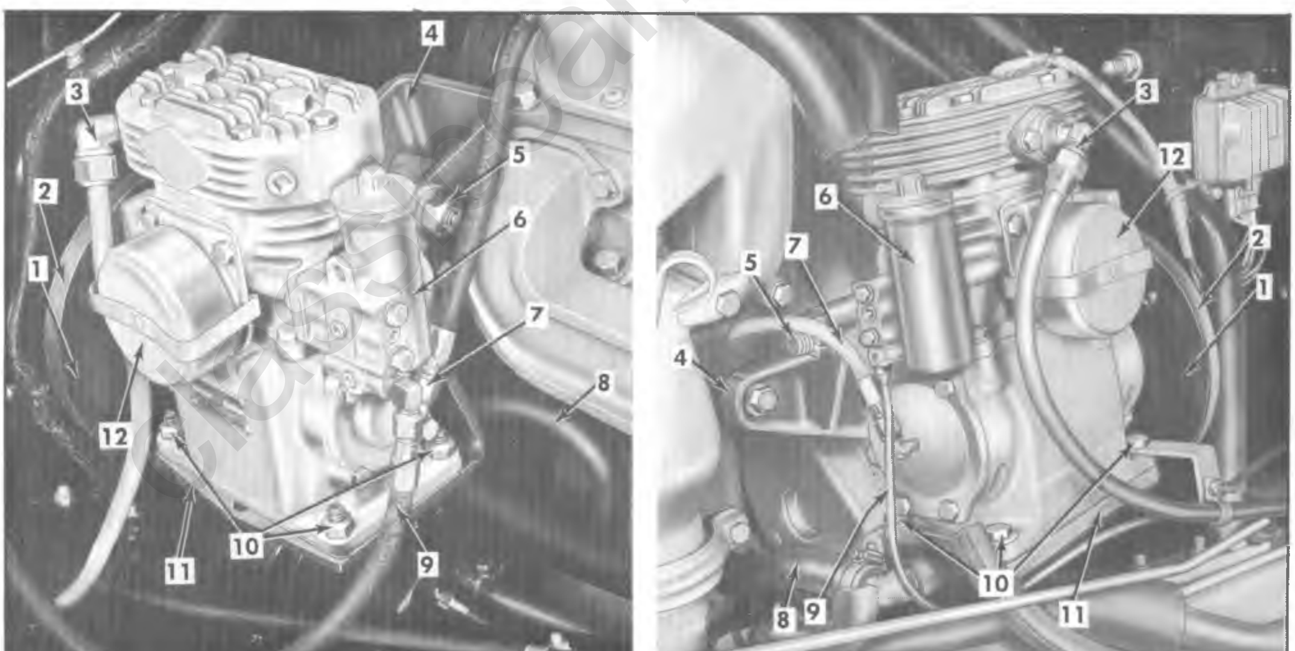
All compressors are lubricated by oil from the engine lubrication system and cooled by air from the fan assembly.

Each compressor is equipped with a governor assembly, which is attached to the cylinder head or cylinder block. This governor, in conjunction with the air compressor unloading mechanism, controls the compression of air.

COMPRESSOR MOUNTING AND DRIVE

(Refer to Figure 1)

Air compressor mounting and drive installations vary from one model to another but all have the same basic principle of attachment and adjustment. An adjusting arm (with a slot at one end) connects the air compressor to the vehicle engine (generally at the engine front cover). This arm is attached solidly to the engine with a bolt and nut.



LEFT SIDE MOUNT — RIGHT SIDE MOUNT

1 Drive Pulley
2 Drive Belt
3 Air Line to Tank
4 Mounting Bracket
5 Swivel Bolt
6 Governor
7 Inlet Oil Line
8 Return Oil Line
9 Governor to Tank Air Line
10 Mounting Base Bolts
11 Mounting Base
12 Intake Air Strainer

T-3012

Figure 1—Air Compressor Installed (Typical)

AIR COMPRESSORS AND GOVERNORS

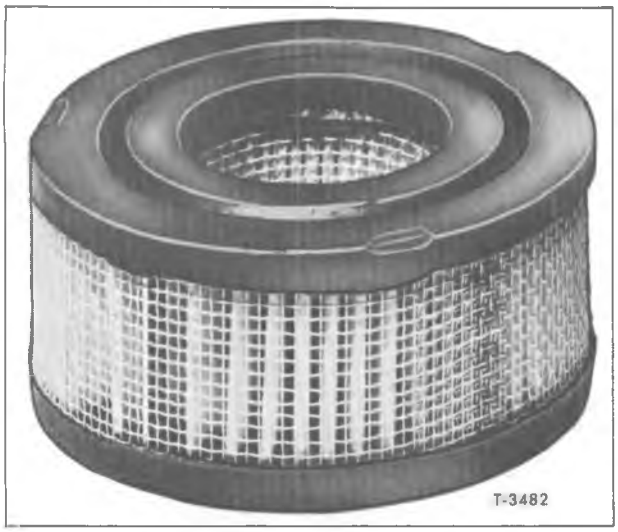


Figure 2—Disposable Air Filter (Typical)

The slotted end of the arm is attached with a nut and bolt to an adjusting arm bracket which is fastened to the air compressor.

The air compressor is mounted on a base with four bolts or four bolts and nuts. This base incorporates a lubricating oil return drain hole and a boss which permits the use of one large pivot bolt or two smaller pivot bolts as a method of fastening the bottom of the air compressor. This base also provides a pivot point for drive belt tension adjustment. The pivot bolt and nut secure the air compressor assembly to a support bracket which is attached to the vehicle engine at the cylinder block or lower front engine cover (dependent on vehicle model).

The size, shape, and relative arrangement of the adjusting arm, the adjusting arm bracket, the base and the support bracket are determined by the requirements for each individual model.

All compressors used by these models are belt-driven and are equipped with a proper size pulley, to produce the rpm recommended by the manufacturer. When replacing a pulley, it is of the utmost importance that the correct one be used.

Some pulleys have a puller groove in the hub. Use this groove when removing pulley to prevent damage. Use extra care in removing a pulley without the groove.

For belt tension adjustment, refer to procedure under "Drive Belt Maintenance and Adjustment" later.

COMPRESSOR LUBRICATION

Lubricating oil, under pressure from the engine lubrication system, enters drilled crankshaft through the crankshaft bearing cap and lubricates the connecting rod bearings. Some of the oil that flows between sides of connecting rod bearings and cheeks on crankshaft is sprayed upward. This oil lubricates the piston pin bushings and the cylinder walls. The oil drains from compressor into the mounting bracket and returns directly to the engine crankcase.

COMPRESSOR AIR INTAKE

Air strainer (filters, fig. 2) used on any of these compressors are of the replaceable paper-type. Bendix-Westinghouse air compressors have an air cleaner which snaps on and off for replacement; while Midland-Ross air compressors have screw-on and -off type air cleaner. The purpose of filters is to filter incoming air and to remove impurities, moisture, dirt, etc., before it is compressed into the vehicle air brake system.

The filter element CANNOT be cleaned and reinstalled, but must be replaced with new filter. Filter should be checked at intervals depending on location and climate in which vehicle operates.

The compressor runs continuously while the engine is running but the actual compression of air is controlled by the governor and the unloading mechanism. During the downstroke of the piston (inlet valve open) a slight vacuum is created, drawing atmospheric air through the filter into the cylinder chamber. This air is compressed by the upward piston stroke (inlet valve closed) and is forced out through the discharge valve into the truck air brake system (reservoir).

AIR COMPRESSOR AND GOVERNOR MAINTENANCE

Service compressor air strainer at intervals recommended in LUBRICATION (SEC. 0). Perform the following inspection and maintenance operations at intervals determined by truck operating conditions.

1. Remove cylinder head and clean carbon from inlet and discharge valves. If valves are damaged in any way, replace with new parts.
2. Make sure compressor discharge line is not choked with carbon.
3. Check governor cut-in and cut-out pressures and adjust, if necessary. Refer to "Governor Adjustment" later in this section.
4. Check compressor and bracket mounting bolts for looseness, and tighten if necessary.
5. Make sure all oil, and air line connections are tight and not leaking.
6. Check compressor drive belt tension and adjust if necessary.

DRIVE BELT MAINTENANCE AND ADJUSTMENT

Drive belts used on models covered by this manual are made of neoprene rubber with polyester cord.

MAINTENANCE

Drive belt must be kept at proper tension. A loose belt will lower output of compressor, while a tight belt will cause eventual bearing failure. A regular, periodic inspection is recommended to check condition and tension of drive belt. Replace belt if frayed or badly worn.

ADJUSTMENT

1. Loosen bolt at adjusting arm. Loosen pivot bolt at compressor mounting bracket.

2. Position compressor so that a reading of 120-130 lbs. (new belt) or 80-90 lbs. (used belt) is obtained on a strand tension gauge.

3. Tighten adjusting arm bolt and/or nut securely. Tighten pivot bolt nut.

NOTE: On a new vehicle, or after a new belt is installed, check belt tension once in first 200 miles of operation.

COMPRESSOR REPLACEMENT

REMOVAL

1. Exhaust compressed air from air system.
2. Disconnect air and oil lines from compressor.
3. Loosen pivot bolt at compressor base, then loosen compressor adjusting arm bolt. Tilt compressor and remove drive belt from compressor pulley.
4. Disconnect adjusting arm from compressor by removing adjusting arm bolt.
5. Remove bolts attaching compressor crankcase to mounting bracket. Lift air compressor assembly off mounting bracket.

INSTALLATION

1. Clean oil supply line to compressor and if possible, run engine a few seconds to be sure oil supply to compressor is flowing freely.
2. Clean oil return line or passage through compressor mounting bracket to be sure oil from compressor crankcase can return to engine crankcase.
3. Lubricate compressor cylinder walls and bearings with lubricating oil before placing compressor in position.
4. Clean or replace any damaged or dirty air lines which may be corroded before connecting them to the compressor.

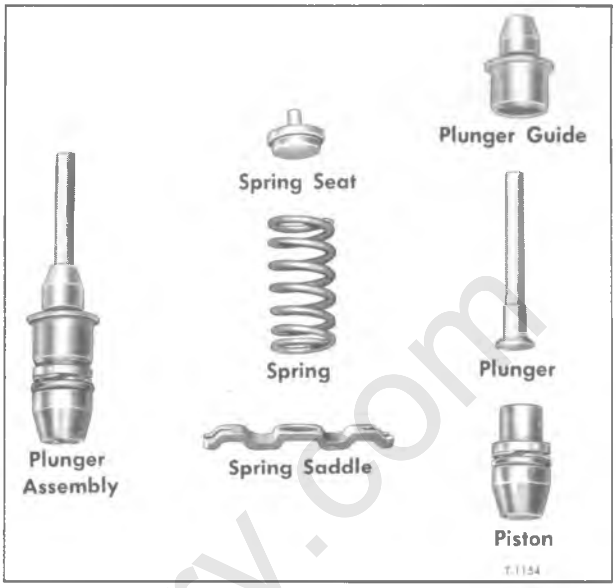


Figure 3—Unloader Assembly Components (B-W)

5. Use new gasket and make sure mating surfaces of compressor crankcase and mounting bracket are clean. Position compressor on mounting bracket and attach with bolts. Connect compressor adjusting arm to bracket on side of compressor cylinder head or block. Do not tighten.
6. Connect air and oil lines to compressor. Check all connections for tightness.
7. Place drive belt in compressor pulley and adjust belt tension as previously directed.
8. Adjust governor as directed later.

UNLOADER ASSEMBLY REPLACEMENT

Unloader assemblies on both Bendix-Westinghouse and Midland-Ross compressors can be replaced without removing compressor from the vehicle. Since the unloader assemblies differ by manufacturer, a separate procedure is given for each assembly.

BENDIX-WESTINGHOUSE

Parts are available in a kit for replacing unloader assembly. Unloader parts (fig. 3) may be changed without removing cylinder head as follows:

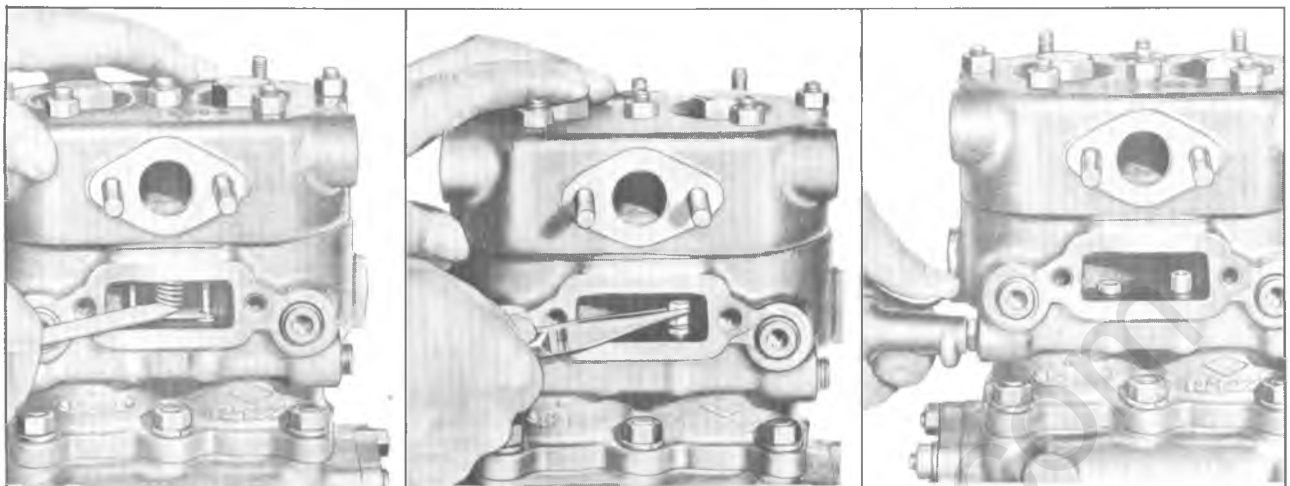
Removal (Fig. 4)

1. Remove air inlet elbow and discard gasket.

2. Insert screwdriver blade under unloader spring and raise spring off unloader spring saddle. Remove spring and spring saddle.

3. Lift each plunger guide and remove guide and plunger. Lift pistons out of bores. If piston is

AIR COMPRESSORS AND GOVERNORS



REMOVING OR REPLACING UNLOADER SPRING | REMOVING UNLOADER PISTON | REMOVING UNLOADER PISTONS USING AIR PRESSURE

Figure 4—Removing Unloader Components (B-W)

not easily removed, build up air pressure in system until governor cuts out, raising piston. If compressor has been removed from vehicle, use air pressure as shown in figure 4.

Installation (Fig. 5)

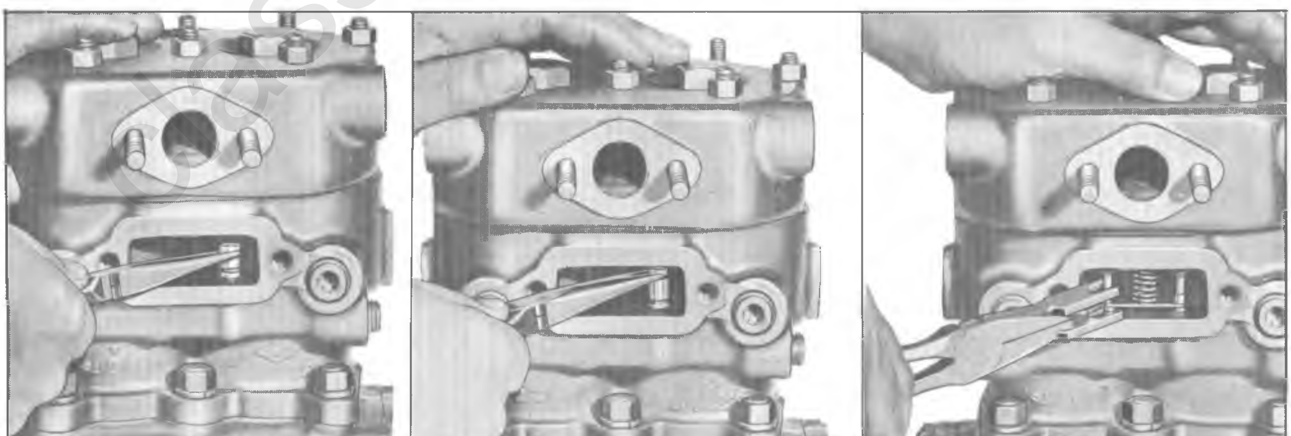
1. Carefully insert each piston, complete with O-ring and back-up ring, in bore.
2. Slide plunger guide down over unloader plunger. Place each guide and plunger in position above unloader piston, then push guide down over top of piston.
3. Install unloader spring and spring saddle. Make sure saddle rests squarely on top of plunger guides, and make sure top of spring engages spring seat in cylinder block.
4. Install new gasket at air inlet and connect air inlet elbow.

MIDLAND-ROSS

If a defective unloader is being removed and a new unloader installed in its place, omit the unnecessary steps.

Removal and Disassembly (Fig. 6)

1. Disconnect both ends of tube between governor and unloader. Remove tube assembly.
2. Remove two bolts attaching unloader assembly to cylinder head.
3. Remove unloader assembly. Remove inlet valve plunger and plunger spring.
4. Remove bushing, valve, diaphragm, and expander spring from body. Should difficulty be encountered in removing these parts, apply air pressure to body to force out these parts.
5. Remove rubber retainer from bushing.



INSTALLING UNLOADER PISTON | INSTALLING GUIDE AND PLUNGER ON UNLOADER PISTON | INSTALLING UNLOADER SPRING AND SADDLE

Figure 5—Installing Unloader Components (B-W)

Assembly and Installation (Fig. 6)

1. Apply thin film of light engine oil to bushing, diaphragm, and body before assembly.
2. Install expander spring around inside of diaphragm, then install these two parts in body.
3. Install rubber retainer on bushing.
4. Place valve in recess of bushing, then install in body.
5. Install plunger spring and inlet valve plunger
6. Set unloader assembly in place on cylinder head and fasten with two bolts.
7. Connect tube assembly from unloader to governor.
8. Test assembly with air pressure. Unloader should withstand a pressure of 100 psi without leaking.

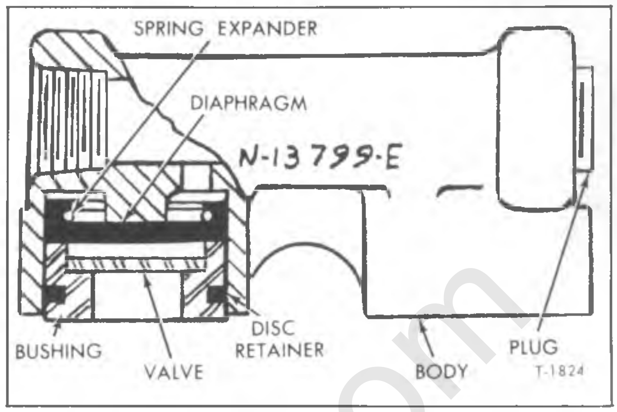


Figure 6—Unloader Assembly (M-R)

AIR COMPRESSOR GOVERNOR

DESCRIPTION

The governor, operating in conjunction with air compressor unloading mechanism, automatically controls air pressure in the air brake or air supply system between the desired, predetermined maximum and minimum pressures. The air compressor runs continually while the engine runs, but actual compression of air is controlled by the governor which stops or starts compression when the maximum or minimum pressures are reached.

MAINTENANCE

Every 500 operating hours or after every 15,000 miles, clean or replace governor filters.

Every 3,000 operating hours or after every 100,000 miles, disassemble the governor and clean and inspect all parts. Repair governor if necessary.

GOVERNOR TESTS

OPERATING TEST

Start the engine and build up air pressure in system. Observe reading on air pressure gauge in gauge panel when governor cuts-out, stopping compression of air by the compressor. Reading on gauge when governor cuts-out should be within range shown on chart at right.

With the engine still running, slowly reduce air pressure in the system by applying and releasing brakes. Observe pressure registered by gauge when governor cuts-in and compression is resumed. Gauge reading when governor cuts-in should be within range shown on chart at right.

Before condemning or adjusting the governor, be sure the dash air gauge is registering accurately. Use an accurate test gauge to check pressure registered by the dash gauge. If the pressure settings of the governor are inaccurate or it is necessary that they be changed, adjust governor as described in the "Adjustment" procedure.

LEAKAGE TEST

Leakage checks on the governor are made at its exhaust port in both cut-in and cut-out positions. In the cut-in position, check exhaust port for inlet valve leakage by applying a soap solution at the port. Leakage could also be past the bottom piston grommet (B-W only). In the cut-out position check the exhaust port to determine if leakage is present at the exhaust valve seat or stem grommet. In this position leakage could also be past the upper piston grommet (B-W only).

If there is excessive leakage, replace or overhaul governor.

GOVERNOR ADJUSTMENT CHART

Governor	Cut-In Pressure	Cut-Out Pressure
All Midland-Ross	85 psi	100-107 psi
All Bendix-Westinghouse	86-90 psi	103-111 psi

GOVERNOR ADJUSTMENT

Readjustment may be necessary if the range falls below 15 psi or if the pressure settings are incorrect. Before making any adjustments, check governor filter (10) and governor supply line (reservoir) for any restriction, then proceed as follows:

MIDLAND-ROSS (Fig. 7)

1. Loosen adjusting plug lock nut (2).
2. Build up pressure to 115 psi and maintain

AIR COMPRESSORS AND GOVERNORS

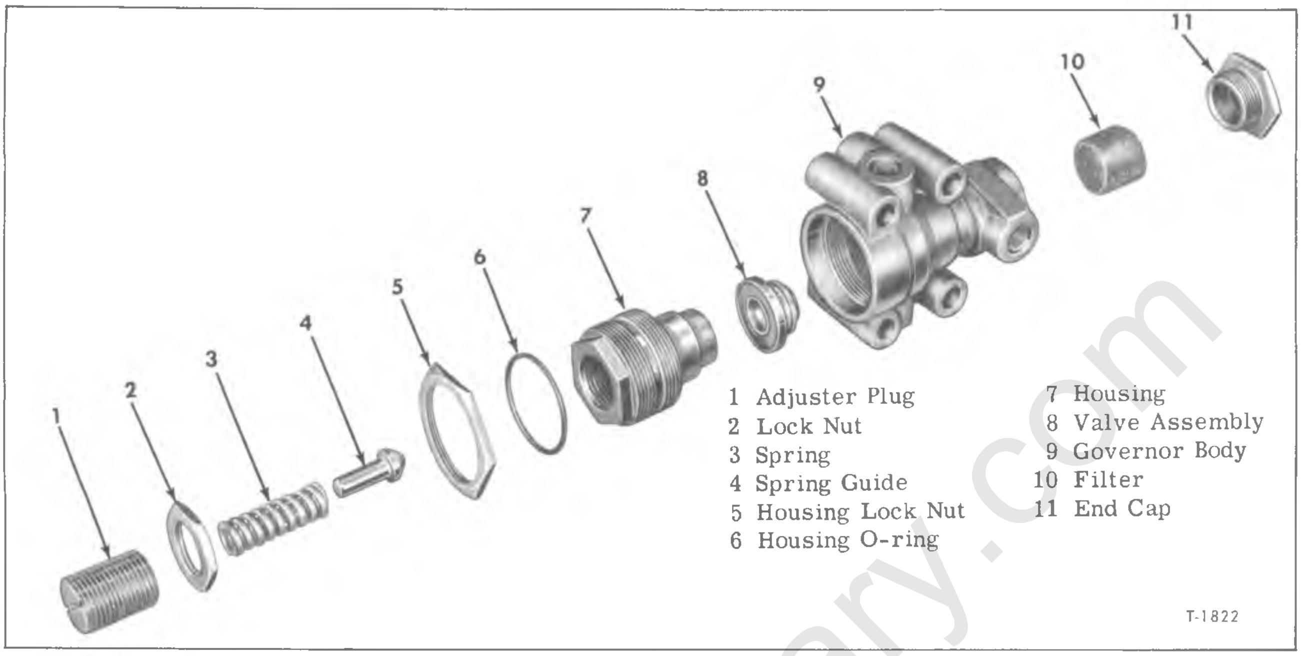


Figure 7—Air Compressor Governor (M-R)

it. If governor cuts out before 115 psi, turn adjusting plug (1) in one turn and repeat this step.

3. If governor does not cut-out at 115 psi, slowly turn adjusting plug (1) out until governor cuts out.

4. Slowly bleed down air pressure until governor cuts in at 93-98 psi. (If it does not cut-in at stated pressure, loosen exhaust valve housing lock nut (5).

5. If cut-in pressure is below 93 psi, hold adjusting plug (1) and turn exhaust valve housing (7) out approximately 1/6 of a turn. Repeat step 4.

6. If cut-in pressure is above 98 psi, hold adjusting plug (1) and turn exhaust valve housing (7) in approximately 1/6 of a turn. Repeat step 4.

NOTE: One-sixth of a turn will result in a change of 5 psi. The difference between cut-in and cut-out pressure must not be less than 15 psi as it could result in erratic operation.

7. Recheck cut-out and cut-in pressures. Tighten both lock nuts (5) making sure the adjusting plug (1) and exhaust valve housing (7) settings are not changed.

BENDIX-WESTINGHOUSE (Fig. 8)

1. Unscrew rubber cover and remove it from the governor.

2. Loosen adjusting screw lock nut.

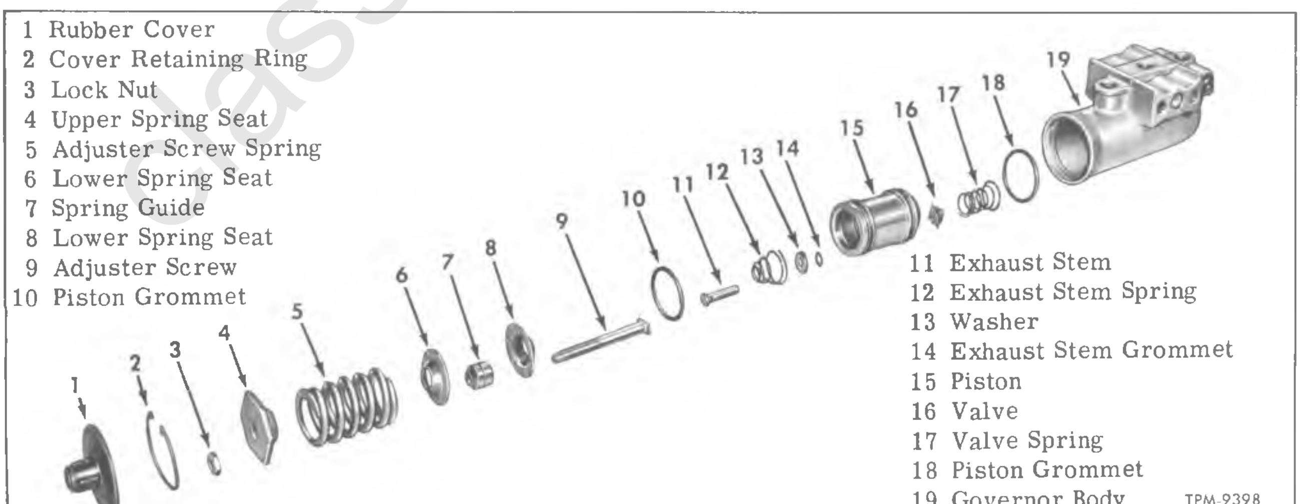


Figure 8—Air Compressor Governor (B-W)

3. Using a screwdriver, turn adjusting screw counterclockwise to raise pressure settings. Turn adjusting screw clockwise to lower the pressure settings indicated in "Governor Adjustment Chart" on page 385.

GOVERNOR REPLACEMENT

The following procedures apply to all governors on both Midland-Ross and Bendix-Westinghouse air compressors.

REMOVAL

1. Exhaust air from system.
2. Disconnect both ends of tube from governor to unloader.
3. Remove nuts and/or bolts which fasten governor to compressor or bracket.
4. Remove governor.

INSTALLATION

1. Place governor in position on compressor or bracket.
2. Install nuts and/or bolts which fasten governor.
3. Connect both ends of tube to governor and unloader.
4. Build up pressure in system and check for operation and leaks.

TROUBLESHOOTING

COMPRESSOR FAILS TO MAINTAIN SUFFICIENT PRESSURE

Dirty intake strainer.
Restriction in compressor cylinder head intake or discharge cavities or in discharge line.
Leakage or broken discharge valves.
Excessive wear.
Drive belt slipping.
Inlet valves stuck open.
Worn inlet valves.
Excessive system leakage or usage.

NOISY OPERATION

Loose drive pulley.
Restrictions in cylinder head or discharge line.
Worn or burned out bearings.
Compressor not getting proper lubrication.
Excessive wear.

COMPRESSOR PASSES EXCESSIVE OIL

Excessive wear.
Dirty air strainer. (Improper air strainer maintenance.)
High inlet vacuum.
Small oil return line.
Excessive oil pressure.
Oil supply or return lines to compressor flooded.
Defective or worn oil seal rings in end cover.
Piston rings not properly installed.
Back pressure from engine crankcase.

COMPRESSOR NOT UNLOADING

Defective unloader pistons or bores.
Intake cavity restrictions.
Defective governor.
Unloader line or cavity to governor restricted.
Unloader mechanism binding or stuck.

NOTE

The air compressor is the only source of supply for the vehicle braking system. Faulty operation of the compressor will result in improper function of brakes.

SECTION 6Y

Engine Electrical

This section, covering "ON-VEHICLE MAINTENANCE AND REPLACEMENT" of charging system components, is divided into sections shown in the Index following:

Battery

The battery has three major functions to perform on the vehicle:

1. It provides a source of current for starting the engine.

2. It acts as a stabilizer to the voltage in the electrical system.

3. It can, for a limited time, furnish current when the electrical demands of the electrical equipment exceed the output of the generator.

Standard and optional type storage batteries used on vehicles covered by this manual are shown in the "Battery Model Application Chart" following:

BATTERY MODEL APPLICATION CHART

STANDARD	PART NO.
Series ES-5500V	1980030
Series LA/LV-4000; EM-4500M/V; ES-4500V; PS-4500P	1980034
Series EM-5500A/M/V; EM-6500A/V	1980034
Series SM-5500M/Y; SS-5500M; SM-6500M/Y	1980038
Series DLA/DLV-4000; EG-5500A/V; SG-5500M/Y; EG-6500A/V	1980758
OPTIONAL	
Series ES-4500V; EM-5500A/V; EM-6500A/V	1980030
Series EM-4500V; 5500V; 6500V	1980036
Series LA/LV-4000; PS-4500P	1980038
Series DLA/DLV-4000; EG-5500A/V; SG-5500M/Y;SM-5500M/Y; SS-5500M; EG-6500A/V; SM-6500M/Y	1980760
Series SM-5500M/Y; 6500M/Y; SS-5500M (Two Batteries in Series)	1980716

BATTERY MAINTENANCE

FILLING BATTERY

Batteries are equipped with "Visual Level" cell covers to facilitate checking electrolyte level and lessen the possibility of overfilling the battery. The cell covers are molded with a long, circular, tapered vent well with two small vertical slots diametrically opposite. Viewed from above with the vent plugs removed, the lower end of the vent well appears as a ring with small portions of the circumference missing. As water is added to the cell, the surface of the rising liquid contacts the slotted lower end of the vent well, causing a distortion of the reflecting surface of the liquid which is very noticeable. Thus, the lower end of the vent well

BATTERY

Figure 1—Typical Battery with One Piece Cover

serves as a reference point in determining proper electrolyte level. The cell is properly filled when the surface of the electrolyte touches the bottom of the vent well. If some overfilling occurs, the amount can be estimated readily by the height of liquid in the vent well. It should be kept in mind that the "visual level" vent wells cannot prevent overfilling, but are rather an aid to proper servicing. Overfilling should be avoided at all times since it contributes to premature battery failure by causing loss of electrolyte. Loss of electrolyte results in poor performance of the battery and causes excessive corrosion of cables, connections, and battery hanger.

On batteries which have a one-piece cover (fig. 1), an electrolyte level indicator is installed in the second cell cap from the positive battery post. The level indicator is a specially designed vent plug having a transparent rod extending through the center. When electrolyte is at proper level, the lower tip of the rod is immersed and the top of the rod will appear as a dark (black) spot in the center of the vent cap. When electrolyte level drops below normal, the spot will change from black to an off-white color. When the indicator shows water is needed, all cells must be checked and adjusted to their correct level using colorless, odorless, drinking water.

ELECTROLYTE LEVEL

Electrolyte level in the battery should be checked periodically. In hot weather, particularly during prolonged driving, checking should be more frequent because of more rapid loss of water. If electrolyte level is found to be low, colorless, odorless, drinking water should be added to each cell until the liquid level rises to the split vent located in the vent well. DO NOT OVERFILL because this will cause loss of electrolyte resulting in poor performance, short life, and excessive corrosion.

The liquid level in the cells should never be allowed to drop below the top of the plates, as the portion of the plates exposed to air may be permanently damaged with a resultant loss of performance.

CLEANING AND INSPECTION

The external condition of the battery should be checked periodically for damage or presence of dirt and corrosion. The battery top should be kept clean to prevent the accumulation of acid film and dirt which may permit current to flow between terminals resulting in a slow discharge of the battery. For best results, when cleaning battery, wash first with a diluted ammonia or soda solution to neutralize any acid present, then flush with clean water. Care must be taken to keep vent plugs tight so that the neutralizing solution does not enter the cells.

Cables

To ensure a good electrical contact, cables should be clean and tight on battery posts. If battery posts or cable terminals are corroded, the cables should be disconnected and the terminals and clamps cleaned separately with a soda solution and a wire brush. After cleaning and installing clamps, apply a thin coating of petroleum jelly on the posts and cable clamps to retard corrosion.

Carrier and Hold-Down

The battery carrier and hold-down should be clean and free from corrosion before installing the battery. The carrier should be in sound mechanical condition so that it will support the battery securely and keep it level.

To prevent the battery from shaking in its carrier, the hold-down bolts should be tight. However, the bolts should not be tightened to the point where the battery case or cover will be placed under a severe strain.

BATTERY PRECAUTIONS

1. The electrical systems are NEGATIVE GROUND. Installing battery with positive terminal grounded will result in serious damage to generator, battery, and battery cables.
2. When using a booster battery, be sure to connect negative battery terminals together and positive terminals together.

3. When attaching battery charger leads to the battery, connect charger positive lead to battery positive terminal and connect charger negative lead to battery negative terminal.

4. DO NOT smoke near a battery which is being charged.

COMMON CAUSES OF BATTERY FAILURE

When a battery fails, the cause of failure may lie outside the battery itself. For this reason, when a battery failure is encountered, do not be satisfied to merely recharge or replace it. Find the cause of the failure and prevent recurrence of the trouble. Listed below are some of the common causes of battery failure:

1. Defect in generating system such as high resistance, slipping generator drive belt, faulty generator or regulator.
2. Overloads caused by defective starter or excessive use of accessories.
3. Battery abuse, including failure to keep battery top clean, cable clamps clean and tight, and improper addition of water to the cells.
4. Hardened battery plates, commonly called "sulfation," due to battery being in a low state of charge over a long period of time.
5. Physical defects such as shorted cells, loss of active material from plates, etc.
6. Driving conditions or requirements under which the vehicle is used only for short drives.

BATTERY TESTS

Testing procedures are used to determine whether the battery is: (1) Good and usable, (2) Requires recharging, or (3) Should be replaced.

The following checks may be performed to determine condition of the battery.

VISUAL INSPECTION

The first step in testing the battery should be a visual inspection, which very often will save time and expense in determining battery condition.

1. Check outside of battery for a broken or cracked case or a broken or cracked cover. If damage is evident, the battery should be replaced.
2. Check the electrolyte level. Levels that are too high or too low will cause poor performance.
3. Check for loose terminal posts, cable connections, and for evidence of corrosion. Correct as required before proceeding with tests.

CAPACITY TEST

This test is one means of determining whether a battery is functioning efficiently to the degree where it can be relied upon to perform all of its duties properly in the vehicle.

A 6-volt battery that will maintain 4.5 volts and a 12-volt battery that will maintain 9.0 volts or better during a capacity test should be considered a good battery. To make this test, use equipment that will take a heavy electrical load from the battery such as a carbon pile or other suitable means. If test equipment is not available for loading battery the starter may be used as a load.

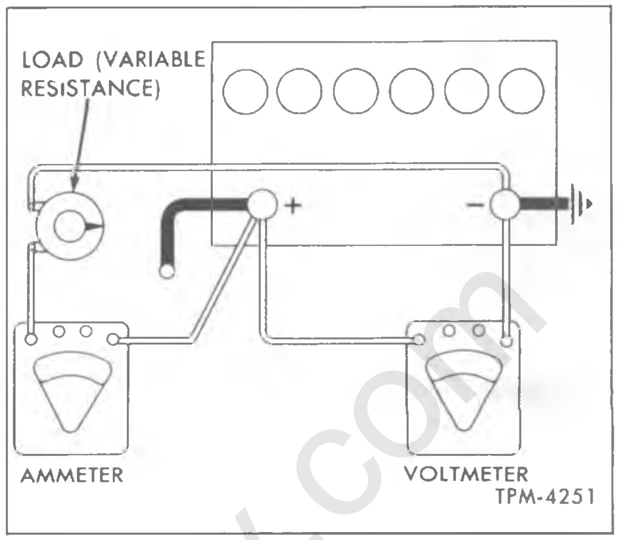


Figure 2—Battery Capacity Test

1. Connect positive voltmeter and ammeter leads to battery positive post and negative voltmeter and ammeter leads to battery negative post (fig. 2).

NOTE: Ammeter cable clips must contact battery posts; voltmeter cable clips must contact battery post or cable clamp.

2. Apply a load to the battery of three times the ampere-hour rating of the battery for 15 seconds. Refer to "Specifications" at end of this section for ampere-hour ratings of various batteries used in vehicles covered by this manual.

3. With ammeter reading specified load, read voltage which should not be less than 4.5 volts for 6-volt battery or 9.0 volts for 12-volt battery.

a. If voltmeter shows 4.5 volts for 6-volt battery or 9.0 volts for 12-volt battery or more, battery has good output capacity and will readily accept a normal charge.

(1) If specific gravity is 1.215 or more, no service is required.

(2) If specific gravity is below 1.215, check charging circuit to determine the cause and correct as required. The battery should be slow-charged for city driving. With highway driving and a good charging system, the battery should charge satisfactorily.

b. If voltmeter shows a reading of less than 4.5 volts for a 6-volt battery or 9.0 volts for a 12-volt battery, perform the "Battery Instrument Test" or "Battery Light Load Test."

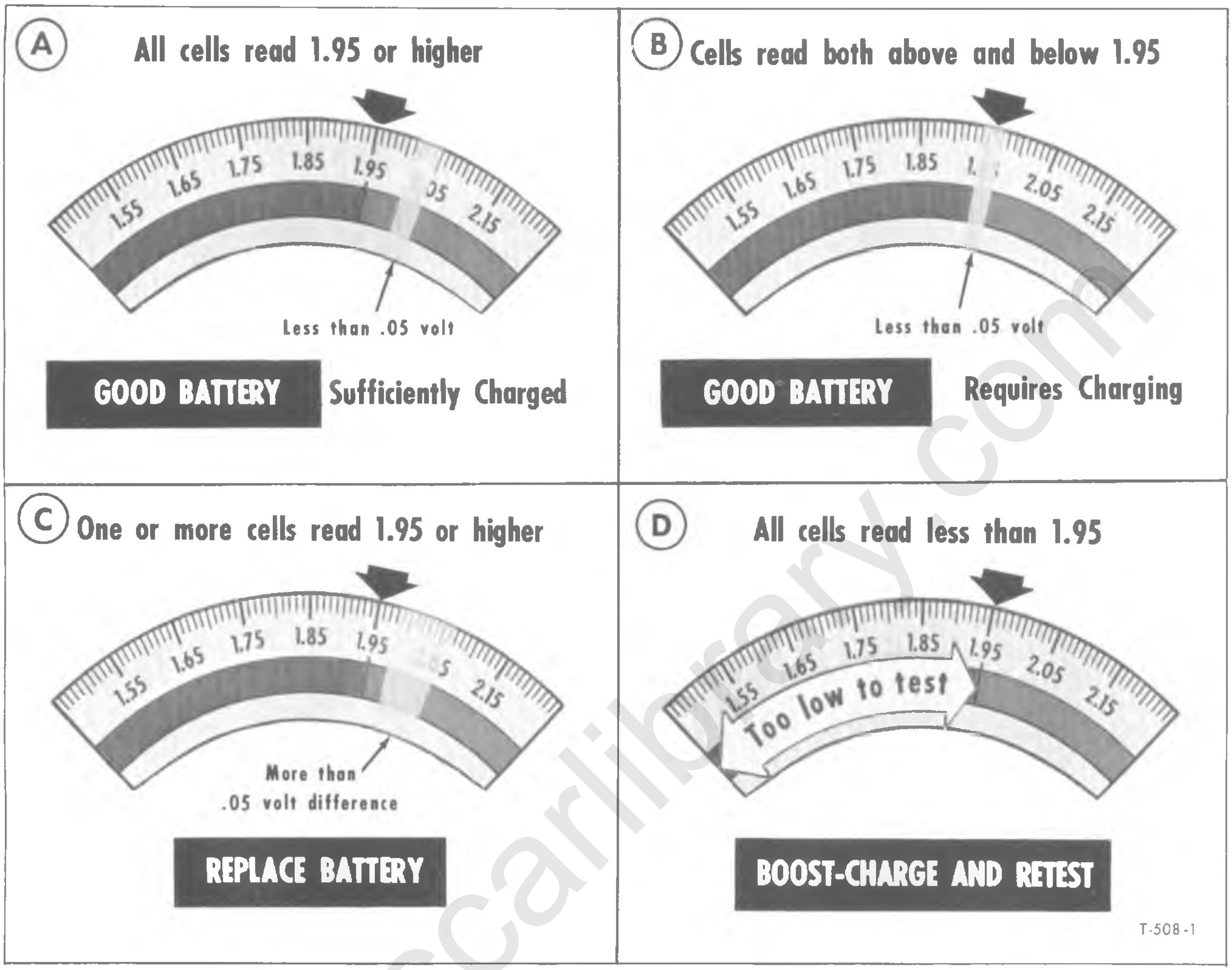


Figure 3—Battery Light Load Test

BATTERY INSTRUMENT TEST

NOTE: A number of suppliers have approved testing equipment available, such as the tester (J-22552).

These testers have a programmed test procedure consisting of a series of timed discharge and charge cycles that will determine the condition of the battery with a high degree of accuracy. When using these testers, follow procedures recommended by the instrument manufacturer.

If a tester is not available, the "Specific Gravity Cell Comparison Test" may be used as an alternate method, but with a sacrifice in testing accuracy.

1. Measure specific gravity of each cell, regardless of state of charge.

2. If specific gravity readings show a difference between the highest and lowest cell of 0.050 (50 points) or more, the battery should be replaced.

BATTERY LIGHT-LOAD TEST

CAUTION: DO NOT attempt to perform this test on batteries which have a one-piece cell cover (fig. 1).

Check electrical condition of battery cells as follows (refer to fig. 3):

1. If electrolyte level in each cell is low, adjust to proper level by adding colorless, odorless, drinking water.

2. Place load on battery by cranking engine. If engine starts, turn off ignition immediately. If engine does not start, hold starter switch "ON" for 3 seconds, then release.

3. Turn on head lights (low beam). After one minute, with lights still "ON" read voltage of each battery cell with voltmeter, compare readings with the following:

Good Battery (Fig. 2, View A)

If all cells read 1.95 volts or more and the difference between the highest and lowest cell is less than .05 volt, battery is good.

Good Battery (Fig. 2, View B)

If cells read both above and below 1.95 volts and the difference between the highest and lowest cell is less than .05 volt, battery is good but requires charging. See "Charging After Light Load Test."

Replace Battery (Fig. 2, View C)

If any cell reads 1.95 volts or more and there is a difference of .05 volts or more between the highest and lowest cell, the battery should be replaced.

Discharged Battery (Fig. 2, View D)

If all cells read less than 1.95 volts, battery is too low to test properly. FAILURE OF THE METER TO REGISTER ON ALL CELLS DOES NOT INDICATE A DEFECTIVE BATTERY. Boost charge battery and repeat "Light Load Test." (See "Boost Charging For Light Load Test.") If battery is found to be good after boosting, it should be fully recharged for good performance. If none of the cells come up to 1.95 volts after the first boost charge, the battery should be given a second boost. Batteries which do not respond after a second boost charge should be replaced.

NOTE: If any battery found to be good by the "Light Load Test" does not perform satisfactorily in subsequent service, it should again be tested by the "Light Load Test" and if it still tests "good" it should be removed from vehicle and tested as outlined under "Full Charge Hydrometer Test."

BOOST CHARGING FOR THE LIGHT LOAD TEST

Boost charge 12-volt batteries having an ampere hour capacity of 100 or less at 50 amperes for 20 minutes (50 x 20 = 1000 ampere minutes). Boost charge batteries having an ampere hour capacity of over 100 at 60 amperes for 30 minutes (60 x 30 = 1800 ampere hour minutes). If charger will not give this rate, charge for an equal number of ampere minutes at best rate available.

IMPORTANT: For purposes of this test, do not boost battery more than the amount indicated.

CHARGING AFTER THE LIGHT LOAD TEST

For best performance, a good battery should be fully charged before being returned to service.

If batteries are to be fully charged by means of a quick charger, the charge rate must be "tapered" (reduced to a safe limit) when the electrolyte temperature reaches 125°F., or when gassing becomes excessive. Failure to do so may harm the battery.

FULL CHARGE HYDROMETER TEST

The specific gravity of the electrolyte varies not only with the percentage of acid in the liquid, but also with temperature. As temperature increases, the electrolyte expands so that the specific gravity is reduced. As temperature drops, the electrolyte contracts and specific gravity increases. Unless these variations are noted, the specific

CHARGING GUIDE FOR BATTERIES

Below is a suggested list of battery charging rates. Refer to applicable chart.

CHART 1: For dry charged batteries being activated with electrolyte at a temperature under 60°F., or with batteries which are expected to go into immediate operation in below freezing weather.

Amp-Hour Capacity	Dry Battery Warm-up Charge
100 or Less	10 Min.
	15 Amps
Over 100	10 Min.
	30 Amps

CHART 2: For batteries which require a boost charge for the "Light Load Test" procedures.

Amp-Hour Capacity	Light Load Test Boost Charge
100 or Less	20 Min.
	50 Amps
Over 100	30 Min.
	60 Amps

CHART 3: For batteries which have become discharged and require charging. It should be recognized that slow charging is the best and only method of completely recharging batteries. However, since time is often of importance, two other methods are offered for partial battery re-charges listed in this chart.

Amp-Hour Capacity	Slow Charging	Fast Charging	Emergency Boost Charging
100 or Less	24 Hours	1-1/2 Hrs.	30 Minutes
	4 Amps	40 to 50 Amps	40 to 50 Amps
Over 100	24 Hours	3 Hours	1-1/2 Hours
	9 Amps	40 to 50 Amps	40 to 50 Amps

gravity obtained by the hydrometer may not give a true indication of the concentration of acid in the electrolyte.

Corrections can be made for temperature by adding .004 (four points of gravity) to the hydrometer reading for every 10^{o}F., that the electrolyte is above 80^{o}F., or by subtracting .004 for every 10^{o}F., that electrolyte is below 80^{o}F.

1. Adjust electrolyte to proper level in each cell by adding water, then replace vent caps.

2. Charge the battery in accordance with applicable chart under "Charging Guide For Batteries."

3. Using a hydrometer, measure specific gravity of electrolyte in each cell. If any cell reads less than 1.230 (corrected to 80^{o}F.) the battery should be replaced.

CAUTION: DO NOT take hydrometer readings immediately after water has been added. Water must be thoroughly mixed with electrolyte by charging for at least 15 minutes at a rate high enough to cause vigorous gassing.

4. If any cell reads above 1.310, the battery may be returned to service. However, specific gravities above 1.310 are harmful to the battery.

BATTERY CHARGING

When a battery is being charged, an explosive gas mixture forms in each cell. Part of this gas escapes through holes in the vent plugs and may form an explosive atmosphere around the battery if ventilation is poor. This gas may remain in or around the battery for several hours after it has been charged. Sparks or flames can ignite this gas causing an internal explosion which may shatter the battery; therefore, do not smoke near a battery which is being charged or which has been recently charged and exercise care when connecting or disconnecting booster leads or cable clamps on a charger. Poor connections are a common cause of electrical arcs which cause explosions.

There are three methods of recharging batteries. They differ basically in the length of time the battery is charged and the rate at which charging current is supplied. One is the "Slow Charge" method, the second is the "Fast Charge" method, and the third is the "Emergency Boost Charge" method.

Before recharging a battery by any method, the electrolyte level must be checked and adjusted, if necessary.

SLOW CHARGING

The "Slow Charge" method supplies the battery with a relatively low current flow for a relatively long period of time. This is the only method that will bring the battery to a full state of charge.

The "Slow Charge" method consists of charging at approximately a 4-ampere rate for 24 hours or more, if necessary, to bring the battery to full charge. A fully charged condition is reached when the cells are gassing freely and three corrected specific gravity readings taken at hourly intervals show no increase.

FAST CHARGING

The "Fast Charge" method supplies current to the battery at a 40 to 50 ampere rate for a 1-1/2-hour period of time. If the electrolyte temperature reaches 125^{o}F., before the 1-1/2-hour period is completed, the battery must be taken off charge temporarily, or the charging rate reduced to avoid damage to the battery.

Although a battery cannot be brought to a fully charged condition during "Fast Charge," it can be substantially recharged or "boosted." In order to bring the battery to a fully charged condition, the charging cycle must be finished by the "Slow Charge" method.

EMERGENCY BOOST CHARGING

In cases where the battery is not sufficiently charged to crank the engine, an emergency boost charge may be applied as a temporary expedient in order to crank the engine. The "Emergency Boost Charge" method consists of charging at a 40 to 50 ampere rate for a period of one-half hour.

It should be particularly noted that the "Emergency Boost Charge" will not necessarily restore the battery to a useful state of charge for continued service. After an "Emergency Boost Charge" failure to charge the battery further, either by a long uninterrupted driving period or by the "Fast Charge" or "Slow Charge" method, may result in failure to crank the engine the next time cranking is attempted. A battery should never be condemned on the basis of failure to crank the engine after an "Emergency Boost Charge." Although an emergency boost charge may put enough energy into the battery to crank the engine once, further charging usually is necessary in order to create a sufficient reserve to crank a second and third time.

NEW VEHICLES IN STOCK

1. Check electrolyte on each new vehicle received; add sufficient distilled water to bring the electrolyte up to bottom of vent wells. DO NOT OVERFILL.

2. Check electrolyte and add distilled water as necessary at weekly or semi-monthly intervals, depending upon the weather. Warm weather causes greater water loss.

3. If the specific gravity of the battery is below 1.215 (corrected to 80^{o}F.), remove it from

vehicle and place it on a charging line. Charge the battery until the specific gravity reaches 1.260-1.280.

Before a new truck is placed in service, make sure the specific gravity of the battery electrolyte is at least 1.250, preferably higher. Under no circumstances should acid be added to a new battery, to increase the specific gravity of the electrolyte.

CARE OF NEW BATTERIES IN STORAGE

New batteries in storage should be stored and cared for in accordance with instructions furnished by the battery manufacturer.

PREPARING DRY-CHARGED BATTERIES FOR SERVICE

Electrolyte should be added to dry-charged batteries in accordance with instructions furnished by the battery manufacturer.

BATTERY CABLES

Excessive resistance caused by terminal connections and partial short circuits through defective cable insulation will result in abnormal voltage drop in starter cable. Low voltage at starter will prevent normal starter operation and will cause hard starting. The following tests must be made with primary wire disconnected from distributor or coil to prevent engine starting:

1. Check voltage drop between grounded (-) battery terminal and vehicle frame. Place one prod of test voltmeter on grounded battery post (not on cable clamp) and the other on frame. Operate starter and note the voltage reading.
2. Check voltage drop between ungrounded (+) battery terminal and starter terminal stud with starter operating.
3. Check voltage drop between starter housing and frame with starter operating.
4. If voltage drop in any of the above tests is more than 0.5 volt on gasoline models or 1.0 volt on Diesel models, there is excessive resistance in the circuit. To eliminate resistance, the cables should be disconnected and connections cleaned. If cables are frayed or the clamps excessively corroded the cables should be replaced. When selecting new cables, be sure they are at least as large as the ones being replaced.

SPECIFICATIONS

BATTERY SPECIFICATIONS

PART NO.	MODEL NO.	CATALOG NO.	VOLTS	NO. OF PLATES PER CELL	AMP. HR. CAPACITY AT 20 HR. RATE	CRANKING ABILITY AT 0°F.
1980030	E-5000; R-58		12	11	61	1.6 Min. @ 300 Amps.
1980034	E-3000; Y-58		12	9	53	1.1 Min. @ 300 Amps.
1980036	E-5000; R-68		12	11	70	2.1 Min. @ 300 Amps.
1980038	E-3000; Y-70		12	11	70	2.0 Min. @ 300 Amps.
1980716	4-HR-160	716	6	21	160	7.0 Min. @ 300 Amps.
1980758	4-DR-150	758	12	19	150	6.0 Min. @ 300 Amps.
1980760	8 DR-205	760	12	27	205	10.5 Min. @ 300 Amps.

Starting System

MODEL APPLICATION CHART

STANDARD	PART NUMBER
Series LV/LA-4000; EM-4500M/V; EM-5500A/M/V; SM-5500M/Y; EM-6500A/V	1107375
Series SM-6500M/Y	1107376
Series ES-4500V	1108368
Series PS-4500P; ES-5500V; SS-5500M	1108360
Series DLA/DLV-4000; EG-5500A/V; SG-5500M/Y	1113686
EG-6500A/V	1113686
OPTIONAL	
Series ES-4500V; ES-5500V; SS-5500M	1108372

GENERAL

The solenoid operated, overrunning clutch type starting motors used as standard and optional equipment on vehicles covered by this manual are shown in the "Model Application Chart" above.

DESCRIPTION

The overrunning clutch type starting motors (fig. 1), are of the enclosed shift lever type.

The drive end housing is extended to enclose the entire shift lever mechanism and solenoid plunger. The solenoid flange is mounted on drive end housing, with sealing compound used between flange and field frame. A compression type shift lever return spring located inside the solenoid case is used to operate the overrunning clutch. On gasoline engine models, primary circuit to ignition coil is fed from solenoid while the starter is operating.

Positive lubrication is provided to bronze bushings in commutator end frame, in the drive end frame and in the nose housing by oil saturated wicks that project through each bushing and contact the armature shaft.

On some models, a starter interlock is used to prevent the starter from being engaged while the engine is running and to prevent starter overspeeding by holding starter in engaged position.

STARTING SYSTEM OPERATION

The starting system consists of the battery, starting motor, including the drive assembly which engages the flywheel ring gear during cranking, the starter solenoid, mounted on the starting motor for shifting the drive assembly and closing the motor circuit and the ignition or control switch which, when in the "START" position connects a lead from the battery to the solenoid switch. During cranking, the ignition switch (gasoline engine models) also connects the battery directly to the ignition coil.

CAUTION: If a remote switch is used to operate starter, the primary wire must be disconnected from coil negative terminal and ignition switch must be turned on. Failure to do this will result in damaged grounding circuit in ignition switch.

When starter circuit is energized, the solenoid operated shift lever slides the pinion into mesh with the flywheel ring gear teeth. The rotary motion between pinion and ring gear, provided by spiral splines on clutch shaft, normally relieves tooth abutment on the first attempt to engage pinion and ring gear. A protective sleeve located on the spiral spline acts as a stop for the pinion when extreme tooth abutment occurs. This limits the clutch travel, preventing switch contacts in the solenoid from closing. Therefore, the armature cannot rotate before pinion is engaged properly, preventing damage to pinion and ring gear. A second attempt to engage rotates pinion enough to assure proper engagement.

STARTER AUTOMATIC DISENGAGEMENT AND LOCK OUT

SERIES SG-5500; EG-5500-6500

A starter interlock relay is used on these vehicles equipped with the D/DH-478 Toro-Flow Diesel engine to prevent starter over-speeding by breaking starter solenoid to engine control switch circuit when engine reaches approximately 400-600 rpm. This system also prevents starter pinion from engaging a running flywheel by breaking circuit between engine control switch and starter solenoid while engine is running. This system is controlled by output at "R" terminal of the generator as shown in figure 2 or 3.

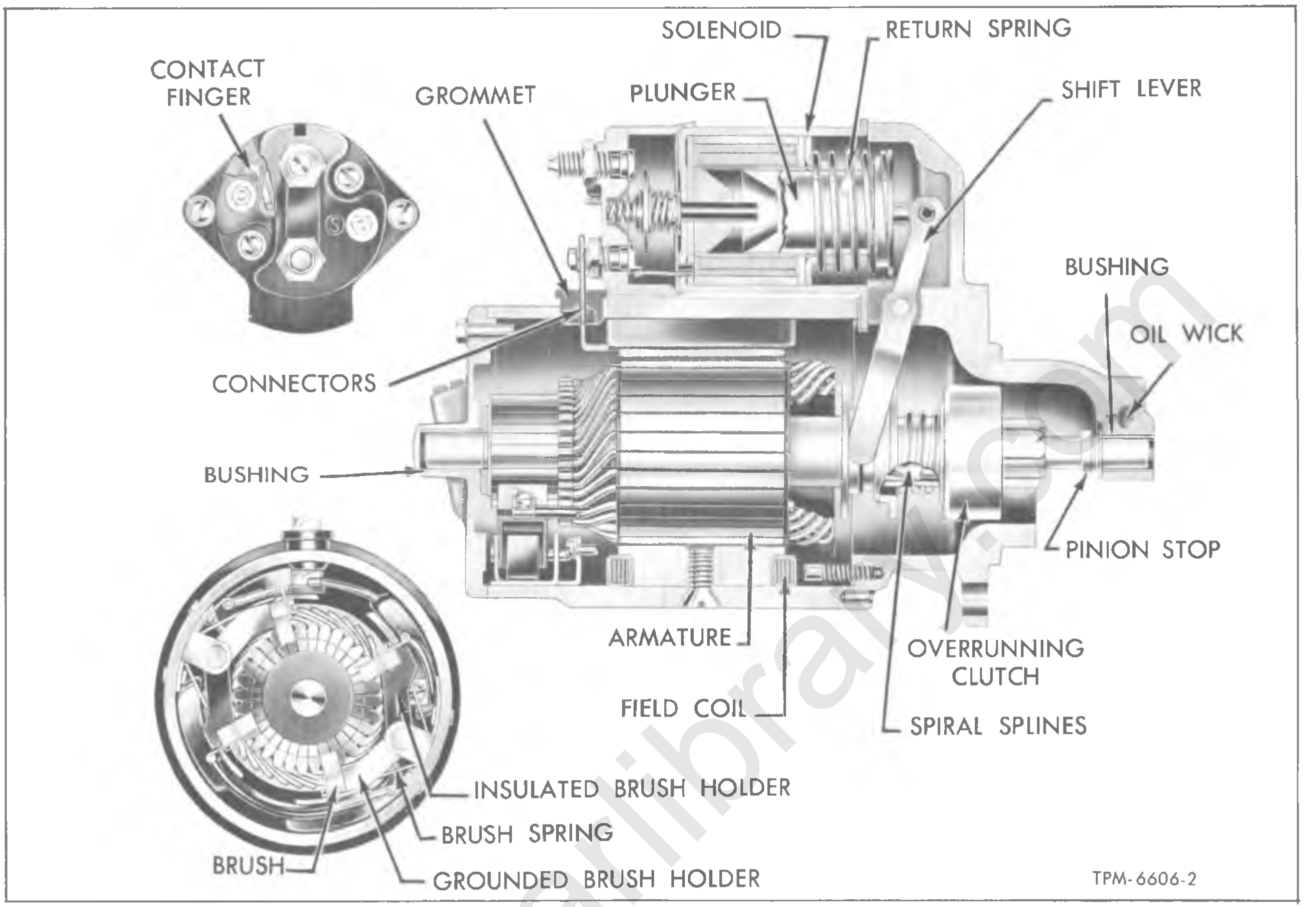


Figure 1—Overrunning Clutch Type Starting Motor (Typical)

When engine control switch is placed in "START position, current from the battery is supplied through engine control switch and closed contact points of starter interlock relay to energize starter solenoid. When engine is started and reaches approximately 400-600 rpm, current from generator "R" terminal is supplied through starter interlock relay operating coil to break circuit to starter solenoid, thus disengaging the starter if engine control switch is not released after engine is started. This also prevents starter from being accidentally engaged by turning engine control switch to "START" position while engine is running.

SERIES DLA/DLV-4000

A starter control relay is used on these vehicles to prevent starter over-speeding by breaking starter solenoid-to-engine control switch circuit when engine reaches approximately 400-600 rpm. This system also prevents starter pinion from engaging a running flywheel by breaking circuit between engine control switch and starter solenoid while engine is running. This system is controlled by output at "R" terminal of generator as shown in figure 4.

When engine control switch is placed in "START" position, current from the battery is supplied through engine control switch and closed contact points of starter control relay to energize starter solenoid. When engine is started and reaches approximately 400-600 rpm, current from generator "R" terminal is supplied through starter control

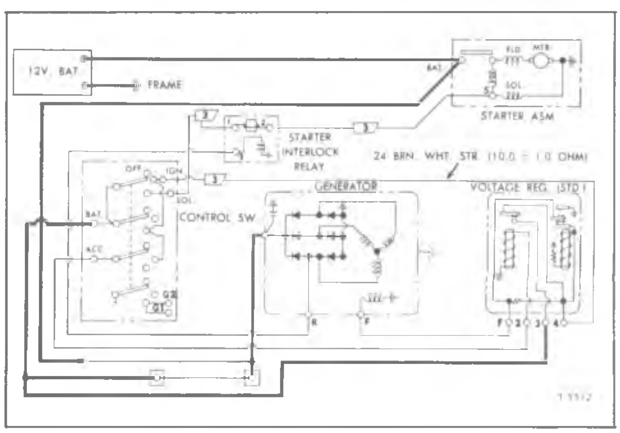


Figure 2—Starter Disengagement and Lock-Out (SG5500) (Typical)

STARTING SYSTEM

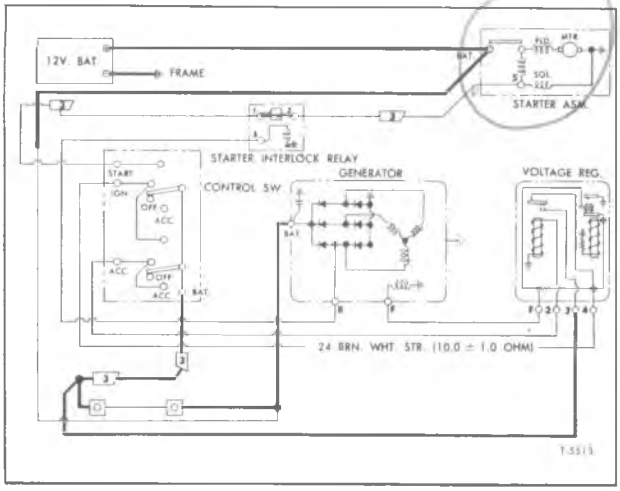


Figure 3—Starter Disengagement and Lock-Out (EG5500—6500)

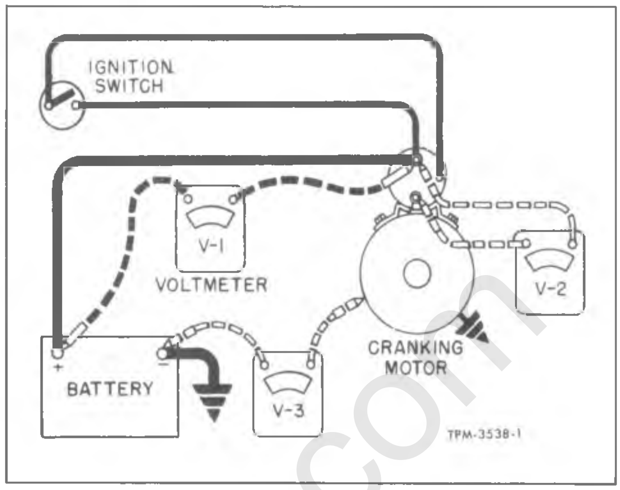


Figure 5—Voltmeter Connections for Checking Circuits (Typical)

relay operating coil to break circuit to starter solenoid, thus disengaging the starter if engine control switch is not released after engine is started. This also prevents starter from being accidentally engaged by placing engine control switch in "START" position while engine is running.

STARTING CIRCUIT TESTS (ON VEHICLE)

Although the starter cannot be checked against specifications on the vehicle, checks can be made for excessive resistance in the starter circuit.

> CAUTION: To make these checks on gasoline engine models, disconnect the primary lead at the distributor to prevent engine starting. On Diesel models, pull stop knob on instrument panel out to set the injection pump in "NO-FUEL" (Stop) position to prevent engine starting.

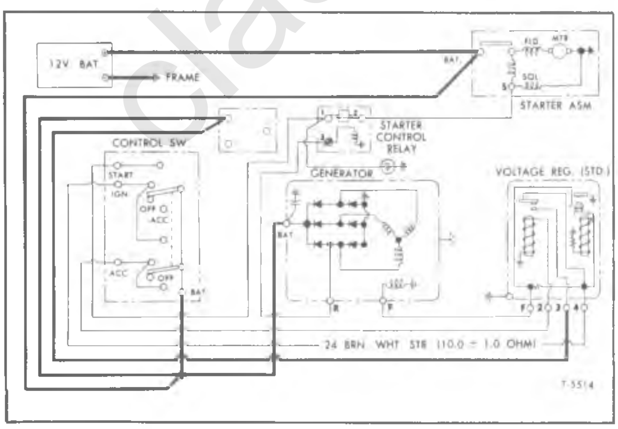


Figure 4—Starter Disengagement and Lock-Out (DLA/DLV 4000)

Referring to figure 5 and with starter cranking engine during each check, measure resistance in various parts of the circuit as follows:

IMPORTANT: When performing the following checks, do not operate starting motor continuously for more than 30 seconds to avoid overheating:

V-1 - Check V-1 with voltmeter leads connected from battery positive post to battery terminal on the starter solenoid.

V-2 - Check V-2 with voltmeter leads connected from solenoid battery terminal to solenoid motor terminal.

V-3 - Check V-3 with voltmeter leads connected from battery negative post to starter field frame.

If voltmeter reading in any of the previous checks exceeds 0.2 volts, excessive resistance is indicated in that part of the circuit being checked. Locate and eliminate the cause of excessive voltage drop in these circuits in order to obtain maximum efficiency from the starting system. Cause of excessive resistance may be loose, corroded, or dirty connections, or frayed cables.

If starter fails to crank engine, first make sure battery is not discharged, then check solenoid operation. If the solenoid fails to operate, the trouble may be due to excessive resistance in the starter control circuit. Check all wiring and connections from ignition or control switch to solenoid for loose or corroded connections. If cause of excessive resistance is not apparent, connect a short jumper lead across the solenoid battery and switch terminals. If solenoid operates with jumper lead connected, trouble is in the control circuit. Check for defective ignition or control switch. If solenoid does not operate with jumper lead connected, solenoid is defective and must be replaced.

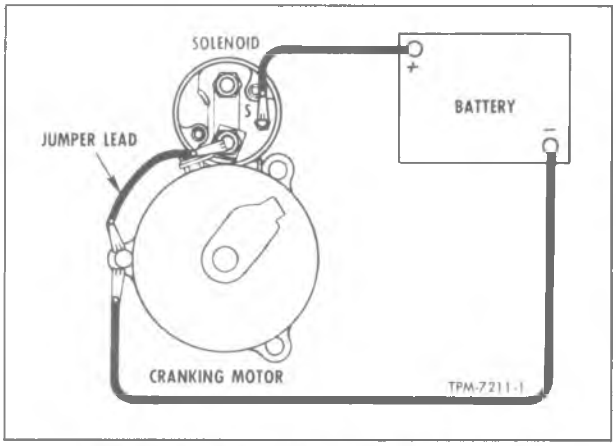


Figure 6—Circuit for Checking Pinion Clearance

STARTER REPLACEMENT

REMOVAL

1. Remove ground strap from battery negative (-) post or tape end of battery cable when disconnected from starter solenoid to prevent discharge of battery by direct short.
2. Disconnect wires from solenoid terminals.
3. Remove bolts, nuts, and lock washers attaching starter to flywheel housing and pull starter forward to remove. Remove spacer (if used).

INSTALLATION

1. Position starter and spacer (if used), at flywheel housing and secure with bolts, nuts, and washers. On gasoline engine models, tighten mounting bolts to 25-35 foot-pounds torque. On Diesel engine models, tighten mounting bolts to 70-80 foot-pounds torque.
2. Connect all wires to starter solenoid terminals, referring to "Wiring Diagrams" in applicable "Wiring Diagrams" booklet to make sure of proper connections. Tighten terminal nuts firmly.

PINION CLEARANCE CHECK

The drive pinion clearance should be checked whenever starter has been overhauled. There is no means of adjusting the pinion clearance on the light duty starting motors. If clearance is not within specified limits, it may indicate excessive wear of the solenoid linkage or shift lever yoke lugs. Clearance between the end of the pinion and pinion stop (retainer), with pinion in cranking position, should be 0.010"-0.140".

1. Connect a voltage source of approximately 6 volts between the solenoid switch terminal (S) and ground.

IMPORTANT: DO NOT connect voltage source to ignition coil (R) terminal of solenoid. Do not use a 12-volt battery in place of the 6-volt battery

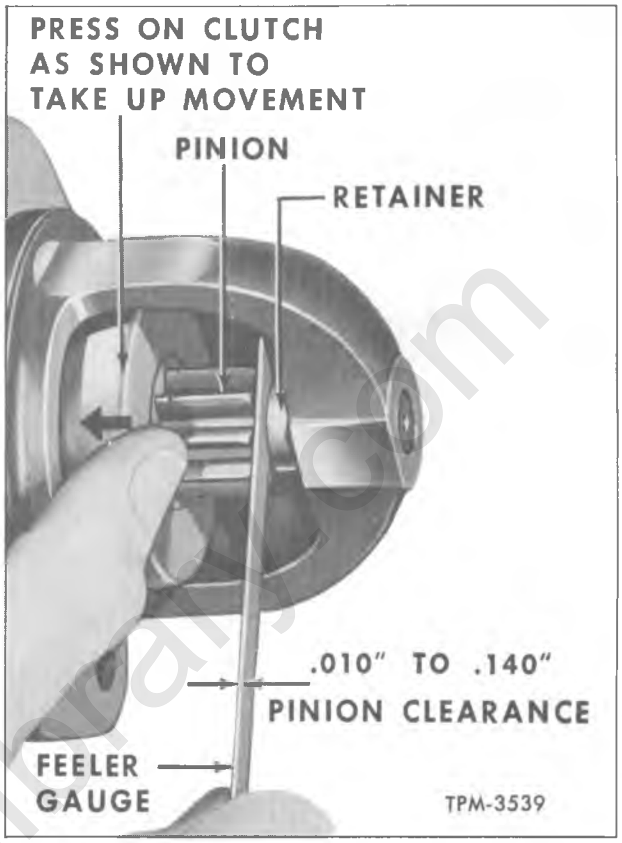


Figure 7—Measuring Pinion Clearance

specified in Step 1 previously, as this will cause the starter to operate. As a further precaution, connect a heavy jumper lead from solenoid motor terminal to ground (fig. 6) to prevent motoring.

2. After energizing the solenoid (clutch shifted forward), push pinion back toward commutator to take up possible slack. Check clearance with a feeler gauge as shown in figure 7. If clearance is not within 0.010" to 0.140", disassemble and replace worn parts in solenoid and shift lever linkage.

STARTER FREE SPEED CHECK

(Refer to Figure 8)

The free speed check is recommended after a starting motor has been overhauled. If necessary test equipment is available, accomplish following steps to perform free speed check:

1. Connect a 12-volt battery in series with an ammeter to "battery" terminal of solenoid on starting motor.
2. Connect a lead from frame of starting motor to negative (-) post on battery.
3. Connect a voltmeter from solenoid battery terminal to ground.
4. Install a tachometer or any suitable rpm indicator to starting motor.

STARTING SYSTEM

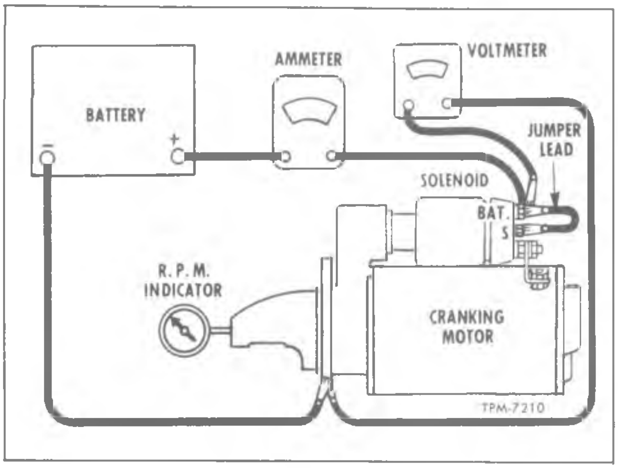


Figure 8—Circuit for Checking Motor Free Speed

5. Connect a jumper lead from "battery" terminal to switch terminal on solenoid.

6. Observe ammeter, voltmeter and tachometer, and compare readings with "No Load Test" specifications listed in "Specifications" at end of this section.

STARTER SOLENOID

Starter solenoid is used to shift the starter drive pinion into engagement with flywheel teeth and to complete the circuit from battery to starter.

Solenoid has two windings, the pulling winding and the holding winding. When ignition switch is turned to "START" position both windings are energized, producing a magnetic field which pulls the plunger in. Inward movement of plunger shifts starter pinion into engagement with flywheel ring gear teeth, and closes main contacts in the solenoid switch to complete circuit from battery to starter.

The pulling winding draws comparatively heavy current for a short interval. This is required to shift the pinion into engagement. The holding winding also aids the pulling winding. As soon as plunger closes the main switch contacts, pulling winding is de-energized and only the holding winding draws current for the balance of the starting cycle.

SOLENOID MAINTENANCE

Solenoids require no periodic maintenance other than keeping the terminals clean and tight. Always check action of solenoid if it has been removed. If unit fails to function, first check wiring before condemning the solenoid. Solenoid windings can be checked for current draw, open circuit, or shorts. Refer to "Specifications" at end of this section for current values. Solenoid coil, terminals, and switch plunger can be replaced if burned or otherwise damaged. Whenever the solenoid is replaced on overrunning clutch type starting motors, pinion clearance must be checked, as previously directed under "Pinion Clearance Check."

STARTING MOTOR SPECIFICATIONS

STARTER MODEL	1107375(a)	1107376(a)	1108360(a)	1108368(a)	1108372(a)	1113686(a)
Type of Drive	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch
Voltage	12	12	12	12	12	12
Rotation (Viewed at Drive End)	CW	CW	CW	CW	CW	CW
No Load Test						
Volts	10.6	10.6	10.6	10.6	11.8	11.0
Amps. (Min.)	65*	55*	65*	49*	—	130 *
Amps. (Max.)	100*	95*	100*	87*	72	160 *
RPM (Min.)	3600	3800	3600	6200	6025	5000
RPM (Max.)	5100	6000	5100	10,700	—	7000

*Includes Solenoid
(a)Pinion Clearance 0.010"-0.140"

STARTER SOLENOID MODEL	1114344	1114359	1114362	1114362	1114343	1115510
Voltage	12	12	12	12	12	12
Current Consumption						
Both Windings						
Amps	41-47	41-47	41-47	41-47	41-47	70.4-77.8
Volts	10	10	10	10	10	10
Hold-In Winding						
Amps	14.5-16.5	14.5-16.5	14.5-16.5	14.5-16.5	14.5-16.5	18-20
Volts	10	10	10	10	10	10

STARTER INTERLOCK RELAY

Model	**1115848**
Make	Delco-Remy
Point Opening (In.)	0.017-0.033
Opening Voltage (Range)	3.7-5.2

Ignition System

GENERAL

The ignition system consists of the source of power (battery or generator) ignition switch, ignition coil, distributor, condenser, spark plugs, and high and low tension wires.

A special resistance wire is used in the body wiring harness connecting the ignition terminal of the ignition switch to the ignition coil on all gasoline engine equipped vehicles except "P" models. The resistance wire is identified on Wiring Diagrams in applicable "Wiring Diagrams" booklet as: 20 WHT.-OR.- & PPL. CR. TR. for V-6 gasoline engine models and 20 WHT.-RED & BLK. Cr. TR. for In-line gasoline engine models.

This resistance serves to increase ignition coil efficiency and lengthen distributor point life. If wire becomes damaged, it should be replaced with wire of same material and length. The resistance value of the wire can be checked as explained later.

On "P" models, a resistor is connected into the ignition circuit between the ignition switch and starter solenoid. The resistor can be checked as explained later in this section.

IMPORTANT: Since the ignition coil is fed through the starter solenoid during cranking, the engine will have a tendency to start any time it is cranked, even though the ignition switch is in the "OFF" position. To prevent this from happening and possibly causing serious injury, always disconnect the ignition primary wire from the coil before making tests which require cranking the engine.

NOTE: When using a remote switch to operate the starter, disconnect primary wire from ignition coil negative terminal and turn ignition switch "ON." Failure to do this will result in damaged grounding circuit in ignition switch.

RESISTANCE WIRE OR UNIT CHECK

NOTE: When replacing a resistive unit, always use factory recommended parts.

Check resistance value of wire or unit as follows:

1. Make sure the ignition switch is "OFF."
2. Connect ohmmeter leads to each end of the resistance wire or to each terminal of the resistance unit.
3. Resistance value of wire used on V-6 gasoline engine models should be 1.52 $\pm$ .07 ohms. Resistance value of wire or unit used on In-Line gasoline engine models should be 1.80 $\pm$ .05 ohms.

