SERVICE MANUAL

FOR

MODEL HD 15A

TRACTOR

1953

PROPERTY OF

W. F. Mott Farms
Lincoln & Co.

FOREWORD

This manual is prepared to provide the customer and the maintenance personnel with complete information and instructions on the maintenance of the Model HD-15A 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 the 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 HD-15A Tractor, unless otherwise stated.

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

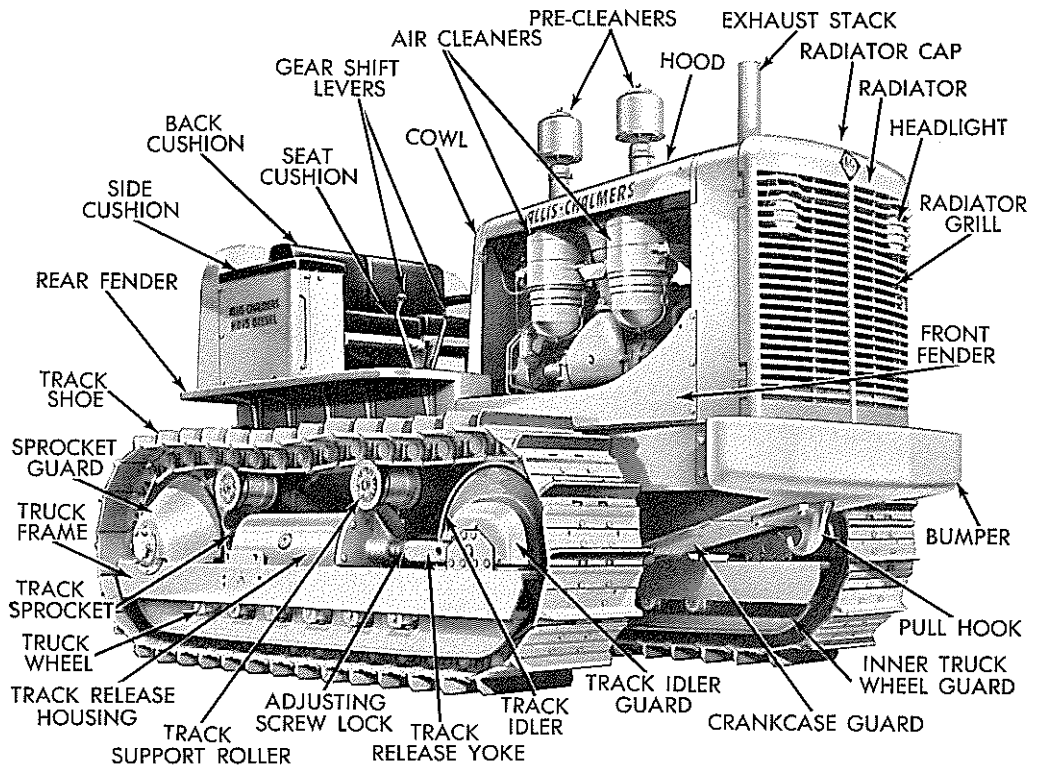


Fig. 1 — Model HD-15A Tractor

The description given herein and the information contained in this manual pertains to the Model HD-15A Tractor (Standard Model), unless otherwise stated.

The model HD-15A Tractor is a 27,850 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 to the transmission through a universal joint drive shaft assembly.

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 6 forward speeds, ranging from 1.39 M.P.H. in low gear to 5.80 M.P.H. in high gear, and 3 reverse speeds, ranging from 1.54 M.P.H. in low reverse to 4.51 M.P.H. in high reverse, under full governed engine speed of 1600 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 standard tractor is equipped with electrical starting and lighting equipment; muffler; full width crankcase guard; positive seal truck wheels, track idlers, and support rollers; guards for the truck wheels, track idlers, and sprockets; front pull hook; front bumper; hinged radiator guard; hydraulic steering controls; suction type fan; and 20 inch integral grouser shoes. *NOTE: The front bumper is not included when front mounted Allied Equipment is installed on the tractor at the factory.*

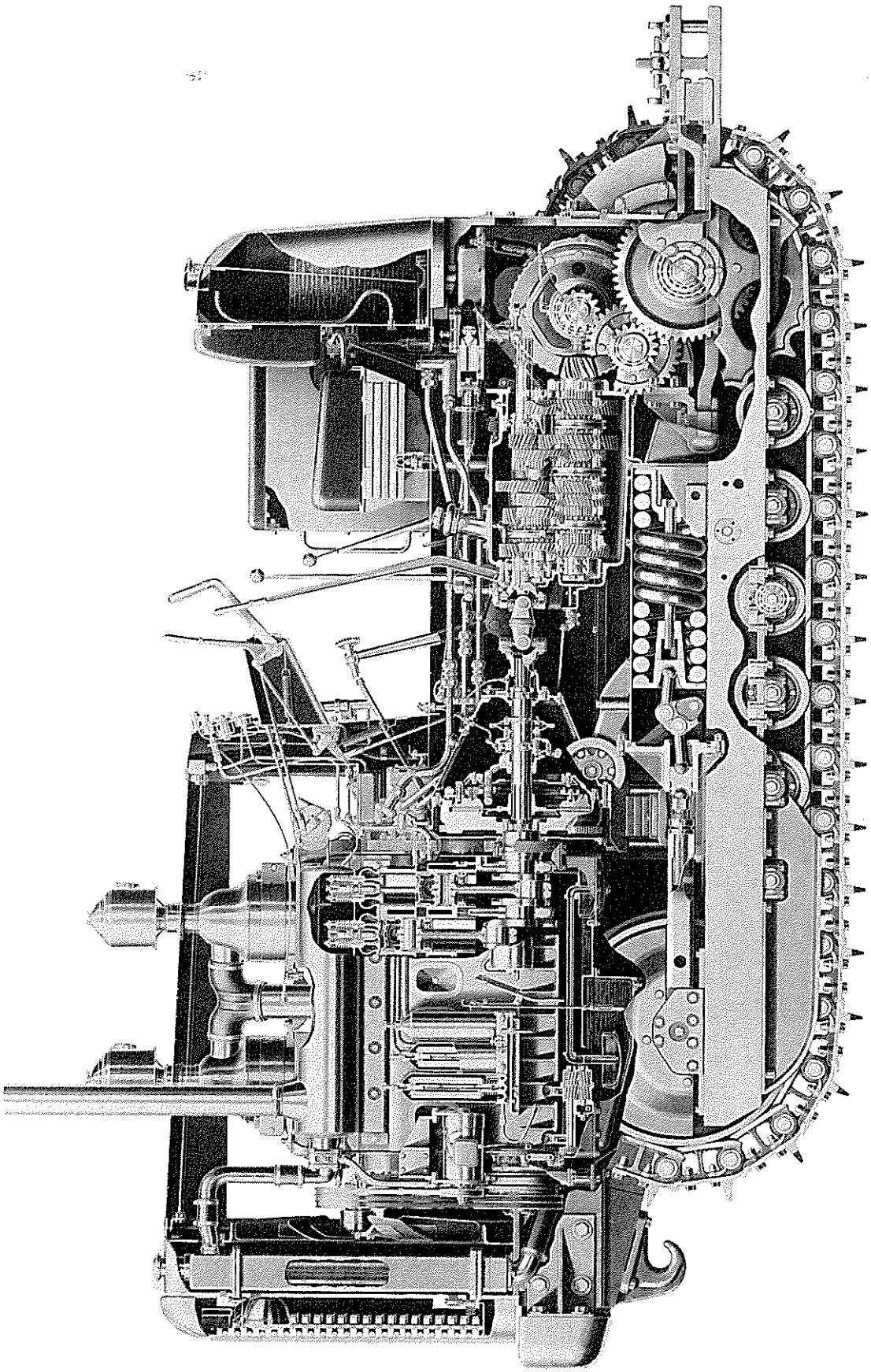


Fig. 2 — Cut-Away View of HD-15 Tractor

2. GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS:

Overall Length	14 ft. 4-13/16 in.
Overall Height (without stacks)	6 ft. 11-15/16 in.
Overall Width	8 ft. ¾ in.
Turning Radius	8 ft. 10 in.
Ground Clearance	14⅜ in.
Drawbar Height (center line of jaw)	17⅞ in.
Lateral Drawbar Movement	35 in.
Shipping Weight (approximate)	27,850 lbs.
Length of Track on Ground	8 ft. 5/16 in.
Width of Standard Track Shoes	20 in.
Maximum Width Track Shoes	28 in.
Maximum Width Track Shoes Available	24 in.
Ground Contact Area (Standard Shoes)	3853 sq. in.
Number of Track Shoes per Track	38
Ground Pressure per Sq. In. (Standard Shoes)	7.23 lb.
Tread Width (center-to-center of tracks)	74 in.

TRACTOR SPEEDS (at Rated Engine Speed):

GEAR RANGE	SPEED
1st Gear	1.39 M.P.H.
2nd Gear	2.09 M.P.H.
3rd Gear	2.97 M.P.H.
4th Gear	3.87 M.P.H.
5th Gear	4.46 M.P.H.
6th Gear	5.80 M.P.H.
1st Reverse	1.54 M.P.H.
2nd Reverse	3.47 M.P.H.
3rd Reverse	4.51 M.P.H.

ENGINE:

Make	General Motors Diesel
Type	Two Cycle
Number of Cylinders	6
Bore	4¼ in.
Stroke	5 in.
Piston Displacement	426 cu. in.
Engine Speed (governed at full load)	1600 R.P.M.
Maximum Net Torque	472 ft. lbs. @ 900 R.P.M.
Lubrication	Forced Feed
Fuel Used	No. 1 or No. 2 Diesel Fuel Oil
Fuel Supplied by	55 cu. mm. Unit Injectors

CAPACITIES (U S. Standard Measure:)

	Approximate
Cooling System	11¾ Gallons
Crankcase and Filters	5 Gallons
Transmission Case	8½ Gallons
Final Drives (Each)	5½ Gallons
Fuel Tank	90 Gallons
Track Release Housing (Each)	4½ Gallons
Air Cleaner (Each)	1 Gallon
Hydraulic Steering System	2½ Gallons

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 insure 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 this 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 a good grade of engine oil purchased from a reputable oil company.

Use oils of the following viscosity:

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

C. Track Release Housing Lubricant

Lubricate these housings with SAE 50 engine oil in all seasons.

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

Lubricate these assemblies with a grease that has been tested and found satisfactory 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 synthetic 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 new greases which have been tested and found satisfactory during each period are added to the list. Ask your nearest "Allis-Chalmers" authorized Dealer for the latest list.

E. Hydraulic Steering System

Use a non-foaming engine lubricating oil having the same viscosity as the oil used in the engine. If the hydraulic steering control system does not operate properly during sub-zero weather due to S.A.E. 10W engine oil being too heavy, the oil may be thinned with kerosene or fuel oil. Contact your local "Allis-Chalmers" Dealer for further information.

F. Pressure Gun Lubricant

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

IMPORTANT: CLEAN ALL LUBRICATION FITTINGS, CAPS, FILLER, AND LEVEL PLUGS AND THEIR SURROUNDING SURFACES THOROUGHLY BEFORE SERVICING. DO NOT ADD "DIRT" WITH LUBRICANT.

4. SPECIFICATIONS OF FUEL OIL

Use No. 1 Diesel Fuel Oil purchased from a reputable oil company. In warm weather, No. 2 Diesel Fuel Oil 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 oil 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. Transportation and subsequent storage account for the addition of most foreign matter found in the fuel.

The most objectionable chemical contaminations are free sulphur and gum, which, even in 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 oils 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 oil should be as low as possible. For normal temperature conditions, the fuel oil should contain less than 0.5% sulphur. For cold weather operation, fuel oils with less than 0.3% sulphur are 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, clog the filters and will 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 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 avoid the fuel becoming contaminated by water which will enter through the filler plugs when it rains, even though the plugs are tight.

The fuel tank of the tractor should be filled at the end of the day's run rather than 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

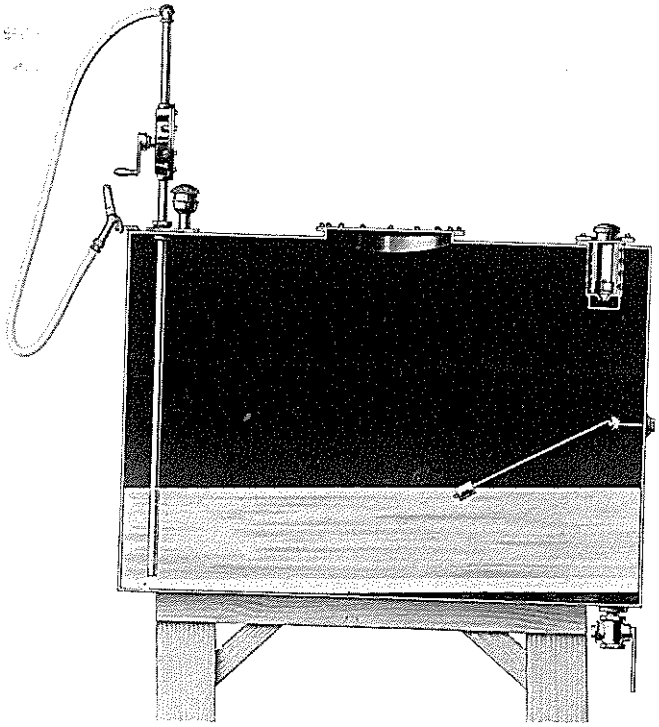


Fig. 3—Fuel Oil Storage Tank

6. TRACTOR AND ENGINE SERIAL NUMBERS

On all parts orders and in all correspondence relative to the tractor, it is necessary that both tractor and engine serial numbers be given. This will properly identify the particular machine and will insure 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 lower center of cowl in front of the operator.

The Engine Serial Number is stamped in the upper right side of the cylinder block near the governor control housing.

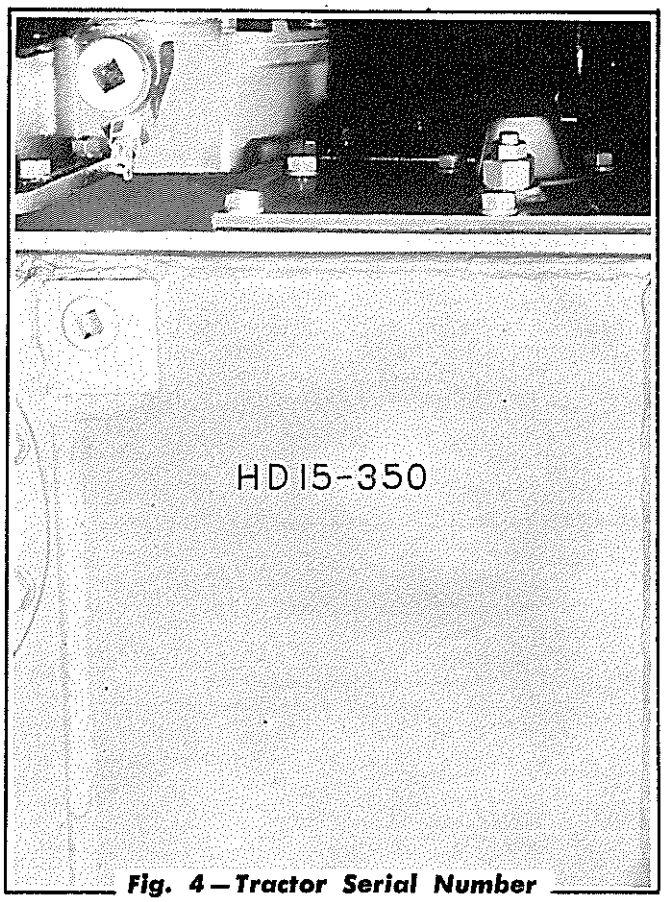


Fig. 4—Tractor Serial Number

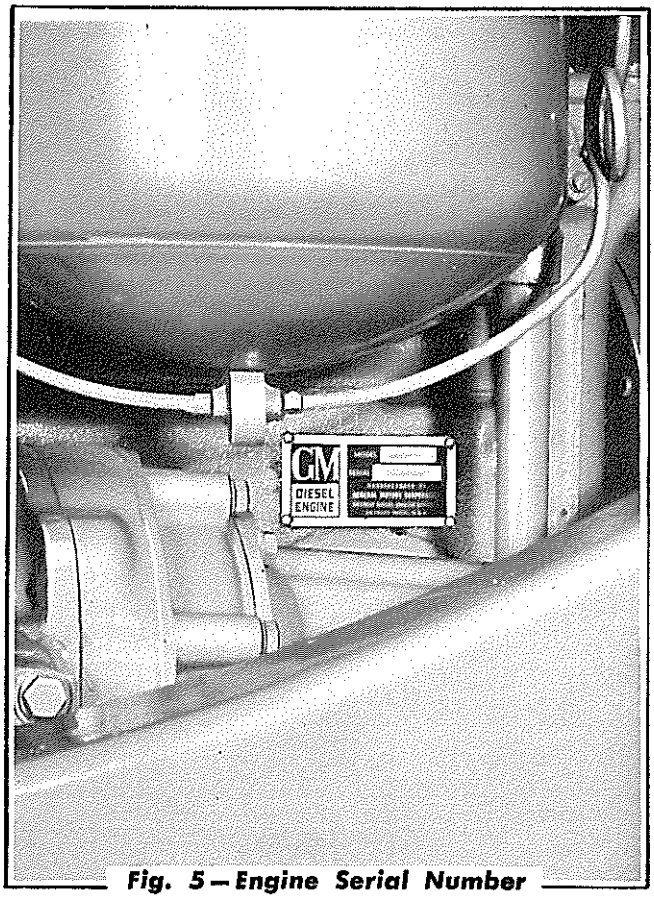


Fig. 5—Engine Serial Number

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, and fuel pressuge gage. 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, inlet fuel manifold on the right side of the cylinder head, and then through 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 and is returned to the fuel tank. A pressure of 25 to 55 pounds is maintained within the fuel system by a restricted fitting located at the rear of the fuel return manifold. The continuous circulation of fuel through the injectors helps to cool them and also eliminates the possibility of air pockets in the fuel system.

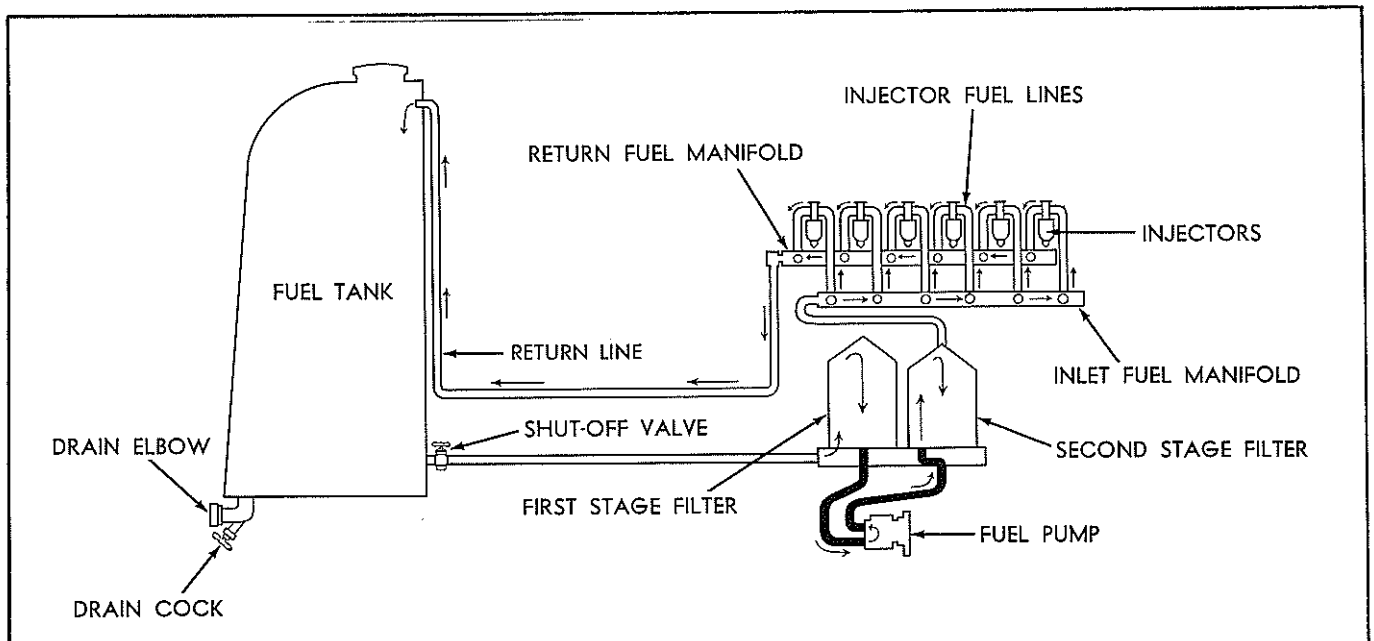


Fig. 1 — Schematic Fuel Flow Diagram

2. CHECKING FUEL SUPPLY SYSTEM

A. General

Under normal conditions, with the engine running at full throttle, 25 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 force 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. 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. 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 funs "ragged" with suitable fuel return, the injector filters for one or more of the cylinders may be partially clogged. Locate the faulty injector as follows:

Run the engine at idling speed and cut out each injector in turn by holding the injector follower down with a screwdriver or small block of wood as illustrated in Fig. 2. A decrease in engine speed with follower held down will indicate that the injector for that cylinder is functioning properly. *Caution. Do not allow screwdriver to slip off follower as damage to the valve assemblies can easily result.*

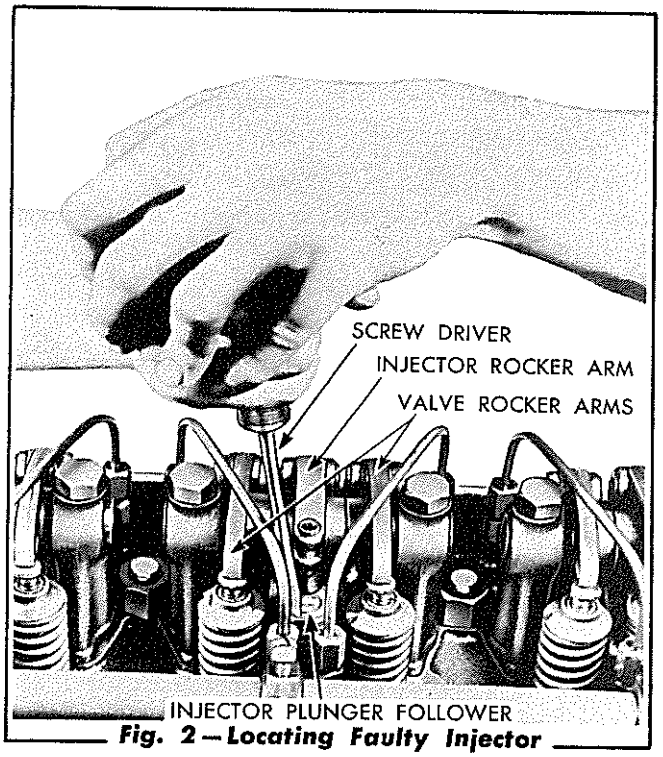


Fig. 2—Locating Faulty Injector

If engine speed does not decrease, the injector is inoperative and should be removed for further inspection. To 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 finger over injector fuel outlet and crank engine with 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, open the air vent in the top of the second stage fuel filter. The fuel should gush from the opening in the filter with the engine running. If it does not, the fuel pump will be considered inoperative and must be repaired or replaced.

E. Excessively High Fuel 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, and fuel return line restrictor assembly (located at the rear of the fuel return manifold), 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 90 gallons. The drain elbow at the bottom of the fuel tank provides a means of flushing the tank and also acts as a sediment sump. Open the drain cock on this elbow 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.

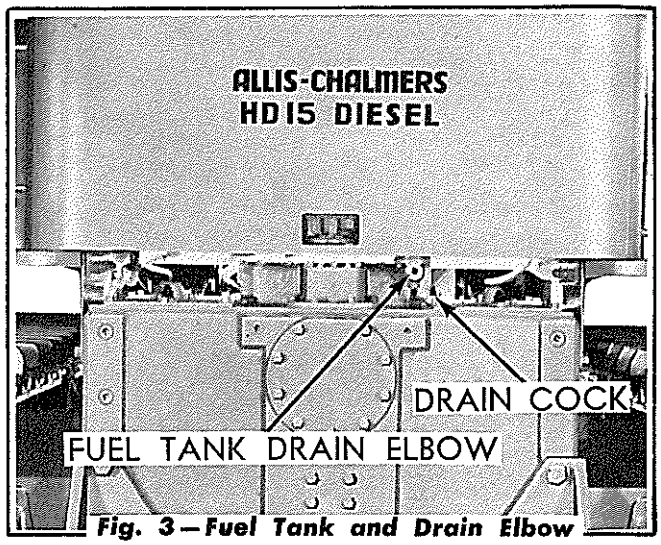


Fig. 3—Fuel Tank and Drain Elbow

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 and the arm cushions from the top of each battery box. Remove the bolts used in fastening each battery box to the fuel tank (one bolt on each side).
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 entrance of foreign material.

4. FUEL FILTERS

A. Description of First and Second Stage Fuel Filters

The two fuel filters and the engine lubricating oil filter are mounted on a common base on the left side of the engine. The rear filter is the first stage fuel filter; the center filter is the second stage fuel filter. The first stage filter contains a 9 inch, and the second stage filter contains an 8 inch length replacement element. 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

Open the air vent, then open 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. Close the drain cock and the air vent when clean fuel runs out. Discard the old element and install new ones when fuel pressure is below 20-25 pounds with engine 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 ever 300 to 500 hours of operation or more often if conditions warrant.

C. To Remove Elements

1. Close the fuel tank shut-off valve and open the air vents on top of the filter shells. Open the drain cocks and allow fuel to drain from the filter base.

2. Clean all dirt from around the filter shells and the filter base thoroughly.

3. Unscrew the studs and lift the filter shells from the filter base.

4. Lift out and discard the filter elements, bottom gaskets, and top and bottom seals, leaving the compression springs and cups in position.

5. Clean the filter shells, studs, and the filter base.

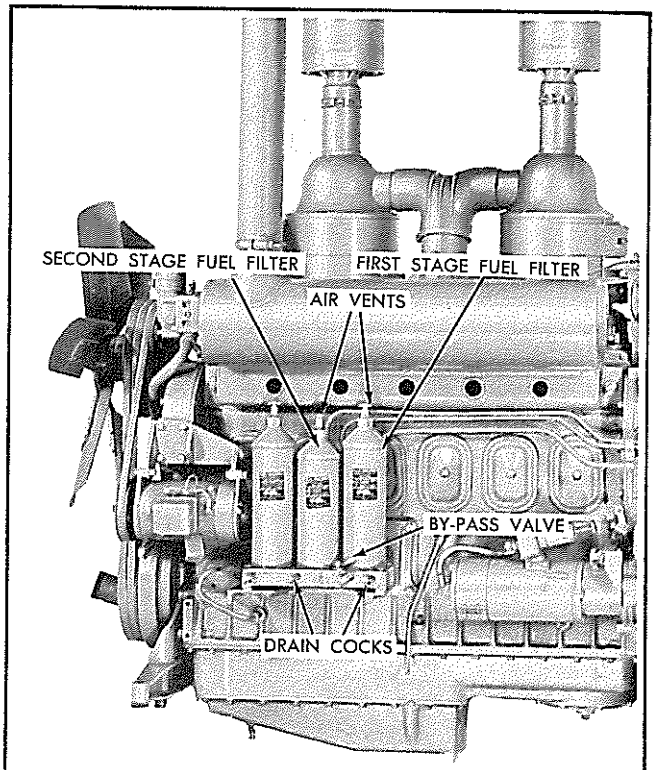


Fig. 4—Filter Assemblies

D. To Install Elements

1. Install new bottom gaskets in the filter base. Then install new seals in the end plates. Install these end plates, complete with seals, in the top and bottom openings of the elements.

