SERVICE MANUAL

FOR

MODEL HD-20H

TRACTOR

SEPTEMBER 1953

PROPERTY OF

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FOREWORD

This manual is prepared to provide the customer and the maintenance personnel with complete information and instructions on the maintenance of the Model HD20H Tractor (standard model). Extreme care has been exercised in the designing, selection of materials and the building of the tractor. By proper maintenance and skillful operation of the tractor, the utmost satisfaction in performance and service will be obtained.

In order to become familiar with the various parts of the tractor, it is urged that the mechanic study the instructions in this manual and use it as a reference when performing repair or maintenance operations.

All information and photographs shown throughout this manual are of the "Standard" Model HD20H Tractor.

Sections I through XIX of this manual contain a detailed description of the various assemblies of the tractor and instructions for the proper adjustment and repair or rebuilding of these assemblies.

Section XX describes the Special Equipment available for the tractor and outlines the service on these parts.

General Maintenance Instructions are given in Section XXI, and Fits and Tolerances in Section XXII.

Trouble Shooting Information given in Section XXIII will aid in determining the cause of operating irregularities and tells what may be done to correct them.

To assure the best results and to maintain the original quality built into the tractor, it is important that Genuine "Allis-Chalmers" Parts be used when new parts are required.

IMPORTANT: ALWAYS FURNISH THE DEALER WITH BOTH THE TRACTOR AND ENGINE SERIAL NUMBERS WHEN ORDERING PARTS.

Many owners of "Allis-Chalmers" equipment employ the Dealer's Service Department for all work other than routine care and adjustment.

This practice is encouraged as our dealers are kept well informed by the factory regarding advanced methods of servicing "Allis-Chalmers" products and are equipped to render satisfactory service.

SUBJECT INDEX

SECTION I—DESCRIPTION AND SPECIFICATIONS

1. GENERAL DESCRIPTION

The description given herein and the information contained in this manual pertains to the Model HD20H Tractor (Standard Model).

The Model HD20H Tractor is a 41,000 pound, track-type tractor powered with a 6 cylinder, 2 cycle "DIESEL" Engine. Power from the engine is transmitted through a single plate, over-center type engine clutch into the Torque Converter which automatically multiplies the engine torque to meet the varying load requirements and transmits the power through a universal joint drive shaft assembly to the transmission.

From the transmission, the power is transmitted to the bevel gear and from the bevel gear to two multiple disc steering clutches (one on each side of the bevel gear cross shaft), thence through the steering clutches to the final drives and to the track sprockets.

The transmission provides 2 forward speeds ranging from 3 M.P.H. in low gear to 7 M.P.H. in high gear and a reverse speed of 5.5 M.P.H. under full governed engine speed of 1700 R.P.M.

Hydraulic steering clutch controls, mechanical self energizing brakes, adjustable and wide operator's seat, and unobstructed vision of the front of both tracks assure easy operation of the tractor.

The tractor is equipped with hydraulic steering controls; 24 inch track shoes; a hinged radiator guard; a full width crankcase guard, a front pull hook, truck wheel guards; track idler guards; sprocket guards; front bumper; electric starting and lighting equipment; and positive seal truck wheels, track idlers, and track support rollers.

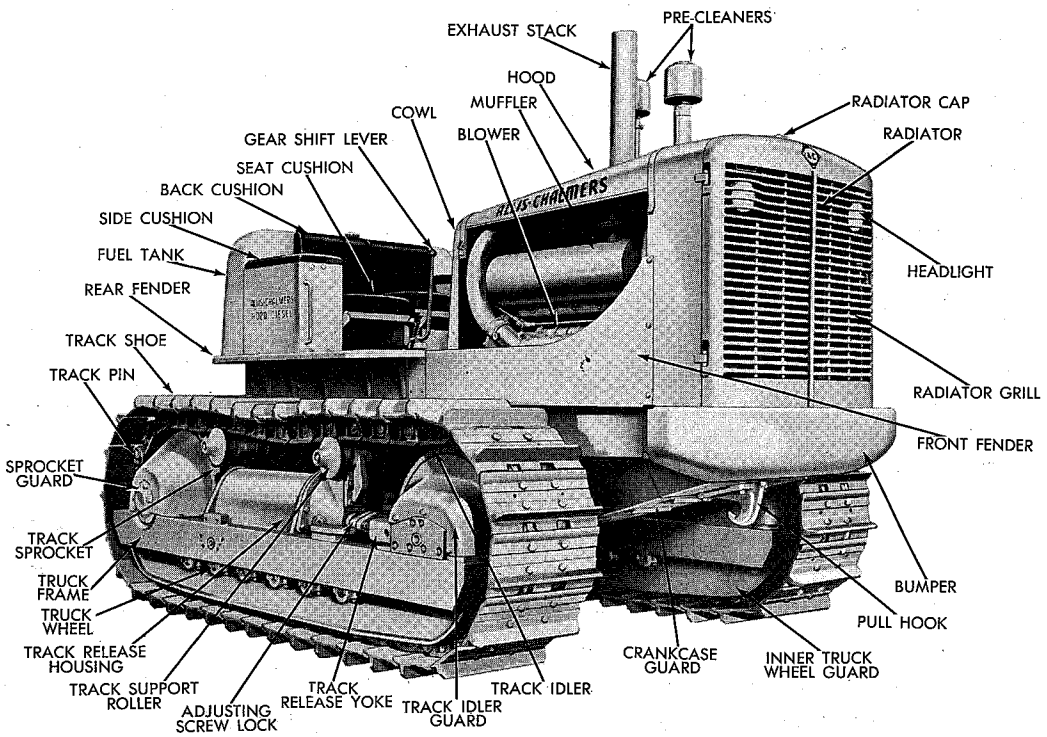


Fig. 1 — Model HD20H Tractor

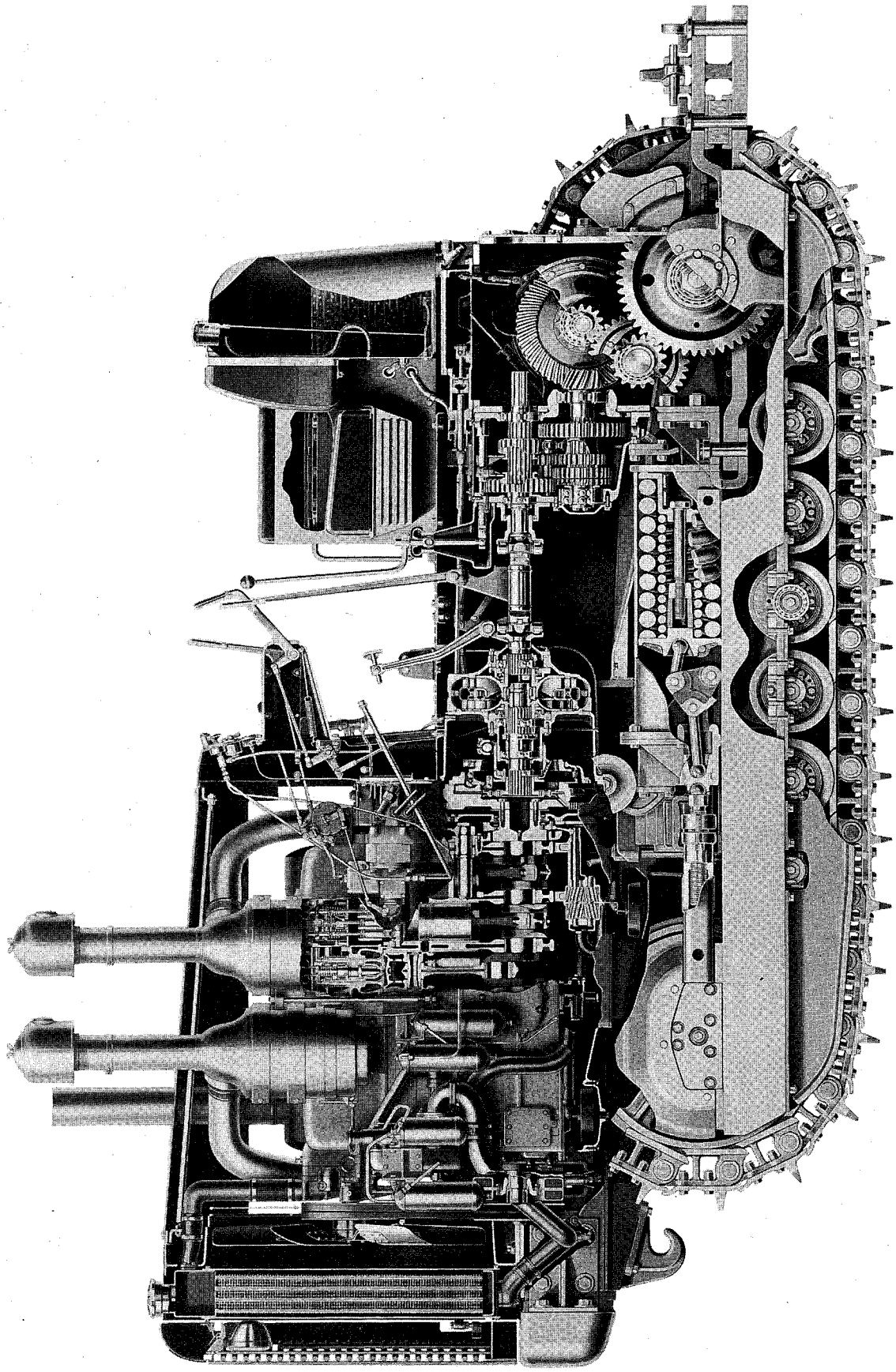


Fig. 2 — Sectionalized View of HD20H Tractor

2. GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS:

Overall Length	15 ft. 10¾ in.
Overall Height (without stacks)	7 ft. 10-5/16 in.
Overall Width	9 ft. 1¼ in.
Turning Radius	10 ft. 2¼ in.
Ground Clearance	16⅛ in.
Drawbar Height (center line of jaw)	19⅞ in.
Lateral Drawbar Movement	44 in.
Shipping Weight (approximate)	41,000 lbs.
Length of Track on Ground (center of Drive Sprocket to center of Track Idler)	8 ft. 10⅝ in.
Width of Standard Track Shoes	24 in.
Maximum Width Track Shoes	34 in.
Maximum Width Track Shoes Available	28 in.
Ground Contact Area (standard shoes)	5118 sq. in.
Number of Track Shoes per Track	37
Ground Pressure per Sq. In. (standard shoes)	8.1 lb.
Tread Width (center-to-center of tracks)	84 in.

TRACTOR SPEEDS:

GEAR RANGE	AVAILABLE SPEED
Low	0 to 3.0 M.P.H.
High	0 to 7.0 M.P.H.
Reverse	0 to 5.5 M.P.H.

ENGINE:

Make	General Motors Diesel
Type	Two Cycle
Number of Cylinders	6
Bore	5 in.
Stroke	5.6 in.
Piston Displacement	660 cu. in.
Engine Speed (governed at full load)	1700 R.P.M.
Maximum Net Torque	679 ft. lbs. @ 800 R.P.M.
Lubrication	Forced Feed
Fuel Used	No. 1 or No. 2 Diesel Fuel
Fuel Supplied by	80 cu. mm. Unit Injectors

TORQUE CONVERTER:

Make	Twin Disc
Type	Three Stage
Torque Ratio Increase	4.5 to 1
Fluid Used	Diesel Fuel
Fluid Supplied	Directly from Engine Fuel Return Manifold Under Pressure

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

Cooling System	15 Gals.
Crankcase and Filters	7½ Gals.
Transmission Case	9¾ Gals.
Final Drives (each)	7½ Gals.
Fuel Tank and Converter System	130 Gals.
Useable Fuel Tank Capacity	120 Gals.
Track Release Housing (each)	5½ Gals.
Air Cleaner (each)	(approximate) 1½ Gals.
Hydraulic Steering System	2¾ Gals.

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 NON-CORROSIVE "DIESEL" ENGINE LUBRICATING OIL CONTAINING ADDITIVES WHICH WILL PREVENT SLUDGE OR GUM DEPOSITS. UNDER NO CIRCUMSTANCES SHOULD A CORROSIVE "DIESEL" ENGINE LUBRICATING OIL EVER BE USED.

Use oils of the following viscosity:

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

Manufacturers 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 oil distributor and oil manufacturer are to be held responsible for the results obtained from their products.

The outstanding lubricating requirements for efficient operation of the engine are: The maintaining of piston rings in a clean, free condition; absence of hard carbon and "varnish" deposits on or within engine parts; the prevention of bearing corrosion; and the promotion of general cleanliness within the engine.

Proper operation and maintenance of the engine is necessary to obtain the desired results from the lubricating oil. Operating and maintenance factors can be effectively controlled by the engine user.

B. Transmission and Final Drive Lubricant

Lubricate these assemblies with any good grade of engine oil purchased from a reputable oil company. Use oils with the following viscosity:

Atmospheric Temperature	Viscosity
Above 32° F.	Use SAE 50
32° F. and below	Use SAE 30

C. Truck Wheel, Track Idler, and Track Support Roller Lubricant

Lubricate these assemblies with a grease that has been tested and found satisfactory for use by the "Allis-Chalmers" Manufacturing Company.

The type of grease used for lubricating these assemblies was selected because of its good pumpability and cold temperature characteristics and because of its having a minimum effect on the rubber seal boots. It is also an extremely stable grease and will not deteriorate excessively with long use.

A revised list of tested greases is issued every six months and greases which have been approved by the Allis-Chalmers Manufacturing Company during each period are added to the list. Ask your nearest "Allis-Chalmers" authorized Dealer for the latest list.

D. Hydraulic Steering System

Use an engine oil of the same viscosity as is used in the engine. "DIESEL" engine oil may be used provided it does not foam. The viscosity of the oil is to be determined by the prevailing temperature. When operating in extremely low temperature, when SAE 10W oil is too heavy to function properly, the oil may be thinned by the addition of kerosene or fuel oil. Contact your local "Allis-Chalmers" Dealer for further information.

E. Track Release Housing Lubricant

Lubricate with SAE Engine oil

F. Pressure Gun Lubricant

Use a ball and roller bearing lubricant with a minimum melting point of 300° F. This lubricant should be in a viscosity range so as to assure easy handling in the pressure gun at prevailing air temperature. The ball and roller bearing lubricant must be waterproof.

4. SPECIFICATIONS OF FUEL

Use No. 1 "DIESEL" Fuel purchased from a reputable oil company. In warm weather, No. 2 "DIESEL" Fuel may be used. This fuel must be within the classification limits as established by the American Society for Testing Material, Tentative Diesel Fuel Oil Specifications (ASTM — D975).

For longer engine life and better performance, fuel requirements must comply with four basic qualifications:

1. Physical cleanliness.
2. Absence of chemical contamination.
3. Proper burning characteristics.
4. Cold starting ability.

Physical cleanliness means freedom from water, dirt, and other incombustible ingredients. Since all present day high speed engine fuels are completely distilled, they leave the refinery in clean condition. Transport and subsquent storage account for the addition of most foreign matter found in the fuel.

Of the chemical contamination, the most objectionable are free sulphur and gum, which, even in relatively small quantities are largely responsible for harmful internal engine deposits. The fuel must also be free from alkali and mineral acids.

Proper burning characteristics are dependent upon ignition quality and volatility.

All fuels meeting the requirements of the No. 1-D and the lighter types of fuel in the No. 2-D grade of the ASTM D-975 "DIESEL" Fuel Oil Specifications are satisfactory. *The volatile grade (ASTM No. 1-D) is recommended for all types of service where frequent speed and load changes occur,* while fuels in the heavier grade (ASTM No. 2-D) may be used with sustained high loads. However, prolonged use of fuel combining low ignition quality (less than 45 Cetane Number) with high boiling temperature (more than 675° F. end point) should be avoided, particularly in cold weather.

CAUTION: The sulphur content of "DIESEL" Fuel should be as low as possible. For normal temperature conditions, the fuel should contain less than 0.5% sulphur. For cold weather operation, fuel with less than 0.3% sulphur is preferable.

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 filters and eventually damage the fuel pump and injectors.

A portable storage tank provides the best method for storing fuel on the job. In 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 local "Allis-Chalmers" Dealer for details about this type of storage tank. Since condensation will occur in the tank it is very important that a sediment sump be provided in the bottom of the storage tank where the water and settlings can be drained daily.

Fuel should be allowed to settle at least 48 hours in the storage container before it is put in the fuel tank of the tractor. It is advisable to use a pump and draw the fuel from the tank or barrel rather than to drain it from the bottom of the container by means of a faucet or through the bung hole.

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 should be used only to within about three inches from the bottom. 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 storage, they should be covered or placed under shelter to prevent the fuel from becoming contaminated by water which will enter through the filter 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 in the morning. This will reduce the water content, as a full tank is less subject to condensation. The fuel tank is provided with a drain elbow and drain cock. Sediment will settle into this elbow and can be drained.

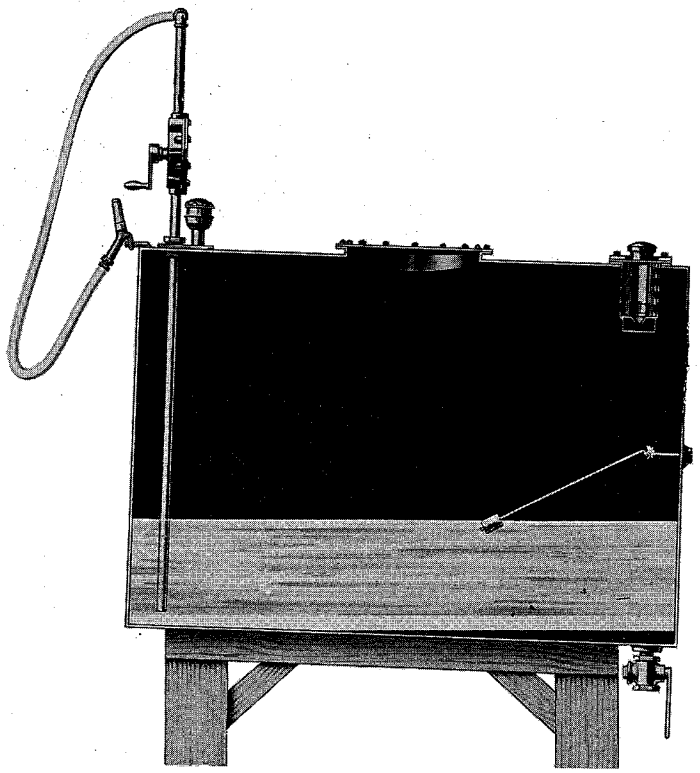


Fig. 3 — Fuel Storage Tank

6. TRACTOR AND ENGINE SERIAL NUMBERS

On all parts orders and in all correspondence relative to the tractor, it is necessary that both the tractor and the engine serial numbers be given. This will properly identify the particular machine and will assure obtaining the correct replacement parts for it.

The tractor serial number is stamped in the rear face of the steering clutch housing near the upper right corner and is also stamped on a small serial number plate attached to the cowl.

The engine serial number is stamped in the upper left rear corner of the cylinder block near the governor.

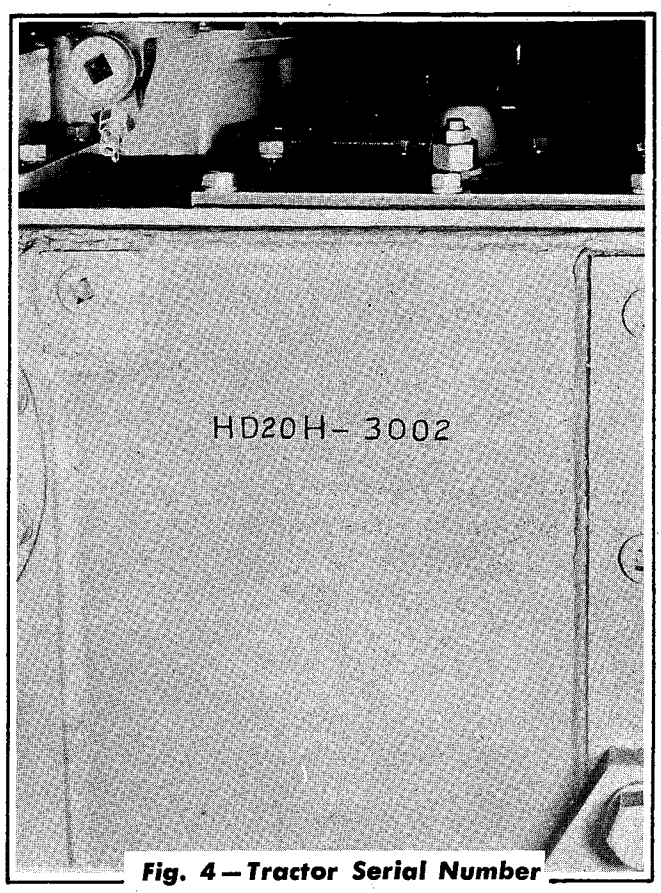


Fig. 4—Tractor Serial Number

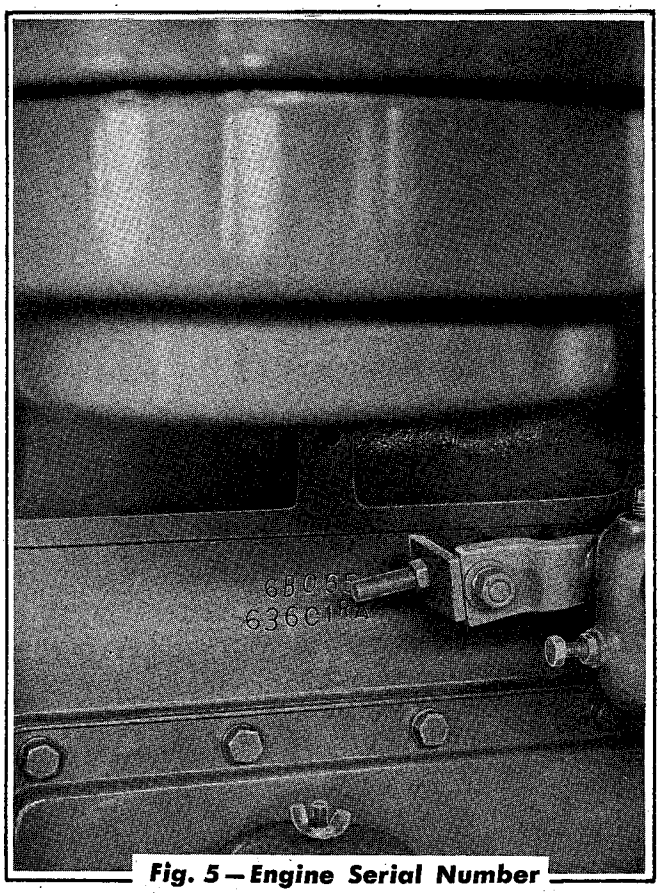


Fig. 5—Engine Serial Number

SECTION II—ENGINE FUEL SYSTEM

1. DESCRIPTION OF SYSTEM

The engine fuel system consists of the fuel tank, first stage fuel filter, fuel pump, second stage fuel filter, injectors, fuel lines, fuel pressure gage, and return line filter. The fuel is drawn from the bottom of the fuel tank and through the first stage fuel filter by the fuel pump. The pump then circulates the fuel under pressure through the second stage fuel filter, through the inlet fuel manifold on top of cylinder head, and into the injectors. As the fuel enters each injector, it passes through a small porous metal filter in the injector body. The amount of fuel required by the engine is injected into the cylinders by the injectors. Surplus fuel not required for combustion leaves each injector through another porous metal filter and enters the return fuel manifold.

From the return fuel manifold, the fuel passes through the torque converter. The fuel then circulates through a cooling radiator (for the torque converter), and is returned to the fuel tank. A filter and restrictor assembly, connected in the fuel return line and located on the lower left side of the radiator, filters the returning fuel and maintains a pressure of 35 to 55 pounds within the system.

The continuous circulation of fuel through the injectors helps to cool them and also eliminates the possibility of air pockets in the converter and engine fuel supply system.

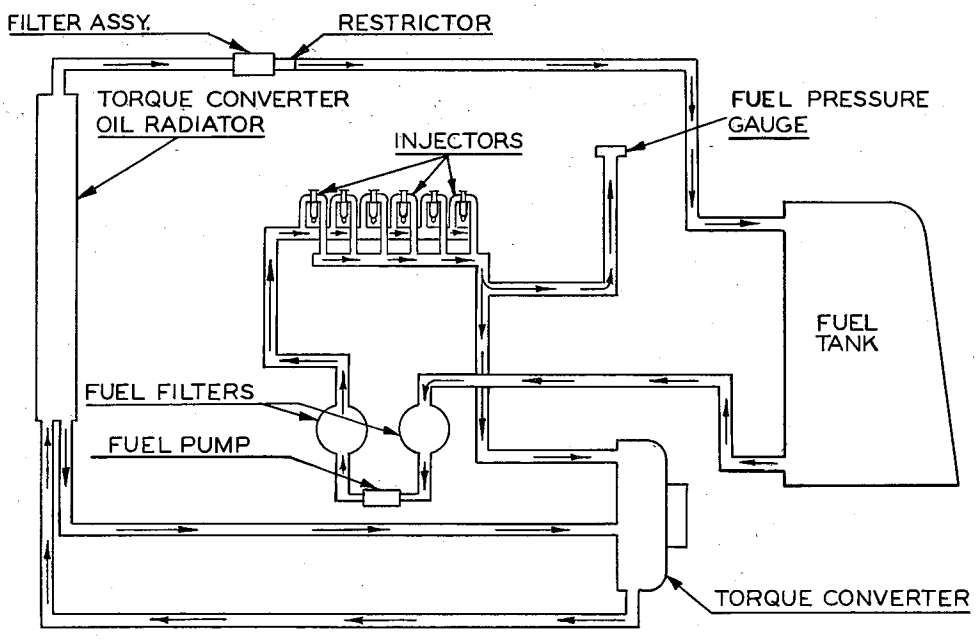


Fig. 1 — Schematic Fuel Flow Diagram

2. CHECKING FUEL SUPPLY SYSTEM

A. General

Under normal conditions, with the engine running at full throttle, 35 to 55 pounds pressure will be indicated on the fuel pressure gage. Fuel pressure below normal, uneven running of the engine, excessive vibration, stalling when idling, and a loss of power are indications of insufficient fuel supply to the injectors. To determine the cause for the above conditions check for the following:

a. Air being drawn into system on suction side of pump.

b. Clogged fuel filter elements and fuel lines.

c. Clogged injector fuel filters.

d. Inoperative fuel pump.

To check the flow of fuel through the system, disconnect the fuel return line at the fuel tank. With the engine operating at full throttle (engine clutch disengaged), the system will be functioning properly when a full stream of fuel with considerable pressure can be observed returning to the fuel tank through the fuel return line. If only a small stream is observed returning to the tank, all causes listed above must be checked and eliminated in turn.

B. Check for Admission of Air Into System and for Clogged Filter Elements and Fuel Lines

To check for air being admitted into system, follow the same procedure as used in checking the flow of fuel through the system. If air is entering the fuel system, foam or bubbles will be observed in the fuel that emerges from the fuel return line. Correct this condition by tightening any loose fuel lines and filter connections between the fuel pump and the fuel tank. Start the engine and test for smooth operation and full flow of fuel.

If the fuel lines or filters are clogged, remove the fuel lines, clean both filter shells and install new elements. Also remove and clean the fuel return line filter, located in the fuel return line at the left side of the radiator. Blow out the lines while they are disconnected. This should eliminate the difficulty. Check for full flow of fuel after the engine is again started.

C. Check for Clogged Injector Filters

If engine still runs "ragged" with suitable fuel return, the injector filters for one or more of the cylinders may be partially clogged. Locate the injector which is not functioning properly.

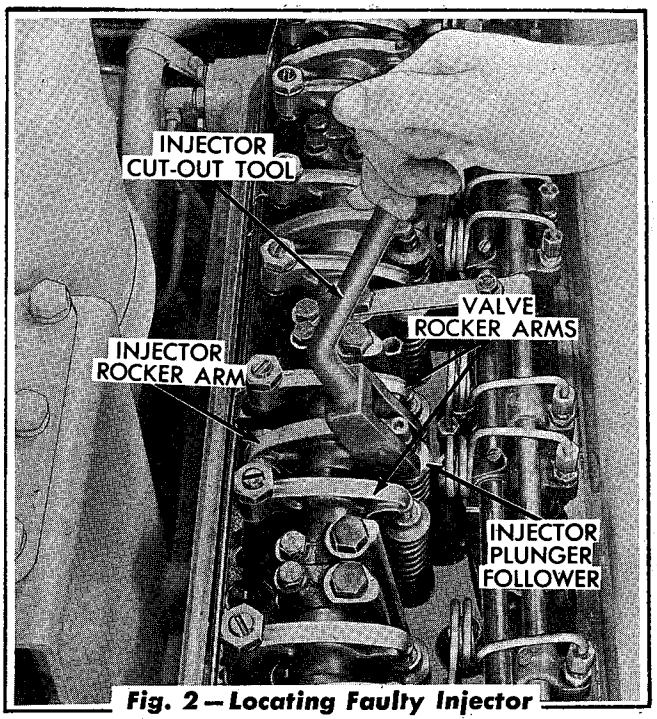


Fig. 2—Locating Faulty Injector

Run the engine at idling speed and cut out each injector in turn by holding the injector follower down using an injector "cut-out" tool, as shown in Fig. 2. A decrease in engine speed with the follower held down will indicate that the injector for that cylinder is functioning properly. *CAUTION: Do not allow "cut-out" tool to slip off follower as damage to valve assemblies can easily result.* If the engine speed does not decrease with the follower held down, the injector is inoperative and should be removed for inspection. Before removing the injector, determine whether or not the faulty injector is obtaining sufficient fuel. Stop the engine and remove the fuel feed line that connects the injector to the return fuel manifold. Hold a finger over the injector fuel outlet and crank the engine with the starter. If fuel gushes from the injector while the starter is cranking the engine, an ample fuel supply is indicated.

D. Check for Inoperative Pump

Assuming that there is a sufficient supply of fuel in the fuel tank, and that fuel is reaching the fuel pump, loosen the air vent screw in the top of the second stage fuel filter. With the engine running, the fuel should gush from the opening in the filter; if it does not, the fuel pump will be considered inoperative and must be removed for repair or replacement.

E. Excessively High Pressure

A relief valve is installed in the fuel pump to prevent high fuel pressure. If the relief valve sticks, high pressure will develop and will be indicated on the fuel pressure gage.

When this occurs, the valve in the fuel pump should be inspected and the cause determined for its sticking. The second stage fuel filter, the fuel return line filter and restrictor assembly (located on the lower left side of the radiator), and all the fuel lines should be inspected for clogged passages.

Continued operation with excessively high pressure (over 60 pounds), may result in damage to the fuel system.

3. FUEL TANK AND DRAIN ELBOW

A. Description

The fuel tank, located at the rear of the tractor, has a capacity of approximately 130 gallons.

The drain elbow on the bottom of the fuel tank provides a means of flushing the tank and also acts as a sediment sump. Open the drain cock in this elbow daily, before the engine is started at the beginning of the day's operation in warm weather, or shortly after the end of the day's operation in freezing weather; close the drain cock when clean fuel runs out. Drain the tank, when an accumulation of rust and scale is evident, by removing the plug in the end of the drain elbow, then flush the tank thoroughly.

B. Maintenance

If a large accumulation of rust or scale in the tank becomes apparent, remove the drain elbow and the fuel lines from the bottom of the tank and flush the tank with clean fuel or clean the tank with live steam. This will prevent frequent clogging of the fuel filters and will eliminate possible trouble in the fuel system.

C. Removal

1. Remove the seat cushions. Remove the arm cushions from the top of each battery box, then remove the bolt attaching each battery box to the fuel tank.

2. Remove the capscrews attaching the battery cable supporting clips to the fuel tank.

3. Close the fuel shut-off valve at the bottom of the tank and disconnect the fuel supply line and the fuel return line from the tank.

4. Remove the bolts attaching the tank to the rear fenders.

5. Place a suitable chain or rope around the tank and remove the tank from the tractor. Protect all openings of the fuel tank and the disconnected lines against the entrance of foreign material.

D. Installation

The fuel tank may be installed by direct reversal of the removal procedure (refer to C above).

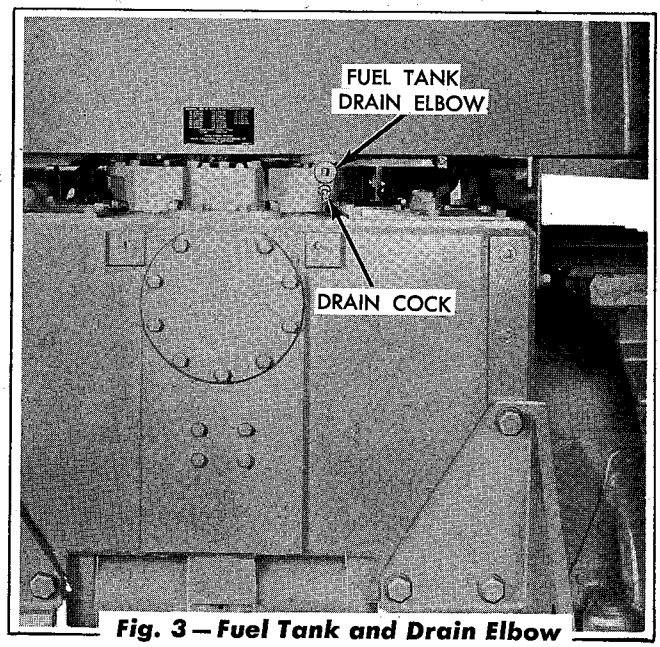


Fig. 3 — Fuel Tank and Drain Elbow

4. FUEL FILTERS

A. Description of First and Second Stage Fuel Filters

Two fuel filters, each containing replaceable filter elements, are mounted on a bracket attached to the front left side of the engine. The filter nearest the front end of the engine is the first stage filter; the rear filter is the second stage filter.

As the filter elements are very similar in appearance, they are made in different lengths; the first stage filter element is 9 inches long, and the second stage filter element is 8 inches long. Dirt and sediment in the fuel is collected by these elements before the fuel enters the injectors. A drain cock is provided at the bottom of each filter for draining of sediment.

B. Service of First and Second Stage Fuel Filters

Loosen the air vent screw and the filter drain cock of each fuel filter 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. Tighten the vent screws and drain cocks when clean fuel runs out. Discard the old elements and install new ones when fuel pressure is below 35 pounds when the engine is running at full throttle, or when the filters become clogged. Clogged filters are usually indicated by irregular engine performance. Remove and discard the old elements and install new ones after every 500-hours of operation, or more often if conditions warrant.

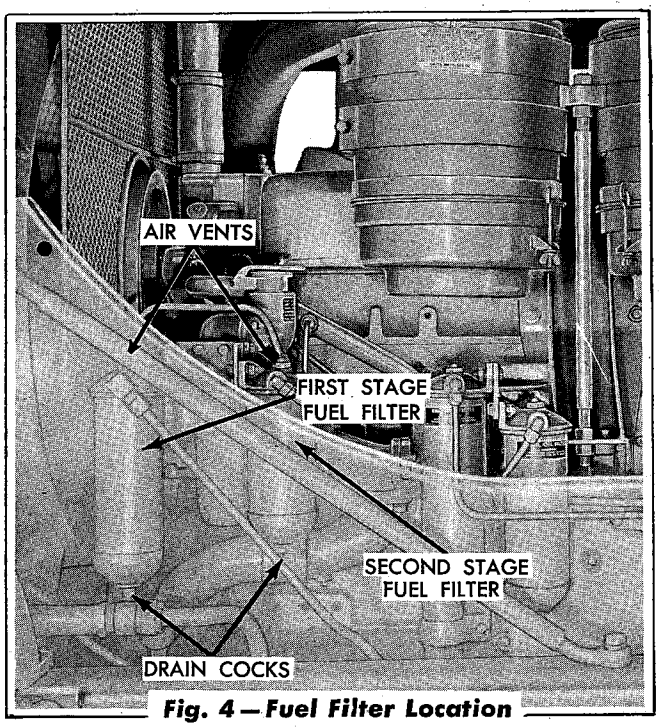


Fig. 4—Fuel Filter Location

C. Replacement of First Stage Fuel Filter Element

1. Close the fuel tank shut-off valve and loosen the air vent screw in the top of the filter head. Open the drain cock and allow fuel to drain from the filter.

2. Clean all dirt from around the filter shell and the filter head thoroughly.

3. Loosen the hex nut in the filter head until the nut is free of the centerbolt, then separate the shell from the head. Remove the element centering guide from the top of the element.

4. Discard the filter element and the shell gasket, then thoroughly wash and clean the inside of the shell and the centerbolt.

5. Install the new filter element from the replacement kit and push it down firmly so that the up-turned edge of the seat plate, attached to the bottom of the centerbolt of the shell assembly, is firmly impressed into the bottom of the filter element. Place element centering guide in position on top of the element.

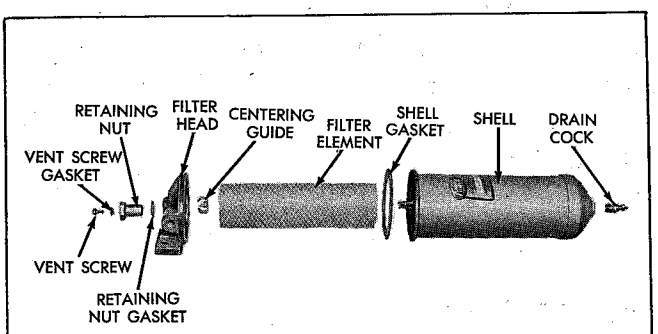


Fig. 5—First Stage Fuel Filter Details

6. Place the new shell gasket (furnished with the filter element replacement kit), in the lip of the shell and press the shell assembly, complete with the element, element center-

ing guide, and gasket, into position against the filter head. Engage the threads of the hex nut with the centerbolt and tighten securely.

7. Close the filter drain cock and remove the air vent screw. Open the fuel tank shut-off valve. When fuel runs out of the air vent, install the vent screw and tighten securely.

8. Check for leaks between the filter shell and the head, and at the fittings. Correct any leaks found.

D. Replacement of Second Stage Fuel Filter Element

1. Close the fuel tank shut-off valve and loosen the air vent screw in the top of the filter head. Open the drain cock and allow fuel to drain from the filter.

2. Clean all dirt from around the filter shell and the filter head thoroughly.

3. Loosen the hex nut in the filter head until the nut is free of the centerbolt, then separate the shell from the head.

4. Discard the filter element, top gasket, seat plate gasket, and washer. Remove and save the centering guide, spring, and seat plate. Thoroughly wash and clean the inside of the shell and the filter components.

5. Install the spring and washer on the centerbolt, pushing them down firmly until seated. Install the new seat plate gasket (furnished with the filter element replacement kit), and push it down over the centerbolt until it touches the washer. Be sure that the smaller side of this gasket is toward the top of the filter. Place the seat plate on the centerbolt and push it down until the gasket and the washer are up inside the recess in the seat plate. Install the centering guide on the top of the centerbolt.

6. Install the new filter element from the replacement kit and push it down firmly so that the upturned edge of the seat plate, attached to the bottom of the centerbolt of the shell assembly, is firmly impressed into the bottom of the filter element.

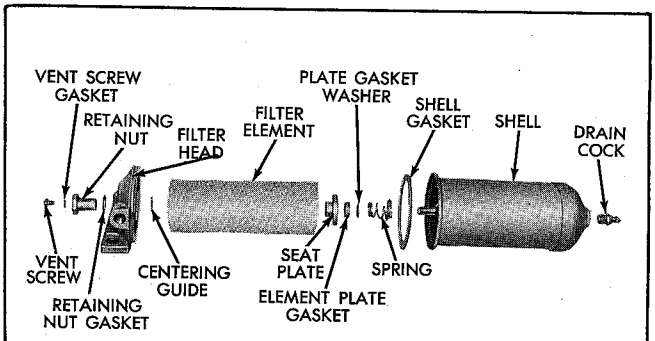


Fig. 6—Second Stage Fuel Filter Details

7. Place the new shell gasket in the lip of the shell and press the shell assembly up in position against the filter head. Engage the threads of the hex nut with the centerbolt and tighten securely.

8. Close the filter drain cock and loosen the filter air vent screw. Open the fuel tank shut-off valve.

9. Start the engine and operate it at about ½ throttle until fuel runs out around the loosened vent screw. Tighten the vent screw securely.

10. Check for leaks between the filter shell and head, and at fittings. Correct any leaks found.

IMPORTANT: Keep parts clean when changing the fuel filter element.

E. Heavy Duty Fuel Filter

On tractors equipped with Heavy Duty Filters, service as follows: Remove the drain plug in the bottom of the filter housing, before the engine is started at the beginning of the day's operation in warm weather or shortly after the end of the day's operation in freezing weather, and allow the water or sediment to drain. Replace the drain plug when clean fuel runs out. Remove and discard the old element and install a new one after every 300 to 500 hours of operation or when the fuel pressure drops below 35 pounds per square inch.

F. Replacement of Heavy Duty Fuel Filter Element

1. Close the fuel shut-off valve at bottom of fuel tank.

2. Remove drain plug from bottom of filter housing and allow fuel to drain from filter. Then, remove lid capscrews and lift lid from housing.

3. Unscrew T-handle hold-down assembly from center tube and remove element from filter housing by lifting with pull-out bail.

4. Clean the filter housing thoroughly and replace drain plug.

5. Install a new "DIESELPAK" element and top gasket in the filter housing. To assure leakproof sealing, examine the seats on each end of the filter elements to see that they are in good condition and clean.

6. Replace the T-handle hold-down assembly and tighten firmly. Fill the filter housing with clean fuel.

7. Replace the lid on the filter housing and tighten the lid capscrews evenly and securely.

8. Fill the fuel tank so that there will be sufficient fuel in the tank to fill the filter by gravity, then open the fuel shut-off valve at the fuel tank and remove the vent plug from the top of the filter housing. Allow the filter to fill by gravity. Install the vent plug when fuel emerges from the vent plug opening.

9. Start the engine and check for leaks at the filter lid, vent plug, and drain plug.

CAUTION: Use only "DIESELPAK" element in the Heavy Duty Filter.

G. Description of Fuel Return Line Filter and Restrictor Assembly

The fuel return line filter and restrictor assembly, located on the lower left side of the radiator, consists of a filter body, restrictor plug, filter screen, and gasket. Its function is to filter the fuel leaving the engine, through the fuel return line, and to maintain an even pressure in the fuel system by the virtue of the restrictor plug.

Tractors prior to serial number 4793 are equipped with restrictor plugs having a .073" opening. Effective with tractor serial number 4793, the size of the opening in the plug was decreased to .058"-.062". This change increased the pressure in the fuel system. When servicing filter and restrictor assemblies on tractors prior to serial number 4793, always install the new restrictor plug having the smaller opening (.058"-.062").

H. Service of Fuel Return Line Filter and Restrictor Assembly

The fuel return line filter and restrictor assembly should be removed, disassembled, and cleaned each time the first and second stage fuel filters are serviced (after every 500-hours of operation, or more often if conditions warrant). Clogging of the filter and restrictor assembly will be indicated by excessively high fuel pressure, air in the system causing "sluggishness" of the torque converter, and uneven running of the engine.

1. Remove the two fuel lines from each end of the filter assembly and the capscrew attaching the filter supporting clip to the radiator shell. Remove the filter assembly and the supporting clip from the shell.

2. Clamp the filter body in a bench vise and remove the filter screen.

3. Using a screwdriver, remove the restrictor plug. Clean the screen thoroughly in clean fuel or solvent and blow out with compressed air. Make certain that the hole in the restrictor plug is open. *CAUTION: Do not enlarge this hole.*
4. Reassemble and install the filter assembly by a direct reversal of the removal procedure.

5. FUEL PUMP

A. Description

The engine may be equipped with either a "BARNES" or a "GENERAL MOTORS" fuel pump. The fuel pump is attached to the engine front cover, as shown in Fig. 7, and is driven from the front end of the water pump shaft. The pump driving shaft rotates in a counter-clockwise direction, viewed from the flywheel end of the engine.

The "BARNES" fuel pump is a constant flow, gear type pump having a delivery capacity of approximately 35 gallons per hour at 1000 engine R.P.M. with a pump discharge pressure of 40 pounds per square inch.

Two steel gears revolve inside the pump housing to create a vacuum in the intake chamber, thus drawing fuel from the fuel tank. The fuel is carried around the pump gears in the spaces between the teeth and is forced out the pump outlet port under pressure. The pump driving gear is mounted on a free-floating type drive shaft and is attached to the shaft by a shear pin. The driven gear is supported in the bore of the pump housing by its supporting journals which are an integral part of the driven gear.

A spring loaded relief valve, located on the inlet side of the pump (left side of pump viewed from pump housing end), is provided to by-pass fuel back to the inlet side when the outlet pressure exceeds 47 to 60 P.S.I. This valve normally does not open since its purpose is to relieve excessive pressure in case clogging occurs in the fuel lines or filters.

Two pump shaft oil seals are used inside the stator at the inner end of the pump. The sealing edge of one seal faces the pump gears and retains the fuel within the pump; the sealing edge of the other seal faces the water pump driving gear and prevents engine lubricating oil from entering the pump. The seals are located approximately 1/16" apart. Two (2) drain holes, located between the two seals, vent to the atmosphere.

The "GENERAL MOTORS" fuel pump is a positive displacement, gear type pump having a delivery capacity of approximately 80 gallons per hour at 1660 engine R.P.M. with a pump discharge pressure of 40 pounds per square inch.

Two pump gears, affixed to the driven and drive shafts, revolve inside the pump housing to create a vacuum in the intake chamber, thus drawing fuel from the fuel tank. The fuel is carried around the pump gears in the spaces between the teeth and is forced out the pump outlet port under pressure.

A spring loaded relief valve, located on the inlet side of the pump (left side of pump viewed from pump cover end), is provided to by-pass fuel back to the inlet side when the outlet pressure exceeds 42 P.S.I. This valve normally does not open since its purpose is to relieve excessive pressure in case clogging occurs in the fuel lines or filters. A small hole in the pump body allows fuel back of the relief valve to return to the gear compartment, otherwise, this fuel might become trapped behind the valve and prevent the valve from opening.

Two pump shaft oil seals are used inside the pump body. The sealing edge of one seal faces the pump gears and retains the fuel within the pump; the sealing edge of the other seal faces the water pump driving gear and prevents engine lubricating oil from entering the pump. The seals are located approximately 1/16" apart. Two (2) drain holes, located between the two seals, vent to the atmosphere.

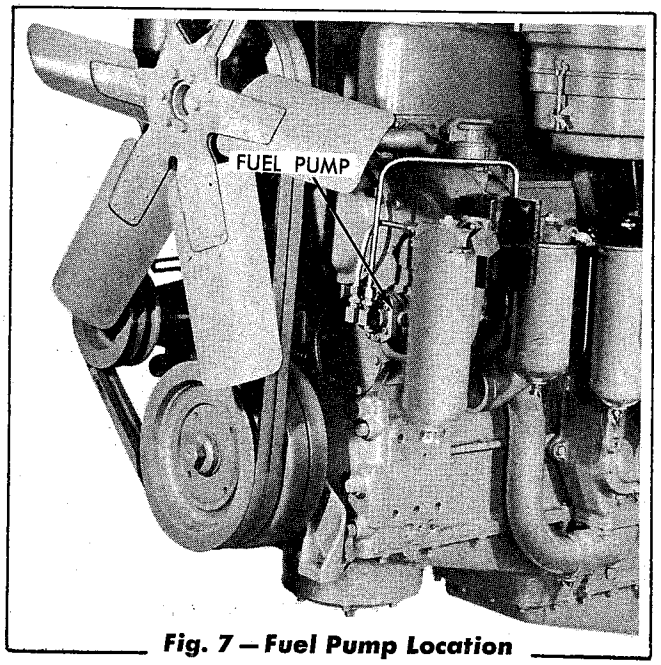


Fig. 7 — Fuel Pump Location

B. Service

If the fuel pump is to be reconditioned, the pump assembly must be removed from the engine.

C. Removal of Fuel Pump

1. Disconnect the fuel lines from the pump.
2. Remove the three (3) capscrews attaching the fuel pump to the engine front cover. Remove the fuel pump and drive coupling as a unit, withdrawing the pump straight forward from the engine front cover.
3. Rotate the pump shaft by hand to see if the internal parts of the pump rotate freely. If binding or sticking is evident, disassembly and inspection of the pump will be necessary.

D. Disassembly of "GENERAL MOTORS" Fuel Pump

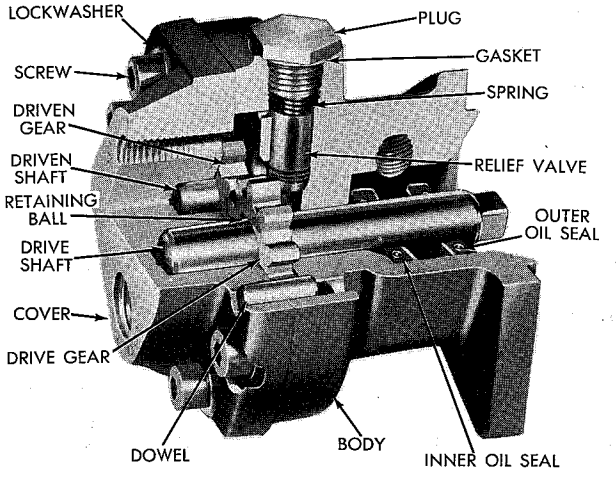


Fig 8—Fuel Pump Sectionalized View (General Motors)

The relief valve assembly may be removed from the pump body without disassembly of the other parts of the pump, by removing the relief valve plug and jarring the valve parts from the body.

When removing the relief valve assembly, note the position of each part so that the parts may be reassembled in their same relative position.

If the relief valve only is to be inspected, no further disassembly is necessary. If the entire pump is to be dismantled, proceed as follows:

1. Remove the cover attaching bolts and install capscrews ¼" x 20 x 3" long, so that the heads of the capscrews extend out ¾" from the pump cover.
2. Holding the pump assembly in hand, tap on the heads of the capscrews with a soft hammer, separating the body and the cover. *CAUTION: DO NOT PRY BODY AND COVER APART.*
3. Withdraw the drive shaft, drive gear, and gear retaining ball as an assembly from the pump body. Use care when withdrawing the drive shaft so as not to damage the pump drive shaft oil seals.
4. Remove the drive gear from the drive shaft being careful not to lose the gear retaining ball.
5. Remove the driven gear, driven shaft, and gear retaining ball as an assembly from the pump body.
6. Remove the driven gear from the driven shaft being careful not to lose the gear retaining ball.
7. If it is necessary to remove the drive shaft oil seals, a tool of the proper design may be used to remove them.

E. Inspection of "GENERAL MOTORS" Fuel Pump

1. Wash all the parts in clean fuel or solvent and inspect them carefully. The oil seals, once removed from the pump, should be replaced with new seals. If the sealing edges of the oil seals are damaged in any way, so that they do not form a perfect seal around the shaft, either a fuel leak or lubricating oil leak will result.
2. Inspect the gears. If the gears are slightly scored, chipped, or worn on the involute surfaces, they should be replaced. If the pump is operated until an appreciable amount of wear is noticeable, the delivery capacity of the pump will be affected.

3. Install the two gears on their respective shafts with the retaining balls in place. If excessive wear between these parts is found, new parts must be installed.

4. Inspect the surfaces inside the fuel pump body and the part of the cover contacted by the gear faces. If these surfaces show excessive wear or are scored, the entire pump must be replaced. The mating faces of the pump body and the cover must be flat and fit together tightly.

5. Check the pump relief valve. If the valve does not form a tight seal on its seat in the pump body, lap the valve seat using fine valve lapping compound. A piece of wood about the size of a pencil makes a good holder for hand lapping. *CAUTION: Use only a small amount of compound so that only the seat of the valve and in the pump body will be affected. The ideal seat is a ring about 1/64" to 1/32" wide in the pump body. Thoroughly wash all the lapping compound and foreign material off the valve and out of the pump body when the lapping process is completed.*

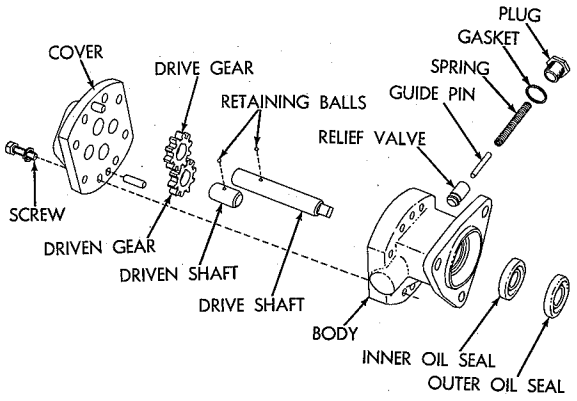


Fig. 9—Fuel Pump Details (General Motors)

F. Assembly of "GENERAL MOTORS" Fuel Pump

1. Install the drive shaft inner oil seal in the pump body, with the sealing edge of the seal pointing toward the gears. Install the seal so that it is down tight in the counterbore of the pump body.

2. Install the drive shaft outer oil seal in the pump body, with the sealing edge of the seal pointing toward the mounting flange end of the pump.

3. Install the retaining ball into the indentation in the drive shaft, then place the drive gear over the drive end of the shaft and position it over the retaining ball. Lubricate the drive shaft and the oil seals and install the drive shaft (with gear in place) in the pump body. Push the drive shaft through the seals being exceptionally careful not to crimp or damage the sealing edges. Use an oil seal pilot tool on the drive end of the shaft if a tool is available.

4. Install the retaining ball into the indentation in the driven shaft, then place the driven gear on the shaft and over the retaining ball. With the slot in the driven gear for the retaining ball facing the pump cover, install the driven shaft (with gear in place) in the pump body. Lubricate the gears with clean engine oil.

5. Coat the machined attaching surfaces of the pump body and the pump cover with a commercial non-hardening sealing compound. *CAUTION: Do not get any sealing compound inside the pump. Place the pump cover in position on the pump body with the two dowels entering their respective holes. The cover can be installed in only one position over the two shafts. Push the parts together and install the attaching screws and lockwashers. Tighten the attaching screws securely.*

6. Turn the pump drive shaft by hand and test it for bind. The shaft should turn smoothly, with a slight drag, but should not bind or have tight spots.

7. Install the relief valve parts, making certain that the parts are installed properly in their respective places.

8. Install the fuel pump on the engine by direct reversal of the removal procedure, making certain that the gasket used between the pump and the engine front cover is in good condition.

G. Disassembly of "BARNES" Fuel Pump

The relief valve assembly may be removed from the pump stator, without disassembly of the other parts of the pump, by removing the relief valve plug and jarring the valve parts from the body.

When removing the relief valve assembly, note the position of each part so that the parts may be reassembled in their same relative position.

If the relief valve only is to be inspected, no further disassembly is necessary. If the pump is to be dismantled proceed as follows:

1. Remove the screws attaching the pump housing to the stator and install capscrews ¼" x 20 x 3" long, so that the heads of the capscrews extend out about ¾" from the pump housing.

2. Holding the pump assembly in the hand, tap the heads of the capscrews with a soft hammer, separating the stator and housing. *CAUTION: DO NOT PRY STATOR AND HOUSING APART.*

3. Remove the pump driven gear.

4. Remove the pump shaft and drive gear from the stator carefully, so as not to damage the pump shaft seals.

5. Remove the dowels from the pump housing if necessary.

6. If it is necessary to remove the shaft seals, a tool of the proper design may be used to remove them.

H. Inspection of "BARNES" Pump Parts

1. Wash all the parts in clean fuel or solvent and inspect them carefully. The shaft seals, once removed from the pump, should be replaced. If the sealing edges of the seals are damaged in any way, so that they do not form a perfect seal around the shaft, either a fuel leak or lubricating oil leak will result.

2. Inspect the gears. If the gears are slightly worn on the involute surfaces, they should be replaced. If the pump is operated until an appreciable amount of wear is noticeable, the delivery capacity of the pump will be affected.

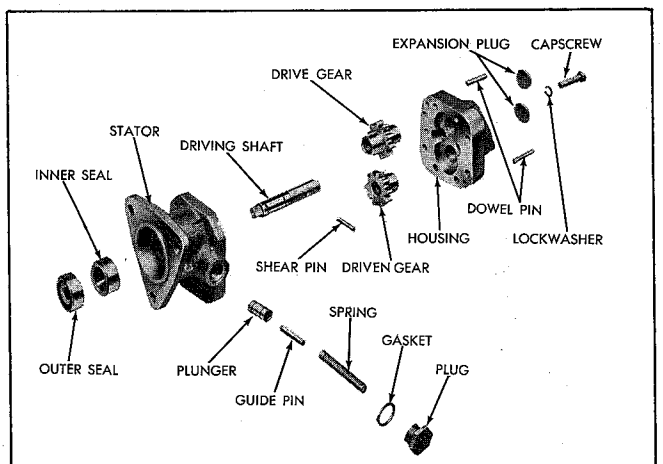


Fig. 10 — Fuel Pump Details "Barnes"

3. Inspect the drive gear on the pump shaft. The shear pin holding the drive gear to the pump shaft must be tight. Replace parts if necessary.

4. Check the fit of the gears in the bores of the stator and housing. If the stator and housing are worn or scored, causing looseness, the entire pump must be replaced.

5. Inspect the surfaces inside the stator and housing contacted by the gear faces. If the surfaces show excessive wear or are scored, the entire pump must be replaced.

6. When the pump is overhauled, it is recommended that the relief valve and spring be replaced. Replacement of these parts may prevent difficulties in pump operation in the future.

I. Assembly of "BARNES" Fuel Pump

1. Install the pump shaft inner oil seal in the stator with the sealing edge of the seal pointing toward the pump housing.

2. Install the pump shaft outer oil seal in the stator with the sealing edge of the seal pointing toward the mounting flange end of pump.

3. Lubricate the pump shaft and seals and install the pump shaft (with drive gear in

place) in the stator. Push the shaft through the seals being exceptionally careful not to damage the seals. Use an oil seal pilot tool on the drive end of the shaft if a tool is available.

4. Install the driven gear in place in the housing. Lubricate the gears with light engine oil.

5. Coat the machined attaching surfaces of the stator and the pump housing with a commercial non-hardening sealing compound. *CAUTION: Do not get any sealing compound inside the pump. Place the pump housing in position on the stator, turn the pump shaft to mesh the gear teeth, and push the parts together. Install the attaching screws and tighten securely.*

6. Turn the pump shaft and test it for bind. The shaft should turn smoothly, with a slight drag, but should not bind or have tight spots.

7. Install the relief valve parts, making certain that the parts are installed properly in their respective places.

8. Install the fuel pump on the engine by a direct reversal of the removal procedure, making certain that the gasket used between the pump and the engine front cover is in good condition.

6. FUEL INJECTORS

A. Description

A fuel injector is provided for each cylinder. Each fuel injector (80 cu. mm.) combines in a single unit all of the parts necessary to meter, atomize and inject the required amount of fuel into the combustion chamber of the cylinder. The fuel is injected under high pressure at the end of each compression stroke and mixes with the charge of air that has been delivered to the cylinder by the blower. Since there is an injector for each cylinder, a complete and independent injection system for each cylinder is thus provided.

The injectors are mounted in the cylinder head, with their spray tips projecting slightly through the cylinder head into the combustion chambers. A clamp holds each injector in place in a water-cooled copper tube which passes through the cylinder head. The tapered lower end of the injector seats in the copper tube forming a tight seal to withstand the high pressure inside the combustion chamber.

B. Operation

The cross section of the unit injector (80 cu. mm.), illustrated in Fig. 12, shows the various fuel injector parts. Fuel is supplied to the injector under pressure and enters the drop-forged steel body of the injector at the top through the filter cap. After passing through the porous metal filter in the inlet passage, the fuel fills the annular supply chamber between the bushing and the spill deflector. The plunger operates up and down in this bushing, the bore of which is connected to the fuel supply in the annular chamber by two funnel-shaped ports.

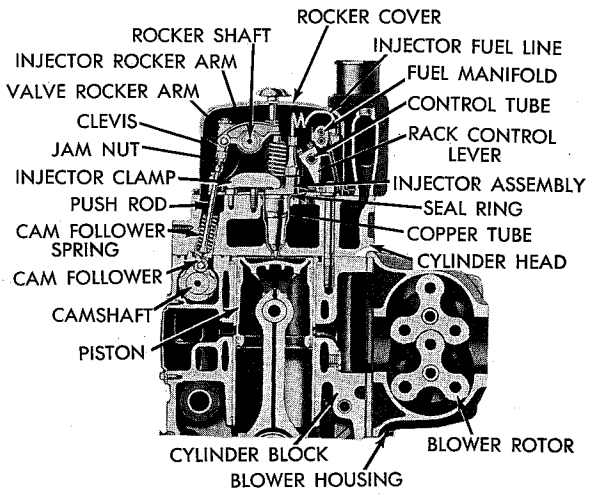


Fig. 11 — Fuel Injector Mounting

The motion of the injector rocker arm is transmitted to the plunger by the follower which bears against the plunger spring. In addition to this reciprocating motion, the plunger can be rotated in operation, around its axis, by the gear which is in mesh with the control rack. An upper helix and lower helix, or cut-off, are machined into the lower end of the plunger for metering purposes. The relation of these helixes to the two ports changes with the

rotation of the plunger.

As the plunger moves downward, the fuel in the high-pressure cylinder or bushing, is first displaced through the ports back into the supply chamber until the lower edge of the plunger closes the lower port. The remaining fuel is then forced upward through the center passage in the plunger into the recess between the upper helix and the lower helix from which it can still flow back into the supply chamber until the upper helix closes the upper port. The rotation of the plunger, by changing the position of the helix, retards or advances the closing of the ports and the beginning and end of the injection period, at the same time controlling the amount of fuel which remains under the plunger for injection into the cylinder.

On the upward movement of the plunger, the high-pressure cylinder in the injector is again filled with fuel through the ports. The constant circulation of fuel through the injectors renews the fuel supply in the chamber, helps to maintain even operating temperatures of the injectors, and effectively removes all traces of air which might otherwise accumulate in the system and interfere with the accurate metering of the fuel. The fuel injector outlet opening, which returns the excess fuel supplied by the fuel pump, is adjacent to the inlet opening, and is protected against dirt or other foreign matter by a porous metal filter, exactly like the one on the inlet side.

Two (2) injector valves, shown in Fig. 12, are used to obtain a "popping" (break-away) pressure of 1100 to 1400 P.S.I.

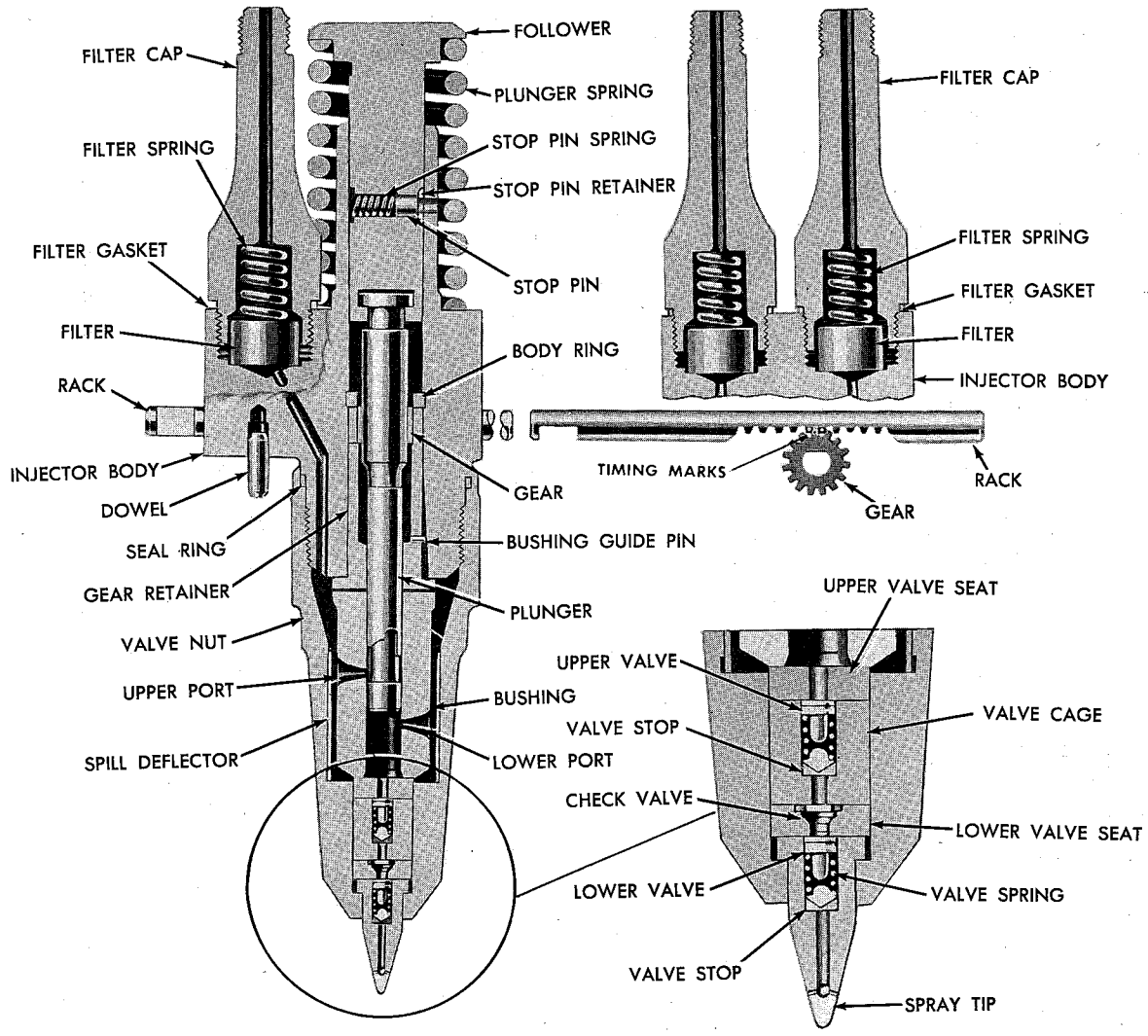


Fig. 12 — Fuel Injector Assembly

A check valve, located between the upper and lower injector valves, prevents air leakage from the combustion chamber into the fuel system in case either injector valve is accidentally held open by a small particle of dirt, thus allowing the injector to continue to operate until the particle works through the valve.

C. Injector Service

Because of the important part the injector plays in the operation of the engine, the necessity for proper care and cleanliness of these units cannot be over-emphasized. The instructions below must be carefully followed in connection with injector service.

1. Whenever the fuel lines are removed from an injector which is installed in the engine, protect the fuel fittings with shipping caps to prevent dirt from entering the injectors and fuel system.

2. After an injector has been operated in an engine, the injector filter caps or filters should not be removed from the injector while the injector is installed in the engine. If the filter caps or filters are to be removed, the injector must be completely disassembled and cleaned.

3. Any used or rebuilt injector must be tested before it is installed in an engine. Refer to "TESTING INJECTOR" in this section.

4. Whenever an injector has been removed and reinstalled, or a new injector has been installed in the engine, the injectors must be timed and equalized. Refer to "INJECTOR TIMING" and "INJECTOR EQUALIZING" in this section.

D. Injector Removal

1. Remove the engine hood, clean off the rocker cover, and remove the cover from the cylinder head.

2. Disconnect and remove the two fuel lines from the injector. Install shipping caps on the fuel fittings to prevent dirt from entering the injector and fuel system.

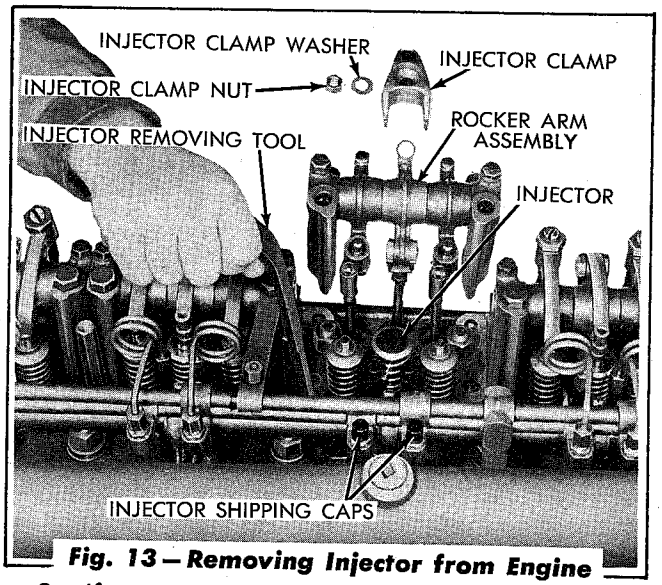


Fig. 13 – Removing Injector from Engine

3. If necessary, turn the engine with the starter until the push rod ends (upper ends) of the injector and valve rocker arms are in line, horizontally. Turn the rocker arm bracket bolts out of the cylinder head and swing the rocker arm assembly away from injector and valves. If it is necessary to remove the front or rear rocker arm brackets, disconnect the oil feed lines from the brackets. *CAUTION: Push rods may be bent if upper ends are not aligned when swinging the assembly away from injector valves.*

4. Remove the nut from the injector clamp hold-down stud, remove the special washer, and the injector clamp.

5. Insert the end of the injector removing tool under the shoulder at the side of the injector body and pry the injector from its seat. Disengage the control rack from the control lever as the injector is lifted up and out.

E. Injector Disassembly

Before starting to dismantle an injector, it is necessary to have an extremely clean work bench on which to work and to store the parts. Cleanliness for the injector and its parts is emphasized because practically all injector service troubles are directly due to dirt, or other foreign material entering the injectors. Use clean paper on the work bench, and, after the injector has been disassembled, place the loose parts in a pan of clean fuel as protection against dirt and corrosion. Leave the parts in the clean fuel until needed for reassembly.

When more than one injector is dismantled, it is necessary to keep the parts of each injector separate. The plungers must always be fitted with the same bushings from which they were removed. It is advisable to keep the parts of the spray tip assembly, the springs, stops, spray tip valves and seats, as a unit, so that the "pop" pressure and calibration built into the injector will remain essentially the same as when it was first tested and assembled.

NOTE: The spray tip, valves, and valve seats may be removed, cleaned, and replaced without disassembling the entire injector by performing steps 4 through 6 in the following disassembly procedure.

Before removing the spray tip, test the injector for free movement of the plunger by pressing down on the plunger follower with the popping fixture handle. Also turn the injector from side to side to see if the control rack moves back and forth by its own weight. If binding of the plunger or control rack is evident by these tests, complete disassembly and inspection of parts will be required. The repair of an injector should not be attempted unless special injector tools described in the following procedure are available.

Disassemble as follows, placing all parts in a pan of clean fuel as they are removed:

1. Clamp the injector in the holding fixture in a vise, right side up, and loosen (do not remove) the two filter caps. Make sure the control rack is not bound or bent when clamped in the fixture.

2. Compress the plunger spring with hand on follower, press in on the stop pin using a small punch, as shown in Fig. 14 then allow the plunger spring to raise to its free length position.

3. Remove the follower, plunger spring, stop pin spring, stop pin retainer, and plunger as an assembly from the injector body. If necessary, spring the stop pin retainer back and remove the stop pin and the stop pin spring. Separate the follower, plunger spring, and plunger.

4. Clamp the injector in the holding fixture with the spray tip of the injector up, as shown in Fig. 15, and loosen the injector valve nut using an injector valve nut wrench. After loosening, remove valve nut by hand, then raise the injector valve nut carefully so that the valves and other small parts resting on the end of the injector plunger bushing will not be dislodged. If the injector has been in use for some time, the spray tip will possibly be removed with the valve nut. In this event, drive the tip from the valve nut with an injector tip remover tool similar to the one shown in Fig. 16.

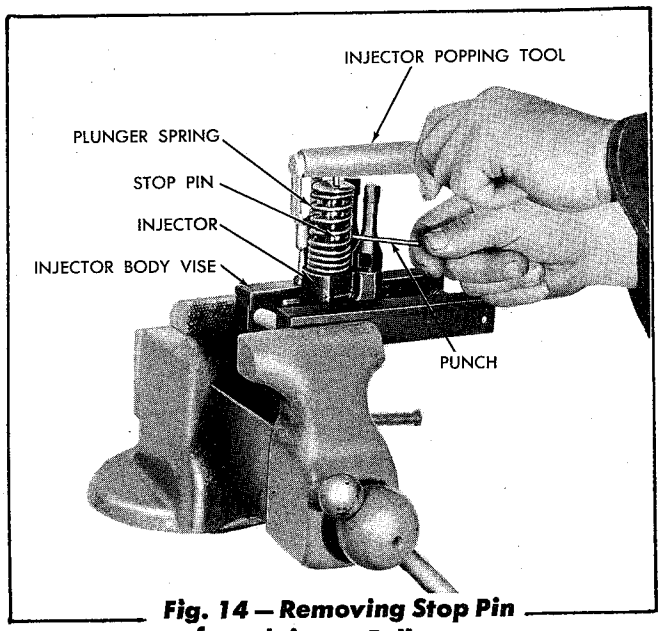


Fig. 14 — Removing Stop Pin from Injector Follower

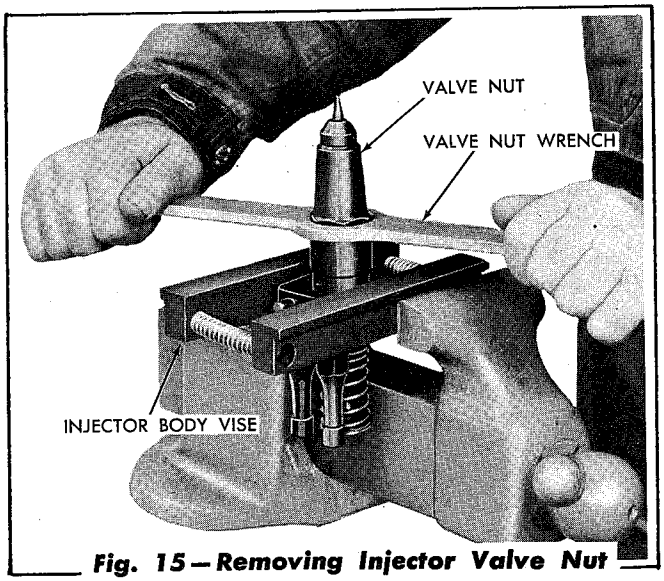


Fig. 15 — Removing Injector Valve Nut

5. Carefully lift the spray tip (if tip was not removed with the nut), lower valve stop, lower valve spring, lower valve, lower valve seat, check valve, cage, upper valve stop,

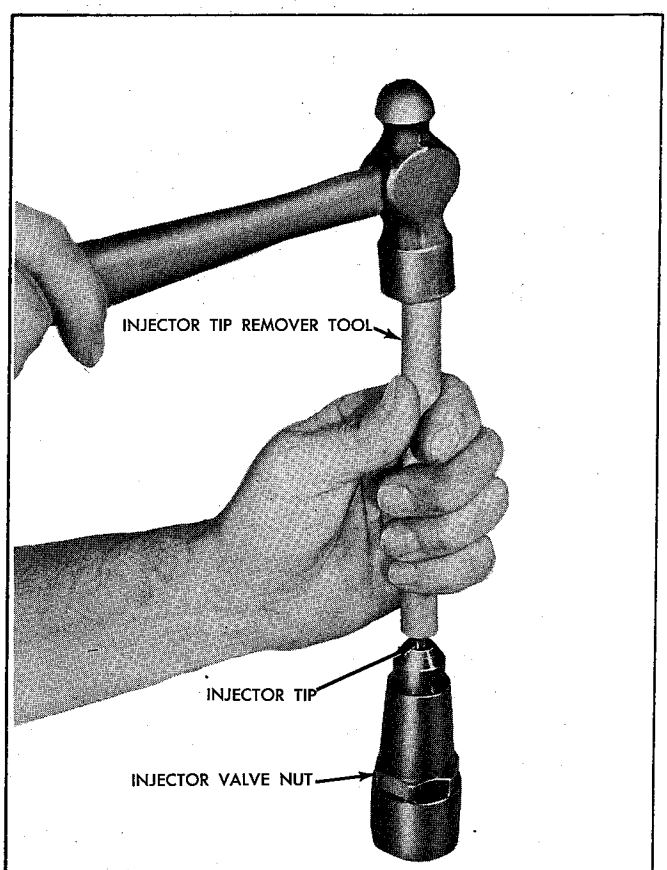


Fig. 16 — Removing Injector Spray Tip

upper valve spring, upper valve, and upper valve seat from the bushing.

6. Remove the plunger bushing from the injector body. Jar the spill deflector from the valve nut.

7. Remove the injector from the holding fixture and jar the gear retainer, gear, and body ring from the injector body. Pull the rack from injector body.

8. Again clamp the injector body in the holding fixture right side up, as shown in Fig. 17, and remove the two filter caps using a 13/16", thin-wall, deep-socket wrench.

   Removal of the filter caps and the filters is not always necessary. If the filters are not plugged, which may be determined by blowing high pressure from an air hose down through the tops of the filter caps past the filters and out the openings in the injector body, it may be well not to disturb the caps or filters.

   In any event, if the filters are removed, each one should be replaced in the cavity from which it was removed. Do not switch the filters from the inlet to outlet openings when replacing the filters.

9. Remove the filter gaskets, filter springs, and filters from the injector body.

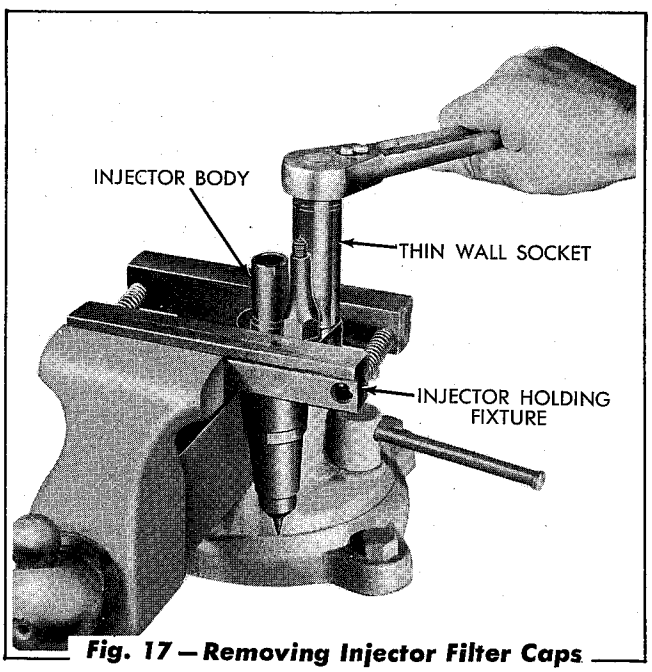


Fig. 17 — Removing Injector Filter Caps

F. Cleaning, Inspection, and Reconditioning of Injector Parts

Wash the hands thoroughly and clean all the injector parts in clean fuel or carbon tetrachloride. Blow the parts dry with compressed air that is free from dust or moisture. Blow through all the passages in the injector body and all drilled holes, slots, etc., in the other parts. Waste or rags should never be used for cleaning the injector parts, since this would leave lint, which could collect on and clog parts of the injector when assembled. Toilet tissue is a good and inexpensive material for wiping injector parts after cleaning.

Many of the close-fitting parts in the injector are carefully lapped, therefore, if any of the internal working parts of the injector are scored or damaged, they are unfit for further use and must be replaced.

After the injector has been disassembled and all the parts carefully cleaned in carbon tetrachloride or fuel, they should be protected from dirt by stor-

ing them in clean fuel until the injector is reassembled.

1. Reaming Injector Spray Tip

Insert the reamer, included in the injector tool kit, into the spray tip, press lightly, and turn with the fingers to remove any carbon or foreign material from the tip. After thoroughly reaming, blow out the tip with compressed air.

Clean the seven (7) spray tip orifices with the .007" wire and holder furnished with the kit. Before using, remove any sharp burrs from the wire by honing it on the small stone included in the injector tool kit.

After the tip has been reamed and the holes in the tip cleaned, blow out loose particles with compressed air. Then again ream the tip, clean the holes, wash the tip with carbon tetrachloride, and blow out with compressed air. Discard the spray tips if the diameter of the holes exceeds .009".

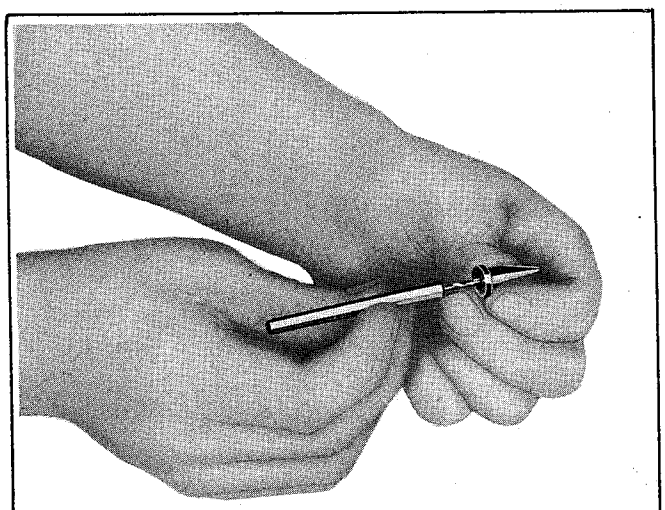


Fig. 18 — Cleaning Injector Spray Tip

2. Valves and Seats

Thoroughly wash and inspect the upper valve seat, upper valve, valve cage, upper valve stop, check valve, lower valve seat,

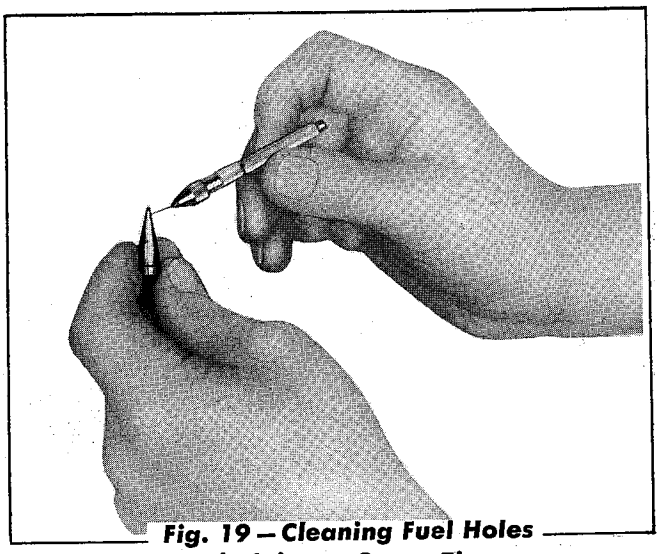


Fig. 19 — Cleaning Fuel Holes in Injector Spray Tip

lower valve, lower valve stop, and spray tip for smoothness (refer to Fig. 20 for identification of parts). If these parts are chipped, pitted, or otherwise damaged, they must be replaced.

If the flat sealing surfaces of the spray tip, lower valve seat, check valve, valve cage, upper valve seat, and the lower end of the plunger bushing show discoloration only they may be lapped on a piece of plate glass or on a lapping block. Use "CARBORUNDUM H-40" medium lapping cream or "NORTON ALUNDUM 600" grain size or equivalent.

Spread the lapping cream on the block, then grasp the part to be lapped firmly with the thumb and the forefinger and lap, using a "figure eight" motion. Always exercise care to keep the part flat on the lapping block. After several strokes, thoroughly clean the part with fuel, then dry and inspect the surfaces by holding it to the light to observe the differences of light reflection as an indication of the flatness. If the surface is perfectly flat, it will present a uniform appearance when held to the light and rotated.

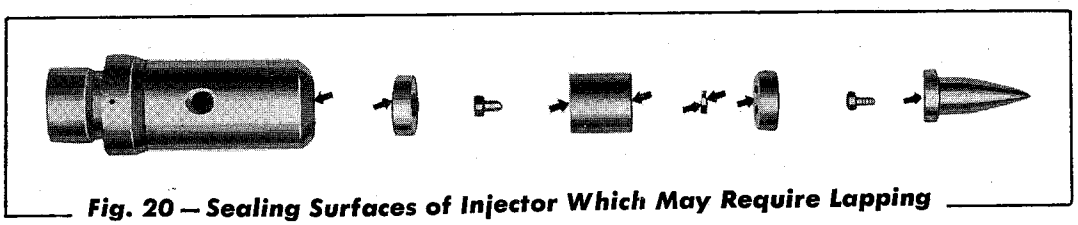


Fig. 20 — Sealing Surfaces of Injector Which May Require Lapping

To obtain a flat mirror finish of the injector parts, "finish lap" the parts on the lapping block after the lapping block has been cleaned with a bristle brush, rinsed in fuel or kerosene, and dried with compressed air.

As frequent refacing of lapping blocks will produce top quality work, it is advisable to have two grooved blocks on hand and maintain their surfaces flat and free from worn or low spots. To remove these spots, hand lap one block on another, using fine grain lapping compound. Protect the blocks when not in use against dust and damage by enclosing them in a close fitting wooden container.

3. Plunger and Bushing

Clean the injector plunger bushing by immersing it in a container of carbon tetrachloride or fuel and working a brush through the bushing. Blow it out with compressed air and again wash it in clean carbon tetrachloride or fuel. For the final cleaning, wrap toilet tissue around the injector bushing cleaner tool, or similar rod, and rotate this rod in and out through the bushing. The plunger must work freely in the bushing. Refer to "TESTING OF INJECTOR."

Worn, scored, or scratched plungers and bushings must be replaced. The plunger and bushing are serviced in matched sets and the two parts should always be used together.

4. Injector Valve Nut

Clean the seat and the bore for the spray tip with tool as shown in Fig. 21. The tool does not cut but merely cleans the seat in the nut and also removes carbon or other deposits from the bore at the lower end of the valve nut for proper seating of the spray tip. Clean the inside of the nut thoroughly with one of the brushes provided in the injector tool kit.

5. Injector Filters

Cleaning of the injector filters is not recommended. If the injector has not been in use over an extended period and the filters are removed, they can possibly be used again if reinstalled in the same cavity from which they were removed.

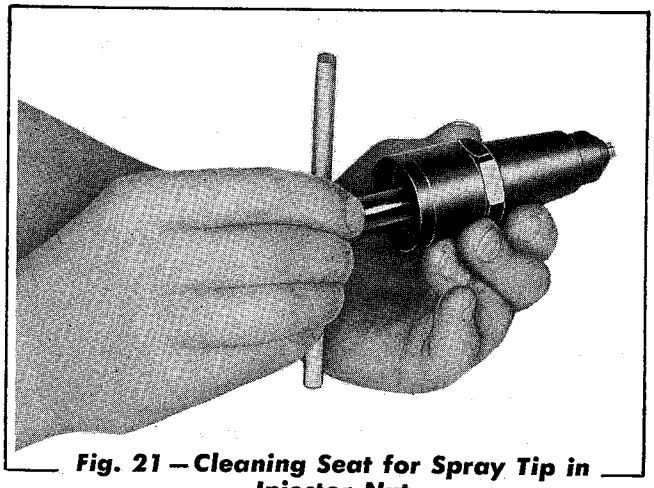


Fig. 21 — Cleaning Seat for Spray Tip in Injector Nut

CAUTION: Do not switch the filter used on the inlet side to the outlet side or vice versa.

6. Control Rack and Gear

Inspect the teeth of both the rack and the gear carefully. Remove any burrs or rough spots from the rack or gear. Replace them with new parts if they are worn or if they bind in the injectors.

G. Injector Assembly

NOTE: When assembling an injector, the room in which the work is being done must be clean and free from flying dust. The mechanic's clothes and hands, the work bench, and the tools used must all be clean. The cleaned injector parts should remain in a pan of clean fuel until reassembly; then each part should be taken from the pan and assembled in the injector. Care must be taken when assembling, to place the various parts in their proper relative positions. The various illustrations accompanying the assembly of the injector should be studied thoroughly.

1. Install Injector Filters

a. Hold the injector body right side up and place an injector filter in each of the two fuel cavities. *NOTE: When installing filters that have been used, it is important*

that each be installed in the same cavity from which it was removed. Even though they may have been washed as thoroughly as possible and dried with compressed air, particles of dirt may remain in them that would be washed into the injector and cause damage if the filter removed from the outlet side was installed in the inlet side. If they have been mixed, the outlet filter can usually be identified by its being darker in color on the inner (bottom) side while the inlet filter will be discolored most on the outer side.

IMPORTANT: The filters have a shallow cavity or dimple in the center; install these filters with the "dimpled" end down.

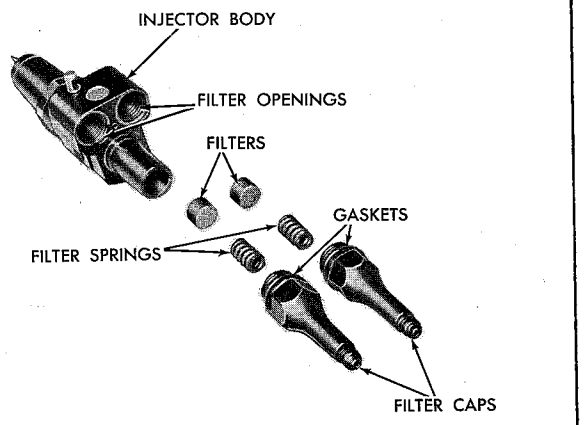


Fig. 22 — Injector Filters, Springs, and Caps

b. With the injector installed in the cylinder head, the filter nearest the rear of the cylinder head is the inlet filter and the filter nearest the front of the cylinder head is the outlet filter. With this in mind, place the inlet and the outlet filters in their correct positions in the injector body, place a filter spring above each filter, and install a filter gasket in position on each filter cap. Lubricate the threads of the filter caps and tighten the filter caps in place in the injector body. Whenever a filter cap is removed, a new filter gasket should be installed when reassembled.

2. Install Control Rack and Gear

Refer to Fig. 23 and note that two of the teeth of the injector rack have a punch mark, and that one tooth of the gear is similarly marked. When the rack and gear are assembled, the marked tooth of the gear engages between the two marked teeth on the rack. This relation of the rack and gear MUST be maintained for proper timing of the injector.

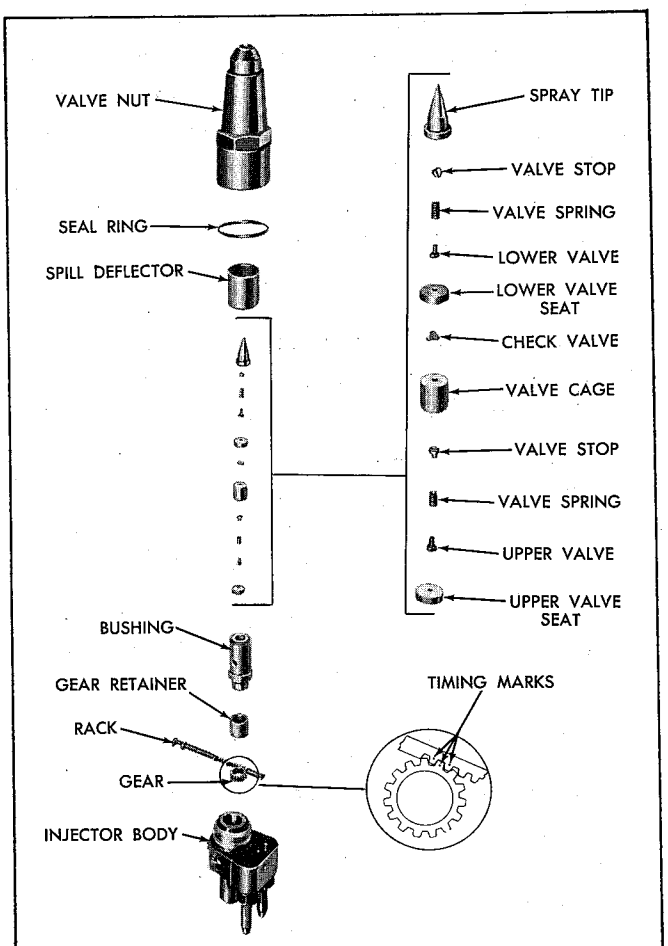


Fig. 23 — Injector Rack, Gear, and Spray Tip Details

a. Hold the injector body, bottom end up, and install the rack through the hole in the body so that the two marked teeth can be seen when looking from the bottom, into the bore for the gear.

b. The injector rack can be placed in the injector body in only one position and have the marked teeth show in the opening for the gear. Holding the rack in position so the marked teeth can be seen, drop the gear into the body of the

injector so that the punch mark on the gear is between the two punch marks on the injector rack.

c. Slide the gear retainer down on top of the gear and the plunger bushing down on the retainer, with the locating pin in the bushing guided into the slot in the injector body.

d. Clamp the injector body in the holding fixture in a vise, with the bottom end of the injector up, taking care not to bind or bend the rack in the injector body. Drop the spill deflector over the bushing then slip a new rubber seal ring over the bushing and against the shoulder of the injector body.

3. Assemble Spray Tip and Valves

Refer to Figs. 23 and 24 for assembly of the following parts:

a. Place the upper valve seat flat on a clean piece of paper. Holding a valve spring with fingers, place the upper valve in one end of the valve spring, and place a valve stop in the opposite end of the spring. Insert these three pieces into position in the valve cage, installing the end with the valve stop first. Place the valve cage (with valve stop, spring, and upper valve) in position on the upper valve seat.

b. Place the check valve in position over the center opening in the valve cage and place the recessed face of the lower valve seat down over the check valve and on the valve cage.

c. Holding the other valve spring with fingers, place the lower valve in one end of the valve spring, and place the other valve stop in the opposite end of the spring. Insert these three pieces into position in the spray tip, installing the end with the valve stop first. Place the spray tip (with valve stop, spring, and lower valve) in position on the lower valve seat.

d. With the injector body still supported in the holding fixture, carefully set the stacked-up assembly of the spray tip and valve parts down on the end of the plunger bushing.

e. Place the hollow end of the injector tip holding tool, or a length of small copper tubing, down through the opening in the small end of the injector valve nut. Holding the valve nut and the holding tool or tubing, in one hand, and holding the valves and the spray tip assembly in place on the plunger bushing with the other hand, lower the valve nut down over the spray tip.

f. With the valves and the spray tip held in position with the holding tool, screw the valve nut on the injector body, making certain that the valve assembly has not shifted. Do not force the nut, even by hand, while screwing it on the body. It can be turned down to within 1/16" of the shoulder on the body of the injector with the thumb and finger, if the valve assembly is lined up properly. If the shoulder inside the nut strikes the edge of the valve and the nut does not screw on easily, shift the valve slightly by turning the spray tip. If the nut and valve can not be brought into line in this manner, the nut will have to be removed and the valves again centrally located on the end of the bushing. Tighten the nut firmly with the injector valve nut wrench.

4. Install Plunger and Follower Assembly

Invert the injector in the holding fixture so that the injector is right side up.

a. Refer to Fig. 25 and place the plunger spring down over the follower neck of the injector body. Insert the head of the plunger into the slot at the bottom of the follower.

b. Notice the position of the flat in the injector gear in the injector body and turn

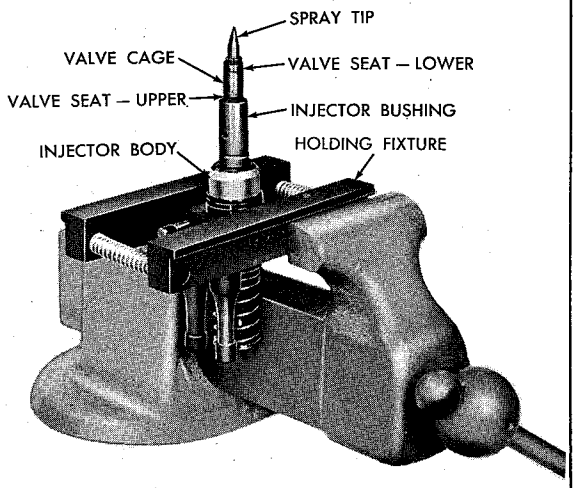


Fig. 24 – Assembly of Spray Tip and Valves

the plunger so that the flat of the plunger will register with the flat in the injector gear when the plunger is inserted down through the gear.

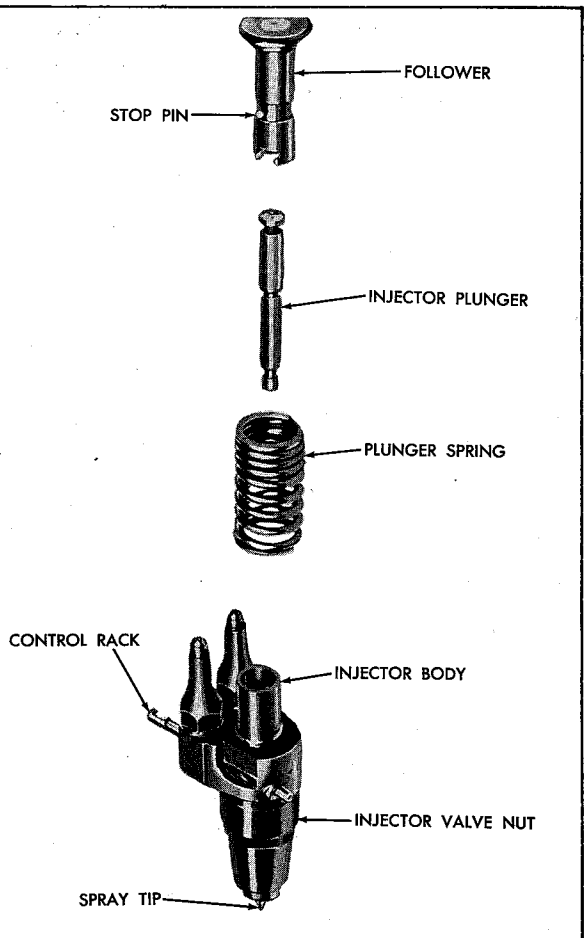


Fig. 25 – Injector Plunger and Follower Details

c. With the flat of the plunger in line with the flat in the gear, turn the follower so that the stop pin at the side of the follower aligns with the slot in the injector body, and insert the plunger and follower down into the plunger spring and injector body. When the stop pin strikes the top of the injector body, press in on the stop pin and at the same time press down on the follower to compress the spring until the stop pin "pops" out into position in the slot of the injector body.

d. Remove the injector from the holding fixture. Hold the injector horizontal and turn it from side to side. If it has been properly assembled and the parts are not binding, the control rack will slide back and forth by its own weight.

H. Testing Injector

After an injector has been repaired or overhauled, it should be tested before it is installed in an engine or put aside for future use. When in doubt about the proper functioning of an injector, a test will usually indicate the difficulties quickly. Two tests are recommended on the injector: (1) "Popping" test; (2) pressure test. The "popping" test consists of operating the plunger to see that all parts are functioning properly and to open the check valve suddenly, which will usually remove any small foreign particles in the fuel or on the injector parts that might prevent proper operation. This test is made as follows:

1. Clamp the injector in the holding fixture and vise and screw the bolt of the "popping" tool into the tapped hole in the fixture. Tighten the lock nut. Using an oil can, introduce clean fuel into one of the injector openings in the filter caps until the injector is completely full and fuel flows from the other opening. Place a glass beaker in position under the injector spray tip so that fuel ejected from the tip hits the inside of the beaker. *CAUTION: Always use a beaker and keep the hands away from the spray tip when "popping" an injector as the finely atomized fuel from the spray tip is ejected with such force that it will penetrate the skin and may cause blood poisoning.*

Push the injector rack all the way in to the

full open position, and work the injector plunger up and down several times with the "popping" handle. Observe if the fuel is being discharged from all seven (7) holes in the spray tip. Keeping the injector filled with fuel from the oil can, press the handle down against the plunger follower with quick motions. It may require a few minutes of operation before the injector will "come in" and a "chirp" will be heard.

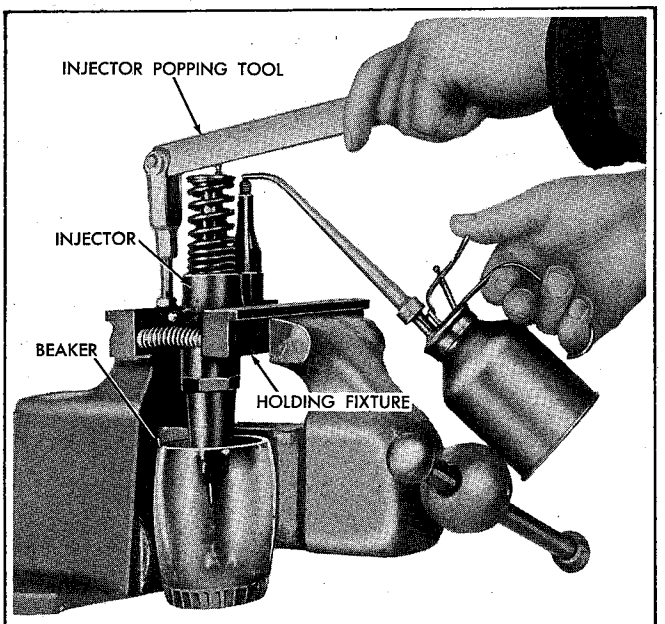


Fig. 26 — "Popping" the Injector

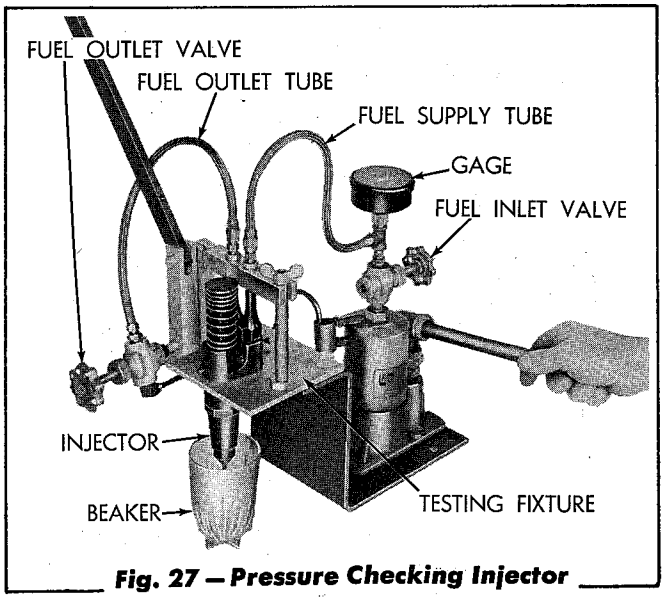


Fig. 27 — Pressure Checking Injector

2. The injector pressure test requires the use of a test fixture, similar to that shown in Fig. 27. Place the injector in the test fixture with the dowel on the underside of the injector body located in the hole of the fixture. Swing the fuel line connecting bar over the injector filter caps and tighten the wing nut. Set the glass beaker in position under the injector spray tip. The hydraulic gage of the test fixture registers the pressure required to spray fuel from the spray tip. Check this "popping" pressure by working the pump handle up and down with smooth even strokes, at the same time watching the pressure gage and noting at what pressure the injector valves open. This pressure may vary from 1100 to 1400 P.S.I.

Check for leaks around the injector valve nut seal ring, control rack, spray tip, and fuel connections by working the hydraulic pump handle until the pressure is just below the popping pressure. If a slight amount of fuel dribbles from the spray tip, pop the injector several times sharply with the popping handle. This will usually clear the injector of any small foreign particles that may be preventing the spray tip valves from seating properly. If a dribble can not be stopped in this manner, remove the valve nut and clean the valve parts as outlined under "VALVES AND SEATS."

Fuel leaking through the hole for the control rack is usually an indication that fuel is leaking past the plunger. In this case a new plunger and bushing must be installed in the injector.

Check the pressure drop in the injector by pumping the hydraulic handle and popping the injector sharply, then close the valve between the pump and the pressure gage and note the pressure drop on the gage. A drop not to exceed 600 pounds (from 1000 to 400) in 50 seconds on a new injector, or the same drop in 35 seconds on a used injector, is permissible.

If the injector functions satisfactorily throughout the above test, it has been properly reconditioned and may be used. If it does not function properly, recheck the injector.

I. Injector Installation

1. With the hood removed, and the rocker cov-

er removed from the cylinder head, inspect the injector copper tube in the cylinder head to be sure that no dirt, grit, or oil is present to prevent the injector from making a tight seal in the copper tube. Insert the injector in the copper tube in the cylinder head, aligning the dowel on bottom of the injector body with the dowel hole in the cylinder head. As the injector is lowered into the copper tube, engage the control rack with the control rack lever.

2. Place the injector clamp on the stud, with the forked end of the clamp resting on the injector body and the opposite end on the clamp support. Drop the special washer over the stud, with the rounded side of washer down, and secure the clamp with the nut, tightening the nut to 30 to 35 foot pounds torque.

3. Swing the rocker arm assembly back over into position on the injector and the valves and secure the assembly with the attaching capscrews. Connect the oil feed line to the front rocker arm bracket for the No. 1 cylinder and to the rear rocker arm bracket for the No. 6 cylinder, when installing the rocker arm assemblies for these cylinders.

4. The injector must now be timed and equalized. Refer to "INJECTOR TIMING" and "INJECTOR EQUALIZING." Remove the shipping caps from the fuel fittings on the injectors and on the fuel manifold and install the two injector fuel lines. Check the valve rocker arms (refer to "VALVE ADJUSTMENT" in Section IX). Start the engine and inspect the connections to be sure that there are no fuel leaks from the injector fuel lines.

5. Install the rocker cover and the engine hood.

J. Injector Timing

Timing of each injector consists of properly locating the top of the plunger follower in relation to the injector body.

The engine is equipped with 80 cu. mm. injectors which require that the top of the follower be set 2.425 inches above the injector body so that the fuel will be injected into the cylinders at the proper time. This is done with the injector installed in the engine.

1. Remove the engine hood and the rocker cover.

2. Make certain that the engine shut-off controls are in the "OFF" position. Rotate the engine with the starter until the two valve rocker arms for the same cylinder are down and the valves are fully opened; the injector for that cylinder will then be in the proper position for timing.

3. Place a timing gage in the hole in the injector body; be sure that the shoulder on the bottom end of the gage rests on the injector body and is not held up by dirt in the hole. Turn the gage so that the extended head (flat portion) of the gage is toward the injector follower.

4. Loosen the injector push rod lock nut and turn the push rod into the push rod clevis to raise the follower or out of the push rod clevis to lower the follower, until the proper timing is obtained. When the injector is properly timed, the bottom (flat part) of the gage head will just pass over the top of the injector follower. The timing gage must be held perpendicular to the top surface of injector body while performing this adjustment.

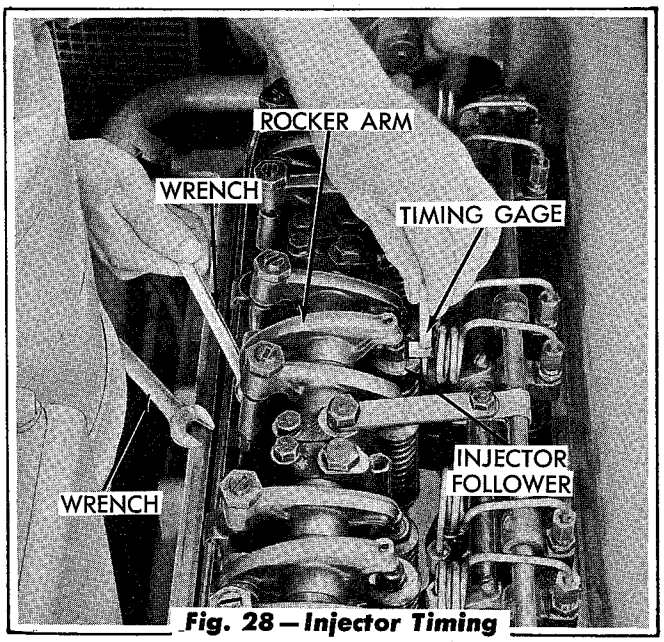


Fig. 28 — Injector Timing

5. Tighten the lock nut and recheck to be sure timing was not changed by tightening the lock nut. Replace rocker cover and engine hood.

K. Injector Equalizing

Equalizing of the injectors consists of adjusting the injector rack control levers so that an equal amount of fuel is delivered to each cylinder. The greatest amount of fuel is injected into the cylinders when the injector racks are moved all the way in; no fuel is injected when the racks are moved all the way out. The engine will run unevenly or detonate (knock) if the injectors are not equalized.

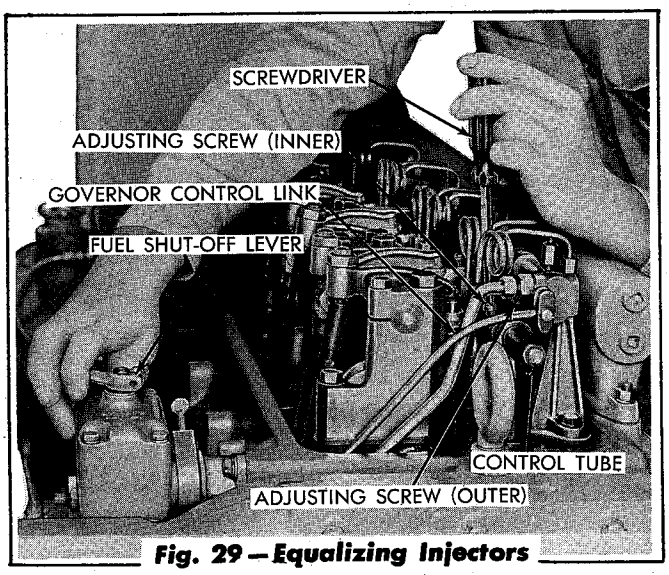


Fig. 29—Equalizing Injectors

1. Remove the engine hood and the rocker cover. Check the valve lash which should be .009" with the engine at normal operating temperature, also see that the injectors are properly timed (refer to "VALVE ADJUSTMENT" in Section IX and "INJECTOR TIMING" in this section).

2. Make certain that the governor linkage is properly adjusted (refer to "GOVERNOR AND ENGINE CONTROLS" in Section VI).

3. Make certain that all the control rack levers are engaged with the injector control racks.

4. Loosen the lock nut on the governor buffer spring adjusting screw and turn the screw out until the outer end is approximately ⅝" from the governor housing.

5. Loosen the inner and outer adjusting screws on all the injector rack control levers approximately 3 turns. Make certain that all the levers are free on the injector control tube and that the control tube rotates freely in the bearings at the ends of the tube.

6. Pull the engine throttle lever all the way back (wide open).

7. Disconnect the governor fuel shut-off control rod from the governor fuel shut-off lever, located above the governor cover.

8. The injector rack control lever for the No. 6 cylinder (cylinder nearest flywheel) must be adjusted first in order to establish the proper relationship between the governor and the injector rack control tube. Turn down the inner adjusting screw on the No. 6 injector rack control lever until the screw starts to contact the flat on the control tube assembly.

9. Move the governor fuel shut-off lever towards the "run" position (towards radiator). Do not force the lever past the point at which resistance to movement increases, but hold it at this point, pressing lightly towards the "run" position.

10. Back off the inner adjusting screw on the No. 6 rack control lever until the fuel shut-off lever moves and *just* bottoms at the end of its forward movement or in the "run" position. Turn down the outer adjusting screw until it is *just* snug, but do not tighten. Tighten the inner adjusting screw, then tighten the outer adjusting screw. *CAUTION: Tighten the adjusting screws moderately, do not force.*

    The setting of the No. 6 injector rack control lever should now be correct. Check the adjustment as follows:

    If the governor fuel shut-off lever is free to travel to the extreme "off" and "run" positions without encountering any set-up in resistance, the rack control lever for the No. 6 injector is properly adjusted.

    After the No. 6 injector rack control lever has been set correctly, do not change its adjust-

ment when adjusting the remaining injector rack control levers.

11. Connect the governor fuel shut-off control rod to the governor fuel shut-off lever, then push the engine shut-off control rod in as far as it will go (run position) and adjust the remaining injector rack control levers.

12. Adjust the No. 5 injector rack control lever by turning down the inner adjusting screw while holding a .0015" or .002" thick feeler gage between the lower end of the injector rack control lever and the injector body. Turn down on the inner adjusting screw until a slight drag on the feeler gage is noted, then tighten the outer and the inner adjusting screws alternately as necessary to maintain the slight drag on the feeler gage.

13. Adjust the injector rack control levers for the remaining cylinders in the same manner as described in step No. 12.

14. Adjust the governor buffer spring adjusting screw as explained in "GOVERNOR ADJUSTMENT."

15. Do not attempt to obtain a smooth running engine by changing the control rack adjustment individually without regard to this method of equalizing.

16. Install the rocker cover and the engine hood.

7. INJECTOR COPPER TUBES

A. Description

As will be seen by referring to Fig. 11, the bore in the cylinder head for each injector is directly through the water jacket of the head. To prevent the cooling water from contacting the injector, a copper tube, shaped to receive the injector, is installed in the injector bore in the cylinder head. This tube is sealed at the top with a neoprene packing ring and is spun into a flare on the lower side of the cylinder head to form water-tight joints at the top and bottom. The coolant in the cylinder head flows around this copper tube and helps to cool the injector.

B. Copper Tube Removal

When it is necessary to remove an injector copper tube, the operations may be carried out with the special tools as shown.

1. Remove the cylinder head from the engine as described in "CYLINDER HEAD REMOVAL" in Section IX.

2. Remove the rocker arm shafts and brackets as an assembly, also remove the exhaust valves. Refer to "EXHAUST VALVES AND OPERATING MECHANISM" in Section IX.

3. Remove the injector from the cylinder (refer to "INJECTOR REMOVAL" in this section).

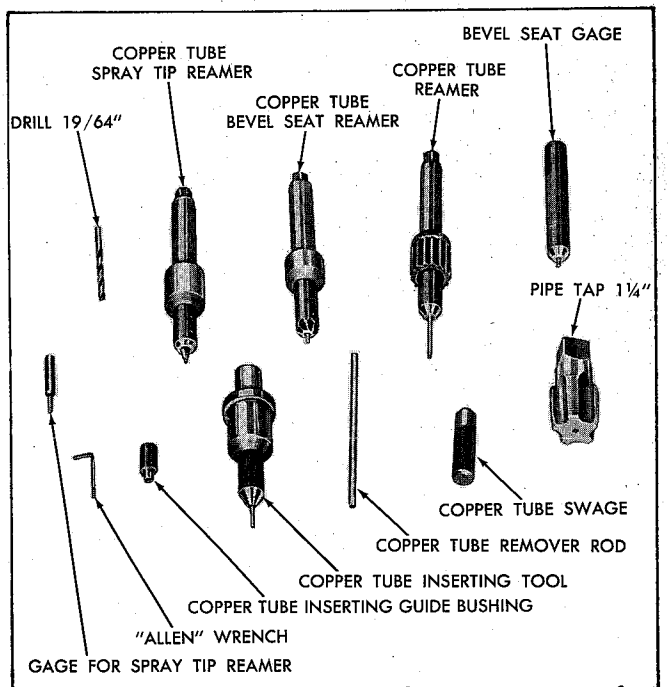


Fig. 30—Injector Copper Tube Remover Tools

4. Support the cylinder head on wooden blocks with the bottom of the cylinder head facing upward. Then, using a 19/64 inch drill, remove the flare from the copper tube at the injector tip end of tube as shown in Fig. 31.

5. Turn a 1¼ inch NPT tap into the top end of the copper tube. Then, working through the previously drilled hole at bottom of tube, drive on the tap using a 9/32 inch rod. Tap

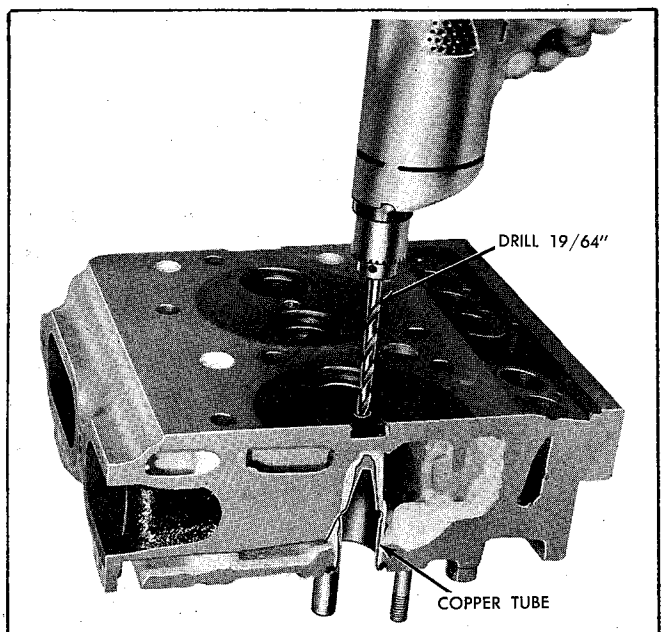


Fig. 31 — Drilling Flared End of Injector Copper Tube

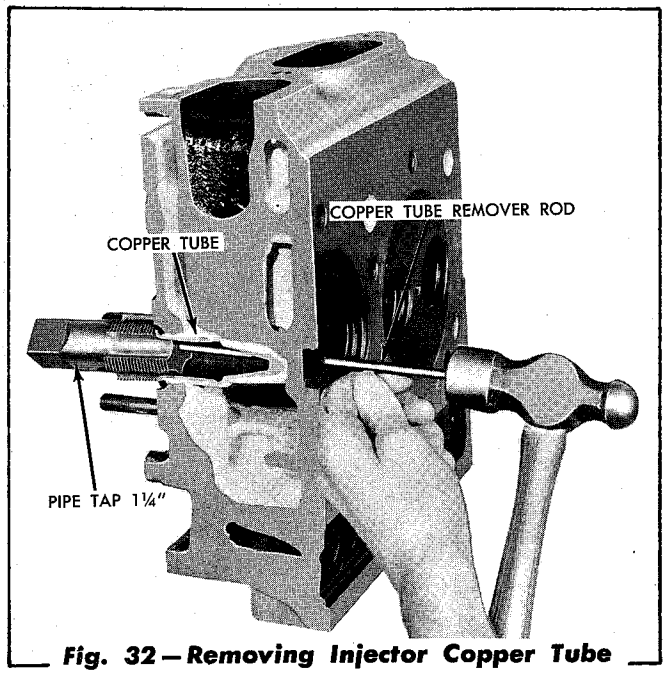


Fig. 32 — Removing Injector Copper Tube

rod lightly until copper tube is forced from cylinder head as shown in Fig. 32.

C. Copper Tube Installation

1. Clean the hole in the lower side of the cylinder head and remove all remnants of the old seal ring from the counterbore in the top of the cylinder head.

2. Install the new seal ring in the counterbore of the cylinder head and force the new injector copper tube through the seal ring into the bore in the cylinder head as shown in Fig. 33.

