SECTION I — DESCRIPTION AND SPECIFICATIONS

1. GENERAL DESCRIPTION

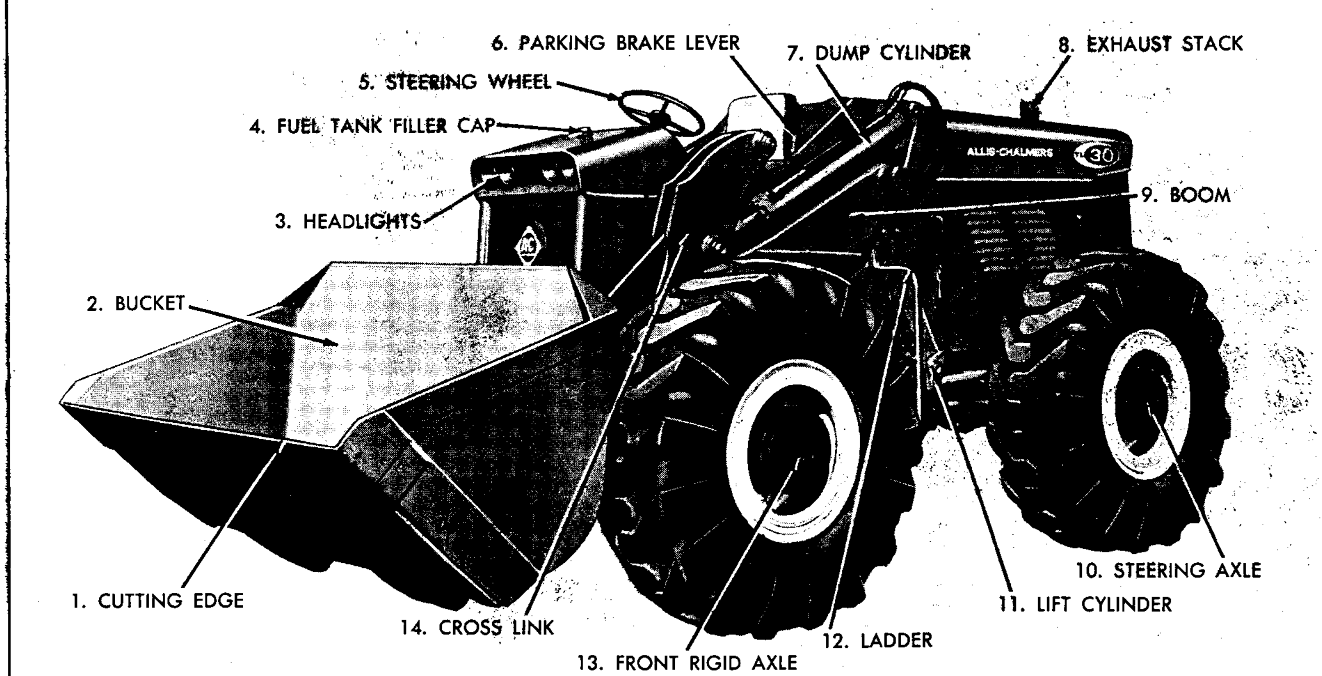

Fig. 1 — Model TL-30D Tractor Loader

The Model TL-30D Diesel Tractor Loader (effective with Serial No. 103) is a 28,400 pound (with standard bucket) four-wheel drive loader unit, powered with a 6-cylinder, turbocharged diesel engine.

The transmission provides 3 forward speeds and 3 reverse speeds ranging from 4.3 M.P.H. in low gear to 30 M.P.H. in high gear at the rated engine speed of 2200 R.P.M. (governed full load).

Operation of the loader is accomplished hydraulically by the transmission mounted pump, a control valve with two control levers, two lift cylinders, two dump cylinders, and the necessary hydraulic lines.

There are no exposed hoses or fittings located in or around the operator's compartment. The hydraulic tank, located behind the operator's compartment, provides a mount for the control valve and incorporates the necessary tubing and safety valves. Short external pressure hoses on each side of the operator's compartment carry oil to the lift and dump cylinders.

The design of the tractor loader provides top visibility, strength, and servicing accessibility. The main frames are mounted to the axles with heat treated pins. The rear stabilizer shroud and the heavy steel seat frame are welded together with side braces to provide a rigid box construction. This provides a mount for the boom, the hydraulic cylinders, and other loader linkage. The boom assembly, made of heavy steel plates, gives added assurance of long life at heavy duty work.

The levers, pedals, gauges, etc., are well situated in the operator's compartment so that full control of the tractor loader can be maintained at all times.

Standard equipment includes: lift and dump cylinders with chrome plated piston rods; cast cowl and steel plates around the operator; heavy duty bumper; drawbar; torque converter and power shift transmission; air brakes and mechanical parking brake; power-booster steering; electric starter; lights and horn; oil bath air cleaner; oil filter, and hour meter.

Optional equipment includes: a heater, operator's cab, special tire equipment.

Special equipment includes: Lift Fork, Cranehook, Back Filler Blade, Ripper, Lift Tongs, and Bucket Teeth.

BUCKET SPECIFICATIONS			DIMENSIONS			
SAE RATED CAPACITY CU. YDS.	WEIGHT (POUNDS)	OUTSIDE WIDTH (INCHES)	A	B*	C	D
6	2550	110	20′ 11″	57¾″	9′ 1″	18′ 1″
5	2245	110	20′ 4⅝″	53¼″	9′ 5½″	17′ 7″
4	2257	110	19′ 10″	49¾″	9′ 11″	17′ ½″
3½	2130	110	19′ 6″	49¼″	10′ 2″	16′ 10″
3	2000	110	19′ 1⅝″	45¾″	10′ 4½″	16′ 6½″
2½	2000	105	18′ 10¾″	43½″	10′ 6³⁄₁₆″	16′ 3″

* Reach quoted from Frame. For reach to Tires deduct 8¼″.

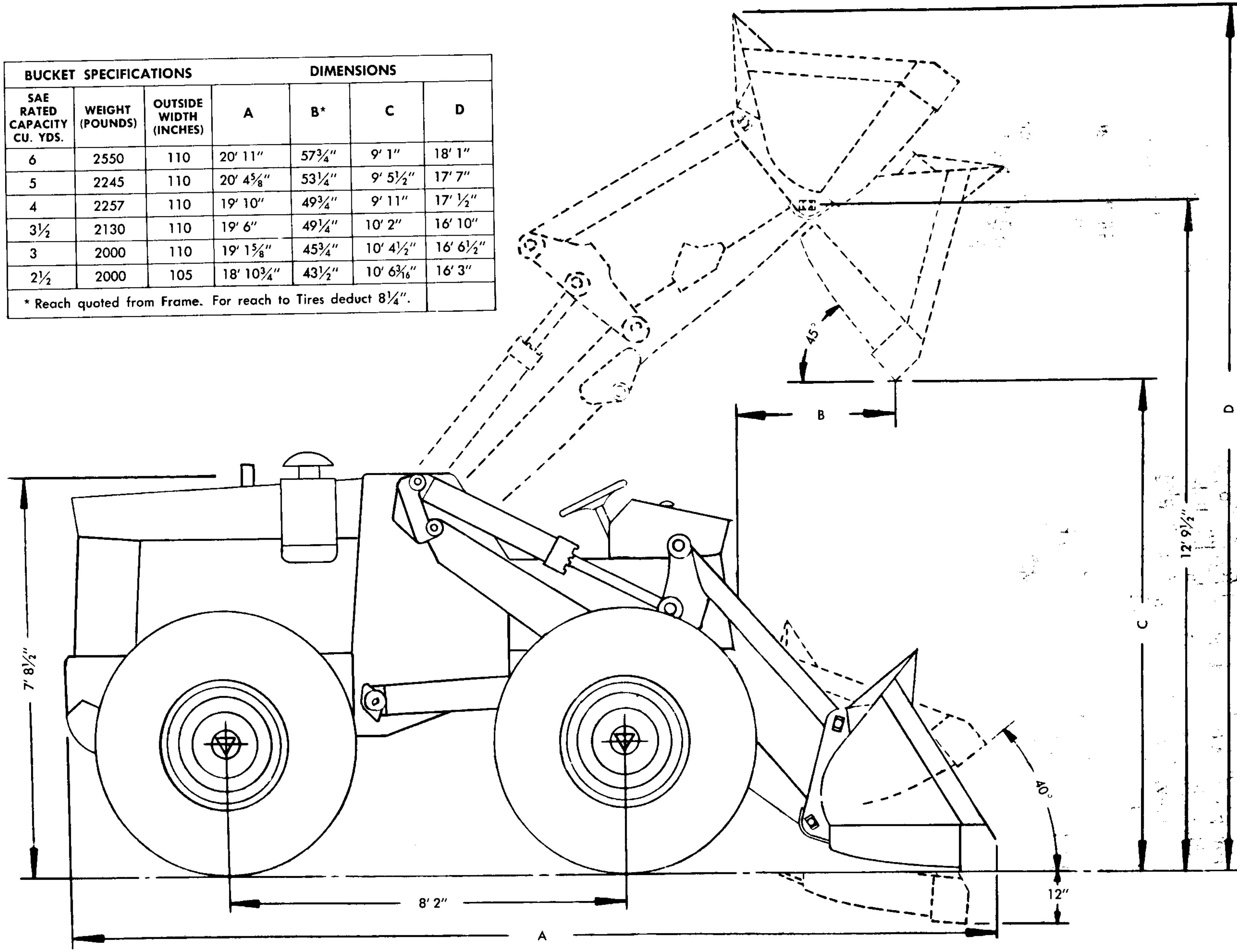

Fig. 2 — Loader Dimensions (General Purpose Bucket)

2. GENERAL SPECIFICATIONS

GENERAL DIMENSIONS AND WEIGHT:

Weight, Shipping (Approximate)	28,400 Lbs.
Front Wheels	13,325 Lbs.
Rear Wheels	15,075 Lbs.
Overall Width (Wheel Hubs)	$8' 5\frac{1}{2}''$
Overall Height with Bucket Down (or to Top of Frame)	$7' 8\frac{1}{2}''$
Overall Length with Cutting Edge Level on Ground	$19'3\frac{5}{8}''$
Ground Clearance	$1' 7\frac{1}{2}''$
Drawbar Height	2' 6"

GENERAL PURPOSE BUCKET (Standard):

	Published
Capacity (Cubic Yards)	3
Published Capacity	"SAE Rating (Nominal Heaped)" Average Volume of Common Earth Handled Per Bucket Load
Maximum Bucket Tip Back	66°
Maximum Dumping Angle (Controllable in All Bucket Positions)	
At Maximum Raise	51°
At Ground Level	109°
Carry Capacity	up to 10,500 Lbs.
Maximum Lifting Capacity	up to 25,000 Lbs.
Breakout Force	28,000 Lbs.
Lifting Time	8.5
Lowering Time	6.0

HYDRAULIC SYSTEM:

Transmission Mounted Pump G.P.M. at 2200 R.P.M.	63 G.P.M.
Capacity, Hydraulic System — Gallons (Approximate)	34 Gal.
Lift Cylinders	(2) "Double Acting" ... 6" Dia. (For Down Pressure)
Dump Cylinders	(2) "Double Acting" ... $5\frac{1}{2}''$ Dia. (For Controlled Dump and Quick Return)
Oil Reservoir	Tank Behind Operator's Seat
Type of Filters	Micronic and Full Flow
Control Valve	Four Positions — Raise, Hold, Lower, and Float

TIRE AND TREAD:

Tread, Front and Rear Wheels	6' 10"
Tires (Tubeless), Front and Rear	18.00 x 25 — 12 Ply
Tire Pressure	40 P.S.I.
Wheel Lug Nut Torque	300 — 350 Lbs. Ft.

ENGINE:

Make	Allis-Chalmers
Model	11000
Type — Vertical In-Line, Compression Ignition, Water Cooled, Four Cycle, Direct Injection, Turbocharged	Full Diesel
Number of Cylinders	6
Bore	$4\frac{7}{16}''$
Stroke	$5\frac{9}{16}''$
Crankshaft Rotation (When Viewed from Fan End)	Clockwise
Number of Main Bearings	7
Piston Displacement	516.17
Firing Order	1 - 5 - 3 - 6 - 2 - 4
Lubrication	Full Pressure

GENERAL SPECIFICATIONS — *Continued*

ENGINE — *Continued*

Fuel Used	See Fuel Specifications
Fuel Supplied By	"American Bosch" Fuel Injection Pump
Low Idle Speed	600 R.P.M.
High Idle Speed	2375-2425 R.P.M.
Rated R.P.M. (Governed at Full Load)	2200 R.P.M.
Air Cleaner	Oil Bath
Oil Filter	Full Flow
Electrical System	24 Volt

TURNING RADIUS:

Tip of Bucket (at 14" Carry Position)	27' 5"
Outer Steering Wheel (Measured at Hub)	28' 1¾"

CAPACITIES (Approximate) (U. S. Standard Measure):

Cooling System		36 Qts.
Crankcase		23 Qts.
Air Cleaner		9½ Pts.
Transmission and Converter		8½ Gals.
Differential	Front	8 Gals.
	Rear	5 Gals.
Planetary Hubs	Front	1 Gal.
	Rear	2½ Qts.
Steering Gear		1½ Lbs.
Fuel Tank		39 Gals.

SPEEDS (M.P.H. at Rated Engine Speed):

1st	0 - 4.3
2nd	0 - 11.5
3rd	0 - 30.0
1st Reverse	0 - 4.3
2nd Reverse	0 - 11.5
3rd Reverse	0 - 30.0

The Allis-Chalmers Manufacturing Company reserves the right to make changes in the above specifications or to add improvements at any time without notice or obligation.

3. SPECIFICATIONS OF LUBRICANTS

A. Engine Crankcase Lubricant

USE AN OIL OF HIGH QUALITY, MANUFACTURED BY A DEPENDABLE OIL COMPANY WHO HAS ESTABLISHED A REPUTATION FOR QUALITY PRODUCTS, AND WHOSE SUCCESS DEPENDS UPON MAINTAINING SUCH QUALITY.

Use oils of the following viscosities:

Atmospheric Temperature	Viscosity
90° F. and above	Use SAE 40
32° F. to 90° F.	Use SAE 30
0° F. to 32° F.	Use SAE 20W
0° F. and below	Use SAE 10W

The manufacturer recommends that only an oil meeting the American Petroleum Institute (A.P.I.) Diesel classification of "Service DS" be used. This oil is frequently referred to in the field as "Series 3" lubricating oil. The "Service DS" will provide the turbocharged engine of the TL-30D Tractor Loader with satisfactory lubrication under all operating conditions. It will also supply the necessary protection when using a fuel that tends to promote deposits or wear. This oil contains additives to promote cleanliness within the engine by helping to prevent the formation of sludge, hard carbon and "varnish" deposits on, or within, engine parts. NOTE: *If the "Service DS" oil is not available through your oil distributor in the various viscosities recommended above, use oil of the viscosity recommended by the particular oil distributor and/or supplier.*

Detergent type oils will become darker in color within a short period of operation. The darkening of the oil is due to minute particles of carbon being suspended in the oil. One of the primary functions of a detergent type oil is to hold the carbon particles in suspension, therefore, darkening of the oil is normal and should not cause concern.

Suppliers of lubricants recognize the importance of the qualities required for use in our equipment and they are cooperating fully to assure the use of only those oils which fulfill these requirements. The source of supply of the lubricant used is to be held responsible for the results obtained from their products.

Proper operation and maintenance of the engine are necessary to obtain the desired results from the lubricating oil.

For additional information regarding engine lubricating oil, contact your "Allis-Chalmers" Dealer.

B. Air Cleaner

Use the same viscosity oil in the air cleaner oil cup as used in the engine crankcase. CAUTION: *Do not use an oil that foams.*

C. Transmission and Converter Lubricant

Lubricate these assemblies with a good grade of transmission fluid type "C-1" oil purchased from a reputable oil company.

D. Axle Lubricant

Both the differential and the planetary hubs use multipurpose (E.P. type) gear oil of the following viscosities:

Atmospheric Temperature	Viscosity
Above 32° F.	Use SAE 140
32° F. and below	Use SAE 90

E. Pressure Gun Lubricant

Use a ball and roller bearing lubricant with a minimum melting point of 300° F. This lubricant should have a viscosity range so as to assure easy handling in the lubricating gun at the prevailing atmospheric temperature, and MUST be waterproof.

F. Hydraulic System Lubricant

A good grade of rust inhibiting hydraulic oil having a viscosity of 210-225 S.U.S. at 100° F. or a good quality SAE 10W engine crankcase oil is recommended for use in the hydraulic system. NOTE: *Do not use an oil that foams.*

No specific brand of oil is recommended. Use only products qualified under the above viscosity specification and recommended by reputable oil companies.

G. Fuel Injection Pump and Governor Lubricant

The fuel injection pump and governor are lubricated from the engine lubrication system.

4. SPECIFICATIONS OF FUEL

The "Diesel" fuel should be a natural distillate petroleum oil and must have certain qualities in order to ignite and burn at the proper rate and temperature. Field experience has shown that the fuel best suited for this engine closely approximates the following specifications:

Gravity API	30 - 35
Viscosity Saybolt Universal at 100° F.	35 - 40
Flash Point	150° F.
Diesel Index	48.5 to 65.5
Cetane Number	46 to 60
Pour Point	0° F.
Volatility 90%	650° F. Max.
End Point 98%	
Summer	700° F. Max.
Winter	600° F. Preferable
Sediment and Water	Trace
Ash	.02 of 1% Max.
Conradson Carbon	.03 of 1% Max.
Sulphur	½ of 1% Max.

For satisfactory fuel flow through lines and filters in cold weather, the pour point of the fuel must be at least 10° F. below the prevailing atmospheric temperature.

The API gravity of a fuel varies with its specific gravity. The low API fuels are desirable because they have a high specific gravity and more heat units per gallon. However, the higher API gravity, the better will be the ignition quality of the fuel.

The ignition quality of a fuel is expressed as a "Cetane number." The higher the cetane number, the higher the quality of the fuel. The higher cetane fuel shortens the ignition delay period to facilitate starting and improve combustion. The "Diesel" index number which is a close approximation of the cetane number, is a field method to represent ignition quality.

The distillation 90% point and the end point are important. High volatility is required to enable complete vaporization of the fuel, clean combustion, and low residue formation.

The flash point of a fuel has no quality significance, but is important with respect to safety in storage and handling of the fuel.

It is important that the fuel be within the specified limits for ash, carbon, water, and sediment content, etc., to prevent excessive wear and damage to engine parts.

It is also important that the fuel has lubricating properties so that the fuel injection pump and fuel injection nozzles are adequately lubricated. At times it may be necessary to use fuel with no lubricating properties. If this occasion arises, add one quart of SAE 10 engine oil to every 10 gallons of fuel. When the proper fuel is again available, the fuel system must be drained before the proper fuel is added. CAUTION: *The sulphur content of "Diesel" fuel should be as low as possible. The fuel should not contain a sulphur content of more than ½ of 1%.*

Generally speaking, a No. 2 "Diesel" fuel purchased from a reputable oil company will meet the above specifications.

5. FUEL STORAGE

The importance of proper storage of fuel cannot be too strongly stressed. Storage tanks, drums or service tanks must be free from rust, scale, sediment or any other foreign matter which will contaminate the fuel. Contaminated fuel will clog the engine fuel filters and eventually damage the fuel injection pump and the fuel injection nozzles.

A portable storage tank provides the best method for storing fuel on the job. In such a tank, the sediment and water can easily be drained and the fuel can be pumped into the tractor fuel tank with a minimum of handling. Consult your nearest "Allis-Chalmers" Dealer for details about this type of storage tank. Since condensation will occur in the storage tank, it is very important that a sediment sump be provided in the bottom of the tank so that water and sediment can be drained daily.

Fuel should be allowed to settle at least 48 hours in a storage container before it is added to the fuel tank of the tractor. It is advisable to use a pump and draw the fuel from the storage tank or barrel, rather than to drain it from the bottom of the fuel container. Where conditions are such that drums must be used to supply fuel, it is advisable to have enough drums to allow sufficient time for the fuel to settle. The fuel thus left in a number of drums can be collected into one drum and used after the usual time allowed for settling. In this manner, the sediment and foreign matter will be disposed of and no fuel will be wasted. Whenever drums are used for fuel storage, they should be covered or placed under shelter so that the fuel will not become contaminated by water, which will enter through the filler plugs when it rains, even though the plugs are tight.

The fuel tank of the tractor should be filled at the end of the day's run rather than at the start; this will reduce the water content, as a full tank is less subject to condensation.

6. TRANSMISSION, ENGINE AND LOADER SERIAL NUMBERS

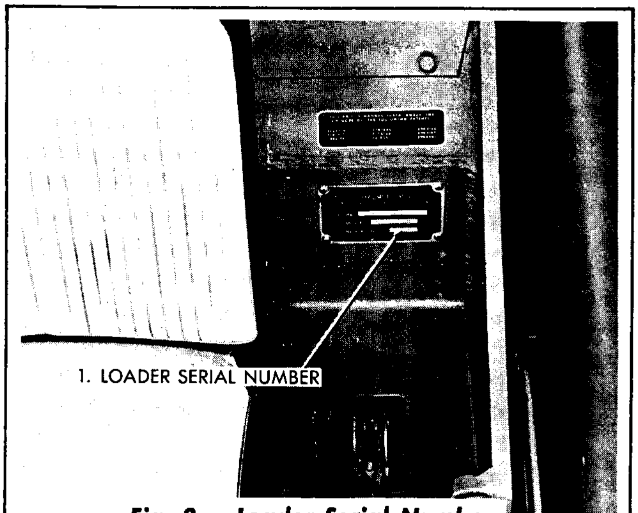

Fig. 3 — Loader Serial Number

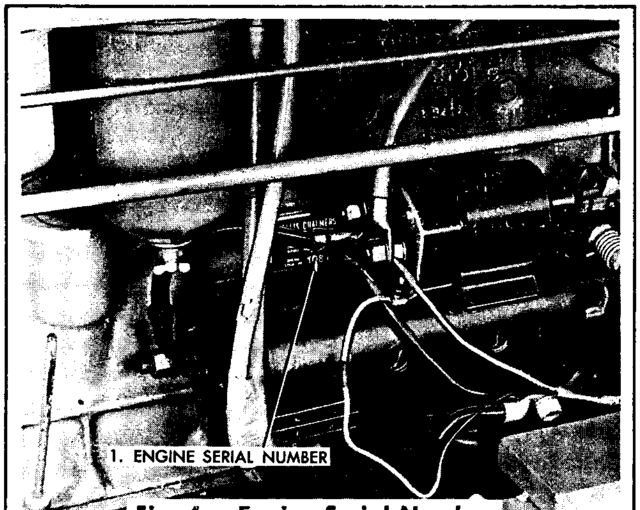

Fig. 4 — Engine Serial Number

On all parts orders and in all correspondence relative to the loader, it is necessary that the loader model and serial number be given. All major components of the loader (such as engine, transmission, hydraulic pump, hydraulic control valve, power steering pump, and front and rear axles), have serial numbers which should also be given to properly identify the unit and component. These will assure obtaining the correct replacement parts.

The loader serial number is located on the nameplate attached to the left rear face of the seat frame in the operator's compartment as shown in Fig. 3.

The engine serial number is located on the nameplate on the right side of the engine block as shown in Fig. 4.

The transmission serial number is located on a nameplate on the left side of the housing as shown in Fig. 5.

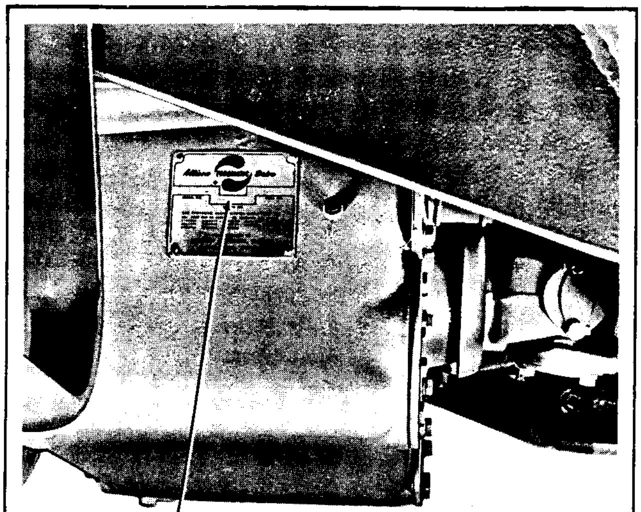

Fig. 5 — Transmission Serial Number

SECTION II — ENGINE FUEL SYSTEM AND GOVERNOR

1. DESCRIPTION OF SYSTEM

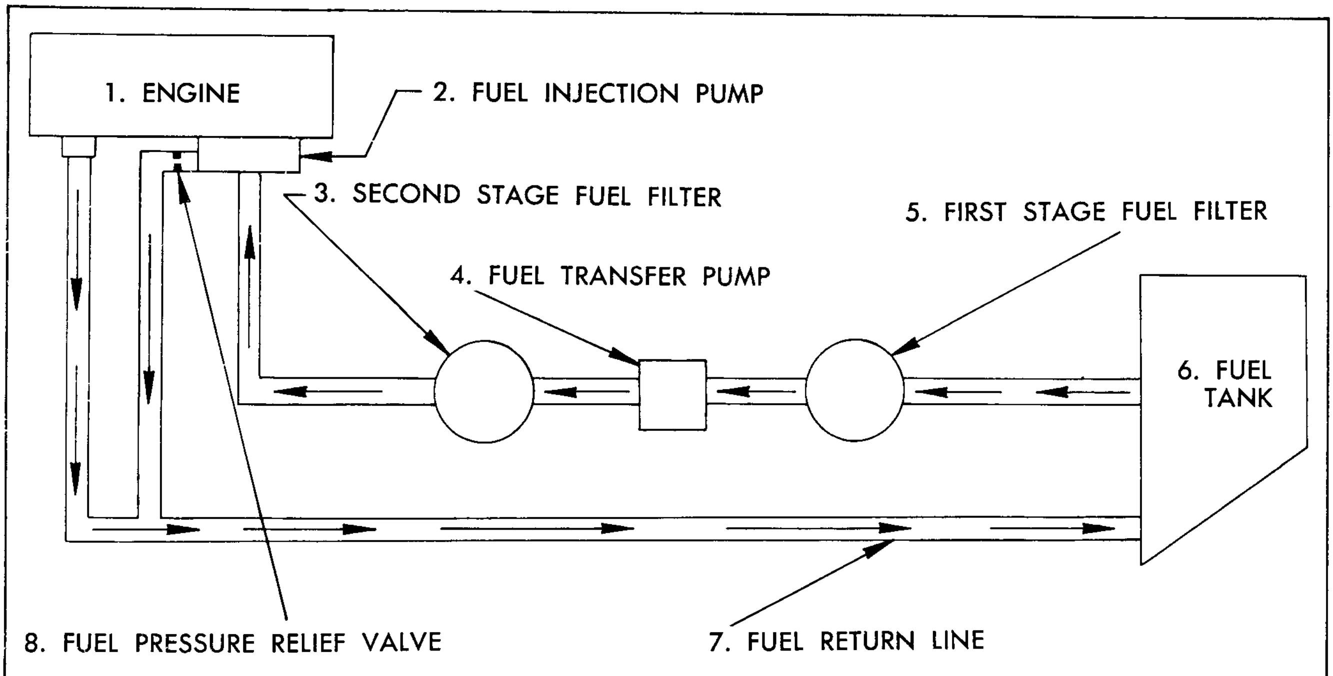

Fig. 1 — Fuel Flow — Schematic Diagram

A. General

The engine fuel system consists of a fuel tank, first stage fuel filter, fuel supply pump, second stage fuel filter, fuel injection pump, fuel injection nozzle-holder assemblies, and the fuel lines. There are two fuel pressure systems: the low pressure system and the high pressure system.

The lower pressure system consists of the fuel tank, first stage fuel filter, fuel supply pump, second stage fuel filter, fuel return manifold, and the fuel return line leading from the fuel pressure relief valve of the fuel injection pump to a passage in the fuel filter head and then to the fuel tank. A pressure of 5 to 15 P.S.I. is maintained between the fuel supply pump in the secondary filter and the pump inlet chamber of the fuel pressure relief valve installed in the fuel return outlet of the fuel injection pump.

The high pressure system consists of the fuel injection pump, fuel injection nozzle-holder assemblies, and fuel injection lines connecting the fuel injection pump to the fuel nozzle-holders. The fuel injection lines are seamless steel tubing and each line is the same length. These lines being the same length assures the proper timing and the proper amount of fuel to each fuel injection nozzle. These lines are not interchangeable; when ordering lines for replacement, specify for which cylinder the line is ordered.

The fuel is drawn from the fuel tank, through the first stage fuel filter, by the fuel supply pump. The fuel is then forced by the supply pump, through the second stage fuel filter and to the fuel injection pump. The amount of fuel required for combustion is forced under high pressure by the fuel injection pump, through the fuel injection lines to the fuel injection nozzles, from which the fuel enters the engine combustion chambers.

The function of the fuel injection nozzles is to direct the metered quantity of fuel, received from the fuel injection pump, into the engine combustion chambers in a definite spray pattern consisting of six cone-shaped sprays and in such a manner as to produce the most efficient engine performance. The valve of each fuel injection nozzle is operated hydraulically by the pressure of the fuel delivered by the fuel injection pump.

There is a certain amount of fuel seepage between the lapped surfaces of each fuel injection nozzle valve and its body, which is necessary for lubrication. This leakage of fuel accumulates around the spindle and in the spring compartment of each fuel injection nozzle holder and is returned through the fuel return manifold to the fuel return line, extending to the fuel tank. The excess fuel delivered to the fuel injection pump by the fuel supply pump is also returned to the fuel tank through a fuel return line.

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B. Fuel Injection Pump, Governor, and Fuel Supply Pump

1. Description

The engine is equipped with an "American Bosch" (Type PSB) heavy-duty fuel injection pump having a mechanical-centrifugal type internal spring governor. The fuel pump is of the constant stroke, multi-outlet, single and distributing-plunger, sleeve control type, the plunger being actuated by a cam and tappet arrangement which also carries the gearing for the distribution function. The fuel injection pump incorporates a "low volume" hydraulic head and many new features to satisfy Allis-Chalmers' engine requirements to provide long service life and improved engine operation. The delivery valve is located in a horizontal position in the side of the hydraulic head resulting in a marked reduction in

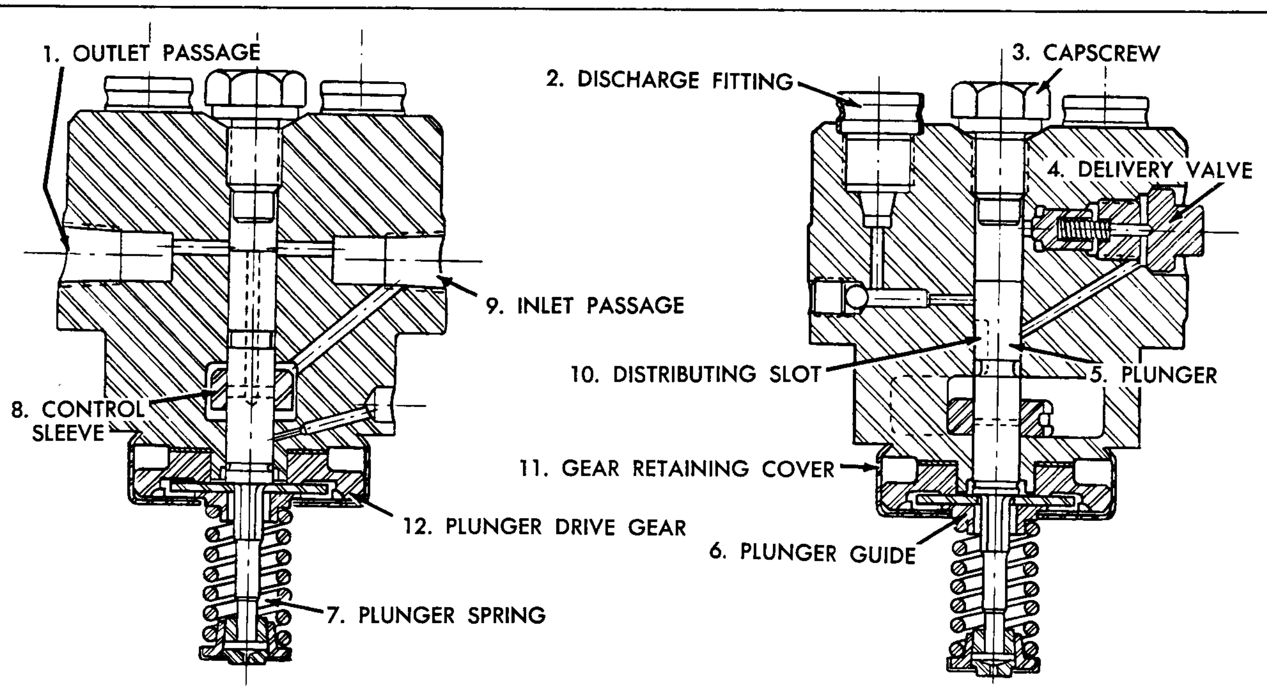


Fig. 2 — Fuel Injection Pump Hydraulic "Low Volume" Head — Sectional Views

the volume of fuel under high pressure within the head. The plunger rides on a thrust button of thorough-hardened, ball-bearing steel that has been lap-fitted to the plunger knob to provide long life. The tappet and roller assembly utilizes a 25 mm. diameter roller on a full floating, ground and lapped pin. The camshaft is forged of SAE 8620 steel, induction hardened and ground.

The pump's purpose is to meter the fuel accurately and deliver it precisely at a definite moment in the engine cycle and under high pressure to the fuel injection nozzles.

The fuel injection pump is driven at crankshaft speed by the pump drive gear in mesh with the engine camshaft gear.

The governor is of the mechanical-centrifugal type and is attached to the rear of the fuel injection pump as an integral unit. The governor is driven directly from the end of the fuel injection pump camshaft. The purpose of the governor is to serve as a means for pre-setting and maintaining within close regulation any desired engine speed within nominal idling and nominal maximum speed range, irrespective of engine load. The governor also controls the engine idling speed to prevent stalling and the maximum speed to prevent racing.

The positive displacement, gear-type fuel supply pump is attached to the right side of the fuel injection pump as an integral unit and is driven from the distributor drive gear of the fuel injection pump camshaft (the distributor drive gear is an integral part of the fuel injection pump camshaft). The purpose of the fuel supply pump is to supply fuel under low pressure to the fuel sump of the fuel injection pump, where the fuel is then forced under high pressure by the fuel injection pump to the fuel injection nozzles.

The fuel injection pump and governor assembly receives lubrication from the engine lubricating system.

2. Operation

a. Pumping

Fuel from the fuel supply pump passes through the second stage fuel filter. It enters the fuel sump of the fuel injection pump, and fills, through two intake ports in the upper bore, that portion of the barrel cavity between the top of the fuel injection pump plunger and the bottom of the delivery valve, when the plunger is at the bottom of its stroke (A — Fig. 3). As the rotating

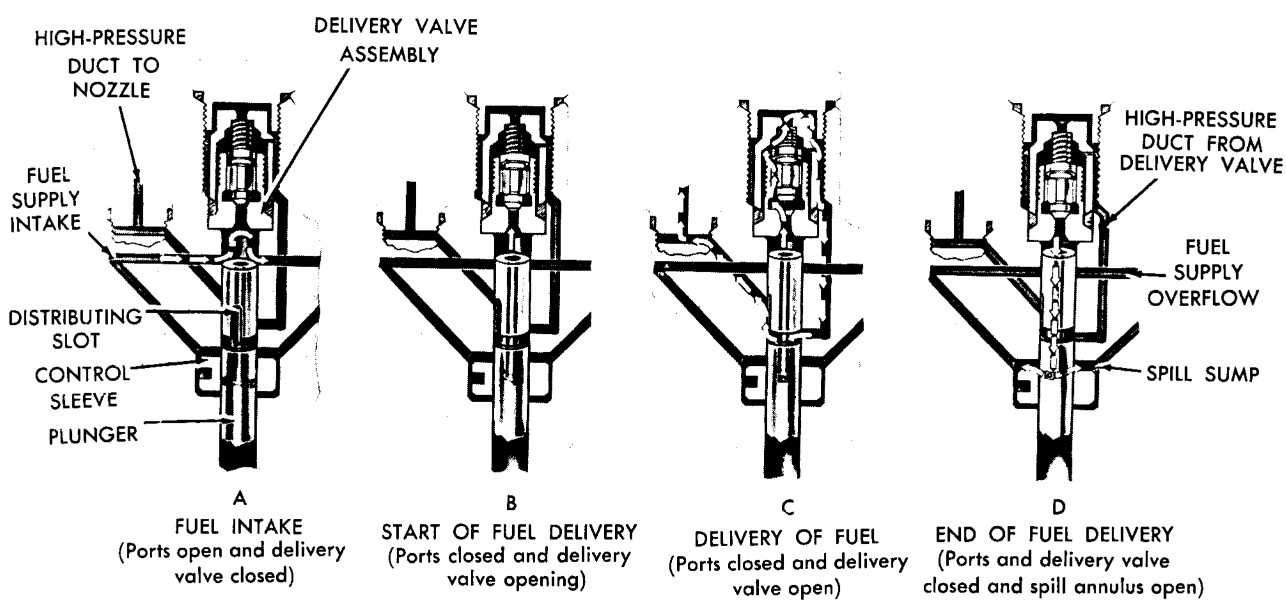


Fig. 3 — Representative Fuel Injection Pump Pumping Cycles

plunger moves upward in its stroke under cam action, it passes and closes the intake ports, trapping and compressing the fuel. The fuel under pressure opens the spring-loaded delivery valve located in the side of the hydraulic head of the fuel injection pump. As the plunger continues its upward stroke, the fuel which is forced through the delivery valve is conveyed through the communicating ducts. It is then delivered to the annulus in the plunger and then through the vertical distributing slot on the plunger to the outlet duct (with which the distributing slot is then registering as the plunger rotates, B and C — Fig. 3). After sufficient upward movement of the plunger, its lower annulus passes the edge of the control sleeve and the fuel, under pressure, escapes down the vertical hole in the center of the plunger and into the sump of the control sleeve, which is at fuel supply pressure (D — Fig. 3). With the decrease of the pressure beneath it, the valve closes and the piston portion of the valve blocks the passage before the valve can reduce the pressure in the discharge system. This is the end of the pumping cycle.

b. **Metering and Control**

The quantity of fuel delivered per stroke is governed by variation of the position of the control sleeve in relation to the fixed port closing position (the point at which the top of the plunger covers the intake ports). This occurs because as the spill annulus on the plunger breaks over the top edge of the control sleeve, pumping pressure is relieved down through the center hole of the plunger. It then flows out into the sump surrounding the control sleeve, and delivery terminates despite the continued upwards movement of the plunger.

If the control sleeve position is raised, the spill annulus on the plunger remains covered by the sleeve until relatively late in the plunger stroke, hence the effective fuel delivery stroke of the plunger is longer and more fuel is delivered (A — Fig. 4). If the control sleeve position is lowered, the spill annulus on the plunger is uncovered by the sleeve relatively sooner in the plunger stroke. Hence, the effective fuel delivery stroke of the plunger is shorter and less fuel is delivered (B — Fig. 4). The position of the control sleeve is controlled by the governor movement transmitted by an internal control rod connecting the fulcrum lever of the governor to the sleeve control lever of the fuel injection pump.

When the control sleeve is lowered to its extreme point (C — Fig. 4), the spill annulus

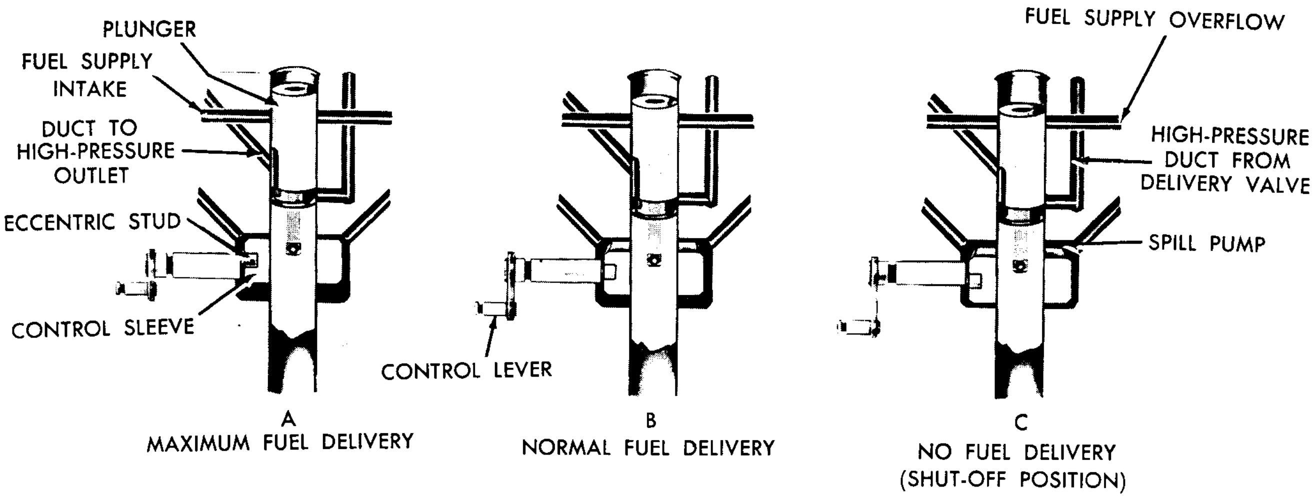


Fig. 4 — Fuel Injection Pump Control Sleeve Positions

on the plunger is uncovered by the top edge of the sleeve before the upper end of the plunger can cover the intake ports. Under this condition, no pressure can build up even after the ports are closed, hence no fuel can be delivered by the plunger. This is the fuel shut-off position.

3. Service

In most cases, malfunctioning of the fuel injection equipment is the direct result of dirty fuel. Dirt in the fuel causes rapid wear on the precision parts, particularly the plunger, hydraulic head, control sleeve, delivery valves and seats, and the fuel injection nozzle valves and valve bodies. Therefore, extreme care should be exercised in the storage and handling of fuel to prevent the entrance of dirt, water, and abrasive particles. Any water or sediment should be drained from the fuel filters daily and the fuel filter elements must be changed after every 500 hours of operation (more often if conditions warrant).

As the fuel injection pump and governor assembly receive lubrication from the engine lubricating system, it is important that the engine lubricating oil and the lubricating oil filter be changed after every 100 hours of operation.

"Allis-Chalmers" Construction Machinery Dealers are equipped with Fuel Injection Pump Calibrating and Test Stands and the special tools required to test, adjust, and repair the fuel injection pump and governor assembly. Therefore, if at any time the fuel injection pump and governor assembly require repairs or adjustments, the assembly should be removed and taken to your nearest "Allis-Chalmers" Construction Machinery Dealer.

2. CHECKING OF SYSTEM

A. General

"Missing" or uneven running of the engine, excessive vibration, stalling when idling, and loss of power are indications of insufficient fuel supply to the engine. Before performing any of the following checks, be certain that there is an ample supply of clean fuel in the fuel tank and that the tank shut-off cock is completely open.

B. Check for Admission of Air Into System

Loosen the vent screw (Fig. 5) located in the top of the second stage fuel filter shell retaining nut. Crank the engine with the starter. If fuel containing bubbles flows from around the vent screw, this indicates that air is being drawn into the system on the suction side of the fuel supply pump. Correct this condition by tightening any loose low pressure fuel line connections, first stage fuel filter connections, and the first stage fuel filter shell retaining nut (Fig. 5).

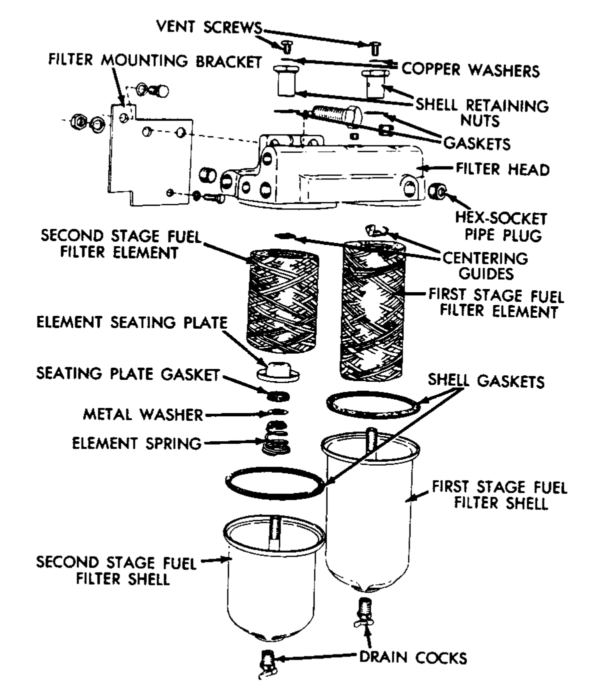


Fig. 5 — First Stage and Second Stage Fuel Filter Details

C. Check for Clogged Fuel Filters and Clogged or Collapsed Fuel Lines

Loosen the vent screw (Fig. 5) in the top of the second stage fuel filter shell retaining nut and crank the engine with the starter. If a full flow of fuel is not obtained from around the loosened vent screw, this indicates a clogged or collapsed fuel line or a clogged first or second stage fuel filter element. If this condition exists, examine the filter elements for a clogged condition and replace the element(s).

D. Check for Inoperative Fuel Pressure Relief Valve or Inoperative Fuel Supply Pump

The positive-displacement gear type fuel supply pump has a relief valve set for 30 P.S.I. and should deliver more fuel to the fuel sump of the fuel injection pump than is required for engine operation. The fuel pressure relief valve connected into the fuel return passage of the fuel injection pump, controls the maximum fuel pressure within the fuel sump of the injection pump. When the fuel pressure within the fuel sump of the injection pump exceeds 15 P.S.I., the fuel pressure relief valve opens and allows the excess fuel to return to the fuel tank through the fuel return hose and the fuel lines. Check for an inoperative fuel pressure relief valve or an inoperative fuel supply pump as follows:

1. Connect a fuel pressure gauge into the pressure side of the filter head Fig. 5. Start the engine and operate at approximately one-half throttle. Observe the fuel pressure gauge. The gauge should indicate a pressure of 5 to 15 P.S.I. If the gauge indicates a pressure below 5 P.S.I., stop the engine and disconnect the end of the fuel return hose from the front end of the filter head.

2. Start the engine and operate at approximately one-half throttle. If the gauge indicates a pressure below 5 P.S.I. and a full flow of fuel is observed from the end of the fuel return hose, this indicates that the relief valve is stuck in the open position and the valve must be replaced as a unit. However, if the gauge indicates a pressure below 5 P.S.I. and little or no fuel is observed from the fuel return hose, this indicates an inoperative fuel supply pump and the pump must be removed, inspected, and replaced as a unit if necessary.

3. If a pressure above 18 P.S.I. is indicated by the gauge, the fuel pressure relief valve is inoperative and must be replaced as a unit.

4. Stop the engine and connect the fuel return hose.

E. Check for Inoperative Fuel Injection Nozzle-Holder Assemblies

"Missing" or uneven running of the engine and loss of power indicates malfunctioning fuel injection nozzle holders, nozzles, or both. Locate the malfunctioning fuel injection nozzle-holder assemblies as follows:

Thoroughly wash and clean the exterior of the fuel injection nozzle holders, injection lines, and the line connections. Run the engine at low idle speed and "cut-out" each fuel injection nozzle-holder in turn by loosening the fuel injection line nut attaching the fuel injection line to its corresponding fuel injection nozzle-holder. CAUTION: *Keep hands away from the loosened nuts while performing this test.* A decrease in engine speed with the injection line nut loosened, indicates that the fuel injection nozzle-holder for that cylinder is functioning properly. If the engine speed does not decrease, the fuel injection nozzle-holder is malfunctioning and must be removed, tested, adjusted and cleaned if necessary (refer to Topic 4 in this Section).

F. Check for Inoperative Fuel Injection Pump

Do not replace the fuel injection pump before making a compression test.

The compression test eliminates the possibility of burned or stuck valves, worn or scored pistons and sleeves, worn or stuck rings, etc., to be causing the improper engine operation.

If all the causes for insufficient fuel supply have been eliminated, and the engine still runs unevenly and normal engine performance is not obtained, the fuel injection pump will be considered at fault and should be replaced. The "faulty" fuel injection pump (with governor) should be taken to your nearest "Allis-Chalmers" Dealer for repairs and testing.

3. FUEL FILTERS

A. First Stage and Second Stage Fuel Filters

1. Description

The first stage and the second stage fuel filters (Fig. 5) each contain a replacement type element. Sediment is collected by the first stage fuel filter and is prevented from entering the fuel supply pump. Any sediment passing through the first stage fuel filter and the fuel supply pump is collected by the second stage fuel filter and is prevented from entering the fuel injection pump. A drain cock is provided in the bottom of each fuel filter shell for draining water or sediment that is collected.

The capacities of the filters are such that they require a change in elements both at the same time.

2. Service

Open the drain cock in the bottom of each fuel filter shell daily, before the start of the day's operation in warm weather or shortly after the end of the day's operation in freezing weather, and allow water or sediment to drain. Close the drain cocks as soon as clean fuel runs out. Remove and discard the filter element in each filter and install new elements each 500 hours of operation (more often if conditions warrant), or when the fuel filters become clogged and a pressure of less than 5 to 8 pounds is indicated by a fuel pressure gauge connected to the pressure side of the filter head. Clogged filter elements are usually indicated by irregular engine performance.

3. Replacement of First Stage and Second Stage Fuel Filter Elements

a. Close the fuel tank shut-off valve. Thoroughly clean the filter head and shells. Loosen the vent screws in the top of the filter head and the drain cocks in the bottom of the filter shells and allow the filters to drain.

b. Loosen the first stage filter shell retaining nut in the filter head until it is free from the shell centerbolt and remove the filter shell from the filter head.

c. Discard the old filter element and shell gasket. Thoroughly wash and dry the interior of the filter shell.

d. Install a new filter element (from the Element Replacement Kit) and push it down firmly so that the up-turned edge of the seat plate, attached to the bottom of the shell center-belt, is firmly impressed into the bottom of the filter element.

e. Install a new shell gasket (from the Element Replacement Kit) in the lip of the shell. Hold the filter shell under the filter head and engage the threads of the shell retaining nut with the shell center-bolt. Then tighten the hex-retaining nut securely. Close the filter drain cock.

f. Loosen the second stage filter shell retaining nut in the filter head until it is free from the shell center-bolt. Then remove the filter shell from the filter head.

g. Discard the filter element, shell gasket, element plate gasket, and the washer. Remove and save the centering guide, the spring, and the seat plate.

h. Thoroughly clean the inside of the shell assembly, the spring, the centering guide, and the seat plate.

i. Install the spring and the plate gasket washer in position on the center-bolt, pushing them down firmly until they are seated. Install a new element plate gasket (furnished with the Element Replacement Kit) and push it down over the center-bolt until it contacts the washer. Be sure that the chamfered side of this gasket is toward the top of the filter. Place the seat plate on the center-bolt and push it down until the gasket and the washer are up inside the recess in the seat plate. Screw the centering guide on the top of the center-bolt.

j. Install the new filter element (from the Element Replacement Kit) and push it down firmly so that the upturned edge of the seat plate (located at the bottom of the center-bolt of the shell assembly) is firmly impressed into the bottom of the filter element.

k. Close the filter drain cock and place a new shell gasket in the lip of the shell. Fill the shell with CLEAN fuel and hold the shell assembly against the filter head. Engage the threads of the shell retaining nut with the center-bolt and tighten the nut securely.

l. Fill the fuel tank so that the fuel level is high enough to fill the first stage fuel filter by gravity. Open the fuel tank shut-off valve and allow the first stage filter to fill with fuel. Tighten the filter vent screw when fuel flows from around the loosened vent screw.

m. Crank the engine with the starter until fuel flows from around the loosened second stage filter vent screw, then tighten the vent screw. Start the engine and correct any leaks that are found.

IMPORTANT: *Keep the filter parts clean when changing the fuel filter elements. To assure maximum protection, replace the filter elements each 500 hours of operation, or more often if conditions warrant.*

4. FUEL INJECTION NOZZLE-HOLDER ASSEMBLY

A. General

Each cylinder of the engine is provided with a multi-hole, differential needle, hydraulically-lifted fuel injection nozzle-holder assembly. The function of each fuel injection nozzle-holder is to direct the metered quantity of fuel, received from the fuel injection pump, into the corresponding combustion chamber of the engine in a highly atomized, pre-determined spray pattern, and in such a manner as to produce the most efficient engine performance.

Each fuel injection nozzle-holder assembly consists of two assemblies; the holder assembly and the nozzle assembly. The holder assembly is used to hold the nozzle in its correct position in the cylinder head and to provide a means of conducting fuel, received from the fuel injection pump, to the nozzle. The holder assembly consists of a holder, spindle, spindle pressure adjusting spring, spring retainer, pressure adjusting screw, holder cap nut, and a nozzle retaining nut.

The nozzle consists of a nozzle valve and a nozzle body in which is located four spray orifices .30MM in diameter and equally spaced 90° apart. The nozzle valve is operated hydraulically within the valve body by fuel delivered under pressure by the fuel injection pump.

The nozzle is positioned on the holder by two dowels (Fig. 6) whereby the four spray orifices are on a plane parallel to the top of the piston (Fig. 7) and the fuel duct in the nozzle is registered with the fuel duct in the holder.

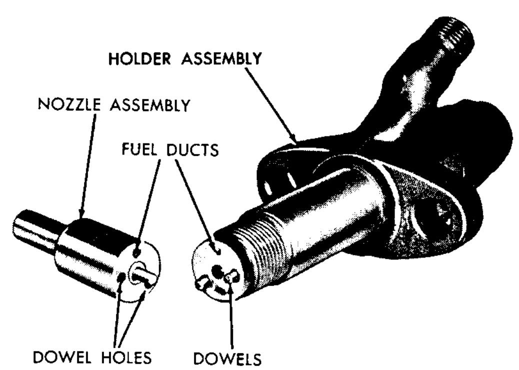


Fig. 6 — Fuel Injection Nozzle-Holder Assembly — Dowel Location

B. Operation

The metered quantity of fuel under pressure, delivered by the fuel injection pump, enters the fuel inlet passage of the nozzle holder, passes through the holder fuel duct into the nozzle fuel duct, and then into the pressure chamber above the nozzle valve seat. At the instant the pressure of the fuel in the pressure chamber exceeds the pressure exerted on the spindle and the nozzle valve by the spindle spring, the nozzle valve is lifted off its seat and the fuel is forced through the orifices in the

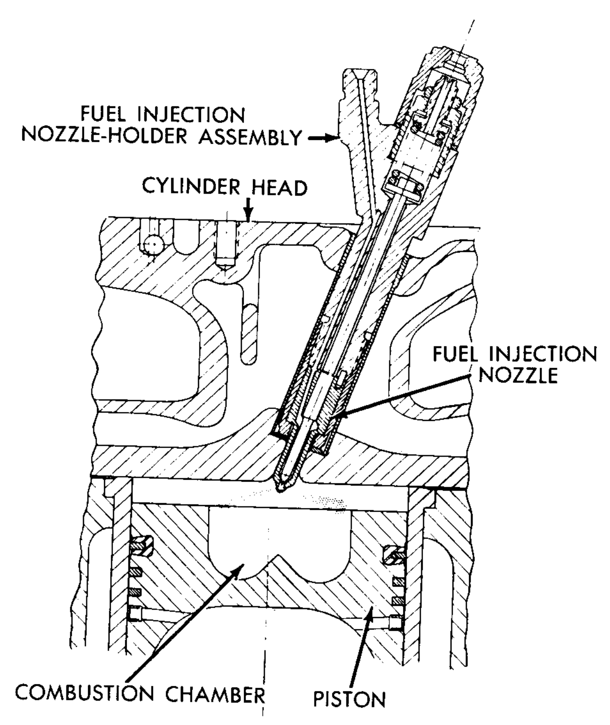


Fig. 7 — Sectional View — Combustion Chamber

end of the valve body and into the corresponding combustion chamber of the engine. The nozzle valve is returned to its seat by the pressure exerted by the spindle spring, as soon as the fuel injection pump has ceased to deliver fuel to the nozzle-holder. There is a certain amount of fuel seepage in the nozzle between the lapped surfaces of each nozzle valve and valve body, which is necessary for lubrication. This leakage of fuel accumulates around the spindle and in the spring compartment of the nozzle-holder, and is returned through the fuel return manifold and fuel return line to the fuel filter head where it is returned to the fuel tank through the fuel return hose and lines extending from the filter head to the fuel tank.

C. Service

The fuel injection nozzle-holder assemblies should be removed after the first 50 to 75 hours of operation, tested for the proper "popping" pressure, and adjusted if necessary. The test and adjustments should be made again periodically (after approximately every 2000 hours of operation). The nozzle-holder assembly when properly adjusted should require a pressure of 2450-2550 PSI to raise the nozzle valve from its seat. The opening pressure ("popping pressure") is adjustable by means of the pressure adjusting screw. Turning the adjusting screw counter-clockwise decreases the opening pressure; turning the adjusting screw clockwise increases the opening pressure. NOTE: *A special nozzle tester, similar to the one shown in Fig. 9 is required for testing and adjusting the fuel nozzles.*

D. Removal of Fuel Injection Nozzle-Holder from Engine

1. Thoroughly clean the fuel injection holders and the surrounding area before removing them from the cylinder head.
2. Loosen the fuel injection line brackets, disconnect the fuel return manifold and the fuel injection line from the nozzle-holder. CAUTION: *Do not bend the line when disconnecting. Cover the end of the disconnected line to prevent the entrance of dirt.*
3. Remove the two nuts and lockwashers securing the nozzle-holder assembly to the cylinder head. Withdraw the assembly without marring the tip of the nozzle.

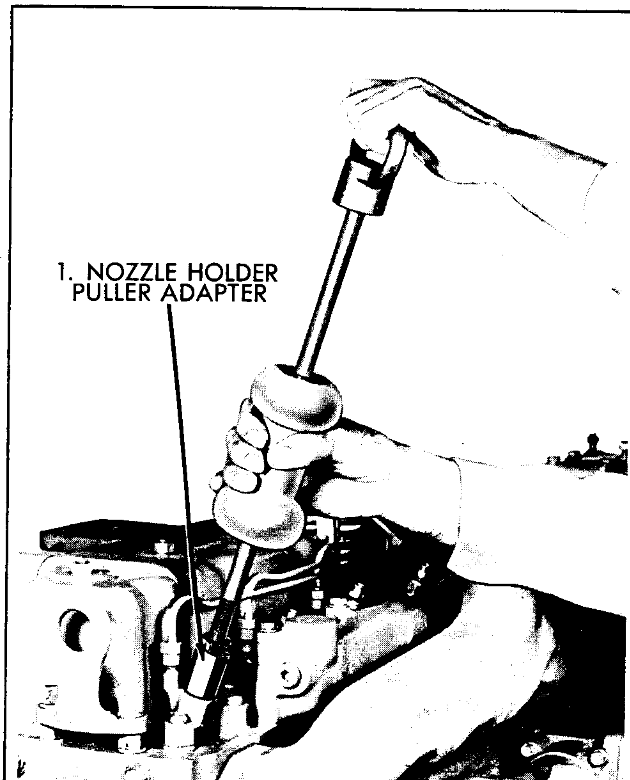


Fig. 8 — Removing Fuel Injection Nozzle-Holder

4. If for any reason the nozzle-holder assembly is stuck in the cylinder head, a nozzle-holder puller adapter and slide hammer puller (similar to the ones shown in Fig. 8) can be used to pull the fuel injection nozzle-holder assemblies.

   a. Remove the holder cap nut, turn the puller adapter onto the holder as shown. NOTE: *Be certain that the puller adapter is turned onto the holder as far as possible, then tighten it with a wrench.*

   b. Turn the end of the slide hammer into the puller adapter as shown. Before pulling the nozzle-holder from the cylinder head, bump inward (lightly) on the holder with the slide hammer to loosen the nozzle-holder, then pull the nozzle-holder assembly from the cylinder head. CAUTION: *Use care when removing a nozzle-holder assembly to prevent marring the nozzle tip.*

   c. Remove the slide hammer puller and nozzle-holder puller adapter. Reinstall the holder cap nut on the holder.

5. If all fuel injection nozzle-holders are to be removed for inspection, the removal can be accomplished in a shorter time if the engine intake manifold is removed from the engine and the fuel injection lines with their clamps and brackets are removed as an assembly.

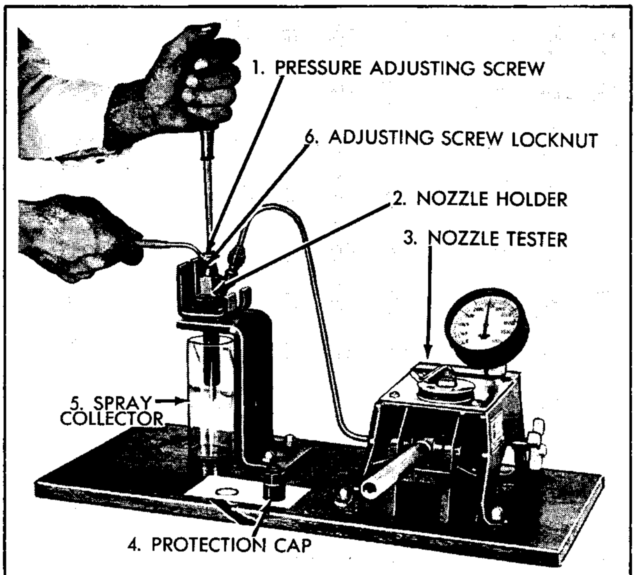


Fig. 9 — Adjusting "Popping" Pressure of Nozzle-Holder

E. Testing and Adjusting of Fuel Injection Nozzle-Holders

1. Testing and Adjusting

To properly test and adjust the fuel injection nozzles for the specified "popping" pressure, a nozzle tester similar to the one shown in Figure 9 is required. Test and adjust each nozzle-holder as follows:

a. Bolt the nozzle tester to a work bench or clamp it in a vise.

b. Turn the valve of the nozzle tester to the open position. Loosen the tester filler cap to prevent an air lock in the tester. Operate the tester handle until fuel flows from the tester fuel line, then close the tester valve.

c. Install the fuel injection nozzle-holder on the nozzle tester as shown.

d. Open the valve of the nozzle tester. Operate the tester handle a few quick strokes and observe the "popping" pressure of the fuel injection nozzle, indicated by the pressure gauge of the nozzle tester. The specified "popping" pressure is 2500 PSI plus or minus 50 PSI. If the specified "popping" pressure is not obtained, adjustment of the nozzle is necessary. Adjust as follows:

   (1) Remove the nozzle holder cap nut and loosen the adjusting screw locknut.

   (2) While operating the tester handle, turn the pressure adjusting screw IN to increase or OUT to decrease the pressure as necessary to obtain the specified "popping" pressure. When the specified "popping" pressure is obtained, hold the adjusting screw with a screwdriver and tighten the adjusting screw locknut to a torque of 15-18 lbs. Install and tighten the nozzle-holder cap nut to a torque of 26-33 lbs.

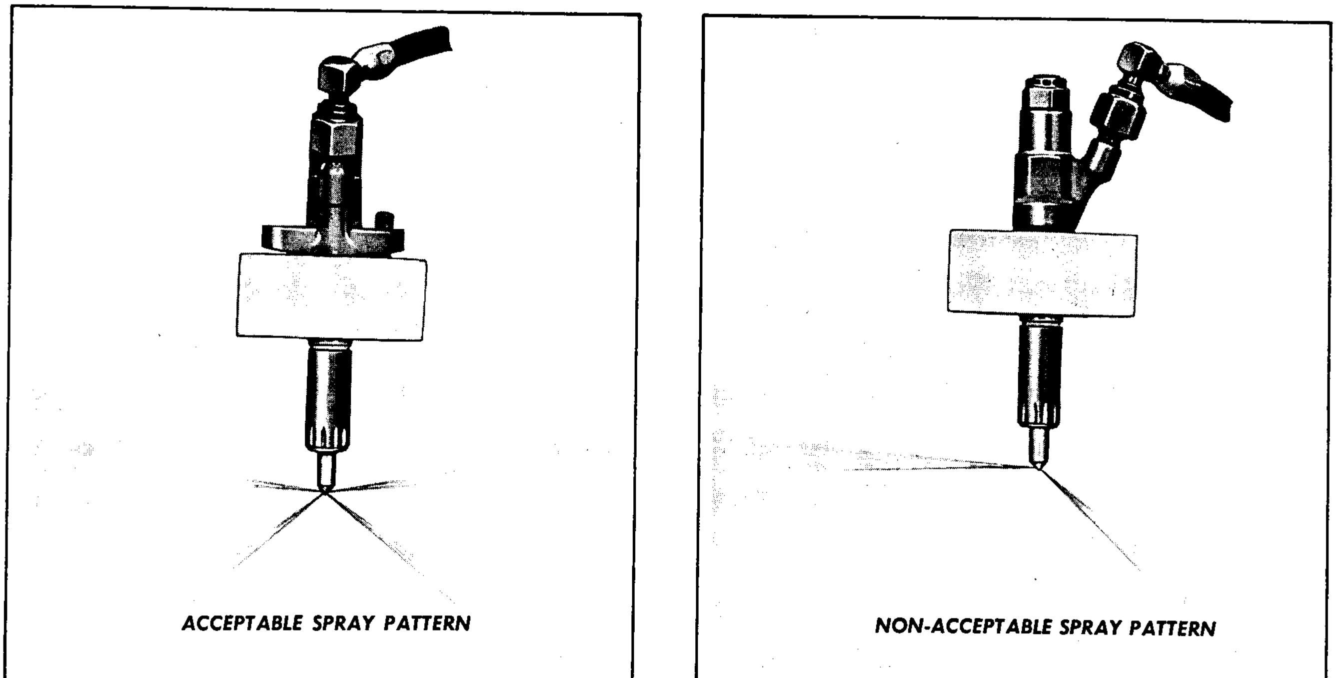


Fig. 10 — Nozzle Spray Patterns

CAUTION: *Always keep hands away from the nozzle tip when "Popping" a fuel injection nozzle because the finely atomized fuel from the nozzle tip is ejected with such force that it will penetrate the skin and may cause blood poisoning.*

e. After adjusting the fuel injection nozzle for the specified "popping" pressure, test the nozzle as follows:

(1) Wipe the tip of the nozzle dry and watch it for about a minute, keeping the pressure about 200 pounds below the "popping" pressure. Observe the tip of the nozzle for fuel leakage. If no leakage is observed, the valve is seating properly on the seat in the valve body. If any fuel leakage is observed at the tip, the valve is not seating properly in the valve body and the nozzle MUST be removed for cleaning and inspection.

(2) If the fuel injection nozzle proved satisfactory when subjected to the leakage test above, operate the tester handle at a speed of approximately 100 strokes per minute and observe the nozzle spray pattern.

2. Nozzle Spray Pattern

The nozzle tip has four equally spaced .30 mm holes. The size and spacing of these holes determine the spray pattern. If fuel is being discharged evenly through all four holes in the nozzle tip at the specified popping pressure, the spray pattern is considered satisfactory. If fuel is not being discharged evenly from all four holes in the nozzle tip, a plugged hole or holes is indicated; then the nozzle must be removed and the holes cleaned, using a .011" diameter wire as shown in Fig. 11.

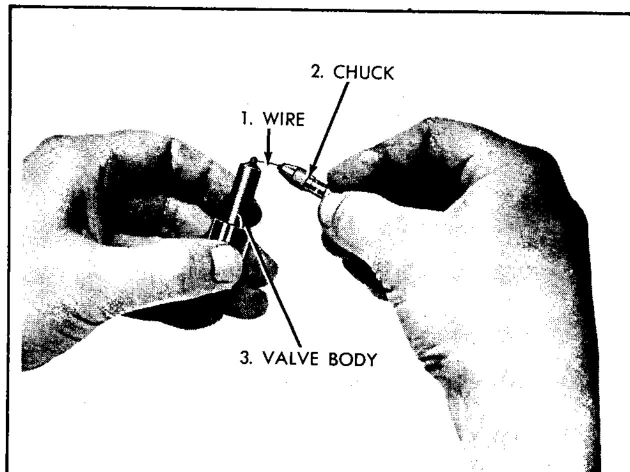


Fig. 11 — Cleaning Nozzle Orifices

F. Cleaning and Inspection of Fuel Injection Nozzle-Holder

Before starting to disassemble a fuel injection nozzle-holder, it is of utmost importance to have a clean work bench, clean washing fluid containers, clean tools, and clean hands. Cleanliness is emphasized because injection nozzle service troubles are, in most instances, due to dirt entering the nozzles. Use clean paper on the work bench and as the nozzle-holder is disassembled, place the components in a container of clean diesel fuel as a protection against dirt and corrosion.

When more than one fuel injection nozzle-holder is disassembled, keep the parts of each separate. Complete disassembly of the injection nozzle holder is seldom necessary. The nozzle valve and the nozzle valve body are mated parts, and they must be kept together; if replacement of either part is necessary, both parts must be replaced as matched sets.

1. Removal, Cleaning, and Installation of Fuel Injection Nozzle

In most cases where service to a fuel injection nozzle-holder is necessary, only the removal and cleaning of the nozzle (valve body and valve) is required to place the nozzle-holder in good operating condition. Remove, clean, and inspect the valve body and valve as follows:

a. Before disassembly, thoroughly wash the injection nozzle-holder to remove any loose dirt or carbon.

b. Place the nozzle-holder on an injection nozzle-holding fixture similar to the one shown in Fig. 14, then clamp the holding fixture in a vise.

c. Remove the holder cap nut from the upper end of the holder. Loosen the adjusting screw locknut and turn the adjusting screw out sufficiently to release the tension on the pressure adjusting spring.

d. Using a suitable socket or box wrench, loosen and remove the nozzle retaining nut. Remove the nozzle from the retaining nut. Start the retaining nut back into the holder, to protect the lapped end of the holder.

e. Withdraw the valve from the valve body and place them in "Allis-Chalmers" carbon and rust remover solution for cleaning. Normally, the valve can easily be withdrawn from the valve body; however, in some cases it may be necessary to soak the nozzle in the carbon and rust remover solution, before the valve can be withdrawn. CAUTION: *Do not allow the solution to get on the hands or body, use tweezers or the basket method to handle the parts. The parts generally can be separated in two or three minutes; however, for stubborn cases they can be left in the solution longer.*

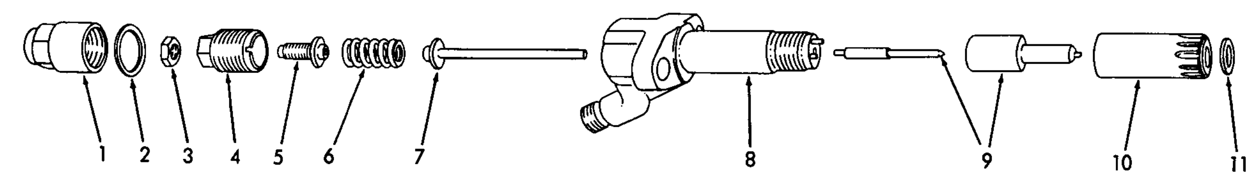
   After removing the parts from the solution, rinse at once in water, dry and immerse in flushing oil or fuel oil. Always handle the parts carefully to protect the lapped surfaces.

f. The valve seat and the seat in the valve body are originally ground to slightly different angles to provide a line contact seat between the two parts. Practically all of the wear occurs in the seat in the valve body. The valve should never be lapped to the seat in the valve body.

   (1) Using a magnifying glass, inspect the condition of the seat in the valve body. If the seat is damaged or worn in any way to prevent proper seating of the valve, the nozzle must be replaced. Examine the lapped bore in the valve body for any signs of scoring. If scoring is apparent, the nozzle must be replaced.

   The outer surfaces of the valve body may be cleaned with a brass wire brush. Do not scrape carbon from the surface around the orifices in the tip of the valve body with any hard object because damage may result.

   (2) Visually inspect the condition of the



1. CAP
2. CAP GASKET
3. LOCKNUT
4. SPINDLE NUT
5. ADJUSTING SCREW
6. SPINDLE SPRING
7. SPINDLE
8. HOLDER BODY
9. NOZZLE ASSEMBLY
10. NOZZLE RETAINING NUT
11. NOZZLE HOLDER GASKET

Fig. 12 — Fuel Injection Nozzle-Holder Details

valve, preferably with the aid of a magnifying glass. The lapped surface (large O.D.) of the valve must be smooth and free of any signs of scoring. Also, the valve must not show any wear or damage at the seat location. If the valve is damaged in any way, the nozzle must be replaced.

g. Thoroughly rinse the valve and the valve body in clean diesel fuel or calibrating oil. The valve must fit freely in the valve body. To check this fit, lift the valve about one-third of its length out of the body. The valve should slide down to its seat without aid when the assembly is held at 45 degree angle.

   If the fit of the valve in the valve body is unsatisfactory, the valve may be cleaned and polished with "Allis-Chalmers" 900G compound and castor oil used on tissue paper. The valve may be held by its stem in a revolving chuck for this cleaning operation. An orange stick or round toothpick will be helpful in cleaning the valve.

   Hard or sharp tools, emery cloth, crocus cloth, jeweler's rouge, grinding compounds, or other abrasives should never be used in cleaning.

h. Thoroughly rinse the valve in clean diesel fuel before installing it in the valve body.

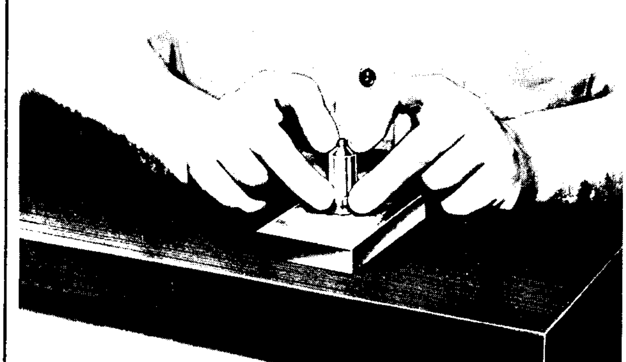


Fig. 13 — Lapping Fuel Injection Nozzle Valve Body

i. Examine the flat sealing surface of the valve body (surface which contacts the lower end of the holder body) and be certain that the surface is clean and free of scratches. This surface may be lapped, if necessary, using "Allis-Chalmers" 900G compound, castor oil, and a lapping block as shown in Fig. 13. After lapping, remove all traces of the lapping compound with clean diesel fuel.

j. Be certain that the bottom flat sealing surface of the nozzle holder is clean and in good condition. Rinse the valve and the valve body in clean diesel fuel, then insert the valve in the valve body. Place the nozzle on the two dowels of the nozzle holder and center the nozzle with the holder. Lower the nozzle retaining nut over the valve body. Tighten the nut to a torque of 44 to 58 lbs. ft. NOTE: *Pressure adjusting screw must be completely backed out prior to this assembly, otherwise dowels may damage nozzle seal face.*

k. Adjust and test the fuel injection nozzle (refer to Par. E, "Testing and Adjusting of Fuel Injection Nozzle-Holders").

2. Disassembly, Cleaning and Assembly of Fuel Injection Nozzle-Holder

If the malfunctioning fuel injection nozzle-holder was not corrected by the removal and cleaning of the nozzle (valve body and valve), disassemble and clean the injection nozzle holder as follows:

a. Remove the holder cap nut and gasket from the upper end of the nozzle holder, loosen and remove the adjusting screw lock nut.

b. Using a 17mm socket and tee handle and an injection nozzle holding fixture similar to the ones shown in Fig. 14, remove the spring retainer. Remove the (spindle) pressure adjusting spring and spindle from the holder.

c. Remove the nozzle retaining nut, then remove the nozzle (refer to Step 1 above).

d. Place all of the parts in clean diesel fuel. Using filtered compressed air, blow out the fuel passages in the holder.

e. Visually inspect the parts for damage or wear and replace worn or damaged parts. Examine the flat sealing surface or the holder (surface which contacts the upper end of the valve body) and be certain that the surface is clean and free from scratches.

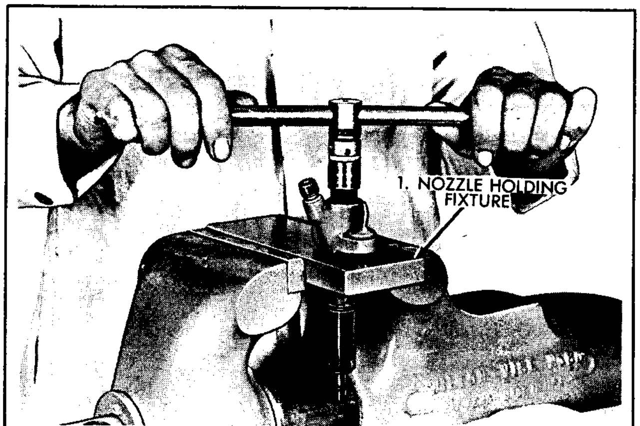


Fig. 14 — Removing Spring Retainer from Fuel Injection Nozzle Holder

Examine the (spindle) pressure adjusting spring. If the spring is scratched or pitted, it must be replaced. Also, the spring must be replaced if the ends have worn from contact with the spring seats. Always replace questionable springs.

f. Rinse the spindle in clean fuel and insert it in the holder. Place the spindle spring on the spindle. Start the spring retainer (with adjusting screw) into the holder. Tighten the retainer securely (36 to 44 lbs. ft. torque). NOTE: *Pressure Adjusting Screw must be completely backed out.*

g. Install the nozzle and the nozzle retaining nut (refer to Step 1 above).

h. Install the adjusting screw locknut and the nozzle holder cap nut (with gasket) but do not tighten at this time as the nozzle-holder assembly must be placed on a nozzle tester and adjusted for the specified "popping" pressure.

i. Adjust and test the fuel injection nozzle-holder (refer to the procedure in Par. E, "Testing and Adjusting of Fuel Injection Nozzle-Holder"). After testing and adjusting, tighten the nozzle-holder cap nut to a torque of 26 to 33 lbs. ft.

G. Installation of Fuel Injection Nozzle-Holder in Engine

Inspect the fuel injection nozzle-holder recess in the cylinder head to be certain that the old nozzle-holder gasket was removed.

1. Thoroughly clean the inside of the injection nozzle sleeves in the cylinder heads before inserting the nozzle-holders. Be certain that no small particles of carbon are present in the nozzle sleeve which would prevent the nozzle-holder gasket from seating properly, thereby permitting "blow-by" from the cylinder.

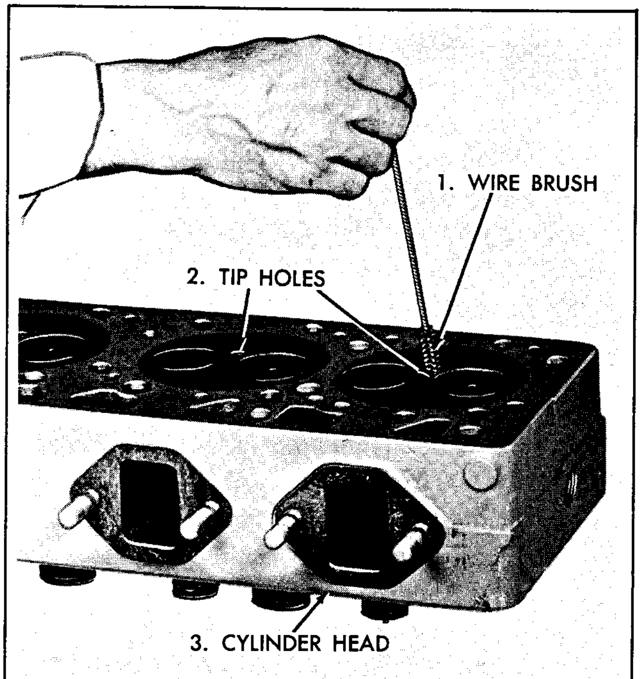


Fig. 15 — Cleaning Fuel Injection Nozzle Tip Hole

When the cylinder heads have been removed from the engine, it is advisable to use carbon removing tool similar to the one shown in Fig. 16 to clean any carbon deposits from the sleeves before installing the cylinder heads on the engine. A wire brush similar to the one shown in Fig. 15 may be used to clean the carbon from the nozzle tip hole in the cylinder heads before the cylinder heads are installed on the engine. Under no circumstances should an engine be operated with a leaky or "blowing-by" nozzle-holder; this will cause a localization of heat which will distort the nozzle-holder, resulting in serious damage.

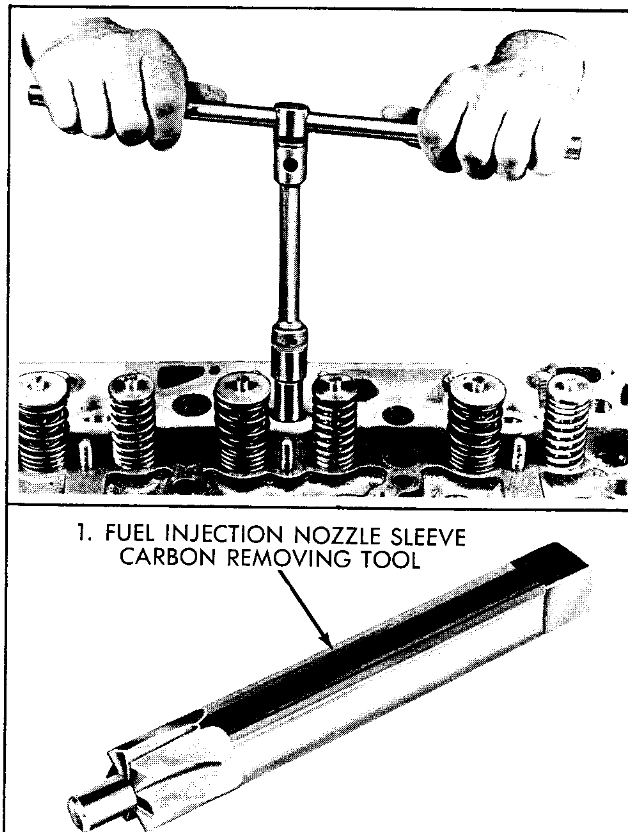


Fig. 16 — Cleaning Carbon from Fuel Injection Nozzle Sleeve

2. Place a new nozzle-holder gasket on each nozzle and carefully insert the nozzle-holders in the injection nozzle sleeves in the cylinder heads.

3. Tighten the nozzle-holder nuts to a torque of 18 to 21 lbs. ft.

5. FUEL INJECTION NOZZLE SLEEVES

A. Description

The bore in the cylinder head for each fuel injection nozzle-holder extends directly through the cylinder head water jacket. To prevent the engine coolant from contacting the fuel injection nozzle-holder, a stainless steel sleeve is pressed into the cylinder heads at each fuel injection nozzle bore. The sleeve forms a water tight receptacle for the fuel injection nozzle-holder. The coolant in the cylinder head flows around the stainless steel sleeve and helps to cool the fuel injection nozzle-holder.

B. Removal of Fuel Injection Nozzle Sleeve

Whenever the cylinder heads are removed from the engine, the fuel injection nozzle sleeve should be thoroughly cleaned (refer to Fig. 16) and inspected. If the condition of the nozzle sleeve is such that replacement is necessary, the sleeve may be removed as follows:

1. Using tools similar to the ones shown in Fig. 17, screw the tap (⅞") down into the sleeve as shown in Fig. 18.

2. Insert the driving rod through the nozzle tip hole in the bottom of the cylinder head, and using a hammer, drive the nozzle sleeve out of the cylinder head.

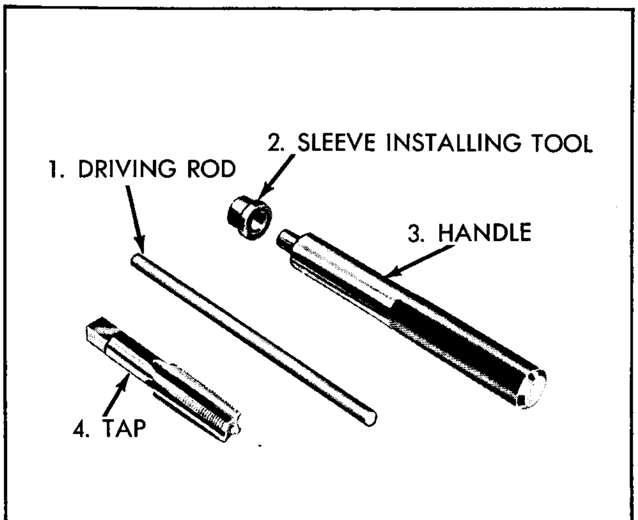


Fig. 17 — Fuel Injection Nozzle Sleeve Removing and Installing Tool Details

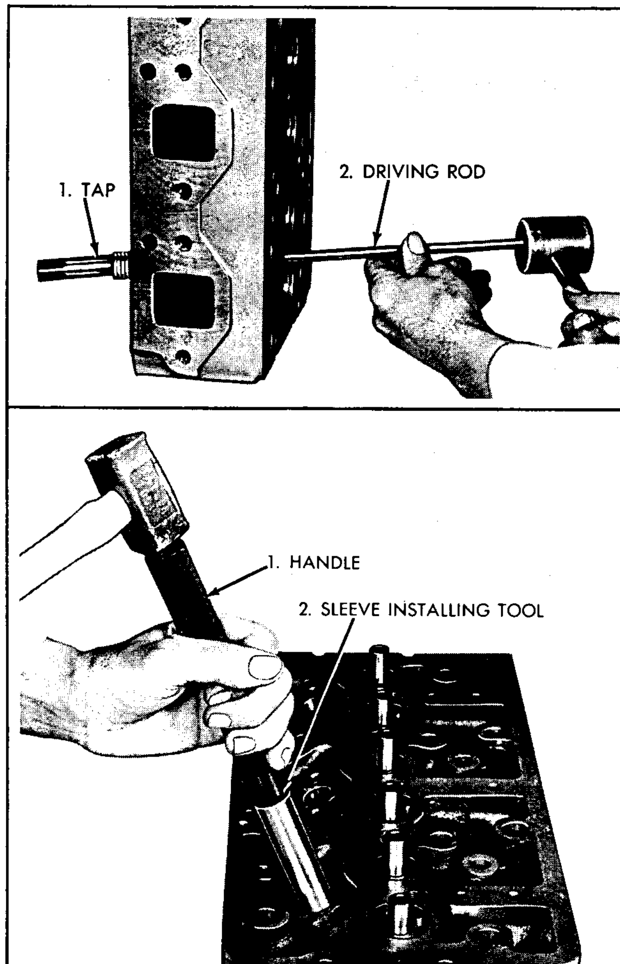


Fig. 18 — Removing and Installing Fuel Injection Nozzle Sleeve

Fig. 18-A — Applying Sealant to Nozzle Sleeve

C. Installation of Fuel Injection Nozzle Sleeve

1. Thoroughly clean the bore in the cylinder head for the fuel injection nozzle sleeve.

2. Clean the new nozzle sleeve with a solvent and dry. Apply sealant to the sleeve at the top and bottom outside surfaces which contact the head. Use Grade "A," "Loctite Sealant" manufactured by American Sealant Company or equivalent. See Fig. 18-A.

3. Install the nozzle sleeve in the head, with the end of the sleeve having the larger O.D. toward the top. Using tools similar to the ones shown in Figure 17 and Figure 18, drive the nozzle sleeve into the cylinder head until it bottoms solidly in the bore.

4. Install the cylinder heads on the engine (refer to Section VIII).

6. REPLACEMENT AND TIMING OF FUEL INJECTION PUMP

A. Removal of Fuel Injection Pump

Before removing the fuel injection pump from the engine, be certain that the No. 1 piston (piston nearest fan) is near the top on its compression stroke. CAUTION: *Be certain that the engine fuel supply is shut off at the fuel tank.*

1. Remove the engine hood and side panels. Thoroughly clean the cylinder head covers and the surrounding area. Remove the cylinder head covers from the engine.

2. Remove the timing hole cover from the upper right side of the engine flywheel housing.

3. Crank the engine intermittently with the starter until the No. 1 piston is approaching top dead center on its compression stroke. This can be determined by observing the valves for No. 1 cylinder. With both valves closed (valve push rods at the bottom of their travel), crank the engine by hand using a suitable socket wrench on the crankshaft pulley retaining capscrew until the F.P.I. mark stamped on the engine flywheel is aligned with the timing pointer.

4. Remove the fuel injection pump timing access cover from the timing gear housing. With the F.P.I. timing marks on the engine flywheel aligned with the timing pointer, the fuel injection pump timing pointer should be in alignment with the center timing marks on the pump drive gear hub.

5. Disconnect the throttle control rod from the governor speed control lever. Disconnect and remove the fuel shut-off rod.

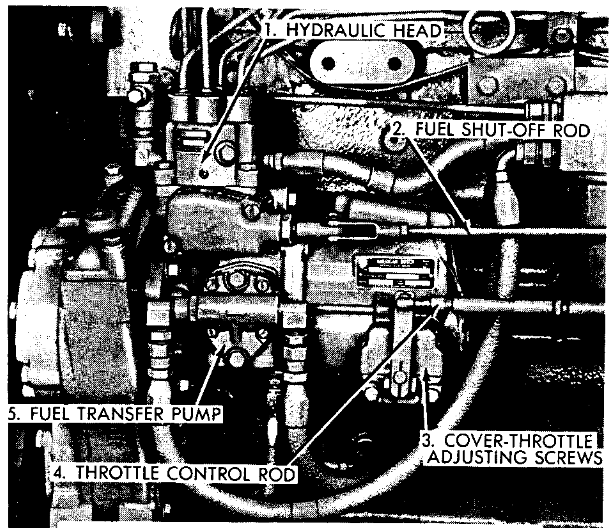


Fig. 19 — Fuel Injection Pump Installed

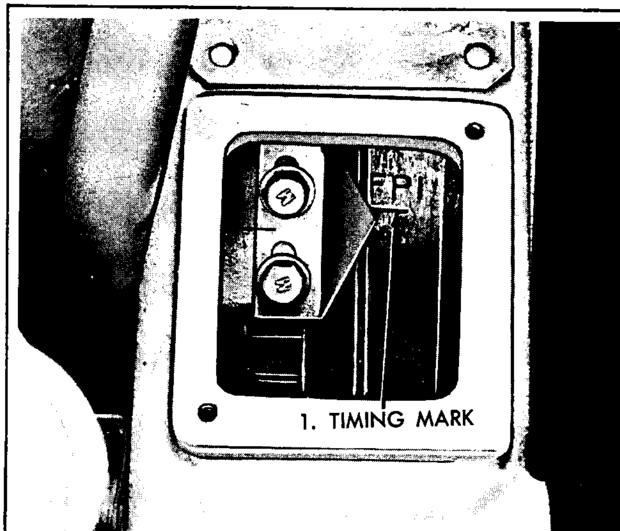


Fig. 20 — Fuel Injection Pump Timing Mark on Engine Flywheel

6. Disconnect and remove the fuel transfer pump inlet and outlet lines. Disconnect and remove the fuel injection pump lubricating oil line.

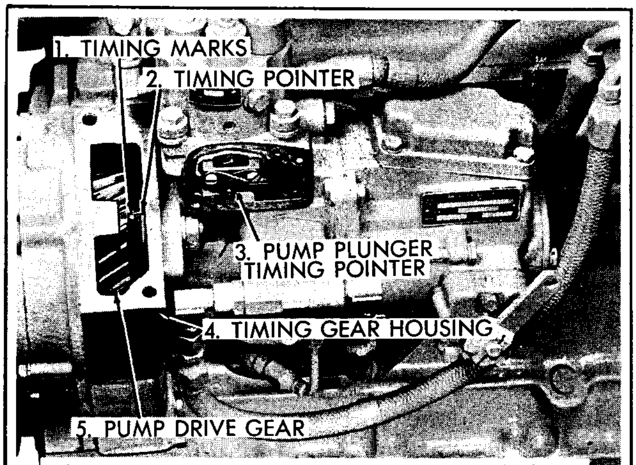


Fig. 21 — Fuel Injection Pump Timing Pointer

7. Disconnect and remove the fuel return line and the fuel inlet line from the fuel injection pump.

8. Disconnect the fuel return manifold from the fuel pressure relief valve. Disconnect all the fuel injection lines from the top of the fuel injection pump, using a 11/16" crow's foot with a 3/8" drive extension, as illustrated in Fig. 22. IMPORTANT: *Cap all fuel openings to prevent the entrance of dirt.*

9. Remove the pump drive gear access cover from the timing gear housing cover. Remove the pump drive gear attaching capscrews and remove the drive gear serrated plate. Withdraw the pump drive gear. NOTE: *When the fuel injection pump is mounted on the engine there is spring pressure on the cam of the pump camshaft. Upon removal of the drive gear attaching capscrews, the pump camshaft will rotate counter-clockwise from the spring pressure. A camshaft holding tool (shown in Fig. 24) is available to hold the cam in its proper timed position. The tool can be fastened to the pump upon removal of the fuel supply pump.*

10. Remove the three pump attaching stud nuts and lockwashers. Remove the fuel injection pump and governor as a unit.

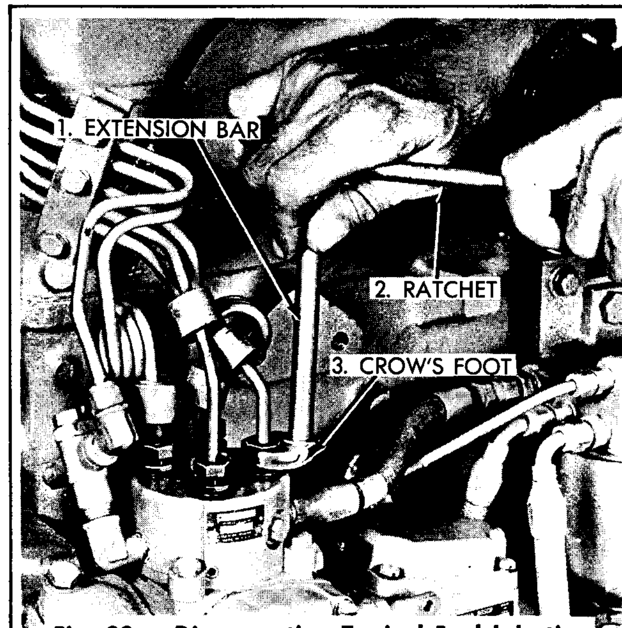


Fig. 22 — Disconnecting Typical Fuel Injection Lines from Fuel Injection Pump

B. Installation and Timing of Fuel Injection Pump

1. Remove the timing window cover from the fuel injection pump. One tooth of the plunger drive gear is marked (painted red) for timing the fuel injection pump for injection of fuel to the No. 1 cylinder. Turn the drive gear hub of the fuel injection pump until the marked tooth of the plunger drive gear is positioned approximately the distance of one tooth to the REAR of the timing pointer in the pump housing, then hold the drive gear hub stationary. While holding the drive gear hub in the above position, the center timing mark on the drive gear hub should be in alignment with the timing pointer. When the drive gear hub is released for installation of the pump on the engine, the spring pressure on the cam of the pump camshaft will rotate the pump drive gear hub slightly in the counter-clockwise direction.

   NOTE: *When the special holding tool is used, the fuel injection pump drive gear hub and the timing pointer will remain in*

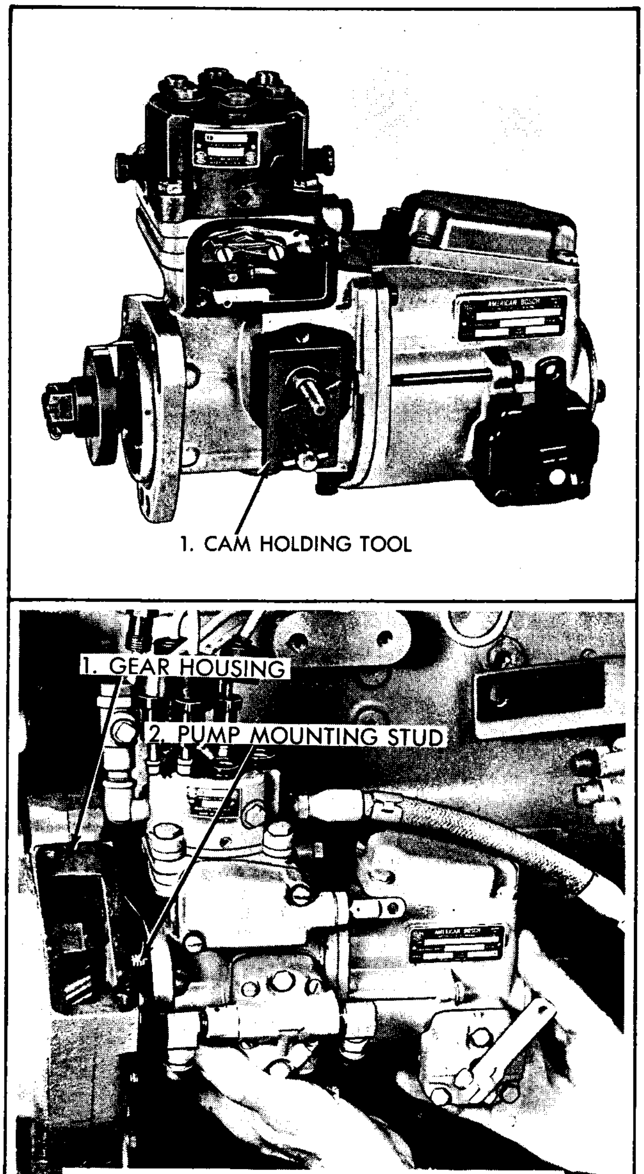


Fig. 23 — Removing Fuel Injection Pump from Engine

the proper position while installing and securing the pump drive gear to the pump drive gear hub with a wrench.

2. With the No. 1 piston near the top on its compression stroke (valve push rods at the bottom of their travel) and with the timing mark stamped on the engine flywheel aligned with its timing pointer, the engine is properly positioned for the installation of the fuel injection pump.

3. Install the O-ring gasket in the pump mounting flange. Install the fuel injection pump on the engine and secure the pump to the engine with the pump attaching stud nuts and lockwashers.

4. Install the pump drive gear on the pump drive gear hub. Install the drive gear serrated plate and start the pump drive gear attaching capscrews, but do not tighten at this time. NOTE: *The attaching holes in the pump drive gear are elongated so that the pump drive gear hub can be turned slightly to properly time the fuel injection pump.*

5. Insert a wrench on the pump drive gear hub retaining nut and turn the nut to align the CENTER timing mark on the drive gear hub with its timing pointer (Fig. 24). While holding the CENTER timing mark on the drive gear hub in alignment with its timing pointer, tighten the three pump drive gear attaching capscrews.

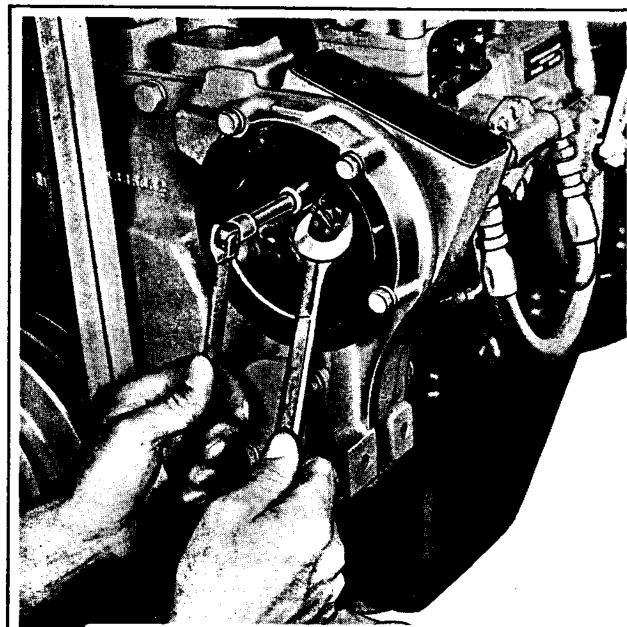


Fig. 24 — Centering Timing Mark on Drive Gear Hub

6. Install the timing window cover and gasket on the fuel injection pump.

7. Connect the fuel injection lines to their corresponding fittings in the top of the fuel injection pump. Tighten the fuel injection line nuts to a torque of 25 to 27 lbs. ft. Connect the fuel return manifold to the fuel pressure relief valve.

8. Connect the fuel injection pump inlet line to the fuel injection pump.

9. Install the fuel return line. Install the fuel transfer pump inlet and outlet line to the fuel transfer pump. Install the fuel injection pump lubricating oil line.

10. Connect the throttle control rod to the governor speed control lever. Install the shut-off assembly.

11. Install the timing hole cover on the engine flywheel housing.

12. Install the cylinder head covers being certain the gasket is in good condition. Install the engine hood and side panels.

13. Turn the fuel tank shut-off valve to its open position. Vent the fuel system (refer to Topic 7 below).

7. VENTING OF FUEL SYSTEM

A. Venting of Low Pressure Fuel System

Vent the first stage and the second stage fuel filters and the low pressure fuel lines as follows:

1. Remove the vent screws located in the shell retaining nuts of the fuel filters.

2. Crank the engine with the starter until a full stream of fuel (free of bubbles) flows from the vent screw opening. Install and tighten the vent screw while continuing to crank the engine.

B. Venting of High Pressure Fuel System

The high pressure fuel system is usually self-venting, due to the fact that any air trapped by the fuel injection pump is forced out through the fuel injection nozzles and into the combustion chambers. However, if the fuel lines have been removed, the engine has run out of fuel, or the unit has not been operated for some time, venting of the high pressure system may be necessary to facilitate starting of the engine.

Vent as follows:

1. Loosen the fuel line connection nut attaching each fuel injection line to its corresponding fuel nozzle-holder.

2. Pull the throttle operating lever back to the high speed position.

3. Crank the engine with the starter until fuel flows from the ends of all the high pressure fuel lines. Connect the fuel injection lines to the fuel nozzle-holders and tighten the fuel line connection nuts.

8. GOVERNOR

A. General

The governor is integral with the fuel injection pump and is adjusted and sealed by the factory to provide the proper horsepower at a full load governed speed. The recommended low idle speed is 600 R.P.M. The recommended high idle speed is 2375 to 2425 R.P.M.

B. Checking Engine Speed

1. The governor very seldom gets out of working order. If the engine speed is irregular, check the fuel system and all other engine adjustments before changing the governor setting.

   Operate the engine until temperature is stabilized (170° F.) minimum. Position throttle operating lever to both the low and high speed positions and be certain that the throttle control linkage is adjusted to insure the full arc of travel. Check the low idle and full load speeds while the engine is under load.

   If the engine speeds are not within the specified ranges, it will be necessary to adjust the governor.

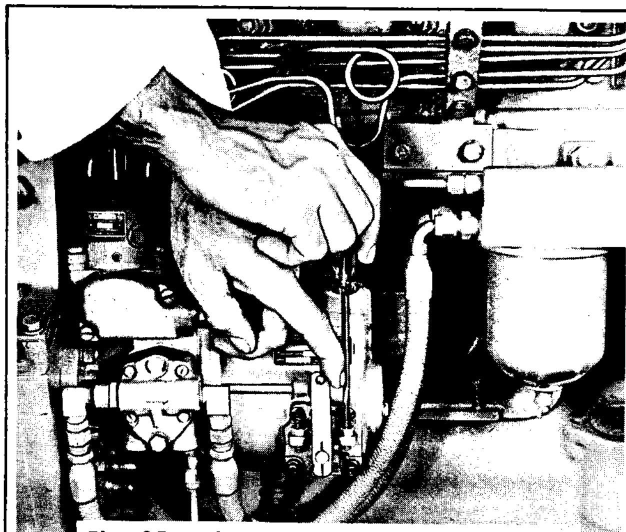


Fig. 25 — Governor Speed Adjustments

C. Low Idle and High Idle Speed Adjustments

1. Remove the speed adjusting screw access cover from the governor.

2. Disconnect the throttle from the governor speed control lever, so that the lever may be moved by hand.

3. With the engine running, loosen the jam nut on the low idle adjusting screw. Hold the governor speed control lever toward the front so that the control lever shaft stop plate contacts the low idle adjusting screw. Turn the low idle adjusting screw *IN* as necessary to increase or *OUT* as necessary to decrease the low idle speed. When the low idle speed is within the specified range, hold the low idle adjusting screw and tighten the jam nut.

4. With the engine running, loosen the jam nut on the high idle adjusting screw. Hold the governor speed control lever toward the rear so that the control lever shaft stop plate contacts the high idle adjusting screw. Turn the high idle adjusting screw *OUT* as necessary to increase or *IN* as necessary to decrease the high idle speed. When the high idle speed is within the specified range, hold the adjusting screw and tighten the jam nut.

5. Install the speed adjusting screw access cover on the governor.

6. Connect the throttle to the governor speed control lever. Be certain the throttle movement covers the full arc of travel from idle to high speed.

9. ENGINE CONTROLS

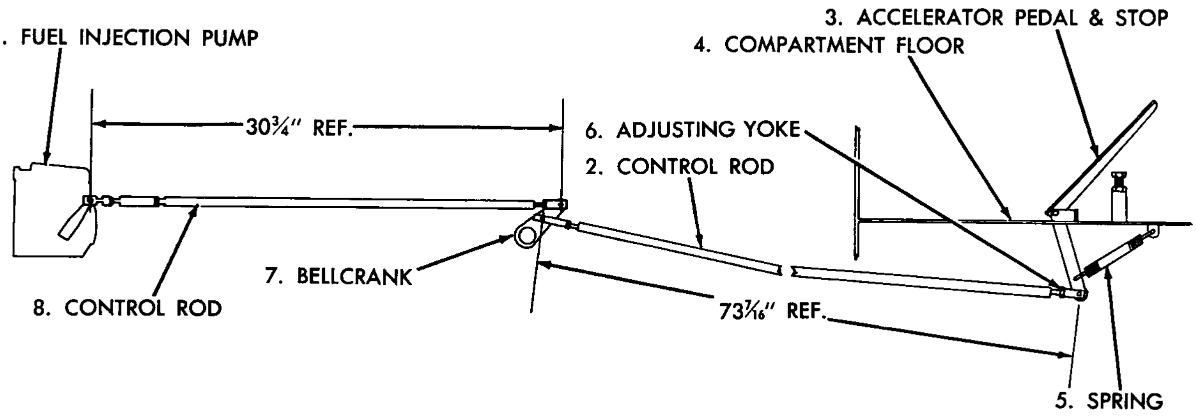


Fig. 26 — Accelerator Pedal and Linkage

The accelerator pedal is used to regulate the speed of the engine. Control rods and linkage connect the accelerator pedal to the throttle shaft assembly on the governor. The engine runs at full governed speed when the throttle shaft assembly is pushed all the way back, and runs at idling speed when the throttle shaft assembly is pulled all the way forward. The accelerator pedal is located on the right side of the operator's compartment; hinged to the floor plate by a pin. The accelerator pedal is connected to the throttle shaft assembly by a long rod, a bellcrank assembly and then a short rod. Both rods have adjustable yokes (Fig. 26).

The short rod should be adjusted so that when the accelerator pedal is fully released the fuel injection pump throttle shaft assembly is in the low idle position. The long rod should be adjusted so that the stop rod inside of the pedal return spring touches both the floor plate anchor lug and the accelerator pedal lever when the accelerator pedal is fully released. A capscrew and locknut comprise a stop for the high idle position of the accelerator pedal and should be adjusted so that the accelerator pedal allows the throttle shaft assembly of the fuel injection pump to operate to the full high idle position.

Improper adjustment of these control rods may result in loss of engine speed. Refer to Fig. 26 for the approximate lengths (center to center of yoke pins) of the control rods, when making adjustment. Lengthen or shorten the control rods as necessary by turning the yokes on the ends of the control rods.

SECTION III — ENGINE AIR INTAKE SYSTEM

3

1. DESCRIPTION OF SYSTEM

The air intake system is designed to supply filtered air to the engine, and the air brake compressor unit in a greater quantity than required by naturally aspirated engines. The air cleaner filters abrasive materials from the air before it enters the cylinders or the air brake compressor unit. The turbocharger increases the supply of air normally required by the engine. This allows the engine to burn more fuel and in turn produce more power.

After passing through the rain cap, air enters the air cleaner through a pipe that extends down through the center of the air cleaner body. At the bottom of the air cleaner body, the air enters the oil cup and is drawn through a screen in the air tray, and into the rust-proof matting in the air cleaner body. Abrasive material is removed from the air as it passes through the oil cup and the matting in the air cleaner body.

The air then flows to the turbocharger which is operated by the engine's exhaust gases. The turbocharger increases the quantity of the air delivered to the engine by compressing the air that is supplied to the engine intake manifold. Air for the air brake compressor unit is supplied from the intake manifold. See BRAKES, Section XII.

Care should be taken to prevent any leaks in the air intake system that will allow abrasive material to enter the engine or the air brake compressor unit. Otherwise, serious damage may result.

2. AIR CLEANER SYSTEM

A. Rain Cap Service

Clean the rain cap whenever dirt and lint have collected on the screen.

1. Loosen the clamp and lift the rain cap from the air cleaner pipe.

2. Wash and brush the screen with a clean solvent or fuel oil. Dry it with compressed air before reinstalling it.

B. Air Cleaner Service

Depending upon operating conditions, the oil cup must be inspected at least daily. The cup must be filled to the level mark with clean non-foaming engine oil to insure proper engine operation.

Whenever the oil becomes discolored, empty and wash the cup and the tray. Then refill the cup to the proper level with clean oil before reinstalling it. Use the same viscosity oil that is used in the engine.

IMPORTANT: *Some engine lubricating oils may foam when used in the air cleaner. These oils reduce the air cleaner's efficiency and may be sucked into the engine and the air brake compressor unit causing serious damage.*

Service the air cleaner as follows:

1. Remove the oil cup and the tray from the air cleaner body. Empty the oil from the cup.

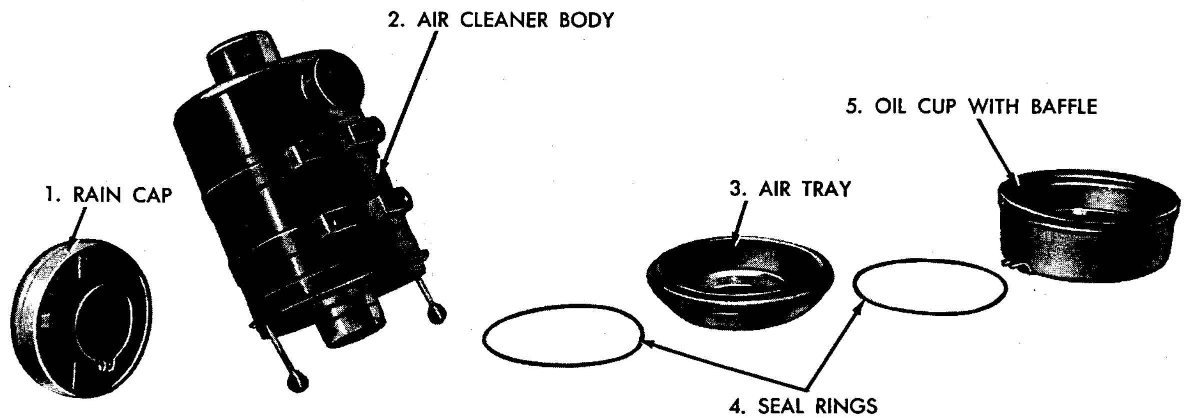


Fig. 1 — Air Cleaner — Disassembled

2. Thoroughly wash the cup and the tray with a clean solvent or diesel oil.

3. Remove the rain cap and swab out the air cleaner pipe. Reinstall the rain cap.

4. Fill the cup to the proper level with clean non-foaming engine oil. Be certain that the gasket is in good condition, and place the tray on the oil cup.

5. With the air cleaner body gasket in good condition, attach the cup and the tray to the bottom of the cleaner body and *hand* tighten the wing nuts. DO NOT USE A WRENCH!

6. Inspect the hose clamps on the air cleaner outlet and turbocharger inlet hoses. If the clamps are loose or if the hoses are crimped, air may enter the engine without being filtered.

7. Once or twice a year (depending upon operating conditions) remove the air cleaner from its mounting and clean the matting. After removing the oil cup and the tray, immerse the air cleaner body in fuel oil or a non-conbustible cleaning solvent, and rinse the matting thoroughly. Allow the cleaning solvent to drain from the matting before reinstalling the cleaner assembly.

3. TURBOCHARGER

A. Description and Operation

1. Description

The turbocharger used on the Allis-Chalmers 11000 engine is essentially an oil cooled exhaust driven blower. Its purpose is to increase the air supply to the engine cylinders. This increased supply of air allows the engine to burn more fuel and in turn produce more power.

The turbocharger consists of a turbine, bearing housing and compressor. The turbine is located at the front of the bearing housing assembly and the compressor at the rear end. A shaft integral with turbine wheel drives the compressor wheel. The shaft is supported in the bearing housing by sleeve type bearings. The compressor wheel and turbine wheel are individually balanced and may be serviced separately.

To facilitate quick repair of the turbocharger in the field, a core assembly is available. It consists of the rotor assembly, bearings, seals, bearing housing, compressor housing, and nozzle back plate, completely assembled.

2. Operation

The turbine utilizes the heat energy from the ex-

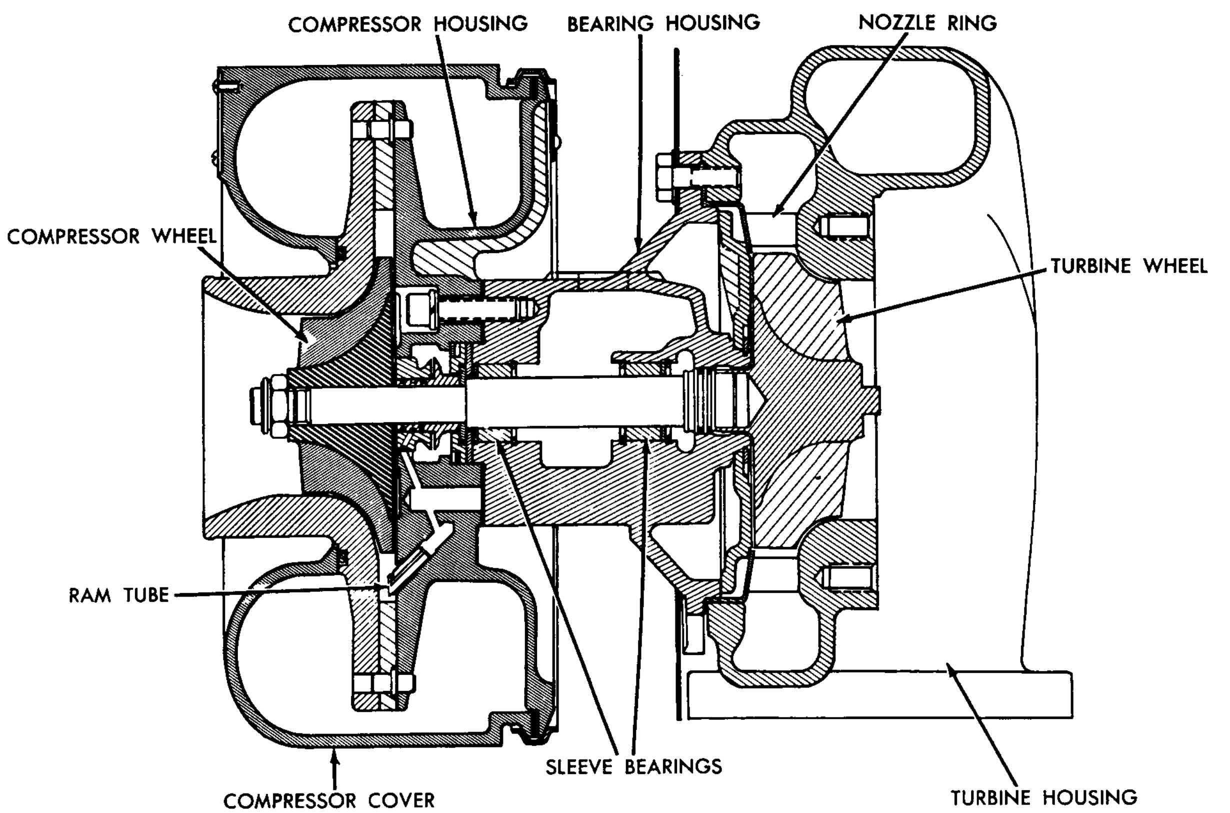


Fig. 2 — Turbocharger — Section View

haust gas. The exhaust gas from the engine enters the turbine housing through a flanged connection in the housing base. The gas flows around the turbine housing and radially inward through a nozzle ring. The nozzle ring imparts a high velocity to the gas before it enters the turbine wheel. The exhaust gas pressure acts upon and drives the turbine wheel. The turbine wheel in turn drives the compressor wheel which is basically a centrifugal blower.

The air enters at the center of the compressor wheel and flows radially outward through a diffuser section into the compressor housing. The air leaves through a tangential outlet on the side of the compressor housing and enters the intake manifold.

The turbocharger is lubricated by engine lubricating oil supplied by an external line extending from the head of the lubricating oil filter to the top of the turbocharger bearing housing. The oil returns to the oil pan through an external oil line extending from the bottom of the turbocharger bearing housing to the side of the cylinder block.

Piston ring type oil seals are located at each end of the shaft. This type seal is used because of its low friction and long life. It is not a positive type seal and will not hold back oil under pressure. However after the oil passes through the bearings it enters a low pressure cavity between the bearings and the seals. These cavities connect to the oil drain opening in the bottom of the bearing housing. In addition to the cavity at the compressor end, an oil flinger revolves with the shaft and a passage (ram tube) enables air pressure in the compressor to enter the area between the seal rings. This pressure will equalize or counteract the slight positive pressure in the cavity and restrict oil from entering the compressor. At the turbine end, the pressure within the turbine housing is greater than the pressure on the cavity side of the seal rings and thus prevents oil from entering the turbine housing.

To avoid damage to the turbocharger and possible disintegration of the turbine wheel from overspeeding when operating the engine at altitudes above sea level, it is important the maximum fuel setting of the injection pump be reduced at the rate of 3% for each 1000 feet above 8000 feet altitude. The reduction of the maximum fuel setting is best accomplished by removing the fuel pump from the engine and adjusting the maximum fuel delivery on an injection pump test stand.

B. Service Inspection and Maintenance

1. Periodic Inspection

Each time the engine lubricating oil and the engine lubricating oil filter elements are replaced, or whenever a routine service operation is performed, inspect the turbocharger as follows:

a. Inspect the hose connections and air inlet tubing between the air cleaner and turbocharger, hose connections and elbow between the turbocharger and the intake manifold for air leaks due to cracks, damaged gaskets, loose clamps; or for restrictions due to dented tubing or collapsed hoses.

b. Inspect for exhaust leakage from the exhaust ports in the heads to turbine housing exhaust gas inlet, due to damaged gaskets, loose turbocharger mounting, loose manifold mounting stud nuts or cracks in the exhaust manifold.

c. Inspect oil inlet and drain lines and fittings for leakage or other damage.

d. Operate the engine at approximate rated output and observe for any unusual vibration or noise which would warrant further inspection of the turbocharger.

e. Note the engine exhaust. Excessive smoke may indicate a restricted air cleaner or intake piping, overfueling or other faulty turbocharger operation.

2. 500 Hour Inspection and Service

After each 500 hours of operation the compressor wheel should be visually inspected for dirt accumulation on the wheel vanes. If the coating of dirt is minor and even, cleaning is not necessary. An uneven build-up of dirt will unbalance the rotor assembly which could lead to failure of the turbocharger, therefore, if the coating of dirt is uneven, excessive or approaching the appearance of a layer which could flake off the wheel, cleaning is necessary. Inspect and clean as follows:

a. Clean turbocharger and surrounding area.

b. Remove turbocharger from engine. Refer to Paragraph C, REMOVAL AND INSTALLATION.

c. Clean compressor wheel. Refer to Paragraph F, CLEANING. CAUTION: *A poor cleaning job, leaving deposits on the wheel, is as destructive as an uneven layer of dirt.*

3. 2000 Hour Inspection and Service

A major inspection of the turbocharger should be made after each 2000 hours of operation. This inspection requires removing the turbocharger from the engine and the removal of the compressor cover and the turbine housing from the turbocharger. Inspect the turbocharger as follows:

a. Remove the turbocharger from the engine. Refer to Paragraph C, REMOVAL AND INSTALLATION.

b. Stand turbocharger on bench with shaft in horizontal position and check for free wheel rotation by rotating wheels by hand. If the wheels do not turn freely, several things could be the cause of the trouble: carbon buildup behind turbine wheel, dirt accumulation behind compressor wheel, bearing seized to shaft, dirt causing drag in bearing, bearing worn excessively. Eliminate these conditions by making necessary repairs.

c. Remove the compressor cover and compressor extension. Refer to Paragraph E, DISASSEMBLY OF TURBOCHARGER.

d. Check turbine wheel radial movement as follows:

(1) Clamp unit in vise by turbine housing flange (Fig. 3).

(2) Install the hole attachment on the indicator and fasten to the turbocharger with either a clamp or magnetic type base holder.

(3) Position the indicator contact point against the middle of one of the flats on the square extension of turbine wheel.

(4) Push the turbine wheel against the indicator contact point and at the same time push compressor wheel in the opposite direction.

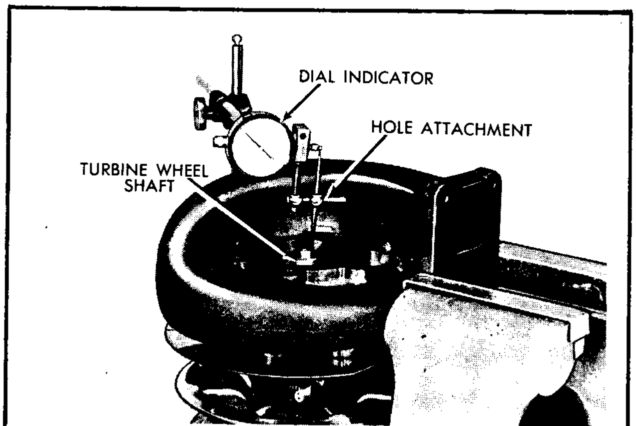


Fig. 3 — Checking Turbine Wheel Radial Movement

(5) With the wheels pushed in these positions oscillate them in both directions until the lowest indicator reading is obtained and note this reading.

(6) Now push each wheel in the opposite direction (180° from the position from which the first reading was taken).

(7) With the wheels pushed in these positions again rotate wheels until the lowest indicator reading is obtained. Note this reading.

(8) The difference between the two readings will be the total wheel movement. This should not exceed .023". Repeat this procedure several times before accepting a final reading.

(9) If the radial movement exceeds .023" it is an indication of shaft and/or bearing wear or the bore in the housing is worn. Unit must be disassembled and repaired.

e. Check shaft end play as follows:

(1) Use either a clamp or magnetic base indicator holder.

(2) Place indicator contact point on end of shaft (Fig. 4).

(3) Move wheels to extreme up position, note indicator reading.

(4) Move wheels in extreme down position, note indicator reading.

(5) The difference between the readings is the end play.

(6) This should be from .004" to .008".

(7) Record the end play. This will be used to determine if thrust washers need to be replaced.

(8) If end play exceeds .008" it indicates that thrust collar faces or thrust washers are worn or distorted. If end play is less than .004" it indicates a carbon build up behind turbine wheel and/or a dirt build up behind compressor wheel. Unit must be disassembled and cleaned and repaired.

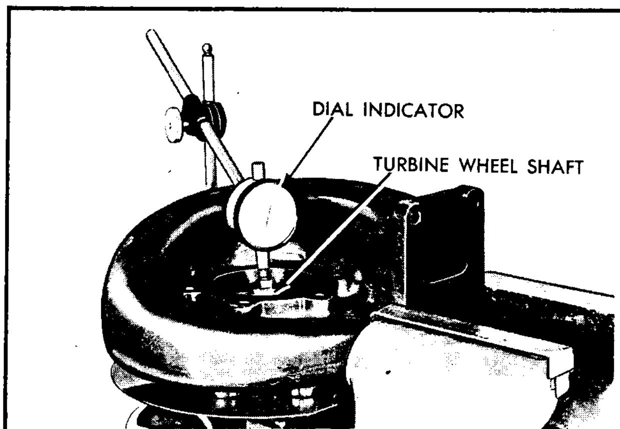


Fig. 4 — Checking Shaft End Play

f. Check compressor wheel radial movement as follows:

(1) Clamp unit in vise by the turbine housing flange with the compressor wheel to the top (Fig. 5).

(2) Check compressor wheel radial movement using the same procedure as outlined in item "d" above covering the checking of the turbine wheel radial movement.

(3) If movement exceeds .023" the cause and correction is the same as for the turbine wheel.

g. Remove turbine housing. Refer to Paragraph E, DISASSEMBLY OF TURBOCHARGER.

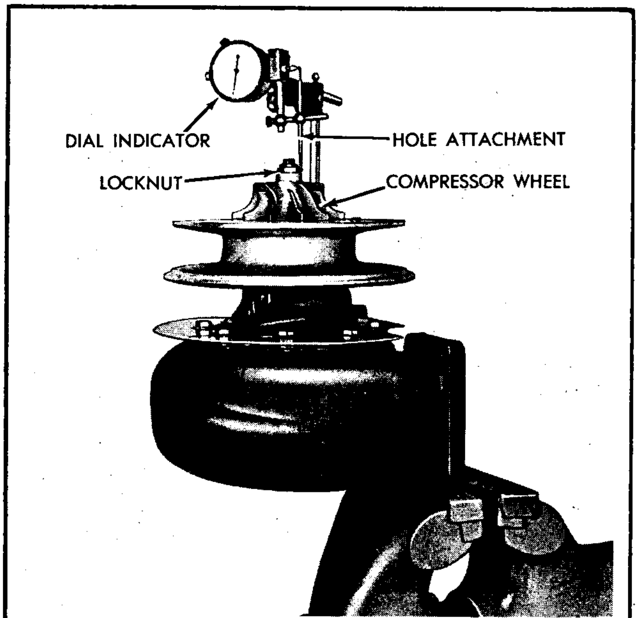


Fig. 5 — Checking Compressor Wheel Radial Movement

h. Inspect compressor cover, compressor extension, compressor wheel, turbine wheel and turbine housing for noticeable dirt accumulation which will impair turbocharger performance. Excessive and uneven build up on the wheels will disturb the precision balance of the rotor assembly. To clean turbocharger refer to Paragraph F, CLEANING.

i. Make a thorough inspection of the compressor wheel and turbine wheel. These parts are precision balanced and a broken or bent blade can throw the assembly out of balance and thereby shorten the life of the turbocharger. Wear appearing on the outer and small diameters of the blades of the wheels indicates bearing and thrust washer wear is excessive. Broken or bent blades indicate large pieces of foreign material have gone through the compressor or turbine. Never attempt to repair a damaged wheel. Replace with new wheel.

j. Inspect nozzle ring for damage and vane spacing. The spacing dimension is stamped on the nozzle ring and a go-no go gauge is available as a special tool. See Paragraph I, TURBOCHARGER SERVICE TOOLS. If the vanes are damaged the nozzle ring should be replaced.

k. If the turbocharger meets the above inspection specifications, it can be reassembled using new gaskets and considered satisfactory.

l. Assemble turbocharger to the engine. Refer to Paragraph C, REMOVAL AND INSTALLATION.

NOTE: *If excessive bearing wear or other damage is believed to have been caused by lack of lubrication, check the flow of oil to the turbocharger with the engine running. Minimum oil flow should be two quarts per minute at 30 PSI and with an oil temperature of 180°F.*

4. Maintenance

Many times the finger of guilt is pointed at the turbocharger when the cause of the trouble is not the fault of the turbocharger, but rather caused by lack of good engine maintenance. For satisfactory turbocharger life special attention must be paid to the following adjustment and maintenance points:

a. Air Cleaner and Intake System

Restriction in the air intake system will cause malfunction of the turbocharger as well as the engine. A clogged air cleaner, deteriorated hose, or hose connection which has collapsed, can cause oil to be pulled past seals on the compressor side of the turbocharger. The restriction (vacuum) should never exceed 30 inches of water at the turbocharger air inlet at engine full speed, full load conditions.

Any restriction in the air intake system which causes the passage of engine oil to the intake air, increases the exhaust temperature. This excessive exhaust temperature is detrimental to the engine, turbocharger turbine wheel, and turbine housing; and can cause the turbine shaft bearing to overheat. If the overheating is not eliminated, it will eventually lead to complete turbocharger failure.

Small leaks in the air intake system caused by loose hose clamps or faulty gaskets, allow dirt to enter the system. This dirt sticks in any oil which is pulled over into the compressor housing and builds up a coat of dirt on the inner surfaces of the housing and the impeller. The coating of dirt, if excessive, will reduce the volume of air drawn into the engine. If the dirt is not distributed evenly on the impeller it will cause an unbalanced condition of the rotating parts.

Lubrication

The engine lubricating oil and engine lubricating oil filter element(s) must be replaced at the specified interval to assure a clean supply of oil to the turbocharger. Many turbochargers have been damaged simply because the operator extended the recommended oil and filter change interval or did not shorten the interval to compensate for adverse operating conditions.

It is important to regularly inspect the oil inlet line and oil return line to make certain all connections are tight, and the lines are not clogged or dented and restricting the free flow of oil.

Loss of engine oil pressure due to worn engine bearings or oil pump failure and clogged turbocharger oil inlet line or restricted oil return line can quickly damage or destroy a turbocharger. CAUTION: *If an engine has been in storage for several months without being operated, it is recommended that the oil inlet connection at the turbocharger be removed and 3 to 4 ounces of lubrication placed in the bearing housing before operating the engine.*

c. Exhaust System

If for any reason the engine is permitted to operate with an exhaust temperature in excess of designed limitations, not only is the turbocharger subject to serious damage, but also the engine. CAUTION: *Under no circumstances should the factory maximum fuel delivery specification for the fuel injection pump be exceeded in order to obtain an increase in power. The resulting damage to the turbocharger and engine will be costly and offset any benefits that might have been derived from increasing the power of the engine.*

The total restriction of the exhaust system must not exceed one (1) inch of mercury back pressure at the turbocharger turbine housing exhaust outlet at engine full speed full load conditions. Excessive back pressure will reduce the turbine speed and subject the turbine to excessive temperatures.

d. Fuel Injection System

It is a known fact that naturally aspirated engines will develop power until nearly all the air is used and beyond this point more power will not be obtained by increasing the fuel supply. A turbocharged engine operates with excess air and when more fuel is added the turbocharger speed increases and supplies still more air. Consequently, it can be easily understood how the progression of a greater amount of fuel to burn with a greater supply of air develops more and more horsepower with increasing exhaust temperature until severe damage is done to the turbocharger and engine.

For this reason it is disastrous to OVER-FUEL a turbocharged engine by exceeding the factory recommended fuel injection pump maximum fuel delivery specification or attempting to set the fuel pump by observing the exhaust smoke, as is the practice with naturally aspirated engines.

Insufficient fuel to the engine will cause low turbocharger speed and lack of power. It is therefore important to service the fuel filters, nozzle and holder assemblies, and check fuel pump timing in accordance with the prescribed engine maintenance schedule. If the fuel injection pump maximum fuel delivery setting is suspected of being incorrect, remove the fuel injection pump from the engine and take it to your "Allis-Chalmers" dealer for checking on an injection pump test stand.

e. Engine Breather System

A clogged engine breather will cause a pressure buildup in the engine. This pressure will prevent the oil from draining down the oil return line and will force oil out the low pressure side of the turbocharger and into the engine air intake system.

C. Removal and Installation

The turbocharger is removed and installed on the engine for one of three reasons: inspection, repair, or overhaul. During the time the turbocharger is removed from the engine, keep all openings in the intake and exhaust manifolds covered. This will prevent foreign objects from accidentally getting into the manifolds and damaging the turbocharger and engine when the engine is again put into operation.

1. Removal

a. Remove the exhaust stack and engine hood.

b. Remove the air cleaner hose connections and connection tube.

c. Remove exhaust outlet elbow and exhaust diffuser.

d. Remove air inlet hose and elbows between intake manifold and turbocharger compressor cover air inlet opening.

e. Remove the oil inlet line.

f. Disconnect and remove oil drain tube.

g. Remove the high temperature, self-locking nuts and washers which secure the turbocharger to the exhaust manifold or turbocharger to exhaust manifold adapter. Remove turbocharger.

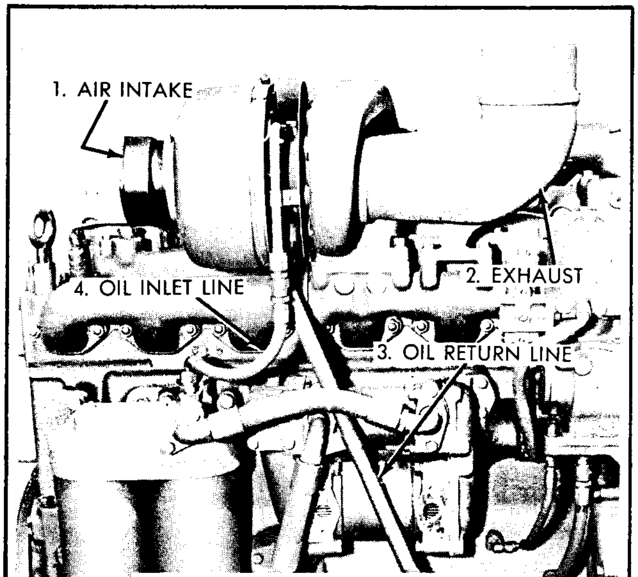


Fig. 6 — Turbocharger Installed

2. Installation

a. Prior to installation of the turbocharger, inspect and service the following:

(1) Service the air cleaner.

(2) Replace the engine lubricating oil filter elements. Renew the lubricating oil in the oil pan.

(3) Check the exhaust manifold for cracks, foreign material, condition of the manifold gaskets, tightness of the manifold

nuts and flatness of the exhaust manifold mounting pad for the turbocharger.

(4) Check the intake manifold and the air inlet elbow and hose for cracks, foreign material, condition of manifold mounting gaskets and tightness of the manifold nuts.

(5) Completely remove the oil inlet and oil drain line. Examine for sludge or clogging, clean if necessary. Any oil inlet or drain line found crimped or dented enough to restrict the flow of oil must be replaced.

(6) Replace any air or oil piping hose connectors found to be deteriorated.

(7) Make certain all air and oil piping hose clamps are tight.

(8) Make certain the gaskets do not extend into the port openings of the intake manifold, exhaust manifold, air inlet elbow, turbocharger mounting adapter and mounting pads.

b. Place a new gasket on the exhaust manifold pad. Mount the turbocharger on the pad and lubricate the mounting studs with an anti-sieze compound. Install washers and lock nuts and tighten securely.

c. Assemble the exhaust diffuser to the turbine housing using a new gasket. Coat the capscrew threads with an anti-sieze compound. Install lockwashers and capscrews and tighten securely.

d. Assemble the exhaust pipe elbow to the exhaust manifold and exhaust diffuser.

e. Assemble the exhaust stack to the exhaust pipe elbow.

f. Loosen the nut on the compressor cover "V" clamp so that the compressor cover can be rotated to the required angular position with the intake manifold inlet elbow and hose connection. Tighten the "V" clamp nut to 7.5 ft. lbs. torque. Tighten the hose connection clamps securely.

g. Install the air cleaner to turbocharger air inlet tube and hose. Tighten hose clamps securely.

h. Connect the oil inlet line to the turbocharger.

CAUTION: *Do not connect the oil return line until it is assured that there is a free flow of oil through the turbocharger.* Hold the engine stop control in the "STOP" position. Crank the engine until there is a free flow of oil from the oil return line connection in the bottom of the turbocharger bearing housing.

i. Connect the oil drain line to the turbocharger and to the side of the cylinder block.

j. Upon completion of the installation, check the turbocharger operation. Refer to Paragraph B, SERVICE INSPECTION AND MAINTENANCE.

CAUTION: *Never operate the engine with the air inlet tube between the air cleaner and turbocharger or the exhaust outlet piping disconnected. Clothing and compressor wheel damaging objects can be drawn into the compressor side, while discharged carbon particles and hot exhaust gas can cause personal injury on the turbine side*

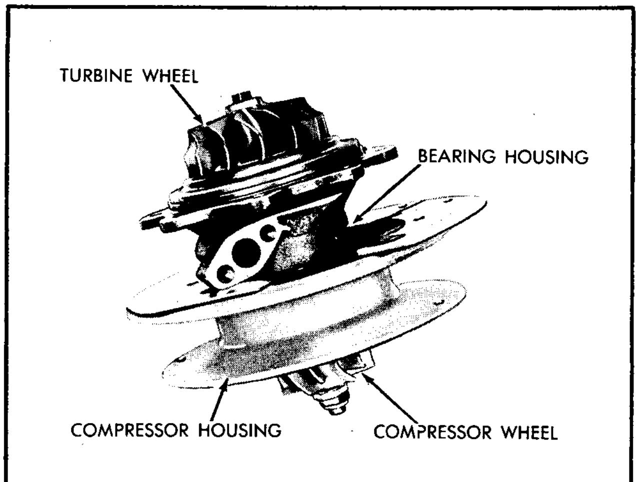


Fig. 7 — Replacement Core Assembly

D. Replacement Core Assembly

When it is not desirable to completely disassemble the turbocharger, a replacement core assembly (Fig. 7) may be used. This assembly contains both wheels, bearings, bearing thrust washers, seals, bearing housing, and compressor housing, all pre-assembled.

When using this unit it is only necessary to transfer the turbine housing, compressor extension, and compressor cover from the old unit to the new core assembly. Follow the disassembly procedure as outlined in Paragraph E, DISASSEMBLY OF TURBOCHARGER, covering the removal of the

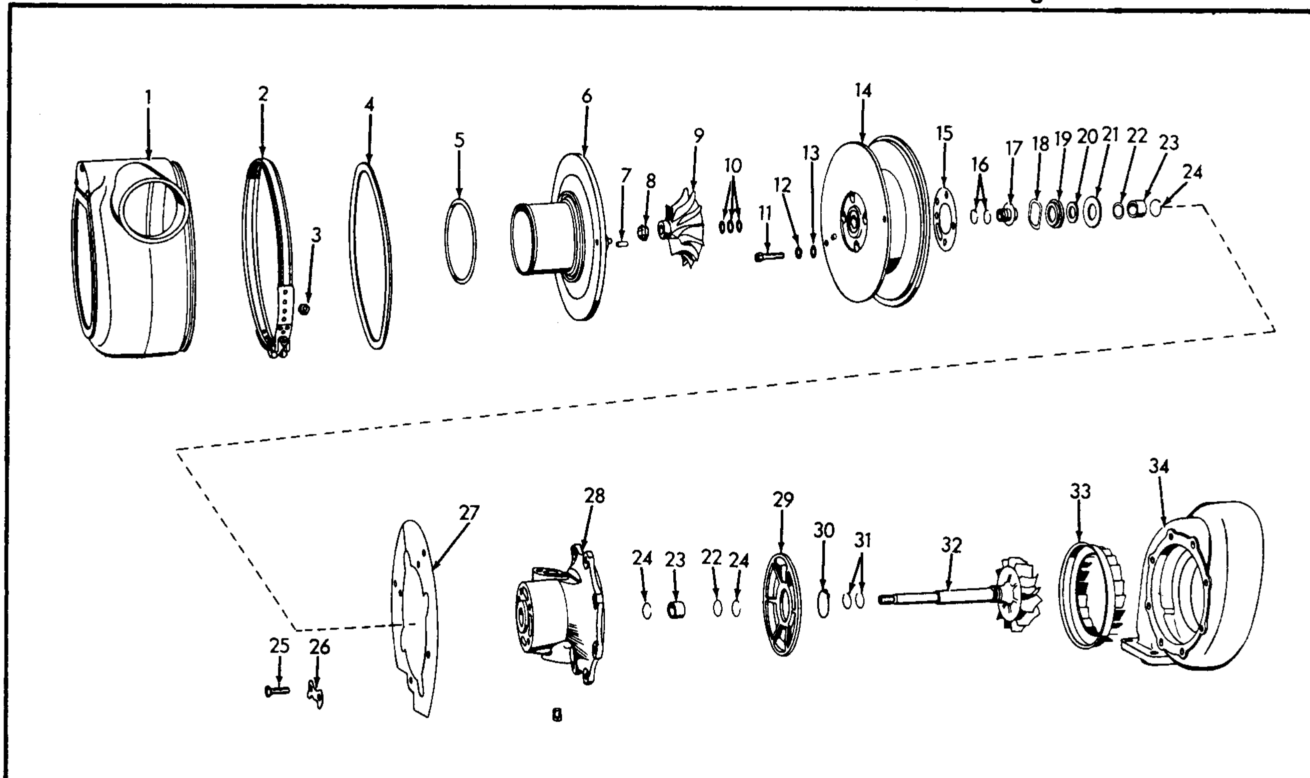


Fig. 8 — Turbocharger — Exploded View

1. Compressor Cover
2. "V" Clamp
3. "V" Clamp Nut
4. Gasket
5. O-Ring
6. Compressor Extension
7. Dowel
8. Locknut-Compressor Wheel
9. Compressor Wheel
10. Shims
11. Socket Head Capscrews
12. Lockwasher
13. Plain Washer
14. Compressor Housing
15. Gasket
16. Seal Rings
17. Flinger Sleeve
18. Spring
19. Flanged Thrust Washer
20. Thrust Ring
21. Flat Thrust Washer
22. Bearing Thrust Washer
23. Bearing
24. Snap Ring
25. Capscrews
26. Lockplates
27. External Shield
28. Bearing Housing
29. Nozzle Back Plate
30. Retaining Ring
31. Seal Rings
32. Turbine Wheel and Shaft
33. Nozzle Ring
34. Turbine Housing

compressor cover, compressor extension and turbine housing.

Assemble by following the instructions in Paragraph H, ASSEMBLY OF TURBOCHARGER. Use a new gasket between the compressor cover and housing, and a new O-ring between the cover and extension.

E. Disassembly of Turbocharger

Disassembly of the turbocharger can best be accomplished with the use of special tools listed under Paragraph I, TURBOCHARGER SERVICE TOOLS. As the parts are removed they should be placed on a clean bench in the order of disassembly. Always handle the parts with care in order to prevent scratching or damaging the precision machined surfaces.

Before disassembling the turbocharger, check radial movement of the compressor and turbine wheels with a dial indicator. Record the movement as it will be used to determine wear of the bearing bores in the bearing housing.

1. Preparation for Disassembly of Turbocharger

a. Clamp unit in vise by turbine housing flange (Fig. 9).

b. Mark related position of the compressor cover to bearing housing and bearing housing to turbine housing.

c. Apply penetrating oil or diesel oil to the capscrews securing the turbine housing to the bearing housing.

2. Removing Compressor Cover and Compressor Extension

a. Remove cover "V" clamp and remove compressor cover and compressor gasket (large).

b. Remove O-ring from compressor extension assembly.

c. Remove compressor extension assembly by lifting it uniformly off the dowel pins. If tight on dowels, use two screwdrivers between extension and compressor housing assembly, one at each dowel pin location. Pry gently using equal pressure on both screwdrivers.

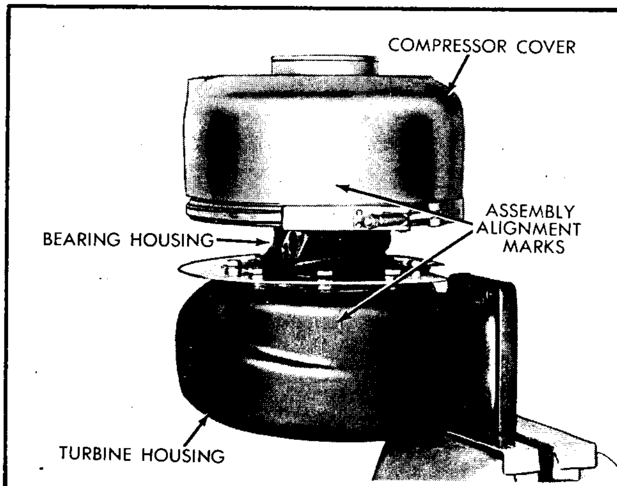


Fig. 9 — Preparing to Disassemble Turbocharger

3. Removing Compressor Wheel Locknut

a. Use 8 point ⅜" socket wrench on square extension of turbine wheel.

b. Use ¾" socket wrench on compressor wheel locknut (Fig. 10).

c. Hold wrenches firmly against nut to prevent slipping off and damaging wheel blades. Loosen and remove nut.

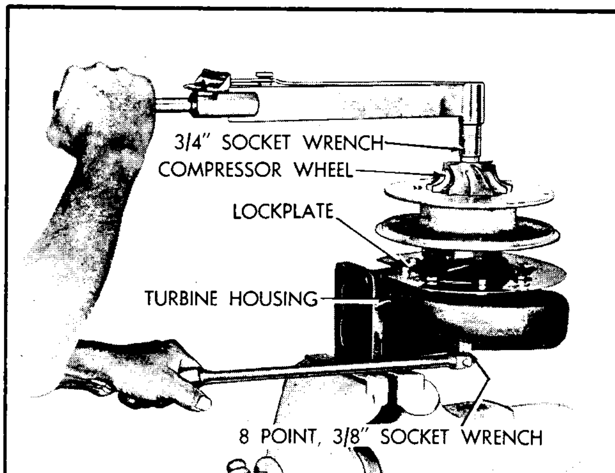


Fig. 10 — Loosening Compressor Wheel Locknut

4. Removing Core Assembly

a. Unlock tabs and remove capscrews and double lock-plates from turbine side.

b. Remove core assembly (Fig. 11). If tight, insert two screwdrivers on opposite side between the bearing housing and turbine housing and pry upwards uniformly. (Tilting the core may damage the turbine wheel).

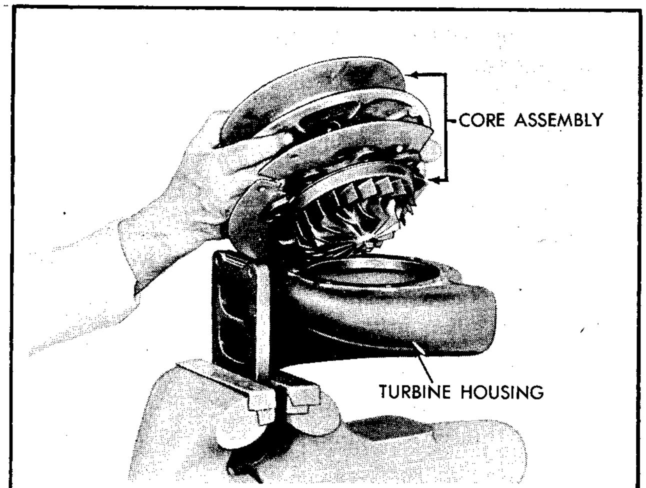


Fig. 11 — Removing Core Assembly

5. Removing Nozzle Ring

a. If nozzle ring is tight on bearing housing or tight in the turbine housing, provide access for screwdrivers by first inserting a sharp edge blade under the nozzle ring flange. Tap blade lightly going completely around ring until gap is sufficient to receive screwdrivers.

b. Insert two screwdrivers (Fig. 12) on opposite sides and pry upward against flange. Move screwdrivers around periphery of ring to prevent tilting while prying nozzle ring off.

6. Removing Compressor Wheel

a. Center tool "J" (Fig. 13) in arbor press.

b. Place unit, turbine side down, in disassembly ring.

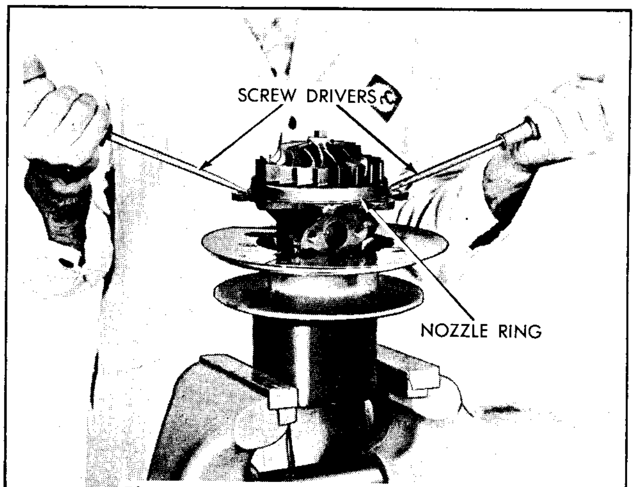


Fig. 12 — Removing Nozzle Ring

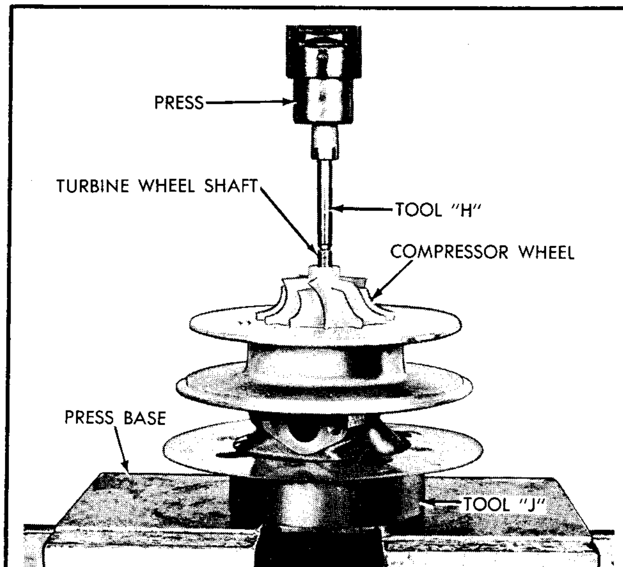


Fig. 13 — Removing Compressor Wheel

c. Check carefully to make sure that turbine wheel will not rub against arbor press base while shaft is being pressed out.

d. Place tool "H" on end of shaft.

e. Hold turbine wheel with one hand and press against shaft until it becomes free. NOTE: *Turbine wheel must be held during this operation to prevent it from falling.*

f. Remove turbine wheel and shaft.

g. Remove compressor wheel and shim(s) from behind wheel.

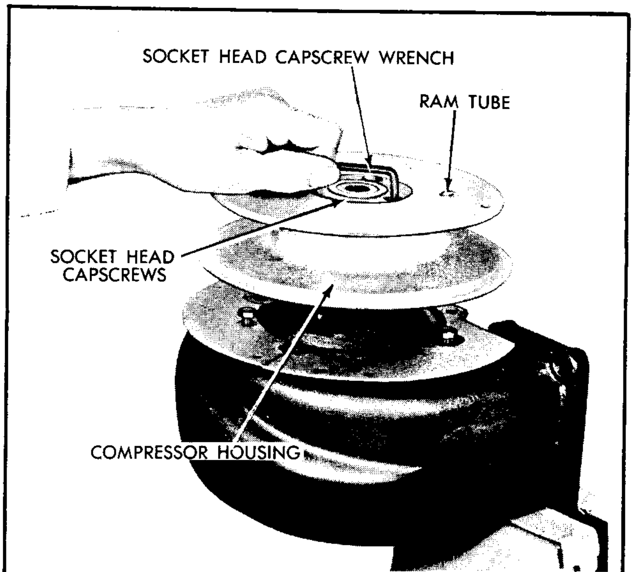


Fig. 14 — Removing Compressor Housing

7. Removing Compressor Housing

a. Replace unit in turbine housing and insert two capscrews and tighten a few turns.

b. Loosen and remove socket head capscrews (Fig. 14).

c. Remove compressor housing and gasket.

d. Remove lockwashers and plain washers from counterbored holes.

8. Flinger Sleeve

a. Push flinger sleeve out of compressor housing.

9. Spring

a. Remove spring from counterbore in compressor housing or from flanged thrust washer.

10. Flanged Thrust Washer, Thrust Ring and Flat Thrust Washer

a. Remove flanged thrust washer, thrust ring and flat thrust washer from bearing housing.

11. Bearing Thrust Washer and Bearing—Compressor End

a. Insert finger through bearing thrust washer

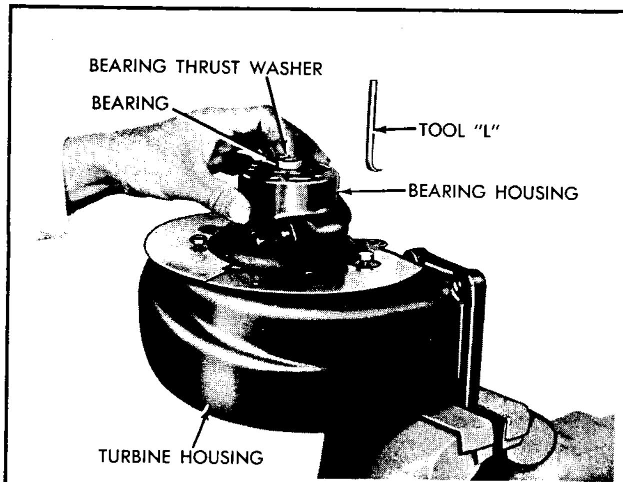


Fig. 15 — Removing Bearing Thrust Washer and Bearing

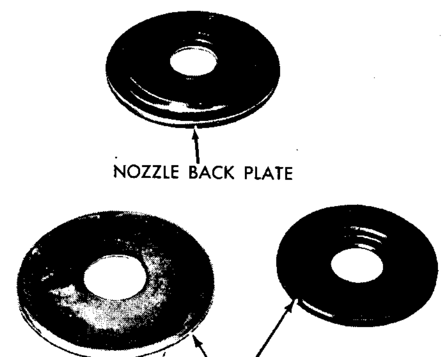


Fig. 16 — Nozzle Back Plate

and bearing (Fig. 15). Lift both parts from housing. If necessary, use tool "L" to remove the parts.

b. Remove inner Snap ring, using Tool "C".

12. Removing Nozzle Back Plate

a. Remove the two loose capscrews.

b. Place bearing housing on bench, flange up.

c. Remove back plate retaining snap ring, using Tool "D".

d. Remove nozzle back plate (Fig. 16). NOTE: *Some turbo-chargers have a large back plate, others have a combination internal shield and small back plate.*

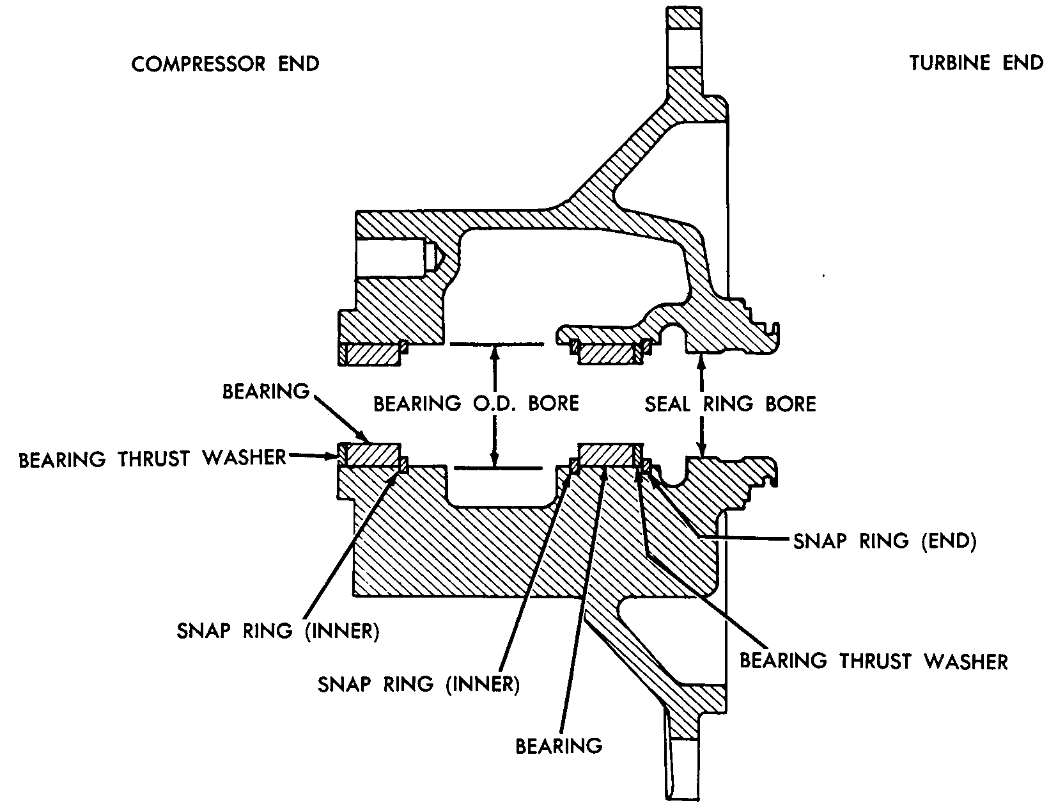


Fig. 17 — Bearing Housing and Bearings

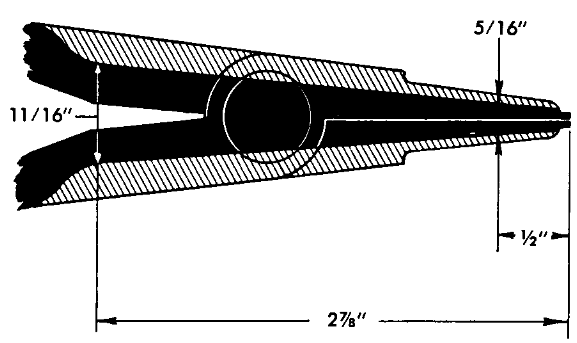


Fig. 18 — Snap Ring Pliers

13. Bearing and Bearing Thrust Washer— Turbine End

a. Because the seal ring bore in the bearing housing is smaller in diameter than the bore for the bearings, it is necessary to remove the turbine end bearing, bearing thrust washer and snap rings from the compressor end of the bearing housing. (Fig. 17).

b. For the removal of the snap rings, rework Truarc #21 pliers or Tool "C" to the dimensions indicated in Fig. 18 by grinding off uniformly each side of pliers. Round sharp corners smooth with fine cut file and emery cloth.

c. Using reworked snap ring pliers, remove the inner snap ring. CAUTION: *Compress sufficiently to prevent snap ring from contacting bore surfaces during removal.*

d. Remove bearing and bearing thrust washer using Tool "L" if necessary.

e. Remove end snap ring if necessary.

14. Seal Rings

a. Remove seal rings from flinger sleeve and turbine shaft.

F. Cleaning

The turbocharger may occasionally require cleaning to keep it and the engine operating efficiently. The cleaning interval is dependent upon operating conditions.

1. Compressor End

a. Remove compressor cover and extension assembly.

(1) Clamp unit in vise by turbine mounting flange and mark relative position of compressor housing to bearing housing. Refer to Fig. 9.

(2) Remove cover clamp and remove compressor cover and compressor gasket (large).

(3) Remove O-Ring from compressor extension assembly.

b. To prevent damaging the compressor wheel, rest the unit on wooden blocks in a pan or container for cleaning fluid. The compressor wheel should be down and the shaft vertical. NOTE: *Never rest the whole weight of the unit on the wheels.*

c. Use "Bendix" metal cleaner or equivalent. CAUTION: *Never use a caustic solution.*

d. Fill the container only up to the edge of the compressor housing. CAUTION: *Do not allow the cleaning fluid to get into the bearing area.*

e. After deposits have softened, remove with a nylon brush or plastic blade scraper.

f. Assemble the compressor extension and compressor cover using a new gasket and O-ring in direct reversal of removal procedure.

2. Turbine End and Other Parts

a. To satisfactorily clean the turbine end, the unit must be completely disassembled. Refer to Paragraph E, Disassembly of Turbocharger.

b. Submerge and soak all parts in "Bendix" metal cleaner or equivalent. The cleaning solution should be agitated to do a satisfactory job but take special care that the parts are not allowed to strike each other. CAUTION: *Never use a caustic solution for cleaning as this will permanently damage certain parts. Use only a soft brush, plastic blade scraper, or compressed air jet to remove the deposits. Never use a wire brush or steel blade scraper for this purpose.*

c. Make sure that all wheel blades are thoroughly cleaned. NOTE: *Deposits left on the blades will affect balance.*

d. Carefully inspect parts to specifications in Paragraph G, OVERHAUL INSPECTION.

e. Clean all internal cavities of bearing housing thoroughly with compressed air jet. Make sure that flow control tube is open (visible through oil outlet hole in casting). Use compressed air jet only, do not use wires, drills, etc.

f. The ram tube located on the compressor side of the compressor housing (Fig. 14) cannot be removed. However the opening in the tube and the opening in the area between compressor end seal rings should be thoroughly cleaned using compressed air jet. If necessary, use a .030 diameter wire to clean the opening between the seal rings.

C. Overhaul Inspection

Prior to inspecting the parts make certain they are thoroughly clean and the work bench area is free of any abrasive material.

1. Shaft

Inspect for scratched, worn or discolored bearing surfaces. Check seal ring groove width with tool "E" which is a go-no go gauge (go .065", no go .069"). Groove walls must be smooth and parallel. Shaft diameter .6861" minimum and must be round.

If shaft is not worn and only slightly scratched or discolored, it may be reused as is. Never grind or polish as this will affect balance. If the shaft does not meet these specifications it must be replaced.

2. Bearings

Inspect for scratches and worn surfaces. If the tin plating is worn off, the bearing should be replaced. Bearing limits: O.D. 1.0585" minimum, I.D. .6883" maximum.

3. Thrust Ring

Measure thrust ring thickness with micrometer. It must not be less than .099". Inspect for worn or scratched thrust faces.

4. Flinger Sleeve

Check seal ring grooves with tool "E". Groove walls must be smooth and parallel. If flinger is not scored and the seal ring grooves are in good condition it may be reused.

5. Thrust Washer (Flat)

Inspect thrust washer for wear, scored faces, flatness and overall thickness. Lay washer thrust face up on flat surface. Pressing lightly downward directly over thrust face, the washer should not rock. Thickness through the thrust face should not be less than .092". Check this dimension at several different spots around washer using a micrometer. Thickness should not vary more than .002".

6. Thrust Washer (Flanged)

The flanged thrust washer will not have to be replaced if the end play was within specifications or if the amount of end play over .007" equals the difference between the actual thickness of the flat thrust washer and .091".

Inspect thrust face for scored or deep surface scratches.

Lay washer on a clean flat surface with flange side down and check for flatness. Using a .0015" thickness gauge and pressing lightly on washer with fingers, gauge should not pass freely between flange and plate.

Leave washer on plate and using depth micrometers, check overall thickness by resting micrometer base on back of cupped portion and stem through hole. This dimension should be between .195" and .205".

Using same micrometers, measure depth of pocket. Place micrometer base against face of flange with stem resting on thrust face. This measurement should not exceed .106". Check pocket depth in three places around the washer.

NOTE: *If thrust faces are only slightly scratched, but washers are flat and within tolerances, they may be reused.*

7. Bearing Housing

Inspect for worn or scored surfaces in piston ring bore. Diameter should not exceed .877" and must be round.

Inspect bearing bore for scored surfaces. To determine bearing wear refer to reading obtained when checking radial movement of both wheels.

If reading was within .023" maximum the bore size is satisfactory.

If reading was in excess of .023"; and the shaft and bearing is within specification; the bore is oversize, and the bearing housing must be replaced.

Replace housing if bores are scored or worn oversize.

8. Compressor Housing

Inspect for scored or worn seal ring seal bore. Diameter should not exceed .720" and must be round. Inspect face behind compressor wheel for excessive wear or scoring. Replace housing if face is deeply scored, or if seal ring bore is scored or out of round.

Inspect the openings in the seal ring bore and in the ram tube to make certain they are open and clean.

9. Compressor Extension

Inspect extension for scored contour, damaged diffuser vanes, mutilated inlet connecting flange and dirt.

10. Seal Rings

Measure thickness of seal rings with micrometers at both outside and inside diameters. The difference between the measurements must not exceed .001" and the lowest reading should not be less than .060". Seal rings not within these measurements or having scratched sides must be replaced.

11. Nozzle Ring

Check vane spacing with tool "F." If spacing is correct and the vanes are not deteriorated, it may be reused.

H. Assembly of Turbocharger

The work bench area and tools must be clean to assure that no abrasive material or foreign particles are allowed to enter the turbocharger during the assembly operation. Parts must be free of nicks or burrs and absolutely clean before being installed in the turbocharger. Assemble the turbocharger using the Turbocharger Special Tools to prevent damaging the parts.

Assemble the turbocharger as follows:

1. Installing Seal Rings

a. Clamp turbine housing in vise with exhaust flange down as shown in Fig. 19.

b. Install nozzle ring in turbine housing. If nozzle ring flange is slightly distorted it may be tapped lightly until flat. If flange is badly mutilated, reforming is not recommended in housing. Either rework flange on a flat edge ring or replace nozzle.

c. Place shaft and turbine wheel assembly (shaft upright) in turbine housing.

d. Place tool "A" over shaft.

e. Install seal rings. Do not over expand rings.

f. Remove Tool "A."

g. Rotate rings until gaps are 180° apart.

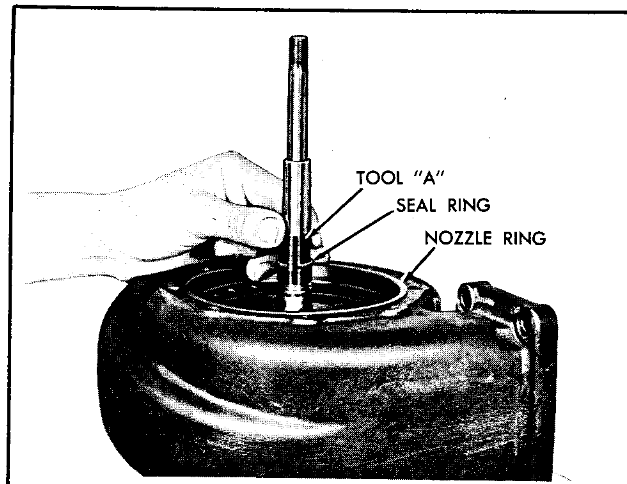


Fig. 19 — Installing Seal Rings — Turbine End

2. Bearing Housing Assembly

a. Thoroughly clean internal and external surfaces of the bearing housing with compressed air.

b. Install turbine end bearing as follows: (Fig. 17).

1. Install end snap ring, using snap ring pliers.
2. Lubricate and install bearing thrust washer.
3. Lubricate and install bearing.
4. Install inner snap ring.
5. Check to make certain both the snap rings are properly seated.

c. Install compressor end bearing inner snap ring making certain it is properly seated.

d. Position nozzle back plate on bearing housing (Fig. 20) with dish side down. NOTE: *For turbochargers having an internal shield and back plate, install the shield with dish side down and then the nozzle back plate.*

e. Install nozzle back plate retaining snap ring with bevel side up, using Tool "D."

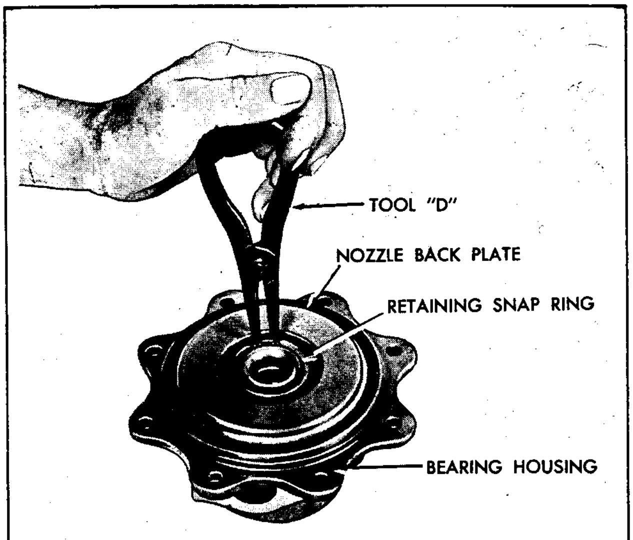


Fig. 20 — Installing Nozzle Back Plate Retaining Snap Ring

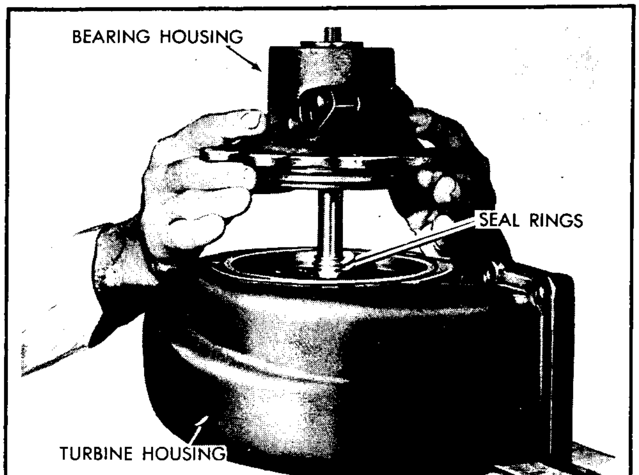


Fig. 21 — Installing Bearing Housing

3. Bearing Housing Installation

a. Apply light film of oil to shaft.

b. Center seal rings on shaft with gaps 180° apart and lubricate rings.

c. Place bearing housing (nozzle back plate down) over shaft. Do not force. If rings do not enter housing easily, remove housing and re-center rings (Fig. 21).

4. Bearing Housing and External Shield Installation

a. Place external shield in position, aligning assembly marks. The cut out portion must clear mounting flange on turbine housing.

b. Place four double lockplates over holes.

c. Coat threads of capscrews with anti-seize compound.

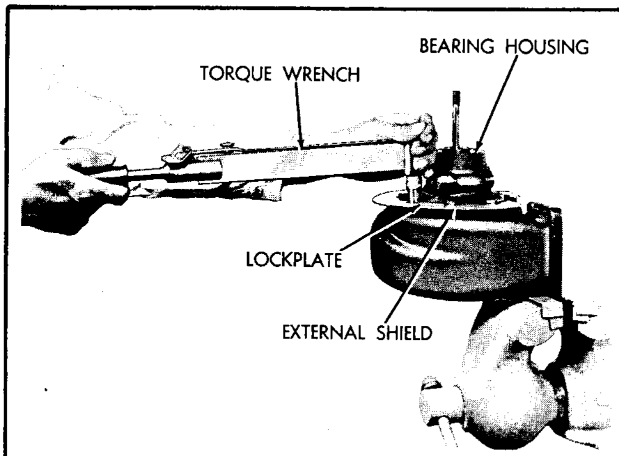


Fig. 22 — Securing Bearing Housing and External Shield

d. Install capscrews and tighten to 17 lbs. ft. torque (Fig. 22). Use torque wrench adapter tool "M" to tighten capscrew under oil inlet boss. The adapter increases the effective length of the torque wrench, therefore, tighten only to a torque of 15 lbs. ft.

e. Bend up tabs of lockplates against side of capscrew heads.

f. Apply oil to remaining bearing.

g. Install bearing over shaft and into bearing housing.

h. Apply oil to bearing thrust washer and install over end of bearing.

5. Thrust Washer (Flat), Thrust Ring and Thrust Washer (Flanged) Installation

a. Place flat thrust washer with notched thrust face up over the shaft and lubricate thrust face.

b. Place thrust ring over the shaft and lubricate.

c. Place flanged thrust washer over shaft with notched thrust face down.

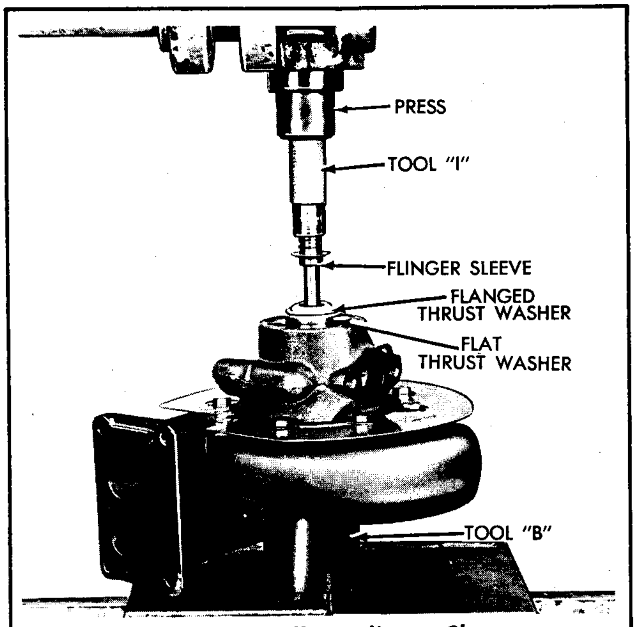


Fig. 23 — Installing Flinger Sleeve

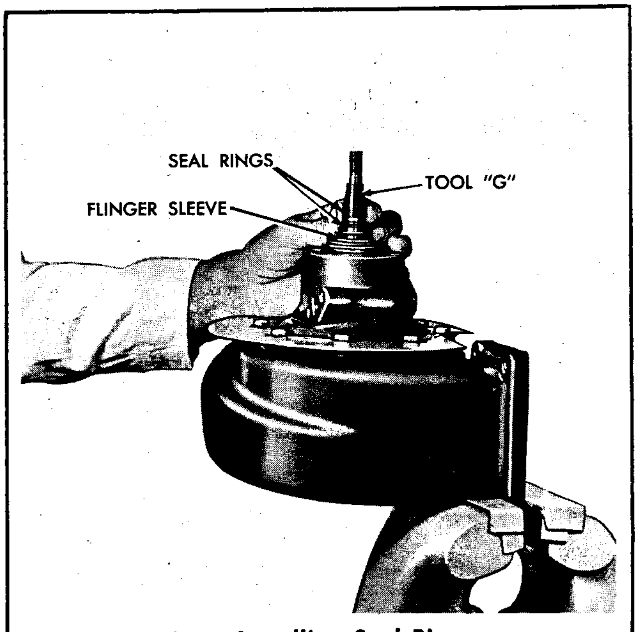


Fig. 24 — Installing Seal Rings on Flinger Sleeve

6. Flinger Sleeve and Seal Ring Installation

a. Start flinger sleeve on shaft, seal ring groove to the top (Fig. 23).

b. If flinger sleeve is not free on the shaft, place tool "B" in arbor press.

c. Place unit in arbor press with square extension of turbine wheel resting on tool "B." CAUTION: *Do not press turbine wheel against contour in turbine housing.*

d. Place tool "I" on flinger sleeve.

e. Press flinger sleeve on shaft until it bottoms against thrust ring.

f. Remove unit from press and clamp in vise. Place tool "G" over flinger sleeve (Fig. 24).

g. Slide seal rings into grooves of flinger sleeve.

h. Remove tool "G."

i. Lubricate seal rings and rotate until gaps are 180° apart.

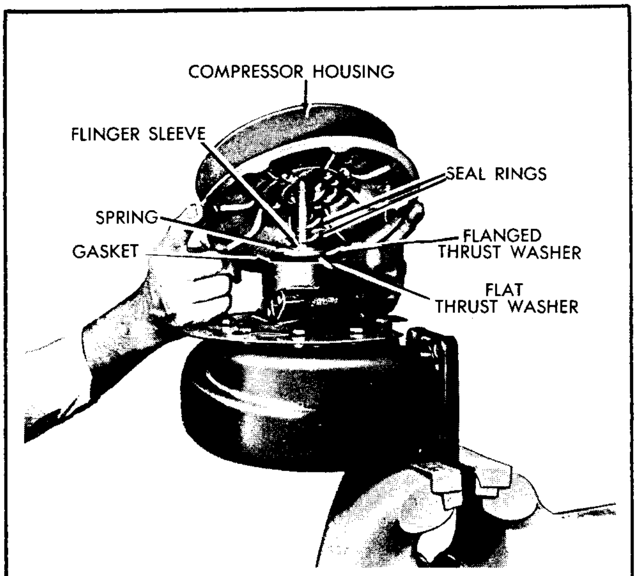


Fig. 25 — Installing Compressor Housing

7. Compressor Housing Installation

a. Place spring over flanged thrust washer (Fig. 25).

b. Mount gasket on bearing housing aligning oil drain slot and socket-head capscrew holes.

c. Center seal rings on flinger sleeve with gaps 180° apart.