IMPORTANT: When making the resistance check, be certain ignition switch is in "OFF" position, otherwise damage to ohmmeter will result.

IGNITION MAINTENANCE

By making the following inspection and adjustments on the ignition system at regular intervals, causes of lowered performance will be located and corrected before they progress to a point where they will seriously affect engine performance.

1. Check condition of battery and cables as directed previously in "BATTERY" section.
2. Check operation of centrifugal advance mechanism by removing distributor cap and turning the rotor in clockwise direction. The cam should rotate freely and when released, it should return to its original position without sticking or binding.
3. Wipe out distributor cap with a soft cloth and clean wire sockets with a small round brush. Inspect cap and rotor for chips, cracks, and carbonized short paths; look for burned metal inserts in cap and for burned metal segment on rotor.
4. Inspect breaker points. Slight discoloration and roughness is normal. Slight roughness can be removed with a few strokes of a clean, fine-cut contact file. If points are badly pitted or burned, replace points as directed later under "Distributor."
5. Check cam dwell angle with a dwell meter. If dwell meter is not available, point opening can be checked with a dial indicator. Never check opening of used points with a feeler gauge. If dwell angle (or point opening) requires adjustment, adjust as directed later under "Distributor."
6. Check ignition timing with timing light as directed later under "Ignition Timing."
7. Inspect all ignition wiring for brittle, cracked, or oil soaked insulation. Check all connections, making sure they are clean and tight.
8. Distributor must be kept properly lubricated. Refer to LUBRICATION (SEC. 0) for intervals and instructions.
9. Remove spark plugs and clean, inspect, and adjust point gap as directed later under "Spark Plugs."

IGNITION SWITCH REPLACEMENT

The ignition switch and harness-to-switch connector features a three tang lock to secure a firm connection (fig. 1). The switch lock cylinder and cylinder housing can be removed as follows:

REMOVAL

1. Disconnect negative cable from battery post.
2. Remove lock cylinder by positioning switch in "OFF" position and inserting wire in small hole in cylinder face. Push in on wire to depress plunger and continue to turn key counterclockwise until lock cylinder can be pulled from cylinder housing.

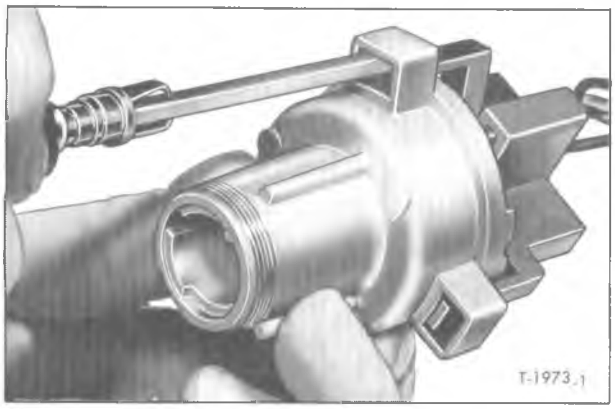


Figure 1—Disengaging Ignition Switch Connector

3. Remove the metal ignition switch retaining nut from the passenger side of the dash, or from top of transmission control island.

4. Pull ignition switch out from under dash or transmission control island and separate wiring connectors by inserting thin blade of small screwdriver under each tang of wiring connector as shown in figure 1. Pull connector from switch.

INSTALLATION

1. Engage lock tangs of wiring connector to switch. Make sure lock tangs are fully engaged by trying to separate.

2. Place the switch with wiring into position from underside of dash or transmission control island and install switch retaining nut firmly.

3. Insert switch lock cylinder in switch housing and rotate clockwise to secure in "LOCK" position.

4. Connect battery negative cable to post and check operation of switch.

Figure 2—Timing Marks (In-Line Engine) (Typical)

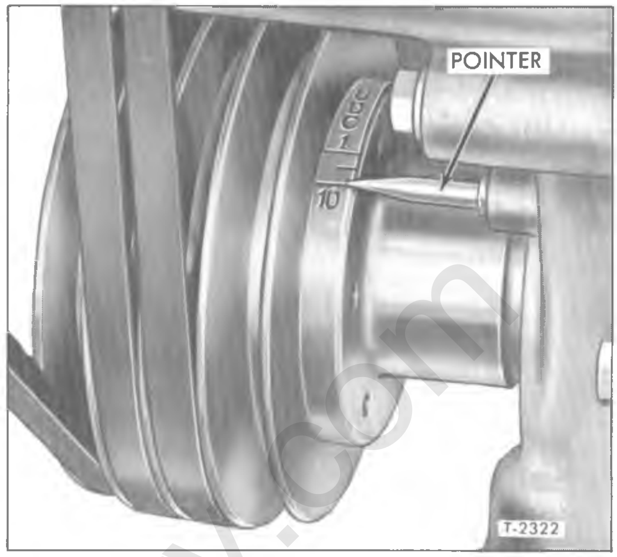


Figure 3—Timing Marks (V6 Engine) (Typical)

IGNITION TIMING

Timing the ignition system comprises:

(1) Initial Timing -- Setting distributor to permit opening of points at correct firing intervals
- and -
(2) Manual Advance Adjustment -- Retarding or advancing the point opening to compensate for various grades of fuel which may be used. These timing factors require checking and adjusting at regular intervals, or whenever performance of engine necessitates such action.

IMPORTANT: Before attempting to adjust ignition timing, make sure carburetor is properly adjusted. Disconnect vacuum line from distributor vacuum advance unit and plug the open end of line.

NOTE: The following timing settings are recommended settings for average nation-wide regular gasoline. Timing must be retarded as required when lower octane gasoline is used.

IN-LINE ENGINES
(WITH ENGINE RUNNING)

On vehicles equipped with the L-250 or L-292 engine, timing is set at 4^{O} BUDC on No. 1 cylinder. Timing tab is located at front of engine above the crankshaft pulley at left side (fig. 2).

On all In-line engines, markings on timing tab are in 2^{O} increments. The "O" mark is upper-dead-center (UDC) and the 4 mark is the second mark toward "A."

With timing light connected to No. 1 spark plug and with engine idling (500 rpm max.) loosen mounting clamp cap screw at base of distributor (fig. 4) and rotate distributor as necessary to synchronize flashes with timing mark when mark is

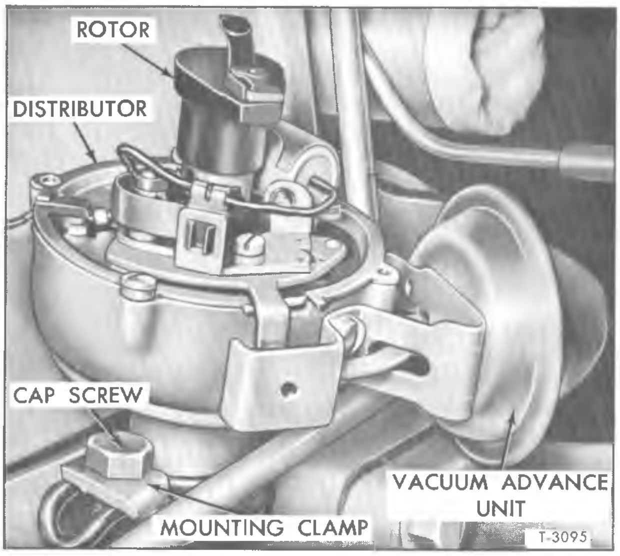


Figure 4—Distributor Installed (with Cap Removed (In-Line Engine) (Typical)

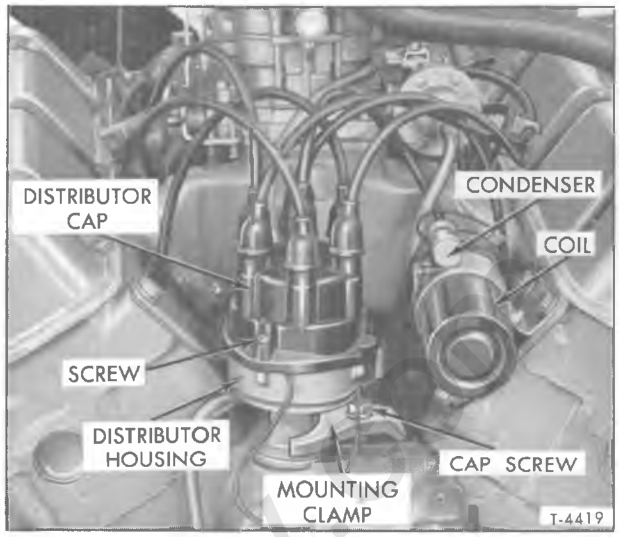


Figure 5—Distributor and Ignition Coil Installed (V6 Engine) (Typical)

aligned with pointer. After completing adjustment, tighten cap screw and connect vacuum line.

V-6 ENGINES
(WITH ENGINE RUNNING) (Fig. 3)

NOTE: Make sure distributor is in good condition and dwell angle is properly adjusted before checking ignition timing. If dwell angle requires adjustment, adjust as directed later under "Distributor."

1. Figure 3 shows location of timing marks on the crankshaft pulley hub. Connect one lead of a timing light to No. 1 spark plug terminal (front plug on left side) and connect the other lead in accordance with instructions furnished with the instrument.

2. Start engine and run at idle (550 rpm max.).

3. On 305-C or 305-E engines, set timing to $7\frac{1}{2}^{\circ}$ before upper-dead-center and on 351-C or 351-M engines, set timing to 10° BUDC. If timing mark does not align with pointer, loosen distributor mounting clamp cap screw (fig. 5) and rotate distributor body as required to synchronize timing light flashes with timing mark on engine crankshaft pulley.

4. Tighten distributor mounting clamp cap screw and connect vacuum advance line after adjustment is completed.

IN-LINE AND V-6 ENGINES
(WITH ENGINE NOT RUNNING)

1. Locate No. 1 cylinder spark plug wire on distributor cap; mark distributor body adjacent to No. 1 wire socket in cap, then remove cap.

2. Intermittently operate starter until proper timing mark on crankshaft pulley is aligned with timing tab or pointer (fig. 2 or 3).

With timing mark aligned with timing tab, or pointer, rotor segment should point toward mark made on distributor body in Step 1 previously. Instead, rotor segment may point 180 degrees away from mark; in this case engine must be rotated one complete revolution and timing mark realigned.

3. With timing mark aligned with timing tab on pointer and with rotor segment pointing to No. 1 spark plug wire, points should just begin to open. Loosen distributor mounting clamp cap screw and turn distributor housing clockwise until points close. Remove high tension wire from center socket in distributor cap. Turn on ignition switch and hold end of high tension wire (still connected to coil) ¼-inch from a ground; then turn distributor housing counterclockwise until a spark jumps the gap between high tension wire and ground. When spark occurs, points are open. Hold distributor in this position and tighten mounting clamp cap screw. Turn ignition switch off and install distributor cap. Install high tension wire in cap.

MANUAL ADVANCE ADJUSTMENT

1. After engine has been thoroughly warmed up, drive vehicle using grade of fuel expected to be used in service. Engine should not ping or knock excessively under load and full throttle.

2. If knock is evident, loosen the distributor mounting clamp cap screw (fig. 4 or 5) and turn distributor housing clockwise to retard spark until knock is eliminated.

NOTE: Manual advance should be set to obtain the best possible engine performance with the particular grade of gasoline being used.

DISTRIBUTOR

Distributor used on In-line engines is mounted on right side of engine and is driven by the engine camshaft by spiral cut gears. A gasket is used between flange on distributor housing and cylinder block. The distributor is held in place by a mounting clamp and cap screw (fig. 4). Lower end of distributor shaft is tongued and engages a slot in upper end of oil pump drive shaft to drive the oil pump.

Distributor used on V-6 engines is mounted on top center of cylinder block at rear end and is driven from the engine camshaft by spiral cut gears. A gasket is used between flange on distributor housing and cylinder block. The distributor is held in place by a mounting clamp and cap screw (fig. 5). The drive gear, secured on lower end of distributor shaft, by a rivet or roll pin, has a hexagonal opening in lower end which engages end of oil pump shaft to drive the oil pump. Model number is stamped on the distributor housing.

DISTRIBUTOR CONTACT POINTS

CLEANING

Dirty contact points should be dressed with a few strokes of a clean, fine-cut contact file. The file should not be used on other metals and should be kept free of grease and dirt. Never use emery cloth to clean contact points. Do not attempt to remove all roughness or dress point surfaces down smooth; merely remove scale or dirt.

Replace contact points which are badly pitted or burned. High resistance or loose connection in the condenser circuit, oil or foreign materials on contact surfaces, improper point adjustment or excessively high voltage may cause oxidized contact points. If excessive point pitting is encountered, check for an out-of-balance condition in the ignition system, often caused by improper condenser capacity.

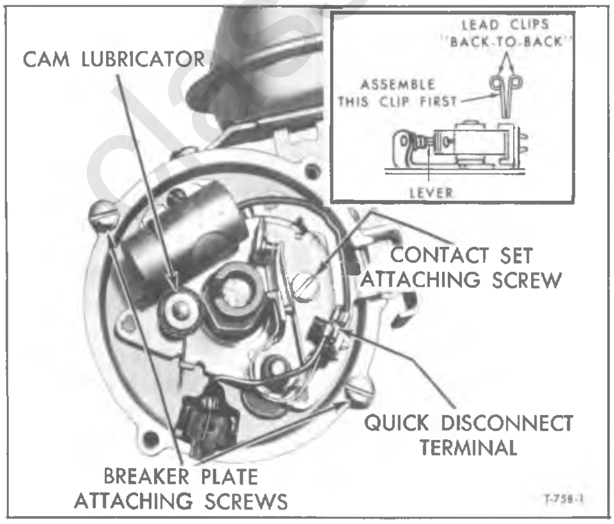


Figure 6—Breaker Plate and Attaching Parts

CONTACT POINT REPLACEMENT
(IN-LINE AND V-6 ENGINES)

Removal

1. Release distributor cap hold-down screws, remove cap and place it out of work area.
2. Remove rotor.
3. Pull primary and condenser lead wires from contact point quick-disconnect terminal (fig. 6).
4. Remove contact set attaching screw, lift contact point set from breaker plate.
5. Clean breaker plate of oil, smudge and dirt.

Installation

1. Carefully wipe protective film from contact set, then place new contact set assembly on breaker plate and install attaching screw.

NOTE: Pilot on contact set must engage matching hole in breaker plate.

2. Connect primary lead and condenser lead to terminals (fig. 6). Lead clips must be assembled "back-to-back." Push clip nearest the contact lever down between the spring and locator; then push the remaining clip down between the first clip and locator. Do not push on the spring.
3. Apply a slight trace of petroleum jelly to the breaker cam and a few drops of S.A.E. #20 oil on top of the shaft.
4. Check and adjust points for proper alignment and breaker arm spring for proper tension (fig. 7). Use an alignment tool to bend stationary contact support if points need alignment.

NOTE: The contact point pressure must fall within specified limits. Weak tension will cause chatter resulting in arcing and burning of the points and an ignition miss at high speed, while excessive tension will cause undue wear of the contact points, cam and rubbing block. Breaker arm spring tension should be 19-23 ounces. The contact point pressure should be checked with a spring gauge. The scale should be hooked to the breaker lever and the pull exerted at 90 degrees to the breaker lever as shown in figure 7. The reading should be taken just as the points separate. The pressure can be adjusted by bending the breaker lever spring. If pressure is excessive, it can be decreased by pinching the spring carefully. To increase pressure, the lever must be removed from the distributor so the spring can be bent away from the lever. Avoid excessive spring distortion.

5. Set point opening to dimension listed in

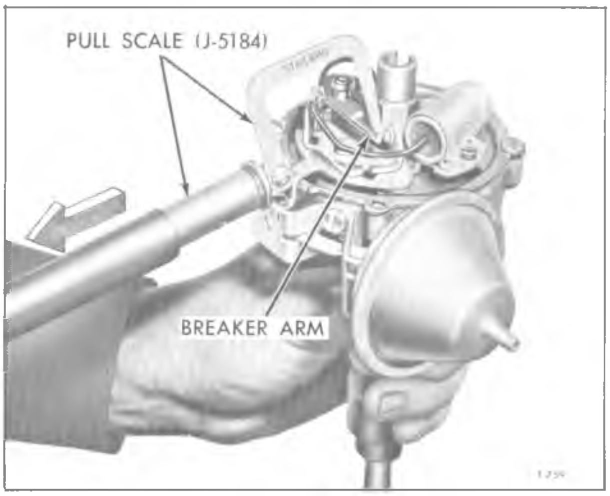


Figure 7—Checking Breaker Arm Spring Tension

"Specifications," at end of this section.

6. Install rotor, position, and secure distributor cap to housing.

SETTING DWELL ANGLE

The point opening of new points can be checked with a feeler gauge, but the use of a feeler gauge on rough or uncleaned used points is not recommended since accurate mechanical gauging cannot be done on such points.

Contact points must be set to the proper opening. Points set too close may tend to burn and pit rapidly. Points with excessive separation tend to cause a weak spark at high speed. Proper point setting for these engines are listed in "Specifications" at end of this section.

New points should be set to the larger opening as the rubbing block will wear down slightly while seating to the cam. Contact points should be cleaned before adjusting if they have been in service.

CONTACT POINT OPENING ADJUSTMENT

1. Release distributor cap hold-down screws, remove cap and place it out of work area.
2. If necessary, align points by bending the fixed contact support. Do not bend the breaker lever. Do not attempt to align used points; replace them where serious misalignment is observed. Use an aligning tool if available.
3. Turn the distributor shaft until the breaker arm rubbing block is on the high point of the cam lobe. This will provide maximum point opening.
4. Loosen the contact support lock screw.
5. Use a screwdriver to move point support to obtain a 0.019" opening for new points (or 0.016" opening for used points) (fig. 8).
6. Tighten the contact support lock screw and recheck the point opening.

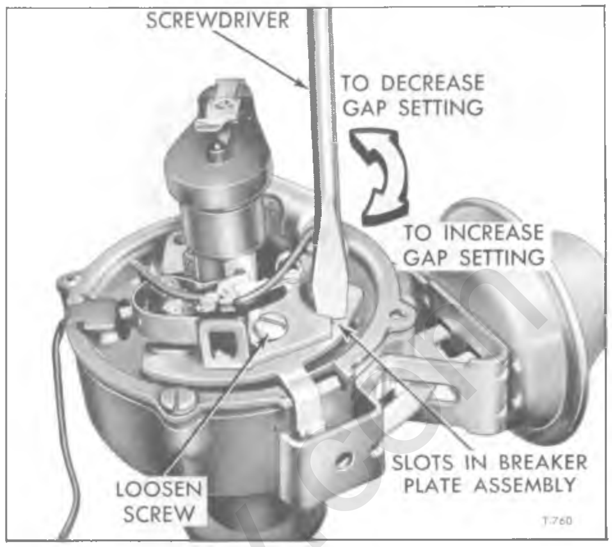


Figure 8—Setting Point Opening

7. After checking and adjusting the contact point opening to specifications, the cam angle or dwell should be checked with a dwell meter, if such equipment is available (see "Specifications" at end of section for proper dwell angle).

NOTE: DISCONNECT AND PLUG VACUUM LINE WHEN CHECKING. If the cam angle is less than the specified minimum, check for defective or misaligned contact points or worn distributor cam lobes. The variation in cam angle readings between idle speed and 1750 engine rpm should not exceed 3 degrees. Excessive variation in this speed range indicates wear in the distributor.

NOTE Cam angle readings taken at speeds above 1750 engine rpm may prove unreliable on some cam angle meters.

CENTRIFUGAL ADVANCE

Distributor is equipped with a centrifugal spark advance mechanism located under the breaker plate assembly. The advance mechanism is part of the main shaft assembly and consists of an automatic cam actuated by two centrifugal weights controlled by springs.

Where speed variations are encountered, spark advance, based on engine speed, is necessary to develop maximum power. As engine speed increases, the weights are gradually thrown out against the springs and rotate the cam to provide the desired spark advance for speed at which engine is running.

The correct weights, cam contour, and spring calibration have been selected to provide spark advance which will give the best performance of engine throughout its entire speed range. The

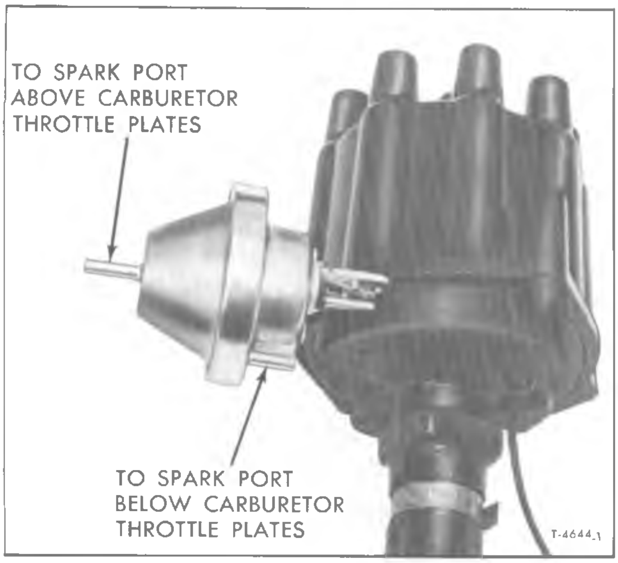


Figure 9—Position of Vacuum Hoses (with C.C.S.) (Typical)

Centrifugal advance mechanism can be checked for freeness of operation as previously directed under "Ignition Maintenance." A distributor tester must be used to check advance action under various speed conditions.

VACUUM ADVANCE

The vacuum advance control unit is mounted to the base of the distributor housing. The vacuum control unit consists of an enclosed, calibrated, spring-loaded diaphragm and is linked to the movable breaker plate. Under part throttle operation, the intake manifold vacuum is sufficient to actuate the vacuum control diaphragm and cause the breaker plate to move, advancing the spark and increasing fuel economy. During acceleration or when engine is under heavy load, the vacuum is not sufficient to actuate the diaphragm and the breaker plate is held in the retarded position by a calibrated return spring which bears against the vacuum diaphragm.

On vehicles equipped with the controlled combustion system, a double-acting diaphragm is used in the distributor vacuum control unit. The vacuum retard side of the diaphragm is connected to manifold vacuum through ports on carburetor. At idle speed, with carburetor throttle valves closed, vacuum on this diaphragm will retard the spark 10 degrees. The opposite side of the diaphragm is connected to a port above the throttle valves (fig. 9). When carburetor throttle valves are open, vacuum on this side of the diaphragm immediately advances the spark to the initial setting. When throttle valves are open, the double-acting vacuum advance unit functions exactly the same as the single diaphragm vacuum advance unit.

DISTRIBUTOR REMOVAL

1. Locate No. 1 cylinder spark plug wire on distributor cap, mark this position on cap and mark distributor housing adjacent to No. 1 wire in cap.

2. Release distributor cap hold-down screws; then remove cap and place clear of work area.

3. Disconnect distributor primary wire from terminal on ignition coil.

4. Intermittently operate starter until crankshaft pulley comes to rest with the correct timing mark aligned with pointer or timing tab (fig. 2 or 3).

NOTE: Refer to "Ignition Timing" in this section for ignition timing point on each engine.

With pointer and timing mark aligned, rotor segment should point toward mark made on distributor body in Step 1 previously; instead, rotor segment may point 180 degrees away from mark; in this case, rotate engine one complete revolution and realign timing mark with pointer.

NOTE: Distributor can be removed and readily reinstalled if engine remains in this position.

5. Disconnect vacuum line(s) from distributor, then remove cap screw and mounting clamp (fig. 4 or 5). Lift distributor straight up until spiral gear disengages, camshaft gear. Rotor will rotate a few degrees clockwise as gears disengage. Mark this position of rotor on distributor housing, also note position of vacuum advance mechanism relative to engine. Lift distributor straight up to complete removal. Remove distributor flange to cylinder block gasket.

NOTE: Always set distributor in upright position so oil from distributor shaft will not run out onto breaker plate and points.

DISTRIBUTOR INSTALLATION

IF ENGINE HAS NOT BEEN CRANKED
(IN-LINE ENGINE MODELS)

1. Turn the rotor approximately 1/8 turn in a clockwise direction past the mark previously placed on the distributor housing to locate the rotor.

2. Place new distributor to cylinder block gasket on block, and lubricate distributor drive gear with engine oil.

3. Push the distributor down into position in the block with the distributor housing in a normal "installed" position.

NOTE: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark on distributor housing when distributor is in place.

4. Tighten the distributor clamp bolt snugly and connect vacuum line. Connect primary wire to coil terminal and install cap. Install spark plug and high tension wires if removed.

5. Time ignition as previously described.

IF ENGINE HAS NOT BEEN CRANKED
(V-6 ENGINE MODELS)

1. If distributor is new, No. 1 firing position can be determined by the mark made on the old distributor housing prior to removal. Also locate mark made on housing after gears were disengaged.

2. Place new distributor to cylinder block gasket on block, and lubricate distributor drive gear.

3. Turn rotor so segment points to the mark made after disengaging gears. As distributor is inserted into place, spiral gear will cause rotor to turn counterclockwise. It may be necessary to insert the assembly several times to find the correct position to bring rotor segment to No. 1 firing position.

4. Tighten distributor clamp bolt snugly and connect vacuum line(s). Connect primary wire to coil terminal and install cap. Install spark plugs and high tension wires, if removed.

5. Check ignition timing as explained previously under "Ignition Timing."

IF ENGINE HAS BEEN CRANKED
(IN-LINE ENGINES)

1. Locate No. 1 piston in firing position by either of two methods described below:

a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until timing mark on crankshaft pulley is aligned with 4° BUDC mark on timing tab.

b. Remove rocker arm cover and crank engine until No. 1 intake valve closes. Continue to crank slowly about 1/3 turn until timing mark on pulley lines up with the 4° BUDC mark on timing tab.

2. Place a new gasket on block; then position distributor to opening in block in normal installed attitude, noting position of vacuum control unit.

3. Position rotor to point toward front of engine (with distributor held in installed attitude), then turn rotor counterclockwise approximately 1/8 turn and push distributor down to engine camshaft. It may be necessary to rotate rotor slightly until engagement is felt.

4. While pressing down on distributor, engage starter several times to make sure oil pump shaft is engaged. Install distributor hold-down clamp and bolt and snug up bolt.

5. Turn distributor body slightly until points just begin to open and tighten clamp bolt.

6. Place distributor cap in position and check to see that rotor lines up with terminal for No. 1 spark plug.

7. Install distributor cap. Install spark plug wires in cap in correct firing sequence -- 1-5-3-6-2-4 -- starting with No. 1 wire in socket adjacent to No. 1 firing position mark on distributor housing, then proceeding clockwise around the cap. Install Hi-tension wire from ignition coil in center socket in distributor cap. Connect distributor primary wire to negative (-) terminal on ignition coil.

8. Connect vacuum line(s) to vacuum advance unit on distributor.

9. Start engine and adjust timing as explained under "Ignition Timing" previously.

IF ENGINE HAS BEEN CRANKED
(V-6 ENGINES)

1. Remove left-hand valve rocker arm cover. Turn engine over by intermittently operating starter and observe movement of No. 1 intake valve (second valve from front). When intake valve starts to close (move up), continue to turn engine slowly until pointer on timing gear cover is at proper timing mark on crankshaft pulley (fig. 3). Engine is then in No. 1 firing position.

2. Install distributor as described in Step 1 previously. It may be necessary to turn the oil pump drive shaft to permit engagement of drive shaft with distributor drive gear.

3. Install distributor hold-down clamp and cap screw.

4. Install distributor cap. Install spark plug wires in cap in correct firing sequence -- 1-6-5-4-3-2 -- starting with No. 1 wire in socket adjacent to No. 1 firing position mark on distributor housing, then proceeding clockwise around the cap. Install secondary wire from ignition coil in center socket in distributor cap. Connect distributor primary wire to negative (-) terminal on ignition coil.

5. Check and adjust ignition timing as previously directed under "Ignition Timing."

DISTRIBUTOR CONDENSER

Condenser, mounted on breaker plate and connected across the points, reduces point arc by its ability to store up electrical energy.

REMOVAL AND INSTALLATION

1. Release distributor cap hold-down screws, remove cap, and place it out of the work area.

2. Remove rotor.

3. Disconnect condenser lead wire from contact point quick-disconnect terminal.

4. Remove condenser attaching screw, lift condenser from breaker plate, and wipe breaker plate clean.

5. Install new condenser, using reverse of procedure outlined above.

TEST

Four factors affect condenser operation, and each must be considered in making tests.

Breakdown. Breakdown is a failure of insulating material, causing direct short between metallic elements of condenser. This condition prevents any condenser action.

IGNITION SYSTEM

Low Insulation Resistance. This condition permits leakage which prevents condenser from holding its charge. A condenser with low insulation resistance is said to be weak.

High Series Resistance. This is excessive resistance in condenser circuit due to broken strands in condenser lead or to defective connections. This will cause burned contact points and ignition failure upon initial start and at high speeds.

Capacity. Capacity is built into a condenser and is determined by the area of the metallic elements, and the insulating and impregnating materials. A condenser of incorrect capacity will result in point pitting.

IGNITION COIL

On In-line engine models, the ignition coil is mounted on side of cylinder block and on V-6 engine models, the ignition coil is mounted on top of block near front of distributor. Ignition coil primary terminals are marked positive (+) and negative (-).

Wire from distributor primary wire (black) must be connected to negative (-) terminal of coil. The light green feed wire from starter solenoid and the special resistance wire must be connected to positive (+) terminal of coil.

IGNITION COIL TEST

If there is any doubt as to the condition of the coil, it should be tested with a conventional coil tester, following instructions furnished by the manufacturer of the testing equipment. Defects indicated by the test are:

1. Weak coil.
2. Open primary circuit.
3. Open secondary circuit.
4. High voltage breakdown in secondary circuit.
5. Shorted turns in primary or secondary.
6. High resistance in primary connections.

If any of the above conditions are evident, coil must be replaced.

Before using a coil test instrument, connect test points of a 110-volt test lamp to both primary terminals of coil. If test lamp does not light, the primary circuit is open.

Apply one test point of the test lamp to the high tension terminal and the other test point to one of the primary terminals. If secondary circuit is not open, the lamp will not light but tiny sparks will appear at test points when they are rubbed over terminals. If secondary circuit is open, no sparks will occur.

Apply one test point of test lamp to coil case and touch the other point to the primary and high tension terminals. If the lamp lights, or if tiny sparks appear at point of contact, the coil windings are grounded.

A coil with open or grounded windings must be replaced. It is unnecessary to test such a coil with a coil test instrument.

If coil windings are not open or grounded, a test for short circuits and other internal defects should be made using a reliable coil test instrument, following instructions furnished with the instrument. The instrument must be frequently checked to make certain that it is accurately calibrated.

NOTE: When using a coil test instrument, coil must be at normal operating temperature since internal defects often fail to show up on a cold coil test.

SPARK PLUGS

GENERAL INFORMATION

Spark plug life is governed to a large extent by operating conditions, and plug life varies accordingly. To insure peak performance, spark plugs should be checked, cleaned, and regapped every 5,000 miles.

Worn and dirty plugs may give satisfactory operation at idling speed, but under operating conditions they frequently fail. Faulty plugs are evident in a number of ways such as wasting gas, power loss, loss of speed, hard starting, and general poor engine performance.

Spark plug failure, in addition to normal wear, may be due to dirty or leaded plugs, excessive gap, or broken insulator.

Dirty or leaded plugs may be evident by black carbon deposits, or red, brown, yellow or blistered oxide deposits on the plugs. The black deposits are usually the result of slow speed driving and short runs where sufficient engine operating temperature is seldom reached. Worn piston rings, faulty ignition, over-rich fuel mixture and spark plugs which are too "cold" will also result in carbon deposits, red, brown, or yellow oxide deposits, a consequence of the combustion of leaded fuel, usually result in spark plug failure under severe operating conditions.

The oxides have no adverse affect on plug operation as long as they remain in a powdery state. But, under high speed or hard pull, the powder oxide deposits melt and form a heavy glaze coating on the insulator which, when hot, acts as a good electrical conductor, allowing current to follow the deposits and short out the plug.

Excessive gap wear on plugs of low mileage usually indicates the engine is operating at speeds or loads that are consistently greater than normal or that a plug which is too "hot" is being used. In addition, electrode wear may be the result of plug overheating, caused by combustion gases leaking past the threads and gaskets, due to insufficient compression of the spark plug gaskets, dirt under gasket, or use of old gaskets. Too lean a fuel mixture will also result in excessive electrode wear.

Spark plug life will also be affected by incorrect timing of the engine which results in excessively high operating temperature.

Broken insulators are usually the result of improper installation or carelessness, when regapping the plug. Broken upper insulators usually result from a poor fitting wrench or an outside blow. The cracked insulator may not make itself evident immediately, but will as soon as oil or moisture penetrates the fracture. The fracture is usually just below the crimped part of the shell and may not be visible.

Broken lower insulators usually result from carelessness when regapping and generally are visible. This type of a break may result from the plug operating too "Hot" such as encountered in sustained periods of high speed operation or under extremely heavy loads, especially if not installed correctly. Spark plugs with broken insulators should always be replaced.

Spark plugs, to give good performance in a particular engine, must operate within a certain temperature range (neither too hot nor too cool). If the spark plug remains too "cool," oil, soot, carbon, and lead components will deposit on the insulator, causing FOULING and MISSING. If the plug runs too "Hot," the deposits accumulated on the insulator surface during continuous slow or stop-and-go driving may become blistered, electrodes will wear rapidly, and under extreme conditions, premature ignition (preignition) of the fuel mixture result. EITHER CONDITION WILL SERIOUSLY AFFECT ENGINE PERFORMANCE.

Refer to "Specifications" at end of this section, as the use of spark plugs in the proper Heat Range is of vital importance to good engine performance. Frequently, the wrong type of spark plug, one with an improper Heat Range for the engine, may have been installed when replacing spark plugs originally fitted by the engine manufacturer and such misapplication may lead to poor performance.

ABNORMAL OPERATION

Where abnormal operating conditions cause chronic carbon or oil fouling of the plugs, the use of a type with one or two numbers higher (a "hotter" type) than recommended in "Specifications," will generally remedy the trouble; and by the same formula, where chronic preignition or rapid electrode wear is experienced, a type with one or two numbers lower (a "cooler" type) will generally be found satisfactory.

SPARK PLUG REMOVAL

IMPORTANT: Before removing any spark plug, blow all dirt out of plug sockets in cylinder head with compressed air.

1. Pull wires off spark plug terminals, using caution to avoid damaging wire terminals. Remove wires by firmly grasping large end of boot.
2. Use special spark plug wrench socket No. S-9704B (manufactured by Snap-On Tool Co.) (fig. 10), and unscrew plugs from cylinder head. Ordinary wrenches may damage porcelain. If gaskets do not remain on plugs, remove from cylinder head.

INSPECTION AND CLEANING

Inspect plugs for cracked porcelain and burned points, and check point gap. Also check for loose terminals. Replace plugs which have excessively burned electrodes or cracked porcelain. Plugs should be cleaned with an abrasive type cleaner. If porcelain is badly glazed or blistered, the spark plugs should be replaced. All spark plugs must be of the same make and number of heat range. Use a wire feeler gauge when checking spark plug gap.

POINT GAP ADJUSTMENT

Setting spark plug gap is a precision operation and should be treated as such. Refer to "Specifications" at end of this section for proper gap dimensions. All plugs must be set to the same dimension, using a standard round feeler gauge.

> **CAUTION: Before adjusting gap, file center electrode flat. In adjusting the spark plug gap, never bend the center electrode which extends through the porcelain center as this may break the lower insulator. Always make adjustment by bending the ground or side electrode.**

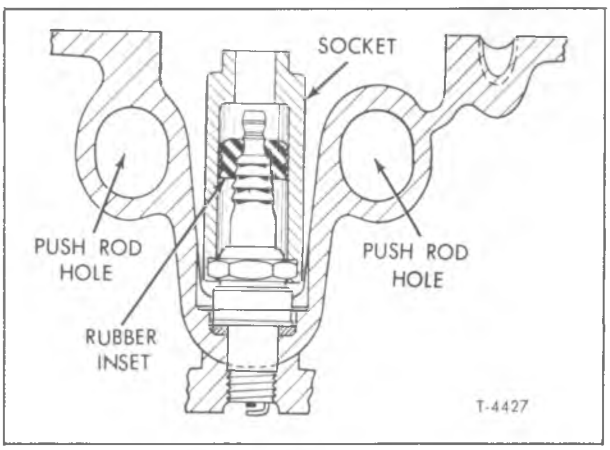


Figure 10—Wrench Socket Installed on Plug

IGNITION SYSTEM

SPARK PLUG INSTALLATION

Be certain that the old gasket is removed before installation of plug and that the gasket seat is clean and smooth. Also check that the spark plug threads and the cylinder head threads are not dirty or damaged. Dirty or damaged threads cause a faulty torque reading, resulting in incorrect installation and consequent poor spark plug life and faulty operation.

Install spark plugs in the engine with new gaskets and tighten finger-tight. Using special spark plug wrench socket (S-9704B) as shown in figure 10, and a torque wrench, tighten plugs to 30-34 foot-pounds torque.

IMPORTANT: It is important that the special socket be used in torquing plugs, as an ordinary socket will bind against cylinder head and give a false torque reading.

Spark plugs which are not tightened correctly will result in too high an operating temperature if too loose, or distortion of the spark plug body and change in gap setting or damage to the gasket if too tight.

HIGH AND LOW TENSION WIRES

High tension wires include the wires connecting the distributor cap to the spark plugs, and the wire connecting the center electrode of the distributor cap to the center terminal of the ignition coil. Low tension wires are the small wires connected to the primary terminals on the coil, and to the primary terminal at the distributor.

High tension wires have a built-in resistance of approximately 4,000 ohms per foot, except coil wire which is 8,000 ohms per foot. When replacing wires, make sure the proper wires are used.

At regular intervals the wires should be inspected for damage. If insulation is cracked or swollen, wires should be replaced.

SPECIFICATIONS

IGNITION SYSTEM SPECIFICATIONS

ENGINE	250	292	305C	305E	351C 351M
DISTRIBUTOR					
Make	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy
Model No.	1110439	1110442	1110471	1110471	1110478
Rotation (Viewed at Rotor)	Clockwise	Clockwise	Clockwise	Clockwise	Clockwise
Point Opening					
New	0.019″	0.019″	0.019″	0.019″	0.019″
Used	0.016″	0.016″	0.016″	0.016″	0.016″
Dwell Angle (Degrees) (a)	31-34	31-34	31-34	31-34	31-34
Centrifugal Advance (b)					
Start (Degrees)	0-2	0-2	0-2	0-2	0-2
RPM	475	510	400	400	510
First Intermediate (degrees)	—	—	—	—	4-6
RPM	—	—	—	—	750
Second Intermediate (degrees)	12-14	8.5-10.5	10-12	10-12	6.5-8.5
RPM	1500	1000	1000	1000	1100
Maximum (degrees)	15-17	13-15	14-16	14-16	10-12
RPM	2100	2100	1700	1700	1750
Firing Order	1-5-3-6-2-4	1-5-3-6-2-4	1-6-5-4-3-2	1-6-5-4-3-2	1-6-5-4-3-2
Ignition Timing Point	4° BUDC	4° BUDC	7½° BUDC	7½° BUDC	10° BUDC

(a) Set with vacuum in retard position.

(b) Specifications are listed in distributor degrees and distributor RPM which are one-half of engine degrees and engine RPM

DISTRIBUTOR VACUUM CONTROL	250	292	305C	305E	351C 351M
Model No.	1116217	1116217	1116228	1116228	1115356
Inches of Mercury to Start Plunger Movement	6-8	6-8	5-7	5-7	3-5
Inches of Mercury For Maximum Advance	15.5-17.0	15.5-17.0	12.2-13.5	12.2-13.5	7-9
Maximum Advance (distributor degrees)*	11.5	11.5	9	9	9

*Plus or Minus 1°

IGNITION COIL	250	292	305C	305E	351C 351M
Model No.	1115208	1115208(*) 1115296	1115161	1115161	1115161

(*) SS-5500 Only

SPARK PLUGS	250	292	305C	305E	351C 351M
Make	AC	AC	AC	AC	AC
Type	R-46N	CR-44N	CR-44NS	R-45NS	CR-43N
Size	14MM	14MM	14MM	14MM	14MM
Point Gap	0.035″	0.035″	0.040″	0.035″	0.035″
Torque (Ft. Lbs.)	30-34	30-34	30-34	30-34	30-34

Alternating Current Generating System

The alternating current generator is used as standard and optional equipment on all vehicles covered by this manual.

Refer to "Model Application Chart" below and "Specifications" at end of this section. This section is divided into sub-sections listed in the Index following:

MODEL APPLICATION CHART

AMPERAGE	TRUCK SERIES	GENERATOR	USE WITH REGULATOR
STD. 42-AMP	- LA/LV-4000; PS-4500	1100842	1119515
STD. 42-AMP	- DLA/DLV-4000; EM/ES-4500	1100842	1119507
STD. 42-AMP	- EG/EM/ES-5500; EG/EM-6500	1100842	1119507
STD. 61-AMP	- SG/SM/SS-5500; SM-6500	1100849	1119507
OPT. 61-AMP	- LA/LV-4000	1100849	1119515
OPT. 61-AMP	- DLA/DLV-4000; EM/ES-4500	1100849	1119507
OPT. 61-AMP	- EG/EM/ES-5500; EG/EM-6500	1100849	1119507
OPT. 62-AMP	- DLA/DLV-4000	1117754	1116374
OPT. 62-AMP	- LA/LV-4000	1117754	1116378
OPT. 130-AMP	- SG/SM/SS-5500; SM-6500	1117128	1119507

GENERATING SYSTEM GENERAL DESCRIPTION

The basic charging system components include the battery, the self-rectifying alternating current generator, the regulator, and interconnecting wiring

An indicator lamp (tell-tale) which indicates only whether or not the generator is charging, or an ammeter is used on all vehicles covered by this manual. A voltmeter is available as optional equipment.

A typical generating system used on vehicles equipped with the two-unit type regulator is schematically illustrated in figure 1, and a typical generating system used on vehicles equipped with the full-transistor type regulator is schematically illustrated in figure 2.

The alternating current type generator is used as standard and optional equipment on all vehicles covered by this manual. All units are self-rectifying, alternating current (A.C.) type with direct current (D.C.) output.

The generators are air-cooled by a single fan attached to a drive pulley or by blades attached to each end of the rotor assembly.

The alternating current generator consists of two major parts, a stator and a rotor. The stator is composed of a large number of windings assembled on the inside of a laminated core which is attached to the generator frame. The rotor revolves within the stator on bearings in each end frame. Two brushes are required to carry current through the two slip rings to the field coils wound concentric with the rotor shaft.

Although generators vary with respect to current output and type of voltage regulation, the operating principles are similar.

The generator is driven from the engine and converts mechanical energy to electrical power. The alternating current produced within the generator is rectified by six diodes installed in the

A/C GENERATING SYSTEM

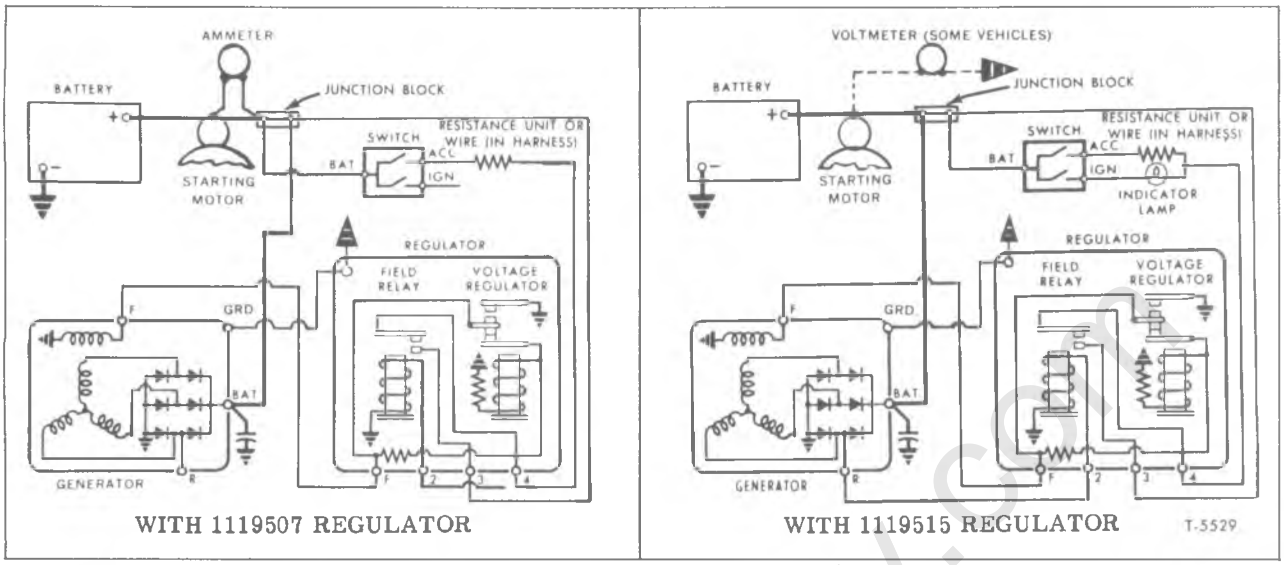


Figure 1—Schematic Diagram of A.C. Charging Circuit with Two-Unit Type Regulator (Typical)

generator end frame and heat sink assembly. Direct current is produced at output (BAT.) terminal on generator.

On all generating systems, except those equipped with the 62-amp generator, voltage is controlled by a vibrating point type regulator (fig. 3). Voltage on 62-amp generating systems is controlled by a full transistor type regulator (fig. 4).

The regulator controls generator voltage output by varying the current flow in field windings in generator rotor assembly. No current regulating device is required in the regulator used with the A.C. generator, since the generator has inherent current regulation as long as the voltage is controlled. Cut-out relay is not required with A.C. generating system as the diodes will not conduct an electrical current in reverse direction; i.e., from battery to ground through the generator.

The full transistor type regulator used on models equipped with the 62-amp generator is composed of transistors, diodes, capacitors, and resistors which form a completely static electrical unit containing no moving parts. The regulator limits generator voltage to a pre-set value by controlling generator field current. Regulator voltage setting can be adjusted externally by removing a

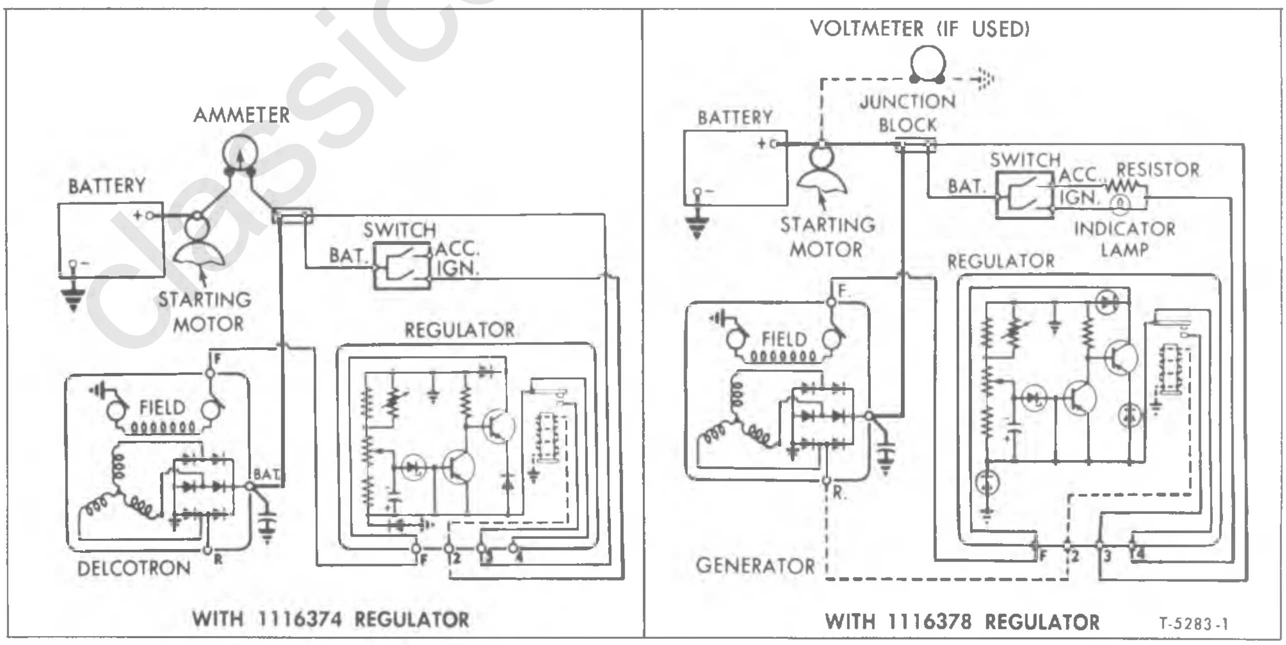


Figure 2—Schematic Diagram of A.C. Charging Circuit with Full Transistor Type Regulator (Typical)

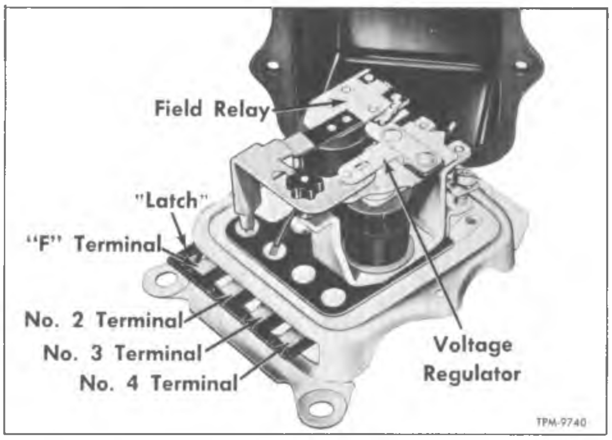


Figure 3—Two-Unit Type Regulator with Cover Removed

pipe plug in cover and rotating the adjusting screw within regulator as explained later in this section.

PRECAUTIONS

Observe the following precautions when performing service operations on the alternating current generating system. Failure to observe these precautions may result in serious damage to the charging system.

1. THE ELECTRICAL SYSTEM IS NEGATIVE GROUND. Connecting the battery or a battery charger with the positive terminal grounded will endanger generator diodes and vehicle wiring by high current flow. Burned wiring harnesses and burned "Open" diodes will result.

2. Never operate the generator on an open circuit (field terminal connected and output terminal disconnected). With no battery or electrical load in the circuit (open circuit) the generator can build-up excessively high voltage. Be sure all connections in the charging circuit are secure.

3. When working near the generator or regulator and before replacing electrical system components, disconnect negative lead from battery to prevent accidental shorting at generator and regulator terminals where battery voltage is available.

NOTE: Replace voltage regulator with same type and model.

4. The generator cannot be polarized. Any attempt to polarize the generator may result in serious damage to charging system components.

5. Do not short across or ground terminals on generator or regulator.

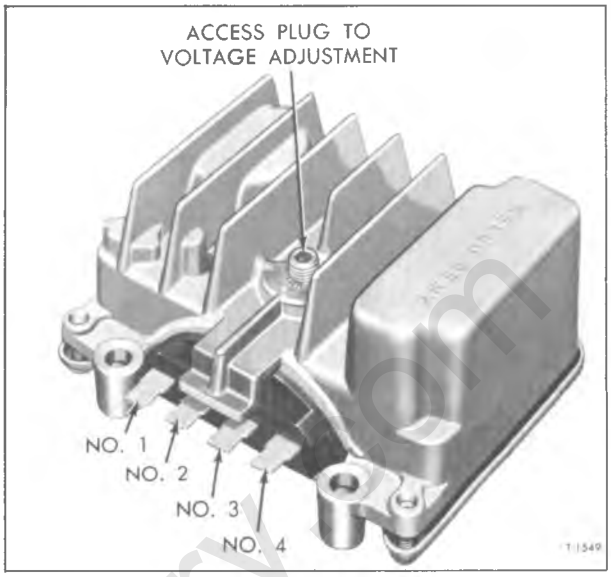


Figure 4—Full Transistor Type Regulator (Typical)

6. When using a booster battery, be sure to connect negative battery terminals together and positive terminals together.

7. Disconnect battery leads while charging batteries. Do not use a fast charger as a booster for starting the engine. When attaching battery charger leads to the battery, connect charger positive lead to battery positive terminal and connect charger negative lead to battery negative terminal.

8. Disconnect battery negative terminal before welding on vehicle since a reverse current flow from the welder may damage generator diodes as well as other electrical components.

9. Never replace the brown and white stripe special resistance wire in harness connected to ignition control switch unless it is of the same material and of same length (approx. 60 inches long). Generating system will not function without this wire. Wire is identified on wiring diagrams in applicable "Wiring Diagrams" booklet as 24-BN.-WS. Resistance value of wire is approximately 10 ± 1.0 ohms, 6.25 watts.

NOTE: Refer to "Charging System Trouble Analysis Chart" later in this section to aid in locating source of charging system malfunctions before replacing components.

IMPORTANT: Always locate and correct the cause of a malfunction to prevent reoccurrence.

A/C GENERATING SYSTEM

ON VEHICLE MAINTENANCE, TESTS, AND ADJUSTMENTS

GENERATING SYSTEM MAINTENANCE

At regular intervals, inspect generating system to locate and correct potential causes of trouble before generating system performance is affected.

1. Check generator drive belt tension and adjust if necessary. See procedure later under "Generator Drive Belt Tension Adjustment."
2. Check generator pulley nut, mounting and adjusting arm bolts and tighten as necessary.
3. Check all electrical connections for tightness and corrosion. Clean and tighten connections as necessary. Be sure wiring insulation is in good condition, and that all wiring is securely clipped to prevent chafing the insulation.
4. With engine running, listen for noise and check generator for vibration. If generator is noisy or vibrates excessively, it should be removed for inspection and repair.
5. Check battery electrolyte level and specific gravity. Replenish electrolyte level, as necessary.

GENERATOR DRIVE BELT

TENSION ADJUSTMENT

Because of the higher inertia and load capacity of rotor used with A.C. generators, PROPER BELT TENSION is more critical than on D.C. generators.

All generators are pivot-base mounted with the belt tension adjustment arm at the top. Use a belt tension dial gauge to check tension on each individual belt. If tension is not within 80-90 lbs. (used belts) or 100-110 lbs. (new belts), loosen the adjustment arm clamp bolt and move generator to obtain recommended tension.

IMPORTANT: When adjusting belt tension, apply pressure at center of generator, never against either end frame.

NOTE: On a new vehicle, or after having installed new belts, check tension of belt(s) twice in first 200 miles of operation. When making adjustment, examine belt(s) and replace if necessary.

A loose or broken drive belt will affect operation of generator. A drive belt that is too tight will place too much strain on bearings.

IMPORTANT: When replacing dual drive belts, it is essential that entire set be replaced at same time. Belts are available in matched sets only.

GENERATING SYSTEM TROUBLE SYMPTOMS

Abnormal operation of the generating system is usually indicated by one or more of the following symptoms:

1. Battery undercharged (low specific gravity of electrolyte).
2. Battery using an excessive amount of water, indicating an extremely high charging rate.
3. Excessive generator noise or vibration.
4. Failure of indicator lamp to illuminate when ignition switch is on (engine not running).
5. Indicator lamp continues to glow with engine running.
6. Indicator lamp fails to go out when ignition or control switch is turned off.
7. Ammeter shows high charging rate with a fully charged battery.
8. Ammeter shows low or no charge with a partially discharged battery.

GENERATOR ON-VEHICLE TEST

The following is a list of the most common generator defects encountered:

1. Open or shorted generator diodes.
2. Open, shorted, or grounded stator winding.
3. Open, shorted, or grounded field winding.
4. Worn generator brushes.
5. Excessive generator noise.

Generator diodes and stator windings should be checked as explained under "Generator Output Test" later in this section. If a defect is indicated by this test, remove generator and repair.

Generator field windings and brushes should be checked as outlined under "Charging System Trouble Analysis Chart" later in this section. If this check indicates a defect in the field winding, remove generator and repair.

Excessive generator noise is usually the result of one or more of the following:

1. Brush "Squeal" caused by a hard spot on one of the brushes or rough or dirty slip rings. To check for brush "Squeal," remove generator drive belt and spin generator drive pulley by hand. Lift brushes off slip rings and spin drive pulley again. If noise disappears, clean and inspect slip rings and replace brushes if worn.
2. Dry or rough bearings in end frame.

> **CAUTION: Dry or rough bearings may be the result of over-tightening generator drive belt(s), loose generator mountings, or an unbalanced generator fan or pulley.**

3. A defective diode or stator resulting in an electrical unbalance.

To check for a defective diode or stator, perform "Generator Output Test" explained later in this section. If a defect is indicated by this test, remove generator and repair.

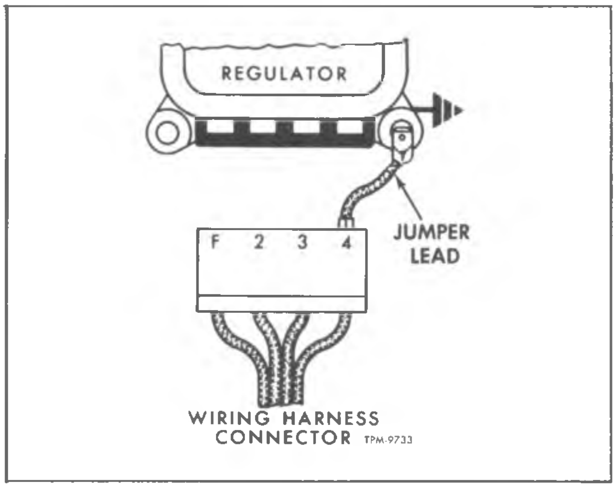


Figure 5—Jumper Lead Connections for Testing Indicator Lamp Circuit (Typical)

GENERATOR CHARGE INDICATOR LAMP CIRCUIT TEST

NOTE: Refer to procedure outlined in "Charging System Trouble Analysis Chart" later in this section to determine whether something other than a generator or regulator defect is indicated before proceeding with this test which applies to vehicles equipped with a charge indicator lamp.

1. Check the indicator lamp bulb which may be burned out. Make sure socket is fully engaged.
2. Check wiring connections at junction.
3. Lift the regulator terminal latch slightly, then pull connector from regulator terminals.

> CAUTION: DO NOT allow any leads to contact a ground or "live" wire or terminal except as directed. A heavy cloth, taped in position below regulator terminals, will assist in preventing contact.

4. Referring to figure 5, insert jumper lead (J-9782-1) into #4 terminal socket in harness connector and ground the other end to regulator base as illustrated. Momentarily (not more than 10 seconds) turn on ignition or control switch. Indicator lamp should light. If not, check for open circuit in wiring between the jumper lead and switch, switch and horn relay, and to the battery.
5. If indicator lamp comes on when #4 socket in wiring harness connector is grounded (fig. 5), connect jumper lead between wiring harness connector terminals "F" and #4 as shown in figure 6. Turn ignition or control switch on momentarily.

a. If light comes on, an open circuit exists within the regulator. Refer to regulator tests later.

b. If light does not come on, an open circuit exists between the connector and generator or in the field circuit within generator.

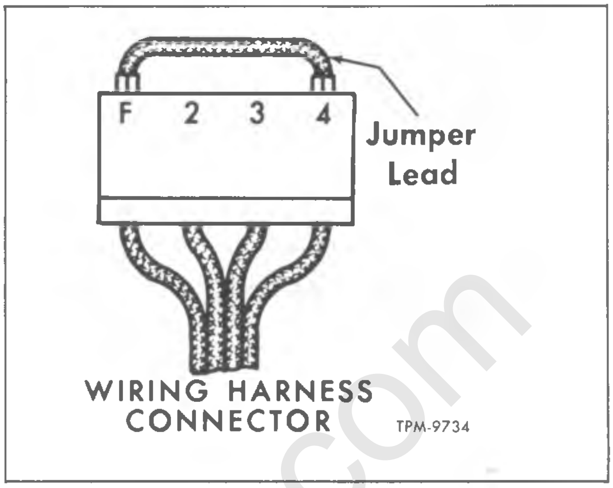


Figure 6—Checking Indicator Lamp Wiring

c. Use a long jumper lead between the #4 socket in harness connector and the "F" (field) terminal at generator. If light then comes on, the generator field circuit is good and an open circuit exists in wiring between "F" terminal on regulator and "F" terminal on generator. If light does not come on, an open circuit exists in the generator field circuit.

6. If, with all wiring connected normally, and the indicator lamp comes on when ignition or control switch is off, a defective diode is indicated.

GENERATOR OUTPUT TEST ON VEHICLE

Refer to procedures outlined in "Charging System Trouble Analysis Chart" later in this section to determine whether something other than a generator defect is indicated before proceeding with this test.

QUICK TEST FOR OUTPUT

1. Connect voltmeter "POS" lead to generator

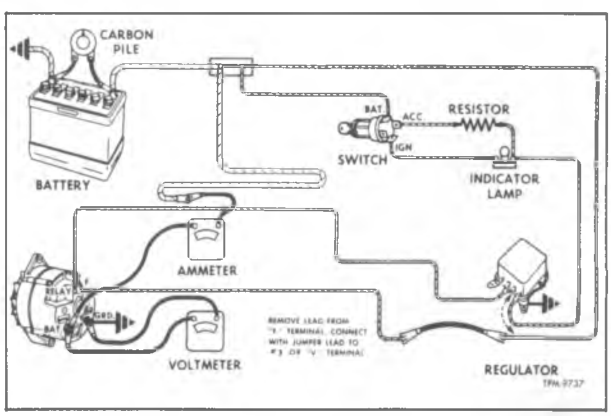


Figure 7—Connections for Testing Generator Output

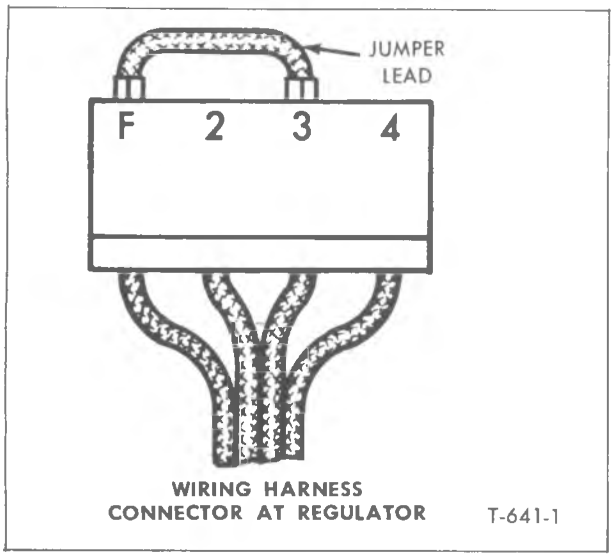


Figure 8—Generator Output Test—Jumper Lead Connection at Regulator (Typical)

output terminal and "NEG" voltmeter lead to ground on chassis.

2. Start engine and turn heater motor to medium speed position.

3. Increase engine speed until voltmeter reading does not increase and record the reading.

CAUTION: DO NOT exceed 2000 rpm.

4. Disconnect ground (NEG.) cable from battery.

5. If voltmeter reading is lower than in Step 3. above, a defective generator is indicated. Remove generator and repair.

GENERATOR OUTPUT TEST

1. Disconnect positive cable from battery.

2. Remove wire from "BAT" terminal on generator, and connect an ammeter between wire and "BAT" terminal on generator (fig. 7).

3. Install a voltmeter between the generator "BAT" terminal and "GRD" terminal.

4. Pull latch on regulator upward to disengage from connector, then pull wiring harness connector from regulator. Connect a jumper lead between "F" terminal socket and #3 socket as shown in figure 8.

IMPORTANT: With wiring connected as shown in figure 7, the voltage regulator is taken out of the circuit, and causes field to be energized by full battery voltage. Generator output voltage must be controlled by loading the battery with a carbon pile or turning on vehicle accessories. Do not permit voltage to exceed setting specified for regulator as listed in "Specifications."

5. Connect a tachometer to engine, then con-

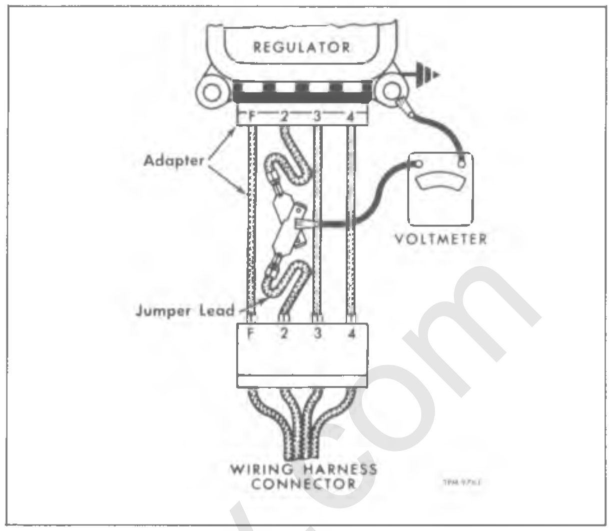


Figure 9—Testing Regulator Field Relay (Two-Unit Type Regulator)

nect positive cable to battery and start engine. Adjust engine speed and carbon pile (if used) or with vehicle accessories to provide rated voltage. Ratings for each generator are given in "Specifications" at end of this section. If generator does not produce current within its rated capacity, it can be considered defective and in need of repair.

6. Remove instruments and jumper lead and connect wiring harness connector to regulator.

7. If no defects were discovered by the foregoing tests, yet the battery remains undercharged, adjust voltage regulator setting as explained under applicable regulator later in this section.

REGULATOR UNIT FIELD RELAY TEST ON VEHICLE

If the generator charge indicator shows no charge, the regulator field relay or possibly the generator is at fault. To determine which is at fault, proceed as follows:

1. Make connections to the regulator and connector terminals as shown in figure 9.

2. Start engine and operate at fast idle speed. Observe the voltmeter reading. If reading is 5 volts or over and indicator shows no charge, the field relay is defective and must be checked.

3. If voltmeter reading is below 5 volts on regulator 1119515, or 8 volts on regulator 1119507, trouble is in generator. Refer to applicable "Generator" section explained later.

4. The field relay closing voltage can be checked on the vehicle as follows:

NOTE: Refer to figure 10 which shows hookup of test equipment.

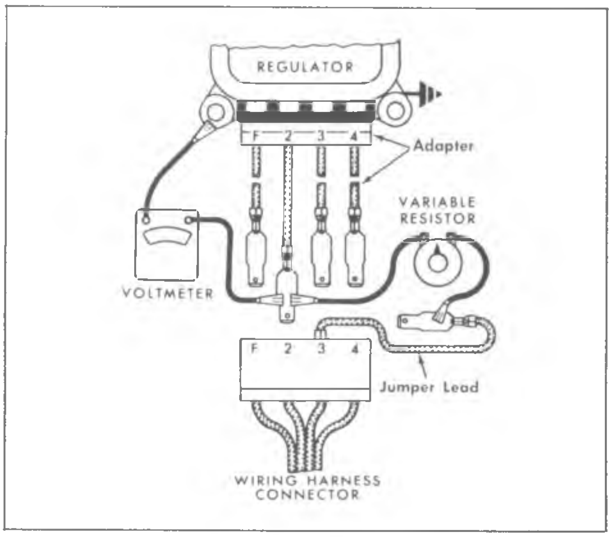


Figure 10—Testing Field Relay Closing Voltage (Two-Unit Type Regulator) (Typical)

a. Connect a 100-150 ohm variable resistor and a voltmeter to the adapter as shown.

NOTE: If the 0-50 ohms variable resistor unit (J-21260) is used, it will be necessary to add a 15 and a 115 ohm resistor in same series to provide required resistance.

b. Turn resistor to the open or "full resistance" position. Leave ignition or control switch off.

c. Slowly decrease resistance and note the closing voltage. Voltage should be 1.5 to 3.2 volts on 1119515 or 3.8 to 7.2 volts on 1119507. If necessary, adjust by bending the armature support heel iron.

REGULATOR VOLTAGE TEST (ON VEHICLE)

The voltage at which the regulator operates varies with changes in regulator ambient temperature which is the temperature of air at a distance of ¼-inch from the regulator.

GENERATING SYSTEM WITH TWO-UNIT TYPE REGULATOR

1. Refer to figure 11 which shows all test equipment connected into system. Figure 12 shows use of special adapter and jumper lead at regulator.

2. Connect an ammeter and a ¼-ohm resistor with a rating of 25 watts or more in series in the circuit at the "BAT" terminal on the generator (fig. 11). In the event the battery is discharged, the ¼-ohm resistor will limit the generator output to 10 amperes or less which is required, when checking and adjusting the voltage setting.

3. Install special adapter as shown in figure 11. Use a 25 ohm 25 watt variable resistor in series with the generator field windings at the regulator "F" terminal, and connect a jumper lead from the #3 adapter lead to the generator "BAT" terminal as shown. Connect a voltmeter from the #3 adapter lead to ground as shown. Turn the resistor to the closed or "no resistance" position.

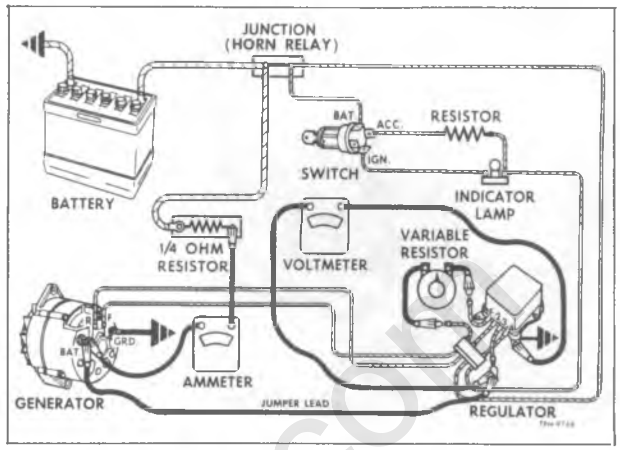


Figure 11—Connections for Testing Regulator Voltage Setting (Two-Unit Type Regulator)

4. Secure a thermometer close to regulator to establish operating temperature. With all accessories and lights off, start and operate engine for 15 minutes at 1500 engine rpm.

5. After warm-up, cycle generator as follows:

a. Turn variable resistor to "OFF" or "FULL RESISTANCE" position.

b. Disconnect lead at #4 terminal of harness connector momentarily, then reconnect lead.

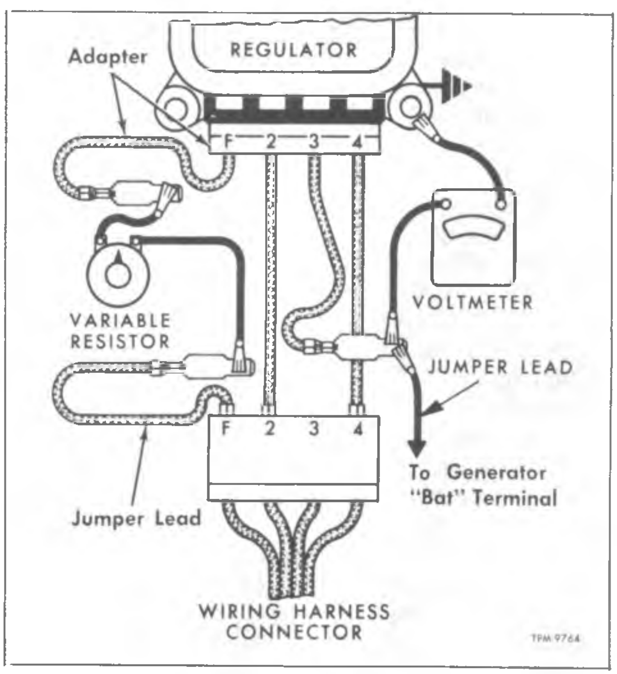


Figure 12—Testing Voltage Setting (Two-Unit Type Regulator)

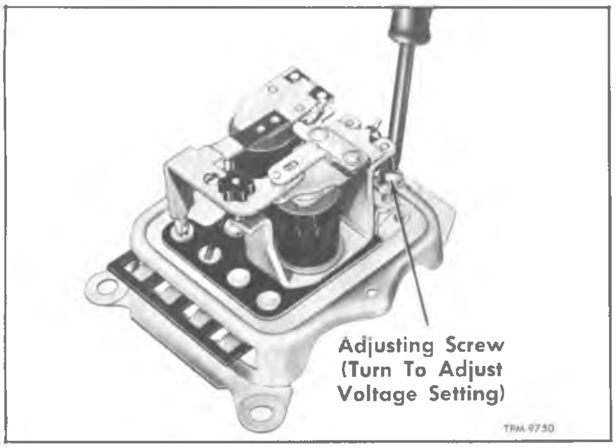


Figure 13—Adjusting Voltage Setting (Two-Unit Type Regulator) (Typical)

c. Return variable resistor to the closed or "no resistance" position.

d. Bring engine speed up to approximately 2500 rpm and note the voltage setting. Refer to applicable "Temperature Voltage Chart" in "Specifications" at end of this section.

NOTE: The regulator unit should be operating on the upper or shorting contacts. If it will not operate on the upper contacts, the battery is in extreme state of discharge, and must be at least partially recharged before proceeding with test.

6. To prevent accidental grounding and consequent damage to internal regulator parts when removing or installing regulator cover, perform the following steps in order listed:

a. Disconnect #4 lead at harness connector.

b. Disconnect jumper lead at generator "BAT" terminal.

c. Remove regulator cover.

d. Reconnect jumper lead to generator "BAT" terminal.

e. Connect #4 lead to harness connector.

7. To adjust the voltage setting, turn adjusting screw as shown in figure 13.

IMPORTANT: Always turn screw clockwise to make final setting to insure spring-holder being against head of adjusting screw. If necessary, pry holder up against screw head before turning screw clockwise.

8. After making the setting, cycle the generator again as directed previously in Step 5.

9. Operate engine at approximately 2500 rpm and note voltage setting. Readjust if necessary.

10. Check the voltage setting while operating on the lower set of contacts as follows:

Slowly increase the resistance of the variable resistor with the engine operating at 2500 rpm until the regulator begins to operate on lower set of contacts. Then, note the change in voltage reading. The upper set voltage should be 0.1 to 0.4 volts higher than on lower contacts.

The most desirable method for determining that the regulator is operating on the lower set of contacts when the cover is installed is to use earphones (if available) connected across the regulator "F" terminal to ground. As the variable resistor is turned, and operation changes from the upper set of contacts to the lower set, the earphones sound will fade away and stop completely and then return when the lower set of contacts begin to operate. The alternate method is visual observation, but this is less desirable because the cover must be removed which affects temperature stabilization.

NOTE: If turning the variable resistor does not cause the regulator to operate on the lower set of contacts, return the variable resistor to the "no resistance" position, turn the carbon pile to slightly load the battery, and then adjust the variable resistor to cause the regulator to operate on the lower set of contacts. Usually, turning on the vehicle head lights can substitute for the carbon pile.

The difference in voltage between the operation of the upper set of contacts and the lower set is increased by slightly increasing the air gap between the armature and center of core and decreased by slightly decreasing the air gap using nylon adjusting nut. This adjustment can be made while the regulator is operating. If necessary to make this air gap adjustment, recheck the voltage setting of both sets of contacts.

11. Always make final voltage test after the regulator cover is installed.

IMPORTANT: Observe special procedure in Step 6 previously when installing and removing regulator cover.

12. The regulator can be removed and checked as directed later under applicable "Voltage Regulator."

SYSTEM WITH 1116374 OR
1116378 REGULATOR

NOTE: On vehicles equipped with the 1116374 regulator, No. 2 terminal on regulator is energized by system voltage rather than by generator "R" terminal voltage.

1. Make connections as shown in View A, figure 14.

CAUTION: DO NOT leave jumper lead connected longer than five minutes.

2. If voltage in Step 1 is less than 0.9 volt or greater than 2.0 volts, repair or replace the regulator.

3. If voltage in Step 1 was between 0.9 and 2.0 volts, proceed as follows:

a. Make connections as shown in View B, Part 1, figure 14, and record the voltage drop.

NOTE: Voltmeter is connected between battery positive terminal and regulator No. 3 terminal, and jumper lead is connected between regulator No. 2 and No. 3 terminals.

b. Connect a voltmeter between battery ground terminal and ground on regulator base as shown in View B, Part 2, figure 14, and record the voltage drop.

c. Add voltage in Step a. to voltage in Step b. above. If total voltage (a. + b.) is above 0.25 volt, check system wiring for high resistance and check regulator for proper ground.

d. If total voltage in Step c. is below 0.25 volt, connect a voltmeter between regulator No. 3 terminal and ground on regulator base as shown in View C, figure 14; then with switch on, operate engine at 1,275 rpm for 15 minutes. Leave cover on regulator. Place a thermometer ¼-inch from regulator cover and compare voltage with "Specifications" given in "Temperature Chart" at end of this section.

4. If voltage is not within specified range, remove access plug from regulator cover and note position of plastic screw slot beneath the plug. The slot will be aligned with one of the divisions or lines cast on the regulator cover.

If actual regulating voltage, as checked, is not within the voltage range specified for the measured ambient temperature, repair or replace the regulator.

5. If voltage is within specified range for the measured ambient temperature, the charging system operation is satisfactory. However, the regulator setting may need to be changed to meet battery charging requirement for a particular type of operation. Remove plug from regulator cover, then use a thin, flat-bladed instrument to turn the slotted adjuster inside the regulator (fig. 15).

6. To raise the voltage setting, turn slotted adjusting plug one notch (clockwise), then check for an improved battery condition.

NOTE: After two notches in each direction there is a positive stop.

7. To lower the voltage setting, turn slotted adjusting plug one notch (counterclockwise), then check for an improved battery condition after a service period of reasonable length.

8. If regulator cannot be adjusted to a value within the specified range, repair or replace the regulator.

NOTE: If repeated regulator failures are experienced on the vehicle, but no defects are found, a shorted, grounded, or open generator field winding, or grounded leads of an intermittent nature should be suspected.

TAILORING THE VOLTAGE SETTING

The proper setting is obtained when the battery remains fully charged with a minimum use of water.