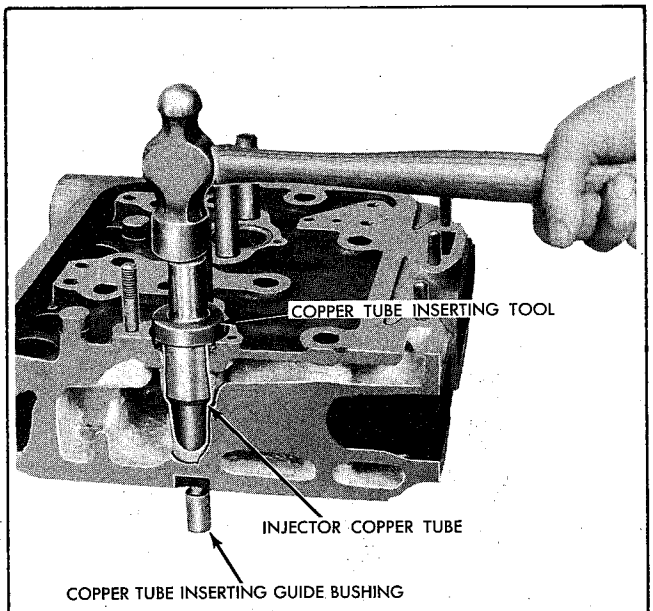


Fig. 33 — Installing Injector Copper Tube in Cylinder Head — Operation 1

3. Place the tube inserting tool into the copper tube, with the pilot of the tool entering the guide bushing at the lower side of the cylinder head. Drive the copper tube down tightly against the seal ring until it contacts the bevel seat in the cylinder head as shown in Fig. 33.

4. Hold the copper tube inserting tool and the copper tube in position by installing the injector hold-down clamp around the inserting tool and securing it in position with the nut and special washer. Using the swage, as shown in Fig. 34, upset the lower end of the copper tube into the counterbore at the bottom of the cylinder head to .020 inch below the bottom of the head. Refer to Fig. 34.

5. Use the injector copper tube reamer, as shown in Fig. 35, to clean the inside diameter of the copper tube for the body of the injector valve nut. Insert the pilot of the reamer through the injector tip opening and ream the copper tube body to a minimum depth of 1.620 inches from top of cylinder head. *CAUTION: Do not exceed the specified reaming depth of 1.620 inches by more than 1/16 inch. If the hole in the tube is reamed*

too deep, the injector valve nut will ride on the shoulder inside the copper tube.

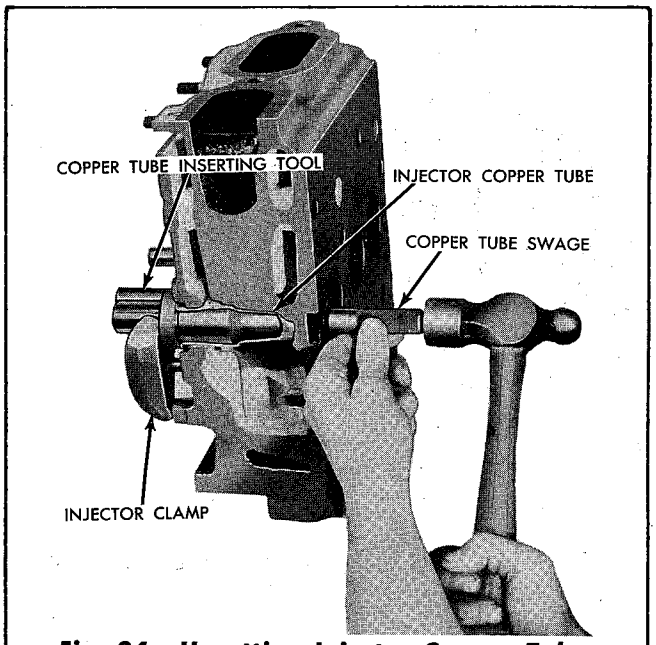


Fig. 34 — Upsetting Injector Copper Tube — Operation 2

After the reamer is once set on the tool shank to produce a reamed depth of 1.620 inches, (with the tapered end of the shank resting on the taper inside the copper tube), it can be left in that position. It will not be necessary to gage the depth of the cut when reaming the rest of the injector copper tubes.

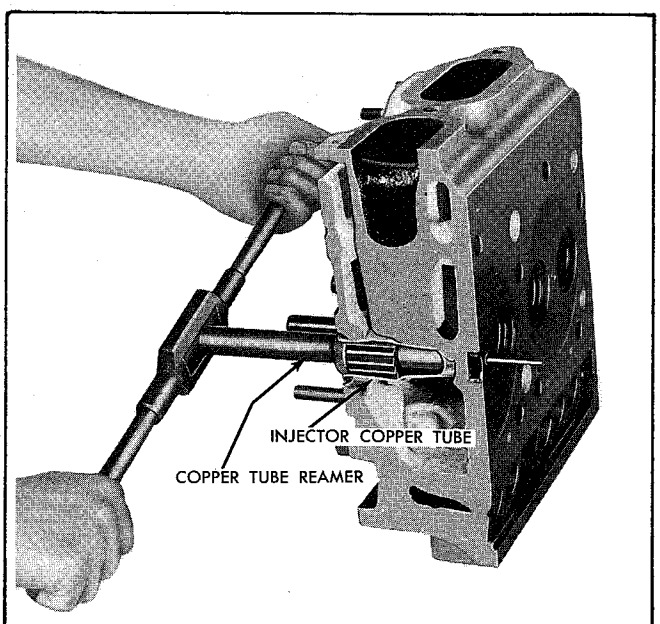


Fig. 35 — Reaming Copper Tube for Injector Valve Nut Body — Operation 3

6. Ream the bevel seat for the injector valve nut with the bevel seat reamer as shown in Fig. 36. Insert the reaming tool inside of the tube, and, using a tap handle, turn the reamer slowly while exerting down pressure on the tool. When the pilot of the tool comes flush with the bottom of the cylinder head, the seat is reamed sufficiently. *NOTE: To assure a proper depth reaming operation, the pilot of the reamer should extend .436 to .432 inches out from the end of the reamer. This distance should be checked before the reaming operation is started.*

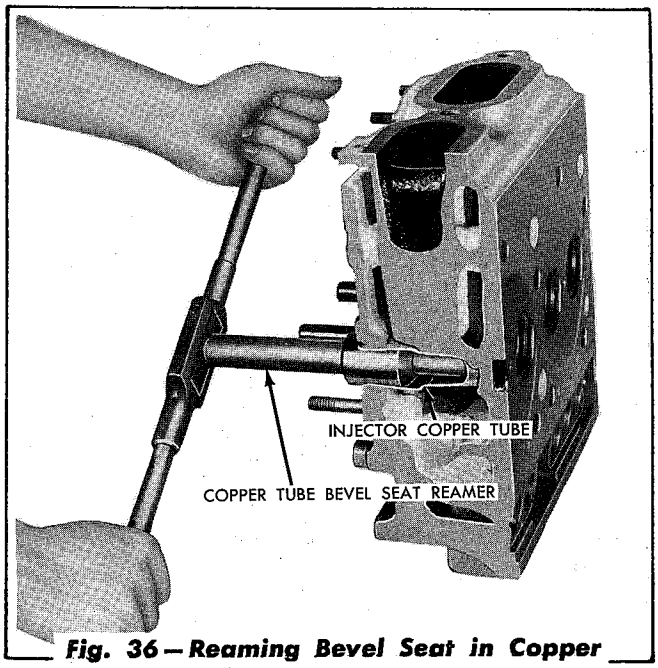


Fig. 36 — Reaming Bevel Seat in Copper Tube — Operation 4

7. The bevel seat depth may be checked with the depth gage as shown in Fig. 37 after each reaming operation to be sure that the bevel seat is the proper depth.

8. Ream the copper tube for the injector spray tip with the spray tip reamer as shown in Fig. 38. When the taper of the reamer meets the flat surface at the bottom of the copper tube, the reaming operation has been completed. The smallest diameter of the spray tip hole should then measure .175 to .185 inches. This measurement can be checked with the injector spray tip hole gage.

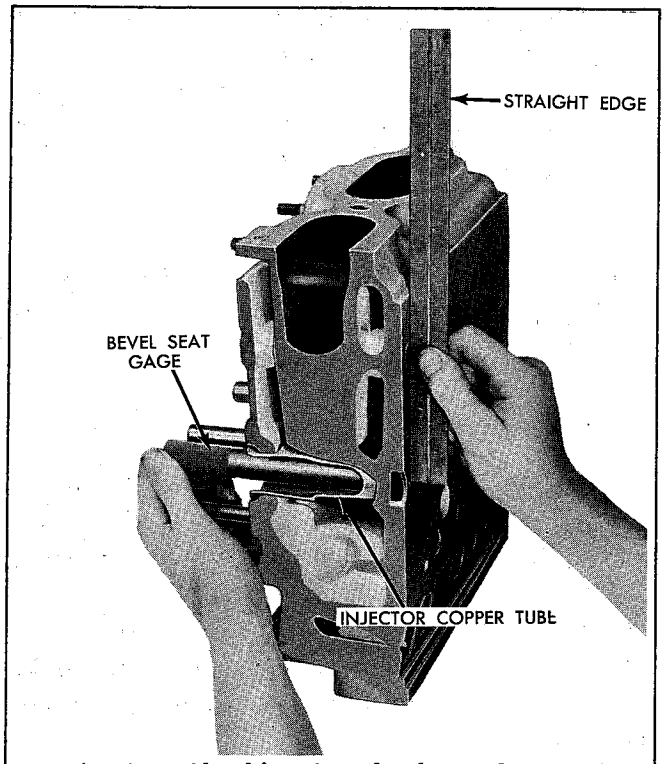


Fig. 37 — Checking Depth of Bevel Seat in Copper Tube — Operation 5

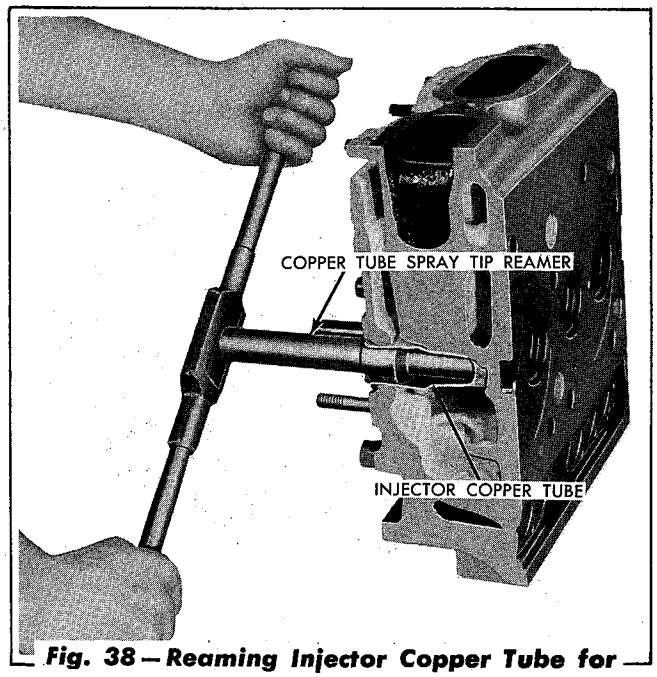


Fig. 38 — Reaming Injector Copper Tube for Spray Tip — Operation 6

NOTE: Consult your local "Allis-Chalmers" Dealer for the availability of the tools shown above.

8. FUEL MANIFOLD

A. Description

Fuel is supplied to the injectors by the fuel pump through the lower tube of the fuel manifold, which is mounted on top of the cylinder head and is connected to the injectors by short steel injector fuel lines. The upper tube of the fuel manifold returns the surplus fuel from the injectors through tubing to the torque converter, then to the torque converter fluid cooling radiator and back to the fuel tank. Pressure is maintained in the fuel system by a restrictor located in the fuel return line filter assembly.

B. Service

No service is required on the fuel manifold other than keeping all tube connectors tight and a periodic inspection to make certain that there is no fuel leakage. If any leakage is noted, it must be corrected immediately. When the manifold is removed for any reason, the fuel passages must be thoroughly cleaned before it is reinstalled.

C. Removal of Manifold

Refer to Fig. 40 for relative location of parts. The manifold may be removed without removing the cylinder head from the engine.

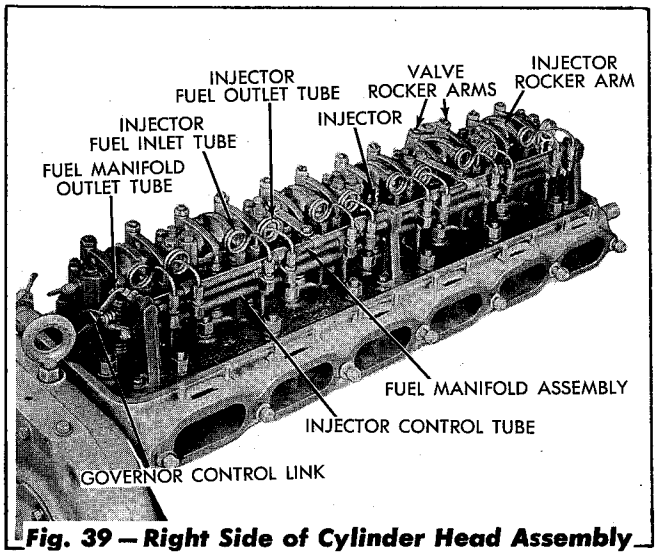


Fig. 39 — Right Side of Cylinder Head Assembly

1. Remove the engine hood.
2. Clean off the rocker cover and remove it from engine.
3. Remove all the injector fuel lines. Cover the injector fuel inlet and outlet openings with

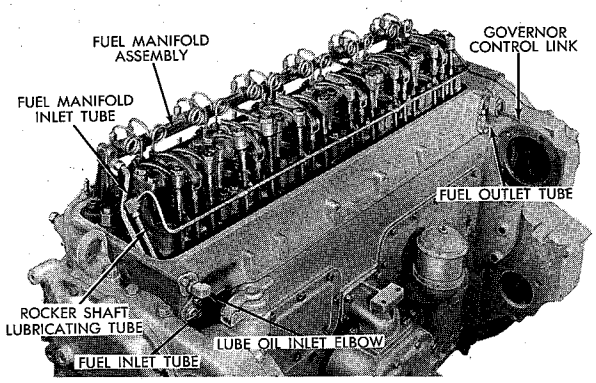


Fig. 40 — Fuel Manifold and Connecting Parts

shipping caps to prevent the entrance of dirt while the lines are removed.

4. Disconnect the fuel inlet tube (at the front of manifold) and the fuel outlet tube (at rear of manifold) from the manifold.

5. Remove the two (2) bolts from the clamps used to brace the manifold to the valve rocker arm bracket bolts.

6. Remove the two (2) capscrews attaching each manifold bracket to the cylinder head and remove the manifold.

D. Installation of Manifold

Be sure that the fuel passages in the manifold are thoroughly clean and install the manifold by reversing the sequence of operations for its removal.

Before reinstalling the rocker cover, start the engine and check for fuel leakage. Correct any leaks that are evident and install the rocker cover and the engine hood.

SECTION III—ENGINE AIR INTAKE SYSTEM

1. DESCRIPTION OF SYSTEM

The engine air intake system includes two (2) air pre-cleaners, two (2) air cleaners, two (2) air shut-off valves, air box, and blower. The blower supplies the fresh air needed for combustion of fuel in the cylinders and for the scavenging or removal of burned gases from the cylinders. The air, drawn from the atmosphere by the blower, passes through the air pre-cleaners and air cleaners before it enters the blower. Dust, always present in the air, is thus filtered from the air before it is delivered to the engine. If the air were delivered to the engine uncleaned, the dust particles would cause rapid wear on pistons, cylinder liners, and other parts.

The air is discharged from the blower into a hollow section of the cylinder block surrounding the cylinders, called the air box. The air passes into the cylinders from the air box through holes (air ports) in the cylinder liners as the ports are uncovered by the downward travel of the pistons. While these ports are uncovered by the pistons, fresh air rushes through the cylinders to scavenge the exhaust gases and leave the cylinders filled with fresh air needed for combustion. This circulation of the air through the cylinders also helps cool the internal engine parts, particularly the exhaust valves.

The fuel injected into the cylinders is ignited by the heat of the air compressed within the combustion chambers on the upstroke of the pistons. In cold weather, the "drag" caused by the cold oil between the pistons and cylinder walls, and in the bearings, reduces the cranking speed of the engine. A large part of the heat generated by compression of the air is then absorbed by the pistons and cylinder walls. This loss of heat and the reduced cranking speed may result in the temperature of the air in the cylinders being too low to ignite the fuel. A cold Weather Engine Primer is provided as an aid for starting the engine in cold weather. The primer is used to inject starting fluid (ethyl ether) into the blower air inlet housing. The starting fluid is then picked up by the engine blower and is blown into the cylinders. Since the starting fluid is highly combustible, it is easily ignited by the heat of compression in the cylinders.

Four (4) air box drain tubes are provided for drainage of fuel that might leak into the air box and would otherwise be drawn into the cylinders with the air.

2. AIR PRE-CLEANERS

A. Description and Purpose

Each pre-cleaner, Fig. 1, is of the centrifugal type and consists of a body and shell (dirt bowl). Fins in the body are set at the proper angle to impart a swirling motion to the incoming air causing the dirt in the air to be thrown to the outside of the shell and deposited therein. All large particles of dirt, as well as leaves and other like material, are thus removed from the air before it enters the air cleaners. The level of the dirt collected in each shell is visible through an inspection glass.

B. Air Pre-Cleaner Service

Each pre-cleaner shell must be emptied whenever

the dirt level reaches half-way up on the inspection glass. Remove and clean as follows:

1. Unscrew the wing nut and remove the cap from the shell.

2. Lift the shell from the pre-cleaner body. Clean the dirt out of the shell and wipe the inside of the shell with a dry cloth. Make certain the fins in the pre-cleaner body are not bent, damaged, or clogged.

3. Wipe the dust from the cap gasket and reassemble the pre-cleaner. Replace the gasket if it is not in good condition. Tighten the wing nut with the fingers. DO NOT USE A WRENCH.

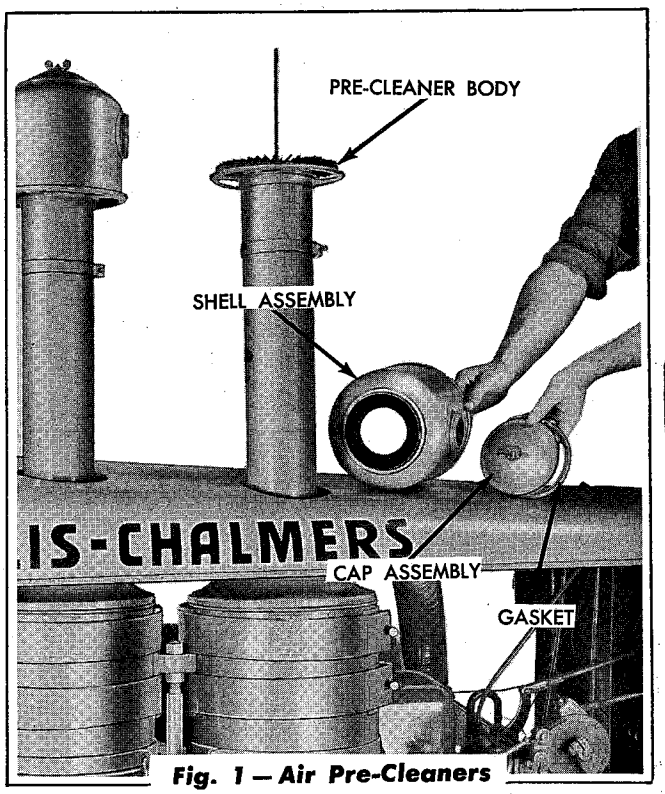


Fig. 1 — Air Pre-Cleaners

3. AIR CLEANERS

A. Description

Each air cleaner consists of a cylindrical body packed to a prescribed density with rust-proof metallic matting and has an oil cup suspended on the lower end of the body. This cup is filled to a specified level with engine lubricating oil. A tube extends down through the center of the cleaner body and into the oil. An air pre-cleaner is mounted on the upper end of the tube. After passing through the pre-cleaner, the air enters the air cleaner, passes down through the tube and into the oil in the cup. As the air is drawn through the cleaner, a portion of the oil in the cup is whipped up into the matting in the main body of the air cleaner. Dust still remaining in the air is collected by the matting as the air passes through it. The oil dripping back into the cup, carries the dust with it, depositing it in the cup. Thus, only clean air enters the blower for delivery to the cylinders.

B. Air Cleaner Service

At periodic intervals, depending on operating conditions, each oil cup must be removed, cleaned, refilled with new oil, and the air cleaner pipe in each air cleaner swabbed out. Dirt mixed with the oil will collect inside the pipes, and if not removed, will in time restrict the flow of air, resulting in an insufficient supply of air to the engine. A broken hose, loose hose clamp, damaged blower gasket or leak of any kind, that allows air to enter the cylinders without first passing through the air cleaners, will defeat the purpose of the air cleaners. Therefore, extreme care must be taken to prevent leqks. Periodic inspection of the above parts and of the air cleaner bodies for dents, cracks, loosened solder connections, etc., should be made frequently. If any of the above mentioned conditions are found they *MUST* be corrected immediately.

Remove the oil cups daily (more often if operating in extremely dusty conditions) to check the oil level in each cup and to determine the condition of the oil. Empty and wash the cups whenever the oil becomes discolored, indicating a quantity of dirt has collected, then refill with clean oil. Keep the cups filled to the "FULL" mark on the air baffle in each cup. *DO NOT OVERFILL.*

Use SAE 30 engine oil when temperature is above 32° F., SAE 20W when temperature is 0°F. to 32° F., and SAE 10W when temperature is 0°F. and

below. *NOTE: Some "DIESEL" lubricating oils may foam when used in the air cleaner. Do not use an oil that foams as it reduces air cleaner efficiency and in some cases allows the oil to be pulled over into the engine, causing serious damage.*

To Service Each Cleaner, refer to Figs. 2 and 3.

1. Remove the oil cup from the bottom of the air cleaner body. Remove the air baffle, then empty the oil from the oil cup.

2. Wash the air baffle and cup with clean fuel or solvent. Swab out the air cleaner inlet pipe in the center of the air cleaner body.

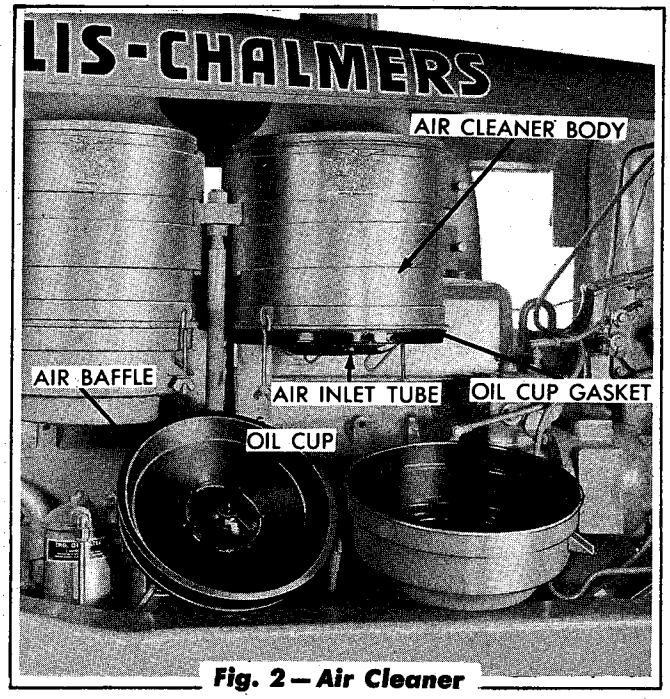


Fig. 2—Air Cleaner

3. Install the air baffle in the cup and fill to the "FULL" mark on the air baffle with clean oil. Install the cup on the bottom of the air cleaner body. See that the gasket above the cup makes a tight seal; replace the gasket if it is not in good condition.

4. Once or twice a year remove the air cleaners from the mounting brackets. Remove the oil cups and immerse each air cleaner in a tub of clean fuel or non-combustible cleaning solvent and rinse the dirt from the filter mat in the body. Allow the air cleaners to dry thoroughly before reinstalling.

5. Tractors bearing Serial Numbers 4543 and above are equipped with air cleaners which have two removable filter mats in the lower part of the air cleaner body. These mats may be removed periodically for cleaning. If the mats become badly clogged with fuzz, leaves, and etc. which can not be removed by washing, the mats may be replaced. The upper part of the air cleaner body contains a non-replaceable filter mat.

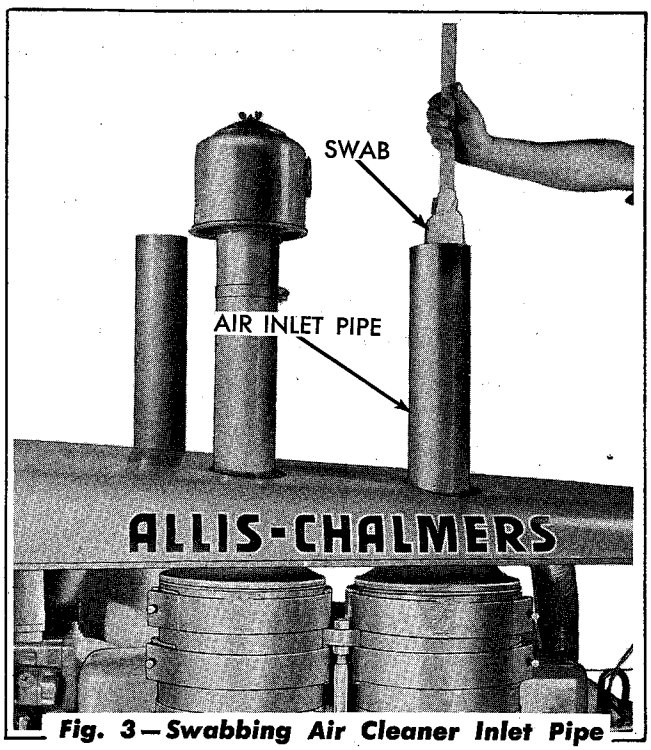


Fig. 3—Swabbing Air Cleaner Inlet Pipe

C. Air Cleaner Removal

Removal of air cleaners used on tractors prior to Serial Number 4543 may be performed as follows:

1. Remove the air pre-cleaners from the top of the air cleaner pipes and remove the engine hood.

2. Loosen the top hose clamps on the air inlet tube and slide the clamps and hose down on the tube.

3. Support the air cleaners, loosen the lower mounting band capscrews as much as possible and remove the capscrews from the upper mounting bands.

4. Raise the air cleaners out of the mounting band brackets and remove the cleaners from the engine.

Removal of air cleaners used on tractors bearing Serial Number 4543 and above may be performed as follows:

1. Remove the air pre-cleaners from the top of the air cleaner pipes and remove the engine hood.

2. Loosen the tops hose clamps on the air inlet tube and slide the clamps and hose down on the tube.

3. Remove the upper and lower air cleaner mounting bands.

4. Raise the air cleaners out of the mounting band brackets and remove the cleaners from the engine.

D. Air Cleaner Installations

Install either air cleaner by a direct reversal of the removal procedure. Make certain that the hose clamps are tightened securely and that the hose forms a tight seal and is not crimped allowing air to enter without first passing through the air cleaners.

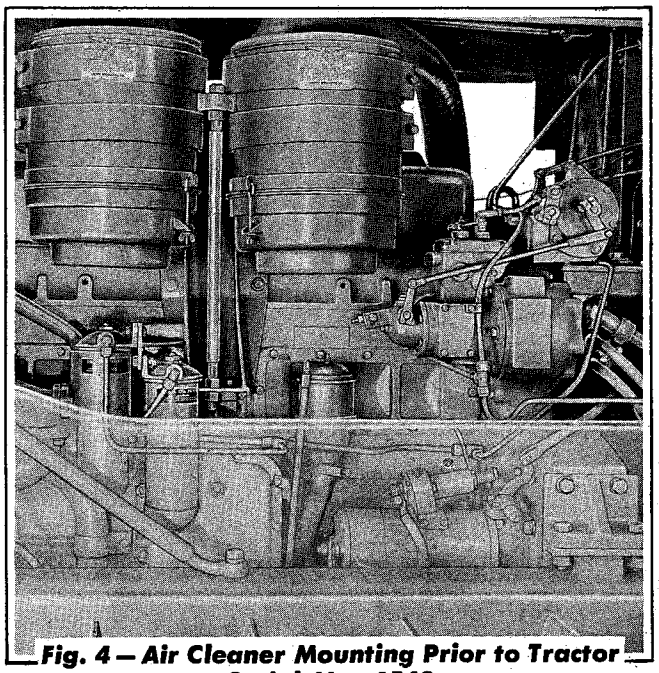


Fig. 4 — Air Cleaner Mounting Prior to Tractor Serial No. 4543

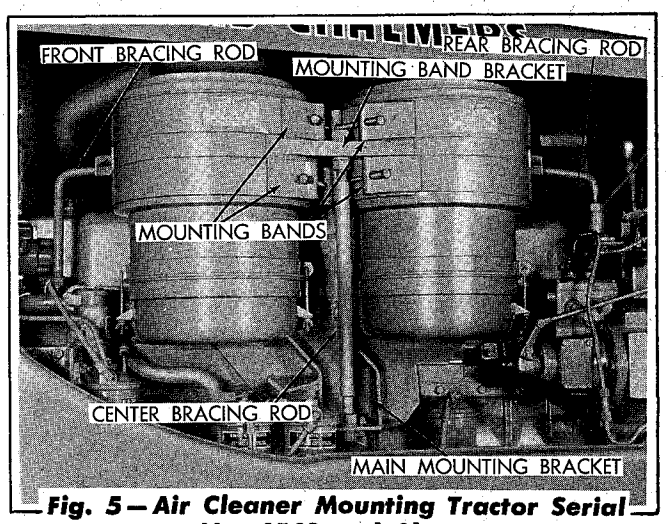


Fig. 5 — Air Cleaner Mounting Tractor Serial No. 4543 and Above

4. AIR INLET HOUSING AND SHUT-OFF VALVES

A. Description

The air inlet housing, located on the blower housing, contains the engine air shut-off valve assemblies. The valves are of the butterfly type, and are manually controlled by the engine shut-off rod. When the engine shut-off rod is pushed in, the valves are opened and air can pass through the inlet housing to the blower. When the engine shut-off rod is pulled back, the valves close against the seating surfaces in the inlet housing and the air supply to the engine is shut off. These valves also act as emergency engine shut-off devices. If for some reason fuel collects in the air box, speeding up of the engine will cause this fuel to be drawn from the air box into the cylinders, and the engine speed will be increased beyond its maximum governed speed because of this added supply of fuel. The governor has no control over the engine in such instances. However, the engine can be stopped by manually closing the air valves, which shuts off the supply of air necessary for combustion of fuel.

B. Removal, Disassembly, and Inspection

1. Disconnect the engine primer copper tube

from the primer elbow assembly, located on the top of the blower air inlet housing. Remove the bolt attaching the engine primer copper tube clip to the blower air inlet housing.

2. Loosen the two (2) hose clamps attaching each air cleaner tube to the air cleaner tube elbows and slide the hoses up on the air cleaner tubes.

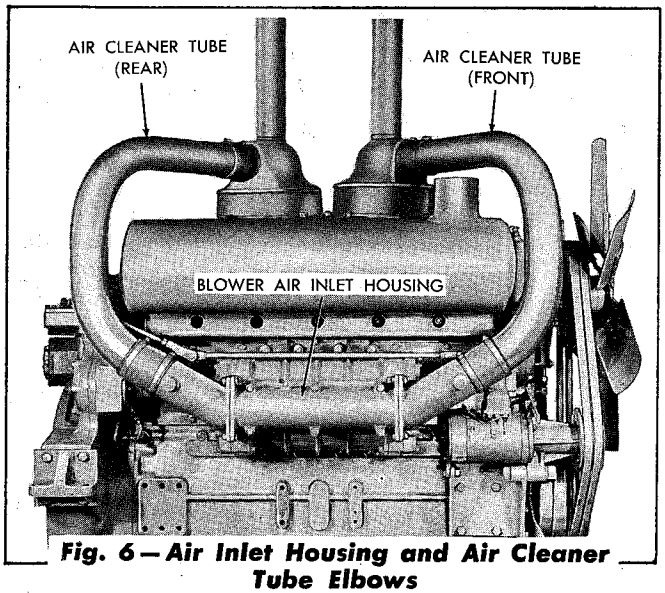


Fig. 6—Air Inlet Housing and Air Cleaner Tube Elbows

3. Remove the cotter pin and the yoke pin attaching the air shut-off rear rod to the engine air shut-off lever.

4. Remove the capscrews attaching the air inlet housing to the blower housing and remove the air inlet housing with the air cleaner tube elbows attached. Remove the combination intake housing gasket and blower screen. *IMPORTANT: Cover the inlet opening of the blower after removing the inlet housing.*

5. Remove the front air shut-off valve lever spring. Remove the bolts attaching the air shut-off valve levers to their respective shafts and remove the levers from the shafts, leaving them connected to the front shut-off rod.

6. Remove the bolts attaching each air cleaner tube elbow to the air inlet housing and remove the tube elbows and gaskets.

7. Remove each of the air shut-off valves as follows:

   a. Remove the locking wire from the screws which attach the shut-off valve to the slotted shaft. Remove the screws and the shut-off valve.

   b. Withdraw the air shut-off valve shaft and remove the shut-off valve shaft seal from the tube elbow.

8. Clean and inspect the parts for wear. The shafts must be straight and not excessively worn or the valves will not seat properly in the tube elbows. The expansion plugs in the outer side of the tube elbows must fit tight in their bores to prevent air being drawn past them. Always install new shaft seals in the tube elbows when assembling.

C. Assembly and Installation

1. Install an expansion plug in position in the bore in the outer side of each tube elbow. Install a shut-off shaft seal in position in the bore on the inner side of each tube elbow.

2. Lubricate the ends of each air shut-off valve shaft and install a shaft in each tube elbow, with the slotted end of the shaft toward the engine.

3. Insert an air shut-off valve in the slot of each shaft and secure in position with drilled head screws and lockwires. Install the air shut-off valve and stop lever on the front air shut-off valve shaft, with the stop lug of the lever facing toward the rear of the tractor. Install the other lever on the shaft of the rear air shut-off valve. Secure the levers to the shafts with capscrews, lockwashers, and nuts.

4. Examine the air inlet elbow gaskets to make certain they are in good condition; replace them if necessary. Coat each side of the gaskets with gasket cement or sealing compound, then, using a gasket between the mating parts, attach the air inlet elbows to the air inlet housing with the capscrews, nuts, and lockwashers removed at disassembly.

5. Perform the balance of the installation pro-

cedure by a direct reversal of the removal procedure.

6. Adjust the engine control linkage as explained in "ENGINE SHUT-OFF CONTROL ADJUSTMENT," Section VI.

7. Install the engine hood and air pre-cleaners.

5. BLOWER

A. Description

The blower supplies the aid needed for combustion and for sweeping the cylinders clear of exhaust gases. Its operation is similar to that of a gear-type oil pump. Two hollow rotors, each with three lobes, revolve with very close clearance in a housing bolted to the side of the engine. To provide continuous and uniform displacement of air, the rotor lobes are made in a twisted or helical form.

Air entering the blower air inlet from the air cleaners is picked up by the lobes and carried to the discharge side of the blower. The continuous discharge of fresh air from the blower creates an air pressure of about five pounds per square inch in the air chamber of the cylinder block when the engine is operating at its maximum speed. As the piston uncovers the intake ports of the cylinder (which begins at 48 degrees of crankshaft rotation before bottom dead center), the air sweeps through into the cylinder. The angle of the ports in the cylinder liners imparts a swirling motion to the intake air as it enters the cylinder.

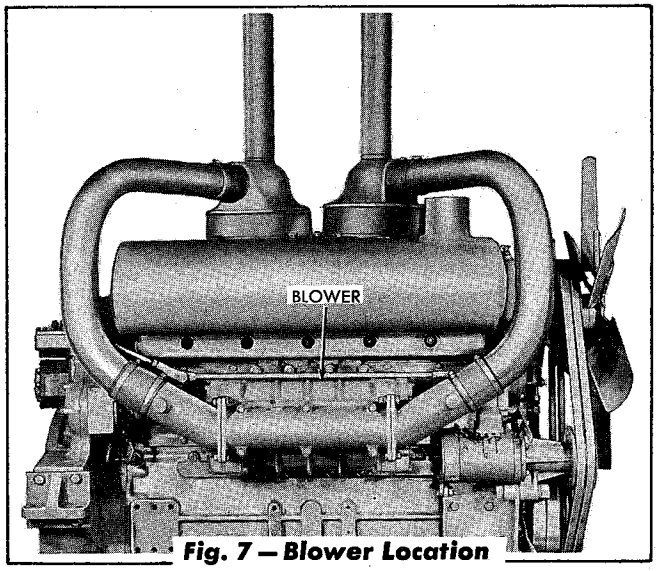


Fig. 7 — Blower Location

Two timing gears on the drive ends of the rotor shafts space the rotor lobes with a slight clearance. Thus, because the rotors do not touch each other at any time, they require no lubrication. Lip type seals prevent air leakage at the ends of the lobes and also prevents the oil used for lubricating the timing gears and the rotor shaft bearings from entering the inside of the blower. The upper rotor is driven at 2.71 times engine speed by the blower drive gear and the drive shaft. The lower rotor is driven from the upper rotor through the blower timing gears.

A flexible coupling attached to the blower drive gear dampens engine torque fluctuations to the blower. The coupling is formed by a cam, driven by two bundles of leaf springs contacting four semi-cylindrical supports. Each rotor is supported on the doweled end plates of the blower housing by a roller bearing at the front end, and a two-row, pre-loaded, radial and thrust ball bearing at the rear, or gear end.

An external oil line, connected to the engine oil galley, provides lubricant to the front blower bearings. The rear blower bearings and gears are lubricated by oil draining from the blower drive support, through the blower drive shaft cover and into blower end cover. Surplus oil passes from a hole in the end of the blower to the oil pan, through drilled holes in the cylinder block.

B. Service and Inspection

The blower is not a delicate device. Nevertheless, great care is taken when the unit is assembled at the factory. The same care must be taken when the blower is serviced in the field.

As pointed out in the foregoing description, the blower rotors revolve with a slight clearance between the two lobes and also between the lobes and the blower housing. Bearings are used at each end of the rotor shafts to support the rotors. The blower rotors are "timed" by the two gears at the rear end of the rotor shafts. This timing or spacing must be correct, otherwise the required clearance between the rotor lobes will not be maintained.

Normal gear wear causes a decrease of rotor-to-rotor clearance on one side of the rotor lobes. When this occurs, clearance between the opposite sides of the rotor lobes is increased correspondingly. While rotor lobe clearance, due to gear wear, may be corrected by adjustment, the gear backlash cannot be corrected. Therefore, when the gears have worn to the point where the backlash exceeds .004", the gears must be changed. The procedure for timing the blower rotors for proper clearance is outlined under "BLOWER TIMING" in this section.

Because of the important part that the blower plays in the efficient operation of the engine, an inspection of the unit should be made every 1,000 engine hours, especially if the tractor has been operating under extremely dusty conditions. If this practice is followed, minor irregularities can usually be detected and corrected before more serious difficulties develop.

A blower may fail to function properly because of any one or a combination of the following reasons:

1. Dirt or foreign matter having been drawn through the blower, thereby scoring the rotor lobes and housing.

2. Worn oil seals, permitting lubricating oil to be drawn into the rotor compartment.

3. Worn blower drive coupling, causing a rattling noise inside the blower.

4. Loose rotor shafts, worn gear teeth, or damaged bearings, causing contact between the rotor lobes, rotors and end plates, and between the rotors and housing.

5. Out of time, due to timing gear wear. When this occurs, the rotor lobes may not have sufficient clearance at one side and too much clearance on the opposite side.

A blower may be inspected for any of these conditions without being removed from the engine. However, if inspection reveals that the blower has been damaged or worn sufficiently to impair its efficiency, then it must be removed from the engine and either overhauled or replaced.

When inspecting the blower with the blower in position on the engine, the blower air inlet housing must be removed. *CAUTION: When the blower rotors are exposed and the engine is in operation, keep fingers, clothing, and any loose parts away from the blower air inlet. Severe bodily injury or damage to the blower may result, if anything is allowed to come into contact with the blower rotors while they are in operation.*

Make the following inspection to determine if any of the above conditions exist in a used blower:

1. SCORED ROTORS OR HOUSING. Dirt or chips drawn through the blower will cause deep scratches in the rotors and the housing and raise up burrs around such abrasions. If such burrs cause interference between the rotors, or between the rotors and the housing, the blower should be removed from the engine and the parts dressed down with a "fine cut" file or hone to eliminate interference. The rotors must be changed if they are badly scored.

2. LEAKY OIL SEALS. Leaky seals are usually indicated by the presence of oil on the blower rotors or on the inside of the housing. Oil on the rotors can also be a result of pull-over from the air cleaners; therefore, the two conditions should not be confused. For a sure check for oil seal leaks proceed as follows:

   a. Operate the engine at approximately 1000 R.P.M.

   b. Direct a strong light into the rotor compartment and observe the end plates for a thin film of oil which will radiate away from a leaky oil seal. *CAUTION: Do not attempt this inspection when dust is blowing as there will be no air cleaner protection when the air inlet housing is removed from the blower.*

3. WORN BLOWER DRIVE.

   a. Operate the engine at approximately 300 R.P.M. by manual control of the injector control tube. A worn blower drive coupling will cause a loose, rattling sound within the blower.

b. Stop the engine. Grasp the top rotor firmly and attempt to rotate it. The rotors should move from 3/8" to 5/8", measured at the lobe crown, and when released should return with a springing action. When released, the rotors should move back at least 1/4". The coupling must be inspected if the rotors cannot be moved as above, or if the rotors move freely, without a springy feel, or if they can be rattled. If the inspection shows the drive coupling to be worn, it may be removed for replacing by removing the blower drive cover and drive shaft, then removing the blower drive assembly.

4. LOOSE ROTOR SHAFTS OR WORN BEARINGS. This condition will cause rubbing and scoring between the crowns of the rotor lobes and the mating rotor roots, between the rotors and the end plates, or between the rotors and the housing. Usually a combination of these conditions exists.

   A loose rotor shaft usually causes contact between the rotors and the end plates. Worn bearings will cause contact between the mating rotor lobes at some point, or may allow the rotor assemblies to contact the blower housing. This condition will usually show up on the end of the rotors at which the bearing has failed.

   Excessive backlash in the blower timing gears usually results in the rotor lobes contacting throughout their entire length.

   To correct any of the above conditions, the blower must be removed from the engine and either repaired or replaced. The procedure for checking the rotor-to-rotor and the rotor-to-housing clearances is described under "BLOWER TIMING." Obviously, if the rotor lobes or the blower housing are scored enough to require a blower overhaul or replacement, a check for clearance would be not only misleading, but unnecessary.

C. Blower Removal

1. Remove the right front fender and loosen the hose clamps on the lower ends of the front and rear air cleaner tubes. Slide the hoses up on the tubes.

2. Remove the yoke pins, which attach the air shut-off valve levers to the yokes on the ends of the air shut-off control rods, and move control rods into a position to provide clearance for removal of the blower.

3. Remove the front blower bearing oil tube from the engine block and blower. Remove the primer line from the air inlet housing. Bend the primer line sufficiently to permit removal of the blower. *CAUTION: Do not crimp the primer line.*

4. Loosen the hose clamp on blower end of blower drive shaft cover and slide the seal and hose clamp onto the drive shaft cover.

5. If the blower is to be removed for disassembly, the air inlet housing may be removed from the blower before the blower is removed from the cylinder block. If the blower is not to be disassembled, remove the capscrews attaching the blower to the cylinder block. Raise the blower slightly and move it toward the front of the tractor until the drive shaft is free of the driving hub. Leave the drive shaft in the cam coupling located inside the timing gear housing. Remove the blower from the engine.

D. Disassembly of Blower

1. Remove the capscrews attaching each blower end plate cover to the blower housing. Tap the end plate covers lightly with a soft hammer to loosen them from the blower housing, then pull the end plates from the dowels at the top and bottom of the bolt flange. Do not pry between the covers and the end plates as the gasket surfaces may thus be damaged.

2. Remove the three (3) capscrews attaching the blower rotor driving hub plate assembly to the upper rotor driving gear and remove the hub, plates, and the three (3) driving hub plate spacers.

3. Remove the capscrews and washers at the center of the blower rotor timing gears and remove the coupling disc and the gear retaining washer.

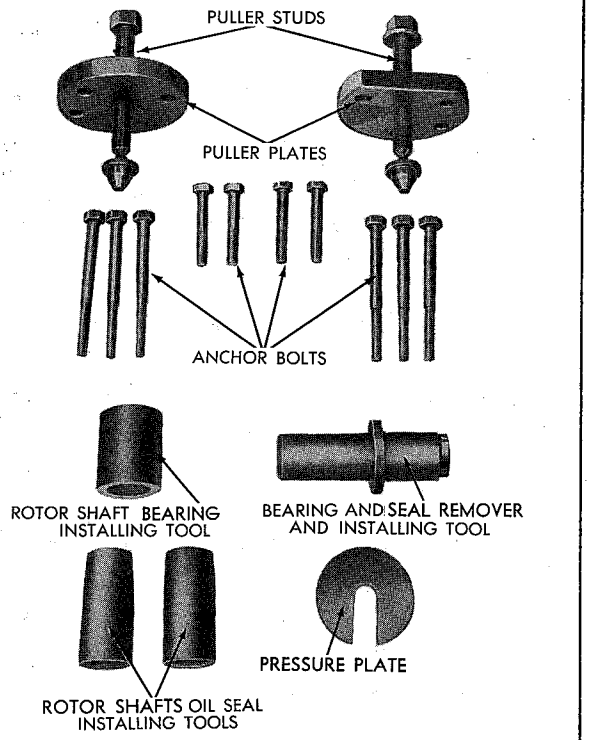


Fig. 8—Special Blower Tools

4. Pull the rotor timing gears. *NOTE: Due to the helical angle of the gear teeth these two gears must be pulled from the shafts at the same time, using the special puller studs and plates as shown in Fig. 9.*

   a. Back out the studs in the puller plates as far as possible.

   b. Install two anchor bolts in diametrically opposite holes of the puller plates and screw the anchor bolts into the gears as far as possible so that the faces of the plates are parallel with the face of the blower.

   c. Place a cloth between the two gears to prevent them from turning, then alternately turn the two puller studs clockwise until the gears are withdrawn from the rotor shafts. In most cases, shims will be found on each rotor shaft, behind the gears. Wire these shims to the respective gears so they may be installed in the correct positions when the blower is reassembled.

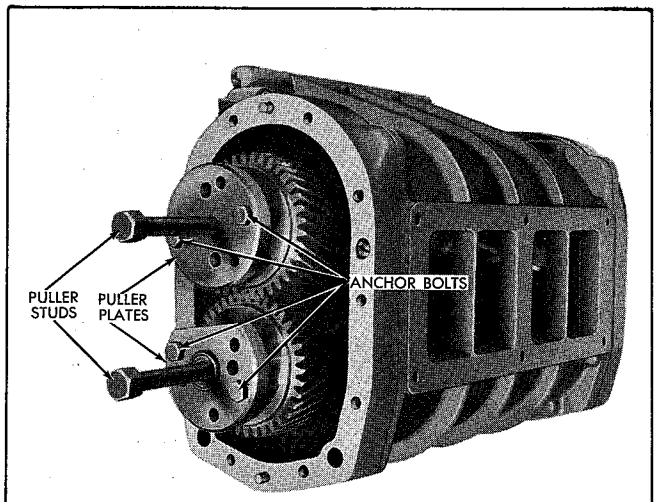


Fig. 9—Pulling Rotor Timing Gears

5. Remove the capscrews from each bearing retainer and remove the retainers from the end plates.

6. Remove the end plates and rotors from the blower housing. The end plates and rotors may be removed from the housing by pushing the rotor shafts from the bearings in the rear end plate, then withdrawing the rotors, still assembled in the front end plate, from the housing.

   a. Remove the two countersunk fillister head screws from the front end plate, and loosen the screws in the rear end plate about three turns.

   b. Using the same puller studs and puller plates used to pull the gears, install three anchor bolts in the three equally spaced holes of each plate as shown in Fig. 10, and screw the anchor bolts into the holes from which the bearing retainer capscrews were removed so that the faces of the puller plates are parallel with the face of the blower.

   c. Turn the two puller studs uniformly clockwise until the rotor shafts are free from the bearings in the rear end plate.

   d. Remove the puller plates from the rear end plates, then remove the two fillister head retaining screws, and pull the plate

from position by hand. Withdraw the rotors and front end plate assembly from the blower housing, then assemble the puller plates on the front end plate and press the rotor shafts out of this plate in the same manner as the shafts were pressed out of the bearings in the rear end plate. If the rotors are scored and can not be removed from the housing with the front end plate attached, assemble the puller plates on the front end plate and pull the end plate from the rotor shafts before withdrawing the rotors from the housing.

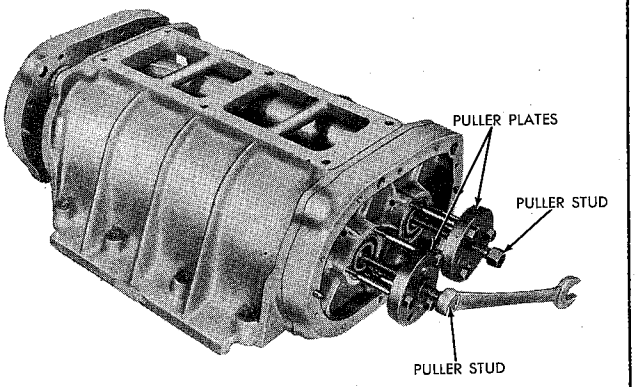


Fig. 10 — Removing End Plates and Rotors

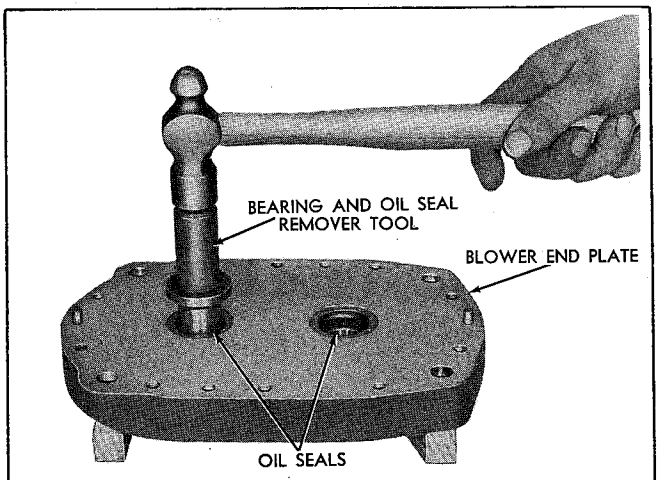


Fig. 11 — Removing Rotor Shaft Bearings

7. Remove the bearings from the blower end plates by using the bearing remover tool as shown in Fig. 11. Insert the tool through the oil seal, from the inner face of the blower end plate, so that the pilot of the tool enters the bore in the inner race of the bearing and the shoulder of the tool rests against the bearing inner race. Support the end plate on wooden blocks about two inches high and drive the bearing out of the end plate. Follow the same procedure for all four bearings.

8. Remove the oil seals from the blower end plates. The seals may be removed from the end plates, at the same time that the bearings are removed, by continuing to drive down on the bearing removing tools until the collar of the tool contacts the seal and drives it out of the plate.

E. Inspection of Blower Parts

After the blower has been disassembled, wash all parts in clean solvent and dry them with compressed air.

1. Wash the bearings by rotating them in a pan of clean solvent or fuel until they are free from grease and oil. Blow the dirt and fuel from the bearings with compressed air, while rotating the bearings by hand. *Do not spin the bearings with air pressure*. Repeat the cleaning operation until all foreign substance has been removed. After cleaning thoroughly, lubricate the bearings with clean engine oil and rotate them by hand to inspect for rough spots or roughness. The double-row bearings are pre-loaded and have no end play; in fact, a new double-row bearing will seem to have considerable resistance to motion when revolved by hand. If the balls or races are discolored instead of having brightly polished surfaces, they have probably run hot at some time and are unfit for further service. Discard any bearings that are worn or have tight or rough spots. Bearings which show heat discoloration must also be replaced.

2. The inspection for the condition of oil seals in the end plates, with the engine running, was described previously in "Leaky Oil Seals." If the leather of the seal is scored or damaged so that a tight seal on the rotor shafts cannot be obtained, or if the leather has become charred and hardened, new seals must be installed.

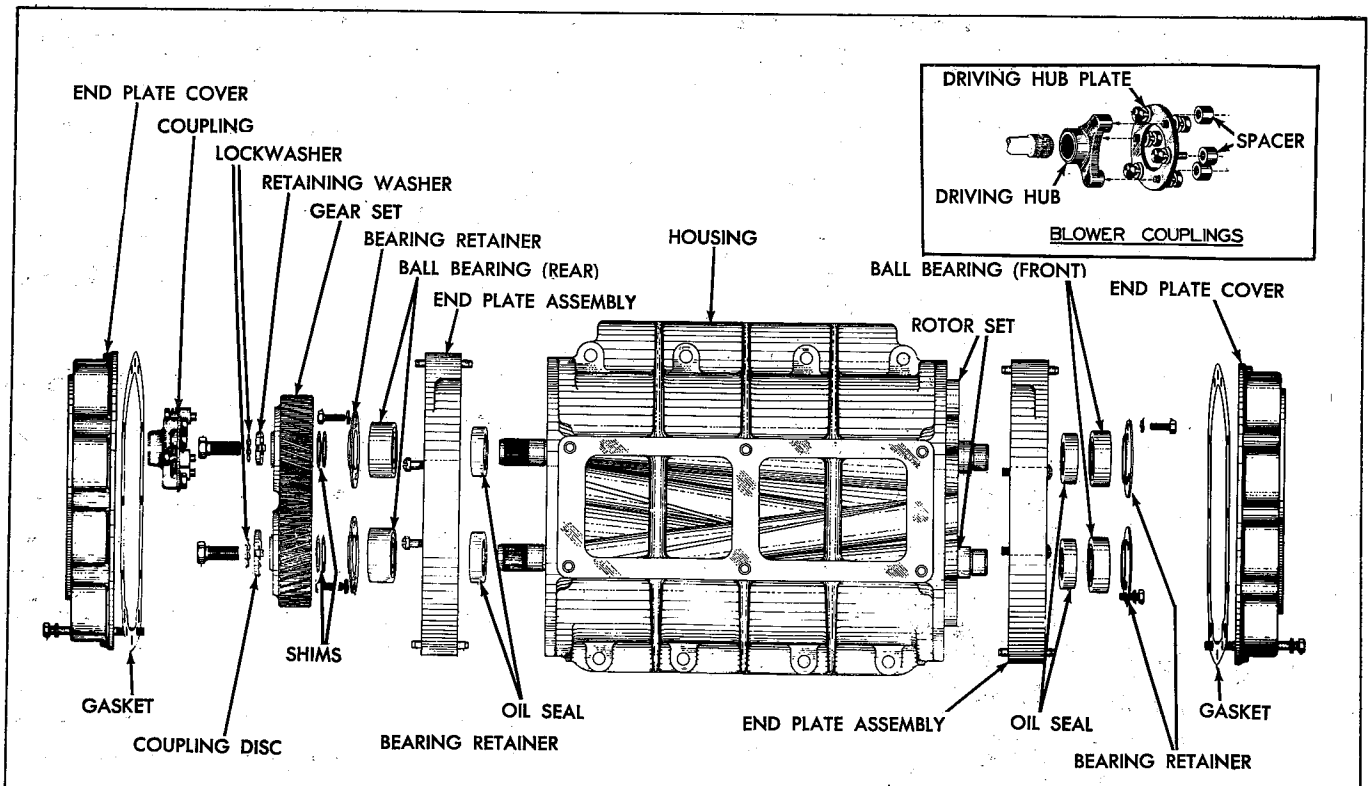


Fig. 12—Blower Details in Relative Position

3. The finished faces of the end plates and the ends of the blower housing must be smooth, flat, and free from burrs. The end plates must fit flat against the ends of the housing.

4. Inspect the blower rotor lobes for smoothness and the bearing surfaces for wear or burrs. The serrations in the ends of the shafts must be in good condition. If the rotors are badly scored or damaged they must be replaced; those having only slight burrs or nicks may be dressed smooth with a "fine cut" file or emery paper and used unless the ends of the rotors are worn to the point where there will be too much clearance between them and the end plates when the blower is reassembled (refer to Blower Clearance Chart, Fig. 19).

5. As stated in the preceding paragraph and shown in Fig. 19, the rotors must revolve inside of the blower housing with a specified clearance between the housing and the rotor lobes.

6. Check the blower gears for wear and general condition. The wear on the gears can be checked only with the blower assembled and the gears installed. Install new gears if the backlash between the gears exceeds .004"

F. Assembly of Blower

After the blower has been inspected and the worn or damaged parts replaced, assemble the blower by reversing the disassembly procedure and use the special tools illustrated, as follows:

1. INSTALL OIL SEALS IN END PLATES. Lubricate the seals with engine oil and install them in the end plates, with the flat face of the seals flush with the inner face of the end plates and with the sealing edges of the leathers pointing away from the inner faces of the plates. Install each of the four seals as follows:

   a. Clamp the end plate between soft jaws of a vise. Use one of the puller plates, the puller stud used in disassembling the blower, and the slotted pressure plate to push the seals into place. Back the puller stud out of the puller plate as far as possible and insert the stud through the hole in the end plate from the inner side so that the puller plate rests against the finished side of the end plate.

b. Place the oil seal in position to enter the plate, and place the slotted pressure plate over the puller stud and against the seal. Turn the stud clockwise to force the seal into position in the end plate.

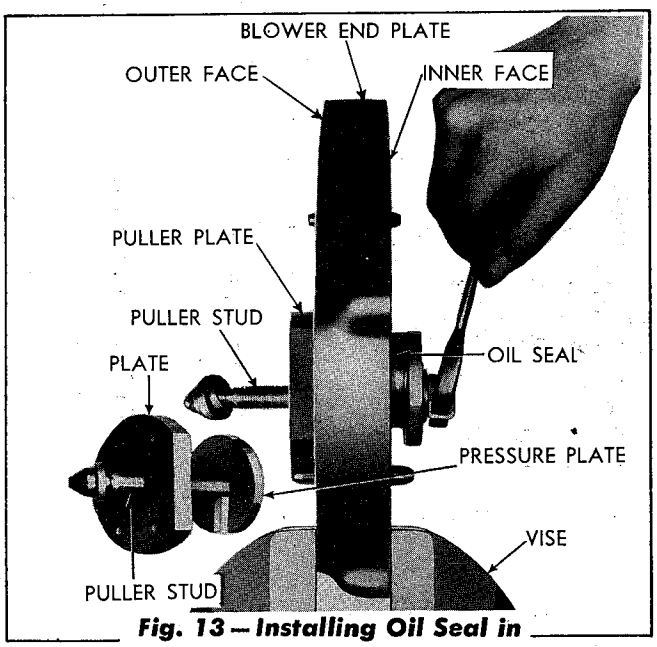


Fig. 13—Installing Oil Seal in Blower End Plate

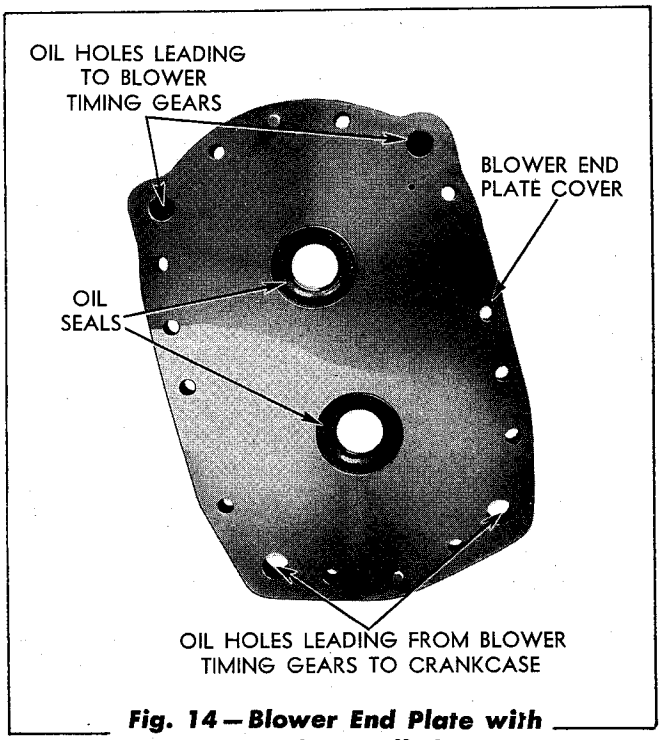


Fig. 14—Blower End Plate with Seals Installed

2. INSTALL BLOWER FRONT END PLATE. Both end plates are identical and may be installed on either end of the blower housing. The top of each end plate is semi-circular and is marked "TOP," on the outer ribbed side. The top of the blower housing can be identified by the flange across the entire length of housing which provides a rest on top of the cylinder block. *IMPORTANT: In the following instructions, the left-hand end of the blower housing, when viewed from the cylinder block side, will be considered the front end. With the above identification in mind, attach the end plate to the front end of the blower housing as follows:*

   a. Start the end plate dowels into the dowel holes of the blower housing. Tap the dowels and the end plate lightly with a soft hammer to fit the end plate to the housing. As there are no gaskets used between the end plates and the housing, the mating surfaces must be perfectly flat and smooth.

   b. Fasten the end plate securely to the housing with the two fillister head screws, using no lockwashers. When the end plates are properly installed, the dowels will project ⅜" beyond the outer face of the end plate.

3. INSTALL ROTORS IN HOUSING. Note that the lobes on one of the blower rotors and the teeth on one of the blower gears form a right-hand helix and the lobes on the other rotor and the teeth on the other gear form a left-hand helix. The rotor having the right-hand helix must be used with the gear having right-hand helical teeth and these parts must be installed in the upper part of the blower housing. The left hand rotor and gear must be installed in the bottom part of

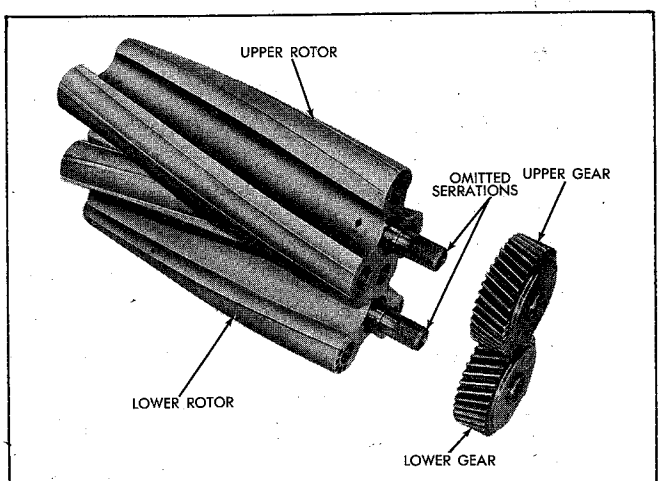


Fig. 15—Upper and Lower Rotors and Gears

the blower housing. The rotors and gears are marked "UPPER" and "LOWER" on the rear faces of the gears and on one lobe of each rotor. Note also that one serration is omitted from the drive (splined) end of each rotor shaft and from the hub of each gear. These serrations are omitted for the purpose of timing the rotors and gears when assembling the blower.

a. Place the blower housing on a bench, with the top flanged side of the housing up.

b. Place the rotors together, with the right-hand rotor on top and with the rotors in mesh and turned so that the omitted serration on the drive end of each rotor shaft is facing up, as shown in Fig. 15, then insert both rotors into the housing. Use an oil seal installing tool on the short end of each rotor shaft to expand the oil seals in the front end plate and to guide the ends of the shafts into the end plate.

c. Remove the oil seal installing tools after the rotors have been installed.

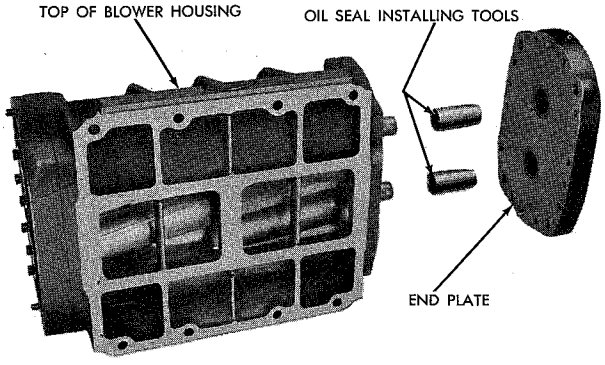


Fig. 16—Installing Rotors in Housing and End Plate

4. INSTALL REAR END PLATE. With the rotors installed in the housing and the omitted serration of each shaft facing the top of the blower housing as explained previously in step 3, install an oil seal installing tool over the end of each rotor shaft, then install the rear end plate in the same manner as the front end plate. Fasten the end plate to the housing with two fillister head screws, using no lockwashers. The dowels in the end plate must project ⅜" beyond the outer face of the plate. Remove the oil seal installing tools from the shafts.

5. INSTALL ROTOR SHAFT BEARINGS. The roller bearings must be installed on the front (non-serrated) ends of the blower rotor shafts and the double-row ball bearings on the rear (serrated) ends of the shafts. The bearing number is stamped on one side of the race of each bearing. When assembled, these numbers should face the outer face of the end plates.

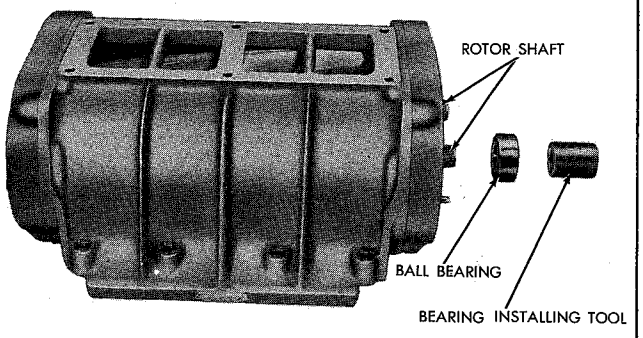


Fig. 17—Installing Rotor Shaft Bearings

a. Start each bearing into the end plate and tap the bearings into place with the bearing installing tool as shown in Fig. 17. After the bearings have been installed, check the rotor-to-housing and the rotor-to-end plate clearances as described under "BLOWER TIMING."

b. Install the bearing retainers with three (3) capscrews and lockwashers, as shown in Fig. 12.

6. INSTALL TIMING GEARS ON ROTOR SHAFTS.

If a used blower is being reassembled with the original parts, shims were probably used behind one or both blower timing gears. These shims, removed when the blower was disassembled, must be placed on the respective rotor shaft from which they were removed. If new gears or rotors are being installed, install the new parts without shims, and use shims later if necessary, when timing the rotors. *NOTE: The timing gears are*

matched, and when replacement is necessary they must be replaced as a set.

a. Be sure that the omitted serrations on the ends of the rotor shafts both point toward the top of the blower housing. The gear that has six (6) tapped holes in its hub (right hand helix) must be installed on the upper rotor shaft. Lubricate the serrated ends of the shafts with engine oil, then install the gears.

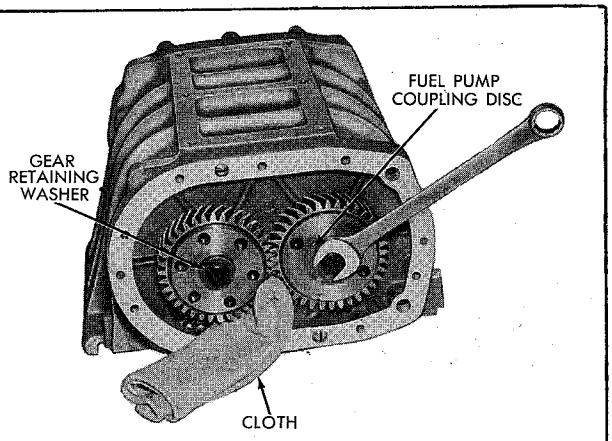


Fig. 18—Pressing Blower Timing Gears on Rotor Shafts

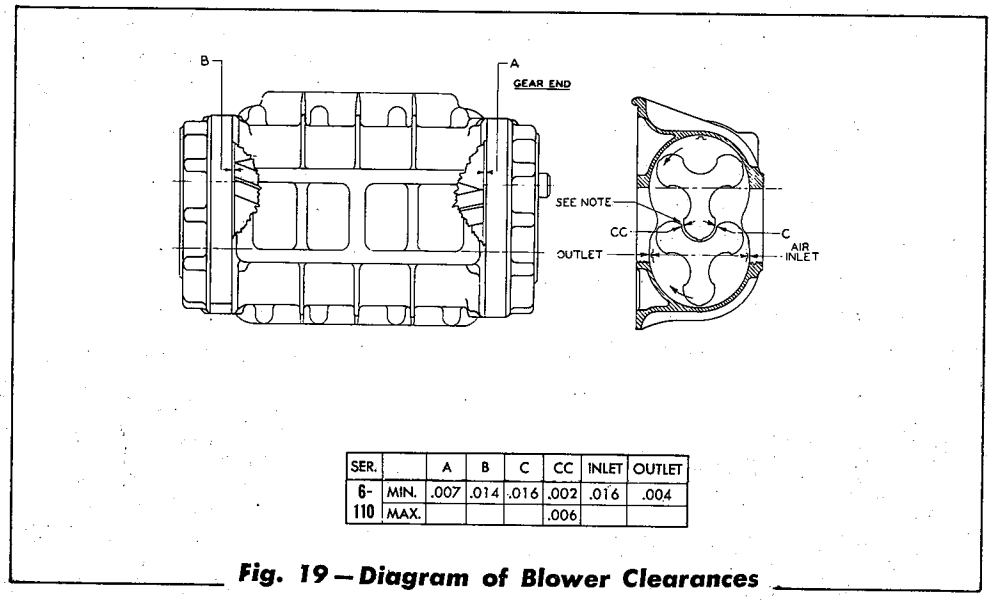
b. With the original shims installed on the rotor shafts, start both gears on the shafts, with the omitted serrations on the shafts and in the hubs of the gears in line. An "O" mark or punch mark is indented into the ends of the shafts, at the omitted serrations, to aid in aligning the gears on the shafts.

c. Using the retaining washer on the upper gear retaining capscrew and the coupling disc on the lower gear retaining capscrew, draw the gears tight against the shoulders of the rotor shafts by means of these capscrews. Place a cloth between the two gears to prevent their turning. *CAUTION: Both gears must be pressed on evenly and at the same time. Do not pull the gears up tight if the rotors come in contact with one another before the gears are pressed all the way on.*

d. After timing the rotors as explained in step 7, install the special lockwashers under the heads of the two capscrews. Bend two ears of each lockwasher into the notches in the retaining washer and the coupling disc, then bend two other ears against the heads of the capscrews. The retaining washer on the upper capscrew and the lugs of the lockwasher engage slots in the gear hubs. Draw the retainer capscrews reasonably tight but not tight enough to bend the coupling disc.

7. TIME BLOWER ROTORS. The rotors must be timed at this stage of assembly. As stated before, the rotors when properly positioned in the housing will revolve with a slight clearance between the lobes. This clearance may be changed by moving one of the blower gears in or out on the rotor shaft. This positioning of the rotors is called "blower timing" and is accomplished by adding or removing shims between the gear hub and the bearing located behind the gear. The shims used to make this adjustment are .002", .003", .005", and .010" thick.

When the upper gear is moved out, the upper rotor will rotate a slight distance in a counter-clockwise direction when viewed from the gear end. When the lower gear is moved out, the lower rotor will rotate clockwise when viewed from the gear end. The clearance between the rotor lobes must be taken between two of the lobes at each end and at the mid-section, while revolving the rotors with the upper rotor turning in a counter-clockwise direction (viewed from gear end). Always determine the point of minimum clearance by using feeler ribbons ½" wide. For measuring clearances of more than .005," use laminated feeler ribbons made up of .002", .003", or .005" thickness. These feeler ribbons will bend around the lobes more easily than a single thick one and a more accurate measurement will be obtained.



SER.		A	B	C	CC	INLET	OUTLET
6-110	MIN.	.007	.014	.016	.002	.016	.004
	MAX.				.006		

Fig. 19 — Diagram of Blower Clearances

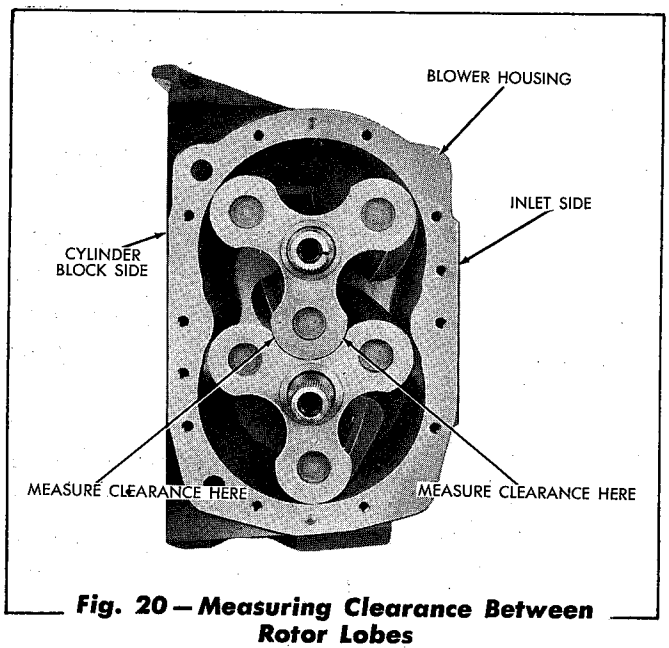


Fig. 20 — Measuring Clearance Between Rotor Lobes

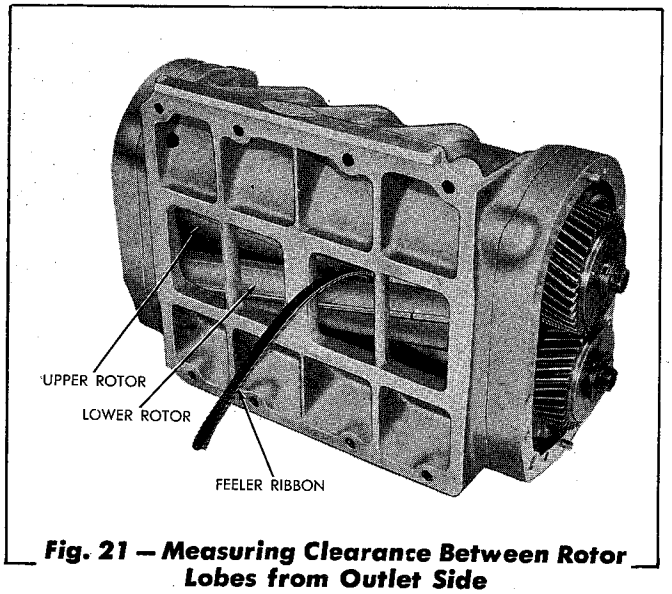


Fig. 21 — Measuring Clearance Between Rotor Lobes from Outlet Side

Turn the rotors by turning the upper gear in a counter-clockwise direction until the end of a lobe of each rotor points straight down at the gear end of the blower, as shown in Fig. 20. Insert a feeler ribbon through the opening in the cylinder block side (outlet side) of the housing and down between the lobes at this point ("CC," Fig. 19). Turn the rotors and take measurements at the mid-section and at the opposite end of the lobe. Record the minimum clearance obtained. Measure the clearance between the second and the third pairs of lobes in the same manner. Let us assume that the minimum clearance obtained from all these measurements was .010". Referring to the chart Fig. 19, we find that the clearance is specified as .002" to .006". Therefore, the clearance is excessive and must be decreased to within the specified range. This can be accomplished by adding shims behind the lower gear or removing shims from behind the upper gear. A .003" adjusting shim in back of the blower gear will affect the rotor clearance approximately .001". The clearance must again be checked after the addition of shims, to make certain that the clearance obtained is correct, and additional shims installed or removed until the proper clearance is obtained. If the clearance between the lobes is less than required, remove shims from behind the lower gear or add shims behind the upper gear. *NOTE: Both gears must be*

removed and installed together each time for the addition or removal of shims.

After the clearance between the lobes has been measured through the cylinder block side (outlet side) of the blower and found to be between .002" and .006", measure the clearance ("C" Fig. 19) between the opposite sides of the lobes, through the inlet side of the housing in the same manner (Fig. 22).

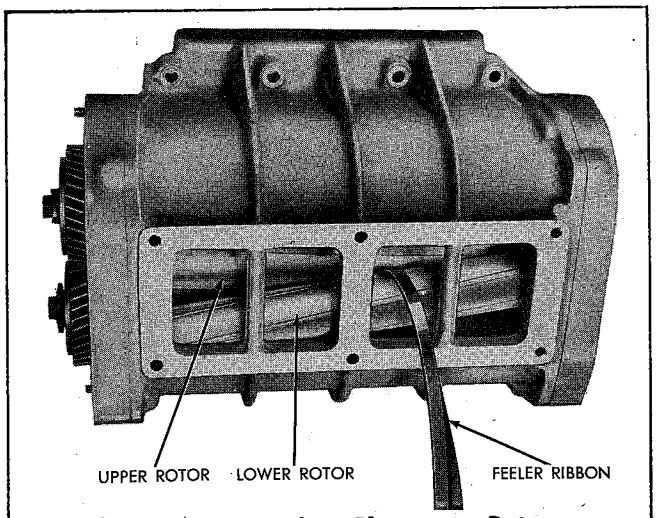


Fig. 22 — Measuring Clearance Between Rotor Lobes from Inlet Side

The specified minimum clearance is .016". When it is impossible to obtain a minimum clearance of .016" between the lobes when checked from the inlet side, and the clearance at the outlet side has been adjusted to the minimum of .002", it must be assumed that the rotors are damaged, making it necessary to install a new set of rotors.

The clearance between the ends of the rotors and the end plates ("A" and "B," Fig. 19) and between the rotor lobes and the housing must also be checked. Measure the rotor-to-end plate clearance at the ends of each lobe, taking twelve measurements in all. As specified on the chart in Fig. 19, there must be a minimum clearance of .007" at "A" and .014" at "B." Measure these clearances by inserting feeler ribbons between the ends of the rotors and the end plate as shown in Fig. 23. Next, insert feeler ribbons between the rotor lobes and the sides of the housing, from both the inlet and outlet sides of the blower. A minimum running clearance of .004" is required between the rotor lobes and the inside of the housing when measuring from the outlet side, and a minimum clearance of .016" is required on the inlet side. These clearances can be obtained if the work is done carefully when assembling the blower.

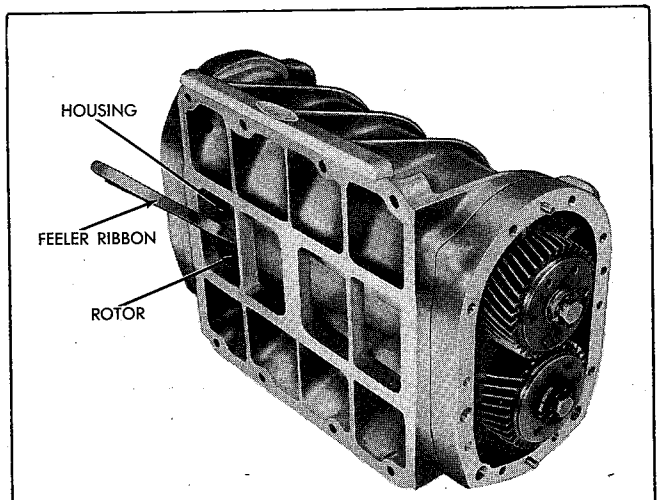


Fig. 23 — Measuring End Clearance Between Rotors and End Plates

8. After the rotors have been properly timed and the gears have been tightened securely in place, install the rotor driving hub and plate assembly (flexible type) on the upper gear as follows:

   a. Refer to Fig. 12 and position the driving hub on the driving hub plates and install the three (3) attaching capscrews with plain washers and lockwashers. Tighten the capscrews securely.

   b. Refer to Fig. 12 and install the driving hub and plate assembly on the upper gear using the three (3) spacers between the plates and the gear. Install three (3) capscrews, plain washers, and lockwashers and tighten the capscrews securely.

9. If the old gaskets on the end plate covers are unsatisfactory in any way, cement a new gasket to each cover and install the covers on the blower end plates. Install the attaching capscrews and lockwashers.

G. Blower Installation

1. Cement a new blower gasket to the cylinder block, then place the blower assembly in

position on the cylinder block, entering the blower drive shaft into the splines of the blower driving hub. Rotate the blower lobes by hand until the splines of the drive shaft can be felt entering the splines in the driving hub of the blower.

2. Properly locate the blower on the cylinder block and install the attaching capscrews. *NOTE: Be sure that the face of the blower and the attaching surface of the cylinder block are clean before installing the blower.*

3. Insert two (2) 3/8" capscrews into the two upper corner holes of the air inlet housing and place the blower screen on these capscrews, then place the air inlet housing assembly in position on the blower and install the six (6) attaching capscrews.

4. Position the two blower drive cover seals and hose clamps and tighten the clamps on the blower drive cover securely.

5. Connect the blower front bearing oil tube to its fittings in the cylinder block and blower cover plate, being careful not to damage the threads on the tube assembly.

6. Connect the primer line to the primer elbow assembly and clip the primer line in position.

7. Connect the air shut-off control rods to the air shut-off valve levers with yoke pins and secure the yoke pins with cotter pins.

8. Slide the air cleaner tube hoses into position on the tubes and elbows and clamp securely with the hose clamps. *CAUTION: To eliminate the possibility of air entering the blower at these two points, check your work carefully to see that the hoses are in good condition and securely installed to form an air tight seal.*

9. Install the right front fender.

6. BLOWER DRIVE ASSEMBLY

A. Description

The blower drive assembly consists of a splined shaft and flexible coupling, mounted in a hub in the flywheel housing, and driven by a gear in mesh with the engine timing gears. The drive is cushioned by two banks of springs which dampen engine torque fluctuations to the blower. The splined drive shaft engages in the driving hub attached to the upper blower rotor gear. The drive gear turns in a bushing in the driving hub support.

B. Removal of Blower Drive Assembly

Check the end clearance between the drive gear hub bushing and the thrust washer, before the blower drive is removed from the engine. Refer to Fig. 24.

A clearance of .004" to .009" is specified at this point. When this clearance exceeds .012", the support and bushing assembly must be replaced. Remove the blower drive as follows:

1. Loosen the nuts at each end of the oil pipe leading from the cylinder block to the blower drive gear support. The oil pipe will be freed from the connectors when the support assembly is withdrawn from the flywheel housing.

2. Remove the flywheel housing star cover, then remove the blower drive shaft snap ring and pull the blower drive shaft. Remove the blower drive shaft cover and the two capscrews

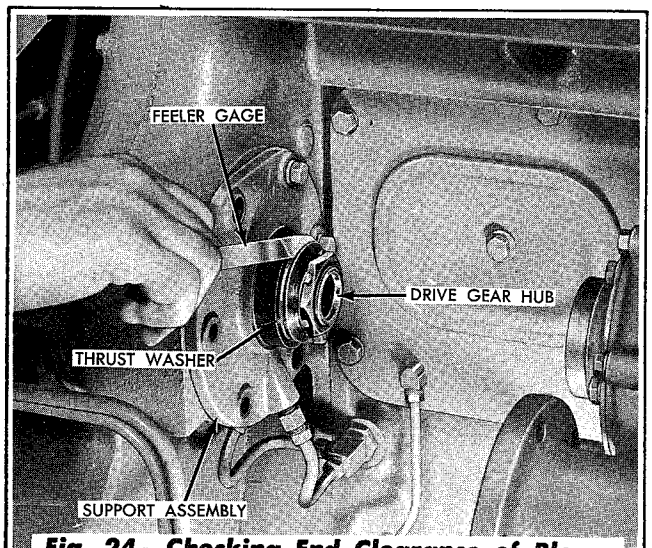


Fig. 24—Checking End Clearance of Blower Drive Assembly

from the blower drive support assembly.

3. Tap the support loose from the timing gear housing and withdraw the drive assembly.

C. Blower Drive Disassembly

1. Remove the capscrews that attach the drive coupling retainer, coupling support, and the blower drive gear to the drive gear hub and remove the coupling support and retainer from the drive gear hub.

2. Clamp the support assembly in a vise. Straighten the lock and remove the nut, lockwasher, thrust washer, and steel lock ball from the front end of the drive gear hub. Withdraw the hub and the drive gear from the support assembly.

3. Press the drive gear from the gear hub. If the support assembly is to be changed, remove the oil tube elbow from the support assembly.

4. If the coupling springs, coupling spring seats, or the coupling cam are to be replaced, clamp the coupling support in a vise, insert the blower drive shaft into the cam and work the cam out of the springs. Remove the springs after the cam has been removed. *CAUTION: Use care when removing the cam so that the springs will not be lost.*

D. Inspection of Blower Drive Parts

Inspect the bores and the thrust faces of the bushings inside the blower drive support assembly. If the bushings show any score marks that would affect the bearing efficiency, a new support and bushing assembly must be installed. These bushings are lined bored, therefore, in case of a bushing failure the entire support assembly must be replaced. Check the inside diameter of the bushings for wear and roundness, and the outside diameter of the drive gear hub, at the bearing surfaces (journals), for wear. The proper clearance between the bushings and the hub is .002" to .0035" and must not exceed .007". If measurements show that the bushings or hub are worn to exceed .007", install a new support and bushing assembly, or drive gear hub, or both.

Inspect the serrations on the blower drive shaft and if they are worn so that excessive backlash is felt between the drive shaft and the coupling cam or between the shaft and the drive coupling, a new shaft must be installed.

Inspect the springs, spring seats, and the cam of the flexible coupling and replace any parts that are worn or damaged.

Be sure that the oil holes in the support assembly are open and that the oil cavities are free from dirt.

E. Assembly of Blower Drive

1. Install the drive gear in position on the drive gear hub. Clamp the support assembly in a vise. Coat the outer side of the drive gear hub and the bushings in the support assembly, with an engine oil and insert the hub into the support assembly, from the rear.

2. Hold the drive gear hub in position in the support assembly and place the steel lock ball in the hole in the front end of the hub. Place the thrust washer on the hub over the ball, with the large diameter of the washer facing the thrust face of the bushing in the support.

3. Prevent the hub from turning by inserting bolts in two of the holes in the hub and holding the bolts with a bar. Install a new lockwasher on the front end of the hub, next to the thrust washer, then install and tighten the lock nut. Check the end clearance betweeen the bushing and the thrust washer, this clearance must be between .004" and .009." Bend the ears of the lockwasher over the flat sides of the nut to prevent the nut from becoming loose.

4. If the coupling springs and the cam were removed from the coupling support, a small "C" clamp may be used when assembling. Lubricate the spring leaves with engine oil and divide them into two (2) banks of 21 leaves each. Place two (2) of the half-round spring seats in position in the coupling support, then place one (1) bank of springs in position in the coupling support and on the seats. Hold the cam in position on the springs,

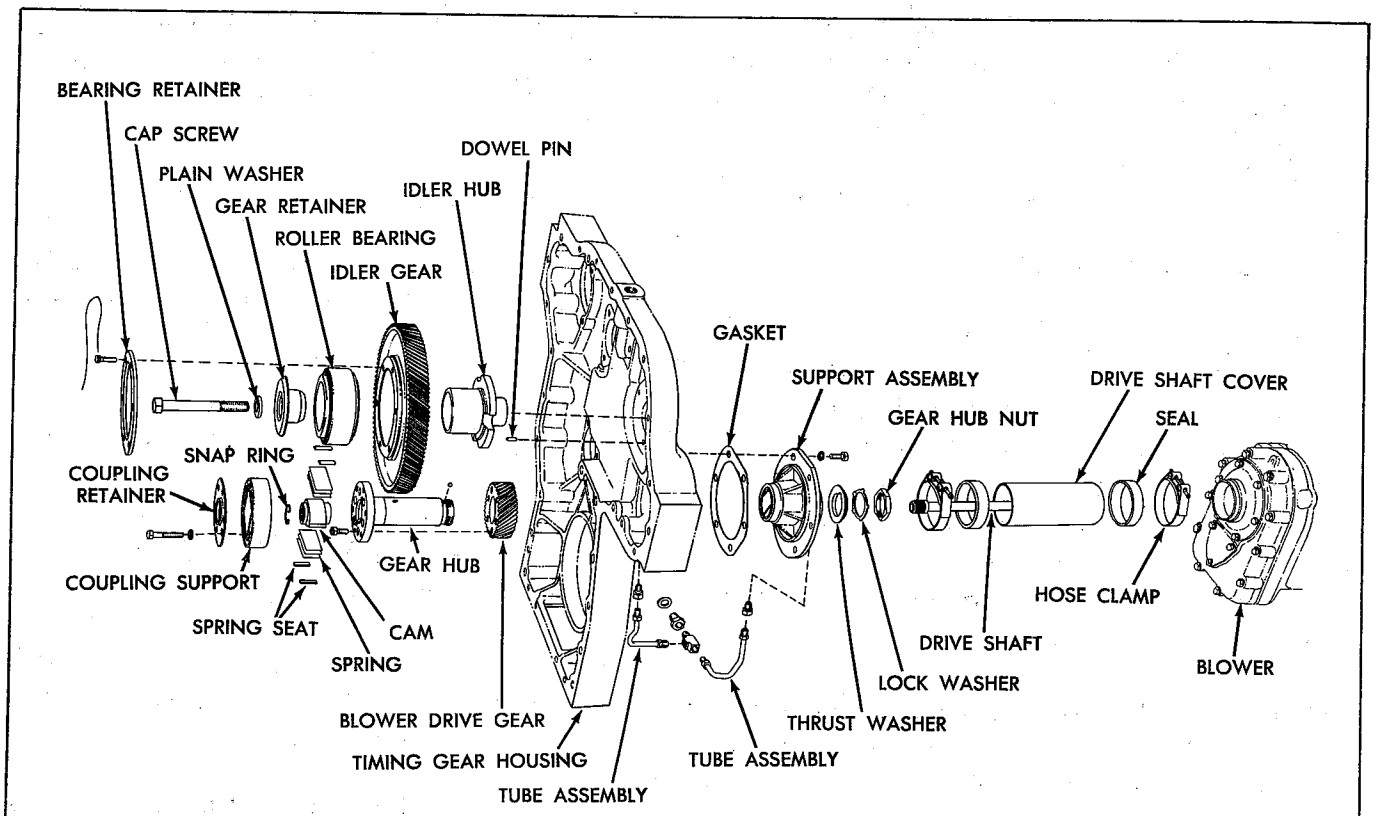


Fig. 25—Blower Drive Details

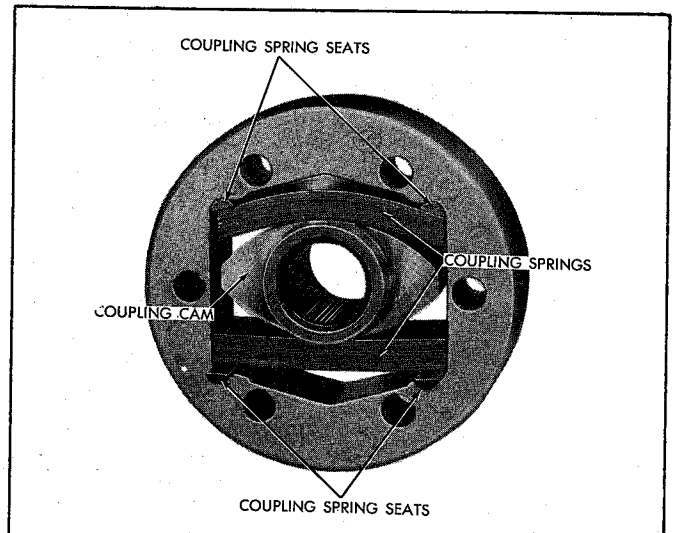


Fig. 26—Flexible Coupling

then using a small "C" clamp in the bore of the cam and over the outside of the coupling support, compress the spring bank enough so that the other bank of springs may be installed. Install the other two (2) half-round spring seats in position and install the other bank of spring leaves. Remove the "C" clamp.

5. Place the flexible coupling assembly in position on the drive gear hub so that the lobes of the coupling cam are located over the 5/32" oil groove slots in the face of the drive gear hub. Make certain that the snap ring groove in the bore of the coupling cam is positioned to the rear when installed.

6. Place the coupling retainer against the coupling support, with its center flange facing away from the coupling support. Install the attaching capscrews and lockwashers.

F. Installation of Blower Drive

1. Cement a gasket to the rear side of the support assembly flange. Place the oil tube, extending to the blower drive, in position against the connections in the cylinder block and the support assembly, as the blower drive assembly is inserted into the timing gear housing. The blower drive gear must mesh with the idler gear as the blower drive is pushed into the timing gear housing. Attach the support, using four (4) 3/8" NF x 6¼" bolts and two (2) 3/8" NC x 1⅛" capscrews. *CAUTION: Make certain that the two (2) short capscrews are of the proper length, as longer capscrews will strike the idler gear.*

2. Install the blower drive shaft cover and the blower drive shaft. Install the blower drive shaft snap ring in position in the coupling cam. Install the flywheel housing star cover and connect the cylinder block to support assembly oil tube.

7. AIR BOX AND CYLINDER LINER AIR PORTS

A. Air Box and Drain Tubes

The upper part of the cylinder block is hollow and is called the air box. The cylinder liners extend through this hollow part and down into the lower part of the block. Air ports in the cylinder liners register with openings in the air box. Air injected into the air box by the blower passes through the air box and into the cylinders, through the air ports in the liners, as the ports in the liners are uncovered by the pistons.

In normal operation, water vapor from the air, as well as a slight amount of fuel and lubricating oil fumes, condense and settle in the bottom of the air box. Four (4) air box drain tubes, located two on the right and left sides at the front and rear of the cylinder block, are provided for drainage. It is important that these drain tubes be kept open at all times.

If the tubes are open and functioning properly, a stream of air can be felt emerging from the end of the tubes when the engine is running. If the tubes become clogged, push a wire through the tubes or remove them and clean the openings.

B. Cylinder Liner Air Ports

The engine is equipped with cylinder liners having a row of 15 holes, 11/16" in diameter, drilled in the circumference of each liner. These holes, or ports, must be kept open to permit free passage of air into the cylinders for combustion of fuel. Inspection for the condition of the air ports should be made at frequent intervals (at least every 500 hours), as hard carbon or sludge will build up in the ports and restrict the port openings. Remove the inspection covers from the left side of the cylinder block to inspect the ports.

If inspection reveals the port openings reduced by 30% or more due to clogging, cleaning of the ports is necessary. The cylinder head must be removed to clean the ports properly and to remove the carbon or sludge scraped from the ports during the cleaning operation. Proceed as follows to clean the ports:

1. Remove the cylinder head assembly. Refer to "CYLINDER HEAD REMOVAL," Section IX.

2. Rotate the engine by hand until the piston in the cylinder liner to be cleaned is at the bottom of its stroke.

3. Using a bolt, or a square stick of wood, sharpened to a tapered point, clean all ports from the inside of the liner.

4. After all the holes in one cylinder liner have been cleaned, use compressed air to blow all carbon particles from the head of the piston and out of the cylinder. Touch up the area around the ports with fine emery paper to be sure no burrs or nicks are left on the inside of the liner. Again clean the cylinder with compressed air, before turning the engine to work on another cylinder.

5. After the air ports in all cylinder liners have been cleaned, clean all the carbon from the

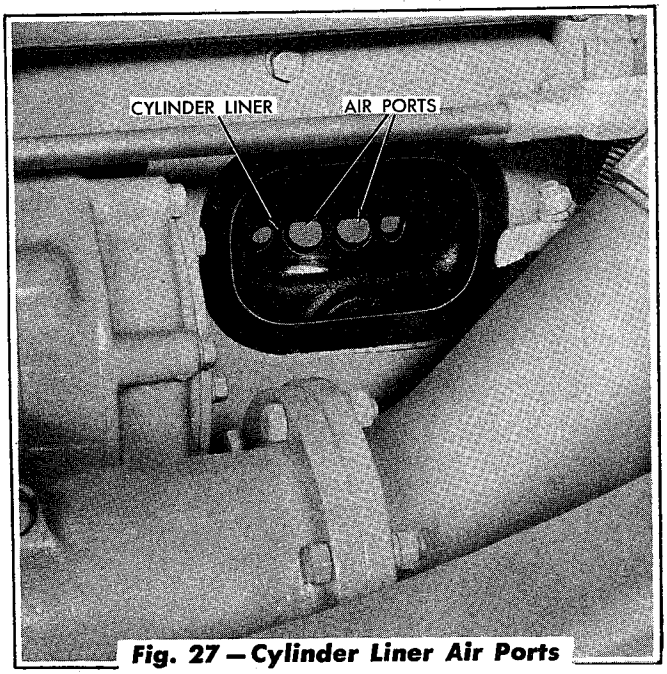


Fig. 27 — Cylinder Liner Air Ports

air box. Remove the air box inspection covers, the blower assembly and the air box drain tubes and fittings, while cleaning the air box.

6. Be sure that the openings in the air box drain tubes and the fittings are clean before reinstalling the tubes.

NOTE: With the cylinder liners removed from the engine, the ports may be cleaned by soaking the liners in a hot caustic solution of soda or lye long enough to loosen carbon deposits. Final cleaning may then be accomplished by brushing away the loosened deposits.

8. COLD WEATHER ENGINE PRIMER

A. Purpose

In warm weather, sufficient heat is generated by the compression of the air within the cylinders to ignite the fuel and start the engine within a very short cranking period. 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. A large part of the heat generated by the compression of the air is then absorbed by the cold pistons and cylinder walls. This loss of heat and the reduced cranking speed may result in the temperature of the air in the cylinders being too low to ignite the fuel. A starting aid must then be used in starting the engine.

B. Description

The cold weather engine primer consists of a dispenser assembly, which holds and punctures a capsule containing ethyl ether fluid, a primer pump to force the fluid through a small nozzle into the air inlet housing on the engine blower, a primer elbow assembly, and the necessary lines to complete the system. The dispenser and primer pump are located on the cowl (to the right of the instrument panel). The vaporized starting fluid is forced through the primer elbow assembly and into the air inlet housing, where it is picked up by the engine blower and is blown into the cylinders. Since the fluid is highly combustible, it is easily ignited by the heat of compression in the cylinders. The engine will start quickly at low ambient temperatures with the aid of the primer, if the starter will crank the engine even at a very low cranking speed. The starting fluid capsules, available in 7 c.c. and 17 c.c. sizes, can be obtained from "Allis-Chalmers" Dealers. Refer to "Operators Manual" for full instructions on the use of the Cold Weather Engine Primer.

C. Cold Weather Engine Primer Trouble Shooting

If the engine is cranked with the throttle wide open and does not start after two or three strokes of the primer pump, it is advisable to stop cranking and inspect the primer system for possible causes of failure.

1. Primer Elbow Assembly Clogged

This condition will usually be indicated by excessive resistance on the primer pump. A partially clogged primer elbow assembly will prevent the delivery of sufficient starting fluid to the air inlet system. To clean the primer elbow assembly, remove the assembly from the air inlet housing and remove the small nozzle from the primer elbow assembly. Remove and clean the nozzle swirl pin and open the hole in the end of the nozzle, if clogged. *CAUTION: Do not enlarge the hole in the end of the nozzle.* After cleaning,

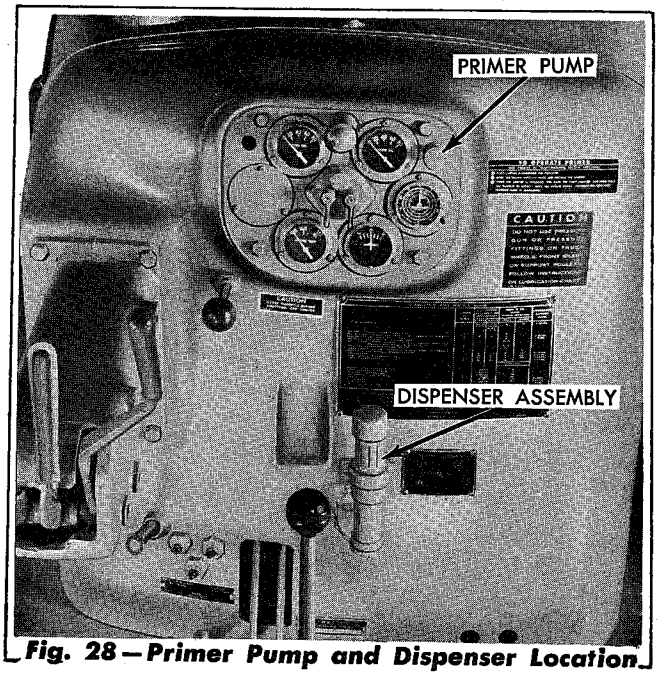


Fig. 28—Primer Pump and Dispenser Location

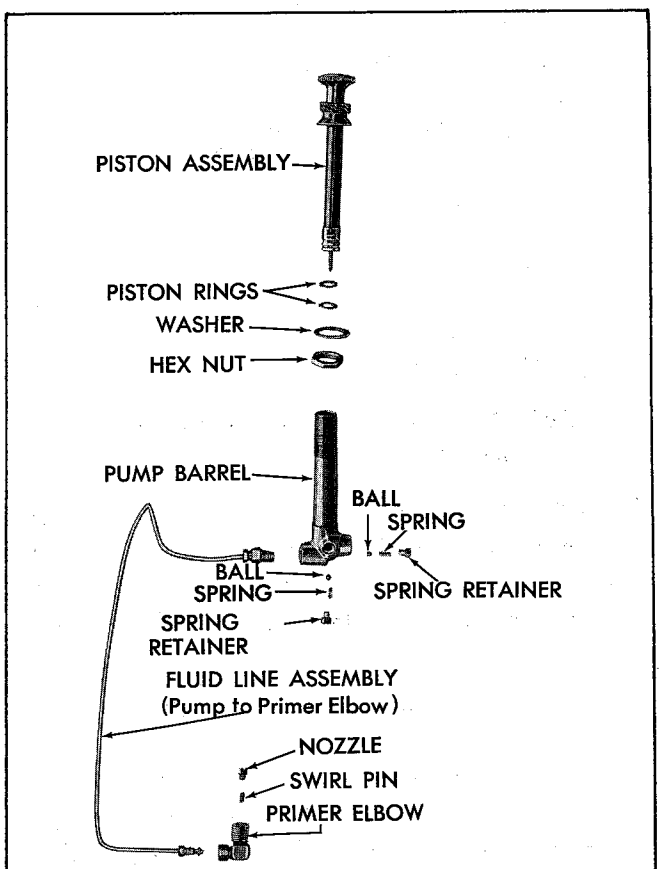


Fig. 29 — Primer Pump and Primer Elbow Details

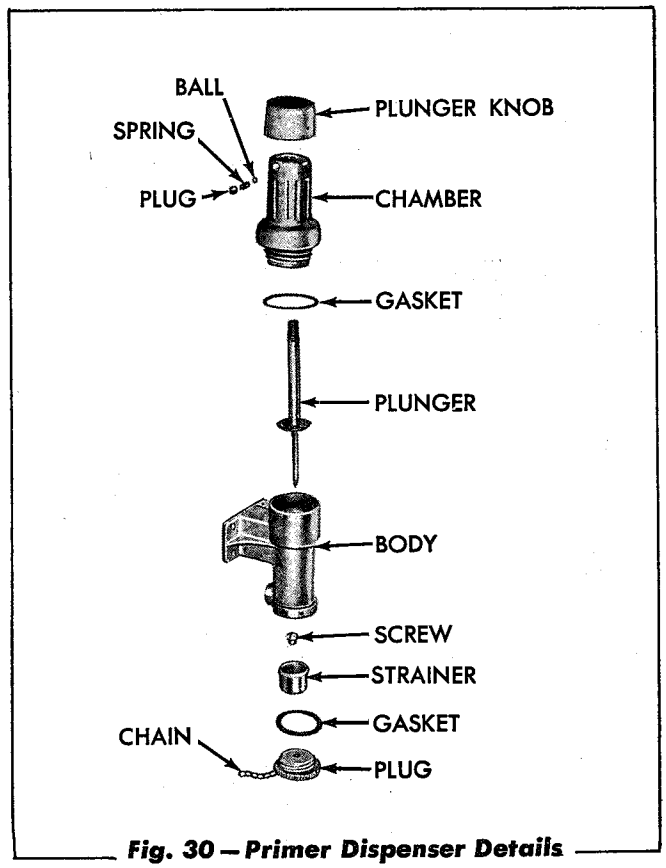


Fig. 30 — Primer Dispenser Details

assemble the primer elbow assembly and install it in the air inlet housing.

2. Inoperative Primer Pump

Failure of the primer pump to function properly may be due to worn or damaged piston rings, a clogged dispenser filter strainer, clogged fluid lines, or "frozen" or worn check valve balls.

The piston rings on the piston are made of a special rubber composition and must be replaced by duplicate parts if worn or damaged.

To replace the piston rings, remove the knurled nut (under knob) from the pump barrel and withdraw the piston assembly from the barrel. Remove the piston rings from the grooves of the piston assembly and install new rings. Lubricate the rings and piston with light engine oil and install the piston assembly in the pump barrel. Do not "roll" the rings in position in the grooves of the piston assembly.

3. Ball Check Valves

The two spring loaded ball check valves, located on the inlet and outlet ports of the pump, are provided to close the pump ports at the proper time. When the pump piston is pulled out (suction stroke, drawing fluid from the dispenser), the ball check valve at the inlet port opens, allowing the fluid to be drawn from the dispenser. When the pump piston is pushed in (delivery stroke, supplying fluid to the primer elbow assembly), the ball check valve at the outlet port opens, allowing the pump to force the fluid to the primer elbow assembly.

Worn or "frozen" ball check valves, or broken springs, will prevent the pump from operating properly. When this occurs, remove the spring retainers, springs, and balls from the inlet and outlet ports of the pump. Inspect the balls, ball seats, and springs for wear or damage. Clean the pump barrel and all its components thoroughly and reassemble, using new parts where necessary.

4. Clogged Dispenser Strainer Screen

The strainer screen is bolted to the strainer plug, which is screwed into the bottom of the dispenser body.

If the gelatine capsules are not removed soon after puncturing, the gelatine will melt and will plug the strainer screen in the bottom of the dispenser body.

To clean the dispenser strainer, unscrew the strainer plug from the dispenser body and wash the strainer and plug in hot water.

The strainer screen may be removed for replacement if necessary by removing the strainer retaining screw from the strainer plug.

The dispenser body may be washed without removing it from the cowl by removing the upper chamber, the connector, and the strainer plug.

Reassemble the dispenser assembly by a direct reversal of the disassembly procedure.

SECTION IV—ENGINE COOLING SYSTEM

1. DESCRIPTION OF SYSTEM

The engine cooling system consists of the water pump, radiator, thermostats, cooling fan, and the water passages in the cylinder block and cylinder head. The oil cooler, while basically a component of the lubricating system, also acts as an engine cooling agent.

A double acting valve is provided in the radiator cap for relieving pressure due to expansion (from heating of the coolant), and allows atmospheric pressure to enter the radiator when contraction occurs (due to cooling of the coolant).

The water pump draws the water from the bottom of the radiator and circulates it through the oil cooler housing and the water passages in the engine. It then passes from the cylinder head of the engine, through the thermostats and the upper radiator hose, to the upper part of radiator. The water is cooled as it passes from the top to the bottom of the radiator by air circulated through the radiator core by the cooling fan.

The thermostats, located in the housing on the front end of the water outlet manifold, operate automatically to maintain a normal operating temperature of 160° to 185° F.

2. GENERAL MAINTENANCE

Keep the cooling system filled with clean water, free from lime or alkali. The use of water containing lime will result in lime deposits in the cylinder head and cylinder block, causing hot spots in the engine and eventually restricting the water passages. Alkali in the water will cause a corrosive action detrimental to the engine.

In freezing weather, use an ethylene glycol anti-freeze solution in the system to protect it against damage from freezing. This type of anti-freeze has a much higher boiling point than water. After any addition of water or ethylene glycol to the cooling system, test the solution after the added quantity has become thoroughly mixed to be sure that it will withstand the prevailing or anticipated temperatures. A mixture of 60% ethylene glycol and 40% water will provide maximum protection; the use of more than 60% ethylene glycol in the solution will raise the freezing point and provide less protection against freezing.

Keep the radiator air passages free of leaves, trash, and other debris that will restrict the flow of air through the radiator.

As this is a pressure cooling system it is necessary to keep the radiator cap screwed on tight. All leaks in the cooling system must be corrected as soon as they are evident and the fan belts must be kept in proper adjustment. The most efficient engine operation is obtained with the operating temperature held within a range of 160° to 185° F. Operating the engine at temperatures below this range will result in incomplete combustion of fuel, higher fuel consumption with less power, and will cause harmful gummy deposits within the engine.

Maintaining the correct engine temperature depends mostly on the proper functioning of the thermostats. If the engine temperature remains consistently below normal, the thermostats should be removed and inspected. If the thermostats are corroded and stuck, or if they leak, install new thermostats.

When operating in cold weather, if the thermostats prove inadequate to maintain the specified operating temperatures, provide suitable covers for the radiator and for the sides of the engine compartment.

3. FILLING AND DRAINING OF SYSTEM

A. Filling Cooling System

The engine is equipped with a water by-pass tube extending from the thermostat housing (on front of water manifold) to the water pump. Its purpose is to allow coolant to pass from the outlet water manifold directly to the water pump and into the engine block and head, by-passing the radiator. This occurs when the engine is first started and until normal operating temperature is obtained. When the engine has reached normal operating temperature, the thermostats will open and allow the coolant to circulate through the radiator.

The air in the cooling system is vented to the atmosphere through a vent cock at the top of the thermostat housing. A drain cock, located on the right side of the thermostat housing, is provided for draining the housing. Refer to Fig. 12.

Fill the cooling system through the radiator, after first closing the drain cocks on the ends of the drain tubes leading from the oil cooler housing and the radiator outlet tube. Refer to Fig. 1.

IMPORTANT: Open the vent cock in the top of the thermostat housing while filling the system to permit the air, trapped in the engine by the closed thermostats, to escape. Close the vent cock when coolant emerges from the vent cock and continue filling the system.

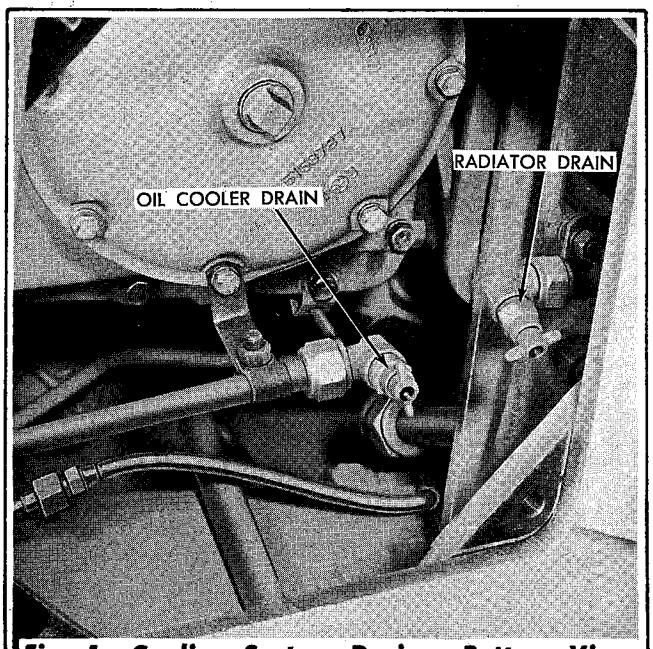


Fig. 1—Cooling System Drains—Bottom View

B. Draining Cooling System

Remove the front cover plate from the bottom of the crankcase guard. Open the drain cocks, located on the ends of the drain tubes leading from the oil cooler housing and lower radiator outlet tube, and allow the system to drain. Also open the thermostat housing vent and drain cocks.

4. CLEANING OF COOLING SYSTEM

Clean the cooling system at least twice a year, usually at the beginning of cold weather before an anti-freeze solution is put in the system and again after the anti-freeze solution is removed. Cleaning at these intervals will reduce clogging and overheating 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 cylinder head. This lime deposit is detrimental to the engine and the radiator core.

1. CLEANING MATERIALS. Sal Soda is a very effective and safe solvent for removing 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.

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. Many other good cleaning solvents for this purpose are available. They also must be used according to the manufacturer's directions. 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 compounds, solutions, or inhibitors with any cleaning, neutralizing, or flushing compounds.

2. FLUSHING. If the tubes in the radiator become clogged, the obstructions causing the clogging can usually be removed by reverse flushing the radiator. When the clogging is caused by leaves or other trash, this material is usually deposited at the tops of the tubes.

   Disconnect the lower radiator hose and connect a pressure water hose to the lower radiator connection with a suitable adapter. Then plug the upper radiator hose connection, remove the radiator cap, and force water upward through the radiator. The trash will then be loosened from the top of the tubes and will be washed out through the top of the radiator. *CAUTION: Do not use over 5 pounds pressure in this flushing operation, as excessive pressure may cause the radiator tubes or tanks to rupture.*

3. INSPECT FOR LEAKS AFTER CLEANING OR FLUSHING. After the cooling system has been cleaned or flushed, and before new coolant is poured into the system, a complete inspection should be made of the entire system to detect and correct any 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 be added to the water to keep the system free from rust. Use the inhibitor as directed on the container.

4. 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 front side of the core and passing through to the back, or the fan side. Never use gasoline, fuel, or kerosene. The radiator grille should be opened 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. RADIATOR

A. Description

The radiator assembly consists of two (2) cores, one for the engine coolant and the other for the torque converter fluid. The two (2) cores are of the conventional tubular type, bolted together and mounted in a heavy (one-piece) radiator shell and shroud assembly. The radiator cores are protected by a heavy grille hinged to the front of the radiator shell. A guard, attached to the rear of the radiator shell, is provided to protect the fan. Vibration snubbers (rubber) are used in attaching the radiator assembly to the shell to minimize shock and vibration. A double acting valve is provided in the radiator cap for relieving pressure due to expansion (from heating of the coolant), and to allow atmospheric pressure to enter when contraction occurs (due to cooling of the coolant). A small hole is provided in the radiator cap, above the pressure valve, for venting and overflowing.

B. Removal of Radiator

1. Drain the engine cooling system as outlined in this section.

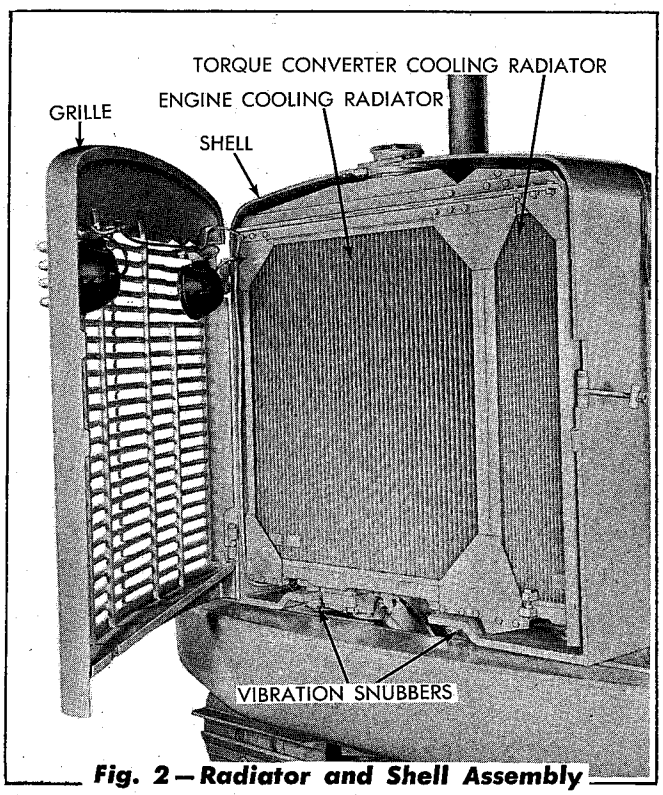


Fig. 2 — Radiator and Shell Assembly

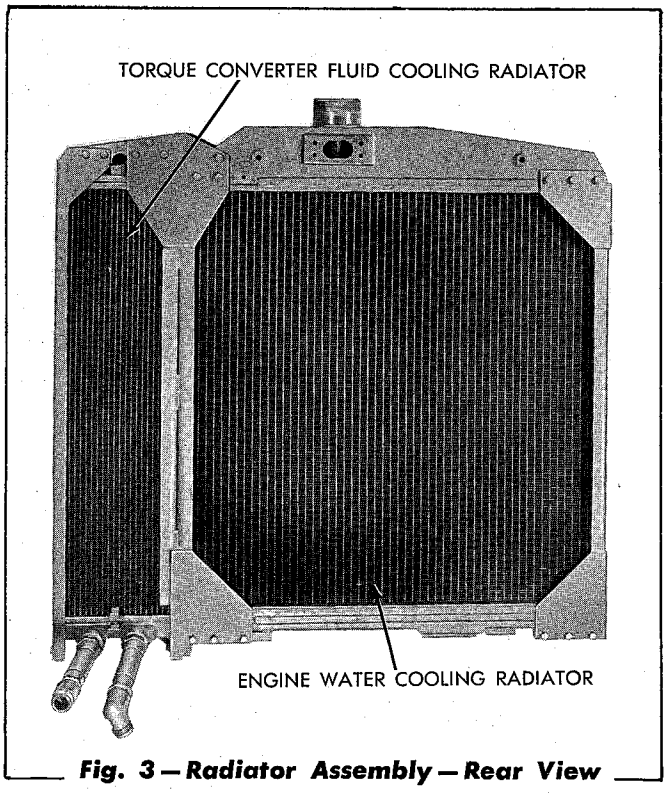


Fig. 3 — Radiator Assembly — Rear View

2. Remove the left front fender, the air precleaners, and the engine hood. Open the radiator grille.

3. Remove the two (2) ⅜" x 1⅛" capscrews and the one (1) ½" x 3¾" capscrew from each of the two (2) radiator upper mountings and remove the mountings from the radiator and shell assembly. Remove the support ring from the top of the radiator shell assembly. *NOTE: Tractors prior to Serial Number 3847 were not equipped with this ring.*

4. Remove the upper inlet and lower outlet elbow from the radiator assembly.

5. Remove the five (5) ⅜" x 2¾" capscrews from the five (5) radiator bottom mountings on the left side of the two (2) similar capscrews from the mountings on the right side.

6. Remove the upper and lower headlight wiring harness clips from the side of the radiator core.

7. Disconnect the upper hose line from the fuel return tube assembly, at the upper left section of the torque converter cooling radiator, and remove the two elbows from the radiator.