2. Place the washers on studs followed by the filter shells. Turn the assemblies bottom up and install the top cups and filter elements complete with end plates and seals. Make certain that the compression springs and cups are in position on the filter base and install the complete assembly of filter shell, cups, end plates, and seals in its proper position on the filter base.

3. Tighten the studs securely, making certain that the filter shells are in the counterbores of the filter base. *NOTE: Use precaution in pulling the studs down tight, since a side pull may break the studs.*

4. Close the drain cocks in the filter base, open the shut-off valve at the fuel tank, then open the air vent in the top of the first stage fuel

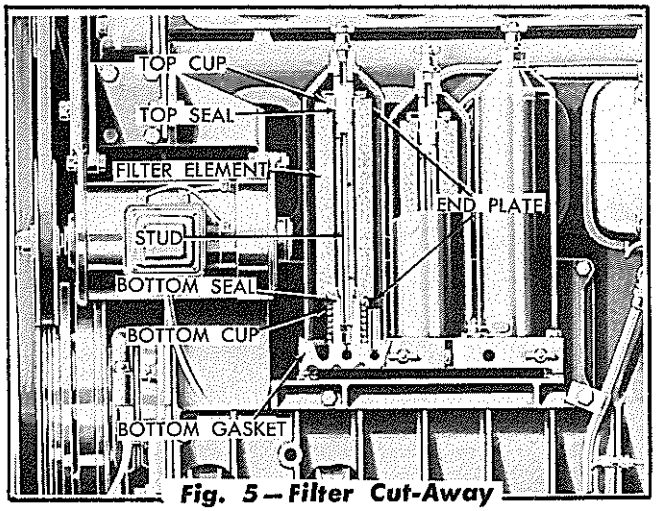


Fig. 5 — Filter Cut-Away

filter. When fuel runs out of the air vent in the first stage fuel filter, close the air vent, then, open the air vent in the top of the second stage fuel filter. Turn the filter base by-pass valve to the on position (handle away from filters) and allow the second stage filter to fill with fuel. Close the filter air vent when fuel runs out, then, turn the filter base by-pass valve to the off position (handle positioned next to first stage filter shell). Start the engine and check for leaks around the filter base, top copper washers, and fuel lines.

IMPORTANT: Keeps parts clean when changing the fuel filter elements.

5. FUEL PUMP

A. Description

The tractor is equipped with a fuel pump, mounted to the engine as shown in Fig. 6.

The fuel pump is a constant flow gear type pump, having a delivery capacity of approximately 35 gallons per hour at 40 pounds pressure at 1000 R.P.M. The pump is bolted to the rear end of the blower housing, and is driven from the lower blower rotor shaft through a self alining U-shaped steel coupling. 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 gears in the spaces between the teeth, and is forced out of the pump under pressure.

The 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.

Two pump shaft oil seals are used inside the stator at the inner end. The sealing edge of one seal faces the pump housing and retains the fuel within the pump, the other faces the mounting flange end of the stator 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.

A spring loaded relief valve, located on the inlet side of the pump (left side of pump viewed from cover 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 pump pressure in case clogging occurs in the fuel lines or filters.

B. Service

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

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 blower housing. (Use the special fuel pump wrench to remove the capscrew nearest the cylinder block). Remove the fuel pump and drive coupling as a unit, withdrawing the pump straight out of the blower.

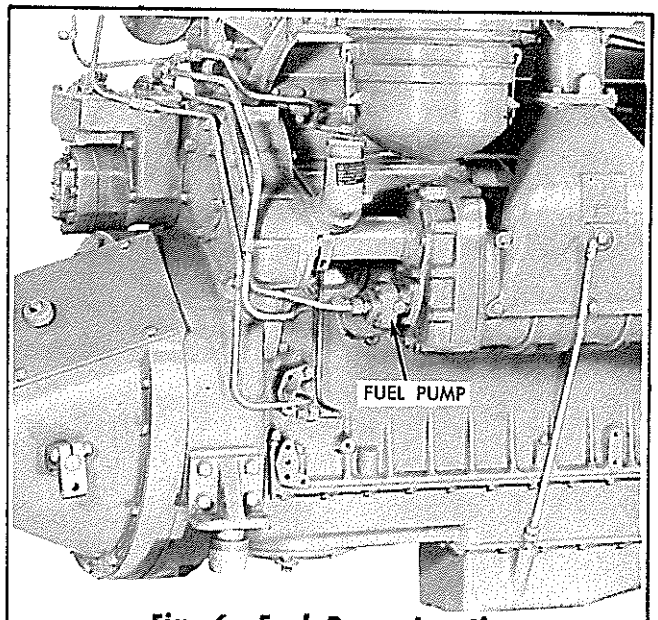


Fig. 6 — Fuel Pump Location

3. Rotate the pump shaft by hand to see if the pump rotates freely. If the pump is binding or sticking, disassembly and inspection will be necessary.

D. Disassembly of Fuel Pump

When disassembling the pump, if a seal expanding tool is not available there is considerable danger in damaging the seals when the shaft is reinstalled back through the seals. When installing the shaft, it is very essential to install it without damage to the seals.

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

When removing the relief 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 hous-

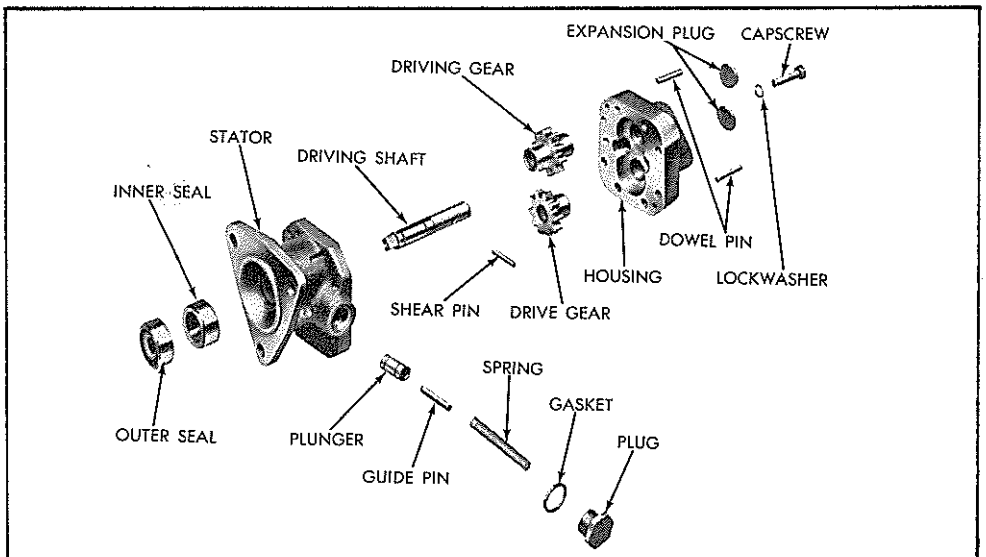


Fig. 7—Fuel Pump Details

ing 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. DO NOT PRY STATOR AND HOUSING APART.

3. Remove the pump driven gear.

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

5. Remove the dowels if necessary.

6. If it is necessary to remove the shaft seals, a tool of the proper design may be used to remove them so they will not be damaged.

E. Inspection of Pump Parts

1. Wash all the parts in clean fuel oil or solvent and inspect them carefully. The shaft seals, once removed from the pump, should be replaced with new seals. 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 oil 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.

3. Inspect the driving gear on the pump shaft. The shear pin holding the gear to the 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.

F. Assembly of Fuel Pump

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

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

3. Lubricate the pump shaft and seals and install the pump shaft (with driving 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, make 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.

6. FUEL INJECTORS

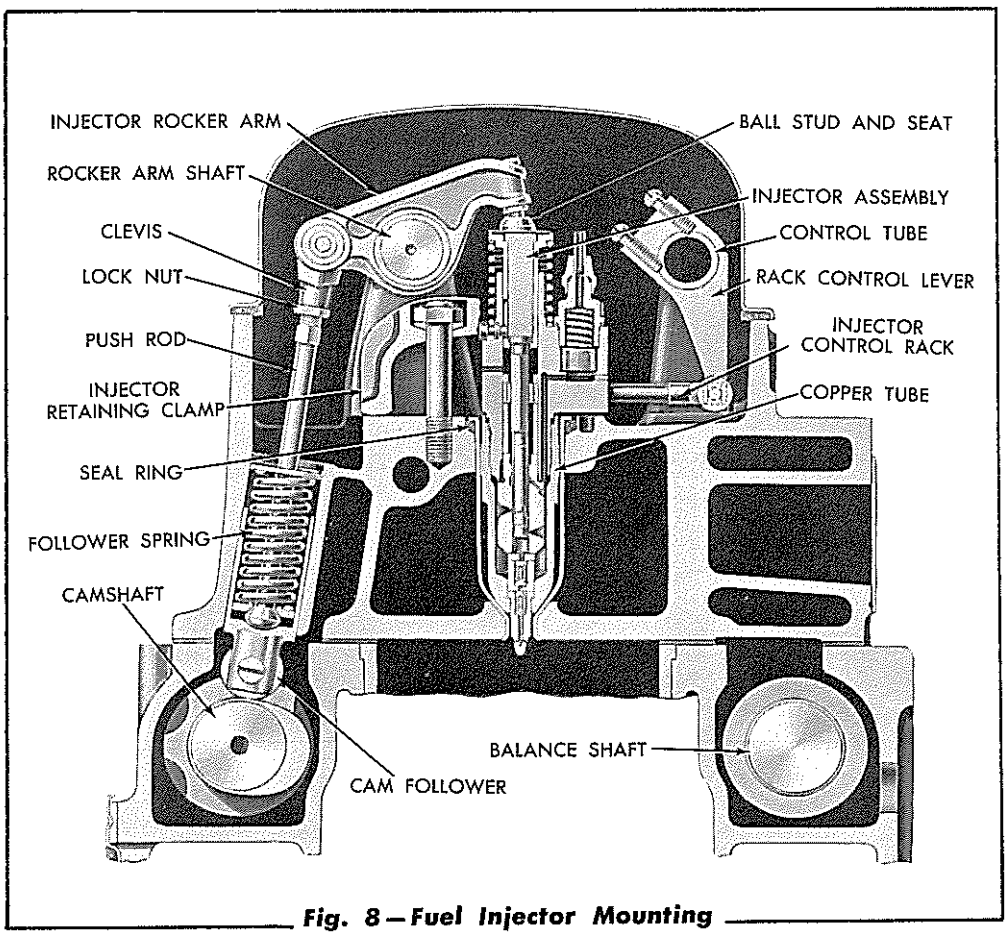


Fig. 8—Fuel Injector Mounting

A. Description

The unit fuel injector (55 cu. mm.) used in the engine of the HD15 Tractor, 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 (55 cu. mm.) illustrated in Fig. 9, shows the various fuel injector parts. Fuel is supplied to the injector under pressure and enters the 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.

The motion of the injector rocker arm is transmitted to the plunger by the follower which bears against the return 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 this helix or cut-off to the two ports changes with the rotation of the plunger.

As the plunger moves downward, the fuel in the 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 cut-off from which it can still flow back into the supply chamber until the upper helix closes the upper port. At this point both the upper and the lower ports are closed, and the fuel remaining under the plunger is then forced through the spray tip into the combustion chamber, until the plunger has reached the end of its downward stroke. 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 increasing or decreasing the desired amount of fuel which remains under the plunger for injection into the cylinder.

When sufficient pressure is built up by the downward travel of the plunger, the injector valves lift

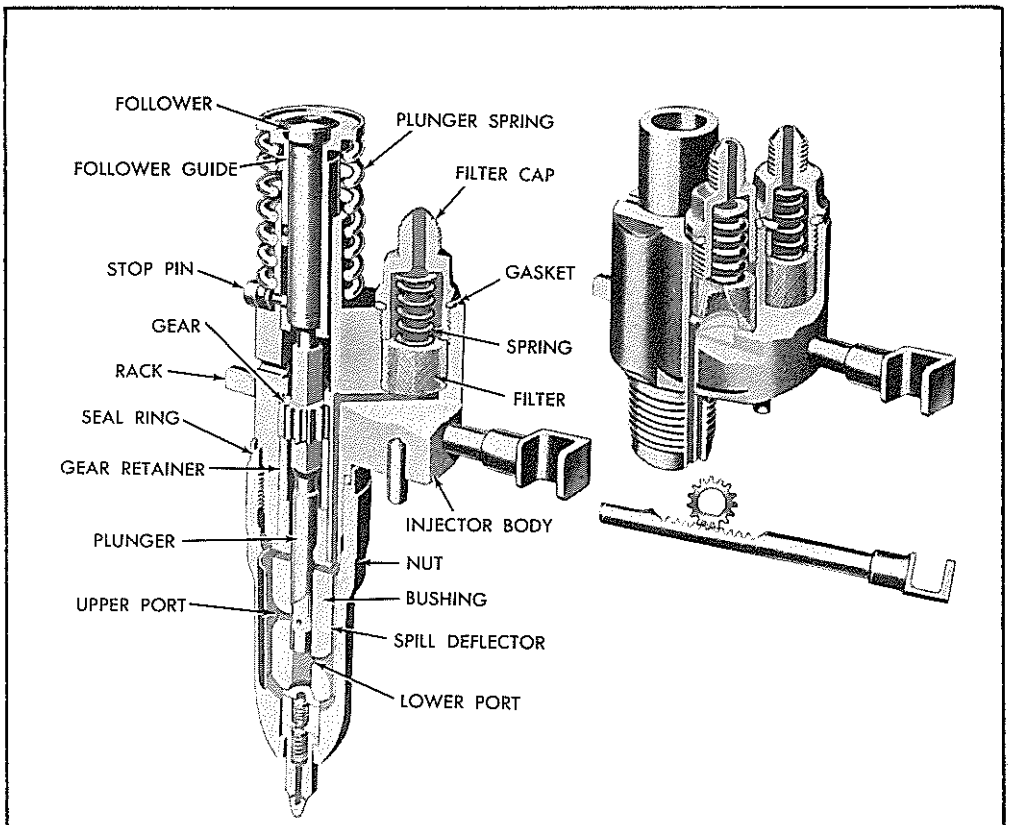


Fig. 9 — Fuel Injector Details

off their seats and fuel is injected through six (6) small orifices of .006" diameter in the spray tip and atomized in the combustion chamber. Two injector valves are used in the 55 cu. mm. injectors to increase their popping (breakaway) pressure.

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.

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 injector and fuel system.

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

3. 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.

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

D. Injector Removal

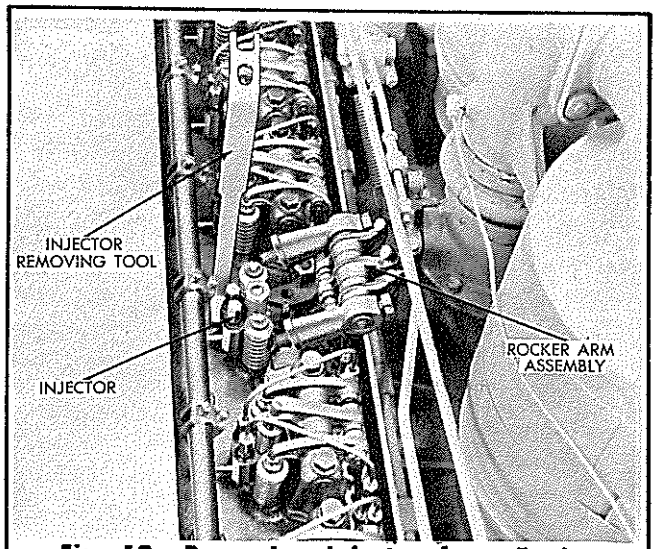


Fig. 10—Removing Injector from Engine

1. Remove the engine hood, clean off the rocker arm 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.

3. If necessary, turn the engine with the starter until the rocker arm clevis pins (at push rod end of arms) are in line, then turn the rocker arm bracket bolts out of the cylinder head and fold the rocker arm assembly back out of the way. *CAUTION: Push rods may be bent if the rocker arms are not aligned when removing this assembly.*

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

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 oil as protection against dirt and corrosion. Leave the parts in the clean fuel oil 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.*

NOTE: The spray tip, valves, and 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 thumb and forefinger. 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 oil as they are removed.

1 Clamp the injector in an injector 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. Using a screwdriver as shown in Fig. 11, raise the follower spring, at the same time holding down on top of the follower, and withdraw the stop pin. Allow the spring to raise to its free length position after the pin is removed.

3. Lift up on the plunger follower until the plunger is withdrawn from the injector. Remove the follower spring and separate the plunger from the plunger follower.

4. Clamp the injector in the holding fixture with the spray tip of the injector up, as shown in Fig. 12 and loosen the injector nut, using

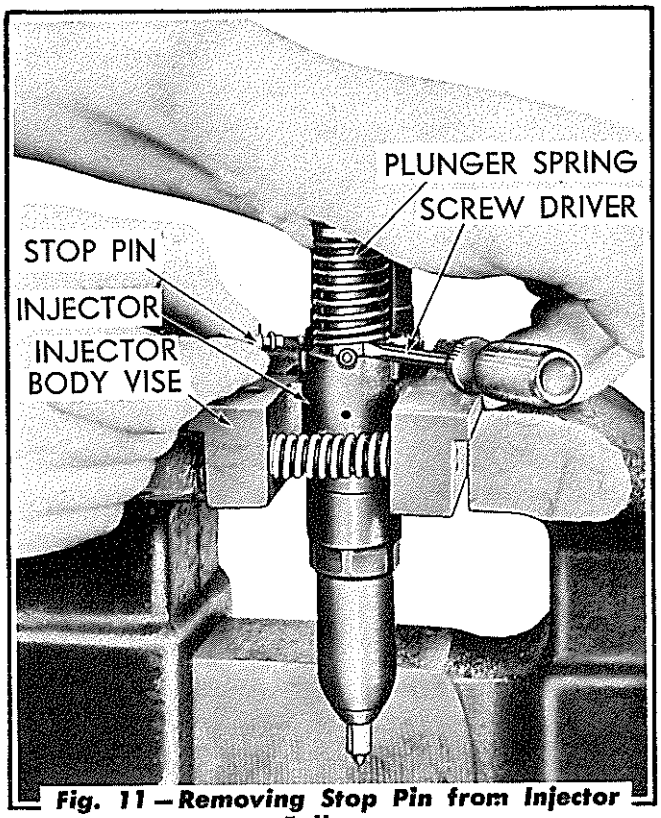


Fig. 11 — Removing Stop Pin from Injector Follower

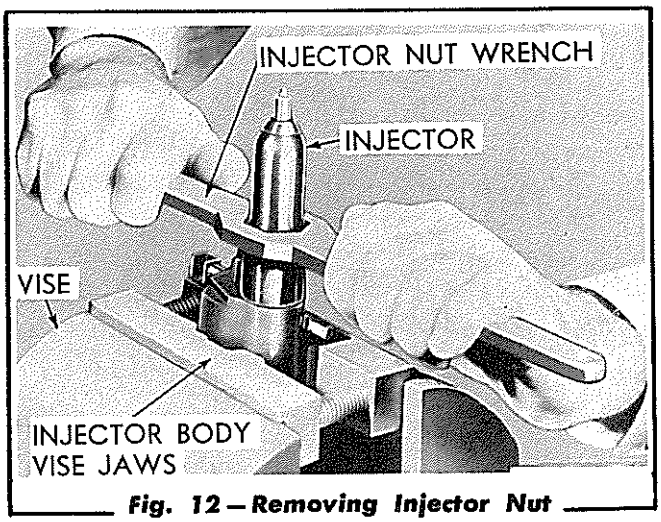


Fig. 12 — Removing Injector Nut

the injector nut wrench. Unscrew the nut from the body, then raise the nut carefully off the spray tip so that the tip and the other small parts resting on the end of the 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 nut. In this event, drive the spray tip from the nut using a spray tip driving tool.

5. Carefully lift the spray tip, lower valve stop, lower valve spring, lower valve, lower valve seat, upper valve stop, upper valve spring, upper valve, and upper valve seat from the

plunger bushing.

6. "Jar" the spill deflector from the nut (if it remained in the nut) or lift it from around the bushing. Remove the bushing from the injector body.

7. Remove the injector body from the fixture and "jar" the plunger gear retainer and gear from the body. Slide the control rack out of the body.

8. Remove the two filter caps, filters, and springs from the body.

F. Cleaning, Inspection, and Reconditioning of Injector Parts

Wash the hands thoroughly and clean all the injector parts in clean fuel oil 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 the 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. When any of the internal working parts of the injector are scored or damaged, they are unfit for further use and should be replaced.

After the injector has been disassembled and all the parts carefully cleaned in carbon tetrachloride or fuel oil, they should be protected from dirt by storing them in clean fuel oil 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 six (6) spray tip orifices with the .006" 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 .008".

2. Valves and Seats

Thoroughly wash and inspect the upper valve seat, upper valve, upper valve stop, lower valve seat, lower valve, lower valve stop, and the flat sealing surface of the spray tip for smoothness (refer to Fig. 15 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, 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 oil, 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.

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

As frequent refacing of lapping blocks will produce top quality work, it is advisable to

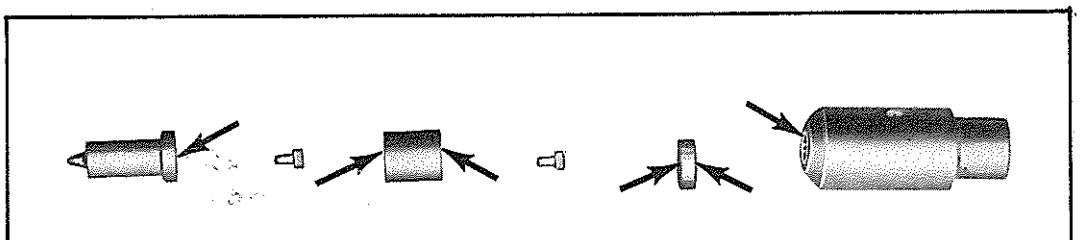


Fig. 13—Sealing Surfaces of Injector Which May Require Lapping

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 oil and working a brush through the bushing. Blow it out with compressed air and again wash it in clean carbon tetrachloride or fuel oil. 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 should 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 a spray tip reaming tool. 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 for the spray tip. Clean the inside of the nut thoroughly with one of the brushes provided in the injector tool kit.

5. Injector Filter

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.

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

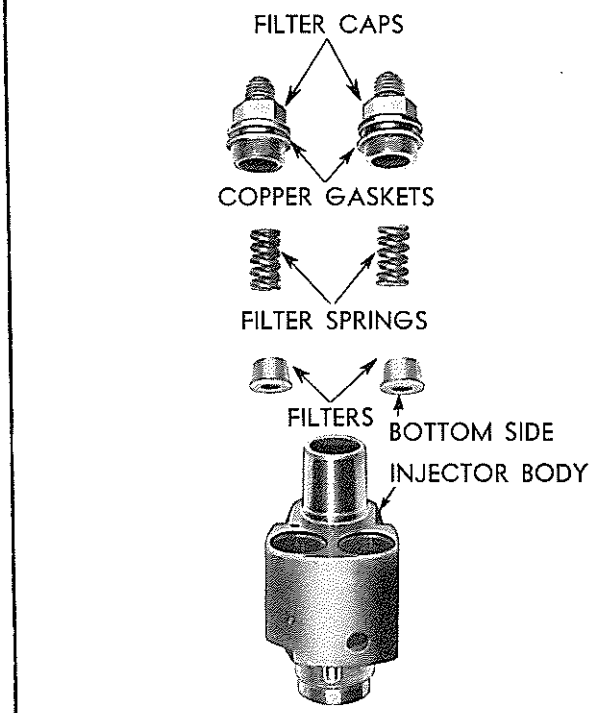


Fig. 14—Injector Filters, Springs, and Caps

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 injector.

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

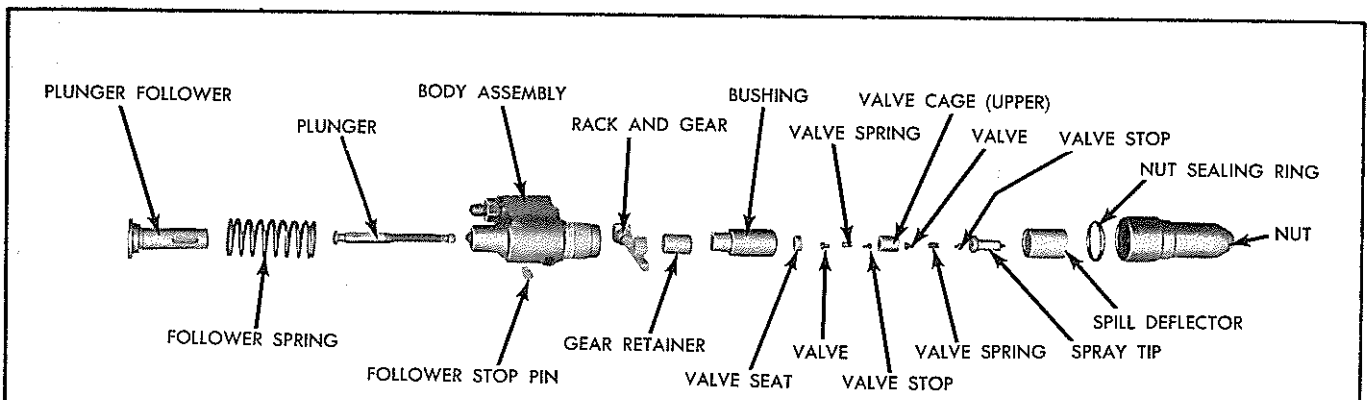


Fig. 15—Injector Rack, Gear, and Spray Tip Details

in a pan of clean fuel oil 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 we 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 of the outer side.*

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

b. Place the inlet filter in the fuel cavity that has the timing gage hole located near its edge and the outlet filter in the other cavity. Place a spring above each filter, and a copper gasket up against the shoulder of each filter cap. Then lubricate the threads and tighten the filter caps in place in the injector body. Whenever a filter cap is removed, use a new copper gasket when it is installed. Tighten the filter caps to a torque of 65 to 75 ft. lbs.

2. Install Control Rack and Gear

Refer to Fig. 9 and note that two of the teeth of the injector rack have a punch spot mark; also, 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.

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 spot on the gear is between the two punch spots 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 injector 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 Fig. 15 for assembly of the following parts:

a. Holding a valve spring with fingers, place the upper valve in one end of the spring, and place a valve stop in the opposite end of the spring. Insert these three parts into position in the lower valve seat, installing the end with the valve stop first.

b. Place the upper valve seat in position over the upper valve and place this assembly in position on the plunger bushing.

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

e. With the valves and the spray tip held in position with the tool, screw the injector 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 to the body. It can be turned down within 1/16" of the shoulder on the body 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 injector nut to a torque of 55 to 65 ft. lbs. *CAUTION: DO NOT OVERTIGHTEN.*

4. Install Plunger and Follower Assembly

Invert the injector in the holding fixture so that the injector is right side up. Refer to Fig. 16 for assembly of the following parts:

a. Place the follower spring down over the follower neck of the injector body. Insert the top of the plunger into the slot in the lower end of the plunger follower.