If any circuit defects are found, yet the battery remains undercharged, raise the setting by 0.3 volts, then check the battery over a period of time to see if improvements were achieved; reset regulator if necessary. If the system is overcharging, lower the setting by 0.3 volts, then check battery over a period of time.

GENERATOR REPLACEMENT

Due to variations in design and equipment on vehicles using A.C. generators, the replacement

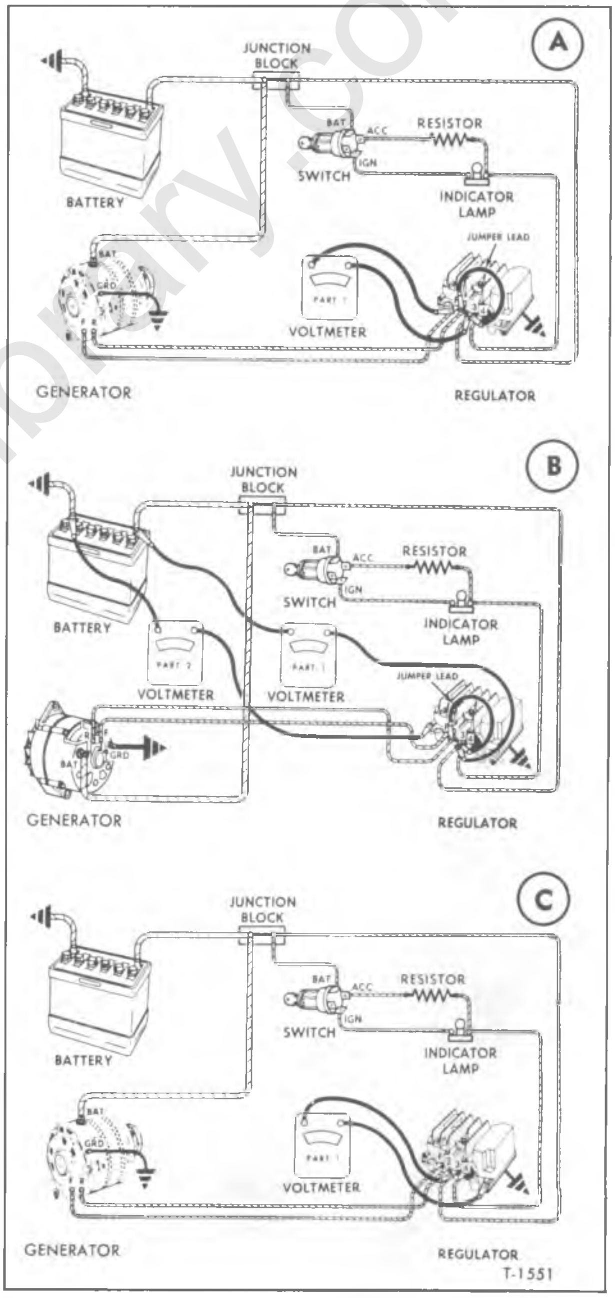


Figure 14—Connections for Testing 1116374 or 1116378 Regulator Voltage Setting (Typical)

A/C GENERATING SYSTEM

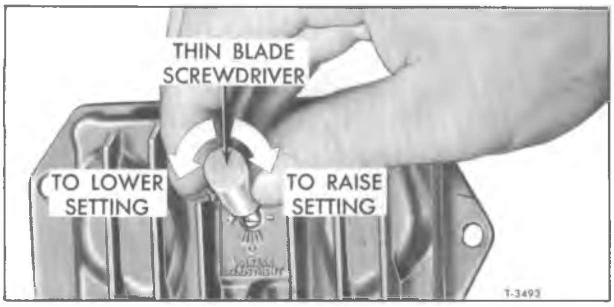


Figure 15—Adjusting Voltage Setting (Typical)

procedures will vary accordingly. The removal and installation instructions given following are intended only as a guide. Additional operations will be required on some vehicles to remove other equipment to permit access to generator, belts, and/or brackets.

GENERATOR REMOVAL

1. Disconnect negative battery cable from the battery.

> **CAUTION: It is important that battery negative terminal be disconnected, since generator will be damaged if wiring or terminals are accidentally shorted or grounded while being disconnected.**

2. On 42-, 61-, and 62-amp generators, depress lock on connector and pull connector out of socket on generator. Pull rubber boot off "BAT" terminal and remove terminal nut. Disconnect wire from "GRD" terminal and remove the wiring clip.

   On 130-amp generator, remove nuts and washers from harness leads at generator terminals. Remove harness clip from generator, then pull leads from terminals.

3. Loosen adjusting arm pivot bolt and generator to mounting bracket bolts; then move generator to loosen the drive belt or belts. Remove generator drive belt or belts.

4. Remove adjusting arm pivot bolt and generator to mounting bracket bolts; then remove generator.

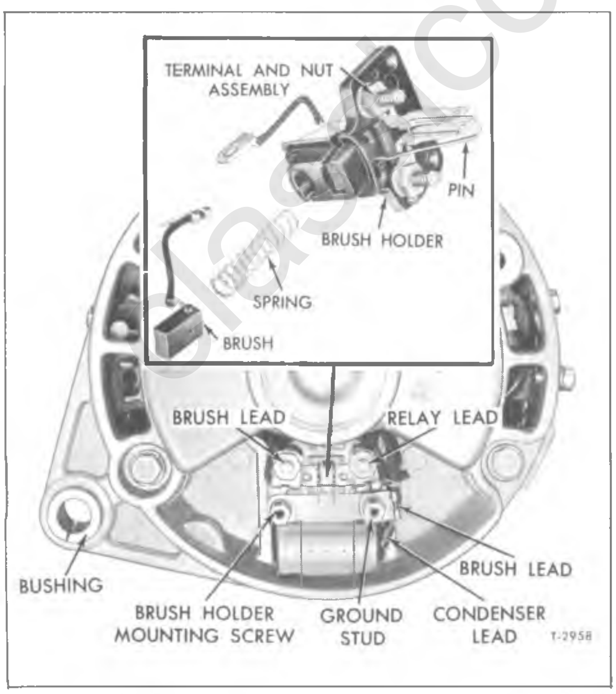


Figure 16—Generator Brush Replacement (Model 1117754)

GENERATOR BRUSH REPLACEMENT
(MODEL 1117754)

NOTE: Brush replacement on 42-, 61-, and 130-amp generator models requires partial disassembly of the generator and is considered a part of the unit overhaul procedure.

<u>Removal (Fig. 16)</u>

1. Remove screws from brush holder cover and remove cover.
2. Remove nut retaining indicator light wire to blade connector post and disconnect lead from post.
3. Remove two screws which attach condenser and brush holder to rear end frame.

   NOTE: Condenser lead is connected inside the generator. Leave condenser with generator to avoid excessive strain on lead wire.
4. Remove brush holder, brushes, and brush springs from generator end frame.

<u>Installation (Fig. 16)</u>

1. Position brush springs and brushes in brush holder and insert a pin through hole in brush holder and brushes to retain in position.
2. Position brush holder and brushes in end frame, then secure brush and condenser leads to terminals as shown in figure 16.
3. Install brush holder mounting screws and tighten firmly.
4. Remove pin from brush holder and check to be sure all leads are properly connected. Install cover over brush holder.

GENERATOR INSTALLATION

IMPORTANT: Be sure negative battery cable is disconnected from battery. Failure to disconnect the negative battery cable may result in damage to generator.

1. Attach generator to mounting bracket and install adjusting arm. Tighten flange-type lock nuts securely.
2. Place drive belt(s) over generator drive pulley and adjust belt tension as explained under

"Drive Belt Tension Adjustment" previously. Tighten flange type lock nuts and mounting bolts to torque recommended in "Specifications."

3. On 42-, 61-, or 62-amp generators, push the wiring harness connector into socket, making sure lock on connector engages end frame. Place harness clip on ground terminal marked "GRD" and connect ground wire to terminal.

On 130-amp generator, connect harness leads to respective generator terminals, then install attaching nuts and washers. Install harness clip.

4. Attach red wire to "BAT" terminal on generator and fit boot on terminal.

5. Perform "Generator Output Test" described previously to determine if generator is operating properly and regulator is correctly adjusted.

TWO-UNIT REGULATOR (MODEL 1119507 OR 1119515)

GENERAL

The two-unit type voltage regulator is used on all models equipped with the 42-, 61-, or 130-amp generating system. Operation of regulator and other affiliated generator system units is explained previously under "Generating System General Description."

REGULATOR REPLACEMENT

REMOVAL

1. Disconnect the negative cable from battery.
2. Carefully lift up on regulator wiring harness connector with one hand and with the other, pull harness connector from regulator.
3. Remove regulator mounting screws, then remove regulator assembly.

INSTALLATION

IMPORTANT: Make sure one battery cable is disconnected from battery.

1. Place regulator-to-generator ground wire (if used) on regulator mounting and install regulator attaching screws.
2. Lift up on regulator terminal latch and insert wiring harness connector over regulator terminals.

IMPORTANT: Make sure connector is fully engaged over terminals and locked in position. Check by attempting to pull connector apart.

3. Connect battery cable to battery terminal.

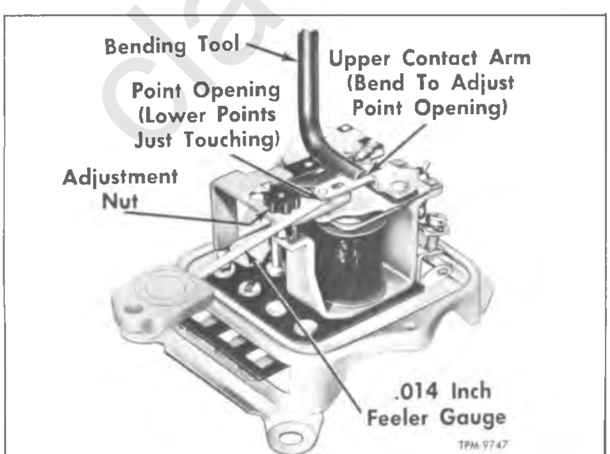


Figure 17—Adjusting Regulator Point Opening

GENERAL INSPECTION

With regulator assembly on work bench, remove cover and inspect various components, connections, and contact points for signs of damage.

VOLTAGE REGULATOR UNIT CHECK

CHECKING AND ADJUSTING CONTACT POINT OPENING

With the lower contacts touching, measure the point opening between the upper contacts as shown in figure 17. Point opening should measure 0.014". Adjust by bending the upper contact arm as shown.

CHECKING AND ADJUSTING AIR GAP

Measure air gap with a 0.057-inch feeler gauge between the armature and the core when lower contacts are just touching as shown in figure 18. To adjust the air gap, turn the adjustment nut located on the contact support.

NOTE: Only an approximate air gap setting should be made by the feeler gauge method above. The final setting must be whatever is required to obtain the specified difference in voltage between

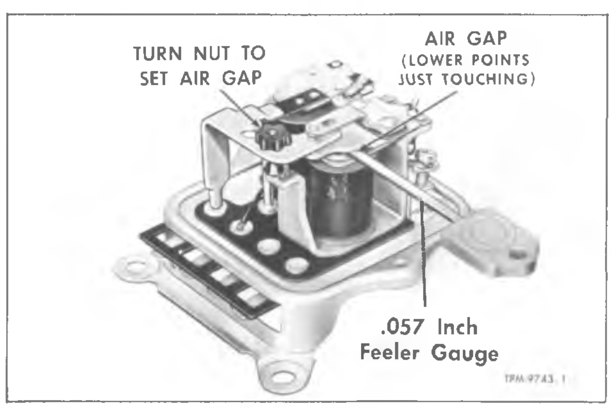


Figure 18—Adjusting Regulator Air Gap

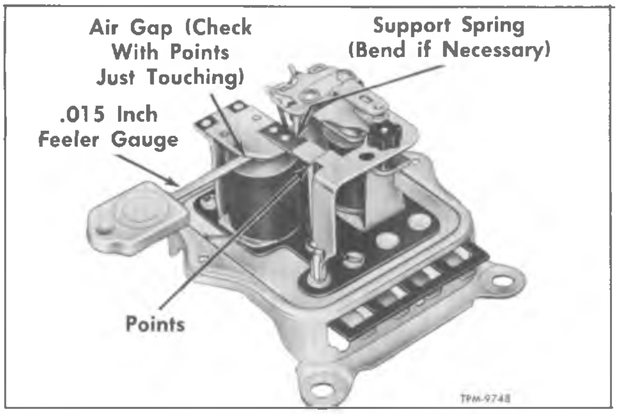


Figure 19—Adjusting Field Relay Air Gap

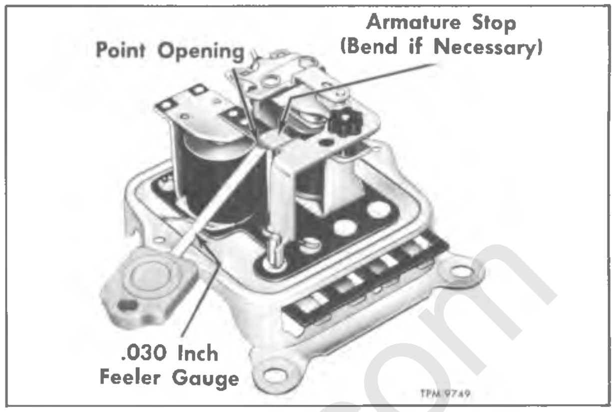


Figure 20—Adjusting Field Relay Contact Points

the upper and lower contacts. Instructions for making final setting are explained previously. See "Regulator Voltage Test (On Vehicle)."

FIELD RELAY UNIT CHECK

NOTE: Check closing voltage as explained under "Regulator Unit Field Relay Test - On Vehicle" in "ALTERNATING CURRENT GENERATING SYSTEM" section previously.

CHECKING AND ADJUSTING AIR GAP

Referring to figure 19, insert a 0.015-inch feeler gauge between the armature and core and exert just enough pressure on the armature to allow it to touch the gauge. The contact set should just close at this time, adjust by bending the flat contact support spring.

CHECKING AND ADJUSTING CONTACT POINT GAP

Referring to figure 20, insert an 0.030-inch feeler gauge between the contact points with the armature in its normal rest position.

The point opening can be adjusted, if necessary, by bending the relay heel iron.

FULL TRANSISTOR REGULATOR (1116374 AND 1116378)

GENERAL

The full transistor regulator is used on models equipped with the 62-amp generator as shown in "Model Application Chart" previously.

The regulator is composed of transistors, diodes, capacitors and resistors which form a completely static electrical unit containing no moving parts.

The function of the regulator is to limit voltage to a given value. The voltage at which the generator is limited is determined by the regulator adjustment which, when adjusted, remains practically unchanged. Refer to "Regulator Adjustment" later in this section.

IMPORTANT: The field wire terminal must not be grounded or flashed when regulator is connected into circuit as instant damage to transistors will result.

OPERATING PRINCIPLES

In the circuit illustrated in figure 2 in "Generating System General Description" section, when ignition switch is closed and engine is not running, the ammeter will show a discharged condition of the indicator lamp will "light," to indicate the generator is not charging. The current flow can be traced from the battery to the "BAT" terminal on the ignition switch, through the indicator lamp and resistor, then to No. 2 or 4 terminal on the regulator. From here it continues to flow through transistor TR-1 to "F" terminal on the regulator and on through the generator field winding to ground, completing the circuit back to the battery.

When the engine is started and generator begins to operate, A.C. voltages are induced in the generator stator windings. These voltages are changed or rectified to D.C. voltage which appears at the output, or "BAT" terminal on the generator. The generator then supplies current to charge the battery and operate vehicle accessories.

On 62-amp generating systems equipped with the 1116374 transistorized regulator, system voltage is impressed through regulator #2 terminal and through field relay winding causing relay contacts to close.

On 62-amp generating systems equipped with

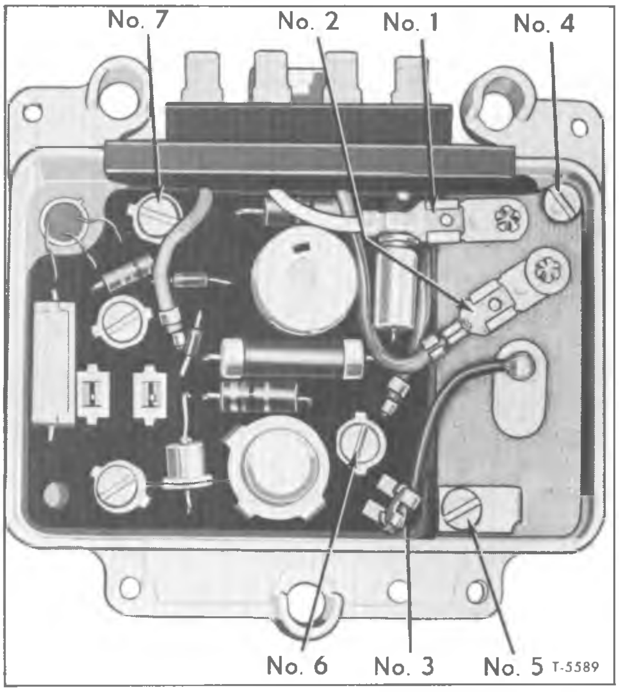


Figure 21—Regulator with Cover Removed

the 1116378 transistorized regulator, voltage from "R" terminal on generator is impressed through regulator #2 terminal and through field relay winding causing the relay contacts to close. This connects the regulator #4 terminal directly to battery through the field relay contacts, causing the indicator lamp to go "OUT." Generator field current then flows from generator or battery to regulator #3 terminal, then through the field relay contacts and transistor TR-1 to the generator field winding.

As generator speed increases, the voltage reaches the pre-set value and components in the regulator cause transistor TR-1 to alternately "turn-off" and "turn-on" the generator field voltage. The regulator thus operates to limit the generator output voltage to the pre-set value.

ANALYZING CHARGING SYSTEM TROUBLES

NOTE: Procedures for analyzing or checking charging system trouble are explained previously.

Adapter (J-9782-3) may be used at the regulator to facilitate checking circuits.

If trouble is located in the generator during the test procedures, refer to the applicable generator section for corrective procedures.

When analyzing the system, make sure all connections between the battery, junction block, and generator are clean and tight, then remove the wiring harness connector from the regulator and connect the adapter between the wiring harness connector and the regulator.

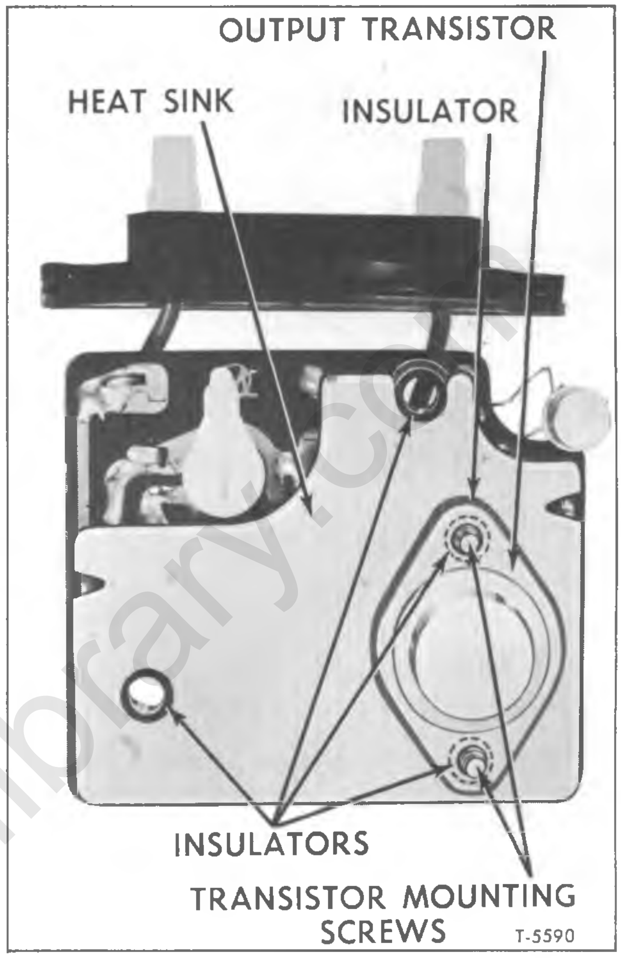


Figure 22—Heat Sink and Circuit Board Assembly

When the trouble is found, it is not necessary to make further checks; however, it is often advisable to complete all checks to ensure that no other troubles exist.

REGULATOR REPLACEMENT

REGULATOR REMOVAL

1. Disconnect the negative cable from battery.
2. Carefully lift up on regulator wiring harness connector with one hand and with the other, pull harness connector from regulator.
3. Remove regulator mounting screws, then remove regulator assembly.

REGULATOR INSTALLATION

IMPORTANT: Make sure one battery cable is disconnected from battery.

1. Place regulator-to-generator ground wire on regulator mounting and install regulator attaching screws.

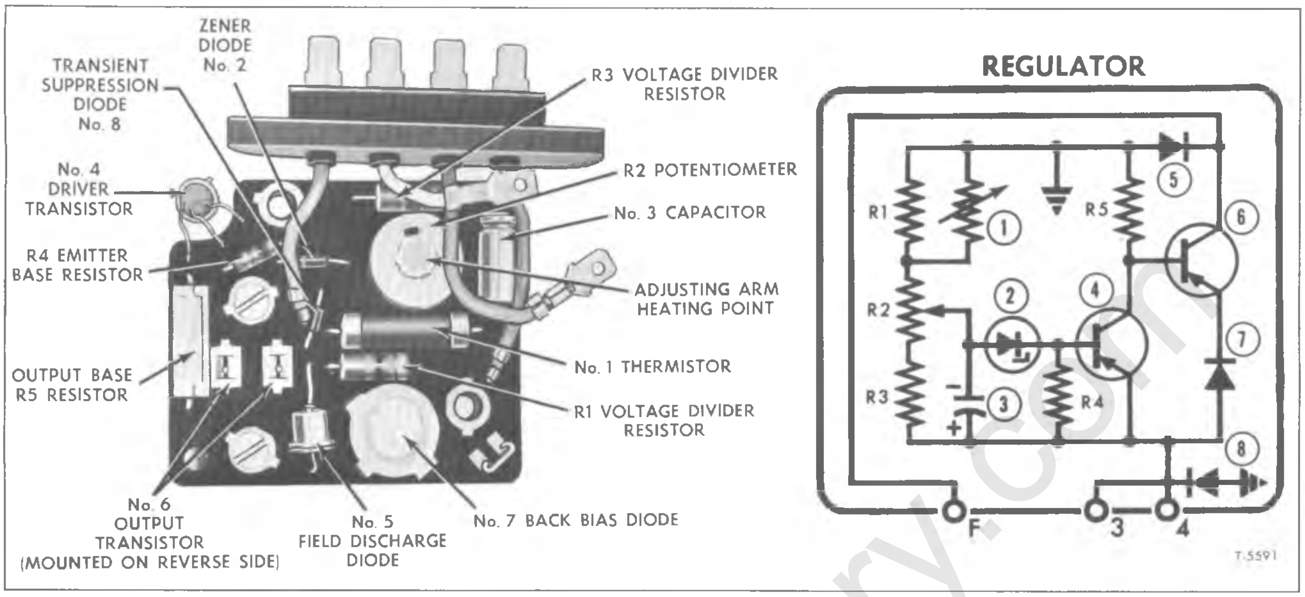


Figure 23—Component Parts of Panel Board Assembly

2. Lift up on regulator terminal latch and insert wiring harness connector over regulator terminals.

IMPORTANT: Make sure connector is fully engaged over terminals and locked in position. Check by attempting to pull connector apart.

3. Connect battery cable to battery terminal.

REGULATOR REPAIR

To check the regulator for defective components proceed as follows:

1. Remove four screws which attach cover to base plate and remove the cover.

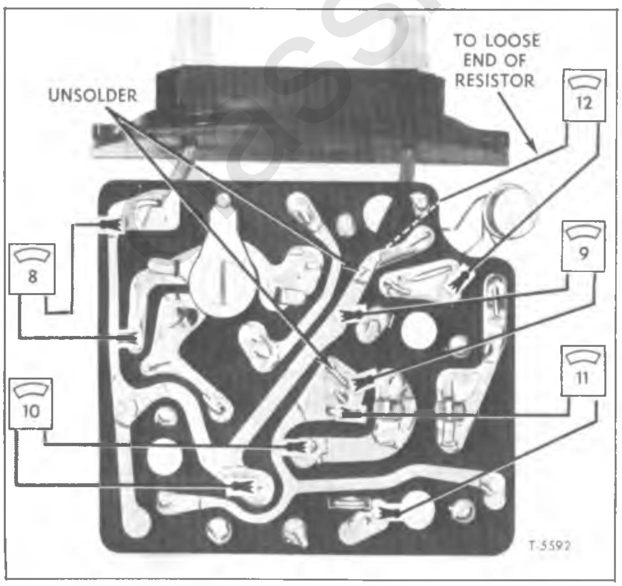


Figure 24—Checking Regulator Circuits

2. Referring to figure 21, remove leads from terminals 1, 2, and 3, then remove screws 4 and 5 which attach relay to base and remove relay.

3. Remove screws (6 and 7, fig. 21) then lift circuit board, heat sink and terminal assembly from the regulator base.

4. Note the insulation between the output transistor and heat sink, and the insulators separating the heat sink from the panel board (fig. 22).

5. Remove screws which attach transistor to panel board and separate the transistor and heat sink and insulators from the panel board.

6. Visually inspect all copper traces on the panel board for opens and for shorts or grounds which could be caused by solder runs.

An ohmmeter having a 1½-volt cell, which is the type usually found in service stations, is recommended for checking transistors and parts of the panel board. The low range scale on the ohmmeter should be used.

If a component part on the panel board is found to be faulty, it should be replaced before proceeding with the remaining checks. A 25-watt soldering gun is recommended, and a 60% tin 40% lead solder should be used when re-soldering. Avoid excessive heat which may damage panel board traces. Component parts are identified in figures 22 and 23.

In all of the following checks, connect the ohmmeter as shown, then reverse ohmmeter leads to obtain a second reading.

NOTE: Refer to figures 22 and 23 for identification and location of following connections:

7. To check component parts of the panel board, it is necessary to carefully unsolder the specific connections at points shown in figure 24.

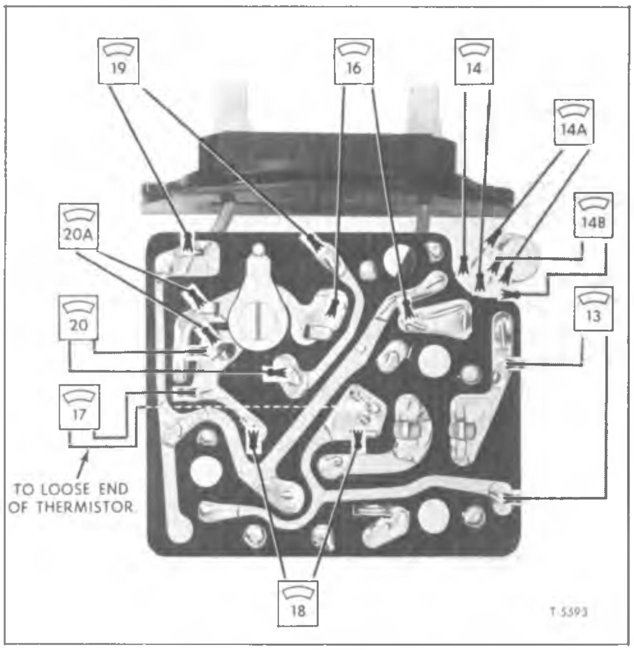


Figure 25—Checking Regulator Circuits

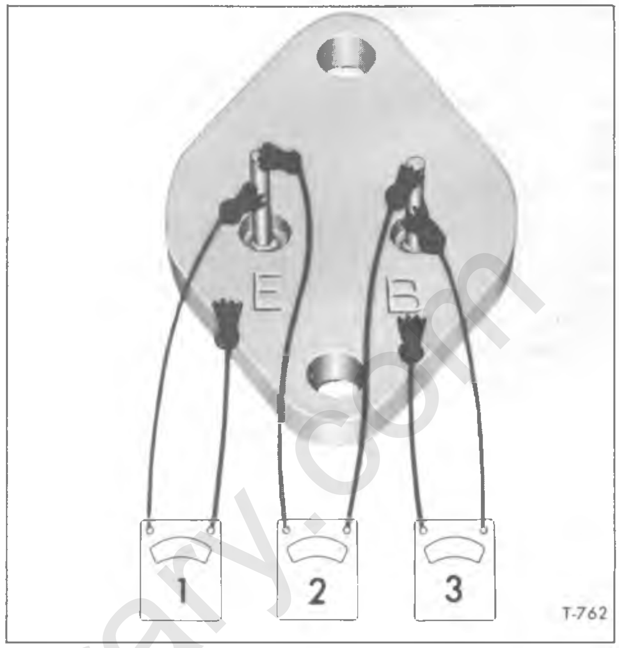


Figure 26—Checking Transistors for Shorts

FILTER CAPACITOR
(PART 8, Fig. 24)

If both ohmmeter readings are zero, the capacitor is defective. Visually inspect for open soldered connections and broken leads. To assemble a new capacitor properly, note location of the "+" identifying mark in figure 23.

TRANSIENT SUPPRESSION DIODE
(PART 9, Fig. 24)

If the two ohmmeter readings are identical, the diode is faulty.

BACK BIAS DIODE
(PART 10, Fig. 24)

Replace the diode if both readings are zero, if both readings are infinite, or if both readings are identical.

FIELD DISCHARGE DIODE
(PART 11, Fig. 24)

Replace the diode if both readings are zero, if both readings are infinite, or if both readings are identical.

EMITTER BASE RESISTOR (If Used)
(PART 12, Fig. 24)

Connect ohmmeter as shown. If the reading is infinite, the resistor is open and must be replaced.

OUTPUT BASE RESISTOR
(PART 13, Fig. 25)

If one reading is infinite or nearly infinite, or if both readings are infinite or nearly infinite, the resistor is open.

DRIVER TRANSISTOR
(PART 14, 14A, 14B, Fig. 25)

If both readings in Step 14 are zero or if both readings are very low and identical, the transistor is shorted and must be replaced. Similarly, if both readings in Step 14A or 14B are zero or very low and identical, the transistor is shorted.

If both readings in Step 14 or 14B are infinite, or if both readings are very high and identical, the transistor is open and must be replaced.

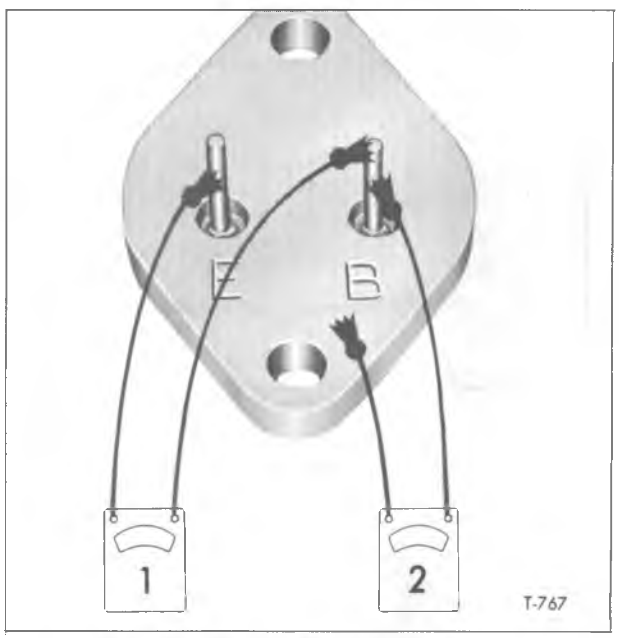


Figure 27—Checking Transistors for Opens

A/C GENERATING SYSTEM

OUTPUT TRANSISTOR
(PART 15, Figs. 26 and 27)

In figure 26, if both readings in Step 1 are zero, or if both readings are very low and identical, the transistor is shorted. Similarly, if both readings in Step 2 or Step 3 are zero or very low and identical, the transistor is shorted.

In figure 27, if both readings in Step 1 are infinite, or if both readings are very high and identical, the transistor is open. Similarly, if both readings in Step 2 are infinite or very high and identical, the transistor is open.

IMPORTANT: Replacing any of the above components should not affect the voltage setting. If any of the following components require replacement, adjust voltage setting as explained under "Regulator Voltage Adjustment" later in this section.

ZENER DIODE
(PART 16, Fig. 25)

If both readings are infinite or if both readings are identical, replace the diode.

THERMISTOR
(PART 17, Fig. 25)

Connect the ohmmeter as shown in figure 25. If the reading is infinite, the thermistor is open and should be replaced.

VOLTAGE DIVIDER RESISTOR R-1
(PART 18, Fig. 25)

If one reading is infinite or nearly infinite, or if both readings are infinite or nearly infinite, the resistor is open and should be replaced.

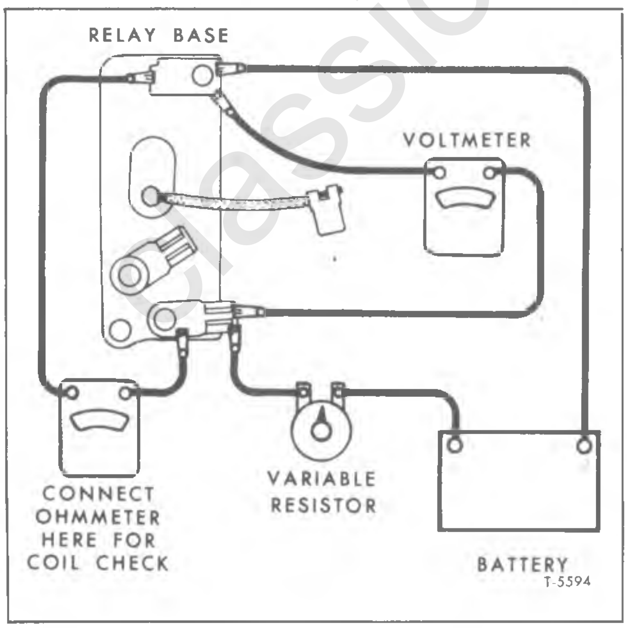


Figure 28—Field Relay Unit Check

VOLTAGE DIVIDER RESISTOR R-3
(PART 19, Fig. 25)

If one reading is infinite or nearly infinite, or if both readings are infinite or nearly infinite, the resistor is open and should be replaced.

POTENTIOMETER
(PART 20 AND 20A, Fig. 25)

If one reading is infinite or nearly infinite when connected as shown in Part 20, the potentiometer is open. If one reading is infinite or nearly infinite when connected as shown in Part 20A, the potentiometer is open.

NOTE: When installing a new potentiometer, locate the adjusting lever in a vertical position (fig. 23), turn the potentiometer resistance adjustment to the middle position, then use a soldering iron to melt the lever into potentiometer.

REGULATOR UNIT RELAY

The relay unit may be checked as follows. Refer to figure 28 for test connections.

1. Connect an ohmmeter across terminals as shown in figure 28. An infinite reading indicates an open shunt coil which will require replacing the relay.
2. To check closing voltage, connect a battery, 50 ohm variable resistor and voltmeter into circuit as shown in figure 28. Slowly decrease resistance and note voltage at which relay points close. If voltage at which points close is not within limits listed in "Specifications" at end of this section, replace the relay.

REGULATOR VOLTAGE ADJUSTMENT

After replacing any components in Part 16 through 20 previously; regulator voltage must be calibrated to compensate for variations in operating characteristics between components. The voltage setting must be precise to maintain system voltage within limits listed in "Specifications" at end of this section.

1. Carefully apply soldering iron to lever of potentiometer at point shown in figure 23, then disconnect lever from opposite side of panel board while heat is being applied.
2. Use a small screwdriver to position center portion of potentiometer in middle position.
3. With regulator assembled, except for bottom cover plate and potentiometer lever, connect the generator, regulator, and battery into circuit per figure 2. Connect a test ammeter between battery post and battery lead.
4. Drive generator at 6,000 rpm with an electric load of 15 to 20 amperes.

NOTE: A carbon pile resistor may be required across battery posts to obtain required amperage.

5. Connect a test voltmeter between regulator No. 3 terminal and ground.

6. Adjust center position of potentiometer to obtain a voltage setting of 14.4 volts at regulator. Voltage will require readjustment every five minutes until voltage becomes stable. Normally 15 to 20 minutes will be required for this process.

NOTE: This voltage is based on the assumption that regulator is being set on a test bench at normal room temperature. If regulator is being set on the vehicle, voltage should be set 0.1 volt lower than the middle range given in "Specifications" to compensate for the higher ambient temperature.

7. Remove the panel board, heat sink and terminal assembly from regulator case. Insert lever into potentiometer so that it will mate with middle position of adjustment slots in regulator case. Use a soldering iron to melt adjustment lever into potentiometer.

8. Assemble regulator components into the case and attach cover plate.

A/C GENERATING SYSTEM

CHARGING SYSTEM TROUBLE ANALYSIS CHART

BATTERY UNDERCHARGED OR DEAD

1. Faulty drive belt tension adjustment.
2. Faulty wiring, connector, or connection.
3. Faulty generator.
4. Faulty voltage regulator.
5. Faulty battery.
6. Incorrect generator application.
7. Accessories left on with engine off.

BATTERY OVERCHARGED

Check for:
1. High voltage regulator setting.
2. Excessive voltage drop in sensing circuit.

VISUAL INSPECTION

1. Check for loose generator mounting.
2. Check generator drive belt tension.
3. Check wiring and clean connectors and connections at generator, regulator, and battery.
4. Check for accessories left on or shorted wiring.

PRELIMINARY TEST

With ignition switch "OFF" connect voltmeter between "BAT" terminal on generator and chassis ground.

Disconnect "NEG" battery cable and connect test light from cable to "BAT" terminal. If light is "ON" wiring is shorted or an accessory is on.

If a voltmeter reading is obtained, record reading and proceed as follows:
Start engine (accessories "OFF") and operate at approximately 1500 RPM.

If voltmeter DOES NOT register, circuit is open between battery and generator.
NOTE: Refer to Wiring Diagram Manual for wiring circuits.

Check generator (on vehicle) since an open circuit could result in damage to generator diodes.

If voltage reading was the same or lower, failure of the following is indicated:

1. Worn or sticking generator brushes.
2. Open circuit to generator field.
3. Open or shorted generator field.

To determine fault - Proceed as directed under applicable regulator chart following.

If voltmeter reading was higher than previous, regulator circuit is satisfactory. FAULT IS:
1. Low regulator setting.
2. Faulty battery.
3. Faulty generator.
4. Incorrect generator application.

1. Charge and check the battery.
2. Check for low regulator or setting.
3. Check generator (on vehicle) for defective diode or stator.
4. Check for incorrect generator application. Consider type of driving or accessories added.

CHARGING SYSTEM TROUBLE ANALYSIS CHART WITH 1119507, 1119515, 1116374, OR 1116378 REGULATOR

Load battery with a carbon pile or with heater and head lamps on. Disconnect wire from field terminal at generator. Momentarily (not more than 10 seconds) connect a jumper from generator "BAT" terminal to field "F" terminal.

If voltage reading increased:
Defective regulator or wiring is indicated.
Proceed as follows:
Remove jumper lead and reconnect wire to generator field terminal. Connect voltmeter "POS" lead to No. 3 regulator terminal and "NEG" voltmeter lead to "F" terminal on regulator.

If voltage remains low -
FAULT IS:
1. Worn or dirty brushes.
2. Open or shorted generator field.

If voltmeter reads "O" or low, connect voltmeter between No. 3 regulator terminal and chassis ground.

If high voltmeter reading was obtained, regulator is open. Repair or replace regulator.

If a voltmeter reading was obtained, connect voltmeter leads between No. 2 regulator terminal and chassis ground.

If voltmeter reading is "O" wiring is open between battery and No. 3 regulator terminal.

If voltmeter reading was obtained, generator field relay is defective. Rep r or replace regulator.

If voltmeter reading was "O" wiring is open to No. 2 regulator terminal.

SPECIFICATIONS

ALTERNATING CURRENT GENERATING SYSTEM SPECIFICATIONS

GENERATOR MODEL	1100842	1100849	1117754	1117128
Make	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy
Rotation (Viewing Drive End)	Clockwise	Clockwise	Clockwise	Clockwise
Brush Spring Tension (Oz.)	—	—	—	10
Field Current at 80° F.				
Amps	2.2-2.6	2.2-2.6	4.14-4.62	2.22-2.4
Volts	12	12	12	12
Output at Specified Voltage				
Specified Volts	14.0	14.0	14.0	14.0
Amps*	28	33	20	40
Generator RPM (Approx.)	2000	2000	1100	1100
Amps	40	58	55	126
Generator RPM (Approx.)	5000	5000	2500	2500
Rated Hot Output	42	61	62	130

*If generator output is checked without a regulator, output should be 5-10% higher than the value given.

TORQUE SPECIFICATIONS

DESCRIPTION	TYPE OF PART	TORQUE (FT. LBS.)
Generator Pulley Nut		
Except "L" and "DL" Models	Nut	55-65
"L" and "DL" Models		
With 42-Amp Generator	Nut	40-50
With 61- or 62-Amp Generator	Nut	60-65
Generator Adjusting Arm To Anchor Bracket	Bolt	25-30
Generator To Mounting Bracket Pivot Bolt*		
Except "L" and "DL" Models	Nut	20-25
"L" and "DL" Models	Nut	15-20
Generator Mounting Bracket To Support	Bolt	40-50
Generator Support To Engine	Bolt	40-50
Generator Mounting Bracket To Engine		
"L" and "DL" Models	Bolt	40-50
EM/ES-4500; EM/ES/SM/SS-5500; EM/SM-6500	Bolt	40-50
	Nut	25-30
EG/SG-5500; EG-6500	Bolt	50-60

*Tighten pivot bolts prior to tightening other mounting bolts.

TWO-UNIT TYPE REGULATORS SPECIFICATIONS

Make	Delco-Remy	Delco-Remy
Model	1119507	1119515
Field Relay		
Air Gap (in.)	0.015	0.015
Point opening (Inc.)	0.030	0.030
Closing Voltage (Range)	3.8-7.2	1.5-3.2
Voltage Regulator		
Point Opening (In.)	0.014	0.014
Ambient Temperature*	See chart below	

*Operation on lower contacts must be .05-.4 volt lower than on upper contacts.

TEMPERATURE VOLTAGE CHART

Degree F.	65	85	105	125	145	165	185
Voltage Setting	13.9-15.0	13.8-14.8	13.7-14.6	13.5-14.4	13.4-14.2	13.2-14.0	13.1-13.9

FULL TRANSISTOR TYPE REGULATOR SPECIFICATIONS

Make	Delco-Remy	Delco-Remy
Model	1116374	1116378
Field Relay Closing Voltage Range	4.5-6.5	2.0-3.0
Ambient temperature*	See chart below	

*Allowable range at "0" position of adjusting screw.

TEMPERATURE VOLTAGE CHART

Degrees F.	65	85	105	125	145	165	185
Voltage Setting	14.1-14.8	13.9-14.7	13.7-14.5	13.6-14.3	13.4-14.2	13.2-14.0	13.1-13.8

SECTION 7
Transmissions and Clutches

SECTION 7A
Transmission Control Linkage

Contents of this section are listed in Index below:

TILT CAB MODELS WITH MANUAL TRANSMISSION

LINKAGE ADJUSTMENT

NOTE: Key numbers in text refer to figure 1.

1. Place transmission selector and shift levers (9) in NEUTRAL position.

2. Adjust selector and shift rods (8) to provide 90° angularity at the lower end of the gearshift lever (1) to the control island panel (2) as shown.

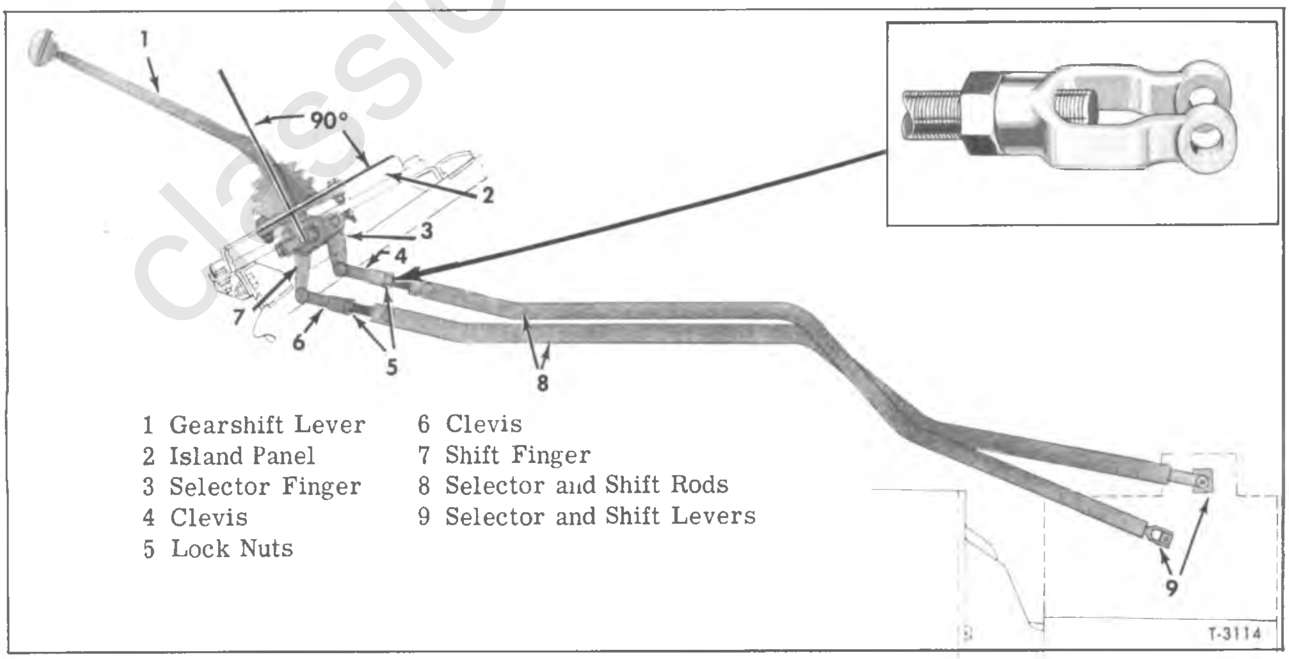
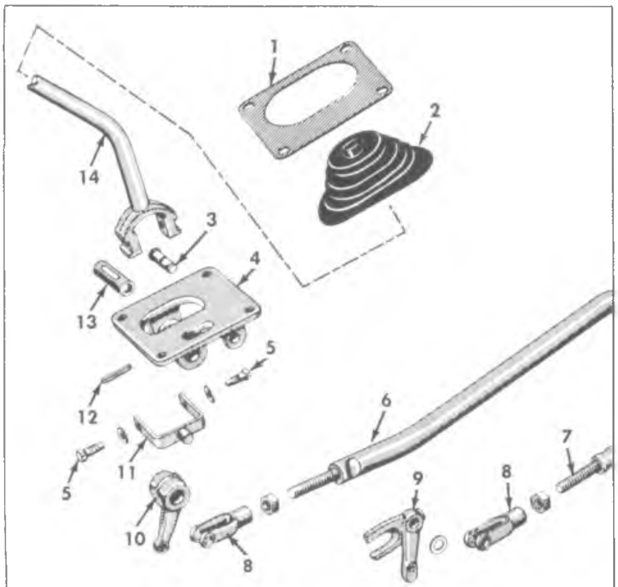


Figure 1—Tilt Cab Manual Transmission Control Linkage (Typical)

TRANSMISSION CONTROL LINKAGE



1 Boot Retainer
2 Boot
3 Selector Finger Pin
4 Control Cover
5 Pivot Screw
6 Shift Rod
7 Selector Rod
8 Adjustable Clevis
9 Selector Finger
10 Shift Finger
11 Selector Finger Strap and Pin Assembly
12 Roll Pin
13 Pivot Pin
14 Gearshift Lever

T-2983

Figure 2—Control Island Shift Mechanism

NOTE: Adjustment of the selector and shift rods is accomplished by disconnecting the rods at the control island or transmission, depending on the location of the adjustable clevis (see Inset, fig. 1). Rotate the adjustable clevis on each rod to the desired position, then reconnect the rods to the control island or transmission. Tighten lock nuts firmly.

3. Check adjustment by moving gearshift lever through the shift pattern. There must be no binding in the linkage.

NOTE: At the extreme selector and shift movements, clevis pins should rotate freely. Readjust linkage, if necessary, to obtain these conditions.

4. Replace any worn or damaged cotter pins.

5. Lubricate control linkage as described in LUBRICATION (SEC. 0) of this manual.

CONTROL ISLAND SHIFT MECHANISM

On tilt cab models with New Process transmission, if shift controls on control island become worn or damaged, make repairs as described in the following text:

NOTE: The control island shift mechanism used with either Corporation or New Process transmissions is basically the same in construction.

REMOVAL

NOTE: Key numbers in following text refer to figure 2.

1. At the control island panel, disconnect shift rod (6) from shift finger (10). Also, disconnect selector rod (7) from selector finger (9).
2. Remove shift mechanism assembly-to-control island panel attaching parts and then remove assembly from vehicle.
3. Remove gearshift knob, boot retainer (1) and boot (2).

DISASSEMBLY

NOTE: Key numbers in following text refer to figure 2.

1. Remove cotter pin and washer from selector finger pin (3), then remove selector finger (9).
2. Remove lockwires from pivot screws (5), then remove pivot screws, washers and selector finger strap and pin assembly (11).
3. Remove gearshift lever (14).
4. Using hammer and punch, remove roll pin (12), pivot pin (13), and then remove shift finger (10) from control cover (4).

CLEANING AND INSPECTION

1. Clean all parts thoroughly in cleaning solvent. Wipe or blow parts dry.
2. Check all parts for wear, distortion, cracks, or other damage.
3. Replace all parts that would affect proper selection of transmission gears.

ASSEMBLY

NOTE: Key numbers in following text refer to figure 2.

1. Place gearshift lever on shift lever finger (10) and position in control cover. Install pivot pin (13) and roll pin (12).
2. Install selector finger strap and pin assembly (11), washers and two pivot screws (5). Torque screws to 60-65 foot-pounds and install new lockwires to pivot screws.
3. Install selector finger pin (3), selector finger (9), washer and new cotter pin.

INSTALLATION

NOTE: Key numbers in text refer to figure 2.

1. Install boot (2), boot retainer (1) and gearshift knob to shift mechanism assembly.
2. Place shift assembly in proper position on control island and install attaching parts.
3. Connect shift control linkage to selector finger (9) and shift finger (10), then adjust control linkage as covered previously under "Linkage Adjustment" procedures.

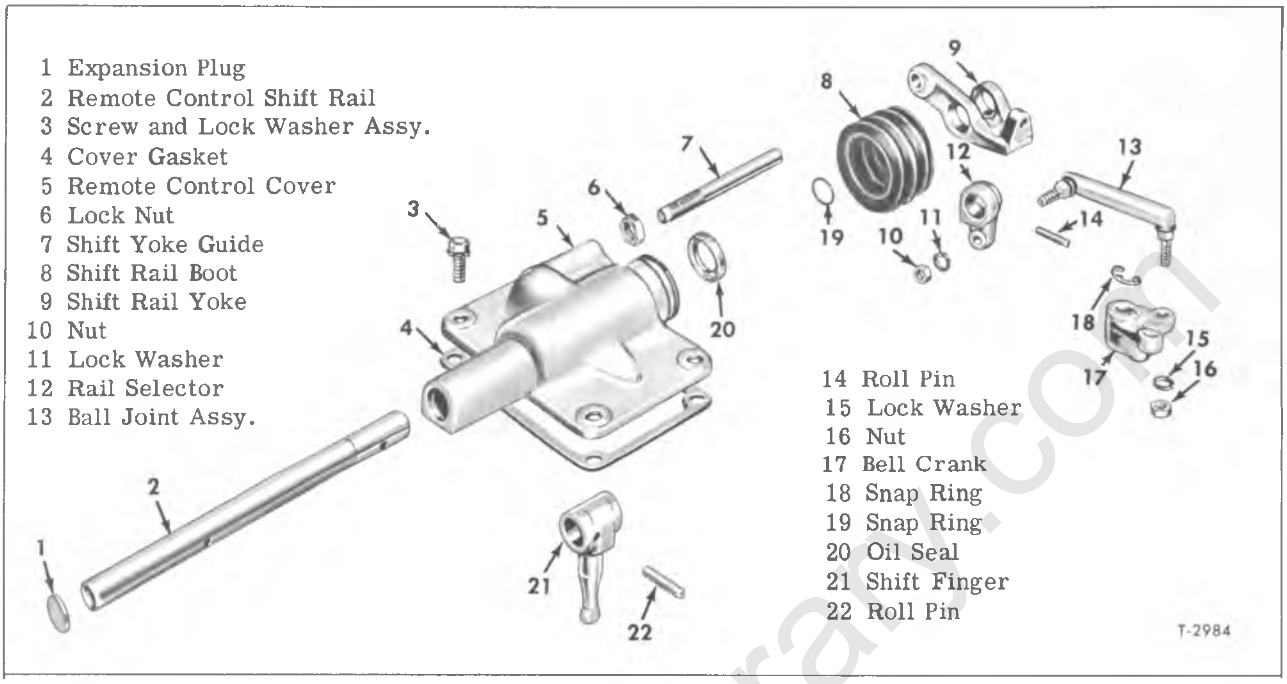


Figure 3—Remote Control Assembly (New Process 435)

REMOTE CONTROL ASSEMBLY (AT TRANSMISSION)

Tilt cab vehicles have transmission remote control assemblies as shown in figures 3 and 4. Should parts become worn or defective make repairs as described in the following text:

REMOVAL

1. Position transmission gearshift lever in "NEUTRAL" and disconnect control rods from shift levers at transmission.

NOTE: On models with New Process transmission, remove selector lever bellcrank snap ring.

2. Remove remote control assembly-to-transmission attaching parts, then remove assembly from vehicle.

3. Place a clean shop cloth over the transmission opening to prevent entry of dirt or other foreign material.

INSTALLATION

1. Position a new gasket on transmission cover.

2. With all parts in "NEUTRAL" position, carefully place remote control assembly on transmission.

3. Install remote control assembly-to-transmission attaching parts. Tighten bolts firmly.

NOTE: On models with New Process transmission, install selector lever bellcrank snap ring.

4. Adjust transmission control linkage as directed previously under "Linkage Adjustment."

NEW PROCESS 435 - REMOTE CONTROL ASSEMBLY

Disassembly

NOTE: Key numbers in text refer to figure 3.

1. Using a hammer and punch, remove roll pin (14) from remote control shift rail (2). Remove shift rail yoke (9) and rail selector (12) from shift rail (2).

2. Remove rubber shift rail boot (8).

3. Using snap ring pliers, remove snap ring (19) from shift rail (2).

4. Loosen lock nut (6), then remove shift yoke guide (7) from remote control cover (5).

5. Using hammer and punch, remove roll pin (22) which retains shift finger (21) to shift rail (2).

6. Drive shift rail (2) forward out of cover (5) forcing out expansion plug (1).

7. Remove all attaching parts retaining rail selector (12) and bell crank (17) to ball joint assembly (13). Remove rail selector and bellcrank from ball joint assembly.

Cleaning and Inspection

1. Clean all metal parts thoroughly in cleaning solvent. Wipe or blow parts dry.

2. Check all parts for wear, distortion, cracks or other damage.

3. Replace all parts that would affect proper selection of transmission gears.

TRANSMISSION CONTROL LINKAGE

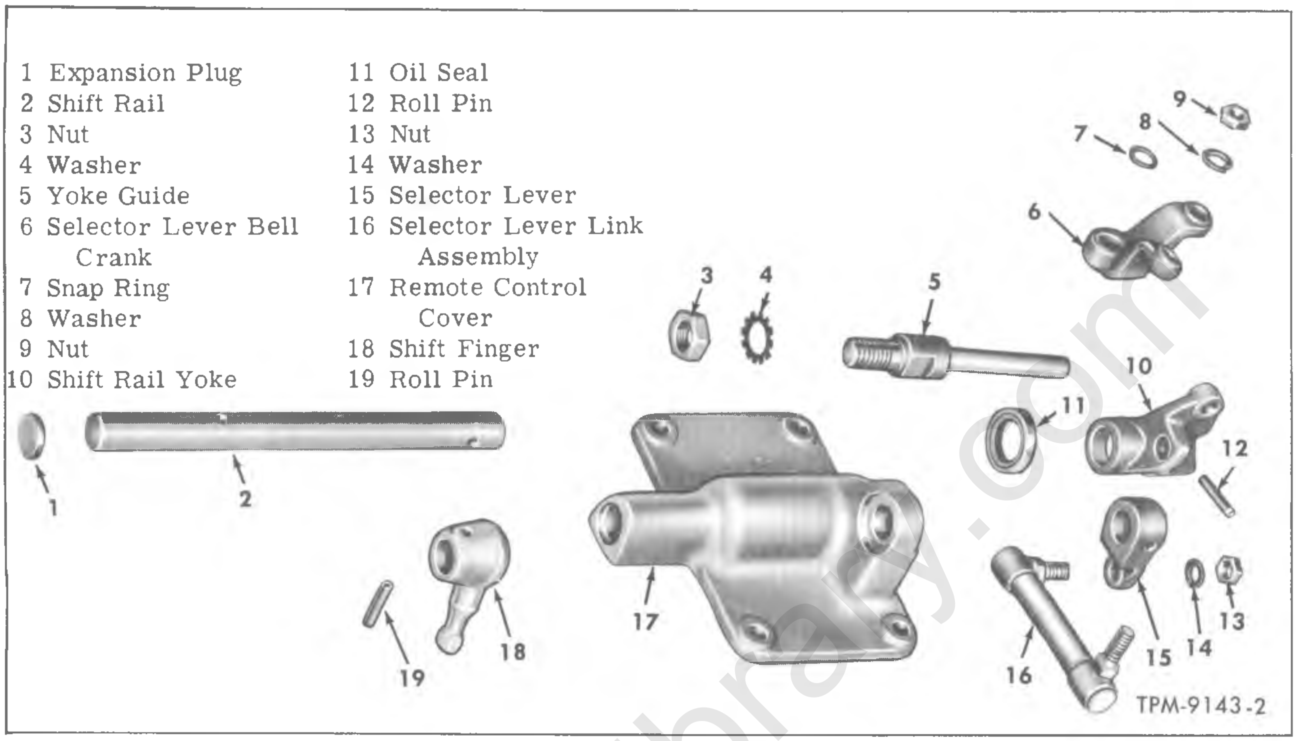


Figure 4—Remote Control Assembly (New Process 540)

Bushing Replacement

1. Press or drive shift rail yoke housing out of bore in shift rail yoke (9, fig. 3).

2. Using a suitable sleeve, press or drive new bushing into bore of shift yoke.

Oil Seal Replacement

1. Press or drive oil seal (20, fig. 3) out of remote control cover.

2. With a suitable sleeve, press or drive new oil seal into bore of cover.

NOTE: Coat outer diameter of oil seal with a light coat of sealing cement prior to installation.

Assembly

NOTE: Key numbers in text refer to figure 3.

1. Coat all moving parts with the lubricant recommended in LUBRICATION (SEC. 0).

2. Insert shift rail (2) part way into remote control cover (5), with flat on rail toward gasket face.

3. Position shift finger (21) on shift rail (2) with off-center hole to the front. Push shift rail the remaining distance into cover.

4. Install roll pin (22) to retain shift finger (21) on shift rail (2).

5. With lock nut (6) installed on shift yoke guide (7), install guide in cover (5). Tighten lock nut firmly.

6. Install snap ring (19) in groove of rail (2).

7. Install shift rail boot (8) on shift rail (2).

8. Position shift rail yoke (9) and rail selector (12), with offset toward front, on yoke guide (7) and shift rail.

9. Install roll pin (14) into holes in rail selector (12) and shift rail (2).

10. Install ball joint assembly (13) on rail selector (12), then install bellcrank (17) on ball joint assembly (13).

11. Install expansion plug (1) in shift rail opening in remote control cover (5).

NEW PROCESS 540 - REMOTE CONTROL ASSEMBLY

Disassembly

NOTE: Key numbers in text refer to figure 4.

1. Remove attaching parts retaining selector lever (15) and selector lever bell crank (6) to selector lever link assembly (16), then remove bell crank and link assembly.

2. Using a hammer and punch, remove roll pin (12) attaching selector lever (15) to shift rail (2). Remove shift rail yoke (10) and selector lever (15) from shift rail.

3. Using an Easy-Out, remove roll pin (19), attaching shift finger (18) to shift rail.

4. Remove shift rail (2) from remote control cover (17).

5. Remove yoke guide (5) from cover (17).

TRANSMISSION CONTROL LINKAGE

Cleaning and Inspection

1. Clean all metal parts thoroughly in cleaning solvent. Wipe or blow parts dry.
2. Check all parts for wear, distortion, cracks or other damage.
3. Replace all parts that would affect proper selection of transmission gears.

Bushing Replacement

1. Press or drive shift rail yoke bushing out of bore in shift rail yoke (10, fig. 4).
2. Using a suitable sleeve, press or drive new bushing into bore of shift yoke.

Oil Seal Replacement

1. Press or pry oil seal (11, fig. 4) out of remote control cover.
2. Using a suitable sleeve, press or drive new oil seal into bore of cover.

NOTE: Coat outer diameter of oil seal with a coat of sealing cement prior to installation.

Assembly

NOTE: Key numbers in text refer to figure 4.

1. Coat all moving parts with transmission lubricant recommended in LUBRICATION (SEC. 0) of this manual.
2. Insert shift rail (2) part way into remote control cover (17).
3. Position shift finger (18) on shift rail with offset to the front. Push shift rail the remaining distance into cover.
4. Install roll pin (19) to retain shift finger in proper position on shift rail.
5. Position yoke guide (5) in offset of remote control cover (17). Install washer (4) and nut (3) on shift yoke guide.
6. Position shift rail yoke (10) and selector lever (15), with offset toward front, on shift rail (2).

NOTE: Be sure shift rail yoke engages both the shift rail and yoke guide (5). With parts properly aligned install roll pin (12) through selector lever (15) and shift rail (2).

7. Install washer (14) and nut (13) retaining selector lever link assembly (16) to selector lever (15).
8. Install washer (8) and nut (9) retaining selector lever bell crank (6) to selector lever link assembly (16).
9. Install expansion plug (1), if removed in shift rail opening in remote control cover (17).

TRUCK MODELS WITH ALLISON AUTOMATIC TRANSMISSION

LINKAGE ADJUSTMENTS

Prior to making any checks or adjustments of transmission manual and throttle control linkage, check performance of the engine. The transmission is often blamed for poor operation of the vehicle when the engine is not tuned to deliver peak power. Refer to ENGINE (SEC. 6) in this manual for recommended tune-up procedures. It should be kept in mind, that to assure efficient performance of power plant, the transmission should be as carefully balanced with the engine as are fuel and ignition systems.

The transmission control linkage must be checked and properly adjusted whenever any of the following events occur:

1. At time of "New Vehicle Inspection," after final engine idle adjustments have been made.
2. After any transmission control linkage has been removed or replaced.
3. After transmission has been removed and reinstalled in vehicle.
4. When the transmission is not performing properly.

WARNING

DO NOT START ENGINE WITH SHIFT LINKAGE DISCONNECTED, AS SERIOUS INJURY COULD RESULT TO VEHICLE OR PERSONNEL.

ACCELERATOR AND TV LINKAGE ADJUSTMENTS

The throttle linkage to transmission must be properly adjusted so that engine and transmission, as a matched pair, can give maximum performance. If transmission throttle linkage is incorrectly adjusted, the engine may not operate at full governed rpm, or the transmission upshift and downshift points may be incorrect.

Throttle linkage to the transmission should be adjusted so that transmission upshift occurs at approximately 50 rpm below engine governed speed during full throttle operation.

A detent position is incorporated in throttle linkage to provide additional control of transmission shifts. If the shift points are not correct at the "TO-DETENT" position (full throttle), the linkage requires adjustment. If the "TO-DETENT" shift points are correct, but the

TRANSMISSION CONTROL LINKAGE

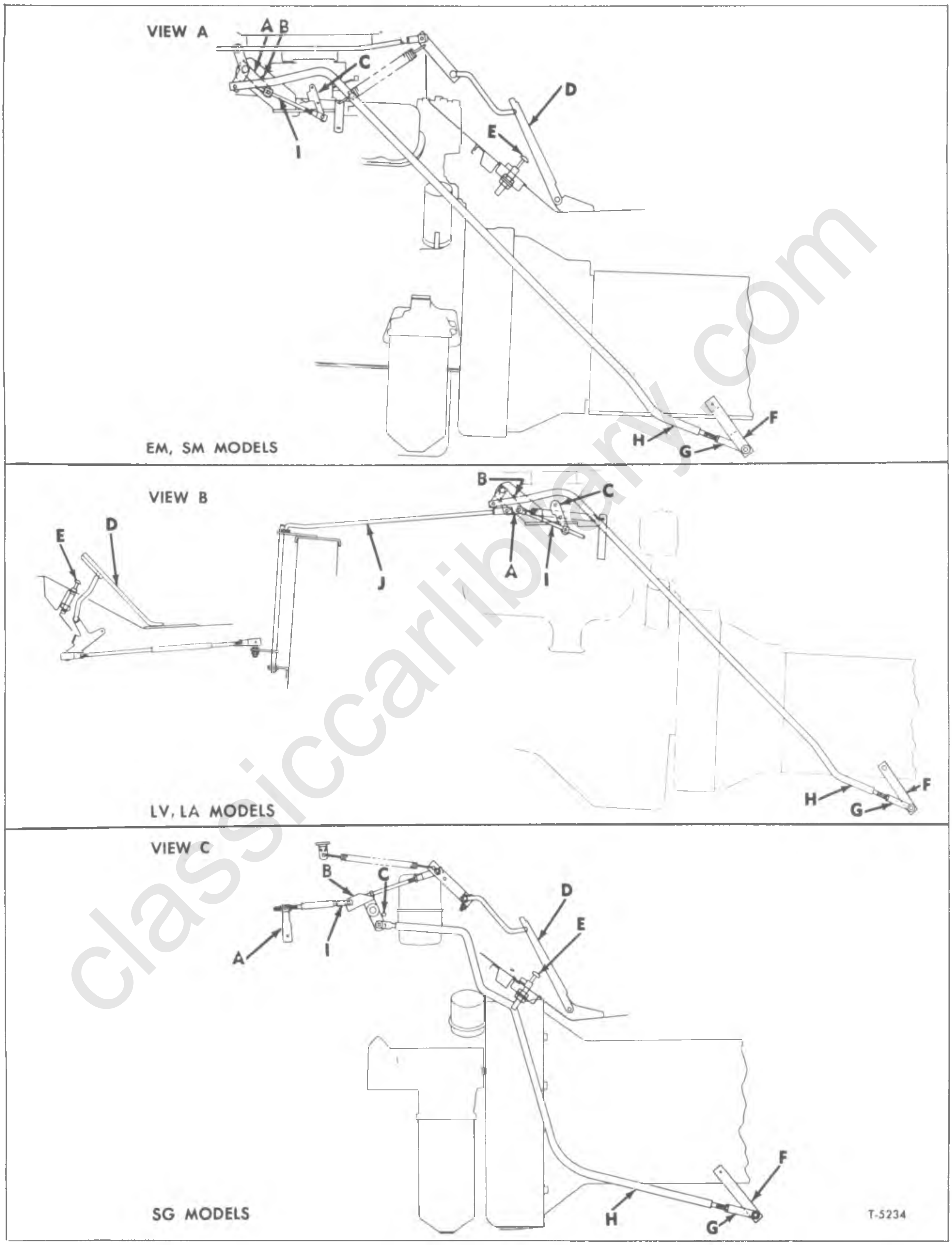


Figure 5—Accelerator and TV Linkage

"THROUGH-DETENT" shift points are not correct, the TV mechanism in the transmission may be sticking. The "THROUGH-DETENT" position should not allow transmission to upshift and should allow downshifts at highest rpm possible.

> CAUTION: The transmission should not be operated if throttle linkage is not adjusted correctly because insufficient TV pressure could cause reduction of main pressure, which in turn, might result in clutch slippage and transmission failure.

Accelerator And TV Linkage Adjustment Procedure - Gas Engine Models (Refer to Views A and B, Fig. 5)

1. Apply parking brake firmly. Adjust engine idle speed to specified rpm in drive (3-6 range), then stop engine.

2. Disconnect clevis (G) from TV lever (F). Position lever (A) 0.060 inch from stop (B).

3. With carburetor throttle lever (C) at idle position and lever (A) 0.060 inch from stop (B), adjust the swivels on rod (I) to provide free-entry into levers (A) and (C).

4. With carburetor throttle lever (C) at idle position, and TV lever (F) against rear stop (rotated away from engine), adjust clevis (G) on rod (H) for free-entry into lever (F). Then turn clevis (G), to shorten rod, two full turns. Install clevis pin, tighten jam nut and secure clevis (G) to TV lever (F) with cotter pin.

NOTE: On tilt cab models, with carburetor throttle lever (C) in idle position, rod (J) should clear radiator support by 1/8-inch. Lengthen rod (J), as necessary.

IMPORTANT: Adjustment of the detent button (E) is accomplished by loosening jam nut located at cab floor, rotating detent button to proper height and then retighten jam nut (see fig. 5). With the accelerator pedal depressed to the thru-detent position (detent button (E) - compressed) ample clearance must exist between the pedal and floor, to assure complete movement of the TV linkage to the thru-detent position.

5. With the accelerator pedal (D) just touching detent button (E), the carburetor throttle lever should be in full throttle position. If adjustment is required shorten or lengthen rods between accelerator pedal and carburetor throttle lever and, if necessary, reposition detent button (E) to obtain above conditions.

6. Using a tachometer to accurately check engine rpm, road test or dynamometer test vehicle to check for full throttle, full load upshift (5th to 6th). Upshift should occur at approximately 50 rpm below the engine governed speed. If upshifts do not occur at specified rpm, adjust as follows:

a. To raise shift point, shorten rod (H), by turning clevis (G) one turn at a time until the desired shift point is obtained. Tighten jam nut securely against clevis.

b. To lower shift point, lengthen rod (H) by turning clevis (G) off rod one turn at a time until the desired shift point is obtained. Tighten jam nut against clevis.

Accelerator And TV Linkage Adjustment Procedure - Toro-Flow Equipped Models (Refer to View C, Fig. 5)

1. Start engine and adjust idle speed to specified rpm, then stop engine.

2. Disconnect clevis (G) from TV lever (F). Position lever (B) 0.060 inch from stop (C).

3. With injection pump control lever (A) at idle position and lever (B) 0.060 inch from stop (C), adjust the swivels on rod (I) to provide free-entry into levers (A) and (B).

4. With injection pump control lever (A) at idle position, and TV lever (F) against rear stop (rotated away from engine), adjust clevis (G) on rod (H) for free-entry into lever (F). Then turn clevis (G), to shorten rod, two full turns. Install clevis pin, tighten jam nut and secure clevis (G) to TV lever (F) with cotter pin.

IMPORTANT: Adjustment of the detent button (E) is accomplished by loosening jam nut located at cab floor, rotating detent button to proper height and then retighten jam nut (see fig. 5). With the accelerator pedal depressed to the thru-detent position (detent button (E) - compressed) ample clearance must exist between the pedal and floor, to assure complete movement of the TV linkage to the thru-detent position.

5. With the accelerator pedal (D) just touching detent button (E), the injection pump control lever should be in full throttle position. If adjustment is required shorten or lengthen rods between accelerator pedal and injection pump throttle lever and, if necessary, reposition detent button (E) to obtain above conditions.

6. Using a tachometer to accurately check engine rpm, road test or dynamometer test vehicle to check for full throttle, full load upshift (5th to 6th). Upshift should occur at approximately 50 rpm below the engine governed speed. If upshifts do not occur, adjust as follows:

a. To raise shift point, shorten rod (H), by turning clevis (G) one turn at a time until the desired shift point is obtained. Tighten jam nut.

b. To lower shift point, lengthen rod (H) by turning clevis (G) off rod one turn at a time until desired shift point is obtained. Tighten jam nut.

TRANSMISSION CONTROL LINKAGE

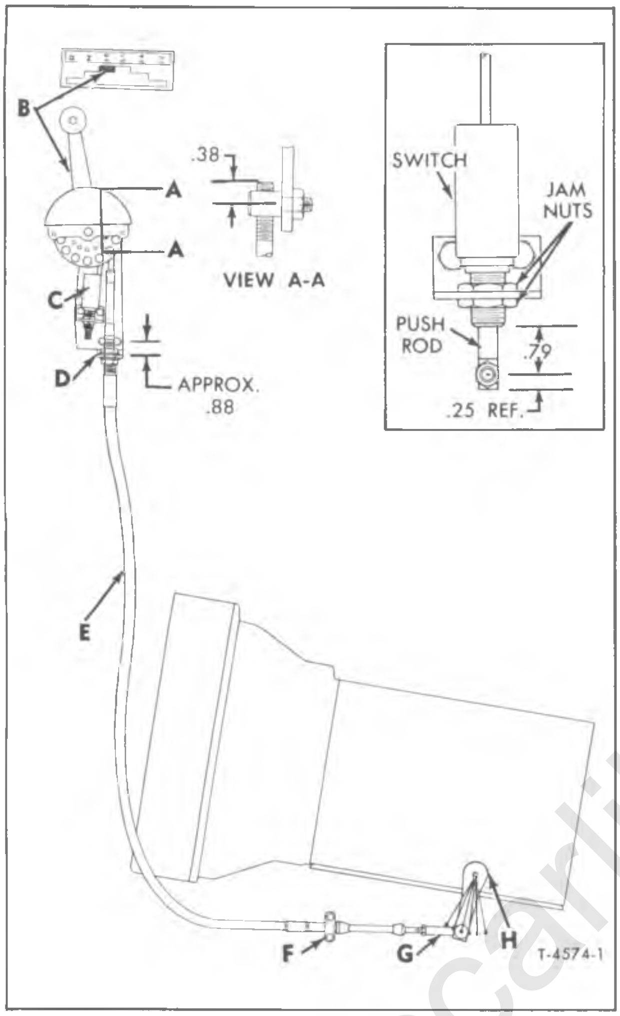


Figure 6—Manual Shift Linkage (Typical All Models)

MANUAL SELECTOR LINKAGE
ADJUSTMENT (Refer to Fig. 6)

The transmission shift control linkage should fully engage all transmission range positions, "R, N, 3-6, 3-5, 3-4, and 1-2," just before the lever hits the "stops" incorporated in the shift control cover. Shift selector lever through each position while feeling for full engagement in transmission. Note the position of selector lever after each shift. Transmission should not engage "3-6" or "R" (Reverse) until selector lever is completely out of the neutral notch. If the lever is not properly located or operating, adjust linkage as follows:

1. Locate transmission selector lever (B) against stop in "3-6" position.
2. Check cable for dimension shown in View A-A, and adjust if necessary. Anchor cable to bracket at point (D).

NOTE: Threaded portion of shift cable extends 0.88 inch above top-side of bracket, as shown at point (D).

3. Disconnect clevis (G) from manual shift lever (H). Anchor cable (E) securely at point (F).
4. Locate manual shift lever (H) in "3-6" position (3rd notch from the rear). Adjust clevis (G) for free-entry of clevis pin through clevis and manual shift lever (H). Then lengthen clevis (G) by 1-1/2 turns, install clevis pin, tighten jam nut, and secure with cotter pin.
5. After completing all adjustments, operate vehicle and check operation of selector lever through all shift ranges. Readjust if necessary.

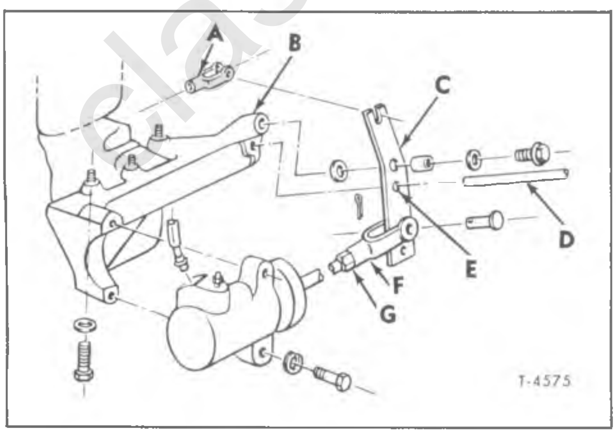


Figure 7—Retarder Slave Cylinder (Tilt Cab Models)

NEUTRAL SAFETY AND BACK-UP LIGHT
SWITCH ADJUSTMENT (Refer to Inset, Fig. 6)

NOTE: "Manual Selector Linkage Adjustment" should be performed as described previously, prior to adjustment of the neutral safety switch.

1. Block wheels, apply parking brake, and perform the following to prevent the vehicle from accidentally starting while performing adjustment:

a. <u>Gas Engine Models</u> - Pull secondary wire out of center socket in distributor cap and ground wire to prevent possible damage to coil.

b. <u>Diesel Engine Models</u> - Place fuel shut-off lever in "SHUT-OFF" position.

2. Move lever (B) to "N" (Neutral) position, then referring to Inset, fig. 6, loosen jam nuts and adjust length of push rod to dimension shown.
3. With switch push rod properly adjusted, tighten jam nuts securely.
4. Check each range position of shift linkage to make sure the starter does not operate with the selector lever in any position other than "N." Have assistant check for proper operation of back-up lights with selector lever in "R." If necessary, readjust switch.
5. Reconnect secondary wire to distributor cap, on gas engine models.

RETARDER ADJUSTMENT

The transmission retarder (when used) on vehicles covered by this manual is actuated by either hydraulic or mechanical type controls. Adjustment for each system is described as follows:

Hydraulic Controls - Tilt Cab Models
(Refer to Fig. 7)

NOTE: Adjustment of hydraulic controls, with the exception of the slave cylinder is the same as hydraulic adjustment as covered in "CLUTCH CONTROLS" (SEC. 7D) in this manual. Be sure to adjust the master cylinder push rod prior to adjustment of the slave cylinder.