8. Disconnect the two torque converter radiator hoses from the metal tube assemblies and remove the 90° elbow from the hose nearest the center of the engine. *NOTE: This is necessary to provide clearance for removal of the radiator and radiator hose assemblies from the radiator shell.*

9. Using a suitable hook through the radiator filler neck, raise the radiator assembly sufficiently to free the snubbers in the lower mounting from the bottom of the radiator, and remove the radiator from the shell. *NOTE: When the radiator is moved from its mounted position in the shell, the spacing tubes used on the center bolts of the top radiator mounts will fall from position. Replace them in the mounts before the radiator is reinstalled.*

C. Inspection and Repair

Clean the air passages in the core and test the core for clogging and leaks. Clean the core if clogging is evident and repair any leaks by soldering. Straighten any bent cooling fins.

D. Installation of Radiator

1. Place the radiator core in position in the shell and start the two (2) top mounting center capscrews into the threads of the radiator core assembly, using a lockwasher next to the head of each bolt. Be sure that the spacing tubes are in position between the front of the top mounting assemblies and the rear *of the threaded boss of the radiator assembly. NOTE: Do not tighten the capscrews at this stage of installation.*

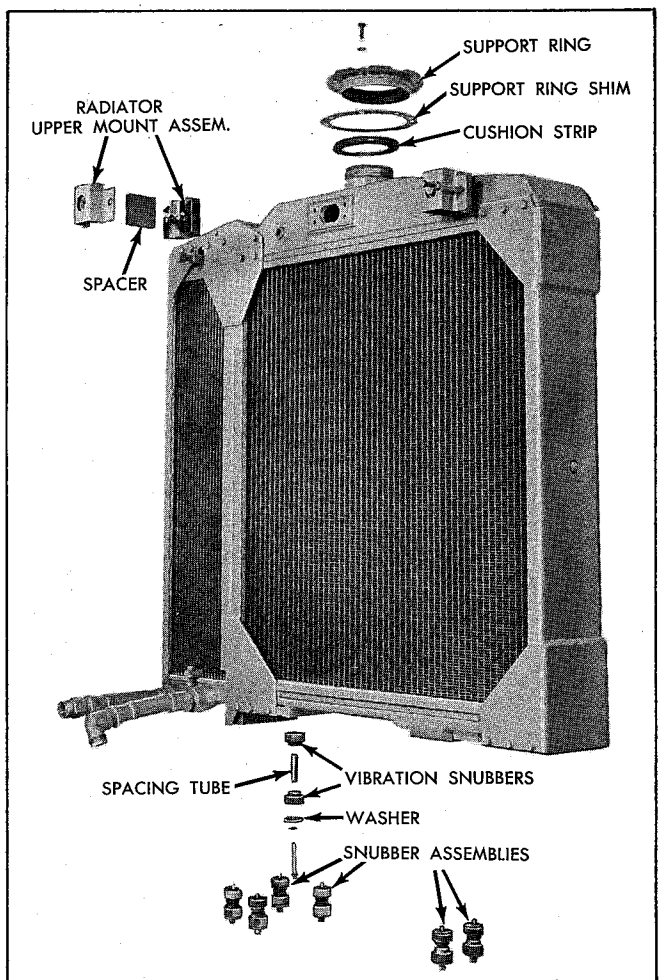


Fig. 4—Radiator Mounting Details

2. Raise the radiator assembly as high as possible without imposing excessive strain on the two (2) top mounting center bolts.

3. Place a lock washer, snubber washer, vibration snubber, and a spacing tube on each of the seven (7) bottom mounting capscrews. The bottom vibration snubber is to be installed on the capscrew with the large diameter of the snubber facing the head of the capscrew.

4. Insert one of these assemblies into the right rear mounting hole on the bottom of the radiator shell assembly, pull the capscrew down until the end of the capscrew is even with the top of the vibration snubber centered on the capscrew, then install another vibration snubber in the top of the snubber mounting hole with the large diameter of the snubber facing the radiator core.

5. Push the capscrew through the upper snubber, align the capscrew with threads in the tapped block, and screw it into the tapped block approximately four (4) threads.

6. Following the procedure as outlined in 4 and 5 above, insert a snubber assembly in the rear mounting hole on the left side of the radiator shell.

7. Install the remaining five (5) snubber assemblies in the other mounting holes at random. Tighten the capscrews until the rubber parts of the vibration snubbers are compressed to the point where the spacing tubes bottom and prevent further compression.

8. Tighten the centerbolts in the top mountings until the spacer tubes bottom and prevent further tightening.

9. Install the support ring to the top of the radiator shell on tractors having Serial Numbers 3847 and above.

10. Install the upper (inlet) and lower (outlet) radiator hose connections to the radiator, using new gaskets if necessary.

11. Install the 90° elbow on the hose nearest the engine then connect both torque converter radiator hoses to the metal tube assemblies.

12. Install and connect the fuel return filter assembly, with the fuel return tube attached, in position on the left side of the torque converter radiator.

13. Bolt the upper and lower headlight wiring harness clips to the side of the radiator core. Close and fasten the radiator grille.

14. Close the drain cocks and fill the cooling system as outlined in this section.

15. Start the engine and operate it at approximately one-half throttle (with engine clutch disengaged) until the torque converter radiator is filled, which will be indicated when the fuel pressure gage registers 30 to 55 pounds.

6. RADIATOR SHELL

A. Description

The radiator shell assembly is a heavy steel weldment consisting of a shell and fan shroud. Brackets and tapped blocks are incorporated in the design of the shell for attaching a radiator screen. A heavy, bar type, hinged grille is attached to the front of the shell for protection of the radiator.

B. Removal of Shell

NOTE: The radiator shell assembly may be removed from the tractor without removing the radiator core from the shell, or it may be removed after the core has been removed. The following instructions pertain to the removal of the shell and core as a unit. Removal of the radiator shell assembly with the radiator core removed from shell is identical with the exceptions of operations 1, 2, and 8 which will be eliminated from the procedure.

1. Drain the cooling system as outlined in this section.

2. Remove the air pre-cleaners and the engine hood.

3. Remove the hex nuts from the front ends of the bracing rods used in bracing the cowl and the radiator shell.

4. Disconnect the head light wiring harness at the fuse plug, located at the right rear of the radiator shell, and remove the clip from the top of the left shell mounting pad.

5. Remove the capscrews attaching each front fender to the radiator shell and frame, then remove the fenders.

6. Remove the ¾" x 2" capscrews from the rear of each radiator shell bracing rod. It is not necessary to remove the bracing rod from the shell assembly.

7. Remove the mounting bolts used to attach the bottom of the radiator shell to the main frame.

8. Remove the four (4) capscrews which attach the radiator inlet to the top of the radiator, and the four (4) capscrews which attach the radiator outlet elbow to the bottom of the radiator.

9. Disconnect the torque converter inlet and outlet hoses from the metal tube assemblies and disconnect the fuel return tube assembly at the left side of the radiator.

10. Remove the four (4) ⅜" x 1" capscrews attaching the fan guard to the radiator shell and allow the guard to rest on the fan pulley.

11. Using a suitable rope sling or chain, raise the core and shell assembly to remove its weight from the main frame, then move the assembly forward being careful not to strike the fan with the shroud part of the shell assembly.

C. Installation of Shell

1. Place the radiator and shell assembly in position on the main frame and secure the mounting pads to the main frame with ¾" x 2¾" capscrews and flat washers. Install the capscrews used to secure the radiator shell bracing rods to the main frame and tighten the capscrews securely.

2. Attach the front fenders to the radiator shell and to the main frame, using flat washers and lockwashers under the capscrew heads attaching the fenders to the main frame, and flat washers, lockwashers, and hex nuts, in the order named to attach the front fenders to the radiator shell and to the rear fender assembly.

3. Place a new gasket on the radiator inlet and secure the radiator inlet to the top of the radiator with four (4) capscrews and lockwashers. Place a new gasket on the radiator outlet elbow and secure the outlet elbow to the bottom of the radiator with four (4) capscrews and lockwashers.

4. Connect the torque converter hoses and the fuel return line.

5. Attach the headlight wiring harness clip to the shell mounting pad, insert the fuse in the fuse plug, and connect the two halves of the fuse plug.

6. Install the bracing rod nuts, engine hood, and air pre-cleaners.

7. Fill the radiator with coolant (refer to "FILLING AND DRAINING OF SYSTEM" in this section).

8. Start the engine and operate it at approximately one-half throttle (with engine clutch disengaged) until the torque converter radiator is filled, which will be indicated when the fuel pressure gage indicates 30 to 55 pounds.

7. WATER PUMP

A. Description

A centrifugal type water pump is used for circulating the coolant through the engine and the radiator. A bronze impeller is pressed on, and pinned to, one end of the steel pump shaft, and a pump drive gear, keyed in position, is bolted to the other end of the shaft. The shaft is supported at the drive end by a sealed single row combination radial and thrust ball bearing secured in position in the pump housing with a retaining ring. A single row sealed bearing is used to support the center of the shaft.

Water is prevented from creeping along the shaft at the impeller end, by means of a spring loaded rubber seal, retained in the impeller by a steel stamping.

NOTE: The water pumps used on HD20 Tractors have had three different sealing arrangements. It is suggested, when overhauling a pump, that the latest type seal be used as outlined in "WATER PUMP ASSEMBLY."

B. Water Pump Lubrication

The water pump ball bearings are of the "shielded" type and were filled with lubricant when assembled, therefore, no further lubrication is necessary.

C. Service

The construction of the water pump is conducive to long life with minimum attention, provided that only clean water is used in the cooling system and care is taken to keep dirt and abrasive material from being circulated through the cooling system. Water containing alkali is very harmful to the water pump as it causes corrosion of the water pump seal.

D. Removal of Water Pump

1. Drain the cooling system as outlined in this section.

2. Remove the left front fender, then remove the oil cup from the bottom of the front air cleaner.

3. Remove the water pump vent tube from the top of the pump housing and the water by-pass tube.

4. Remove the four (4) hex nuts and lockwashers attaching the water inlet elbow to the pump body elbow. Loosen one of the large hose clamps on the water inlet elbow and the two small hose clamps used between the water by-pass tube elbow and the water by-pass tube. Loosen the lower hose clamp used between the water by-pass adapter assembly and the by-pass tube. Turn the tube and the water inlet elbow to provide clearance for the removal of the water pump.

5. Remove the six (6) hex nuts and lockwashers attaching the water pump to the cylinder

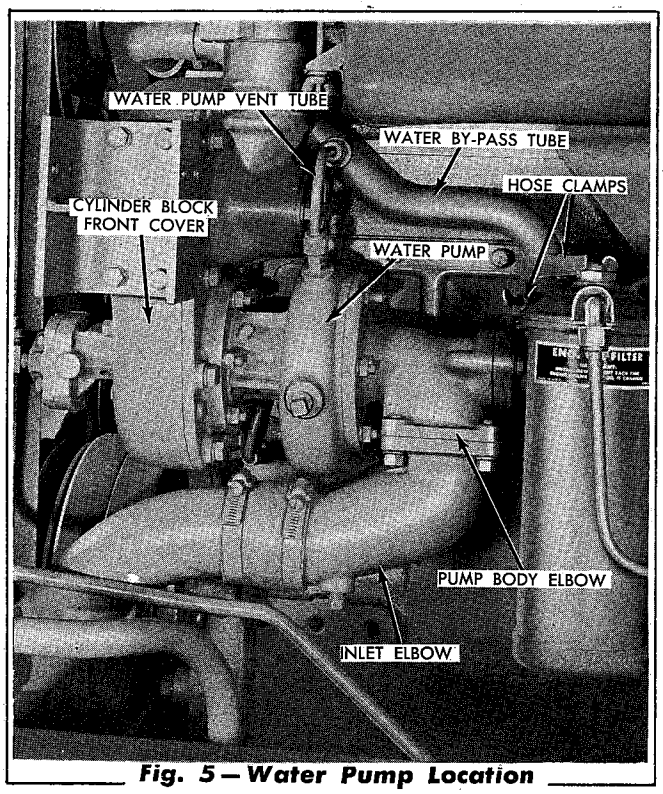


Fig. 5 — Water Pump Location

block front cover and remove the water pump from the cover.

E. Water Pump Disassembly

1. Remove the six (6) hex nuts and lockwashers attaching the pump body elbow to the pump body and remove the elbow and gasket from the body.

2. Using a small punch, drive the ⅛" x 1" pin out of the shaft and impeller assembly.

3. Remove the pump shaft gear retaining bolt, lockwasher, coupling disc, and the pump shaft gear from the pump shaft. Remove the retaining ring used in retaining the front bearing in the pump body assembly.

4. Place the pump in an arbor press, as shown in Fig. 6, and press the shaft out of the impeller. The shaft, both bearings, and the spacer will be removed from the pump housing as an assembly in this operation. If replacement of the carbon sealing washer or the pump body steel insert washer is the only repair necessary, no further disassembly of the pump need be made as all seal parts may now be removed.

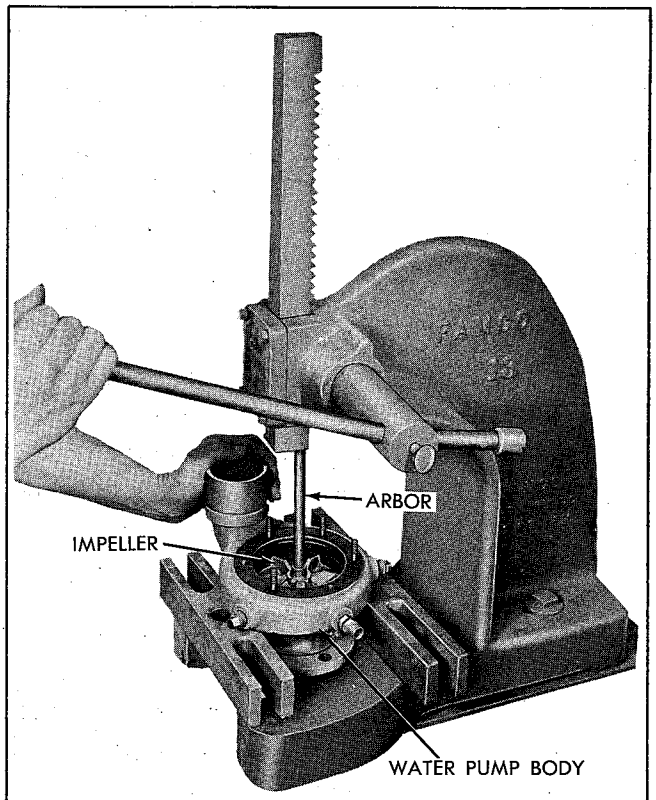


Fig. 6 — Pressing Water Pump Shaft from Impeller

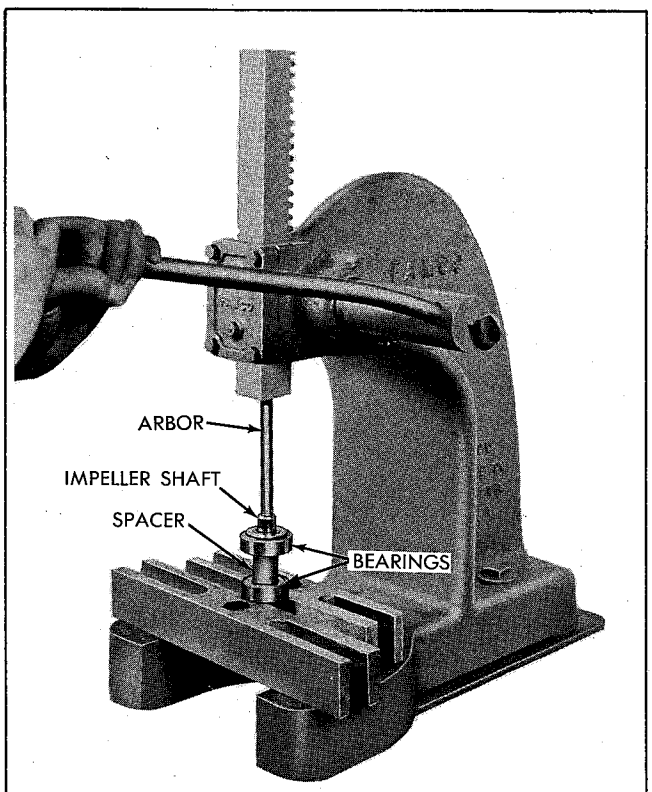


Fig. 7 — Removing Bearings from Impeller Shaft

5. If further disassembly of the impeller shaft is necessary, the bearings may be removed

from the impeller shaft as shown in Fig. 7.

F. Inspection and Repair

Repair of the water pump will consist of the replacement of any parts that are worn. If the carbon seal washer or the steel insert washer (in the pump body) are scored or rough, they must be replaced as follows:

1. Turn the pump body so that the rear side of the pump housing is down, insert a ⅞" diameter shaft against the steel insert washer, and drive the insert washer from the pump housing.

2. Discard the complete seal assembly and inspect the four (4) impeller slots for wear at the points of contact with the lugs of the old carbon seal. If the wear in the impeller slots does not exceed 1/16", the worn areas may be filed smooth, removing the same amount of material from each impeller slot. If the slots are worn more than 1/16", the impeller must be replaced.

3. When re-conditioning a pump used on tractors having engine serial numbers prior to 6B-2985, several modifications must be made to the impellers as follows:

   a. The four (4) seal drive slots in the impeller must be tapered as shown in Fig. 8. This will prevent the metal seal washer from "hanging-up" in the seal drive slots, as the seal lugs form notches in the seal drive slots due to wear. Tapering the slots permits the carbon seal washer to remain pressed against the insert washer at all times.

   b. Drill four (4) ¼" diameter holes in the impeller as shown in Fig. 9. These holes allow the coolant to circulate around the seal assembly, thus providing better cooling and lubrication for the seal. It also provides for a flushing action to wash away sludge or foreign material which may tend to collect near the rear of the pump housing.

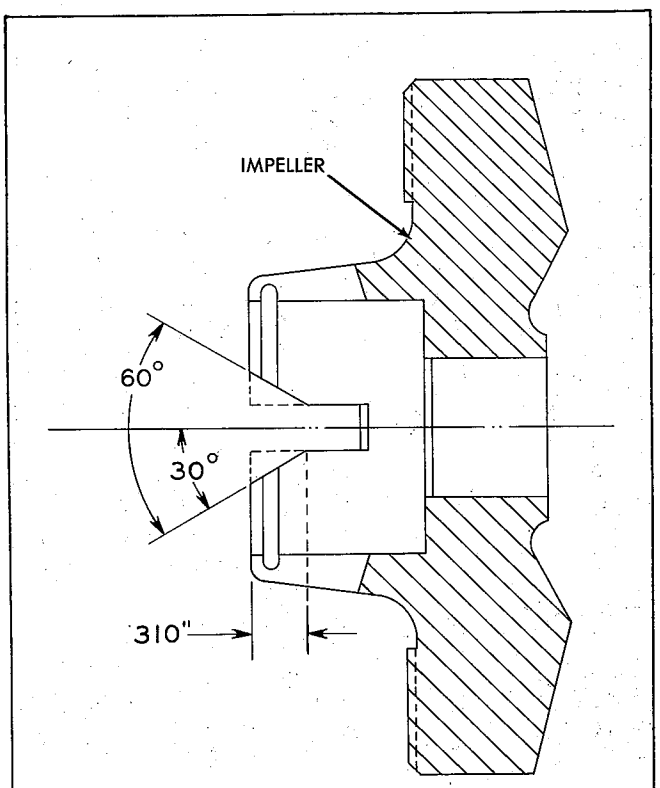


Fig. 8 — Impeller Drive Slots Reworked

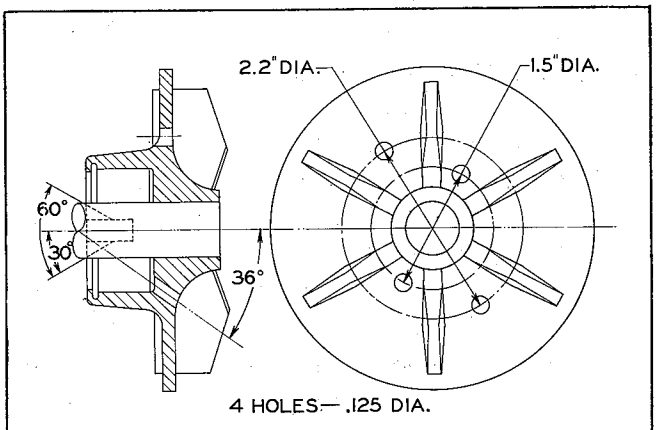


Fig. 9 — Location of Holes in Impeller

4. Inspect the water pump shaft and remove all rust and scale. This is necessary as the shaft acts as a pilot for the new carbon seal washer.

G. Water Pump Assembly

Before starting to assemble the pump study Fig. 10, which shows the relative location of all parts of the pump, then assemble as follows:

1. Install a new type insert washer in the water pump housing, using an arbor press. Use

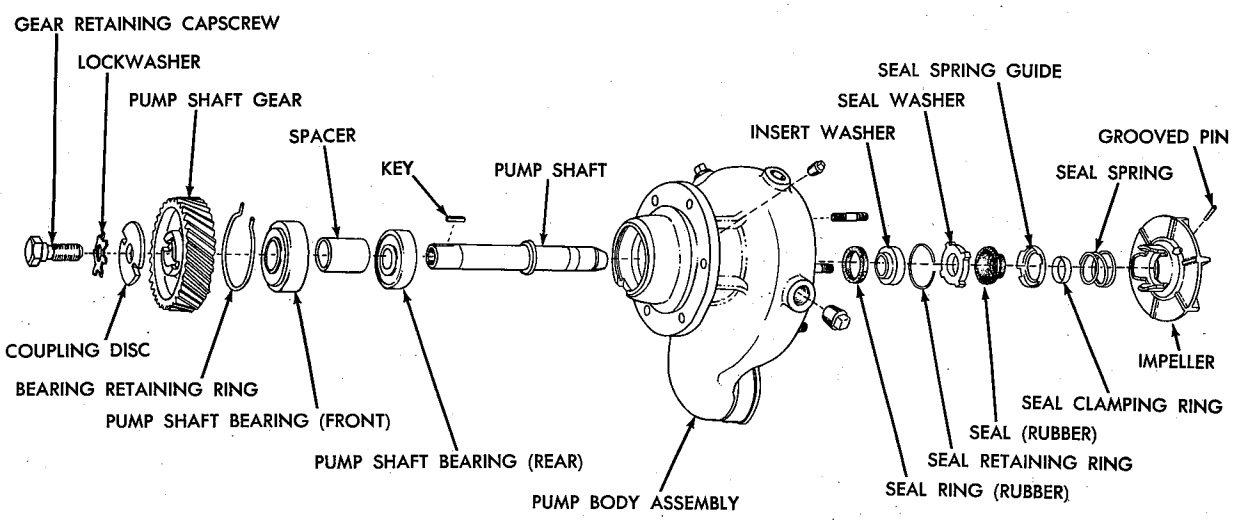


Fig. 10 — Water Pump Details

care to avoid damaging the sealing face of the insert washer.

2. If the ball bearings were removed from the pump shaft, install the bearings and spacer on the shaft, then install the shaft and bearings into the bore of the pump housing by pressing on the inner race of the outer bearing. Install the bearing retaining ring.

3. Assemble the seal spring, seal clamping ring, seal spring guide, seal, and seal washer in the impeller hub and secure in position with the seal retaining ring. Check the action of the seal assembly in the impeller hub, by pressing in on the seal washer with the thumbs. The seal assembly should compress approximately ⅛" and when released, must return freely to its position against the seal retaining ring.

4. Start the impeller and seal assembly on to the shaft so that the pin hole in the shaft is midway between two adjacent blades of the impeller. Support the drive gear end of the pump shaft on the bed of an arbor press, using a sleeve or tube with a bore of 13/16" placed over the small hub of the impeller, press the impeller on to the shaft so that the distance from the hub face of the impeller to the face of the pump housing is .654" to .658."

5. Insert a .125" drill in the pin hole of the shaft and drill through the hub of the impeller. Install the ⅛" x 1" pin in the hole until it protrudes through the impeller hub.

6. Install the pump shaft gear key in the shaft, align the slot in the gear with the key, and press the gear onto the shaft. *NOTE: Support the other end of the shaft when performing this operation; do not use the bell of the pump housing as a support.*

7. Install the coupling disc, lockwasher, and retaining capscrew on the pump shaft. Tighten the retaining capscrew to 50-60 ft. lbs. torque and lock in position with the lockwasher.

8. Place a new pump housing elbow gasket on the studs of the pump housing then install the pump body elbow on the studs, so that the opening in the elbow will point down when the pump is installed. Secure the elbow to the pump with nuts and lockwashers.

9. Rotate the pump by hand to check for clearance of the impeller in the pump housing.

10. Remove the ⅛" NPT pipe plug at the location between the two pump shaft bearings, from the pump body. Install a lubricating fitting in the pipe plug hole and fill the bear-

ing cavity with high temperature ball and roller bearing grease. *CAUTION: Do not force grease out of seals at ends of shaft.* Remove the lubricating fitting and reinstall the ⅛" pipe plug.

H. Installation of Pump

1. Install the pump assembly in the opening of the cylinder block front cover, using a new attaching gasket between the pump assembly and the cover. Rotate the pump to mesh the pump drive gear with the pump driving gear.

2. Secure the pump to the cylinder block front cover with hex nuts and lockwashers, then turn the water inlet elbow to align with the pump body elbow and attach the two elbows with the hose. Tighten the hose clamp securely.

3. Turn the water by-pass tube to align with the by-pass tube elbow and connect with the hose. Tighten the connecting hose clamps securely.

4. Install the water pump vent tube to the top of the pump housing and to the water by-pass tube.

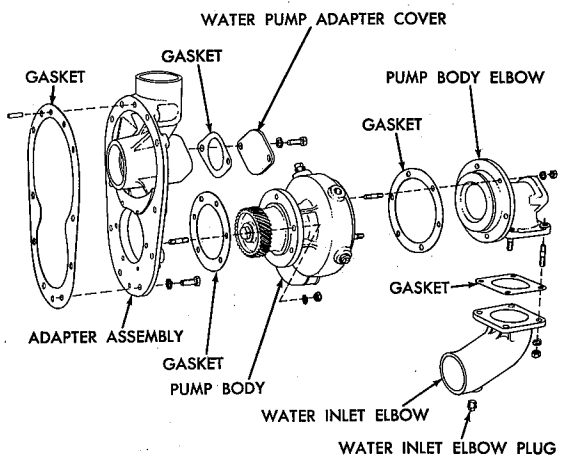


Fig. 11 — Water Pump and Connecting Parts

5. Install the air cleaner oil cup in position on the bottom of the front air cleaner and install the left front fender.

6. Fill the cooling system as outlined in this section.

8. WATER MANIFOLD AND THERMOSTATS

A. Description

Coolant leaving the cylinder head through the openings directly over each exhaust port, enters the water manifold attached to the cylinder head. A gradually increasing area in the manifold from the rear end terminates in a flange at the front of the manifold where the thermostat housing is attached.

Unrestricted water flow through the circulating system is accomplished by the use of two thermostats, positioned so that, when the thermostats are closed, the flow of water from the engine water manifold to the radiator inlet (upper hose) is shut off. The flow of water is then directed from the manifold to the water by-pass tube and then back to the inlet side of the water pump.

Before the thermostats start to open (below water temperature of approximately 165° F.), the water circulates through the engine circulating system only. When the thermostats open (fully opened at approximately 185° F.), the water circulates through the radiator and the entire circulating system.

B. Service

Replacement of the thermostats will be necessary when the thermostats become corroded and stick in the open or closed position, or when the thermostats become inoperative for any other reason.

C. Thermostat Replacement

1. Drain the cooling system as outlined in this section.

2. Disconnect the radiator inlet hose from the water outlet elbow on front of water manifold.

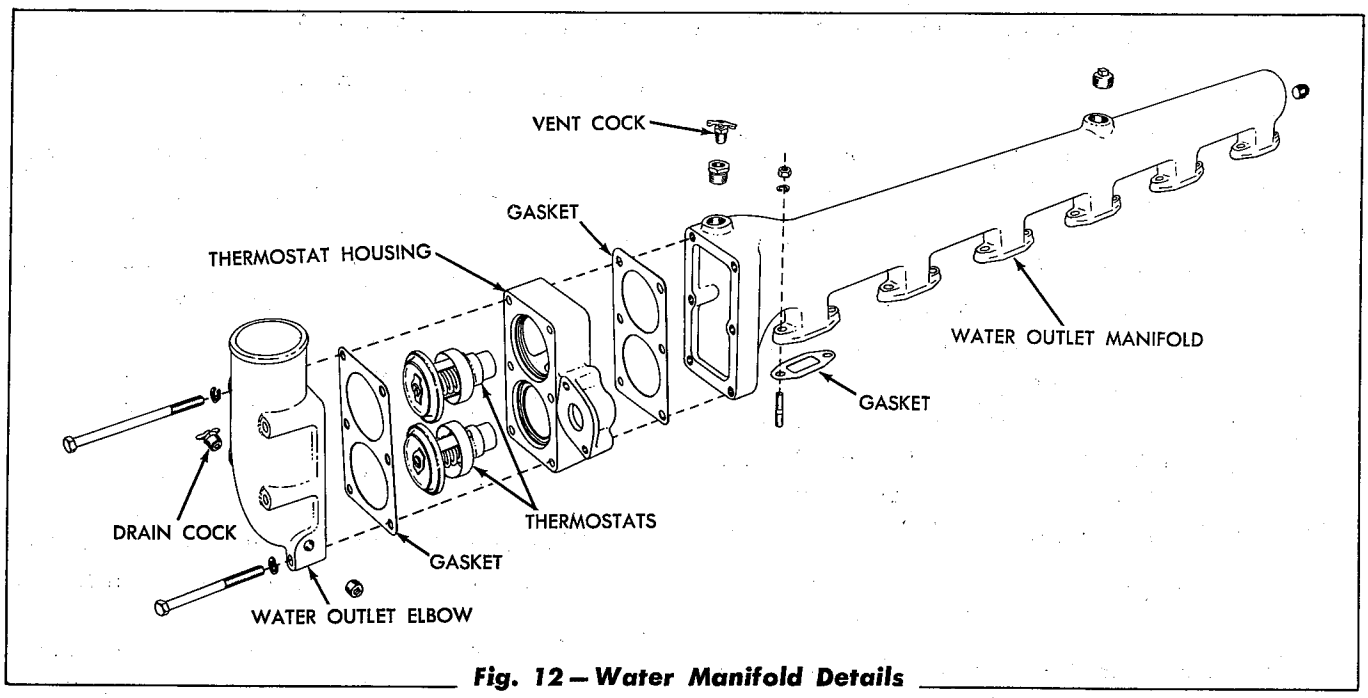


Fig. 12 — Water Manifold Details

3. Remove the six (6) capscrews attaching the elbow to the front of the water manifold, then remove the elbow, gasket, thermostat housing, and the thermostats.

4. Clean the thermostat seats in the elbow. Examine the gaskets, used between the elbow and the housing and between the water manifold and the housing, and replace if necessary.

5. Using gasket cement or sealing compound, cement the gaskets in place. Place the thermostats in position in the thermostat housing (large end facing forward), then install the elbow. Install the attaching capscrews and tighten securely.

6. Coat the inside of the elbow connecting hose with sealing compound and connect it to the elbow.

7. Fill the engine cooling system with coolant as outlined in this section.

D. Water Manifold Replacement

1. Drain the cooling system as outlined in this section.

2. Remove the engine air pre-cleaners, engine hood, and the exhaust muffler.

3. Remove the thermo gage tube from the rear of the water manifold. Remove the six (6) capscrews attaching the outlet elbow to the front of the manifold.

4. Remove the nuts and lockwashers attaching the manifold to the cylinder head and remove the manifold. Remove the manifold-to-cylinder head gaskets. Clean all traces of the old gaskets from the cylinder head and the manifold.

5. Using gasket cement or sealing compound, cement a new gasket in position around each opening in the cylinder head and place the manifold over the attaching studs. Install the lockwashers and nuts on the studs and tighten the nuts evenly, starting at the center of the manifold and working towards each end.

6. Install the outlet elbow and thermostats as described in "THERMOSTAT REPLACEMENT" in this section.

7. Install the thermo gage tube in the rear of the manifold. Install the exhaust muffler using new gaskets. Install the engine hood and the engine air pre-cleaners.

8. Fill the engine cooling system with coolant as outlined in this section.

9. FAN, FAN BELTS, AND FAN BELT ADJUSTMENT

A. Description

The fan circulates air through the engine cooling radiator and helps to cool the engine coolant as it flows from the top to the bottom of the radiator core. The fan assembly is mounted on a bracket which is bolted to the engine camshaft gear cover. The fan is bolted to the fan pulley, which rotates on two ball bearings and is driven by two (2) V-belts from a pulley on the front end of the engine crankshaft. A generator mounting bracket, bolted to the right side of the engine block is provided as a means for adjusting the fan belts.

B. Lubrication

The fan bearings and the generator drive bearings must be lubricated after each 200-hours of operation. A lubricating fitting is provided on top of the fan mounting bracket and on top of the generator drive housing for lubricating the bearings. Use only a hand operating type grease gun when lubricating, to prevent damage to the oil seals from too much pressure.

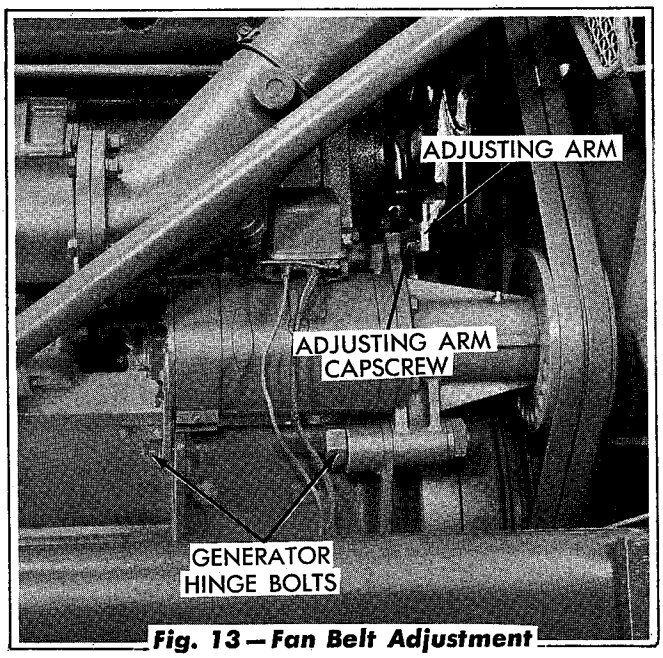


Fig. 13—Fan Belt Adjustment

C. Fan Belt Adjustment

The belts are properly adjusted when the straight (left) side of the belts can be pressed inward approximately 1¼ inches at a point half-way between the crankshaft and the fan pulleys.

To Adjust the Fan Belts

1. Loosen the two generator hinge bolts and the adjusting arm capscrew.
2. Move the generator in or out until the correct tension of the belts is obtained.
3. Tighten the capscrew in the adjusting arm and the two generator hinge bolts.

D. Removal of Fan

1. Remove the engine pre-cleaners, engine hood, fan guard, and the right front fender.
2. Drain only enough of the engine coolant from the system so that the radiator inlet may be disconnected and removed, then disconnect and remove the radiator inlet from the radiator.
3. Loosen the tension on the fan belts, remove the three (3) capscrews attaching the fan mounting bracket to the engine camshaft gear cover, and remove the two (2) fan belts from the fan pulley. Remove the fan assembly from the engine.

E. Disassembly of Fan

1. Remove the capscrews attaching the fan to the pulley hub and remove the fan and the fan spacer.
2. Remove the nut and the fan mounting washer from the rear end of the fan spindle (shaft), then using a suitable puller, remove the fan mounting bracket from the spindle. Remove the "WOODRUFF" key from the shaft.
3. Remove the snap ring from the fan pulley and turn the seal washer retainer out of the fan pulley. Remove the seal washer, retaining washer, and retaining washer gasket.
4. Install the nut back on the rear end of the fan spindle (shaft), place the assembly in a vise by clamping the nut, then drive the pulley off the fan spindle assembly.

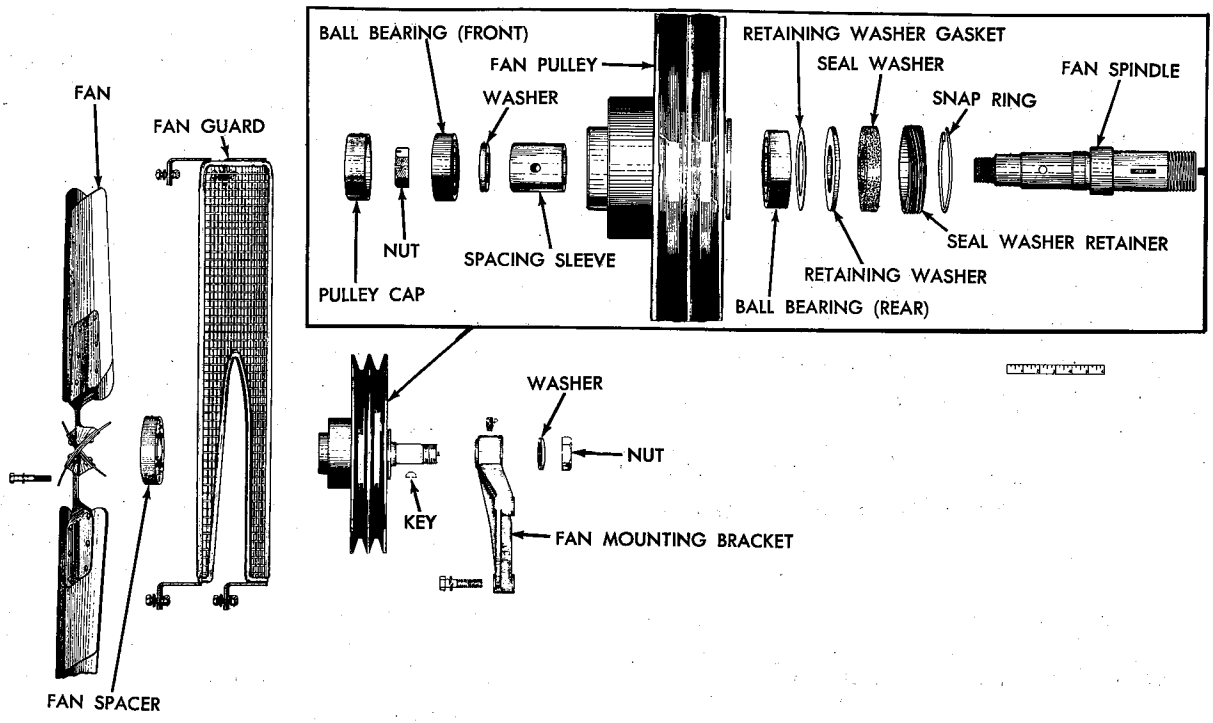


Fig. 14—Fan Details

5. Remove the fan spindle nut from the front end of the spindle, place the spindle assembly in a press, and press the shaft out of the bearings.

F. Inspection of Fan Parts

Wash all the parts in clean solvent or fuel and inspect them for wear or damage. Lubricate the bearings with engine oil and rotate them by hand to check them for binding or roughness. Replace them if they do not roll easily or if they have tight spots. The bearings must fit snugly in the pulley hub and on the fan spindle. Replace the spindle if it is bent or worn, or if the threads are damaged beyond repair. Discard the seal washer (cork seal) in the retainer and install a new one when assembling. Replace the fan belts if they are frayed. Make certain that the pulley grooves are smooth.

G. Assembly of Fan

Refer to Fig. 14 which shows the relative location of the fan parts.

1. Press the rear ball bearing into position on the fan spindle. Place the bearing spacing sleeve and the bearing spacing washer in position on the spindle and line up the lubricating hole in the spacing sleeve with the hole in the spindle. Press the front ball bearing into position on the spindle, making certain that it is pressed on tight against the spacing washer. Install the fan spindle nut on the front end of the spindle and tighten it securely.

2. Start the spindle assembly into the back bore of the pulley, then press or drive it into position.

3. Place the rear bearing retaining washer gasket and the retaining washer in position on the spindle and install a new seal washer (cork seal) in the seal washer retainer. Before installing the seal washer retainer in the fan pulley, it is necessary to mark the location of the hole (in the retainer) for the locking prong of the snap ring, as the hole is not visible when the retainer is installed. Install the retainer and tighten it snugly by using a punch and hammer, but do not overtighten as the seal washer (cork seal) might be damaged. Install the snap ring around the hub of the pulley with the prong of the snap ring inserted through the hole in the hub and into the hole in the retainer.

4. Install the pulley cap in the front end of the pulley hub if it was removed. Install the "WOODRUFF" key in the rear end of the spindle, then press the fan mounting bracket into place on the spindle. Install the fan mounting washer and nut. Tighten the nut securely.

5. Install the grease fitting in the top of the fan mounting bracket if it was removed. Fill the bearing compartment of the pulley with lubricant through this fitting.

6. Place the fan spacer and the fan in position on the pulley and install the attaching capscrews.

H. Installation of Fan

1. Hold the fan assembly in position on the engine, then place the fan belts and the generator driving belt in the grooves of the fan pulley. Install the three (3) capscrews and lockwashers used to attach the fan mounting bracket to the engine camshaft gear cover and tighten the capscrews securely.

2. Adjust the fan belts as outlined in this section.

3. Coat the inside of the radiator inlet connection hose with sealing compound, then install the radiator inlet. Tighten the hose clamps securely.

4. Install the right front fender, fan guard, engine hood, and the engine air pre-cleaners.

5. Fill the engine cooling system with coolant as outlined in this section.

SECTION V—ENGINE LUBRICATING SYSTEM

1. DESCRIPTION OF SYSTEM

The engine lubrication system, shown schematically, consists of a gear driven oil pump, an oil cooler, oil filters, a by-pass valve and a pressure regulator valve.

The pump draws oil from the oil pan and delivers it to the oil cooler. From the cooler, the oil enters the longitudinal oil gallery in the cylinder block where the oil supply divides, part of it going to the camshaft end bearings and part to the main bearings and the connecting rod bearings—via the hollow crankshaft. Oil for the lubrication of the connecting rod bearings, piston pins and bushings and for the cooling of the piston heads is provided through the drilled crankshaft. The oil for the lubrication of the piston pin bushings and for cooling the under side of the piston heads is conducted through the drilled passages in each connecting rod.

An external oil line, leading from the oil gallery at the left front side of the cylinder block to a two (2) way elbow in the front rocker shaft bracket, and the addition of an oil jumper tube connecting to an elbow in the rear rocker shaft bracket provides increased lubrication to the entire valve actuating mechanism, including the cam followers.

The idler gear roller bearing in the rear timing gear train and the blower drive support shaft and bushing are lubricated by external oil lines, these

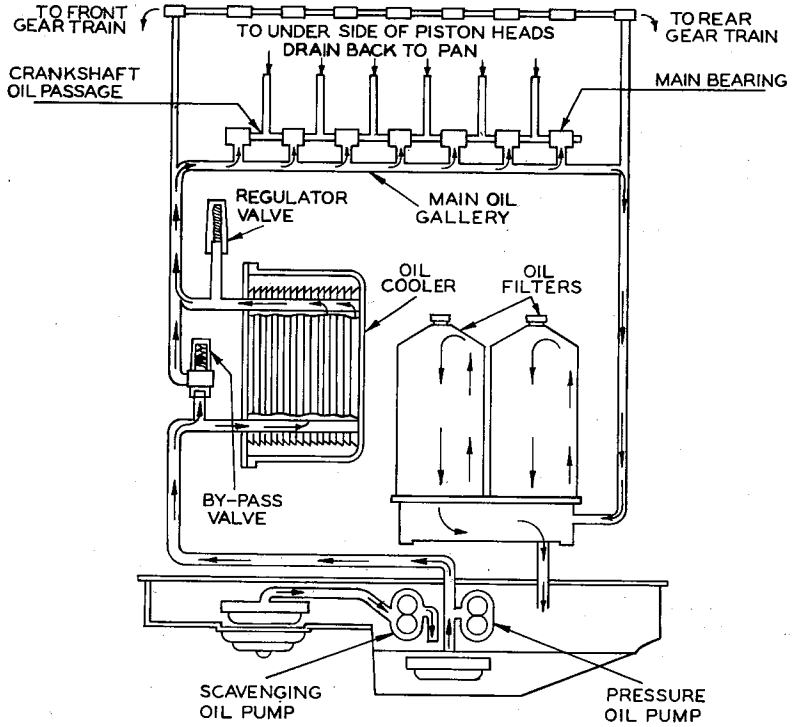


Fig. 1 — Schematic Lubrication Oil Diagram

lines connect to an oil gallery at the right rear side of the cylinder block. The front blower bearings are lubricated by an oil line attached to the oil gallery at the right side of the cylinder block near the front. The rear blower bearings are lubricated by oil draining from the blower drive support through the blower drive shaft cover into the blower end cover.

The camshaft end bearings are pressure lubricated through drilled passages in the cylinder block and into a cavity in the center of the camshaft end bearing. A hole leading from the cavity allows oil pressure lubrication to the camshaft end bearings. The oil then flows through the drilled camshaft for pressure lubrication of the camshaft intermediate bearings.

The camshaft end bearings have a slot cut in the raised section of the outer diameter of the bearing cage. Oil, under pressure from the camshaft bearing, is forced through the ¼" milled slot and out along the small grooves of each intermediate bearing.

The ends of the small grooves act as nozzles, thus spraying lubricating oil on the lobes of the camshaft, creating a splash of oil which provides a better and more efficient method of lubricating the rollers and bushings of the cam follower assemblies.

2. LUBRICATING OIL PUMP

A. Description

The lubricating oil pump consists of two sets of pump gears enclosed in a pump body bolted to the two rear main bearing caps and driven by a gear on the rear end of the crankshaft.

Two drive gears are keyed to a drive shaft, which is supported in the housing on two bronze bearings with a driving gear keyed to the outer end of the shaft. Two driven gears in mesh with the driving gears are bushing mounted on a dead shaft pressed into the pump body.

The oil pump draws the oil supply from the oil pan. The discharge from the pump is into a pressure regulator and relief valve casting. The regulator valve maintains a nominal pressure of 50 psi in the main oil passage. The by-pass valve opens and allows oil to by-pass the oil cooler when the pressure drop through the cooler exceeds 26 psi.

B. Oil Pump Removal

1. Remove the crankcase guard assembly.
2. Drain the oil from the oil pan and remove the upper and lower oil pans from the engine.
3. Remove the two (2) oil screens to the inlet pipes. Remove both inlet pipes from the pump body.
4. Remove the oil pump screen brackets from the main bearing caps and remove the five (5) capscrews used in attaching the pressure regulator casting to the cylinder block. Remove the assembly from the engine.

C. Disassembly of Oil Pump

1. Remove the oil pressure regulator from the oil pump by removing the capscrews attaching the regulator to the oil pipe.
2. Remove the four (4) capscrews attaching the scavenging pump body to the oil pump body and separate the two bodies.
3. Remove the scavenging pump drive gear and driven gear from the pump drive and driven shafts, then remove the "WOODRUFF" keys from the pump drive shaft. Slide the pump body spacer off the shafts.
4. *Remove the oil pump driven gear from the driven shaft. NOTE: If the driven shaft is worn or scored, so that replacement is necessary, press the shaft from the oil pump body at this time. If shaft replacement is not necessary, the shaft need not be removed from the pump body.*
5. Support the oil pump body on a bench vise, and, using a suitable puller, pull the pump driving gear from the drive gear shaft.

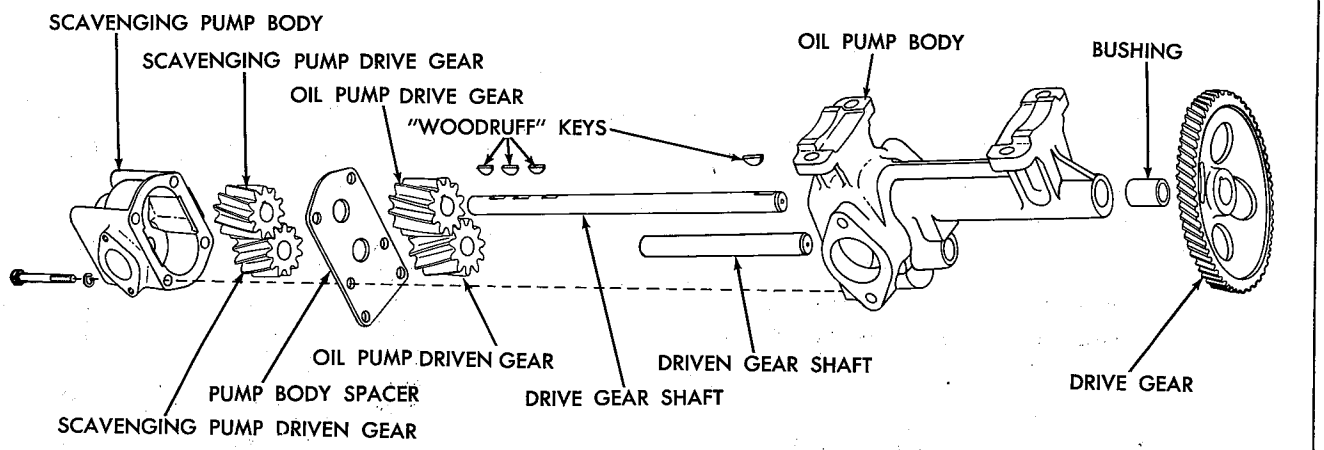


Fig. 2—Oil Pump Details

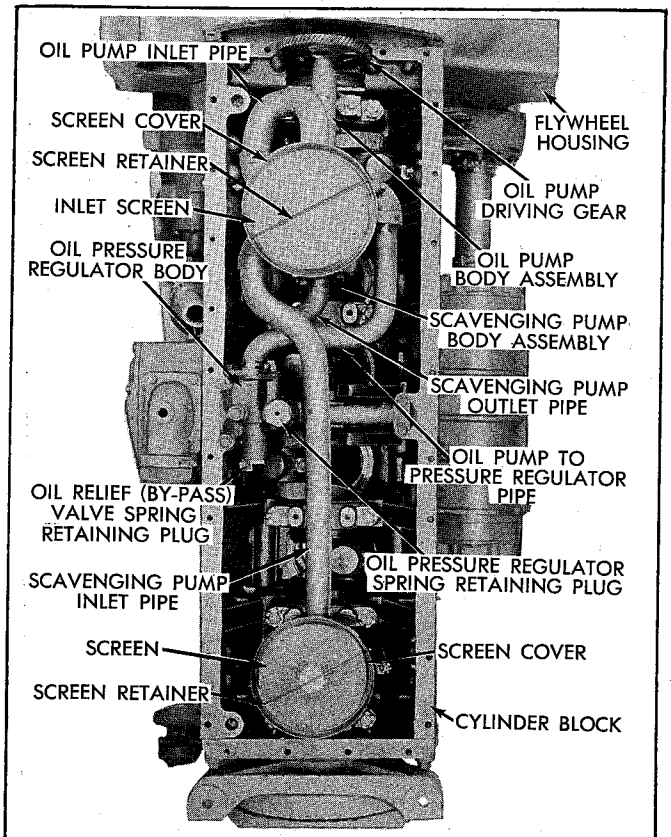


Fig. 3—Lubricating Oil Pump Mounting

6. Remove the "WOODRUFF" key from the driving end of the shaft, then push the drive shaft and gear from the oil pump body.

7. Using a suitable arbor press and arbor, press the drive gear from the drive shaft.

8. Support the pump body in a bench vise and thread the bushing remover (tap) into one of the bushings until sufficient threads are cut in the inside diameter of the bushing to hold the bushing remover in position when pressing on the remover to remove the bushing from the pump housing.

9. Place the pump housing in position on an arbor press, and press the bushing from the pump housing. Repeat the above procedure on the other pump housing bushing.

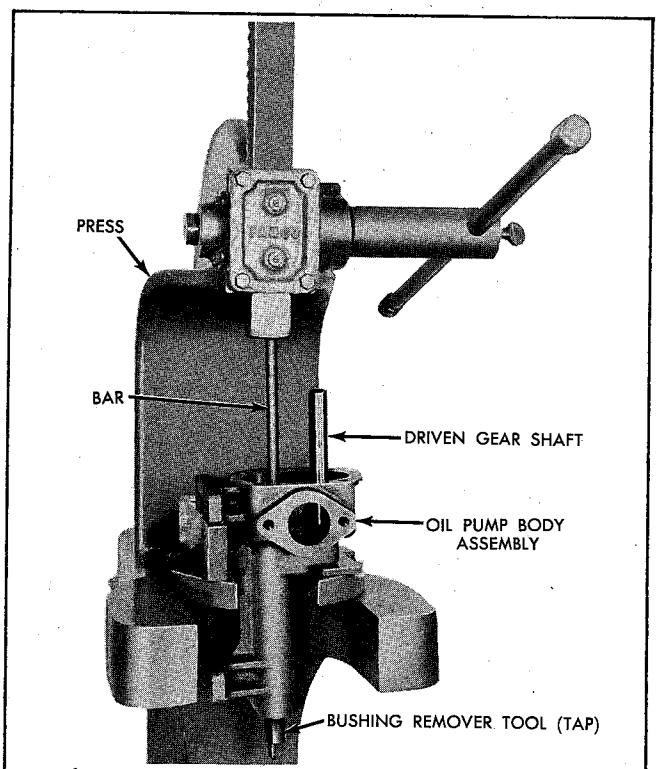


Fig. 4—Removing Oil Pump Body Bushings

D. Cleaning and Inspection of Oil Pump Parts

1. Wash the oil pump parts in clean solvent of

fuel oil and thoroughly inspect them before reassembly of the pump is made.

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

2. Inspect the pump gear teeth and the inside of the pump body for wear and scoring. The gear teeth and the inside of the body must be smooth, having no scratches, score marks, or rough spots. When the gear teeth or the inside of the body are scratched or scored, they must be discarded and replaced with new parts.

   There must be a minimum of .002" radial clearance between the gears and the pump body and an end clearance of .002" between the gears and the pump body. Replace the affected parts when gears are pitted and worn or when wear is apparent on the pump body.

3. Inspect the pump shafts and the bushings in the body and in the driven gears for excessive wear or scoring. Replace if necessary.

E. Assembly of Oil Pump

1. If the bushings were removed from the pump body, install new bushings as follows:

   a. Start a bushing into the bore on the outer end (driving gear end) of the pump body

   b. With the opposite end of the pump body resting on the bed of an arbor press, insert the bushing installing tool in the bushing and press the bushing in the bore so that the driving gear end of the bushing is flush with (or to .015" below) the driving gear end of the pump body.

   c. Press the other bushing in the opposite bore of the pump body in the same manner as in (b) above.

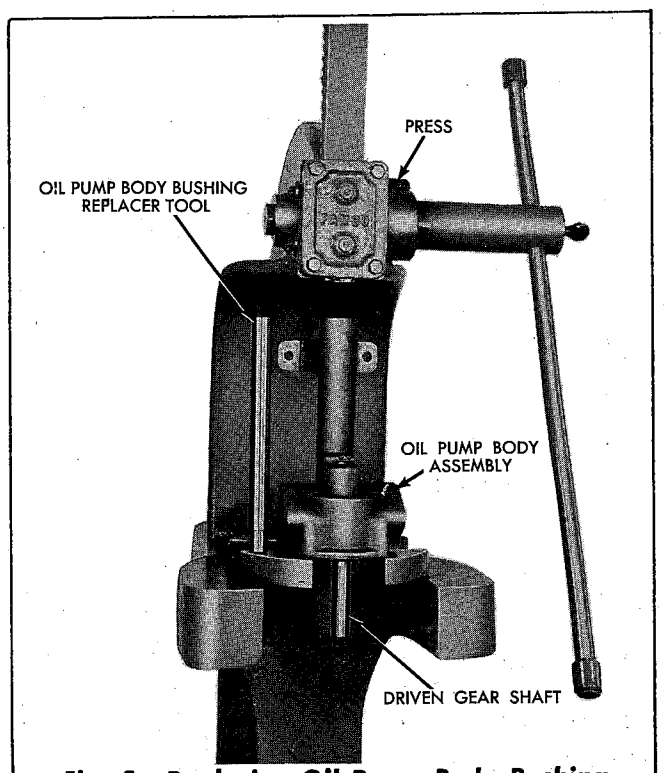


Fig. 5 — Replacing Oil Pump Body Bushing

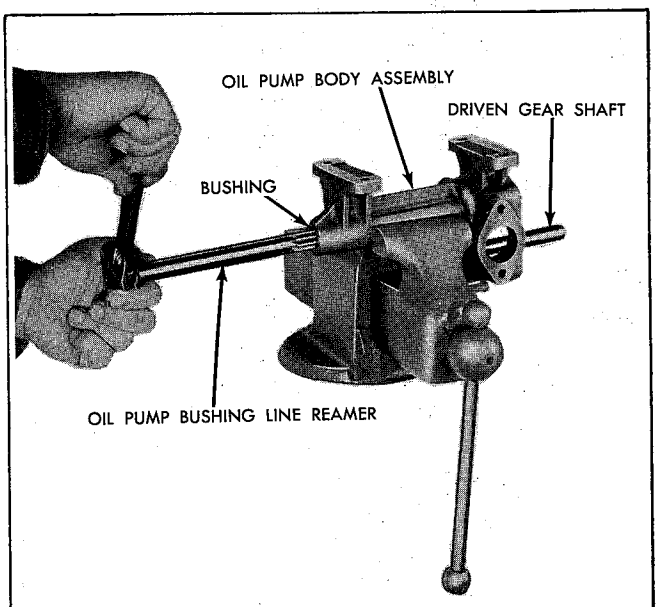


Fig. 6 — Line Reaming Bushings in Oil Pump Body

   d. The bushings in the scavenger pump body are not serviced separately and when worn, the entire body assembly must be replaced.

2. Support the pump housing in a bench vise and line ream the bushings with the special line reamer as shown in Fig. 6.

3. Lubricate the oil pump driven shaft (short

shaft) and start it into the bore of the oil pump body if it was removed for replacement.

4. Press the driven shaft into the bore so that the end of the shaft extends 5.160" from the finished surface of the pump gear cavity.

   An easy way to obtain the proper stand-out of the shaft is to machine a piece of tubing having an I.D. of ¾" to a length of 5.160." Place the tubing over the shaft and against the finished surface inside the pump housing then press the shaft into the housing until the ram of the press contacts the tubing.

5. Install a "WOODRUFF" key in the inner of the three (3) keyways of the pump drive shaft, lubricate the end of the shaft and start the oil pump drive gear on the drive shaft, aligning the key in the shaft with the keyway in the gear. Press the shaft into the gear until the end of the shaft having the single keyway stands out 7.880" from the face of the oil pump drive gear. Use a spacer made of tubing to obtain the correct stand out of 7.880" as shown in Fig. 7.

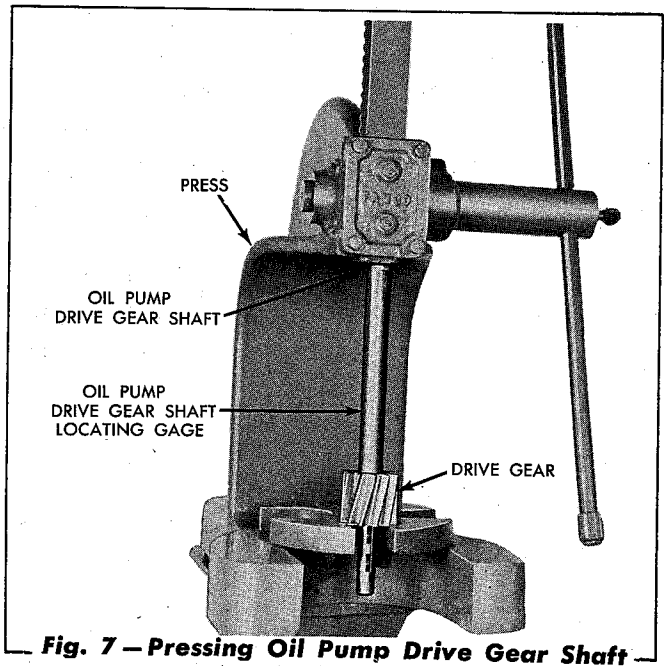


Fig. 7 — Pressing Oil Pump Drive Gear Shaft Into Drive Gear

6. Lubricate and insert the drive shaft and gear assembly in place in the pump housing, then lubricate and install the driven gear in place on the driven shaft. Rotate the drive shaft to assure that the drive and driven gears rotate freely.

7. Referring to Fig. 2 for the correct position of parts, place the oil pump spacer over the ends of the drive and driven gear shafts.

8. Insert two (2) "WOODRUFF" keys in the keyways provided in the drive shaft for the scavenging pump drive gear, then tap the scavenging pump drive gear on the shaft (aligning the two (2) keys with the keyway in the gear), until the gear contacts the spacer.

9. Lubricate the bore of the scavenging pump driven gear and place it on the driven shaft. Again rotate the drive shaft to assure that the gears revolve freely.

10. Place the scavenging pump body over the gears and against the oil pump spacer, then secure the scavenging pump body to the oil pump body with four (4) bolts and lockwashers.

11. Install the remaining "WOODRUFF" key in the keyway of the pump drive shaft and lubricate the end of the shaft, then start the oil pump driving gear (large gear) on the shaft with the hub of the gear facing toward the pump body and the keyway of the gear aligned with the key in the shaft.

12. Place a .009" feeler gage between the end of the oil pump body and the driving gear hub and press the gear on the shaft until a slight drag is felt on the feeler gage when the gage is moved for checking gear hub to pump housing clearance. *NOTE: Use a ¾" I.D. hollow sleeve between the gear and the ram of the press when pressing the gear into position on the shaft.*

13. Rotate the driving gear to assure that the pump turns freely without binding.

14. Assemble the oil pressure regulator and inlet pipe to the oil pump body using a new gasket. Draw the attaching bolts finger tight only at this time.

15. Assemble the oil pump inlet pipe, the inlet screen and the mounting brackets, then install them on the oil pump housing, using new gaskets on the flanges of the inlet pipe.

16. Attach the scavenging pump outlet pipe to the scavenging pump body using a new gasket between the flange of the pipe and the scavenger pump housing.

17. Attach the scavenging pump inlet pipe, the screen, the cover and the mounting bracket to the scavenging pump body using new gaskets at the flanges of the inlet pipe. Tighten the bolts finger tight only at this time. The oil pressure regulator and scavenging pump inlet pipe to the oil pump attaching bolts are tightened after the oil pump mounting bolts have been drawn tight.

F. Oil Pump Installation

1. The oil pump may be installed by reversing the sequence of operations for removal.

2. If the combination regulator and by-pass valve assembly was removed with the pump, attach the oil pump outlet pipe to the pump body and regulator body, using a new gasket at each outlet pipe attaching flange.

3. If only the pump was removed, and not the valve assembly, place the pump on the four mounting studs, using the same shims under the pump mounting pads that were in this position when the pump was removed.

4. Install the oil pump outlet pipe between the pump housing and the valve assembly, using new gaskets at the attaching flanges of the pipe.

5. Tighten the nuts on the pump mounting studs securely.

6. Install the oil pans by a direct reversal of the removal procedure.

3. OIL PRESSURE REGULATOR

A. Description

Stabilized lubricating oil pressure is maintained within the engine at all speeds, regardless of the oil temperature by means of a regulator valve encased in a housing which also accommodates the oil by-pass valve. The regulator valve is introduced into the main oil passage beyond the cooler so that when the valve opens, the oil passing the valve spills directly into the oil pan. The regulator valve maintains a nominal pressure of 50 psi in the main oil gallery.

Under ordinary conditions the oil from the pump passes through the cooler, however, should the cooler become clogged or partially clogged, so that the pressure drop through the cooler exceeds 26 psi, the by-pass valve opens and allows the oil to by-pass the cooler and flow directly to the main oil gallery in the cylinder block.

The valve assemblies consist of hollow piston type valves, compression springs, and plugs to retain the valves and springs in the housing.

B. Service of Pressure Regulator Valve

Under normal conditions, the valves should require very little attention. If the lubricating system has been allowed to sludge up, the regulator valve or the by-pass valve may not work freely, thereby remaining open or failing to open.

Whenever the lubricating oil pump is removed for inspection or repairs, the valve assemblies should also be removed, thoroughly cleaned and inspected.

C. Disassembly and Inspection of Pressure Regulator Valve

1. Remove the crankcase guard assembly and the engine oil pan.

2. Remove the plugs from the valve bodies and remove the springs and valves from the body.

3. Thoroughly clean the parts in clean solvent or fuel oil and dry with compressed air, then

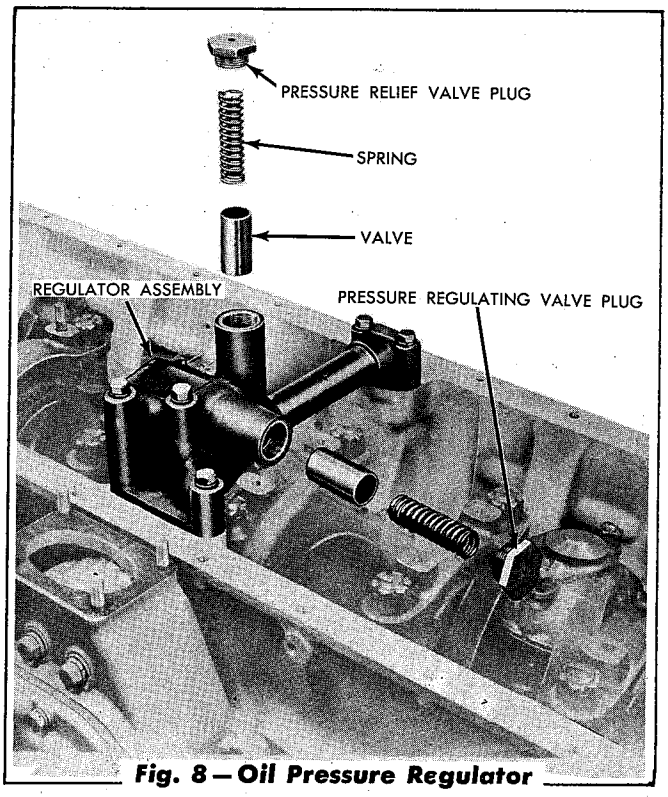


Fig. 8—Oil Pressure Regulator

inspect them before reassembly. All the passages must be open and the valves free from score marks. Lubricate the valves with light engine oil, then insert them into place in the valve body; the valves must move freely in the body.

D. Assembly and Installation of Pressure Regulator Valve

Refer to Fig. 8 which shows the relative location of all parts.

1. Lubricate the valves with light engine oil and insert them into position in the valve body, with opened end of valves towards the threaded end of valve opening.

2. Insert the springs inside the valves, then install the plugs. Tighten the plugs securely.

3. Install the engine oil pan and the crankcase guard assembly.

4. PUMP DRIVING GEAR

A. Description

The oil pump driving (crankshaft) gear, in mesh with the pump driven gear, is bolted to the rear of the crankshaft with six (6) ⅜" bolts. Whenever inspection or replacement of the pump driving (crankshaft) gear is necessary the removal of the flywheel and flywheel housing is required.

B. Removal of Oil Pump Driving (Crankshaft) Gear

Check the backlash between the oil pump driving gear and the driving (crankshaft) gear. The backlash is .003" to .004". If the backlash between these two gears exceeds .008" the gears should be replaced.

1. Remove the engine from the tractor. Refer to "ENGINE REMOVAL" in Section IX, Topic 11.

2. Remove the engine oil pan, the flywheel and the flywheel housing as outlined in Section IX.

3. Remove the six (6) crankshaft gear retaining bolts, then screw two (2) of the gear retaining bolts into the tapped puller holes in the bolt circle of the crankshaft gear.

4. Turn the bolts alternately against the flange of the crankshaft to pull the gear from the crankshaft.

C. Inspection

Inspect the gear for rough and worn teeth and replace if necessary. Also examine the oil pump driving gear for worn or rough teeth and install a new gear if necessary as outlined in this section.

D. Installation of Oil Pump Driving (Crankshaft) Gear

1. Install the oil pump driving (crankshaft) gear on the rear end of the crankshaft with the face of the gear which has the timing mark facing the flywheel. Push the gear on the crankshaft until the gear is just ready to mesh with the accessory drive gear.

2. Align the bolt holes in the gear with the cor-

responding tapped holes in the crankshaft and insert two (2) long bolts through the gear to hold the gear in position on the crankshaft, then rotate the crankshaft until the timing mark on the pump driving (crankshaft) gear aligns with the timing mark on the accessory drive gear. Refer to Section IX for engine timing procedures.

3. Install the flywheel and flywheel housing, using a new rear oil seal in the flywheel housing. Refer to Section IX.

4. Install the engine oil pan and the crankcase guard assembly as outlined in Section IX.

5. LUBRICATING OIL COOLER

A. Description

A dual element oil cooler is bolted to the side of the cylinder block with communicating oil passages from the cylinder block to the two cooler elements.

Gaskets are used between the cooler housing and the cylinder block at the oil passages to prevent oil leaks between the two members. Gaskets between the cooler housing and the element plate and between the element plate and the cover serve the dual purpose of preventing leaks and conducting the oil to the two cooler elements simultaneously. The elements operate in parallel.

A water opening at the bottom of the cooler housing admits the coolant from the water pump; while a similar opening at the top of the housing connects with the cylinder block for exit of the coolant to the block, after passing from bottom-to-top past the cooler elements.

B. Operation

Oil from the pump enters an opening near the bottom of the cooler housing and is conducted to the top of the housing through a cored passage. From the cored passage, oil is conducted to the top opening in each cooler element. After passing down through the elements the two cool streams of oil again unite, then enter a cored passage near the bottom of the cooler housing and flow to the oil gallery in the cylinder block.

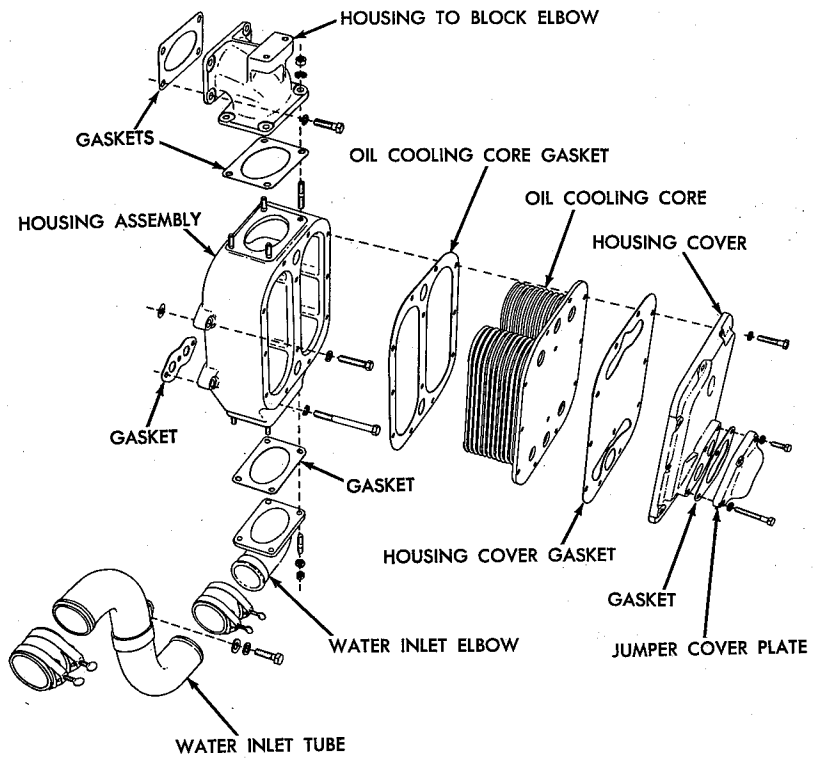


Fig. 9—Oil Cooler Details

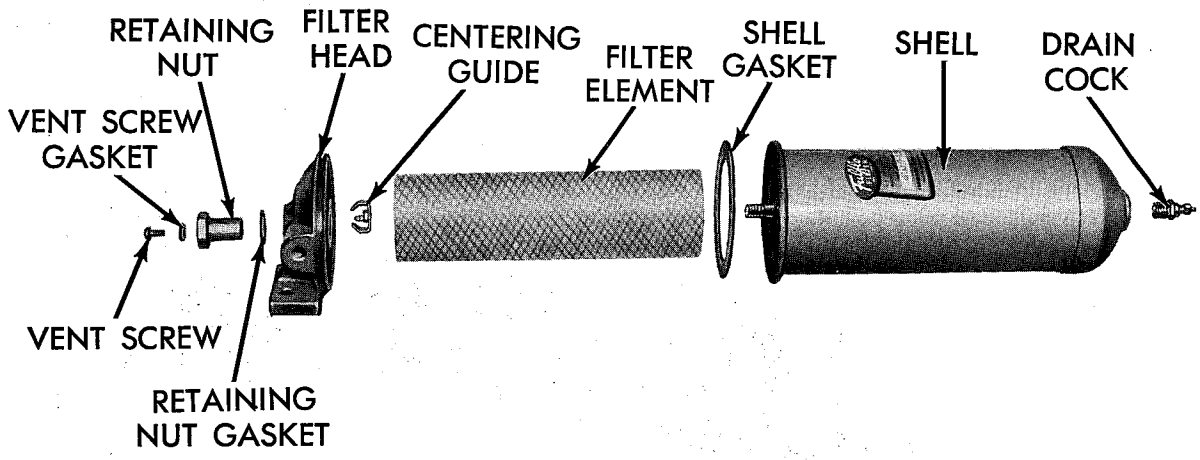


Fig. 11 — Lubricating Oil Filter Details (By-Pass Type)

leaks between the shells and filter heads, and at fittings. Correct any leaks found.

F. Full Flow Type Filter Assembly (effective on HD20-5434)

Effective with tractor Serial Number HD20-5434, a dual element, full flow type, engine oil filter assembly was incorporated. The filter adapter is bolted to the left side of the engine oil cooler housing and serves as the oil cooler housing cover and as the base for the oil filter element and filter shell assemblies. An oil by-pass valve is located in a machined oil inlet passage between the two elements in the filter base.

If the oil filter elements are not replaced at the proper intervals, the elements will become clogged and the oil filter by-pass valve will open, allowing the oil to pass directly into the engine main oil gallery without being filtered.

NOTE: When servicing the oil filter assembly, inspect for signs that oil has not been circulating through the filters. This indicates that the elements are clogged and that the oil filter by-pass valve is stuck in the open position. When the oil filter by-pass valve is in the open position, oil by-passes the oil filters and flows directly into the engine main oil gallery. If the above condition exists, remove the filter by-pass valve, thoroughly clean, inspect, and reinstall. New elements must also be installed at this time.

G. Service

When using the full flow type lubricating oil filter, the engine crankcase oil should be changed after each 150 hours of engine operation. The filter elements must be changed at each oil change. The crankcase oil capacity of engines equipped with the full flow type filters is 8¼ gallons.

H. To Change Each Filter Element

1. Remove the drain plug from the filter adapter (filter base) to drain the filter adapter.
2. Loosen the stud assembly (centerbolt) and remove the shell assembly and the filter element from the filter adapter.
3. Remove and discard the old filter element and the shell gasket.
4. Thoroughly clean the inside of the filter shell assembly and the filter adapter.
5. Install a new shell gasket in position in the adapter and place a new element on the stud assembly inside the filter shell.
6. Install the shell assembly and element in

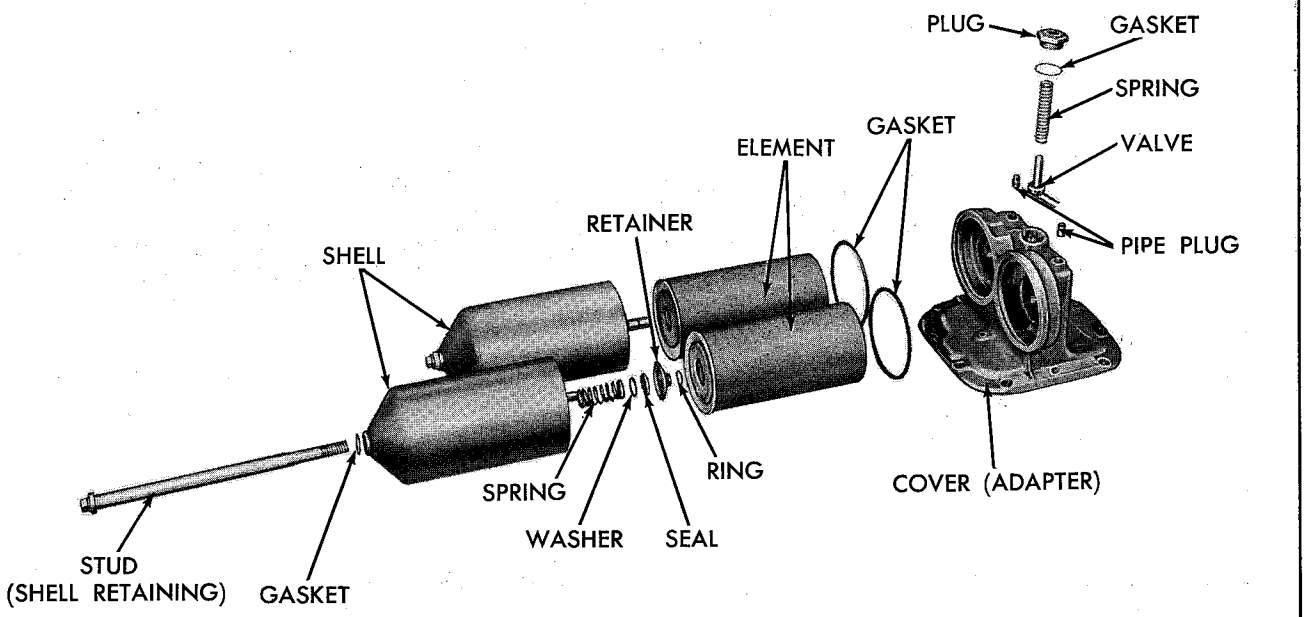


Fig. 12—Lubricating Oil Filter Details (Full Flow Type)

position on the adapter and tighten the stud (centerbolt) securely.

7. Start the engine and check for leaks at the shell assembly gaskets. *NOTE: Keep all parts clean when replacing elements.*

I. Heavy Duty Filter

On tractors equipped with Heavy Duty Filters, the elements must be changed at each oil change. To change the element, proceed as follows:

1. Remove the drain plug from the bottom of the filter housing and allow the oil to drain from the filter. Then, remove the lid cap-screws and lift lid from housing.

2. Unscrew the T-handle hold-down assembly from center tube and remove element from filter housing by lifting with the pull-out bail.

3. Clean filter housing thoroughly and replace drain plug.

4. Install a new "DIESELPAK" element and top gasket in filter housing. To assure leak proof sealing, examine the seats on each end of the filter element to see that they are in good condition and clean.

5. Replace T-handle hold-down assembly and tighten firmly.

6. Replace lid on filter housing and tighten the lid capscrews evenly.

7. Fill crankcase to proper level with prescribed lubricating oil, then add 2 additional gallons for the filter.

8. Run engine 5 minutes, stop and bring oil to proper level on bayonet gage.

9. Check for leaks around filter top and drain plug.

CAUTION: Use only "DIESELPAK" elements in the Heavy Duty Filters.

control rod, then pull the shut-off control rod to the "off" position (as far back as it will go). Push the control rod forward 1/16", then move the clamp on the rear control rod so that it contacts the rod guide boss, welded in cowl, and tighten the clamp securely. With the clamp in this position, the clamp will prevent the air valves from "bottoming" in the housings when the control rod is pulled to its "off" position, but will still permit the air valves to close fully.

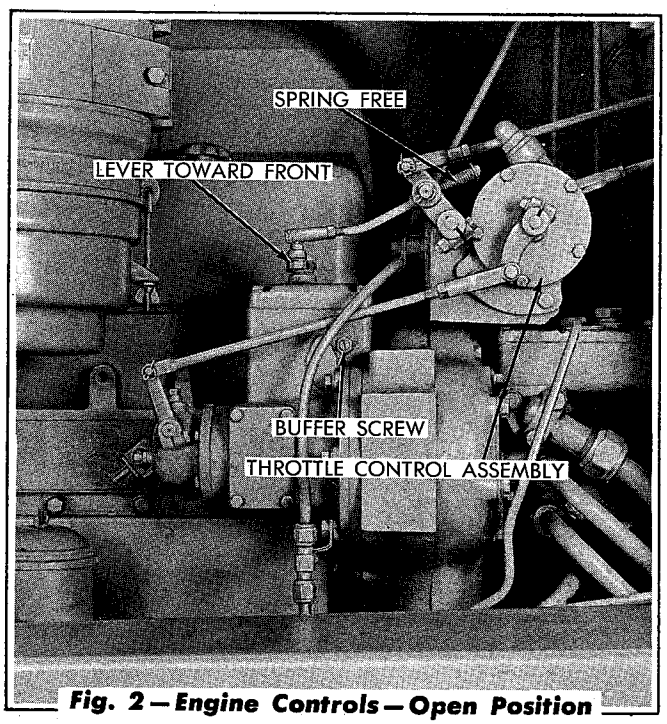


Fig. 2—Engine Controls—Open Position

When the linkage is properly adjusted, the stop on the rear of the front air valve lever should contact the stop pin with the engine shut-off control rod in the "run" position, and the clamp on the rear shut-off control rod should contact the rod guide boss, welded in cowl, with the shut-off control rod in the "off" position.

3. To adjust the governor fuel shut-off control, push the engine shut-off control rod into the running position (all the way in), then remove the governor fuel shut-off rod from the governor fuel shut-off lever. Hold the governor fuel shut-off lever all the way forward, as far as it will go, and check to see if the screw in the end of the ball joint lines up with the hole in the fuel shut-off lever. This is necessary to make sure that the injectors are being fully opened by the fuel shut-off lever. If the screw in the ball joint does not line up with the hole in the fuel shut-off lever, loosen the capscrew clamping the lever to the shaft and move the lever on the shaft so that the ball joint screw will line up with the hole when the lever is all the way forward. Tighten the capscrew used to clamp the lever to the shaft, then install the ball joint screw in the lever and tighten the retaining nut.

2. GOVERNOR

A. Description

The variable speed governor, illustrated in Fig. 3, is of the mechanical type with one set of weights and one variable speed spring. The motion of the governor weights, which is opposed by the compression of the governor variable speed spring, is transmitted to the injector racks by a system of levers and links on which is imposed a manual control.

The governor, which is mounted on the forward face of the gear housing, is divided into four (4) main subassemblies: the drive support and weight assembly, the control and spring mechanism, the spring housing and shaft assembly, and the cover.

1. Drive Support and Weight Assembly

The drive support and weight assembly consists of a pair of weights supported on one end of the horizontal shaft, a drive gear keyed to the opposite end, and two ball bearings between the weights and gear. Both bearings are carried in a support which bolts to the governor control housing.

2. Control and Spring Mechanism

The control and spring mechanism consists of those parts that transmit the motion produced by the governor weights to the injector racks, which, in turn, control the

amount of fuel injected into the engine cylinders.

A vertical operating shaft, supported on suitable bearings inside the housing, has an operating lever at the upper end and an operating fork at the lower end.

The motion of the governor weights, which is opposed by a spring on which the tension may be varied at will by the engine operator, is transmitted to the vertical shaft through the fork on the lower end of the shaft and a riser on the horizontal weight shaft. This motion is, in turn, transmitted to the injector control tube and the injector racks by means of the operating lever and the differential lever at the upper end of the vertical shaft.

The governor variable speed spring is contained within an outer retainer and an inner retainer. The spring will accommodate engine speeds from 1200 r.p.m. to 1800 r.p.m. by removing variable speed control shims from the speed spring retainer and spring retainer stops from between the two retainers. The spring retainer stops form a stop for the speed spring retainer and limit the travel of the speed control lever, Fig. 4, and the compression on the governor variable speed spring.

3. Spring Housing and Shaft Assembly

The spring housing and shaft assembly serves as a retainer and a means of changing the tension on the governor variable speed spring.

The variable speed lever is keyed to the same shaft as the speed control lever. Since the spring housing is bolted to the control housing and the spring lever shaft is supported in the former, by moving the speed control lever, the tension on the governor variable speed spring may be varied at will.

4. Cover Assembly

The cover assembly serves the dual purpose of closing the opening at the top of the control housing and carrying the throttle shaft lever, which is manually operated to position the differential lever in the various positions.

5. Booster Spring

A booster spring, Fig. 13, at the outside of the governor, assists in moving the speed control lever from idle to maximum speed.

A lever is fastened to the spring lever shaft with an adjustable bracket fastened thereto. When the speed control lever is in the idle position, the pull of the spring is through the approximate center of the speed lever shaft as shown on line "B-B" in Fig. 13. When the lever is moved toward the open position, the booster spring line "B-B" of pull falls below the center of the shaft and the spring assists in moving the speed control lever.

B. Governor Inspection and Service

The governor was adjusted at the factory to provide the full governed engine speed (under load) of 1700 r.p.m. and an idling speed of 500 r.p.m. The governor very seldom gets out of order. If the engine speed is irregular check for the following before changing the governor setting:

1. Make certain that the speed changes are not the result of load fluctuations.

2. Make certain that all cylinders are firing properly.

3. See that no bind exists in the governor mechanism, or operating linkage, between the governor and the engine; also, that no bind exists in the injector control rack tube or its mounting brackets. The injector control mechanism must move freely throughout the entire travel of the injector racks. Should friction exist in the mechanism, it may be located and eliminated as follows:

   a. If the injector racks stick or move too hard, inspect them for an accumulation of gum or sludge. Sticking from this cause can usually be corrected by washing the parts in clean solvent or fuel. If

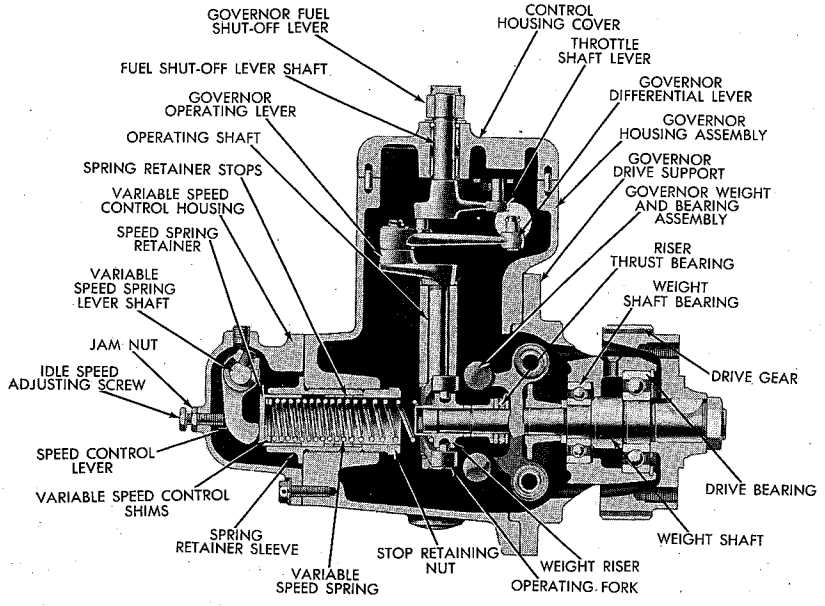


Fig. 3—Governor Sectional View

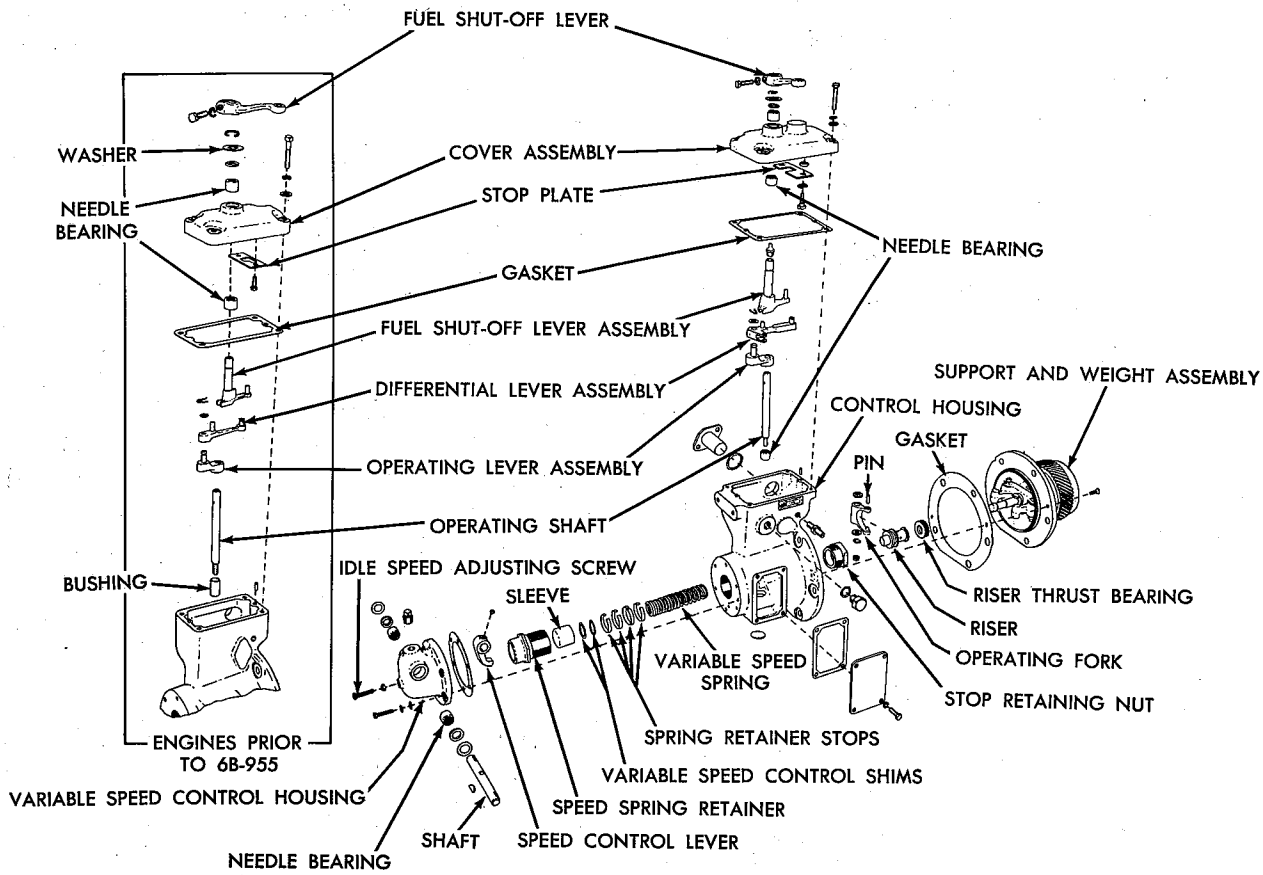


Fig. 4—Governor Details

an injector rack sticks as a result of a "cocked" or "cramped" rack control lever, loosen the adjusting screws in the rack control lever and move the lever endwise on the control tube until the lever no longer cramps the injector rack. After the trouble has been remedied, adjust the lever to equalize the affected injector with the others. Refer to "INJECTOR EQUALIZING" in Section II.

b. Make certain that the injector control tube turns freely in its bearings. Binding due to poor alignment of the bearing bracket assemblies can be corrected by loosening the bracket assembly capscrews and realigning the shaft brackets with the control tube. The tube must turn freely to the "NO FUEL" position by the action of the return spring only. *CAUTION: Never stretch or tamper with the control tube spring to change the tension.* If the spring is not standard, replace it with a new one.

c. Remove the bind from the pin in the link, that connects the governor control lever to the injector control tube lever, if any bind is evident. If the governor does not reach its maximum rated speed of 1850 r.p.m. at high idle, with the engine clutch disengaged, inspect the stop retaining nut inside the governor as it may have come loose and backed off the speed control spring retainer sleeve. To check this nut, remove the control housing side cover from the governor and tighten the nut through the opening in the housing as shown in Fig. 5.

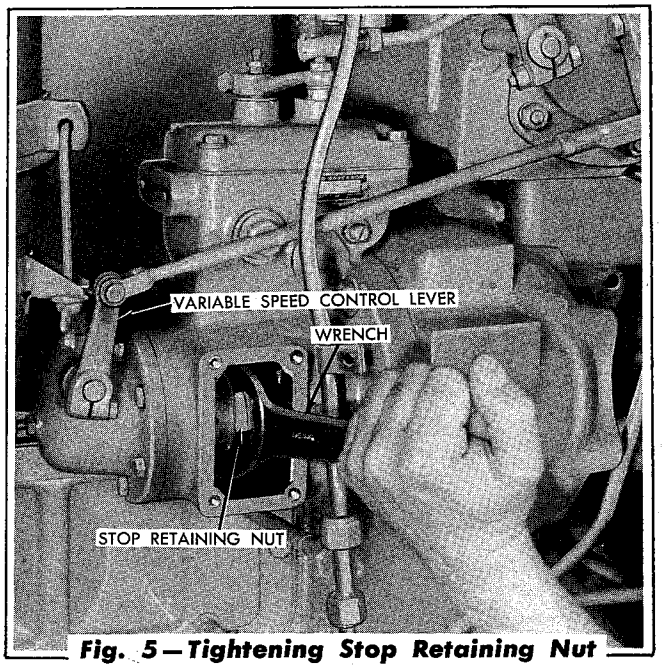


Fig. 5—Tightening Stop Retaining Nut

If the governor still fails to control the engine properly after all the above inspections have been made, and all causes of failure other than the governor have been eliminated, the governor may be worn or otherwise unfit for further use. The governor must then be removed, disassembled, and inspected.

C. Governor Removal

1. Remove the capscrews used in attaching the oil tube supporting clips to the governor housing.

2. Clean off the rocker cover and remove it from the engine cylinder head. Disconnect the governor control link from the injector control tube lever.

3. Disconnect the engine control rods from the governor variable speed control lever and the governor fuel shut-off lever.

4. Remove the cover assembly and gasket from the governor control housing. Disconnect the governor control link from the differential lever and remove the link.

5. Remove the capscrews attaching the governor housing to the cylinder head and to the gear housing, then remove the governor assembly from the engine.

D. Governor Disassembly

Before removing any parts from the governor assembly, the entire unit should be thoroughly washed in fuel, dried with compressed air, and inspected for worn or damaged parts, or for bind in any of the parts that cannot be corrected without disassembly. Disassembly need be carried only far enough to correct those difficulties which interfere with proper governor operation.

The variable speed governor assembly has been divided into the following four main subassemblies:

Drive Support and Weight Assembly

Control and Spring Mechanism

Spring Housing and Shaft Assembly

Cover Assembly

Disassembly of the governor will be carried out in the above order.

1. DISASSEMBLE DRIVE SUPPORT AND WEIGHT ASSEMBLY

a. Remove the two governor drive support attaching screws. Pull the drive support and weight assembly from the governor housing and remove gasket, refer to Fig. 4.

b. Slide the governor weight riser and the riser thrust bearing off the end of the governor drive shaft.

c. Clamp the governor drive gear in a soft jawed vise and remove the gear retaining nut.

d. Clamp the flange of the governor drive support in a vise and, using a gear puller, pull the governor drive gear from the drive shaft.

e. Remove the "WOODRUFF" key from the drive shaft.

f. Using special pliers remove the governor drive bearing retaining ring from the drive support.

g. Place the governor drive support and weight assembly in an arbor press, with the inside face of the flange of the drive support resting on the bed of the press and the ram of the press against the large end of the shaft. Press the shaft and weight assembly from the support and the governor drive bearing.

h. Remove the support from the arbor press and push the governor drive bearing from the outer end of the support.

i. Place the governor weight carrier shaft, bearing, and weight assembly in the arbor press, with the carrier shaft bearing resting on the bed of the press and the ram of the press on the small end of the shaft, refer to Fig. 6. Press the shaft from the weight carrier, weight carrier spacer, and bearing.

j. To disassemble the governor weight and weight carrier assembly, remove the cotter pins from the ends of the governor weight shafts. Slide the shafts from the carrier, washers, and weight and bearing assembly.

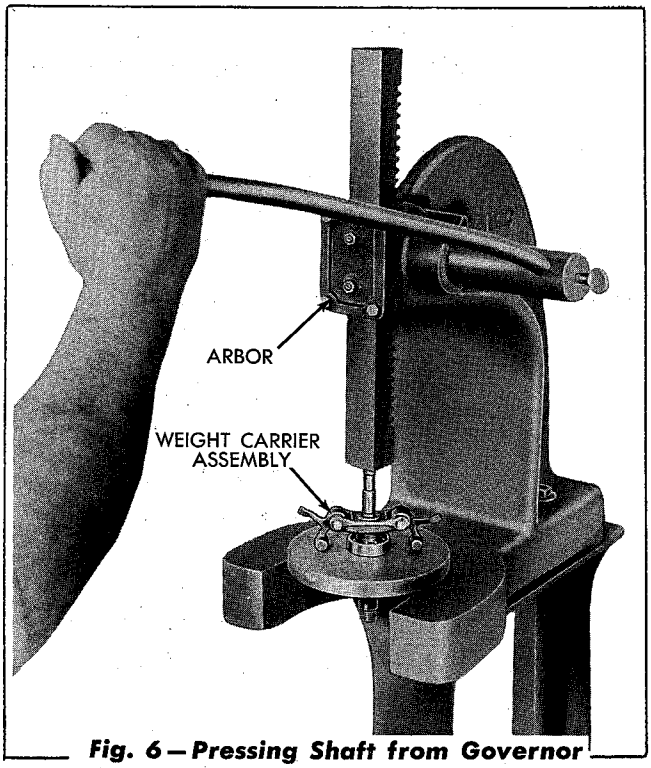


Fig. 6—Pressing Shaft from Governor Weight Carrier Assembly

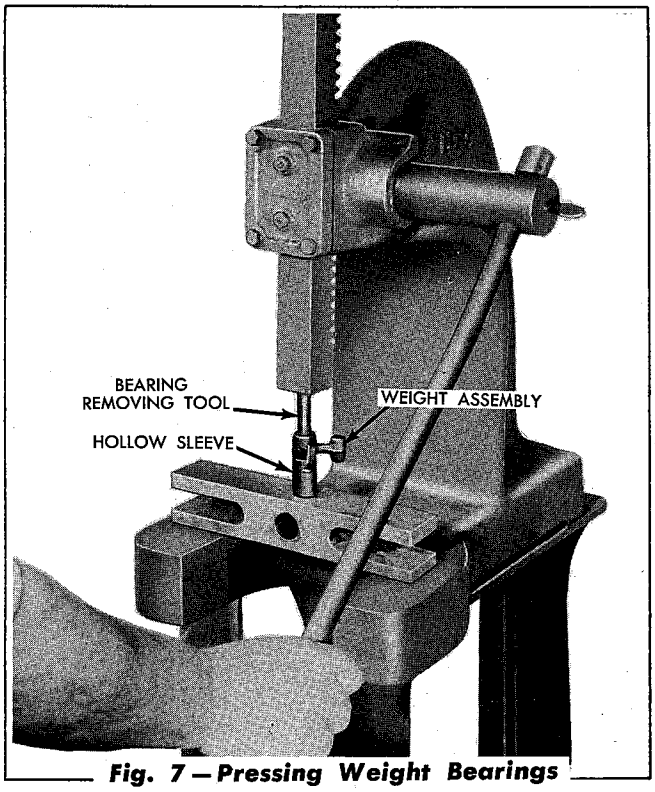


Fig. 7—Pressing Weight Bearings from Weight Assembly

k. If the governor weight bearings are to be removed, place the weight in the arbor press with the weight supported on a hollow sleeve and, using a tool as shown in Fig. 7, press the bearings from the weight.

2. DISASSEMBLE CONTROL AND SPRING MECHANISM

With the governor control housing detached from the drive support and weight assembly, the control and spring mechanism may be removed from the housing as follows:

a. Place the governor housing on a bench, with the flange face down and let the variable speed spring and shims drop from the housing.

b. Remove the variable speed control housing attaching bolts, lockwashers and flat washers.

c. Pull the variable speed control housing away from the governor housing and remove the gasket.

d. Loosen the variable speed spring retainer sleeve and remove it from the governor housing.

e. Tilt the spring retainer sleeve and let the spring retainer slip from the sleeve.

f. Push the spring retainer stops from the sleeve.

g. Remove the spring retaining nut from the inside of the governor housing.

h. Place a suitable rod against the inner side of the expansion plug and drive the plug out of the housing. Insert a socket wrench through the plug opening and remove the fork retaining nut, lockwasher, and washer.

i. At the top of the vertical shaft, remove the differential lever retaining spring and washer, and lift the differential lever and pin assembly from the operating lever pin.

j. Place the housing in an arbor press, with the top face of the housing supported so that the cover plate dowel pins are clear of the press. Insert a ¼" brass rod through the expansion plug opening and against the end of the operating shaft. With the opposite end of the brass rod under the ram, press the shaft from the operating fork, washer, and housing.

k. If the operating shaft bushings or needle bearings are to be replaced, support the housing in an arbor press as in the previous step. Insert a tool through the expansion plug opening in the housing so that the shoulder on the tool rests against the bushing or needle bearing, then press the bushing or needle bearing from the housing. *NOTE: Engines prior to 6B-955 have bushings for the operating shaft instead of the needle bearings mentioned above. Procedure for removing the bushings is similar to that used in removing the needle bearings.*

3. DISASSEMBLE SPRING HOUSING AND SHAFT ASSEMBLY

With the spring housing and shaft assembly detached from the governor housing, refer to Fig. 4 and disassemble as follows:

a. Loosen the variable speed control lever clamp bolt and slip the control lever from the control lever shaft.

b. Loosen the booster lever clamp bolt and slip the booster lever from the control lever shaft.

c. Remove the "WOODRUFF" keys, washers, and packing from the ends of the shaft.

d. Remove the pipe plug from the spring housing. Insert an "ALLEN" wrench through the plug opening in the housing and back out the speed control lever attaching setscrew.

e. Place the spring housing in an arbor press, with the face of the lever shaft boss supported on a hollow sleeve on the bed of the press as shown in Fig. 8.

Bring the ram of the press down on the end of the shaft and press the shaft through the needle bearing, thus releasing the speed control lever. *NOTE: Replacement of this needle bearing will be necessary because damage will be caused when the "WOODRUFF" key is pressed through it.*

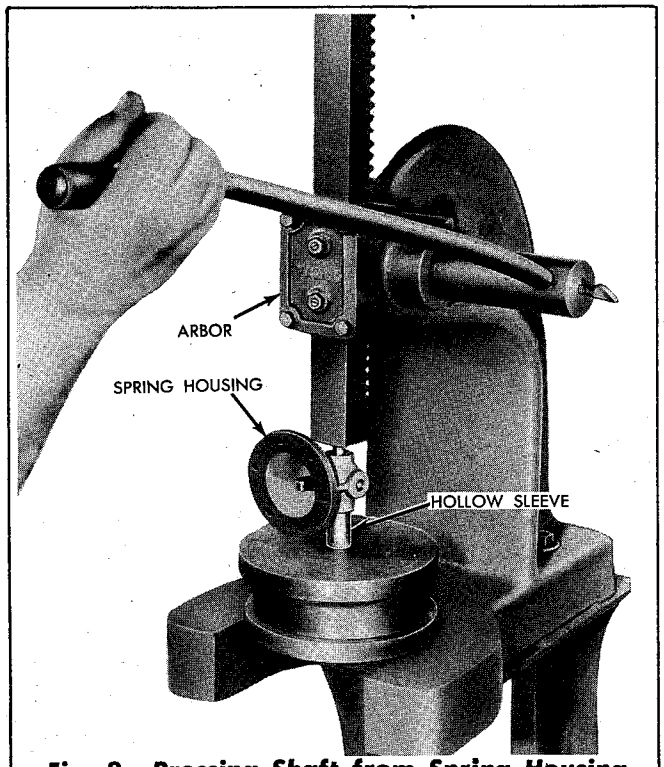


Fig. 8—Pressing Shaft from Spring Housing

f. Insert the bearing aligning tool in the boss of the housing and press the upper bearing out of the housing as shown in Fig. 9. Then turn the housing over and press the lower bearing out of the housing.

g. Remove the "WOODRUFF" key from the control lever shaft.

4. DISASSEMBLE COVER ASSEMBLY

With the governor cover assembly removed from the control housing the cover assembly may be disassembled as follows:

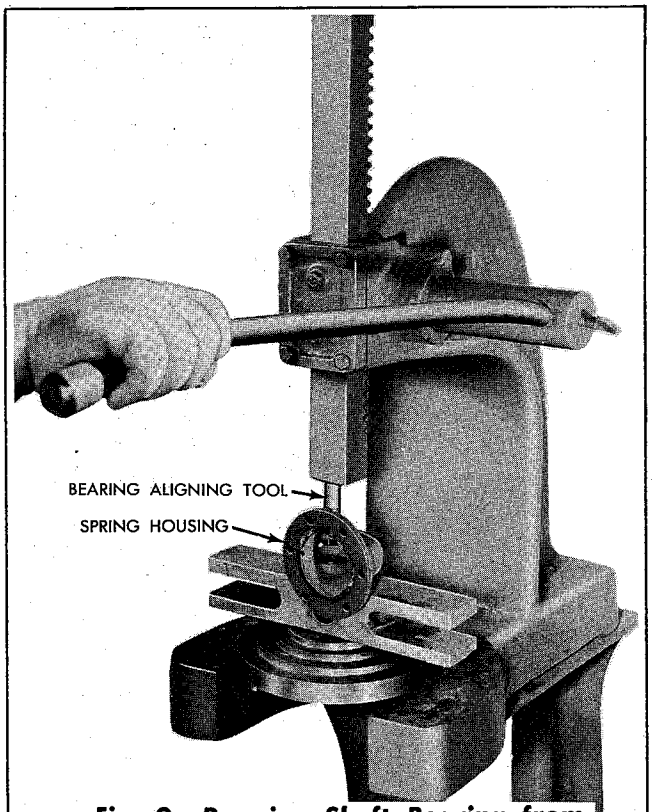


Fig. 9—Pressing Shaft Bearing from Spring Housing

a. Loosen the fuel shut-off lever and lift the lever from the fuel shut-off lever shaft.

b. Remove the fuel shut-off lever shaft retaining ring and washer. Pull the shaft, lever, and pin assembly from the bottom of the cover and remove the shaft seal ring from the top of the cover.

c. Remove the stop plate attaching bolts and the stop plate.

d. If the shaft bearings are to be removed, place the cover in an arbor press, with the face of the cover on the bed of the press. Insert a suitable tool between the top of the bearing and the ram of the press, and press the bearings out of the cover.

E. Inspection of Governor Parts

Clean the parts thoroughly, using clean fuel or solvent. Inspect the parts for wear and replace with new parts where needed.

Since the function of the governor is to control the

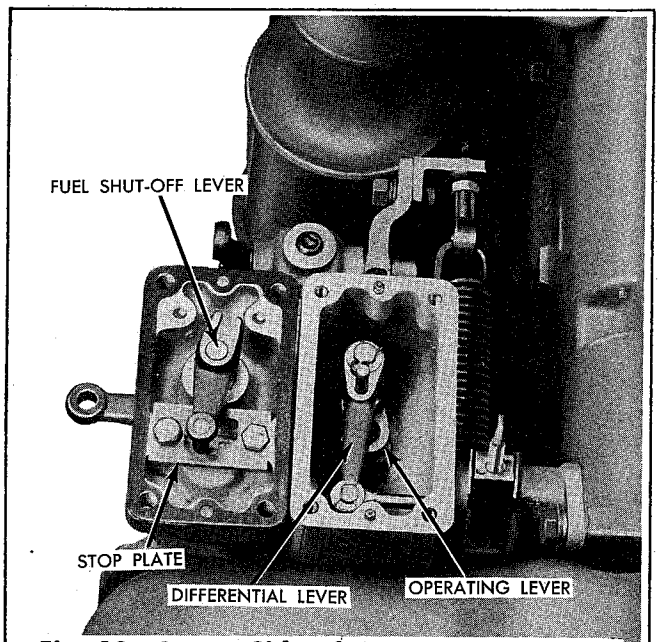


Fig. 10—Lower Side of Governor Top Cover

fuel injection by means of suitable linkage within the governor, and linkage between the governor and the injector control, the freedom of all moving parts within the governor, as well as the linkage, is of utmost importance.

When inspecting governor parts, therefore, bear in mind that all parts must work freely with their mating parts.

Annular and thrust ball bearings should be thoroughly cleaned in fuel and blown out with compressed air. After such treatment, hold in fingers and revolve the outer race of annular bearings slowly for any indication of rough spots. Balls and races that have corroded or pitted surfaces should be replaced with new parts.

The rollers and races of roller bearings should be inspected for loose fit of rollers in the races or taper on the rollers.

Examine the journals on the shaft at the roller bearing locations, and if the journals are worn excessively, replace the shafts.

Examine all sleeves, pins, shaft journals, and links for wear, also for fits, and, if necessary, dress with crocus cloth for proper fit. The weights should be suspended in their carrier sufficiently free to fall from the extended to the inner position by their own weight, and the suspending pins should not be used if worn more than .002" out of round.

F. Governor Assembly

The governor may be assembled by reversing the sequence of operations for disassembly. The work will be very much simplified by close reference to the various detailed illustrations that accompany the text.

1. COVER ASSEMBLY

Refer to Fig. 4 for names and relative location of parts, and assemble the governor as follows:

a. If the fuel shut-off lever shaft bearings were removed from the cover, place the cover in an arbor press, with the face of the cover on the bed of the press, and start the upper bearing straight in the cover. Then, press the bearing into the cover until it is flush with the top of the cover.

Place the cover in an arbor press, with the top of the cover on the bed of the press, and start the lower bearing straight in the cover. Bring the ram of the press down on the bearing and press the bearing into the cover until it is flush with the face of the cover.

b. Lubricate the roller bearings with a liberal amount of good cup grease and slide the fuel shut-off lever shaft through the bearings, from the bottom of the cover, making sure that the shaft detent pin enters the slot in the stop plate.

c. Install the shaft bearing seal ring over the upper end of the shaft and against the upper bearing.

d. Place the washer over the shaft and against the seal ring.

e. Install the shaft retaining ring over the shaft and into the groove in the shaft.

f. Slide the fuel shut-off lever onto the shaft and against the retaining ring. Tighten the lever locking bolt.

2. SPRING HOUSING AND SHAFT ASSEMBLY

a. Install a "WOODRUFF" key in the speed control lever shaft.

b. Hold the speed control lever between the bosses inside the spring housing, so that the lever arm faces toward the opening in the flanged end of the housing. Then, facing the flange end of the spring housing, with plug opening in housing up, start the shaft end which has only one key slot into the boss in the right side of the housing. Align the keyway in the speed control lever with the key in the shaft and push the shaft through the lever until the flat on the shaft is opposite the setscrew hole in the lever. Install and tighten the setscrew, then install the pipe plug in the spring housing.

c. Place the spring housing in an arbor press, with the shaft boss supported on a hollow sleeve on the bed of the press and the opposite boss under the ram of the press. Start the speed control lever shaft bearing over the upper end of the shaft and straight in the boss in housing. Insert a bearing installing tool over the shaft and against the bearing, and, with the opposite end of the tool under the ram of the press as shown in Fig. 11, press the bearing into place.

Reverse the spring housing in the press and install the second bearing in the opposite boss in the same manner as above.

d. Install the packing and washers over the ends of the speed control lever shaft and install the "WOODRUFF" keys in the shaft.

e. Slip the booster lever over the "WOODRUFF" key on the long end of the speed control lever shaft and tighten the clamp bolt.

f. Slip the control lever over the "WOODRUFF" key on the short end of the speed control lever shaft and tighten the clamp bolt.

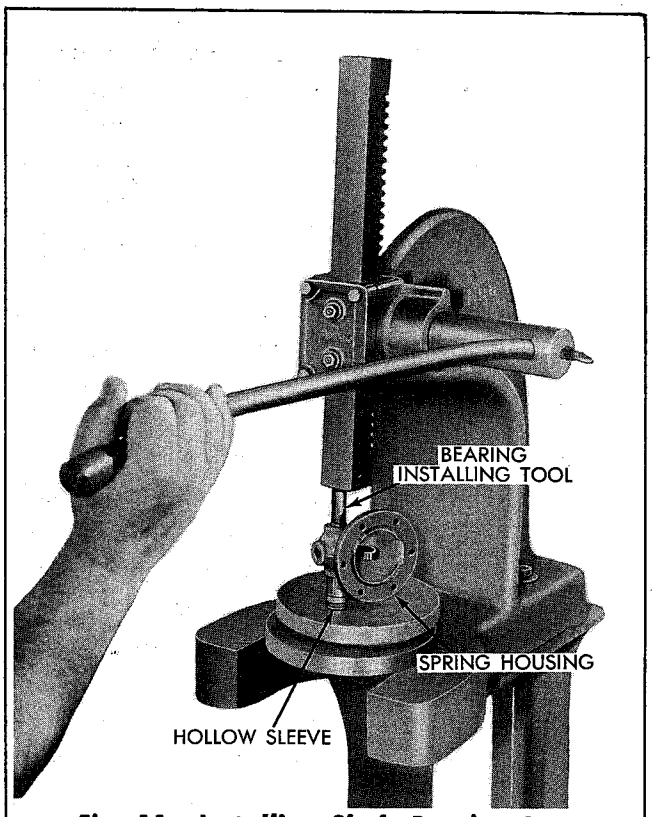


Fig. 11 — Installing Shaft Bearing Into Spring Housing

3. ASSEMBLE CONTROL AND SPRING MECHANISM

Since the operating shaft is flattened on both top and bottom for the operating lever and the operating fork, respectively, the levers can be assembled in their correct positions only. To assemble the part in the control housing, refer to Fig. 4 and assemble as follows:

a. If new operating shaft bearings are to be installed, support the housing on the bed of the arbor press so that the cover plate dowel pins are clear of the bed. Start the bearing straight into the boss in the housing. Press the bearing into place. Reverse the housing on the press and install the bearing in the opposite end of the boss in the same manner and with the same tool.

b. Remove the governor housing from the arbor press and insert the operating shaft through the needle bearings, from the top of the housing, so that the flat side of the shaft faces the flange of the

housing. Make sure the operating shaft turns freely in the needle bearings. *NOTE: On early model tractors which contain bushings, the procedure for installing them is similar to the needle bearings, however, the bushings must be burnished to a fit of .4395" to .4405".*

c. Install the flat washer over the lower end of the shaft and against the boss in the housing.

d. Align the flat in the bore of the operating fork with the flat on the operating shaft and start the fork onto the shaft. Place the housing in an arbor press, with the lower end of the fork supported on a hollow sleeve and a brass rod between the ram of the press and the upper end of the shaft. Press the fork onto the shaft and against the shoulder on the shaft.

e. Install the flat washer, lockwasher, and nut on the lower end of the operating shaft.

f. Install the differential lever and pin assembly in position on the operating lever pin and secure with the retaining washer and retaining spring.

g. Install the governor housing expansion plug in the bottom of the housing.

h. If the stop retaining nut was removed, install it inside the governor housing at this time.

i. Place the four spring retainer stops in the spring sleeve, and install the sleeve in the governor housing.

j. Attach the spring housing gasket and spring housing onto the governor housing with bolts, lockwashers and plain washers.

k. Tilt the governor housing assembly so that it rests on the spring housing and insert six thin variable speed control shims and two thick variable speed control shims into the spring retainer. Insert the close-coiled end of the spring through the stop retaining nut and against the shims in the retainer.

4. DRIVE SUPPORT AND WEIGHT ASSEMBLY

a. If the governor weight bearings were removed, place the governor weight on an arbor press and start the bearing straight into one end of the bore in the weight. Bring the ram of the press down on the bearing and press the bearing into the weight until it is flush with the face of the weight. Install the bearings in the other weight in the same manner.

Holding the governor weight carrier, with the boss on the carrier facing upward, start the weight shaft through the carrier from the left side.

Place the weight shaft washer over the shaft inside the carrier.

Place the weight and bearing assembly over the shaft and against the washer, with the weight arm pointing under the carrier.

Place a second washer over the shaft and against the weight and slide the shaft into place. Secure the shaft with cotter pins at the ends of the shaft.

Install the weight on the opposite side of the carrier in the same manner.

b. Place the governor weight carrier shaft bearing on the bed of the press, with the inner race of the bearing resting on the bed of the press. Insert the small end of the weight carrier shaft through the bearing and, with the opposite end under the ram, press the shaft into the bearing until tight against the shoulder on the shaft.

c. Place the weight carrier spacer over the small end of the shaft and against the bearing.

d. Start the boss of the weight carrier straight onto the small end of the shaft and place the assembly in an arbor press, with the threaded end of the shaft resting on the bed of the press and opposite end under the ram of the press as shown in Fig. 12. Using a hollow sleeve over the end of the shaft and against the carrier, press the carrier tight against the spacer.

e. Insert the large end of the shaft, with the bearing and weight assembly installed, into the flanged end of the support and push the shaft through the support until the bearing slides into place in the support.

f. Place the support in an arbor press with the small end of the shaft resting on the press. Slide the governor drive shaft bearing over the large end of the shaft and, using a hollow sleeve against the inner race of the bearing, press the bearing into place in the support.

g. With the governor drive support assembly on a bench, install the governor drive bearing retaining ring in the support.

h. Install the "WOODRUFF" key in the slot in the governor drive shaft.

i. Place the governor drive support assembly in an arbor press, with the small end of the shaft resting on the bed of the press. Align the slot in the drive gear with the "WOODRUFF" key in the shaft and using a hollow sleeve against the face of the gear, press the gear onto the shaft.

j. Clamp the governor drive gear in a soft jawed vise and install the drive gear retaining nut on the end of the shaft.

k. Install the riser thrust bearing over the small end of the shaft, so that the bearing race with the larger inside diameter will face toward the riser when the riser is installed.

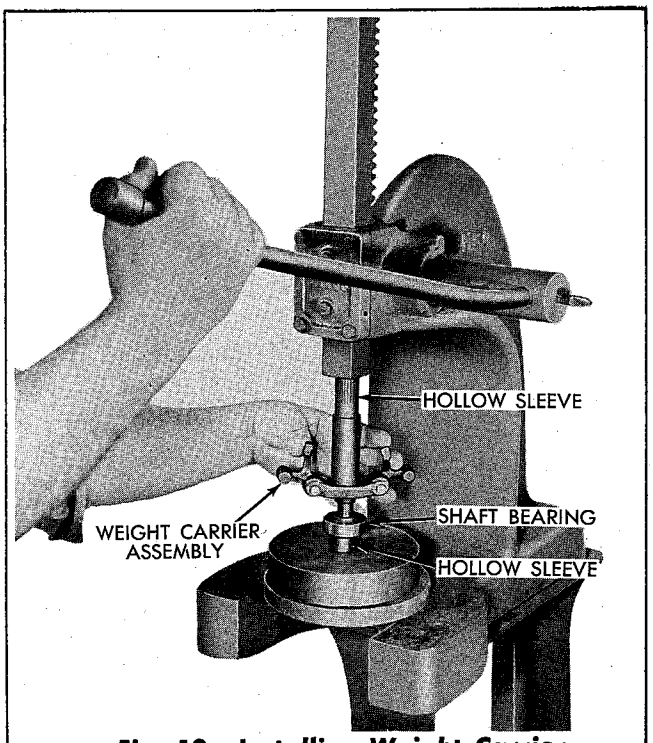


Fig. 12 — Installing Weight Carrier Assembly on Shaft

l. Start the flanged end of the weight riser onto the small end of the shaft and slide it into place against the thrust bearing.

m. Install the governor drive support gasket on the governor housing assembly.

n. Insert the riser end of the shaft into the housing and locate the pins of the governor operating fork in the groove of the riser. Attach the drive support to the housing with two screws.