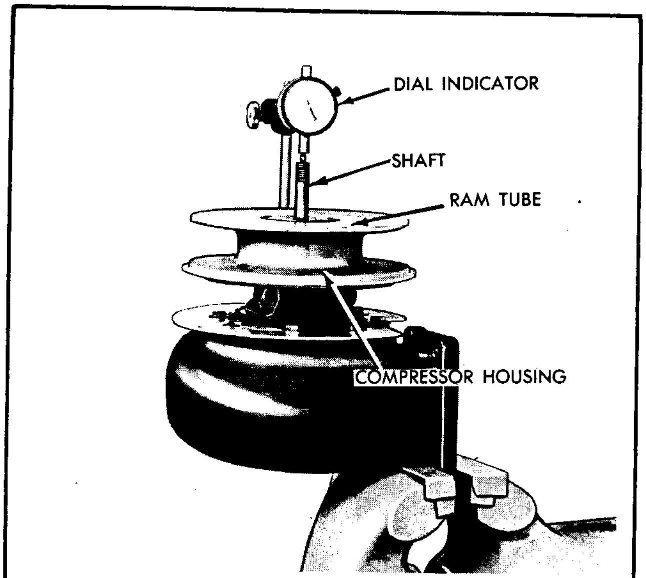


Fig. 26 — Checking Shaft End Play

d. Install compressor housing, matching oil drain holes. Do not use force. If rings do not enter housing easily, remove housing and re-center rings.

e. Place four plain washers in the four counterboard holes in compressor housing, then a lockwasher over each plain washer.

f. Install four socket head capscrews and tighten to 20 lbs. ft. torque.

8. Checking End Play

a. Mount dial indicator with contact point resting against end of shaft (Fig. 26).

b. Move shaft to extreme up and down positions. Make sure there is no movement of shaft in flinger sleeve while making this check.

c. Total movement should be from .004" to .008".

9. Checking Compressor Wheel Back Clearance

a. Place shim(s) over shaft.

b. Place tool "K" over shaft (Fig. 27).

c. Install locknut.

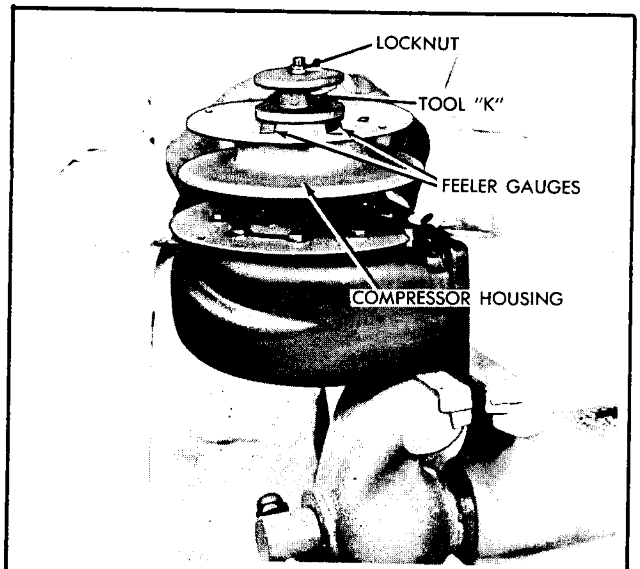


Fig. 27 — Checking Compressor Wheel Back Clearance

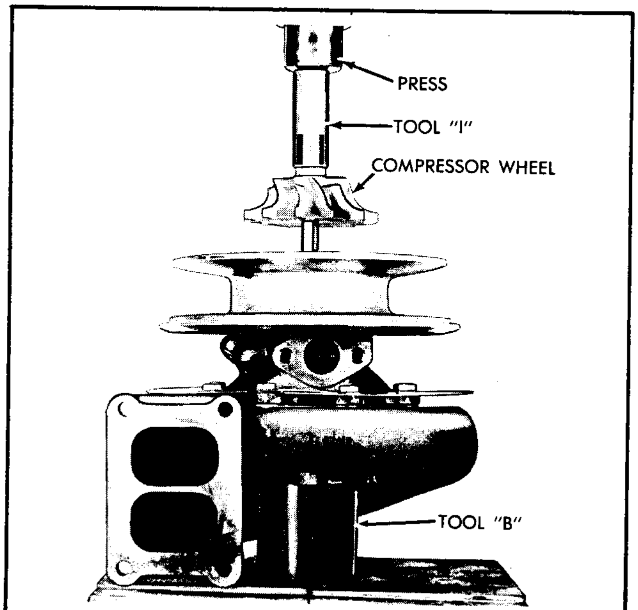


Fig. 28 — Installing Compressor Wheel

d. Use an 8 point ⅜" socket wrench on square extension of turbine wheel and a torque wrench with ¾" socket on locknut.

e. Tighten to 30 lbs. ft. torque.

f. Use feeler gauges to check back clearance of compressor wheel. This should be from .020" to .022". Shims .002", .005" and .010" are available to adjust for proper back clearance.

g. After proper clearance has been obtained, remove tool "K."

10. Compressor Wheel Installation

a. Apply light coat of "Lubriplate" to shaft.

b. Place compressor wheel over shaft.

c. The wheel is soft and should be started squarely on the shaft to prevent shaving the hole when the wheel is pressed onto the shaft.

d. Place Tool "B" in arbor press (Fig. 28).

e. Remove unit from vise and place in arbor press with square extension of turbine wheel resting on Tool "B."

f. Place Tool "I" on compressor wheel.

g. Press wheel on shaft until it bottoms.

h. Return unit to vise.

11. Installing Compressor Wheel Locknut

a. Install locknut.

b. Use 8 point ⅜" socket on square extension of turbine wheel and a torque wrench with ¾" socket on locknut.

c. Tighten to 30 lbs. ft. torque.

d. Place .020" - .022" thickness gauges under compressor wheel blades. Rotate wheel over gauges to check for bent blades.

12. Compressor Extension Installation

a. Install new gasket on compressor housing.

b. Place compressor extension uniformly over dowel pins. If dowel pins are tight in holes, tap extension lightly with plastic or raw-hide mallet.

c. Place new O-ring in groove in compressor extension.

d. Place cover over extension and seat against gasket. Secure cover to extension with cover "V" clamp.

e. Stand unit on bench with shaft in horizontal position and spin wheels by hand. Wheels should rotate freely.

f. Mount turbocharger on engine following installation instructions in Paragraph C, REMOVAL AND INSTALLATION.

I. Turbocharger Service Tools

To enable the mechanic to perform the particular disassembly and assembly operations of the turbocharger in the proper manner and in the least amount of time, the following tools are available. These tools must be ordered directly from the tool manufacturer, Kent-Moore Organization, Inc., 1501 South Jackson Street, Jackson, Michigan.

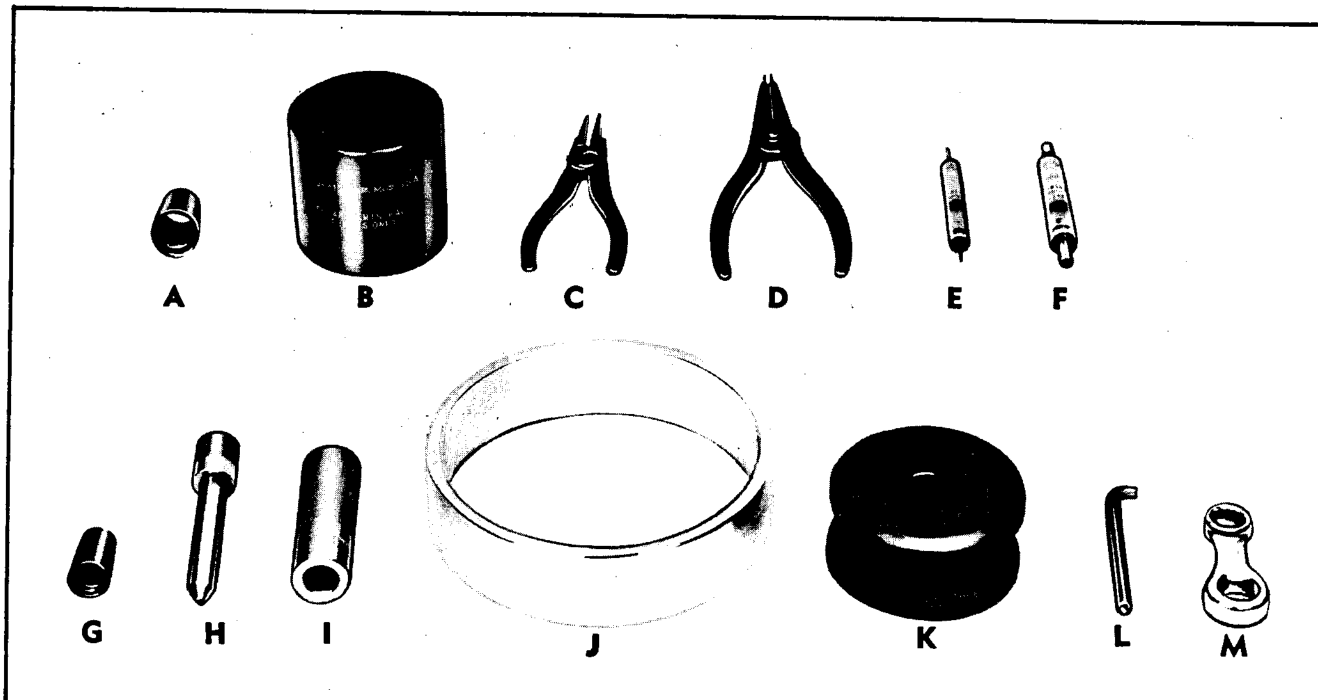


Fig. 29 — Turbocharger Service Tools

TOOL	KENT-MOORE TOOL No.	DESCRIPTION
A.	J-9134	Ring Expander for Turbine End
B.	J-9135	Support Block
C.	J-9136	Bearing Snap Ring Pliers
D.	J-6083	Bearing Snap Ring Pliers
E.	J-9116	Ring Groove Width Gauge
F.	J-9118	Nozzle Vane Spacing Gauge (.169)
G.	J-9126	Ring Expander for Compressor End
H.	J-9127	Compressor Wheel Disassembly Tool
I.	J-9129	Compressor Wheel Assembly Tool
J.	J-9128	Compressor Wheel Disassembly Tool
K.	J-9131	Compressor Wheel Spacer Block
L.	J-9282	Bearing and Thrust Washer Remover
M.	J-9113	Torque Wrench Adapter

J. Turbocharger

TROUBLE	POSSIBLE CAUSE	REMEDY
Wheel drags	1. Carbon build-up behind turbine wheel and/or dirt accumulation behind the compressor wheel.	1. Disassemble and clean unit.
	2. Bearing seized to shaft. Dirt causing drag in bearing.	2. Check oil pressure at turbocharger. Inspect condition of oil.
Turbine wheel radial movement exceeds .023"	1. Worn bearings. Bore in bearing housing worn. Shaft worn.	1. Check oil flow pressure at turbocharger. Inspect condition of oil. Wheels unbalanced.
Shaft end play exceeds .008"	1. Thrust ring faces or thrust washers worn or distorted.	1. Inspect for dirty oil or lack of oil.
Shaft end play less than .004"	1. Carbon build-up behind turbine wheel. Dirt build-up behind compressor wheel.	1. Disassemble and clean unit.
Compressor wheel radial movement exceeds .023"	1. Worn bearings. Bore in bearing housing worn. Shaft worn.	1. Check oil flow pressure at turbocharger. Inspect condition of oil. Wheels unbalanced.
Dirt on compressor housing face and/or inside cover	1. Excessive intake restriction. Restricted oil drain line. Operating in dusty areas under long idle periods.	1. Check for clogged air cleaner. Collapsed hose, or leaks in air inlet hose. Clean unit.
	2. Insufficient air filtration.	2. Leaks in air intake between cleaner and turbocharger.
	3. Long period of operating without cleaning.	3. Disassemble and clean unit.
Compressor wheel rubbing on O.D. of blades	1. Worn bearing. Unbalanced turbine wheel.	1. Check condition of oil. Foreign material passing through turbine side.
Compressor wheel rubbing on cover or back face	1. Insufficient clearance. Cover damaged. Thrust washer worn.	1. Check end play. Inspect cover for damage.
Inlet leading edge of compressor wheel blades either worn or pieces broken off	1. Loosen pieces in air intake system and striking wheel.	1. Inspect air intake system for loose nuts, bolts, or other foreign material.
Evidence of rubbing on the small diameter of the turbine wheel blades	1. Worn bearing. Unbalanced wheel because of a bent or broken blade.	1. Dirty oil or lack of oil. Inspect for foreign material. Replace wheel.

TROUBLE	POSSIBLE CAUSE	REMEDY
Turbine wheel rubbing on face of bearing housing	1. Carbon deposits on housing behind wheel. Improper end play. Bent shaft.	1. Disassemble and clean. Check end play.
Broken or bent turbine wheel blades	1. Impact from failed engine parts, fins or projection from exhaust manifold or exhaust parts. Wheels striking housing after bearing has been damaged or worn.	1. Inspect and clean exhaust system to turbocharger. Replace wheel, inspect condition of oil.
Nozzle ring vanes peened, reducing the opening between vanes. Vanes pitted	1. Foreign material such as debris, projection from exhaust manifold or head castings, or failed engine parts passing through turbine side.	1. Replace nozzle ring.
Shaft bearing surfaces scratched and worn	1. Dirty lubrication, insufficient oil, or failure of oil supply. Wheel overspeeding.	1. Replace.
Shaft worn on one side only	1. Operating with unbalanced wheel.	1. Replace.
Bearing scratched and worn both I.D. and O.D.	1. Dirty lubrication, insufficient oil or failure of oil supply. Wheel overspeeding.	1. Replace.
Bearing seized on shaft or O.D. wear	1. Overheated, or lubrication failure.	1. Replace.
Bearing worn one side only	1. Operating with unbalanced wheel.	1. Replace.
Thrust ring faces scored or worn	1. Dirty lubrication, lack of oil. Unit overheated, improper end play.	1. Replace.
Thrust washer faces scored or worn	1. Dirty lubrication, lack of oil. Unit overheated, improper end play.	1. Replace.
Bearing housing bore scratched or worn	1. Dirty oil, lack of oil. Wheels unbalanced.	1. Replace if scored or out of round.

TROUBLE	POSSIBLE CAUSE	REMEDY
Bearing housing has carbon deposits	1. Oil leakage. Over fueling.	1. Clean housing. Check for restriction in air intake system or restricted oil drain.
Compressor housing seal ring bore worn or scratched	1. Dirty oil, lack of oil. Wheels unbalanced.	1. Replace if scored or out of round.
Dirt accumulated on face behind compressor wheel	1. Excessive intake restriction. Restricted oil drain line. Operating in dusty areas under long idle periods or leak in air intake system.	1. Service air cleaner. Check air intake system.
Compressor extension has scored contour	1. Wheel rubbing because of excessive end play. Worn thrust faces or cover damaged by inpact from dropping etc.	1. Replace cover if deeply scored or damaged.
Dirty compressor extension	1. Excessive intake restriction. Restricted oil drain line. Operating in dusty areas under long idle periods or leak in air intake system.	1. Clean.
Shaft discolored	1. Overheating. Insufficient oil supply.	1. Reuse if only slightly discolored and not deeply scratched.

SECTION IV — ENGINE COOLING SYSTEM

1. DESCRIPTION OF SYSTEM

The engine cooling system includes the water pump, radiator, engine oil cooler, thermostats, engine temperature gauge, cooling fan, and the water passages in the cylinder block and cylinder heads. The water pump draws the coolant from the bottom of the radiator and circulates it through the engine oil cooler, the transmission oil cooler, and through the water passages in the engine. The coolant is discharged from the cylinder heads into the water outlet manifold and passes through the thermostat housing and the radiator inlet elbow to the upper part of the radiator. The coolant is cooled as it passes from the top to the bottom of the radiator core by air forced through the radiator core by the cooling fan.

The two thermostats, located in the thermostat housing at the front of the water outlet manifold are of the "FULL CHOKE" type and operate automatically to maintain a minimum coolant operating temperature of 170° F.

2. GENERAL MAINTENANCE

In warm weather, keep the cooling system filled with clean soft water or rain water whenever possible. If soft water is not available and hard water must be used, the hard water should first be treated with a water softener. A commercially reliable rust inhibitor should be added to the cooling system for warm weather operation. A rust inhibitor (soluble oil), available in half pint or quart containers, can be obtained from "Allis-Chalmers" Dealers and should be added to the cooling system in proportions of 1 pint of soluble oil to every 15 quarts of water. CAUTION: *NEVER ADD AN ANTI-FREEZE SOLUTION TO A COOLING SYSTEM THAT CONTAINS A RUST INHIBITOR.* Drain and flush the cooling system with clean water before adding an anti-freeze solution for cold weather operation.

In winter weather, use an ethylene glycol anti-freeze solution in the system to protect against damage from freezing. This type of anti-freeze has a much higher boiling point than water. After any addition of water or anti-freeze compound, test the solution after the added quantity has become thoroughly mixed to be sure that it will withstand the prevailing or anticipated temperature. Refer to instructions or protection chart furnished by the manufacturer of the anti-freeze for information on protection required for the lowest anticipated temperature. Usually a mixture of 64% ethylene glycol and 36% water provides maximum protection.

Keep the radiator air passages free from leaves, trash, and other material which will restrict the flow of air through the radiator.

All leaks in the cooling system must be corrected as soon as they are evident. The fan drive belts and the water pump and generator drive belt must be kept properly adjusted.

The most efficient engine operation is obtained with the coolant operating temperature held to a mini-

4

mum of 170° F. Operating the engine with the coolant temperature below this range will result in incomplete combustion of fuel, higher fuel consumption with less power, and will cause harmful deposits within the engine.

Maintaining the coolant operating temperature (minimum 170° F.) depends mostly on proper functioning of the thermostats. If the coolant temperature remains consistently below normal, the thermostats should be removed, checked for proper operation, and replaced if necessary.

3. DRAINING AND FILLING OF SYSTEM

A. Draining of Cooling System

Remove the radiator cap and open the cylinder block drain cock located on the right side near the front and rear of the engine. Open the drain cock located on the bottom of the timing gear housing below the water inlet to the water pump.

After the coolant has started to drain, open the vent cock on the side of the water outlet manifold. To remove the water from above the thermostat it is necessary to open the vent cock in the side of the thermostat housing. NOTE: *When draining the cooling system in freezing weather, be certain that the coolant flows freely from all drain cocks and that the system drains completely.*

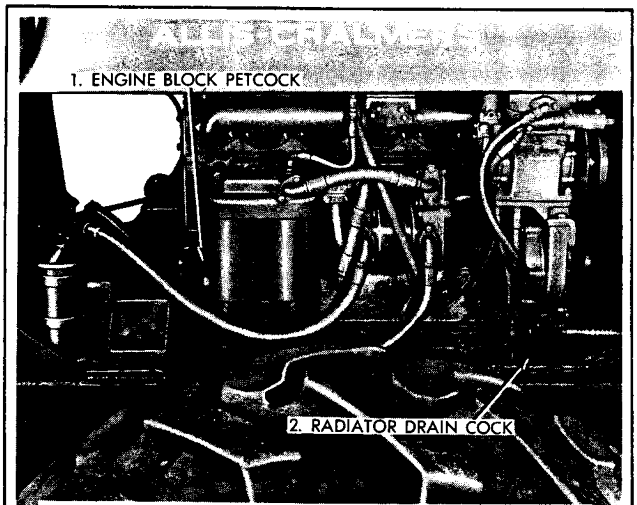


Fig. 1 — Cooling System Drain Cock Locations

B. Filling of Cooling System

Close the drain cocks which were open to drain the system (Paragraph A above). Leave the vent cocks located at the water outlet manifold and thermostat housing open. Fill the system with coolant through the radiator. Observe the vent cocks and as soon as bubble free coolant appears, close the cocks. This allows air trapped in the engine by the closed thermostats to escape. Install the radiator cap.

4. CLEANING OF SYSTEM

It is recommended that the cooling system be cleaned at least twice a year, usually at the beginning of cold weather (before adding an anti-freeze solution) and again after the anti-freeze solution is removed. Cleaning at these intervals will reduce clogging and over-heating and will minimize the necessity of removing the radiator for cleaning.

If hard water has been used, the necessity for cleaning is greater, since lime deposits, or scale, will form in the radiator, cylinder block, and the cylinder head. This lime deposit is detrimental to the engine and the radiator core. Flushing the radiator will remove obstructions in the radiator tubes and other water passages, which, if not removed, would eventually clog these passages. It is also important that the air passages through the radiator be kept free of obstructions and the exterior of the engine be kept free from thick deposits of dust and oil.

A. Cleaning Materials

Sal Soda is a very effective and safe solvent for the removal of lime, scale, and other foreign deposits from the cooling system. It should be used in the proportions indicated and according to the directions printed on the container in which it is purchased. Many other good cleaning solvents for this purpose are available; these should be used according to the Manufacturer's directions. After the solvent has been in the cooling system the prescribed length of time, the system should be completely drained, and after the engine has cooled sufficiently, thoroughly flushed with clean water. The use of certain cleaning compounds requires the use of a neutralizer solution, which is usually packed and sold with the cleaning compound, and should be used as directed. CAUTION: *Never mix anti-freeze solutions or inhibitors with any cleaning, neutralizing, or flushing compounds.*

B. Flushing

If the tubes in the radiator become clogged, the obstructions may sometimes be removed by reverse flushing of the radiator. When the clogging is caused by leaves or other trash, this material is usually deposited at the tops of the radiator tubes. Disconnect the radiator lower hose, and using a suitable adaptor, connect a pressure water hose to the radiator water outlet elbow. Remove the radiator upper hose and plug the opening of the radiator. Remove the radiator cap and force water upward through the radiator. The trash will be loosened from the top of the tubes and will flow out through the top of the radiator with the water. CAUTION: *Do not use over 5 pounds pressure in this flushing operation as excessive pressure may cause the radiator tubes or tanks to rupture.*

C. Inspect for Leaks After Cleaning or Flushing

After the cooling system has been cleaned or flushed, and after the system is refilled, a complete inspection of the system should be made for coolant leaks. Correct all leaks to avoid foaming, loss of solution, and corrosion.

When servicing the cooling system for summer operation, it is recommended that a reliable rust inhibitor (soluble oil) be added to the coolant to keep the system free from rust. Use the inhibitor as directed on the container.

D. Cleaning Exterior of Radiator

Cleaning the fins of the radiator can best be accomplished by means of an air blast carrying a grease solvent, such as oleum spirits or carbon tetrachloride, directed at the core and passing through to the fan side. Never use gasoline, fuel, or kerosene. The radiator guard should be removed and the engine should be covered before performing this operation. CAUTION: *Provide adequate ventilation of the working area during this operation to avoid possible toxic effects of the cleaning spray.*

5. WATER PUMP

A. Description

A centrifugal type water pump assembly is provided for circulating the coolant through the engine cooling system. The water pump is flange mounted on the rear of the engine block, as shown in Fig. 2, and is belt driven at 1.263 times crankshaft speed. The pump shaft is supported in the pump housing by two ball bearings.

The impeller (Fig. 3), is retained on the tapered end of the pump shaft by means of a retaining nut and cotter pin. The bearings are shielded on one side only and the bearing compartment of the pump housing is packed with lubricant at assembly. A neoprene seal assembly and a water flinger are provided at the front of the impeller to prevent coolant from entering the bearing compartment side of the pump housing. The pump shaft and bearings are retained in the pump housing by a threaded bearing seal retainer and snap ring installed in the housing.

The driving pulley is secured to the driving pulley flange with capscrews and lockwashers. The driving flange is secured to the water pump shaft assembly with a "WOODRUFF" key, retaining nut and lock nut. A drilled and tapped lubricating passage is provided in the pump housing to accommodate a lubricating fitting for added lubricant to the bearings periodically (each 100 hours of operation).

B. Service

The construction of the water pump is conducive to long life with minimum attention, providing only clean coolant is added to the cooling system. Water containing alkali is especially harmful to the components of the water pump because alkali causes corrosion.

C. Removal of Water Pump

1. Drain the cooling system (refer to "DRAINING AND FILLING OF SYSTEM" in this Section).

2. Loosen the air compressor belt adjustment at the air compressor pulley and slip the belt from the water pump and air compressor pulleys.

3. Remove the capscrews and lockwasher securing the driving pulleys to the pulley driving flange. Remove the pulley. Remove the capscrews and the lockwashers securing the water pump assembly to the timing gear housing. Remove the water pump assembly. NOTE: *It may be necessary to "jar" the pump assembly to free it from the timing gear housing.*

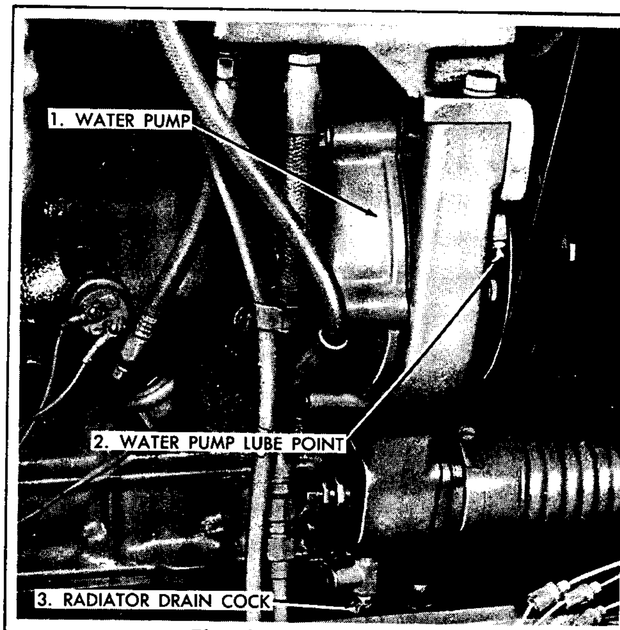


Fig. 2 — Water Pump

D. Water Pump Disassembly

1. Remove the cotter pin and the impeller retaining nut from the shaft.

   NOTE: *Two ⁵⁄₁₆" — 18 NC tapped holes are provided in the impeller for the use of a puller to remove the impeller from the shaft. Using a suitable bar type puller, pull the impeller from the shaft.* NOTE: *The seal assembly is now accessible. If a seal assembly replacement only is to be made, it will not be necessary to remove the shaft assembly from the pump.*

2. Loosen the two nuts and using a suitable puller, remove the pulley drive flange.

3. Remove the sealing washer retainer snap ring from the housing, turn the sealing washer retainer from the housing and remove the retainer, sealing washer, and the retaining washer.

4. Place the pump housing assembly on a press, with the impeller end of the shaft up. Press on the upper end of the shaft and remove the shaft and bearings from the pump housing.

5. Press the shaft from the bearings.

E. Water Pump Inspection

Repair of the water pump will consist of the replacement of any worn or damaged parts.

1. If the ceramic insert for the seal assembly (bonded to the impeller) is scored or rough, a new impeller assembly must be installed. If the sealing face of the seal assembly is scored or rough, drive the seal assembly from the pump housing. NOTE: *The seal assembly is serviced only as a unit.*

2. Clean and inspect the bearings for looseness, roughness, and bind, and replace if necessary.

3. Thoroughly clean the pump housing and check the condition of the bore for the bearings in the housing; replace the housing if necessary.

4. Inspect the condition of the shaft and the water flinger and replace if necessary.

F. Water Pump Assembly

1. Install the water flinger on the shaft so that the flanged end is located ⁵⁄₁₆" from the front face of the shoulder on the shaft.

1. Pump Assembly
2. Shaft Assembly
3. Water Flinger
4. Seal Assembly
5. Impeller Assembly
6. Cotter Pin
7. Impeller Nut
8. Lockwire
9. Retainer
10. Sealing Washer
11. Retaining Washer
12. Ball Bearing
13. Bearing Spacer
14. Ball Bearing
15. Water Pump Body
16. Driving Pulley Flange
17. Driving Pulley
18. Water Pump Gasket
19. Water Pump Volute Gasket
20. Volute

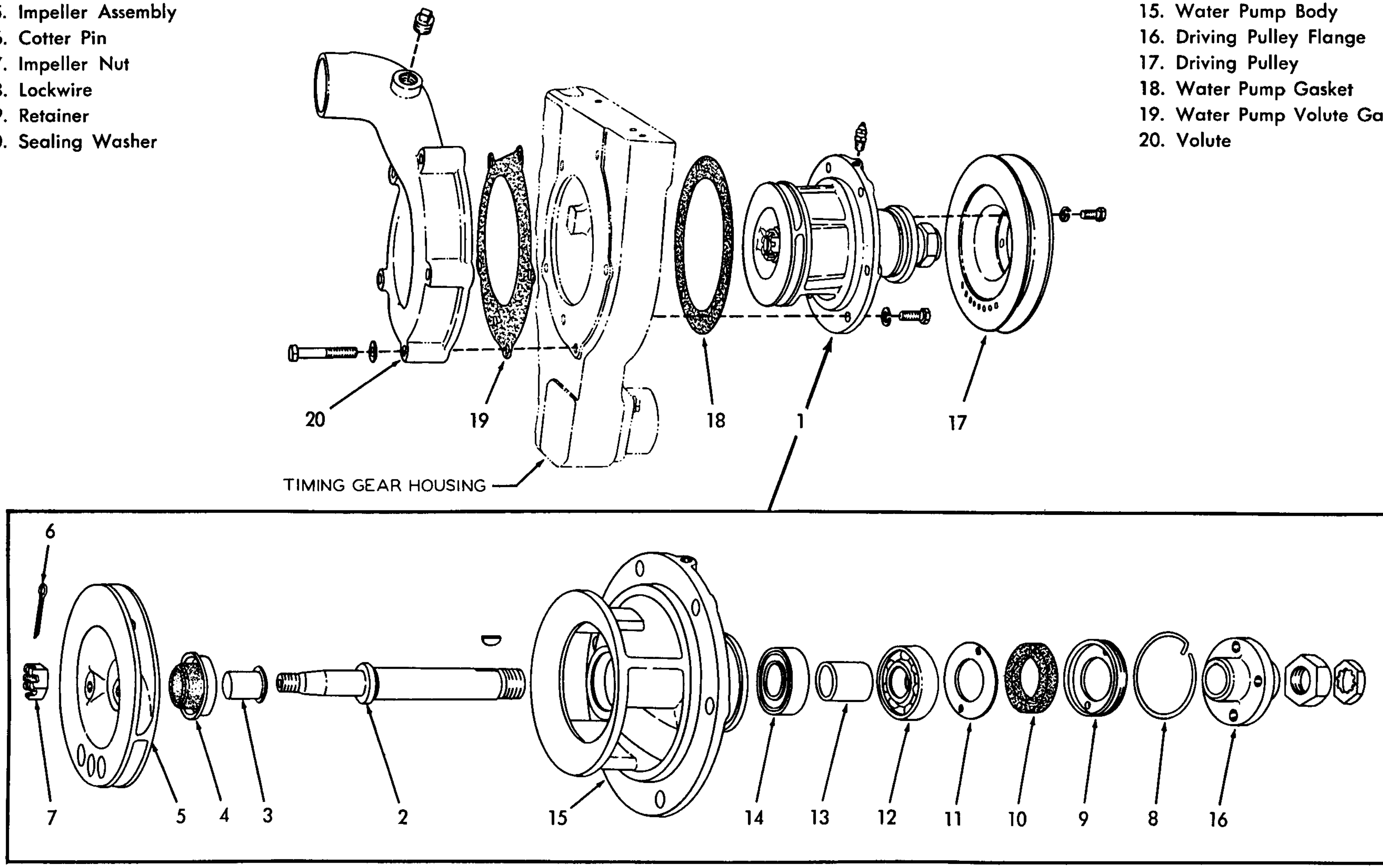


Fig. 3 — Water Pump Details

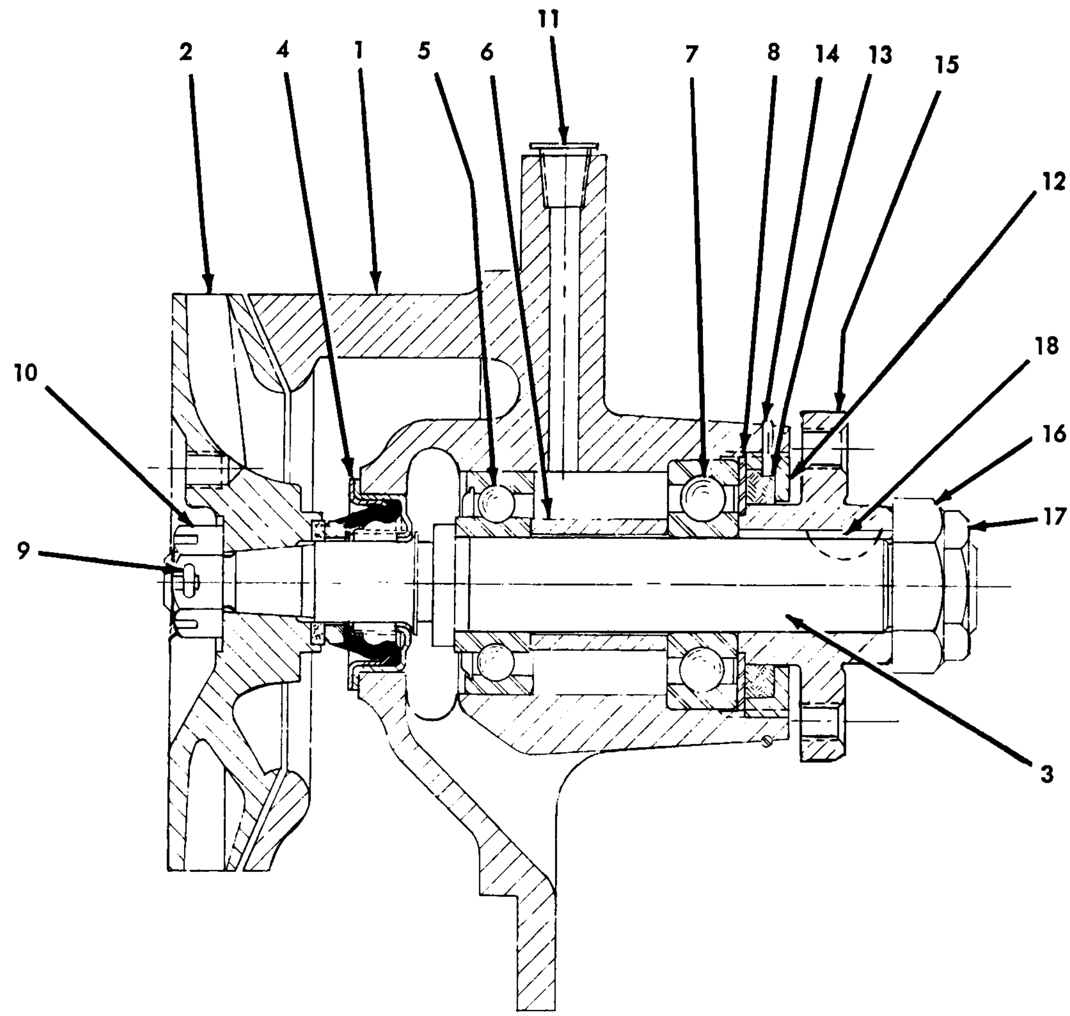


Fig. 4 — Water Pump — Sectional View

1. Body
2. Impeller Assembly
3. Shaft and Flinger Assy.
4. Seal Assembly
5. Bearing
6. Bearing Spacer
7. Bearing
8. Seal Retaining Washer
9. Cotter Pin
10. Nut
11. Shipping Cap
12. Seal Retainer
13. Seal Washer
14. Snap Ring
15. Flange
16. Hex Nut
17. Pal Nut
18. Woodruff Key No. 5

2. Press the rear bearing onto the shaft, being certain that the shielded side of the bearing is toward the impeller end of the shaft. Place the bearing spacer on the shaft. Press the front bearing onto the shaft, being certain that the shielded side of the bearing is toward the pulley end of the shaft.

3. Place the pump housing on a press, with the impeller side of the housing downward. Start the shaft (with bearings) in the pump housing. Pressing on the inner race of the rear bearing, press the shaft (with bearings) in the housing. IMPORTANT: *Hand pack the area between the bearings with clean ball and roller bearing lubricant.*

4. Install the retaining washer. Insert a new sealing washer in the sealing washer retainer and turn the washer retainer into the pump housing until the hole in the retainer is aligned with the hole in the housing for the retainer snap ring. Install the retainer snap ring.

5. Insert the "WOODRUFF" key in the shaft and insert the driving pulley flange on the shaft. Place the retainer nut on the shaft, tighten securely, and install the locking nut.

6. Install the seal assembly on the impeller end of the shaft and into position in the housing, using care to prevent damage to the seal assembly.

7. Place the impeller on the shaft and start the impeller retaining nut. Tighten the retaining nut to a torque of 40 to 50 lbs. ft. NOTE: *Tightening of the retaining nut to the above torque should press the impeller onto the shaft so that a clearance of .018" to .049" is provided between the impeller and the rear face of the housing. Insert the cotter pin in the retaining nut.*

G. Installation of Water Pump

1. Place the water pump assembly in the timing gear housing, using a new gasket. Be certain that the square cored opening (seal drain opening) in the pump housing is to the bottom. Secure the water pump to the timing gear housing with capscrews and lockwashers. Place the driving pulley on the driving flange and secure it with the lockwashers and capscrews.

2. Be certain that the lubricating fitting is in good condition.

3. Install the water pump and air compressor drive belt and adjust.

4. Fill the cooling system (refer to "DRAINING AND FILLING OF SYSTEM" in this Section).

6. THERMOSTATS AND THERMOSTAT HOUSING

A. Description

The two thermostats, located in the thermostat housing at the rear of the water outlet manifold, operate automatically to maintain a minimum coolant operating temperature of 170° F. The thermostats are so positioned, that when they are closed, the flow of coolant from the engine water outlet manifold to the radiator is completely shut off. The flow of coolant is then directed from the water outlet manifold through the water by-pass tube and back to the inlet side of the water pump.

Before the thermostats open, the coolant circulates through the engine circulating system only. When the thermostats open, the coolant circulates through the radiator, the engine circulating system and the by-pass tube to the inlet side of the water pump. The by-pass is constantly open regardless of whether the thermostats are open or closed.

The thermostats are of the "full choke" type and do not have a bleed or vent hole. One thermostat has an opening temperature rate of 170° F. and the other an opening rate of 180° F. It does not make any difference in their operation which thermostat is placed in the front or rear opening in the water outlet manifold. When a coolant temperature of 170° F. is reached, the lower rating thermostat starts to open and allows the coolant to pass to the radiator. The higher rating thermostat remains closed until a coolant temperature of 180° F. is reached, at which time the lower rating thermostat is nearing its maximum open rate and the higher rate thermostat starts to open. This two thermostat set-up with different opening temperature rates, results in a better stabilized coolant temperature. Because the thermostats do not have a bleed or vent hole, it is necessary to have a vent cock in the water outlet rear manifold and in the thermostat housing to vent out trapped air in the engine cooling system when filling the system with a coolant.

B. Service

Replacement of the thermostats will become necessary when the thermostats become corroded, sticking in the open or closed position. If the engine

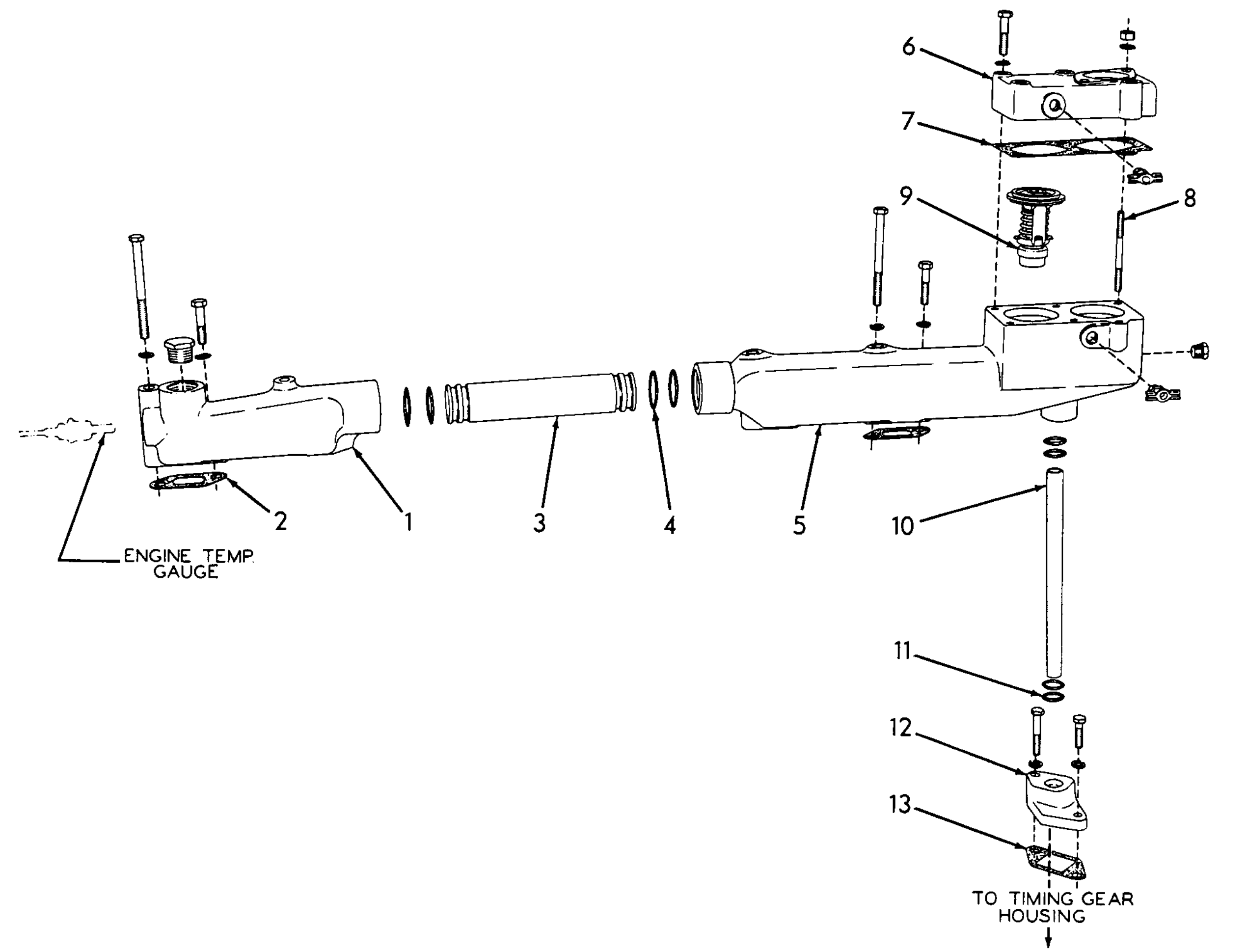


Fig. 5 — Water Outlet Manifold Details

1. Water Outlet Manifold
2. Gasket
3. Water Manifold Connecting Tube
4. O-Ring
5. Water Outlet Manifold
6. Thermostat Housing
7. Gasket
8. Thermostat Housing Stud
9. Thermostat (2 used, 170° and 180°)
10. Water By-Pass Tube
11. O-Ring
12. Water By-Pass Flange
13. Gasket

overheats or does not reach and maintain a minimum temperature of 170° F., the thermostats should be removed and tested as a possible cause of the trouble. Remove the thermostats (refer to C below).

One thermostat starts to open at 170° F. and is fully open at 185° F. and the other starts to open at 180° F. and is fully open at 195° F. A variation of plus or minus 5° is permissible. Suspend the thermostats in a pan of clean water so that the thermostats are completely immersed. Use an accurate thermometer to check the water temperature and gradually heat the water. As the temperature of the water approaches opening temperature, observe the thermostats and verify opening temperature as well as the full open temperature. The amount of travel between the closed and open position is approximately 5/16". Stir the water to obtain an accurate check. The thermostats are not adjustable and if they do not open and close within the above limits, they must be replaced. The only service necessary on the thermostat housing is to be certain that the housing is not cracked and that new gaskets are used during reassembly of the housing.

C. Thermostat and Thermostat Housing Replacement

1. Drain the cooling system (refer to "DRAINING AND FILLING OF SYSTEM" in this Section).

2. Remove the nuts and the lockwashers securing the water outlet elbow to the thermostat housing; remove the water outlet elbow.

3. Remove the capscrews and lockwashers securing the thermostat housing to the water outlet manifold and remove the thermostat housing, gasket and thermostats.

4. Clean and inspect the thermostat housing.

5. Place the two thermostats in the water outlet manifold. Install a new gasket. Place the thermostat housing in position and secure with capscrews, nuts and lockwashers.

6. Place the water outlet elbow on the thermostat housing and into the radiator inlet hose. Secure the water outlet elbow to the thermostat housing with the nuts and lockwashers, being certain that the gasket between the elbow and housing is properly positioned. Tighten the hose clamps on the radiator inlet hose securely.

7. Fill the cooling system with coolant (refer to "DRAINING AND FILLING OF SYSTEM" in this Section).

7. FAN, FAN BELTS AND FAN BELT ADJUSTMENT

A. Description

The fan pushes air through the radiator and the engine coolant is cooled as the coolant circulates from the top to the bottom of the radiator core. The fan hub assembly is mounted on a bracket, which is bolted to the rear of the engine cylinder block. The fan is bolted to the fan hub assembly, which rotates on two ball bearings, and is driven by two matched drive belts from the crankshaft pulley. A fan belt tightener assembly, mounted on the fan mounting bracket, is provided for adjusting the fan belt tension.

The original fan driving belts supplied on the engine are a matched pair of identical length. If only one belt replacement is required, it is imperative that both belts are replaced with a matched pair, otherwise satisfactory belt life will not be obtained.

B. Lubrication

The fan hub bearings must be lubricated each 100 hours of operation.

C. Fan Drive Belt Adjustment

The fan drive belts are properly adjusted when the straight side of the belts can be pressed inward by hand approximately ½ to ¾-inch at a point halfway between the crankshaft pulley and the fan hub pulley. To adjust the drive belts, drive the roll pin from the jam nut at the front of the fan hub spindle. Loosen the belt adjusting screw locknut, then loosen the spindle jam nut. Turn the adjusting screw in or out as necessary to obtain the proper tension on the belts. Tighten the spindle jam nut and install the roll pin, then tighten the adjusting screw lock nut.

D. Fan Hub Removal

1. Refer to "FAN DRIVE BELT ADJUSTMENT," Paragraph C, and loosen and remove the fan drive belts.

2. Loosen the generator adjustment capscrew and remove the drive belt.

3. Loosen the fan, air compressor and water pump drive belt. Refer to "AIR BRAKES."

4. Remove the roll pin used to lock the slotted jam nut on the front end of the fan hub spindle. Loosen the lock nut on the adjusting screw and remove the screw and locknut as an assembly. Remove the jam nut and washer from the spindle and withdraw the fan hub assembly from the fan mounting bracket.

5. The fan mounting bracket may now be removed if necessary.

E. Disassembly of Fan Hub

1. Remove the cap retaining snap ring at the rear of the hub. Pump grease into the hub until the hub cap pops out to where it can be pried from the hub. Otherwise it will be necessary to punch a hole in the hub cap and pry it from the hub with a screwdriver.

2. Remove the fan hub snap ring at the front of the hub and turn the spindle sealing washer retainer out of the fan hub; remove the retainer, spindle sealing washer, rear bearing retaining washer, and the retaining washer gasket.

3. Place the fan hub assembly in a suitable press, with the fan end of the pulley upward, and press the spindle and bearings from the fan hub.

4. Remove the cotter pin and fan spindle nut from the spindle and press the spindle from the bearings.

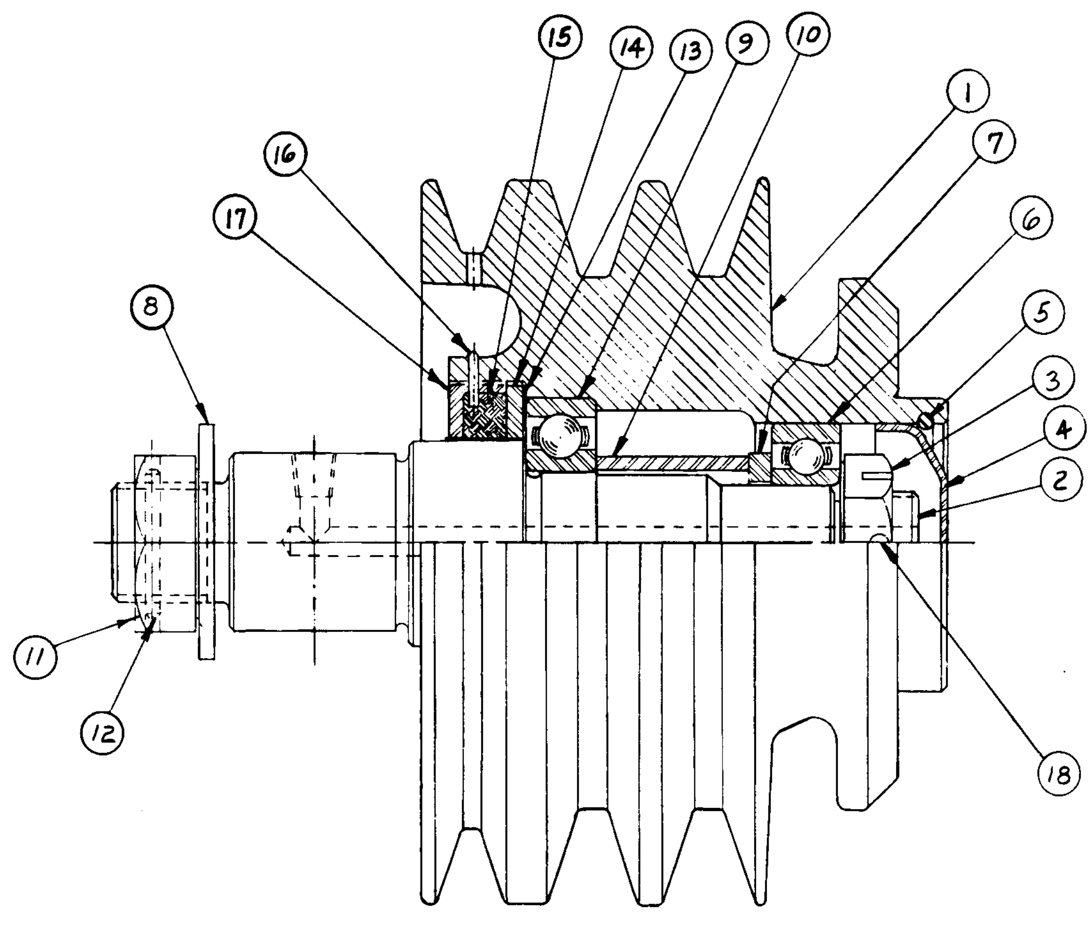
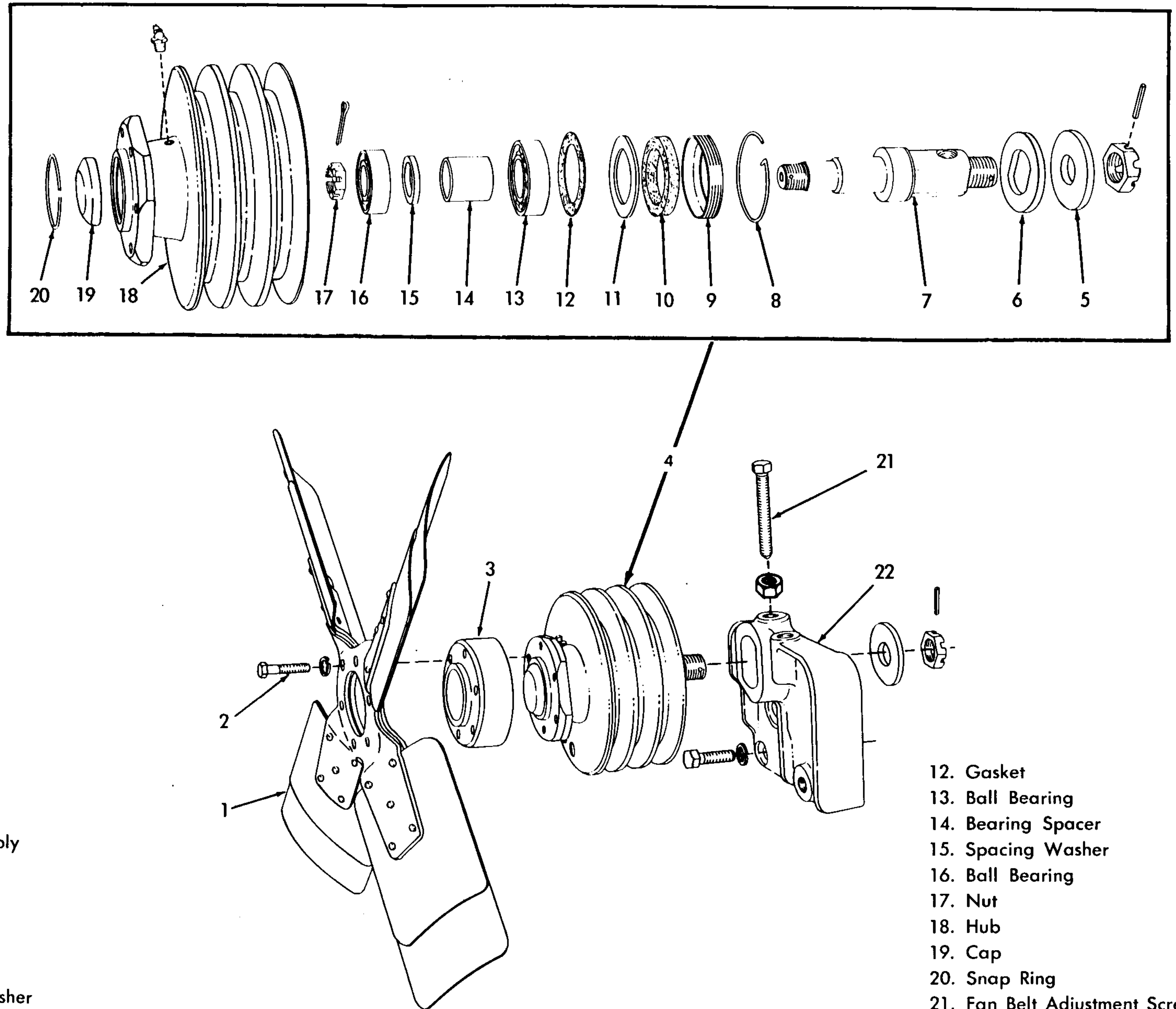


Fig. 6 — Fan Hub — Cross Section

1. Hub
2. Spindle
3. Nut
4. End Cap
5. Snap Ring
6. Ball Bearing
7. Spacer — Washer
8. Washer Clamp
9. Ball Bearing
10. Bearing Spacer
11. Nut (Slotted Hex)
12. Roll Pin
13. Gasket
14. Seal — Retaining Washer
15. Seal — Washer
16. Snap Ring
17. Seal Retainer
18. Cotter Pin



1. Fan
2. Capscrew
3. Spacer
4. Hub Assembly
5. Washer
6. Washer
7. Spindle
8. Snap Ring
9. Retainer
10. Sealing Washer
11. Retaining Washer
12. Gasket
13. Ball Bearing
14. Bearing Spacer
15. Spacing Washer
16. Ball Bearing
17. Nut
18. Hub
19. Cap
20. Snap Ring
21. Fan Belt Adjustment Screw and Jam Nut
22. Fan Mounting Bracket

Fig. 7 — Fan

F. Inspection of Fan Hub Assembly

Wash all parts thoroughly in a clean solvent or fuel and inspect the parts for wear or damage. Rotate the bearings by hand and check for looseness, roughness, and binding, and replace them if necessary. Inspect the spindle and be certain that it is not bent or worn and that the threads are not damaged beyond repair. Inspect the fan hub for wear and be certain that the pulley grooves are smooth and that the pulley is not chipped or cracked. Discard the spindle sealing washer and the retaining washer gasket and install new ones when assembling. Replace the generator drive belt, the air compressor and water pump drive belt, and the fan drive belts if they are worn or frayed.

G. Assembly of Fan Hub

1. Press the front ball bearing onto the spindle. Place the spindle bearing spacer and the rear bearing spacing washer on the rear end of the spindle. Press the rear bearing into the spindle.

2. Install the spindle nut, tighten securely, and install the cotter pin.

3. Place the pulley on a press, with the fan end of the pulley downward. Start the spindle (with bearings) in the pulley. Pressing on the front end of the spindle, press the spindle (with bearings) in the pulley. NOTE: *While pressing the spindle into the pulley, hand pack the area between the bearings with clean ball and roller bearing lubricant.*

4. Install a new retaining washer gasket and the rear bearing retaining washer on the spindle. Insert a new spindle sealing cork washer into the spindle sealing washer retainer and turn the washer retainer into the pulley until the hole in the retainer is aligned with the hole in the pulley for the fan hub snap ring. Install the fan hub snap ring.

5. Hand pack the hub cap with grease before installing and secure with the cap retaining snap ring.

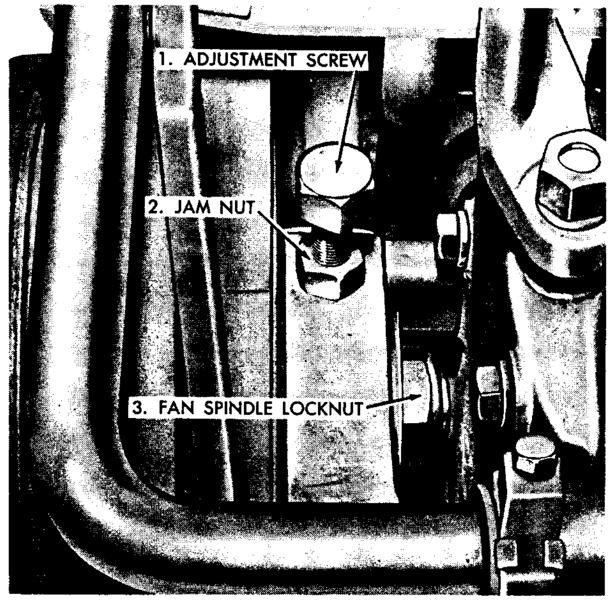


Fig. 8 — Fan Drive Belts Adjuster

H. Fan Hub Installation

1. Install the fan mounting bracket if it was removed.

2. Insert the front end of the fan hub spindle in the fan mounting bracket. Install the spindle clamping rear washer, and start the slotted jam nut onto the fan spindle and snug the jam nut, but do not tighten.

3. Place the air compressor and water pump drive belt, the fan drive belts, and the generator drive belt on the pulleys.

4. Adjust the fan drive belts (refer to "FAN DRIVE BELT ADJUSTMENT," Par. C, in this Topic). Adjust the air compressor and water pump drive belts (refer to "AIR COMPRESSOR AND WATER PUMP DRIVE BELT ADJUSTMENT," in Section XII). Adjust the generator drive belt (refer to "GENERATOR DRIVE BELT ADJUSTMENT," in Section VI).

SECTION V — ENGINE LUBRICATING SYSTEM

5

1. ENGINE LUBRICATING SYSTEM

A. Description

The engine lubricating system is designed so that the engine can be operated at an angle of 20° in any direction. This system is known as a full pressure lubricating system. Oil pressure at normal operating temperature should be 30 — 55 P.S.I. at high idle engine speed.

The engine is pressure lubricated throughout by a gear type lubricating oil pump (pressure pump) driven by a gear in mesh with the crankshaft gear, located on the rear end of the crankshaft. A pump pressure relief valve (located in the pump housing) is provided and is set to relieve when discharge pressure in the engine oil pressure pump exceeds 130 P.S.I.

The lubricating oil pump draws the oil from the crankcase through the lubricating oil pressure pump suction screen which is submerged in the lubricating oil. The pump then circulates the oil under pressure through the full flow oil filter, the engine oil cooler, and then to the main oil gallery of the engine which extends lengthwise through the cylinder block. Oil passages direct the oil from the main oil gallery to the camshaft and main bearings and through the rifle drilled connecting rods to the piston pins.

Stabilized oil pressure is maintained within the engine by an oil pressure regulating valve, located in the main oil gallery at the left front corner (flywheel housing end) of the cylinder block. Excess oil by-passed through this valve returns to the crankcase oil pan.

A horizontal and vertical oil passage through the center of the cylinder block extends from the main oil gallery to a cavity in the left side of the cylinder block. From this cavity there are two openings which align with an oil passage in each cylinder head, conveying the oil to a passage in the Nos. 3 and 4 rocker arm shaft brackets and to the hollow center of the rocker arm shafts which have passages for each rocker arm.

A horizontal oil passage to the side of the block below the fuel injection pump is connected to the injection pump by an external line. This external line conveys oil to the fuel injection pump housing. Excess oil from the fuel injection pump is dumped into the timing gear housing and returned to the oil pan.

The oil filter head contains a pressure relief valve which is provided to by-pass the filter, sending the unfiltered oil into the main gallery if the filter becomes clogged or if in cold weather the oil is too thick to circulate freely through the oil filter.

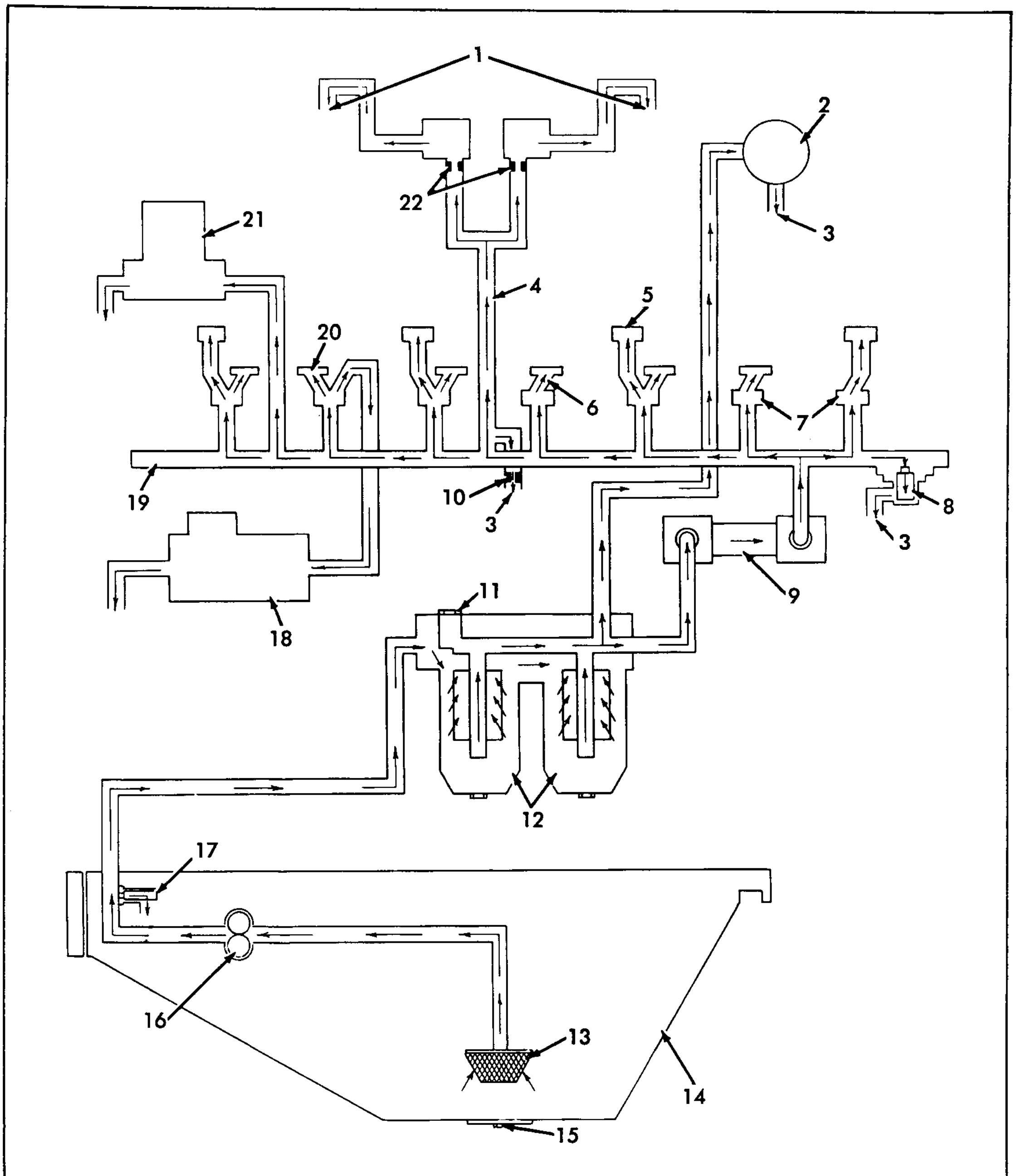


Fig. 1 — Lubricating Oil Flow — Schematic Diagram

1. Rocker Arm Shaft Drain Tubes (Drain Back to Oil Pan)
2. Turbocharger
3. Returns to Oil Pan
4. To Valve Rocker Arm Shafts
5. Camshaft Bearing
6. Crankshaft Oil Passage
7. Main Bearings
8. Oil Pressure Regulating Valve
9. Engine Oil Cooler
10. Restrictor
11. Oil Filter Pressure Relief Valve
12. Lubricating Oil Filters
13. Oil Pressure Pump Suction Screen
14. Oil Pan
15. Oil Drain Plug
16. Lubricating Oil Pressure Pump
17. Lubricating Oil Pump Pressure Relief Valve
18. Fuel Injection Pump
19. Main Oil Gallery
20. To Connecting Rod Bearings and Piston Pins (Drains Back to Oil Pan)
21. Air Compressor
22. Restricted Rocker Arm Shaft Brackets at Nos. 3 and 4 Cylinders

2. OIL PAN

A. Description

The cast iron oil pan is the reservoir for the engine lubricating oil. It is so designed that the engine can operate at an angle of 20° in any direction. The sump is provided with a drain plug to facilitate the oil changing procedure.

B. Removal and Inspection

In order to remove the oil pan, the engine must be removed from the loader (refer to "ENGINE").

1. Place the engine on a suitable engine stand.
2. Remove the drain plug from the sump and drain the lubricating oil.
3. Remove the capscrews and lockwashers securing the front of the pan to the flywheel housing. Remove the capscrews and lockwashers from the rear and side rails of the oil pan.
4. Jar the oil pan loose from the cylinder block and remove it from the engine.
5. Thoroughly wash all of the parts in a cleaning solvent.
6. Inspect the drain plug and oil pan for cracks or other damage. Replace them if necessary.
7. Inspect the sealing ring in the rear of the flywheel housing which contacts the front of the oil pan. CAUTION: *Be positive that it is in perfect condition.*

C. Assembly of Oil Pan to Engine

1. Using gasket cement, cement the oil pan gaskets to the rear and side rails of the oil pan.
2. For ease of installing the oil pan, make up guide studs and screw them into the side oil pan rails of the new cylinder block. Also have available a greased sheet of shim stock larger than the front area of the oil pan. The greased sheet of shim stock is to be placed against the seal ring in the lower half of the flywheel housing to protect the seal from damage when the oil pan is installed.
3. Mount the oil pan on the guide studs. Hold it in position by inserting a capscrew and lockwasher near each corner, but do not tighten it so that the oil pan cannot be shifted. Carefully ease out the greased sheet of shim stock protecting the seal ring in the flywheel housing.
4. Remove the guide studs. Install the capscrews and lockwashers which secure the front flange of the oil pan to the flywheel housing and tighten them securely.
5. Install the remaining capscrews in the oil pan rear and side rails and tighten them securely.
6. Install the drain plug with a new gasket into the drain plug hole and tighten it securely.
7. Fill the oil pan with lubricating oil to the proper level (refer to Par. E, Topic 7, of this Section).

3. LUBRICATING OIL PRESSURE PUMP

A. Description

The gear-type oil pressure pump is mounted on the cylinder block below the rear main bearing cap. The oil pressure pump driving gear is a helical gear which meshes directly with the crankshaft gear.

The oil pressure pump driving gear and the upper gear (internal) are keyed as well as pressed onto the upper shaft. The lower gear (internal), containing a bushing, rotates as an idler on a shaft pressed into the pump body and held by a retainer. Bushings are provided in the pump housing and in the pump cover assembly for the upper shaft.

A plunger type pressure relief valve, located in the pressure side of the oil pressure pump housing, by-passes excess oil back to the oil pan when the discharge pressure exceeds 130 P.S.I. To protect the oil pump gears, a suction screen is attached to the oil pump suction pipe.

B. Removal (Fig. 3)

1. Drain the engine lubricating oil and remove the oil pan. (Refer to "OIL PAN," Par B — Removal and Inspection.)

2. Remove the capscrews and lockwashers attaching the oil pressure pump discharge pipe to the oil pressure pump assembly. Remove the capscrews and lockwashers securing the front end of the oil pressure pump discharge pipe to the cylinder block. Loosen the pipe supporting clamp and remove the oil pressure pump discharge pipe.

3. Remove the capscrews and lockwashers securing the oil pressure pump suction pipe to the oil pressure pump. Remove the capscrew, flat washers, lockwasher, nut and cotter pin, securing the oil pressure pump suction pipe to the supporting clamp and remove the oil pressure pump suction pipe.

4. Remove the capscrews and lockwashers securing the oil pressure pump assembly to the cylinder block and remove the oil pressure pump assembly.

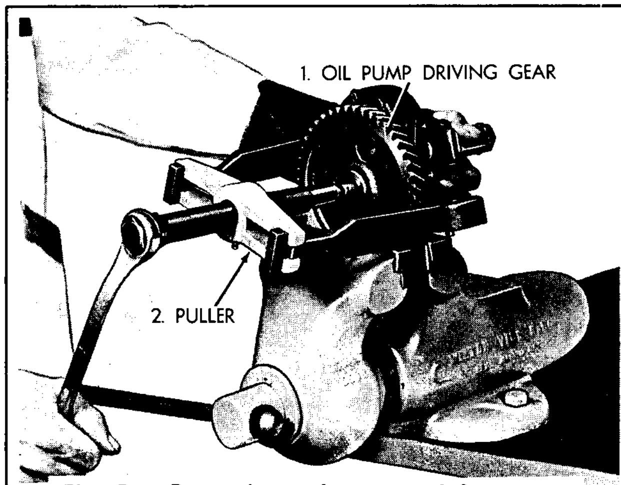


Fig. 2 — Removing Lubricating Oil Pressure Pump Driving Gear

C. Disassembly (Figs. 2 and 3)

1. Thoroughly wash the pump assembly. Remove the cotter pin and slotted nut from the rear end of the upper shaft. Place the oil pump assembly in a vise equipped with copper jaws, clamping the driving gear. Using tools as shown in Fig. 2, press the pump from the gear. Remove the "WOODRUFF" key from the pump shaft. File off any burrs on the shaft.

2. Remove the locking wires and drilled head capscrews and lockwashers securing the cover assembly to the pump housing. Then tap the cover lightly to loosen it from the dowel pins and remove the cover assembly.

3. Remove the upper shaft assembly with the gear.

4. Slide the lower gear from the lower shaft.

5. Unlock and remove the pressure relief valve assembly from the pump housing.

6. Remove the capscrew and lockwasher securing the lower shaft retainer and remove the retainer and the lower shaft.

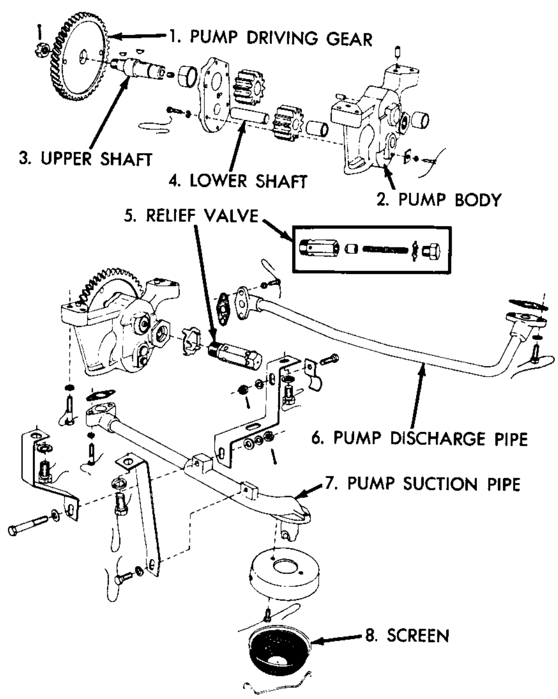


Fig. 3 — Oil Pressure Pump Assembly Details

D. Cleaning and Inspection of Oil Pressure Pump Parts

1. Wash all of the oil pump components in a clean solvent and thoroughly inspect all of the parts before reassembling the oil pump.

   The principal wearing parts of the oil pump are the upper and lower gears. If dirt and sludge have been allowed to accumulate in the lubricating system, oil pump gear wear may be rather pronounced in a comparatively short time. When the oil has been kept clean and the oil filter has been properly serviced, the wear on these parts should be very slight.

2. Inspect the pump gear teeth, the inside of the pump housing, and the inner face of the cover for wear and scoring. The gear teeth, the inside of the pump housing, and the inner face of the cover must be smooth, with no scratches, score marks, or rough spots.

   The radial clearance between the pump gears and the pump housing should be .00175" to .00275". When the radial clearance exceeds .004" to .006", it will be necessary to replace the worn parts. The end clearance of the gears in the pump should be .002" to .004". When the end clearance exceeds .005" to .007", it will be necessary to replace the worn parts. If replacement of the oil pump gears is necessary, the oil pump gear must be pressed off the shaft. When installing the upper gear on the upper shaft, install the "WOODRUFF" key in the shaft and press the shaft into the gear (chamfered side of gear next to shoulder on shaft) until the gear is against the shoulder on the shaft.

3. Inspect the pump shafts and bushings for excessive wear or scoring and replace them if necessary.

   a. The specified clearance between the upper shaft and the bushing located in the pump housing is .0015" to .0030". After installing a new bushing in the pump housing, it should be reamed to .937" / .938".

   b. The specified clearance between the upper shaft and the bushing located in the pump cover is .0015" to .0035". After installing a new bushing in the pump cover, it should be reamed to 1.2495" / 1.2505".

   c. The specified diameter of the upper shaft at the housing location is .9350" to .9355" and at the cover location is 1.247" to 1.248".

   d. The specified clearance between the lower gear bushing and the lower shaft is .0005" to .002". After pressing a new bushing into the lower gear, drill a 1/8" oil hole through the bushing (in line with the oil hole provided in the gear), then burnish or ream the bushing to .7495" / .7505". The specified diameter of the lower shaft is .7485" to .7490".

   e. Also, be certain that the oil holes and passage in the upper shaft and the oil hole in each gear are open before reassembling the pump.

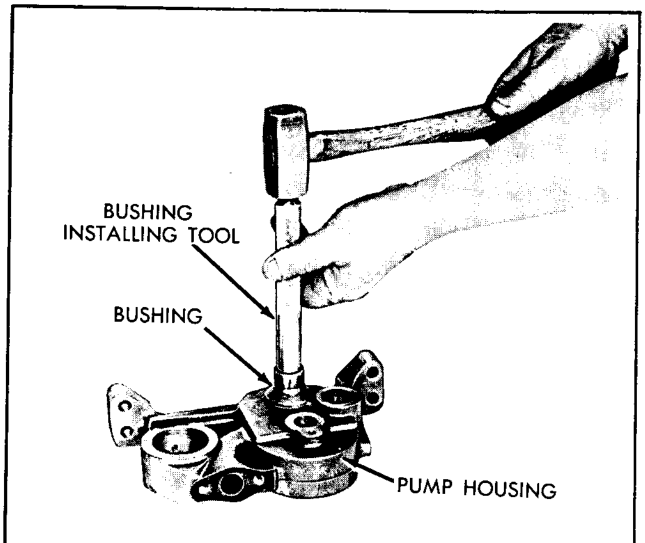


Fig. 4 — Installing Bushing in Typical Oil Pressure Pump Housing

4. Disassemble and inspect the pressure relief valve. The piston must slide smoothly in the bore of the valve body. When the piston or the bore of the valve body show excessive wear or roughness, a new valve assembly must be installed.

5. Remove the oil screen from the suction pipe. Thoroughly clean, and reinstall.

E. Assembly (Fig. 3)

The upper shaft has two keyways; one for the pump driving gear and one for the upper gear. A #6 ($\frac{5}{32}$" x $\frac{5}{8}$") "WOODRUFF" key is required for each keyway. Lubricate the bushings and shafts with clean oil and assemble the oil pump as follows:

1. Install the pressure relief valve assembly and secure it with the pressure relief valve body lock.

2. Install the lower shaft in the pump housing and secure it with the retainer, lockwasher, and capscrew. Secure the capscrew with a locking wire.

3. Install the lower gear on the lower shaft.

4. Insert the upper shaft, with the upper gear on the shaft, into the pump housing.

5. Position the pump cover assembly over the dowel pins in the pump housing and secure it with the drilled-head capscrews, lockwashers, and locking wires.

6. Install the "WOODRUFF" key in the upper shaft and press the pump driving gear on the shaft. Install and tighten the slotted nut and secure it with the cotter pin.

7. Be sure that the assembled pump will turn without binding before proceeding to attach it to the engine.

F. Installation

1. Install the oil pump on the cylinder block, inserting the dowel pins into the holes in the cylinder block, and secure the pump to the cylinder block with the capscrews and lockwashers.

   NOTE: *The specified backlash between the oil pump driving gear and the crankshaft gear is .003" to .007" and should not exceed .020".*

2. Using new gaskets, install the oil pressure pump suction pipe onto the oil pressure pump and secure it with the lockwashers and capscrews.

3. Place the pipe supporting clamp over the oil pressure pump suction pipe and tighten the capscrew and nut securing the oil pressure pump suction pipe to the supporting bracket.

4. Using new gaskets, install the oil pressure pump discharge pipe onto the oil pressure pump and the cylinder block and secure it with the lockwashers and capscrews.

5. Place the pipe supporting clamp over the oil pressure pump discharge pipe and tighten the capscrew and nut to secure the oil pressure pump suction pipe to the supporting bracket.

6. Install the engine oil pan, using a new oil pan gasket set. Fill the engine crankcase to the proper level with the specified lubricant (refer to "LUBRICATING OIL FILTER," Topic 6, in this Section).

4. OIL PRESSURE REGULATING VALVE

A. Description

Stabilized oil pressure is maintained within the engine by an oil pressure regulating valve (Fig. 5), located in the main oil gallery at the left front corner of the cylinder block. When conditions are such that the oil pressure in the regulating valve exceeds approximately 40 – 50 P.S.I., the valve piston is pushed off its seat and the excess oil is by-passed through this valve to the crankcase oil pan.

The pressure regulating valve should require very little attention under normal conditions. If the lubricating system is allowed to sludge, the valve may not work properly. If the valve sticks in the open position, a sharp drop in the engine oil pressure will occur; or if the valve sticks in the closed position, a sharp rise in the engine oil pressure will occur. If the oil pressure should rise or drop sharply, the regulating valve must be disassembled and checked for damage or sludge.

Whenever the oil pump or engine is disassembled, all of the components of the oil pressure regulating valve assembly should also be removed, thoroughly cleaned, and inspected.

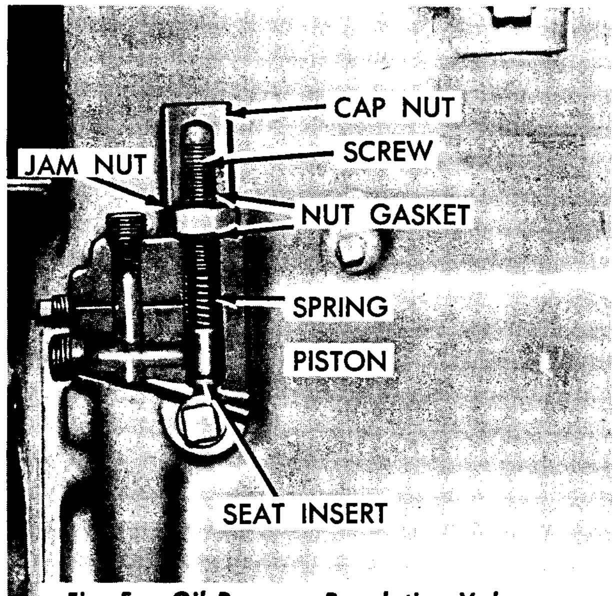


Fig. 5 — Oil Pressure Regulating Valve — Cutaway View

B. Disassembly of Oil Pressure Regulating Valve

1. Remove the pressure regulating valve cap nut and valve nut gasket.

2. Remove the jam nut and valve nut gasket.

3. Remove the pressure regulating valve screw, noting the number of turns required for removal. Remove the valve spring and valve piston.

4. Wash all of the parts thoroughly and inspect them. Replace any worn or damaged parts.

   NOTE: *The insert seat for the regulating valve piston is held in position in the cylinder block by a press fit of .0015″ to .0030″.* Very seldom does it require replacement. However, the condition of the seat can be determined by the use of Prussian Blue on a new regulating valve piston. Make up a wooden holder and press the piston onto it. Cover the seat area of the piston with a light coat of Prussian Blue and insert the piston into the bore in the cylinder block. Turn the holder about a sixth of a turn and remove piston and holder. Examine the seat marking on the piston. It should be a continuous fine line seat because the seat angle of the piston is 45° and the seat angle of the regulating valve seat insert is 30°. If the seat contact is not continuous, it can be improved by installing the piston and using caution, place a 3/8″ brass rod on top of it and strike lightly with a hammer. Again check the seat with Prussian Blue.

   If necessary, the insert seat can be replaced. Using a 9/16″ x 18″ tap, cut threads into the inside diameter of the seat insert. Turn a 9/16″ x 18″ stud just a few turns into the seat insert. Connect the stud to a sliding hammer and remove the insert seat. To install a new seat insert, make up a driving tool and drive the seat in the cylinder block.

C. Assembly of Oil Pressure Regulating Valve

1. Lubricate the valve seat insert and valve piston with clean oil. Install the oil pressure regulating valve piston and valve spring in the cylinder block.

2. Install the pressure regulating valve screw. NOTE: *Turn the valve screw into the cylinder block the same number of turns as required for removal.*

3. Place a valve nut gasket in position over the pressure regulating valve screw and install the jam nut.

4. After the engine has been reassembled and is running, operate the engine until normal operating temperature (170° F. minimum) is indicated by the engine temperature gauge. Adjust the oil pressure regulating valve screw to obtain a maximum oil pressure of 40 — 50 P.S.I. at high idle engine speed, then tighten the jam nut. No further adjustment should be necessary.

5. Place a valve nut gasket over the pressure regulating valve screw and install the pressure regulating valve cap nut.

5. LUBRICATING OIL COOLER AND TRANSMISSION OIL COOLER

A. Description

The lubricating and transmission oil coolers (Fig. 6), located on the left side of the engine, consist of two corrosion resistant cooling cores and tanks. The water pump circulates coolant through the cooling cores, tubes and the engine lubricating oil pump and the transmission torque converter circulate oil through their respective tanks around the outside of the tubes of the cooling cores, thereby controlling the oil temperatures.

The cooling cores consist of small copper tubes which dissipate heat from the oil to the engine coolant. If proper lubricating oil and transmission oil maintenance procedures are followed, the oil coolers will function efficiently. However, if the oil in the engine and transmission is not changed at the recommended intervals, impurities will be deposited in the oil coolers and will restrict the flow of oil around the tubes of the cooling cores. Restriction of the flow of oil around the tubes of the cooling cores is usually indicated by a drop in oil pressures due to the oil overheating. If this occurs, the cooling cores must be cleaned or new ones installed.

IMPORTANT: *IT IS ABSOLUTELY NECESSARY THAT THE OIL COOLER UNIT BE KEPT CLEAN FOR PROPER OIL COOLING.*

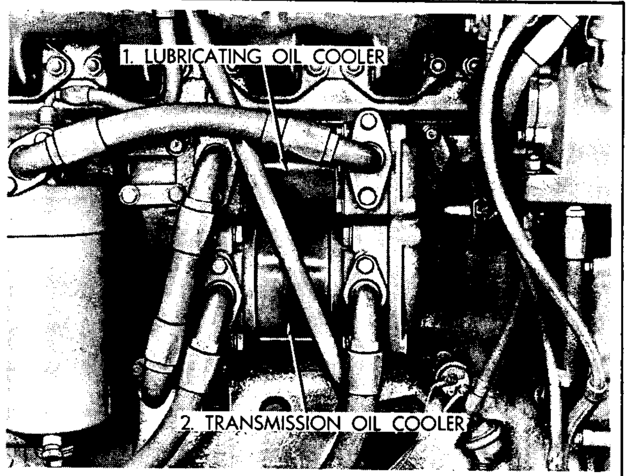


Fig. 6 — Lubricating Oil Cooler and Transmission Oil Cooler Location

B. Removal of Oil Coolers

1. Drain the cooling system (refer to "ENGINE COOLING SYSTEM," Section IV).

2. Loosen the hose clamps on the water pump-to-oil cooler hose.

3. Remove the capscrews and lockwashers attaching the four oil lines to the oil coolers.

4. Remove the capscrews and lockwashers attaching the oil coolers to the cylinder block and remove the oil coolers complete with water inlet and outlet connections.

C. Disassembly of Oil Coolers

1. Remove the capscrews and lockwashers attaching the water inlet connection to the oil coolers and remove the connection.

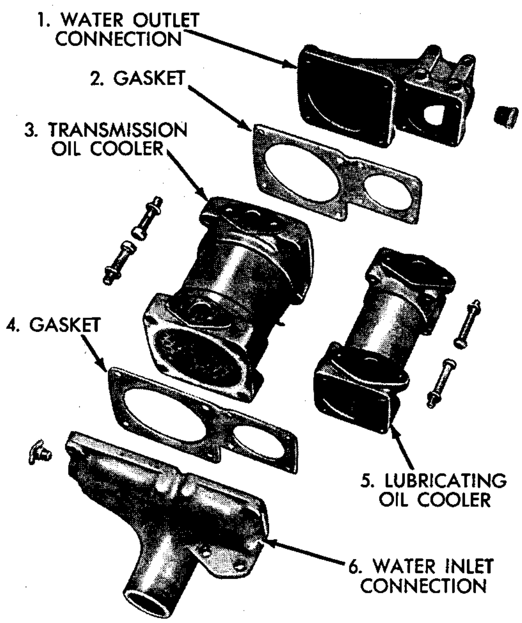


Fig. 7 — Lubricating Oil Cooler and Transmission Oil Cooler — Assembly Details

2. Remove the capscrews and lockwashers attaching the water outlet connection to the oil coolers and remove the connection.

D. Cleaning of Oil Coolers

Cleaning the oil coolers requires the use of special solvents. The following solvents have been found effective when used according to the manufacturer's direction:

Excello Floor Cleaning Compound

Turco Cleaning Compound

No. 70 Stripper

Mixture of 3 Parts Oakite No. 7 and 5 Parts Fuel Oil

Bendix Cleaning Compound

To use the last named solvent, merely submerge the oil coolers into the solution for a sufficient length of time to allow the chemical action of the solvent to dissolve or loosen the sludge or other foreign matter. Flush the oil coolers thoroughly with live steam or spirits after cleaning regardless of type of cleaner used.

NOTE: *If the oil coolers are badly clogged, a new oil cooler must be installed.*

E. Assembly and Installation of Oil Coolers

1. Using gasket cement, cement a new oil cooler gasket to the face of the oil cooler. Coat the other side of the gasket with gasket cement, then install the water outlet connection and secure it with the capscrews and lockwashers.

2. Using gasket cement, cement a new oil cooler gasket to the face of the oil cooler. Coat the other side of the gasket with gasket cement, then install the water inlet connection and secure it with the capscrews and lockwashers.

3. Place the oil cooler assembly on the cylinder block, using new gaskets, and secure it with the capscrews and lockwashers.

   NOTE: *When installing the oil cooler assembly on the cylinder block, the water inlet connection can also be inserted into the end of the water pump-to-oil cooler hose.*

4. Tighten the water pump-to-oil cooler hose clamps securely.

5. Place the oil lines in position on the oil cooler, using new gasket and gasket cement, and secure them with the capscrews and lockwashers.

6. Close the cooling system drain cocks and open the thermostat vent cocks. Fill the cooling system until coolant (free of bubbles) flows from the vent cocks. Close the vent cock and continue filling the system until the coolant level is approximately one (1) inch below the radiator filler pipe.

7. Operate the engine and check for oil and water leaks. Correct any leaks found.

6. LUBRICATING OIL FILTERS

A. Description

The lubricating oil filters located on the left side of the engine are of the full flow type and contain replaceable type elements. New elements must be installed each time that the oil in the crankcase is changed or more often if conditions warrant.

The oil filter head contains a pressure relief valve, which is provided to by-pass the filters, sending the unfiltered oil into the main gallery, if in the event the filters become clogged, or if in cold weather the oil is too thick to circulate freely through the oil filters.

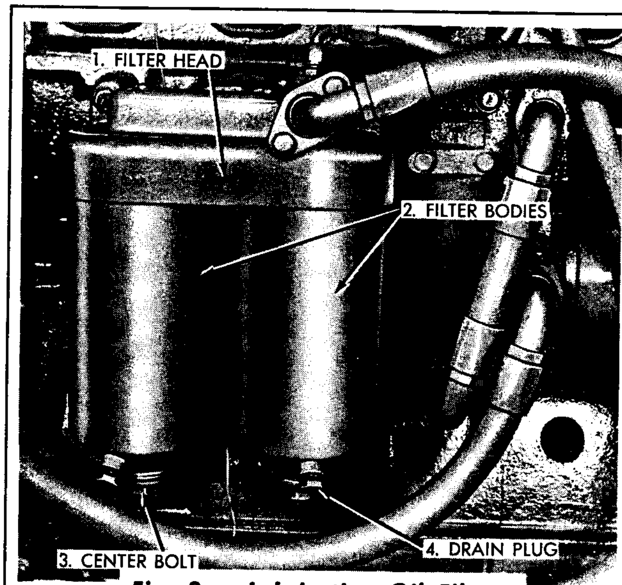


Fig. 8 — Lubricating Oil Filters

B. Service

Under normal conditions, the pressure relief valve should require very little attention. If the lubricating system has been allowed to sludge, the valve may not work freely.

Whenever the engine is disassembled for repairs, the oil filter valve assembly should also be removed, thoroughly cleaned in fuel oil, and inspected.

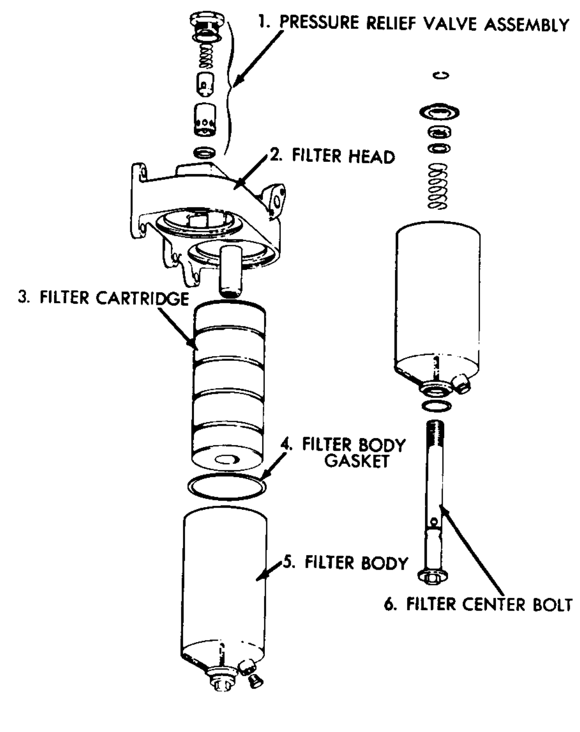


Fig. 9 — Lubricating Oil Filters Assembly Details

C. Removal and Installation of Lubricating Oil Filter Assembly

1. Thoroughly clean the filter body and the surrounding area. Remove the oil drain plug from the filter body and allow the filter to drain.

2. Disconnect the oil line from the oil filter head assembly.

3. Disconnect the oil line to the turbocharger.

4. Remove the capscrews and lockwashers attaching the filter head to the cylinder block and remove the filter and head as a complete assembly.

5. Install the lubricating oil filter assembly by a direct reversal of the removal procedure, using a new "O" ring between the oil filter head and the cylinder block. Tighten the filter center bolt to a torque of 75 to 80 lbs. ft. Install the oil drain plug in the filter body and tighten it securely.

D. Removal and Installation of Oil Filter Pressure Relief Valve

1. Thoroughly clean the filter head and the

surrounding area. Remove the oil drain plugs from filter bodies and allow the filters to drain.

2. Remove the pressure relief valve cap, gasket, spring and piston.

3. Wash the parts thoroughly and inspect them for wear or damage. Replace any worn or damaged parts.

4. Install the parts by a direct reversal of the removal procedure and tighten the cap securely.

E. To Change Engine Oil and Replace Filter Elements

The engine crankcase lubricant must be drained and refilled to the proper level with the specified lubricant and new oil filter elements installed each 100 hours of operation, or more often if conditions warrant. NOTE: *The engine should be at normal operating temperature when draining the lubricant.*

1. Loosen and remove the oil drain plug from the oil pan and allow the oil to drain. Install and tighten the oil drain plug being certain that the oil drain plug gasket is in good condition.

2. Thoroughly clean the filter head and the surrounding area. Remove the oil drain plugs from the filter bodies and allow the filters to drain.

3. Loosen the center bolts and remove the center bolts, the filter bodies, and the filter elements as units from the filter head.

4. Remove the filter elements from the filter bodies and discard the elements.

5. Thoroughly wash and dry the interior of the filter bodies.

6. Install two new filter body gaskets in the filter head. Install two new elements in the filter bodies.

7. Install the filter body assemblies on the filter head, being certain that the filter body gaskets are properly installed in the head. Then tighten the center bolts to a torque of 75 to 80 lbs. ft. Install the oil drain plugs in the filter bodies and tighten them securely.

8. Fill the crankcase (through the crankcase oil filler tube) with 5 gallons of the specified lubricant.

   a. Start the engine and operate it at $\frac{1}{4}$ throttle for several minutes.

   b. Stop the engine and allow several minutes for the oil to drain back before checking the oil level.

   c. Using the oil level gauge rod, check the oil level and add oil if necessary to raise the oil level even with the "FULL" mark on the gauge rod.

   d. Observe the lubricating oil filters for oil leakage and be certain that the filter bodies and gaskets are properly installed. Observe the oil pan drain plug for leakage.

SECTION VI — ELECTRICAL SYSTEM

1. DESCRIPTION OF SYSTEM

The electrical system, which includes the starter, generator, generator regulator, batteries, headlights, and wiring, is a 24-volt system throughout. Current is supplied by two 12-volt, wet cell, storage batteries carried in a compartment under the forward end of the engine hood and directly behind the hydraulic tank.

Electrical energy drained from the batteries through the operation of the above named units is replaced by the generator. The output of the generator is controlled by the generator regulator to prevent overcharging of the batteries.

2. WARRANTY AND ADJUSTMENT POLICY

Manufacturers of the batteries, starter, generator, and generator regulator used in the tractor loader are responsible for this equipment during the warranty period. Any claim for replacement or repair of any of these units must be presented to the manufacturer, not to the Allis-Chalmers Manufacturing Company. Suppliers of such equipment are represented by distributors or dealers in nearly all cities; they are authorized to make reasonable adjustments or replacements for their respective companies. Always give the serial number of the tractor and the date the machine was delivered when presenting a claim of this nature.

3. WIRING SYSTEM

Heavy cables (#0) connect the batteries and the starter. 12 gauge cables connect the generator and generator regulator, a 12 gauge cable connects the ammeter and generator regulator, 14 gauge cables connect the light switch and ammeter and the light switch and headlights, and a 12 gauge cable connects the ammeter and the starter solenoid. Two 10 amp fuses, connected into the cables between the main headlight, auxiliary headlights, back-up lights and the light switch, prevents burning out of the lights in the event of a short circuit. Connectors are installed in the back-up lights and tail light cables to permit the removal of the radiator guard without disturbing the lights.

Inspect the wiring frequently to detect any loose connection, frayed insulation, and make certain all grommets and cable protecting boots are in good condition and properly installed. Tighten the connections and wrap any frayed spots with friction tape to prevent short circuits. Check all cable clips and make certain they are properly installed and secured. CAUTION: *To prevent the possibility of bodily injury, always disconnect the battery-to-ground cable before cleaning, repairing, disconnecting, or connecting any of the heavy electrical cables.*

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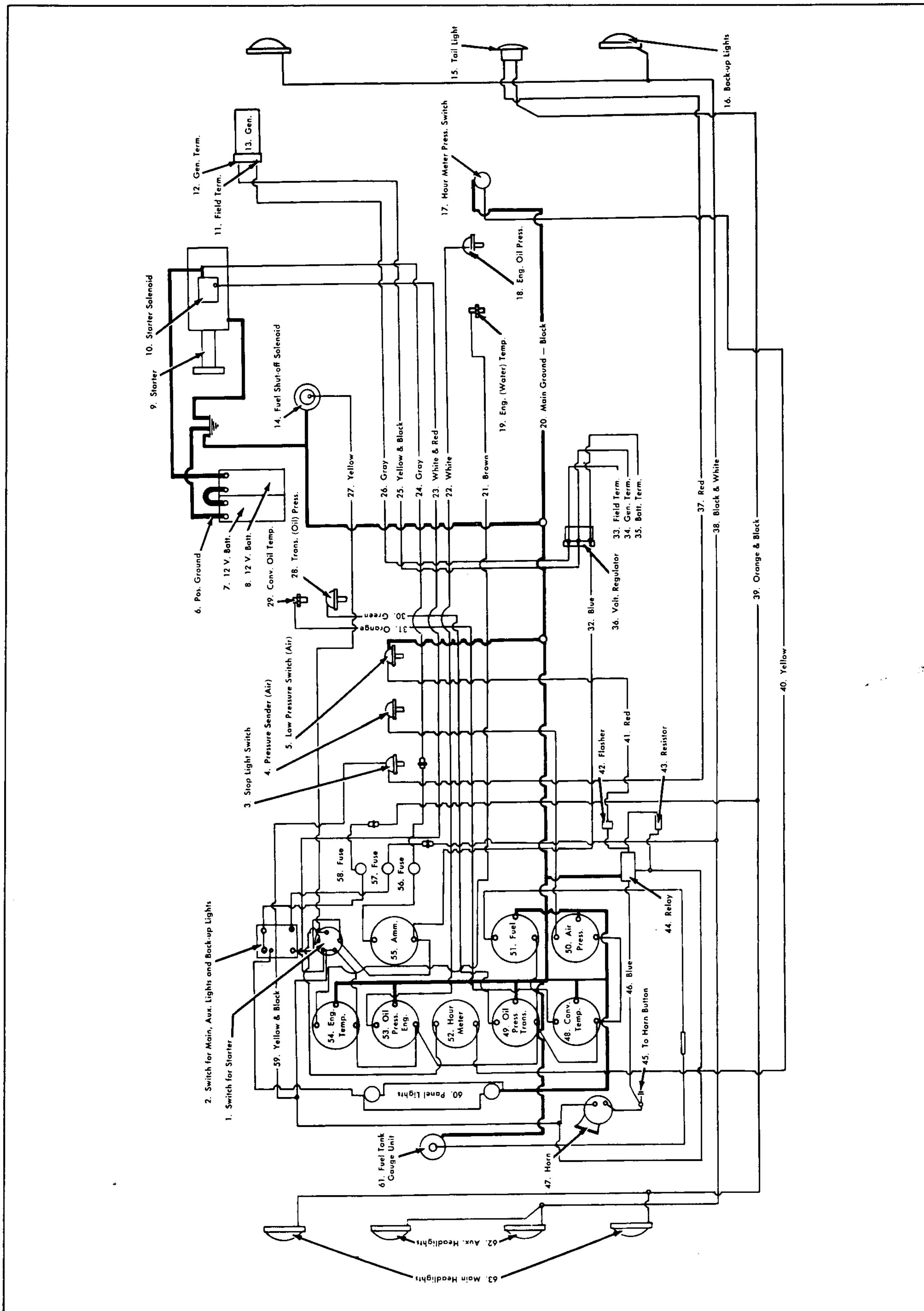


Fig. 1 — Wiring Diagram — Schematic

4. BATTERIES

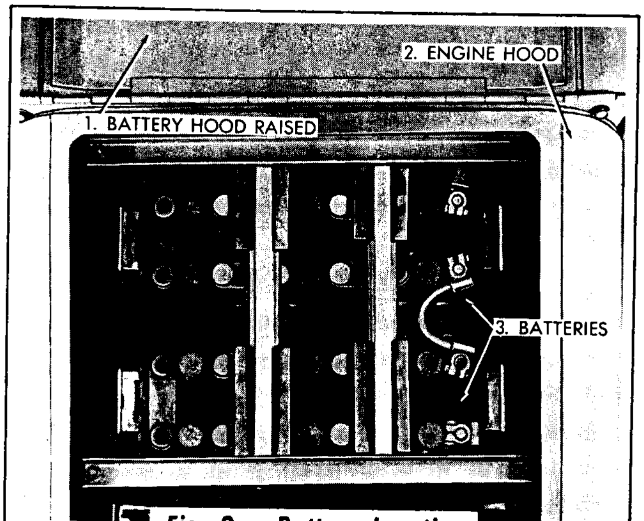


Fig. 2 — Battery Location

A. Description

The two batteries are 12-volt, wet cell type, located in a compartment under the forward end of the engine hood, directly behind the hydraulic tank, and accessible through a hinged hatch. The batteries are connected in series to provide 24-volt current and the positive post of the forward battery is grounded directly to the engine block by the battery-to-ground cable.

B. Service

Check the level of the electrolyte in the batteries after every 10 hours of operation, or as often as operating conditions prove it necessary. Maintain the level of the solution as indicated on the battery caps by the addition of clean distilled water. NOTE: *Do not overfill.* Keep the battery and cable terminals tight and clean. If corrosion occurs, clean the battery parts and terminals with a strong soda solution and coat the terminals lightly with petroleum jelly before connecting them again. The petroleum jelly will prevent further corrosion.

CAUTION: *To prevent the possibility of bodily injury, always disconnect the battery-to-ground cable (positive terminal) before disconnecting or repairing any of the heavy electrical cables.*

When the atmospheric temperature is below the freezing point, special attention should be given to the hydrometer readings of the batteries. A specific gravity of 1.270 to 1.215 at 80° F. is considered satisfactory for continued use. Specific gravity readings without correction for temperature are practically meaningless. For each 10 degrees that the temperature of the electrolyte is above 80° F., add 4 points to the hydrometer reading, and for each 10 degrees below 80° F., subtract 4 points to get the true specific gravity. For example, if the hydrometer reading is 1.250 and the electrolyte temperature is 20° F. (60 degrees below 80° F.), 1.250 minus 24 points equal 1.226 — the true specific gravity.

If the corrected readings are below 1.215, the batteries are not receiving sufficient charge. This might indicate that the generator or the generator regulator require attention. If these units prove satisfactory, inspect the system for short circuits and for loose or corroded connections. In zero weather there is a danger of the batteries freezing if the specific gravity is below 1.100. Batteries with a specific gravity of 1.100 will freeze at 18° F.; batteries with a specific gravity of 1.220 will freeze at 31° below zero F. During freezing weather, any addition of water to the cells should be made after the engine is started at the beginning of an operating period to be certain that the water and electrolyte solution will be thoroughly mixed; otherwise it may freeze. The filler caps must be kept tight at all times and the tops of the batteries kept clean and dry.

5. GENERATOR AND GENERATOR REGULATOR

A. Description

1. Generator

The generator is a two-brush, shunt wound unit, designed with openings in the frame and a cover band. The brush holders are mounted to the commutator end frame. The brushes can be inspected by removing the generator cover plate. The armature shaft is supported at both ends by ball bearings. A ventilating fan draws air through the generator to prevent over-heating.

The generator is hinged from a mounting bracket attached to the right side of the cylinder block. The generator is driven by a single belt from the fan pulley.

2. Generator Regulator

The generator regulator is a three unit regulator designed for use with generators which have the field circuit insulated in the generator, but grounded in the regulator. A field connection of this type designated as "Circuit A." The regulator consists of a cutout relay, a voltage regulator, and a current regulator unit. The cutout relay closes the generator-to-battery circuit when the generator voltage is sufficient to charge the batteries and it opens the circuit when the generator slows down or stops. The voltage regulator unit is a voltage limiting device that prevents the system voltage from exceeding a specific maximum and thus protects the batteries and other voltage sensitive equipment. The current regulator unit is a current limiting device that limits the generator output so as not to exceed its rated maximum.

B. General Maintenance and Inspection

Inspection of the generator brushes, commutator, and leads should be made periodically.

1. Brushes

A stop is provided to prevent the brush arm from touching and scoring the commutator. The brush should never be allowed to wear down until the brush arm actually touches the stop. The brush spring tension must be sufficient to give good clean contact of the brushes on the commutator and the brushes must be free to slide in their brush holders. The pig tail leads in the brushes must be tight and the lead clips fastened securely to the brush holders.

2. Commutator

The commutator must be smooth and round, without excessive roughness, dirt, gum, or burned areas. The slots between the segments must be open and not filled with carbon or copper dust. The mica between the segments should be undercut $\frac{1}{32}$". The armature leads must be properly soldered to the commutator segments. If the condition of the commutator does not meet with the above requirements, the generator must be removed for repair.

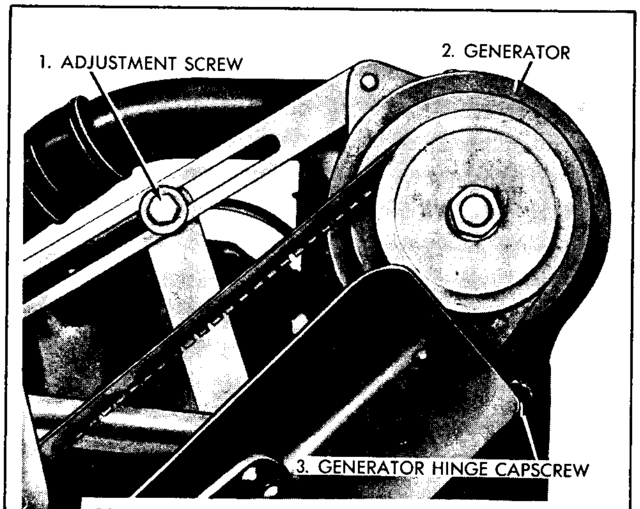


Fig. 3 — Generator — Belt Adjustment

3. Generator Drive Belt Adjustment

Keep the generator drive belt properly adjusted. The belt is properly adjusted when it can be pressed inward by hand approximately ½ inch at a point half-way between the generator and fan pulleys.

To adjust the drive belt, loosen the generator adjustment capscrew (Fig. 3) and move the generator up or down to obtain the correct tension of the belt, then tighten the adjustment capscrew.

4. Connections

The connections at the terminals should be checked to be certain they are tight and in good condition. If abnormal operation of the charging system is noted, it is necessary to determine whether it is the generator, generator regulator, or some other part of the electrical system which is at fault.

C. Testing and Adjustment of Generator and Generator Regulator

Testing and adjustment of the generator and the generator regulator should not be attempted without dependable testing equipment; therefore, it is recommended that these units be taken to a dependable electrical repair shop when repair service is required. CAUTION: *Do not run or test the generator on an open circuit.*

D. Removal and Installation of Generator and Generator Regulator

1. Removal of Generator

Disconnect the wiring harness from the generator. Remove the belt adjustment link capscrew and lockwasher (Fig. 4). Remove the two generator hinge capscrews and remove the generator from the engine.

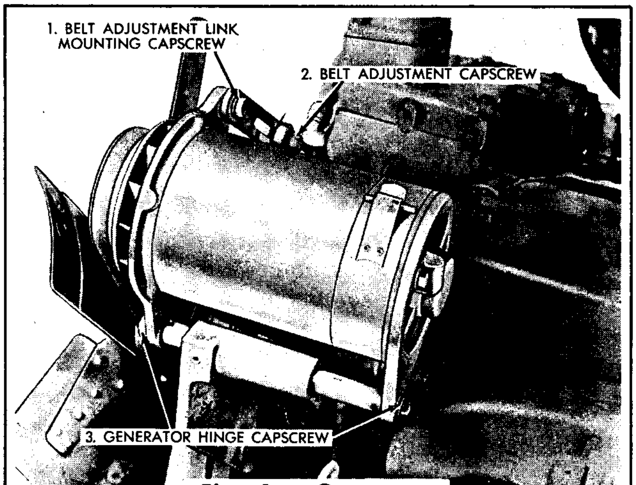


Fig. 4 — Generator

2. Installation of Generator

Place the generator in position on the generator mounting bracket and install the two generator hinge capscrews and washers, but do not tighten at this time. Install the drive belt and the belt adjustment link mounting capscrew. Adjust the belt tension for approximately ½ inch deflection at a point half-way between the generator and fan pulley. Tighten the adjustment link mounting capscrew and the two generator hinge capscrews. Connect the wiring harness to the generator (the smaller terminal to field marked "F" on the generator).

3. Removal of Generator Regulator

Remove the two generator-to-regulator leads and the ammeter-to-regulator lead from the generator regulator and identify them so that they can be reinstalled in their original positions. Remove the four capscrews and washers, attaching the generator regulator to the stabilizer support and remove the regulator.

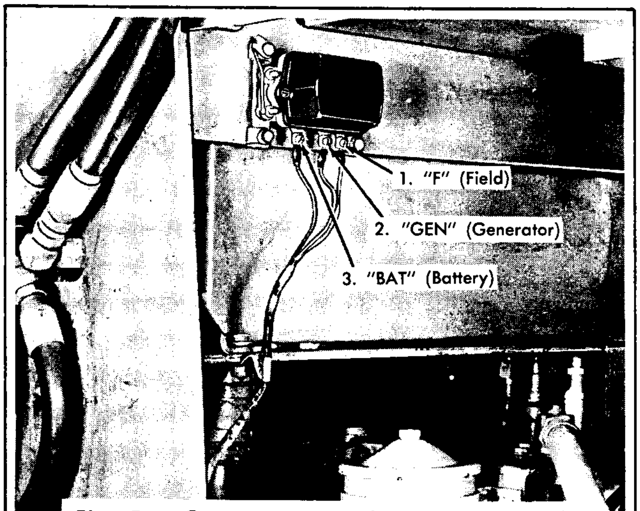


Fig. 5 — Generator Regulator — Mounted

4. Installation of Generator Regulator

Attach the generator regulator to the stabilizer support with the four capscrews and washers. Be certain that the generator regulator ground is attached to the upper left hand mounting capscrew. Connect the ammeter-to-regulator lead to the post on the regulator marked "BAT" (Battery). Connect the two generator-to-regulator leads to the proper posts on the regulator marked "GEN" (Generator) and "F" (Field).

IMPORTANT: *Whenever the generator has been removed for repairs or replacement, or when the generator regulator leads have been disconnected and reconnected, the generator must be polarized BEFORE the engine is started.*

Polarizing causes the current to flow in the normal direction through the field coils and will prevent vibration, arcing, burning, and sticking of the regulator points.

POLARIZE THE GENERATOR AS FOLLOWS:

a. With a screwdriver or similar tool raise one of the generator brushes to break contact with the commutator.

b. Using a short "jumper" lead, momentarily touch the "jumper" to the "BAT" (Battery) and the "GEN" (Generator) terminals of the generator regulator.

   NOTE: *Starting on the cover side of the regulator (as installed on the loader) the terminals are marked from left to right "BAT" (Battery), "GEN" (Generator) and "F" (Field).*

c. Lower the generator brush to make contact with the commutator.

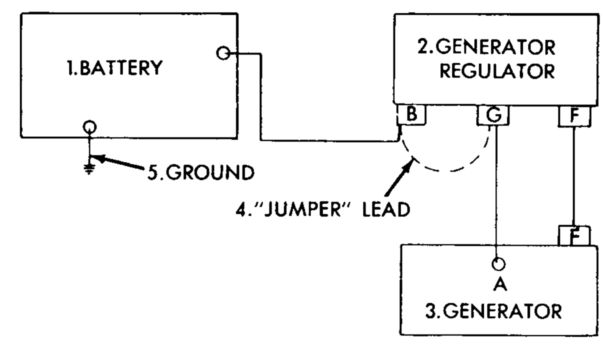


Fig. 6 — Polarizing Circuit Diagram

CAUTION: *Do not operate or test the generator on an open circuit.* If it should become necessary to operate the generator without it being connected to the batteries, it should be short circuited. This can be done by disconnecting the lead connected to the "GEN" (Generator) terminal of the regulator and connecting the end of the lead to a convenient ground.

6. STARTER

A. Description

The starter, mounted on the right side of the engine flywheel housing is an 8-brush, 4-pole, 24-volt, heavy duty unit. The armature is supported by bushings at the drive end, center, and commutator end.

The unit is equipped with a heavy duty solenoid switch which is actuated electrically by the key type starter switch located on the instrument panel. The shift lever of the starter is connected, by linkage, to the solenoid plunger. When the starter switch key is turned to operate the starter, current from the battery energizes the solenoid. The current passes through windings in the solenoid switch and produces a magnetic field which pulls in the solenoid plunger, causing the shift lever to move the drive pinion of the starter into mesh with the flywheel ring gear. As the solenoid plunger continues to move in, it closes the main switch in the solenoid which in turn connects the batteries to the starter.

B. Starter Service

Field service on the starter will be limited to cleaning of the starter, cleaning and adjustment of the drive assembly, cleaning of the commutator and replacement of the brushes, brush springs, or starter solenoid. All other adjustments or repairs require the use of special equipment. For this reason it will be necessary to remove the starter and take it to a dependable electrical repair shop, when repair or adjustment is necessary. With fully charged batteries and an ambient temperature of 70° F., the starter will engage promptly and crank the engine at an adequate cranking speed. However, in cold weather the "drag" caused by cold oil between the pistons and cylinder walls and in the bearings, reduces the cranking speed of the engine. IMPORTANT: *The starter must never be used for more than 30 seconds at any one time without a pause to allow it to cool.* Failure to observe this rule may result in failure of the starter.

1. If the starter fails to operate properly remove the cover band from the starter and

inspect the commutator and brush connections. The commutator should be clean, not out of round or excessively worn, and without high mica or burned bars. A glazed or blued commutator does not indicate a condition requiring service as this is a normal and satisfactory condition on a used unit. All electrical connections should be kept clean and tight, the brush spring tension should be from 36 to 40 ounces, and the brushes must not be worn shorter than half of their original length. The brush spring tension can be tested by attaching a small spring scale to each brush, directly under the head of the screw that holds the brush in the arm.

2. A dirty commutator should be cleaned with No. 00 sandpaper. IMPORTANT: *Never use emery paper.* If dirt or dust has accumulated in the starter, it should be cleaned with compressed air as such accumulations are likely to interfere with the operation of both the starter and the starter drive assembly.

3. After extended use, the contact surfaces of the starter switch may become burned or corroded so that insufficient current is transmitted to the starter. A slow cranking speed or difficulty in keeping the batteries charged may indicate a faulty starter solenoid. The solenoid is easily disassembled for reconditioning of burned or corroded surfaces.

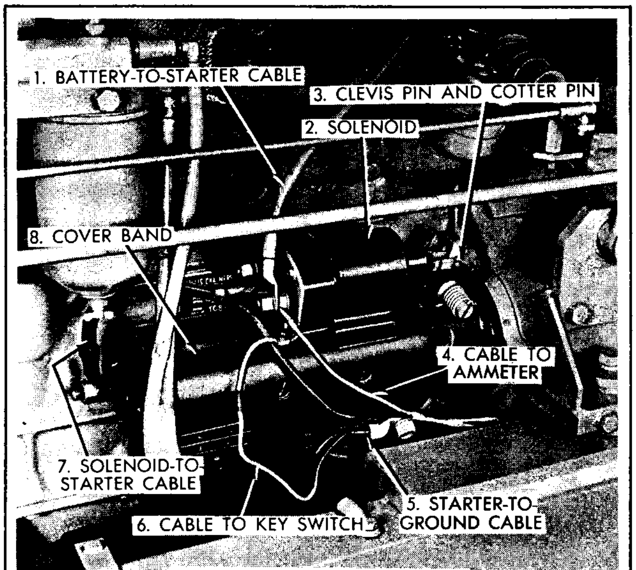


Fig. 7 — Starting Motor

C. Starter Drive Assembly

1. Disassembly, Cleaning and Reassembly

If hard dirt or grease accumulates on the splined part of the armature shaft or on the starter drive mechanism, the drive may "seize" while it is in mesh with the flywheel ring gear and damage to the starter may result. The drive assembly must be disassembled for cleaning or adjustment.

a. Remove the starter (refer to "REMOVAL AND INSTALLATION OF STARTER" in this Section).

b. Remove the cotter pin and clevis pin from the solenoid to starter drive linkage.

c. Separate the drive housing from the starter field frame by removing the attaching capscrews; mark both housings before they are separated to establish relationship of one with the other.

d. Remove the cotter pin from the pinion stop and remove the pinion stop, pinion, spring, pinion guide, shift sleeve, cup washer, and the spacer washer from the armature shaft.

e. Clean all parts thoroughly and inspect.

f. Reassemble as follows: Place the parts, in the following sequence, on the drive end of the armature shaft — plain spacer washer, cup washer (cup side away from field frame), and shift sleeve. Place the spring inside of the hollow pinion, with the drive pinion guide next to the spring and the ears on the outside diameter of the guide facing the pinion. Start the ears into the slots in the pinion and hold the guide approximately half the distance down the slots, then start the pinion guide and the spring assembly on the splines of the armature shaft. The pinion and guide assembly cannot be started on the shaft unless the ears on the guide are held in the slots in the pinion. Install the pinion stop, with the cotter pin hole toward the end of the shaft. When the lugs on the stop enter the groove in the shaft, rotate the stop until the cotter pin holes align and install the cotter pin.

g. Place the drive end housing assembly over the end of the armature shaft and against the center bearing plate, guiding the finger of the shaft liner into the slot of the shift sleeve, and install the attaching capscrews.

h. Replace the clevis pin and cotter pin in the solenoid to starter drive linkage.

2. Starter Drive Adjustments

The starter drive was properly adjusted at the factory and seldom requires readjustment. Failure of the drive to operate properly will usually be caused by dirt or damaged parts. When the shift lever is in the cranking position it should be possible to push the pinion back against spring pressure $\frac{1}{8}$ to $\frac{3}{16}$ inch. Adjustment can be made by disconnecting the lead between the solenoid and the cranking motor and connect a battery of the specified voltage to the battery terminal and the small ground terminal on the solenoid. Operate the shift lever by hand until the switch is closed. Battery current will then maintain it in the operating position so that the pinion travel can be checked. Adjustment is made by turning the stud in the plunger in or out as required.

D. Removal and Installation of the Starter

1. Disconnect the battery-to-ground cable from the front of the engine block. Tape the end of the cable to prevent a short circuit in the electrical system when removing the battery-to-starter cable from the solenoid.

2. Disconnect the battery-to-starter cable and the two small cables from the starter solenoid. Disconnect the starter-to-ground strap from the starter.

3. Remove the three capscrews attaching the starter to the flywheel housing and remove the starter and the starter adapter.

4. Install the starter by a direct reversal of removal procedure.

SECTION VII — INSTRUMENTS

1. DESCRIPTION

The instruments, which are standard equipment on the tractor loader, consist of the engine temperature gauge, the engine oil pressure gauge, the fuel gauge, the ammeter, the transmission oil pressure gauge, the transmission temperature gauge, the engine hour meter, and the air pressure gauge. The purpose of the gauges is to indicate the operation of the engine, transmission, generator, fuel tank, and air brakes. They are important warning devices which should be observed periodically while the tractor loader is operating. Abnormal operation of a gauge usually indicates either a faulty sender unit, or a serious malfunction of the component to which it is connected. Grouped conveniently on the instrument panel, the easy-to-read dials are illuminated by two panel lights for night work.

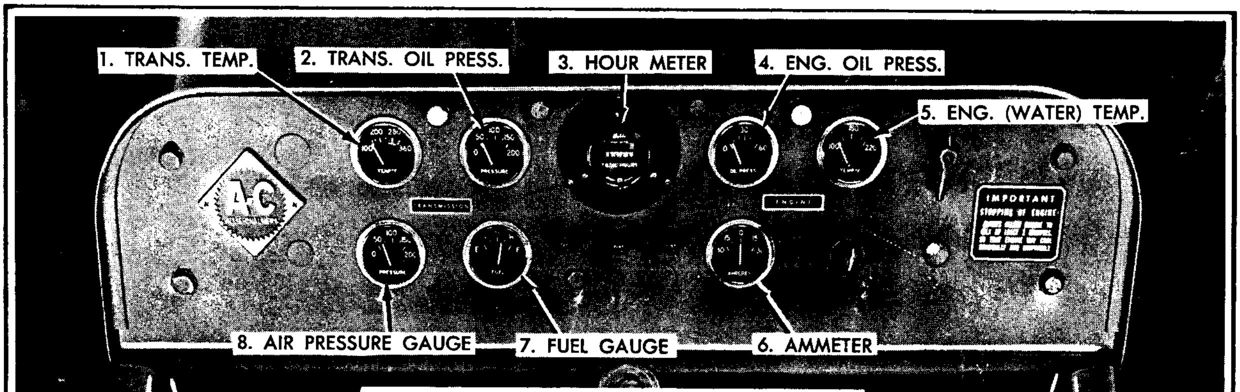


Fig. 1 — Instrument Panel — Front View

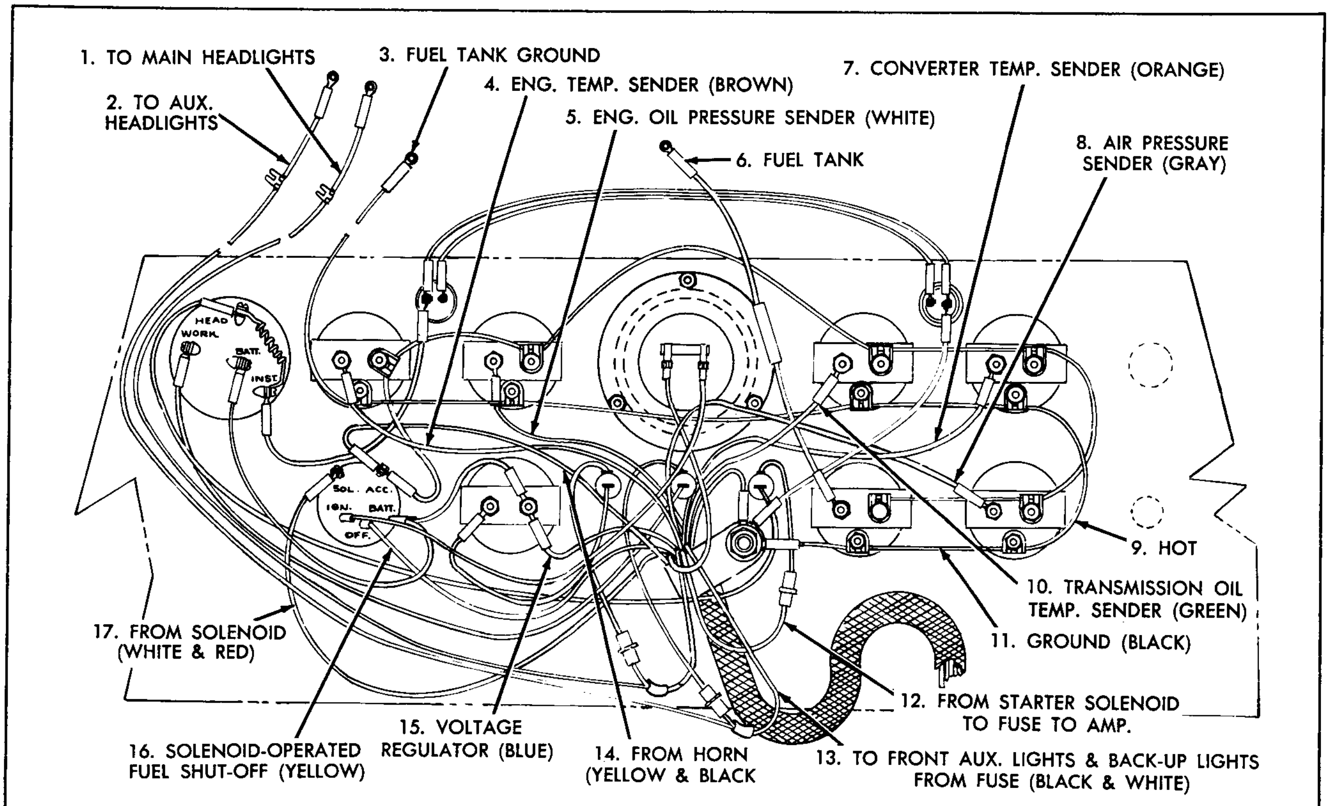


Fig. 2 — Rear View of Instrument Panel

COLOR CODE

Instrument	Color of Wire to Sender
Engine Temperature	Brown
Engine Oil Pressure	White
Fuel	Black
Ammeter	Gray (to starter motor solenoid) Blue (to voltage regulator)
Transmission Oil Pressure ..	Green
Transmission Temperature..	Orange
Hour Meter	Yellow
Air Pressure	Gray

2. ENGINE TEMPERATURE GAUGE

The engine temperature gauge indicates the engine coolant operating temperature which should be maintained between 170° and 190° F. at all times.

3. ENGINE OIL PRESSURE GAUGE

This gauge indicates the pressure at which the engine lubricating oil is circulated through the engine. At full throttle the oil pressure should be between 30 and 35 pounds at normal operating temperature (170° to 190° F.). CAUTION: *If no oil pressure is indicated by the gauge, the engine must be stopped immediately and the cause determined and corrected.*

4. FUEL GAUGE

The fuel gauge indicates the quantity of fuel that is contained in the fuel tank. It is connected to a rheostat and float unit that is located in the tank. The gauge indicates "E" (EMPTY), "¼," "½," "¾," and "F" (FULL). The fuel tank should be filled at the end of each operating period, rather than at the start, to reduce the possibility of water condensation.

5. AMMETER

The ammeter indicates the charging rate of the generator. When the batteries are in a discharge condition, the ammeter should indicate a good rate of charge until the battery approaches a fully charged condition. When the battery is fully charged, the ammeter will indicate nearly zero except for a short time after the starter is used.

6. TRANSMISSION OIL PRESSURE GAUGE

The transmission oil pressure gauge indicates the pressure at which the transmission clutches are operating. The normal operating pressure of the clutches is from 140 to 150 pounds.

7. TRANSMISSION TEMPERATURE GAUGE

The transmission temperature gauge indicates the temperature of the oil before it leaves the torque converter on its way to the oil cooler. Normal operating temperature is 150° to 200° F. CAUTION: *Converter oil temperature (indicated by the transmission temperature gauge) must not exceed 250° F.* Refer to "TORQUE CONVERTER, TRANSMISSION AND HYDRAULIC CLUTCH ASSEMBLY" for detailed information.

8. ENGINE HOUR METER

The engine hour meter is a direct reading type. The meter records up to 10,000 hours and repeats. The four figures of the hours are read directly. The red (or right side) figure indicates 10ths of an hour. The small indicator (upper left) visibly turns when the meter is recording.

9. AIR PRESSURE GAUGE

The air pressure gauge indicates the amount of available brake air pressure in the reservoirs. Never operate the machine with less than 60 PSI. For normal operation the gauge must read between 105 PSI and 120 PSI.

A warning device is provided to warn the operator whenever the pressure drops below 55 to 60 PSI. At any time that the brake air pressure in the reservoirs drops below 55 to 60 PSI, while the engine is running, the loader horn will blow short, repeated blasts until the pressure has risen to the 55 to 60 PSI level again. CAUTION: *At no time must the loader be operated while the brake air pressure warning signal is sounding.*

10. INSTRUMENT SERVICE

Any of the various instruments may be removed from the instrument panel for replacement by removing the five instrument panel capscrews. Carefully rest the instrument panel against the steering column and disconnect the leads. Then remove the nuts from the retaining clamps.

Do not attempt to repair an engine hour meter. Return it to your "Allis-Chalmers" Construction Machinery Dealer for a trade-in allowance on a new hour meter.

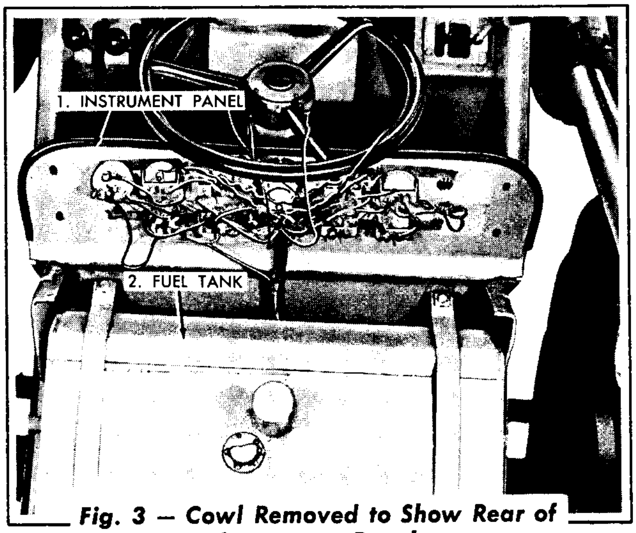


Fig. 3 — Cowl Removed to Show Rear of Instrument Panel

SECTION VIII — ENGINE

1. DESCRIPTION

A. General

The engine is a six cylinder vertical in-line, four stroke cycle, water cooled, compression ignition, direct injection, turbocharged, full diesel engine. Fuel is supplied to the cylinders by a fuel injection pump, high pressure fuel lines and fuel injection nozzles. The fuel injection pump delivers accurately metered quantities of diesel fuel under high pressure through hole type fuel injection nozzles and into the engine cylinders at a definite timing in relation to the engine firing cycle. The fuel is compression ignited by the heat generated by the compression of the air in the cylinders. The expanding gases generated by the burning fuel are converted into mechanical energy in the cylinders of the engine. The engine is full pressure lubricated by a gear type oil pump driven by the crankshaft gear.

B. The Four Stroke Cycle Diesel Engine

In a four stroke cycle engine, a power stroke is made by each piston for every two complete revolutions of the crankshaft. The sequence of the strokes is as follows: Intake, compression, power and exhaust.

1. Intake Stroke

As the piston moves downward on the first, or intake stroke, air enters the cylinder through the air intake manifold and the intake valve(s) which started to open a few degrees before the piston reached top dead center. A rocker arm, push rod, and camshaft are used to actuate both the intake and exhaust valves. The intake charge consists of air only, with no fuel mixture, and the induced volume of air is trapped in the cylinder.

2. Compression Stroke

Shortly after the piston starts to move upward on the second, or compression stroke, the intake valve(s) is closed by spring pressure. The air is compressed in the cylinder and the compression of air raises the air temperature in the cylinder to approximately 1000° F. At the proper moment during the compression stroke, a metered quantity of fuel is injected into the combustion chamber under very high pressure. The finely atomized fuel is ignited by the heat of the compressed air and starts to burn immediately.

3. Power Stroke

Expansion of the burning gases forces the piston downward on its third, or power stroke. Near the bottom of the power stroke, the exhaust valve opens.

4. Exhaust Stroke

As the piston moves upward on the fourth, or exhaust stroke, the exhaust valve is open and the burned gases are forced out of the combustion chamber through the open exhaust valve port by the upward travel of the piston. A few degrees before the piston reaches top dead center, the intake valve(s) starts to open to admit a fresh charge of air to the cylinder. A few degrees beyond top dead center, the exhaust valve completely closes and the cycle is repeated.

5. Combustion Chamber

The combustion chamber is located in the head of each piston. Each fuel injection nozzle is located in the cylinder head, above the piston. The shape of the chamber in the piston head, the angle of injection, plus the turbulence of the air induced by shrouded intake valves causes the fuel and air to be thoroughly mixed for complete controlled combustion.

2. CYLINDER HEADS

A. Description

The cylinder heads are one-piece alloy iron castings and are securely held to the upper part of the cylinder block by heat treated alloy steel studs and nuts. Cored passages are provided in the cylinder heads for the intake of air and expulsion of exhaust gases. Cored passages are also provided for the circulation of coolant. To seal the compression, combination steel, asbestos, and copper cylinder head gaskets are installed between the cylinder heads and the top of the cylinder block.

Located in the cylinder heads above each cylinder, is an intake valve, an exhaust valve, a fuel injection nozzle, and two rocker arms. One rocker arm actuates the intake valve and the other rocker arm actuates the exhaust valve.

Valve guides are pressed into the cylinder heads and hold the valve heads in accurate alignment with the valve seats. The guides have a shallow spiral thread cut in the lower two-thirds of their bore. This thread collects and retains enough lubricating oil during engine operation to considerably reduce valve guide wear and increase valve guide life. It also allows for less running clearance and a tighter initial fit between the valve stems and guides. The guides are also Parco-lubricated to deter scuffing of the valve stems during the initial run-in period.

Indexing intake valve guides are held in place by a dowel pin and prevent the shrouded intake valves from rotating. All of the valve seat inserts are replaceable. The top of each cylinder head is completely enclosed by a cylinder head cover.

The two cylinder heads are identical in structure and are interchangeable between the front and rear position on the cylinder block.

The cylinder heads and gaskets are properly positioned in relation to the cylinder sleeves and combustion chamber in the pistons by short dowel pins pressed into the top deck of the cylinder block.

B. Cylinder Head Service

Service on some of the parts contained in the heads can be accomplished with the heads installed; for others, the heads must first be removed from the engine.

1. Operations Not Requiring the Removal of the Cylinder Heads Are:

a. Replacement of fuel nozzles.

b. Adjustment of valves.

c. Replacement of rocker arms, or rocker arm shafts.

d. Replacement of valve push rods.

e. Replacement of valve lifters.

2. Operations Requiring the Removal of the Cylinder Heads Are:

a. Grinding, reseating, or replacement of valves.

b. Replacement of valve guides.

c. Replacement of valve springs.

d. Replacement of intake valve indexing guide.

e. Replacement of valve seat inserts.

f. Replacement of fuel injection nozzle sleeves.

(Refer to "FUEL INJECTION SYSTEM AND GOVERNOR," Section II.)

C. Cylinder Head Removal

1. Remove the engine side panels and engine hood.

2. Drain the cooling system (refer to "DRAINING AND FILLING OF SYSTEM," Section IV).

3. Shut off the fuel supply.

4. Loosen the hose clamp attaching the air cleaner hose to the air inlet elbow and free the hose from the elbow. Remove the air intake tube and/or hose.

5. Disconnect and remove the engine temperature gauge tube from the front of the water outlet manifold.

6. Remove the air intake elbow between the turbocharger and the air intake manifold by loosening the hose clamp and removing the capscrews and lockwashers that secure the elbow to the intake manifold.

7. Remove the air compressor intake pipe supporting clamp from the intake pipe. Loosen the pipe fitting and pull the air compressor intake pipe free of the intake manifold.

8. Remove the nuts and lockwashers attaching the air intake manifold to the cylinder heads and remove the intake manifold.

9. Disconnect the oil inlet and oil return lines from the turbocharger. Cap all exposed lines and fittings.

10. Remove the nuts and washers attaching the front section of the exhaust manifold to the cylinder heads and slide the front section of the exhaust manifold off of the rear section.

11. Remove the nuts and washers attaching the rear section of the exhaust manifold to the cylinder heads and remove the exhaust manifold, turbocharger and exhaust stack as a unit.

12. Disconnect the air compressor coolant line from the water outlet manifold.

13. Remove the capscrews and lockwashers attaching the water outlet manifold to the cylinder heads and remove the water outlet manifold and the thermostat housing.

14. Remove the Nylok nuts and sealing washers attaching the cylinder head covers to the cylinder heads and remove the cylinder head covers.

15. Disconnect and remove the fuel return manifold assembly from the injection nozzle-holder assemblies. Disconnect high pressure fuel lines from the fuel pump and injection nozzles and remove as an assembly. Cap all fuel openings. Remove the injection nozzle-holder assemblies from the cylinder heads.

16. Remove the nuts and lockwashers attaching the rocker shaft brackets to the cylinder heads and remove the rocker shaft brackets, shafts, and rocker arms as an assembly from each cylinder head.

17. Withdraw the push rods from the cylinder heads and the block.

18. Remove the cylinder head stud nuts, and with a sling similar to the one shown in Fig. 1, remove the cylinder head(s).

D. Inspection

Inspect the cylinder heads and component parts for wear or damage. Repair or replace any worn or damaged parts. If the cylinder heads are to be

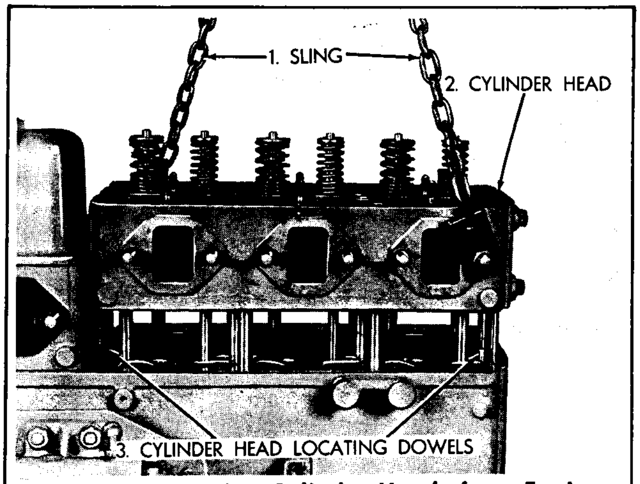


Fig. 1 — Removing Cylinder Heads from Engine

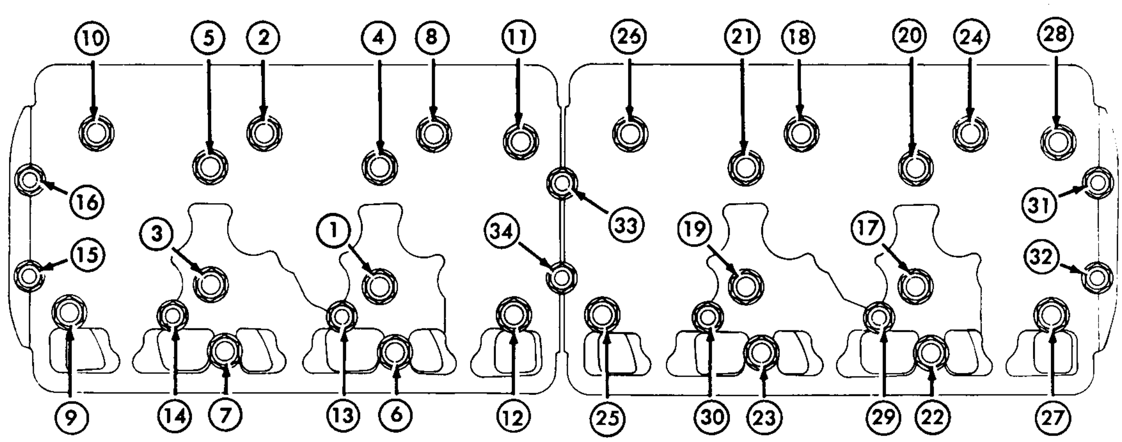
replaced, the working parts removed from the old heads must be thoroughly inspected before installing them in the new heads. The proper procedure to be followed in making the inspection and installation of the various parts will be found under "VALVES" in this Section and "ENGINE FUEL SYSTEM AND GOVERNOR," Section II.

E. Cylinder Head Installation

Be certain that the machined surfaces of the cylinder block and cylinder heads are thoroughly cleaned. Install the cylinder heads by a direct reversal of the removal procedure, using new gaskets. IMPORTANT: *New cylinder head gaskets MUST be used when installing the cylinder heads and be certain that the gaskets are installed with the proper side up, as stamped on the gaskets.* When tightening the cylinder head stud nuts refer to Fig. 2 and tighten in the sequence shown. Before tightening the cylinder head stud nuts, the cylinder heads should be aligned with each other by use of a straightedge or the air intake manifold. All 5/8" nuts must be tightened to a torque of 180 to 185 lbs. ft. and the 1/2" nuts to a torque of 95 to 105 lbs. ft. See Figure 2 for nut torque sequence and instructions. After the first 10 and 100 hours of operation the tightness of the cylinder head stud nuts MUST be checked.

Fill the cooling system (refer to "DRAINING AND FILLING OF SYSTEM," Section IV). Adjust the valves (refer to "VALVE ADJUSTMENT" in this Section for proper procedure).

Open the fuel supply to the engine, start the engine, vent the fuel injection system and inspect for fuel, water and oil leaks. Correct any leaks found.



INSTRUCTIONS

1. Tighten stud nuts in numerical sequence to 1/2 final torque
2. Tighten stud nuts in numerical sequence to full recommended torque
3. Retighten stud nuts in numerical sequence to full recommended torque
4. Run engine until water temperature reaches minimum of 160° F., and retighten stud nuts in numerical sequence to full recommended torque

Fig. 2 — Torque Sequence and Instructions

3. VALVES

A. Description

The intake valves are made of chrome nickel steel. The exhaust valves are made of austinitic steel, carefully heat-treated to develop the special properties required for valve service. Each valve stem is accurately ground to size and hardened at the end to provide the extreme hardness needed.

The hardened valve seats, installed in the cylinder heads, are accurately ground to very close limits. The valve guides, made of special alloy cast-iron, are pressed into the cylinder heads. Cylindrical valve springs are held in place, on the upper end of the valve stems, by valve spring retainers and tapered valve spring retainer locks.

There are two intake valve springs (inner and outer) and one exhaust valve spring for each cylinder. An indexing guide to position and prevent rotation of the intake valve is used.

The rocker arm assemblies, consisting of two rocker arms for each cylinder, are mounted on a common shaft supported by rocker shaft brackets attached to the cylinder head.

The push rods extend down through the cylinder heads, cylinder block, and into the valve lifters, which are held in position by valve lifter brackets.

The valve lifters contact the lobes on the camshaft. The upper ends of the pushrods are concave to receive the ends of the valve lash adjustment screws, threaded into one end of the rocker arms. The other end of the rocker arms actuate the valves through the action of the push rod. When the push rod is forced upward by the camshaft lobe, the rocker arm is raised on one end and forces the other end down, opening the valve. The tension of the valve spring closes the valve when the push rod moves downward.

A drilled oil passage in each cylinder head is in line with a drilled oil passage in the cylinder block, permitting oil to pass from the main oil gallery in the cylinder block to the top of the cylinder heads and into the drilled restricted rocker shaft bracket at the No. 3 and No. 4 cylinder location.

The rocker arm shafts are hollow and contain oil holes at each rocker arm location. The oil enters the hollow rocker shafts under pressure and is forced out through the oil holes at each rocker arm location, to lubricate the rocker arm bushing. The oil then passes out the drilled holes in the rocker arms and spills down over the push rods and valve springs.

B. Service

Several operations on the valve mechanism may be performed without removing the cylinder heads. The heads must be removed for certain other operations. The operations not requiring removal of the heads are:

1. Adjustment of valves.
2. Replacement of valve push rods.
3. Replacement of valve lifters.
4. Replacement of valve lifter brackets.

The cylinder heads must be removed to perform the following operations:

1. Replacement of valves.
2. Replacement of valve springs.
3. Replacement of intake valve indexing guide.
4. Replacement of valve guides.
5. Grinding, reseating, or replacement of valves.
6. Replacement of valve seat inserts.
7. Replacement of fuel injection nozzle sleeves. (Refer to "FUEL INJECTION SYSTEM AND GOVERNOR," Section II.)

C. Valve Adjustment

1. General

The correct clearance (lash) between the ends of the intake and exhaust valve stems and the rocker arms is very important in a "DIESEL" engine due to the high compression developed within the cylinders. Insufficient valve clearance will cause hard starting due to loss of compression, mis-firing, and will eventually cause burning of the valves and valve seats. Excessive valve clearance will result in faulty engine operation, valve tappet noise, and cause rapid wear on the valve operating mechanism.

With the engine at minimum operating temperature of 170° F. the proper valve lash for both the intake and exhaust valves is .018". After any mechanical work had been done which would disturb the valve lash, the valves may be set "cold" at .020" clearance so that the engine may be run and allowed to warm up to normal operating temperature. After the engine has been "warmed up" to normal operating temperature, the valve lash should be checked for proper clearance.

A quick and easy method of adjusting the valve clearance (lash) is as follows:

a. Knowing the #1 — #6 pistons move up and down in their respective cylinders together and when one piston is on the firing stroke the other is on the intake stroke and vice versa and that this relationship is the same for the #2 — #5 pistons and the #3 — #4 pistons, all the valves can be adjusted in two revolutions of the crankshaft. Adjust both the intake valve and exhaust valve of each cylinder following the firing order sequence 1-5-3-6-2-4. Remember it is only necessary to turn the crankshaft 120° between cylinders — starting with #1 cylinder.

To position the #1 cylinder for adjusting the valves, observe the valves of the #6 cylinder and stop turning the engine when the #6 cylinder exhaust valve is closed and the intake valve starts to open. At this point, adjust both the valves of the #1 cylinder because the piston is near top dead center on the compression stroke and both the intake and exhaust valves are completely closed. The above is true for the balance of the cylinders per the following tables:

Adjust the valves of cylinder Number:	**When the exhaust valve is closed and the intake starts to open on cylinder Number:**
1	6
5	2
3	4
6	1
2	5
4	3

2. Adjustment of Valve Lash

Check the valve clearance periodically and adjust when necessary to maintain the specified lash of .018" as follows:

a. Operate the engine until it reaches a minimum operating temperature of 170° F., then stop the engine.

b. Remove the cylinder head covers.

c. Crank the engine with the starter or by pinch bar until both valves for the No. 1 cylinder are closed and the valve push rods are at their lowest position.

d. Check the clearance between the valve stems and the rocker arms. Use a .018" feeler gauge when checking the lash. The feeler gauge should pass between the rocker arm and the corresponding valve stem with a slight drag when the valve lash is properly adjusted. Refer to Fig. 3 for location of the intake and exhaust valves.

e. Adjust each valve by loosening the locknut on the adjusting screw and turning the screw clockwise to decrease the clearance or counter-clockwise to increase the clearance as necessary (refer to Fig. 4). When the proper clearance is obtained, hold the rocker arm adjusting screw stationary and tighten the locknut. Recheck the lash to be certain that the clearance did not change when the locknut was tightened.

f. Repeat the above operations on the valves for the other cylinders. Install the cylinder head covers.

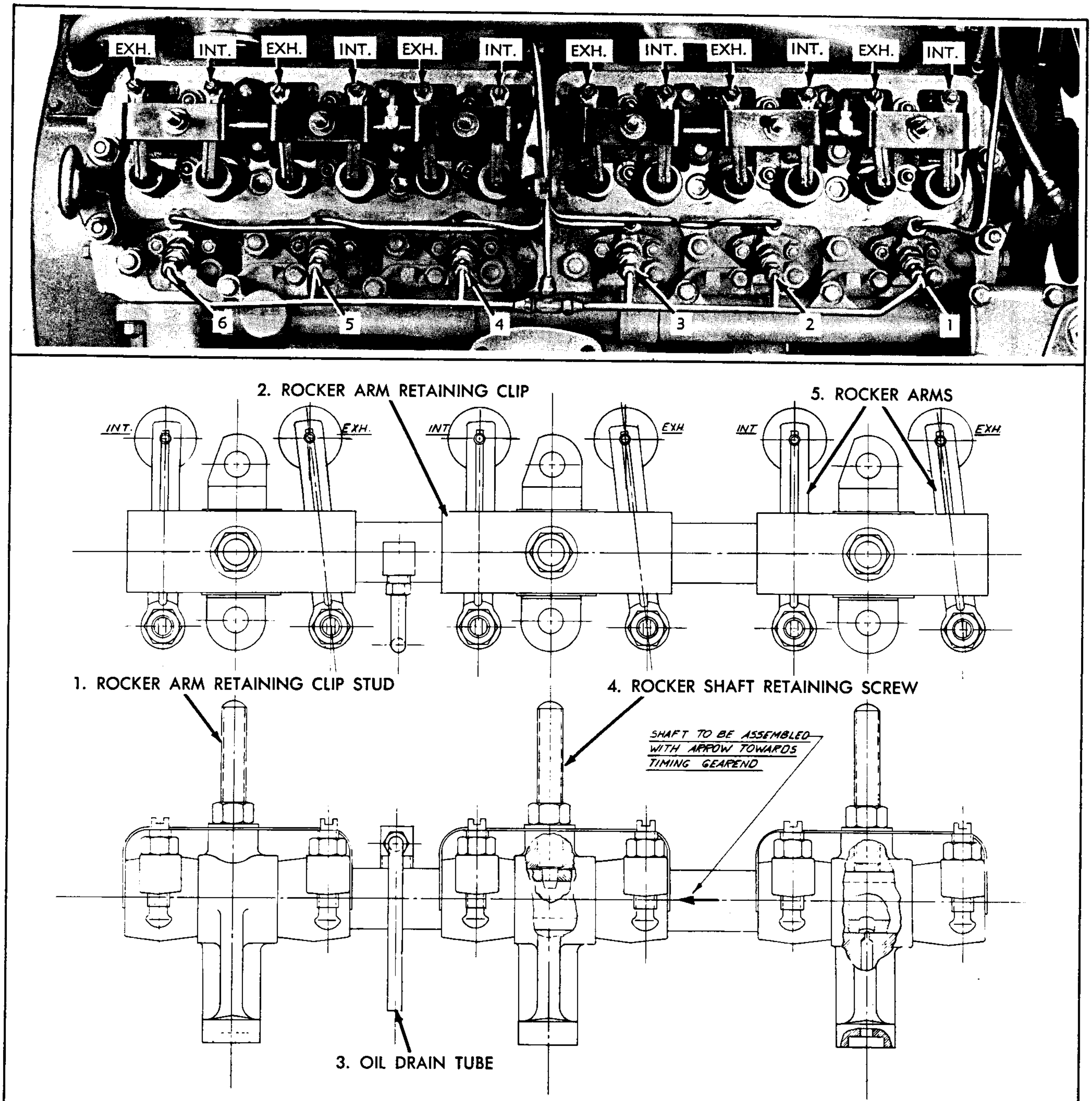


Fig. 3 — Valve Location

D. Rocker Arm Removal, Inspection, and Installation

1. Thoroughly clean the cylinder head covers. Remove the cylinder head covers.

2. Remove the nuts and lockwashers attaching the rocker shaft brackets to the cylinder heads and remove the rocker shaft brackets, shafts, and rocker arms as assemblies.

3. Remove the oil drain tube and elbow from each rocker arm shaft.

4. Remove the nuts and washers from the rocker shaft retaining screws (Fig. 3) and remove the rocker shaft retaining screws. Remove the nuts and washers from the remaining rocker arm retaining clip studs.

5. Remove the rocker arm retaining spring clips and slide the rocker arms and brackets from the shaft.

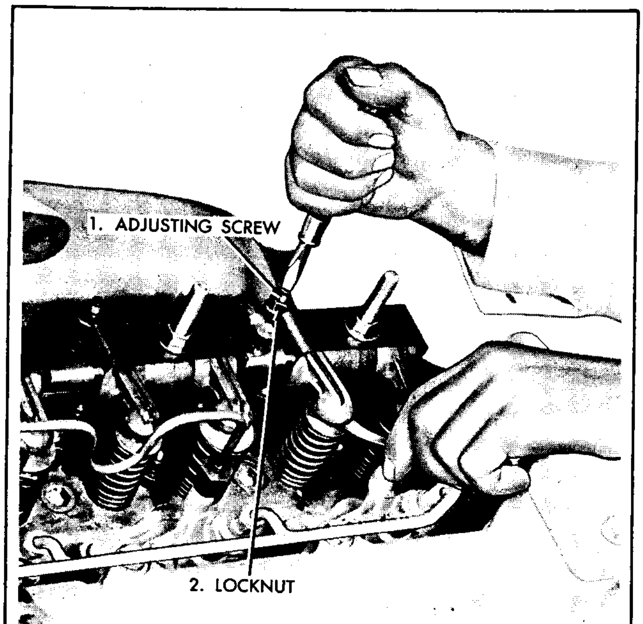


Fig. 4 — Adjusting Valve Clearance

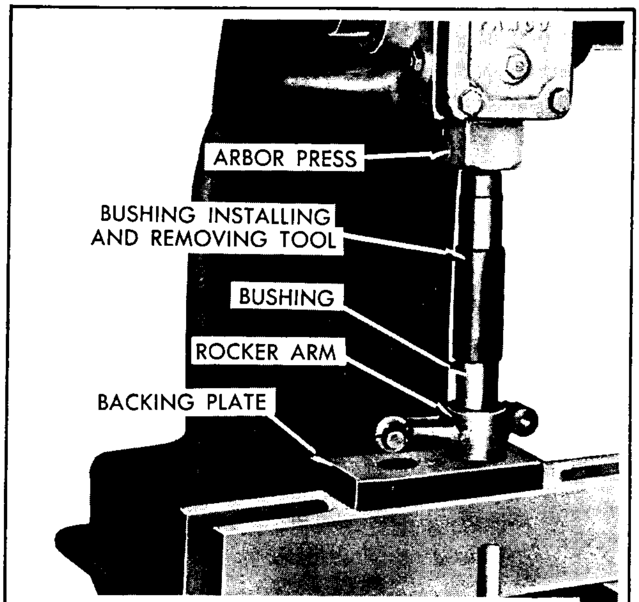


Fig. 6 — Installing Rocker Arm Bushing

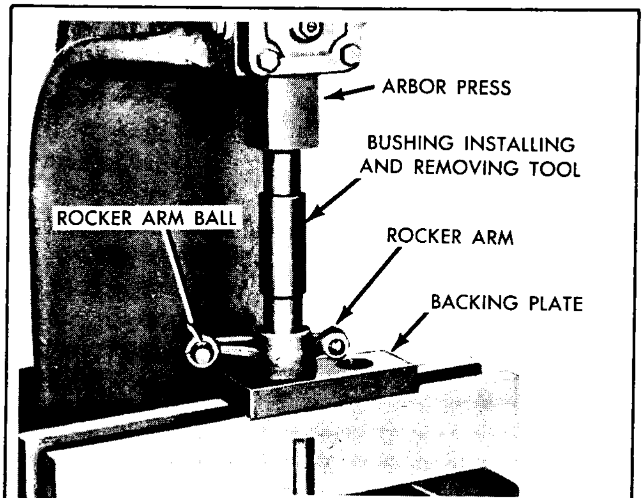


Fig. 5 — Removing Rocker Arm Bushing

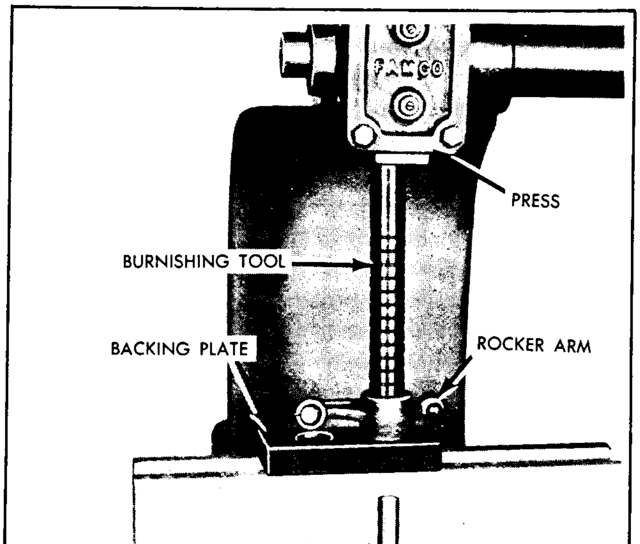


Fig. 7 — Burnishing Rocker Arm Bushing

6. Inspect the bushings inside the rocker arms for wear. Normal clearance between the shaft and bushings is .001″ to .0025″ and must not exceed .005″. If the bushings are excessively worn, remove the bushings as shown in Fig. 5. After a new bushing is installed, an oil hole must be drilled through the bushing, in line with the oil hole in the rocker arm, using a 1/8″ drill. A burnishing tool, as shown in Fig. 7 must be pressed through the bushings to establish .001″ to .0025″ clearance with the shaft.

   Remove the rocker arm ball retainer and rocker arm ball. Check the ball for wear and replace if necessary. Inspect the rocker ball oiling wick in the rocker arm and if the wick has become hard, replace the wick. Inspect the rocker arm shaft for wear and replace if necessary. Clean the oil holes in the rocker arms and rocker arm shaft with solvent, a small wire, and compressed air.

7. Lubricate the rocker arm bushings and shafts with clean oil. Refer to Fig. 3 and install the rocker arms and rocker shaft brackets by reversing the sequence of operations for removal. IMPORTANT: *When in-*

stalling the rocker arms and brackets, be certain that the exhaust valve rocker arms and intake valve rocker arms are installed in their proper positions as shown in Fig. 3. Be certain that the rocker arm shafts are positioned so that the oil holes for the rocker arm bushings are nearest the adjusting screw end of the rocker arms. This can be confirmed by observing the arrow etched on the shaft. The arrow must be on the push rod side and pointing to the rear (fan end) of the engine. See Fig. 3.

The rocker arms, shaft and bracket assemblies when assembled properly are identical and can be installed on either the front or rear cylinder heads. This is possible, because all rocker arm shaft brackets, except the center brackets have the restricted drilled oil passages.

8. Tighten the rocker shaft bracket stud nuts to a torque of 19 to 22 lbs. ft. Place the rocker arm retaining spring clips in position and secure with plain washers and hex-nuts.

9. Install the oil drain tube elbows and the tubes to the elbows as shown in Fig. 3. Adjust the valves for proper clearance (refer to "VALVE ADJUSTMENT," Paragraph C).

10. Install the cylinder head covers, being certain the gaskets are in good condition and properly positioned.

E. Valve Lifter and Push Rod Removal, Inspection and Installation

1. Remove the rocker arm assemblies (refer to "ROCKER ARM REMOVAL, INSPECTION AND INSTALLATION," Par. D above).

2. Withdraw the push rods. Inspect the ball and cup ends for signs of wear; polish out any nicks or scores. If the push rods are bent, twisted, or damaged, they must be replaced.

3. In order to remove the front valve lifter cover from the left side of the cylinder block, remove the fuel injection pump as explained in Section 2, "ENGINE FUEL SYSTEM AND GOVERNOR." Remove the front and rear valve lifter covers. Remove the capscrews attaching the valve lifter brackets to the cylinder block, then remove the valve lifter brackets and valve lifters as shown in Fig. 8. When removing the valve lifter brackets and valve lifters, use care to prevent the lifters from falling into the crankcase. Inspect the contact surface of the valve lifters. If scuffing or pitting has taken place, install new lifters. The outside diameter of the lifter is .8102"/.8107". The inside diameter of the lifter bore in the lifter bracket is .8127"/.8137", giving an operating clearance of .002"/.0035".

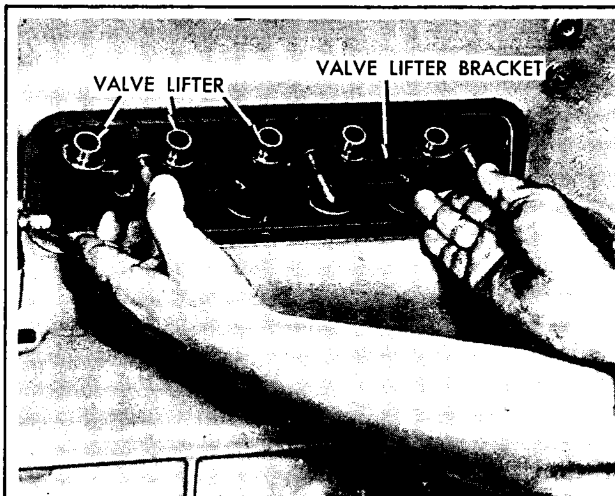


Fig. 8 — Removing Valve Lifter Bracket

4. Lubricate the valve lifters with clean oil and install the lifters and lifter brackets by a direct reversal of the removal procedure.

5. Install the push rods with the cup end to the top. Make certain that the push rods are seated in the valve lifters.

F. Valve Spring Removal, Inspection, and Installation

1. Remove the cylinder heads from the engine (refer to "CYLINDER HEAD REMOVAL" in this Section).

2. Place the cylinder heads on blocks, depress the valve springs with a tool similar to the

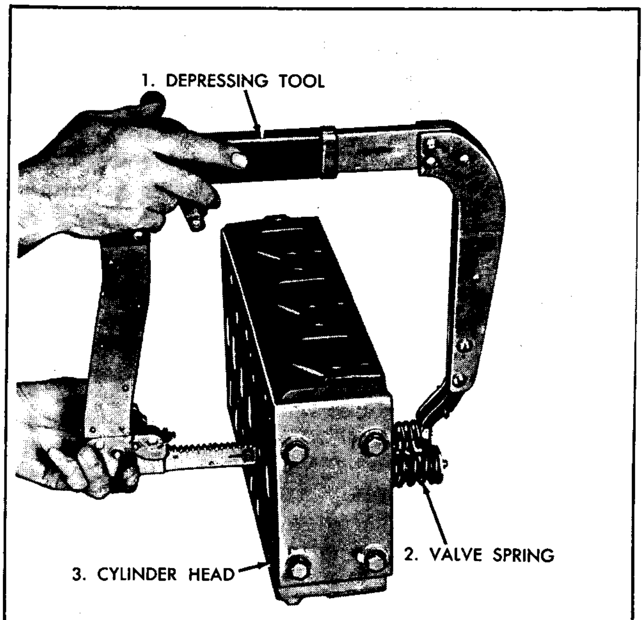


Fig. 9 — Removing Valve Springs

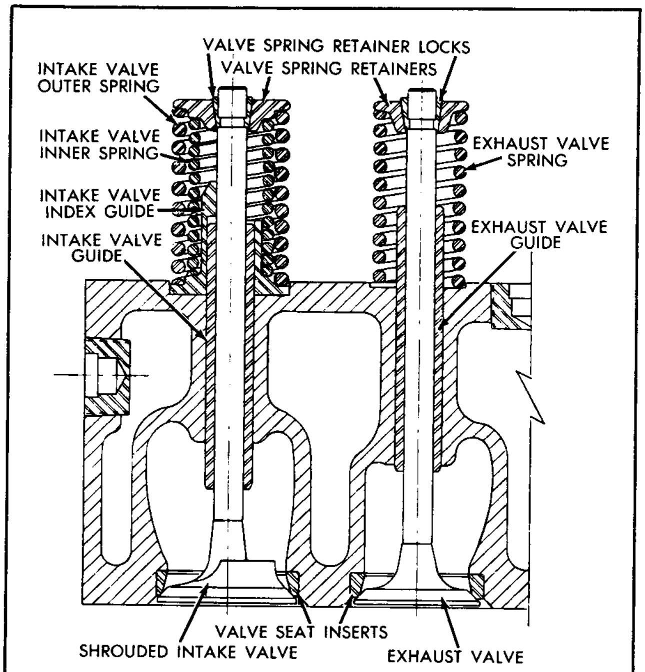


Fig. 9-A — Valves in Head — Sectional View

one shown in Fig. 9, and remove the valve spring retainer locks. Release the valve spring depressing tool and remove the valve spring retainer and the valve spring.

3. Inspect the valve springs for cracks. The exhaust valve spring when compressed to a length of $2\frac{5}{16}$" should have a load of 57 to 64 lbs. When the spring is compressed to a length of $1\frac{53}{64}$", it should have a load of 136 to 146 lbs. The intake inner valve spring should have a load of 30 to 35 lbs. when compressed to $2\frac{1}{16}$" and 66 to 72 lbs. when compressed to $1\frac{37}{64}$". The intake outer valve spring should have a load of 40 to 45 lbs. when compressed to $2\frac{1}{32}$" and 88 to 97 lbs. when compressed to $1\frac{53}{64}$". Replace the springs if they are cracked or weak.

4. The intake valve indexing guide may be removed after the removal of the valve springs. Figure 10.

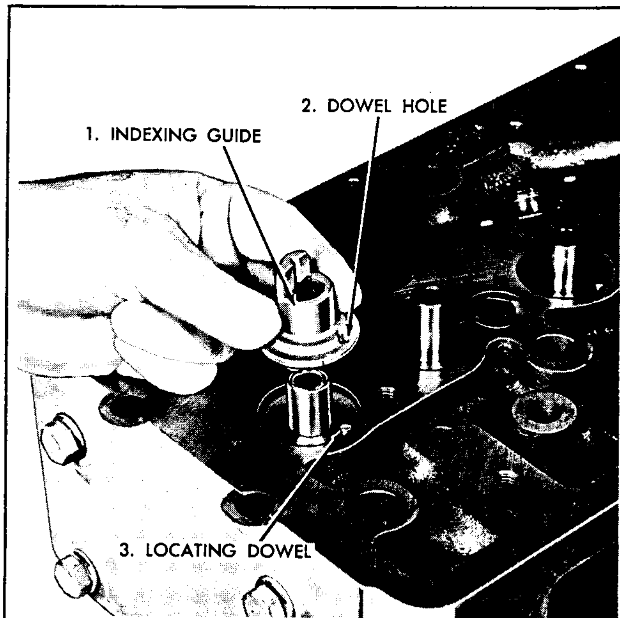


Fig. 10 — Intake Valve Indexing Guide

5. To install each intake valve indexing guide, start the guide over the valve stem, hold upward on the valve stem and index guide with the valve stem. Lower the guide on the cylinder head, aligning the hole in the guide with the guide dowel pin (Fig. 10) in the cylinder head.

6. Install the valve springs by a direct reversal of the removal procedure (with the dampening coils to the bottom).

G. Valve, Valve Guide, and Valve Seat Insert Removal, Inspection and Installation

1. Remove the cylinder heads from the engine (refer to "CYLINDER HEAD REMOVAL" in

this Section).

2. Remove the valve springs (refer to "VALVE SPRING REMOVAL, INSPECTION AND INSTALLATION," Par. F above). Remove the intake valve indexing guides and the valves from the cylinder heads. Place the valves and indexing guides in a rack as they are removed from the cylinder heads so they can be identified and reinstalled in their original positions.

3. Clean the carbon from the valves, and valve seats. Clean the carbon from the valve guide bores with a nylon brush. CAUTION: *Do not use a metal type cleaning tool.*

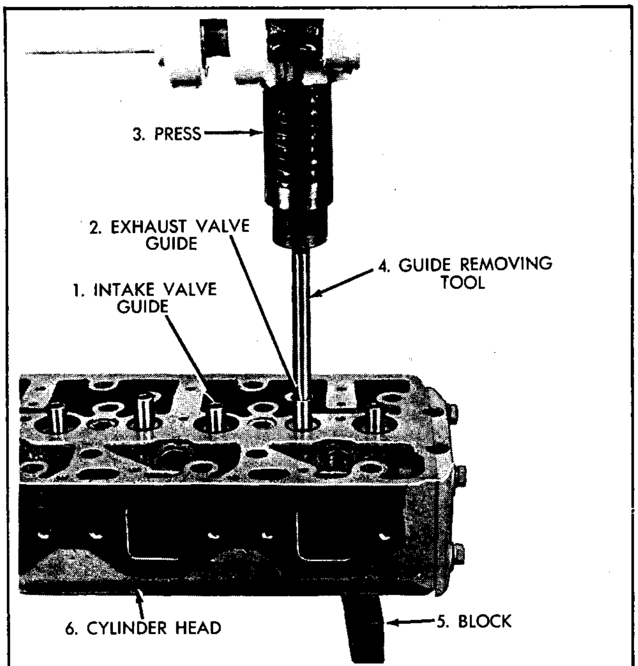


Fig. 11 — Removing Valve Guides

4. Replace the valves if they are cracked, bent, or worn. The specified diameter of both the exhaust and intake valve stems is .3715" to .3720". The specified clearance of the stem in the guide is .0015" to .0025" and should not exceed .005".

5. Inspect the groove in the indexing guides and replace if wear is excessive.

6. The valve guides may be removed by pressing them out through the bottom of the cylinder head, using a valve guide removing tool similar to the one shown in Fig. 11.

The intake and exhaust valve guides are identical in size. The top of the guide is that portion which protrudes above the top of the cylinder head and has a smaller outside diameter than the portion which forms the press fit to hold the guide in position in the cylinder head. When installing new guides it is important the upper end of the guide is to the top of the cylinder head so that the spiral thread cut into the lower two thirds of the bore in the guide is to the bottom of the head.

The exhaust valve guides are installed with the upper end 1$\frac{1}{16}$" above the bottom of the counterbore in the head around the guide. The intake guide is installed with the upper end $\frac{7}{8}$" above the bottom of the counterbore in the head around the guide.

New valve guides are pressed into position from the bottom of the head with a guide installing tool (Fig. 12) consisting of a stop plate, pilot, exhaust valve guide adaptor and intake valve guide adaptor. The adaptors establish the proper protrusion of the guides above the cylinder head. To use the tool place the head in a press with the head gasket surface up. Assemble the guide installing tool by screwing the pilot into the stop plate. Insert the particular adaptor, exhaust or intake, on the pilot. Insert valve guide on the pilot with the bottom end against the adaptor. Insert the installing tool with guide into the guide bore in the head and press downward until the stop plate rests on the head gasket surface of the head. CAUTION: *To eliminate the possibility of scuffing the guide or the bore in the head for the guide, coat the outside surface of the guide with a mixture of white lead and lubricating oil before pressing the guide into position.*

7. The bores of the guides are .373"/.3735" before pressing them into the cylinder head. The interference fit of the guides in the head is .0005"/.002". The guide bores will close in approximately .001" when installed with the maximum interference fit. To resize the guides after installation, use

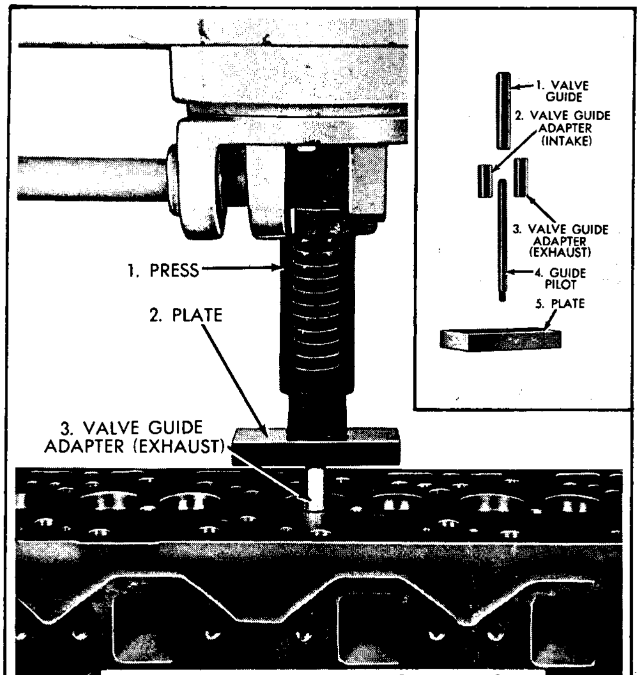


Fig. 12 — Installing Valve Guides

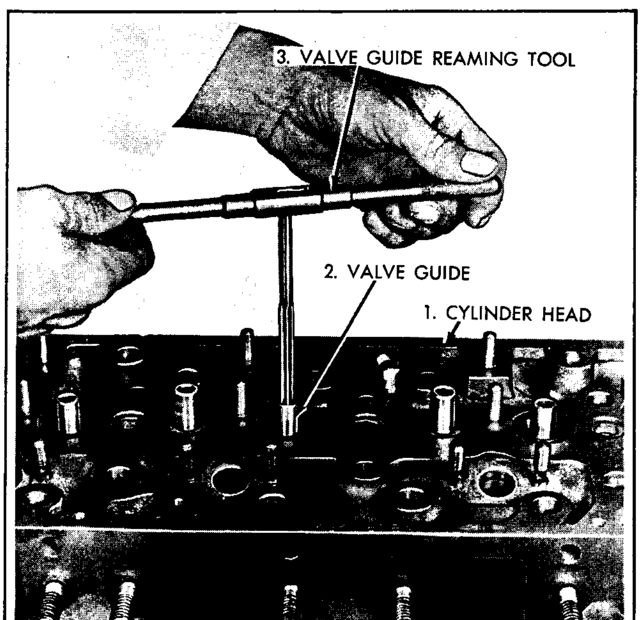


Fig. 13 — Reaming Valve Guides

a .372" valve guide reamer first and follow with a .373" valve guide reamer (Fig. 13). Valve guide reamers of these sizes can be acquired from most automotive supply houses.

After installation of the valve guides in production and service cylinder heads at the factory, their bores are resized with a "Bearingizing" tool to .3735"/.374" and checked for straightness with a .3725" "Go" gauge and a .3735" "No Go" gauge.

8. Inspect the valve seat inserts. If they are loose, cracked, or pitted, new ones must be installed. The valve seat inserts are a press fit in the cylinder head.

   A tool for removing the valve seat inserts as illustrated in Fig. 14 is available.

   As an alternate method, the valve seat inserts may be removed by electric welding a bead around the inside circumference of the insert on the beveled portion.

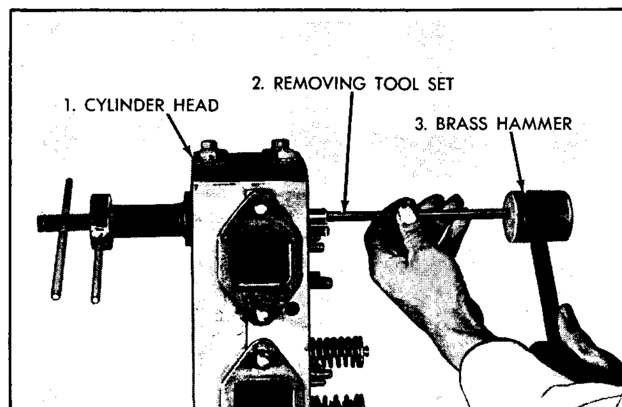


Fig. 14 — Removing Valve Seat Insert

   Allow the insert to cool, then lift out. CAUTION: *Protect machined surfaces from arc splatter.*

9. Carefully install the new valve seat inserts. The inserts are installed into the cylinder heads with a .0025" to .0045" press fit and must be started in place "true" with the counterbore in the cylinder heads.

Install the valve seat inserts as follows:

a. Be certain the valve seat counterbores in the cylinder heads are clean and free of burrs and of the correct size to insure the correct interference fit of .0025" to .0045".

b. Immerse the cylinder head for approximately 30 minutes in water heated to near boiling temperature, or thoroughly chill the inserts in a cold box or with dry ice.

c. Place the cylinder head bottom side up on a bench. Thoroughly clean the counterbores for the inserts with compressed air and start an insert into the counterbore (valve seat side up).

d. Using a valve seat insert installing tool similar to the ones shown in Fig. 15, drive the insert down tightly into the counterbore. This operation must be done quickly while the insert is cold.