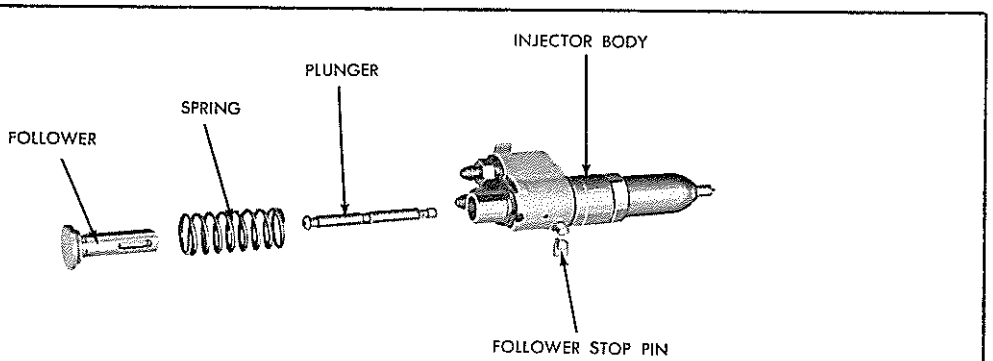


Fig. 16—Injector Plunger and Follower Details

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

c. With the flat of the plunger in line with the flat in the gear, lower the plunger and the plunger follower into the injector. Line up the slot in the plunger follower with the hole in the injector body for the follower stop pin. Insert a screwdriver or a spring lifter tool beneath the lower end of the follower spring, push down on the top of the plunger follower, and, raising the spring at the same time with one hand; insert the follower stop pin with the other hand (refer to Fig. 11). The stop pin will slip into place as soon as the slot in the plunger follower and the hole in the injector body are in alignment. When the spring is released, it will lock the stop pin in place.

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. Also, when in doubt about an injector functioning properly, a test will usually indicate the difficulties quickly. Two tests are recommended on the injector: (1) A "popping" test, (2) A 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 injector holding fixture and vise and screw the bolt of the popping tool into the tapped hole in the fixture. Tighten the lock nut. Introduce clean fuel oil into one of the injector openings in the filter caps by means of an oil can until the injector is completely full and fuel flows from the other opening. Set a glass beaker under and surrounding the injector spray tip so fuel injected 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 injected with such force that it will penetrate the skin and may cause blood poisoning.*

   Push the injector rack all the way in to 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 six (6) holes in the spray tip. Keeping the injector filled with fuel from the oil can, press the handle down on 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.

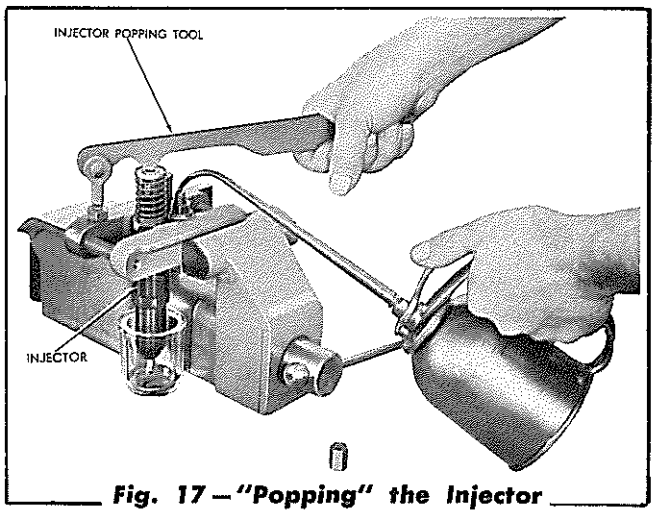


Fig. 17 — "Popping" the Injector

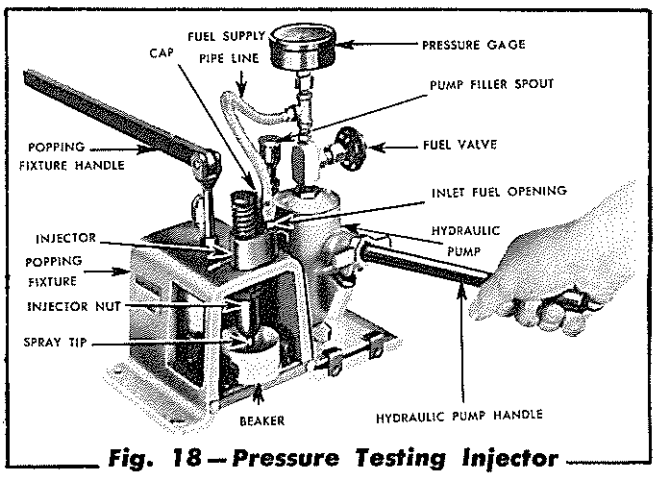


Fig. 18 — Pressure Testing Injector

2. The injector pressure test requires the use of a test fixture similar to that shown in Fig. 18. The injector is installed in the stand and a fuel line from the hydraulic pump is connected to the injector. A hydraulic gage 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 spray tip valves open. This pressure should be between 1000 and 1400 pounds per square inch.

   Check for leaks around the injector 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 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 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 closing the valve between the pump and pressure gage and noting 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 arm cover 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 the 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 and center the side arms of the clamp as well as possible in the machined recesses of the injector body. Drop the special washer over the stud with the rounded side of the washer down. Tighten the injector clamp nut using 20 to 25 foot pounds torque.

3. Swing the rocker arms over on the valves and injector and install the bolts in the brackets. If the brackets were removed, they must be installed on the shaft with the machined sides facing the valve rocker arms. While tightening the bracket bolts, hold the rocker arms and brackets together, allowing a total of about .006" clearance between these parts. Tighten the rocker shaft bracket bolts using 90 to 100 foot pounds torque.

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 in the cylinder head and connect 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 arm 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 55 cu. mm. injectors which require that the top of the follower be set

1.484 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 arm cover.

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

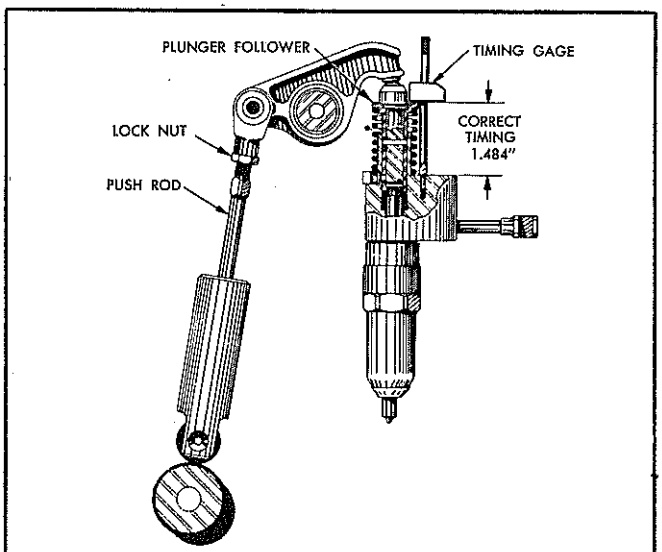


Fig. 19—Injector Timing

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 the copper washer under fuel connector or by dirt in the hole. Turn the timing gage so that the extended head (flat portion) of the gage is toward the injector plunger.

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 proper timing is obtained (refer to Fig. 19). 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 the injector body while performing this adjustment.

5. Tighten the lock nut and re-check to be sure the timing was not changed by tightening the lock nut. Replace the rocker arm cover and the hood.

K. Injector Equalizing

Equalizing of the injectors consists of adjusting the injector rack control levers so that an equal amount

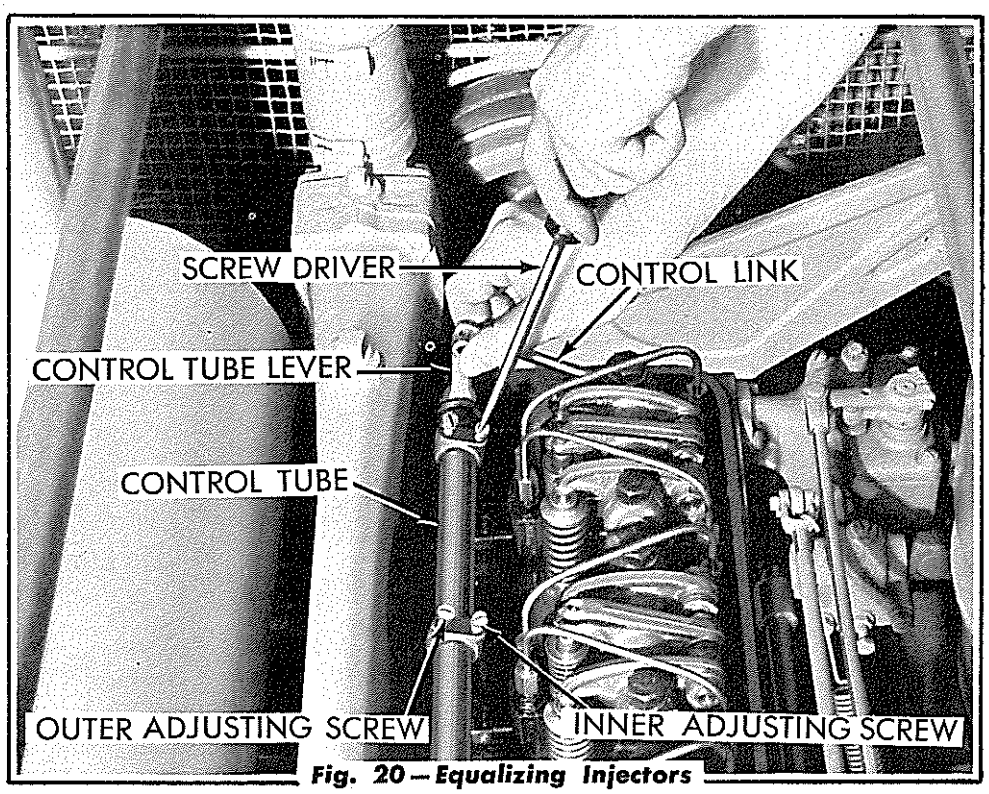


Fig. 20—Equalizing Injectors

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.

1. Remove the engine hood and the rocker arm 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).

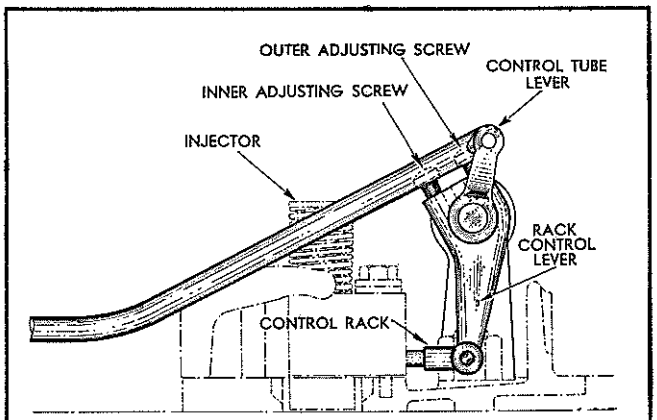


Fig. 21 — Control Rack

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 adjusting screws on all the rack control levers and make certain that the levers are free on the control tube and that the tube rotates freely on the bearings at the ends of the tube.

5. Push the engine "shut-off" knob all the way in (run position) and pull the throttle lever all the way back (wide open).

6. Push the control tube lever toward the water manifold as far as possible and hold it in that position. This will take up any possible slack in the control linkage.

7. Use a screw driver and turn down the inner adjusting screw on No. 1 rack control lever (nearest to the engine fan) until the No. 1 control rack moves in as far as it will go. At this point a slight pressure will be felt on the control tube lever. Rotate the screwdriver back and forth with the finger tips, to set the screw at the exact point where the pressure on the tube lever starts; this is the point where the control rack just begins to "bottom" in the injector when the injector is in full open position.

8. Tighten the outer adjusting screw on the No. 1 injector to lock the control lever in place on the control tube. This will also move the injector rack outward a few thousandths of an inch to prevent "bottoming" of the injector racks during full load (maximum injection) operation of the engine. The rack should move freely when rocked lightly with the finger tips. *CAUTION: Use moderate pressure on the screwdriver when tightening the adjusting screws.*

9. Repeat the above procedure on the remaining injector control racks.

10. Still holding the control tube lever in position as described in paragraph No. 6, inspect the control racks. The racks, when the rack controls are adjusted properly will all be tight. If any should be found loose, readjust them by loosening the outer screw and tightening the inner screw. DO NOT CHANGE THE SETTING OF NO. 1 CONTROL LEVER AFTER THE INITIAL ADJUSTMENT HAS BEEN MADE.

11. If all the injectors have been properly equalized the racks will just "bottom" gently in the full load position when the control tube lever is held toward the water manifold and will be free when the control tube is not held.

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

13. Install the rocker arm cover and the engine hood.

7. INJECTOR COPPER TUBES

A. Description

As will be seen by referring to Fig. 8, 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 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, or their equivalent, and in the following manner:

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, and unscrew the rocker arms from the push rods. Also remove the exhaust valves. (Refer to "EXHAUST VALVES AND OPERATING MECHANISM" in Section IX).

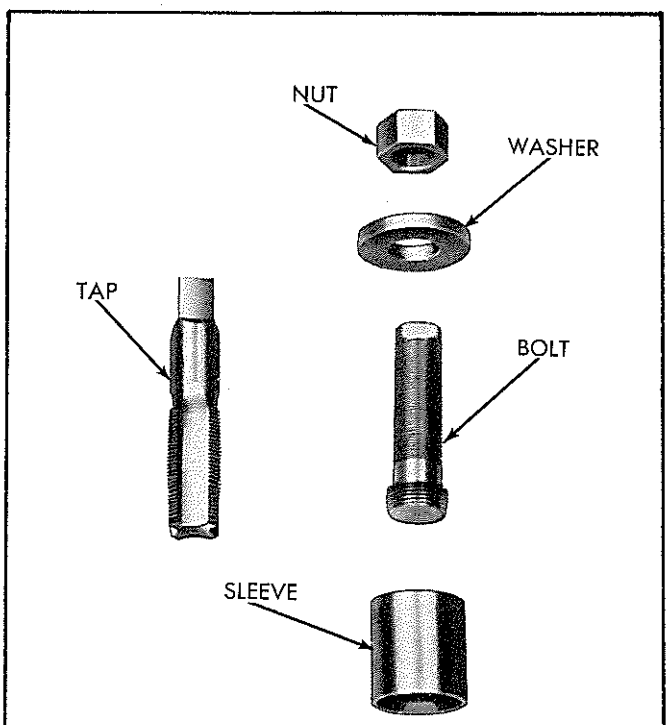


Fig. 22 — Injector Copper Tube Remover Tools

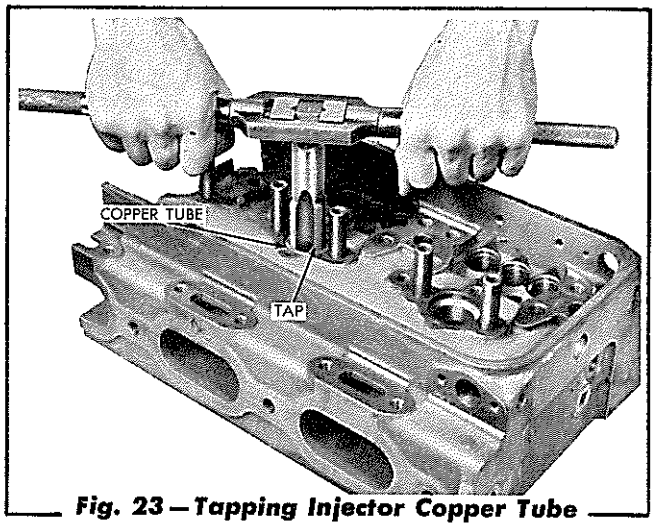


Fig. 23 — Tapping Injector Copper Tube

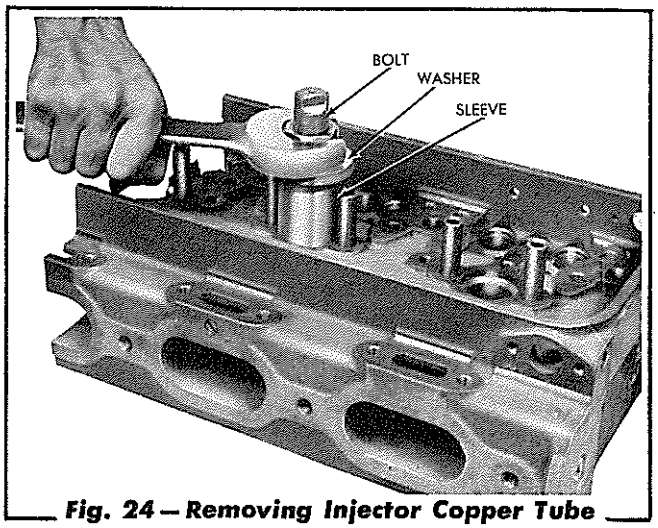


Fig. 24 — Removing Injector Copper Tube

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

4. Support the cylinder head, top side up, on blocks and screw the tap down into the upper end of the copper tube as shown in Fig. 23. Remove the tap.

5. Screw the special bolt down tight into the threads produced by the tap, then place the sleeve down over the threaded shank of the bolt. Place the flat washer over the bolt and on top of the sleeve, then start the nut on the puller and tighten down to withdraw the tube from the cylinder head.

C. Copper Tube Installation

1. Clean the hole in the lower side of the cylinder head and scrape any remnants of the old neoprene packing ring from the counterbore in the top of the head.

2. With the cylinder head supported on blocks, top side up, install the neoprene packing ring in the counterbore of the head.

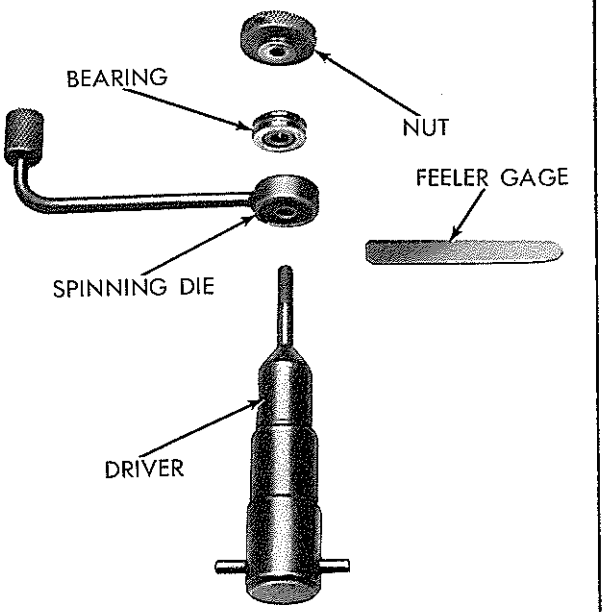


Fig. 25—Injector Copper Tube Flaring Tool

3. Force the injector tube through the packing ring and down into the bore in the cylinder head. Insert the driver tool into the tube and drive the tube firmly into position in the head. When the tube is properly located, the flange at the upper end will seat on the packing ring and into the counterbore in the cylinder head.

4. After the tube is driven into place, the lower end of the tube must be flared out to lock in place with a driver, spinning die, and nut as follows:

   a. Suitably support the cylinder head on a work bench and install the driver into the copper tube, with the small threaded end of the tool extending through the opening at the lower end of the copper tube.

   b. Place the spinning die over the threaded end of the driver as shown in Fig. 26.

   c. Install the bearing next to the spinning die and start the nut.

   d. While maintaining a light tension on the nut, gently tap on the large end of the driver to firmly seat the copper tube and upset the small end of the tube.

   e. Place a .002" feeler gage between the cylinder head and the spinning die, as illustrated in Fig. 26, then, with a light tension on the nut, rotate the spinning die and flare the lower end of the copper tube into the cylinder head recess until a drag is felt on the feeler gage.

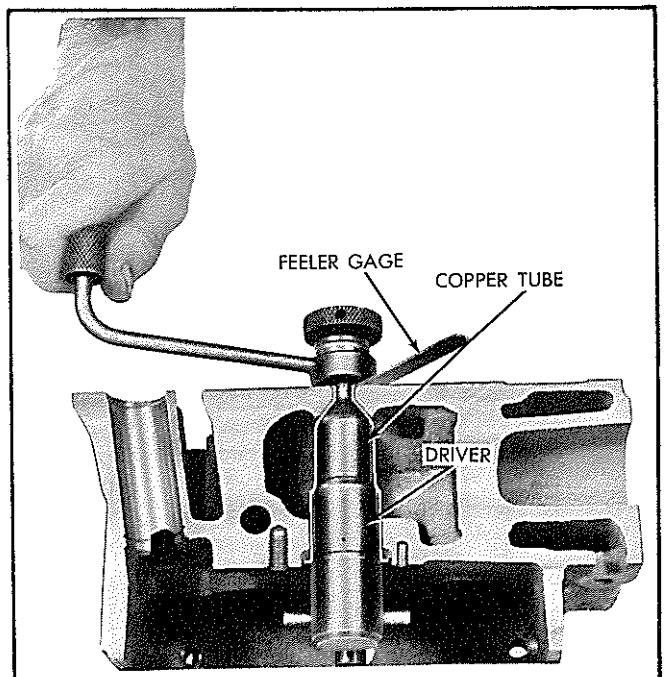


Fig. 26—Flaring End of Copper Tube

5. The tube must now be reamed; first, to receive the injector body nut and the spray tip; and second, for good seating of the bevel on the lower end of the injector nut. Reaming the upper end of the tube to its proper size for the body nut and spray tip is accomplished by use of the reamer illustrated in Fig. 27. Reaming the bevel seat in the tube is accomplished as follows by use of the bevel seat reamer shown in Fig. 28.

   a. Insert the injector tube bevel seat reamer into the tube and place the reamer

feed clamp plate and block on the cylinder head as illustrated in Fig. 28. Position the feed screw of the tool directly over the center of the reamer.

b. Bolt the plate and block securely on the cylinder head and turn the feed screw down FINGER TIGHT ONLY.

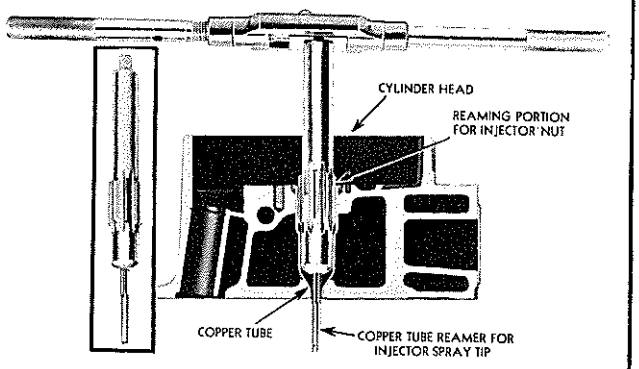


Fig. 27 — Reaming Copper Tube for Injector Body and Spray Tip

c. Using a cutting compound consisting of equal parts of cutting oil and kerosene, ream the bevel seat for the injector nut so that the shoulder of the spray tip will be just flush with the under surface of the cylinder head (Fig. 29). Check the depth of the cut during the reaming operation by installing an injector in the tube and taking measurements.

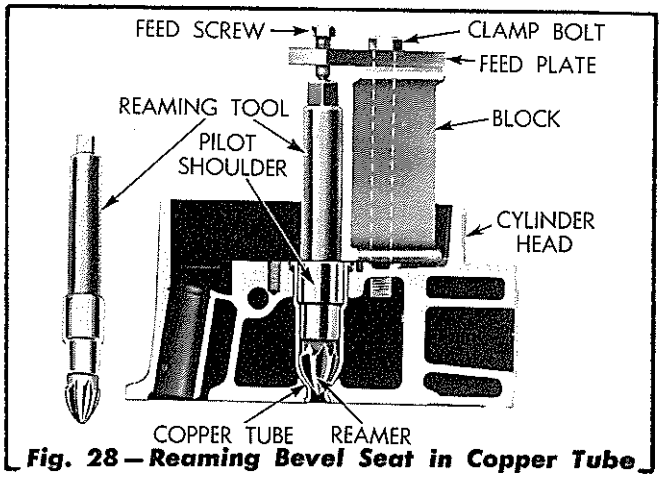


Fig. 28 — Reaming Bevel Seat in Copper Tube

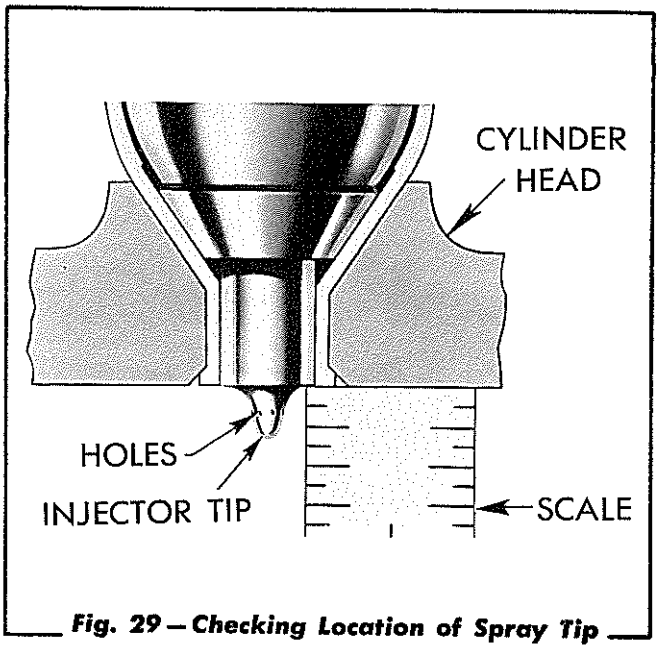


Fig. 29 — Checking Location of Spray Tip

8. FUEL MANIFOLDS

A. Description

Fuel is supplied to the injectors by the fuel pump through the lower of the two fuel manifolds located on the right side of the cylinder head and connected to the injectors by short steel injector fuel lines. The upper (return) manifold returns the excess fuel oil from the injectors through tubing and back to the fuel tank. Pressure is maintained in the fuel system by a restricting fitting located at the rear of the fuel return manifold. Both manifolds are locked in position by fuel connectors which set in tapered seats in the manifold fittings.

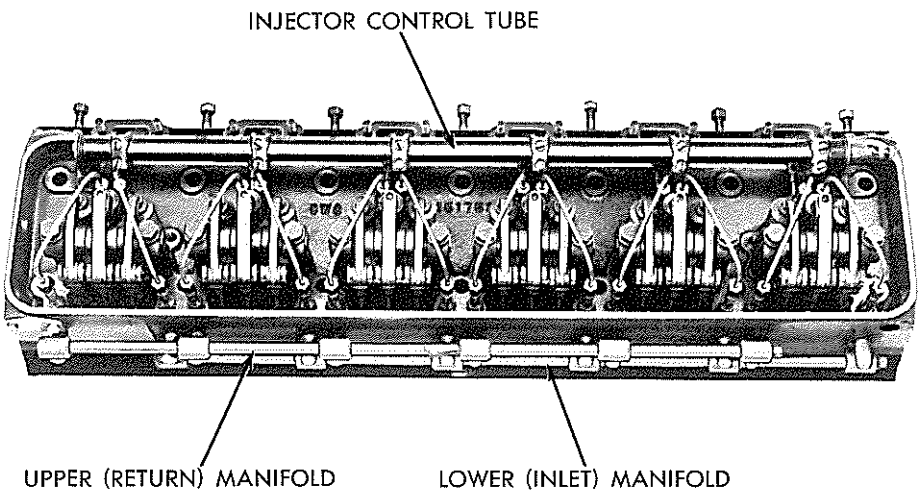


Fig. 30 — Cylinder Head and Fuel Manifolds

B. Service

Since the fit of the lower ends of the fuel connectors with the tapered seats in the manifold fittings is the only connection between these parts, prevention of fuel oil leaks at these points depends on good contact surfaces, and on the connectors being held tightly in the seats. Any leakage between the fuel connectors and the tapered seats of the manifolds will be observed at the holes on the outside of the cylinder head. If a leak occurs, remove the injector fuel lines in line with the leaking connector, then loosen the lock nut on the connector inside the cylinder head, and test it to see if the connector is tight.