G. Governor Installation

1. Examine the gaskets used between the governor and the gear housing and the cylinder head. Replace with new gaskets if the old ones are not in good condition.

2. Place a gasket in position on the mounting flange of the governor and install the governor drive gear into the bore of the gear housing, so that the drive gear is in mesh with its mating gear.

3. Install the governor housing attaching capscrews but do not tighten at this time.

4. Place a gasket in position between the gov-

ernor control housing attaching flange and the cylinder head. Install and tighten the two (2) attaching capscrews.

5. Tighten the governor housing attaching capscrews at this time.

6. Connect the governor control link to the governor differential lever and the injector control tube lever. Secure the control link with a control link pin and cotter pin on the control tube end and with a flat washer and retaining clip on the governor end.

7. Inspect the control housing cover gasket and replace if it is not in good condition, then install the governor control housing cover and secure with four (4) capscrews, flat washers, and lockwashers.

8. Connect the engine control rods to the governor variable speed control lever and the governor fuel shut-off lever.

9. Install the rocker cover, then attach the oil tube supporting clips to the governor housing.

H. Governor Adjustments

If the governor has been dismantled for repairs or if a new governor assembly is installed, certain adjustments must be checked and engine speed adjustments made as necessary. Proceed as follows to check the governor adjustments.

NOTE: If the fuel shut-off lever has been removed from the fuel shut-off lever shaft it will have to be reset.

To reset the fuel shut-off lever, place the air shut-off knob in the "RUN" position, then loosen the capscrew used to clamp the fuel shut-off lever to the shaft. Using a wrench on the lubricating fitting in the top of the shaft, turn the shaft until the stop pin on the lever is against the governor control stop plate located inside the governor cover. *NOTE: This adjustment must be made with the injector control tube in the full open position.*

Tighten the clamping screw on the fuel shut-off lever and move the air shut-off valve to the open and closed positions to check the injector control tube for proper operation.

1. CHECKING ENGINE SPEED

Operate the engine until the normal operating temperature of 160° to 185° F. is indicated on the temperature gage. Hold an accurate tachometer against the front end of the crankshaft. With the throttle lever all the way forward (idling position) and the engine clutch disengaged, the engine speed should be 500 R.P.M. With the throttle lever all the way back (wide open) the high idle engine speed should be 1850 R.P.M.

NOTE: If front mounted equipment on the tractor prevents use of a tachometer on the front end of the crankshaft, remove the two (2) capscrews from the small cover plate, located directly above the water pump housing and to the rear of the crankcase oil filler tube, and remove the cover. Hold a tachometer against the rear end of the accessory drive gear shaft to check the engine speed. This shaft runs at the same speed as the engine crankshaft.

2. LOW IDLE SPEED ADJUSTMENT

a. Loosen the lock nut on the side of the governor housing and back out the buffer screw until 5/8" of the screw extends beyond the lock nut. Refer to Fig. 2.

b. Push the engine shut-off knob to the *RUN* position and pull the throttle control lever to part throttle, then start the engine and run it until the normal operating temperature of 160° to 185° F. is indicated on the temperature gage.

c. Move the throttle control lever to the *IDLE* position. Loosen the lock nut on the idle speed adjusting screw. Turn the idle screw to obtain the desired idling speed. Turn the screw *IN* to increase and *OUT* to decrease the engine speed. If the engine "rolls" excessively after setting the idling speed, the cause may be due to a bind in the governor, governor linkage

and/or the injector control tube assembly. Determine the reason for the bind and correct the same. If excessive "roll" cannot be removed when freeing the linkage, turn the buffer screw *IN* until the "roll" decreases or disappears completely.

d. Tighten lock nut on the idle speed adjusting screw.

3. BOOSTER SPRING ADJUSTMENT

a. Place the throttle lever in the *IDLE* position, check to be sure that there is sufficient tension on the idling screw in the front of the variable speed spring housing so that all play is removed from the speed control lever, then loosen the nut on the booster lever bolt and position the booster lever bracket, that carries the spring attaching eyebolt so that a line "B-B" extending from fulcrum to fulcrum of the spring passes through the center of the spring lever shaft. Refer to Fig. 13.

b. Tighten the eyebolt sufficiently to produce the desired booster effect when the throttle lever is moved to the *FULL* speed position.

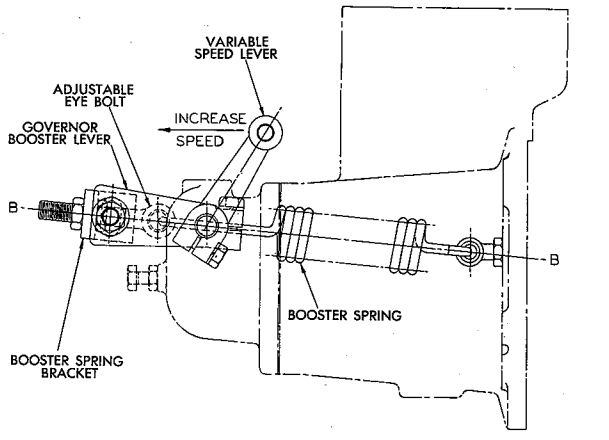


Fig. 13 — Booster Spring Adjustment

4. BUFFER SCREW ADJUSTMENT

a. With the engine running at low idle, turn the buffer spring adjusting screw *IN* until the screw contacts the governor differential lever and a very slight increase in engine speed is noted. This increase in engine speed should not exceed 20 r.p.m.

b. Tighten the adjusting screw lock nut.

5. HIGH IDLE SPEED ADJUSTMENT

NOTE: In most cases, the cause for the engine not reaching the proper high idle speed of 1850 r.p.m. will be found due to loose or incorrectly adjusted throttle linkage and not due to the governor being out of adjustment. For this reason, it is necessary to make the following checks before changing the adjustment of the governor.

a. Be sure that the governor fuel shut-off lever on the governor control housing moves to its forward position (as far forward as it will go), when the engine shut-off control rod is pushed into running position.

b. Remove the pipe plug in the top of the governor variable speed spring housing, and check to be sure that the setscrew in the speed control lever has not loosened, permitting the lever to turn on the shaft. Tighten the screw firmly so that the screw is drawn down tightly on the seat in the shaft. Replace the pipe plug.

c. To increase the high idle speed, add the necessary amount of variable speed control shims between the spring and the inside of the spring retainer.

d. To decrease the high idle speed, remove the necessary amount of variable speed control shims from between the spring and the inside of the spring retainer. Whenever the high idle speed is reset it will be necessary to check and adjust the low idle speed. The speed control shims are .010" thick. The removal or installation of one shim will affect the engine speed approximately 10 r.p.m.

e. Remove the governor spring housing

from the governor and then remove the spring retainer, speed control shims and spring from the spring housing.

f. Unscrew the outer spring retainer sleeve from the governor housing and remove a spring retainer stop from the inside of the spring retainer sleeve. The removal of one (1) stop will increase the engine speed approximately 220 r.p.m. by allowing the outer spring retainer sleeve and the inner spring retainer nut to come closer together when the speed control lever is in the *"FULL"* open position.

SECTION VII—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, connected in series, and carried in compartments at the ends of the seat.

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 on the tractor 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. All the 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 that the machine was delivered, when presenting a claim of this nature.

3. WIRING SYSTEM

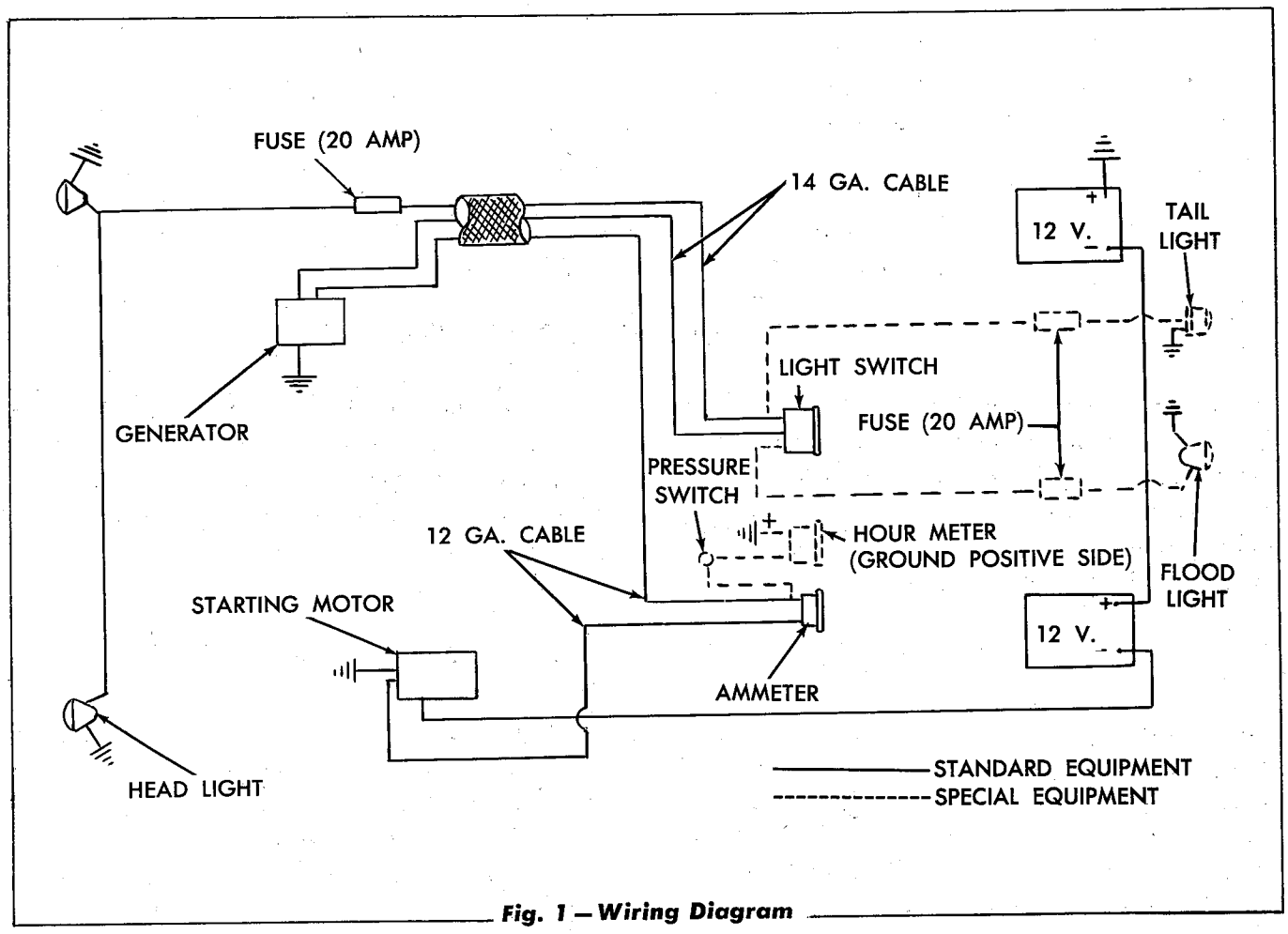


Fig. 1 — Wiring Diagram

Heavy cables connect the batteries and the starter A wiring harness is used to connect the generator, ammeter, headlight switch, air pre-heater and pre-heater switch (if the tractor is equipped with ignition type heater), to the electrical system. Twelve (12) gage wire is used to connect the generator to the ammeter, and fourteen (14) gage wire is used to connect the headlights to the wiring harness. A 20-ampere fuse, introduced in the wire leading to the headlights and located under the lower right corner of the radiator, prevents burning out the lights in event of a short-circuit.

Inspect the wiring frequently to detect any loose connections or frayed insulation. Tighten the connections and wrap any frayed spots on the wires with friction tape to prevent short circuits.

4. BATTERIES

A. Description

The batteries are 12-volt, wet cell type, located in compartments at the ends of the seats and are held solidly in position by special hold-down assemblies. The batteries are connected in series to provide 24-volt current.

B. Service

Check the level of the electrolyte in the batteries weekly, or as often as operating conditions prove it necessary. Maintain the level of the solution ⅜" above the plates by the addition of clean distilled water. *CAUTION: DO NOT OVERFILL.* Keep the battery and cable terminals tight and clean. If corrosion occurs, clean the battery posts and terminals with a strong soda solution. To prevent further corrosion, coat the terminals lightly with vaseline before connecting them again.

When air temperature is below the freezing point, special attention should be given to hydrometer readings of the batteries. The electrolyte in fully charged batteries will have a hydrometer reading of 1.280 to 1.300 specific gravity when corrected to 77° F. Specific gravity readings without correction for temperature are practically meaningless. For each 30 degrees that the temperature of the electrolyte is above 77° F., add 10 points to the hydrometer reading and for each 30 degrees below 77° F., subtract 10 points to get the true specific gravity. For example, if the hydrometer reading is 1.250 and the electrolyte temperature is 17° F. (60 degrees below 77° F.) 1.250 minus 20 points equals 1.230—the true specific gravity.

If the corrected readings are below 1.240, the batteries are not receiving sufficient charge. This might indicate that the generator or the generator regulator requires attention. If these units prove satisfactory, inspect the system for short circuits and loose or corroded connections. In zero weather, there is danger of batteries freezing if the specific gravity is below 1.175. Batteries with a specific gravity of 1.225 will freeze at 35° below zero F.

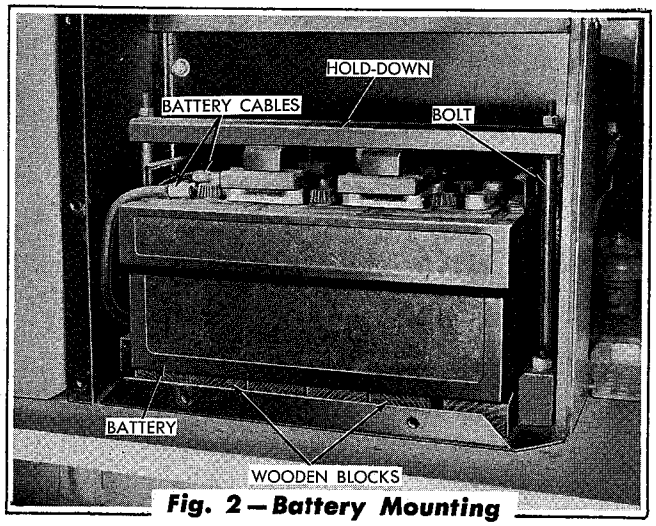


Fig. 2—Battery Mounting

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 make 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

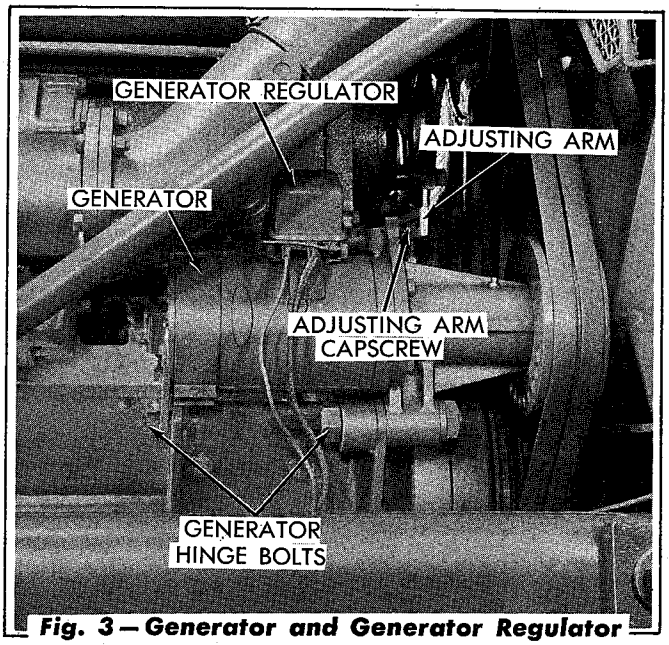


Fig. 3—Generator and Generator Regulator

A. Description

The generator is a bi-polar unit, controlled internally by an adjustable third brush and externally by a step-voltage control. The armature shaft is supported at both ends by ball bearings. The brushes are held in reaction type holders and bear on the commutator with a pressure of 25 ounces. The third brush bears on the commutator with a pressure of 17 ounces.

The generator is hinged from a bracket, attached to the right side of the cylinder block, and is driven by two (2) V-belts from the fan and the engine crankshaft pulleys.

The output of the generator is approximately 7 to 9 amperes when cold and 5 to 7 amperes when hot, at 2100 armature r.p.m.

1. Step Voltage Control

This unit is mounted on the generator field frame as shown in Fig. 3.

The purpose of the step-voltage control is to increase or decrease the generator output in accordance with the requirements of the batteries and the connected electrical load. When the batteries become properly

charged, a set of contact points in the control, open and shunt the generator field circuit through a resistance unit to the ground.

With the resistance unit in the field circuit, the generator maximum output is reduced approximately 4 to 8 amperes. If the batteries should become partially discharged, the contact points in the control close, removing the resistance from the field circuit, and the generator output increases to its maximum.

The voltage control does not increase the maximum output of the generator, as this is dependent entirely upon the design of the generator and the position of the third brush. Should the generator output be too high, the output may be reduced by adjusting the third brush to meet the desired output requirements. The voltage control unit will then reduce the output when the batteries become fully charged, and prevent high voltages within the electrical system.

2. **Cut-Out Relay**

The cut-out relay, a component part of the voltage control unit, closes the circuit between the generator and the batteries only when the generator voltage has built up sufficiently to charge the batteries. The cut-out relay opens the circuit when the generator slows or stops and the current begins to flow back from the batteries into the generator. Thus, a cut-out relay may be thought of as an electrical check valve which permits current to flow in only one direction from the generator to the batteries.

B. General Maintenance and Inspection

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

1. **Brushes**

The original length of the main brushes is 13/16"; the third brush 23/32". Replace the brushes if they are worn down to a length of 7/16". 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 well 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 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.

3. **Generator Drive Belt Adjustment**

Keep the drive belts in proper adjustment. They are correctly adjusted when the straight (right) side of the belts can be pressed inward approximately 1¼" at a point halfway between the fan and crankshaft pulleys.

To adjust the belts, loosen the capscrew in the adjusting arm at the front of the generator and loosen the generator hinge bolts (refer to Fig. 3). Then, move the generator in or out until the correct tension on the belts is obtained. Tighten the capscrew and the generator hinge bolts. Excessive belt tension causes rapid wear on the belts and the bearings, while low belt tension causes slippage, rapid belt wear, and possible failure of the generator to charge in a normal manner.

4. **Connections**

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

C. Testing and Adjusting of the Generator and the 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.

6. STARTER

A. Description

The starter is an 8-brush, 4-pole, heavy-duty unit, with the armature supported by bushings at the drive end, center, and commutator end. The unit is equipped with a heavy duty starter switch. A "DYER" drive is used at the rear end of the starter and provides for positive engagement of the starter pinion with the engine flywheel gear, before the starter switch contacts are closed or the armature is rotated. The pinion is thrown out of mesh with the flywheel gear by the reversal of the torque when the engine starts. A shift lever in the drive housing is connected to the starter rod. Operation of the shift lever first moves the starter drive pinion into mesh with the flywheel; completion of the shift lever movement closes the starter switch, so that the current can flow from the batteries to the starter.

B. 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 switch. 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 if repair or adjustment is necessary. With fully charged batteries and normal temperature of 70° F., the starter will take hold promptly and spin the engine at a good cranking speed (a minimum of 80 r.p.m. is required for dependable starting). Colder weather will, however, cause the engine to turn harder and the cranking speed will naturally be decreased. *CAUTION: The starter must never be used for more than 30 seconds at any one time without a pause to allow it to cool. The starter must NEVER be used to move the vehicle. Failure to observe these rules may result in complete failure of the starter.*

1. If the starter fails to operate properly, remove the cover band 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 34 to 40 ounces, and the brushes must not be worn shorter than half their original length of ½". 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 to the arm.

2. A dirty commutator should be cleaned with No. 00 sandpaper. *CAUTION: NEVER USE EMERY PAPER TO CLEAN IT.* If dust and dirt have accumulated in the starter, it should be blown out with compressed air as such accumulations are likely to interfere with the operation of both the motor and the drive assembly.

3. After extended use, the contact surfaces of the starter switch may become burned or corroded so that either no current at all, or insufficient current for starting, is transmitted to the motor. A slow cranking speed, or difficulty in keeping batteries charged, may indicate a faulty starting motor switch. The switch is easily disassembled for reconditioning of burned or corroded surfaces. To recondition the switch proceed as follows:

   a. Disconnect the battery ground cable from the right battery terminal and bend the cable upward to prevent contact with the battery terminal. Disconnect the battery cable at the starting motor.

   b. Remove the switch from the starter, then remove the bottom plate from the switch.

   c. Remove the contact disc from the plunger

by removing the castellated nut.

d. Clean and smooth the contacting surfaces with a file or sandpaper. Be sure that the surfaces contact over the entire area when reassembled.

C. Starter Drive Assembly

1. Disassembly, Cleaning, and Reassembly

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

a. Remove the starter. Refer to "STARTER REMOVAL AND INSTALLATION."

b. Separate the drive housing from the field frame after removing the capscrews that hold them together. Mark both housings before they are separated to establish relationship of one with the other.

c. Remove the cotter pin from the pinion stop, then remove the pinion stop, pinion, spring, pinion guide, shift sleeve, and the spacer washers from the armature shaft.

d. Clean all the parts thoroughly and inspect them.

e. Reassemble as follows: Place the following parts in the sequence given, on the drive end of the armature shaft—plain spacer washer, cupped washer (cup side away from field frame), and shift sleeve. Place the spring inside the hollow pinion, with the drive pinion guide next to the spring and the ears on the outside diameter of 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 down in the slots in the pinion. Slip the pinion stop in place, 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. Insert a cotter pin and secure in place.

f. Place the drive end housing assembly over the end of the armature shaft and against the center bearing plate, guiding the finger of the shift lever into the slot of the shift sleeve.

2. Starter Drive Adjustments

The "DYER" drive was properly adjusted at the factory and seldom requires readjustment. Failure to operate properly will usually be caused by dirt or damaged parts.

When the shift lever is moved to where the starter switch contacts are closed, there should be 1/8" to 3/16" travel of the pinion against the spring pressure. The pinion travel can be checked by pushing the pinion back against the spring pressure.

A test can be made to determine if the engagement action is being completed before the switch contacts are closed. This can be done by placing a 3/4" spacer between the pinion and the pinion stop. The shift lever can then be moved forward, forcing the pinion against the spacer. It should not be possible to close the switch contacts with the spacer inserted. When the pinion is in the driving position, there should be clearance between the pinion guide and the bottom of the slot, as indicated. If there is no clearance at this point, the drive will be taken directly from the lugs on the pinion guide, rather than from the heavy spline in the pinion itself. If there is no clearance at this point, the pinion and the pinion guide should be replaced. The pinion with its lock and lock spring is released by moving the pinion shift sleeve forward and along the splines of

the shaft. In reassembling the parts, the pinion lock lugs should be in the slots in the pinion hub, with the lugs toward the pinion, or the pinion will not be in the proper position to lock on the shaft. Lubricate the three starter bearings with engine oil.

D. Starter Removal and Installation

1. Disconnect the starting motor operating rod from the starter shift lever.

2. Disconnect the battery ground cable from the right steering clutch housing and tape the loose cable end to prevent a short circuit in the electrical system, when removing the starter motor cable from the starter switch.

3. Disconnect the starting motor cable, the starter ground, and the wire leading to the wiring harness from the starter switch.

4. Remove the three (3) capscrews attaching the starter to the flywheel housing and remove the starter.

5. Install the starter by direct reversal of the removal procedure.

SECTION VIII — INSTRUMENTS

1. DESCRIPTION

The instruments which are standard equipment on on the tractor and mounted on the instrument panel of the cowl consist of: engine oil pressure gage, engine temperature gage, fuel pressure gage and ammeter.

The hour meter, which may be obtained as special equipment, is mounted in the instrument panel.

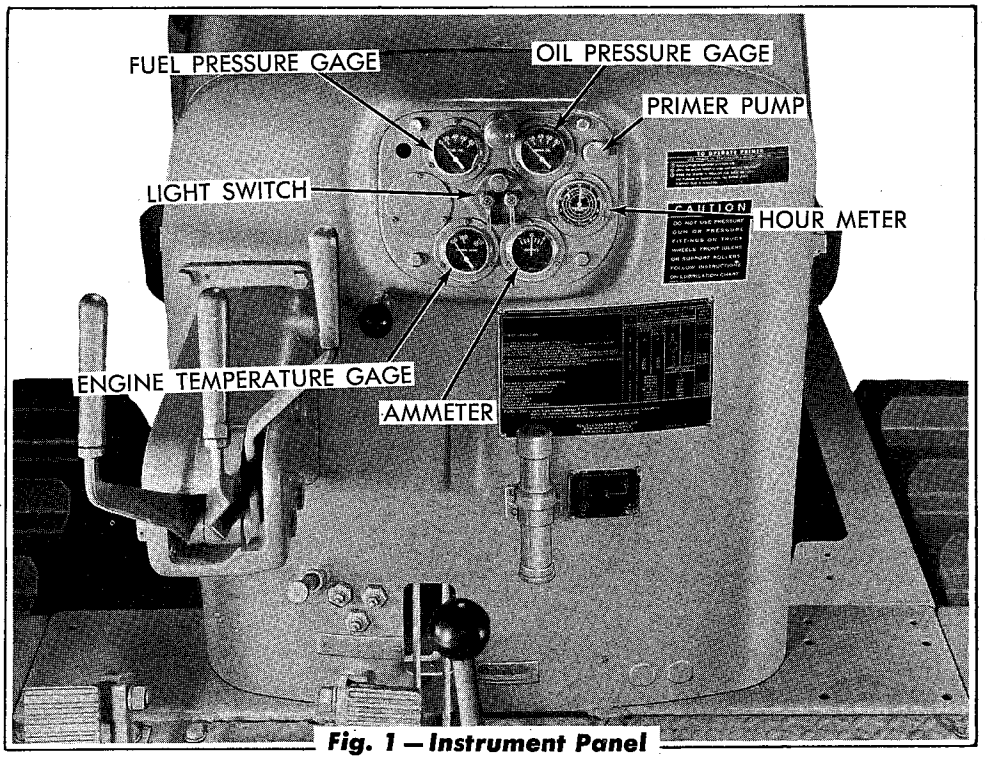


Fig. 1 — Instrument Panel

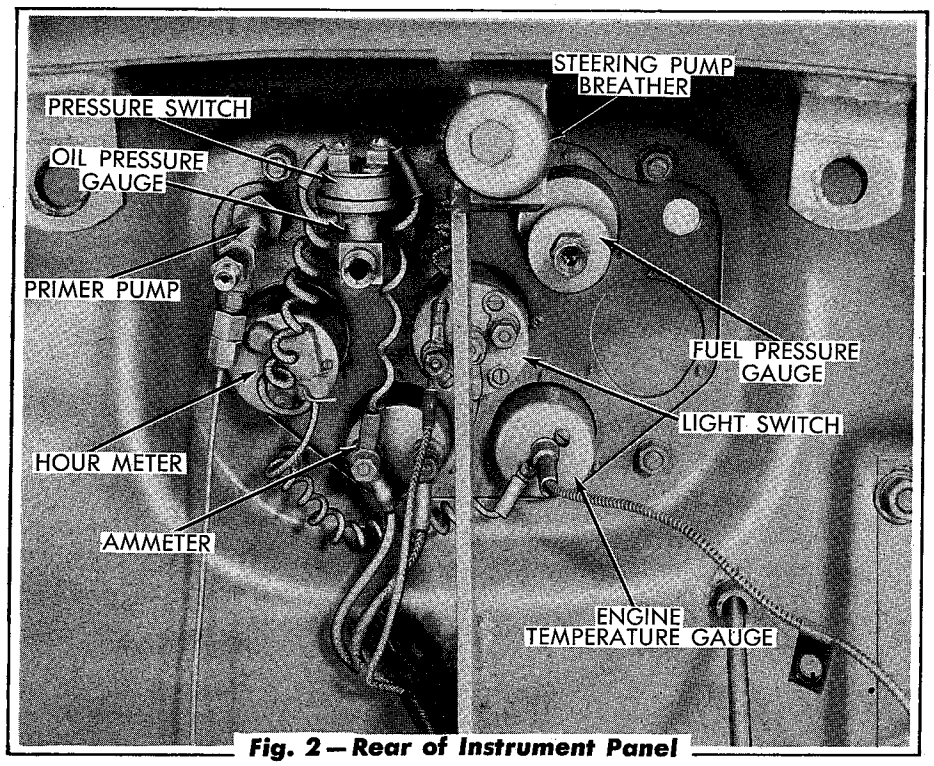


Fig. 2—Rear of Instrument Panel

2. ENGINE OIL PRESSURE GAGE

This gage registers the pressure at which the oil is circulated through the engine. The oil pressure gage tube is connected to a fitting on the left side of the engine block. With the engine running at high idle, the engine oil pressure should be between 45 and 60 pounds at normal engine operating temperature. *CAUTION: If no pressure registers on the gage or if the pressure is excessive (with the engine at normal operating temperature), the engine should be stopped immediately and the cause determined.*

3. ENGINE TEMPERATURE GAGE

The end of the engine temperature gage tube is inserted in, and connected to, the rear of the water outlet manifold. This gage registers the engine temperature, which should be maintained between 160° and 185° F. at all times. The temperature is controlled by two thermostats located in a thermostat housing mounted on the front of the water outlet manifold.

4. AMMETER

The ammeter registers the charging rate of the generator. When the batteries are in a discharged condition, the ammeter should register charge until the batteries approach a charged condition. When the batteries are fully charged, the ammeter will register nearly zero through the action of the generator regulator except for a short time after the starter has been used.

5. FUEL PRESSURE GAGE

The fuel pressure gage is mounted in the instrument panel and the fuel pressure gage tube is connected to a tee at the left rear of the engine.

The fuel pressure gage indicates the pressure at which the fuel is circulated through the fuel system. Under normal conditions, with the engine operating at full governed speed, this pressure should be 35 to 55 pounds. *DO NOT OPERATE ENGINE WITH FUEL PRESSURE ABOVE OR BELOW* Investigate for clogged filters, clog fuel lines or connections, leaks at c verter lines or improper fuel pump and pu lator valve operation.

NOTE: In order to obtain maximum efficiency from the torque converter, the fuel pressure must not be allowed to drop below 35 pounds.

6. HOUR METER (SPECIAL EQUIPMENT)

The hour meter registers the number of hours that the engine has operated. For instructions on how to read the hour meter, refer to "HOUR METER" in the Special Equipment Section.

7. INSTRUMENT SERVICE

Any one of the various instruments can be removed from the instrument panel by removing the attaching screws and disconnecting them from the wiring, tubes, etc., to which they are connected.

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

SECTION IX—ENGINE

1. DESCRIPTION

A. General

The "DIESEL" Engine is an internal combustion power unit. Fuel is atomized as it is injected into the cylinders and is ignited by the heat generated by the compression of the air within the cylinders. The expanding gases generated by the burning fuel are converted into energy in the cylinders of the engine.

In "DIESEL" Engines, air is compressed in the cylinder; then a charge of fuel is sprayed into the cylinder, after the air has been compressed, and ignition of the fuel is accomplished by the heat of the compressed air.

The engine in the HD20-H Tractor is a watercoooled, 6-cylinder, 2-cycle, "DIESEL" Engine.

B. The Two-Cycle "DIESEL" Engine

In the 2-cycle engine, intake and exhaust take place during part of the compression and power strokes. A 2-cycle engine, therefore, does not function as an air pump, so an external means of supplying the air is provided. A specially designed blower, bolted to the side of the engine, forces air into the cylinders in order to expel the exhaust gases and fill the cylinders with fresh air for combustion, as shown in Figs. 1, 2, 3 and 4.

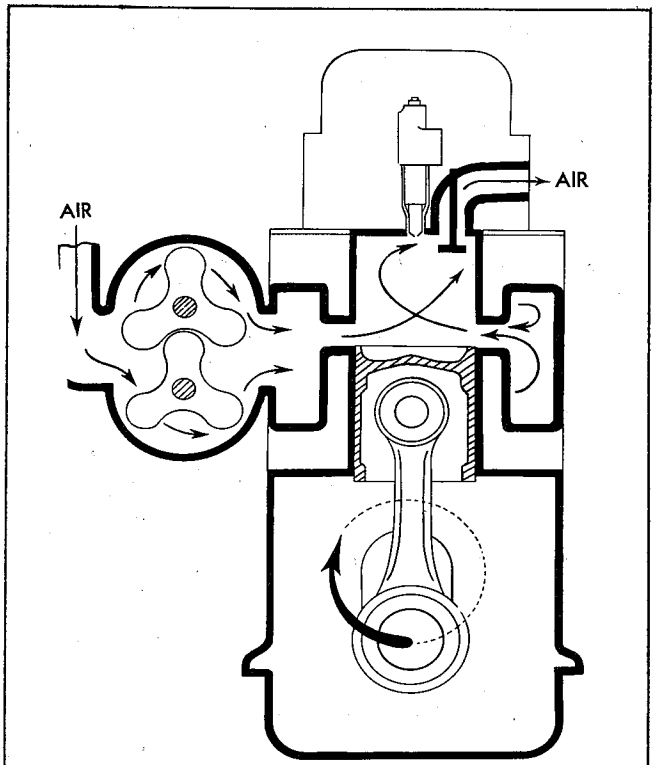


Fig. 1 — Air Entering Through Ports to Combustion Chamber

A series of ports cut into the circumference of the cylinder wall, above the piston, in its lowest position, admits the air from the blower into the cylinder as soon as the top face of the piston uncovers the ports in the cylinder liner as shown in Fig. 1. The flow of air towards the exhaust valves produces

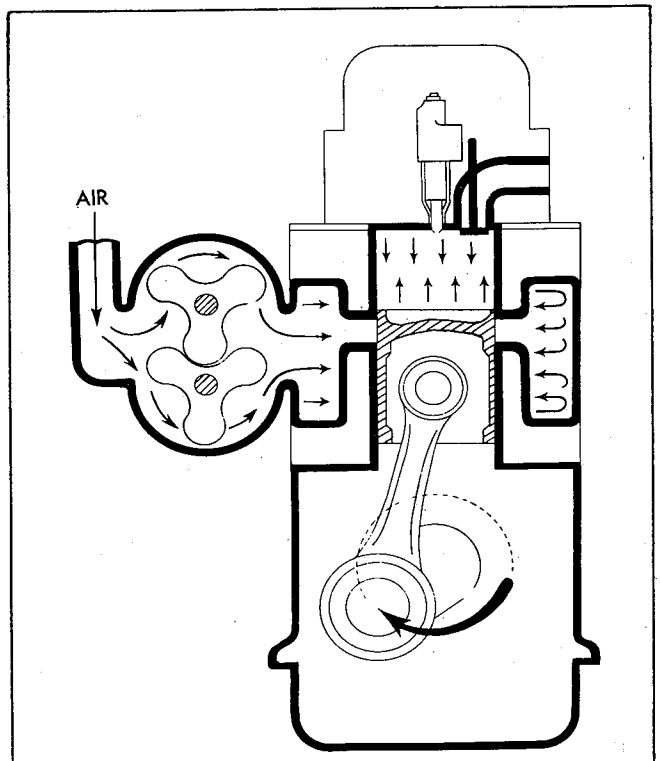


Fig. 2 — Air Being Compressed with Exhaust Valves Closed

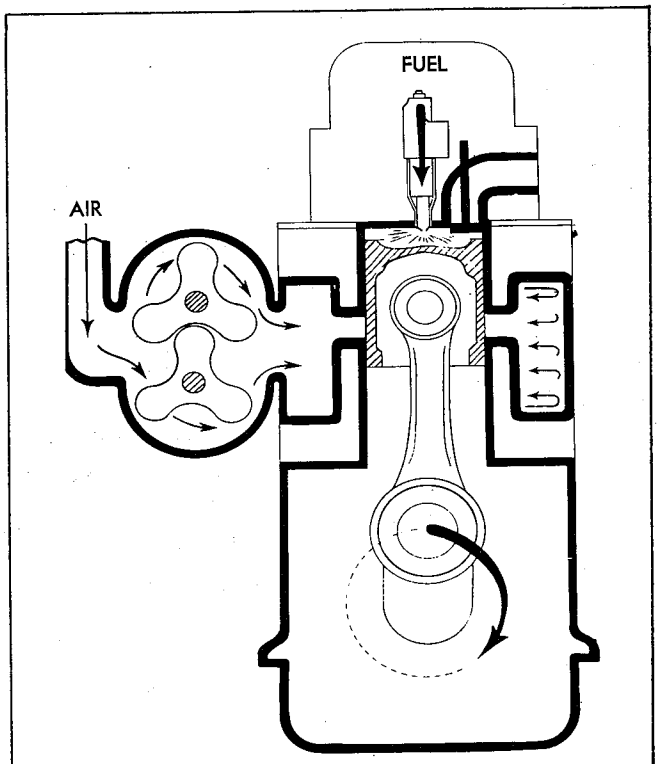


Fig. 3 — Charge of Fuel Being Injected Into Combustion Chamber

a scavenging effect, leaving the cylinders full of clean fresh air when the piston again covers the inlet ports.

As the piston continues on the upward stroke, the exhaust valves close and the charge of fresh air is subjected to the final compression, as shown in Fig. 2. This engine is designed for a highly efficient 18 to 1 compression ratio.

Shortly before the piston reaches its highest position, the required amount of fuel is sprayed into the combustion space by the unit fuel injector, as shown in Fig. 3. The intense heat generated during the high compression of the air ignites the fine fuel spray immediately, and the combustion continues as long as the fuel spray lasts. The resulting pressure forces the piston downward until the exhaust valves are again opened. As shown in Fig. 4, the burned gases escape into the exhaust manifold as the downward moving piston is about to uncover the inlet ports.

When these ports are uncovered, the entire cylinder is again swept with clean scavenging air, as shown in Fig. 4. This entire combustion cycle is completed in each cylinder for each revolution of the crankshaft, or in other words, two strokes; hence, the "2-stroke cycle."

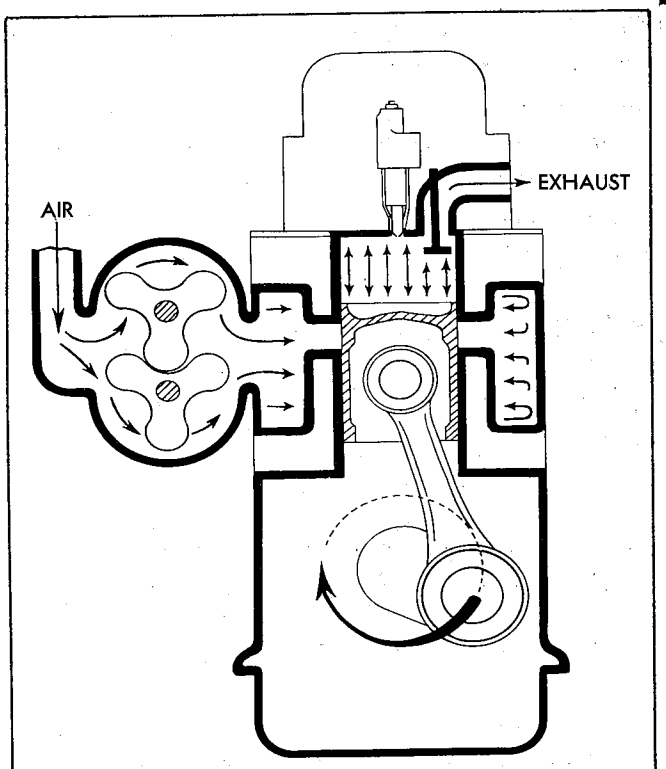


Fig. 4 — Exhaust Taking Place and Cylinders About to Be Swept with Clean Scavenging Air

2. CYLINDER HEAD

A. Description

The cylinder head is a one-piece casting which can be removed from the engine as an assembly containing the injectors, cam followers, guides, rocker arms, and valves. The head is securely bolted to the upper part of the cylinder block.

Located in the head are two exhaust valves, two valve seats, two valve guides, a fuel injector, and three rocker arms, for each cylinder. The center rocker arm operates the injector plunger; the other two operate the exhaust valves. The valve guides are pressed into the cylinder head and hold the valve heads in accurate alignment with the valve seats which are also pressed into the head.

To provide efficient cooling, each fuel injector is inserted into a thin walled copper tube passing through the water passages into the cylinder head. The lower end of the copper tube is pressed into the cylinder head and spun over; the upper end is flanged and sealed with a neoprene seal. The spun-over lower end and the sealed upper end prevent any water leaks around the copper tube.

Two exhaust passages from each cylinder lead through a single port to the exhaust muffler. The exhaust passages, exhaust valve seats, and injectors are surrounded with engine coolant.

To seal the compression, a laminated circular gasket composed of steel sheets is installed between the cylinder head and the top of each cylinder liner. A neoprene gasket is installed between the cylinder head and the cylinder block, around the openings for the valve operating mechanism, to provide an oil seal. Circular rubber gaskets are used between the cylinder head and the cylinder block to avoid engine coolant leaks. The top of the cylinder head is completely enclosed by an oil tight rocker arm cover, which is held in place by four (4) screws fitted with hand knobs. A rubber gasket, held in place around the perimeter of the rocker arm cover by the flanged edge of the cover, is used as an oil seal between the top of the cylinder head and the cover.

B. Service of Parts Contained in Cylinder Head

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

1. Operations not Requiring the Removal of the Head

a. Timing, equalizing, or replacement of injectors.

b. Adjustment of valve lash.

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

d. Replacement of push rods or cam follower assemblies.

c. Replacement of fuel manifolds.

2. Operations Requiring the Removal of the Head

a. Grinding, reseating, or replacement of the valves and valve seats.

b. Replacement of the valve guides.

c. Replacement of the injector copper tubes.

C. Cylinder Head Removal

1. Remove the air pre-cleaners from the air cleaner center tubes, then remove the engine hood and the front and rear air cleaner tubes from the air cleaners and air inlet elbows. Refer to "AIR INTAKE SYSTEM" Section 3.

2. Drain the engine cooling system (refer to "ENGINE COOLING SYSTEM" Section 4). Remove the radiator inlet hose and elbow.

3. Remove the exhaust muffler from the cylinder head and remove the engine thermo gage from the rear of the water manifold.

4. On engines after Serial Number HD20 4543 remove the four (4) capscrews used to attach the air cleaner support bracket to the cylinder head. Tractors prior to the above Serial Number have a different air cleaner mounting arrangement and the above procedure is not necessary.

5. Disconnect the cylinder block to cylinder head lubricating oil tube assembly and the fuel supply tube assembly at the elbows on the left front of the cylinder block. Also disconnect the fuel return tube assembly at the elbow on the left rear of the cylinder head.

6. Thoroughly wash all dirt from the upper part of the engine and from the governor housing, then remove the rocker cover from the cylinder head and the governor control housing cover from the governor housing.

7. Remove the link connecting the governor to the injector control tube lever, then remove the two (2) capscrews used to attach the flange of the governor control housing to the cylinder head. Do not lose the gasket when removing the capscrews. On early model engines, loosen the attaching hose clamp on the connector flange and slide the hose over the connector to free it from the governor housing.

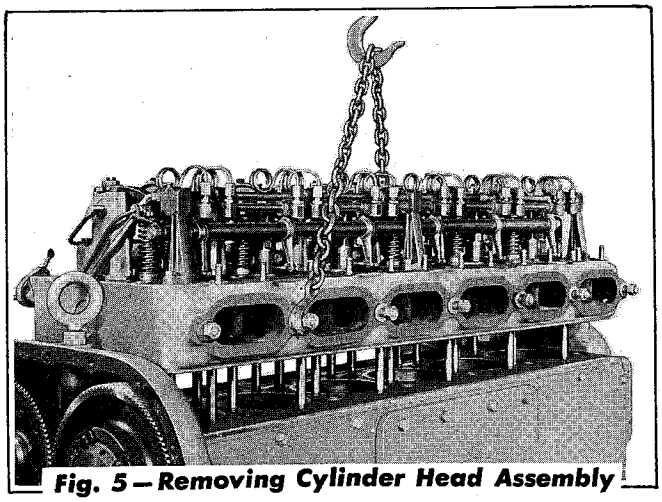


Fig. 5—Removing Cylinder Head Assembly

8. Remove the nuts and special washers from the cylinder head studs, then, using a chain and hoist or other suitable equipment, raise the cylinder head assembly from the cylinder block and place it on a clean work bench.

NOTE: Place a wood block crosswise under each end of the cylinder head to prevent the cam followers and injector tips from contacting the bench.

D. Cylinder Head Disassembly

If the cylinder head has been removed for replacement by a new cylinder head, removal of the following parts from the cylinder head will be required. Refer to Figs. 6 and 7 for relative location of parts.

1. Remove the fuel manifold to injector tube assemblies, then remove the fuel supply and fuel return lines from each end of the fuel manifold assembly.

2. Remove the two (2) capscrews attaching the fuel manifold supports to the No. 2 and No. 4 rocket shaft brackets, then remove the six (6) capscrews from the fuel manifold brackets and lift the manifold from the cylinder head.

3. Remove the two (2) capscrews from each injector control tube bracket and remove the control tube and the brackets from the cylinder head.

4. Remove the water outlet manifold from the top of the cylinder head and scrape all remnants of the gaskets from the manifold and cylinder head.

5. Remove the injectors from the cylinder head. Refer to "ENGINE FUEL SYSTEM," Section II.

6. Remove the valve operating mechanism. Refer to Topic 3 in this section.

7. Remove the injector copper tubes. Refer to "ENGINE FUEL SYSTEM," Section II.

8. If the cylinder head is to be reconditioned, remove all exhaust muffler studs, water manifold studs, rocker cover studs, injector clamp studs, valve guides, water nozzles, and breather hole screens from the head. After the head has been reconditioned, the above parts, with the exception of the water noz-

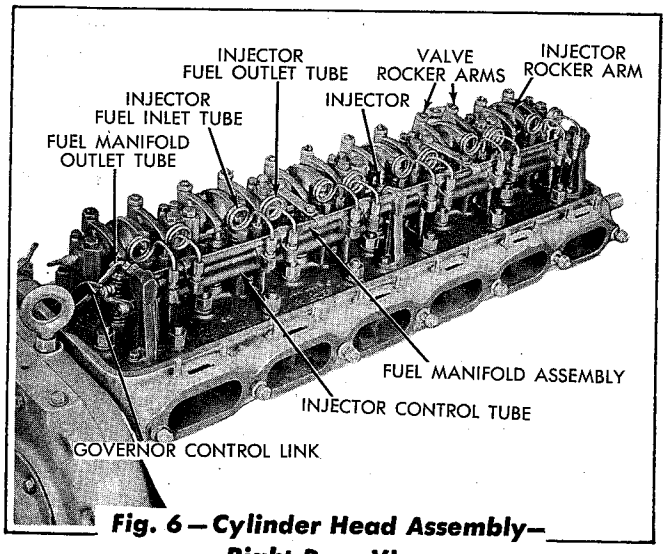


Fig. 6—Cylinder Head Assembly—Right Rear View

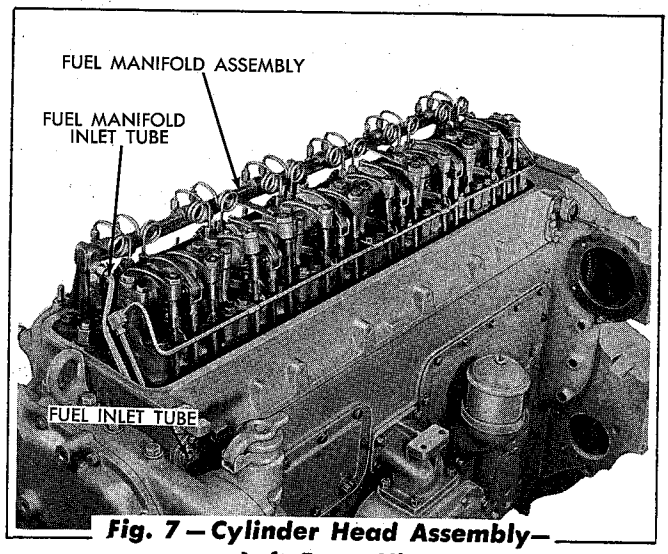


Fig. 7—Cylinder Head Assembly—Left Front View

zles, will be installed in the reconditioned head. If the cylinder head is to be replaced, removal of the above parts is not necessary as the new head assembly will contain the above parts.

E. Inspection

All parts removed from the cylinder head must be thoroughly cleaned and inspected before installing them in the reconditioned or new head. The proper procedure to be followed in making the inspection and installation of the various parts will be found under "EXHAUST VALVES AND OPERATING MECHANISM" in this section and in "ENGINE FUEL SYSTEM," Section II.

F. Cylinder Head Parts Installation

New cylinder heads are furnished with valve guides, valve seat inserts, water nozzles, studs, pipe plugs and a fuse plug. When a cylinder head change is made, the parts removed from the discarded head or corresponding new parts should be installed in the head before the head is attached to the cylinder block. These parts, or subassemblies, consist of the following:

1. Valves and valve springs.
2. Cam followers, follower springs, spring retainers, and push rods.
3. Rocker arm assemblies for valve and injectors. Refer to pertinent paragraphs in this section for installation and adjustment procedures on the above three (3) items.
4. Fuel injectors and injector control tube assembly.
5. Fuel manifold assembly. Refer to "ENGINE FUEL SYSTEM" Section II for information on the above two (2) items.
6. Water manifold, including the thermostat housing. Refer to "ENGINE COOLING SYSTEM," Section IV.

G. Cylinder Head Assembly Installation

With the parts itemized in Topic "F" installed in the cylinder head, install the cylinder head as follows:

1. Clean the top surface of the cylinder block and the bottom surface of the cylinder head thoroughly, being especially careful to remove all foreign matter from the water seal recesses in the cylinder block and from the cylinder gasket recesses above the cylinder liners.
2. Install twelve (12) water hole seal rings (1⅛" I.D.), twelve (12) rings (⅜" I.D.) diameter and two (2) rings 13/16" diameter in the proper recesses in the cylinder block.
3. Place the cam pocket oil seal ring in its groove on top of the cylinder block and place one (1) cylinder gasket in position in the recess above each cylinder liner with the flange of the gasket down.

4. Loosen the lock nuts on the valve lash adjusting screws and back out the screws until the ends of the threads next to the ball end of the screws are flush with the bottom face of the rocker arms. The valve push rod sockets must be screwed on the push rods until the push rods "bottom" in the sockets. Also, turn the jam nut down on the injector push rod then turn the push rod into the injector rocker arm clevis, until the upper end of the push rod is flush with the inside of the clevis yoke.

5. Using suitable hoisting equipment, lower the cylinder head over the studs and into place on the cylinder block. NOTE: On engines prior to Serial Number 6B-2750, make certain that the valve rocker shaft bracket hold-down capscrews are loosened just enough so that the rocker shaft bracket base plates can be shifted and properly aligned with the cylinder block studs, when lowering the cylinder head into position on the cylinder block. 2On engines Serial Number 6B-2750 and above, different type rocker shaft bracket base plates were provided making the above instructions unnecessary.

6. On engines prior to Serial Number 6B-2750 (having early type rocker shaft bracket base plates), it is unnecessary to tighten the capscrews securely before the cylinder head nuts are tightened. On these engines, tighten the rocker shaft bracket down capscrews, to prevent shifting of the rocker shaft bracket base plates, then INSTALL AND TIGHTEN the cylinder head nuts a little at a time until the proper torque of 150-160 Ft. lbs. is obtained. Refer to Fig. 8 for proper tightening sequence.

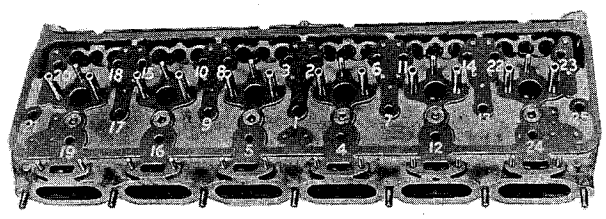


Fig. 8 — Sequence Chart — Cylinder Head Stud Nuts

On engines Serial Number 6B-2750 and above, install a flat washer in each stud and install and tighten the cylinder head nuts a little at a time until the proper tightening sequence. Make certain that the rocker shaft bracket holding capscrews are tightened securely.

7. Connect the governor control housing attaching flange to the cylinder head. On early model engines, position the hose on the connector flange and governor housing. Tighten the hose clamp securely. Also connect the fuel supply and return lines to the cylinder head.

8. Install the rocker shaft oil line assembly to the rocker shaft and clip in position with the four (4) clips. Install the cylinder head to cylinder block oil tube assembly.

9. Attach the air cleaner support bracket to the cylinder head with four (4) capscrews. This is necessary on engines above Serial Number 4543 only.

10. Install the link connecting the injector control tube lever to the governor and replace the governor control housing cover assembly using a new gasket if necessary.

11. Install the engine thermo gage in the rear of the water manifold.

12. Install the exhaust muffler, using new gaskets between the muffler and the cylinder head, then install the front and rear air cleaner tubes, being sure that the attaching hoses are in good condition and that the hose clamps are tight. This is very important to assure leak-proof sealing at these points.

13. Attach the radiator inlet hose to the water manifold elbow and fill the engine cooling system. Refer to "FILLING AND DRAINING OF SYSTEM" in Section IV.

14. After the installation of the cylinder head is completed, adjust the valve lash (refer to "VALVE LASH ADJUSTMENT" in this section). Time and equalize the injectors (refer to "INJECTOR TIMING" and "INJECTOR EQUALIZING" in Section II).

15. Pour approximately one quart of lubricating oil on the valve rocker mechanism, then start the engine and inspect all air, water, and fuel connections to be sure that there are no leaks, particularly on the fuel manifold to injector tube assemblies.

16. Examine the rocker cover gasket and replace if necessary. Install the rocker cover, engine hood, and air pre-cleaners.

3. EXHAUST VALVES AND OPERATING MECHANISM

A. Description

The exhaust valves are made of silichrome steel and 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 seat inserts, shrunk into the cylinder head, are accurately ground to very close limits and their freedom from warpage under ordinary working conditions reduces valve grinding to a minimum. The valve guides, made of fine-grained cast iron, are pressed into the cylinder head for the desired fit. A straight cylindrical valve spring, made of alloy steel, is held in place by the valve spring cap and a tapered two-piece lock.

Three drop FORGED rocker arms are provided for each cylinder. The inner rocker arm operates the injector and the two outer rocker arms operate the exhaust valves. The rocker arm assemblies for each cylinder are supported by a separate rocker shaft which is supported by two (2) cast iron brackets. A 3/16" thick base plate is used between the cylinder head and the bottom of the front and the rear rocker shaft bracket. A base plate of the same thickness is used between the cylinder head and each adjacent pair of the remaining rocker shaft brackets, the bottom surface of these base plates contain a groove between the adjacent rocker shaft bracket hold-down bolts for an oil passage.

One short and one long bolt fasten each rocker shaft bracket to the cylinder head. The long bolt fits loosely in the bracket, thus providing an oil passage to the hollow rocker shaft from which the rocker arm bushings are lubricated.

A clevis joins one end of each injector rocker arm to a push rod; the opposite end has a ball joint which operates on the fuel injector plunger follower. The push rod end of each valve rocker arm carries a ball on an adjusting screw which rides in a socket at the upper end of each push rod. Thus, the injector rocker arms are the only ones joined by the push rod. By removing the valve rocker bracket bolts, each group of rocker arms may be tilted back providing free access to the injector and valve springs. The rocker arms are operated through the cam followers and the push rods.

The roller of each cam follower assembly is always in contact with the camshaft. The roller of each cam follower assembly contains a plain bearing and the roller and the plain bearing are assembled in a pin of the cam follower assembly. The rollers of the cam follower assemblies are held squarely in respect to the camshaft by cam follower guides, which are bolted to the bottom of the cylinder head. A separate coil spring (cam follower spring) located inside of each hollow cam follower assembly, is held in place by a retaining washer (upper spring seat) and a snap ring (upper spring seat retainer).

Oil for the valve operating mechanism is pumped through an oil pipe leading from the oil gallery in the cylinder block to the front rocker arm shaft bracket where oil is supplied into the cavity surrounding one of the rocker shaft bracket bolts. From the bracket bolt cavity, oil is fed to the hollow rocker arm shaft and thence to each rocker arm bushing. Surplus oil within the hollow shaft flows into the cavity surrounding the bracket bolt of the opposite shaft bracket, thence across to the adjacent bracket of the next cylinder via a slot in the plate beneath the two adjacent brackets. This process is repeated for the group of rocker arms for each engine cylinder. Oil that spills from the rocker arms onto the cylinder head deck, lubricates the valves, injectors, and cam followers then returns through openings to the engine crankcase. An oil tube assembly, leading from a tee fitting in the front rocker arm shaft bracket to an elbow in the rear rocker arm shaft conducts additional lubricant to the rear of the engine to assure an ample supply of lubricant to the valve mechanism and cam followers.

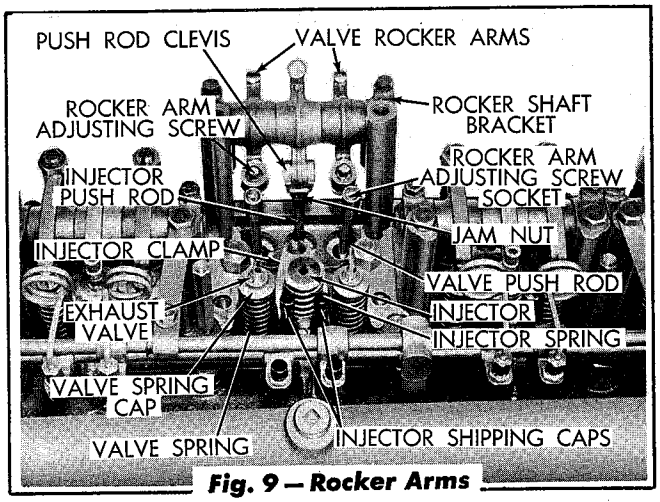


Fig. 9 — Rocker Arms

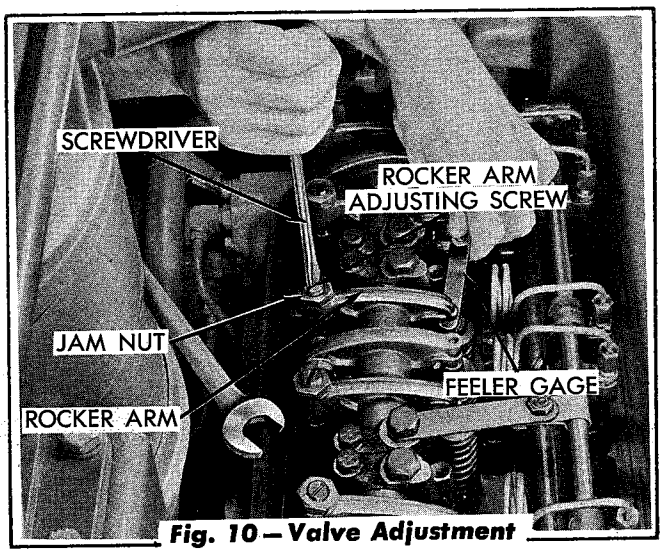


Fig. 10 — Valve Adjustment

B. Service

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

1. Adjustment of valve lash.
2. Removal or replacement of a rocker arm.
3. Removal or replacement of a valve spring.
4. Removal or replacement of rocker arm, shaft or shaft bracket.

It is also possible, if occasion requires, to remove or replace a cam follower or a push rod without removing the cylinder head.

The cylinder head must be removed to perform the following valve operations:

1. Remove or replace a valve or a valve insert.
2. Remove or replace a valve guide.
3. Grind valves or valve seat inserts.

C. Valve Lash Adjustment

Correct clearance between the ends of the valve stems and the rocker arms is very important in a "DIESEL" Engine because of the high compression pressures developed. Insufficient valve clearance will cause loss of compression, "missing," and eventual burning of valves and valve seats. Excessive valve clearance will result in loss of power, noisy engine operation, and rapid wear on the valve operating mechanism. Adjustment should be made to allow .009" clearance with engine at operating temperature.

After any mechanical work has been done which would disturb the valve setting, the valves may be set "cold" to .012" clearance so that the engine may be run and allowed to warm up to operating temperature in preparation to the final correct adjustment.

1. Remove the hood and the rocker arm cover.
2. Rotate the engine with the starter until the injector rocker arm is down and the injector plunger is at the bottom of its stroke. The valves for that cylinder will then be closed and the valve rocker arms will be raised off the valve stems.
3. Check the clearance between the valve stems and the rocker arms. When adjusted properly a .009" feeler gage should pass between them with a slight drag when the engine is at normal operating temperature. Adjust each valve by loosening the jam nut on the rocker arm adjusting screw and turn the screw to obtain .009" clearance between the valve stem and the rocker arm. Tighten the locknut and recheck clearance with feeler gage to be sure that the clearance was not changed by tightening the lock nut.
4. Rotate the engine and repeat the above operations on the valves for each cylinder. Replace the rocker arm cover and the hood.

NOTE: The valves on this engine may also be adjusted with the engine running at idling speed. However, when adjusting the valves with the engine running, care must be taken to prevent damage to the rocker arm mechanism, which might occur if the screwdriver is allowed to slip from the slot in the adjusting screw.

If, for any reason, a socket has been removed from a valve push rod, be sure, when reassembling, to turn the socket on the push rod as far as it will go and bottom it securely to lock it in position.

If an adjusting screw has been removed from a valve rocker arm, be sure to turn the adjusting screw into the rocker arm until the end of threads, next to the ball, are flush with the bottom face of the rocker arm. If this is not done, the valve will open too far and the piston may strike the valve when the piston moves to the top of its stroke.

D. Rocker Arm Removal, Inspection, and Installation (Cylinder Head Not Removed from Engine)

1. Clean the dirt off the valve rocker arm cover and remove the cover.

2. Loosen the rocker shaft bracket clamping bolts in the rocker shaft brackets and remove the rocker shaft bracket attaching bolts. Swing the rocker arm assembly away from the valves and the injector. If it is necessary to remove the front rocker shaft bracket for the No. 1 cylinder or the rear rocker shaft bracket for the No. 6 cylinder, disconnect the oil feed line for the No. 1 bracket at the fitting in the bracket, also disconnect the oil feed line from the fitting in the end of the rocker arm shaft in the No. 6 rocker shaft bracket.

3. Remove the rocker shaft bracket clamping bolts. Remove the shaft brackets from the shaft and slide the shaft out of the rocker arms. To remove the injector rocker arm, loosen the jam nut on the injector push rod and unscrew the clevis from the push rod.

4. Inspect the bushings inside the rocker arms for wear. Normal clearance between the shaft and the bushings is .001" to .0025" and must not exceed .004". Replace the bushings if they are excessively worn. Ream new bushings to allow .001" to .0025" clearance with the shaft. Clean out the oil holes in the rocker arms, bracket bolts, and rocker shafts with solvent, small wire, and compressed air. Smooth the ends of the rocker arms if they are worn and cupped by contact with the valve stems.

5. Lubricate the outside of the rocker arm shaft with light engine oil and install the rocker arms and the shaft by reversing the sequence of operations for removal (refer to Fig. 9). Install and tighten the rocker shaft bracket attaching bolts before tightening the rocker shaft bracket clamping bolts.

6. Turn the jam nut down on the injector push rod then turn the push rod into the injector rocker arm clevis until the end of the push rod is flush with the inside of the clevis yoke.

7. *CAUTION: Make certain that the adjusting screw in each valve rocker arm is turned into the rocker arm so that the end of threads, next to ball, are flush with the bottom face of the rocker arm.* If this is not done, the valve will open too far and the piston may strike the valve when the engine is turned and damage to the valve, push rod, or piston will result. Also make certain that the oil feed line to the front rocker shaft bracket and the oil line to the rear rocker shaft are connected.

8. Adjust the valve lash (refer to "VALVE LASH ADJUSTMENT" in this Section). Time and equalize the injectors (refer to "INJECTOR TIMING" and "INJECTOR EQUALIZING" in Section II).

9. Install the rocker arm cover.

E. Removal, Inspection, and Installation of Cam Follower Assemblies (Cylinder Head Not Removed from Engine)

1. Clean the dirt off the valve rocker arm cover and remove the cover.

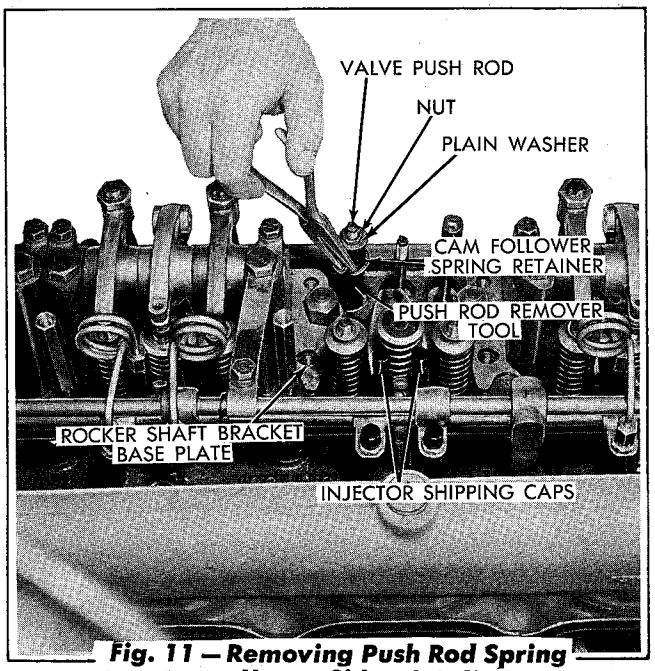


Fig. 11 — Removing Push Rod Spring Retainer from Upper Side of Cylinder Head

2. Remove the rocker arms (refer to "ROCKER ARM REMOVAL, INSPECTION, AND INSTALLATION" in this Section). To remove the injector rocker arm, loosen the jam nut on the injector push rod and unscrew the clevis from

3. Remove the rocker arm adjusting screw sockets from the valve push rods.

4. Compress the cam follower spring and remove the cam follower spring retainer with special long nose pliers as shown in Fig. 11.

5. Lift the push rod and spring assembly from the cylinder head, then insert a finger into the cam follower and slide the follower up out of the head.

6. If the cylinder head is removed from the engine, the follower assemblies can best be removed from the cylinder head by removing the cam roller guides from the bottom of the cylinder head and sliding the complete assembly out through the bottom of the head.

7. After the cam followers have been removed, they should be cleaned in solvent, blown dry with compressed air, and inspected before they are again assembled into the cylinder head.

8. The cam rollers must rotate smoothly and freely. Measure the total clearance between the cam follower roller bushing and the pin. Since the cam forces the cam follower roller against the bottom-side of the pin during the engine operation, all the wear is taken on the bottom side of the pin. The clearance between the roller bushing and the pin must be taken crosswise to the direction of operation of the cam follower body (across the unworn diameter of the pin). By measuring the clearance in this manner, a better indication of bushing wear is determined as the measurement is taken across the unworn diameter of the pin. The maximum clearance between the roller bushing and pin is .015" before replacement is indicated. The cam rollers must be free of flat spots or scuff marks. The presence of such marks are indications that the rollers have not been rotating freely. If such marks exist on the rollers, inspect the cams on which the rollers have operated. If the noses of the cams are worn or scuffed, replace the camshaft. *NOTE: NEW OR SOLVENT CLEANED CAM FOLLOWER ASSEMBLIES MUST BE IMMERSED IN CLEAN LUBRICATING OIL FOR AT LEAST FIVE MINUTES BEFORE INSTALL-*

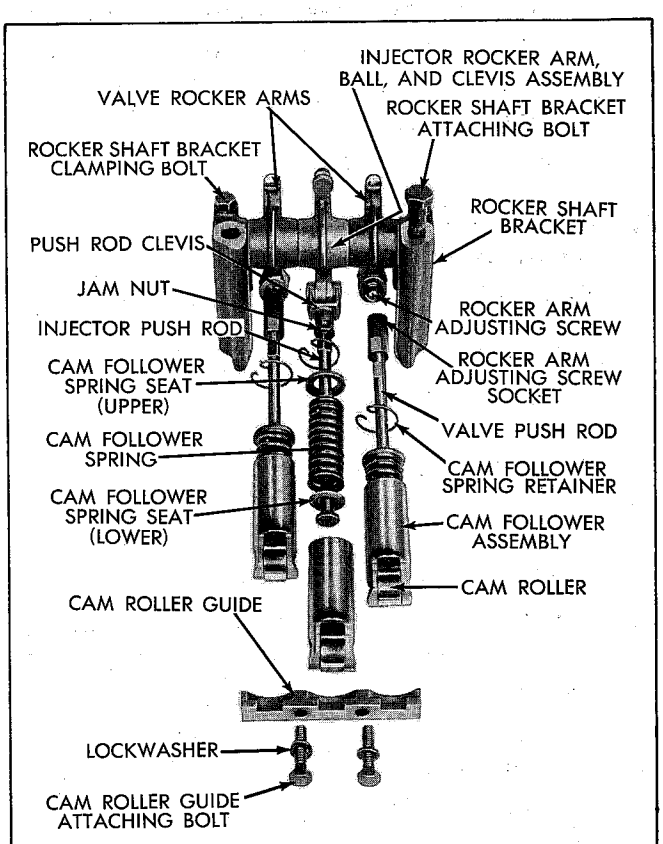


Fig. 12 — Cam Follower and Rush Rod Assembly

ING THE FOLLOWER ASSEMBLIES INTO THE CYLINDER HEAD. THIS WILL ASSURE INITIAL LUBRICATION OF THE FOLLOWER ASSEMBLIES WHICH IS ESSENTIAL TO SATISFACTORY FOLLOWER PERFORMANCE.

9. When installing the cam follower and push rod assembly with the cylinder head not removed, refer to Fig. 12 and proceed as follows:

   a. With roller end of cam follower down and with roller crosswise of cylinder head, insert the cam follower into the cylinder head. Make certain that the roller engages the slot in the roller guide and that the hole in the bottom of the cam follower is to the outside of the cylinder head.

   b. With the spring retainer removed, and with the lower spring seat, follower spring, and upper spring seat installed on the push rod, insert the push rod assembly into position in the follower.

   c. Compress the cam follower spring and install the spring retainer in the groove in the cylinder head, above the upper spring seat.

   d. Install the rocker arm adjusting screw sockets on the valve push rods and tighten securely. Turn the jam nut down on the injector push rod, then turn the push rod into the injector rocker arm clevis until the end of the push rod is flush with the inside of the clevis yoke.

   e. Install the valve rocker arms, rocker shaft, and the rocker shaft brackets as explained in "ROCKER ARM REMOVAL, INSPECTION, AND INSTALLATION" in this Section.

10. When installing the cam follower and push rod assembly with the cylinder head removed, refer to Fig. 12 and proceed as follows:

    a. Install the follower spring retainer in the groove in the cylinder head.

    b. With the cam follower spring seats and the spring installed in position on the push rods, slide the push rod assemblies into position from the bottom of the cylinder head.

       Lubricate the cam follower and roller, and with the cam roller crosswise of the cylinder head, slide the cam followers into position in the bottom of the head.

    c. Insert the attaching bolts in the cam roller guide and place the guide in position so that the cam rollers engage with the slots in the guide. Tighten the attaching bolts securely.

    d. Install the cylinder head on the cylinder block, then complete the assembly of the injector and valve rocker arms, rocker shaft, and rocker shaft brackets as explained in "ROCKER ARM REMOVAL, INSPECTION, AND INSTALLATION" in this Section.

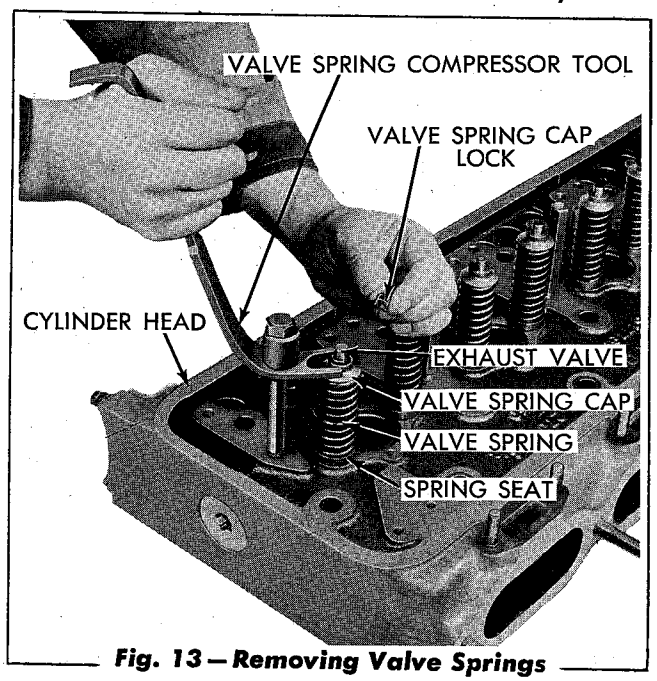


Fig. 13—Removing Valve Springs

F. Exhaust Valve Spring Removal and Installation (Cylinder Head Not Removed from Engine)

Removal of the cylinder head is not necessary if replacement of the exhaust valve springs only is desired. However, special care should be taken to prevent the valves from falling into the cylinders when the springs are removed. If this should occur, it would be necessary to remove the cylinder head in order to retrieve the fallen valve.

1. Remove the rocker arm cover and turn the engine until the piston, in the corresponding cylinder for which the valve spring is to be replaced, is at the top of its stroke. The piston is at the top of its stroke when the injector rocker arm is down (injector plunger at bottom of its stroke).
2. Loosen the rocker shaft bracket clamping bolts in the rocker shaft brackets and remove the rocker shaft bracket attaching bolts. Swing the rocker arm assembly away from the valves and the injector. If it is necessary to remove the front rocker shaft bracket for the No. 1 cylinder or the rear rocker shaft bracket for the No. 6 cylinder, disconnect the oil feed line from the No. 1 bracket at the fitting in the bracket, also disconnect the oil feed line from the fitting in the end of the rocker arm shaft in the No. 6 rocker shaft bracket.
3. Insert one of the long rocker arm bracket attaching bolts through the valve spring compressor tool spacer and the compressor tool. Turn the capscrew into the tapped hole of the cylinder head,nearest the valve spring to be removed (refer to Fig. 13).
4. Depress the valve spring and remove the valve spring cap locks. Lift the spring cap, spring, and spring seat from the valve and valve guide.
5. Inspect the valve spring, cap, and seat for wear or damage and replace the necessary parts. A load of 191 to 201 lbs. is the specified load to compress an exhaust valve spring to the length of 2-31/64". The spring should be replaced if a load of less than 180 lbs. will compress the spring to 2-31/64" length.
6. Install the spring by reversing the sequence of operations for its removal. Install the rocker arm assembly as explained in "ROCKER ARM REMOVAL, INSPECTION, AND INSTALLATION."

G. Exhaust Valve Spring Removal and Installation (Cylinder Head Removed from Engine)

When an exhaust valve spring is being removed with the cylinder head off the engine, the operation is done with the same tool as when the head is in place, and in a similar manner. In order to hold the valves in place, however, when the springs are being compressed, the valve heads should rest on a wood block.

NOTE: Remove all injectors to avoid damaging injector spray tips when resting valve heads on wood block.

H. Removal and Installation of Exhaust Valves, Guides, and Seats

1. Remove the cylinder head from the engine (refer to "CYLINDER HEAD REMOVAL" in this Section). Lay the cylinder head on a work bench right side up, with the valve heads resting on a 2" thick block of wood to protect the cam follower rollers which project through the bottom of the head.
2. Remove the valve springs as described in "EXHAUST VALVE SPRING REMOVAL AND INSTALLATION." Then turn the head over on its side and slide the valves out of the head. Place the valves in a rack as they are removed so they can be reinstalled in the same order.
3. Clean the carbon from the valves and seats and clean the carbon from the valve guides with a tool similar to the one shown in Fig. 16. This is an expanding device which may be rotated in the valve guides to remove all gum or other foreign deposits.

   If the above tool is not available, a stiff wire brush slightly more than 3/8" in diameter may be used to clean the guides.
4. Replace the valves if they are bent or worn. The valve stem diameter is from .372" to .373", the clearance of the stem in the guide is from .001" to .003" and should not exceed .006."
5. Remove the valve guides by driving them out from the underneath side of the cylinder head with a special tool similar to the one shown in Fig. 14.

   To install the valve guides, start the guides into place from the top of the cylinder head (countersunk-end of the guides upward), place special guide installing tool (similar to one shown in Fig. 15) over the guides, and

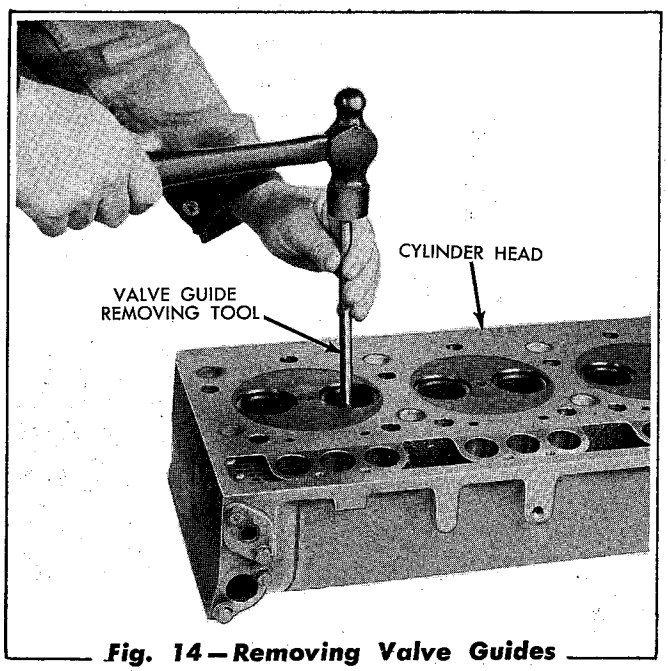


Fig. 14—Removing Valve Guides

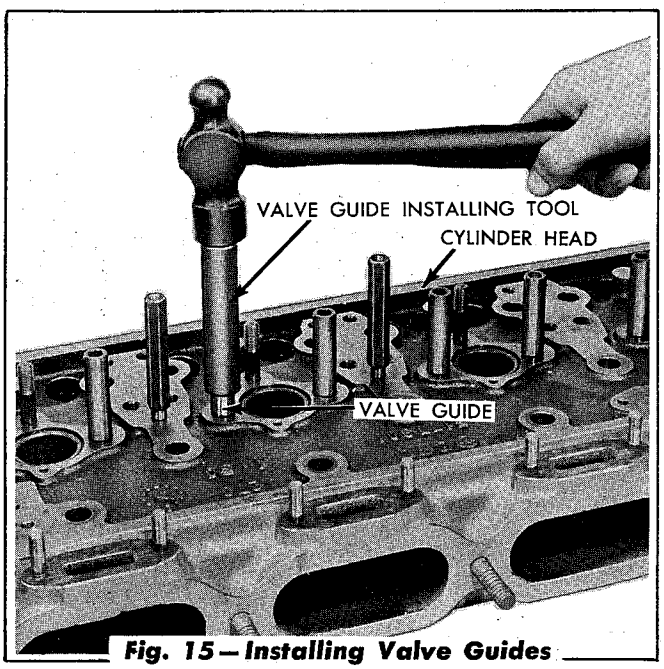


Fig. 15—Installing Valve Guides

drive each guide into the head until the tool contacts the head. This locates the valve guides for proper height. The specified height of the guides above the cylinder head is 2.490" when properly installed.

6. Inspect the valve seat inserts. If they are loose, cracked, or pitted, new ones should be installed. In order not to damage the head, they must be removed with a special tool provided for that purpose; also, unless the new inserts are installed with care, and according to the following instructions, the results will be unsatisfactory.

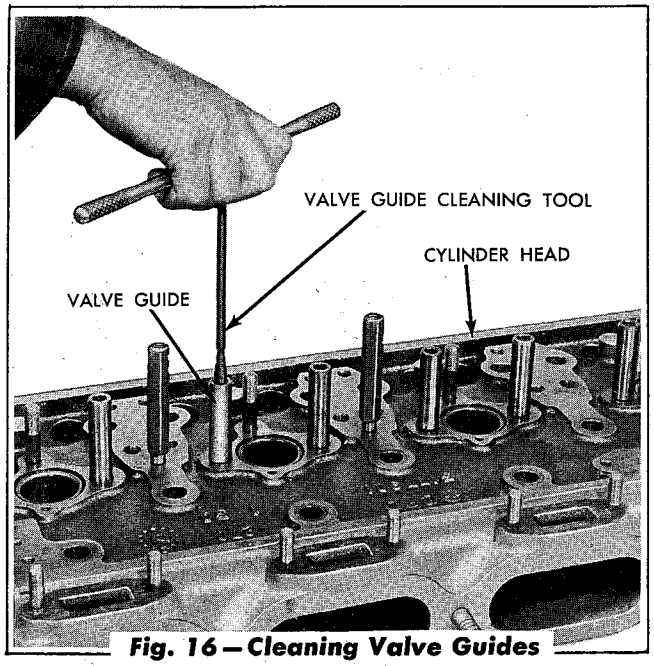


Fig. 16—Cleaning Valve Guides

7. Remove the valve inserts as follows:

   a. Place the cylinder head on its side on a bench.

   b. Insert the guide pin of the remover tool, similar to the one shown in Fig. 17, into the valve guide and insert the collet of the tool inside the valve insert so that the lip at the bottom of the collet flange is flush with the bottom of the valve insert. Hold the remover tool in its position and expand the collet by turning the upper handle of the tool.

   c. Be sure that the flange of the collet is firmly entered just below the valve insert, then holding the lower handle of the remover tool, expand the collet tightly against the insert by turning the upper handle.

   d. Use a hammer and drive on the end of the remover tool guide pin to drive the insert from the cylinder head.

8. Particular care must be exercised when replacing the valve seat inserts. The inserts are installed into the cylinder head with a .0005" to .0025" press fit, and must be started in place "true" with the counterbore in the head. To install the valve seat inserts, proceed as follows:

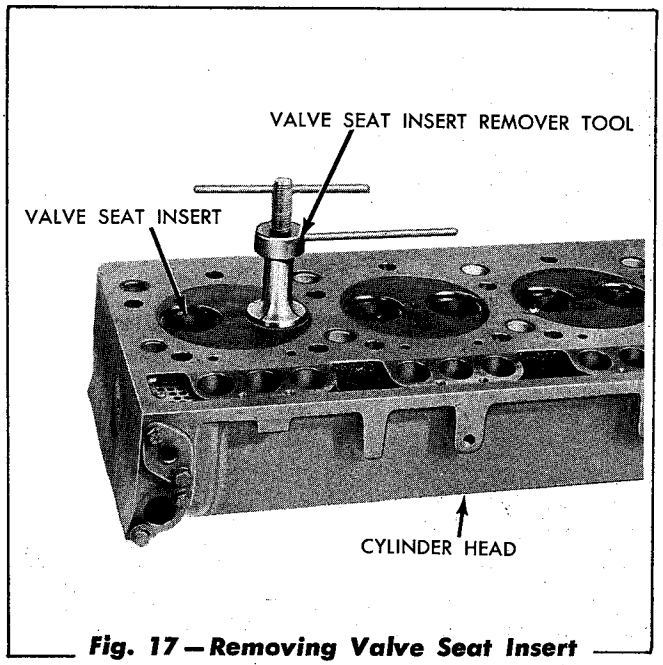


Fig. 17—Removing Valve Seat Insert

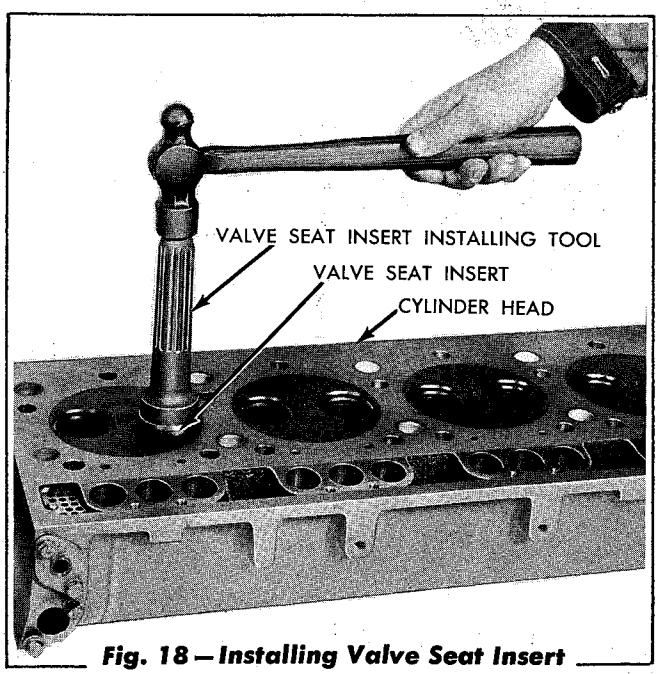


Fig. 18—Installing Valve Seat Insert

a. See that the cylinder head is perfectly clean, particularly the counterbore for the inserts.

b. Immerse the cylinder head for approximately 30 minutes in water heated to 180° to 200° F., or cool the inserts with dry ice for approximately 45 minutes.

c. Place the cylinder head bottom-side up on a bench, blow out the insert counterbores with air, and start an insert in the counterbore (seat side up).

d. Using the valve insert installing tool, similar to the one shown in Fig. 18, insert the pilot end of the tool into the valve guide and drive the insert down tight into the counterbore. This operation must be done quickly, while the valve seat insert is cold.

e. Check the valve seat for concentricity with the valve guide (refer to Fig. 19) and, if necessary, recondition the seat or seats as directed below.

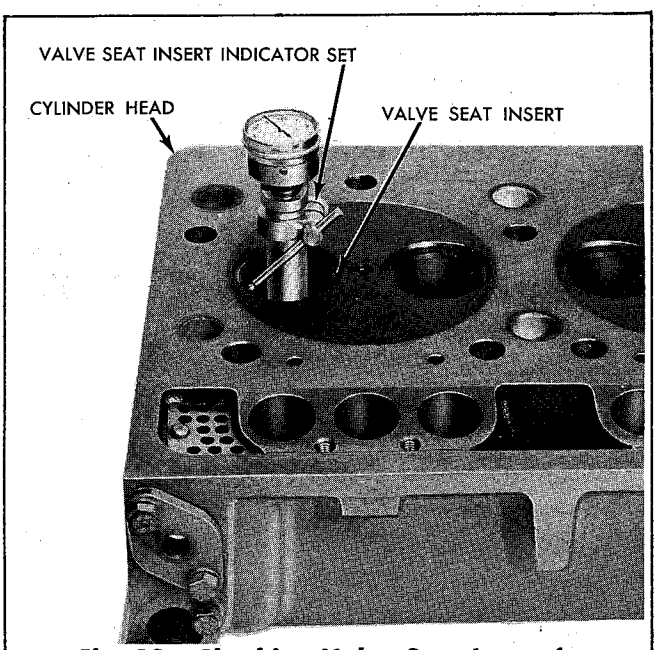


Fig. 19—Checking Valve Seat Insert for Concentricity

I. Valve and Valve Seat Grinding

Before installing either a new or used valve, the seat in the cylinder head for the valve should be examined for proper valve seating. Furthermore, if a valve once used is to be installed again, the valve stem should be cleaned, and the seat reground to the recommended angle of 30 degrees.

The valve guide should be thoroughly cleaned with a cleaner. If the bore in the valve guide is worn oblong, or if the valve heads are warped relative to the stem, the parts should be replaced.

The width of the valve seats must be between 5/64" and 7/64". When new valve inserts are installed, or old inserts refaced, the work must be done with a valve seat grinding set, similar to the one shown in Fig. 20, as the ordinary method of grinding valve seats is ineffective for the operation because of the very hard valve insert material.

Use a 30° grinding wheel for refacing the valve

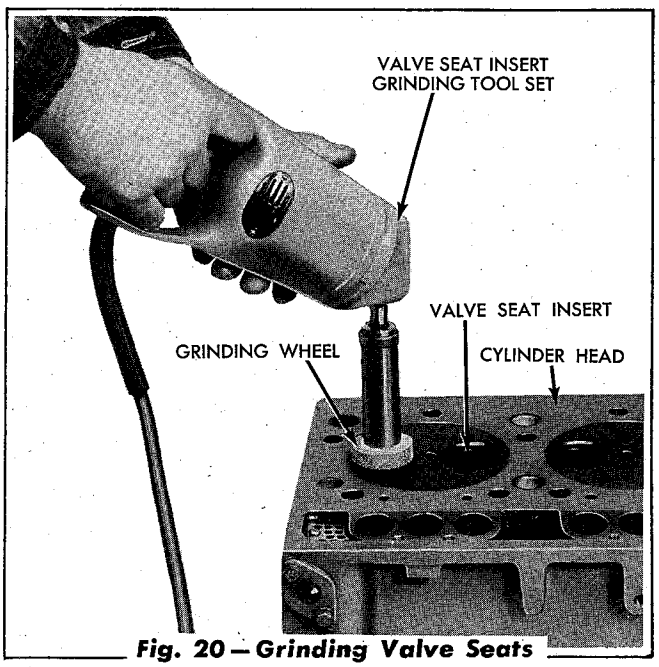


Fig. 20 — Grinding Valve Seats

seats and a 70° grinding wheel for opening the throat below the valve seats and for narrowing the seats to the specified seat width of 5/64" to 7/64". After the valve seats have been dressed with the grinding wheel, the dial gage, shown in Fig. 19, is used to check the concentricity of the valve seats relative to the valve guides. The total runout for a good valve seat should not exceed .002". *IMPORTANT: The valve heads, with valves in closed position, must not stand out more than .022" maximum beyond the fire deck of the cylinder head.*

After a grinding wheel has been used for a certain amount of grinding, the cutting angle of the stone must be reground and made true to obtain the proper seat angle when grinding the inserts. Place stone on the dressing tool, and set the arbor for the required angle.

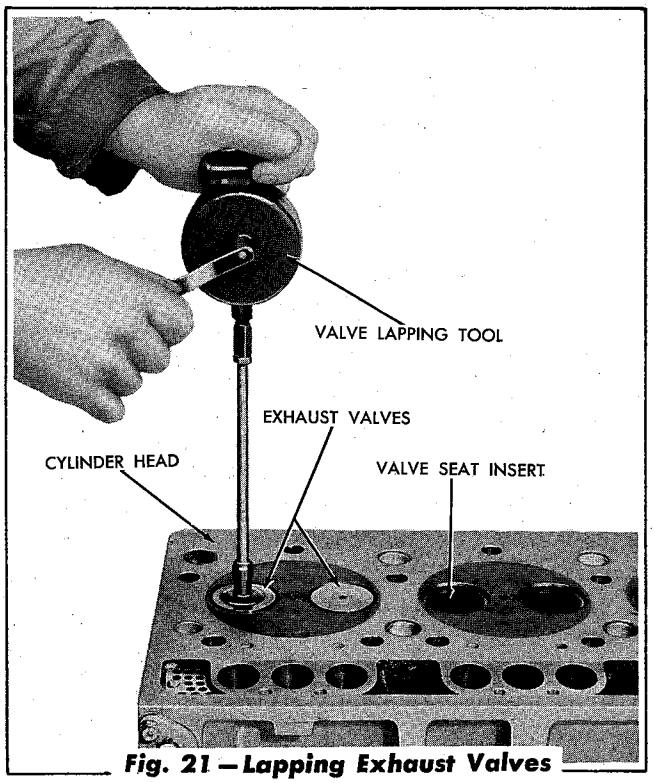


Fig. 21 — Lapping Exhaust Valves

After the valve seats have been ground, the valves may be put in place and lapped to perfect seats in the regular manner, as shown in Fig. 21. After lapping, the contact between the valves and the seats may be checked by wiping a thin film of Prussian Blue on each valve seat, setting the valves in place, and bouncing each valve on its seat. If the valve seats are properly ground, a continuous thin, blue line will be evident around the face of the valve.

Assemble and install the cylinder head as outlined in pertinent pages in this book.

4. CYLINDER BLOCK AND LINERS

A. Description

The cylinder block and crankcase, which is the main structural part of the engine, is a box-like, one-piece casting made of alloy cast iron. Rugged transverse members, cast integral, provide rigidity and strength, insuring perfect alignment of the bores and bearings under all loads. The cylinders are bored to receive the cylinder liners.

The water jackets extend the full length of the bores and are divided into upper and lower sections, which are connected by hollow struts. Coolant enters at the bottom of the water jacket, and leaves the jacket at the top through holes which register with corresponding openings in the cylinder head. Surrounding the water space is an air chamber (air box) which conducts the air from the blower to the inlet ports in the cylinder liners.

The upper halves of the main bearing seats are cast integral with the cylinder block. Drilled passages in the block carry lubricating oil to all internal moving parts. Hand-hole covers on the side oppo-

site the blower permit access to the air chamber, and inspection of pistons and rings through the intake ports in the cylinder walls. Cylinder blocks ordered for service are furnished with main bearing caps, studs, and the necessary plugs. Cylinder liners are serviced separately. The replaceable cylinder liner, made of hardened alloy cast iron, in each cylinder, is accurately honed to a very smooth finish. A flange at the top of the liner fits into a recess in the cylinder block, insuring proper positioning in the block. A snap ring, fixed in the cylinder block near the lower end of each cylinder bore, contacts an under cut on the lower end of the liner. Even temperature and minimum distortion are insured by cooling each liner over its entire length with water, except at the ports. The liners are cooled at the ports by the scavenging air from the blower. To permit introduction of fresh air into the cylinder, one row of holes, 11/16" in diameter, are drilled in the circumference of each liner as shown in Fig. 22.

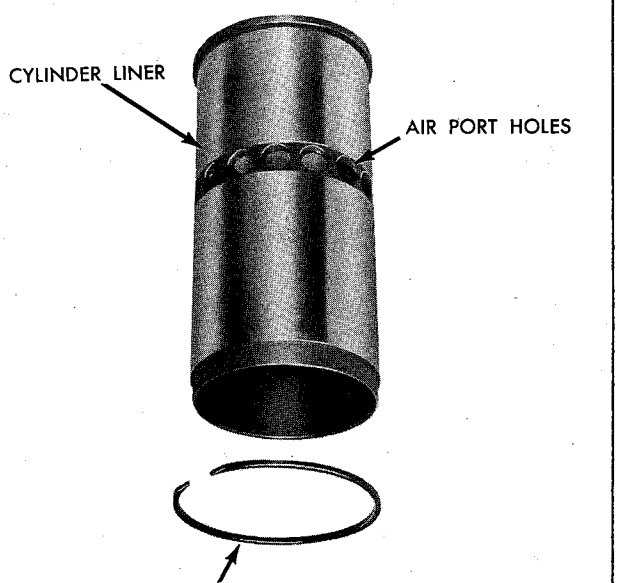


Fig. 22—Cylinder Liner

B. Cylinder Liner Service

The cylinder liners will render satisfactory service for extended periods if the engine has proper care. The wear on a cylinder liner and piston is directly related to the amount of dust and dirt (abrasive) introduced into the engine combustion chambers through the air intake. Dust combined with lubricating oil on the cylinder walls forms an ideal lapping compound. To avoid such a condition, the air cleaners provided on the tractor should be serviced regularly.

The air ports in the cylinder liners sometimes become clogged with sludge or hard carbon. Inspection should be made of their condition at least every 500 hours of engine operation, and if the openings are restricted as much as 30%, the ports should be cleaned as outlined in "ENGINE AIR INTAKE SYSTEM," Section III. If the engine has been disassembled and the cylinder liners removed, the ports may be cleaned by inserting the pointed end of a piece of wood in each port and twisting. Avoid using a tool which will cause burrs around the ports on the inside of the liner.

An alternate method of cleaning air inlet ports, with the liners removed, is to soak the liner in a hot caustic soda or lye solution long enough to loosen the carbon deposits. Final cleaning can then be accomplished with a bristle brush.

C. Cylinder Liner Removal

The liners will, in most cases, slide out of the block when the pistons are removed. Liners that stick in the cylinder block may be loosened and removed by placing the end of a hardwood block against the bottom of the liner and striking the block sharply with a hammer. Be careful not to strike the liner retaining snap ring in the cylinder bore.

D. Cylinder Liner Cleaning and Inspection

1. Remove all dirt, carbon, or grease from the liners and the liner bores in the cylinder block. Discard the liners if they are scored, cracked, or worn beyond the allowable limits. Slightly scuffed liners, if not worn, may sometimes be made usable by polishing or lapping to remove the surface irregularities. Clean the air inlet ports, removing any burrs made in the cleaning of the ports, with No. 250 grit emery paper. Failure to remove all the burrs from the insire of the liners can result in the early failure of an engine.

2. Check the liners for roundness, taper, and the amount of wear by means of a gage similar to the one shown in Fig. 23. Measure each liner as outlined in the diagram in Fig. 24.

Do not install liners that have more than .001" taper or that are more than .001" out of round when installed. Be sure that the liners slide into the cylinder block bores freely to insure a loose fit. It the bores in the block are in a tapered or out of round condition, they should be honed slightly with a fixed-stone hone to remove the high spots.

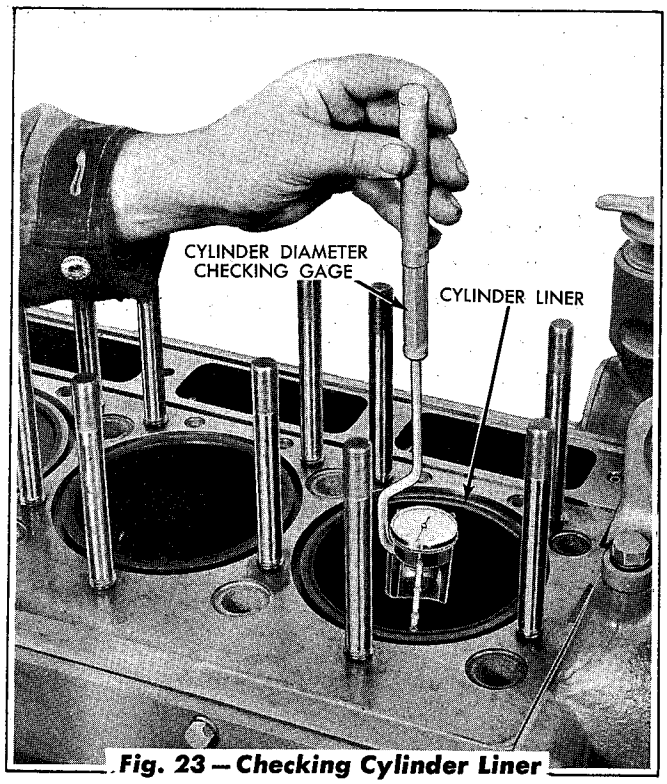


Fig. 23 — Checking Cylinder Liner for Roundness

3. Measure the new liners after they are installed, in the manner described above. Due to their thin walls, it is possible for the liners to go out of round while in stock or through careless handling.

4. Refer to "FITTING PISTONS WITH LINERS" in this section, for fit of the pistons with the liners.

E. Cylinder Liner Installation

1. Clean the liner and the bore in the cylinder block thoroughly, making sure that the bottom of the flange on the liner and counterbore for the flange are clean.

2. Insert the cylinder liner in the block and check the location of the top of the cylinder liner flange in relation to the top flat surface of the cylinder block. The top surface of the

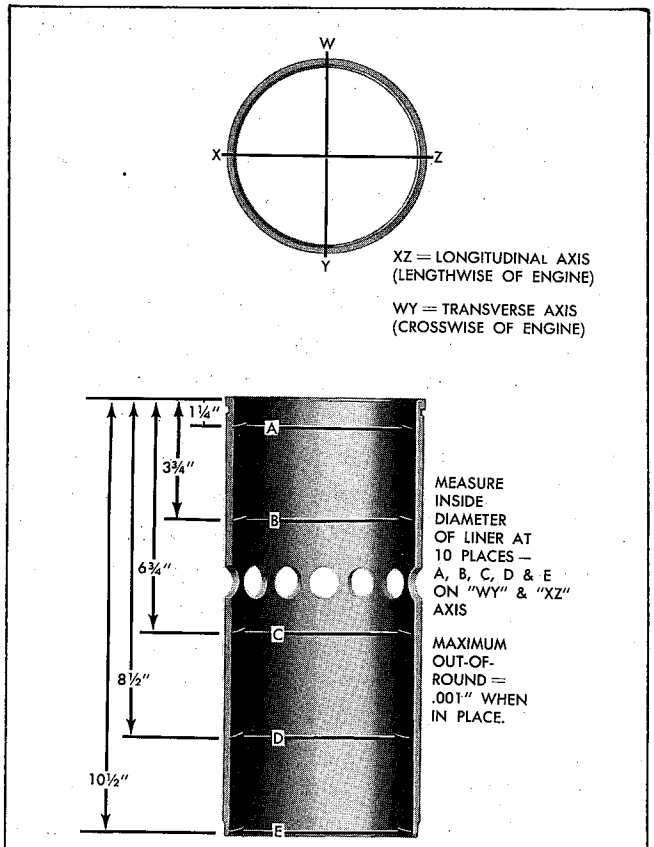


Fig. 24 — Measuring Liners

cylinder liner flange must be .046" to .058" *BELOW* the top flat surface of the cylinder block.

3. Install the cylinder gasket on the top of the cylinder liner flange and press down firmly by hand. The top of the gasket, when properly positioned should stand out .006" to .014" *ABOVE* the top flat surface of the cylinder block.

IMPORTANT: These dimensions must be held in order to obtain proper sealing of the gasket set between the cylinder head and the block, when the cylinder head is tightened in place.

F. Cleaning and Inspection of Cylinder Block

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 block and

it has been thoroughly cleaned with live steam or a suitable solvent and dried with compressed air.

Inspect the entire block for cracks or damage. If the cylinder liners are not to be changed and are left in the block, clean all the air ports in the liners as explained in "ENGINE AIR INTAKE SYSTEM," Section III.

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, as these would not be removed if only a brush and solvent or similar cleaning method were used. Remove the various plugs at the ends of the oil galleries to clean the passages. After cleaning, flush the passages in the block with clean water under pressure to remove all traces of the solvent.

To clean the water jacket of the 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 all these plugs are installed in their proper places after the block has been cleaned and dried. Coat the threads of all 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 the fit of the attached parts.

G. Air Box Drain Tube

Four (4) air box drain tubes are provided for drainage of fuel oil that might leak into the air box and would otherwise be drawn into the cylinders with the air. The drain tubes are located at the front and rear of each side of the cylinder block. These tubes must be kept open at all times. Remove the tubes and elbows and clean them if clogging occurs. Air emerging from the tubes while the engine is operating will indicate that the tubes are open. *NOTE: The rear drain tube on the left side of the cylinder block is connected to the torque converter seal drain tube to form an outlet for seal seepage.*

5. CRANKSHAFT, FLYWHEEL, AND MAIN BEARINGS

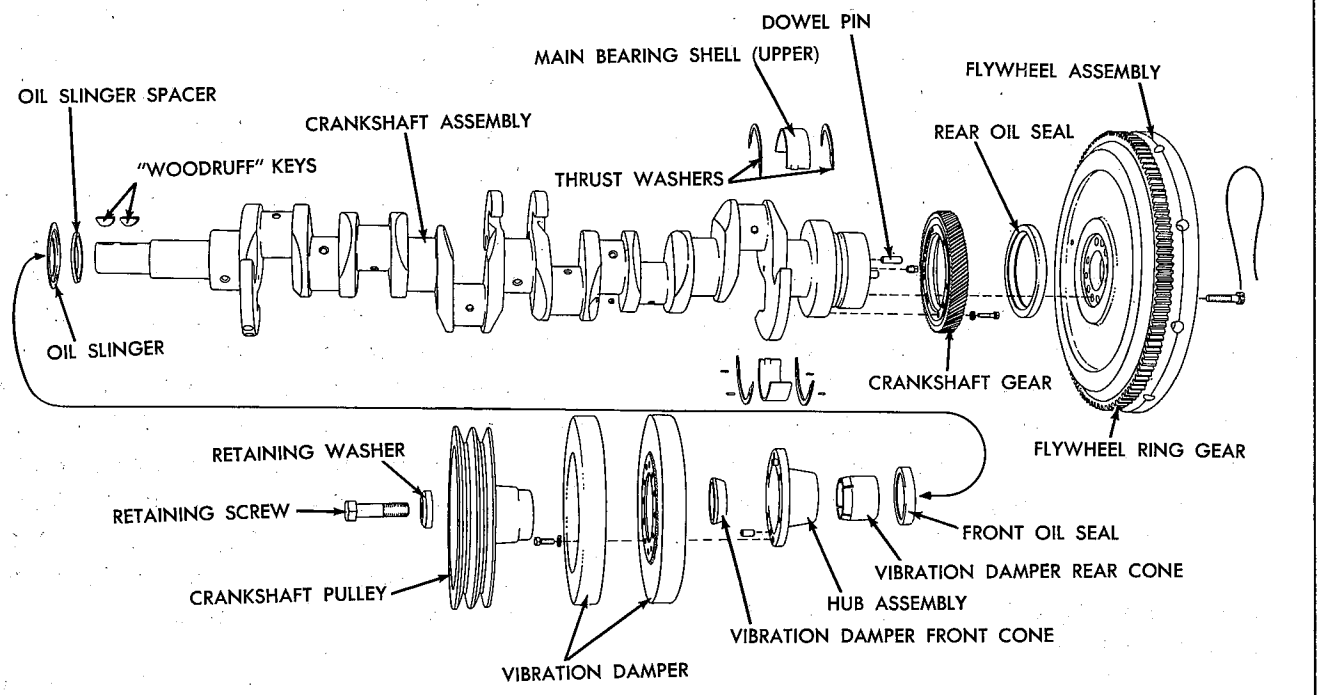


Fig. 25 — Crankshaft and Flywheel Details

A. Description

1. CRANKSHAFT: The rigid crankshaft is a high alloy steel drop forging, carefully heat-treated to assure utmost strength and durability. All the main and connecting rod bearing journals are hardened and ground to a smooth finish of utmost wear-resistant quality. Complete static and dynamic balance of the rotating parts has been achieved by counter-weights incorporated with the crankshaft.

   The end thrust of the crankshaft is taken through two piece bronze washers on each side of the rear main bearing. The crankshaft is drilled for full pressure lubrication to the main and connecting rod bearings.

2. MAIN BEARINGS: There are 7 main bearings 4" in diameter and 1.60" wide. These are of the precision type, readily replaceable without machining. The main bearing caps are attached to the crankcase and carefully machined in place to receive the precision bearing shells. Each bearing cap is numbered and when removed should always be replaced in its respective position (numbers on bearing caps located on camshaft side of the engine).

   The upper halves of the main bearing shells are seated in the crankcase. The lower halves are held in place by the main bearing caps, each of which is bolted to the crankcase by two (2) special steel studs. Each half of the bearing shell is prevented from endwise or radial movement by a tang at the parting line on one side of the bearing. Transverse movement of the bearing caps is prevented by the serrations at the parting line of cap and block.

   A spring loaded, lip type oil seal at the rear main bearing consists of a special treated leather ring (seal) set into the flywheel housing. The rolled-over inner diameter of the leather is held against the crankshaft journal by a coil spring, to prevent oil from creeping along the journal into the flywheel compartment.

A spring loaded, lip type oil seal is also used at the front main bearing. This seal is pressed into the crankshaft front cover; and the leather lip of the seal bears against a removable sleeve (vibration damper rear cone) on the front end of the crankshaft.

3. FLYWHEEL: The even torque of the engine permits the use of a relatively light, cast iron flywheel, which assures exceptional operating flexibility. The flywheel is bolted securely to a flange on the rear end of the crankshaft and doweled in two places. One of the capscrew holes is off-set and the flywheel can be attached to the crankshaft flange in only one position. A starter ring gear of heat-treated steel is shrunk on the rim of the flywheel.

B. Removal, Inspection, and Installation of Crankshaft

1. Inspection can be made of the crankshaft main bearings and journals by removing the lower and the upper oil pans and removing the bearing caps one at a time (refer to "REPLACEMENT OF CRANKSHAFT MAIN BEARINGS" in this Section). However, if the crankshaft has been damaged, removal of the engine will be required for its replacement. A complete inspection should be made of the other parts of the engine at the same time. After the crankshaft has been removed, inspect it as outlined in the following discussion.

2. Inspect the crankshaft 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.

3. If oil leakage into the flywheel housing has been noted, inspect the crankshaft at the point of contact with the lip of the rear oil seal. If the crankshaft is scored or excessively worn at this point, discard the crankshaft.

4. Measure the main bearing and connecting rod journals. The journals should be measured at several places on the diameter in order to show the smallest diameter in case the journal has worn out of round. The original diameter of the main bearing journals is 3.999" to 4.000"; the connecting rod journals are 3.249" to 3.250".

5. All main and connecting rod bearings surfaces are hardened to a depth of approximately .0625". If regrinding becomes necessary, the work should be done by some reputable machine shop that has suitable equipment to handle precision work of this type. Main bearing inserts of .002", .010", .020", and .030" undersize can be obtained, and if the crankshaft is ground, the diameter of the journals should be reduced in steps to .010", .020", and .030" below 4.000" to fit the undersize bearing shells.

6. Remove the slotted head 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 installing them and tighten them securely.

C. Main Bearing Inspection

1. Any bearings that are scored, chipped, pitted, or worn beyond the prescribed limits given below must be replaced. Inspect the backs of the shells for bright spots. Bright spots on the backs of the shells indicate they have shifted in their supports and are unfit for further use. If all shells are worn beyond the specified limit, they all must be replaced. Only the lower (non-grooved) shells are loaded and subject to wear; therefore, if the upper shells (grooved) are serviceable and not scored, the lower halves only may be changed. In a majority of cases, however, it will be wise to replace all the shells when rebuilding an engine.

2. The running clearance between the main bearing shells and the crankshaft journals is from .0024" to .0054." in a new engine. New bearing shells must be installed when this clearance exceeds .007". The amount of

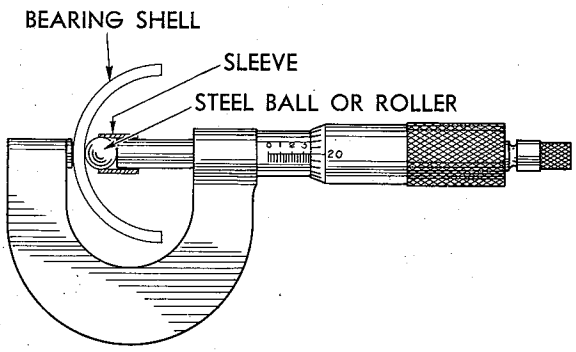


Fig. 26 — Measuring Main Bearing Shells

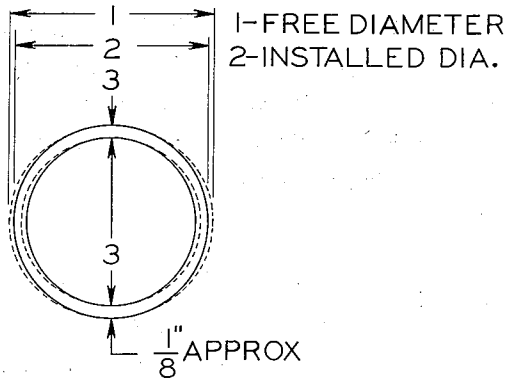


Fig. 27 — Measuring Inside Diameter of Main Bearing Shell

wear on the bearing shells may be determined by measuring each shell with micrometers as shown in Fig. 26. New shells, measured at the point shown (3, in Fig. 27) are .125" thick, and any variation from .125" will show the amount of wear on the particular shell being measured. Those less than .122" are worn beyond the allowable limits and must be replaced.

3. As will be seen from Fig. 27, the bearing shells (when in place) are .001" larger in diameter at the parting line than they are 90° from the parting line. The two (2) shells do not form a true circle when not installed and, when measured for inside diameter, they should be installed in the cylinder block and the caps bolted tightly in place (crankshaft removed). The two (2) halves of the shells have a squeeze fit in the seat and cap, and must be tight when the cap is drawn down. Draw each cap down with 180 to 190 foot pounds pull on a torque wrench. Drawing the caps any tighter will distort the bearings.

4. A recommended method of determining the running clearance between the bearings and journals is to insert a 1/32" diameter soft lead wire or foil across the center of each lower bearing shell by removing and replacing one bearing cap at a time. When the lead wire or foil insertions have been made, tighten the bearing cap bolts, to 180 to 190 foot pounds torque, thus "squeezing" the wire or foil to shim thickness between the shell and the crank journals. Remove the lead shims and measure them for thickness; the clearance between the shells and the journals should be from .0024" to .0054."

5. Check the end thrust of the crankshaft, which is controlled by the rear main bearing thrust washers. The minimum end play is .006" and should not exceed .018"; replace the thrust washers if the play exceeds .018".

D. Main Bearing Replacement

The main bearings may be replaced with the engine in the tractor as explained in "REPLACEMENT OF CRANKSHAFT MAIN BEARINGS" in this Section. However, it is not advisable or recommended that the work be done in that manner except in emergency cases. Installation of the bearings with the engine disassembled is described in "ASSEMBLY OF ENGINE" in this Section.

E. Replacement of Crankshaft Oil Seals

Drive or press the oil seals from the flywheel housing and the crankshaft front cover and install new ones each time that the engine is disassembled. Use a flat piece of metal to press the new seals into place to prevent damaging the seal. The lip side of each seal should be toward the inner side of the housing and the cover. The lips must face each other when the housing and the cover are installed on the engine.

F. Flywheel and Ring Gear Inspection and Replacement

To remove the flywheel from the engine with it assembled in the tractor, it is necessary to remove the engine clutch and clutch housing (refer to "ENGINE CLUTCH REMOVAL" Section X).

1. FLYWHEEL: Inspect the clutch wearing sur-

face of the flywheel and make sure that the surface is flat and smooth. If it is scored and heat checked it may be machined smooth. Replace the flywheel if more than 1/16" stock must be removed to smooth it up.

It is very important that all burrs and nicks be removed from the front surface of the flywheel that fits up against the flange of the crankshaft. If the surface is not smooth and true, the flywheel will have a slight wobble which will result in improper clutch operation, clutch wear, and engine vibration.

2. RING GEAR: Inspect the flywheel ring gear for general condition and wear. Replace the 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 ring gear, proceed as follows:

   a. The ring gear is shrunk on the flywheel by uniformly heating the gear to 400° F. (red heat visible in the dark), then placing it in position on the flywheel which is at room temperature. *NOTE: Do not heat ring gear to a bright red as 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 the pinion of the starter. Drive the ring gear down tight against the shoulder on the flywheel. Allow ring gear to cool slowly. Do not cool it by using water.

6. VIBRATION DAMPER

A. Description

The vibration damper, connected to the front end of the crankshaft in the form of a flywheel, operates to reduce crankshaft stresses.

The vibration damper assembly is made up of two damper units bolted to a common hub which is retained on the front end of the crankshaft by an inner and outer cone. The outer cone is held in place by the crankshaft pulley, movement of the inner cone is prevented by a shoulder on the crankshaft. Each damper unit consists of an inertia mass enclosed in a fluid tight outer case but separated from contact with the case by a thin wall of viscous liquid not responsive to temperature changes. Any movement of the inertia mass, within the damper units, is resisted by the friction of the fluid surrounding the mass and tends to dampen the excessive torsional vibrations in the crankshaft.

B. Service

The vibration damper is rigidly constructed and should give no trouble if given the proper care, however, certain precautions are necessary because of its construction. The damper must never be struck with a hammer or similar object as to do so will upset its balance. For the damper to function properly and safeguard the crankshaft, it should be securely fastened to the shaft by the cones, hub, and the hub retaining capscrews.

C. Removal of Vibration Damper (Engine in Tractor)

1. Remove the radiator assembly (refer to "RADIATOR REMOVAL" in Section IV).

2. Release the tension on the fan belts and remove the belts from the crankshaft pulley.

3. Remove the capscrew and washer used to retain the crankshaft pulley. Using a puller similar to the one shown in Fig. 28 remove, the crankshaft pulley from the crankshaft, then remove the two (2) "WOODRUFF" keys.

4. Remove the capscrews attaching the two (2) dampers to the damper hub, then using a soft hammer tap the dampers and remove the dampers from the hub.

5. If it is necessary to remove the damper hub, use two (2) pusher screws in the tapped holes

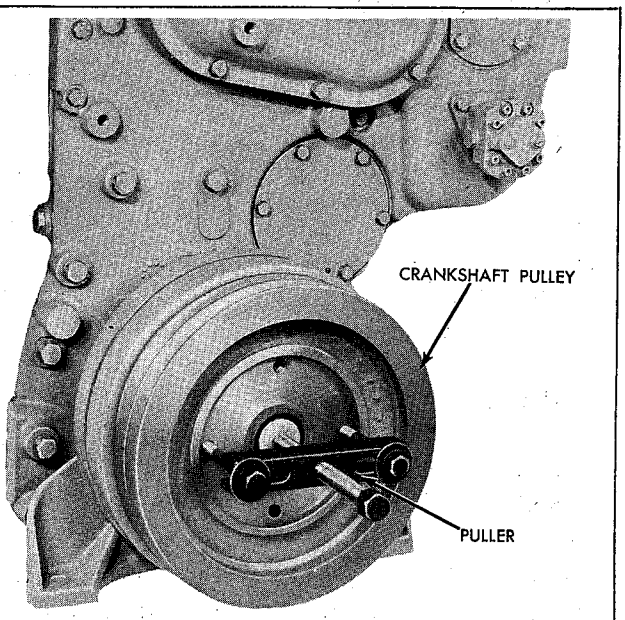


Fig. 28—Pulling Crankshaft Pulley

in the hub and apply pressure on the screws and tap the hub with a soft hammer at the same time until the front cone can be removed from the shaft. Remove the front cone and the damper hub. The rear cone may now be removed by sliding it off the crankshaft.

D. Inspection of Vibration Damper

Inspect the damper for fluid leaks. A leak in the outer cases would render the damper useless. Inspect both retaining cones (inside and outside diameters), damper hub, and the front end of the crankshaft for gall marks or burrs. Slight scratches or burrs may be removed with emery cloth. If these parts are seriously damaged they must be replaced and the crankshaft remachined. Examine the crankshaft front oil seal and replace if necessary.

E. Installation of Vibration Damper

Refer to Fig. 25 showing the relative location of the parts, and assemble as follows:

1. Lubricate the rear cone and install it in position on the crankshaft with the tapered end of the cone towards the front of the crankshaft. When installing the cone, slide it back through the crankshaft front oil seal and against the oil slinger.