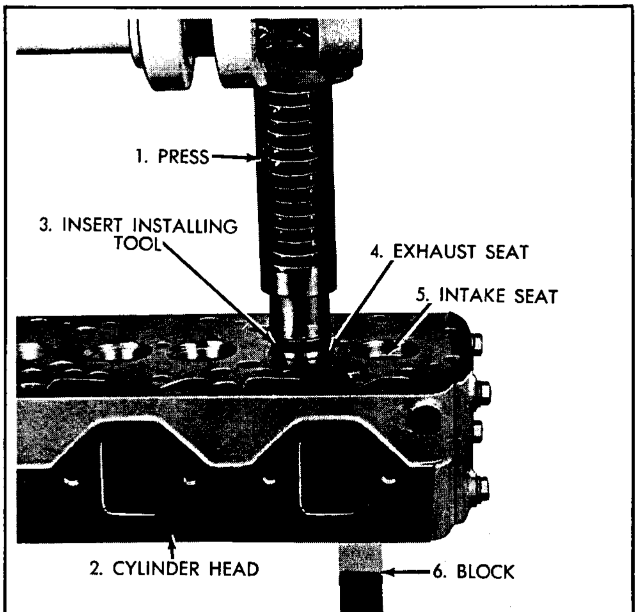


Fig. 15 — Installing Valve Seat Insert

e. It will be necessary to refinish the valve seat inserts with a grinder (refer to "VALVE FACE AND VALVE SEAT GRINDING," Paragraph H, below).

H. Valve Face and Valve Seat Grinding

Before installing either new valves or valves used previously, the valve seat inserts in the cylinder head should be inspected for proper valve seating. If previously used valves are to be reinstalled, the valve stem should be cleaned and the face ground to an angle of 45°. When refacing valves, remove just enough to clean up the face, removing all evidence of pitting and grooving. If the bore in the valve guide is worn oblong, or if the valve head is warped relative to the valve stem, the necessary parts must be replaced.

When new valve seat inserts are installed, or previously used inserts reseated, the work must be done with a valve seat grinder set similar to the one shown in Fig. 16.

The usual equipment furnished with the valve seat grinder set includes the following items:

1. Valve seat grinder.
2. Dial gauge.
3. Tool pilot.
4. Three grinding wheels — 30° — 45° and 60°.

The cutting face of the stone must be maintained at the correct angle and in proper condition by frequent dressing with a diamond wheel dresser. The frequency of dressing will be determined by the condition of the seats and the amount of metal required to be removed during the facing operation. NOTE: *It is very important that the valve grinder set be used in accordance with the manufacturer's directions.*

By grinding the valve face and insert seat at slightly different angles, a fine line contact of the face and seat is obtained, thus eliminating the need to lap the seating surfaces with grinding compound, inasmuch as the valve will peen or pound a full seat after a short period of operation.

The difference of angles is termed "interference angle" Fig. 17 and is usually between $\frac{1}{2}$° to $1\frac{1}{2}$°. The included angle of the insert seat is made greater than that of the valve face, so as to assure contact of the top of the insert seat. Thus, for 45° valve face angle and a 1° interference angle the insert seat grinder wheel must be dressed to grind the insert seat at an angle of 46°. This is a positive interference angle. A negative angle illustrated Fig. 17 must be avoided.

The first step in reconditioning the insert is to grind the seat, removing only enough metal to produce a pit free continuous seat. After the seat has been ground, use a dial gauge as shown in Fig. 18 to check the concentricity of the seat relative to the valve guide. The total run out for a good seat should not exceed .002 total indicator reading. The valve should then be installed to determine the seat contact of the valve face.

This can be accomplished by wiping a thin film of Prussian Blue on the valve face and bouncing it once on the valve seat. A thin continuous line must be evident on the valve face, otherwise further grinding is required. If the insert seat is too wide after reconditioning, use a 30° grinding wheel to narrow the seat to the recommended width of $\frac{3}{32}$".

IMPORTANT: *After installing new valves or insert seats or reconditioned previously used valves or insert seats, be certain that the valves are set in .050" to .064" minimum from the head gasket surface of the cylinder head, otherwise, serious damage will result.*

Assemble valves in the head (refer to "VALVES," Topic 3, in this Section).

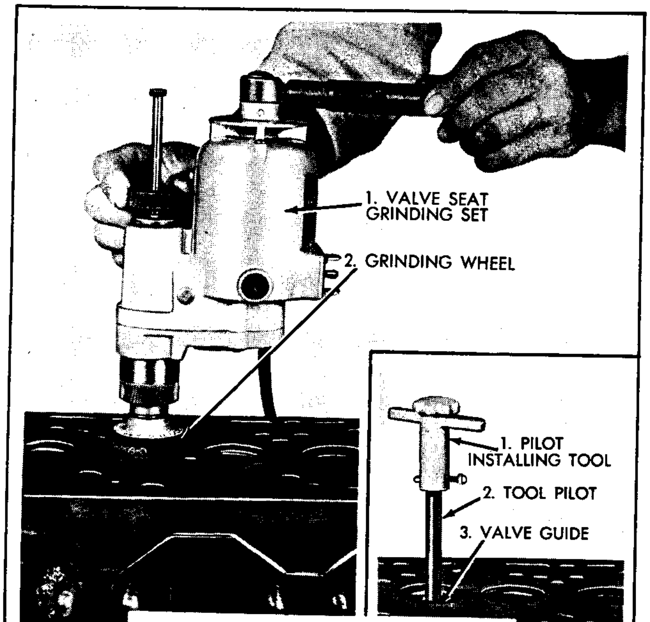


Fig. 16 — Grinding Valve Seats

I. Fuel Injection Nozzle Sleeves

(Refer to "FUEL INJECTION SYSTEM AND GOVERNOR," Section II.)

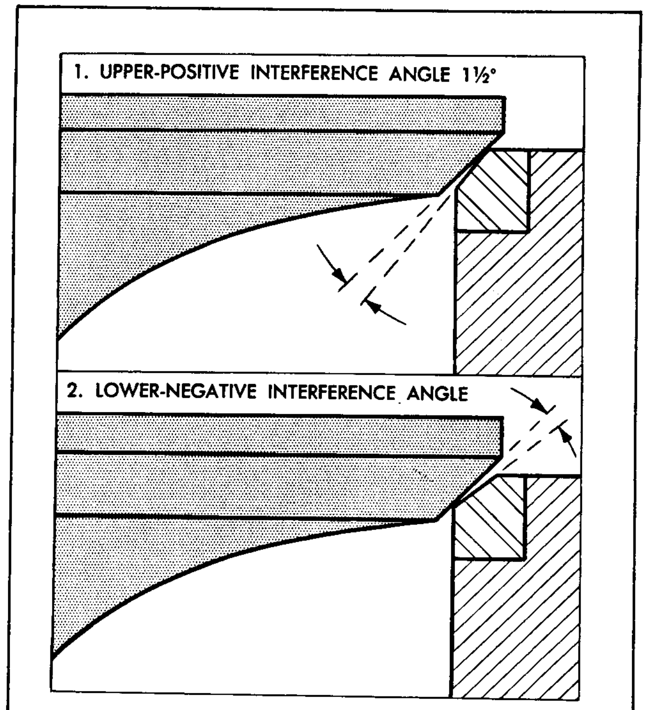


Fig. 17 — Interference Angle

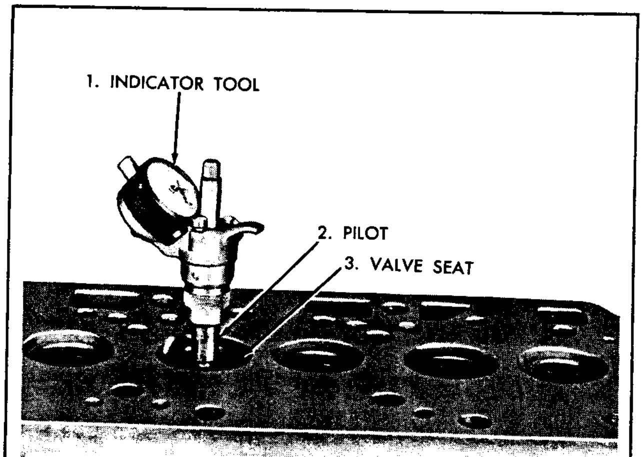


Fig. 18 — Checking Concentricity of Valve Seats

4. CYLINDER BLOCK AND CYLINDER SLEEVES

A. Description

The cylinder block, which is the main structural part of the engine, is a one-piece casting made of alloy cast iron. Traverse members, cast integral, provide rigidity and strength, assuring perfect alignment of the crankshaft bearings and cylinder sleeves. The cylinder block is bored to receive removable "wet-type" cylinder sleeves. The cylinder sleeves are completely surrounded by water jackets which extend the full length of the cylinder walls for maximum cooling.

The cylinder block contains a main oil gallery which extends lengthwise through the cylinder block. Oil passages direct the oil flow from the main oil gallery to the camshaft and main bearings and through the rifle drilled connecting rods to the piston pins. A horizontal oil passage through the center of the cylinder block extends from the main oil gallery to a cavity in the left side of the cylinder block. From this cavity there are two openings which extend to the rocker arm assemblies.

Short dowel pins pressed into the top deck of the cylinder block, properly positioned, the cylinder head gasket and head assembly in relation to the cylinder sleeves and the combustion chamber in the pistons.

The cylinder block, when ordered for service is furnished with cam bearings, main bearing caps and studs, and the necessary plugs.

The removable "wet-type" cylinder sleeves are made of alloyed cast iron. Two rubber packing rings, fitted into grooves in the lower outside circumference of the sleeve, prevent water leakage into the crankcase. The sleeve is sealed at the top by a flange which fits into a machined recess in the cylinder block. The cylinder head gaskets are compressed between this flange and the cylinder heads, holding the sleeve in place and serving as a coolant seal at the upper end of the sleeve.

B. Cylinder Sleeve Removal

With the pistons removed, the cylinder sleeves may be removed with a cylinder sleeve remover tool similar to the one shown in Figs. 19 and 20.

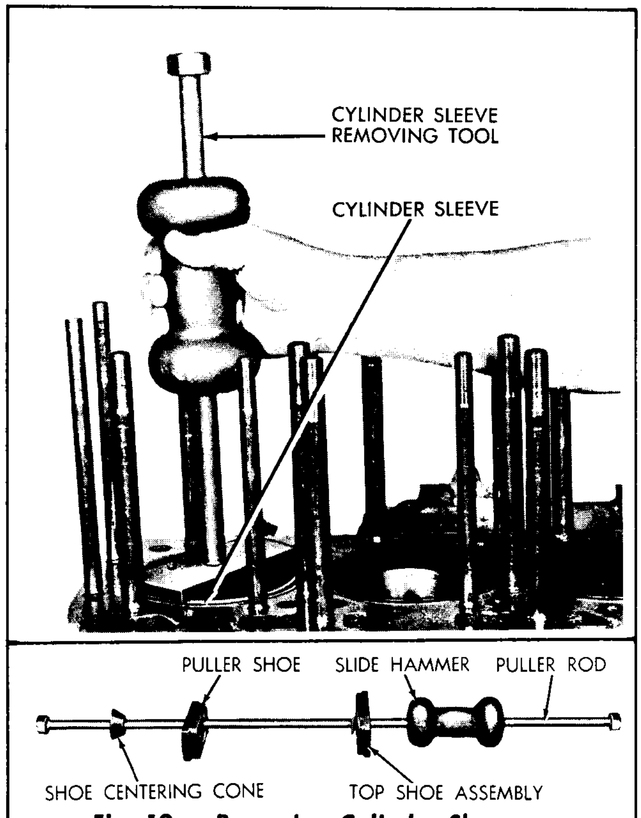


Fig. 19 — Removing Cylinder Sleeve — Top View

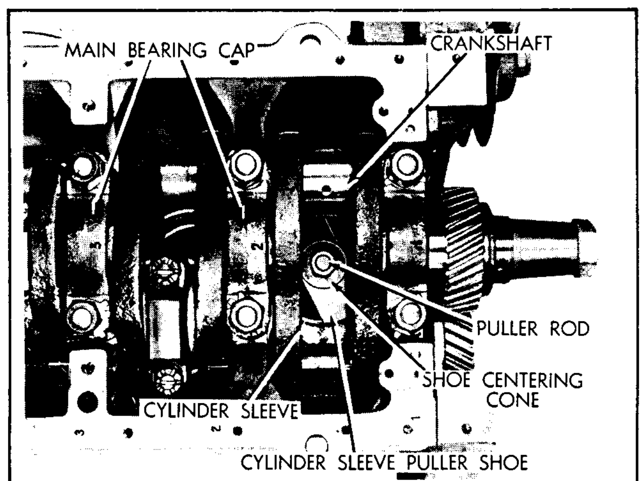


Fig. 20 — Removing Cylinder Sleeve — Bottom View

C. Cylinder Sleeve Cleaning and Inspection

1. Remove all dirt, carbon, and grease from the cylinder sleeves and the machined recess and bore in the cylinder block. Replace the cylinder sleeves if they are scored or cracked.

2. Check the cylinder sleeves for roundness by means of a gauge similar to the one shown in Fig. 21. Using an inside micrometer, measure the cylinder sleeve for taper and wear. The inside diameter of a new cylinder sleeve is 4.4370" to 4.4385". The out of round and taper of sleeve should not exceed this maximum tolerance.

   NOTE: *When measuring the cylinder sleeves with an inside micrometer, first measure in a position parallel to the crankshaft and then at right angles to the crankshaft. These measurements should be taken at several locations within the area of piston ring travel.*

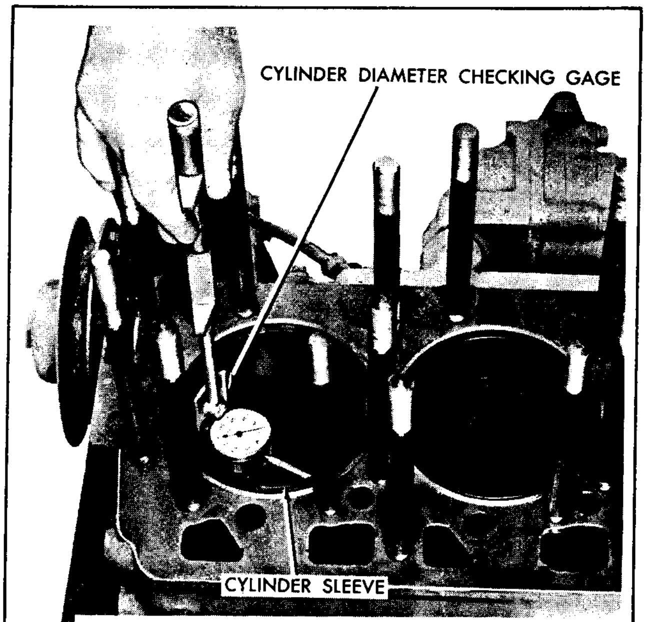


Fig. 21 — Checking Cylinder Sleeve for Roundness

3. The normal pattern of wear in cylinder sleeves will show maximum wear at the top three fourths of the ring travel and diminish to a small amount of wear at the bottom of the ring travel to negligent wear below the ring travel. Therefore, cylinder sleeve life is generally dictated by the tolerable wear at the top of ring travel.

   Excessive dirt consumption through the air intake system, overheating, excessive combustion temperature caused by abuse or maladjustment, and faulty lubrication can alter these patterns of normal wear and cause deterioration and failure not associated with normal wear.

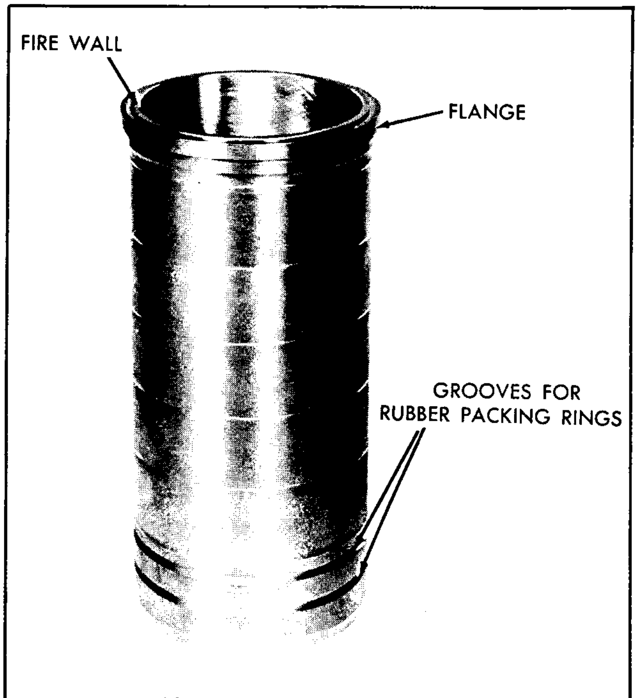


Fig. 22 — Cylinder Sleeve

   If the maximum cylinder sleeve wear at the top of the ring travel does not exceed .003" out of round and .008" total wear, no deterioration of the top sleeve flange has occurred to decrease the specified protrusion above the top deck to adversely affect head gasket sealing, no scores, cracks or other physical defects are present the sleeves may be re-used with a reasonable life expectancy of approximately ½ to ¾ that of new sleeves.

   If the sleeves are within the limits as mentioned above and are to be re-used, it is important that the ridge above the ring travel be removed with a ridge removing tool similar to the one shown in Figure 23, and the glaze in the ring travel area is broken.

D. Cylinder Sleeve Installation

1. Thoroughly clean the cylinder sleeve and the bore in the cylinder block. Be certain that the bottom surface of the flange on the cylinder sleeve and the counterbore in the cylinder block are clean and free from

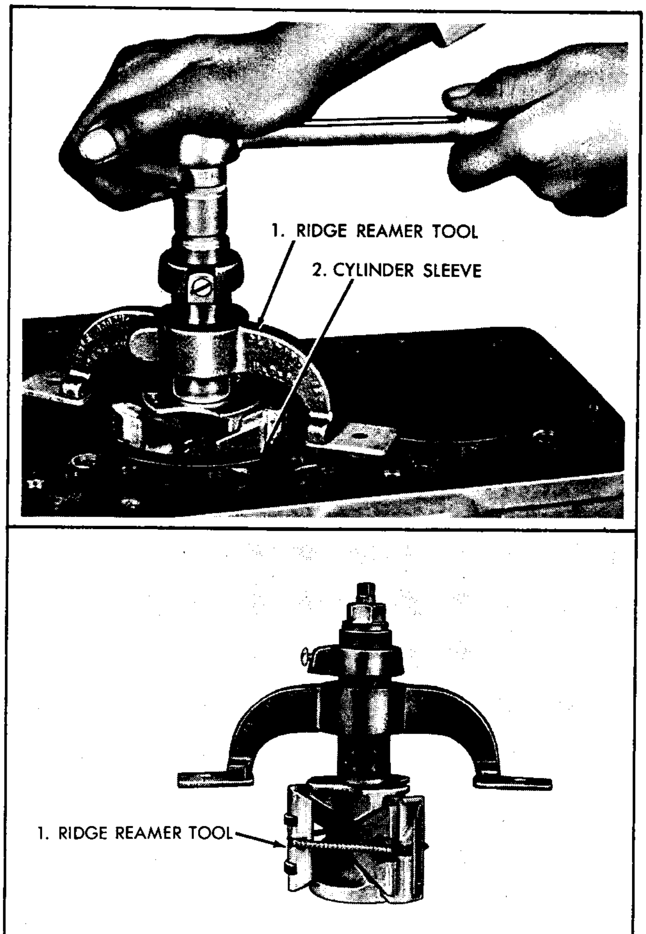


Fig. 23 — Removing Ring Travel Ridge from Cylinder Sleeve

nicks or burrs. Before installing the rubber packing rings on the sleeve, insert the sleeve into the bore of the cylinder block to be certain that the sleeve can be pushed down into place and turned in the bore by hand pressure. If the sleeve cannot be inserted in the above manner, more cleaning is necessary.

2. With the flange of the cylinder sleeve firmly seated in the counterbore of the cylinder block, the top surface of the cylinder sleeve flange must be .0065" to .0095" above the top flat surface of the cylinder block.

   Hold a straightedge across the top of the cylinder sleeve flange and using a feeler gauge as shown in Figure 24, measure the standout of the cylinder sleeve flange above the cylinder block. CAUTION: *When measuring in the above manner, be certain that the straightedge is on the flange of the*

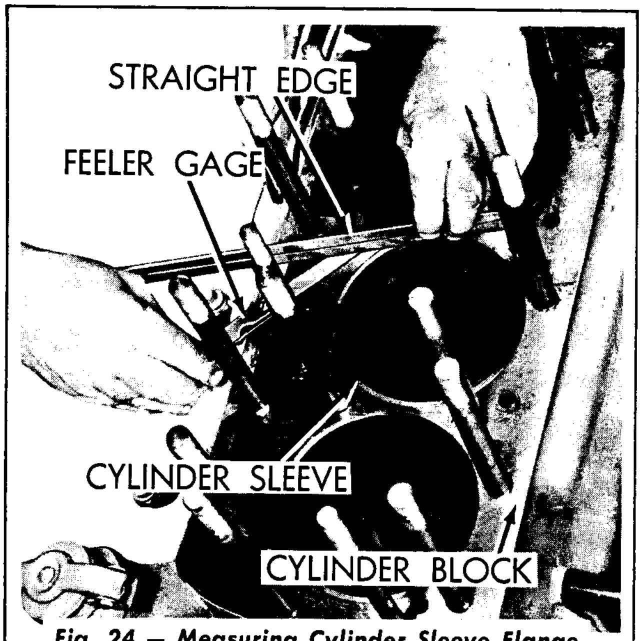


Fig. 24 — Measuring Cylinder Sleeve Flange Height Above Block

sleeve and not on the firewall. (Refer to Fig. 22.)

3. Longer life and better sealing of the cylinder head gaskets is obtained if the cylinder sleeve flange standout is held within .0065" to .0095" above the top flat surface of the cylinder block. Replacement of the cylinder sleeves, remachining of the counterbore in the cylinder block, or both, may be necessary if the standout is not .0065" to .0095". (Refer to Par. "E" under this topic.)

4. Thoroughly clean the packing ring grooves in the cylinder sleeve. Stand the cylinder sleeve on a clean work bench with the lower end of the sleeve upward. Install the new packing rings over the lower end of the sleeve and into the grooves, using care not to twist or roll the packing rings while installing. Apply liquid soap (green soap) or hydraulic brake fluid to the packing rings before installing the cylinder sleeve into the cylinder block.

5. Install the cylinder sleeve in position in the cylinder block, using care to prevent damage to the packing rings.

E. Cylinder Sleeve Reseating

Cylinder sleeve reseating may become necessary if the cylinder sleeves have been allowed to move due to incorrectly torqued cylinder head nuts, deteriorated head gasket, and/or from block counterbore or sleeve flanges eroding from long use. The cylinder sleeve flange standout must be held within .0065" to .0095" above the top flat surface of the cylinder block.

A cylinder sleeve reseating tool (Fig. 25) is available on a purchase of rental basis. Sleeve shims in sizes .005", .010", .015" and .020" are available to re-establish the correct sleeve protrusion above the top deck of the cylinder block.

When using the reseating tool and shims, you must use a depth micrometer for the counterbore measurements and an outside micrometer to measure the thickness of the cylinder sleeve flange and install the correct combination of shims. CAUTION: *Do not attempt to determine the sleeve protrusion and projection above top deck of cylinder block with a rule and feeler gauge as rough edges on shims can give a false reading.*

F. Cylinder Block Cleaning and Inspection

Since the cylinder block is the main structural part of the engine, whenever the engine is being overhauled, the block should be thoroughly inspected for any conditions that would render it unfit for further use. Such inspection must be made after all the parts have been removed from the cylinder block and it has been thoroughly cleaned, with live steam or a suitable solvent, and dried with compressed air.

All the oil passages in the cylinder block must be cleaned before assembling the engine. Effective cleaning of these passages can be accomplished only with the use of high steam pressure, with a solvent used in the water to dissolve the sludge and foreign material that has collected. Remove the oil pressure regulator and the various plugs of the oil galleries to clean the passages.

After cleaning, flush the passages in the cylinder block with clean water (under pressure) to remove all traces of the solvent.

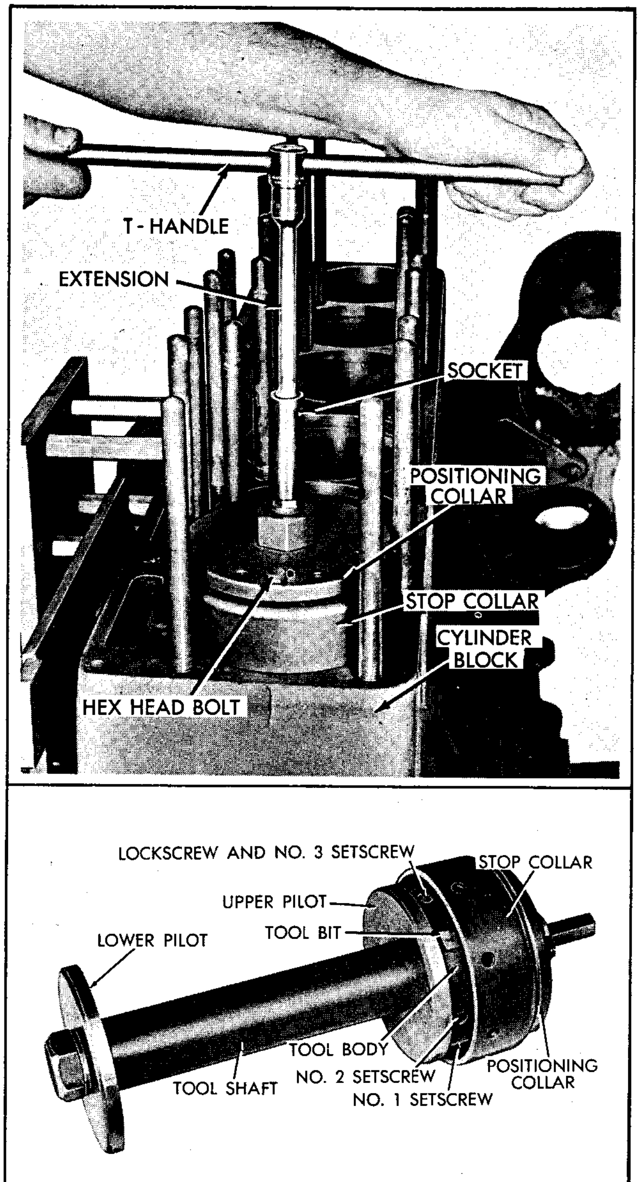


Fig. 25 — Cylinder Sleeve Reseating Tool

To clean the water jacket of the cylinder block, remove the plugs from the jacket. Apply high pressure steam and water through these openings; turn the block in various positions while this is being done so that the loose scale will be washed out.

IMPORTANT: *Note the location of the plugs removed for cleaning of the oil and water passages in the cylinder block and be sure that all of these plugs are reinstalled in their proper places after the block has been cleaned and dried. Coat the threads of all the plugs with white lead to assure a tight seal. The plugs must be installed so that they do not project from the block to interfere with attached parts.*

5. CRANKSHAFT, CRANKSHAFT HUB, FLYWHEEL, MAIN BEARINGS AND FLYWHEEL HOUSING

A. Description

1. Crankshaft

The seven bearing, counter balanced crankshaft is a steel drop forging, carefully heat treated to assure utmost strength and durability. The crankshaft is balanced both statically and dynamically. The end thrust of the crankshaft is taken by the flanges of the center bearing.

2. Main Bearings

The main bearings are of the precision type and are replaceable without machining.

The main bearing caps are attached to the cylinder block and line bored in position to receive the precision bearing shells. Each bearing cap is numbered on the camshaft side and when removed should always be reinstalled in its respective position and with the numbers on the bearing caps to the camshaft side of the engine, and corresponding to the numbers stamped on the bottom edge of the cylinder block.

The upper halves of the main bearing shells are seated in the cylinder block. The lower halves are held in place by the main bearing caps, each of which is attached to the cylinder block by studs and nuts. Each half of the bearing shell is prevented from radial movement by a tang at the parting line on one side of the bearing shell. A spring loaded, lip type oil seal, pressed into the bore of the flywheel housing is used to seal the crankcase oil from the flywheel compartment.

A spring loaded, lip type oil seal, pressed into the timing gear housing cover, located on the rear of the engine, is used to seal the crankcase oil from leaking out at the rear end of the crankshaft. The seal bears against an oil seal sleeve pressed onto the crankshaft. The sleeve is serviced separately and may be replaced if worn.

3. Flywheel

The flywheel is bolted securely to a flange on the front end of the crankshaft and is doweled in two places. One capscrew hole in the flywheel is offset and the flywheel can be attached to the crankshaft flange in only one position. A starter ring gear made from heat treated steel is shrunk on the rim of the flywheel.

4. Flywheel Housing

The flywheel housing is a one piece casting, ribbed for strength and is positioned on the front of the cylinder block with dowels and secured in place with capscrews. It serves several purposes, such as, covers the flywheel, contains the crankshaft rear oil seal and starter, supports the rear of the engine and positions the converter housing so the converter shaft is in alignment with the center of the crankshaft.

The only time the flywheel housing requires service or replacement is when it is cracked or distorted on the converter housing mounting face or pilot bore, usually from an accident. Whenever the engine is overhauled, inspect the crankshaft front oil seal and replace if necessary. Inspect the housing for cracks and other damage. After mounting the housing on the rear of the engine, check the converter mounting face and pilot bore for distortion (runout) with a dial indicator.

B. Removal, Inspection, and Installation of Crankshaft

1. Remove the engine from the loader (refer to "ENGINE – REMOVAL AND INSTALLATION OF ENGINE," in this Section).

2. Drain the lubricating oil.

3. Inspection can be made of the crankshaft main bearings and journals by removing the oil pan and removing the bearing caps one at a time (refer to "REPLACEMENT OF CRANKSHAFT MAIN BEARINGS" in this Section).

   Remove the crankshaft as follows:

   a. Remove the starter from the flywheel housing.

b. Remove the flywheel and ring gear assembly.

c. Loosen the fan belt tightener and remove the fan belts.

d. Remove the capscrews from the power steering pump drive pulley and remove the drive pulley from the hub.

e. Remove the crankshaft pulley retaining capscrew and remove the pulley (refer to "REMOVAL OF CRANKSHAFT PULLEYS," Par. "H," this Section).

f. Loosen the rear engine mounting bracket capscrews and remove rear engine mount from the timing gear cover.

g. Remove the capscrews attaching the timing gear housing cover to the timing gear housing. Remove the capscrews attaching the timing gear housing cover to the oil pan and remove the timing gear housing cover.

h. Using puller tools similar to the ones shown in Fig. 26, remove the rear oil seal sleeve and sleeve spacer from the crankshaft.

i. Using a puller similar to the one shown in Fig. 27, pull the crankshaft gear from the crankshaft.

j. Remove the remaining capscrews attaching the oil pan to the cylinder block and flywheel housing and remove the oil pan. Remove the capscrews attaching the flywheel housing to the cylinder block and remove the flywheel housing.

k. Refer to "ENGINE LUBRICATION SYSTEM," Section V, and remove the oil pump.

l. Remove the connecting rod bearing caps and lower bearing shells. Remove the main bearing caps and the lower main bearing shells. Remove the crankshaft.

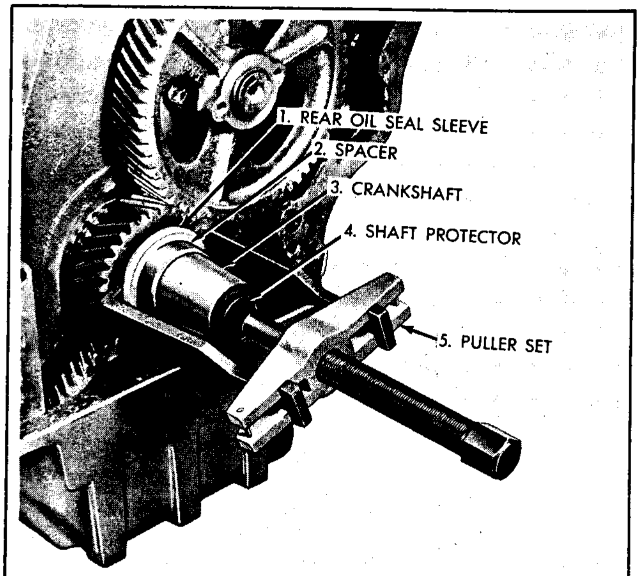


Fig. 26 — Removing Front Oil Seal Sleeve and Sleeve Spacer from Crankshaft

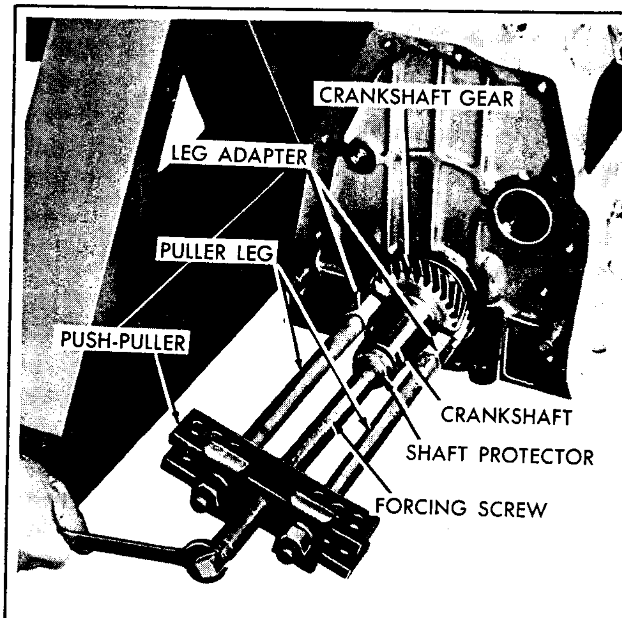


Fig. 27 — Removing Crankshaft Gear

4. Inspect the crankshaft journals for scoring, chipping, cracking or signs of overheating. If the crankshaft has been overheated (usually indicated by discolored or blue bearing journal surfaces), or is scored or excessively worn, reconditioning or replacement will be required. Examine the bearing journals for cracks if overheating has occurred.

5. Measure the crankshaft main bearing and connecting rod journals at several places on their diameter to check for roundness.

The original diameter of the main bearing journals is 3.498" to 3.499" and the connecting rod journals is 2.7715" to 2.7725". If out of round or taper exceeds .002" the shaft must be reground to a standard undersize or replaced. If worn to the extent that installation of new bearing shells will not decrease clearance below .007" the shaft must be reground or replaced.

6. All main and connecting rod bearing surfaces of the crankshaft are hardened to a depth of approximately .090". If regrinding of the crankshaft journals become necessary, the work should be done by a reputable machine shop that has suitable equipment to handle precision work of this type. Main bearing shells and connecting rod bearing shells of .010", .020", .030" and .040" undersize are available, and if the crankshaft is ground, the diameter of the journals should be reduced in steps of .010", .020", .030", .040" below 3.498"/3.499" to fit the available undersize main bearing shells, and below 2.7715"/2.7725" to fit the available undersize connecting rod bearing shells. The fillets at the ends of each bearing journal must not be reduced from their original radius when regrinding a shaft.

7. Remove the hex-socket pipe plugs from the crankshaft and blow out all the oil passages in the crankshaft with compressed air. Coat the threads of the plugs lightly with white lead when reinstalling and tightening them securely.

8. If the crankshaft front oil seal sleeve shows signs of excessive wear, it can be turned end for end on the crankshaft to provide a new sealing surface for the crankshaft oil seal, or it may be replaced.

9. Install the crankshaft by a direct reversal of the removal procedure. Refer to "MAIN BEARING INSPECTION" and "MAIN BEARING REPLACEMENT" in this Section for the specified bearing clearances.

C. Main Bearing Inspection

1. Any bearing shells that are scored, chipped, pitted, or worn beyond the specified limits given below must be replaced. Inspect the tangs of the upper and lower halves for indication of radial movement of the bearing within the cylinder block. If a bearing has been radially shifting the tang will have worn down below the parting line of the bearing shell and is unfit for further use.

2. The specified vertical clearance between the main bearing shells and the crankshaft journals is .002" to .0047". New bearing shells must be installed and possibly the crankshaft will have to be reground or replaced when this clearance exceeds .009". The amount of wear on the bearing shells may be determined by measuring each shell with micrometers as shown in Figure 28. New shells, measured at point "C" in Figure 29 are .1549"/.1554" thick. Bearing shells less than .153" thick are worn beyond the allowable limits and must be replaced.

Fig. 28 — Measuring Bearing Shell Thickness

3. As shown in Figure 29, the bearing shells (when in place) are .002" larger in diameter at the parting line than they are 90°

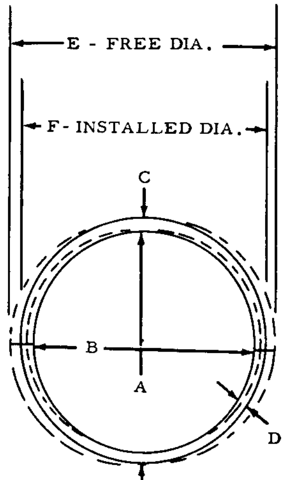


Fig. 29 — Measuring Inside Diameter of Main Bearing Shell

from the parting line. The two shells do not form a true circle when installed. When measured for inside diameter, they should be installed in the cylinder block and the bearing caps tightened to the specified torque (crankshaft removed). The two halves of the shells have a crush fit in their bore in the block and must be tight when the cap is secured in place. Tighten the front, intermediate, and rear main bearing caps to 210 to 230 lbs. ft. torque. Tighten the center main bearing cap to 160 to 170 lbs. ft. torque.

4. To determine the approximate running clearance between the bearings and the crankshaft journals use plastigauge. The most accurate method of determining the running clearance is to calculate the difference between the micrometer readings of the bearing inside diameters and the outside diameter readings of the crankshaft journals.

5. Check the end play of the crankshaft, which is controlled by the doweled flanges on the center main bearing. The end play may be measured as shown in Fig. 30. The specified clearance is .006" to .014" and should not exceed .022"; replace the center main bearing flanges if necessary. Flanges are available in standard, .005", .010" and .015" oversizes.

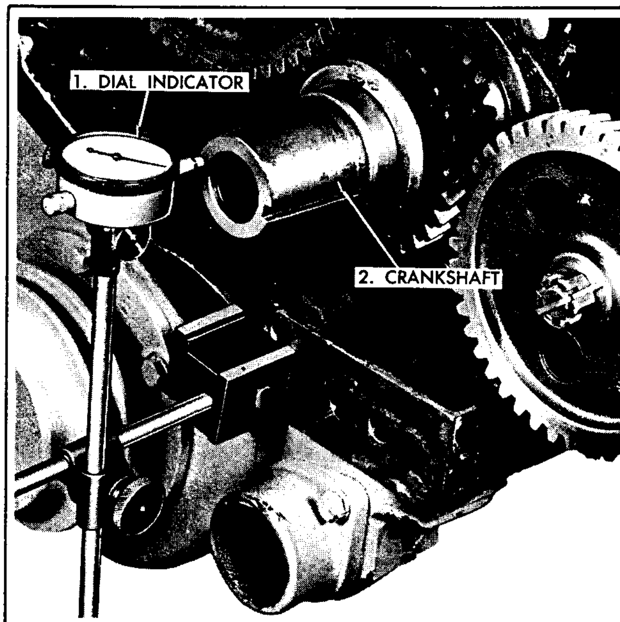


Fig. 30 — Measuring End Play of Crankshaft

D. Main Bearing and Bearing Cap Replacement

Remove the main bearings as follows:

1. Remove the crankshaft (refer to "REMOVAL, INSPECTION, AND INSTALLATION OF CRANKSHAFT" in this Section).

2. Using a small wooden block and a hammer, remove the main bearings from the crankcase and the main bearing caps. NOTE: *As a general recommendation, if removed bearings have seen 2000 to 3000 hours service, the cost of new replacement bearings will offset the gamble of undetected fatigue or accelerated fatigue from minute repositioning upon reinstallation of used bearings and warrant installation of new bearings.*

After the main bearings have been removed and inspected as outlined above, and if they are in satisfactory condition and within specified size tolerances, they may be reinstalled or, preferably, new bearings installed as follows:

a. Install the upper halves of the main bearing shells in the bearing seats of the cylinder block. Be certain that the tangs on the bearing shells are properly located in the corresponding slots in the bearing seats.

b. Lubricate all the crankshaft main bearing journals and lower the crankshaft in the cylinder block.

c. Place the lower halves of the main bearing shells in the main bearing caps, inserting the tangs of the shells into the slots in the caps. The bearing caps are numbered 1, 2, 3, etc., indicating their respective positions. Install the caps with the numbers facing the camshaft side of the engine and corresponding to the number stamped on the lower edge of the cylinder block, as shown in Figure 31, and install the main bearing cap lockwashers and stud nuts. Use a torque indicating wrench and tighten the nuts to a torque of 210 to 230 lbs. ft. on the ¾" nuts used on the front, intermediate, and rear main bearings; tighten the ⅝" nuts used on the center main bearing to a torque of 160 to 170 lbs. ft. Lock the nuts with the lockwashers and/or locking plates.

CAUTION: *Do not overtighten the main bearing stud nuts. If these nuts are overtightened, the bearing caps may be distorted, causing the bearings to be drawn tight against the crankshaft and premature failure will result. The crankshaft should turn freely after all the nuts are properly torqued. Never file or shim a bearing cap to make the bearing shell fit; install new bearing shells if the fit on the crankshaft is unsatisfactory.*

E. Bearing Cap Replacement

Main bearing caps are not interchangeable and if replacement becomes necessary, the new caps must be machined in place. To maintain correct alignment and size in the main bearing bore in the block, the caps must be installed with the specified torque of 210 to 230 lbs. ft. on the ¾" stud nuts and 160 to 170 lbs. ft. on the ⅝" stud nuts. As a general rule replacement of bearing caps is a machine shop job.

Replacement, front, intermediate and rear caps are finished machined except for the bore which is semi-finished. The replacement center cap is fin-

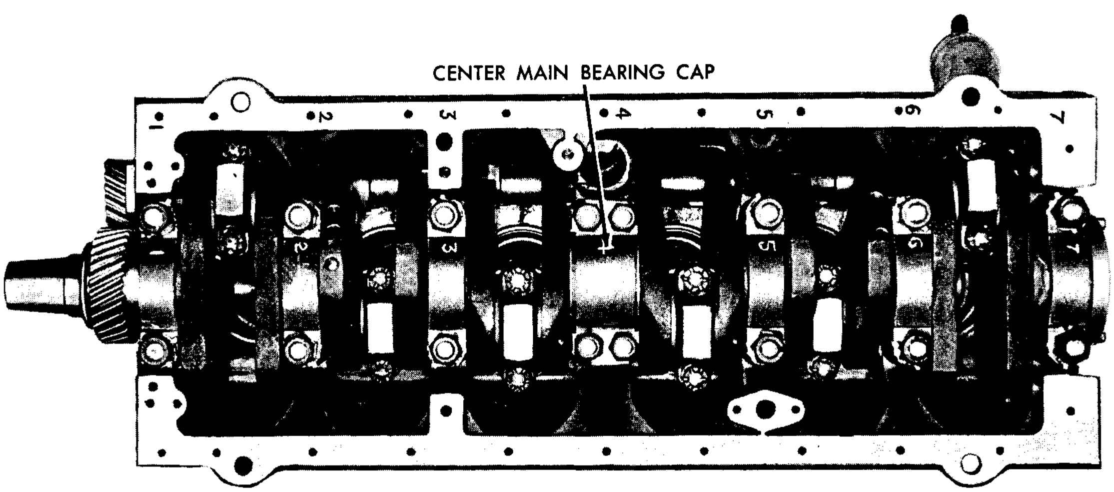


Fig. 31 — Main Bearing Caps Location

ished machined except for the bore and the thrust faces.

When it is necessary to do any machining to the main bearing bore in the block, it is important that the center line of the crankshaft is not altered from its original center line, especially at the timing gear end. Raising the bore .003"-.004" at the flywheel end of the engine can be tolerated if the bore is made straight and the rear main bore is not repositioned. The bearing caps are positioned or located by their side fits in the saddles in the block and when installing a replacement cap be sure the bearing tang slot is on the same side of the bore as the bearing tang slot in the block.

If a main bearing burns out with enough heat to cause distortion at one or more of the main bearing bores or saddles, generally the block and bearing caps will pull in at their joint causing an oblong bore. If the flat areas where the cap contacts the block around the main bearing studs have distorted so they are no longer flat and straight, this area will have to be hand filed and fitted to the replacement bearing cap so when the new cap is installed it will not be distorted from being pulled down on an out-of-square surface. The main bearing studs will have to be removed to make this check. Also a thin coat of Prussian Blue can be used on the new cap to detect any out-of-squareness at this point.

F. Replacement of Crankshaft Oil Seals

Drive the oil seals from the flywheel housing and the timing gear housing cover and install new oil seals each time that the engine is disassembled. To prevent damaging the new seals, lubricate the lip and use a tool similar to the one shown in Figure 32, to drive the new seals into place. The sealing lip of each seal must be directed toward the inner side of the housing or the cover. When installing the timing gear housing cover, a crankshaft housing oil seal protector similar to the one shown in Figure 33 should be used to prevent damage to the seal lip.

G. Flywheel and Ring Gear Removal, Inspection, and Replacement

To remove the flywheel from the engine, remove the capscrews and lockwashers attaching the flywheel to the crankshaft flange. Refer to Figure 34 and insert two $\frac{1}{2}$" NF x 6" guide studs with slotted ends into the crankshaft flange to act as guides and to prevent damage to the flywheel when removing. It may be necessary to remove the flywheel housing timing hole cover and pry the flywheel loose with a suitable bar.

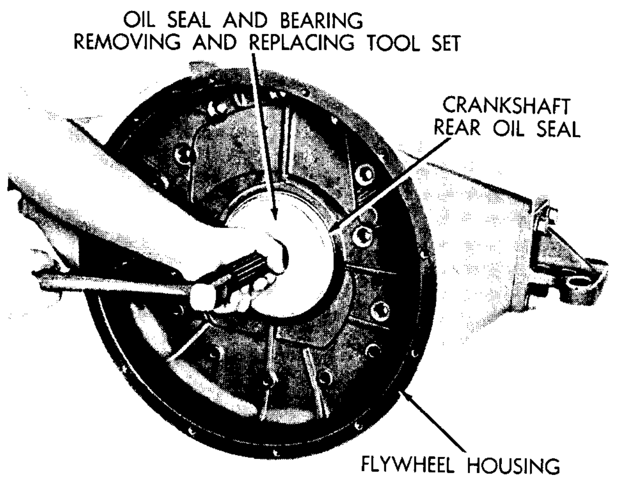


Fig. 32 — Installing Crankshaft Front Oil Seal

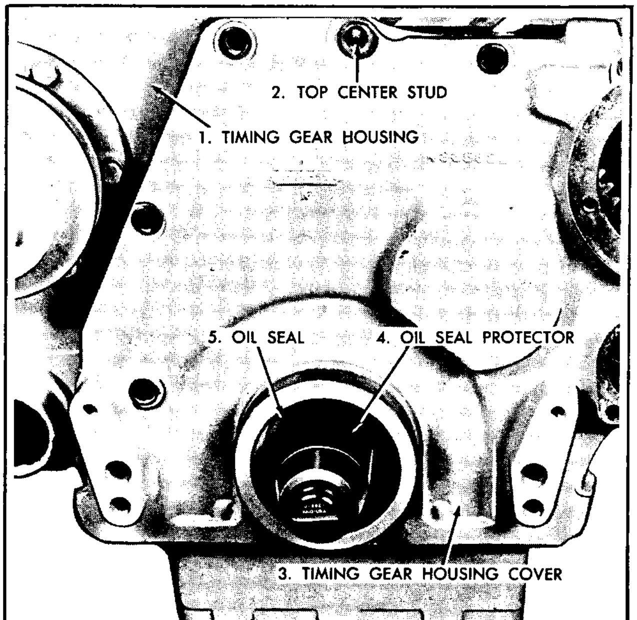


Fig. 33 — Installing Timing Gear Housing Cover

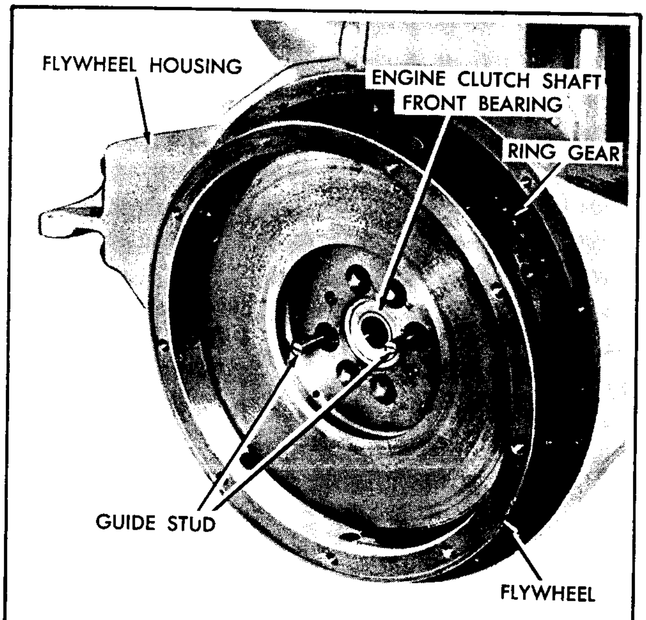


Fig. 34 — Removing Flywheel from Crankshaft

1. Flywheel

It is very important that all burrs and nicks be removed from the rear surface of the flywheel that fits against the flange of the crankshaft. If this surface is not smooth and true, the flywheel may have a slight wobble which will result in improper converter operation, converter wear, and engine vibration. It is advisable to attach a dial indicator to the flywheel housing and check the flywheel for run-out.

The variation of the flywheel face run-out should not exceed .0005" maximum total indicator reading per inch of diameter. NOTE: *When making the above check be sure that the crankcase is forced either to the front or rear of the engine to eliminate the crankshaft end play, otherwise the dial indicator reading will not be accurate. Also, be certain that the surface on which the finger of the dial indicator rides is clean and free of burrs and nicks.*

2. Ring Gear

Inspect the flywheel ring gear for general condition and wear. Replace the ring gear if it is not in good condition. Remove the ring gear from the flywheel by grinding a notch through the ring at the root of one of the teeth, then expand the ring and drive it from its position. Do not attempt to remove the ring gear without first expanding it. To install a flywheel ring gear proceed as follows:

a. The ring gear is shrunk on the flywheel by uniformly heating the gear to approximately 300° to 325° F. (dull red heat visible in the dark), then placing it on the flywheel which is at room temperature. NOTE: *Do not heat the ring gear to a bright red because the heat treatment of the gear will be destroyed.*

b. After heating, start the ring gear on the flywheel so that, when the flywheel is installed, the chamfered ends of the teeth on the ring gear will face the cylinder block; these ends of the teeth engage with the pinion of the starter. Drive the ring gear down tight against the shoulder on the flywheel. Allow the ring gear to cool slowly; do not cool it with water.

H. Removal and Installation of Crankshaft Pulley

The crankshaft pulley is secured to the front end of the crankshaft by a tapered fit, key and large capscrew with washer. To remove the pulley, loosen the capscrew about ½". Using a puller similar to the one shown in Figure 35, break the pulley loose from the crankshaft. Remove the capscrew, washer and pulley. If necessary, remove the key.

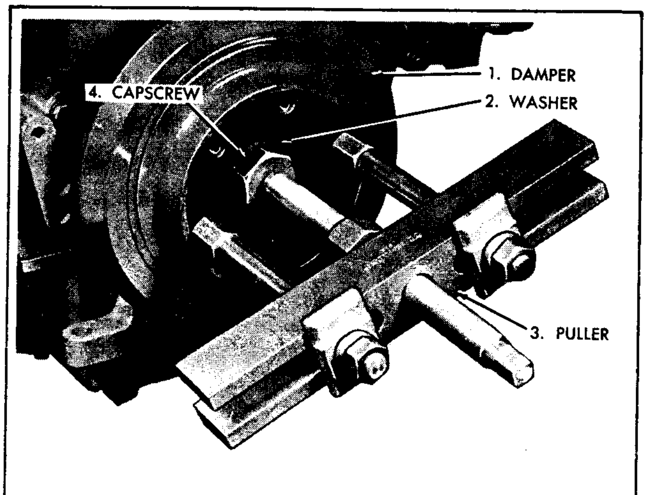


Fig. 35 — Removing Crankshaft Pulley

Install the key in the crankshaft. Install the pulley, washer, and the capscrew. Tighten the capscrew to a torque of 290 to 310 lbs. ft.

I. Removal, Inspection and Installation of Flywheel Housing

1. Remove the engine from the loader (refer to "ENGINE — REMOVAL AND INSTALLATION" in this Section).

2. Remove flywheel (refer to "FLYWHEEL AND RING GEAR INSPECTION AND REPLACEMENT" in this Section).

3. Remove capscrews securing the rear of the oil pan to flywheel housing.

4. Remove the capscrews securing the flywheel housing to the cylinder block. Tap the housing with a brass hammer to break it loose from the dowels. Remove the housing.

5. Thoroughly clean the housing with a cleaning solvent.

6. Inspect it for cracks or other damage — replace it if the cracks or damage is extensive.

7. If necessary, install a new crankshaft front end oil seal using a tool similar to the one shown in Figure 32.

8. Position a new flywheel housing to the cylinder block sealing ring in the groove of the housing.

9. Clean front of the cylinder block and assemble the flywheel housing in reverse order of removal.

10. Assemble flywheel to crankshaft.

11. Check converter housing mounting face and pilot bore for excessive run-out.

    a. Converter housing mounting face — Mount dial indicator to the flywheel so that the indicator is vertical to the housing face and the indicator stem rides on the housing face. The face run-out should not exceed .008" total indicator reading.

    b. Housing bore — Readjust the indicator so that the stem rides the bore of the flywheel housing. The bore run-out should not exceed .008" total indicator reading.

6. PISTONS AND CONNECTING RODS

A. Description of Pistons

The precision-machined and balanced pistons are cast aluminum alloy, cam ground, and anodized. The combustion chamber is in the head of the piston and is offset from center. The camshaft side is marked on the flat surface of the piston head. Each piston is fitted with three compression rings and one oil control ring, all located above the piston pin. The compression ring installed in the uppermost groove is "Chrome Plated." The bottom ring is a three piece type oil control ring, consisting of two segments and an expander-spacer. Holes are drilled through the walls of the piston in the oil ring grooves to allow any excess oil that collects in the ring grooves to return to the crankcase. The piston pins are of the full floating type and are held in place in the piston by two retainer rings fitted into grooves in the pin bosses of the piston.

B. Description of Connecting Rods

Each connecting rod is made of drop-forged, heat treated steel, and forged to an "I" section with a closed hub at the upper end and an integral cap at the lower end. The rod is rifle-drilled for pressure lubricating of the piston pin. Each connecting rod is statically and electronically balanced.

The connecting rod bearings are of the replaceable precision type, consisting of two identical halves. At 90° to the parting line is an oil hole which aligns with the rifle drilled oil passage in the "I" section of the connecting rod. The purpose of the oil hole is to allow the passage of lubricating oil under pressure to the piston pin bushing at the upper end of the connecting rod. The bearings are positioned in the connecting rods by tangs which are located at one end of each bearing at the parting line.

The bearings are held in place by an interference or crush fit, created when the cap is secured in place by two special bolts, castellated nuts and cotter pins.

The piston pin bushing is held in position in the upper end of the connecting rod by an interference fit. An oil hole in the internal groove registers with the rifle drilled oil passage in the connecting rod and allows oil under pressure to flow around the piston pin.

The removal and installation of pistons and connecting rods and the replacement of connecting rod bearing shells is described in "REPLACEMENT OF PISTON AND CONNECTING ROD," also, in "DISASSEMBLY OF ENGINE" and "ASSEMBLY OF ENGINE" in this Section.

C. Removal of Connecting Rod and Rings from Piston

1. Using a pair of Truarc #23 pliers, remove the piston pin retainer at each end of the piston pin.

2. Using tools similar to those shown in Fig. 36, drive the piston pin from the piston. If a suitable driver tool is not available, immerse the piston in water (not oil) heated to 180° F. for approximately five minutes and remove the piston pin while the piston is still hot. NOTE: *The characteristic of an aluminum alloy piston is for the piston pin bore in the piston to expand as the piston heats, therefore, the piston pin is a tight fit in the piston when the piston is at room temperature.*

3. Remove the piston rings using a ring remover and installer tool similar to the one shown in Figure 37. NOTE: *If for any reason the piston rings are removed from the pistons, even after a short period of operation, it is recommended not to install the same rings, because in most cases they will not again seat properly. It is cheaper to install new rings. On the surfaces of new piston rings that contact the cylinder walls, there are tool marks and reasonably rough surfaces which allows for a fast wear-in and seating of the rings to the cylinder walls.* After a period of operation, the rings wear or lap themselves to fit perfectly with the cylinder walls and the rings "SEAT." If, for any reason, the pistons are removed after a short period of operation, the location of the rings on the pistons will be altered. It is impossible to again locate them in their original seating location on the cylinder wall.

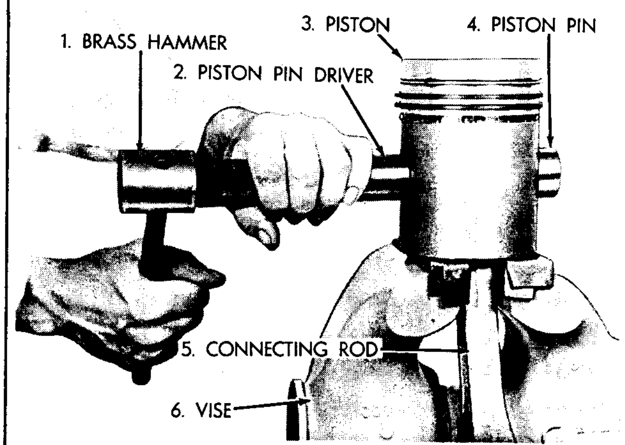


Fig. 36 — Removing Piston Pin from Piston

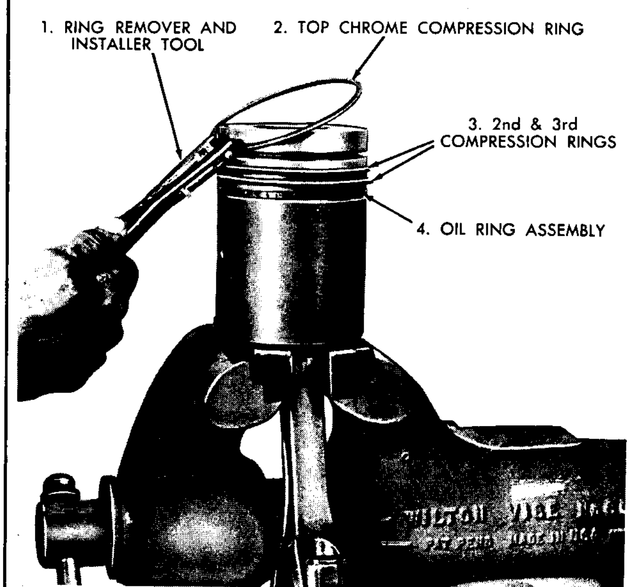


Fig. 37 — Removing Piston Ring from Piston

D. Piston and Piston Ring Inspection

Before inspecting the pistons they must be thoroughly cleaned. Remove gummy deposits by using fuel oil or a cleaning solvent and drying with compressed air. Be sure that the oil drain holes in the oil ring grooves are open and clean. If the cleaning solution does not remove all carbon from the bottom of the ring grooves, break the old rings in half and use the butt ends as a scraper. Be careful to remove only carbon or foreign matter; do not scrape away any metal from the sides or bottom of the ring grooves.

The skirt of the piston should be carefully inspected for score marks or other indications of improper piston clearance. Any scored pistons should be replaced. Inspect the inside of the piston for cracks. Any cracks in the pistons make them unfit for further use. The piston skirt diameter of a new piston is 4.429" to 4.430"; the inside diameter of a new cylinder sleeve is 4.370" to 4.4385", giving a running clearance of .0070" to .0095". NOTE: *Pistons, sleeves, and rings are available in standard size only.*

The normal pattern of wear on pistons will show maximum wear in the compression ring grooves. Seldom is piston replacement required because of excessive wear in the oil ring grooves or because the piston skirt or piston pin bores are excessively worn.

Excessive dirt consumption through the air intake system, overheating, excessive combustion temperature caused by abuse or maladjustment, and faulty lubrication can alter these patterns of normal wear and cause deterioration and failure not associated with normal wear.

If the wear in the piston compression ring grooves does not create side clearance with new piston rings greater than .007", piston pin bore clearance does not exceed new maximum tolerance more than .001", no cracks or scores are detected in piston pin bosses, on skirt or in the combustion chamber area, and the carbon is completely removed from the bottom of all ring grooves, the pistons may be re-used with a reasonable life expectancy of approximately ½ to ¾ that of new pistons.

New piston rings should always be used with new pistons. If the engine has been in service for some time, even though the same pistons are again used, it is advisable to use new rings when the engine is again assembled.

Measure the ring-to-groove clearance (top of ring to top of groove in piston) as shown in Figure 38. The specified clearances using a new piston and new rings are as follows:

Top Ring (Chrome Plated Compression Ring)	.004" to .0055"
2nd and 3rd (Compression Rings)	.003" to .0045"
4th Ring (Oil Control Ring)	.003" to .009"

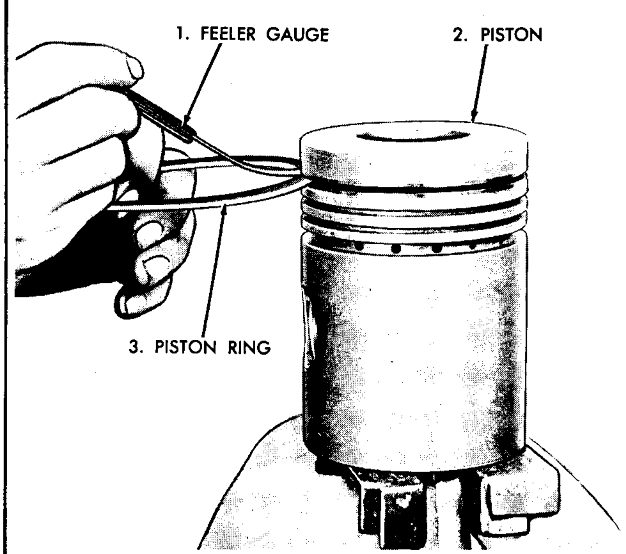


Fig. 38 — Checking Ring-to-Groove Clearance

E. Checking Piston Ring Gap

When pistons and sleeves are within the new specified dimensions and original new replacement rings are being used, the gap between the ends of the piston rings should be measured before the rings are installed on the pistons. This is a precautionary measure, because insufficient end gap will cause scored rings and cylinder sleeves and other damage. Select the rings that are to be used and insert them one at a time into the cylinder sleeve in which they are to operate.

Use a piston to push the ring squarely into the cylinder sleeve so that it is parallel with the cylinder head. Push the ring far enough down in the bore of the cylinder sleeve to be on the ring travel area. Check the ring gap with a feeler gauge as shown in Figure 39.

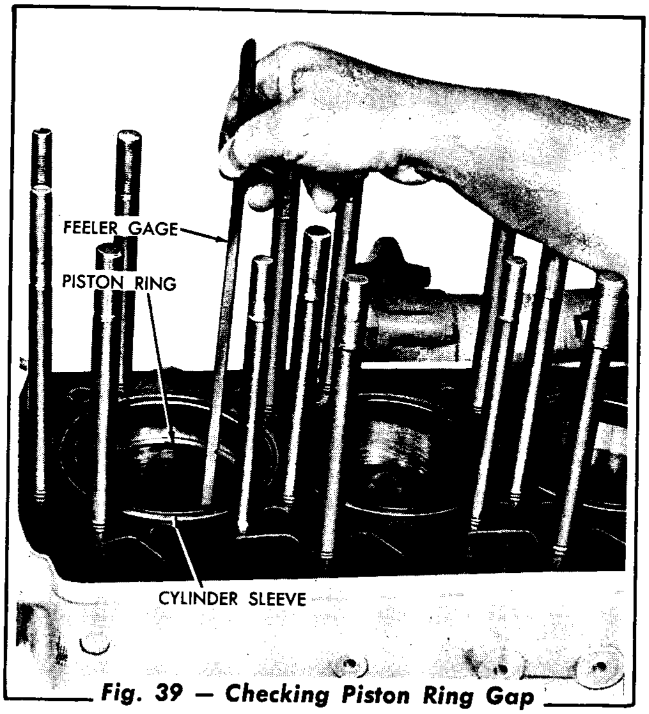


Fig. 39 — Checking Piston Ring Gap

The specified ring end gaps in standard size original cylinder sleeves of 4.437"/4.4385" bore are:

Top Ring	.023" Min. — .038" Max.
2nd and 3rd Rings	.013" Min. — .026" Max.
4th (3-piece) Ring	.013" Min. — .058" Max.

CAUTION: *The chrome plated compression ring should never be filed to open the gap because the plating might be loosened by the file and later distributed through the engine, causing damage or scoring of the piston and the cylinder sleeve.*

F. Installation of Rings

1. Install the rings on the piston (with side marked TOP towards top of piston) using a piston ring remover and installer as shown in Figure 37. NOTE: *When installing the rings on the pistons, do not spread the rings more than necessary.*

2. The control ring expander must be installed first in the lower groove in the piston. The oil control ring segments must be installed, one from the top and one from the bottom.

3. The 3rd, 2nd and top rings are to be installed after the oil control set.

4. Stagger the ring gaps evenly around the piston and apply oil to the rings and the pistons before installing them in the cylinder sleeves.

G. Inspection of Connecting Rod Assembly

Wash the connecting rod assembly in clean solvent or fuel. Whenever connecting rods are removed from an engine it is good practice to check alignment of the piston pin bushing end with the big bore end. Alignment can be checked with a direct reading alignment gauge similar to the one shown in Figures 40 and 41. Note that with this type alignment gauge the rod can be checked with or without the piston assembled to the rod.

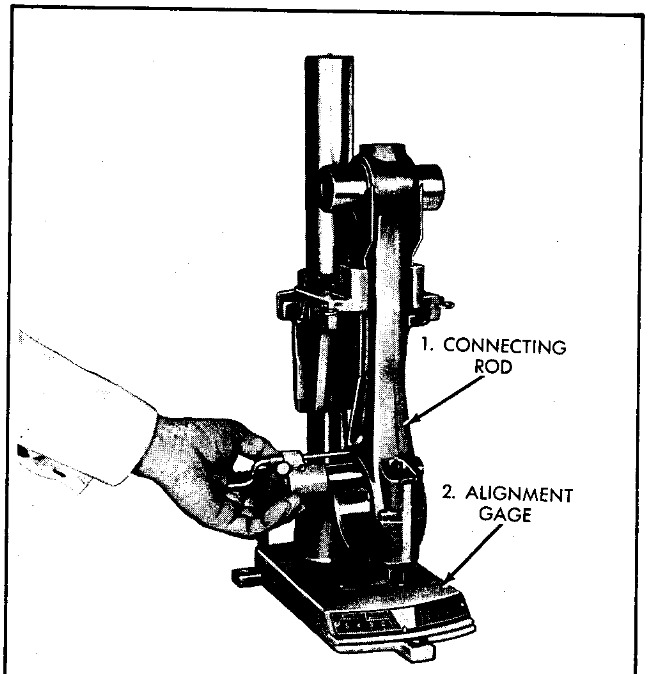


Fig. 40 — Checking Rod Alignment (Rod Only)

1. Measure the outside diameter of the piston pin to determine the wear. The specified diameter of a new piston pin is 1.6265" to 1.6267".

2. The specified inside diameter of the bushing in the connecting rod is 1.6277" to 1.6282". These dimensions of the pin and bushing provide a clearance of .001" to .0017"; clearances up to .003" are permissible. If the wear is close to or beyond this limit, replace the connecting rod bushing (see "REPLACEMENT OF CONNECTING ROD BUSHING" in this Section).

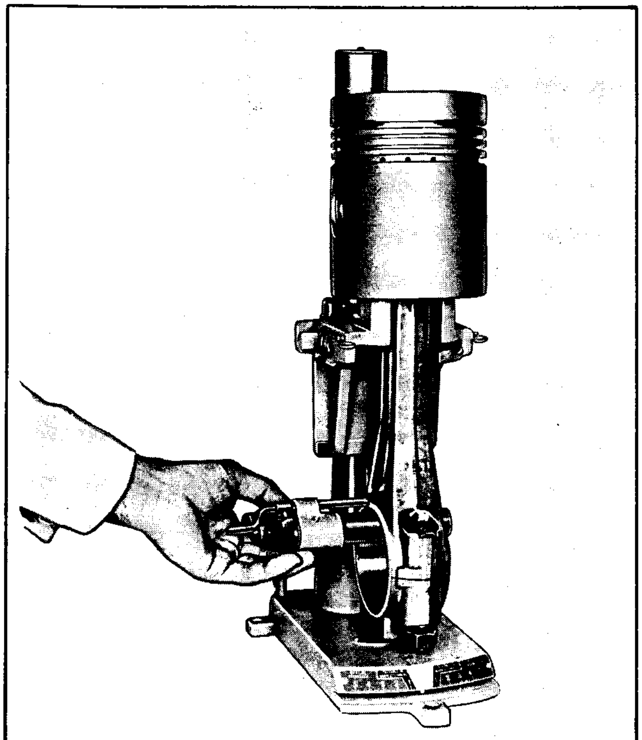


Fig. 41 — Checking Rod Alignment (With Piston)

3. Blow dry compressed air through the oil passages in the connecting rod. IMPORTANT: *Be sure that all oil passages are open.*

4. Inspect the connecting rod bearing shells for scoring, chipping, corrosion, cracking, or signs of overheating; discard the bearing shells if any of these conditions are apparent. Inspect the tangs of the upper and lower bearing shells for indication of radial movement within the connecting rod. If a bearing has been radially shifting the tang will have worn down below the parting line of the bearing shell and is unfit for future use.

5. Inspect the bearing shells for wear. The specified inside diameter of the bearing shells when installed and the nuts tightened to the specified torque is 2.7745" to 2.7760". This provides a running clearance of .002" to .0045"; new bearing shells must be installed when this clearance exceeds .009". The specified thickness of the bearing shells is .12475"/.12525" and should be measured for wear in the same manner as the main bearing shells (refer to Figure 28). Connecting rod bearings that measure less than .123" at the center should be discarded and new ones installed. In the event that the crankshaft is worn and damaged and must be reground, bearing shells .010", .020", .030", and .040" undersize are available.

H. Replacement of Connecting Rod Bushing

If the connecting rod bushing is worn, it may be replaced. The old bushing may be pressed out of and a new bushing pressed into the connecting rod. When new bushings are installed, be sure that the oil hole in the bushing lines up with the rifle drilled oil hole in the connecting rod. The specified diameter of a new piston pin is 1.6265" to 1.6267" and the inside diameter of the bushing is 1.6277" to 1.6282"; this provides a clearance of .001" to .0017" between the pin and bushing. It will be necessary to ream the connecting rod bushing to obtain this clearance. NOTE: *Whenever it is necessary to replace a connecting rod bushing, it is recommended that the work be done by a reputable machine shop suitably equipped to bore the bushing to the specified dimension given above and in alignment with the big end bore.*

I. Assemble Connecting Rods and Pistons

1. Install one of the piston pin retainers in one end of the piston pin hole in the piston.

2. Insert the upper end of the connecting rod into the piston. Lubricate the piston pin with clean oil and with a driver tool similar to the one shown in Figure 36, drive the piston pin into the piston and the connecting rod. If a suitable driver tool is not available, immerse the piston in water heated to 180° F. for approximately five minutes, then insert the piston pin into the piston. CAUTION: *Do not heat the piston in oil.*

3. Install the other piston pin retainer at the opposite end of the piston pin.

NOTE: *When assembling the piston to the connecting rod be certain that the side of* *the piston stamped "Camshaft Side" is toward the side of the rod stamped with numbers identifying the cap with upper portion of the connecting rod.*

7. CAMSHAFT AND CAMSHAFT BEARINGS

A. Description

The one piece camshaft is drop forged, open-hearth steel, case hardened at the cams and journals, and is located in the lower half of the cylinder block on therighthand side of the engine. The camshaft is rigidly supported in the cylinder block by four precision type bronze bearings. A smoothly ground hardened steel camshaft thrust collar is provided at the rear (gear) end of the camshaft.

B. Lubrication

Lubrication is supplied to the camshaft from four oil passages drilled through the cylinder block from the rear, two to the intermediate, and the rear main bearings.

C. Removal and Installation of Camshaft

1. Remove the push rods and the valve lifters (refer to "VALVE LIFTER AND PUSH ROD REMOVAL, INSPECTION, AND INSTALLATION" in this Section).
2. Remove the crankshaft pulley retaining capscrew and remove pulley (refer to "REMOVAL OF CRANKSHAFT PULLEY" in this Section).
3. Loosen the fan belt tightener and remove the fan belts.
4. Remove the capscrews from the power steering drive pulley and remove pulley from the hub.
5. Loosen the large capscrew in the crankshaft pulley and using a puller similar to the one shown in Fig. 35 break the pulley loose from the crankshaft. Remove the capscrew, washer and pulley.
6. Loosen the rear trunnion bracket capscrews and remove the trunnion from the cover.
7. Remove the capscrews attaching the timing gear housing cover to the timing gear housing. Remove the capscrews attaching the timing gear housing cover to the oil pan and remove the timing gear housing cover.
8. Remove the capscrews attaching the capscrew locking plate and the camshaft thrust collar to the cylinder block. Remove the capscrew locking plate. Using care to prevent the cams from damaging the bearings, remove the camshaft and camshaft gear as an assembly. Slide the thrust collar from the camshaft.
9. Remove the gear retaining snap ring from the end of the camshaft and press the camshaft from the camshaft gear. Remove the "WOODRUFF" key.

To install the camshaft gear, install the "WOODRUFF" key in the camshaft. Heat the gear in oil to a temperature of approximately 240° F. and press the gear onto the camshaft, being certain that the rear face of the gear hub contacts the

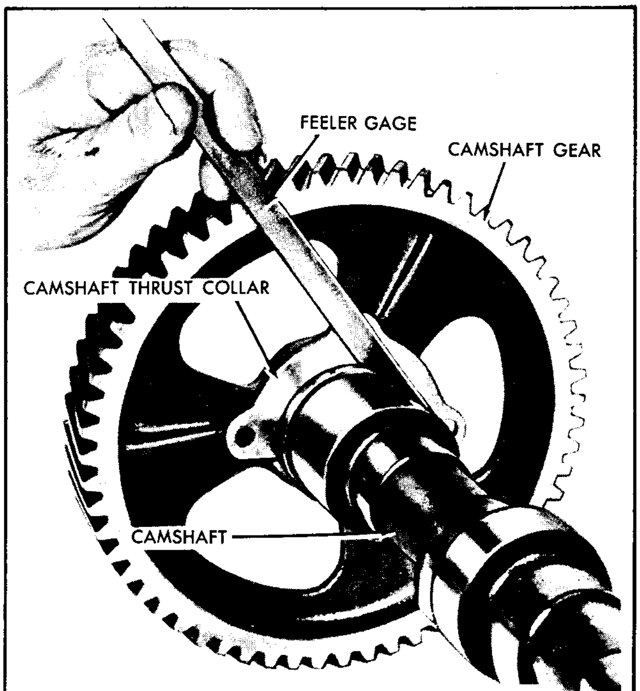


Fig. 42 — Checking Camshaft End Play

shoulder of the shaft. Install the gear retaining snap ring. After the gear has cooled, place the camshaft thrust collar on the camshaft and measure the clearance between the thrust collar and the camshaft using a feeler gauge as shown in Fig. 42. The clearance (end play) should be .003" to .009". The specified thickness of a new thrust collar is .205" to .206"; install a new thrust collar if necessary.

The camshaft may be installed by a direct reversal of the removal procedure. When installing, be certain that the oil grooved side of the thrust collar is toward the camshaft gear. NOTE: *Be certain that the timing marks (Fig. 47) on the camshaft gear and the crankshaft gear are aligned when installing the camshaft.*

D. Removal and Installation of Camshaft Bearings

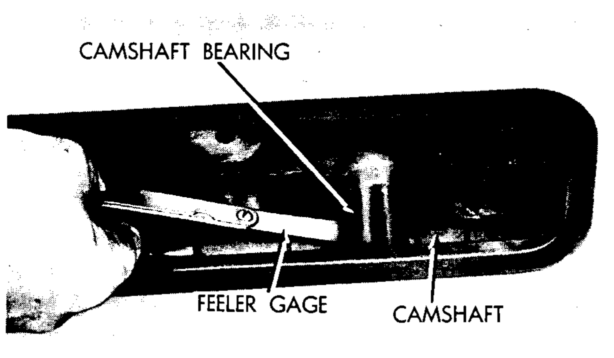


Fig. 43 — Checking Camshaft Bearing Clearance

The clearance between the camshaft bearings and the camshaft journals should be .0019" to .0055". If the clearance is .0075" or more, new camshaft bearings must be installed. The specified diameter of the camshaft bearing journals is 2.2465" to 2.2475" and the inside diameter of new camshaft bearings when installed is 2.2494" to 2.2520". To install new camshaft bearings, proceed as follows:

1. Remove the engine from the loader (refer to "ENGINE REMOVAL AND INSTALLATION," this Section).

2. It is possible to remove and install the camshaft bearings without removing the oil pan, however, to prevent dirt from falling into the crankcase and to facilitate the camshaft bearing removal and installation, it is recommended that the oil pan be removed.

3. Remove the camshaft as outlined in Paragraph "C" above.

4. Remove the capscrews attaching the timing gear housing to the cylinder block and remove the timing gear housing, water pump, and the water pump volute as an assembly.

5. Remove the starter.

6. Remove the flywheel (refer to "FLYWHEEL AND RING GEAR INSPECTION AND REPLACEMENT" in this Section).

7. Remove the capscrews attaching the flywheel housing to the cylinder block and remove the flywheel housing.

8. Remove the 2¾" expansion plug from the rear end of the cylinder block, at the camshaft rear bearing location.

9. With a camshaft bearing removing and installing set similar to the one shown in Figure 44, proceed as shown in Figures 45 and 46 to remove and install new camshaft bearings. NOTE: *When installing new camshaft bearings with the puller set illustrated, be certain that the "C" washer (stop plate) is inserted in the SECOND NOTCH from the FRONT end of the puller shaft.* The hex nut on the puller shaft is turned onto the shaft until the "C" washer on the front of the puller shaft contacts the front machined surface of the cylinder block. The notches in the puller shaft are accurately located so that when the "C" washer (Stop Plate) contacts the front face of the cylinder block, the oil grooves in the new bearings are automatically located with the oil holes in the cylinder block.

IMPORTANT: *All four camshaft bearings have one end beveled. The bearings MUST be installed with the beveled end facing*

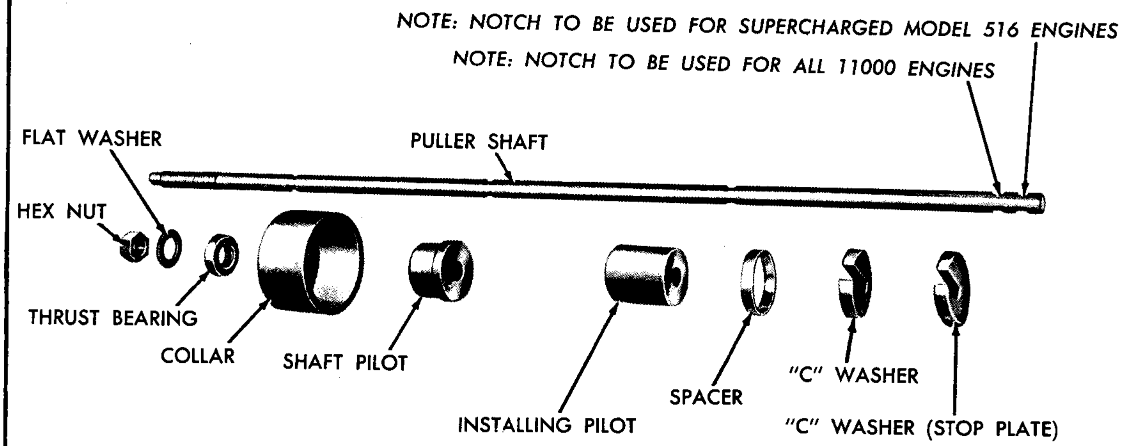


Fig. 44 — Camshaft Bearing Removing and Installing Tool Set

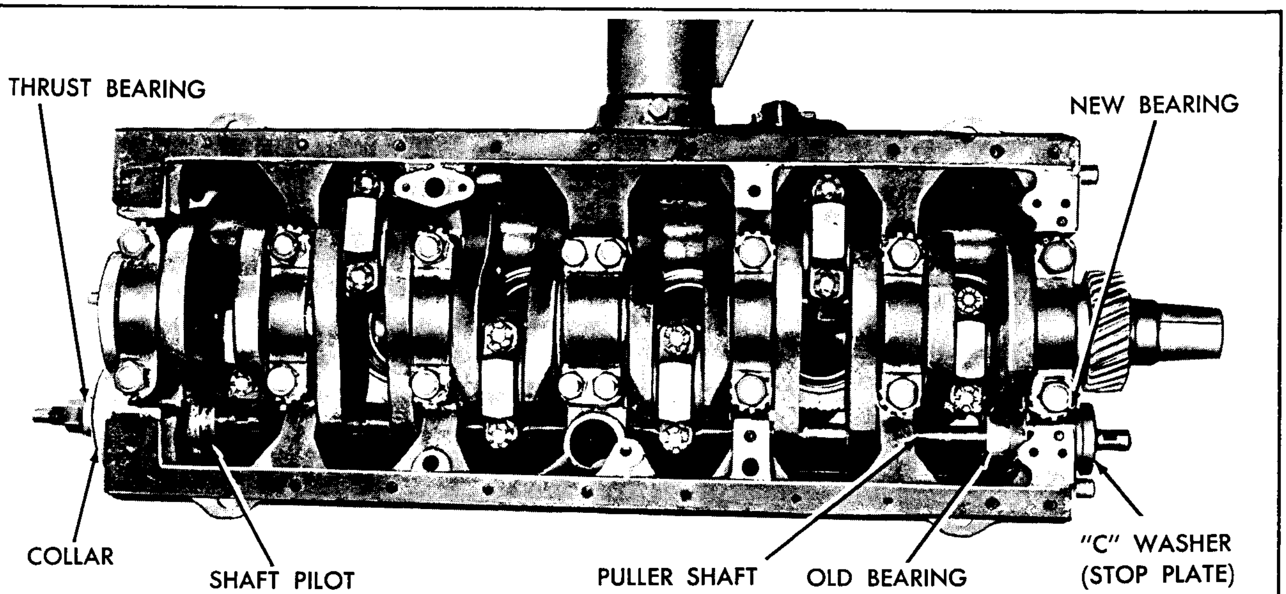


Fig. 45 — Removing and Installing Camshaft Rear Bearing

the front *(flywheel end) of the engine.* The camshaft rear bearing, which is 1.560" to 1.564" long, has an oil groove machined into the outer circumference and has one large (3/8") and two small (1/8") oil holes drilled through the bearing. Determine and mark the location of the oil hole in the cylinder block so that when the new rear bearing is installed, the large (3/8") oil hole in the bearing is aligned with the oil hole in the cylinder block.

The two camshaft intermediate bearings are .935" to .939" long and have an oil groove. The front camshaft bearing is 1" long and has an oil groove. Both of the intermediate and front bearings have three 1/8" oil holes. One of the 1/8" oil holes in each bearing should be aligned with the oil supply hole in the cylinder block.

After installing the bearing, use a piece of wire to check and be certain that the oil hole is properly located. The camshaft bearings are of the precision type and do not require reaming after installation.

Insert the O-ring in the groove of the cam-

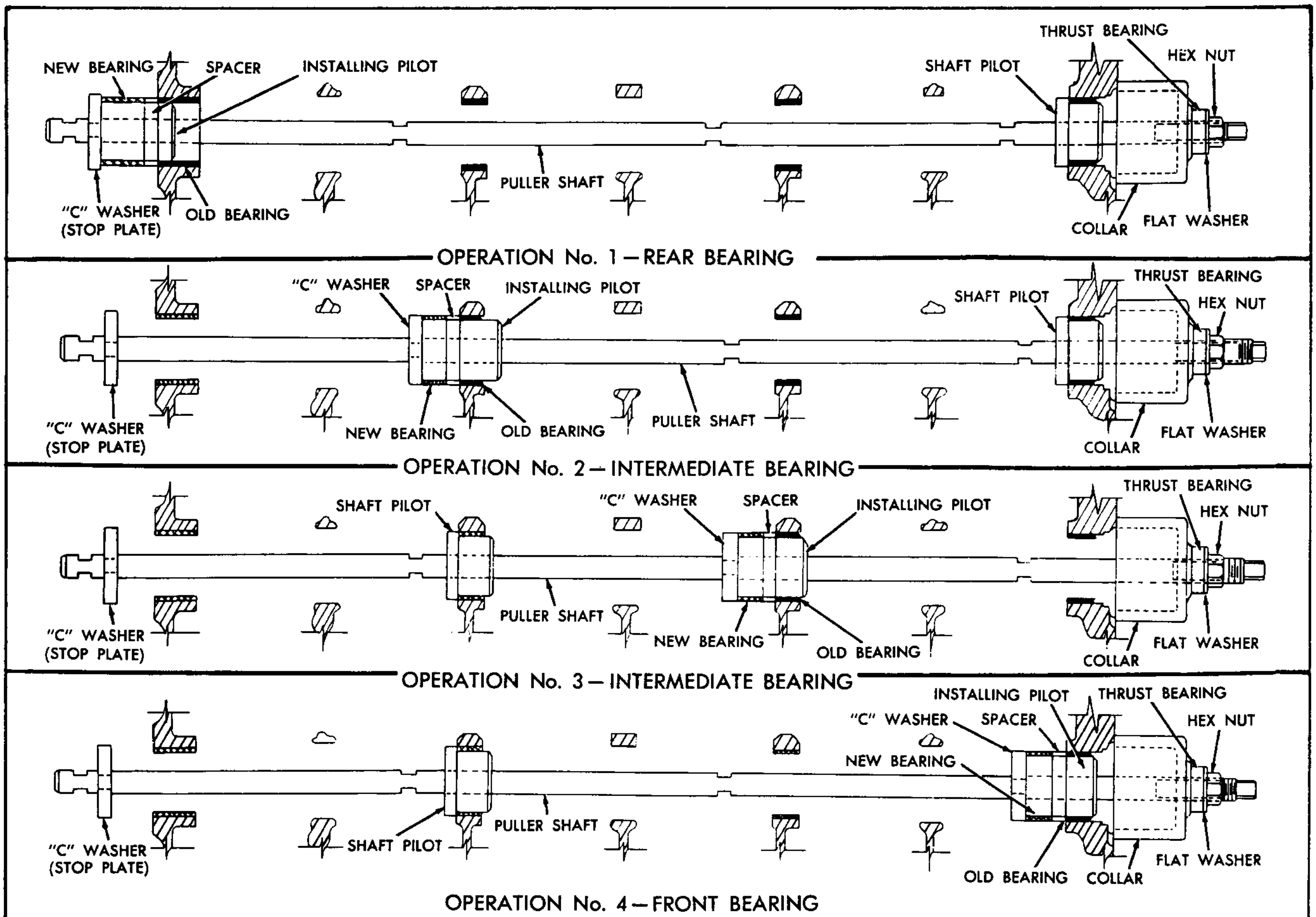


Fig. 46 — Sequence of Operation for Removing and Installing Camshaft Bearings

shaft hole plug. Press the O-ring and plug as an assembly into the cylinder block at the front bearing location. NOTE: *One edge of the plug is chamfered for ease of installation. The threaded hole in the center of the opposite side is for removing the plug and must face to the front of the engine.*

Install the camshaft and assemble the engine by a direct reversal of the removal procedure outlined above.

Check the fuel injection pump timing (refer to "ENGINE FUEL SYSTEM AND GOVERNOR," Section II).

A. Description

Located in the timing gear housing at the rear end of the engine is a completely enclosed train of four helical gears as shown in Fig. 47. A crankshaft gear, pressed and keyed onto the crankshaft, drives the oil pump and the camshaft gears. The camshaft gear in turn drives the fuel injection pump gear. The gear train is splash lubricated by oil thrown by the gears and by oil being returned to the crankcase.

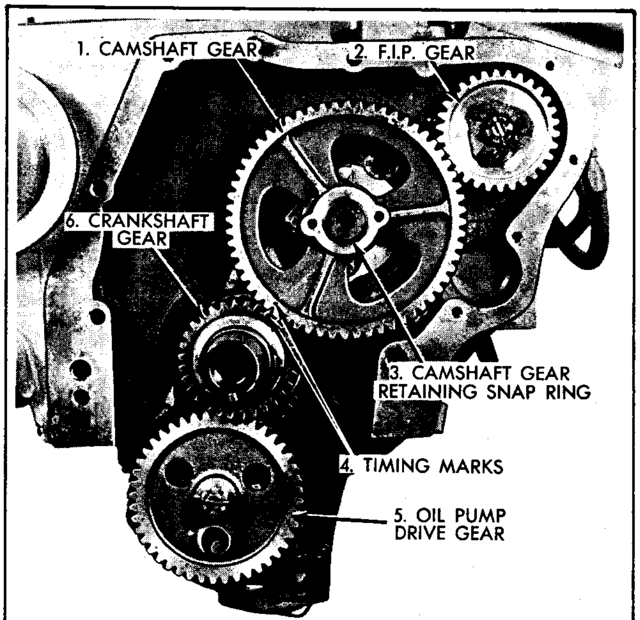


Fig. 47 — Gear Train

B. Service

The helical gear train will run quietly if the gears and bearings are in good condition. The specified backlash between any of the mating gears is from .003" to .007". As the gears or the bearings become worn, the backlash will increase and the gear train may become noisy.

The gear train may be exposed for inspection by removing the timing gear housing cover.

1. Remove the timing gear cover (refer to Paragraph "C," Topic 7, "REMOVAL AND INSTALLATION OF CAMSHAFT" in this Section).

2. Inspect the gears for nicked, scored, or broken teeth. Replace any worn or damaged gears. After inspection, cleaning or replacement, assemble the above items in direct reversal from the removal procedure.

C. Camshaft Gear Removal and Installation

1. Removal of Camshaft Gear

Remove the gear retaining snap ring from the camshaft. With a puller similar to the one shown in Fig. 48, remove the camshaft gear. NOTE: *Before removing the camshaft gear, rotate the crankshaft until the timing marks on the crankshaft gear and the camshaft gear are aligned as shown in Fig. 47.*

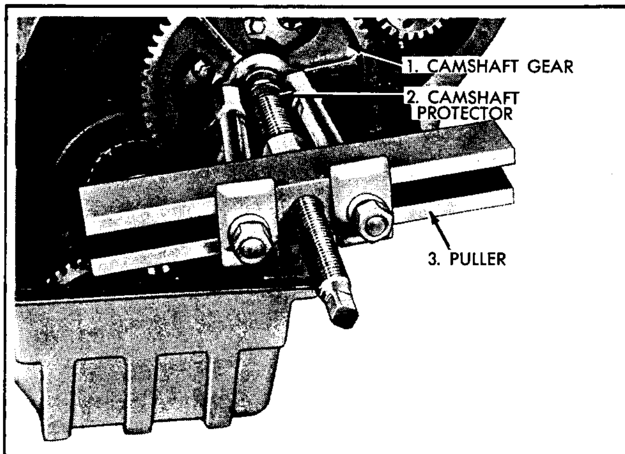


Fig. 48 — Removing Camshaft Gear

2. Installation of Camshaft Gear

a. Be certain that the "WOODRUFF" key is in the camshaft.

b. Heat the camshaft gear in oil to a temperature of approximately 240° F. and with a suitable driving collar or a hard wooden block, drive the camshaft gear onto the camshaft. NOTE: *Be certain that the timing marks on the camshaft gear and the crankshaft gear are aligned when the camshaft gear is installed.*

c. Install the gear retaining snap ring (Fig. 47) on the camshaft.

D. Crankshaft Gear Removal and Installation

1. Removal of Crankshaft Gear

a. With puller tools similar to the ones shown in Fig. 26, remove the rear oil seal sleeve and spacer from the crankshaft.

b. With a puller tool similar to the one shown in Fig. 27, pull the crankshaft gear from the crankshaft.

2. Installation of Crankshaft Gear

a. Be certain that the "WOODRUFF" key is in the crankshaft.

b. Heat the crankshaft gear and the rear oil seal sleeve in oil to a temperature of approximately 240° F. and with a suitable driving collar or a hard wooden block, drive the crankshaft gear onto the crankshaft. Place the rear oil sleeve spacer on the crankshaft and with a suitable driving collar, drive the rear oil seal sleeve onto the crankshaft.

NOTE: *Be certain that the timing marks on the crankshaft gear and the camshaft gear are aligned as shown in Fig. 47 when the crankshaft gear is installed.*

E. Injection Pump Drive Gear Removal and Installation

Refer to "ENGINE FUEL SYSTEM AND GOVERNOR," Section II.

F. Oil Pump Driving Gear Removal and Installation

In order to remove the oil pump driving gear, it is necessary to remove the engine from the loader and remove the oil pan (refer to "ENGINE — REMOVAL AND INSTALLATION" in this Section).

1. Removal of Oil Pump Driving Gear

a. Drain the engine lubricating oil.

b. Remove the capscrews attaching the oil pan to the cylinder block, the timing gear housing, and to the flywheel housing and remove the oil pan.

c. Remove the cotter pin and the slotted nut from the end of the oil pump upper shaft.

d. Using a puller tool similar to the one shown in Fig. 2, Topic 3, "LUBRICATING OIL PRESSURE PUMP," Section V, pull the oil pump driving gear from the shaft.

2. Installation of Oil Pump Driving Gear

a. Be certain that the "WOODRUFF" key is in the oil pump upper shaft.

b. Position the driving gear onto the shaft and tighten the slotted nut to a torque of 75 — 85 ft. lbs. Secure the slotted nut with a cotter pin.

c. Install the oil pan and the timing gear housing cover, using new gaskets, by a direct reversal of the removal procedure. NOTE: *A new crankshaft oil seal should be installed in the timing gear housing cover (refer to "REPLACEMENT OF CRANKSHAFT OIL SEALS" in this Section).*

9. REPAIR OF ENGINE WHILE INSTALLED

A. General

Repair or replacement of the crankshaft, camshaft and camshaft bearings, camshaft gear, crankshaft gear, and crankshaft front oil seal requires the removal of the engine. Practically all other parts can be removed and new parts installed without removal of the engine. IMPORTANT: *It is unwise to replace the cylinder sleeves, pistons and connecting rods, or the main and connecting rod bearings without taking it into a clean shop where it can be disassembled and all of the parts thoroughly cleaned and inspected before new parts are installed. There are several reasons why this should not be done in the open, namely:*

1. It is impossible to keep the engine and parts clean and free from dust or foreign material if the repair work is performed in the open.

2. Failure of the parts needing replacement, may be due to clogged or restricted oil passages or gritty substances in the engine. If the oil passages are not properly cleaned, or if all abrasive material is not removed by thorough cleaning, failure may again occur within a short period of operation after the new parts are installed.

3. If some parts have become worn or damaged to the point where replacement of these parts is required, it is only reasonable to assume that other parts may also be worn, and, if not replaced at the same time, will result in further shut-down within a short time.

The following procedures described the replacement of the pistons and the connecting rods, and the main and connecting rod bearings. These instructions are given to provide for emergency repairs when it is impractical to move the engine to a shop. The engine must be removed from the loader for all the following repair procedures (refer to "ENGINES – REMOVAL AND INSTALLATION" in this Section).

B. Replacement of Pistons and Connecting Rods

1. Remove the cylinder heads (refer to "CYLINDER HEAD REMOVAL" in this Section). Cover the cylinder heads and the top of the engine to prevent dust from blowing onto the exposed parts.

2. Drain the oil from the crankcase and remove the oil pan.

3. Remove the oil pressure pump from the cylinder block (refer to Section V).

4. Pull the cotter pins and remove the nuts and the bearing cap from each connecting rod in turn and push the piston and the connecting rod assembly out through the top of the cylinder block. Reassemble the bearing caps on their respective connecting rods as they are removed.

5. Inspect, disassemble, and reassemble the pistons and connecting rods as required (refer to "PISTONS AND CONNECTING RODS" in this Section).

6. Inspect the bearing journals of the crankshaft for scoring, checking, or signs of overheating. If any of these conditions exist, the crankshaft will require reconditioning or replacement.

7. Install the pistons and the connecting rods as explained in "ASSEMBLY OF ENGINE" in this Section. Be sure that all parts are clean and lubricated before they are installed.

8. Install the oil pressure pump and the oil pan (refer to Section V). Fill the engine crankcase to the proper level with the specified oil.

9. Install the cylinder heads (refer to "CYLINDER HEAD INSTALLATION" in this Section).

10. Check the engine oil pressure immediately after starting the engine and be sure that the pressure is within the normal range.

C. Replacement of Crankshaft Main Bearings

1. Remove the fuel injection nozzle assemblies (refer to "ENGINE FUEL SYSTEM AND GOVERNOR," Section II). in order to relieve the compression and allow free turning of the crankshaft.

2. Drain the oil from the crankcase and remove the oil pan.

3. Remove the oil pressure pump from the cylinder block (refer to Section V).

4. Remove the main bearing caps one at a time and install new bearing shells. Do not fully tighten the bearing caps until all the bearing shells have been installed. The lower bearing shell can be removed from the bearing cap after the cap is removed. Remove the upper bearing shell as follows:

   a. Insert a 1/4" x 1" capscrew, with the head ground down to a thickness of approximately 3/32" into the crankshaft main bearing oil hole as shown in Fig. 49. Then rotate the crankshaft in the direction that will turn the head of the bolt against the end of the bearing shell that has no locking tang. Continue rotating the crankshaft until the shell has been pushed out.

   b. The upper half of the front main bearing shell may be rolled out of place by driving on the edge of the bearing shell with a small curved rod or a suitable length of copper tubing (flattened on one end) as shown in Fig. 50, while rotating the crankshaft.

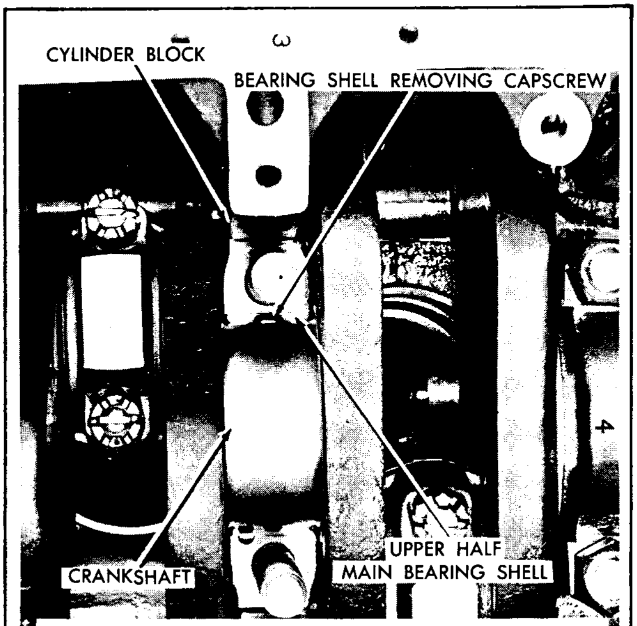


Fig. 49 — Removing Main Bearing Upper Shell

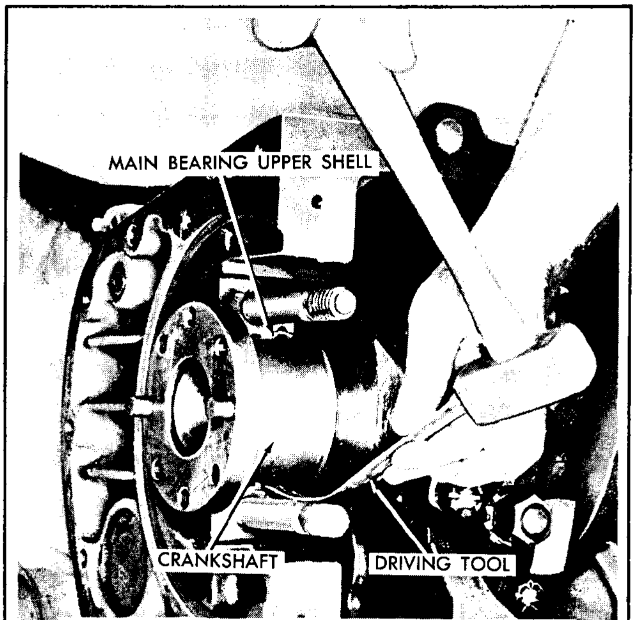


Fig. 50 — Removing Front Main Bearing Upper Shell

5. Inspect the crankshaft and each bearing shell as explained in "CRANKSHAFT, CRANKSHAFT PULLEY, FLYWHEEL, MAIN BEARINGS, AND FLYWHEEL HOUSING" in this Section. If the crankshaft is unfit for use, it must be reconditioned or replaced before new bearings are installed. NOTE: *The halves of new main bearing shells are identical, therefore, they may be installed in either the upper or lower positions.*

6. Install the upper half of each main bearing shell as follows: Lubricate the bearing shell and start the end of the bearing shell (end having no tang) around the crankshaft bearing journal, so that when the bearing

shell is in place, the tang will fit into the slot in the shell seat.

7. After the upper bearing shell has been installed, place the lower bearing shell in the bearing cap, with the tang of the shell in the corresponding slot in the cap. Lubricate with clean engine oil and install the bearing cap. NOTE: *The main bearing caps are numbered 1, 2, 3, etc., indicating their respective positions. Install the bearing caps with the numbers facing the rear (fan end) of the engine and corresponding to the number stamped on the lower right edge of the cylinder block (refer to Fig. 31).*

8. After all the bearing shells have been installed, tighten the main bearing stud nuts using a torque indicating wrench. Tighten the ¾" stud nuts, used on the front, intermediate, and rear main bearings to a torque of 210 to 230 lbs. ft.; tighten the ⅝" stud nuts used on the center main bearing to a torque of 160 to 170 lbs. ft.

   CAUTION: *Do not overtighten the main bearing stud nuts.* If these nuts are overtightened, the bearing caps may be distorted, and cause premature failure of the bearings. The crankshaft should turn freely after all the nuts are tightened to the specified torque. Lock the nuts with the lockwashers and/or locking plates.

9. Install the oil pressure pump and the oil pan (refer to Section V). Fill the engine crankcase to the proper level with the specified oil.

10. Install the fuel injection nozzle assemblies (refer to "ENGINE FUEL SYSTEM AND GOVERNOR," Section II).

11. After the new bearings have been installed, the engine should be operated on a run-in schedule as outlined in "ASSEMBLY OF ENGINE" in this Section.

10. REMOVAL AND INSTALLATION OF ENGINE

A suitable hoist, cable or chain and a sling spacing bar, or equivalent equipment will be needed to lift the engine from the loader.

An engine stand or suitable blocks, to support the engine after it is removed should also be provided, along with an ample supply of cleaning solvent, clean wiping rags, and at least 6 to 8 boxes or pans to hold bolts and small parts removed from the engine and loader. A supply of plastic or neoprene caps or their equivalent, in various sizes is also a necessity in closing the open ends of hoses, lines and parts to prevent the entrance of foreign material while the lines are separated. CAUTION: *Do not use loose fitting plugs that can become lodged in the hoses, tubes, or fittings.*

The use of caps, which cover the threads, rather than plugs, is desired, thus necessitating their removal before the lines can be joined.

It is recommended that the loader, particularly the engine, be washed before the engine is removed. This will not only prevent dirt from getting on the exposed parts at disassembly, but will make the work much quicker and more easily done.

A. Engine Removal

1. Remove the hood and side panels.

2. Drain the cooling system (refer to "DRAINING AND FILLING OF SYSTEM," Section IV). Loosen the rear hose clamps on the upper and lower radiator hoses.

3. Disconnect all cables and wires from batteries and the battery box and remove the battery box.

4. Remove the air cleaner from the side brace. Remove the left and right side braces being careful that the correct amount of shims are kept with their respective brace.

5. Disconnect the fan guard from the radiator guard assembly. The fan guard may be removed after the radiator assembly is removed.

6. Disconnect the tail light and back-up light wires from the radiator guard assembly, at the connectors located at the left front corner of the radiator guard.

7. Remove the capscrews and lockwashers that secure the radiator and radiator guard assembly to the main frame and using a suitable rope, cable or chain, remove the radiator and guard assembly.

8. Remove the power steering pump assembly from the rear engine support hanger. Cap all open hydraulic lines.

9. Disconnect the throttle linkage at the bell-crank.

10. Disconnect the starter ground cable. Disconnect the wires to the generator, engine temperature sender, engine oil pressure sender, hour meter pressure switch and the fuel shut-off solenoid.

11. Disconnect the lines from the air compressor and air compressor governor. Disconnect the fuel and return lines from the fuel filter. Disconnect the transmission oil cooler to converter lines at the converter. Cap all exposed lines and fittings.

12. Remove the capscrews and lockwashers securing the transmission to the engine flywheel housing.

13. Remove the capscrews, plain washers and locknuts that secure the rear engine support hanger to the main frame. Remove the capscrew, lockwasher and special flat washer that secure the front engine mounting bracket to the main frame. CAUTION: *Do not lose or mix shims under the front engine mounting brackets.*

14. The engine is now ready for removal from the loader. Using a suitable lifting sling and hoist of the proper capacity, raise the engine up slightly so that the weight is off the engine mounts. Move the engine toward the rear of the loader to disengage the transmission and then raise the engine slowly out of the loader. CAUTION: *Use care when removing the engine; be certain that all necessary wiring, lines, linkage, etc. is disconnected and that no parts are damaged by careless handling.*

B. Engine Installation

The installation of the engine is practically a reversal of the removal procedure, except that certain inspections and adjustments must be made which are listed as follows:

> NOTE: *Inspect the two rubber shock mounts for the engine. If the rubber has deteriorated or if the hole in the rubber is enlarged, the mountings must be replaced.*

1. Check for correct shimming under the front engine mounts.

2. Check for proper fuel injection pump timing (refer to "ENGINE FUEL SYSTEM," Section II).

3. Check for proper engine crankcase level. If the engine has been rebuilt or a new engine has been installed, remove the rocker arm cover and pour approximately two (2) quarts of oil over the rocker arm assemblies and cylinder head compartments when filling crankcase. This will assure initial lubrication of various components within the engine.

4. Polarize the generator (refer to "ELECTRICAL SYSTEM — GENERATOR AND GENERATOR REGULATOR").

5. Bleed the fuel system (refer to "ENGINE FUEL SYSTEM, GOVERNOR AND ENGINE CONTROLS").

6. Adjust the throttle linkage (refer to "ENGINE FUEL SYSTEM, GOVERNOR AND ENGINE CONTROLS").

7. Fill the cooling system with the proper coolant (refer to "ENGINE COOLING SYSTEM").

8. If the engine has been rebuilt, or if a new

engine has been installed, the engine should be operated in a run-in schedule as outlined in "ASSEMBLY OF ENGINE" in this Section.

9. On the initial starting after the engine has been installed in the loader, make an immediate check of the instruments for proper oil pressure, coolant temperature and generator characteristics. Check all oil, coolant and air lines for leaks. Check all filters for leaks. Correct as necessary.

11. DISASSEMBLY OF ENGINE

A. Removal of Accessories from Engine

The lubricating oil, fuel oil, and coolant must be thoroughly drained from the engine.

Enough pans or boxes should be available so that each of the various components removed from the engine can be placed in them and kept separated. Keeping the components and their capscrews separated will make the reinstalling easier and quicker.

The following procedure gives a logical sequence for the removal of the accessories, starting at one side and working around the engine.

1. With the engine suspended from a hoist, or supported on blocks, remove the following parts from the left side of the engine so that the engine can be mounted to an engine stand, if a stand is available.

   Remove all the oil lines from the lubricating oil filter and the oil coolers. Remove the capscrews and lockwashers attaching the filter head assembly to the cylinder block. Loosen and remove the complete filter and head assembly. Remove the capscrews and lockwashers attaching the lubricating oil cooler and transmission oil cooler to the cylinder block and after loosening the water hose clamp, remove the combined oil cooler assembly complete with the inlet and outlet connections.

2. With the above accessories removed, install the engine stand adaptor plate on the left side of the engine.

3. Remove the air intake manifold. Remove the crankcase oil level gauge rod.

4. Remove the capscrews attaching the fan to the fan hub and remove the fan. Loosen the tension on the fan belts and remove all the drive or driven belts.

5. Remove the capscrews attaching the generator mounting bracket and remove the generator with mounting bracket. Remove the generator belt adjustment link capscrew and remove the link from the engine.

6. Remove the inlet and outlet oil lines from the turbocharger. Loosen the hose clamps on the turbocharger to intake manifold pipe. Remove the stud nuts and lockwasher on the turbocharger mounting pad and exhaust pipe mounting pad and remove the turbocharger and exhaust pipe as a unit. Remove the nuts and plain washers attaching the exhaust manifold to the cylinder heads and remove the exhaust manifold.

7. Remove the capscrews and lockwashers attaching the water outlet manifolds to the cylinder heads and remove the water outlet manifolds and the thermostat housing as an assembly. Remove the by-pass tube.

8. Remove the fan hub and fan belt tightener assembly from the engine.

9. Remove the crankshaft pulley (refer to "REMOVAL OF CRANKSHAFT PULLEY ASSEMBLY" in this Section). Loosen the capscrews clamping the engine rear trunnion mounting bracket to the timing gear housing cover and remove the trunnion and bracket.

10. Remove the starter.

B. Disassembly of Engine Into Sub-Assemblies

Refer to pertinent sections of this manual for detailed information on the various engine sub-assemblies. If the engine is mounted on an engine stand, turn the engine to the position most convenient for removal of the sub-assemblies.

1. Disconnect the fuel injection lines from the fuel injection nozzles and from the fuel injection pump. Disconnect the fuel return manifold from the return line and from the nozzles. Remove the fuel return manifold. Disconnect the fuel injection line brackets from the engine. Remove the injection lines with brackets as an assembly.

2. Disconnect the fuel (low pressure) lines from the fuel pump and remove the fuel filter head, filters, bracket and low pressure lines as an assembly.

3. Remove the injection pump lubrication hose with fittings. Remove the injection pump mounting nuts and lockwashers and remove the fuel injection pump and governor.

4. Remove the fuel injection nozzles. Remove the cylinder head covers. Remove rocker arm assemblies and push rods. Remove the cylinder heads from the cylinder blocks.

5. Remove the capscrews and lockwashers attaching the flywheel to the crankshaft flange. Turn two ½" NF x 6" guide studs into the crankshaft flange to act as guides and to prevent damage to the flywheel when removing. It may be necessary to tap the flywheel loose by using a wooden block inserted through the starter opening.

6. Remove the oil pan. Remove the capscrews attaching the flywheel housing to the cylinder block and remove the flywheel housing.

7. Remove top center nut and capscrews attaching the timing gear housing cover to the timing gear housing and remove the cover.

8. Remove the front and rear valve lifter covers. Remove the valve lifters and the valve lifter brackets.

9. Remove the lubricating oil pressure pump, with the relief valve. Remove the oil pressure regulating valve (refer to "ENGINE LUBRICATING SYSTEM," Section V).

10. Remove the camshaft and camshaft gear as an assembly. Remove the capscrews attaching the timing gear housing to the cylinder block and remove the timing gear housing, water pump, and water volute as an assembly.

11. Remove the cotter pins and nuts from each of the connecting rod bearing caps. Remove each piston and connecting rod assembly from the engine by pushing the assembly out through the top of the cylinder. Install each bearing cap on its respective connecting rod as they are removed.

12. Remove all the main bearing caps, lift the crankshaft from the cylinder block.

13. Remove the camshaft bearings.

14. Remove the cylinder sleeves from the cylinder block. Remove all the plugs from oil and water passages so that the cylinder block can be thoroughly cleaned. CAUTION: *Note the location of all plugs removed so that they can be reinstalled in their original positions.*

15. Wash and inspect all parts thoroughly, including the cylinder block. Refer to pertinent sections of this manual for instructions on disassembly, cleaning, and inspection of the various sub-assemblies removed from the engine.

16. If a new cylinder block is to be installed, remove the cylinder head studs from the old block.

12. ASSEMBLY OF ENGINE

A. General

Be sure that all of the parts are thoroughly cleaned before they are installed in or on the engine. Use new gaskets where gaskets are required. It is not necessary to cement gaskets used to seal against water leaks, on the other hand, BOTH SIDES of gaskets used to seal against oil or air leakage should be coated with gasket cement.

IMPORTANT: *Lubricate all bearings or bearing surfaces with clean engine oil as parts are assembled.*

Before any parts are installed in the cylinder block, be certain that all of the plugs which were removed to clean the oil and water passages in the cylinder block have been coated with sealing compound, installed, and securely tightened.

1. If a new cylinder block is to be used, install all studs at this time. Be certain that the threads of the studs are clean, dry, and in good condition. Turn the studs into the cylinder block to obtain the proper stud heights above the flat machined surface of the cylinder block.

2. Turn the cylinder block upside down and install the upper halves of the main bearing shells in the crankshaft bearing seats of the cylinder block; the tangs of the bearing shells must engage in the corresponding slots in the bearing seats.

3. Lubricate all of the crankshaft main bearing journals and lower the crankshaft into the cylinder block.

4. Place the lower halves of the main bearing shells in the main bearing caps, being certain that the tangs of the bearing shells are engaged in the corresponding slots in the bearing caps. The bearing caps are numbered 1, 2, 3, etc., on the camshaft side, indicating their respective positions. Install the caps with the numbers to the camshaft side of the engine and corresponding to the number stamped on the lower right edge of the cylinder block as shown in Fig. 31. Install the main bearing cap lockwashers and stud nuts. Use a torque indicating wrench and tighten the nuts to a torque of 210 to 230 lbs. ft. on the ¾" nuts used on the front, intermediate, and rear main bearings and tighten the ⅝" nuts used on the center main bearings to a torque of 160 to 170 lbs. ft. Check the end thrust of the crankshaft which is taken by the flanges of the center main bearing; the end play may be measured as described in "MAIN BEARING INSPECTION" in this Section. The specified clearance is .006" to .014" and should not exceed .022". Lock the nuts with the lockwashers and/or locking plates.

   CAUTION: *Do not overtighten the main bearing stud nuts. If these nuts are overtightened, the bearing caps may be distorted, causing the bearings to be drawn tight against the crankshaft and cause premature failure of the bearings.*

   The crankshaft should turn freely after all the nuts are tightened to the specified torque. Never file or shim a bearing cap to make the bearing shell fit; install new bearing shells if the fit on the crankshaft is unsatisfactory.

5. Install the crankshaft gear and the rear oil seal sleeve and spacer on the crankshaft (refer to "CRANKSHAFT GEAR REMOVAL AND INSTALLATION" in this Section). The rear oil seal sleeve is serviced separately and should be replaced if worn.

6. Install the camshaft bearings in the cylinder block. All four camshaft bearings have one end beveled. The bearings must be installed with the beveled end facing the front (flywheel end) of the engine. Refer to "REMOVAL AND INSTALLATION OF CAMSHAFT BEARINGS" in this Section.

7. Turn the cylinder block on end, or lay it on its side, for installation of the cylinder sleeves. Before installing the cylinder sleeve,

new packing rings must be installed. If the old sleeves are to be installed, remove the old packing rings and clean any rust or scale from the packing ring grooves in the cylinder sleeve. Stand the cylinder sleeve on a clean work bench with the lower end of the sleeve upward. Install the new packing rings over the lower end of the sleeve and into the grooves using care not to twist or roll the packing rings when installing. Apply liquid soap (green soap) or hydraulic brake fluid to the packing rings before installing the cylinder sleeve into the cylinder block. Use care to prevent damage to the packing rings and install the cylinder sleeve in the cylinder block. When the flange of the cylinder sleeve is firmly seated in the counterbore in the cylinder block, the surface of the cylinder sleeve flange should protrude above the cylinder block .0065" to .0095". Cylinder sleeve shims are available to maintain this dimension (refer to "CYLINDER BLOCK AND CYLINDER SLEEVES" in this Section).

8. Install the pistons with rings and connecting rods as an assembly. The lower end of each rod, as well as the bearing caps, are numbered 1, 2, 3, etc., on the camshaft side. These numbers identify the bearing caps with the rods and indicate the particular cylinder from which each rod was removed. The connecting rods must be installed with the numbered side of the rod facing the camshaft side of the cylinder block. The piston is also marked to reflect the camshaft side.

   a. Stagger the piston ring gaps evenly around the piston and apply clean engine oil to the pistons and rings. With a piston inserter, similar to the one shown in Fig. 52, install the piston and connecting rod in the cylinder sleeve by tapping on the upper end of the piston with the wooden handle of a hammer. Be certain that the cylinder identification number stamped on the lower end of the connecting rod faces the camshaft side of the cylinder block and that the numbers correspond with the cylinder number. Number one cylinder is the first cylinder at the rear, or fan end, of the engine. Align the lower end of the connecting rod with the crankshaft before inserting the piston into the cylinder.

   b. Lubricate and install a bearing shell in the connecting rod, with the tang of the bearing shell in the corresponding slot

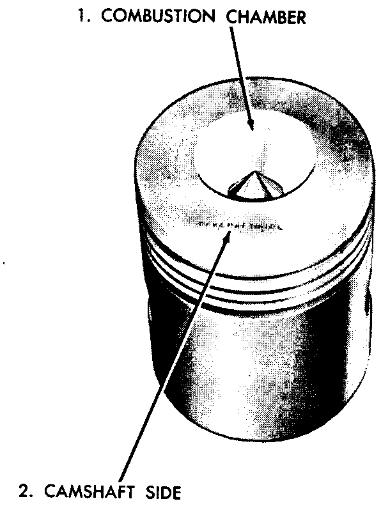


Fig. 51 — Piston

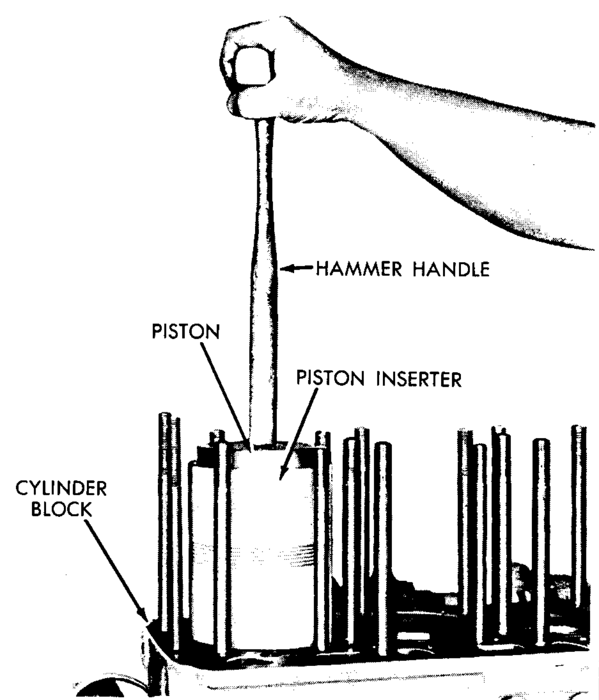


Fig. 52 — Installing Piston in Cylinder Sleeve

in the connecting rod, and position the rod on the crankshaft journal.

c. Lubricate and install a bearing shell in the connecting rod bearing cap, with the tang of the bearing shell in the corresponding slot in the bearing cap. Install the bearing cap and shell, being certain that the identification number stamped in the bearing cap is located on the same side as the corresponding number stamped in the connecting rod.

d. Install the connecting rod nuts and, using a torque indicating wrench, tighten the nuts to a torque of 120 to 130 lbs. ft. Secure the nuts with cotter pins. NOTE: *Never file or shim the bearing caps to make the bearing fit; install new bearing shells if the fit is unsatisfactory. The crankshaft must turn freely after all the connecting rod nuts have been tightened to the specified torque.*

e. Check to see that there is sufficient side clearance between the connecting rods and the crankshaft journals. The specified clearance is .004" to .009".

9. Using gasket cement, cement a new timing gear housing gasket to the rear end of the cylinder block and coat the outer surface of the gasket with gasket cement. Install the timing gear housing assembly on the cylinder block and attach it with three ½" NC x 1¹⁄₁₆" capscrews and lockwashers.

10. Install the camshaft gear on the camshaft (refer to "CAMSHAFT GEAR REMOVAL AND INSTALLATION" in this Section). Install the camshaft and gear assembly into the cylinder block using care not to damage the camshaft bearings. Install the camshaft thrust collar (with the oil grooves facing the rear) and install the capscrew locking plate and the three ⁵⁄₁₆" NC x ⅝" capscrews. Tighten the capscrews securely and lock with the locking plate.

CAUTION: *Be sure that the timing marks on the camshaft gear and the crankshaft gear are aligned when the camshaft is installed.*

11. Install a new crankshaft front oil seal in the flywheel housing (refer to "REPLACEMENT OF CRANKSHAFT OIL SEALS" in this Section). Install a new flywheel housing to crankcase sealing ring and attach the flywheel housing to the cylinder block.

12. Turn two ½" NF x 6" guide studs into the crankshaft flange to serve as guides for installing the flywheel and to prevent damage to the oil seal, as shown in Fig. 34. Install the flywheel on the crankshaft flange. Remove the guide studs and attach the flywheel to the crankshaft flange. NOTE: *One of the capscrew holes is offset so that the flywheel can be attached to the crankshaft flange in only one position.*

13. Install the valve lifters and valve lifter brackets. Use new gaskets and install the front and rear valve lifter covers (refer to "VALVE LIFTER PUSH ROD REMOVAL, INSPECTION, AND INSTALLATION" in this Section).

14. Install the lubricating oil pressure pump (refer to "ENGINE LUBRICATING SYSTEM," Section V).

15. Using gasket cement, cement a new oil pan gasket to the cylinder block and coat the outer surface of the gasket with gasket cement. Attach the oil pan to the cylinder block and the flywheel housing. (Refer to "ASSEMBLY OF OIL PAN TO ENGINE" in Section V).

16. Install a new crankshaft rear oil seal in the timing gear housing cover (refer to "REPLACEMENT OF CRANKSHAFT OIL SEALS" in this Section). Cement a new timing gear housing cover gasket to the timing gear housing.

    Using an oil seal protector as shown in Fig. 33, install the timing gear housing cover and secure the cover to the housing with the proper size capscrews and nut shown in Fig. 53.

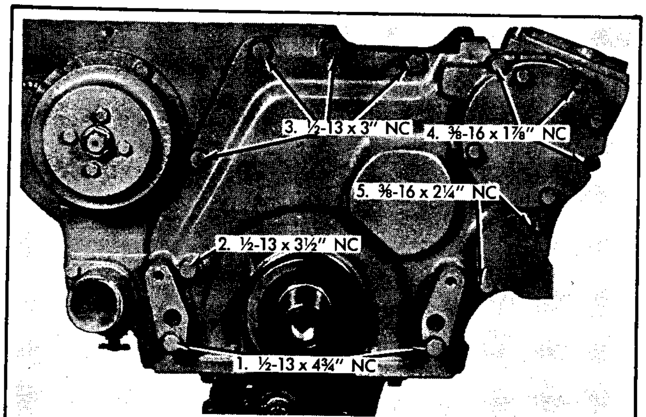


Fig. 53 — Timing Gear Housing Cover

Install the capscrews attaching the oil pan to the timing gear housing cover.

17. Install the fan drive assembly. Install and time the fuel injection pump as outlined in "ENGINE FUEL SYSTEM AND GOVERNOR," Section II). Install the fuel injection pump lubricating oil lines. Install the cover plates to the timing gear housing and cover, if removed, and not previously installed.

18. Inspect the rubber pads in the engine rear mounting brackets. If the material has deteriorated or become too hard, the pads must be replaced.

19. Install the crankshaft hub key in the crankshaft. Install the hub, pulley, washer, and the capscrew; tighten the capscrew to a torque of 290 to 310 lbs. ft.

20. Install the water pump (refer to "INSTALLATION OF WATER PUMP," Section IV). If the volute has been removed from the timing gear housing, install the volute using a new gasket and proper capscrews and plain washers.

21. Install the oil pressure regulating valve (refer to "ASSEMBLY OF OIL PRESSURE REGULATING VALVE," Section V).

22. Install the cylinder head (refer to "CYLINDER HEAD INSTALLATION" in this Section).

23. Install the valve push rods and the rocker arm assemblies (refer to "ROCKER ARM REMOVAL, INSPECTION AND INSTALLATION" in this Section). Install the cylinder head cover and gasket.

24. Install the fuel injection nozzles (refer to "INSTALLATION OF FUEL INJECTION NOZZLES IN ENGINE," Section II). Mount the fuel injection lines and brackets as an assembly. Connect the injection lines to the fuel pump and the nozzles. Secure the injection line brackets to the block and head. Connect the fuel return manifold to the injection nozzles.

25. Install the first and second stage fuel filter with head as an assembly. Connect all fuel lines between the filter head, the injection pump and injection nozzle return manifold.

26. Install the generator mounting bracket and generator. Mount the generator belt adjustment link.

27. Install the water by-pass flange and tube using a new gasket and O-rings. Install the water outlet manifold and thermostat housing as an assembly using new gasket and O-rings.

28. Install the fan mounting bracket, fan hub assembly and belt tightening assembly. Position the air compressor water pump and fan belt. (Refer to "FAN BELT TIGHTENER AND FAN HUB INSTALLATION," Section IV).

29. Using new gaskets, install the engine air intake manifold. Install the exhaust manifold, using new gaskets. Install the breather caps and the crankcase oil level gauge rod.

30. Install the starter on the flywheel housing.

31. If the engine is mounted on an engine stand, it must now be removed in order to install the various accessories on the left side of the engine.

32. Install the lubricating oil filter and oil cooler units as an assembly, using new gaskets. IMPORTANT: *New elements must be installed in the lubricating oil filter.*

33. Coat the threads of the cylinder block drain cocks with sealing compound. Install the drain cocks in the cylinder block and tighten them securely.

34. Adjust generator drive belt, the fan drive belts and the air compressor drive belt.

35. Adjust the oil pressure regulating valve (refer to "ENGINE LUBRICATING SYSTEM," Section V).

B. Engine Run-In Schedule

After the installation of new cylinder sleeves or piston rings, the engine must be run-in to allow the rings to seat and avoid the possibility of cylinder sleeve scoring and excessive oil consumption. When an engine is first started after installation of cylinder sleeves or piston rings, excessive smoking and raw fuel and lubricating oil may appear in the exhaust. This condition will correct itself as the engine is run-in.

Before starting the engine after an overhaul, inspect the levels of the engine oil, fuel oil, and the coolant level in the cooling system. Inspect the air cleaner to determine if it has been properly serviced.

The most important factor in running in a new engine, or one which has just been rebuilt, is the OPERATING TEMPERATURE. The thermostats must function properly to maintain a minimum operating temperature of 170° F.

As a guide, the following run-in schedule is suggested:

1. In the field, the run-in schedule will, of necessity, be governed largely by the degree to which the engine's load and speed can be controlled. Avoid sustained operation at maximum rated load for the first 24 hours. Likewise, prolonged idle or sustained light load should be avoided for the first 50 hours.

2. Run at about 1000 R.P.M., no load, only long enough to ascertain that oil and water are circulating properly. Check engine for water and oil leaks.

3. Run under varying conditions at light to medium loads for two to four hours.

4. Put engine into normal service, but at reduced loads, for the next 24 hours. Avoid lugging or sustained full load operation.

5. Resume normal operation, within limitation of Paragraph 1.

13. SERVICE TOOLS

Description	Kent-Moore Tool Co.
Rocker Arm Bushing Tool Set	J–6332
Injection Nozzle Sleeve Remover Set	J–7857
Injection Nozzle Sleeve Installer (Used with Drive J–7079–2)	J–7865
Injection Nozzle Sleeve Cleaner	J–7871–01
Adapter Set for Eccentric Valve Seat Grinder (Used with Eccentric Valve Set Grinder J–7040)	J–9296
Nozzle Hole Cleaner-Wire (Used with Pin Vise J–4298–1)	J–8976
Exhaust Valve Seat Insert Installer (Used with Driver J–7079–2)	J–8834
Instake Valve Seat Insert Installer (Used with Driver J–7079–2)	J–8835
Exhaust Valve Seat Insert Remover (Used with Driver J–4140–14)	J–8870–1
Intake Valve Seat Insert Remover (Used with Driver J–4140–14)	J–8870–2
Exhaust and Intake Valve Guide Remover	J–269
Exhaust Valve Guide Installer Adapter (Used with J–9317–1 and J–9317–4 listed below)	J–9317–20
Intake Valve Guide Installer Adapter (Used with J–9317–1 and J–9317–4 listed below)	J–9317–17
Exhaust and Intake Valve Guide Installer Plate	J–9317–1
Exhaust and Intake Valve Guide Installer Spindle (3/8" Dia.)	J–9317–4
Valve Guide Cleaning Brush Set	J–5585
Front Seal Protector	J–6897
Cylinder Sleeve Remover	J–6833
Nozzle Tester Set	J–8625
Adapter Set (American Bosch used with above Tester Set)	J–8839
Nozzle Spray Collector	J–6445–50
*Nozzle Cleaning Kit	4040025
Nozzle Lapping Kit	J–3179
Nozzle Remover Adapter (Used with Slide Hammer J–6471–1)	J–6865
Slide Hammer	J–6471–1
Fuel Injection Line Nut Wrench (Nozzle Holder Assy. End)	J–6765
Fuel Injection Line Nut Wrench (Injection Pump End)	J–9162
Cylinder Diameter Checking Gauge	J–8060
Cylinder Hone	J–5902
Cylinder Ridge Reamer	J–9325
Compression Gauge Set	J–6762–02
Compression Gauge Set Carrying Case	J–7125
Piston Vise	J–1218
Piston Pin Retainer Pliers	J–4245

Description	Kent-Moore Tool Co.
Piston Pin Remover and Installer	J–7092
Piston Inserter (Piston Ring Compressor)	J–7061
Piston Ring Remover and Installer	J–8128
Piston to Sleeve Feeler Gauges	J–5438
Piston Ring Gap Feeler Gauges	J–3172
Gear Puller with 9½" Legs	J–8190
Legs 4½" for above Gear Puller	J–8180
Puller Adapter (Pair ¼–20)	J–8181
Puller Adapter (Pair 5/16–18)	J–8182
Puller Adapter (Pair ⅜–16)	J–8183
Puller Adapter (Pair 7/16–20)	J–9302
Puller Adapter (Pair ½–13)	J–8184
Puller Adapter (Pair ⅝–11)	J–8185
Drive Rod (Used with Valve Seat Insert Remover Tools)	J–4140–14
Driver (Used with Nozzle Sleeve Installer and Valve Seat Insert Installers)	J–7079–2
Camshaft Bushing Remover and Installer Set	J–6786
Oil Seal Remover and Replacer Set	J–3154–04
Torque Wrench 0–150 ft. lbs.	J–1313
Torque Wrench 0–300 ft. lbs.	J–9187
Pin Vise — for Holding Nozzle Hole Cleaning Wire	J–4298–1
Gear Puller Set (Small)	J–8111

*Order this tool from your Allis-Chalmers dealer.

SECTION IX — DRIVE SHAFTS AND UNIVERSAL JOINTS

1. DESCRIPTION

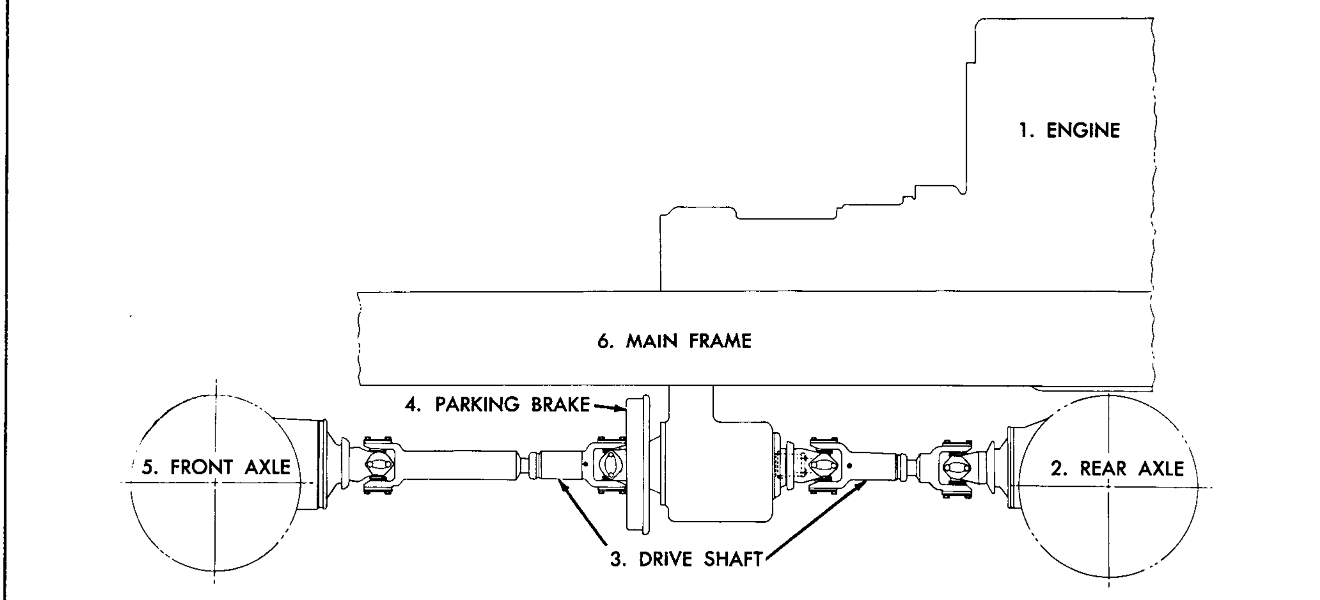


Fig. 1 — Location of Universal Joint Drive Shafts

Power from the engine is transmitted directly to the torque converter and transmission. From the transmission, power is transmitted to the axles by means of a front and rear drive shaft universal joint.

The main components of each of the two drive shaft universal joint assemblies are the front and rear yokes, the connecting yokes, and the spider assemblies.

The axles and the transmission can be removed without disturbing any other component by disconnecting the yokes.

2. LUBRICATION

The drive shaft universal joint assemblies each have three lube fittings; one in each spider assembly and one in each slip yoke.

Lubricate after each 100 hours of operation.

3. REMOVAL, DISASSEMBLY AND INSPECTION

1. Suitably block the loader, or apply the parking brake, to prevent it from rolling.
2. Remove the capscrews, the lockplates, and carefully remove the bearing assemblies from the universal joints at the transmission ends of the drive shafts.

3. Disconnect the universal joints at the transmission end of the drive shafts. Remove the spider.

4. Disassemble the universal joints at the axle end of the drive shaft in the same manner as above.

5. Remove the yoke from the differentials by removing the cotter pins and the castellated nuts.

6. Remove the yoke (with the parking brake drum) by removing the capscrews, the lockplate, and the yoke retainer.

7. Remove the yoke from the transmission (front axle drive side) in the same manner as in Step 6.

8. Thoroughly wash all of the parts in a clean solvent or fuel. Inspect the parts for damage and wear. Replace any worn or damaged parts.

4. INSTALLATION

Assemble and install the universal joint drive shafts in the reverse order of the instructions in Topic 3.

SECTION X — TRANSMISSION

1. GENERAL DESCRIPTION

A. Description

The Allison Torqmatic Transmission, Model No. CRT-3531 (Figs. 1 and 2) is a device for transmitting power from the engine to the drive wheels. This heavy duty transmission has transfer gears which provide output drives 20 inches lower than the input gears. The transfer gear housing, which acts as an oil sump, has a front and a rear output for driving the front and the rear wheels.

The Torqmatic transmission combines all of the desirable characteristics of a hydraulic torque multiplier and a fluid coupling to transmit engine power. It automatically adjusts the output torque to the load demand. The advantages of hydraulic torque multiplication are further advanced by the constant mesh planetary gearing. This combination provides an almost unlimited range of speed ratios with three speeds forward and three reverse — and eliminates the conventional clutch.

The Torqmatic converter uses the rotating principle. It is a 3-element, single stage, poly-phase type of converter. (Refer to Topic 2.) The converter protects the engine from damaging shock loads and harmful engine lugging and stalling. This increases the engine and the equipment life and provides longer service availability. Because torque is multiplied hydraulically and automatically, the engine power is adjusted to the load. This eliminates "gearshift guess" and driver fatigue. The transmission can be "quick shifted" under full load at wide open throttle without interrupting the power flow from the engine to the load.

The transmission planetary gearing is a compound planetary gear train in constant mesh. The gears and the multidisc clutches are compactly arranged in a small area. Five multidisc, oil cooled, friction clutches control the gear train. These clutches are applied hydraulically and are spring released. Because the clutches are hydraulically controlled, there is automatic compensation for normal wear. No adjustment is necessary. The friction plates have sintered bronze facings and the reaction plates are steel. The torque converter has a ratio of 2.61:1 while the implement pump drive has a ratio of 1.00:1.

The transmission is equipped with a remote mounted, full flow oil filter, and a parking brake on the front output shaft (for braking the front wheels). It has a rear output disconnect, which disconnects the rear wheels, for open road travelling. An oil cooler is remote mounted in front of the engine cooling radiator, for maximum cooling efficiency of the transmission.

The flow of oil in the transmission hydraulic system is supplied by the input pump. Oil is pumped from the reservoir in the transfer gear housing to the remote mounted oil filter. The oil filter is connected to the converter housing by a tube inserted in an oil passage. The tube is installed through a tapped hole. The oil then goes to both the main-pressure

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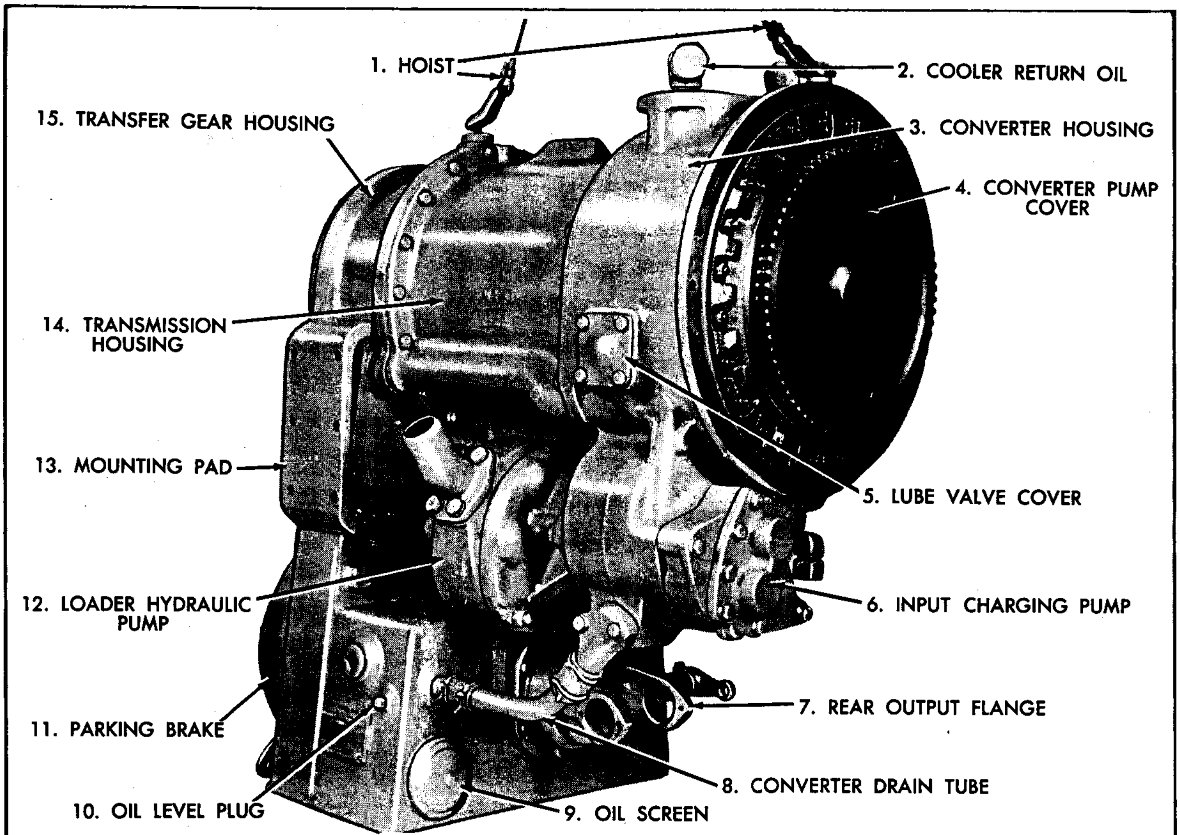

Fig. 1 — Transmission (Left Side)

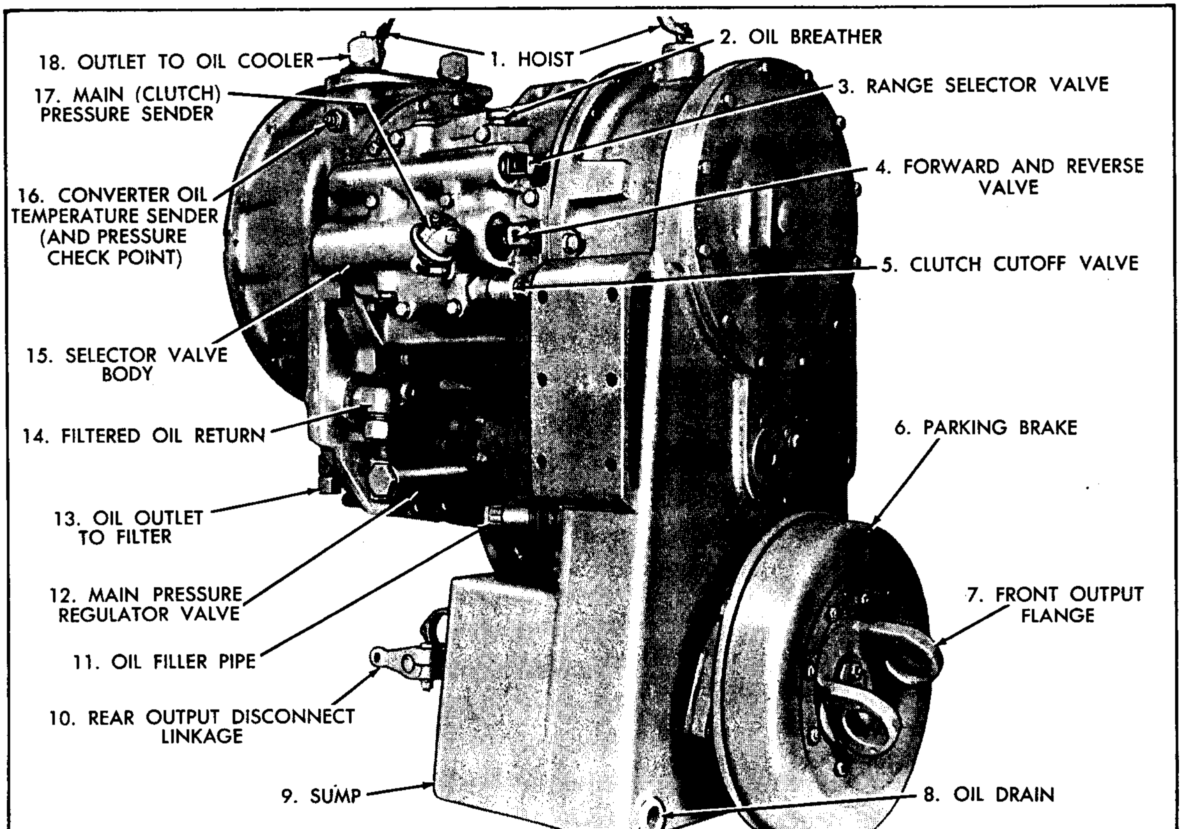

Fig. 2 — Transmission (Right Side)

regulator valve and the forward and reverse-range selector valve. From the forward and reverse-range selector valve, the oil is directed to either the forward or the reverse-range clutch apply piston to engage the desired clutch. The main pressure regulator valve moves against spring pressure and sends the oil to both the clutch cutoff valve and the torque converter. From the clutch cutoff valve, the oil is directed to the range selector valve which then directs the oil to the desired range clutch. From the torque converter, the oil passes through the cooler and flows to the lube regulator valve. The lube regulator valve operates against spring pressure and sends the cooled oil to the lubrication system, and diverts any excess oil back to the sump.

A clutch cut-off valve is provided, which automatically disconnects the range clutches when the brakes are applied, thus providing full engine power for the loader's hydraulic system. When the hydraulic pressure, from the power brake unit, is applied to one end of the clutch cut-off valve, the valve operates against the spring pressure. This cuts off the main oil pressure supply to the range selector valve, permitting spring pressure to disengage the range clutch, stopping the power flow to the output shaft. Therefore, as long as the brakes are applied, all of the engine power is available for operation of the loader hydraulic system. When the brakes are released, the cut-off valve again directs the main oil pressure supply to the range selector valve. When precise control of the engine is required on grades, a control lever is provided in the operator's compartment to disengage the automatic clutch cut-off valve. Control is accomplished through a manually operated check valve that is located in the line between the hydraulic brake circuit and the clutch cut-off valve. NOTE: *When changing the position of the control lever, the brake pedal should be fully released.*

The forward and reverse selector valve has a built-in "inching control" feature that is unique in design. It operates as follows: When the valve is moved to select either forward or reverse direction, main oil is admitted into the valve cavity which allows oil to flow to the clutch piston cavity and to the clutch plate area of the clutch being applied.

The oil going to the clutch plates also exerts pressure on a piston that is attached in the center of the selector valve. The clutch piston movement is started by the clutch apply line oil and the oil going to the clutch plate area lubricates the plates as they are being applied. At the beginning of the clutch application, the valve piston allows a free flow of lube oil to the clutch plates plus a low apply pressure to the clutch piston. As the selector valve is moved further to the full-apply position, the valve piston moves over the lube line hole completely shutting off the lube oil flow to the clutch plate area, directing full main oil pressure to the clutch piston, to fully apply the clutch.

A normal spring detent action resists the movement of the piston in the selector valve so that the valve can be moved easily to the full-apply position. Thus, the transmission can reverse directions with a minimum of delay, or the clutches can be applied gradually to "inch" the machine carefully in either direction.

This inching control feature allows the operator to slip the clutches with the engine at full throttle if he wishes to lift maximum loads and also "feel" the load pick-up.

B. Driving Tips

The transmission is of the full power shifting type. It is possible to upshift or downshift the transmission with the throttle wide open regardless of the load. However, a downshift should not be made if the machine's speed exceeds the maximum speed normally attained in the next lower range. Downshifting at excessive speeds causes the engine to act as a brake. This overspeeds the engine. In addition to possible engine damage, it may cause the machine to dump its load and may cause serious injury to the operator if the braking action is severe enough.

If the converter oil "out" temperature rises above 250° F., stop the machine immediately. Shift the transmission to neutral, and run the engine at 1000 to 1300 rpm. The temperature should drop rapidly to the engine water temperature (170°-190° F.). If the temperature does not drop, the cause should be determined and corrected.

C. Specifications and Data

Input Rotation
(viewed from input end) .... Clockwise
Output Rotation
(viewed from input end) .... Clockwise
Torque Multiplication ratio at Converter stall only 2.61:1
Converter "Out" Oil Pressure .... 25-65 P.S.I.
Maximum Converter "Out" Oil Temperature .... 250° F.
Range Gearing — Constant mesh planetary. All ranges operate in both forward and reverse.
Transfer Gearing .... Constant mesh, in line
Gear Type .... Spur
Oil Sump .... Integral
Input-Oil Pump — Positive displacement, gear-type (driven at engine speed).
Oil Capacity .... initial fill 8.5 gal. (US)
.... refill (approx. 7.25 gal. (US)
Oil Filter — Full-flow, remote mounted. Strainer in sump.
Oil Radiator .... Remote
Oil Type ... Hydraulic transmission fluid Type C-1
Controls — Forward and reverse (manual), range selection (manual) and clutch cut-off (service brake actuated).
Selector Valve Body — Incorporates three features to provide for, (a) range selection; (b) direction selection; (c) clutch cut-off to disengage transmission, making full engine power available for the loader hydraulic system operation.
Clutch Type — Multidisk, oil cooled, hydraulic-actuated, spring-released, automatic wear compensation and no adjustment. Clutches are oil-cooled.
Clutch Friction Plate .... Sintered Bronze
Clutch Reaction Plate .... Steel
Clutch Pressure .... 140-150 P.S.I.
Accessory Drives — Loader hydraulic system oil pump 1.00:1

2. TORQUE PRINCIPLES AND OPERATION

A. General

The transmission is a hydraulic torque multiplier with a fluid coupling and planetary range gearing.

Torque multiplication is an increase in twisting or rotating effort, or the multiplication of force. For every lb. ft. of torque effort developed by the engine, the torque converter multiplies it 2.61 times. This is accomplished by using a hydraulic coupling (pump and turbine) and a fulcrum (a stator, or reaction member).

The hydraulic coupling (Fig. 3) is the simplest means of transmitting torque hydraulically. It can be called a fluid coupling, a fluid flywheel, or a fluid clutch. The ratio of input to output is always one-to-one. The hydraulic coupling consists of two elements: a pump and a turbine. Each element has a number of straight, flat, radial blades leading from the hub to the outside edge.

A cover, integral with the pump and filled with oil, completely encloses the turbine. When the engine is started the pump starts turning. As it turns faster the oil is thrown against the outside circumference of the pump. But because of the pump blade design, the blades guide the flow of oil to the turbine. When the oil hits the turbine blades with enough force, the turbine turns. This movement slows the oil which then travels inward toward the turbine hub, then returns again to the pump, completing the cycle (Fig. 3). Note that the oil flows "outward" in the pump, and "inward" in the turbine. Note also that there is no stationary or reaction member to use as a fulcrum to increase leverage. Thus the fluid coupling cannot multiply torque.

To make the hydraulic coupling perform as a torque multiplier, it is necessary to add only a reaction member or fulcrum. The stator becomes the reaction member by placing a stator (fulcrum) between the load (output) and power source (input). This fulcrum is "grounded" to the housing of the converter which is attached to the frame.

The oil circulates in the same manner as in the hydraulic coupling, except that in the converter, the blading is curved in all of the elements. The pump pushes the oil outward and in the direction that the pump is turning. The oil strikes the turbine, causing the turbine to turn. After striking the blades, the oil is directed inward, toward the inner

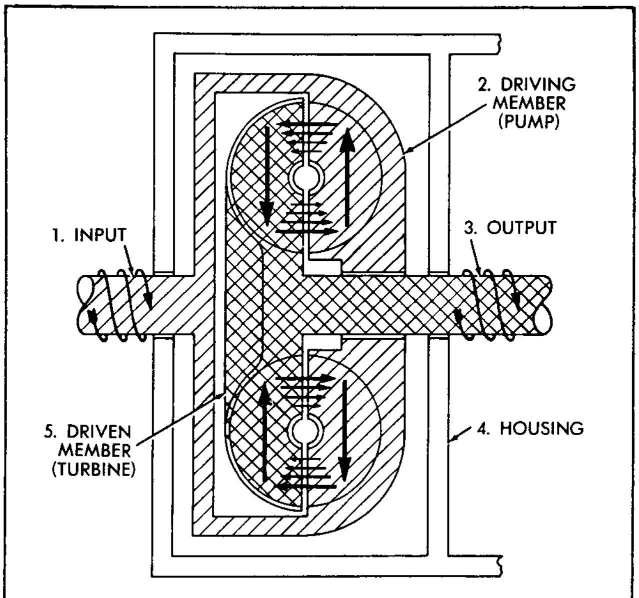

Fig. 3 — Fluid Coupling (Schematic)

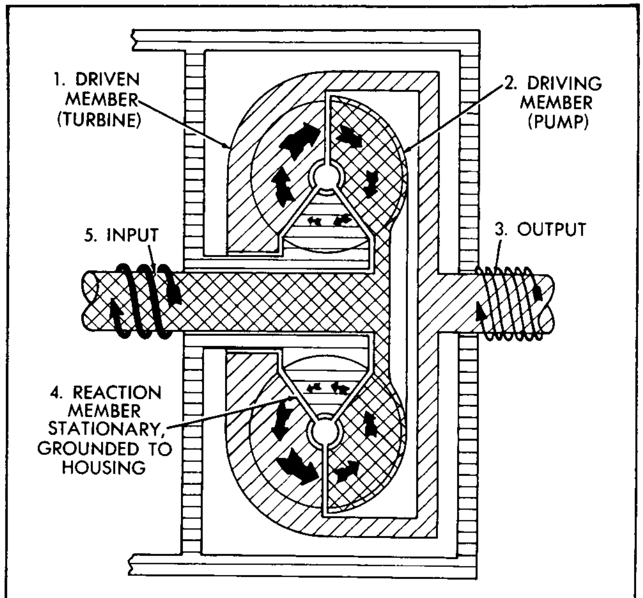

Fig. 4 — Torque Converter (Schematic)

circumference of the turbine. As the oil leaves the turbine, it is moving in a direction opposite the pump rotation. The stator being held stationary, causes the oil to change direction and add its motion to the pump.

Oil in motion has *kinetic energy* (imparted to the oil by the pump). The flow of the oil around the outer circumference in the converter is called the *rotary flow*. The flow of oil across the converter is called the *vortex flow*.

Only part of the kinetic energy is removed from the oil as it strikes the turbine. The oil leaving the turbine has some kinetic energy left. The stator deflects the oil in motion with its remaining kinetic energy so that it enters the pump in the same direction that the pump is moving. This aids the pump rather than hinders it.

The multiplication of input torque results from the velocity (kinetic energy) imparted to the oil by the pump, plus the velocity (kinetic energy) entering the pump from the stator. The more the turbine resists turning (because of a heavier load) the greater the velocity of the vortex flow will be of the oil circulating in the converter, and the greater the torque multiplication will be. The less the turbine resists turning (because of a lighter load) the less the velocity of the vortex oil flow will be in the converter, and the less the torque multiplication will be.

The transmission employs what is called the floating fulcrum principle of multiplying the torque. Floating suggests a cushioning of shock, and an infinite number of torque ratios. The common step gear transmission provides a set number of fulcrum points that is determined by the number of gear speeds. This transmission furnishes an infinite number of fulcrum points, and does so automatically, without guesswork on the part of the operator.

Because of the full floating principle, the converter acts as a hydraulic torque converter and a hydraulic coupling. This is possible because the stators can "float," so that, when no torque multiplication is necessary, the converter becomes a hydraulic coupling. This permits a more economical overall range of operation.

The transmission, with its planetary gearing, provides six fixed gear ratios, three in forward and three in reverse. The converter provides (within design limits) an infinite number of variable torque ratios hydraulically. It is this combination which gives the transmission its flexibility, its full power shifting, and, at the same time it frees the engine from harmful lugging and prevents shock loads.

B. Torque Converter

1. Description

The converter consists of three elements: the pump;

the turbine; and the stator. It is called a rotating housing type because the elements are enclosed in a housing consisting of the converter pump cover assembly (or the transmission cover) and the converter pump. The converter pump cover assembly is driven directly from the engine. The stator is designed so that it can free wheel, or automatically lock-up to provide the necessary reaction for torque multiplication.

Mounted on the converter housing is an oil pump driven through the transmission gearing. This oil pump pressurizes the converter and transmission. It also supplies a cooling flow of oil.

Oil from the oil pump flows through internal passageways in the transmission, the converter housing, and through converter ground. It then enters the converter elements between the stator and the converter pump (Fig. 5). The oil that leaves the converter elements between the stator and the turbine, flows inside a hollow ground sleeve along the turbine shaft, and out the converter housing to the oil cooler. From the external oil cooler, the oil flows into the lubricating circuit, and then back to the transmission sump.

2. Operation

The instant that the torque converter pump starts rotating, the oil spins in the same direction with the pump. This movement of oil is called a rotary flow. The converter turbine, connected to the load, resists turning as the oil strikes its blades. Because of the resistance, and because of the shape of the blade within the converter elements, the oil takes a second path of travel — crosswise. This second path is called the vortex flow.

The greater the load resistance transmitted by the turbine, the greater will be the vortex flow with the engine operating at its governed speed. The greater the vortex flow, the greater the torque multiplication. All of the action is automatic. The "floating fulcrum" automatically chooses the exact torque ratio required.

In tracing the action of the torque converter, remember that it is a three-element, single stage, poly-phase converter. The first converter phase means that the stator is being held stationary, and that the greatest torque multiplication between the input torque and the output torque is being accomplished. In this phase the stator is being held stationary because the oil leaving the turbine strikes the stator so that it tries to turn in a direction opposite both the pump and the turbine rotation. But the stator is mounted on cams on the ground sleeve.

These cams, with rollers, permit the stator to rotate in one direction only, like a coaster brake on a bicycle, which permits the pedals to rotate forward only. The stator, when stationary, redirects the vortex flow of oil so that it enters the pump in the same direction that it is turning. This flow aids the pump and multiplies the torque.

The second converter phase means that the stator is freewheeling. The stator starts to freewheel as

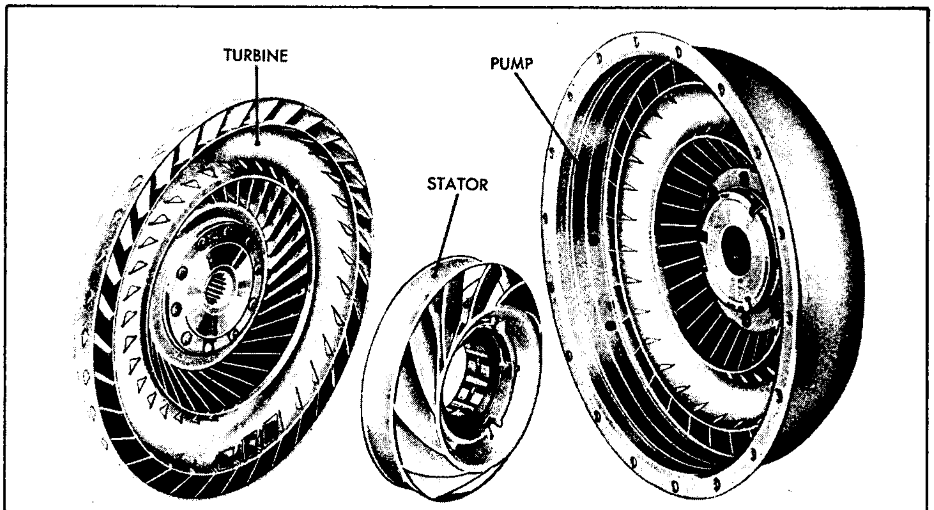

Fig. 5 — Three Element Torque Converter

soon as the load demand for output torque becomes less. This means that the turbine is turning faster in relation to the pump. As the turbine speed increases, the oil leaving the turbine strikes the blades of the stator in such a manner that it no longer locks-up on the cam, but starts to freewheel in the direction of the turbine. Torque multiplication is decreasing while turbine speed is increasing and the vortex flow is becoming less.

The torque converter is in fluid coupling when the stator starts to freewheel. This means that the turbine speed is approaching the pump speed, and that the input torque and the output torque are approaching a one-to-one ratio. The vortex flow has practically stopped. This stopping of the vortex flow permits the stator to freewheel. But as soon as the turbine slows down and the demand (load variation) for the output torque increases, the "floating fulcrum" adjusts the torque input to the torque output demand. The stator then becomes stationary to aid the torque multiplication.

C. Planetary Gearing Principle

1. Description

A simple planetary gear system consists of four members: a planetary sun gear; two planetary pinions; a planetary pinion carrier, and a planetary ring gear (Fig. 6). The sun gear meshes with the planetary pinions which are attached to the carrier. The planetary pinions are in mesh with the ring gear. This is a different arrangement than the conventional sliding gear transmission, in which the gears are slid into mesh.

In order to obtain the necessary reduction or variation in torque multiplication, one member of the planetary unit must be held stationary while the two other members become either the driving or the driven memoers.

2. Operation

This transmission uses three of these combinations providing six output combinations. In Fig. 6, View A, the input torque is transmitted to the sun gear clockwise; consequently, the planetary pinions must also rotate. Since the ring gear is being held, the planetary pinions rotate on their own shafts, and "walk" around the ring gear taking the planetary carrier with them. This makes the planetary carrier the driven member, or the output member. The planetary carrier will be turning more slowly than the sun gear, and in the same direction.

In Fig. 6, View B, the input torque is transmitted to the sun gear clockwise; consequently, the planetary must rotate counterclockwise. Since the planetary

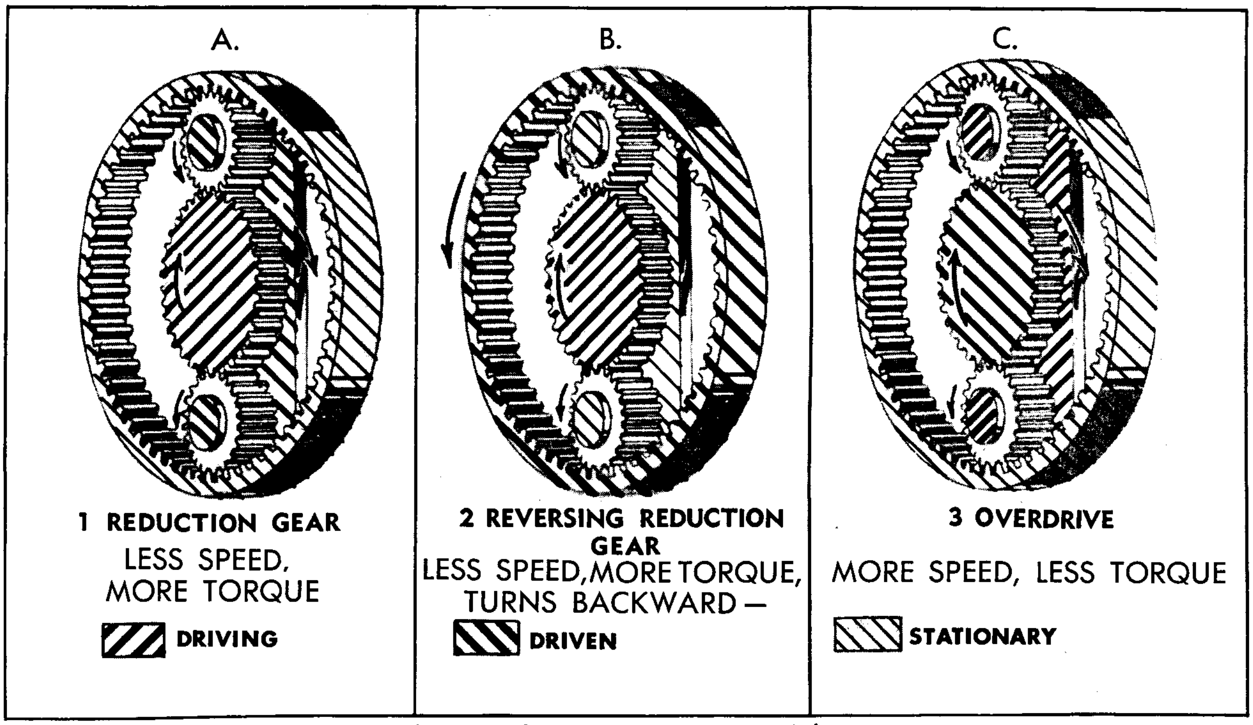

Fig. 6 — Planetary Gearing Principles

carrier is being held, the planetary pinions rotate on their own shafts and force the ring gear to rotate slowly in the same direction as the planetary pinions, or counterclockwise. This imparts a reverse motion and a reduction in speed to the output.

In Fig. 6, View C, the input torque is transmitted to the planetary carrier clockwise; consequently, the planetary pinions must rotate counterclockwise. Since the ring gear is being held, the planetary pinions rotate on their own shafts and drive the sun gear clockwise with more speed. This makes the sun gear the driven member.

The transmission employs a compound planetary gearing system. The gearing operates as a simple planetary system in the intermediate range, either forward or reverse, and as a compound planetary system in the high and the low ranges. When two planetary systems are used simultaneously to obtain a desired output ratio, the gearing is referred to as compound. Compound planetary gearing is used to obtain the desired gear ratios from the least number of parts in the smallest space possible.

3. Clutches

For either forward or reverse directions, both a direction clutch (forward or reverse) and a range clutch (low, intermediate, or high) must be engaged. If the intermediate range clutch is applied, the forward planetary carrier is locked to the transmission shaft. In this range, since only the direction planetary is working, the gearing operates as a simple planetary system. If either the low or high range clutch is applied, both the direction planetary and the range planetary are working. Hence in the low or the high range, the gearing operates as a compound planetary system.

The hydraulically actuated clutches include two types of clutch plates. The friction plates are splined to the ring gears (high and low ranges) and to the intermediate range clutch hub. The other plates are called the reaction plates and are either secured to the transmission housing (high and low range), or to the intermediate range clutch drum (intermediate range). Note that both the high and the low range ring gears can be held.

When putting the machine in motion, both a range clutch (low, intermediate, or high) and a direction clutch (forward or reverse) must be applied. When the reverse clutch is applied, the drive is from the converter shaft through the sun gear.

Since the reverse clutch is applied, the reverse planetary is being held. The reverse sun gear drives the planetary pinions and, since the reverse planetary carrier is held, the pinions turn the reverse ring gear. The reverse ring gear drives the forward planetary carrier, which in turn drives the range gearing.

Note that when the sun gear is driving, the planetary carrier is held, the ring gear is driven, and the motion of the ring gear is opposite to that of the converter shaft. This causes the output shaft to turn backward. When the forward clutch is applied, the input torque is transmitted to the sun gear; consequently, the planetary pinions must also rotate. Since the forward ring gear is being held, the planetary pinions rotate on their own shafts, and "walk" around the ring gear taking the planetary carrier with them. This makes the planetary carrier the driven member, or the output member. The planetary carrier will be turning more slowly than the sun gear, and in the same direction. This gives forward motion.

D. Hydraulic Direction and Range Control

1. Description

The heart of the hydraulic direction and range control system is the selector valve body assembly. This assembly contains the valves that control shift from one direction to the other, and also from one range of operation to another. Both the forward and the reverse valve, and the range selector valve, are manually actuated. The clutch cutoff valve is actuated by the hydraulic power brake pressure. When the brakes are applied, the hydraulic brake pressure is applied to the end of the clutch cut-off valve moving it against spring pressure. The valve cuts off the oil pressure to the range selector valve and exhausts the applied clutch line.

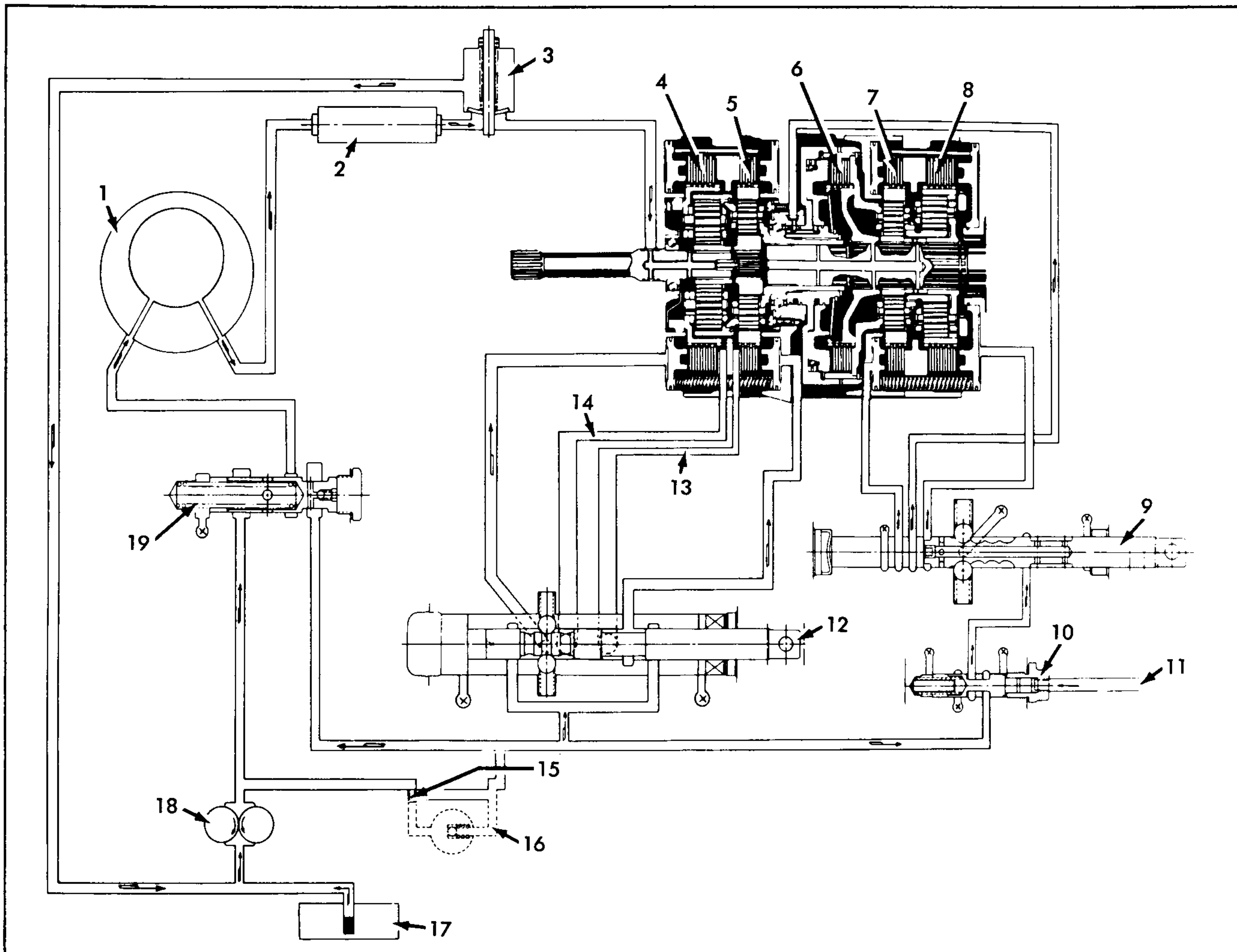

Fig. 7 — Hydraulic System (Schematic)

1. Torque Converter
2. Oil Cooler
3. Lube Regulator Valve (20-25 P.S.I.)
4. Reverse Clutch
5. Forward Clutch
6. Intermediate-Range Clutch
7. High-Range Clutch
8. Low-Range Clutch
9. Range Selector Valve Showing High, Intermediate, Low and Neutral Positions
10. Clutch Cut-Off Valve
11. Hydraulic Brake Pressure
12. Forward and Reverse Selector Valve
13. Forward Clutch Lube Line
14. Reverse Clutch Lube Line
15. Oil Transfer Tube Inserted in Converter Housing
16. External Filter and 15 P.S.I. By-Pass Valve
17. Suction Strainer
18. Input Driven Pressure Pump (2200 R.P.M. Engine Speed, 21.5 G.P.M.)
19. Main Pressure Regulating Valve (140-150 P.S.I.)

2. Neutral Range

Referring to Figs. 7 and 8, notice that no power flows through the transmission because none of the direction or range clutches are applied. Their lines are open to the sump through the forward and the reverse valve, and the range selector valve.

3. Low Forward Range (Figs. 7 and 9)

Referring to Figs. 7 and 9, notice that when the shift control lever is moved into low range position, the range selector valve directs the main oil pressure to the low range clutch to actuate the clutch. When the direction lever is moved into the forward

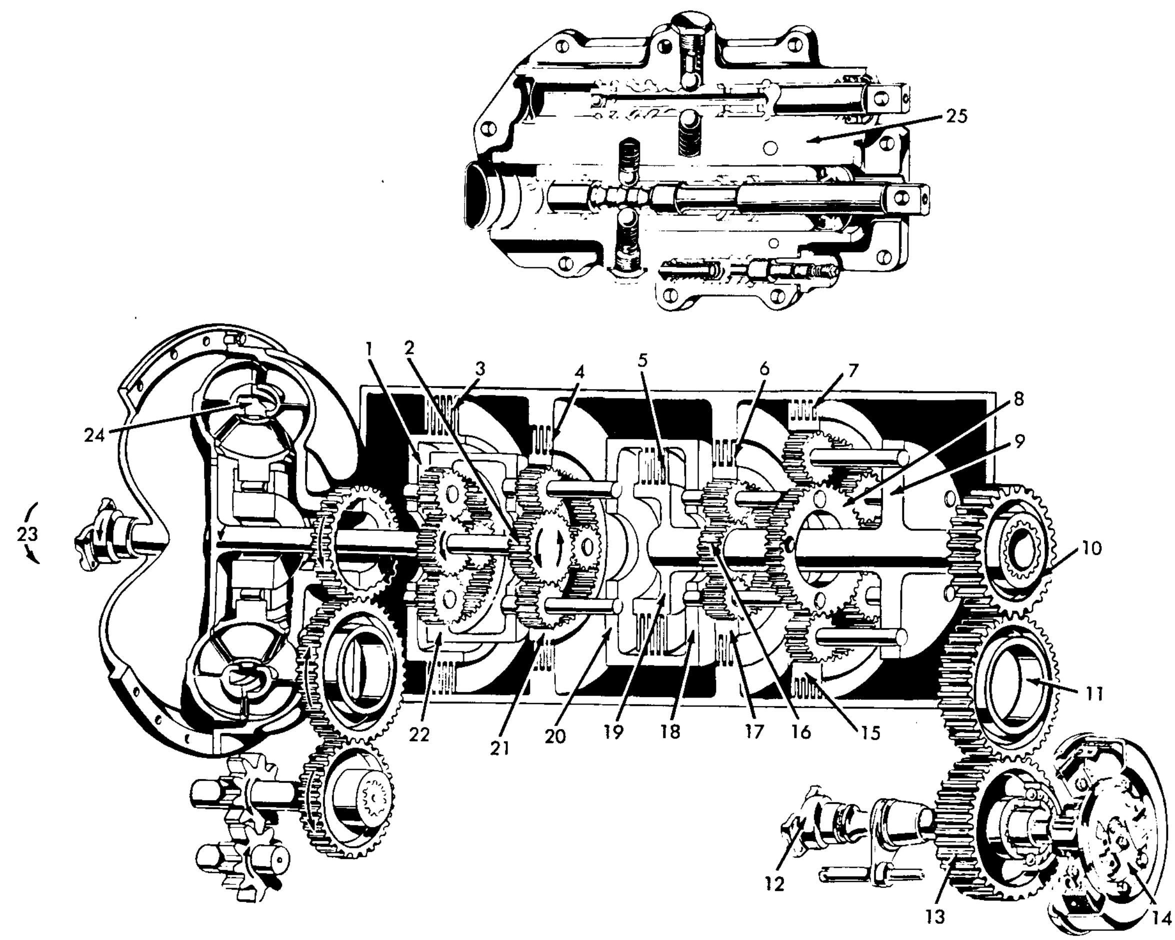

Fig. 8 — Torque Path — Neutral Range

1. Reverse-Range Planetary Carrier
2. Forward-Reverse Range Sun Gear
3. Reverse-Range Clutch
4. Forward-Range Clutch
5. Intermediate-Range Clutch
6. High-Range Clutch
7. Low-Range Clutch
8. Low-Range Sun Gear
9. Low-Range Planetary Carrier
10. Transfer Drive Gear
11. Transfer Idler Gear
12. Rear Output
13. Transfer Driven Gear
14. Front Output
15. Low-Range Ring Gear
16. High-Range Sun Gear
17. High-Range Ring Gear
18. High-Range Planetary Carrier
19. Intermediate-Range Clutch Hub
20. Forward-Range Planetary Carrier
21. Forward-Range Ring Gear
22. Reverse-Range Ring Gear
23. Input
24. Torqmatic Converter
25. Selector Valve Body Assembly

position, the forward and reverse valve directs main oil pressure to the forward clutch to actuate it.