If the seating surfaces for the connector are a trifle corroded or rough and do not make a good seal, removal of the manifold and lapping of the two surfaces, with a very fine lapping compound, may correct the leak. Clean the manifold and connector thoroughly after this operation before they are again installed to prevent any of the compound from entering the injectors. Use new copper washers under the connector lock nuts when installing the manifold.

C. Removal of Manifolds

Refer to Fig. 31 for relative location of parts. Either manifold may be removed separately and without removing the cylinder head from the engine.

1. Remove the hood.

2. Clean off the rocker arm cover, the right side of cylinder head, and the governor control housing.

3. Remove the rear line of each pair of injector fuel lines if the outlet (upper) manifold is to be removed, or the front lines if the inlet (lower) manifold is to be removed, and all injector fuel lines if both manifolds are to be removed. Cover the injector fittings with shipping caps to prevent the entrance of dirt while lines are removed.

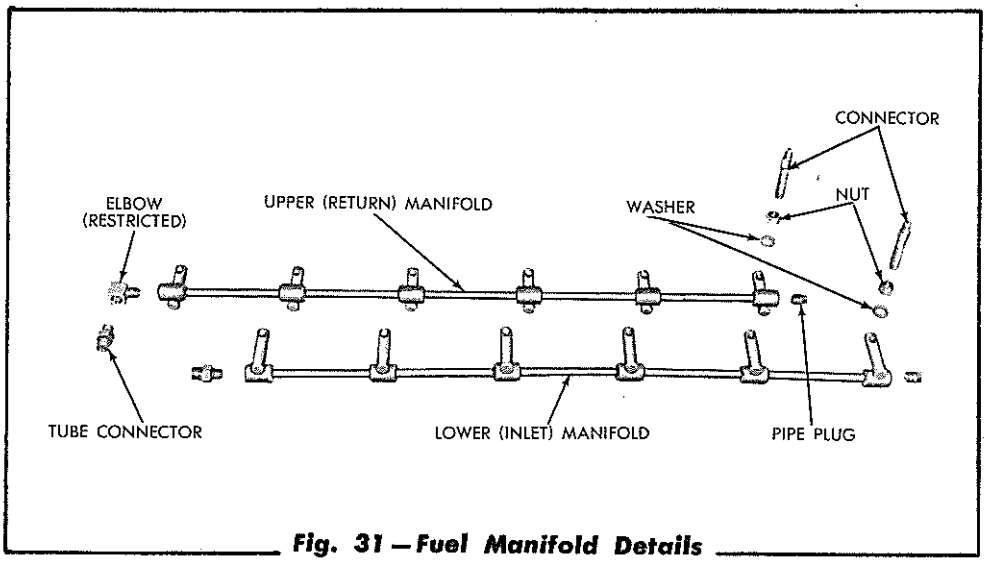


Fig. 31 — Fuel Manifold Details

4. Remove the governor control shaft housing (refer to "GOVERNOR REMOVAL" in Section VI).

5. Disconnect the fuel line from the rear end of the manifold to be removed.

6. Loosen the lock nuts on the connectors in contact with the manifold. Remove the connectors.

7. Remove the manifold, being careful not to bind the tee connectors in the head.

D. Installation of Manifolds

The fuel manifolds are replaced by reversing the sequence of operations for their removal. Refer to Fig. 31 and note that the tee connectors on the manifolds leading into the cylinder head are on the top side of the lower (inlet) manifold and on the bottom side of the upper (return) manifold. These manifolds are not interchangeable, due to the location of the tapered seats. To install:

1. Clean the holes in the cylinder head for the fuel connectors and manifold fittings.

2. Guide the manifold tee connectors attached to the fuel manifold into the openings at side of the cylinder head so that the tapered seat is in approximate alignment with the hole in the top of the head for the fuel connector.

3. Centralize the tee connectors with fuel connectors by alternately turning the connectors and moving the manifold. This is an important operation and is necessary to insure leak-proof joints.

4. Tighten the fuel connectors equally and secure the lock nuts against new copper washers. The lock nuts are special, containing fiber inserts which seal the threads against leakage. When a new lock nut is to be installed, first turn it on the fuel connector so that the fiber end of the nut is down. Turn it on until threads are cut through the fiber and then remove the nut from the connector and install it on the connector with the fiber end up. Failure to do this may result in misalignment of the threads in the fiber with those cut in the metal part of the nut.

5. Install the injector fuel lines.

6. Connect the fuel lines to the rear ends of the manifolds and install the governor control housing.

7. Before replacing the valve rocker arm cover, run the engine to check all fuel line connections for leaks. Correct any leaks that are evident, and install the cover and the hood.

SECTION III—ENGINE AIR INTAKE SYSTEM

1. DESCRIPTION OF SYSTEM

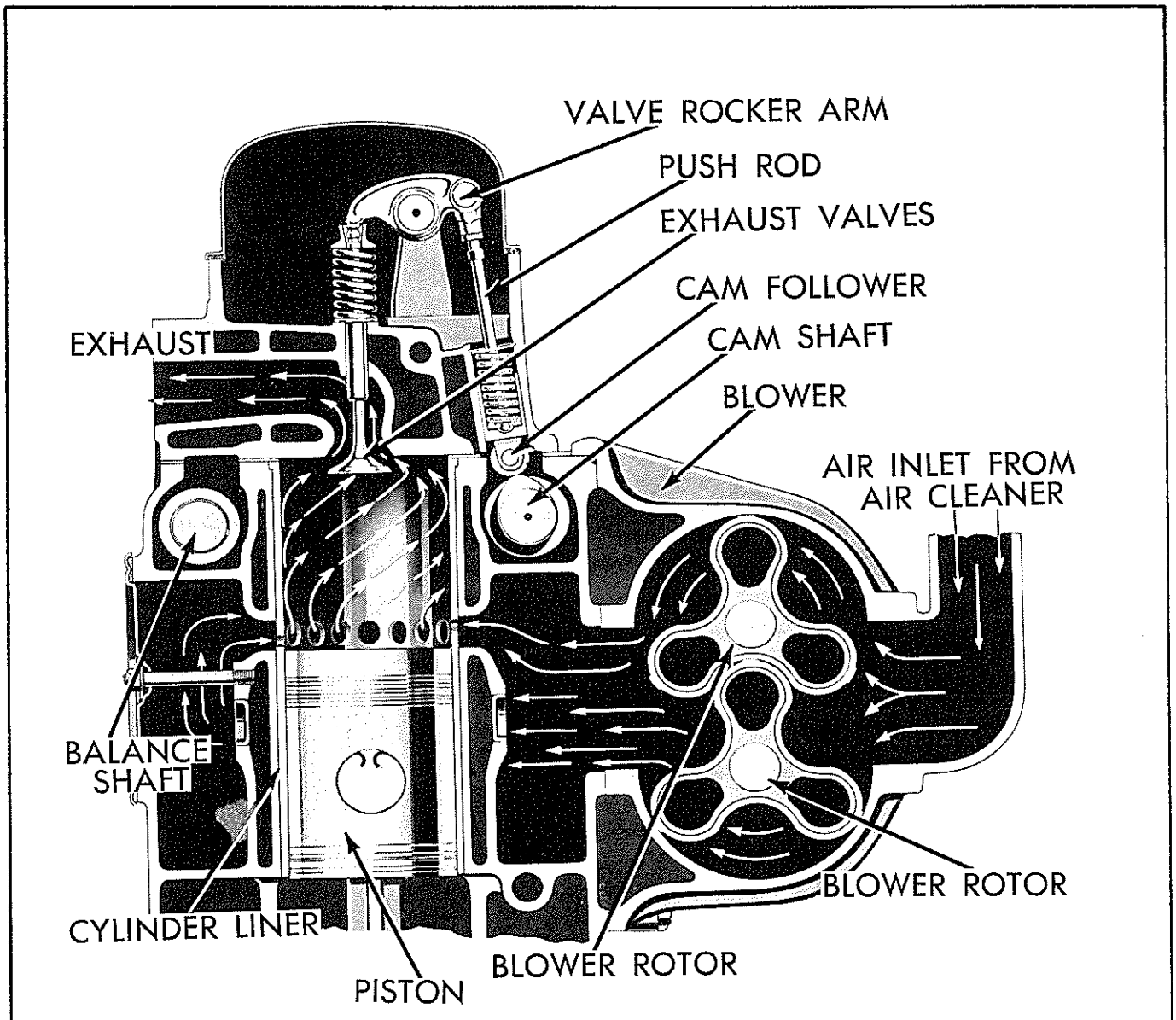


Fig. 1—Air Flow Through Engine

The engine air intake system includes two (2) air pre-cleaners, two (2) air cleaners, air shut-off valve, 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 the 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 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 clean 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 up-stroke of the pistons. 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 compression of the air is 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 intake elbow. 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.

Three (3) 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. One drain tube is located approximately in the center on the left hand side of cylinder block; the other two tubes are located on the right hand side at the front and rear of the cylinder block.

2. AIR PRE-CLEANERS

A. Description and Purpose

Each pre-cleaner (Fig. 2) 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 give the incoming air a swirling motion and cause the dirt in the air to be thrown to the outside and deposited in the shell. 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.

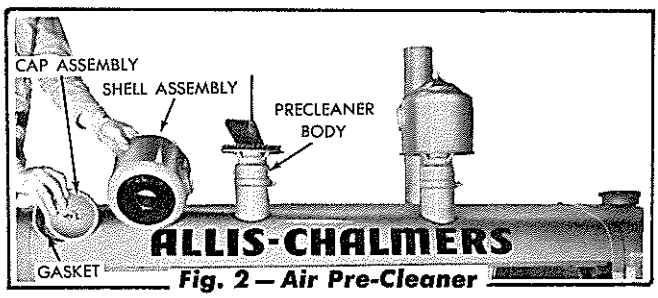


Fig. 2 — Air Pre-Cleaner

B. Air Pre-Cleaner Service

Each pre-cleaner shell must be emptied whenever the dirt level reaches halfway 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 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.

3. AIR CLEANERS

A. Description

Each air cleaner consists of a cylindrical body packed to a prescribed density with rustproof 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 and the air passes on through the matting to the blower. The oil with which the matting is saturated, collects the dust from the air, and, in dripping back into the cup, carries the dirt with it and deposits 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, and refilled with new oil and the air cleaner pipe in each 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 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, and MUST be corrected at once. 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 top of the cone in the center of the air baffle in each cup. DO NOT OVERFILL. Use same viscosity oil in the cleaners as is used in the engine crankcase for prevailing temperatures (refer to "SPECIFICATIONS OF LUBRICANTS," SECTION 1). *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.

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

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

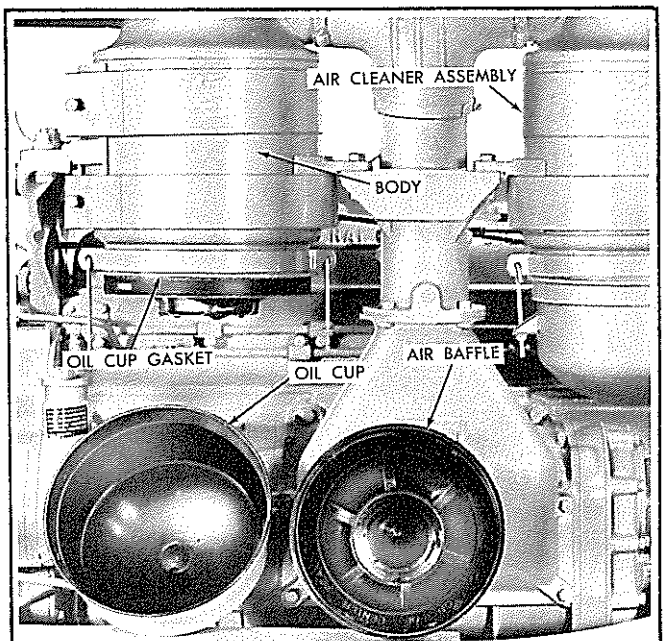


Fig. 3 — Air Cleaners

3. Install the air baffle in the cup and fill to the top of the center cone with clean oil. Install the cup on the bottom of the cleaner body. See that the gasket above the cup makes a tight seal.

4. Once or twice a year remove the cleaners from the mounting brackets. Remove the oil cup and immerse each cleaner in a tub of

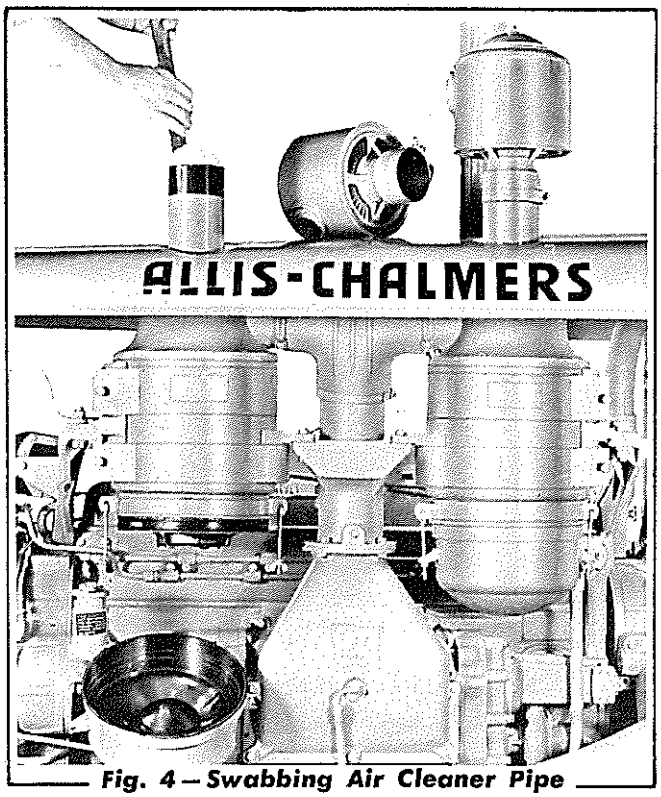


Fig. 4 — Swabbing Air Cleaner Pipe

clean fuel oil or non-combustible cleaning solvent and rinse the dirt from the filter mat in the body. Allow the air cleaners to dry thoroughly before installing.

C. Air Cleaner Removal

Either of the air cleaners may be removed from the engine as follows:

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

2. Loosen the hose clamps on the rubber tee, connecting the cleaners to the air inlet elbow, and remove the rubber tee.

3. Remove the capscrews, washers, and nuts attaching the air cleaner mounting band brackets to the air inlet elbow and to the front or rear air cleaner mounting brackets.

4. Raise the air cleaner and remove from the engine.

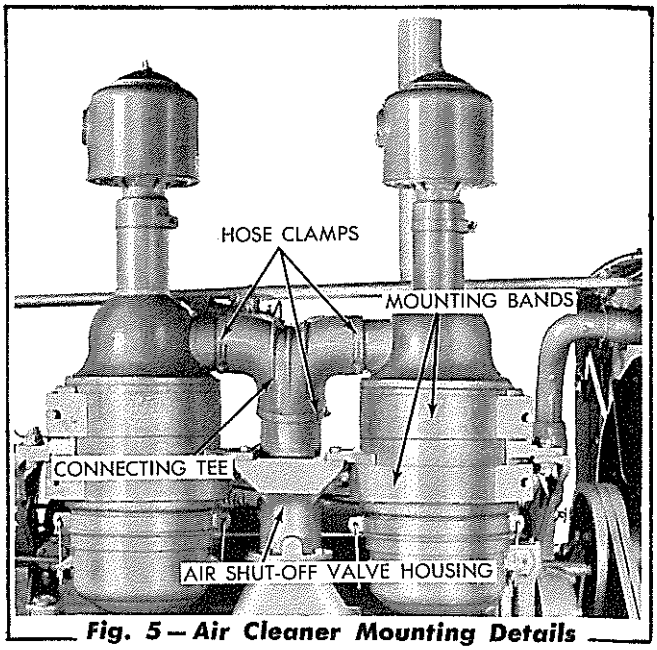


Fig. 5 — Air Cleaner Mounting Details

D. Air Cleaner Installation

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

4. AIR INLET ELBOW AND AIR SHUT-OFF VALVE

A. Description

The air inlet elbow located above the blower air inlet housing (Fig. 5) contains the engine air shut-off valve assembly. This is a butterfly type valve, manually controlled by the engine shut-off rod. When the engine shut-off rod is pushed in, the valve is opened and air can pass through the inlet elbow to the blower. When the engine shut-off rod is pulled back, the valve closes against the seating surfaces in the air inlet elbow and the air supply to the engine is shut-off. This valve also acts as an emergency engine shut-off device. 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 valve which shuts off the supply of air necessary for combustion of fuel.

B. Removal, Disassembly, and Inspection

1. Remove the cotter pin and plain washer from the swivel pin in the front end of the engine shut-off front rod, used to connect the shut-off rod to the air shut-off valve lever. Push the engine shut-off front rod towards the engine rocker arm cover to uncouple the swivel pin from the air shut-off valve lever.

2. Loosen the hose clamps on the rubber tee, connecting the air cleaners to the air inlet elbow, and remove the rubber tee. Disconnect the front end of the engine primer tube from the air inlet elbow.

3. Remove the two capscrews, washers, and nuts attaching the air cleaner mounting band brackets to the air inlet elbow.

4. Remove the capscrews attaching the air inlet elbow to the blower air inlet housing. Make certain the air shut-off valve is in the closed position.

5. Loosen the capscrews used to attach the air cleaners to the front and rear mounting brackets, tip the cleaners as necessary to free the air inlet elbow, and remove the elbow from the engine. *IMPORTANT: Cover the opening in the blower air inlet housing after removing the air inlet elbow.*

6. Remove the capscrew used to clamp the air shut-off valve lever to the shaft and remove the lever. Remove the locking wire from the screws used to hold the air shut-off valve in place in the slotted shaft, then remove the screws and the shut-off valve.

7. Remove the air shut-off valve shaft and the shaft seal from the air inlet elbow.

8. Clean and inspect the parts for wear. The shaft must be straight and not excessively worn or the valve will not seat properly in the elbow. The expansion plug in the outer side of the elbow must fit tight in its bore to prevent air being drawn past it. Always install a new shaft seal in the elbow when assembling. Make certain the shaft rotates freely.

C. Assembly and Installation

1. Lubricate the ends of the air shut-off valve shaft and install the shaft in the air inlet elbow, with the notched end of the shaft toward the engine.

2. Place the shut-off valve in the slot of the shaft and attach it with the screws, then lock the screws with lockwire.

3. Install a new shaft seal in the elbow, and install the air shut-off valve lever on the shaft. Install the capscrew in the lever and tighten securely.

4. Install the expansion plug in the outer side of the elbow if it was removed. Make certain that the plug fits tightly in the counterbore.

5. Examine the air inlet elbow gasket and make certain that it is in good condition. Coat each side of the gasket with gasket ce-

ment or sealing compound, then install it in place on the blower air inlet housing.

6. Tip the air cleaners as necessary to install the air inlet elbow in position on the blower air inlet housing, place the inlet elbow in position, and install the capscrews to attach it to the blower air inlet housing.

7. Install the two capscrews, washers, and nuts used to attach the air cleaner mounting band brackets to the air inlet elbow. Tighten all of the air cleaner mounting capscrews securely.

8. Examine the rubber tee and if it shows signs of cracking and is not in good condition, it MUST be discarded and a new one installed. *CAUTION: It is of the utmost importance that the rubber forms a tight seal when installed, otherwise, air will be drawn into the system without first passing through the air precleaners and air cleaners.* Coat the inside of the rubber tee, where it seals with the cleaners and the air inlet elbow, with gasket cement or sealing compound and install the tee in position. Tighten the hose clamps securely, making certain that the rubber tee forms a tight fit and is not crimped.

9. Connect the front end of the engine primer tube to the air inlet elbow.

10. Insert the swivel pin, in the front end of the engine shut-off front rod, into the hole in the air shut-off valve lever and install the plain washer and the cotter pin. Make certain that the air shut-off lever spring is properly hooked.

11. Adjust the controls as explained in "ENGINE SHUT-OFF CONTROL ADJUSTMENT," Section VI.

12. Install the engine hood and the air precleaners.

5. BLOWER

A. Description

The blower supplies the air 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 right 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 inlet from the air cleaners is picked up by the lobes and carried to the discharge side of the blower as indicated in Fig. 1. The continuous discharge of fresh air from the blower creates an air pressure of about seven 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.

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 keep 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 1.95 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, preloaded, radial and thrust ball bearing at the rear, or gear end.

The blower gears and bearings are lubricated by oil draining from the valve operating mechanism in the cylinder head into the camshaft pockets in the cylinder block. After this oil reaches a certain

level in the pockets, it overflows through a hole at each end of the blower housing, providing lubrication for the blower drive gears at the rear end of the blower and for the governor and water pump drives at the front end. A dam in the blower end plate cover maintains an oil level which submerges the teeth of the lower rotor timing gear. A slinger, on the opposite end of the lower rotor, throws oil into the governor weight assembly. 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 replaced. 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—that is, due to timing gear wear, the mating 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 should be removed from the engine and either overhauled or replaced.

Before inspecting the blower with the blower in position on the engine, remove the blower air inlet housing. *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 to eliminate interference. The rotors must be changed if they are too 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. (See Fig. 10 for location of blower oil seals.) *CAUTION: Do not attempt this inspect when dust is blowing as there will be no air cleaner protection when the air inlet housing is removing 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 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 will have a springing action. When released, the rotors should move back at least 1/4". The coupling should 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, 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 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 change, a check for clearance would be not only misleading, but unnecessary.

C. Blower Removal

1. Remove the right front fender. Drain the engine cooling system. Remove the oil cups from the air cleaners.

2. Loosen the capscrew in the adjusting arm of the fan belt tightening idler and loosen the two (2) fan belt idler hinge bolts. Release the tension on the fan belts, then remove the belts from the tightening idler pulley. Remove the three (3) capscrews attaching the tightening idler assembly to the engine front cover (balance weight cover) and remove the assembly from the engine.

3. Remove the breathing tube from the governor and remove the governor control shaft housing assembly (refer to "GOVERNOR REMOVAL" in Section VI).

4. Loosen the hose clamp connecting the engine water by-pass tube to the water pump body cover.

5. Loosen the hose clamp on the seal used between the water pump body cover and the top of the oil cooler housing. Remove the two (2) capscrews used to attach the water pump outlet packing flange to the cylinder block.

6. Close the fuel tank shut-off valve, then disconnect the fuel lines from the fuel pump.

7. Loosen the hose clamp used on the blower drive shaft cover seal.

8. Remove the capscrews attaching the air inlet elbow to the blower air inlet housing.

9. Remove the engine oil level gage rod and gage rod tube. Remove the capscrews attaching the blower air inlet housing to the blower and remove the housing and the blower screen from the blower.

10. Remove the capscrews attaching the blower to the cylinder block. Raise the front end of the blower slightly to clear the water pump-to-oil cooler connection and move the blower assembly (including accessories) towards the front, leaving the blower drive shaft in the drive gear housing. Remove the blower from the engine.

11. Remove the fuel pump, water pump, blower drive shaft cover, and the governor weight housing from the blower.

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, then pull them 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 socket head capscrew in the center of the water pump drive coupling at the front end of the lower rotor shaft and withdraw the coupling from the rotor shaft.

3. Remove the three (3) capscrews used to attach the blower rotor driving hub plate assembly to the upper rotor driving gear and remove the rotor driving hub and plate assembly.

4. Remove the capscrews and washers at the centers of the blower rotor timing gears. The fuel pump coupling disc will be removed with the lower capscrew.

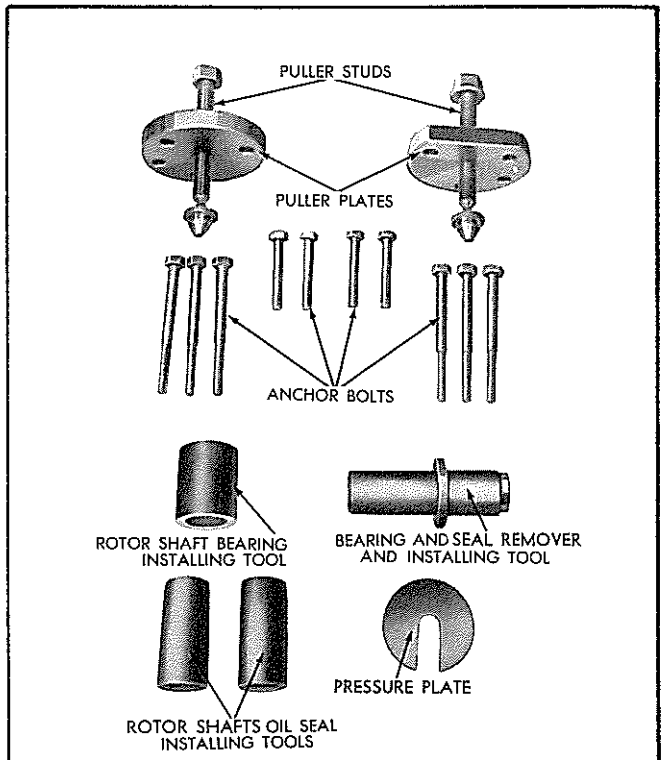


Fig. 6—Special Blower Tools

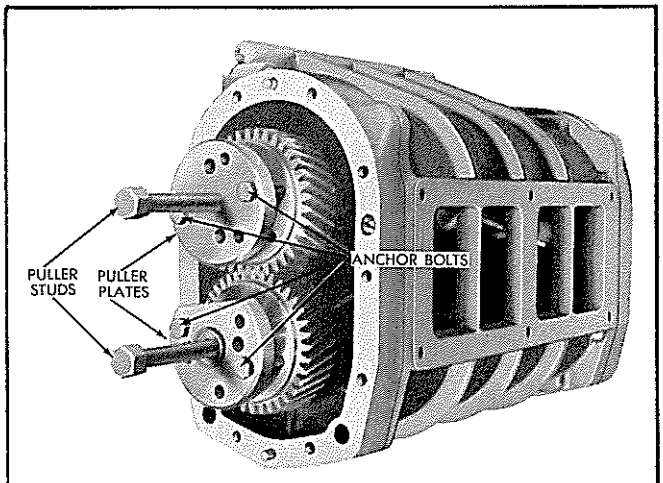


Fig. 7—Pulling Rotor Timing Gears

5. Pull the rotor timing gears. *NOTE: These two gears must be pulled from the shafts at the same time, using the special puller studs and plates as shown in Fig. 6.*

   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 in 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 turn the two puller studs uniformly clockwise until the gears are withdrawn from the rotor shafts. In most cases, shims will be found on each rotor shaft under the gears. Wire these shims (removed from each shaft), to the respective gears so they may be installed properly when the blower is reassembled.

6. Remove the three (3) capscrews from each bearing retainer and remove the retainers from the end plates.

7. Remove the end plates and rotors from the blower housing. In most cases the end plates and rotors are 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 two 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. 8, and screw the anchor bolts in 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.