2. Hold the damper hub in position on the crankshaft and install the front cone with the tapered end of the cone next to the hub.

3. Place the front and the rear damper units together with the flat faces of the dampers facing each other, and with the holes for the dowels in line. Install the damper assembly in position on the hub and onto the two (2) dowels in the hub. Install the attaching capscrews and lockwashers and tighten securely.

4. Install the two (2) "WOODRUFF" keys in the crankshaft, then install the crankshaft pulley, pulley retaining washer, and the retaining capscrew. Tighten the capscrew securely.

5. Place the fan belts in the grooves of the crankshaft pulley, then adjust the belts (refer to "FAN BELT ADJUSTMENT" in Section IV.)

6. Install the radiator assembly (refer to "INSTALLATION OF RADIATOR" in Section IV).

7. PISTONS AND CONNECTING RODS

A. Description of Pistons

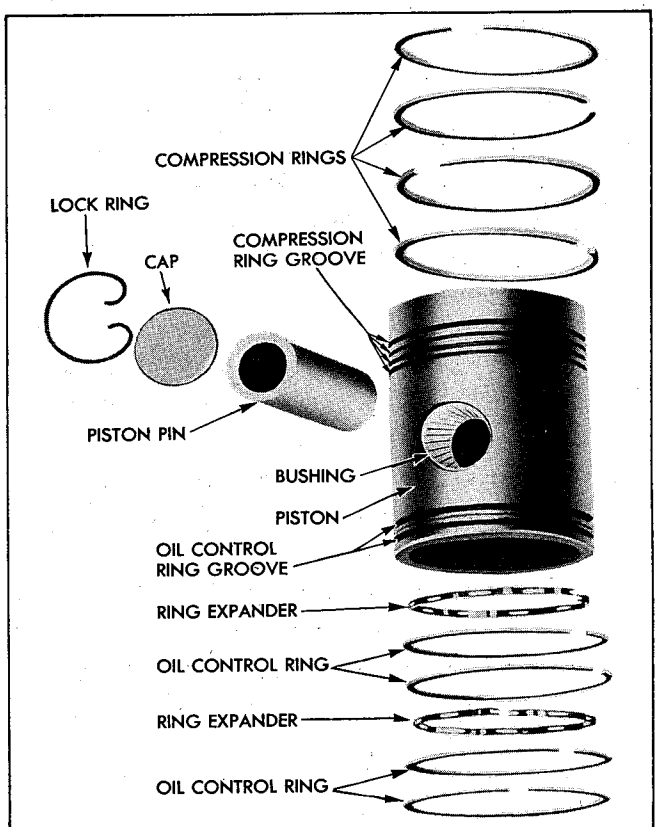


Fig. 29 — Piston Assembly Details

The pistons are made of malleable iron with extra long skirts, accurately ground the full length, and plated with a protective coating of tin, which permits close fitting. The top of the piston forms the combustion chamber and is designed to displace the air into proximity to the fuel spray.

To add strength, rigidity, and cooling effect, the head of each piston is cast with ribs on the inside and is connected to the piston pin bosses by vertical struts placed at right angles to the piston pin. The ribbed head (inside of the piston), is cooled by lubricating oil forced from a spray jet on the top of the connecting rod.

Two steel-backed bronze bushings, with helical grooved oil passages, are pressed into the piston to provide a bearing for the hardened, floating piston pin. After the piston pin has been installed, the hole in the piston at each end of the pin is sealed with a tight steel cap and locked in place with a lock ring. Thus the lubricating oil returning from the sprayed piston head and working through the grooves in the piston bushings is prevented from reaching the cylinder walls.

A balancing rib is provided on the inside of the bottom of the piston skirt to balance the piston.

Each piston is fitted with six rings of the conventional cut-joint type. Four 1/8" wide, chrome plated, grooved, compression rings are placed above the pin and two 3/16" wide special oil-control rings are placed below the piston pin.

B. Description of Connecting Rods

Each connecting rod is made of drop-forged heat-treated carbon 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 lubrication to the upper end, and is equipped with an oil spray jet for cooling the under side of the piston head. The lower end of the connecting rod shank is fitted with an orifice which meters oil to the rifle-drilled connecting rod.

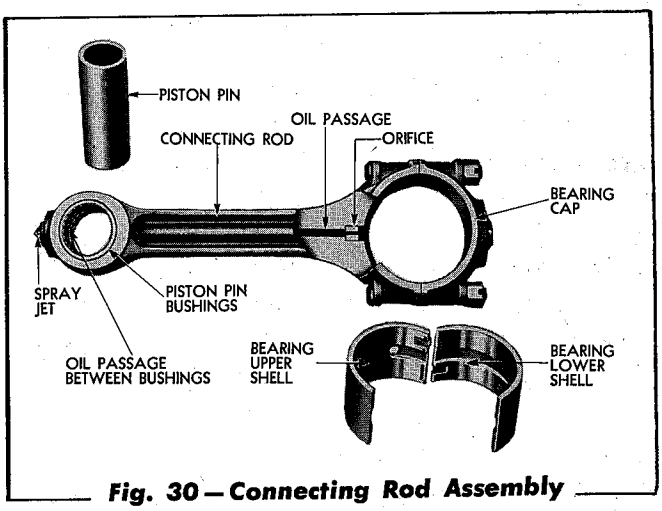


Fig. 30 — Connecting Rod Assembly

The connecting rod bearings are precision type, without shim adjustments. The upper and the lower halves of the connecting rod bearing shells are different, and are not interchangeable, but are replaceable without machining.

The upper bearing shell is grooved midway between the bearing edges, part way up from each parting line, with an oil hole through the shell at the termination of each groove.

The lower shell has an oil groove in line with that of the upper shell and circling the shell from parting line to parting line. These grooves are always in line with the oil holes in the crankshaft, thereby providing a constant supply of oil through the hol-

low connecting rod to the piston pin bearings and the spray nozzle at the top of the connecting rod.

A helically-grooved steel-backed bronze bushing is pressed into each side of the upper end of the connecting rod, for the piston pin. A cavity of approximately 3/16" between the inner ends of these bushings, in line with the oil passage in the connecting rod, forms a duct around the piston pin whereby the pin bushings are lubricated and oil also is forced to the spray nozzle for piston cooling. The piston pin floats in the bushings of both the piston and connecting rod.

C. Service

The piston and connecting rod are so closely associated from a service standpoint that one cannot be entirely separated from the other; the two will, therefore, be treated collectively in the following discussion on pistons and connecting rods.

The removal and installation of pistons and connecting rods and the replacement of connecting rod bearings is described in "REPLACEMENT OF PISTON AND CONNECTING ROD," also in "DISASSEMBLY OF ENGINE" and "ASSEMBLY OF ENGINE" in this section.

A certain amount of inspection to determine the condition of the pistons and the piston rings can be made by removing the hand-hole covers from the sides of the engine block and directing a strong light through the air inlet ports in the cylinder liners. With the piston at the bottom of its stroke and the air inlet ports uncovered; the pistons may be inspected for score marks or for worn, stuck, or broken rings as each piston is moved upward. The presence of the original tool marks on the piston ring surfaces indicates negligible wear.

The upper part of the piston (above the upper compression ring) is not plated and does not touch the cylinder wall. If this part of the piston shows any coating of hard carbon, the rings must be removed and the piston surface, as well as the ring grooves, thoroughly cleaned. The piston head should be absolutely clean on the outside. A thick coating of carbon indicates failure of the cooling oil supply and necessitates the cleaning of the oil passages and of the spray nozzle in the connecting rod.

D. Removal of Connecting Rod and Rings from Pistons

1. Using a pair of small nose pliers, remove the spring clips at each end of the piston pin.

2. Tap the piston on a wood block and remove the cap and pin through the open pin hole. If the steel cap lodges in the groove for the spring clip, it may be readily removed with a rubber suction cup such as is used for lapping valves.

3. To avoid breaking the piston rings, the use of a ring remover tool is advised when removing or installing piston rings. Care must be taken not to overstress the piston rings by spreading the ends more than is necessary to remove the rings from the piston. Before removing the rings from the pistons, they should be inspected for wear and for the amount of side clearance in the grooves. However, their removal will be necessary in most cases in order to clean the carbon from the grooves.

E. Piston and Piston Ring Inspection

As gummy deposits are not always easily removed from the piston walls and ring grooves with fuel oil, these parts may be cleaned by using a solvent and then blowing off with dry compressed air. After cleaning, the piston skirt, the piston rings, and the ring grooves, should be thoroughly inspected.

The coating on the skirt of the plated piston is thin and the presence of the coating will, therefore, indicate the absence of wear. If, however, the coating is worn off in spots, a careful examination should be made for score marks or other indications of improper piston clearance. A badly scored piston should be discarded.

Examine the inside of the piston for cracks across the struts or ribs. Such cracks make the piston unfit for further use.

Check the piston for wear by inserting the piston in the cylinder liner and measuring the clearance between the piston and the liner. The standard clearance is .006" minimum. This clearance is to be established with a .006" feeler gage ½" wide

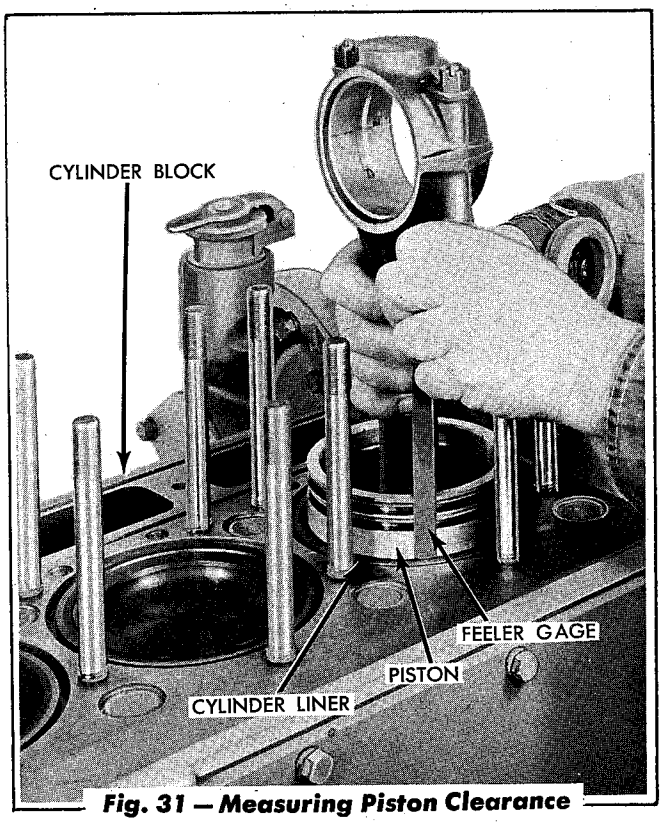


Fig. 31 — Measuring Piston Clearance

placed between the piston and cylinder liner with the cylinder liner in position in the block as shown in Fig. 31. The piston skirt diameter of a new piston is 4.9908" to 4.9930"; the inside diameter of a new cylinder liner is 4.9990" to 5.0005." The piston diameters and cylinder liner bore sizes given are to be used in checking new parts only. The differential in the size of the two parts are not to be considered as clearances at assembly.

New piston rings should always be used with new pistons; furthermore, 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.

The piston pin bushings in the piston are available for service, however, it is not recommended that new bushings be installed in the pistons due to the special tools required for their installation. A maximum clearance of .010" between the pin and the bushings is allowable. If they are worn beyond this limit, the piston will, in practically all cases, also be worn beyond the limits and require replacement. New pistons include these bushings already installed and reamed to the proper size.

F. Inspection of Connecting Rod Assembly

After washing the connecting rod assembly in clean solvent or fuel oil, the bushings at the upper end, oil passages, spray nozzle, etc., should be examined.

1. Measure the outside diameter of the piston pin to determine the wear. The standard dimension for the piston pin diameters is 1.6246" to 1.6250".

2. The standard inside diameter of the bushing in the connecting rod is 1.6265" to 1.6270." These dimensions of the pin and bushings provide a clearance of .0015" to .0024." Clearances up to .010" are permissible. If the wear is close to or beyond this limit, replace the connecting rod bushings (see "REPLACEMENT AND REAMING OF PISTON PIN BUSHINGS IN CONNECTING ROD" in this section).

3. Open the holes in the orifice at the lower end, and the spray jet at the upper end of the connecting rod and blow dry compressed air through the oil passage in the rod. *BE SURE THAT ALL OIL PASSAGES ARE OPEN.*

4. Inspect the connecting rod bearing shells at the lower end of the rod for scoring, chipping, corrosion, cracking, or signs of overheating. Discard shells if any of these conditions are apparent. The backs of the shells should also be inspected for bright spots, and discarded if any bright spots are found as this condition indicates that the shells have been moving in their supports.

5. Inspect the bearing shells for wear. The connecting rod bearing load is on the upper half of the shell. Any wear, therefore, will show only on the upper half. The inside diameter of the shells when installed in the rod is 3.2524" to 3.2544." The shells may be measured for wear in the same manner as the main bearing shells (refer to "CRANKSHAFT, FLYWHEEL, AND MAIN BEARINGS" in this section). Standard size bearing shells when new have a thickness of .1543" to 1548" when measured at the center. Therefore, any variation from this dimension will indicate the amount of wear on a used bearing shell. The connecting rod bearing to shell crankshaft journal clearance is .0024" to .0054"

for new parts; whenever this clearance exceeds .007" on used parts, new parts shells .002", .010", .020" and .030" undersize are available in the event the crankshaft is worn or has been damaged and must be reground.

G. Fitting Pistons with Liners

Measurements of the pistons and the liners and running clearances between the pistons and the liners should be taken at room temperature (70° F.). *PISTONS MUST BE FITTED TO THEIR RESPECTIVE LINERS TO PROVIDE A RUNNING CLEARANCE OF NOT LESS THAN .006".* Insufficient clearance will result in premature failure of these parts.

Measure the liners as described in "CYLINDER LINER CLEANING AND INSPECTION" in this section. The bore of the liners must be round within .001" and the pistons must also be round within .001". Measure each piston its full length both crosswise and parallel with the pin. Measure each liner over its entire length at corresponding points.

Use a .005" feeler ribbon 12" to 18" long to measure the clearance between the pistons and the liners. The ribbon must be perfectly flat and free of nicks or scratches. Hold the feeler ribbon along the side of the cylinder liner wall, then with rod connected to the piston, insert the piston into the liner in running position. With a .006" clearance between the piston and the liner, the .005" feeler ribbon can be withdrawn with a slight pull (not to exceed 6 pounds). Refer to Fig. 31. Check the clearance at the ends of the piston pin and at points 90° from the ends of the pin. If a bind exists in one place only, turn the liner 90° in the block and check the clearance again. This sometimes eliminates the binding. Also inspect for slight burrs on the piston or the liner if binding exists. Remove the burrs with a honing stone or fine emery paper.

If, after removing the burrs, the piston still fails to fit properly, wire brush the piston area uniformly below the ring lands with a medium bristle wire brush. Continue the brushing until the specified clearance is obtained. Brushing the piston in this manner will remove part of the material with which the piston is coated.

H. Fitting Piston Rings

The gap between the ends of the piston rings should be measured before the rings are installed on pistons. Select the rings that are to be used on each piston and fit them one at a time in the cylinder in which they are to operate. Use a piston to push the ring squarely into the cylinder so that it is parallel with the cylinder head. Push the ring far enough down in the bore to be on the travel area of the cylinder liner when the piston is installed. Check the ring gap with a feeler ribbon as shown in Fig. 32.

The specified gap of the "chromium plated" piston compression rings is .035" to .060". *NOTE: These rings should never be filed to open the gap because the plating might be loosened by the file and later distributed through the engine or might cause scoring of the piston and cylinder liner.*

The piston compression ring-to-groove clearances (top of ring to top of groove) using a new piston and new rings are as follows:

Top Ring	.010" to .013"
2nd Ring	.008" to .011"
3rd and 4th Ring	.006" to .009"

The piston oil control ring gap specification is .015" to .025" the oil control ring-to-groove clearance (top of ring to top of grove) is .0015" to .0055".

After the rings have been fitted for proper gap, install them on the piston. The oil control rings are the 3-piece type and must be installed in the two lower grooves in the piston skirt in the position shown in Fig. 29. The expanders must be installed first, then the rings, with the scraper edges down and the chamfered edges toward the top of the piston. This is important to control piston lubrication properly. Stagger the ring gaps evenly around the piston and apply oil to the rings and pistons before installing them in the cylinders.

IMPORTANT: When installing the rings on the pistons, the rings should not be spread so the gap is opened beyond 1¼". Opening the gap beyond this limit might distort the ring and cause it to take a set, contributing to ring breakage.

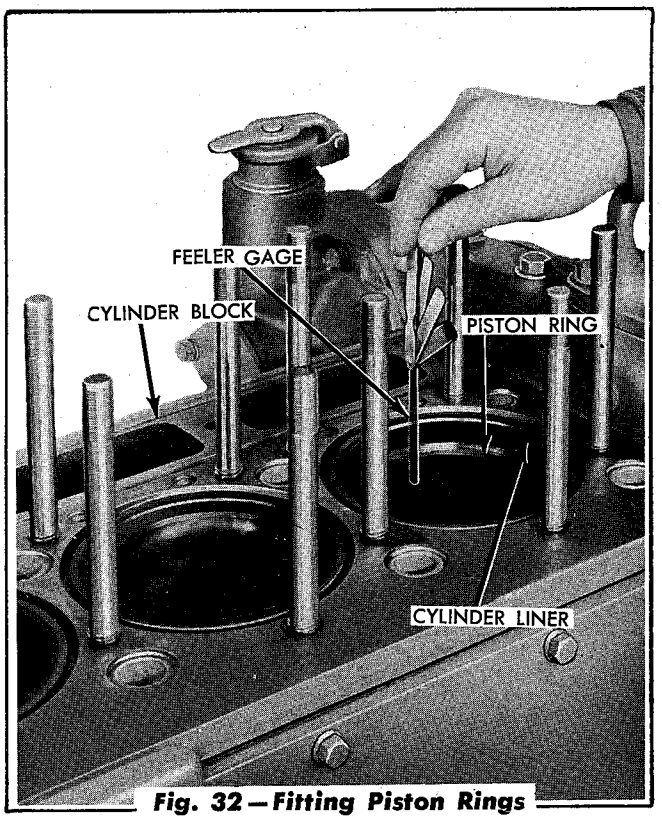


Fig. 32 — Fitting Piston Rings

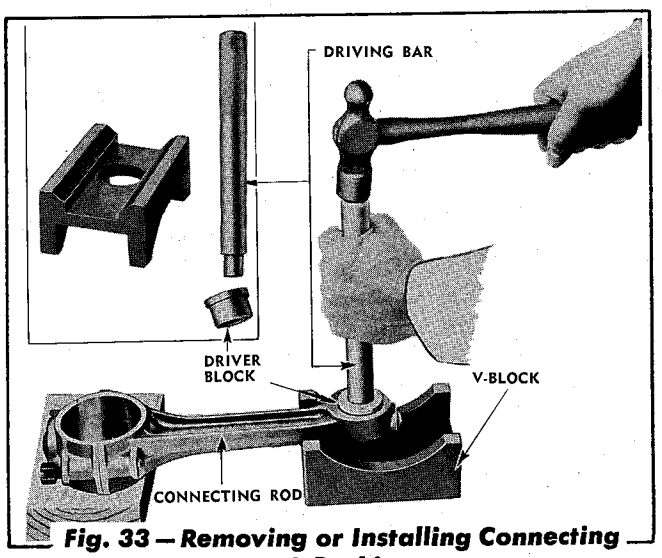


Fig. 33 — Removing or Installing Connecting Rod Bushings

I. Replacement and Reaming of Piston Pin Bushings in Connecting Rod

1. Remove the bushings from the connecting rod with the driving bar and driver block as shown in Fig. 33.
2. Install the new bushings, pressing one into each side of the connecting rod, with outer end of each bushing flush with the outer edge of the rod and with the joints of the bushings toward the top of rod. This will leave an oil space of approximately 3/16" between the bushings.

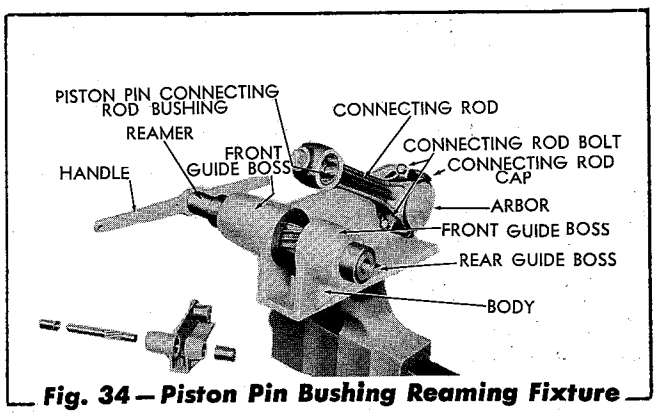


Fig. 34 — Piston Pin Bushing Reaming Fixture

3. After the bushings have been installed, they must be reamed. The special reaming fixture and reamer shown in Fig. 34 must be used to assure proper alignment of the piston with the rod and to obtain proper clearance of the piston pin with the bushings.
   a. Place the bore at the lower end of the rod over the arbor on the fixture, and draw the bearing cap up tight.
   b. Slide the bushing into the rear guide boss of the fixture, with the hollow end of the bushing facing the slot in the fixture which accommodates the upper end of the connecting rod.
   c. Rotate the connecting rod into position for reaming so that the upper end of the rod rests on the boss of the tool bed.
   d. Install the front guide bushing on the reamer. Insert the reamer into the front guide boss and turn it clockwise with a uniform motion. Do not crowd the reamer too hard as better results will be obtained by moderate pressures when turning.
   e. After reaming, inspect the bearing between the bushing and pin. If the bushings have been properly reamed, the clearance between the piston pin and the bushing will be from .0015" to .0024".

J. Assemble Connecting Rods and Pistons

1. Install one of the piston pin retainers and a lock ring in one end of the piston pin hole.

2. Insert the upper end of the connecting rod into the piston. Lubricate the piston pin with light oil and slide the pin through the piston and rod. The pin will slip easily into place without forcing if it has been correctly fitted.

3. Install the second retainer and the lock ring at the opposite end of the pin.

IMPORTANT: Install the piston pin retainer lock rings so that the offset in the tips of the rings will bear against the retainers. This is necessary to keep the retainers from turning and also to hold the retainers tightly in position, thus, preventing oil returning from the sprayed piston head and through the grooves in the piston bushings from reaching the cylinder walls.

8. CAMSHAFT AND ACCESSORY DRIVE SHAFT

A. Description

The camshaft, located near the top of the cylinder block, on the left hand side, is a one piece drop forging, case hardened at the cams and journals. It is drilled through its entire length and cross drilled at the intermediate bearing journals for bearing lubrication. The accessory drive shaft is located directly below the camshaft. A bearing assembly, containing graphite-bronze steel backed bushings, is used to support each end of the camshaft and accessory drive shaft. Steel backed, bronze replaceable thrust washers are used on the thrust ends of the shafts. Intermediate bearings, between each set of cams on the camshaft, and near the center of the accessory drive shaft provide additional support for the shafts.

As will be seen from Fig. 35, the intermediate camshaft bearings are two-piece and are held together by lock rings. Each bearing assembly is located and locked in position in the cylinder block by a shouldered locking bolt sunk into a counterbore at the top of the block.

The cams are ground with parallel surfaces to assure efficient quiet roller action. Heat-treatment provides hard, wear-resistant cam lobes.

The function of the accessory drive shaft, as its name implies, is to provide a means of driving accessory components of the engine.

B. Lubrication

Lubrication is supplied to the camshaft and acces-

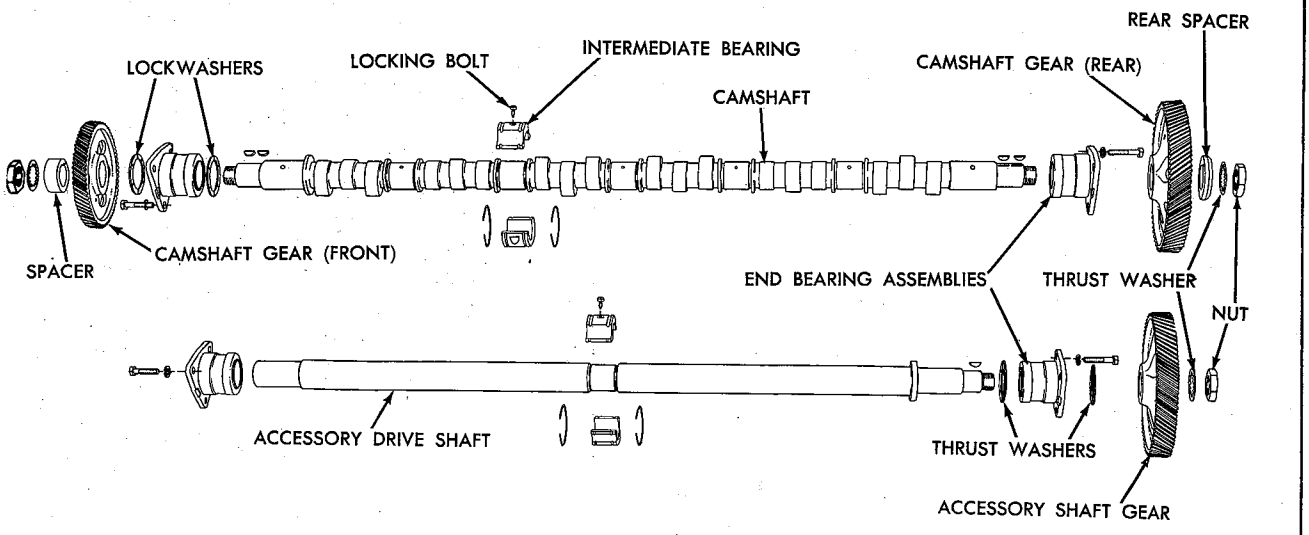


Fig. 35—Camshaft and Accessory Drive Shaft Details

sory drive shaft end bearings through vertical oil passages in the cylinder block which communicate with the main oil gallery. The camshaft intermediate bearings are lubricated by oil from the drilled camshaft. The center bearing of the accessory drive shaft is lubricated through a horizontal oil passage from the main oil gallery.

C. Service

If service on the camshaft gear or the accessory shaft gear necessitates removal of the gears from the shafts, the work can best be performed by first removing the shafts from the engine.

D. Removal of Camshaft and Accessory Drive Shaft Assemblies

When removal of the camshaft or accessory drive shaft becomes necessary, the work can best be performed by first removing the engine from the tractor as outlined in Topic 11 of this section. The engine disassembly procedures given in Topic 12 of this section will be followed for operations prior to removing the shafts from the engine.

1. Remove the camshaft front gear as illustrated in Fig. 36. Also remove the outer thrust washer when the gear is removed.

2. Remove the three (3) capscrews used to attach the camshaft and accessory drive shaft bearing assemblies to the front of the cylinder block, then slide the bearings off the end of the camshaft and accessory drive shaft. Remove the inner thrust washer from the camshaft.

3. Remove the six (6) capscrews attaching the steering pump drive adapter to the camshaft gear, then remove the adapter and the steering pump drive coupling plate.

4. Wedge a clean rag between the teeth of the camshaft rear gear and the accessory drive gear to prevent rotation, then loosen but do not remove the gear retaining nuts from the camshaft and accessory drive shaft.

5. Rotate the accessory drive shaft and the camshaft as necessary to align the holes in the web of the gears with the three (3) bearing

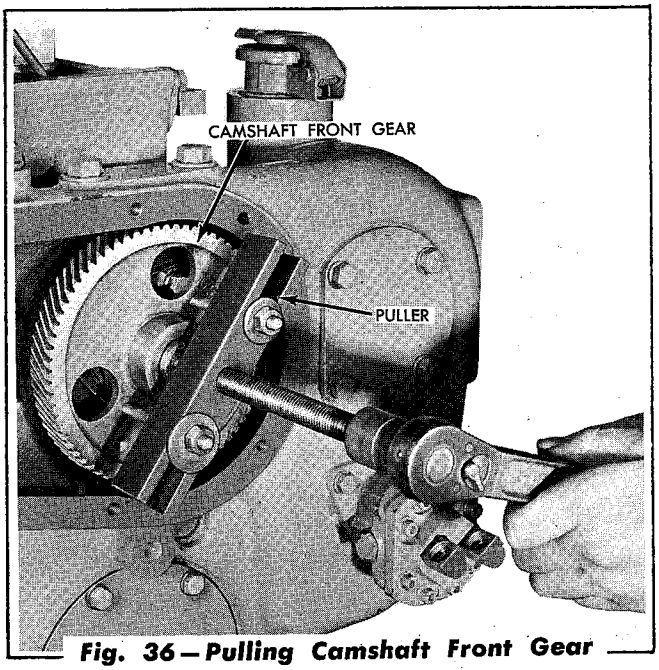


Fig. 36 — Pulling Camshaft Front Gear

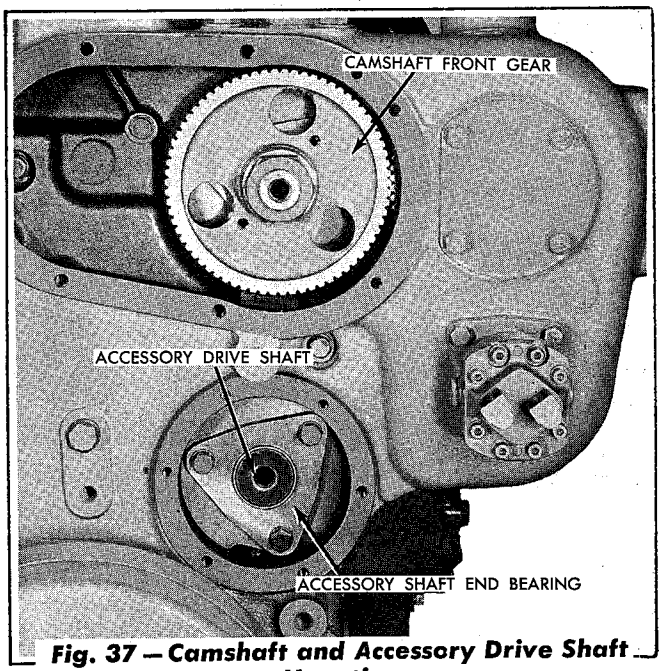


Fig. 37 — Camshaft and Accessory Drive Shaft Mounting

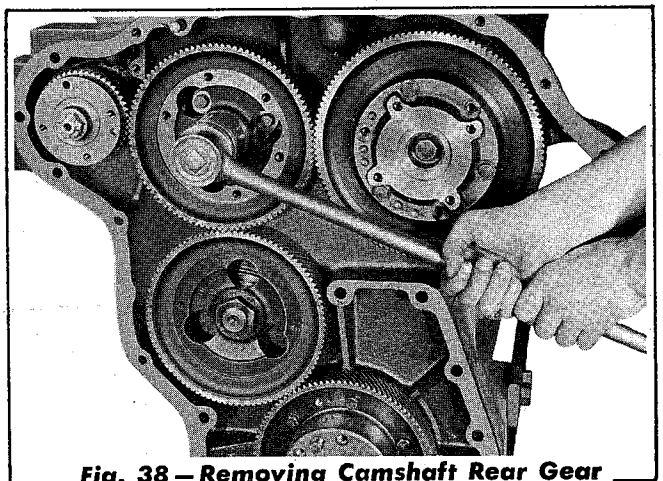


Fig. 38 — Removing Camshaft Rear Gear Retaining Nut

assembly retaining bolts and remove the bolts from the bearing assemblies.

6. Check to make sure that all five (5) of the intermediate bearing locking bolts are removed from the bearings then slide the camshaft assembly, complete with gear and intermediate bearings out of the rear of engine as shown in Fig. 40.

7. Remove the oil cooler as instructed in "ENGINE LUBRICATING SYSTEM" Section V, then insert a screwdriver into the opening in the cylinder block directly below the oil cooler outlet opening and remove the intermediate bearing locking bolt from the accessory drive shaft intermediate bearing.

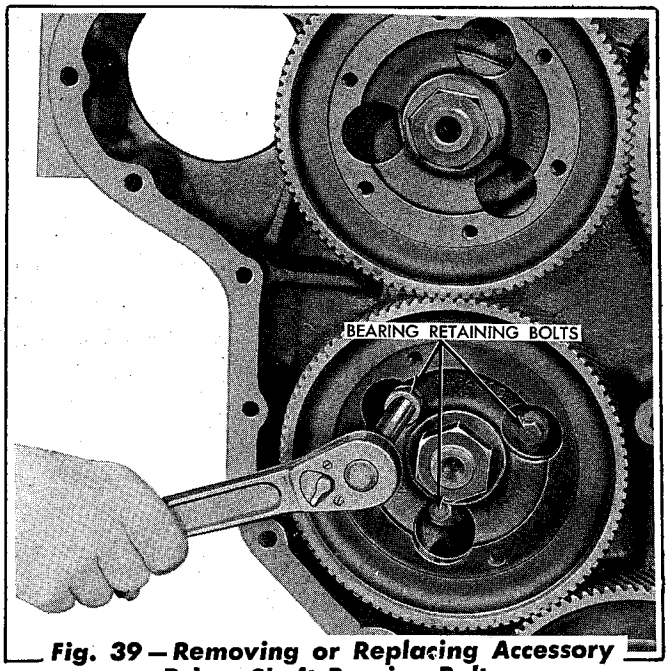


Fig. 39 — Removing or Replacing Accessory Drive Shaft Bearing Bolts

8. Slide the assembly of accessory drive shaft, gear, and intermediate bearing out of the rear of the engine.

E. Removal of Parts from Camshaft and Accessory Drive Shaft

1. Remove the retaining nut, spacer, and lockwasher from the gear end of the camshaft and remove the nut and washer from the accessory drive shaft.

2. Place the camshaft in an arbor press and press the gear from the shaft. Perform the same operation on the accessory drive shaft.

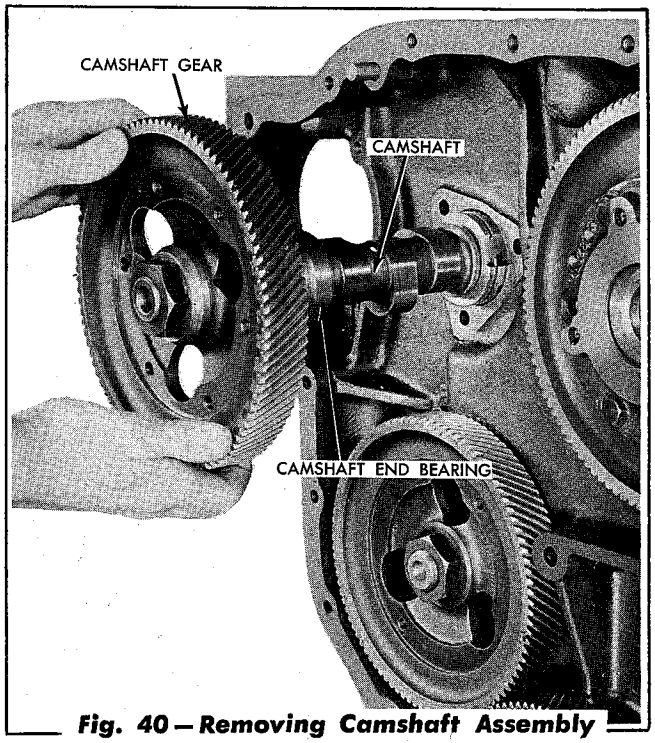


Fig. 40 — Removing Camshaft Assembly

3. Remove the bearing assemblies from the shafts and the thrust washer from the accessory drive shaft.

4. Remove two (2) "WOODRUFF" keys from the camshaft and one (1) key from the accessory drive shaft.

5. Remove the lock rings from the intermediate bearings of both shafts and remove the bearings from the shafts.

F. Inspection of Camshaft and Accessory Drive Shaft Parts

After all the parts have been cleaned with solvent or fuel oil and dried by compressed air, inspect all the bearings and journals for wear before reinstalling the parts in the engine.

Examine both faces of the cam and the accessory drive shaft bearing thrust washers and if either face is scored, replace the washers. Examine the surfaces against which the thrust washers contact and if the surfaces are scratched, but not severely scored, they may be smoothed with an oil stone, however, score marks too deep to be removed or parts badly worn, necessitate the use of new parts.

The radial clearance on the camshaft and accessory drive shaft bearings is from .0045" to .0065"

and should not exceed .009". The end play of the thrust washers should be .006" to .014".

The camshaft intermediate bearings should have a radial clearance of from .0025" to .005." The clearance should not exceed .009".

Examine the cam surfaces for wear or scoring. A shaft with scored cams should not be used. Allowable backlash between the gears is .003" to .008". Replace worn or damaged gears (refer to "GEAR TRAIN" in this section).

Oil is fed through the drilled camshaft to its intermediate bearings; therefore, all oil holes should be examined in both the shaft and bearings. Sludge accumulations which might restrict the oil flow, should be removed.

G. Installation of Parts on the Camshaft and Accessory Drive Shaft

Assembly at this time will consist of installing the gears and bearing assemblies on the rear ends of both shafts, installing the intermediate bearings on the shafts and installing the shafts in the engine block. The remaining parts will be installed as the engine is assembled. Refer to "ASSEMBLY OF ENGINE" in this section. Refer to Fig. 35 for relative location of parts and assemble the shafts as follows:

1. Lubricate the bearing assemblies with oil and place one assembly on the rear end of each shaft, placing a thrust washer between the thrust shoulder of the accessory drive shaft and the bearing. Be sure that the steel face of the washer is against the bearing assembly and that the bearing assemblies are installed with the attaching flanges of the bearings toward the outer (gear) end of the shafts.

2. Install two (2) "WOODRUFF" keys in the keyways on the end of the camshaft having an arrow stamped in the end of the shaft and install one (1) "WOODRUFF" key in the keyway of the accessory drive shaft.

3. Start the gear having the left hand helix (gear having six (6) 3/8" diameter holes drilled for mounting of steering pump adapter) on the end of the camshaft, aligning the keyway in the gear with the keys in the shaft and using an arbor press, push the gear tight against the shoulder on the shaft.

4. Apply heavy cup grease to the steel face of a thrust washer and place the washer on the accessory drive shaft with the steel face of the washer against the bearing assembly.

5. Place the gear having the right hand helix on the end of the accessory drive shaft, align the key in the shaft with the keyway in the gear and press the gear tight against the shoulder of the shaft.

6. Install the camshaft gear spacer over the "WOODRUFF" key on the camshaft with chamfered side of the spacer facing away from the gear.

7. Install the lockwashers and gear retaining nuts on the shafts but do not tighten the nuts at this time.

8. Lubricate the two halves of the intermediate bearings, install them on the journals of the camshaft and accessory drive shaft and lock the two halves of the bearings together with the lock rings.

NOTE: Prior to engine serial number 6B-3487, felt plugs were used in the cam pockets at the No. 1-3-4 and 6 positions. This was done to dam the oil and provide more lubrication for the intermediate bearings and cam follower rollers. When an engine repair is made, the felt plugs must be removed and discarded, and new camshaft end bearings and intermediate bearings installed.

To provide adequate lubrication of the intermediate bearings and cam followers on engines prior to serial number 6B-3487, new lower camshaft intermediate bearings and camshaft end bearing assemblies should be installed. The lower half of the new intermediate bearings are made with a groove or orifice along the horizontal surface at the point mating with the upper half of the bearing.

Oil emerging under pressure from the drilled camshaft is forced through a milled slot in the lower bearing and out the orifice to spray on the cam follower rollers. The new camshaft end bearing assembly has a groove cut on the outer diameter through which oil is forced under pressure to spray on the cam follower rollers. The bearings on the accessory drive shaft are not affected by this change and need not be replaced if in good condition.

H. Installation of Camshaft and Accessory Drive Shaft in Cylinder Block

1. Turn all intermediate bearings so that the locking holes are up and insert the camshaft into the upper bore at rear of cylinder block being careful not to damage cams and bearings when installing the shaft.

2. Attach the camshaft end bearing to the cylinder block with three (3) capscrews and lockwashers inserted through the holes in the web of the gear. Do not tighten the capscrews at this time. *NOTE: Install the camshaft end bearing with the part marked "TOP" upward.*

3. Apply heavy cup grease to the steel side of a thrust washer and set the washer against the inner end of the remaining camshaft end bearing assembly with the steel face of the washer next to the bearing.

4. Insert the camshaft end bearing into the upper bore of the front end of the cylinder block with the part of the bearing marked "TOP" upward. Be sure that the thrust washer does not drop from position when installing the bearing assembly in the cylinder block.

5. Attach the bearing assembly to the cylinder block with three (3) capscrews and lockwashers but do not tighten at this time.

6. Revolve the camshaft intermediate bearings to align the locking holes in the bearings with the holes in the top of the cylinder block. Install and tighten the intermediate bearing locking bolts to hold the bearings in position.

7. Tighten the front and rear end bearing bolts evenly while checking camshaft rotation for freedom from bind.

8. Insert the accessory shaft assembly, consisting of shaft, gear, end bearing, thrust washers, and intermediate bearing into the lower bore on the rear of the cylinder block and push it toward the front of the block to the point where the gear teeth are about to engage with the teeth on the crankshaft and camshaft gears.

9. There are two timing marks "A" and "C" stamped on the face of each gear. Position the camshaft gear, crankshaft gear and accessory drive shaft gear so that the "A" timing marks on all three gears are adjacent, as shown in Fig. 42, and slide the accessory gear into mesh with the camshaft and crankshaft gears.

10. Attach the accessory shaft end bearing to the cylinder block with three (3) capscrews and lockwashers but do not tighien at this time.

11. Install the remaining end bearing to the front end of the accessory shaft, attach the bearing to the cylinder block with three (3) capscrews and lockwashers but do not tighten at this time.

12. With the oil cooler removed from the left side of the cylinder block, revolve the accessory drive shaft intermediate bearing to align the locking hole in the bearing with the hole in the cylinder block. Install the bearing locking bolt and tighten securely.

13. Tighten the accessory drive shaft end bearing bolts securely.

14. Wedge a clean rag between the teeth of the camshaft and accessory shaft gears to prevent rotation and tighten the gear retaining nuts to a torque of 450 to 500 ft. lbs.

15. Install two (2) "WOODRUFF" keys in the keyways on the front end of the camshaft.

16. Apply heavy cup grease to the steel face of

the remaining thrust washer and press the washer against the outer face of the front camshaft end bearing with the steel face of the thrust washer against the end bearing.

17. Start the gear on the front end of the camshaft with the keys and keyway aligned, then drive the gear tight against the shoulder on the shaft.

18. Install the camshaft front spacer, lockwasher, and nut, tightening the nut to a torque of 300 to 325 ft. lbs.

19. Check the backlash between the crankshaft, accessory shaft, and camshaft gears. The backlash between the crankshaft and accessory shaft should be .003" to .008". The accessory shaft and camshaft should have a backlash of .003" to .008".

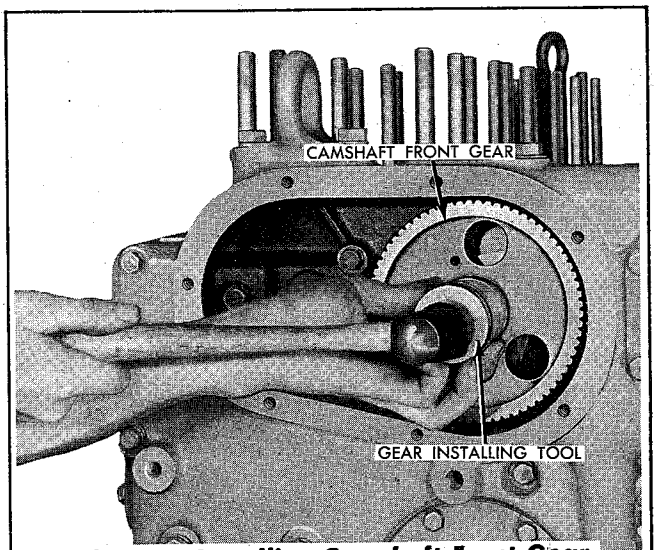


Fig. 41 — Installing Camshaft Front Gear

20. The engine assembly procedures given in Topic 13 of this section will be followed to complete the assembly of the engine.

9. GEAR TRAIN

A. Description

A completely enclosed set of five (5) helical gears is located at the rear of the engine as shown in Fig. 42. A gear, bolted to the flange on the rear of the crankshaft drives the accessory drive gear as well as the camshaft gear, idler gear, blower drive gear and governor drive gear.

Camshaft timing is accomplished through the rear gear train. The crankshaft and camshaft gear turn at the same speed, and the accessory drive gear, serving as an idler between the two gears also turns at the same speed as the crankshaft. The rims of the camshaft, crankshaft, and accessory drive gears are stamped with the timing marks "A" and "C." When the letters "A" are matched in pairs, that is, adjacent to each other on all three gears, the camshaft is properly timed. Refer to Fig. 42.

The idler gear, used between the camshaft and blower drive gears, is mounted on a double row, tapered roller bearing. The idler gear bearing is lubricated from the engine oil gallery through a short outside line on the right rear side of the block.

B. Service

Whenever the flywheel housing is removed for inspection or repair of the gear train, the idler gear

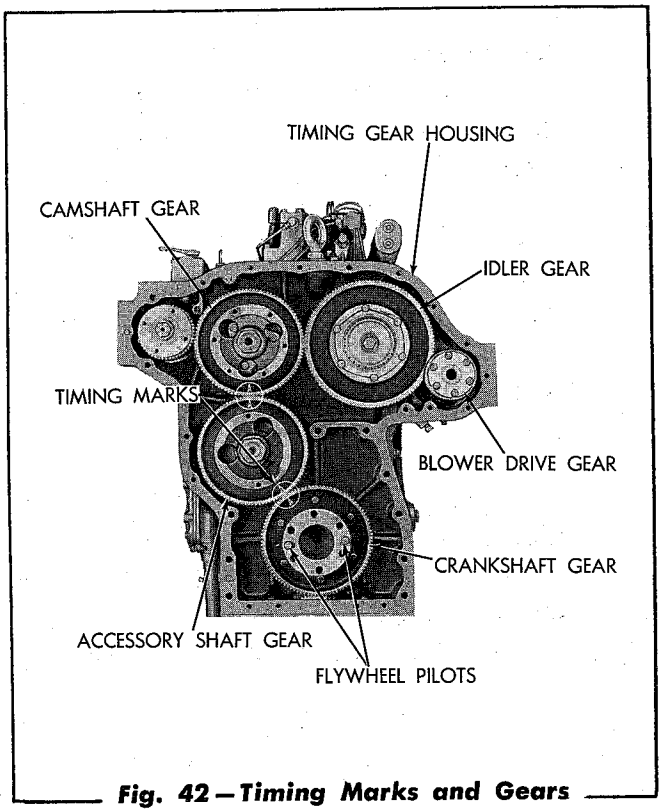


Fig. 42 — Timing Marks and Gears

assembly should be removed and inspected.

Two different types of tapered roller bearings are used in the idler gears of the engines.

The inner races, tapered rollers, and bearing retainers of the later types bearings are assembled

during manufacture to produce a non-separable inner race assembly thereby preventing the rollers from falling out of place when installing or removing the bearing. The bearing also contains a selected spacer assembled between the inner races. As the spacer is of a selected width for the particular bearing, the proper pre-load between the bearing races is obtained when the bearing is assembled.

The inner races, tapered rollers, and bearing retainers of the early type bearings are held in place by a "U" shaped snap ring assembled between the two inner races to provide a means of holding the two inner races together. When the snap ring is removed, as is necessary when removing or installing the bearing, special care must be used in handling so that the roller retainers are not allowed to escape, thereby allowing the rollers to fall out and become mixed (from one race to the other race).

The later type idler gear bearing can not be distinguished from the early type bearing until the idler gear hub is pressed out of the inner races of the roller bearing. If the bearing is of the late type, the two inner races and roller assemblies will separate and a spacer will be found assembled between the two inner races. If the bearing is of the early type, the two inner races and roller assemblies will remain locked together when the hub is removed, as a snap ring is used between the two races to lock them together.

The idler gear, hub assembly, and roller bearing are available as an assembly or the individual parts can be obtained for service. *NOTE: Only the later type roller bearing assembly is available for service. If the engine being repaired contains the early type bearing assembly and it is found necessary to replace the assembly, the later type bearing assembly may be installed as the early and late type assemblies are interchangeable.*

The gear train will run quietly if the gears and bearings are in good condition. If the gears or the bearings have become worn, the backlash will be increased and the gear train may become noisy, or if the gear teeth become chipped or burred from careless handling, the gear train will be noisy.

When noisy conditions develop in the gear train, it will be necessary to remove the engine and inspect the gears and the bearings. The entire gear train is exposed when the combination flywheel housing and gear train cover is removed from the rear of the cylinder block.

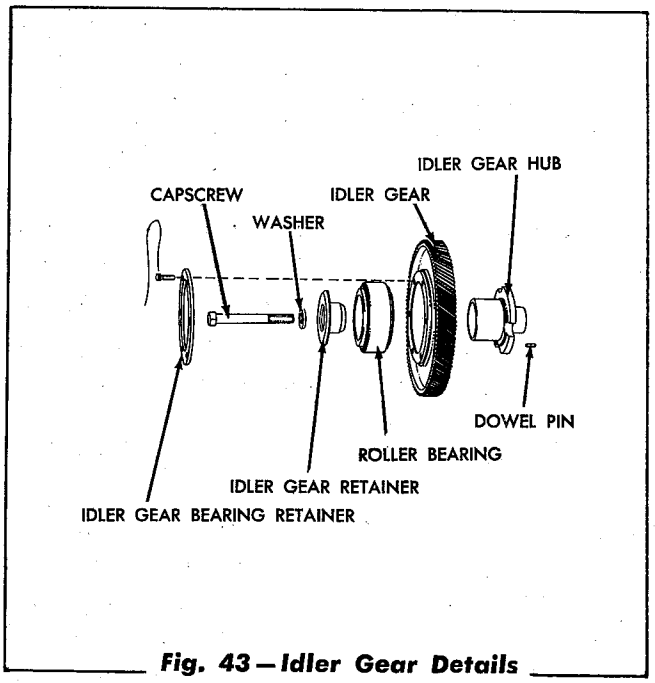


Fig. 43—Idler Gear Details

C. Inspection and Disassembly of Idler Gear, Hub, and Bearing Assembly Parts

When the idler gear assembly has been removed from the engine, the roller bearing should be removed from the hub and the gear, all parts washed in clean solvent, and inspected for wear before they are reinstalled in the engine, all damaged or worn parts must be replaced.

1. Removal of Late Type Idler Gear Roller Bearing from Idler Gear

With the idler gear assembly removed from the engine, proceed as follows:

a. Wash the idler gear assembly thoroughly in clean solvent.

b. Press the idler gear hub out of the inner races of the bearing. *IMPORTANT: When pressing the hub out of the inner races, use a suitable press plate under the inner races for support so that no load is imposed on the bearing rollers.*

c. Remove the two inner races and roller as-

semblies of the bearing and also the spacer used between the inner races. Mark the inner races so that they may be reinstalled in their original location with respect to the outer bearing race in the idler gear.

d. Inspect the outer bearing race in the idler gear and if necessary remove it from the gear. Remove the locking wire and the capscrews attaching the retainer to the gear. Remove the bearing retainer.

e. Mark the outer race so that it may be reinstalled in the idler gear as originally with respect to the inner races and the rollers. Position the gear in a press, with the flat face of the gear down, then using a suitable plug, insert the plug in position in the outer race and press the outer race from the gear. If a press is not available, a suitable drift pin may be used to drive the outer race from the gear by inserting the drift pin into the notcher (put-out slots) in the shoulder of the gear.

f. Coat the parts with clean lubricating oil and store them in a suitable place which will protect them against damage from moisture and dirt until they are required for reassembly.

2. Removal of Early Type Idler Gear Roller Bearing from Idler Gear

With the idler gear assembly removed from the engine, proceed as follows:

a. Wash the idler gear assembly thoroughly.

b. Press the idler gear hub out of the inner races of the bearing. *IMPORTANT: When pressing the hub out of the inner races, use a suitable press plate under the inner races for support so that no load is imposed on the bearing rollers.*

c. Place the gear on a work bench covered with clean paper, with the rear face of the gear next to the work bench.

d. Insert the end of a small screwdriver down in the notch in the bearing inner race and use the screwdriver to release the snap ring. Rock the gear gently when releasing the snap ring with the screwdriver. If the snap ring does not release at this position, turn the inner race until the correct position is obtained to release it. Ordinarily, when the snap ring is released, it will remain engaged with one of the two inner races.

CAUTION: When the snap ring is released, use care to prevent the rollers escaping their cage while performing the following steps. In the event that some of the rollers do escape, the rollers MUST be reinstalled with the small end facing the small end of the inner race.

e. Lift the gear and the top inner race and its rollers from the bottom inner race and its rollers.

f. Hold the top inner race and its rollers tight against the outer race, turn the gear over, and place it on the work bench.

g. Mark the bottom inner race (and its rollers) and the side of the outer race from which the inner race and its rollers were removed so that when the bearing is reassembled, these parts can be assembled in their original location.

h. Lift the gear from the other inner race and its rollers. Mark this race and its rollers and the outer race so that these parts may be assembled in their original position.

i. Inspect the outer bearing race in the idler gear and if it is necessary to remove it from the gear, unlock and remove the capscrews and locks attaching the retainer to the gear. Remove the retainer.

j. Mark the outer race so that it can be reinstalled in the idler gear as originally. Position the gear in a press, with flat face

of gear down, then using a suitable plug, insert the plug in position in the outer race and press the outer race from the gear. If a press is not available, and if the hub of the shoulder of the gear contains notches (push-out slots) a drift pin may be used by inserting it in the notches and driving the outer race from the gear.

k. Coat the parts with clean lubricating oil and store them in a suitable place which will protect them from moisture and dirt until they are required for reassembly.

D. Assembly and Installation of Idler Gear Assembly and Flywheel Housing Spacer Assembly

1. Assembly of Late Type Idler Gear Roller Bearing Into Idler Gear

a. Clean all parts thoroughly and place them on a clean paper on a work bench. Separate the parts that were marked for identification when the parts were disassembled so that they can be reinstalled in their same respective locations.

b. Place the idler gear (flat face of gear up) on suitable supports in a press. Start the outer race of the roller bearing squarely into the bore of the idler gear. Using a round plug, insert the plug evenly into the outer race, and press the outer race into the bore of the gear until the race is firmly against the shoulder of the gear. Remove the gear from the press. If a press is not available, the race may be installed by driving it into place with a hardwood block or soft hammer.

c. Place the idler gear on a bench with the shoulder side of gear up, select the inner race and rollers which match with the outer race on this side of the gear, and place the inner race and rollers in position in the outer race. Turn the gear and inner race over (with inner race down), and place the gear and inner race in position on a press with suitable supports under the inner race to stop the hub when it is pressed into the bearing.

d. Place the spacer in position on the inner race in the gear, then insert the other inner race and rollers in position in the outer race in the gear.

e. Determine the position of the gap in the spacer used between the inner races, then start the hub in position (dowel pin end down) so that the oil hole in the hub is turned approximately 180° from the gap in the spacer. Press the hub into the inner races, simultaneously, pressing the hub and rotating the gear (to seat the rollers properly between their races) until the lower face of the hub contacts the supports used under the inner race and the lower face of the hub is flush with the inner race.

f. Remove the idler gear assembly from the press. Place the bearing retainer in position on the gear and install the attaching capscrews. Tighten the capscrews to a torque of 24 to 29 ft. lbs. Lock the capscrews in position with lockwire.

2. Assembly of Early Type Idler Gear Roller Bearing Into Idler Gear

a. Clean the parts thoroughly and place them on a clean paper on a work bench.

b. Place the idler gear (flat face of gear up) on suitable supports in a press. Start the outer race of the bearing squarely into the bore of the idler gear. Using a suitable round plug, insert the plug evenly into the outer race, and press the outer race into the bore of the gear until the race is firmly against the shoulder of the gear. If a press is not available, the outer race may be installed by driving it into place with a hardwood block or soft hammer.

c. Pick the idler gear up (with the shoulder side of the gear up), select the inner race and rollers which match with the opposite side of the outer race, then place the idler gear over the inner race and rollers.

d. Lift the idler gear and the inner race together, and using care not to drop the rollers, turn the gear and inner race over and place the idler gear over the remaining inner race.

e. Press down on the inner race (the upper one as installed in the gear) by hand, then rock the race slightly to engage the snap ring in the grooves of the inner races. *CAUTION: Do not lift the gear and bearing assembly from the work bench before it is certain that the snap ring is properly engaged.*

f. Turn the inner races so that the notches, which are on the inside surfaces of the inner races, are together. Place the idler gear assembly (with shoulder side of gear down) in a press with suitable supports under the inner race to stop the hub when it is pressed into the bearing.

g. Determine the position of the slots in the two inner races (slots must be together) then start the hub in position (dowel pin end down) so that the oil hole in the hub is turned approximately 180° from the slots in the inner races. Press the hub into the inner races, simultaneously pressing the hub and rotating the gear (to seat the rollers properly between their races) until the lower face of the hub contacts the supports used under the inner race and the lower face of the hub is flush with the inner race.

h. Remove the idler gear assembly from the press. Place the bearing retainer in position on the gear and install the attaching capscrews. Tighten the capscrews to a torque of 24 to 29 ft. lbs. Lock the capscrews in position with lockwire.

3. Testing Idler Gear Bearing Pre-Load

a. Lubricate the idler gear bearing with clean, light, engine oil and rotate the gear on the bearing so that all rollers are lubricated.

b. Install the flat washer on the idler gear retaining capscrew, insert the capscrew through the retainer and hub, and using a flat washer and a 5/8" NC hex nut on the other end of the capscrew, tighten the capscrew to a torque of 137 to 147 ft. lbs.

c. Place the hex nut (on the hub end of the retaining capscrew) in a vise, with the head of the retaining bolt up and clamp it securely in this position.

d. Tie one end of a lintless cord around a 1/8" round piece of wood (or metal stock) about 3/4" long. Place the piece of wood between two teeth of the idler gear, then wrap the cord around the outer diameter of the gear several times.

e. Make a loop in the other end of the cord and attach it to the hook of a pull scale (fish scale). Maintain a steady pull on the scale and note the pounds pull required to turn the gear on its bearing.

f. On the late type idler gear (factory preloaded bearing), the pull should be between 1 and 5 pounds. On the early type idler gear (shim adjusted bearing) the pull should be between 1/2 and 15 pounds. If the pull required to rotate the gears on the bearings is within the specified ranges, the assembly is satisfactory for use. If the pull does not fall within the specified ranges, the assembly should be removed and the bearing inspected. Replace the bearing assembly if necessary.

10. REPAIR OF ENGINE WHILE INSTALLED

A. General Information

Repair or replacement of the crankshaft, camshaft, and bearings, accessory drive shaft and bearings, timing gears, and the rear crankshaft oil seal requires the removal of the engine from the tractor. Practically all other parts can be removed and new parts installed with the engine in the tractor, however, *IT IS UNWISE TO REPLACE THE CYLINDER LINERS, PISTONS, AND CONNECTING RODS, OR THE MAIN AND CONNECTING ROD BEARINGS WITHOUT REMOVING THE ENGINE AND TAKING IT INTO A CLEAN SHOP WHERE IT CAN BE DISASSEMBLED AND ALL PARTS THOROUGHLY CLEANED AND INSPECTED BEFORE THE 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 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.

4. When new main and connecting rod bearings are required, the idler gear bearing, camshaft bearings, and accessory drive shaft bearings must also be inspected, and if excessively worn, they must be replaced. The oil pressure may remain low and the new bearings or pistons and rings may not receive sufficient lubrication, if the camshaft and the accessory drive shaft bearings are worn close to, or beyond the allowable limits and are not replaced.

The following procedures describe 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 tractor to a shop.

B. Replacement of Piston and Connecting Rod

1. Remove the cylinder head (refer to "CYLINDER HEAD REMOVAL" in this section). Cover the cylinder head and the top of the engine to prevent dust from blowing on the exposed parts.

2. Remove the engine crankcase guard, then drain the oil from the crankcase and remove the lower and the upper oil pans.

3. Remove the oil pump from the engine block (refer to "OIL PUMP REMOVAL" in 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 pump assembly and the upper and lower oil pans, then fill the crankcase

with new oil. Refer to "OIL PUMP INSTALLATION" in Section V.

9. Install the cylinder head and the hood. 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 before operating the tractor.

C. Replacement of Crankshaft Main Bearings

1. Remove the engine hood and the valve rocker arm cover.

2. Close the fuel tank shut-off valve, and remove the injectors (refer to "INJECTOR REMOVAL" in Section II). Removal of the injectors is necessary to relieve the compression and allow free turning of the engine and crankshaft.

3. Remove the engine crankcase guard, then drain the oil from the crankcase, and remove the lower and the upper oil pans.

4. Remove the oil pump assembly from the engine block (refer to "OIL PUMP REMOVAL" in Section V).

5. Remove the main bearing caps and install the new inserts *one at a time*. Do not fully tighten the caps until all the bearings have been installed. The lower shell can be removed from the bearing cap after the cap is removed. Remove the upper shell as follows:

   a. Insert a 5/16" x 1" capscrew with a head ½" in diameter and 1/16" thick into the crankshaft main bearing oil hole, then revolve 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 to turn the shaft until the shell has been pushed out of position, as shown in Fig. 44.

   b. The upper half of the rear main bearing must be rolled out of place by driving on the edge of the bearing shell with a small curved rod, while revolving the crankshaft. Refer to Fig. 45.

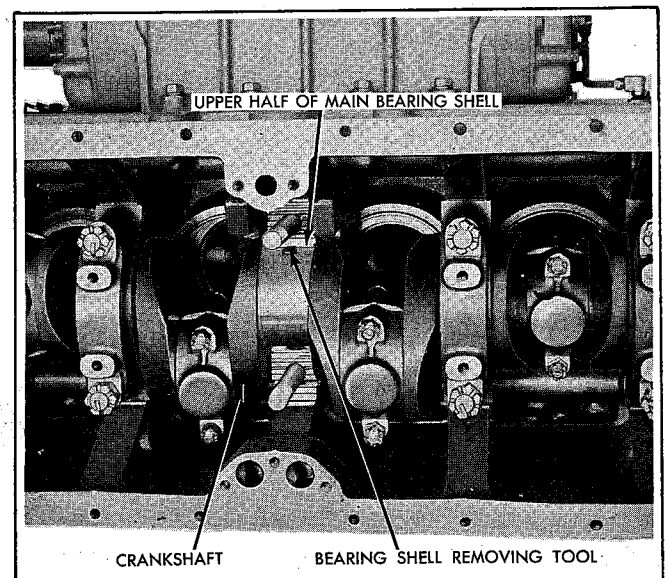


Fig. 44 — Removing Main Bearing Upper Shell

6. Inspect the crankshaft and each bearing as explained in "CRANKSHAFT, FLYWHEEL, AND MAIN BEARINGS" in this section. If the crankshaft is unfit for use, it must be reconditioned or replaced before new bearings are installed.

7. Install the upper (grooved) half of each main bearing as follows: Lubricate the shell and start the end of the shell having no tang around the crankshaft bearing journal, so that when the shell is in place, the tang will fit into the groove in the shell seat.

8. After the upper shell has been installed, place the lower (non-grooved) shell in the bearing cap, lubricate with light engine oil, and install the cap. *NOTE: The main bearing caps are marked 1, 2, 3, etc. Whenever the caps are removed, they should be replaced in their original positions with marked side toward the camshaft side of cylinder block.*

9. After all of the bearings have been installed, draw the bearing caps tight. Use a torque wrench and tighten the nuts to 180 to 190 ft. lbs. torque. *NOTE: Do not overtighten main bearing nuts as bearings will be distorted out of round.* If the bearings have

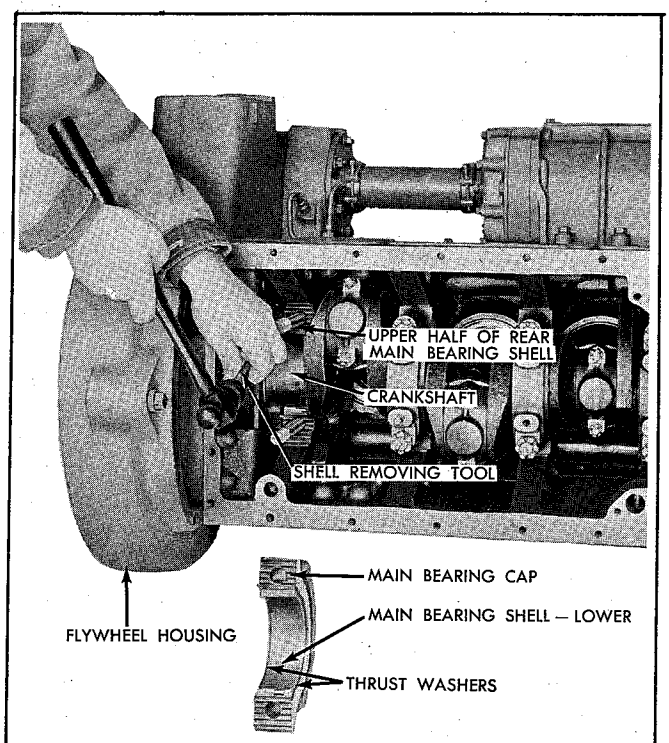


Fig. 45 – Removing Rear Main Bearing Upper Shell

been installed properly, the crankshaft will turn freely with all of the main bearing caps tightened.

10. Install the oil pump and the upper and lower oil pans, then fill the crankcase with new oil. Refer to "OIL PUMP INSTALLATION" in Section V.

11. Install the injectors and make the proper adjustments as explained in "INJECTOR TIMING" and "INJECTOR EQUALIZING" in Section II. Also adjust the valve lash as explained in "VALVE LASH ADJUSTMENT" in this section.

12. Install the rocker arm cover and the engine hood.

13. 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.

11. ENGINE REMOVAL AND INSTALLATION

A. General

A suitable hoist and the necessary cable or chain, or equivalent equipment, will be needed to lift the engine from the tractor.

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, wiping rags, and at least 6 to 8 boxes or pans to hold the bolts and small parts removed from the engine and the tractor.

It is recommended that the tractor, particularly the engine, be washed before the engine is removed. This will not only prevent dirt from getting on the exposed parts, but will also make the operation much quicker and more easily done.

B. Engine Removal

1. Remove the engine air pre-cleaners, engine hood, front fenders, and the front and center floor plates.

2. Drain the engine cooling system (refer to "FILLING AND DRAINING OF SYSTEM" in Section IV). Loosen the hose clamps used on the hoses connecting the radiator inlet elbow to the water manifold elbow and to the radiator inlet then remove the radiator inlet elbow. Loosen the hose clamp connecting the radiator outlet hose to the water pump elbow.

3. Remove the bolts attaching the fan guard to the radiator shell assembly and allow the guard to rest on the fan bracket.

4. Remove the capscrew attaching the battery ground cable to the steering clutch and final drive housing, then tape the end of the cable to prevent a ground when disconnecting other wiring. Disconnect the starter ground wire from the main frame. Close the fuel tank shut-off valve at the fuel tank.

5. Disconnect the main wiring harness from the starter and the generator. Disconnect the front fuel supply hose, leading to the fuel filter, from the fuel supply tube.

6. Remove the pipe plug, located in the bottom of the torque converter and drain the fluid from the converter. Reinstall the pipe plug after draining.

7. Disconnect the primer line from the primer pump if tractor is equipped with the primer. If tractor is equipped with an engine air heater, disconnect the wiring harness from the air heater and disconnect the two lines from the air heater pump.

8. Remove all wires, tubes, and lines connected to the instruments on the cowl. This is necessary to allow the cowl assembly to be positioned on the right track.

9. Disconnect the hydraulic steering pump breather line from the hydraulic steering pump or from the breather.

10. Disconnect the engine thermo gage from rear of the water outlet manifold.

11. Disconnect the starter operating rod from the starter and remove the rod. Disconnect the engine shut-off rear rod from the engine shut-off lever. Disconnect the throttle control rear rod from the throttle control intermediate lever.

12. Disconnect the vertical control rods, for the steering levers, from the lower control levers.

13. Remove the jam nuts attaching the front and rear torque converter lubricating hoses and the engine clutch shifter bearing lubricating hose to the bottom of the cowl and pull the hoses from the cowl.

14. Remove the capscrews and bolts attaching the cowl to the rear fenders and the main frame. Remove the rear nut on each of the radiator shell bracing rods. Raise the cowl up and set it on the right track, clamp or bolt the cowl to the track. *NOTE: By removing the cowl assembly, the engine may be removed without removing the radiator assembly.*

15. Disconnect the steering clutch lower control rods from the hydraulic spool valves, then remove the two (2) capscrews attaching the lower cross shaft bracket, for the steering controls, to the torque converter and remove the bracket and rods as an assembly.

16. Remove the two (2) capscrews securing the right brake shaft bracket to the main frame. Tie the shims, if any, to the bracket to prevent losing them. Remove the pins from the right brake rod and parking brake lock bar. Remove right brake pedal, shaft and bracket as an assembly by sliding the shaft out of the needle bearing in the left brake bracket. The left brake pedal, shaft and bracket can remain in position.

17. Remove the capscrews attaching the universal joint rear yoke to the rear spider assembly. Pry the universal joint assembly forward far enough to separate the spider assembly from the rear yoke, use care and do not allow the bearings to fall off the spider assembly. Tape or wire the bearings in place on the spider. Move the rear end of the universal joint assembly to one side, pull back until the front yoke is out of the converter, then remove the assembly from the tractor.

18. Disconnect the fluid return tube at the elbow on the hydraulic steering pump adapter by removing the three (3) capscrews. Disconnect the two (2) oil supply tubes at the connector nuts at the pump and allow oil to drain. Cover the openings to prevent entrance of dirt.

19. Remove the capscrews attaching the torque converter fluid inlet and outlet elbows to the converter. Disconnect the fluid supply tube from the upper right side of the converter and at the tee fitting on left rear corner of engine. Remove the tube. Cover the openings to prevent entry of dirt.

20. Disconnect the engine clutch operating lever control rod from the intermediate lever located on the left side of the clutch housing.

21. Disconnect all other wires, tubes, hoses, etc., from the engine which would prevent its removal.

22. Remove the two (2) bolts attaching the front trunnion support assembly to the engine supporting front hanger. Remove the bolts attaching the engine supporting rear brackets (one bracket on each side) to the main

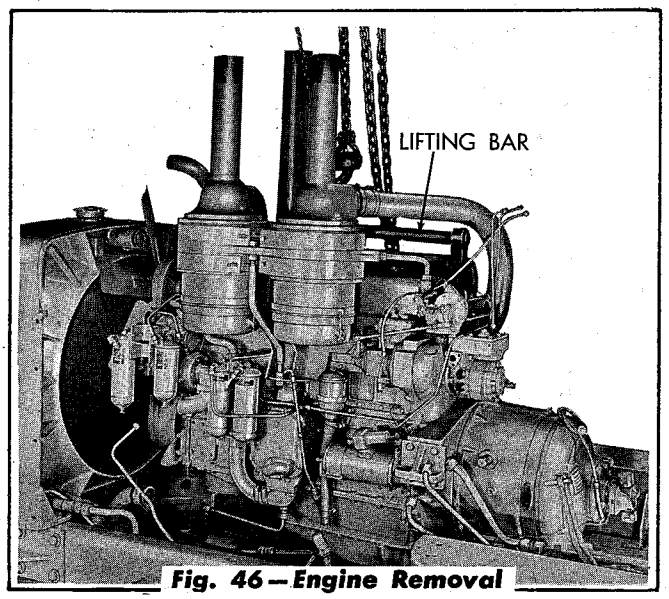


Fig. 46—Engine Removal

frame. The engine is now ready to be removed from the tractor. If lifting facilities are inadequate, the torque converter may be removed from the engine and placed back as far as possible against the transmission case, (refer to "TORQUE CONVERTER REMOVAL" in Section X). If the proper lifting facilities are available, remove the engine leaving the torque converter attached.

23. Using an engine lifting bar, similar to the one shown in Fig. 46, and with hoisting equipment available, raise the engine only enough so that the weight is off the mountings. Move the engine to the rear far enough so that the fan will clear the fan shroud, then raise the engine until it is clear of the main frame and remove it from the tractor.

C. Engine Installation

The installation of the engine is practically a reversal of the removal procedure, *except that certain inspections and adjustments must be made when installing.*

1. Install the engine in position in the main frame. Install the attaching bolts in the engine supporting mountings.

2. Connect the engine clutch operating lever rod to the intermediate lever located on the left side of the clutch housing. Check the adjustment of the engine clutch linkage and of the engine clutch (refer to "CLUTCH ADJUSTMENT" and "CLUTCH LINKAGE ADJUSTMENT" in Section X).

3. Using new gaskets coated with gasket cement, attach the torque converter fluid inlet and outlet elbows to the converter. Tighten the attaching capscrews securely.

4. Connect the upper ends of the three (3) hydraulic steering fluid tubes to the hydraulic steering pump adapter housing.

5. Insert the front yoke, with universal joint assembly attached, into position in the torque converter. Position the universal joint assembly with the rear yoke and install the capscrews attaching the rear spider assembly to the rear yoke. Tighten the capscrews securely and lock with the lock wire.

6. Install the assembly of the right brake pedal, brake cross shaft and bracket assembly by a direct reversal of the removal procedure.

7. Place the lower cross shaft (for steering clutch lower control rods) with the lower rods attached in position, then install the two (2) capscrews used to attach the bracket to the torque converter. Connect the rear ends of the lower control rods to the hydraulic spool valves.

8. Install the radiator shell bracing rods in position on the shell. Place the cowl assembly in position on the main frame and insert the radiator shell bracing rods in position in the two holes in the cowl. Install the capscrews and bolts used to attach the cowl to the main frame and the rear fenders. Install the nuts on the rear ends of the radiator shell bracing rods.

9. Place the ends of the lubricating hose (torque converter and engine clutch) in position in the holes in the cowl and install the jam nuts. *NOTE: Be sure that the hoses are properly located in the holes in the cowl.*

10. Connect the vertical control rods, for the steering levers, to the lower control levers.

11. Connect the throttle control rear rod to the throttle control left intermediate lever. Connect the engine shut-off rear rod to the engine shut-off lever. Insert the starter operating rod in position and connect it to the starter.

12. Connect the engine thermo gage to the rear of the water outlet manifold.

13. Connect the hydraulic steering pump breather tube to the hydraulic steering pump adapter.

14. Install the two capscrews used to attach the wiring harness clips to the left lower corner of the cowl.

15. Connect the primer line to the primer pump if the tractor is equipped with the primer. If the tractor is equipped with an engine air heater, connect the wiring harness to the heater and connect the two lines to the air heater pump.

16. Make certain that the pipe plug in the bottom of the torque converter housing is installed and is tightened securely.

17. Connect the main wiring harness to the starter and also the generator. Also connect the starter ground wire to the main frame. Connect the front fuel supply tube to the fuel filter.

18. Open the fuel tank shut-off valve at the fuel tank. Attach the end of the battery ground cable to the steering clutch and final drive housing.

19. Place the fan guard in position and install the attaching bolts. Coat the inside of the hoses used to connect the radiator inlet elbow to the water manifold elbow and to the radiator inlet with gasket cement or sealing compound, install the elbow in position, then tighten the hose clamps. Coat the inside of the radiator outlet hose with gasket cement or sealing compound, then place the end of the hose in position on the water pump elbow and tighten the hose clamps.

20. Fill the engine cooling system (refer to "FILLING AND DRAINING OF SYSTEM" in Section IV).

21. Check the adjustment of the engine control linkage (refer to "ENGINE CONTROLS AND GOVERNOR" in Section VI).

22. Check the exhaust valve lash (refer to "VALVE LASH ADJUSTMENT" in this section).

23. Time and equalize the injectors (refer to "INJECTOR TIMING" and "INJECTOR EQUALIZING" in Section II).

24. Fill the engine crankcase with the specified lubricant. If the engine has been rebuilt or a new engine has been installed, remove the valve rocker arm cover and pour approximately 1 gallon of oil over the rocker arm assemblies and cylinder head components when filling the crankcase. This will assure initial lubrication of the various components within the engine.

25. Open the air vent in the top of the first stage fuel filter. When clean fuel runs out of the vent, close the air vent, then, open the air vent in the top of the second stage fuel filter. Close the filter air vent when fuel runs out.

26. Check the adjustment of the steering clutch linkage (refer to "STEERING LEVERS AND LINKAGE" in Section XII). Refill the hydraulic steering system with the specified lubricant (refer to "Service" Topic 5, in Section XII).

27. Start the engine and operate it at approximately one-half throttle (with engine clutch disengaged) until the torque converter fluid system is filled, which will be indicated when the fuel pressure gage registers normal (30 to 55 pounds) pressure.

28. If the engine has been rebuilt or if a new engine has been installed, the engine should be operated on a run-in-schedule as outlined in "ASSEMBLY OF ENGINE" in this section).

12. DISASSEMBLY OF ENGINE

A. Removal of Accessories from Engine

Enough pans or boxes should be available so that each of various components removed from the engine can be placed in them and kept separated. Keeping the components and their bolts separated will make the installing easier and quicker.

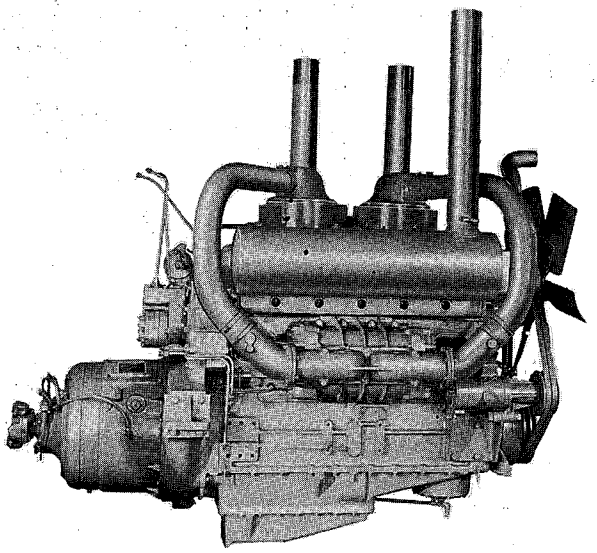


Fig. 47 — Right Side of Engine

The following procedure gives the most logical sequence for the removal of the accessories, starting at one side and working around the engine. Refer to Fig. 47 when removing the accessories.

1. With the engine suspended from a hoist or supported on blocks, remove the following parts from the right side of the engine so that the engine can be mounted to an engine stand if one is available:

   Remove the muffler, generator mounting bracket, air inlet tubes and the blower.

2. If the torque converter was removed with the engine, remove the jam nut, for the clutch shifting sleeve bearing lubricating hose, located on the left side of the clutch housing, and push the end of the lubricating hose inside of the clutch housing. Disconnect the fluid supply hose from the upper right side of the converter housing. Support the converter, then remove the capscrews attaching the engine clutch housing to the flywheel housing and remove the converter assembly.

3. With the above accessories removed, the engine can be mounted on a stand similar to the one shown in Fig. 48. With this stand, the engine is held by a heavy mounting plate provided with screw clamps to fasten to the right side of the engine. The engine may be rotated on the stand for convenience in assembly or disassembly.

4. Remove the three (3) capscrews attaching the fan mounting bracket to the engine balance weight cover, then remove the fan assembly from the engine.

5. Remove the crankshaft pulley and the vibration damper assembly (refer to "REMOVAL OF VIBRATION DAMPER" in this section).

6. Remove the air cleaners (complete with brackets), fuel filters (complete with brackets), starter, oil cooler assembly and the crankcase breather from the left side of the engine.

7. Drain the engine lubricating oil. Loosen the hose clamp on the water pump to oil cooler elbow and remove the water pump. Remove the water outlet manifold, the water by-pass tube and the water pump.

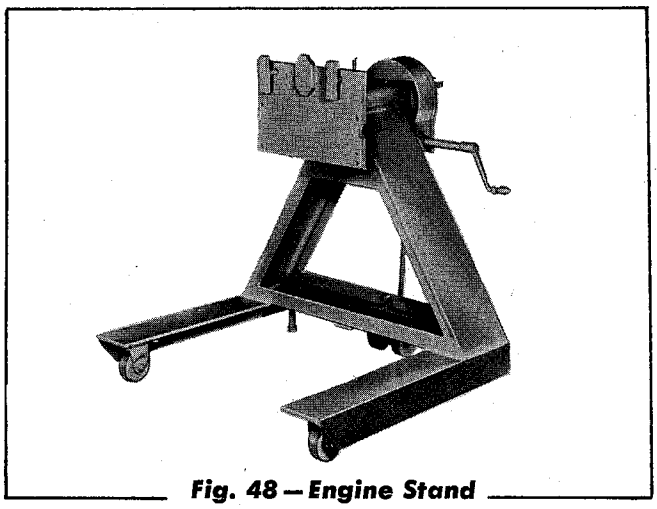


Fig. 48 — Engine Stand

8. Disconnect the throttle and engine shut-off control rods, located on the upper left side of the engine, and remove the rod assemblies. Remove the throttle assembly, without disturbing the adjustment of the control rods.

9. Remove the valve rocker arm cover and the governor control shaft housing cover assembly. Disconnect the governor control link from the injector tube lever, and disconnect the control link from the governor differential lever. Remove the link. Remove the capscrews attaching the governor control housing to the cylinder head, then remove the governor control housing assembly.

10. Disconnect the fuel lines from the fuel pump and remove the pump. Remove the oil level gage rod and the gage rod tube.

11. Remove the five (5) capscrews attaching the hydraulic steering pump adapter assembly to the engine flywheel housing, then remove the pump and the adapter assembly, using care not to drop the pump coupling gear and the coupling spring. Remove the capscrews attaching the hydraulic pump coupling disc to the cam shaft gear and remove the coupling disc.

12. Remove the capscrews attaching the engine clutch assembly to the flywheel and remove the clutch assembly including the driven plate.

13. Refer to pertinent sections of this manual for detailed information on the various removal procedures.

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. Remove the cylinder head from the engine block (refer to "CYLINDER HEAD REMOVAL" in this section).

2. Unlock and remove the capscrews attaching the flywheel to the crankshaft, then screw two (2) 7/16" NC capscrews into the two (2) tapped holes in the flywheel and use them as puller studs to force the flywheel from the crankshaft hub.

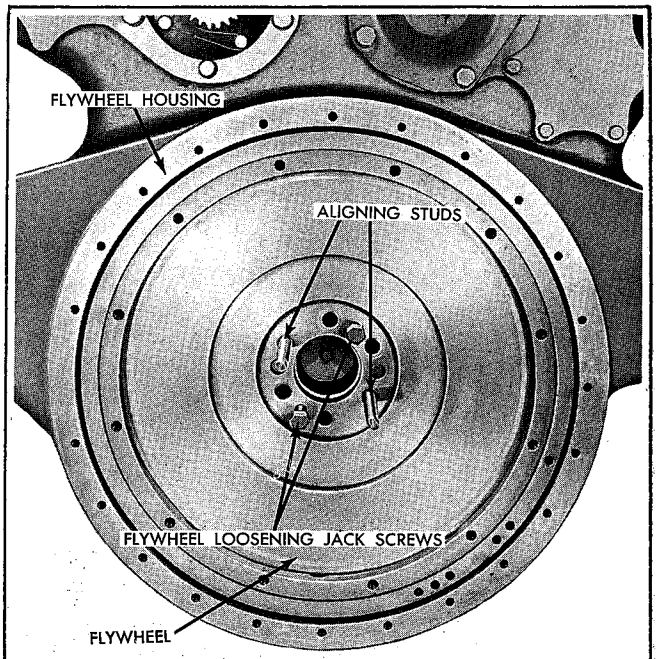


Fig. 49 — Flywheel Removal

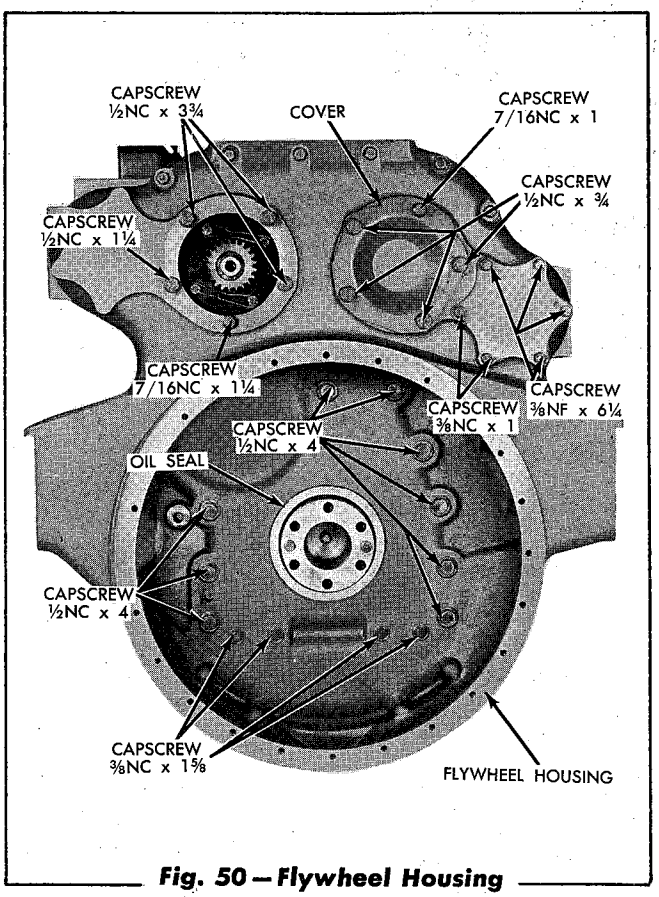


Fig. 50 — Flywheel Housing

3. Remove the lower and the upper oil pans.

4. Remove the bolts and capscrews attaching the flywheel housing to the cylinder block. Remove the capscrews inside the flywheel compartment that attach the housing to the

cylinder block. Tap and pry the housing off the two (2) dowels located on each side of the crankshaft and remove the housing from the cylinder block.

5. Remove the capscrews attaching the accessory drive shaft bearing cover to the front of the cylinder block and remove the cover.

6. Remove the camshaft and the accessory drive shaft from the cylinder block as outlined in Topic 8 of this section.

7. Remove the capscrew in the center of the idler gear assembly and remove the assembly from the cylinder block.

8. Remove the capscrews attaching the crankshaft gear to the crankshaft hub. Install two (2) 3/8" NF capscrews in the tapped holes in the crankshaft gear and push the gear off the end of the crankshaft.

9. Remove the capscrews attaching the front support trunnion to the cylinder block front cover assembly and slide the vibration damper rear cone, front oil seal, and the cover assembly off the crankshaft.

10. Remove the capscrews attaching the timing gear housing assembly to the cylinder block and remove the assembly. Remove the capscrews attaching cylinder block front cover assembly to the cylinder block and remove the assembly.

11. Remove the oil pump (refer to "OIL PUMP REMOVAL" in Section V). Remove the oil pressure regulator from the cylinder block.

12. Pull the cotter pins and remove the nuts from each of the connecting rod bearing caps and remove each piston and connecting rod assembly from the engine by sliding it out through the top of the cylinder. Reassemble each bearing cap on its respective connecting rod as they are removed.

13. Remove all the main bearing caps and lift the crankshaft from the cylinder block.

14. Remove the cylinder liners from the 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 correct position.

15. Wash and inspect all parts, including the cylinder block. Refer to pertinent sections of this manual for instructions on the disassembly, cleaning, and the inspection of the various sub-assemblies removed.

13. ASSEMBLY OF ENGINE

A. General

Make sure all parts are thoroughly cleaned before they are installed in the engine. Use only new gaskets where gaskets are required between attached parts. 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 cemented.

Lubricate all bearings or bearing surfaces with light engine oil as the parts are assembled.

Before any parts are installed in the cylinder block, be sure all plugs that have been removed to clean the oil and water passages in the block have been coated with sealing compound, installed, and securely tightened.

NOTE: In the following procedure, references will be made to the "BLOWER" side of the cylinder block. This side will be identified by the large opening at the center of the block, also, when viewing the block from this side, the left end will be the rear end of the block.

1. Turn the cylinder block upside down and install the upper halves of the main bearing shells in the crankshaft bearing seats of the block. The upper shells have a continuous oil groove extending from parting line to parting line and are marked "UPPER." The tangs

on the bearing shells must engage in the small slots in the bearing seats. Install the upper-halves of the two-piece thrust washers on each side of the rear main bearing.

2. Lubricate all the crankshaft bearing journals and lower the crankshaft into the block with the flywheel flange of the shaft toward the rear end of the block.

3. Place the lower (non-grooved) halves of the bearing shells in the main bearing caps. Place the lower halves of the two piece thrust washers in place on the dowels in the rear bearing cap. The caps are numbered 1, 2, 3, etc., indicating their respective positions. Install the caps with the numbered side opposite the blower side of the block and tighten the stud nuts to 180 to 190 foot pounds torque. The use of a torque wrench is recommended for this purpose. Secure the nuts with cotter pins.

   CAUTION: DO NOT OVERTIGHTEN THE NUTS. If they are drawn too tight, the bearing caps will 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 caps are tight. Never file or shim a cap to make the bearing fit. Install new bearings if the fit is unsatisfactory.

4. Install the crankshaft gear on the rear end of the crankshaft and tighten the attaching capscrews securely.

5. Turn the cylinder block on end or lay it on its side and install the cylinder liners. Be sure that the recesses in the top of the cylinder bores and the flanges on the cylinder liners are clean so that the liners will seat properly. Refer to Topic 4 in this section for the correct installation procedures.

6. Install the piston and connecting rod assemblies. The lower end of each rod, as well as the caps, are numbered 1, 2, 3, etc. on one side. These numbers identify the caps with the rods and show the particular cylinder with which each rod is used; the numbered side of the rod is always opposite the blower side of the cylinder block.

   a. Stagger the piston ring gaps evenly around the piston, apply clean oil to the pistons and rings, then slide a piston ring compressor over the lower end of the piston skirt, with flared end toward the top of the piston. Turn the piston and rod so that the identification mark on the lower end of the rod is opposite the blower side of the cylinder block. Align the lower end of the rod with the crankshaft before pushing the piston in the cylinder. By tapping on the upper end of piston, drive the piston into the cylinder bore. Be sure the compressor tool is down tight on the top of the liner so that the rings cannot snap out before entering the liner bore.

   b. Lubricate and install the upper bearing shell, with one short groove at each parting line, in the connecting rod and position the rod on the crankshaft journal.

   c. Lubricate and install the lower bearing shell, with one continuous groove from parting line to parting line, into the bearing cap with tang of shell in the groove of the cap, and put cap and shell in place.

   d. Tighten the connecting rod nuts to 65-75 ft. lbs. torque and secure the nuts with cotter pins. *NOTE: Never file or shim the caps to make the bearings fit. Install new bearings if the fit is unsatisfactory. The crankshaft must turn freely after all of the connecting rod bolts have been tightened.*

   e. Hold the cylinder liners in place while turning the crankshaft. Since the liners are a loose fit in the bore, the drag of the piston rings on the cylinder walls is sufficient to pull them out of the block.

7. Cement a new gasket to the front end of the cylinder block and coat the outer surface of the gasket with cement. Install the cylinder

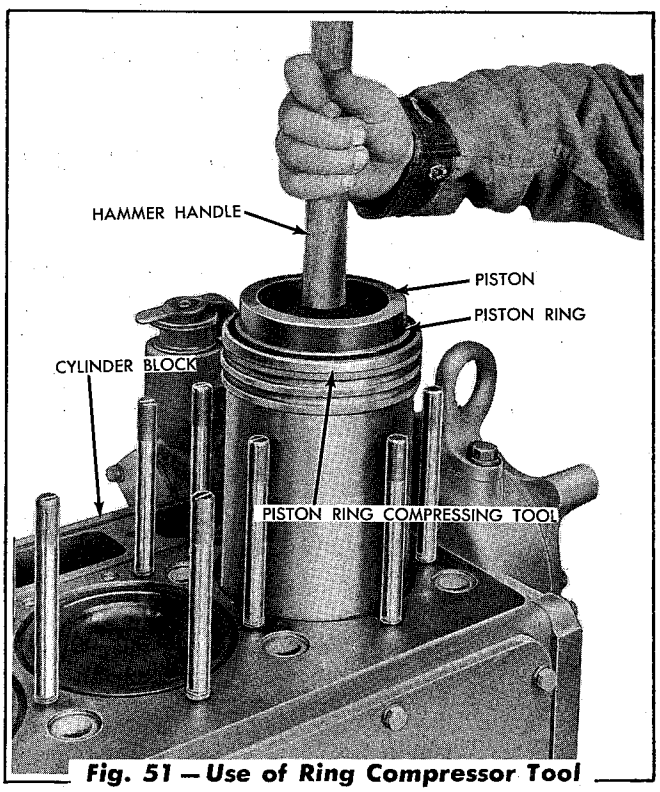


Fig. 51 — Use of Ring Compressor Tool

block front cover assembly, first making sure that both surfaces are free of nicks or burrs. Attach the cover assembly with capscrews and lockwashers. *NOTE: Before tightening the cover attaching capscrews, insert the camshaft and accessory drive shaft front bearings in the holes in the cover to accurately align the holes in the cover with the bore in the block.*

8. Install the rear timing gear cover housing and gasket on the rear end of the cylinder block in the same manner, with the hole in the cover for the blower drive support toward the blower side of the block. Attach this plate with capscrews. Use the same method as explained in step 7, to align the holes in the cover with the camshaft and the accessory drive shaft bores in the block, before tightening the capscrews.

9. Install the rear bearings and the gears on the camshaft and the accessory drive shafts as explained in Topic 8 of this section. Then install the shafts as explained in Topic 8 of this section.

10. Install the idler gear assembly (refer to Topic 9 in this section).

11. Cement a gasket to the rear face of the attaching flange of the blower drive support assembly and place the assembly in position in the timing gear housing, meshing the drive gear with the idler gear. No timing of this gear is required. Attach the support to the end plate with two (2) capscrews and lockwashers used in the inner holes of the support (side next to cylinder block).

12. Install the flywheel housing as follows:

    a. Press a new rear crankshaft oil seal into the housing (the lip of the seal should face the engine when the housing is installed).

    b. Cement attaching gaskets to the front face of the housing.

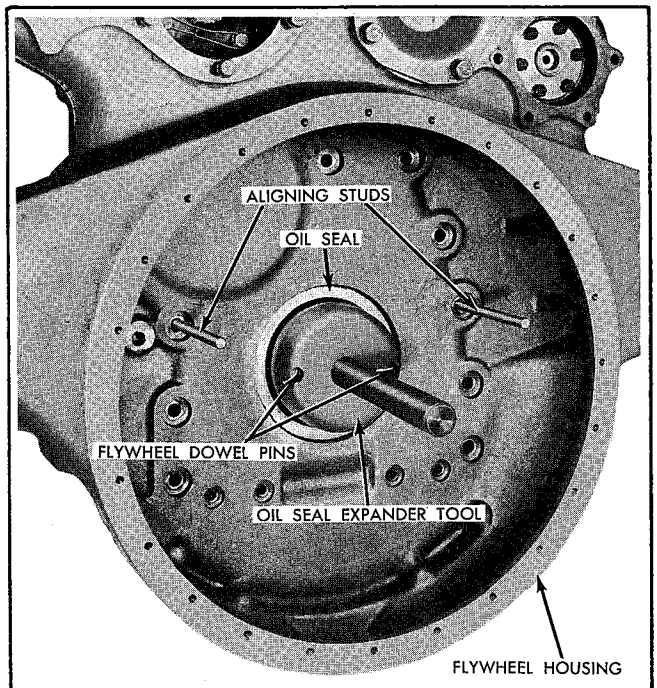


Fig. 52 — Use of Oil Seal Expander Tool

    c. Using the oil seal expander tool placed on the dowels in the crankshaft as shown in Fig. 52 to expand the seal, lubricate the seal and slide the flywheel housing on the crankshaft and against the end plate. Remove the expander tool and attach the housing with capscrews and lockwashers.

d. Cement a gasket to the flywheel housing, on opening to the accessory drive shaft gear, and install the flywheel housing cover.

e. Install the small snap ring in the groove in the cam of the blower drive coupling (if it was removed), then install the gasket and cover over the blower drive gear.

13. Install the front crankshaft oil seal in the crankshaft front cover in the same manner as was used in installing the rear seal in the flywheel housing. The lip of the seal should face the oil slinger on the crankshaft when the front cover is installed.

14. Cement a new gasket to the front cover and install the cover in position on the crankshaft and onto the dowel pins in the engine block, then lubricate the oil seal in the cover. Install the vibration damper rear cone, with the split end of the cone towards the front, on the crankshaft and through the oil seal and against the oil slinger. Make certain that the outside diameter of the cone is smooth where it contacts the oil seal. Fasten the crankshaft front cover in position with the lockwashers and capscrews, making certain that the proper length capscrews are installed in their proper location.

15. Install the vibration damper assembly and the crankshaft pulley. Refer to "VIBRATION DAMPER" in this section.

16. Turn the engine upside down and after checking to be sure that cotter pins have been installed in all main bearing and connecting rod nuts, install the oil pressure regulator and the oil pump assembly. Refer to "OIL PRESSURE REGULATOR" and "OIL PUMP INSTALLATION" in Section V.

17. Install the upper and lower oil pans using new attaching gaskets. Install the oil pan hand hole cover, using a new gasket, if it was removed. Install and tighten the oil pan drain plug.

18. Turn the engine right side up. Cement a new gasket to the fan mounting bracket and install the bracket with the capscrews and lockwashers removed at disassembly.

19. Install the cylinder head (refer to "CYLINDER HEAD INSTALLATION" in this section).

20. Install the injectors in the cylinder head (refer to "INJECTOR INSTALLATION" in Section II). Install the rocker arm assemblies if they were removed (refer to "EXHAUST VALVES AND OPERATING MECHANISM" in this section).

21. Install the flywheel on the rear end of the crankshaft with six drilled head capscrews. Due to one offset hole in the flange on the crankshaft and in the flywheel, the flywheel can be located in only one position. Make certain that the contacting surfaces of the flywheel and the bolting flange of the crankshaft are smooth and free from nicks or burrs that would prevent the flywheel from fitting up tight against the flange. After the capscrews have been tightened securely install the locking wires in the heads of the capscrews and twist the ends of the wires.

22. Install the oil cooler as outlined in Section V.

23. If the engine was mounted on an engine stand, remove it from the stand so that the various accessories may now be installed.

24. Install the governor control shaft housing assembly (refer to "GOVERNOR INSTALLATION" in Section VI).

25. Using new gaskets, install the water manifold and water by-pass tube assembly.

26. Install the fan, and the fan and generator drive belts and adjust the belts. Refer to "FAN, FAN BELTS, AND FAN BELT ADJUSTMENT" in Section IV.

27. Install the engine blower (refer to "BLOWER INSTALLATION" in Section III).

28. Place the hydraulic steering pump coupling disc in position on the engine cam shaft gear,

then install the attaching capscrews securely. Install the capscrew locking wires. Make certain the locking wires are bent away from the internal teeth of the coupling disc far enough to clear the small internal tooth driven coupling. This may be determined by placing the coupling gear in the driven coupling and inserting the coupling gear into the coupling disc. The small internal tooth coupling should contact the coupling disc with no interference from the locking wires. Attach the hydraulic steering pump to the engine (refer to "INSTALLATION OF HYDRAULIC PUMP" in Section XII).

29. Install the generator and adjust the generator drive belt (refer to "GENERATOR REMOVAL AND INSTALLATION" in Section VII). Install the starter in the flywheel housing.

30. Install the lubricating oil and fuel filters and connect the fuel and lubricating oil tubes. *IMPORTANT: New filter elements should be installed after overhauling the engine.*

31. Install the air box drain tube assemblies on each corner of the engine.

32. Install the engine clutch and the torque converter (refer to "ENGINE CLUTCH AND TORQUE CONVERTER" in Section X).

33. Install the throttle and engine shut-off control rods. Using new gaskets, install the muffler.

34. Using new gaskets, install the handhole covers on the cylinder block.

35. The engine may now be installed in the tractor (refer to "ENGINE INSTALLATION" in this section).

B. Engine Run-In Schedule

After installation of new cylinder kits or piston rings, the engine must be run to allow rings to seat and avoid the possibility of liner scoring and excessive oil consumption. When engines are first started after installation of cylinder kits 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 engine after overhaul, inspect engine oil level, fuel level, and cooling system and see that air cleaners have been properly serviced. Start engine and allow it to run at ½ throttle. See that all instrument panel gage readings are normal.

The most important factor in running a new engine or one which has just been overhauled is OPERATING TEMPERATURE. The thermostats must function properly to maintain a normal operating temperature of 160° to 185° F. Temperatures of 150° F. and below are conducive to the formation of gum and sludge, both highly detrimental to an engine. *DO NOT ALLOW THE ENGINE TO OPERATE AT LOW TEMPERATURE.*

The following run-in schedule is recommended:

½ hour at half throttle
3 hours at two-thirds throttle
3 hours at full throttle

NOTE: The engine clutch must be disengaged during the run-in period.

After this run-in, inspect engine lubrication and all points of adjustment, making any necessary minor corrections.

The tractor can then be put to work but should operate only under light load for the next 24 hours. After another examination and necessary adjustments the tractor is ready for full load.

SECTION X—ENGINE CLUTCH AND TORQUE CONVERTER

1. ENGINE CLUTCH

A. Description

The engine clutch is a single-plate, dry disc type clutch. The main parts of the clutch assembly are: the driven disc with facings bonded on both sides, the pressure plate and lever assembly, the adjusting ring, back plate, and the shifting bearing and sleeve assembly. The clutch back plate is bolted to the rear face of the flywheel and carries most of the clutch weight, thus adding to the flywheel effect. The pressure plate is driven by lugs on the back plate which engage in slots in the pressure plate. The driven disc, which is splined to the input shaft of the torque converter, is engaged between the pressure plate and the rear face of the flywheel by pressure exerted from the over center action of the lever assembly.

The pressure plate is actuated by the over center action of the clutch actuating levers when the clutch operating lever is pulled into its engaged position. When the clutch is disengaged, the pressure between the pressure plate, clutch driven plate, and flywheel is released. The fluid in the torque converter acts as a brake and stops rotation of the driven plate and the torque converter input shaft. The other clutch parts continue to turn with the engine flywheel.

A shifter sleeve and bearing assembly carried on the converter input shaft bearing carrier, and connected by linkage to the clutch actuating levers, is operated by the clutch operating lever to engage and disengage the clutch. The operating lever, pressure plate, actuating levers, and the clutch shifting fork shaft are assembled on needle bearings that are sealed and grease packed for life. The clutch shifting sleeve bearing and the torque converter bearings are the only parts that require periodic lubrication. An adjusting ring assembly threaded into the back plate, provides a means of maintaining the necessary adjustment to compensate for normal wear on the clutch facings.

The torque converter input shaft, to which the clutch driven disc is splined, is supported by a large ball bearing in a bearing carrier attached to the clutch housing, eliminating the use of a clutch pilot bearing in the engine flywheel.

When assembled, the torque converter turbine wheel housing and the engine clutch housing are attached together. The engine clutch housing serves as an integral part of the converter assembly, and the assembly is attached to the engine flywheel housing. Removal of the engine clutch may be accomplished without disturbing the engine or the transmission.

B. Clutch Service

Specified time intervals between clutch adjustments can not be established because of the variable operating conditions which determine the amount of clutch facing wear. Keep the clutch adjusted so that it requires 28 to 30 pounds pull on the clutch operating lever for its engagement (engine stopped). As the clutch wears, the pull on the clutch operating lever diminishes. When the pull on the lever diminishes to 15 pounds, an adjustment is necessary. *IMPORTANT: Do not operate the tractor when the pull on this lever is less than 15 pounds.*

Frequent adjustments may be an indication that the facings on the driven plate are worn out. A new plate assembly must be installed as the facings are bonded to the driven plate and cannot be serviced in the field.

C. Clutch Adjustment

Attach a spring scale to the clutch operating lever (attach scale just below the lever hand grip) and weigh the pull required to engage the clutch. When the clutch is properly adjusted a maximum pull of 30 pounds is required on the clutch operating lever for its engagement (engine stopped). The

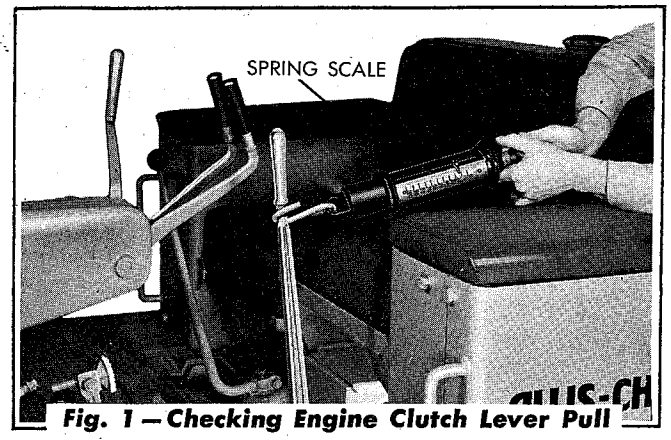


Fig. 1 — Checking Engine Clutch Lever Pull

clutch should engage with a distinct over center snap. Refer to Fig. 1.

1. Remove the clutch inspection cover from the top of the clutch housing by removing the two (2) front capscrews and loosening the two (2) rear capscrews. The rear holes in the cover are slotted which allows the cover to be slid out of position.

2. With the clutch disengaged, revolve the engine until the adjusting ring locking screw can be reached through the inspection hole.

3. Using a ⅜" hex wrench, loosen but do not remove the locking screw. Back the screw out until its spreads the slot of the clamp ring and raise the adjusting ring lock out of the slot in the adjusting ring. Spread the clamp ring only enough so that the adjusting ring can be turned freely.

4. Tighten the clutch by turning the adjusting ring in clockwise direction. Insert the adjusting ring lock back in a slot in the adjusting ring and tighten the clamp ring locking screw to 35 ft. lbs. torque, before checking the pull required on the clutch operating lever for the clutch engagement. Refer to Fig. 2.

D. Clutch Linkage Adjustment

The engine clutch operating rod should be adjusted to give a clearance of approximately ¼" between the front of the clutch operating lever (lever in its disengaged position) and the center floor plate.

Adjust the clutch operating rod by turning the front adjusting yoke to lengthen or shorten as required, to obtain the clearance between the operating lever and the center floor plate.

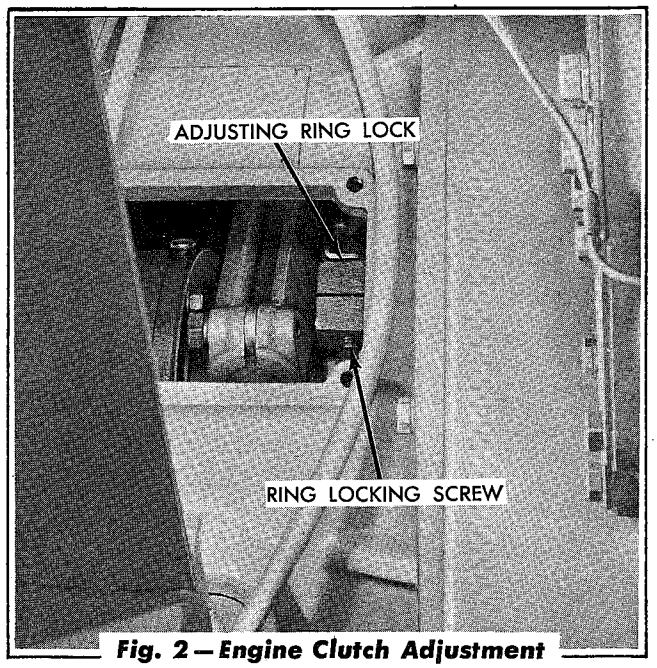


Fig. 2 — Engine Clutch Adjustment

E. Washing Engine Clutch

Oil leaks or over-lubrication of the clutch shifting bearing may cause the clutch facing to become coated with oil or grease. This will cause the clutch to slip even though it is properly adjusted. In this event, the clutch must be washed.

1. Remove clutch inspection plate. With the engine running (at low idle speed) and the clutch disengaged, use a flushing gun and force about two (2) gallons of cleaning solvent on the clutch. Do not direct the cleaning fluid on the front converter bearing, as to do so may wash the grease from this bearing. Remove the engine clutch compartment drain plug and drain the solvent. If the clutch is excessively greasy and dirty, repeat the cleaning process. Replace the cover, making certain that the gasket is in place.

2. *LUBRICATE THE CLUTCH SHIFTING BEARING THOROUGHLY AFTER THE CLUTCH HAS BEEN WASHED AND THE HOUSING DRAINED, AS THE LUBRICANT WILL BE WASHED OUT OF THIS BEARING IN THE WASHING PROCESS.* Operate the tractor with no load or with a light load in low gear for a short period (until the clutch dries) to

prevent slippage due to the presence of solvent on the clutch facing.

F. Clutch Removal

1. Remove the front and center floor plates and the supporting channel for the front and center floor plates.

2. Remove the hydraulic steering lower control rod yoke pins connecting the control rods to the spool valves. Remove the two (2) pins connecting the vertical control rods to the lower cross shaft, then remove the two (2) capscrews attaching the lower cross shaft bracket to the torque converter. Remove the lower control rods and the cross shaft assembly.

3. Remove the two (2) capscrews securing the right brake shaft bracket to the main frame. Tie the shims, if any, to the bracket to prevent losing them. Remove the pins from the right brake rod and parking brake lock bar.

   Remove the right brake pedal, shaft, and bracket as an assembly by sliding the shaft out of the needle bearing in the left brake bracket. The left brake pedal, shaft, and bracket can remain in position.

4. Remove the capscrews attaching the universal joint drive tube to the rear yoke. Pry the drive tube forward enough to clear the rear yoke, tie or tape the two bearing assemblies to keep them from falling off the spider assembly, then move the drive tube over to one side and pull the drive tube assembly back out of the torque converter splines.

5. Remove the engine air pre-cleaners, engine hood, and the front and the rear nuts from the two (2) radiator shell bracing rods.

6. Drain the engine cooling system sufficiently to disconnect the engine temperature gage at the water manifold. Disconnect battery ground cable from front side of right steering clutch housing and tape the end of the cable to prevent it from grounding. Disconnect the rear flood light wire, if so equipped, from the light switch. Disconnect the starter switch to ammeter wire at the ammeter and remove the clips. Disconnect the generator and light wire at the ammeter and light switch and remove the clips. Disconnect the necessary engine control linkage, the lubricating hoses for the converter and engine clutch bearings, and the fuel and engine oil gage lines. Remove the starter operating rod, disconnect the hydraulic steering breather tube and remove the clip from the torque converter fluid supply tube. Remove the capscrews and bolts attaching the cowl to the main frame and the fenders. Position and bolt the cowl on the right fender as shown in Fig. 3.

7. Remove the square head pipe plug from the bottom of the turbine wheel housing and drain the fluid from the housing.

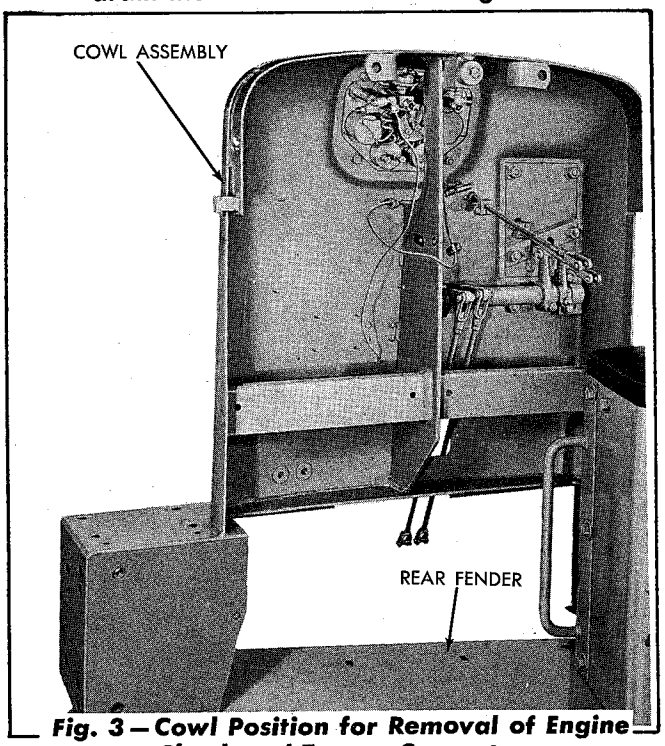


Fig. 3 — Cowl Position for Removal of Engine Clutch and Torque Converter

8. Remove the torque converter fluid supply tube assembly. Disconnect the seal drain tube from the front of the tee connection on the left side of the clutch housing. Remove the capscrews attaching the fluid inlet and outlet elbows to the torque converter. *IMPORTANT: Cover the fluid inlet and outlet passages in the converter and the elbows, to prevent dirt from entering the lines or the converter.* Remove the thread protecting plug, located in the top of the clutch housing

and install a lifting ring, having 5/8" NC threads, into the hole in the housing.

9. Remove the clutch inspection plate from the top of the clutch housing by removing the two (2) front capscrews and loosening the two (2) rear capscrews. The rear holes in the cover are slotted which allows the cover to be slid out of position.

10. Remove the clutch shifter bearing lubricating extension hose from the left side of the converter. Remove the jam nut from the clutch shifter bearing lubricating hose on the left side of the converter. Remove the pin from the engine clutch control rod. Attach a suitable hoist to the lifting ring, then remove the capscrews attaching the clutch housing to the engine flywheel housing, removing the upper capscrews last. Remove the lever from the engine clutch shaft to eliminate interference between the lever and the hydraulic steering tubes.

11. Reach through the inspection hole in the clutch housing and position the shifting bearing lubrication hose so that it will not be damaged when removing the torque converter assembly. Remove the converter assembly by pulling it straight back until the torque converter input shaft splines will clear the clutch shifting bearing sleeve. Remove the torque converter and clutch housing assembly using care not to damage the seal drain tube, connecting the rear seal drain to the tee connection on the clutch housing. Refer to Fig. 4.

12. If a hoist is used to lift the engine clutch assembly, attach a small chain to the back plate, then remove the capscrews attaching the back plate to the engine flywheel. Remove the engine clutch assembly and clutch driven plate from the tractor. Refer to Fig. 5.

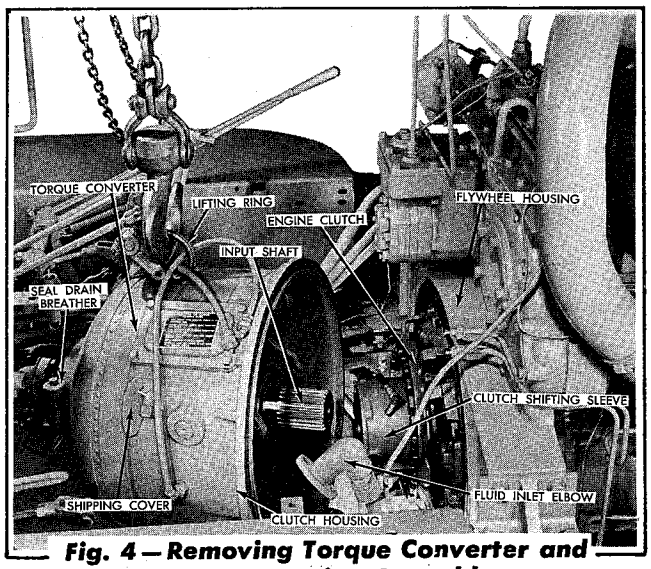


Fig. 4 — Removing Torque Converter and Clutch Housing Assembly

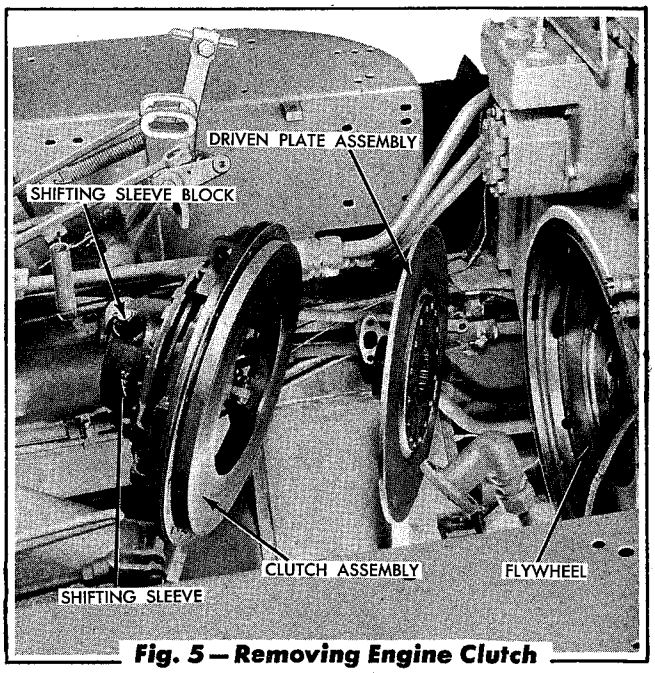


Fig. 5 — Removing Engine Clutch

G. Clutch Disassembly

1. Place the engine clutch assembly on a clean work bench, with the pressure plate down. Remove the four (4) pressure plate retracting springs, then lift the back plate and adjusting ring off the pressure plate. Using a 3/8" hex wrench, loosen (but do not remove) the capscrew used to lock the adjusting ring, then remove the adjusting ring by turning it in (clockwise) until it is free from the backing plate.

2. Remove the four (4) pins attaching the shifting sleeve collar to the actuating lever links

and remove the shifting sleeve, collar, and bearing from the pressure plate.

3. Remove the small retaining ring from the shifting sleeve collar, then press the collar out of the shifting bearing. *IMPORTANT: Do not drive on the inner surface of the collar to remove it, or damage to the bearing retaining ring groove will result.* If a press is not available, use a brass drift pin or a soft hammer and drive on the outer pin hole bosses of the collar, to drive it out of the bearing.

4. Remove the large retaining ring from the shifting sleeve. The shifting bearing can now be removed from the shifting sleeve by bumping the sleeve on a block of wood.

5. The needle bearings in the pressure plate levers are grease packed and require no further lubrication, however, if replacement of the bearings and the lever pins become necessary, remove the lever locking pin, then drive through one of the bearing retainers and drive the pin and other bearing assembly out of the lever and the pressure plate. Using the same procedure outlined above, remove the other three (3) levers and needle bearing assemblies.

H. Clutch Inspection and Repair

1. Wash all the clutch parts thoroughly and inspect them to see that they are in good condition.

2. Inspect the facing on the driven plate for wear and looseness of the facings on the plate. Also check the condition of the splines in the hub of the plate. Replace plate if necessary.

3. Inspect the face of the pressure plate for roughness, heat cracks, and warpage. If the face of the pressure plate is in bad condition it may be machined smooth. Replace the pressure plate if more than 1/16" stock must be removed to smooth it up.