Adjust slave cylinder as follows:

1. Disconnect slave cylinder return spring from lever (C).
2. Disconnect clevis (F) from lever (C).
3. Insert 1/4-inch diameter pin (D) through hole (C) and into alignment hole in cylinder bracket (B).
4. Loosen nut (G) and adjust clevis (F) for free-entry of clevis pin into lever (C). Tighten nut (G) and retain clevis pin in place with cotter pin.
5. Connect slave cylinder return spring to lever (C).
6. Remove 1/4-inch diameter pin from lever (C).

Mechanical Controls - "E" and "S" Models (Refer to Fig. 8)

NOTE: On some models the adjustment swivel on the push rod is located at the idler lever, instead of the retarder lever, as shown. When the adjustment swivel is located idler lever the following procedure is simply revised by replacing retarder lever with idler lever.

1. Loosen nuts "A" and "B".
2. Remove clip retaining swivel to retarder lever, then remove swivel from retarder lever.
3. With retarder pedal against stop bumper (in cab), adjust swivel on push rod for free-entry into retarder lever.
4. Tighten nuts "A" and "B" to retain swivel in position. Install clip to retain swivel to retarder lever.

NOTE: Referring to Inset, figure 5, the retarder valve is shown in the "OFF" position. Full travel of valve from "OFF" to "ON" position is 1/2-inch.

5. Have an assistant depress retarder pedal (in cab), while checking for proper movement of retarder valve. Use a scale to be sure movement of valve from "OFF" to "ON" position is 1/2-inch.
6. Have assistant release retarder pedal. The retarder valve must return to the "OFF" position (retarder valve fully closed) when the pedal is released. The pedal must return positively and immediately to released position (pedal against bumper stop) when foot pressure is released.
7. Readjust linkage, if necessary.

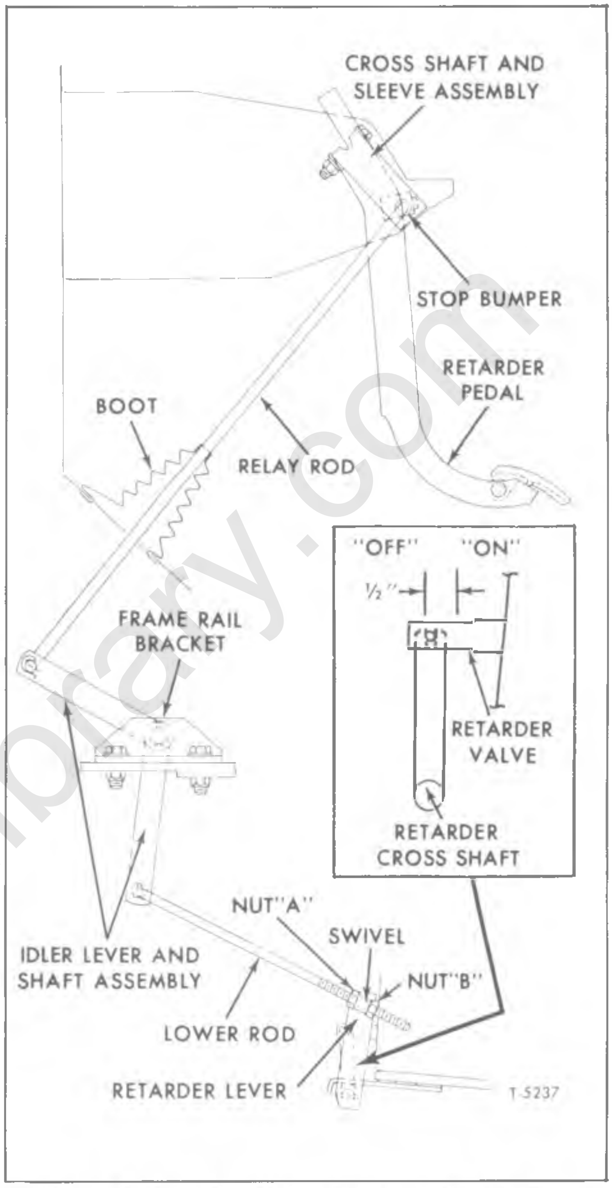


Figure 8—Retarder—Mechanical Controls (Typical)

TRANSMISSION CONTROL LINKAGE

NOTE: On all vehicles equipped with Allison Automatic Transmissions, it is recommended that the transmission be filled with DEXRON automatic transmission fluid.

SECTION 7B

Transmission On-Vehicle Service Operations

NOTE: Allison transmission overhaul information is contained in separate publication Form Number SA 1126E.

MANUAL TRANSMISSION SERVICING

MANUAL TRANSMISSION TROUBLE DIAGNOSIS

The following trouble diagnosis information will assist in locating transmission troubles, but in addition will serve as a guide to find the "cause" to prevent reoccurence.

Whenever possible, road test the vehicle prior to overhaul. Mechanics usually get second or third hand reports of trouble experienced with the unit and these reports do not always accurately describe the actual conditions. Sometimes symptoms seem to indicate trouble in the transmission; while actually the trouble may be caused by the axle, propeller shaft, universal joint, engine or clutch. Therefore, before removing transmission or related components to locate trouble, always road test to check possibility that trouble may exist in other closely associated units. If the mechanic can drive, road testing will be more effective; however, just riding with the driver can be very informative.

Many times the answer to the trouble is apparent when the unit is inspected prior to disassembly, but this evidence is often lost when the parts are separated. If possible, check the unit prior to disassembly. Bear in mind that a careful inspection of the unit should be made as each disassembly step is performed.

It is poor practice to disassemble a unit or complete transmission as quickly as possible without bothering to examine the parts as they come down. It happens many times that a mechanic has completely disassembled a unit and failed to find the cause of the trouble because he did not bother to examine the parts as they came apart. After the transmission is disassembled, check the lubricant for foreign particles which often reveal sources of trouble that are overlooked during the disassembly.

NOISY OPERATION

Noise is usually very elusive and generally not the fault of the transmission; therefore, mechanics should road test to determine if the driver's complaint of noise is actually in the transmission.

<u>Noise Arising Outside Transmission</u>

In numerous instances, drivers have insisted that the noise was in the transmission, however, investigations revealed the noise to be caused by one of the following conditions:

1. Fan out-of-balance or blades were bent.
2. Defective vibration damper.
3. Crankshaft out-of-balance.
4. Flywheel out-of-balance.
5. Flywheel mounting bolts loose.
6. Engine rough at idle producing rattle in gear train.
7. Clutch assembly out-of-balance.
8. Engine mounts loose or broken.
9. Power take-off engaged.
10. Universal joints worn out.
11. Propeller shafts out-of-balance.
12. Universal joint angles out of plane or at excessive angle.
13. Center bearings in drive line dry - not mounted properly, etc.
14. Wheels out-of-balance.
15. Tires treads humming or vibrating at certain speeds.
16. Air leaks on suction side of induction system - especially with turbo-chargers (if used).

<u>Noise Arising In Transmission</u>

Mechanics should try to locate and eliminate noise by means other than transmission removal, or overhaul. However, if the noise appears to be in the transmission try to break it down into the following classifications. If possible, determine what position the gearshift lever is in when the noise occurs. If the noise is evident in only one gear position, the cause of the noise is generally traceable to the gears in operation.

TRANSMISSION ON-VEHICLE SERVICE

1. Growl and Humming, or more serious, a grinding noise. These noises are caused by worn, chipped, rough, or cracked gears. As gears continue to wear, the grinding noise will be noticeable, particularly in the gear position that throws the greatest load on the worn gear.

2. Hissing, or more serious, a thumping or bumping-type noise. Hissing noises could be caused by bad bearings. As bearings wear and retainers start to break up, etc., the noise could change to a thumping or bumping.

3. Metallic Rattles within the transmission usually result from a variety of conditions. Engine torsional vibrations are transmitted to the transmission through the clutch. A characteristic of the two-plate clutch is a rattling noise, due to oscillation of the intermediate plate drive lugs within the flywheel openings when the clutch is released. In general, engine speeds could be 600 rpm or above, to eliminate objectionable rattles and vibration during the idle. A defective or faulty injector would cause a rough or lower idle speed and a rattle in the transmission. Rattle could also be caused by excessive backlash in power take-off unit mounting.

4. Improper Lubricants, or lack of lubricant can produce noises. Transmissions with low oil levels sometimes run hotter than normal, as there is insufficient lubricant to cool and cover the gears.

5. Squealing, particularly when the transmission is operating at higher speeds, could be caused by one of the free-running gears seizing on the thrust face or fluted diameter temporarily and then letting go. In general, a mild seizure will clear itself up and the transmission will continue to operate very satisfactorily without this defect being known. Refer to Step 7 following:

6. Gear Seizure at high speed, usually accompanied with loud squealing noise. This type of seizure is readily apparent to the driver since the truck will suddenly slow down as if the brakes were being applied. If the truck continues to move ahead, even though the gearshift lever is placed in neutral, it would indicate the floating gear on the mainshaft had seized. Depressing the clutch should interrupt the driving torque. The seized gear could be checked quite readily by depressing clutch and checking the action with the gearshift lever progressively in all shift positions. If releasing the clutch tends to kill the engine, then this gear position has not seized. In other words, the transmission would be in two gears at the same time. By a process of elimination, the gear at fault can be readily identified. Refer to Step 7 following:

7. Vibration: Gear seizures on thrust faces or fluted diameters are usually caused by vibrations in the power train; this could be engine, propeller shafts, joint angle, rear axle, differentials, etc.

a. Improved highways permit sustained high speeds. The fact that engines and entire power trains can now cruise at a high rpm can introduce vibration frequencies, that were not critical in the past. At slower speeds these items would get by or only pass through critical periods while accelerating or decelerating through the gears.

b. In the past, drive line vibrations such as bent tubes, joints out of phase or alignment, bad angles due to short couples, clutches out of balance, gears and shafts in transmission out of balance, were fairly obvious. These items will become more critical in vehicles running at sustained high speeds.

c. Critical vibrations associated with higher speeds are not the old thumping or bumping type, but are high frequency vibrations. This type of vibration will cause gear seizures, damaged synchronizers, bearing failure due to retainer bolt failures, promote brinelling, fretting corrosion, etc.

8. Gear Whine is usually caused by lack of backlash between mating gears or improper shimming of power take-off units.

Noise In Neutral

1. Misalignment of transmission.
2. Worn or scored main drive gear and/or countershaft bearings.
3. Scuffed gear tooth contact surfaces on gears.
4. Unmatched constant mesh gears.
5. Worn, rough reverse idler gear.
6. Eccentric countershaft gear assembly.
7. Sprung or worn countershaft.
8. Excessive backlash in constant mesh gear.
9. Excessive end play in countershaft, or reverse idler pinion.
10. Worn mainshaft pilot bearing.
11. Scuffed gear tooth contact surface insufficient lubrication.
12. Incorrect grade of lubricant.
13. Incorrect clutch linkage adjustment.

Noise In Gear

1. Worn, or rough mainshaft rear bearing.
2. Rough, chipped or tapered sliding gear teeth.
3. Noisy speedometer gears.
4. Excessive end play of mainshaft gears.
5. Refer to conditions listed under "Noise in Neutral."

WALKING OR SLIPPING OUT OF GEAR

1. If the units are walking out of gear it could be caused by:

a. Interference or resistance in the shift mechanism preventing full engagement of the sliding clutch gear, or -

b. If the gear has been shifted completely into position some other malfunction which could move the gear out of its proper location.

2. A number of items which would prevent full engagement of gears are:

a. Shift fork pads or groove in sliding gear or collar worn excessively.

b. Worn taper on gear clutch teeth.

c. Transmission and engine out of alignment either vertically or horizontally.

3. A few items which could move the gear or shaft out of proper position, particularly on rough roads are:

a. Use of heavy shift lever extensions.

b. Shift rod poppet springs broken.

c. Shift rod poppet notches worn.

NOTE: When gearshift lever can be held in to prevent jump-out, detent modifications will often correct it. When a gear has been allowed to jump out for a long period generally the cause must be corrected plus replacement of the affected gears.

d. Shift rod bent or sprung out of line.

e. Shift fork pads not square with shift rod bore.

f. Excessive end-play in drive gear, mainshaft or countershaft, caused by worn bearings, retainers, etc.

g. Thrust washers or faces worn excessively, missing, etc.

HARD SHIFTING

1. Sliding gear tight on shaft splines.
2. Insufficient chamfer of sliding gear teeth.
3. Burred mainshaft or sliding gear splines.
4. Misaligned mainshaft.
5. Damaged synchronizing unit.
6. Improper adjustment of shifting linkage or excessively worn.
7. Worn shift rods.
8. Worn, sprung shifter fork.
9. Wrong lubricant especially if extreme pressure type lubricants are added.
10. Free-running gears, seized or galled on either the thrust face or diameters.

STICKING IN GEAR

1. Insufficient chamfer on detent ball notches.
2. Chips wedged between or under splines of shaft and gear.
3. Misaligned mainshaft and/or countershaft.

CRASH SHIFTING OR RAKING OF GEARS

Raking of gears during the manual shift is usually caused by a defective synchronizer or improper shifting technique for synchronized transmission.

When the shift lever moves directly into the manual shift position without resistance, the raking of teeth will be audible and felt through the gearshift lever. This condition does not always mean the synchronizer is worn out. The following may cause this condition:

1. Quite often, small chips may lodge in the synchronizer temporarily, which prevents proper synchronization and causes raking shifts. Continued operation of the transmission may either embed the chip below the surface of the bronze or reject it and the synchronizer will return to normal functioning.

2. Use of improper oils often causes raking of synchronizer. Heavy oil prevents the synchronizer from breaking through the oil film and doing the job properly. The above condition usually occurs with cold, heavy oil, but the synchronizer begins to work properly when the transmission oil reaches normal operating temperature.

The use of extreme pressure type lubricants is not recommended. Glazing of the synchronizer cone due to breakdown of oil is especially common with extreme pressure additives found in multi-purpose or rear axle type lubricants.

Broken synchronizer components sometimes jam under poppet preventing proper movement of synchronizer cone, resulting in crash shifts.

Worn synchronizer components with the loss of clutching action are usually caused by poor driver technique, or failure to control engine speed drop-off during upshift, or failure to bring engine speed nearly up to governor speed when downshifting, causes overwork of synchronizer and failure to shift. Also, drivers who try to shift without using the clutch will burn or wear out manual synchronizers at relatively low mileage.

OIL LEAKS

1. Oil level too high.
2. Wrong lubricant in unit.
3. Non-shielded bearing used at front or rear bearing cap. (Where applicable.)
4. Seals (if used) defective or omitted from bearing cap, wrong type seal used, etc.
5. Transmission breather omitted, plugged internally, etc.
6. Cap screws loose, omitted or missing from remote control, shifter housing, bearing caps, power take-off, or covers, etc.
7. Welch "seal" plugs loose or missing entirely from machine openings in case.
8. Oil drain-back openings in bearing caps or case plugged with varnish, dirt, covered with gasket material, etc.
9. Broken gaskets, gaskets shifted or

TRANSMISSION ON-VEHICLE SERVICE

squeezed out of position, pieces still under bearing caps, clutch housing, power take-off, and covers, etc.

10. Cracks or holes in castings.
11. Drain plug loose.

BEARING FAILURES

More than 90% of all bearing failures are caused by dirt which is always abrasive.

Dirt may enter the bearings during assembly of the units or be carried into the bearing by the lubricant while in service. Dirt may enter through seals, breather or even dirty containers used for addition or change of lubricant.

Softer material such as dirt, dust, etc., usually form abrasive paste or lapping compounds within the bearings themselves since the unit pressure between the balls and raceways makes a perfect pulverizer. The rolling motion tends to entrap and hold the abrasives. As the balls and raceways wear, the bearings become noisy. The lapping action tends to increase rapidly as the fine steel from the balls and rollway adds to the lapping material.

Hard coarse material such as chips, etc., may enter the bearings during assembly from hammers, drifts, power chisels, etc., or be manufactured within the unit during service from raking teeth, etc. These chips produce small indentation in balls and races. Jamming of these hard particles between balls and races may cause the inner race to turn on shaft, or the outer race to turn in the housing.

Corrosion

Water, acid, and corrosive materials formed by deterioration of lubricant will produce reddish-brown coating and small etched holes over outer and exposed surfaces of race. Corrosive oxides also act as lapping agent.

Fatigue

All bearings are subject to fatigue and must be replaced eventually. Your own operating experience will dictate mileage replacement of bearings showing only normal wear.

Shaft Fits

Excessive looseness under load is very objectionable because it produces a creeping or slipping of the inner ring on the rotating shaft. This causes the surface metal of shaft to scrub or wear off.

Bearing fits on rotating shafts are usually specified as tight. When play or looseness, even .001", exists between the bearing and shaft, there is a very powerful force tending to rotate the inner race on the shaft; this force is caused by the looseness or lost motion between the parts and disappears when no looseness exists.

BEARING REPLACEMENT

It is far more difficult to remove bearings from a shaft than to put them on. In most cases it is necessary to remove the bearing by pulling on the outer race which can damage the balls or races. Since such damage is seldom visible, it does not become known until after complete reassembly. If a bearing is not going to be replaced, avoid removal during low mileage rebuild.

Brinelling caused by improper assembly or removal -- usually hammering with off-center blows. Use drivers, preferably under an arbor, or pullers.

TRANSMISSION REPLACEMENT

The procedures required to remove the transmission from trucks covered in this manual are dependent generally upon the type of cabs (i.e., conventional or tilt), type of body, and lifting equipment available in the repair shop. Operations other than those included in this section may be necessary if the vehicle has special equipment such as a power take-off unit and controls, etc.

The required operations will be obvious upon visual inspection of the vehicle. The instructions contained herein under "Removal" and "Installation" will serve as a guide in accomplishing transmission replacement.

REMOVAL

1. On tilt cab models, disconnect shift control rods from shift levers on the transmission remote control assembly.
2. On conventional cab and school bus models perform the following: Remove the floor mat, remove the transmission floor pan cover, place the transmission gearshift lever in "NEUTRAL," and then remove the gearshift lever.

NOTE: Remove the gearshift lever using tool (J-8109) as shown in figure 1. Press down and rotate counterclockwise to release gearshift lever.

3. Place clean lint-free cloth or other suitable covering over opening at top of transmission to prevent entry of dirt or other foreign material.
4. Drain lubricant from transmission.
5. Disconnect speedometer cable from transmission adapter.
6. Disconnect clutch control linkage.
7. Disconnect parking brake lever and controls (if used).
8. Disconnect propeller shaft from transmission as described in "PROPELLER SHAFTS" (SEC. 4D) of this manual.
9. Remove engine ground strap and battery cable support clip if attached to transmission or clutch housing.

10. If vehicle is equipped with power take-off remove unit and controls from transmission. Place protective covering over opening.

11. Position a suitable dolly or jack under the vehicle and adjust to carry the weight of the transmission.

12. Visually inspect to determine if other equipment, lines or brackets must be removed to permit removal of the transmission.

13. Remove flywheel housing pan and transmission-to-flywheel housing mounting bolts.

IMPORTANT: Be sure to support the clutch release bearing and support assembly during removal of the transmission from the flywheel housing. This will prevent the bearing and support assembly from falling out of the flywheel housing when the transmission is removed.

14. Move the transmission assembly straight away from the engine, using care to keep the transmission main drive gear shaft in alignment with the clutch disc hub.

IMPORTANT: When removing the transmission, do not allow the weight of the transmission to hang on the clutch disc hub, as the disc will become distorted, seriously affecting clutch operation.

15. When the transmission is free from the engine, lower the transmission and move from under the vehicle.

16. If desired, a careful check of clutch components should be made after the transmission has been removed. If the clutch requires repair, refer to "CLUTCHES" (SEC. 7E) in this manual before transmission is reinstalled in the vehicle.

INSTALLATION

1. Apply a light coating of high temperature grease, symbol S-27, to the main drive gear bearing retainer and splined portion of transmission main drive gear shaft to assure free movement of clutch and transmission components during assembly. Refer to LUBRICATION (SEC. 0) of this manual for explanation of High Temperature Grease, symbol S-27.

2. Shift the transmission into high gear.

3. Mount transmission on dolly or jack and move into position under the vehicle.

4. Position the clutch release bearing and support assembly inside the flywheel housing. Be sure the clutch release fork properly engages the clutch release bearing.

5. Align the transmission main drive gear shaft with the clutch disc hub by rotating the transmission companion flange. Move the transmission forward, guiding the main drive gear shaft into the clutch disc splines.

IMPORTANT: Avoid springing the clutch when the transmission is being installed to the engine. Do not force the transmission into clutch disc splines. Do not let transmission drop or hang unsupported in the splined hub of the clutch disc.

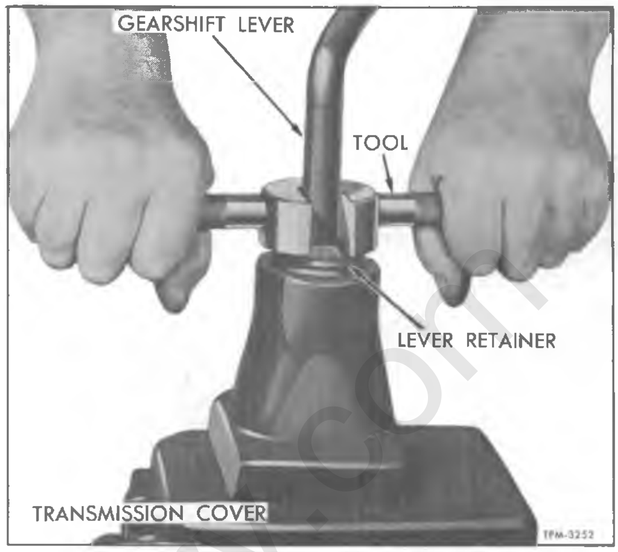


Figure 1—Replacing Gearshift Lever

6. Install transmission-to-flywheel housing mounting bolts and washers.

NOTE: Tighten bolts to 60-65 foot-pounds on New Process transmissions and 60-90 foot-pounds on Corporation SM465 transmissions.

7. If vehicle is equipped with power take-off reinstall unit and controls on transmission.

8. Install engine ground strap and battery cable support clip, if attached to transmission or clutch housing.

9. Connect propeller shaft to transmission as described in "PROPELLER SHAFTS" (SEC. 4D) of this manual.

10. Connect parking brake lever and controls (if used). Adjust brake as outlined in "PARKING BRAKE" (SEC. 5C) of this manual.

11. Reconnect clutch control linkage. Install flywheel housing pan. Tighten capscrews firmly.

12. Reconnect speedometer cable to adapter at transmission.

13. If other equipment (exhaust pipe, support brackets, etc.) was removed, reinstall these parts.

14. On conventional cab or school bus models, shift the transmission into "NEUTRAL." Install gearshift lever using tool (J-8109) as shown in figure 1. Press down firmly and rotate clockwise to install gearshift lever.

15. On tilt cab models, reconnect shift control rods to the shift levers on the transmission remote control assembly.

16. Refill transmission with lubricant recommended in "LUBRICATION" (SEC. 0) of this manual.

TRANSMISSION ON-VEHICLE SERVICE

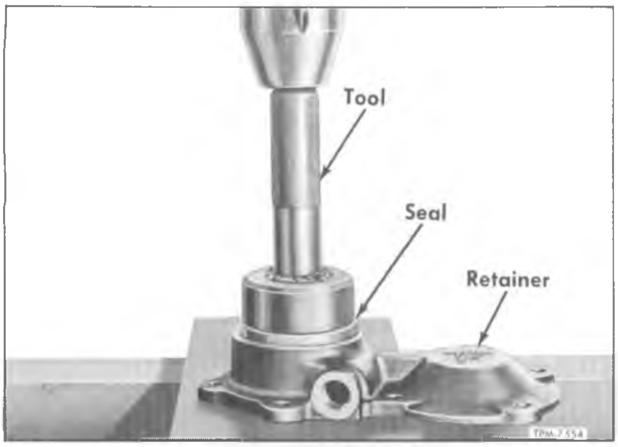


Figure 2—Replacing Rear Oil Seal (Typical)

17. If necessary, adjust clutch or transmission control linkage to achieve proper transmission opération.

REAR OIL SEAL REPLACEMENT

The oil seal used at the rear of Corporation or New Process transmissions can be replaced without removing the transmission from the vehicle. Replace rear oil seal as follows:

REMOVAL

1. Drain lubricant from transmission.
2. Disconnect propeller shaft from transmission as described in "PROPELLER SHAFTS" (SEC. 4D) of this manual.
3. Remove parking brake from rear of transmission as described in "PARKING BRAKE" (SEC. 5C), when used.
4. Disconnect speedometer cable and remove speedometer driven gear from mainshaft rear bearing cap.
5. Using flange or yoke holding tool remove the output yoke or companion flange nut. Pull output yoke or companion flange off the mainshaft.
6. Remove mainshaft rear bearing retainer and gasket. Discard gasket.
7. Using tool (J-3154-04), drive oil seal from rear bearing retainer. Discard oil seal.

INSTALLATION

1. Coat outer diameter of new oil seal with sealing cement. Install oil seal in rear bearing retainer using tool (J-3154-04). Drive seal flush with outside of rear bearing retainer, being careful not to damage seal (see fig. 2).
2. Clean all gasket surfaces, then install the rear bearing retainer and oil seal assembly with a new gasket to the transmission. Tighten capscrews firmly.
3. Install output yoke or companion flange on mainshaft. Using a flange or yoke holding tool, install retaining nut. Torque the retaining nut as follows:

Transmission	Retaining Nut-Torque
SM465	90-120 Ft.-Lbs.
NP435	125-150 Ft.-Lbs.
NP540	125-150 Ft.-Lbs.

SECTION 7D

Clutch Controls

All conventional cab and cowl models, and also PS4500 are equipped with mechanical clutch control linkage. Tilt cab models are equipped with hydraulically actuated clutch controls. For servicing of either mechanical or hydraulic actuated clutch controls refer to appropriate procedures following:

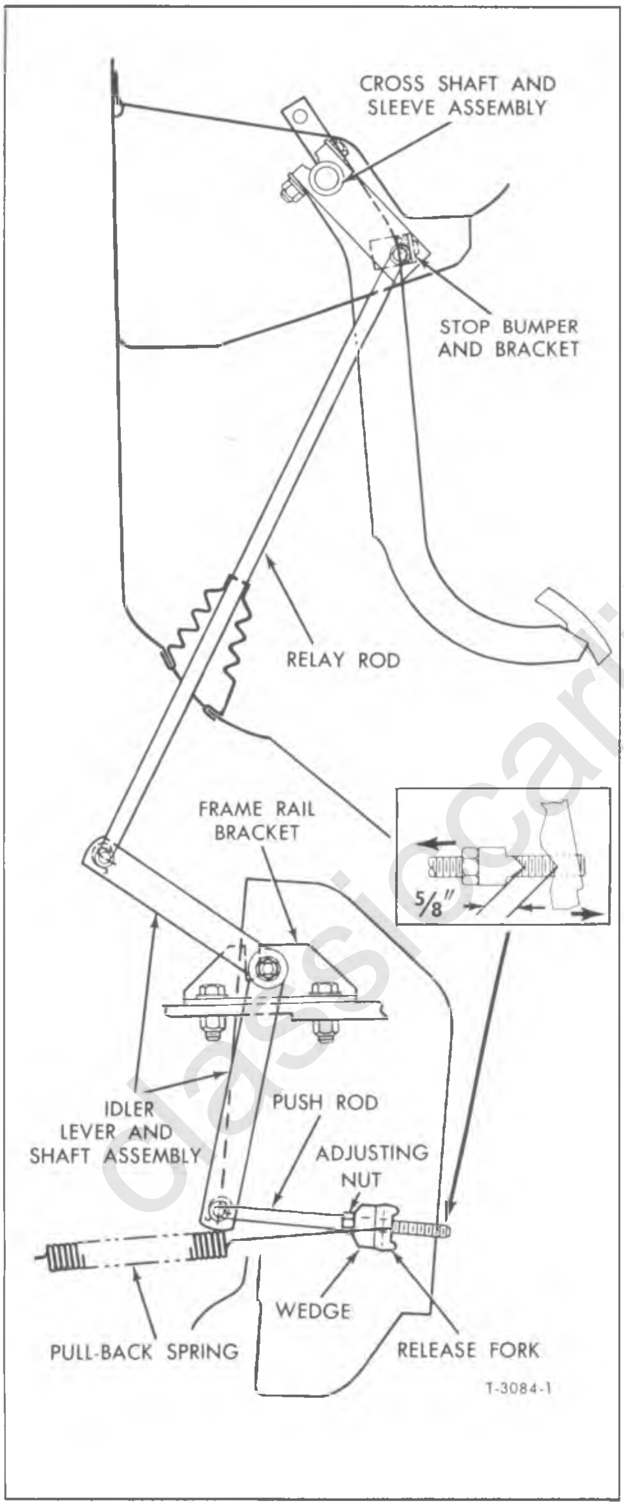


Figure 1—Mechanical Clutch Linkage (with V6 Engine)

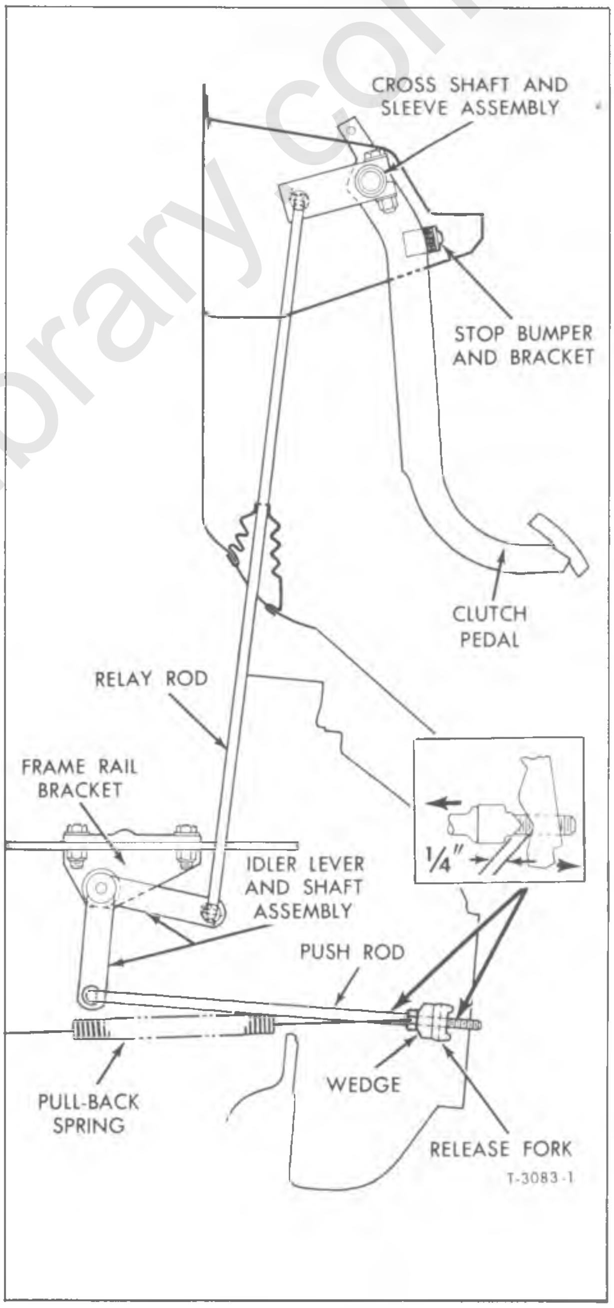


Figure 2—Mechanical Clutch Linkage (with In-Line Engine—Except PS4500)

MECHANICAL LINKAGE CONTROLS

MECHANICAL LINKAGE ADJUSTMENTS

All Models Except PS4500
(Refer to Figs. 1 and 2)

1. Disconnect the release fork pull-back spring.

2. Move the release fork to a position where the release bearing can be felt to just barely contact the clutch release fingers.

3. Adjust clearance between wedge and release fork as described below:

a. On all vehicles with V-6 engines, adjust the length of push rod at adjusting nut to give a clearance of 5/8-inch between wedge and release fork.

b. On vehicles with In-line engines, adjust the length of push rod at adjusting nut to give a clearance of 1/4-inch between wedge and release fork.

4. Connect pull-back spring to the release fork, then check operation of clutch linkage.

PS4500 Linkage Adjustment

NOTE: Key letters in text refer to figure 4.

1. Disconnect return spring and loosen nuts (A) and (B).

2. Apply approximately 5 pounds force to the push rod in direction of arrow (E) to eliminate clearance between release bearing and internal release levers.

3. Move idler lever (D) in direction of arrow (G) until pedal makes contact with stop.

IDLER LEVER AND SHAFT ASSEMBLY REPLACEMENT

REMOVAL (Refer to Figs. 1, 2, and 5)

1. Disconnect pull-back spring.

2. Disconnect relay rod and push rod from idler lever and shaft assembly.

3. Remove lock washer and nut (11, figure 5) and lock strap (10) from ball stud.

4. Slide the outer end of lever and shaft assembly (7) with ball stud forward and up following the slot in frame bracket.

5. Pull lever and shaft assembly away from the engine mounted ball stud.

6. Remove the engine mounted ball stud.

INSTALLATION (Refer to Figs. 1, 2, and 5)

NOTE: Check all parts for wear, cracks, distortion, or other damage. Replace all components that would affect proper operation of the

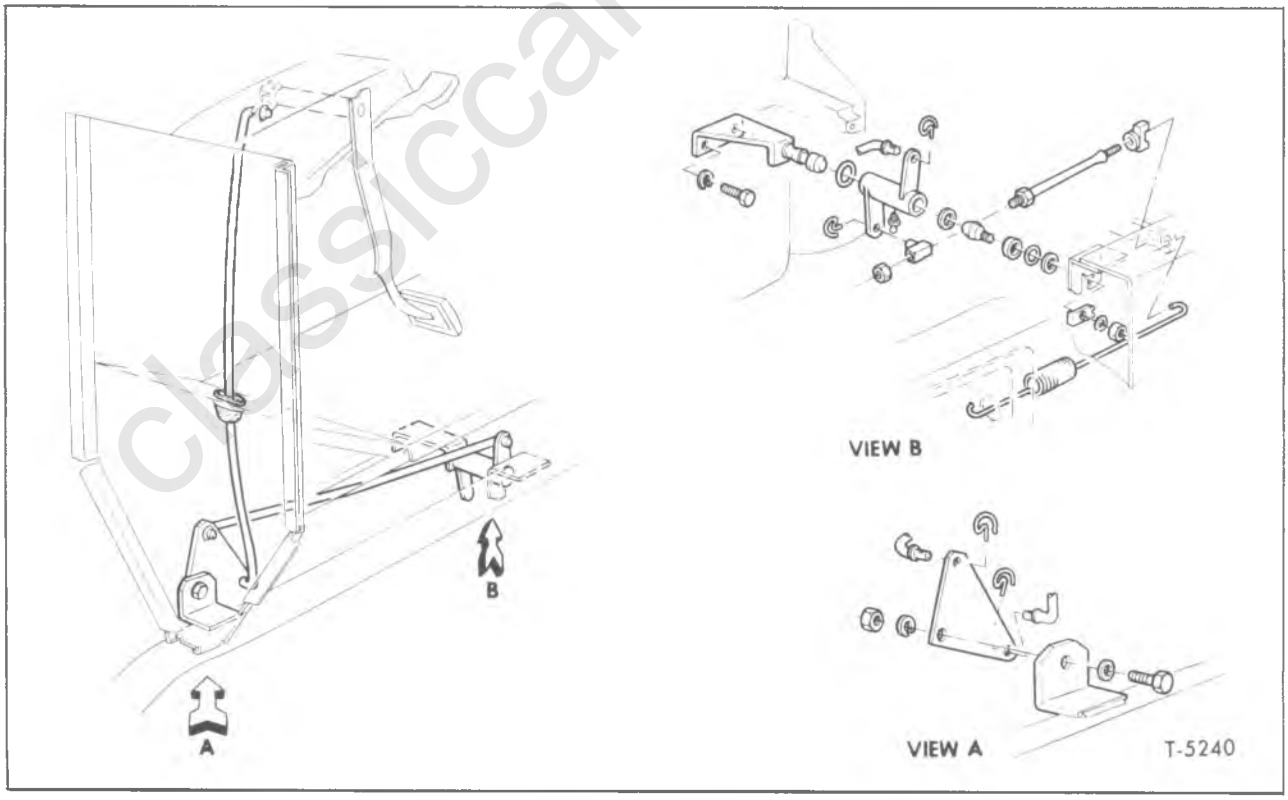


Figure 3—Mechanical Clutch Linkage (PS4500)

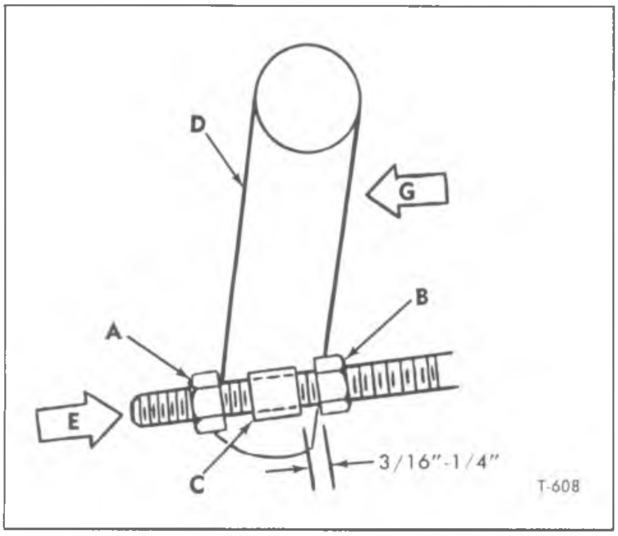


Figure 4—Linkage Adjustment (PS4500)

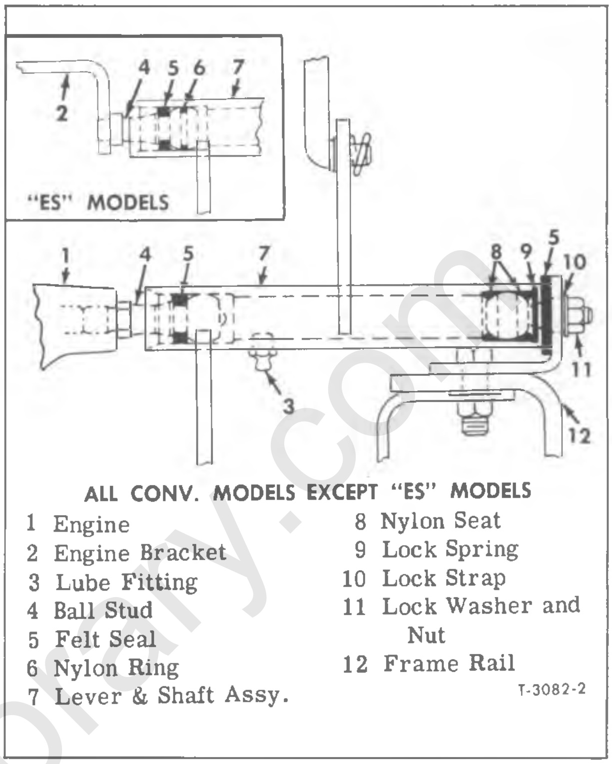


Figure 5—Idler Lever and Shaft Assembly

idler lever and shaft assembly.

1. Install felt seal (5, fig. 5) and ball stud (4) on the engine (1) or engine bracket (2).

2. Push the lever and shaft assembly onto the engine mounted ball stud. Position nylon seat (8), lock spring (9) and felt seal (5) on this outer ball stud.

3. Guide the outer ball stud into the slot in the frame bracket.

4. Install lock strap (10) and lock washer and nut (11) on outer ball stud.

5. Connect relay rod and push rod to lever and shaft assembly.

6. Adjust mechanical clutch linkage as described previously in this section.

CLUTCH PEDAL AND SHAFT REPLACEMENT

Procedures for replacing clutch pedal and shaft on models equipped with a mechanical clutch linkage are given in "HYDRAULIC BRAKES" (SEC. 5A).

HYDRAULIC TYPE CONTROLS

DESCRIPTION AND OPERATION

The clutch hydraulic control system is typically and schematically illustrated in figure 6. This system utilizes hydraulic pressure as a means of transmitting clutch pedal movement to the clutch release mechanism. The system consists of a pedal-operated master cylinder and a slave cylinder, interconnected with hydraulic lines. Clutch pedal is connected to the master cylinder push rod, and the slave cylinder push rod is connected to the clutch release fork.

When clutch pedal is depressed, hydraulic fluid is displaced from the master cylinder into the slave cylinder, forcing the slave cylinder piston outward. Movement of piston is transmitted through slave cylinder push rod, and clutch release fork to disengage the clutch.

When pedal is released, pedal return spring returns pedal to released (clutch engaged) position. With pressure removed from hydraulic fluid, clutch engages. Slave cylinder push rod return spring forces push rod and piston rearward in slave cylinder, displacing hydraulic fluid back into the master cylinder. The above events occur with each clutch disengagement.

The system should be checked and serviced periodically as stated below:

1. Maintain proper level of hydraulic fluid in master cylinder. Refer to LUBRICATION (SEC. 0) for recommended fluid and checking intervals. At least once a year, drain and flush entire clutch system and refill with new fluid.

2. Inspect entire clutch system regularly for fluid leakage. Leakage must be corrected immediately.

CLUTCH CONTROLS

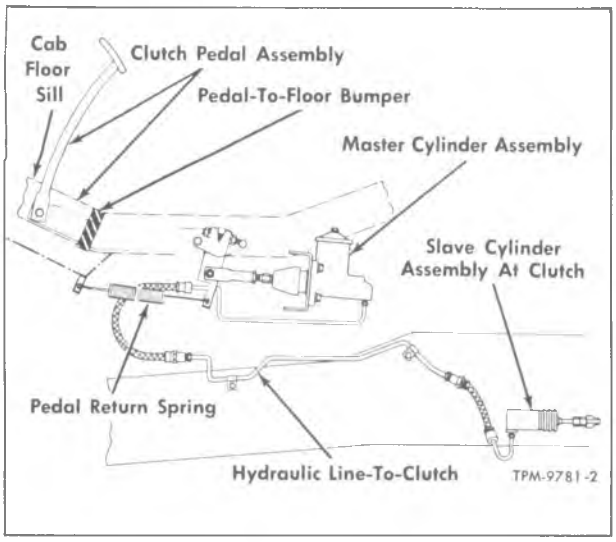


Figure 6—Clutch Hydraulic System ("L" Models)

3. Make sure return spring at release fork is not weak or broken.
4. Check, and if necessary, adjust clutch linkage.
5. If clutch pedal action is springy or spongy, it is an indication that air needs to be bled from hydraulic system.

A specified clearance at two points in the hydraulic control linkage is necessary for proper operation. One adjustment is made between the master cylinder piston and the end of foot pedal push rod. This adjustment is referred to as the "Master Cylinder Push Rod Check and Adjustment."

The other adjustment is made by obtaining the proper operating length of the slave cylinder push rod down at the clutch. This adjustment is referred to as the "Slave Cylinder Push Rod Check and Adjustment."

IMPORTANT: The master cylinder check and adjustment must be performed before the slave cylinder check and adjustment. Also, before making either adjustment, make sure that level of fluid in master cylinder is 1/2 inch below the top of reservoir. The fluid system must be free of air.

Access to master cylinder filler cap on "L" models is gained after removing small access

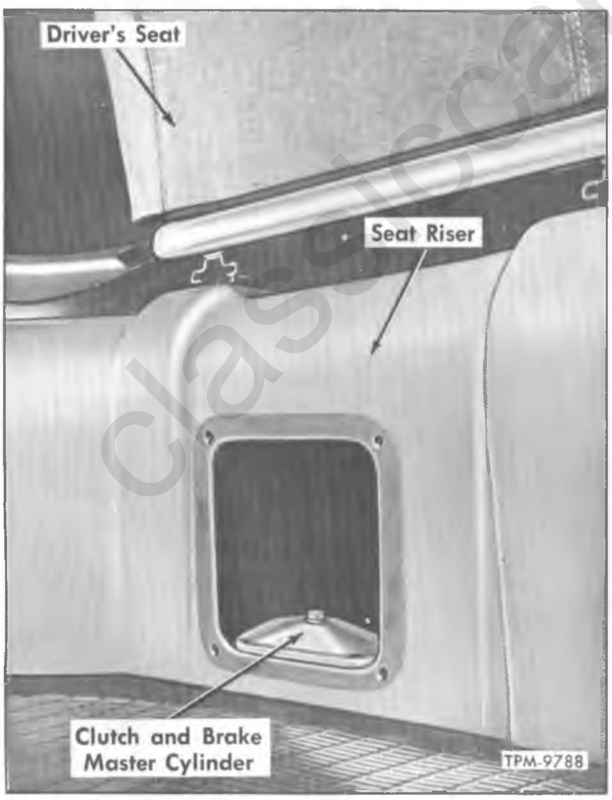
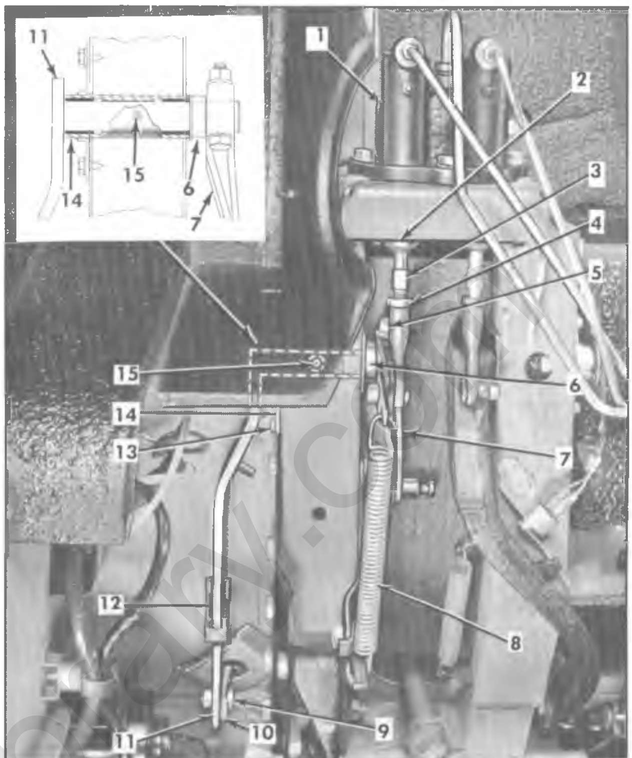


Figure 7—Access to Master Cylinder ("L" Models)



1 Master Cylinder
2 Push Rod Boot
3 Master Cylinder Push Rod
4 Push Rod Lock Nut
5 Lever-to-Shaft Clamp Bolt
6 Special Spacer
7 Pedal Shaft Lever
8 Pedal Return Spring
9 Pedal Attaching Bolt
10 Pedal (Upper Section)
11 Pedal (Lower Section)
12 Pedal Stop (Bumper)
13 Sleeve Attaching Screws
14 Sleeve and Bushing Assy.
15 Lubrication Fitting

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Figure 8—Clutch Pedal and Linkage ("L" Models)

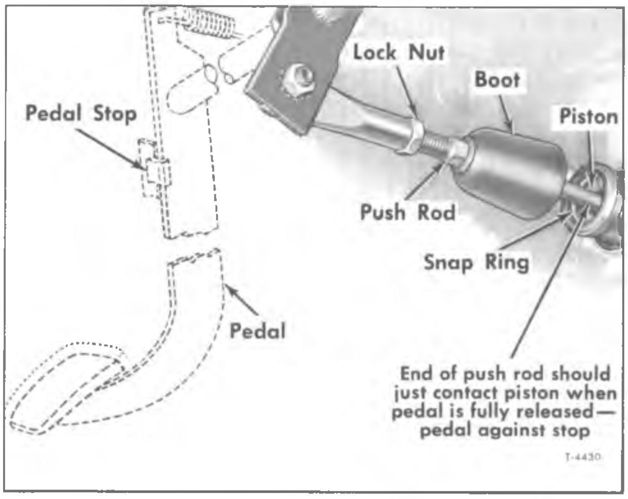


Figure 9—Master Cylinder Push Rod Check and Adjustment ("L" Models)

door located at front of driver's seat riser as shown in figure 7.

Master cylinder on "L" models is bracket-mounted below cab flooring as shown in figure 8. Access to pedal linkage for checking and adjusting purposes is made when cab is tilted completely forward. However, when checking and replenishing fluid in master cylinder, the cab must be in its lowered or operating position.

After servicing fluid system on "L" models, examine door opening or cover seal. Apply new caulking if necessary before installing door, otherwise dust may enter cab later at this point.

MASTER CYLINDER PUSH ROD CHECK AND ADJUSTMENT

Before making adjustment, pull the master cylinder boot back on push rod. Visually check to see if the piston is seated firmly against piston snap ring in cylinder bore (fig. 9). If not, the push rod is too long and should be shortened, as directed later.

IMPORTANT: It is better to have push rod adjusted too short than for it to be too long. If the push rod is too long the clutch will not fully engage.

Loosen lock nut on master cylinder push rod assembly, then turn hex portion of push rod (fig. 10) as necessary to provide 0 to 1/16-inch clearance between push rod and master cylinder piston. After making adjustment, tighten lock nut on push rod. Make sure piston contacts snap ring in master cylinder bore when pedal is released. Install boot on master cylinder.

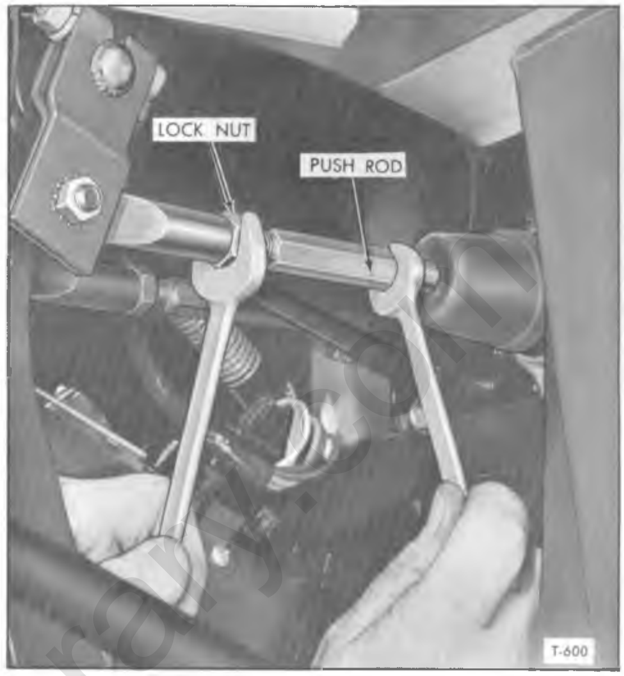


Figure 10—Adjusting Master Cylinder Push Rod

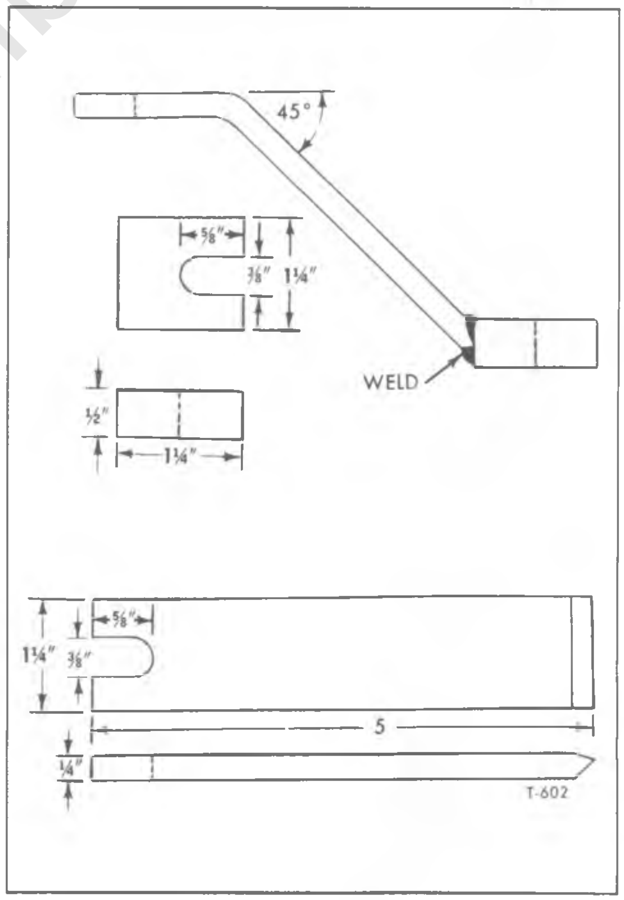


Figure 11—Improvised Tool Dimensions (for Checking 1/2-Inch Clearance)

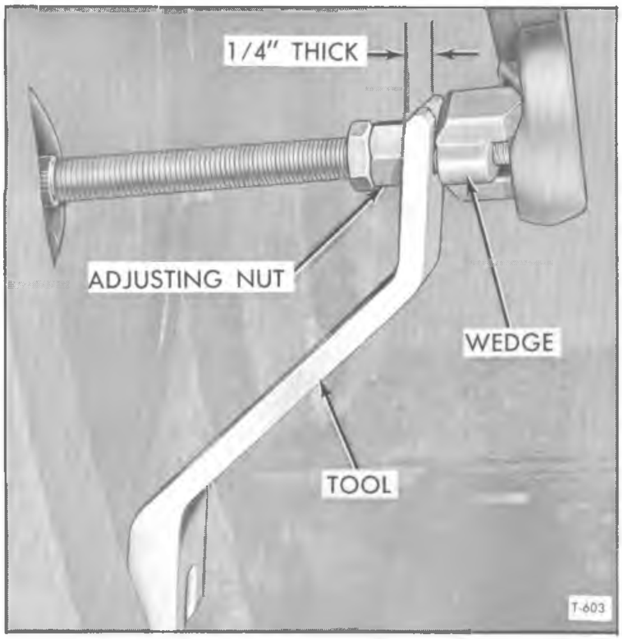


Figure 12—Checking Adjustment of Slave Cylinder Push Rod

SLAVE CYLINDER PUSH ROD CHECK AND ADJUSTMENT

This procedure is required periodically to compensate for clutch facing wear. Purpose of adjustment is to maintain a clearance between the release bearing and the clutch release fingers with clutch engaged.

IMPORTANT: The clearance between wedge and adjusting nut on all models with hydraulic clutch controls is 1/2-inch. A short ruler may be used for checking the clearance.

NOTE: A tool for checking the 1/2" clearance can be improvised locally as shown in figure 11. Perform the following when using this tool:

1. Disconnect the slave cylinder return spring.
2. With the push rod and piston seated in the slave cylinder, push clutch fork and wedge on push rod away from the slave cylinder. Insert smaller end of gauge on push rod between the adjusting nut and wedge (fig. 12). If the tool will not go between the nut and wedge the push rod needs to be adjusted. If the small tool end fits between the adjusting nut and wedge, the rod does not require adjustment.
3. To adjust the push rod, use the thicker end of the tool and insert between adjusting nut and wedge on the slave cylinder push rod. Back off adjusting nut until the tool just fits between the nut and wedge.
4. Remove the tool, lock adjusting nut with lock nut and install the slave cylinder return spring.

BLEEDING HYDRAULIC SYSTEM

Use only Hydraulic Brake Fluid recommended in LUBRICATION (SEC. 0). When other than recommended fluid has been used, drain and flush the entire hydraulic system, using clean alcohol or a hydraulic brake system cleaning fluid. Disassemble, clean, and inspect hydraulic units. Replace all rubber parts. Refill with RECOMMENDED fluid.

The need for bleeding air from system is generally indicated by a springy, spongy pedal action. The presence of air in system is a result of low fluid level in master cylinder, or if some part of system has been opened. Bleeder valve is provided at the slave cylinder alongside of clutch (fig. 14).

Plain end of bleeder hose can be slipped over end of bleeder valve.

Clutch system may be bled either manually or with pressure bleeding equipment.

PRESSURE BLEEDING

1. Make sure fluid level in fluid supply pressure tank is up to petcock above outlet and that tank is charged with 25 to 30 psi air pressure.

2. Clean dirt from around master cylinder cover or cap. On units having reservoir cover instead of cap, remove standard cover and install special cover (J-8554). Connect pressure tank hose to filler cap or special cover opening. Bleed air from hose before tightening connection. Open valves at both ends of hose.

3. Slip end of bleeder drain hose over bleed valve at slave cylinder (8, figure 15) and place the other end in a glass jar containing enough hydraulic fluid to cover end of hose. Open bleeder valve with wrench and observe flow of fluid from hose. Close bleeder valve as soon as bubbles stop and fluid flows in a solid stream.

MANUAL BLEEDING

Manual bleeding is the same as pressure bleeding, except that the hydraulic fluid is forced through the line by pumping the clutch pedal. Fluid in master cylinder must be replenished after bleeding. Clutch pedal should be pumped up and down slowly, and should be on downstroke as bleeder valve is closed.

CLUTCH PEDAL AND BUSHING ASSEMBLY REPLACEMENT (ALL "L" MODELS)

REMOVAL (Refer to Fig. 8)

1. Tilt cab forward.

IMPORTANT: Make sure cab safety catch at right front pivot mounting is securely engaged.

2. Disconnect pedal return spring (8).

3. Separate pedal upper section (10) from lower section (11) after removing attaching bolt (9).

4. Loosen bolt (5) which clamps pedal shaft lever (7) to pedal shaft. Slide pedal and shaft assembly (11) from cab sill and from spacer (6), and pedal shaft lever (7).

5. Through small access hole at base of cab sill, remove the pedal shaft lubrication fitting (15).

6. Remove two hex-head screws (13) which attach the flange of pedal shaft sleeve and bushing assembly (14) to the cab sill.

7. Using a pointed tool under flange of sleeve, pry shaft sleeve and bushing assembly (14) from cab sill.

INSTALLATION (Refer to Fig. 8)

1. Temporarily install pedal shaft back into sleeve and bushing assembly (14) and check for excessive wear. If necessary, press worn bushings from sleeve and press new bushings in their place.

2. Making sure that the lubrication fitting hole is at the bottom, insert sleeve and bushing assembly (14) into cab sill and secure with two screws (13).

3. Install lubrication fitting (15) into tapped hole at bottom of sleeve.

4. Slide pedal and shaft assembly (11) through sleeve assembly (14), through special spacer (6), and into the partly serrated hole of the pedal shaft lever (7). Make sure shaft lever is positioned as shown in figure 8.

5. Remove all shaft end play, then clamp pedal shaft lever (7) to end of shaft by tightening lever clamp bolt (5) and nut.

6. Attach pedal upper section (10) to pedal lower section (11) with bolt (9), nut, and washer.

IMPORTANT: Make sure that bolt is inserted in direction shown.

7. Referring to figure 8, install clutch pedal return spring (8).

IMPORTANT: Exercise caution when installing spring.

8. Make sure that pedal stop (12) is in good condition and is located on pedal shaft as shown.

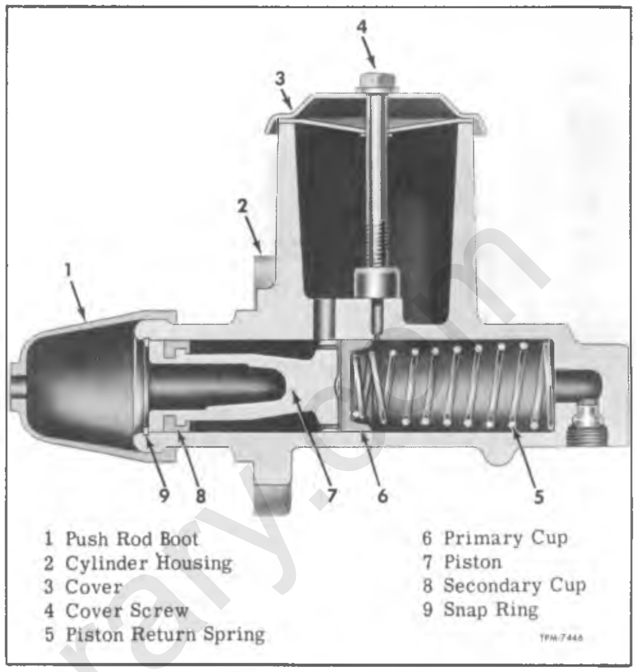


Figure 13—Clutch Master Cylinder

CLUTCH MASTER CLYINDER

A double-barrel master cylinder (see fig. 13) is used on all "L" models with mechanical transmission and hydraulic brakes. The unit consists of two cylinders with an integral reservoir. The right cylinder serves as the brake master cylinder, and the left cylinder serves as the clutch master cylinder.

MAINTENANCE (ALL TYPES)

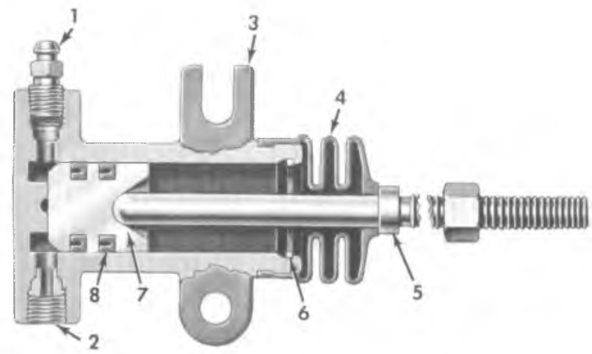
Filler cap or cover on all clutch master cylinders are designed to vent the fluid reservoir without permitting loss of fluid. Bypass port between cylinder bore and reservoir and vent hole in filler cap must be kept open to assure proper clutch control. An obstructed bypass port will prevent return of fluid to reservoir, preventing full engagement of clutch. Bypass ports may be obstructed by one of the following causes:

1. Cogged with dirt -- remove master cylinder and disassemble and clean all parts.

2. Swollen primary cup due to the use of wrong fluid -- overhaul master cylinder, drain and flush entire clutch control system, and refill with proper fluid.

3. Pedal binding on shaft, preventing full return of piston -- free up and lubricate pedal.

4. Improper push rod adjustment -- adjust push rod.



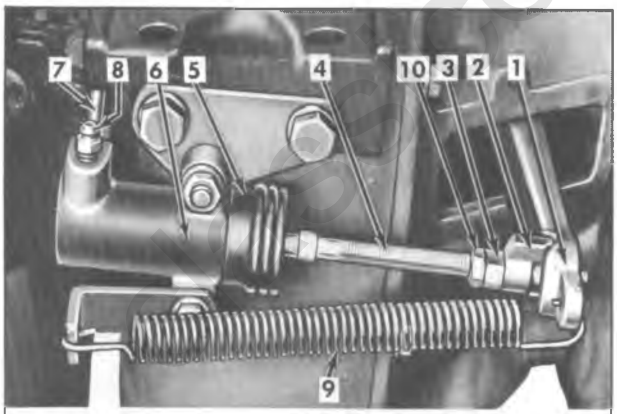
1 Bleeder Valve
2 Fluid Entry Port
3 Cylinder Body
4 Push Rod Boot
5 Push Rod
6 Piston Retaining Ring
7 Piston
8 Piston Seals
T-1006

Figure 14—Clutch Slave Cylinder

MASTER CYLINDER REPLACEMENT

Instructions for replacing clutch master cylinders are the same as for brake master cylinders as described in "HYDRAULIC BRAKES" (SEC. 5C).

After installing clutch master cylinder, bleed system and adjust push rod as described previously under "Bleeding Hydraulic System" and "Master Cylinder Push Rod Check and Adjustment."



1 Clutch Release Fork
2 Wedge
3 Adjustment Nut
4 Slave Cylinder Push Rod
5 Push Rod Boot
6 Slave Cylinder Assembly
7 Hydraulic Line From Master Cylinder
8 Slave Cylinder Bleeder Valve
9 Release Fork Return Spring
10 Adjustment Nut Lock Nut
T-3087

Figure 15—Clutch Slave Cylinder Installed (Typical)

CLUTCH SLAVE CYLINDER

The clutch slave cylinder (fig. 14) mounted at side of clutch assembly (fig. 15) activates the mechanical clutch release fork to disengage clutch when cylinder is pressurized.

REMOVAL (Refer to Fig. 15)

1. Remove return spring from clutch release fork.
2. Disconnect fluid line at slave cylinder.
3. Remove bolts retaining slave cylinder, then remove cylinder assembly and mounting spacers (if used).

DISASSEMBLY (Refer to Fig. 14)

1. Remove cylinder push rod (5) and push rod boot (4) from cylinder.
2. Remove piston retaining ring (6) from slave cylinder.

CAUTION: Use extreme care while removing retaining ring to prevent damage to the bore of the cylinder body (3).

3. Remove piston assembly (7) with seals (8) from cylinder body (3).

NOTE: Piston can be jarred from body or small amount of air pressure at line fitting will force piston from bore. Use caution to prevent damage to the piston.

4. If seals are found in good shape, they need not be removed.

INSPECTION (Refer to Fig. 14)

1. Inspect slave cylinder bore, making sure that it is smooth. A scored or damaged cylinder body (3) must be replaced.

NOTE: Burrs at the bore side of inlet port can be removed by honing or by use of crocus cloth.

2. Check piston seals (8) if removed. Swelling of seals could be due to use of improper brake fluid.
3. Check fit of the piston in the cylinder bore, using a feeler gauge. This clearance should be from 0.002" to 0.004".

ASSEMBLY (Refer to Fig. 14)

1. Install seals (8) into grooves of piston (7) with lips of seals positioned to fluid end of piston.
2. Dip piston and seals into clean brake fluid then carefully install piston assembly into bore of cylinder. Refer to figure 14 for proper position of piston in cylinder.
3. Install retaining ring (6) into groove at open end of cylinder.
4. Install boot (4) over push rod (5) and install rod and boot to slave cylinder.

INSTALLATION

1. Bolt slave cylinder assembly to engine (fig. 15).

2. Adjust slave cylinder push rod clearance as outlined in this section under "Slave Cylinder Push Rod Check and Adjustment."

3. Attach hydraulic line to slave cylinder and bleed air from system at slave cylinder bleed fitting. See "Bleeding Hydraulic System" as described previously.

SECTION 7E
Clutches

CLUTCH APPLICATION CHART

Clutch Type	Engine Application
GM (11-Inch Single Disc)	250
Borg & Beck (11-Inch Single Disc)	305E
Borg & Beck (12-Inch Single Disc)	292
Lipe-Rollway (12-Inch Single Disc)	305C, 305E, DH478
Long (12-Inch Single Disc)	305C, 305E, DH478
Lipe-Rollway (13-Inch Single Disc)	305C, 351M, DH478
Long (13-Inch Single Disc)	305C, 351M, DH478

CLUTCH REPLACEMENT

IMPORTANT: Whenever clutch components require replacement, use only genuine General Motors Parts or equivalent to assure maximum clutch performance and life.

CLUTCH REMOVAL

NOTE: Following removal procedures apply to all vehicles with exceptions as indicated.

1. Remove transmission assembly as outlined in "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" (SEC. 7B).

2. Remove clutch release bearing and support assembly from clutch release fork.

3. Disengage clutch release fork return spring from end of fork.

4. Secure slave cylinder push rod and push rod wedge to slave cylinder.

IMPORTANT: Do not lose wedge.

5. Remove clutch release fork from ball stud by prying it away from the ball with a screwdriver until it snaps loose from the ball.

NOTE: Some difficulty may be encountered when removing the clutch release fork from the ball stud. This condition could be the result of insufficient clearance between the release fork and the clutch cover. If the fork cannot be pried from ball stud, remove the ball stud and spacer (when used) from clutch housing, then if necessary, seperate the fork from stud after the assembly is removed.

6. Install aligning tool or an old transmission main drive gear into the hub of the clutch driven disc assembly, to support the clutch components during removal.

IMPORTANT: To facilitate removal of the Long or Borg and Beck clutch cover assemblies, install three hardwood wedges between the release levers and cover as shown in figure 1.

On Lipe-Rollway clutches, install three flat washers and hold-down bolts as shown in figure 2.

7. Mark clutch cover in relation to engine flywheel to assure original position when reassembled later if either part is to be reused.

8. Loosen the cover bolts alternately one turn at a time to avoid creating undue stresses in the clutch cover.

NOTE: It is most important that the cover bolts be loosened one turn at a time on the GM 11-inch clutch (used on vehicles equipped with In-Line engine).

9. Remove aligning tool, then carefully remove driven disc and cover assembly from flywheel.

NOTE: If frame crossmember interferes with disc and cover removal, force the bottom of cover rearward and at the same time push cover upward slightly. This will allow the disc to drop down before the cover.

CLUTCHES

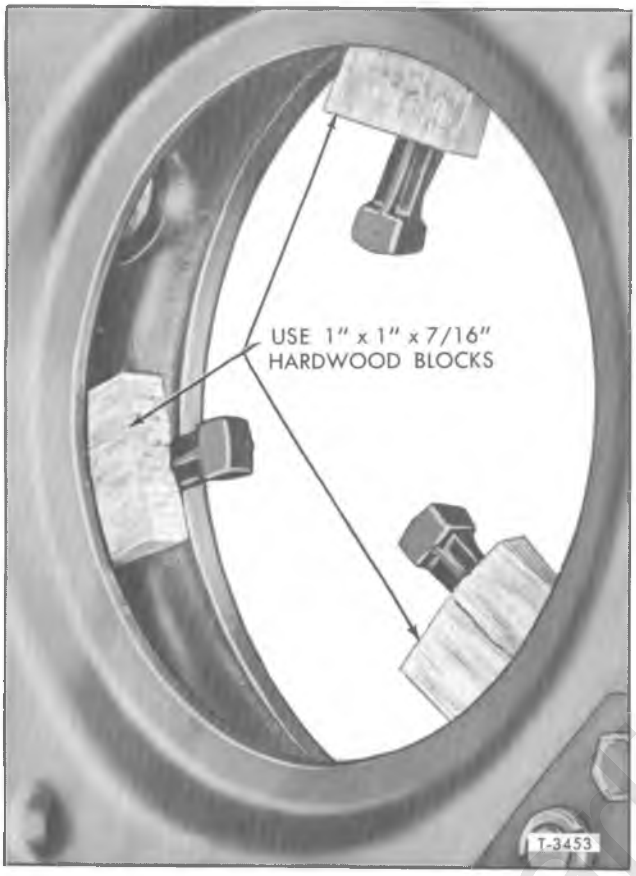


Figure 1—Use of Blocks Between Release Levers and Cover

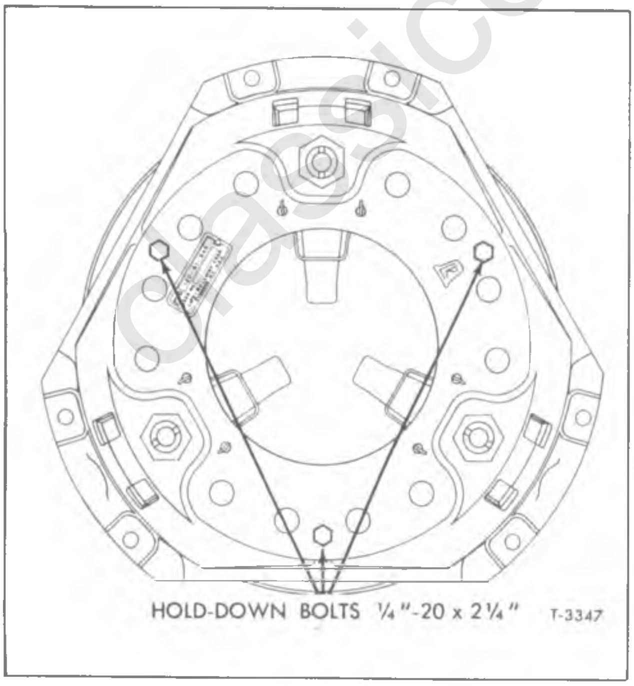


Figure 2—Use of Hold-Down Bolts

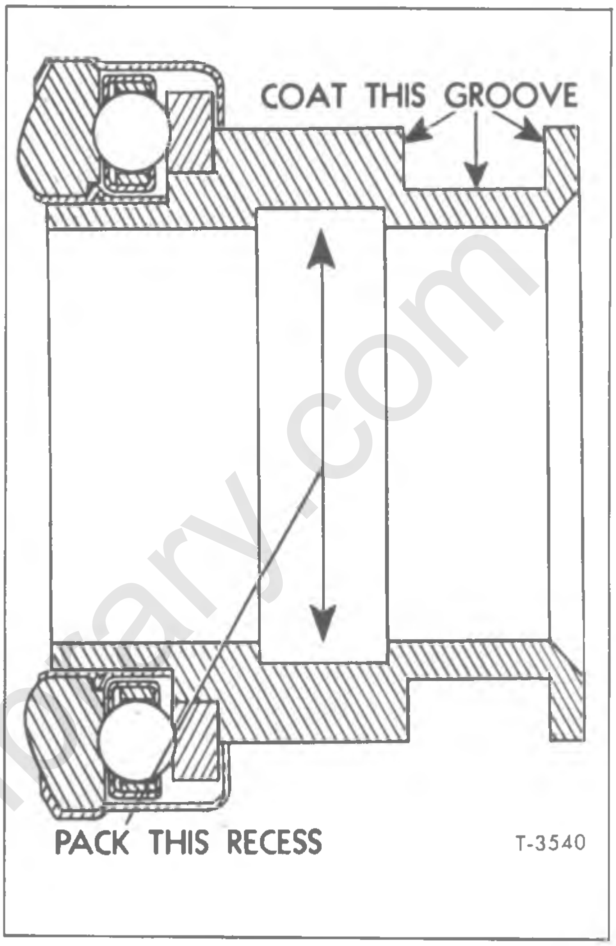


Figure 3—Release Bearing and Support Assembly (Typical)

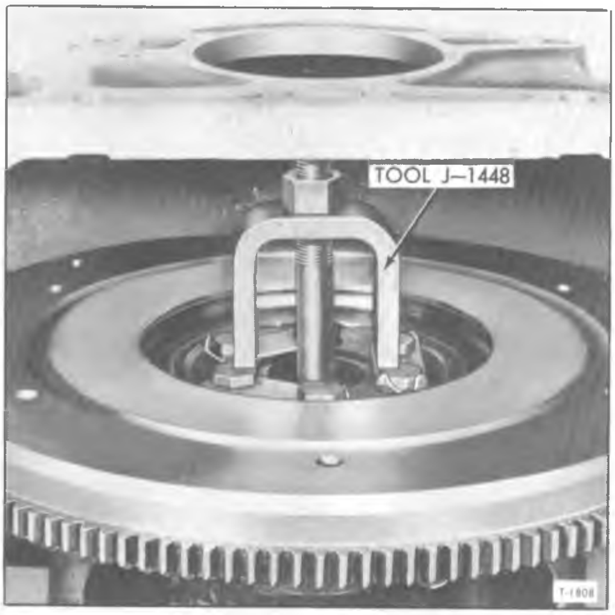


Figure 4—Pilot Bushing Removal

INSPECTION AND REPAIR

The following procedures apply to all clutch components with exceptions as indicated.

CLUTCH RELEASE MECHANISM

1. Check release fork and ball stud for wear, distortion, cracks or other damage.
2. Check release bearing for roughness or noise by rotating bearing race while applying light pressure.
3. Replace all components that would affect proper operation of the clutch release mechanism.
4. Prior to installation of the clutch release bearing and support assembly, coat the inside and outside grooves with a small quantity of high temperature grease. Refer to figure 3.

PILOT BUSHING (IN-LINE ENGINES)

The pilot bushing, which is pressed into crankshaft is an oil impregnated type bronze bearing. This bushing requires attention only when the clutch is removed from the vehicle, at which time it should be cleaned and inspected for excessive wear or damage and should be replaced if necessary.

Removal

Install tool J-1448, and pull bushing from crankshaft bore (fig. 4).

Installation

In replacing this bearing, use tool J-1522. Place bearing on pilot of tool with radius in bore of bearing next to shoulder of tool and drive into crankshaft.

PILOT BEARING ("V" ENGINES)

Vehicles equipped with a V-6 engine utilize a pilot bearing which is pressed into the flywheel. Rouchness or noise can be detected by rotating the bearing race while applying light pressure. Replace bearing if it is rough, noisy, or damaged.

Removal

Remove clutch pilot bearing from engine, using pilot bearing remover (J-5901-2) with slide hammer (J-2619). With fingers on puller closed, insert fingers through bearing inner race as far as they will go, then tighten thumb screw to spread fingers. Slide weight sharply against stop on puller shaft to remove bearing.

Installation

1. Pack clutch pilot bearing with small quantity of high temperature lubricant specified in LUBRICATION (SEC. 0) of this manual.
2. With shielded side of bearing toward the rear, drive pilot bearing into position using a suitable driver. Bearing should be seated firmly.

FLYWHEEL

Inspect flywheel surface which is contacted by the clutch facing. This surface must be smooth and should not be grooved or show deep heat checks. Replace flywheel if the above conditions are evident.

DRIVEN DISC

Inspect driven disc assembly for worn, loose, and grease or oil-soaked facings. Check for broken springs, loose rivets, or cracks in the driven disc hub. Examine splines in hub for wear and make sure they slide freely on splines of the main drive gear. If any wear or damage is evident, replace with a new driven disc assembly.

If hub and springs are in good condition, but facings are worn or grease or oil-soaked, replace facings.

PRESSURE PLATE AND COVER ASSEMBLY

Detailed inspection and repair procedures for the pressure plate and cover assembly are not covered in this manual.

CLUTCH INSTALLATION

1. Be sure the hardwood blocks (fig. 1) or hold-down bolts and washers (fig. 2) are installed in the clutch cover assembly.

NOTE: The above step applies to all clutch cover assemblies, except the GM 11-inch clutch cover.

2. Place the driven disc against engine flywheel with larger exposed portion of disc damper springs toward the rear. While holding driven disc in place, move clutch cover and pressure plate into place against the driven disc.

NOTE: If frame crossmember interferes with the installing of disc and cover, install cover first with top of cover against flywheel and bottom toward the rear, then raise the disc into position. Insert alignment tool or old transmission main drive gear through driven disc hub and into pilot bearing.