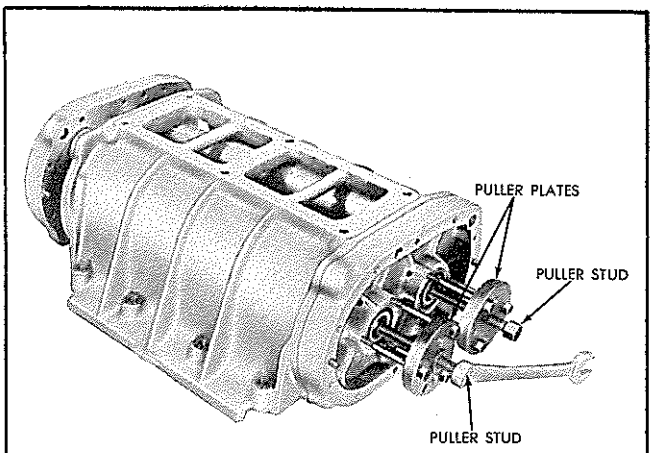


Fig. 8 — Removing End Plates and Rotors

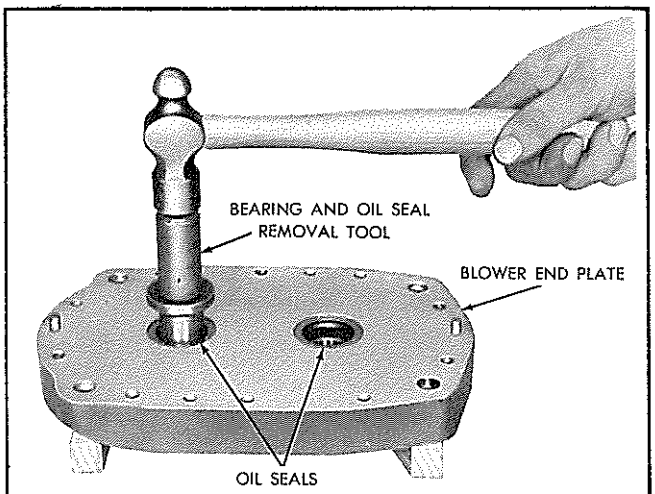


Fig. 9 — Removing Rotor Shaft Bearings

   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 plate, 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, assemble the puller plates on the front end plate and pull the front end plate from the rotor shafts before withdrawing the rotors from the housing.

8. Remove the bearings from the blower end plates by using the bearing remover tool as shown in Fig. 9. 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 blocks about two inches high and drive the bearing out of the end plate. Follow the same procedure on all four bearings.

9. 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 tool shown in Fig. 9; the collar of the tool will contact the seal and drive 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 oil until they are free from grease and oil. Blow the dirt and fuel oil 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 light engine oil and rotate them by hand to inspect for rough spots or roughness. The double-row bearings used at the rear are preloaded and have no end play; in fact, a new double-row bearing will seem to have considerable resistance to motion when revolved by hand. Due to blower rotor expansion and contraction in relation to temperature during engine operation, the roller bearings used at the front of the blower rotors are designed for end movement within the bearing proper. The inner races and the rollers of the bearings are free to move endwise in relation to the outer races as the outer races are greater in width than the bearing rollers. If the balls, rollers, or races of the blower rotor bearings are discolored instead of having brightly polished surfaces,

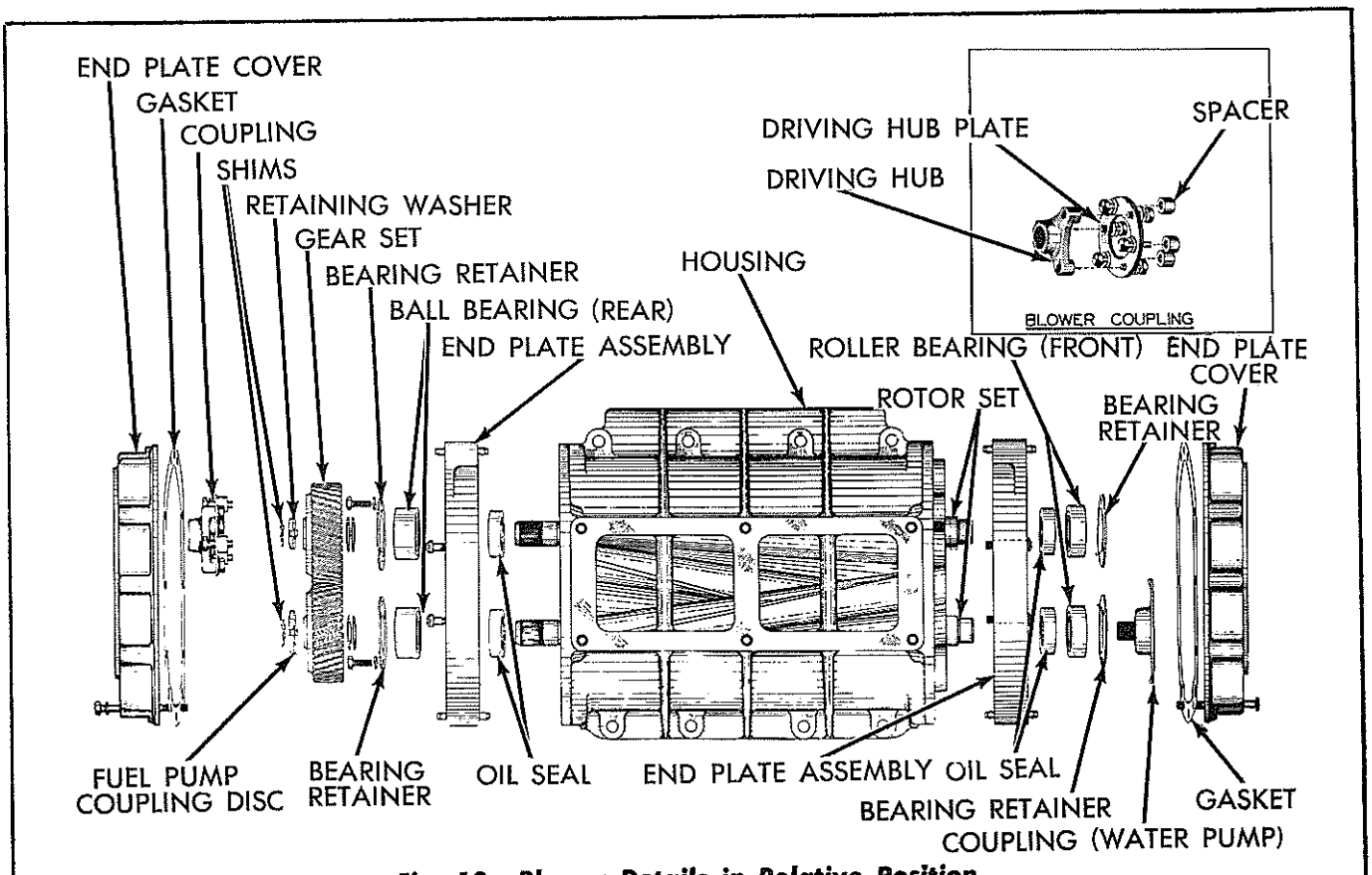


Fig. 10—Blower Details in Relative Position

they have probably run hot at some time and are unfit for further service. Discard any bearings that have tight or rough spots, or that are worn or discolored from heat.

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.

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 smoothed up with a file and emery paper and used, providing that the ends of the rotors are not worn to the point where there will be too much clearance between them and the end plates when the blower is reassembled (see Blower Clearance Chart, Fig. 16).

5. As stated in the preceding paragraph and shown in Fig. 17, 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 all of the blower parts have been inspected and the worn or damaged parts replaced, assemble the blower by reversing the disassembly procedure and using the special tools illustrated, as follows:

1. INSTALL OIL SEALS IN END PLATES. Lubricate the seals with light engine oil or light grease 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:

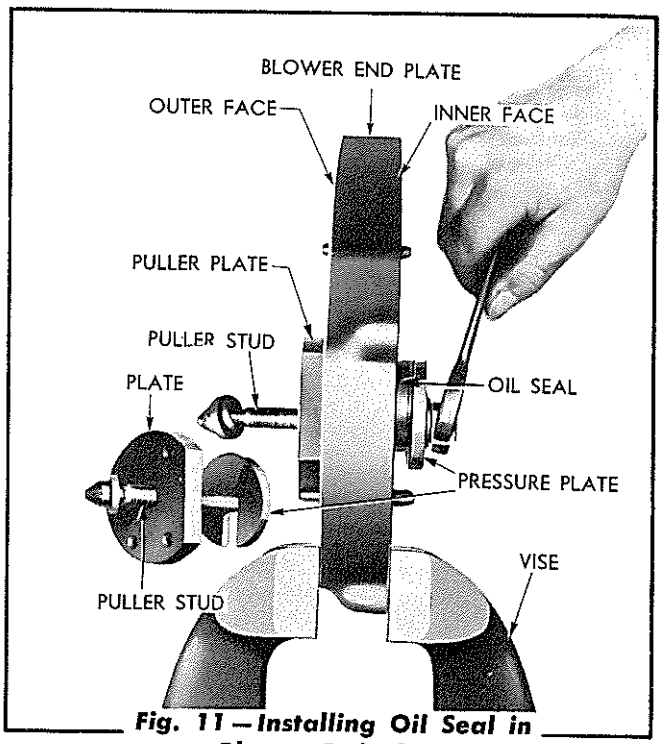


Fig. 11—Installing Oil Seal in Blower End Plate

a. Clamp the end plate between soft jaws in 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 against the seal. Turn the stud clockwise to force the seal into the end plate.

2. INSTALL BLOWER FRONT END PLATE. Both end plates are alike and may be installed

on either end of the blower housing. The upper end 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 the 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 or, water pump drive end. With the above identification in mind, attach the end plate to the front end of the blower housing as follows:

a. Start the dowels in the end plate 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, smooth and clean.

b. Fasten the end plate securely to the housing with the two fillister head screws, using no lockwashers. The dowels must project 3/8" beyond the outer face of the end plate after it is installed.

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; 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 of the 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 they are installed during the assembly of blower.

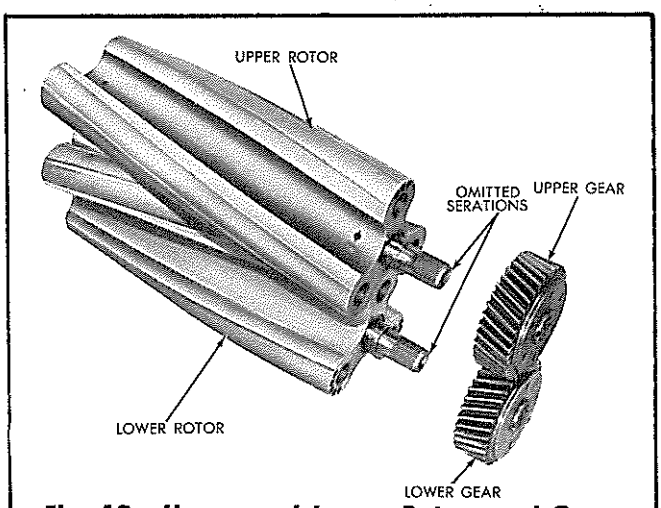


Fig. 12 — Upper and Lower Rotors and Gears

a. Place the blower housing on a bench with top (flanged) side 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. 12, then slide the rotors into the housing. Use an oil seal pilot 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 pilots after the rotors have been installed.

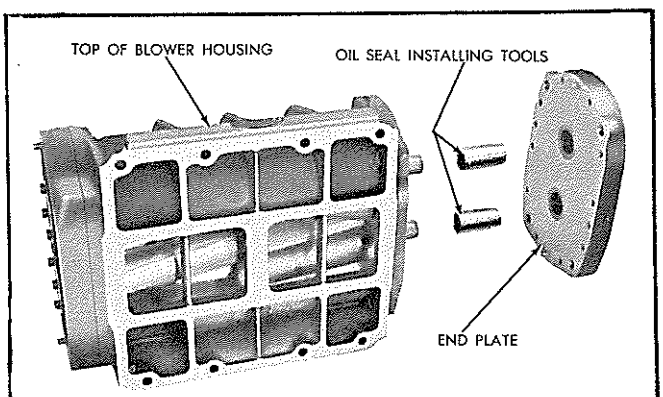


Fig. 13 — Installing Rotors in Housing and End Plate

4. INSTALL REAR END PLATE. With the rotors installed in the housing and the omitted splines in each shaft facing the top of the blower housing as explained previously in step 3, install an oil seal pilot over the end of each 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 pilots from the shafts.

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

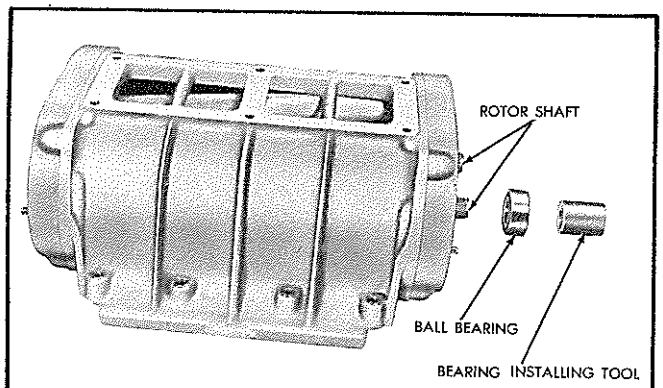


Fig. 14—Installing Rotor Shaft Bearings

a. Start each bearing into the end plate and tap the bearings into place with the bearing driver shown in Fig. 6. After the bearings have been installed, check the rotor-to-housing and the rotor-to-end plate clearances as described under "BLOWER TIMING."

b. Place the bearing retainers in position and install the attaching capscrews and lockwashers. *NOTE: The bearing retainers used at the front and at the rear are identical.*

6. PRESS TIMING GEARS ONTO ROTOR SHAFTS.

If a used blower is being reassembled with the used parts, shims were probably used in back of the one or both blower timing gears. These shims, removed when the blower was disassembled, must be placed on the respective shaft from which they were removed. If new gears or shafts 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 blower 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 shaft. Lubricate the serrated ends of the shafts with light engine oil, then install the gears as follows:

b. With the original shims installed on the shafts, start both gears on the shafts with 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 assist in locating the gears on the shafts.

c. Using the retaining washer on the upper gear retaining capscrew and the fuel pump coupling disc on the lower gear retaining capscrew, draw the gears tight against the shoulders of the shafts by means of these capscrews. Place a cloth between the two gears to prevent their turning. 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*

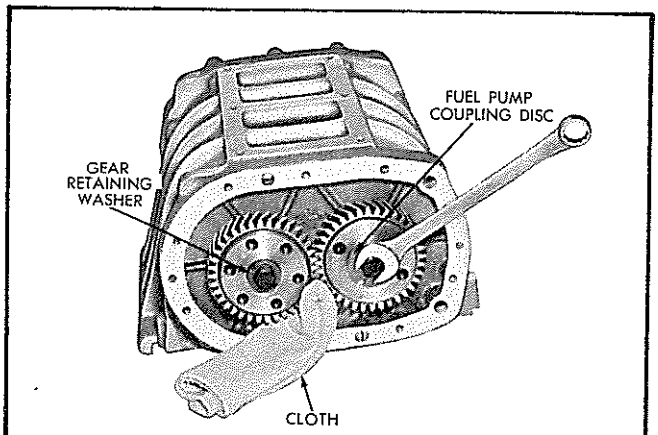


Fig. 15—Pressing Blower Timing Gears Onto Rotor Shafts

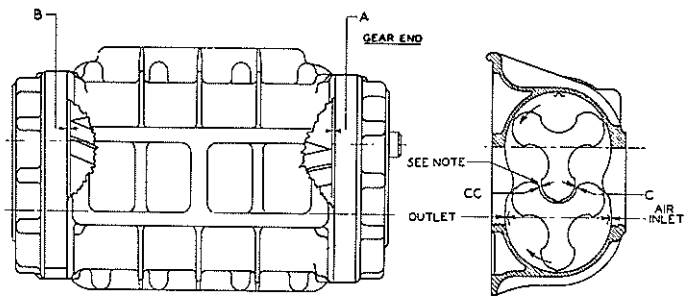
gears are pressed all the way on. Damage to the rotors would result.

d. After timing the rotors as explained in the following step 7, install the special lockwashers under the heads of the two capscrews. Bend two ears of each lockwasher into the notches in the washer and coupling disc, then bend two other ears against the heads of the capscrews. The lugs of the retaining washer on the upper capscrew and the lugs of the fuel pump coupling disc engage in the slots in the gear hubs. Tighten the retaining capscrews using a torque of 55 to 65 ft. lbs.

7. TIME BLOWER ROTORS. The rotors must be timed at this stage of assembly (refer to Figs. 16 and 17). As stated before, the rotors, when properly positioned in the housing, run with a slight clearance between the lobes. This clearance may be varied 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, back of 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 both ends 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 feelers 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.

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 Figs. 16 and 17. 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. 16). Turn the rotors and take measurements at the midsection and at the opposite end of the lobe. Record the minimum clearance obtained. Measure the clearance between the secand 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 in Fig. 16, we find that the clearance



SER.		A	B	C	CC	INLET	OUTLET
8-71	MIN.	.007	.014	.016	.002	.016	.004
	MAX.				.006		

Fig. 16 — Diagram of Blower Clearances

is specified as .002" to .006". Therefore, the clearance must be decreased to within that range. This can be accomplished by adding shims back of the lower gear or removing shims from behind the upper gear. A .003" adjusting shim in back of the blower gear will revolve the rotor .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.*

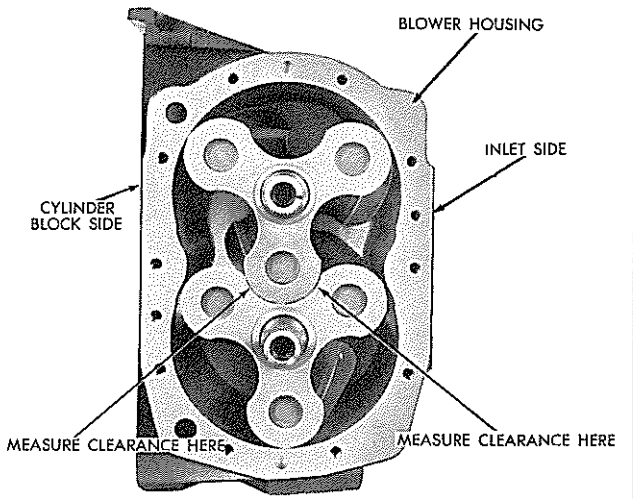


Fig. 17 — Measuring Points for Clearance Between Rotor Lobes

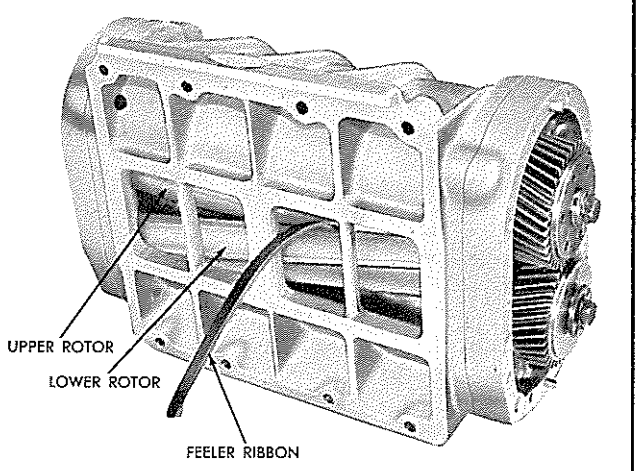


Fig. 18 — Measuring Clearance Between Rotor Lobes from Outlet Side

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. 16) between the opposite sides of the lobes through the inlet side of the housing in the same manner (Fig. 19). 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. 16) 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. 16, 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. 20. 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 will be correct if the work was done carefully when assembling the blower. If the work was done carelessly, the assembly operation may have to be repeated.

8. After the rotors have been properly timed and the gears have been tightened securely in place, install the rotor driving hub plate assembly (flexible type) on the upper gear as follows, (refer to Fig. 10):

   a. Place the two driving hub plates in position on the blower driving hub and install the three (3) attaching capscrews (5/16" NF x ¾") with plain washers and

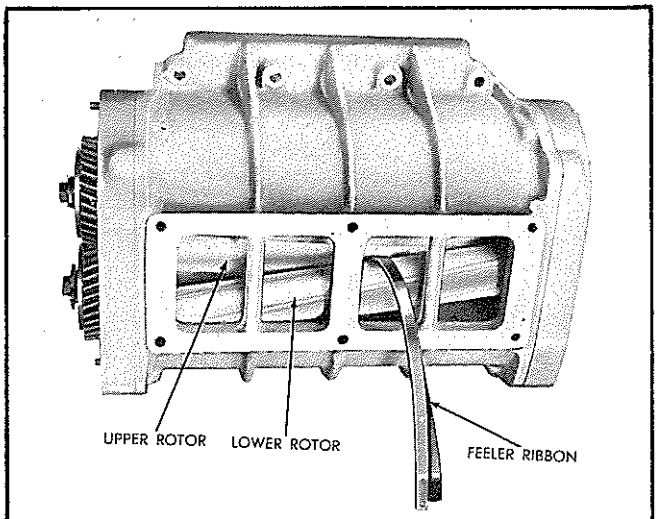


Fig. 19 — Measuring Clearance Between Rotor Lobes from Inlet Side

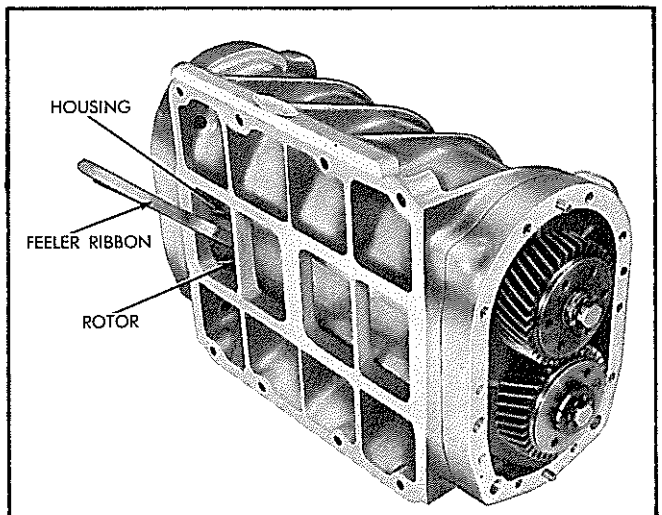


Fig. 20 — Measuring End Clearance Between Rotor and Housing

lockwashers. Tighten the capscrews to a torque of 25 to 30 ft. lbs.

b. Install the driving hub and plate assembly on the upper rotor gear, installing the three (3) plate spacers between the plates and the gear, and install the attaching capscrews (5/16" NF x 1") with plain washers and lockwashers. Tighten the capscrews to a torque of 25 to 30 ft. lbs.

9. Insert the splined end of the water pump drive coupling into the front end of the lower rotor shaft, insert the socket head capscrew used to attach the drive coupling to the rotor shaft, and tighten the capscrew to a torque of 25 ft. lbs.

10. 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. Place the fuel pump to blower gasket in place on the fuel pump, place the fuel pump fork coupling in position on the pump driving shaft, then install the fuel pump in position at the rear of the lower blower rotor, inserting the ends of fork coupling into the slots in the disc coupling. Install the attaching capscrews and lockwashers and tighten securely.

2. Install the blower drive shaft cover and gasket on the rear cover of the blower, then place the cover seal clamp on the drive shaft cover. Install the blower drive shaft cover seal (rubber) in place on the blower drive support assembly.

3. Install the water pump and gasket on the front cover of the blower. Place the water pump outlet packing flange and packing in position on the water pump. Place the water pump to oil cooler seal and the seal clamp in position on the oil cooler.

4. Install the governor weight housing assembly and gasket on the blower front cover.

5. Insert the threaded end of the blower drive shaft into the splines of the blower drive gear. Cement a gasket to the cylinder block, then place the blower assembly in position on the cylinder block, entering the other end of the blower drive shaft into the upper blower gear. Rotate the blower lobes by hand until the splines on the drive shaft can be felt entering the splines in the blower gear.

6. Properly locate the blower on the cylinder block and install the attaching capscrews and plain washers. Tighten the capscrews to a torque of 55 to 60 ft. lbs.

7. Position the blower drive shaft cover seal

and seal clamp, then tighten the clamp securely.

8. Position the water pump outlet packing flange and packing, then install the attaching capscrews. Position the water pump to oil cooler seal and seal clamp, then tighten the clamp securely.

9. Install the water by-pass tube hose and hose clamps in position on the by-pass tube and the water pump body cover, then tighten the hose clamps.

10. Using gasket cement or sealing compound, cement the air inlet elbow gasket in position on the blower air inlet housing. Position the blower screen and the blower air inlet housing on the blower and start the attaching capscrews. Start the air inlet elbow to blower housing capscrews, then tighten them and the air inlet housing to blower capscrews securely. Install the engine oil level gage tube and the oil level gage.

11. Connect the fuel lines to the fuel pump and open the fuel tank shut-off valve.

12. Install the governor control shaft housing assembly (refer to "GOVERNOR INSTALLATION" in Section VI).

13. Attach the fan belt tightening idler assembly to the engine front cover (balance weight cover), then install the belts on the tightening idler pulley. Adjust the belts (refer to "FAN BELT ADJUSTMENT" in Section IV).

14. Install the oil cups on the air cleaners. Install the right front fender. Fill the engine cooling system (Refer to "FILLING COOLING SYSTEM" in Section IV).

6. BLOWER DRIVE ASSEMBLY

A. Description

The blower drive assembly consists of a splined shaft and flexible coupling mounted in a hub in the upper side of the flywheel housing and driven by a gear in mesh with the engine timing gears. This drive transmits power to the blower, governor, water pump, and fuel pump. The drive is cushioned by two banks of springs which dampen engine torque fluctuations to the blower and the other driven assemblies. 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

The blower assembly must be removed from the engine before removing the blower drive assembly. Refer to "BLOWER REMOVAL."

After the blower and its attached assemblies have been removed, the end clearance between the drive gear hub bushing and the thrust washer should be checked before the blower drive is removed from the engine (refer to Fig. 21.). A clearance of .003" to .006" is specified at this point. When this clearance exceeds .010", 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 is withdrawn from the flywheel housing.

2. Remove the nuts and lockwashers from the four bolts that extend through the flange of the support and through the flywheel

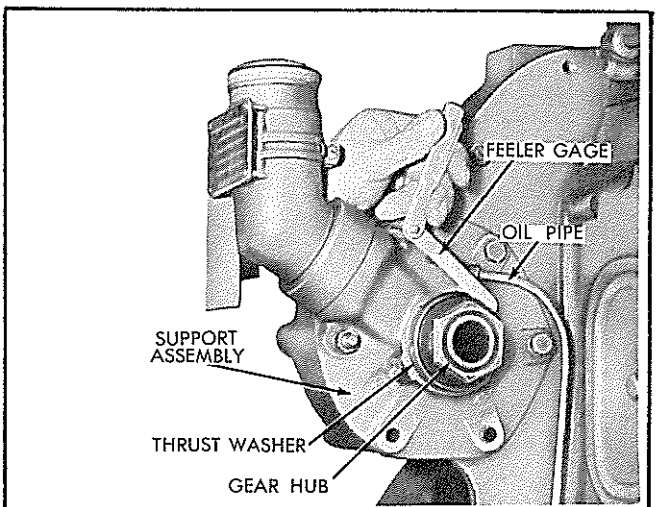


Fig. 21 — Checking End Clearance of Blower Drive Gear Assembly

housing, also the two capscrews at the inner front side of the support flange.