4. Inspect the pressure plate retracting springs for breakage. Replace if necessary.

5. Inspect the levers, links, pins, and bearings for wear. Install new parts where necessary.

6. Check the clutch back plate for cracks. Replace if cracks are evident.

7. Check the shifting sleeve bearing for roughness or wear. Replace the bearing if it is worn excessively or does not turn freely.

I. Clutch Assembly

Refer to Fig. 6 and assemble the clutch by a direct reversal of the disassembly procedure. When assembling make certain that the pressure plate retracting springs are installed with the hooks of the springs towards the outside.

Install the shifting bearing into the shifting sleeve with the shielded side of the bearing to the rear. *IMPORTANT: When installing the actuating lever*

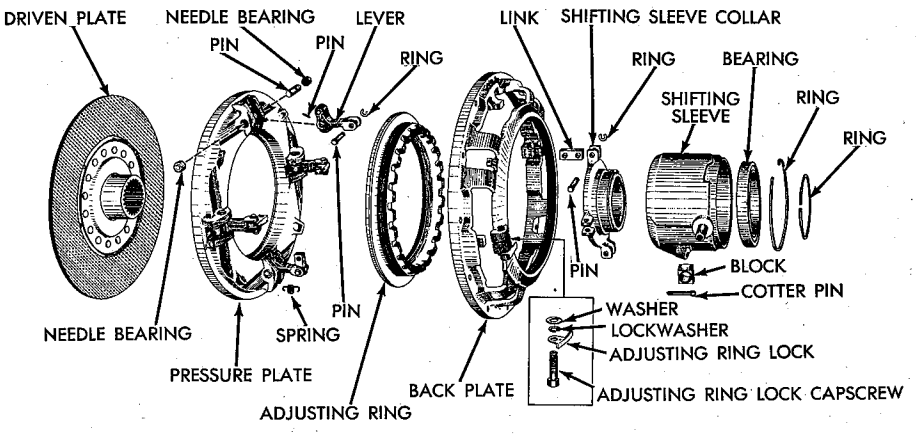


Fig. 6—Engine Clutch Details

link pins make certain that they are installed so that the heads of the pins are located on the left side when viewed from the rear of the clutch. Grease the clutch linkage and pins sparingly when assembling.

J. Inspection and Replacement of Clutch Shifting Fork

1. Inspect the clutch shifting sleeve blocks for excessive looseness on the shifting sleeve and in the shifting fork, if there is excessive looseness between the parts due to wear, replacement of the parts will be necessary.

2. Replace the shifting fork as follows:

   a. Remove the two (2) bolts clamping the shifting fork to the shifting fork shaft, then remove the two (2) "washer type" keys.

   b. Spread the fork open using a broad faced chisel to free the fork on the shaft, then pull the shifting shaft out of the fork and the clutch housing.

   c. Inspect the needle bearings, the bearing dust seals, and the shifting shaft for wear. Replace the necessary parts.

   d. Lubricate the shifting fork shaft needle bearings with grease and start the shaft in place.

   e. Install the new shifting fork by reversal of the removal procedure.

K. Clutch Installation

1. Place the driven plate assembly in the engine flywheel, with the opened end of the splined hub towards the rear.

2. Place the clutch assembly in position on the flywheel. Start all of the attaching capscrews and tighten evenly so that the clutch back plate enters the recess in the flywheel.

   IMPORTANT: Make certain that the clutch adjusting ring is backed out enough so that the driven plate will be free after the pressure plate assembly is attached to the flywheel.

3. Position the shifting sleeve bearing lubrication hose on the pressure plate so that it will not be damaged when installing the torque converter and clutch housing.

4. Install the torque converter and clutch housing assembly in position, guiding the shifting fork on to the blocks of the shifting sleeve. *IMPORTANT: Keep the assembly straight when installing. Use care and do not clamp the seal drain tube (attached to the air box drain) between the two housings.* If the splines in the clutch driven plate fail to align with the input shaft splines, insert the universal drive tube into the turbine wheel splines and rotate the shaft enough to align.

5. Install the shifting sleeve bearing lubrication hose in position in the clutch housing by reaching through the inspection hole, then install the lockwasher (external teeth) and retaining nut.

6. Install the capscrews and the lockwashers attaching the clutch housing to the engine flywheel housing. Tighten the capscrews securely.

7. Install the torque converter drain plug. Connect the seal drain line to the tee connection. Using new gaskets, install the fluid inlet and outlet elbows to the torque converter assembly. Install the universal drive tube assembly, then install the right brake shaft and pedal assembly and the right brake lock.

8. Adjust and connect the clutch operating control rod to the clutch shaft control lever (refer to "CLUTCH LINKAGE ADJUSTMENT" in this section).

9. Adjust the engine clutch (refer to "CLUTCH ADJUSTMENT" in this section).

10. Install the cowl by direct reversal of the removal procedure. *NOTE: When the cowl is placed in position pull the top of the cowl back and place the radiator shell bracing rods into their positions.*

11. Install the front and center floor plate supporting channel and the floor plates.

12. Start the engine and operate it at approximately one-half throttle (with engine clutch disengaged) until the torque converter fluid system is filled, which will be indicated when the fuel pressure gage registers normal (35 to 55 pounds) pressure.

2. TORQUE CONVERTER

A. Description

The torque converter consists of three principal parts: the impeller (connected to the engine), the turbine wheel (connected to the universal joint drive tube) and the housing. In the tractor, the impeller, driven by the engine, causes a flow of fluid in the converter. This fluid, striking the blades of the turbine wheel, causes the turbine wheel to turn.

Any load, including the tractor and whatever may be attached to it, is connected through the gear train and the top transmission shaft to the turbine wheel. Therefore, any increase in the load will have a tendency to slow down the turbine wheel which will call for an increase in torque (or turning effort) in order to keep the load moving. This increase in torque is automatically provided by the converter. Conversely, any decrease in the load diminishes the torque necessary to move it. Again the torque converter automatically meets the requirements and speeds up the movement of the load.

An over-running clutch is a component of the torque converter. This clutch operates freely except when the load pushes the tractor in descending steep grades or when the tractor is being towed or pushed to start the engine. The clutch then engages and effects a direct connection between the transmission and the engine.

The torque converter and engine clutch housing are bolted to the flywheel housing of the engine. A universal joint drive tube connects the converter turbine wheel to the input shaft (top shaft) of the transmission. Two large fuel oil lines lead from the converter to a converter fluid cooling radiator located in the radiator shell along with the engine cooling radiator. The fuel used in the converter is cooled by its circulation through these lines and radiator.

The engine fuel pump keeps the converter housing completely filled with fuel oil from the fuel tank through a pipe connecting the engine fuel return manifold with the converter. Surplus fuel not used by the engine returns to the fuel tank through a return tube connected to the top of the converter radiator and leading back to the tank. A pressure of 35 to 55 pounds is maintained in the fuel and converter system by a restricted fitting located in the fuel return line.

A seal drain tube, which allows the escape of fuel oil that might seep through the converter seals, leads from the converter housing and connects with the engine air box drain tube. Any fuel seepage through the seals of the converter is ejected through this tube.

B. Service

The only service required on the torque converter is the periodic lubrication of the converter bearings, inspection of the seal drain, and the air passages through the converter cooling radiator.

The torque converter bearings require lubrication daily (after each 10 hours of operation) with a good grade of wheel bearing, or ball and roller bearing grease having a minimum melting point of 300° F. This lubricant should be in a viscosity so as to permit easy handling in a pressure gun at the prevailing air temperature. In cold weather it may be necessary to use a lubricant of No. 1 consistency to obtain satisfactory pumpability. In warmer weather either a No. 2 or No. 3 lubricant may be used.

The amount of lubricant required daily will depend on operating conditions. Over lubrication will not harm the bearings or the seals. However, if grease is allowed to accumulate in the engine clutch housing, difficulty with the clutch may result.
Inspect the clutch housing periodically and remove any accumulation of grease.

Make certain that the air passages in the cooling radiator are free from obstructions. Inspect the seal drain lines, making certain that they are open. Also be sure that the seal drain breather, located at the rear of the converter housing is clean.

C. Torque Converter Removal

Remove the torque converter from the tractor as outlined under "ENGINE CLUTCH REMOVAL" (steps 1 through 11) in this section.

D. Converter Disassembly

Before starting to disassemble the torque converter, thoroughly clean the outside of the converter housing. Select a clean, dust free location. *CLEANLINESS IS VERY IMPORTANT WHEN REPAIRING THE CONVERTER.*

When a torque converter is to be moved or shipped from one location to another, always make certain that all fluid openings are covered. The splines of the shaft must also be protected from damage. Rain or foreign material entering the converter while in transit will cause serious damage, and improper handling may damage the splines of the input shaft.

1. Remove the seal drain tube, connecting the rear seal to the tee connection on the left side of the clutch housing, then remove the seal drain tube and its breather attached to the turbine wheel rear bearing retainer.

2. Remove 23 of the 24 nuts and lockwashers attaching the turbine housing to the clutch housing, leaving the one nut by the inspection hole in the clutch housing to hold the turbine housing and clutch housing together.

3. Position the assembly on a bench with the turbine housing up. Place suitable blocks under the clutch housing so that the input shaft will clear the bench. Remove the remaining nut and lockwasher through the opening in the clutch housing.

4. Remove the capscrews attaching the turbine wheel bearing retainer to the turbine housing. Install 3/8" NC pusher screws in the tapped holes in the retainer. Turn the screws in and remove the bearing retainer and gasket.

5. To facilitate lifting the turbine wheel and housing assembly from the clutch housing, a short chain or a bracket (made from a piece of metal 1" x 1/4") may be attached to the turbine housing with the bearing retainer capscrews, and a suitable hoist used to lift the turbine housing assembly.

6. It is not necessary to mark the two housings before separating them as there are two longer studs, located over the fluid inlet passage which may be used to align the two housings when reassembling.

7. Remove the turbine wheel and housing assembly from the clutch housing by lifting it up straight. *CAUTION: Use care and do not damage the turbine or the impeller wheels, and the over running clutch and roller assembly.*

8. Unlock and remove the turbine wheel bearing retainer nut (spanner nut) from the hub of the turbine wheel. *NOTE: Use a spanner wrench to remove the nut by striking the wrench sharply with a hammer. DO NOT ATTEMPT TO HOLD THE TURBINE WHEEL FROM TURNING BY INSERTING ANYTHING IN THE BLADES OF THE TURBINE WHEEL.* The blades of the turbine wheel are accurately located and any disturbance of their location or damage to them will affect the efficiency of the torque converter. If a spanner wrench is not available, a tool similar to the one shown in Fig. 7 may be made from 3/8" material machined to an outside diameter of 8 1/4" and the inside diameter of 4-13/16". Four (4) pieces of 3/8" key stock are set in four (4) key seats, cut into the plate, and welded into position. The key stock should project 3/8" out on one side of the plate. Three holes are drilled in the plate to align with the tapped holes in the turbine housing, used for attaching the bearing retainer to the housing. The other tool shown in Fig. 7 is made from the inner race of the over-running clutch and a high nut is welded to the race. To use the tool, the flat plate is

placed over the spanner nut and is attached to the housing with three of the bearing retainer attaching capscrews. The other tool is inserted into the splines of the turbine wheel and is used to turn the turbine wheel out of the spanner nut. *NOTE: The later tool may also be used in conjunction with a spanner wrench to hold the turbine wheel while loosening the spanner nut, if a spanner wrench is available.*

9. Support the turbine housing, large end down, and press the turbine wheel assembly out of the bearing by pressing on the end of the turbine hub. *CAUTION: Do not press on the plug inside the splines as the plug must be kept tight to prevent the torque converter fluid from leaking at the universal joint front yoke.*

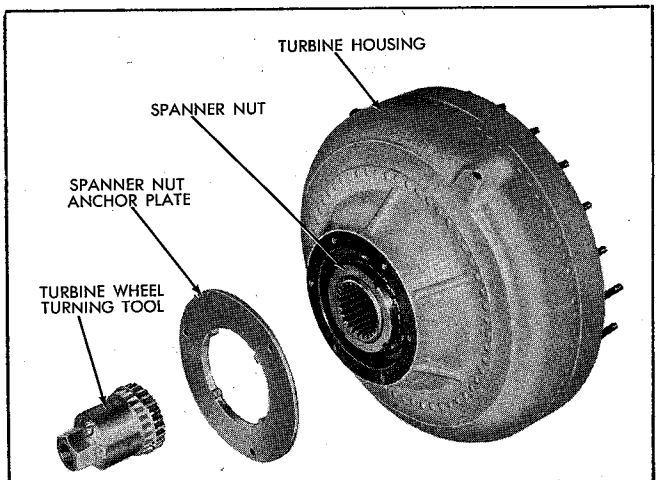


Fig. 7—Tool for Removing Turbine Wheel Retaining Nut

10. Remove the socket head capscrews from the seal assembly and remove the assembly from the turbine housing.

11. Referring to Fig. 11, remove the carbon ring and the rubber sealing washer, under the carbon ring, from the hub of the turbine wheel assembly. *NOTE: Be careful and do not break the carbon sealing ring when removing it from the hub and do not scratch or damage the sealing surface of the ring.*

12. Disassemble the seal assembly by removing the two (2) slotted head capscrews from the seal retaining clips. *NOTE: When any part of a ground joint seal requires replacement, the entire seal, including the mating ring, the mating ring rubber sealing washer, and the nose piece must be replaced. No attempt should be made to replace a nose piece or a carbon mating ring only.*

13. Remove the turbine wheel bearing from the housing. When removing the bearing, press or drive on the outer race of the bearing.

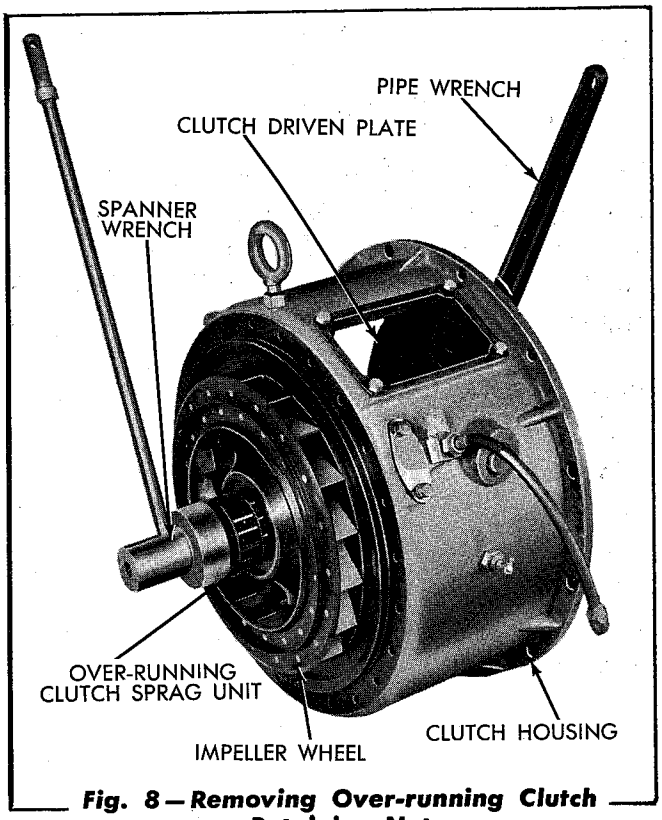


Fig. 8—Removing Over-running Clutch Retaining Nut

14. Referring to Fig. 11, unlock the lockwasher and remove the over-running clutch retaining nut from the input shaft. The removal of this nut may be accomplished by using a spanner wrench similar to the one shown in Fig. 8, a large pipe wrench, and an engine clutch driven plate. Place the clutch driven plate in position on the input shaft, then place a pipe wrench on the hub of the driven plate; by using the pipe wrench on the hub of the driven plate, damage to the shaft splines will be eliminated. Hold the pipe wrench stationary, then remove the nut from the input shaft using the spanner wrench. *CAUTION: DO NOT ATTEMPT TO HOLD THE PUMP WHEEL FROM TURNING BY INSERTING ANYTHING IN THE BLADES OF THE WHEEL, AS TO DO SO WILL DAMAGE THE BLADES.*

15. Remove the locking washer, the over-running clutch retaining washer, the cage, the roller bearing, and the over-running clutch cam from the input shaft.

16. Remove the capscrews and lockwashers attaching the input shaft bearing carrier to the clutch housing. Insert ⅜" NC pusher screws into the tapped holes in the bearing carrier, and push the input shaft and bearing carrier assembly from the clutch housing. Remove the input shaft from the bearing in the carrier.

17. Remove the gasket and spacer from the bearing carrier and press the ball bearing out of the carrier.

18. Referring to Fig. 9, unlock the lockwasher and remove the nut (spanner) from the hub of the impeller wheel, being careful not to damage the impeller wheel while performing this operation. Remove the spacer from the impeller hub. *NOTE: Use the same procedure in removing this nut as was used in removing the other nuts.*

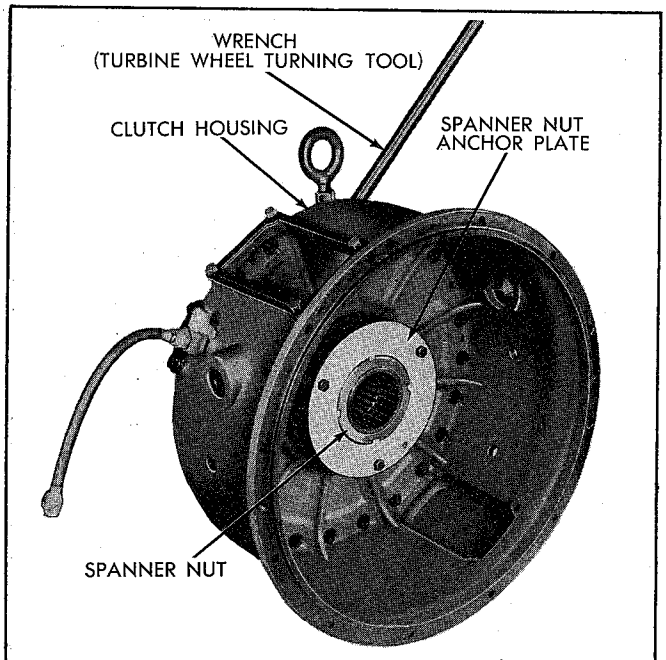


Fig. 9 — Removing Impeller Wheel Bearing Retaining Nut

19. Remove the turbine housing to clutch housing gasket from the rear flange of the clutch housing. Support the rear face of the clutch housing in a press and press the impeller wheel out of the ball bearing, being careful not to damage the impeller wheel.

20. Remove the socket head capscrews from the seal assembly and remove the assembly from the clutch housing.

21. Remove the carbon mating ring and the rubber sealing washer from the hub of the impeller wheel.

22. Disassemble the seal assembly by removing the two (2) slotted head capscrews from the seal retaining clips. Refer to Fig. 10.

23. Place the clutch housing on its large diameter face and drive the ball bearing from its bore.

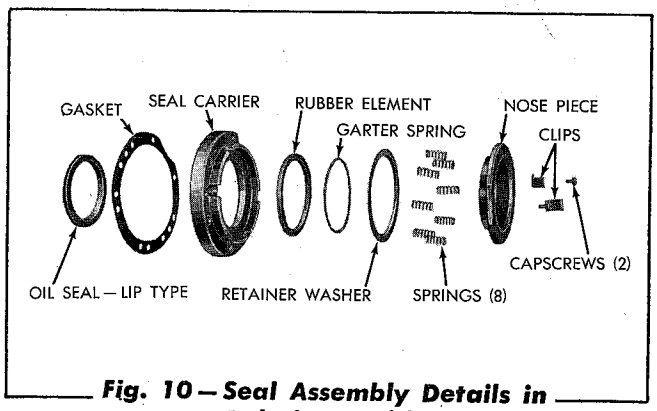


Fig. 10 — Seal Assembly Details in Relative Position

E. Inspection and Repair

1. Inspect the over-running clutch cam outer race, the cage, the rollers, and the roller assembly for wear or damage. Replace any parts that are worn to the point where the wear affects the operation of the over-running clutch. The outer race is part of the turbine assembly and is not serviced separately. When the outer race is damaged or worn, the complete turbine assembly must be replaced.

2. Inspect the plug in the hub of the turbine wheel assembly and make certain it is tight. If it is loose, remove it, coat the outer diameter of the plug and the back face of the turbine wheel assembly with a good sealing compound and press the plug back in position. *NOTE: This plug must be tight to*

prevent converter fluid from leaking at the universal joint front yoke.

3. Inspect the sealing edges of the lip type seals to make certain that they are in good condition. Replace any seals that are worn or damaged.

4. Inspect the carbon mating rings, the mating ring rubber sealing washers, and the nose pieces of the seals for wear or scratches on the sealing surfaces. Replace any worn or damaged parts.

5. Inspect the eight (8) springs in each seal assembly to make certain that they are not broken or have not lost their tension. Replace any broken or weak springs.

6. Make certain that the seal drain and grease passages in the seal carriers, the rear bearing retainer, and the clutch housing are open.

7. Inspect and clean all tubes and piping removed when removing the converter.

8. Inspect the blades on the turbine wheel and the impeller wheel for burrs and remove any slight roughness with a mill file.

9. Inspect all ball bearings for wear or damage. Replace worn or damaged bearings.

F. Assembly of Torque Converter

Before starting to assemble the torque converter, make certain that all parts are clean and in good condition. To avoid confusion, refer to Fig. 11 and assemble the turbine wheel in the turbine housing first, then assemble the impeller wheel to the clutch housing and bolt the two complete assemblies together.

1. Assembly of Turbine Wheel

a. Place the turbine housing large side up then lubricate one of the large ball bearings and press it in the bore, flush with the inside of the housing.

b. If the seal assembly has been disassembled, refer to Fig. 10 and assemble it as follows:

(1) Install the lip type oil seal in the

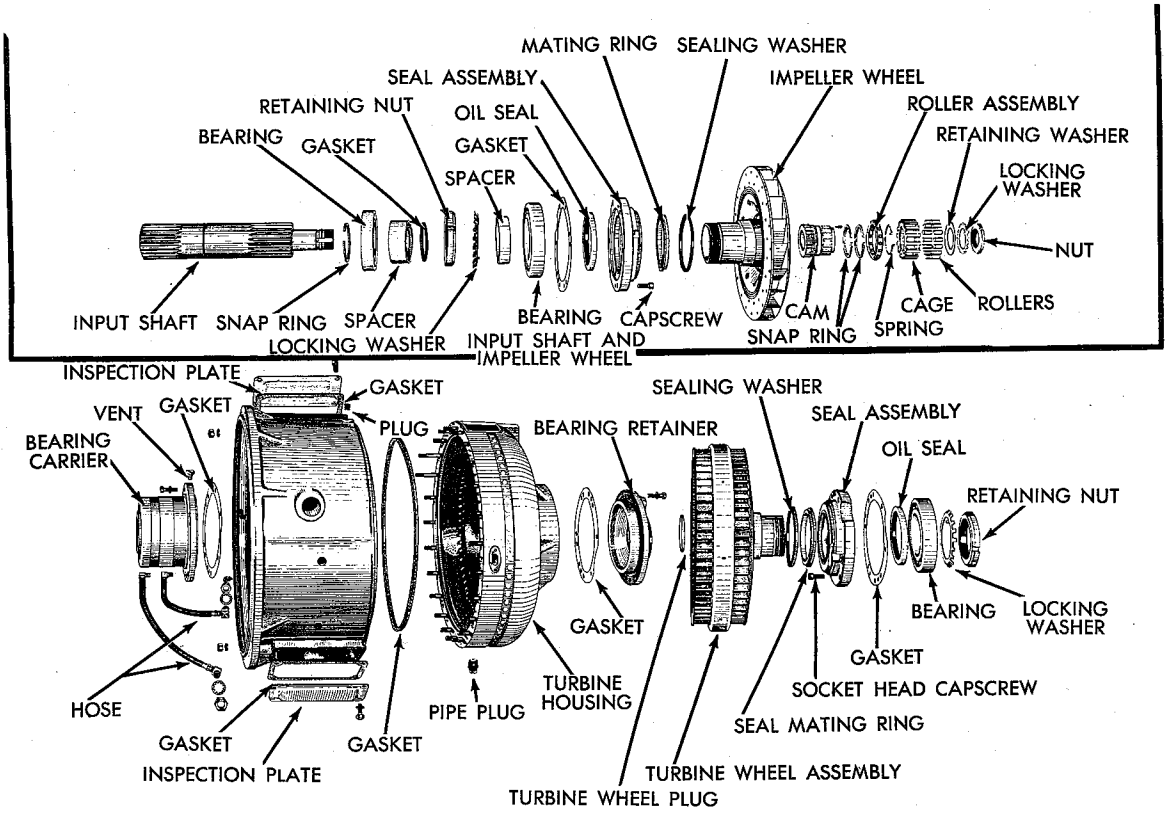


Fig. 11—Torque Converter Details

large bore of the seal carrier with the lip of the seal facing out.

(2) Place the nose piece of the seal on a clean cloth with the sealing edge down.

(3) Insert the eight (8) springs in the counterbores of the nose piece.

(4) Place the garter spring in the rubber element and place the assembly of the spring and element on the shoulder of the retaining washer, with the garter spring facing the flange of the retaining washer.

(5) Install the assembly of the washer, spring, and element on the shoulder of the nose piece, with the retaining washer against the springs.

CAUTION: Make certain that the lip of the element does not turn under when it is assembled to the nose piece.

(6) Compress the assembly on the nose piece and install it in the bore of the seal carrier, with the clip notches of the nose piece and carrier in line.

(7) Bolt the seal to the seal carrier with the two clips and slotted head capscrews.

c. Cement a new gasket to the seal assembly and bolt the seal assembly to the inside of the turbine housing with the six socket head capscrews. *NOTE: The seal assembly must be installed with the part marked "top" toward the top of the housing.* This positions the assembly so that the seal drain hole is on the left and the grease hole on the right when looking into the housing.

d. Turn the housing over, lay it on its large face, and bolt the bearing retainer to the housing with two capscrews, using a new gasket cemented to the retainer. *NOTE: The retainer is installed to hold the ball bearing in position until the turbine hub is pressed through the bearing.*

e. Place the mating ring sealing washer on the carbon mating ring, with the flat side of the sealing washer against the shoulder of the carbon mating ring.

f. Lubricate the carbon mating ring with clean oil and install the carbon mating ring and the sealing washer (rubber) on the hub of the turbine wheel, with the sealing washer facing the turbine wheel.

CAUTION: Make certain that the sealing surfaces are clean and smooth.

g. Lubricate the sealing surface on the nose piece of the seal and insert the turbine wheel in the turbine housing. Press the hub of the turbine wheel through the ball bearing in the housing. *CAUTION: Do not press or drive on the plug inside the bore of the turbine wheel hub, and do not allow the turbine wheel to drop on the seal face, as to do so may crack the carbon ring.*

h. After the turbine wheel is in position, remove the bearing retainer and install the locking washer on the turbine hub. Tighten the turbine retaining nut securely and lock it in position with the locking washer. Refer to Fig. 7 showing the tools.

i. Bolt the bearing retainer to the turbine housing with the six (6) 3/8" capscrews and lockwashers.

j. Turn the turbine wheel in the housing to make certain it is free and does not drag or bind.

2. Assembly of Impeller Wheel Into the Clutch Housing

a. Support the clutch housing in a press, with the mounting flange side down. Lubricate the remaining large ball bearing and press it into the bearing bore in the clutch housing.

b. If the seal assembly was disassembled, assemble it as outlined in "ASSEMBLY OF TURBINE WHEEL" in this section.

c. Cement a new gasket to the seal assembly using gasket cement, then bolt the seal assembly to the grooved end of the clutch housing with the six (6) socket head capscrews. *NOTE: The seal drain holes and grease passage holes in the seal assembly must line up with the holes in the clutch housing.*

d. Place the mating ring sealing washer on the carbon mating ring, with the flat side of the sealing washer against the shoulder of the carbon mating ring.

e. Lubricate the carbon mating ring with clean oil and install the mating ring and sealing washer on the hub of the impeller wheel, with the sealing washer facing the impeller wheel. *CAUTION: Make certain that the sealing surface of both the seal nose piece and the carbon mating ring are clean and smooth. Lubricate both surfaces with clean oil.*

f. Set the clutch housing up and install the input shaft bearing carrier with two (2) capscrews. *NOTE: The carrier will hold the ball bearing in position while the impeller wheel hub is pressed through the bearing.*

g. Insert the hub of the impeller wheel through the seal assembly and into the ball bearing in the clutch housing, then press the impeller wheel hub into place in the bearing. *CAUTION: Do not allow the impeller wheel to drop on the seal face, as to do so may crack the carbon mating ring.*

h. Remove the bearing carrier and install the larger of the two (2) spacers on the hub of the impeller wheel, followed by the locking washer and nut. Tighten the nut securely and lock it in position with the locking washer. Refer to Fig. 9 showing the tools.

i. Lubricate the input shaft ball bearing and press it into the bearing carrier as far as it will go. Install the bearing snap ring in the groove in the input shaft if it was removed. Start the threaded end of the input shaft into the bearing, from the small end of the bearing carrier, and press the shaft into position using a sleeve under the inner race of the ball bearing.

j. Install the counterbore spacer on the input shaft, with the counterbore of the spacer facing the threaded end of the shaft, then insert the spacer gasket in the counterbore of the spacer. Use care and do not damage the gasket when placing it over the input shaft.

k. Pack the cavity inside the bearing carrier with the specified pressure gun lubricant (refer to "SERVICE" in this section).

l. Coat a new gasket with gasket cement and place it in position on the attaching flange of the bearing carrier, then bolt the carrier, complete with the bearing input shaft, spacer, and gasket, to the clutch housing. The splines of the input shaft must enter the splines on the inside of the impeller wheel.

m. Position the assembly with the mounting flange side down, and use suitable blocking so that the end of the input shaft will clear the work bench.

3. Assembly of Over-running Clutch

a. Install the two (2) snap rings in the grooves in the freewheel cam if they were removed, and place the freewheel cam over the input shaft, with the splined end down.

b. Install the roller bearing assembly over the freewheel cam. *NOTE: The side plate is etched to read "REAR SIDE. "This surface must be installed up, or facing the turbine wheel.*

c. Install the freewheel spring into position on the freewheel cage, engaging the end of the spring in the hole in the freewheel cage, then place the freewheel cage and spring over the freewheel cam and pull the tip of the spring into position with a wire hook, allowing the tip of the spring to enter into the hole in the freewheel cam. A light wire such as a tag wire may be used. Oscillate the cage on the cam against the spring, the spring should then return the cam to its normal position. The cage must operate freely after it is installed.

d. Place a natural rubber band, (not synthetic), around the freewheel cage, then insert the freewheel rollers in their proper locations in the cage. The rubber band will hold the rollers in position for assembly and will dissolve in the fluid after the initial operation.

e. Place the retaining washer on the input shaft, then install the locking washer and the retaining nut. Tighten the retaining nut securely and lock in position with the locking washer. Refer to Fig. 8 showing the tools.

4. **Assembly of Turbine Housing to the Clutch Housing**

a. Position the clutch housing, flanged end down, and use suitable blocking so that the end of the input shaft will clear the work bench and the shaft will be accessible for rotating.

b. Install a new turbine wheel housing to clutch housing gasket on the shoulder of the clutch housing. Make certain all parts of both assemblies are clean and that all bearings have been properly packed with the specified grease.

c. Raise the turbine assembly with a suitable hoist and position it over the clutch housing so that the two (2) long studs in the turbine housing will enter the holes on each side of the fluid inlet boss in the clutch housing. This will place the converter seal drains and grease passages in line on the same side, or down, when the converter is installed.

d. Lower the turbine housing assembly until the over-running clutch is started in the outer race, using the long studs to align the two housings. *NOTE: The roller cage must be rotated to the freewheel position before it will enter the outer race located in the turbine wheel.* Lower the turbine wheel assembly just enough to contact the rollers, then rotate the input shaft clockwise (viewed from the front) and lower the turbine assembly while turning the input shaft. This will rotate the freewheel cage to the low point on the cam, or the freewheel position. Do not force the two housings together, as to do so may damage the over-running clutch assembly. The weight of the turbine assembly should be sufficient to assemble the two housings to the point where the pilot on the clutch housing contacts the turbine assembly. At this point it is permissible to tap the turbine housing lightly with a block of wood until the pilot enters the bore.

e. Bolt the two housings together using 24 nuts and lockwashers. Tighten the nuts securely.

f. After the assembly is completed, test the converter for leaks as follows:

(1) Cover all openings in the converter except the seal drain, grease passages, and the fuel inlet passage with the shipping covers and gaskets.

(2) Fill the converter approximately ¾ full of clean fuel, then cover the inlet passage, and add from 25 to 80 pounds or air pressure in the converter. *NOTE: An air valve from an old inner tube welded to a fuel tube nut is a suggested means of introducing air into the converter. Screw the nut on to the fuel inlet fitting on the clutch housing.*

CAUTION: Do not use more than 80 pounds of air pressure, as to do so may damage the seals of the housings.

A slight seepage of fluid from the seal drain passages is permissible. This seepage, from each seal, must not exceed 6 drops per minute, however, if considerable fluid is seen emerging from the openings, turn the turbine and pump wheels to seat the seals. If any fluid at all leaks through the gaskets or housings, or if the seals continue to leak excessively after the seals are seated, it will be necessary to disassemble the converter and determine the reason for the leakage. When the converter has been assembled in accordance with the instructions it is unlikely that any leakage will occur.

(3) After the converter has been tested for leakage, drain the converter and prepare it for installation.

G. Installation of Converter

Before installing the torque converter, inspect the engine clutch, clutch linkage, and the clutch shifter bearing grease tube. Replace any parts which are worn or damaged. Lubricate the clutch shifter bearing and linkage thoroughly.

The torque converter may be installed by direct reversal of the removal procedure. Refer to "CLUTCH INSTALLATION" in this section.

3. TORQUE CONVERTER PIPING

A. Description

The torque converter piping consists of two large tubes leading from the converter to a converter fluid cooling radiator, located in the radiator shell to one side of the engine coolant radiator. The fluid used in the converter is cooled by its circulation through these tubes and the converter fluid radiator.

The engine fuel pump keeps the converter housing completely filled with fuel as follows: Surplus fuel not required for engine operation leaves each injector and enters the return fuel manifold. From the return fuel manifold, the fuel passes through the torque converter. From the converter, the fuel then circulates through the cooling radiator and is returned to the fuel tank through a fuel return tube connected to the top of the converter radiator and leading back to the tank. A pressure of 30 to 55 pounds is maintained in the fuel and the converter system by a restricted fitting located in the fuel return tube near the bottom of the fluid cooling radiator. The restrictor is protected by a small screen filter located in the filter assembly with the restrictor. Prior to Serial No. HD20-4794, the restrictor plug in the return line filter had an opening .073" in diameter. In order to increase the fuel pressure, this opening was changed to .058" to .062" diameter. This change became effective on tractors after Serial No. HD20-4794. Whenever it becomes necessary to remove a fuel return line filter on tractors prior to Serial No. HD20-4794, it is suggested that the restrictor plug be removed and replaced with a new plug having the smaller diameter opening. A seal drain tube, which allows the escape of fuel that might seep through the converter seals, leads from the converter housing and connects with the engine air box drain tube. Any fuel seepage through the seals of the converter is ejected through this tube.

B. Cleaning and Inspection of Piping

Whenever the torque converter is removed for repairs, *ALL FUEL TUBES AND SEAL DRAIN TUBES SHOULD BE REMOVED AND CLEANED THOROUGHLY*. Make certain that the grease passages and seal drain holes in the seal carriers, the rear bearing retainer, and the clutch housing are open. *NOTE: When connecting the front seal drain hose, make certain that it is connected to the tee connection on the left side of the clutch housing.*

4. TORQUE CONVERTER FLUID COOLING RADIATOR

A. Description

The torque converter fluid cooling radiator is of the tubular type. The radiator is mounted on the left side and attached to the engine coolant radiator, and both radiators are mounted together in one radiator shell.

The right hand radiator fluid tube is connected to the right side of the converter housing and to a passage in the housing to the center or low pressure area of the impeller wheel. The left hand radiator fluid tube is connected to the left side of the converter housing, directly over the impeller wheel and the first set of turbine wheel blades. Since this fluid tube is connected directly over the impeller blades, the impeller aids in circulating the fluid through the converter radiator.

B. Torque Converter Cooling Radiator Removal

To remove the radiator assembly from the tractor refer to "RADIATOR REMOVAL," steps 1 through 8, in Section IV.

With the radiator removed as outlined in steps 1 through 8 in Section IV, remove the torque converter fluid cooling radiator from the engine cooling radiator as follows: Refer to Section IV.

1. Remove the bolts attaching the left side member to converter fluid cooling radiator and remove the side member.

2. Remove the bolts attaching the converter fluid cooling radiator to the center side member (leaving center side member attached to the engine cooling radiator) and remove the converter fluid cooling radiator.

C. Cleaning, Inspection, and Repair

External cleaning of the torque converter fluid cooling radiator is important to obtain proper cooling of the converter fluid. Make certain that the air passages through the radiator are clean, and that the cooling fins are not bent to restrict the air flow. In the event of a major failure in the torque converter, where any metal particles from the failed converter enter the fluid tubes and the converter radiator, it is of the utmost importance that the fluid tubes and radiator be removed, cleaned, and flushed thoroughly.

If all the metal particles are not removed, they will again be circulated through the converter fluid system, and a repeated failure will result. The metal particles will also enter the engine fuel system and may damage the fuel pump and injectors.

If cleaning and flushing facilities are inadequate to thoroughly clean the radiator of the metal particles, the radiator should be replaced.

Inspect the torque converter fluid cooling radiator for leaks. This radiator should be submerged in water and tested under an air pressure of 100 psi. If repair of the radiator is necessary, the repair should be made by a reputable radiator shop, as it requires special soldering (silver soldering) and repairs to withstand the pressure.

D. Installation

1. Place the torque converter fluid cooling radiator in position on the center side member (attached to the engine cooling radiator), and install the attaching bolts, nuts, and lockwashers. Place the left side member in place on the converter fluid cooling radiator and install the attaching bolts, nuts, and lockwashers.

2. Complete the radiator assembly installation by referring to "INSTALLATION OF RADIATOR," steps 2 through 9, in Section IV of this manual.

SECTION XI—TRANSMISSION AND BEVEL GEAR

1. GENERAL DESCRIPTION

Power from the engine is delivered through the engine clutch, torque converter, and universal joint drive tube assembly to the transmission, then through the transmission to the bevel gear. From the bevel gear to the steering clutches, thence through the steering clutches to the final drives and to the track sprockets.

The transmission case is piloted to the steering clutch and final drive housing by a boss located on the rear of the transmission case. This boss also serves as the rear bearing retainer for the transmission pinion shaft. The transmission case is attached to the steering clutch and final drive housing with capscrews.

A fixed gear reduction is made between the transmission bevel pinion and the bevel gear to the final drive gears; further reduction for power or speed change is automatically obtained through the torque converter and by the shifting of the transmission gears.

2. TRANSMISSION

A. Description

The transmission is, in effect a speed reduction unit combined with the use of the torque converter to provide the proper ratio for the required speed or power for operation of the tractor. The various speed changes are obtained by the use of sliding gears on the transmission top shaft. Reversal of direction is accomplished by meshing the low and reverse sliding pinion, located on the transmission top shaft, with the reverse shaft gear.

The sliding gears on the transmission top shaft are shifted into mesh by shifter forks actuated by the gear shifting lever. They are located for proper mesh by detent notches in the gear shifting shafts and detent balls (steel balls) in a block attached to the transmission case.

The sliding gears are locked in mesh by a locking mechanism consisting of two (2) spring loaded pins, which centers the gear shifting lever in between the two (2) blocks attached to the shifting shafts. The gears cannot be shifted out of mesh until the shifting lever is forced against the spring loaded pin, allowing the shifting lever to pass the corresponding shifter shaft block. Refer to Fig. 6.

The transmission top shaft is supported by a single row ball bearing on the front end and by a roller bearing at the rear end. The power input to the transmission is applied to the transmission top shaft. The bevel pinion shaft is supported by a double row ball bearing at the front end and by a roller bearing at the rear end.

B. Transmission Removal

1. Remove the oil drain plug from the bevel gear compartment. *NOTE: When removing the bevel gear compartment drain plug, the oil from both the transmission and the bevel gear compartment will be drained.*

2. Remove the seat cushions, seat adjusting frame, and the floor plates.

3. Remove the hydraulic steering lower control rods.

4. Unlock and remove the four (4) capscrews attaching the rear universal joint yoke to the spider assembly. Hold the two (2) universal joint bearing assemblies to prevent them falling off. Place a small pry-bar between the

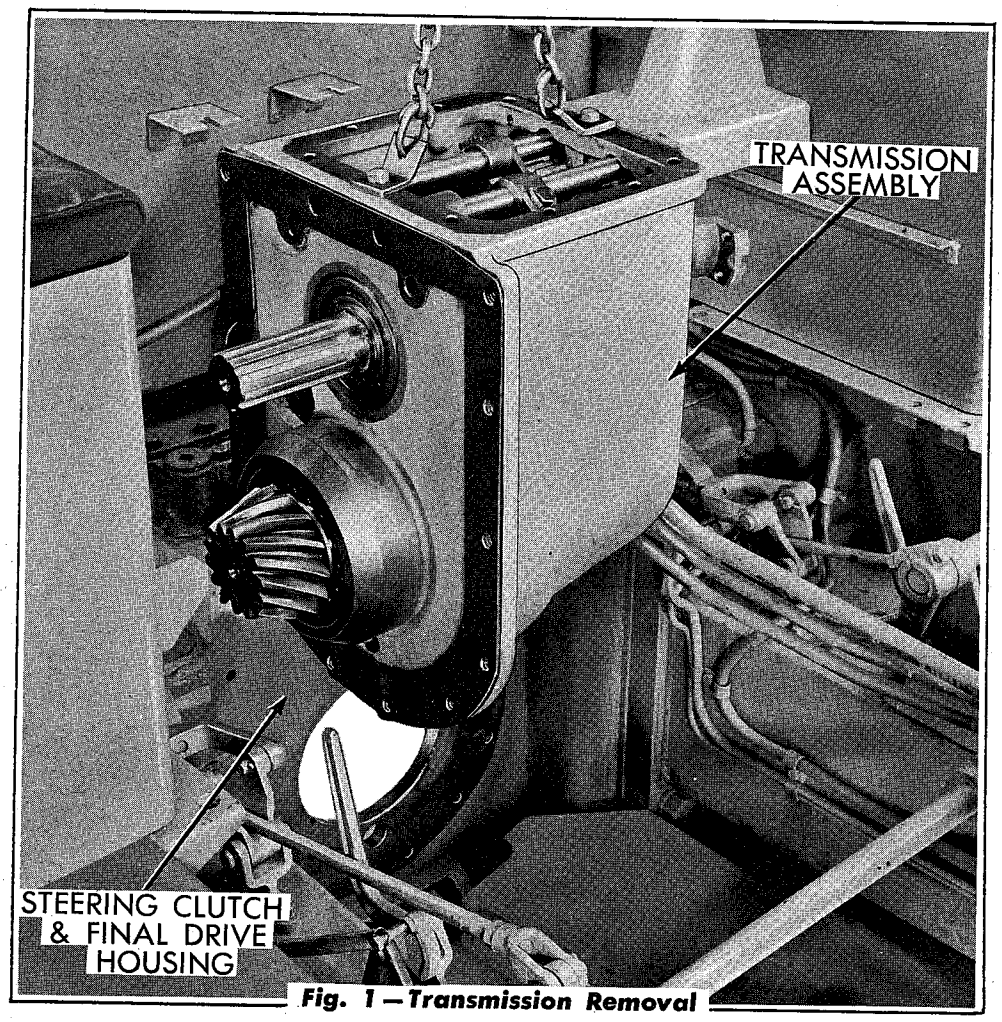


Fig. 1 — Transmission Removal

spider assembly and the rear yoke, then pry the drive tube assembly forward to clear the rear yoke. Tie or tape the bearing assemblies in place on the spider. Remove the universal joint drive tube and front yoke by pulling the assembly out of the torque converter splines.

5. Remove the hydraulic tube rear clamp and the rear clamp supporting bracket from the top of the transmission case.

6. Remove the two (2) capscrews attaching the oil filler pipe to the transmission and the transmission cover, and remove the oil filler pipe and the oil level rod gage.

7. Clean thoroughly around the transmission case top cover, remove the cover attaching capscrews, and remove the cover.

8. Remove the locking wire from the two (2) capscrews inside the transmission case, attaching the transmission case to the steering clutch and final drive housing, and remove the capscrews.

9. Attach a short chain to the transmission case with two (2) of the top cover attaching capscrews, as illustrated in Fig. 1, to lift the case for removal. Attach a chain hoist, then remove the remaining capscrews attaching the transmission case to the steering clutch and final drive housing.

10. Remove the transmission by forcing it forward until the boss on the rear of the transmission case is out of the bore in the steering clutch and final drive housing.

    NOTE: Keep the transmission case in alignment (straight) while removing, to prevent the boss on the transmission case from binding in the bore of the steering clutch and final drive housing.

C. Transmission Disassembly

(Transmission Removed From Tractor)

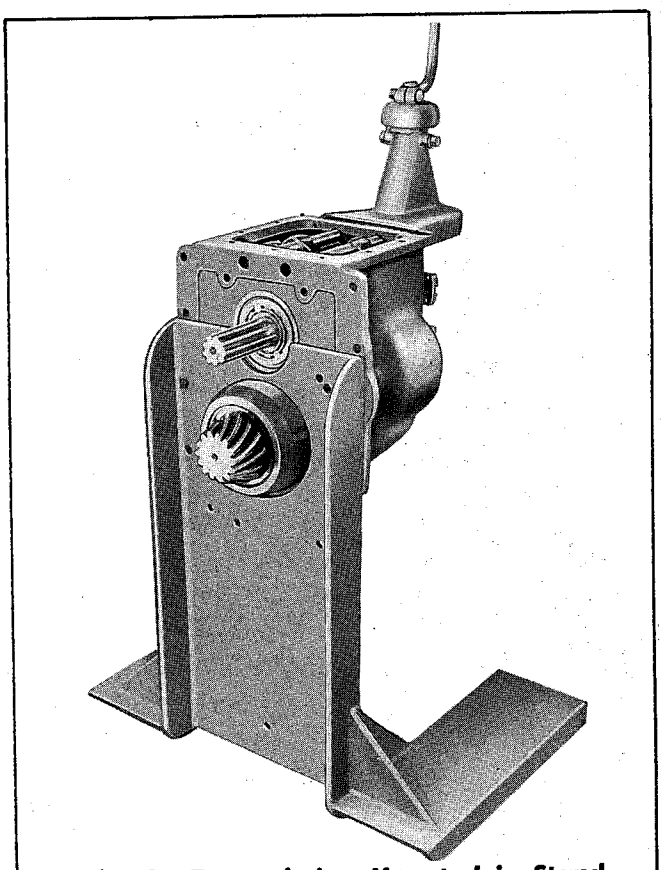


Fig. 2—Transmission Mounted in Stand

1. Clean the transmission thoroughly before disassembly.

2. Place the transmission on a clean work bench, or on a transmission stand similar to the one shown in Fig. 2.

3. Remove the capscrews attaching the gear shift lever housing to the transmission case.

4. Hold the gear shifting lever forward (as far as possible to the front of the transmission case), and remove the gear shifting lever and the housing.

5. To disassemble the gear shifting lever and housing, remove the bolt clamping the gear shifting lever to the lower shifting lever, loosen the clamp holding the shifting lever boot in position on the housing, then remove the shifting lever, rubber boot, and the clamp. Remove the two shifting lever pivot screws (dog point) and remove the lower shifting lever from the housing.

6. With the shifting shafts in the neutral position, unlock and loosen the capscrews clamping the shifting forks to the shifting shafts. Turn one of the shifting shafts until the detent notch in the shaft is pointing up. Pull the shaft, that was turned, out of the shifting fork and the transmission case. When removing the shaft, use a clean cloth over the locking plunger block and the shaft to catch the one steel ball and locking plunger.

7. Remove the other shifting shaft, then remove the remaining steel ball, locking plunger, and the locking plunger spring from the locking plunger block.

8. Lift the shifting forks from the transmission. *NOTE: The two (2) shifting forks are identical.*

9. Unlock and remove the capscrew attaching the rear universal joint yoke to the transmission top shaft and remove the lock, retaining washer, rubber seal and the yoke.

10. Remove the capscrews attaching the top shaft bearing retainer to the transmission case and remove the bearing retainer and the oil seal assembly. If the seal is to be replaced, drive the seal from the bearing retainer.

11. Use a sliding hammer type puller, with an adapter having ¾" N.F. thread, screw the puller into the tapped hole in the front of the transmission top shaft. Remove the snap ring from the rear end of the transmission top shaft. Using the sliding hammer puller, pull the top shaft and front bearing until the front bearing is out of the bore, then move the top shaft forward until the sliding gears contact the inner race of the rear bearing. Hold the shaft in this position, and use the sliding hammer puller to remove the rear bearing inner race and spacing washer from the shaft. Continue pulling the shaft and remove the gears as they are freed from the shaft.

12. Place the transmission top shaft in a vise, protecting the splines of the shaft by the use of copper jaws, or similar protecting measures. Unlock and remove the front bearing

the bore of the transmission case. Install the pinion shaft end washer, locking washer, and three (3) capscrews. Tighten capscrews securely making certain the pinion shaft front bearing is pressed against its seat. Lock the capscrews securely, and bump the pinion shaft back (towards the rear) until the snap ring on the front bearing is against the transmission case.

e. Using a depth gage, measure the depth of the recess in the front bearing retainer and lock the depth gage. Place the depth gage against the front face of the front pinion shaft bearing, then using a feeler gage, measure the clearance between the depth gage and the front face of the transmission case. Add .001" to the thickness of the feeler gage leaves used in measuring. This gives the total thickness of the front bearing retainer adjusting shims required to give a specified bearing end play of .000" to .002" in the bearing retainer when assembled. EXAMPLE: If the total thickness of the feeler gage leaves is .014", use an adjusting shim pack of .015" when assembling the front bearing retainer.

f. Drive the pinion shaft forward approximately 1/16" and remove the snap ring from the pinion shaft front bearing. Install a .055" shim pack of pinion depth adjusting shims in place on the front pinion bearing. Reinstall the snap ring and drive the pinion shaft back until the bearing snap ring is tight against the shims.

g. Install front bearing retainer with the correct amount of bearing retainer adjusting shims, as determined in step (e). Install the attaching capscrews and tighten securely.

h. If the bevel pinion has a mounting distance dimension marked on the toe end, subtract this dimension from 12.258", which is the specified dimension from the back mounting face of the transmission case to the center of the bevel gear hub. The difference between these two dimensions, is the distance the toe end of pinion teeth should extend from the rear mounting face of the transmission case,

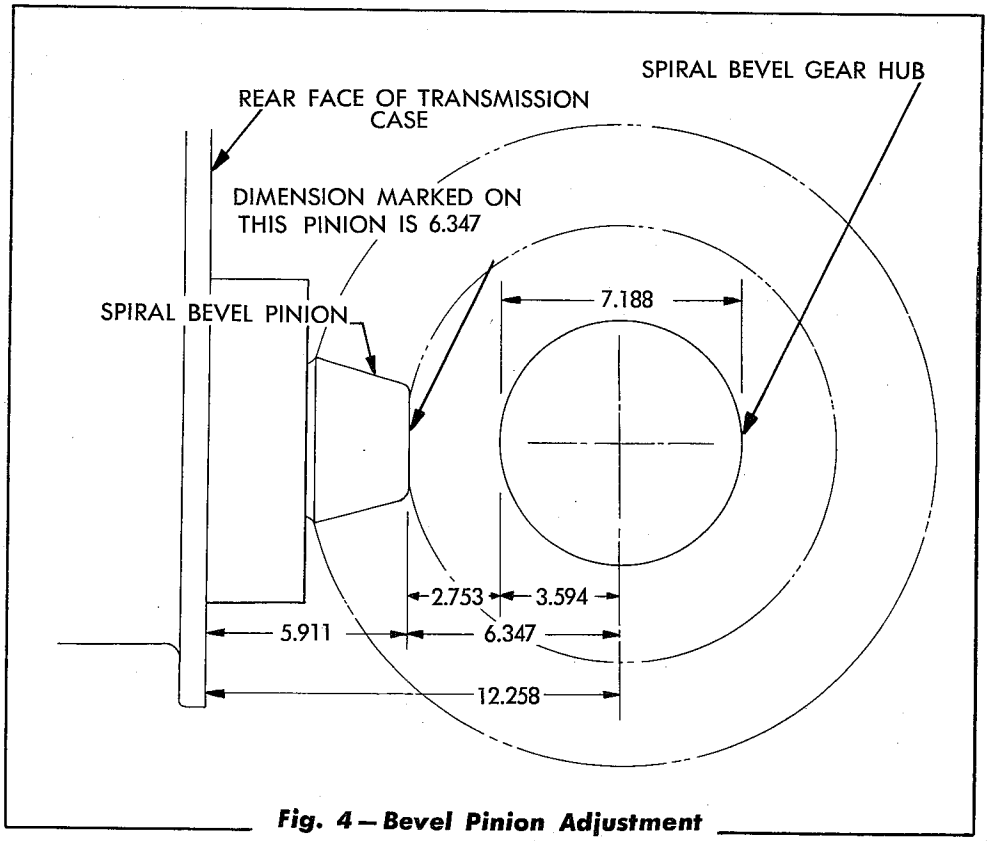


Fig. 4 — Bevel Pinion Adjustment

without the mounting gasket in place. EXAMPLE: Dimension marked on toe end of pinion is 6.347"; 6.347" from 12.258" equals 5.911", which is the distance the toe end of the pinion should extend from the rear mounting face of the transmission case.

Measure the distance from the toe end of the pinion teeth to the rear mounting face of the transmission case. Add or remove the front bearing pinion depth adjusting shims to obtain the proper calculated dimension. Refer to Fig. 4.

i. If the bevel pinion does not have a mounting distance dimension marked on the toe end, measure the distance (with the pinion installed as outlined in step (h) above), from the toe end of the pinion to the rear mounting face of the transmission case. This distance should be 5.916". Add or remove the front bearing pinion depth adjusting shims to obtain this measurement. Refer to Fig. 5.

NOTE: The above specified dimensions in steps (h) and (i) allow for the thickness of the gasket used between the transmission case and the steering clutch housing when assembled.

3. Install the Top Shaft and Gears

If all bearings and spacers have been removed from the transmission top shaft and the transmission case, proceed as follows:

a. Install the top shaft front bearing spacer on the shaft. Lubricate the top shaft front bearing (ball bearing) and install the bearing on the top shaft. Make certain the bearing is pressed tight against the front bearing spacer. Install the top shaft nut locking washer, inserting the tang of the washer in the groove in the shaft. Install the front bearing retaining nut and tighten securely. Lock the nut with the locking washer.

b. Lubricate the top shaft rear bearing (roller bearing) and install the snap ring in the groove of the bearing if it was removed. Drive the rear bearing into position in the bore of the transmission case.

c. Insert the rear end of the top shaft

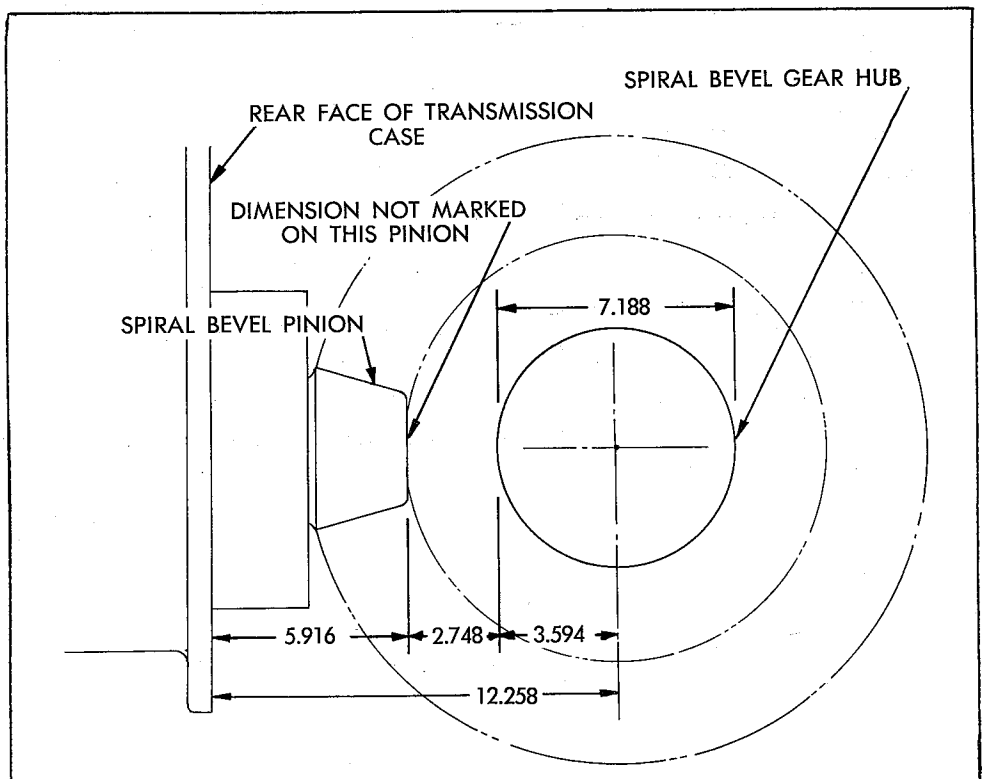


Fig. 5—Bevel Pinion Adjustment

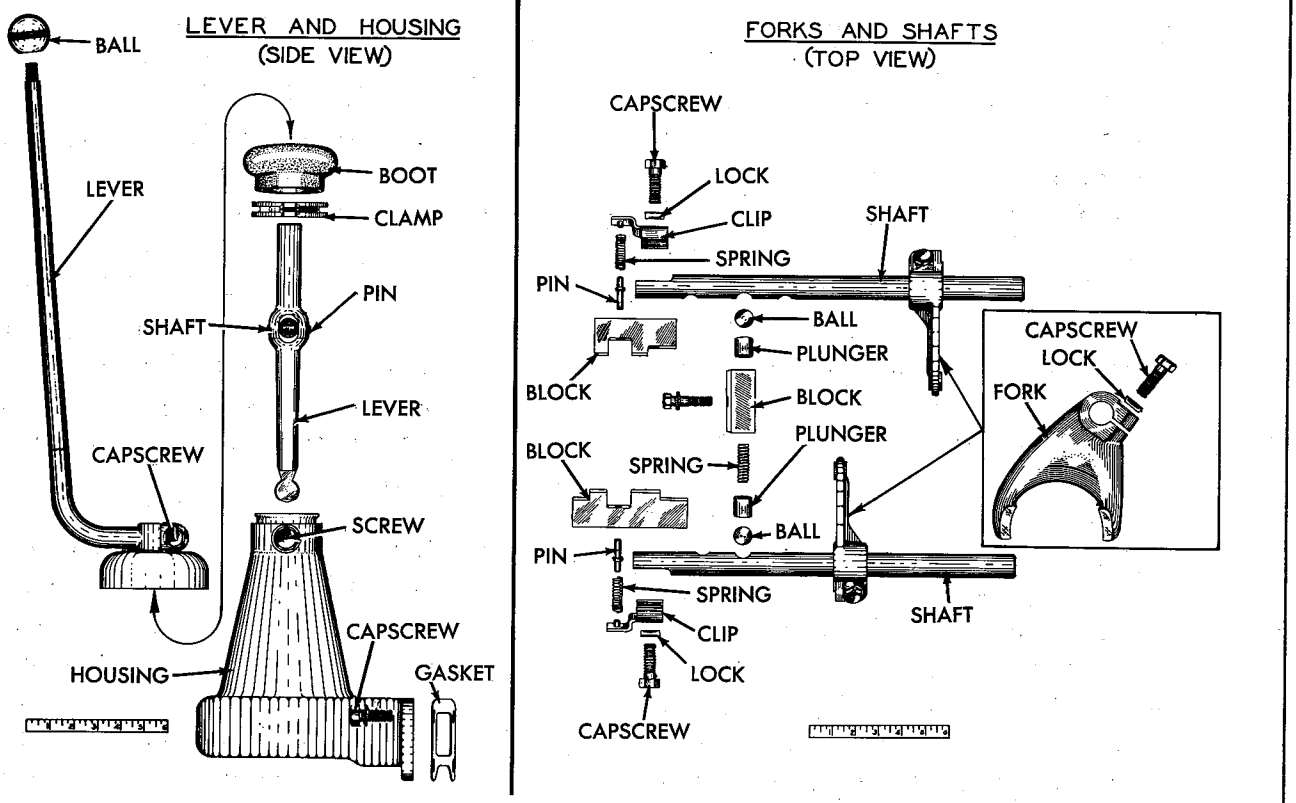


Fig. 6—Gear Shift Details

through the top front bore of the transmission case. Refer to Fig. 3, and install the top shaft gears in their proper position and with the hubs of the gears in the direction as shown. After the gears are started on the shaft, place the top shaft rear bearing spacer washer on the shaft, with the tang or raised portion of the washer aligned with the detent in the top shaft, then push the shaft into position in the rear bearing. Lubricate the front bearing retainer oil seal and install the seal into its position in the front bearing retainer, with the lip of the seal toward the transmission case. Install the front bearing retainer and seal in position on the transmission case, using a new mounting gasket on the bearing retainer, then install the attaching capscrews and tighten securely.

d. Place the inner race of the top shaft rear bearing on the rear end of the top shaft, with the larger chamfer of the race towards the shaft splines. Drive or press the inner race into position, making certain that the rear bearing spacer washer tang aligns with the detent or notch in the top shaft. Install the inner race retaining snap ring in the groove in the shaft.

e. Place the universal joint yoke, retaining washer seal (rubber), retaining washer, and the retaining capscrew lock in position, then install the yoke retaining capscrew and tighten securely. Lock the retaining capscrew in position with the retaining capscrew lock.

4. Install the Gear Shift Controls

a. Install the shifter shaft locking plunger block, if it was removed from the transmission case, and tighten the retaining capscrew securely.

b. Place the shifting forks in position on the top shaft sliding gears. *NOTE: The two (2) shifting forks are identical, however, they must be positioned correctly when they are installed.* Position the forks so that the reinforcing web on the forks face toward each other (refer to Fig. 6).

c. Start the shifting shaft containing the three (3) notches into the front bore in the right hand side of the transmission case. Push the shifting shaft back through the low and reverse shifting fork and into the bore at the rear of the transmission case. Position the shifting shaft and align the center or neutral notch in the shaft with the locking plunger block. Install one of the steel locking balls into the locking plunger block from the left side (viewed from the rear of the transmission case), then place the locking plunger spring into the counterbore of the two (2) locking plungers, and install the plungers into the locking plunger block. Place the other steel locking ball into position in the locking plunger block; hold in on the ball and start the left shifting shaft into the bore of the transmission case. Hold the high gear shifting fork in position, then push the shifting shaft back into the bore at the rear of the transmission case.

d. Place the shifting shafts in their neutral position, then position the shifting fork (on the right shaft) so that the low and reverse pinion is located equally between the low speed and the reverse shaft gear. Hold the shifting fork in position and tighten the clamping capscrew in the shifting fork.

e. Push the right shifting shaft back until the locking ball enters the front groove in the shaft. Check the low and reverse pinion for full tooth contact with the low speed gear. Pull the right shifting shaft forward until the plunger ball enters the rear groove in the shaft. Check the low and reverse pinion for full tooth contact with the reverse shaft gear. Change the position of the fork on the shaft, if necessary, to obtain full tooth contact of the gears.

f. Push the right shaft back to the neutral position (plunger ball in the center groove in the shaft).

g. Push the left shifting shaft back until the plunger ball enters the front groove in the shaft. Position the shifting fork (on the left shifting shaft) so that the high speed gear has full tooth contact with the high speed pinion. Pull the left shaft forward to the neutral position and check for clearance between the shifter forks. Tighten the clamping capscrews securely and make certain that shifting blocks on the end of the shifting shafts are in alignment. Lock the clamping capscrew of each shifting fork in position with the capscrew lock.

h. Using gasket cement, cement the gear shift housing gasket in place on the transmission case. Assemble the gear shift lever to the housing if it was removed. Install the gear shift housing by holding the top of the shifting lever all the way forward, allowing the lower end of the gear shifting lever to enter the blocks between the two (2) centering pins, then push the gear shift housing into position. Install the four (4) attaching capscrews and tighten the capscrews securely.

The transmission is now ready to install in the tractor. Use a new gasket between the transmission case and the steering clutch housing and install the transmission by direct reversal of the removal procedure. *NOTE: Do not forget to install the two (2) capscrews inside the transmission case and secure them with lockwire.* After the transmission has been bolted into place, recheck the backlash between the bevel gear and the pinion teeth (refer to "BEVEL GEAR AND PINION ADJUSTMENT" in this section).

Install the lubricating oil drain plug in the bevel gear compartment and the drain plug in the transmission if it was removed, then fill the transmission and bevel gear compartment to the proper level using the specified lubricant.

3. BEVEL GEAR

A. Description

The bevel gear, located in the steering clutch and final drive housing, is bolted to a flange which is an integral part of the bevel gear shaft. The bevel gear shaft bearings are installed in replaceable bearing cages that fit in bores in the bevel gear housing. Shims are provided between the bearing cages and the walls of the housing, for bevel gear adjustment.

The bevel gear is driven by the transmission bevel pinion. Power from the bevel gear is delivered through the steering clutches to the final drives. An approximate 4 to 1 speed reduction is made through the bevel gear and pinion.

B. Removal of Bevel Gear

With the transmission removed, the bevel gear may be removed as follows:

1. Remove both steering clutches. Refer to "CLUTCH REMOVAL" in Section XII.

2. Remove the drain plug in the hydraulic steering control housing and drain the oil. Remove the front clamp from the hydraulic steering control tubes.

3. Remove the three (3) sealastic nuts attaching the hydraulic steering control tubes to the fittings on the hydraulic steering control housing. Remove the capscrews attaching the hydraulic steering control housing to the steering clutch and final drive housing. *NOTE: Four (4) of the attaching capscrews extend through the housing cover, one (1) in front and one (1) in back of each steering clutch actuating shaft.*

4. Remove the two (2) bolts (one in each steering clutch compartment), clamping the lower steering clutch actuating levers to the actuating shafts, then raise the control housing and remove the lower actuating levers from the shafts as the housing is being raised. Remove the control housing.

5. Remove the steering clutch driving hub retaining capscrews from both ends of the bevel gear shaft, then remove the capscrew locks and retaining washers. Disconnect the steering clutch throughout bearing lubricating tubes from the steering clutch and final drive housing (one in each steering clutch compartment). Install four (4) 5/8" N.C. pusher screws into the tapped holes in the steering clutch driving hub, then turn the pusher screws in to push the hub from the shaft. Remove the hub, throwout bearing, and throwout yoke as an assembly. Use the same procedure mentioned above and remove the other steering clutch driving hub.

6. Remove the capscrews attaching the bevel gear shaft bearing cages to the steering clutch and final drive housing. Using three (3) 1/2" N.C. pusher screws in the tapped holes in each cage, turn the screws in evenly and remove the cages. Tie the shims to their respective cages so that they will not be lost. Mark the cages so that they may be reinstalled in the side from which they were removed. *CAUTION: When removing and installing the bearing cages, use care and do not damage or crimp the lips of the oil seals.*

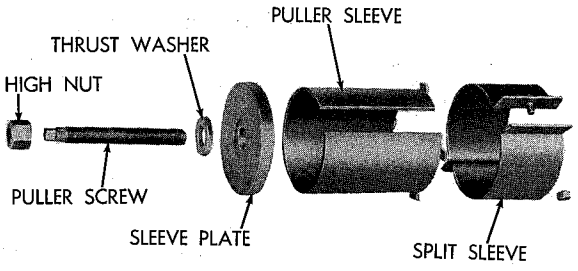


Fig. 7 — Bevel Gear Shaft Puller Details

7. Straighten the bevel gear shaft nut locking plates and remove the nuts. Using tools similar to those shown in Fig. 7, proceed to pull the bevel gear shaft as follows:

   a. Insert the screw into the tapped hole in the left hand end of the bevel gear shaft. Turn the puller screw into the shaft far enough to bottom the screw in the threads of the shaft.

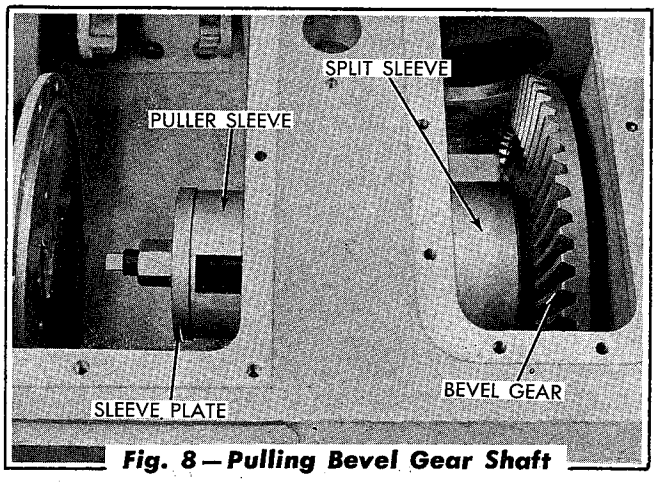


Fig. 8—Pulling Bevel Gear Shaft

b. Place the slotted puller sleeve over the puller screw and bolt the four (4) ears of the sleeve in position against the inner wall of the steering clutch housing. Place the sleeve plate over the screw, with the recessed side of the plate toward the puller sleeve, then install the thrust washer and the nut on the puller screw.

c. Bolt the split sleeve, as shown in Fig. 8, over the bevel gear shaft with one end against the bevel gear and the other end against the wall of the bevel gear housing.

d. Tighten the puller screw nut and pull the bevel gear shaft from the bevel gear retaining capscrews. The right bevel gear bearing cone will be removed from the bevel gear shaft at the same time.

e. Remove the nut from the puller screw, sleeve plate, and the puller sleeve. Remove the puller screw from the bevel gear shaft and remove the bevel gear shaft and bearing through the left steering clutch housing.

f. Remove the split sleeve and the bevel gear through the top of the bevel gear compartment.

C. Cleaning and Inspection of Parts

Clean and inspect all the parts thoroughly as described in pertinent pages in "GENERAL MAINTENANCE INSTRUCTIONS" in Section XXI. Replace or recondition any damage parts and use new oil seals when assembling.

D. Assembly of Bevel Gear

1. Drive the twelve (12) bevel gear retaining capscrews into the capscrew holes in the bevel gear, with the threaded ends of the capscrews on the toothed side of the gear. Be sure that the heads of the capscrews are properly turned so that the capscrew locking ring can be installed.

2. Place the bevel gear in the bevel gear compartment, with the back face of the gear

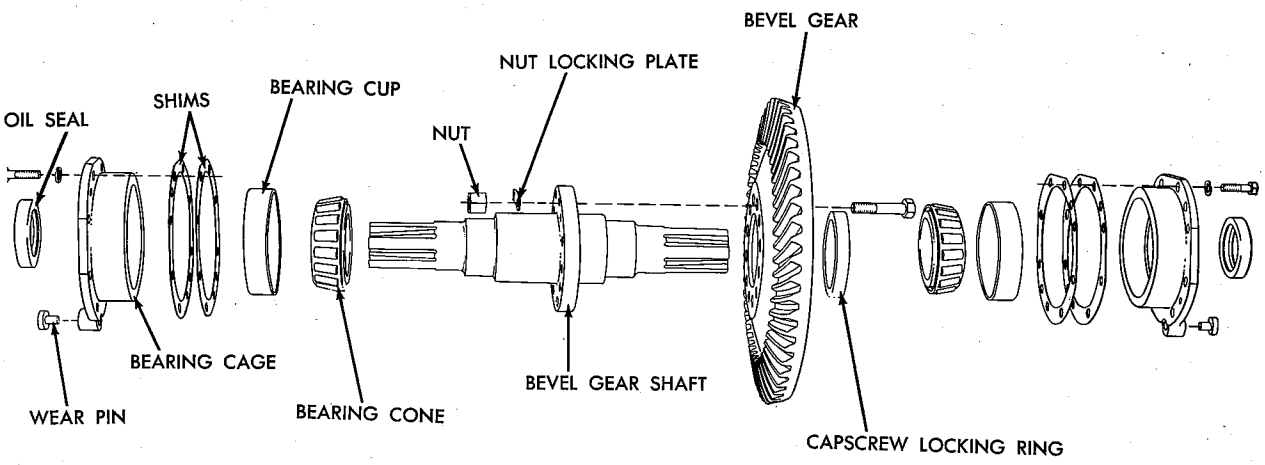


Fig. 9—Bevel Gear and Shaft Details

these shims to those under the bearing cage on the left side. If the backlash is insufficient, remove the adjusting shims from the left side and add them to the right side. In this manner, the bevel gear is moved without disturbing the adjustment of the bevel gear shaft bearings.

NOTE: Moving a .005" shim will change the gear backlash approximately .0035".

After the backlash has been adjusted, the tooth bearing should be checked. The tooth bearing can be determined by painting the bevel gear teeth with a marking compound or bluing, then rotate the gear and the tooth bearing will show plainly. Refer to Fig. 12, showing the correct and incorrect tooth bearings.

NOTE: Setting up a bevel gear and pinion by reference to Figs. 4 and 5 will always result in a setting very close to that desired. However, do not consider the setting obtained by following Figs. 4 and 5, as the final mounting distance. Always use bearing blue or marking compound to determine the tooth contact and change the pinion position as necessary to obtain the correct tooth pattern as shown on Fig. 12.

16. After the backlash of the bevel gear and pinion has been adjusted, remove the bevel gear shaft bearing cages (keep adjusting shims with respective cages) then lubricate and install the oil seals in the cages. Install the seals in the cages so that the lips of the seals are towards the bevel gear when installed. Lubricate the bevel gear shaft, then reinstall the cages using care so that the lips of the seals are not crimped or damaged. *IMPORTANT: When installing the cages make certain that they are positioned so that the wear pin for the clutch throwout yokes are to the bottom.*

17. Install the steering clutch throwout bearings, throwout yokes, and steering clutch driving hubs on the bevel gear shaft as an assembly. Install the steering clutch driving hub retaining washers, locks, and retaining capscrews. Tighten the retaining capscrews to 550 to 600 foot pounds torque, then lock the capscrews in position with the capscrew locks. Connect the upper ends of the lubricating tubes (right and left) for the steering clutch throwout bearings.

18. Install both steering clutches and brake assemblies, refer to "CLUTCH INSTALLATION" in Section XII.

19. Install the lubricating oil drain plug in the bevel gear compartment, then fill the transmission and bevel gear compartment to the proper level using the specified lubricant.

20. Install a new gasket between the bottom of the hydraulic steering control housing and the steering clutch and final drive housing.

    Coat the gasket with gasket cement, then install the control housing in position on the steering clutch and final drive housing. Install all of the attaching capscrews, except the four (4) long capscrews that extend through the control housing cover, and tighten the capscrews securely.

21. Remove the hydraulic steering control housing cover attaching capscrews and remove the cover.

22. Remove the two (2) connecting rod yoke pins located in the control housing. Place one (1) of the lower steering clutch actuating levers in position on the clutch throwout yoke ball. *Note: When installing the lower actuating lever, make certain that the chamfered edge around the hole for the actuating shaft is up. Raise the actuating shaft only enough to start the shaft into the lower actuating lever. Hold the lever up when tightening so that the end of the shaft is flush with the bottom of the lever.*

23. Install the connecting rod yoke pin in the yoke and upper actuating lever. Push the clutch throwout yoke against the clutch throwout plate, then push the hydraulic spool valve back as far as it will go (against the control piston). The distance from the front end of the spool valve (end in front of pin

hole) back to the gasket used between the spool valve bracket and the housing should be 8" + or – ⅜". Refer to Fig. 6 in Section XII. If this measurement is not correct, remove the connecting rod yoke pin, then remove the bolt clamping the lower actuating lever to the shaft. Raise the actuating shaft only enough to free the lower actuating lever, then rotate the shaft with the upper actuating lever to relocate the lower lever on the shaft, then insert the shaft back into the lower actuating lever and install the clamping bolt and tighten it securely. Replace the connecting rod yoke pin and install the cotter pin. *IMPORTANT: This measurement is important since it provides the necessary movement of the actuating levers to operate the steering clutch and also provides for pressure relief in the hydraulic system.*

24. Install the other steering clutch actuating lever following the procedure outlined above.

25. Coat a new gasket with gasket cement, place the control housing cover in position, and install the cover attaching capscrews. Tighten the capscrews securely.

26. Connect the three (3) sealastic nuts attaching the hydraulic steering control tubes to the fittings on the hydraulic steering control housing. Install the clamp used to hold the hydraulic steering control tubes in position on the corner of the transmission cover.

27. Install the drain plug in the steering clutch control housing. Fill the housing with the specified lubricant. Refer to "HYDRAULIC STEERING CONTROL HOUSING" in Section XII.

28. Check the steering clutch and brake adjustment. Refer to "STEERING LEVERS AND LINKAGE" in Section XII and "BRAKE ADJUSTMENT" in Section XIII.

4. UNIVERSAL JOINT

A. Description

Power from the engine is transmitted through the torque converter to the transmission by a universal joint drive tube assembly, which connects the torque converter turbine wheel (out-put) to the transmission top shaft. The main parts of the assembly are: the front and rear yokes, spider and bearing assemblies, and yoke connecting tube. By removing the universal joint drive tube assembly, either the transmission, torque converter, or engine clutch may be removed without disturbing the bevel gear and steering clutch assembly or the engine.

B. Service

The universal joint is provided with two (2) lubricating points, one in each spider assembly. To reach these points, remove the floor plates. After the universal joints have been lubricated, replace the floor plates.

The universal joint assemblies should be lubricated after each 1000 hours of operation. Whenever the transmission, torque converter, or engine clutch are removed, the universal joint assembly should be inspected.

C. Removal, Disassembly, and Inspection

1. Remove the floor plates.

2. Remove the four (4) capscrews attaching the rear yoke to the bearing assemblies. Remove the assembly, using a small pry-bar between the rear yoke and the spider assembly to pry the universal joint tube assembly forward, until it is free from the rear yoke. Do not drop the rollers from the bearing assemblies. Tape or tie the two (2) bearing assemblies to the spider, then remove the drive tube assembly by pulling it back until the front yoke is free from the torque converter splines.

3. Remove the capscrews attaching the front yoke to the spider assembly and those attaching the drive tube to the front and rear spider assemblies. Remove the bearing assemblies from the spiders. Then remove the bearing sealing washers and the dust shields.

4. Wash the parts thoroughly in clean solvent, then inspect the components for damage and

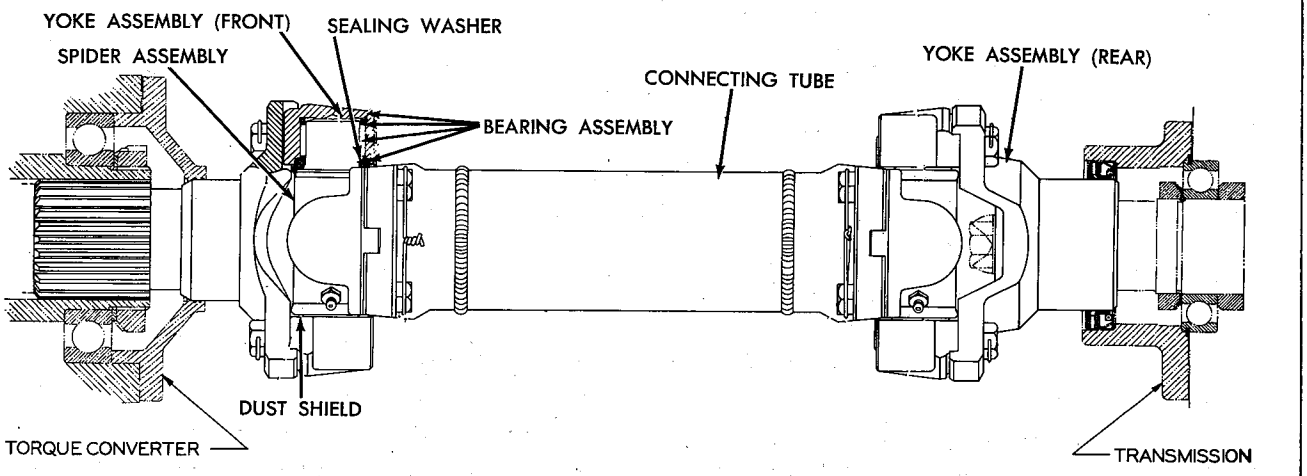


Fig. 13 — Universal Joint Assembly

abnormal wear. Replace the necessary parts.

D. Assembly and Installation

The universal joint assembly may be reassembled and installed by direct reversal of the removal and disassembly procedure. When installing the spider assemblies to the drive tube, install them so that both lubrication fitting holes are in line and accessible at the same time when lubricating the universal joints. Install the rollers in the bearing retainers, thirty (30) in each race, and pack them with grease to hold them in position. Install the retainers.

SECTION XII—STEERING CLUTCHES AND CONTROLS

1. GENERAL DESCRIPTION

Two steering clutch assemblies, one at each end of the bevel gear cross shaft, are employed for steering the tractor. Each steering clutch assembly is enclosed in a brake drum which is bolted to a flange connected to a final drive pinion. The brake drums serve in conjunction wi'h the steering clutches by stopping the rotation of the final drives when the brakes are applied. Each steering clutch is actuated by a hand lever which controls a hydraulic valve to move a piston in the hydraulic steering arrangement. The movement of the hydraulic pistons is transferred to the steering clutch throwout bearings through leverage to engage or disengage the steering clutches.

2. STEERING CLUTCHES

A. Description

The two steering clutches, one on each side, are of the multiple disc type, having sixteen (16) friction discs and sixteen (16) steel discs assembled alternately in each clutch assembly. Springs hold the discs tightly together in assembly between the pressure plate and the driving hub. The complete assemblies are contained in the brake drums.

Power is transmitted through these clutches from the bevel gear shaft to the final drive pinions. The steering clutches are disengaged by pulling back on the steering levers directly in front of the operator. This hydraulically forces a throwout sleeve against a throwout plate in the clutch and compresses the springs, thereby allowing the steel discs and friction discs to separate and disengage the clutch.

When either clutch is disengaged, the bevel gear shaft turns without driving or supplying power to the final drive pinion shaft on the side disengaged.

B. Clutch Service

Specified time intervals between linkage adjustments can not be established because of the variable operating conditions which determine the amount of clutch disc wear.

The steering clutch linkage is properly adjusted when the steering levers each have 2" of free travel, measured at the tops of the levers. As the clutch discs wear, this free travel decreases. When the free travel has decreased to 1", an adjustment of the clutch linkage is required. Free travel of the lever is necessary to assure proper clearance between the clutch throwout sleeve and the clutch throwout plate and to assure full engagement of each clutch.

C. Washing Steering Clutches

Oil leaking into the steering clutch compartments may get on the clutch discs and cause the clutches to slip. If this occurs, wash the clutches in the following manner:

1. Install pipe plugs in the two drain holes in the bottom of the steering clutch housing, at each side of the bevel gear compartment drain plug.

2. Remove the brake band adjusting nut covers from the top of the housing and pour about

three gallons of solvent into each compartment. Drive the tractor back and forth in a straight line for approximately five minutes, leaving the steering clutches engaged. The oil on the exterior of the clutches and brakes will be washed off in this operation.

3. Drain the compartments and refill with the same amount of solvent, then drive the tractor back and forth for approximately another five minutes, disengaging one clutch and then the other continually during this period. Disengaging the clutches allows the clutch discs to separate so that the solvent can get in between the discs to wash the oil from their friction surfaces.

4. Drain the compartments and allow the clutches a short time to dry. Operate the tractor with a light load in low gear until the clutches become thoroughly dry, otherwise they may slip due to the presence of solvent on the discs.

D. Clutch Removal

1. Remove the fuel tank (refer to "FUEL TANK REMOVAL" in Section II).

2. Remove the center and rear floor plates.

3. Remove the jam nut, and the brake band support adjusting nut.

4. Remove the steering clutch compartment covers.

5. Turn the brake band adjuster counter-clockwise until it is loosened from the brake band adjusting fork.

6. Remove the yoke pin connecting the brake rod yoke assembly to the brake band lever. Remove the pipe plug located in the side of the steering clutch case in line with the brake band pin, and using a suitable 3/8" NC capscrew inserted through the hole, turn it into the tapped hole in the end of the pin. Now pull the brake band adjusting fork pin out and remove the brake band adjusting fork. Lift up on the brake band lever until the pin attaching the lower end of the band to the lever, can be removed. Push the pin towards the bevel gear compartment and remove, then remove the brake band lever. Do not remove the brake band as it will be used in lifting the steering clutch and brake drum assembly.

7. Remove the capscrews attaching the steering clutch assembly to the driving hub and the brake drum hub. This will necessitate turning the clutch assembly and brake drum which can be accomplished by inserting a suitable bar in one of the ventilating holes in the brake drum.

8. Using a chain hooked around the brake band adjuster and around a yoke pin placed in the lower end of the band, lift the steering clutch assembly and brake drum out of the compartment as shown in Fig. 1.

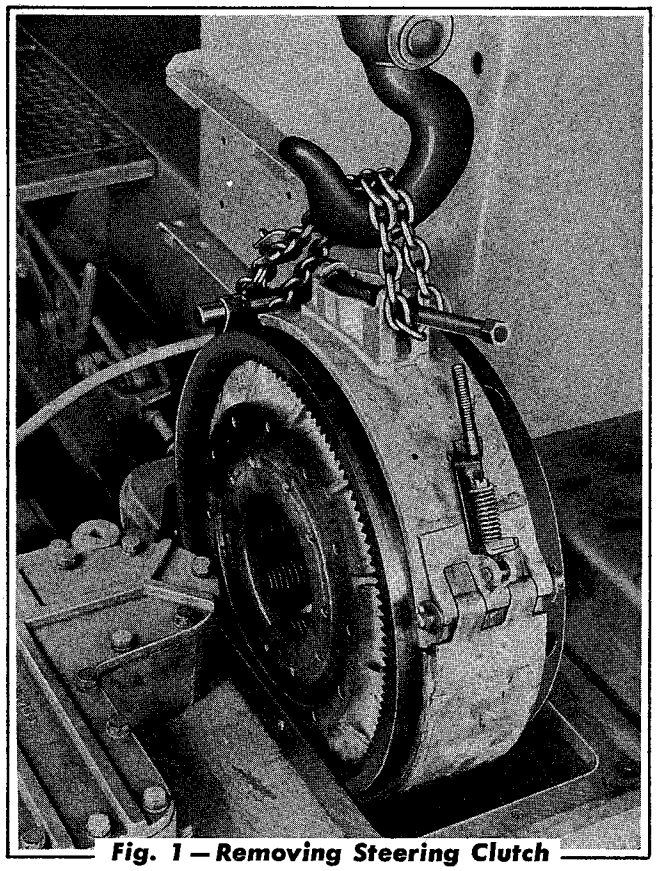


Fig. 1 — Removing Steering Clutch

E. Disassembly of Steering Clutches

1. Remove the drum from the clutch assembly being careful not to bend the clutch disc teeth.

2. Before disassembling the clutch, center

punch the pressure plate, the back plate, the hub, and the throwout plate so that they can be reassembled in the same position as they were before disassembly.

3. Remove the lockwires and five (5) of the ten (10) drilled head capscrews used in holding the clutch together, (every other one). *NOTE: it will be necessary to use five (5) studs to hold the load of the compressed steering clutch springs when disassembling the steering clutch.* Each stud should be ½" diameter by 11⅜" long, having one end threaded ½" NF for a distance of approximately 1". The other end should be machined square for a wrench hold and threaded ½" NF for a distance of approximately 8½".

4. Install the five studs with the short threaded end into the throwout plate, followed by flat washers and hex nuts. Screw the nuts down against the pressure plate. Refer to Fig. 3.

5. Remove the remaining capscrews, then loosen the stud nuts evenly until all tension is taken off the clutch springs.

6. The throwout plate, discs, springs, etc., can now be removed.

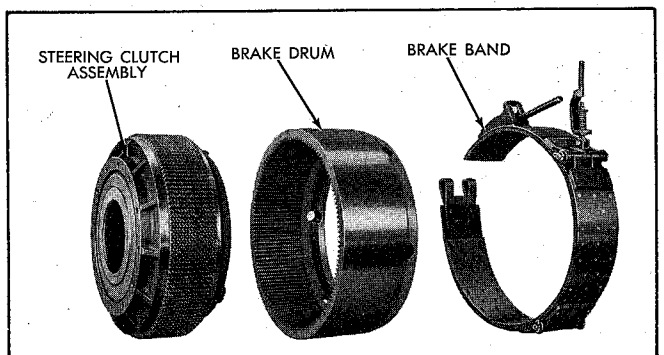


Fig. 2 — Steering Clutch, Brake Drum, and Brake Band

F. Clutch Inspection and Repairs

When the clutches have been disassembled, inspect the following items:

1. **Steel Discs**

   Specified thickness when new is .084" to .096". Inspect the discs for wear and scoring. The discs must be flat within .015".

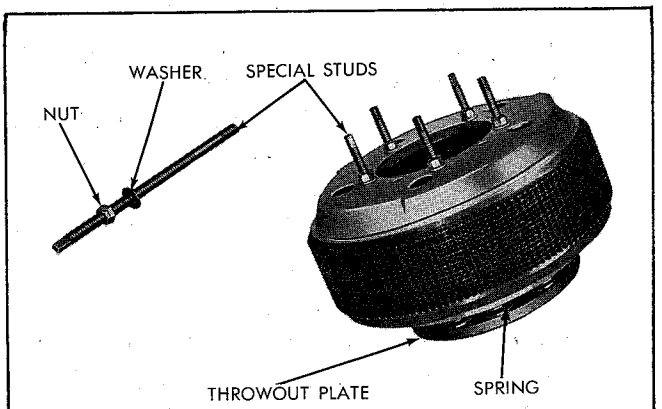


Fig. 3 — Disassembly of Steering Clutch

2. **Friction Discs**

   The specified thickness when new is .152" to .157". Inspect the discs for wear, condition of teeth, and scoring. If the thickness of discs is less than .125", or the teeth are in bad condition, new discs must be installed.

3. **Pressure Springs**

   Each pressure spring when new exerts a pressure of 320 to 340 pounds when compressed to 5-3/64". If a spring does not check reasonably close to this tolerance, it is an indication that it has lost its tension and a new spring should be installed.

4. **Hub**

   Inspect the hub splines for wear as heavy grooving may cause binding of the teeth of the steel discs in the hub splines.

G. Assembly of Steering Clutch

Refer to Fig. 4 showing the parts in their relative position.

1. Lubricate the hub teeth and the extreme outer surface of the throwout plate sparingly with a "Supremalube" or its equivalent.

2. Place the throwout plate on a bench with the the spring bosses up.

3. Install a spring over each boss and install a spacer in each spring.

4. Place an insulating washer on each spring.

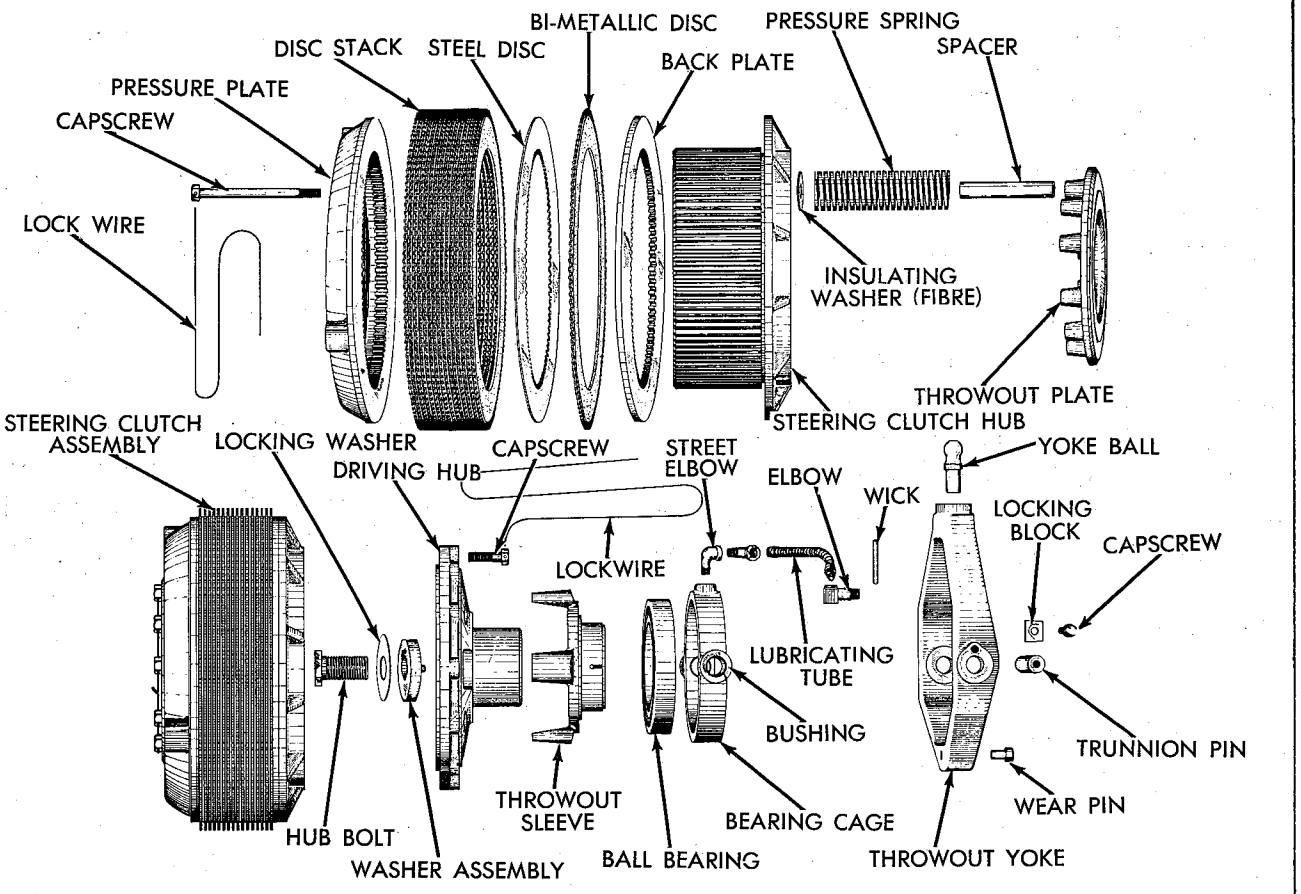


Fig. 4 — Steering Clutch and Throwout Yoke Details

5. Place the hub over the springs. Make certain that the center punch marks on the hub and throwout plate are in line.

6. Place the back plate on the hub. Make certain that the center punch marks on these parts are in line.

7. Stack the discs (16 each friction and steel) alternately on the hub beginning with a friction disc next to the back plate. Line up the external teeth as near as possible.

8. Lay the pressure plate in place, making certain that the center punch mark on the pressure plate lines up with the others, and install the five (5) special studs (studs used in disassembly of clutch) into the throwout plate.

9. Place the brake drum over disc stack, then turn the nuts down on the studs, forcing the pressure plate down, until the assembly is securely bolted together.

10. Using a suitable scale or straight edge, measure the distance between the machine finished end face of the hub, and the machined finished face of the throwout plate. These faces must be in line within 1/16". Add steel discs as required to obtain the desired 1/16" measurement; placing them next to the pressure plate.

11. Install five (5) attaching capscrews and tighten them, then remove the five (5) special studs and install the five remaining capscrews. Tighten the ten (10) capscrews securely and install the lockwire.

H. Clutch Installation

The installation of the clutch may be made by direct reversal of the procedure outlined under "CLUTCH REMOVAL" in this section. Adjust the clutch linkage as explained in "STEERING LEVERS AND LINKAGE" in this section.

3. STEERING CLUTCH THROWOUT BEARING ASSEMBLIES

A. Description

Each steering clutch throwout bearing assembly consists of the following parts: throwout ball bearing, throwout bearing cage, throwout bearing sleeve, throwout yoke assembly, and a lubricating wick. The ball bearing is a press fit in the throwout bearing cage, and on the hub of the throwout bearing sleeve. The throwout sleeve and bearing assembly is carried by the steering clutch driving hub and the bore in the throwout sleeve is machined to allow a sliding fit of the sleeve on the driving hub. The throwout yoke is attached to the throwout bearing cage with two (2) trunnion pins. Both the ball bearing and the bore of the throwout bearing sleeve are lubricated from the bevel gear compartment by means of a lubricating wick assembly.

B. Removal

1. Remove the steering clutch (refer to "CLUTCH REMOVAL" in this section).

2. Disconnect the upper end of the steering clutch throwout bearing lubricating tube.

3. Unlock the steering clutch driving hub retaining bolt and remove the bolt and washer. Now, using four (4) 5/8" NC puller bolts in the tapped holes in the clutch driving hub, turn the bolts in to push the hub off the shaft. Remove the hub, throwout bearing, and throwout yoke assembly.

4. Remove the driving hub from the assembly.

5. Remove the locks and throwout yoke trunnion pins.

6. Remove the throwout bearing lubricating tube.

7. Place the cage assembly in a press and press out the throwout sleeve and bearing.

C. Inspection and Repairs

The steering clutch throwout bearing and sleeve mechanism should be removed and inspected completely, whenever the clutches are removed.

1. Check the clutch throwout bearing for looseness.

2. Check the components for abnormal wear and the throwout bearing lubricating tube for oil leakage. Replace the necessary parts. If the wick, in the wick holder, has become hard it should be replaced. The wick may be replaced as follows:

   a. Soak the wick in light oil until it is completely saturated, heat the oil if necessary.

   b. Work the wick into the wick holder until 1/4" of wick protrudes from the holder. *CAUTION: Do not twist the wick as this will put a spiral in the wick, thus changing the amount of oil flow through the wick.*

D. Assembly and Installation of Steering Clutch Throwout Bearing and Sleeve Assembly

Assembly and installation of the steering clutch throwout bearing and sleeve assembly can be accomplished by direct reversal of the procedure explained under "REMOVAL" in this section. When assembling, pack the throwout bearing with a light grease. Before installing the assembly on the driving hub, lubricate the bore in the throwout sleeve with light engine oil. Tighten the driving hub retaining bolt to 550-600 ft. lbs. torque.

4. STEERING LEVERS AND LINKAGE

A. Description

The hydraulic steering control spool valves located in the control housing, are manually operated by two (2) steering levers and their control linkage. The two steering levers are mounted in a bracket bolted to the cowl assembly. The upper and lower lever cross shafts are mounted on needle bearings which are packed at assembly and require no further lubrication.

When either of the steering levers are actuated, the connecting linkage moves the corresponding spool valve back and closes the port in the control piston. The hydraulic pressure then moves the control piston back and disengages the steering clutch. It is necessary however that the spool valve follow up the control piston to fully disengage the clutch; this is accomplished manually by actuating the steering levers.

B. Linkage Adjustment

If the upper control levers have been removed from the upper cross shaft and the upper cross shaft tube, it will be necessary to position the two levers on the cross shaft tube correctly when reinstalling, as they are mounted on serrations of the cross shaft tube. When installing the two (2) levers on the cross shaft tube, position the levers on the tube 80° apart, as illustrated in Fig. 5, before the linkage is adjusted.

1. Adjust Steering Lever Linkage

a. Remove the upper yoke pin from the vertical control rod, then raise the steering lever up against its stop in the bracket. Block the lever in this position, then move the lower control rod all the way forward and make certain that the lower control rod all the way forward and make certain that the lower control rod front pin is against the stop in the lower cross shaft bracket. With the steering lever and the lower control rod in this position, adjust the vertical control rod yoke so that the pin will just enter the upper control lever. Remove the block from the steering lever, install the vertical rod yoke pin and cotter pin. The approximate length of the vertical rod from the center to center of yoke pin holes is 20-7/32".

b. Adjust the other steering lever linkage

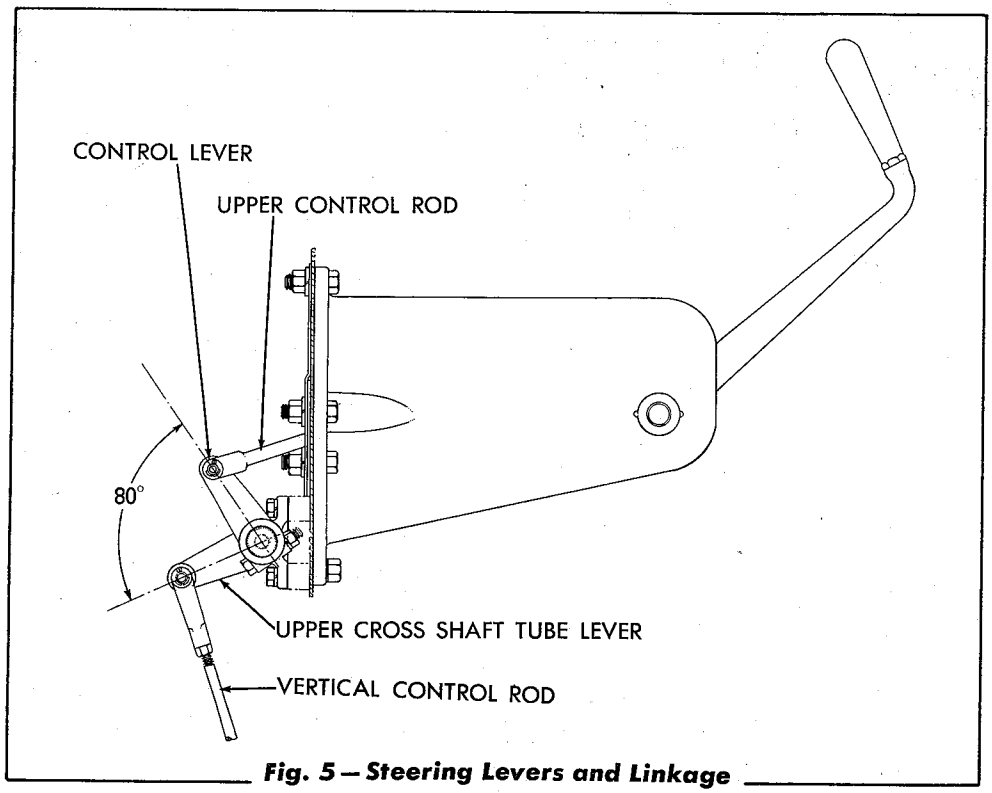


Fig. 5 — Steering Levers and Linkage

using the same procedure as outlined above.

2. **Adjust Control Piston Linkage**

a. Remove the steering clutch compartment rear cover on the side that the linkage is to be adjusted.

b. Remove the yoke pin connecting the lower control rod to the spool valve, then move the spool valve back against the control piston. Make certain the steering clutch throwout yoke assembly is against the clutch throwout plate, then measure from the front surface of the spool valve back to the machined surface where the spool valve bracket attaches to the control housing (refer to Fig. 6).

When the hydraulic piston control linkage is correctly adjusted this measurement should be 8" + or – 3/8".

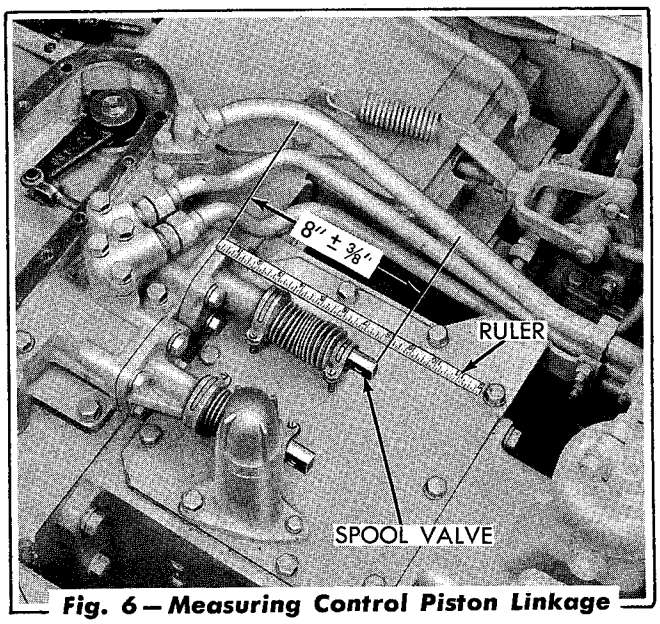


Fig. 6 — Measuring Control Piston Linkage

c. If this measurement is not correct, remove the oil drain plug from the hydraulic control housing and drain the oil from the housing.

d. Remove the capscrews attaching the control housing cover to the control housing, then remove the control housing cover and gasket. Remove the clamping bolt clamping the lower actuating lever to the shaft. Remove the connecting rod yoke pin located in the control housing. Determine which way the upper actuating lever should be moved to correct the measurement, and approximately how far the lever should be moved. Then raise the upper actuating lever and the shaft just far enough to free the lower actuating lever, and rotate the upper lever to position and push the shaft back into the lower actuating lever. Install the clamping bolt. Make certain the lower actuating lever is flush with the lower end of the shaft, then tighten the clamping bolt securely. Install the connecting rod yoke pin. *IMPORTANT: This measurement is important since it provides the necessary movement of the actuating lever to operate the steering clutch and also provides for pressure relief in the hydraulic system. The spool valve should never be actuated by any method other than the lever control linkage, or damage to the hydraulic may result.*

When the proper adjustment of the linkage for the control piston is obtained, install the cotter pin in connecting rod yoke pin. Coat the control housing cover gasket with gasket cement and install it in position on the control housing, then install the control housing cover and the attaching capscrews. Tighten the capscrews securely.

e. Fill the hydraulic system with the specified oil (refer to "HYDRAULIC STEERING CONTROL HOUSING" in this section).

C. Measuring and Adjusting Free Travel of Steering Clutch Levers

The steering clutch levers are properly adjusted when each have 2" of free travel. As the clutch discs wear, this free travel becomes less, an adjustment is required when the free travel has decreased to less than 1". Free travel of the levers is necessary to assure clearance between the clutch throwout sleeve and clutch throwout plate, and for proper engagement of each clutch. To measure the free travel of each steering lever proceed as follows:

1. Place one end of a ruler or scale against the cowl so that it projects horizontally past the top of the steering lever.

2. Holding the lever forward, measure the distance from the cowl to the top of the lever.

3. Pull the lever back until pressure is felt, which is the point where disengagement of the clutch begins, and note distance between the cowl and the top of the lever. The difference between the two measurements is the free travel of the lever.

   If the free travel is less than 1" an adjustment must be made. Refer to Fig. 7.

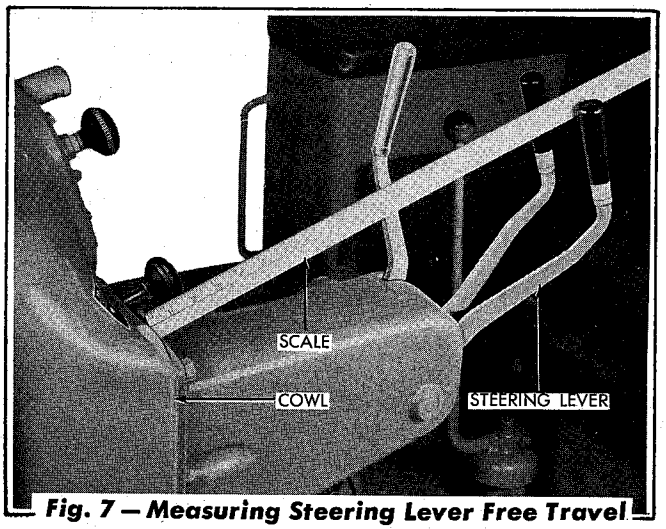


Fig. 7 — Measuring Steering Lever Free Travel

To adjust the steering lever free travel proceed as follows:

1. Remove the seat cushions.

Fig. 8 — Adjusting Steering Lever Free Travel

2. Loosen the jam nuts from the adjusting nut, located at the rear end of the lower control rod leading from the lower cross shaft bracket to the spool valve. Adjust the length of the control rod so that 2" of free travel at the top of the steering lever is obtained. This adjustment is made by turning the adjusting nut to lengthen or shorten the control rod. As this adjusting nut has both right and left hand threads, it is not necessary to disconnect the yoke from the end of the spool valve assembly. Refer to Fig. 8.

   CAUTION: Hold the end of the spool valve, protruding from the control housing, to prevent the valve from turning and damaging the rubber boot.

3. Tighten the jam nuts.

4. Adjust the free travel of the other lever using the same procedure as outlined above.

5. HYDRAULIC STEERING CONTROL HOUSING

A. Description

The hydraulic steering control housing is mounted on the steering clutch and final drive housing. The control housing incorporates the steering clutch release linkage, the control pistons, and oil passages. The spool valve assemblies are mounted in brackets which are attached to the front of the control housing by capscrews. The spool valve seals are protected from dirt by a rubber boot attached to the spool valve bracket and the spool valve.

The hydraulic pump, driven by the engine cam shaft, discharges oil to the control housing through passages to the front of the control piston bore. The oil then passes through an opening in the center of the control piston and into the main body of the control housing where it is returned to the pump inlet through the oil return tube. When the spool valve is actuated (by the steering lever), the spool valve moves back and closes the hole in the control piston. The free flow of oil is then cut off and the oil pressure moves the piston back, thus disengaging the steering clutch through the linkage attached to the control piston. It is necessary that the spool valve follow the control piston back to fully disengage the steering clutch. This is accomplished manually by operating the steering levers.

The clutch actuating shafts are mounted on needle bearings. The needle bearings and the lip type oil seals are mounted in bearing retainers, which are attached to the control housing by a cone point setscrew and a setscrew lock nut. The bearing retainers have two (2) grooves machined at the top of the retainer. The upper groove provides for a seal ring to prevent an oil leak between the retainer and the control housing, and the lower groove (taper groove) forms the seat for the cone point setscrew used to hold the retainer in position.

B. Service

After each 1000 hours of operation, the oil in the hydraulic system should be drained and the system refilled. Use an engine oil of the same viscosity as is used in the engine. "DIESEL" engine oil may be used provided it does not foam. The viscosity of the oil is to be determined by the prevailing temperature. Refer to "SPECIFICATIONS OF LUBRICANTS" in Section I.

Drain the hydraulic system by removing the drain plug located on the right side of the control valve housing. Refill with new oil as follows:

1. Re-install the oil drain plug.
2. Remove the oil filler plug from the top of the control housing and fill the housing with the specified lubricant.
3. Reinstall the filler plug and open the air vent valve on top of the control housing.
4. Remove the oil filler plug located in the top of the hydraulic steering pump adapter assembly and fill the adapter to the proper level. Reinstall the oil filler plug.
5. Operate the engine at low idle until all the air in the system is bled through the air vent valve in the control housing and then close the air vent valve.

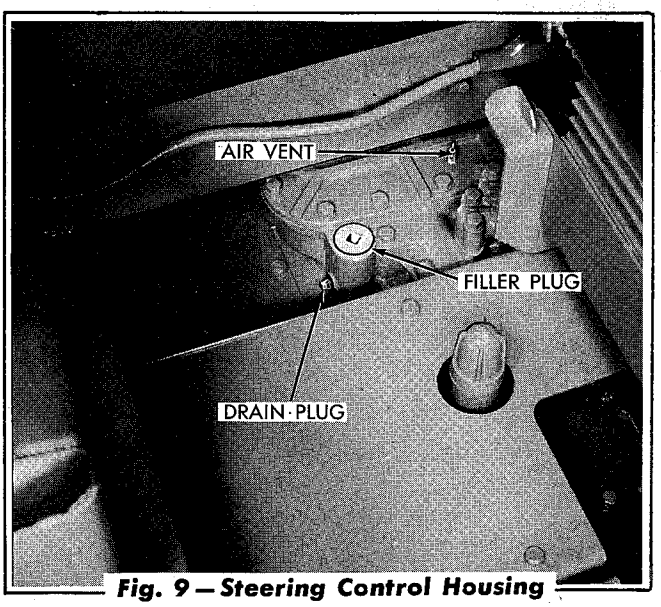


Fig. 9 — Steering Control Housing

6. Stop the engine and add oil if necessary to bring the oil level to the "FULL" mark on the hydraulic steering pump oil level gage rod.
7. Repeat, items 5 and 6 above, until further operation does not lower the oil level in the pump housing. *IMPORTANT: Make certain that the hydraulic system is kept clean when servicing.*

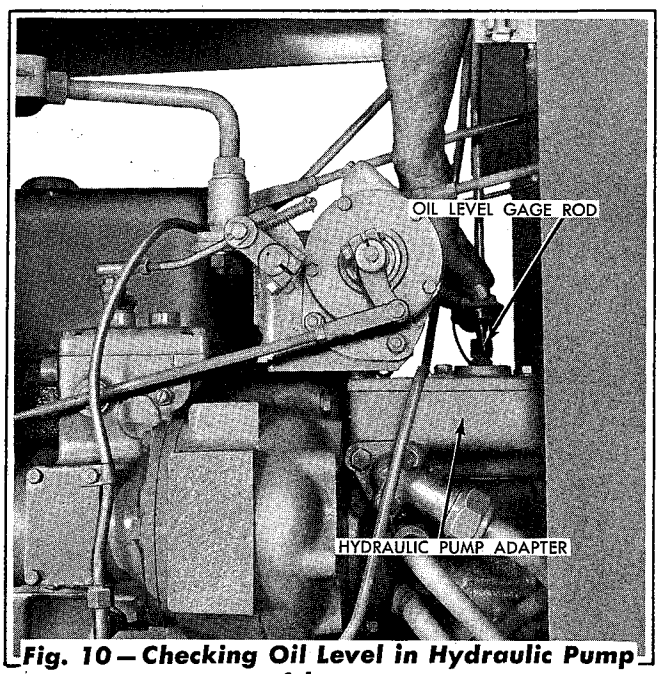


Fig. 10 — Checking Oil Level in Hydraulic Pump Adapter

C. Removal of Control Housing

1. Remove the seat cushions and seat back cushions. Remove the seat adjusting frame. Remove the rear floor plate.

2. Close the fuel tank shut-off valve. Disconnect the fuel lines from the tank, remove the capscrews used to attach the battery cable clips to the fuel tank, remove the six (6) bolts attaching the fuel tank to the rear fenders and remove the fuel tank.

3. Remove the drain plug in the hydraulic steering control housing and drain the oil. Remove the two (2) clamps holding the hydraulic steering control tubes in position (one clamp located on the corner of the transmission case and the other located below the brake pedal levers).

4. Remove the capscrews attaching the hydraulic steering control tube connecting caps to the control housing. Remove the two (2) yoke pins connecting the lower steering control rods to the spool valve assemblies. Remove the capscrews attaching the control housing to the steering clutch and final drive housing. *NOTE: Four (4) of the attaching capscrews extend through the control housing cover and into the steering clutch housing and are located one in front and one in back of each steering clutch actuating shaft.*

5. Remove the steering clutch compartment rear covers. Remove the two (2) bolts (one in each steering clutch compartment), clamping the lower steering clutch actuating levers to the actuating shafts.

6. Raise the control housing and free the lower actuating levers from the shafts. Remove the control housing.

D. Disassembly of Control Housing

1. Place the control housing on a clean work bench and use suitable blocking under the control housing so that the lower ends of the actuating shafts will clear the bench.

2. Remove the remaining capscrews attaching the control housing cover to the control housing, then remove the cover and gasket.

3. Remove the hose clamps (two on each spool valve) clamping the boots to the spool valves and the spool valve brackets, then remove the spool valve assemblies and the rubber boots.

4. Remove the capscrews attaching the spool valve brackets to the control housing, then remove the two (2) spool valve brackets and gaskets. If the spool valve seals are to be replaced, drive the seals out of the spool valve bracket towards the front. The spool valve brackets are counterbored deep enough to accommodate two (2) lip type oil seals. One seal is used as a dirt seal and the other as an oil seal.

5. Remove the cotter pins from the connecting rod yoke pins located inside the control housing and remove the yoke pins. Remove the control pistons and the connecting rods by pushing them out (forward) of the control housing. Remove the connecting rod from the control piston by driving the piston pin out of the connecting rod. *IMPORTANT: Protect the surface of the piston while driving the piston pin out.*

6. Remove the upper actuating levers and the

actuating shafts by raising them up out of the control housing. Place the upper control lever in a vise, remove the locking wire and the clamping capscrew used to clamp the upper actuating arm to the shaft, then remove the shaft from the actuating lever.

7. To remove the actuating shaft bearing retainers, loosen the locking nut on the slotted head setscrew, then remove the setscrew. The bearing retainers, bearings, and the seals may now be removed by pushing them up through the control housing.

8. If the actuating shaft seals and bearings are to be replaced, press the lower needle bearing and the seal out of the retainer towards the lower end of the retainer. Press the upper needle bearing out of the retainer towards the top.

E. Inspection and Repair

1. Clean all parts thoroughly in clean solvent or fuel oil. Inspect the actuating shafts and needle bearings. If they are worn excessively they must be replaced.

2. Inspect the spool valves, control pistons, bores for the pistons, and the bores for the spool valves. If these parts show excessive wear or scoring, replace the necessary parts.

3. Inspect the oil seals for damage or wear and replace if necessary.

F. Assembly of Control Housing

Make certain that the control housing is thoroughly clean. Place the housing on a clean work bench and use suitable blocking under the housing so that the lower ends of the actuating shafts will clear the bench when they are installed.

1. If the needle bearings and the seals were removed from the retainers, lubricate and start one of the needle bearings into the bore at the top end of the retainer, (end with the grooves). Press the bearing into the bore for a depth of one (1) inch, measured from the top surface of the retainer to the lower end of the bearing. Turn the retainer over, lubricate and start one of the needle bearings into the bore from the lower end, (end with the counterbore for the seal assembly). Press the bearing into the bore for a distance of 1-13/16", measured from the lower surface of the retainer to the upper end of the bearing. Press the double lip oil seal into the counterbore at the lower end of the retainer, with the lips of the seal towards the bearing.

2. Install a new seal ring in the top groove in each retainer. Install each retainer into position from the top side of the control housing, making certain the seal ring is not damaged, then install the cone point setscrew used to hold the retainer in position in the control housing. Tighten each setscrew securely and secure with the lock nut.

3. Install the upper actuating levers on the actuating shafts if the levers were removed.

   NOTE: Install the actuating levers on the shafts so that the chamfered edge, around the hole for the shaft, will be towards the bearings when installed.

4. Install the clamping capscrews and tighten securely, then lock in position with the locking wire.

5. Lubricate the actuating shafts and the seals. Insert the actuating shafts into position, from the top side of the control housing. Use care and do not damage the seals when installing the shafts.

6. When installing the piston pin, the surface of the piston should be protected, and the pin should be centered. Centering of the pin may be determined by moving the connecting rod over against each boss and checking each end of the pin to make certain it does not protrude out past the piston.