3. If alignment marks were made on clutch cover and engine flywheel prior to removal, align these marks.
4. Install cover-to-flywheel bolts and washers. Tighten bolts alternately one turn at a time to compress clutch tension springs evenly and prevent possible distortion of cover.

NOTE: Tighten clutch cover-to-flywheel bolts to 35 to 45 foot-pounds torque. Remove aligning tool.

IMPORTANT: After installing clutch cover assembly be sure to remove wood blocks or hold-down bolts and washers.

5. Coat inside and outside grooves of clutch release bearing and support assembly (fig. 3) with

a small quantity of high temperature grease.

NOTE: The clutch release bearing on some vehicles is equipped with a lubrication fitting. Apply high temperature grease to this fitting (when used). Do not overfill as excess grease may be thrown on the clutch facings.

6. Install release fork ball stud and spacer (when used) to the clutch housing.

7. Apply a small amount of high temperature grease to ball stud recess in release fork, then install ball stud retainer spring in fork. Force ball stud into fork recess until engaged by spring.

8. Before installing transmission assembly, release bearing must be positioned in yoke portion of release fork. Install transmission as outlined in "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" (SEC. 7B).

9. Adjust the clutch controls as outlined in "CLUTCH CONTROLS" (SEC. 7D).

ON-VEHICLE SERVICE OPERATIONS (GM 11-INCH CLUTCH)

RETRACTING SPRING REPLACEMENT

A rattle in the clutch assembly at idle speeds with the clutch disengaged may be caused by insufficient tension on the three retracting springs (fig. 5). This noise can be eliminated by replacing the retracting springs as follows:

1. Remove the clutch housing underpan.

2. Crank engine until one retracting spring and bolt is at the bottom. Bolts and springs are accessible through openings in clutch cover. Remove bolt attaching retracting spring to pressure plate and install a new spring. Tighten bolt to 15-20 foot-pounds torque.

3. Replace the other two retracting springs in same manner.

4. Install clutch housing underpan.

CLUTCH ADJUSTMENT

If the GM 11-inch clutch fails to release perform the following:

1. Check clutch controls for proper adjustment as described in "CLUTCH CONTROLS" (SEC. 7D).

2. Check clutch retracting springs (fig. 5) for proper retention of pressure plate to diaphragm spring. Replace retracting springs, if necessary, as described previously.

3. If steps 1 and 2 do not eliminate trouble, check pressure plate lift with dial indicator (fig. 6) as follows:

a. With proper linkage adjustment, zero indicator with clutch fully engaged (pedal up).

b. Measure pressure plate lift at three strap bolt positions with full pedal travel.

All three readings should be within .010" and within total lift reading. If more than .010" check retracting springs per Step 2. If trouble still exists, loosen clutch-to-flywheel mounting bolt at position of lowest reading (leave other bolts tight), pry cover, away from flywheel and insert feeler gauge to determine thickness of shim required to bring reading within .010".

NOTE: Use shim stock between the clutch cover and flywheel at attaching bolt locations.

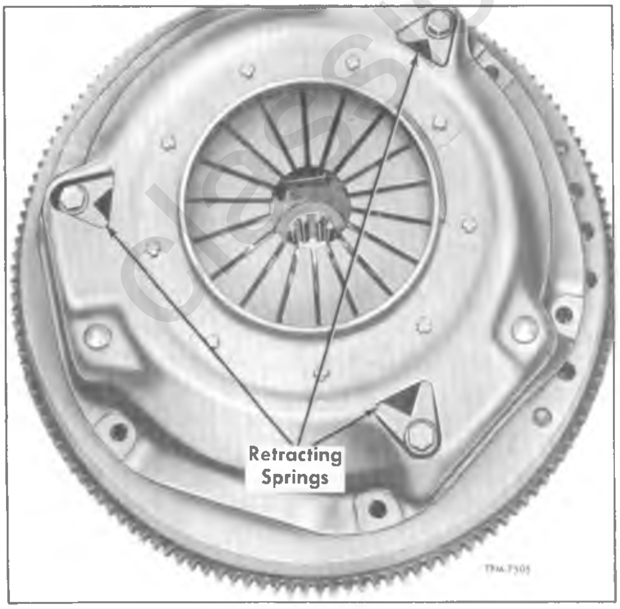


Figure 5—Pressure Plate Retracting Springs (GM 11-Inch Clutch)

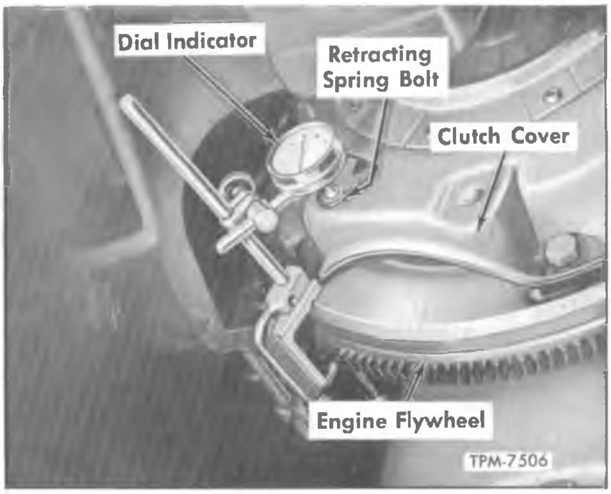


Figure 6—Checking Pressure Plate Lift (GM 11-Inch Clutch)

Total lift readings should be .055" to .075".

NOTE: Excessively high readings indicate that the diaphragm spring is being over-stressed which may eventually cause loss of load and result in slippage.

If above measures fail to correct the trouble, checke driven disc with clutch pedal depressed (it should spin freely with transmission in neutral).

NOTE: If trouble still exists, refer to "Clutch Troubleshooting."

CLUTCH TROUBLESHOOTING

SYMPTOMS AND PROBABLE CAUSE	PROBABLE REMEDY
SLIPPING	
1. Improper adjustment.	1. Adjust slave cylinder travel clearance or if control is of link type, make adjustment at release fork or lever adjustment rod.
2. Oil soaked clutch disc.	2. Install new disc.
3. Worn splines on transmission drive gear.	3. Replace drive gear.
4. Lining loose on clutch disc.	4. Install new disc.
5. Warped pressure plate or engine flywheel.	5. Replace pressure plate or flywheel.
GRABBING	
1. Oil on disc lining.	1. Install new disc.
2. Worn splines on transmission drive gear.	2. Replace drive gear.
3. Loose engine mountings.	3. Tighten or replace engine mountings.
4. Warped pressure plate or engine flywheel.	4. Replace pressure plate or flywheel.
RATTLING	
1. Weak retracting springs.	1. Replace springs.
2. Release fork loose on ball pivot stud.	2. Check stud and retaining spring and if necessary, replace.
NOISY	
1. Worn clutch release bearing.	1. Replace release bearing.

HYDRAULIC CONTROLS

PEDAL SPONGY	
1. Air in clutch hydraulic line.	1. Bleed clutch slave cylinder.
EXCESSIVE PEDAL TRAVEL	
1. Leaking slave cylinder line.	1. Tighten or replace line.
2. Fluid low in hydraulic master cylinder.	2. Fill cylinder to 1/2" below top of reservoir.
3. Clutch master cylinder push rod lever loose or not properly adjusted.	3. Adjust length of clutch push rod under dash.
CLUTCH PEDAL RELEASES CLUTCH BUT PEDAL GRADUALLY TRAVELS DOWNWARD	
1. Clutch master cylinder leaks past primary cup.	1. Overhaul master cylinder.
2. External leaks.	2. Tighten all line fittings and check for leaks in line.

Always Be Sure To Readjust The Clutch Linkage

After Performing Clutch Maintenance Operations.

SECTION 8

Fuel Tank and Exhaust

NOTE: Refer to ENGINE FUEL SYSTEM (SEC. 6M) for information pertaining to fuel filters and fuel pumps.

SECTION 8A

Fuel Tank, Lines, and Gauge System

GENERAL DESCRIPTION

FUEL TANK MOUNTINGS

In general, fuel tanks are located on side of chassis and lay lengthwise to frame side rail. A mounting of two metal straps anchor tanks to mounting brackets which are bolted to frame side member. Metal-to-metal contact between tank and brackets and straps is prevented by use of anti-squeak material.

FUEL TANK CONSTRUCTION

Typical frame mounted tanks consist of an upper and lower half, each with a wide flange and baffles which are pressed into the tank halves. The two tank sections are seam-welded at the flange around the entire tank to assure leakproof construction. Exceptional stiffness is secured by the combination of the welded flanges and depressed ribs in both upper and lower tank sections. Baffle plates are incorporated to provide additional stiffness and to prevent the surging of gasoline within the tank.

FILLER CAPS AND NECKS

Fuel tank filler caps and neck assemblies conform to the latest S.A.E. Standards for filler caps and related filler neck cams. Upper and lower filler necks vary as to size, length, and shape, depending on model requirements. Filler necks are treated so that rust will not form and get into the fuel system. In general, lower filler necks are first bolted or riveted to the tank and then sweat soldered in place to eliminate any possibility of leakage. All tanks are equipped with a vented filler neck cap.

FUEL PICKUP PIPE

The fuel pickup pipe is built integrally with the tank gauge unit, located at the top of the tank in line with safety recommendations. A large area, fine-mesh screen is located on the bottom of the fuel pickup pipe. This screen is designed to prevent the entrance of dirt or water into the fuel system. See "Fuel Gauge System" later in this section for complete description of tank sending unit.

FUEL TANK REPLACEMENT

DRAINING FUEL TANK

If fuel tank does not incorporate a drain plug, it will be necessary to siphon fuel from tank. The following procedure is recommended:

1. Obtain an 8 to 10-foot length of 3/8", or slightly less, I.D. hose and cut a flap type slit 18" from one end. Refer to figure 1.

NOTE: Hose with larger than 3/8" I.D. is not recommended as it is difficult to erect and maintain a siphon using this method with a larger hose.

2. Insert a small nipple (at least 1/8" larger O.D. than the hose I.D.) into opposite end of hose from slit.

3. Insert nipple end of hose into tank until it strikes bottom.

4. With the opposite end of the hose in a suitable container which is positioned below bottom of fuel tank, insert an air pressure hose nozzle into

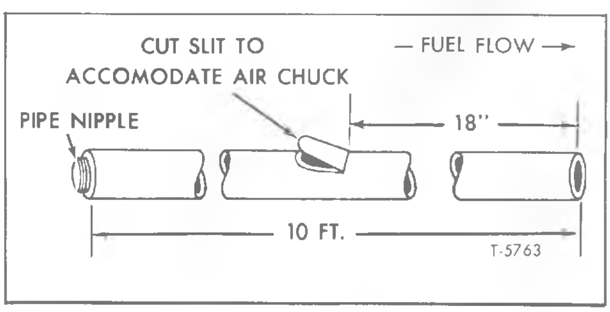


Figure 1—Tank Siphon Construction

FUEL TANK AND EXHAUST

Figure 2—Tube Flaring Tool J-8051

flap-type slit and trigger flow of fuel by forcing air pressure through siphon towards container.

TANK REMOVAL

The following procedure is intended as a general guide only and will vary according to truck series and model.

1. Drain tank by removing drain plug (if equipped) or using siphon as described previously.
2. Disconnect filler neck hose at lower clamp as required to provide clearance for tank removal.
3. Disconnect fuel line(s) and wiring from tank unit. Ignition switch must be in "OFF" position.

NOTE: On models when top of tank is not readily accessible, loosen tank support straps enough to disconnect tank unit wire.

4. Remove tank support straps and lower tank from vehicle. To remove fuel tank sending unit, refer to procedure under "Tank Unit Replacement" described later in this section.
5. To install, reverse the "Removal" procedure. Replace all anti-squeak material and be sure tank straps are positioned properly and tightened evenly.

NOTE: When replacing polyethylene tank, tighten strap nuts securely with minimum bulging of fuel tank.

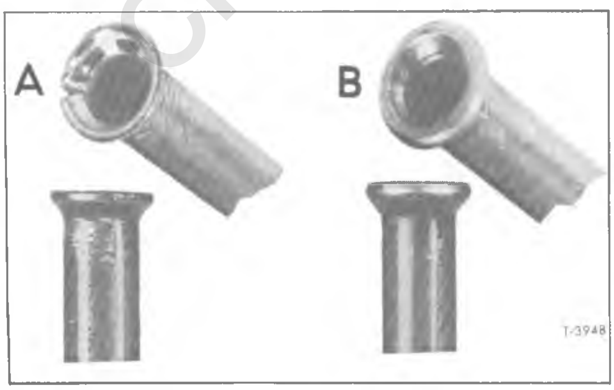


Figure 3—Single and Double Lap Flare

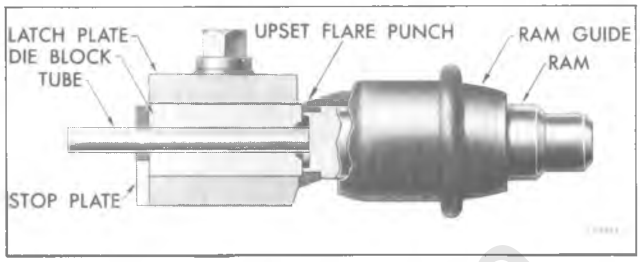


Figure 4—Flaring Operation (Positioning Tubing)

FUEL LINE INSTALLATION

In making up fuel lines, it is important that the ends of the tubing be flared properly for the compression couplings. Unless the tubing is properly flared, the couplings will leak.

The tubing must be double-lap flared at the ends in order to produce a strong leak-proof joint.

The Tool (J-8051) (fig. 2) must be equipped with the proper size die block and upset flare punch for each size tubing to form the double-lap flare.

The proper size die blocks and upset flare punches are as follows:

Tubing Size	Die Block	Upset Flare Punch	Finish Flare Punch
3/16"	J-2185-27	J-2185-3	J-2185-26
1/4"	J-2185-28	J-2185-37	J-2185-26
5/16"	J-2185-29	J-2185-4	J-2185-26

NOTE: These special tools are also part of Kit J-8051.

Figure 3 shows two pieces of tubing - one with a single-lap flare "A" and the other with a double-lap flare "B." It will be noted that the single-lap flare splits the tubing while the double-lap flare shown in "B" is a heavy, well-formed joint.

The following procedure should be followed in making up fuel pipes:

1. Cut tubing to the desired length, using Tool (J-8000). Square off ends of tube and ream sharp edges with reamer tool provided on the tube cutter.
2. Install compression couplings on tubing and dip end of tubing to be flared in hydraulic brake fluid. This lubrication results in better formation of the flare.
3. Select the correct size upset flare punch. One end of this punch is hollowed out to gauge the amount of tubing necessary to form a double-lap flare.
4. Slip the punch into the tool body with gauge end toward the die blocks, install ram and tap lightly until punch meets the die blocks and they are forced securely against the stop plate (fig. 4).

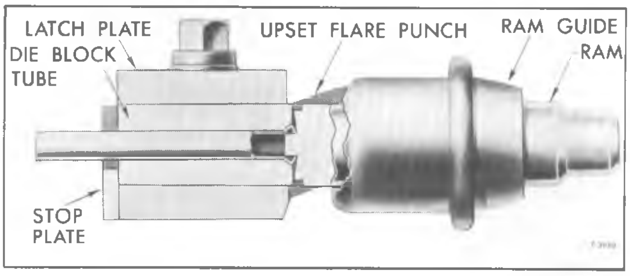


Figure 5—Flaring Operation (First Flare)

5. Draw latch plate nuts down tight to prevent tube from slipping. Draw nuts down alternately beginning with nut on closed side to prevent distortion of plate.

6. Remove punch and ram. Reverse punch and place back in tool body. Install ram and tap lightly until face of punch contacts face of die blocks to complete first flare operation (fig. 5).

7. Remove ram and punch.

8. Insert finish flare and ram in tool body and tap ram until a good seat is formed (fig. 6).

9. Blow tubing out with compressed air.

FUEL LINE MAINTENANCE

The fuel lines should be inspected occasionally for leaks, kinks, or dents. If evidence of dirt is found in the carburetor, fuel pump, or fuel filter on disassembly, the lines should be disconnected and blown out. Check the fuel strainer in the tank for damage or omission. A leaking fuel tank should be repaired or replaced immediately. Crimped, kinked, or leaking fuel lines should be replaced.

When installing fuel lines, tighten tubing nuts only enough to prevent leakage and provide a secure connection. Where possible, a back-up wrench should be used to prevent twisting or excess stress on tubing.

When replacing a flexible fuel line, be sure hoses are properly located to prevent chafing against frame members. Fuel line retainers should be positioned properly on fuel lines to assure secure support, yet not result in line constriction. Cracked, corroded, or bent retainers should be replaced.

NOTE: Refer to FUEL SYSTEM (SEC. 6M) of this manual for information pertaining to maintenance and replacement intervals for In-line and frame mounted fuel filters.

FUEL LINE RETAINER CLIP (Fig. 7)

A periodic inspection should be made to be sure lines are securely mounted. If fuel pipes and retainer clips are removed, Tool (J-7777) should be used to install new retainer clips (fig. 7). After removal of the old clip from the frame, position the new clip in the location of the old clip. Index the "blind rivet" and press hard (hand pressure should do) to expand rivet.

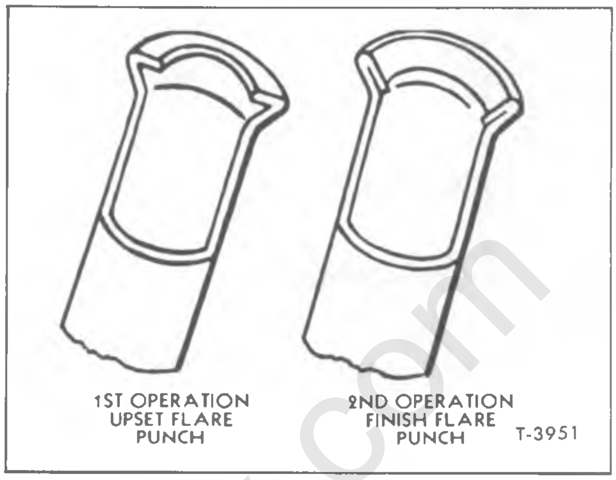


Figure 6—Flaring Operation (First and Second Flare)

FUEL GAUGE SYSTEM

TANK UNIT (Fig. 8)

The fuel tank strainer, fuel pickup pipe, and tank gauge unit are one assembly. The sock-type strainer, located on bottom of fuel pickup pipe, is of plastic wrap construction with a heat sealed end. The large area fuel strainer is of sufficiently fine mesh to prevent entrance of contaminants into fuel system and operates with a self-cleaning action. Inspect condition of strainer if tank unit is removed and replace or clean as required.

The tank unit houses a variable resistor (rheostat) which controls current through the dash gauge according to position of float. The tank unit rheostat may be checked with an ohmmeter. With float on "EMPTY" position, ohmmeter connected across rheostat should indicate .00 to 1.0 ohms resistance. With float on "FULL" position, resistance should measure about 90 ohms for conventional cab models and 30 ohms for steel tilt models.

TANK UNIT REPLACEMENT

NOTE: Tank may incorporate a protective top (fig. 9) to shield tank unit electrical connections

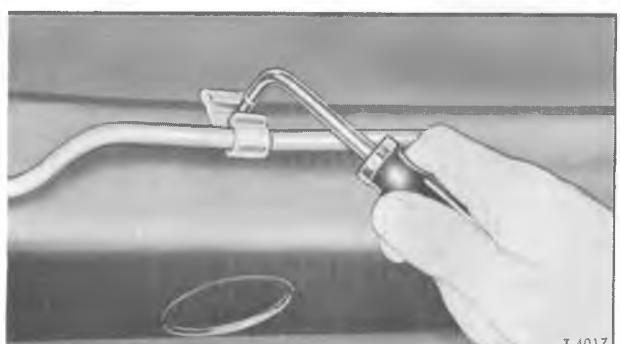


Figure 7—Installing Fuel Line Retainer

FUEL TANK AND EXHAUST

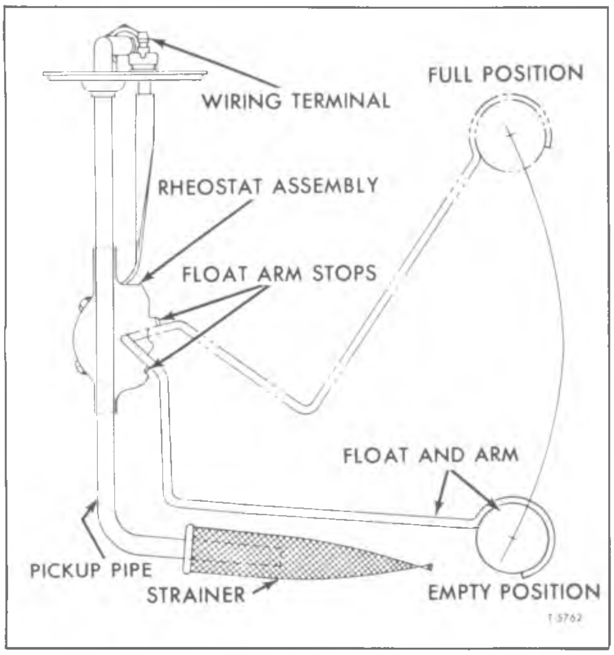


Figure 8—Gasoline Tank Sending Unit

and fuel line(s). To remove the protector top, a bolt at each side must be removed. The lower portion of the gauge protector is sandwiched between two gaskets beneath the top of the fuel gauge and can be removed only after removal of gauge unit from fuel tank.

Tilt Cab Models

1. Turn ignition switch or engine control switch to "OFF" position.
2. Disconnect electrical wire from terminal on tank unit.
3. Disconnect fuel line(s) at tank unit.
4. Remove screws or bolts attaching tank unit flange to tank. Then lift tank unit out of tank.
5. Carefully install new gasket and tank unit in tank and align flange bolt holes.

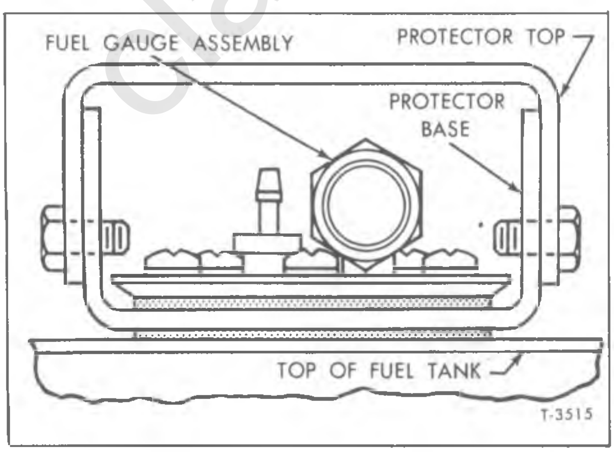


Figure 9—Tank Unit Protector

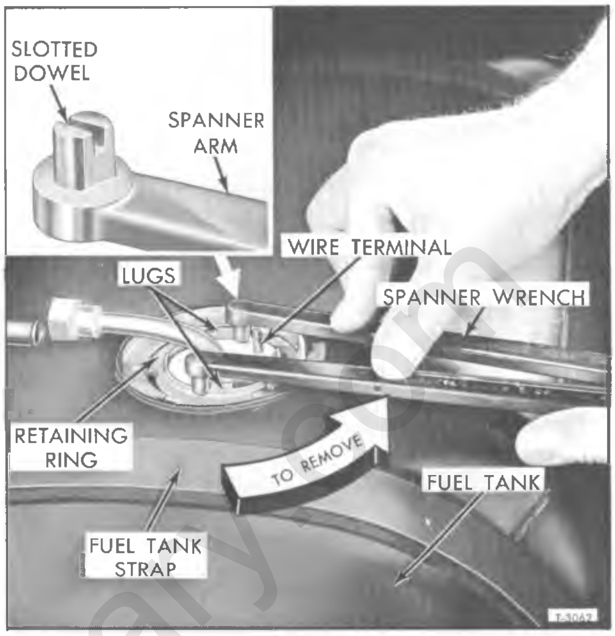


Figure 10—Removing Retainer Ring

6. Install screws holding flange to tank.
7. Connect fuel line(s) at tank unit. Connect electrical wire to terminal on tank unit.

Conventional Cab Models

A special tool can be devised to facilitate removal and installation of tank unit. Tool can be made from a common spanner wrench as follows:

Saw one slot in each dowel at end of each spanner arm (see Inset on figure 10). Each slot should be parallel to spanner arm as shown. The saw slots should measure approximately 1/8 inch deep and 1/16 inch wide (width of two hack saw blades). File a flat surface perpendicular to slot at each end of slots. Grind end of spanner arms if additional clearance is needed.

Replace tank unit as follows:

1. Turn ignition switch or engine control switch to "OFF" position.
2. Disconnect electrical wire from terminal on tank unit. Also disconnect tank unit ground wire at the frame.
3. Disconnect fuel line(s) at tank unit.
4. Position tool as shown in figure 10 to engage two of the four ring lugs, then turn retaining ring counterclockwise to loosen ring. Lift tank unit out of tank. Remove and inspect neoprene O-ring. Replace O-ring if necessary.
5. Carefully install new tank unit in tank. Use tool (fig. 10) to turn retaining ring clockwise and secure tank unit.
6. Connect fuel line(s). Then connect electrical wire to terminal on tank unit. Secure ground wire

to frame. Start engine and check for leaks and gauge operation.

DASH GAUGE

Refer to wiring diagram shown on "Fuel Gauge System Trouble Diagnosis Chart."

The dash fuel gauge is an electromagnetic instrument which visually indicates quantity of fuel in tank when the ignition switch is turned to the "ON" or "ACCESSORY" position.

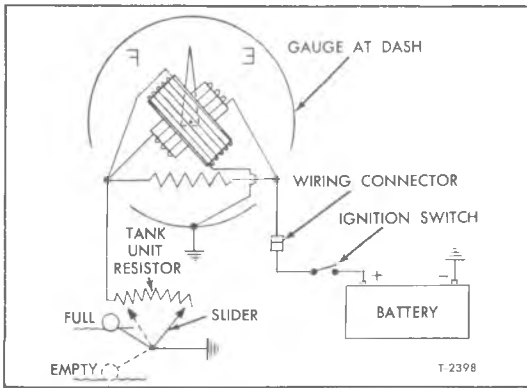
The dash gauge consists of a permanent magnetic armature and spindle assembly to which a pointer is attached. Surrounding the magnetic armature are two coils wound perpendicular to each other. These coils provide the magnetic field which deflects the armature and pointer. The intensity and direction of the resultant magnetic field of the coils is dependent on current flow controlled by resistance of the tank unit rheostat. When the position of the slider arm varies, a change in rheostat resistance occurs which results in a proportional current change in the dash gauge coils. This allows the armature (and pointer) to align itself according to the resultant magnetic field produced by the coils. The total angular travel of armature and pointer from "EMPTY" to "FULL" is 90 degrees.

As mentioned previously, the tank unit rheostat resistance is approximately zero ohms when the fuel tank is empty (float arm is at its lowest position). As the tank is filled, the tank unit float arm will rise to increase rheostat resistance which in turn, will result in the pointer in the dash gauge to deflect towards the "FULL" position.

The dash gauge is not repairable and is replaced as an assembly. The dash gauge fixed calibration resistor shown on the "Fuel Gauge Wiring Diagram" is connected across the two external wiring terminals of the gauge. Refer to CHASSIS ELECTRICAL AND INSTRUMENTS (SEC. 12) of this manual for illustrations of dash gauge as positioned on various types of instrument clusters.

WARNING: Conventional cab models have a 90 ohm dash gauge and a 90 ohm tank sending unit. All steel tilt models have a 30 ohm dash unit and a 30 ohm tank sending unit. It is important that dash gauge and sending units not be interchanged between conventional and tilt cab models If wrong fuel gauge components are installed, inaccurate fuel quantity readings will result. To be certain that mating resistances between dash gauge and tank unit are maintained, be sure to install correct parts as listed in current GMC Master Parts Book.

FUEL GAUGE SYSTEM TROUBLE DIAGNOSIS CHART



Fuel Gauge System Wiring Diagram

PROBABLE CAUSE	Reads 1/4 when empty or won't read empty	Reads accurately between "E" and 1/4; above 1/4 reads "F"	Needle does not move	Reads "E" all the time	Reads "F" all the time	Reads 3/4 when full or won't read full	Reads 1/4 when full	Reads too high for amount in tank	Erratic reading	SUGGESTED REMEDIES
1. Loose connection anywhere in circuit									x	Inspect and, if necessary, clean and tighten all connections in circuit
2. Poor dash fuel gauge calibration								x		Install new dash fuel gauge
3. Poor tank unit calibration								x		Install new tank unit*
4. Circuit grounded in resistor of tank unit						x	x			Install new tank unit*
5. Circuit grounded between tank unit resistor and dash gauge				x						Insulate grounded circuit
6. Circuit within dash gauge grounded.								x		Install new dash fuel gauge
7. Circuit grounded between battery and dash gauge.			x							Insulate grounded circuit
8. Open circuit between ignition switch and dash gauge			x							Clean and tighten appropriate terminals or repair broken wire
9. Open circuit between ground terminal on gauge and ground				x						Clean and tighten mounting bracket where contact is made between dash gauge and ground
10. Open circuit between sending unit terminal on dash gauge and resistor terminal on tank unit					x					Clean and tighten appropriate terminals or repair broken wire
11. Open circuit in resistor of tank unit at 1/4 full position		x								Install new tank unit*
12. Open circuit between tank unit slider resistor and ground					x					Install new tank unit*
13. Needle rubbing on face of gauge			x	x	x	x	x			Position needle to prevent contact with face or install new gauge
14. Fuel tank float hang-up	x		x	x	x	x	x			Free binding float or install new tank unit*
15. Top of fuel tank deformed						x				Straighten tank top or replace tank
16. Bottom of fuel tank deformed	x									Straighten bottom of tank or replace tank
17. Tank unit mounting flange bent	x					x	x			Straighten mounting flange or replace tank unit*

* Ignition switch must be "OFF" before removing tank sending unit, otherwise full battery voltage may destroy unit or ignite fuel vapors. For maximum safety, remove cable from negative battery terminal.

SECTION 8B

Exhaust System

GENERAL INFORMATION

Exhaust system configurations vary according to engine type and model designation. In general, all exhaust system connections are of split-joint coupled design secured with clamp bolts. Flexible hangers are used to reduce noise transfer to body and to relieve concentrated loads on exhaust system components.

In general, mufflers are of heavy duty construction designed for optimum quieting efficiency, reduced exhaust back pressure, and long life due to use of aluminized tubes and baffles.

MAINTENANCE

EXHAUST RESTRICTION AND LEAKS

Exhaust system should be inspected periodically for restrictions and leaks. Restrictions such as kinked or crimped pipes result in excessive back pressure which can lead to increased fuel consumption, power loss, and possible damage to engine combustion chamber components. Exhaust leaks are commonly the result of loose clamp bolts, defective exhaust pipe to manifold packing, corroded pipes, or a punctured muffler. In addition to objectionable noise, a leaking exhaust system could allow toxic gases to enter cab.

Damaged or corroded exhaust system components should be replaced without delay. If it is absolutely necessary to operate vehicle when an exhaust leak exists, use extreme caution and keep cab well ventilated.

EXHAUST SYSTEM ALIGNMENT

During installation of a new exhaust pipe, muffler or tail pipe, care should be taken to properly position components in relation to each other. Particular care should be given to the installation of the exhaust pipe and crossover pipe assembly on "V" engines equipped with single exhaust system.

Incorrectly assembled parts of exhaust system are frequently the cause of annoying noises and rattles due to improper clearances. Therefore, leave all clamp bolts and muffler strap bolts loose temporarily until the entire system has been inspected to determine if there is adequate clearance between exhaust components and frame members. The weight of the exhaust system should be properly distributed on all supporting brackets and hangers. If the load is not properly balanced, reposition pipes at connecting joints to relieve any concentrated loads. After adjusting hangers, aligning pipes, and repositioning muffler, check entire system for adequate clearance and then tighten all clamps, working from front to rear. Start engine and inspect all connections for leakage.

NOTE: When installing exhaust pipe to manifold, always use new packings and nuts. Be sure to clean manifold stud threads with a wire brush before installing new nuts.

CAUTION

If a gasoline engine is operated with a faulty exhaust system, poisonous (carbon monoxide) gas may enter cab and cause serious or fatal injury to personnel. Carbon monoxide may or may not have a detectable odor, and is tasteless and colorless. In the presence of carbon monoxide, physical symptoms such as headache, eye smarting and/or drowsiness may be experienced.

FUEL TANK AND EXHAUST

When working on fuel system, fire fighting and appropriate safety equipment should be provided in accordance with local fire and safety regulations.

Before making adjustments on Fuel System Units, be sure Electrical System is functioning properly.

WARNING - CARBON MONOXIDE

Keep cowl vent and heater intakes closed when operating in congested traffic to prevent deadly exhaust gases from entering cab.

SECTION 9

Steering System

Contents of this section are listed in Index below:

SECTION 9A

Mechanical Steering

Contents of this section are listed in Index below:

DESCRIPTION

Rotation of the steering wheel is transmitted to the front axle right and left steering arms from the steering gear pitman arm by linkage consisting of a drag link and tie rod. Toe-in is also adjusted and maintained through use of the tie rod.

Steering shaft on cab models is of one-piece construction and uses a rag-type flexible coupling to connect shaft to steering gear worm shaft. Tilt cab, "P," and cowl models use a two-piece shaft arrangement comprised of two universal yoke-type joints and a splined shaft and sleeve which is essential to permit movement of shaft while revolving. Ball bearings are provided at upper and lower ends of steering column, to center steering shaft in column, and to ensure smooth operation of steering system. Components of column and shaft(s) which are subject to wear are replaceable, and methods used for repair are described in detail later.

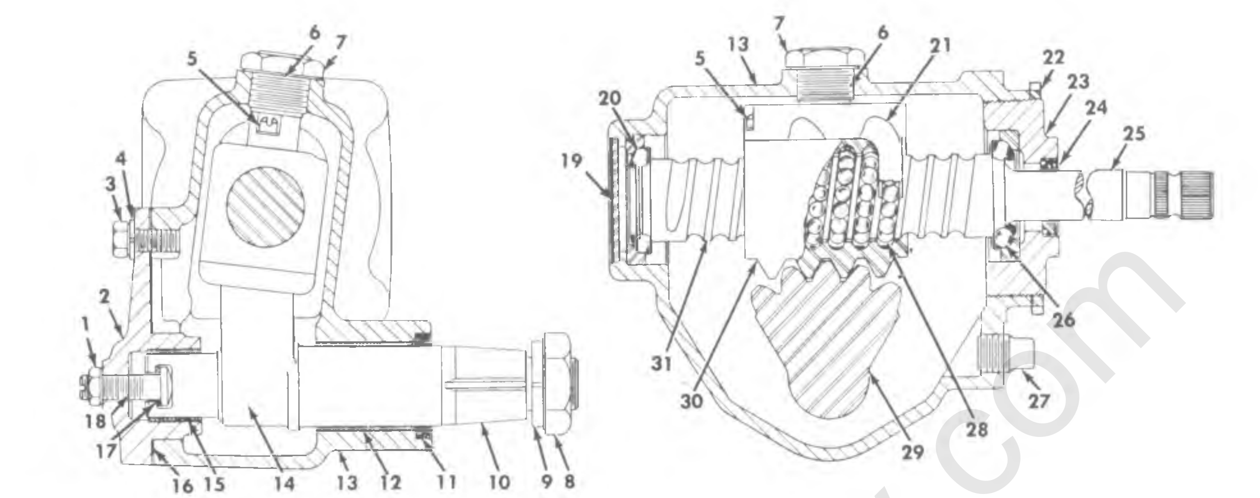
A recirculating ball bearing and sector nut type steering gear, mounted on left frame side rail forward of front wheels, is used on all vehicles covered by this manual. This unit is adjustable for normal wear.

Steering gear assemblies, while similar in construction, vary in size and mounting, depending on truck model application. Refer to "Model Application Chart" at end of this section for proper steering gear application on each truck series.

The major differences in the steering gear assemblies are described in the following text:

NOTE: Refer to "Steering Gear Adjustments" later in this section for adjustment of Pitman shaft lash, back-up adjuster, and worm thrust bearings.

The type 549-D and 553-D steering gear assemblies shown in figure 1 have an adjuster assembly at shaft end of gear housing for adjustment of worm thrust bearing; lip-type oil seals at steering worm and Pitman shaft; shims for adjustment of Pitman shaft lash, and bushings in gear housing and side cover. A back-up adjuster is used on the 553-D-17 type steering gear to prevent the worm shaft from flexing up and down. Figure 5 shows tilt cab steering gear and linkage components.



1 Lash Adjuster Lock Nut
2 Side Cover
3 Side Cover Bolt
4 Lock Washer
5 Clamp Retainer Screw
6 Back-up Adjuster (Type 553-D-17 Only)
7 Back-up Adjuster Lock Nut (Type 553-D-17 Only)
8 Pitman Arm Nut
9 Lock Washer
10 Pitman Shaft
11 Pitman Shaft Oil Seal
12 Housing Bushing
13 Steering Gear Housing
14 Pitman Shaft Sector Gear
15 Side Cover Bushing
16 Side Cover Gasket
17 Lash Adjuster Shim
18 Lash Adjuster
19 Expansion Plug
20 Worm Thrust Bearing
21 Ball Guide
22 Adjuster Lock Nut
23 Cup and Adjuster Assembly
24 Adjuster Worm Thrust Bearing Oil Seal
25 Steering Shaft
26 Upper Worm Thrust Bearing
27 Filler Plug
28 Worm Balls
29 Pitman Shaft Sector Gear
30 Ball Nut
31 Worm Shaft

T-3332

Figure 1—Type 549-D and 553-D Steering Gear

STEERING SYSTEM MAINTENANCE

The following maintenance operations may be accomplished with the steering gear assembly installed in the vehicle.

1. At regular intervals, check and if necessary tighten all steering gear mounting bolts, Pitman arm nut, and gear housing upper cover and side cover attaching bolts.

2. Lubricate the steering gear and related linkage as described in LUBRICATION (SEC. 0) of this manual.

If excess looseness is evident in steering system, all components of steering column should be inspected for wear. Drag link, connecting rod, and tie rod end ball sockets should be checked and repaired if worn. These checks should be made before attempting to inspect or adjust steering gear. If the above checks indicate components to be in good condition, gear assembly may be adjusted.

4. To adjust steering gear assembly, refer to "Steering Gear Adjustments" later in this section.

5. Periodically check steering column mounting bolts and check torque on stop clamp, and worm shaft clamp bolt nuts.

STEERING WHEEL CHUCKING OR CLUNKING NOISE

When steering wheel clunking noise is noted, or an up-and-down chucking movement of steering wheel is encountered, it is possible that upper and lower mast jacket clamps have loosened and should be re-torqued. To tighten and adjust steering column clamps, observe the following:

1. Loosen mast jacket clamps at dash and fire wall.

2. Push steering wheel down until all up-and-down movement has been removed.

3. Tighten clamp at dash; then tighten clamp at fire wall (if used).

4. Adjust "stop" clamp at bottom of steering shaft to allow 0.012" to 0.015" up and down movement of the upper shaft assembly (fig. 2).

NOTE: If "clunking" still exists, the yoke and sleeve assemblies should be disconnected, inspected for wear, and replaced if necessary. This is an important safety procedure which will prevent internal steering shaft joint interference.

Other factors should be considered when attempting to determine source of clunking movement in system. Loose linkage, or worn ball joints

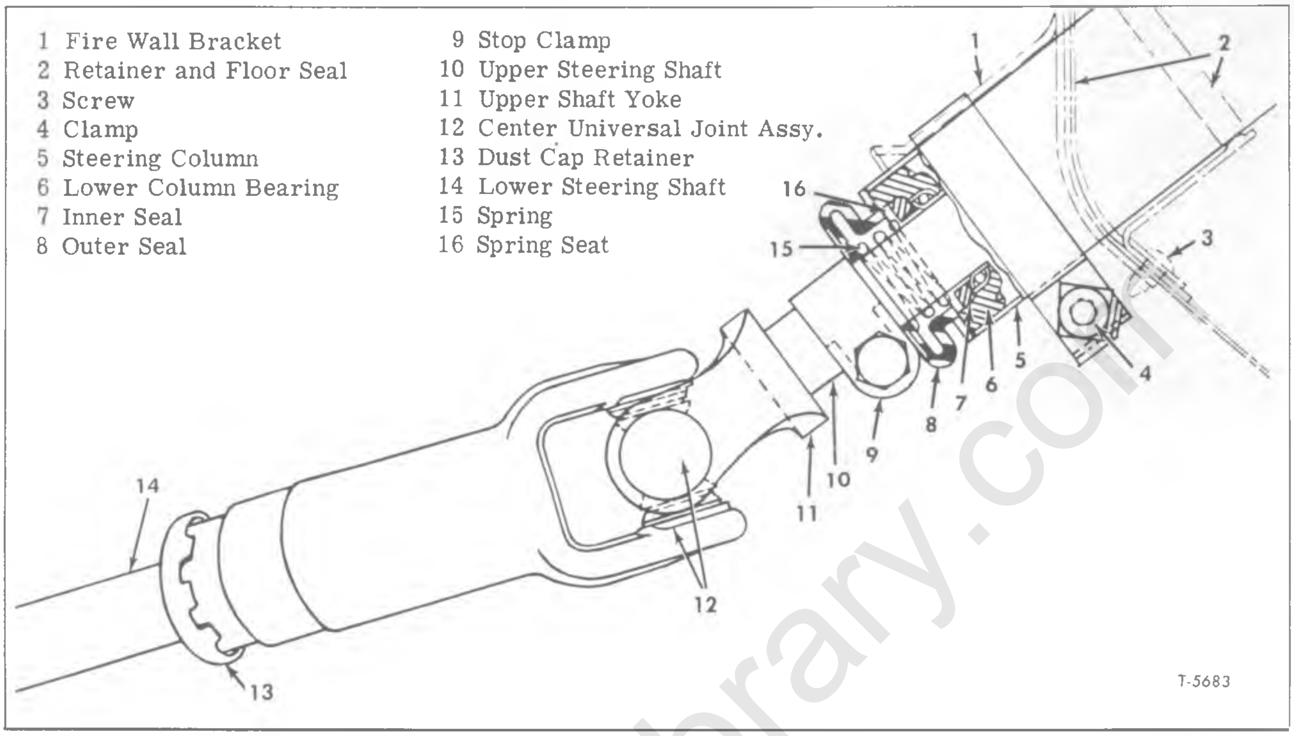


Figure 2—Steering Column Stop Clamp Components

can produce a telescoping effect through steering gear and column to the steering wheel, and it may be difficult to determine whether trouble is in steering column, gear assembly, or linkage components. Some of the most common causes of steering clunk, or chucking movment are as follows:

a. Insufficient lubricant in steering gear assembly.
b. Pitman arm loose on Pitman shaft.
c. Steering gear loose on chassis frame.
d. Steering gear incorrectly adjusted.
e. Air pressure in tires too high.
f. Shock absorbers defective.
g. Worn king pins and bushings.

STEERING GEAR ADJUSTMENTS
(Refer to Figure 3)

The steering gear assembly is designed to provide adjustment to compensate for normal wear at worm bearings, Pitman shaft, and mating parts.

Before adjustments are made to the steering gear in an attempt to correct such conditions as shimmy, loose or hard steering and road shocks, a careful check should be made of front end alignment, shock absorbers, wheel balance, and tire pressure for possible causes.

NOTE: Before making any steering gear adjustment, check lubricant in gear housing and fill to proper level, if necessary, as directed in LUBRICATION (SEC. 0) of this manual. Tighten all mounting bolts to torque recommended in "Specifications" at end of this section.

Procedures for checking and adjusting the steering gear must be performed in sequence given in the following paragraphs:

Always check worm bearing adjustment first, and adjust if necessary, before making Pitman shaft lash adjustment.

NOTE: Before making any adjustments on the steering gear, loosen back-up adjuster lock nut (if used); then loosen back-up adjuster.

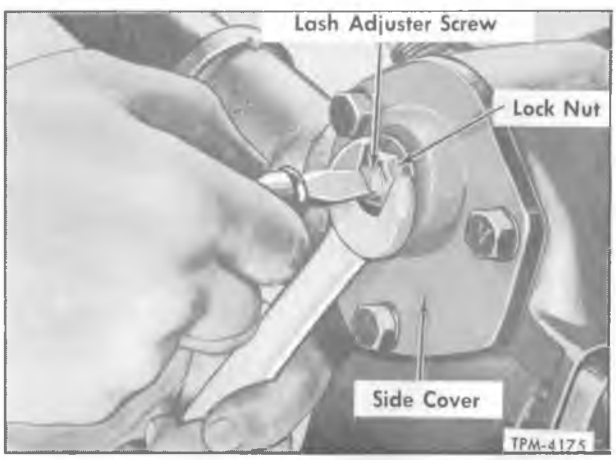


Figure 3—Adjusting Sector Gear Lash

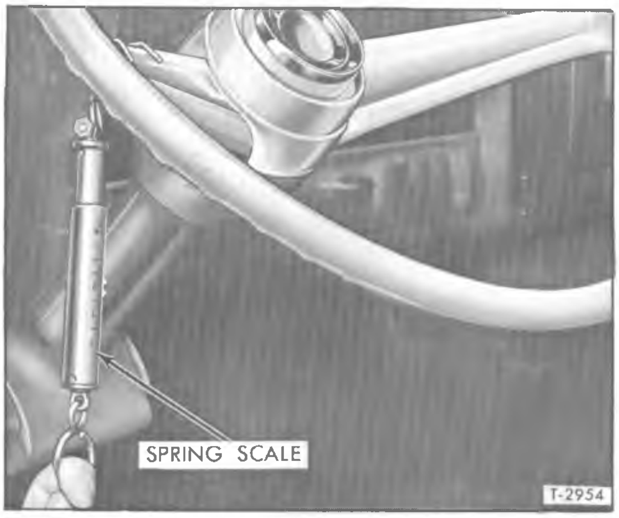


Figure 4—Checking Steering Wheel Rim Pull

CHECKING WORM BEARING ADJUSTMENT

1. Disconnect drag link or connecting rod from Pitman arm. Note relative position of linkage and Pitman arm so parts may be reassembled in same relative position. Refer to "Steering Linkage" later in this section for correct procedures.

2. Loosen lock nut and turn lash adjuster (fig. 3) a few turns counterclockwise to relieve load from worm bearings and to provide clearance between the sector gear and worm ball nut.

3. Turn steering wheel GENTLY in one direction until stopped by gear "stops" or by reaching end of travel, then back away one full turn.

> **CAUTION: DO NOT turn steering wheel hard against "stops" when linkage is disconnected from Pitman arm as damage to ball guides may result.**

4. Attach spring scale (J-544-01) at rim of wheel as shown in figure 4. Pull on scale in a line at right angle to wheel spoke and measure the amount of pull required to keep the wheel moving. If worm bearings are properly adjusted, reading on spring scale should be between 1½ and 2 pounds.

If pull is not within 1½ to 2 pounds, worm bearings require adjustment. If "rough" or "lumpy" action is noted during check, worm bearings are probably damaged. Steering gear should then be removed, disassembled, and bearings examined. If worm bearings do not require adjustment, adjust Pitman shaft lash as described later in this section. Adjust worm bearings as follows:

WORM BEARING ADJUSTMENT

1. Loosen adjuster lock nut (22) (fig. 1) at shaft end of steering gear and turn worm bearing adjuster screw (23) clockwise until there is no perceptible end play in the worm.

2. Using spring scale (J-544-01), check steering wheel rim pull as outlined previously. Turn adjuster screw until a pull of 1½ to 2 pounds is obtained on spring scale at steering wheel.

3. Tighten adjuster lock nut to torque recommended in "Specifications."

PITMAN SHAFT LASH ADJUSTMENT

1. Center steering gear by turning steering wheel from extreme right to extreme left positions, counting the exact number of turns. Turn wheel back exactly half-way, to center position. Mark wheel at top or bottom center with a piece of tape.

2. Loosen lash adjuster lock nut and turn adjuster screw (fig. 3) clockwise to remove all back lash between gear teeth. Tighten lock nut to 25-35 foot-pounds torque, then check steering wheel rim pull as outlined previously. Measure greatest pull as wheel is pulled through center position. Rim pull should be 2¾ to 3¼ pounds.

3. If rim pull is not within specified limits, loosen lock nut and turn lash adjuster to obtain proper wheel rim pull.

IMPORTANT: Always check wheel rim pull after lock nut has been tightened.

4. On vehicles equipped with the 553-D-17 type steering gear, turn back-up adjuster in until it bottoms, then back off 1/8 to 1/4 turn and tighten lock nut to torque listed in "Specifications" at end of this section.

5. After all adjustments have been completed, reconnect drag link or connecting rod to Pitman arm as described under "Steering Linkage" later in this section.

STEERING GEAR REPLACEMENT

(Refer to Figures 5 and 6)

If the steering gear cannot be properly adjusted, or if during adjustment procedures "rough" operation is noticed, the steering gear must be removed from the vehicle and overhauled. The steering gear must be removed from the vehicle for all overhaul or repair procedures.

STEERING GEAR REMOVAL

1. Disconnect steering linkage from Pitman arm.

2. Scribe an alignment mark on steering gear worm shaft and clamp yoke or coupling on steering gear lower or intermediate shaft (fig. 6).

3. Remove bolt attaching lower or intermediate shaft clamp yoke or coupling to steering gear worm shaft (3).

NOTE: When removing flexible coupling-type joint (fig. 6), remove the two bolts and nuts which secure lower clamp plate to balance of rag joint assembly.

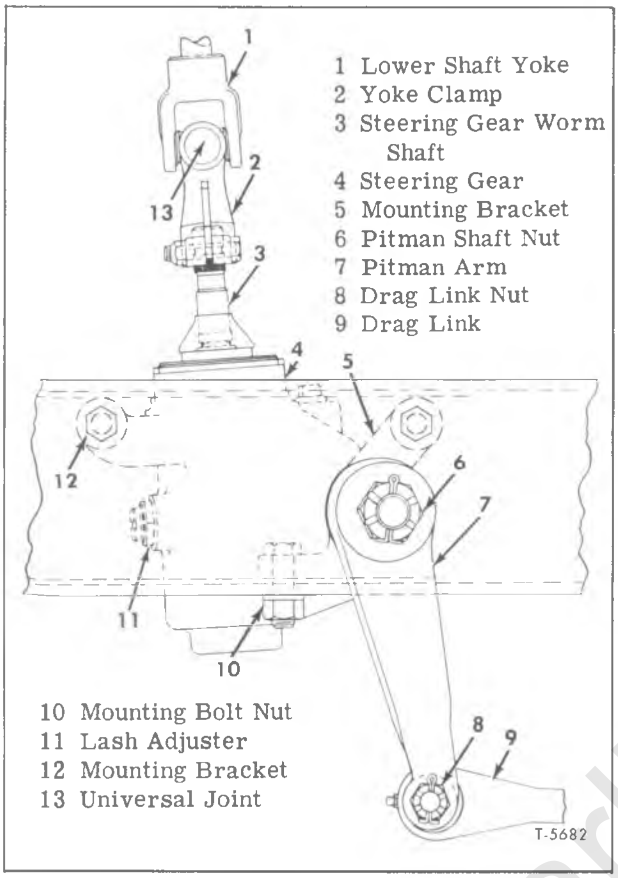


Figure 5—Steering Gear and Connections (Tilt Cab Models)

4. Remove Pitman arm nut (6) and lock washer; then using puller (J-3186) remove Pitman arm (7) (fig. 5).

5. Remove bolts, nuts, and washers which attach steering gear to frame and remove steering gear.

STEERING GEAR INSTALLATION

1. Position steering wheel in straight-ahead position and steering gear in center position. Mark on worm shaft should be in 12 o'clock position on vehicles equipped with the 549-D type steering gear and in 6 o'clock position on vehicles equipped with the 553-D type steering gear.

2. Position steering gear on frame side member, and at the same time slide the worm shaft (3) into the clamp yoke (2) or coupling on steering lower or intermediate shaft.

IMPORTANT: Check to make sure match marks on lower or intermediate shaft clamp yoke or coupling and steering gear worm shaft are aligned.

3. Install bolts, nuts, and washers which attach steering gear to frame. Tighten bolts to torque listed in "Specifications" at end of this section.

On all models with "In-line" 292 engine, install spacer washer (2) between steering gear and frame at rear bolt location as shown in figure 7.

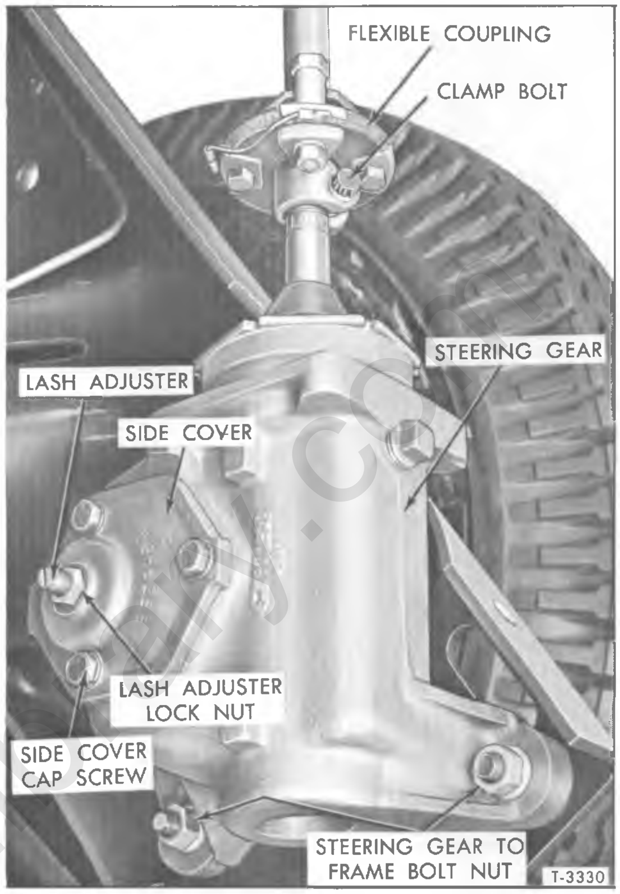


Figure 6—Steering Gear and Shaft (with Flexible Coupling)

4. Attach lower or intermediate shaft clamp yoke or coupling to steering gear worm shaft with bolt; or bolt, nut, and washer. Tighten bolt or nut to torque listed in "Specifications" at end of this section.

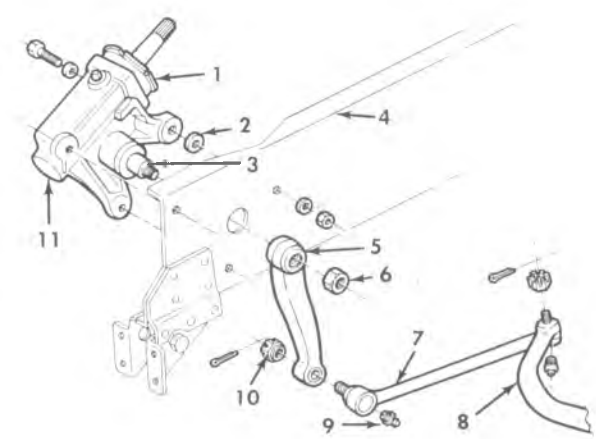
On all vehicles Pitman arm and Pitman shaft have matching blank serrations which must be aligned. With Pitman arm and shaft aligned, press Pitman arm onto shaft and install washer and Pitman shaft nut. Tighten nut to torque listed in "Specifications" at end of this section.

STEERING LINKAGE

(Refer to Figure 7)

DESCRIPTION

Turning motion of steering wheel is transmitted through the steering gear (1) and Pitman shaft (3) to the Pitman arm (5), which is connected to the drag link (7). Drag link is designed with a ball joint at each end, and is connected to left front steering arm (8). Steering control of right wheel is accomplished through use of the tie rod which is located



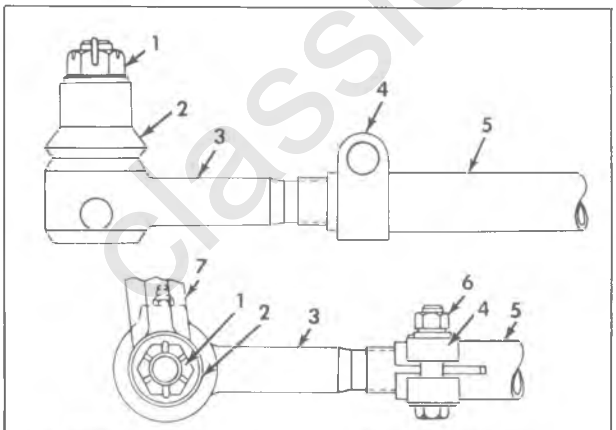
1 Worm Shaft Adjuster Lock Nut
2 Spacer Washer
3 Pitman Shaft
4 Frame
5 Pitman Arm
6 Pitman Shaft Nut
7 Drag Link
8 Steering Arm
9 Lubrication Fitting
10 Drag Link Stud Nut
11 Steering Gear T-5684

Figure 7—Steering Linkage (Typical)

at rear of axle. This tie rod is connected by means of ball sockets to left rear steering arm and it extends to opposite side of axle and fastens to right wheel steering arm. Steering linkage although similar, is not the same for all series vehicles covered in this manual.

Steering linkage between steering gear and front wheels affects steering action. If parts are out-of-adjustment, bent, damaged, worn, or twisted, poor steering will result. Steering linkage should be properly adjusted at all times.

NOTE: Whenever any steering linkage components have been repaired or replaced, check steering geometry and front end alignment as described in FRONT SUSPENSION (SEC. 3).



1 Nut
2 Seal
3 Tie Rod End
4 End Clamp
5 Tie Rod
6 Clamp Bolt Nut
7 Steering Arm
T-5685

Figure 8—Steering Tie Rod

STEERING DRAG LINK OR CONNECTING ROD

(Refer to Figure 7)

A non-adjustable drag link or connecting rod (7) is used to connect the Pitman arm to the left steering arm. No periodic maintenance is required other than lubrication and keeping stud nuts properly torqued. If drag link or connecting rod becomes worn or damaged, replace the complete assembly as follows:

REMOVAL

1. Remove cotter pin at each end of drag link or connecting rod. Discard cotter pins, and remove nut (10) from ball socket stud.
2. Using a soft hammer, tap each ball stud until drag link or connecting rod is loose. Remove drag link or connecting rod from vehicle.

INSTALLATION

1. Position drag link or connecting rod to Pitman arm (5) and steering arm (8), then install ball stud nut (10) at each end. Tighten nuts firmly to fit tapered studs snugly and prevent movement when nuts are torqued.
2. Using a torque wrench, tighten ball stud nuts to 125 to 150 foot-pounds torque, then advance to next cotter pin hole and install cotter pin to secure stud nut.

STEERING TIE ROD

(Refer to Figure 8)

DESCRIPTION

Vehicles covered in this manual have a three-piece tie rod connecting left and right steering arms. The tie rod assembly consists of a tube and two socket end assemblies. Socket end assemblies are threaded into tube and locked in place with clamps. Right- and left-hand threads are provided to facilitate toe-in adjustment and steering wheel centering.

The tie rod ends are self-adjusting and require no attention in service other than periodic lubrication and inspection to see that ball studs are tight. Socket ends should be replaced when excessive up and down motion or any lost motion or end play at ball end of stud exists.

MAINTENANCE

1. Clamp bolt nuts should be periodically checked for tightness.

2. Inspect tie rod for bent condition. If tie rod is bent more than 5 degrees, replace assembly. If tie rod is bent less than 5 degrees, tie rod may be straightened provided cold straightening method is used.

3. Lubricate tie rod ends as directed in LUBRICATION (SEC. 0) of this manual.

TIE ROD REPLACEMENT

Removal

1. Remove cotter pins and stud nuts attaching tie rod to right or left steering arm.

2. Remove ball stud from steering arm by positioning a jack under arm and applying light lifting force, while tapping on socket end with a hammer. A heavy hammer as a backing at the steering arm may be used as an alternate method, if desired. Push downward, on tie rod to remove from steering arm.

NOTE: If tie rod end assemblies are damaged in any way, they must be replaced.

Installation

1. If tie rod was dismantled, position clamps on ends of rod.

NOTE: Threads on socket end, and in tie rod tube must be clean and free from rust or difficulty in adjusting toe-in will be experienced.

2. Thread socket ends into tie rod tube and make certain ends are threaded in an equal distance.

3. Position socket end studs into steering arm holes, and install stud nuts, tighten nuts to torque specified in "Specifications" at end of this section. Install new cotter pins, and spread ends. Lubricate socket ends as described in LUBRICATION (SEC. 0) of this manual.

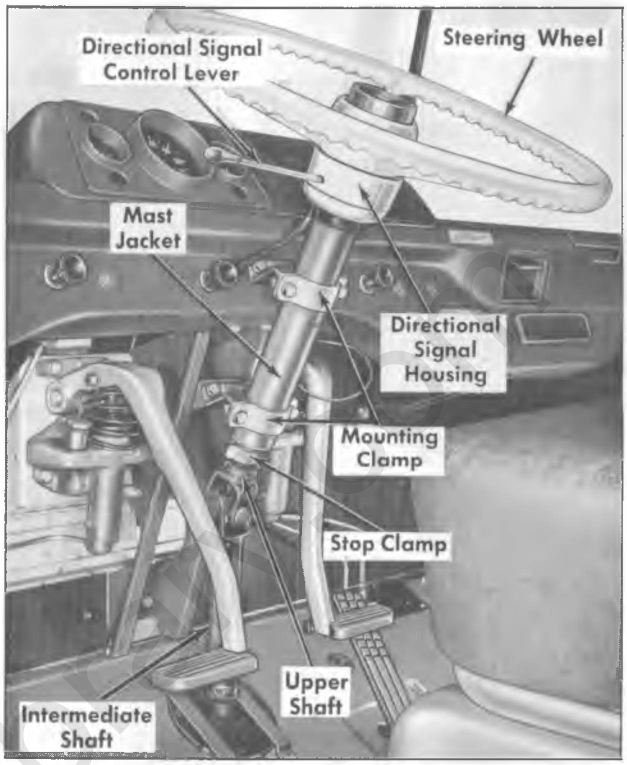


Figure 9—Steering Column and Shaft (Tilt Cab Models)

4. Adjust toe-in as described in FRONT SUSPENSION (SEC. 3). Refer to "FRONT AXLE" (SEC. 3B) of this manual for correct dimension.

5. Before tightening tie rod clamp bolts, make sure tie rod ends are in alignment with each other. Position clamps so that clamp bolt opening is in line with slot in tie rod tube. Clamp will be difficult to tighten sufficiently to lock socket end in place, if not properly positioned on tie rod.

STEERING WHEEL AND STEERING COLUMN

DESCRIPTION

(Refer to Figures 14, 16, and 17)

Steering column on models covered in this manual may be either one-piece or two-piece construction depending upon type of model it is used on. Universal type joints are used on models where straight steering shafts are not suitable (see fig. 9). Shafts are clamp fastened to steering worm shaft at steering gear assembly. Column is secured to dash and cowl by brackets and fastened with bolts and nuts. Ball-type bearings are used in steering column upper and lower ends. Steering wheel used on tilt cab and PS4500 series is a three-spoke type, while the two spoke type is used on remaining models covered in this manual. Steering wheel is a tapered splined fit on steering shaft, and it houses the horn switch assembly. It is retained by a washer and lock nut. Steering shaft has an alignment mark stamped on its end, and wheel should be installed with the cut-out portion of horn contact centered with mark on shaft as shown in figure 15.

Turn signals and hazard warning switch are located in upper steering column housing, except on tilt cab models where hazard warning switch is located on dash.

MULTIPLE WIRE CONNECTORS

DISASSEMBLY

On all models except PS-4500, to remove harness from steering column it will be necessary to remove multiple connector at end of harness. Tool

MECHANICAL STEERING

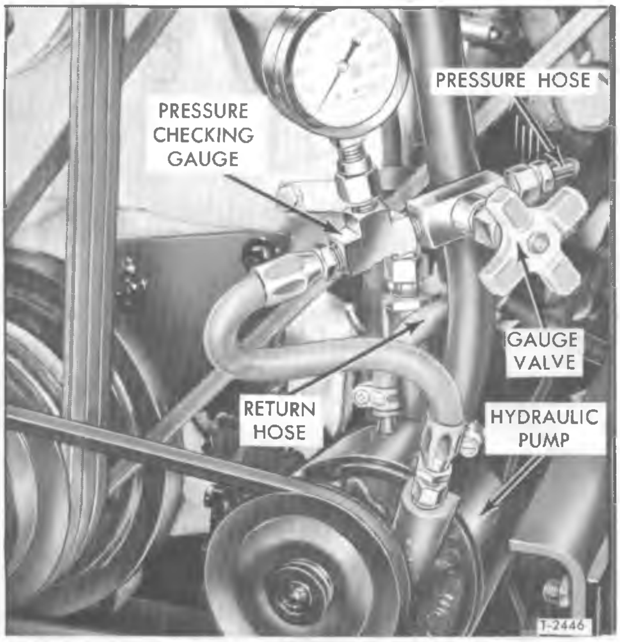


Figure 10—Steering Wheel Removal (Typical)

(J-21091) may be used on twin lock-type connector. If not available, two small thin screwdrivers may be inserted at each side of connector to relieve tension on lock tabs. Thin screwdriver may also be used on blade-type connector to accomplish removal of terminal.

NOTE: Before removing wires from connector, wires should be tagged, and numbered in relation to the holes in which they are to be re-inserted in connector. If doubt exists as to proper location of wires in connector, see appropriate Wiring Diagrams booklet.

STEERING WHEEL REPLACEMENT

(Refer to Figure 16)

Removal

1. Disconnect directional signal switch harness from chassis wiring harness connector.
2. Set front wheels in straight-ahead position; then pry horn button cap (13) and retainer (12) from steering wheel.
3. Remove steering wheel locking nut (11) and washer.
4. Using puller (J-2927-01), remove steering wheel (fig. 10). It may be necessary to tap on bolt head of tool with a hammer as it is tured down to loosen a tight steering wheel.

Installation

NOTE: Front wheels must be in straight ahead position and directional signal control assembly must be in neutral position when installing steering wheel.

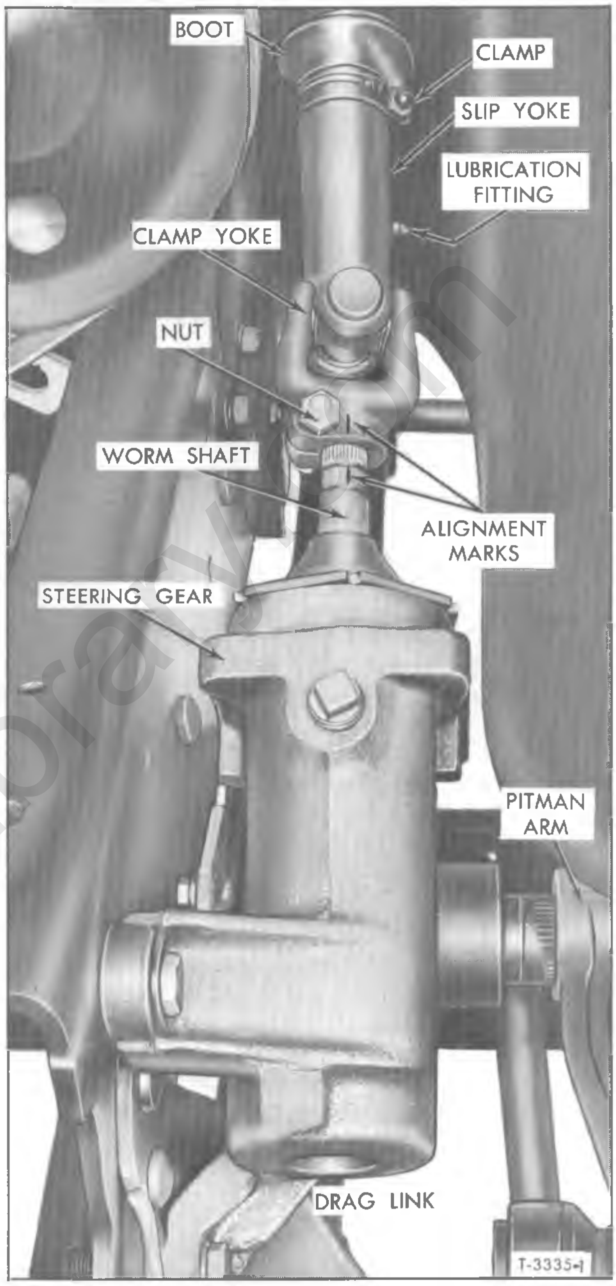


Figure 11—Steering Gear and Lower Shaft Installed

1. On vehicles equipped with a two-spoke steering wheel, position wheel on steering shaft with spokes of wheel in a horizontal position. On vehicles equipped with a three-spoke wheel, position wheel on shaft with lower spoke of steering wheel in vertical position. Line up cut-out portion of horn receiver cup with mark on steering shaft as shown in figure 15.
2. Tap steering wheel gently into place.
3. Install washer and steering wheel locking nut on steering shaft. Tighten nut to torque listed in "Specifications" at end of this section.

4. Install retainer and horn button cap and connect directional signal wiring harness to chassis wiring harness connector.

STEERING COLUMN AND SHAFT (CAB AND COWL MODELS)

REMOVAL (Refer to Fig. 14)

NOTE: A one-piece steering shaft is used on all cab models and a two-piece shaft is used on all cowl models.

1. Disconnect directional signal and emergency disability lighting connector from multiple connector under dash.
2. Remove steering wheel as described under "Steering Wheel Replacement" previously.
3. Mark clamp yoke (19) or coupling and steering gear worm shaft (20) to insure installation in the same relative position (figs. 6 and 11).
4. Remove bolt attaching clamp yoke or coupling on steering shaft to steering gear worm shaft.
5. If used, remove cap screws which attach trailer brake hand control valve to steering column and remove attaching clamp.
6. Remove screws which attach steering column seal retainer and seal (2) to cab floor.
7. Remove bolts which attach steering column (5) to supports and braces, then pull housing off steering shaft and remove from vehicle.

NOTE: On vehicles equipped with the one-piece steering shaft, the dash support brace (4) must be removed to gain sufficient clearance to remove steering shaft and coupling.

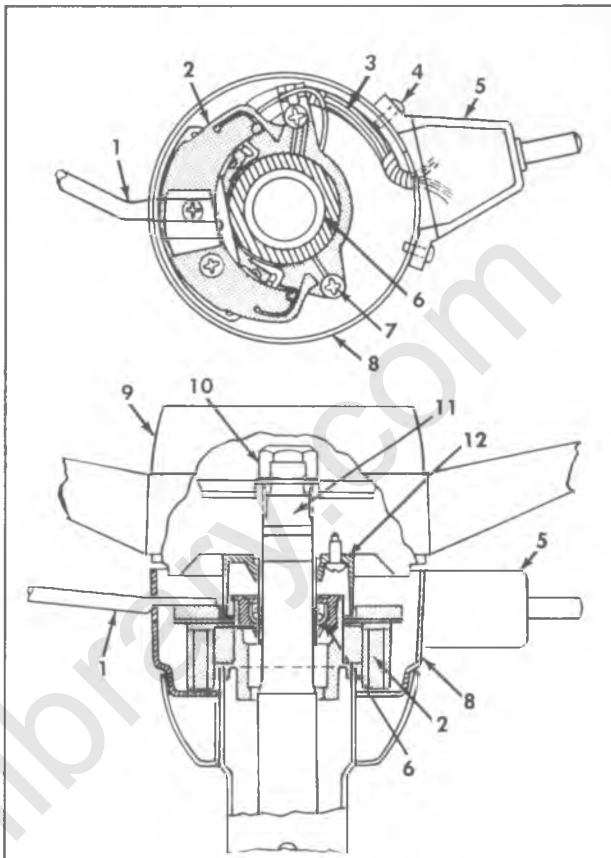
8. Lift clamp yoke or coupling off steering gear worm shaft, then twist and turn shaft assembly as required to remove from vehicle.

DISASSEMBLY

1. Remove screws attaching directional signal control lever to control switch assembly and remove lever (1, fig. 12).

NOTE: It is necessary to remove multiple wire connector at end of harness before directional switch can be removed. See "Multiple Wire Connectors" as described previously in this section.

2. Remove three screws (7, fig. 12) which attach directional signal control switch assembly (2) to control housing (8). Remove switch and harness (3) from housing.
3. Twist directional control housing (8, fig. 12) counterclockwise and remove from steering column
4. Pull steering shaft (7) from steering column (5), and pry lower bearing (11) from tube, if bearing is worn or defective.
5. Remove bearing inner seal (12), spring seat (13), spring (14) and outer seal assembly (15). Remove stop clamp (16) and bolt, if desired.



1 Directional Lever	8 Directional Housing
2 Directional Switch	9 Steering Wheel
3 Harness	10 Steering Shaft Lock Nut
4 Screw	
5 Hazard Warning Switch	11 Upper Steering Shaft
6 Upper Bearing	12 Canceling Cam
7 Switch Retainer Screw	T-5686

Figure 12—Upper Steering Column (Typical)

6. Referring to figure 13, on vehicles with two-piece shaft, remove snap rings (2) from inside of universal joint. Tap yoke sideways to dislodge bushing (1) of adjoining yoke, repeat operation until all bushings are removed. Remove cork seals (3) from journal and discard.
7. Referring to figure 13, to remove slip yoke (6) from lower shaft assembly (9), bend tabs of dust shield (8) away from retainer groove. Pull shaft (9), felt seal (7), and washer (5) from yoke sleeve (6).

CLEANING, INSPECTION, AND REPAIR (ALL MODELS)

Inspect steering column bearings for rough spots or loose worn condition, if bearing shows slightest indication of deterioration it should be

MECHANICAL STEERING

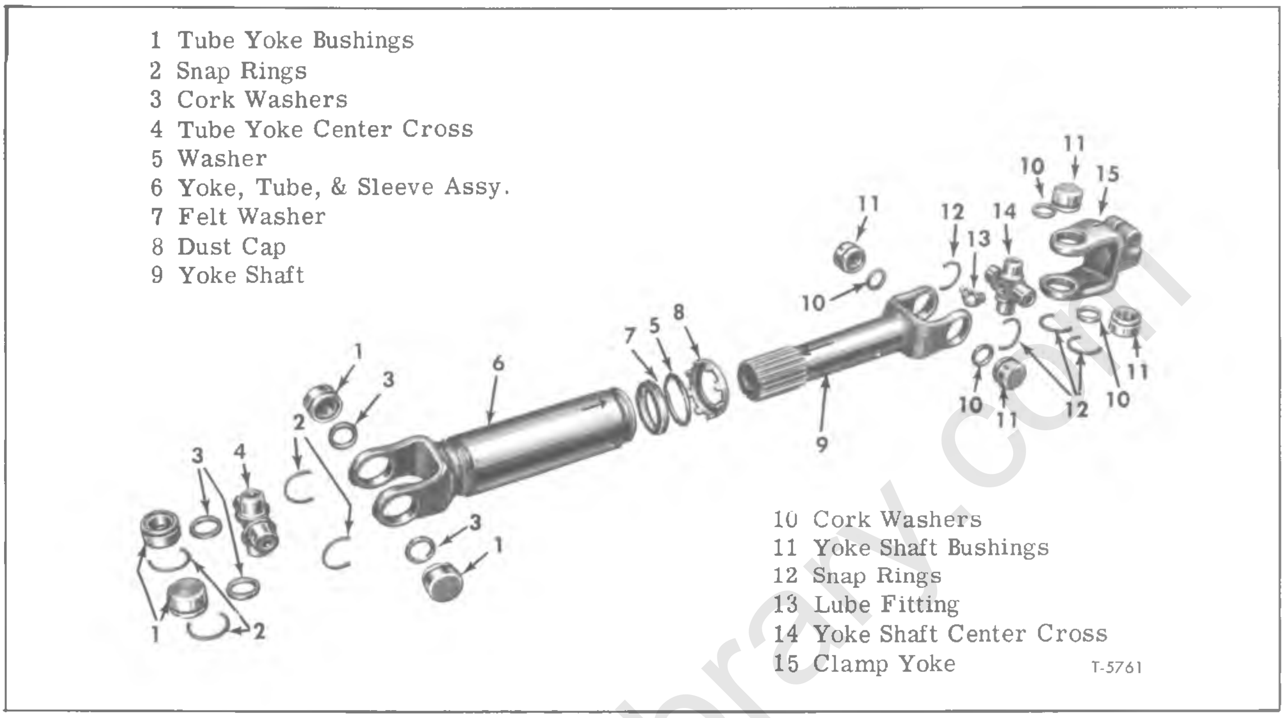


Figure 13—Intermediate Shaft (Typical)

replaced. Inspect all wiring, connections, and directional control switch assembly for bare spots, loose connections, or general deterioration. Directional switch is serviced as an assembly, complete with wiring harness. Switch should operate smoothly and be free from binding condition. Check horn contact brush surface, and inspect contact plunger for freedom of action and binding condition. Upper column bearing horn contact surface should not be worn excessively or have deep grooves cut it it.

Clean all universal joint parts in a suitable solvent. Inspect bearing bushings for galling, which is evidenced by pitting or deep ridges in bores. Inspect journal bearing surfaces for galled spots. Check amount of journal and bushing clearance, if it is excessive, replace joint or correct steering adjustment will be difficult to obtain. If any of the above conditions exist, parts should be replaced. Journal and bushing assembly should be replaced as a complete unit only. If only badly worn parts of a unit are replaced, premature replacement of remaining parts will be necessary later.

All mounting brackets and components should be checked for cracks and breaks, repair or secure new parts as necessary. All dust shields of rubber or similar construction should be replaced with new, if slightest evidence of damage is present. Install all new seals when assembling steering system.

ASSEMBLY

Key numbers in text refer to figure 14, except where noted.