3. Tap the support loose from the end plate and withdraw the drive assembly from the flywheel housing and end plate.

C. Blower Drive Disassembly

1. Withdraw the drive shaft from the gear hub and the coupling cam. Remove the shaft snap ring from the coupling cam.

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

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

4. Press the drive gear from the gear hub. If the bearing support is to be changed, remove the oil pipe elbow.

5. If the coupling spring assemblies, the 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 gear hub support. 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 bored in line; therefore, in case of a bushing failure the entire support and bushing assembly must be replaced.

Check the inside diameter of the bushings for wear and roundness, and the outside diameter of the hub at the bearing surfaces (journals) for wear. The proper clearance between the bushings and the hub is from .001" to .002" and must not exceed .005". If measurements show that the bushings or hub are worn to exceed .005" install a new support and bushing assembly or the drive hub, or both.

Inspect the serrations on the blower drive shaft; if they are worn so that excessive back lash is felt between the drive shaft and the coupling cam or between the drive shaft and the blower drive coupling hub (in blower), a new drive shaft or its mating parts must be installed.

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

Make certain that all the oil holes are open and that the oil cavities are free from dirt.

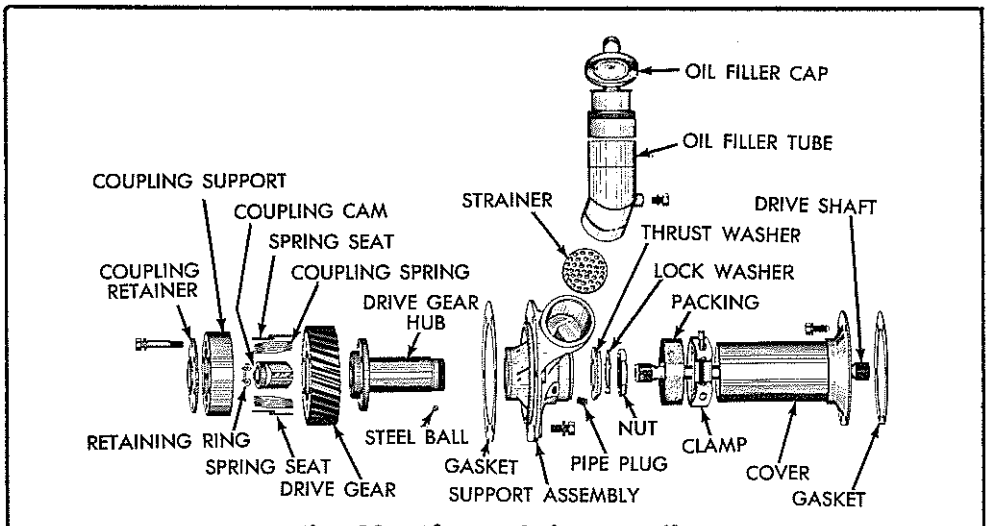


Fig. 22 — Blower Drive Details

E. Blower Drive Assembly

1. Clamp the bearing support assembly in a vise. Coat the outer side of the drive gear hub and the bushings in the support with a light engine oil and insert the hub in the support from the rear.

2. Hold the gear hub in the support 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.

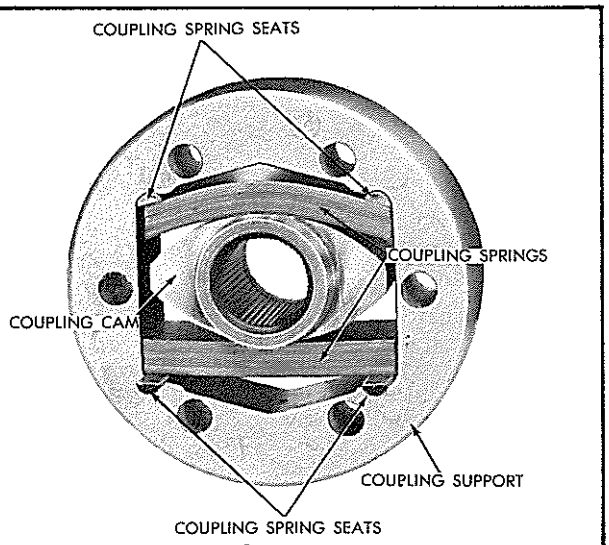


Fig. 23 – Flexible Coupling

3. Prevent the hub from turning by inserting bolts in two 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 between the bushing and the thrust washer, this clearance must be between .003" and .006". Bend the ears of the lockwasher over the flat sides of the nut to lock the nut in place.

4. Remove the bolts from the hub and tap the drive gear on the flange of the hub with the flat side of the gear away from the bearing support. Line up the holes in the gear with the holes in the flange.

5. 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 light 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, 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.

6. Place the flexible coupling assembly in position on the gear so that the lobes of the coupling cam are located over the 5/32" oil groove slots in the face of the gear hub. Make certain that the counterbore in one end of the coupling cam is positioned away from the gear when installing.

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

8. Install the retaining ring (snap ring) in place in the coupling cam.

F. Installation of Blower Drive Assembly

1. Cement a gasket to the rear side of the support assembly. Place the oil pipe leading to the blower drive in position against the connections in the cylinder block and the support as the blower drive assembly is inserted into the flywheel housing. The blower drive gear must mesh with the camshaft gear as the blower drive is pushed into the flywheel housing. Attach the support, using four (4) ⅜" N.F. x 5" bolts and two (2) ⅜" N.F. x 13/16" capscrews. *CAUTION: Make certain that the two (2) capscrews are of the proper length (13/16") as longer capscrews will strike the camshaft gear. Connect the oil pipe to the pipe fittings.*

2. Insert the short splined end (tapped end) of the blower drive shaft through the drive gear

hub and into the splines in the coupling cam.

3. Install the blower assembly (refer to "BLOWER INSTALLATION" in this section).

7. AIR BOX AND CYLINDER LINER AIR PORTS

A. Air Box and Drain Tube

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 into the air box. Air supplied by the blower passes through the air box and into the cylinders through the air ports in the liners as the ports 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. Three (3) air box drain tubes, one located approximately in the center on the left hand side of the cylinder block and two on the right hand side 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, run a wire through the tubes or remove and clean the openings.

B. Cylinder Liner Air Ports

The engine is equipped with cylinder liners having a single row of ⅝" holes (15 holes) drilled in the circumference of each liner. These holes, or ports, must be kept open to allow 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 passage of air. Remove the inspection covers from the left side of the cylinder block to inspect the ports.

If the inspection shows 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 material 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.

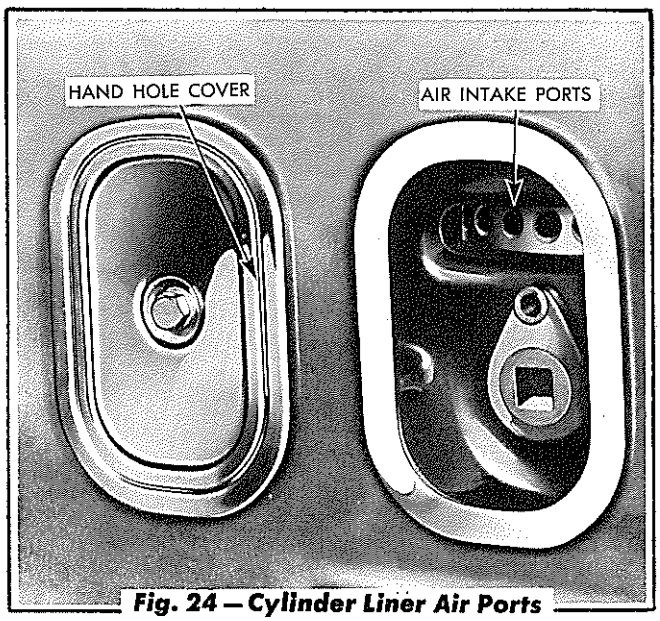


Fig. 24 — Cylinder Liner Air Ports

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 rotating 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 air box. Remove the air box inspection cov-

ers and the air box drain tubes and fittings, while cleaning the air box.

6. Be sure that the air box drain tubes and the fittings are open before replacing the tubes.

NOTE: With the 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 in 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 compression of the air is absorbed by the pistons and cylinder walls. This heat loss and reduced cranking speed may result in the temperature of the air in the cylinders being too low to ignite the fuel. A engine primer 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 elbow near the engine blower, a primer elbow assembly, and the necessary lines to complete the system. The primer pump is located in the upper right corner of the instrument panel and the dispenser assembly is attached to the cowl directly below the instrument panel.

The vaporized starting fluid is forced through the primer elbow assembly into the air inlet elbow, 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 compression in the cylinders. The engine will start quickly at low ambient temperatures with the aid of the primer even when the starter turns the engine at a low cranking speed.

The starting fluid capsules, available in 7 c.c. and 17 c.c. sizes, can be obtained from "Allis-Chalmers" Dealers.

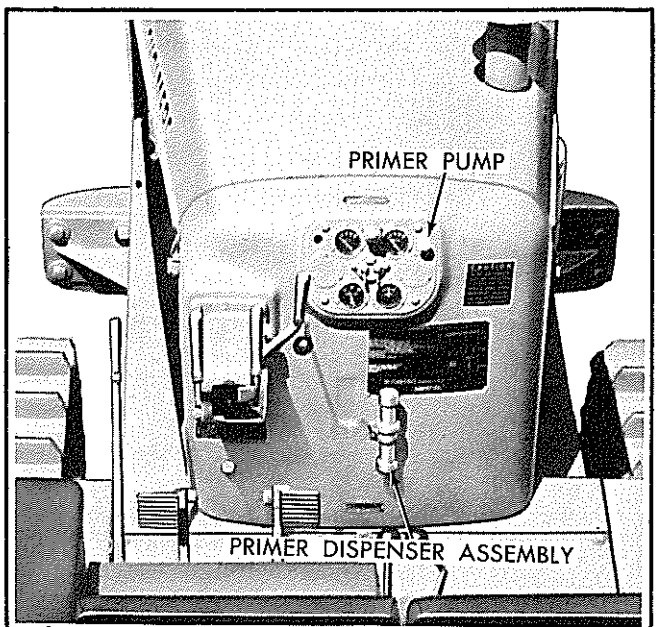


Fig. 25—Primer Pump and Dispenser Location

C. Operation

1. Unscrew the upper chamber of the primer dispenser.

2. Place a capsule of fluid, small or large size, depending upon the air temperature and the requirements established by trial, in the lower chamber (body) of the dispenser. In extremely low temperatures, one large and one small capsule may be necessary.

3. Pull the plunger to the top of the upper chamber and screw the chamber tightly into the dispenser body.

4. Push the plunger to bottom, thus puncturing the capsule and releasing fluid so it can be picked up by the primer pump.

5. Push the engine shut-off knob all the way in (run position), and pull the throttle lever all the way back (wide open).

6. Press forward on the starter pedal to crank the engine, and at the same time use the primer pump to pump the starting fluid into the air intake system until the engine starts and runs normally on regular fuel. Use a capsule only of the size required to start the engine and pump until all fluid has been injected into the engine.

7. While the engine is warming up, unscrew the upper chamber of the dispenser and remove the empty capsule, then screw the upper chamber back into the dispenser body.

CAUTION: The starting fluid contained in the capsule is essentially ethyl ether, highly inflammable, and should be treated with the same caution as high octane gasoline. Gelatine capsules dissolve in water and soften at high temperatures. Therefore, the following precautions must be taken:

1. Avoid breathing large quantities of the fumes from the fluid.

2. Avoid cutting of hand by barbs on puncturing plunger.

3. Avoid proximity of fluid and capsules to open flames, sparks, or hot surfaces.

4. Avoid contact of capsules with water.

5. Avoid subjection of capsules to high temperatures (above approximately 120° F.).

D. Inspection and Service

If the engine is cranked with the engine shut-off knob in run position (pushed all the way in) and 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 system to determine the reason for starting failure.

Check the primer system as follows:

1. Primer Elbow Assembly Clogged

This condition will usually be indicated by excessive resistance on the primer pump. A partially clogged primer 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 blower air inlet elbow and remove the small nozzle. 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, re-assemble the primer elbow assembly and install it in the blower air inlet elbow.*

2. Inoperative Primer Pump

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

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

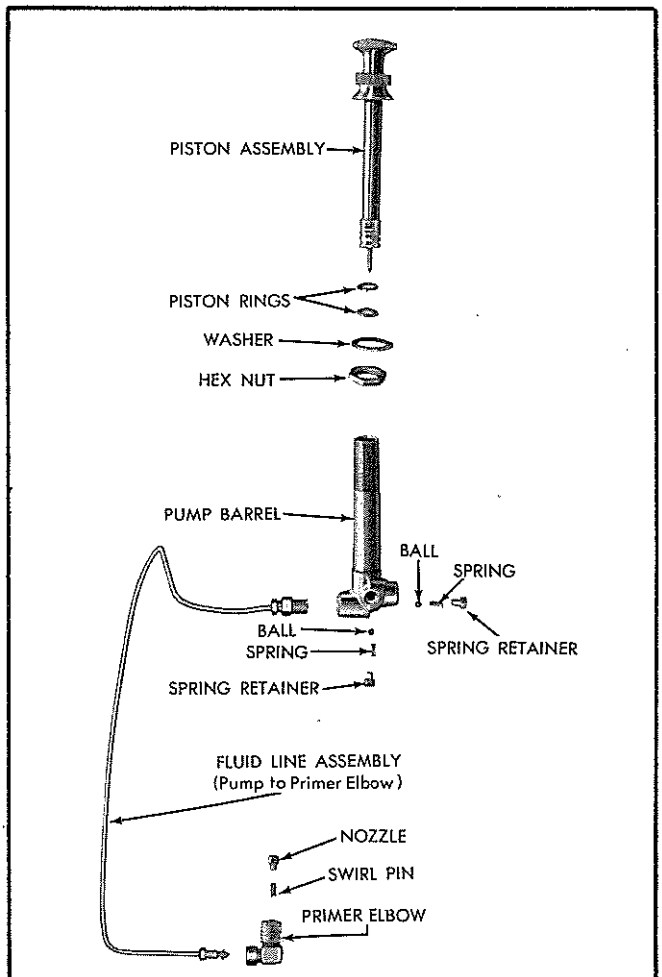


Fig. 26 — Primer Pump and Primer Elbow Details

To replace the packing rings, loosen the knurled nut (under knob) from the pump barrel and withdraw the piston assembly from the barrel. Remove the packing rings from the grooves of the piston assembly and install new rings. Lubricate the packing rings and piston with light engine oil and install the piston assembly in the barrel.

The two spring loaded ball check valves, located on the inlet and outlet openings of the pump, are provided to close the pump openings at the proper time. When the pump piston is pulled out (suction stroke, drawing fluid from 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 body and all its components thoroughly and reassemble using new parts where necessary.

3. Clogged Dispenser Strainer Screen

The strainer screen is bolted to the strainer plug, screwed into the bottom of the dispenser body. If the gelatine capsules are not removed soon after puncturing, the gelatine will melt and 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.

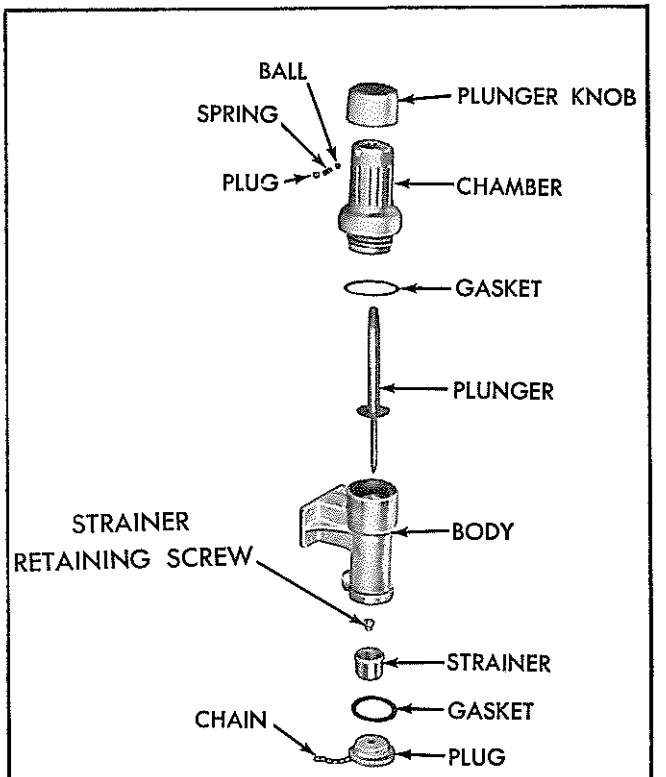


Fig. 27 — Primer Dispenser Details

SECTION IV—ENGINE COOLING SYSTEM

1. DESCRIPTION OF SYSTEM

The engine cooling system consists of the water pump, radiator, oil cooler, thermostat, cooling fan, and the water passages in the cylinder block and head.

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 thermostat 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 drawn through the radiator core by the cooling fan.

The thermostat, located in the housing on the front of water outlet manifold, operates automatically to maintain a normal operating temperature of 160° F. 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 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, 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.

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 temperature held within a range of 160° F. to 185° F. Operating the engine with temperature below this range will result in incomplete combustion of fuel and higher fuel consumption with less power, and will cause harmful gummy deposits within the engine.

Maintaining the correct engine temperature depends most on the proper function of the thermostat. If the engine temperature remains consistently below normal, the thermostat should be removed and inspected. If the thermostat is corroded and stuck or if the bellows of the unit leaks, install a new unit.

When operating in cold weather, provide a cover for the radiator and for the sides of the engine

compartment if the thermostat proves inadequate to maintain the normal operating temperature. If the engine is operated below this temperature range, sludge will build up in the engine, conditions will develop which will cause damage to engine parts, and engine efficiency will drop.

3. FILLING AND DRAINING OF SYSTEM

A. Filling Cooling System

The engine is equipped with a water by-pass tube extending from the water outlet manifold to the water pump. This tube allows the coolant to pass from the water outlet manifold directly to the water pump, by-passing the radiator. The coolant by-passing the radiator will warm up more quickly as will the engine oil circulating through the oil cooler. When the coolant within the engine reaches approximately 160° F. the thermostat opens and the coolant circulates through the radiator (the coolant to the by-pass tube is then shut off).

The air in the cooling system is vented through a vent cock in the top of the thermostat housing. Three drain cocks, one in the bottom of the thermostat housing, one in the bottom of the water pump housing, and one in the bottom of the oil cooler housing are provided to drain the system.

Fill the cooling system through the radiator, after first closing all three drain cocks. *IMPORTANT: Open the vent cock in the top of the thermostat housing and fill the system through the radiator until coolant flows from the vent cock.* This allows air, trapped in the engine by the closed thermostat, to escape. Close the vent cock and complete the filling of the cooling system.

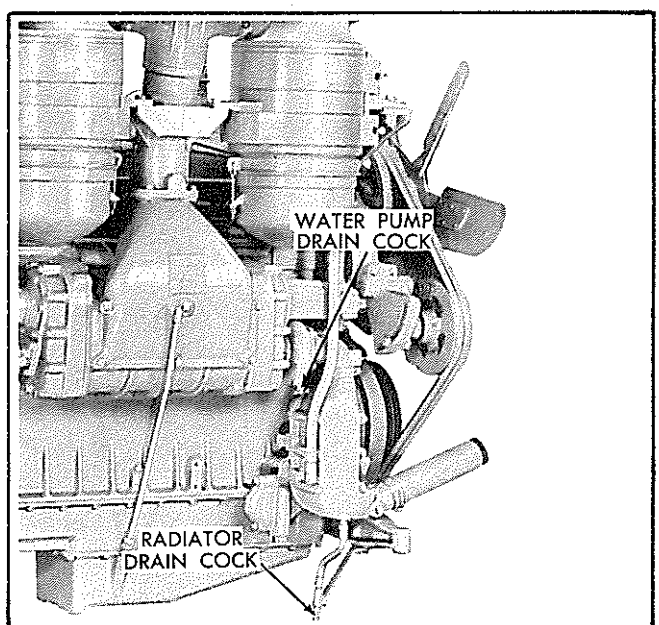


Fig. 1 — Cooling System Drain Cocks

B. Draining Cooling System

Open the drain cocks in the water pump housing, bottom of oil cooler housing, and bottom of thermostat housing. Also open the vent cock at the top of the thermostat housing and allow the coolant to drain.

4. CLEANING OF COOLING SYSTEM

It is recommended that the cooling system be cleaned 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, engine block, and cylinder head. This lime deposit is detrimental to the engine and the radiator core.

Flushing the radiator will remove obstructions in the radiator tubes and other water passages, which, if not removed, would eventually clog these passages. It is also important that the air passages through the radiator be kept free of obstructions and that the exterior of the engine be kept free from thick deposits of dust and oil.

1. CLEANING MATERIALS. Sal Soda is a very effective and safe solvent for removal of lime, scale, and other foreign deposits in the cooling system. It should be used in the proportions indicated and according to the directions printed on the container in which it is purchased. Many other good cleaning solvents for this purpose are on the market;

these should also be used according to directions. *CAUTION: Never mix anti-freeze compounds, or solutions, or inhibitors with any cleaning, neutralizing, or flushing compounds.*

After the solvent has been in the cooling system the prescribed length of time, the system should be completely drained, and, after the engine has cooled sufficiently, thoroughly flushed with clean water. The use of certain cleaning compounds requires the use of a neutralizer solution which is usually packed and sold with the cleaning compound and should be used as directed.

2. FLUSHING. If the tubes in the radiator become clogged, the obstructions may sometimes be removed by reverse flushing of the radiator. When the clogging is caused by leaves or other trash, this material usually is 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 flow out through top of the radiator with the water. *CAUTION: Do not use over 5 pounds pressure in this flushing operation as excessive pressure may cause the radiator tubes or tanks to rupture.*

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 that may have been uncovered. 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 oil, 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

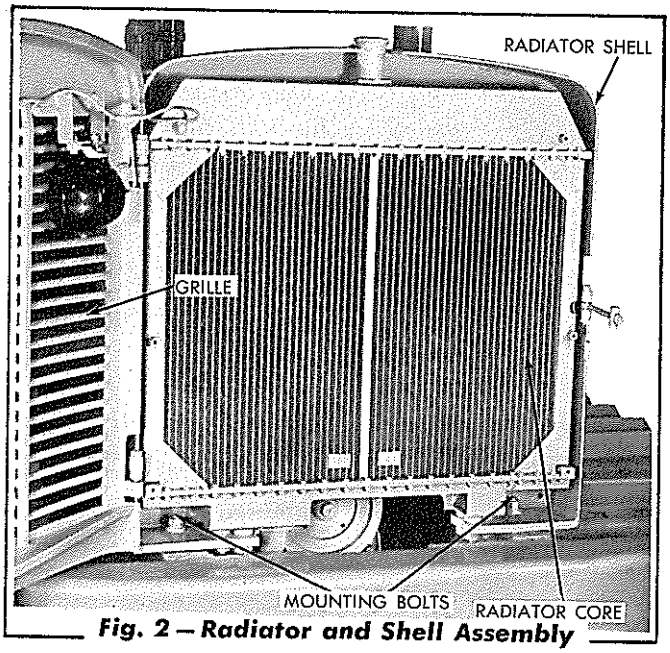


Fig. 2 — Radiator and Shell Assembly

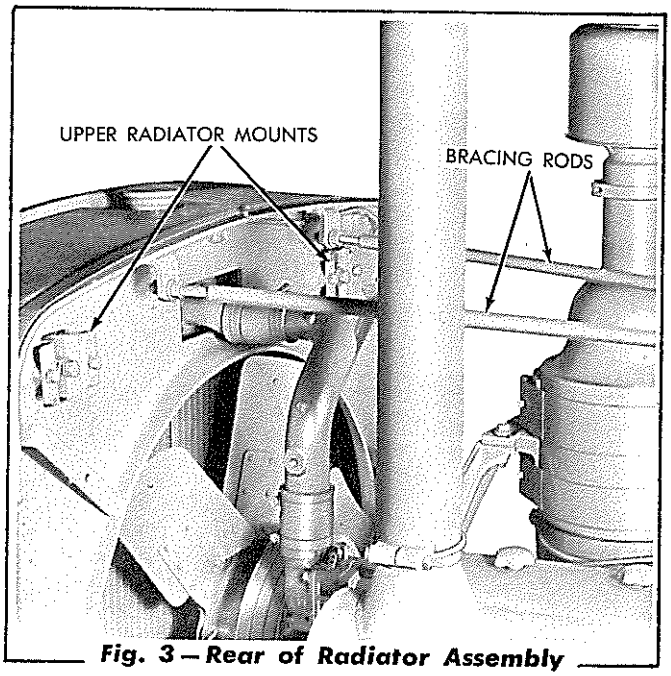


Fig. 3 — Rear of Radiator Assembly

A. Description

The radiator core is of the conventional tubular type, mounted in a heavy one piece shell and shroud assembly. It is protected by a grille hinged to the front of the radiator shell. Vibration snubbers (rubber) are used in attaching the radiator core to the shell to minimize shock and vibration.

B. Removal of Radiator

1. Drain the cooling system (refer to "FILLING AND DRAINING OF SYSTEM" in this section).
2. Open the hinged grille and remove the capscrew from the head light wire clip at the upper left side of radiator.
3. Remove the upper (inlet), and lower (outlet), radiator hose connections from the radiator.
4. Remove the ½" x 2¾" capscrews from the center of both top radiator mounting assemblies.
5. Remove the three (3) ⅜" x 3" capscrews from each side of the bottom radiator mounting assemblies.
6. Using a suitable hoist, and a chain or rope encircling the radiator core vertically, remove the radiator core from the shell. *NOTE: When the radiator is removed from the shell, the two spacing tubes used on the center bolts of the top radiator mounts will fall from position. Replace them in the top mounting assemblies before radiator is re-installed.*

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 and a centering washer 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 core assembly. *NOTE: Do not tighten the capscrews at this stage of installation.*
2. Raise the radiator assembly as high as possible without imposing excessive strain on the two (2) top mounting center bolts.
3. Place a lockwasher, snubber washer, vibration snubber, and a spacing tube on each

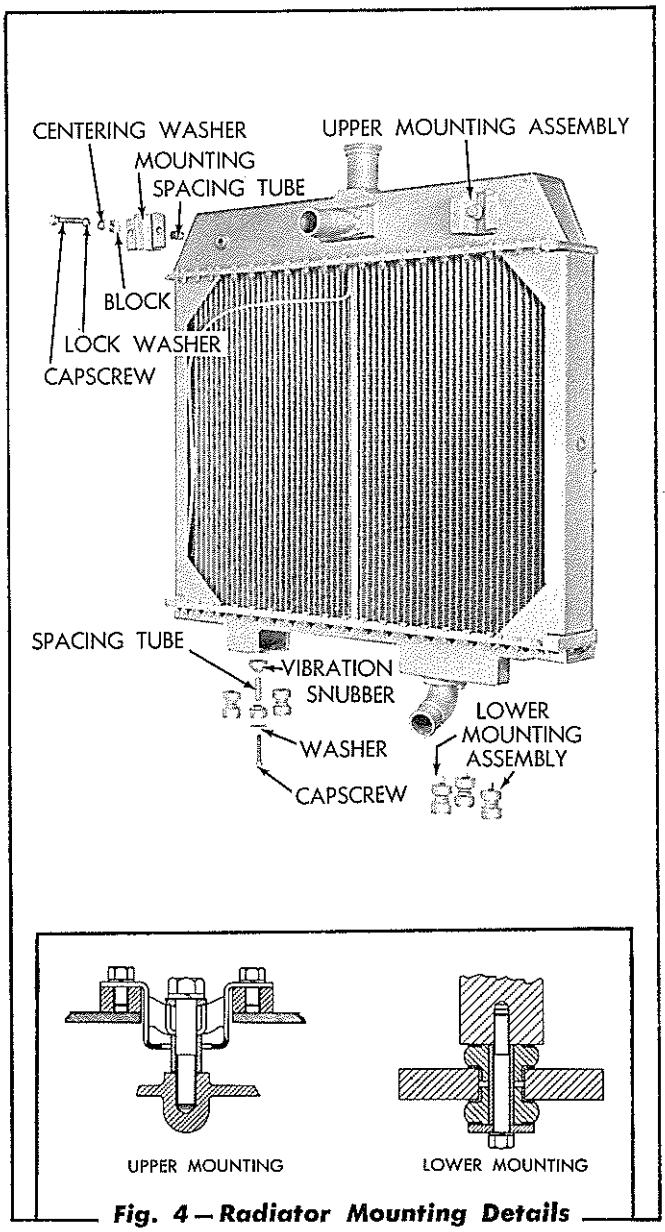


Fig. 4 — Radiator Mounting Details

of the six (6) 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 end of capscrew is even with top of vibration snubber centered on 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 tapped block, and screw it into the tapped block approximately four (4) threads.