4. Intermediate Forward Range (Figs. 7 and 10)

The range selector valve allows the pressure in the low range clutch line to exhaust to the sump, and directs the pressure to the intermediate range clutch line. The clutches function simultaneously for smooth shifting without an interruption in the transmission of the torque to the wheels.

5. High Forward Range (Figs. 7 and 11)

The range selector valve allows the pressure in the intermediate range clutch line to exhaust to the sump, and directs the pressure to the high range clutch line.

6. Low, Intermediate, and High Reverse Ranges (Figs. 7 and 12 through 14)

The action of these clutches is similar to the forward low, the intermediate, and the high range clutches.

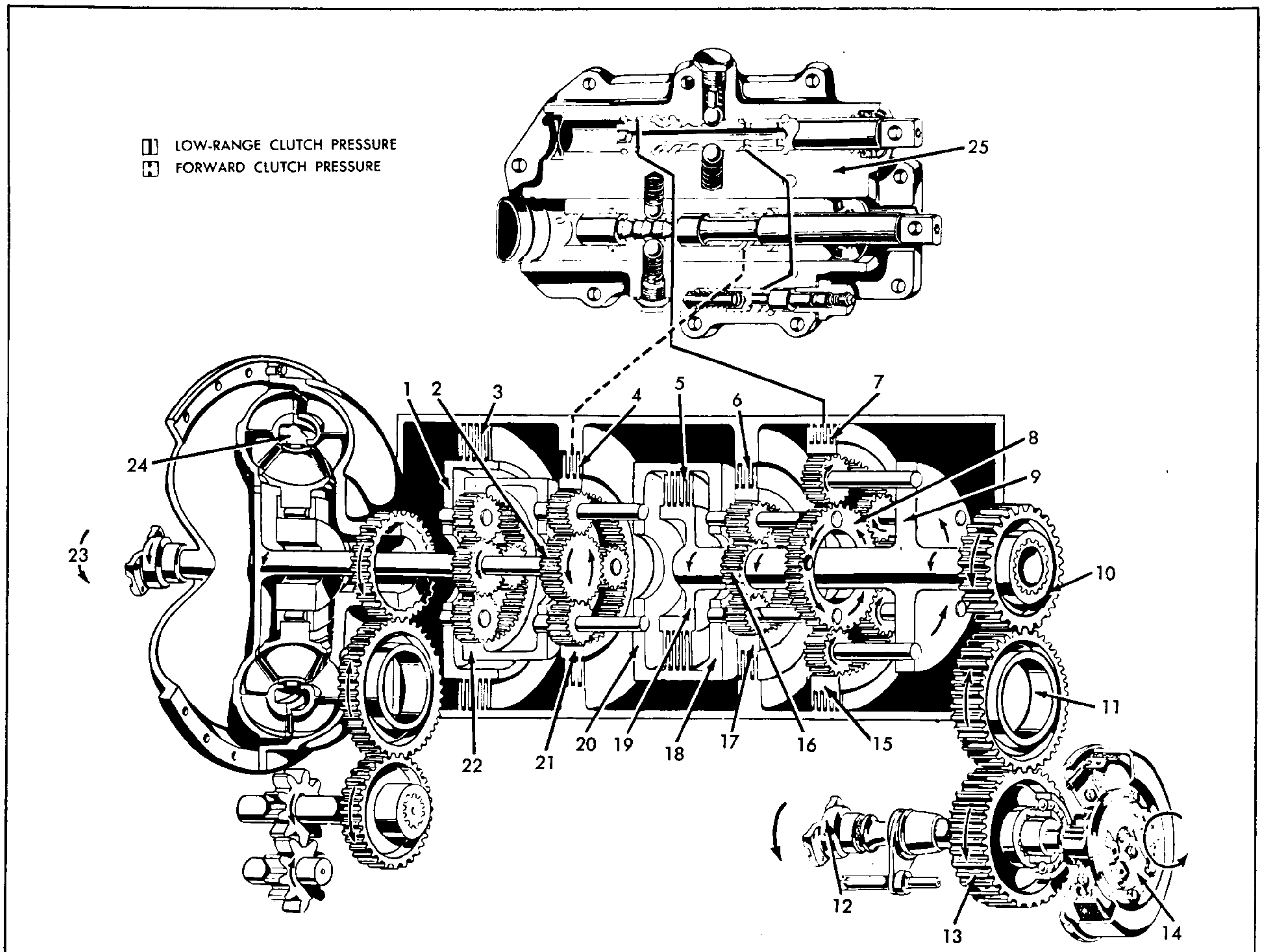

Fig. 9 — Torque Path — Forward Low Range

1. Reverse-Range Planetary Carrier
2. Forward-Reverse Range Sun Gear
3. Reverse-Range Clutch
4. Forward-Range Clutch
5. Intermediate-Range Clutch
6. High-Range Clutch
7. Low-Range Clutch
8. Low-Range Sun Gear
9. Low-Range Planetary Carrier
10. Transfer Drive Gear
11. Transfer Idler Gear
12. Rear Output
13. Transfer Driven Gear
14. Front Output
15. Low-Range Ring Gear
16. High-Range Sun Gear
17. High-Range Ring Gear
18. High-Range Planetary Carrier
19. Intermediate-Range Clutch Hub
20. Forward-Range Planetary Carrier
21. Forward-Range Ring Gear
22. Reverse-Range Ring Gear
23. Input
24. Torqmatic Converter
25. Selector Valve Body Assembly

E. Torque Paths Through Transmission

1. General

The flow of power or torque through the transmission is smooth and continuous, and may take any one of seven different paths, called torque paths, which are illustrated in Figs. 8 through 14.

2. Neutral (Fig. 8)

There is no torque transmitted in neutral range from the input to the output. The forward and reverse-range sun gear is the driven member but, since none of the clutches are applied, there is no stationary member. With no stationary member there cannot be a driven member, consequently, there is no output torque.

3. Low-Forward Range Torque Path (Fig. 9)

a. The intermediate-range clutch drum, which is splined to the forward-range planetary carrier, transmits the torque from the carrier to the high-range carrier. The low-

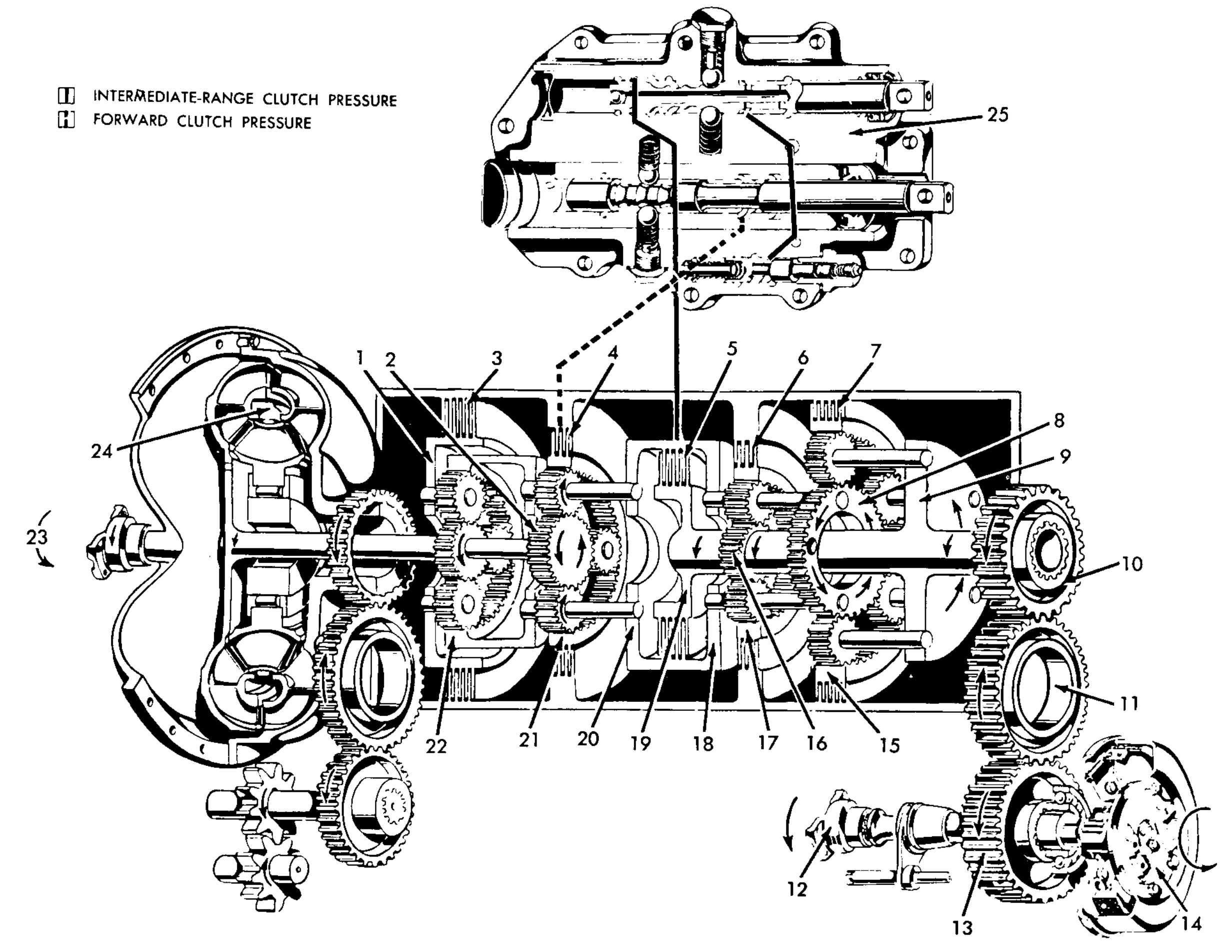

Fig. 10 — Torque Path — Forward Intermediate Range

1. Reverse-Range Planetary Carrier
2. Forward-Reverse Range Sun Gear
3. Reverse-Range Clutch
4. Forward-Range Clutch
5. Intermediate-Range Clutch
6. High-Range Clutch
7. Low-Range Clutch
8. Low-Range Sun Gear
9. Low-Range Planetary Carrier
10. Transfer Drive Gear
11. Transfer Idler Gear
12. Rear Output
13. Transfer Driven Gear
14. Front Output
15. Low-Range Ring Gear
16. High-Range Sun Gear
17. High-Range Ring Gear
18. High-Range Planetary Carrier
19. Intermediate-Range Clutch Hub
20. Forward-Range Planetary Carrier
21. Forward-Range Ring Gear
22. Reverse-Range Ring Gear
23. Input
24. Torqmatic Converter
25. Selector Valve Body Assembly

range sun gear, which is attached to the high-range planetary carrier, drives the low-range planetary pinions. The low-range ring gear is held stationary by the hydraulic-actuated, low-range clutch. At this point, the torque is transferred from the low-range sun gear to the low-range planetary pinions where it is further multiplied mechanically. The pinions transmit the torque to their carrier which drives the transmission shaft assembly counterclockwise. The overall gear reduction is 8.00:1 in this range.

b. The engine torque is transmitted through the hydraulic torque converter to the converter shaft assembly. The forward and reverse-range sun gear, splined to the converter shaft assembly, drives the forward-range planetary pinions. The forward-range ring gear is held stationary by the hydraulic-actuated forward clutch. There-

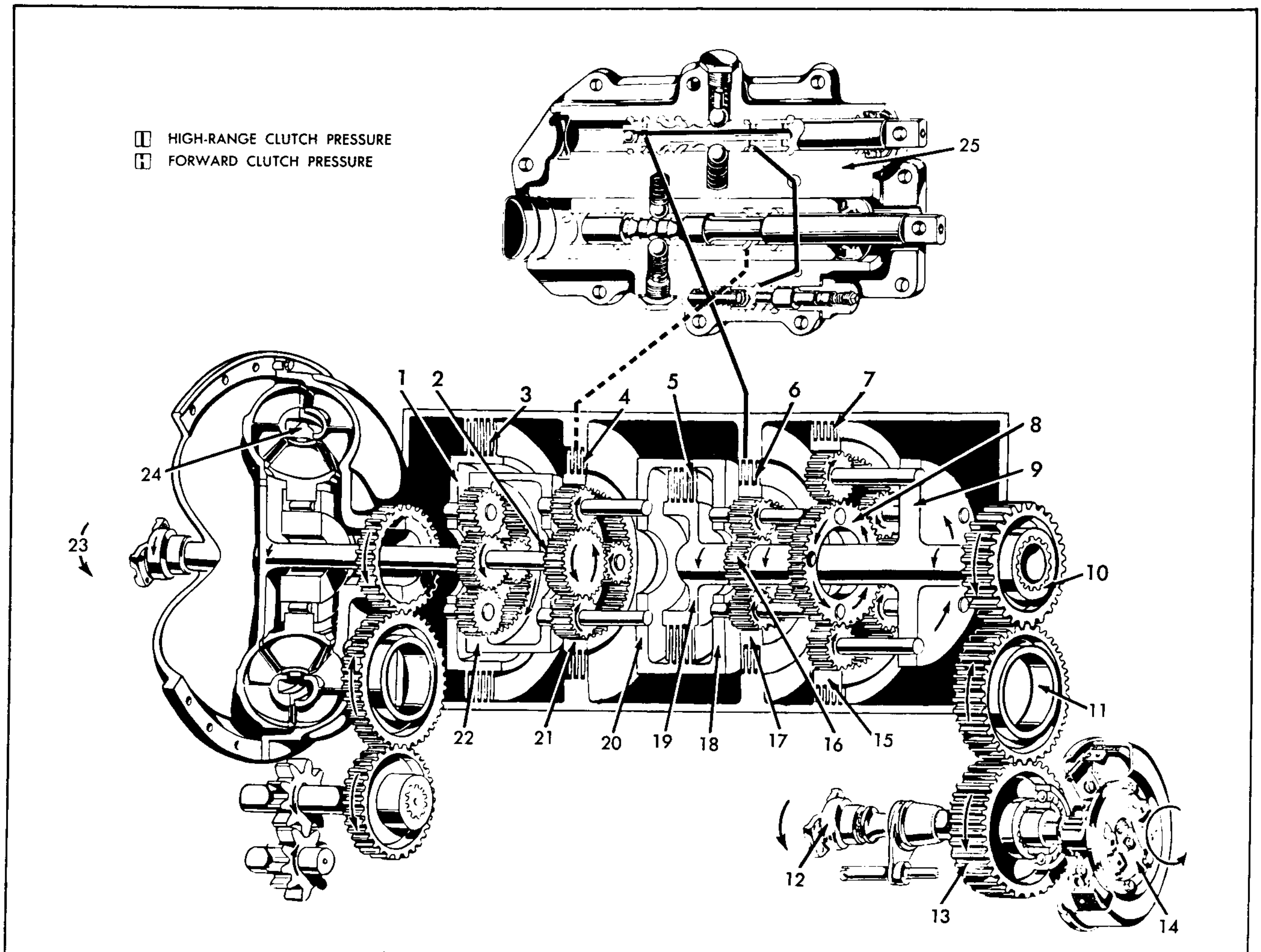

Fig. 11 — Torque Path — Forward High Range

1. Reverse-Range Planetary Carrier
2. Forward-Reverse Range Sun Gear
3. Reverse-Range Clutch
4. Forward-Range Clutch
5. Intermediate Range Clutch
6. High-Range Clutch
7. Low-Range Clutch
8. Low-Range Sun Gear
9. Low-Range Planetary Carrier
10. Transfer Drive Gear
11. Transfer Idler Gear
12. Rear Output
13. Transfer Driven Gear
14. Front Output
15. Low-Range Ring Gear
16. High-Range Sun Gear
17. High-Range Ring Gear
18. High-Range Planetary Carrier
19. Intermediate-Range Clutch Hub
20. Forward-Range Planetary Carrier
21. Forward-Range Ring Gear
22. Reverse-Range Ring Gear
23. Input
24. Torqmatic Converter
25. Selector Valve Body Assembly

fore, the planetary pinions mechanically multiply the torque and drive their carrier counterclockwise.

4. Intermediate-Forward Range Torque Path (Fig. 10)

a. In the intermediate range, there is no planetary action in the range gearing. The hydraulic-actuated intermediate range clutch locks the intermediate-range clutch drum, the clutch hub, and the high-range carrier together. The intermediate-range clutch drum is splined to the forward-range planetary carrier which is the input to the range gearing. The intermediate range clutch hub is splined to the transmission shaft assembly. Therefore, the input torque to the range gearing is transmitted directly to the shaft assembly which is driven counterclockwise. The resulting gear reduction in this range is 2.90:1.

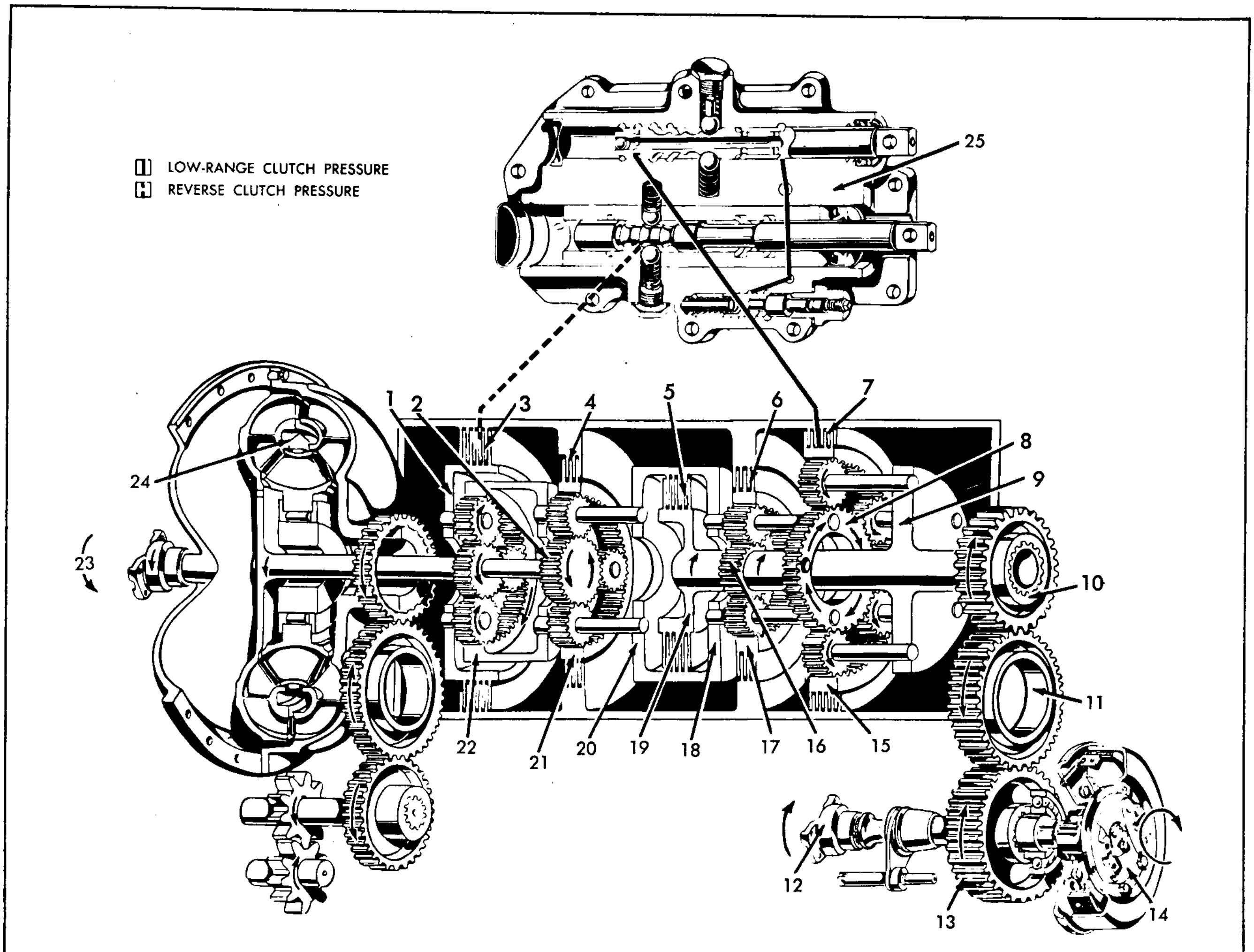

Fig. 12 — Torque Path — Reverse Low Range

1. Reverse-Range Planetary Carrier
2. Forward-Reverse Range Sun Gear
3. Reverse-Range Clutch
4. Forward-Range Clutch
5. Intermediate Range Clutch
6. High-Range Clutch
7. Low-Range Clutch
8. Low-Range Sun Gear
9. Low-Range Planetary Carrier
10. Transfer Drive Gear
11. Transfer Idler Gear
12. Rear Output
13. Transfer Driven Gear
14. Front Output
15. Low-Range Ring Gear
16. High-Range Sun Gear
17. High-Range Ring Gear
18. High-Range Planetary Carrier
19. Intermediate-Range Clutch Hub
20. Forward-Range Planetary Carrier
21. Forward-Range Ring Gear
22. Reverse-Range Ring Gear
23. Input
24. Torqmatic Converter
25. Selector Valve Body Assembly

b. The engine torque is transmitted through the converter to the converter shaft assembly. The forward and reverse-range sun gear, splined to the converter shaft assembly, drives the forward-range planetary pinions. The forward-range ring gear is held stationary by the hydraulic-actuated forward clutch. Therefore, the planetary pinions mechanically multiply the torque and drive the carrier counterclockwise.

5. High-Forward Range Torque Path
(Fig. 11)

a. The forward-range carrier transmits the torque to the intermediate-range clutch drum which is splined to the high-range carrier. The high-range ring gear is held by the hydraulic-actuated, high-range clutch. The high-range carrier, therefore, drives the high-range sun gear, which is splined to the transmission shaft assembly.

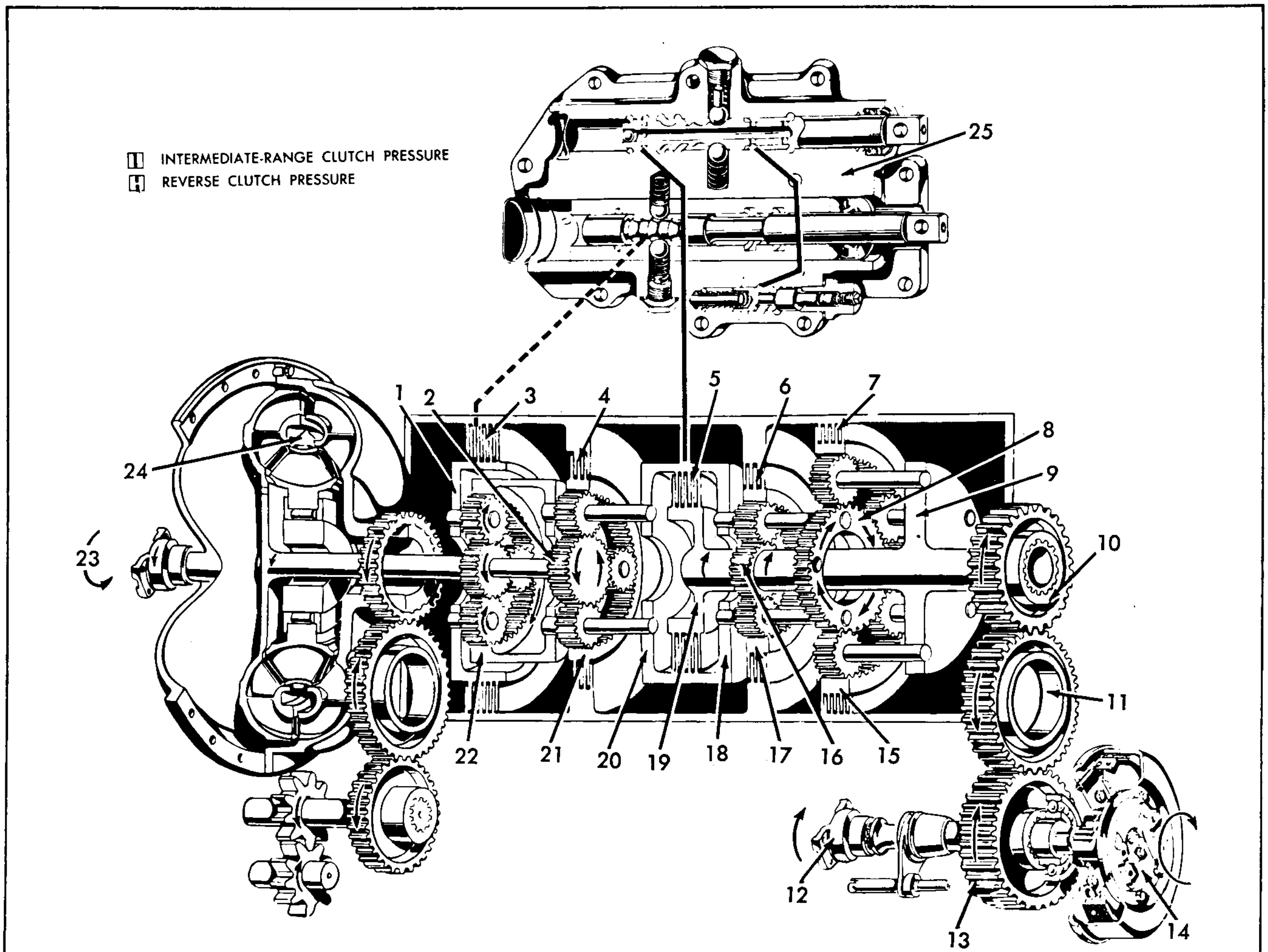

Fig. 13 — Torque Path — Reverse Intermediate Range

1. Reverse-Range Planetary Carrier
2. Forward-Reverse Range Sun Gear
3. Reverse-Range Clutch
4. Forward-Range Clutch
5. Intermediate-Range Clutch
6. High-Range Clutch
7. Low-Range Clutch
8. Low-Range Sun Gear
9. Low-Range Planetary Carrier
10. Transfer Drive Gear
11. Transfer Idler Gear
12. Rear Output
13. Transfer Driven Gear
14. Front Output
15. Low-Range Ring Gear
16. High-Range Sun Gear
17. High-Range Ring Gear
18. High-Range Planetary Carrier
19. Intermediate-Range Clutch Hub
20. Forward-Range Planetary Carrier
21. Forward-Range Ring Gear
22. Reverse-Range Ring Gear
23. Input
24. Torqmatic Converter
25. Selector Valve Body Assembly

Since the high-range ring gear is held, and the high-range planetary carrier is driving the high range sun gear counterclockwise, the planetary action results in an overdrive condition. The overall gear reduction is 1.00:1.

b. The engine torque is transmitted through the converter to the converter shaft assembly. The forward and reverse-range sun gear, splined to the converter shaft assembly, drives the forward-range planetary pinions. The forward-range ring gear is held stationary by the hydraulic-actuated forward clutch. Therefore, the planetary pinions mechanically multiply the torque and drive their carrier counterclockwise.

6. Low-Reverse Range Torque Path (Fig. 12)

a. The intermediate-range clutch drum, splined to the forward-range planetary carrier, transmits the torque from the forward-range planetary carrier to the high-range

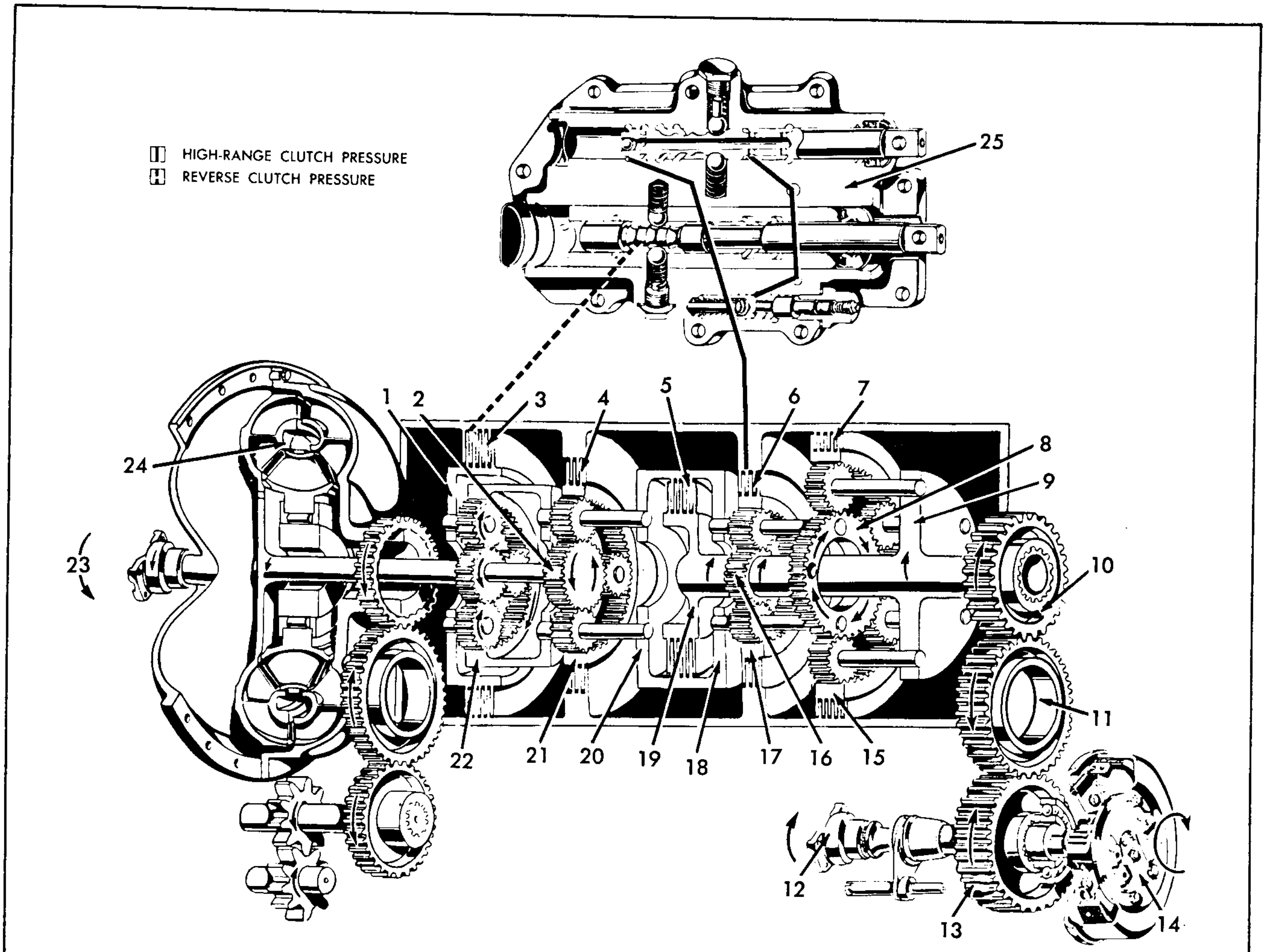

Fig. 14 — Torque Path — Reverse High Range

1. Reverse-Range Planetary Carrier
2. Forward-Reverse Range Sun Gear
3. Reverse-Range Clutch
4. Forward-Range Clutch
5. Intermediate Range Clutch
6. High-Range Clutch
7. Low-Range Clutch
8. Low-Range Sun Gear
9. Low-Range Planetary Carrier
10. Transfer Drive Gear
11. Transfer Idler Gear
12. Rear Output
13. Transfer Driven Gear
14. Front Output
15. Low-Range Ring Gear
16. High-Range Sun Gear
17. High-Range Ring Gear
18. High-Range Planetary Carrier
19. Intermediate-Range Clutch Hub
20. Forward-Range Planetary Carrier
21. Forward-Range Ring Gear
22. Reverse-Range Ring Gear
23. Input
24. Torqmatic Converter
25. Selector Valve Body Assembly

planetary carrier. The low-range sun gear, which is attached to the high-range planetary carrier, drives the low-range planetary pinions. The low-range ring gear is held stationary by the hydraulic-actuated low-range clutch. At this point the torque is transferred from the low-range sun gear to the low-range planetary pinions where it is further multiplied mechanically. The pinions transmit the torque to their carrier, which is splined to the transmission shaft assembly, clockwise. The overall gear reduction is 7.55:1 in this range.

b. The engine torque is transmitted through the converter to the converter shaft assembly. The forward and reverse-range sun gear, splined to the converter shaft assembly, drives the reverse-range planetary pinions. The pinions, in turn drive the reverse-range ring gear. The reverse-range planetary carrier is attached to the reverse-range clutch hub which is held stationary by the hydraulic-actuated reverse clutch. The planetary action here results in less speed, more torque, and a rotation opposite to the rotation in forward. The ring gear now transmits the torque to, and drives, the forward-planetary carrier clockwise.

7. **Intermediate-Reverse Range Torque Path** (Fig. 13)

   a. In the intermediate range, there is no planetary action in the range gearing. The hydraulic-actuated, intermediate-range clutch locks the intermediate-range clutch drum, the clutch hub, and the high-range planetary carrier together. The intermediate-range clutch drum is splined to the forward-range carrier which is the input to the range gearing. The intermediate-range clutch hub is splined to the transmission shaft assembly. Therefore, the input torque to the range gearing is transmitted directly to the transmission shaft assembly, which is driven clockwise. The total gear reduction in this range is 2.81:1.

   b. The engine torque is transmitted through the converter to the converter shaft assembly. The forward and reverse-range sun gear, splined to the converter shaft assembly, drives the reverse-range planetary pinions. The pinions, in turn, drive the reverse-range ring gear. The reverse-range planetary carrier is attached to the reverse-range clutch hub which is held stationary by the hydraulic-actuated, reverse-range clutch. The planetary action here results in less speed, more torque, and a rotation opposite to the rotation in forward. The ring gear now transmits the torque to, and drives the forward planetary carrier clockwise.

8. **High-Reverse Range Torque Path** (Fig. 15)

   a. The forward-range planetary carrier transmits the torque to the intermediate-range clutch drum which is splined to the high-range planetary carrier. The high-range ring gear is held stationary by the hydraulic-actuated high-range clutch. The high-range planetary carrier, therefore, drives the high-range sun gear which is splined to the transmission shaft assembly. Since the high-range ring gear is held, and the high-range carrier is driving the high-range sun gear, the planetary action results in an overdrive condition. The transmission shaft assembly is driven clockwise with an overall gear reduction of 0.97:1.

   b. The engine torque is transmitted through the converter to the converter shaft assembly. The forward and reverse-range sun gear, splined to the converter shaft assembly, drives the reverse-range planetary pinions. The pinions, in turn, drive the reverse-range ring gear. The reverse-range planetary carrier is attached to the reverse-range clutch hub which is held stationary by the hydraulic-actuated, reverse-range clutch. The planetary action here results in less speed, more torque, and rotation opposite the rotation in forward. The reverse-range ring gear now transmits the torque to, and drives the forward-range planetary carrier clockwise.

3. PREVENTATIVE MAINTENANCE

A. Simple Maintenance

Like all of the mechanical equipment, your transmission will need attention and servicing. Routine checks will help to prevent downtime. The operator can aid in preventive maintenance by occasionally reading the gauges that are provided to indicate the functioning of the transmission. Because the transmission operates *in* oil and *by* oil, most of the maintenance is concerned with oil replenishment and oil *cleanliness.*

B. Transmission Gauges on the Instrument Panel

The instrument panel contains two gauges pertaining to the transmission. One is the transmission oil pressure gauge, which indicates the clutch pressure (140-150 PSI). The other is the converter "out" temperature (which should never be allowed to go above 250° F. maximum).

The transmission oil pressure gauge measures the main system (clutch) pressure. It should read 140 to 150 P.S.I. any time that the engine is running. If the pressure consistently drops below 140 P.S.I. with any one of the five clutches engaged, it may allow the clutch to slip and overheat.

The converter "out" temperature gauge measures the temperature of the hydraulic oil as it leaves the converter, and before it reaches the external cooling radiator. This temperature should never be allowed to go above 250° F. maximum. If it should exceed this maximum, stop the machine, shift to neutral, and run the engine at ⅓ throttle. The temperature should drop rapidly (2 to 3 minutes) to approximately the engine water temperature (170° - 190° F.). If the temperature does not drop, stop the engine immediately. The cause should then be determined and corrected.

Ordinarily, the converter "out" *pressure* reading is not required during operation. Therefore, no gauge is provided on the instrument panel. The reading may be obtained by installing a pressure gauge in place of the converter "out" temperature sender, located at the converter check point (Fig. 2). The pressure is specified at 25 P.S.I. minimum at full throttle, converter stall; and 65 P.S.I. maximum at full throttle, no load.

CAUTION: *Do not stall the converter longer than 30 seconds at a time when observing this pressure.*

C. Maintenance Intervals and Precautions

1. Intervals

The type of service and the operating conditions will determine the maintenance intervals. Refer to Operating Instructions and Field Maintenance Manual. However, it is well to check the hydraulic system daily, or at the end of each shift. At the same time, check for oil leaks.

2. Keeping the Oil Clean

Because the hydraulic system is the "heart" of your transmission, it is especially important that the oil be kept clean. The area around the oil filler hole must be clean, and oil containers must be kept free from mud, dirt, and other harmful matter. Refer to Par. F, in this Topic.

3. Keeping Oil Breather Clean

a. The oil breather should be checked regularly and as frequently as necessary, depending upon operating conditions.

b. Loader operation with a clogged breather allows hot, moist air in the transmission to condense when the equipment cools, causing the oil to oxidize. The resulting varnish and sludge can cause the valves to stick, and plug the orifices, the filters, and the oil screens.

D. Checking the Oil Level

1. Cold Check

The cold check (engine not running) is made to insure that there is sufficient oil in the hydraulic system before starting the engine — especially if the equipment has been standing idle for a long period. The oil level should be even with the oil level plug (Fig. 1 and 15).

2. Hot Check

Check the level of the oil in the transmission as follows:

a. Checking the oil level should be done with the engine running at 1,000 R.P.M. with the oil at operating temperature, and with the transmission in the neutral range.

b. Check the hydraulic system oil level at the transmission oil level plug, located on the left side of the transfer gear housing assembly (Fig. 1 and Fig. 16). With the oil level plug removed, oil in the transmission sump should be level with or should flow from the oil level hole. If the oil does not run out from the hole, add oil until the oil runs out freely.

E. When to Change the Oil

1. Oil Capacity

The hydraulic system oil capacity of the transmission is 8.5 gallons (US) initial fill and approximately 7.25 gallons refill.

2. When to Change the Oil

Oil should be changed in the hydraulic system every 1,000 hours of operation, or more often, depending upon the operating conditions. Also, the oil in the system must be changed whenever the oil shows traces of dirt, or the effects of high operating temperature evidenced by discoloration or strong odor. If the oil shows metal contamination, the system must be thoroughly cleaned. Refer to paragraph 4, below in this Topic.

3. When to Change the Filters

The hydraulic system filter should be replaced with every oil change, and the strainer should be cleaned with every oil change.

4. Metal Contamination of the Oil

If the oil in the hydraulic system becomes contaminated with metal particles, all of the components of the hydraulic system — the transmission, the torque converter assembly, the oil lines, and the passages, the sump, the filter, the strainer, the cooler, the valves and the oil pumps — must be thoroughly cleaned. This usually means disassembly of the components. (Refer to Topic 4.)

F. Changing the Oil

1. Hydraulic System

The oil should be warm when draining the oil from the hydraulic system. All filters, the screens, and the strainers should be replaced or cleaned. Oil should be examined for metallic contamination and evidence of high temperature operation.

2. Draining of the Transmission

Drain the transmission as follows:

a. Remove the drain plug from the front of the transfer gear housing (Fig. 2) and allow the oil to drain.

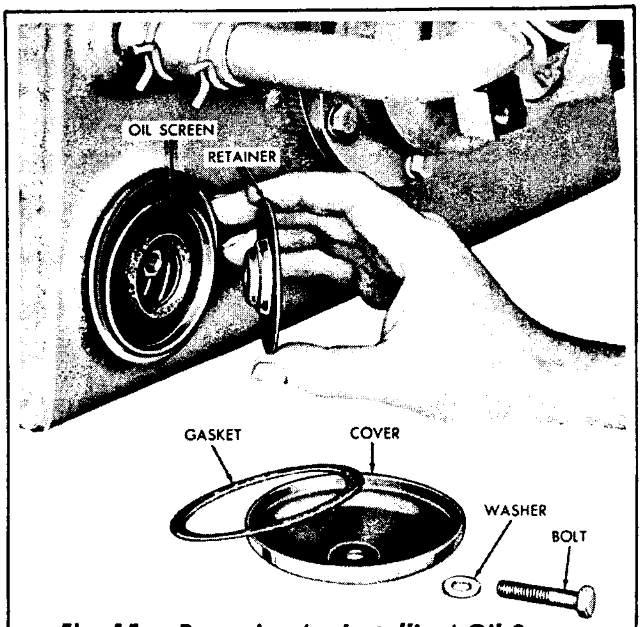

Fig. 15 — Removing (or Installing) Oil Screen Components

b. Remove the oil screen from the transfer gear housing (Fig. 15). Clean the oil screen with a solvent, using a soft-bristle brush, and reinstall.

c. Reinstall the drain plug in the transfer gear housing.

3. Filling of the Transmission

a. Remove the pipe plug from the oil filler line (Fig. 1).

b. Fill the transmission, through the filler line, with 4 to 5 gallons of the specified lubricant (Type C-1 Transmission Oil).

c. Start the engine and allow it to run at idling speed with the transmission in neutral range.

d. After the engine has been running at idling speed for at least two minutes, add more of the specified oil to bring the oil up to the proper oil level. (Refer to Subject D, in this Topic.)

G. Checking the Main Oil Pressure

With the transmission in neutral range, and with the parking brake applied, allow the engine to operate at 1,000 R.P.M. Read the oil pressure. The main-oil pressure check can also be made as follows:

1. Install a pressure gauge at the main-oil pressure check point (Fig. 2).

2. Start the engine, and let it run at idling speed with the transmission in neutral range to bring the transmission oil to operating temperature (170° - 190° F.).

3. Shift the transmission into each range and direction. As the transmission is shifted, observe the main-oil pressure gauge reading in each range. The pressure readings should not be less than 140 P.S.I. for any range.

4. If the main-oil pressure is less than minimum for any range, refer to Topic 9.

H. Checking the Oil Temperature

1. Out Temperature

The maximum converter "Out" oil temperature is 250° F. This temperature reading can be taken at the converter oil temperature gauge on the instrument panel.

2. Checking for Locked Stators

If it should become necessary to check for locked stators by observing the temperature drop rate, increase the converter "Out" temperature to 230° F., using the following procedure:

a. Start the engine, and let it run at idling speed with the transmission in the neutral range to bring the transmission and engine up to operating temperatures (170°-190° F.).

b. Next, block the wheels securely. But, do not apply the hydraulic brakes.

c. Shift the transmission into high range, forward direction, and increase the engine speed to full throttle.

d. When the converter "Out" temperature reaches 230° F., shift the transmission to the neutral range, releasing the throttle momentarily when shifting. *Immediately* check the rate of temperature drop. The temperature should start to drop within 15 seconds. A slow temperature drop rate probably indicates that stator is locked. A rapid temperature drop rate indicates normal stator operation.

I. Converter Stall Check

The stall check determines whether or not the engine, and the converter in the transmission, are functioning satisfactorily as a unit. This can be checked as follows:

1. Start the engine and let it run at idling speed with the transmission in the neutral range to bring the transmission and engine up to operating temperatures (170°-190° F.).

2. Next, block the wheels securely. But, do not apply the hydraulic brake.

3. Shift the transmission into high range, forward direction, and increase the engine speed to full throttle. Do not permit the converter "Out" temperature to exceed 250° F.

4. Record the engine speed and converter "Out" pressure. The converter "Out" pressure should be at least 25 P.S.I. If the pressure is not at least 25 P.S.I., refer to Topic 9.

J. Checking and Adjusting the Linkage

1. General

Described below are the checks and adjustments of the range selector valve linkage. For the forward and reverse-range valve linkage, the same procedure will generally apply.

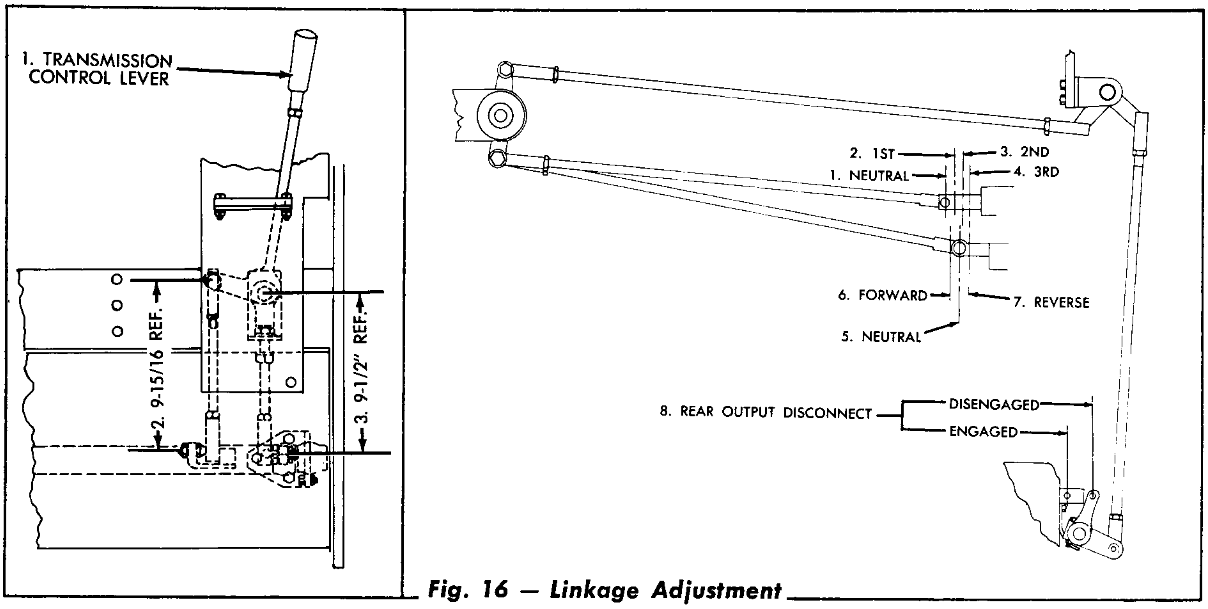

Fig. 16 — Linkage Adjustment

2. Checking the Linkage

a. Before checking the transmission range selector valve linkage, lubricate the linkage connection between the range selector valve assembly and at the shift levers.

b. With the engine stopped, move the range selector valve into each range position. The lever should move freely, but with a definite "detent" feel, as it is moved from one range position to the next.

c. Check the shifting control linkage for bent, or excessively worn parts. Straighten or replace the parts as necessary.

3. Adjusting the Linkage

a. Move the range selector valve to the high-range poppet position, all the way into the valve body.

b. Disconnect the control linkage at the range selector valve. Check to see that both the range selector valve lever and range selector valve have remained in high-range position.

c. Check the alignment of the hole in the end of the range selector valve with the corresponding hole in the shifting control linkage. If the holes do not align, make the necessary adjustment in the linkage. (Fig. 17):

The two rods connecting the transmission shift lever with the shaft may be adjusted by loosening their jam nuts and turning the joint clockwise to decrease the rod length, or counterclockwise to increase it. After the transmission shift lever is installed, it should be centered, and should travel freely through the gated slot in the transmission control plate. Then, adjust the rods using the dimensions in Fig. 16 as a reference.

The axle disconnect lever should travel far enough to engage, or disengage, the axle disconnect plunger without striking its guide plate. Then adjust the rods (Fig. 16).

Connect the linkage and the selector valve, and repeat the above procedures in all of the range positions. The only difference will be that the range selector valve lever, and the range selector valve, will be moved into the range that is to be checked and adjusted.

4. Shifter Fork Lever Adjustment

a. Push the shifter fork shaft into the transmission as far as possible. This is the engaged position for the disconnect clutch.

b. Measure from the center of the hole in the shaft to the housing surface adjacent to the shaft. The distance should be 5/8" minimum. If an adjustment is necessary, turn the shifter fork shaft, which is threaded, to obtain the correct adjustment.

c. Pull the shifter fork shaft out of the transmission as far as possible. This is the disengaged position for the disconnect clutch.

d. Repeat the measurement made in Step 2. The distance should be 2 3/8" maximum.

K. Troubleshooting

Refer to the "Troubleshooting" Section and Topic 9 in this section which will help you to locate the source of transmission trouble. A chart is prepared to cover first the troubles that may occur due to improper maintenance. Remember that the whole power package — engine and transmission — must be considered when running down the source of trouble.

The schematics illustrated in Topic 2, show how the oil flows in neutral, low-forward range, intermediate-forward range, high-forward range, low-reverse range, intermediate-reverse range, and high-reverse range. The schematics also show the arrangement of the pumps, the valves, the oil filter, the oil cooler, the torque converter and the clutches.

These schematics may be used in troubleshooting any hydraulic malfunctions which may arise. By studying the schematic which applies to the particular area in which there seems to be trouble, it may be possible to correct, or repair quickly and easily, any malfunction which may occur in the hydraulic system.

4. CLEANING AND INSPECTION

A. General

The following is general information on cleaning and inspection procedures, and wear limits. When handling the transmission parts, handle them with care. Nicks, dents or scratches caused by careless handling can cause subsequent transmission failure.

NOTE: *Each transmission has part numbers and a serial number. When ordering parts, always include the transmission serial number in addition to the part numbers. Refer to your parts book when ordering parts. Do not use the exploded view reference numbers in this manual to order the parts you need.*

It is recommended that all of the gaskets and the seal rings be replaced with new gaskets and seal rings when they are removed from the transmission. If the transmission has been overheated, replace all of the springs.

Inspect all of the parts each time that the transmission is disassembled. Metal in the oil indicates that some part has failed. If metal particles are found, both the transmission and the converter must be thoroughly cleaned and inspected as follows:

1. All metallic parts of the transmission, *except the bearings,* should be thoroughly cleaned with a dry-cleaning solvent, volatile mineral spirits, a paint thinner, or by the steam-cleaning method. Do not use a caustic soda solution for steam cleaning.

2. All parts (except the bearings) should be dried with compressed air. Steam cleaned parts should be oiled immediately after drying.

3. Clean the oil passages by working a piece of wire back and forth through the passages, and then flushing them with a clean solvent or paint thinner. Dry the passages with compressed air.

4. Examine all the parts, especially the oil passages, after cleaning to be sure that they are entirely clean. Reclean them if necessary.

B. Tools and Equipment

1. Tools

A minimum amount of special and improvised tools

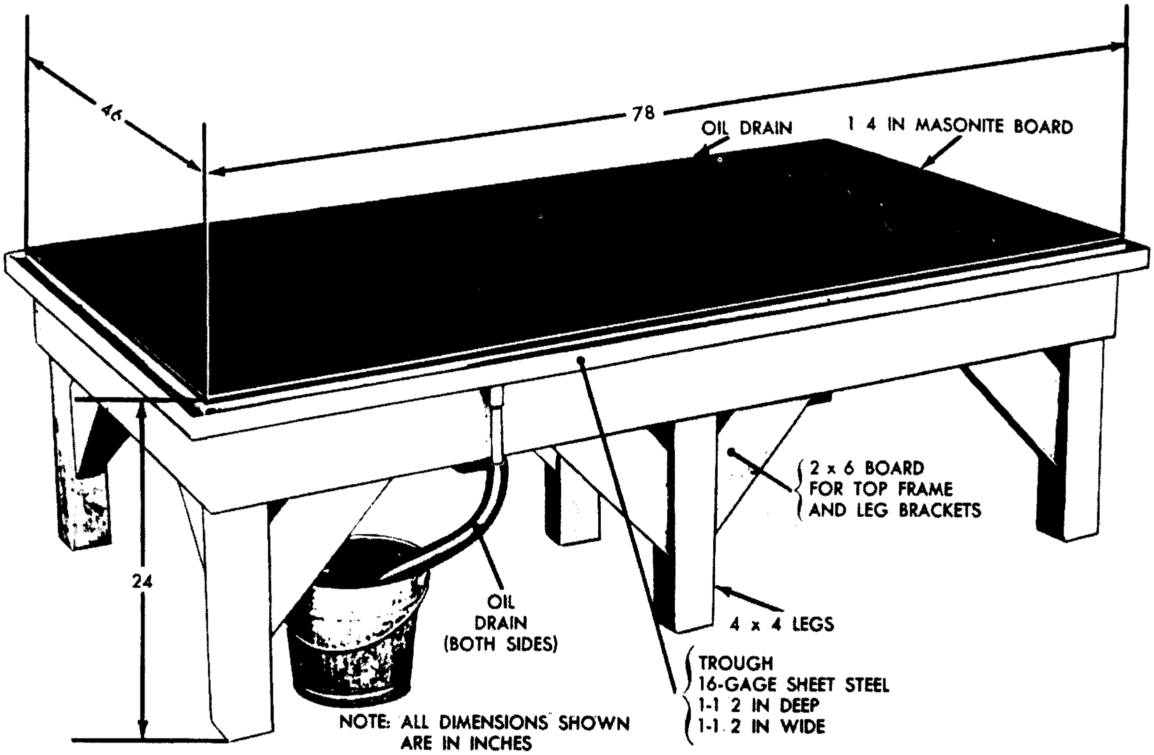

Fig. 17 — Disassembly and Assembly Table

are required for overhaul procedures. The tools and their uses are listed below:

a. A sling for lifting the transmission and its components.

b. A slide hammer remover and adapter for removing the implement pump idler gear spindle.

c. A special tool for the removal of the transfer gear idler spindle. Refer to Topic 10.

2. Equipment

The equipment outlined below should be available before removal and disassembly is started:

a. Proper hand tools and receptacles for small parts.

b. A suitable hoist of one-ton capacity.

c. An arbor press.

d. A disassembly and assembly table is essential for proper and efficient overhaul procedures. Refer to Fig. 17.

e. A container for cleaning parts and a supply of mineral spirits or dry-cleaning solvent.

C. Bearings

1. Cleaning the Bearings

Because dirt or grit in the ball bearings is usually responsible for bearing failures, it is important that they are kept clean during their installation and removal. Clean the bearings as follows:

Thoroughly wash the bearings in a dry-cleaning solvent, volatile mineral spirits, or a paint thinner. If the bearings are particularly dirty, or filled with hardened grease, soak them in the cleaning solvent. Then oil the bearings with Type C-1 transmission oil.

NOTE: *Never dry the bearings with compressed air. Do not spin the bearings while they are not lubricated.*

2. Inspecting the Bearings

a. Inspect the bearings for roundness. Replace a bearing if its rotation is rough after cleaning and oiling.

b. Inspect the races for scores, pits, scratches, cracks, or chips. Look for excessive wear on the rollers and the balls. Replace the bearing if these defects are found.

c. Inspect the housing and shaft of a defective bearing for grooved, burred, or gaulled conditions. These indicate that the bearing housing has been turning. If the damage cannot be repaired with crocus cloth, replace the damaged part.

NOTE: *When installing a bearing on a shaft, heat the bearing to 300° F. on an electric hot plate, or in an oil bath. Coat the mating surface with white lead. Use the proper size installation sleeve and an arbor press to seat the bearing. If an arbor press is not available, seat the bearing with a drift and a hammer, driving against the supported race.*

CAUTION: *If the bearing must be removed or installed without a sleeve, be careful to press only on the race that is adjacent to the mounting surface.*

D. Inspecting the Cast Parts and the Machined Surfaces

Thoroughly inspect the cast parts and machined surfaces as follows:

1. Inspect the bores for wear, grooves, scratches, and dirt. Remove scratches and burrs with a crocus cloth. Remove any foreign matter. Replace the parts that are deeply grooved or scratched.

2. Inspect all of the oil passages for obstructions. If an obstruction is found, remove it with compressed air, or by working a wire back and forth through the passage, and flushing it out with a cleaning solvent.

3. Inspect the mounting faces for burrs, scratches, nicks, and foreign matter. Remove such defects with a crocus cloth or a soft stone. If the scratches are deep, replace the scratched part.

4. Inspect the threaded openings for damaged threads. Chase any damaged threads with the correct size tap.

5. Replace housings or other cast parts that are cracked.

6. Inspect all of the machined surfaces for damage that could cause oil leakage or other malfunction of the part. Rework, or replace, the damaged parts.

E. Inspecting the Bushings and the Thrust Washers

Inspect the bushings and the thrust washers as follows:

1. Inspect the bushings for roundness, scores, burrs, sharp edges, and evidence of overheating. Remove the scores with crocus cloth. Remove the burrs and the sharp edges with a scraper, or a knife blade. If the bushing is out-of-round, deeply scored, or excessively worn, replace it, using the proper size replacer.

   NOTE: *Sometimes it is necessary to cut out a damaged bushing. Be careful not to damage the bore into which the bushing fits.*

2. Inspect the thrust washers for distortion, scores, burrs and wear. Replace the thrust washer if it is damaged or worn. It is much less expensive to replace such parts than to replace the converter elements or the transmission gearing, which can fail due to damaged bearings, bushings, or thrust washers.

F. Inspecting Gears, Splined and Threaded Parts, Snap Rings and Springs

1. Gears

Inspect the gears as follows:

a. Inspect the gears for scuffed, nicked, burred, or broken teeth. If the defect cannot be removed with a soft stone, replace the gear.

b. Inspect the gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace the gear.

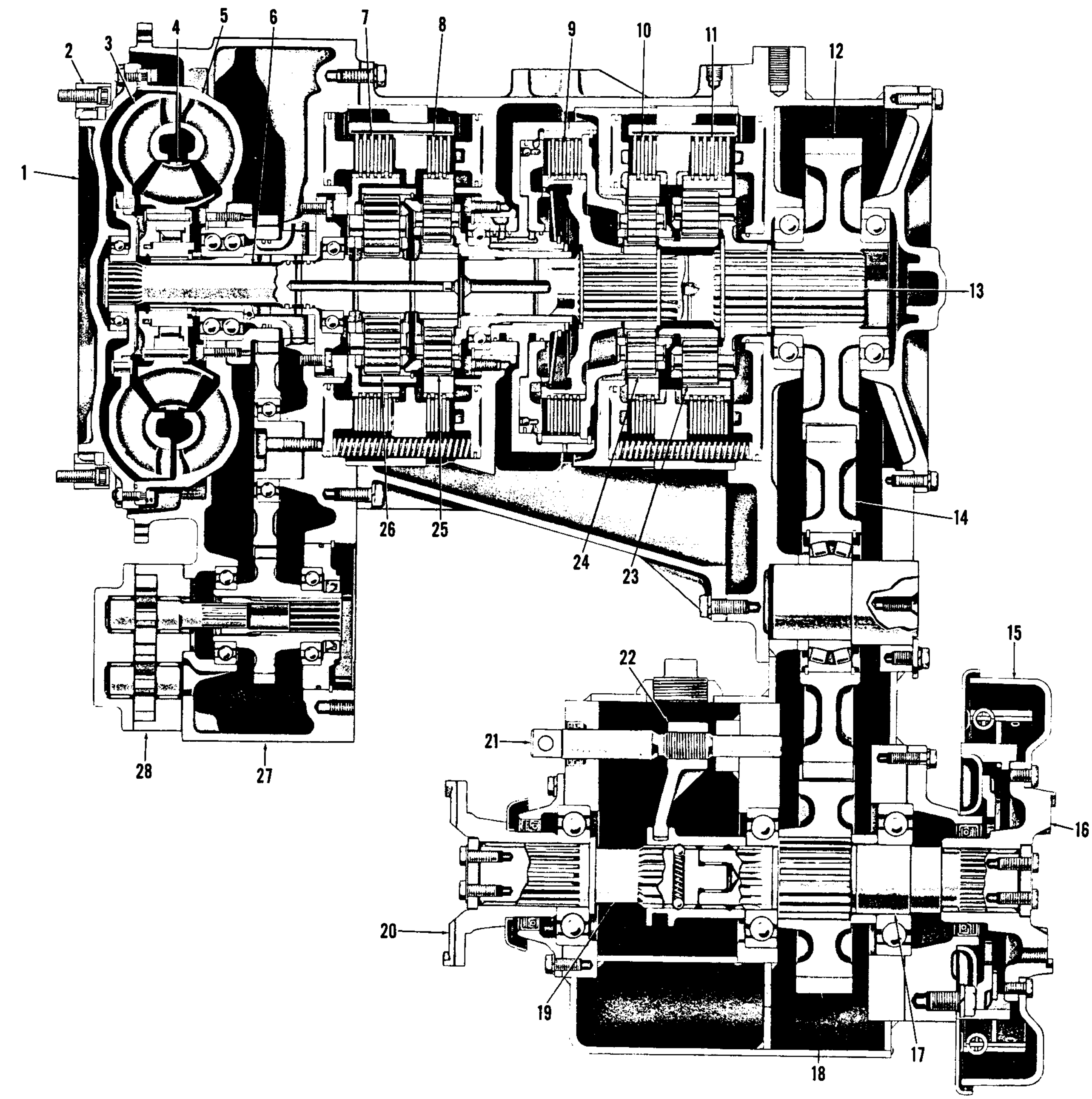

Fig. 18 — Cut-Away View of Transmission — Legend

1. Converter Pump Cover
2. Converter Drive Ring
3. Converter Turbine
4. Stator
5. Converter Pump
6. Converter Shaft
7. Reverse Clutch
8. Forward Clutch
9. Intermediate Range Clutch
10. High Range Clutch
11. Low Range Clutch
12. Transfer Drive Gear
13. Transmission Main Shaft
14. Transfer Idler Gear
15. Parking Brake
16. Front Output Flange
17. Front Output Shaft
18. Transfer Driven Gear
19. Rear Output Shaft
20. Rear Output Flange
21. Shifter Fork Shaft (Rear Output Disconnect)
22. Shifter Fork
23. Low Range Planetary Carrier
24. High Range Planetary Carrier
25. Forward Planetary Carrier
26. Reverse Planetary Carrier
27. Torque Converter Housing
28. Input Charging Oil Pump

c. Inspect the thrust faces of the gears for scores, scratches and burrs. Remove such defects with a soft stone. If the scores and the scratches cannot be removed with a soft stone, replace the gear.

2. Inspecting the Splined Parts

Inspect the splined parts for stripped, twisted, chipped, or burred splines. Remove the burrs with a soft stone. Replace the part if other defects are found. Spline wear is not considered detrimental except where it affects tightness of fit of the splined parts.

3. Inspecting the Threaded Parts

Inspect the parts for burred, or damaged threads. Remove the burrs with a soft stone, or fine file. Replace the damaged parts.

4. Inspecting the Snap Rings

Inspect all of the snap rings for nicks, distortion, and excess wear. Replace the part if one of these defects is found. The snap ring must snap tight in its groove for proper functioning.

5. Inspecting the Springs

Inspect all of the springs for signs of overheating, permanent set, or wear due to their rubbing against adjacent parts. Replace the spring if any one of these defects is found.

G. General Torque Specifications

Unless otherwise specified, the torque specifications listed in the following chart will apply to all assembly procedures:

TORQUE CHART

Size	Threads Per Inch	Standard Heat Treated Capscrews	Special Heat Treated Capscrews, Allen Head Screws and Self-Locking Capscrews
1/4	20 28	6-8 8-10	9-11 10-12
5/16	18 24	15-18 17-20	17-20 19-23
3/8	16 24	26-32 33-40	36-43 41-49
7/16	14 20	42-50 50-60	54-65 64-77
1/2	13 20	67-80 83-100	81-97 96-115
9/16	12 18	85-100 100-120	103-123 122-146
5/8	11 18	117-140 134-160	164-192 193-225
3/4	10 16	180-210 215-250	284-325 337-385
7/8	9 14	315-360 372-425	490-550 575-650
1	8 14	445-500 535-600	685-770 830-925

NOTE: All torque values are given in lbs. ft.

5. REMOVAL AND INSTALLATION OF TRANSMISSION

A. General

This section contains general information on removal from and installation into the loader.

B. Removing the Transmission from the Drive Line

1. Preparation for Removal:
   Drain the transmission oil.
   (Refer to Topic 3, in this Section.)
   Drain the hydraulic tank.
   (Refer to "LOADER HYDRAULIC SYSTEM" Section.)

2. Removal Procedure:

a. Remove the hood and side panels.

b. Disconnect the battery cables and remove the battery box with the two batteries.

c. Remove the air cleaner from the side brace.

d. Remove the hydraulic tank compartment cover and disconnect the control linkage from the bell cranks.

e. Disconnect all hoses and tubes from the bottom of the hydraulic tank. Cap all the open lines.

f. Disconnect the parking brake.

g. Remove the rear axle disconnect linkage from the hydraulic tank mounting plate and the transmission.

h. Disconnect the dump and lift cylinder hoses from the side of the hydraulic tank. Cap the hoses. Remove the swivel elbows from the hydraulic tank and cap the tank openings.

i. Remove the engine compartment side braces.

j. Disconnect the voltage regulator wires. Remove the capscrews, lockwashers, and hex nuts that secure the upper rear stabilizer cross member and remove the cross member.

k. Remove the capscrews, lockwashers and hex nuts that hold the hydraulic tank to the tank mounting plate and remove the hydraulic tank with a suitable sling and hoist.

l. Remove the capscrews, lockwashers and hex nuts that secure the hydraulic tank mounting plate to the stabilizer and remove the mounting plate.

m. Disconnect the transmission control linkage from the selector valve. Disconnect the wires from the converter temperature sender and the main pressure sender. Remove the two transmission oil cooler lines from the top of the converter housing and cap all the open ends.

n. Disconnect the front and rear universal joints from the transmission output shafts.

o. Remove the capscrews and lockwashers that secure the transmission converter housing to the engine flywheel housing. NOTE: *It will be necessary to remove the transmission charging pump in order to remove all of* the converter housing capscrews.

p. Attach a sling and hoist of at least 1-ton capacity to the transmission using the tapped holes provided in the converter housing and the transfer gear housing.

q. Remove the capscrews, flatwashers, lockwashers and hex nuts that secure the transmission mounting brackets to the loader main frame. Remove the transmission by lifting it straight up and out of the loaders.

NOTE: *If overhead clearance is not sufficient to raise the transmission out of the loader an alternate method is to lower it and at the same time roll the transmission on its side on a suitable dolly or pallet for removal to the overhaul table.*

C. Installation of the Transmission in the Loader

1. Installation Procedure.

   a. Distribute a sufficient quantity of wheel bearing grease to fill the gear tooth spaces and the cavity formed by the flywheel and drive ring.

   CAUTION: *Do not use more grease than is required to fill any cavities outside the diameter of the drive ring teeth.*

   b. Attach a hoist and sling of at least 1-ton capacity to the transmission and lower it into its approximate position in the loader.

   c. Index the teeth in the drive ring with the teeth in the converter pump cover. Carefully secure the transmission to the engine flywheel housing with the mounting capscrews and lockwashers and torque to 30 to 35 lbs. ft.

   d. Remove the hoist and sling and install the mounting bracket capscrews, flatwashers, lockwashers and hex nuts that secure the transmission to the main frame mounting pads and torque to 168-178 lbs. ft. Install the converter charging pump.

   e. Connect the front and rear universal joints to their corresponding output shafts.

   f. Connect the two transmission oil cooler lines to the converter housing. Connect the wires to the main pressure sender and the converter temperature sender. Connect the clutch cut-off line. Connect the transmission control linkage to the control valve spools.

   g. Install the hydraulic tank mounting plate in the stabilizer and tighten the capscrews securely. Using a suitable hoist and sling lower the hydraulic tank into place on the mounting plate and bolt it in position.

   h. Connect all lines and hoses to their proper adapters on the bottom of the hydraulic tank.

   i. Install the upper rear stabilizer cross member and secure with its capscrews, lockwashers and hex nuts. Install the voltage regulator and connect the lead wires to their proper terminals.

   j. Install the engine compartment side braces.

   k. Install the rear axle disconnect linkage to the transmission and the hydraulic tank mounting plate. Reconnect the parking brake.

   l. Install the swivel elbows in the sides of the hydraulic tank. Connect the lift and dump cylinder hoses to the swivel elbows. CAUTION: *Position the hoses so that they do not rub, bind or chafe.*

   m. Install the air cleaner. Install the battery box and connect the battery cables. Connect the loader control linkage to the hydraulic tank mounted bellcranks. Adjust the linkage if necessary so that the boom and bucket levers are centered in their slots.

   n. Fill the hydraulic tank to the proper level on the dipstick with approved fluid. (Refer to Loader Hydraulic System Section.)

   o. Fill the transmission. (Refer to Topic 3, this Section.) CAUTION: *Do not operate the transmission without fluid in the hydraulic tank and do not start the engine without adequate fluid in the transmission.*

   p. Replace the hood and side panels. Replace the hydraulic tank cover. Replace the battery box cover. Carefully recheck the fluid levels of both the transmission and the hydraulic system before putting the loader to work.

6. TRANSMISSION REAR GROUP

A. General

While the rebuilding procedures in this Topic pertain to the Rear Group (Fig. 19) only, it is recommended that the entire Transmission be disassembled for cleaning and inspection whenever it is necessary to overhaul any of the groups.

Before attempting to disassemble the transmission, be sure that the oil is completely drained and that proper equipment is available. This equipment includes a hoist, hand tools, special tools, receptacles for small parts, lint free wiping cloths, a bench vise, and a heavy work table. Refer to Topic 4.

Be sure that the transmission and work table is clean and free of dirt and grease. Cleanliness is of major importance for the proper functioning of the transmission and for longer service life of the parts. Refer to Topic 4 before proceeding with the disassembly.

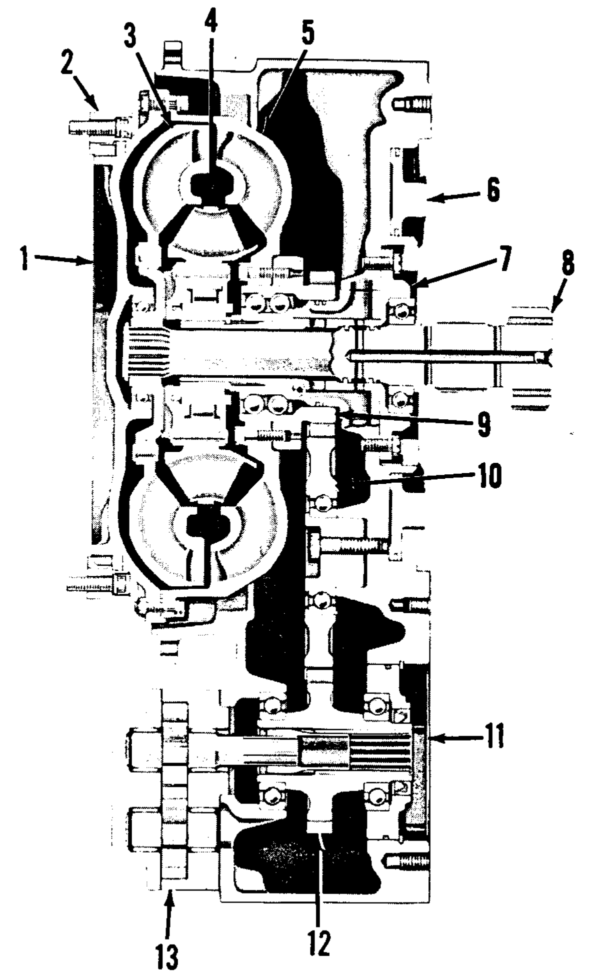

Fig. 19 — Transmission Rear Group

1. Converter Pump Cover
2. Converter Drive Ring
3. Converter Turbine
4. Stator
5. Converter Pump
6. Reverse Piston
7. Converter Ground Sleeve
8. Converter Turbine Shaft
9. Oil Pump and Implement Pump Drive Gear
10. Oil Pump and Implement Pump Drive Idler Gear
11. Torque Converter Housing
12. Oil Pump and Implement Pump Drive Driven Gear
13. Input Driven Charging Oil Pump

B. Rear Group, Disassembly

1. Attach a lifting sling to the transmission and lower it onto the work table, leveling it with wooden blocks.

2. Remove the input-charging oil pump and its gasket.

3. Remove the converter housing drain tube flange (Fig. 20). Remove the hose clamp. Remove, as a unit, the flange, the hoses, and the tube.

4. Remove the capscrews and lockwashers (Fig. 21) from the selector valve body and remove the valve and gasket. Remove the main pressure regulator valve body and gasket.

5. Flatten the corners of the lockstrip (Fig. 22). Remove the self-locking capscrews, the lock strip, and the flange retainer washer.

6. Using a puller (Fig. 23), remove as a unit, the parking brake drum and the front output flange. If necessary only for parts replacement, remove the self-locking capscrews and remove the flange from the drum.

7. Remove the brake return spring (Fig. 24) and the brake shoe assembly from the brake back plate.

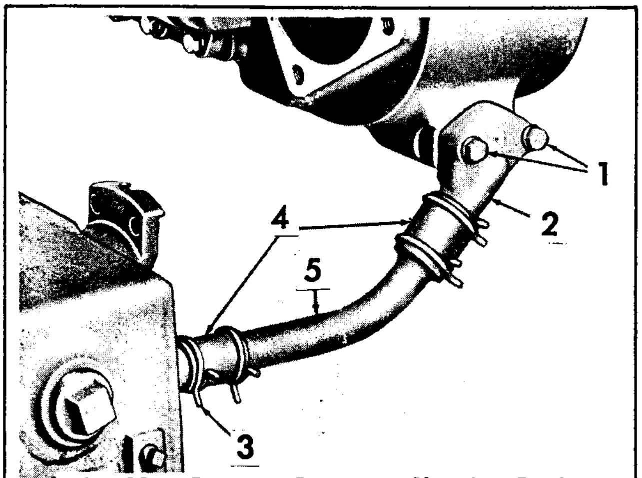

Fig. 20 — Remove Converter Housing Drain Tube Assembly

1. Capscrews and Lockwashers
2. Converter Housing Drain Tube Flange
3. Hose Clamp
4. Hoses
5. Tube

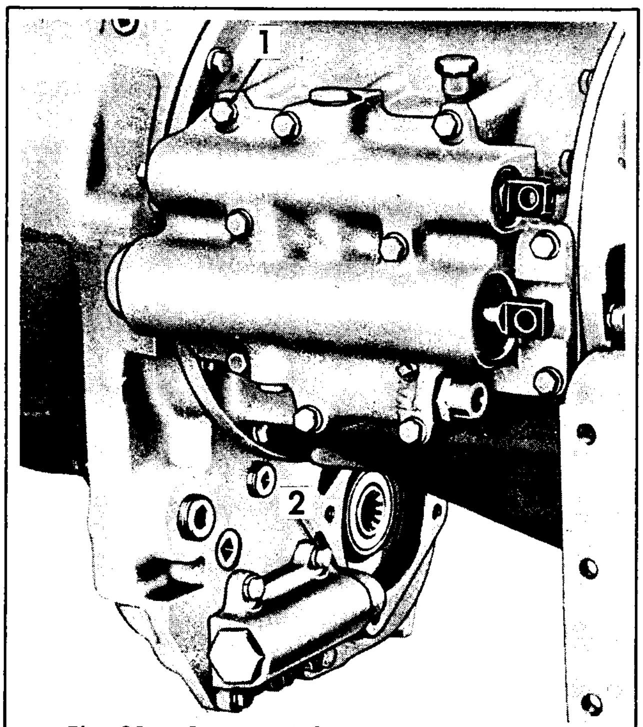

Fig. 21 — Remove Selector Valve Body and Main Pressure Regulator Valve Body

1. Capscrews and Lockwashers
2. Main Pressure Regulator Valve Body

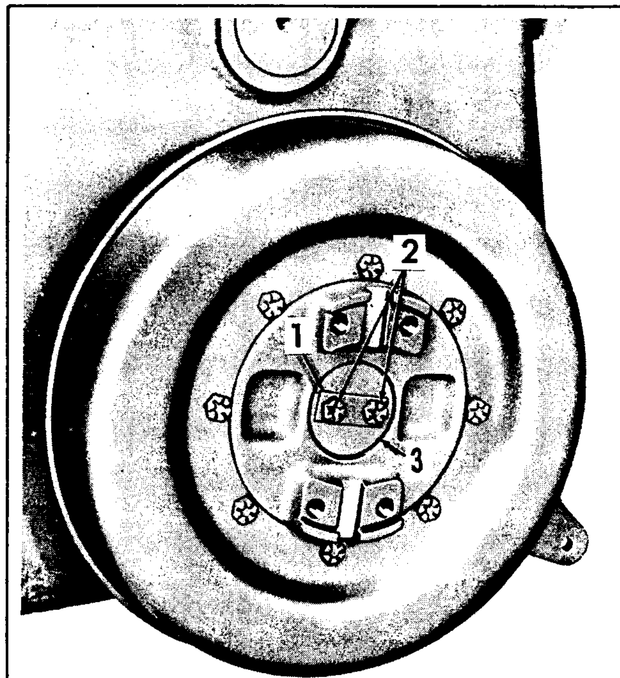

Fig. 22 — Remove Front Output Flange Retainer

1. Lock Strip
2. Self-Locking Capscrews
3. Flange Retainer Washer

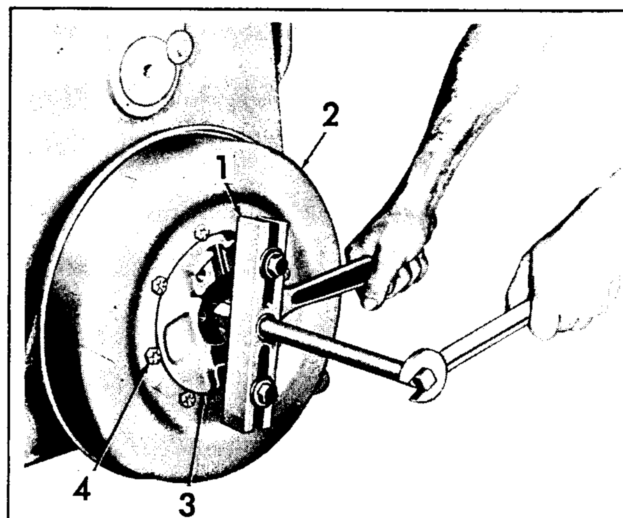

Fig. 23 — Using a Puller to Remove Parking Brake Drum

1. Puller
2. Parking Brake Drum
3. Front Output Flange
4. Self-Locking Capscrews

8. Remove the brake roller (Fig. 25) and the brake apply lever. Remove the capscrews and lockwashers and remove the back plate.

9. Attach a lifting sling to the rear of the transmission and position it so that it rests on its front surface. Block the transmission sufficiently high to clear the output shaft.

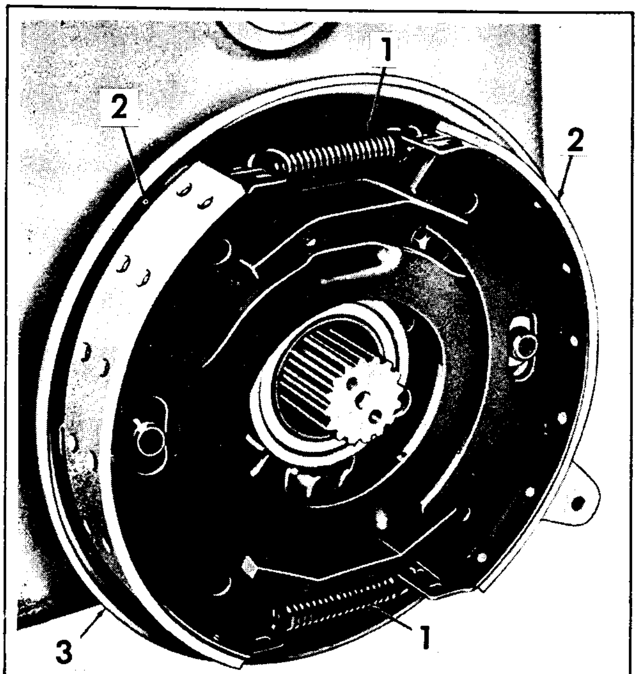

Fig. 24 — Remove Brake Shoe Assembly

1. Brake Return Springs
2. Brake Shoe Assembly
3. Brake Back Plate

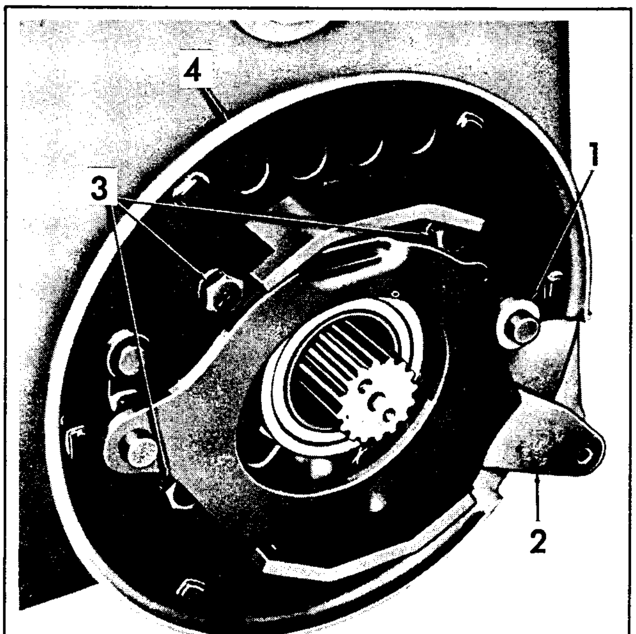

Fig. 25 — Remove Brake Back Plate Assembly

1. Brake Roller
2. Brake Apply Lever
3. Capscrews and Lockwashers
4. Back Plate

10. Using snap ring pliers, remove the snap ring (Fig. 26) from the converter shaft. Remove as a unit, the turbine and the bearing.

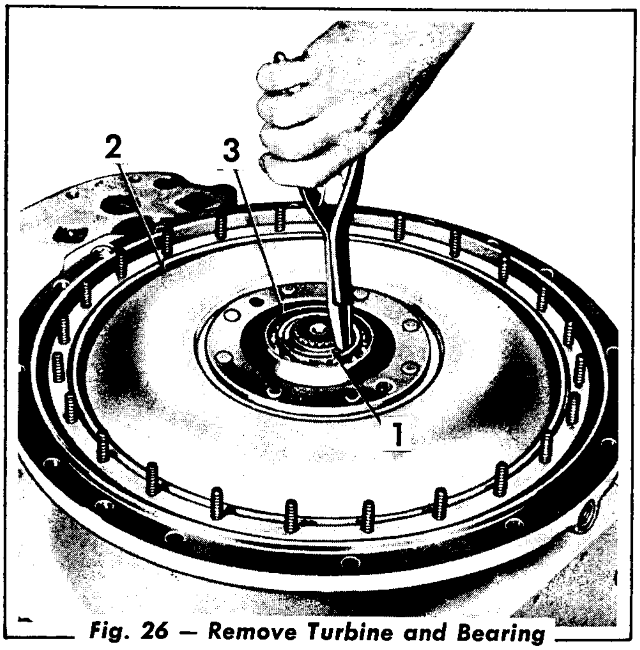

Fig. 26 — Remove Turbine and Bearing

1. Snap Ring
2. Turbine
3. Bearing

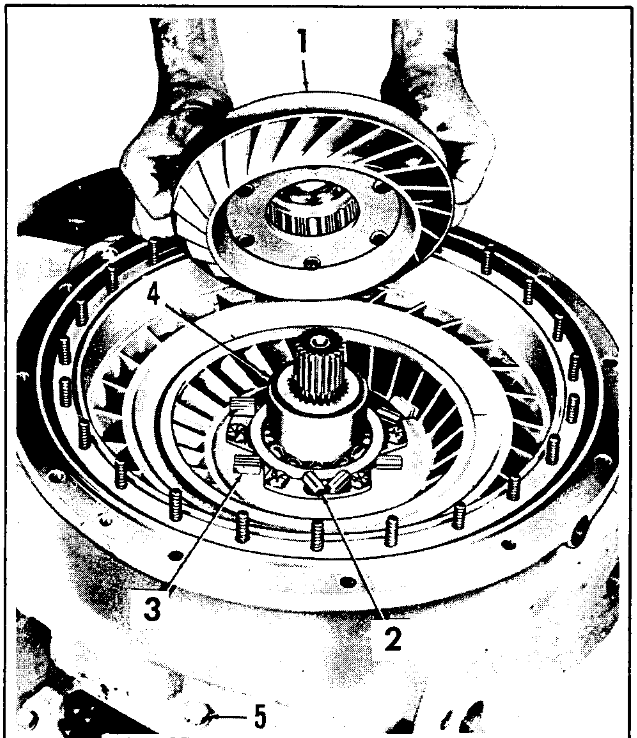

Fig. 27 — Remove Stator Assembly

1. Stator Assembly
2. Freewheel Rollers (10)
3. Freewheel Roller Springs (10)
4. Freewheel Roller Race
5. Capscrews and Lockwashers

If necessary, use wire lifting hooks under the outer circumference of the turbine.

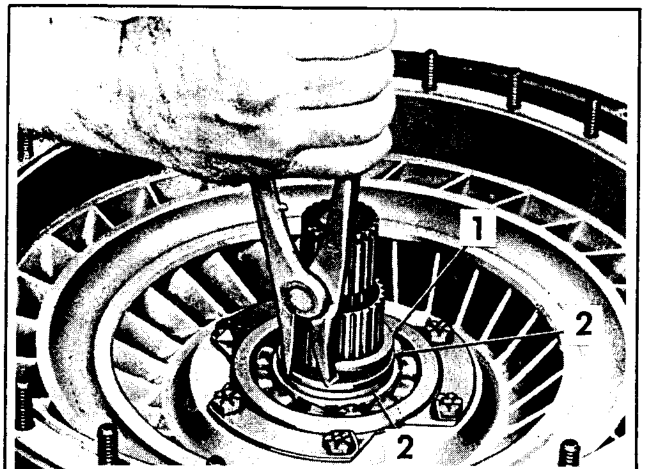

Fig. 28 — Remove Ground Sleeve Internal-Splined Spacers

1. Snap Ring
2. Internal-Splined Spacers (2)

11. Remove the stator assembly (Fig. 27), the ten freewheel rollers and the ten freewheel roller springs. Remove the freewheel roller race.

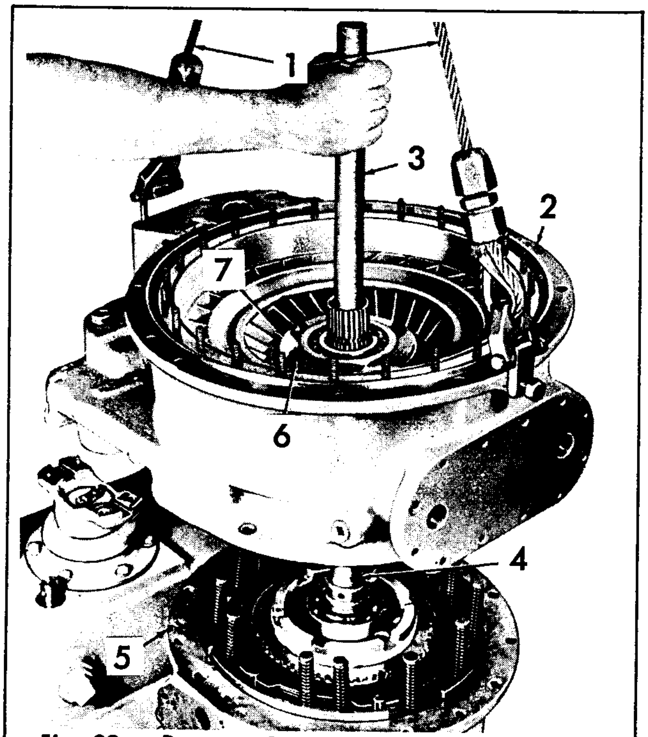

Fig. 29 — Remove Converter Housing Assembly

1. Lifting Sling
2. Converter Housing
3. Drift
4. Converter Shaft
5. Gasket
6. Self-Locking Capscrews
7. Lock Strips (2) and Bearing Retainers (3)

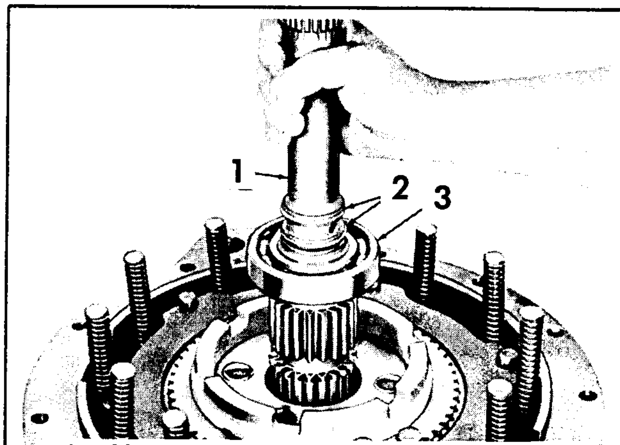

Fig. 30 — Remove Converter Shaft Assembly

1. Converter Shaft Assembly
2. Seal Rings (Hook Type)
3. Bearing

CAUTION: *Some of the rollers and springs may drop out when the stator is lifted.*

12. Using snap ring pliers, remove the snap ring (Fig. 28) from the converter ground sleeve. Remove the two internal-splined spacers.

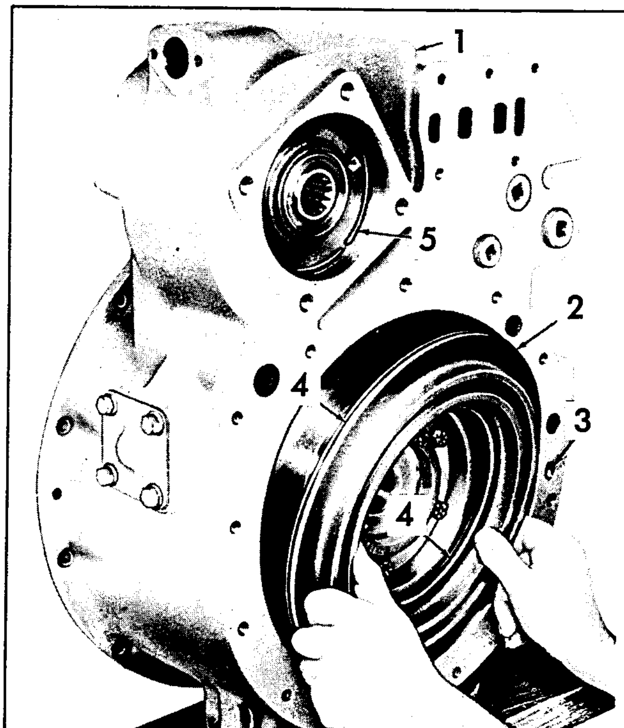

Fig. 31 — Remove Reverse Range Piston Assembly

1. Converter Housing Assembly
2. Reverse Range Piston Assembly
3. Piston Apply Hole
4. Piston Seals
5. Snap Ring

13. Remove the capscrews and lockwashers (Fig. 27) from the converter housing. Attach a lifting sling (Fig. 29) to the converter housing and raise the assembly. Use a drift to prevent the converter shaft from rising. Remove the gasket. Remove the self-locking capscrews, the two lock strips and the three bearing retainers.

14. Remove the converter shaft assembly (Fig. 30). Remove the hook type seal rings. If necessary for parts replacement, remove the bearing by pressing it toward the small end of the shaft.

15. Position the converter housing assembly (Fig. 31) on the oil cooler pad and remove the reverse range piston assembly.

    NOTE: *Use compressed air in the piston apply hole to loosen the piston.*

    Remove the piston seals and the snap ring.

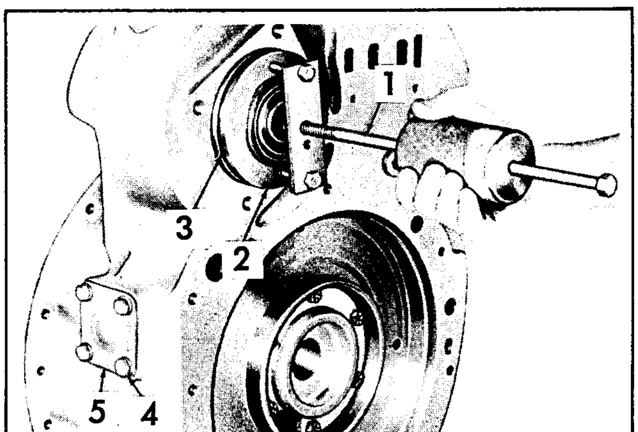

Fig. 32 — Remove Implement Pump Gear

1. Slide Hammer
2. Implement Pump Bearing Retainer, Bearings, and Gear
3. Seal
4. Capscrews and Lockwashers
5. Lube Valve Cover

16. Using a slide hammer (Fig. 32), remove as a unit the implement pump bearing retainer, the bearings, and the gear. Remove the seal. Remove the capscrews and lockwashers, and remove the lube valve cover.

17. Remove the gasket (Fig. 33), the pin, the washer, the lube pressure regulator valve

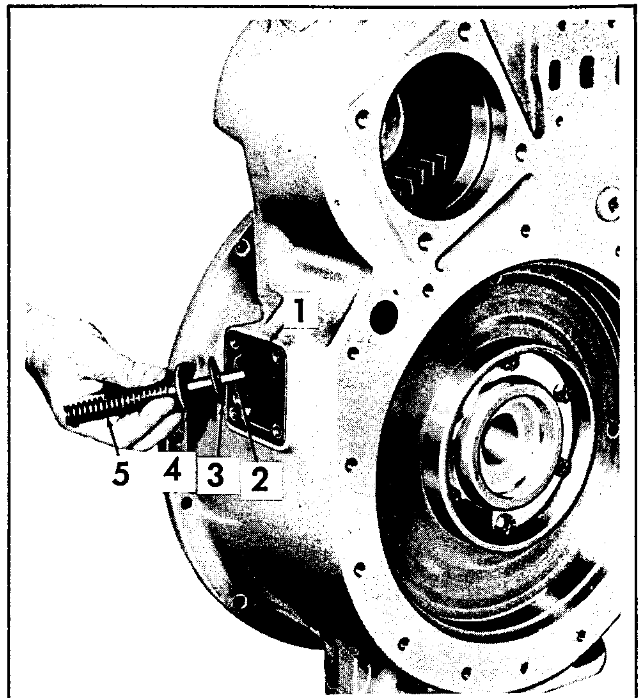

Fig. 33 — Remove Lube Pressure Regulator Valve

1. Gasket
2. Pin
3. Washer
4. Tube Pressure Regulator Valve
5. Valve Spring

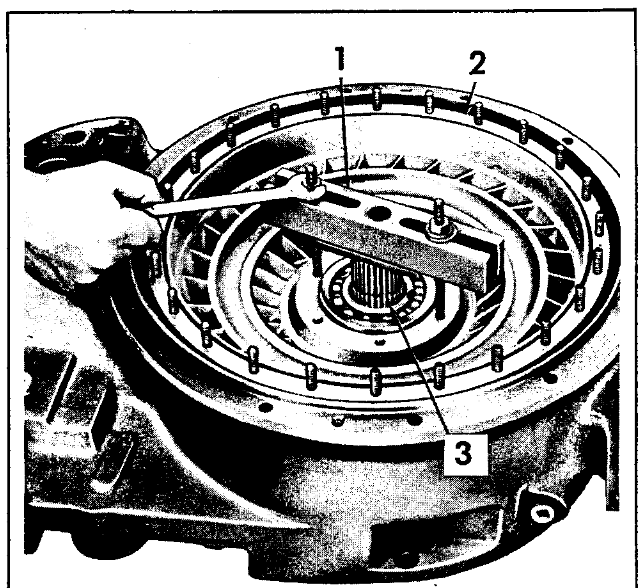

Fig. 34 — Remove Converter Pump and Bearing Assembly

1. Puller
2. Converter Pump and Bearing Assembly
3. Ground Sleeve

and the valve spring.

18. Position the converter housing on its front

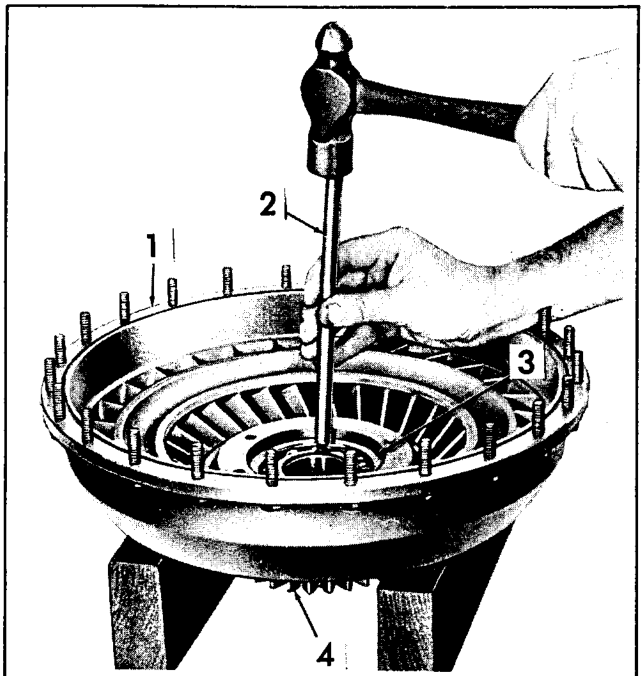

Fig. 35 — Remove Implement Pump Drive Gear from Converter Pump

1. Converter Pump Assembly
2. Drift
3. Bearing
4. Implement Pump Drive Gear

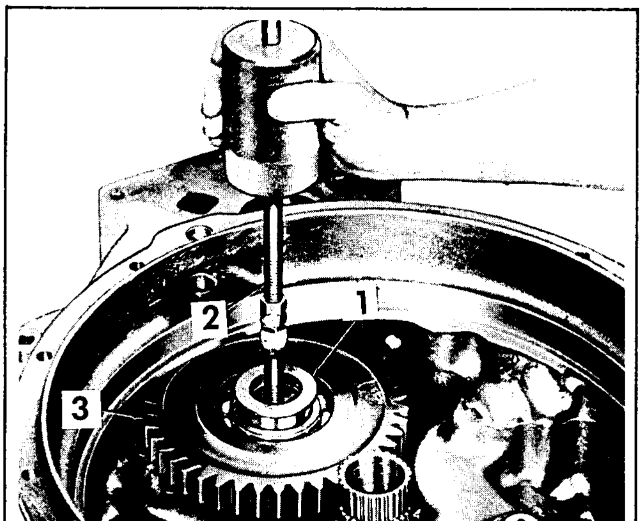

Fig. 36 — Remove Implement Pump Idler Gear Spindle

1. Implement Idler Gear Spindle
2. Slide Hammer
3. Implement Pump Idler Gear and Bearing

surface. Using a puller (Fig. 34), remove the converter pump and bearing assembly from the ground sleeve.

19. Position the converter pump assembly (Fig. 35) on wooden blocks. Using a soft drift, drive the bearing and the implement pump drive gear from the converter pump.

20. Remove the spindle retainer capscrew from the implement pump idler gear spindle (Fig. 36). Install a slide hammer (2) and remove the spindle. Remove the implement pump idler gear and bearing (3). Do *not* remove the bearing from the gear.

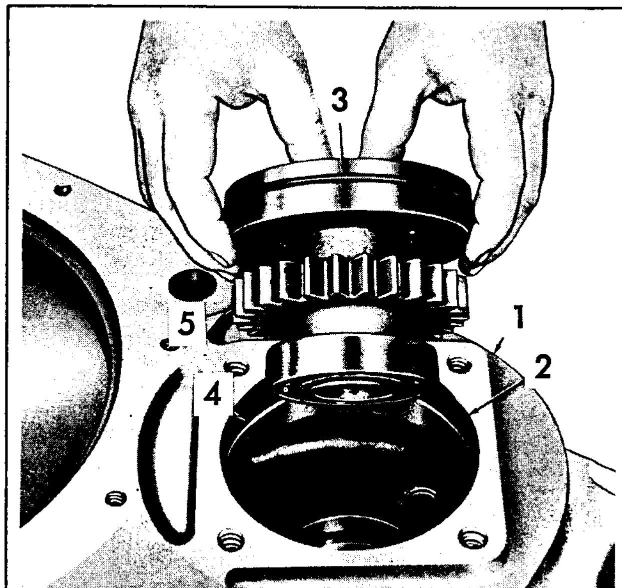

Fig. 37 — Install Implement Pump Gear, Bearing and Bearing Retainer Assembly

1. Converter Housing Assembly
2. Bore
3. Seal Ring
4. Snap Ring Groove
5. Implement Pump Gear

C. Rear Group, Assembly

1. Position the converter housing assembly (Fig. 37) to rest on its rear surface. Grease the bore so that the seal ring will not be damaged by the snap ring groove. Install the seal ring. Install as a unit, the implement pump gear, the bearing, and the bearing retainer. Tap on the unit to seat the bearing.

2. Install the implement pump gear snap ring (Fig. 38). Install as a unit, the pin, the washer, the lube valve, and the spring. Install the gasket and the cover. Secure the cover with the lockwashers and capscrews.

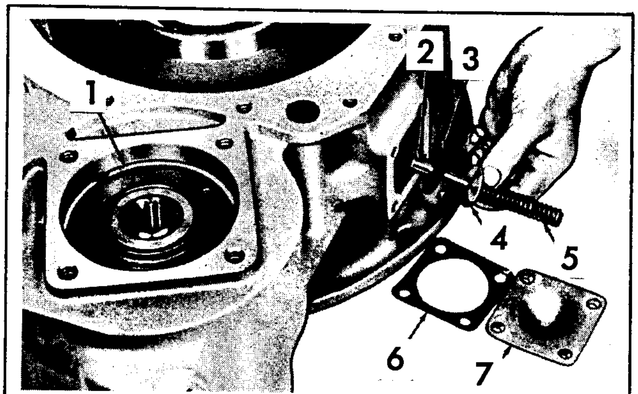

Fig. 38 — Install Lube Pressure Regulator Valve and Implement Pump Gear Snap Ring

1. Implement Pump Gear Snap Ring
2. Pin
3. Washer
4. Lube Valve
5. Spring
6. Gasket
7. Cover

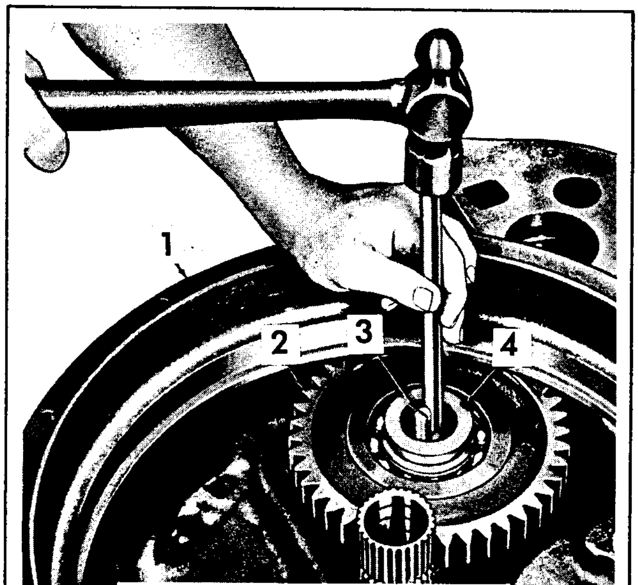

Fig. 39 — Install Idler Gear and Bearing Assembly

1. Converter Housing
2. Idler Gear and Bearing
3. Guide Bolt
4. Idler Gear Spindle

3. Position the converter housing (Fig. 39) to rest on its front surface and install the idler gear and bearing with the hub side down. Using a guide bolt, install the idler gear spindle. Tap on the spindle to set it in its bore.

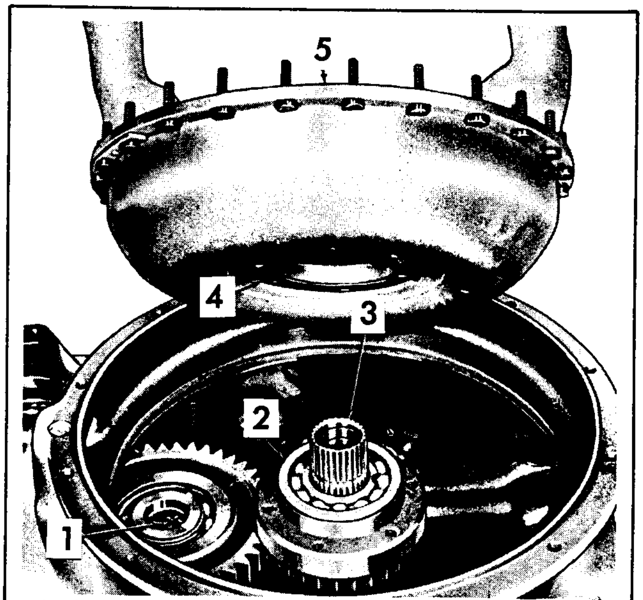

Fig. 40 — Install Implement Pump Drive and Converter Pump Assembly

1. Idler Gear Spindle Retainer Capscrew
2. Pump Gear and Bearing Assembly
3. Converter Ground Sleeve
4. Gasket
5. Converter Pump Assembly

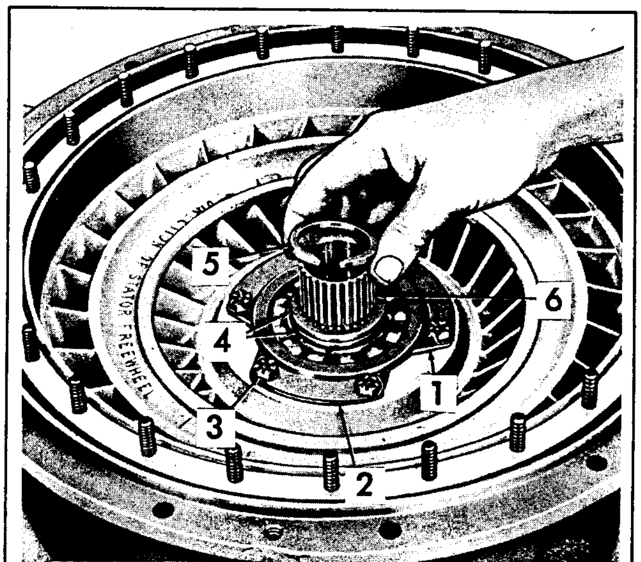

Fig. 41 — Install Converter Pump Retainers

1. Bearing Retainers (3)
2. Lock Strips (3)
3. Self-Locking Capscrew
4. Internal-Splined Spacers (2)
5. Snap Ring
6. Ground Sleeve

4. Install the idler gear spindle retainer capscrew (Fig. 40). Install the pump gear and bearing assembly onto the converter

ground sleeve. Install the gasket, using oil soluble grease. Install the converter pump assembly, aligning the capscrew holes.

5. Install the three bearing retainers (Fig. 41), the three lock strips, and the self-locking capscrews. Bend the corners of the lock strips against the capscrew heads. Install the two internal-splined spacers and the snap ring on the ground sleeve.

6. Position the converter housing (Fig. 42) to rest on its left side. Install the hook type seal rings onto the converter shaft. Install the bearing, if it was removed. Install the shaft assembly into the front of the housing and tap on the bearing to seat it in its bore.

7. Grease the spacer (Fig. 43) with oil soluble grease and install it with the recesses clearing the ground sleeve capscrew heads. Grease and install the seal rings. Install the reverse range piston into the converter housing.

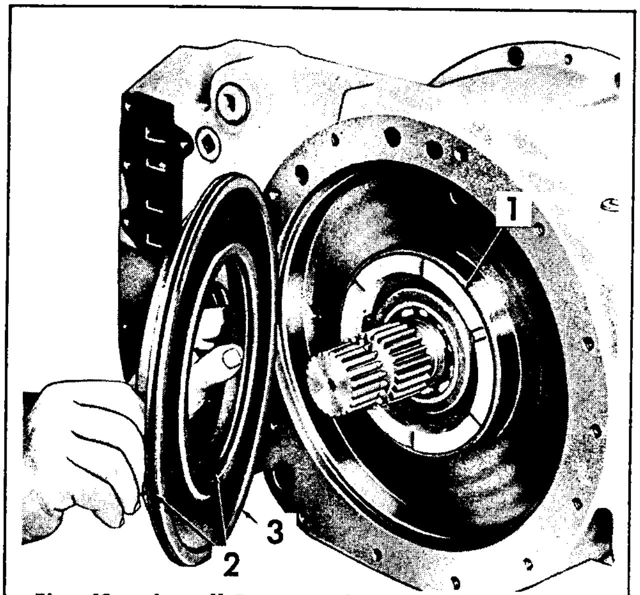

Fig. 43 — Install Reverse Flange Piston Assembly

1. Spacer
2. Seal Rings
3. Reverse Range Piston

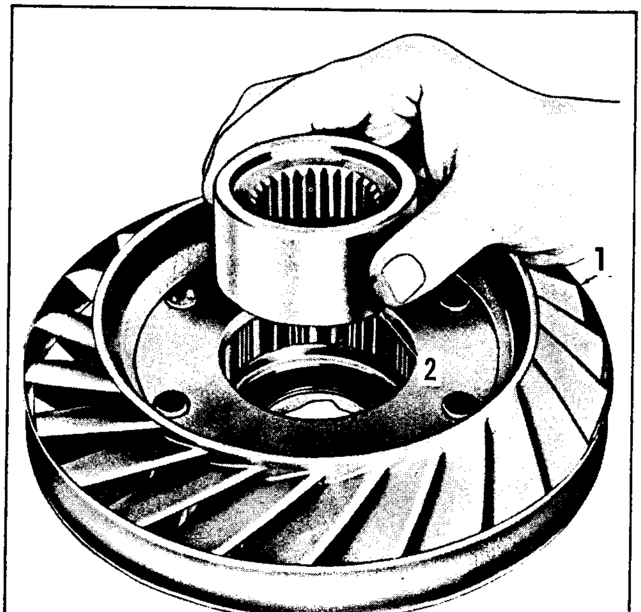

Fig. 44 — Install Stator Freewheel Roller Race

1. Stator Assembly
2. Freewheel Roller Race

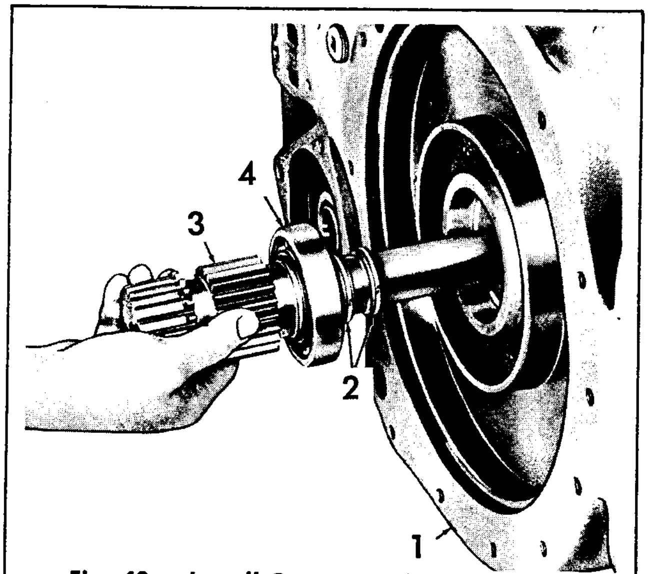

Fig. 42 — Install Converter Shaft Assembly

1. Converter Housing
2. Seal Rings (Hook Type)
3. Converter Shaft
4. Bearing

8. Position the stator assembly (Fig. 44) with the flat side down and install the freewheel roller race with the recess up.

9. Grasp the stator assembly (Fig. 45). Hold the freewheel roller race in position. Turn the stator on edge and install it onto the ground sleeve (6, Fig. 41).

10. Install the turbine assembly (Fig. 46) and secure it with the snap ring.

11. Install the gasket (Fig. 47). Install the twelve

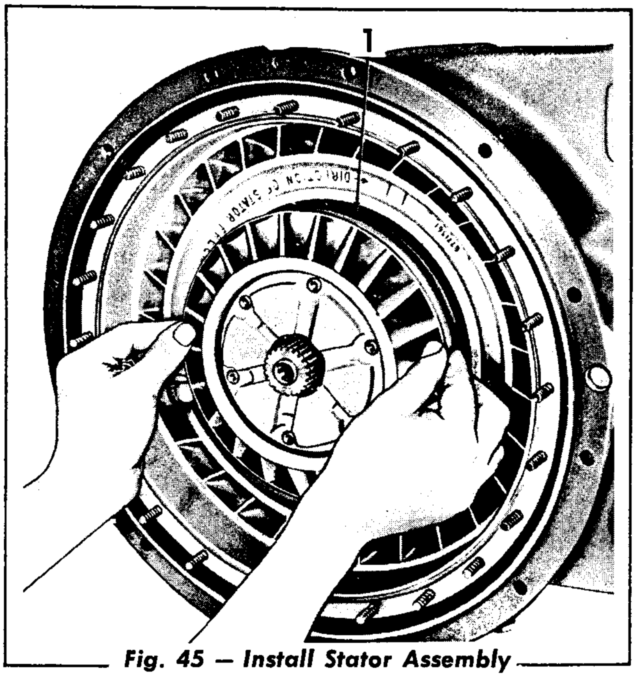

Fig. 45 — Install Stator Assembly

1. Stator Assembly

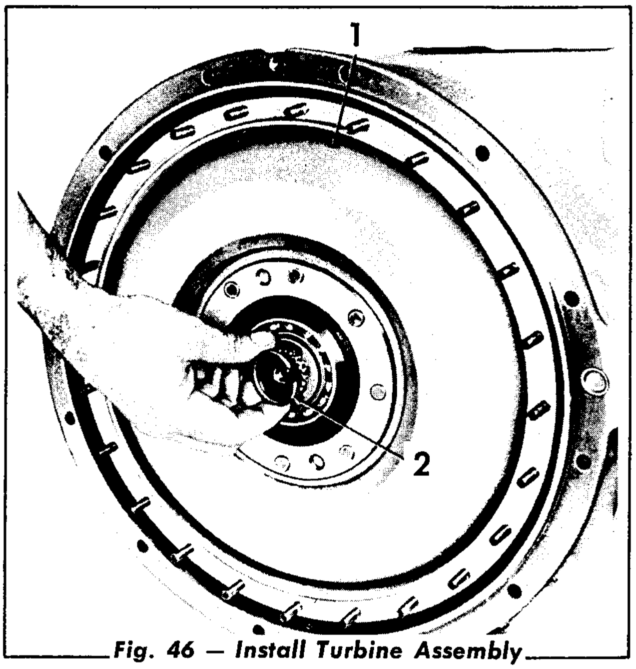

Fig. 46 — Install Turbine Assembly

1. Turbine Assembly
2. Snap Ring

piston return springs and spring guides. Attach a lifting sling to the converter housing and lower it into position. Use a guide bolt to align the capscrew holes. If necessary, rotate the turbine to align the turbine shaft splines with the forward range sun gear and the reverse range carrier.

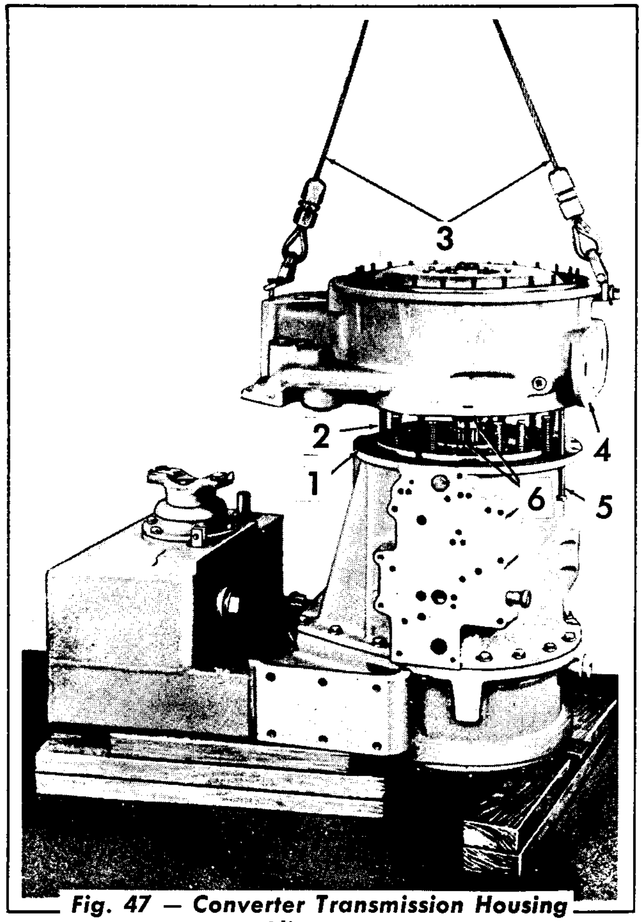

Fig. 47 — Converter Transmission Housing Alignment

1. Gasket
2. Piston Return Spring and Spring Guide (12)
3. Lifting Sling
4. Converter Housing
5. Guide Bolt
6. Turbine Shaft Splines

12. Install the pump gasket (Fig. 48). Install the coupling on the pump shaft and install the input charging oil pump assembly.

13. Secure the oil pump (Fig. 49) with the two short capscrews and lockwashers and the four long capscrews and lockwashers. Assemble the oil drain tube assembly and install it on the transmission. Secure the assembly with the two capscrews and lockwashers and the hose clamp.

14. Attach a lift sling to the rear lifting hole in the top of the converter housing and raise the transmission to a vertical position. Install the brake back plate (Fig. 50) and secure it with the three capscrews and lock-

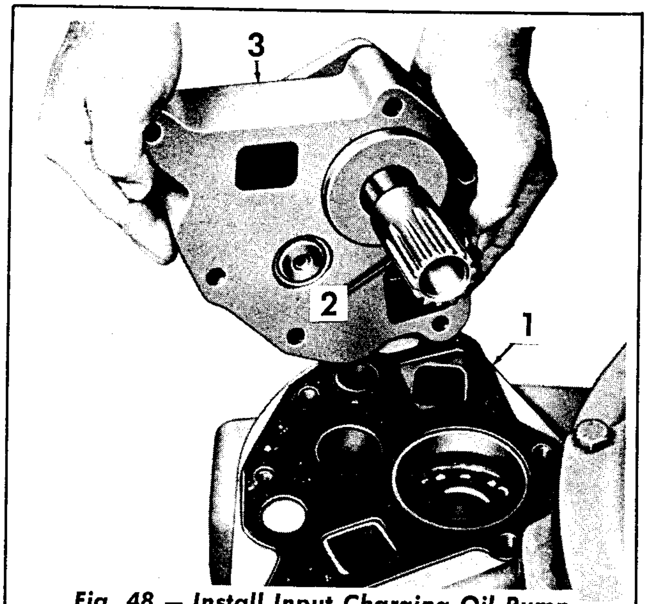

Fig. 48 — Install Input Charging Oil Pump Assembly

1. Gasket
2. Coupling
3. Input Charging Oil Pump Assembly

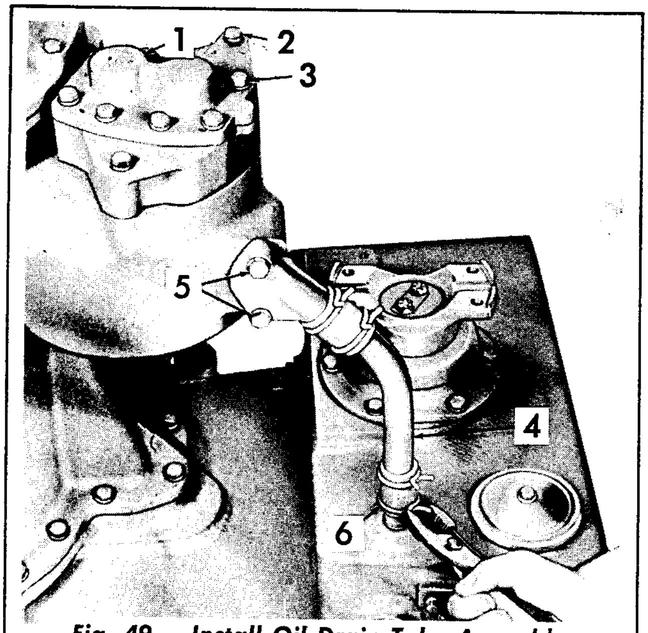

Fig. 49 — Install Oil Drain Tube Assembly

1. Oil Pump
2. Capscrew (2 Short) and Lockwasher
3. Capscrew (4 Long) and Lockwasher
4. Oil Drain Tube Assembly
5. Capscrews and Lockwashers
6. Hose Clamp

washers. Install the brake lever and the brake roller.

15. Install the brake shoe assemblies (Fig. 51)

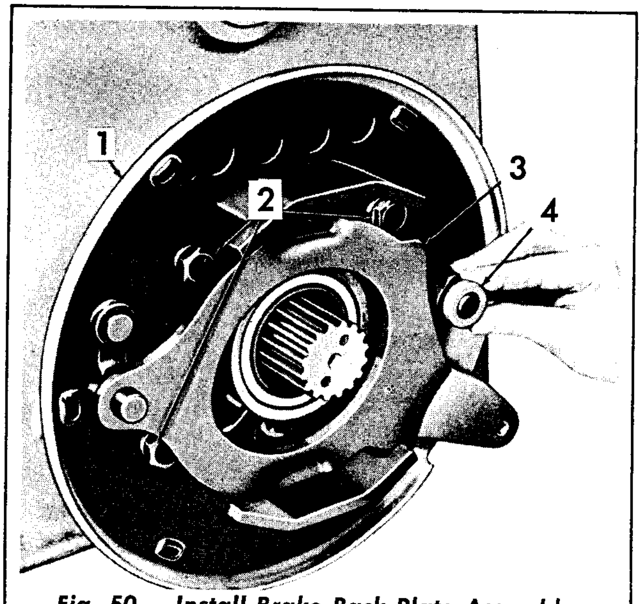

Fig. 50 — Install Brake Back Plate Assembly

1. Brake Back Plate
2. Capscrews and Lockwashers
3. Brake Lever
4. Brake Roller

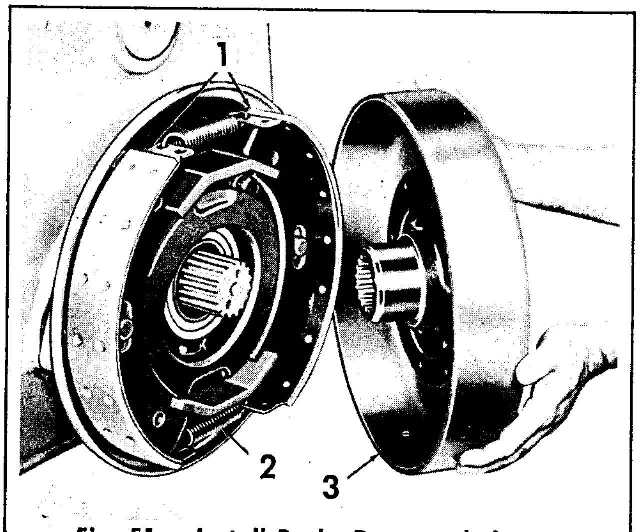

Fig. 51 — Install Brake Drum and Flange Assembly

1. Brake Shoe Assemblies
2. Springs
3. Brake Drum and Flange Assembly

and the springs. Install the brake drum and flange assembly onto the front output shaft. If necessary, heat the flange to 300° F. for one hour before installation.

16. Install the flange retainer washer (Fig. 52) with the machined surface toward the flange. Install the lock strip and the self-

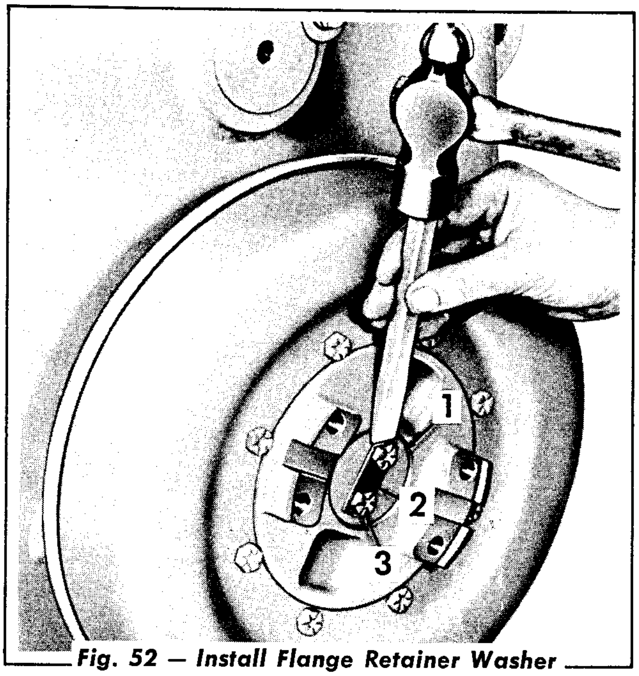

Fig. 52 — Install Flange Retainer Washer

1. Flange Retainer Washer
2. Lock Strip
3. Self-Locking Capscrew

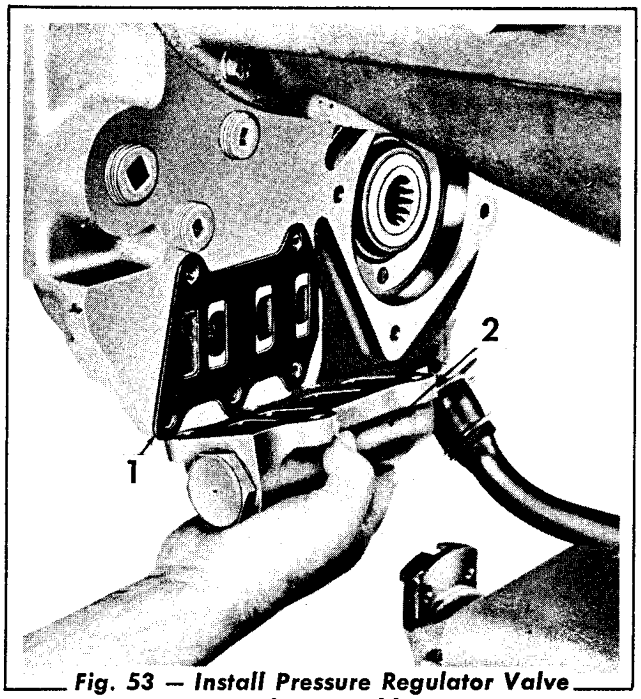

Fig. 53 — Install Pressure Regulator Valve Body Assembly

1. Gasket
2. Pressure Regulator Valve Body Assembly

locking capscrews. Bend the corners of the lock strip against the capscrew heads.

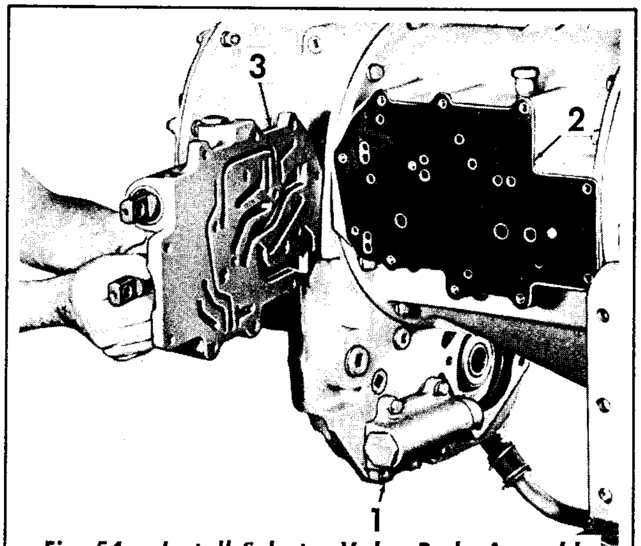

Fig. 54 — Install Selector Valve Body Assembly

1. Pressure Regulator Valve Body Capscrews and Lockwashers (5)
2. Gasket
3. Selector Valve Body Assembly

17. Install the gasket (Fig. 53) and the pressure regulator valve body assembly onto the lower front surface of the torque converter housing.

18. Install the five pressure regulator valve body capscrews and lockwashers (Fig. 54). Using oil soluble grease, install the gasket. Install the selector valve body assembly and secure the valve with eleven capscrews and lockwashers.

D. Torque Converter Drive

1. Disassembly (Fig. 55-A)

a. Remove the seal ring from the converter pump cover (4).

b. Remove the self-locking nuts (3) from the converter pump cover (4) and remove the cover from the transmission.

2. Cleaning and Inspection

Refer to Topic 4.

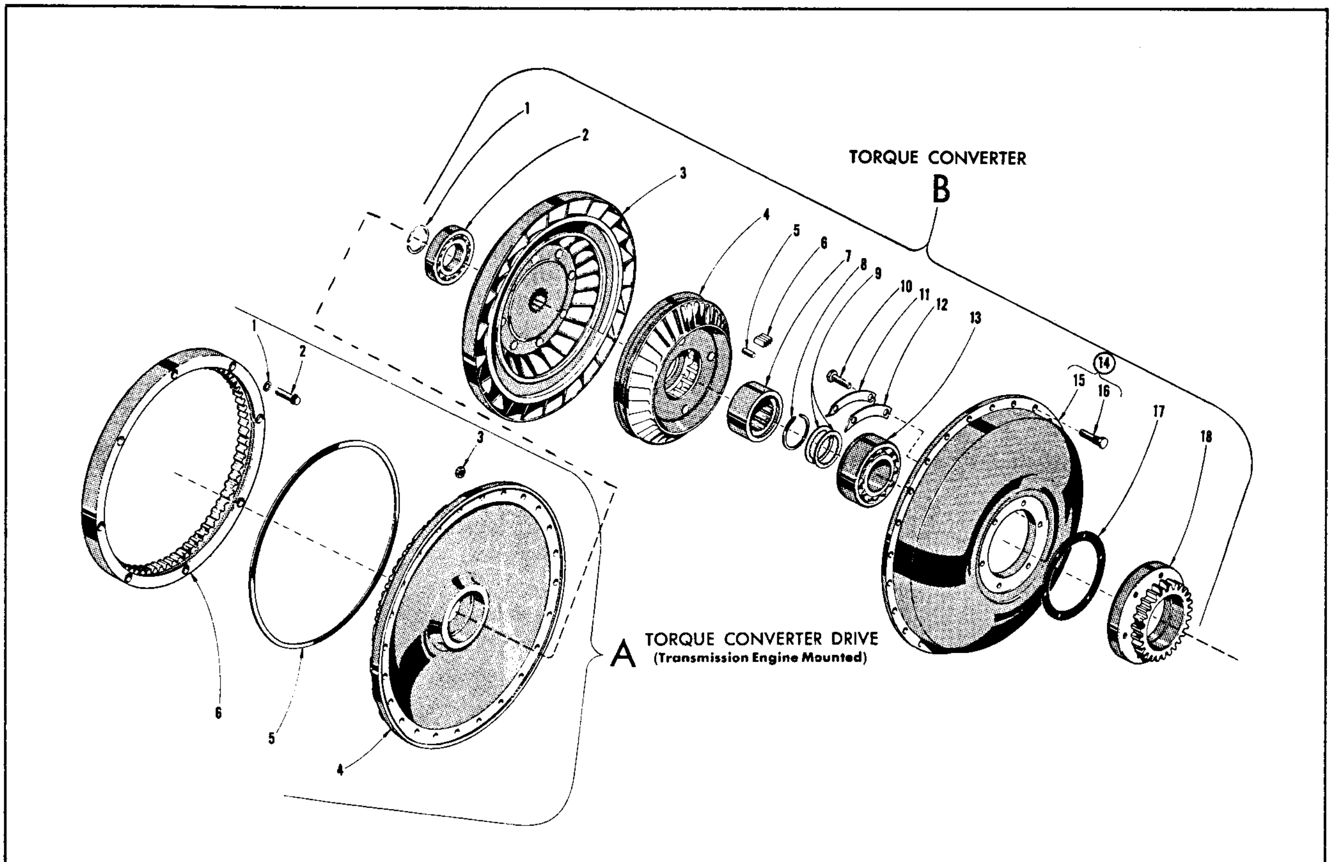

Fig. 55 — Torque Converter Drive and Torque Converter Assemblies

A — TORQUE CONVERTER DRIVE

1. Internal Tooth Lock Washer — 3/8
2. 12-Point Head Capscrew — 3/8–16 x 1¼
3. Nut — 3/8–16
4. Converter Pump Cover
5. Seal Ring
6. Converter Drive Ring

B — TORQUE CONVERTER

1. Snap Ring
2. Single-Row Ball Bearing
3. Turbine
4. Stator Assembly
5. Freewheel Roller
6. Freewheel Roller Spring
7. Freewheel Roller Race
8. Snap Ring
9. Freewheel Roller Race Spacer
10. Hexagon-Head, Self-Locking Capscrew — 5/16–24 x 1¼
11. Tab Lock Strip
12. Bearing Retainer
13. Double-Row Ball Bearing
14. Pump Assembly
15. Pump
16. Special Capscrew — 5/16–24 x 1.30
17. Drive Gear Gasket
18. Oil Pump and Implement Pump Drive Gear

3. **Assembly** (Fig. 55-A)

a. Install the converter pump cover (4) onto the transmission and secure it with the self-locking nuts (3).

b. Install the seal ring (5) onto the converter pump.

E. Torque Converter

1. **Disassembly** (Fig. 55-B)

a. Remove the freewheel rollers (5) and the roller springs (6) from the stator (4).

b. Remove the bearing (2) from the turbine (3).

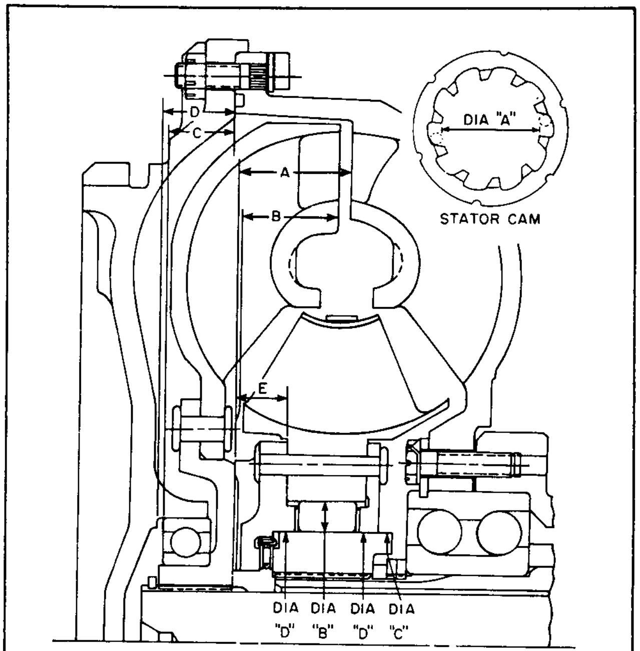

Fig. 56 — Converter Cross-Section View Showing Wear Limits

Dimension A minus B — 0.0095 in. min.
Dimension D minus C — 0.005 in. min.
Dimension E — thickness $\frac{0.692}{0.688}$ in., 0.655 in. min.
Diameter "A" — $\frac{2.800}{2.798}$ in., 2.788 in. min.
Diameter "B" — $\frac{0.3750}{0.3748}$ in., 0.3743 in. min.
Diameter "C" — $\frac{2.8435}{2.8430}$ in., 2.833 in. min.
Diameter "D" — $\frac{2.853}{2.849}$ in., 2.839 in. min.
Total Wear Diameters "A," "B," "C" and "D" — 0.010 in. max.

2. Cleaning, Inspection, and Wear Limits

a. Refer to Topic 4 for cleaning and inspection. Refer to Fig. 56 for wear limits.

b. Inspect the roller ramps (Fig. 55) on the stator for wear pits and scores.

c. Inspect the stator blades for dents, nicks and burrs. Remove them with a file or a smooth stone. If dents cannot be removed, or if there are cracks, replace the stator.

d. Inspect the roller springs for distortion and replace them if necessary.

e. Inspect the rollers (5) for nicks, burrs, excessive wear, or signs of galling. If these conditions cannot be corrected with a crocus cloth, replace the rollers.

f. Check the movement of the rollers in their ramps in the stator to be sure that they do not bind or drag.

3. Assembly (Fig. 55)

a. Grease each of the stator cam ramps with oil soluble grease, and install the ten freewheel rollers (5) in the shallow part of the ramp.

b. Install the ten freewheel springs (6) into the deep part of the ramp, being sure that the spring is all the way back.

c. Install the bearing (2) onto the turbine (3). Seat the bearing against the shoulder on the turbine hub.

F. Torque Converter Ground Sleeve and Implement Drive

1. Disassembly (Fig. 57)

a. If necessary for parts replacement, remove the converter ground sleeve (19) by pressing the sleeve toward the front of the converter housing (Fig. 58). Be sure to press on the shoulder of the ground sleeve.

b. If necessary for parts replacement, remove the bearings (30 and 32) from the gear (31).

2. Cleaning, Inspection, and Wear Limits

Refer to Topic 4 for cleaning and inspection. Refer to Fig. 57 for wear limits.

3. Assembly (Fig. 57)

If the converter ground sleeve (19) was removed, chill the sleeve in dry ice for one hour and install into the front side of the converter housing (37). Secure the ground sleeve with the capscrews (Fig. 59).

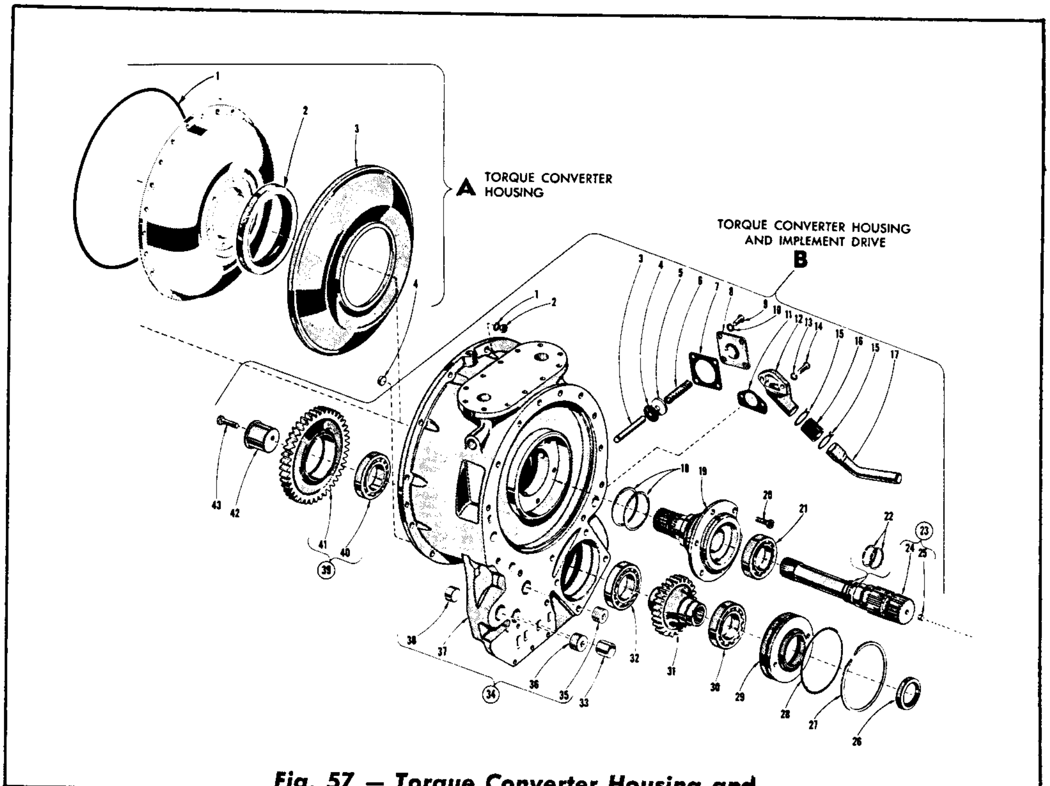

Fig. 57 — Torque Converter Housing and Implement Drive Assembly — Legend

A — TORQUE CONVERTER HOUSING

1. Converter Seal Ring
2. Oil Seal
3. Diaphragm
4. Expansion Plug

B — TORQUE CONVERTER HOUSING, OIL PUMP AND IMPLEMENT PUMP DRIVE

1. Lockwasher — 3/8
2. Hexagon Nut — 3/8–24
3. Pin
4. Lube Pressure Regulator Valve Rubber Seal Washer
5. Lube Pressure Regulator Valve
6. Spring
7. Valve Cover Gasket
8. Valve Cover
9. Hexagon-Head Capscrew — 3/8–16 x 34
10. Lockwasher — 3/8
11. Drain Tube Flange Gasket
12. Drain Tube Flange
13. Lockwasher — 3/8
14. Hexagon-Head Capscrew — 3/8–16 x 2 1/2
15. Drain Tube Hose Clamp, Type "E"
16. Drain Tube Hose
17. Drain Tube
18. Hook-Type Seal Ring
19. Converter Ground Sleeve
20. Hexagon-Head, Self-Locking Capscrew — 3/8–16 x 7/8
21. Single-Row Ball Bearing
22. Hook-Type Seal Ring
23. Converter Shaft Assembly
24. Converter Shaft
25. Lube Orifice Plug
26. Lip-Type Seal
27. Internal-Snap Ring
28. Seal Ring
29. Bearing Retainer
30. Single-Row Ball Bearing
31. Charging Oil Pump and Implement Pump Drive Gear
32. Single-Row Ball Bearing
33. Not Used in This Group
34. Converter Housing Assembly
35. Plug — 3/4 NPTF
36. Plug — 1 NPTF
37. Converter Housing
38. Plug — 1/2 NPTF
39. Oil Pump and Implement Pump Drive Idler Gear Assembly
40. Single-Row Ball Bearing
41. Oil Pump and Implement Pump Drive Idler Gear
42. Oil Pump and Implement Pump Drive Idler Spindle
43. Hexagon-Head, Self-Locking Capscrew — 7/16 x 14 x 1 3/4

WEAR LIMITS DATA

Item 6 Spring — 35.1 ± 3.5 lb at 2.000 in Operating Height

G. Torque Converter Housing

1. Disassembly (Fig. 57)

Position the torque converter housing (B-37) on the work table with the rear side down. Place a piece of bar stock across the oil seal (A-2) and the diaphragm (A-3). Drive the seal and the diaphragm toward the rear of the housing.

2. Assembly (Fig. 57)

a. Coat the outer diameter of a new oil seal (A-2) with Permatex and install it into a new diaphragm (3). Coat the outer diameter of the diaphragm with Permatex.

b. Position the torque converter housing (B-37) on the work table with the rear side up. Install the seal and diaphragm assembly into the housing. Place a soft hammer on the shoulder near the outer diameter of the diaphragm (3) and tap on the hammer to seat the diaphragm in the housing.

H. Input Driven Charging Oil Pump

1. Disassembly (Fig. 60)

a. Remove the capscrews (30) and lockwashers (31) from the oil pump cover assembly (32) and separate the pump assembly. Remove the gasket (36).

b. Remove the oil pump drive gear (37) and the oil pump driven gear (38) from the oil pump body (41).

c. Do not remove the needle bearings (35 and 40) unless replacement is necessary. Press or drive out the bearings (40) to remove them. The bearings (35) will have to be pried out.

2. Cleaning, Inspection, and Wear Limits

Refer to Topic 4 for cleaning and inspection.

Refer to Fig. 60 for wear limits.

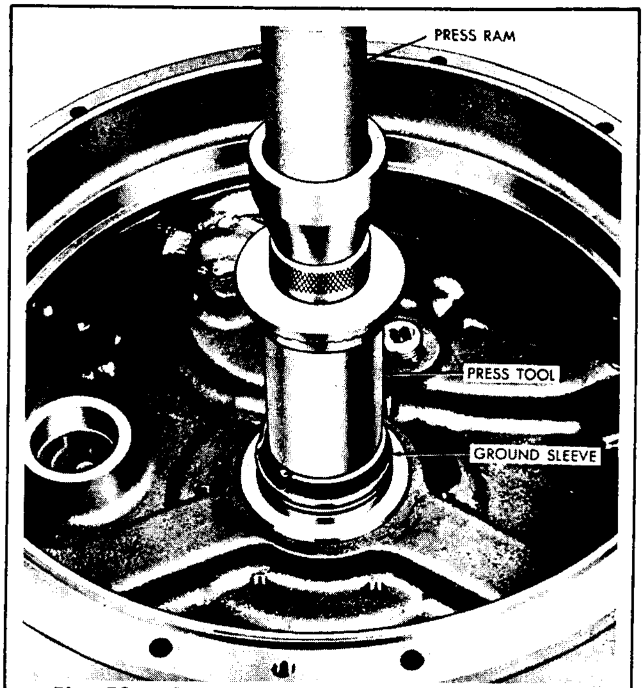

Fig. 58 — Removing Converter Ground Sleeve

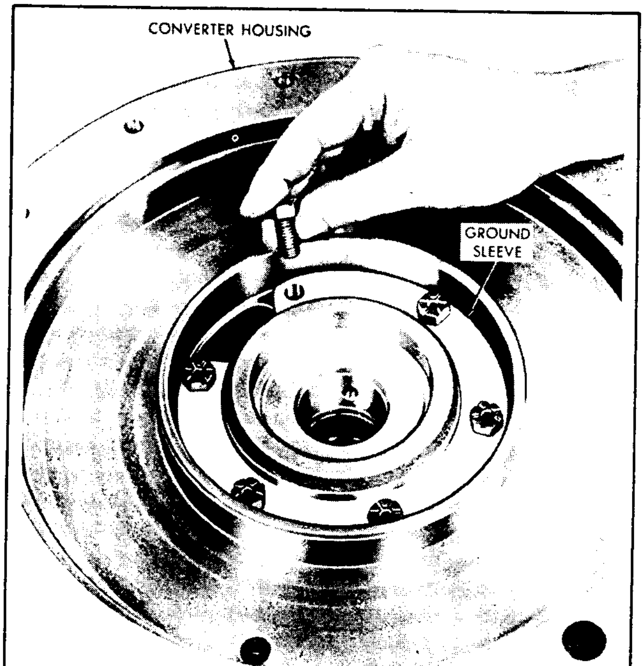

Fig. 59 — Installing Converter Ground Sleeve

3. Assembly (Fig. 60)

a. If the needle bearings (35 and 40) were removed, install new bearings by pressing on the lettered end. Press the bearings (35) to 0.090" below the split line surface. Press the bearings (40) to 0.090" below the gear sprocket surface.

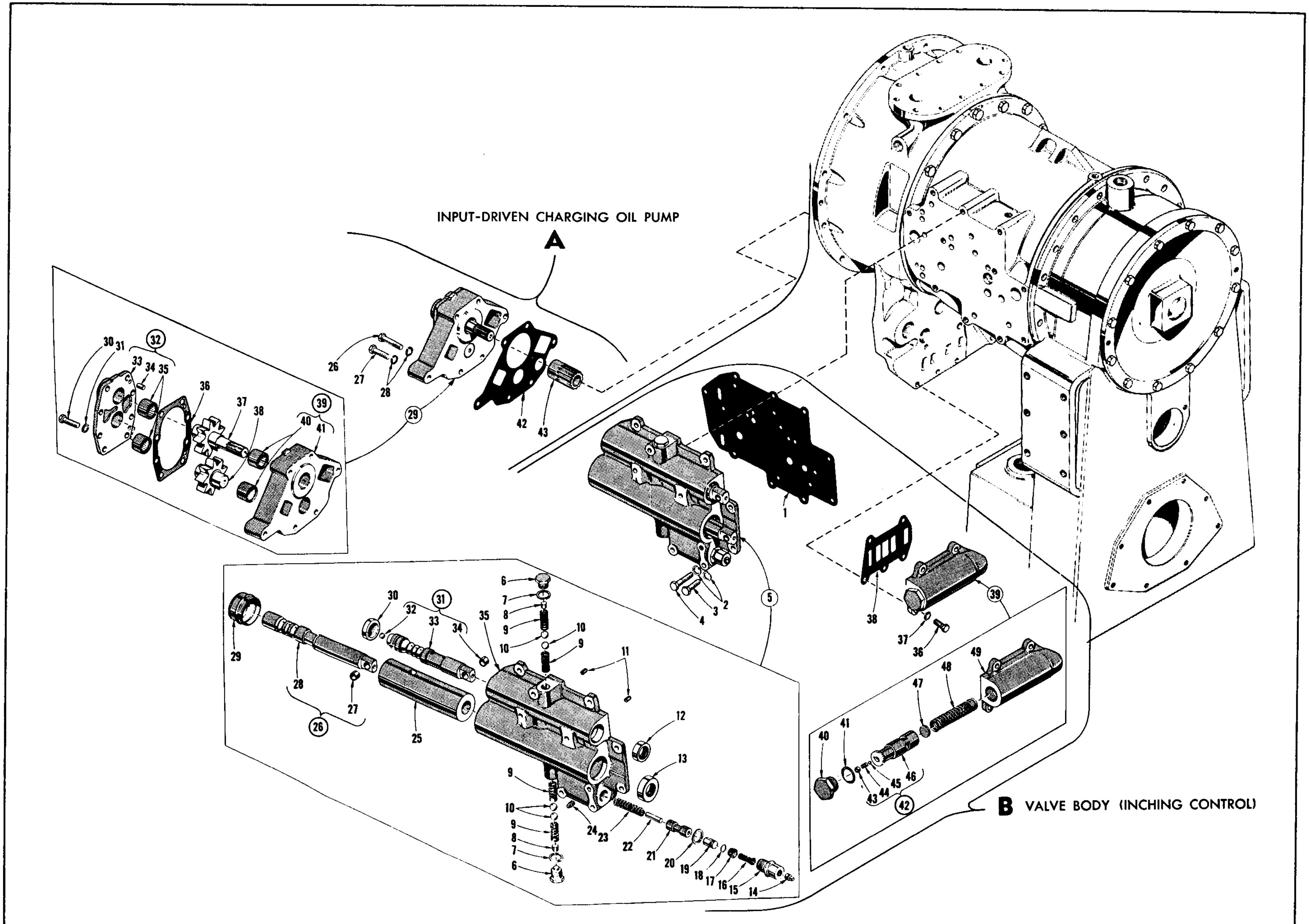

Fig. 60 — Input Charging Oil Pump, Selector, and Main Pressure Regulator Valves

A — INPUT DRIVEN CHARGING OIL PUMP

26. Hexagon-Head Capscrew — 3/8–16 x 2 1/4
27. Hexagon-Head Capscrew — 3/8–16 x 1 3/4
28. Lockwasher — 3/8
29. Input-Charging Oil Pump Assembly
30. Hexagon-Head Capscrew — 3/8–16 x 1
31. Lockwasher — 3/8
32. Cover Assembly
33. Cover
34. Dowel Pin
35. Needle Bearing
36. Gasket
37. Drive Gear
38. Driven Gear
40. Needle Bearing
41. Oil Pump Body
42. Gasket
43. Oil Pump Drive Coupling

WEAR LIMITS DATA

Item	
29	Input-Charging Oil Pump — Gear End Clearance with Unit Assembled
38	Driven Gear Shaft — 1.000 in. Diameter, 0.9975 in. Minimum
37	Drive Gear Shaft — 1.000 in. Diameter, 0.9975 in. Minimum
41	Oil Pump Body — 2.758 in. Diameter Bore, 2.768 in. Maximum

B — VALVE BODY (Inching Control)

1. Selector Valve Body Gasket
2. Lockwasher — 3/8
3. Hexagon-Head Capscrew — 3/8–16 x 1 1/4
4. Hexagon-Head Capscrew — 3/8–16 x 3
5. Selector Valve Body Assembly
6. Hexagon-Head Plug — 3/4–16 UNF
7. Copper Gasket
8. Pin — 3/8 x .535
9. Spring
10. Ball — 5/8
11. Spring Pin, Type A
12. Seal
13. Seal
14. Pipe Plug — 1/8
15. Cutoff Valve Retainer Plug
16. Valve Cup Spring
17. Clutch Cutoff Valve Piston Cup
18. Seal Ring
19. Clutch Cutoff Valve Plug
20. Annular Gasket — 7/8
21. Clutch Cutoff Valve
22. Pin — 3/8 x 1 3/8
23. Spring
24. Pipe Plug — 1/8
25. Forward and Reverse Shift Valve Sleeve
26. Forward and Reverse Valve Assembly
27. Bushing
28. Forward and Reverse Valve
29. Cup
30. Range Selector Valve Plug
31. Range Selector Valve Assembly
32. Ball — 15/32 Diameter
33. Range Selector Valve
34. Bushing
35. Selector Valve Body
36. Capscrew — 3/8–16 x 1 1/4
37. Lockwasher — 3/8
38. Pressure Regulator Valve Body Gasket
39. Pressure Regulator Valve Body Assembly
40. Hexagon-Head Plug
41. Gasket
42. Main Pressure Regulator Valve Assembly
43. Dash Pot Spring Retainer
44. Spring
45. Ball — 1/4 Diameter
46. Main Pressure Regulator Valve
47. Main Pressure Regulator Shim
48. Spring
49. Pressure Regulator Valve Body

WEAR LIMITS DATA

Item	
9	Spring — 15 ± 1.5 lb. at 13/16 in. Operating Height
15, 19	Cutoff Valve Retainer Plug-Clearance with Cutoff Valve Plug 0.004 in. Maximum
21, 35	Clutch Cutoff Valve-Clearance with Selector Valve, 0.004 in. Maximum
23	Spring — 18 ± 1.8 lb. Load at 1.531 in. Operating Height
25, 28	Valve Sleeve-Clearance with Forward and Reverse Valve, 0.004 in. Maximum
33, 35	Range Selector Valve-Clearance with Selector Valve Body, 0.004 in. Maximum
46, 49	Main Pressure Regulator Valve-Clearance with Pressure Regulator Valve Body, 0.004 in. Maximum
48	Spring — 133 ± 2.5 lb. Load at 4.20 in. Operating Height

b. Install the pump drive gear (37) and the oil pump driven gear (38) into the oil pump body (41). Install the gasket (36) into the oil pump body (41).

c. Install the oil pump cover assembly (32) onto the oil pump body and secure the assembly with the capscrews (30) and lockwashers (31).

I. Valve Bodies

1. Selector Valve Disassembly (Fig. 60)

a. Remove the cutoff valve retainer plug (15) from the selector body (35).

b. Remove the valve cup spring (16), the clutch cutoff valve piston cup (17), the seal ring (18), the clutch cutoff valve plug (19), the gasket (20), the clutch cutoff valve (21), the pin (22), and the spring (23).

c. Remove the plug (6), the copper gasket (7), the pin (8), the spring (9), and one detent ball (10) from the bottom of the selector valve body (35).

d. Remove the cup (29). Tap on the linkage end of the forward and reverse valve (28) and remove the valve (Fig. 61). Remove the remaining detent ball (10) and the spring (9).

e. Remove the pin (11) from the selector valve body (35) by using an "Easy Out" to screw the pin out. If this method is not successful, use a ¼ x 20" tap to thread the pin. Install a ¼ x 20" adapter into the pin and use a slide hammer to remove the pin. Remove the sleeve (25).

f. Drive the seal (13) toward the linkage end of the valve bore.

g. Remove the plug (6), the copper gasket (7), the pin (8), the spring (9), and the detent ball (10) from the top of the selector valve body (35).

h. Remove the range selector valve assembly (31). Collapse the seal (12) and remove it

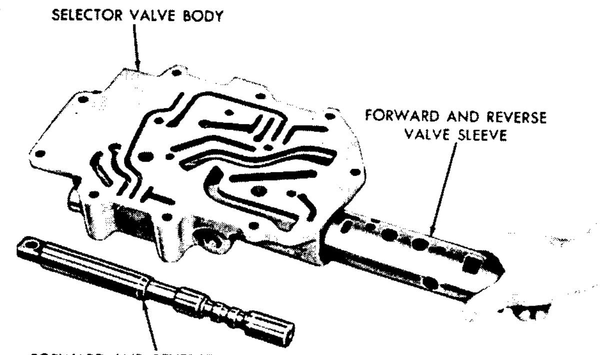

Fig. 61 — Removing (or Installing) Forward and Reverse Valve Sleeve

from the valve bore. Do not remove the plug (30) unless replacement is necessary.

i. Remove the remaining detent ball (10) and spring (9).

2. Main Pressure Regulator Valve Disassembly (Fig. 60)

a. Remove the plug (40) and gasket (41) from the main pressure regulator valve body.

b. Remove the main pressure regulator valve assembly (42).

c. Remove the shim (47) and the spring (48) from the main pressure regulator valve body (49).

3. Cleaning, Inspection, and Wear Limits

Refer to Topic 4 for cleaning and inspection.

Refer to Fig. 60 for wear limits.

4. Main Pressure Regulator Valve, Assembly (Fig. 60)

a. Install the spring (48) and the shim (47) into the main pressure regulator valve body (49).

b. Install the valve assembly (42) into the valve body (49) and secure the valve with the plug (40) and gasket (41).

5. Selector Valve, Assembly (Fig. 60)

a. If the plug (30) was removed, install the plug into the valve body bore and position it against the shoulder in the bore.

b. Install the spring (9) and the detent ball (10) into the top of the selector valve body (35).

c. Install the range selector valve assembly (31).

d. Install the remaining detent ball (10), the detent spring (9), the pin (8), the gasket (7), and the plug (6) into the top of the valve body (35).

e. Grease the seal (12) and the exposed portion of the valve assembly (31). Use oil soluble grease. Place the seal on the valve, spring loaded side next to the valve body. Using care to prevent damage to the lip of the seal, install the seal into its bore in the valve body. Position the seal in the bore 0.00 to 0.06" below the valve body surface.

f. Install the sleeve (25) into the valve body (35). Align the spring pin hole in the sleeve with the spring pin hole in the valve body.

g. Install the pin (11) into the valve body (35) flush with the valve body mounting surface.

h. Install cup (29) into the valve body (35). Install the detent spring (9) into the ball (10) into the bottom of the selector valve body (35).

i. Install the remaining detent ball (10) and the spring (9). Install the pin (8), the gasket (7), and the plug (6).

j. Grease the seal (13) and the exposed portion of the forward and reverse valve assembly (26). Use oil soluble grease. Place the seal (13) on the valve assembly (26), the spring-loaded lip of the seal facing the valve body (35). Using care to prevent damage to the lip of the seal, install the seal into its bore in the valve body. Position the seal in the bore 0.40 to 0.46" below the valve body surface.

k. Install the clutch cutoff valve spring (23), the pin (22), the clutch cutoff valve (21), the gasket (20), the clutch cutoff valve plug (19), the seal ring (18), the clutch cutoff valve position cup (17), the valve cup spring (16), and the clutch cutoff valve retaining plug (15).

J. Front Output Flange and Brake

The front output flange and brake was completely disassembled in Par. B, and assembled in Par. C. Refer to Topic 4 for cleaning and inspection. Refer to Fig. 145 for wear limits.

7. TRANSMISSION CENTER GROUP

A. General

While the procedures in this Topic cover the Center Group (Fig. 62) only, it is recommended that the entire transmission be disassembled for inspection and cleaning whenever it is necessary to overhaul any group.

It will be necessary to remove the transmission Rear Group in order to rebuild the Center Group.

B. Center Group, Disassembly

1. Remove the thrust washer (Fig. 63), the piston return spring guides, and the springs.

2. Remove the five external and the four internal splined reverse clutch plates (Fig. 64). Note the clutch plate positioning ring.

3. Remove the reverse planetary carrier assembly (Fig. 65) and the remaining clutch plate. Remove the forward sun gear.

4. Remove the forward sun gear thrust washer (Fig. 66). Remove the clutch anchor pin from the transmission housing.

5. Using wire lifting hooks (Fig. 67), remove the forward and reverse clutch anchor.

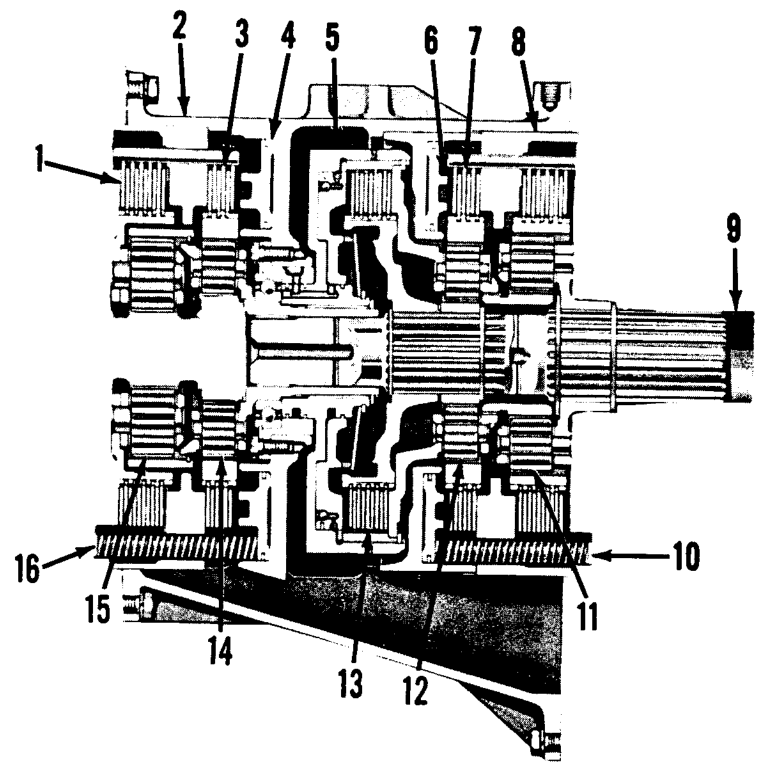

Fig. 62 — Transmission Center Group

1. Reverse Clutch
2. Forward- and Reverse-Clutch Anchor
3. Forward Clutch
4. Forward Piston
5. Intermediate-Range Clutch Housing
6. High-Range Piston
7. High-Range Clutch
8. High- and Low-Range Clutch Anchor
9. Transmission Main Shaft
10. High- and Low-Range Piston Return Springs
11. Low-Range Planetary Gearing
12. High-Range Planetary Gearing
13. Intermediate-Range Clutch
14. Forward Planetary Gearing
15. Reverse Planetary Gearing
16. Forward- and Reverse-Piston Return Spring

6. Remove the two internal and the two external splined clutch plates (Fig. 68).

7. Attach a lifting sling (Fig. 69) to the front lifting hole in the transmission housing and position the transmission on the work table with the front end up. Block under the flange to level it. Remove the eighteen capscrews and lockwashers.

8. Attach a lifting sling (Fig. 70) to the center of the transfer gear housing and raise the transfer gear housing assembly. Remove the gasket. Remove the twelve low range springs and the spring guides.

9. Remove the two external and the one internal splined low range clutch plates (Fig. 71). Remove the clutch anchor pin. Remove the snap ring. Remove the low range ring gear.

10. Remove the low range planetary carrier assembly (Fig. 72), the thrust washer, and the low range sun gear. Remove the remaining low range clutch plates (four external and three internal splined).

11. Remove the high and low range clutch anchor (Fig. 73).

12. Remove the two external and the two internal splined high range clutch plates (Fig. 74). Remove the high range ring gear. Remove the remaining clutch plates (one internal and one internal splined).

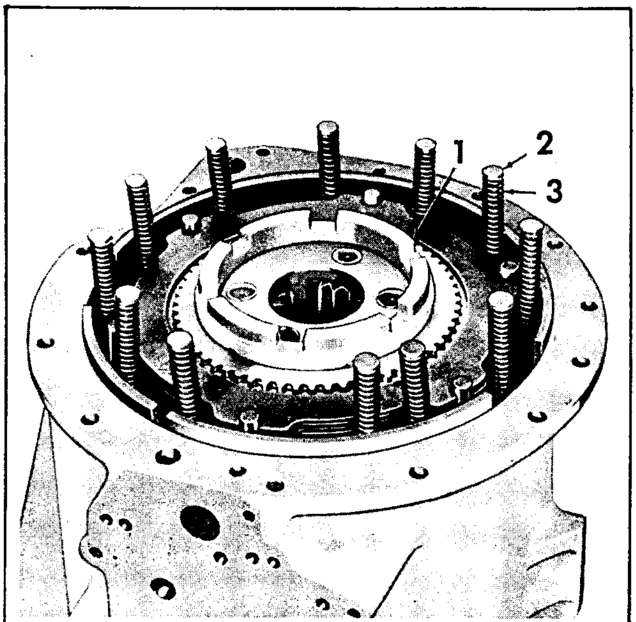

Fig. 63 — Remove Piston Return Springs

1. Thrust Washer
2. Piston Return Spring Guides
3. Sprngs

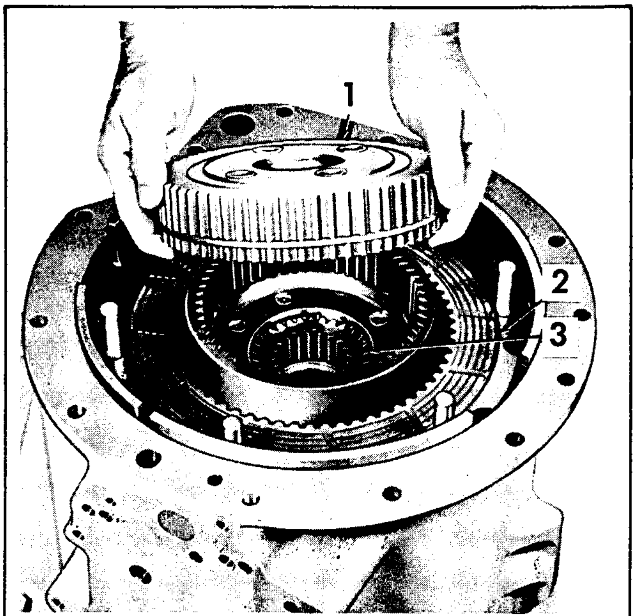

Fig. 65 — Remove Reverse Planetary Carrier Assembly

1. Reverse Planetary Carrier Assembly
2. Clutch Plate
3. Forward Sun Gear

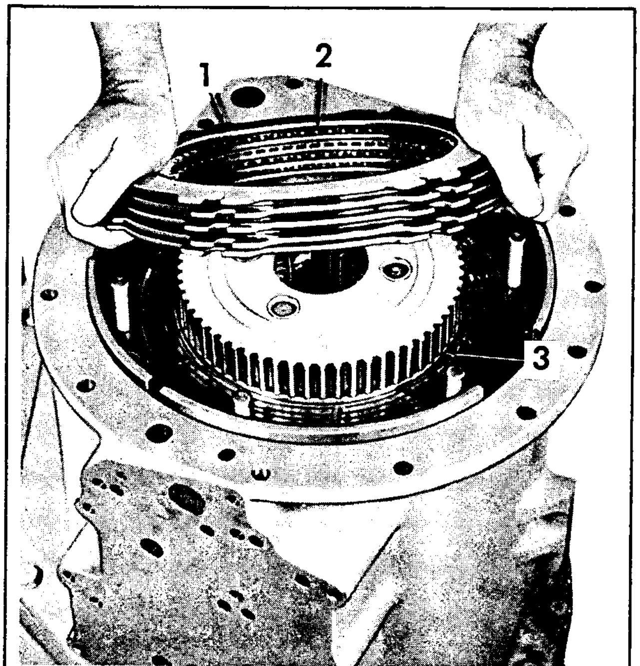

Fig. 64 — Remove Reverse Clutch Plates

1. External Splined Reverse Clutch Plates (5)
2. Internal Splined Reverse Clutch Plates (4)
3. Clutch Plate Positioning Ring

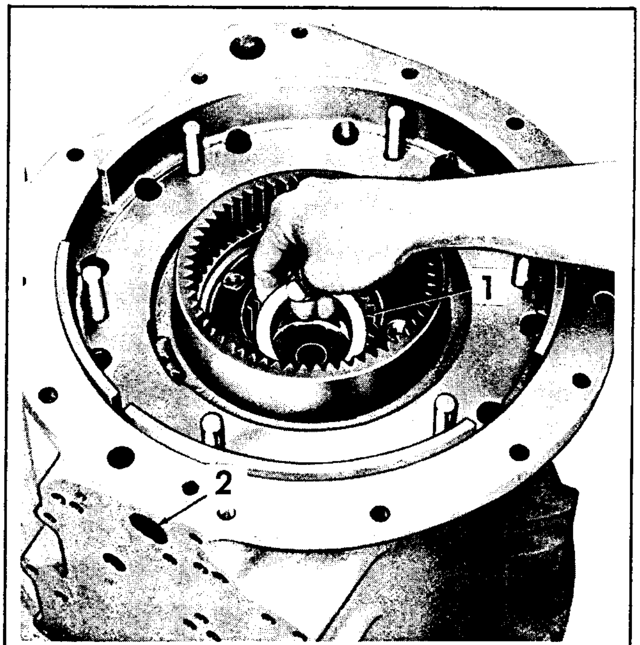

Fig. 66 — Remove Forward Sun Gear Thrust Washer

1. Forward Sun Gear Thrust Washer
2. Clutch Anchor Pin

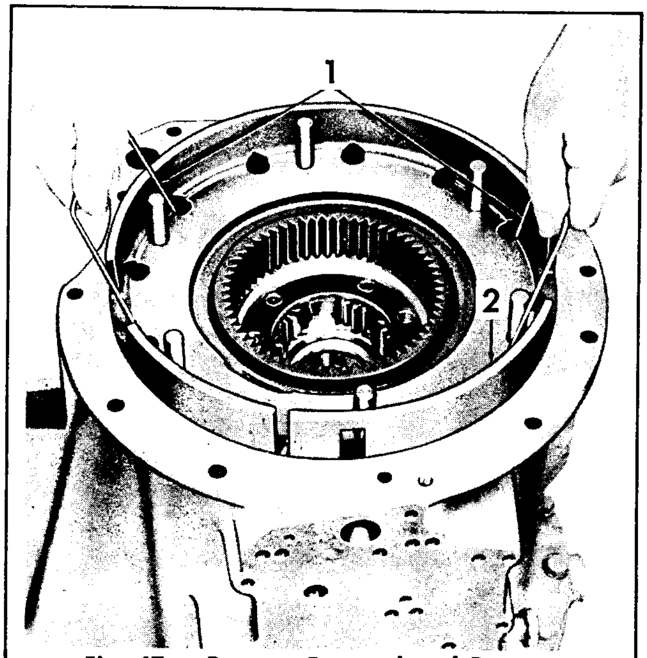

Fig. 67 — Remove Forward and Reverse Clutch Anchor

1. Wire Lifting Hooks
2. Forward and Reverse Clutch Anchor

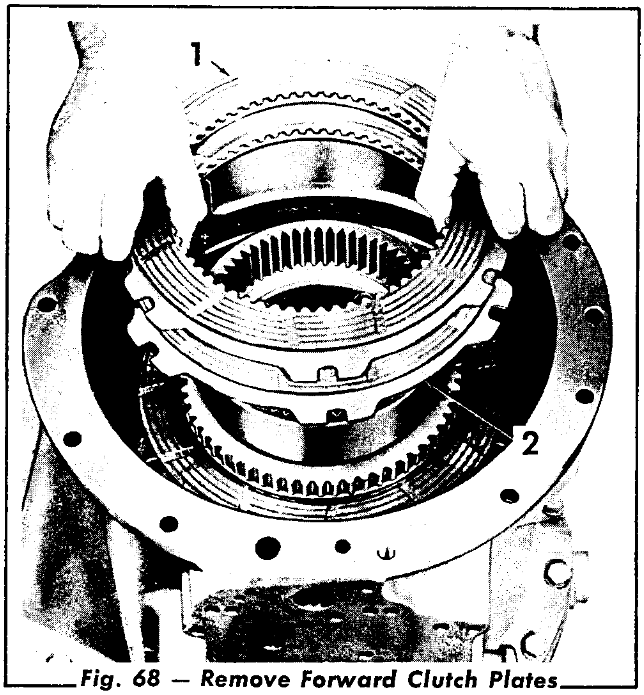

Fig. 68 — Remove Forward Clutch Plates

1. Internal Splined Clutch Plate (2)
2. External Splined Clutch Plate (2)

13. Using a wrench (Fig. 75), remove the high range piston housing retainer capscrew. Remove the high range piston and housing assembly.

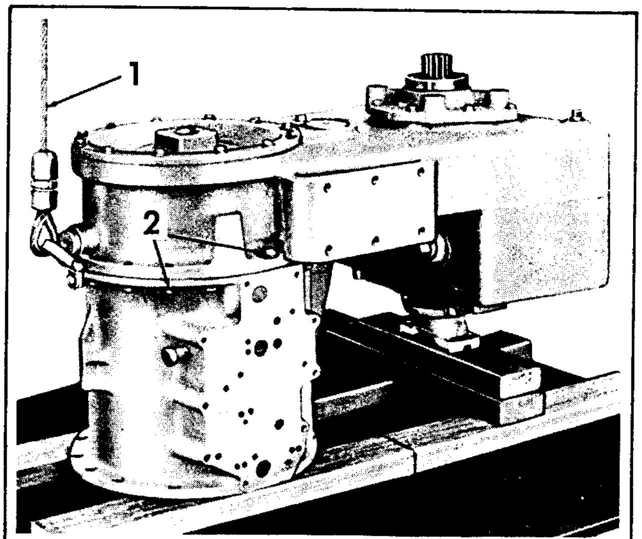

Fig. 69 — Positioning Transmission on Blocks

1. Lifting Sling
2. Capscrews and Lockwashers

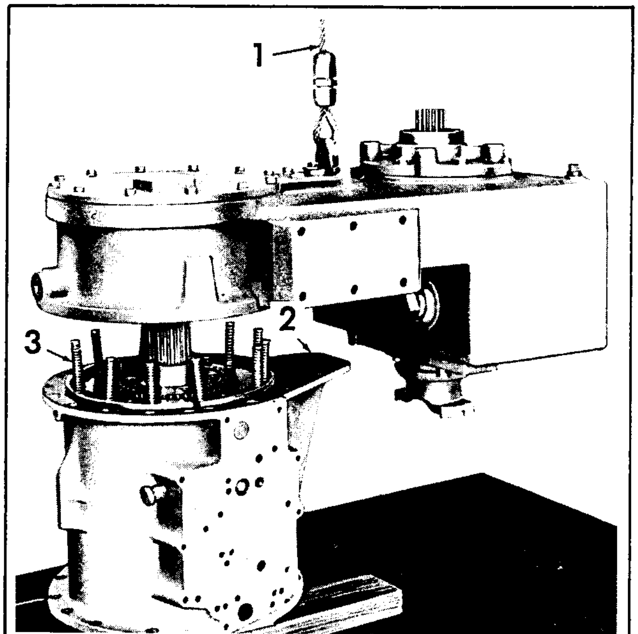

Fig. 70 — Remove Transfer Gear Housing

1. Lifting Sling
2. Gasket
3. Low Range Springs and Spring Guides

14. Remove the high range piston (Fig. 76) from the piston housing. Remove the piston seals from the piston.

15. Remove the internal snap ring (Fig. 77) from the intermediate range clutch hub. Remove the high range planetary carrier assembly.