1. Press bearing (11) into lower end of steering column tube (5). Install directional signal housing (6) at upper end of column by turning unit clockwise to lock it in place in upper jacket.

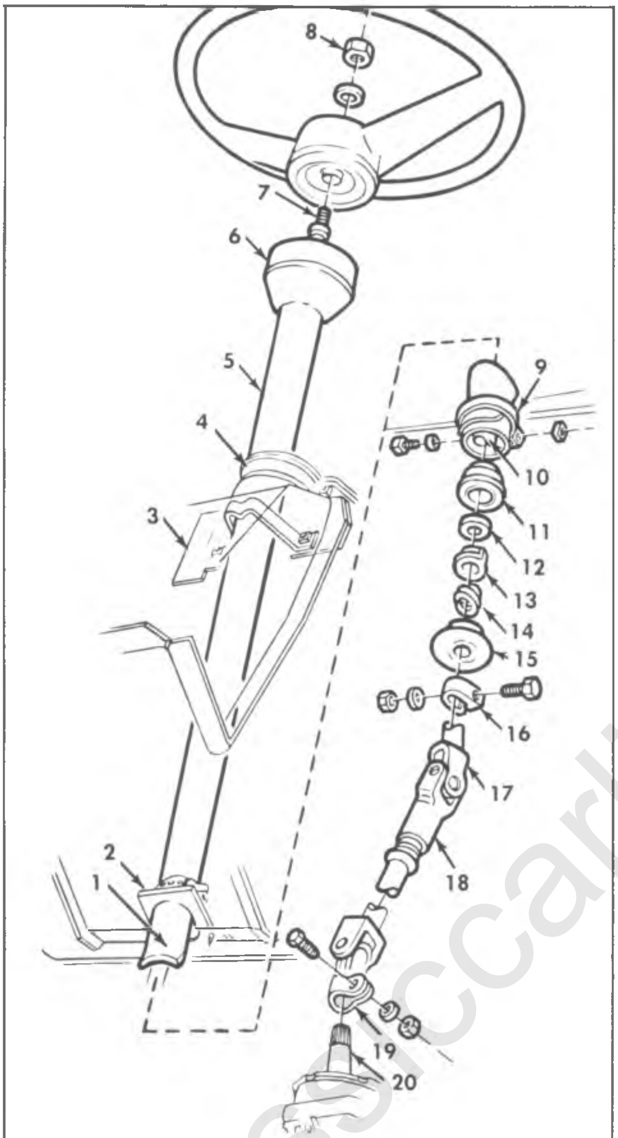
NOTE: It is necessary to insert wiring harness through opening in base of upper column jacket before locking switch and directional housing, to column with the three attaching screws. See "Multiple Wire Connectors" of this section for connector installation.

2. Referring to figure 12, install directional and hazard warning control switch and harness (2 and 3) in housing (8) using the three retainer screws (7). Tighten screws securely. Install hazard warning switch (5) to housing. Inspect wiring harness (3) and make certain it is not pinched and is properly positioned. Install directional control lever (1) to bracket on control switch. On columns using clips, secure harness to clips.

3. On vehicles using two-piece steering column, assemble center universal joint (17), bushings, and seals to yokes, and journal using new repair kit. Lubricate joint when assembled.

4. If lower universal joint was disassembled, assemble joint as described in Step 3 above.

5. Referring to figure 13, install tabbed dust cap (8), washer (5), and felt seal (7) on lower

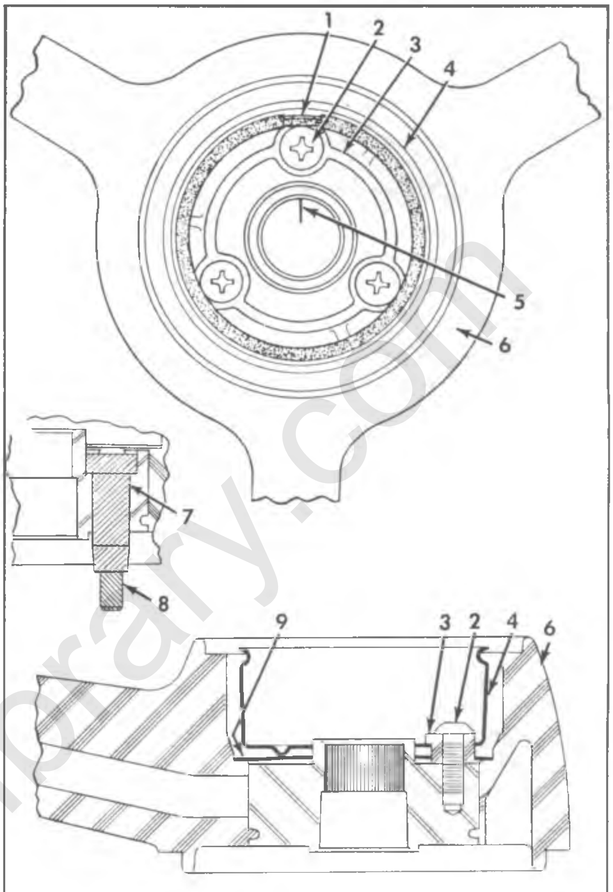


1 Cowl Bracket
2 Floor Seal
3 Dash Bracket
4 Column Clamp
5 Steering Column
6 Directional Switch Housing
7 Upper Steering Shaft
8 Steering Wheel Lock Nut
9 Lower Column Clamp
10 Steering Shaft
11 Lower Bearing
12 Inner Seal
13 Spring Seat
14 Spring
15 Outer Seal
16 Stop Clamp
17 Center Universal Joint
18 Slip Yoke
19 Lower Shaft Clamp
20 Worm Shaft

T-5796

Figure 14—Steering Column and Shaft (Conv. Models)

splined shaft, and joint assembly. Lubricate and insert splined end of shaft (9) into intermediate slip yoke assembly (6). Crimp ends of dust cap tabs into groove at end of slip yoke.



1 Notch in Receiver Cup
2 Retainer Screw
3 Bushing Spacer
4 Receiver Cup
5 Alignment Mark
6 Steering Wheel Hub
7 Horn Contact Cartridge
8 Contact Brush
9 Bellville Spring

T-5799

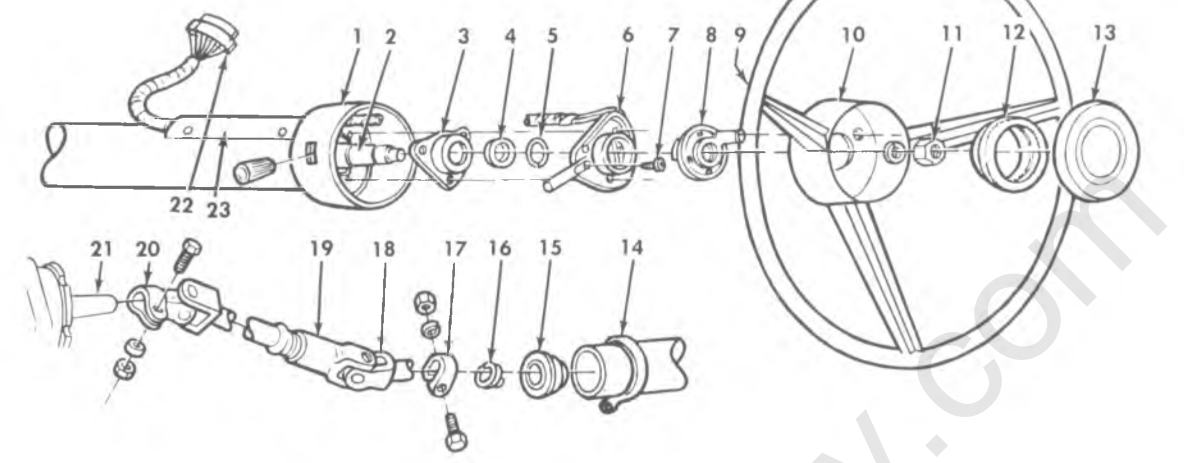
Figure 15—Horn Assembly Components

6. Slide stop clamp and bolt (16), outer seal (15), spring (14), spring seat (13), and inner seal (12) on upper steering shaft, and in that order. Install floor column seal (2) on steering shaft or column before assembling shaft to steering column.

7. Insert single or two-piece shaft through lower bearing (11), and push upward through upper bearing until shaft (7) extends past top of mast jacket.

8. Referring to figure 15, insert horn contact cartridge assembly (7) into hole in steering wheel hub. Insulator and brush should extend past the underside of hub when fully positioned as shown.

9. Referring to figure 15, install diaphragm type spring (9) receiver cup (4) and plastic bushing spacer (3) into opening at top side of steering wheel hub. Secure all parts with three screws (2) and torque to 20-30 inch-pounds. At under-side of hub, check movement of horn contact brush (8); it should



1 Directional Housing
2 Upper Steering Shaft
3 Switch Support
4 Upper Bearing
5 Snap Ring
6 Directional and Hazard Warning Switch
7 Screw
8 Cam Assembly
9 Steering Wheel
10 Steering Wheel Hub
11 Steering Wheel Lock Nut
12 Retainer
13 Horn Button
14 Lower Steering Column Clamp
15 Lower Bearing
16 Spring
17 Stop Clamp
18 Center Universal Joint Assy.
19 Slip Yoke
20 Lower Shaft Clamp
21 Worm Shaft
22 Multiple Connector
23 Upper Harness Cover

T-5797

Figure 16—Steering Column and Shaft (P Models)

be under spring tension and be free from binding condition. Place canceling cam over brush, and align holes in cam with two tapped holes in hub. Secure cam to hub with two screws and tighten securely.

INSTALLATION

1. Position steering shaft and coupling, or upper and lower column assembly of two section units in vehicle. Place yoke clamp (19), or coupling clamp, on steering gear worn shaft (20), with match marks aligned.

2. Raise column into position and loosely install all brackets, and bolts or clamps (4) as they were previous to removal. Position floor seal (2) in place at cowl or floor.

IMPORTANT: To prevent axial bind, all steering column attaching brackets, or supports should be tightened first where they fasten to cab. Tighten steering shaft coupling, or yoke clamp at steering gear worm shaft, before tightening clamps which actually secure the column to mounting brackets.

3. Install screws which attach steering column floor seal and retainer to floor or cowl.

4. Tighten all the steering column attaching clamps, bolts, and nuts in the sequence just described. Tighten all clamps to the torque listed in "Specifications" at end of this section.

5. Install steering wheel to steering shaft (7) using care to align mark on shaft end, with center of cut-out portion of horn receiver cup as shown in figure 15. Tap wheel on shaft and install washer and lock nut (8). Torque nut to 45-50 foot-pounds. Press horn button into place in wheel hub.

6. At lower end of steering column position inner seal (12), spring seat (13), spring (14), outer column seal (15), and stop clamp bolt and nut (16) against lower column bearing (11). Install with inner seal inserted in lower bearing recess. Adjust stop clamp so that 0.12" minimum to 0.15" maximum axial shaft end play movement exists. This clearance must be maintained to prevent binding of bearings or steering wheel chucking condition.

7. Connect directional signal and hazard warning wiring connector to multiple connection under dash.

8. Secure trailer hand brake control to column if previously removed.

9. Test action of steering wheel for bind, looseness, or chucking, and make adjustments, if necessary. Check turn lights, hazard warning, and horn operation. Inspect all components for loose bolts and tighten if necessary.

STEERING COLUMN AND SHAFT ("P" MODELS)

REMOVAL (Refer to Fig. 16)

1. Disconnect directional signal wiring from multiple connector (22) under dash.

2. Remove steering wheel as described previously under "Steering Wheel Replacement."

3. Mark lower shaft slip yoke clamp (20), and steering gear worm shaft (21) to insure installation in same relative position.

4. Remove clamp bolt from lower steering shaft clamp, at steering gear worm shaft.

5. Remove the two upper and lower steering column clamps (14).

NOTE: On some models sufficient clearance may exist at top of column to remove column and shaft by pulling straight up until bottom of shaft clears floor board. On other models it may be necessary to remove bolts and spacers holding parking brake to dash bracket. Column can then be readily removed by pivoting sideways and pulling up through floor board.

6. Pry rubber seal loose at floor board and slide it up on steering column.

7. Pry or pull yoke clamp (20) from steering gear worm shaft. Remove steering column assembly from vehicle.

DISASSEMBLY

1. Remove snap ring (5) from groove of upper steering shaft (2), and pull shaft from steering column.

2. Lift bearing (4) from switch assembly (6). Remove directional control lever from directional switch assembly. Remove the three special screws (7) which retain directional and hazard warning switch (6) to housing (1). At side of steering column, remove four screws and cover (23) which retain harness to column. Lift switch support (3), and harness assembly from column and housing.

3. Remove directional switch housing (1) by turning counterclockwise off steering column.

4. Pull, or pry lower bearing (15) from steering column.

5. Remove stop clamp bolt, and remove stop clamp (17), and spring (16) from upper steering shaft.

6. Referring to figure 13, to separate upper and lower shaft assembly, remove two inner snap rings (2) from bushings (1). Tap yoke sideways to dislodge bushings of adjoining yoke. Repeat operation until all bushings are removed. Remove cork seals (3) from journal (4) and discard.

7. Referring to figure 13, to remove slip yoke (6) from lower shaft assembly (9) bend tabs of dust shield (8) away from retainer groove. Pull shaft (9), with dust shield (8), washer (5) and felt seal (7) from yoke sleeve.

INSPECTION

Inspect steering column components and replace or repair as described previously in "Inspection" of this section.

ASSEMBLY

1. Insert bearing (15) into lower end of steering column.

2. Install upper directional and hazard warning housing (1) to steering column. Align slots in base of housing with locking tabs of steering column, twist housing clockwise to lock.

3. Assemble switch support (3), directional and hazard switch (6) and bearing (4) together. Insert unit in housing (1) with hazard warning lever through hole in housing and with wiring harness through cut-out portion of mounting base plate. Secure all parts to housing with the three special screws (7) provided.

4. Align harness as it leaves housing in formed groove of steering column. Place tape over harness at edge of steering column to prevent chafing of wires. Secure cover (23) to column, over harness with four screws, using care not to pinch wires.

5. Fasten directional control lever to switch using single screw. Tighten firmly.

6. Referring to figure 13, at lower steering shaft, position tabbed dust cap (8), metal washer (5) and new felt seal (7) on splined yoke shaft (9). Lubricate splines lightly. Align arrows on yoke shaft (9), and slip yoke tube (6). Slide shaft into tube and crimp tabs of dust cap into groove in yoke tube.

7. Referring to figure 13, position center cross (4) of lower shaft yoke in upper shaft yoke. Install all new cork washers (3), yoke bushings (1), and snap rings (2). Tap or press bushings in yokes until snap rings can be installed.

8. Assemble lower clamp yoke (15), to lower shaft yoke, using new cork seal (10), bushing (11), and snap ring (12) if joint was previously disassembled.

9. Slide stop clamp (17), and spring (16) over end of upper shaft (2).

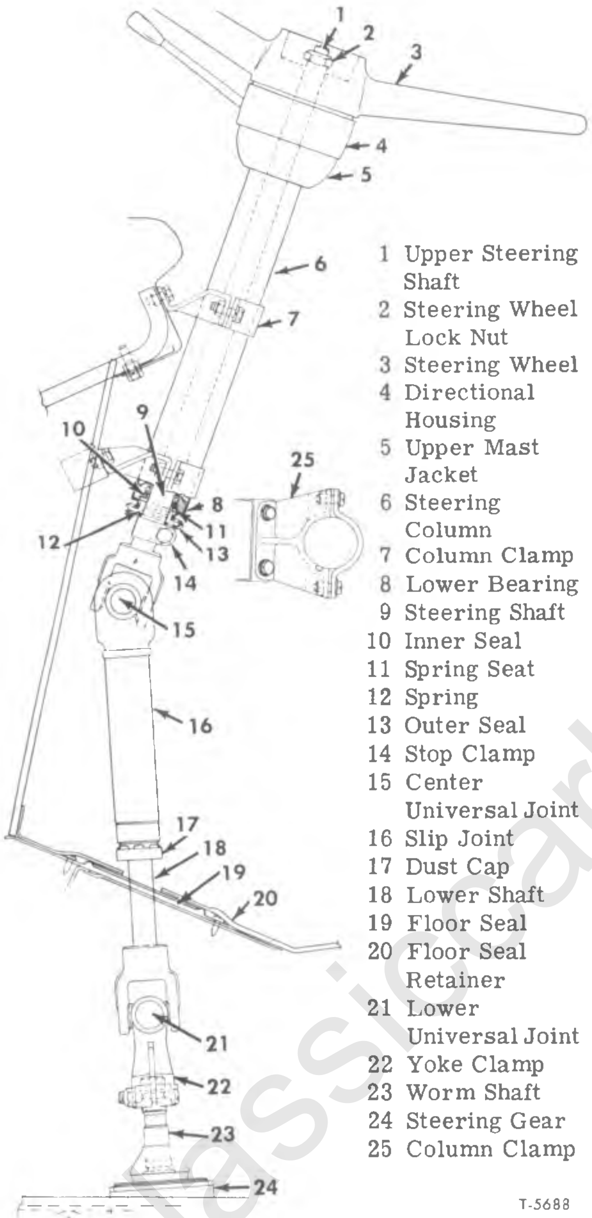
10. Insert upper and lower shaft assembly into lower steering column bearing (15), push shaft upward through column until it passes upper directional housing (1). Place upper column bearing (4) over shaft and in recess of directional switch (6), if not previously done.

11. Slide snap ring (5) over end of steering shaft (2) and push downward until seated in recessed groove of steering shaft.

INSTALLATION

1. Position steering column, upper and lower steering shaft, and steering column floor seal in vehicle.

2. Place lower yoke clamp (20) on steering



1 Upper Steering Shaft
2 Steering Wheel Lock Nut
3 Steering Wheel
4 Directional Housing
5 Upper Mast Jacket
6 Steering Column
7 Column Clamp
8 Lower Bearing
9 Steering Shaft
10 Inner Seal
11 Spring Seat
12 Spring
13 Outer Seal
14 Stop Clamp
15 Center Universal Joint
16 Slip Joint
17 Dust Cap
18 Lower Shaft
19 Floor Seal
20 Floor Seal Retainer
21 Lower Universal Joint
22 Yoke Clamp
23 Worm Shaft
24 Steering Gear
25 Column Clamp

Figure 17—Steering Column and Shaft (Tilt Models)

gear worm shaft (21) and install bolt and nut; tighten clamp bolt nut to 30-40 foot-pounds torque.

3. Raise steering column to position and install parking brake spacers, brackets, and bolts and nuts if previously removed. To prevent axial bind, tighten nuts firmly at dash bracket before installing remaining clamps. Install upper and lower steering column clamps (14) and torque bolt nuts to 8-12 foot-pounds.

4. Slide steering column floor seal down column to floor board, and pry lip of seal into opening of floor until it is properly seated.

5. Place cam and horn contact assembly (8) at under-side of steering wheel hub (10), with horn contact extension inserted in hub. Install steering wheel and cam over shaft end (2), with lower spoke aligned at the 6 o'clock position. Line up cut-out portion of receiver cup with mark on center of shaft end as shown in figure 15. Install washer and nut (11), and torque to 35-45 foot-pounds. Press horn button (13) and retainer ring (12) into place over receiver cup.

NOTE: Steering wheel must be installed first before adjusting steering shaft to steering column stop clamp, or axial clearance. If steering wheel is not properly positioned and torqued, before adjusting stop clamp, it will be necessary to readjust clamp after installing wheel.

6. Adjust stop clamp (17) on upper steering shaft to allow 0.12" minimum to 0.13" maximum axial movement of shaft. Torque clamp bolt nut to 8-12 foot-pounds.

7. Connect directional and hazard warning connectors (22) to multiple connector under dash.

STEERING COLUMN AND SHAFT ASSEMBLY (TILT CAB MODELS)

(Key Numbers Refer to Figure 17 Unless Otherwise Indicated)

DESCRIPTION

Steering column assembly of tilt cab models is two-piece type, connected by universal joints. A slip yoke sleeve arrangement is provided on lower shaft to facilitate the tilting of cab. Directional switch is housed in upper steering column, while hazard warning switch is mounted to dash.

REMOVAL

1. Remove steering wheel as described previously in this section under "Steering Wheel Replacement."

2. Disconnect all wiring from steering column under dash.

3. Mark clamp yoke (22) and steering gear worm shaft (23) so they can be installed in same position, loosen, or remove clamp bolt and nut at worm shaft.

4. Remove trailer hand brake control valve if used, from steering column.

5. Remove steering column seal (19) and retainer (20) from cab floor.

6. Remove all bolts attaching steering column clamps (7) to supports and braces. Remove steering column and shaft assembly.

DISASSEMBLY

1. Pull upper steering shaft (1) from steering column (6).

2. Referring to figure 12, remove directional control lever from control switch.

NOTE: It is necessary to remove multiple wire connector at end of harness before directional switch can be removed. See "Multiple Wire Connectors" as described previously in this section.

3. Remove three screws (7) which retain directional signal switch to signal housing. Remove directional switch and harness.

4. Remove directional switch housing (4) from column (5) by turning counterclockwise to unlock from tabs.

5. Pull, or pry lower bearing (8) from steering column, if damaged or defective.

6. Remove inner seal (10), spring seat (11), spring (12), outer seal assembly (13) and stop clamp (14) from upper steering shaft.

7. Refer to figure 13 to separate upper and lower steering shafts at joint (15) (fig. 17). Remove two snap rings (2), and tap yoke sideways to dislodge bushings (1) of adjoining yoke; repeat operation until all bushings are removed. Remove cork seals (3) from journal (4) and discard.

8. To remove slip yoke (16) from lower shaft assembly (18), bend tabs of dust shield (17) away from retainer groove. Pull shaft, felt seal, and washer from yoke sleeve. Slide components from shaft, and discard seal.

9. If disassembly of lower clamp yoke to shaft is desired, proceed as described in Step 7 above.

INSPECTION

Inspect steering column components and replace, or repair, as described previously in "Inspection" of this section.

ASSEMBLY

Refer to figure 17 unless otherwise indicated.

1. Press bearing (8) into lower end of upper steering column tube (6).

2. Install directional signal housing (4) at upper end of column by turning it clockwise to lock it in place in upper jacket.

NOTE: It is necessary to insert wiring harness through opening in base of upper column jacket before locking switch and harness to column with the three attaching screws. See "Multiple Wiring Connectors" of this section for connector installation.

3. Referring to figure 12, install directional control switch in housing using the three retainer screws. Tighten screws securely. Inspect wiring harness and make certain it is properly positioned and not pinched. Secure harness to column with attached clips. Fasten directional control switch lever to switch using single screw.

4. At lower steering shaft (18), position floor seal (19), tabbed dust cap (17), metal washer, and new felt seal on splined yoke shaft (18). Lubricate splines lightly. Align arrows on yoke shaft, and slip joint tube. Slide shaft into tube and crimp tabs of dust cap into groove in yoke tube.

5. Refer to figure 13, if lower shaft yoke clamp (15) was previously disassembled, assemble installing new cork seals (10) to cross journal (14), install new bushings (11) and snap ring (12). Press, or tap bushings in yoke over cross journals until snap rings can be installed in bushings.

6. Refer to figure 13, position center cross (4), and lower shaft (6) upper yoke in upper shaft yoke. Install all new cork washers (3), on journals (4), install new bushings (1) and snap rings (2). Press or tap bushings in yoke over cross journals until snap rings can be installed in bushings.

7. Slide stop clamp (14), outer seal (13), spring (12), spring seat (11) and inner seal (10) on upper shaft. Insert upper shaft into lower steering column bearing (8), and push upward through upper bearing until shaft extends past top of mast jacket.

INSTALLATION

1. Position steering shaft assembly in vehicle. Align match marks and place lower yoke clamp (22) on steering gear worm shaft (23). Tighten clamp bolt nuts to 40-50 foot-pounds torque.

2. Raise column to position, and loosely install all brackets, and bolts or clamps (7) as they were previous to removal. Position floor seal (19) in place at floor.

IMPORTANT: To prevent axial bind, all steering column attaching brackets, or supports should be tightened first where they fasten to cab. Tighten steering shaft yoke clamp at steering gear worm shaft before tightening clamps which actually secure the column to mounting brackets.

3. Install screws which attach steering column floor seal, and retainer to floor.

4. Tighten all the steering column attaching clamps, bolts and nuts, in sequence described above. Tighten all column clamps to torque listed in "Specifications" at end of this section.

5. Install steering wheel to steering shaft, using care to align mark (5) on shaft end with cutout portion (1) of horn receiver cup (4) as shown in figure 15. Tap wheel on shaft and install washer and lock nut. Torque nut to 45-50 foot-pounds. Press horn button into place in wheel hub.

6. At lower end of steering column, position inner seal (10), spring seat (11), spring (12), outer column seal (13), and stop clamp (14), bolt and nut, against lower column bearing (8).

7. Install with inner seal (10) inserted in bearing recess. Adjust stop clamp so that 0.005" minimum to 0.030" maximum axial shaft end play movement exists. This clearance must be maintained to prevent binding of bearings, or steering wheel chucking condition.

8. Connect directional signal wiring connector

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to multiple connector under dash.

9. Secure trailer hand brake control to column if previously removed.

10. Test action of steering wheel for bind, looseness, or chucking and make adjustments, if necessary. Check turn lights and horn operation.

MECHANICAL STEERING TROUBLE DIAGNOSIS CHART

PROBLEM - STEERING WANDERS

CAUSE
1. Toe-in out of adjustment, or tie rod ends worn. Toe-out causes steering to wander.
2. Steering system out of alignment.
3. Tires badly worn, edge of tires are rounded off.
4. All steering components worn and loose.
5. Lack of lubrication in linkage and king pins.

REPAIR
1. Replace tie rod ends if worn, adjust to correct toe-in, and inspect steering arm and tie rod for bent condition.
2. Align steering complete, caster, camber, and toe-in. Inspect spring components for condition and wear.
3. Install new tires, and check alignment; abnormal tire wear indicates improper alignment.
4. Replace or adjust loose or worn parts as necessary.
5. Lubricate as described in LUBRICATION (SEC. 0) of this manual. Free up any components which are frozen and will not take lubrication.

PROBLEM - STEERING PULLS TO LEFT OR RIGHT

CAUSE
1. Camber incorrectly adjusted. Steering will generally pull to side of axle having greatest positive camber.
2. Low air pressure in right or left tire. Steering will pull to side having low air pressure.
3. Axle loose and shifted at spring U-bolts.
4. Rear axle loose at spring U-bolts if shifted at one side will cause steering to pull.

REPAIR
1. Adjust camber to correct specifications.
2. Inflate tire to correct pressure, check for air leak.
3. Align axle, and tighten U-bolt nuts to proper torque. Inspect for damaged parts.
4. Align rear axle and replace defective parts, if any. Tighten U-bolts to proper torque.

PROBLEM - HARD STEERING

CAUSE
1. Lack of lubrication - frozen king pins or ball joints.
2. Tire pressure too low.
3. Improper or excessive positive caster.
4. Steering gear adjusted too tight, or binding condition in steering column.

REPAIR
1. Lubricate, and free up king pins. Make certain all fittings take lubricant properly.
2. Inflate tires to proper pressure.
3. Adjust caster to correct specification as described in "FRONT END ALIGNMENT" (SEC. 3A) of this manual.
4. Adjust steering gear as described previously in this section. Adjust steering column mounting clamps, and stop clamp as previously described in this section.

PROBLEM – VIBRATION OR SHIMMY

CAUSE
1. Tires, wheels, or brake drums out of balance.
2. Bent wheel or out of round tire.
3. Loose steering linkage components.
4. Wheel loose on hub.
5. Drive line universal joints rough, or defective. This condition may be confused with steering vibration.
6. Engine misses or is out of balance, this may also be confused with steering shimmy.
7. Defective shock absorbers.

REPAIR
1. Balance tires and wheels, preferably with on-vehicle type balancer, as this method balances entire wheel and drum assembly.
2. Replace wheel, and remount tire, or replace.
3. Adjust, tighten, and repair linkage as necessary.
4. Inspect wheel bolt holes for damage, and tighten to proper torque if OK.
5. Repair drive line as described in "PROPELLER SHAFTS" (SEC. 4D) of this manual.
6. Correct miss in engine, or repair out of balance condition, clutch, pressure plate, or harmonic balancer etc.
7. Replace shock absorbers.

PROBLEM – EXCESSIVE ROAD SHOCK

CAUSE
1. Tire air pressure too high.
2. Wheel bearings adjusted too loose.
3. Camber adjustment incorrect - (negative camber contributes to road shock).
4. Weak or broken front spring.
5. Defective shock absorbers.
6. Loose suspension components.

REPAIR
1. Deflate to correct pressure.
2. Adjust bearings as described in "FRONT HUBS AND BEARINGS" (SEC. 3D).
3. Adjust camber to correct specification as described in "FRONT END ALIGNMENT" (SEC. 3A) of this manual.
4. Repair or replace spring.
5. Replace shock, or shock absorbers.
6. Inspect, adjust or repair, and replace parts as necessary.

PROBLEM – SNAPPING OR CHUCKING IN STEERING COLUMN OR WHEEL

CAUSE
1. Steering shaft stop clamp loose, this permits excessive up and down movement of steering shaft and wheel in column.
2. Loose steering gear at frame.
3. Worn steering shaft universal joints.
4. Worn steering linkage components. The effect of these components will telescope through steering system and be felt in steering wheel.
5. Steering gear incorrectly adjusted.

REPAIR
1. Adjust steering shaft stop clamp as described previously in this section.
2. Tighten mounting bolts to proper torque listed in "Specifications" at end of this section.
3. Replace and repair joints as necessary.
4. Adjust, tighten and repair components as described previously in this section.
5. Adjust steering gear as previously described in this section.

MECHANICAL STEERING

MECHANICAL STEERING SPECIFICATIONS

STEERING GEAR APPLICATION CHART

TRUCK MODELS	GEAR MODEL	GEAR RATIO	CENTER* POSITION
Steel Tilt Cab Models	553-D-17	28.14 to 1	6 O'Clock
PS4500	549-D-99	28.14 to 1	6 O'Clock
EM4500, 5500, 6500	549-D-191	28.14 to 1	8 O'Clock
ES4500, 5500	549-D-191	28.14 to 1	8 O'Clock
SM/SS5500; SM6500	549-D-191	28.14 to 1	8 O'Clock
EG/SG5500; EG6500	549-D-193	28.14 to 1	8 O'Clock

*Mark on worm shaft should be located, as described to position steering gear in straight ahead position.

STEERING GEAR ADJUSTMENTS

WORM BEARINGS
- Pull to keep wheel moving .... 1½ to 2 lbs.

SECTOR GEAR LASH:
- Pull over center .... 2¾ to 3¼ lbs.
- Lash Adjuster Shim Thickness .... 0.063", 0.065", 0.067", 0.069"

TORQUE SPECIFICATIONS

LOCATION	TYPE OF PART	TORQUE (1) FT. LBS.
Steering Gear		
Lash Adjuster Screw	Nut	25-35
Side Cover to Housing	Bolt	25-35
Worm Bearing Adjuster Screw	Nut	70-100
Back-Up Adjuster (Tilt Cab Models)	Nut	30-50
Steering Wheel-to-Steering Shaft		
Steering Wheel-to-Steering Shaft	Nut	
E and S Models		40-50
Tilt Cab Models		45-50
PS4500		35-45
Steering Column Clamp Bolt		
Tilt and Conventional Cab Models	Bolt	15-20
Cowl Models	Bolt	20-25
PS4500	Nut	8-12
Steering Column U-Bolt Nut (E Models)	Nut	6-8
Steering Shaft "STOP" Clamp Bolt		
Tilt Cab Models	Nut	5-6
E, S Models	Nut	15-20
PS4500	Nut	8-12
Steering Shaft-to-Worm Shaft Clamp Bolt		
Tilt Cab and Cowl Models	Nut	40-50
PS4500	Nut	30-40
Steering Shaft Coupling-to-Worm Shaft Clamp Bolt		
Cowl Models	Bolt	35-40
Steering Gear-to-Frame Bolt		
Tilt Cab Models and PS4500	Nut	90-110
E, S Models	Nut	50-60
Pitman Arm-to-Pitman Shaft (All Models)	Nut	185-215
Connecting Rod (Drag Link) Stud-to-Pitman Arm and Steering Arm		
Except PS4500	Nut	125-150 (2)
PS4500	Nut	40 (2)
Steering Arm-to-Tie Rod Stud		
F040 Axle	Nut	100-110 (2)
F055 Axle	Nut	150-160 (2)
F070 Axle	Nut	230-250 (2)
Steering Tie Rod Clamp Bolt		
F040 Axle	Nut	25-35
F055 Axle	Nut	45-55
F070 Axle	Nut	80-100
Steering Arm-to-Steering Knuckle Stud		
F040 Axle	Nut	65-95 (2)
F055 Axle	Nut	115-165 (2)
F070 Axle	Nut	180-240 (2)

(1) NOTE: All tapered studs must be clean and dry.
(2) Tighten as indicated, then tighten to next notch to insert cotter pin.

SECTION 9B

Power Steering

Contents of this section are listed in Index below:

POWER STEERING SYSTEM

DESCRIPTION

The power steering system provides automatic hydraulic assistance to the turning effort applied to the mechanical steering system.

The power steering system consists of a control valve, power cylinder, and a hydraulic pump used in conjunction with the steering gear. An oil cooler is attached to front of radiator on all vehicles except those equipped with air conditioning.

The power steering system is a complete inline unit. The steering shaft, hydraulic valve, worm, and ball nut are in a line, making a compact, space-saving steering gear. The recirculating ball-type mechanical steering gear is used in conjunction with the control valve.

The power steering will not operate without driver guidance; therefore, when turning effort is relieved, the front wheels return to neutral or straight ahead position.

The power cylinder is actuated by operation of the control valve which supplies hydraulic fluid to either side of the power cylinder piston as required, depending on the position of the valve. The pressure used to operate this system is supplied by either a vane-type or slipper type oil pump.

If, for any reason, the power steering system should fail, the control valve "locks up" and the steering gear operates manually, giving the driver full control of the vehicle. Although greater manual effort will be required to operate steering mechanism.

On all hydraulic pump models, the fluid reservoir either encases the pump or is mounted on top of the pump. An additional reservoir is mounted on a bracket attached to the radiator support on conventional cab models or to the transmission control island panel front support on tilt cab models.

MAINTENANCE

The power steering system requires little maintenance. However, the hydraulic system should be kept clean to ensure maximum operating performance and trouble-free service. Periodic inspection to check for leaks should also be made.

At regular intervals the pump hydraulic fluid level in the reservoir should be checked and fluid added when required. Refer to LUBRICATION (SEC. 0) for type of fluid to be used, method, and intervals for filling.

When the slightest evidence of dirt, sludge, or water is discovered in the system, drain and refill with clean hydraulic fluid recommended in LUBRICATION (SEC. 0) of this manual. To drain system, disconnect fluid lines at power cylinder. Air in the fluid system will cause spongy action and noisy operation. When any hose has been disconnected or when fluid has been lost for any reason, the system must be bled after adding fluid. Bleed system as directed later in this section under "Bleeding Hydraulic System."

Should the power steering system become inoperative due to loss of hydraulic fluid, pump pressure line should be re-routed from pump outlet directly back to pump reservoir.

IMPORTANT: DO NOT operate pump without fluid in pump reservoir.

The hydraulic pump, control valve, and power cylinder do not require adjustment on the vehicle. The only adjustments are on the steering linkage. Adjustment of these parts are normally required

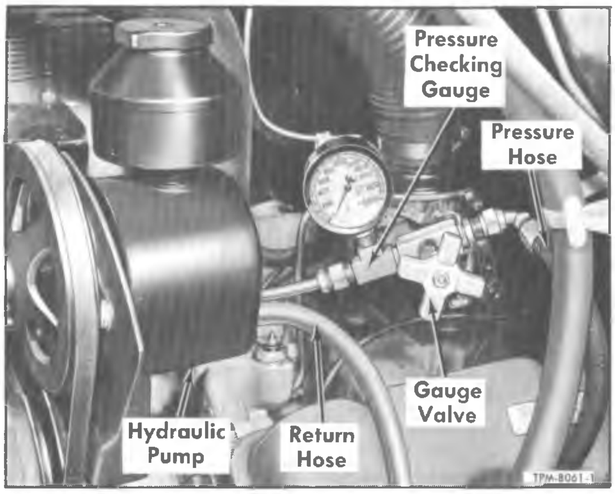


Figure 1—Checking Pump Hydraulic Pressure (Vane Type Pump) (Typical)

only when the units have been removed or disconnected.

NOTE: These adjustments, with the exception of the power cylinder piston rod end, are the same as previously described in "MECHANICAL STEERING" of this group.

Wheel alignment must be maintained to proper specifications. Refer to FRONT SUSPENSION (SEC. 3) of this manual, for proper procedures for checking front end alignment. Improper tire inflation will also affect operation of the power steering. The tires should be checked at regular intervals.

Because of the power assist from the power steering system it is more difficult to detect defects in the steering system. Therefore, periodic maintenance is very important on a vehicle having power steering.

BLEEDING HYDRAULIC SYSTEM

When a power steering pump or power cylinder has been installed or a disconnected oil line has been reconnected, the air that has entered the system must be bled out before the vehicle is again operated. If air is allowed to remain in the hydraulic fluid system, noisy and unsatisfactory operation of the steering system will result. Bleed air from the hydraulic system as follows:

NOTE: When hydraulic fluid is added to power steering system, fluid should be poured through a 200 mesh wire screen. Use only the hydraulic fluid recommended in LUBRICATION (SEC. 0) of this manual.

1. Fill pump fluid reservoir to proper level and let fluid remain undisturbed for about two minutes.
2. Raise front end of the vehicle so that front wheels are off the ground.
3. Turn wheels to right and left to wheel "stops" to eliminate air pockets in the power cylinder. Continue this operation until fluid in reservoir stops bubbling. Maintain fluid level during this operation.
4. Start the engine and run at idle for two minutes, turn wheels to right and left as before. DO NOT HIT THE WHEEL STOPS. Recheck fluid level and hose connections for leaks. Continue this operation until fluid in reservoir is clear.
5. Increase engine speed to approximately 1500 rpm and continue running at this speed until all signs of air bubbles cease to appear in reservoir. Turn wheels (off the ground) to right and left. DO NOT HIT THE WHEEL STOPS.
6. Lower the vehicle and turn wheels on the ground. Recheck for leaks.
7. Check fluid level in reservoir and refill as required.

HYDRAULIC PRESSURE TEST

VANE-TYPE HYDRAULIC PUMPS

1. Disconnect pressure hose from fitting at the hydraulic pump. Connect a 0 to 2000 psi pressure gauge (J-22181) between the pressure hose and the pump pressure port. Leave valve in pressure gauge line open (fig. 1).
2. Bleed steering hydraulic system to remove all air from pressure line as directed previously under "Bleeding Hydraulic System."
3. Start engine and run at idle speed. Turn wheels through normal operating range several times until the hydraulic fluid temperature reaches 170°F. When fluid temperature reaches 170°F., close valve in pressure gauge line and observe reading on pressure gauge. Pressure reading should be within 900-1000 psi.
4. Open valve in pressure gauge line. Turn wheels to extreme right and left against "stops" (with wheels on ground). At extreme right or left position the maximum pressure reading should be within the amount specified in procedure 3 above.

SLIPPER TYPE HYDRAULIC PUMP

1. Disconnect hydraulic pump to steering gear pressure line at pump. Connect a 0 to 2000 psi pressure gauge (J-22181) to the pump outlet; then connect a shut-off valve between the pressure gauge and pressure line (fig. 2). Make sure all connections are tight and that shut-off valve is fully open.

NOTE: The pressure gauge must be installed between the pump and the shut-off valve.

2. Start the engine and run for several minutes at idle speed. Turn wheels from right to left several times to expel all air from system and to bring fluid temperature to approximately 170°F.

3. Close shut-off valve and observe pressure gauge. Pressure should be 1000 to 1100 psi.

NOTE: Do not close valve for more than a few seconds, as this would increase fluid temperature and cause excessive pump wear.

4. Open shut-off valve; then turn wheels to extreme right and left with wheels on ground. At extreme positions, the maximum pressure reading should be within above limits.

5. If pressure is greater than 1100 psi or less than 1000 psi, replace the pressure relief valve and repeat the test. If pressure is still not within limits specified, remove the pump and disassemble.

PUMP DRIVE BELT

MAINTENANCE

The drive belt must be kept at proper tension. A loose belt will reduce output of the hydraulic pump, while a tight belt will cause eventual bearing failure. A regular, periodic inspection is recommended to check condition of drive belt. Replace belt if frayed or badly worn.

NOTE: On a new vehicle or after having installed a new drive belt, check belt tension twice in first 200 miles of operation.

ADJUSTMENT

1. Loosen hydraulic pump to mounting bracket attaching bolts.

2. Position pump so that a reading of 120-130 pounds (new belt) or 90-100 pounds (used belt) is obtained on a strand tension gauge.

3. Tighten pump to mounting bracket bolts firmly.

NOTE: Mounting brackets and bolt holes should be inspected for cracks or elongated condition. If defective, they should be repaired or replaced.

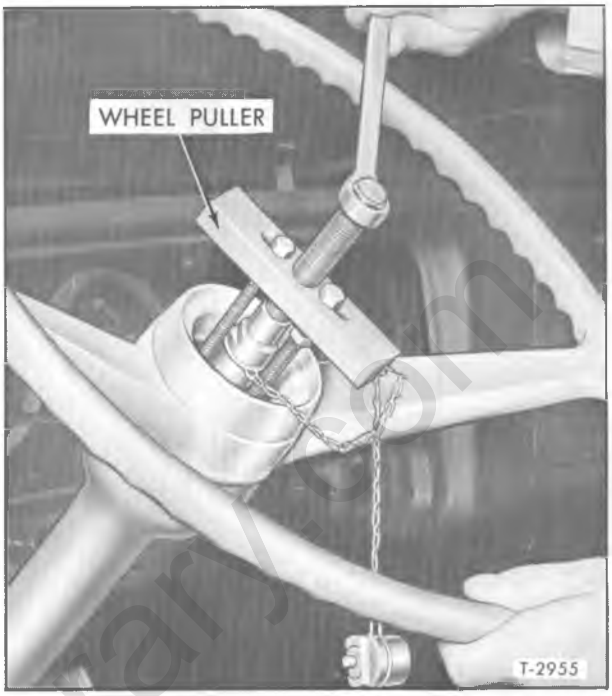


Figure 2—Checking Pump Hydraulic Pressure (Slipper Type Pump) (Typical)

TUBES, HOSES, AND FITTINGS

Stationary tubes and flexible hoses are used to carry hydraulic fluid through the power steering system. These tubes and hoses connect the steering gear to the power cylinder and hydraulic pump.

All tubes, hoses, and fittings should be inspected for leakage at regular intervals. Fittings must be tightened to torque listed in "Specifications" at end of this section. Make sure clips, clamps, and unions supporting tubes and hoses are in place and properly secured.

POWER STEERING GEAR AND CONTROL VALVE

The 549-DV and 553-DV type power steering gear assemblies are basically the same except for size and mounting. Refer to "Model Application" at end of this section for steering gear application on each series vehicle.

CONTROL VALVE

The power steering system control valve is mounted on top of the steering gear housing and is activated by a torsion bar that tends to keep the valve in neutral position. Should the torsion bar break, the spool and valve body "lock up" into a complete unit, and steering gear then operates as a mechanical unit.

The valve shown in figure 3 is an open-centered, rotary-type, three-way valve. The spool is held in the neutral position by means of the torsion bar. The spool is attached by means of a stud fastened to one end of the torsion bar and the valve body to the other end. Twisting of the torsion bar allows the spool to displace in relation to the valve body, thereby operating the valve.

CONTROL VALVE OPERATION

When the valve is in neutral or straight-ahead position, the fluid flows from pump through the open-center valve, and back to pump reservoir without traveling through the power cylinder. This

POWER STEERING

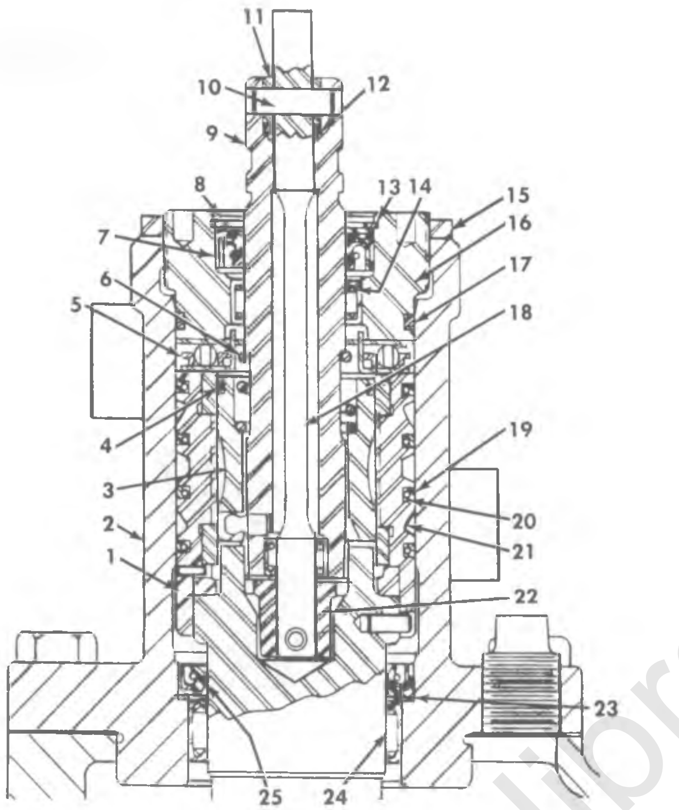


Figure 3—Power Steering Control Valve (Typical)

open-center position of the valve reduces pump losses to a minimum. Valve is in open-center position at all times except when turning. The power cylinder is always full of fluid, which acts as a cushion to absorb shocks so that they are not transferred to the driver. This fluid lubricates all internal components of valve, making it unnecessary to lubricate the valve.

With the steering wheel turned to the right, the torsion bar is deflected, changing the relationship of the spool grooves and valve body grooves with each other. The right-turn grooves of the spool are closed off from the return grooves and opened to the pressure grooves. The left-turn grooves of the spool are closed off from the pressure grooves and opened to the return grooves. This causes the fluid to flow into the appropriate half of the power cylinder, overcoming the tire friction in that direction. The fluid in the opposite end of the cylinder is simultaneously forced out through the valve and back to the pump reservoir.

The greater the resistance to turning between road bed and front wheels, the more the valve spool is displaced and the higher the fluid pressure is on the resisting side of the piston. Since the amount of valve displacement and consequently the amount of hydraulic pressure built in the cylinder is dependent upon the resistance to turning, the operator is assured of the proper amount of smooth hydraulic assist at all times. The instant the operator stops applying steering effort to the steering wheel, the valve is returned to its neutral position by the torsion bar. The fluid pressure is equalized on both sides of the piston when the torsion bar returns to neutral position. The wheels return to a straight-ahead position due to the steering geometry of the vehicle.

When the steering wheel is turned to the left, the fluid flow in the valve is the same as when making a right-turn but takes place in the opposite direction. Parking pressure, the most difficult of turning conditions, should range from 900 to 1000 psi on vane-type hydraulic pump models and from 1000 to 1100 psi on the slipper type hydraulic pump, depending upon road bed conditions, weight of vehicle, and pressure relief setting in the pump.

During normal straight-ahead driving, steering wheel effort will be approximately the same as manual effort under the same conditions. The control valve will give the driver a smooth transition through the driving range of wheel effort and retain the "road-feel" necessary for effortless driving.

NOTE: Trouble Diagnosis Chart to aid in diagnosing noise, and steering problems can be found at rear of this section. It is intended as a quick reference and covers most problems encountered.

POWER STEERING GEAR REPLACEMENT

REMOVAL

1. Mark steering gear worm shaft and coupling or clamp yoke on steering shaft to assure installation in the same position.
2. Remove cotter pin and nut, attaching drag link or connecting rod to Pitman arm. Use a soft hammer to tap drag link or connecting rod loose from Pitman arm.
3. Remove Pitman arm to shaft nut and washer, then use puller (J-3186) to remove Pitman arm from shaft.
4. Drain as much fluid as possible from the steering gear.
5. Disconnect control valve to pump return tube, pump to control valve pressure tube, and control valve to power cylinder right- and left-turn tubes from control valve ports.

IMPORTANT: Cover or plug exposed tubes and ports to prevent dirt from entering the hydraulic system.

6. Remove steering shaft to steering gear worm shaft clamp bolt and nut.
7. Remove bolts, nuts, and washers which attach steering gear assembly to frame left side member. Remove steering gear and control valve from frame, and steering shaft.

INSTALLATION

1. Adjust steering gear to straight ahead position with mark on worm shaft located as described in "Specifications" at end of this section.
2. Position steering gear on frame side member and at same time, slide worm shaft into steering shaft clamp yoke or coupling. Check to make sure alignment marks are aligned.
3. Install bolts, nuts, and washers to attach steering gear to frame side member. Tighten bolts to torque listed in "Specifications."
4. Position Pitman arm on Pitman shaft, aligning the blank serrations. Install washer and nut on shaft and tighten to 185 to 215 foot-pounds torque.
5. Connect drag link or connecting rod to Pitman arm and attach with nut. Tighten nut to 125 to 150 foot-pounds torque, advance to next slot and install cotter pin.
6. Connect control valve to pump return tube, pump to control valve pressure tube, and right- and left-turn tubes from power cylinder to control valve ports. Tighten fittings to torque listed.
7. Bleed the system and fill reservoir to proper level as described under "Bleeding Hydraulic System" previously.

TROUBLESHOOTING THE POWER STEERING GEAR

NOISE

Several different types of noise may be heard with the control valve steering gear. Troubleshoot noises as follows:

RATTLE OR CHUCKLE

1. Cause could be loose adjustment. Adjust thrust bearing preload.
2. Noise could be caused by steering gear being loose on frame.

a. Check steering gear installation as described previously in this section under "Steering Gear Replacement."

b. Torque steering gear mounting bolts to torque specified under "Specifications" later in this section.

3. Coupling pin stops hitting against the upper flange could also cause this type of noise. Re-alignment of the shaft with the gear or an endwise adjustment of shaft should correct this condition.

NOTE: A slight rattle may occur on turns because of the increased lash off the high point. This is normal.

HISS

There is some noise in all power steering gears which cannot be eliminated. One of the most common is the "hissing" sound most evident at standstill parking with wheels at end of travel. The "hissing" noise is usually caused by a faulty valve.

Do not replace the valve unless the "hiss" is extremely objectionable, since the replacement valve will also have a slight "hissing" noise. Be sure, however, that the steering shaft and gear are properly aligned as the shaft rotates, since misalignment will transmit the "hissing" noise into the cab.

VALVE SQUAWK

Valve squawk when turning or when recovering from a turn may be caused by a worn dampener ring on the valve spool or by a loose or worn valve body. In both cases replace faulty parts.

STEERING GEAR LEAKS

INTERNAL LEAKS

High internal leakage will cause a momentary increase in the steering effort when turning the wheel fast. If this situation should occur, replace the control valve.

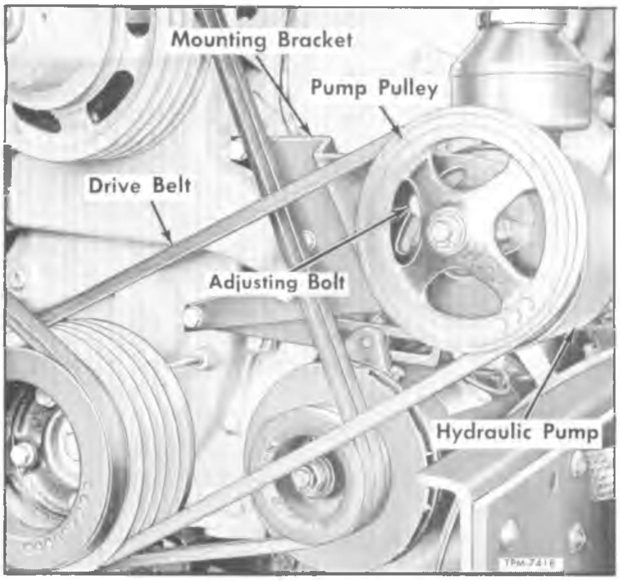


Figure 4—Power Steering Hydraulic Pump Installed (Typical)

EXTERNAL LEAKS

To determine the source of external leaks, thoroughly clean the steering gear and inspect. External leakage may be due to loose hose connections or damaged hose, adjuster plug seals or torsion bar seals. Correct external leaks as follows:

CAUSE	REMEDY
1. Loose hose connections	Tighten Connections
2. Damaged hose	Replace Hose
3. Damaged adjuster plug seals	Replace Seals
4. Damaged torsion bar seal	Replace Seal

STEERING GEAR MALFUNCTIONS

Each of the malfunctions listed here have a number of causes and each cause has a remedy. These causes and remedies are given in the "Troubleshooting Quick Reference Chart" later in this section.

1. Hard steering while driving.
2. Poor return of steering.
3. Leads to one side or the other.
4. Momentary increased effort on fast turn.
5. Excessive wheel kickback.
6. Steering wheel jerks.
7. Hard steering when parking.
8. Effortless turn.

POWER STEERING HYDRAULIC PUMP

A positive displacement vane-type or slipper-type hydraulic oil pump is used on vehicles covered by this manual. Refer to "Hydraulic Pump Model Application" in "Specifications" at end of this section for proper pump application on each truck series.

VANE TYPE HYDRAULIC PUMP

The vane-type hydraulic pumps have a maximum output of 3.5 gallons per minute of Type "A" Automatic Transmission Oil at 170°F., with pump operating at 1500 rpm against 50 psi pressure. Minimum output of the pumps is 2.35 gallons per minute with pump idling at a speed of 590 rpm, against 665 to 735 psi pressure.

The hydraulic pump is mounted at front of engine and is belt driven from the engine crankshaft or water pump pulley (fig. 4).

NOTE: On "E" and "S" models, the hydraulic pump is mounted on top of engine front cover and is driven from the engine water pump pulley.

The oil reservoir encases the pump and on some vehicles, an additional reservoir is remotely mounted on the radiator front support or on the transmission control island support.

On all vane-type hydraulic pumps, the drive shaft is supported by one ball bearing and one needle bearing in the pump housing.

The pump rotary group is the heart of the pump and consists of the drive shaft, rotor, vanes, pump ring, thrust plate, and pressure plate. Flow control valve is the nerve center of the pump and includes flow control plunger, flow control spring, and the pressure relief ball and spring. This assembly controls flow and pressure in the system.

PUMP OPERATION

NOTE: Refer to figures 5 and 6.

As the drive shaft rotates the rotor, the vanes follow the cam surface in the pump ring. This cam consists of two rising and falling areas which cause a complete pumping cycle to occur every 180 degrees of rotation (fig. 5).

The spaces between rotor vanes pick up oil on the rising portions of the cam from two openings between thrust plate and pump ring and from opening between the pressure plate and pump ring. This oil is discharged on the falling portion of the cam through two openings in the pressure plate and two openings in the thrust plate which are connected to openings in the pressure plate by crossover holes in the pump ring (fig. 5). The oil passes through the pressure plate into cavity (1) behind it. A portion of this oil is directed back through other passages in the pressure plate so that it may enter behind the vanes forcing them to follow the cam surface of the pump ring (fig. 6B).

From cavity (1) the oil flows into passage (2) which is controlled in size to provide definitely known oil velocities. From passage (2) a certain quantity of oil passes through orifice (3) into passage (8) and then to the steering gear. Notice that passage (8) is connected to cavity (10) by passage (9). When the quantity of oil exceeds the predetermined system requirements, the pressure drop through orifice (3) exceeds force of spring (12), flow control plunger (11) starts to move back, thereby providing flow control through passages (4), (6) and (7), with (7) being the suction or intake part of the pump. Supercharging occurs as a result of pressure oil in passage (4) discharging into passage (6) at high velocity, picking up the make-up oil from reservoir through passage (5) on the jet-jump principle. Then by a reduction of velocity in passages (6) and (7), velocity energy is converted into supercharge pressure (fig. 6, View B).

The pressure relief valve is contained inside flow control plunger (11). If pump pressure exceeds a certain predetermined pressure, the pressure relief ball will open, allowing a small amount of oil to flow through passages (8) and (9), hole (13), through flow control plunger (11) and into passage (6). This flow of oil causes a pressure drop across hole (13), thus creating a pressure unbalance which moves the flow control plunger back against spring pressure, allowing the major portion of oil to bypass through passages (2), (4), and (6) in the same manner as is accomplished by flow control (View B, fig. 6).

Figure 6, View "A" is typical of pump operation when the vehicle is driven at low speed during a partial turn. The oil pressure cannot build up high enough to cause the pressure relief valve to open as the external circuit still allows some oil to flow through the system.

Figure 6, View "B" is typical of pump operation when vehicle is driven at high speed. In this case, the flow control valve has opened to allow oil flow in excess of system requirements to bypass into intake chamber of the pump.

PUMP REPLACEMENT

Removal

1. Disconnect hoses at pump and secure ends in raised position to prevent drainage of oil.
2. Install caps at pump fittings to prevent drainage of oil from pump.
3. Remove drive pulley attaching nut.
4. Loosen mounting bracket to pump bolts.
5. Remove pump drive belt.
6. Slide pulley from pump drive shaft. DO NOT HAMMER PULLEY OFF SHAFT AS THIS WILL DAMAGE THE PUMP.
7. Remove bracket to pump attaching bolts and remove pump.

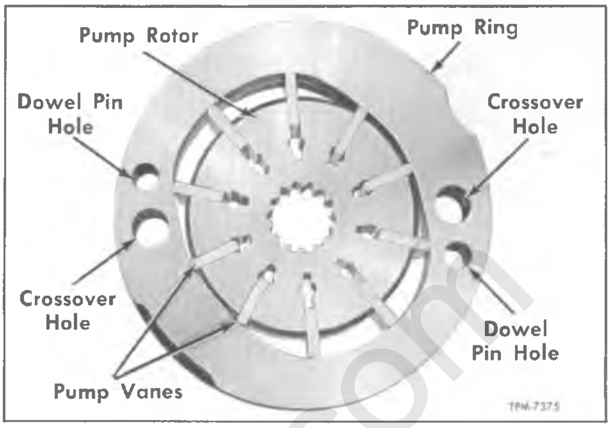


Figure 5—Cross Section of Rotor and Vanes in Pump

Installation

1. Position pump assembly on mounting bracket with holes aligned and install attaching bolts loosely.
2. Slide pulley on drive shaft. DO NOT HAMMER PULLEY ON SHAFT.
3. Install pulley nut (finger-tight) against the pulley.
4. Connect and tighten hose fittings.
5. Fill pump reservoir with fluid recommended in LUBRICATION (SEC. 0) of this manual.
6. Bleed pump by turning pulley backward (counterclockwise as viewed from the front) until all air bubbles cease to appear.
7. Install pump drive belt over drive pulley.
8. Adjust belt tension as previously described, then tighten attaching bolts securely.
9. Tighten drive pulley attaching nut to 25-35 ft.-lbs.

SLIPPER TYPE HYDRAULIC PUMP

The slipper-type hydraulic pump is a constant displacement type pump with a minimum output of 1.45 gallons per minute with pump idling at a speed of 450 rpm against 665-735 psi pressure. The pump has a maximum flow control range of 3.4 to 4.1 gallons per minute with a 1000 to 1100 psi pressure relief valve. The pump is mounted at front of engine and is belt-driven from the crankshaft.

PUMP OPERATION

As the drive shaft rotates the rotor, spring loaded slippers, which contact the eccentric diameter inside the pump housing, force oil from the inlet side of the pump to the flow control valve (fig. 7). Pressure inside the pump is controlled by a valve which permits fluid to be recirculated within the pump. Maximum pressure in the system is limited by a pressure relief valve which opens into the reservoir when pressure exceeds specified maximum of 1000-1100 psi.

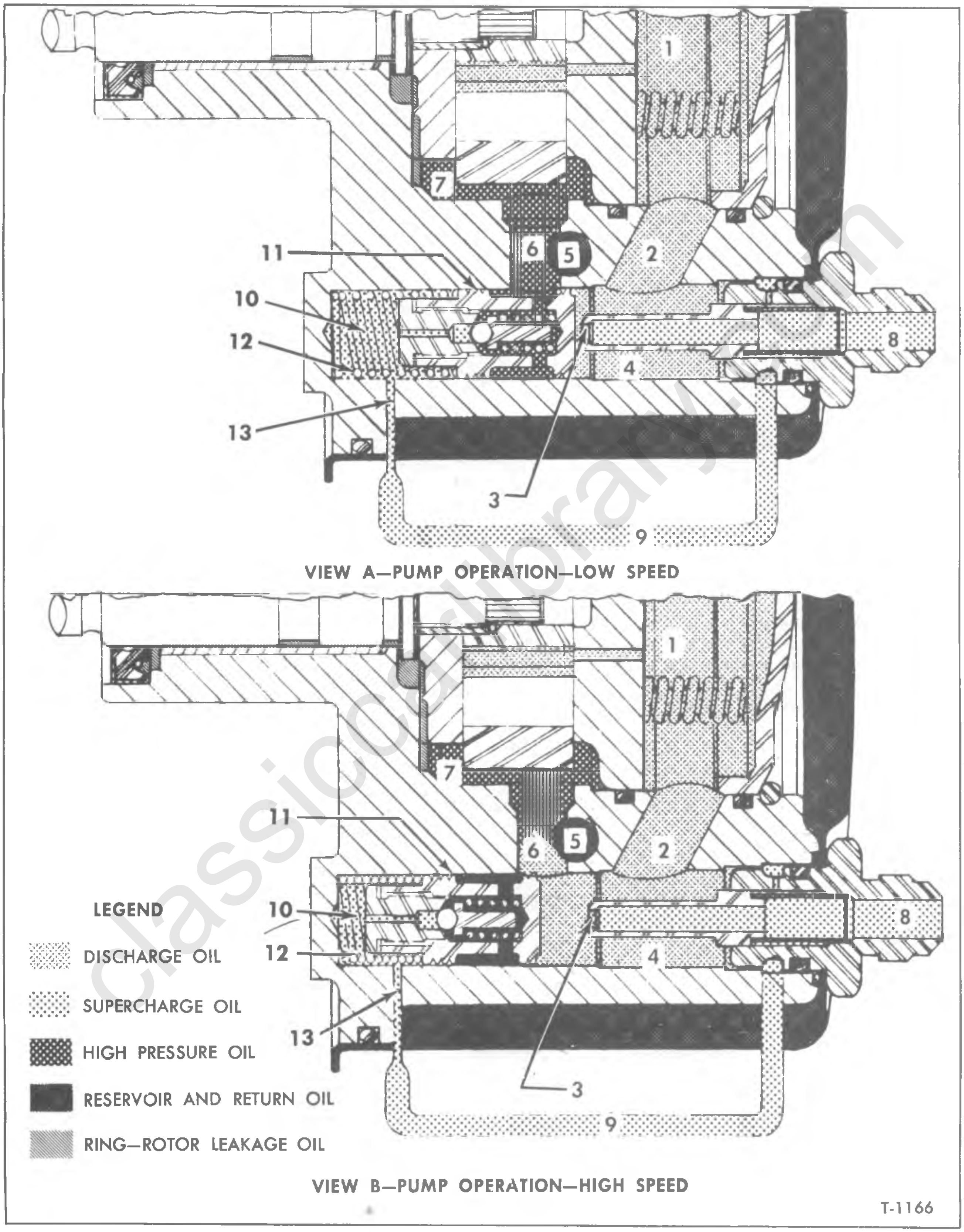


Figure 6—Vane Type Hydraulic Pump Operation

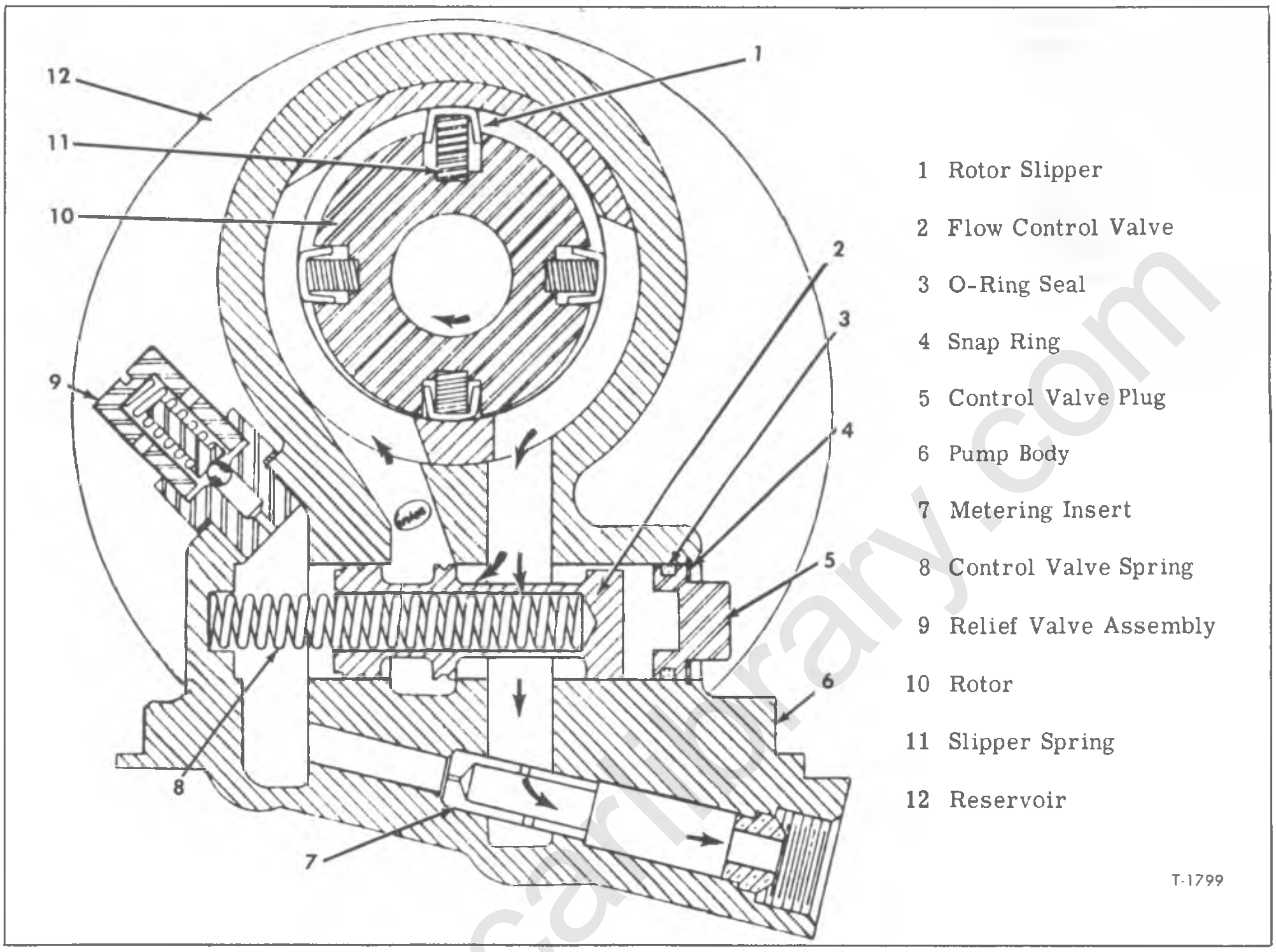


Figure 7—Slipper Type Hydraulic Pump Operation

NOTE: At regular intervals, the fluid level in the reservoir should be checked and fluid added when level is more than two inches below filler cap. Refer to LUBRICATION (SEC. 0) of this manual for type of fluid to be used.

IMPORTANT: Before checking fluid level, start the engine and turn steering wheel to the left and right several times to expel air from system, then shut off the engine.

PUMP REPLACEMENT

Removal

1. Loosen two cap screws which attach pump mounting bracket to engine; then move pump inward and remove drive belt.
2. Disconnect hoses at pump. When hoses are disconnected, secure ends in raised position to prevent drainage of oil. Install caps at pump fittings to prevent loss of fluid from pump.
3. Remove two cap screws and lock washers which attach pump and mounting bracket to engine.

Installation

1. Position pump and mounting bracket on engine and attach with cap screws and washers.
2. Install drive belt and adjust as previously described under "Belt Tension."
3. Connect and tighten hose fittings.
4. Fill pump reservoir with fluid recommended in LUBRICATION (SEC. 0) of this manual.
5. Start engine and run for several minutes at idle speed. Turn wheels from right to left several times to expel all air from system. Recheck fluid level in reservoir and fill to proper level.

TROUBLESHOOTING THE HYDRAULIC PUMP

PUMP NOISE

The power steering pump is not completely noiseless. Some noise will be present whenever the wheels are against the wheel stops. The noise usually becomes greater as the engine speed is

POWER STEERING

increased as when making a full cramped U-turn. The noise is caused by the relief valve and is normal. Momentary aeration of the oil is sometimes noticeable under these conditions. Some noise may also be present under standstill parking condition, particularly when the wheel stops are contacted. Power steering pump noise can be confused with many other things such as transmission, rear axle, generator, etc. If excessive noise is present, remove the pump drive belt to make sure the pump is at fault. If it is determined that the pump is at fault proceed as follows:

1. Check Drive Belt Tightness. Adjust belt tension, if necessary, as described previously under "Pump Belt Tension Adjustment."

2. Check Oil Level. Refill, if necessary, as described in LUBRICATION (SEC. 0) of this manual.

3. Check Hose. Make sure hose is not touching any other parts of the vehicle, especially the sheet metal.

4. Check For Presence of Air in The Oil. Air will show up as bubbles or oil will appear milky. Small amounts of air cause extremely noisy operation. If air is present in oil accomplish the following:

a. Tighten all fittings and bolts.

b. Check the entire system for source of air leak. Air can leak into the system at many places. Air leaks usually occur at joints in the system where oil passes through at high velocity - such as hose connections or at the drive shaft seal.

NOTE: After each step in attempting to eliminate air, the pump should be operated for a few minutes at idle speed while occasionally turning the steering wheel between extreme turns to allow air to bleed out of oil.

5. After Eliminating Air From The Oil. Install a pressure gauge in the pressure line between the pump and steering gear. If, when racing the engine to about 1000 rpm and without turning the wheels, pressure exceeds 125 psi, the hose and/or the steering gear are restricting the oil flow. These parts should be examined to determine cause of restriction.

6. If The Pressure is Less Than 125 Psi in Step 5 Above, remove the pump and repair.

PUMP LEAKS

Whenever oil leakage occurs in the hydraulic pump, all fittings and bolts should be cleaned and tightened. If this does not stop leakage, wipe pump assembly clean to determine where it is leaking. Following are some of the possible causes of pump leakage (see Table below):

POOR, OR NO ASSIST, OR PUMP INOPERATIVE

When the pump is inoperative, providing little or no assist in turning, first check the belt tension and adjust it as necessary, as previously described. If this does not correct the problem, check the oil level, fill and bleed the system as described previously.

If there is no improvement, it must be established whether the pump, steering gear, or hose is the source of trouble. This may be determined by two tests after placing a pressure gauge in the pressure line between pump and steering gear.

Test #1 is Performed With the Oil Circuit Open. Raise the temperature of oil to operating range of 150 to 170 degrees measured with a thermometer. This may be accomplished by turning the wheels from wheel stop to wheel stop several times. Do not hold steering wheel against wheel stop for any extended period as this will overheat the oil. As previously mentioned, the pressure relief valve in the pump will not be able to handle the excessive pressure created by contacting the wheel stop for an extended period of time, therefore, the oil will overheat.

After heating the oil to at least 150°F., set engine idle to 450 rpm; then turn the steering wheel from one end to the other and read pressure on gauge while holding the wheel momentarily against the stops. The reading should be the maximum with engine idling at 450 rpm. If it is not, trouble is in the hydraulic circuit, but it does not indicate whether the pump or steering gear or both are at fault.

This can be determined by performing Test

SOURCE OF LEAK	CAUSE	REMEDY
Top of reservoir	Reservoir too full	Fill to proper level.
	Air in the oil	Eliminate air as previously described under "Pump Noise."
At the pressure fitting or studs	Not tightened sufficiently	Torque to 25-40 foot-pounds.
	Cross threaded or defective seat on fittings or hose end. Damaged seals.	Correct as necessary.
At shaft seal	Defective seal or damaged shaft	Replace damaged parts.
Leaks in metal parts	Damaged castings	Replace damaged parts.

#2 and comparing it with test No. 1.

Test #2 is Performed With the Oil Circuit Closed. Set engine idle at 450 rpm and turn the shut-off valve of gauge to the closed position.

NOTE: Shut-off valve must be located between the gauge and steering gear. Observe pump pressure on gauge at idle and compare it with Test #1.

Diagnosis of the Two Tests. If the first test is below specifications and the second test is equal to specifications, or greater, the steering gear is at fault. When the first test is below specifications and the second test is not more than 50 psi greater, the pump is at fault.

NOTE: If steering gear is found to be at fault, use the troubleshooting procedures for the steering gear described under "Troubleshooting The Power Steering Gear" previously in this manual.

NOTE: For additional troubleshooting information, refer to "Quick Reference Troubleshooting Chart" later in this section.

POWER STEERING POWER CYLINDER

An axle mounted power cylinder acts as a power assist to the mechanical steering, and is bracketed to the front axle at one end, and to the steering rie rod at the other end.

Stationary metal tubes and flexible hose assemblies carry hydraulic fluid to operate the power cylinder piston for right or left turns.

When steering wheel is turned, the control valve on steering gear housing, directs hydraulic fluid, under pressure, from the hydraulic pump to right or left side of power cylinder piston. This produces movement of piston and attached steering linkage. The force applied by the power cylinder is the amount of thrust required for all steering requirements.

When turn is completed, reduced effort in steering wheel allows steering geometry of the vehicle to return wheel to a neutral or straight-ahead position. When returning to a neutral position, oil on one side of the cylinder piston is forced back to the hydraulic pump reservoir by oil on other side of the piston, thus equalizing the oil pressure. This constant amount of oil in the cylinder acts as a shock absorber or cushion to dissipate road shocks to the operator.

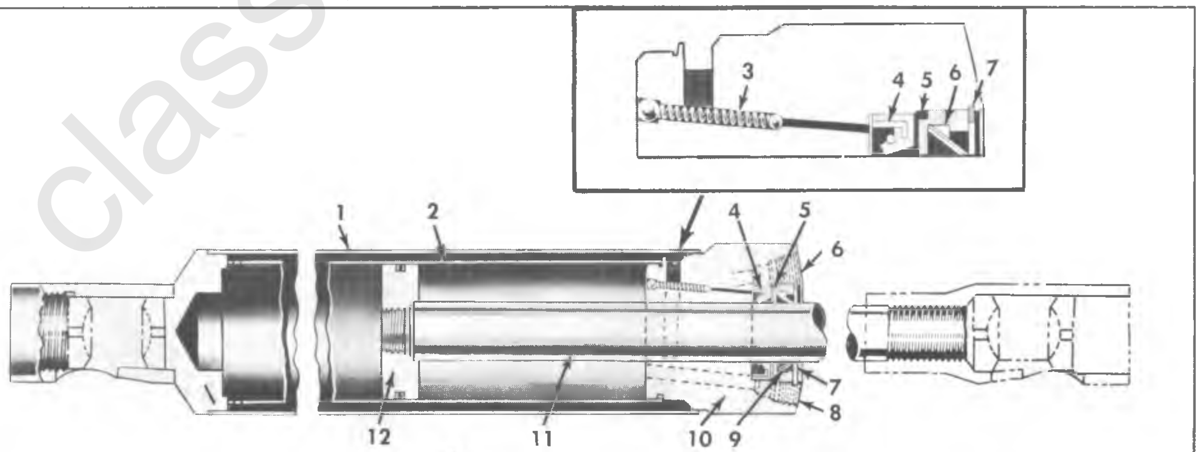
POWER CYLINDER REPLACEMENT

REMOVAL

1. Clean dirt from around hose connections at power cylinder ports.
2. Disconnect hoses from power cylinder, catching hydraulic fluid in a clean container. Cover hose fittings and ports in cylinder to keep dirt out.
3. Remove cotter pin and loosen adjuster screw securing end of power cylinder to support bracket mounting; then remove cylinder from mounting ball.
4. Repeat procedures in Step 3 previously, and remove opposite end of cylinder from tie rod ball stud.

INSTALLATION

1. Position power cylinder on tie rod ball stud and on support bracket mounting ball.
2. Turn adjuster screw at each end of power



1 Outer Tube
2 Inner Tube
3 Pressure Relief Valve
4 Oil Seal
5 Oil Seal
6 Extension Port
7 Retaining Ring
8 Retraction Port
9 Wiper Assembly
10 Guide Assembly
11 Piston Rod
12 Piston

T-3346

Figure 8—Power Cylinder

cylinder in tight; then back off to nearest cotter pin hole and install new cotter pin.

3. Turn front wheels from extreme right to extreme left and check to see that power cylinder does not bottom, preventing stops from hitting the axle.

4. Connect hydraulic hoses to power cylinder ports. Tighten hose fittings to 25-40 foot-pounds torque.

NOTE: Make certain hoses are not kinked and do not bind when wheels are turned.

5. Bleed the hydraulic system and bring fluid to proper level as previously directed.

POWER CYLINDER SEAL REPLACEMENT

REMOVAL (Fig. 8)

NOTE: The piston rod seal, wiper ring and retainer, socket end ball stud seats, and adjuster screws are the only parts of the power cylinder that can be replaced.

1. If not previously removed, remove cotter pin, adjuster screw, and ball seats from one end of the power cylinder. Use a wide blade screwdriver to turn adjuster screw out. Repeat these procedures at opposite end of the cylinder.