6. Following 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 four (4) snubber assemblies in the other mounting holes at random and 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 center bolts in the top mountings until spacer tubes bottom.

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

10. Bolt the head light wire clip in position on radiator. Close and fasten the radiator grille.

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

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 7 which will be eliminated from the procedure.

1. Drain cooling system (refer to "FILLING AND DRAINING OF SYSTEM" 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 left rear of radiator shell and remove clip from top of left shell mounting pad.

5. Remove the capscrews attaching each front fender to the radiator shell.

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

7. Loosen the hose clamps from the top and bottom radiator elbows and slide hoses onto elbows.

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

C. Installation of Shell

1. Place radiator and shell assembly in position on main frame and secure mounting pads to main frame with the ¾" x 3" capscrews, lockwashers, flat washer, and nuts. The capscrews are installed with the heads down and a flat washer, lockwasher, and nut are used at the top of the shell mounting pads. *CAUTION: Be sure that the front ends of the front fenders are to the outside of the sides of the radiator shell when the shell is placed in position on main frame and that the brace rods enter the brackets on the radiator shell.*

2. Attach the front fenders to the radiator shell with three (3) ½" x 1¼" capscrews, using flat washers under the capscrew heads and flat washers, lockwashers, and hex nuts, in the order named, on the inside of the radiator shell.

3. Place hoses in position on the upper and lower radiator elbows and secure with the hose clamps.

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

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

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

7. WATER PUMP

A. Description

A centrifugal type water pump is used for circulating the cooling liquid through the engine and radiator. A bronze impeller is pressed on, and pinned to, one end of a case-hardened steel shaft and a pump drive coupling with an oil thrower is pressed on the opposite end. The oil thrower shrouds the inner end of the pump body flange to prevent oil from creeping along the shaft and through the shaft bearing. The shaft is supported at the drive end on a sealed double row combination radial and thrust ball bearing, and is prevented from moving endwise by "staking" the pump housing at the inner end of the bearing.

Water is prevented from creeping along the shaft from the impeller end by means of a spring-loaded "Neoprene" seal, retained in the impeller by a steel stamping. The pump shaft and the bearing constitute one assembly and are serviced as such.

B. Water Pump Lubrication

The water pump ball bearing is the "shielded" type and 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, providing that only clean water is poured into the cooling system and care is taken to keep grit or abrasive material from being circulated through the system. Water containing alkali is especially harmful to the water pump because it causes corrosion of the seating surface for the water pump seal.

D. Removal of Water Pump

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

2. Remove the right front fender, then remove the breathing pipe from the governor.

3. Loosen the hose clamp on the water pump to oil cooler seal and the hose clamp attaching the by-pass tube hose to the water pump body cover.

4. Remove the three (3) capscrews attaching the water pump to the blower; the inner capscrew can be removed with the special fuel pump and water pump wrench.

5. Free the pump from the blower by "jarring" it with the palm of the hand and revolve it until the pump will clear the adjacent parts and can be removed.

E. Water Pump Disassembly

1. Remove the four (4) nuts and lockwashers and separate the pump cover from the pump body cover.

2. Using a small punch, drive the 3/16" x 7/8" pin out of the shaft and impeller assembly.

   Place the pump in an arbor press, as shown in Fig. 5, and press the shaft out of the impeller. The shaft and bearing assembly will also be removed from the pump body in this operation. If replacement of the carbon sealing washer or of the steel pump body insert is the only repair necessary, no further disassembly of the pump need be made as all the seal parts may now be removed.

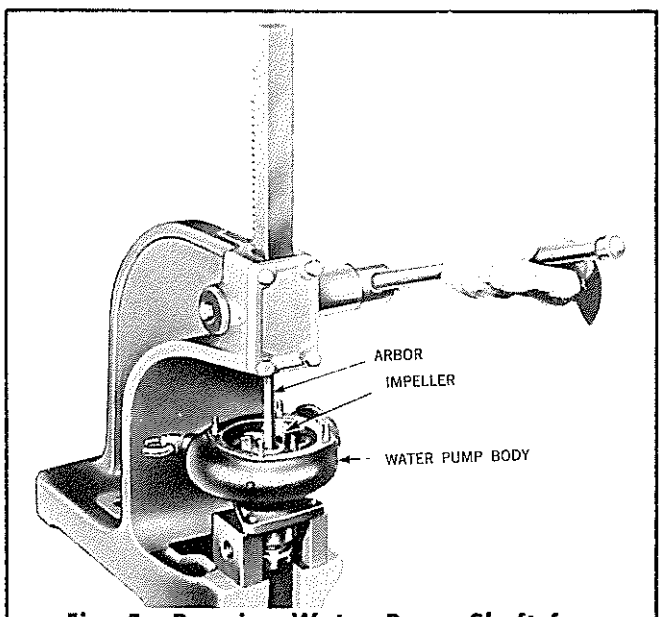


Fig. 5—Pressing Water Pump Shaft from Impeller

3. If further disassembly is necessary, the pump shaft coupling and the oil thrower assembly may be forced from the shaft with the water pump shaft coupling remover as illustrated in Fig. 6.

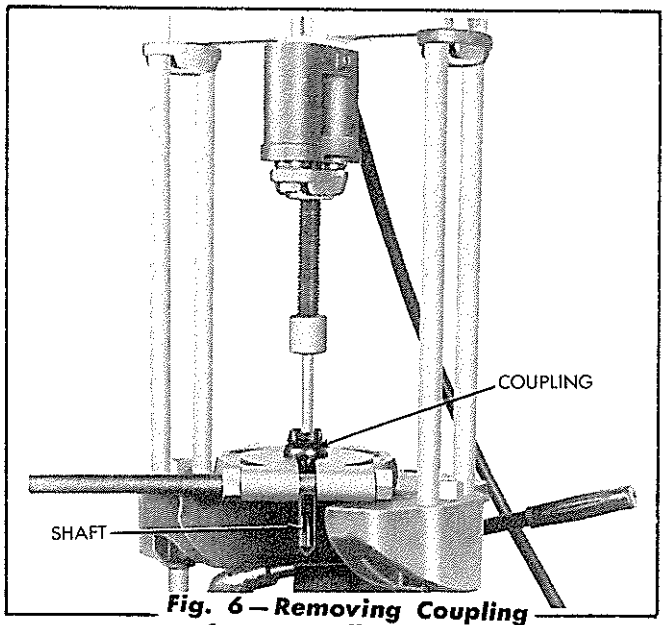


Fig. 6—Removing Coupling from Impeller Shaft

The pump drive coupling is pressed on the shaft and is driven solely through the press fit. The metal stretches when being pressed onto the shaft and, if repeatedly removed and installed, the bore of the drive coupling will become enlarged, causing a loose fit on the drive shaft. This fit should be checked and, if necessary, a new coupling should be installed.

F. Inspection and Repair

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

1. Remove the steel insert by driving it from position in the pump body.

2. The carbon sealing washer, "Neoprene" impeller seal, ring spring, or guide may be removed from the impeller by removing the seal retaining cup if replacement of any of these parts is necessary.

3. Install a new pump body insert (mating ring for carbon sealing washer) by pressing it into position in the counterbore of the pump body. *CAUTION: Be sure that the polished surface of the ring is up when installing it in the pump body and that the counterbore of the pump body is clean so that the insert will seat squarely in the pump body.*

G. Water Pump Assembly

Before starting to assemble the pump, study Fig. 7, which shows the relative location of all parts of the pump, then assemble as follows:

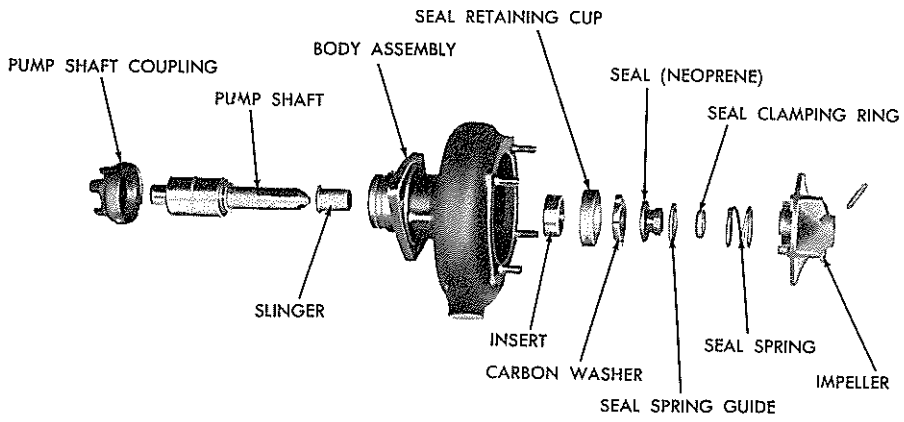


Fig. 7—Water Pump Details

1. Place the pump body on a bench (cover end down). Insert the shaft and the bearing assembly into the pump and drive the bearing down through the bore in the pump body until the inner end of the bearing is flush with the inner face of the flange. Using a center punch, stake the pump body flange against the end of the bearing outer race in three or four places to prevent the bearing from moving endwise.

2. Assemble the spring guide, seal, clamp ring, and carbon seal washer together. Insert the spring into the impeller hub, then put the assembled seal parts next to the spring and lock the assembly in the impeller hub by driving the retaining cup down over the hub of the impeller.

3. Place the impeller and seal assembly on the end of the shaft inside the pump body, then position the impeller so that the hole in the shaft lines up with the hole in the impeller. Support the other end of the shaft on the bed of a press, then press the impeller on so that it is located 11/32" past the end of the shaft. Drive the pin in place and stake the shaft against the end of the pin to prevent the pin from working out.

4. Support the impeller end of the pump shaft on a suitable arbor, and, using a brass hammer, drive the coupling and oil thrower assembly on the inner end of the shaft, flush with the end of the shaft.

5. Rotate the shaft by hand to check for clearance between the impeller and the pump body. A clearance of .005" is satisfactory.

6. Place a gasket on the pump body at the bolting flange. Place the cover over the studs so that the elbow will point down when the pump outlet is attached to the cylinder block. Tighten the cover in place with four nuts and lockwashers. Again turn the pump shaft by hand to check for clearance between the impeller and the cover.

H. Installation of Pump

1. If the pump coupling and thrower assembly were removed from the blower shaft, insert the splined end of the coupling into the mating splines of the blower shaft, and screw the 5/16" x 1½" socket head capscrew into blower shaft securely.

2. Place the water outlet packing flange over the pump outlet, with the flat machined face towards the pump body, then install the pump outlet packing in place on the pump

3. Place the hose clamp and the water pump inlet seal over the inlet elbow.

4. Hold the pump assembly in place at the end of the blower cover so that the lugs on the two drive couplings are in line when the pump inlet elbow points down. Fasten in position with three (3) capscrews and lockwashers.

5. Slide the water outlet packing and the packing flange up against the cylinder block and fasten with two (2) capscrews and lockwashers.

6. Slide the pump inlet seal and hose clamp in place at the junction of the oil cooler and pump inlet elbow, and tighten the hose clamp.

7. Connect the by-pass tube hose to the water pump body cover.

8. Install the breathing pipe on the governor and install the right front fender.

9. Fill the engine cooling system with coolant (refer to "FILLING AND DRAINING OF SYSTEM" in this section).

8. WATER MANIFOLD AND THERMOSTAT

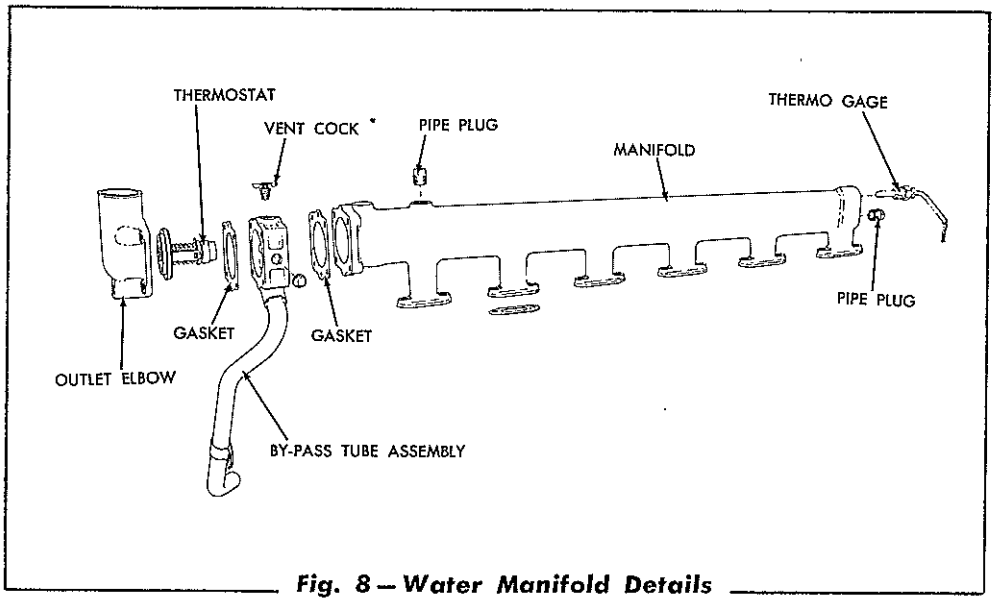


Fig. 8 — Water Manifold Details

A. Description

Coolant leaving the cylinder head through the openings directly over each exhaust port, enters the water manifold which is 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 a thermostat, so positioned, that when the thermostat is 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 thermostat starts to open (below water temperature of approximately 165° F.), the water circulates through the engine circulating system only. When the thermostat opens (fully opened at approximately 185° F.), the water circulates through the radiator and the entire circulating system.

B. Service

Replacement of the thermostat will be necessary when the thermostat becomes corroded and sticks in the open or closed position, or when the bellows of the thermostat becomes ruptured and fails to operate.

C. Thermostat Replacement

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

2. Disconnect the radiator inlet hose from the water manifold elbow.

3. Remove the four (4) capscrews attaching the elbow to the front of the water manifold, then remove the elbow, gasket, and the thermostat.

4. Clean the thermostat seat in the elbow. Examine the gaskets used between the elbow and the upper end of the by-pass tube, and between the upper end of the by-pass tube and the water manifold, and replace if necessary.

5. Using gasket cement or sealing compound, cement the gaskets in place. Place the thermostat in position in elbow (bellows end projecting out), then install the elbow and thermostat. Install the attaching capscrews.

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 (refer to "FILLING AND DRAINING OF SYSTEM" in this section).

D. Water Manifold Replacement

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

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

3. Remove the thermo gage tube from the rear of the water manifold. Remove the four (4) 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 thermostat as described in "THERMOSTAT REPLACEMENT" in this section.

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

8. Fill the engine cooling system with coolant (refer to "FILLING AND DRAINING OF SYSTEM" in this section).

9. FAN, FAN BELTS, AND FAN BELT TIGHTENING IDLER

A. Description

The fan draws air through the engine cooling radiator and helps to cool the engine coolant as it circulates from the top to the bottom of the radiator core. The fan assembly is mounted on a bracket which is bolted to the engine balance weight 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 fan belt tightening idler assembly, mounted on a hinged type bracket and bolted to the right side of the engine balance weight cover, is provided as a means for adjusting the fan belts.

B. Lubrication

The fan bearings and the fan belt tightening idler bearings must be lubricated after each 200-hours of operation. A lubricating fitting is provided in the rear end of the fan spindle and in the pulley of the fan belt tightening idler 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.

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 pulley.

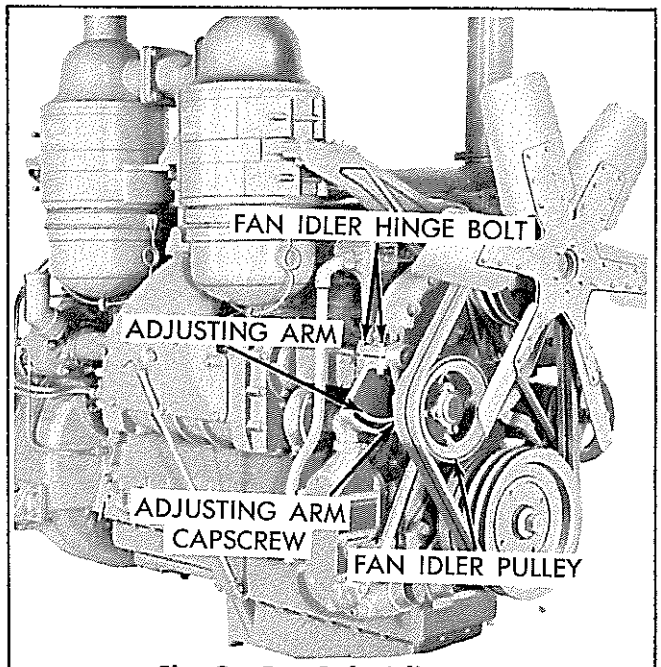


Fig. 9 — Fan Belt Adjustment

To Adjust the Fan Belts

1. Loosen the capscrew in the adjusting arm at the idler pulley, and loosen the two fan idler hinge bolts.

2. Move the fan idler in or out until the correct

tension of the belts is obtained.

3. Tighten the capscrew in the adjusting arm and the fan idler hinge bolts.

D. Removal of Fan

1. Remove the engine air pre-cleaners, engine hood, and the right front fender.

2. Drain only enough of the engine coolant from the system so that the radiator inlet elbow may be disconnected and removed, then disconnect and remove the radiator inlet elbow.

3. Loosen the tension on the fan belts and on the generator driving belt.

4. Remove the three (3) capscrews attaching the fan mounting bracket to the engine balance weight cover, then remove the generator driving belt and 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 blade assembly to the pulley hub and remove the fan blade assembly 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. Remove the "Woodruff" key from the shaft.

3. Remove the snap ring from the fan pulley and turn the seal retainer out of the fan pulley. Remove the sealing washer, retaining washer, and retaining washer gasket.

4. Install the nut back on the rear end of the fan spindle (shaft), and place the assembly in a vise by clamping the nut, then drive the pulley off the fan spindle assembly.

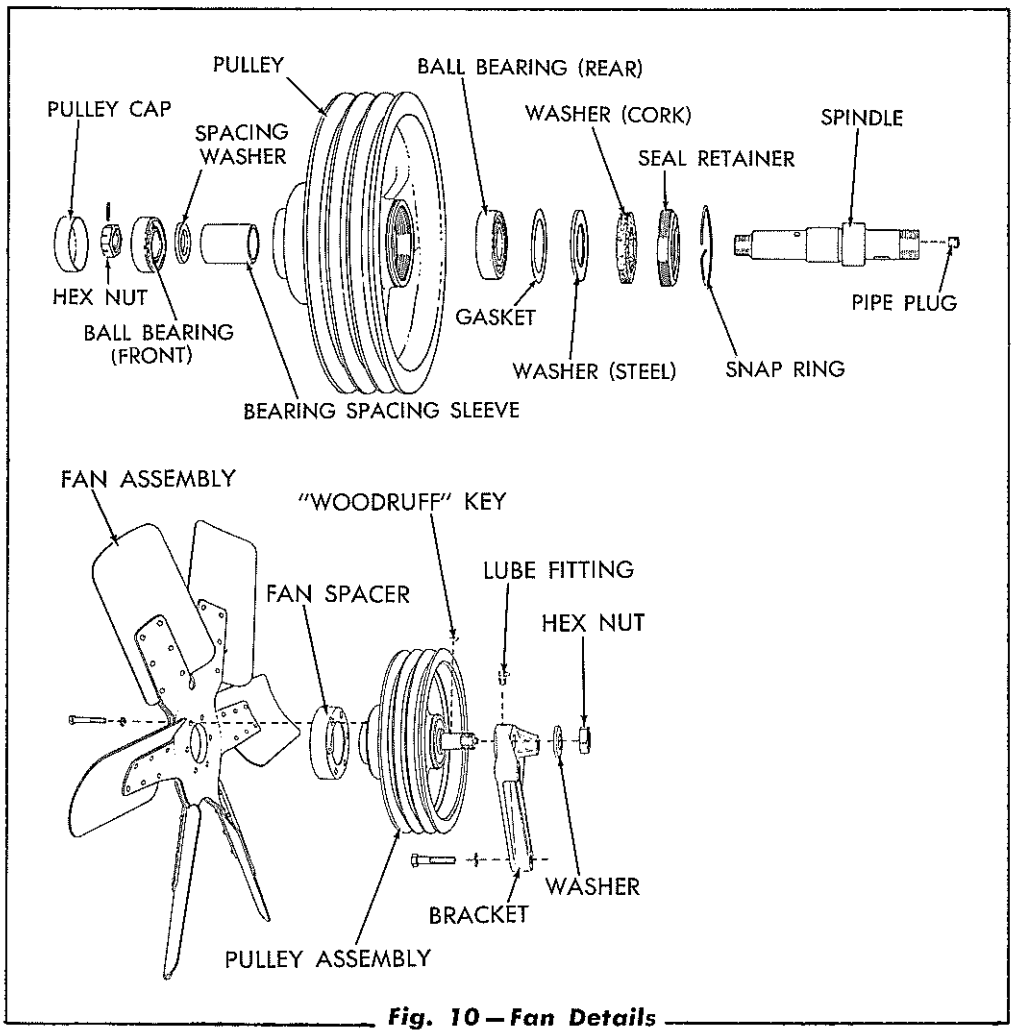


Fig. 10—Fan Details

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 oil and inspect them for wear or damage. Lubricate the bearings with light engine oil and rotate them by hand to check for binding or wear. Replace them if they do not roll easily or if they are worn. 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 sealing 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. 10, which shows the relative location of the component fan parts.

1. Press the rear ball bearing in 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 in 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 sesecurely.

2. Start the spindle assembly in 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 sealing washer (cork seal) in the seal retainer. Before installing the seal 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 sealing 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 in place on the spindle. Install the fan mounting washer and nut. Tighten the nut securely.

5. Install the grease fitting in the rear end of the spindle 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 balance weight cover and tighten the capscrews securely.

2. Adjust the fan belts (refer to "FAN BELT ADJUSTMENT" in this section). Adjust the generator driving belt (refer to "GENERATOR DRIVING BELT ADJUSTMENT" in Section VII).

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

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

5. Fill the engine cooling system with coolant (refer to "FILLING AND DRAINING OF SYSTEM" in this section).

I. Removal of Fan Belt Tightening Idler

1. Remove the right front fender. Loosen the

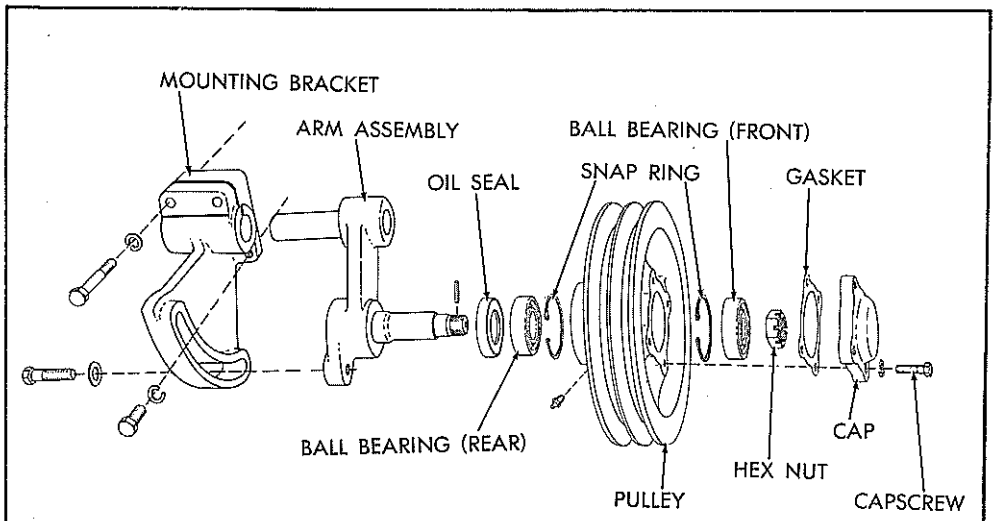


Fig. 11 — Fan Belt Tightening Idler Details

capscrew in the adjusting arm at the idler pulley, and loosen the two (2) fan belt idler hinge bolts.

2. Move the idler adjusting arm in and release the tension on the fan belts, then remove the belts from the grooves in the pulley.

3. Remove the capscrews attaching the mounting bracket to the engine balance weight cover and remove the assembly from the tractor.

J. Disassembly of Fan Belt Tightening Idler

1. Remove the mounting bracket from the adjusting arm.

2. Remove the capscrews attaching the pulley cap, then remove the cap and cap gasket. Remove the pulley shaft nut.

3. Place the assembly in a suitable press, then press the adjusting arm assembly out of the pulley assembly. Remove the bearings, snap rings, and the oil seal.

K. Inspection of Fan Belt Tightening Idler Parts

Wash all the parts in clean solvent or fuel oil and inspect them for wear or damage. Lubricate the bearings with light engine oil and rotate them by hand to check for binding or wear. Replace them if they do not roll easily or if they are worn. The bearings must fit snugly in the pulley hub and on the shaft of the adjusting arm. Examine the oil seal for damage or wear and replace if necessary. Make certain that the pulley grooves are smooth. Replace the fan belts if they are frayed.

L. Assembly of Fan Belt Tightening Idler

Refer to Fig. 11, which shows the relative location of all the parts.

1. Install the two (2) snap rings in the pulley, then install the front and the rear ball bearings in the pulley. Install the oil seal (with the lip of the seal pointing away from the bearing) in the pulley.

2. Lubricate the shaft of the adjusting arm with light engine oil, then press it into the bearings and pulley, using care so that the oil seal is not damaged. Install the pulley shaft nut and tighten it securely. Install the pulley cap gasket and the pulley cap.

3. Install the grease fitting in the pulley if it was removed, then fill the bearing compartment of the pulley with lubricant through this fitting.

4. Install the mounting bracket on the adjusting arm but do not tighten the clamping bolts.

M. Installation of Fan Belt Tightening Idler

1. Place the assembly in position on the engine and install the capscrews attaching the mounting bracket to the engine balance weight cover.