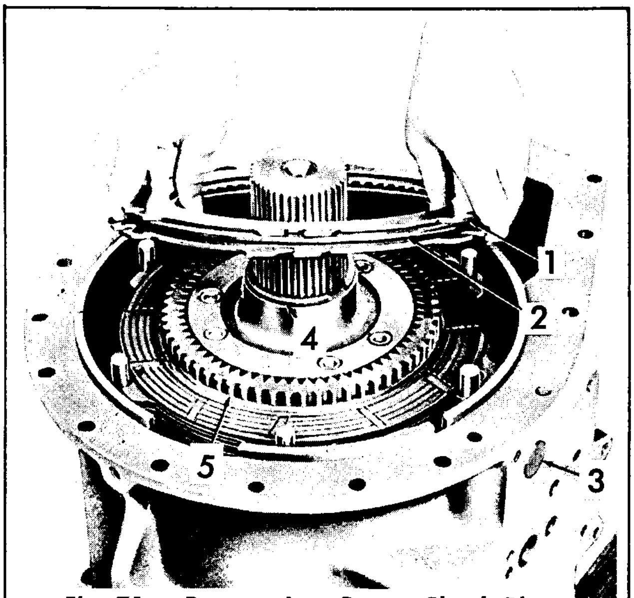

Fig. 71 — Remove Low Range Clutch Plates

1. External Splined Low Range Clutch Plates
2. Internal Splined Low Range Clutch Plates
3. Clutch Anchor Pin
4. Snap Ring
5. Low Range Ring Gear

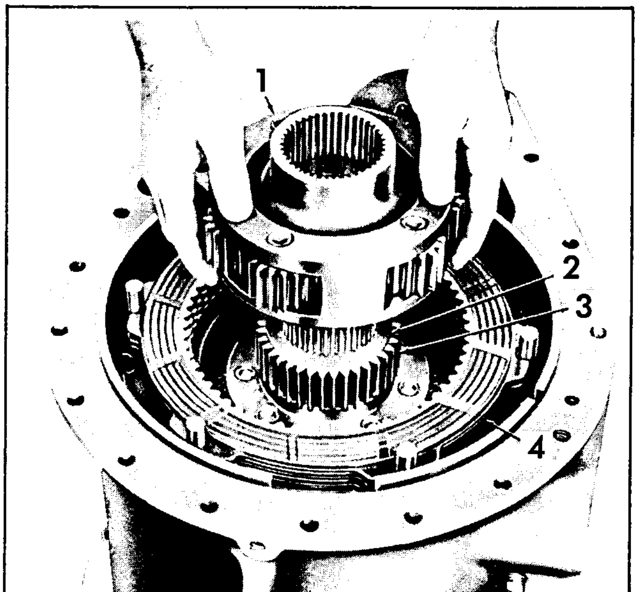

Fig. 72 — Remove Low Range Planetary Carrier Assembly

1. Low Range Planetary Carrier Assembly
2. Thrust Washer
3. Low Range Sun Gear
4. Low Range Clutch Plates

16. Remove the transmission main shaft and attached parts (Fig. 78). Remove the snap ring from the shaft.

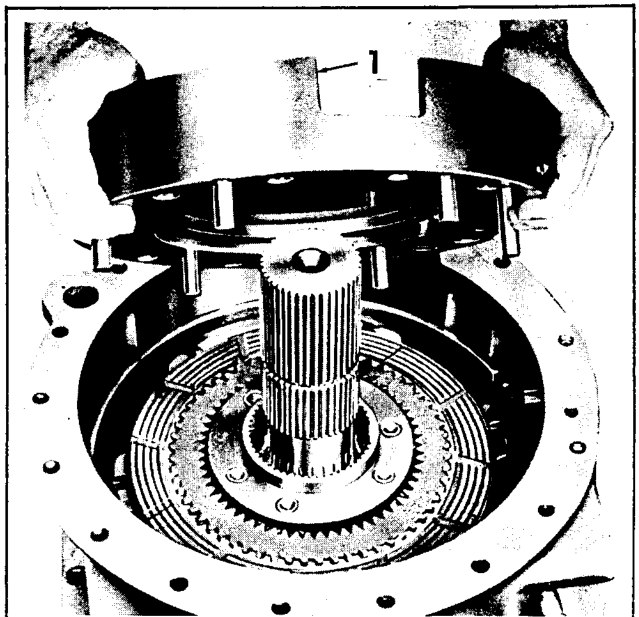

Fig. 73 — Remove High and Low Range Clutch Anchor

1. High and Low Range Clutch Anchor

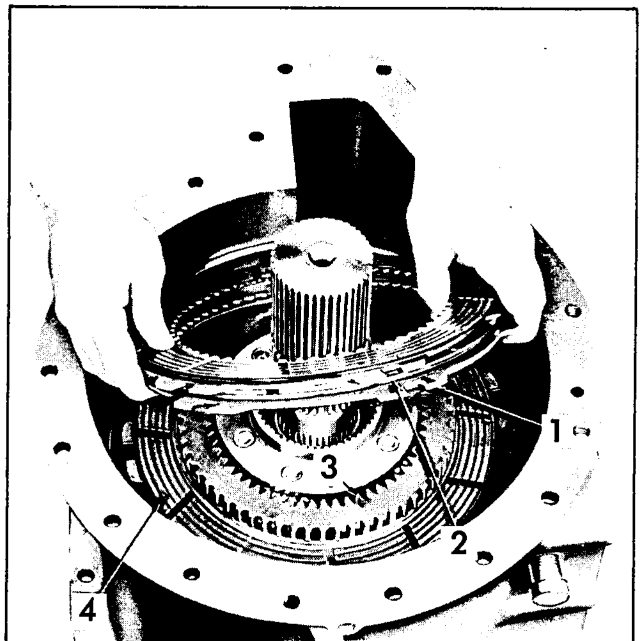

Fig. 74 — Remove High Range Clutch Plates

1. External Splined High Range Clutch Plate
2. Internal Splined High Range Clutch Plate
3. High Range Ring Gear
4. Clutch Plates

17. Remove the intermediate range clutch hub (Fig. 79) and the high range sun gear. Remove the snap ring from the transmission main shaft.

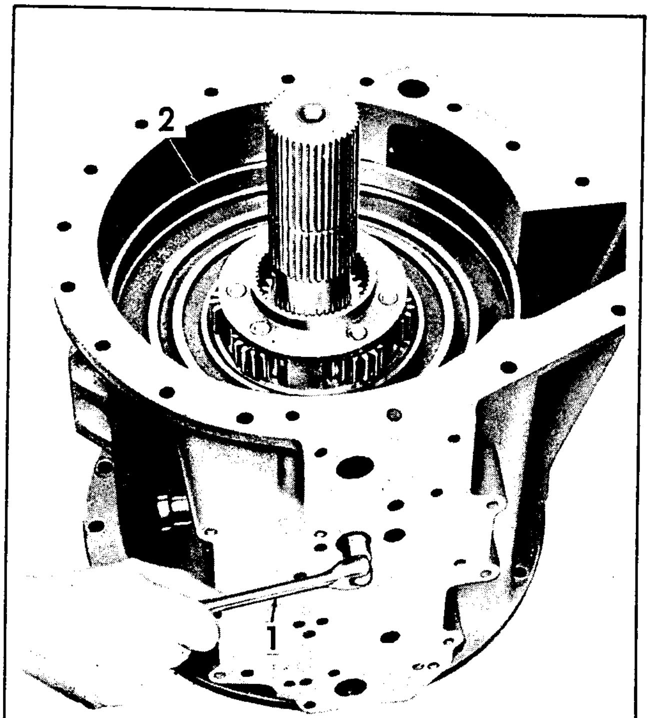

Fig. 75 — Remove High Range Piston Housing Retainer Capscrew

1. Wrench
2. High Range Piston and Housing Assembly

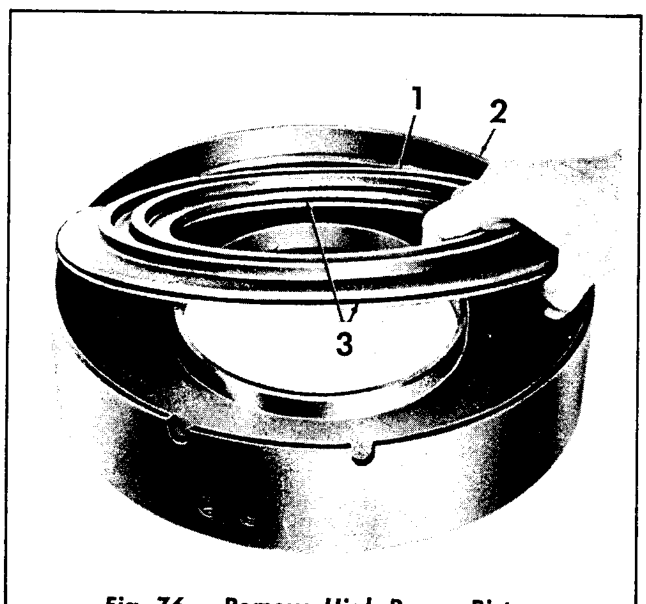

Fig. 76 — Remove High Range Piston and Housing

1. High Range Piston
2. Piston Housing
3. Piston Seals

18. Remove the five internal and the four external splined intermediate range clutch plates (Fig. 80). Remove the snap ring from the forward carrier shaft.

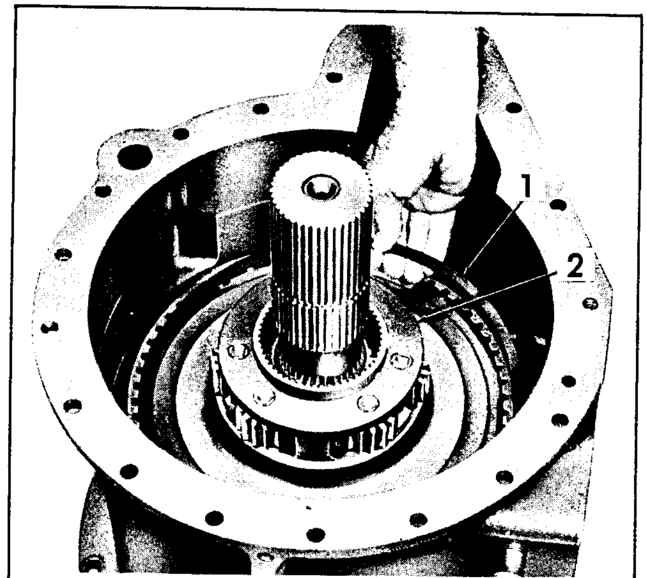

Fig. 77 — Remove Intermediate Range Clutch Hub Snap Ring

1. Internal Snap Ring
2. High Range Planetary Carrier Assembly

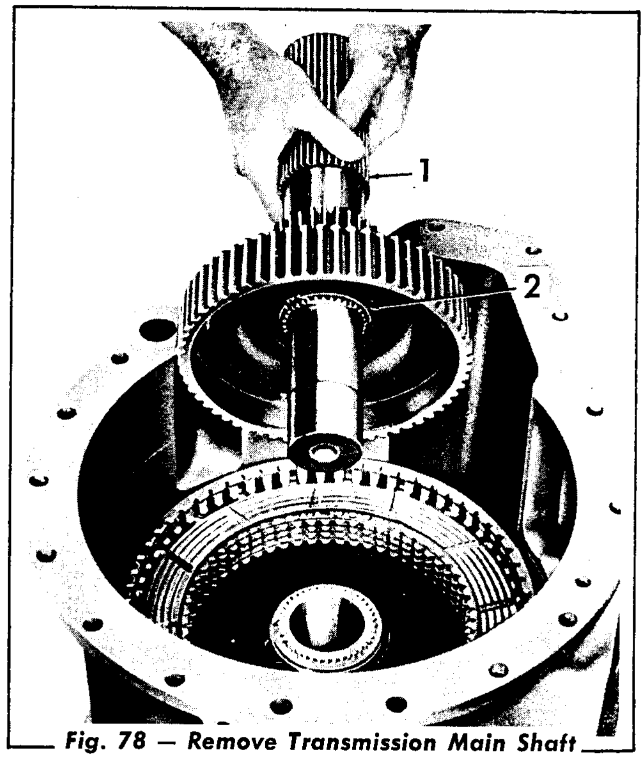

Fig. 78 — Remove Transmission Main Shaft

1. Transmission Main Shaft
2. Snap Ring

19. Install the external splined clutch plate (Fig. 81) and snap the ring into the intermediate range clutch drum. Grasp the plate and remove the drum assembly.

20. Using a soft drift (Fig. 82) and block, tap

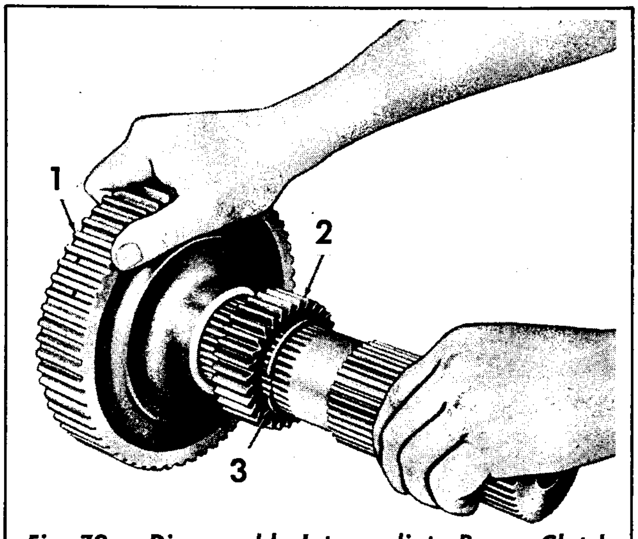

Fig. 79 — Disassemble Intermediate Range Clutch Hub and High Range Sun Gear

1. Intermediate Range Clutch Hub
2. High Range Sun Gear
3. Snap Ring

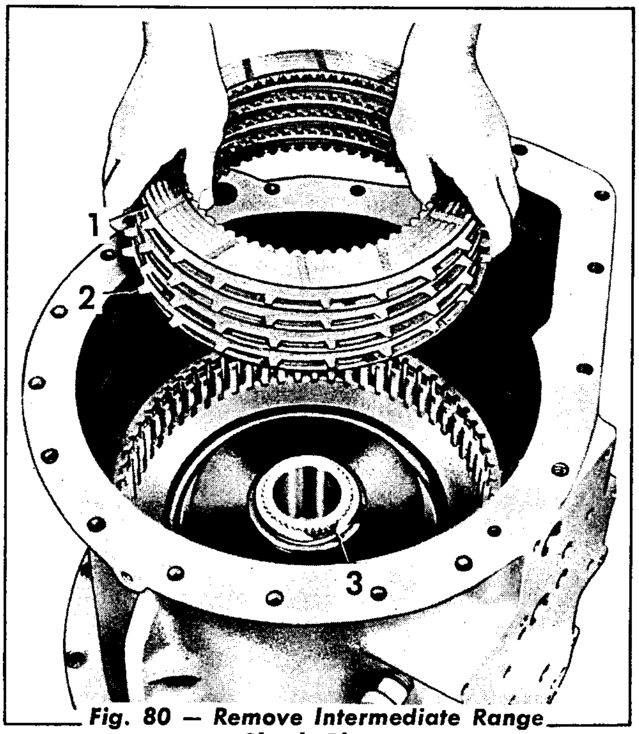

Fig. 80 — Remove Intermediate Range Clutch Plates

1. Internal Splined Intermediate Range Clutch Plates (5)
2. External Splined Intermediate Range Clutch Plates (4)
3. Snap Ring

on the forward carrier shaft.

CAUTION: *Be certain that the transmission housing (4) is blocked sufficiently high to allow the forward range carrier to drop out.*

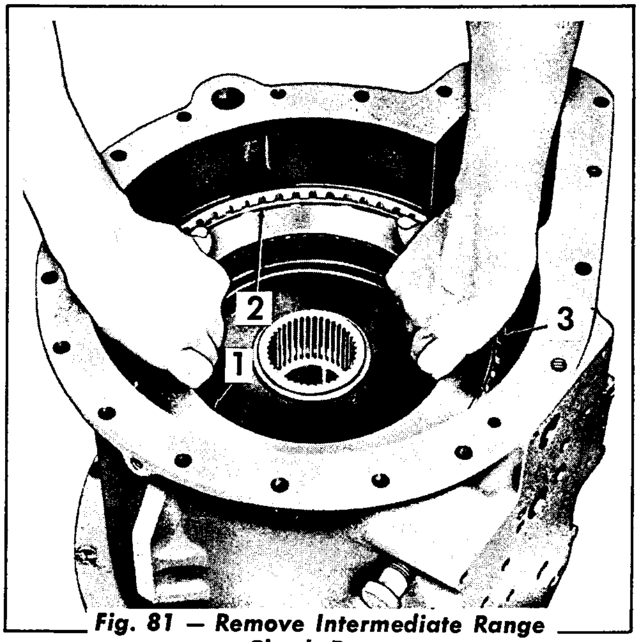

Fig. 81 — Remove Intermediate Range Clutch Drum

1. External Splined Clutch Plate
2. Ring
3. Drum Assembly

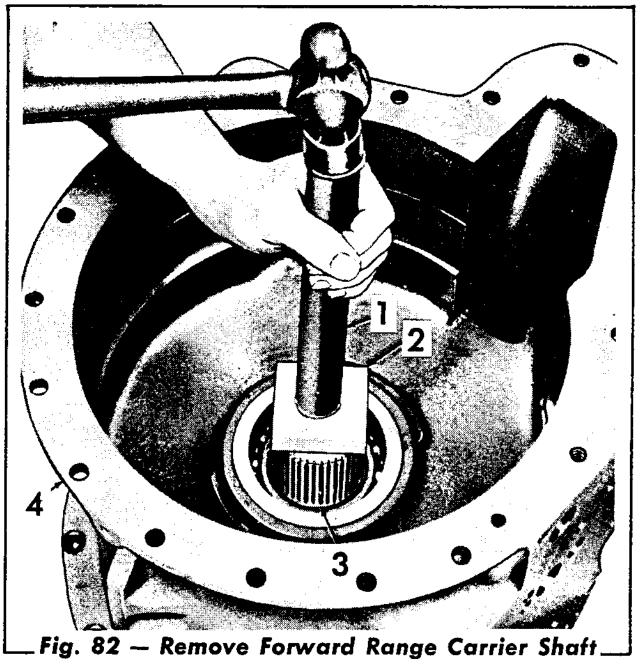

Fig. 82 — Remove Forward Range Carrier Shaft

1. Drift
2. Block
3. Forward Carrier Shaft

21. Position the transmission housing (Fig. 83) on its side and remove the self-locking capscrews and the two bearing retainers. Remove one external and one internal splined forward clutch plates. Remove the forward ring gear.

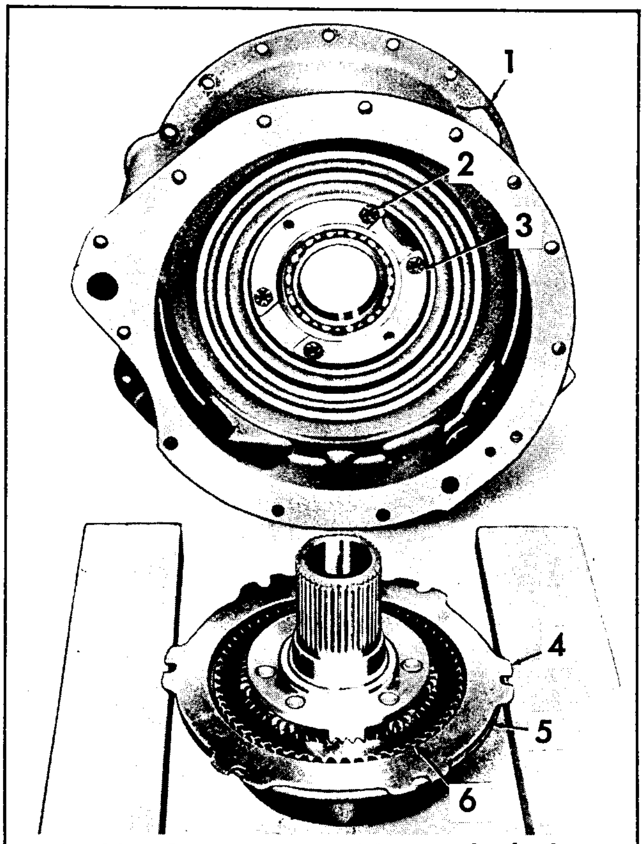

Fig. 83 — Remove Forward Range Clutch Plates

1. Transmission Housing
2. Self-Locking Capscrew
3. Bearing Retainer
4. External Splined Forward Clutch Plate
5. Internal Splined Forward Clutch Plate
6. Forward Ring Gear

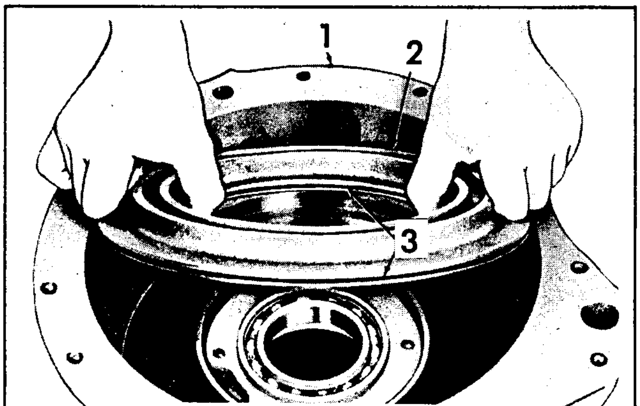

Fig. 84 — Remove Forward Piston

1. Transmission Housing
2. Forward Piston
3. Seal Rings

22. Position the transmission housing (Fig. 84) on the work table with the piston up and remove the forward piston. Remove the seal rings from the piston.

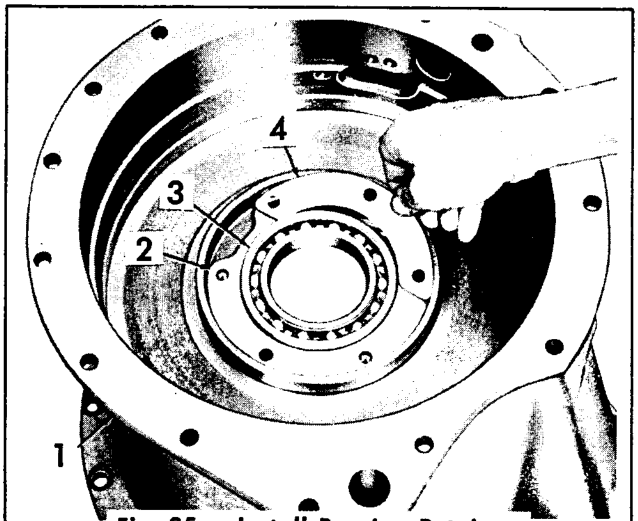

Fig. 85 — Install Bearing Retainers

1. Transmission Housing
2. Hub
3. Bearing
4. Bearing Retainer

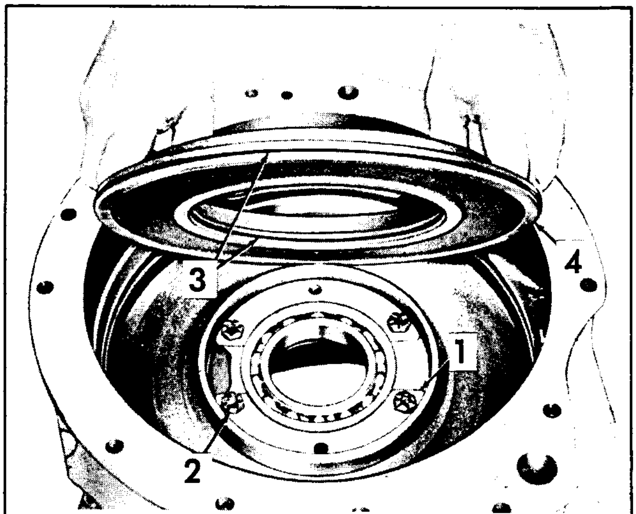

Fig. 86 — Install Forward Piston and Seal Rings

1. Retainer
2. Self-Locking Capscrew
3. Piston Seal Rings
4. Forward Piston

C. Center Group, Assembly

1. Position the transmission housing (Fig. 85), rear end up, on wooden blocks. If the hub and the bearings were removed, press the hub and the bearing toward the rear of the housing aligning the capscrew holes. Install the two bearing retainers.

2. Secure both retainers (Fig. 86) with the self-locking capscrews. Oil the piston seal rings

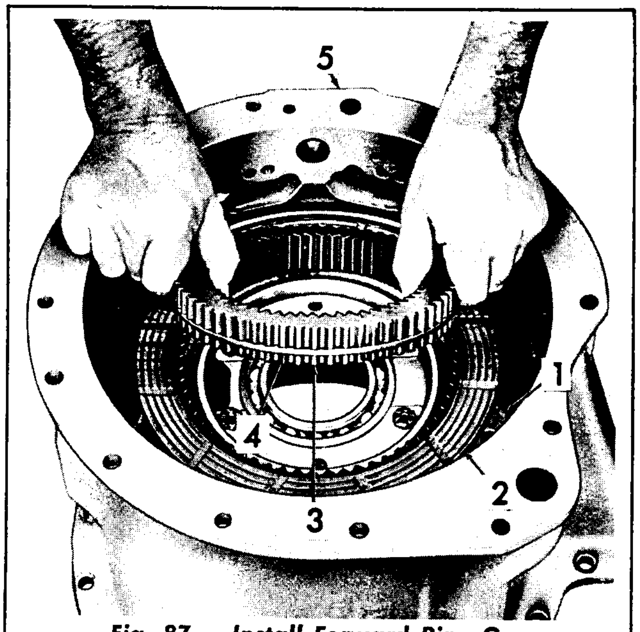

Fig. 87 — Install Forward Ring Gear

1. External Splined Forward Clutch Plate
2. Internal Splined Forward Clutch Plate
3. Forward Ring Gear
4. Positioning Ring
5. Housing

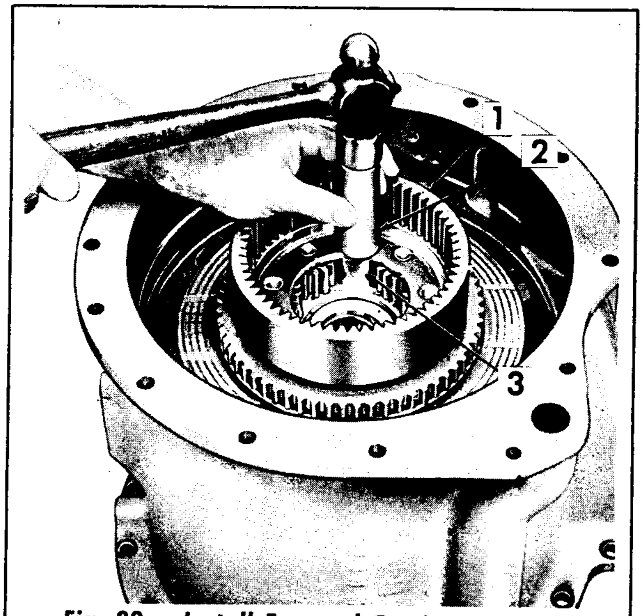

Fig. 88 — Install Forward Carrier Assembly

1. Forward Carrier Assembly
2. Drift
3. Carrier Web

and install them on the forward piston. Install the piston into the housing.

3. Install one external (Fig. 87) and one internal splined forward clutch plate. Install the forward ring gear with the positioning ring toward the rear of the housing.

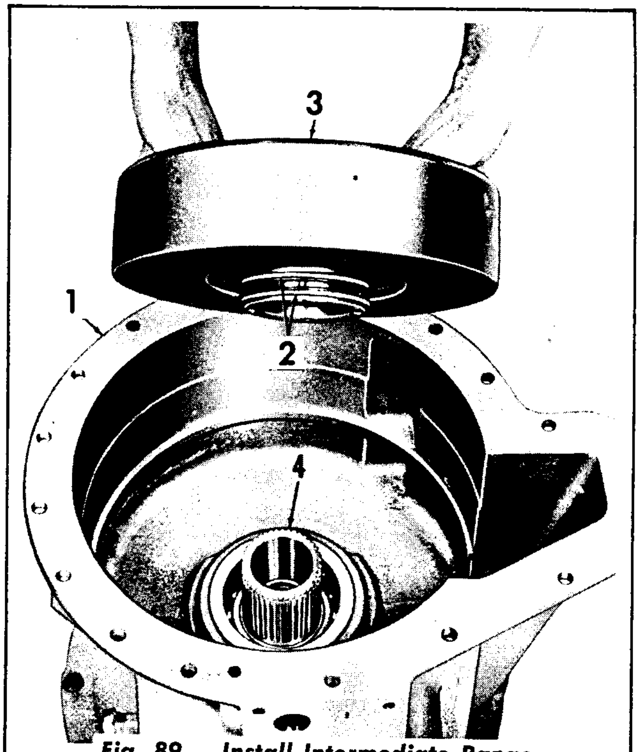

Fig. 89 — Install Intermediate Range Clutch Housing

1. Transmission Housing
2. Seal Rings (Hook Type)
3. Intermediate Range Clutch Housing
4. Forward Carrier Hub

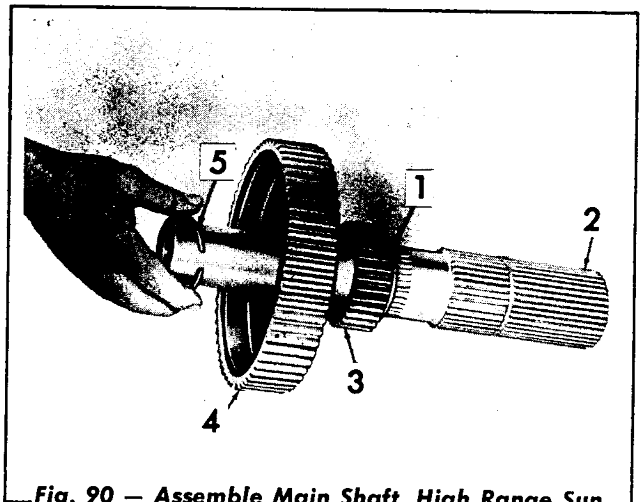

Fig. 90 — Assemble Main Shaft, High Range Sun Gear, and Intermediate Range Clutch Hub

1. Snap ring
2. Transmission Main Shaft
3. High Range Sun Gear
4. Intermediate Range Clutch Hub
5. Snap Ring

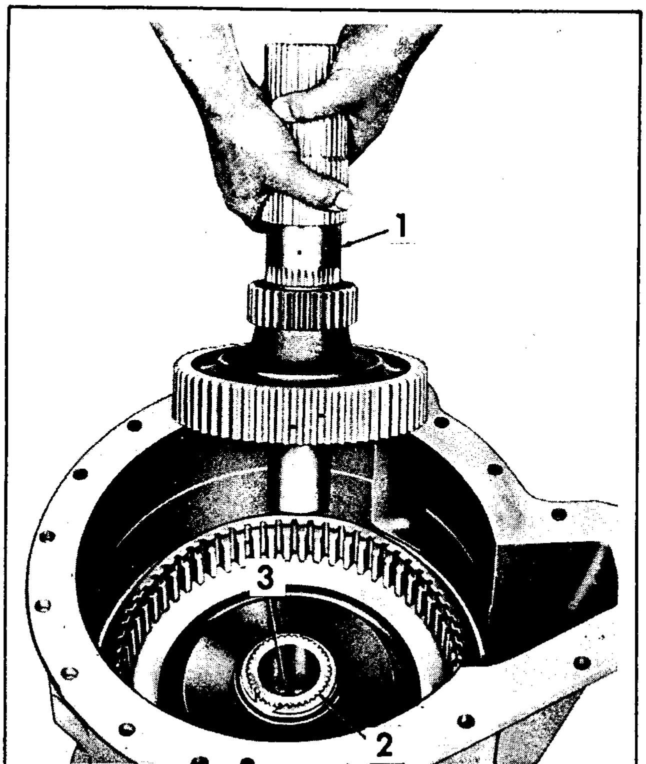

Fig. 91 — Install Main Shaft Into Forward Carrier Hub

1. Transmission Main Shaft
2. Forward Carrier Hub
3. Bushing

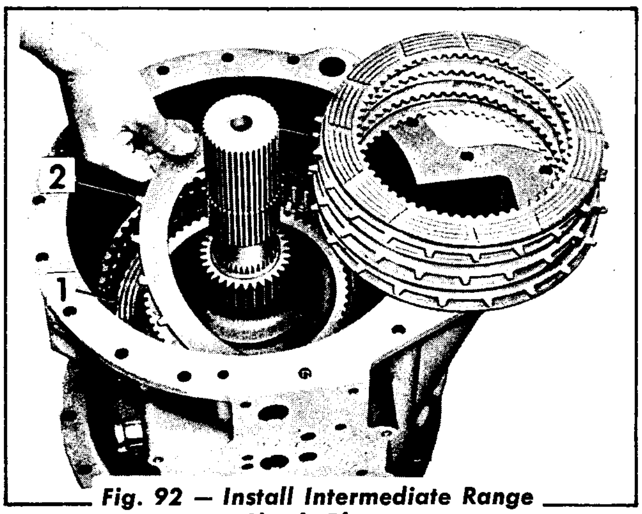

Fig. 92 — Install Intermediate Range Clutch Plates

1. Internal Splined Intermediate Range Clutch Plate
2. External Splined Intermediate Range Clutch Plate

4. Install the forward carrier assembly (Fig. 88) aligning the pinions with the internal splines of the forward ring gear. Using a soft drift on the carrier web, seat the carrier in its bearing.

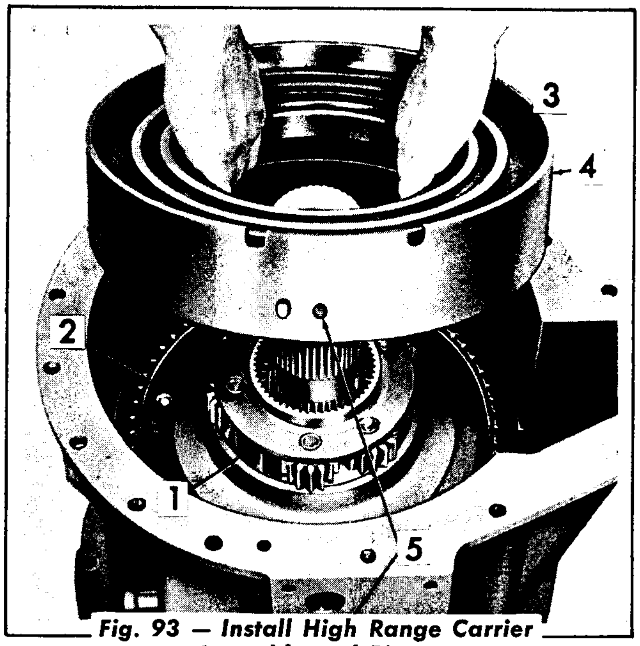

Fig. 93 — Install High Range Carrier Assembly and Piston

1. High Range Carrier Assembly
2. Internal Snap Ring
3. High Range Piston
4. Piston Housing
5. Capscrew Holes

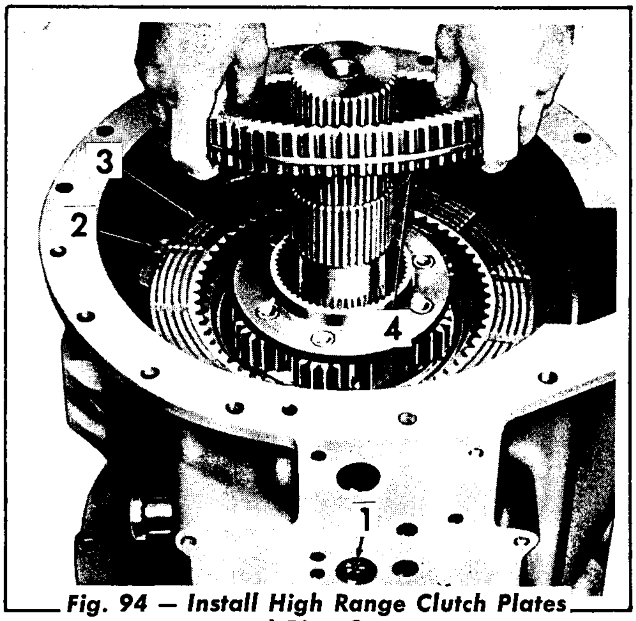

Fig. 94 — Install High Range Clutch Plates and Ring Gear

1. High Range Piston Retainer Capscrew
2. External Splined High Range Clutch Plate
3. Internal Splined High Range Clutch Plate
4. High Range Ring Gear

5. Turn the transmission housing (Fig. 89) over to rest on its rear surface. Install and grease the hook type seal rings. Install the inter-

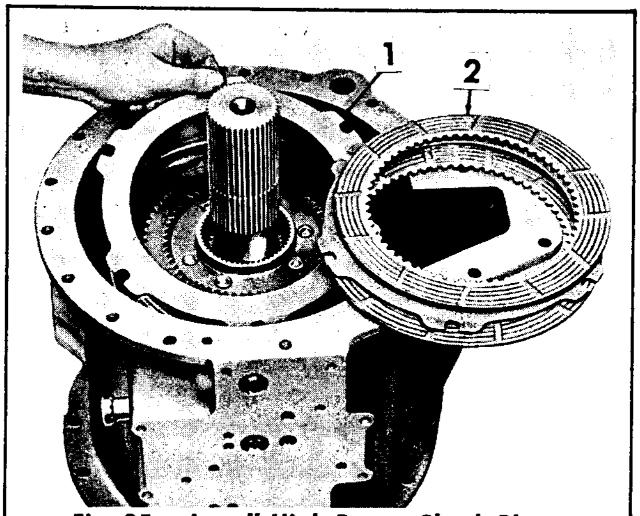

Fig. 95 — Install High Range Clutch Plates

1. External Splined High Range Clutch Plate
2. Internal Splined High Range Clutch Plate

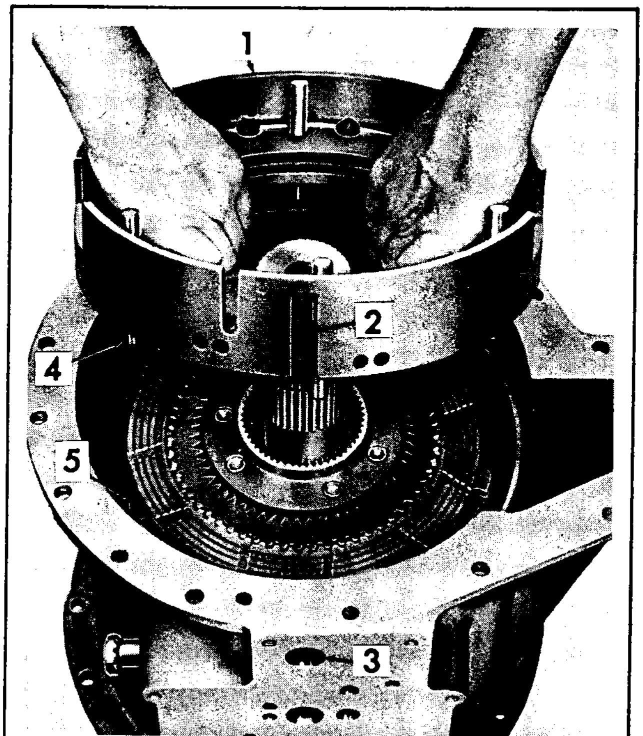

Fig. 96 — Install High and Low Range Clutch Anchor

1. High and Low Range Clutch Anchor
2. Slot
3. Hole
4. Pin
5. Tang

mediate range clutch housing onto the forward carrier hub.

6. Install the snap ring (Fig. 90) on the transmission main shaft. Install the high range sun gear and the intermediate range clutch hub. Secure the hub with the snap ring.

7. Install the transmission main shaft and attached parts (Fig. 91) into the forward carrier hub. Be careful not to damage the bushing.

8. Beginning with an internal splined plate (Fig. 92), alternately install five internal and four external splined intermediate range clutch plates.

9. Install the high range carrier assembly (Fig. 93) and secure it with the internal snap ring. Install the high range piston into the piston housing. Install the piston housing assembly aligning the capscrew holes.

10. Install the high range piston retainer capscrew (Fig. 94). Install one external and one internal splined high range clutch plates. Install the high range ring gear with the short splines down.

11. Beginning with an external splined plate (Fig. 95), alternately install two external and two internal splined high range clutch plates. Align the splines of the external splined plates.

12. Install the high and low range clutch anchor (Fig. 96), aligning the slot with the hole. Be sure that the pins align with the slotted tangs.

13. Install the clutch anchor pin (Fig. 97). Install the low range sun gear, the thrust washer, and the low range planetary carrier assembly, aligning the carrier pinions with the sun gear.

14. Grasp the shaft (Fig. 98) and pull upward to install the snap ring. Beginning with an internal splined plate, alternately install four internal and three external splined low range clutch plates. Install the low range ring gear with the short splines up.

15. Install the remaining internal (Fig. 99) and the two external splined low range clutch plates.

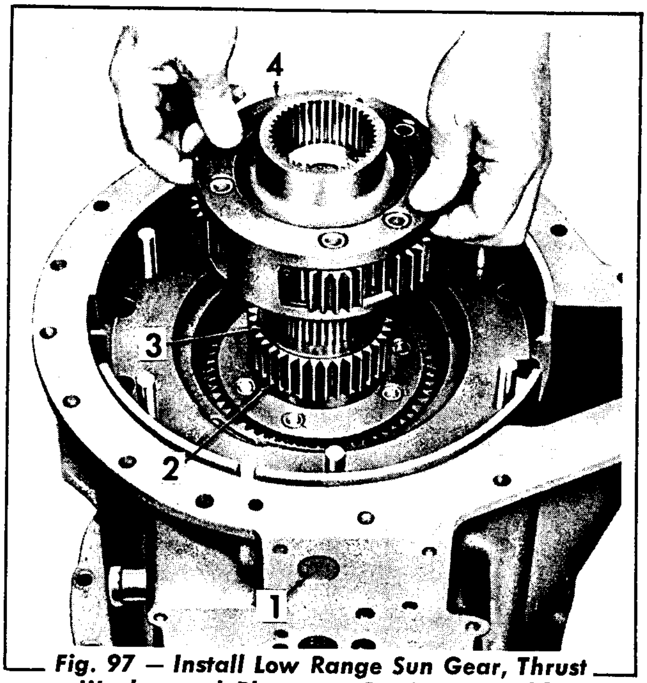

Fig. 97 — Install Low Range Sun Gear, Thrust Washer and Planetary Carrier Assembly

1. Clutch Anchor Pin
2. Low Range Sun Gear
3. Thrust Washer
4. Low Range Planetary Carrier Assembly

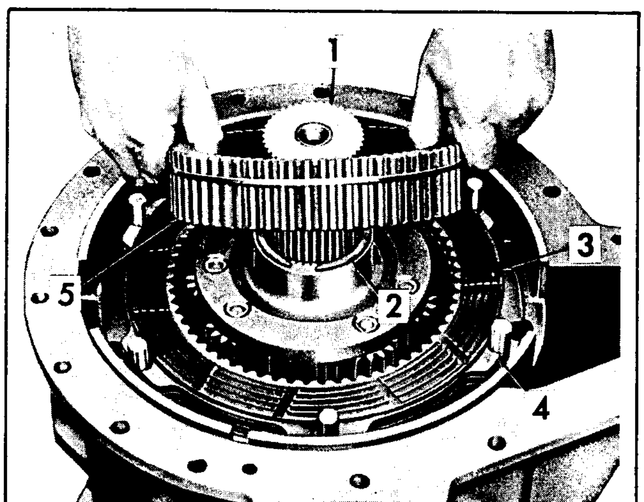

Fig. 98 — Install Low Range Clutch Plates and Ring Gear

1. Shaft
2. Snap Ring
3. Internal Splined Low Range Clutch Plate
4. External Splined Low Range Clutch Plate
5. Low Range Ring Gear

16. Install the twelve clutch return springs (Fig. 100) and the guide pins into their recesses in the high and low range clutch anchor. Install the gasket. All springs should be of

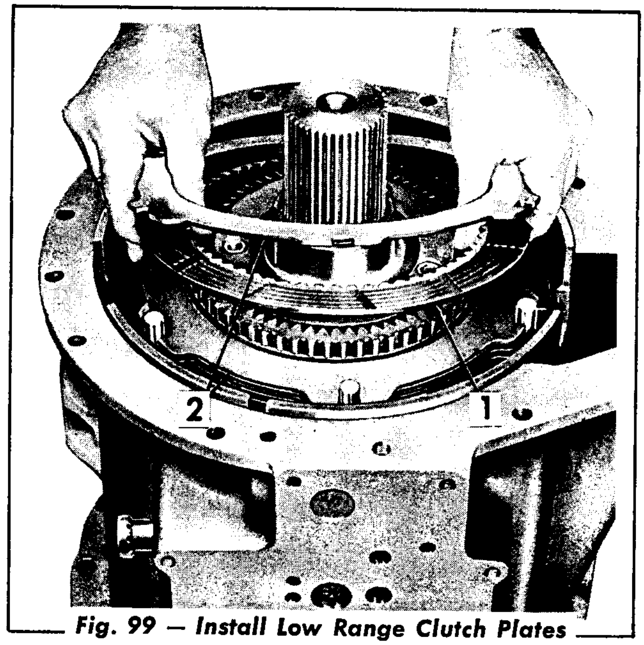

Fig. 99 — Install Low Range Clutch Plates

1. Internal Splined Low Range Clutch Plates
2. External Splined Low Range Clutch Plates

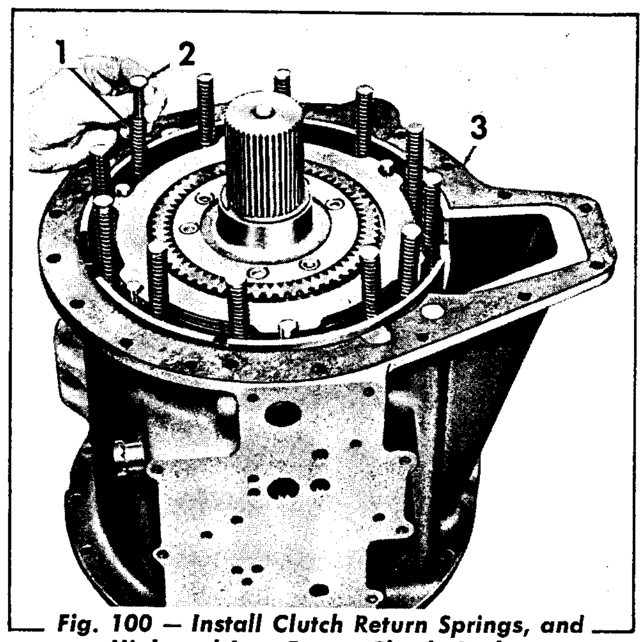

Fig. 100 — Install Clutch Return Springs, and High and Low Range Clutch Anchor

1. Clutch Return Spring (12)
2. Guide Pin
3. Gasket

equal height. If they are not, an external splined plate is out of position.

17. Attach a lifting sling (Fig. 101) to the center of the transfer gear housing and lower it onto the transmission housing, being certain that the springs remain straight and that

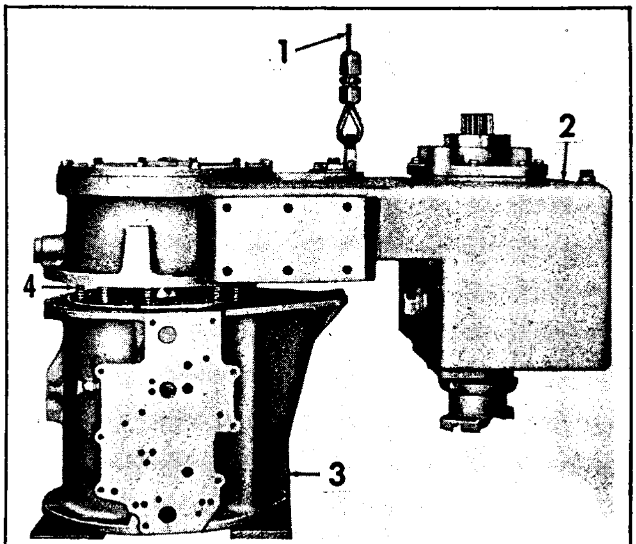

Fig. 101 — Positioning Transfer Gear Housing for Installation on Transmission Housing

1. Lifting Sling
2. Transfer Gear Housing
3. Transmission Housing
4. Spring

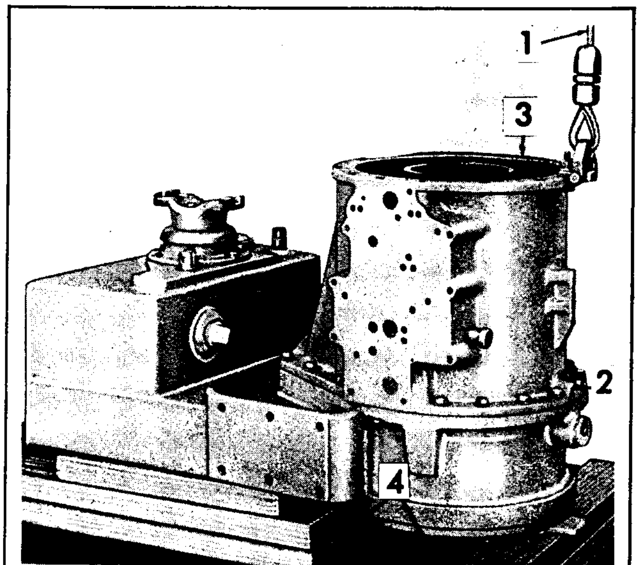

Fig. 102 — Positioning Transmission on Front Surface

1. Lifting Sling
2. Front Lifting Hole
3. Rear Split Line
4. Wooden Blocks

the capscrew holes are aligned. Install the eighteen capscrews and lockwashers at the split line. Place wood blocks under the housing.

18. First, attach a lifting sling (Fig. 102) to the

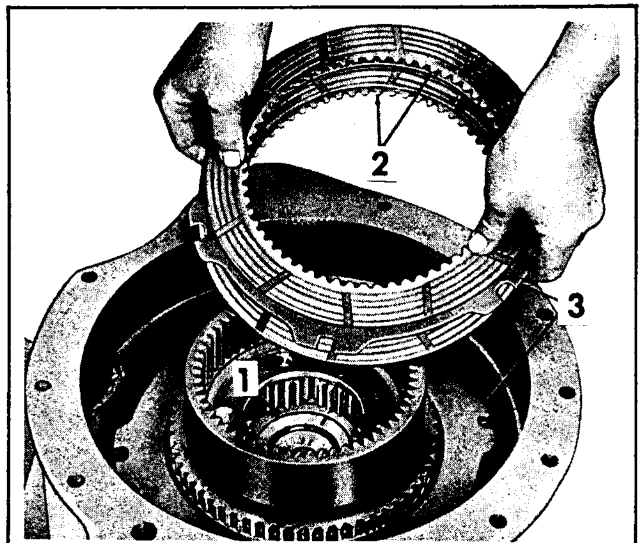

Fig. 103 — Install Thrust Washer and Forward Clutch Plates

1. Thrust Washer
2. Internal Splined Forward Clutch Plates
3. External Splined Forward Clutch Plates

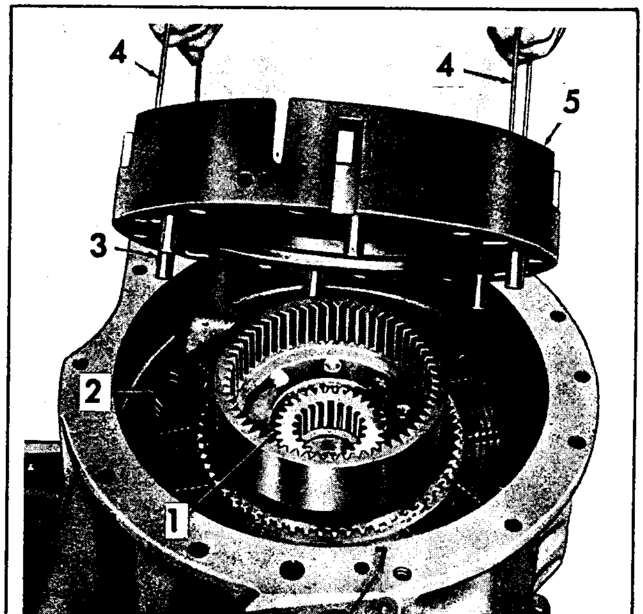

Fig. 104 — Install Forward Sun Gear, and Forward and Reverse Clutch Anchor

1. Forward Sun Gear
2. External Splined Clutch Plate Tang
3. Anchor Pin
4. Wire Lifting Hooks
5. Forward and Reverse Clutch Anchor
6. Aligning Pin Slot
7. Hole

front lifting hole and raise the transmission to a vertical position. Next, attach the lifting sling to the rear split line and lower the

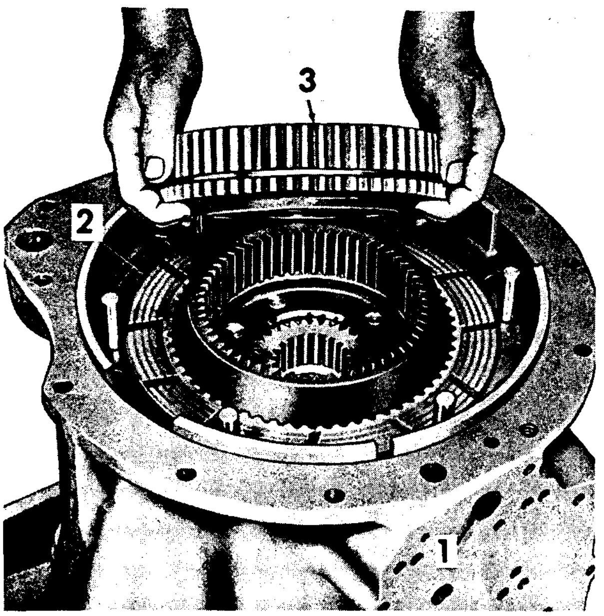

Fig. 105 — Install Reverse Carrier Assembly

1. Clutch Anchor Pin
2. Internal Splined Reverse Clutch Plate
3. Reverse Carrier Assembly

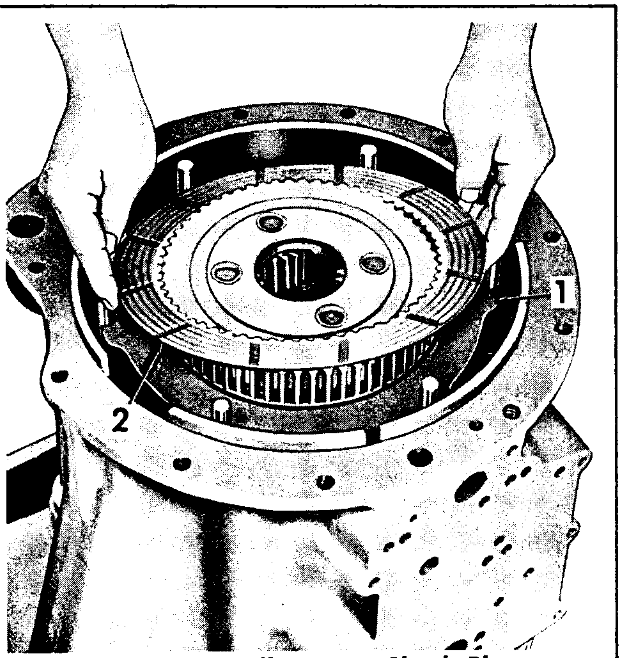

Fig. 106 — Install Reverse Clutch Plates

1. External Splined Reverse Clutch Plate
2. Internal Splined Reverse Clutch Plate

transmission to rest on its front surface. Use wooden blocks to level the transmission.

19. Install the thrustwasher (Fig. 103) inside the forward carrier. Beginning with an external splined clutch plate, alternately install two internal and two external splined forward clutch plates.

20. Install the forward sun gear (Fig. 104) with the flat side up. Align the external splined clutch plate tangs with the anchor pins. Using wire lifting hooks, install the forward and reverse clutch anchor, aligning pin slot with hole.

21. Install the clutch anchor pin (Fig. 105). Install one internal splined reverse clutch plate. Install the reverse carrier assembly with the short splines down.

22. Beginning with an external splined plate, alternately install five external (Fig. 105), and four internal splined reverse clutch plates.

D. Forward and Reverse Range Planetaries and Clutches

1. General

All items, except 7 and 22, Fig. 107, are disassembled in Par. B, in this Topic.

2. Reverse Planetary Carrier, Disassembly (Fig. 107)

a. Using a drill of slightly smaller diameter than the outside diameter of the planetary spindle pin (10), drill a hole in one end of each pin to weaken the staking.

b. Press on the drilled end of each pin (10) to remove them from the planetary carrier (13) and the planetary hub (8).

c. Remove the pinion rollers (9), the thrust washers (11), and the planetary pinions (12).

3. Forward Planetary Carrier, Disassembly (Fig. 107)

a. Remove the snap ring (29) and separate the reverse ring gear (21) from the carrier assembly (22).

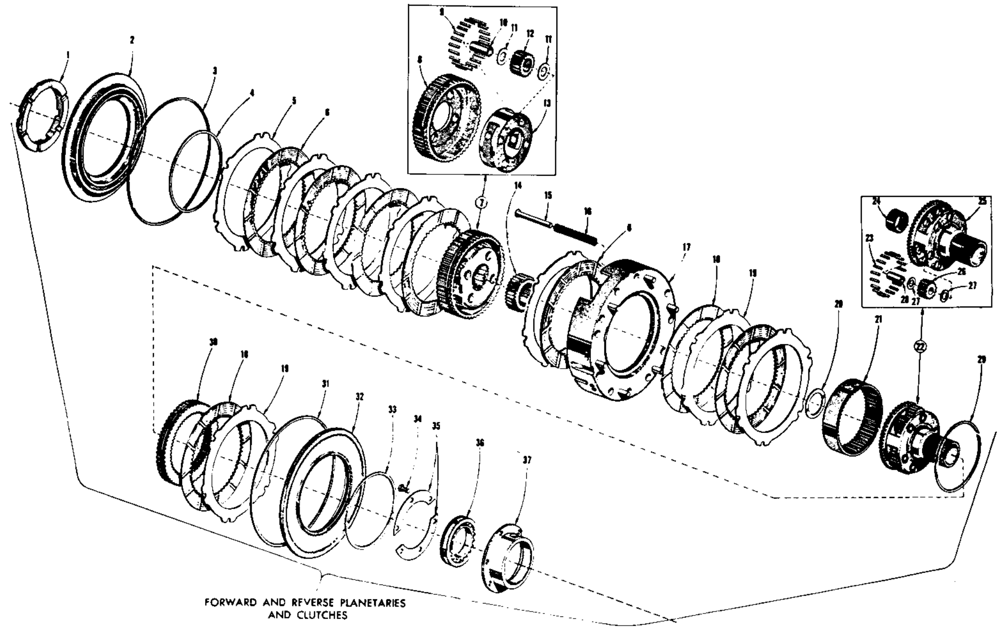

Fig. 107 — Forward and Reverse Planetaries and Clutches — Legend

1. Spacer
2. Clutch Apply Piston
3. Seal Ring
4. Seal Ring
5. External-Splined Clutch Plate
6. Internal-Splined Clutch Plate
7. Reverse Planetary Carrier Assembly
8. Reverse Planetary Hub
9. Planetary Pinion Roller
10. Planetary Spindle Pin
11. Pinion Thrust Washer
12. Planetary Pinion
13. Planetary Carrier
14. Forward Sun Gear
15. Spring Guide Pin
16. Piston Return Spring
17. Reverse Clutch Anchor
18. Internal-Splined Forward Clutch Plate
19. External-Splined Forward Clutch Plate
20. Thrust Washer
21. Reverse Ring Gear
22. Forward Planetary Carrier Assembly
23. Planetary Pinion Roller
24. Bushing
25. Forward Planetary Carrier
26. Forward Planetary Pinion
27. Pinion Thrust Washer
28. Planetary Spindle Pin
29. Internal-Snap Ring
30. Forward Ring Gear
31. Seal Ring
32. Forward Clutch Apply Piston
33. Seal Ring
34. Hexagon Head, Self-Locking Capscrew — $\frac{3}{8}$–16 x $\frac{7}{8}$
35. Bearing Retainer
36. Single-Row Ball Bearing
37. Oil Transfer Hub

Item	WEAR LIMITS DATA
5	External-splined Clutch Plate — Thickness $\frac{0.123}{0.107}$ in., 0.097 in. Minimum, Cone, 0.030 in. Maximum
6	Internal-splined Clutch Plate — Thickness $\frac{0.156}{0.150}$ in., 0.130 in. Minimum, Cone 0.012 in. Maximum
7	Reverse Planetary Carrier Assembly — Gear End Clearance with Unit Assembled, 0.55 in. Maximum
16	Piston Return Spring — 16.0 = 1.6 lb. at 5.34 in. Operating Height
17	Reverse Clutch Anchor — Face Wear 0.020 in. Maximum
20	Thrust Washer — Thickness 0.90-0.75 in.
22	Forward Planetary Carrier Assembly — Gear End Clearance with Unit Assembled, 0.55 in. Maximum
24	Bushing — Clearance with Transmission Main Shaft — 0.010 in. Maximum. (See Item 17, Fig. 111)
	Total Clutch Wear Permissible — Forward 0.162 in. Maximum
	Reverse 0.307 in. Maximum
	Groove Depth in Internal-splined Plates — Not Less Than 0.005 in.

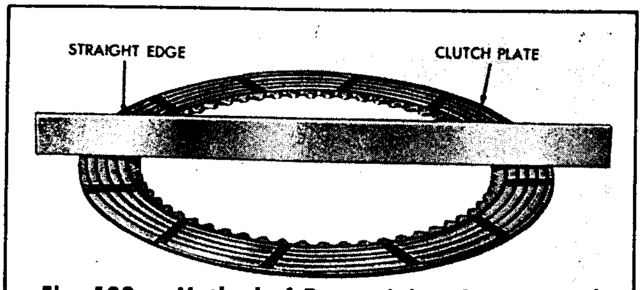

Fig. 108 — Method of Determining Amount and Direction of Clutch Plate Cone

b. Using a drill of slightly smaller diameter than the outside diameter of the planetary spindle pin (28), drill a hole in one end of each spindle to weaken the staking.

c. Press on the drilled end of each pin (28) to remove them from the planetary carrier (25).

d. Remove the planetary pinion rollers (23), the thrust washers (27), and the planetary pinions (26).

e. If necessary for parts replacement, use a soft drift and hammer to drive the bushing (24) toward the large opening in the carrier (25).

4. Cleaning, Inspection, and Wear Limits

Refer to Topic 4 for cleaning and inspection. All clutch plates should be inspected to determine the amount and the direction of cone. Place the plate on a flat surface and lay a straight edge across the plate (Fig. 108). Measure the amount of cone by placing a thickness gauge between the straight edge and the inside diameter of the plate. When assembling the plates, be sure that the cone of each plate is installed in the same direction. Refer to Fig. 107 for wear limits.

5. Forward Planetary Carrier, Assembly (Fig. 107)

a. If the bushing (24) was removed, press in a new bushing to the depth shown in Fig. 109.

b. Grease the pinion thrust washers (27) and install one on one end of each planetary pinion (26).

c. Grease the bores of the planetary pinions (26) and install twenty pinion rollers (23) into each pinion. An aligning tool placed in the bore of the pinion will facilitate this

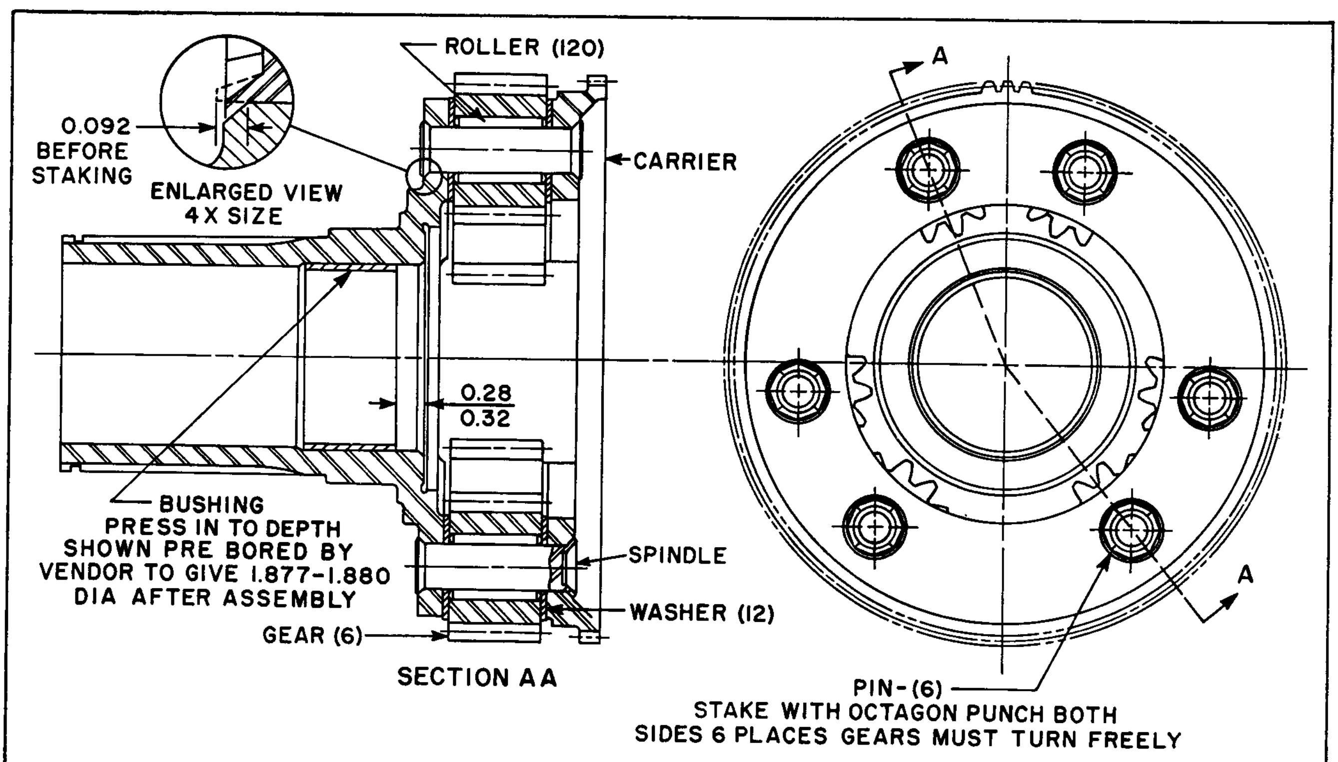

Fig. 109 — Forward Planetary Carrier — Cross Section

installation. The tool can be made by grinding a discarded spindle pin to 0.005" undersize.

Install a pinion thrust washer (27) on the other end of each planetary pinion (26).

d. Install, as a unit, the pinions, the rollers, and the washers into the planetary carrier (25).

e. Align the bores in the pinions with the bores in the carrier and press the planetary spindle pins (28) into the carrier (25) to the dimensions shown in Fig. 109. Stake both sides of each spindle pin with an octagon punch. Check each pinion after staking it to see that they rotate freely.

f. Install the reverse ring gear (21) onto the forward planetary carrier assembly (22) and secure it with the snap ring (29).

6. Reverse Planetary Carrier, Assembly (Fig. 107)

a. Grease the pinion thrust washers (11) and install one on one end of each planetary pinion (12).

b. Grease the bores of the pinions (12) and install twenty-two pinion rollers (9) onto each pinion. An aligning tool placed in the bore of the pinion will facilitate this installation. The tool can be made by grinding a discarded spindle pin to 0.005" undersize. Install a pinion thrust washer (11) on the other end of each planetary pinion (12).

c. Install, as a unit, the pinions, the rollers, and the washers into the planetary carrier (13).

d. Align the bores in the pinions with the bores in the carrier and planetary hub (8) and press new spindle pins (10) into the carrier

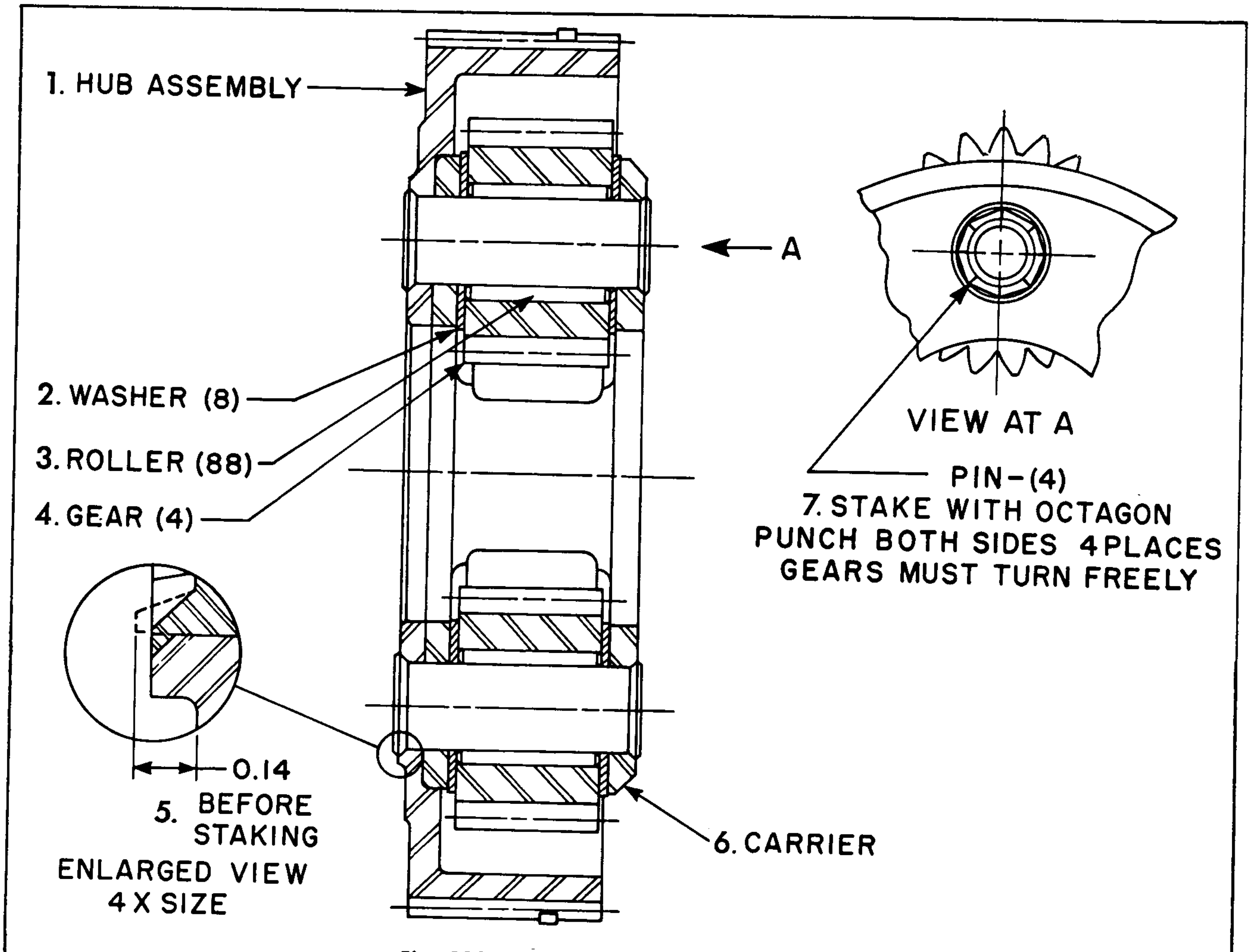

Fig. 110 — Reverse Planetary Carrier — Cross Section

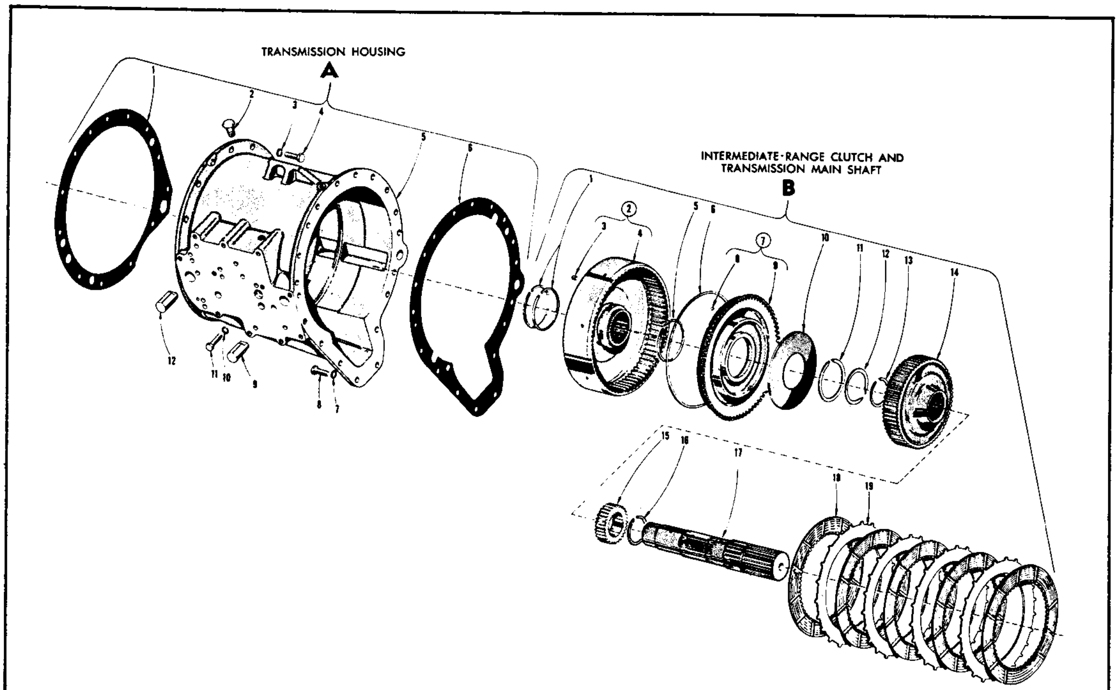

Fig. 111 — Transmission Housing, Intermediate Range Clutch, and Transmission Main Shaft — Legend

A — TRANSMISSION HOUSING

1. Converter Housing Gasket
2. Breather
3. Lock Washer — $\frac{7}{16}$
4. Hexagon-Head Capscrew — $\frac{7}{16}$–14 x $1\frac{3}{8}$
5. Transmission Housing
6. Transmission Housing Gasket
7. Lockwasher — $\frac{7}{16}$
8. Hexagon-Head Capscrew — $\frac{7}{16}$–14 x $1\frac{3}{8}$
9. Low- and High-Range Clutch Anchor Pin
10. Lockwasher — $\frac{3}{8}$
11. Hexagon-Head Capscrew — $\frac{3}{8}$–16 x $1\frac{1}{2}$
12. Forward and Reverse Clutch Anchor Pin

B — INTERMEDIATE-RANGE CLUTCH AND TRANSMISSION MAIN SHAFT

1. Hook-Type Seal Ring
2. Intermediate-Range Clutch Drum Assembly
3. Pin, $\frac{1}{4}$ x $\frac{1}{4}$
4. Drum
5. Hook-Type Seal Ring
6. Piston Outer-Seal Ring
7. Intermediate-Range Clutch Apply Piston Assembly
8. Ball
9. Intermediate Range Clutch Apply Piston
10. Piston Belleville Return Spring
11. Spring Retainer Snap Ring
12. Drum Retainer Snap Ring
13. Hub Retainer Snap Ring
14. Intermediate-Range Clutch Hub
15. High-Range Sun Gear
16. Sun Gear Retainer Snap Ring
17. Transmission Main Shaft
18. Internal-Splined Clutch Plate
19. External-Splined Clutch Plate

Item	WEAR LIMITS DATA
9	Intermediate-range Clutch Apply Piston — Face Wear 0.010 in. Maximum
10	Piston Belleville Return Spring — Free Height at $\frac{0.259}{0.279}$ in.
18	Internal-splined Clutch Plate — Thickness $\frac{0.156}{0.150}$ in., 0.130 in. Minimum, Cone 0.012 in. Maximum
19	External-splined Clutch Plate — Thickness $\frac{0.123}{0.127}$ in., 0.197 in. Minimum, Cone 0.030 in. Maximum
	Total Clutch Wear Permissible — 0.080 in. Maximum
	Groove Depth in Internal-splined Plates — Not Less Than 0.005 in.

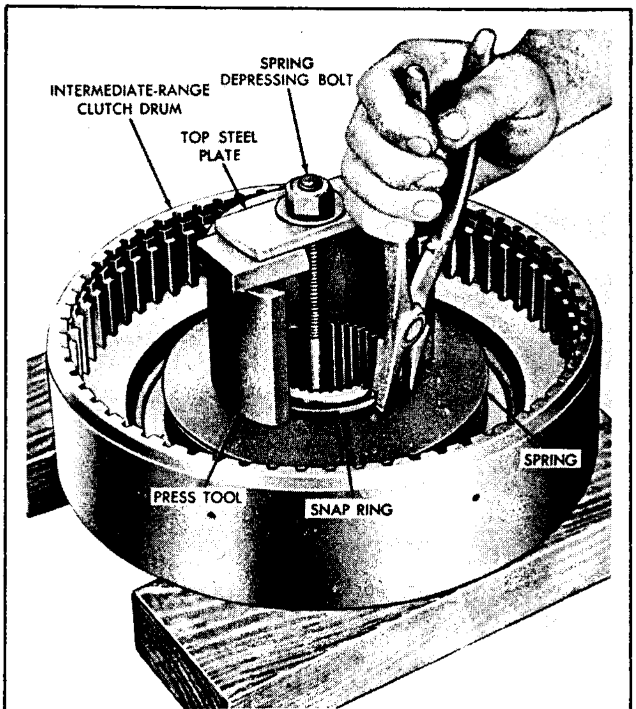

Fig. 112 — Removing (or Installing) Intermediate Range Clutch Snap Ring

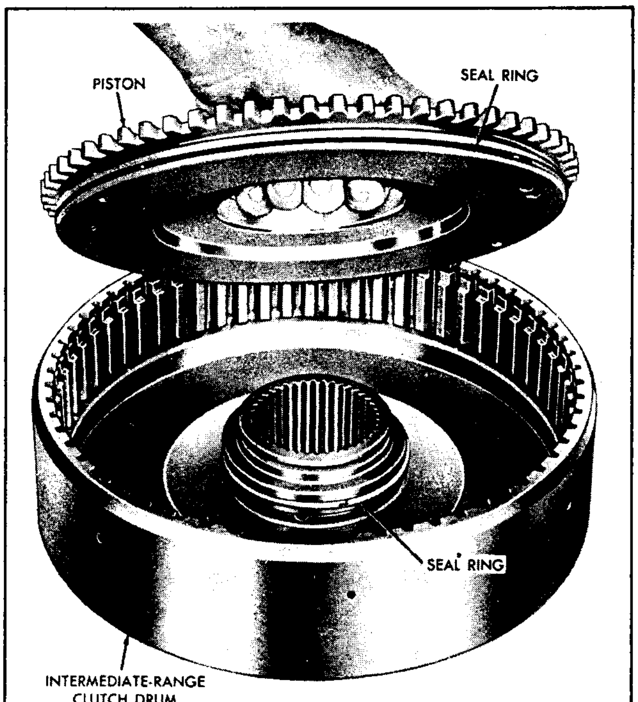

Fig. 113 — Removing (or Installing) Intermediate Range Piston Assembly

(13) and the hub (8) to the dimension shown in Fig. 110. Stake both sides of each spindle pin with an octagon punch. Check each pinion after staking to see that it rotates freely.

E. Intermediate Range Clutch and Transmission Main Shaft

1. General

All items, except 1 through 11, Fig. 111, are removed in Par. B, in this Topic.

2. Intermediate Range Clutch and Transmission Main Shaft, Disassembly (Fig. 111)

a. Remove the two hook type seal rings (1) from the intermediate clutch drum (4).

b. Place the intermediate range clutch drum assembly on wooden blocks (Fig. 112). Place a steel plate, similar to the one shown in Fig. 112, under the clutch drum. This plate, and the one shown in Fig. 112, must have a ½" hole drilled through the center for the spring depressing capscrew. Place a press tool on the spring (Fig. 112). Install a capscrew and nut through the bottom steel plate (not shown), the press tool, and the top steel plate. Tighten the nut to depress the spring (Fig. 112).

c. Using snap ring pliers, remove the spring retainer snap ring and remove the press tool.

d. Remove the piston return spring.

e. Remove the intermediate range piston assembly and remove the seal ring from the piston. Remove the hook type seal ring from the drum (Fig. 113).

3. Cleaning, Inspection, and Wear Limits

Refer to Topic 4 for cleaning and inspection.

Refer to Fig. 111 for wear limits.

4. Intermediate Range Clutch and Transmission Main Shaft, Assembly (Fig. 111)

a. Install the seal ring onto the intermediate range piston (Fig. 113). Install the hook type seal ring onto the intermediate range clutch drum.

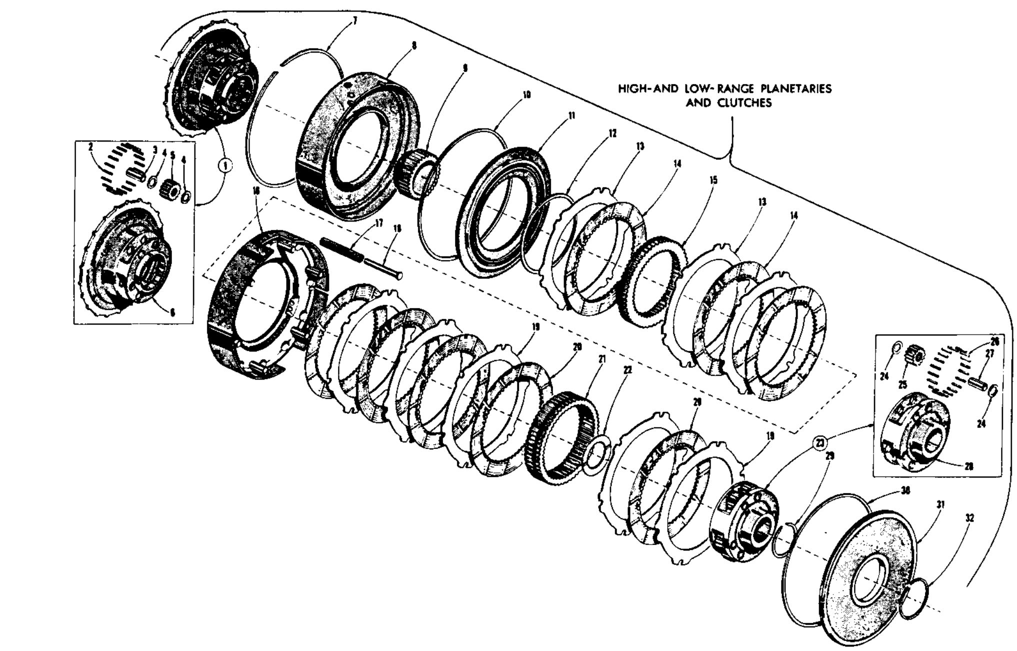

Fig. 114 — High and Low Range Planetaries and Clutches

1. High-Range Planetary Carrier Assembly
2. Planetary-Pinion Roller
3. Planetary Pinion Pin
4. Pinion Thrust Washer
5. Planetary Carrier Pinion
6. High-Range Carrier
7. Carrier Retainer Snap Ring
8. High-Range Piston Housing
9. Low-Range Sun Gear
10. Piston Outer-Seal Ring
11. High-Range Clutch Piston
12. Piston Inner-Seal Ring
13. External-Splined Clutch Plate
14. Internal-Splined Clutch Plate
15. High-Range Planetary Ring Gear
16. High- and Low-Range Clutch Anchor
17. Piston Return Spring
18. Spring Guide Pin
19. External-Splined, Low-Range Clutch Plate
20. Internal-Splined, Low-Range Clutch Plate
21. Low-Range Planetary Ring Gear
22. Thrust Washer
23. Low-Range Planetary Carrier Assembly
24. Pinion Thrust Washer
25. Low-Range Planetary Pinion
26. Planetary Pinion Roller
27. Planetary Pinion Pin
28. Planetary Carrier
29. Carrier Retainer Snap Ring
30. Piston Outer-Seal Ring
31. Low-Range Planetary Piston
32. Piston Inner Hook-Type Seal Ring

WEAR LIMITS DATA

Item	
1	High-range Carrier Assembly-gear End Clearance with Unit Assembled, 0.055 in. Maximum
6	High-range Carrier — Reaction Surface Face Wear, 0.010 in. Maximum
13, 19	External-splined, Low- and High-range Clutch Plate — Thickness $\frac{0.123}{0.107}$ in., 0.097 in. Minimum, Cone 0.030 in. Maximum
14, 20	Internal-splined Low- and High-range Clutch Plate — Thickness $\frac{0.156}{0.150}$ in., 0.130 in. Minimum, Cone 0.012 in. Maximum
16	High- and Low-range Clutch Anchor — Face Wear 0.020 in. Maximum
17	Piston Return Spring — 16.0 = 1.6 lb. at 5.34 in. Operating Height
22	Thrust Washer — Thickness 0.126-0.122 in., 0.112 in. Maximum
23	Low-range Planetary Carrier Assembly — Gear End Clearance with Unit Assembled, 0.035 in. Maximum
	Total Clutch Wear Permissible — High Range, 0.062 in.
	— Low Range, 0.134 in.
	Groove Depth in Internal-splined Plates — Not Less Than 0.005 in.

b. Install the piston into the clutch drum (Fig. 113). Install the piston return spring (10), convex side up.

c. Install the press tool (refer to Step 2 in the disassembly procedures) and install the snap ring (Fig. 112).

d. Install the two hook type seal rings (1) onto the intermediate range clutch drum.

F. High and Low Range Planetaries and Clutches

1. General

All items, except 1 and 23, Fig. 114, were disassembled in Par. B, in this Topic.

2. High Range Planetary Carrier, Disassembly (Fig. 114)

a. Using a drill of slightly smaller diameter than the outside diameter of the planetary pinion pin (3), drill a hole in one end of each pin to weaken the staking.

b. Press on the drilled end of each pin (3) to remove them from the planetary carrier (6).

c. Remove the pinion rollers (2), the pinion thrust washers (4) and the planetary pinions (5).

3. Low Range Planetary Carrier, Disassembly (Fig. 114)

a. Using a drill of slightly smaller diameter than the outside diameter of the planetary pinion pin (27), drill a hole in one end of each pin to weaken the staking.

b. Press on the drilled end of each pin to remove it from the planetary carrier (28).

c. Remove the pinion rollers (26), the pinion thrust washers (24), and the planetary pinions (25).

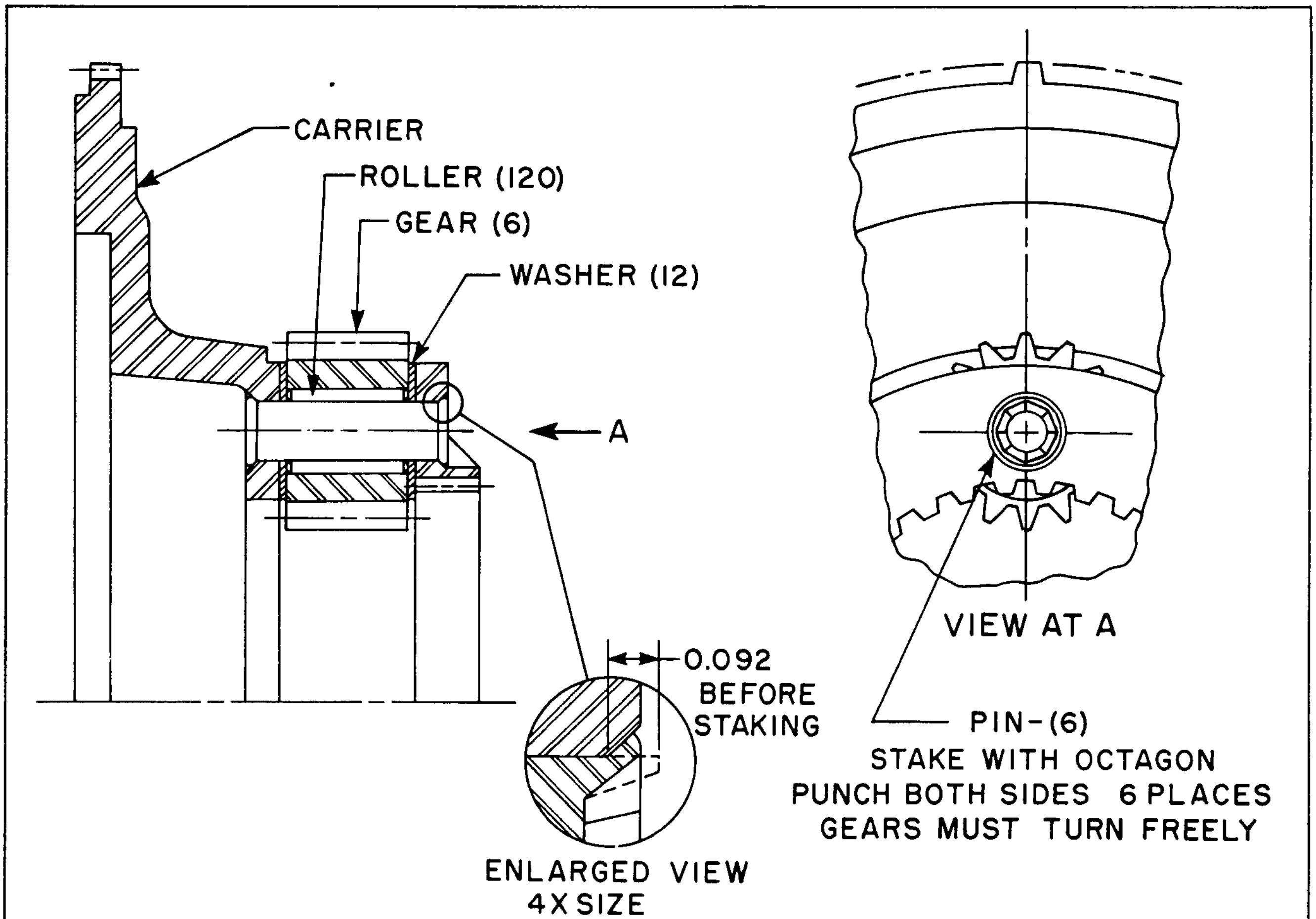

Fig. 115 — High Range Planetary Carrier — Cross Section

4. Cleaning, Inspection, and Wear Limits

Refer to Topic 4 for cleaning and inspection.

Refer to Fig. 114 for wear limits.

5. High Range Planetary Carrier, Assembly (Fig. 114)

a. Grease the pinion thrust washers (4) and install one on one end of each planetary pinion (5).

b. Grease the bores of the planetary pinions (5) and install twenty rollers (2) into each pinion. An aligning tool placed in the bore of the pinion will facilitate this installation. The tool can be made by grinding a discarded spindle pin to 0.005" undersize. Install a pinion thrust washer (4) on the other end of each planetary pinion (5).

c. Install, as a unit, the pinions, the rollers, and the washers into the planetary carrier (6).

d. Align the bores in the pinions with the bores in the carrier and press new spindle pins (3) into the carrier to the dimension shown in Fig. 115. Stake both sides of each spindle pin with octagon punch. Check each pinion after staking to be sure that it rotates freely.

6. Low Range Planetary Carrier, Assembly (Fig. 114)

a. Grease the pinion thrust washers (24) and install one on one end of each planetary pinion (25).

b. Grease the bores of the planetary pinions (25) and install sixteen pinion rollers (26) into each pinion. An aligning tool placed in the bore of the pinion will facilitate this installation. The tool can be made by grinding a discarded spindle pin to 0.005" undersize. Install a pinion thrust washer (24) on the other end of each planetary pinion (25).

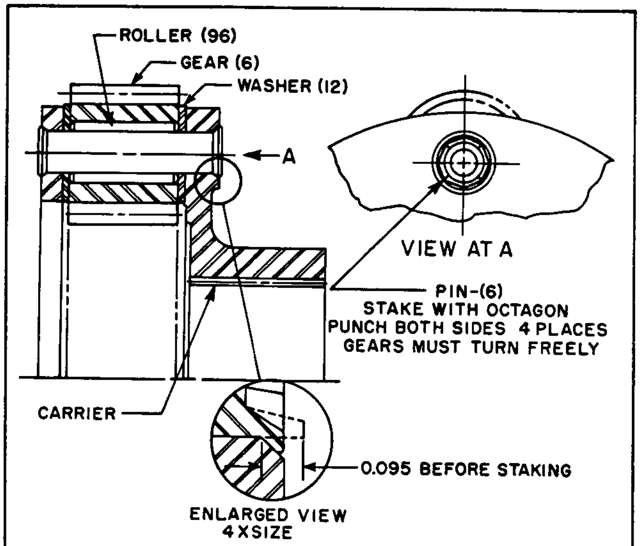

Fig. 116 — Low Range Planetary Carrier — Cross Section

c. Install, as a unit, the pinions, the rollers, and the washers into the planetary carrier (28).

d. Align the bores in the pinions with the bores in the carrier and press new spindles into the carrier to the dimensions shown in Fig. 116. Stake both sides of each spindle pin with an octagon punch. Check each pinion after staking to see that it rotates freely.

G. Transmission Housing

The transmission housing was completely disassembled in Par. B, and completely assembled in Par. C. Refer to Topic 4 for cleaning and inspection.

8. TRANSMISSION FRONT GROUP

A. General

While the procedures in this Topic cover the Front Group (Fig. 117) only, it is recommended that the entire transmission be disassembled for inspection and cleaning whenever it is necessary to overhaul any group. In order to rebuild the Center Group, the Front Group was removed in Topic 7.

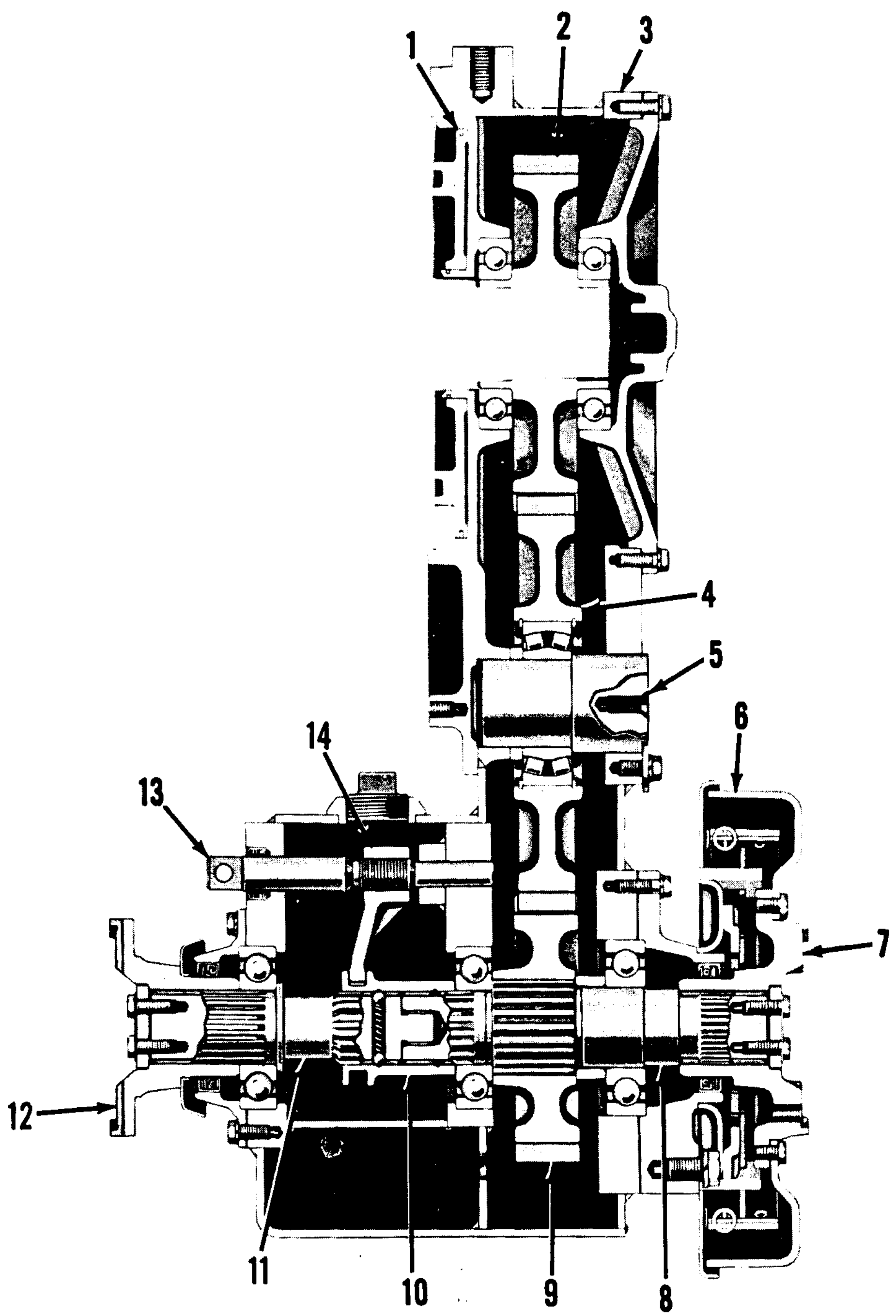

Fig. 117 — Transmission Front Group — Cross Section

1. Low Range Piston
2. Transfer Drive Gear
3. Transfer Gear Housing
4. Transfer Idler Gear
5. Transfer Idler Gear Spindle
6. Parking Brake
7. Front Output Flange
8. Front Output Shaft
9. Transfer Driven Gear
10. Disconnect Coupling
11. Rear Output Shaft
12. Rear Output Flange
13. Shifter Shaft (Output Disconnect)
14. Shifter Fork (Output Disconnect)

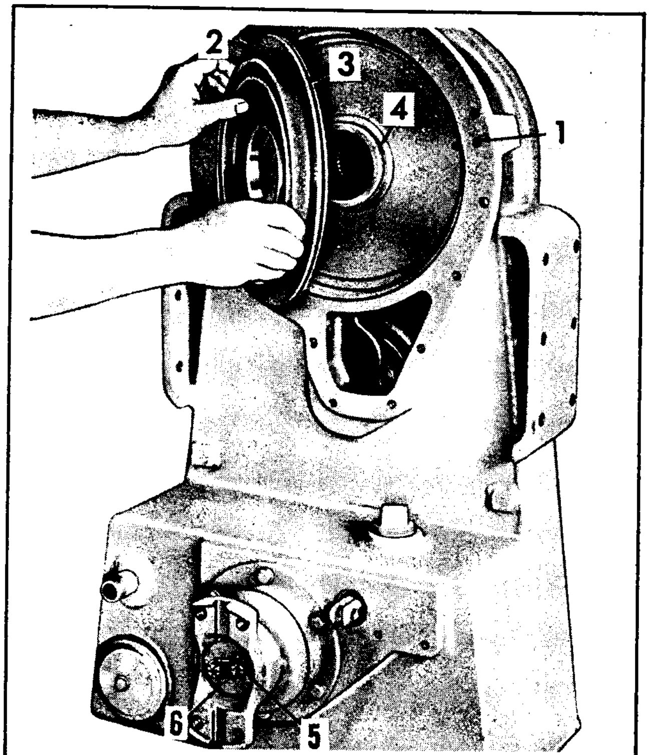

Fig. 118 — Remove Low Range Piston

1. Piston Apply Hole
2. Low Range Piston
3. Seal
4. Seal (Hook Type)
5. Lock Strip
6. Flange Retainer Washer

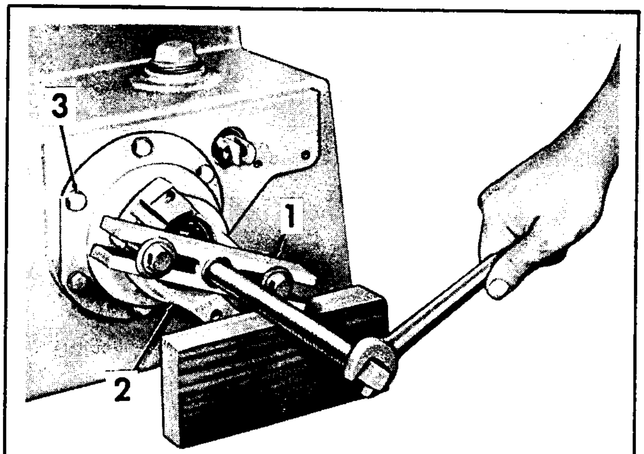

Fig. 119 — Remove Rear Output Flange

1. Puller
2. Rear Output Flange
3. Capscrews and Lockwashers

B. Front Group, Disassembly

1. Use compressed air in the piston apply hole (Fig. 118) and remove the low range piston. Remove the seal from the piston. Remove the hook type seal. Flatten the corners of the lock strip and remove the two flange retainer washer capscrews, the lock strip, and the flange retainer washer.

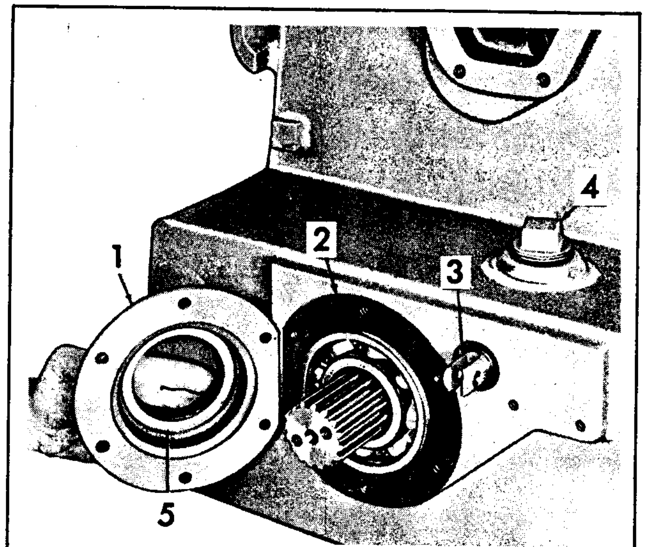

Fig. 120 — Remove Bearing Retainer and Shifter Shaft

1. Bearing Retainer Assembly
2. Gasket
3. Shifter Shaft
4. Pipe Plug
5. Seal

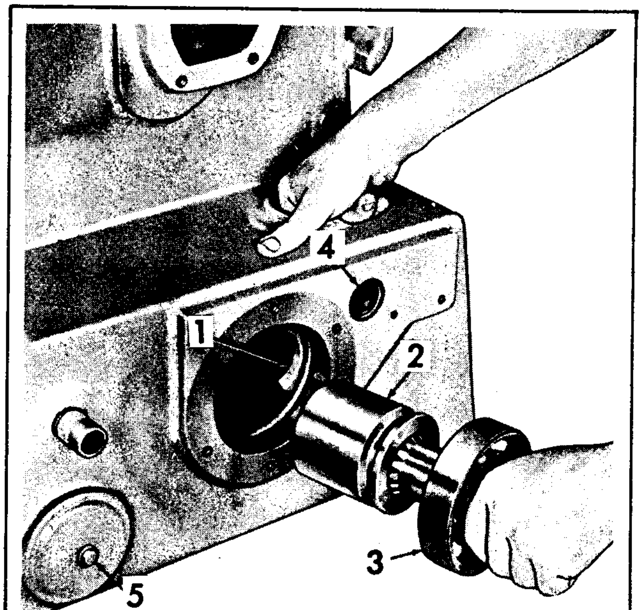

Fig. 121 — Remove Rear Output Shaft

1. Shifter Fork
2. Coupling
3. Bearing
4. Shifter Shaft Seal
5. Capscrew and Washer

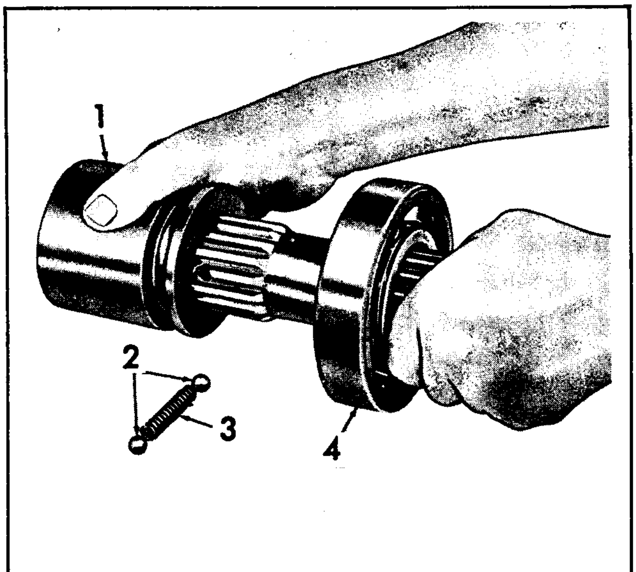

Fig. 122 — Disassemble Rear Output Shaft

1. Rear Output Disconnect Coupling
2. Detent Balls
3. Spring
4. Bearing

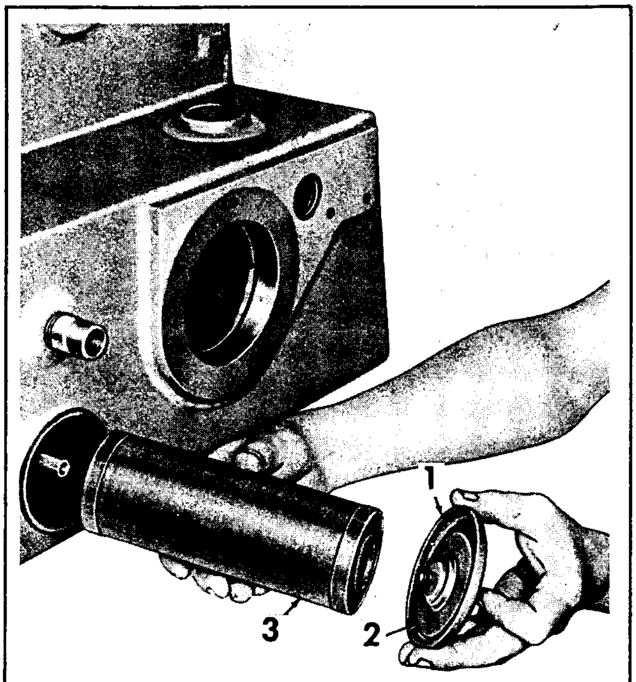

Fig. 123 — Remove Oil Screen

1. Oil Screen Cover and Gasket
2. Retainer
3. Oil Screen Assembly

2. Using a puller (Fig. 119), remove the rear output flange. Remove the capscrews and the lockwashers from the bearing retainer.

3. Remove the bearing retainer assembly (Fig.

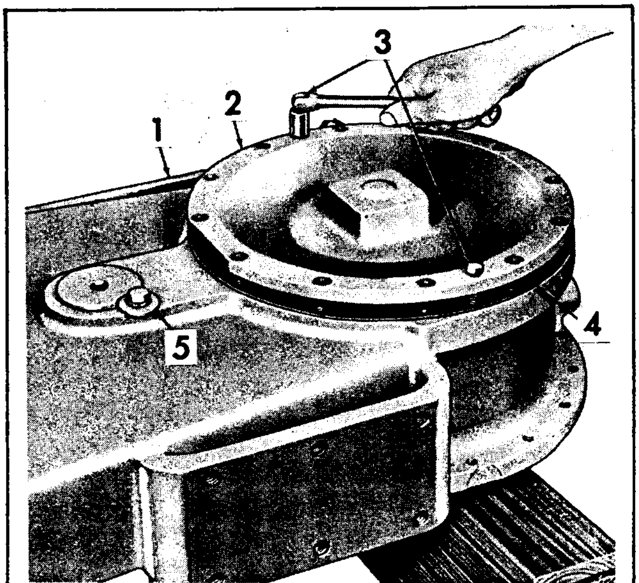

Fig. 124 — Remove Transfer Drive Gear Cover

1. Transfer Gear Housing Assembly
2. Transfer Gear Cover
3. Jackscrews
4. Gasket
5. Transfer Idler Gear Spindle Retainer Washer

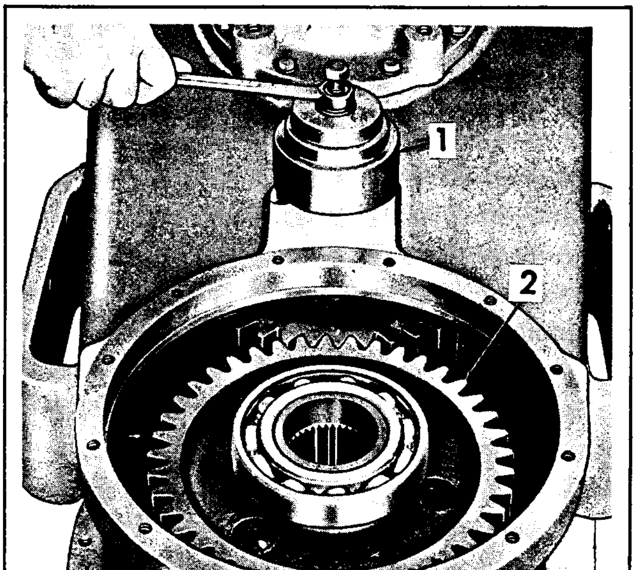

Fig. 125 — Remove Transfer Drive Gear

1. Special Tool
2. Transfer Drive Gear and Bearing Assembly

120) and the gasket. Thread the shifter shaft out of the shifter fork and remove it from the housing. Remove the pipe plug. Press the seal toward the inside of the retainer.

4. Using one hand to hold the shifter fork (Fig. 121) in position, grasp the rear output shaft with the other hand and remove, as a

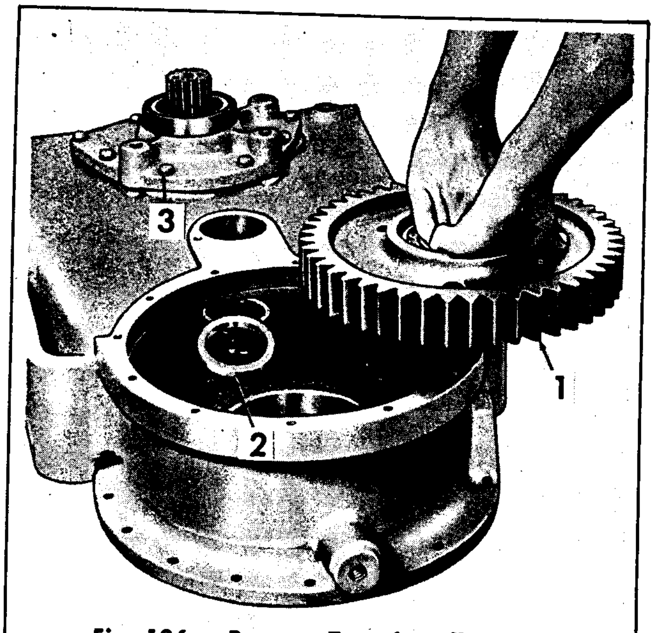

Fig. 126 — Remove Transfer Idler Gear

1. Transfer Idler Gear and Bearing Assembly
2. Transfer Idler Gear Spacer
3. Capscrew and Lockwasher

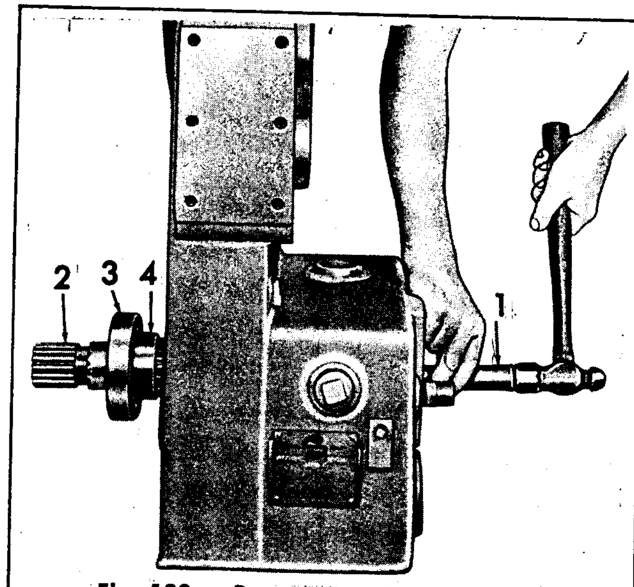

Fig. 128 — Remove Front Output Shaft

1. Drift
2. Front Output Shaft
3. Bearing
4. Spacer

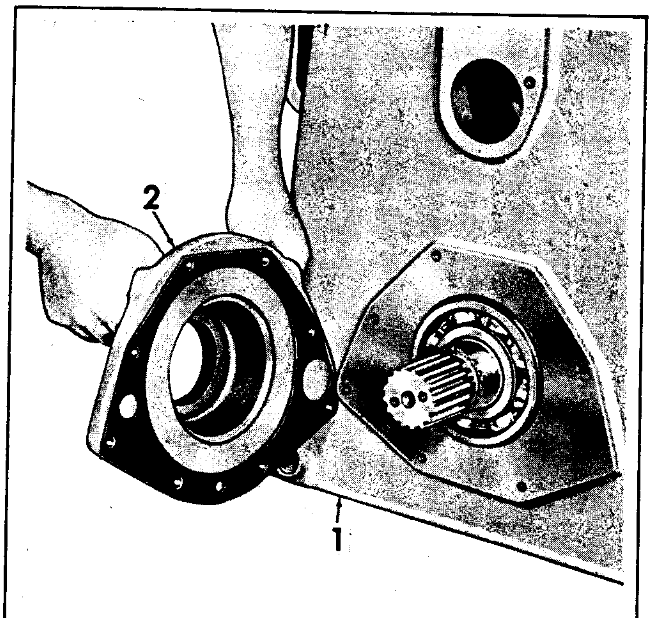

Fig. 127 — Remove Front Output Bearing Retainer Assembly

1. Transfer Gear Housing Assembly
2. Front Output Bearing Retainer Assembly and Gasket

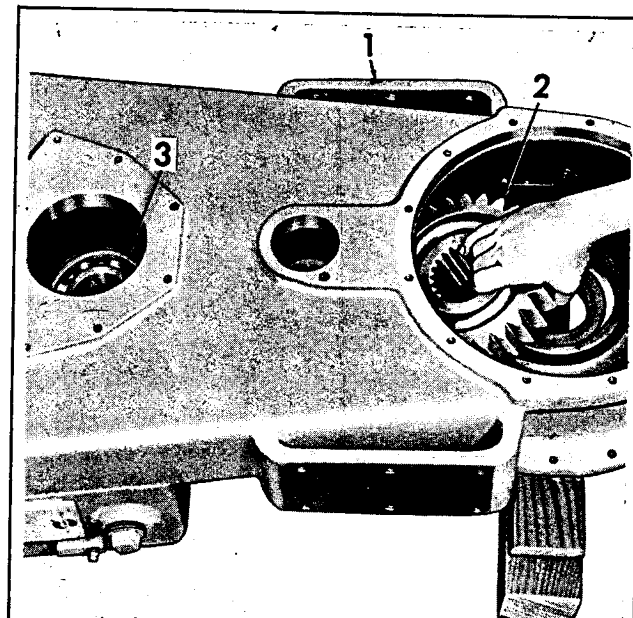

Fig. 129 — Remove Transfer Driven Gear

1. Transfer Gear Housing
2. Transfer Driven Gear
3. Bearing

unit, the shaft, the coupling, and the bearing. Remove the shifter shaft seal. Remove the capscrew and the washer.

5. Remove the rear output disconnect coupling (Fig. 122) from the rear output shaft. Remove the two detent balls and the spring.

If necessary, remove the bearing from the shaft.

6. Remove the screen cover and the gasket (Fig. 123). Remove the retainer and the oil screen assembly.

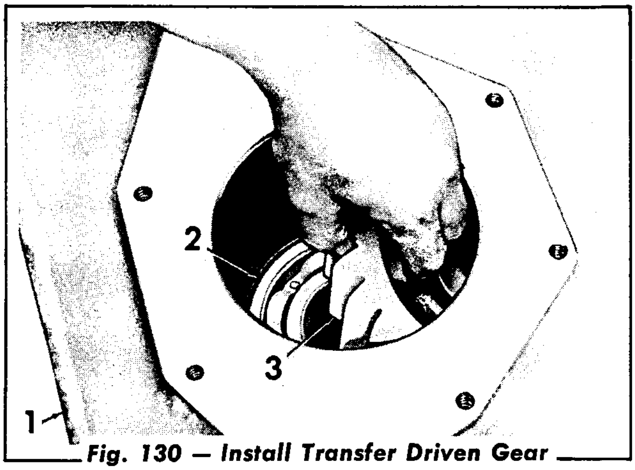

Fig. 130 — Install Transfer Driven Gear

1. Transfer Gear Housing
2. Bearing
3. Transfer Driven Gear

7. Position the transfer gear housing assembly (Fig. 124) on its rear surface and level it with blocks. Remove the capscrews and lockwashers from the transfer gear cover. Use jackscrews to loosen the cover. Remove the cover and the gasket. Remove the capscrew, the lockwasher, and the transfer idler gear spindle retainer washer.

8. Using special tool (Fig. 125), remove the transfer idler gear spindle from the housing. Remove the transfer drive gear and the bearing assembly.

9. Remove the transfer idler gear and bearing assembly (Fig. 126). Remove the transfer idler gear spacer. Remove the capscrews and lockwashers from the bearing retainer.

10. Position the transfer gear housing assembly (Fig. 127) upright on the work table and remove the front output bearing retainer assembly and gasket.

11. Using a hammer and a soft drift (Fig. 128), tap on the front output shaft and remove the shaft, the bearing, and the spacer. NOTE: *Use a drift of approximately 1¼" diameter so that the drift will not enter the pilot bearing diameter of the front output shaft.*

12. Position the transfer gear housing (Fig. 129) on its rear surface and move the transfer driven gear (2). Remove the bearing (3) from the housing.

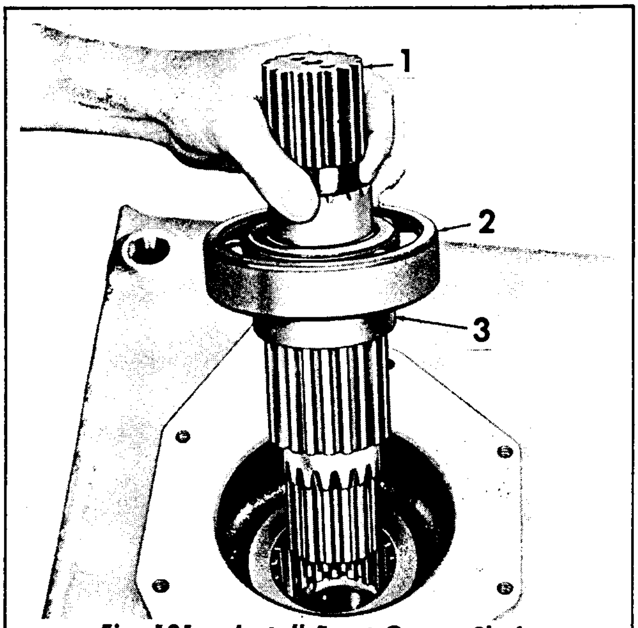

Fig. 131 — Install Front Output Shaft

1. Front Output Shaft
2. Bearing
3. Spacer

C. Front Group, Assembly

1. Position the transfer gear housing (Fig. 130) on the work table with the rear surface down and install the bearing. Install the transfer driven gear into the housing with the long hub toward the rear of the housing.

2. Install the front output shaft (Fig. 131), the bearing, and the spacer into the front of the transfer gear housing. Align the shaft splines with the gear splines.

3. Install the front output bearing retainer (Fig. 132) and the gasket. Secure the retainer with the capscrews and lockwashers. Install the transfer idler gear spacer in the housing.

4. Install the transfer idler gear assembly (Fig. 133) into the housing. Align the gear and the spacer with the spindle bore in the housing. Chill the transfer idler gear spindle in dry ice for one hour.

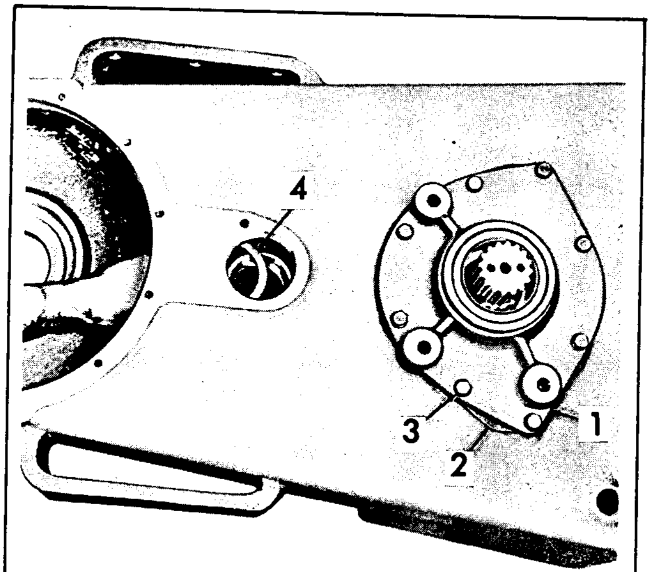

Fig. 132 — Install Front Output Bearing Retainer, and Transfer Idler Gear Spacer

1. Front Output Bearing Retainer
2. Gasket
3. Capscrew and Lockwasher
4. Transfer Idler Gear Spacer

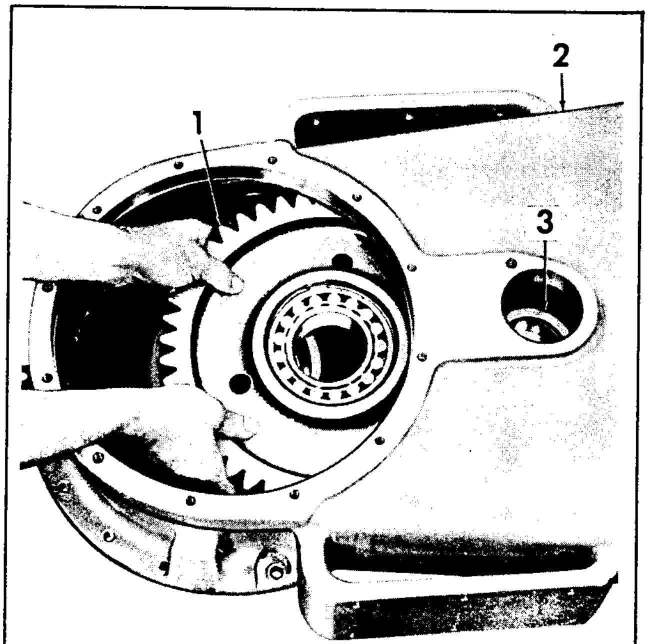

Fig. 133 — Install Transfer Idler Gear Assembly

1. Transfer Idler Gear Assembly
2. Housing
3. Spacer

5. Install the transfer idler gear spindle (Fig. 134) into its bore, aligning the recess in the spindle with the capscrew hole in the housing. Use a soft hammer to seat the spindle. If necessary, use blocks between the transfer idler gear and the housing to prevent the housing from springing when tapping the spindle into place. Remove the blocks.

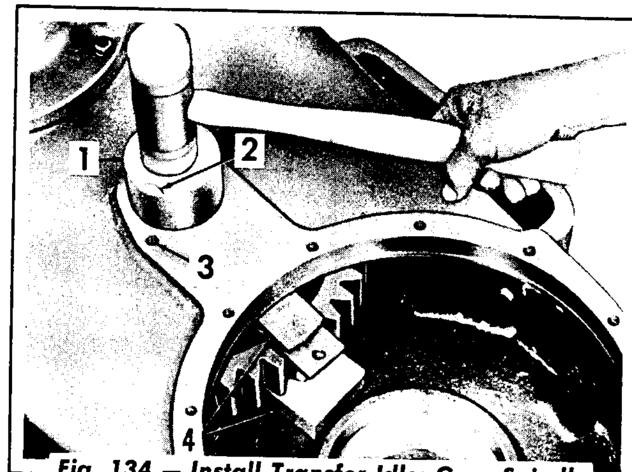

Fig. 134 — Install Transfer Idler Gear Spindle

1. Transfer Idler Gear Spindle
2. Recess
3. Capscrew Hole
4. Blocks

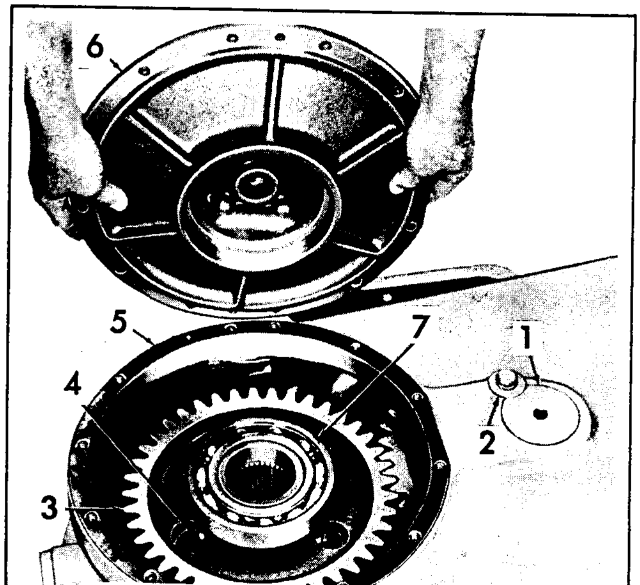

Fig. 135 — Install Transfer Drive Gear

1. Spindle
2. Retainer, Capscrew, and Lockwasher
3. Transfer Drive Gear Assembly
4. Bearing
5. Gasket
6. Transfer Gear Cover
7. Bearing

6. Secure the spindle (Fig. 135) with the retainer, the capscrew, and lockwasher. Install the transfer drive gear assembly. Tap

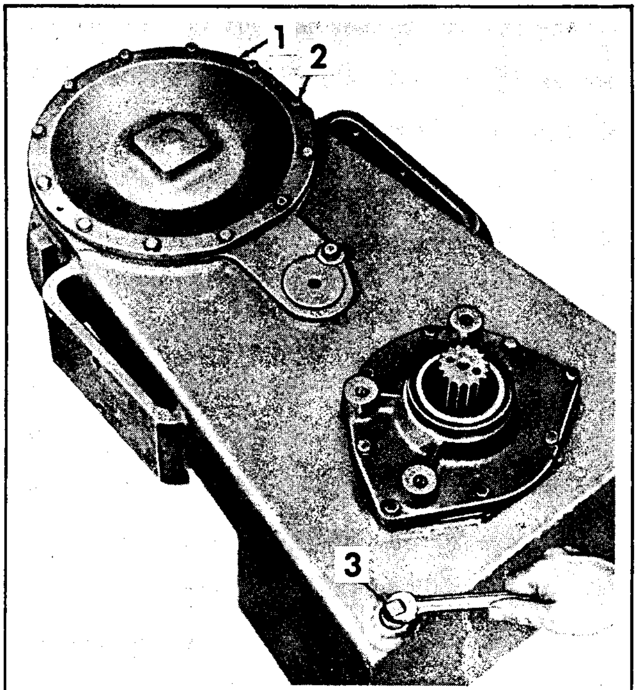

Fig. 136 — Install Transfer Gear Cover and Oil Drain Plug

1. Transfer Gear Cover
2. Capscrew and Lockwasher
3. Oil Drain Plug

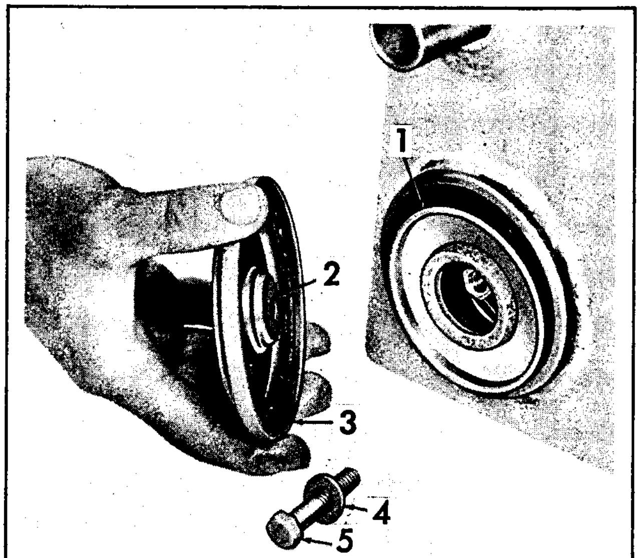

Fig. 137 — Install Oil Screen Assembly

1. Oil Screen Assembly
2. Retainer
3. Cover and Gasket
4. Washer
5. Capscrew

the bearing to seat it in its bore. Install the gasket and the transfer gear cover, aligning the capscrew holes. Tap the cover to seat it on the bearing.

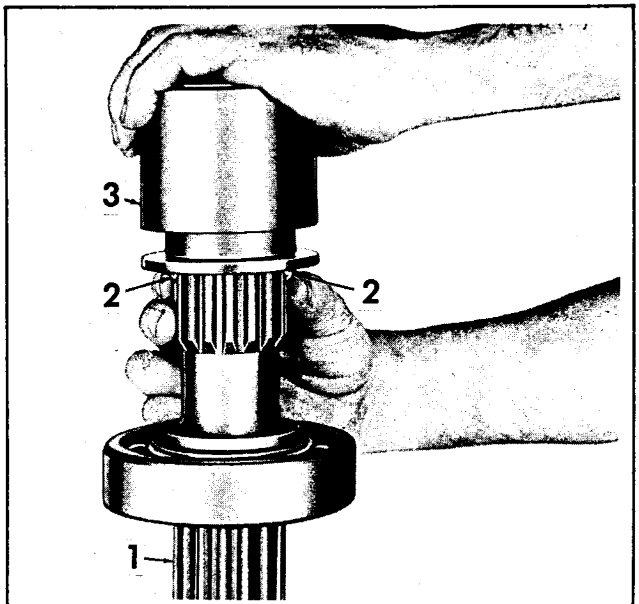

Fig. 138 — Assemble Rear Output Shaft

1. Rear Output Shaft
2. Detent Spring and Balls
3. Coupling

7. Secure the transfer gear cover (Fig. 136) with the capscrews and lockwashers. Install the oil drain plug.

8. Position the transfer gear housing upright and install the oil screen assembly (Fig. 137). The retainer, and the cover and gasket. Install the capscrew and washer. Be sure that the washer is in good condition to prevent oil or air leakage.

9. Holding the rear output shaft (Fig. 138) with one hand, install the detent spring and two balls into the shaft. Holding the balls, install the coupling onto the shaft with the groove toward the bearing.

10. Install the shifter fork (Fig. 139) into the housing. Install the rear output shaft and the coupling, engaging the fork in the coupling groove. Continuing to hold the fork in position, install the shifter into its bore and thread it into the fork.

11. Install the pipe plug (Fig. 140) and the gasket. Install the seal into the rear of the bearing retainer. Install the retainer.

12. Secure the retainer with the capscrews and

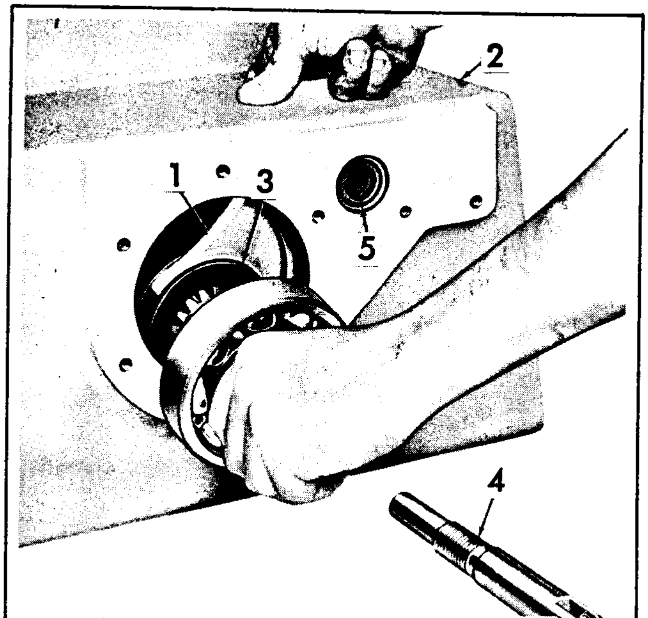

Fig. 139 — Install Shifter Fork and Rear Output Shaft

1. Shifter Fork
2. Housing
3. Rear Output Shaft and Coupling
4. Shifter Shaft
5. Bore

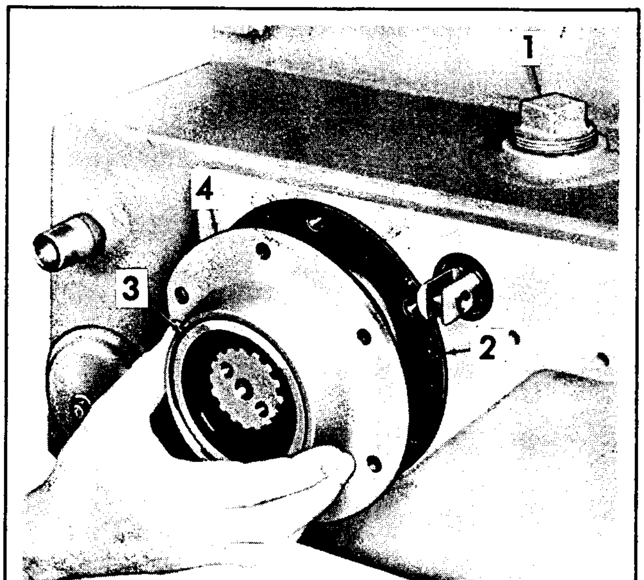

Fig. 140 — Install Rear Output Shaft Bearing Retainer

1. Pipe Plug
2. Gasket
3. Seal
4. Bearing Retainer

lockwashers (Fig. 141). With the shifter shaft pushed all the way in, check the shaft adjustment by placing a scale against the face of the transfer gear housing. Measure

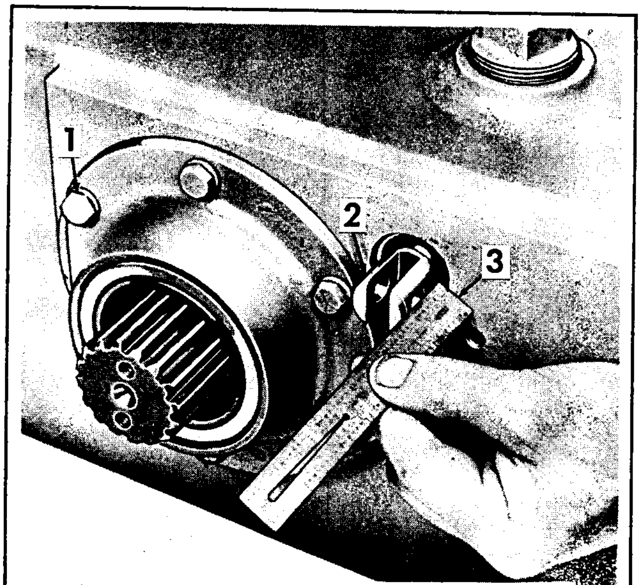

Fig. 141 — Check Shifter Shaft Adjustment

1. Capscrew and Lockwasher
2. Shifter Shaft
3. Scale

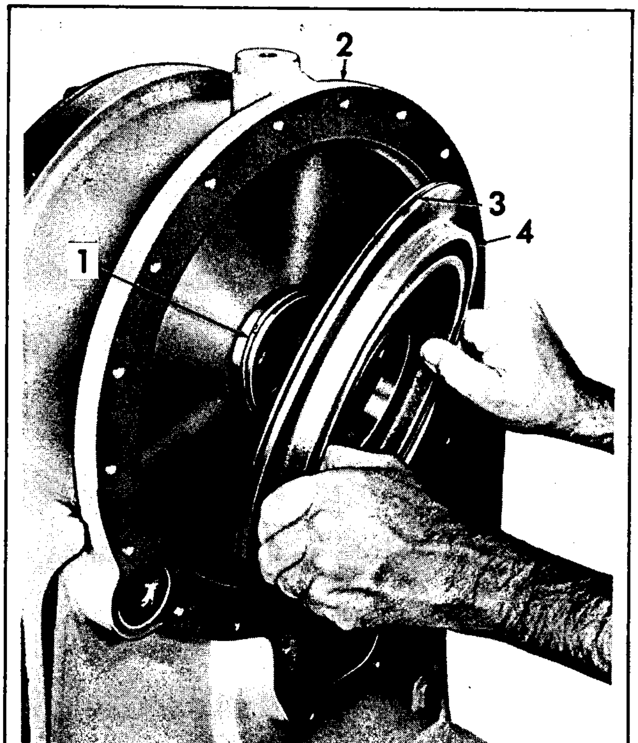

Fig. 142 — Install Low Range Piston

1. Seal Ring (Hook Type)
2. Transfer Gear Housing
3. Seal Ring
4. Low Range Piston

to the center of the linkage hole in the shaft. Rotate the shaft until the measurement is 0.610 to .0650″.

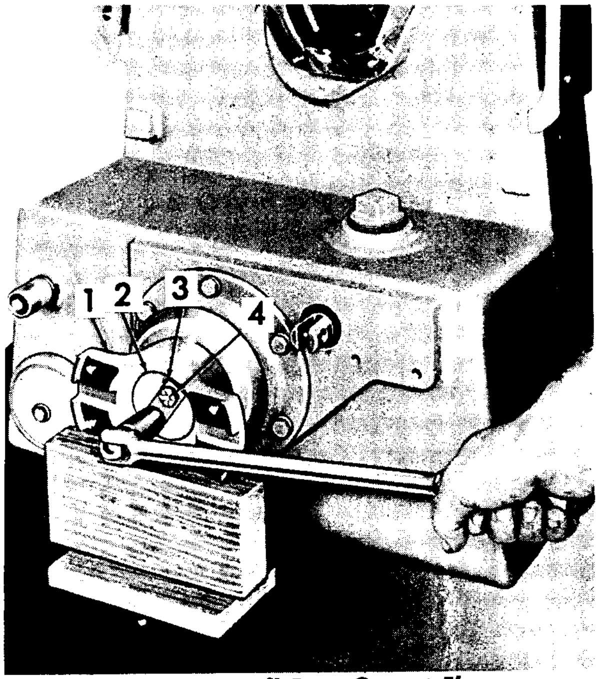

Fig. 143 — Install Rear Output Flange

1. Rear Output Flange
2. Flange Retainer Washer
3. Lock Strip
4. Self-Locking Capscrew

13. Install the hook type seal ring (Fig. 142) into the groove on the transfer gear housing. Install the seal ring onto the low range piston. Install the piston into the housing.

14. Heat the rear output flange (Fig. 143) to 300° F. for one hour and install it onto the rear output shaft. Secure the flange with the flange retainer washer, the lock strip and the self-locking capscrews. Bend the corners of the lock strip against the capscrew heads.

D. Transfer Gear Housing

All items in Fig. 144 are removed in Par. B, and installed in Par. C. Refer to Topic 4 for cleaning and inspection.

E. Rear Output Shaft and Flange

All items in Fig. 144 are removed in Par. B, and installed in Par. C. Refer to Topic 4 for cleaning and inspection, and Fig. 144 for wear limits.

F. Transfer Gears and Front-Output Shaft

1. Disassembly (Fig. 145)

a. Remove the bearings (1 and 3) from the transfer drive gear (2).

b. Remove the snap ring (12) from the transfer idler gear (10). Remove the transfer idler gear bearing (11) from the transfer idler gear.

c. Press the oil seal (28) out of the front bearing retainer (25).

d. Remove the transfer driven gear bearing (23) from the shaft (20). Remove the transfer driven gear spacer (22) from the front output shaft (20).

e. If replacement of the bushing (19) is necessary, collapse the bushing and remove it from the shaft (20).

2. Cleaning, Inspection, and Wear Limits

Refer to Topic 4 for cleaning and wear limits. Refer to Fig. 145 for wear limits.

3. Assembly (Fig. 145)

a. If the bushing (19) was removed, install a new bushing. Press the bushing 0.160 to 0.200" below the end of the shaft.

b. Install the transfer driven gear spacer (22) onto the shaft (20). Install the transfer driven gear bearing (23) onto the front output shaft (20).

c. Press the oil seal (28) into the front (chamfered end) of the front bearing retainer (25).

d. Install the transfer idler gear bearing (11) into the transfer idler gear (10). Secure the bearing with the snap ring (12).

e. Install the bearings (1 and 3) onto the transfer drive gear.

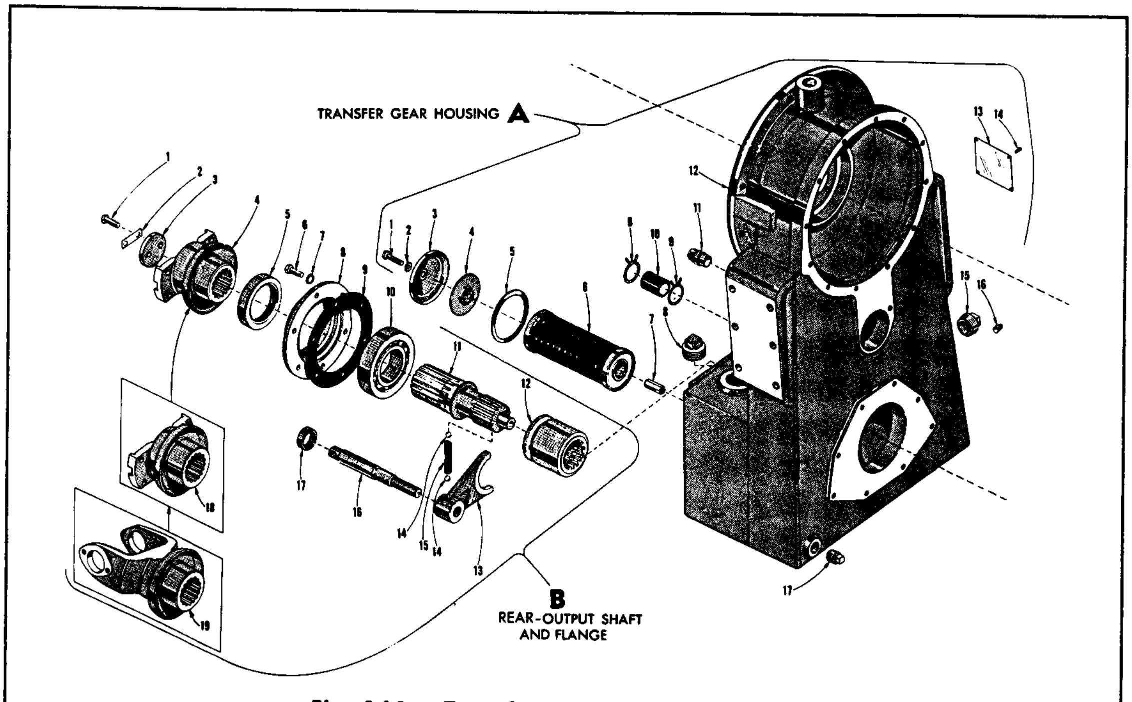

Fig. 144 — Transfer Gear Housing, and Rear Output Shaft and Flange

A — TRANSFER GEAR HOUSING

1. Hexagon-Head Oil Screen Capscrew — $\frac{5}{16}$–24 x $1\frac{1}{2}$
2. Plain Washer — $\frac{11}{32}$
3. Oil Screen Cover
4. Oil Screen Retainer
5. Oil Screen Cover Gasket
6. Oil Screen
7. Oil Screen Coupling
8. Pipe Plug — $1\frac{1}{2}$
9. Hose Clamp
10. Converter Housing Drain Hose
11. Nipple — $\frac{3}{4}$ NPTF
12. Transfer Gear Housing
13. Name Plate
14. Drive Screw
15. Oil Filler Plug — $1\frac{1}{4}$
16. Oil Level Check Square-Head Pipe Plug — $\frac{1}{4}$
17. Sump Drain Square-Head Plug — $\frac{3}{4}$

B — REAR-OUTPUT SHAFT AND FLANGE

1. Hexagon-Head Capscrew — $\frac{3}{8}$–24 x $1\frac{1}{8}$
2. Lock Strip
3. Flange Retainer Washer
4. Rear-Output Flange
5. Flange Oil Seal
6. Hexagon-Head Capscrew — $\frac{3}{8}$–16 x 1
7. Lockwasher — $\frac{3}{8}$
8. Rear-Output-Bearing Retainer
9. Bearing Retainer Gasket
10. Single-Row Ball Bearing
11. Rear-Output Shaft
12. Rear-Output-Shaft Coupling
13. Shifter Fork
14. Detent Ball — $\frac{3}{8}$
15. Detent Spring
16. Shifter Fork Shaft
17. Shifter Fork Shaft Seal
18. Rear-Output Flange
19. Rear-Output Flange (TL-30 D)

Item	WEAR LIMITS DATA
15	Detent Spring — 28.6 ± 2.8 lb. at 1.20 in. Operating Height

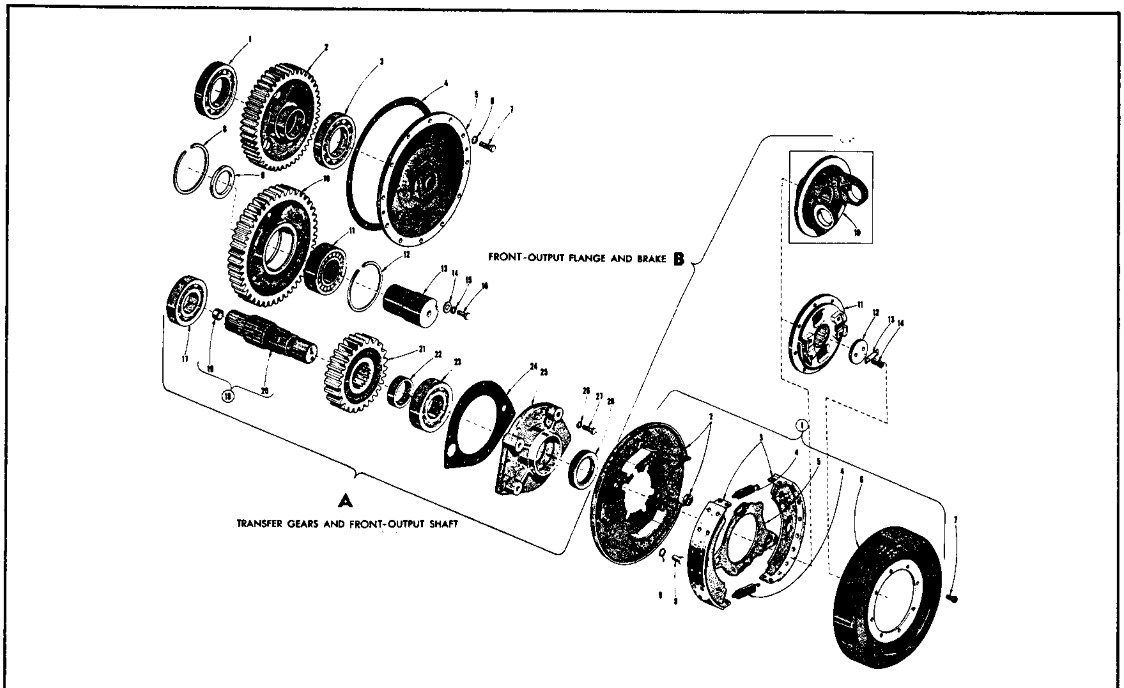

Fig. 145 — Transfer Gears, Front Output Shaft, and Front Output Flange and Brake — Legend

A — TRANSFER GEARS AND FRONT-OUTPUT SHAFT

1. Single-Row Ball Bearing
2. Transfer Drive Gear
3. Single-Row Ball Bearing
4. Transfer Drive Gear Cover Gasket
5. Transfer Drive Gear Cover
6. Lockwasher — $\frac{3}{8}$
7. Hexagon-Head Capscrew — $\frac{3}{8}$–16 x $1\frac{1}{4}$
8. Bearing Retainer Snap Ring
9. Transfer Idler Gear Bearing Spacer
10. Transfer Idler Gear
11. Transfer Idler Gear Double Roller Bearing
12. Bearing Retainer Snap Ring
13. Transfer Idler Gear Spindle
14. Spindle Retainer Washer
15. Lockwasher — $\frac{7}{16}$
16. Hexagon-Head Capscrew — $\frac{7}{16}$–14 x $\frac{7}{8}$
17. Single-Row Ball Bearing
18. Front-Output-Shaft Assembly
19. Bushing
20. Front Output Shaft
21. Transfer Driven Gear
22. Transfer Driven Gear Spacer
23. Single-Row Ball Bearing
24. Front-bearing Retainer Gasket
25. Front-Bearing Retainer
26. Lockwasher — $\frac{3}{8}$
27. Hexagon-Head Capscrew — $\frac{3}{8}$–16 x $1\frac{3}{8}$
28. Rear-Oil Seal

Item	WEAR LIMITS DATA
19	Bushing — Clearance with Rear Output Shaft, 0.005 in. (See Item 11)

B — FRONT-OUTPUT FLANGE AND BRAKE

1. Parking Brake Assembly
2. Brake Back Plate
3. Shoe and Lining
4. Brake Shoe Return Spring
5. Operating Cam Lever
6. Brake Drum
7. Hexagon-Head Capscrew — $\frac{3}{8}$–24 x $\frac{3}{4}$
8. Hexagon-Head Capscrew — $\frac{5}{8}$–11 x $1\frac{1}{4}$
9. Lockwasher — $\frac{5}{8}$
10. Front-Output-Brake Mounting Flange (TL-30D)
11. Front-Output Brake Mounting Flange
12. Flange Retainer Washer
13. Lock Strip
14. Hexagon-Head Capscrew — $\frac{3}{8}$–24 x $1\frac{1}{8}$

G. Front Output Flange and Brake

All items in Fig. 145 are removed in Par. B, and installed in Par. C. Refer to Topic 4 for cleaning and inspection.

9. TROUBLE SHOOTING

Refer to the "TROUBLESHOOTING" Section which will assist in locating sources of transmission troubles. A study of the hydraulic system and the hydraulic schematics in Topic 2 will help in locating and correcting any hydraulic system malfunctions.

Refer to Figs. 146, 147 and 148 to identify the oil passages in the selector valve body, its mounting pad on the transmission housing, the main pressure regulator valve and its mounting pad on the converter housing. Use them as necessary for tracing the various circuits in the hydraulic system when locating hydraulic malfunctions.

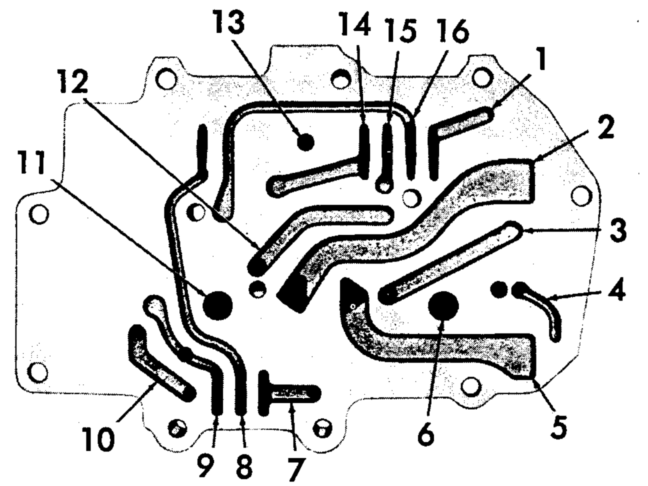

Fig. 146 — Selector Valve Body Oil Passages

1. Sump
2. Forward Lube Pressure
3. Reverse Clutch Apply Pressure
4. Sump
5. Reverse Lube Pressure
6. Main Oil Pressure
7. Sump
8. Main Oil Pressure
9. Main Oil Pressure
10. Sump
11. Main Oil Pressure
12. Forward Clutch Apply Pressure
13. Sump
14. Low-Range Clutch Apply Pressure
15. Intermediate-Range Clutch Apply Pressure
16. High-Range Clutch Apply Pressure

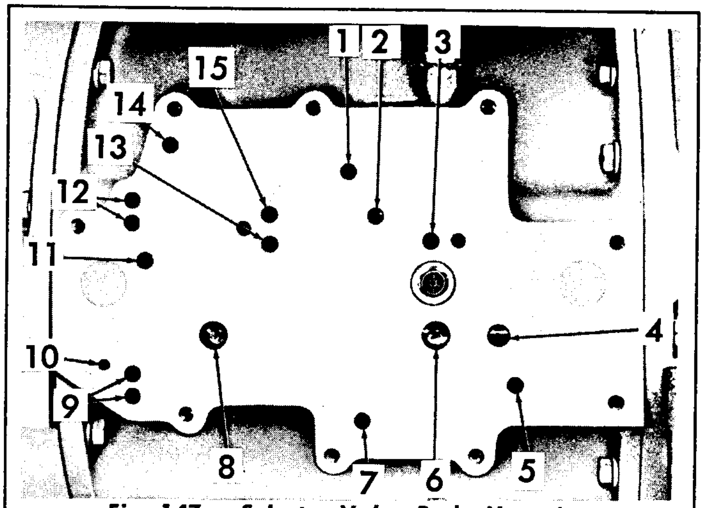

Fig. 147 — Selector Valve Body Mounting Pad Oil Passages

1. Sump
2. Low-Range Clutch Apply Pressure
3. High-Range Clutch Apply Pressure
4. Main Oil Pressure
5. Sump
6. Main Oil Pressure
7. Sump
8. Main Oil Pressure
9. Reverse Lube Pressure
10. Sump
11. Reverse Clutch Apply Pressure
12. Forward Lube Pressure
13. Forward Clutch Apply Pressure
14. Sump
15. Intermediate-Range Clutch Apply Pressure

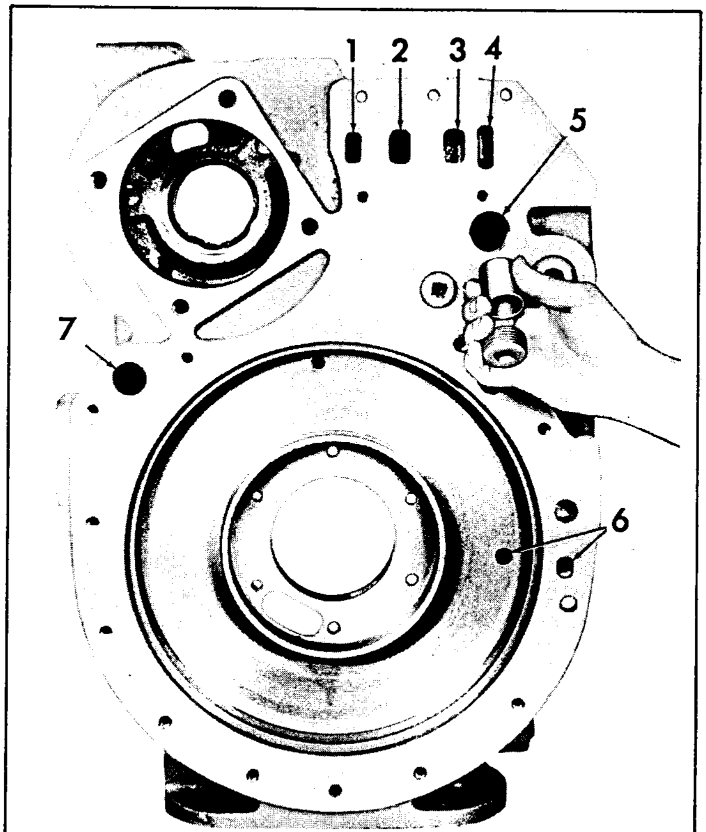

Fig. 148 — Converter Housing Oil Passages

1. Sump
2. Main Oil Pressure
3. Converter — In Oil Pressure
4. Main Oil Pressure
5. Remote Oil Filter Oil Director Tube
6. Oil from Remote Oil Filter (Passage for Oil to Filter Shown in Fig. 2)
7. Piston Apply

10. SPECIAL TOOLS AND KITS

A. Special Tools

In most cases the use of Special Tools for Disassembly, Repairs, and Assembly are required to perform the particular operation and to obtain the best results. The use of Special Tools also helps the Serviceman, or Mechanic, to make the necessary repairs in the least amount of time.

Contact your nearest "Allis-Chalmers" Construction Machinery Dealer for information regarding the availability of Special or Standard Tools.

B. Kits

Contact your "Allis-Chalmers" Construction Machinery Dealer for Information regarding availability of complete overhaul gasket kits.

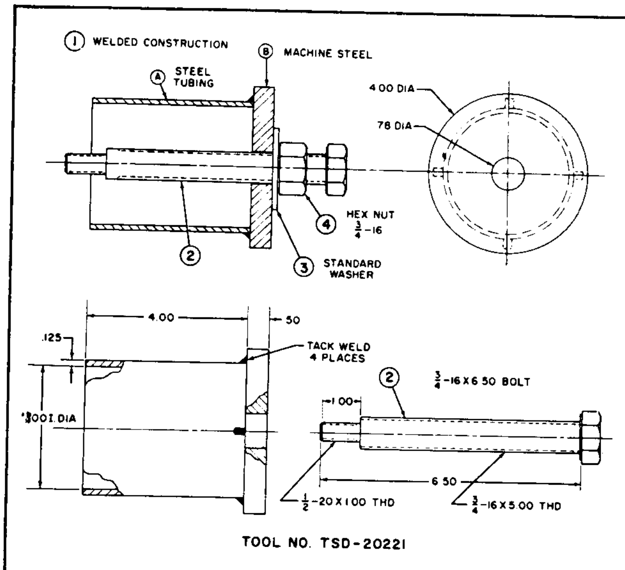

Fig. 149 — Sketch of Special Tool for Removal of Output Idler Gear Spindle

SECTION XI — AXLES

1. GENERAL DESCRIPTION

The front (rigid) and the rear (steering) axles are heavy duty, planetary type axles matched to the operations of the machine. The axles incorporate a single reduction carrier with hypoid gearing mounted in the center of the axle. The second reduction is a planetary spur gear design built into the wheel hubs. This arrangement permits hypoid gearing at the carrier, allowing the axle shafts to carry only a normal torsional load, while at the same time providing the highest practical numerical gear reduction at the wheels.

The hypoid pinion and differential assembly is supported by tapered roller bearings. The pinion bearing preload is adjusted and maintained by a hardened precision spacer between the inner and outer bearings. The differential tapered bearing preload is adjusted and maintained by the positioning of the threaded adjusting rings in the carrier leg and cap bores.

The spur teeth of the planetary floating sun gear mesh with the teeth of the planet spur gears. The planet spur gears rotate on bronze planet pins which are mounted in a spider. The planet spur gear teeth in turn mesh with teeth of the floating ring gear.

The axle assemblies and the transmission are connected by slip type propeller shafts. Power is transmitted by the differential pinion and gear to the axle shafts which empower the planetary sun gear, through the revolving planet gears, and into the planetary spider which drives the wheel hubs.

The front axle is pin-connected to the heavy box type sectional main frame of the loader. The rear axle is pin-connected to the oscillating cast steel yokes. The pin connecting points of the axle housings, each have two steel hardened, replaceable bushings.

2. REMOVAL OF AXLES

A. General

It is not absolutely necessary to remove the complete axle assemblies from the machine to disassemble and inspect the planetary hubs. However, it is necessary that the complete steering axle assembly be removed to disassemble and inspect the differential assembly. The drive or front axle need not be removed in order to remove the differential assembly.

A suitable hoist, rope, or chain, and a portable hydraulic floor jack (approximately five-ton capacity), or equivalent equipment, will be required to remove the axle assemblies from the loader.

B. Removal of Front (Rigid) Axle Assembly

1. Lower the bucket to ground level. This can be done by placing the boom control lever in the float position.

2. Using a ¾" drive breaker bar extension, remove the differential drain plug located at the bottom of the axle housing center section, and drain the differential.

3. Properly position a portable hydraulic floor jack (approximately five-ton capacity) at center of the axle housing or directly underneath the differential (Fig. 1), and carefully

jack up the front of the loader so that the tires clear the floor about two inches. Suitably block up under the front of the loader.

IMPORTANT: *The rear steering wheels should be blocked so as to prevent movement. Also, the portable hydraulic jack should be left in position for later use in rolling the axle assembly out from beneath the loader.*

4. Remove the lug nuts that secure each tire and wheel assembly to the planetary hubs and remove the tire and wheel assemblies.

5. Rotate the planetary hubs so that the drain plug is at the bottom. Remove the drain plugs and drain the planetary hubs.

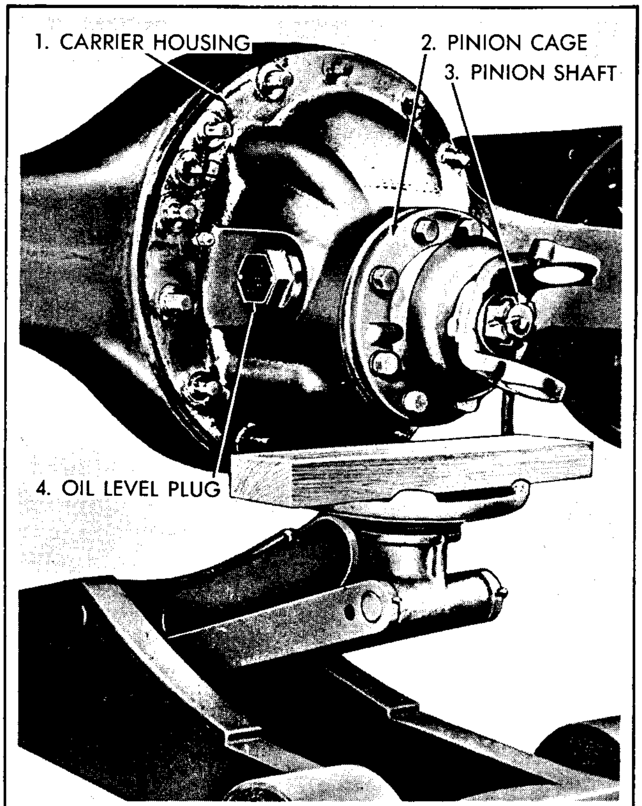

Fig. 1 — Removing Axle Assembly

6. Remove and plug the air brake lines from the axle assembly to prevent their being damaged or clogged during the removal and installation of the axle assembly.

7. Disconnect the drive shaft universal joint at the differential.

8. Remove the cotter pin, the castle nut, and the washer from the two pin weld assemblies that secure the axle assembly to the loader main frame assembly. Using a soft drift, drive out the pin weld assemblies.

   CAUTION: *The portable hydraulic floor jack must be properly centered under the axle housing so as to prevent any cocking or binding of the axle which may result in damage to the pin weld assemblies or the axle during removal.*

9. Being certain that the axle assembly is properly balanced on the portable hydraulic floor jack, carefully lower the axle assembly and roll the hydraulic jack and the axle assembly out from under the loader.

10. Attach a sling around the axle housing and using a suitable hoist, lift the axle assembly from the hydraulic jack and place the axle assembly on blocks or stands so that the planetary hubs do not rest on the floor. Position the axle so that the pinion shaft is in a vertical position.

11. At this time, inspect, and if necessary, replace the connecting point bushings in the axle housing. There are two steel hardened bushings in each connecting point. The old bushings can be driven out and new bushings installed.

12. Before installing the axle assembly, the pin weld assemblies should be inspected for wear or damage. New pin weld assemblies should be used if there are any signs of wear or damage.

The axle assembly may be installed by a direct reversal of the above procedure. Be certain that the castle nuts on the pin weld assemblies are drawn up tight and new cotter pins have been installed.

C. Removal of Rear (Steering) Axle Assembly

1. Using a ¾″ drive breaker bar extension, remove the differential drain plug (located at the bottom of the axle housing center

section) and drain the differential.

2. Properly position a portable hydraulic floor jack (approximately five-ton capacity) at the center of the axle housing or directly underneath the differential, and carefully jack up the rear of the loader so that the tires clear the floor (about two inches). Suitably block up the rear of the loader.

   IMPORTANT: *The front wheels should be blocked so as to prevent movement. Also, the portable hydraulic floor jack should be left in position for later use in rolling the axle assembly out from under the machine.*

3. Remove the nuts that secure each tire and wheel assembly to the planetary hubs, and remove the tire and wheel assemblies.

4. Rotate the planetary hubs so that the drain plug is at the bottom. Remove the drain plugs and drain the planetary hubs.

5. Remove the air brake lines from the axle assembly.

   NOTE: *The open end of the brake lines should be covered or plugged to prevent entrance of foreign material.*

6. Disconnect the drive shaft universal joint, located at the differential.

7. Disconnect the drag link. Disconnect the hydraulic lines from the power steering cylinders and disconnect the piston rods from the axle. Disconnect the tie rod.

8. Remove the cotter pin, the castle nuts, and the washers from the two pin weld assemblies that secure the axle assembly to the axle support assemblies. Using a soft drift, drive out the pin weld assemblies.

   CAUTION: *The portable hydraulic floor jack must be properly centered under the axle housing so as to prevent any cocking or binding to the pin weld assemblies or the axles during the removal.*

9. Being certain that the axle assemblies are properly balanced on the portable hydraulic floor jack, carefully lower the axle assembly and roll the hydraulic jack and the axle assembly out from under the loader.

   NOTE: *To obtain clearance it may be necessary to (hand) pivot the axle support assemblies.*

10. Attach a sling around the axle housing and, using a suitable hoist, lift the assembly from the hydraulic jack and place the axle assembly on blocks, or stands, so that the planetary hubs do not rest on the floor. Position the axle so that the pinion shaft is in a vertical position.

11. At this time, inspect and, if necessary, replace the connecting point bushings in the axle housing. There are two steel hardened bushings in each connecting point. The old bushings can be driven out and new bushings installed.

12. Next, inspect the bushings (2) in the frame assembly and the condition of the pivot pin of the axle support assemblies. If necessary, replace, and also inspect pin weld assemblies before installing axle assembly.

The axle assembly may be reinstalled by a direct reversal of the above procedure. Be certain that the castle nuts on the pin weld assemblies are drawn up tight and new cotter pins are installed.

3. DIFFERENTIAL AND GEAR ASSEMBLY

A. General

The front and the rear differential carrier sections are identical in construction. Each consists of a differential assembly with hypoid type ring gear and pinions. The differential and gear assembly is mounted on tapered roller bearings. The straddle mounted pinion has two tapered roller bearings in front of the pinion teeth to carry the radial load. The housing for this section also serves as a reservoir for the lubricating oil for these parts.

B. Removal of Differential Carrier from Steering Axle Housing

1. Drain and remove the steering (or rear) axle assembly.

2. Disassembly of the planetary hubs of the steering axle assembly is necessary (in order to remove the axle shaft assemblies) before removing the differential and gear assembly (Refer to Par. B, in Topic 4).

3. Remove the capscrews that secure the carrier assembly to the axle housing.

4. Using a rope or chain attached to the end of the pinion shaft, and a suitable hoist, break the carrier assembly loose from the axle housing using a rawhide mallet. Then carefully lift carrier assembly from the axle housing.

   IMPORTANT: *It will be necessary on the rear or steering axle only, to remove the tie rod assembly before the carrier assembly can be removed. This can be done by removing the nuts, the washers, and the pins which connect both ends of the tie rods to the planetary rear knuckle housings.*

C. Removal of Differential Carrier from Drive Axle

1. Remove the differential drain plug, located at the bottom of the axle housing center section, and drain the differential.

2. Rotate the planetary hubs until the drain plug is at bottom. Remove the drain plugs and drain the planetary hubs.

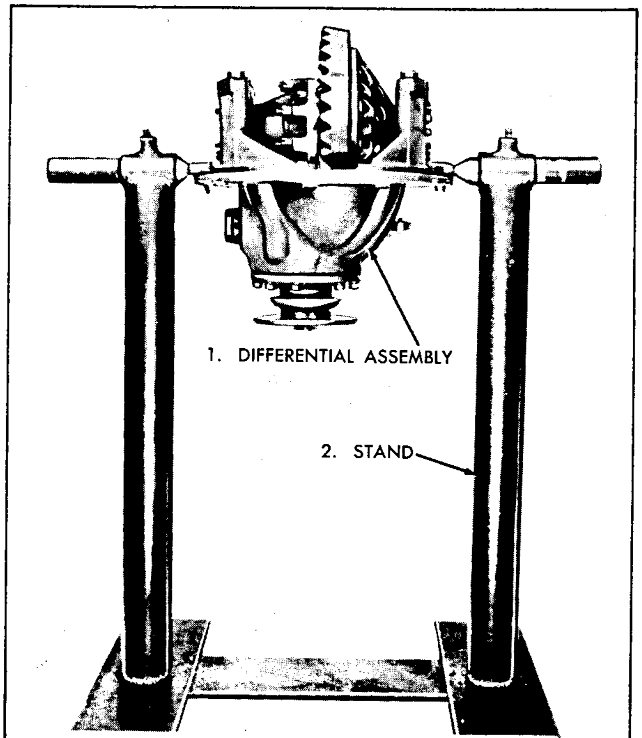

Fig. 2 — Differential Mounted on Stand

3. Remove the axle shafts from the axle assembly (Refer to Par. B, in Topic 4).

4. Position a portable hydraulic floor jack under the differential carrier assembly. Remove the capscrews that secure the carrier assembly to the axle housing.

5. Slide the carrier from the housing with the use of the hydraulic jack and remove it from beneath the loader.

   NOTE: *Keep the carrier assembly balanced on the hydraulic jack.*

6. Installation of the drive axle differential carrier assembly may be accomplished by the direct reversal of the above procedure.

D. Disassembly of Differential and Gear

1. Place the carrier assembly in a suitable holding fixture similar to the one shown in Fig. 2.

2. Remove the lockwire, the capscrews, and the adjusting lockplate (Fig. 3).

3. Center punch one of the differential carrier legs and bearing caps (Fig. 3). This will properly identify the parts during reassembly.

4. Remove the bearing cap capscrews, the bearing caps, and the adjusting nuts.

5. Loosen the locknut (Fig. 4), back off the thrust block adjusting screw, and lift out the differential and gear assembly (Fig. 5).

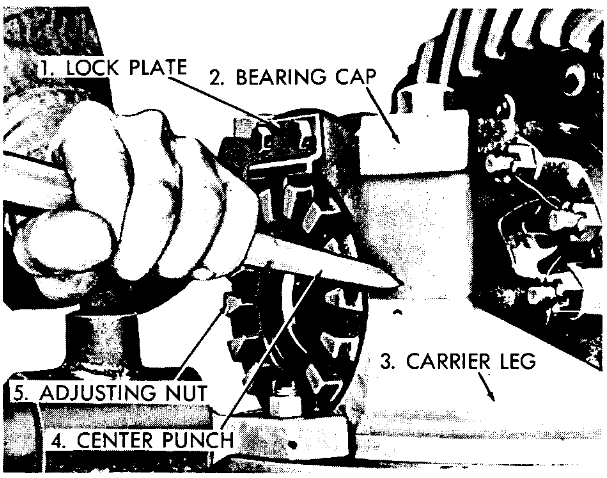

Fig. 3 — Center Punching Differential Carrier Leg

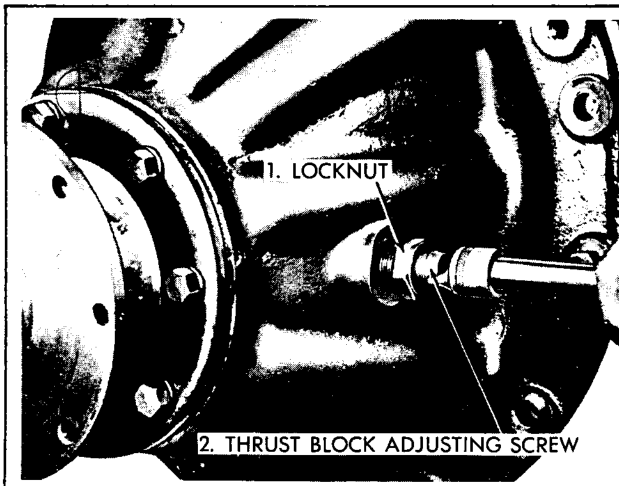

Fig. 4 — Loosening Thrust Block Adjusting Screw

E. Disassembly of Differential Case and Gear

1. If the original identification marks are not clear, mark differential case halves with a punch or chisel. This will properly identify the parts for correct alignment during reassembly.

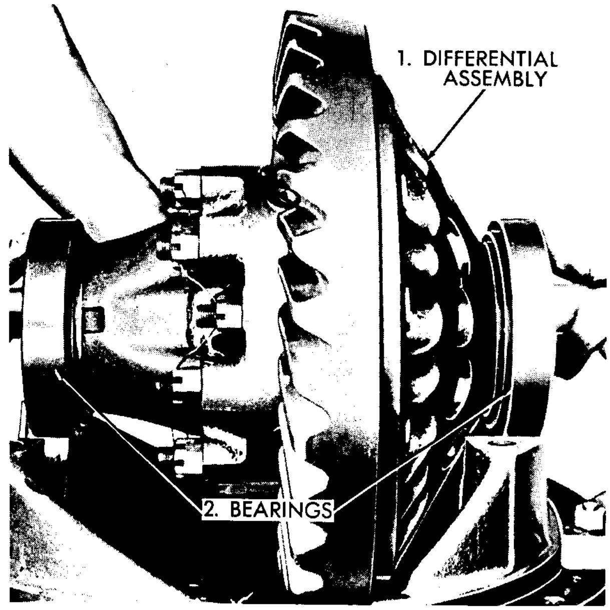

Fig. 5 — Removing Differential from Carrier

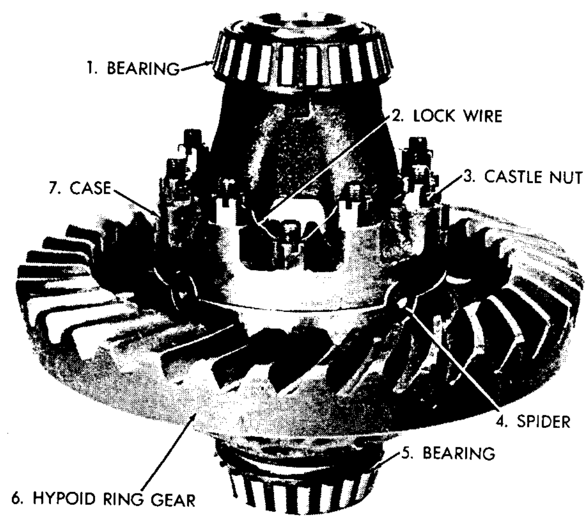

Fig. 6 — Differential Case and Gear Assembly

2. Cut the lockwire and remove the castle nuts that secure the case halves (Fig. 6).

3. Remove the case halves, the spider, the pinions, the side gears, and the thrust washer.

4. If necessary, remove the ring gear rivets and support the gear and case. The ring gear should be removed as follows:

   a. Carefully center punch each rivet in the center of the rivet head.