2. Loosen clamp bolt on the outside of the socket.

3. Using a wide blade screwdriver to keep the piston from turning, unthread socket end from piston rod.

4. Force piston rod in and out of power cylinder to drain remaining fluid.

5. Using Tru-Arc snap ring pliers, remove the scraper retainer snap ring from groove in piston rod guide assembly.

6. Apply air pressure to the retraction port in the guide assembly while at the same time holding a finger over the extension port (fig. 8). This will dislodge wiper ring assembly, scraper retainer, scraper retainer O-ring seal, and piston rod seal from the guide assembly

CLEANING AND INSPECTION

Clean and inspect the components using cleaning solvent and compressed air. Replace all parts that are not in first class condition.

ASSEMBLY (Refer to Fig. 8)

1. Lubricate lip of the piston rod seal with a thin layer of Lubriplate or equivalent, and insert it into the guide assembly with the "U" of the cup toward the bottom of opening in guide.

2. Install scraper retainer O-ring seal.

3. Install the scraper retainer in guide with "U" side pointing out.

4. Insert the wiper ring assembly; then using Tru-Arc snap ring pliers, install the retaining snap ring. Make sure retaining ring is well seated in groove of the guide assembly.

5. Thread the socket end assembly on piston rod until it shoulders against the rod.

6. Tighten the clamp bolt securely.

7. At both ends of the power cylinder, install ball seats; then thread the adjuster screws into the sockets loosely.

POWER CYLINDER ADJUSTMENT

AXLE MOUNTED CYLINDER

Adjustment dimensions for all axle mounted cylinders are shown in figure 9.

1. Attach power cylinder to axle.

2. Position wheels in full right-hand turn, against wheel stop.

3. Depress power cylinder piston rod into

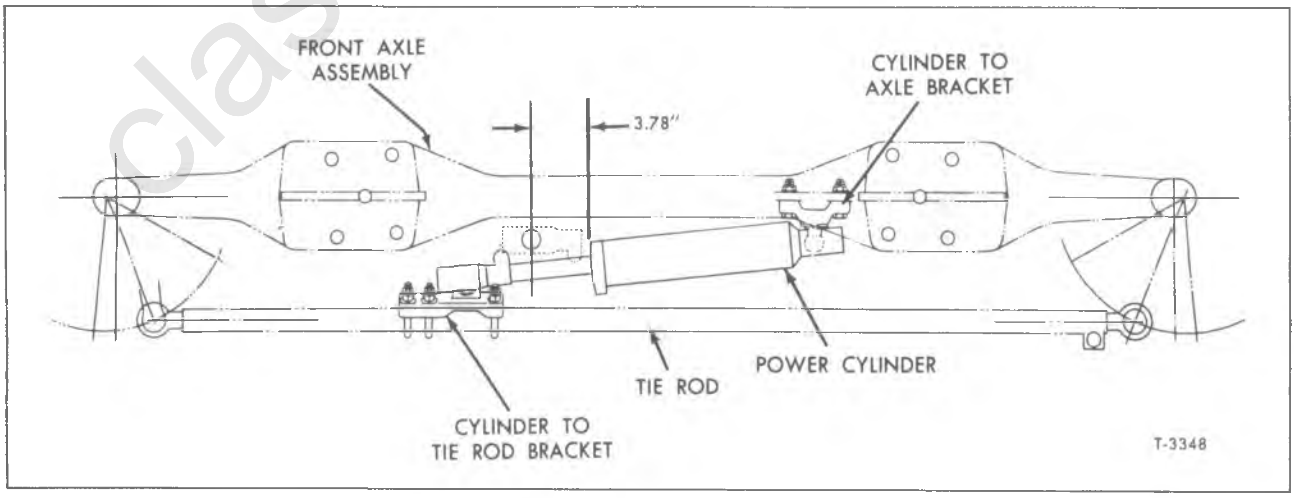


Figure 9—Axle Mounted Power Cylinder Adjustment

cylinder housing, until it bottoms. Using a grease pencil or other suitable marking device, place mark on piston rod at cylinder housing.

4. Loosely attach cylinder tie rod bracket, to tie rod so that it is free to slide on rod.

5. Extend power cylinder piston rod out of cylinder housing to its full length of travel (bottomed) and mark piston rod.

6. Depress piston rod 1/8-inch and tighten to tie rod. It is most important the piston rod be depressed 1/8-inch from the fully extended position while the piston rod is secured to the tie rod.

NOTE: For proper torque on power steering components, refer to "Power Steering Specifications" later.

7. Position wheels in a full left-hand turn, against wheel stop.

8. Check that first marking on piston rod (piston rod depressed) is still visible.

NOTE: Proper adjustment of power cylinder is achieved when cycled from a full left-hand to right-hand turn without the cylinder bottoming.

9. Check for clearance of cylinder at both axle and tie rod while wheels are being turned. Repeat adjustment procedure, if necessary.

TROUBLESHOOTING THE POWER CYLINDER

POWER CYLINDER LEAKAGE

INTERNAL LEAKS

Internal leakage in the power cylinder will show up in a momentary increase in driver effort when turning the wheel fast. If this occurs, replace complete cylinder assembly.

EXTERNAL LEAKS

If the power cylinder is leaking externally, wipe it clean to determine where it is leaking. Leakage around the piston rod seals may be corrected by replacing the seals. If the power cylinder still leaks after replacing the seals, the pressure relief valve is not operating properly and the complete power cylinder will have to be replaced. Any leakage around the welds on the cylinder will necessitate replacing the complete power cylinder assembly. Tighten the hose connections at the extension and retraction ports if this is a source of leakage. If tightening the connection does not stop leakage, replace complete cylinder assembly.

NOTE: Any damage to the cylinder which will hamper its operation necessitates replacement of the complete power cylinder assembly. The cylinder is not serviced except for the piston rod seals.

NOTE: For additional troubleshooting information, refer to "Quick Reference Troubleshooting Chart" at end of this section.

OIL COOLER

An oil cooler is attached to the radiator front support on all vehicles with power steering except with air conditioning.

The oil cooler may be removed for repair or replacement by disconnecting hoses and removing screws which attach it to support braces.

OIL COOLER MAINTENANCE

At regular intervals, or when operating conditions warrant, examine the cooler for leaks and bent fins. A damaged or leaking cooler should be serviced by a radiator specialist or replaced with a new assembly. Proper repair requires the use of special tools and equipment as well as provisions for making proper tests.

If the cooler assembly requires painting, spray with special radiator paint; do not use paint mixed with oil, as oil mixed paint will form an insulation and prevent efficient dissipation of heat.

Occasional external flushing with water, using an ordinary hose, will help remove dirt, bugs and other foreign matter from between fins of cooler. Water under pressure should be directed from behind the cooler to force dirt out in opposite direction of its entrance. Direct the water stream against edges of fins (not sideways) to eliminate danger of bending fins.

QUICK REFERENCE TROUBLE SHOOTING CHART

NOTE: Some of the remedial procedures suggested for conditions outlined in this chart constitute overhaul of components which is not within the scope of this manual. Refer to "Overhaul" section of applicable manual for proper method of accomplishing these corrections.

(Type 549-DV and 553-DV Power Steering)
HYDRAULIC PUMP

CONDITION	CAUSE	REMEDY
1. Pump Noise.	Loose belt.	Tighten belt.
	Hoses touching other parts of truck.	Adjust hose position.
	Low oil level.	Fill reservoir.
	Air in the oil.	Locate source of air leak and correct.
	Excessive back pressure caused by hoses or steering gear.	Locate restriction and correct. Bleed system.
	Scored pressure plate.	Lap away light scoring. Replace heavily scored part.
	Vanes not installed properly.	Install properly.
	Extreme wear of pump ring.	Replace ring.
	Vanes sticking in rotor slots.	Free up by removing burrs or dirt.
	Face of thrust plate scored.	Lap away light scoring. Replace heavily scored part.
	Scored rotor.	Lap away light scoring. Replace heavily scored part.
	Defective flow control plunger.	Replace assembly.
2. Leaks at top of of reservoir.	Reservoir too full.	Fill to proper level.
	Air in the oil.	Locate source of air leak and correct.
3. Leaks at the reservoir.	O-Ring seal cut.	Replace O-Ring seal.
	O-Ring improperly installed.	Install seal properly.
4. Leaks at the pressure fitting or mounting stud.	Not tightened sufficiently.	Torque to 30-40 ft.-lbs.
	Cross threaded or damaged seat.	Replace damaged part.
	Defective seat on hose end.	Replace hose.
	Damaged seals.	Replace seals.
5. Leaks at the shaft seal.	Defective seal.	Replace seal.
	Damaged shaft.	Replace shaft.
6. Leaks in metal parts.	Poor casting.	Replace defective parts.
7. Pump inoperative, poor, or no assist.	Loose drive belt.	Tighten belt.
	Low oil level.	Fill reservoir to proper level.
	Air in the oil.	Locate source of air leak and correct.
	Defective hoses or steering gear as determined by test outlined under gear section later in this chart.	Correct.
	Flow control valve stuck.	Remove burrs or dirt.
	Loose nut in end of flow control valve.	Tighten nut.
	Pressure plate not flat against ring.	Correct condition.
	Extreme wear of pump ring.	Replace pump ring.
	Scored pressure plate, thrust plate, and or rotor.	Lap away light scoring. Replace heavily scored parts.

8. Pump inoperative, poor, or no assist.	Vanes not installed properly. Vanes sticking in rotor slots. Faulty flow control valve assembly.	Install vanes properly. Free up by removing burrs or dirt. Replace assembly.

CONTROL VALVE AND POWER STEERING GEAR

CONDITION	CAUSE	REMEDY
1. Gear noise (rattle or chuckle).	Loose over-center adjustment. Coupling pin stops, hitting against upper flange. **NOTE:** A slight rattle may occur on turns because of the increased lash off the high point. This is normal. Gear loose on frame.	Adjust to specification. Re-align shaft with gear. Adjust endwise if necessary. Check gear to frame mounting bolts. Tighten bolts to specifications.
2. Gear noise (hissing sound).	There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking.	Do not replace valve unless "hiss" is extremely objectionable. Be sure steering shaft and gear are aligned so the flexible coupling is not distorted as shaft rotates. Any metal to metal contact through the flexible coupling will transmit the valve hiss into the truck.
3. Valve squawk when turning or when recovering from a turn.	Cut or worn dampener O-Ring on spool Loose or worn valve.	Replace dampener O-Ring. being careful not to cut the new ring at installation. Replace valve.
4. Internal leaks.	Momentary increased effort on fast turn.	Replace valve.
5. External oil leaks (wipe gear thoroughly and make sure source of leakage is determined).	Loose hose connections. Damaged hose. Adjuster plug seals Torsion bar seal	Tighten. Replace. Replace seal. Replace torsion bar and stub shaft assembly.
6. Hard steering while driving.	Frozen steering shaft bearings. Lower coupling flange rubbing against adjuster. Steering wheel rubbing against gearshift bowl. Steering adjustment tight.	Replace bearings. Loosen bolt and assemble properly. Adjust jacket endwise. Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary.
7. Poor return of steering.	Frozen steering shaft bearings. Lower coupling flange rubbing against adjuster. Steering wheel rubbing against gearshift bowl. Tires not properly inflated. Incorrect caster or toe-in front wheels. Tight steering linkage. Steering gear misalignment. Tightness of suspension joints. Steering adjustment tight. Tight sector to ball nut adjustment. Thrust bearing adjustment too tight. Sticky valve spool.	Replace bearings. Loosen bolt and assemble properly. Adjust jacket endwise. Inflate to specification. Adjust as described in front axle (Sec. 3) of this manual. Lubricate linkage as described in lubrication (Sec. 0) of this manual. Re-shim at frame. Lubricate or otherwise free up. Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary. Adjust in truck to specification. Remove gear and adjust to specifications. Remove and clean valve or replace valve.

CONTROL VALVE AND POWER STEERING GEAR (Cont.)

CONDITION	CAUSE	REMEDY
8. Truck leads to one side or to the other.	Due to front end misalignment.	Adjust to specification.
	Unbalanced or badly worn valve. **NOTE:** If this is the cause, steering effort will be very light in direction of lead and heavy in opposite direction.	Replace valve.
9. Momentary increase in effort when turning wheel fast.	Low oil level in pump.	Check oil level in pump reservoir and bring to proper level.
	Pump belt slipping.	Tighten or replace belt.
10. Excessive wheel kick-back or loose steering.	Lash in steering linkage.	Adjust parts affected.
	Air in the system.	Add oil to pump reservoir.
	Excessive lash between pitman shaft sector and ball nut.	Adjust to specification.
	Loose thrust bearing adjustment.	Remove steering gear and adjust to specification.
11. Steering wheel surges or jerks when turning with engine running—especially during parking.	Loose pump belt.	Adjust to specification.
12. Hard steering when parking.	Loose pump belt.	Adjust to specification.
	Low oil level in reservoir.	Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage.
	Lack of lubrication in linkage for front suspension.	Add lubricant where needed as described in lubrication (Sec. 0) of this manual.
	Tires not properly inflated.	Inflate to recommended pressure.
	Insufficient oil pressure.	If all of the above checks do not reveal the cause of hard steering, make the following tests of oil pressure: a. Disconnect the pressure line at oil pump. Attach gauge to pump. Connect the hose to end of gauge where the valve is located. b. With the engine at warm idle and gauge valve open, note the oil pressure on the gauge while turning steering wheel from one extreme position to the other. Especially note the maximum pressure which can be built up with the wheel held in either right or left extreme position. **CAUTION:** Do not hold wheel in extreme position for an extended period of time because it will drastically increase the oil temperature and will cause undue wear on the oil pump. c. With oil temperature between 150 degrees F and 170 degrees F, as measured with a thermometer in the reservoir, the maximum oil pressure should not be less than 600 PSI for satisfactory power steering operation. d. If the maximum oil pressure is less than 600 PSI, it indicates trouble in the pump, steering gear, cylinder, or a combination of these parts. To eliminate the gear, close the gauge valve and quickly test pressure of the pump only with the engine at warm idle; then open the valve to avoid increasing oil temperature.

CONTROL VALVE AND POWER STEERING GEAR (Cont.)

CONDITION	CAUSE	REMEDY
Hard steering when parking. (Cont'd)		Comparing the maximum pressures obtained in these two tests will indicate source of trouble as follows: (a) First test pressure low and second test pressure normal—indicates faulty external oil lines, or steering gear. (b) First test and second test pressures equally low—indicates faulty oil pump. If the above test shows trouble to be in pump, see hydraulic pump procedures described previously. If trouble is shown to be in steering gear or hoses, examine for external oil leaks as described under LEAKS—ITEM 5.
	Low oil pressure due to restriction in hoses:	
	a. Check for kinks in hoses.	Remove kinks.
	b. Foreign object stuck in hose.	Remove hoses and remove restricting object or replace hose.
	Low oil pressure due to steering gear	
	a. Leakage at valve rings, valve body to worm seal.	Remove gear from truck for disassembly and replace seals.
	b. Loose fit of spool in valve body or leaky valve body.	Replace valve.
13. Excessive effort required to turn.	Broken torsion bar	Replace torsion bar and stub shaft assembly.

POWER CYLINDER

1. Internal leaks.	Momentary increased effort when turning wheel.	Replace cylinder assembly.
2. External leaks.	Around piston rod seals.	1. Replace seals. 2. Cylinder relief valve not working—replace cylinder assembly.
	At hose connections.	Tighten or replace cylinder if tightening does not remedy condition.
	Around welded joints.	Replace cylinder assembly.
3. Excessive ball socket movement.	End play present. Worn ball seats.	Adjust to specifications. Replace seats.
4. Piston rod end clamp movement.	Loose bolts.	Torque to specifications after proper positioning to specifications.

POWER STEERING

SPECIFICATIONS

POWER STEERING GEAR SPECIFICATIONS

TRUCK MODEL	GEAR MODEL	GEAR RATIO	CENTER POSITION
STEEL TILT CAB MODELS	553-DV-54	28.14-1	6 O'CLOCK
PS-4500	553-DV-59	28.14-1	12 O'CLOCK
EM-4500-5500-6500	549-DV-192	28.14-1	8 O'CLOCK
ES-5500, SS-5500	549-DV-180	28.14-1	12 O'CLOCK
SM-5500-6500	549-DV-192	28.14-1	8 O'CLOCK
SG-5500, EG-5500-6500	549-DV-194	28.14-1	8 O'CLOCK

STEERING GEAR ADJUSTMENTS

Thrust Bearing Preload	1 to 3 inch-pounds in access of valve assembly drag.
Thrust Bearing Adjustment Plus Seal Drag	8 inch-pounds maximum.
Pitman Shaft Preload	4 to 8 inch pounds in access of total bearing preload and valve drag.
Final Over-Center Reading—(Total of Valve and Seal Drag, Worm Bearing Preload, and Lash Adjuster Preload)	16 inch-pounds maximum.

POWER STEERING TORQUE SPECIFICATIONS

	TYPE OF PART	TORQUE FT. LBS.
POWER STEERING GEAR		
Hose Fittings-to-Ports		20-30
Adjuster Plug	Nut	50-110
Side Cover-to-Housing	Bolt	25-35
Lash Adjuster Screw	Nut	25-35
Control Valve-to-Steering Gear	Bolt	35-45
POWER STEERING PUMP PULLEY		
Except In-Line Engine	Nut	25-30
In-Line Engine	Nut	65-95
STEERING GEAR-TO-FRAME BOLT		
E, S Models and PS-4500	Nut	50-60
Tilt Cabs	Nut	90-110
Pump to Mounting Bracket	Bolt	25-30
PUMP STUD-TO-MOUNTING BRACKET (When Used)		
Except In-Line Engine	Nut	16-18
In-Line Engine	Nut	20-30
CYLINDER ANCHOR STUD-TO-AXLE		
Tilt Cab Models	Nut	320-420 (2)
E. S Models	Nut	200-225 (2)
PS4500	Nut	50-70 (2)
CYLINDER-TO-TIE ROD U-BOLT		
Tilt Cab Models	Nut	35-45
E, S Models	Nut	35-45
PS4500	Nut	30-40
Cylinder Socket Clamp (Except PS4500)	Bolt	40-50
Cylinder-to-Tie Rod Bracket (PS4500)	Nut	25-35
Oil Cooler-to-Radiator Support	Bolt	10-15

(2) Torque as indicated, then tighten to next notch to insert cotter pin.

HYDRAULIC PUMP APPLICATION CHART

TRUCK MODEL	PUMP-MODEL
LV, LA-4000	235-P-49
PS-4500	235-P-122
EM-4500-5500-6500	235-P-36
EG, SG-5500, EG-6500	235-P-36
ES, SS-5500, ES-6500	235-P-36
SM-5500-6500	235-P-36
DLV, DLA-4000	14-150100-09

SPECIFICATIONS (CONT.)

HYDRAULIC PUMP SPECIFICATIONS

VANE TYPE PUMP	
Make	Saginaw Steering Gear Division
Type	Vane
Model	235-P
Capacity Per Minute:	
Maximum	3.5 gpm of Type "A" automatic transmission fluid at 170°F. temperature when operating pump against 50 psi pressure.
Minimum	2.35 gpm of Type "A" automatic transmission fluid at 170°F. temperature when operating pump at idle speed against 665/735 psi pressure.
Pressure Relief Valve:	
Minimum PSI	900
Maximum PSI	1000
SLIPPER TYPE PUMP	
Capacity	
Maximum	3.4-4.1 gpm
Minimum	1.45 gpm when operating pump at idle speed against 665/735 psi pressure
Pressure Relief Valve	
Minimum PSI	1000 psi
Maximum PSI	1100 psi

HYDRAULIC PUMP TORQUE SPECIFICATIONS

VANE TYPE PUMP	
Mounting Bolt or Stud	25-40 Ft. Lbs.
Port Fitting	25-40 Ft. Lbs.
SLIPPER TYPE PUMP	
Reservoir Cap Screw	15-20 Ft. Lbs.
Pressure Relief Valve	30 Ft. Lbs.
Front Insert Nut	95-105 Ft. Lbs.

POWER STEERING POWER CYLINDER SPECIFICATIONS

Make	Saginaw Steering Gear Division
Type	Hydraulic
All Models, except PS4500 with F040 Axle	
Cylinder Part No.	5690726
Retracted Length	15.735"
Extended Length	24.795"
Stroke	$9\frac{1}{16}$"
PS4500 with F040 Axle	
Cylinder Part No.	5691112
Retracted Length	16.857"
Extended Length	25.335"
Stroke	$8\frac{15}{32}$"

A satisfactory steering system depends upon maintaining components in good condition, with a minimum amount of wear permitted. Proper alignment, and lubrication will pay dividends in driver satisfaction, and in tire economy.

SECTION 10
Wheels and Tires

Wheels used on vehicles covered in this manual are Disc, Cast, or Budd type (fig. 1). Disc wheels are secured on hub studs with nuts. Budd type front wheels have a single nut, while rear wheels have inner and outer nuts. On cast steel wheels, tires are mounted on rims which are secured on wheel with rim clamps, studs, and nuts.

WHEEL NUT TORQUE CHECK

IMPORTANT: When truck is new, or after wheel has been changed, the wheel nut torque should be checked at 100, 500, 1000 miles, and every 1000 miles thereafter.

TIGHTENING WHEEL STUD NUTS - DISC AND BUDD WHEELS

IMPORTANT: On all type wheels never use oil or grease on studs or nuts. When installing dual rear tires, valve stems should be positioned 180 degrees apart.

When Budd type wheels are used, studs and nuts on right side of vehicle have right-hand threads, and studs and nuts on left side have left-hand threads. Inner and outer nuts are stamped "L" or "R" to indicate at which side of vehicle they are to be used.

To tighten nuts on Budd type dual rear wheels (fig. 1) loosen outer nuts, then tighten inner nuts. Tighten opposite nuts alternately so wheel will be square against hub flange. After tightening inner nuts, tighten outer nuts. When replacing 10 hole wheels the tightening sequence shown in figure 2 should be used. Tighten nuts numbers 1, 2, 3, and 4 in sequence indicated. Draw nuts up alternately, a little at a time until torque of approximately 200 foot-pounds is reached. Tighten the balance of nuts to 450 to 500 foot-pounds, while alternating from side-to-side of wheel. Finish tightening nuts 1, 2, 3, and 4 to 450 to 500 foot-pounds.

CAST SPOKE WHEELS (Refer to Fig. 3)

1. Install rim clamps and nuts finger-tight.

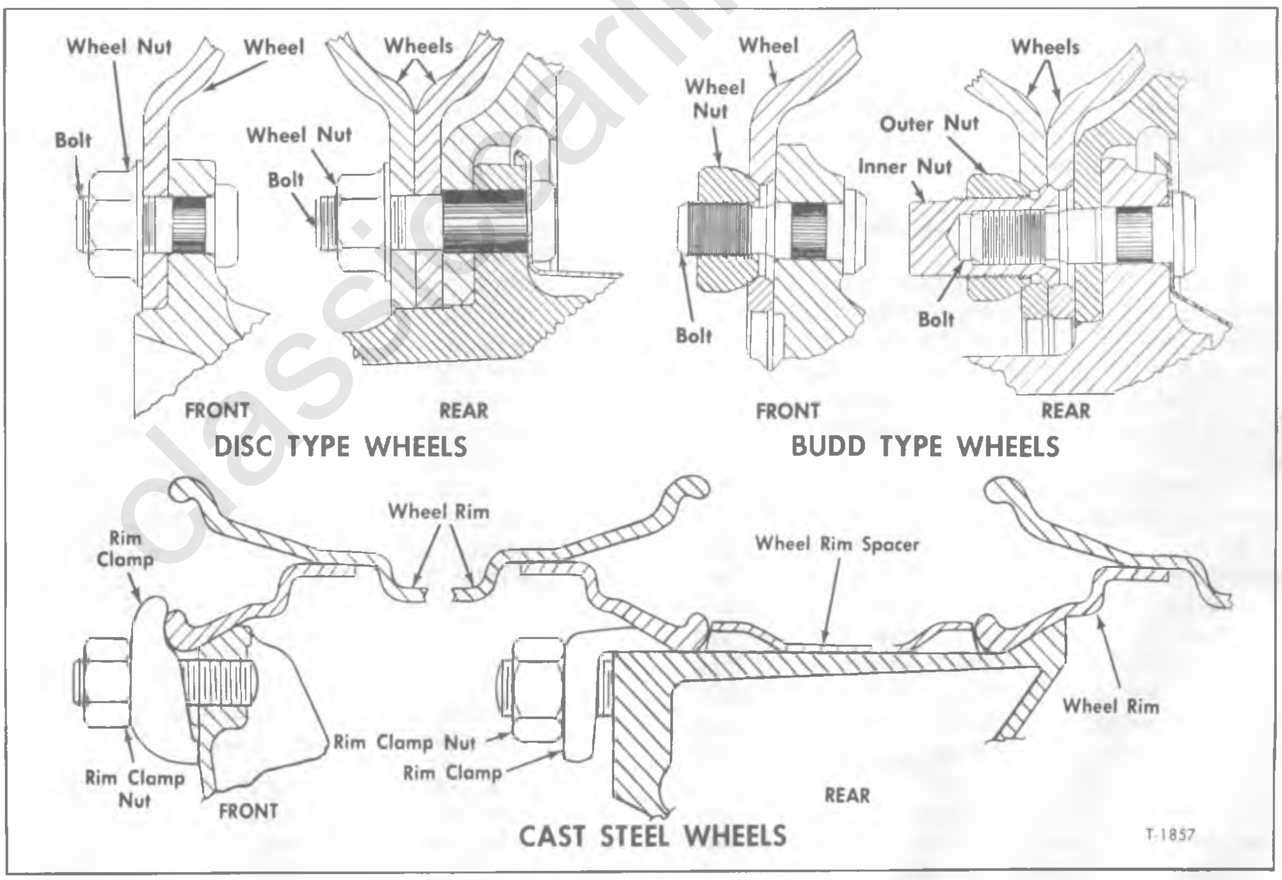


Figure 1—Typical Disc, Budd, and Cast Wheels

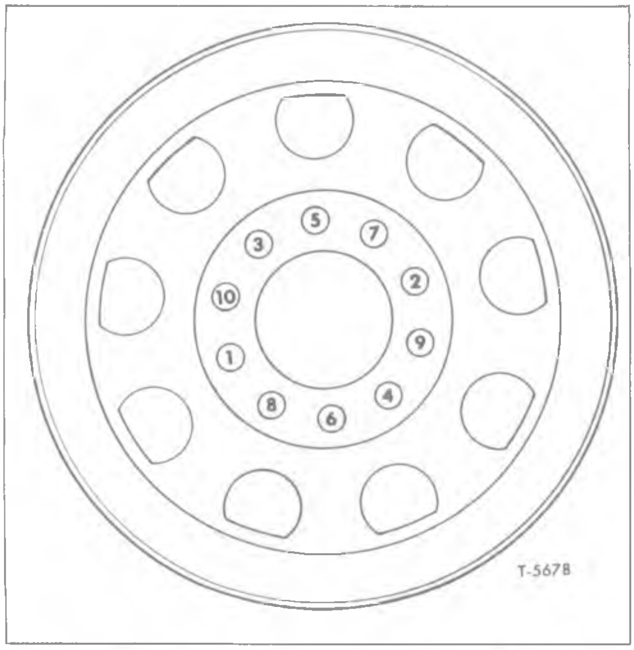


Figure 2—Wheel Nut Tightening Sequence for 10 Hole Wheels

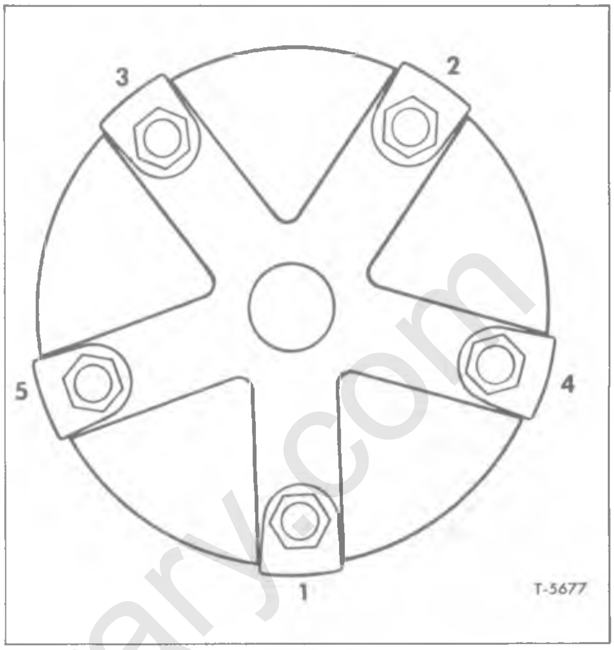


Figure 3—Wheel Nut Tightening Sequence for Cast Wheels

2. Starting at bottom, tighten #1 nut 15-20 foot-pounds.

3. Tighten nuts 2, 3, 4, and 5 to 190-210 foot-pounds, in this sequence.

4. Retorque nut #1 to 190-210 foot-pounds.

This torquing sequence will give proper torque with minimum wheel run-out. Maximum permissible wheel run-out is 1/8-inch.

WHEEL INSPECTION

Do not use wheels with bent rims. The continued use of such wheels will result in excessive tire wear and, if wheel is mounted on front of vehicle, difficulty in steering will be experienced. Wheels that are thought to be distorted may be checked as follows, referring to figure 4 for checking points:

1. Raise axle at side to be checked and safely support underneath.

2. Tool for checking run-out may be readily improvised as follows: secure block of wood approximately 6" x 6" x 14" or material with suitable base so it will remain positioned. Secure thin piece of wood or suitable material 10" long such as ruler or yardstick, and fasten to wood block to a height in relation to rim surfaces as shown in figure 4. Tighten screw sufficiently so pointer will hold its position when adjusted.

3. Position pointer at crown of rim (A, fig. 4). Slowly revolve wheel and move pointer toward wheel until it contacts wheel at nearest point.

4. Continue to revolve wheel and check amount of lateral run-out (amount of wheel side wobble). This should not exceed 3/32-inch.

5. Place point of marker at inside of wheel at point (B, fig. 4). Follow the above procedure to check radial run-out (out-of-round condition); this should not exceed 3/32-inch. If wheel is distorted beyond these dimensions it should be replaced.

6. If doubt exists whether the wheel or hub is distorted, hub may be checked as follows: Replace the existing wheel with a wheel known to be true. Revolve the wheel and make the previously mentioned tests. If tests are within limits, the hub is satisfactory, but wheel is sprung.

7. A dismounted wheel may be checked for side wobble by placing a straight-edge on face or hub of wheel. Measure distance from straight-edge to edge of wheel rim, this should be checked at four equally spaced locations. If distance is the same at all positions wheel is not distorted (see fig. 5). A dismounted wheel may also be checked for radial, and lateral run-out if desired, by temporarily mounting it to a hub on vehicle. Follow the previous Steps 2, 3, 4, and 5.

TIRES

Tube-type tires are standard and optional on all vehicles covered in this manual.

One of the most important factors of economical and safe truck operation is systematic and correct tire maintenance. The tires must not only support the weight of the loaded vehicle, but they also serve to transmit driving and braking forces to road surface. Therefore, the tires used on all trucks should receive the same amount of careful systematic, and regular maintenance as do other operating units. The three major causes of tire troubles are (1) underinflation (2) bruises and (3) misalignment. Tires should be checked periodically to prevent excessive damage caused by these conditions.

Periodically check the valve stem cores and caps for leakage. Also, check around tires for embedded steel, rock, or glass. If any of these objects are allowed to remain in tread, they may eventually reach the tube.

NOTE: In some instances the tube of an inflated tire may already be punctured and pressure will be lost only when object is removed.

INFLATION OF TIRES

Under-inflation is the greatest cause for loss of tire life expectancy. Tires should be checked frequently for this condition. The fabric, rubber, bead, contour, and size of tires used on these vehicles are designed to obtain maximum length of service under all operating conditions to which vehicles may be subjected. TIRES ARE DESIGNED TO OPERATE EFFICIENTLY ONLY ON A PRESCRIBED AMOUNT OF AIR. Unless the correct air pressure is consistently maintained, the tires will not function as they should; consequently, safe economical operation of vehicle will be materially affected.

An under-inflated tire runs sluggishly, heats up quickly because of the greater flexing, and is subjected to more frequent bruising. In the situation of duals, loss of pressure in one tire could cause slippage of rim on wheel with the result of tire, tube, rim and spacer loss. On the other hand, over-inflation may weaken the tire, causing a blow-out. In addition to the deteriorating effect improperly inflated tires may have on the tire life, this condition will affect steering, riding comfort, and safe driving. FOLLOW THE TIRE PRESSURE RECOMMENDATIONS OF THE TIRE MANUFACTURER.

For greater riding comfort, prolonged tire life, and to reduce wear and tear on the truck chassis, tires should be inflated for loads carried on tires as indicated in "Tire Load and Inflation Table" in "Specifications" at end of this section. In no case should this combined front and rear tire load exceed the maximum recommended load shown in "Load Capacity Chart" in the current Owner's and Driver's Manual.

BALANCED INFLATION

The whole efficiency of the vehicle will be upset if air pressure in the tires are out-of-balance. Balanced inflation may be expressed as: All tires on the same axle should always carry the same

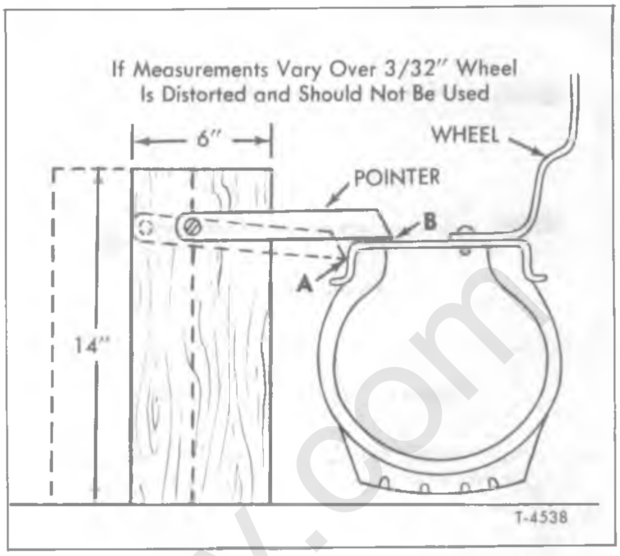


Figure 4—Method of Checking for Distorted Wheels

air pressure. A difference in air pressure of the rear tires and the front tires may be permissible within certain limitations; however, there should not be a difference in pressures between the right and left tires on the same axle. A five-pound under-inflation in one front tire not only can destroy ease of steering, but creates steering hazards which generally point to a potential accident. An under-inflated rear tire can destroy the value of the most efficient brakes. Balance tires for ease of steering, comfort in riding, safety in driving, as well as for minimum fuel consumption and maximum tire mileage.

PRESSURE LOSS

At periodic intervals, each tire should be gauged for pressure loss with an accurate gauge before tires are brought to correct operating pressure. The purpose of this check is to determine the exact pressure loss in each tire. In other words, if at the time this check is made, a definite pressure loss is noted in any one of the tires, an

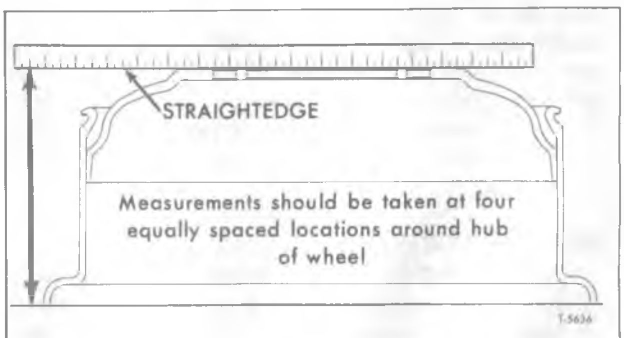


Figure 5—Typical Wheel Checking Diagram

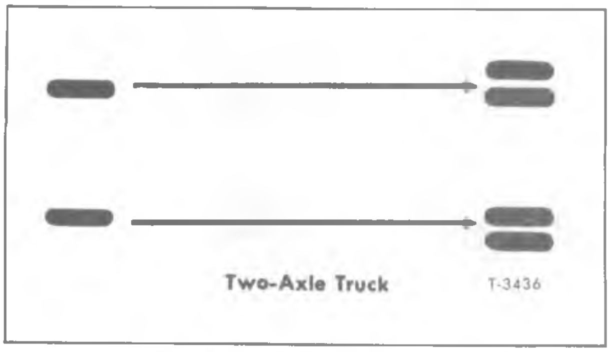


Figure 6—Tire Rotation Diagram

inspection should be made of the tire showing the loss and the cause of loss corrected. This method should definitely establish a "danger signal" on the condition of the tires. The pressure loss check should be made consistently with the same gauge, so that any element of inaccuracy in the gauge will be the same for all tires.

VALVE CORE AND CAP

The valve core is a spring-loaded check valve in the valve stem, permitting inflation or deflation of the tube or tire. This check valve, or core, is not intended to hold the air during operation. The valve cap is provided to seal the air in the tube and tire. When valve cap is tightened down on stem, the sealing washer inside cap is pressed tightly against top of stem, preventing air leakage. It is important, therefore, that valve caps be used at all times.

SELECTION OF TIRES

All tires on an axle should, whenever possible, be of the same make, since difference in design and tread in some instances result in unequal tire rolling radii. When installing tires, all tires on each axle should have the same outside diameter within 1/4-inch on tires up to and including size 9.00-20, or within 1/2-inch on sizes 10.00-20. If tires do not have the same outside diameter (within the above limitations), excessive tread scuffing and hard steering will result. In highway service, the smaller of the two tires on a dual assembly should be installed on the inside position, provided its diameter is within the tolerance described previously.

WHEEL STUDS OR BOLTS

IMPORTANT: If any wheel experiences a single stud failure caused by a loose-running wheel all studs should be replaced. A loose running wheel may cause only one stud to break, but several more studs may become fatigued to the point of failure, but not actually breaking. Replacing only the one broken stud and remounting wheel will then set the stage for a second and possibly more serious failure. If holes in wheel have become elongated or enlarged, replace wheel.

TIRE ROTATION

Tires should be interchanged at regular intervals to obtain maximum tire life. Refer to figure 6. If there is uneven tread wear on front tires, rotate tires immediately and check vehicle for mechanical irregularities. Since there are three tires on each side of the vehicle, the front tires should be moved to the rear when 1/5 of the tread life has been used. When tires are moved to rear, follow recommendations previously described under "Selection of Tires" in matching them with other tires.

TIRE MOUNTING

UNLESS EXPERIENCED, DO NOT ATTEMPT TO REPAIR TIRE. HAVE REPAIRS MADE BY A RELIABLE TIRE REPAIR SHOP.

CAUTION

Most truck "rim accidents" are caused by carelessness, thoughtlessness, or lack of experience, when inflating the tire after mounting. Such accidents are always serious and sometimes fatal. Be on the safe side -- always follow the precautions explained following:

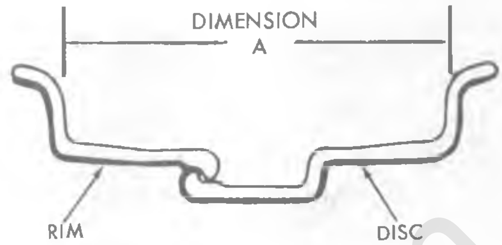
On all rims, the lock ring must be fully seated in the rim gutter before inflating tire. This is important for the safety of the person inflating the tire. As a safety measure, observe the following precautions:

On Budd or disc type wheels, use a steel bar approximately 1" in diameter and long enough to extend several inches over the lock ring at both ends. Bend bar so it can be inserted through wheel spoke openings with both ends of bar extending over the lock ring. Leave bar in place until tire is fully inflated, examine lock ring to see that it is fully seated, then remove safety bar.

On cast wheels, wrap tire and rim with a chain at opposite sides of rim and secure ends of chain. Leave chain loose enough to permit expansion of tire during inflation. After inflating, examine lock ring to see that it is fully seated, then remove chain.

IMPORTANT: When servicing wheels, care should be taken to prevent wheel discs, and rims from becoming mixed. Rims should be tagged or marked to assure assembly to correct disc. The following chart is provided (fig. 7) to aid in assembling the correct rim to disc if they should become mixed.

On vehicles with tires that are secured on rim by a one-piece split lock ring, or by a continuous side ring held in place by a split ring, conventional methods are used to mount and dismount tires.



Wheel Size	Dimension A	Tire Size
20 x 5.0	5.0″	7.00-20
20 x 6.0	6.0″	7.50-20 8.25-20
20 x 6.5	6.5″	8.25-20 9.00-20

T-5634

Figure 7—Rim Chart

WHEEL AND TIRE BALANCING

It is desirable from the standpoints of tire wear and vehicle handling ease to maintain proper balance of front wheel and tire assemblies on all models. All wheels intended for use on front of vehicle, such as those switched during periodic tire rotation and those installed as new or repaired replacement equipment should be accurately balanced. This may be accomplished by either of two types of balancing systems in current use which balance wheels either on the vehicle or off. The "on-the-vehicle" type, however, is the more desirable in that all rolling components (brake drums, bearings, seals, etc.), are included in the balancing procedure and thereby have any existing unbalance corrected.

Wheel balance is the equal distribution of the weight of the wheel and tire assembly around the axis of rotation. There are two ways in which wheels can be balanced -- statically and dynamically; wheels must be statically balanced before they can be balanced dynamically.

STATIC BALANCE

Static balance (sometimes called still balance) is the equal distribution of weight of the wheel and tire assembly about the axis of rotation in such a manner that the assembly has no tendency to rotate by itself, regardless of its position. For example: A wheel with a chunk of dirt on the rim will always rotate by itself until the heavy side is at the bottom. Any wheel with a heavy side like this is statically out-of-balance. Static unbalance of a wheel causes a hopping or pounding action (up and down) which frequently leads to wheel "flutter" and quite often to wheel "tramp."

DYNAMIC BALANCE

Dynamic balance (sometimes called running balance) means that the wheel must be in static balance, and also run smoothly at all speeds on an axis which runs through the centerline of the wheel and tire and is perpendicular to the axis of rotation.

To ensure successful, accurate balancing, the following precautions must be observed:

Wheel and tire must be clean and free from all foreign matter. The tires should be in good condition and properly mounted with the balance mark on the tire, if any, lined up with the valve.

Bent wheels that have run-out over 3/32" should either be replaced or straightened before being balanced.

Inspect tire and wheel assembly to determine if an eccentric or out-of-round condition exists. Note that this condition, if severe, cannot be "balanced out." An assembly which has an out-of-round condition exceeding 5/16" is not suitable for use on the front of the vehicle. Its use on the rear should be governed by its general condition and whether the roundness defect seriously detracts from overall ride quality.

When balancing wheels and tires, it is recommended that the instructions covering the operation of the wheel balancer being used be closely followed.

WHEELS AND TIRES

WHEEL NUT TORQUE

	TORQUE FT. LBS.
WITH DISC TYPE WHEELS (PS 4500)	300-400
WITH DISC TYPE WHEELS (EXCEPT PS 4500)	275-305
WITH CAST TYPE WHEELS	
TIGHTEN NUTS ALTERNATELY AND EVENLY TO:	
FRONT AND REAR	190-210
WITH BUDD TYPE WHEELS	
FRONT	450-500
REAR (INNER AND OUTER NUTS*)	450-500

*LOOSEN OUTER NUTS, TIGHTEN INNER NUTS, THEN TIGHTEN OUTER NUTS.

TIRE LOAD AND INFLATION TABLES

Tire and Rim Association Standard Tire Loads At Various Inflation Pressures.

Load Range Letters and Corresponding Ply Rating
(**D** = 8 ply, **E** = 10 ply, **F** = 12 ply and **G** = 14 ply)

SINGLE TIRES FOR TRUCKS IN HIGHWAY SERVICE

TIRE SIZE	LOAD RANGE	TIRE LOAD LIMITS AT VARIOUS INFLATION PRESSURES										
		50	55	60	65	70	75	80	85	90	95	100
7.00-20	D	2100	2260	2390	2530	2670	**2790**					
7.00-20	E	2100	2260	2390	2530	2670	2790	2920	3030	**3150**		
7.50-20	D	2360	2530	2680	2840	2990	**3140**					
7.50-20	E	2360	2530	2680	2840	2990	3140	3270	3410	**3530**		
8.25-20	E	2800	3010	3190	3370	3560	3730	3890	**4050**			
8.25-20	F	2800	3010	3190	3370	3560	3730	3890	4050	4210	4350	**4500**
9.00-20	E		3560	3770	4000	4210	4410	**4610**				
9.00-20	F		3560	3770	4000	4210	4410	4610	4790	4970	**5150**	
10.00-20	F			4290	4530	4770	4990	5220	**5430**			
10.00-20	G			4290	4530	4770	4990	5220	5430	5640	5840	**6040**

DUAL TIRES FOR TRUCKS IN HIGHWAY SERVICE

TIRE SIZE	LOAD RANGE	TIRE LOAD LIMITS AT VARIOUS INFLATION PRESSURES										
		40	45	50	55	60	65	70	75	80	85	90
7.00-20	D	1840	1980	2100	2220	2340	**2450**					
7.00-20	E	1840	1980	2100	2220	2340	2450	2560	2660	**2760**		
7.50-20	D	2070	2220	2350	2490	2620	**2750**					
7.50-20	E	2070	2220	2350	2490	2620	2750	2870	2990	**3100**		
8.25-20	E	2460	2640	2800	2960	3120	3270	3410	**3550**			
8.25-20	F	2460	2640	2800	2960	3120	3270	3410	3550	3690	3820	**3950**
9.00-20	E		3120	3310	3510	3690	3870	**4040**				
9.00-20	F		3120	3310	3510	3690	3870	4040	4200	4360	**4520**	
10.00-20	F			3760	3970	4180	4380	4580	**4760**			
10.00-20	G			3760	3970	4180	4380	4580	4760	4950	5120	**5300**

SECTION 11

Sheet Metal

(CONVENTIONAL CAB AND COWL MODEL TRUCKS)

Information in this section covers replacement and adjustment of sheet metal components. Figure 1 illustrates the various sheet metal units as used on a conventional cab model.

Figure 1—Front End Components (Typical)

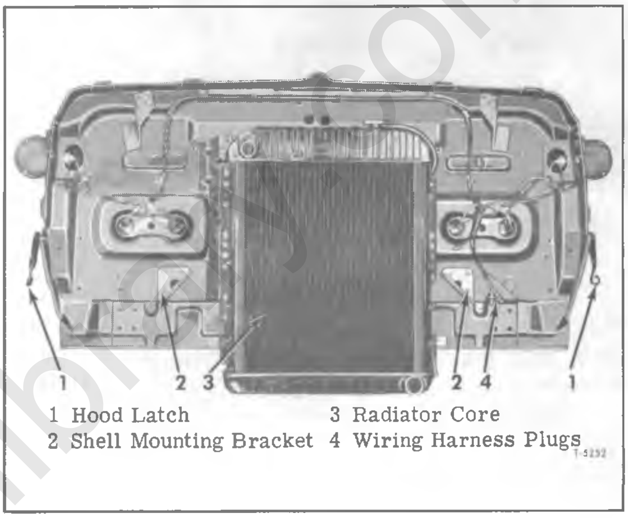


Figure 2—Radiator Shell and Radiator Assembly

RADIATOR SHELL GRILLE REPLACEMENT

NOTE: It is not necessary to remove grille in order to make head lamp beam adjustments. Notches in grille are provided for this purpose.

1. Remove eight cross-recess screws which attach grille to radiator shell. Remove grille.
2. Place grille in position at radiator shell, then install attaching screws firmly.

RADIATOR SHELL REPLACEMENT

NOTE: The following explains procedure for replacing the radiator shell with radiator core and support as shown in figure 2.

REMOVAL (Refer to Fig. 2)

1. Raise and support hood side panels.
2. Open drain cock to drain cooling system.
3. Loosen hose clamps, then disconnect upper and lower radiator hoses.
4. Disconnect power steering hoses at radiator, when so equipped.
5. Disconnect head lamp wiring harness connector which is located at right side of radiator shell panel. Also, disconnect the wiring harness ground wire which is attached to radiator shell.
6. Remove bolts and washers which attach each side of shell mounting bracket to flexible mounting (fig. 3).
7. Remove bolt, nut, and washer which attach each shell support strut rod to shell.
8. Remove two bolts and nuts which attach hood center panel to radiator shell.
9. Raise and support front end of hood center panel by placing a prop between top of engine and center panel.
10. With aid of an assistant to lift radiator and shell assembly upward so that radiator core clears front bumper, move assembly forward from vehicle.

Refer to RADIATOR AND SURGE TANK (SEC. 13) of this manual for instructions necessary to remove radiator core from shell.

INSTALLATION (Refer to Fig. 2)

Install the radiator and shell unit to vehicle in the reverse of the "Removal" procedures.

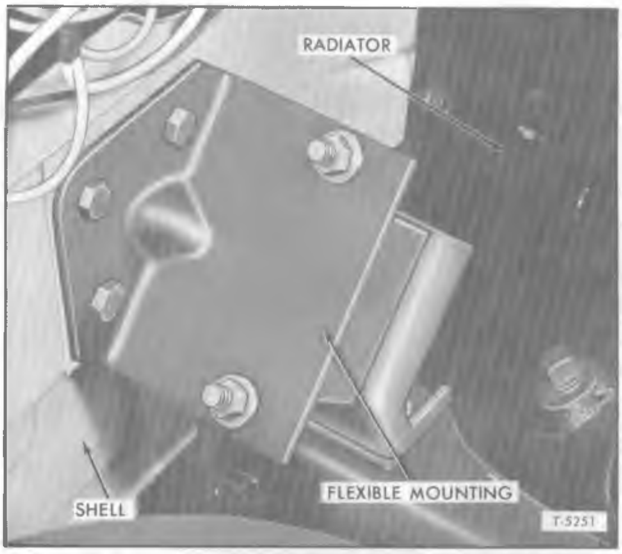


Figure 3—Radiator Shell Flexible Mounting

NOTE: If collision repairs were made to front end of vehicle, it may be necessary to re-align the shell and hood panels, using means of threaded yoke on radiator shell support strut rods (fig. 4). By shortening or lengthening rods, top of radiator core and shell can be tilted fore and aft to obtain proper hood alignment.

FENDER ASSEMBLY REPLACEMENT

NOTE: The following describes procedure for replacing the complete fender assembly which includes components shown in figure 5. Replacing the right-hand fender assembly necessitates removing the battery and box bolted to the right-hand fender skirt and fender support.

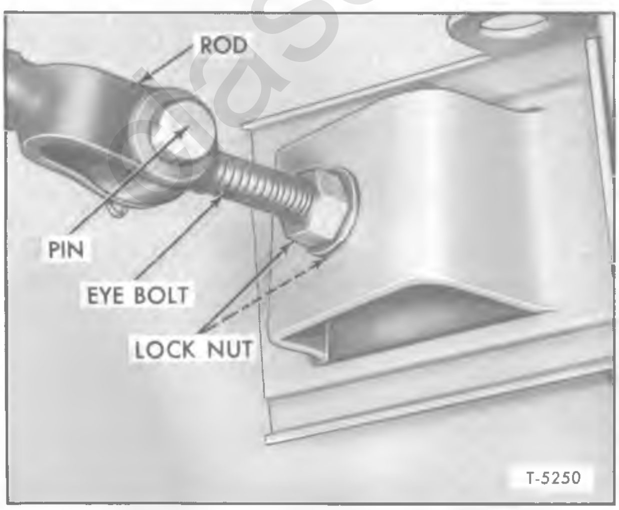


Figure 4—Radiator Shell Strut Rod

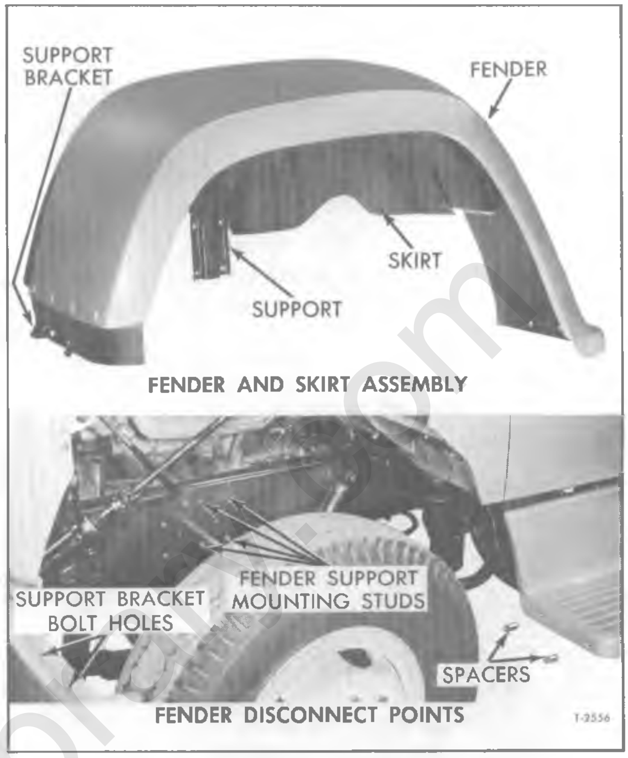


Figure 5—Fender Replacement (Typical)

REMOVAL

1. Lift hood panel.
2. Remove bolts, nuts, and washers which attach bumper to fender front support bracket.
3. At rear of fender remove bolt(s), bolt spacer(s), nut(s) and washer(s) which attach fender to running board.
4. Remove nuts from four bolts which attach fender support to frame side rail. Lift fender assembly from vehicle.
5. Pull fender out from vehicle as far as possible, then roll it forward over the wheel.

NOTE: If desired, the skirt and fender support can be readily separated from fender. It is necessary to remove the entire fender assembly in order to replace the fender skirt.

INSTALLATION

Care should be taken with fender and skirt prior to assembling in order to prevent twisting.

Assemble fender and skirt if necessary, then install fender assembly in reverse of "Removal" procedures. Install battery and battery box to right fender assembly.

NOTE: If all attaching hardware is installed loosely, components can be readily aligned before final tightening.

IMPORTANT: Care should be taken throughout replacement procedure not to scratch paint on hood side panel latches mounted just above fenders.

RUNNING BOARD REPLACEMENT

(Refer to Figure 6)

REMOVAL

1. Remove bolt(s), nut(s), and washer(s) which attach running board to fender. Remove bolt spacer(s), if used.
2. Remove four bolts and lock washers which attach running board to frame supports. Remove running board.

INSTALLATION

1. Place running board in position on frame supports, then install loosely, four attaching bolt nuts and lock washers.
2. With bolt spacers (if used) held in position at fender, install bolts, flat washers, lock washers and nuts which attach running board to fender.

NOTE: Bolt holes at front of running board and in the frame supports are slotted for purpose of obtaining proper alignment with fender outer surface which should be flush.

3. Align running board with fender, then final tighten all attaching bolts and nuts.

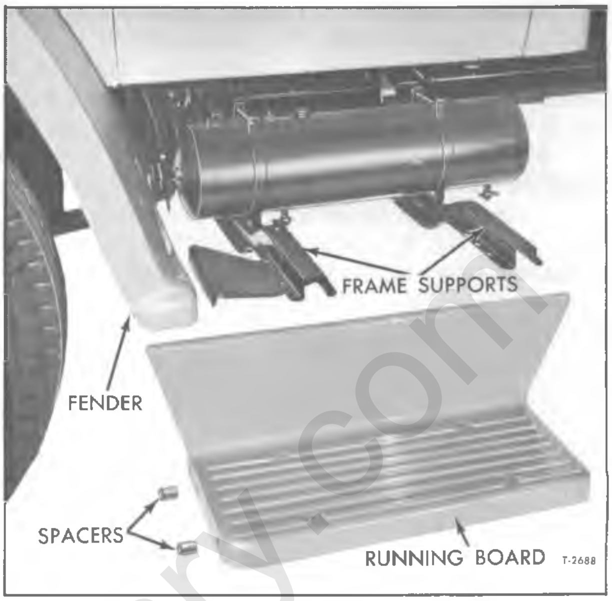


Figure 6—Running Board and Attachments (Typical)

HOOD ASSEMBLY REPLACEMENT

NOTE: The separate halves of hood assembly can be readily replaced after first marking the hinge-to-hood panel positions, then removing the hinge bolts.

The following describes procedure for replacing the complete hood assembly which includes the right and left, and center panels.

REMOVAL (Refer to Fig. 7)

1. Raise both hood side panels and support with attached props.
2. At front of hood center panel, remove two attaching screws, washers, and nuts.
3. Underneath hood center panel, at the rear, remove two nuts and washers which attach center panel mounting cushion assemblies to cab bracket.
4. With the aid of an assistant, carefully lift the hood assembly from vehicle.

INSTALLATION

Install the hood assembly in reverse of the "Removal" procedure.

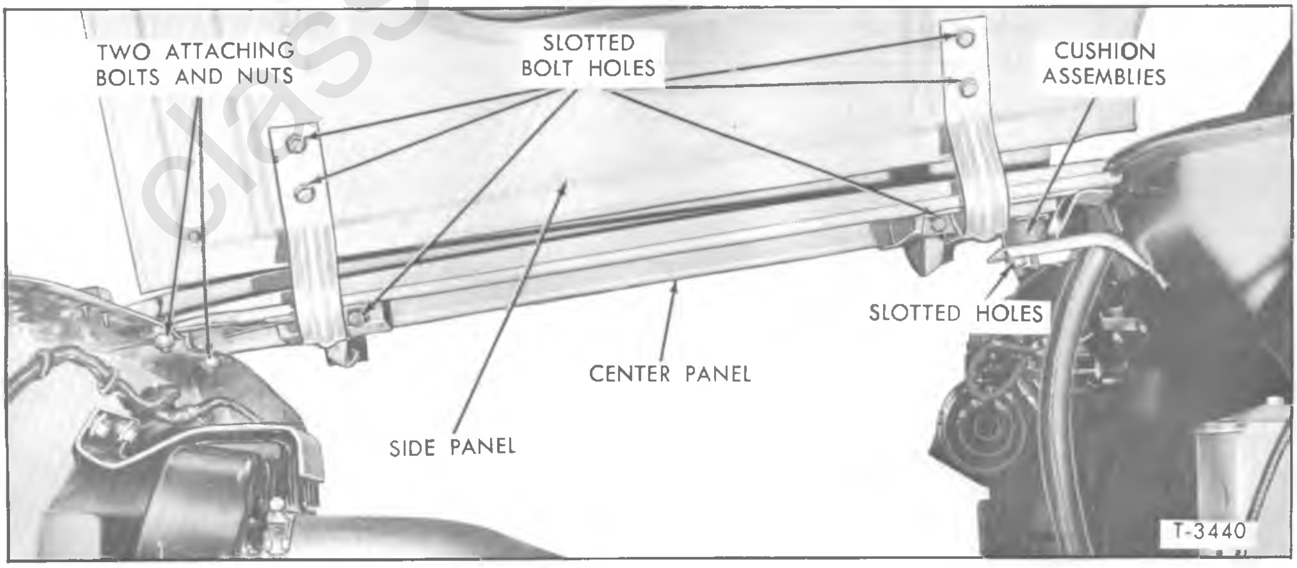


Figure 7—Hood Center Panel Mounting

SHEET METAL

NOTE: If collision repairs were made or if new sheet metal parts were installed, it may be necessary to re-align the sheet metal. This can be accomplished by changing the length of radiator shell strut rods, one each side of core (fig. 4).

NOTE: Slotted mounting bolt holes at rear of hood center panel are provided to allow fore and aft movement at top of shell. If necessary, loosen lock nuts (fig. 4). Adjust rod length to obtain good front end sheet metal alignment. Tighten lock nuts.

IMPORTANT: DO NOT OVER-ADJUST TO CAUSE ENGINE FAN TO CONTACT CORE.

Adjustment to this extreme would indicate collapsed mountings at engine or cab.

Each half of hood assembly is adjustable in side opening by means of slotted attaching bolt holes in the two hinge straps. If necessary, loosen hinge strap bolts and reposition hinge. After making adjustment, tighten attaching bolts firmly.

PROTECTION OF SHEET METAL FINISH

Proper protection and maintenance of finish will add to its luster. Road elements are injurious to painted surfaces of vehicle. These can be removed by regular washings. As an additional protection, polish vehicle, using a good grade of wax, 30 days after delivery. Apply a coat of polish thereafter at least once a year.

SECTION 12

Chassis Electrical and Instruments

This section, covering maintenance of chassis electrical system and units, is divided into sub-sections as shown in the Index following:

MISCELLANEOUS ELECTRICAL

NOTE: Certain electrical units, when closely associated with other systems or units, are covered in other sections of this manual as listed below:

Unit	Section
Gauge, Engine Temperature	6K
Gauge, Fuel Tank Unit	8
Gauge, Vacuum	12
Indicator, Water Temperature	6K
Motor, Electric Windshield Wiper	1
Motor, Heater Blower	1
Motor, 2-Speed Axle Shift	4A
Relay, Blower Control	1
Speedometer Adapter, 2-Speed Axle	4A
Switch, Air Conditioning Control	1
Switch, Differential Lock	4A
Switch, Engine Overheat	6K
Switch, Heater Blower Control	1
Switch, Low Air	5B
Switch, 2-Speed Axle Shift	4A
Switch, Windshield Wiper	1
Tachometer Drive	6A

WIRING DIAGRAMS

Wiring diagrams, included in applicable "Wiring Diagrams" booklet, show electrical circuits and connections for standard and optional equipment used on truck series covered by this manual. Standard equipment is shown in solid lines on diagrams and optional equipment is shown in broken lines. Truck series to which each diagram applies is shown on each diagram.

WIRING HARNESSES AND WIRES

Connections between chassis wiring harness and the engine, body, and lighting wiring harness are made through a multiple plug and receptacle type connector. Connections at instrument clusters, gauges, and units are made through a multiple plug and receptacle type connector and through plastic insulated blade-type connectors and screw-type terminals.

Some wires are grouped and taped together with a moisture and heat resistant black, plastic type tape to form a wiring harness; in other instances it is more practical to use a single wire or cable. Every wire is of a specific size with plain colored or striped insulation as indicated on the wiring diagram. Insulation colors assist in tracing circuits and in making proper connections.

In-line and V6 gasoline engine models have a special resistance wire in the engine wiring harness to connect the "IGN" terminal of the ignition switch to the positive (+) terminal of the ignition coil. The proper length wire is used to provide correct resistance. This wire is identified on applicable wiring diagrams as: (20-WHT.-ORN.-& PPL.-CR. TR.) or (20-WHT.-RED & BLK.-CR. TR).

On In-line engine models, the resistance value of wire is approximately 1.80 ohms, and on V6 engine models, resistance value of the wire is approximately 1.52 ohms.

During cranking, a full 12-volts is supplied to coil by shunt wire between starter terminal and coil terminal.

Figure 1—Replacing Blade Type Connector Terminals

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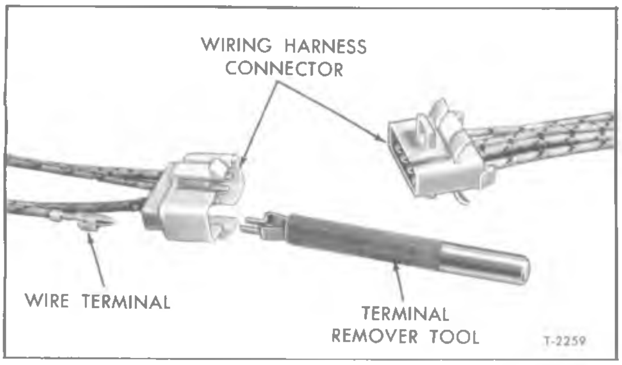


Figure 2—Removing Twin-Lock Connector Terminals

MAINTENANCE AND REPAIR

All electrical connections must be kept clean and tight. Loose or corroded connections may cause a discharged battery, difficult starting, dim lights, and possible damage to generator and regulator. Wires must be replaced if insulation becomes burned, cracked, or deteriorated.

Whenever it is necessary to splice a wire or repair one that is broken, always use rosin flux solder to bond the splice and insulating tape to cover all splices or bare wires.

When replacing wires, it is important that the correct size wire as shown on applicable wiring diagram in "Wiring Diagrams" booklet be used. Each harness or wire must be held securely in place by clips or other holding devices to prevent chafing or wearing away insulation due to vibration.

CAUTION: Never replace a wire with one of a smaller size. DO NOT replace a fusible link with a wire of a larger size.

By referring to the wiring diagrams in applicable "Wiring Diagrams" booklet, circuits may be tested for continuous circuits or shorts with a conventional test lamp or low reading ohmmeter.

REPLACING WIRING CONNECTOR TERMINALS

Either blade-type or twin lock type terminals are used in the wiring harness connectors. Mating ends of the connectors are secured by tang locks which must be disengaged at the same time to separate the connector.

Terminal Removal

1. To remove a blade-type terminal from the connector, disengage lock tangs and separate connector. Insert a thin bladed instrument under mating end of connector terminal and pry up on terminal being careful not to damage connector. Pull wire and terminal from connector as shown in figure 1.
2. To remove a twin lock type terminal from connector, disengage the lock tangs and separate connector. Insert terminal remover (J-21091) or equivalent, as shown in figure 2 to disengage terminal locks from the connector. Pull wire and terminal from cable connector.

Terminal Installation

NOTE: If original terminals are to be used,

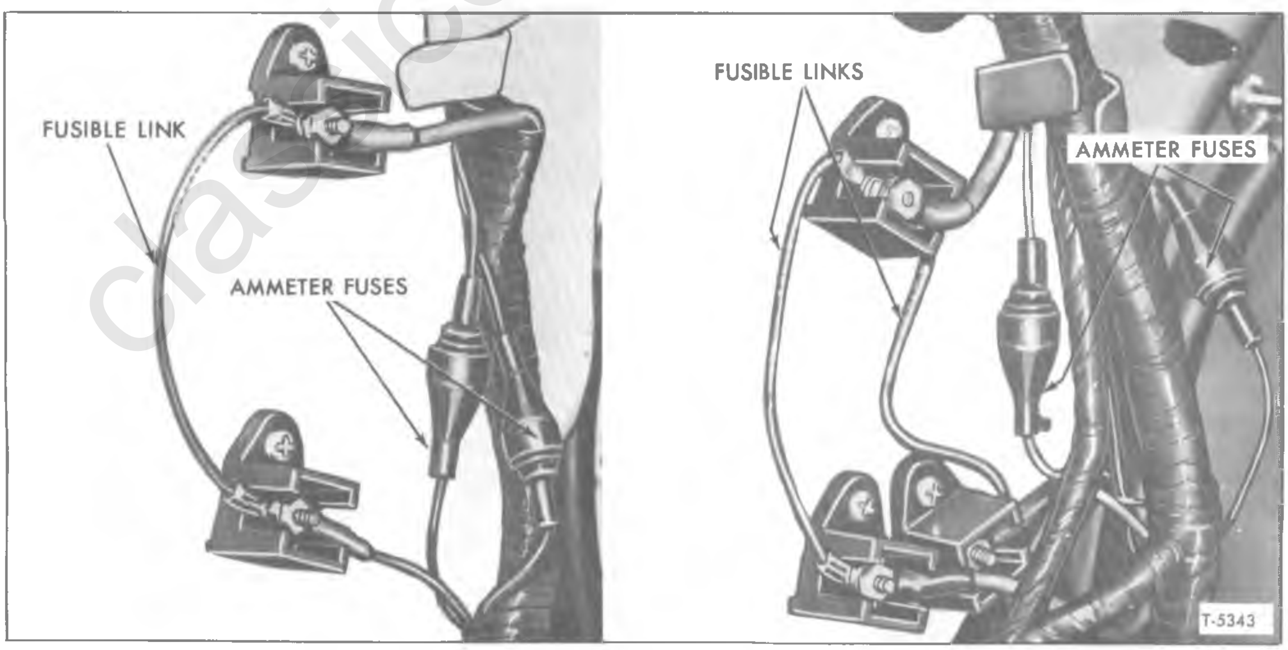


Figure 3—Fusible Links and Ammeter Fuses (Typical)

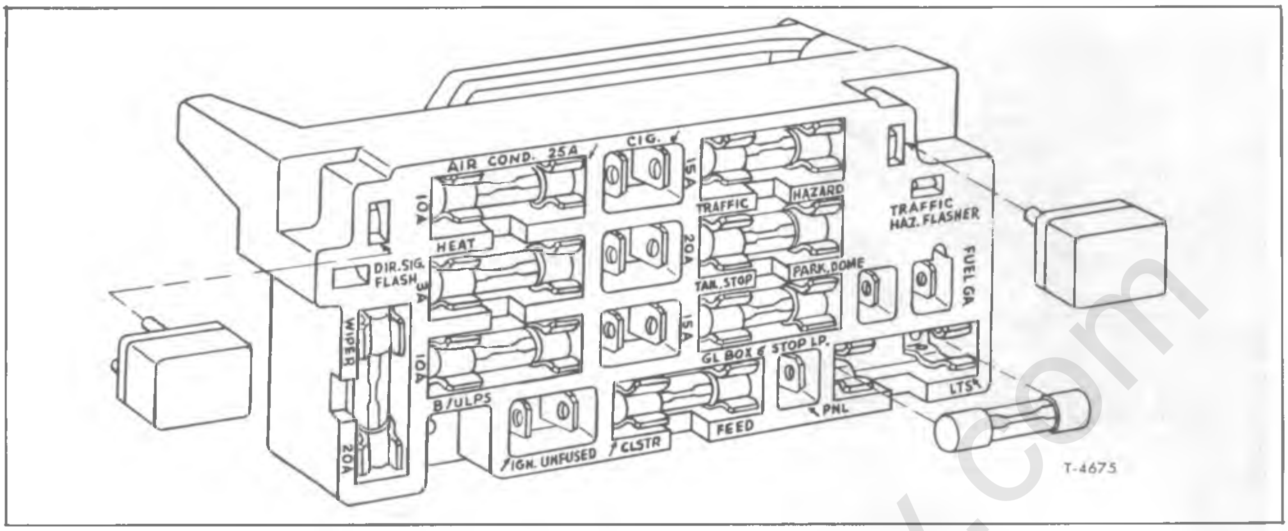


Figure 4—Typical Fuse Block (PS4500)

pry lock on terminal clips down to assure a firm connection when terminals are inserted into the connector.

1. Press terminals into mating end of connector, then check to make sure terminals are firmly engaged in connector by attempting to pull apart.
2. Connect mating ends of connector and check to be sure all lock tangs are firmly engaged by attempting to separate.

FUSE BLOCKS AND FUSES

A bulkhead fuse panel provides power takeoffs and fuse clips for appropriate circuits. The engine wiring harness connectors are bolted to the fuse panel.

Fuse and circuit breaker block on all conventional cab models is located behind the dash compartment door. Block on cowl models is located on the cowl panel near the center and is accessible from under dash panel. On all steel tilt cab models the block is located under left end of dash panel.

Two 4-ampere fuses are used to protect the ammeter. Fuses are located on fire wall near fusible links (fig. 3).

All models have two flashers -- one for turn signals, and one for hazard warning signals. In all models, the hazard signals are wired independently and can be turned on when the ignition is off. Flashers are located at fuse block. Refer to rear of this section for information pertaining to the flasher circuitry.

A typical fuse block used on Series PS-4500 is shown in figure 4. A typical fuse block and circuit breaker mounting used on Series "E" and "S" Models is shown in figure 5, and a typical fuse block used on steel tilt cab models is shown in figure 6.

IMPORTANT: When replacing fuses, circuit breakers, or flashers, be certain replacement is the same part number as defective component.

FUSIBLE LINKS

On some models, one or two replaceable fuse links are located under hood on cowl in the major wiring harness feed circuit. The fusible link(s) (fig. 3) is incorporated as part of the wiring system to provide increased overload protection to all electrical circuits, except the starting motor circuit, which are not otherwise protected by fuses.

The fusible link is a wire of at least four gauge sizes smaller than the smallest feed wire; for

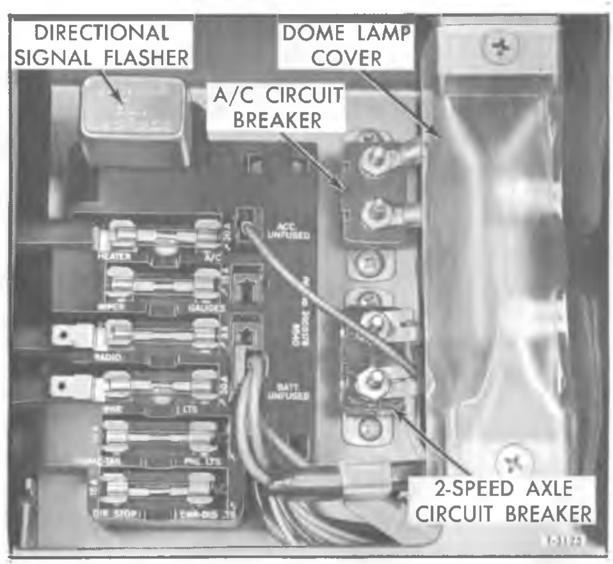


Figure 5—Fuse Block and Circuit Breaker Mounting ("E" and "S" Models) (Typical)

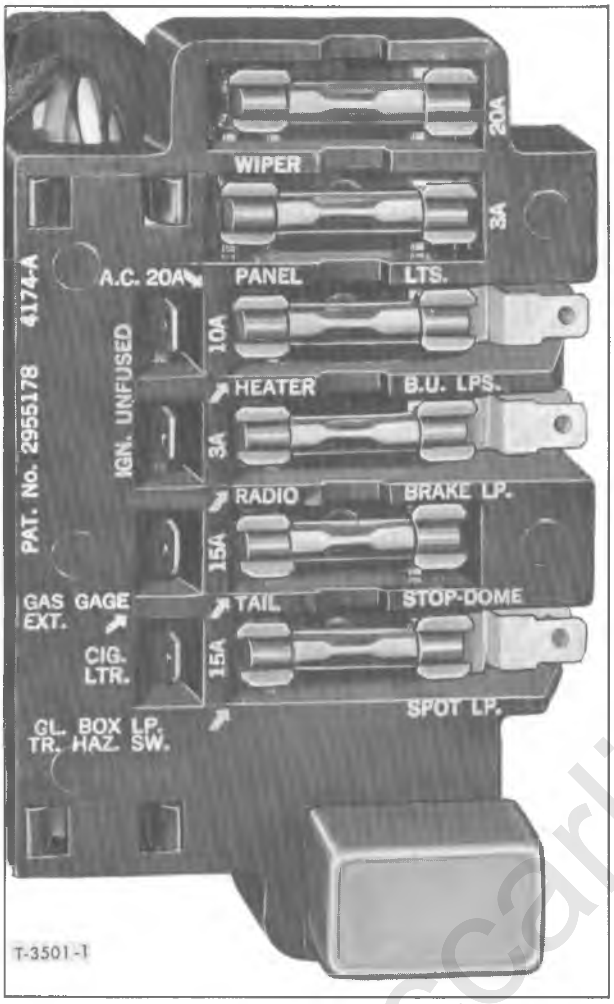


Figure 6—Fuse Block (Tilt Cab Models) (Typical)

example: a fusible link of 16 gauge wire must have 12 gauge wire or larger in all unprotected circuits of the link system. To aid in identification, the gauge size of the wire is labeled on the side of the link.

IMPORTANT: If an overload or some other condition destroys a link, locate and correct the cause of the failure, then replace the link with a wire of the same gauge size and length. DO NOT replace a fusible link with a wire of larger size. Refer to Master Parts Book for correct replacement part number.

CHASSIS JUNCTIONS

Terminal posts on junction blocks are numbered to correspond with symbols shown on wiring diagrams in applicable "Wiring Diagrams" booklet.

NOTE: On some models, wiring junctions are made by use of mating connectors. Refer to applicable wiring diagrams for arrangement of wiring.

TILT CAB MODELS

Chassis junction block (fig. 7) is located under left-hand step riser panel and is accessible when door is open and cover is removed. One 12-terminal junction block is used on vehicles with standard equipment and an additional 12-terminal junction is used when required for additional electrical equipment. A 6-terminal chassis junction block is also located on frame side rail at left of cab.

CIRCUIT BREAKERS

The headlight circuit is protected by a 25-amp automatic reset type circuit breaker built into the main light switch. Any condition which causes an overload on this circuit causes the bimetallic element to open the circuit. When element cools, the circuit breaker will close the circuit. This off-and-on cycle will repeat until light switch is turned off or until cause of overload has been located and corrected. Circuit breaker is shown in main light switch wiring diagram (fig. 17). If circuit breaker becomes defective, the complete light switch assembly must be replaced.

A 15- or 20-amp automatic reset type circuit breaker is used in the two-speed axle shift switch circuit on vehicles equipped with the two-speed axle.

Circuit to the two-speed axle electric shift motor is protected by an automatic reset type circuit breaker. Any condition which causes an overload on a circuit, such as a short, will cause circuit breaker bimetallic element to open the circuit; when element cools, the circuit breaker will again close circuit. This off and on cycle will repeat until the switch controlling the defective circuit is turned off, or until the cause of overload has been located and corrected. In the event a circuit breaker becomes defective (burns open), the defective circuit breaker must be replaced. Install circuit breakers so the feed or battery wire is connected to the "BAT" or short terminal and the wires carrying the circuit to the electrical units is connected to the "AUX." or long terminal.

SPEEDOMETER

Speedometer is mechanically driven from speedometer adapter by a flexible cable. The miles per-hour hand is magnetic cup actuated, while the odometer is direct gear actuated. If speedometer becomes inoperative, disconnect cable at rear of speedometer head and adapter and check to make sure cable and drive gear on transmission are operating properly. This can be done by driving the vehicle forward while an assistant checks movement of the drive cable inside the flexible cable.

If the drive cable and drive gear appear to be operating properly, repair or replace the speedometer head. Replace the cable if kinked or broken. If the speedometer head, adapter, and cable are operating properly, replace the speedometer drive gear.

To check speedometer for accuracy, use a test machine equipped with a drive. Connect speedometer head to drive and operate at a known 1000 rpm. The miles-per-hour hand should register 60 mph and the odometer should register one mile-per-minute. If not, speedometer head is defective and must be replaced.