7. Lubricate the pistons, then install them in position from the front of the control housing. Place the connecting rod yokes in position on the upper actuating levers and install the connecting pins. Do not install the cotter pins.

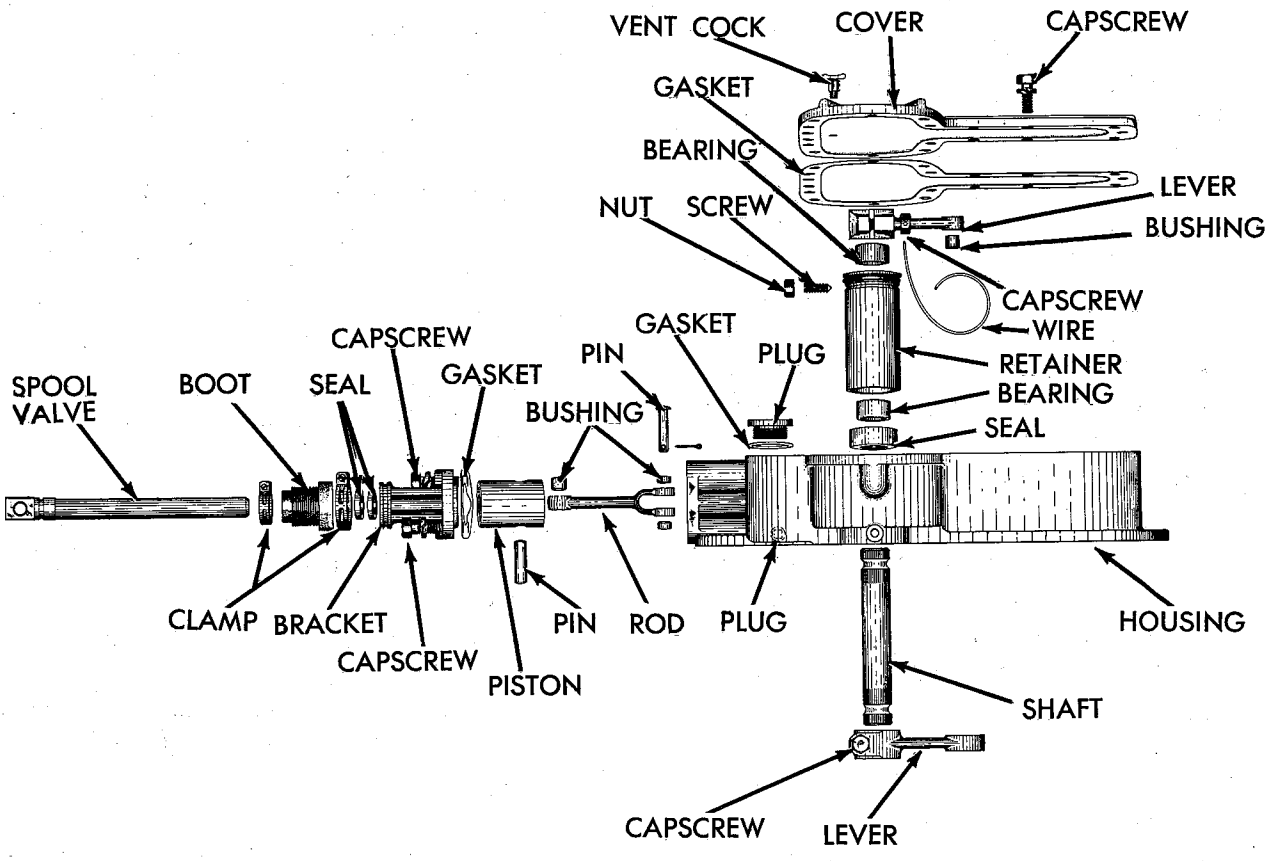


Fig. 11 — Control Valve and Housing Details

8. If the seals were removed from the spool valve brackets, lubricate the seals and install the first seal in each bracket with the seal lip in, (towards the control housing). Install the second seal in each bracket with the seal lip out, (away from the control housing). Coat the new spool valve bracket gaskets with gasket cement and place the gaskets in position on the spool valve brackets. Install the spool valve brackets in position on the control housing, then install the attaching capscrews and tighten the capscrews securely.

9. Place the clamps on the small end of the spool valve boots and install the boots in position on the spool valves, with the vent hole in the boots down. Tighten the boot clamps securely.

10. Place the clamps on the large end of the boots. Lubricate the spool valves, then install them in position in the spool valve brackets, being careful not to damage the seals when installing. Push the large ends of the boots into position on the spool valve brackets and tighten the boot clamps securely.

G. Installation of Control Housing

1. Inspect the gasket, used between the bottom of the hydraulic steering control housing and the top of the steering clutch housing, and replace if necessary. Coat the gasket with gasket cement, then install the control housing on the steering clutch housing and tighten the attaching capscrews securely.

2. Remove the two (2) connecting rod yoke pins located in the control housing. Place the lower steering clutch actuating lever in position on the ball of the clutch throwout yoke.

   NOTE: When installing the lower actuating lever, make certain that the chamfered edge around the hole for the actuating shaft is up.

3. Raise the actuating shaft only far enough to start the shaft into the lower actuating lever. Install the clamping bolt in the lower lever and hold the lever up when tightening so that the lower end of the shaft is flush with the bottom of the lever.

4. Install the connecting rod pin in the yokes and the upper actuating levers. Hold the clutch throwout yoke over towards the clutch as far as it will go, then push the hydraulic spool valve back as far as it will go, (against the control piston). Measure the distance from the front surface of the spool valve back to the machined surface on the control housing, where the spool valve bracket is attached. This measurement should be 8" + or – ⅜". Refer to Fig. 6. If this measurement is not correct, adjust. Refer to "ADJUST CONTROL PISTON LINKAGE" in this section.

5. When the proper adjustment of the linkage for the control piston is obtained, install the cotter pins in the connecting rod yoke pins. Install the lower control rod yoke pins, connecting the control rods to the spool valve assemblies. Install the cotter pins.

6. Inspect the hydraulic control housing cover gasket and replace if necessary. Coat the gasket with gasket cement and install the cover. Tighten the cover attaching capscrews securely.

7. Install the steering clutch covers, inserting the end of the brake band adjusting supports up through the holes in the covers. Hook the brake rod springs to the spring clips.

8. With the brake pedals free (pedals all the way back), turn the brake band adjusting support nut down on the support until the nut contacts the seat in the cover, then turn the nut an additional ¼ turn. Lock the adjusting nut in position with the jam nut. This adjustment centers the brake band on the brake drum.

9. Inspect the gaskets used between the hydraulic control tube connecting caps and the control housing and replace if necessary. Coat the gaskets with gasket cement and bolt the tube connecting caps securely to the housing. Install the two clamps used to hold the hydraulic steering control tubes in position, (one clamp attached to the corner of the transmission case and the other attached to the frame below the brake pedals).

10. Install the fuel tank. Connect the fuel lines to the tank and open the fuel tank shut-off valve. Install the capscrews used to attach the battery cable clips to the tank.

11. Install the rear floor plate. Install the seat adjusting frame, seat cushions, and seat back cushions.

12. Adjust the steering lever free travel, (refer to "MEASURING AND ADJUSTING FREE TRAVEL OF STEERING CLUTCH LEVERS" in this section).

13. Install the oil drain plug in the steering clutch control housing. Fill the housing with specified lubricant. Reinstall the oil filler plug in housing and open the air vent valve located in the top of the housing. Remove the oil filler plug located in the top of the hydraulic steering pump adapter and fill the adapter housing to the proper level. Reinstall the oil filler plug. Operate the engine at low idle until all the air in the system is bled through the air vent valve in the control housing, then close the air vent valve. Stop the engine and add oil if necessary to bring the oil level to the "FULL" mark on the hydraulic steering pump oil level gage rod.

6. HYDRAULIC STEERING PUMP

A. Description

The tractor may be equipped with either a "ROPER" or a "SUNDSTRAND" gear type hydraulic pump, both being of similar design, therefore, the service and repair will be much the same for either of the two pumps. The hydraulic pump and the pump adapter assembly are attached to the engine flywheel housing and the pump is driven by the engine cam shaft through a gear and disc coupling. The pump assembly consists of two (2) sets of pump gears separated by a spacing plate. Oil is supplied to both sets of pump gears from the pump adapter assembly through one inlet passage. The oil is discharged from the pump gears through two (2) separate outlets which are connected to the hydraulic steering control housing by two (2) fluid supply tubes.

When operating the tractor with the steering clutches in the engaged position, the oil from the pump supply tubes flows through passages in the control housing and the spool valve brackets to the front of the right and left control piston bores. The oil then passes through the valve port in the center of the control pistons and to the main body of the steering control housing. The oil is then returned through the fluid return tube back to the pump adapter assembly. Steering of the tractor is accomplished "hydraulically" by operating the steering levers. When either of the steering levers are pulled back, the level linkage moves the corresponding spool valve back in the control housing, thus closing the valve port in the control piston. The oil flow from the pump then moves the piston back and actuates the clutch throwout yoke assembly to disengage the steering clutch. The oil flow from the front set of pump gears actuates the right control piston, and the rear set of pump gears actuates the left control piston.

The steering lever linkage, when properly adjusted, controls the travel of the spool valve, thus releasing the hydraulic pressure through the valve port in the control piston at the end of the spool valve travel.

The hydraulic system is provided with a breather mounted at the top of the cowl on the front side, and is attached by a tube to the pump adapter cover.

B. Removal of Hydraulic Pump and Adapter Assembly

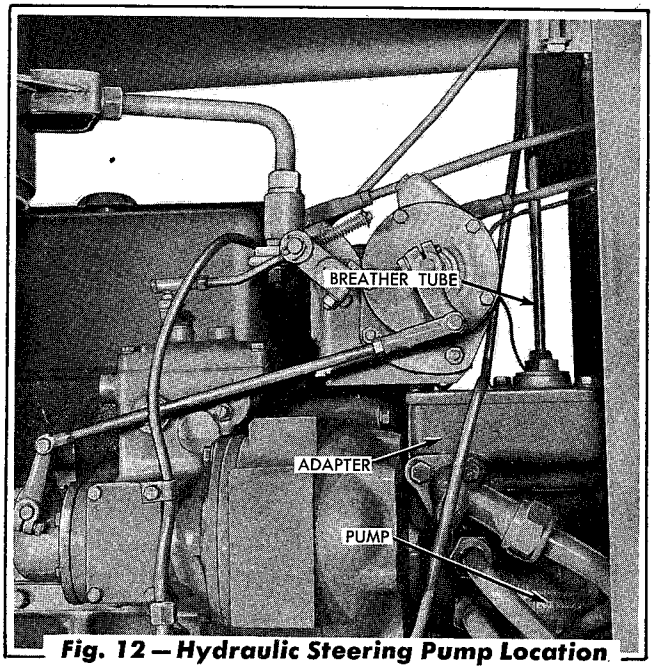


Fig. 12 — Hydraulic Steering Pump Location

1. Disconnect the fluid return tube at the elbow on the pump adapter housing and drain the housing by removing three (3) capscrews and a sealastic nut from the fluid return elbow. Disconnect the two (2) fluid supply tubes at the adapter housing by removing the sealastic nuts and let the balance of the oil drain from the two lower lines. Remove the throttle assembly. Tape the ends of the tubes leading to the control housing to prevent dirt or foreign material from entering the supply tubes.

2. Remove the capscrews attaching the oil pressure gage tube clips to the pump adapter cover. Remove the pump adapter breather tube from the pump adapter cover and the breather.

3. Remove the five (5) capscrews attaching the pump and the adapter assembly to the engine flywheel housing, then remove the pump and the adapter assembly, being careful not to drop the pump coupling gear and the coupling spring. Refer to Fig. 13.

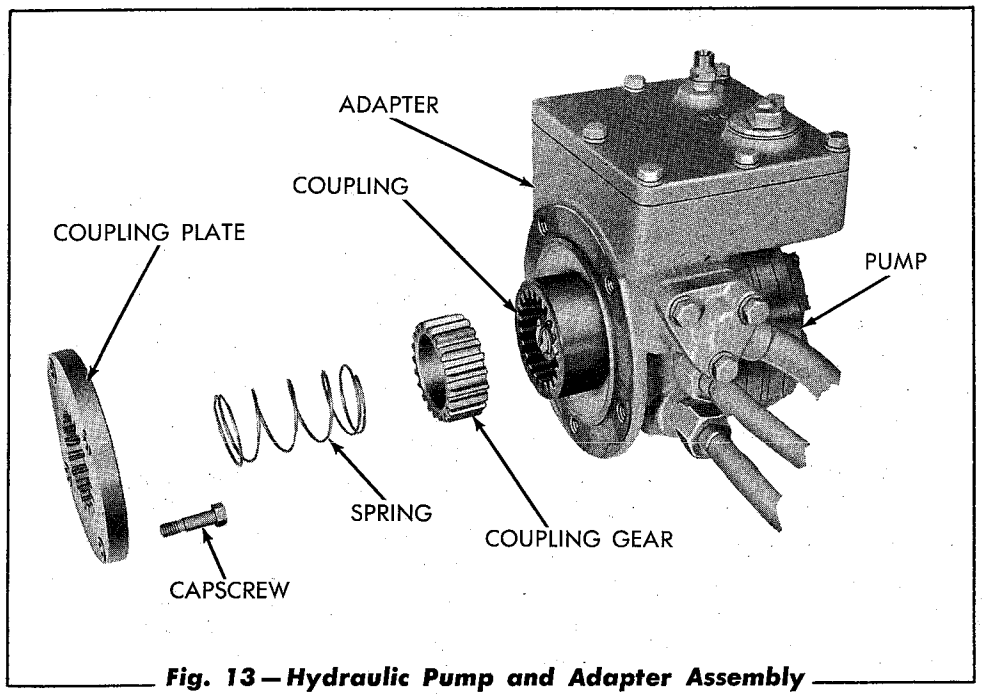


Fig. 13 — Hydraulic Pump and Adapter Assembly

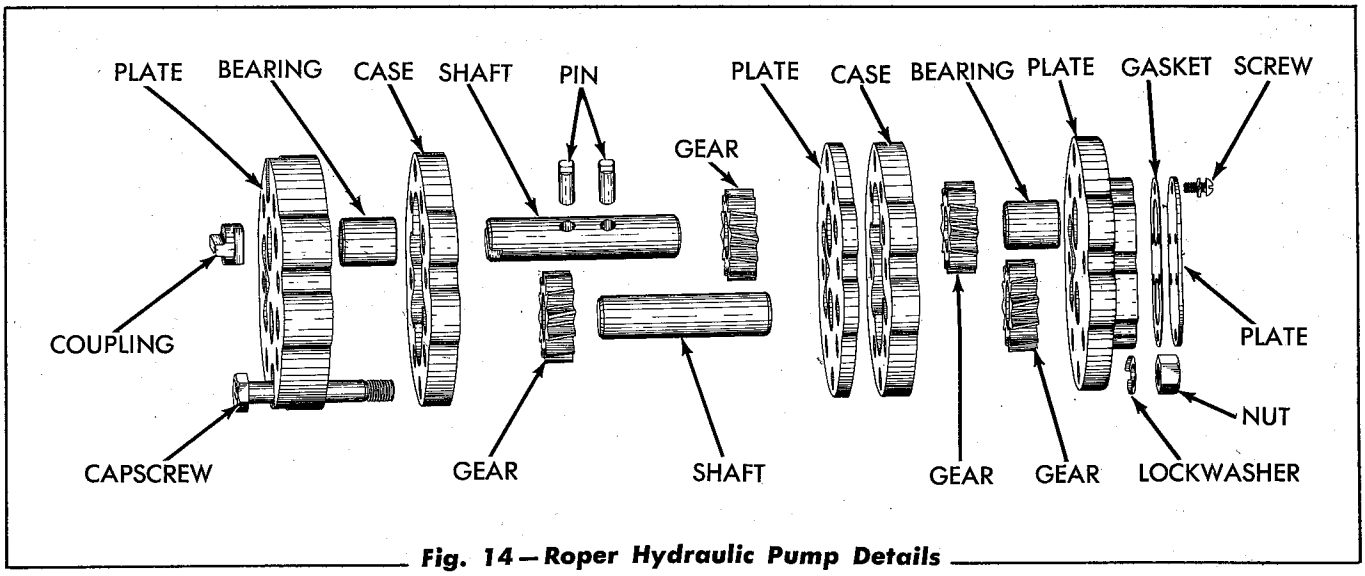


Fig. 14 — Roper Hydraulic Pump Details

C. Disassembly of Hydraulic Pump

1. Place the pump and adapter assembly in a vise, being careful not to damage the machined mounting surface on the adapter assembly.

2. Remove the remaining capscrews attaching the pump adapter cover to the adapter assembly, then remove the cover and gasket.

3. Grasp the internal tooth coupling with the hand and pull the coupling, the drive shaft, thrust washer, and the small metal drive coupling from the pump adapter assembly.

4. If the internal tooth coupling or the pump driving shaft are to be replaced, clamp the shaft in a vise using soft jaw inserts or a similar method to protect the shaft, then remove the cotter pin and the retaining nut. Place the assembly in an arbor press and press the driving shaft out of the coupling. Remove the "WOODRUFF" key from the shaft.

5. Remove the capscrews attaching the hydraulic pump to the adapter assembly, (it is not necessary to remove the dowel bolt nuts located at the top and bottom of the pump at this time) and remove the pump from the pump adapter.

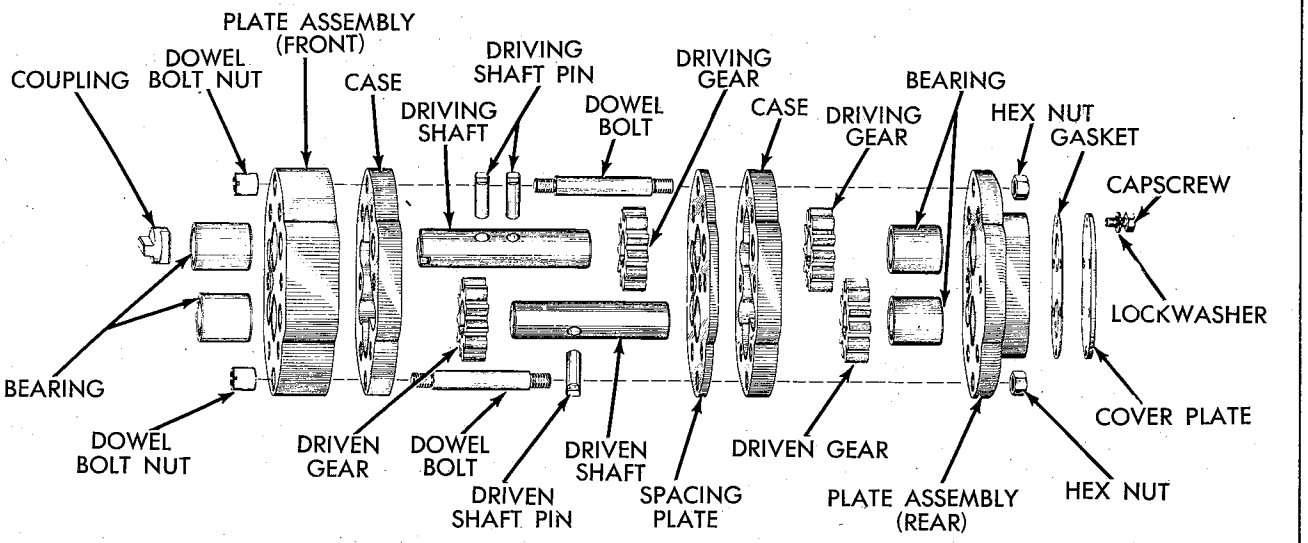


Fig. 15 — Sundstrand Hydraulic Pump Details

6. If the bronze bushing and seal are to be replaced in the pump adapter assembly, use a bushing driver and drive the bushing and seal from the adapter assembly.

7. Before disassembly of the pump, mark the plates and cases by scribing in a line the entire length of the pump, or use a center punch to index the cases and the plates to facilitate reassembly of the pump. Refer to Figs. 14 and 15.

8. Remove the two (2) dowel bolt nuts from the rear of the pump, then remove the rear plate using a soft hammer to tap the plate off the dowel bolts.

   IMPORTANT: Do not use a screwdriver or similar tool to drive between the plates as this will damage the sealing surface of the plates. Use care after plates are removed so that the sealing surfaces are not scratched or damaged.

9. Remove the rear gear case, using the same procedure as outlined above, and do not drop the rear set of oil pump gears after the case has been removed. Remove the gears from the shaft (no puller is required), then remove the driving shaft pin from the shaft.

10. Remove the spacing plate, the front gear case, the front set of gears, and the front driving shaft pin, using the same procedure as outlined above. Remove the two (2) dowel bolt nuts attaching front plate to the dowel bolts, then remove the dowel bolts.

D. Inspection of Hydraulic Pump Parts

Wash all the parts in clean fuel oil or solvent, being careful not to scratch or damage the sealing surface of the plates and cases. These sealing surfaces are ground and no gasket is necessary for sealing. Inspect all parts carefully. The principal wearing parts of the hydraulic pump are the gears. If the oil has been kept clean the wear of these parts will be very slow. If, however, the oil in the hydraulic system is not changed as recommended, and cleanliness is not used when servicing, the pump wear may be rather pronounced in a comparative short time. Before assembling the pump, examine the gear teeth, inside of both gear cases, shaft bearings, and the shafts for wear. If the gear teeth are scored or excessively worn they should be replaced. If gear cases or the pump plates are scored or excessively worn, replace the plates and cases. Inspect the drive shaft seal for damage or wear and replace the seal if necessary.

E. Assembly of Hydraulic Pump

Refer to Figs. 14 and 15 showing the parts in relative position.

1. Install the pump bearings as follows:

a. **"ROPER" Pump**

Press a drive shaft bearing into each of the front plate and the rear plate assemblies. Check the fit of the pump shaft in the bearing and ream the bearing if necessary. The inside diameter of the bearing should be 1.0017".

b. **"SUNDSTRAND" Pump**

Install the four (4) bearings in the pump as follows: Press two (2) of the short bearings into the upper and lower bores of the rear plate, then press the remaining short bearing into the lower bore of the front plate. Press the long bearing in the upper bore of the front plate. The inside diameter of the bearings should be .984" to .986".

NOTE: The long bearing will protrude out from the front of the plate assembly approximately 3/32". This serves as a pilot when assembling the pump to the adapter assembly.

2. After the bearings have been installed and properly fitted to the shafts, the assembly of the two pumps ("ROPER" and "SUNDSTRAND") is very similar. Install the dowel bolts into position in the front plate assembly then install the dowel bolt nuts and tighten the nuts securely.

3. Clamp the front plate assembly in a vise, with the dowel bolts up, using care not to damage the plate. Lubricate and insert the drive shaft into the upper bore, with the driving slot in the shaft down. Hold the shaft in position and place one of the driving pins into the front hole in the shaft. Install one of the drive gears over the shaft and turn the flat on the drive pin to align with the pin seat in the gear, then push the gear over the pin.

4. Install the driven shaft into the lower bore of the front plate assembly, then install the driven gear on the shaft.

NOTE: The driven shaft on the "ROPER" pump is held stationary in the front plate and the driven gear revolves on the shaft, whereas in the "SUNDSTRAND" pump, the shaft turns in the end plates since the driven gear is pinned to the shaft.

5. Lubricate the front set of gears, then install the gear case in position over the dowel bolts and the front set of gears. Make certain the case is installed with marks in line. If replacement of the cases or plates was necessary, align the cases and plates so the inlet ports ("V" shaped ports) are all on the inlet side of the pump (right side when viewed from the rear).

6. Place the spacer plate over the dowel bolts and into position on the front case, then install the rear driving pin in the driving shaft and place the rear driving gear in position on the driving pin. Install the rear driven gear in position on the driven shaft.

7. Lubricate the rear set of pump gears and install the rear case in position over the gears. Lubricate the bearings in the rear plate assembly and install the plate in position on the shafts. Install the dowel bolt nuts and tighten the nuts securely.

8. Coat a new rear plate cover gasket with gasket cement and place it in position on the rear plate, then install the plate cover and tighten the cover attaching screws securely.

9. Install a new bushing in the adapter assembly if it was removed. Lubricate a new seal and install it in position in the adapter, with the lip of the seal toward the hydraulic pump.

10. Coat a new pump to adapter gasket with gasket cement and place it in position on the adapter assembly, then install the pump making certain the inlet port ("V" shape port) is in alignment with the inlet port in the adapter assembly. Install the capscrews attaching the pump to the adapter assembly, then tighten the capscrews securely.

F. Inspection of Hydraulic Pump Drive

1. Inspect the internal teeth of the coupling plate attached to the pump drive coupling; adapter, which is bolted to the rear face of the camshaft gear. If the teeth in the coupling plate are worn excessively, replacement of the plate is necessary, to replace the coupling plate, remove the locking wires from the four (4) capscrews attaching the coupling plate to the pump drive coupling adapter. Remove the coupling plate attaching capscrews and the coupling plate. Place a new coupling plate in position on the coupling adapter and install the attaching capscrews and tighten securely. Install the capscrew locking wires. Make certain the two (2) locking wires are bent away from the internal teeth of the coupling plate far enough to clear the O.D. of the internal tooth coupling, installed on the front of the pump drive shaft.

2. Inspect the coupling gear for wear, and also check the length of the coupling gear. The length of the gear should be 1.177" to 1.187". If the length of the gear is not within these limits, replacement of the gear is nec-

3. Inspect the teeth in the coupling (used at the front end of the pump drive shaft) for wear and if they are worn excessively, replacement of the coupling is necessary. Inspect the pump drive shaft for scoring and wear and replace if necessary.

4. Install the "Woodruff" key and the thrust washer in position on the threaded end of the pump drive shaft. Install the coupling in position on the pump drive shaft, with the internal teeth of the coupling toward the threaded end of the shaft. Install and tighten the coupling retaining nut. When tightening the nut, hold the drive shaft from turning by placing the driving slot in the end of the shaft on a flat piece of metal clamped in a vise. This will prevent damage to the bearing surface of the shaft. Install the cotter pin to lock the retaining nut to the drive shaft.

vise. This will prevent damage to the bearing surface of the shaft. Tighten the retaining nut securely and install the cotter pin.

G. Installation of Hydraulic Pump

1. Lubricate the pump drive shaft and install the small metal coupling in the slot in the end of the drive shaft. Place the pump drive shaft and coupling into position in the pump adapter, then rotate the pump drive shaft to engage the small metal coupling into its corresponding slot in the pump driving shaft.

2. Coat a new gasket with gasket cement and place it in position on the front of the adapter assembly. Place the gear coupling in position in the internal tooth coupling, then place the coupling spring in position inside the gear coupling. Hold the drive assembly in this position and install the adapter and pump assembly on the flywheel housing of the engine. Make certain that the spring enters the coupling plate and the teeth of the gear enter the internal teeth of the coupling plate. Install the capscrews attaching the adapter assembly to the engine flywheel housing. Tighten the capscrews securely.

3. Coat a new pump adapter cover gasket with gasket cement and place it in position on the pump adapter, then install the adapter cover and the attaching capscrews. *NOTE: One (1) of the cover attaching capscrews are used to attach the pressure gage tube supporting clip to the adapter cover.*

4. Connect the breather tube to the pump adapter cover and breather. Connect the fluid return tube and the two (2) fluid supply tubes.

5. Remove the oil filler plug from the pump adapter cover and fill the hydraulic system with the recommended oil (refer to "SERVICE" in topic 5 of this section).

7. HYDRAULIC STEERING SYSTEM PIPING

A. Description

The hydraulic system piping consists of two (2) fluid supply tubes to deliver the oil from the pump discharge passages to the control pistons located in the control housing, and one (1) fluid return tube to return the oil from the control housing back to the hydraulic pump. Each of the tubes have front and rear sections and are connected with flexible sealastic unions which serve as a flexible connection between the pump and the fluid tubes. The fluid supply tubes and the fluid return tube are supported by two (2) clamp supporting brackets, one of the brackets is located on the main frame below the brake pedals and the other is located on the corner of the transmission case. Refer to Fig. 16.

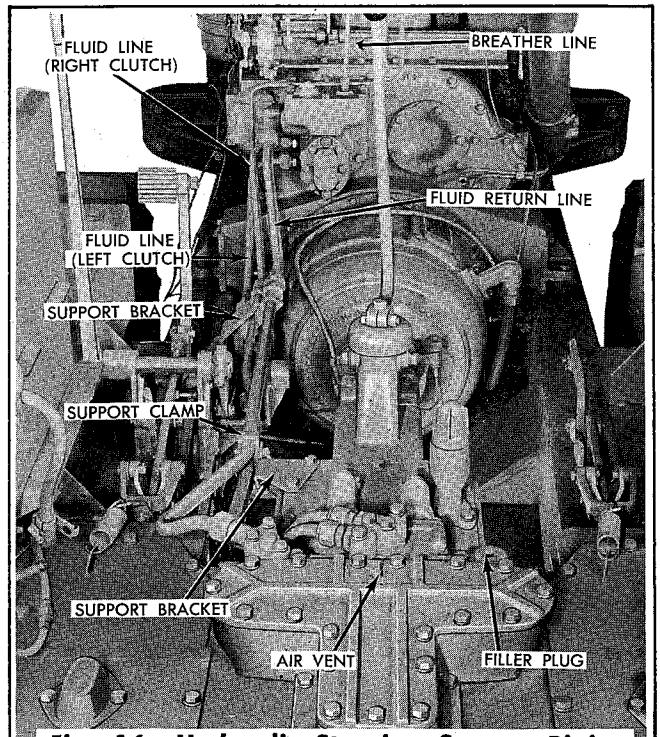


Fig. 16—Hydraulic Steering System Piping

B. Service and Inspection of Piping

The fluid supply tubes and the return tube have sealastic fittings and unions at each connection. Care must be used when tightening the nuts on the unions as over-tightening will result in damage to the rubber rings in the fittings and cause leakage.

The fluid supply and return tube clamps and the clamp supporting brackets must be kept tight to prevent damage to the tubes and fittings.

In the event of a failure of the hydraulic system and cuttings are noted within the system, the system and the fluid tubes should be cleaned thoroughly.

SECTION XIII—STEERING BRAKES

1. GENERAL DESCRIPTION

The steering brakes are foot operated, mechanically controlled, self energizing brakes. Brake bands are of the wrap around, three-piece, removable lining type and operate on brake drums which enclose the steering clutches.

Foot pressure on the brake pedals is transmitted through linkage and a bellcrank, located under the floor plates, to the brake band actuating lever assembly. Action of the brake band actuating lever assembly pulls the ends of the brake band together and causes the brake band to tighten around the brake drum.

The steering brakes are used as an aid in steering when use of the steering clutches alone will not provide adequate steering. No attempt to use a steering brake for steering should be made without first completely disengaging the proper steering clutch.

Steering brakes may be used singly or together as service brakes to slow or stop the tractor when working on a grade. The steering brakes are each provided with a brake lock to provide a means of holding the brake in the applied position for parking purposes.

Brake pedal pads, clamped to the pedal lever assemblies with eyebolts, are adjustable within limits. The brake pedal levers are mounted on sealed needle bearings, which are grease packed at time of assembly, and require no further lubrication. Adjustable brake operating rods connect the brake pedal to the brake band actuating lever. The brake band actuating lever is attached to both ends of the brake band. A brake pedal retracting spring is attached to each brake operating rod to return the brake pedal to the normal position after application.

The brake band is made up of three (3) steel segments (with replaceable linings) to provide for easy removal and installation. Each segment of the steel band is serviced separately with lining attached, or the lining alone may be replaced.

2. STEERING BRAKE SERVICE

Because of variable operating conditions, specific time intervals for brake service are not given. Brakes need adjusting before they are loose enough to allow the brake pedal to strike the floor plate. The brake pedal and brake pedal shaft needle bearings do not require lubrication service as they are grease packed and sealed. The brake linkage pins should be oiled for ease of operation.

A. Steering Brake Adjustment

The brakes are properly adjusted when the brake pedals each have 3" of free travel.

Brakes require adjustment before they are loose enough to allow the pedals to strike the floor plate when fully applied. When brakes are adjusted too tight, they will heat, causing unnecessary brake wear and loss of power. When brakes are too loose, they will not hold properly and will wear rapidly because of excessive slipping.

1. Adjust the rod assembly, connecting the brake band actuating lever to the bellcrank, so that the distance between the centers of the pin holes at each end of the rod assembly is 15".

2. With the brake band actuating lever held toward the rear, against the elongated stops in the brake band actuating lever bracket, adjust the rod assembly between the bellcrank and the foot pedal lever, to provide 1/16" clearance between the stop on the foot pedal lever and the floor plate.

3. Remove the small oval cover from the steering clutch compartment cover. Turn the

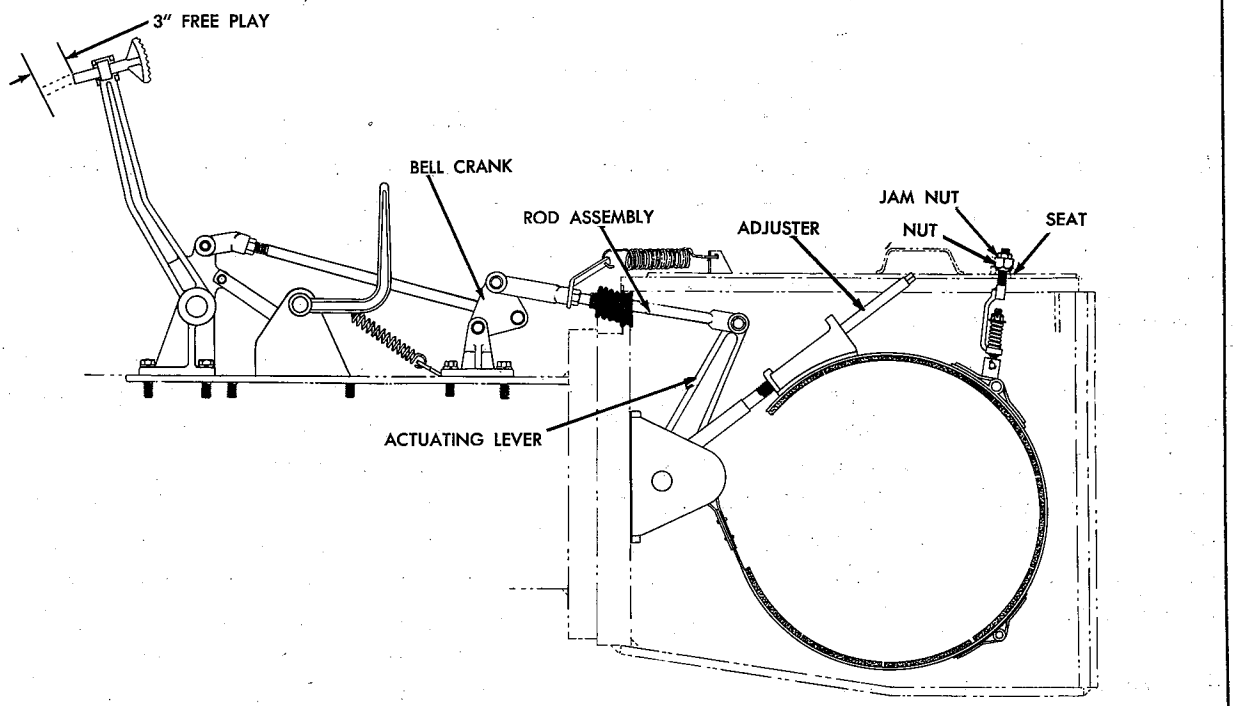


Fig. 1 — Brake Assembly

brake adjuster clockwise until the brake pedal has 3" of free play. *NOTE: When adjusting the brakes it is necessary to turn the adjuster at ½ turn increments so that the lobes on the adjuster will center in the grooves of the spring loaded locking block.*

4. With the brake pedal free (pedal all the way back), loosen the jam nut on the brake band adjusting support, then turn the adjusting support nut up out of seat in the cover. Turn the adjusting nut back down until it contacts the seat in the cover, then give the nut an additional ¼ turn and lock the adjusting nut in position with the jam nut. This centers the brake band on the brake drum. Replace and secure the small oval cover.

B. Washing Brakes

When steering brakes do not hold properly because of oil on the linings, they may be washed as outlined in "WASHING STEERING CLUTCHES" in Section XII.

C. Brake Band Removal

1. Remove the center and rear floor plates.
2. Remove the jam nut and the brake band support adjusting nut.
3. Remove the steering clutch compartment covers.
4. Turn the brake band adjuster counter-clockwise until it is loosened from the brake band adjusting fork.
5. Remove the yoke pin connecting the brake rod assembly to the top of the brake band actuating lever.
6. Remove the pipe plug located in the side of the steering clutch case, in line with the brake band pin, and using a suitable ⅜" N.C. capscrew inserted through the hole, turn it into the tapped hole in the end of the pin. Now pull the brake band pin out and remove the brake band adjusting fork and the brake band adjuster. Lift up on the brake band actuating lever until the pin attaching the lower end of the band to the lever can be removed. Push the pin towards the bevel gear compartment and remove, then remove the brake band actuating lever.

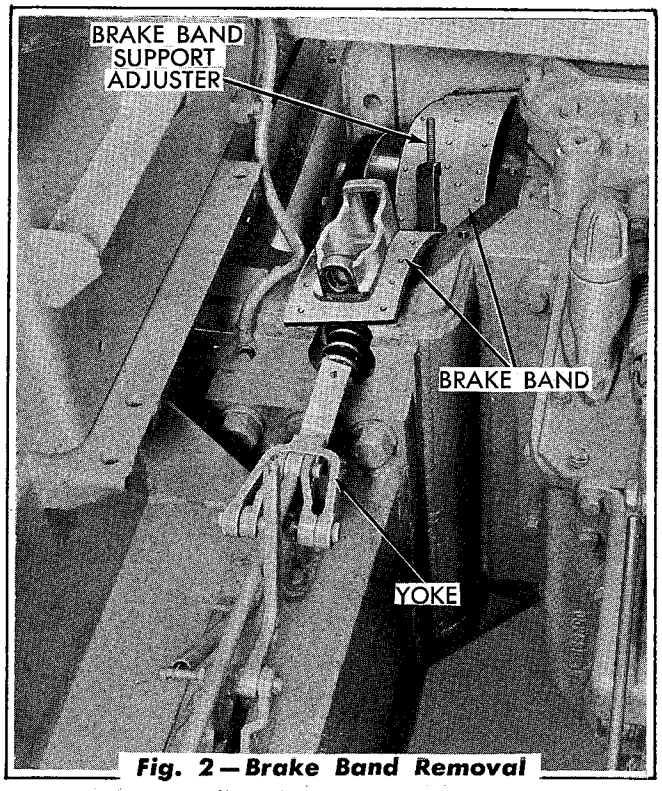


Fig. 2—Brake Band Removal

7. Move the brake band toward the bevel gear compartment and remove the band as shown in Fig. 2.

D. Brake Inspection and Repair

1. If the brake linings are worn down to the rivets, the brake bands must be relined or replaced.
2. If the brake drum is worn, scored, or grooved excessively, it must be removed and replaced (refer to "STEERING CLUTCH REMOVAL" in Section XII).
3. Inspect the brake pins, yoke pins, and bushings for wear. Replace the necessary parts.
4. Actuate each brake pedal to make certain that the needle bearings are in good condition.
5. Observe the seals at each end of the needle bearing for signs of excessive grease leakage. Replace the necessary parts.
6. Before installing, particularly after relining, the brake band should be checked for roundness. Place the brake band on a brake drum, and form, if necessary, with a soft hammer to make it fit uniformly around the brake drum.
7. All pins and bushings should be lubricated sparingly when reinstalled.

E. Brake Band Installation

Steering brakes may be installed by a direct reversal of the removal procedure and should be properly adjusted. Refer to "STEERING BRAKE ADJUSTMENT" in this section.

SECTION XIV—FINAL DRIVES

1. DESCRIPTION

The final drives are of the double reduction type, consisting of a pinion and shaft, intermediate pinion and shaft, sprocket shaft and gear, and their component parts. They are assembled in a combination "one piece," fabricated steel, steering clutch and final drive housing. The final drive housings are an integral part of the steering clutch housing, and misalignment of the bores is eliminated by the use of line boring.

The final drive pinion shafts, intermediate shafts, and sprocket shafts are mounted on tapered roller bearings. The bearings on all of the shafts are adjustable by means of shims. The pinion shaft bearings and the intermediate shaft bearings are lubricated by oil thrown by the gears.

Replaceable bearing cages are used to accommodate the bearing cups used on the final drive pinions, the intermediate pinions, and at the inner and intermediate positions on the sprocket shaft.

The sprocket shaft outer bearings are located in cages which attach to the truck frames, and absorb thrust in both directions.

The two (2) seal assemblies (inner and outer) in each final drive are of the positive type.

The final drive pinions are driven by the bevel gear through the steering clutches. The pinions drive the intermediate shaft gears, the intermediate shaft pinions drive the sprocket shaft gears, which in turn drive the track driving sprockets.

2. DISASSEMBLY

A. Removal of Sprocket Shaft

1. Uncouple the track by driving out the master pin, then move the tractor backward until the top of the track is off the track driving sprocket (refer to "TRACK REMOVAL" in Section XVII).

2. Drain the oil from the final drive.

3. Remove the sprocket guard, truck frame pivot shaft caps, the two (2) capscrews attaching the sprocket shaft outer bearing upper clamping cap, and remove the one remaining capscrew attaching the outer bearing adjusting cap to the truck frame. Remove the two (2) bolts attaching the equalizer spring seat to the truck frame.

4. Place a suitable jack and cribbing under the drawbar, and under the equalizer spring, and raise the tractor off the truck frame. Roll the truck frame forward on the track until it contacts the equalizer spring, so that the track sprocket can be removed. It will be necessary to raise the tractor high enough so that the track sprocket can be tipped and will clear the truck frame when removing.

5. Remove the sprocket shaft outer bearing cap and the adjusting shims. Tie the adjusting shims to the cap so that they will not be lost. Remove the cotter pin, then remove the outer bearing retaining nut.

6. Using a puller similar to the one shown in Fig. 1, pull the sprocket shaft outer bearing cage and bearing from the shaft. Use care in handling, so that the oil seal rings are not damaged or scratched.

7. Remove the two (2) capscrews attaching the track sprocket retaining nut lock, then remove the lock and sprocket retaining nut.

Use care when removing the retaining nut so that the oil seal ring, cemented to the nut, is not damaged or scratched. Using a puller similar to the one shown in Fig. 2, with a hydraulic jack having approximately 20 ton capacity, pull the track sprocket and remove it from the shaft. Use care and do not damage or scratch the seal ring cemented to the sprocket, and do not damage the threads on the sprocket shaft.

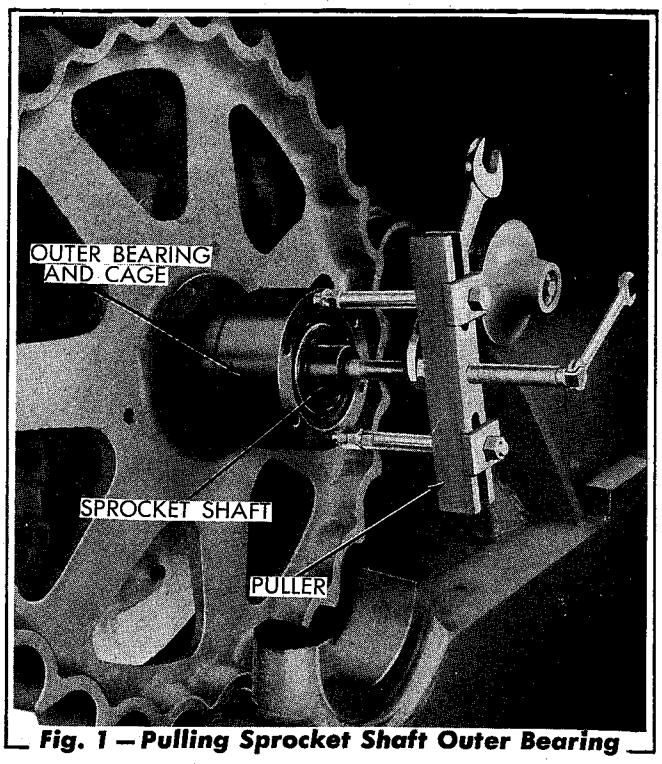


Fig. 1 — Pulling Sprocket Shaft Outer Bearing

8. Remove the capscrews attaching the final drive compartment rear cover and remove the cover. Unlock and remove the capscrews from the sprocket shaft gear retaining locks, then remove the capscrew locks and the gear retaining locks. *NOTE: To rotate the sprocket shaft to the correct position for removal of the gear retaining locks, it is necessary to block the corresponding steering clutch throwout yoke assembly in the disengaged position.* This may be accomplished by placing a wood block, cut from 2" material, 3½" in length and 2½" in width, in back of the corresponding steering clutch throwout yoke. With the steering clutch cover removed, start the engine and release the clutch with the hydraulic control, and place the wood block between the throwout lever and the inner wall of the steering clutch compartment. This will hold the clutch in the disengaged position and the final drive gears may then be rotated to the proper position for removal of the gear retaining locks. Refer to Fig. 3.

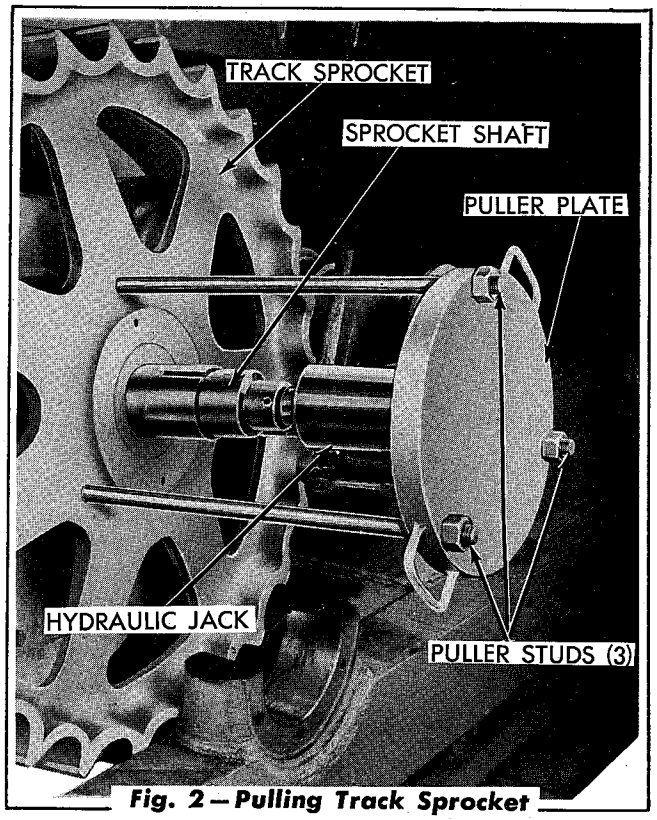


Fig. 2 — Pulling Track Sprocket

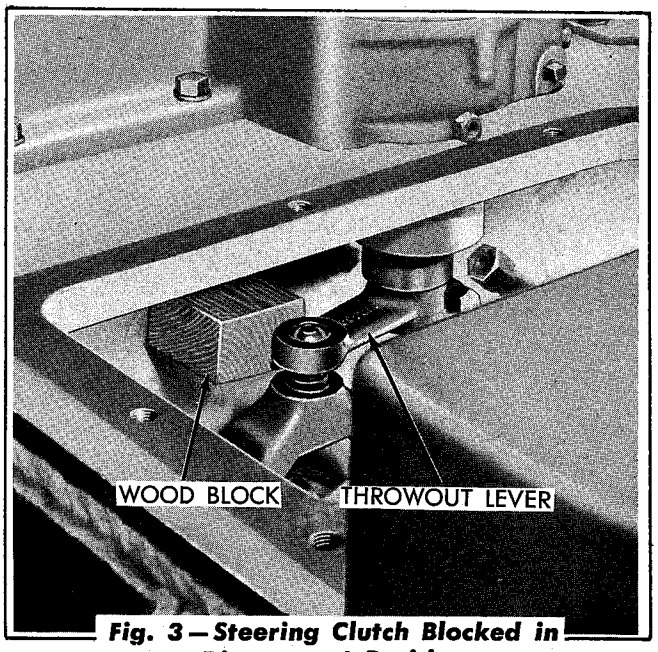


Fig. 3 — Steering Clutch Blocked in Disengaged Position

9. Remove the capscrews attaching the sprocket shaft intermediate bearing cage and the seal guard to the housing, then remove the seal guard, bearing cage, and the bearing

adjusting shims. Tie the adjusting shims to the bearing cage so that they will not be lost. Place suitable blocking under the sprocket shaft gear to prevent the gear from dropping down when the sprocket shaft is removed.

10. Remove the sprocket shaft and the sprocket shaft gear.

11. If it is necessary to remove the sprocket shaft inner bearing cup, the bearing cup and its cage may be removed by pressing or driving the sprocket shaft inner cover from position in the final drive case. It is not necessary to loosen the bearing cage retaining setscrew when removing the cage from its bore.

B. Removal of Final Drive Intermediate Pinion and Gear

To remove the intermediate gear lock capscrews, it will be necessary to turn the shaft; this is accomplished by blocking the corresponding steering clutch in the disengaged position, as outlined previously under sprocket shaft removal.

1. Unlock and remove the capscrews attaching the two (2) intermediate gear locks, then remove the capscrews and the capscrew locks. *NOTE: The intermediate gear locks cannot be removed at this time.*

2. Remove the capscrews attaching the intermediate pinion outer bearing cage to the housing. Remove the bearing cage by using two (2) 5/8" N.C. pusher capscrews in the two (2) tapped holes in the cage. Tie the bearing adjusting shims to the cage so that they will not be lost.

3. Use a holding tool similar to the one shown in Fig. 5, support and remove the intermediate pinion. Screw the threaded end of the tool into the 7/8" N.C. tapped hole in the end of the pinion, and pull the pinion out far enough to remove the intermediate gear locks. Remove the intermediate gear locks, then block the intermediate gear in position and remove the intermediate pinion. Remove the intermediate gear from the housing.

4. If it is necessary to remove the intermediate pinion inner bearing cup, first remove the bearing cage retaining capscrews and locks, then, using pusher capscrews, push the cage from its bore in the case.

C. Removal of Final Drive Pinion

With the final drive sprocket shaft and the intermediate pinion and gear removed, the final drive pinion may be removed as follows:

1. Remove the steering clutch on the side on which the final drive is being disassembled. Refer to "CLUTCH REMOVAL" in Section XII.

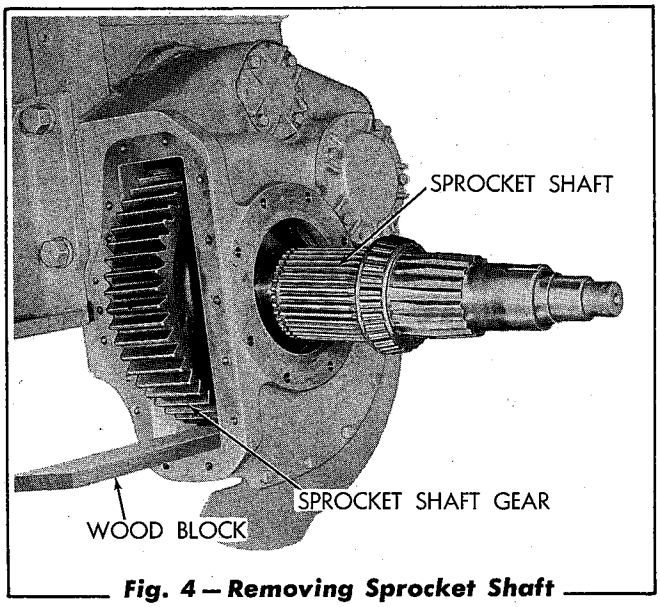


Fig. 4 — Removing Sprocket Shaft

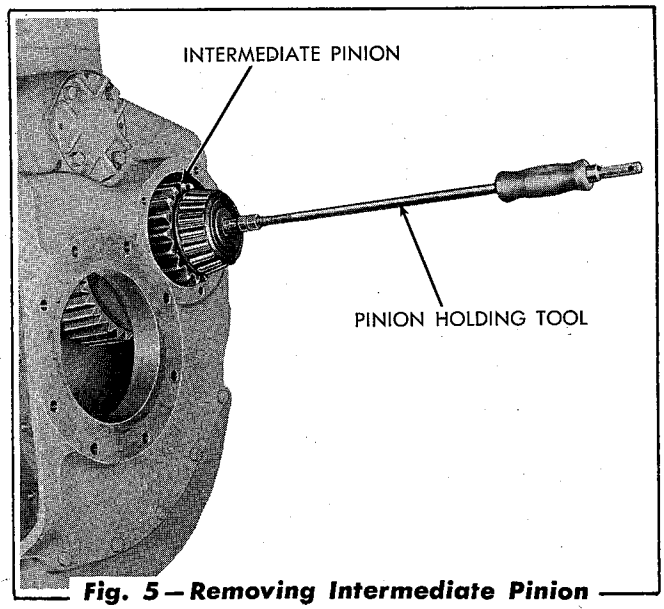


Fig. 5 — Removing Intermediate Pinion

2. Remove the final drive pinion:

   a. Unlock and remove the brake drum hub retaining screw, then remove the locking washer and the hub retaining washer. Use three (3) pusher capscrews, having ¾" N.C. threads in the tapped holes in the brake drum hub, and push the hub off the final drive pinion shaft. Remove the brake drum hub.

   b. Remove the capscrews attaching the pinion inner bearing cage to the housing. Use three (3) ½" pusher capscrews having N.C. threads, in the tapped holes in the cage, and push the cage from the housing. Remove the final drive pinion outer bearing cage and the bearing adjusting shims. Tie the adjusting shims to the cage so that they will not be lost.

   c. Remove the pinion from the final drive housing by pushing it through the inner bore of the final drive housing, into the steering clutch compartment.

3. CLEANING AND INSPECTION

Clean and inspect all the parts thoroughly as described in pertinent pages in "GENERAL MAINTENANCE INSTRUCTIONS" in Section XXI. Replace or recondition any damaged parts when assembling.

4. ASSEMBLY

Before assembling the final drive, the sprocket shaft and the intermediate pinion bearings should be adjusted correctly without the gears in place on the shafts. Proceed as follows:

A. Final Drive Intermediate Pinion Bearing Adjustment

1. Install the intermediate pinion bearing cup in the inner bearing cup cage and bolt the cage in position in the housing. Press the bearing cones onto the intermediate pinion shaft if they were removed. *NOTE: Make certain the bearing cones are pressed tightly against their seats on the shaft.*

2. Lubricate the bearings and insert the intermediate pinion (without the intermediate gear) into position in the housing. Install the outer bearing cup in the outer bearing cage, then install the outer bearing cage into the housing using the original amount of bearing adjusting shims.

3. The intermediate pinion bearings are correctly adjusted when they have .002" to .003" pre-load. Add or remove bearing adjusting shims until a very slight pre-load (start of pre-load) is noted when turning the shaft, then substitute the proper combination of shims to reduce the total shim pack thickness .002" to .003", to obtain the proper pre-load. When adjusting, bump the outer bearing cage to make certain the bearings are seated.

4. Remove the outer bearing cage, as described previously in "REMOVAL OF FINAL DRIVE INTERMEDIATE PINION AND GEAR." Keep the bearing adjusting shim pack with the bearing cage. Remove the intermediate pinion using a tool similar to the one shown in Fig. 5. *IMPORTANT: Keep bearings clean.*

B. Sprocket Shaft Bearing Adjustment

1. Install the sprocket shaft cover seal in the bore of the steering clutch and final drive housing, then install the sprocket shaft inner cover.

2. Install the bearing cup in the bearing cage, used on the inner end of the sprocket shaft, and install the cage in the housing, being sure that the bearing cage retaining setscrew is entered in the groove on the outside of the cage. *NOTE: The retaining setscrew is not designed to prevent lateral movement of the bearing cage. Its only function is to prevent rotation of the cage in its bore. Therefore, it is important that the flange of the bearing cage is tight against the inner wall of the final drive case, when the cage is installed. If the cage is not tight against the wall of the case, it will be impossible to ob-*

tain a correct adjustment of the sprocket shaft bearings.

3. Install the inner and center bearing cones onto the sprocket shaft if they were removed, pressing them tightly against their seats on the sprocket shaft.

4. Lubricate the bearing cones with engine oil and insert the sprocket shaft (without the gear) into the bore of the final drive housing.

5. Install the bearing cup in the sprocket shaft intermediate bearing cage and install the cage into the housing, using the original amount of bearing adjusting shims.

6. The sprocket shaft bearings (inner and center) are correctly adjusted when they have .002" to .003" pre-load.

   Add or remove bearing adjusting shims until a very slight pre-load (start of pre-load) is noted when turning the shaft, then substitute the proper combination of shims to reduce the total shim pack thickness .002" to .003", to obtain the proper pre-load. Bump the end of the sprocket shaft to make certain the bearings are properly seated against the shoulders of the shaft when adjusting.

7. Remove the sprocket shaft intermediate bearing cage and bearing adjusting shims. Keep the bearing adjusting shim pack with the cage. Remove the sprocket shaft. *IMPORTANT: Keep bearings clean.*

C. Installation of Sprocket Shaft Seal Assemblies

If the seal assemblies for the sprocket shaft were removed, the seals should be installed at this time so that the neoprene cement, used for cementing the assemblies in place, will have sufficient time to dry.

1. Install the Inner Seal Assembly

a. Place the sprocket shaft intermediate bearing cage on a clean bench, with the flat face of the cage up.

b. Make certain the spring follower assembly, rubber seal boot, and the inner seal ring (stationary ring), are clean and dry. Install the rubber boot on the spring follower, lining up the holes in the boot with the protruding pins in the follower assembly. Hold each lip of the boot out, and coat the inside of the lips and the sides of the spring follower assembly with neoprene cement. Press the lips back in place against the spring follower assembly.

c. Coat the outer face of one lip of the rubber boot and the machined face of the bearing retainer with neoprene cement. Immediately place the boot and spring follower assembly on the bearing retainer, inserting the ends of the pins into the corresponding holes in the bearing retainer.

d. Coat the face of the outer lip of the boot and the back face of the inner seal ring with neoprene cement. Immediately place the seal ring on the boot and follower assembly, inserting the ends of the pins into the corresponding holes in the seal ring.

e. Place a weight on the seal ring, using a clean cloth between the weight and the seal ring, and allow the neoprene cement to dry and set thoroughly.

   NOTE: When coating the above parts with neoprene cement, do not use an excessive amount. The neoprene cement and solvent for thinning can be purchased from your "Allis-Chalmers" Dealer.

f. Clean and dry the inner machined surface of the track sprocket and the outer seal ring thoroughly. Coat the machined surface of the sprocket with neoprene cement and immediately install the sprocket shaft inner seal ring gasket over the dowels. Coat the outer surface of the gasket with neoprene cement. Immediately install the outer seal ring (rotating ring) on the sprocket, inserting the dow-

els into corresponding holes in seal ring. Place a suitable weight on the seal ring, using a clean cloth between the weight and the seal ring, and allow the neoprene cement to dry and set thoroughly.

2. **Install the Outer Seal Assembly**

a. Place the sprocket shaft outer bearing cage on a clean bench, with the cap attaching side of the bearing cage down.

b. Make certain the inner surface of the bearing cage, the follower assembly, outer seal boot, and the seal ring are clean and dry. Install the outer seal boot on the follower assembly, lining up the holes in the boot with the protruding pins in the follower assembly. Hold each lip of the boot out and coat the inside of the lips and the sides of the follower assembly with neoprene cement. Press the lips back in place against the follower assembly.

c. Coat the outer face of one lip of the rubber boot and the machined face in the bottom of the counterbore in the bearing cage with neoprene cement. Immediately place the boot and follower assembly in the bearing cage, inserting the ends of the pins into the corresponding holes in the bearing cage.

d. Coat the face of the outer lip of the rubber boot and the back face of the seal ring with neoprene cement. Immediately place the seal ring on the rubber boot, inserting the ends of the pins into the corresponding holes in the seal ring.

e. Place a weight on the seal ring, using a clean cloth between the weight and the seal ring, and allow the neoprene cement to dry and set thoroughly.

f. Coat one side of the seal ring gasket and the outer face of the sprocket retaining nut with neoprene cement. Place the gasket over the dowels on the retaining nut. Coat the other side of the gasket and the back face of the seal ring with neoprene cement, and place the seal ring on the gasket, lining up the holes in the seal ring with the dowels in the nut.

g. Place a weight on the seal ring, using a clean cloth between the weight and the seal ring, and allow the neoprene cement to dry and set thoroughly.

NOTE: When coating the above parts with neoprene cement, do not use an excessive amount.

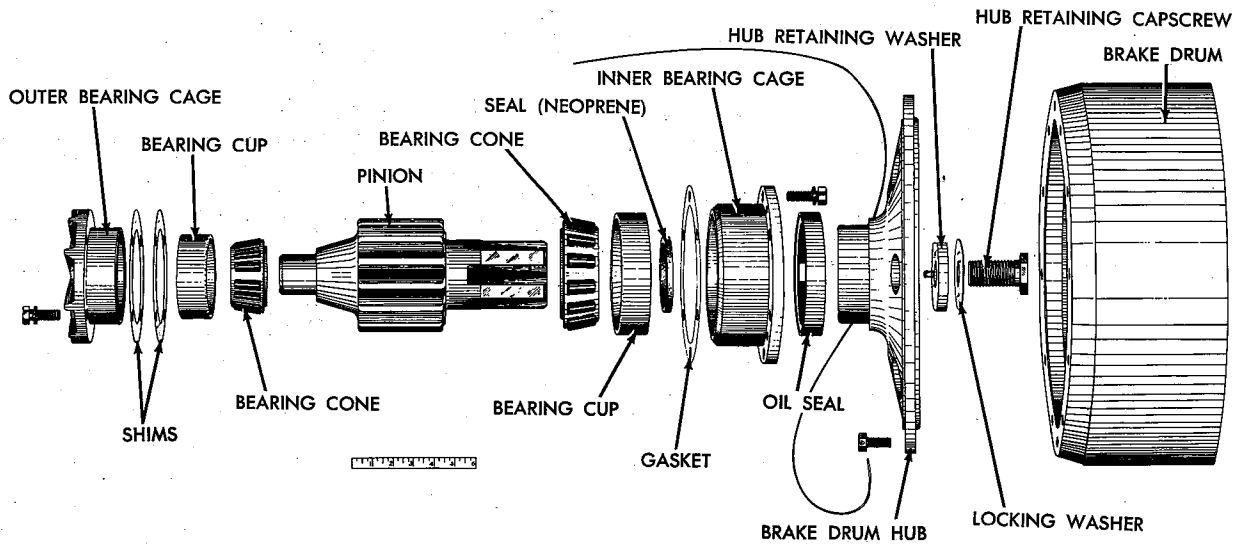


Fig. 6—Final Drive Pinion Details

D. Installation and Bearing Adjustment of Final Drive Pinion

1. Install the inner and outer bearing cones on to the pinion shaft. Make certain the bearing cones are pressed against their seats on the shaft.

2. Install the outer bearing cup in the outer bearing cage, and using the original amount of bearing adjusting shims, install the outer bearing cage into the outer bore of the final drive housing. Lubricate the bearing cones on the pinion and install the pinion into the bore. *NOTE: The pinion and bearing assembly must be installed from the steering clutch compartment side.*

3. Install the bearing cup in the inner bearing cage. Lubricate the brake drum hub oil seal and install it into the inner bearing cage, with the lip of the seal facing the final drive compartment.

4. Use a new gasket and install the inner bearing cage into the housing. Tighten the attaching capscrews securely. Bump the outer bearing cage to make certain the bearings are seated. Turn the pinion to determine the bearing pre-load.

5. The final drive pinion bearings are correctly adjusted when they have .002" to .003" pre-load. Add or remove bearing adjusting shims until a very slight drag (start of pre-load) is noted when turning the shaft, then substitute the proper combination of shims to reduce the total shim pack thickness .002" to .003", to obtain the proper pre-load.

6. Install a new pinion shaft oil seal (neoprene) on the inner end of the pinion shaft. Install the brake drum hub, hub retaining washer, hub retaining capscrew locking washer, and the hub retaining capscrew. Tighten capscrew to 550 to 600 ft. lbs. torque. Lock the capscrew securely with the capscrew locking washer.

7. Install the steering clutch and steering brake (refer to "STEERING CLUTCH INSTALLATION," Section XII).

E. Installation of Final Drive Intermediate Pinion and Gear

1. Place the final drive intermediate gear into

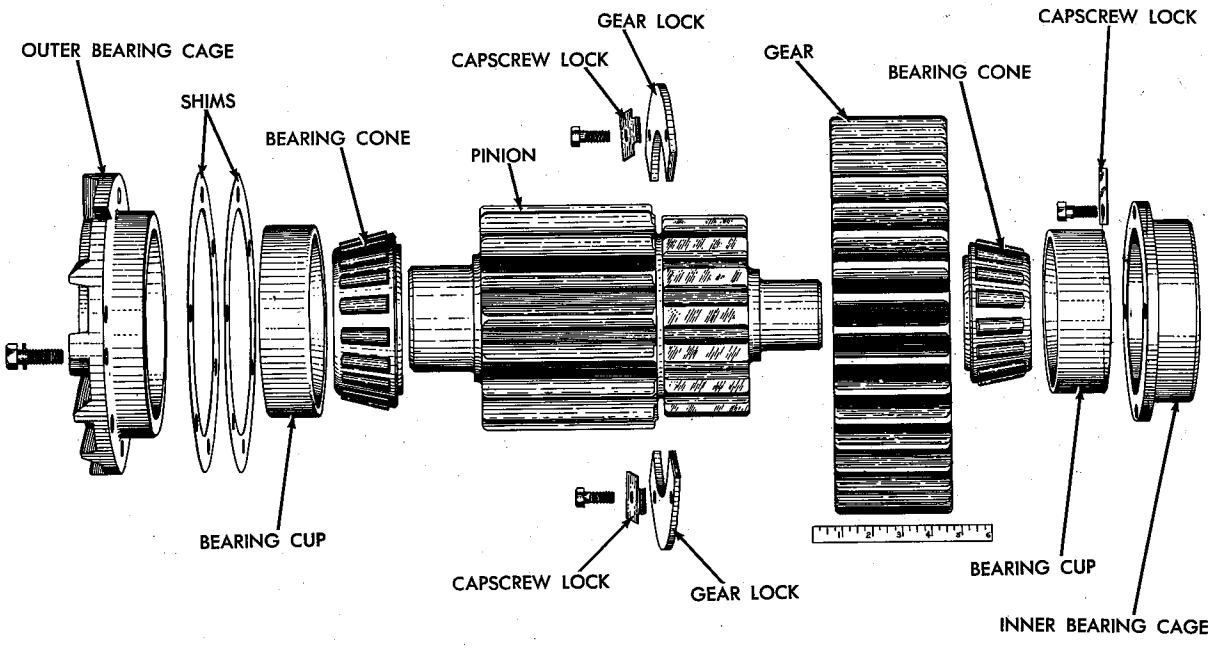


Fig. 7—Final Drive Intermediate Pinion and Gear Details

the housing, with the gear lock attaching holes in the gear facing the outer bearing bore. Block the gear in place with suitable blocking. Lubricate the bearings and insert the intermediate pinion into the bore of the housing. Align the splines on the intermediate pinion with the corresponding splines in the gear, and insert the intermediate pinion into the gear.

2. Using a bar and suitable blocking, through the opening in the rear of the final drive compartment, raise the intermediate pinion so that it is in line and the outer bearing cage can be installed. Start the outer bearing cage into the bore, using the correct amount of bearing adjusting shims as determined previously in "INTERMEDIATE PINION BEARING ADJUSTMENT." When installing the bearing cage, install it into the bore just enough to start the attaching capscrews, then remove the blocking. To install the gear locks, use a bar to move the intermediate pinion out against the outer bearing cage. Install the two (2) locks in place in the groove in the shaft, then move the intermediate pinion back into position in the gear. Install the gear lock attaching capscrews and the capscrew locks. Tighten the capscrews securely, and lock in position with the capscrew locks.

3. Tighten the outer bearing cage attaching capscrews securely.

F. Installation of Sprocket Shaft

1. Install the sprocket shaft gear (with the tapped holes for the gear retaining lock attaching capscrews towards the inner bearing cup) and block the gear in position.

2. Lubricate the bearing cones on the sprocket shaft and insert the shaft through the bore of the final drive housing and into the gear, aligning the splines of the shaft with those in the gear. Push the sprocket shaft in until the inner bearing cone is in position in its mating cup, then install the intermediate bearing cage into its bore in the housing, using the correct amount of bearing adjusting shims as previously determined in

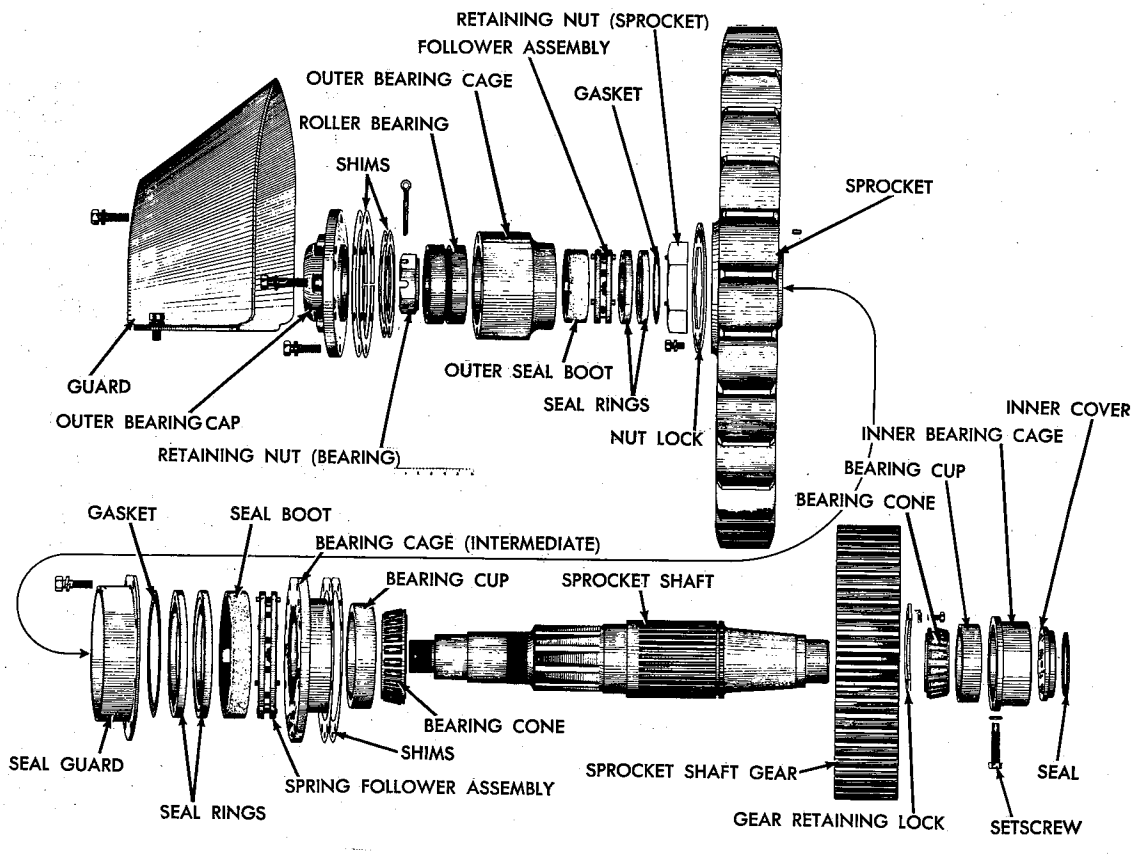


Fig. 8—Sprocket Shaft Details

"SPROCKET SHAFT BEARING ADJUSTMENT."

3. Install the seal guard and tighten the capscrews securely.

4. Position the sprocket shaft gear so that the gear retaining locks may be installed on the gear and into the machined groove in the shaft. Install the gear retaining locks, attaching capscrews, and capscrew locks. Tighten the capscrews securely and lock in position with the capscrew locks. Install the final drive compartment rear cover and gasket. Tighten the attaching capscrews securely.

5. Before installing the track sprocket, it is necessary to heat the sprocket hub to approximately 190° to 200° F. to expand the hub for ease of installation, and to assure the hub seating properly on the splines of the sprocket shaft. This may be accomplished by the use of a No. 2 "PHOTOFLOOD" light bulb and a reflector. Place the light bulb inside of the track sprocket hub, with the reflector resting on the track sprocket. The time required for heating is approximately one (1) hour. Another suggested method of heating, is the use of a 1000 Watt "ELECTRIC HEATER ELEMENT," which can be purchased from a local appliance store at a small cost, and will fit into an ordinary light socket. The light cord, however, should be an asbestos covered cord. Use the same heating procedure as described for heating with the light bulb. The time required to heat the sprocket will be approximately 25 to 30 minutes when using the heater element. If available, a sheet of asbestos may be placed around the track sprocket hub to prevent heat loss. Refer to Fig. 9. *NOTE: Do not use open flame heat when heating the track drive sprocket hub.*

6. Lubricate the mating surfaces of the inner seal rings, then install the track sprocket (with the seal ring in place) onto the sprocket shaft. Coat the back face of the sprocket retaining nut (face which contacts the sprocket) with No. 1 "PERMATEX" or its equivalent.

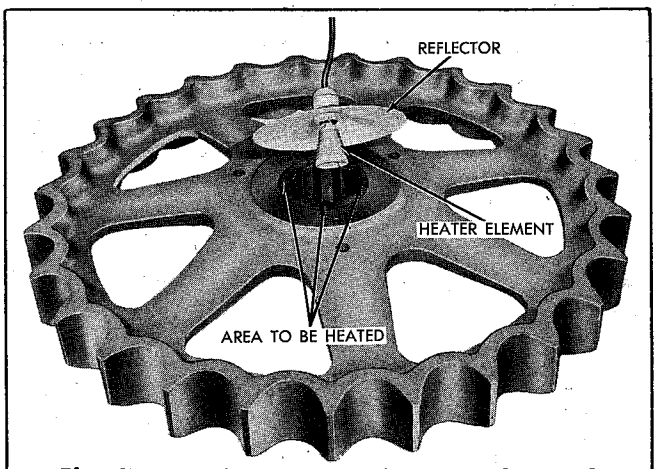


Fig. 9—Heating Track Drive Sprocket Hub

Make certain the oil holes in the track sprocket retaining nut are not obstructed with the "PERMATEX," then install the nut. Tighten the sprocket retaining nut to 4500 to 5000 foot pounds torque. This may be accomplished by using the reduction of the transmission and final drive when tightening. With the opposite steering clutch blocked in the disengaged position, proceed as follows:

a. Remove the front floor plate. Remove the hydraulic steering lever control rods.

b. When tightening the left track drive sprocket retaining nut, place a wrench

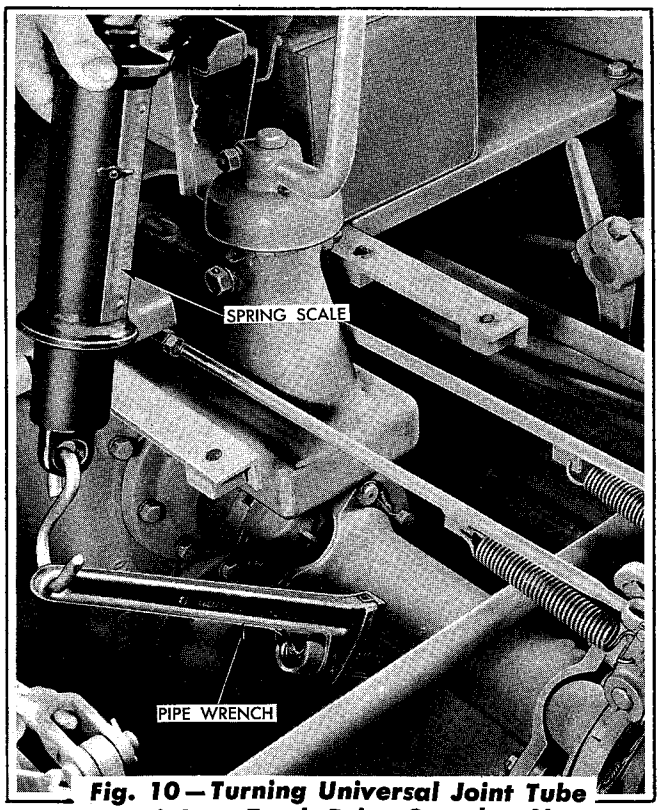


Fig. 10—Turning Universal Joint Tube to Tighten Track Drive Sprocket Nut

on the sprocket retaining nut and place a block of wood between the wrench handle and the top of the truck frame, to hold the wrench in position. When tightening the right track drive sprocket retaining nut, place a wrench on the nut and place a block of wood on the floor (in back of tractor) so that the wrench handle may rest on the block.

c. Shift the transmission into low gear. Use a 36" pipe wrench or chain wrench to turn the universal joint tube or use a bar in the universal joint. With a 100 pound spring scale (sometimes called a fish scale) hooked on the end of the wrench handle, turn the universal joint drive tube counterclockwise (viewed from the operator's seat), to tighten the left track drive sprocket retaining nut. Turn the universal joint drive tube clockwise (viewed from the operator's seat), to tighten the right track drive sprocket retaining nut. Turn the universal joint drive tube until a pull of 25 pounds is indicated on the spring scale; this will impose 4500 to 5000 foot pounds torque on the track drive sprocket retaining nut.

NOTE: During this procedure, strike the sprocket with a sledge hammer as near the hub as possible, to make certain the sprocket is firmly seated on the shaft splines. Allow the hub to cool, then recheck the tightness of the nut for the correct torque.

The following is the pounds pull required on the spring scale, when using various length wrenches or bars.

Wrench-Feet*	Pounds-Pull
2	38
2½	30
3	25
3½	22
4	19

**NOTE: Distance from center of universal joint tube to point on wrench to which spring scale is attached.*

d. Install the track drive sprocket retaining nut lock and the lock attaching capscrews.

e. Install the hydraulic steering lower control rods and install the front floor plate.

f. Remove the block used to hold the steering clutch in the disengaged position.

G. Install Sprocket Shaft Cage and Outer Bearing

1. With the seal assembly and the outer bearing in place in the cage, install the cage on the sprocket shaft, using a tool similar to the one shown in Fig. 11. Press the cage and bearing assembly onto the shaft to a position allowing .050" to .060" clearance between the sealing surfaces of the two (2) outer seal rings.

   NOTE: The tool mentioned above and shown in Fig. 11 is made of two (2) sprocket shaft outer bearing retaining nuts. Place one nut in a lathe and machine the threads out of the nut. Then place the two (2) nuts together (so the nut with threads is to the inside) and weld them together as shown in Fig. 11. Place the welded nut assembly in a lathe and machine the outer diameter of the inner nut (the nut with the threads) down to 3.375" and back (from the inner face) for a distance of 1-5/16". This will form a collar to push the bearing and cage assembly into position on the sprocket shaft. It is necessary that a tool of this type be used when installing the outer sprocket shaft bearing, as the shock of driving the bearing into position may loosen the "NEOPRENE" cement used to cement the seal boot to the bearing cage.

   Lubricate the outer bearing with engine oil. *IMPORTANT: Do not allow the two (2) seal rings to contact, as this will cause a drag between the seal rings, thus a false reading will be obtained when checking the adjustment of the outer bearing.*

2. Install the sprocket shaft outer bearing cap using the original amount of bearing adjusting shims.

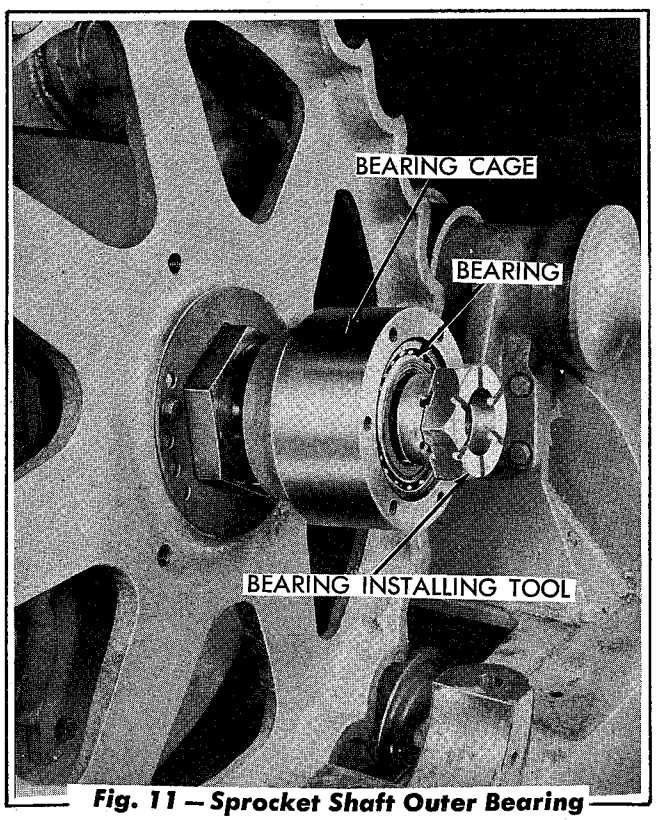


Fig. 11 — Sprocket Shaft Outer Bearing Installation

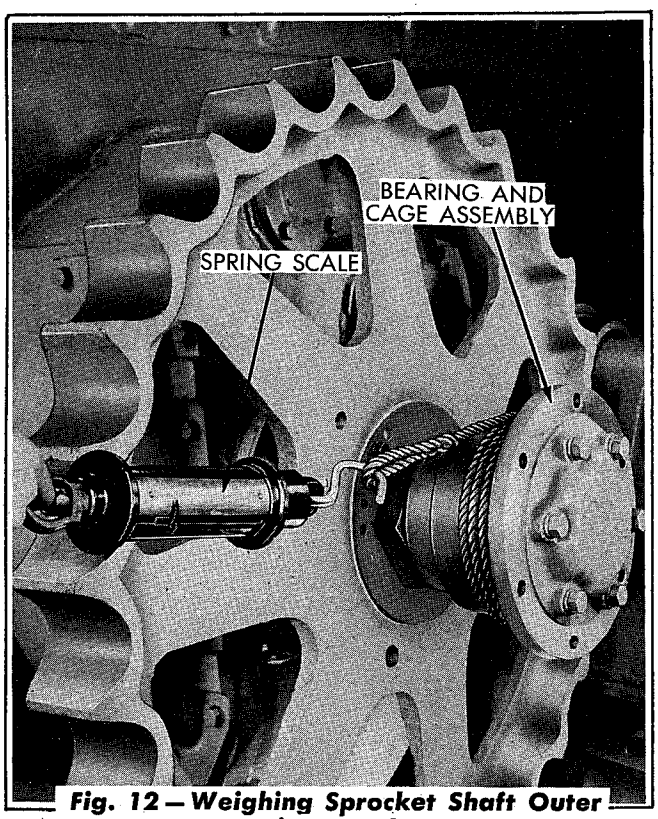


Fig. 12 — Weighing Sprocket Shaft Outer Bearing Pre-load

3. The sprocket shaft outer bearing is correctly adjusted when it has 33 to 44 inch pounds pre-load. A spring scale, sometimes called a fish scale, may be used to weigh the bearing pre-load. Refer to Fig. 12.

4. To weigh the sprocket shaft outer bearing pre-load proceed as follows:

   a. Use a length of small rope and wind the rope around the outer bearing cage several turns. Tie a loop in the free end of the rope and attach the hook of the spring scale in the loop. Pull on the spring scale and note the pounds pull required when revolving the bearing cage. The distance from the center of the sprocket shaft to the point of pull on the bearing cage is 4⅛", therefore, to obtain the desired 33 to 44 inch pounds pre-load, a pull of 8 to 10 pounds is required on the spring scale. *EXAMPLE: 4⅛ inches x 8 pounds = 33 inch pounds.*

   b. Add or remove bearing adjusting shims to obtain the correct bearing pre-load.

5. After the correct amount of bearing adjusting shims has been determined, remove the sprocket shaft outer bearing cap and adjusting shims. Lubricate the sealing surfaces of the seal rings, then install the outer bearing retaining nut and tighten it securely. When tightening the nut, the cage assembly will be pressed onto the shaft to the proper distance. Install the cotter pin to lock the retaining nut.

6. Reinstall the sprocket shaft outer bearing cap and the correct amount of bearing adjusting shims. Tighten the attaching capscrews securely.

7. Place the outer bearing cage clamping cap in position on the cage, then start three (3) of the outer bearing adjusting cap capscrews to hold the clamping cap in position. Do not tighten the three (3) capscrews at this time. Roll the truck frame back into position under the tractor. Remove the blocking and lower the tractor onto the truck frame, making certain that the truck frame is positioned correctly under the tractor so that the hollow dowel for the truck frame pivot shaft enters the hole in the pivot shaft. Also make certain that the sprocket shaft outer bearing cage

enters the truck frame. The outer bearing clamping cap will serve as a guide to align the holes in the outer bearing adjusting cap with the holes in the truck frame. Make certain the holes are in line by inserting the attaching capscrews. Do not tighten the capscrews at this time.

8. Start the two (2) outer bearing clamping cap attaching capscrews.

9. The truck frame pivot shaft caps are center punched on the back side, one (1), two (2), three (3), and four (4) so that they may be reinstalled in their original positions to match the center punch marks in the case. Install the caps, being certain that they are installed in their original positions. Tighten the attaching capscrews to 500 to 600 foot pounds torque.

10. Tighten the two (2) capscrews attaching the sprocket shaft outer bearing clamping cap to the truck frame.

11. Install the bolts which attach the equalizer spring pad to the truck frame. Tighten the bolts securely.

12. Remove the capscrews attaching the sprocket shaft outer bearing adjusting cap to the truck frame and to the outer bearing cage clamping cap, then install the sprocket guard. Reinstall the attaching capscrews and tighten securely.

13. Install the oil drain plug in the final drive compartment, then fill the final drive compartment to the proper level using the specified lubricant.

14. Install the fuel tank and connect the fuel lines.

15. Couple the track. Refer to "TRACK INSTALLATION" in Section XVII.

SECTION XV—TRUCK FRAME ASSEMBLIES

1. DESCRIPTION

The major components of a truck frame assembly are: the truck frames, truck wheels, track support rollers, track release, and track idler.

The truck frame is made of steel sections welded into a rigid "A" frame assembly. Each truck frame pivots on a pivot shaft attached to the bottom of the steering clutch and final drive housing, and the sprocket shaft mounting cage and bearing. The truck frames support the main frame by the use of an equalizing spring.

Each truck frame assembly incorporates six (6) truck wheel assemblies: two (2) single flange wheels having heavy duty type tapered roller bearings and located in the front No. 1 and rear No. 6 positions (shaft marked HD); two (2) double flange wheels having standard type tapered roller bearings and located in the No. 2 and No. 5 positions (shaft stamped S); and two (2) single flange wheels having standard type tapered roller bearings and located in the No. 3 and No. 4 positions (shaft stamped S).

The truck wheels are attached to the truck frame by capscrews threaded into replaceable tapped blocks. The truck wheels have positive type grease seals.

Both the support rollers and the track idlers contain tapered roller bearings, positive type seals, and seal spring assemblies. Internally, their construction is much the same as that of the truck wheels.

Truck frame guards furnished as standard equipment, consist of heavy full length truck wheel guards, inner and outer track idler guards, and inner and outer track driving sprocket guards. Truck frame guard equipment is fastened to the truck frames by capscrews and is readily removable. The track idlers are guided on the truck frames by replaceable wear plates (slide bars).

The track release mechanism consists of a yoke, adjustment screw, bellcrank, two (2) push rods, push rod pins, and a heavy spring, with a relatively lighter and shorter spring inside the heavy spring. These components are enclosed in an oil tight housing which is an integral part of the truck frame. The bellcrank is provided with a stop which effectively controls the pressure required to make the mechanism start to release.

2. TRUCK FRAME

A. Maintenance

Maintenance of the truck frames consists of periodic inspection to maintain proper operation. Check the truck frames to see if they are reasonably parallel with one another, by measuring the distance between the frames at both the front and rear ends. Refer to Fig. 1. The measurement between the front end of the frames should be within plus or minus ⅜ inch of that at the rear end. A measurement not within this range will indicate that the truck frame pivot shafts and bushings, or the sprocket shaft outer bearings, may be worn excessively, or that the truck frames are sprung or twisted. Truck frames "out-of-line" will contribute to rapid wear of the truck wheels, track idlers, support rollers, track sprockets, and track assemblies and should be corrected immediately.

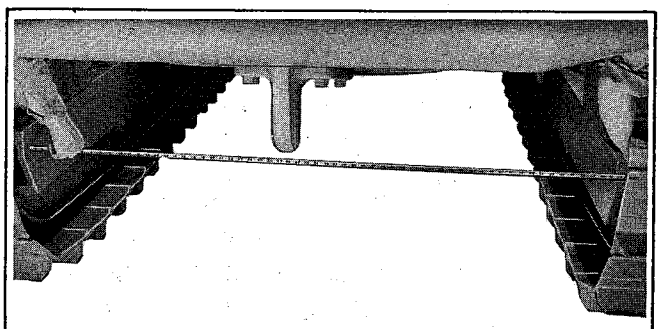


Fig. 1 — Measuring the Distance Between Truck Frames

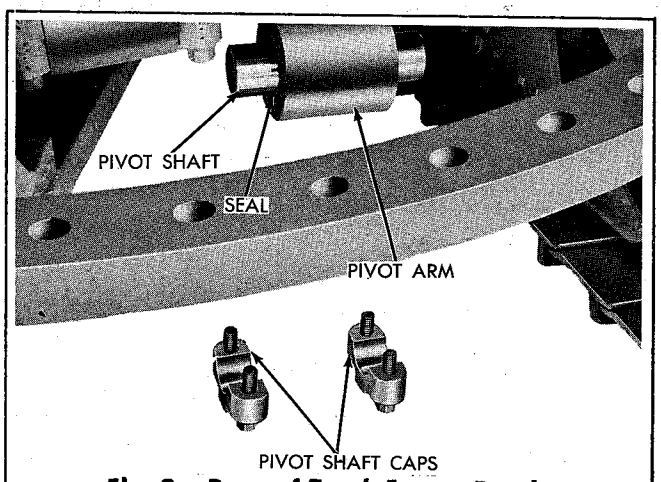


Fig. 2 — Rear of Truck Frame Ready for Removal

B. Truck Frame Removal

1. Uncouple the track (refer to Section XVII).

2. Remove the track idler, track release yoke, truck frame pivot shaft caps, track sprocket guard, and the track sprocket outer bearing clamping cap. Remove the three (3) capscrews attaching the outer bearing adjusting cap to the truck frame.

3. Remove the bolts attaching the equalizing spring seat to the truck frame and raise the free end of the spring approximately eight (8) inches off the truck frame. Block under the equalizing spring with suitable cribbing.

4. Raise the rear of the tractor approximately ten (10) inches and block under the drawbar with suitable cribbing.

5. Move the truck frame as far forward as it will go and pull the truck frame and track out from the side of the tractor.

C. Pivot Shaft, Pivot Shaft Bushing, and Dirt Seals

1. Maintenance

The pivot shaft and the bushing are automatically lubricated by an oil wick assembly from the bevel gear compartment. No maintenance is necessary other than periodic checks to make certain that the pivot shaft attaching caps are tight and that the bushing and the shaft are not excessively worn.

NOTE: The wicks used to lubricate the pivot shaft are of a prescribed density. Use only the specified lubricant in the transmission, as the use of oils heavier than the specified viscosity will not flow through the wicks in sufficient quantity to lubricate the pivot shafts properly.

2. Removal of Pivot Shaft, Bushing, and Dirt Seals

a. With the track uncoupled, the sprocket shaft outer bearing loosened from the truck frame, and the pivot shaft caps removed from the housing, the pivot shaft may be removed by raising the rear of the tractor high enough so that the pivot shaft is in line with the drawbar; then, using the drawbar as a sliding hammer, drive the shaft out of the bushing. A suitable "leg type" puller may also be used to remove the shaft from the bushing. When removing the shaft, one of the dirt seals will be removed with the shaft; drive the other seal out by using a suitable punch.

b. The pivot shaft bushing may be removed by using tools similar to, and as shown in Fig. 3. Refer to Fig. 5 showing the tool details.

3. Installation of Pivot Shaft, Bushing, and Dirt Seals

a. Coat the outer diameter of the bushing, with a white lead and oil mixture or similar compound, and start the bushing into place in the bore making certain that

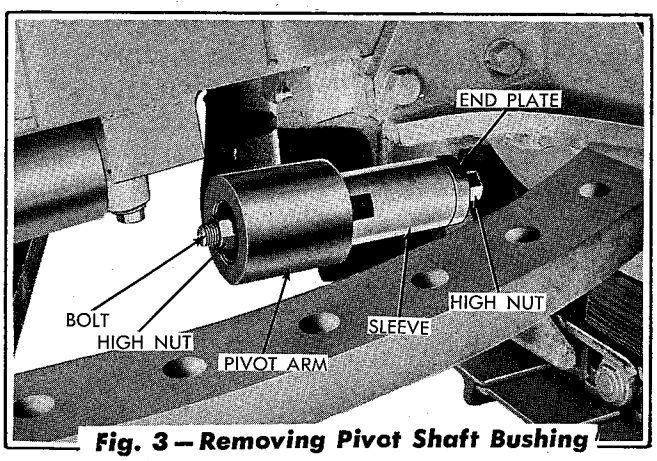


Fig. 3 — Removing Pivot Shaft Bushing

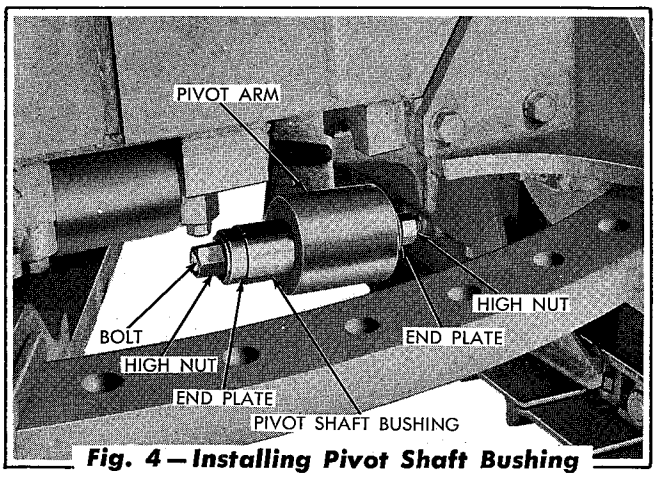


Fig. 4 — Installing Pivot Shaft Bushing

the bore and the bushing are smooth and free of burrs.

b. Using tools similar to those shown in Fig. 4, which consist of one (1) bolt, two (2) end plates, two (2) thrust washers, and two (2) high nuts install the bushing into position in the bore of the truck frame. When installed make certain that the bushing is centered in the bore (each end of the bushing located ½ inch in from the outer ends of the bore in the truck frame).

c. Install a new dirt seal on one end of the pivot shaft, using a driver similar to the one shown in Fig. 6. The outside diameter of the driver should be 3¾". The inside diameter should be 3" and should be machined to a depth of 2-7/16". Lubricate the pivot shaft and start it into the bushing, with the oil hole in the shaft to the inside and positioned on the top as installed. Using the driver, drive the dirt seal and shaft into position. Start the other dirt seal, and while "bucking" the opposite end of the shaft, drive the seal into position using the driver.

4. Installation of Truck Frame

Install the truck frame by a direct reversal of the removal procedure. *CAUTION: The truck frame pivot shaft and bushing are lubricated by a wick assembly that also serves as a dowel pin for locating the pivot shaft to the steering clutch and final drive housing. When lowering the tractor on to the pivot shaft, care should be used to prevent damaging the lubricating wick holder. Misalignment of the truck frame and abnormal wear of the pivot shaft and bushing will result from a damaged lubricating wick holder.*

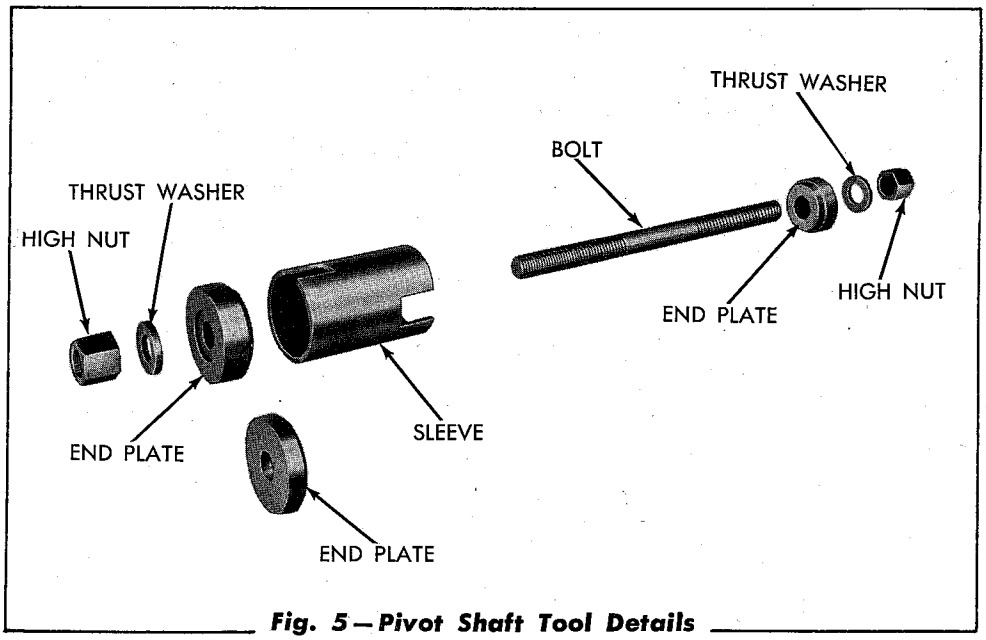


Fig. 5 — Pivot Shaft Tool Details

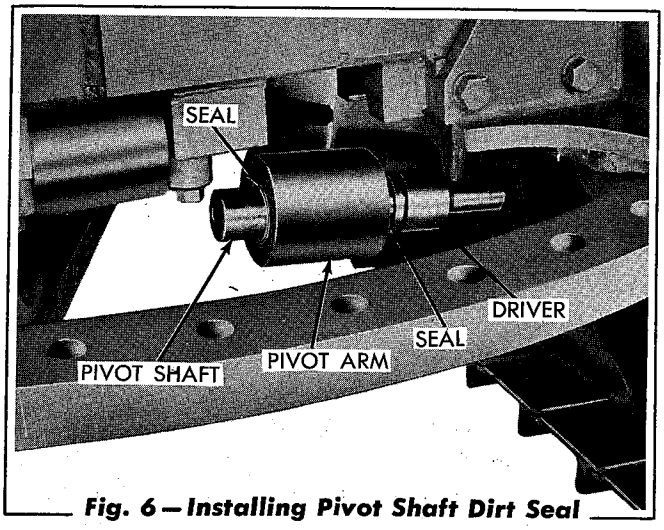


Fig. 6—Installing Pivot Shaft Dirt Seal

The truck frame pivot shaft caps are center pinched: one (1), two (2), three (3), and four (4) so that they may be reinstalled in their original positions to match the center punch marks in the case. When installing the caps, make certain that they are installed in their original position. Tighten the attaching capscrews to 500-600 foot pounds torque.

3. TRUCK WHEELS

A. Maintenance

Maintenance of truck wheels consists of a 1000-hour lubricating period and a periodic check for loose bearings, grease leakage, and excessive wear.

B. Checking and Removal of Truck Wheels

The truck wheels may be checked or removed without uncoupling the track or removing the truck frame. To check or remove a truck wheel without uncoupling the track, loosen the capscrews in the track adjusting screw lock and turn the adjusting screw into the idler yoke as far as possible. Place blocks, approximately 16" high in front of the track and move the tractor forward until the blocks are under the first truck wheel. Then place blocks approximately 16" high, against the rear of the track and move the tractor backward until the weight of the tractor is carried by the track drive sprocket and the track idler. In this position, the track slack should be at the bottom of the track. Lock the brakes in the applied position, and check the truck wheels for bearing end play by grasping the wheels by hand and moving them endwise. If there is any end play, or indication of grease leakage, the truck wheel must be removed and inspected. If the truck frame is removed, it should be turned over for removal of the truck wheels. *NOTE: Truck wheels are attached by capscrews threaded into replaceable tapped blocks.*

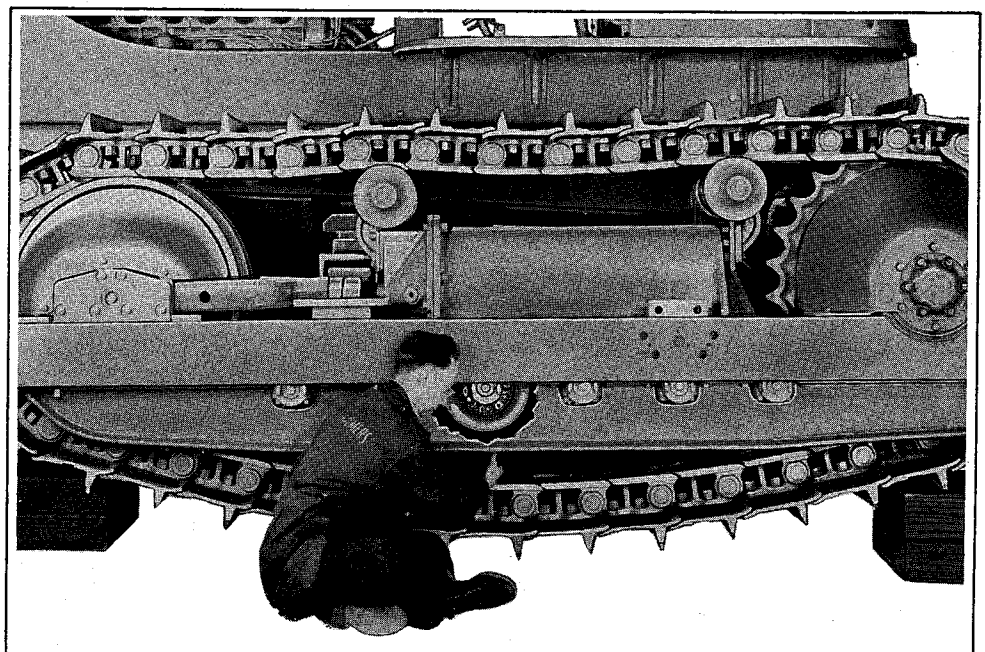


Fig. 7—Checking Truck Wheels for Bearing End Play

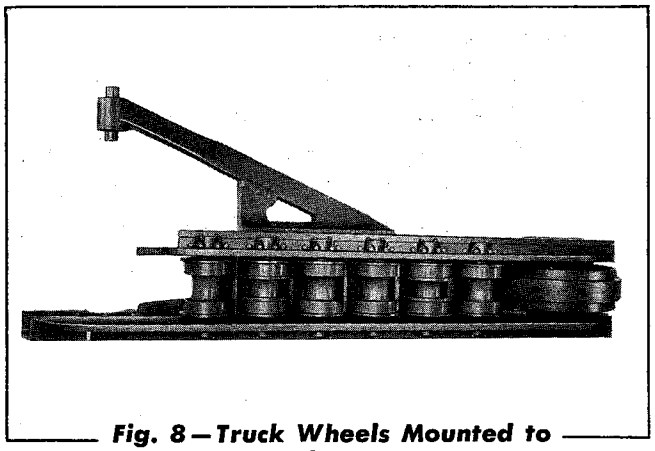


Fig. 8—Truck Wheels Mounted to Truck Frame

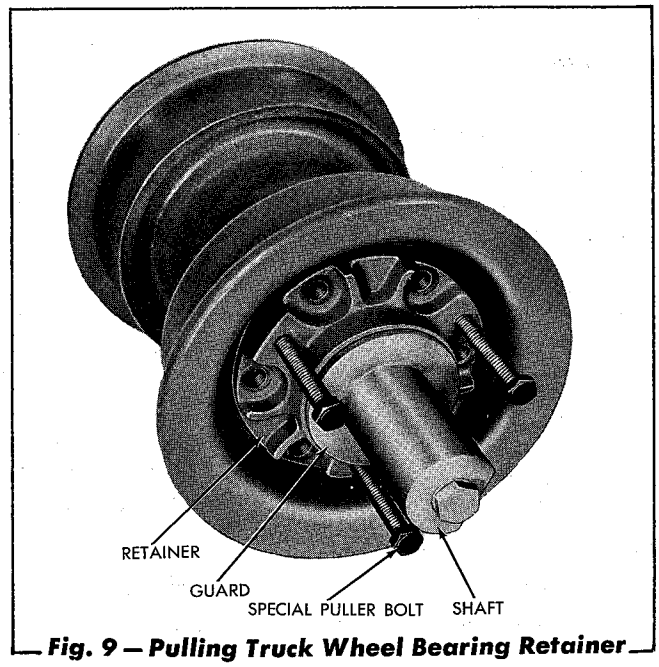


Fig. 9—Pulling Truck Wheel Bearing Retainer

C. Disassembly of Truck Wheels

1. With the tractor placed on blocks as shown in Fig. 7, remove the inner and outer truck frame guards. Remove the capscrews attaching the truck wheel to the truck frame and remove the truck wheel.

2. Place the truck wheel in a vise by clamping on the truck wheel bracket. Then remove the bracket from the opposite end of the shaft, using a hammer and a bar to turn the bracket on the shaft approximately one-quarter turn. In this position the bracket may be easily removed from the shaft as there is a flat machined surface on the shaft. Clamp the end of the shaft in a vise and using the same procedure, remove the other bracket.

3. Wash the outside of the truck wheel thoroughly.

4. Remove the capscrews attaching the bearing retainers to the truck wheel. *IMPORTANT: When disassembling the truck wheel, keep the parts separated so that they can be reassembled in their original positions.* Tie the bearing adjusting shims to the bearing retainer to facilitate bearing adjustment when reassembling.

5. Three (3) equally spaced tapped holes are provided in each bearing retainer for a means of removal. Using three (3) ½ N.C. Puller bolts in these holes, turn the bolts in evenly to pull the bearing retainers, including the seal guard and the seal assemblies, off the shaft. *CAUTION: USE CARE AND DO NOT SCRATCH OR DAMAGE THE SEAL RINGS.*

6. Press on the end of the truck wheel shaft to remove the bearing cups and shaft from the truck wheel.

D. Inspection of Truck Wheels

1. Wash all the parts thoroughly before inspection. Make sure that the grease passage in the truck wheel shaft is clean.

2. Make a visual examination of the shaft and bearings. If the bearings or the cups show excessive wear or if they are pitted, they must be replaced. If the bearing cups are found to be loose in the bore of the truck wheel, replace the necessary parts.

3. Examine the sealing surfaces of the mating seal rings for scratches, nicks, or burrs as these surfaces *MUST* be smooth and flat. If the sealing surfaces are scratched or damaged in any way, both mating seal rings must be replaced.

4. Examine the rubber seal boot in each bearing retainer and make certain that it is firmly cemented in place and forms an oil proof bond between the mating parts. The inner faces of the boot lips should be firmly cemented to the ends of the spring assembly. The outer face of one boot lip should be

firmly cemented to the bottom of the counterbore of the bearing retainer, and the outer face of the other lip should be firmly cemented to the inner seal ring. No cement is used on the I.D. or the O.D. of the rubber seal boot, as it is necessary that the outer part remain flexible to follow the action of the springs in the follower assembly.
Examine the boot and make certain that the rubber is pliable and the boot is in good condition. If the boot and the seal ring are in good condition and are firmly cemented in place, do not remove.

5. Examine the truck wheel seal guard assembly and make certain that the gasket and the seal ring are firmly cemented to the guard.

E. Assembly and Installation of Truck Wheels

NOTE: Each truck frame is equipped with two (2) single flange heavy duty, two (2) single flange standard, and two (2) double flange standard truck wheels. The heavy duty wheels differ from the standard wheels in that they have heavy duty bearings and shafts. The single flange heavy duty truck wheels are used only in the front and rear positions, the double flange standard wheels in the second positions from the front and rear, and the single flange standard truck wheels in the center positions on the truck frame. The ends of the shafts are marked "HD" for the heavy duty wheels and "S" for the standard wheels.

1. Make certain that all parts are clean.

2. If a new seal assembly is to be installed in the bearing retainers, the seals should be installed at this time so that the neoprene cement, used for cementing the assembly in place, will have sufficient time to dry.

3. To install the seal assembly proceed as follows:

   a. Place the bearing retainer on a clean bench with the machined face down.

   b. Make certain the seal spring assembly, rubber boot, and seal ring are clean and dry. Install the rubber boot on the seal spring assembly, lining up the holes in the boot with the protruding pins in the spring assembly. Hold each lip of the boot out away from the end of the spring assembly and coat the inside of the lips and the ends of the spring assembly with neoprene cement. Press the lips back in place against the spring assembly.

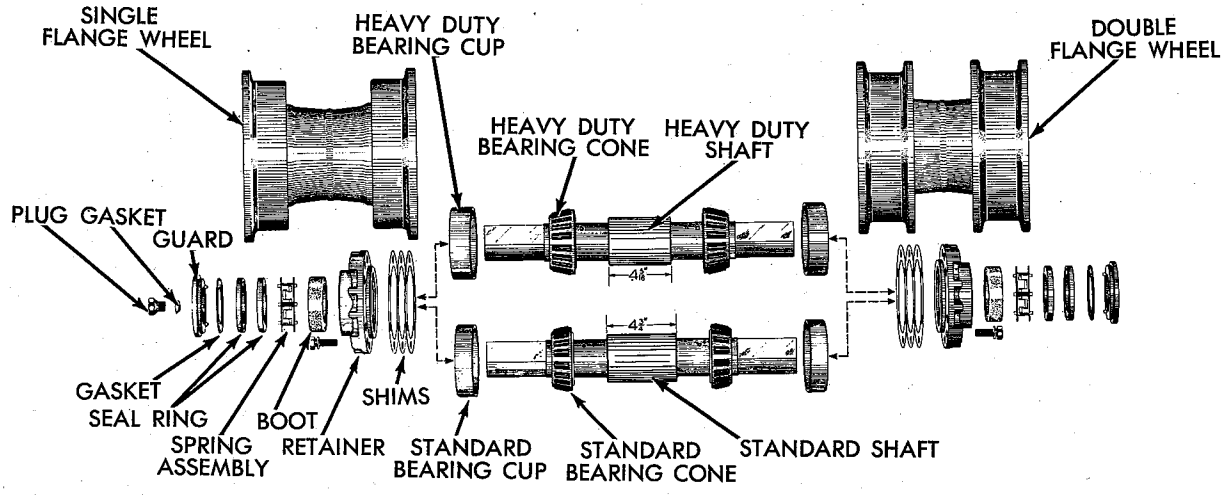


Fig. 10—Truck Wheel Details

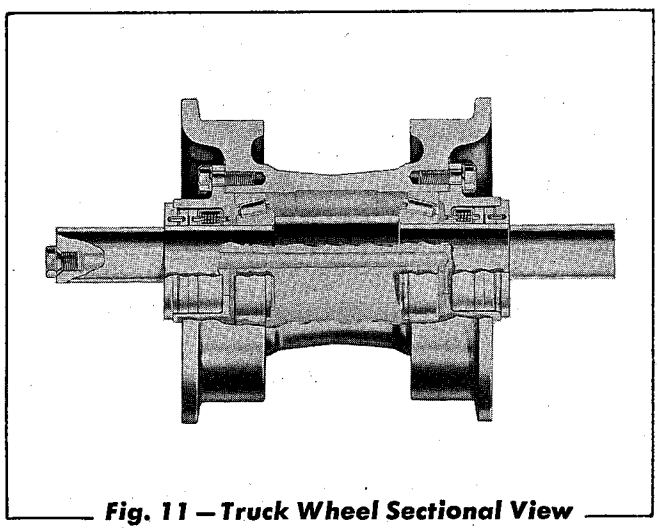


Fig. 11 — Truck Wheel Sectional View

c. Coat the outer face of one lip of the rubber boot and coat the machined face in the bottom of the counterbore in the bearing retainer with neoprene cement. Immediately place the boot and spring assembly in the bearing retainer, inserting the ends of the pins into the corresponding holes in the retainer.

d. Coat the face of the outer lip of the boot and the back face of the seal ring with neoprene cement. Immediately place the seal ring on the boot assembly, inserting the ends of the pins into the corresponding holes in the seal ring.

e. Place a weight on the seal ring, using a clean cloth between the weight and seal ring, and allow the neoprene cement to dry and set thoroughly.

f. Clean the seal guard. Coat one side of the gasket with neoprene cement and place the gasket on the seal guard. Coat the other side of the gasket and the back of the seal ring with neoprene cement, then place the seal ring on the gasket and guard immediately.

g. Place a weight on the seal ring, using a clean cloth between the weight and seal ring, and allow the neoprene cement to dry and set thoroughly.

NOTE: When coating the above parts with neoprene cement, do not use an excessive amount. The neoprene cement and solvent for thinning can be purchased from your nearest "Allis-Chalmers" Dealer.

4. To assemble the wheels proceed as follows:

a. Press the bearings on the shaft until they are seated against the shoulders on the shaft.

b. Install a bearing cup in one end of the truck wheel. Insert the shaft, complete with bearings, into the truck wheel and install the other bearing cup.

c. Install one of the bearing retainers, complete with seal assembly and the original amount of shims, on the truck wheel and tighten the attaching capscrews securely.

d. Install the other bearing retainer, complete with seal assembly and the original amount of shims, on the truck wheel. When tightening the attaching capscrews, turn the shaft occasionally to be certain that an excessive pre-load is not being placed on the bearings. The bearings are properly adjusted when a slight drag (15 to 45 inch pounds pre-load) can be felt when turning the shaft by hand.

If the bearings are too tight or too loose, it will be necessary to remove or add adjusting shims as needed. To do this, remove the bearing retainer, then add or remove the estimated number of shims required, and reassemble. Follow this procedure until the proper pre-load of the bearings is obtained.

IMPORTANT: When adding or removing shims, do not add or remove shims on one side only. The total thickness of the shims required to adjust the bearings should be divided as evenly as possible between the two sides.

e. Coat the mating surfaces of the seal rings with clean oil. Press the seal guards, with the outer seal ring and gasket cemented in place, onto each end of the

shaft. Press the guards on until the outer face is flush with the shoulder on the shaft.

f. Drive or press the truck wheel attaching brackets onto the shaft (lining up the flat surface of the brackets with the flat machined surface on the shaft). Make certain the brackets are up against the shoulders on the shaft.

g. Using a hand grease gun and special lubricating nozzle, fill the truck wheel assembly with the specified grease. Pump the grease in slowly, while holding the nozzle firmly against its seat in the shaft, until grease is forced out the end of the shaft around the nozzle. This will indicate the truck wheel is full. Approximately 2½ pounds of grease is required to fill the standard wheel and 2¼ pounds to fill the heavy duty wheel.

5. To install the wheels, proceed as follows:

a. Install the truck wheel in its proper location of the truck frame, making certain the lubricating plug in the end of the truck wheel shaft is to the outside.

b. Install the truck frame guards.

c. Drive the tractor forward until the blocks used under the rear of the track can be removed. Back the tractor off the blocks used under the front of the track.

d. Adjust the track by turning the track adjusting screw out of the track release yoke as necessary, thus forcing the idler ahead. The track is properly adjusted when the top of the track can be lifted 1½" to 2" off the support rollers with the use of a bar. Run the tractor forward and backward a few times, then check the adjustment of the track. When the correct adjustment is obtained, tighten the capscrews in the track adjusting screw lock.

4. TRACK RELEASE

A. Maintenance

Remove the oil filler plug in the track release housing and inspect the lubricant for contamination and proper level after ever 200 hours of operation. The oil level should be even with the bottom of the tapped hole for the filler plug. If the oil has become contaminated by water or dirt, drain and refill. Since there is no drain plug provided, it is necessary to use a suction pump (rose gun) to remove the oil from the housing.

Periodic checks should be made to assure that the track release mechanism functions properly.

B. Removal of the Track Release

1. Uncouple the track and back the tractor so that the top end of the track is to the rear of the front support roller.

2. Move the track idler forward and remove the yoke assembly.

3. Remove the three (3) lower capscrews attaching the crosshead guide to the track release housing. The lower middle capscrew can be removed by inserting a suitable length socket wrench extension through the opening provided in the truck frame cross member, however, the extension itself must be placed in position before installing the socket.

4. Loosen the remaining six (6) bolts uniformly until the crosshead guide is noticeably loose on the bolts, in other words, until the crosshead guide is no longer forced outward by the spring load. If the force is not relieved after loosening these bolts approximately ⅜", it is an indication that the spring adjusting capscrew (inside the housing) is either broken or out of adjustment, and 1" longer bolts must be used in order to relieve the force on the crosshead guide.

5. The crosshead guide assembly and the spring assembly can then be removed from the housing.

6. The bellcrank may be disassembled by removing the pins which are a press fit in the bellcrank.

7. The spring assembly may be disassembled by compressing the springs sufficiently, to relieve the tension on the spring adjusting capscrew, and removing the capscrew. If no means for compressing the spring is available, clamp the spring assembly to hold it from turning, then remove the capscrew.