5. If it is necessary to replace the differential bearings, remove the bearings using a suitable puller (Fig. 9).

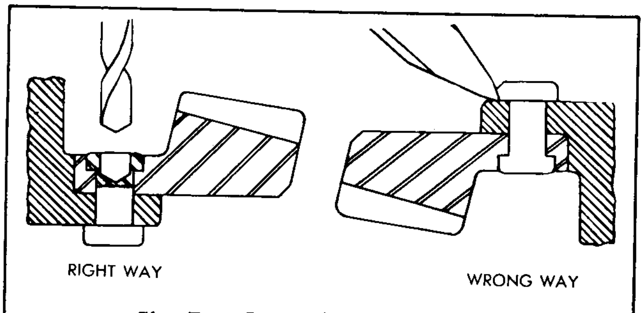

Fig. 7 — Removing Gear Rivets

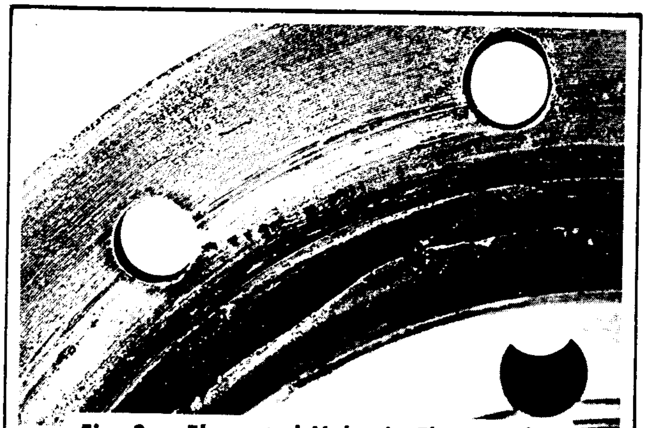

Fig. 8 — Elongated Holes in Flange when Rivets were Chiseled Out

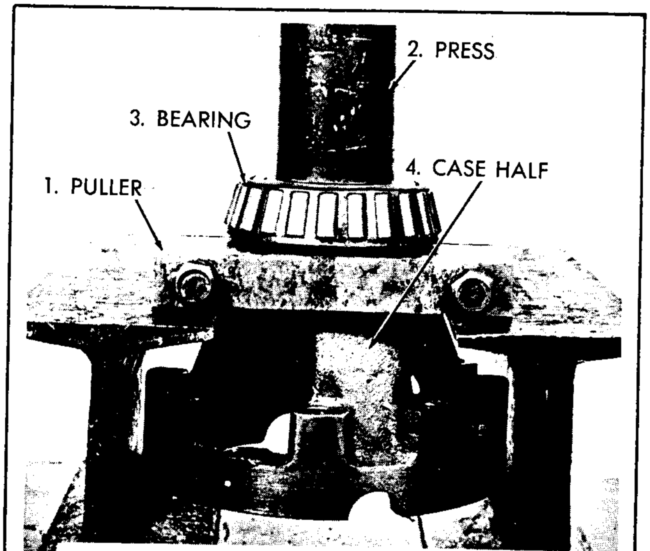

Fig. 9 — Removing Differential Bearings

b. Using a drill 1/16" smaller than the body of the rivet, drill through the rivet body as shown in Fig. 7. Press out the rivet.

IMPORTANT: *Under no circumstances should any attempt be made to remove the rivets by using a chisel as it is possible to elongate the rivet holes in the flange (refer to Figs. 7 and 8).*

F. Removal of Pinion and Cage Assembly

1. The pinion and cage assembly cannot be removed without removing the differential carrier from the axle housing and removing the differential case and gear assembly from the differential carrier.

2. Holding the yoke with a suitable tool, remove the cotter pin, the pinion shaft nut, and the washer.

3. Remove the yoke and slinger assembly.

4. Remove the capscrews (Fig. 10) securing the bearing cover and the seal assembly to the pinion cage assembly.

5. Install jackscrews in the holes provided (Fig. 10) and remove the pinion bearing cage assembly.

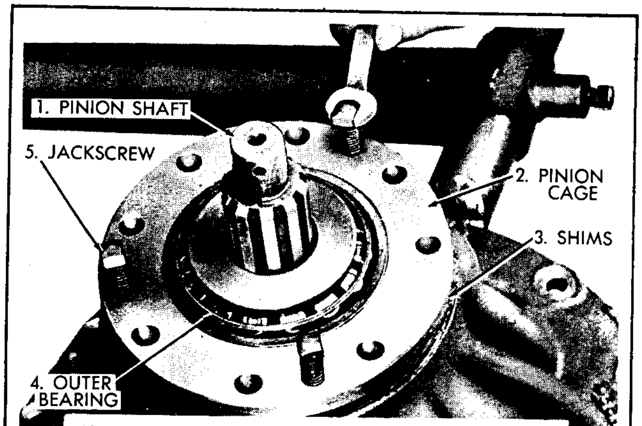

Fig. 10 — Removing Pinion Bearing Cage Assembly

NOTE: *The use of a punch bar will damage the shims under the bearing cage. Also, attempting to drive the pinion from the inner end with a drift may damage the bearing lock ring groove.*

6. Measure the thickness of the shims used under the pinion bearing cage assembly (Fig. 10) and wire the shim pack together to facilitate adjustment on reassembly.

G. Disassembly of Pinion and Cage

1. Using a soft mallet or a suitable press, remove the pinion shaft from the cage.

2. Remove the outer tapered bearing from the cage.

3. Remove the spacer (or spacer combination) from the pinion shaft.

4. Remove the inner tapered bearing from the shaft as shown in Fig. 11.

5. If it is found necessary to replace the rear (radial) bearing, remove the snap ring and remove the bearing with a suitable puller.

6. Remove the oil seal assembly from the bearing cover.

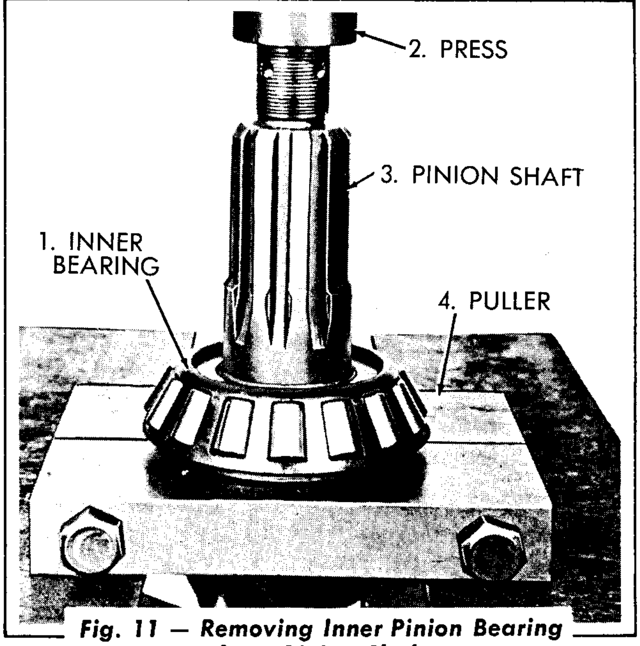

Fig. 11 — Removing Inner Pinion Bearing from Pinion Shaft

H. Cleaning and Inspection

Clean all of the parts having ground and polished surfaces, such as the gears, the bearings, and the shafts, with solvent type cleaners such as emulsion cleaners, carbon tetrachloride, or petroleum solvents excluding gasoline. Do not clean these parts in a hot solvent tank or with water and alkaline solutions, such as sodium hydroxide, orthosilicates or phosphates.

Other parts, such as the differential carrier castings and the cast brackets, may be cleaned in hot solution tanks with mild alkali solutions. These parts should remain in the tank long enough to be thoroughly cleaned and heated through. This will aid the evaporation of the cleaning solution and the rinse water. Parts cleaned in solution tanks or with alkali cleaners should be thoroughly rinsed after cleaning to remove all traces of alkali.

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

1. Inspect all of the bearings, cups and cones, including those not removed from the drive unit and replace them if the rollers or the cups are worn, pitted, or damaged in any way. Remove parts needing replacement with a suitable puller or in a press with sleeves. Avoid the use of drifts and hammers as they may mutilate or distort the component parts.

2. Inspect the hypoid gears for wear or damage. Gears which are worn, rigged, pitted or scored, should be replaced. When it is necessary to replace either the pinion or the gear of the hypoid set, the entire set must be replaced.

3. Inspect the differential case halves, the thrust washers, the spider, the trunnions, and the gears for pits, scores or wear. Thrust washers must be replaced in sets because the use of a combination of old and new washers will result in premature failure.

4. Inspect the differential pinion and side gear teeth for any damage or wear. Always replace the differential pinions and side gears in sets.

5. Inspect all the studs for tightness and machined or ground surfaces for nicks, mars,

or burrs. Threads on studs or capscrews must be clean in order to obtain accurate adjustment and correct torques. A fine mill file or India Stone is suitable for cleaning the threads.

IMPORTANT: *New oil seals and gaskets MUST be used during assembly. Should any bearings need replacing, the bearing and the bearing cup must be replaced. If cleaned parts are to be reused immediately, coat them with oil. If cleaned parts are to be stored, they should be treated with a good RUST PREVENTATIVE and wrapped in special paper or other material designed to prevent corrosion.*

I. Assembly of Pinion and Cage

1. Press the rear thrust bearing firmly against the shoulder on the pinion shaft, using a suitable sleeve that will bear only on the bearing inner race (Fig. 12).

2. Install the radial bearing snap ring into the pinion shaft groove using snap ring pliers.

3. Install the rear tapered bearing on the pinion shaft being certain that bearing is tight against the pinion gear.

4. If new bearing cups are to be installed, press the bearing cups into the pinion bearing cage so that the cups are tight against the shoulder in the pinion bearing cage.

5. Install the bearing spacer on the pinion shaft, and after lubricating the rear tapered bearing, install the pinion bearing cage assembly.

   IMPORTANT: *Do not install the bearing cage capscrews.*

6. Lubricate and install the front tapered bearing on the pinion shaft, being certain that the bearing is firmly against the bearing spacer. Rotate the pinion bearing cage several revolutions to assure normal bearing contact.

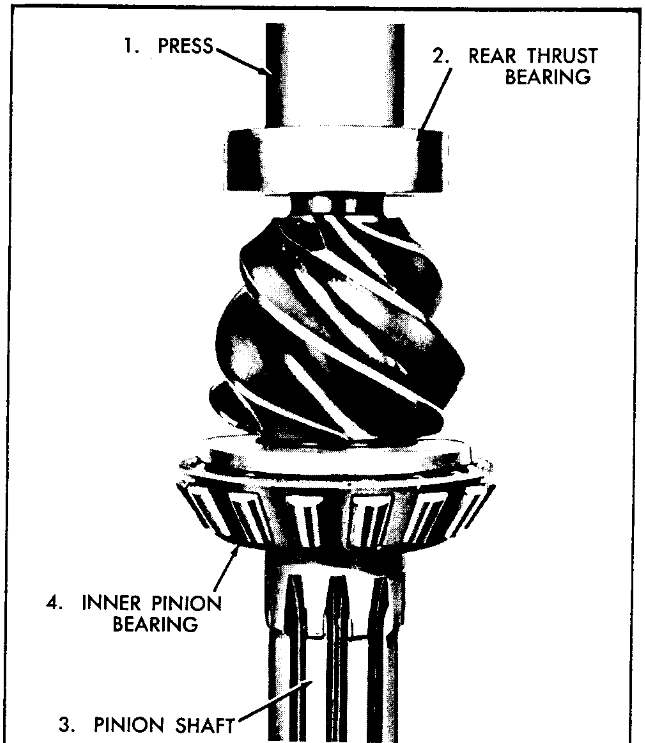

Fig. 12 — Installing Rear Thrust Bearing on Pinion Shaft

7. Install the yoke, the washer, and the pinion shaft nut and, while holding the yoke, tighten the nut to the correct torque (refer to Topic 5).

8. Suitably support the pinion assembly and wrap a piece of soft wire or string around the pinion bearing cage. Using a pound or fish scale, check the pinion-tapered bearing preload torque (Fig. 13). This ROTATING TORQUE (not starting torque) should be 5 to 15 lbs. in. If the rotating torque is not 5 to 15 lbs. in., it will be necessary to remove the front tapered bearing and the pinion bearing cage to install a thinner (or thicker) spacer between the bearings. A thinner spacer will increase the bearing preload and a thicker spacer will decrease the bearing preload.

   EXAMPLE: *Assuming the pinion cage diameter to be 6 inches, the radius would be 3 inches. Then, a 5-pound pull would equal 15-pound inches of preload torque.*

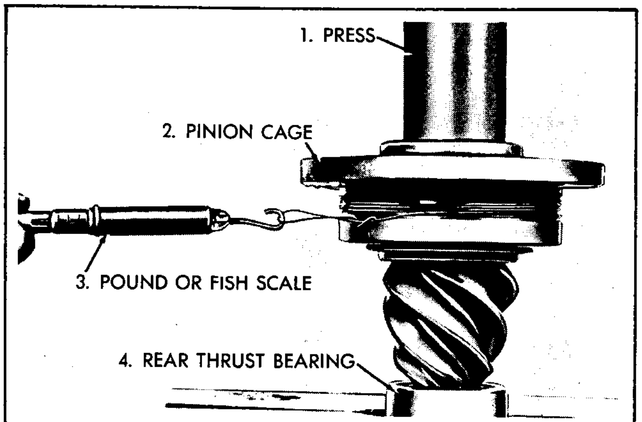

Fig. 13 — Checking Preload on Pinion Bearings

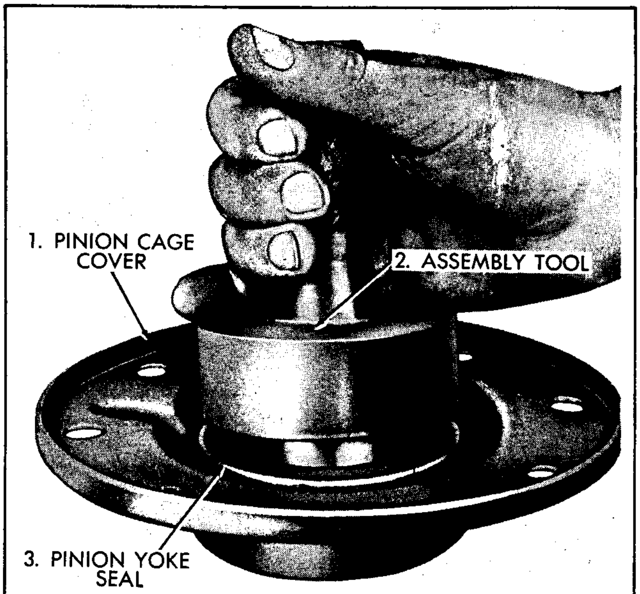

Fig. 14 — Installing Pinion Yoke Seal in Cover

IMPORTANT: *Should it be necessary to change the spacer, always be certain that the pinion shaft nut is retorqued to the proper torque before rechecking the preload on the tapered bearings.*

9. After obtaining the proper preload on the pinion tapered bearings, remove the yokes, the washer, and the pinion shaft nut.

10. Coat outer edge of the pinion yoke seal with a non-hardening sealing compound and press the seal into the cover (Fig. 14), being certain that the seal is firmly against the shoulder in the cover.

J. Installation of Pinion and Cage

1. Install the original shim pack between the pinion bearing cage and the differential housing (refer to Par. F, in this Topic).

   IMPORTANT: *Locate thin shims on both sides for maximum sealing ability.*

2. Install two capscrews between the pinion and cage assembly and the differential housing as guides. Using a soft mallet, tap the pinion and cage assembly in position. Install the remaining capscrews and the lockwashers, but do not tighten them securely at this time because it may be necessary to add or subtract shims to obtain the correct tooth contact between the pinion gear and the hypoid gear.

3. Lubricate the lip of the yoke seal, and install the cover together with the yoke, the washer, and the pinion shaft nut. Tighten the pinion shaft nut to correct torque and install the cotter pin.

   IMPORTANT: *Do not back off the nut to align the cotter pin hole.*

K. Assembly of Differential and Gear

1. Rivet the hypoid gear to the differential case half, using new rivets. Rivets should not be heated, but always set cold. When the correct rivet is used, the head being formed will be at least 1/8" larger than the diameter of the rivet hole. The head will then be approximately the same height as the preformed head. Excessive pressure will cause distortion of the case holes and may result in gear eccentricity.

   NOTE: *Approximately 30 tons of pressure is required to properly squeeze cold annealed steel rivets.*

2. Lubricate the inner walls of the differential case and all of the other differential parts, with axle lubricant.

3. Install one thrust washer and one side gear in the bevel gear and case half assembly. Assemble the pinion gears, the thrust washers, and the spider and place them in position (Figs. 15 and 16).

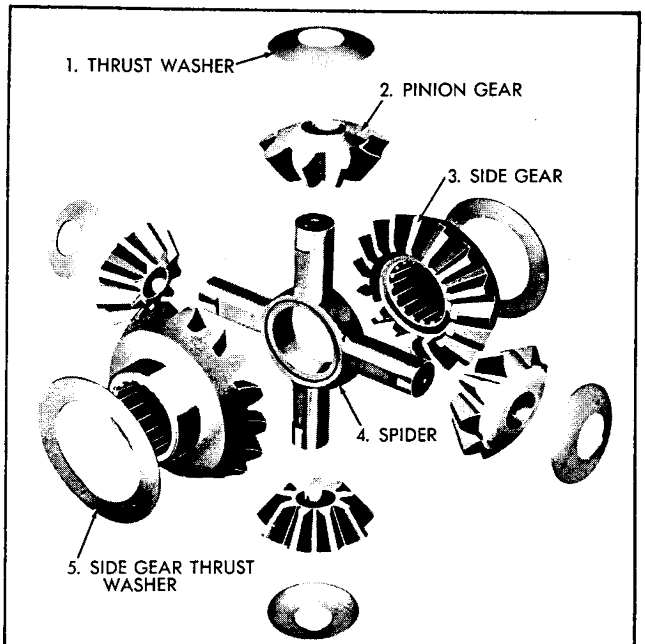

Fig. 15 — Component Parts of Differential

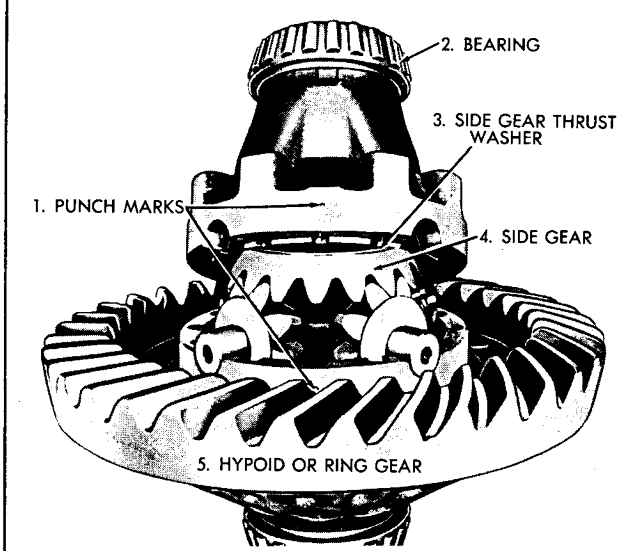

Fig. 16 — Assembling of Differential

4. Install the component side gear and the thrust washer in the other half of the case. After aligning the mating marks (Fig. 16) on the differential case halves, draw the assembly together with four of the capscrews and the nuts equally spaced around the case. Check for free rotation of the differential gears.

5. If there is no presence of binding in the gears, install the remaining capscrews and the nuts. Tighten all of the nuts to the correct torque (Topic 5) and install the lockwires.

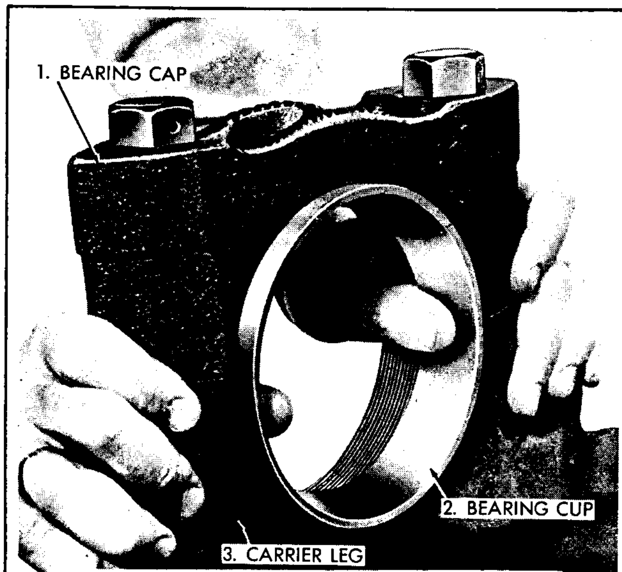

Fig. 17 — Checking Fit of Bearing Cups

NOTE: *If the differential bearings (Fig. 16) are to be replaced, press the bearings squarely and firmly on the differential case. The bearing cups must also be replaced.*

L. Installation of Carrier Cups in Carrier Leg Bores (Fig. 17)

Temporarily install the bearing cups, the threaded adjusting rings and bearing caps. Install the bearing cap capscrews and tighten to the proper torque. The bearing cups must be of a hand push fit in their respective bores (Fig. 17). If the bearing cups are not a hand push fit, the bores must be reworked until a hand push fit is obtained. Use a bearing scraper or emery cloth for reworking. Check work progress often.

M. Installation of Differential and Gear Assembly

1. Pack the two outer differential bearing cones and the cups with fiber base grease ("Marfax" #2 or equal), and install the differential assembly into the carrier.

2. Insert the bearing adjusting nuts (Fig. 18) and turn the nuts hand tight against the differential outer bearing cups.

3. Install the carrier bearing caps in the correct location as marked (Fig. 18) and tap them lightly into position.

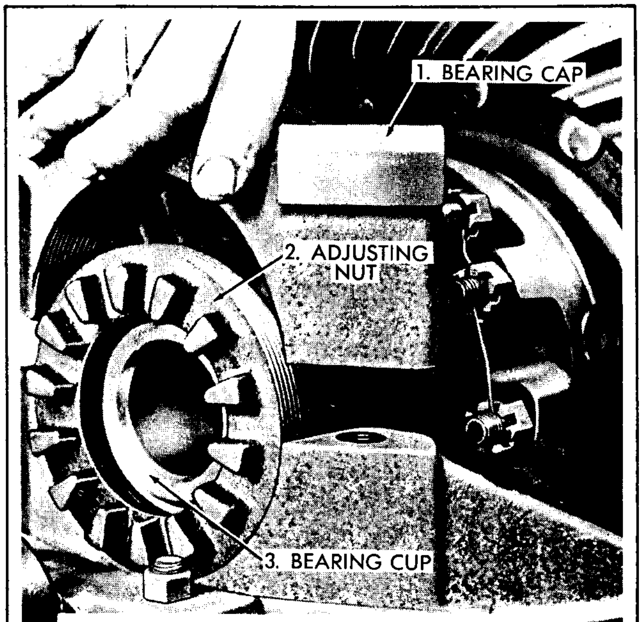

Fig. 18 — Installing Bearing Adjusting Nuts and Bearing Caps

NOTE: *If the bearing caps do not position properly, the adjusting nuts may be cross threaded. Remove the caps and reposition the adjusting nuts. Forcing the caps into position will ruin the carrier housing or the bearing caps.*

4. Install the bearing cap capscrews. Draw the capscrews up to finger tightness only. Do not tighten them securely.

N. Adjustment of Differential Bearings

1. Install a dial indicator on the back face of the hypoid gear. Loosen the end bearing adjusting nut (located on the opposite side of the hypoid gear) just enough to permit some end play as noted on the indicator. Then by tightening the end bearing adjusting nuts, adjust for .000" end play (Fig. 19).

2. With the dial indicator still in position, check the run-out of the hypoid gear (Fig. 19). Run-out should not exceed .008".

3. Using two pinch bars, tighten each bearing adjusting nut one notch each from the .000" end play to preload the end differential bearings.

4. Tighten the bearing cap capscrews to the correct torque (Section **XXI**).

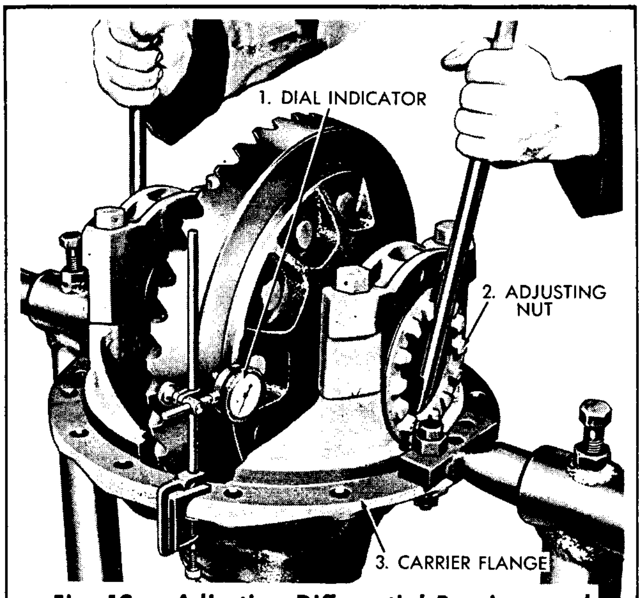

Fig. 19 — Adjusting Differential Bearings and Checking Run-Out of Ring Gear

O. Checking Backlash of Hypoid Gear

Install a dial indicator as shown in Fig. 20. Moving the hypoid gear by hand, note the reading on the indicator. The correct backlash for new gears should be .006" to .012". If the backlash exceeds .012", adjust the hypoid gear only. Adjustment is made by backing off on one of the adjusting rings and advancing the opposite adjusting ring by the same amount.

P. Adjustment of Tooth Contact Between Pinion and Hypoid Gear

It is very important that the correct tooth contact be obtained between the pinion and the hypoid gear. Adjustment for the correct tooth contact can be obtained by adding or removing the shims between the pinion gear case assembly and the differential housing which in turn moves the pinion gear forward or backward in relationship to the hypoid gear.

IMPORTANT: *Adding or removing the shims between the pinion gear case assembly and the differential housing will affect the .006" to .012" backlash between the pinion and the hypoid gears. Always recheck this backlash.*

To check for the proper tooth contact, apply oiled

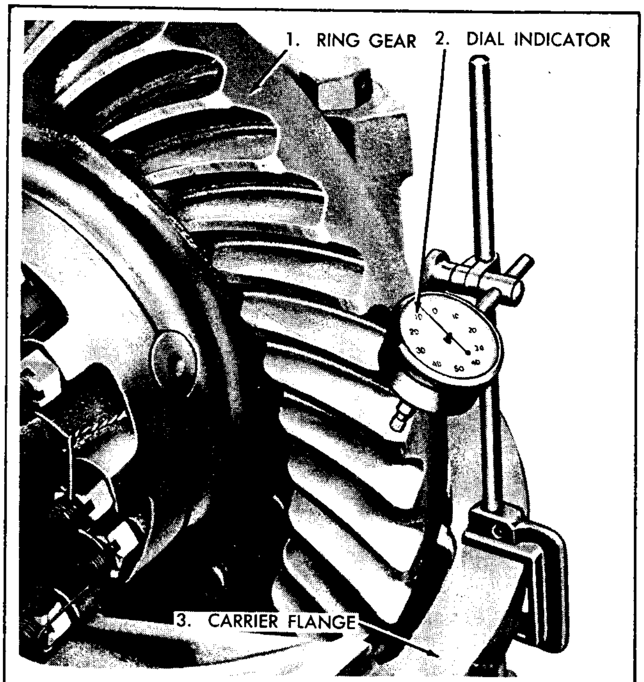

Fig. 20 — Checking Backlash Between Ring Gear and Pinion Gear

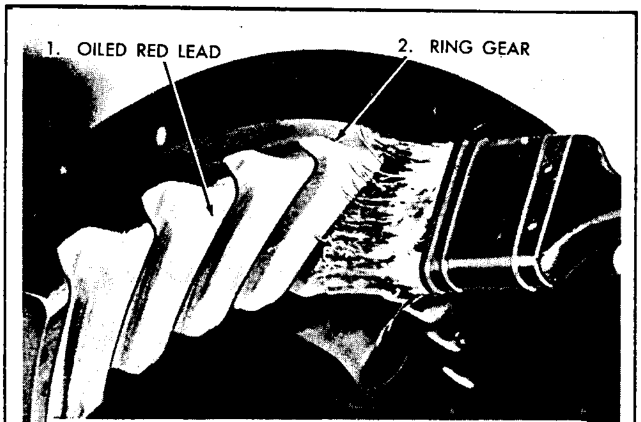

Fig. 21 — Checking for Proper Tooth Contact Between Ring Gear and Pinion Gear

red lead lightly to approximately twelve teeth on the hypoid gear (Fig. 21). Then by rotating the pinion gear, the red lead on the hypoid gear teeth will be squeezed away by the contact of the pinion gear, leaving bare areas, the exact size, shape, and location of the contact. The area of contact must favor the toe of the gear tooth, should extend ½ to ⅔ of the tooth length toward the heel, and be centered between the top and the bottom of the tooth (Fig. 22).

A high contact as shown in Fig. 23 is not desirable and will only result in noise, galling, and rolling over the top edges of the teeth. To obtain the correct adjustment, move the pinion toward the hypoid gear to lower the contact area. This adjustment will decrease the backlash between the pinion and the gear teeth. This must be corrected by moving the hypoid gear away from the pinion. Correct

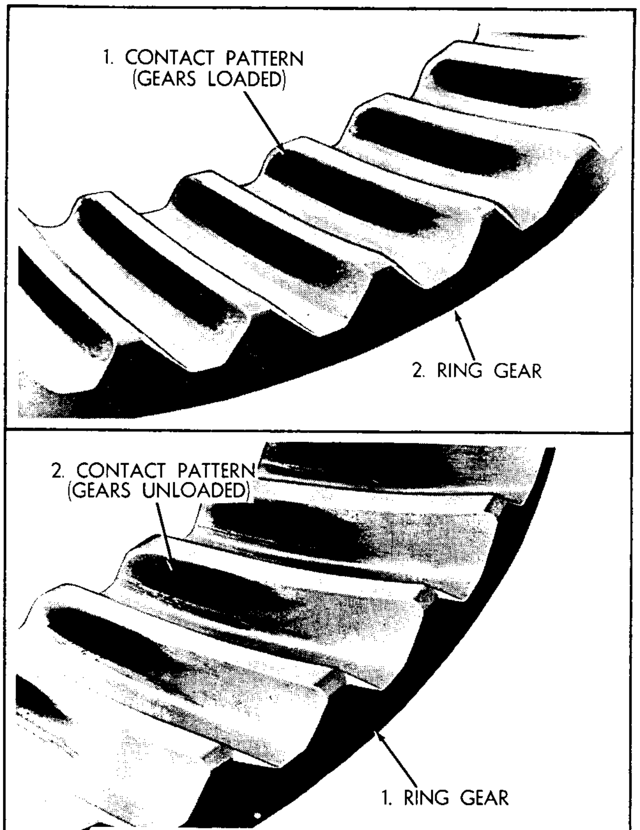

Fig. 22 — Satisfactory Tooth Contact

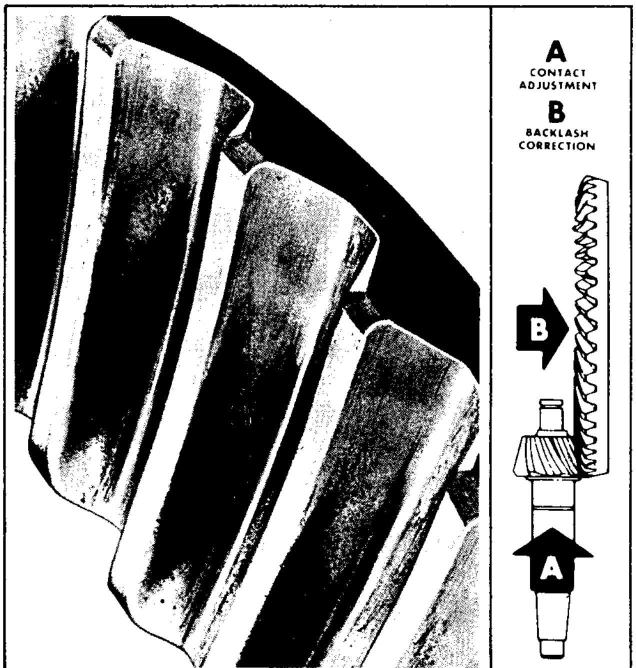

Fig. 23 — High Contact

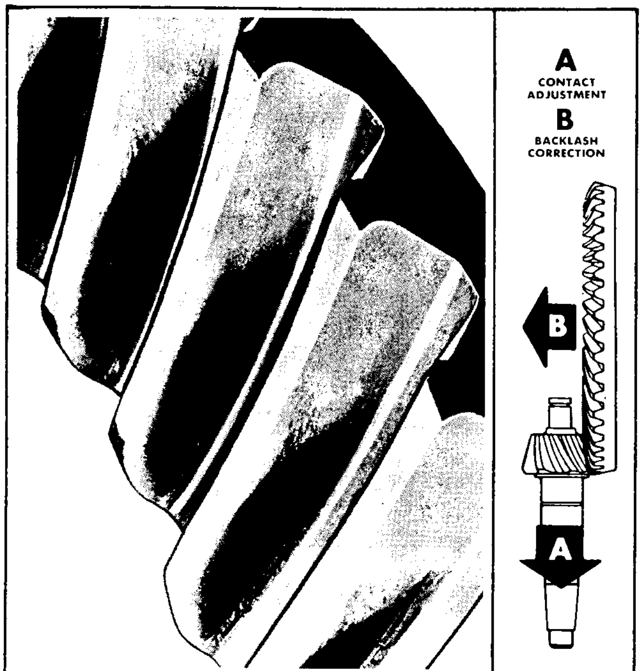

Fig. 24 — Low Contact

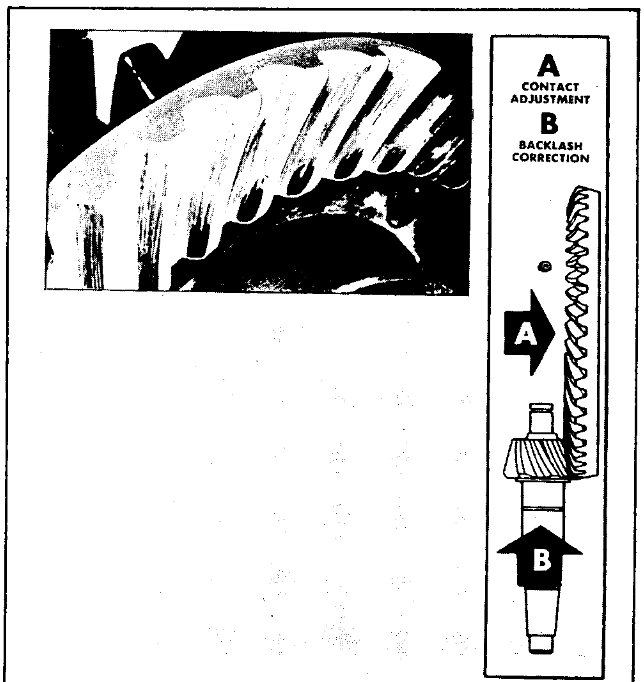

Fig. 25 — Short Toe Contact

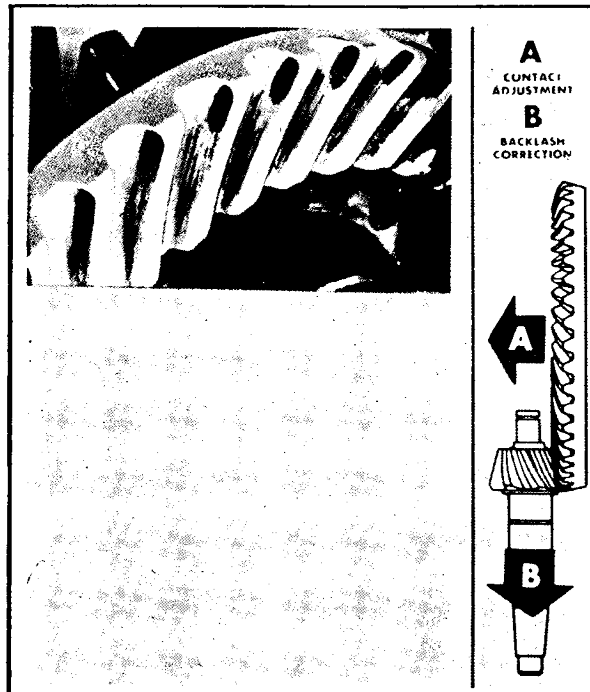

Fig. 26 — Short Heel Contact

backlash is .006" to .012" (refer to Par. O in this Topic).

A low contact (Fig. 24) will result in galling, noise, and grooving of the teeth. To obtain the correct adjustment, move the pinion away from the hypoid gear to raise the contact area. This adjustment will affect the backlash between the pinion and the gear teeth which must be corrected by moving the hypoid gear toward the pinion. Correct backlash is .006" to .012" (refer to Par. O, in this Topic).

A short toe contact (Fig. 25) will result in chipping the teeth edges and excessive wear due to the small contact area. To obtain correct adjustment, move the hypoid gear away from the pinion gear to increase the lengthwise contact and to move the contact toward the heel of the tooth. This adjustment will affect the backlash between the pinion and the gear teeth which must be corrected by moving the pinion toward the gear. Correct backlash is .006" to .012" (refer to Par. O, in this Topic).

A short heel contact (Fig. 26) will result in chipping, excessive wear, and noise. To obtain the correct adjustment, move the hypoid gear toward the pinion to increase the lengthwise contact and to move the contact toward the toe of tooth. This adjustment will affect the backlash between the pinion and the gear which must be corrected by moving the pinion away from the gear. Correct backlash is .006" to .012" (refer to Par. O, in this topic).

NOTE: *Several adjustments of both the pinion and the hypoid gear may be necessary before the correct contact and backlash are secured.*

After the correct contact and backlash between the pinion and the hypoid gears is obtained, install the two bearing adjusting nut lock plates and the capscrews (Fig. 3). Torque the capscrews to 15-16 lbs. ft. and install the lockwires. Also tighten the capscrews that secure the pinion gear case assembly to the differential housing. Torque capscrews to correct torque.

Q. Adjustment of Hypoid Gear Thrust Block

1. Remove the carrier assembly from the stand and position the carrier so that the hypoid gear is upward.

2. Remove the adjusting screw and the locknut from the carrier housing (Fig. 27).

3. Place the thrust block on the rear face of the hypoid gear, and then rotate the gear until the hole in the thrust block is aligned with the adjusting screw hole.

4. Install the adjusting screw and the locknut and tighten adjusting screw sufficiently (Fig. 28) to locate the thrust block firmly against the back face of the hypoid gear. Then loosen the adjusting nut ¼-turn so as to obtain .010" to 0.015" clearance between the thrust block and rear face of the hypoid gear.

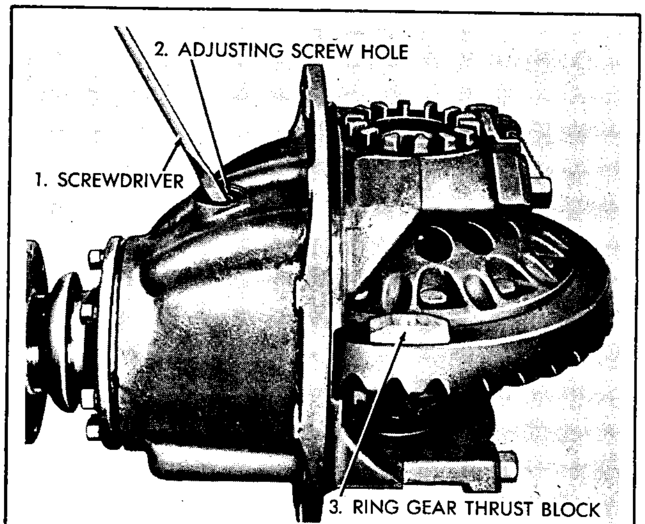

Fig. 27 — Positioning Ring Gear Thrust Block

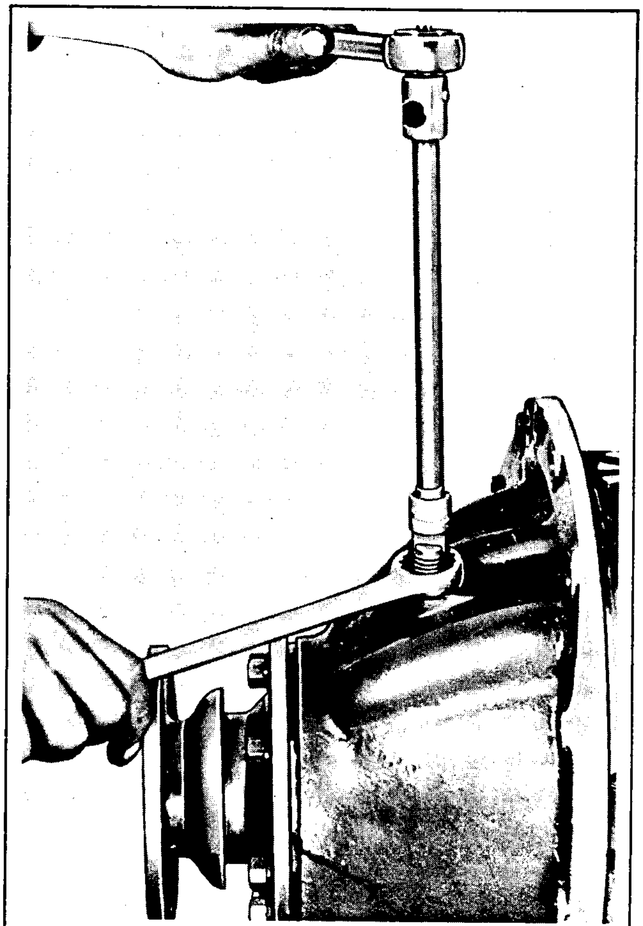

Fig. 28 — Installing and Tightening Ring Gear Thrust Block

5. Recheck to be sure that there is a minimum clearance of .010" between thrust block and the hypoid gear during full rotation of the hypoid gear.

R. Installation of Differential Carrier Assembly in Axle Housing

1. Using a solvent, clean the axle housing thoroughly and dry it with compressed air. Inspect the housing for cracks, loose studs, nicks and burrs on the machined surfaces. Remove all nicks and burrs with a stone or fine file.

2. Install a new differential carrier-to-axle housing gasket. With a suitable hoist and sling attached to the pinion shaft, position the differential carrier assembly into axle housing.

3. Install the lockwashers and the stud nuts on the studs under the carrier housing offsets.

It is impossible to start these nuts after carrier is drawn into housing.

4. Install four flat washers and nuts equally spaced. Then tighten the nuts equally to draw the carrier squarely into the housing.

5. Remove the four nuts and flat washers. Install the stud nuts and the lockwashers. Tighten them to the correct torque (Topic 5).

6. Install the axle assembly in the loader (refer to Topic 2).

7. Fill the differential assembly and the planetary hubs to the correct level, using SAE 90 lubricant. Lubricate the universal joint.

8. If the front axle differential carrier was rebuilt, the front end of the loader must be jacked up so that the tires clear the floor approximately two inches. Start the engine and place the transmission selector in high gear, forward, and allow wheels to turn approximately 25 to 30 miles per hour to assure satisfactory lubrication of all parts of the carrier assembly.

9. If rear axle differential carrier was rebuilt, both the rear axle and the front axle must be jacked up so that all four tires clear the floor approximately two inches. Then follow the same procedure in Step 8 above.

   CAUTION: *Both front wheels must be jacked up when attempting the procedures in Step 8, above, and all four wheels must be jacked up when attempting the procedures in Step 9, above. Otherwise, serious damage will result from overheating the differential spider that will cause galling or shearing of the spider pins, damage to other parts of the loader, and injury to personnel.*

10. Recheck the oil levels in the differentials and the planetary hubs. Be certain that all of the nuts and the capscrews are properly torqued and (where required) cotter pins are installed.

4. PLANETARY SHAFTS AND HUBS

A. General

All four planetary hubs are similar. Each consists of a floating gear, a floating sun gear, and three planetary pinions which rotate on forged bronze planet pins. These parts are lubricated by the oil carried in each planetary hub.

As the wheel hub and the planetary spider rotate, they pick up oil (contained in the hub) and channel it to the wheel bearings and gears. The oil, therefore, is constantly flowing around these parts and through the channels in the planet pins to lubricate the pinions. This assures full flow lubrication under all operating conditions.

The steering knuckles and the hub assembly in the rear axle (Fig. 30) each consist of a "Rzeppa" type universal joint, a trunnion socket, and a flange. The universal joint contained in the steering knuckle socket, is designed to transmit power while the machine is being steered—thus, a drive steering axle. The steering knuckle socket is the "ball-shaped" portion of the axle housing with integral king pins on which are mounted bushings. The trunnion socket bushings support the wheel hub and allow it to pivot during steering.

The trunnion socket bushings are pre-packed with grease during assembly so that very little lubrication is required in the field. The trunnion socket caps are adjusted by shims located under the caps. The quantity of shims used under the upper cap should approximately equal those used under the lower cap to center the universal joint in the steering trunnion socket.

Replacement of parts in all the planetary hubs can be done without removing the complete axle from the machine. The drive axle shafts in the front (rigid) axle can also be removed without completely disassembling the planetary hubs.

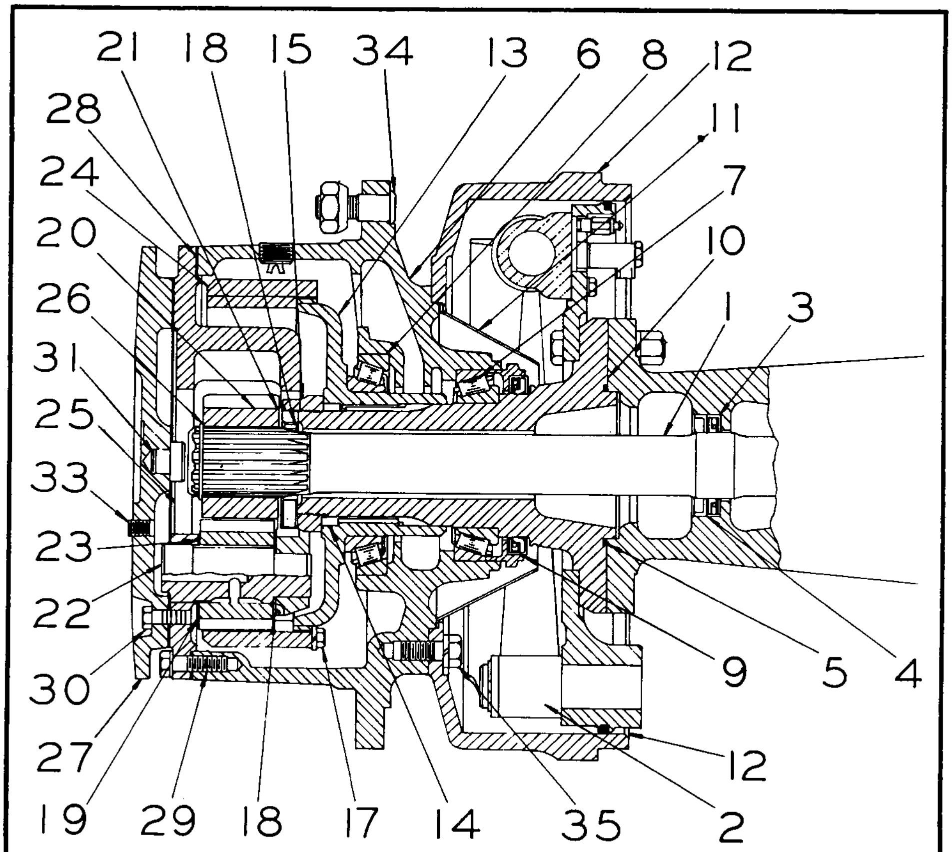

Fig. 29 — Rigid Planetary Hub — Cut-Away View

1. Drive axle shaft (front axle)
2. Brake assembly, front and rear
3. Oil seal (axle shaft)
4. Retainer assembly and seal ring
5. Seal ring
6. Hub assembly, front axle
7. Cup (front axle)
   Cup (rear axle)
   Cone (front axle)
   Cone (rear axle)
8. Cup (front & rear axles)
   Cone (front & rear axles)
9. Retainer assembly and seal ring
10. Spindle
11. Oil slinger
12. Brake drum
13. Hub (planetary ring gear)
14. Sleeve
15. Nut
17. Capscrew, lock plate, and lockwire
18. Washer (inner)
19. Washer (outer)
20. Gear, planetary sun (20 teeth)
21. Washer
22. Shaft
23. Pinion
24. Gear, planetary ring (52 teeth)
25. Spider
26. Snap ring
27. Gasket and cover assembly
28. Gasket
29. Capscrew, ½" — 20 NF x 1⅝"
    Lockwasher, ½" ASA med.
30. Capscrew (spider cover)
31. Thrust button
33. Plug, ¼", steel, ctsk., ¼" sq.
    (planetary oil filler & drain)
34. Stud and nut (special)
35. Capscrew, ⅝" — 11 NC x 1½"
    Lockwire, #16 W & M ga. x 50" lg.

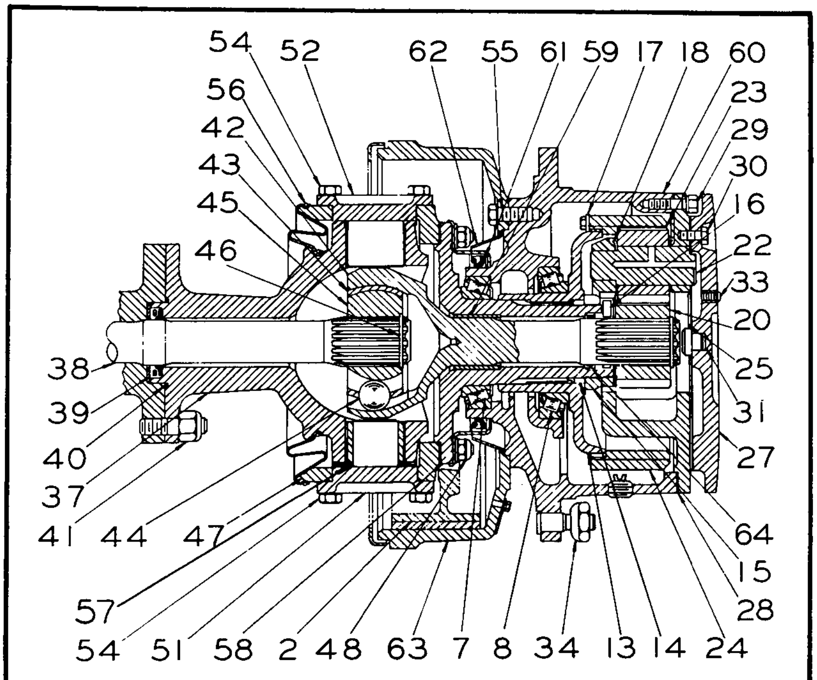

Fig. 30 — Planetary Steering Hub — Cut-Away View

2. Brake assembly, front and rear
7. Cup (front axle)
   Cup (rear axle)
   Cone (front axle)
   Cone (rear axle)
8. Cup (front & rear axles)
   Cone (front & rear axles)
13. Hub (planetary ring gear)
14. Sleeve
15. Nut
16. Retainer
17. Capscrew, lock plate, and lockwire
18. Washer (inner)
20. Gear, planetary sun (20 teeth)
22. Shaft
23. Pinion
24. Gear, planetary ring (52 teeth)
25. Spider
27. Cover assembly and gasket
28. Gasket
29. Capscrew, ½" — 20 NF x 1⅝"
    Lockwasher, ½" ASA med.
30. Capscrew (spider cover)
31. Thrust button
33. Plug, ¼", steel ctsk., ¼" sq. (planetary oil filler & drain)
34. Stud and nut (special)
37. Trunnion socket assembly
    Bushing
38. Drive shaft
39. Oil seal (axle shaft)
40. Seal
41. Stud and locknut
42. Universal joint assembly (outer)
43. Out race, stud axle, and cage
44. Ball
45. Inner race
46. Snap ring
47. Steering knuckle flange assembly, left & right
    Knuckle flange, inner
    Knuckle flange, companion
48. Stud
49. Plain washer, 9/16" SAE
    Locknut, 9/16" — 18 NF
51. Cap, lower bearing
    Shim (.003" thick)
    Shim (.005" thick)
    Shim (.020" thick)
52. Cap, upper R.H. bearing
    Shim (.003" thick)
    Shim (.005" thick)
    Shim (.020" thick)
54. Capscrew, ⅝" — 11 NC x 1½" (flange to bearing cap)
    Lockwire
55. Capscrew, ⅝" — 11 NC x 1½", rd. hd.
    Lockwire, #16 W & M Ga. x 50" long
56. Boot
    Boot clamp (inner)
    Boot clamp (outer)
    Sleeve clamp
57. Thrust washer
58. Steering knuckle
59. Bushing
60. Hub & bearing assembly
61. Oil seal
    Seal ring
    Retainer assembly
62. Oil slinger
63. Brake drum
64. Oil seal (drive joint)

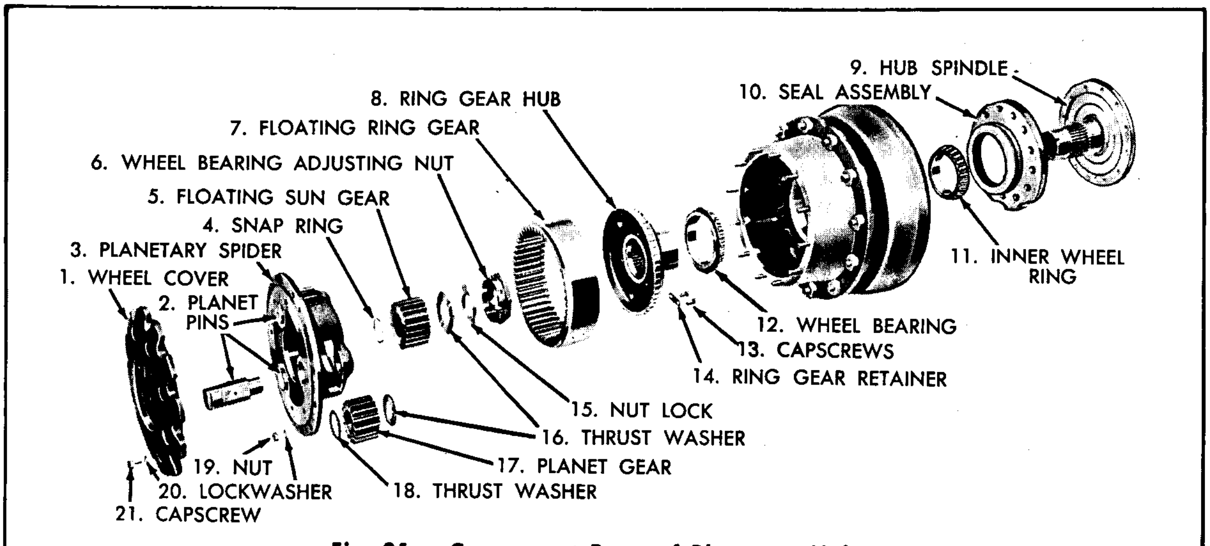

Fig. 31 — Component Parts of Planetary Hubs

B. Removal and Disassembly of Planetary Hubs

1. Removal of Spider and Hub

a. Using a suitable hydraulic jack (approximately five ton capacity), raise the axle so that the tires clear the floor approximately two inches.

CAUTION: *Never rely upon the hydraulic jack to support the weight of the loader, use suitable blocking or stands under each side of the axle which will prevent the axle from falling or slipping.*

b. Remove the wheel nuts and remove the wheel assembly.

c. Rotate the planetary hub assembly so that the drain plug is at the bottom. Remove the drain plug and drain the lubricant.

d. Remove the planetary hub cover capscrews and remove the cover and the gasket. Remove the planetary spider stud nuts, the lock washers, the spider, and the gasket (Fig. 32).

NOTE: *Jackscrew holes are provided for removal of the spider assembly.*

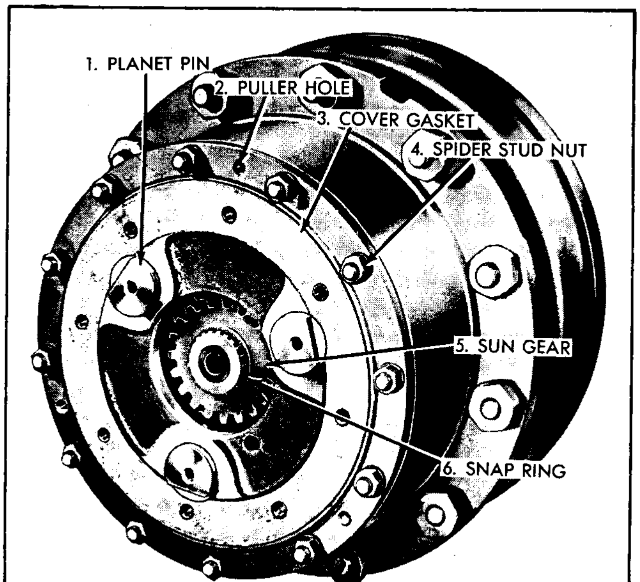

Fig. 32 — Planetary Spider Assembly

2. Disassembly of Planetary Spider Assembly

a. Position the spider face down, on wooden blocks. Using a suitable press, press out the planet pins from the inside out (Fig. 33).

b. Remove the planet gears and their respective thrust washers (Fig. 31).

IMPORTANT: *The thrust washers are designed for use on both ends of the planet pinions and must be reinstalled in their original positions.*

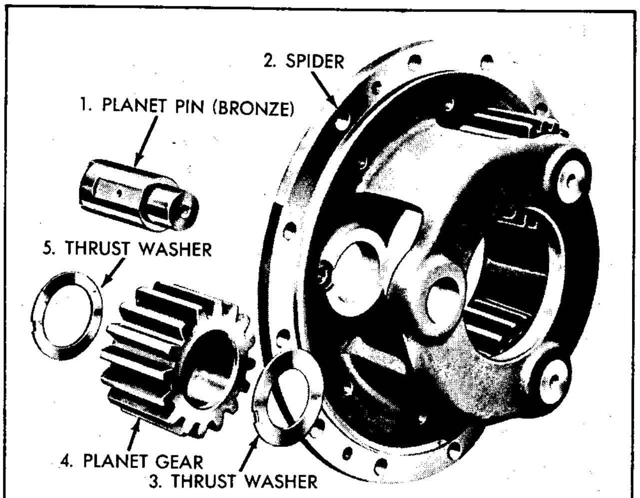

Fig. 33 — Spider Planet Gear and Pin Removed

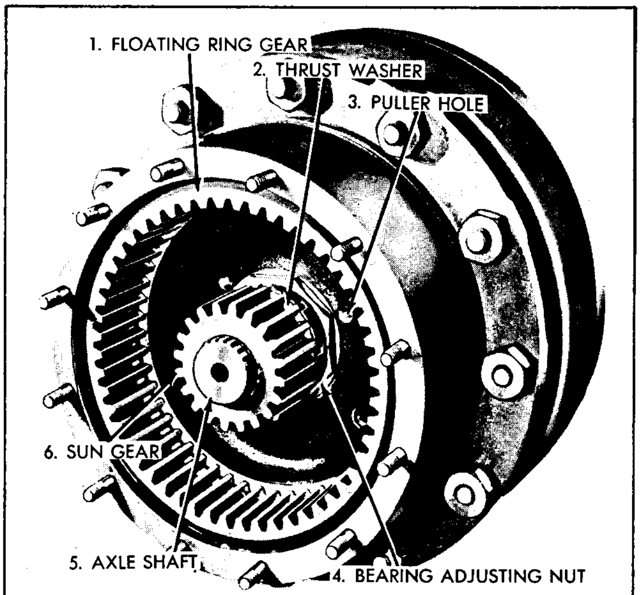

Fig. 34 — Sun Gear and Floating Ring Gear

3. Removal of Floating Ring Gear

a. Remove the snap ring that retains the sun gear (Fig. 34).

b. Remove the sun gear and the thrust washer.

c. Remove the wheel bearing adjusting nut locks and remove the wheel bearing adjusting nut (Fig. 34). Threaded puller holes are provided in the ring gear hub flange that are used for the removal of the floating ring gear assembly.

d. Remove the lockwire, the ring gear retainer, the plates, and the capscrews that secure the floating ring gear to the ring gear hub.

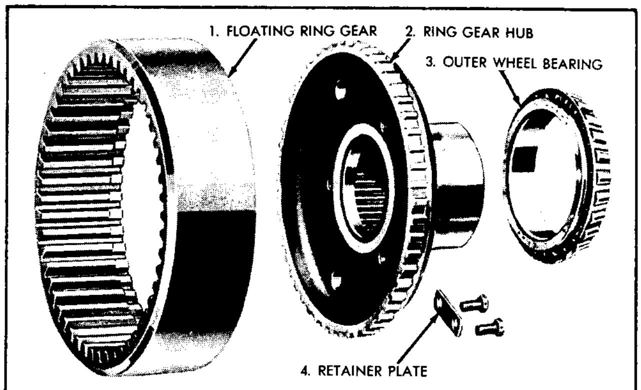

Fig. 35 — Floating Ring Gear, Hub, and Bearing — Exploded View

Separate the floating ring gear and the ring gear hub (Fig. 35). Then remove the outer wheel bearing from the ring gear hub.

NOTE: *The ring gear hub assembly is made up of the hub and a hardened ring sleeve insert which is pressed into the hub from the outerside.*

4. Removal of Wheel Hub and Brake Drum Assembly

a. With the brakes fully released, lift the hub and drum assembly slightly to relieve the weight of the hub and drum assembly from the brake shoe. Remove the assembly from the hub spindle.

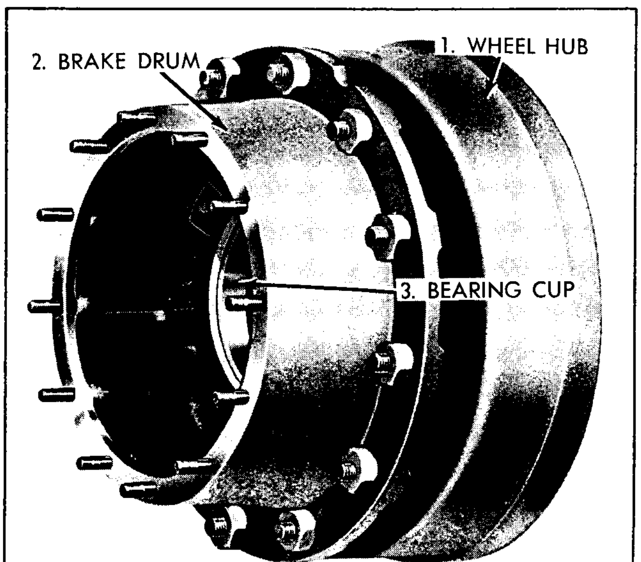

Fig. 36 — Wheel Hub and Brake Drum Assembly

b. If the wheel bearing cup (Fig. 36) is to be replaced, remove the wheel bearing cup with a suitable puller.

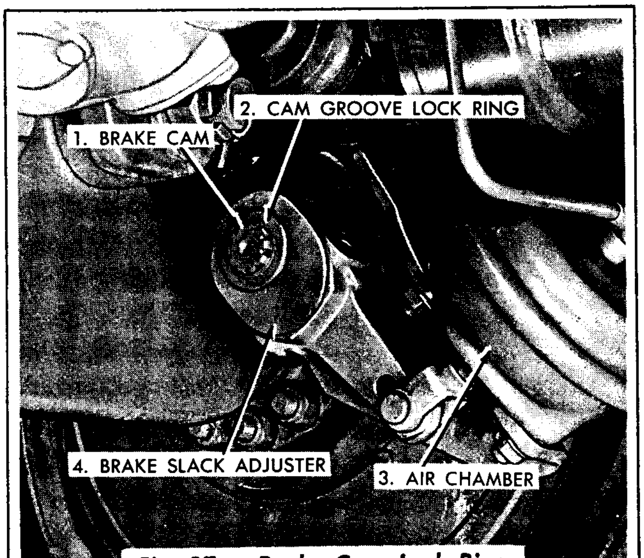

Fig. 37 — Brake Cam Lock Ring

5. Removal of Rear (Steering) Hub Spindle

a. Remove the cam groove lock ring and the washer (Fig. 37).

b. Remove the inner bearing and the brake return springs (Figs. 38 and 39).

c. Remove the hub spindle nuts and the lockwashers.

d. Remove the oil seal assembly by lifting the retainer from the stud nuts and the seal ring located behind the retainer in a recess in the hub spindle (Fig. 38).

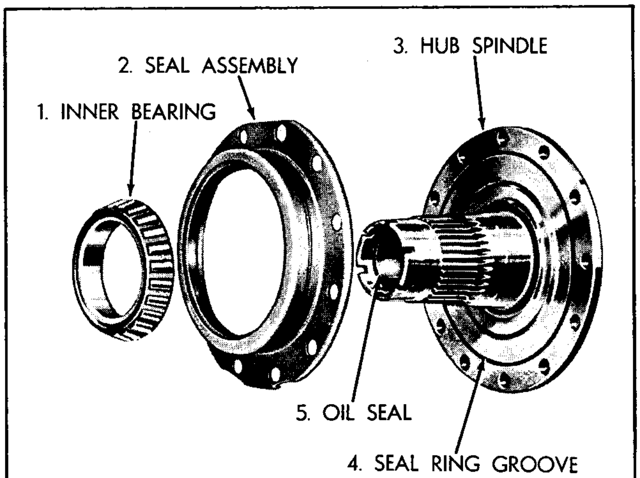

Fig. 38 — Hub Spindle Assembly (Steering Axle)

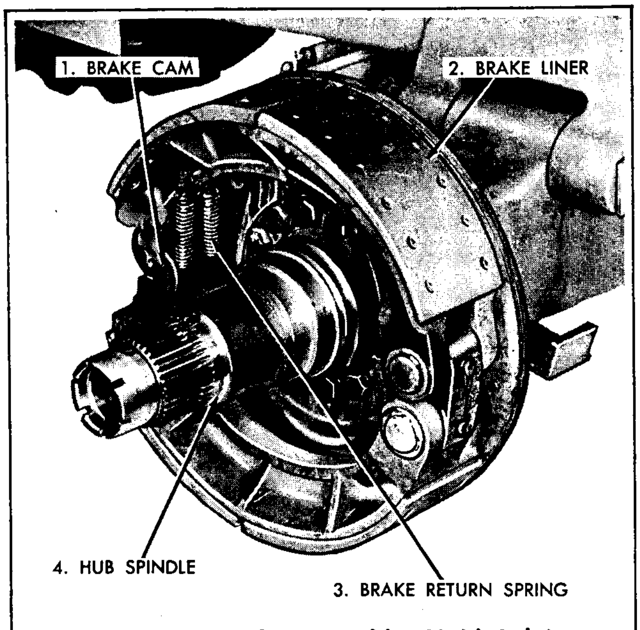

Fig. 39 — Brake Assembly (Rigid Axle)

e. Remove the hub spindle.

NOTE: *It may be necessary to tap the spindle with a soft hammer to release it from the studs.* IMPORTANT: *Care must be taken not to damage the outer oil seal located in the outer end of the spindle while sliding the spindle over the axle shaft splines.*

6. Removal of Front (Rigid) Hub Spindle

a. Remove the cam groove lock ring and the inner wheel bearing if not previously removed. Refer to Par. 5, above.

NOTE: *The oil seal and retainer assembly is located in the wheel hub against the hub rear bearing cups and wipes the hub spindle. Remove the retainer and seal assembly from the wheel hub with a suitable puller. Do not remove the oil seal from the retainer unless replacement is necessary.*

b. Remove the nuts, the lockwashers, and the capscrews that secure the hub spindle to the axle housing and then remove the hub spindle.

IMPORTANT: *Care must be taken not to damage the seal ring located in the recess in the axle housing.*

C. Removal and Disassembly of Planetary Steering Universal Joint and Steering Knuckle Flange Assembly

1. Removal of Axle Shaft and Ball Joint

a. Remove the axle shaft and the ball joint as an assembly (Fig. 40), being careful not to damage the oil seal that is located in the axle housing.

b. Place the inner shaft into a bronze jawed vise so that the outer race bell is positioned downward (Fig. 41).

c. Drive off the shaft, the bell, the bearing, and the cage assembly by using a bronze or brass drift against the end of the inner race (Fig. 41).

d. Remove the lock ring on the end of the inner shaft.

NOTE: *This is an expander type lock ring and must never be reused. Always install a new lock ring.*

2. Disassembly of Universal Joint

a. Place the axle shaft into a bronze jawed vise (Fig. 42). Turn the inner race in the outer race bell until one of the joint balls can be lifted out. Continue turning the race until all of the balls are removed.

b. Next roll the cage and the inner race at right angles to the outer race bell so that the two elongated openings in the cage align with the opposite teeth of the bell. Remove the cage and the inner race from the outer race bell.

c. To separate the inner race from the cage, turn the inner race at right angles to the cage, aligning the short tooth on the inner race with the elongated hole in the cage. Then roll the inner race out of the cage.

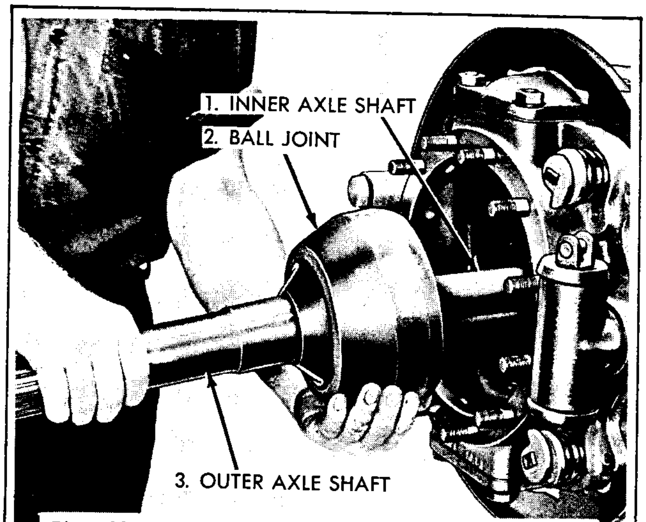

Fig. 40 — Removing Axle Shaft and Universal Joint Assembly

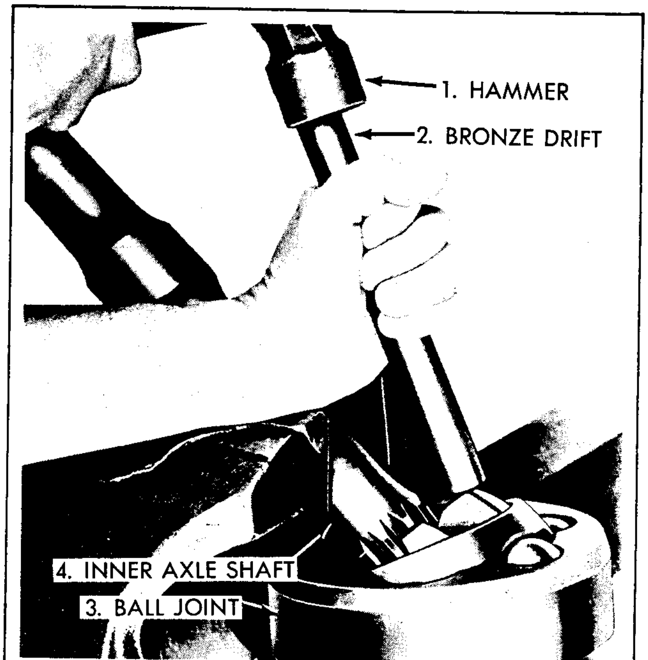

Fig. 41 — Separating Inner and Outer Axle Shafts

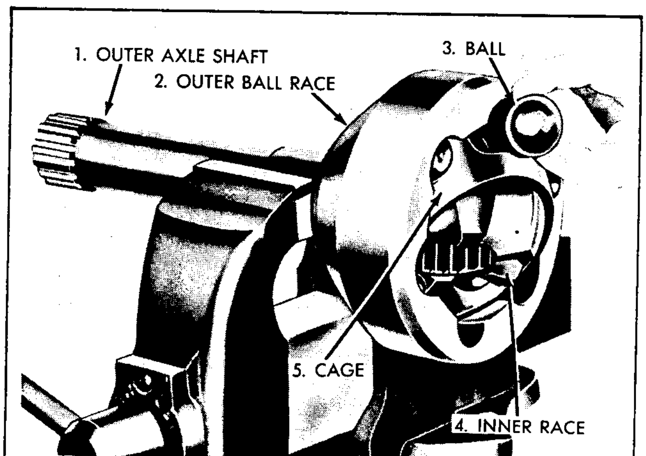

Fig. 42 — Removing Universal Joint Balls

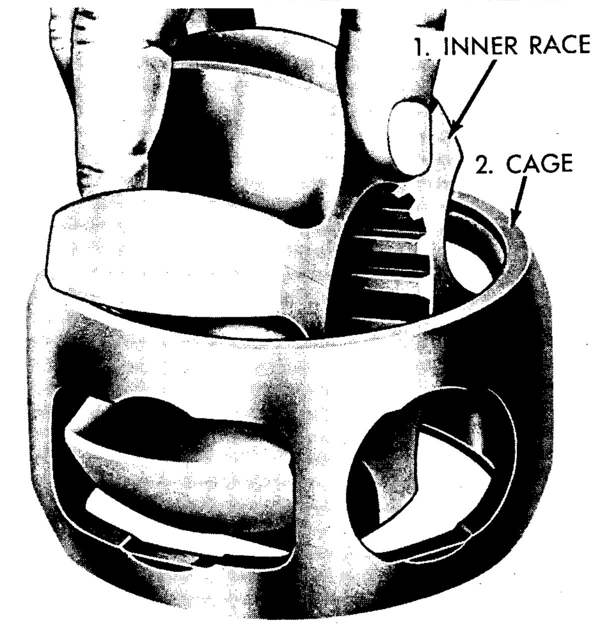

Fig. 43 — Removing Cage from Inner Ball Race

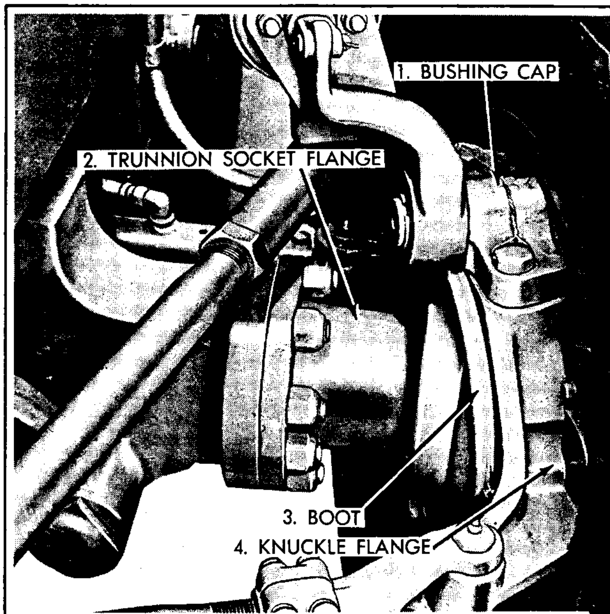

Fig. 44 — Trunnion Socket and Knuckle Flange

3. Removal of Knuckle Flange Assembly

a. If axle has not been removed from the machine, disconnect the steering arm linkage and the tie rods (refer to Topic 2 and Fig. 44).

b. Remove the capscrews that secure the dust shields to the knuckle flange housing.

c. Remove the outer boot clamp that secures the boot to the knuckle flange.

d. Fold the boot back and remove the inner clamp.

e. Remove the nuts, the lockwashers, and the capscrews that secure the trunnion socket flange to the axle housing flange (Fig. 44). Then remove the knuckle flange assembly.

4. Disassembly of Steering Knuckle Flange

a. Place the trunnion socket flange of the knuckle flange assembly in a bronze jawed vise.

b. Remove the upper and lower bushing capscrew lockwires, the capscrews, the bushing caps, and the shims (Figs. 44 and 45).

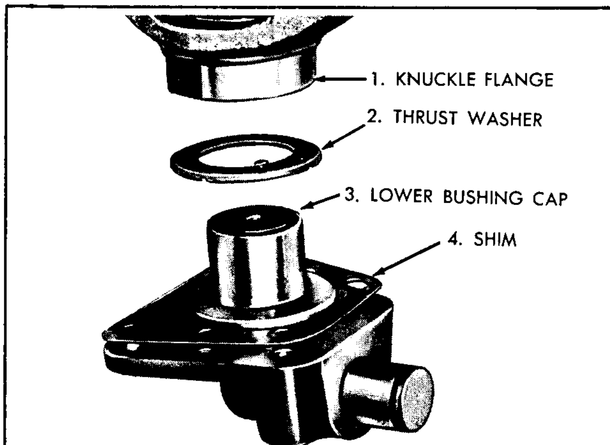

Fig. 45 — Removing Lower Bushing Cap and Thrust Washers

Remove the thrust washer from the lower bushing.

NOTE: *The shim pack should be wired together to keep them intact and to facilitate adjustment on reassembly.*

c. If the bushings are to be replaced, remove them by using a press.

d. Remove the oil seal from the oil seal recess in the axle housing at the connecting flange.

e. Remove the rubber boot from the axle socket by carefully stretching it over the bell housing.

D. Cleaning and Inspection

Clean all of the parts that have ground and polished surfaces such as the gears, the spindles, the balls, the bearings, and the shafts, with solvent type cleaners such as emulsion cleaners, carbon tetrachloride or petroleum solvents excluding gasoline. Do not clean these parts in a hot solvent tank or with water and alkaline solutions such as sodium hydroxide, orthosilicates, or phosphates.

Other parts, such as wheel cones, planetary spiders, and cast brackets, may be cleaned in hot solution tanks with mild alkali solutions. These parts should remain in the tank only long enough to be thoroughly cleaned and heated through. This will aid in the evaporation of the cleaning solution and the rinse water. Parts cleaned in solution tanks or with alkali cleaners should be thoroughly rinsed after cleaning to remove all traces of alkali.

The importance of careful and thorough inspection of the drive unit parts prior to reassembly cannot be overstressed. Thorough visual inspection for indications of wear and stress and the replacement of such parts as necessary will eliminate costly and avoidable drive unit failures. Inspect these parts as follows:

1. Inspect all of the bushings, the bearings, the cups and cones, including parts not removed from the drive unit. Replace the rollers or the cups if they are worn, pitted, or damaged in any way. Remove parts that need replacement using a suitable puller or a press with sleeves. Avoid the use of drifts and hammers because they may easily mutilate or distort the component parts.

2. Inspect the planetary reduction gears, the planet gears, the sun gear, and the drive or ring gear assembly for wear or damage. Gears that are scored, pitted, ridged, or worn should be replaced.

3. Inspect the planetary spider assembly for the following:

    a. Pitted, scored, or worn thrust washer .

    b. Worn or ridged planet pinion gears.

    c. Worn, scored, or chipped planet pinions.

4. Inspect the axle shafts for signs of torsional fractures or other indications of impending failure.

5. Inspect the steering trunnion sockets. If damaged, replacement will be necessary.

6. Inspect all the studs for tightness and the machined surfaces for nicks, mars or burrs. Threads on studs or capscrews must be clean so that accurate adjustment and correct torques can be obtained. A fine mill file or India Stone is suitable for cleaning the threads.

E. Assembly of Planetary Steering Knuckle Assembly

1. Installation of Oil Seals

a. Front or Rigid Axle

Install the oil seal in the carrier or the axle housing at the connecting flange end with a suitable driver.

IMPORTANT: *The seal must face toward the differential or the center of the axle assembly. Also, be sure to locate the seal squarely against the seal recessed shoulder in the housing.*

b. Rear or Steering Axle

Install the outer oil seal in the hub spindle in the threaded end of spindle.

IMPORTANT: *The seal lip must face toward the planetary end cover. Also, be sure to locate the seal squarely against the seal recessed shoulder in the housing.*

2. Installation of Steering Trunnion Socket Cap Bushings

a. If the steering trunnion socket bushings have been removed, place the trunnion socket in a press or another suitable fixture.

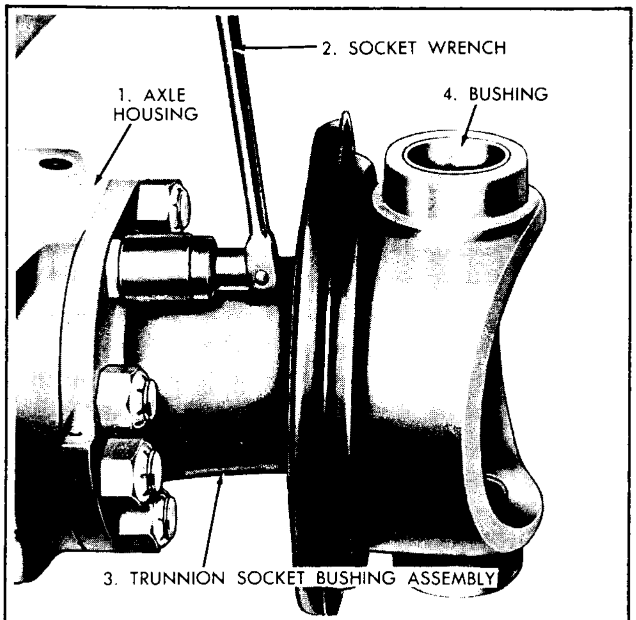

Fig. 46 — Installing Trunnion Socket Bushing Assembly

b. Install the bushings in the trunnion socket by using a sleeve driver that bears against the bushing.

3. Adjustment and Installation of Knuckle Flange Assembly

a. Install the trunnion socket bushing assembly on the axle housing (Fig. 46).

b. Slip the rubber boot over the trunnion socket and fold it back. Secure the boot with the inner clamp.

c. Carefully slip the knuckle flange over the flange on the trunnion socket.

d. Install the original shim packs on the upper and lower bushing caps.

e. Install the thrust washer on the lower bushing cap.

CAUTION: *Install the thrust washer on the lower bushing cap only. Otherwise serious damage to the housing may result.*

f. Install the bushing caps.

g. Torque the lower bushing cap retaining capscrews to 168-180 ft. lbs. Place a hydraulic jack at the lower bushing cap and apply a slight pressure. Snug the upper bushing cap retaining capscrews against the cap to eliminate any end play. If the shim pack is loose, measure the gap between the cap and the shims using a thickness gauge, and then install the correct amount of shims. If there is any end play after torquing the capscrews properly (when using the original shim pack), determine the amount of end play and remove the shims accordingly.

IMPORTANT: *The maximum preload of the bushing cap should not exceed .001. The thickness of the upper and lower shim packs should be equal to insure proper seating.*

The size of the shim packs at the top and the bottom should be nearly the same in order to center the joint assembly for proper shaft alignment.

h. Install the dust shields and the outer boot clamp.

4. Assembly and Installation of Axle Shafts and "Rzeppa" Universal Joints

a. Install the inner bearing race into the cage at right angles and align the race teeth with the elongated hole in the cage. Turn the race within the cage to a position parallel with the cage.

CAUTION: *Do not attempt to force any portion of this assembly together.*

b. Insert the drive shaft universal bell into a bronze jawed vise. Install the race and the cage into the universal bell at right angles and tilt it into position while, at the same time, aligning the bell teeth with the elongated holes in the bearing cage (Fig. 43).

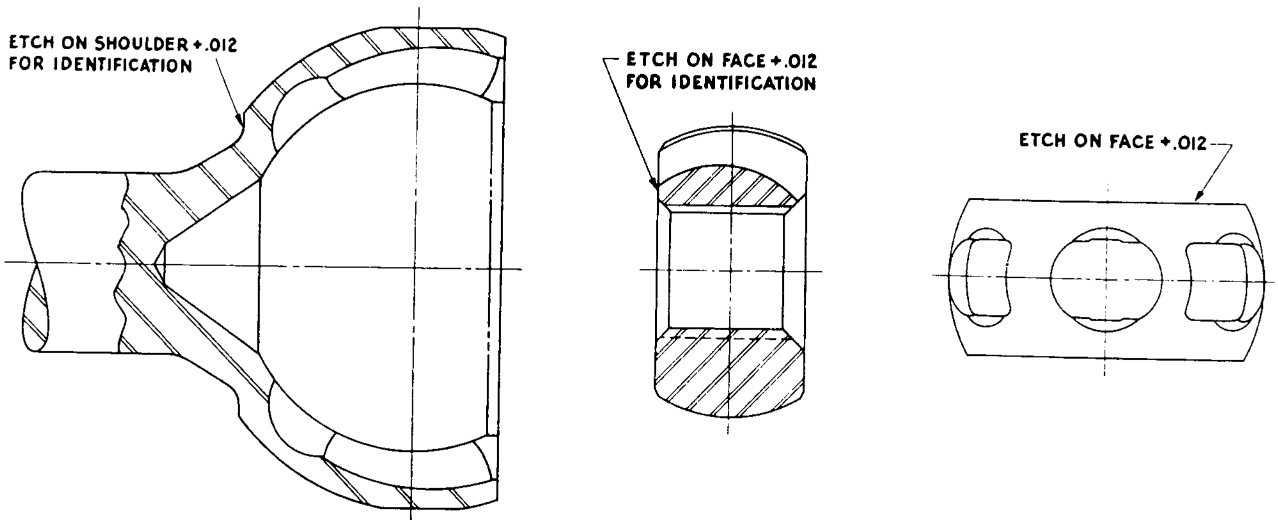

Fig. 47 — Rzeppa Joint Identification Marks

NOTE: *Approximately 10% of the original "Rzeppa" universal joints are made with .012" oversize balls, raceways, and cages. All of the original joints that employ oversize components are marked accordingly on the individual pieces (aside from the balls) in the places noted in Figure 47.*

When disassembling "Rzeppa" universal joints for the purpose of cleaning, inspecting, or replacing the individual components, it is advisable to rework them one at a time to avoid mixing standard and oversize parts.

If a considerable number of joints are to be reworked at one time, it will be necessary to carefully separate the standard from the oversize joints.

Only standard size components are furnished for replacement. The standard size parts are to be used for replacement of either standard or oversize parts in the original assemblies. If the outer race, the inner race, or the cage in an original oversize joint is replaced, it will also be necessary to replace all the balls at the same time. If the original oversize balls are to be reused, the resulting assembly would be too tight and would lead to hard steering and short life.

The use of standard size replacement balls in a joint having one or more of the other components oversize, will in no way affect its performance or life though there will be slightly more backlash.

c. Install the joint balls into the inner race and the cage (Fig. 42), tilting the race and cage each time so that another ball can be inserted.

d. Pack the ball joint assembly with approximately three pounds of fiber base lubricant ("Marfax" #0, or equal). Align the inner race splines parallel with the ball face.

e. Install the "expander" type locking ring in the inner shaft lock ring groove. Align the splines of the inner shaft with the splines of the inner race. Holding the shaft in a vertical position and with the locking ring resting in the chamfer on the inner race, tap the end of the shaft with a rawhide mallet to collapse the locking ring. Drive the shaft in until the locking ring clears the inner race splines to lock the shaft in place.

f. Hand pack the inner walls of the trunnion socket with approximately two pounds of lubricant ("Marfax" #2, or equal).

g. Rub a small amount of grease on the machined surface of the drive axle where the axle shaft oil seal will contact. This will help to prevent damage to the seal lip during the first few hours of operation.

h. Insert the axle shaft through the housing and into the side drive gear in the differential.

CAUTION: *Do not force the shaft because this will cause damage to the splines on the shaft and the mating splines in the drive gear of the differential.*

5. Installation of Hub Spindle, Brake Assembly, Seal Retainer and Seal

a. If replacement of the spindle outer oil seal is necessary, remove it with a pinch bar and replace it by using a suitable driver.

NOTE: *The seal must be installed from the outer end of the spindle with its lip facing toward the planetary section.*

b. Locate the seal retainer flange on the knuckle flange studs. There is no centering dowel so be careful to center the flange on the studs for the best seal contact (Fig. 55).

c. Dip the inner bearing in SAE 90 oil and install it on the spindle.

d. Install the spindle and seal assembly on the knuckle flange studs and secure it with the washers and the nuts. Torque the nuts to 186-205 lbs. ft.

NOTE: *On the front (or rigid axle), install the seal ring on the spindle flange and join the spindle to the connecting axle housing flange with the capscrews, the lockwashers, and the nuts. Torque the capscrews to 186-205 lbs. ft.*

e. Install the brake shoe and liner assemblies. Install the brake return springs.

f. Install the brake cam (Fig. 39).

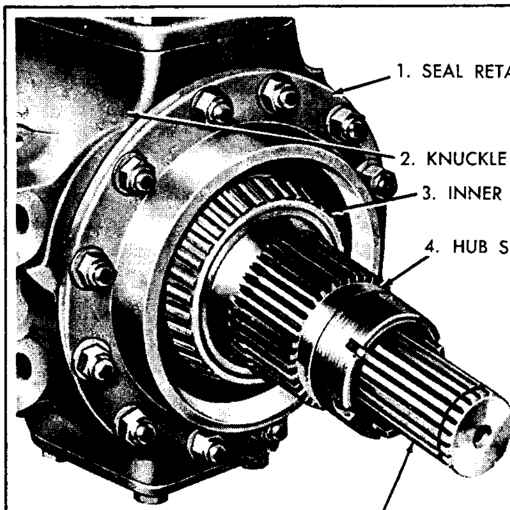

Fig. 48 — Hub Spindle, Inner Seal, and Seal Retainer (Steering Axle)

6. Assembly of Floating Ring Gear and Installation of Hub, Drum and Ring Gear

a. Assemble the floating ring gear as follows:

(1) Insert the splined ring gear hub into the floating ring gear until it is flush with the shoulder on the ring gear hub.

(2) Install the ring gear retainer plates and the capscrews. Torque the capscrews to 22-24 lbs. ft. and install the lock wires.

(3) Dip the outer wheel bearing in SAE 90 oil and install it on the ring gear hub journal being sure that the bearing is tight against the hub shoulder.

NOTE: *The bearing should be a slide fit over the spindle hub journal.*

b. Install the hub, drum, and the ring gear as follows:

(1) Coat the bearing cups with a light film of oil and lift the hub and drum assembly on the hub spindle, positioning the assembly so that the bearing inner cups rest on the inner bearing rolls.

(2) Install the floating ring gear assembly (Fig. 34) while, at the same time, lifting the weight of the hub and drum assembly to allow the outer bearing to mate with the outer hub bearing cup. Install the wheel bearing adjusting nut.

(3) Tighten the adjusting nut to 400 lbs. ft. while the wheel is being rotated. Rotate the wheel in both directions to be sure bearings and related parts are fully seated.

(4) Back off adjusting ¼ turn to relieve preload on bearings.

(5) Attach a suitable cord to one of the wheel mounting lugs and wrap cord around hub several times. Attach a spring scale to end of cord. After starting resistance is overcome, read the ROLLING TORQUE on the spring scale. Rolling torque is the amount of torque necessary to keep the hub rolling after it is in motion. Adujst the torque on the bearing adjusting nut until a rolling torque of 11 - 15 lbs. ft. for the front hubs or 6 - 10 lbs. ft. for the rear hubs is indicated on the spring scale.

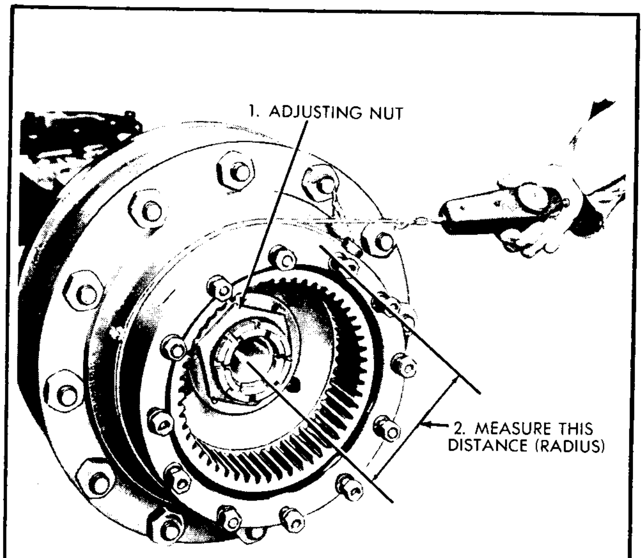

Fig. 49 — Checking Bearing Preload

Bearing preload torque is figured by multiplying the radius (the distance from the center of the wheel to the point where the cord, attached to the spring scale, just contacts the wheel hub) by the reading on the pound scale.

For example: Assume the distance from the center of the wheel to the cord contact point is 7 inches, and the reading on the pound scale is 24 pounds—multiplying 7 inches by 24 pounds we get 168 inch pounds. Since our preload specifications are listed in *foot pounds* we divide 168 inch pounds by 12 and arrive at a reading of 14 foot pounds.

(6) Install nut lock. Back off adjusting nut to nearest slot if necessary. Recheck rolling torque with cord and spring scale.

7. Installation of Sun Gear

a. Install the sun gear thrust washer on the axle shaft.

b. Install the sun gear on the axle shaft splines

c. Install the sun gear snap ring in the groove on the axle shaft.

8. Installation of Planetary Spider and Wheel Cover

a. Place the planetary spider cage on a bench or block it up on metal plates.

b. Align the inner thrust washer hole with the planet pin hole so that the locating tab of the washer lies in the spider indentation (Fig. 33).

c. Slide the planet gear and the outer thrust washer into the planetary spider and align the holes.

d. Press the planet pins into the spider, small diameter end first, until the shoulder of the pins rests against the thrust washers. Turn the outer end of the pins so that the machined flat is to the outside of the hub circle. This not only allows for the cover clearance, but also properly locates the pin oiling flat.

e. Install a new spider to the hub gasket after being sure that all of the studs on the hub are tight and properly seated.

f. Align the teeth of the planet pinions with the sun gear and the ring gear teeth, and install the spider and pinion assembly.

g. Install the spider lockwashers and the nuts. Torque the nuts to specification (Section VI).

h. Install the planetary wheel cover and the capscrews. Torque to specification (Section VI).

9. Lubrication

a. Rotate the complete hub and drum assembly so that the "oil level" plug (located in the wheel cover) is at the bottom.

b. Remove the "fill" plug (located in the top of the hub) and the "oil level" plug.

c. Fill the planetary hub with SAE 90 multipurpose lubricant until the lubricant appears at the "oil level" plug hole. Reinstall the plugs and tighten them securely.

NOTE: *Use SAE Multipurpose lubricant in the planetary axle outer ends for both summer and winter operations.*

SECTION XII—BRAKES

1. DESCRIPTION

The tractor loader is equipped with air brakes powered by a Bendix-Westinghouse air compressor. It is also equipped with a hand operated parking brake located on the front of the transmission.

The Bendix-Westinghouse compressor is belt driven, pressure lubricated, water cooled, and governor controlled. It has an output of 7¼ cubic feet per minute.

The air supply that is delivered from the compressor is stored in two reservoir tanks (located below the operator's compartment). The tanks maintain an adequate supply of air that is needed to actuate the brakes of the front and rear wheels of the loader. A safety valve (set at 175 P.S.I.) is located in the left reservoir to prevent excessively high pressures.

The air application valve releases an air supply to the front and rear-wheel brake rotochambers whenever the foot brake pedal is depressed. The brake rotochambers simultaneously actuate all four brakes. At the same time, the air application valve releases an air supply to the transmission cut-off valve whenever the check valve located in the operator's compartment is open. When actuated, the clutch cut-off valve diverts all of the power developed by the engine to the loader hydraulic system. The air application valve, the air chambers, the brakes, and the clutch cut-off valve are all spring released when the foot brake pedal is released.

A quick release valve is located between the air chambers of the rear wheels to decrease the release time of the air supply. Otherwise the air would have a long distance to travel back to the air application valve in order to be released.

A constant flow of air is delivered from the reservoir tanks and through the air application valve to the air compressor governor. The governor controls the supply of air whenever the pressure in the air brake system reaches the minimum of (105 to 110 P.S.I.) or maximum (120 to 125 P.S.I.).

12

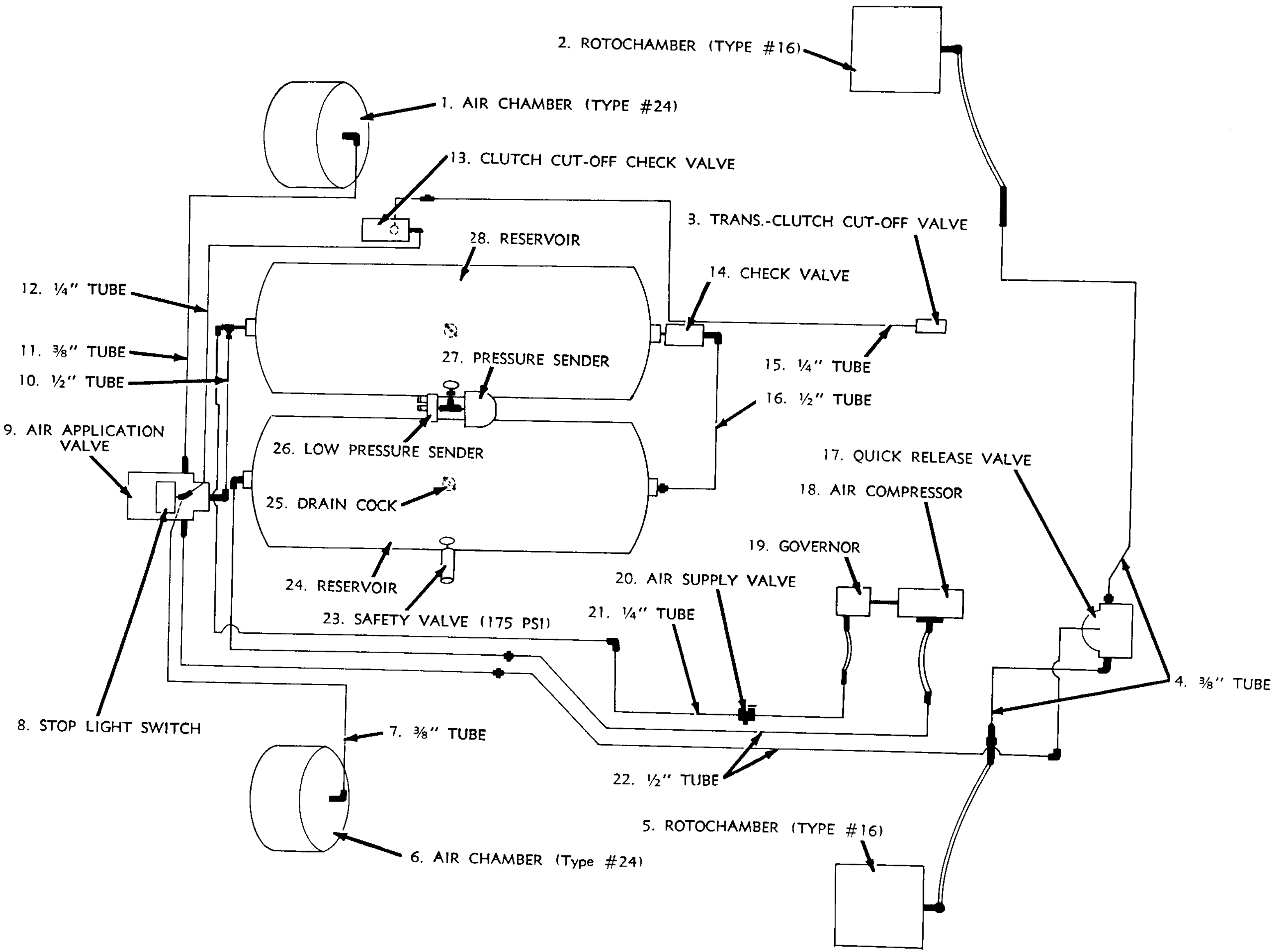

Fig. 1 — Air Brake System — Schematic

An air supply valve is located in the line between the air application valve and the governor. The valve contains a fitting into which a line may be connected which may be used to maintain an adequate supply of air in the loader's tires.

Located between the two air reservoir tanks are two pressure senders. A low pressure sender is connected to the loader's horn. Whenever the pressure drops below 60 P.S.I., the minimum pressure required for effective brake application, the horn signals intermittently to warn the operator. A high pressure sender is connected to the air pressure gauge on the instrument panel.

2. AIR COMPRESSOR AND GOVERNOR

A. Air Compressor (Fig. 4)

The air compressor is a single acting, reciprocating 2-cylinder type. The compressor is mounted on the left rear side of the engine and is belt driven from the engine crankshaft.

Lubrication for the compressor is provided by an external oil line extending from the main oil gallery of the engine to the rear cover of the compressor. The oil enters the drilled passage in the compressor crankshaft. From this passage, oil flows through drilled holes in the connecting rods, pressure lubricating the piston pins and bearings.

The main ball bearings are splash lubricated by the oil that spills down into the hollow mounting base of the compressor. Excess oil drains back into the engine crankcase through an external oil line.

The compressor is water cooled by an external water line extending from the engine cylinder block to the compressor cylinder block. The coolant is returned from the compressor cylinder head to the rear portion of the engine water outlet manifold.

The air supply for the compressor is obtained from the engine air intake manifold. It is cleaned and filtered by the engine air cleaner.

B. Governor

The air compressor runs continuously whenever the engine is operating, but the actual compression of the air is controlled by the air compressor governor. The governor, in conjunction with the air "unloading" mechanism in the cylinder block, controls the air supply by "unloading" the compressor when the pressure in the air reservoirs reaches a maximum of 120 to 125 pounds.

1. Compressor Loading (Supplying Air)

During the down stroke of each piston, a partial vacuum is created above the piston which unseats the inlet valve. This allows the intake air to enter the cylinder above the piston.

As the piston starts its upward stroke, the air pressure on top of the inlet valve, plus the force of the inlet valve return spring, closes the inlet valve.

The air above the piston is further compressed until the pressure lifts the discharge valve. Air is then released through the discharge line into the reservoirs.

As each piston starts its down stroke, the discharge valve returns to its seat, preventing the air that is delivered to the air reservoirs from escaping back into the cylinder. The cycle is repeated until the pressure in the reservoirs reaches 120 to 125 lbs.

2. Compressor Unloaded (Not Supplying Air)

When the pressure in the air reservoirs reaches the maximum setting of the governor (120 to 125 pounds), compressed air from the reservoirs passes through the governor and into the compressor block. Entering the cavity below the unloading pistons, the air pressure lifts the unloading pistons to open both air inlet valves.

With the inlet valves held off their seats, the inlet air is passed from one cylinder to the other. During the upstroke of one piston, the inlet air is forced through its inlet cavity to the adjacent cylinder where the piston is on the downstroke.

When the pressure in the reservoirs is reduced to the minimum setting of the governor (105 to 110 pounds), the valve in the governor closes. The unloading piston return spring forces its pistons down and releases the inlet valve springs. The inlet valves return to their seats and compression is resumed.

3. AIR COMPRESSOR AND GOVERNOR REMOVAL

A. Preparations for Removal

1. Open the air reservoir drain cocks located at the bottom of the reservoirs and drain the air system.

2. Drain the engine cooling system; refer to "ENGINE COOLING SYSTEM," Section IV.

3. Disconnect all of the air, water, and oil lines from the compressor.

4. Relieve the tension on the fan and compressor drive belts. Remove the belts from the compressor driving pulley.

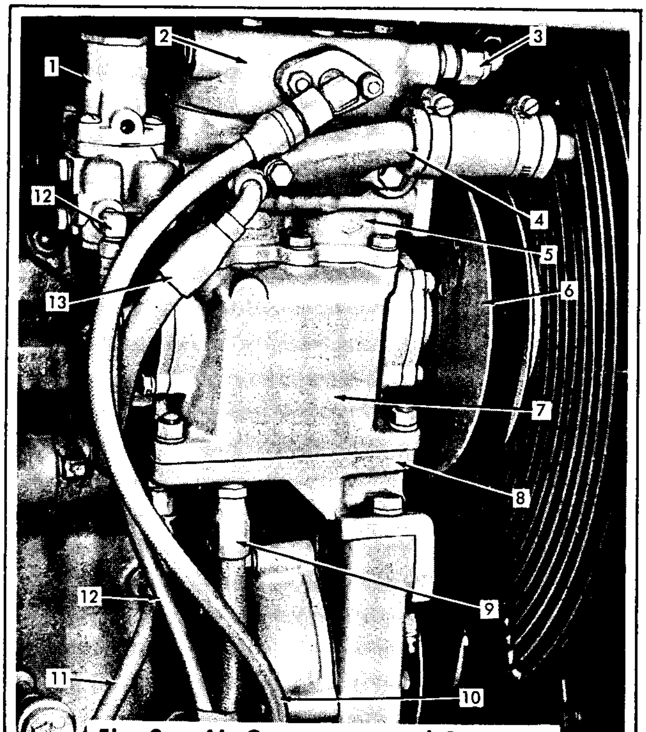

Fig. 2 — Air Compressor and Governor (Installed)

1. Governor
2. Compressor Head
3. Water Coolant Outlet
4. Air Intake
5. Compressor Cylinder Block
6. Drive Pulley
7. Compressor Crankcase
8. Mounting Bracket
9. Lubricating Oil Outlet
10. Air Outlet to Reservoirs
11. Lubricating Oil Inlet
12. Reservoir to Governor Air Inlet
13. Water Coolant Inlet

B. Compressor and Governor, Removal

1. Remove the capscrews, hex nuts, and lockwashers that secure the compressor to the mounting bracket. Remove the compressor and governor as a unit.

4. DISASSEMBLY OF AIR COMPRESSOR

A. Removal of Governor and Driving Pulley

1. Thoroughly clean the exterior of the compressor. Place the parts on a clean work bench as they are removed in the order of disassembly. To aid in properly positioning the cylinder head, the cylinder block, and the crankcase when they are reassembled, it is suggested that they be marked.

2. Remove the capscrews and lockwashers securing the air compressor governor to the compressor cylinder block. Remove the governor and the gasket.

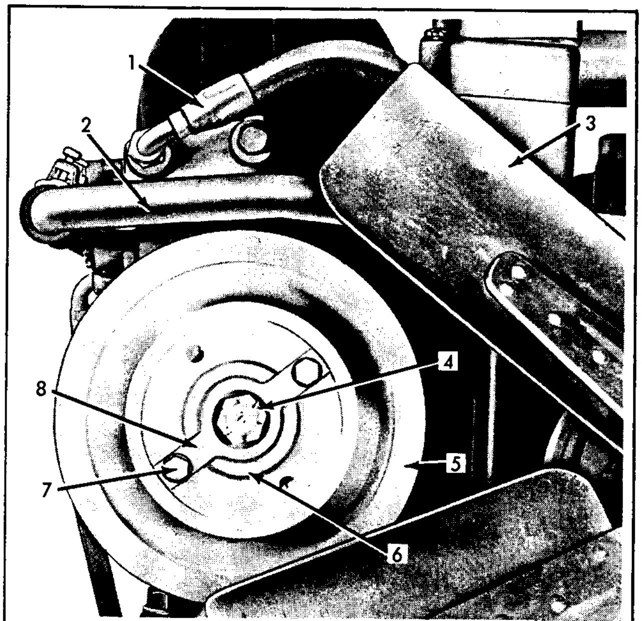

Fig. 3 — Compressor Driving Pulley

1. Compressor Water Coolant Outlet
2. Compressor Air Intake
3. Engine Fan
4. Compressor Drive Shaft, Castle Nut and Cotter Pin
5. Compressor Driving Pulley (Front Section)
6. Driving Pulley Hub
7. Driving Pulley Lockplate Capscrew
8. Driving Pulley Lockplate

3. Remove the cotter pin and the castle nut that secures the air compressor driving pulley on the compressor crankshaft (Fig. 3). Remove the pulley and the "Woodruff" key.

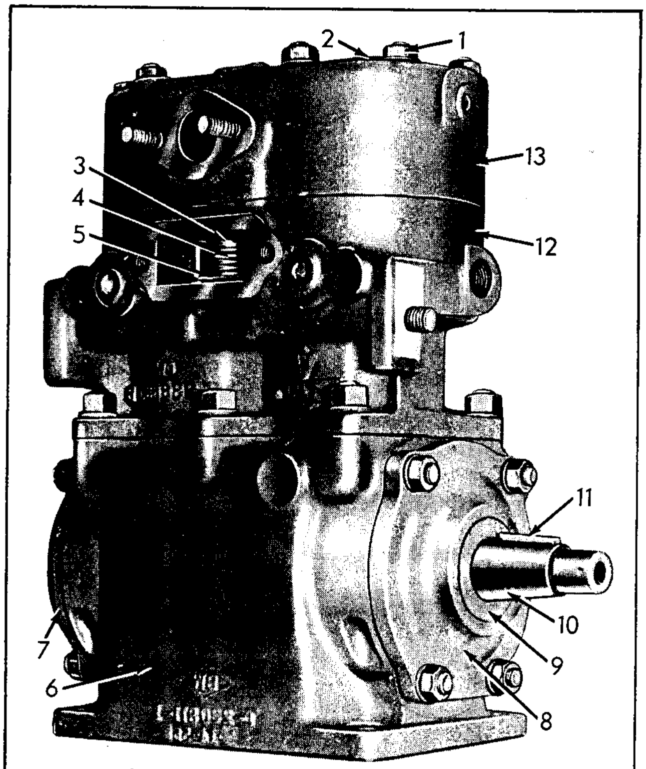

Fig. 4 — Air Compressor (Removed)

1. Capscrew (or Nut) and Lockwasher
2. Discharge Valve Capnut
3. Unloader Piston
4. Unloader Spring
5. Unloader Spring Saddle
6. Crankcase
7. Crankcase Cover (Front)
8. Crankcase Cover (Rear)
9. Crankcase Cover Oil Seal
10. Crankshaft
11. "Woodruff" Key
12. Cylinder Block

B. Air Compressor Disassembly

1. Remove the capscrews that secure the cylinder head to the cylinder block. Remove the cylinder head and the cylinder head gasket (Figs. 4 and 5).

2. Remove the discharge valve cap nut from the top of the cylinder head.

3. Remove the discharge valve springs and discharge valves from the counterbores in the top of the cylinder head.

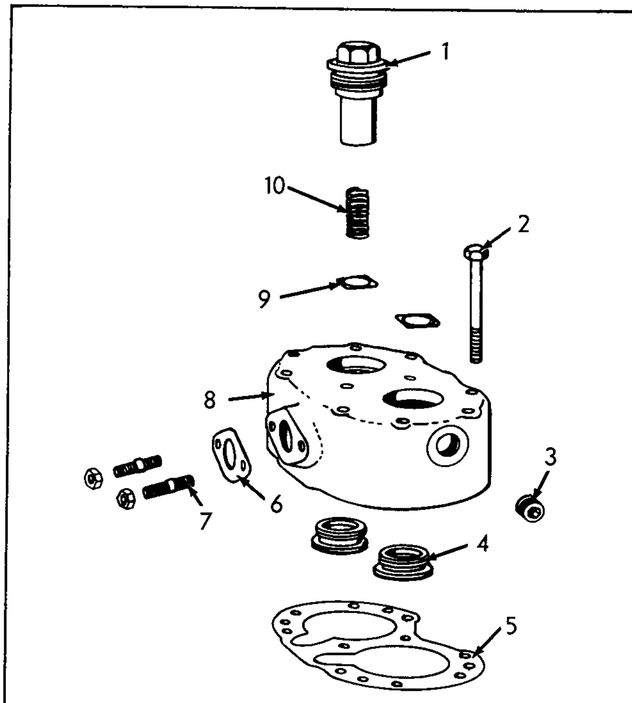

Fig. 5 — Air Compressor Cylinder Head Details

1. Discharge Valve Cap Nut
2. Capscrew
3. Pipe Plug
4. Discharge Valve Seat
5. Cylinder Head Gasket
6. Discharge Fitting Gasket
7. Stud
8. Cylinder Head
9. Discharge Valve
10. Discharge Valve Spring

NOTE: *The discharge valve seats may be removed at this time if they are worn or damaged.*

4. Remove the inlet valve springs and inlet valves from their respective counterbores in the top of the cylinder block (Fig. 6).

5. Remove the unloader spring and spring seat (Fig. 7).

6. Remove the unloader spring saddle, the unloader plunger, the unloader pistons, and the unloader piston grommets (Figs. 6 and 7).

7. Remove the cotter pins, the nuts, and the bearing caps from each connecting rod (Fig. 6). Push each piston and connecting rod assembly out through the top of the

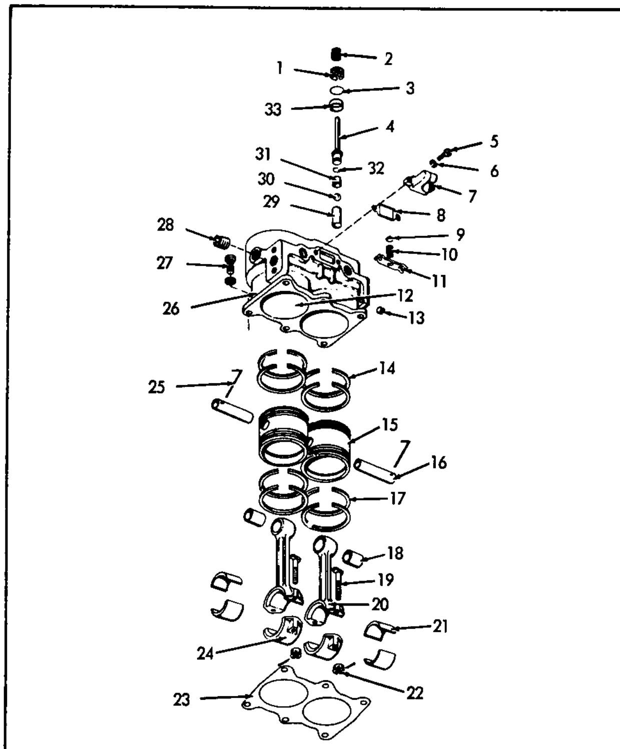

Fig. 6 — Air Compressor Cylinder Block Details

1. Inlet Valve Guide
2. Inlet Valve Spring
3. Inlet Valve
4. Unloader Plunger and Piston
5. Capscrew (Air Inlet Elbow)
6. Lockwasher
7. Elbow, Air Inlet
8. Gasket
9. Unloader Spring Seat
10. Unloader Valve Spring
11. Unloader Spring Saddle
12. Cylinder Bore
13. Pipe Plug
14. Piston Ring
15. Piston
16. Wrist Pin
17. Piston Ring
18. Wrist Pin Bushing
19. Capscrew
20. Connecting Rod
21. Bearing Inserts
22. Nut
23. Cylinder Block Gasket
24. Connecting Rod Cap
25. Wrist Pin Lockwire
26. Cylinder Block
27. Capscrew and Lockwasher
28. Pipe Plug
29. Bushing
30. Unloader Cup Stop
31. Unloader Cup
32. Grommet
33. Inlet Valve Seat

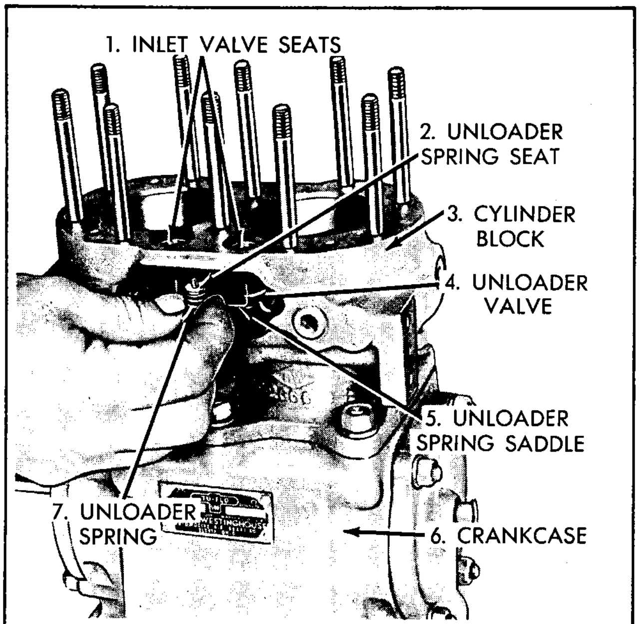

Fig. 7 — Removing Unloader Spring and Spring Seat from Cylinder Block

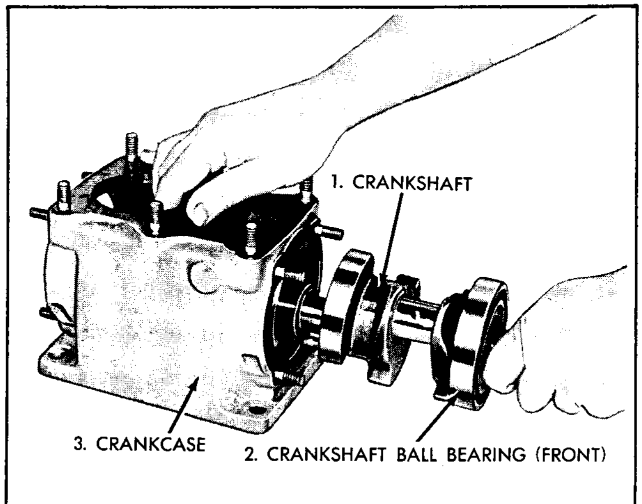

Fig. 9 — Removing Crankshaft from Crankcase

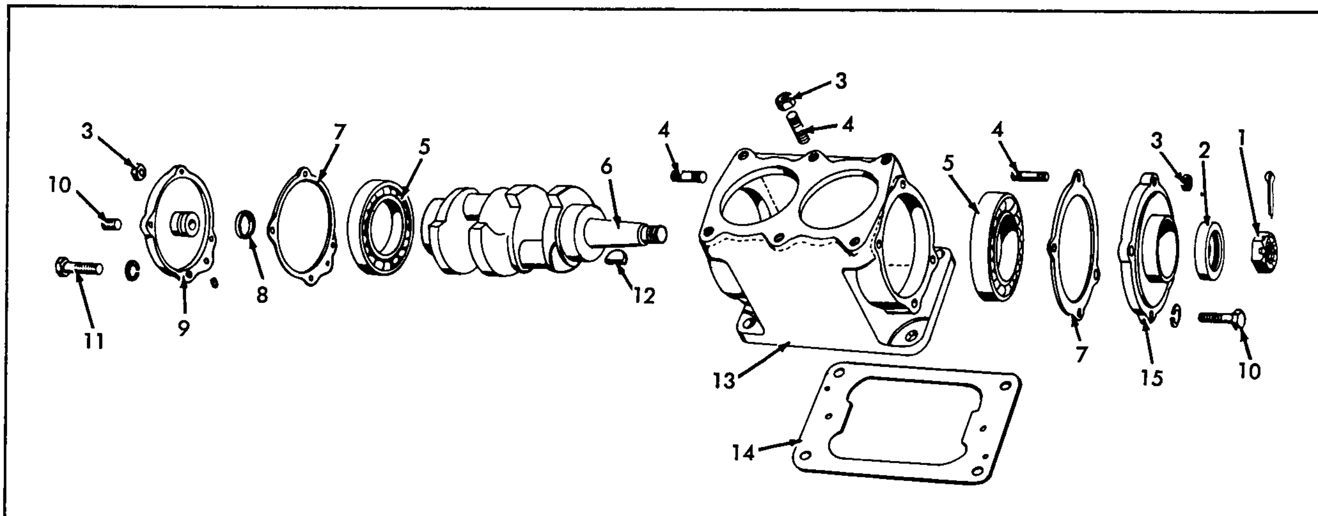

Fig. 8 — Air Compressor Crankcase Details

1. Crankcase Cover
2. Flange Gasket
3. Crankcase
4. "Woodruff" Key
5. Capscrew
6. Pipe Plug
7. Crankcase Cover (Rear)
8. Metal Seal Ring
9. Gasket
10. Crankshaft
11. Crankshaft Ball Bearing
12. Stud
13. Nut
14. Front Cover Oil Seal
15. Crankshaft Nut

cylinder block. Reassemble the bearing caps on their respective connecting rods as they are removed.

8. Remove the pistons from the connecting rods.

9. Remove the capscrews and lockwashers that secure the cylinder block to the crankcase. Remove the cylinder block and the gasket.

10. Remove the capscrews and lockwashers that secure the end covers to the crankcase. Remove the end covers (Figs. 4 and 8). NOTE: *Mark the position of the drive end of the crankshaft in relation to the crankcase before removing the crankshaft from the crankcase.*

11. Remove the crankshaft and the ball bearings from the crankcase as a unit (Fig. 9).

5. AIR COMPRESSOR INSPECTION, REPAIRS AND TESTING

Clean all of the parts with a clean solvent to remove all traces of dirt, oil, and grease before inspection.

Place the cylinder head and the cylinder block in a cleaning solution to remove all carbon from the valve cavities, and to remove all rust and scale from the water cavities.

Use compressed air to blow foreign material from the cavities. Scrape carbon, dirt and particles of old gaskets from all surfaces.

Thoroughly clean all of the oil passages in the crankshaft, the connecting rods, and the end covers with a wire brush. Then flush them with a cleaning solvent and compressed air.

A. Inspection of Cylinder Head and Discharge Valves

1. Inspect the cylinder head for cracks or warpage. Repair or replace the head if necessary.

2. Test the water passages in the cylinder head with compressed air. If a leakage is found, replace the head.

3. Replace the discharge valves if they are grooved .003" or more at their position of contact with the valve seat.

4. Replace the valve seats if they are excessively worn. NOTE: *The valve seats may be reused if there is sufficient metal remaining after they are refaced with a lapping stone.*

   The discharge valve seat may be replaced by inserting an "Allen" wrench in the valve seat as shown in Fig. 10. Then unscrew the valve seat from the cylinder head.

   NOTE: *When installing a new valve seat, tap the "Allen" wrench with a soft hammer to tighten it securely.*

After installing new discharge valves, discharge valve springs, and discharge valve cap nuts, the discharge travel should be between .036" and .058".

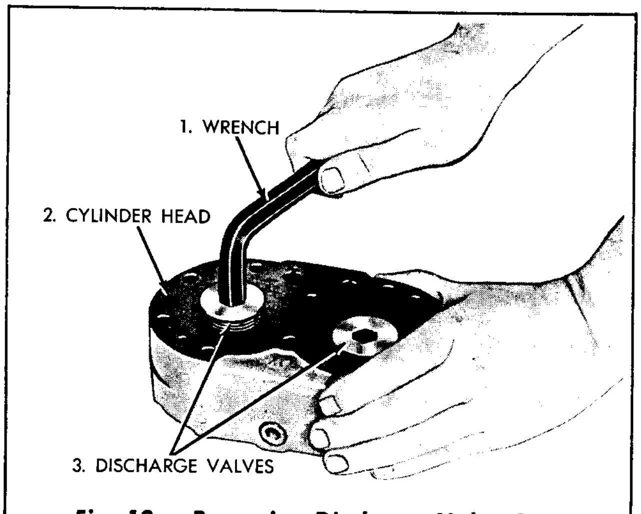

Fig. 10 — Removing Discharge Valve Seat from Cylinder Head

To test for leakage, apply 100 pounds of air pressure through the discharge part of the cylinder head. Apply soap suds to the discharge valve openings in the floor of the cylinder head. Leakage should not exceed a one inch soap bubble in not less than five seconds.

If excessive leakage is found, leave the air pressure applied. Using a fiber or hardwood dowel and a light hammer, tap the discharge valves off their seats. Do this several times to improve the seal between the valves and their seats. If the valves and the valve seats have been conditioned properly, this will reduce the leakage.

Leakage tests must also be made by applying soap suds around the discharge valve cap nuts, with air pressure applied as above. Leakage at the cap nuts is not permissible.

B. Inspection of Cylinder Block and Components

1. Inspect the cylinder bores for excessive wear and scoring.

2. Check the cylinder bores for roundness. Use an inside micrometer similar to the one shown in Fig. 11. Measure the bores for taper and wear. Each should be round within .002". There should be no more than .003" taper. Rebore a cylinder that is more

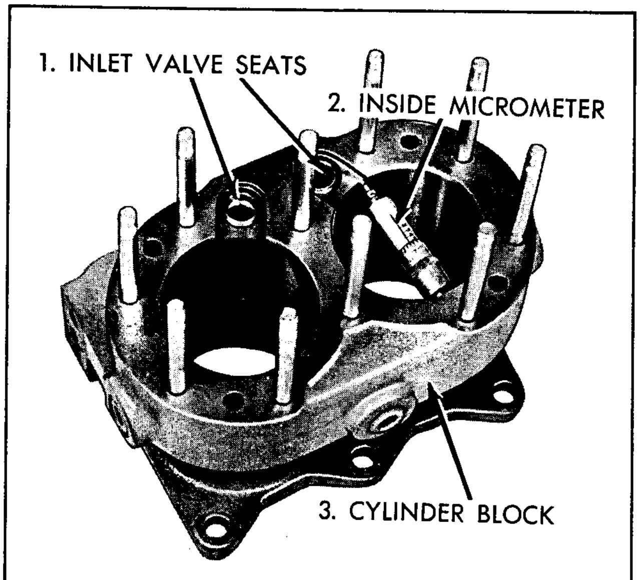

Fig. 11 — Checking Cylinder Bore for Roundness

than .002" out of round, or that has more than .003" taper.

NOTE: *Cylinder bores should be finished bored or honed while the cylinder block is secured to the crankcase.*

3. Inspect the unloader pistons and the piston grommet for wear (Fig. 6). Replace any scored unloader pistons. The grommet or seal ring in the unloader piston should be replaced. Be careful in reinstalling the unloader piston in the bore so that the grommet is not damaged or cut.

   When reinstalled, the piston should be a neat sliding fit in its bore. It may be necessary to use air pressure, *WITH CAUTION,* at the governor part of the cylinder block to remove the unloader piston for inspection (after removing the unloader plunger and associated parts).

   After the unit is assembled, the unloader pistons should be tested by application of 100 pounds of air pressure through the governor line port. When coating the unloader pistons with soap suds, leakage should not exceed a ½" soap bubble in not less than 5 seconds.

4. Replace the inlet valves if they are grooved .003" or more at their position of contact

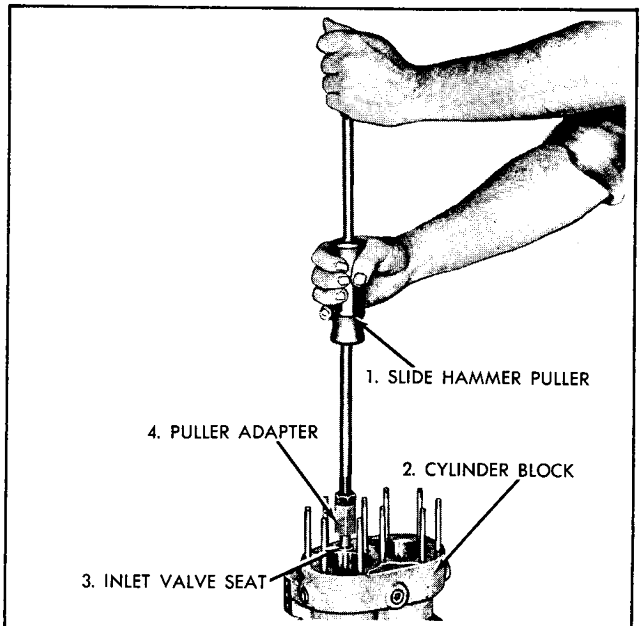

Fig. 12 — Removing Inlet Valve Seat from Cylinder Block

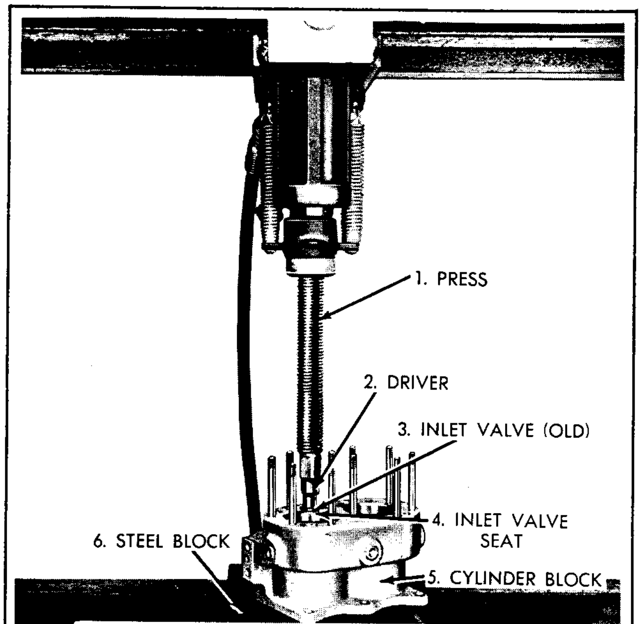

Fig. 13 — Pressing Inlet Valve Seat Into Cylinder Block

with the valve seats.

5. If the inlet valve seats are not worn excessively, they may be refaced. Otherwise replace them.

   The dimension from the top of the cylinder block to the inlet valve seat should not exceed .145". After installing new seats, the dimension should be .101" to .113".

Using a ⅝" tap, tap the I.D. of the inlet valve seat. Using a tool similar to the one shown in Fig. 12, remove the valve seat from its bore in the cylinder block.

Press in a new valve seat by using an old inlet valve positioned on the top of the new one. Press the valve seat into its bore in the cylinder block as shown in Fig. 13.

C. Inspection of Pistons and Connecting Rods

1. Replace a piston that is scored or shows other indications of improper piston clearance.

2. Replace a piston that is cracked on the inside. Be certain that the drilled holes in the piston walls are open and clean.

3. Measure the O.D. of the pistons in relation to the cylinder bore diameter. The specified clearance between the piston (without rings) and the cylinder bore is .002" to .004".

4. Check the fit of the piston pin in the connecting rod bushing by rocking the piston. Clearance of the piston pin to the connecting rod bushing should not exceed .0015". If excessive clearance is apparent, replace the piston pin bushings in the connecting rod. The bushings should be reamed after being pressed in place. Replace all used piston pin lock wires.

5. Inspect the connecting rod bearings for proper fit on the crankshaft journals. Also check them for wear. If they are worn, cracked, or broken, the inserts must be replaced. Connecting rod caps are not interchangeable. Position the caps so that the two locking slots are both located adjacent to the same capscrew.

   Clearance between the connecting rod journal and the connecting rod bearing must not be less than .0003" or more than .0021" after rebuilding the compressor using insert type rods.

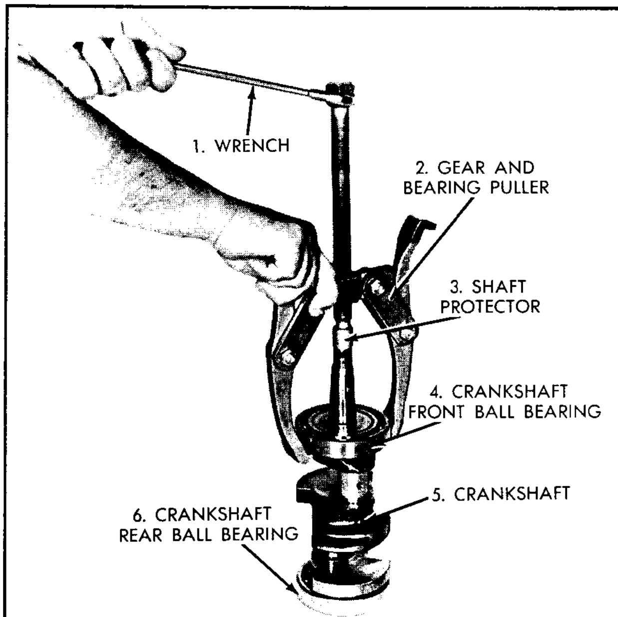

Fig. 14 – Removing Front Ball Bearing from Crankshaft

D. Inspection of Crankshaft

1. Crankshaft journals that are more than .001" out-of-round or bruised must be reground. When regrinding, the fillets at the ends of the journals must be maintained. Connecting rod bearing inserts .010", .020", and .030" undersize are available for reground crankshaft.

2. The screw threads, the keyways, the tapered ends, and all of the ground and machined surfaces of the crankshaft must not be worn excessively or mutilated.

3. The oil seal ring groove in the crankshaft (fitted with oil seal rings) must not be worn sufficiently to prevent a good fit on the oil seal ring. Walls of the oil seal ring grooves must be square and have a good finish.

4. Inspect the crankshaft ball bearings for wear and flat spots. NOTE: *If the ball bearings do not rotate freely, the bearings must be replaced.*

5. Inspect the crankshaft ball bearing bores in the crankcase for wear or damage.

   NOTE: *The bearings must be a finger press fit. If the bearings are loose in the bores, the crankcase must be replaced (Fig. 14).*

6. ASSEMBLY OF AIR COMPRESSOR

A. Crankcase, Assembly

1. Position the crankshaft with the ball bearings in the crankcase bores. Be certain that the drive end of the crankshaft is positioned as marked in relation to the crankcase.

2. Install a new metal oil seal ring in the rear end cover (Fig. 15). Using a new gasket, install the end cover. Secure it to the crankcase with the capscrews and lockwashers.

3. Install a new oil seal in the front end cover. Place the sealing lip of the seal toward the inside face of the cover. Using a new gasket, install the end cover. Secure it to the crankcase with the capscrews and lockwashers.

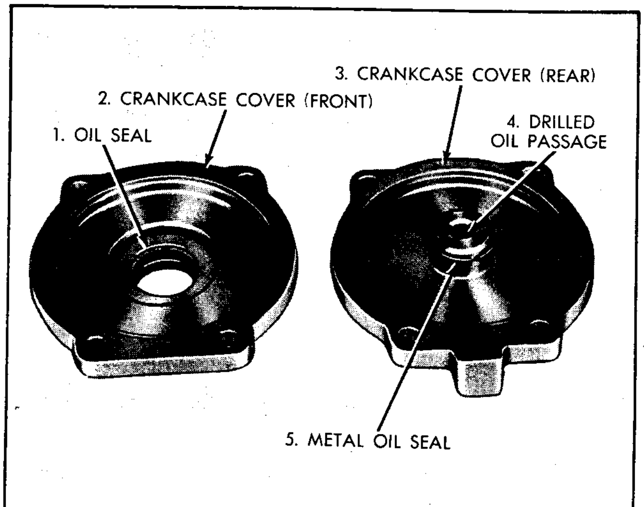

Fig. 15 — Crankcase End Cover Assemblies

B. Connecting Rods and Pistons, Assembly

1. Measure the gap between the ends of the piston rings before the rings are installed on the pistons.

   Select the rings that are to be used on each piston. Insert them, one at a time, into the cylinder bore in which they will operate. Using a piston, push the ring into the ring travel area.

   Measure the ring gap with a feeler gauge (Fig. 16). The specified ring gap is .007" to .019".

2. Measure the ring-to-groove clearance from the top of the ring to the top of the groove in the piston (Fig. 17). The specified clearance for the rings is .0015" to .0030".

3. After the rings are properly fitted, install the rings on the pistons with the bevel (or the punch mark) toward the top of the pistons.

   NOTE: *When installing the rings on the pistons, do not spread the rings more than necessary.*

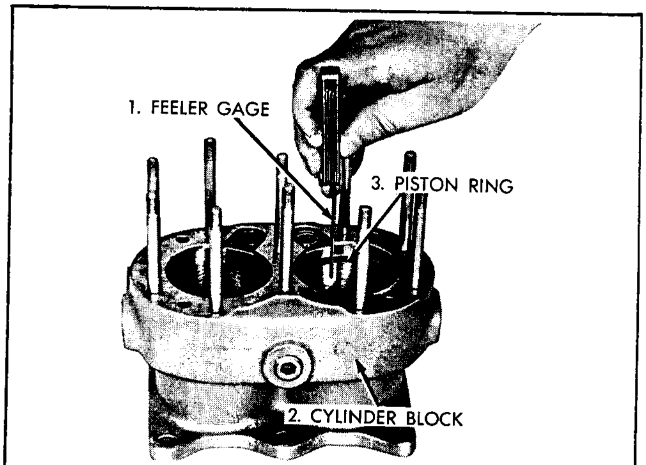

Fig. 16 — Checking Piston Ring Gap

Fig. 17 — Checking Piston Ring-to-Groove Clearance

Position the rings with the scraper edges down and the chamfered edges toward the top of the piston. Stagger the ring gaps evenly around the piston. Apply clean oil to the rings and the pistons before installing them in the cylinder bores.

4. Replace the connecting rod bushings if they are worn. Press out the old bushing from the connecting rod and press in a new one.

   When new bushings are installed, be sure that the oil hole in the bushings line up with the rifle drilled oil hole in the connecting rod.

   The specified clearance of the piston pin to the connecting rod bushing should not exceed .0015". Ream the connecting rod bushing to obtain the specified clearance.

5. Insert the upper end of the connecting rod into the piston. Install the piston pin in the piston so that the lock wire pin holes in the piston pin are aligned with the lock wire pin holes in the piston.

   Install the long end of the lock wire pin in the piston and the piston pin so that the short end of the lock wire pin may be locked near the bottom of the piston skirt.

   NOTE: *Install new lock wire pins each time that the pistons and the connecting rods are assembled.*

C. Cylinder Block and Components, Assembly

1. Place a new cylinder block gasket on the crankcase; then position the cylinder block on the crankcase in accordance with the markings made before disassembly. Secure them with the capscrews and lockwashers.

2. Remove the connecting rod cap from the connecting rod. Stagger the piston ring gaps evenly around the pistons. Lubricate the piston and the rings with clean engine oil. Use a piston ring compressor and tap on the upper end of the piston (Fig. 18) to insert the piston and connecting rod in the cylinder bore.

   NOTE: *Align the lower end of the connecting rod with the crankshaft before inserting the piston into the bore.*

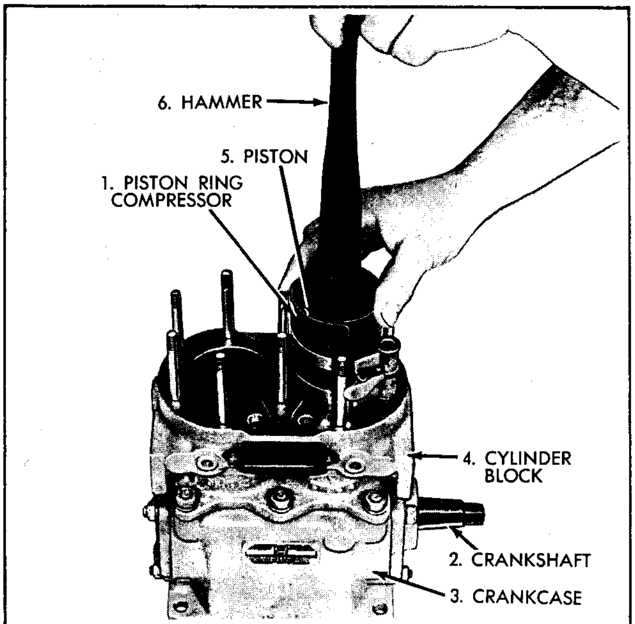

Fig. 18 — Installing Piston in Cylinder Block

3. Lubricate and install a bearing shell in the connecting rod. Position the tang of the bearing shell in the corresponding slot in the connecting rod. Then position the rod on the crankshaft journal.

4. Lubricate and install a bearing shell in the connecting rod bearing cap. Position the tang of the bearing shell in the corresponding slot in the bearing cap.

   Install the bearing cap and shell. Install and tighten the connecting rod nuts and secure them with cotter pins.

5. Lubricate the unloader cup counterbores in the cylinder block (Figs. 6 and 7), the unloader pistons, the piston cups, and the piston cup grommets with clean oil. Install the grommets on the unloader cups.

6. Install the unloader cups (with grommets in the unloader cup counterbores) in the

cylinder block. Install the unloader pistons in the unloader cups. Install the unloader spring saddle on the unloader pistons. Install the spring seats in the top of the cylinder block strainer opening; and install the unloader spring between the spring guide and the spring saddle.

7. Install the inlet valve guide, the valves, and the inlet valve springs on the inlet valve seat.

D. Cylinder Head and Discharge Valves, Assembly

1. Install the discharge valve seat if it was removed (Fig. 10).
2. Install the discharge valve and the discharge valve spring in the cylinder head (Fig. 5).
3. Install and tighten the discharge valve capnut.
4. Place a new cylinder head gasket on the cylinder block. Position the cylinder head on the cylinder block in accordance with the markings made before disassembly. Secure them with the capscrews and lockwashers.

NOTE: *Carefully align the inlet valve springs with the counterbore in the cylinder head.*

7. GOVERNOR DISASSEMBLY, INSPECTION AND ASSEMBLY

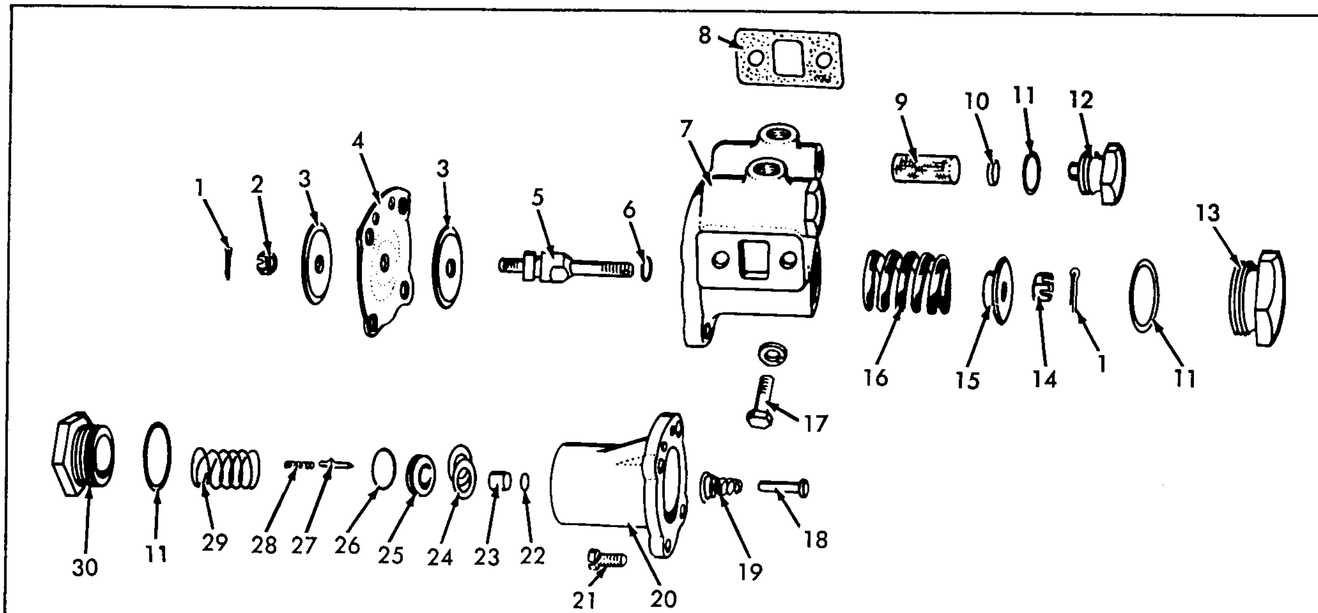

Fig. 19 — Air Compressor Governor Details

1. Cotter Pin
2. Locknut
3. Upper and Lower Diaphragm Followers
4. Diaphragm
5. Diaphragm Stem
6. Diaphragm Stem Grommet
7. Spring Cage
8. Gasket
9. Filter
10. Rubber Washer
11. Sealing Ring
12. Filter Cap
13. Spring Cage Capnut
14. Adjusting Nut
15. Pressure Spring Seat
16. Pressure Setting Spring
17. Capscrew
18. Exhaust Stem
19. Exhaust Stem Spring
20. Valve Body
21. Machine Screw
22. Exhaust Stem Grommet
23. Guide Bushing
24. Shims
25. Inlet Valve Seat
26. Inlet Valve Seat Grommet
27. Inlet — Exhaust Valve
28. Inlet Valve Spring
29. Inlet Valve Seat Retaining Spring
30. Valve Body Capnut

A. Governor Disassembly

1. Remove all of the dirt and grease from the exterior of the governor using a clean solvent or fuel oil.

2. Remove the two filter caps (Fig. 19) with the sealing rings (located at the bottom of the governor). Remove the rubber washer and the filters from the counterbores in the bottom of the spring cage.

3. Remove the valve body capnut and the sealing ring. Remove the inlet valve spring, the seat retaining spring, and the inlet exhaust valve. Remove the inlet valve seat and the shims.

   NOTE: *When removing the inlet valve seat, use care to prevent damage to the seat surface.*

4. Remove the spring cage capnut and the sealing ring. Remove the cotter pin and the locknut from the diaphragm stem assembly. Remove the spring seat and the pressure setting spring from the diaphragm stem.

5. Remove the machine screws that secure the valve body to the spring cage. Remove the valve body. Remove the diaphragm and stem assembly from the spring cage.

6. Remove the cotter pin and the locking nut from the diaphragm and the followers from the stem.

7. Remove the exhaust stem and the exhaust stem spring from the valve body.

8. Remove the grommets from the inlet valve seat and the diaphragm stem.

B. Governor Inspection

1. Thoroughly clean all of the parts in a clean solvent. Be certain that all of the passages in the valve body, the spring cage, and the exhaust stem are not obstructed. Reuse the filters after they are thoroughly washed in a clean solvent.

2. Replace the seats on the inlet-exhaust valve if it is worn or damaged.

3. Replace the inlet valve seat and the valve seat in the exhaust stem if they are worn or damaged.

4. Replace the exhaust stem in the guide bushing if they fit loosely.

   NOTE: *The exhaust stem should be a slide fit in the guide bushing.*

C. Governor, Assembly and Installation

1. Install a new grommet in the groove in the exhaust stem bore of the valve body. (Fig. 19).

2. Install a new grommet in the groove in the diaphragm stem. Place the lower follower on the stem with the beveled side up. Place the diaphragm over the lower follower. Then place the upper follower on the stem with the beveled side toward the diaphragm.

3. Install the diaphragm locknut and tighten it to a torque of 10 to 15 lbs. in. Secure the locknut with a cotter pin.

4. Position the diaphragm assembly so that the two openings of the diaphragm are aligned with the air passages of the spring cage.

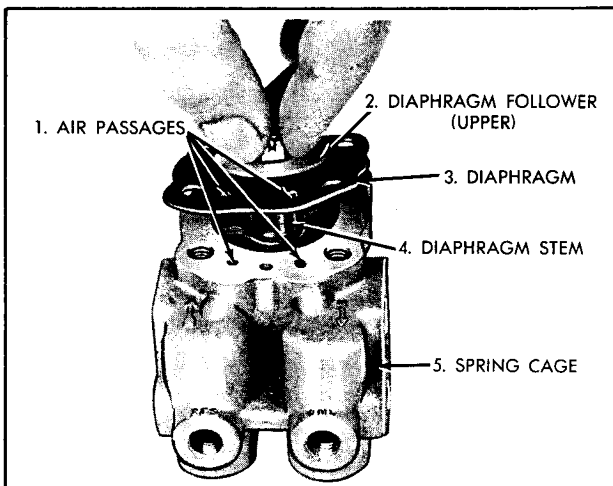

Fig. 20 — Installing Diaphragm and Stem Assembly in Spring Cage

5. Place the exhaust stem spring and the exhaust stem in the valve body. Then position the valve body on top of the spring cage. Be sure that the air passages of the valve body are aligned with air passages of the spring cage.

   Secure the valve body to the spring cage with the machine screws.

6. Install the filters and the rubber washers in the bores of the spring cage. Using a new sealing ring on each filter cap, install and tighten the filter caps securely.

7. Measure the total inlet-exhaust valve travel, using a dial indicator, as follows:

   Pull the diaphragm assembly stem out as far as it will go. Set the dial indicator at zero when it contacts the exhaust valve stem. Then push the stem completely in and note the reading on the indicator. The total valve travel should be .060" to .098".

8. Install the shims, the inlet valve seat, and the inlet-exhaust valve. Repeat the above procedure with the dial indicator. Set the indicator at zero when it contacts the end of the inlet valve.

   Add or remove shims under the inlet valve seat until the valve travel is .030" to .040".

9. Place the inlet valve spring and the inlet valve seat retaining spring in the valve body. Install the valve body capnut (with the sealing ring). Tighten it securely.

10. Place the pressure setting spring and the pressure spring seat over the diaphragm. Install the adjusting nut, but do not install the cotter pin at this time. Install the pressure spring capnut (with the sealing ring), but do not tighten it at this time.

11. Using a new gasket, install the governor on the air compressor. Secure them with the capscrews and lockwashers.

8. AIR COMPRESSOR AND GOVERNOR, INSTALLATION

A. Installation

1. Install the "Woodruff" key in the air compressor crankshaft. Install the compressor driving pulley on the crankshaft; align the keyway in the pulley with the key in the shaft. Secure the pulley with the nut and the cotter pin.

2. Using a new flange gasket, install the compressor on its mounting bracket. Secure it with the hex nuts and lockwashers.

3. Position the compressor drive belts on the compressor driving pulley. Adjust the belts. The fan and compressor drive belt is properly adjusted when the belt can be pressed inward approximately ½- to ¾-inch at a point half-way between the fan and compressor.

B. Preparing Loader for Governor Adjustment

1. Connect all of the air, water, and oil lines to the air compressor.

2. Fill the engine cooling system; refer to the "ENGINE COOLING SYSTEM," Section IV.

C. Governor Adjustment

1. Remove the pressure spring capnut.

2. Start the engine.

3. Observe the air pressure gauge on the instrument panel at the time that air begins to escape from the spring cage. If the gauge registers 120 to 125 pounds, the governor is properly adjusted. If the pressure gauge reading is below 120 pounds, turn the adjusting nut (Fig. 19) clockwise; if the reading is above 125 pounds, turn the adjustment nut counterclockwise until the proper adjustment is obtained.

4. Install and tighten the spring cage capnut.

9. AIR RESERVOIRS

A. Description

The two air reservoirs (located beneath the operator's compartment) store a volumn of compressed air needed for the operation of the brakes.

The reservoirs are made from steel plates with stamped heads and rolled shells. The seams are electrically welded, and each is internally coated for corrosion resistance.

Although some water vapor condenses in the reservoir on the right side of the loader, the left side, or "wet" reservoir provides a location where air, heated by compression, may be cooled and most of the water vapor condensed. It is equipped with a safety valve to unseat at 175 P.S.I.

When the engine is stopped there is an adequate supply of air for several brake applications. A check valve is installed in the reservoir on the right side of the loader so that a supply of air is available for braking if the air supply line from the compressor should become inoperative.

Drains are located in the bottom of each reservoir. The reservoirs should be drained daily so that the air system is kept clean and free of condensation.

B. Removal and Installation of Air Reservoirs

Either air reservoir may be removed by disconnecting the air hoses, and by removing the capscrews attaching the reservoir to the loader. The reservoirs may be installed by a direct reversal of the removal procedure.

10. SAFETY VALVE

A. Description

The safety valve (located in air reservoir on the left side of the loader) protects the air system from excessive air pressure above 175 pounds.

The safety valve consists of a spring-loaded ball check valve which lifts and permits air to exhaust into the atmosphere if the pressure in the reservoir rises above the safety valve setting.

B. Safety Valve Removal, Disassembly, Assembly and Installation

1. Remove all of the dirt and grease from the exterior of the safety valve.
2. Remove the safety valve from the air reservoir.
3. Loosen the locknut. Remove the adjusting screw, the pressure regulating spring, the stem, the spring seat, and the base valve from the spring cage. Remove the spring cage from the valve body.
4. Clean all of the parts in a clean solvent or diesel fuel. Inspect the ball valve for pitting or scratches. Replace the safety valve if the ball valve or the valve seat is nicked or pitted.
5. Assemble the safety valve in reverse order of the disassembly procedure.
6. Install the safety valve and tighten it securely.

C. Testing the Safety Valve

Both an operating and a leakage test must be made after the safety valve is rebuilt or repaired.

The valve must meet the following specifications:

1. The leakage at the exhaust port should not exceed a one inch soap bubble in one second (exhaust port coated with soap suds).
2. The safety valve should be set to unseat at approximately 175 pounds. The pressure setting may be adjusted by loosening the locknut and then turning the adjusting nut.

   Turn the adjusting nut clockwise to raise the pressure setting, or counterclockwise to lower the pressure setting.

After the pressure setting is completed, secure the adjusting nut with the locknut.

NOTE: *An accurate test gauge should be used when adjusting the pressure setting of the safety valve.*

11. BRAKE PEDAL AND AIR APPLICATION VALVE

A. Description

Movement of the brake pedal controls the air application valve (Fig. 21) which in turn controls the air pressure being delivered to, or released from, the brake rotochambers and air chambers. The chambers then actuate the brakes.

The further the brake pedal is depressed, the greater the amount of air pressure delivered to the rotochambers — and the more effective the brake application.

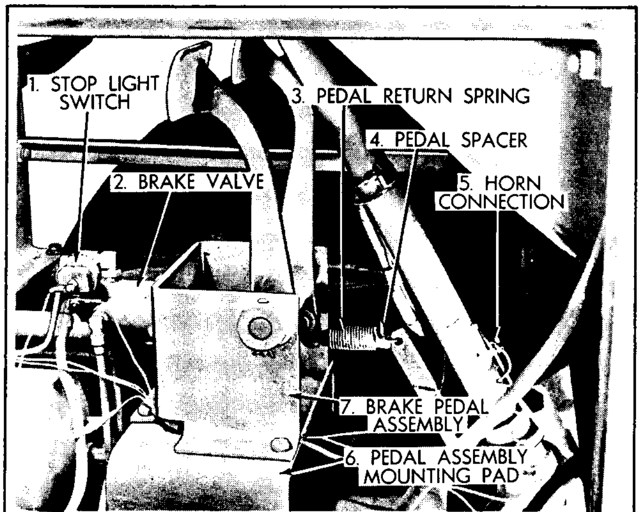

Fig. 21 — Brake Pedal Assembly Installed

As the brake pedal is depressed, pressure is exerted on the piston and the pressure regulating spring (Fig. 22). The movement of the piston is stopped when it contacts the inlet-exhaust valve and pushes the valve against the exhaust seat on the air application valve body. Simultaneously, the inlet valve opens. Air pressure from the reservoirs passes through the inlet valve to the chambers, applying the brakes. Air pressure from the chambers is prevented from escaping at the exhaust valve seat on the air application valve body.

With the brake pedal partially depressed, the inlet air pressure from the reservoirs closes the inlet valve. At the same time, the exhaust valve moves from its seat on the air application valve body, but *remains seated on the exhaust port* that extends through the piston. Air pressure from the reservoirs *and* from the chambers is stopped. The brakes are held in the applied position.

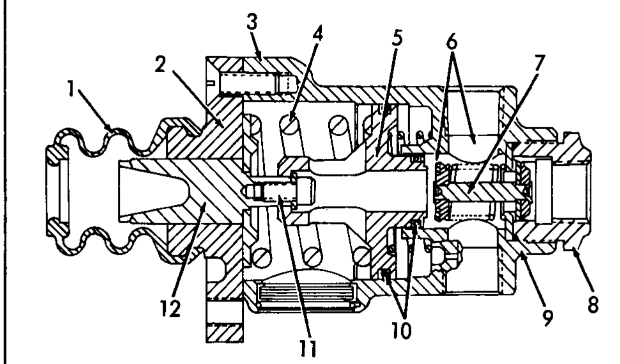

Fig. 22 — Air Application Valve Cut-Away View

1. Boot
2. Valve Body Mounting End Plate
3. Valve Body
4. Pressure Regulating Spring
5. Piston
6. Exhaust Valve Seats
7. Inlet-Exhaust Valve
8. Inlet Nut
9. Seal Ring (Valve Body)
10. Seal Rings (Piston)
11. "Allen" Head Machine Screw
12. Piston Rod

When the brake pedal is fully released, the inlet valve remains closed. As the piston moves from the inlet-exhaust valve, air pressure from the rotochambers is exhausted. The brakes are then fully released.

B. Brake Pedal and Air Application Valve Removal, Disassembly, and Inspection

1. Remove the panels from both sides of the operator's compartment.

2. Remove all of the dirt and grease from the exterior of the valve and brake pedal assembly.

3. Disconnect all of the air lines leading to the valve. Remove the leads from the stop light switch.

4. Remove the brake return spring and the spacer from the brake pedal. Remove all of the capscrews, the lockwashers, and the nuts that secure the brake pedal assembly to the mounting pad (Fig. 21). Remove the assembly from the mounting pad and place it on a clean work bench.

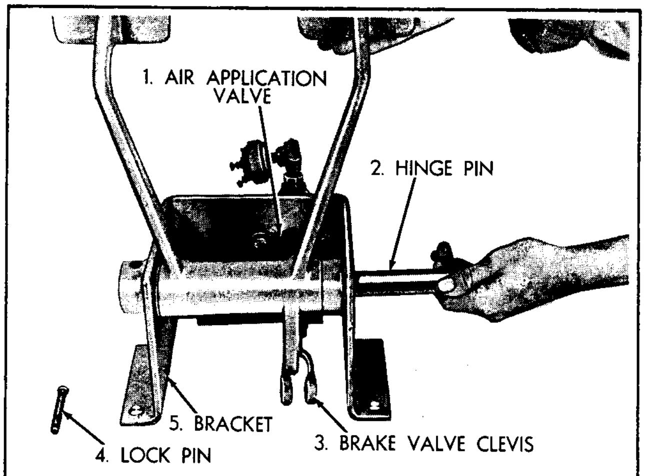

Fig. 23 — Removing Brake Pedal Assembly Hinge Pin

5. Remove the cotter pin and the lock pin from the brake pedal hinge pin. Remove the hinge pin (Fig. 23).

6. Remove the cotter pin and the pin that connects the valve clevis to the brake pedal (Fig. 23).

7. If necessary for parts replacement, remove the seals and the bearings from both ends of the brake pedal.

8. Remove the rubber boot from the valve mounting plate. Remove the capscrews, the lockwashers, and nuts that secure the valve to the bracket (Fig. 23).

9. Remove the machine screws from the end plate (Fig. 25). Remove the piston and pres-

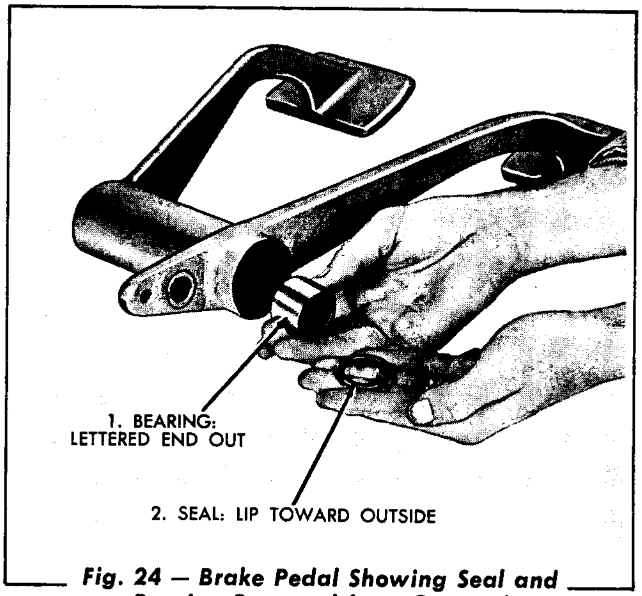

Fig. 24 — Brake Pedal Showing Seal and Bearing Removed from One End

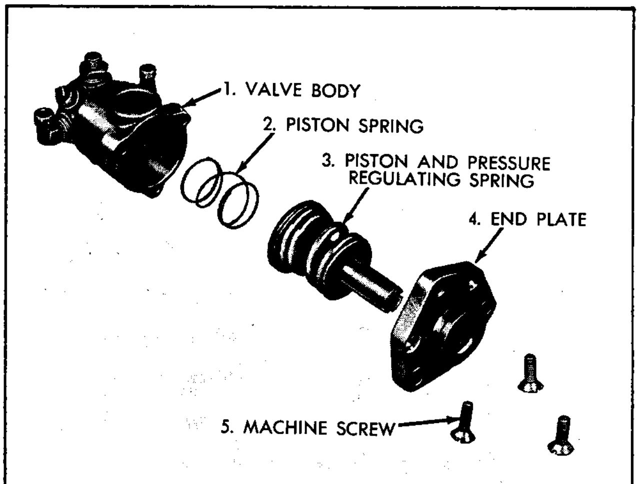

Fig. 25 — Valve End Plate, Piston and Pressure Regulating Spring, Piston Spring, and Valve Body

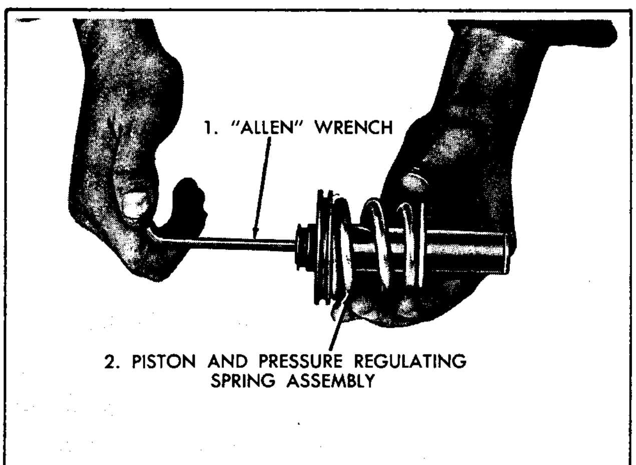

Fig. 26 — Removing Machine Screw from Piston and Pressure Regulating Spring Assembly

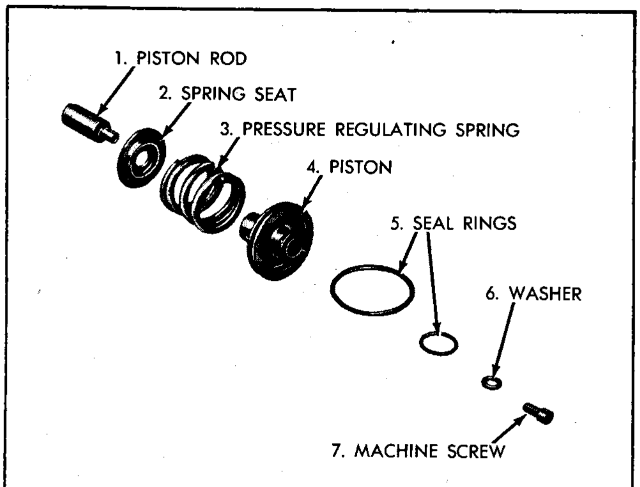

Fig. 27 — Piston and Pressure Regulating Spring Details

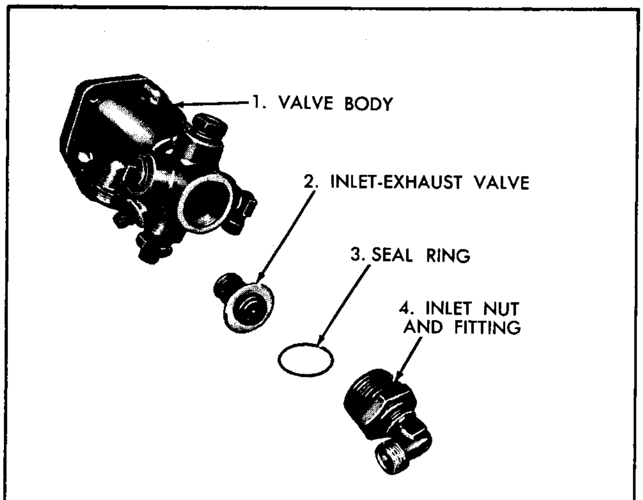

Fig. 28 — Valve Inlet Nut, Seal Ring, Intake-Exhaust Valve, and Valve Body Details

sure regulating spring assembly, and the piston spring from the valve body.

10. Remove the "Allen"-head machine screw and the washer from the piston rod (Fig. 26). Remove the pressure regulating spring, the spring seat and the piston rod from the piston (Fig. 27). Remove the seal rings from the piston.

11. Remove the inlet nut and the seal ring from the valve body (Fig. 28). Remove the inlet-exhaust valve.

12. Wash all of the metal parts in a clean solvent or diesel fuel. Inspect them for cracked, broken, or worn parts.

    Replace the piston assembly as a unit if it is damaged in any way. Replace the other parts of the brake and valve assembly if they are worn or damaged.

C. Brake Pedal and Air Application Valve Assembly and Installation

The brake pedal and valve assembly may be assembled and installed in reverse order of the removal and disassembly procedure above.

NOTE: *Replace the seal rings on the inlet nut (Fig. 28), and on the piston (Fig. 27).*

IMPORTANT: *Lubricate the seal rings and the surfaces that they contact in the valve body with barium grease.*

12. QUICK RELEASE VALVE

A. Description

The rear brake rotochambers are equipped with a quick release valve (Fig. 1). The quick release valve decreases the release time of the rear brakes by exhausting the volume of air in the rotochambers close to the rotochambers.

If the quick release valve was not used, the air would have to travel through relatively long lines to exhaust at the air application valve.

The quick release valve consists of a body containing a spring loaded diaphragm. It permits air pressure to flow through the valve in one direction except when the supply of air pressure is reduced. Then the air which has passed through the valve is permitted to escape through the exhaust port of the valve.

B. Quick Release Valve Removal and Disassembly

1. Remove all of the dirt and grease from the exterior of the quick release valve, using a clean solvent or diesel fuel.

2. Disconnect all of the air lines leading to the quick release valve assembly.

3. Remove the capscrews, the lockwashers, and the nuts securing the valve assembly. Remove the valve.

4. Unscrew the valve cover from the valve body.

5. Remove the diaphragm spring, the diaphragm seat, and the diaphragm from the valve body.

C. Quick Release Valve Inspection and Assembly

1. Wash all of the metal parts in a clean solvent or diesel fuel.

2. Inspect the diaphragm for signs of cracking, wear, or damage.

   Inspect the lower face of the diaphragm which contacts the exhaust port seat in the valve cover for signs of pitting or grooving. Replace the diaphragm if any of these conditions are found.

3. Inspect the condition of the exhaust port seat on the valve cover for signs of pitting. The seat must be smooth and flat. If the exhaust port has deep scratches or pitting, the cover must be replaced.

4. Inspect the diaphragm spring seat for wear or damage. Replace it if necessary.

   NOTE: *If the exhaust port seat on the valve cover shows scratches or pitting, it can sometimes be repaired by carefully lapping the seat. Use a piece of fine emery cloth on a flat surface.*

5. Install the diaphragm in the valve body with the shoulder of the valve directed toward the top of the valve body.

6. Install the diaphragm spring seat with the shoulder of the seat directed toward the top of the valve body.

7. Install the diaphragm spring in the valve body. Install the valve cover in the valve body. Tighten it securely.

8. Place the quick release valve assembly in position. Secure it with the attaching capscrews, lockwashers and the nuts.

9. Connect the air lines to the valve.

13. ROTOCHAMBERS AND AIR CHAMBERS

A. Description

The brake rotochambers, and the air chambers, convert the energy of compressed air into the mechanical force and motion necessary to operate the brakes. Rotochambers are located on the rear wheels and air chambers are located on the front wheels. Although both operate similarly, they are not constructed exactly alike.

As air pressure enters the chamber (air chamber or rotochamber) behind the diaphragm, the diaphragm forces the push rod outward actuating the brake slack adjuster and the brake cam.

The slack adjustor (or adjustor lever), the camshaft, and the cam are rotated and spread the brake shoes against the brake drum, applying the brake.

When the air pressure is released from the chamber, the brake shoe release spring and the chamber release spring both return the brake shoes, the camshaft, the slack adjuster, and the diaphragm to release the brake.

B. Rotochambers (Rear Wheels) Removal

1. Thoroughly clean the rotochamber and the surrounding area (Fig. 29). Disconnect the air hose from the rotochamber. Cover the end of the hose.

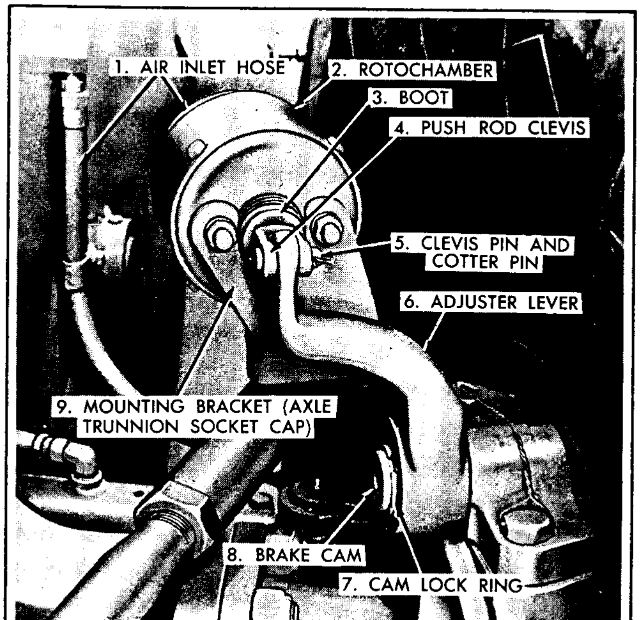

Fig. 29 — Rotochamber Installed

2. Remove the cotter pin from the clevis pin that attaches the rotochamber push rod to the adjustor lever. Remove the clevis pin.

3. Remove the nuts and the lockwashers that attach the rotochamber to its mounting bracket. Remove the rotochamber and place it on a clean work bench.

C. Rotochamber (Rear Wheels) Removal, Disassembly and Inspection

1. Loosen the clevis locknut (Figs. 30 and 31) and turn the push rod clevis off of the push rod.

2. Remove the capscrews and the lockwashers that attach the cover to the rotochamber body. Remove the cover and the return spring.

3. Remove the nuts and the lockwashers from the outer diaphragm clamp studs. Remove the outer and the inner diaphragm clamps, the diaphragm, the diaphragm guide, and the push rod as a unit from the rotochamber body.

4. Free the edge of the diaphragm from the outer diaphragm clamp. Remove the outer diaphragm clamp.

5. Remove the nuts and the lockwashers from the inner diaphragm clamp studs. Remove the inner diaphragm clamp, the diaphragm, and the diaphragm guide from the push rod.

6. Clean all of the parts in a clean solvent or diesel fuel. Inspect the rotochamber body, the inner and the outer diaphragm clamps, and the diaphragm guide for wear. Replace them if necessary.

   Inspect the push rod assembly. Replace it if it is bent. Replace the push rod spring if it is damaged.

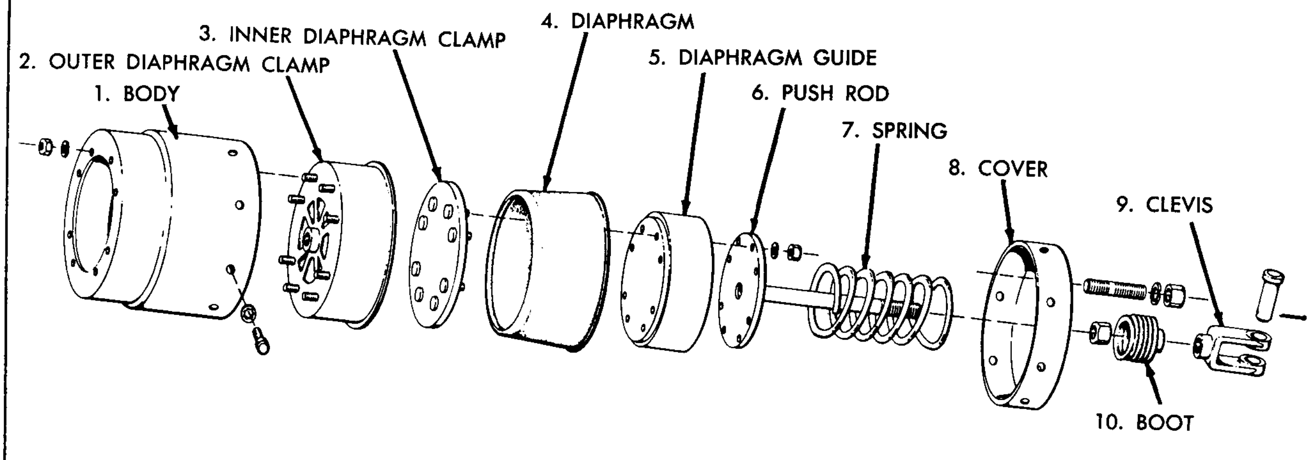

Fig. 30 — Rotochamber Details

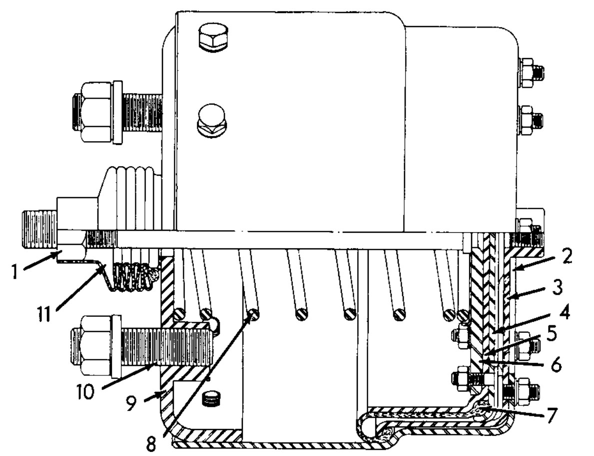

Fig. 31 — Rotochamber — Sectional View

1. Clevis Locknut
2. Rotochamber Body
3. Outer Diaphragm Clamp
4. Inner Diaphragm Clamp
5. Diaphragm Guide
6. Push Rod
7. Diaphragm
8. Push Rod Return Spring
9. Rotochamber Cover
10. Rotochamber Mounting Stud
11. Rubber Boot

D. Rotochamber (Rear Wheels) Assembly, Installation, Adjustment, and Final Inspection

1. Using a good grade of air brake cylinder grease, lightly coat the inside wall of the rotochamber body.

2. Using a new diaphragm and rubber boot (Figs. 30 and 31), assemble the rotochamber in reverse order of the assembly procedures above.

3. Position the rotochamber on the mounting bracket. Secure it with the nuts and the lockwashers. Connect the push rod clevis and the adjustor lever with the clevis pin. Secure the pin with a cotter pin. Connect the air hose to the rotochamber.

4. Adjust the brakes, refer to "BRAKES" in this Section.

5. With the air system operating at normal pressure (110 to 120 P.S.I.) and the brakes fully applied, check for air leakage through the rotochamber diaphragm as follows. Free the rubber boot from the rotochamber cover. Coat the push rod clearance hole with soap suds. If there is an air leak at this point, the diaphragm is leaking air and it must be replaced.

E. Air Chamber (Front Wheels) Removal, Disassembly and Inspection

1. Thoroughly clean the air chamber and the surrounding area (Figs. 32 and 33). Disconnect the air hose from the air chamber. Cover the end of the hose.