SPEEDOMETER CABLE
REPLACEMENT OR LUBRICATION

1. Disconnect speedometer cable from speedometer head.
2. Remove cable by pulling it out from speedometer end of conduit.

NOTE: If cable is broken, it will be necessary to remove lower portion of cable from transmission end of conduit.

3. Lubricate lower ¾ of cable with lubricant specified in LUBRICATION (SEC. 0), then push cable into conduit. Connect upper end of cable to speedometer head and road test vehicle to check for proper speedometer operation.

CAUTION: DO NOT over-lubricate the flexible cable or adapter. Excessive lubrication will seriously affect speedometer operation.

ELECTRIC HORN

An electric air-tone "S" type horn is used on all vehicles covered by this manual. The horn is carefully adjusted and inspected during manufacture and should operate indefinitely without attention. The horn assembly should not be adjusted or repaired. If horn becomes inoperative, it must be replaced.

If horn fails to operate, use a jumper lead to check the external circuit as follows:

1. Connect a jumper lead from No. 1 terminal on horn relay to ground. If horn then operates, trouble is in the horn control circuit. If horn does not operate, remove jumper lead and proceed with Step 2.
2. Momentarily connect a jumper lead between No. 1 and No. 3 terminals on horn relay. If horn operates, the relay is defective and must be replaced.
3. Connect jumper lead from horn bracket to vehicle frame or grounded side of battery. Be sure contact is made through paint on horn bracket and frame.

NOTE: Since the horn circuit is internally grounded through the horn mounting, a good ground

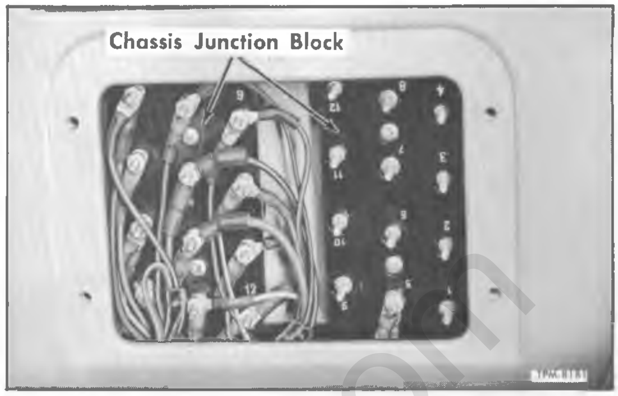


Figure 7—Chassis Junction Block (Tilt Cab Models) (Typical)

connection must be maintained between the horn mounting bracket and its mating part.

If the horn fails to operate after completing the above checks, the trouble may be that horn contacts are being held open by a foreign particle. This can sometimes be corrected by energizing the horn, then lightly tapping the horn to dislodge the particle. If this fails to correct the condition, replace the horn assembly.

AIR HORN

Air horns (when used) are mounted on pedestals attached to the cab roof panel. Air pressure to horns is controlled by a control valve mounted on the inner hinge pillar panel at left side of cab. A signal cord is used to manually activate the control valve.

Air pressure is supplied by the pressure protection valve. Refer to "AIR BRAKES" (SEC. 5B) for information on the pressure protection valve.

If the air horn control valve becomes inoperative, a service kit consisting of a spring, rubber seat, and plunger may be installed after disconnecting the air inlet line and removing end plug from valve.

RELAYS

HORN RELAY

NOTE: Refer to applicable wiring diagram in "Wiring Diagrams" booklet for wiring connections at horn relay.

The horn button in center of steering wheel is connected in series with relay operating coil at relay terminal No. 2. When circuit through relay operating coil is completed at the horn button, a small amount of current flows from the battery through the coil winding. With winding energized, armature is attracted to core and points close. Current from the battery (No. 1 terminal), then flows directly through relay contacts and out No. 3 terminal to the horn. The relay thus provides a higher voltage to the horn by avoiding voltage drop through the long circuit through the horn button. Relay is non-adjustable, therefore, if it becomes inoperative, replace.

TRAILER I.C.C. MARKER
LAMP RELAY (WHEN USED)

NOTE: Refer to applicable wiring diagram in "Wiring Diagrams" booklet for wiring connections at relay.

The marker lamp switch on instrument panel is connected in series with main light switch and operating coil of I.C.C. marker lamp relay operating coil at terminal No. 3.

When the main light switch and the marker lamp switch are placed in "ON" position, a small amount of current will flow through the relay coil winding. With winding energized, armature is attracted to core and points close. Current from the battery (No. 1 terminal), then flows directly through relay contacts and out terminal No. 2 to complete circuit to rear I.C.C. marker lamps.

ALARM SYSTEM

LOW VACUUM ALARM SYSTEM

The low vacuum alarm system, on vehicles so equipped, consists of a low vacuum switch, a buzzer, and a gauge to audibly and visually warn the driver when vacuum is below a safe limit.

The low vacuum alarm buzzer is mounted on left side of dash panel inside the cab. When circuit through buzzer is completed at low vacuum switch, action of the vibrating armature striking the core produces a buzzing sound.

Low vacuum alarm system wiring connections are shown on applicable wiring diagrams in "Wiring Diagrams" booklet. The alarm buzzer and switch are not repairable units. If unit becomes inoperative, replace.

LOW AIR PRESSURE ALARM SYSTEM

The low air pressure alarm system, on vehicles so equipped, consists of a low air pressure switch, a buzzer, and a tell-tale and/or gauge to audibly and visually warn the driver when air pressure in the system is below a safe limit for brake operation. Refer to "AIR BRAKES" (SEC. 5B) for information on low air pressure switch.

The low air pressure alarm buzzer is mounted on left side of dash panel inside the cab on conventional cab models; or on instrument panel to steering column support bracket on tilt cab models. When circuit through buzzer is completed at low air pressure switch, action of the vibrating armature striking the core produces a buzzing sound.

Low air pressure alarm system wiring connections are shown on applicable wiring diagrams in "Wiring Diagrams" booklet. In the event of failure, the buzzer must be replaced.

ENGINE ALARM SYSTEM

This system, used as optional equipment on some vehicles, audibly and visually warns the driver of low air pressure, low oil pressure, or an overheated engine. The alarm system consists of a low air pressure switch, low oil pressure switch, hot engine switch, alarm buzzer and rectifier assembly, and a separate tell-tale light for each condition. The buzzer and rectifier is mounted on left side of dash panel inside the cab on conventional cab models and on steel-tilt cab models, it is mounted on instrument panel to steering column support bracket. Wiring connections are shown on applicable wiring diagrams.

Buzzer and rectifier assembly consists of a vibrating armature type relay which produces a buzzing sound when the circuit through relay coil is completed by either of three controlling switches and a three circuit rectifier. The rectifier permits current flow in one direction only, preventing a back flow of current from one alarm circuit from illuminating the other tell-tale lights. Thus, when only one abnormal condition exists, the buzzer will sound but only the tell-tale light connected to that circuit will illuminate.

If alarm buzzer or rectifier assembly does not operate properly, replace the complete unit.

INSTRUMENT CLUSTER AND GAUGES

CONVENTIONAL CAB MODELS

A typical instrument cluster used on these vehicles is shown in figure 8. Cluster contains instrument lights, tell-tale lights, gauges, speedometer, and tachometer.

NOTE: The instruments, gauges, and tell-tale lights will vary with truck models, depending upon the size of vehicle and equipment used.

REMOVAL

IMPORTANT: Disconnect negative battery

cable from battery before removing instrument cluster to prevent accidental grounding at ammeter.

1. Disconnect multiple wiring connector plug from under dash.

2. Remove six screws which attach instrument cluster to dash panel and tilt cluster outward far enough to gain access to connections at back of gauges and units.

NOTE: It may be necessary to disconnect the oil pressure gauge line before tilting the cluster outward.

3. Disconnect drive cables, lines, and wiring connections from each gauge and unit.

4. Each gauge and unit is retained in the cluster by two mounting brackets. To remove a gauge or unit, disconnect wiring, then remove nuts and washers from gauge mounting bracket.

INSTALLATION

1. Position each gauge or unit in cluster and install nuts and washers to secure to mounting bracket.

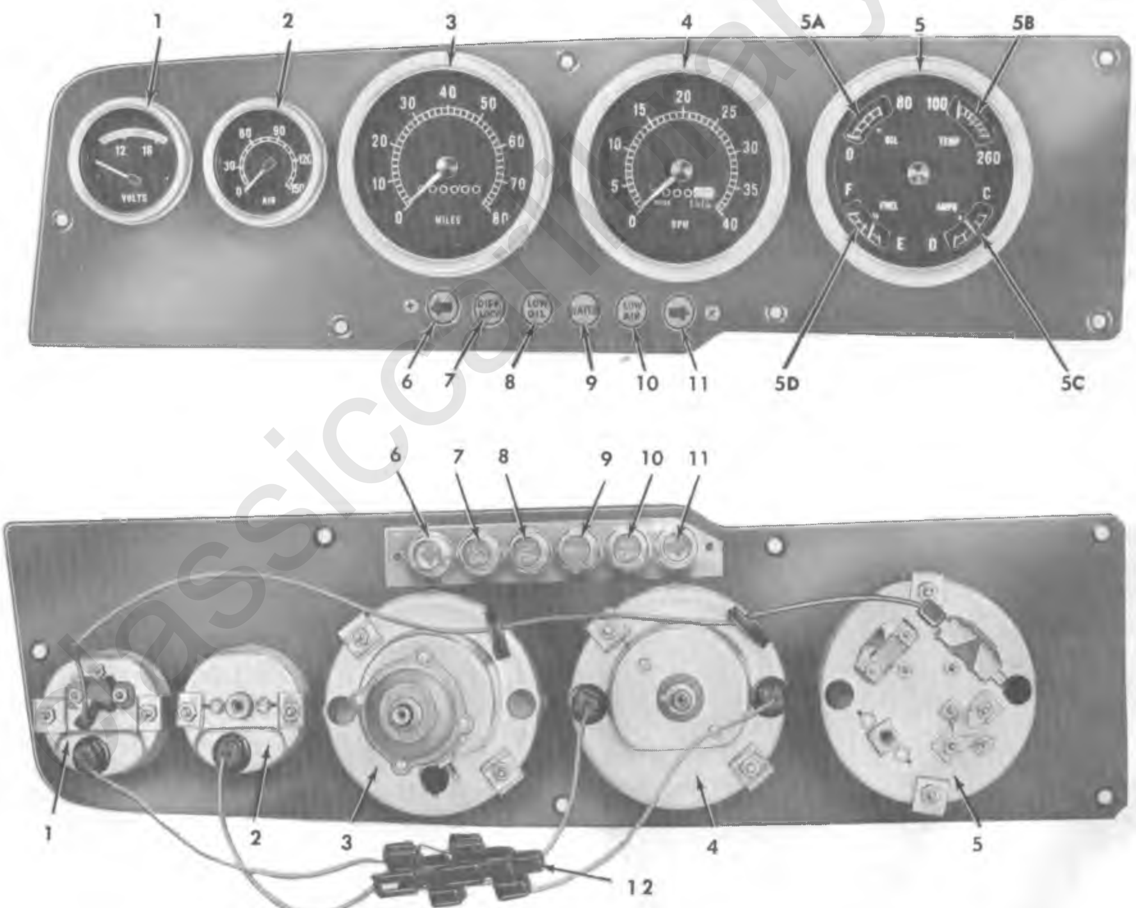
2. Position instrument cluster in dash panel far enough to gain access to rear of each gauge and unit.

3. Connect drive cable, lines, and wiring connectors to each gauge or unit. Insert tell-tale and illumination lamp bulbs in sockets.

4. Move instrument cluster into position and secure with retaining screws. Connect multiple plug connector under dash, then connect battery cable to battery.

COWL "S" AND "P" MODELS

The cluster contains a generator ammeter, engine temperature gauge, oil pressure gauge, and



1 Voltmeter
2 Air pressure
3 Speedometer
4 Tachometer
5 Four Gauge Cluster
5a Oil Pressure Gauge
5b Engine Temperature Gauge
5c Ammeter
5d Fuel Gauge
6 L.H. Turn Signal Tell-tale
7 Differential Lock Tell-tale
8 Low Oil Tell-tale
9 Water Temp. Tell-tale
10 Low Air Tell-tale
11 R.H. Turn Signal Tell-tale
12 Wiring Connector

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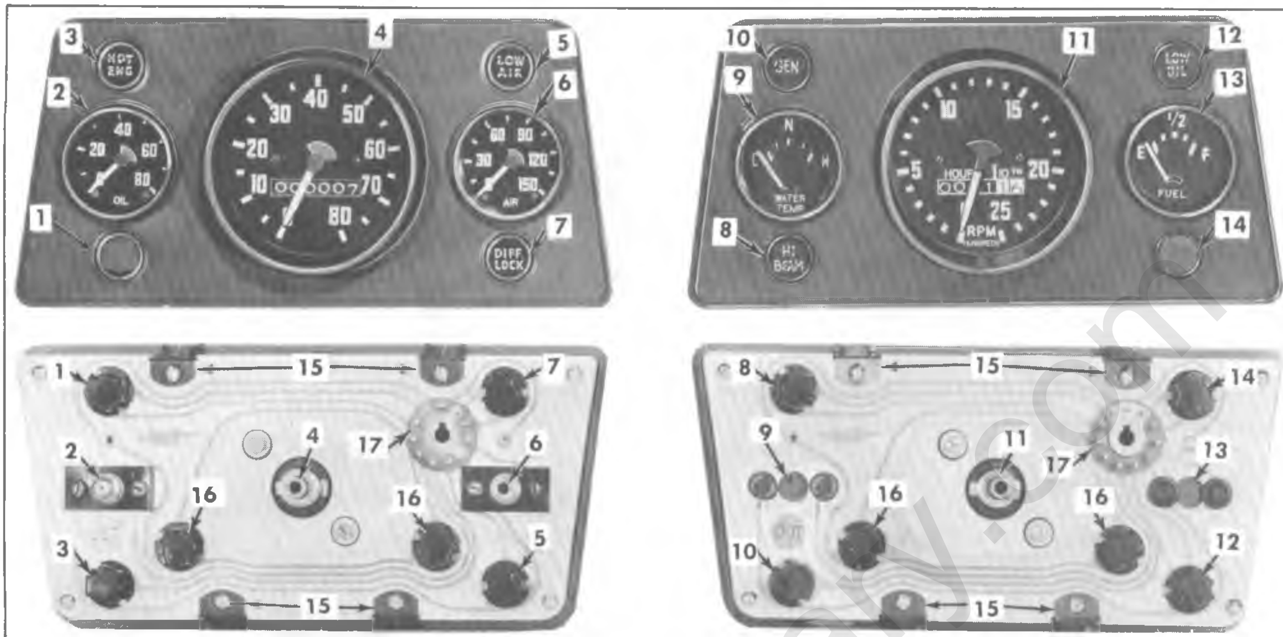
Figure 8—Typical Instrument Cluster (Conventional Cab Model)



LEFT CLUSTER

RIGHT CLUSTER

1 Turn Signal Tell-tale
2 Oil Pressure Gauge
3 Hot Engine Tell-tale
4 Speedometer
5 Low Air Pressure Tell-tale
6 Air Pressure Gauge
7 Differential Lock Tell-tale
8 Hi Beam Indicator
9 Engine Temperature Gauge
10 Generator No-Charge Tell-tale
11 Tachometer
12 Low Oil Pressure Tell-tale
13 Fuel Gauge
14 Turn Signal Tell-tale
15 Cluster Retaining Clips
16 Instrument Lights
17 Wiring Connectors

T-3590-1

Figure 9—Typical Instrument Cluster (Tilt Cab Model)

Figure 10—Removing Instrument Cluster (Tilt Cab Model) (Typical)

a fuel gauge. A matching round speedometer is also used on these models and an air pressure gauge or vacuum gauge is mounted on the instrument panel.

Electrical connections to gauges are made through blade type connectors. Instrument and tell-tale light bulbs are installed in sockets which snap into holes in back of cluster.

STEEL TILT CAB MODELS

One or two instrument clusters, mounted directly in front of driver, provide the necessary instruments, gauges, and tell-tale lights for efficient operation of the vehicle. Figure 9 illustrates a typical set of instrument clusters, although the instruments, gauges, and tell-tale lights may vary due to different truck models, depending upon the size of the vehicle and the equipment used.

Wiring harness connections are made through multiple plug and receptacle type connectors. A locating key on harness receptacle engages a slot in cluster plug to assure correct installation.

Electrical circuits to tell-tale lights, instrument lights, and electrical gauges are printed on back of instrument case. Each printed circuit starts and terminates at a terminal post. Each instrument and tell-tale light bulb is a wedge base bulb, installed in a plastic holder which locks into the case and makes contact with the printed circuit.

In the event of a visible break in a printed circuit, it can be repaired by soldering; however, this work must be performed by a competent electrician. The case must be disassembled to facilitate replacement of gauges or instruments. The cluster face is attached to the case by eight screws; the two center screws at top and bottom also attach the retaining clips. Tell-tale and instrument light bulbs can be replaced by removing the bulb holder from the back of the case.

Each cluster is retained in panel by four spring retaining clips, two at top and two at bottom. Holes are provided in instrument panel to permit using hooked tool (J-7900) to depress clips and release cluster from panel. To remove cluster, maintain a slight pressure on cluster from back side while releasing the two lower retaining clips, then release the two upper clips. Use of tool is shown in figure 10.

CAUTION: DO NOT try to force bent end of tool too far into opening; this will require more leverage to depress the clip and may deform the panel opening. Do not pry under edges of cluster at front side of panel; this could damage the bakelite case.

LIGHTING SYSTEM

GENERAL

Headlights are equipped with single or dual long-life "T-3" Sealed Beam units; all other lights are the conventional bulb type. Refer to "Specifications" at the end of this section for bulb size and number. Refer to applicable Wiring Diagram in "Wiring Diagrams" booklet for lighting system wiring circuits and wire identification.

In accordance with the Federal Motor Vehicle Safety Standards, models with overall width of 80 inches or more have clearance and identification lights as standard equipment. The main light switch turns on all lights except back-up, hazard warning, stop, and tell-tale lights.

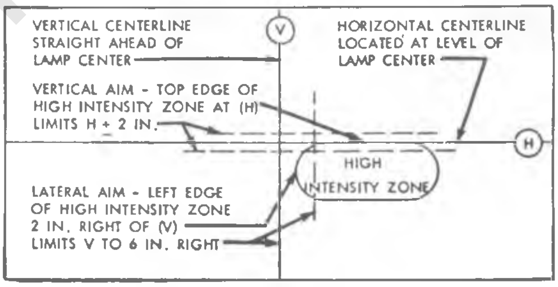
HEADLIGHTS

All vehicles covered by this manual use the 7-inch single sealed-beam unit type headlights or dual headlights, using four 5-¾-inch sealed-beam units.

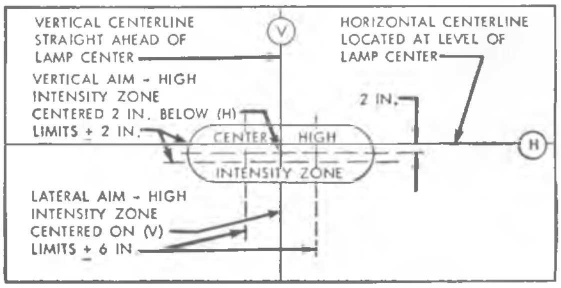
HEADLIGHT BEAM ADJUSTMENT (Fig. 11)

Both the 5-¾-inch and 7-inch sealed-beam units are "T-3" type units. Each "T-3" sealed-beam unit lens incorporates three projecting guide points which are optically ground to provide flat surfaces at right angles to the light beam. This design, in addition to providing superior lighting, permits adjustment of the light beams without the use of an aiming screen and without requiring a large work area. Aiming is accomplished with the use of an aimer (J-6878-01). Instructions for using the aimer are supplied by the instrument manufacturer.

Headlight beam adjustment requirements will vary on different vehicles due to size and distribution of load, type of standard or optional suspension, size of tires, tire pressures, and other factors. Average requirements are for the high intensity zone of the high beams of inner lights on dual units to be straight ahead and 2 inches below the headlight level at 25 feet. Low beam of outer lights of dual units and all 7-inch units should be



AIM INSPECTION LIMITS FOR LOWER BEAM OF:
5¾ in. Type 2 Sealed Beam
7 in. Type 2 Sealed Beam
Caution—Do not aim or inspect these lamps on the upper beam



AIM INSPECTION LIMITS FOR UPPER BEAM OF:
5¾ in. Type 1 Sealed Beam
7 in. Sealed Beam, except Type 2
T-3491

Figure 11—Headlight Beam Adjustment (Typical)

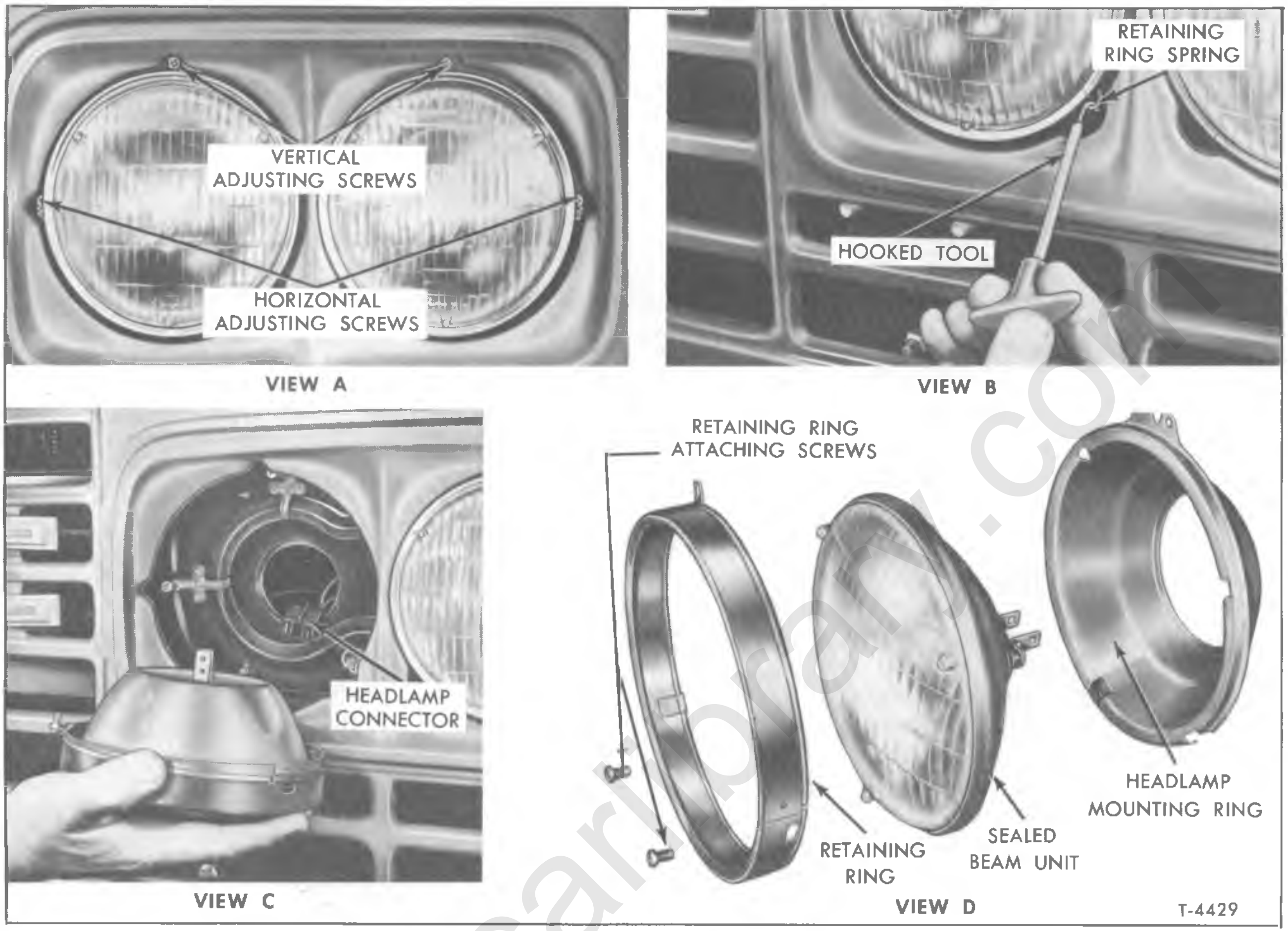


Figure 12—Dual Sealed Beam Unit Replacement

adjusted so the high intensity zone of the light beam is just to the right of the headlight center and just below the headlight level at 25 feet. To obtain correct adjustment, beam adjustment should be made with the vehicle loaded with the normal average load it will be carrying during the majority of its operation. Tires should be uniformly inflated to recommended pressure when adjusting headlight beams. Beam adjusting screws are identified in View A, figure 12, for dual units and in figure 13 for single units.

In all cases, it must be remembered that state or local legislation and specific vehicle conditions will govern the final aim for the best and safest lighting. Especially in the case of vehicles carrying widely varying loads during night-time operation, the final decision as to safe operation must still be made on the basis of "the most light on the road with the least annoyance to oncoming traffic."

DUAL SEALED BEAM UNIT REPLACEMENT

Removal (Fig. 12)

1. Using a hooked tool, disengage spring from headlamp retaining ring as shown in View "B."
2. Rotate the sealed beam unit slightly to disengage mounting ring from horizontal and vertical adjusting screws, then pull the assembly forward to remove (View B).
3. Pull headlamp wiring connector off back of sealed beam unit.
4. Remove screws which attach retaining ring to mounting ring. Separate retaining ring from mounting ring and remove sealed beam unit and discard (View D).

Installation (Fig. 12)

NOTE: Sealed-beam unit with number "1" molded on top of lens must be used at inside light position and unit with number "2" on lens must be used at outside position.

1. Position sealed-beam unit in mounting ring, then place retaining ring over sealed-beam unit and attach to mounting ring (View D).
2. Move sealed-beam unit assembly into position and press wiring connector plug onto terminals on sealed-beam unit.

3. Press in on the assembly and rotate slightly to engage horizontal and vertical adjusting screws in slot in headlamp mounting ring.

4. Using the hooked tool, pull outward on retaining ring spring and engage in slot in retaining ring as shown in View "B."

5. Check headlight adjustment as explained under "Headlight Beam Adjustment" previously.

SINGLE SEALED-BEAM UNIT REPLACEMENT

Removal (Fig. 13)

1. Remove screws which attach headlamp bezel to mounting ring, then remove the bezel.

2. Remove two screws which attach headlamp retaining ring to mounting ring. Using a hooked tool, release retaining spring from slot in retaining ring (inset, fig. 13). Swing bottom of retaining ring out and disengage from retaining clip near top.

3. Remove sealed-beam unit from mounting ring and pull wiring connector plug off back of unit.

Installation (Fig. 13)

1. Push wiring connector plug over blade-type terminals on back of sealed-beam unit.

2. Position sealed-beam unit in mounting ring with molded lugs on back of sealed-beam unit engaged in locating holes in mounting ring.

3. Hook slot in retaining ring over retaining clip near top of mounting ring and position retaining ring over sealed-beam unit.

4. Using a hooked tool, pull out on retaining spring and engage in slot near bottom of retaining ring (Inset, fig. 13).

5. Adjust headlight beam as previously recommended under "Headlight Beam Adjustment."

6. Position headlamp bezel over mounting ring and attach with screws.

PARKING LIGHTS

Parking lights (when used) are illuminated with main light switch pulled out to first detent position. The parking light circuit is protected by a fuse located in the main fuse block.

BULB REPLACEMENT

Removal

On conventional cab, cowl, and "S" models, raise hood and pull bulb and socket assembly from lamp assembly mounted in grille panel. Press inward on bulb and turn counterclockwise to remove from socket.

On tilt cab models, remove two screws which attach parking lamp lens to light assembly and remove lens. Press bulb inward and turn counterclockwise to remove from socket.

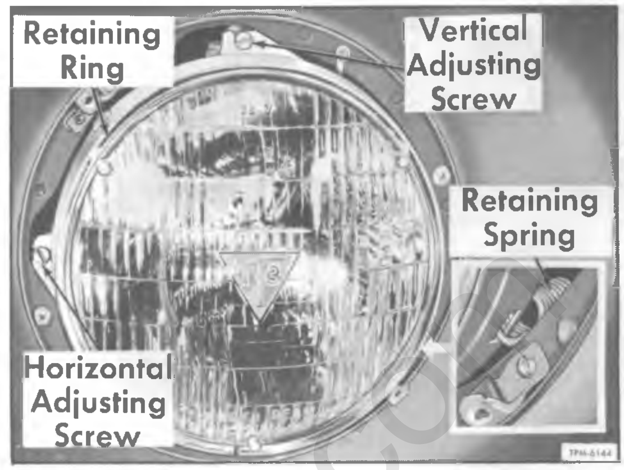


Figure 13—Single Sealed Beam Unit Replacement

Installation

NOTE: Refer to "Light Bulb Data" at end of this section for bulb size and type.

On conventional cab, cowl, and "S" models, install new bulb in socket and insert socket and bulb in lamp assembly. On tilt cab models, install new bulb in socket, then attach lens and gasket to lamp assembly with two screws.

LAMP ASSEMBLY REPLACEMENT

To remove parking lamp assembly on conventional cab, cowl, and "S" models, remove bulb and socket assembly, then remove two screws which attach lamp assembly to front grille panel. Pull lamp assembly from opening in grille panel.

On tilt cab models, remove two nuts which attach lamp assembly to front end sheet metal. Pull lamp assembly from opening and disconnect harness at junction.

To install a new lamp assembly, position the assembly in opening and install two attaching nuts. Insert bulb and socket in lamp assembly or connect harness at junction.

REAR LIGHTING

Due to numerous models, various rear lighting arrangements are used. Typical rear directional signal lights are integral part of stop and taillight assembly. Back-up light assembly is located beside or above taillight assembly. Rear lamp bulbs may be replaced by removing lens attaching screws and lens. The lamp housing may be replaced by removing the housing attaching nuts or screws, or by removing nuts and bolts from the mounting bracket.

NOTE: Refer to "Light Bulb Data" at end of this section for bulb size and type.

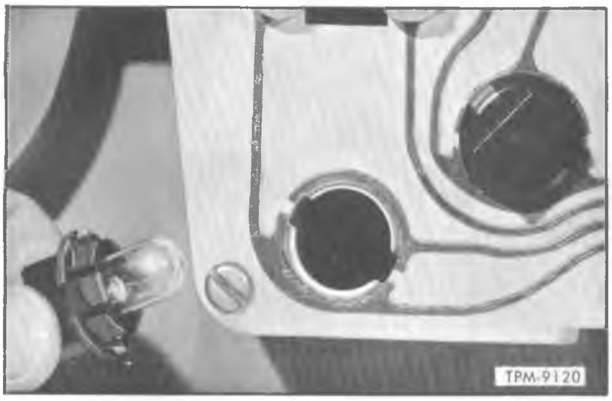


Figure 14—Replacing Instrument or Tell-Tale Light Bulb (Typical)

STOP AND TAILLIGHT

The stop and taillight is a combination-type lamp, having a double-filament bulb. The taillight filament is of 3 candlepower, and the stop light filament is of 32 candlepower.

BULB REPLACEMENT

Removal
Remove lens retaining screws, then remove lens and gasket from housing. Press bulb inward and turn counterclockwise to remove.

Installation
Refer to "Specifications" for bulb size and type. Note that J-slots in bulb sockets are of different depths and lugs on bulb base are located at different distances from end of base. Lugs and slots must be matched to permit installation of bulb. Insert bulb in socket, press inward and turn clockwise to lock in place. Position lens and gasket on body and attach with screws.

BACK-UP LIGHTS

The back-up light circuit is fed from the ignition switch control circuit. The back-up lamp switch, mounted on the transmission, is activated by the reverse shift rail (meahcnical transmission) when the ignition or control switch is placed in the "ON" position and transmission shift lever is in reverse. Switch adjustment on vehicles with Allison Transmission is covered in "TRANSMISSION CONTROL LINKAGE" (SEC. 7A) of this manual.

If back-up lights become inoperative, disconnect the wiring harness connector plug from the switch. Connect both terminals in the connector

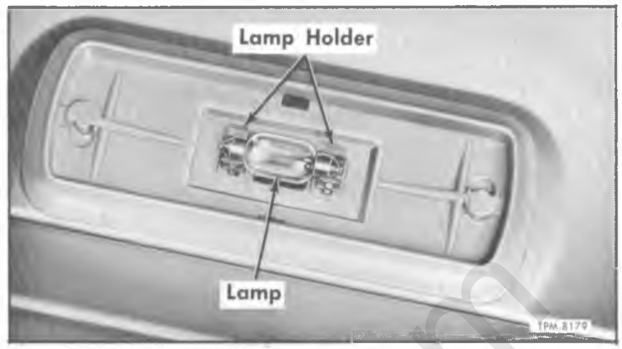


Figure 15—Dome Light (Tilt Cab Model) (Typical)

with a jumper wire, then place the ignition or control switch in the "ON" position. If back-up lights operate, replace the switch.

BULB REPLACEMENT
Remove screws from lens to lamp assembly and remove lens. Press bulb inward and turn counterclockwise to remove from socket.

Press new bulb into socket and turn clockwise to lock in place. Position lens and gasket on housing and attach with screws.

INSTRUMENT AND TELL-TALE LIGHTS

The instrument and tell-tale light bulbs are either wedge base or single contact, miniature base type. On all vehicles, except tilt cab models, bulbs are installed in pronged bulb sockets which snap into openings in instrument cluster, gauges, speedometer, and tachometer case. On tilt cab models, bulbs are installed in plastic holders which lock into the instrument case and make contact with the printed circuit. The instrument panel lamp circuit is protected by a fuse located on the fuse block.

BULB REPLACEMENT
Refer to "Light Bulb Data" at end of this section for bulb size and trade number.

Except Tilt Cab Models
Pull bulb socket out of instrument cluster, gauge unit, speedometer case, or tachometer case. Press bulb in and turn counterclockwise to remove from socket. Install new bulb in socket, press in and turn clockwise to lock in place. After replaceing bulb, press socket firmly into place in opening in cluster, gauge unit, speedometer, or tachometer case.

Tilt Cab Models
Turn bulb holder counterclockwise to remove from case (fig. 14). Pull the bulb straight out to

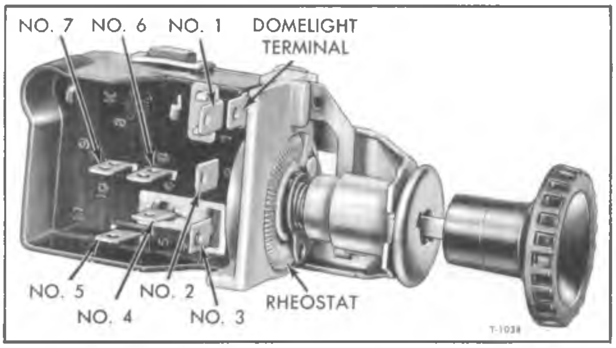


Figure 16—Main Light Switch

remove from holder. Install new bulb in holder, press inward to lock in place. Insert holder in case with lugs on holder entering notches in case; then turn clockwise to lock in place.

DOME LIGHT

On conventional cab models, dome lamp is mounted on instrument panel and provides lighting to cab interior, glove box, and across the fuse block. On tilt cab models, dome light is mounted at rear of cab above rear window. Dome light on all vehicles is operated by turning main light switch knob to extreme counterclockwise position.

BULB REPLACEMENT

Conventional Cab Models

A tubular type bulb is mounted inside glove box in front of fuse block and is held in position by two spring-loaded clips. To remove bulb, remove two screws which attach lens to dash compartment pillar, then remove lens. Pull bulb forward until bulb releases from clips. Press new bulb in until secure in clips.

Tilt Cab Models (Std. & Conv. Model RPO)

Dome light lens is of molded plastic, with a lug molded on edge of lens at center top and bottom. To remove lens, grasp lens between thumb and finger at center, and squeeze sides together to disengage lugs from assembly. Bulb used in dome light is of the tubular type, and is held in position by two spring-loaded clips (fig. 15). To remove bulb, pull forward until bulb releases from clips. Replace bulb and position lens in assembly and press in until lugs snap into place.

MAIN LIGHT SWITCH

Main light switch on instrument panel controls all lights except the stop light and tell-tale lights. Light switch assembly is shown in figure 16, and switch circuit diagram is shown in figure 17.

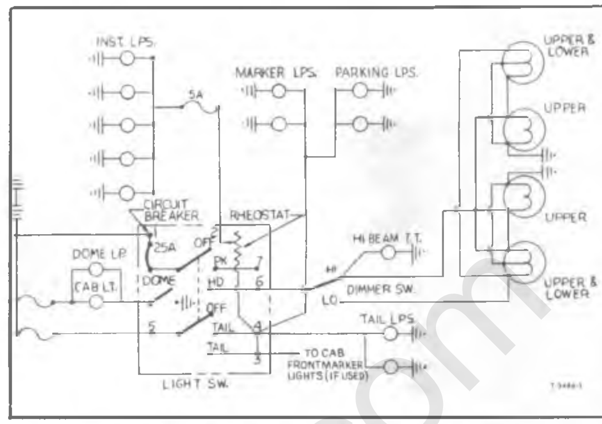


Figure 17—Main Light Switch Circuit Diagram

Switch terminals are blade-type. Connector plug, attached to wiring harness, engages the blade-type terminals on switch. Connector plug can be installed only in one position. Circuit diagram (fig. 17) is shown as an aid in checking circuits. A rheostat is incorporated in the instrument panel light circuit for purpose of dimming these lights if desired.

The 25-amp automatic reset type circuit breaker built into the switch assembly protects the headlight and parking light circuits. Before replacing light switch, make sure trouble is in switch and not elsewhere in the lighting system by checking circuits with suitable equipment.

SWITCH REPLACEMENT

Removal

NOTE: On some models, it may be necessary to remove the instrument cluster to gain access to the light switch.

1. Pull wiring harness connector plug off switch terminals.
2. Pull switch knob out to extreme position, then press on spring-loaded release button on top of switch assembly and pull switch knob and rod all the way out.
3. Use a wide-blade screwdriver to remove ferrule securing switch to instrument panel, then remove switch assembly.

Installation

1. Position switch under instrument panel, with locating lug on switch frame engaging hole in instrument panel. Thread ferrule into switch frame and tighten firmly, using a wide blade screwdriver.
2. Insert switch rod through ferrule and push in until spring-loaded latch engages groove near end of rod.
3. Install wiring harness connector plug on switch terminals, pressing it firmly into place.
4. Check operation of all lights.

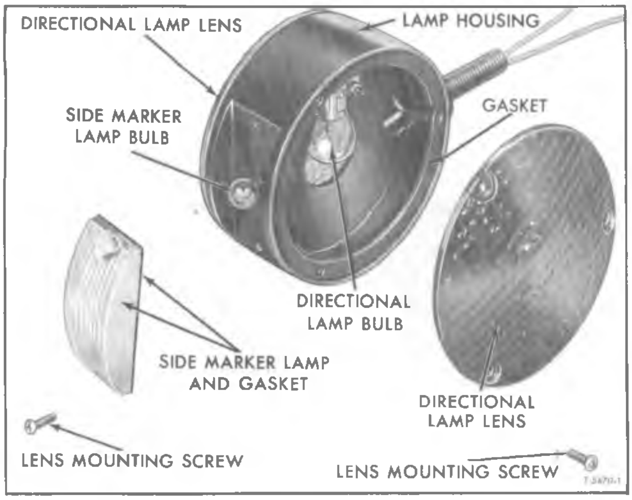


Figure 18—Directional and Side Marker Light

DIMMER SWITCH

Foot-operated dimmer switch is used to select headlight high or low beam. Switch is mounted on left side of cab floor panel and is operative when headlights are illuminated. Switch terminals are blade type with connector plug attached to harness.

SWITCH REPLACEMENT

Removal

Make sure main light switch is pushed all the way in or placed in "OFF" position, then remove dimmer switch as follows:

On Conventional Cab Models - raise floor mat to gain access to switch. Remove two screws which attach switch to floor panel and pull wiring connector plug off switch terminals.

On Cowl and "S" Models - remove two screws which attach switch and mounting bracket to floor panel. Pull wiring harness connector plug off switch terminals, then remove two cap screws which attach switch to mounting bracket and remove switch.

On Tilt Cab Models - remove two screws from inside cab which attach switch to toeboard riser. Tilt cab and from underneath, pull switch free from toeboard riser. Pull wiring connector plug off switch terminal.

Installation

On Conventional Cab Models - install wiring connector plug on switch terminals. Position switch on cab floor panel and attach with two mounting screws. Place floor mat over switch and wiring connector plug.

On Cowl and "S" Models - position switch on mounting bracket and secure with cap screws, washers, and nuts. Install wiring connector plug on switch, then position switch and mounting bracket on cab floor panel and secure.

On Tilt Cab Models - tilt cab forward and install wiring connector plug on switch terminals. Position switch under toeboard riser with button portion of switch extending through cab floor. From inside cab, attach switch to toeboard riser.

STOP LIGHT SWITCH

Either a mechanically-operated or air-operated stop light switch is used on vehicles covered by this manual.

MECHANICALLY OPERATED TYPE

The mechanically operated type switch used on models equipped with vacuum-hydraulic brakes, is a plunger or lever type switch. With brake pedal released, edge of pedal lever holds switch plunger in, breaking circuit to the stop light. When brake is applied and pedal lever moves away from switch plunger, a spring within the switch moves the plunger out to complete the stop light circuit. Switch terminals are blade type with wiring connections made through a connector plug on wiring harness. Switch cannot be disassembled; therefore, if switch becomes inoperative, it must be replaced.

When installing a lever type switch, make sure lever on switch is located above brake pedal lug, otherwise switch will not be operative. Also, make sure wiring connections at switch are fully engaged.

After installing switch, it must be adjusted so that initial movement of brake pedal, measured at the pedal pad, will permit switch to close and complete stop light circuit. After adjusting and tightening switch mounting nuts or bolts, visually check operation of stop light to make sure stop light comes on when brakes are applied and goes out when brake pedal is released.

AIR OPERATED TYPE

The air operated type stop light switch is used on vehicles equipped with air brakes or I.C.C. trailer brake controls. Refer to "AIR BRAKES" (SEC. 5B) for information pertaining to this switch.

DIRECTIONAL SIGNAL LIGHTS

Directional signal lights are either an integral part of the stop and taillight assemblies or are mounted on each side of cab, or in combination.

NOTE: On some models, a combination directional and side marker lamp (fig. 18) is mounted on each side of cab.

When ignition or control switch is placed in "ON" position, 12-volts is supplied through a fuse to the flasher unit on tilt cab models. On conventional cab models, the flasher is fed through a from flasher unit through switch, then to right-hand signal. The same procedure applies to the left-hand signal, except that lever is in the down position and a different set of contacts are engaged in switch assembly.

On conventional cab models, an arrow at either side or tell-tale cluster flashes when either the left or right signal light is illuminated. When turn is completed, switch lever is automatically returned to "OFF" position by a canceling cam installed on steering wheel.

On tilt cab models, a tell-tale light on instrument panel marked "TURN-SIG" flashes when either the left or right signal light is illuminated. When turn is completed, switch lever is automatically returned to "OFF" position by a cancelling cam installed on steering wheel.

If directional tell-tale on instrument panel flashes in one position but not the other, check for the following:

1. Directional lamp bulb burned out.
2. Incorrect directional lamp bulb installed.
3. Defective ground between bulb socket and mounting.
4. Defective directional control switch assembly.

If directional tell-tale on instrument panel does not flash in either direction, check for the following:

1. Burned out fuse on fuse block.
2. Defective flasher or flasher terminals not properly engaged in junction block.
3. Directional tell-tale bulb on instrument panel burned out.
4. Short or open circuit. Check indicator lamp circuit referring to wiring diagram in applicable "Wiring Diagrams" booklet.
5. Defective directional control switch assembly.

If directional tell-tale light does not cancel after completing a turn, remove the steering wheel as explained in "MECHANICAL STEERING" (SEC. 9A) and check for a worn or damaged cancelling cam.

MARKER BULB REPLACEMENT (Fig. 18)

Remove two screws which retain amber marker lens to light assembly, then detach lens. To remove bulb, press inward on bulb and turn counterclockwise to release from socket. Reverse above procedure to install bulb.

DIRECTIONAL SIGNAL BULB REPLACEMENT (Fig. 19)

Remove three screws which retain circular directional signal lens to light assembly, then detach lens. To remove bulb, press inward on bulb and turn counterclockwise to release from socket. Reverse above procedure to install bulb.

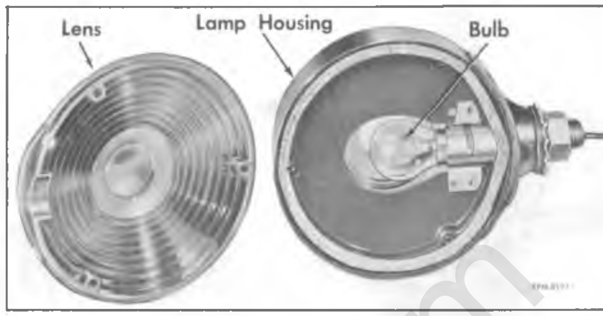


Figure 19—Directional Signal Light (Typical)

DIRECTIONAL SIGNAL CONTROL ASSEMBLY

The control assembly consists of a switch, contact, wiring and bearing assembly and a cancelling cam (fig. 20). The control assembly is installed over the steering shaft, inside the housing and the cancelling cam is attached to the steering wheel hub.

NOTE: On vehicles equipped with the hazard warning system, an additional switch is mounted on side of the directional signal control housing as shown in figure 21, except on tilt cab models.

REMOVAL (Fig. 20 or 21)

1. Remove the steering wheel as directed in "Steering Wheel Replacement" in "MECHANICAL STEERING" (SEC. 9A) of this manual.
2. Remove steering shaft upper bearing sleeve.
3. Disconnect wiring harness at instrument panel harness connector.

NOTE: On some models it may be necessary

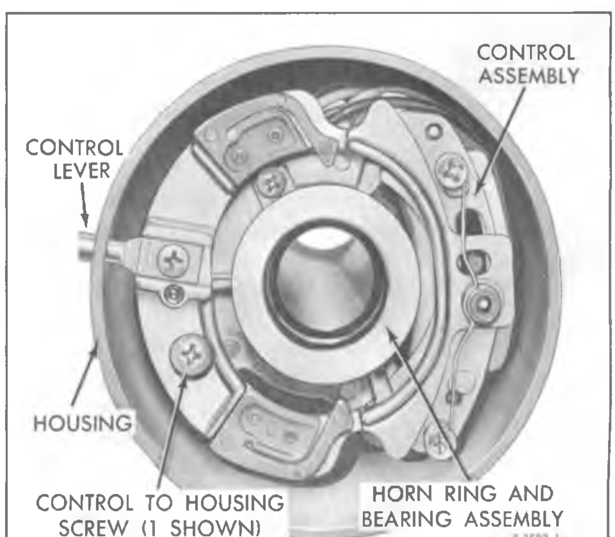


Figure 20—Directional Signal Control Assembly

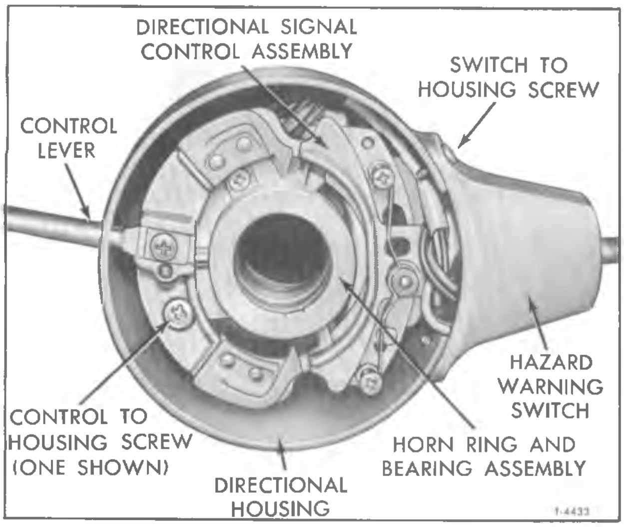


Figure 21—Directional Signal Control Assembly (with Hazard Warning Switch)

to remove control assembly wiring from the wiring harness connector.

4. Remove screw attaching control lever to switch and remove lever.
5. If hazard warning switch is mounted on side of control housing, remove two screws which attach switch to housing.
6. Remove three screws which attach control assembly to housing, then remove control assembly with wiring from housing.

INSPECTION

Inspect control switch, hazard switch (if used), wiring and bearing. Replace worn or damaged parts. Inspect cancelling cam on steering wheel hub and replace if worn or damaged.

INSTALLATION (Fig. 20 or 21)

1. Position control assembly in housing and attach to housing with three screws. Tighten screws firmly, however, do not exceed 30 inch-pounds torque.
2. Position control lever on control assembly and attach with screw. Tighten screw firmly.
3. If hazard warning switch was removed from housing, position switch on housing and attach with two screws. Route switch wires on outside of control assembly.
4. Connect wires at harness connector.
5. Install steering shaft upper bearing sleeve, then install steering wheel as directed under "Steering Wheel Replacement" in "MECHANICAL STEERING" (SEC. 9A) of this manual.

HAZARD WARNING SYSTEM

All vehicles are equipped with a hazard warning or disability lighting system to be operated when on-the-road disability occurs. This system is fed from the battery and can be operated regardless of ignition or control switch position.

NOTE: Refer to Wiring Diagram in applicable "Wiring Diagrams" booklet for wiring arrangement.

A switch mounted on side of the directional signal control housing or on the instrument panel operates front and rear directional signal lights simultaneously. When hazard warning or disability lights are operating, the directional signal tell-tale lights or a light inside the switch knob will flash. To cancel or "turn off" the lights, pull plunger out (or depress the knob).

If switch becomes inoperative, check for a blown fuse or a defective flasher. If this fails to correct the condition, replace the hazard warning or disability lighting switch. The hazard warning switch shown in figure 21 may be replaced as explained under "Directional Signal Control Assembly" previously. To replace the dash-mounted-type switch, remove the knob, then remove nut attaching switch to dash panel. Pull switch from dash panel and disconnect wiring harness. Install new switch.

NOTE: On models which have an indicator bulb in the switch knob, the bulb may be replaced by removing the threaded knob.

FLASHERS

Two or three prong specific load or variable load flashers are used in the directional and hazard warning system on vehicles covered by this manual. Refer to "Specifications" at end of this section for type of flasher and trade number.

On vehicles equipped with the specific load flasher, the tell-tale will not operate if one directional lamp bulb is taken out of the circuit.

On vehicles equipped with the variable load flasher, the directional tell-tale will operate even though one or more of the indicator bulbs are taken out of the circuit.

IMPORTANT: On vehicles equipped with the variable load flasher, each lamp bulb should be checked daily for proper operation.

If directional tell-tale on instrument panel flashes in one position but not the other, check for the following:

1. Directional lamp bulb burned out.
2. Incorrect directional lamp bulb installed.
3. Defective ground between bulb socket and mounting.
4. Defective directional control switch assembly.

If directional tell-tale on instrument panel does not flash in either direction, check for the following:

1. Burned out fuse on fuse block.
2. Defective flasher or flasher terminals not properly engaged in junction block.
3. Directional tell-tale bulb on instrument panel burned out.
4. Short or open circuit. Check indicator lamp circuit referring to "Wiring Diagram" in applicable "Wiring Diagrams" booklet.
5. Defective directional control switch assembly.

If directional tell-tale light does not cancel after completing a turn, remove the steering wheel as explained in "MECHANICAL STEERING" (SEC. 9A) and check for a worn or damaged cancelling cam.

SPECIFICATIONS

HORN RELAY

Model	2480982
Voltage	12

HORN RELAY

Make	Delco-Remy
Model	1115824
Air Gap at Core Points Closed (In.)	0.020
Point Opening (In.)	0.018
Closing Voltage (Range)	1.5-9.5

TRAILER I.C.C. MARKER LAMP RELAY

Make	Delco-Remy
Model	1115841
Air Gap at Core Points Closed (In.)*	0.012 (Min.)
Point Opening (In.)	0.015-0.025
Closing Voltage (Range)	7-8
Sealing Voltage	10 (Max.)

*Tolerance Plus or Minus 10%

LOW AIR PRESSURE & LOW VACUUM ALARM BUZZER

Make	Delco-Remy
Model	1116882
Point Opening (In.)	.017
Closing Voltage	Adjust to Buzz at .25-.35 Amperes at 13.5-14.5 Volts

ENGINE ALARM BUZZER

Make	Delco-Remy
Model	1116914
Point Opening (In.)	.015
Closing Voltage	Adjust to Buzz at .30-.35 Amperes at 13.5-14.5 Volts

FLASHER UNIT

SPECIFIC LOAD—2-PRONG	SIG. STAT 144
VARIABLE LOAD—2-PRONG	SIG-STAT 175
VARIABLE LOAD—3-PRONG	SIG-STAT 180

LIGHT BULB DATA

	BULB NO.	CANDLE-POWER
Headlamp		
Conventional Cab and "S" Models		
Inside Light (Type 1)	4001 (L)*	37½ Watts
Outside Light (Type 2)	4002 (L)*	37½-55 Watts
"P" Models	6012 (L)*	45-50 Watts
Tilt Cab Models	6013 (L)*	45-50 Watts
Stop and Taillight	1157	32-4
Parking Lights (When Used)	67	4
Front Marker Lights	1155	4
Instrument and Tell-Tale Lights		
Except Tilt Cab Models	57	2
Tilt Cab Models	161	1
Directional Signals	1156	32
Dome Light	211	12
Voltmeter Tell-Tale Light (When Used)	57	2
Ammeter Tell-Tale Light (When Used)	57	2
License Plate Light	67	4
Back-up Light	1156	32
Turn Signal Light	1156	32

*Long Life Unit.

KEEP ALL WIRING CONNECTIONS
CLEAN AND TIGHT

DO NOT REPLACE FUSIBLE LINKS WITH
WIRE OF LARGER GAUGE OR LENGTH

DISCONNECT NEGATIVE BATTERY CABLE
FROM BATTERY BEFORE REPLACING
INSTRUMENTS OR GAUGES

SECTION 13

Radiator and Surge Tank

NOTE: Refer to ENGINE COOLING (SEC. 6K) of this manual for information relative to engine coolant circulation, system capacities, temperature indicators, thermostats water filters, and fan belts. Information on replacement of radiator shell and front end sheet metal is provided in SHEET METAL (SEC. 11) of this manual.

DESCRIPTION

Pressurized cooling with regulated coolant flow is standard on all models. Use of pressurized system allows increased coolant operating temperatures for improved efficiency, extended engine life, and minimum coolant loss. Pressure valve in radiator filler cap is used to maintain specified pressure within cooling system. Temperature of coolant is regulated by thermostat control in engine.

Radiator assemblies are engineered with optimum frontal core area and maximum heat transfer characteristics. Some radiator assemblies are fitted with a shroud designed to assist fan in directing air flow through radiator core and also serve as a fan guard. For continuous heavy-duty applications, radiator assemblies with increased cooling capacity are available as optional equipment.

Provision for coolant expansion is achieved by maintaining an air reservoir in upper radiator tank or surge tank. This retards coolant overflow reducing necessity of frequent refills.

Surplus coolant is released through filler cap pressure valve and neck vent to which is connected an overflow tube. Purpose of overflow tube is to allow excess coolant to be released beneath vehicle.

Pressure in cooling system is maintained by use of radiator cap equipped with two valves; one which relieves excessive pressure in system and another which admits outside air to compensate for coolant contraction after engine is stopped. Radiator caps are provided with pressure ratings of 9 or 13 pounds per square inch. Coolant boiling point increases approximately 3 degrees for each additional pound of pressure. Refer to "Specifications" at end of this section for correct replacement radiator filler cap.

MAINTENANCE

At regular intervals, cooling system components should be inspected to determine if service is required. Regular systematic checks will reveal faulty condition of various units and indicate necessity of servicing or replacement of such components before failure occurs. Suggested checks are:

1. Frequently check coolant level. If low, add recommended coolant as required.

2. Check hose connections and tighten clamps if seeping is evident. Cracked, stripped, or corroded clamps should be replaced.

3. Inspect radiator hoses for spongy or checked appearance. Deteriorated hoses should be replaced before bursting occurs which would result in coolant loss and could cause extensive engine damage due to overheating.

3. Check radiator core for leaks and for accumulation of dirt which obstructs air passage and reduces effective heat transfer.

4. Inspect resilient radiator mountings for deterioration and replace as required. Keep mounting bolts tight to prevent core damage due to road shocks and vibration. Check side flanges and support braces for evidence of metal damage if mounting bolts are missing, loose, or stripped.

5. Inspect for proper clearance between fan blades, radiator core, and shroud (if equipped). Check fan attaching bolts for tightness and observe alignment of fan blades in relation to each other. Replace fan if any blade is bent. Distance between blades and shroud should be equal around entire perimeter of shroud. If adjustment is required, shroud attaching bolts may be loosened and shroud shifted as necessary to provide proper clearance.

6. Check filler cap seals for evidence of cracking or separation. Replace as required.

To assist in maintaining efficient heat dissipation, an occasional external flushing with water will remove majority of dirt accumulation and foreign matter from between core fins. Water under moderate pressure should be directed from behind core to force debris out in opposite direction of its entrance. Water should be directed in line with fins, not sideways, to reduce possibility of bending fins.

When coolant loss is evident or engine overheating occurs, the damaged or clogged radiator should be serviced by a radiator specialist or replaced with a new one. Efficient repair of radiators requires the use of special tools and equipment as well as provisions for making proper tests. If radiator core requires painting, spray with special radiator paint; do not use paint mixed with oil, as oil mixed paint will form an insulation and prevent efficient dissipation of heat.

RADIATOR MOUNTINGS

All radiator core mountings consist of three major components; upper tank, center core section, and lower tank. All "L" models employ a separate bracket mounted surge tank which serves as a coolant reservoir for the radiator core.

Type of radiator core mounting varies according to model and engine type. All "E" and "S" model radiator assemblies are equipped with side flanges which are mounted flush against radiator shell and fastened into position with mounting bolts (fig. 1). On "L" models, the radiator is supported by upper and lower mountings (fig. 2). Radiator on "P" models rest on a lower support and is retained at sides by radiator flanges bolted to side supports (fig. 3). Also, an upper cross bar is used to add stability to side supports.

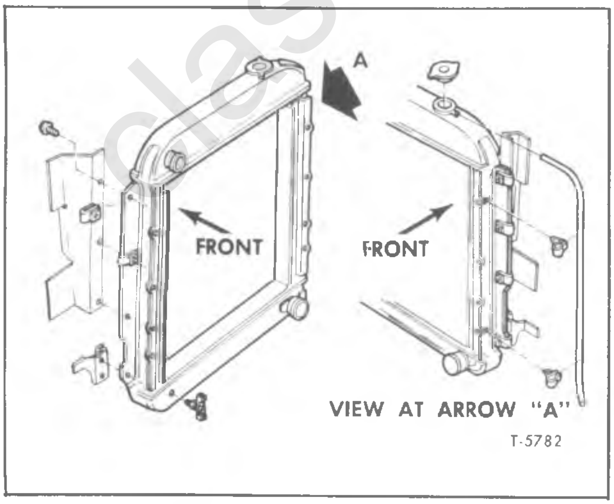


Figure 1—Radiator Mounting ("E" and "S" Models)

RADIATOR REPLACEMENT

Due to various types of radiator mountings, the following general information applies to all models. The radiator assembly may include a fan shroud and an oil cooler at base of radiator core. If equipped with a fan shroud, remove attaching bolts and then lay shroud back over fan blade. When oil lines are removed, make provisions for catching oil drainage from cooler tank and lines. Do not re-use this oil. Replenish transmission to recommended level with fresh fluid after installing radiator.

Some models may be equipped with a separate power steering oil cooler which is attached in front of radiator core by means of cooler support braces. On models so equipped, it may be necessary to remove power steering oil cooler in order to replace radiator core. For information relative to removal and installation of oil cooler, see "POWER STEERING" (SEC. 9B) of this manual.

"E" AND "S" MODELS (Fig. 1)

Removal

1. Drain radiator.
2. Remove hood assembly as instructed under "Hood Assembly Replacement" in SHEET METAL (SEC. 11) of this manual.
3. Remove fan shroud (if equipped) and position it back over fan.
4. Remove coolant hoses and transmission oil lines (if equipped).
5. Support radiator safely in position and remove radiator mounting bolts.
6. Carefully lift radiator up and out of vehicle.

Installation

1. Lower radiator into position against radiator shell. Install radiator mounting bolts. Tighten bolts to 10 to 15 foot-pounds torque.
2. Connect coolant hoses and oil lines.
3. Install fan shroud (if equipped).
4. Install hood assembly as instructed under "Hood Assembly Replacement" in SHEET METAL (SEC. 11) of this manual.
5. Fill cooling system and transmission to proper level.
6. Start engine and inspect system for leaks.

"L" MODELS (Fig. 2)

Removal

1. Drain radiator.
2. Disconnect throttle linkage at linkage bracket on radiator support.
3. Remove electrical components from radiator support assembly.

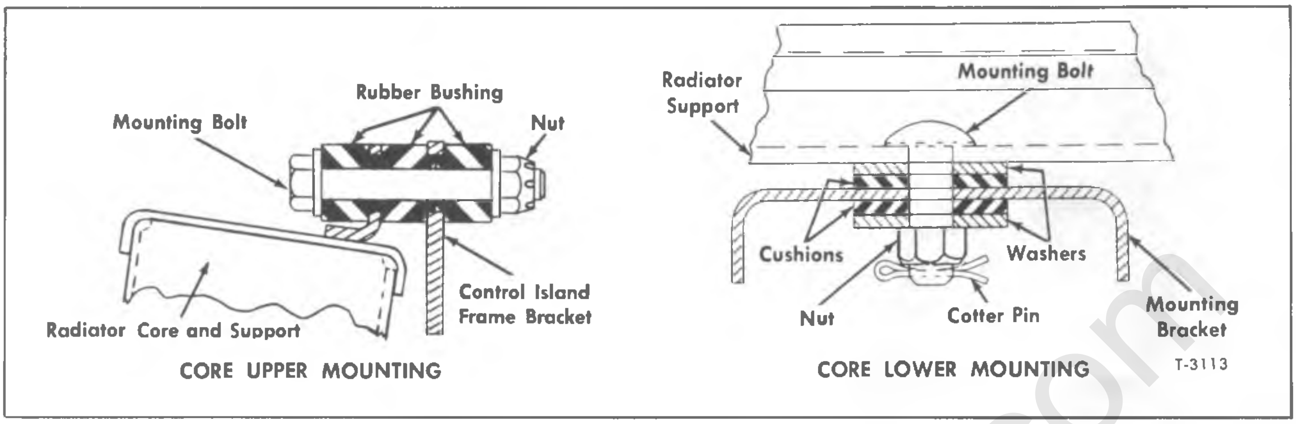


Figure 2—Radiator Upper and Lower Mountings ("L" Models)

4. Disconnect upper and lower coolant hoses from radiator.
5. If vehicle is equipped with air conditioning or power steering cooling coils, remove coils if necessary.
6. Remove cotter key, nut, washer and lower cushion from lower mount.
7. Remove upper mounting bolts and rubber bushings.
8. To remove radiator and support assembly, tilt assembly forward and lift assembly out of vehicle.
9. To remove radiator core assembly from support assembly, remove cap screws from fan shroud and remove fan shroud. Remove cap screws attaching radiator core assembly to support assembly and remove core assembly.

Installation

1. Position radiator core assembly in support assembly and secure with cap screws.
2. Install fan shroud and retain with cap screws.
3. Carefully place radiator and support assembly in vehicle. Be sure components of lower mount are properly positioned.
4. Assemble radiator upper mounts and complete assembly of lower mounts.
5. Connect upper and lower coolant hoses to radiator.
6. Install air conditioning or power steering cooling coils (if removed).
7. Install electrical components on radiator and connect throttle linkage to radiator support.
8. Fill cooling system and inspect system for leaks.

PS-4500 MODELS (Fig. 3)

Removal

1. Support vehicle on blocks at a height sufficient to allow lowering the radiator out of vehicle.
2. Drain radiator.
3. If necessary, remove grille and baffle to gain access to radiator mounting bolts.
4. Disconnect radiator upper and lower hoses at radiator.
5. Retain radiator safely in position and remove radiator mounting bolts. Carefully lower the radiator out of vehicle.

Installation

1. Carefully insert radiator into position in vehicle and retain with radiator mounting bolts.
2. Connect radiator upper and lower hoses.
3. Install grille and baffles (if removed).
4. Fill cooling system and check for leaks.

PRESSURE RELIEF VALVE AND FILLER CAP

Pressure relief valve assembly, integral with radiator filler cap, incorporates a pressure valve

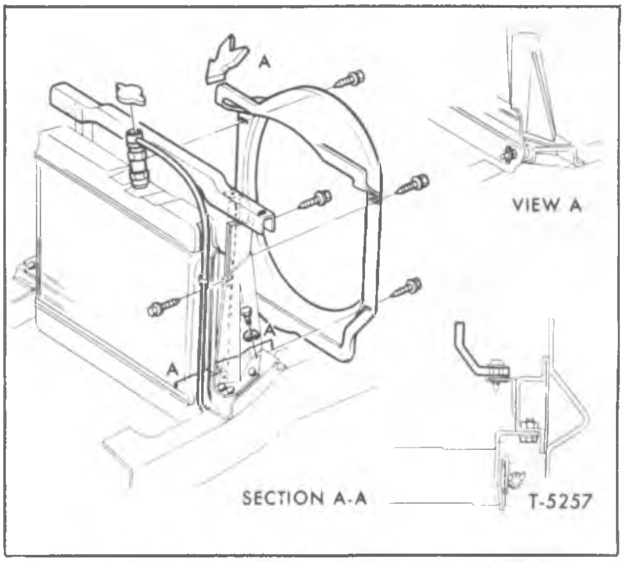


Figure 3—Radiator and Shroud Mounting (PS4500)

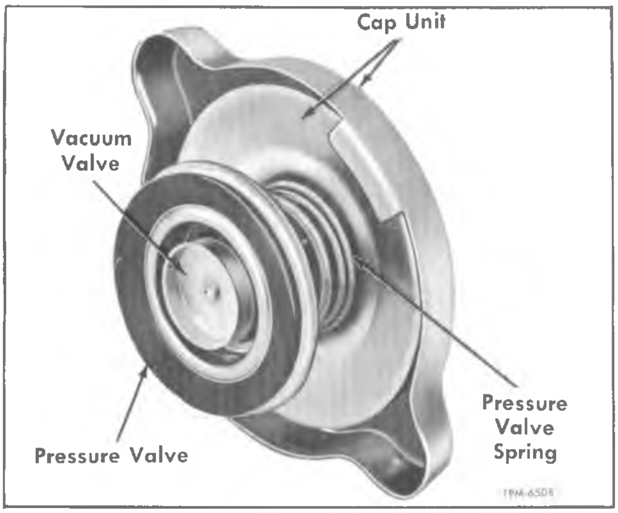


Figure 4—Pressure Relief Valve and Filler Cap

and a vacuum valve (fig. 4). When pressure in system reaches valve setting (see "Specifications" at end of this section), pressure valve opens and vapor is allowed to escape. As liquid in system cools it contracts; this allows pressure valve to close and also creates a partial vacuum in system. Atmospheric pressure acting through overflow tube unseats vacuum valve and allows air to enter system. The overflow pipe connects to valve outside the valve seal; thus no liquid or air can escape from the system when both valves are in the closed position.

Radiator filler cap is constructed with a spring-loaded rubber seal which is pressed firmly against surface of filler neck seat when cap is installed. Rubber seal must be in good condition and top of radiator filler neck must be clean and smooth in order to form an air-tight seal. Seal of filler cap and operation of pressure relief valve can be checked using a conventional cooling system testing kit.

NOTE: When engine is at normal operating temperature or above, the internal pressure built up in the cooling system will blow out scalding fluid and vapors if the radiator cap is suddenly removed. To prevent loss of coolant and to avoid the danger of being burned, the coolant level should be checked or coolant added only when the engine is cool. If the cap must be removed when the engine is hot, place a cloth over the cap and rotate the cap slowly counterclockwise to first stop and allow pressure to escape completely. Then turn cap again slowly counterclockwise to remove.

RADIATOR SURGE TANK

A separate radiator surge tank on all "L" models, is mounted to rear of control island framing. Tank serves as a coolant reservoir for the radiator core which is mounted at front of engine. Hoses and pipes connect tank to radiator and water pump. Surge tank incorporates the cooling system filler cap which is accessible from inside cab through door at top of seat riser. Tilt cab forward to gain access to surge tank.

At regular intervals check tank and connecting hoses for leaks. Keep hose clamps and mounting bolts tightened securely.

ENGINE COOLANT

COOLANT RECOMMENDATIONS

The year-around engine coolant used to fill the cooling system at the factory is a high quality solution that meets General Motors Specification 1899-M. This factory-fill coolant solution is formulated to withstand two full calendar years of normal operation without draining or adding inhibitors, provided the same concentration of coolant is added if the system needs additional fluid between drain periods. The original factory fill coolant provides freezing protection to -20°F.

Every two years, the cooling system should be serviced as described in ENGINE COOLING (SEC. 6K) of this manual. A thorough description of inspection, draining, and cleaning of the cooling system is given.

IMPORTANT: Alcohol, methanol base coolants, or plain water are not recommended. Only a sufficient amount of Ethylene Glycol base coolant meeting GM Specification 1899-M should be used. DO NOT use glycol ether (methoxy propanal type) base permanent type anti-freeze coolants in DH478 diesel engine as damage to cylinder head gasket seals will occur.

COOLANT TESTING

Always test solution before adding water or anti-freeze. Engine should be warmed up to operating temperature. Fill and empty tester several times to warm tester before using. Keep tester clean inside and out.

Some testers will indicate correct freezing point only when test is made at a specific temperature. Other testers are provided with thermometers and tables and indicate freezing points corresponding to readings made at various temperatures. Disregarding temperatures of solution may cause an error as large as 30°F. Read and be guided by instructions furnished by tester manufacturer.

In the event coolant freezes solid in extreme cold weather, place vehicle in warm building or improvise some means of thawing coolant before starting engine. Under no circumstances should engine be operated when coolant is frozen solid.

After thawing, refill system with a higher concentration of anti-freeze solution and start engine. Inspect entire system for leakage and then test coolant with hydrometer to determine if adequate anti-freeze protection is provided.

COOLANT PRECAUTIONS

1. Overheating is not always caused by a defective cooling system; incorrect ignition timing, dragging brakes, under-inflated tires, and improper use of transmission gears can cause overheating.

2. Keep water pump and fan drive belts at proper tension. Refer to ENGINE COOLING SYSTEM (SEC. 6K) of this manual.

3. Do not over-fill cooling system. Expansion of coolant when hot will cause loss of coolant through overflow tube.

4. Do not remove radiator filler cap when engine is hot. Wait until system cools off.

5. Do not pour cold water into cooling system when the engine is hot. Wait until system cools off.

6. If cooling system requires frequent refilling, check for leaks.

7. Keep all connections tight, and make sure gasket on radiator filler cap is in good condition.

8. When filling system with anti-freeze solution ALWAYS FOLLOW RECOMMENDATIONS of anti-freeze manufacturer.

9. Use only Ethylene Glycol base coolant meeting GM Specification 1899-M. DO NOT use Glycol Ether (Methoxy Propanol Type) in Toro-Flow II engines.

10. Drain and flush cooling system every other year, preferably at start or end of winter operation.

SPECIFICATIONS

COOLING SYSTEM PRESSURE RELIEF VALVE

MODELS	VALVE STAMPED	OPENING PRESSURE
PS4500	RC-6-13#	13 psi
All Other Models	RC-12-9#	9 psi

RADIATOR AND SURGE TANK

Always use coolant containing rust and corrosion inhibitor compounds.

When vehicle is operated in freezing weather, protect cooling system by use of permanent-type antifreeze.

Special Tools

References are made to special tools in the various sections of this manual. These tools, or their equivalent, are necessary and are recommended to readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck and Coach Division. Information regarding availability of these tools can be obtained from the Zone Office or from the Technical Publications Department at the factory.

SECTION 1 – CAB AND BODY

Tool No.	Tool Name
J-2189	Glass Seal and Insert Installer
J-9316	Windshield Alignment Blocks (Tilt Cab)
J-9886	Door Inside Handle Clip Remover
AIR CONDITIONING	
J-5725-04	Gauge Set
J-5420	Valve Adapter
J-9459	Valve Adapter
J-5428 or J-5428-03	Vacuum Pump
J-8695-18	Hose-to-Drum Adapter
J-6084	Leak Detector
J-6272-01	Multi-Opener
J-6271	Fits-All Valve (1 Can Opener)
J-8393	Deluxe Portable A/C Service Station
J-22132-01	Schrader Valve Core Remover and Installer

SECTION 3C – FRONT SPRINGS

*J-21058	Remover and Replacer Set (Plain Spring Eye Bushing)
J-21978-1 & J-21978-2	Remover and Replacer (Spring Eye Bushing (Model PS4500)
J-21830-4	Spring Bushing Receiver (PS4500)
J-21830-7	Spring Bushing Receiver Bridge (PS4500)

SECTION 4A – REAR AXLE

J-3453	Pinion Yoke Holding Bar
J-22281	Pinion Oil Seal Installer - H135, H110, and H150
J-22283	Pinion Oil Seal Installer - T150

SECTION 4B – REAR SPRINGS

*J-21058	Remover and Replacer (Plain Spring Eye Bushing)

SECTION 4C – REAR HUBS AND BEARINGS

J-870	Wheel Bearing Nut Wrench H110 & H135
J-5955	Wheel Bearing Nut Wrench H150 & T150; Rockwell G161 & G361

SECTION 4C (CONT'D.)

Tool No.	Tool Name
J-7341	Wheel Bearing Nut Wrench Eaton 16121, 16221, 17121 & 17221

SECTION 5A – HYDRAULIC BRAKES

J-4707	Brake Adjustment Tool
J-4705	Piston Cup Installer
J-8049	Brake Spring Replacer (FR-3)
J-23339	Master Cylinder Bleeder Adapter
J-22348	Brake Spring Replacer (Twin-Action)

SECTION 6A – GASOLINE ENGINES

J-7879-01	Crankshaft Pulley or Hub Replacement Set (Includes Oil Seal Installer - V6 Engines)
J-6978-04	Crankshaft Damper Puller (In-Line Eng.)
J-22197	Crankshaft Damper Installer "
J-21058	Damper and Gear Installer "
J-21546	Air Hose Adapter
J-0966 or J-21742	Timing Gear Cover Centering Gauge
J-8340	Timing Gear Cover Oil Seal Replacer (In-Line Engine, Cover Installed)
J-8514	Cylinder Head Bolt Torque Wrench Adapter (V6 Eng.)
J-5892	Valve Spring Compressor
J-971 & J-995	Oil Seal Installation Tools (Cover Removed - In-Line Engines)
J-22808-1, 2	Flywheel Dowel Pin Hole Reamers (292 In-Line Eng.)

SECTION 6B – TORO-FLOW DIESEL ENGINE

J-21735-02	Compression Gauge Adapter (Use With J-6692)
J-6692	Gauge and Hose for Checking Cylinder Compression
J-21544	Valve Spring Compressor
*J-7879-01	Crankshaft Pulley or Damper Remover and Installer Set
*J-7879-10	Crankshaft Front Oil Seal Installer (Part of J-7879-01 Set)
J-22123	Cylinder Head Bolt Torque Wrench Adapter
J-22975	High Pressure Tube Nut Wrench

*Listed in more than one section.

SPECIAL TOOLS

SECTION 6M - GASOLINE ENGINE FUEL SYSTEM

Tool No.	Tool Name
J-8824	Float Gauge (Bendix Stromberg)
J-4395	Float Lever Bending Tool (Bendix-Stromberg)

SECTION 6M - TORO-FLOW DIESEL FUEL INJECTION SYSTEM

J-22452	Governor Spring Pack Adjustment Tool
J-21761-2	Nozzle Tip Orifice Needle Holder Kit
J-21762	Nozzle Seat Cleaner
J-8152	Nozzle Hole Brush
J-21731	Secondary Filter Testing Set
J-21770	Nozzle Testing Pump
J-22975	Fuel Line Nut Wrench

SECTION 6Y - ENGINE ELECTRICAL

BATTERY

J-22552	Battery Tester - Charger (421 Test)

IGNITION SYSTEM

S-9704B	Spark Plug Wrench Socket

A.C. GENERATING SYSTEM

J-9782-1	Test Adapter Jumper Wire
J-9782-3	Regulator Test Adapter
J-21260	Variable Resistor (0 to 50 Ohms)

SECTION 7B - TRANSMISSION ON-VEHICLE SERVICE

J-8109	Gearshift Lever Remover
J-3154-04	Transmission Seal Replacement Tool Set

*Listed in more than one section.

SECTION 7D - CLUTCH CONTROLS

Tool No.	Tool Name
J-8554	Master Cylinder Cover (For Connecting Pressure Bleeder Hose)

SECTION 7E - CLUTCHES

J-5901-2	Pilot Bearing Remover
*J-2619	Slide Hammer
J-1448	Clutch Pilot Bearing Puller
J-1522	Clutch Pilot Bushing

SECTION 8 - FUEL TANK AND EXHAUST

J-8051	Fuel Line Flaring Set
J-8000	Fuel Line Cutting Tool
J-7777	Fuel Line Retainer Clip Installer

SECTION 9A - MECHANICAL STEERING

J-544-01	Spring Scale
J-2927-01	Steering Wheel Puller
J-21091	Multiple Wire Connector Separator

SECTION 9B - POWER STEERING

J-22181	Power Steering Pressure Gauge Kit

SECTION 12 - CHASSIS ELECTRICAL AND INSTRUMENTS

J-7900	Instrument Cluster Retainer Clip Depressor (Steel Tilt Cab Models)
J-6878-1	Headlight Aimer (Single Lights)
J-6663	Headlight Aimer (Dual Lights)
J-21091	Multiple Wire Connector Separator

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