C. Installation of the Track Release

The installation of the track release group, for the most part, may be accomplished by direct reversal of the procedure described under "REMOVAL OF THE TRACK RELEASE." However, special attention should be given to the following parts:

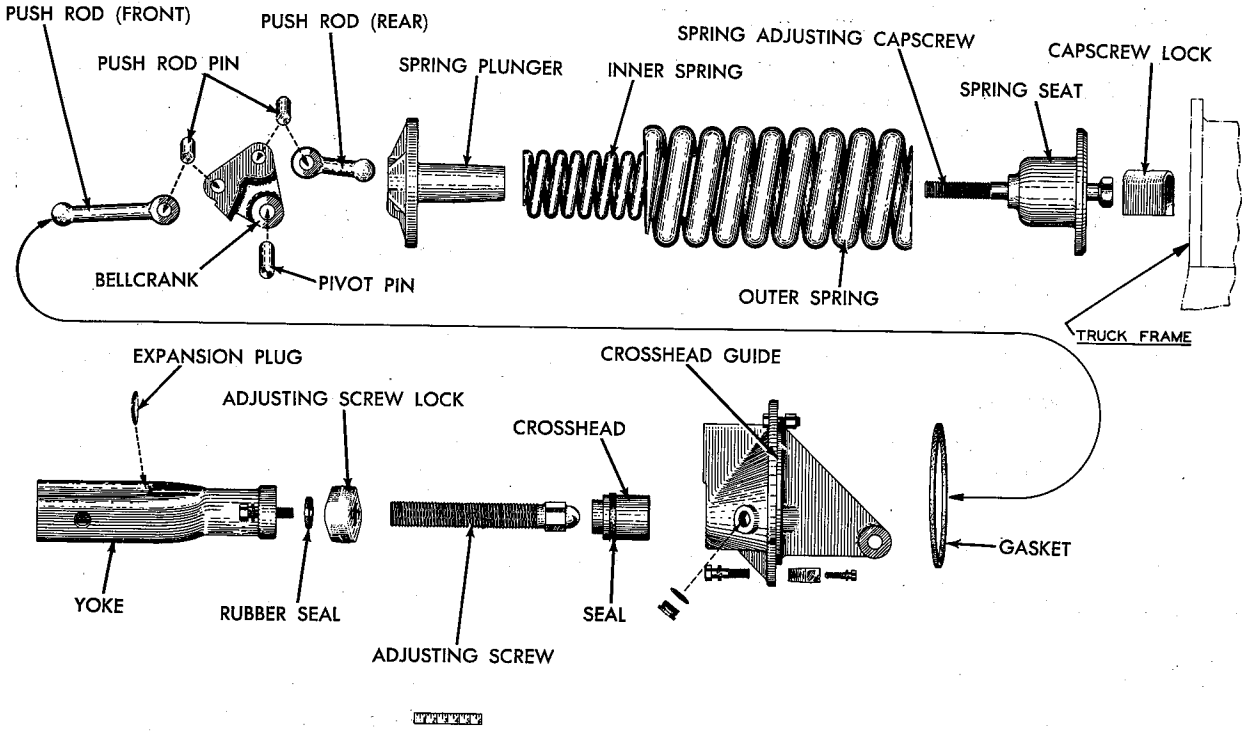


Fig. 12—Track Release Details

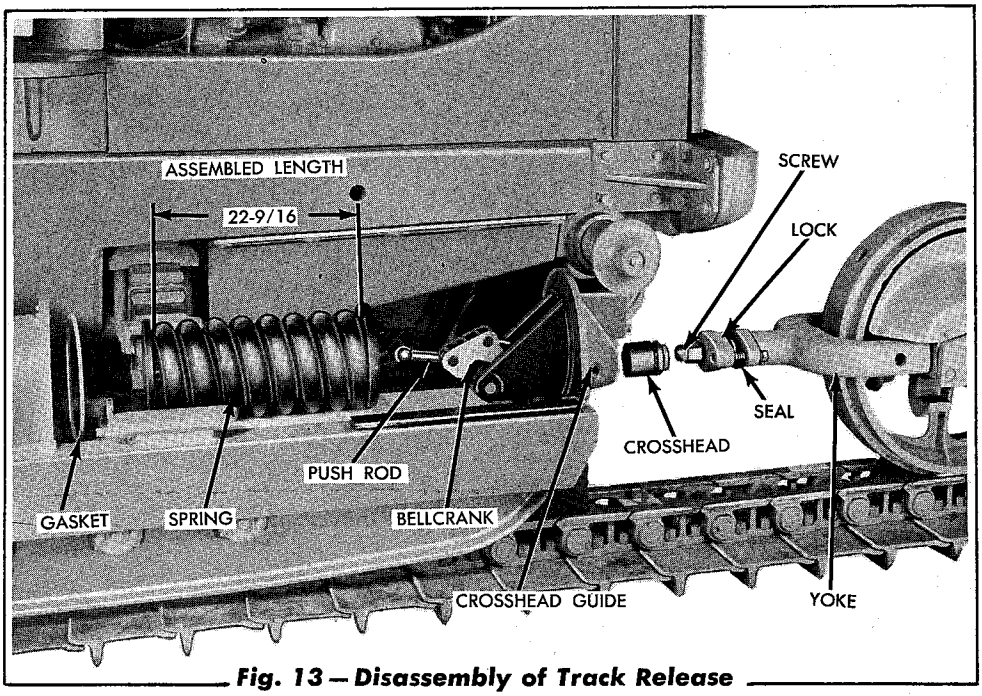


Fig. 13—Disassembly of Track Release

1. The spring assembly must be compressed so that the assembled length of the large spring is 22-9/16". Refer to Fig. 13.

2. Make certain that the capscrew lock is in position over the head of the spring adjusting capscrew.

3. Cement the gasket to the counterbore in the housing.

4. When installing the crosshead guide and crosshead, make certain that the ends of the push rods are properly seated in the spring plunger and the crosshead.

5. SUPPORT ROLLERS

A. Maintenance

Maintenance of support rollers consists of a 1000-hour lubricating period and a periodic check for loose bearings, grease leakage, and excessive wear.

The following checks should be made after each 1000-hours of operation.

1. Raise the track high enough to clear the support rollers.

2. Grasp the roller and check for end play. If end play is found, the roller assembly should be removed immediately and taken to a shop where it can be disassembled, inspected, and rebuilt. *NOTE: If grease leakage through the seals is noted at any time, the support roller should be removed and checked for bearing end play and the seals inspected. Grease leakage is one indication of loose bearings.*

B. Removal of Support Roller

1. Raise and block the track so that it clears both support rollers.

2. Remove the bolts attaching the support rollers to the crosshead guide and the track release housing.

C. Disassembly of Support Roller

1. Wash and clean the outside of the support roller assembly thoroughly.

2. Place the support roller assembly in a press and press each support roller off the shaft.

   NOTE: A press having approximately 20 ton capacity is needed to press the support rollers off the shaft.

3. Wash and clean the outside of the bearing retainers thoroughly after removing the sup-

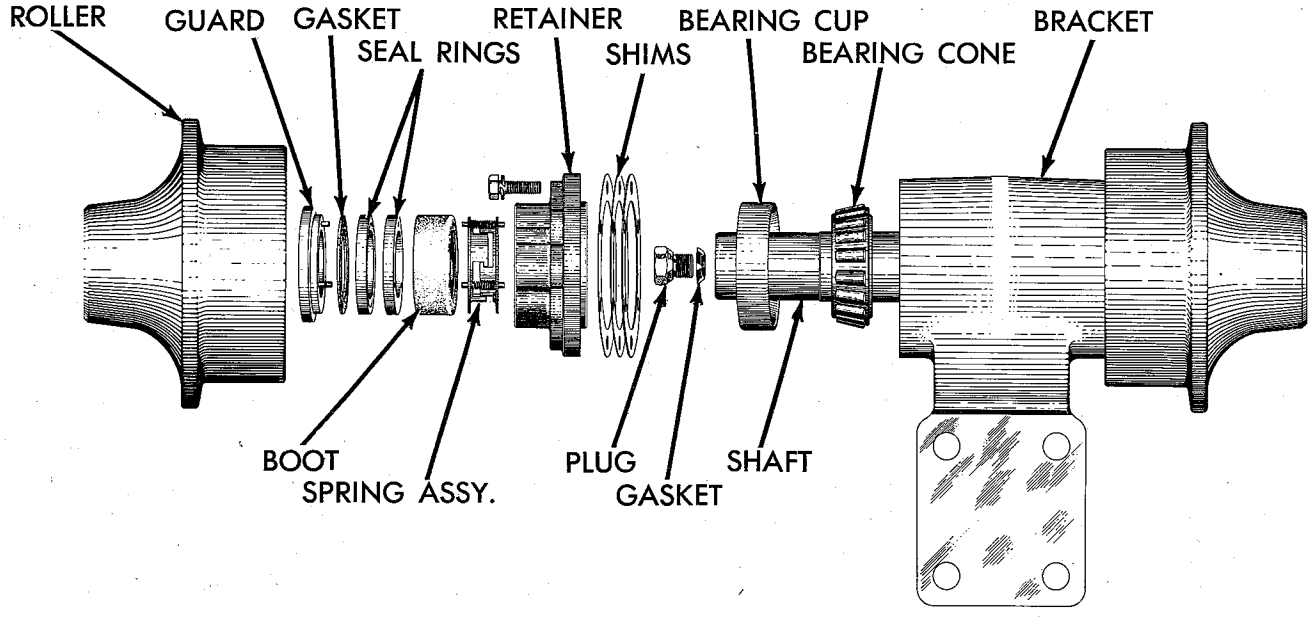


Fig. 14—Track Support Roller Details

port rollers. Clamp the support roller bracket in a vise so that the assembly can be dismantled.

4. Remove the capscrews attaching the bearing retainers to the support roller bracket. *IMPORTANT: When disassembling, keep the parts separated so that they can be reassembled in their original positions.*

5. Three (3) equally spaced tapped holes are provided in each bearing retainer for a means of removal. Using three (3) ⅜" N.C. puller bolts in these holes, turn the bolts in evenly to pull the bearing retainers, including the seal assemblies, off the shaft. *CAUTION: USE CARE AND DO NOT SCRATCH OR DAMAGE THE SEAL RINGS.*

6. Press on the end of the support roller shaft to remove the bearing cups and shaft from the bracket.

D. Inspection of Support Roller

1. Wash and clean the parts thoroughly before inspecting. Make certain that the grease passage in the shaft is open.

2. Make a visual examination of the shaft and bearings. If the bearings and cups show excessive wear, or if they are pitted, they must be replaced. If the bearing cups are found to be loose in bearing bores of the bracket, the bracket should be replaced.

3. Examine the sealing surfaces of the mating seal rings for scratches, nicks, or burrs, as these faces MUST be smooth and flat. If the sealing surfaces are scratched or damaged in any way, both mating seal rings must be replaced.

4. Examine the rubber seal boot in each bearing retainer and make certain that it is firmly cemented in place. The inner face of the boot lips should be firmly cemented to the ends of the seal spring assembly. The back face of the seal ring should be firmly cemented to the outer lip of the boot, and the inner lip of the boot should be firmly cemented to the machined face in the counterbore of the bearing retainer. No cement is used on the O.D. or the I.D. of the boot since it is necessary for the boot to flex in following the spring action.

   Examine the boot and make sure the rubber is pliable and the boot is in good condition. If the boot and seal ring are in good condition and are firmly cemented in place, do not remove.

5. Examine the support roller seal guard assembly and make certain that the gasket and seal ring are firmly cemented to the guard.

E. Assembly of Support Roller

1. Make certain all the parts are clean.

2. If a new seal assembly is to be installed in the bearing retainers, the seals should be installed at this time so that the neoprene cement, used for cementing the assembly in place, will have sufficient time to dry.

   NOTE: The installation of a new seal assembly in the support roller may be accomplished by referring to the procedure described under "E" in "TRUCK WHEELS" of this section.

3. Press the bearings onto the shaft until they are seated against the shoulders on the shaft.

4. Install a bearing cup in one end of the bracket. Insert the shaft with the bearings in place into the bracket and install the other bearing cup.

   CAUTION: When installing the shaft, make certain that the end with the grease plug will be to the outside when installed in place on the tractor.

5. Install one of the bearing retainers, complete with seal assembly and the original amount of shims, on the bracket and tighten the attaching capscrews securely.

6. Install the other bearing retainer, complete with seal assembly and the original amount

of shims, on the bracket. When tightening the attaching capscrews, turn the shaft occasionally to be certain that an excessive pre-load is not being placed on the bearings. The bearings are properly adjusted when a slight drag (15 to 45 inch pounds pre-load) can be felt when turning the shaft by hand.

If the bearings are too tight or too loose, it will be necessary to remove or add adjusting shims as needed. To do this, remove the bearing retainer, then, add or remove the estimated number of shims required, and reassemble. Follow this procedure until the proper pre-load of the bearings is obtained. *IMPORTANT: When adding or removing shims, do not add or remove shims on one side only. The total thickness of the shims required to adjust the bearings should be divided as evenly as possible between the two sides.*

7. Coat the mating surfaces of the seal rings with clean oil. Press the seal guards, with the outer seal ring and gasket cemented in place, onto each end of the shaft. Press the guards on until the outer face is flush with the shoulder on the shaft.

8. Press the support rollers (wheels) on to the shaft until they bottom against the shoulders on the shaft.

9. Using the hand grease gun and special lubricating nozzle, fill the support roller assembly with the specified grease. Pump the grease in slowly, while holding the nozzle firmly against its seat in the shaft, until grease is forced out the end of the shaft around the nozzle. This will indicate the roller is full. Approximately 1½ pounds of grease is required to fill the support roller assembly.

10. The support roller may now be installed on the tractor by a direct reversal of the removal procedure.

6. TRACK IDLERS

A. Maintenance

Maintenance of the track idlers consists of a 1000-hour lubricating period and a periodic check for loose bearings, grease leakage, and excessive wear.

The following checks should be made after each 1000-hours of operation:

1. Remove the track idler guards. Loosen the capscrews in the track adjusting screw lock and turn the adjusting screw into the idler yoke and release the track tension.

2. Place a block of wood in front of the track and move the tractor forward until the block is under the first truck wheel. This will insure that no load is being carried on the idler, other than the section of the track which it supports.

3. Using a bar approximately 5 foot long, pry against the idler bearing retainer and check for end play. If end play is found, the idler assembly should be removed from the tractor for disassembly and inspection, and rebuilt.

NOTE: If at any time grease is noted leaking from the seals, the track idler should be removed and disassembled and all parts inspected. Grease leakage is one indication of loose bearings.

B. Idler Slide Bars and Alignment

1. Inspect the upper and lower track idler slide bars bolted to the truck frames. If they are worn excessively they must be turned or replaced, to renew the wearing surfaces. Add or remove shims between the lower slide bars and the truck frames to provide a sliding fit between the track idler brackets and the slide bars.

2. If the track idler flange is wearing unevenly or cutting on one side, because it is not centered in the track rail assembly, adjust. Remove the track idler guiding plates and move

sufficient shims from the side which shows no wear to the side which shows excessive wear. Reinstall the guiding plates.

C. Removal of Track Idler

1. Move the tractor until the master track pin is at the lower front face of the track idler. The master track pin can be identified as being longer than the standard track pins, protruding approximately ⅛" beyond the boss in the side bars.

2. Release the tension of the track and drive the master track pin out with a sledge hammer and a driving bar. Uncouple the track and move the tractor backward until the top of the track is free of the track idler.

3. Remove the track idler assembly from the truck frame by sliding the idler forward until it is free of the frame.

D. Disassembly of Track Idler

1. Remove the track idler guards and clean the track idler thoroughly.

2. Remove the track idler guiding plates and tie the spacing shims to the plates to facilitate alignment of the track idler when reassembling. Remove the clamping bolts from the track idler bracket assemblies. Spread the track idler brackets, using a broad faced chisel, and drive the brackets off the track idler shafts.

3. Remove the capscrews attaching the bearing retainers to the track idler. Each track idler bearing retainer is provided with three (3) holes, tapped for ½" N.C. bolts, to be used for removal. Use three (3) ½" N.C. puller bolts and remove the bearing retainers and seal assembly, being careful to pull the retainer evenly so that the seal assembly will not be damaged. *NOTE: Keep all parts separated so that the track idler may be rebuilt with the same parts if they are found satisfactory on examination.* Keep all parts clean and protected against dirt at all times. Be careful and do not scratch or damage the seals in handling.

4. Press on the end of the idler shaft to remove the bearing cups and shaft from the track idler.

E. Inspection of Track Idler

1. Wash all parts thoroughly before inspection. Make certain that the grease passage in the idler shaft is clean.

2. Make a visual examination of the shaft and bearings. If the bearings or the cups show excessive wear, or if they are pitted, they must be replaced. If the bearing cups are found to be loose in the bore in the idler hub, replace the necessary parts.

3. Examine the sealing surfaces of the mating seal rings for scratches, nicks, or burrs as these surfaces MUST be smooth and flat. If the sealing surfaces are scratched or damaged in any way, both mating seal rings must be replaced.

4. Examine the rubber seal boot in each bearing retainer and make certain that it is firmly cemented in place and forms an oil proof bond between the mating parts. The inner faces of the boot lips should be firmly cemented to the ends of the spring assembly. The outer face of one lip of the boot should be firmly cemented to the bottom of the counterbore in the bearing retainer, and the outer face of the other lip should be firmly cemented to the inner seal ring. No cement is used on the I.D. or the O.D. of the rubber seal boot as it is necessary that the outer part remain flexible to follow the action of the springs in the follower assembly.

   Examine the boot and make sure the rubber is pliable and the boot is in good condition. If the boot and seal ring are in good condition and are firmly cemented in place, do not remove.

5. Examine the track idler seal guard assembly and make certain that the gasket and the seal ring are firmly cemented to the guard.

F. Assembly of Track Idler

1. Make certain all parts are clean.

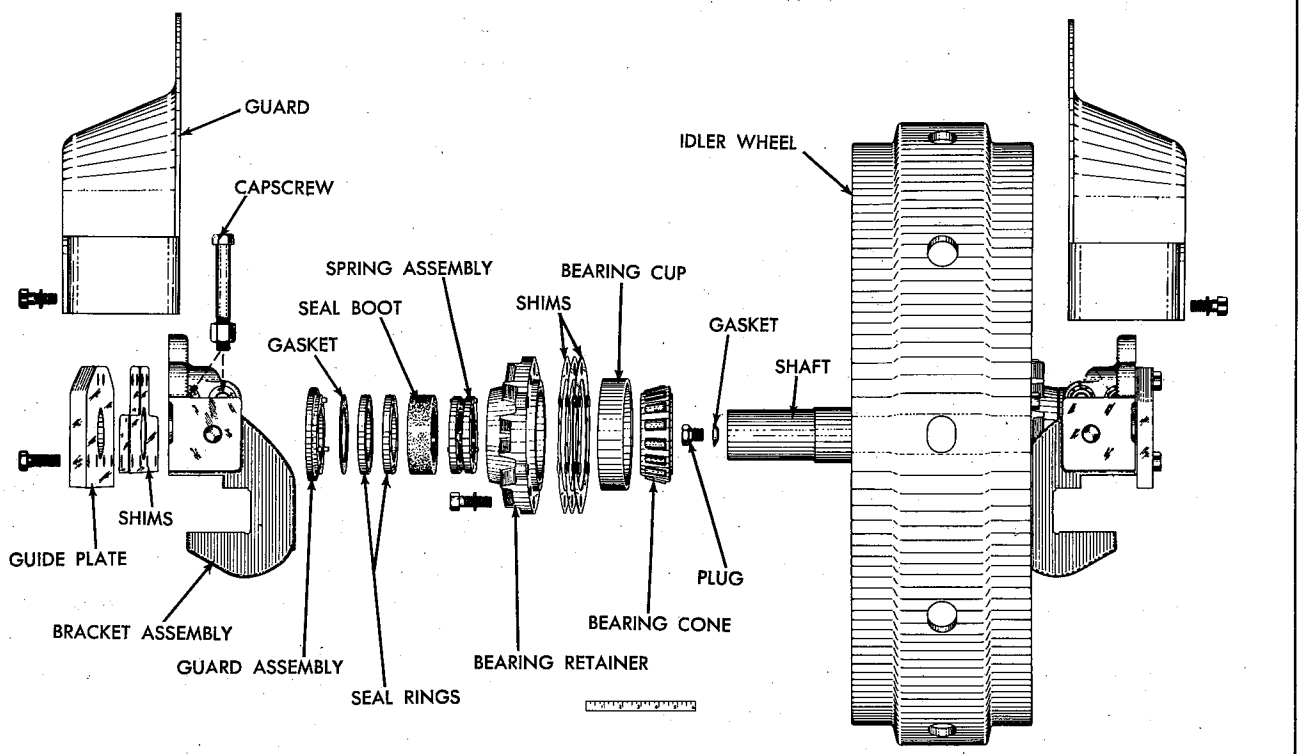


Fig. 15—Track Idler Details

2. If a new seal assembly is to be installed in the bearing retainers, the seals should be installed at this time so that the neoprene cement, used for cementing the assembly in place, will have sufficient time to dry.

   NOTE: The installation of a new seal assembly in the track idler may be accomplished by referring to the procedure described under "E" in "TRUCK WHEELS" of this section.

3. Press the bearings onto the shaft until they are seated against the shoulders on the shaft.

4. Install a bearing cup in one end of the idler hub. Insert the shaft with the bearings in place into the idler hub and install the other bearing cup.

5. Install one of the bearing retainers, complete with seal assembly and the original amount of shims, onto the idler hub and tighten the attaching capscrews securely.

6. Install the other bearing retainer, complete with seal assembly and the original amount of shims, onto the idler hub. When tightening the attaching capscrews, turn the shaft occasionally to be certain that an excessive pre-load is not being placed on the bearings. The bearings are properly adjusted when a slight drag (15 to 45 inch pounds pre-load) can be felt when turning the shaft by hand.

   If the bearings are too tight or too loose, it will be necessary to remove or add the necessary adjusting shims. To do this, remove the bearing retainer, then add or remove the estimated number of shims required, and reassemble. Follow this procedure until the proper pre-load of the bearings is obtained.

   IMPORTANT: When adding or removing shims, do not add or remove shims on one side only. The total thickness of the shims required to adjust the bearings should be divided as evenly as possible between the two sides.

7. Coat the mating surfaces of the seal rings with oil. Press the seal guards, with the outer seal ring and gasket cemented in place, on

to each end of the shaft. Press the guards on until the outer face is flush with the shoulder on the shaft.

8. Spread the track idler brackets using a broad faced chisel. Drive or press the brackets on to the track idler shaft until they bottom against the shoulder on the shaft. When installing the brackets on the shaft make certain that the lower machined surfaces of the brackets are parallel to each other so that they will set flat on the truck frame. *CAUTION: When installing the idler brackets on the shaft, make certain that the brackets are so positioned that the grease plug in the end of the idler shaft will be to the outside when the idler is installed on the tractor.*

9. Using the hand grease gun and special lubricating nozzle, fill the track idler assembly with the specified grease. Pump the grease in slowly, while holding the nozzle firmly against its seat in the shaft, until grease is forced out the end of the shaft around the nozzle. This will indicate the idler is full. Approximately 5 pounds of grease is required to fill the idler.

G. Installation of Track Idler

1. Install the track idler on the truck frame.

2. Install the clamping bolts in the track idler brackets.

3. Install the track idler guiding plates in their original positions with their original shim pack. Sufficient shims should be added or removed to provide a sliding fit between the track idler bracket and the slide bars. If necessary, the track idler may be aligned with the track by moving shims from one track idler guiding plate to the other guiding plate as explained in "IDLER SLIDE BARS AND ALIGNMENT" in this Section.

4. Install the track idler guards.

5. Couple the track and adjust. Refer to "TRACK" Section XVII, for installation and adjustment of the track.

SECTION XVI—DRAWBAR

1. DESCRIPTION

The drawbar group consists of a drawbar, hinge pin, hinge pin bracket, lock pin, coupling pin, lock shaft and arm assembly, two (2) shoes (wear plates), drawbar plate, and two (2) drawbar plate brackets. Refer to Fig. 1.

One end of the drawbar attaches to the lower front face of the steering clutch and final drive housing by means of a hinge pin bracket and hinge pin; the other end which incorporates the lock pin, coupling pin, lock shaft and arm assembly, and shoes, is supported by the drawbar plate. The drawbar plate attaches to the rear face of the steering clutch and final drive housing with two (2) brackets.

The drawbar and shoes may swing from side to side on the drawbar plate, or they can be held rigid, in various positions, by a series of holes provided in the drawbar plate and the use of the lock pin. Both the lock pin and the coupling pin are held in position by the lock shaft and arm assembly.

2. SERVICE

The bolts and capscrews attaching the hinge pin bracket and the drawbar plate brackets should be checked periodically to make certain that they are tightened securely.

A. Removal and Inspection

1. Disconnect the drawbar from the hinge pin bracket by removing the hinge pin retaining plate and hinge pin.
2. The drawbar and drawbar plate can then be removed by removing the capscrews at each end of the drawbar plate. Replace or repair any parts that show excessive wear.

B. Installation

The drawbar assembly may be installed by direct reversal of the procedure outlined under "REMOVAL AND INSPECTION" in this section.

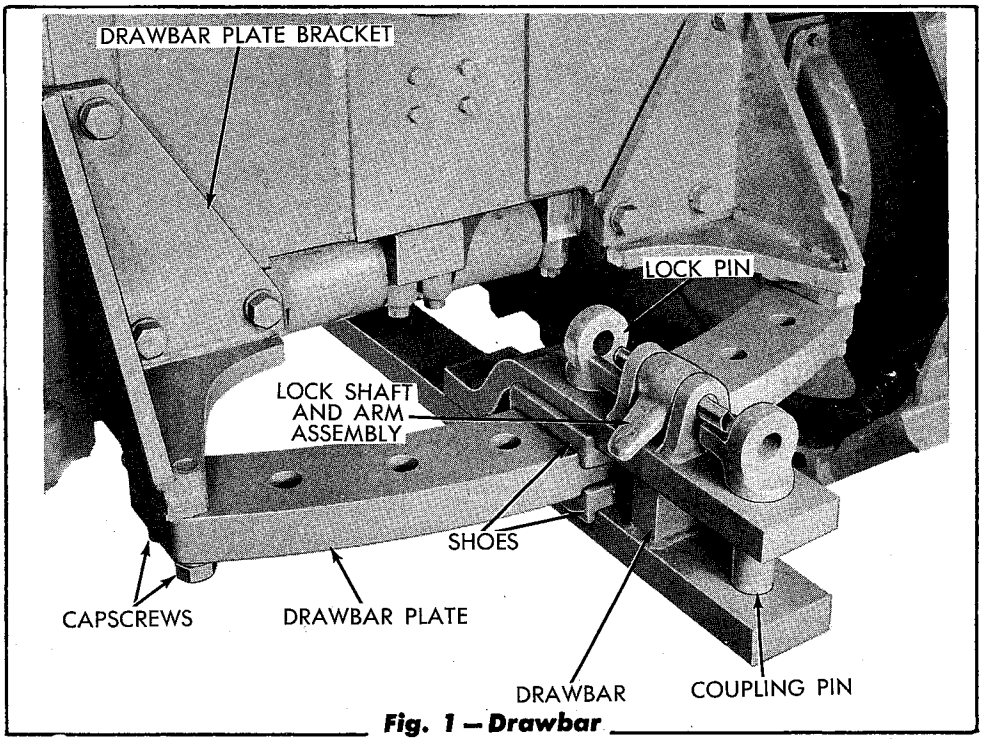


Fig. 1 — Drawbar

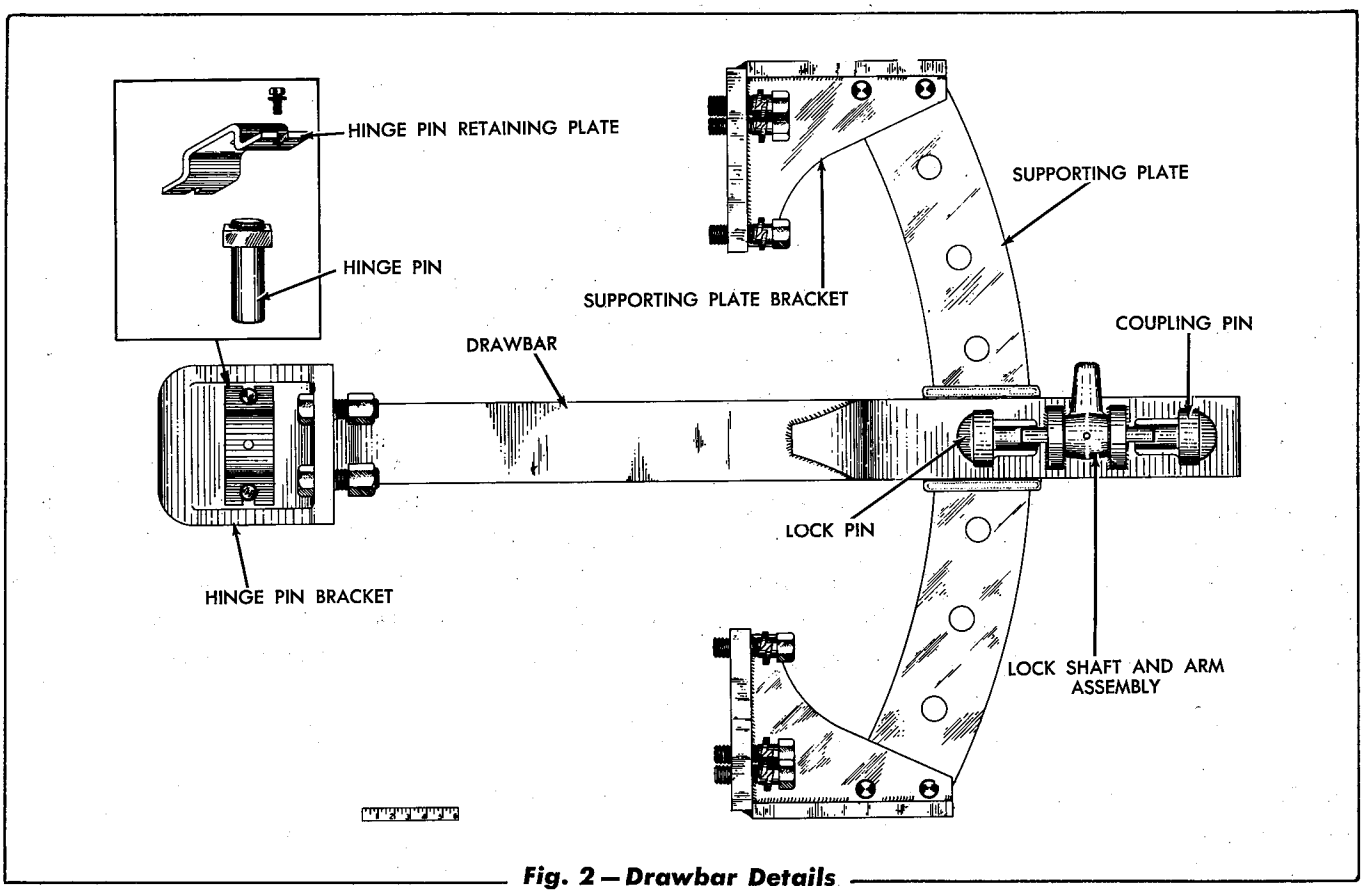


Fig. 2 — Drawbar Details

SECTION XVII—TRACKS

1. DESCRIPTION

The standard (Model HD-20H) track rail assembly consists of thirty-seven (37) links. Each track rail assembly is made up of two (2) side bars (right and left), pins, bushings, and grouser shoes. The master link, for coupling the track together, has a master bushing which is 1-5/16" shorter than the other thirty-six (36) bushings and is provided with two ⅝" wide spacers which are used at each end of the bushing. These spacers fit in a recess on the inner sides of the side bars. A master pin, which is 5/16" longer and slightly smaller in diameter than the other pins, is provided to facilitate the coupling and uncoupling of the track.

There are several different types and lengths of track shoes available; each adapted to a particular application, but the most common or standard shoe is essentially a flat plate having one (1) cleat or grouser which is rolled integral with the plate and extends its full length.

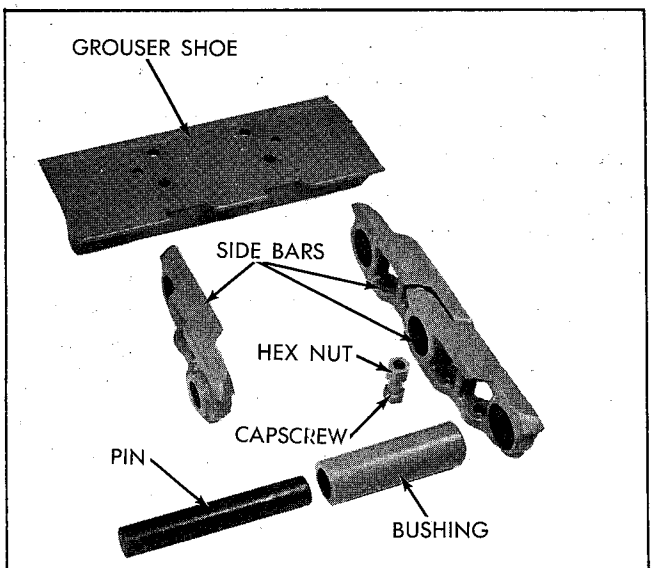


Fig. 1—Track Details

2. SERVICE AND INSPECTION

Periodic care of the tracks will materially prolong their useful life. Probably because of the apparent simplicity of the track, the average owner and operator may give very little thought to the factors that tend to affect its life.

Of utmost importance is the matter of keeping the track properly adjusted and the track shoe bolts properly tightened. The bolts should be tightened using 500 to 550 foot pounds torque.

The rail links, or side bars, have only one wearing surface, that being the surface which contacts the truck wheels, track idler, and the support rollers.

Usually, however, it becomes necessary to replace the pins and bushings before the rails wear out and it is a matter of judgment then as to whether or not the links are good enough to justify the installation of a new set of pins and bushings.

The pins and bushings, and their relation to each other and to the sprockets, constitute the most important factor in track life. Since only the external wear on the bushings is apparent, some means other than visual inspection must be used to determine the amount of wear on the pins and on the bore of the bushing. The amount of "stretch" in the track, as indicated by the take-up on the track adjusting screw, is usually regarded as an index to the condition of the interior wear on the bushings and the wear on pins. However, this must be considered in connection with the external wear on the bushings in order to determine the proper time for turning the pins and bushings.

When the pins and bushings are pressed out of the track, turned 180° and reinstalled, new surfaces are brought into contact between the pin and bushing, and between the bushing and the sprocket. If this operation is performed at the right time, track life will be prolonged.

It must be remembered too, that as the tracks wear

and the pitch length increases, the point of contact of the bushings on the sprocket teeth changes. Any appreciable wear at the base of the sprocket tooth tends to decrease its pitch, whereas, an increase in wear of the track pins and bushings increases its pitch length. As a result, the track bushings are inclined to ride higher on the sprocket teeth. In such case, the sprockets will finally spin in the tracks. Under no condition should the combined wear of the sprockets and tracks be allowed to reach the stage where such spinning of the sprockets can occur, as this causes extremely severe repeated shock to the tractor and may result in serious breakage.

It is always preferable to install new sprockets with new tracks, however, this may not always be possible. When new tracks are to be used with old sprockets, it is suggested that the right and left sprocket be interchanged, thus presenting the better side of the sprocket tooth to the bushings of the new track.

The pitch length of a new track (distance between centers of track pins) is 9.000". The maximum allowable pitch length for a used track is 9.250."

Some owners have erroneously adapted the practice of removing one link in order to bring the track again within the range of the adjustment screw. This should never be done, as a track worn badly enough to take up the length of one (1) link, (9 inches), will be so far out of pitch that the increased wear on the sprocket will far more than counteract the saving that may be obtained by further life on the track.

Occasionally, under extremely abrasive conditions, the sprocket tooth may wear deep enough into the bushing to justify turning the pins and bushings before any appreciable wear shows on the inside of the bushing and on the pins. In other words, the pitch length of the track may only slightly exceed the pitch length when new but the outer diameter of the bushing will show very heavy wear. In any case, the remaining thickness of the bushing is the determining factor. Pins and bushings must be turned before the bushing wears through and the pin is destroyed, or before the bushing becomes thin enough to allow it to crack in service.

A. Track Adjustment

The tracks are correctly adjusted when the upper part of the tracks can be lifted 1½" to 2" above the support rollers with the use of a bar. *IMPORTANT: Run the tractor backward and forward a few times before checking the adjustment of the track.* Proper adjustment is important because rapid wear of the tracks and other affected parts will occur if the tracks are too tight or too loose.

To adjust each track, loosen the capscrews in the adjusting screw lock nut, then turn the adjusting screw out of the idler yoke, to force the track idler ahead and tighten the track, or turn the screw into the yoke to loosen the track. Run the tractor forward and backward a few times and check the adjustment of the track. When correct adjustment of the track is obtained, tighten the capscrews in the lock nut.

B. Track Removal

1. Move the tractor until the master pin is at the lower front face of the track idler. The master pin can be identified as being longer than the standard pins and protrudes approximately ⅛" beyond the boss in the side bar.

2. Loosen the capscrews in the adjusting screw lock and turn the adjusting screw into the track release yoke until the track is loose.

3. Hold a "bucking bar" on the inside rail close to the master pin.

4. Drive the master track pin out with a sledge hammer and a driving bar. Uncouple the track and move the tractor backward until the track is free of the track sprocket.

C. Track Installation

1. Place the track under the truck frame with open end of links to rear of the tractor.

2. Place an 8" block under the grouser (cleat), of the first track shoe.

3. Place a bar through the pin hole in rear end of track.

4. Now move the tractor backward until the bar may be hooked over a tooth of the sprocket. Drive the tractor forward holding the bar firmly in place so the track will roll around the sprocket.

5. Hold the track up so it will go over the support rollers and the track idler.

6. Remove the bar and line up the holes in the ends of the track; make certain that the 5/8" spacers at each end of the master bushing, are in position.

7. Drive the master pin in place allowing an equal amount of the master pin to extend through on each side of the rail.

8. Adjust the track. Refer to "TRACK ADJUSTMENT" in this section.

SECTION XVIII—MAIN FRAME AND EQUALIZER SPRING

1. GENERAL DESCRIPTION

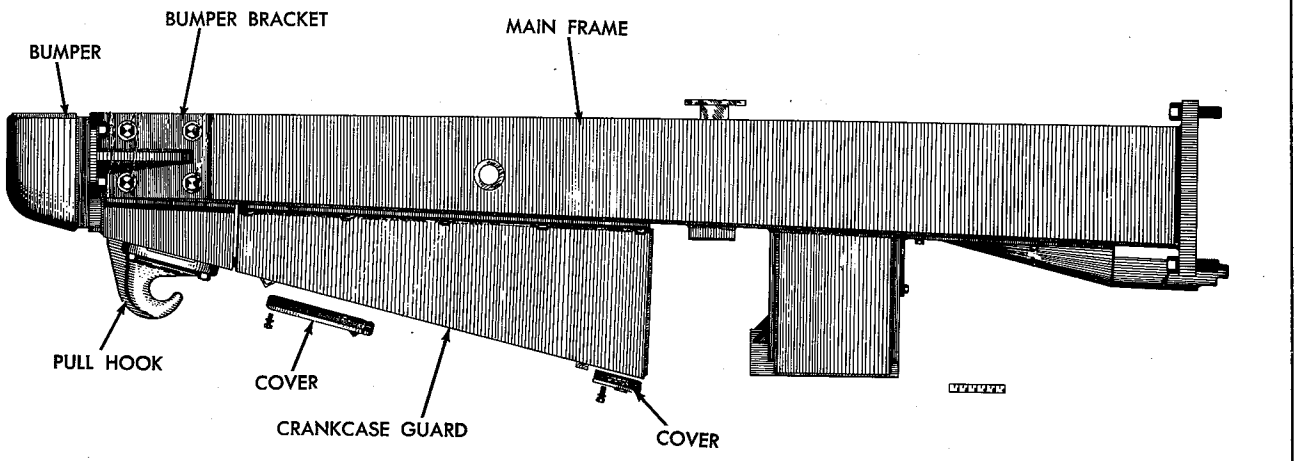


Fig. 1—Main Frame

A. Main Frame

The main frame is a one piece welded steel structure. The rear end of the main frame is bolted to the steering clutch and final drive housing, and is attached to, and supported by, an equalizer spring.

B. Crankcase Guard

The engine crankcase guard is a pressed steel plate bolted to the main frame for protection of the engine crankcase and the underside of the tractor. Removable plates in the bottom of the guard are provided for draining the engine oil and coolant.

2. MAIN FRAME

A. Maintenance and Inspection

The main frame should be checked periodically for loose bolts, cracked welds, bending and misalignment. Any of the above conditions should be corrected immediately.

B. Repair

If the main frame becomes cracked or broken because of unusually rough work, it may be practical to weld the cracks and reinforce the frame with suitable steel plates. Before welding the frame it should be checked for alignment and straightened if necessary.

If it is not practical or desirable to straighten or weld the frame, it may be replaced.

3. CRANKCASE GUARD

A. Maintenance and Inspection

The crankcase guard should be checked periodically for loose bolts and dents which may cause damage to the engine crankcase. If the crankcase guard becomes dented it should be removed and straightened or replaced. Never operate the tractor without the crankcase guard in place, as it is essential that the crankcase oil pan be guarded at all times against obstructions. Periodically clean all debris from the inside of the crankcase guard.

B. Removal

1. Support the crankcase guard with suitable cribbing or jacks, then remove the attaching capscrews.
2. Remove the crankcase guard.

C. Installation

1. Support the crankcase guard in position for installation. Then install the attaching capscrews, locks, and nuts and tighten securely.
2. Remove the cribbing or jacks used to support the crankcase guard.

4. EQUALIZER SPRING

A. Maintenance and Inspection

Maintenance of the equalizer spring consists of periodic checks for loose bolts and excessive wear of equalizer spring seats and the saddle assembly. If the spring saddle capscrews are broken or will not tighten they should be replaced. Broken spring leaves should be replaced immediately. The spring assembly must be removed when installing new spring leaves.

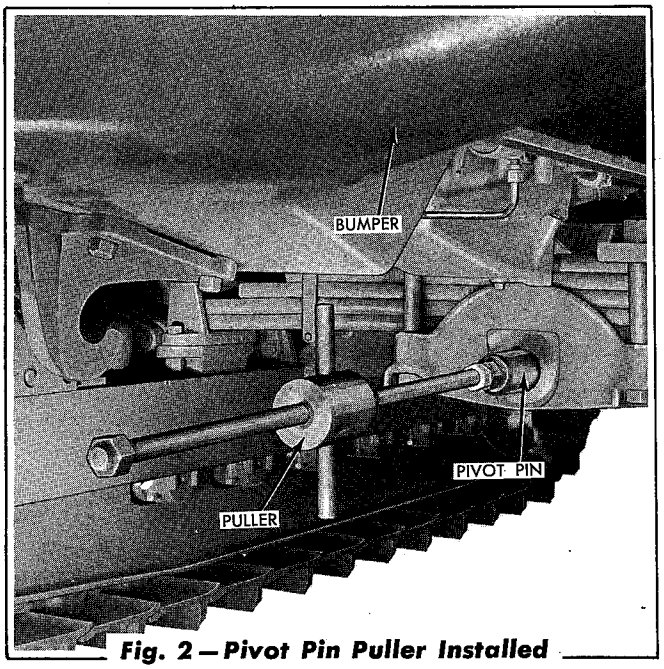


Fig. 2—Pivot Pin Puller Installed

B. Removal

1. Remove the crankcase guard. Refer to "CRANKCASE GUARD REMOVAL" in this section.
2. Remove the capscrews attaching one spring seat to the truck frame.
3. Apply the brakes and lock them in position.
4. Remove the attaching capscrews and remove the retainer plates from the front and rear of the equalizer spring pivot pin.
5. Using a chain hoist or jack, raise the front end of the tractor and block the main frame securely so that the free end of the spring is approximately 8" off the truck frame.
6. Install the sliding hammer type puller as shown in Fig. 2 and remove the equalizer spring pivot pin. The free end of the equalizer spring should be supported with a block when pulling the pin.
7. Push the spring to the side and allow it to fall on the ground. Remove the spring from beneath the tractor.

C. Disassembly

1. Remove the bolts from the rebound clips.
2. Remove the spring saddle capscrews.

3. Remove the spring from the saddle assembly and place the spring in a suitable vise or press.

4. Compress the spring and remove the center bolt.

5. Disassemble the spring. Clean all the mating surfaces of the spring leaves, seats, saddle assembly, and spring saddle bolts with a wire brush. Clean all new parts to be installed. Do not lubricate the spring leaves.

D. Assembly

1. Using a guiding pin in place of the center bolt, assemble the spring leaves in a suitable vise or press. Compress the spring leaves fully.

2. Remove the guiding pin and install the center bolt and tighten securely.

3. Install the rebound clip bolts, compressing the spring as necessary.

4. Remove the assembled spring from the vise and assemble the spring with the saddle assembly. Tighten the saddle capscrew nuts securely.

E. Installation

1. Position the spring right side up on the ground under the tractor with one end near the truck frame mounting bracket (spring seat removed) and the other end forward.

2. Use a hoist to place the spring on the truck frame having the spring seat removed, and chain the spring to the allied equipment mounting pad. Push the spring around under the spring mountings.

3. Use the hoist to raise the other end of the spring, using a suitable block between the end of the spring and the truck frame to keep the end of the bottom spring leaf from digging into the truck frame. Put the spring in position on the seat. Lubricate the pivot pin hole and the pivot pin.

4. Move the hoist to the other end of the spring and raise the spring to align the pivot pin holes. Install the pivot pin and the spring seat.

5. Install the pivot pin retainer plates, remove the cribbing, lower the tractor and install the bolts attaching the spring seat to the truck frame.

6. Install the crankcase guard as explained in "CRANKCASE GUARD INSTALLATION," in this section.

SECTION XIX—FENDER AND SEAT GROUP

1. FENDERS

A. Front Fenders

Two front fenders are provided to protect the lower sides of the engine and serve as mountings for the hood side plates which may be obtained as special equipment.

The fenders may be removed by removing the attaching bolts and capscrews. When reinstalling the front fenders, the attaching bolts and capscrews should all be started before any of them are tightened.

B. Rear Fenders

The rear fender group protects the operator, seats, fuel tank, and battery boxes from debris carried by the tracks and serves as a mounting for the cowl, battery boxes, fuel tank, and seats.

2. SEATS

The tractor is provided with two seats. The right seat may be removed, if desired, for such applications as scraper or winch work. The left seat is adjustable in height. Arm rests are provided which also serve as battery box covers. Both the seat cushions and arm rests are replaceable and are covered with weather resistant material.

Reasonable care should be taken to avoid damaging the seat cushions with sharp or heavy objects, unnecessary exposure, battery acids, oils, and greases.

SECTION XX—SPECIAL EQUIPMENT

1. GENERAL

Special Equipment, mentioned in this section, may be purchased separately for field installation or the tractor may be ordered with the equipment factory installed. For a more complete list of available special equipment, contact your "Allis-Chalmers" Dealer.

2. GUARD EQUIPMENT

The standard tractor is equipped with a full width crankcase guard, a bumper, hinged radiator grille, fan guard, truck wheel guards, track idler guards, and sprocket guards. Additional protecting guards are available to protect vital parts of the tractor if they are desired.

A. Logging Guard Equipment

Logging guard equipment includes a fuel tank and seat guard group, heavy rear fenders, a bottom guard group, a heavy mesh grille screen, and engine side screens.

B. Heavy Fenders

Heavy fenders replace the standard rear fenders and serve as mountings for the battery boxes, fuel tank, and seat guard group, refer to Fig. 1.

C. Fuel Tank and Seat Guard Group

The fuel tank and seat guard group consists of a heavy guard and rear fenders designed to protect the fuel tank and seats. The fuel tank guard is mounted to the heavy fenders and to the rear of the steering clutch and final drive housing (refer to Fig. 1).

D. Bottom Guard Group

The bottom guard group consists of a heavy front section, which replaces the standard crankcase

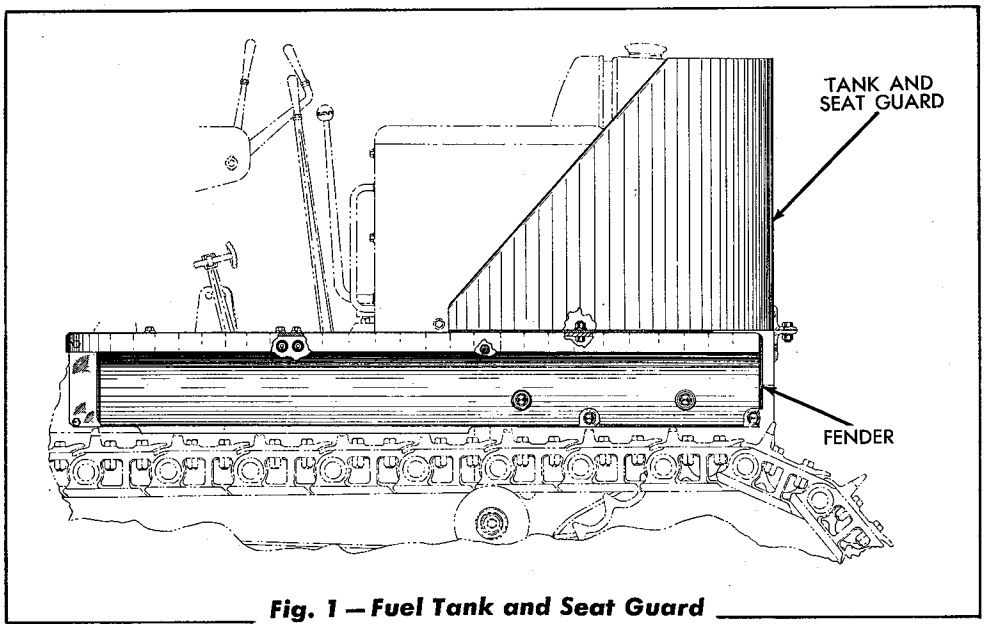


Fig. 1 — Fuel Tank and Seat Guard

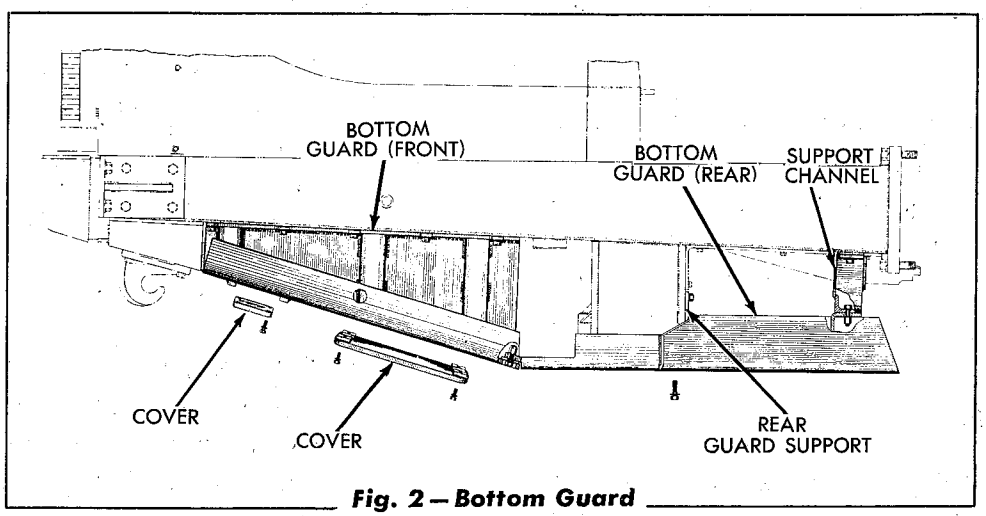


Fig. 2 — Bottom Guard

guard, and a heavy rear section which protects the truck frames and the steering clutch and final drive housing. The bottom guard group gives the tractor a smooth underside and the tractor is less likely to hang up on stumps or rocks.

The bottom guard group is attached to the tractor with capscrews and requires only periodic maintenance checks. The attaching capscrews should be kept tight.

E. Heavy Mesh Grille Screen and Engine Side Screens

The radiator grille screen has a heavy mesh and should not be confused with a "bug screen." The grille screen is bolted to the outside of the radiator grille and does not interfere with opening and closing of the hinged radiator grille.

The engine side screens fasten to the front fenders and hood. They protect the engine from debris with a minimum of air restriction.

3. HOOD SIDE PLATES

Solid hood side plates are available for cold weather use. They hook to the hood and fasten to the fenders with over center spring loaded snap fasteners.

4. PUSHER TYPE FAN

A pusher type fan is available as a substitute for the standard fan if tractor operation makes its use desirable.

Installation

Refer to "REMOVAL OF FAN" in Section IV. Remove the suction fan and fan spacer. *Discard the fan spacer and suction fan attaching capscrews.* Install the pusher type fan with the capscrews provided.

5. PUSHER PLATE

A. Description

The pusher plate for the HD20 Tractor is of the adjustable type, making it applicable to most pusher operations. The adjustment is accomplished by removing two upper pins, raising or lowering the pusher plate to the desired position, and inserting the pins in the alternate set of pin holes on the pusher plate.

B. Installation

1. To install the pusher plate it will be necessary to rework the radiator grille as outlined below. To avoid confusion the right and left sides of the grille will be determined as viewed from the front (facing the grille) when reworking.

   a. Use a cutting torch and cut the radiator grille frame on the right side (viewed from the front). Make two cuts. Make the first cut just above the fifth round horizontal grille bar from the bottom of the grille. Make a second cut just below the sixth round horizontal grille bar.

   b. Cut through the five (5) vertical grille support bars (flat bars), making two cuts on each bar, above the fifth round horizontal grille bar and just below the sixth round horizontal grille bar.

   c. Cut the radiator grille frame on the left side (viewed from the front). Make two cuts, the first cut above the lower base of

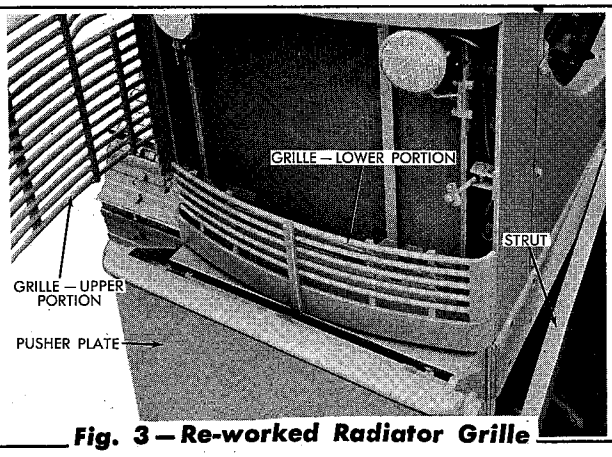


Fig. 3 — Re-worked Radiator Grille

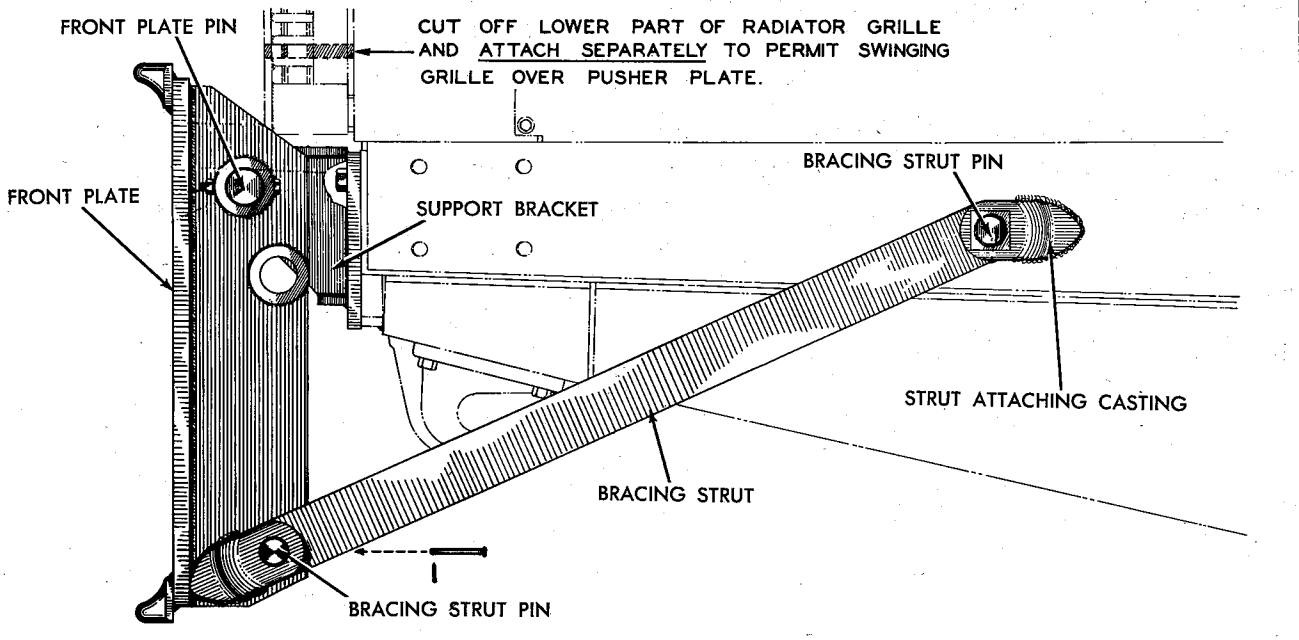


Fig. 4 — Pusher Plate Details

the grille, then measure up from the base 5/8" and make the second cut through the left side frame of the grille. Then cut the five (5) round horizontal bars on the left side (viewed from the front) where they are attached to the left side frame of the grille. Refer to Fig. 3.

d. Weld the mounting plates to the lower portion of the radiator grille as outlined in the instructions included in the Pusher Plate field installation Kit. Remove the front bumper and bolt a mounting plate to each side of the main frame using the two upper (bumper) mounting holes.

2. Weld a strut attaching lug to each side of the tractor main frame using a 3/4" fillet weld on the outside of the lug and a 1/2" fillet weld on the inside of the lug.

3. Place the pusher plate support bracket in position on the front of the main frame, install the attaching capscrews, and tighten the capscrews securely.

4. Weld the lugs in position on the main frame as outlined above, make certain that the lugs and pins are correct for the mounting holes in the main frame.

5. Place the struts in position at the lugs, on the tractor main frame, and install the pins. Secure the pins with a plain washer, castellated nut and cotter pin.

6. Using a suitable hoist, hang the pusher plate in position on the support bracket. Install the pusher plate to support bracket attaching pin, install the attaching pin locking bolts, lockwashers, and the nuts and tighten the nuts securely.

7. Place the struts in position on the pusher plate, and install the attaching pins. Install the locking pins, and cotter pins. Refer to Fig. 5.

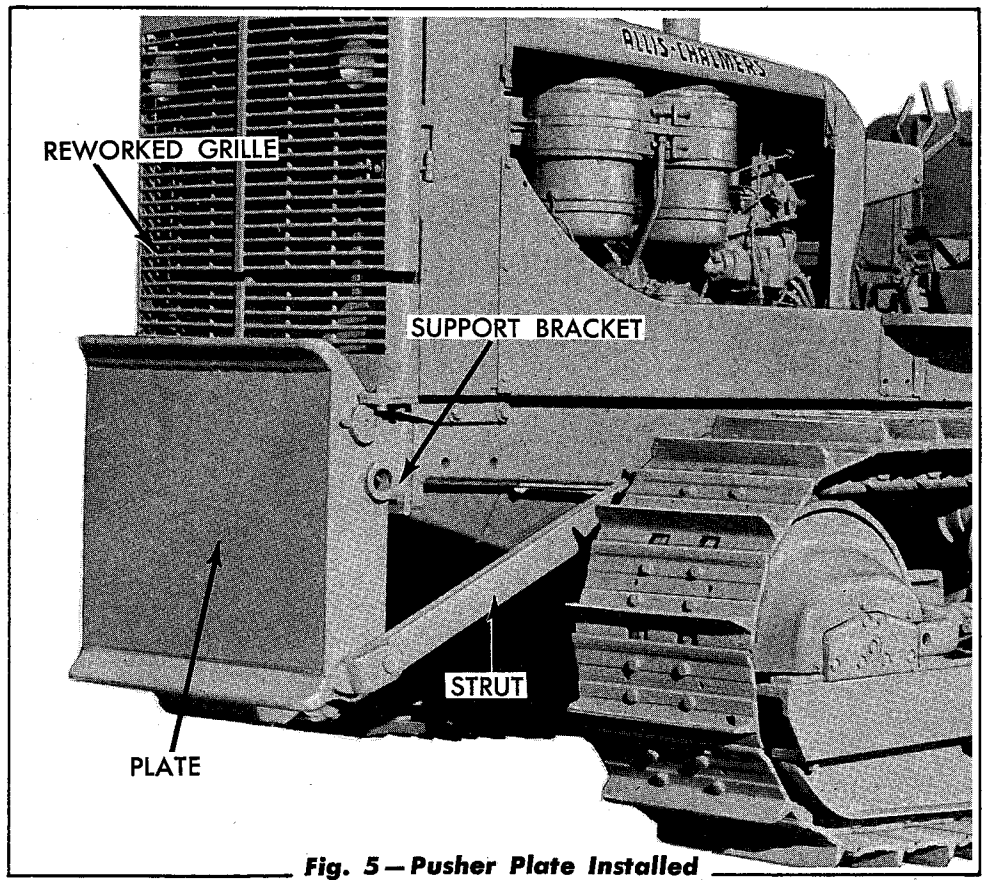


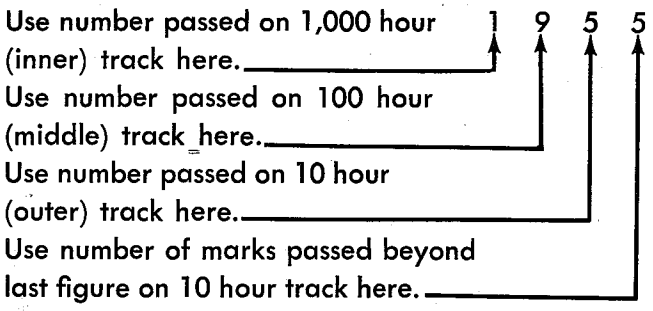
Fig. 5—Pusher Plate Installed

6. HOUR METER

A. Description

The hour meter is a spring driven electrically wound unit (or clock) which records the number of hours the engine has operated. The switch, controlled by the engine oil pressure, closes the meter winding circuit whenever the oil pressure is above 3 pounds. Therefore, the meter can not wind when the engine is not running. The clock may continue to run as much as 3 minutes after the engine stops or until the spring has run down. It has been adjusted to run a little slow to compensate for the overrun.

All hands move clockwise. The small indicator (upper left) visibly turns when the meter is recording. The meter records up to 10,000 hours and repeats. The four figures of the hours of operation are read from the three hands as follows:



B. Installation

1. Install the hour meter in the opening provided for its mounting in the right side of the instrument panel. Refer to Fig. 1 in Section VIII.

2. Install the Tee fitting and pressure switch between the oil pressure line and the lubricating oil pressure gage. Install the oil pressure line.

3. Install the pressure switch wires and hour meter wires as shown in Fig. 2 in Section VIII. The small hour meter wire is grounded to the engine temperature gage, the large wire is fastened to either terminal of the pressure switch. The other terminal of the pressure switch is connected to the left side of the ammeter as viewed from the rear.

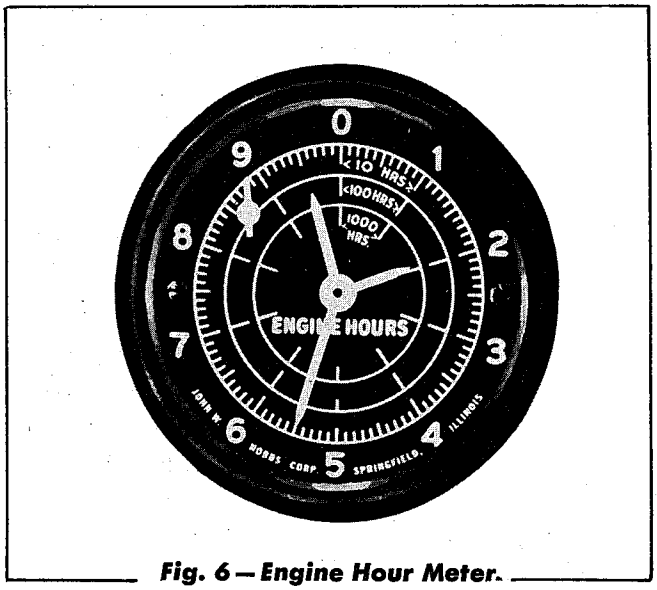


Fig. 6 — Engine Hour Meter.

C. Inspection

Inspect all hour meter wiring for poor terminal connections, broken wires, and frayed or oil soaked wires. Replace if necessary.

D. Check Pressure Switch

Remove the pressure switch to hour meter wire, at pressure switch end of the wire. Connect a 24 volt test lamp (a 24 volt tail light bulb may be used) to the pressure switch terminal in place of the wire that was removed, and ground the other end of the test lamp wire to the engine or main frame. Start the engine. If the lamp fails to light (with engine oil pressure normal) the switch is inoperative, and must be replaced.

If the pressure switch and wiring are in good condition, indicated by the lighting of the test lamp, and the hour meter does not operate, the hour meter should be removed and returned to the nearest "Allis-Chalmers" Industrial Dealer for a trade in allowance on a new meter.

7. LIGHTS

A. General

Either a rear flood light or a tail light may be installed on the bracket located on the upper left hand corner of the fuel tank. Since both the flood light and tail light use the same mounting bracket, both cannot be used at the same time.

B. Installation of Tail Light or Rear Flood Light

1. Mount the light on the welded bracket located on the front of the fuel tank near the upper left hand corner.

2. Install the terminal end of the short cable provided with the light, to the terminal connection of the light, place the two cable supporting clips on the cable and attach the clips to the fuel tank and the left fender. The cable should extend a few inches ahead of the fuel shut-off valve.

3. Remove the floor plates. Thread the long cable provided with the light, along the inside of the left fender and main frame (terminal end toward the front) and through the bottom of the cowl to the light switch. Attach the cable terminal to the light switch. Install the cable supporting clips and attach the clips to the cowl, main frame, and left fender. Install the fuse in the fuse holder and connect the two cables together at the fuse holder.

4. Install the floor plates.

8. POWER PULLEY

A. Description

The power pulley is mounted on the rear of the tractor and driven by the transmission top shaft. The pulley is twenty (20) inches in diameter and has a fifteen (15) inch face.

Because of the torque converter, the speed or rotation of the pulley is dependent on the belt load as well as the engine speed. Rotation of the pulley is clockwise (viewed facing the pulley retaining nut). A manually operated lever is provided to engage or disengage the power pulley.

B. Installation

1. Remove the capscrews attaching the rear bevel gear compartment cover to the steering clutch and final drive housing and remove the cover and gasket.

2. Place the female splined coupling on the power pulley coupling shaft, with the pin hole in the coupling facing the power pulley. Align the pin hole in coupling with the hole in the shaft and install the coupling attaching pin.

3. Cement a new gasket (using gasket cement) in position on the power pulley, place the power pulley in position entering the splines of the transmission top shaft into the shaft coupling. Install the attaching capscrews and lockwashers supplied, then tighten the capscrews securely.

4. Remove the filler plug located on the top of the power pulley gear case and the level plug located on the right side of the power pulley, and fill the power pulley gear case to the level plug hole with the same lubricant specified for the transmission and final drives. Install the level and filler plugs and tighten them securely.

C. Removal

The power pulley may be removed by direct reversal of the installation procedure.

When the power pulley is removed, install the rear bevel gear compartment cover using a new gasket and the original length capscrews.

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 of the bore or shaft where the bearing has been used.

Always lubricate a replacement bearing at assembly with clean lubricant.

B. Tapered Roller Bearings

1. Thoroughly clean and inspect the bearings for worn or 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. DO NOT EXPERIMENT. A properly set up tapered roller bearing will give satisfactory service for a very long time, while a bearing preloaded 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 very 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 except in emergencies.

2. Keep all bearings spotlessly clean and well lubricated to prevent rusting.

3. Use a press or driver when installing bearings. If these are not available use a copper or brass rod to install the bearings.

4. When installing a bearing on a shaft, drive on the inner race; when installing it in a bore, drive on the outer race.

5. Be careful not to strike the shield, snap ring or balls when using a rod to install the bearings.

6. When using a sliding hammer 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 cone separated, would cause the cup and the cone to be rammed together and may damage the bearing.

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 or a driver to install the bushings and ream them to the specified dimensions when reaming is required.

2. SHAFTS AND SPLINES

A. Shafts

1. Inspect all shafts for worn areas and to see that they are not twisted or bent.

B. Splines

1. Inspect the splines of splined shafts for roughness or wear. Remove any slight roughness from the splines with a stone or mill file.

2. Be sure that all splined shafts are smooth and try all the gears on their respective shafts to be sure that they slide freely on the splines.

3. SHIFTING FORKS

Check the shifter forks for tightness and proper location on the shifter shafts, also, make certain that they are not bent as indicated by uneven wear. Observe the shifter prongs for wear on the side faces and the inside faces. Refer to "FITS AND TOLERANCES," Section XXII, for tolerances when new.

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 a seal from its bore, the 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 inside the lip must have the proper tension to return the lip to its proper position when it is pressed in by hand.

3. Be sure that the portion of the shaft contacted by the seals is smooth and free from tool marks or burrs.

4. When installing a seal on a shaft or a shaft through a 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 a seal installing bushing or a thin sheet of stiff paper wrapped around the sharp portion of the shaft, then slide the seals over the bushing or paper.

5. Use a seal installing tool or a press when installing seals in their bores to prevent damage to the outer case of the seals. If the proper tools are not available, a smooth piece of iron 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.

B. Positive Type

The sealing surfaces of the seal rings (positive type) must be smooth and flat; any scratches on the sealing 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 light engine oil.

5. GASKETS

1. When a gasket is removed from the tractor, clean it 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.

7. HOSES

1. Inspect all water and air hoses, fuel lines, and lubricating oil lines for leaks and signs of collapsing, or deterioration of the rubber on the inside of the hoses. Replace if necessary.

8. WIRING

1. Do not allow the insulation of the wires and cables to become soaked with fuel oil or lubricating oil.

2. Wrap all frayed spots of the insulation with tape.

3. Keep all terminals and connections clean and tight.

9. BATTERIES

1. Keep the batteries clean and filled to the proper level with electrolyte.

2. Be sure that the battery hold-down assemblies are tight and do not allow the batteries to move around in their compartment.

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. Keep the radiator cap on tight.

3. Remove all leaves and other debris from the air passages of the radiator. DO NOT PAINT THE RADIATOR CORE.

4. Keep all radiator mounting bolts properly tightened. Replace mountings if they become oil soaked or damaged.

5. The torque converter radiator should be kept free from debris and its mounting bolts should be kept tight.

11. FILTERS

1. Fuel filter elements should be changed when clogged (indicated by insufficient supply of fuel to engine). Engine oil filter elements should be changed at the same time the engine oil is changed.
2. When installing new filter elements be sure that all gaskets are in place and are in good condition.

12. TORQUE CONVERTER

1. The torque converter bearings should be lubricated with high melting point pressure gun grease daily or every ten hours of operation.
2. The torque converter over-running clutch should be checked periodically (approximately 300-hour intervals) to insure that it is in proper operating condition.

   Check the over-running clutch as follows: With the engine stopped and the engine shut-off knob in the "OFF" position (all the way back), remove the front floor plate. Place the transmission shift lever in neutral position. Check the engine clutch lever pull (approximately 30 pounds is the correct lever pull). Engage the engine clutch.

   Turn the universal drive shaft clockwise (viewed from the rear of the tractor). It should turn freely.

   Using a pipe wrench on the universal drive shaft, turn the drive shaft counter-clockwise (viewed from the rear of the tractor). If the unit is in good condition the engine can be turned without any chattering or slipping of the over-running clutch. If any chattering or slipping is noted the over-running clutch should be replaced immediately to avoid damage to the torque converter and oil cooler radiator.

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. Inspect the track shoe bolts frequently, especially if operating over rough hard terrain.
3. Replace any broken or missing capscrews, nuts or lockwashers.

14. 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. When cleaning parts, use a non-combustible cleaning fluid and blow parts dry with compressed air.
3. Make all adjustments as specified in this manual.

SECTION XXII—FITS AND TOLERANCES

1. GENERAL

This section is written to provide the mechanics responsible for maintenance of the tractor with the proper fits and tolerances of 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, always refer to this section to obtain information on the proper fits and tolerances.

2. ENGINE

Description	Size of New Parts	Install New Parts When Clearance Exceeds
A. Cylinder Liners		
1. Inside diameter	4.999" to 5.0005"	
2. Clearance of piston with liner	.006" to .0097" this clearance to be taken with feeler ribbon as outlined in text, Section IX.	.012"
3. Allowable taper on O.D.	.001"	
4. Allowable out of round (when installed)	.001"	
5. Clearance liner with block	slip fit	
6. Distance from top of cylinder liner to top of cylinder block	.046" to .058"	
B. Pistons		
1. Diameter of piston skirt	4.9908" to 4.9930"	
2. Piston length	6.500"	
3. Piston pin length	4.325" to 4.335"	
4. Inside diameter of piston pin bushing	1.6265" to 1.6270"	
5. Outside diameter of piston pin	1.6246" to 1.6250"	
6. Clearance — pin and piston bushing	.0015" to .0024"	.010"

Description	Size of New Parts	Install New Parts When Clearance Exceeds
C. Piston Rings — Compression		
1. Number of rings and width	4 — .123" to .124"	
2. Gap between ends — fitted	.035" to .060"	
3. Clearance in groove		
Upper ring	.010" to .013"	.022"
2nd ring from top	.008" to .011"	.015"
3rd and 4th rings from top	.006" to .009"	.013"
D. Piston Rings — Oil Control		
1. Number of rings and width	2 — 3/16" three piece ring	
2. Gap between ends — fitted	.015" to .025"	
3. Clearance in grooves	.0015" to .0055"	.008"
E. Crankshaft		
1. Diameter of crank pin journals	3.249" to 3.250"	
2. Width between cheeks	2.188" to 2.192"	
3. Diameter of main bearing journals	3.999" to 4.000"	
4. Width between cheeks	1.935" to 1.945"	
5. Crankshaft journals may be ground	.010", .020", and .030"	
6. Undersize bearings available for service	.002", .010", .020", and .030"	
7. Crankshaft end play	.006" to .013"	.018"
8. Oversize rear main thrust washers available for service	.005" to .010"	
F. Main Bearings		
1. Number of bearings in engine	7	
2. Diameter — inside of shell	4.0024" to 4.0044"	
3. Diameter of crankshaft main bearing journals	3.999" to 4.000"	
4. Clearance — shell and journal	.0024" to .0054"	.007"
5. Width of shell	1.60"	
6. Undersize bearings available for service	.002", .010", .020", and .030"	
G. Connecting Rod Bearings		
1. Width of bearings	1.930"	
2. Diameter — inside of shell	3.2524" to 3.2544"	
3. Diameter of crankshaft connecting rod journals	3.249" to 3.250"	
4. Clearance — shell and journal	.0024" to .0054"	
5. Undersize bearings available for service	.002", .010", .020", and .030"	

Description	Size of New Parts	Install New Parts When Clearance Exceeds
H. Connecting Rods		
1. Diameter — inside of connecting rod bearing shell	3.2524" to 3.2544"	
2. Clearance — connecting rod bearing shell and journal	.0024" to .0054"	.007"
3. Width of rod — lower end	2.180" to 2.182"	
4. End play — lower end on journal	.008" to .012"	
5. Diameter of piston pin	1.6246" to 1.6250"	
6. Diameter inside connecting rod bushing	1.6265" to 1.6270"	
7. Clearance — pin and bushing	.0015" to .0024"	.010"
I. Exhaust Valve		
1. Angle of valve seat	30°	
2. Valve lash	.009" at operating temperature	
3. Diameter of valve head	1.930" to 1.935"	
4. Diameter of valve stem	.372" to .373"	
5. Diameter — inside of valve guide	.374" to .375"	
6. Clearance — stem and guide	.001" to .003"	.006"
7. Valve standout — with bottom of cylinder head	.018" to .022"	
J. Exhaust Valve Insert		
1. Seat angle	30°	
2. Seat width	5/64" to 7/64"	
K. Exhaust Valve Guide		
1. Outside diameter	.6605" to .6610"	
2. Inside diameter	.374" to .375"	
3. Clearance — valve stem and guide	.001" to .003"	.006"
L. Rocker Arms		
1. Outside diameter of rocker arm shaft	.9985" to .9990"	
2. Inside diameter of rocker arm bushing	1.000" to 1.001"	
3. Clearance — shaft and rocker arm	.001" to .0025"	.004"
M. Cam Followers		
1. Outside diameter of cam followers	1.170" to 1.171"	
2. Inside diameter of follower bore in cylinder head	1.172" to 1.173"	
3. Clearance — follower and cylinder head	.001" to .003"	.006"
4. Clearance — follower roller bushing and pin	.001" to .0018"	.015"

Description	Size of New Parts	Install New Parts When Clearance Exceeds
N. Gear Train Backlash		
1. Camshaft and accessory shaft gear	.003" to .008"	Replace when pitted or worn
2. Crankshaft and accessory shaft gear	.003" to .008"	Replace when pitted or worn
3. Crankshaft and oil pump gear	.003" to .008"	Replace when pitted or worn
4. Governor drive gear	.003" to .008"	Replace when pitted or worn
5. Water pump drive gear	.003" to .008"	Replace when pitted or worn
6. Blower drive to idler gear	.003" to .008"	Replace when pitted or worn
O. Accessory Drive Shaft		
1. Inside diameter — end bearings	1.6435" to 1.6445"	
2. Outside diameter — shaft journals	1.6380" to 1.6385"	
3. Clearance — bearing with shaft	.005" to .0065"	.009"
4. End clearance — thrust washer with thrust shoulder on shaft	.006" to .014"	.018"
P. Camshaft		
1. Inside diameter of end bearings	1.643" to 1.6445"	
2. Outside diameter of shaft front and rear journals	1.638" to 1.6385"	
3. Clearance of end bearings with shaft	.0045" to .0065"	.009"
4. Inside diameter if intermediate bearings	1.643" to 1.645"	
5. Outside diameter of shaft intermediate journals	1.640" to 1.6405"	
6. Clearance of intermediate bearings with shaft	.0025" to .005"	.009"
7. End clearance — between thrust washer and thrust shoulder on shaft	.006" to .014"	.018"
Q. Blower		
1. Clearance — rotors to front end plate	.014" minimum	
2. Clearance — rotors to rear end plate	.007" minimum	
3. Clearance of rotors — between leading side of upper rotor and trailing side of lower rotor	.016" minimum	
4. Clearance of rotors — between trailing side of upper rotor and leading side of lower rotor	.002" to .006"	
5. Backlash between blower rotor gears	.001" to .0015"	.004"

Description	Size of New Parts	Install New Parts When Clearance Exceeds
R. Blower Drive		
1. Inside diameter of support assembly bushings	1.626" to 1.6265"	
2. Outside diameter of drive gear hub	1.623" to 1.624"	
3. Clearance — support assembly bushing with drive gear hub	.002" to .0035"	.007"
4. End clearance — support assembly bushing with drive gear hub	.004" to .009"	.012"
5. Backlash — blower drive gear with idler gear	.003" to .008"	Replace when pitted or worn
S. Lubricating Oil Pump		
1. Radial clearance — gears with pump body	.002" minimum	Replace when pitted or worn
2. End clearance — gears with pump body	.002" minimum	Replace when pitted or worn
3. Backlash — pump driven gear with crankshaft gear	.003" to .008"	Replace when pitted or worn

T. Torque Wrench Specifications

	Torque - Foot Pounds
1. Injector clamp nuts	20 - 25
2. Exhaust muffler nuts	35 - 40
3. Injector control shaft bracket bolts	8 - 10
4. Cam follower guide bolts	13 - 17
5. Air intake elbow to blower housing bolts	25 - 30
6. Blower to block bolts	46 - 50
7. Connecting rod nuts	65 - 75
8. Rocker shaft bracket clamp bolts	40 - 45
9. Flywheel bolts	150 - 160
10. Cylinder head nuts	150 - 160
11. Main bearing nuts	180 - 190
12. Blower rotor gear bolts	55 - 65
13. Crankshaft end bolt	180 - 200
14. Camshaft and accessory shaft nuts	450 - 500
15. Lube oil tube assembly to cylinder head adapter	40 - 45
16. Fuel oil tube assembly to cylinder head adapter	40 - 45
17. Starter to flywheel housing bolt	85 - 95
18. Governor drive gear nut	100 - 110
19. Special water plug ½ - 13	35 - 40
20. Special water plug ⅝ - 11	60 - 70
21. Special water plug ⅞ - 14	90 - 100
22. Special water plug 1¼ - 12	150 - 170
23. Special plug 1¾ - 16	75 - 100

3. TRANSMISSION

Description	Size of New Parts	Install New Parts When Clearance Exceeds
1. Fit of transmission case pilot in bore of steering clutch housing	.002" to .005" loose	
2. Clearance between bevel pinion shaft front bearing and bearing retainer	.000" to .002"	
3. Clearance between oil slinger gear bushing and hub	.004" to .008"	
4. Backlash between bevel pinion teeth and bevel gear teeth	.008" to .014"	
5. Width of shifter fork grooves in gears and pinions	.432" to .442"	
6. Thickness of shifter fork prongs	.412" to .422"	
7. Clearance — shifter fork prongs in groove	.010" to .030"	

4. BEVEL GEAR AND STEERING CLUTCHES

1. Pre-load of steering clutch and bevel gear shaft bearings	.002" to .004" tight
2. Backlash between bevel gear teeth and bevel pinion teeth	.008" to .014"
3. Foot pounds torque specified for tightening steering clutch driving hub retaining capscrew	550 to 600
4. Specified standout — face of steering clutch hub flange to face of clutch throwout plate in assembly	1/16"
5. Specified thickness of steering clutch internal tooth friction disc	.084" to .096"
6. Specified thickness of steering clutch external tooth friction disc	.152" to .157"
7. Assembled height of steering clutch pressure spring	5-3/64"
8. Pounds load of steering clutch pressure spring at 5-3/64" height	320 to 340 per spring

5. FINAL DRIVES

1. Pre-load of final drive pinion shaft bearings	.002" to .003" tight
2. Pre-load of final drive intermediate pinion bearings	.002" to .003" tight
3. Pre-load of final drive sprocket shaft bearings	.002" to .003" tight
4. Pre-load of final drive sprocket shaft outer bearing	33 to 44 in. lbs.
5. Foot pounds torque specified for tightening driving sprocket retaining nut	4500 to 5000
6. Foot pounds torque specified for tightening brake drum hub retaining capscrew	550 to 600

6. TRUCK WHEELS

1. Pre-load of truck wheel bearings	15 to 45 in. lbs.
2. Standout — each end of shaft to face of seal guard assembly	4.000" to 4.005"
3. Foot pounds torque specified for tightening truck wheel bracket capscrews	290 to 300

7. TRACK SUPPORT ROLLERS

1. Pre-load of bearings in track support roller	15 to 45 in. lbs.
2. Standout — each end of shaft to face of seal guard	3.088" to 3.093"
3. Standout — each end of shaft to outer face of roller	.375" to .380"

8. TRACK IDLERS

1. Pre-load of track idler bearings	15 to 45 in. lbs.
2. Standout — each end of shaft to face of seal guard assembly	4.800" to 4.805"

SECTION XXIII—TROUBLE SHOOTING

This section contains trouble shooting information and tests which can be made to determine the cause of troubles that may develop in the tractor when used under average working conditions. Each symptom of trouble is recorded under an individual unit or system 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.

1. ENGINE

A. Engine Will Not Turn

1. Engine Is Locked or Seized.

This can be due to extended idle or storage periods or to the improper preparation of the engine for storage, in which case the parts may have rusted or corroded and seized. Broken piston rings, gears, etc., may also be the cause of the locking. Try to turn the engine by using a large wrench on the pulley end of the crankshaft. If the engine turns, the lock is relieved. If the engine does not turn, internal damage is indicated and further investigation must be made.

2. Starter or Starter Switch Inoperative

Refer to Topic No. 2 in this section.

3. Incorrect Oil Viscosity

Refer to "DESCRIPTION AND SPECIFICATIONS" in Section I for correct grade of oil. If weather is extremely cold, use of the cold weather engine primer is necessary. Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

4. Batteries Weak

Recharge the batteries or replace them with fully charged batteries.

B. Engine Fails to Start

1. Slow Cranking Speed

A cranking speed of 80 r.p.m. is required

for dependable starting. The batteries may be too weak or the starting motor may not be delivering its maximum torque. Cold weather starting requires the use of the cold weather engine primer. Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

2. **Engine Shut-Off Controls Out of Adjustment**

Check the adjustment of the engine shut-off air valves, and governor linkage. Make certain the throttle lever is in starting position (half way open). Refer to "GOVERNOR AND ENGINE CONTROLS" in Section VI.

3. **Insufficient Supply of Fuel to Injectors**

Refer to "ENGINE FUEL SYSTEM" in Topic 3 of this section.

4. **Blower Not Turning**

Refer to "ENGINE AIR INTAKE SYSTEM" in Topic 4 of this section.

5. **Water in Air Box**

(Possibly after a disassembly of the cylinder head). Dry the air box through the handholes in the cylinder block after removal of the covers. Check the air box drain tubes for clogging.

6. **Improper Timing**

This could be possible just after the engine has been rebuilt. Refer to "ENGINE" in Section IX.

C. Loss of Power

1. **Injector Racks Not Properly Positioned**

Refer to "ENGINE FUEL SYSTEM" in Section II.

2. **Injector Improperly Timed**

Refer to "ENGINE FUEL SYSTEM" in Section II.

3. **Cylinders Cutting Out**

Trace a missing cylinder as follows:

a. Remove the hood and rocker cover. Check the adjustment of the exhaust valve lash as explained in "ENGINE" in Section IX. Operate the engine at 600 to 800 r.p.m., cutting out each injector in turn by holding the injector follower down with an injector cut-out tool as explained in Section II. A decrease in engine speed with the injector follower held down indicates that the injector for that cylinder is working. If no decrease in engine speed is noted, the injector is not working.

b. Stop the engine and remove the fuel line that connects the injector with the return fuel manifold. Hold a finger over the injector fuel outlet and crank the engine with the starter. Fuel emerging from the injector, with the engine turning, indicates that fuel is reaching the injector but is not being injected into the cylinder. Remove the injector and replace it with a new or reconditioned injector.

c. If replacement of the injector fails to eliminate the condition, the compression pressure of the cylinder should be checked and the reason for loss of compression determined. Refer to "LOSS OF COMPRESSION," next item.

4. **Loss of Compression**

This may be due to leaking exhaust valves or worn pistons, rings, or cylinder liners. Use a pressure gage to check the compression pressures of each cylinder.

a. Remove the hood and valve rocker cover, and start with No. 1 cylinder to check the compression pressure.

b. Remove the fuel lines from both the injector and the fuel connectors for that cylinder.

c. Remove the injector and install the compression gage in its place in the same manner as the injector was installed. Use one of the fuel lines that were removed as a "JUMPER" connection between the fuel inlet and the fuel return connectors. This will permit fuel from the inlet to pass directly to the return fuel manifold. A fuel manifold to injector tube can be reformed to be used as a "JUMPER" line.

d. Close the vent valve of the gage, start the engine, run at approximately 500 r.p.m., and take a reading on the gage. *NOTE: Do not take the compression pressure by cranking the engine with the starter.*

e. Perform this same operation on the remaining cylinders. The compression pressure of one cylinder should not drop below 480 p.s.i. nor should the pressure for any one cylinder be more than 25 pounds below the reading on the other cylinders as for example:

Cylinder Number	Gage Reading
1	490 lbs./sq. in.
2	525 lbs./sq. in.
3	520 lbs./sq. in.
4	515 lbs./sq. in.
5	520 lbs./sq. in.
6	525 lbs./sq. in.

Note that the compression pressure in No. 1 cylinder falls considerably below the pressures in the five other cylinders, indicating compression leak in No. 1 cylinder. In this case, the cylinder head must be removed, the valves and seats inspected for leaks, the valve stems for wear and sticking, and the cylinder head gasket for leaks. If these parts are found to be in good condition, the leakage is taking place past the piston rings. The pistons must then be removed and all the parts inspected and the correction made.

NOTE: When using a compression gage to check the compression pressures, make certain that the gage has been properly tested to give accurate pressure readings. In no case should an engine be rebuilt only because a compression gage registers readings below 480 lbs./sq. in. unless the gage is known to be accurate or a loss of power or excessive oil consumption also indicates the need of repair.

5. **Air in Fuel System**

Refer to "CHECKING OF FUEL SUPPLY SYSTEM," in Topic 3 of this section.

6. **Air Cleaner Restricted**

Refer to "ENGINE AIR INTAKE" in Section III.

7. **Clogged Fuel Filters**

Refer to "CHECKING OF FUEL SUPPLY SYSTEM," Topic 3 of this section.

8. **Improper Governor Adjustment**

Refer to "ENGINE CONTROLS and GOVERNOR" in Section VI.

9. **Insufficient Fuel**

Check the fuel supply in the tank. Also, see "CHECKING OF FUEL SUPPLY SYSTEM," Topic 3 of this section.

D. Engine Stalls Frequently

1. **Idling Speed Too Low**

Adjust idling speed for a minimum of 500 r.p.m. Refer to "ENGINE CONTROLS AND GOVERNOR" in Section VI.

2. **Engine Temperature Too Low**

Inspect the thermostats, replace the thermostats if necessary.

3. **Injector Controls Sticking**

Remove all bind from the control tube and linkage. Make certain that the injector racks

move freely without bind.

4. **Restricted Fuel Filter, Air in Fuel System or Unsatisfactory Injectors**

Refer to "CHECKING OF FUEL SUPPLY SYSTEM," in Topic 3 of this section.

E. Uneven Running and Excessive Vibration

1. **Faulty Injector Equalizing or Timing**

Refer to "ENGINE FUEL SYSTEM" in Section II.

2. **Fuel Supply Erratic or Insufficient**

Refer to "CHECKING OF FUEL SUPPLY SYSTEM," Topic 3 in this section.

3. **"Hunting" Governor**

Check and adjust governor and linkage. Refer to "ENGINE CONTROLS AND GOVERNOR" in Section VI.

4. **Valves in Bad Condition**

Recondition valves. Refer to "ENGINE" in Section IX.

5. **Engine Temperature Too Low**

Maintain temperature of 160° F. to 185° F. Check the thermostats, replace the thermostats if necessary.

6. **Cylinders Cutting Out**

Refer to sub-topic C, paragraph 3 of this section.

F. Engine Detonates

If a hard metallic knock indicates detonation in one or more cylinders, the engine must be stopped immediately to prevent serious damage due to the excessive pressures accompanying the detonation. Detonation is caused by the presence of fuel or lubricating oil in the air charge of the cylinders during the compression stroke. Check for leaky injectors, incorrectly adjusted injectors, leaking fuel connections in the cylinder head with accompanying crankcase dilution, oil pull over from the air cleaners, clogged air box drain, leaky blower housing gasket, or leaky blower oil seals.

G. Black Smoke

1. **Poor Grade of Fuel**

Refer to "DESCRIPTION AND SPECIFICATIONS" in Section I for fuel specifications.

2. **Unsatisfactory Injectors or Incorrect Timing or Equalizing**

Refer to "CHECKING OF FUEL SUPPLY SYSTEM," in Topic 3 of this section.

3. **Air Box Cover Plate Gasket Ruptured**

Replace the gasket.

4. **Air Ports in Cylinder Liners Choked**

Remove the cylinder head; remove the sludge and carbon from the ports and the air box. Refer to "ENGINE AIR INTAKE SYSTEM," in Section III.

5. **Air Cleaner Pipes Restricted**

Remove the air cleaner oil cups and precleaners and swab the obstruction from the pipe. Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

H. Blue Smoke

1. **Engine Temperature Too Low**

Inspect the Thermostats and test for proper action.

2. **Injector Racks Improperly Positioned**

Refer to "ENGINE FUEL SYSTEM" in Section II.

3. **Cylinder "Cutting Out"**

Refer to sub-topic C, paragraph 3 of this section.

4. **Lubricating Oil Enters Combustion Chambers**

This can be caused by worn or stuck piston

rings, leaky blower gasket or seals, oil level being too high in the air cleaners, or oil level being above "FULL" mark on gage rod.

I. Engine Overheats

1. **Insufficient Coolant in Cooling System**

   Fill the cooling system with clean coolant.

2. **Radiator Core Clogged**

   Clean and flush radiator.

3. **Fan Belts Loose**

   Adjust the belts.

4. **Water Pump Inoperative**

   Repair or replace the pump.

5. **Radiator Air Passages Clogged**

   Clean the radiator core.

6. **Tractor Overloaded**

   Lighten load on tractor.

7. **Oil Cooler Clogged**

   Clean or replace oil cooler.

J. Excessively Fast Wear on Engine Parts

1. **Oil of Unsuitable Grade, Composition, or Viscosity**

   Change to suitable oil. Refer to "DESCRIPTION AND SPECIFICATION" in Section I, for lubricating oil specifications.

2. **Dirt in Oil**

   Use only clean oil in the engine. Keep the oil supply in clean storage containers, and use clean containers when filling the crankcase. Keep the rocker arm cover tight.

3. **Engine Oil and Filter Elements Used Longer Than Recommended Time**

   Change engine oil and the filter elements at periods specified in the lubrication instructions as outlined in the "OPERATORS MANUAL."

4. **Insufficient Oil**

   Maintain the crankcase oil level to the "FULL" mark on the level gage rod.

5. **Air Cleaners Not Serviced Properly or Damaged**

   Inspect the air cleaners and the air cleaner tubes for cracks. Make certain all hose connections are tight and that the air cannot enter the blower without passing through the filtering oil in the air cleaners. Service the cleaners. Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

2. ENGINE STARTING SYSTEM

A. Starter Does Not Turn

1. **Brushes Not Making Good Contact**

   If the brushes are not seating properly, they may be fitted to conform to the contour of the commutator in the following manner: Place a strip of No. 00 sandpaper between the brushes and the commutator (rough side toward the brush) and work the sandpaper back and forth around the commutator until each brush is "seated in." After this is done clean and polish the commutator as explained in Item 3 below.

2. **Brush Arms Sticking or Brush Springs Weak**

   Free the bind in the arms or replace the springs. Weak springs will cause poor brush contact. Test the spring tension with a small spring scale. Attach a scale to each brush directly under the head of the screw that attaches the brush to the arm. If less than a

36 oz. pull will raise the brushes off the commutator, the springs have lost tension and new springs must be installed.

3. **Commutator Dirty or Worn**

Inspect the commutator by removing the cover band. If it is dirty or slightly grooved, polish it by placing a strip of No. 00 sandpaper around the commutator and under the brushes (rough side toward the commutator) and rotating the armature.

Blow the dust from the commutator after polishing. If the commutator is badly worn and has high mica, it must be turned true in a lathe.

4. **Armature Burned Out**

Replace the armature.

5. **Starter Switch Inoperative**

Contact surfaces may be burned out or not making contact. Disassemble, clean the contacts, reassemble, and adjust the switch lever.

6. **Cables Loose or Broken or Connection Corroded**

Inspect all cables and make the necessary repairs.

B. Starter Pinion Does Not Engage with the Flywheel

1. **Grease and Dirt in Starter Drive Mechanism**

Disassemble and clean the drive assembly.

2. **Shift Lever Out of Adjustment**

Refer to "ELECTRICAL SYSTEM" in Section VII.

3. **Broken Parts**

Replace broken or excessively worn parts.

C. Starter Does Not Turn Engine

1. **Batteries Weak**

Inspect and test the batteries.

2. **Cables or Connections Loose or Corroded**

Make certain cables are in good condition and the terminals and ground connections are tight.

3. **Starter Armature Shaft Bushings Worn**

This allows the armature to drag on the field pole pieces. Replace the bushings.

4. **General Condition of Starter Poor**

Overhaul the starter.

3. ENGINE FUEL SYSTEM

(Refer to Section II for full details on components of the fuel system.)

A. Checking of Fuel Supply System

1. Under normal conditions at full throttle, the fuel pump will maintain a pressure of 30 to 55 pounds per square inch in the engine fuel system and pump approximately 35 gallons per hour. Fuel pressure below normal, uneven running of the engine, excessive vibration, stalling when idling, and a loss of power will be symptoms of insufficient fuel supply to the injectors and insufficient fluid supply for the torque converter. The insufficient supply of fuel may be due to:

   a. Insufficient fuel in fuel supply tank.

   b. Air being drawn into the system.

   c. Clogged fuel filter elements and fuel lines.

   d. Clogged injector fuel filters.

   e. Inoperative fuel pump.

To check the above mentioned symptoms refer to "ENGINE FUEL SYSTEM" in Section II.

4. ENGINE AIR INTAKE SYSTEM

(Refer to "ENGINE AIR INTAKE SYSTEM" in Section III for full details on the components of the air system.)

The air cleaners, the engine air shut-off valves in the shut-off valve housing, the blower, the engine air box, the engine starting aid, and the cylinder liners will be discussed in the following paragraphs.

Conditions may arise in these units to cause:

a. Insufficient air supply to the cylinders for the proper combustion and burning of fuel.

b. Difficult starting or stopping of the engine.

c. Fuel or oil leaks into the air box.

A. Insufficient Air Supply to Cylinders

This condition will be indicated by black smoke from the exhaust, loss of power, and hard starting. Inspect for the following in turn:

1. **Air Cleaner Pipes Clogged**

   Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

2. **Air Shut-Off Valves Out of Adjustment**

   Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

3. **Blower Drive Shaft Broken**

   Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

4. **Air Ports in Cylinders Clogged**

   Clean the carbon and sludge from the ports.

B. Difficult Starting of Engine Due to Air Supply

1. **Insufficient Air Supply**

   Check items listed in "A" above.

2. **Engine Starting Aid Inoperative**

   (For cold weather starting.) Service the cold weather engine primer as explained in "ENGINE AIR INTAKE SYSTEM" Section III.

C. Difficult Stopping of Engine

1. **Air Shut-off Valves Do Not Close Properly**

   Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

D. Oil in Air Box

1. **Blower Housing Gasket Leaks**

   Install new gasket.

2. **Blower Oil Seals Leak**

   Install new seals.

3. **Air Box Drains Clogged**

   Remove the obstructions from the tubes.

E. Rapid Wear on Engine Parts

1. **Dirt Admitted with Air**

   Inspect the air cleaners and all pipes and connections *thoroughly*, to detect any cracks or openings where air can pass into the pipes or blower and enter the engine, without first passing through the filtering oil in the air cleaners.

2. **Dirty Lubricating Oil**

   Change oil and filter elements regularly. Keep oil clean when filling engine.

3. **Improper Fuel**

   Refer to "FUEL SPECIFICATIONS" in Section I.

5. ENGINE COOLING SYSTEM

(Refer to "ENGINE COOLING SYSTEM" in Section IV for full details on the components of the cooling system.)

A. Engine Overheats

1. Overheating with Ample Coolant in System

Remove the radiator cap. If the cooling system is full and the engine is running at normal operating temperature (160° to 185° F.), the water can be observed or heard circulating freely. Inspect the radiator, for debris in the air passages of the radiator core, for clogged radiator or water passages, inoperative water pump, loose or broken fan belts, or the thermostats being stuck in the closed position. In some cases, lime will be deposited in the water passages of the radiator, cylinder block, and head, in sufficient quantities to restrict the water flow and cause overheating. Refer to "ENGINE COOLING SYSTEM" in Section IV, for cleaning of the system and repair or replacement of inoperative units.

2. Overheating Due to Loss of Coolant

a. After the engine has been allowed to cool down to its normal temperature, fill the radiator. Inspect for, and repair all external leaks found, such as hoses, gaskets, etc. Remove the radiator for repair if it is leaking.

b. If no external leaks are present, a cracked cylinder head or block, a leaking cylinder head gasket, or a ruptured oil cooler element may be the cause. If oil is present in the water in the cooling system, remove and inspect the oil cooler core or cylinder head. Refer to "ENGINE LUBRICATING SYSTEM" in Section V. If water is present in the engine crankcase oil, inspect the water pump.

c. Seals on injector copper tubes leaking. Refer to "ENGINE FUEL SYSTEM" in Section II.

B. Engine Does Not Reach Operating Temperature

1. Operation in Arctic Temperature

It is very important that the engine temperature be maintained at 160° to 185° F. In extremely cold weather, it may be necessary to cover the radiator and the openings at the sides of the engine, to maintain the correct operating temperature.

2. Thermostat Stuck in Open Position

The two (2) thermostat units, when operating properly, close when the engine temperature goes down and causes the water to circulate through the engine only until the engine temperature again reaches a temperature of approximately 158° F., at which time the thermostats begin to open and are fully opened at 185° F. When the thermostats open, the water is allowed to circulate through the radiator and is thus cooled. If either thermostat sticks open, normal temperature may not be attained. Refer to "ENGINE COOLING SYSTEM" in Section IV. If either thermostat is not at fault, check the accuracy of the temperature gage by installing a tested gage.

6. ENGINE LUBRICATING SYSTEM

(Refer to "ENGINE LUBRICATING SYSTEM" in Section V, for full details on the engine lubricating system.)

A. Low or No Oil Pressure

1. Insufficient Oil Supply

Maintain the oil level to the "FULL" mark on the oil level gage rod.

2. Crankcase Oil Diluted By Fuel

Inspect for fuel leaking into the crankcase and correct the cause. Refer to "ENGINE FUEL SYSTEM" in Section II.

3. Improper Lubricant

Refer to the "DESCRIPTION AND SPECIFICATIONS" in Section I, for the correct viscosity of oil for the prevailing temperature.

4. Worn Bearings

Worn or loose bearings in the engine will cause pressure to drop. Replace the bearings. Refer to "ENGINE" in Section IX.

5. Oil Pump Relief Valve Stuck Open

Examine the valve. Refer to "ENGINE LUBRICATING SYSTEM" in Section V.

6. Oil Cooler Choked

Inspect and clean the oil cooler. Refer to "ENGINE LUBRICATING SYSTEM" in Section V.

7. Oil Pump Screens Clogged

Remove the lower oil pan and the handhole cover from the upper oil pan, remove the oil pump screens, and clean the screens.

8. Oil Pump Inoperative

Inspect the pump drive and the pump. Refer to "ENGINE LUBRICATING SYSTEM" in Section V. Also inspect for clogged oil lines or passages, ruptured gaskets, or loose connections. Choked oil lines, oil passages and screens are the result of dirty and sludging oil. If this condition exists, clean the interior of the engine thoroughly before resuming operation.

9. Oil Pressure By-Pass Valve Stuck Open

Inspect the valve. Refer to "ENGINE LUBRICATING SYSTEM" in Section V. Inspect the oil cooler for clogging if this valve has stuck in the open position.

10. Inoperative Oil Pressure Gage

Test the accuracy of the gage by installing a tested gage.

11. Worn Camshaft or Accessory Drive Shaft Bushings

Replace the worn parts. Refer to "ENGINE" in Section IX.

12. Excessive End Clearance of Rocker Arms or Rocker Arm Shafts

Adjust. Refer to "Engine" in Section IX.

13. Blower Drive Bearings Loose

Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

B. Excessive Oil Pressure

1. Oil Pressure By-Pass Valve Stuck

This valve is designed to open to relieve excessive pressure due to cold heavy oil, clogged oil cooler, or clogged oil passages. Refer to "ENGINE LUBRICATING SYSTEM" in Section V.

C. Oil Too Hot

1. Oil Cooler Clogged

This causes the by-pass valve to open and the oil by-passes the cooler. Continued operation with the oil circulating through the engine and not through the cooler will cause the oil

to heat. Refer to "ENGINE LUBRICATING SYSTEM" in Section V.

D. Excessive Oil Consumption

1. **Pistons, Rings, and Cylinders Worn**

   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.

2. **Oil Leaks**

   Inspect for loose connections, damaged gaskets, loose cylinder block end housings, loose bolts, and cracks. Make the necessary corrections.

3. **Crankshaft Oil Seals Worn or Damaged**

   Observe the front end of the engine while running the engine with the tractor standing still. Oil leaking through the front seal can then be seen. Inspect to see if oil drips out of the engine clutch housing. This could indicate that the rear crankshaft seal is leaking. Refer to "ENGINE" in Section IX.

4. **Blower Gasket or Oil Seals Leaking**

   Inspect the gasket. Inspect for leaking blower oil seals. Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

5. **Piston Pin Retainers Loose**

   This allows too much oil to run out at the ends of the pins. Correct this by removing the pistons and bending the ends of the lock rings in to exert more pressure against the pin retainers. If retainers are worn replace retainers.

6. **Oil Too Light**

   Change to oil of proper viscosity, for the prevailing temperature. Refer to "DESCRIPTION AND SPECIFICATIONS" in Section I.

7. **Oil Level Carried Too High**

   Do not fill the crankcase above "FULL" mark on the oil level gage rod.

8. **Valve Guides Worn**

   Replace guides. Refer to "ENGINE" in Section IX.

7. GENERATOR, REGULATOR, LIGHTS, AND WIRING

(Refer to "ELECTRICAL SYSTEM" in Section VII, for full details on the electrical system.)

A. Generator Not Working

1. Generator and fan drive belts loose or broken. Tighten or replace the belts.
2. **Wires Broken or Loose**

   Repair or replace the wires or tighten the connections.

3. **Regulator Stuck**

   Check as outlined in "ELECTRICAL SYSTEM" in Section VII.

   If the generator still does not charge, remove the cover band and inspect the commutator for dirty or discolored surface. Operation may be restored by holding a strip of fine sandpaper against the commutator with a wood block while the generator is turning. *CAUTION: Do not use emery cloth for this purpose.* If the generator still does not operate, inspect it for sticking or worn brushes, or weak brush springs, replace them if necessary. Other causes, such as a rough or out-of-round commutator, are not readily apparent and require removal of the generator for further inspection. Refer to "ELECTRICAL SYSTEM" in Section VII, for testing and adjusting the generator or regulator.

B. Lights and Wiring

1. **Lights**

   If the headlight switch is turned on and the

headlights or tail light fail to burn, look for a burned out fuse, loose mountings, grounded or broken wires or loose connections, discharged batteries, burned out bulbs or a damaged switch. Make the necessary corrections. Dim lights may be due to low batteries, poor ground connections, or tarnished lenses. Use the same procedure to check for the cause of the dash light failing to burn when the dash light switch is turned on.

2. **Wiring**

Refer to "ELECTRICAL SYSTEM" in Section VII, for a wiring diagram of the tractor. When replacing any wires, connect them as shown on the diagram. The batteries must be kept charged and all connections must be kept clean and tight, including the battery terminals and the cables.

8. INSTRUMENTS

(Refer to "INSTRUMENTS" in Section VIII, for information on the mechanical operation of the various instruments.) If any of the instruments fail to register proper readings while the tractor is in operation, the system to which the instrument applies should be thoroughly checked as outlined in the preceding parts of this section to determine the cause. If failure of the instrument is suspected, test by installing a new tested instrument in its place.

9. ENGINE STARTING AID

A. Cold Weather Engine Primer

1. **Inoperative Pump**

The pump piston rings may be worn, dry or broken or the check valve balls may be stuck. In this case, the valve must be removed and cleaned; or the pump piston rings must be replaced. Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

2. **Poor Fluid Spray**

Clean nozzle in primer elbow assembly.

3. **Dispenser Screen Clogged**

Clean screen, using warm water.

4. **Lines Clogged**

Clean lines.

10. ENGINE CLUTCH AND TORQUE CONVERTER

(Refer to "ENGINE CLUTCH AND TORQUE CONVERTER" in Section X, for full details of the clutch group and torque converter.)

A. Clutch Slips

1. **In Need of Adjustment**

Adjust clutch.

2. **Clutch Facings Worn Out**

Replace the driven plate. *NOTE: The facings are bonded to the driven plate and are not serviced separately.*

3. **Clutch Worn Out**

Replace the clutch. Refer to "ENGINE CLUTCH AND TORQUE CONVERTER" in Section X.

B. Clutch Hard to Engage

1. **Clutch Improperly Adjusted**

Clutch adjusted too tight, or clamp ring locking screw not properly tightened. Adjust clutch.

2. **Clutch Linkage Binding**

Unless due to bent or broken parts, binding will in most cases be relieved by applying oil to all the working parts.

C. Gears Clash When Shifting

1. Warped Pressure Plate or Torn Facings

This condition causes the clutch to drag, thereby not allowing gears to stop turning. The affected parts cannot be inspected unless removed.

2. Clutch Will Not Release Completely

a. **Clutch Adjusted Too Tight**

Adjust clutch and clutch linkage.

D. Air in Torque Converter Fluid System

1. Air Entering Fuel System

Refer to "ENGINE FUEL SYSTEM" in Section II.

E. Excessive Fuel Oil Being Ejected At Air Box Drain

1. Torque Converter Seal Leakage

A seepage of approximately 6 drops per minute of fuel through each of the two converter seals is permissible. If excessive fuel is being ejected at the air box drain it will indicate converter seal leakage. To examine and replace the seals refer to "ENGINE CLUTCH AND TORQUE CONVERTER" in Section X.

F. Engine Fails To Turn When Towing Tractor to Start the Engine

1. Engine Clutch Slips

Refer to Sub-Topic "A" above.

2. Overrunning Clutch Inoperative

Check the over-running clutch as outlined under "ENGINE CLUTCH AND TORQUE CONVERTER" in Section X.

G. Engine Fails to Aid in Slowing the Speed of Tractor When Descending a Steep Grade

Check as outlined under Sub-Topic "F" above.

11. TRANSMISSION AND GEAR SHIFT

(Refer to "TRANSMISSION AND BEVEL GEAR" in Section XI, for further detailed instructions on repairs.)

A. Gears Hard to Shift

1. Transmission Oil Too Heavy

Refer to "DESCRIPTION AND SPECIFICATIONS" in Section I for correct viscosity of oil for prevailing temperatures.

2. Worn Shifting Controls

Remove gear shift mechanism, inspect for worn parts, repair or replace any worn parts.

3. Burred Gears

Repair or install new gears.

4. Rough or Worn Splines

Smooth the splines or replace the worn or rough parts.

B. Gears Slip Out of Mesh in Operation

1. Shifting Lever Locking Mechanism Worn

Inspect for worn or broken locking plungers, broken or weak springs, or edges rounded off lock notches in shifter shafts.

2. Incorrect Positioning of Shifter Forks on Shafts

Reset forks.

3. Shifter Forks Worn

Remove and repair or replace forks.

4. Worn Gears, Bearings, or Shafts

This condition will allow misalignment of gears and cause them to slip out of mesh. Remove and repair or replace the worn parts.

C. Noise in Transmission

1. **Broken or Worn Gears, Bearings or Shafts**

   Replace broken parts.

2. **Bevel Gear and Pinion or Bearings Improperly Adjusted**

   Adjust as explained in "TRANSMISSION AND BEVEL GEAR" in Section XI.

3. **Insufficient Oil Supply**

   Check oil level. Fill to the level on gage rod.

12. STEERING BRAKES

(Refer to "STEERING BRAKES" in Section XIII, for further adjustment and repair of the brakes.)

A. Brakes Do Not Hold

1. **Brake Lining Worn**

   Install new lining.

2. **Improper Adjustment**

   Adjust the brake band adjusting screw and brake band support.

3. **Oil on Brakes**

   Wash brakes and repair oil leak.

4. **Brake Band Broken**

   Install new band and adjust.

5. **Broken Controls**

   Install new parts.

B. Brakes Overheating

1. **Brakes Adjusted Too Tight**

   Adjust brakes.

2. **Steering Clutches Not Disengaging**

   Adjust steering clutches.

3. **Oil on Brakes.**

   Wash brakes and repair oil leak.

4. **Brake Linkage Binding**

   Free linkage and lubricate.

C. Lining Wears Excessively

1. **Improper Adjustment**

   Adjust brakes.

2. **Linkage Binding**

   Free linkage and lubricate.

3. **Brake Drum Rough**

   Repair or replace brake drum.

4. **Improper Use of Brakes**

   Refer to "OPERATOR'S MANUAL" for instructions on proper use of brakes.

D. Movement of Brake Pedals When Tractor Is in Motion

1. **Hub to Brake Drum Bolts Loose**

   Tighten bolts.

2. **Erratic Brake Band Contact**

   Adjust brakes.

3. **Pinion Shaft Bearings Worn or Broken**

   Install new bearings.

4. **Brake Drum Hub Loose on Pinion Shaft**

   Tighten and lock hub retaining bolt.

5. **Warped Brake Drum Hub**

   Repair or install new parts.

6. **Worn or Damaged Brake Drums**

   Repair or install new parts.

13. STEERING CLUTCHES

(Refer to "STEERING CLUTCHES" in Section XII, for adjustments and repairs of the Steering Clutches.)

A. Clutches Slip

1. **Friction Discs Worn**

   Install new discs.

2. **Steel Discs Warped**

   Install new discs.

3. **Oil on Discs**

   Wash clutches.

4. **Improper Adjustment**

   Adjust control linkage.

5. **Springs Weak**

   Install new springs.

B. Clutch Control Levers Chatter When Operating

1. **Oil Low in Hydraulic System**

   Check oil level and fill with specified oil, refer to "STEERING CLUTCHES" in Section XII.

2. **Air in Hydraulic System**

   Bleed the hydraulic system and fill to proper level.

3. **Binding in Linkage**

   Free linkage and lubricate sparingly.

4. **Steering Clutch Throwout Sleeve Binding on Clutch Driven Hub**

   Check lubrication of sleeve. Sleeve must work freely on driven hub.

C. Clutches Shift Sideways

1. **Clutch Driving Hub Retaining Screw Loose**

   Tighten screw to 550-600 foot pounds torque.

2. **Bevel Gear Bearings Loose**

   Adjust bearings.

D. Unable to Disengage Clutches

1. **Improper Adjustment**

   Adjust linkage.

2. **Throwout Yoke Ball Broken or Lost**

   Install new ball.

3. **Throwout Yoke Trunnion Pin Broken or Out of Yoke**

   Replace pin.

E. Short Steering Clutch Life

1. **Improper Use of Clutches**

   Refer to "OPERATOR'S MANUAL" for instructions on proper use of clutches.

2. **Improper Adjustment**

   Adjust linkage.

3. **Improper Brake Adjustment**

   Adjust brakes.

14. EQUALIZER SPRING

(Refer to "MAIN FRAME AND EQUALIZER SPRING" in Section XVIII, for repairs on the spring.)

A. Front End of Tractor Too Low

1. **Spring Leaves Broken**

   Replace broken leaves.

2. **Pivot Shaft Worn Badly or Broken**

   Replace shaft.

3. **Pivot Shaft Bushing Worn**

   Replace bushing.

15. FINAL DRIVES

(Refer to "FINAL DRIVES" in Section XIV, for full details on the components of the Final Drives.)

A. Seal Rings Leak

1. **Bearings Out of Adjustment**

   Adjust bearings as explained in "FINAL DRIVES" in Section XIV.

2. **Seal Boot Torn Loose**

   Remove and repair or replace the boot. Refer to "FINAL DRIVES" in Section XIV.

3. **Seal Rings Worn**

   Install new seal rings. Refer to "FINAL DRIVES" in Section XIV.

4. **Seal Rings Not Contacting**

   Remove and inspect the seal spring assembly. Clean, inspect, and replace if necessary. Refer to "FINAL DRIVES" in Section XIV.

B. Noise in Final Drive Assembly

1. **Bearings Out of Adjustment**

   Adjust bearings as explained in "FINAL DRIVES" in Section XIV.

2. **Final Drive Gears and Pinions Badly Worn or Broken**

   Install new gears and pinions.

3. **Insufficient Oil Supply**

   Check oil level. Fill to the level plug.

C. Excessive Wear on Track Sprockets

1. **Tracks Out of Adjustment**

   Adjust tracks. Refer to "TRACKS" in Section XVII.

2. **Tracks Worn Out**

   Install new tracks.

3. **Truck Wheels Badly Worn**

   Repair or install new truck wheels. Refer to "TRUCK FRAMES" in Section XV.

4. **Truck Frame Twisted, Loose or Broken**

   Remove and repair or replace. Refer to "TRUCK FRAMES" in Section XV.

5. **Track Idler Out of Line**

   Adjust idler, by shims. Refer to "TRUCK FRAMES" in Section XV.

6. **Sprocket Shaft Bearings Out of Adjustment or Damaged**

   Replace or adjust bearings as explained in "FINAL DRIVES" in Section XIV.

7. **Sprocket Loose on Shaft**

   Tighten retaining nut to 4500-5000 foot pounds torque. Refer to "FINAL DRIVES" in Section XIV.

16. TRUCK WHEELS, SUPPORT ROLLERS, AND TRACK IDLERS

A. Excessive Wear on Flanges

1. **Truck Frame Out of Line**

   Repair or replace. Refer to "TRUCK FRAMES" in Section XV.

2. **Track Idler Out of Line**

   Adjust idler, by using shims. Refer to "TRUCK FRAMES" in Section XV.

3. **Track Rail Assembly Badly Worn**

   Repair or install new track.

4. **Tracks Out of Adjustment**

   Adjust tracks. Refer to "TRACKS" in Section XVII.

B. Bearing Failure

1. **Foreign Material in Lubricant**

   Keep lubricant and lubricating equipment clean. Use clean containers and be clean about servicing.

2. **Improper Lubricant**

   See "Allis-Chalmers" approved list of lubricants.

3. **Not Serviced at Proper Intervals**

   Service every 1000-hours of operation. Refer to "OPERATOR'S MANUAL" for instructions on servicing.

4. **Improper Lubricator Used**

   Use proper lubricator furnished with tractor. Refer to "OPERATOR'S MANUAL" for instructions.

5. **Lubricant Leakage**

   Repair or replace seals.

C. Lubricant Leakage

1. **Damaged or Worn Seals**

   Repair. Install new seals and other necessary parts.

2. **Loose or Badly Worn Bearings**

   Remove and inspect. Replace the necessary parts. Refer to "TRUCK FRAMES" in Section XV.

3. **Bond (Cement) of Seal Assemblies Torn or Broken Loose**

   Remove and repair. Refer to "TRUCK FRAMES" in Section XV.

17. TRACKS

(Refer to "TRACKS" in Section XVII, for further detailed instructions on repairs.)

A. Excessive Wear on Pins, Bushings, and Rails

1. **Track Idler Out of Line**

   Adjust idler, by using shims. Refer to "TRUCK FRAMES" in Section XV.

2. **Badly Worn Truck Wheels, Support Rollers or Track Idlers**

   Repair or Replace.

3. **Truck Frames Out of Line**

   Repair or replace. Refer to "TRUCK FRAMES" in Section XV.

4. **Track Sprocket Teeth Badly Worn**

   Replace sprocket.

5. **Tracks Out of Adjustment**

   Adjust. Refer to "TRACKS" in Section XVII.

B. Parts of Tracks Worn

1. **Pins and Bushings Worn, but Rails in Good Condition**

   Pins and bushings may be turned. If pins and bushings are excessively worn, new pins and bushings should be installed. Refer to "TRACKS" in Section XVII.

2. **Badly Worn Pins, Bushings, and Rails**

   Install new track assembly.

18. TRACK RELEASE

A. Release Mechanism Does Not Function Properly

1. **Release Spring Adjusting Capscrew Broken**

   Remove spring and install new capscrew. Refer to "TRUCK FRAMES" in Section XV.

2. **Release Springs Broken**

   Replace springs.

3. **Improper Fit of Track Idler Brackets on Track Idler Slide Bars**

   Adjust by shimming between the lower slide bars and the truck frame. Refer to "TRUCK FRAMES" in Section XVII.

4. **Tracks Out of Adjustment**

   Adjust. Refer to "TRACKS" in Section XVII.

19. TRUCK FRAMES

A. Truck Frames Out of Line

1. **Bent or Twisted Frames**

   Repair or install new frames.

2. **Truck Frame Pivot Shaft and Bushing Worn**

   Install new parts.

3. **Loose Capscrews on Sprocket Shaft Outer Bearing Cap**

   Tighten capscrews.

4. **Sprocket Shaft Outer Roller Bearing Worn or Broken**

   Replace the necessary parts. Refer to "FINAL DRIVES" in Section XIV.