2. Remove the cotter pin from the clevis pin

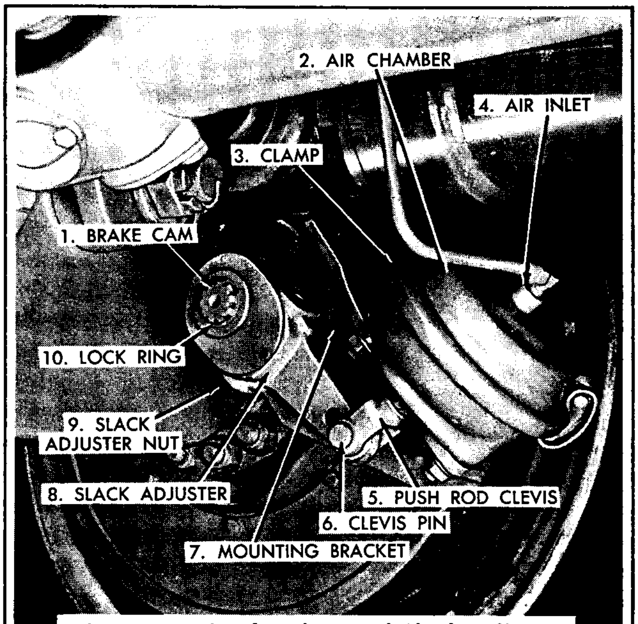

Fig. 32 — Air Chamber and Slack Adjustor Installed

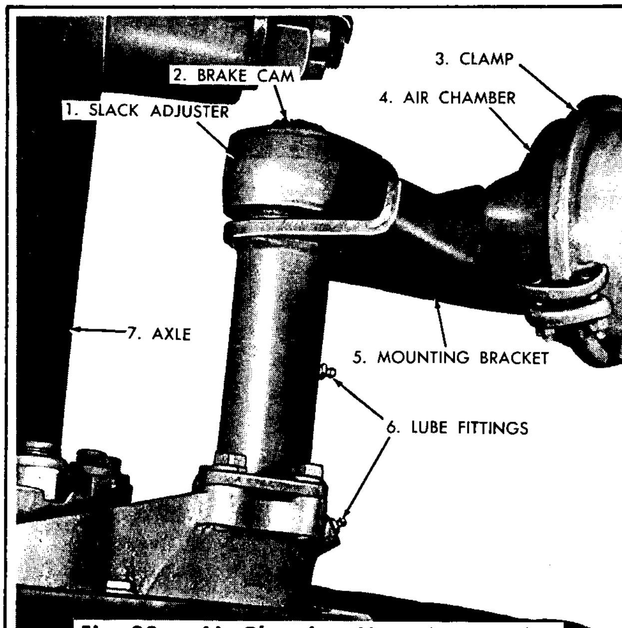

Fig. 33 — Air Chamber Mounting Bracket

that attaches the air chamber push rod to the slack adjustor. Remove the clevis pin.

3. Remove the nuts and the lockwashers that attach the air chamber to the mounting bracket. Remove the air chamber and place it on a clean work bench.

4. Loosen the clevis locknut and turn the push rod clevis off the push rod. Remove the locknut.

5. Remove the clamp from the air chamber body halves. Be careful not to damage the diaphragm that is held by the clamp between the two air chamber body halves.

6. Separate the body halves. Remove the diaphragm, the push rod, and the return spring.

7. Clean all of the metal parts in a clean solvent. Inspect them for wear or damage. Replace them if necessary.

F. Air Chamber (Front Wheels) Assembly and Installation

The air chamber may be assembled and installed in reverse order of the removal and disassembly procedures above.

NOTE: *Lubricate the front brake camshaft at the lube fittings shown in Fig. 33 with pressure gun lubricant.*

14. SERVICE BRAKES

A. Description

The foot operated brakes are actuated by compressed air. As previously described in this Section, a group of valves in the air brake system maintain a supply of compressed air, some of the valves direct and control the flow of compressed air; and the other valves (the air chambers and rotochambers) transfer the energy of the compressed air into mechanical force and motion.

The brake shoe assemblies are attached to the axles. They are heavy duty, two-shoe type assemblies that are designed for use with power. The brake shoes are mounted with individual anchor pins. They are actuated by "S" type, constant lift cams. The cams are forged integral with the shaft and they are mounted in bushings. When the brakes are applied cam pressure is applied directly to the brake shoes. Dust shields are mounted on the back side of the brake shoes to protect the assemblies from dirt.

B. Service

Time intervals for brake service depend upon the operating conditions. However, the brakes require adjustment when the travel of the brake rotochamber push rod reaches 2¼".

Lubrication of the brake linkage is also a periodic service. It should be lubricated when necessary for ease of operation.

When frequent brake adjustment is necessary, remove the dust shield from the back side of the brake assembly. Inspect the brake linings for wear. The linings must be replaced before they are worn to a point where the lining retaining rivets contact and score the brake drum.

C. Service Brakes, Adjustment

The brakes are properly adjusted when the travel of each air chamber and rotochamber push rod is approximately 1½" when the brakes are applied.

As the brake shoe linings wear, the free travel of the brake chamber push rod increases. When the travel (the total travel between the fully released and the fully applied positions) increases to approximately 2¼", the brakes require adjustment.

Brakes that are adjusted too tightly cause heating, unnecessary brake wear, and loss of power. If they are adjusted too loosely, they wear rapidly because of excessive slipping.

To adjust the rear brakes proceed as follows:

1. Remove the brake cam lock ring that secures the adjustor lever to the camshaft (Fig. 29).
2. Remove the cotter pin from the push rod clevis pin. Remove the clevis pin.
3. Remove the adjustor lever, and rotate it as necessary to obtain 1½" travel of the rotochamber push rod when the brakes are fully applied.
4. When the correct adjustment is obtained, insert the adjustor lever on the splined end of the brake camshaft. Secure it with the lock ring.
5. Install the clevis pin through the push rod clevis and the adjustor lever. Secure it with a cotter pin.

   CAUTION: *After adjusting the rear brake, suitably block the loader and raise the wheels off the ground. Check the wheels to be certain that the brakes are not dragging when they are fully released.*

To adjust the front brakes proceed as follows:

Turn the slack adjustor nut (Fig. 32) as necessary to obtain 1½" travel of the rotochamber push rod when the brakes are fully applied.

CAUTION: *After adjusting the front brakes, suitably block the loader and raise the wheels off the ground. Check the wheels to be certain that they are fully released.*

D. Service Brake Shoes, Removal

The wheels and brake drums must first be removed from the tractor; refer to "AXLES," Section XI.

After the wheels and brake drums are removed, the shoes may be removed as follows:

1. Remove the return springs from the lugs on the brake shoes (Figs. 34, 35, and 36).
2. Remove the retainer spring and the retainer from the ends of each anchor pin.
3. Remove the locking wire and the capscrews that secure the anchor pin in the spider.
4. Remove the anchor pin and remove the brake shoes.

E. Service Brake Shoes Inspection and Repair

New brake shoes must be installed, or the linings on the brake shoes replaced, before the linings

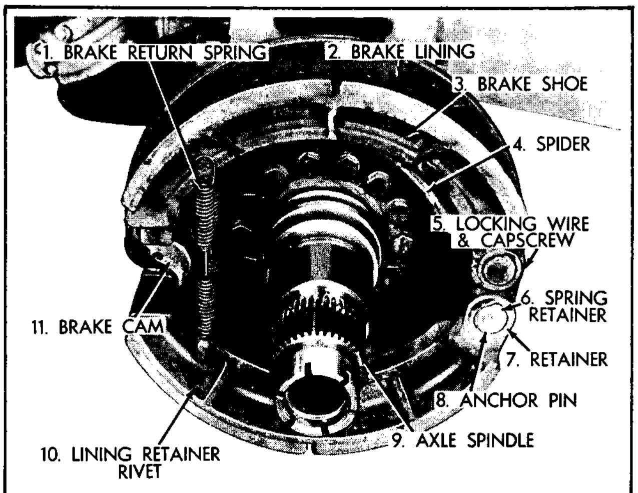

Fig. 34 — Front Brake Shoe Assembly Installed

are worn to a point where the lining retainer rivets contact and score the brake drums.

If the brake drum is worn, scored, or grooved excessively, it must be replaced.

NOTE: *Refacing of the brake drums is not recommended because of the reduced strength of refaced drums.*

Inspect the brake shoe bushings, the anchor pins, and the felt washers. Replace any worn or damaged parts.

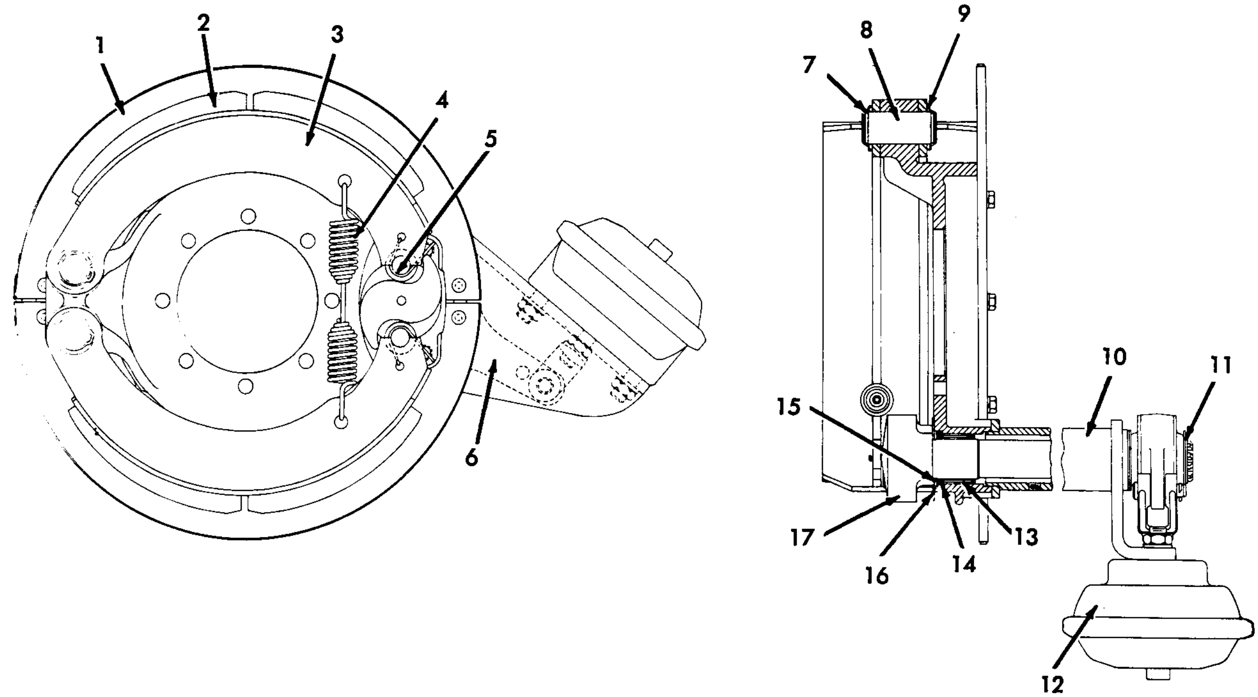

Fig. 35 — Front Brake Assembly Details

1. Dust Shield
2. Brake Lining
3. Brake Shoe
4. Return Spring
5. Retainer Spring
6. Slack Adjuster
7. Retainer Spring
8. Anchor Pin
9. Retainer
10. Mounting Bracket (Air Chamber)
11. Lock Ring
12. Air Chamber
13. Bushing
14. Felt Seal
15. Retainer
16. Washer
17. Camshaft

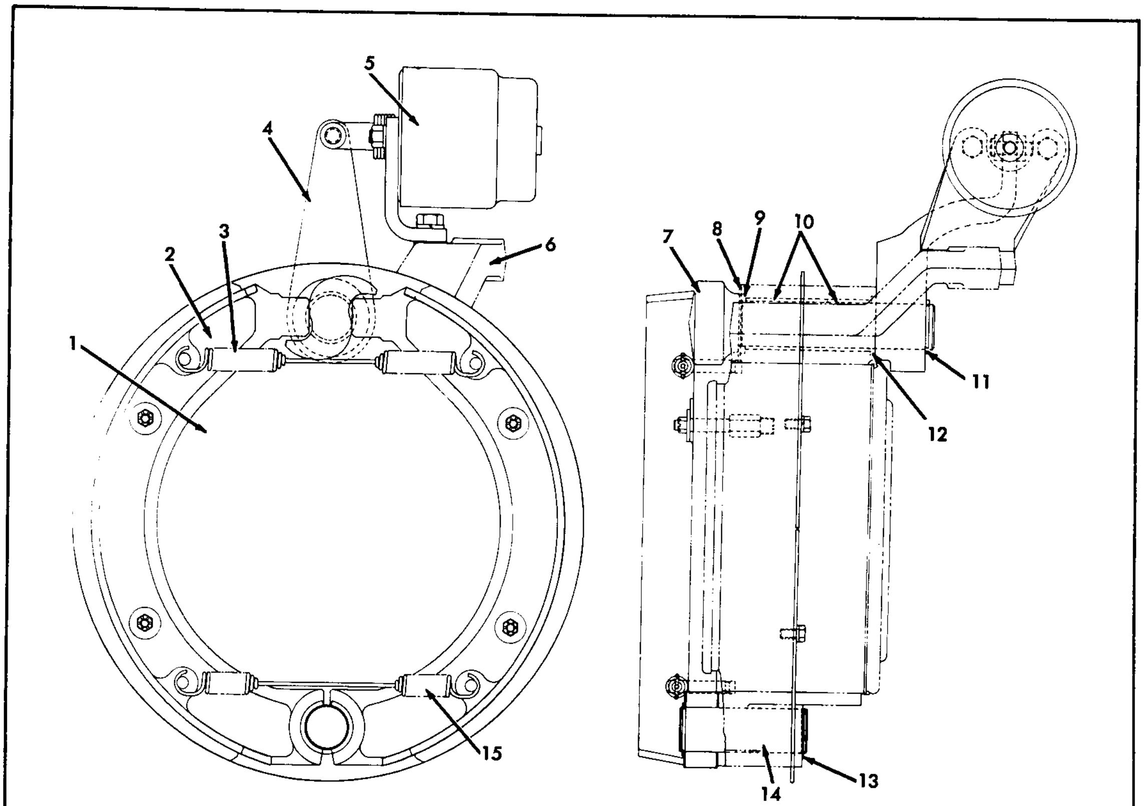

Fig. 36 — Rear Brake Assembly Details

1. Dust Shield
2. Brake Shoe
3. Return Spring
4. Slack Adjuster Lever
5. Rotochamber
6. Mounting Bracket (Rotochamber)
7. Camshaft
8. Washer
9. Retainer and Felt Washer
10. Bushings
11. Retainer Ring
12. Felt Washer and Retainer
13. Retainer
14. Anchor
15. Return Spring

NOTE: *If new bushings are installed in the brake shoes, the bushing must be reamed to the anchor size.*

F. Service Brake Shoes, Brake Drum and Wheel, Installation

1. Install the brake shoes in reverse order of the removal procedure above.
2. Install the brake drums and wheels; refer to "AXLES," Section XI.
3. Adjust the brakes; refer to "SERVICE BRAKES, ADJUSTMENT," in this topic.

15. CLUTCH CUT-OFF CHECK VALVE

A. Description

With the service brakes applied, the clutch cut-off check valve (located below the seat in the operator's compartment) controls the flow of air pressure required to actuate the transmission clutch cut-off valve (Fig. 1).

When the check valve is open and the brakes are applied, an air supply flows from the air application valve, through the check valve, and to the clutch cut-off valve. The clutch cut-off valve is actuated to stop the flow of oil in the transmission and the oil pressure required to apply the transmission clutches. Full engine power is then available for the operation of the loader hydraulic system.

When the check valve is closed, no air pressure is applied to the transmission clutch cut-off valve. Normal oil pressure is available to operate the transmission clutches for precise control of the loader at all times.

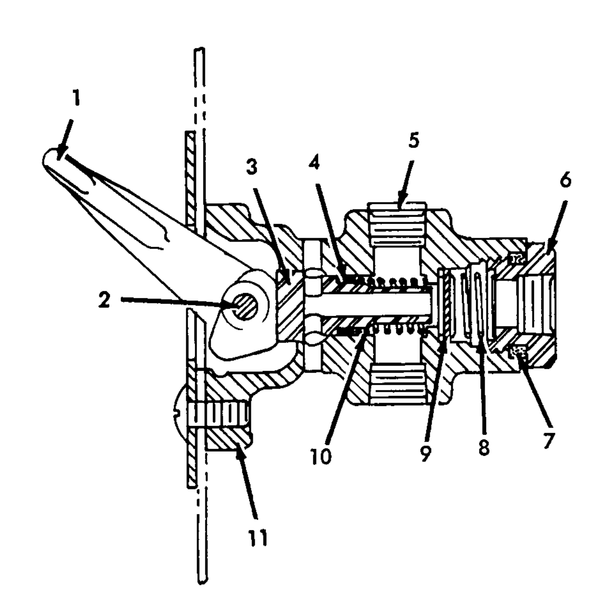

Fig. 37 — Clutch Cut-Off Check Valve — Cut-Away View

1. Lever
2. Pin
3. Plunger
4. Plunger Grommet
5. Pipe Plug
6. Capnut
7. Sealing Ring
8. Valve Spring
9. Valve
10. Plunger Return Spring
11. Valve Body

B. Clutch Cut-Off Check Valve Removal, Disassembly, Inspection, Assembly and Installation

1. Clean the dirt and grease from the check valve and surrounding area. Remove the air lines leading to the valve.

2. Remove the capscrews, the washers, and the nuts that secure the valve to the loader. Remove the valve and place it on a clean work bench.

3. Remove the pin (Fig. 37) that secures the lever to the valve body. Remove the lever. Remove the plunger, the plunger grommet, and the plunger return spring.

4. Remove the capnut and the sealing ring from the end of the valve body. Remove the valve spring and the valve.

5. Clean all of the metal parts in a clean solvent or diesel fuel.

6. Inspect the parts for wear or damage. Replace them if necessary.

7. The clutch cut-off check valve may be assembled and installed in reverse order of the removal and disassembly procedures above.

NOTE: *Be careful not to damage the plunger grommet when installing the plunger.*

16. PARKING BRAKE

A. Description

The parking brake is located on the front output side of transmission. It is hand operated and adjusted by means of a lever located on the left rear side of the operator's compartment.

B. Parking Brake, Removal and Disassembly

Refer to "TRANSMISSION," Section X.

C. Parking Brake, Inspection

New brake shoes must be installed, or the linings on the brake shoes replaced, before the linings are worn to a point where the lining retainer rivets contact and score the drums.

If the brake drum is worn, scored, or grooved excessively, it must be replaced. The brake drum may be refaced if the refacing does not reduce the strength of the drum.

Inspect the brake shoe parts for any worn or damaged parts. Replace them if necessary.

D. Parking Brake, Assembly and Installation

Refer to "TRANSMISSION," Section X.

E. Parking Brake Lever, Removal, Disassembly and Inspection

1. Remove the parking brake lever and transmission lever cover panel.

2. Remove the cotter pin and the lower clevis pin and the washer from the lever assembly (Fig. 38).

3. Remove the capscrews, the lockwashers, and the nuts that attach the lever assembly to the loader. Remove the lever assembly.

4. Turn the cap and the adjusting knob out from the threaded rod. Remove the ball and the spring.

5. Turn the threaded rod out from the adjusting tube.

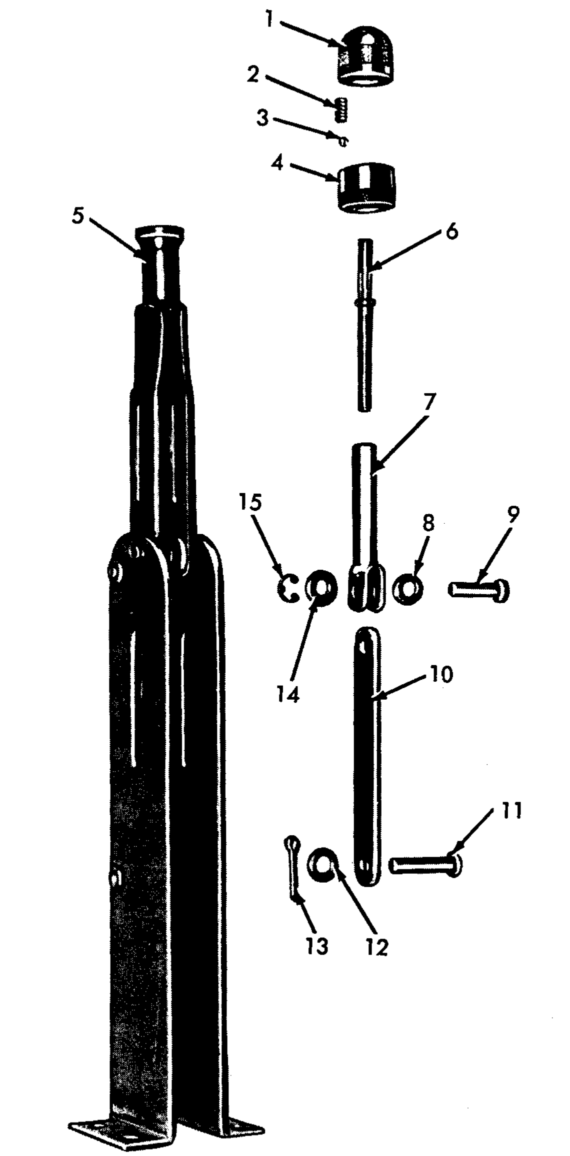

Fig. 38 — Parking Brake Lever Assembly Details

1. Cap
2. Spring
3. Ball
4. Adjusting Knob
5. Lever Assembly
6. Rod (Threaded Both Ends)
7. Adjusting Tube
8. Spring Washer
9. Clevis Pin
10. Link
11. Clevis Pin
12. Plain Washer
13. Cotter Pin
14. Plain Washer
15. Retaining Ring

6. Remove the retaining ring, the clevis pin and the washers. Remove the adjusting tube and the link.

7. Inspect the parts for wear or damage. Replace them if necessary.

F. Parking Brake Lever, Assembly and Installation

The parking brake lever assembly may be assembled and installed in reverse order of the removal and disassembly procedures above.

G. Parking Brake, Adjustment

The parking brake is adjusted by turning the adjusting knob (Fig. 38) on the parking brake lever assembly.

Turn the adjusting knob clockwise as far as it will go. With the adjusting knob in this position, the lever should not be able to be pulled down into the "release" position.

Turn the knob counterclockwise until it requires firm pressure to release and apply the parking brake. In this position, the parking brake is properly adjusted.

SECTION XIII — MAIN FRAME, DRAWBAR AND COUNTERWEIGHTS

1. GENERAL DESCRIPTION

A. Main Frame

The main frame (Figs. 1 and 2) is a one-piece welded steel structure. The front end of the frame consists of a steel box made of two channels. The rear end is a bolting plate that is used to attach the drawbar and the upper and lower counterweight castings.

B. Axle Supports

The front and rear axle supports (Figs. 1 and 2) are welded to the side frames. The front axle support has bosses for pin-connecting the axles to the loader, and also provides a means for attaching the brake valve mounting and the brake levers.

The rear axle support provides the bosses and bushings for pin-connecting the steering axle support yokes.

C. Stabilizer Weld Assembly

The two stabilizer weld assemblies (Figs. 1 and 2) are welded to the side frames, one located near the center on each side frame. They provide pivot points for the lift and dump cylinders; a means for attaching the hydraulic tank supports; the operator's seat; the hood and radiator braces; and the ladder.

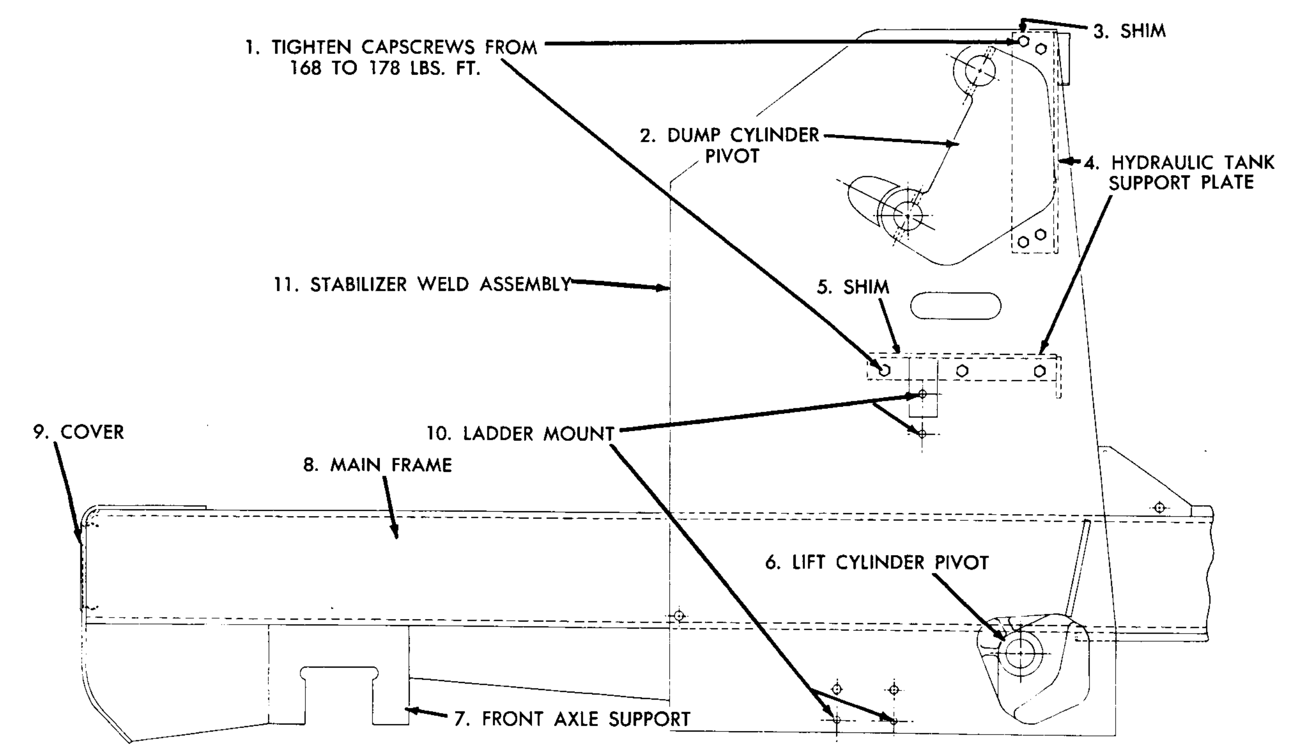

Fig. 1 — Main Frame and Stabilizer

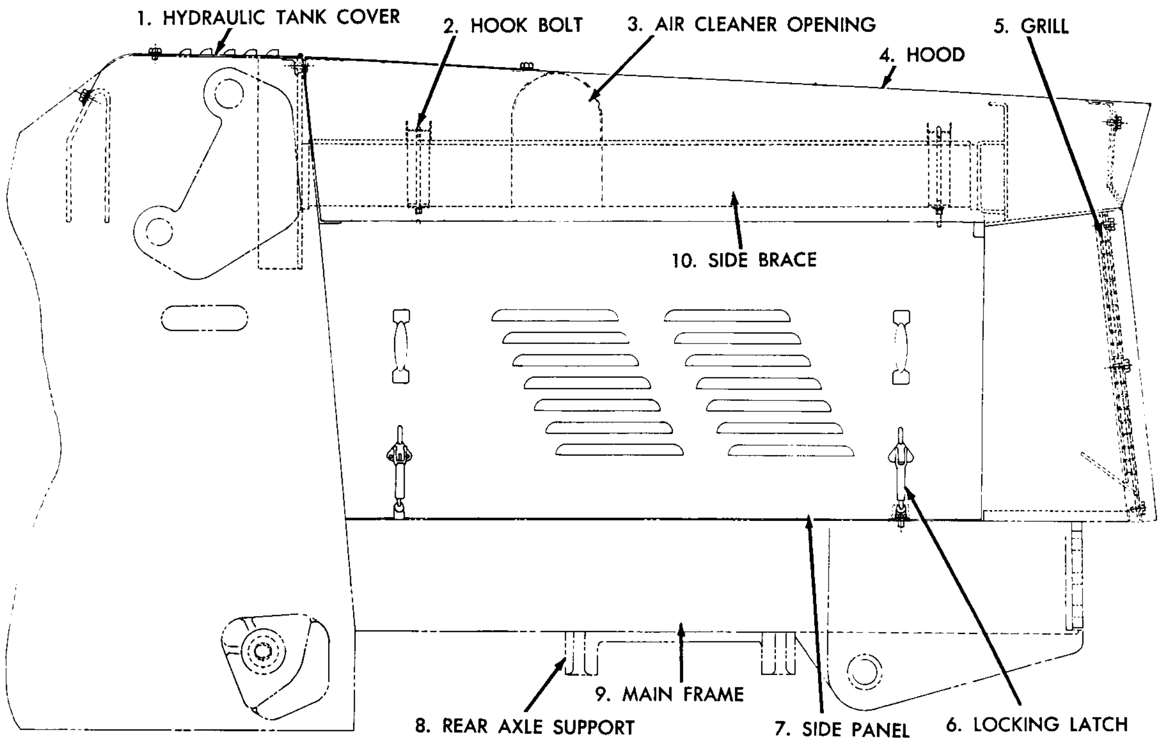

Fig. 2 — Hood and Side Panels

D. Counterweight Castings

The upper casting is bolted to the rear main frame plate by the two end capscrews. Two center capscrews extend through the lower casting, the rear plate of the main frame, and the drawbar. A lockwasher and a hex nut are used with the capscrew to secure the castings and the drawbar to the frame. The lower casting is pin-connected to the side frames by the same pins that extend through the drawbar.

E. Drawbar

The drawbar is pin-connected to the side frames and is bolted to the upper counterweight casting through the rear plate of the frame.

F. Braces

A brace is bolted between the rear ends of the stabilizer weld assemblies. It supports the front end of the hood and the hydraulic tank cover plate. It also supports the tops of the stabilizer weld assemblies.

The side braces, one located on each side of the loader, are bolted to the top rear end of the stabilizer weld assemblies. The other ends of the braces are bolted to the radiator support at the rear end of the loader. Constructed of angle and steel plates, they provide a mount for the hood and the air cleaner.

G. Radiator, Grill, and Support

The radiator and the grill are mounted on a support weld assembly that is secured to the rear of the main frame and the two side braces. As a stabilizer for the rear of the loader main frame and side braces, the support weld assembly holds the radiator securely in place. The support, the grill, and the fan guard protect the radiator from damage.

13

2. MAIN FRAME

A. Inspection

The main frame and stabilizer (Figs. 1 and 2) should be inspected periodically for loose capscrews, cracked welds, bending, and misalignment. If any of these conditions are found, they should be corrected immediately.

B. Repair

If the frame cracks or breaks because of severely rough use, the frame may be reinforced by welding suitable steel plates to it. Before reinforcing the frame, it should be inspected for proper alignment and straightened if necessary.

3. BRACES

A. Inspection

The front brace (supporting the front end of the hood), the two side braces, and the radiator support (Figs. 1 and 2) should be inspected periodically for loose capscrews and cracked welds. These conditions must be corrected immediately.

B. Removal

1. Remove the engine side panels, the hood, and the hydraulic tank cover plate (Fig. 2).
2. Remove the brace located between the stabilizers. Note the location and quantity of shims at each end of the brace.
3. Disconnect the air cleaner. Remove the side braces from the stabilizer and radiator support. Note the location and quantity of shims at each end of the braces.

C. Installation

Install the braces in reverse order of the removal procedures above. Insert the shims in their proper locations and quantities as noted above.

D. Maintenance and Inspection

1. Inspect the braces for alignment and for cracks.
2. Braces must be correctly aligned before welding them.

4. HYDRAULIC TANK SUPPORT PLATE

A. Removal

1. Remove the hydraulic tank; refer to "LOADER HYDRAULIC SYSTEM" Section XVI).
2. Remove the support plate (Fig. 1) from each stabilizer. Note the location and quantity of shims between the support plates and the stabilizers.

B. Installation

Install the support plates in reverse order of the removal procedures above. Insert the shims in their proper locations and quantities as noted above.

5. RADIATOR, GRILL, AND SUPPORT

A. Removal of Grill and Fan Guard

1. Remove the side panels and the hood (Fig. 3).
2. Remove the grill (Fig. 3) from the rear of the radiator support. Remove the fan guard from the front of the radiator support.

B. Removal of Radiator and Support

1. Thoroughly drain the radiator; refer to "ENGINE COOLING SYSTEM" Section IV. Remove the hoses from the radiator.
2. Disconnect the radiator from the support (Fig. 4). Lift the radiator from the support (Fig. 5).

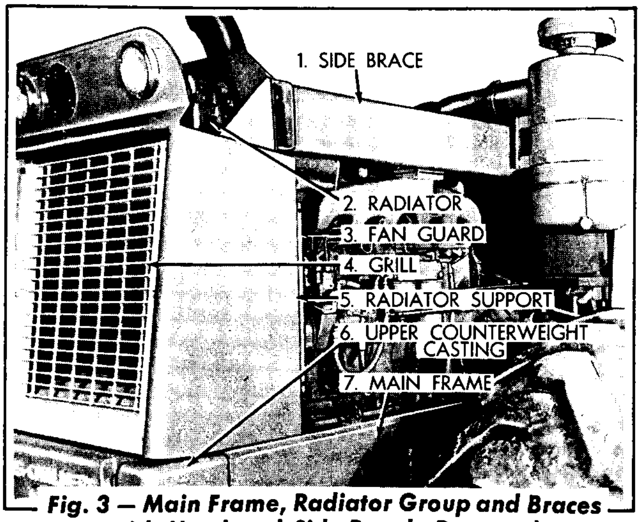

Fig. 3 — Main Frame, Radiator Group and Braces with Hood and Side Panels Removed

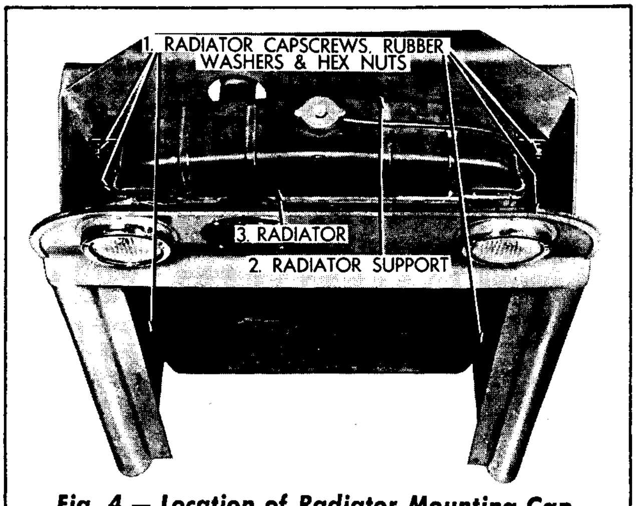

Fig. 4 — Location of Radiator Mounting Capscrews, Rubber Washers, and Hex Nuts

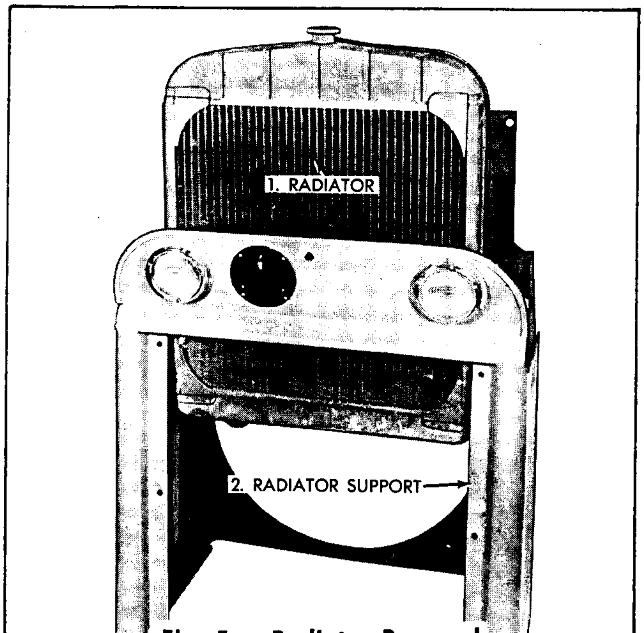

Fig. 5 — Radiator Removal

3. Disconnect the rear light cables at the cable connectors.

4. Block the rear of the side braces. Remove the capscrews, lockwashers, and hex nuts from the rear end of the braces. (Fig. 6).

   Remove the capscrews and the lockwashers from the bottom of the radiator support. Remove the support.

C. Inspection and Repair

Clean the air passages in the radiator core and test it for clogging or leaks. Clean the core if it is clogged and repair any leaks that are found. Straighten bent cooling fins.

D. Installation of Support, Radiator, Fan Guard, and Grill

Install the radiator support, the radiator, fan guard, and the radiator grill in reverse order of the removal procedures above. NOTE: *Be sure to use the rubber washers when installing the radiator.*

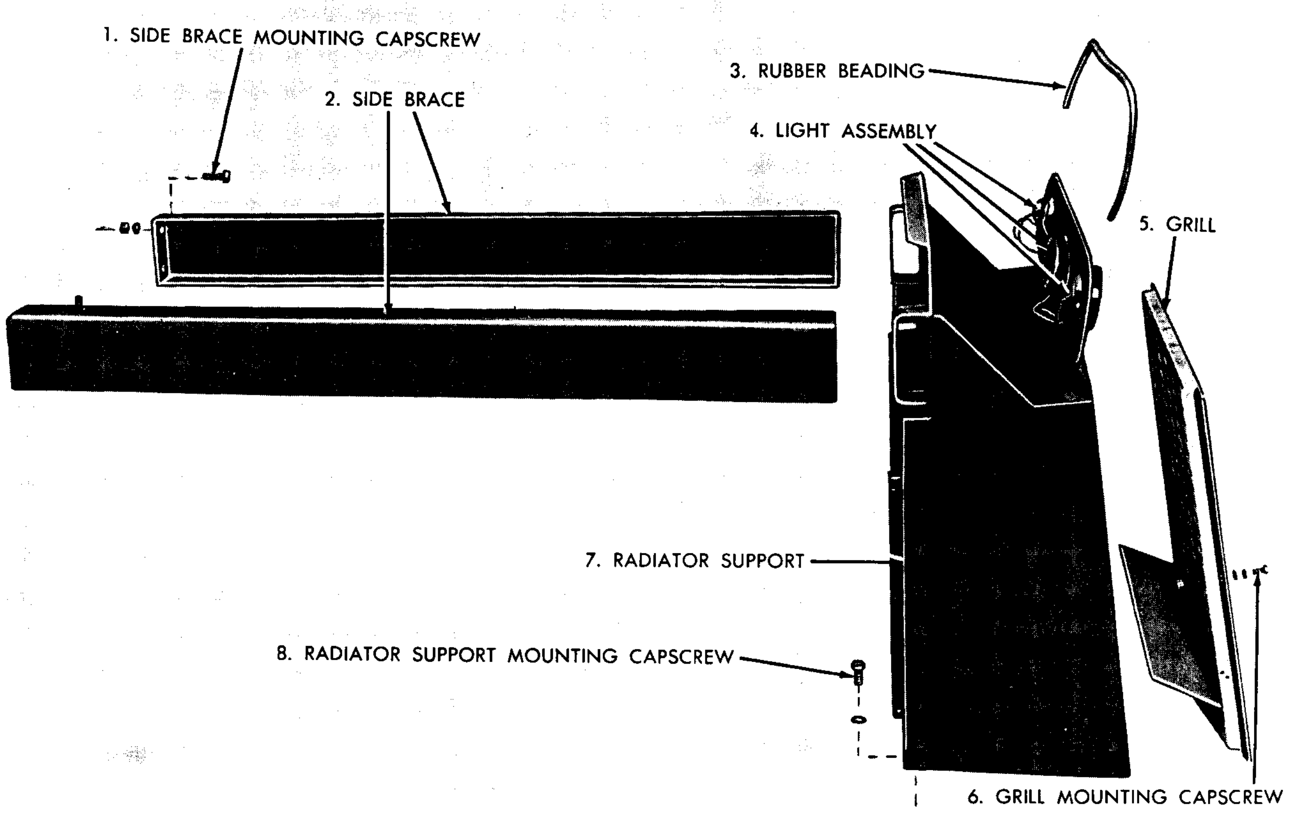

Fig. 6 — Exploded View of Radiator Support, Grill, and Side Braces

6. UPPER COUNTERWEIGHT CASTING

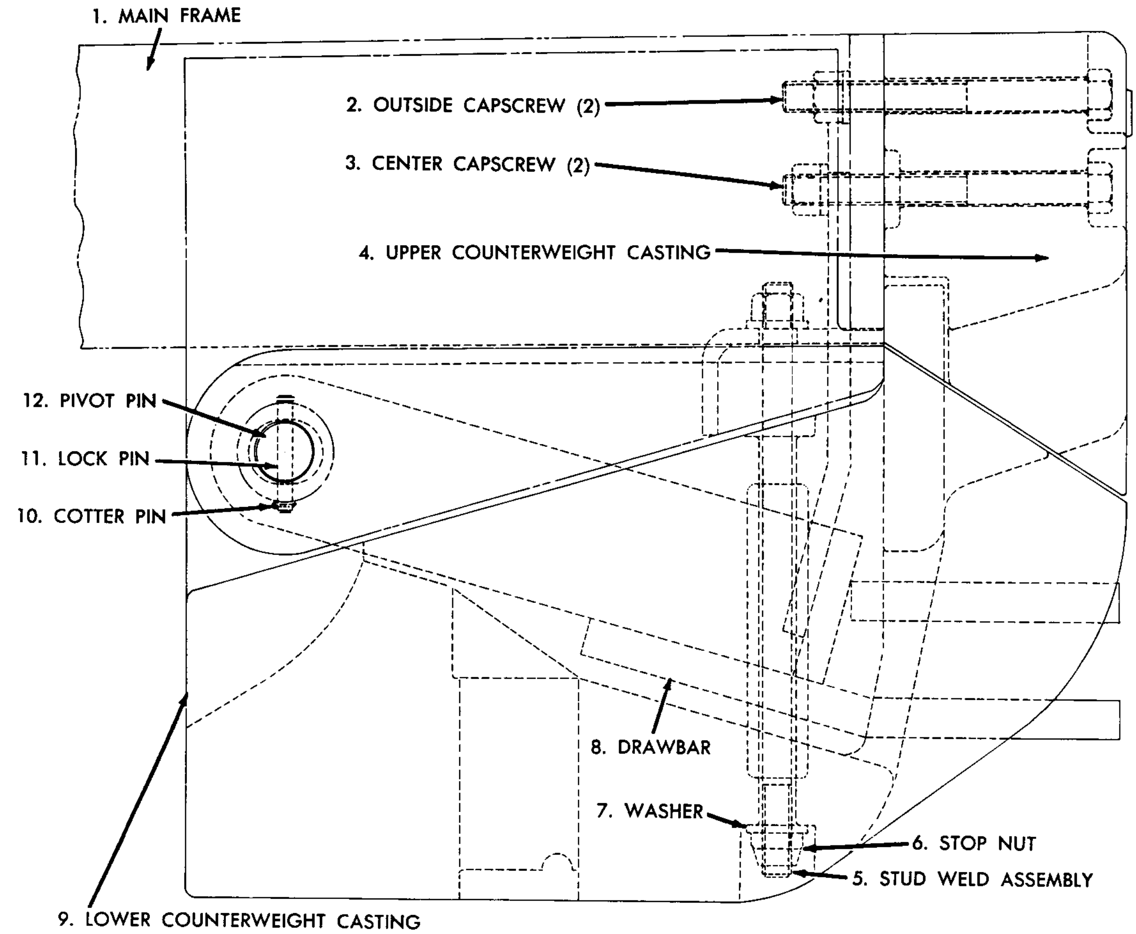

Fig. 7 — Counterweights and Drawbar

A. Removal (Fig. 7)

1. Remove the two center capscrews, the lock-washers, and the hex nuts.

2. Suitably support the casting while removing the two outside capscrews, the lock-washers, and the hex nut.

3. Remove the upper casting.

B. Installation

Install the upper casting in reverse order of the removal procedures above.

7. LOWER COUNTERWEIGHT CASTING

A. Removal (Fig. 7)

1. Suitably support the lower casting. Remove the stop nuts and plain washers from the two stud weld assemblies located in the bottom of the casting.

2. Remove the cotter pins and the lock pins from the pivot pins. Remove the pivot pins from the sides of the casting.

3. Remove the casting.

B. Installation

Install the lower counterweight casting in the reverse order of the removal procedures above.

8. DRAWBAR

A. Removal (Fig. 7)

1. Remove the lower counterweight casting; refer to Topic 7, above. Remove the two center capscrews, lockwashers, and hex nuts from the upper casting.

2. Lower the drawbar down through the frame and remove.

B. Installation

Install the drawbar in reverse order of the removal procedures above.

SECTION XIV — TIRE AND WHEEL GROUP

1. DESCRIPTION

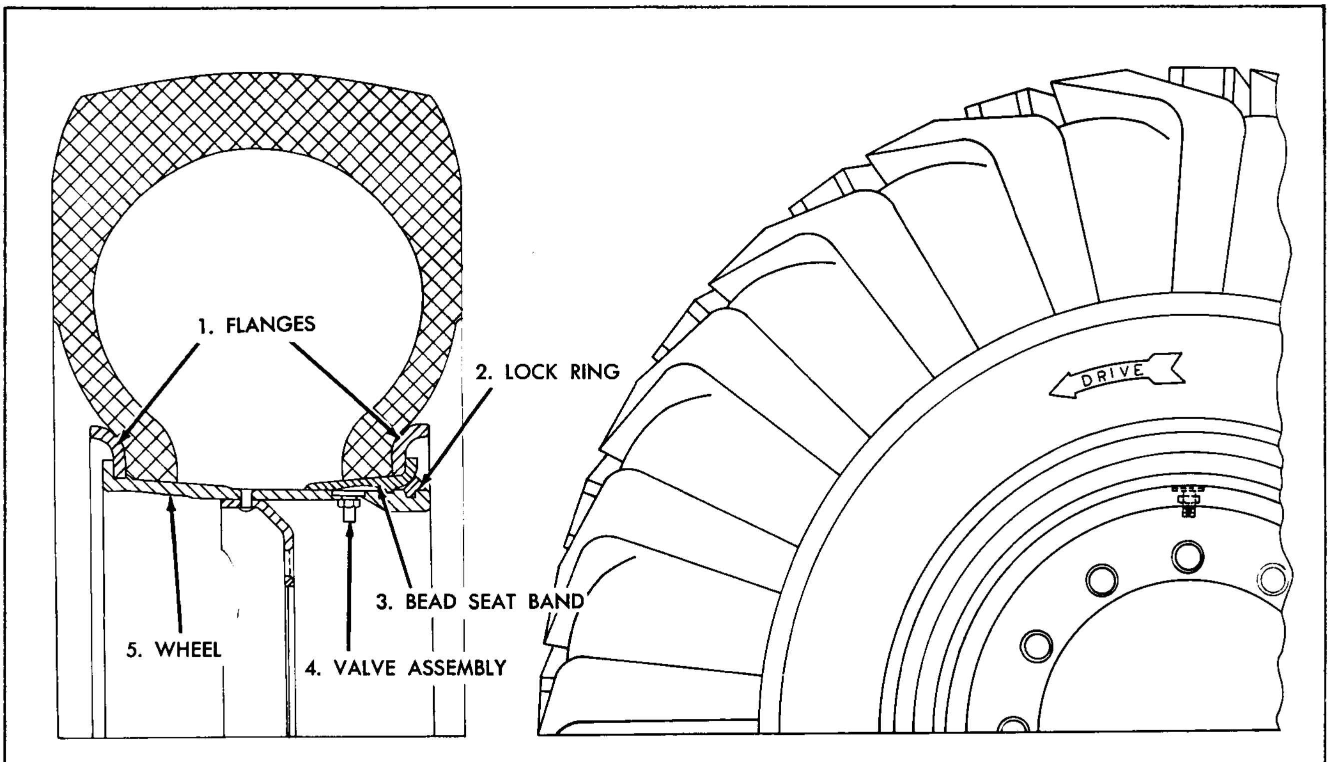

Fig. 1 — Tires and Wheels

The standard tubeless tires used on both the front and rear wheels are 18:00-25, 12 ply Grader Lug Type to give sufficient traction for normal work loads. The tires are mounted on the rim so that the lug center points are toward the bucket or front of the machine. The five piece wheel assembly consists of the wheel and rim, two flanges, a bead seat ring and a lock ring. A tire valve is also installed in the wheel. The tire is mounted by placing one flange over the wheel followed by the tire. The remaining flange is then placed over the wheel assembly, followed by the bead seat ring. The lock ring is then installed. As the tire is filled with air and its pressure rises, the side wall of the tire pushes the second flange and bead seat ring into position.

14

2. INFLATION

The tire pressure of 40 P.S.I. should be maintained because under- or over-inflation causes excessive wear, damage and improper steering. Uneven tire pressure causes hard steering and improper operation. Maintenance of the correct inflation pressure is one of the most important elements in tire care. Higher inflation pressure than recommended will give:

a. A harder riding loader.

b. Tire more susceptible to various types of bruises.

c. Uneven wear when driving the loader on the road.

d. Fast tread wear in the center of the tire.

Lower inflation pressure than recommended will give:

a. Higher fuel consumption.

b. Rapid and uneven wear on the edges of the tire tread.

c. A tire more susceptible to rim bruises and various types of rupture.

d. Increased cord fatigue or broken tire cords.

e. Hard steering.

f. Higher tire temperatures.

g. Possible tire to wheel slippage.

SECTION XV—POWER STEERING SYSTEM

1. DESCRIPTION

The oil for the power steering system is supplied by the main hydraulic system tank, thus eliminating the need of a special reservoir. The other main components of the power steering system are the pump, safety relief valve, control valve and hydraulic cylinders. An arm and linkage assembly connect the steering gear to the rear, or steering, wheels.

One short drag link is attached to the steering gear "Pitman" arm and to the top of the steering arm assembly. Another drag link (long) is connected to the lower end of the steering arm assembly and to an arm projecting inward from the upper left hand bearing cap on the rear (steering) axle.

Oil flows from the hydraulic tank through the suction line to the pump, where the oil under pressure is discharged from the pump and delivered to the pressure side of the control valve. From the con-

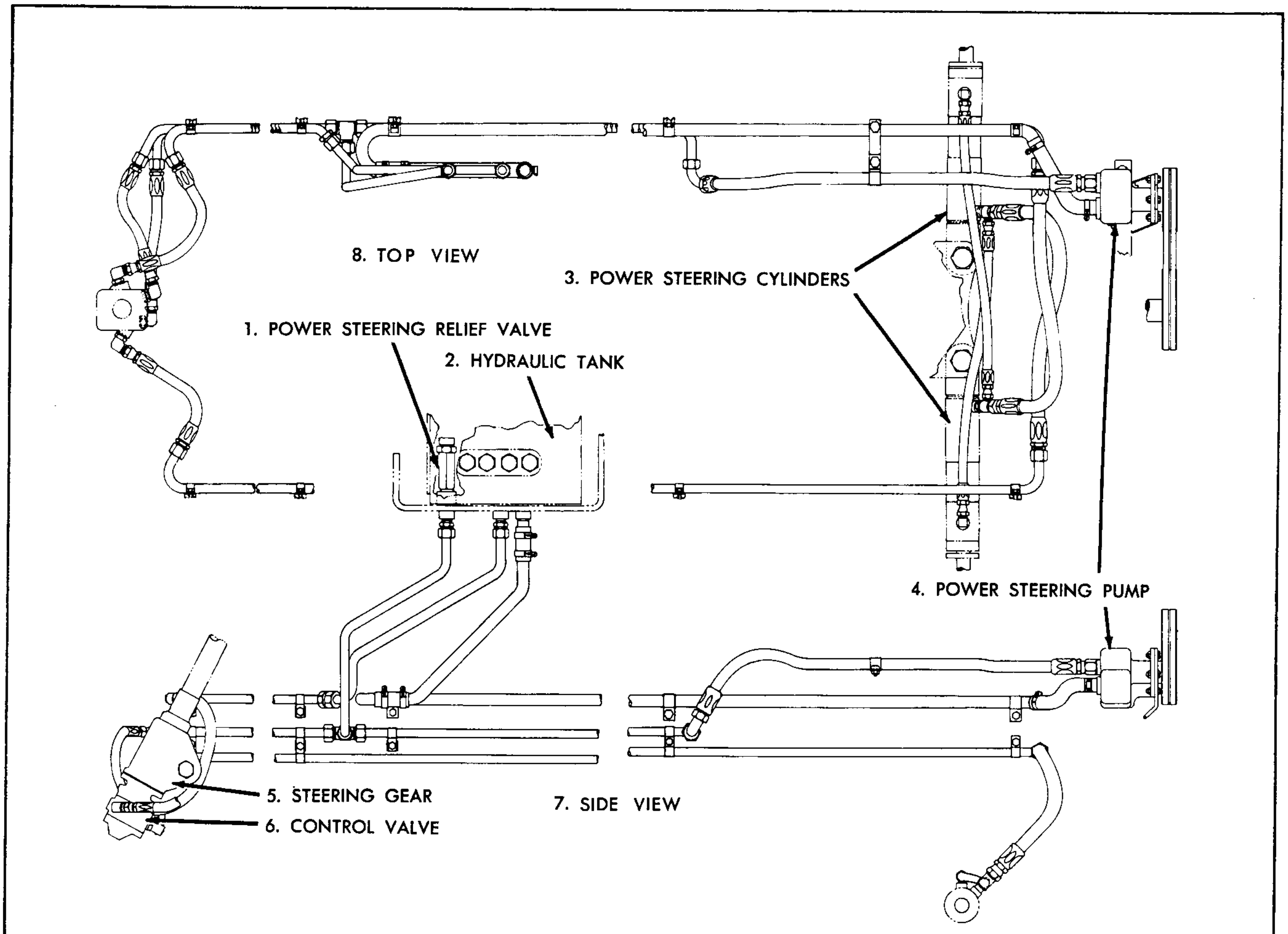

Fig. 1 — Power Steering System

trol valve it is piped to the power steering or actuating cylinders. As oil is returned to the hydraulic tank from the actuating cylinders it again passes through the control valve.

The power steering relief valve is housed within the hydraulic tank and is properly adjusted at the factory to open at a pressure of 950 to 1000 P.S.I. It should require no further adjustment in the field.

2. PUMP AND DRIVE BELTS

A. General

The power steering "gear type" pump is located in the rear, right hand corner of the engine compartment. It is attached to the rear engine support by an adjustable bracket. The crankshaft pulley operates the pump through a double belt drive, therefore, oil under pressure is supplied to the steering control valve whenever the engine is running.

B. Pump Belts Adjustment

The pump belts are correctly adjusted when the top side of the belts can be pressed downward approximately ⅜" at a point half-way between the crankshaft pulley and the pump pulley. Adjust the pump belts as follows:

1. Loosen the two capscrews attaching the power steering pump to the rear engine support.

2. Slide the pump bracket with pump, toward or away from the crankshaft pulley as required to obtain the correct tension on the belts. NOTE: *The tension on both belts must be equal.*

3. Tighten the capscrews to a torque of 83 to 93 lbs. ft.

C. Pump Belts Replacement

1. Loosen the two capscrews attaching the power steering pump to the rear engine support.

2. Slide the pump toward the crankshaft and remove the belts from the pump pulley and crankshaft pulley.

3. Install TWO new pump belts in their respective grooves on the pulleys. IMPORTANT: *Power steering pump belts must be replaced in matched pairs.*

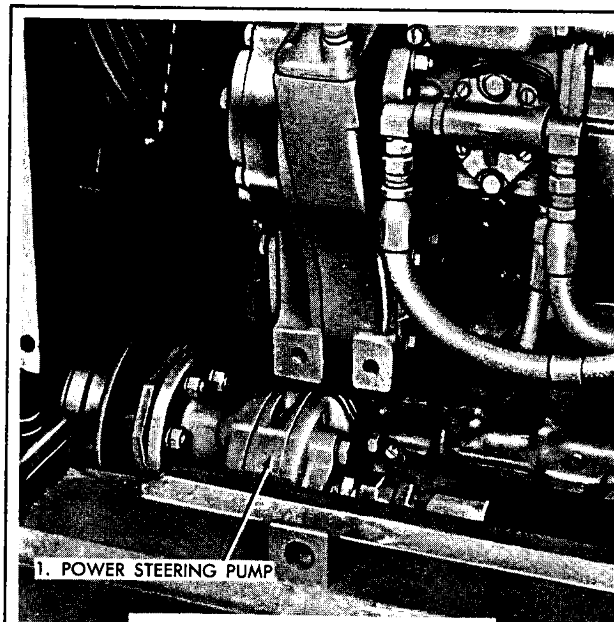

Fig. 2 — Power Steering Pump

4. Adjust the belts as in "B. Pump Belts Adjustment" above.

D. Pump Removal

The hydraulic power steering pump should be removed, disassembled, and inspected after one year of operation even though there is no noticeable decrease in operating efficiency. Without actually inspecting the internal parts of the pump, it is difficult to determine from the operating test, exactly when an overhaul should be made to the gear type pump. A gear type pump may maintain its maximum operating efficiency to a point where the bearings start to fail. Remove the pump from the loader as follows:

1. Disconnect the pressure line from the pump. Loosen the suction line clamp and remove the suction line from the pump. Cap both hoses securely.

2. Remove the capscrews, flatwashers, lockwashers and hexnuts that secure the pump

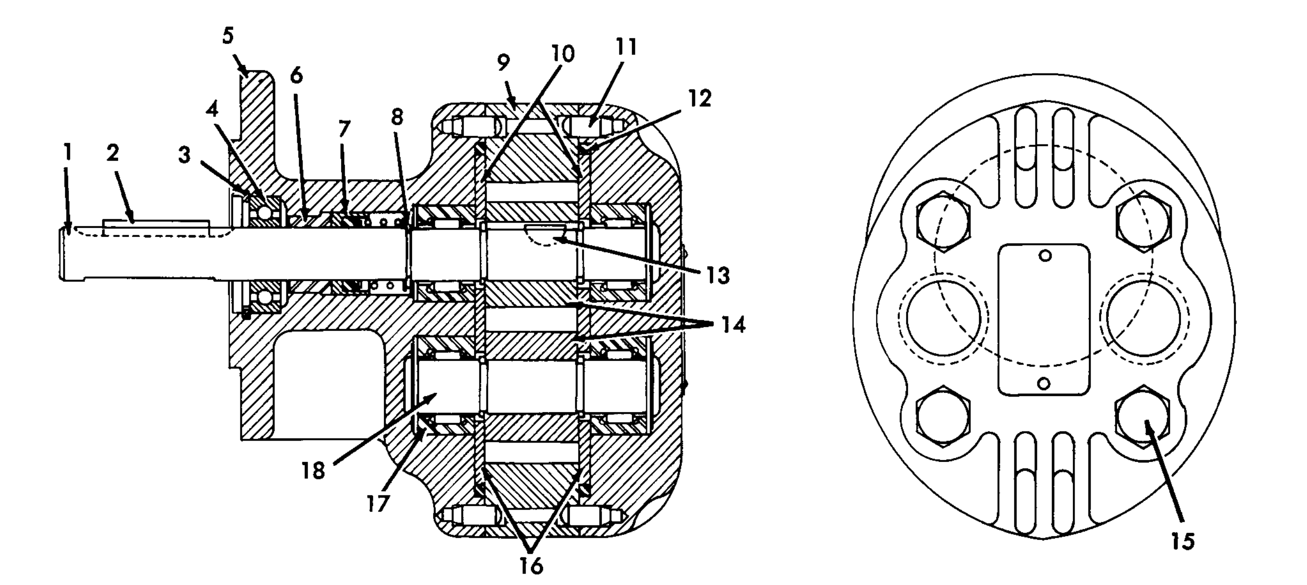

Fig. 3 — Power Steering Pump — Cross Section

1. Drive Shaft
2. Pulley Key
3. Snap Ring
4. Outboard Bearing
5. Adapter
6. Seal Seat
7. Seal Assembly
8. Snap Ring
9. Housing
10. Wear Plates
11. Dowel Pin
12. O-ring
13. Woodruff Key
14. Pump Gears
15. Capscrew
16. Gaskets (Shims)
17. Bearing
18. Driven Shaft

to the rear, engine support bracket and remove the pump.

3. Loosen the pump pulley set screw and slide the pulley off the pump shaft. Remove the pulley key from the shaft.

4. Remove the capscrews, lockwashers, and hexnuts that secure the pump mounting bracket to the pump and remove the mounting bracket.

E. Disassembly

1. Clean the outside of the pump with an oil solvent, fuel oil or gasoline, and dry thoroughly. With file or oil stone remove sharp edges or burrs from the shaft splines, drill point, keyway or the shaft end before proceeding with disassembly. Mark the sections of the pump with a prick punch for proper reassembly.

2. PUMP

Remove the four cover capscrews. Remove the cover which may come off separately or with the housing. To prevent possibility of leakage, avoid scoring or nicking the machine surfaces of the pump section. DO NOT USE A SCREW DRIVER to pry the sections apart. Tap with a fibre hammer, if necessary to loosen.

Note position of relief pocket and drilled holes in the wear plate for proper reassembly. Mark the drive and driven gears with an India stone, Fig. 4 for proper reassembly. Note the location and number of gaskets when disassembling.

Remove driven shaft and gear. By pressing on the keyed end of the shaft, press out the bearing. Remove the seal assembly and the snap ring, freeing the shaft and the wear plate. Before removing the outboard ball bearing, be sure to coat the end of the shaft with white lead and remove any burrs before pressing it out to prevent the bearing from being scored. Cover the ends of the dowel pins and remove the pins from adapter with pliers or a lever jaw wrench.

3. ROLLER BEARINGS

CAUTION: *Replace roller or ball bearings only*

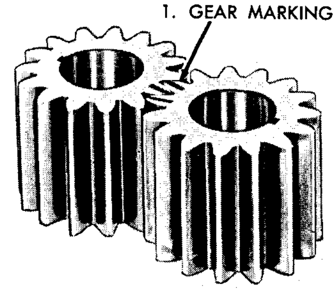

Fig. 4 — Marking the Pump Gears

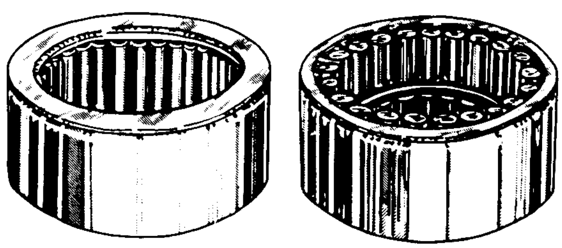

Fig. 5 — Pump Bearing Types

if necessary, and then only with the SAME MAKE AND TYPE as originally installed.

TYPE A ROLLER BEARINGS — Fig. 5

Check the bearings for freeness of the rollers and pitted, broken or excessively worn rollers. Replace the bearing if it is possible to insert a .020" feeler gauge between rollers.

More gap indicates the rollers are worn excessively. Remove roller bearings by starting them with tool shown in Fig. 6. Insert the tool under the bearing and into the cored hole between the bearing bores, Fig. 7. Complete the removal of the bearing using the puller Fig. 8, and tap out with heavy bar, Fig. 10.

TYPE B ROLLER BEARINGS — Fig. 5

Remove the retaining ring and all the rollers. Start the bearing shell out with the tool, Fig. 6. Complete removal with puller, Fig. 8. Tap out with heavy bar as in Fig. 10.

4. BALL BEARINGS (Outboard Bearing)

   a. Remove the outboard bearing retaining snap ring with a ring pliers.

   b. Reach down through the drive shaft bear-

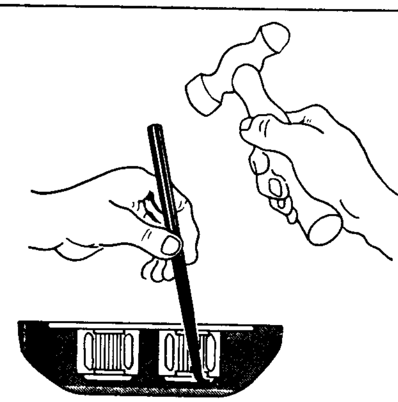

Fig. 7 — First Step of Bearing Removal

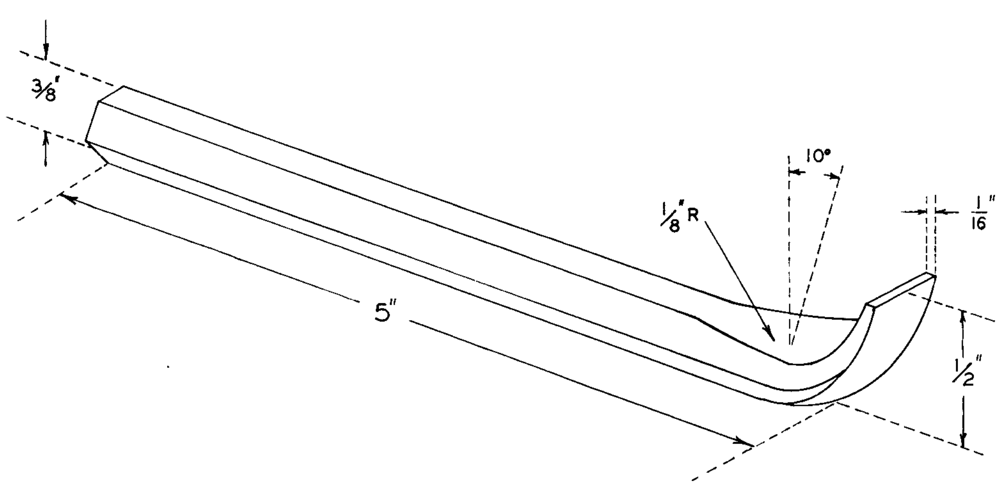

Fig. 6 — Starter Tool for Bearing Removal

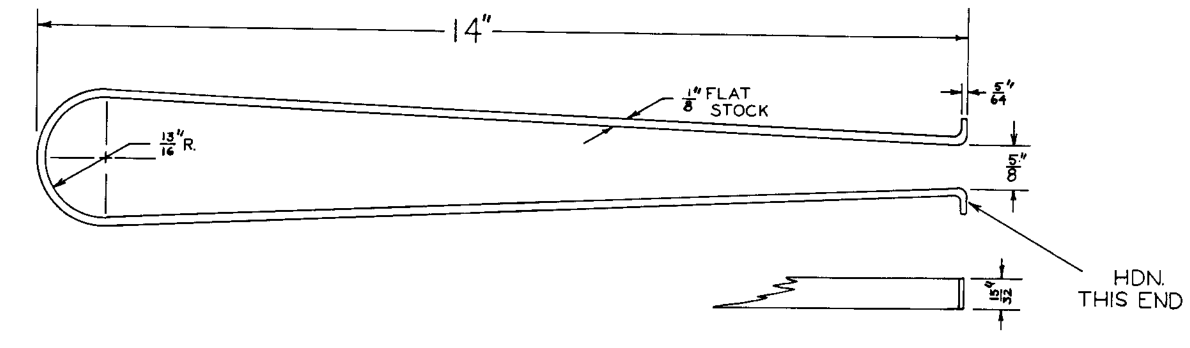

Fig. 8 — Bearing Removal Tool

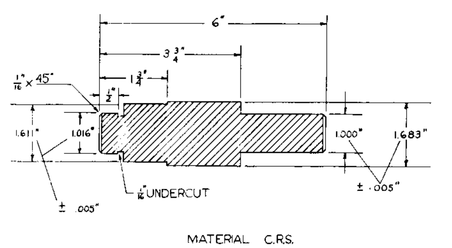

Fig. 9 — Seal Seat Driver

ing bore with a brass drift and tap out the outboard bearing. Tap opposite sides alternately.

5. SEAL SEAT

The seal seat should not be removed unless the seal face is excessively worn or damaged. To remove the seal seat, invert the adapter and drive out the seat with a wooden block. If a new seat is required, press into adapter, using seal seat driver, Fig. 9.

6. GEARS

If the gears or shafts must be replaced, remove snap rings and press off gears on an arbor press. To reassemble, coat the gear bore with white lead, and after installing one snap ring, press the gear onto shaft until the gear covers approximately one quarter of the key slot. Hold key in place and press the gear onto the shaft until it contacts the snap ring. Install the second snap ring. The same procedure is used for driven shaft except no key is required.

CAUTION: *To prevent bending of drive shaft, push drive or keyed end of shaft through the gear and press on straight end of the shaft.*

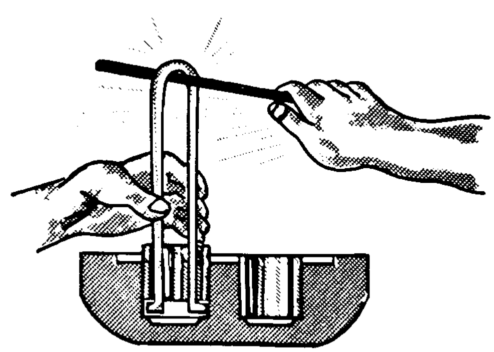

Fig. 10 — Second Step of Bearing Removal

F. Inspection of Parts

1. Wash all parts in oil solvent, fuel oil or gasoline. Dry them thoroughly with clean cloths or dry compressed air.

2. Inspect all parts of the pump.

3. With a small piece of flat file remove nicks and burrs from around the bearing bores and drilled holes of the adapter and cover, Fig. 11. Clean up any burrs and nicks on the machined mating surfaces of housing, cover and adapter, Fig. 11 with India stone and a fine mill file. Rewash before assembly.

4. SHAFTS

Inspect at the bearing points and seal areas for rough surfaces and excessive wear.

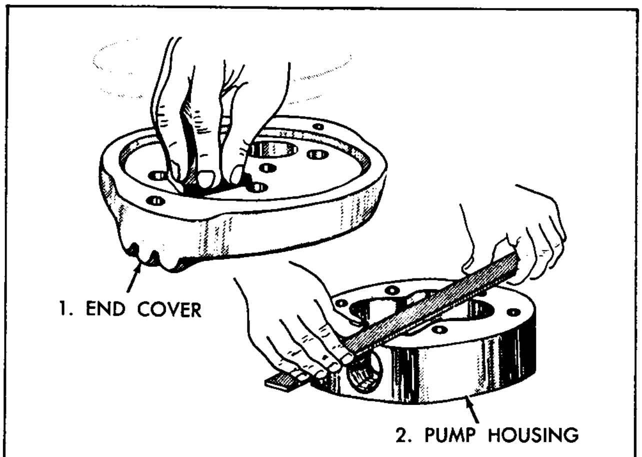

Fig. 11 — Removing Burrs and Nicks

5. GEARS

   Inspect the edge of the teeth and gear face for scoring. Stone the face of the gears, Fig. 12, and the edge of the teeth before reassembly.

6. BEARINGS

   Refer to Par. E-3.

7. GASKETS

   Always replace the housing gaskets if they are damaged. Replace all seal rings.

8. WEAR PLATES

   Replace them if they are found to be scored or excessively worn.

   NOTE: *Do not turn a wear plate as the counter-bored relief pocket is on gear side only. If the wear plate is steel backed, the bronze side should be next to the gears. Even though only a slight wear is shown on the gear pattern, check for an erosion path in vicinity of the relief pocket, see Fig. 13 and replace the wear plate if it is in evidence.*

9. Check for proper seating of the wear plate in the adapter or cover, Fig. 14. A rocking motion indicates either a burr on the face of the adapter or the cover. (Par. F-3).

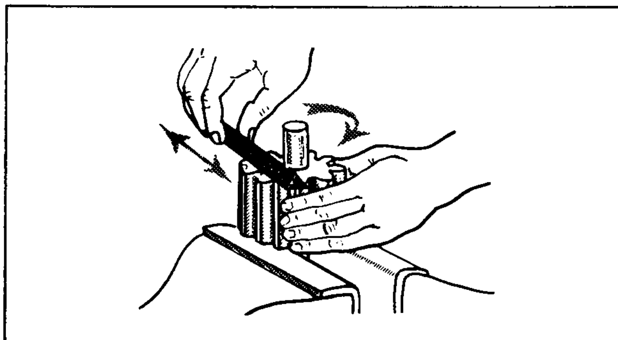
Fig. 12 — Stoning Gear Face

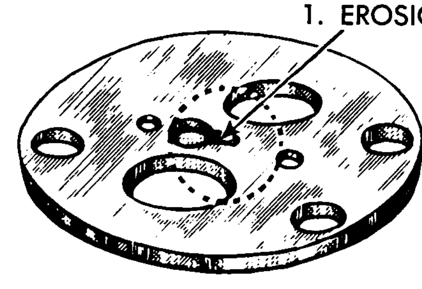

Fig. 13 — Erosion Path on a Wear Plate

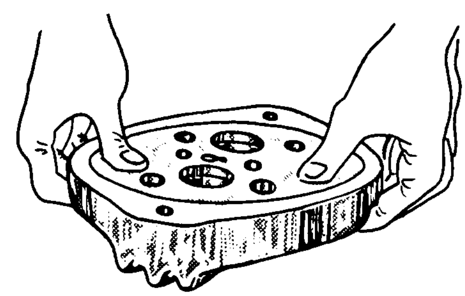
Fig. 14 — Checking Seating of Wear Plate

RECOMMENDED WEAR TOLERANCES

a. Discard any housing whose gear bores measure greater than 3.259 through the dowel pin hole centerline.

b. Replace both gears if the differential between the housing width and the gears, with no gaskets in the pump, is in excess of .0035.

c. Assembled, the total end clearance between the gear faces and the housing width should be .0025 minimum and .0035 maximum.

d. Replace the shaft if the wear at the roller patterns exceeds .001 from that of the major diameter.

e. Replace the wear plates that have severe score marks or show erosion marks in the vicinity of the counterbored relief pocket.

f. If the pump shafts have been replaced because wear at the roller patterns exceeds .001, also replace the bearings.

g. Replacement of the Seal Assembly and the Seat is recommended.

G. Assembly

1. TYPE A ROLLER BEARINGS — Fig. 5

Lubricate the rollers with light grease. Coat the I.D. of the bearing bore with white lead. Press the bearing assembly into the bearing bore of the adapter and cover with the tool in Fig. 15.

TYPE B ROLLER BEARINGS — Fig. 5

Coat the rollers with light grease, the bearing bore with white lead and press the bearing into the bearing bore of the adapter and cover.

2. FINAL HOUSING AND COVER ASSEMBLY

a. Install the dowel pins in the adapter.

b. To assemble the wear plate, bearing and seal assembly, use the adapter end bolted to the bench plate as a support, Fig. 16. Insert the drive shaft in the adapter end with the long end UP in the side that has a bearing driven in. Put the wear plate over the drive shaft as in Fig. 16-A, making sure the counterbored relief pocket is FACING the gear.

Place the bearing on the drive shaft. Now assemble the oil seal parts in the following order: Back up washer, coil spring, synthetic rubber ring, (lubricate this ring with light grease or oil) and the seal cup with lapped surface UP. Make sure the rubber ring is seated in the cup. *Make certain the rubber ring is not cut when placing it on the shaft and when passing it over the key slot or spline.* Press the entire seat assembly down against the spring and compress it. When released, the spring should return the cup to the position held before compressing. If it sticks on the shaft, replace the seal assembly.

c. Wipe off any foreign matter from the seal seat. Lubricate the lapped surfaces of the seal seat and seal cup with light oil. Turn the entire drive shaft assembly over and

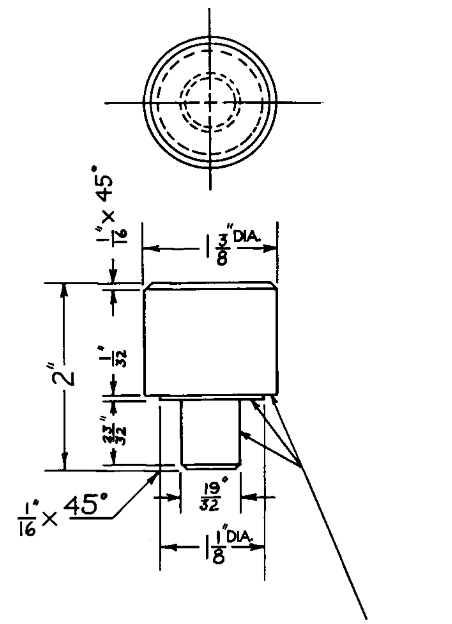

Fig. 15 — Bearing Tool

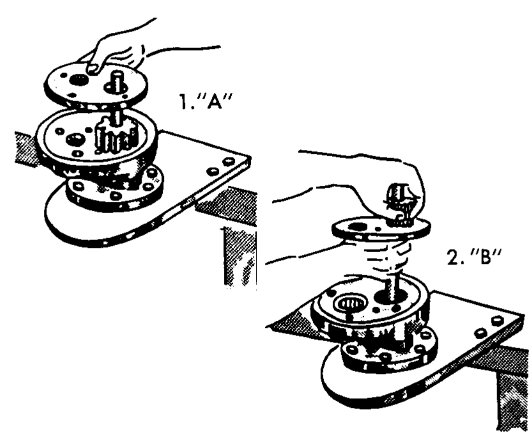

Fig. 16 — Assembling Pump

install it in the adapter end as shown in Fig. 16-B. Use a composition hammer to drive the entire assembly down, driving the bearing into the bearing bore. Place the O-ring seal around the wear plate. Lubricate with light oil the section of the wear plate that comes into contact with the gear face.

d. With an India stone polish out any scratches on drive shaft that were made when shaft was driven out through the outboard bearing.

e. Clearance between the gear face and the wear plate is provided by the plastic shim gasket between housing, adapter and cover. With a micrometer, Fig. 17, measure the housing width and the width of the gears.

The following chart indicates the color, number and location of the shim gaskets to be used to provide the proper clearance between the gear face and the wear plate.

CLEARANCE CHART

Gear Width Greater (+) or less (—) than Housing Width	Add Gasket size as indicated on:	
	Adapter Side	Cover Side
+ .002	.002	.002
+ .001	.001	.002
.001	.001	.001
— .001	.....	.001
— .002	.....	.....

Color Code: .001 — Amber .002 — Red .0015 — Purple
Note: Only Plastic Shim Gaskets are used on 1500 Series Pumps.

If the gears are so worn that the housing width becomes more than .0035 greater than the gear width, both of the gears should be replaced.

f. Insert the driven assembled gear and shaft into the adapter end. Line up the marks previously made on the gear faces if the original gears are reinstalled. Fig. 4. If new gears are used keep the keyways 180° apart. Lubricate face of gears with light oil.

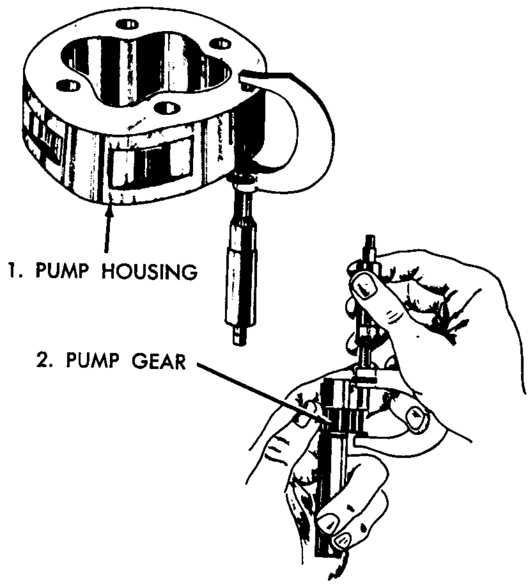

Fig. 17 — Measuring Pump Housing and Gears

g. Place the proper gasket as selected by the chart, over the gears and on the face of the wear plate. If it is not practical to use micrometers to measure the gears and housing use a gasket that measures .002 thickness.

h. Line up the punch marks and place the pump housing over the gears and the gasket. Tap it down with a fibre hammer.

i. Select another gasket from the chart or if no measurement (2e) is available use a gasket of .002 thickness. Place the gasket on the housing face. Lubricate the gear face with clean oil.

j. After selecting the proper gasket from the chart, and putting it in place on the housing face, install the wear plate, making sure that the $\frac{1}{16}''$ deep counterbored relief pocket is in its original position facing the gears and is rotated 180° from the pocket of the adapter wear plate. Place the seal ring around the wear plate and position it on the wear plate with an equal air gap around each shaft. Put the cover in place and tap it down, being careful not to pinch the O-ring seal.

k. Install the dowel pins in the cover. Line up the punch marks previously made on the housing and cover and put the cover in place. Tap the cover down on the dowel pins with a fibre hammer until the cover bottoms on the housing. Be careful not to pinch the O-ring seal around the wear plate.

I. Install the four capscrews. Be sure that the proper washer is in place before installing. If for any reason the replacement of the capscrews is required, always use the same type as originally furnished. Tighten gradually opposite capscrews, using torque wrench set at 60 ft. pounds torque. After assembly turn the shaft with a 6" Crescent wrench. If the shaft will turn with a slight drag and not too freely, the proper clearances are assured between the gears and the wear plate. If the shaft is too tight or too free add or remove as many (.001) or (.002) gaskets as necessary for the proper clearance.

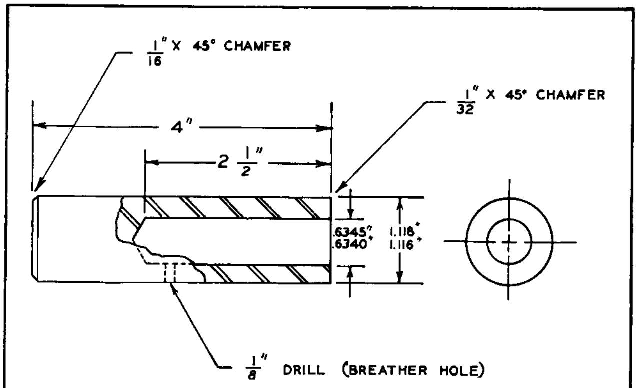

Fig. 18 — Outboard Bearing Driver

4. ASSEMBLY OF OUTBOARD BEARINGS

a. Coat the I.D. of the bearing bore with white lead.

b. Lubricate the bearings with light grease.

c. Drive the outboard bearing down over the drive shaft until it bottoms with the tool in (Fig. 18).

d. Insert the snap ring in bearing bore.

e. Remove the grease plug and repack the outboard bearing bore with a good quality bearing grease. Use the fingers for repacking. A grease gun will force grease into the oil seal and cause it to leak.

H. Pump Break-In

1. If a shop test stand is available on which the pump can be mounted and operated against full pressure and at maximum speed, the following procedure is recommended for break-in and test:

   a. Start the pump and run it for 2 min. at zero pressure. Be sure that the test stand reservoir is filled and that all the inlet and outlet lines are open.

   b. By restricting the pump discharge line with a needle or globe valve, raise the discharge pressure to 500 PSI for 10 seconds and lower it to zero pressure for 10 seconds. Continue this procedure for five minutes. CAUTION: *Do not apply pressure for more than 10 second intervals.*

   c. Stop the pump and rotate the drive shaft coupling by hand to determine if the drive shaft is free. If it cannot be turned freely, remove and rebuild the pump.

   d. Resume the test and apply 1000 PSI for 10 seconds intermittently for five minutes. CAUTION: *Do not apply pressure for more than 10 second intervals.*

   e. Stop the pump and check the freeness as in (c). Check for possible leaks at the mating surfaces of the adapter, housing and cover and around the seal assembly and the four assembly capscrews.

   f. Be sure the oil level is up to normal in oil reservoir. Start the pump and run the pressure to 1000 PSI and run a flow test by whatever means is available on the test stand.

2. If a shop test stand is not available, the following alternate break-in and test procedure may be used:

a. Mount the repaired pump in place on the equipment and run the pump at one quarter engine speed for 5 minutes at zero pressure.

b. Operate the control valve until the relief pressure is obtained, then hold in this position for 10 seconds and release for 10 seconds. Follow this procedure for 10 minutes.

c. Increase the engine speed to one-half throttle, and repeat step (b) for ten minutes.

d. Increase the engine speed to full throttle, and repeat step (b) for 5 minutes.

e. Idle the engine and check the pump for possible leaks at the mating surfaces of housing, adapter end cover, shaft seal area, and any of the capscrews.

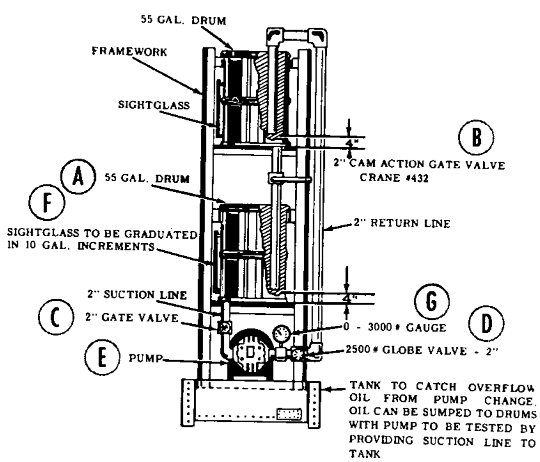

Fig. 19 — Suggested Pump Test Rack

I. Pump Test Procedure

1. Fill the bottom drum (A) with 50 gals. of oil.

2. Be sure the cam action valve (B) is open.

3. Be sure the 2" gate valve (C) is open.

4. Be sure the 2" globe valve (D) is open.

5. Start the pump (E) and run in for 2 minutes at 0 PSI. NOTE: *Check the oil level in the drum (A) during the run in period for an oil level drop. If the oil level drops in the sight glass (F), stop the pump until the oil level is above the sight glass and continue.*

6. Apply 500 PSI intermittently (by closing globe valve (D) for 2 to 5 min. CAUTION: *Do not apply pressure for more than 10 second intervals.*

7. Stop the pump (E) and check for pump drive shaft freeness by turning the drive shaft coupling by hand. If free, continue the test, if not, remove and rebuild the pump.

8. Start the pump (E) and apply 1000 PSI intermittent pressure for 2 to 5 minutes. CAUTION: *Do not apply pressure for more than 10 second intervals.*

9. Stop the pump and check the pump for drive shaft freeness as outlined in Step 7.

10. Be sure that the oil level is above the sight glass (F). Start the pump. Apply pressure until 1000 PSI is recorded on gauge (G).

11. Close the cam action valve (B) and observe the sight glass (F). Start a stop watch on the uppermost sight glass (F) graduation and stop the stop watch when the 10 gal. graduation on the sight glass is reached. Immediately open the cam action valve (B).

12. Stop the pump and close the gate valve (C) and close the globe valve (D) and remove the pump.

13. Figure the G.P.M. of the pump using the following formula: $60/T \times 10 =$ __ G.P.M. where "T" is the time in seconds for the 10 gals. removed from the drum. Example: the stop watch shows 12 seconds of elapsed time for 10 gals. of oil removed from the drum, therefore $60/12 \times 10 = 50$ G.P.M.

3. CONTROL VALVE AND STEERING GEAR

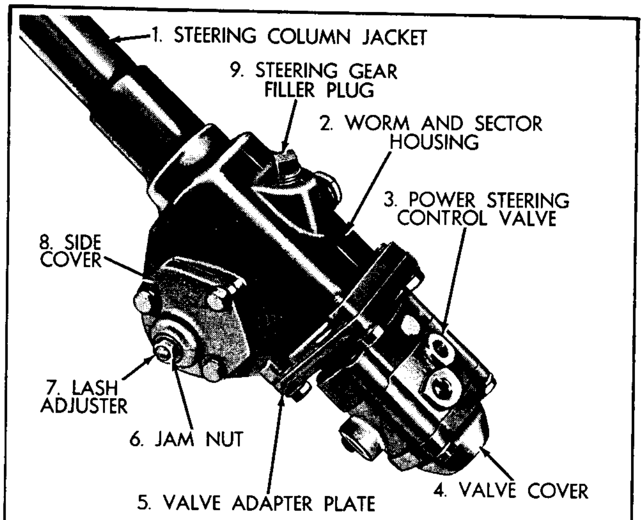

Fig. 20 — Power Steering Gear

A. General Description

This steering gear is a recirculating ball bearing, worm, and nut type. A spool type control valve is mounted concentrically on the worm shaft and bolted to the lower end of the steering gear housing. The worm is mounted in needle bearings which confine the worm radially, but allow endwise movement of the shaft. Ball thrust bearings are located at either end of the valve. The worm shoulder is pulled against the upper bearing, valve spool, and lower bearing by means of a nut. The bearing on each side of the spool can move into counterbores in the end faces of the valve housing, permitting a slight axial movement of the worm, valve spool and steering shaft. The unit is so designed that when the spool is at the midpoint of the allowable axial play, the valve is in the neutral position.

The valve is held in neutral position by 10 plungers and 5 springs in the valve housing which bear against the thrust bearing and at the same time against the adapter and valve cover.

B. Operation

In operation, oil is delivered from the pump to the control valve through the hydraulic lines. When the steering wheel is turned, the worm will tend to move up or down depending on the direction the wheel is being turned, because the position of the ball nut engaged in the sector shaft is fixed due to the load on the pitman arm. This axial movement of the worm and shaft assembly is transmitted to the control valve and movement of the valve directs oil pressure to the appropriate end of the power cylinders. The movement of the valve within the valve housing is limited by the thrust bearing engaging the valve housing itself which acts as a positive stop.

When the operator stops the steering wheel at the desired position, the thrust is removed from the steering shaft and the action of the valve centering springs returns the valve to the neutral position.

When the loader wheels are in the straight ahead position, the control valve spool is held in the neutral position by the centering springs. In this position, oil from the pump flows through the valve and returns to the pump through the return port. The pump output will simply be recirculated in the system without doing any work.

When the steering wheel is turned to the left, a thrust will be developed between the sector gear shaft and the ball nut. Thrust increases as the effort at the steering wheel increases. As it becomes more difficult to move the ball nut, it reaches a point where the axial force exerted by the worm overcomes the centering springs in the valve. As a result the worm and valve spool shift, directing the flow of oil to the related side of the steering cylinders, thereby adding hydraulic force to the steering wheels and moving them in the desired direction. Oil from the non-pressurized side of the cylinders is directed back through the valve body and routed to the hydraulic tank.

The system operates in the same manner for a right turn except that the worm and spool move in the opposite direction.

C. Service

1. Removal

a. Remove the side plates and both floor plates from the operator's compartment (See Sec. XVII).

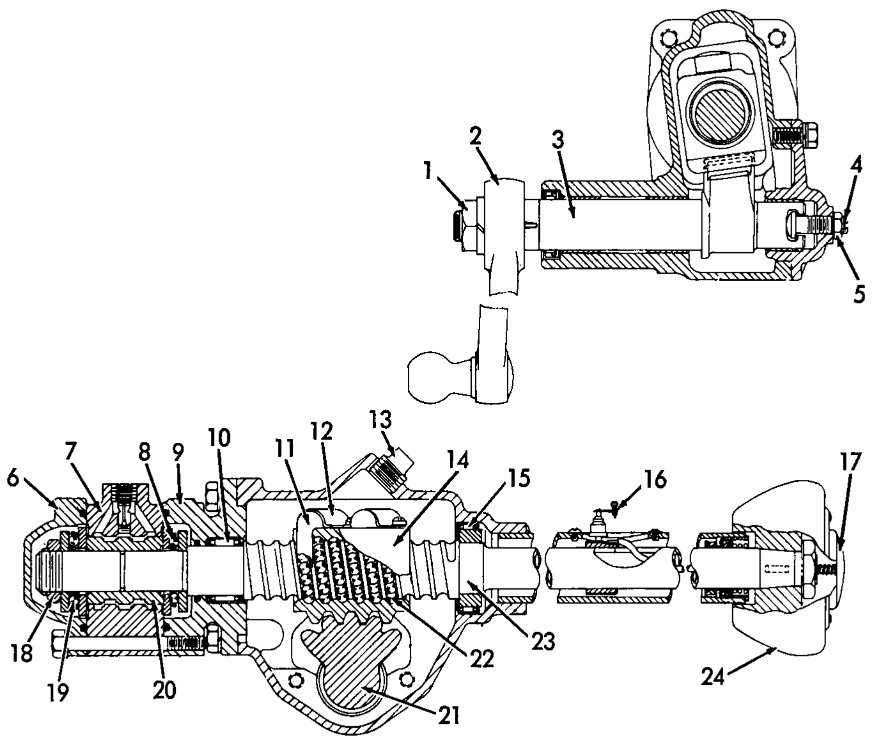

Fig. 21 — Power Steering Gear — Cross Section

1. "Pitman" Arm Retaining Hex-Nut
2. "Pitman" Arm
3. "Pitman" Arm Shaft
4. Lash Adjustor
5. Lash Adjustor Jam Nut
6. Valve Cover
7. Valve Body
8. Upper Valve Bearing
9. Valve Adapter Plate
10. Lower Worm Needle Bearing
11. Ball Return Guide
12. Ball Return Guide Clamp
13. Filler Plug
14. Ball Nut
15. Upper Worm Needle Bearing
16. Horn Wire Connector
17. Horn Button
18. Thrust Adjustor Hexnut
19. Lower Valve Bearing
20. Valve Spool
21. Sector Gear
22. Balls (106)
23. Worm and Worm Shaft
24 Steering Wheel Hub

b. Remove the hexnut and lockwasher that secures the "Pitman" arm to the sector shaft. Mark the "Pitman" arm and sector shaft as to their relative positions. Using a suitable puller, pull the "Pitman" arm from the sector shaft.

c. Thoroughly clean the four hydraulic hoses, fittings and the surrounding area at the power steering control valve. Mark each hose and its corresponding fitting to eliminate confusion when installing.

d. Remove the four hydraulic hoses from the control valve. As each hose is removed cap the open end tightly. Cap each elbow adapter on the control valve also. This will prevent the entrance of dirt into the lines and minimize fluid loss.

e. Disconnect the horn wire. Remove the clamps that secure the wiring loom to the steering column jacket. Remove the hexnuts, lockwashers, and "U" bolt assembly that secures the lower end of the steering gear assembly to the main frame.

f. Remove the two hexnuts, lockwashers, the shims and the clamp that hold the upper end of the steering gear assembly to the

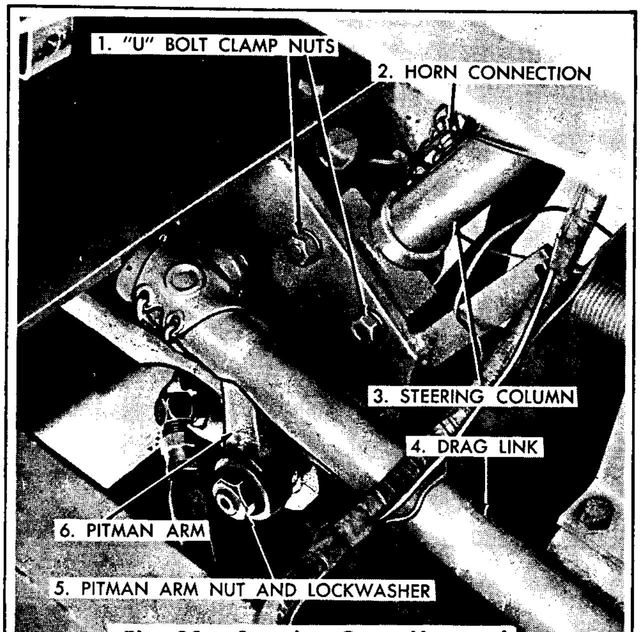

Fig. 22 — Steering Gear Mounted

instrument panel. CAUTION: *Do not lose the shims. An incorrect amount of shims installed at this point can result in a steering bind.*

g. Slide the steering gear assembly to the right to disengage the sector shaft mounting collar in the main frame and remove the steering gear assembly.

2. Disassembly of Valve from Gear

a. Scribe a mark on the valve cover, valve body and adapter to insure the proper positioning of parts on reassembly.

b. Remove the 3 bolts and lockwashers that secure the valve cover to the valve body. Remove the valve cover.

c. The control valve worm bearing nut is staked in a groove provided in the worm shaft. Cut out the staked area being careful not to damage the threads on the shaft. Remove and discard the nut.

d. Remove the small bearing race, the bearing and the large bearing race. Keep these parts together as an assembly so that the same three pieces will be installed together on reassembly.

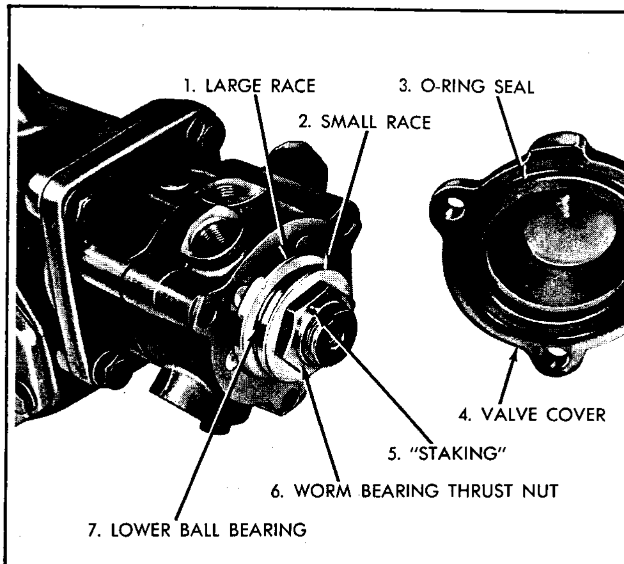

Fig. 23 — Steering Gear Valve Cover Removed

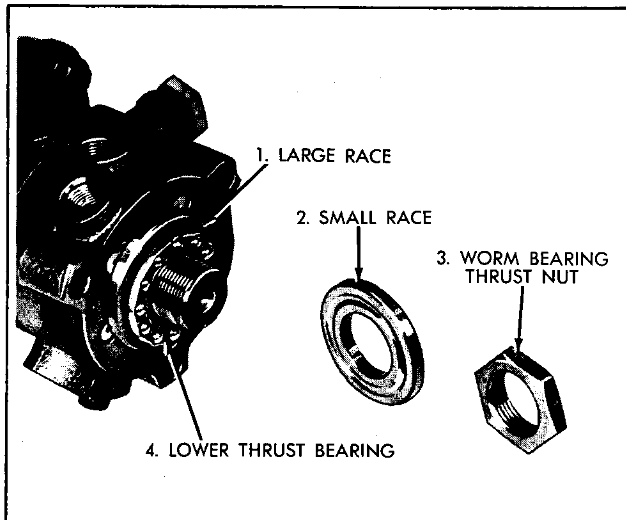

Fig. 24 — Steering Gear Lower Bearing Assembly

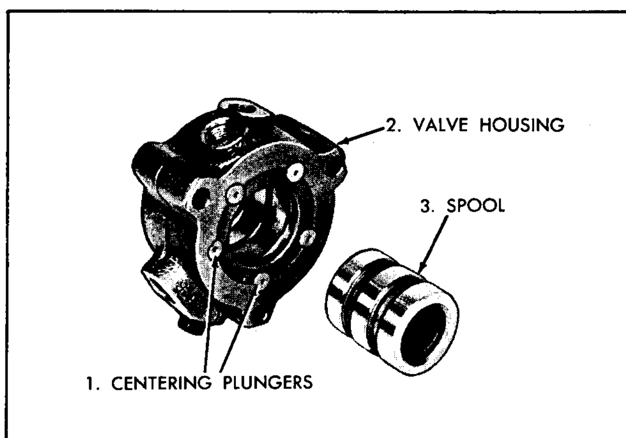

Fig. 25 — Control Valve

e. Remove the valve housing, spool and plungers as an assembly being careful not to drop any parts. Place the valve on a clean piece of paper to protect them from foreign material.

f. Remove the upper large bearing race, bearing and small bearing race, keeping these parts together as an assembly.

g. Remove the four bolts and lockwashers that secure the adapter to the steering gear housing. Remove the adapter from the steering shaft.

3. Valve Disassembly and Inspection

a. Remove the plungers and springs from their bores.

b. Remove the spool from the valve housing, noting which end of the spool has a groove or counterbore on the I.D.

c. Inspect the spool and valve housing for signs of damage. If these parts are damaged, the valve body and spool must be replaced as an assembly.

d. Inspect the centering springs for damage or distortion. Replace if necessary.

e. Inspect the plungers for nicks or scratches. Replace if necessary.

f. Inspect the thrust bearings and races for smooth turning. Replace if the turning is rough.

4. Valve Reassembly

a. Coat the plungers and spool with Lubriplate.

b. Install the spool in the valve body with the groove or counterbore at the same end in relation to the valve body and was noted upon removal. DO NOT FORCE THE SPOOL INTO THE VALVE BODY. When the spool is properly aligned it will drop into place. Forcing the spool will damage both the spool and the valve bore.

c. Install a centering spring in each bore.

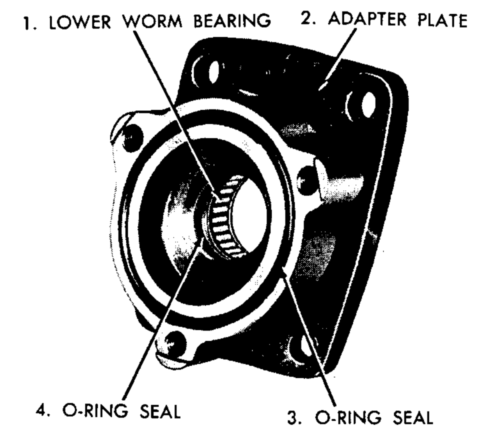

Fig. 26 — Adapter

d. Install a plunger at each end of the centering springs.

5. Seal Inspection

a. Remove O-ring seals from the cover and adapter. Replace with new seals.

b. Inspect the seal in the adapter. Remove and discard it and replace with new seal if necessary.

c. Inspect the needle bearing in the adapter. The rollers should be smooth, polished and free to turn in their retainer. If the bearing is worn, remove and replace. Press the new bearing in place with the trade marked side out. The bearing should be pressed in below the adapter face BUT NOT BOTTOMED in the bore.

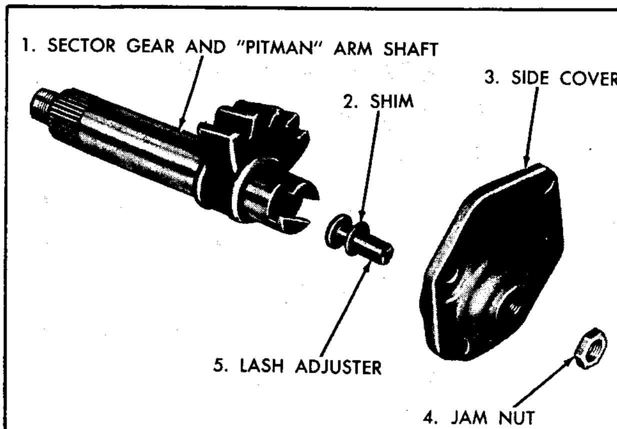

Fig. 27 — Sector Gear and Shaft Assembly

6. Steering Gear Disassembly

a. Secure the gear in a vise.

b. Remove the bolts which attach the side cover to the housing. Pry the side cover away from the housing. Remove the side cover by turning the lash adjuster screw clockwise thru the side cover.

c. Turn the steering shaft until the sector gear on the pitman shaft will pass through the housing opening, then remove the pitman shaft.

d. Carefully withdraw the shaft and ball nut as an assembly from the housing and column assembly.

CAUTION: *If the shaft with the ball nut is held in a vertical position, the ball nut will travel by its own weight to the end of the shaft. If the ball nut sharply strikes either end of the worm, the ball guides will be damaged. If the worm ball nut does not require disassembly, tape each end of the shaft worm to prevent the ball nut from rotating to either end.*

e. Try the action of the ball nut on the shaft worm. The ball nut must rotate smoothly with no evidence of binding or roughness. If there is evidence of roughness or damage, disassemble in the following manner:

Remove the screws which attach the ball guide clamp to the ball nut. Remove the clamp. Pull the ball guides out of the ball nut, one pair at a time. Remove the balls from the guides by separating the guides.

Turn the ball nut upside down, and rotate the shaft back and forth until all of the balls (106) have dropped out of the ball nut into a clean pan. With the balls removed, pull the ball nut endwise from the shaft worm.

f. The removal of the steering jacket upper bearing assembly, and the replacement of the housing bearing and bushings can be deferred until after inspection of the parts.

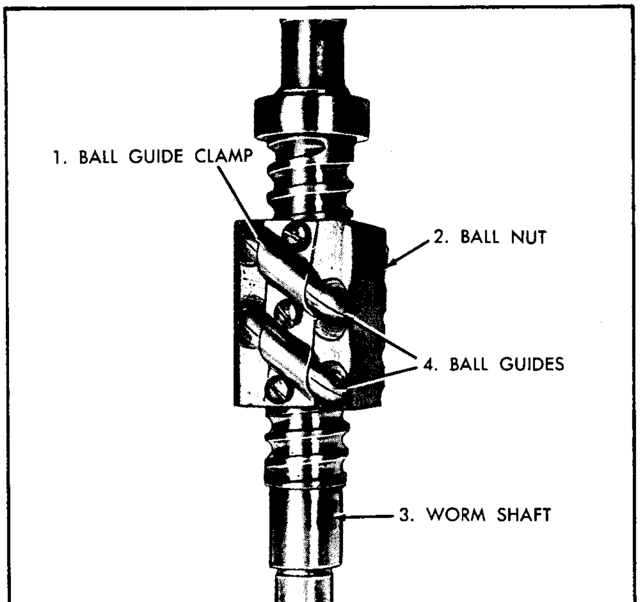

Fig. 28 — Ball Nut

7. Inspecting Steering Gear

a. Clean all parts in solvent before inspecting.

b. Examine the steering gear housing for cracks or stripped threads in the cover mounting surfaces. If the column is damaged, replace the housing and column assembly.

c. Check the clearance between the pitman shaft and the bushing in the housing. If the bushing is worn, replace it as later described under "Pitman Shaft Bushing Replacement," item 8 this section.

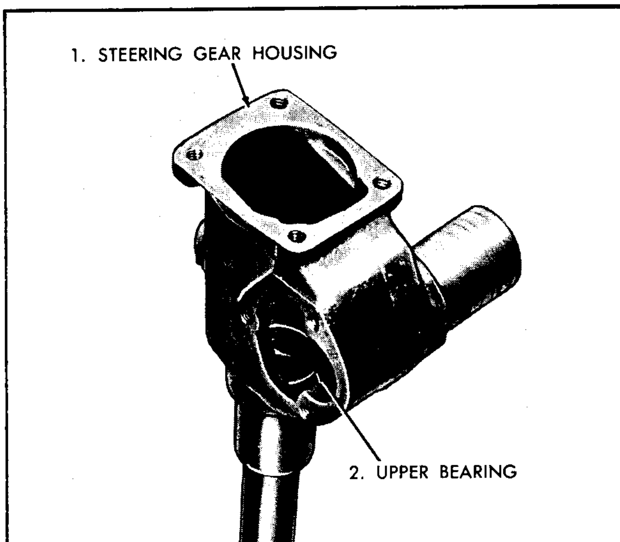

Fig. 29 — Gear Housing

d. Check the condition of the upper needle bearing in the housing. If the rollers are damaged or worn, replace. When installing, be sure the trade marked side of the retainer is against the tool.

e. Check the condition of the steering column jacket upper bearing assembly and spring. Replace if parts are damaged.

f. Examine the side cover for cracks and damage. Check the clearance between the pitman shaft and the side cover bushing. If the bushing is scored, damaged, or excessively worn, it is recommended that the side cover and bushing be replaced as an assembly.

g. Inspect the pitman shaft for damaged serration or threads. Examine the sector teeth for signs of scuffing or scoring. Check the O.D. of the shaft. If excessive wear is shown at any of these points, replace the shaft. The grease seal should be removed and replaced if cracked or damaged.

h. Inspect the bearing areas and the thread groove on the worm. If worn or galled, replace the steering shaft and the ball nut assembly complete.

i. Examine the worm ball nut rack teeth for scuffing and scoring. Check the holes and passages for obstructions. Check all the worm balls for flat spots, checking, wear or damage. Balls should be the same size within 0.0001 inch.

j. Examine the ball guides for distortion and bent pick up fingers. Place two halves of a guide together and try the action of the balls.

8. Pitman Shaft Bushing Replacement

a. To replace the pitman shaft bushing in the housing, drive the bushing from the housing. An improvised tool can be made if desired.

b. Drive the bushing into the housing. Again an improvised tool may be made. A tool can also be made to install the housing seal at final assembly.

9. Assembling Valve and Gear

One of the most important phases of assembling steering gear components is cleanliness. All parts must be kept clean. Any bits of abrasive material which may get inside of the housing during assembly will quickly damage the mechanism. Grease and oil used at assembly must be free from dirt. Prelubricate all bearings and moving parts with Lubriplate.

a. Place the steering shaft assembly flat on a bench. Place the ball nut over the worm with the ball return guide holes in the ball nut in the upper surface. Align the groove in the worm and ball nut by sight.

b. Count one-half of the total quantity of balls into a clean container.

c. Drop the balls into one of the ball return guide holes in the upper circuit. Gradually turn the worm away from the hole while inserting the balls. Continue until the circuit is filled from the bottom of one hole to the bottom of the other, or until stopped by reaching the end of the worm.

d. In the event the balls are stopped by reaching the end of the worm, hold down the balls already inserted with a rod or punch. Turn the shaft in the reverse direction a few turns. Filling of the circuit can then be continued. It may be necessary to work the shaft back and forth, holding the balls down, first in one hole then in the other. This will close up the spaces between the balls, filling the circuit completely.

e. Lay one-half of the ball guide with the groove up on a bench. Place the remaining balls selected into the groove of the guide. Close this half. Hold the two halves together, then plug each end with heavy chassis grease to prevent the balls from dropping out.

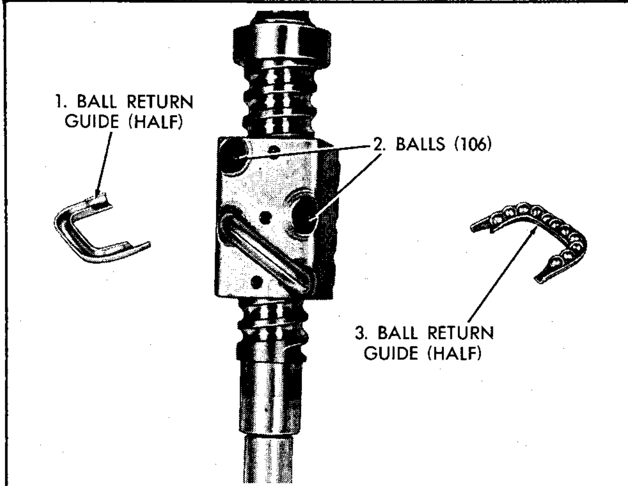

Fig. 30 — Assembling Ball Nut

f. Push the ball return guide completely into the holes in the ball nut. This completes one circuit of balls.

g. Fill the lower circuit in the ball nut in the same manner as described.

h. Install the ball return guide clamp on the ball nut. Tighten the screws securely.

i. Make certain the ball nut and balls are thoroughly lubricated. Test the assembly by rotating the ball nut on the worm. Do not rotate the ball nut to the end of the worm threads. The assembly must move freely. Temporarily tape the shaft at both ends of the ball nut until ready to install the assembly into the steering gear housing.

j. Remove the tape. Grip the worm below and above the ball nut to prevent the nut from running to the extreme ends. Insert the steering shaft assembly through the lower opening in the gear housing and guide the shaft carefully through the upper column bearing.

k. Install the valve adapter, gasket and bolts. Tighten the bolts to 25-30 foot-pounds.

l. Place the upper thrust bearings against the opposite sides of the valve and install on the worm shaft. Be sure to check the following:

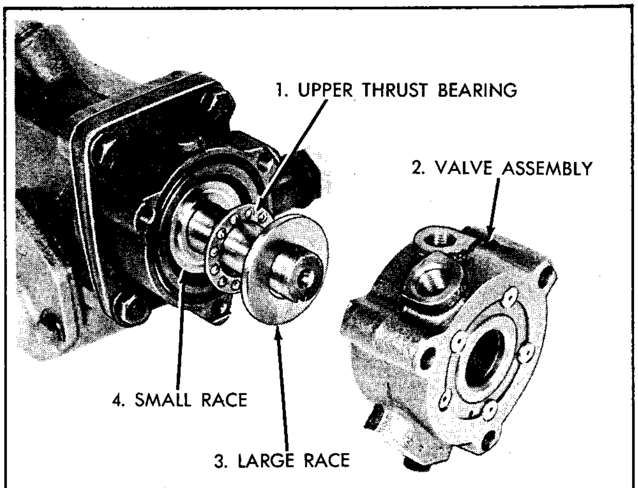

Fig. 31 — Assembling Control to Steering Gear

Thrust bearings have the small races away from the valve faces.

Scribed marks on the valve, the adapter, and the spacer are aligned.

m. Install a new adjuster nut finger tight.

n. Install the valve clamping ring and valve bolts. Tighten the bolts to 15-20 foot-pounds. A valve clamping ring can be made from an end cover by cutting out the middle portion and leaving outer ring only.

o. Hold the handwheel on center and tighten the locknut firmly to remove all end play of the valve spool. Back off the nut and retighten lightly. Release the handwheel, being sure the nut exerts a light pressure against the spring loaded plungers. Tighten nut until a load of ½ lb. to 1 lb. is measured on the rim of an 18″ diameter wheel. Stake the nut in place.

p. Remove the valve clamping ring and install the valve cover and bolts. Tighten the bolts to 15-20 foot-pounds.

10. Pitman Shaft and Side Cover Assembly

a. Place the original lash adjuster screw shim on the lash adjuster screw. Insert the adjuster screw and shim into the slotted end of the pitman shaft.

b. Check the clearance between the adjuster head and the shaft. Clearance must not exceed .002 inch. If the clearance is greater, select a thicker shim. Four sizes are available.

c. With the lash adjuster screw and shim in place in the slotted end of the pitman shaft, start the side cover over the end of the shaft. Insert a screwdriver into the hole in the side cover to engage the slot in the screw.

d. Turn the steering shaft until the ball nut is in the approximate center of the shaft worm. The center tooth of the pitman shaft must enter the center tooth space of the ball nut.

e. With a new side cover gasket in place on the side cover, insert the pitman shaft into the housing, meshing the teeth as described. Turn the lash adjuster to pull the cover over the end of the shaft. Back off the adjuster screw to permit lash between the sector and ball nut.

f. Install the side cover bolts and tighten securely.

g. With the gear on center, adjust the pitman shaft adjuster screw so that the pull on an 18" diameter wheel is 1¼-2 lbs. thru a 20° arc over center. Tighten the lock nut. The total pull on 18" wheel for all adjustments should be 1⅛ to 2 lbs. over center.

h. Install the pitman shaft seal.

i. Position the felt washer, the spring and the steering wheel on the shaft. Tighten the wheel nut securely.

j. Lubricate the gear with approximately 1½ lbs. of G.M.C.-4567-M lubricant or S.A.E. 90 gear lubricant.

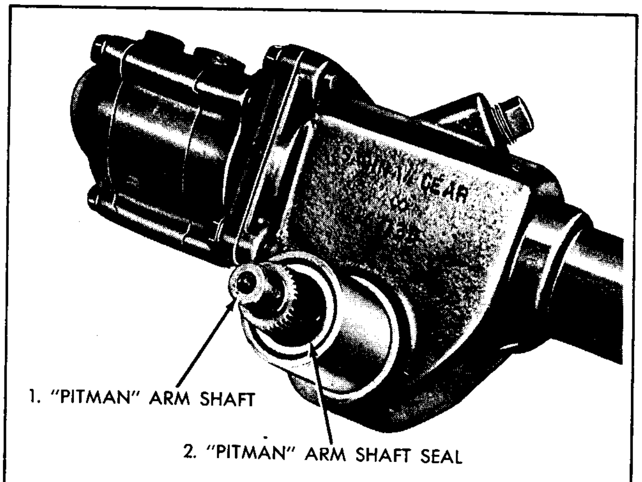

Fig. 32 — Pitman Shaft Seal — Installed

11. Installation

a. Slide the steering gear assembly into the sector shaft mounting collar. Install the "U" bolt on the lower end of the steering gear and snug, but do not tighten the nuts.

b. Install the clamp, shims, lockwashers and nuts on the upper end of the steering gear assembly at the instrument panel and snug, but do not tighten the nuts.

c. Turn the steering wheel slowly from one extreme to the other, counting the number of turns then return the wheel to the midway or "center" position.

d. Install the pitman arm, noting the position of the locating marks, the lockwasher and the hexnut. Tighten the hexnut securely.

e. Tighten the clamp hexnuts at the instrument panel. Tighten the hexnuts on the "U" bolt. Connect the horn wire. Clamp the wiring harness to the steering column jacket.

f. Connect the hydraulic hoses to their respective fittings and tighten securely.

g. Replace the floor plates and side plates on the operator's compartment. (Refer to Section XVII).

4. STEERING CYLINDERS

A. General

The dual double acting power steering cylinders are mounted to the rear of the rear differential housing by heat treated pins. The piston rods are pinned to short extensions on the steering knuckles. All four pins are identical and each is fitted with a lubrication fitting.

The cylinders are connected to the power steering control valve, at the base of the steering gear, by a series of hydraulic lines. As the wheel is turned, oil at pump pressure is directed through the correct lines and to their corresponding area in the cylinders. As one piston rod is extended the other is contracted, turning the wheels in the desired direction. The low pressure oil on the opposite side of the piston is returned to the hydraulic tank after it passes through the discharge side of the control valve.

Each cylinder has a honed cylinder tube with an end casting welded on for the pivot pin anchorage. A rod assembly includes two pistons, piston packing set, piston bearing ring, hex nut, packing gland end plate with wiper seal and the cylinder head assembly. The head assembly includes the rod packings set and the packing gland bushing. The cylinder head is threaded and uses an O-ring in a groove in the head to make its connection with the cylinder oil tight. A spanner is used to loosen or tighten the cylinder head. Two capscrews are used to adjust the rod packing in the head of the cylinder and are locked in place by bendable tabs on the lockwashers. The packing adjustment is controlled by the cylinder end plate. The packing gland end plates should be adjusted so that there is a light film of oil on the piston rods when the unit is in operation.

B. Adjusting Hydraulic Power Steering Cylinders

Adjust the steering cylinders as follows:

1. Disconnect the drag link.
2. With the frame and axle level turn the left wheel to 25° (front end of tire in and rear end of tire out) and adjust the open length of the left steering cylinder and the closed length of the right steering cylinder to fit.
3. Turn the right wheel to 25° and check the cylinder lengths. If the right cylinder is not fully open or the left cylinder is not fully closed adjust the cylinder length to the average required.
4. Turn the wheels straight and center the "Pitman" arm. Adjust the drag link to the correct length and install it.

C. To Replace Worn Rod Packing Rings

1. Start the engine. Turn the steering wheel in a direction that extends the piston rod to its full length, in the cylinder to be worked on. Stop the engine.

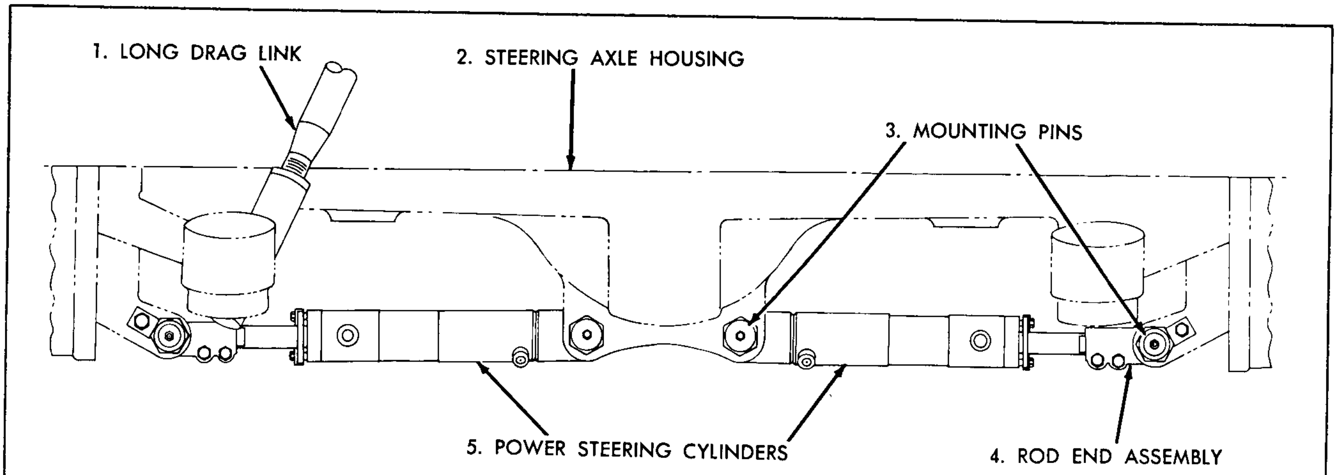

Fig. 33 – Hydraulic Power Steering Cylinders

2. Bend down the tabs on the lockwashers (Fig. 34) and remove the two capscrews that secure the cylinder end plate to the cylinder head. Slide the end plate and bushing forward on the piston rod.

3. Remove the four packing rings and wipe out the packing gland recess. Do not remove the bottom adapter ring.

4. Insert four (4) new packing rings into position in the recess of the cylinder head, being certain that the open end of the "V's" are toward the piston. CAUTION: *When installing the packing rings, stagger the gaps so that no two gaps are adjacent and be certain the edges are not overlapped or doubled back.*

5. Slide the bushing and the end plate back into position and using new lockwashers install the capscrews in the end plate and cylinder head. Tighten the capscrews evenly and alternately, using slight pressure on a short wrench; DO NOT OVERTIGHTEN. Bend up the lockwasher tabs.

D. To Replace Worn Piston Packing Rings

1. Disconnect the hydraulic lines from the cylinder. Cap the open ends of the lines.

2. Remove the locknut plain washer and pin from both ends of the cylinder and remove the cylinder.

3. With a spanner wrench loosen the cylinder head and pull the piston rod assembly from the cylinder tube. Thoroughly wipe out the cylinder tube.

4. Remove the locknut, first piston, four (4) packing rings, top and bottom adapter rings and the bearing ring from the piston.

5. Install a new packing set (having a free stacking height of $^{15}/_{16}$ + $^{1}/_{32}$ − 0) on the second piston. Shims may be used to attain these stacking heights if necessary. Refer to Fig. 34 for direction and order of assembling piston packing rings.

6. Assemble the piston, locknut and new bear-

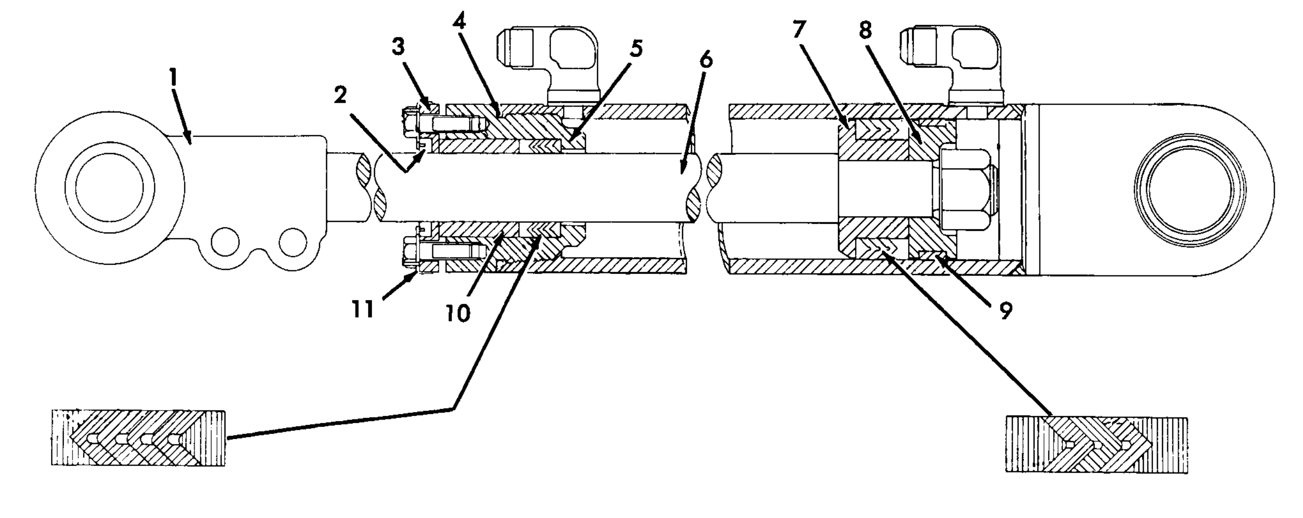

Fig. 34 — Power Steering Cylinder — Cross Section

1. Rod End Assembly
2. Rod Wiper Seal
3. Cylinder End Plate
4. Seal Ring
5. Cylinder Head
6. Piston Rod
7. Second Piston
8. First Piston
9. Bearing Ring
10. Packing Gland Bushing
11. Lockwashers

ing ring and inspect the seal ring of the cylinder head to tube connection. Replace the seal ring (O-ring) if necessary.

7. Slide the piston rod assembly into the cylinder tube and turn the cylinder head into place with a spanner wrench.

8. Install cylinder and connect hydraulic line in a direct reversal of Steps 1 and 2 above.

E. Power Steering Cylinder Piston Rod Wiper Seals

The wiper seal (Fig. 34) installed in the end plate of each hydraulic cylinder, serves to wipe off dirt and foreign material from the piston rod surface. The wiper seal should be replaced when there are indications that the seal is not wiping the rod surface properly. Replace the wiper seal as follows:

1. Remove the locknut, plain washer, and pin from the piston rod end of the cylinder assembly. Swing the rod end of the cylinder towards the rear of the loader slightly.

2. Loosen the two (2) clamp nuts on the rod end assembly and unscrew the rod end, noting the amount of turns necessary to remove it.

3. Bend down the tabs on the lockwashers and remove the two (2) capscrews that secure the end plate to the cylinder head. Slide the end plate off of the rod.

4. Pry the wiper seal out of the end plate.

5. Coat the O.D. of the new wiper seal with white lead and press the seal into the end plate with the lip of the seal towards the outside of the cylinder.

6. Use masking tape to cover the threads on the end of the piston rod, slide the end plate back on the rod and into position on the cylinder head. Using new lockwashers on the two (2) capscrews, attach the end plate to the cylinder head. Tighten the capscrews evenly and alternately using slight pressure on a short wrench. DO NOT OVER-TIGHTEN. Bend up the locking tabs on the lockwashers.

7. Remove the masking tape from the piston rod and replace the rod end assembly using the same number of turns that were required to remove it.

8. Attach the rod end assembly to the bracket on the steering knuckle flange assembly using the pin, flatwasher and locknut. Tighten the clamp nuts on the rod end assembly.

F. Removing Hydraulic Power Steering Cylinders

1. Disconnect the hydraulic lines from the cylinder(s). Cap the open ends of the lines. Cap the fitting on the cylinder.

2. Remove the locknut, plain washer and pin from each end of the cylinder.

3. Remove the cylinder.

G. Installing Hydraulic Power Steering Cylinders

Install the power steering cylinders in a direct reversal of Steps 1, 2 and 3 in Para. E. above.

5. DRAG LINKS

A. General

The drag links are adjustable in length and easily accessible for service. The end socket assemblies on both drag links are for ball socket connections.

To remove the drag links, remove the dust cover, pull the cotter pin from the end plug and loosen the end plug until there is sufficient clearance to lift the connector clear of the ball joint.

B. Drag Links Adjustment

Adjust the drag links as follows:

1. Center the steering wheel by counting the number of turns from the extreme left to the extreme right turn position; from the extreme right turn position, turn the wheel half as many turns back to the left. The steering wheel is centered in this position, and the "Pitman" arm at the base of the steering column should be perpendicular to the ground.

2. Hold a straight edge across each of the rear tires at rim height and measure between the straight edge and the main frame at points forward and rear of the axles. If the measurements are unequal, the drag link or the tie rod must be adjusted until the wheels are parallel with the loader's main frame.

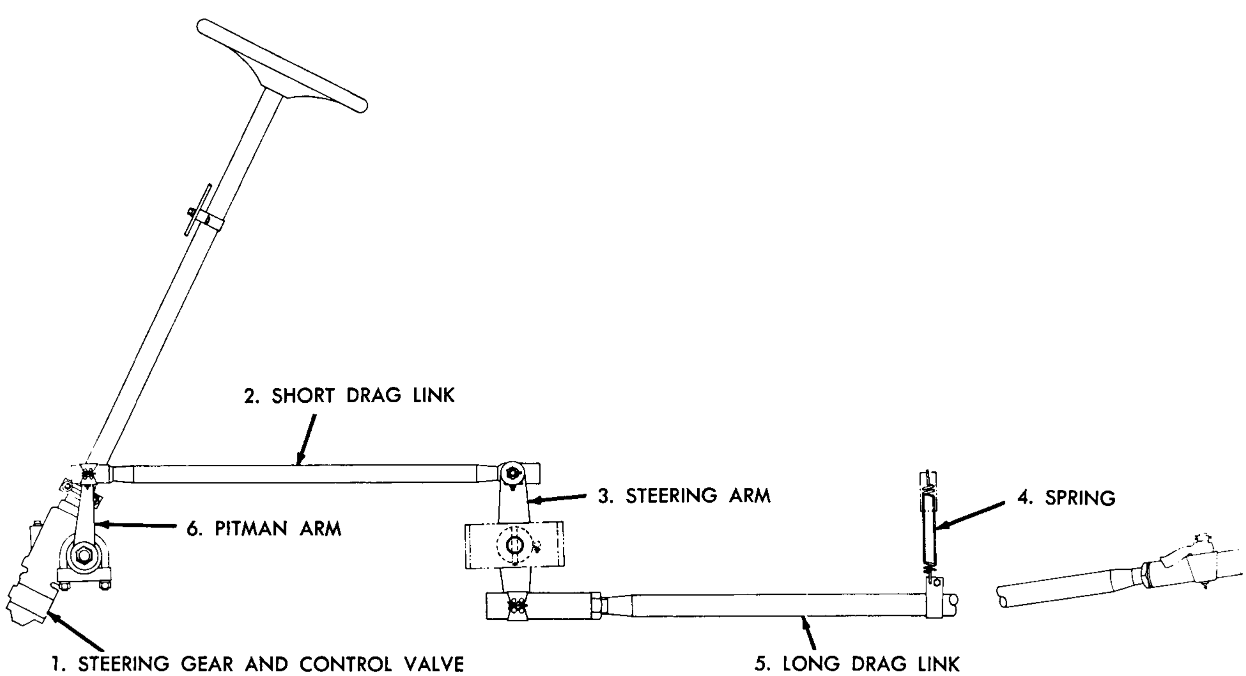

Fig. 35 — Steering Arm and Drag Links

6. STEERING ARM ASSEMBLY

A. Description

The steering arm assembly is located on the inner side of the left main frame box section and pivots around its center pin. The steering arm transmits the motion of the "Pitman" arm, through the short and long drag links to the small steering arm on the left hand rear axle steering flange. The center pivot pin is mounted on roller bearings for ease of operation, with seals on the outside of the bearings to maintain the lubricant and eliminate dirt getting into the bearings.

B. Removal of Steering Arm Assembly

1. Remove the short drag link from the top of the steering arm and the long drag link from the bottom.

2. Remove the cotter pin, lock pin and pivot pin.

C. Disassembly and Assembly of the Steering Arm Assembly

1. Press each bearing and seal out of the arm assembly.

2. Press the new bearings in place with the lettering on the bearing facing the outside of the arm assembly.

3. Press the new seals into place with the seal lip toward the outside. Lubricate the bearings with wheel bearing grease.

D. To Install the Steering Arm Assembly

1. Install the steering arm assembly in a direct reversal of Para. "B" above.

2. Adjust the drag link assemblies to maintain good steering without excessive looseness at the connection points.

SECTION XVI—HYDRAULIC SYSTEM

1. GENERAL DESCRIPTION

The hydraulic system consists of the gear type hydraulic pump, hydraulic tank assembly, control valve, double-acting hydraulic cylinders for the loader booms and the bucket, and the necessary tubes and lines to complete the system.

The hydraulic pump supplies hydraulic oil power to operate the loader. The pump is externally mounted on the torque converter housing of the transmission, and is directly connected to the engine crankshaft through a gear train.

The loader is controlled by the double spool valve mounted to the top of the hydraulic tank, which is located behind the operator's seat.

The bucket dump line safety valve, the bucket return line safety valve, and the lift circuit safety valve located inside the hydraulic tank as shown in Fig. 2, are properly adjusted at the factory and require no further adjustment in the field. To insure positive bucket positioning, a compensator check valve is located in the dump cylinder circuit inside the hydraulic tank, to permit oil to flow from the front ends to the rear ends of the dump cylinders to keep the cylinders full of oil.

The lift cylinder safety relief valve is to relieve excessive pressures that can be developed when the bucket and boom levers are in their neutral positions while the tractor loader is driven into a load. Set at 2050 to 2100 P.S.I., the valve prevents the booms, bucket, and linkage from being damaged.

The flow control valve, Fig. 2, located in the top front end of the loader's control valve assembly and connected to the lift cylinders lowering line, is provided so that oil may be transferred from the bottom side to the top side of the lift cylinders as required to keep the lift cylinders full of oil at all times.

The hydraulic oil pump draws the oil from the hydraulic tank through the suction line screen and magnet which is located in the bottom of the hydraulic tank. The pump circulates the oil under pressure to the pressure side of the central by-pass core in the hydraulic control valve, with the control valve plungers in the neutral position, the oil flows through this central by-pass core and out of the control valve into the filtration regulator valve (snorkel) of the hydraulic tank. The filtration regulator valve (consisting of a spring and plunger, inside a pipe) maintains the maximum flow of oil through the oil filter. Oil returning into this pipe, backs up from the regulator valve to the oil filter line and into the oil filter.

Cold oil, a dirty filter element or a flow of oil in excess of 70 gpm will open the regulator valve and permit the unfiltered oil to return directly to the hydraulic tank.

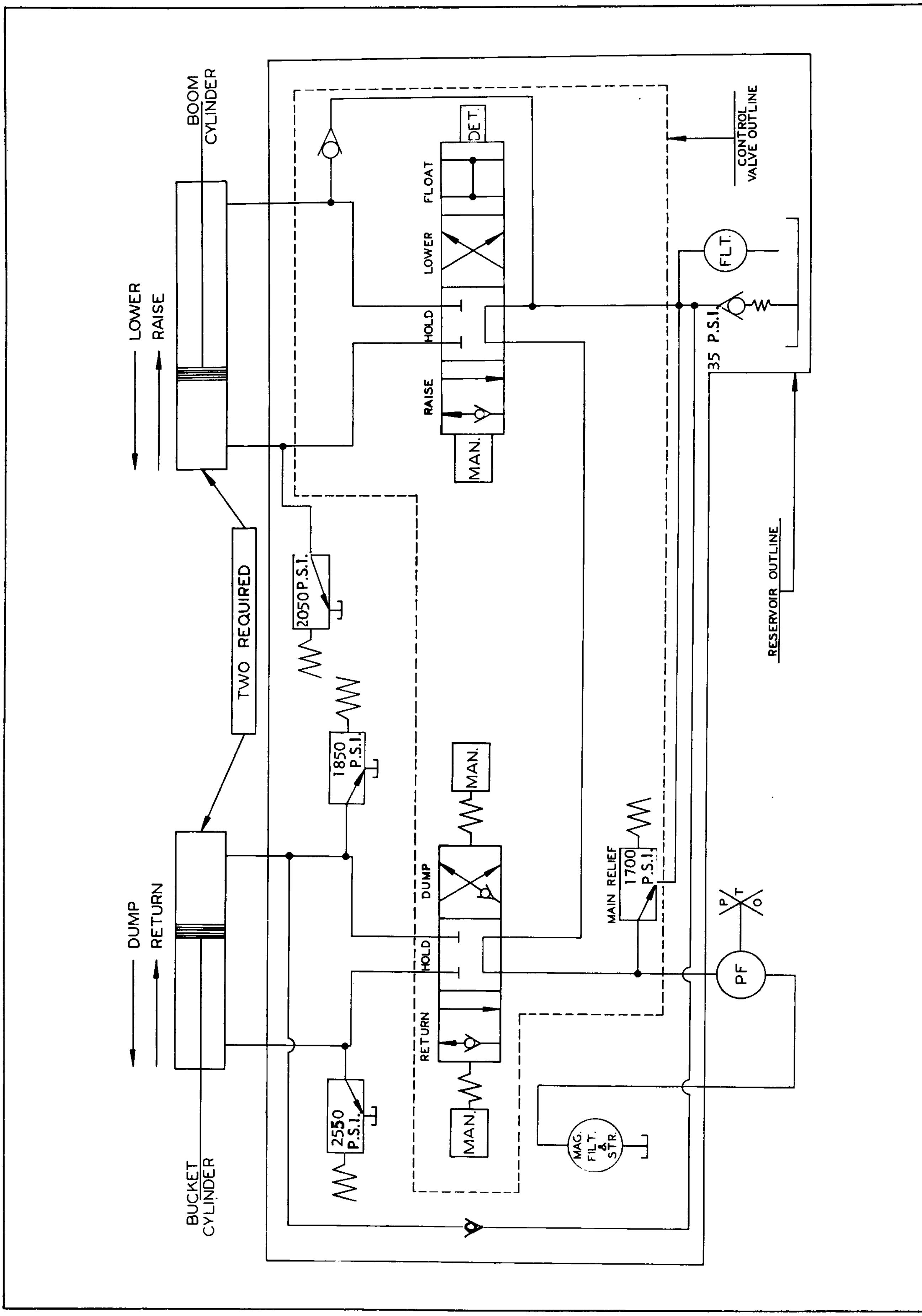

Fig. 1 — Hydraulic System Schematic

16

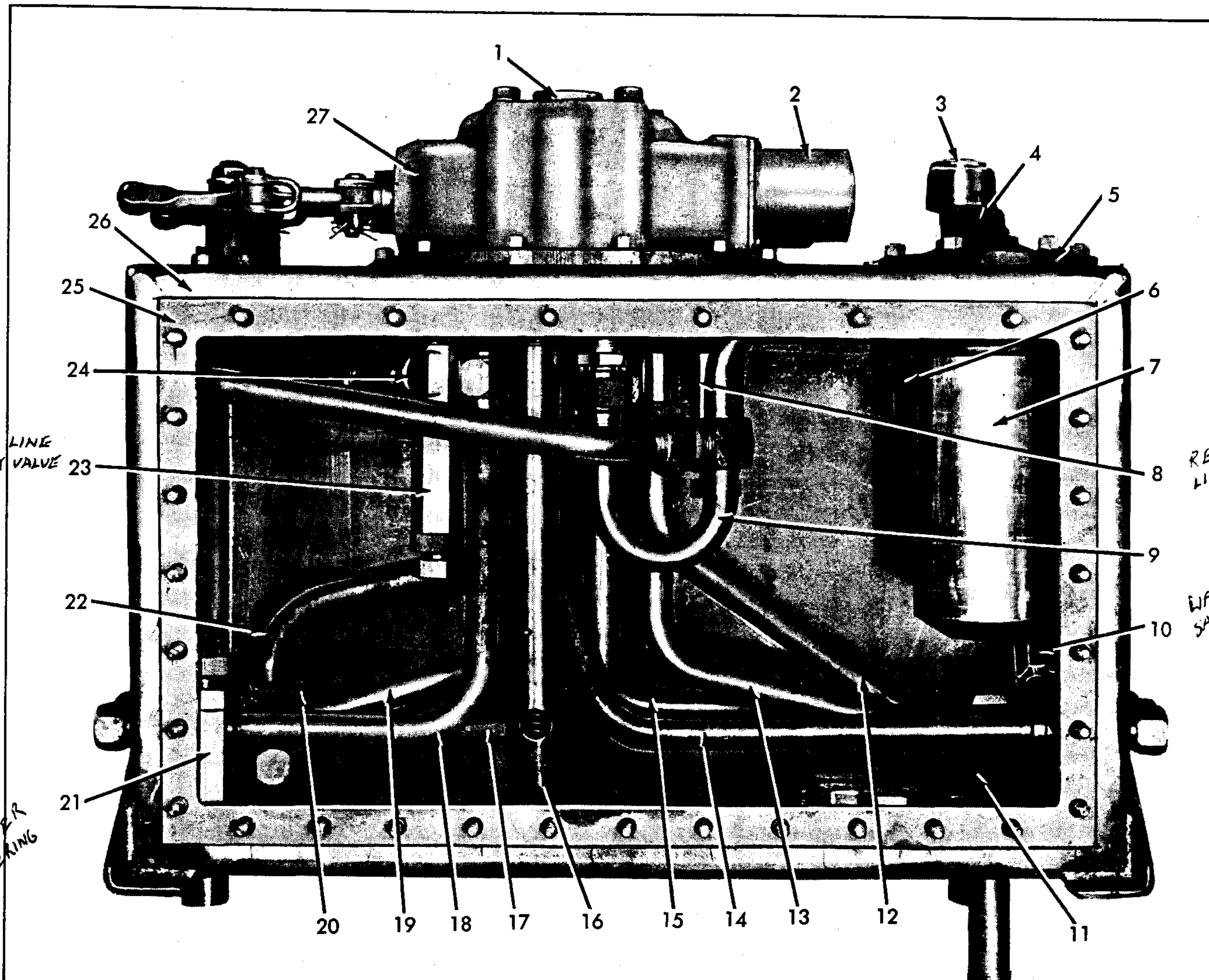

Fig. 2 — Hydraulic Tank

1. Flow Control Valve Cap
2. Detent Cap
3. Hydraulic Tank Breather
4. Oil Filler Plug and Dip-stick
5. Filter Cover and Gasket
6. Air Filter
7. Oil Filter
8. Return Line Safety Valve (2550 to 2600 P.S.I.)
9. Filter Tube
10. Lift Circuit Safety Valve (2050 to 2100 P.S.I.)
11. Suction Line Screen and Magnet
12. Raise Tube (L.H. Cyl.)
13. Return Tube (L.H. Cyl.)
14. Lower Tube (L.H. Cyl.)
15. Dump Tube (L.H. Cyl.)
16. Discharge Line (Snorkel)
17. Raise Tube (R.H. Cyl.)
18. Lower Tube (R.H. Cyl.)
19. Return Tube (R.H. Cyl.)
20. Dump Tube (R.H. Cyl.)
21. Power Steering Relief Valve (950 to 1000 P.S.I.)
22. Pressure Tube
23. Dump Line Safety Valve (1850 to 1900 P.S.I.)
24. Check Valve (one way)
25. Cover Plate Gasket
26. Hydraulic Tank
27. Hydraulic Control Valve

2. OIL RECOMMENDED FOR HYDRAULIC SYSTEM

A good grade of rust inhibiting hydraulic oil or automotive crankcase oil having a viscosity of 210-225 S.S.U. at 100° F. (SAE 10W) is recommended for use in the hydraulic system. NOTE: Do not use an oil that foams.

No specific brand of oil is recommended for use in the hydraulic system. Use only products qualified under the above specification and recommended by reputable oil companies.

3. CHECKING OIL LEVEL OF HYDRAULIC SYSTEM

An oil level dip-stick, attached to the oil filler plug (Fig. 2), is provided in the left front corner on top of the hydraulic tank. The oil level should be checked after every 10 hours of operation by removing the dip-stick and oil filler plug. NOTE: Be certain the loader is level before checking the oil level. With the engine running at full throttle, raise the boom to radiator height. Actuate the bucket through its full travel several times to make certain the dump cylinders are full of oil, then fully retract the dump cylinders. Move the boom control lever to the LOWER position and lower the bucket to ground level, then return the control lever to its NEUTRAL (HOLD) position. Be sure the engine is running at full throttle when performing these operations. Stop the engine and check the level as follows:

a. Thoroughly clean the top of the hydraulic tank (at the oil filler plug location) before removing the filler plug.

b. Remove the dip-stick and oil filler plug and dry the dip-stick with a clean cloth.

c. Insert the dip-stick back into the hydraulic tank, resting the oil filler plug on the top of the oil filter cover. Withdraw the dip-stick and note the oil level; the oil level should be even with the ring groove in the dip-stick.

d. Add oil to the hydraulic tank as necessary to raise the level even with the ring groove in the dip-stick. Install the dip-stick and oil level plug and tighten securely.

IMPORTANT: *The oil level should never be allowed to drop more than 1 inch below the ring groove in the dip-stick. When the oil level in the hydraulic tank is too low, the action of the lifting and dumping cylinders will be sluggish because the hydraulic pump is not receiving enough oil and is, to some extent, pumping air. The upward movement of the bucket during the lifting operation might be slowed to half its normal speed, or it may stop entirely, due to an insufficient supply of oil in the system. The same applies to the dumping cylinders. Considerable damage can be done to the hydraulic pump when the oil level is allowed to get so low that the suction line is not full.*

4. TESTING OF HYDRAULIC SYSTEM FOR PROPER OPERATION

The following test can be made to determine if functioning properly: The time required to raise an empty bucket from ground level to the full raise position, with the engine running at full throttle, should be approximately 8.5 seconds. NOTE: *THE HYDRAULIC SYSTEM SHOULD BE AT NORMAL OPERATING TEMPERATURE WHEN MAKING THIS TEST.*

If it is found that the bucket raises slowly when testing as above, check the following:

a. Make certain that the oil in the hydraulic tank is at the proper level. (Refer to Topic 3 in this Section).

b. Be certain that the suction line screen, located inside the hydraulic tank, is clean.

c. Make certain that the hydraulic pump is in good operating condition. (Refer to Item 7. "Pump" in this Section.)

d. The pressure relief valve, of the hydraulic control valve, is properly adjusted to open at a pressure of 1700 to 1750 P.S.I. As this valve was properly adjusted at the factory, no further adjustments should be necessary in the field. However, if repairs to the loader control valve assembly have been made, or if a new control valve assembly has been installed, the pressure relief valve should be tested and adjusted for the proper opening pressure. Testing and adjusting of the relief valve is also necessary when a new or a rebuilt hydraulic pump has been installed. CAUTION: *Never adjust*

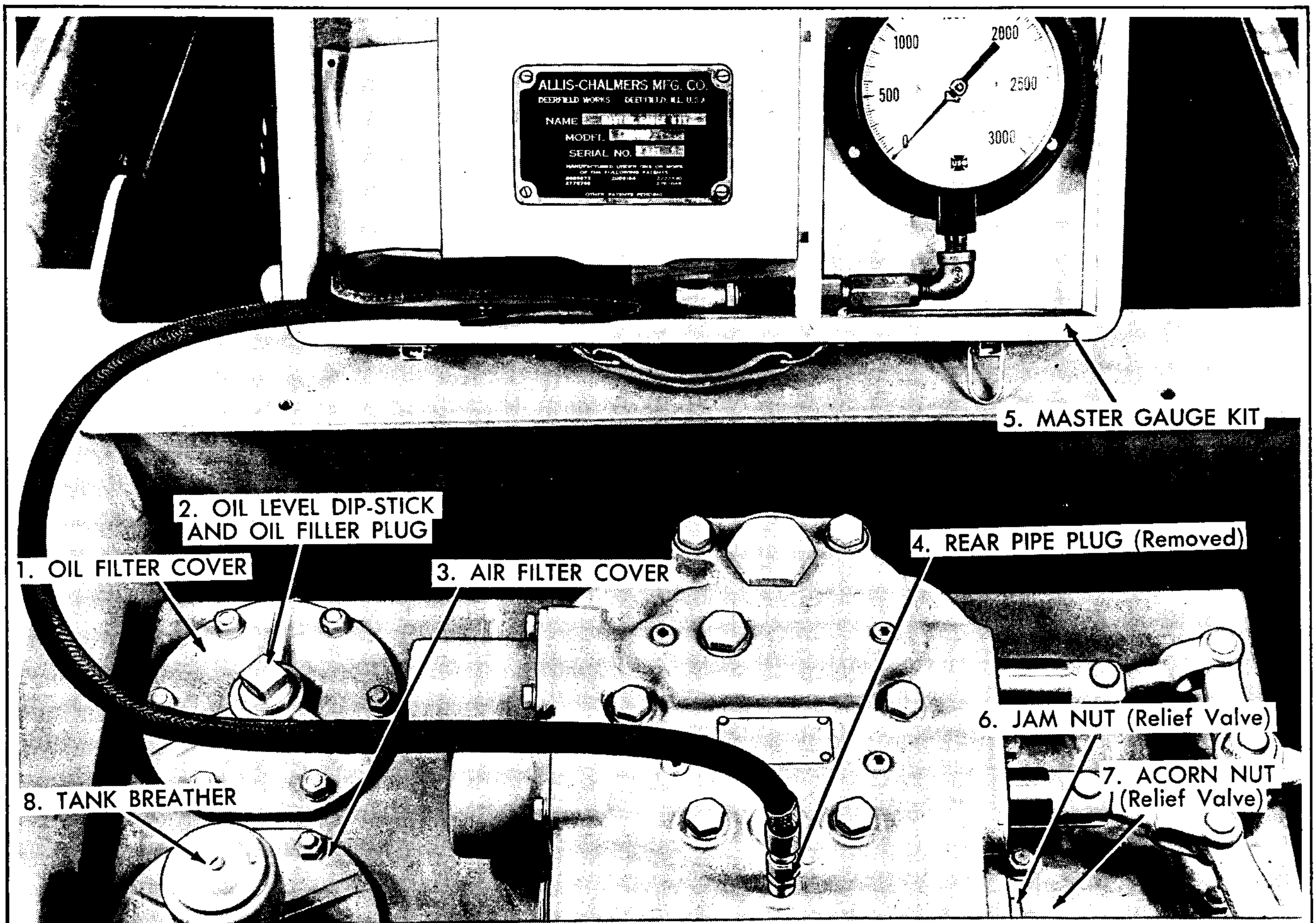

Fig. 3 — Checking Hydraulic Relief Valve Pressure

the pressure relief valve (to increase the pressure) without first making certain that the suction line screen in the hydraulic tank is clean. Also, make certain that the oil in the hydraulic system is at normal operating temperature.

Test and adjust the pressure relief valve as follows:

1. Lower the bucket to the ground. Remove the cover plate from the top of the stabilizer. Thoroughly clean the top of the loader control valve.

2. Remove the rear pipe plug from the loader control valve and install a 3000 P.S.I. capacity pressure gauge. NOTE: *A master gauge kit is available through your "Allis-Chalmers" Construction Machinery Dealer.*

3. Start the engine and operate it at full throttle. Raise the bucket to its maximum height.

4. Move the boom control lever to its fully "RAISED" position and observe the pressure indicated by the gauge. The pressure should be 1700 to 1750 P.S.I. Return the boom control lever to its neutral position. CAUTION: *When performing this test, do not hold the boom control lever in the "RAISED" position for long period of time: hold it just long enough to obtain an accurate gauge reading.*

5. If the pressure indicated by the gauge is above or below the recommended pressure setting (1700 to 1750 P.S.I.), adjustment of the pressure relief valve is necessary.

6. To adjust the pressure relief valve, remove the pressure relief valve acorn nut and loosen the jam nut on the adjusting screw. First "back off" the adjusting screw about 2 turns. Carefully turn the adjusting screw IN to increase the pressure as necessary.

The valve carries an instruction plate which states: CAUTION: *Do not turn the adjusting screw IN more than ¼ turn at a time.* When the correct adjustment is obtained, lock the adjusting screw securely with the jam nut and install the acorn nut. NOTE: *Pressure in excess of 1750 P.S.I. has no effect on the speed or the efficiency of the bucket operation, but definitely causes unnecessary wear on component parts—particularly the pump assembly.*

7. Slow the engine to idling speed and lower the bucket to the ground. Move the boom control lever to the "FLOAT" position and stop the engine.

8. Remove the pressure gauge. Install the pipe plug and tighten it securely. Replace the cover plate on top of the stabilizer.

5. DRAINING, FLUSHING, AND FILLING OF HYDRAULIC SYSTEM

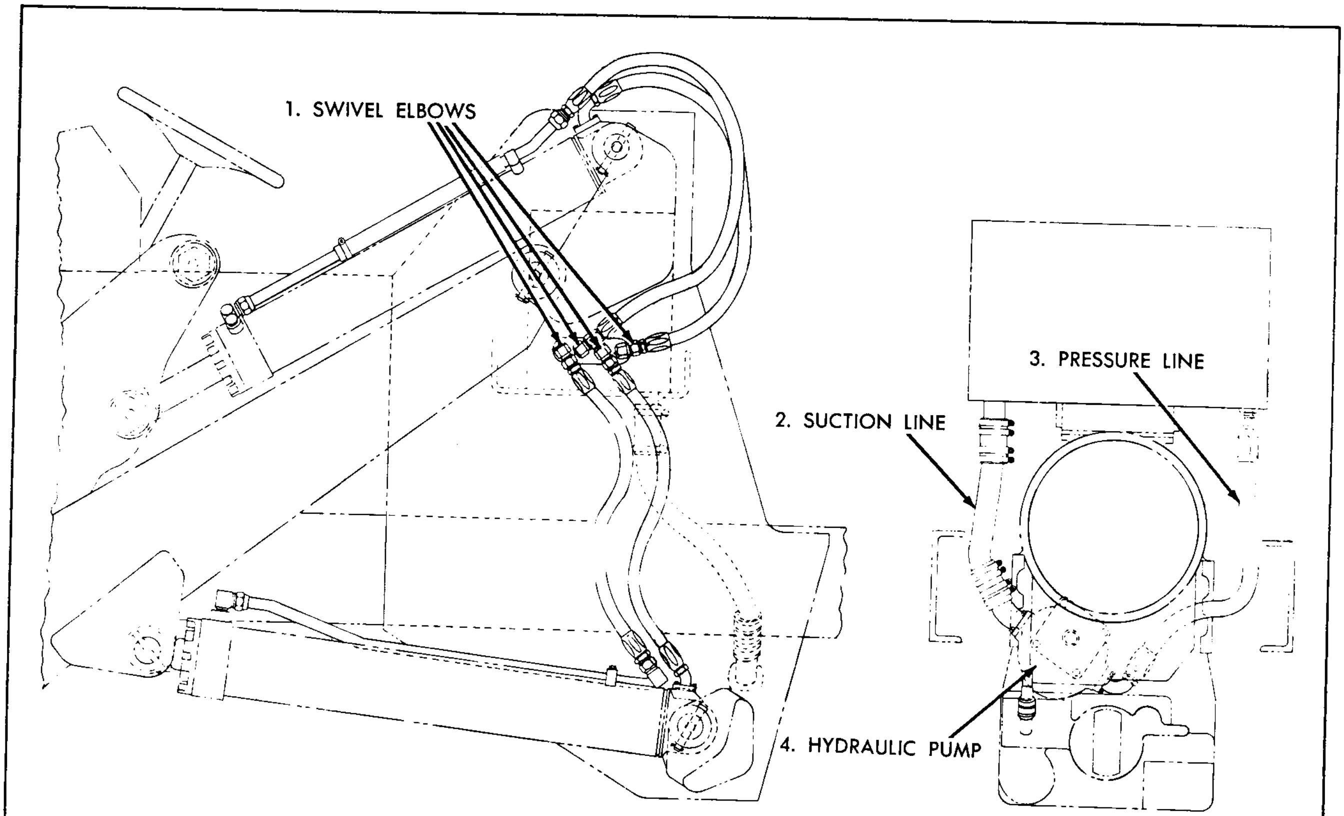

Fig. 4 — Hydraulic Piping

The hydraulic system should be drained, flushed, and refilled with new oil after every 1000 hours of operation, or more often if oil is found discolored. NOTE: *The oil should be at normal operating temperature when draining from the system.*

Drain, flush, and refill the system as follows:

a. Remove the bucket from the machine.

b. Start the engine and carefully retract the dump cylinders all the way. Use care to see that the front end of the dump links are moving freely.

c. Raise the booms to full height. When the oil reaches operating temperature, stop the engine. CAUTION: *SUITABLY SUPPORT THE BOOM TO PREVENT ACCIDENTAL DROPPING DURING THE NEXT OPERATION.*

d. Drain the hydraulic tank completely as follows:

   1. Remove drain plug located on left hand side in bottom of tank.

   2. Remove the suction and pressure elbow

fittings from the loader hydraulic pump to accelerate the draining operation. The baffle cup placed upside down over the suction line opening inside the tank serves as a temporary cover to prevent oil flow while removing the suction elbow.

e. Move the bucket (dump) control lever back and forth several times to relieve pressure Disconnect both dump cylinder hoses on each side of the machine where they pass through the loader frame. Place a container under the hoses (and close to the tank bulkhead fittings) to catch the drained oil — about 3 gallons on each side.

f. Remove the boom support. Place the boom control lever in the LOWER position, allowing the booms to descend until all the oil is expelled from the lift cylinders into the tank and out through the drain. Do not use FLOAT position. NOTE: *Some oil will discharge through the dump cylinder hoses while the booms are being lowered.*

g. Use an external power source to completely extend the dump cylinder rods, thereby expelling all the oil. Be careful not to damage the cylinder eye.

h. The oil remaining in the loader control valve may be drained by disconnecting the lift cylinder hoses at the cylinders.

i. Disconnect both lines from the power steering cylinders. By turning the steering wheel from one extreme to the other, oil will be expelled from the valve and cylinders. The rear of the machine must either be jacked up or the drag link disconnected from the steering axle to facilitate turning the steering wheel. Disconnect the suction line from the power steering pump for draining.

j. Install new oil filter, air filter, and tank breather elements. (Refer to items B, C, and D of "Hydraulic Tank Assembly" in this Section.)

k. Reconnect all lines which were disconnected during draining as follows:

1. Pressure and suction lines — pump to tank.

2. Lift and dump cylinder hoses—cylinders to tank.

3. Power steering cylinder hoses — both tank and pump to cylinder.

4. Suction line — power steering to pump.

l. COMPLETELY fill the hydraulic tank with the best grade of kerosene. Start the engine to circulate the kerosene through the system. Operate both of the loader control valve levers four or five times to thoroughly flush out the lift and the dump cylinders.

m. Drain the hydraulic system by following steps B through I, above. Referring to step K, reconnect all of the lines.

n. Remove the dip-stick and oil filler plug from the hydraulic tank. Fill the hydraulic tank to a level with the ring groove in the dipstick with the specified oil. Install the dipstick and oil filler plug.

o. Start the engine. Operate the loader control valve levers to fill the lift and the dump cylinders with oil. Add oil to the hydraulic tank as necessary to keep the suction line filled.

p. Reinstall the bucket.

q. Fully retract the dump cylinders and lower the bucket to ground level.

r. Remove the dip-stick and oil filler plug and dry with a clean cloth. Insert the dipstick back into the tank, resting the oil filler plug on top of the oil filter cover. Withdraw the dip-stick and oil filler plug and note the oil level; the level should be even with the ring groove in the dip-stick.

s. Add oil to the hydraulic tank as necessary to raise the level even with the ring groove in the dip-stick. On the final check allow a few minutes for the oil to settle before rechecking the proper level. Install the dip-stick and oil filler plug and tighten it securely. The hydraulic system is now full and ready to operate.

6. GENERAL CARE OF HYDRAULIC SYSTEM

A. Keep all tube fittings and hose connections tight to prevent oil leaks. Do not over-tighten or use sealing compound.

B. Use such compounds as "Permatex #2" on pipe threads when replacing fittings. Make certain that all parts are thoroughly cleaned before installation.

C. When installing a hose assembly be sure that it is not twisted when the connections are tightened.

D. Keep all hose clamps tightened to avoid hose chafing.

E. Keep the packing glands for the hydraulic lift and dump cylinders properly adjusted to avoid oil leakage. The packing gland and end plates should be adjusted so that there is a light film of oil on the piston rods when the unit is in operation.

The packing glands of each cylinder are adjusted by removing the lockwire from the capscrews in the packing gland end plate. Tighten the four capscrews evenly using a slight pressure on a short wrench. Lock the capscrews with lockwire.

NOTE: *Excessive tightening of the packing glands results in rapid wear on the packing rings and severe wiping of the piston rod. If the packing gland leaks oil after being adjusted properly, it is an indication that the packing rings are worn and should be replaced.*

7. HYDRAULIC TANK

The hydraulic tank is designed so that with little periodic service, top performance can be maintained indefinitely. Service of the filters, breathers, suction line screen and magnet, of the tank assembly is dependent upon operating conditions. (Refer to Fig. 2.)

A. Oil Filter Element and Case

The oil filter, located inside of the hydraulic tank (as shown in Fig. 2), has a micronic element which should be replaced after every 100 hours of operation, or more often if conditions warrant. When the oil is at operating temperature, all oil is 100% filtered. Refer to Fig. 2 and replace the oil filter element as follows:

1. Oil Filter Service

a. Remove cover plate from the top of the stabilizer for access to the hydraulic tank assembly. Thoroughly clean the filter cover and surrounding area.

b. Remove the filter cover (with oil dip-stick) from the top of the hydraulic tank.

c. Pull the filter element from the oil filter case and discard the element. Thoroughly clean the inside of the filter case.

d. Make certain that the spring and metal washer are in position on the pipe in the bottom of the filter case. Insert the new filter element into position in the filter case, making certain that the lower end of the element seats squarely on the metal washer.

e. Place a new cover gasket in position on the tank and install the filter cover (with oil dip-stick). Tighten the hex nut evenly and alternately to a torque of 20-25 lbs. ft.

2. Oil Filter Case Service

Refer to Fig. 2, to remove and install the oil filter case in the hydraulic tank assembly as follows:

a. With cover plate off and filter element out, the filter case and ring seal can be lifted out of the tank assembly.

b. Inspect the ring seal for cuts or damage and replace it if necessary. Thoroughly clean the filter case and check for cracks, holes or dents and replace if necessary.

c. Install the ring seal in the groove of the tank assembly filter case bore and apply a thin coat of oil on the outside of the filter case. Rotate the case so that the flat at the top of the case is aligned with the oil inlet line of the hydraulic tank, and install the filter case into the hydraulic tank.

d. Install the filter element, the gasket and the cover plate.

B. Hydraulic Tank Breather and Air Filter

To permit the hydraulic tank to expell air which otherwise might cause an "air-lock" in the hydraulic system components, a fiber element type breather is used on top of the tank. To further filter the dust and dirt which could pass through this type breather, an air filter is used and is located underneath the breather inside the hydraulic tank.

1. Tank Breather Service

The tank breather (Fig. 2) should be serviced after every 10 hours of operation, or more often if conditions warrant. The breather element should be replaced after every 100 hours of operation. Clean the breather element as follows:

a. Loosen and remove the machine screw and lockwasher attaching the breather cap to the base. Remove the breather cap and the breather element.

b. Wash the element in clean solvent or diesel fuel, dry with compressed air (from the inside out), and dip the element in clean oil. Shake off the excess oil and reinstall the element, breather cap, and the machine screw (with lockwasher).

2. Breather Air Filter Service

The element of the air filter, located inside the hydraulic tank as shown in Fig. 2, should be replaced after every 100 hours of operation, or more often when operating in extremely dusty conditions. Replace the filter element as follows:

a. Thoroughly clean the filter cover and surrounding area.

b. Remove the hex nuts, filter cover (with the tank breather), and cover gasket from the top of the hydraulic tank.

c. Pull the filter element from the filter case and discard the element and cover gasket. Thoroughly clean the inside of the filter case.

d. Insert the new element (with the open end upward) into position in the filter case and center the element within the case.

e. Place a new cover gasket in position on the tank and install the filter cover (with tank breather). Tighten the hex nuts evenly and alternately to a torque of 20-30 lbs. ft.

3. Air Filter Case Service

To remove the air filter case, follow the same procedure as described under "B. Oil Filter Case" in this Section, except that there is no flat on the air filter case.

C. Hydraulic Suction Line Screen and Magnet

1. Service

A screen and magnetic ring placed in the suction line at the bottom of the hydraulic tank, serve to screen or collect the dirt, lint, fibers and metal particles from the oil. Therefore, it is important that the suction line screen and magnet (Fig. 5) be cleaned daily during the first week of operation or until the amount of foreign material collected daily has practically disappeared. Thereafter, the screen and magnet should be cleaned after every

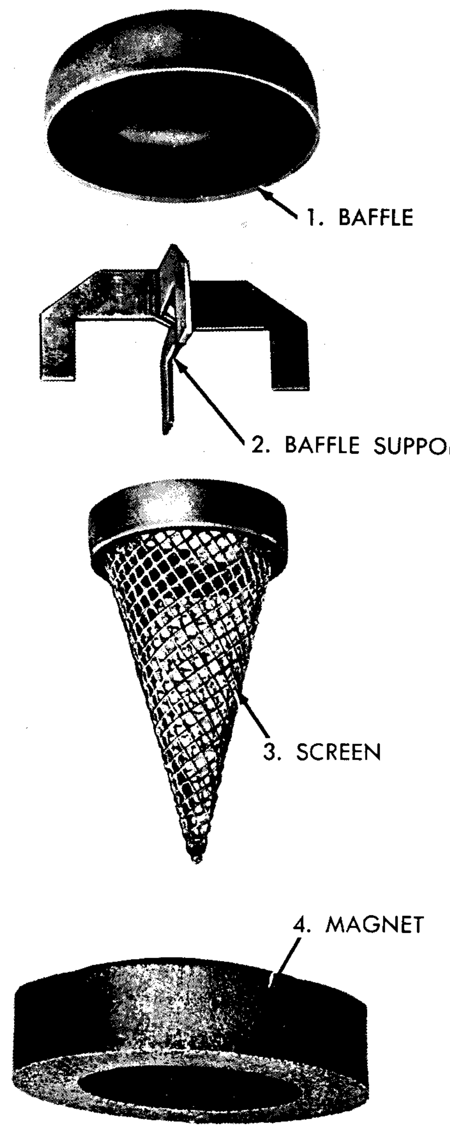

Fig. 5 — Suction Line Screen and Magnet

100 hours of operation. These parts are accessible for cleaning by the removal of the oil filter cover, the filter element, and the air filter case and reaching down into the tank.

IMPORTANT: *Plugging of the Suction Line Screen with Foreign Material (particularly fibers worn from the Packing Rings) will starve the Hydraulic Pump, which almost always results in serious damage to the internal parts of the Pump. Therefore, it is imperative that the Suction Screen be kept clean.*

2. Cleaning Screen and Magnet

Clean the suction line screen and magnet as follows:

a. Remove the air filter element and case following the same procedure in item "C" of this Section.

b. Reaching down through the air filter bore of the hydraulic tank, push sideways on the bail to loosen the suction line screen baffle cup (Fig. 2) and remove the baffle cup and the suction line screen. Remove the magnet (ring) from the suction line.

c. Wash the suction line screen in clean solvent or diesel fuel and dry with compressed air. If the screen is torn or damaged in any way, it should be replaced.

d. Wash magnet in clean solvent or diesel fuel and wipe clean. Place the magnet in position on the suction line and insert the suction line screen into the suction line. Install the suction line screen baffle cup and secure with the bail.

e. Reinstall air filter element and case following same procedure in item "C" of this Section.

D. Tank Removal

1. Remove the four (4) capscrews, lockwashers and plain washers from the hydraulic tank and valve cover, and remove the cover.

2. Remove the engine side panels and hood, refer to "Radiator Guard, Grill, Shroud and Radiator," Section IV.

3. Remove the cotter pin and clevis pin from each control lever to disconnect the control levers from the bell crank assemblies.

4. Drain the hydraulic tank, refer to "Draining, Flushing and Filling of Hydraulic System" in this Section.

5. Disconnect the four (4) hoses on each side of the main frame, and remove the swivel elbow assemblies. Cap the open fittings.

6. Disconnect the pressure power steering and suction lines from the tank.

7. Remove the four (4) capscrews, plain washers, lockwashers and hex nuts attaching the hydraulic tank to the tank support plate.

8. With a sling or suitable strap, lift the tank out of the loader.

E. Tank Maintenance and Inspection

Check all seal rings in the bulkhead connections and valve mounting and manifold plate. Check all gaskets for leaks or damage. If any of these conditions exist, the seal rings or gaskets must be replaced. Torque all cover hex nuts to 20-25 lbs. ft.

F. Tank Installation

Install the hydraulic tank in direct reversal of "D. Removal" above. Torque the capscrews fastening the hydraulic tank to the tank support plate to 75 lbs. ft.

8. HYDRAULIC CONTROL VALVE

The two lift cylinders and two dump cylinders are controlled through the control valve which is located underneath the hydraulic tank cover plate behind the cperator's seat and is attached to the top of the hydraulic tank (refer to Fig. 2). The control valve houses the hydraulic system main pressure relief valve, which provides for regulating the pressure throughout the hydraulic system (refer to Fig. 7).

A. Removal of Hydraulic Control Valve

1. Relieve the pressure in the system by moving both control levers back and forth from their neutral positions, with the engine stopped and the bucket resting flat on the ground.

2. Disconnect the control valve plungers from the lever linkage by removing the cotter pin and celvis pin from each plunger eye.

3. Remove the seven ½" capscrews and lockwashers, eight seal rings and the control valve from the hydraulic tank.

B. Disassembly of Control Valve (Refer to Fig. 7)

1. Thoroughly clean the exterior of the valve assembly.

2. Clamp the valve housing in a vise so that the pressure relief valve cap is accessible. Always use a copper jawed vise to protect the machined surfaces of the valve and its parts.

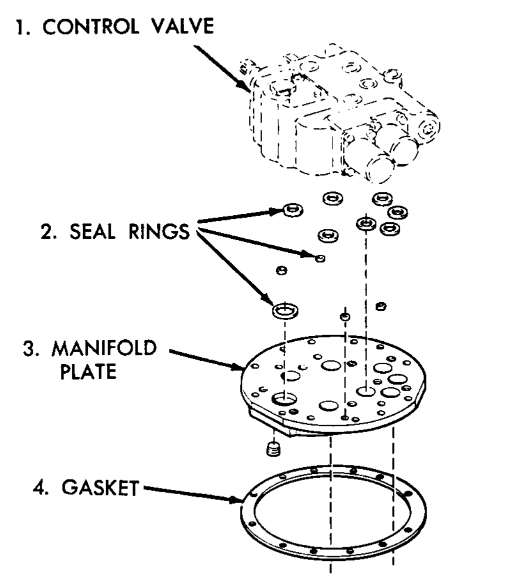

Fig. 6 — Control Valve to Manifold Plate Seal Rings

3. Remove the relief valve acorn nut, locknut and adjusting screw.

4. Remove the pressure relief valve cap and seal ring, spring guide, relief valve spring, and relief valve plunger.

5. Remove the 1¼" NPT plug from the end of the housing opposite the plunger end.

6. Insert a brass or bronze drift through the pipe plug opening and drive the relief valve seat from the housing.

7. With the valve housing clamped in a vise, and the operating plungers in a horizontal position, remove the four capscrews, lock-

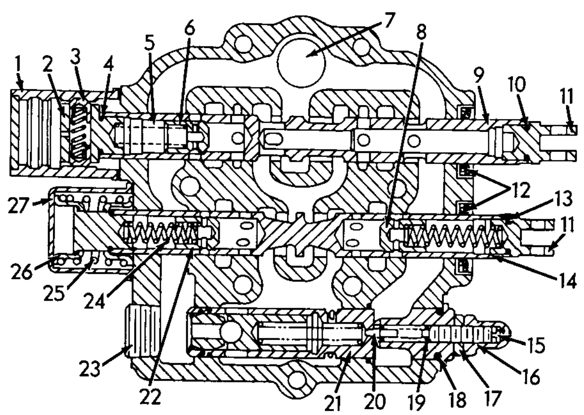

Fig. 7 — Control Valve — Cross Section

1. Detent Cap
2. Cap
3. Detent Poppet
4. O-Ring
5. Spring
6. Plunger
7. Flow Valve (Steel ball)
8. Plunger
9. Range Spool
10. O-Ring
11. Spool Eye
12. Seal
13. O-Ring
14. Direction Spool
15. Adjusting Screw
16. Acorn Nut
17. Jam Nut
18. O-Ring
19. Spring
20. Poppet
21. Relief Valve Assembly
22. Plunger
23. Pipe Plug
24. Spring
25. Spring
26. Spring Retainer
27. Spring Cover

washers, gasket and plunger spring cover from the valve housing.

8. Hold the plunger cap with a suitable wrench. Place a brass or bronze rod or drift in the plunger eye. Strike the drift sharply, counter-clockwise to the direction of the plunger cap thread, and loosen the plunger eye for removal.

   An alternate method for holding the operating plunger so that the eye can be loosened for removal, is to insert a brass rod through one of the valve inlet or outlet openings and into a convenient hole in the plunger.

9. Remove the plunger eye, seal ring, rear check valve spring and the rear check valve. NOTE: *Check valves and springs are not interchangeable. Identify these parts as they are removed from the operating plunger.*

10. With the plunger eye removed, push on the end of the dump plunger, where eye was removed, until the plunger and plunger return spring emerge from the valve housing and can be removed.

    NOTE: *The valve plungers are individually fit and are not interchangeable with the dump control plunger because of the float control hole in the lift plunger, and because the float control is longer due to the detent control mechanism. Identify these parts as they are removed from the valve housing to assure reassembly in the same bore.*

11. Clamp the dumping cylinder plunger in a copper jawed vise with the end cap accessible.

12. Remove the plunger cap, seal ring, outer washer, check valve spring, inner washer and the check valve. NOTE: *Check valves and springs are not interchangeable. Identify these parts as they are removed from the dump cylinder plunger.*

13. Remove four capscrews, lockwashers, detent plunger cap and gasket from the lift cylinder plunger of the valve housing.

14. Remove lift cylinder plunger eye as in step 8 above, and pull the lift cylinder plunger from the valve.

15. Remove the detent poppet plungers and springs from the lift plunger, then follow same steps 11 and 12 above to disassemble the lift plunger.

16. Remove the plunger oil seals with a heavy screwdriver or pry bar. Care must be taken to prevent scoring the seal bore.

17. Remove the flow control valve cap with seal ring. Catch the steel ball check so that it will not be damaged when removing.

18. Inspect the ball check seat for burrs or worn spots, which would prevent the ball check from seating properly. If the ball check or the ball check seat are damaged, they should be replaced. To reinstall the ball check seat, use a puller to remove the seat, and after applying white lead to the outside diameter of the new valve seat, drive the seat into position in the housing with a tool which completely covers the outer diameter of the ball check seat.

C. Fits and Tolerance Recommendations for Replacement of Parts

1. When the valve plunger oil seals are removed, replace with new seals.

2. Replace the plunger eye seal and the plunger cap seal rings if they are swollen or damaged.

3. Inspect the plungers and the plunger bores for worn spots, scoring, or gummy deposits.

4. Inspect the plunger relief valve and the return springs for breaks or fatigue.

5. When the plunger-to-housing clearances become excessive due to normal wear, the valve assembly must be replaced.

   Should the excessive wear of a plunger arise, the diametrical clearance between the plunger and the plunger bore is .0007" to .0009". Plungers are not replaceable or interchangeable. The valve housing and plungers are select fitted at the factory of the manufacturer and are not serviced individually.

   NOTE: *The pressure relief valves of all new or factory rebuilt control valve assemblies are set at 1400 P.S.I. Adjust the pressure relief valve of a new or factory rebuilt control valve to a pressure of 1700 to 1750 P.S.I. for this loader.*

6. Remove any burrs from the seal bores with fine emery cloth.

D. Control Valve Assembly Procedure

1. Clean all parts in cleaning solvent or diesel fuel and dry thoroughly.

2. Coat the two seating diameters of the relief valve seat with white lead and install the seal ring in its groove of the seat. Press the seat into the bore of the valve housing from the relief valve end, making certain that the relief valve seat is aligned correctly with the housing bore.

3. Lubricate the relief valve plunger with clean oil and install it in the relief valve seat. It is not necessary to lap or grind the relief valve plunger and seat.

4. Install the relief valve spring, spring guide, pressure relief valve cap and seal ring, adjusting screw, locknut and acorn nut.

5. Install the 1¼" pipe plug in the valve housing, after coating the threads with white lead. Tighten securely with a hex socket wrench.

6. Clamp the plungers in a copper jawed vise with the cap ends accessible.

7. Install the marked check valve, check valve spring and the plunger cap, respectively. The return spring of the dump cylinder must be centered and not caught on the shoulder of the plunger when installing the plunger in the valve.

   NOTE: *If the plunger check valves are replaced, it is necessary to lap the plunger into its seat with fine grain valve lapping compound. Remove all lapping compound before proceeding.*

8. Lubricate the plunger with clean oil and carefully insert it (open end first) into its bore, from the cover end of the valve housing.

9. Attach the end cover or detent cap to the valve housing to hold the plunger in place; do not tighten the end cover or detent cap capscrews at this time.

10. Coat the O.D. of the plunger oil seal assembly with white lead.

11. Install the plunger oil seals on the plungers, with the sealing lips of the seal assembly turned as shown in Fig. 3. Drive each seal into its bore until it stops at the bottom of its bore.

12. Install the check valve, check valve spring, seal ring and the plunger eye of the dump cylinder plunger, and the seal ring and plunger eye in the lift cylinder plunger.

13. Tighten each plunger eye by a direct reversal of steps 8 and 9, under "Control Valve Assembly."

14. Tighten the capscrews of the plunger detent cap and cover to a torque of 18 lbs. ft.

E. Installation of Control Valve Assembly

1. Thoroughly clean the top surface of the tank and valve mounting plate of the tank.

2. Place the eight seal rings into their respective grooves in the top of the valve mounting plate.

3. Carefully place the control valve on the mounting plate and install the seven capscrews and lockwashers. Tighten capscrews evenly and alternately to a torque of 50 to 60 lbs. ft.

4. Attach control valve plungers to their respective linkage levers with the clevis pins and cotter pins removed in step 2 of "A. Removal of Control Valve Assembly."

9. HYDRAULIC PUMP

The hydraulic pump should be removed, disassembled, and inspected after one year of operation even though no noticeable decrease in operating efficiency has become apparent. Without actually inspecting the internal parts of the pump, it is difficult to determine from the operating test exactly when an overhaul should be made to the gear type pump. A gear type pump may maintain its maximum operating efficiency to a point where the bearings start to fail.

A. To Remove Hydraulic Pump

1. Drain the hydraulic tank. Refer to Topic 5 in this Section.

2. Remove the four capscrews and lockwashers with gasket from the suction side of the hydraulic pump, and remove the adapter.

   Remove the four capscrews and lockwashers from the pressure side of the hydraulic pump, and remove the flange halves, hose assembly and seal ring.

3. Remove the four capscrews and lockwashers from the pump adapter flange to the transmission housing, and pull the pump from the transmission.

B. Disassembly of Hydraulic Pump (Refer to Fig. 8)

Clean the pump with a solvent. Remove burrs and sharp edges from shaft at drive end. Mark the housing sections to reassemble as taken apart.

1. Remove the capscrews at the seal retainer.

2. Remove the retainer from the adapter cover by prying at the two undercuts of the retainer.

3. Pry the two lip seals out from the retainer, remove the two O-rings and discard. The seals seat may be removed by hand. DO NOT remove the seal seat unless necessary.

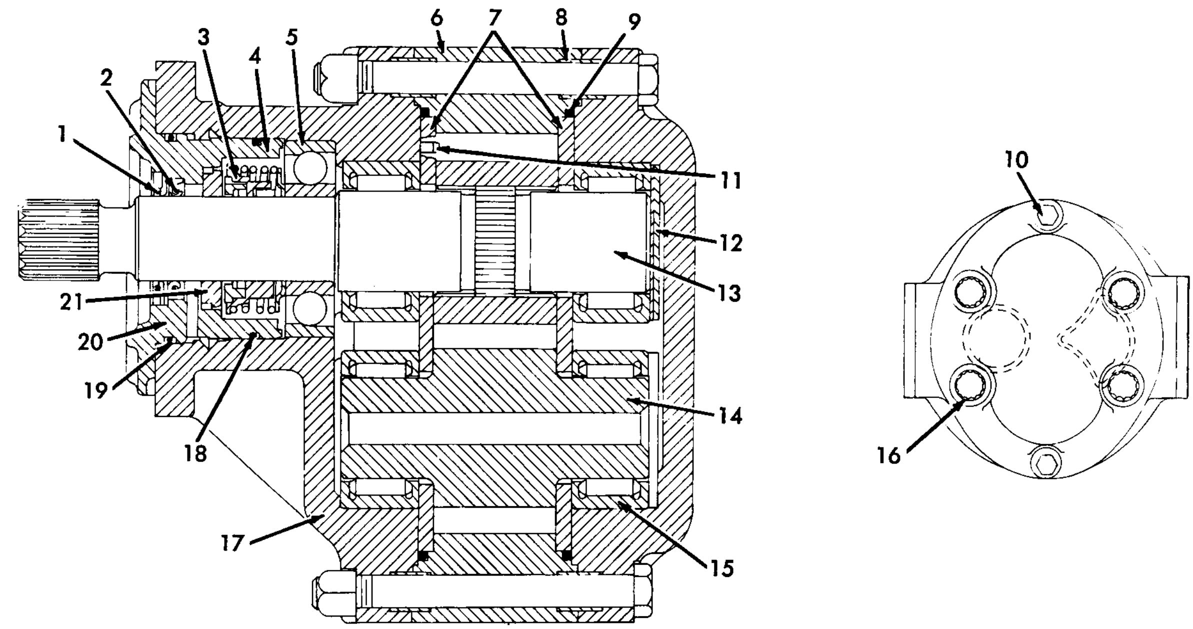

Fig. 8 — Loader Hydraulic Pump — Cross Section

1. Seal
2. Low Pressure Seal
3. Seal Assembly
4. Seal Retainer
5. Ball Bearing
6. Gear Housing
7. Wear Plates
8. Sleeve
9. Seal Ring
10. Hex-Hd. Capscrew
11. Roll Pin
12. Thrust Washer
13. Drive Shaft
14. Driven Gear
15. Bearing
16. Socket Head Capscrew
17. Adapter
18. O-Ring
19. O-Ring
20. Seal Retainer
21. Seal Seat

NOTE: *Follow the procedure under "Seal Reassembly" if it is necessary to replace the seal seat and seal assembly, only.*

4. Remove the bronze seal, drive key, spring and washer.

5. Remove the four large head capscrews and the two capscrews with nuts.

6. Remove the end cover housing by tapping with a soft hammer. The cover may come off separately or with the gear housing. Separate the two sections if together.

NOTE: *Do not pry the housing sections apart, as the machined sealing surfaces will be damaged.*

7. Removal of the end cover housing will permit removal of the wear plate, any shims, O-ring and formed ring with backup ring. Discard the rings.

8. Tap the gear housing with a soft hammer to remove it from the adapter cover housing.

9. Mark the gears with an India stone, to reassemble them in the same position, Fig. 9.

10. Remove the gears.

11. Tap the gear end of the drive shaft with a soft hammer to remove the outboard bearing from the adapter cover housing then, remove the drive shaft.

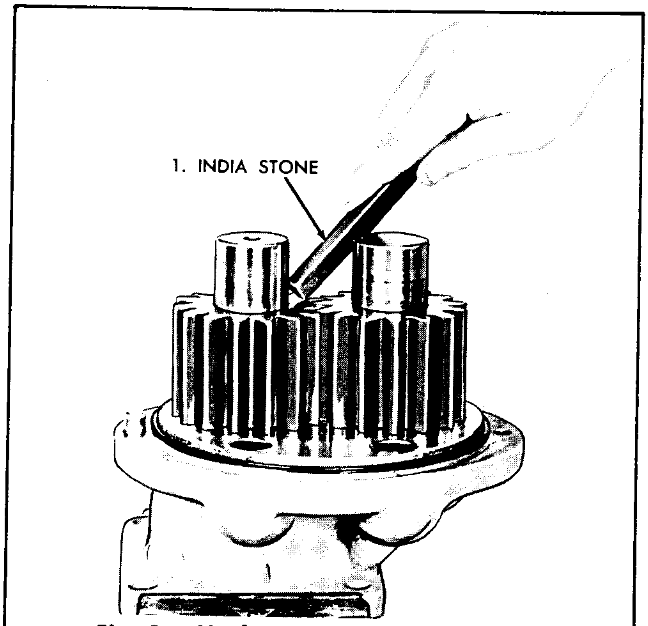

Fig. 9 — Marking Typical Pump Gears

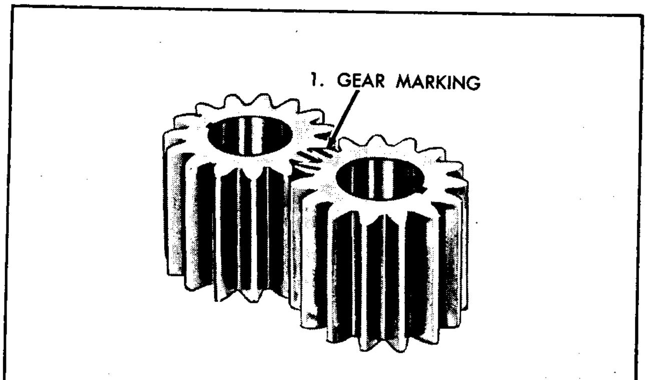

Fig. 10 — Typical Pump Gears Showing Marking

12. Remove the wear plate, any shims, O-ring, formed ring with backup ring. Discard the rings.

13. Start the removal of bearings with tool, Fig. 11. Complete the removal of the bearings as shown in Fig. 12. DO NOT remove the bearings unless they are being replaced.

    The bearing in the adapter cover housing on the drive shaft side can be removed by pressing or tapping it from the retainer end.

14. Before removing the thrust washer from the end cover housing, NOTE the Bearing Bore from Which it is Removed. This thrust washer goes in the bearing bore on the drive

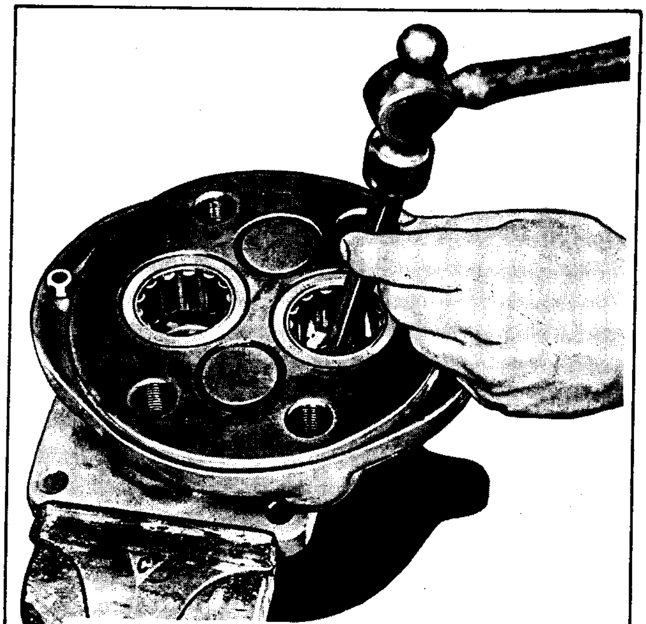

Fig. 11 — Starting Pump Bearing Removal

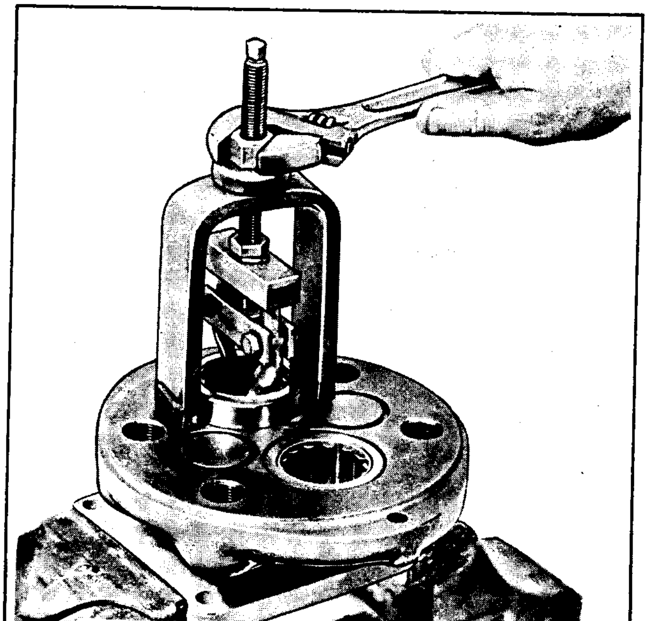

Fig. 12 — Completing Removal of Pump Bearings

shaft side only with the BRONZE side facing the shaft end.

C. Inspection

Wash all parts in solvent and dry with lint free cloths or dry compressed air. DO NOT spin dry the bearings with compressed air.

1. Remove nicks and burrs from the machined surfaces of the end cover, adapter cover

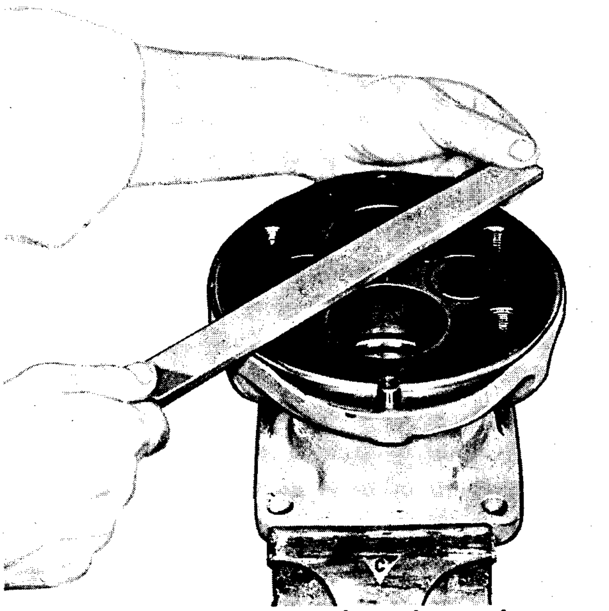

Fig. 13 – Removing Nicks and Burrs from Adapter Cover

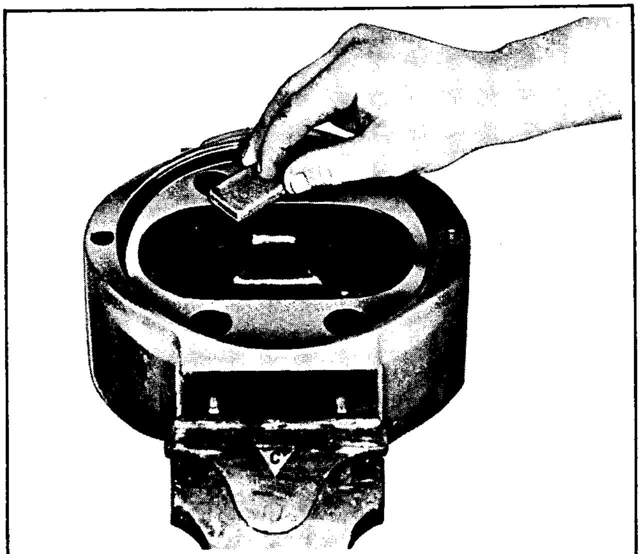

Fig. 14 – Removing Nicks and Burrs from Gear Housing

and gear housing. See Fig. 13 and 14.

2. Inspect the edges of the gear teeth and gear surfaces for burrs and scoring. Remove with an India stone. See Fig. 15.

3. Check the seating of the wear plates on the end cover and adapter cover surfaces. A rocking motion indicates a burr on the machined surface of either the housing or the wear plate.

4. Wear plates that are severely scored, ex-

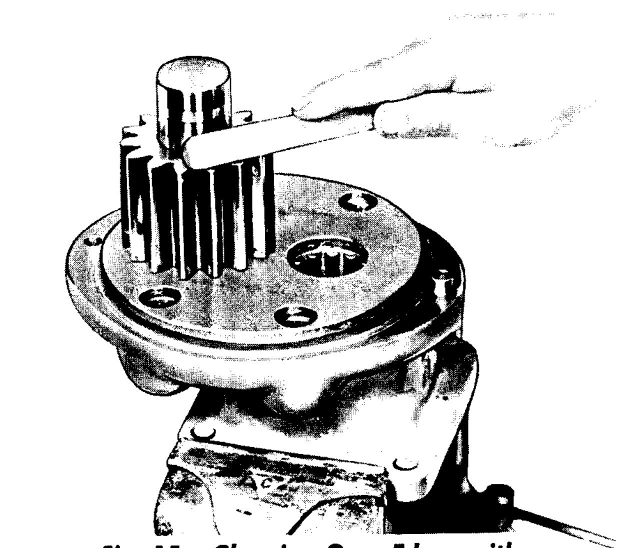

Fig. 15 – Cleaning Gear Edges with India Stone

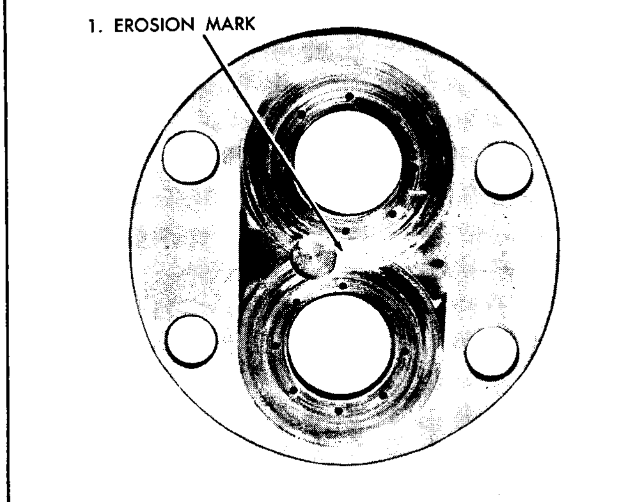

Fig. 16 – Pump Wear Plate with Erosion Mark

cessively worn, or have an erosion mark in the relief pocket area of the gear pattern, Fig. 16 must be replaced.

NOTE: *Score marks around the shaft holes can be an indication of spalled bearing.*

5. Inspect the shafts at the roller bearing and seal areas for spalling and wear. Replace if the roller journal wear exceeds the nominal shaft diameter by .001 inch or if damaged at the seal area.

WARNING: *Shaft and bearing failures are of a fatigue nature; therefore judgment must be used and consideration given to* *the hours of operation under load. The parts could be close to the fatigue point even though they show little wear.*

6. Inspect the bearings for roller freeness, pitting and wear. Spalling of the outer raceway cannot be observed visually; however, any roughness can be detected by carefully rolling a roller around the raceway. The bearing area under greatest load will be on the suction side of the pump. Spalling will also result in the rollers becoming pitted.

   NOTE: *Wear can be determined by a feeler gage inserted between the shaft and the rollers with the bearing in the housing bore. The maximum allowable clearance is .003 inch.*

   Replace the bearings if the clearance exceeds this amount.

   NOTE: *IF THE SHAFTS ARE REPLACED because of excessive wear, install new bearings, or vice versa.*

7. Inspect the gear housing for gear cutout. and replace it and the gears as required if the gear tooth to housing bore clearance exceeds .010 inch at the "C" location while holding the gear tightly against .008 inch of feeler or shim stock between the gears and housing bore.

   NOTE: *Measurements are to be taken with the pump shafts in a vertical position in the bearings of the adapter cover and with the gear housing piloted on the adapted cover.*

8. Replace the gears if the faces are severely scored or if the width is smaller by more than .0055 inch of the gear housing width.

9. Replace the lip seals, O-rings, formed rings and backup ring.

10. Replace both the seal seat and bronze seal if the lapped mating surfaces are not smooth.

11. Replace the thrust bearing if the ball bearing and/or the raceways are pitted or spalled. Refer to fatigue failure in Step 5.

D. Assembly of Pump

Rewash and dry all parts that were stoned or filed.

1. Place the thrust washer in the correct bore of the end cover housing. Refer to Step 14 of Disassembly. Place bearings in the bores and press in until the face of the race is JUST BELOW the machined surface of the housing. DO NOT EXCEED .005 INCH MAXIMUM DEPTH.

2. Measure the gears and the gear housing as in Figures 17 and 18. Make note of the dimensions for the installation of the proper quantity of .002 inch thick brass shims only for .0035 to .0055 inch running clearance.

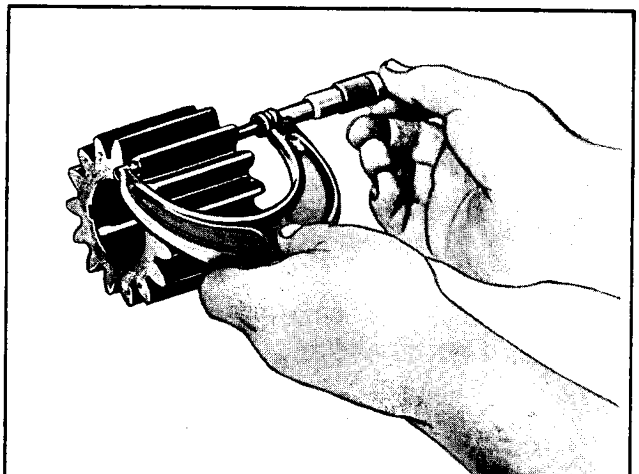

Fig. 17 — Measuring the Pump Gears

3. Install a formed ring with backup ring and an O-ring to the grooves of the adapter end housing. Align the dowel hole of the wear plate with the dowel pin of the adapter cover and place the wear plate with the bronze side toward the gears onto the housing face, and a seal ring around the wear plate. Coat the gear contact area of the wear plate with light oil.

   NOTE: *The dowel pins in the adapter and end cover housings and the one dowel locating hole in the wear plates and gear*

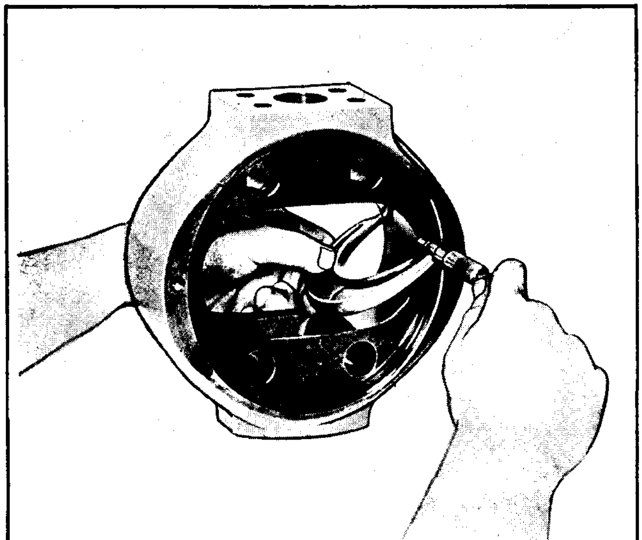

Fig. 18 — Measuring the Gear Housing

housing, makes it impossible to assemble the parts incorrectly.

4. Install the driven gear to the adapter end housing.

5. Install the drive shaft to the adapter end housing. The gear spline resting against the bearing will prevent the shaft from sliding through. Slide the gear over the shaft splines and against the wear plate. Line up the reference marks, Figure 10, if the gears are reused.

   NOTE: *The gear on the drive shaft MUST float after installation.*

6. Refer to Step 2 and install any brass shims.

7. Install the gear housing, over the shafts and gears, and tap down until bottomed against the wear plate with a soft hammer, Make sure the dowel hole of the housing is aligned with the dowel pin in the adapter end housing. Align reference marks if housing is reused.

8. Refer to Step 2 and install any brass shims.

9. Lubricate the gear faces with light oil. Align the dowel hole of the wear plate with the dowel hole in the gear housing and place the wear plate with bronze side toward the gears over the shafts and onto the gear housing. Place an O-ring around the wear plate.

10. Place a formed ring with backup ring and an O-ring coated with light grease to grooves in the end cover housing and install it over the shafts and tap down with a soft hammer until bottomed against the wear plate. Make sure the rings do not fall out of place. Install the large capscrews and torque to 190 ft. lbs. with a torque wrench. Be sure capscrews and spot-faces are free of nicks and burrs.

11. Install the capscrews with nuts and torque to 70 ft. lbs. with a torque wrench.

12. You have proper running clearance if: The shaft can be rotated with a wrench or other tool eight inches long, with only a slight drag. If effort is too great, add shims as required. DO NOT exceed .0055 clearance.

    Before adding shims, BE SURE the parts are clean and free of burrs or nicks. Also, first loosen the capscrews and turn the shaft while again tightening the capscrews and try effort to rotate again.

E. Shaft Seal Reassembly

1. With the drive shaft up, install the thrust bearing. MAKE SURE the side of the bearing having the greatest ball and retainer area exposed faces toward the roller bearing. Tap lightly on the bearing outer race with a soft drift and hammer until bottomed in the adapter cover housing.

2. Install the parts of the seal assembly onto the shaft in the following order:

   a. The steel washer with the shoulder against the thrust bearing.

   b. The drive key so the square head aligns with the slot in the bronze seal.

   c. The spring.

   d. The bronze seal. Coat the O-ring with light grease or oil before installing. MAKE SURE the slot is aligned with the drive key.

3. If the seal seat was removed from the retainer, reinstall it if the lapped seal surface is unmarred. If not, replace with a new seal. In either instance, coat the seal ring with light grease or oil, and hand press the seat into the retainer with the lapped surface facing toward the bronze seal. Use caution when installing, to prevent damage to the seal ring.

4. Place a seal ring in each of the outer grooves of the retainer and coat them and the seal seat lapped surface with light grease or oil, then install the retainer over the shaft and press into the adapter cover until bottomed. Install the six capscrews and tighten down evenly to 30 ft. lbs. with a torque wrench.

   NOTE: *Be sure to use capscrews of quality originally furnished with Nylock insert.*

5. Place the smaller outside diameter seal over the shaft with the lip facing toward the seal seat. Press the seal into the retainer until bottomed with a sleeve slightly smaller in diameter than the outside of the seal.

6. Place the large outside diameter seal over the shaft with the lip facing up then, press the seal into the retainer until bottomed with a sleeve slightly smaller in diameter than the outside of the seal.

F. Seal Reassembly

1. With the drive shaft up, install the thrust bearing over the shaft. MAKE SURE the side having the greatest ball and retainer area exposed faces toward the roller bearing. Tap lightly on the outer race with a soft drift and hammer until bottomed in the adapter cover housing.

2. Install the parts of the seal assembly and key dowel onto the shaft in the following order:

   a. Steel washer with the shoulder against the thrust bearing.

   b. The drive key so the square head aligns with the slot in the bronze seal.

   c. The spring.

   d. The bronze seal. Coat the O-ring in the bronze seal with light grease or oil before installing onto the shaft.

   NOTE: *Make sure that the bronze seal has two small drilled holes 180 degrees apart opening into the lapped sealing surface next to the shaft and that the slot is aligned with the drive key.*

3. If the seal seat was removed from the retainer, reinstall it if the lapped sealing surface is unmarred. If not, replace with a new seat. In either instance, coat the seal ring with light grease or oil, and hand press the seat into the retainer with the wide lapped surface facing the bronze seal. Use caution when installing, to prevent damage to the seal ring.

4. Install the seal to the retainer with the side stamped OUTSIDE facing up. Press in and bottom with a sleeve or other tool that is slightly smaller in diameter than the retainer to prevent damaging the metal case of the seal.

   Coat the outside surface of the bushing, and lips of the seal, with light grease or oil and install the bushing to the seal with the internal teeth of the bushing up.

5. Coat the O-ring *red in color,* with light grease or oil and install over the shaft to the groove next to the splines. To prevent damaging the ring when assembling, wrap the splines with some protective material and then remove.

6. Align the slot in the bronze seal of assembly, with the key dowel, and apply a few drops of light oil to the lapped face of the bronze seal.

NOTE: *The key dowel can easily be deformed or sheared off, if it is not in alignment with the bronze seal slot.*

7. Install the retainer assembly with the O-rings in place and coated with light grease or oil into the adapter end housing. Align the capscrew holes of the retainer with the threaded holes of the end housing and press the retainer in, being careful not to damage the O-rings, until capscrews will engage a few threads. Tighten the capscrews down evenly and torque to 30 ft. lbs. with a torque wrench.

NOTE: *Be sure to use capscrews of the quality originally furnished with Nylock insert.*

Install the snap ring.

G. To Install Hydraulic Pump

1. Place the adapter to transmission gasket in position on the transmission, and slide the splined adapter onto the transmission shaft.
2. Align pump drive shaft and splined adapter, and push pump drive shaft into splined adapter.
3. Rotate pump to align capscrew holes of pump adapter and transmission. Install capscrews with lockwashers and secure to a torque of 75 lbs. ft.
4. Attach suction line to pump with a new gasket adapter and four capscrews with lockwashers. Place seal ring in end fitting of pressure line and attach the pressure line to the pump using the two flange halves and four capscrews and lockwashers. Tighten both the suction and pressure line capscrews to the pump to a torque of 75 lbs. ft.
5. Fill the Hydraulic Tank. (Refer to Topic 5 in this Section.)

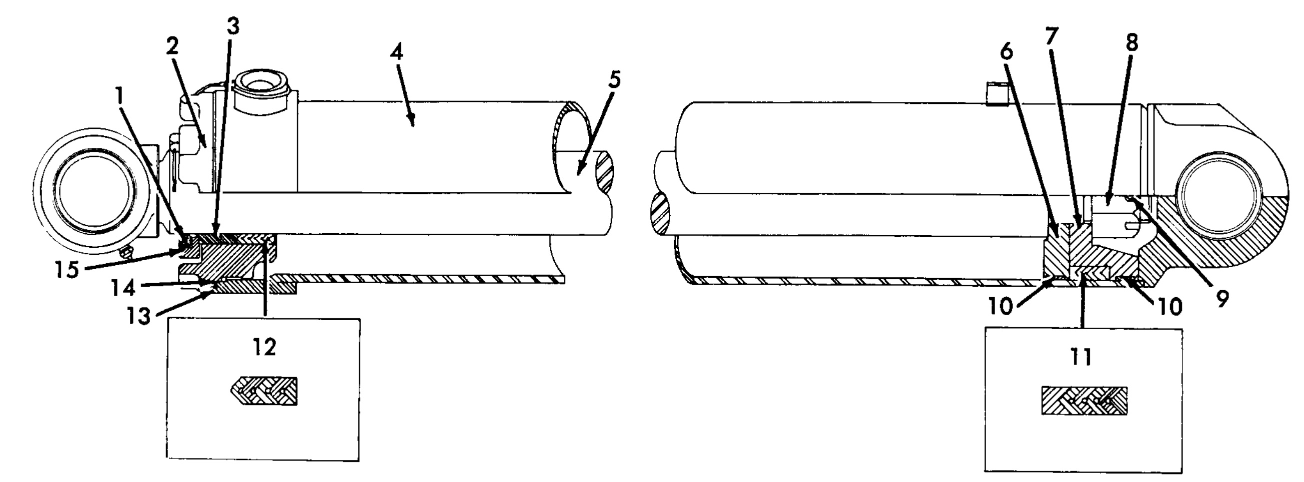

Fig. 19 — Lift Cylinder Cross Section

1. Wiper Seal
2. Cylinder Head
3. Packing Gland Bearing
4. Cylinder
5. Piston Rod
6. Upper Piston
7. Lower Piston
8. Slotted Hex Nut
9. Cotter Pin
10. Bearing Ring
11. Piston Packing
12. Rod Packing
13. Back-up Ring
14. Seal Ring
15. End Plate

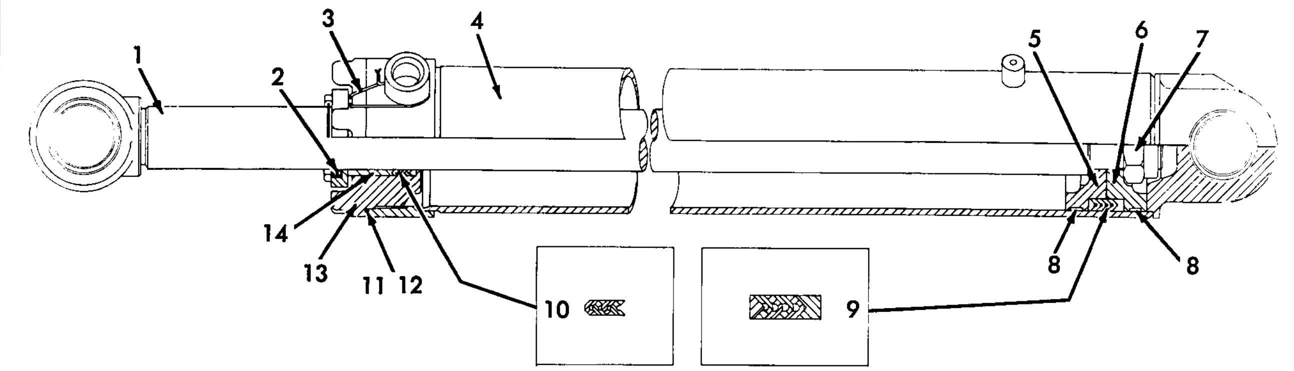

Fig. 20 — Dump Cylinder Cross Section

1. Piston Rod
2. Wiper Seal
3. Lockwire
4. Cylinder
5. Piston (Upper)
6. Piston (Lower)
7. Locknut
8. Bearing Ring
9. Piston Packing Set
10. Rod Packing Set
11. Back Ring
12. Seal Ring (O-Ring)
13. Cylinder Head
14. Packing Gland Bearing

10. HYDRAULIC CYLINDERS

A. General

The diameter and the length are the only differences between the two dump cylinders and the two lift cylinders, as the general make-up of both is the same. Each cylinder has a honed cylinder tube with an end casting welded on for the pivot pin anchorage. A rod assembly including the two pistons, piston packing set, piston bearing ring, hex nut, the packing gland end plate with wiper seal and the cylinder head assembly. The head assembly includes the rod packing set and the packing gland bearing. The cylinder head is threaded and has notches on the outer diameter. A seal ring is used in the groove of the cylinder tube to make the threads of the head and the threads of the cylinder head oil tight. A spanner wrench is used to tighten or loosen the head. Four capscrews in the end plate are used to adjust the cylinder rod packing, and are locked in position with a lockwire. Four capscrews are used to adjust the rod packing in the head of the cylinder, and after adjustment is made, a lockwire is used to lock the capscrews to maintain the adjustment. The

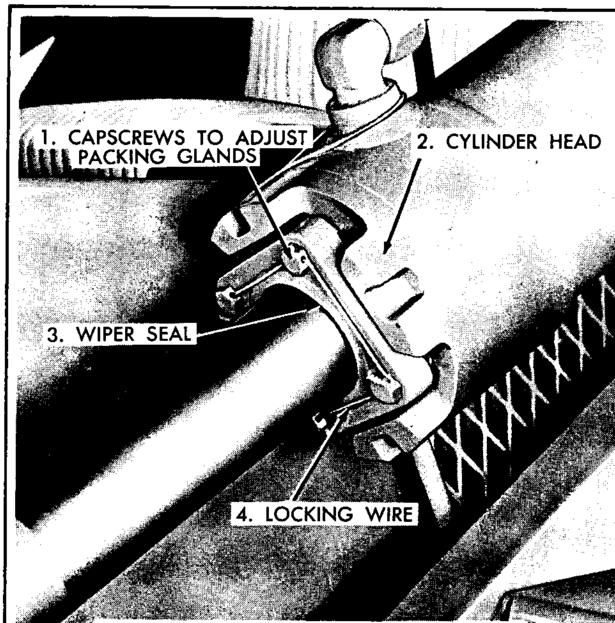

Fig. 21 — Hydraulic Cylinder Head

packing gland end plates (Fig. 21) should be adjusted so that there is a light film of oil on the piston rods when the unit is in operation.

B. To Replace Worn Rod Packing Rings

1. Lower the bucket to its normal position (dig position) on the ground. Remove the lockwire and the four capscrews attaching the packing gland end plate to the cylinder head.

2. Slide the packing gland end plate and packing gland bearing forward on the piston rod.

3. Remove the four (4) packing rings and wipe out the packing gland recess. Do not remove the bottom adapter ring.

4. Insert four (4) new packing rings into position in the recess of the cylinder head, making certain that the open end of the "V's" are toward the rear of the cylinder. CAUTION: *When installing the packing rings, stagger the gaps so that no two gaps are adjacent and make certain the edges are not over lapped or doubled back.*

5. Slide the packing gland bearing and the end plate back on the piston rod and install the attaching capscrews. Tighten the capscrews evenly and alternately, using slight pressure on a short wrench; DO NOT *OVER-TIGHTEN! Lock the capscrews with lockwire.*

C. To Replace Worn Piston Packing Rings

1. Relieve the pressure in the system by moving the control levers back and forth from the neutral position, with the bucket level on the ground.

2. Disconnect the hoses at the cylinder. Remove the cotter pin, lock pin and pivot pin from each end of the cylinder, and remove the cylinder from the loader.

3. With a spanner wrench loosen the cylinder head and pull the piston rod assembly from the cylinder tube.

4. Remove the locknut, bottom piston, four (4) packing rings, top and bottom adapter rings and the bearing rings from the piston.

5. Install a new packing set (having a free stacking height of $1\frac{15}{32}'' + \frac{1}{32}'' - 0$) in the lift cylinder or a new packing set (having a free stacking height of $1\frac{15}{32}'' + \frac{1}{32}'' - 0$) in the dump cylinder. Shim rings are available to attain these stacking heights if necessary. Refer to Figs. 19 and 20 for direction and order of assembly of piston packing rings.

6. Assemble piston, locknut and new bearing rings and inspect seal ring of cylinder head to tube, replace if necessary.

7. Slide piston rod assembly into cylinder tube and turn the cylinder head into place with a spanner wrench.

8. Install the cylinder in direct reversal of Step 2 above.

9. Connect the hoses disconnected in Step 2 above.

D. Hydraulic Cylinder Piston Rod Wiper Seals

The wiper seal (Fig. 21), installed in the packing gland end plate of each hydraulic cylinder, serves to wipe off dirt and foreign material from the piston rod surface. The wiper seal should be replaced when there are indications that the seal is not wiping the rod surface properly. Replace the wiper seal as follows:

1. Follow same procedure as in steps 1 through 4 of "To Replace Worn Piston Packing Rings."

2. Slide the top piston and cylinder head assembly off the rod.

3. Remove the lockwire, four (4) capscrews and packing gland end plate from the cylinder head.

4. Press the wiper seal out of the packing gland end plate.

5. Coat the O.D. of the new wiper seal with white lead. Lubricate the I.D. of seal with oil soluble grease. Press the seal into the packing gland end plate with the lip of the seal towards the outside of the cylinder.

6. Attach packing gland end plate to the cylinder head with the four capscrews. Tighten the capscrews evenly and alternately using slight pressure on a short wrench; *DO NOT OVER-TIGHTEN*. Lock the capscrews with lockwire.

E. To Remove the Hydraulic Cylinders

1. If it becomes necessary to replace the bushings in a hydraulic cylinder, remove the hydraulic hoses from the cylinder, after relieving the pressure in the system.

2. Support the cylinder while removing the cotter pin, lockpin and pivot pin from each end of the cylinder.

3. Align the bore of the bushing in an arbor press and suitably support the boss of either the casting end or the rod end, and push both bushings out through the bore.

4. Coat the new bushings with white lead and press one bushing from each side, flush with the face of the casting or rod eye.

F. Installation of Hydraulic Cylinders

Install the hydraulic cylinders in direct reversal of steps 1 and 2 of "E. To Remove the Hydraulic Cylinders," above.

SECTION XVII—SEAT FRAME AND OPERATOR'S COMPARTMENT

1. OPERATOR'S SEAT

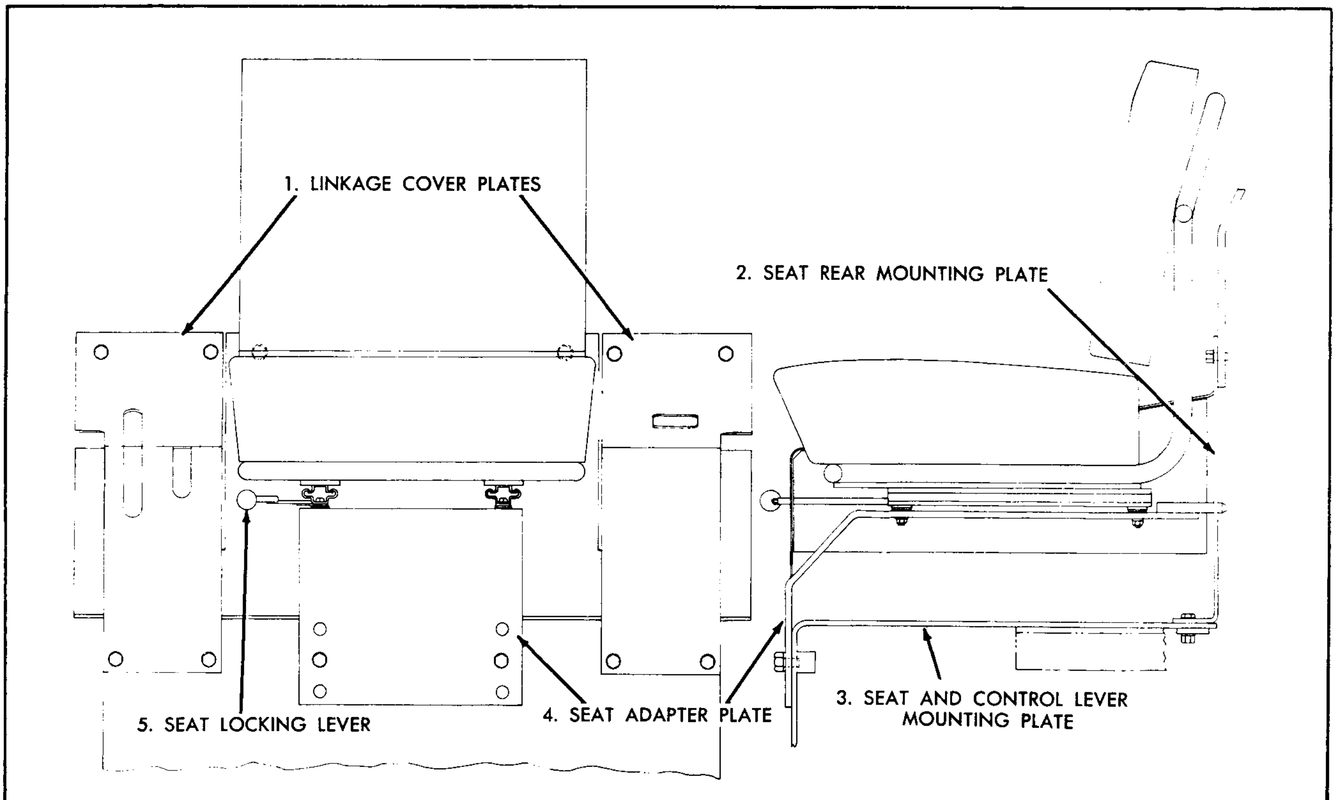

Fig. 1 — Seat Assembly Mounted

The tractor is equipped with an adjustable and removable seat. The seat cushion and back cushion are covered with weather resistant material and can be replaced if necessary. Reasonable care should be taken to avoid damaging the cushions with sharp or heavy objects, unnecessary exposure, battery acids, oil, and grease.

The seat height is adjustable by removing the two capscrews that hold the seat adapter plate to the mounting plate, and moving the seat assembly up or down to the desired height.

Forward and back seat travel is controlled by the locking lever at the front right hand corner of the seat frame. Push the lever to the left, move the seat forward or back and release the lever.

2. LINKAGE COVER PLATES, LEFT AND RIGHT

A. Removal

1. Remove the control lever knobs from the control levers.

2. Remove the four capscrews and lockwashers from each plate and remove the plates.

B. Maintenance and Inspection

Inspect the plates for bending and cracked welds. Should these conditions exist they must be corrected immediately.

C. Installation

Install the plates in a direct reversal of steps 1 and 2 of "A. Removal," above.

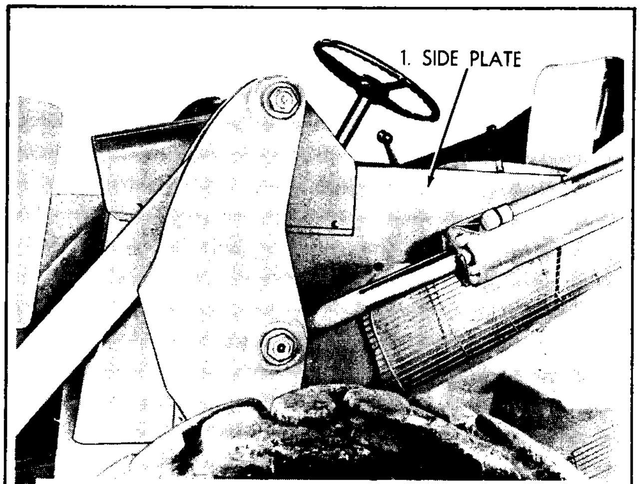

Fig. 2 — Operator's Compartment Side Plates

3. SIDE PLATES

A. Removal

1. Remove the seven capscrews, lockwashers, and two nuts that secure each side plate.

2. Lower each plate enough to clear the cowl top, pull the plate away from the tractor and raise it straight up and out of position.

B. Installation

Install the plates in a direct reversal of steps 1 and 2 of "A. Removal," above.

4. SEAT REAR MOUNTING PLATE

A. Removal

1. Remove the operator's compartment seat, side plates and linkage cover plates as described in Topics 1, 2 and 3 above.

2. Remove the four capscrews, lockwashers and hex nuts that secure the seat, rear mounting plate to the stabilizer weld assembly.

3. Tip the plate forward and remove.

B. Installation

Install the seat rear mounting plate in a direct reversal of steps 1 through 3 of "A. Removal," above.

17

5. FLOOR PLATES

A. Removal

1. Remove the Operator's compartment side plates as described in Topic 3 above.

2. Remove the six capscrews, lockwashers and hex nuts securing the front floor plate and remove the plate.

3. Disconnect the throttle linkage from the accelerator pedal, remove the six capscrews, lockwashers and nuts securing the rear floor plate and remove the plate.

B. Installation

Install the floor plates in a direct reversal of steps 1 through 3 of "A. Removal," above.

6. CONTROL LEVER AND SEAT, MOUNTING PLATE

A. Removal

1. Raise the boom to its full height. CAUTION: *Suitably support the boom to prevent accidental dropping during the following operations.*

2. Remove the operator's compartment side plates, seat assembly, linkage cover plates and seat rear mounting plate as described in Topics 2, 3 and 4 above,

3. Remove the linkage from the transmission control lever, parking brake lever, bucket control lever and boom control lever. WARNING: *When removing linkage from boom control lever and bucket control lever do not move either valve spool from its neutral (hold) setting.*

4. Remove the capscrews, lockwashers, and hex nuts that secure the lever assemblies to the mounting plate and remove the assemblies.

5. Disconnect the accelerator linkage between the accelerator pedal and the bell crank and remove the linkage. Remove the accelerator return spring, limit rod, and hinge pin and remove the accelerator pedal.

6. Remove the capscrews, flat washers, lock washers and hex nuts that secure the front and rear floor plates and remove the floor plates. Remove the four capscrews, lockwashers, and hex nuts that secure the left and right floor support angles and remove the angles.

7. Disconnect the transmission control linkage from the lower lever assembly. Remove the six capscrews, flatwashers, lockwashers and hex nuts that secure the lower lever assembly to the mounting plate and remove the lever assembly.

8. Disconnect the two lines from the clutch cut-off check valve. Remove the four capscrews, flatwashers, lockwashers and hex nuts that secure the air tanks front mounting bracket to the mounting plate.

9. Disconnect the five air lines from the brake application valve. Disconnect the two wires from the stop light switch. Remove the spring and limit rod from the brake pedal assembly.

10. Remove the four capscrews, lockwashers and hex nuts that secure the pedal and valve mounting bracket to the mounting plate provided on the frame cross member and remove the pedal and valve assembly as a unit.

11. Remove the four remaining capscrews, flatwashers, lockwashers and hex nuts that secure the seat and lever mounting plate to the loader main frame. Pull the mounting plate forward until its rear edge clears the stabilizer. The mounting plate can then be removed from the loader through either side opening.

B. Maintenance and Inspection

Check the mounting plate for misalignment, bending or cracked welds. If any of these conditions exist, they must be corrected immediately.

C. Installation

Install the mounting plate in direct reversal of steps 1 through 11 of "A. Removal," above.

CAUTION: *After installing check and adjust linkage before operating tractor.*

7. OPERATOR'S CONTROLS

A. General

The operator's controls for the transmission, the loader boom and bucket, the rear axle disconnect, the parking brake and the clutch cut-off are mount-

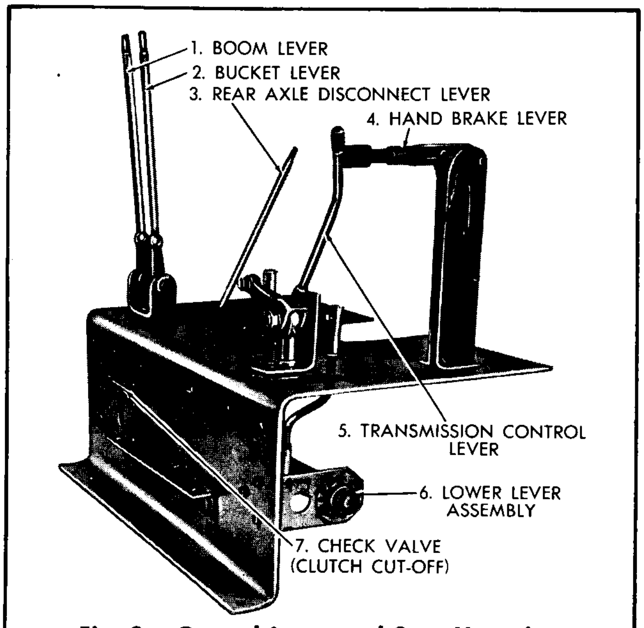

Fig. 3 — Control Lever and Seat Mounting Plate with Controls Attached

ed on the seat mounting plate. With the exception of the clutch cut-off check valve, they are of the lever and linkage type. A lower lever assembly is attached to the underside of the seat mounting plate and conveys the movement of the transmission selector lever on the left side of the operator's compartment to the range and directional valve spools on the right side of the transmission. The lower lever assembly also serves as a pivot point for the rear axle disconnect lever. These levers are all bearing mounted and require a minimum of service. However, at any time that the side panels are removed from the operator's compartment, lubricate the bearing on either end of the lower lever assembly and the transmission selector lever bearing with one or two shots of pressure gun lubricant.

If it is deemed necessary to lubricate the loader control levers or the rear axle disconnect lever, they must be disassembled and hand packed with pressure gun lubricant.

B. Transmission Control Lever Assembly

1. Removal

a. Remove the linkage cover plates. (Refer to Topic 2 in this Section.)

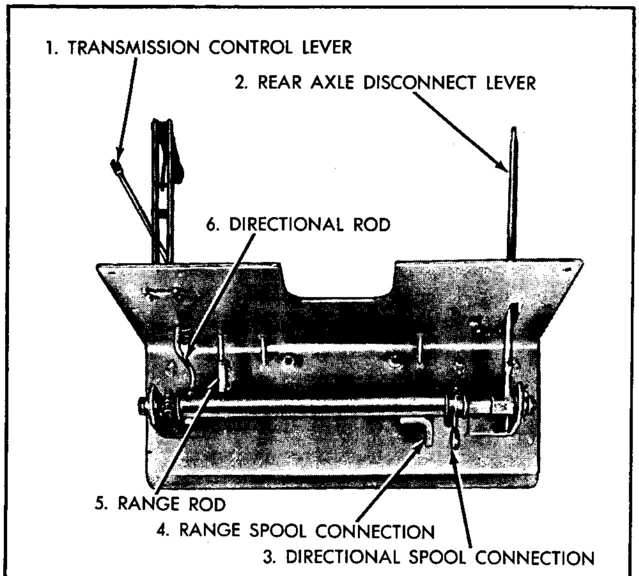

Fig. 4 — Rear of Mounting Plate Showing Lower Lever Assembly

b. Remove the operator's compartment side plates. (Refer to Topic 3 in this Section.)

c. Disconnect the directional and range rods from the lower lever assembly by removing the hex nuts and lockwashers and pushing the ball stud from the lever assembly, Fig. 5.

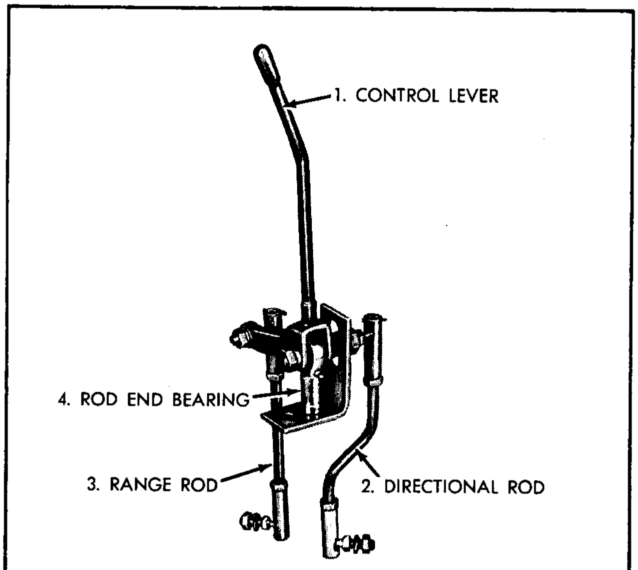

Fig. 5 — Transmission Control Lever Assembly

2. Disassembly

a. Remove the range and directional rods by removing the cotter pin from the ball joint assembly and backing off the ball adjusting screw until the ball clears the ball joint housing.

b. Loosen and remove the ball stud and lockwasher from the attaching pin.

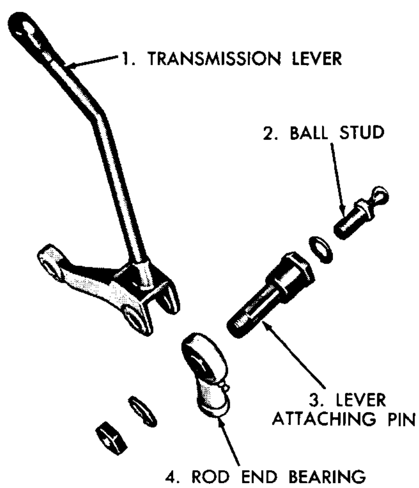

Fig. 6 — Transmission Lever Disassembled

c. Remove the hex nut and lockwasher from the lever attaching pin and remove the pin from the assembly.

3. Inspection of Parts

Rotate the rod end bearing in the fingers and check for roughness or drag. Check the lever and the attaching pin for cracks. Check the ball on the ball stud for scratches or galling. Replace all necessary parts.

4. Assembly

Assemble the transmission control lever in a direct reversal of the steps in Par. 2. "Disassembly."

C. Loader Control Levers

1. Removal

a. Remove the right hand linkage cover plate. (Refer to Topic 2 in this Section.)

b. Remove the right hand operator's compartment plate. (Refer to Topic 3 in this Section.)

c. Disconnect the rods from the boom and bucket lever.

d. Drive the roll pin (Fig. 7) from the mounting shaft and remove the shaft, two levers and the flat washer spacer.

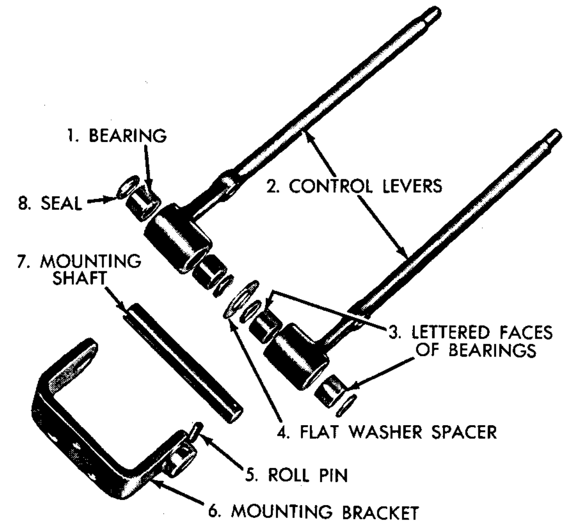

Fig. 7 — Loader Control Levers Disassembled

2. Inspection of Parts

Check the bearings for roughness and the mounting shaft for scoring and roughness. Replace all necessary parts. The bearings must be pressed in and out of the control levers. When pressing a bearing in, the lettering on the bearing must be towards the outside (Fig. 7) of the lever boss. Be sure that the seals are installed with the lips to the outside.

3. Installation

Install the loader controls in a direct reversal of the steps in "1. Removal" and referring to Fig. 7 for correct placement of the levers in the mounting bracket.

D. Lower Control Lever Assembly and Rear Axle Disconnect Lever

1. Removal

a. Remove the linkage cover plates (Refer to Topic 2 in this Section).

b. Remove the operator's compartment side plates. (Refer to Topic 3 in this Section).

c. Remove the four transmission rods from the lower lever assembly.

d. Remove the six capscrews, lockwashers and hex nuts that secure the lever assembly to the seat mounting plate. Remove the assembly.

2. Disassembly

a. Loosen the Allen head set screws that secure the shaft end bearings to the shaft. (Fig. 8).

b. Slide the bearings and the mounting brackets off of the shaft. If bearing replacement is necessary the bearing may now be removed from the mounting bracket by removing the three capscrews, lockwashers and hex nuts from each bearing assembly.

c. Slide the rear axle disconnect lever, the spacer and the large flat washer off of the shaft.

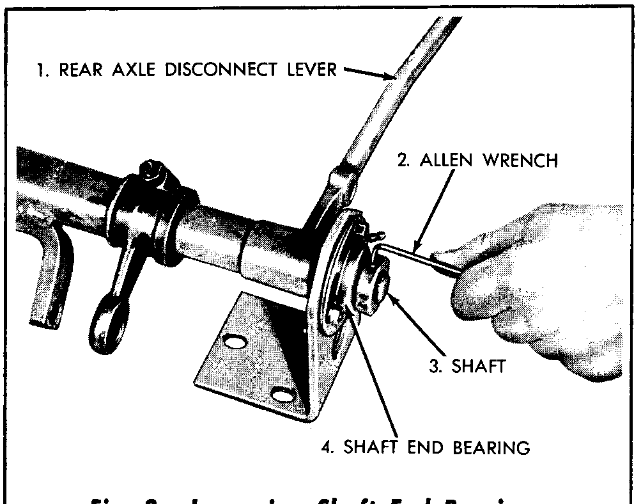

Fig. 8 — Loosening Shaft End Bearings from Shaft

d. Loosen the capscrew clamps in the directional levers and slide the levers off of the shaft. Remove the two Woodruff keys. Remove the two flat washers.

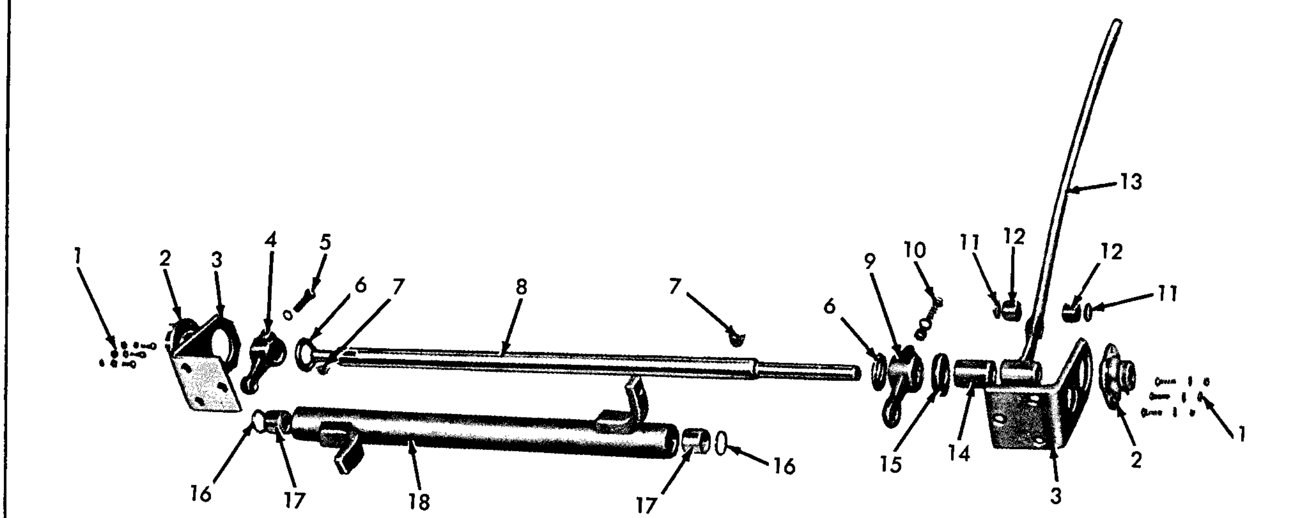

Fig. 9 — Lower Control Lever Assembly — Disassembled

1. Capscrews, Lockwashers and Hex Nuts (End Bearing to Mounting Bracket)
2. End Bearing
3. Mounting Bracket
4. Left Hand Lower Control Lever (Directional)
5. Capscrew and Lockwasher (L.H. Lower Control Arm)
6. Flat Washer
7. Woodruff Key
8. Shaft
9. Right Hand Lower Control Lever (Directional)
10. Capscrew, Lockwasher and Hex Nut (R.H. Lower Control Lever)
11. Seal (Installed Lip Out)
12. Bearing (Installed Lettered Side Out)
13. Rear Axle Disconnect Control Lever
14. Spacer
15. Large Flat Washer
16. Seal (Installed Lip Out)
17. Bearing (Installed Lettered Side Out)
18. Lower Control Lever (Range)

e. Slide the range lever assembly off of the shaft.

3. Inspection of Parts

Inspect all of the parts for cracks, bends or worn areas. If the needle bearing in the disconnect lever or the range-lower control lever are replaced the new bearings must be pressed in with the lettered end out. The seal must be pressed in with the lip out.

4. Assembly

Assemble the lower control lever assembly in a direct reversal of the steps in "2. Disassembly" above. Check the following during the assembly procedure:

a. Do not reverse the positioning of the left and right directional levers on the shaft. (Refer to Fig. 8 and 9.)

b. Install the rear axle disconnect lever with the large end of the boss toward the center of the assembly. (Refer to Fig. 8.)

c. Adjust the thrust on the shaft end bearings so that all levers move freely on the shaft but no lateral movement is apparent on the shaft.

d. Hand pack all needle bearings before assembly with pressure gun lubricant.

5. Installation

Install the lower control lever assembly in a direct reversal of the steps in "1. Removal." When the assembly is in place and before the side plates are installed, apply one or two shots of pressure gun lubricant to the shaft end bearings. CAUTION: *When the installation is complete, the transmission linkage must be adjusted before the unit is put back in service. Refer to Section 10 for correct procedure.*

E. Ball Joint Linkage Rods

The linkage rods with ball joint ends are all of identical construction. The ball and seats may be inspected by removing the cotter pin and backing the threaded seat out of the socket. Pull the socket clear of the ball and allow the smooth seat to drop from the socket. If replacement is deemed necessary, the whole unit must be replaced. If the unit is to be reused be sure the smooth seat is assembled with the small concave end facing the ball. Ball joint lubricant consists of one or two drops of motor oil.

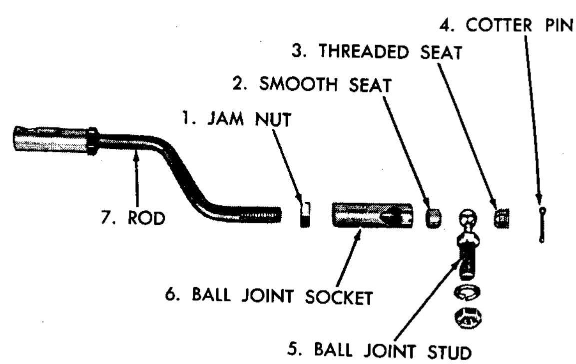

Fig. 10 — Linkage Rod and Ball Joint

F. Parking Brake Lever

Refer to Section XII "Brakes."

G. Clutch Cut-Off Check Valve

Refer to Section XII "Brakes."

SECTION XVIII—LOADER LINKAGE

1. DESCRIPTION

The major components of the linkage group are: boom, cross links, dump links, bucket, and the pivot pins necessary to attach these components. The lift cylinders operate the front end of the boom, to raise and lower the bucket, and the dump cylinders dump and retract the buckets, by actuating the cross links to which the dump links are attached. Proper lubrication at the correct intervals is imperative to troublefree linkage operation.

A. Boom

The boom is a one piece steel weldment with a formed steel plate on each side and a formed steel tubular cross-brace welded to the outside plates of the boom to provide for; connecting the lift cylinders; cradling the bucket through the carrying position; and stopping and cleaning the bucket at the full dump position. The rear of the boom is connected to the side plates of the frame, just behind the operator's compartment, and to the bottom mounting holes of the bucket, at the front end. Replaceable bushings are pressed into all the bores of the boom except the lift cylinder bores.

B. Cross Links

The four cross links are formed steel plates with welded bosses provided to insert the pins for; attaching the cross links to the side plates of the boom; attaching the dump cylinders, and attaching the dump links.

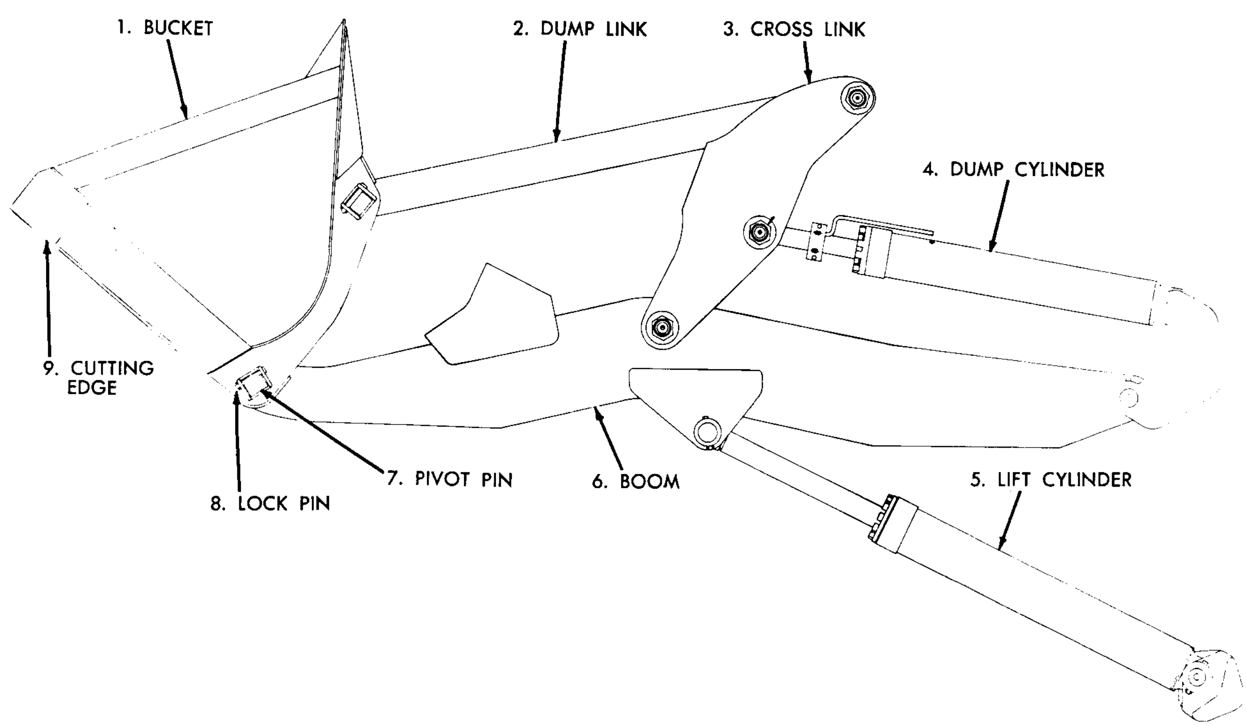

Fig. 1 — Loader Linkage

C. Dump Links

The dump links are steel plates with bosses welded to each end to provide for attaching the dump links to the bucket and to the cross links. The cross link end and the bucket end bores of the dump links each contain replaceable bushings.

D. Bucket

The bucket is a steel weldment consisting of: spill guard, back sheet, side plates, side reinforcing plates, angles, lugs, double bottom plates and ribs. The cutting edge is a one-piece wrap-around type riveted to the bottom plate and side plates of the bucket.

2. BOOM

A. Maintenance and Inspection

The boom should be checked periodically for cracked welds, bending and misalignment. Any of these conditions should be corrected immediately.

B. Repair

If the boom becomes cracked or broken due to unusually rough work, it may be practical to weld and reinforce it with suitable steel plates. Before welding the boom, it should be aligned and straightened if necessary. If it is not practical or desirable to straighten or weld the boom, it must be replaced.

C. Removal

1. Raise the bucket and dump it so that the cutting edge rests on the ground, and place approximately a 12" block under the spill guard.

2. Remove the cotter pin, lock pin, and pivot pin from each of the boom to bucket, and dump link to bucket locations.

3. Remove the hex jam nuts, washer and pivot pin from the dump link to cross link connections, noting the location and quantity of shims at each connection.

4. Support each dump cylinder and remove the hex jam nut, washer, and pivot pin from each dump cylinder to cross link and cross link to boom connection, noting the location and quantity of shims at each point. Remove the cross links.

5. Support each lift cylinder and remove the cotter pin, lock pin, and pivot pin from each lift cylinder to boom connection.

6. Support the boom and remove the cotter pin, lock pin and pivot pin from each side of the boom to frame connection, and remove the boom.

D. Bushings

If the bushings are to be replaced, press the bushings out, coat the O.D. of the new bushings with white lead and press them into their respective bores of the boom.

E. Installation

Install the boom in direct reversal of "C. Removal" above, and install shims as noted.

3. CROSS LINKS

A. Maintenance

The cross links should be checked periodically for cracked welds, bending and misalignment. Any of these conditions should be corrected immediately.

If the pivot pin bores are worn or the cross links are damaged, they should be replaced.

B. Removal

Removal of the cross links may be accomplished by following Steps 3 and 4 of "2. Boom" in this Section.

C. Installation

To install the cross links, directly reverse steps in "B. Removal," above, and install shims as noted.

4. DUMP LINKS

A. Maintenance and Inspection

The dump links should be checked periodically for cracked welds, bending, misalignment and loose or worn bushings. Any of these conditions should be corrected immediately. Before welding the dump links, they should be aligned and straightened, if necessary.

B. Removal

1. With the bucket cutting edge flat on the ground, remove the cotter pin, lock pin, and pivot pin from the bucket end of the dump link.
2. Remove the hex nut, washer and pivot pin from the cross link end of the dump link, noting the location and quantity of shims.
3. Remove the dump link.

C. Bushings

If the bushings become worn or damaged, they should be replaced. Press the bushing out of the dump link; coat the O.D. of the new bushings with white lead; press the bushings into their respective bores of the dump link.

D. Installation

To install the dump links directly reverse the steps in "B. Removal" above, and install shims as noted.

5. BUCKET

A. Maintenance and Inspection

The bucket should be checked periodically for cracked welds, bending, misalignment and broken rivets in the cutting edge. Any of these conditions should be corrected immediately.

B. Repair

If the bucket becomes cracked or broken due to rough work it may be practical to weld and reinforce it with suitable steel plates. Before welding the bucket it should be aligned and straightened, if necessary. If it is not practical or desirable to straighten or weld the bucket, it must be replaced.

If the rivets in the cutting edge become loose or broken, they must be replaced, as a loose cutting edge may cause considerable damage to the bucket.

To remove the cutting edge, melt the rivets out of their holes, making certain not to cut into the bucket bottom plate or end plate.

Locate and align the new cutting edge on the bucket.

Install hot rivets and flatten the rivets to fill the counterbore of the bottom plate holes. Be certain that the rivets are flattened flush with the top surface of the bottom plate.

C. Removal

To remove the bucket, follow steps 1 and 2 of "C. Boom Removal," in this Section.

D. Installation

Install bucket in direct reversal of steps in "C. Removal."

SECTION XIX—LADDER AND GUARD GROUP

1. DESCRIPTION

The ladder and step are provided to assist the operator in entering or leaving the operator's compartment. The guards are provided to protect the operator when the unit is in operation. The ladder is a formed steel rod weldment bolted to the left hand side of the main frame. The step is bolted to the boom and positioned so that when the boom is down (bucket near the ground) the step is horizontal to the ground. The guards are formed rod weld assemblies bolted to the inside of each boom arm.

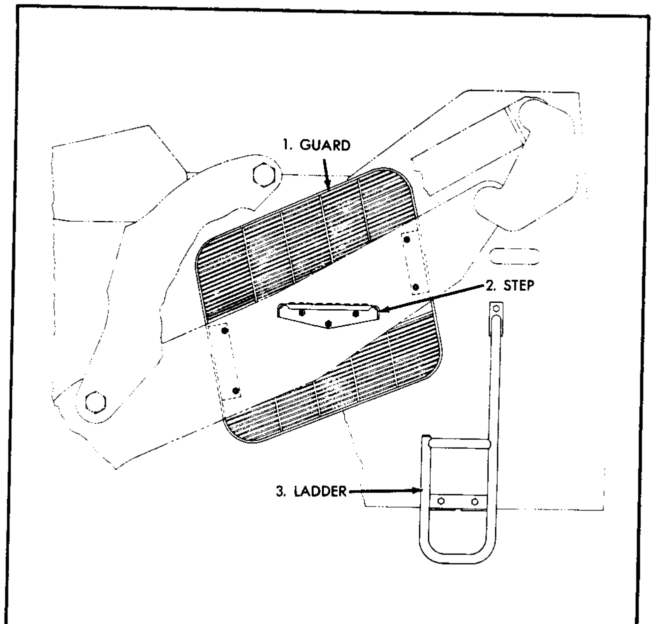

Fig. 1 — Ladder and Guards

2. LADDER

A. Removal

1. Remove the two capscrews, lockwashers and hex nuts securing the lower end of the ladder to frame.

2. Remove the two capscrews and lockwashers securing the top end of the ladder to frame, and remove the ladder.

B. Installation

Install the ladder in direct reversal of "A. Removal," above.

3. STEP

A. Removal

1. Remove the three capscrews, lockwashers and hex nuts from the step to boom.

2. Remove the step.

B. Installation

Install the step in direct reversal of "A. Removal," above.

4. GUARDS

A. Removal

1. Remove the capscrews, lockwashers, flat washers and hex nuts that secure the guard to the boom.

2. Remove the guard.

B. Installation

Install the guard in direct reversal of "A. Removal," above.

SECTION XX—SPECIAL EQUIPMENT

1. GENERAL

The special equipment mentioned in this section may be purchased separately for field installation or, with the exception of the winch, the tractor loader may be ordered with the equipment factory installed. For a more complete list and additional information concerning special equipment, contact your "Allis-Chalmers" Construction Machinery Dealer.

2. LIFT FORK

The lift fork, is constructed for lifting and carrying almost any material not in loose form. The lift forks are adjustable horizontally on their mounting and installation is identical to bucket installation.

3. CRANE HOOK

The crane hook is designed for lifting and carrying bundles or objects that can be moved with slings or wire ropes. Installation is identical to bucket installation.

4. LIFT TONGS

The lift tongs are manufactured primarily for the lumber industry to be used in transporting and stockpiling logs. A third hydraulc control is added to control the clamping action of the upper tongs.

5. DOZER BLADE

The dozer blade, mounted in place of the bucket, is well suited for back-filling, digging, pushing, dumping and spreading. It is used primarily for short haul excavation. Its installation is identical to the bucket installation.

6. WINCH

The hydraulically operated winch is mounted on the rear of the loader with its controls conveniently mounted in the operator's compartment. A free spooling clutch enables the line to be payed out from the ground.

7. BUCKET TEETH

Bucket teeth with replaceable tips can be installed on the cutting edge of the bucket to increase the digging ability of the loader in heavily compacted material.

SECTION XXI—GENERAL MAINTENANCE INSTRUCTIONS

1. BEARINGS AND BUSHINGS

A. Ball Bearings

Clean and inspect all ball bearings to see that they roll freely and are free from cracked, pitted, or worn balls and races.

Badly worn bearings can be detected by the presence of excessive end play between the outer and inner races. This condition can be detected by holding one race steady and moving the other race endwise, comparing the difference in movement of the races of the used bearing and a new bearing.

Check the outer and inner races for indications of bearing creepage. This can be detected by marks on the bearing races or on the bearing area or the bore or shaft where the bearing has been used.

Always lubricate a bearing at assembly with clean lubricant.

B. Tapered Roller Bearings

1. Thoroughly clean and inspect the bearings for worn and pitted rollers and races.
2. Inspect the outside of the bearing cup (outer race) and the inside of the cone (inner race) for marks which indicate creepage.
3. Always set up a tapered roller bearing in accordance with the specifications. IMPORTANT: DO NOT EXPERIMENT. A properly set up tapered roller bearing will give satisfactory service for a very long time, while a bearing pre-loaded too much or set up too loose may fail in a comparatively short time.
4. Lubricate the bearings at assembly with clean lubricant.

C. Needle Bearings

Needle bearings are used primarily in place of bushings where an oscillating motion is present. They are seldom used on a revolving part.

1. Thoroughly clean and inspect the rollers for wear or damage.
2. Inspect the needle retaining cage for dents

which may interfere with the free rolling of the needles.

3. Be sure that the needles or rollers are not "cocked" in the cage and rotate each needle individually to be sure that it will turn.

4. Lubricate or pack the bearings at assembly with clean lubricant.

D. General

1. Do not use a bearing which is in bad condition.

2. Keep all bearings spotlessly clean and well lubricated to prevent rusting. When installing new bearings, do not remove the bearings from package until ready for assembling.

3. Use a press and a suitable sleeve or driver when installing bearings. If these are not available, a cold rolled soft steel rod and hammer may be used to drive the bearings into position.

   Bearing inner races may be heated to expand the bore, thus facilitating the installation of the bearing on a shaft. One method of transferring heat to bearings is through the use of hot oil. The bearings should never be placed directly on the bottom of a tank or container, but should be suspended in the oil on hooks or laid on a screen so that they may be heated uniformly. A light or medium grade of clean lubricating oil should be used and the temperature must never exceed 300° F.

4. When installing a bearing on a shaft, drive or press on the inner race; when installing it in a bore, drive or press on the outer race.

5. Be careful not to strike the shield, snap ring, or balls when using a rod and hammer to install the bearings.

6. When using a sliding hammer type puller to remove or install an assembly containing tapered roller bearings, be sure that the pull is evenly distributed on the bearing. Do not allow the cup and the cone of the bearings to become separated, as each blow of the sliding hammer, with the cup and the cone separated, would cause the cup and the cone to be rammed together and damage to the bearing would result.

E. Bushings

1. Do not remove the bushings for inspection unless the bushings are loose in their bores or are excessively worn, then they must be removed and replaced.

2. Use a press and a suitable sleeve or driver to install the bushings. Ream the bushings to the specified dimensions when reaming is required.

2. SHAFTS AND SPLINES

A. Shafts

Inspect all shafts for worn areas and make certain they are not twisted or bent. Check the bearing journals and make certain they are smooth, round, and are of the specified diameter, to assure the proper fit of the bearing or bushing.

B. Splines

1. Inspect the splines of all shafts for roughness, burrs, and wear. Remove all burrs and roughness from the splines with a stone or mill file.

2. Be sure the splines of all shafts are smooth and try all the gears on their respective shafts to be sure that they slide freely on the splines.

C. Detents

Inspect the detent notches in the transmission and hydraulic control valve spools. Make certain the detent balls have been entering the detent notches.

3. SHIFTING FORKS

Check the spools for binding and make certain the spools are not bent as indicated by uneven wear. Observe the side faces of the spools for wear and roughness.

4. OIL SEALS

A. Lip Type

1. When any work has been done which involves the removal of a shaft from an oil seal, or the removal of an oil seal from its bore, the sealing lip of the seal must be carefully examined.

2. The sealing lip must not be scratched, folded over, torn, or charred from heat. The lip must be flexible and the spring, located inside the lip, must have the proper tension to return the lip to its proper position when the lip is pressed in by hand.

3. Be sure that the surface of the shaft contacted by the lip of the oil seal is smooth and free from tool marks or burrs.

4. When installing an oil seal on a shaft, or a shaft through an oil seal, be sure to protect the sealing lip from damage which might be caused from a keyway, splines, threads, or a hole through the shaft. A small scratch or cut, or a fold in the lip of the seal, will render the seal useless. Use an oil seal installing bushing, or a thin sheet of stiff paper wrapped around the sharp portion of the shaft, then slide the seal over the bushing or paper.

5. Use an oil seal installing tool or a press when installing seals into their bores, to prevent damage to the outer case of the seals. If the proper installing tools are not available, a smooth piece of metal or a block of wood can be placed flat against the face of the seal and the seal can be driven into position with a hammer.

6. When a new oil seal is to be installed, always lubricate the sealing lip before installing.

B. Positive Type

The sealing surfaces of the seal rings (positive type) must be smooth and flat. Scratches on the surface, no matter how slight, may be conducive to leakage of lubricant. If replacement of a seal ring is necessary, its mating ring must also be replaced. When assembling, make certain that the sealing surfaces are clean and lubricate the sealing surfaces with clean engine oil.

5. GASKETS

1. When a gasket is removed from the loader, clean the gasket and inspect it for damage. If it is in good condition, and is to be used again, immerse it in a container of oil and keep it in the container until it is needed.

2. Do not use a gasket which is torn, hardened, or shrunken out of shape.

6. GEARS

1. Thoroughly clean and inspect all gears for worn, pitted, chipped, or cracked teeth.

2. Check the internal splines for galling, roughness, and wear.

3. Make certain that the teeth of the transmission gears are in good condition.

7. HOSES

Inspect all water and air hoses, fuel lines, hydraulic hoses, and lubricating oil lines for leaks and signs of collapsing and deterioration of the rubber on the inside of the hoses. Replace if necessary.

8. WIRING

1. Do not allow the insulation of the cables to become soaked with fuel or lubricating oil.
2. Wrap all frayed spots of the insulation with tape.
3. Keep all terminals and connections clean and tight.
4. When replacing or repairing electrical cables, make certain that the proper gauge cable(s) are used.

9. BATTERIES

1. Keep the batteries clean and maintain the level of the electrolyte solution above the battery plates as indicated on the cap, by the addition of clean distilled water.
2. Be sure that the battery hold-down assemblies are tight so that the batteries do not shift around in their compartment.
3. Periodically, clean the battery terminals and apply a light coating of petroleum jelly to the terminals.
4. Periodically check the specific gravity of the batteries with a hydrometer (refer to "Electrical System," Section VI).

10. RADIATOR

1. Keep the radiator filled to the proper level with clean coolant. Only clean water free from lime or other minerals should be used. A permanent type (ethylene glycol) antifreeze solution should be used in freezing weather.
2. Remove all leaves and other debris from the air passages of the radiator. IMPORTANT: *DO NOT PAINT THE RADIATOR CORE.*
3. Keep the radiator and the radiator shell mounting bolts properly tightened.
4. Keep the fan and water pump drive belts properly adjusted and make certain the belts are in good condition.

11. FILTERS

1. Fuel filter elements should be changed after every 500 hours of operation (more often if conditions warrant) or when the filter elements become clogged. Engine oil filter elements should be changed each time the oil in the crankcase is changed.
2. Hydraulic oil filter elements in hydraulic tank should be changed after every 100 hours of operation (more often if conditions warrant). Refer to "Hydraulic System," Section XVI.
3. Transmission filter element and screen should be replaced and cleaned respectively after every 1000 hours of operation (refer to "Torque Converter and Transmission," Section X).
4. When installing new filter elements be sure that all gaskets are in place and are in good condition.
5. Check all filter connections for leaks after an element has been replaced.

12. PIPING

1. Tighten fittings only tight enough to prevent leakage. If the fittings are drawn up too tight they will be damaged and must be replaced.
2. Always be sure that the tubing flares and nuts are clean before tightening.

13. FASTENERS

1. Keep all nuts, bolts, hose clamps, etc., tight at all times. A periodic check of these parts does not take long and may prevent the occurrence of a major failure.
2. Replace any broken or missing capscrews, nuts, or lockwashers.

14. ADJUSTING SHIMS

Shims should be flat and the surfaces clean and free from foreign substances or corrosion. When removing or adding shims, check the thickness of each shim with a micrometer to obtain accurate adjustment.

15. MAGNET

Hydraulic system magnet should be cleaned daily for the first 4 or 5 days of operation. Thereafter, clean magnet every 100 hours of operation (refer to "Hydraulic System," Section XVI).

16. SCREENS

1. Suction line screen in hydraulic tank shouid be cleaned daily for the first 4 or 5 days of operation. Thereafter, clean screen after every 100 hours of operation (refer to "Hydraulic System," Section XVI).
2. Clean or replace the transmission oil screen every 1000 hours (refer to "Torqmatic Transmission," Section X).

17. MISCELLANEOUS

1. Keep the outside of the engine free from deposits of oily dust, which acts as an insulation material and prevents cooling by radiation.
2. Make all adjustments as specified in this manual.
3. Use only genuine "Allis-Chalmers" parts for replacement.

SECTION XXII—FITS AND TOLERANCES

1. GENERAL

This section has been prepared to provide those responsible for the maintenance of the tractor with the proper fits and tolerance information for the various assemblies.

The information herein deals with the fits and tolerances of parts when they are new and the amount of wear permissible before the parts must be replaced.

When making repairs to the tractor, refer to this section for the proper fits and tolerances information.

2. TURBOCHARGER

Description	Size of New Parts
A. Turbine Wheel	
1. Radial movement not to exceed	.023"
B. Turbine Wheel Shaft	
1. End play	.004" min. & .008" max.
2. Shaft diameter	.6861 min.
C. Compressor Wheel	
1. Radial movement not to exceed	.023"
2. Back clearance	.020" — .022"
D. Bearing	
1. Bearing limits	O.D. .871" min. I.D. .6883" max.
E. Thrust Collar	
1. Thrust flange thickness	.099" min.
2. Distance from bottom face of thrust collar to back of flinger	.450" — .453"

Description	Size of New Parts
F. Thrust Washers	
1. Flat thrust washer thickness	.092" min. (may not vary more than .002")
2. Flange thrust washer overall thickness	.195" to .205"
3. Flanged thrust washer pocket depth	.106" max.
G. Bearing Housing	
1. Piston ring bore	.877" max.
H. Compressor Housing	
1. Piston ring seal bore	.720" max.

3. ENGINE

A. Cylinder Sleeve	
1. Type	Replaceable Wet
2. Inside diameter	4.4370" — 4.4385"
3. Diameter of sleeve at machined area just below flange	5.030" — 5.032"
4. Diameter of cylinder sleeve at packing ring location	4.967" — 4.969"
5. Sleeve flange outside diameter	5.249" — 5.253"
6. Cylinder block-to-sleeve clearance at sleeve lower diameter	.001" — .005"
7. Cylinder block-to-sleeve clearance at machined area just below flange	.0005" — .0045"
8. Cylinder block-to-sleeve clearance at sleeve flange	.003" — .012"
9. Clearance of piston skirt with sleeve	.0070" — .0095"
10. Fire wall height above cylinder sleeve flange	.042" — .045"
11. Top surface of cylinder sleeve flange above cylinder block with sleeve installed	.0065" — .0095"
12. Flange height adjusting shims available	.005", .008", .010" .015" and .020"
13. Allowable taper	.0015"
14. Allowable out of round (when installed)	.001"
B. Cylinder Block	
1. Counterbore diameter in cylinder block for cylinder sleeve flange	5.256" — 5.261"
2. Depth of counterbore for cylinder sleeve flange	.3125" — .3135"
3. Bore in cylinder block for cylinder sleeve — top	5.0325" — 5.0345"
4. Bore in cylinder block for cylinder sleeve — bottom	4.970" — 4.972"
5. Bore in cylinder block for camshaft bearings	2.4975" — 2.4985"
6. Bearing bore in cylinder block for main bearings (without bearing, cap in place, and nuts tightened to specified torque)	3.8118" — 3.8125"

Description	Size of New Parts
C. Piston	
NOTE: *Combustion chamber is in piston*	
1. Combustion chamber I.D.	2.258" — 2.262"
2. Combustion chamber depth	1.183" — 1.187"
3. Material	Aluminum Alloy
4. Length	5.993" — 5.997"
5. Diameter between top and second ring groove	4.406" — 4.410"
6. Diameter at bottom of skirt measured at right angle to piston pin	4.429" — 4.430"
7. Bore for piston pin	1.6264" — 1.6266"
8. Measurement from center of piston pin bore-to-top of piston	3.609" — 3.613"
9. Clearance of piston skirt with sleeve	.0070" — .0095"
D. Piston Pin	
1. Type	Full floating
2. Piston pin length	3.789" — 3.804"
3. Diameter of pin	1.6265" — 1.6267"
4. Fit of pin in piston at room temperature	.0001" — .0003" tight
5. Inside diameter of connecting rod bushing	1.6277" — 1.6282"
6. Piston pin-to-connecting rod bushing clearance	.001" — .0017"
E. Piston Rings	
1. Number of rings on each piston	4
2. Location of rings	3 compression and 1 oil control; all above piston pin
3. Gap between ends — fitted — 4.437"/4.4385" bore sleeves	
1 — Top	.023" min. — .038" max.
2 — 2nd & 3rd	.013" min. — .026" max.
1 — 4th (3 piece)	.013" min. — .058" max.
4. Clearance of rings in grooves:	
Top compression ring (chromium plated)	.004" — .0055"
2nd and 3rd (compression rings)	.0030" — .0045"
4th (oil control ring)	.003" — .009"
5. Only standard size rings are available	
F. Crankshaft	
1. Journal diameter for connecting rods	2.7715" — 2.7725"
2. Journal diameter for main bearings	3.498" — 3.499"
3. Width between connecting rod journal cheeks	1.750" — 1.754"
4. Width of main bearing journals:	
a. Front bearing	2.250" — 2.255"
b. Intermediate bearings	1.623" — 1.627"
c. Center bearing	2.688" — 2.692"
d. Rear bearing	2.229" — 2.239"

Description	Size of New Parts	Install New Parts When Clearance Exceeds
5. Crankshaft end clearance	.006" — .014"	.022"
6. Separate type thrust flanges	Available in standard size and .005", .010", 0.15" oversize	
7. Crankshaft journals may be ground	.010", .020", .030", or .040" undersize	
8. Fit of crankshaft gear on crankshaft	.0005" — .0025" tight	
G. Main Bearings		
1. Number used	7	
2. Type	Replaceable precision	
3. Inside diameter of front, intermediate, center and rear bearing (with nuts tightened to specified torque)	3.501" — 3.5027"	
4. Diameter of crankshaft main bearing journals	3.498" — 3.499"	
5. Bearing-to-journal clearance at front, intermediate, center and rear bearings (with nuts tightened to specified torque)	.002" — .0047"	.009"
6. Overall length of main bearings:		
Front and intermediate	1.348" — 1.358"	
Center	2.244" — 2.254"	
Rear	1.991" — 2.001"	
7. Undersize bearings available for service	.010", .020", .030" and .040"	
8. Separate type thrust flanges	Available in standard size and .005", .010", .015" oversize	
9. Front, intermediate, center and rear bearing wall thickness (standard bearing)	.1549" — .1554"	.153"
10. Bearing bore in cylinder block (without bearing, cap in place, and nuts tightened to specified torque)	3.8118" — 3.8125"	
11. Torque for tightening main bearing cap nuts:		
⅝" N.F.	160 — 170 lbs. ft.	
¾" N.F.	210 — 230 lbs. ft.	
H. Connecting Rod Bearings		
1. Type	Replaceable precision	
2. Inside diameter of bearing (with nuts tightened to specified torque)	2.7745" — 2.776"	
3. Diameter of crankshaft connecting rod journals	2.7715" — 2.7725"	
4. Connecting rod bearing-to-journal clearance (with nuts tightened to specified torque)	.002" — .0045"	.009"
5. Overall length of connecting rod bearings	1.363" — 1.373"	
6. Undersize bearings available for service	.010", .020", .030" and .040"	
7. Bearing wall thickness (standard bearing)	.12475" — .12525"	.123"
I. Connecting Rods		
1. Type	Balanced forging	

Description	Size of New Parts	Install New Parts When Clearance Exceeds
2. Bolts used per rod	2	
3. Connecting rod length (center-to-center)	10.498" — 10.502"	
4. Inside diameter of connecting rod bushing (finished bore)	1.6277" — 1.6282"	
5. Outside diameter of connecting rod bushing	1.8170" — 1.8202"	
6. Bearing bore (without bearing, cap in place, and nuts tightened to specified torque)	3.025" — 3.0255"	
7. Connecting rod bearing-to-crankshaft journal clearance (with nuts tightened to specified torque)	.002" — .0045"	.009"
8. Connecting rod width at lower end	1.745" — 1.746"	
9. Side clearance-to-crankshaft journal	.004" — .009"	
10. Piston pin diameter	1.6265" — 1.6267"	
11. Piston pin bushing length in connecting rod	1.552" — 1.572"	
12. Piston pin-to-connecting rod bushing clearance	.001" — .0017"	.003"
13. Torque for tightening connecting rod cap nuts	120 — 130 lbs. ft.	

J. Exhaust Valves

1. Valve lift (at valve)	.482"	
2. Valve lift (at cam)	.327"	
3. Seat Angle	45°	
4. Valve seat contact width	(.08768") 3/32"	
5. Valve lash (cold)	.020"	
6. Valve lash (engine coolant at normal operating temperature)	.018"	
7. Head diameter	1 5/8"	
8. Overall length	6.804"	
9. Stem diameter	.3715" — .3720"	
10. Inside diameter of valve guide	.3735" — .3740"	
11. Stem-to-guide clearance	.0015" — .0025"	.005"
12. Valve spring free length	2 49/64"	
13. Valve spring length (valve closed)	2.312"	
14. Valve spring length (valve open)	1.832"	
15. Spring load at 2.312" length	57/64 lbs.	
16. Spring load at 1.832" length	136 — 146 lbs.	
17. Refacing wheel angles	.30°, 45°, 60°	

K. Intake Valves

1. Valve lift (at valves)	.482"	
2. Valve lift (at cam)	.327"	
3. Seat angle	45°	
4. Valve seat contact width	(.08768") 3/32"	
5. Valve lash (cold)	.020"	
6. Valve lash (engine coolant at normal operating temperatures)	.018"	
7. Head diameter	1.840"— 1.850"	
8. Overall length	6.804"	
9. Stem diameter	.3715" —.3720"	
10. Inside diameter of valve guide	.3735" — .3740"	
11. Stem-to-guide clearance	.0015" — .0025"	.005"

Description	Size of New Parts	Install New Parts When Clearance Exceeds
L. Intake Valve Inner Spring		
1. Valve spring free length	2⅝"	
2. Valve spring length (valve open)	1.578"	
3. Valve spring length (valve closed)	2.062"	
4. Spring load at 1.578" length	66 — 72 lbs.	
5. Spring load at 2.062" length	30 — 35 lbs.	
6. Combined load of inner and outer springs		
Valve closed	70 — 80 lbs.	
Valve open	154 — 169 lbs.	
M. Intake Valve Outer Spring		
1. Valve spring free length	3 1/16"	
2. Valve spring length (valve open)	1.828"	
3. Valve spring length (valve closed)	2.312"	
4. Spring load at 1.828" length	89 — 97 lbs.	
5. Spring load at 2.312" length	40 — 45 lbs.	
6. Combined load of inner and outer spring		
Valve closed	70 — 80 lbs.	
Valve open	154 — 169 lbs.	
N. Exhaust Valve Seat Insert		
1. Seat angle	45°	
2. Seat contact width	(.08768") 3/32"	
3. Seat runout	.002"	
4. Insert press fit	.0025" — .0045"	
5. Insert O.D. not installed	1.690" — 1.691"	
6. Bore in cylinder head for insert	1.6865" — 1.6875"	
O. Intake Valve Seat Insert		
1. Seat angle	45°	
2. Seat width	(.08768") 3/32"	
3. Seat runout	.002"	
4. Insert Press fit	.0025" — .0045"	
5. Insert O.D. not installed	1.8745" — 1.8755"	
6. Bore in cylinder head for insert	1.871" — 1.872"	
P. Exhaust and Intake Valve Guide		
1. Length	3½"	
2. Inside diameter	.3725" — .3740" (after assembly)	
3. Stem-to-guide clearance	.0015" — .0025"	.005"
4. Guide stand-out from bottom of counterbore in cylinder head		
Exhaust	1 1/16"	
Intake	⅞"	

Description	Size of New Parts	Install New Parts When Clearance Exceeds
Q. Rocker Arms		
1. Bore in rocker arm for bushing	1.061″ — 1.062″	
2. I.D. of rocker arm bushing (finished bore)	1.001″ — 1.0015″	
3. Fit of rocker arm bushing in rocker arm bore	.004″ — .0065″ tight	
4. O.D. of rocker arm shaft	.999″ — 1.000″	
5. Rocker arm shaft-to-bushing clearance	.001″ — .0025″	.005″
6. Rocker arm ratio	1.53:1	
7. Concave expansion plug size	¾″	
R. Camshaft		
1. Number of bearings used	4	
2. I.D. of camshaft bearings (when installed)	2.2494″ — 2.252″	
3. O.D. of camshaft journals	2.2465″ — 2.2475″	
4. Camshaft bearing-to-journal running clearance	.0019″ — .0055″	.0075″
5. O.D. of camshaft bearings	2.5005″ — 2.5015″	
6. Bearing bore in cylinder block	2.4975″ — 2.4985″	
7. Fit of camshaft bearings in bore of cylinder block	.002″ — .004″ tight	
8. Overall width of camshaft bearings:		
Front bearing	1.560″ — 1.564″	
Intermediate bearings	.935″— .939″	
Rear bearing	1″	
9. Camshaft end play	.003″ — .009″	
10. Camshaft gear width	1.3125″	
11. Fit of camshaft gear on camshaft	.0005″ — .002″ tight	
12. Specified thickness of thrust collar	.205″ — .206″	
S. Valve Lifter and Valve Lifter Bracket		
1. Bore in valve lifter bracket for lifter	.8127″ — .8137″	
2. O.D. of valve lifter stem	.8102″ — .8107″	
3. Fit of valve lifter in bore of valve lifter bracket	.002″ — .0035″	
T. Gear Train		
Backlash between mating gears	.003″ — .007″	
U. Cylinder Head		
1. Valve sequence (front-to-rear in each head)	Intake — Exhaust	
2. Cylinder head gasket thickness (compressed)	.057″ — .067″	
V. Lubricating Oil Pressure Pump		
1. Radial clearance — gears-to-pump body	.00175″ — .00275″	.004″ — .006″
2. End clearance — pump gears	.002″ — .004″	.005″ — .007″
3. I.D. of gear shaft bushings (finished bore)		
Front cover	1.2495″ — 1.2505″	
Housing	.937″ — .938″	
4. Upper shaft O.D. at cover bushing location	1.247″ — 1.248″	
5. Upper shaft O.D. at housing bushing location	.9350″ — .9355″	

Description	Size of New Parts	Install New Parts When Clearance Exceeds
6. Clearance — upper shaft-to-shaft bushings:		
Cover	.0015" — .0035"	
Housing	.0015" — .0030"	
7. Capacity at engine speed at 1800 R.P.M.	15.3 G.P.M.	
8. I.D. of lower gearing housing	.7495" — .7505"	
9. Lower shaft O.D.	.7485" — .7490"	
10. Clearance — lower gear bushing-to-shaft	.0005" — .0020"	

W. Water Pump

Description	Size of New Parts	Install New Parts When Clearance Exceeds
1. Clearance between impeller and water pump body	.018" — .049"	
2. Front bearing:		
Bearing bore (I.D. for shaft)	.78725" — .78740"	
Shaft diameter	.7871" — .7876"	
Fit — shaft to bearing	.0035" tight — .0003" loose	
Bearing O.D.	2.0470" — 2.0472"	
Bore in water pump body (for bearing)	2.0467" — 2.0477"	
Fit — bearing O.D. to body	.0005" tight — .0007" loose	
3. Rear bearing:		
Bearing bore (I.D. for shaft)	.78725" — .78740"	
Shaft diameter	.7871" — .7876"	
Fit — shaft to bearing	.00035" tight — .0003" loose	
Bearing O.D.	1.8502" — 1.8504"	
Bore in water pump body (for bearing)	1.8499" — 1.8509"	
Fit — bearing O.D. to body	.0005" tight — .0007" loose	
4. Pulley driving flange bore	.7856" — .7866"	
Fit — flange I.D. to shaft	.0005" — .002" tight	

X. Fan Hub Assembly

Description	Size of New Parts	Install New Parts When Clearance Exceeds
1. Front bearing:		
Bearing bore (I.D. for shaft)	.98415" — .98430"	
Shaft diameter	.9835" — .9840"	
Fit — shaft to bearing	.00015" — .0008" loose	
Bearing O.D.	2.0470" — 2.0472"	
Bore in hub (for bearing)	2.0466" — 2.0476"	
Fit — bearing to hub	.0006" loose — .0006" tight	
2. Rear bearing:		
Bearing bore (I.D. for shaft)	1.18095" — 1.18110"	
Shaft Diameter	1.18030" — 1.18080"	
Fit — shaft to bearing	.00015" — .0008" loose	
Bearing O.D.	2.4407" — 2.4409"	
Bore in Hub (for bearing)	2.4403" — 2.4413"	
Fit — bearing to hub	.0006" loose — .0006" tight	

4. TRANSMISSION

Description	Size of New Parts
A. Lube Pressure Regulator Valve Spring	
1. Spring pressure	35.1 ± 3.5 lb. at 2.000 inch operating height
B. External Splined Reverse Clutch Plate	
1. Thickness	0.123" — 0.107"
2. Cone	0.097" min. — 0.030" max.
C. Internal Splined Reverse Clutch Plate	
1. Thickness	0.156" — 0.150"
2. Cone	0.130" min. — 0.012" max.
3. Groove depth	0.005" min.
D. Reverse Planetary Carrier Assembly	
1. Gear end clearance with unit assembled	0.55" max.
E. Clutch Piston Return Spring	
1. Spring pressure	16.0 ± 1.6 lbs. at 5.34 inch operating height
F. Reverse Clutch Anchor	
1. Face wear	0.020" max.
G. Forward Sun Gear to Forward Planetary Carrier Thrust Washer	
1. Thickness	0.90" — 0.75"
H. Forward Planetary Carrier Assembly	
1. Gear end clearance with unit assembled	0.55" max.
2. Bushing clearance with transmission main shaft	0.010" max.
I. Total Clutch Wear Permissible	
1. Forward	0.162" max.
2. Reverse	0.307" max.
J. Intermediate-Range Clutch Apply Piston	
1. Face wear	0.010" max.
2. Belleville return spring free height	0.259" — 0.279"

Description	Size of New Parts
K. Intermediate-Range Internal Splined Clutch Plate	
1. Thickness	0.156" — 0.150"
2. Cone	0.130" min. — 0.012" max.
3. Groove depth	0.005" min.
L. Intermediate-Range External Splined Clutch Plate	
1. Thickness	0.127" — 0.123"
2. Cone	0.197" min. — 0.030" max.
M. Total Clutch Wear Permissible	
1. Intermediate	0.080" max.
N. High Range Carrier Assembly	
1. Gear end clearance with unit assembled	0.055" max.
2. Reaction surface wear	0.010" max.
O. External Splined Low and High Range Clutch Plate	
1. Thickness	0.123 — 0.107"
2. Cone	0.097" min. — 0.012" max.
P. Internal Splined Low and High Range Clutch Plate	
1. Thickness	0.156" — 0.150"
2. Cone	0.130" min. — 0.012" max.
3. Groove depth	0.005" min.
Q. High and Low Range Clutch Anchor	
1. Face wear	0.020" max.
2. Piston return spring pressure	16.0 ± 1.6 lb. at 5.34" operating height
R. Low Range Sun Gear to Low Range Planetary Assembly Thrust Washer	
1. Thickness	0.126" — 0.122"
S. Low Range Planetary Carrier Assembly	
1. Gear end clearance with unit assembled	0.035" max.
T. Total Clutch Wear Permissible	
1. High range	0.062"
2. Low range	0.134"

Description	Size of New Parts

U. Shifter Fork Detent Spring

1. Pressure	28.6 ± 2.8 lb. at 1.20″ operating height

V. Front Output Shaft Bushing

1. Clearance with rear output shaft	0.005″

W. Input Charging Oil Pump

1. Driven gear shaft diameter	1.000″ max. — 0.9975″ min.
2. Drive gear shaft diameter	1.000″ max. — 0.9975″ min.
3. Pump body bore diameter	

X. Valve Body

1. Detent spring pressure	15 ± 1.5 lb. at 13/16″ operating height
2. Clutch cut-off retainer plug clearance with valve plug	0.004″ max.
3. Clutch cut-off valve clearance with valve body	0.004″ max.
4. Clutch cut-off valve spring pressure	18 ± 1.8 lb. at 1.531″ operating height
5. Valve sleeve clearance with forward and reverse valve	0.004″ max.
6. Range selector valve clearance with valve body	0.004″ max.

Y. Main Pressure Regulator

1. Valve clearance with valve body	0.004″ max.
2. Spring pressure	133 ± 2.5 lb. at 4.20″ operating height

5. AXLES

A. Differentials

1. Differential tapered pinion bearing preload	5 to 15 lbs. in Rotating Torque
2. Ring gear run-out	Not to exceed .008″
3. Backlash for ring and pinion gear	.006″ to .012″
4. Thrust block to ring gear clearance	.010″ to .015″
5. Bearing lock plate capscrews	15 to 17 lbs. ft.

B. Planetary Hubs

1. Maximum preload of the bushing caps	.001″ shim
2. Lower bushing cap retaining capscrews torque	168 to 180 lbs. ft.
3. Knuckle flange stud nuts	186 to 205 lbs. ft.
4. Spindle flange capscrews	186 to 205 lbs. ft.
5. Ring gear retaining plate capscrew torque	22 to 24 lbs. ft.
6. Wheel bearing adjusting nut torque	350 to 400 lbs. ft.

C. Pinion Shaft

Pinion Shaft Thread Size	Torque Required to Obtain Correct Preload
1" x 20	350 — 400 lbs. ft.
1¼" x 18	850 — 900 lbs. ft.
1½" x 12	1000 — 1100 lbs. ft.
1½" x 18	1000 — 1100 lbs. ft.
1¾" x 12	1000 — 1100 lbs. ft.

D. Ring Gear Rivet Pressure

Diameter of Rivet	Tonnage Required
7/16"	22
½"	30
9/16"	36
⅝"	45

E. Assembly Torque Specifications

Diameter	No. Threads	Torque Minimum	Torque Maximum

1. Differential Case Halves

Diameter	No. Threads	Torque Minimum	Torque Maximum
½"	20	94	102
9/16"	18	132	145
⅝"	18	186	205
¾"	16	325	360

2. Differential Bearing Caps

(Torques Given are for Capscrews or Stud Nuts)

Diameter	No. Threads	Torque Minimum	Torque Maximum
⅝"	11	127	140
⅝"	18	127	140
¾"	10	230	250
¾"	16	230	250
⅞"	9	345	370
⅞"	14	345	370
⅞"	14	375	415

3. Pinion Cage

Diameter	No. Threads	Torque Minimum	Torque Maximum
⅜"	16	26	29
7/16"	14	54	58
½"	20	94	102
9/16"	12	120	129
⅝"	11	168	180

Diameter	No. Threads	Torque Minimum	Torque Maximum
4. Differential Carrier to Axle Housing			
7/16"	14	54	58
1/2"	20	94	102
5/8"	18	186	205
3/4"	16	325	360
5. Steering Knuckle Socket to Axle Housing			
9/16"	12	120	129
3/4"	10	290	320
7/8"	14	510	570
6. Spider and Wheel Cover to Drum			
7/16"	14	54	58
1/2"	13	85	91
1/2"	20	94	102

7. General Torque Specifications SAE Capscrews, Studs and Nuts

The Torque Specifications listed in the following chart apply only when not listed in the assembly procedures, or machine limit and torque specifications.

(All Torque Values are Given in Pound Feet)

Size	Threads Per Inch	Grade 5 (Standard Heat Treated)	Grade 8 (Special Heat Treated, Allen Head or Self Locking)
5/16	18	16 — 18	24 — 26
5/16	24	18 — 20	27 — 29
3/8	16	29 — 32	43 — 46
3/8	24	33 — 37	49 — 53
7/16	14	46 — 50	69 — 73
7/16	20	52 — 57	76 — 82
1/2	13	71 — 78	106 — 113
1/2	20	80 — 88	118 — 128
9/16	12	101 — 111	148 — 160
9/16	18	113 — 124	165 — 180
5/8	11	140 — 155	210 — 225
5/8	18	160 — 175	230 — 255
3/4	10	255 — 275	365 — 400
3/4	16	280 — 310	405 — 445
3/4	20	285 — 320	415 — 460
7/8	9	380 — 410	585 — 645
7/8	14	415 — 455	645 — 710
7/8	20	430 — 475	670 — 745
1	12	610 — 675	955 — 1055
1	14	625 — 690	975 — 1080
1	16	640 — 705	990 — 1100

Diameter	No. Threads	Torque Minimum	Torque Maximum
Size	Threads Per Inch	Grade 5 (Standard Heat Treated)	Grade 8 (Special Heat Treated, Allen Head or Self Locking)
1	20	655 — 720	1015 — 1125
1⅛	12	835 — 925	1385 — 1535
1⅛	16	870 — 960	1430 — 1590
1¼	12	1180 — 1290	1935 — 2135
1¼	16	1210 — 1330	1985 — 2210
1¼	18	1215 — 1345	2000 — 2230
1⅜	12	1565 — 1730	2600 — 2875
1⅜	16	1605 — 1785	2650 — 2960
1½	12	2045 — 2270	3390 — 3765
1½	16	2100 — 2330	3475 — 3875

6. AIR COMPRESSOR

Description	Size of New Parts
A. Discharge Valves	
1. Maximum groove depth in face of valve	.003″
2. Discharge valve travel with new valves, springs and cap nuts installed	.036″ to .058″
B. End Covers	
1. Oil seal ring gap when placed in end bore of crankshaft	.008″ to .015″
C. Inlet Valve	
1. Maximum groove depth in face of valve	.003″
2. Distance from top of cylinder block to inlet valve seat	.145″
3. After installing new seats the distance from the top of the cylinder block to the valve seat should be	.101″ to .113″
D. Cylinder Bores	
1. Maximum out-of-round	.002″
2. Maximum taper	.003″
3. Clearance between pistons and cylinder bores	.002″ to .004″
E. Piston Rings	
1. Ring gap. Ring in cylinder bore	.007″ to .019″
2. Groove clearance. Ring installed on piston	.0015″ to .0030″
F. Wrist Pins	
1. Clearance of wrist pin to connecting rod bushing	.0015″

Description	Size of New Parts
G. Connecting Rod Bearings	
1. Clearance between connecting rod journal and connecting rod bearing	.0003″ to .0021″
H. Crankshaft	
1. Maximum journal out-of-round before regrinding	.001″
I. Connecting Rods	
1. Clearance between wrist pin bushing and wrist pin	.0001″ to .0006″

7. POWER STEERING

Description	Size of New Parts
A. Power Steering Pump	
1. Maximum gap between bearing rollers	.020″
2. Maximum housing gear bores (Measured through the dowel pin hole centerline)	3.259″
3. Maximum differential between housing width with no gaskets, and gears. Replace gears if maximum is exceeded	.0035″
4. Assembled total end clearance between the gear faces and the housing width	min. .0025″ — max. .0035″
5. Maximum shaft wear at roller pattern. (Replace bearings if it is necessary to replace the shaft)	.001 of major dia.
6. Housing capscrew torque. Tighten opposite capscrews	60 lbs. ft.
B. Power Steering Valve	
1. Maximum diameter differential in worm balls	.0001″
2. Valve adapter capscrew torque	25 to 30 lbs. ft.
3. Valve cover capscrew torque	15 to 20 lbs. ft.
C. Power Steering Gear	
1. Maximum clearance between lash adjuster head and shaft	.002″
2. Thrust bearing preload. Amount of pull on rim of 18″ diameter wheel	½ to 1 lb.
3. Total preload on steering gear. Amount of pull on rim of 18″ diameter wheel in a 20° arc over center. Thrust and lash adjustments completed	1⅛ to 2 lbs.

8. HYDRAULIC SYSTEM PUMP

Description	Size of New Parts
A. Maximum shaft wear at bearing area	.001"
B. Maximum clearance between shaft bearing rollers	.003"
C. Maximum gear tooth to housing bore clearance	.010"
D. Maximum differential between width of gears and width of gear housing	.0055"
E. Running clearance of gears between wear plates	.0035" to .0055"
F. Maximum depth of bearing below machined surface of housing	.005"
G. Capscrew torque:	
1. Capscrews with hex nuts	70 lbs. ft.
2. Large capscrews	190 lbs. ft.
3. Seal retainer capscrews	30 lbs. ft.

SECTION XXIII—TROUBLE SHOOTING

1. GENERAL

This section contains trouble shooting information and outlines tests which can be made to determine some of the troubles that may develop in the loader when it is used under average working conditions. Each symptom of trouble is recorded under the individual unit or system of the loader and is followed by a list of the possible causes of the trouble. The tests necessary to determine which of the possible causes is responsible for the trouble are explained after each possible cause, with reference to where instructions for their correction may be found.

2. ENGINE FUEL SYSTEM, GOVERNOR AND ENGINE CONTROLS

Refer to Section II for full details on components of the fuel system.

A. Checking of Fuel Supply System

The function of the fuel injection pump is to meter the fuel and deliver it, under high pressure, to the fuel injection nozzles at the proper interval in the engine cycle. Uneven running of the engine, excessive vibration, stalling when idling, and loss of power are symptoms of low fuel pressure or insufficient supply of fuel; check the following possible causes.

1. Insufficient fuel in fuel tank.
2. Air being drawn into the system on the suction side of the fuel transfer pump.
3. Clogged fuel filter elements and fuel lines.
4. Inoperative fuel return pressure relief valve or inoperative fuel transfer pump.
5. Inoperative fuel injection nozzle(s).
6. Inoperative fuel injection pump.

The following causes and remedies refer to steps 2 through 6 above.

TROUBLE	POSSIBLE CAUSE	REMEDY
Steps 2 thru 6 above.	1. Failure of electrical shut-off.	1. Readjust or replace if necessary.
	2. Fuel lines clogged or restricted.	2. Blow out all fuel lines with filtered air. Replace if damaged. Remove and inspect all flexible lines. Refer to Section II in Manual.
	3. Air leaks on suction side of system.	3. Pressurized system with air to locate leaks. Repair as needed.
	4. Transfer pump worn or broken.	4. Replace.
	5. Shut-off device at "stop."	5. Move to "run" position.
	6. Passage from transfer pump to metering valve clogged with foreign matter.	6. Disassemble and flush out hydraulic head.
	7. Governor spring worn or broken.	7. Remove and replace.
	8. Governor linkage broken.	8. Remove, replace and readjust.
	9. Tank valve closed.	9. Open valve.
	10. Cranking speed too low.	10. Charge or replace batteries.
	11. Lube oil too heavy at low temperature.	11. Refer to Section VIII in the Manual.
	12. Engine engaged with load.	12. Disengage load.
	13. Nozzles faulty or sticking.	13. Replace or correct nozzles.
	14. Intake air temperature low.	14. Provide starting aids.
	15. Engine compression poor.	15. Correct compression. Refer to Section VIII in the Manual.
	16. Pump timed incorrectly to engine.	16. Correct timing. Refer to Section VIII in the Manual.
	17. Transfer pump faulty, pressure too low.	17. Remove and inspect parts. Refer to Section II in Manual.
	18. Filters clogged.	18. Remove and replace clogged elements.
	19. Engine valves faulty or out of adjustment.	19. Correct valves or valve adjustment as in Section VIII in Manual.
	20. Water in fuel.	20. Drain fuel system and pump housing, provide new fuel, prime system.
	21. Return oil line restricted.	21. Remove line, blow clean with filtered air and reassemble. Replace if damaged.
	22. Engine rotation wrong.	22. Check for proper injection pump.
	23. Air intake restricted.	23. Check. Refer to Section III in Manual.

TROUBLE	POSSIBLE CAUSE	REMEDY
	24. Pump housing not full of fuel.	24. Operate engine for approximately 5 minutes until pump fills with fuel.
	25. Low cetane fuel.	25. Provide fuel per engine specifications.
	26. Injection lines leaking or connected to wrong engine cylinder.	26. Relocate lines for correct engine firing sequence.
	27. Nozzle return lines clogged.	27. Remove lines, blow out, inspect and reassemble.
	28. Governor high-idle adjustment incorrect.	28. Adjust to pump specifications.
	29. Throttle arm travel not sufficient.	29. Check installation and adjust throttle linkage.
	30. Engine overheating.	30. Correct as in Sections II and IV in Manual.
	31. Exceeding rated load.	31. Reduce load on engine.
	32. Engine cold.	32. Check thermostats, warm to operating temperature. Refer to Sections III and IV in Manual.
	33. Lube oil pumping past valve guides or piston rings in engine.	33. Correct as in Section VIII in Manual.
	34. Excess lube oil in engine air cleaner.	34. Remove, check and reduce oil quantity to specified level.

B. Engine Controls

Engine controls vary the speed of the engine to suit loader requirements. If the engine does not respond to accelerator action, and the other components of the engine fuel system are in working order, refer to Section II for proper adjustment of controls. In addition, make sure that the rods move freely.

3. ENGINE AIR INTAKE

Refer to "Engine Air Intake System," Section III, for full details of the components of the air system.

TROUBLE	POSSIBLE CAUSE	REMEDY
Insufficient air supply to cylinders. (This condition will be indicated by black smoke from the exhaust, loss of power, and hard starting.)	1. Air cleaner pipe clogged.	1. Remove the oil cup, swab the obstruction from the pipe, and service the air cleaner (refer to "Engine Air Intake System," Section III).
	2. Loose hose clamp, damaged gasket, or damaged hose.	2. Tighten all hose clamps and replace damaged gasket and hose (refer to "Engine Air Intake System," Section III).

TROUBLE	POSSIBLE CAUSE	REMEDY
Rapid wear on engine parts.	1. Dirt admitted with intake air.	1. Inspect the engine air cleaner body and the air cleaner pipe and connections THOROUGHLY, to detect any cracks or openings which would allow air to enter the engine, without first passing through the air cleaner.
	2. Dirty Lubricating oil.	2. Change engine oil and the lubricating oil filter element at the intervals recommended. Keep oil clean when filling engine.
	3. Improper fuel.	3. Use the proper fuel (refer to "Specifications of Fuel," in Section I).

4. TURBOCHARGER

Refer to Section III for detailed information on the Turbocharger.

TROUBLE	POSSIBLE CAUSE	REMEDY
Wheel drags	1. Carbon build-up behind turbine wheel and/or dirt accumulation behind the compressor wheel.	1. Disassemble and clean unit.
	2. Bearing seized to shaft. Dirt causing drag in bearing. Short bearing life.	2. Check oil pressure at turbocharger. Inspect condition of oil.
Turbine wheel radial movement exceeds .023".	1. Worn bearings. Bore in bearing housing worn. Shaft worn.	1. Check oil flow pressure at turbocharger. Inspect condition of oil. Oil screen plugged. Wheels unbalanced.
Shaft end play exceeds .008".	1. Thrust collar faces or thrust washers worn or distorted.	1. Inspect for dirty oil or lack of oil.
Shaft end play less than .004".	1. Carbon build up behind turbine wheel. Dirt build up behind compressor wheel.	1. Disassemble and clean unit.
Compressor wheel radial movement exceeds .023".	1. Worn bearings. Bore in bearing housing worn. Shaft worn.	1. Check oil flow pressure at turbocharger. Inspect condition of oil. Oil screen plugged. Wheels unbalanced.
Dirt on compressor housing face and/or inside cover.	1. Excessive intake restriction. Restricted oil drain line. Operating in dusty areas under long idle periods.	1. Check for clogged air cleaner. Collapsed hose, or leaks in air inlet hose. Clean unit. Refer to Section III in Manual.
	2. Insufficient air filtration.	2. Leaks in air intake between cleaner and turbocharger.
	3. Long period of operating without cleaning.	3. Disassemble and clean unit.

TROUBLE	POSSIBLE CAUSE	REMEDY
Compressor wheel rubbing on O.D. of blades.	1. Worn bearing. Unbalanced turbine wheel.	1. Check condition of oil. Foreign material passing through turbine side.
Compressor wheel rubbing on cover or back face.	1. Insufficient clearance. Cover damaged. Thrust washer worn.	1. Check end play. Refer to Section III in Manual. Inspect cover for damage.
Inlet leading edge of compressor wheel blades either worn or pieces broken off.	1. Loose pieces in air intake system and striking wheel.	1. Inspect air intake system for loose nuts, bolts, or other foreign material.
Evidence of rubbing on the small diameter of the turbine wheel blades.	1. Worn bearing. Unbalanced wheel because of a bent or broken blade.	1. Dirty oil or lack of oil. Inspect for foreign material. Replace wheel.
Turbine wheel rubbing on face of bearing housing.	1. Carbon deposit on housing behind wheel. Improper end play. Bent shaft.	1. Disassemble and clean. Check end play.
Broken or bent turbine wheel blades.	1. Impact from failed engine parts, fins or projections from exhaust manifold or exhaust ports. Wheels striking housing after bearing has been damaged or worn.	1. Inspect and clean exhaust system to turbocharger. Replace wheel, inspect condition of oil.
Nozzle ring vanes peened, reducing the opening between vanes. Vanes pitted.	1. Foreign material such as debris, projections from exhaust manifold or head castings, or failed engine parts passing through turbine side.	1. Replace nozzle ring.
Shaft bearing surfaces scratched and worn.	1. Dirty lubrication, insufficient oil, or failure of oil supply. Wheel overspeeding.	1. Replace.
Shaft discolored.	1. Overheating. Insufficient oil supply.	1. Reuse if only slightly discolored and not deeply scratched.
Shaft worn on one side only.	1. Operating with unbalanced wheel.	1. Replace.
Bearing scratched and worn both I.D. and O.D.	1. Dirty lubrication, insufficient oil or failure of oil supply. Wheel overspeeding.	1. Replace.

TROUBLE	POSSIBLE CAUSE	REMEDY
Bearing seized on shaft or O.D. wear.	1. Overheated, or lubrication failure.	1. Replace.
Bearing worn one side only.	1. Operating with unbalanced wheel.	1. Replace.
Thrust collar faces scored or worn.	1. Dirty lubrication, lack of oil. Unit overheated, improper end play.	1. Replace.
Thrust washer faces scored or worn	1. Dirty lubrication, lack of oil. Unit overheated, improper end play.	1. Replace.
Bearing housing bore scratched or worn.	1. Dirty oil, lack of oil. Wheels unbalanced.	1. Replace if scored or out of round.
Bearing housing has carbon deposits.	1. Oil leakage. Over fueling.	1. Clean housing. Check for restriction in air intake system or restricted oil drain.
Compressor housing seal ring bore worn or scratched.	1. Dirty oil, lack of oil. Wheels unbalanced.	1. Replace if scored or out of round.
Dirt accumulated on face behind compressor wheel.	1. Excessive, intake restriction. Restricted oil drain line. Operating in dusty areas under long idle periods or leak in air intake system.	1. Service air cleaner. Check air intake system.
Compressor extension has scored contour.	1. Wheel rubbing because of excessive end play. Worn thrust faces or cover damaged by impact from dropping, etc.	1. Replace cover if deeply scored or damaged.
Dirty compressor extension.	1. Excessive intake restriction. Restricted oil drain line. Operating in dusty areas under long idle periods or leak in air intake system.	1. Clean.

5. ENGINE COOLING SYSTEM

Refer to pertinent Topics in Section IV for detailed information on the Engine Cooling System.

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine operating temperature too high with ample coolant in system.	1. Temperature gage inoperative.	1. Check gage. Replace if necessary (refer to Topic 8 in this Section).
	2. Radiator air passages restricted.	2. Clean exterior of radiator.
	3. Thermostats inoperative.	3. Check and replace thermostats if necessary (refer to Section IV).
	4. Loose or broken fan drive belts.	4. Adjust or replace fan drive belts.
	5. Lime deposits in water passages of radiator cylinder heads and/or cylinder block.	5. Thoroughly clean affected parts.
	6. Water passages in oil cooler restricted.	6. Remove and clean oil cooler core.
	7. Water pump inoperative.	7. Repair or replace water pump.
Engine operating temperature too high due to loss of coolant.	1. External leaks.	1. Repair affected parts.
	2. Ruptured oil cooler core (oil in coolant).	2. Replace oil cooler core.
	3. Cylinder head gaskets leaking.	3. Replace gaskets and torque cylinder head nuts as specified.
	4. Cylinder head cracked.	4. Replace cylinder head.
	5. Cylinder block cracked.	5. Replace cylinder block.
Engine operating temperature too low.	1. Thermostats stuck in open position.	1. Replace thermostats (refer to Section IV).
	2. Operating in extremely cold weather.	2. Provide covers for radiator and engine side openings.

6. ENGINE LUBRICATING SYSTEM

Refer to "Engine Lubricating System," Section V, for full details of the engine lubricating system.

TROUBLE	POSSIBLE CAUSE	REMEDY
Low or no oil pressure.	1. Insufficient oil in crankcase.	1. Maintain the oil level to the full mark on the oil level gauge rod.
	2. Improper lubricant.	2. Use the specified lubricant (refer to "Specifications of Lubricants," Section I).
	3. Worn bearings.	3. Worn main bearings or connecting rod bearings will cause oil pressure to drop; replace the bearings (refer to "Engine," Section VIII).

TROUBLE	POSSIBLE CAUSE	REMEDY
	4. Lubricating oil pump pressure regulating valve stuck open.	4. Inspect this valve (refer to "Engine Lubricating System," Section V).
	5. Lubricating oil pump screen clogged.	5. Remove the oil pan. Remove and clean the oil pump screen (refer to "Engine Lubricating System," Section V).
	6. Lubricating oil pump inoperative.	6. Inspect the pump drive and the pump (refer to "Engine Lubricating System," Section V). Also inspect for clogged oil lines or passages, ruptured gaskets, or loose connections. Clogged oil lines, oil passages, and screen are the result of dirty and sludging oil; if this condition exists, clean the interior of the engine thoroughly before resuming operation.
	7. Inoperative oil filter by-pass valve.	7. Refer to "Engine Lubricating System," Section V.
	8. Inoperative oil pressure gauge.	8. Test the accuracy of the gauge by installing a test gauge.
	9. Worn camshaft bearings.	9. Replace worn parts (refer to "Engine," Section VIII).
Excessive oil pressure.	1. Oil pressure regulating valve stuck closed.	1. Refer to "Engine Lubricating System," Section V.
	2. Inoperative oil pressure gauge.	2. Test the accuracy of the gauge by installing a test gauge.
Oil overheating.	1. Insufficient oil in crankcase.	1. Maintain the oil to the full mark on the oil level gauge rod.
Excessive oil consumption.	1. Pistons, rings, and cylinder sleeves worn.	1. Examine the engine to determine if these parts are worn, or if the rings are stuck or have excessively wide gaps. Blue smoke, loss of power, and hard starting are indications of this condition. Inspect and replace all necessary parts.
	2. Oil leaks.	2. Inspect for loose connections and damaged or leaking gaskets.
	3. Crankshaft oil seals worn or damaged.	3. Observe the front end of the engine while running the engine with the loader standing still. Oil leaking through the crankshaft rear (fan end) oil seal can then be seen. Inspect the engine flywheel housing for an accumulation of oil. The presence of oil will indicate the crankshaft front oil seal is leaking (refer to "Engine," Section VIII).
	4. Oil too light.	4. Use the specified oil (refer to "Specifications of Lubricants," Section I).

TROUBLE	POSSIBLE CAUSE	REMEDY
	5. Oil level carried too high.	5. Do not fill the crankcase above full mark on the oil level gauge rod.
	6. Valve guide worn.	6. Replace valve guide (refer to "Engine," Section VIII).

7. ELECTRICAL SYSTEM

Whenever the electrical system trouble seems to be general, start with the battery and check through the likeliest circuits. Many electrical system troubles can be easily solved by common sense and a little thought.

The correct instruments and testing equipment should be available when checking the electrical system. Be sure each circuit and electrical component is thoroughly understood before attempting repairs and adjustments. If the proper testing equipment is not available or if there is any doubt about an electrical component, take it to a reliable electrical repairman or to the nearest factory authorized serviceman.

TROUBLE	POSSIBLE CAUSE	REMEDY
Slow cranking speed.	1. Crankcase oil too heavy or cold.	1. Change to proper grade oil or heat oil.
	2. Loose or dirty cable connections.	2. Clean and tighten connections.
	3. Worn brushes.	3. Replace.
	4. Armature rubbing the field coils.	4. Replace starter shaft bushings.
	5. Low battery voltage or low specific gravity.	5. Check generator and generator regulator for correction operation; then add electrolyte to bring battery up to correct specific gravity.
	6. Brushes sticking or brush springs weak.	6. Remove and clean brushes. Replace springs.
	7. Armature burned out.	7. Replace armature.
	8. Starter switch inoperative.	8. Check for loose connections or replace switch.
Engine does not turn over. Starter pinion does not engage flywheel ring gear.	1. Grease and dirt in starter drive mechanism.	1. Remove, clean and replace.
	2. Shift lever out of adjustment.	2. Adjust.
	3. Broken or excessively worn parts.	3. Replace.
	4. Batteries dead or at low charge.	4. Recharge batteries.
	5. Loose battery cables.	5. Tighten connections.
	6. Faulty ignition switch.	6. Repair or replace.
	7. Faulty solenoid.	7. Repair or replace.
	8. Wires disconnected or broken in starter circuit.	8. Trace circuit and replace broken wires.
	9. Starting motor fuse blown.	9. Replace fuse. NOTE: *Determine cause of blown fuse before replacing it.*

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine turns over but does not start.	1. See "Engine" Section.	1. See "Engine" Section.
Solenoid clicks, but starter doesn't turn.	1. Loose wires.	1. Tighten any loose wires between the solenoid and starting motor.
	2. Low battery charge.	2. Recharge battery.
Low or no output.	1. Dry battery.	1. Refill to correct level with electrolyte.
	2. Drive belt loose or broken.	2. Tighten or replace.
	3. Broken or loose cables.	3. Tighten or replace.
	4. Generator regulator stuck or inoperative.	4. Repair or replace.
	5. Burned contacts on regulator units.	5. File (if not burned too badly) or replace.
	6. Ground armature wires or terminal ports.	6. Remove generator and check electrical circuits. NOTE: *Do not test generator on an open circuit.*
	7. Burned commutator bars.	7. Check brushes and springs; then replace armature.
	8. Worn or sticking brushes.	8. Loosen or replace.
	9. Open circuits in the field or armature.	9. Remove generator and test.
	10. Brush springs weak or improperly adjusted.	10. Replace or adjust.
	11. Rough, dirty or greasy commutator bars.	11. Remove generator, rework or clean commutator.
	12. High mica on the commutator.	12. Undercut mica $\frac{1}{32}''$ with hacksaw blade or some suitable tool.
	13. Commutator out of round.	13. Remove generator and turn commutator to concentricity.
Noisy generator.	1. Loose mountings.	1. Tighten.
	2. Worn or loose drive pulley.	2. Tighten or replace.
	3. Worn bearings.	3. Remove generator and replace bearings.
Excessive output.	1. Generator field grounded.	1. Remove generator and test circuit.
	2. Regulator circuit breaker closed.	2. Check current regulator setting, if unable to adjust, replace the regulator.
	3. Defective regulator.	3. Replace.

TROUBLE	POSSIBLE CAUSE	REMEDY
Erratic output.	1. Low belt tension.	1. Adjust generator to correct belt tension.
	2. Broken or worn generator brush spring.	2. Replace spring.
Batteries won't hold charge.	1. Plates shorted or destroyed.	1. Replace battery.
	2. Faulty electrolyte used.	2. Replace with correct solution and recharge.
	3. Faulty regulator.	3. Check cutout relay, repair or replace. Also check generator for possible damage.
	4. External short.	4. Check all wiring or other metal objects touching battery terminals, remove or insulate. Also, make sure that the battery case is insulated from its mounting.
	5. Internal short.	5. Replace battery.
	6. Switch or other electrical apparatus left in operation after engine stopped.	6. Make sure switch and electrical accessories turned off before leaving operator's compartment.
	7. One or more electrical accessories shorted out.	7. Trace circuits and repair or replace faulty accessory.
	8. Battery self-discharging due to impurities within the batteries, high temperatures and too low a charge.	8. If battery plates still in good condition, replace electrolyte. If battery plates warped or destroyed replace battery. Allow battery to cool before recharging — check electrolyte solution for specific gravity. Check generator regulator for proper charging rate.
	9. Battery overcharged.	9. Check generator and generator regulator for correction operation and replace battery.
	10. Too high a rate of charge.	10. Check generator and voltage regulator for correct operation. If battery plates not buckled, recharge battery at a slow rate. If plates warped or buckled, replace battery.
	11. Battery frozen.	11. Allow battery to thaw, if plates not damaged, recharge to full charge before installing in machine.
Battery won't take charge.	1. Shorted plates.	1. Replace battery.
	2. Improper electrolyte solution or low level of solution.	2. Replace solution or add more.
	3. Battery stored too long without use.	3. Replace battery.
	4. Battery overcharged previously, destroying plates.	4. Replace battery.

TROUBLE	POSSIBLE CAUSE	REMEDY
Battery won't fully charge.	1. Improper electrolyte solution.	1. Adjust to correct solution.
	2. Faulty regulator or generator.	2. Check regulator setting or see Generator Trouble Shooting Section.
Poor battery performance.	1. Corroded terminals.	1. Clean.
	2. Loose connections.	2. Tighten.
	3. Low electrolyte level.	3. Check for leaks and overcharging or high charge rate.
	4. High water usage.	4. Check for leaks or overcharging.
	5. Raised cell covers.	5. Check for overcharging. Check voltage regulator for high setting if specific gravity is above 1.215. If damage is severe, replace battery.
Generator regulator has excess vibration, heavy arcing or burning at voltage or current regulator points.	1. Regulator out of polarity with generator.	1. If regulator not damaged, lightly file points and reset. If regulator damaged, replace it. See Generator Regulator Section for establishing polarity.
	2. Open resistance unit.	2. Repair or replace.
	3. Defective regulator winding.	3. Replace.
	4. Pitted or oxidized contact points.	4. Lightly file and reset. If too badly damaged, replace.
	5. Contact points out of alignment.	5. Align points.
	6. Shorted field coil in the generator.	6. Repair if possible or replace.
	7. Poor ground connections at generator or regulator.	7. Clean ground contacts and tighten connections.
Fully charged battery, high charging rate.	1. Voltage regulator not reducing generator output.	1. Check for faulty operation. Reset or replace.
	2. Improper voltage regulator setting.	2. Reset.
	3. Defective voltage regulator unit.	3. Repair or replace.
	4. Short circuit between charging circuit and field circuit either in the generator, regulator or wiring.	4. Check circuits, repair or replace defective parts.
	5. Poor ground connection at generator or regulator.	5. Clean ground areas and retighten connection.

TROUBLE	POSSIBLE CAUSE	REMEDY
Low battery and low or no charging rate.	1. Loose connections.	1. Tighten.
	2. Frayed or damaged wires.	2. Replace.
	3. Low regulator setting.	3. Reset.
	4. Oxidized regulator contact points.	4. File lightly and reset.
	5. Defective generator.	5. To determine whether the generator or regulator is at fault, bridge the regulator armature and field terminals momentarily with a jumper lead with the generator running at medium speed. If the output does not increase, the generator is probably at fault. If the generator output increases, the trouble is due to: A low voltage (or current) regulator setting. Oxidized regulator contact points which exert excessive resistance in the generator field circuit so that the output remains low. Generator field circuit open within the regulator, either at the connecions or in the regulator windings.
Headlight switch on, but one light remains unlit.	1. Defective light.	1. Replace it.
	2. Loose, disconnected or broken wire.	2. Tighten, reconnect or repair.
If any two lights go out (two main lights or two auxiliary lights or two back-up lights).	1. Disconnected or broken jumper wires.	1. Reconnect or replace.
If two main lights and tail light go out, or two auxiliary and two back-up lights go out.	1. Burned fuse.	1. Determine cause of trouble, then replace fuse.
If all lights remain unlit.	1. Defective light switch.	1. Check light switch for correct operation.
	2. Wire from hot side of ignition switch broken or disconnected.	2. Repair, replace or reconnect.
	3. Cable from battery to solenoid wire from solenoid to ammeter, or wire from ammeter to ignition switch loose, broken or disconnected.	3. Tighten, repair or reconnect proper wire.
	4. Blown fuses.	4. Before replacing fuses, determine cause.
	5. Fully discharged or dead battery.	5. If possible, recharge battery, otherwise replace it.

TROUBLE	POSSIBLE CAUSE	REMEDY
Lights flicker.	1. Loose wiring or fuses.	1. Tighten connection.
	2. Faulty generator, regulator or low battery voltage.	2. Reset, repair, or replace or recharge.
Dim lights.	1. Low battery voltage.	1. Recharge.
	2. Faulty generator or regulator.	2. Reset, repair or replace.
	3. Old lights.	3. Replace.
If stop light fails to operate.	1. Loose or broken wires and connections.	1. Tighten, repair or replace.
	2. Defective stoplight.	2. Replace.
	3. Defective stop light switch.	3. Repair or replace.
If dash lights fail to operate.	1. Loose or broken wires.	1. Tighten, repair or replace.
	2. Defective light.	2. Replace.
If horn fails to operate.	1. Loose or broken wiring or connection.	1. Tighten, repair or replace.
	2. Horn button fails to contact.	2. Repair or replace.
	3. Defective horn.	3. Replace.
If horn operates continuously	1. Shorted wiring.	1. Check for bare wires, repair or replace.
	2. Shorted horn.	2. Repair or replace.

8. INSTRUMENTS

In general, except for the temperature gauges, the instruments should begin to function shortly after the machine has started. By watching them closely, possible damage to the loader can be avoided. When a gauge appears to be malfunctioning, shut off engine and check the faulty gauge for loose connections. If there are no loose connections, check the component to which the gauge is connected. That is, if the engine oil pressure gauge is inoperative, check the engine for oil and proper functioning of the engine oil system (if the component is malfunctioning refer to that Section in the Service Manual for corrective measures). If the component is functioning properly and the gauge still fails to operate, check its connecting wires for shorts or breaks. If there is nothing wrong with the connecting wires, remove and replace the gauge.

NOTE: *Always check the component before assuming that the gauge or meter is at fault.*

9. ENGINE

TROUBLE	POSSIBLE CAUSE	REMEDY
Sudden stopping.	1. Broken shaft or sheared key.	1. Replace broken parts.
	2. No fuel.	2. Refill fuel tank and bleed or vent the fuel injection system.

TROUBLE	POSSIBLE CAUSE	REMEDY
	3. Insufficient flow of fuel.	**3.** Check for dirty filters, deteriorating flexible lines, insufficient fuel, and inoperative fuel supply pump or air leak in suction line.
	4. Air traps.	**4.** Bleed the fuel injection system of air.
	5. Dirt in fuel.	**5.** Replace the fuel filters. Clean the tank.
	6. Water in fuel.	**6.** Drain the filters, the tank and the fuel injection pump.
	7. Plugged line.	**7.** Clean the fuel lines and examine for deterioration.
	8. Overheating of engine.	**8.** Check the water and oil. Also check for clogged radiator or other restrictions in the cooling system, loose or broken fan belt.
	9. Low oil pressure.	**9.** Check for burned bearings, dirt under the oil pressure relief valve, suction screen brackets for looseness, or loose oil lines and oil plugs or diluted or light oil. Check oil supply. It may be low, allowing suction screen to suck air. Oil cooler choked with sludge, or oil gauge line connections may be plugged with dirt or pinched shut.
	10. Fuel too heavy.	**10.** Drain the fuel filters and fuel tank and refill with fuel of proper specifications.
	11. Fuel supply pump inoperative.	**11.** Replace or repair the fuel supply pump.
	12. Loose fuel pump drive gear resulting in improper timing.	**12.** Check fuel pump drive gear, align timing marks and tighten capscrews securely.
Loss of power.	**1.** Insufficient fuel.	**1.** Check fuel tank.
	2. Air in fuel lines.	**2.** Vent or bleed the fuel injection system and check for air leaks.
	3. Restriction in fuel line.	**3.** See "Sudden Stopping" item 7 this section.
	4. Fuel too heavy.	**4.** See "Sudden Stopping" item 10 this section.
	5. Loose fuel pump drive gear resulting in late injection.	**5.** See "Sudden Stopping" item 12 this section.
	6. Weak or missing cylinders.	**6.** Check valve clearance. Injectors should be checked for atomization. Loosen the nipple nut at the injector a half turn so that the fuel leaks. If there is no appreciable change in engine performance, that cylinder is not operating.
	7. Sticking fuel injection pump plunger.	**7.** The fuel injection pump should be checked and replaced with a new one by the maintenance repair shop.

TROUBLE	POSSIBLE CAUSE	REMEDY
	8. Sticking valves.	8. Free valves by applying a 50 per cent mixture of lubricating oil and kerosene between valve stem and guide. A penetrating oil similar to Casite may also be used. While oil is being applied, manually work the valve up and down, using a piece of wood if necessary. CAUTION: *If a quantity of oil is allowed to flow between the valve stem and guide, remove the injector and turn the engine over with the starter several revolutions to blow the excess oil out of the combustion chamber.*
	9. Loss of compression.	9. Check for pitted, burned or warped valves, insufficient valve clearance, worn piston rings or stuck rings, leaking cylinder head gasket.
	10. Clogged air cleaner.	10. Remove air cleaner and clean.
	11. Valve clearance out of adjustment.	11. Check rocker arms, tappet clearances.
	12. Faulty nozzle.	12. Replace with serviceable nozzle.
	13. Fuel injection pump out of time.	13. Retime fuel injection pump.
	14. Leaky or sticky valves.	14. Grind valves.
	15. Worn injection pump.	15. Replace pump.
	16. Throttle does not open wide.	16. Adjust or tighten linkage.
Hard starting.	1. Insufficient fuel.	1. Check fuel tank.
	2. Air traps.	2. Bleed fuel injection system of air.
	3. Incorrect timing.	3. Retime fuel injection pump.
	4. Worn rings.	4. Replace rings.
	5. Pitted or warped valves.	5. Grind valves.
	6. Dirty nozzles.	6. Replace with serviceable nozzle.
	7. Battery charge low.	7. Replace with fully charged battery.
	8. Valve clearance incorrect.	8. Check rocker arm clearance, tappet clearance.
	9. Fuel supply pump.	9. Replace or repair fuel supply pump.
	10. Worn injection pump.	10. Replace pump.
Overheating.	1. Lack of cooling water.	1. Check coolant level.
	2. Sediment in water jackets.	2. Flush out cooling system.
	3. Water pump damaged by ice or other substance.	3. Check water pump.

TROUBLE	POSSIBLE CAUSE	REMEDY
	4. Fuel injection too late or too early.	**4.** Pump should be timed.
	5. Sheared drive gear hub key on fuel injection pump drive shaft.	**5.** Check fuel pump drive gear hub for slippage.
	6. Improper lubrication.	**6.** See lubrication specifications.
	7. Dirty air cleaner.	**7.** Service air cleaner.
	8. Back pressure in exhaust line.	**8.** Check piping. Loosen deposits. Clean out.
	9. Thermostat sticking or inoperative.	**9.** Remove, clean thermostats and housing or replace with new thermostat.
	10. Too much load on engine.	**10.** Reduce load.
	11. Loose fan belts.	**11.** Adjust belt tension.
	12. Radiator air passages plugged.	**12.** Clean exterior of radiator.
Engine fails to turn with starting motor.	**1.** Loosen connections in wiring circuit or starting switch not contacting.	**1.** Check wiring circuit and switch, tighten connections, clean battery terminals.
	2. Starting motor loose on engine.	**2.** Check and tighten capscrews.
	3. Battery too weak to turn engine.	**3.** Replace with fully charged battery.
	4. Starting motor worn out or burned out.	**4.** Replace with new motor.
	5. Foreign object in gears or on top of piston (after general overhaul).	**5.** Remove.
	6. Stuck pistons.	**6.** This is usually caused by overheating or lack of lubrication and will necessitate the removal of the pistons and liners and replacing them with new.
Irregular engine operation.	**1.** Missing cylinder or cylinders.	**1.** See No. 1, 2, 3, 4, 5, 6, 7, 12 under "Loss of Power."
	2. Fuel injection pump control rod binding.	**2.** Remove governor cover, inspect rod, and oil (engine oil).
	3. Governor springs broken or weak.	**3.** Replace governor with new, or replace springs.
	4. Governor surge.	**4.** Install correct governor springs with specified gap.
	5. Fuel pump sump overflow valve spring weak or broken.	**5.** Replace overflow valve, if not available, temporary repair may be made by stretching spring with fingers.
	6. Fuel delivery valve not seating properly.	**6.** Remove delivery valve holder, spring and valve, and clean thoroughly in fuel oil.
	7. Water in fuel.	**7.** Drain filters, tank and fuel injection pump.

TROUBLE	POSSIBLE CAUSE	REMEDY
	8. Engine operating temperature too low.	8. Check for correct thermostats. Do not idle engine excessively.
	9. Broken or weak fuel pump plunger return spring.	9. Install new pump.
	10. Broken nozzle spring.	10. Renew spring.
	11. Late injection timing.	11. Advance injection.
Knocking.	Knocks in the Diesel engine can be divided into fuel knocks and those which cannot be directly assigned to the injection process. Knocks other than fuel are either from loose bearings, piston, flywheel, improper adjusted valve mechanism, or blow-by due to sticking piston rings. Excessive fuel knocks are caused by too early injection of the fuel for the speed and load on the engine. This may be due to too great an advance on the injection or improper timing of the fuel pump in servicing. Trouble from knocking, other than fuel knocks, can usually be found by sounding the knocks out under different load conditions and by cutting out one cylinder at a time. When the loose or incorrectly adjusted part is found, the remedy is usually obvious and reference to articles under name of the parts affected will be found helpful in making the needed corrections. Because these corrections should be made by an experienced mechanic, the operator should report any of the mentioned conditions to the mechanic.	
Low oil pressure.	1. Low oil level.	1. Check oil level and add oil as necessary.
	2. Broken oil line.	2. Replace oil line.
	3. Restricted or clogged oil line to gauge.	3. Remove, clean or replace oil line.
	4. Clogged oil cooler.	4. A clogged oil cooler will cause oil to overheat. Remove and clean or replace oil cooler core.
	5. Inoperative oil pressure regulator valve.	5. Remove, clean, inspect and adjust oil pressure regulator valve.
	6. Improper lubricating oil.	6. Drain the lubricating system and refill with the specified lubricant.
	7. Clogged oil pump suction screen.	7. Remove and clean oil pump suction screen.
	8. Worn oil pump.	8. Remove and repair or replace oil pump.
	9. Worn components within engine.	9. Check for worn bearings within engine. Make the necessary repairs.
Excessive smoking.	This may be caused by faulty nozzles (incorrect pressure setting, plug orifices, faulty spray pattern, dribbling, sticking or worn), improperly indexed intake valves, malfunctioning turbocharger, leaky inlet or exhaust valves, stuck or worn piston rings, and/or scored cylinder sleeves, late injection timing, improperly set "smoke stop."	

TROUBLE	POSSIBLE CAUSE	REMEDY
	Check inlet and exhaust valve clearance. Make sure valves are not sticking in guides. Check for a dirty air cleaner. As a last resort, assume the trouble to be in fuel injection pump. If the latter is the cause, remove and replace with new.	

10. DRIVE SHAFT GROUP

TROUBLE	POSSIBLE CAUSE	REMEDY
Excessive noise or vibration.	1. Wallowed out yoke.	1. Determine the cause of wear and replace the yoke. Inspect the splined shafts for damage.
	2. Worn needle bearings.	2. Replace bearing assembly. Inspect spider contact surfaces for wear. Replace if necessary.
	3. Loose yoke capscrews.	3. Tighten capscrews (refer to Section IX in Manual, for correct torque). Inspect yokes, spiders and shafts for possible damage.
	4. Damaged or bent shafts.	4. Repair or replace.
	5. Bent or damaged yokes.	5. Repair or replace.
	6. Bent or damaged spiders.	6. Replace. Inspect bearings and yokes for excessive wear or damage. Replace if necessary.
	7. Lack of lubrication.	7. Inspect for damage and lubricate properly.

11. TRANSMISSION

TROUBLE	POSSIBLE CAUSE	REMEDY
Low converter-out pressure.	1. Low oil level.	1. Add oil.
	2. Oil line leakage (remote-mounted cooler or filter.	2. Check for oil leaks in oil lines.
	3. Lube valve held open.	3. Clean and inspect lube valve and seal. If dirt or metal chips are found in lube valve area, check sump screen and filter.
	4. Plugged oil screen.	4. Check oil screen. Clean if necessary.
	5. Defective oil pump.	5. Check for wear in oil pump.
	6. Aerated oil.	6. Check oil level. Check for leaks in pump suction passages or clogged breather.
High oil temperature.	1. Low oil level (low flow rate).	1. Add oil.
	2. High oil level.	2. Drain to "Full" mark.
	3. Low water level in cooling system.	3. Add water. Check for leaks.

TROUBLE	POSSIBLE CAUSE	REMEDY
	4. Low converter-out pressure.	4. Refer to cause as listed in "Trouble" column.
	5. Clogged or dirty oil cooler.	5. Clean or replace as necessary.
	6. Operating too long in an inefficient converter range.	6. Readjust work cycle to allow operation in an efficient converter range.
	7. Locked stator.	7. Check for low top speed of vehicle.
	8. Stator installed without rollers (low stall speed).	8. Disassemble converter and install rollers.
	9. Cooling system temperature too high.	9. Check for stuck thermostats, defective water pump, hot engine.
High engine speed at converter stall.	1. Low oil level.	1. Add oil.
	2. Low converter-out pressure.	2. Refer to cause as listed in "Trouble" column.
	3. High oil temperature.	3. Refer to cause as listed in "Trouble" column.
	4. Slipping clutch.	4. (a) Low main oil pressure. Check for defective main pressure regulator valve. (b) Overhaul transmission.
	5. Failed turbine shaft or output shaft.	5. Replace turbine shaft or output shaft.
Low engine speed at converter stall.	1. Low engine output torque.	1. Tune engine and check output.
	2. Converter element interference.	2. Check for noise at stall. Overhaul converter if necessary.
	3. Stator installed without rollers.	3. Disassemble converter and install rollers.
Loss of power.	1. Stator installed without rollers (low stall speed).	1. Disassemble converter and install rollers.
	2. Low converter-out pressure.	2. Refer to cause as listed in "Trouble" column.
	3. Low engine speed at converter stall.	3. Refer to cause as listed in "Trouble" column.
	4. Clutch plates slipping.	4. (a) Check for low clutch pressure. (b) Check for worn piston seals.
	5. Selector valves inoperative.	5. Check shifting linkage adjustment and possible failure of valve components.
	6. Low clutch pressure.	6. Refer to cause as listed in "Trouble" column.
	7. Foaming oil.	7. Check for low oil level, worn parts or air leaks in input-oil pump. Check for water in oil or clogged breather.

TROUBLE	POSSIBLE CAUSE	REMEDY
No power transmitted in any range.	1. Selector valves inoperative.	1. Check shifting linkage adjustment or failure of selector valve parts.
	2. Low clutch pressure.	2. Refer to low clutch pressure in "Trouble" column. Check for loose implement pump drive idler gear spindle bolt.
	3. Clutch cut-off valve inoperative.	3. Check for failure of cutoff valve parts.
Low clutch (main) pressure.	1. Clutch cut-off valve cup turned sideways.	1. Replace cup.
	2. Low oil level.	2. Check oil level.
	3. Leaks in lube system.	3. Clean and inspect lube valve and seal. If dirt or metal chips are found in lube valve area, check sump screen and filter.
	4. Parts failure in main-pressure regulator valve body assembly.	4. Overhaul main-pressure regulator valve body assembly.
	5. Worn input-oil pump assembly.	5. Overhaul input-oil pump assembly.
	6. Plugged oil screen.	6. Drain oil and clean screen.
	7. Selector valves inoperative.	7. Check shifting linkage and valve components.
No power transmitted in one range.	1. Low clutch pressure in one range only.	1. Check for worn piston seals.
	2. Failed planetary carrier.	2. Overhaul transmission.
	3. Selector valves inoperative.	3. Check shifting linkage and valve components.
	4. Failed transmission components.	4. Overhaul transmission.
	5. Plugged clutch piston cavity inlet line.	5. Disassemble transmission enough to check inlet line.
Slow clutch engagement.	1. Foaming oil.	1. Check oil level, worn parts or air leaks in input-oil pump, water in oil or clogged breather.
	2. Low clutch pressure.	2. Refer to cause as listed in "Trouble" column.
	3. Worn piston seals.	3. Check for worn piston seals.
	4. Slow clutch cutoff valve return.	4. Check vehicle brake system.
High converter pressure.	1. Failed or restricted oil cooler or lines.	1. Inspect cooler or lines for restrictions.
	2. Lube valve stuck closed.	2. Inspect valve and correct condition found.

TROUBLE	POSSIBLE CAUSE	REMEDY
Vehicle drives in Forward or Reverse direction, Low Range, and creeps when range selector valve is shifted to Neutral, but stalls when shifted to Intermediate Range or High Range.	1. Failed low-range clutch.	1. Overhaul transmission.
Vehicle drives in Forward or Reverse direction, Intermediate Range, and creeps when range selector valve is shifted to Neutral, but stalls when shifted to High Range or Low Range.	1. Failed intermediate-range clutch.	1. Overhaul transmission.
Vehicle drives in Forward or Reverse direction, High Range, and creeps when range selector valve is shifted to Neutral, but stalls when shifted to Low Range or Intermediate Range.	1. Failed high-range clutch.	1. Overhaul transmission.
Vehicle drives in any range, Reverse direction, and creeps backward when Forward-Reverse selector valve is shifted to Neutral, but stalls when shifted to Forward.	1. Failed reverse clutch.	1. Overhaul transmission.
Vehicle drives in any range, Forward direction, and creeps forward when Forward-Reverse selector valve is shifted to Neutral, but stalls when shifted to Reverse.	1. Failed forward clutch.	1. Overhaul transmission.

TROUBLE	POSSIBLE CAUSE	REMEDY
Loss of hydraulic fluid and constant overfilling of transmission with hydraulic fluid.	1. High pressure seal on loader hydraulic pump leaking.	1. Remove loader hydraulic pump and replace seal. Refer to Section XVI in this Manual.

12. AXLES

TROUBLE	POSSIBLE CAUSE	REMEDY
Oil leakage at differentials.	1. Damaged, loose or reversed seals.	1. Replace or tighten. If a reversed seal has not been damaged, reinstall it in the correct position. Refer to "Differential and Planetary Hubs," Section XI.
	2. Scored or damaged surfaces which seal contacts.	2. If possible, stone surfaces carefully to remove nicks or burrs, otherwise replace components.
Differentials overheating.	1. No oil, low oil, high oil, dirty oil or wrong weight of oil.	1. Refer to "Differential and Planetary Hubs," Section XI for correct oil level and weight.
	2. Misadjusted thrust block.	2. Refer to "Differential and Planetary Hubs," Section XI, for adjustment.
Failure to drive.	1. Axle disconnected (rear axle only).	1. Check axle disconnect lever for positioning.
		2. Check for broken or disconnected linkage.
		3. Inspect for broken component in drive train.
Noise in differentials.	1. Loose or worn bearings, loose capscrews, loose or stripped splines.	1. Tighten or replace components as necessary.
	2. Little or no oil.	2. Add oil to correct level.
	3. Misadjusted thrust block.	3. Refer to "Differential and Planetary Hubs," Section XI, for correct adjustment.
Oil leakage from planetary wheel covers.	1. Loose planetary wheel cover capscrews.	1. Tighten capscrews in accordance with torque values shown in Section XI in Manual.
	2. Damaged or bad planetary spider gasket.	2. Replace gasket. Refer to Section XI, in Manual.
	3. Cracked or broken planetary wheelcover.	3. Replace. Refer to Section XI, in Manual.
Oil leakage from planetary spider assembly and wheel hub.	1. Loose planetary spider stud nuts.	1. Tighten in accordance with torque values shown in Section XI, in Manual.
	2. Damaged or bad planetary spider assembly gasket.	2. Replace gasket. Refer to Section XI, in Manual.

TROUBLE	POSSIBLE CAUSE	REMEDY
Oil leakage from trunnion socket assembly, steering axle only.	1. Worn or damaged drive joint oil seal.	1. Replace seal. Refer to Section XI, in Manual.
	2. Worn or damaged axle shaft oil seal.	2. Replace seal. Refer to Section XI, in Manual.
Oil leakage between planetary housing and brake drum.	1. Worn or damaged planetary housing and brake drum oil seal.	1. Replace seal. Refer to Section XI, in Manual.
Oil leakage from brake drum and brake drum dust cover.	1. Inner hub seal leaking.	1. Refer to Section XI in Manual.
Excessive amount of grease on trunnion socket from felt seals. Steering axle only.	1. Over-lubrication of trunnion socket and universal joint assemblies.	1. Refer to Section XI, in Manual.
Planetary housing, wheel hub and brake drum heating excessively.	1. Oil level too low.	1. Refer to Section XI in Manual for proper filling. Determine reason before continuing with operation.
	2. Incorrect gear alignment, end play or backlash.	2. Refer to Section XI in Manual.
	3. Brake lining contracting drum.	3. Refer to Section XII in Manual.
	4. Excessive wheel bearing preload.	4. Refer to Section XI in Manual.
	5. Oil level too high.	5. Refer to Section XI in Manual.
	6. Insufficient universal joint lubrication (steering axle only).	6. Refer to Section XI in Manual.
Wheel locked (not rotating).	1. Planetary gearing jammed (broken teeth, etc.).	1. Refer to Section XI in Manual.
	2. Wheel bearings frozen or jammed.	2. Refer to Section XI in Manual.
	3. Universal joint.	3. Refer to Section XI in Manual.
	4. Broken universal joint shaft in hub spindle allowing wheel and brake drum to cock on brake lining.	4. Refer to Section XI in Manual.
Excessive side movement of wheel assembly.	1. Improper preload on wheel bearings.	1. Refer to Section XI in Manual.
	2. Broken hub spindle shaft flange.	2. Refer to Section XI in Manual.

TROUBLE	POSSIBLE CAUSE	REMEDY
	3. Loose or broken trunnion socket assembly. Steering axle only.	3. Refer to Section XI in Manual.
Hard steering (NOTE: *Eliminate problems in the power steering cylinder, drag links, tie rod and steering gear systems first*).	1. Incorrect bearing preload on steering bearings.	1. Refer to Section XI in Manual.
	2. Failure of steering bearings.	2. Refer to Section XI in Manual.
	3. Damaged or broken trunnion socket assembly.	3. Refer to Section XI in Manual.
	4. Tie rod interference.	4. Refer to Section XV in Manual.

13. AIR BRAKES

TROUBLE	POSSIBLE CAUSE	REMEDY
No braking action.	1. Worn brake linings.	1. Replace linings.
	2. Poor or no brake adjustment.	2. Adjust brakes. Refer to Section XII in Manual.
	3. Loss of brake air due to leak or broken line.	3. Repair or replace. Refer to Section XII in Manual.
	4. New linings.	4. "Burn" brake surfaces in by moving loader with the brakes on. Only do this long enough to provide good braking surface. Do not cause brakes to overheat. Adjust brakes.
	5. Oil or grease on linings.	5. Thoroughly clean linings, brake drums and internal brake areas. Repair leak or eliminate source of contamination. "Burn" in brake surfaces as in 4 above.
Partial or poor braking action.	1. Worn brake linings.	1. Adjust or replace.
	2. Heavily worn or scored brake drums.	2. Resurface or replace drum.
	3. Poor brake adjustment.	3. Adjust.
	4. Crimped, clogged or dirty lines.	4. Repair, replace or clean as necessary.
	5. Leaking diaphragm in roto-chamber.	5. Replace.
	6. Maladjusted linkage between pedal and brake application valve. (Pedal travel.)	6. Adjust. Refer to Section XII in Manual.

TROUBLE	POSSIBLE CAUSE	REMEDY
Compressor fails to maintain adequate pressure in the air brake system.	1. Dirty or obstructed intake lines.	1. Clean or replace lines.
	2. Excessive carbon in compressor cylinder, head or discharge line.	2. Remove carbon or replace the affected parts.
	3. Discharge valves leaking.	3. Reseat or replace valves.
	4. Excessive wear.	4. Overhaul the compressor.
	5. Drive belt slipping.	5. Adjust drive belt.
	6. Inlet valve stuck open.	6. Clean up valve stems and guides or replace.
	7. Excessive leakage of inlet valves.	7. Reseat or replace valves.
Noisy operation.	1. Loose drive pulley.	1. Tighten pulley retaining nut. Tighten adjustment lock capscrews.
	2. Excessive carbon in cylinder head or discharge line.	2. Clean carbon from head and line. Replace the parts if it is impossible to remove the carbon.
	3. Worn or burned out bearings.	3. Replace bearings. Determine the cause of the bearing failure.
	4. Excessive wear.	4. Overhaul compressor.
Compressor passes excessive oil.	1. Excessive wear.	1. Overhaul compressor.
	2. Dirty air cleaner or intake lines.	2. Service air cleaner. Clean out intake lines.
	3. Excessive oil pressure.	3. Check setting of engine lube pressure regulator valve.
	4. Oil return line clogged.	4. Clean out return line. Change engine oil filters.
	5. Oil seal ring in end cover excessively worn.	5. Replace seal.
	6. Back pressure from engine crankcase.	6. Change engine oil. Change engine oil filters. Clean or replace breather caps on engine rocker arm covers.
	7. Piston rings improperly installed.	7. Disassemble compressor and install rings correctly.
Compressor does not unload.	1. Defective unloading piston, grommet.	1. Replace grommet.
	2. Unloading cavity plugged with carbon.	2. Clean carbon from cavity.
	3. Unloading mechanism binding or stuck.	3. Clean and polish mating parts or replace unloading mechanism.

14. TIRE AND WHEEL GROUP

TROUBLE	POSSIBLE CAUSE	REMEDY
Uneven tread wear.	1. Under or over inflation.	1. Refer to Tire and Wheel Group, Section XIV for proper inflation pressures.
Failures.	1. Overloading tires.	1. Work machine only within its capacities.
	2. Over-inflation.	2. Proper inflation pressures.
	3. Under-inflation.	3. Proper inflation pressures.
	4. Bent rim.	4. Correct or replace.
	5. Rough road conditions.	5. Constant inspection or use a tire designed for rough operations.
	6. Incorrectly mounted tires.	6. Refer to your local tire representative for correct mounting procedures.
	7. Boots.	7. Boots should be used as an emergency repair only until the tire can be vulcanized.
	8. Oil, grease or gasoline.	8. Do not allow tires to stand, or be covered with oil, grease or gasoline. Wash with soap and water.
	9. Neglected cuts.	9. Vulcanize cuts immediately.
Rapid tread wear.	1. Spinning tires.	1. Operate in lower speed.
	2. Rough road conditions.	2. Smooth haul road or use tires designed for rough wear.
	3. Excessive high speeds.	3. Do not race loader unnecessarily.

15. POWER STEERING

TROUBLE	POSSIBLE CAUSE	REMEDY
No power steering action.	1. No or low oil in hydraulic tank.	1. Fill tank to correct level. Refer to "Hydraulic System," Section XVI.
	2. Hydraulic oil being directed to loader operation.	2. Check oil level in hydraulic tank and add oil if necessary.
	3. Pump belts loose, worn or broken.	3. Tighten (refer to "Power Steering," Section XV) or replace.
	4. Pump gears worn or broken.	4. Replace. Refer to "Power Steering," Section XV for removal of pump.
	5. Malfunctioning power steering pressure relief valve.	5. Repair or replace.
	6. Crimped or broken hoses or lines.	6. Repair or replace.

TROUBLE	POSSIBLE CAUSE	REMEDY
	7. Damaged control valve, drag links, steering mechanism or steering arm.	7. Repair or replace.
	8. Worn or damaged power steering cylinder piston packing.	8. Replace. Refer to "Power Steering," Section XV, for removal, replacement and reinstallation.
	9. Clogged hydraulic tank magnet and screen.	9. Clean. Refer to "Hydraulic System," Section XVI for procedure.
	NOTE: *Lack of power steering action may also be caused by malfunctioning steering components such as the Pitman arm, steering mechanism, steering knuckle, etc. Check steering components first before assuming that the power steering system is at fault.*	
Hard steering.	1. Under-inflated tires.	1. Refer to Tire and Wheel Group, Section XIV.
	2. Extremely soft working areas.	2. Allow work area to dry or lay new road bed.
	3. Power steering system not operating.	3. Refer to Causes and Remedies above.
	4. Misadjustment of steering gear.	4. Adjust. Refer to "Power Steering," Section XV.
	5. Crimped or restricted lines.	5. Clean, repair or replace. Refer to "Power Steering," Section XV.
	6. Lack of lubrication on all moving steering components.	6. Refer to proper sections for lubrication information.
	7. Binding of linkage.	7. Inspect linkage for damage, if in operating condition, check for adjustments and free movement.
Power steering in one direction only.	1. Crimped or restricted lines.	1. Repair or replace.
	2. Valve port clogged.	2. Clean valve, and change hydraulic oil, filters and screen if necessary.
	3. Bent or damaged linkage.	3. Repair or replace.
Cavitation, pump unusually noisy.	1. Low oil supply.	1. Fill to proper level.
	2. Heavy oil.	2. Change to proper oil.
	3. Dirty oil filter.	3. Clean and replace filter.
	4. Restriction in suction line.	4. Remove.

TROUBLE	POSSIBLE CAUSE	REMEDY
Pump takes too long to respond or fails to respond.	1. Low oil supply.	1. Fill to proper level.
	2. Insufficient relief valve pressure.	2. Reset to correct pressure setting using gauge.
	3. Pump worn or damaged.	3. Inspect, repair or replace.
Oil heating up.	1. Foreign matter lodged between the relief valve plunger and relief valve seat.	1. Inspect and remove foreign matter.
	2. Using very light oil in a hot climate.	2. Drain and refill with proper oil.
	3. Dirty oil.	3. Drain, flush and refill with clean oil.
	4. Oil level too low.	4. Fill to proper level.
	5. Insufficient relief valve pressure.	5. Set to correct pressure.
	6. Relief valve pressure too high.	6. Same as 5.
	7. Pump worn (slippage).	7. Replace or repair.
Oil foaming.	1. Air leaking into suction line from tank to pump.	1. Tighten all connections.
	2. Wrong kind of oil.	2. Drain and refill with a non-foaming type of hydraulic oil.
	3. Oil level too low.	3. Fill to proper level.

16. HYDRAULIC SYSTEM

TROUBLE	POSSIBLE CAUSE	REMEDY
Lack of hydraulic power.	1. Low hydraulic oil level.	1. Fill to correct level. Refer to "Hydraulic System," Section XVI, for procedures and quantity.
	2. Worn or damaged hydraulic pump.	2. Refer to "Hydraulic System," Section XVI, for removal, repair and reinstallation of pump.
	3. Using an oil that foams.	3. Refer to "Hydraulic System," Section XVI for proper oil specifications.
	4. Malfunctioning relief valves.	4. Refer to "Hydraulic System," Section XVI for correct settings of relief valve or replace valves if necessary.
	5. Leaking control valve.	5. Repair or replace.
	6. Leaking piston packing.	6. Replace packing. If more than one piston is leaking, check oil filters, screen and magnet for excessive dirt or metal particles. If hydraulic system is contaminated, drain and flush system, replace filters and inspect pump for wear and damage.

TROUBLE	POSSIBLE CAUSE	REMEDY
	7. Crimped or broken lines.	7. Repair or replace.
	8. Clogged suction line screen.	8. Clean screen.
Oil overheats.	1. Restriction in line.	1. Repair or replace.
	2. Low oil level.	2. Refill tank.
	3. Short operation cycle.	3. Allow slight rest between cycles.
	4. Clogged oil cooler.	4. Clean. Refer to "Engine Cooling System," Section IV.
	5. Dirty coolant.	5. Drain and flush cooling system. Refer to "Engine Cooling System," Section IV.
	6. Wrong weight oil.	6. Refer to "Hydraulic System," Section XVI for correct oil specifications.
	7. Dirty oil.	7. Drain and flush hydraulic system. Replace filters.
Malfunctioning control valve.	1. Bent or misadjusted control linkage.	1. Straighten or replace. Refer to "Seat Frame and Operator's Compartment," Section XVII.
	2. Weak or broken detent springs.	2. Replace.
	3. Worn or damaged plungers.	3. Replace.
	4. Worn or damaged seals.	4. Replace.
	5. Worn or damaged flow control valve.	5. Replace.
	6. Maladjusted or weak relief valve spring.	6. Adjust or replace. Refer to "Hydraulic System," Section XVI for proper adjustment.

17. LINKAGE

TROUBLE	POSSIBLE CAUSE	REMEDY
Bent booms, cross links, pump links or buckets.	1. Misapplication of loader.	1. Loader should be operated within its design capabilities. Repair or replace parts as necessary. Refer to "Linkage Group," Section XVIII.
	2. Obstruction wedged between loader, and boom or cross link.	2. Remove obstruction. Repair or replace parts as necessary.
	3. Lack of lubrication causing parts to bind or freeze.	3. Repair any damage, replace any parts and lubricate. Refer to Section XVIII.
Damaged or broken booms, cross links, dump links or buckets.	1. Refer to causes above.	1. Repair or replace wherever necessary.

SECTION XXIV—SPECIAL TOOLS

1. GENERAL

In many cases, the use of special tools for disassembly and assembly are required to perform the particular operation and to obtain the best results. The use of special tools enables the serviceman, or mechanic, to perform the operation in the proper manner and in the least amount of time.

The following special tool listing was prepared to assist service and maintenance personnel in the selection of proper tools and combination of tools to accomplish the various service and maintenance operations described and illustrated in the Model TL-30D Service Manual.

The special tools listed below must be ordered directly from the tool manufacturer.

Tool Manufacturers

Kent-Moore Organization, Inc.
28635 Mound Road
Warren, Michigan

Allison Division
General Motors Corp.
Box 894
Indianapolis 6, Indiana

2. TURBOCHARGER TOOLS

Description	Kent-Moore Tool Co.
Compressor Wheel Spacer Block	J–9131
Torque Wrench Adapter ½″	J–9113
Torque Wrench Adapter 7/16″	J–9115
Bearing Snap Ring Pliers	J–6083
Thrust Collar and Compressor Wheel Support Block	J–9135
Compressor Wheel Disassembly Ring	J–9128
Compressor End Ring Expander	J–9126
Turbine End Ring Expander	J–9134
Bearing Thrust Washer Remover	J–9282
Thrust Collar Compressor Wheel Assembly Tool	J–9129
Oil Flinger Assembly Gauge	J–9133
Compressor Wheel Disassembly Tool	J–9127
Bearing Snap Ring Pliers	J–9138
Oil Flinger Removing Tool	J–9132
Bearing Snap Ring Pliers	J–9136
Ring Groove Width Gauge — .066″	J–9116
Nozzle Vane Spacing Gauge — .210″	J–9124

3. ENGINE TOOLS

Description	Kent-Moore Tool Co.
Rocker Arm Bushing Tool Set	J–6332
Injection Nozzle Sleeve Remover Set	J–7857
Injection Nozzle Sleeve Installer (Used with Drive J–7079–2)	J–7865
Injection Nozzle Sleeve Cleaner	J–7871–01
Adapter Set for Eccentric Valve Seat Grinder (Used with Eccentric Valve Set Grinder J–7040)	J–9296
Nozzle Hole Cleaner-Wire (Used with Pin Vise J–4298–1)	J–8976
Exhaust Valve Seat Insert Installer (Used with Driver J–7079–2)	J–8834
Instake Valve Seat Insert Installer (Used with Driver J–7079–2)	J–8835
Exhaust Valve Seat Insert Remover (Used with Driver J–4140–14)	J–8870–1
Intake Valve Seat Insert Remover (Used with Driver J–4140–14)	J–8870–2
Exhaust and Intake Valve Guide Remover	J–269
Exhaust Valve Guide Installer Adapter (Used with J–9317–1 and J–9317–4 listed below)	J–9317–20
Intake Valve Guide Installer Adapter (Used with J–9317–1 and J–9317–4 listed below)	J–9317–17
Exhaust and Intake Valve Guide Installer Plate	J–9317–1
Exhaust and Intake Valve Guide Installer Spindle (⅜" Dia.)	J–9317–4
Valve Guide Cleaning Brush Set	J–5585
Front Seal Protector	J–6897
Cylinder Sleeve Remover	J–6833
Nozzle Tester Set	J–8625
Adapter Set (American Bosch used with above Tester Set)	J–8839
Nozzle Spray Collector	J–6445–50
*Nozzle Cleaning Kit	4040025
Nozzle Lapping Kit	J–3179
Nozzle Remover Adapter (Used with Slide Hammer J–6471–1)	J–6865
Slide Hammer	J–6471–1
Fuel Injection Line Nut Wrench (Nozzle Holder Assy. End)	J–6765
Fuel Injection Line Nut Wrench (Injection Pump End)	J–9162
Cylinder Diameter Checking Gauge	J–8060
Cylinder Hone	J–5902
Cylinder Ridge Reamer	J–9325
Compression Gauge Set	J–6762–02
Compression Gauge Set Carrying Case	J–7125
Piston Vise	J–1218
Piston Pin Retainer Pliers	J–4245

Description	Kent-Moore Tool Co.
Piston Pin Remover and Installer	J–7092
Piston Inserter (Piston Ring Compressor)	J–7061
Piston Ring Remover and Installer	J–8128
Piston to Sleeve Feeler Gauges	J–5438
Piston Ring Gap Feeler Gauges	J–3172
Gear Puller with 9½" Legs	J–8190
Legs 4½" for above Gear Puller	J–8180
Puller Adapter (Pair ¼–20)	J–8181
Puller Adapter (Pair 5/16–18)	J–8182
Puller Adapter (Pair ⅜–16)	J–8183
Puller Adapter (Pair 7/16–20)	J–9302
Puller Adapter (Pair ½–13)	J–8184
Puller Adapter (Pair ⅝–11)	J–8185
Drive Rod (Used with Valve Seat Insert Remover Tools)	J–4140–14
Driver (Used with Nozzle Sleeve Installer and Valve Seat Insert Installers)	J–7079–2
Camshaft Bushing Remover and Installer Set	J–6786
Oil Seal Remover and Replacer Set	J–3154–04
Torque Wrench 0–150 ft. lbs.	J–1313
Torque Wrench 0–300 ft. lbs.	J–9187
Pin Vise — for Holding Nozzle Hole Cleaning Wire	J–4298–1
Gear Puller Set (Small)	J–8111

*Order this tool from your Allis-Chalmers dealer.

4. TRANSMISSION TOOLS

Description	Allison Division Tool No.
Gear Spindle Tool	TSD–20221