2. Place the fan belts in the grooves of the pulley.

3. Move the idler out until the correct tension of the belts is obtained (belts adjusted so that the straight (left) side of the belts can be pressed in approximately 1¼ inches at a point half way between the crankshaft and the fan pulleys), then tighten the capscrews in the adjusting arm and the fan idler hinge bolts. Refer to Fig. 9 in this section.

4. Install the right front fender.

SECTION V—ENGINE LUBRICATING SYSTEM

1. DESCRIPTION OF SYSTEM

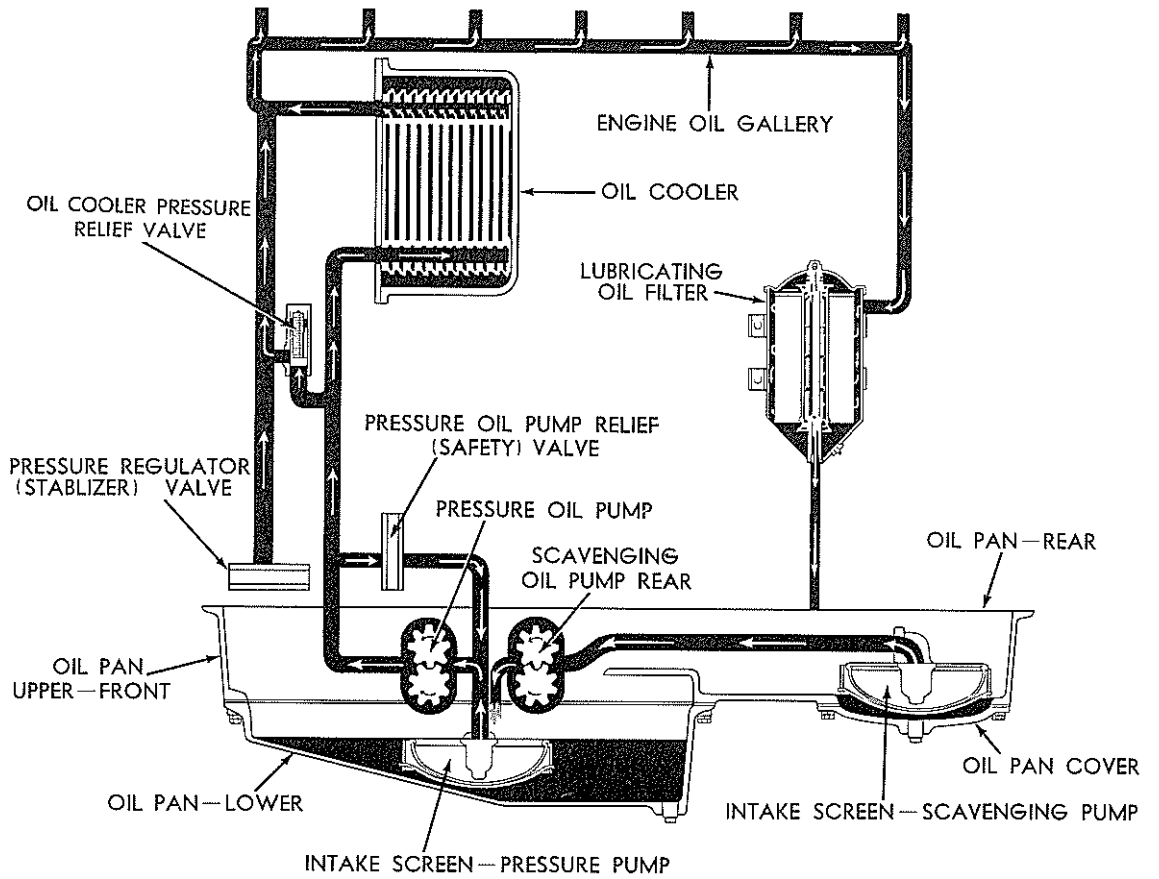


Fig. 1 — Schematic Lubrication Oil Diagram

The engine lubrication system shown schematically, includes the gear driven oil pump, oil cooler, oil filter, and oil pressure regulator valve.

A spring-loaded plunger and spring type pressure relief valve, located in the pump body, limits the pump discharge pressure to approximately 100 pounds per square inch. Stabilized oil pressure is maintained within the engine by the oil pressure regulator valve located in the oil gallery at front end of the cylinder block. A pressure relief valve, located in the adapter assembly of the oil cooler, by-passes the oil directly from the pump to the lubricating system in the engine if the oil passages in the oil cooler become clogged, or if in cold weather, the oil is too thick to circulate freely through the cooler.

The oil pump draws the oil from the crankcase and circulates it under pressure through the oil cooler,

oil filter, and the engine. The oil, after passing through the oil cooler, is conducted through a vertical drilled passage in the cylinder block to a longitudinal main oil gallery on the blower side of the cylinder block. This gallery distributes the oil to the main bearings and to the horizontal passages at each end of the block. A portion of the oil from the main gallery is conducted through an external line to the filter. After passing through the filter where it is cleaned, it returns to the crankcase.

From the two horizontal passages in the end of the block, two vertical passages (in each end of the block) carry the oil to the end bearings of the camshaft and the balance shaft, as well as to the oil passage in the camshaft, which conducts the oil to the camshaft intermediate bearings.

Oil for the lubrication of the connecting rod bearings, piston pins, and for the cooling of the piston heads, is provided through the drilled crankshaft from the adjacent forward main bearings. The gear train is lubricated by the overflow of oil from the camshaft pocket through a communicating passage into the gear cover from the camshaft, balance shaft, and idler gear bearings. The blower drive gear bearing is lubricated through an external pipe from the rear horizontal oil passage of the cylinder block.

A second longitudinal gallery is provided on the camshaft side of the cylinder head and is supplied with oil from one of the vertical bores at each end of the cylinder block. Oil from this gallery enters the hollow rocker arm shafts through the hollow rocker shaft bracket capscrews and lubricates the rocker arm bearings and push rod clevis bearings.

Excess oil from the rocker arms lubricates the valve ends and push rods and drains to the cam pockets in the cylinder head from which the cams are lubricated. After reaching a certain level, this oil overflows through two holes at each end of the blower housing, providing lubrication for the blower drive gears at the rear end and the governor drive assembly at the front. A dam in the blower housing cover maintains an oil level which submerges the teeth of the lower blower rotor timing gear. An oil slinger on the opposite end of the lower rotor throws oil into the governor weight assembly. Surplus oil passes from the blower to the oil pan through drilled holes in the cylinder block.

2. LUBRICATING OIL PUMP

A. Description

The lubricating oil pump is a gear type pump driven by an intermediate gear in mesh with the gear on the front end of the crankshaft. The intermediate driving gear bracket is doweled and bolted to the front of the oil pump body assembly.

The oil pump consists of two sets of pump gears enclosed in a pump body bolted to No. 1 and No. 2 main bearing caps. The rear set of pump gears is used to pick up and transfer the oil from the rear end of the upper oil pan to the sump of the lower front oil pan. The oil is then picked up by the front set of gears and is forced under pressure through the engine lubricating system.

A plunger type relief valve is provided in the pressure side of the pump body to by-pass excess oil to the inlet side of the pump when the discharge pressure exceeds approximately 100 pounds per square inch. To protect the oil pump gears, and to prevent the pump losing its prime, a screen is attached to each suction pipe of the pump. The screens are partially immersed in the lubricating oil contained in the oil pan.

B. Oil Pump Removal

1. Remove the crankcase guard assembly.

2. Drain the oil from the oil pan and remove the upper and the lower oil pans from the engine.

3. Remove the two (2) capscrews attaching the rear supporting bracket for the scavenging oil pump screen to the main bearing cap. Remove the two (2) capscrews attaching the oil pump scavenging tube to the oil pump front screen support, then remove the scavenging tube assembly. Remove the capscrews attaching the oil pump to regulator pipe and remove the pipe.

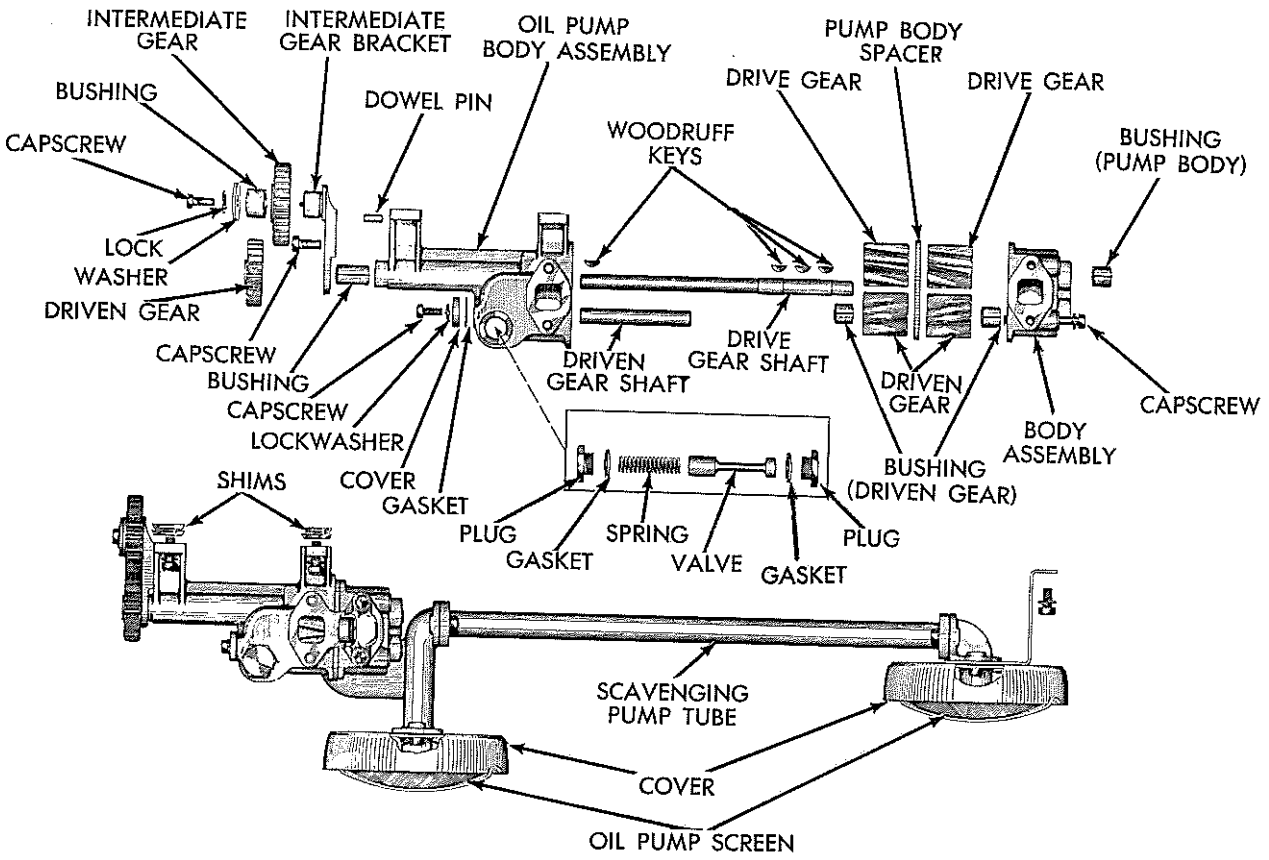


Fig. 2—Oil Pump Details

4. Remove the four (4) capscrews attaching the oil pump body assembly in position to the front two (2) main bearing caps, then remove the pump assembly from the engine using care not to lose the oil pump spacing shims. Keep the shims separated so that they may be reinstalled in their original location.

C. Disassembly of Oil Pump

1. Remove the capscrews attaching the oil pump screen support to the pump body and remove the support.

2. Remove the two (2) relief valve plugs and copper washers from each side of the pump body, then jar the relief valve assembly from the body.

3. Remove the four (4) capscrews attaching the oil pump scavenging body to the oil pump body and separate the two bodies.

4. Remove the oil pump driven gear (lower rear gear) from the driven gear shaft. Remove the oil pump drive gear (upper rear gear) from the drive gear shaft and remove the two (2) "WOODRUFF" keys from the shaft. *NOTE: This gear is a slip fit on the shaft and keys and may be removed easily.*

5. Remove the pump body spacing plate. Place the pump assembly in a vise, then, by means of a gear puller, pull the oil pump driven gear (front gear used to drive the pump) from the drive gear shaft and remove the "WOODRUFF" key.

6. Pull the oil pump drive gear shaft (including the upper front drive gear) from the body, then place the shaft and gear in an arbor press, with the long end of the shaft down, and press the shaft out of the gear. Remove the "WOODRUFF" key from the shaft.

D. Cleaning and Inspection of Oil Pump Parts

1. Wash the oil pump parts in clean solvent or 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 filter has been properly serviced, the wear on these parts will be very slow.

2. Inspect the pump gear teeth and the inside of the 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.

   The radial clearance between the gears and the pump body and the end clearance between the gears and pump body must be within the range of .002" to .0045". When these clearances are exceeded, it will be necessary to replace the affected parts.

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

4. Inspect the seat and the plunger of the oil pump relief valve (by-pass valve). When they show excessive wear or roughness they must be replaced.

E. Assembly of Oil Pump

Refer to Fig. 2 which shows the relative location of all parts. *NOTE: The drive gear shaft has three (3) keyways in one end and one (1) keyway in the opposite end. The end having the three (3) keyways will be referred to as the rear.*

1. Install one of the "WOODRUFF" keys in the third keyway from the rear end of the drive gear shaft, then place one of the pump drive gears on the rear end of the shaft and start it in position on the "WOODRUFF" key. Press the shaft into the gear so that the inner end of the gear is located 6-15/32" from the front end of the shaft.

2. Lubricate the drive gear shaft with engine oil and insert it into the pump body assembly. Install a "WOODRUFF" key in keyway in front end of the shaft and start the oil pump driven gear (gear used to drive the pump) onto the shaft with the flat face of the gear facing the pump body assembly. Place the assembly on a bed of an arbor press and press the gear onto the shaft to within .005" of pump body.

3. Lubricate and place one of the oil pump driven gear assemblies in position on the pump driven gear shaft (stub shaft), then install the pump body spacer in position on the body assembly and on the dowel pins.

4. Install two (2) "WOODRUFF" keys in the keyways in the rear end of the drive gear shaft and install the other drive gear in position on the shaft and keys. Install the other driven gear assembly in position on the driven gear shaft (stub shaft).

5. Install the scavenging pump body assembly in position on the pump body assembly and on the dowel pins. Install the four (4) capscrews and lockwashers used to attach the body assemblies together. Tighten the capscrews securely.

6. Install one of the oil pump relief valve plugs and plug gasket in the left side (viewed from rear of pump as installed in engine) of the pump body assembly. Lubricate the relief valve with engine oil and insert the valve in the other side of the pump body assembly so that the spring end of the valve is to the outside (towards blower side of engine). Insert the relief valve spring into position in the valve, then install the other valve plug and plug gasket.

7. Install the oil pump screen support assem-

bly on the pump assembly. Use new gaskets.

F. Oil Pump Installation

1. Install the pump assembly in position on the main bearing caps and install the attaching lockwashers and capscrews. Be sure that the shims used between the pump mounting pads and the main bearing caps are installed in the same positions as they were when the pump was removed.

   NOTE: The backlash between the oil pump driven gear and the oil pump driving gear (intermediate gear) should be .002" to .006". This backlash is NOT adjustable. If the backlash between these two gears exceeds .006", the gears must be replaced.

   The backlash between the oil pump driving gear (intermediate gear) and the driving crankshaft gear (gear on front end of crankshaft) should be .002" to .006". The backlash between these two gears is controllable by use of shims between the pump mounting pads and the main bearing caps. The addition of a .005" shim under each mounting pad will increase the backlash between the two gears approximately .0035".

   The above clearance measurements must always be taken with the pump fastened securely to the main bearing caps in its normal position.

2. Install the oil pump to regulator pipe, using new gaskets. Attach the oil pump scavenging tube assembly to the pump assembly, using a new gasket. Position the scavenging tube supporting bracket with the tapped holes in the main bearing cap, then install the attaching capscrews and lockwashers.

3. Re-check all the attaching capscrews for tightness to make certain there will be no leaks in the connections.

4. Install the upper and the lower oil pans, using new gaskets, then fill the engine with the proper viscosity oil to the full mark on the oil level gage rod.

5. Install the crankcase guard assembly.

3. OIL PRESSURE REGULATOR

A. Description

Stabilized lubricating oil pressure is maintained within the engine at all speeds, regardless of oil temperature, by means of a regulator valve located at the front right corner of the engine crankcase and in registration with the vertical oil gallery.

The regulator valve assembly consists of a hollow piston-type valve, a compression spring, a plug to retain the spring, and a valve body.

The valve is held on its seat by the spring, which is held in compression by the plug screwed into the valve opening in the valve body. The assembly is bolted to the lower flange of the engine block and sealed against oil leaks by a gasket between the two members. When conditions are such that the oil pressure at the valve exceeds approximately 45 pounds per square inch, the valve is lifted off its seat and the oil from the engine gallery is by-passed to the engine crankcase.

B. Service of Pressure Regulator Valve

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

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

C. Removal of Pressure Regulator Valve

With the oil pump removed from the engine, the regulator valve may be removed as follows:

1. Remove the two (2) capscrews attaching the valve body to the cylinder block.

2. Strike the lower end of the valve body lightly to separate the valve body from the gas-

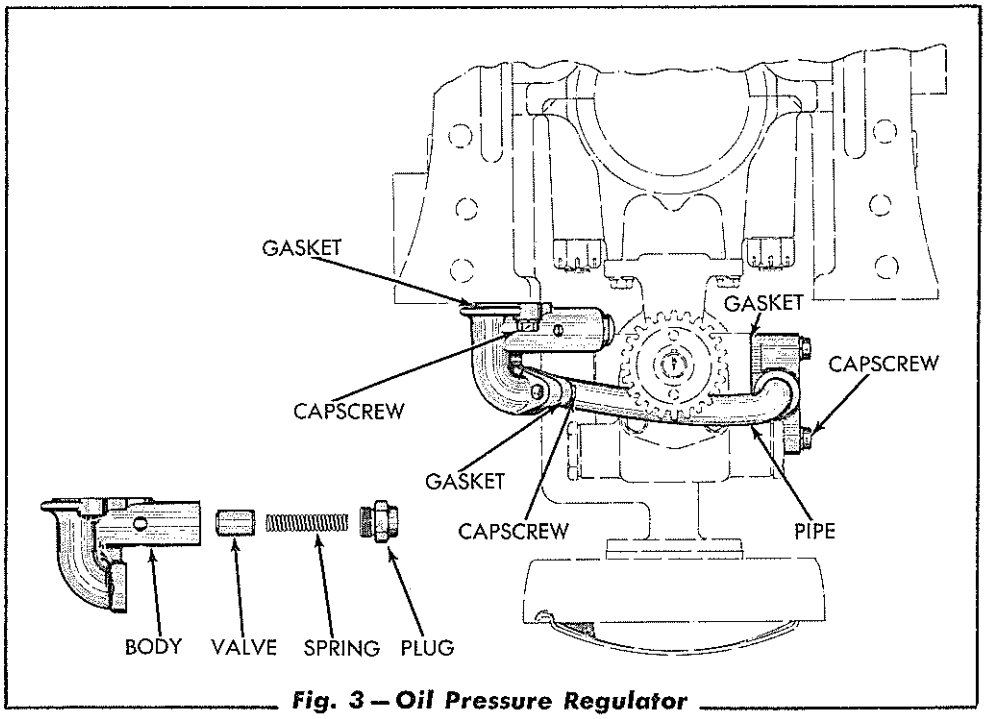


Fig. 3 — Oil Pressure Regulator

ket and cylinder block. Remove the valve and gasket.

D. Disassembly and Inspection of Pressure Regulator Valve

1. Clamp the valve body in a vise and remove the plug from the valve body.

2. Remove the spring and valve from the body.

3. Thoroughly clean the parts in clean solvent or fuel oil and dry with compressed air, then inspect them before reassembly. All the passages must be open and the valve free from score marks. Lubricate the valve with light engine oil, then insert it into place in the valve body; the valve must move freely in the body.

E. Assembly and Installation of Pressure Regulator Valve

Refer to Fig. 3 which shows the relative location of all parts.

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

2. Insert the spring inside the valve, then install the plug. Tighten the plug securely.

3. Remove all traces of the old gasket from the valve body and the cylinder block, then position a new gasket, coated with gasket cement, on the valve body.

4. Attach the valve body to the cylinder block with two (2) lockwashers and capscrews. Tighten the capscrews securely.

5. Install the lubricating oil pump (refer to "OIL PUMP INSTALLATION" in this section).

4. PUMP DRIVING CRANKSHAFT GEAR AND PUMP INTERMEDIATE DRIVING GEAR

A. Description

The intermediate driving gear is mounted on a bracket which is doweled and bolted to the front of the lubricating oil pump body assembly as shown in Fig. 2. With this type mounting, the intermediate driving gear may be inspected or replaced by the removal of the lubricating oil pump.

The oil pump driving crankshaft gear is keyed to the front end of the engine crankshaft with a "WOODRUFF" key. The driving crankshaft gear meshes with the intermediate driving gear which is also in mesh with the driven gear on the front end of the oil pump. Whenever inspection or replacement of the driving crankshaft gear is necessary, removal of the crankshaft front cover is required.

B. Removal of Oil Pump Driving Crankshaft Gear and Intermediate Driving Gear

Whenever the lubricating oil pump is removed for inspection or repairs, these two (2) gears should be inspected and replaced if necessary. Check the backlash between the intermediate driving gear and the driving crankshaft gear. The minimum backlash is .002", and the maximum is .006". If the backlash exceeds .006" the gears should be replaced.

With the lubricating oil pump removed proceed as follows:

1. Remove the engine air pre-cleaners, engine hood, and the radiator assembly. Refer to "REMOVAL OF RADIATOR" in Section IV.

2. Remove the crankshaft pulley and the vibration damper assembly. Refer to "VIBRATION DAMPER" in Section IX.

3. Remove the two (2) bolts attaching the engine front trunnion support to the front supporting hanger. Loosen but do not remove, the bolts attaching the engine rear supporting brackets to the main frame. Raise the front end of the engine only enough so that the front trunnion support may be removed.

4. Remove the two (2) capscrews attaching the trunnion support cap to the front trunnion and remove the cap and trunnion.

5. Remove the capscrews attaching the crankshaft front cover to the cylinder block and remove the cover. Remove the capscrew on the oil pump intermediate support assembly, then remove the intermediate gear from the support.

6. Remove the vibration damper rear cone, oil slinger, and the driving gear from the front end of the crankshaft.

C. Inspection

Inspect both gears for rough or worn teeth and inspect the intermediate driving gear journal (on bracket) for wear and roughness. Examine the bushing in the intermediate driving gear for wear and make certain it is smooth. Replace the necessary parts.

D. Installation of Oil Pump Intermediate Driving Gear and Oil Pump Driving Crankshaft Gear

1. Insert the "WOODRUFF" key in the crankshaft and push the crankshaft driving gear in position on the crankshaft with the hub of the gear facing the main bearing. Install the oil slinger with the "dished" outer diameter away from the gear.

2. Lubricate the intermediate driving gear journal with engine oil, then install the gear on the journal with the hub of the gear towards the front. Fasten the intermediate gear in position with the retaining washer, lockwasher, and capscrew.

3. Slide the crankshaft front 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 split end of cone towards the front, on the crankshaft and through the oil seal and against the oil slinger. Make certain that the outer diameter of the cone is smooth

where it contacts the oil seal. Fasten the crankshaft front cover in position with the lockwashers and capscrews. Make certain that the proper length capscrews are installed in their proper location when fastening the cover in position.

4. Examine the cushion ring (rubber ring) for the engine front trunnion support and make certain that it is in good condition, then install the front trunnion support and support cap in place on the crankshaft front cover and start the attaching capscrews but do not tighten.

5. Lower the front end of the engine so that the front trunnion support rests on the engine front supporting hanger, then install the bolts attaching the front trunnion support to the supporting hanger.

6. Tighten the capscrews attaching the front trunnion support cap to the trunnion support assembly.

7. Tighten the bolts attaching the engine rear supporting brackets to the main frame.

8. Install the vibration damper assembly and crankshaft pulley. Refer to "VIBRATION DAMPER." in Section IX.

9. Install the radiator assembly, engine hood, and air pre-cleaners. Refer to "INSTALLATION OF RADIATOR" in Section IV.

10. Install the lubricating oil pump. Refer to "OIL PUMP INSTALLATION" in this section.

5. LUBRICATING OIL COOLER

A. Description

The oil cooler consists of a multiple plate, corrosion-resistant, cooling core contained in a cast iron housing. The surrounding water drawn through the cooler housing by the water pump regulates the oil temperature during the time the oil travels through the small passages within the cooling core. The hot oil enters the cooling unit at the bottom, flows through the inside passages, and is discharged at the top into a gallery in the cylinder block.

B. Removal of Oil Cooler

1. Drain the engine cooling system (refer to "FILLING AND DRAINING OF SYSTEM" in Section IV). Remove the right front fender and the governor breathing pipe.

2. Loosen the hose clamp on the water pump to

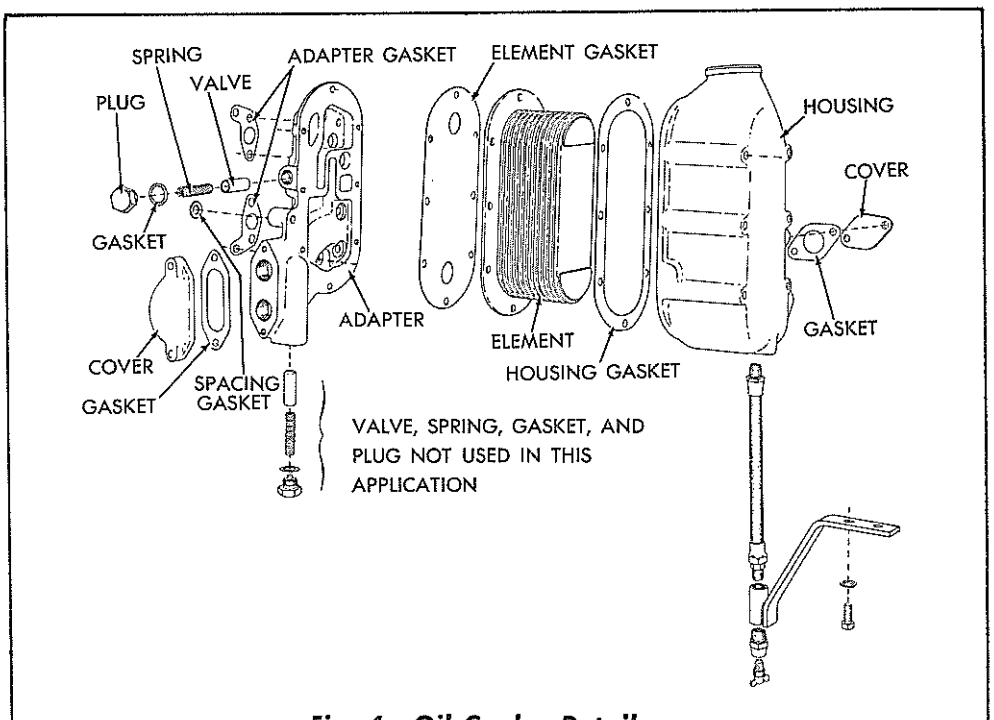


Fig. 4—Oil Cooler Details

oil cooler seal and slip the seal up on the pump inlet.

3. Disconnect the oil cooler water inlet elbow from the bottom of the oil cooler housing by removing two (2) capscrews from the attaching flange. Disconnect the water drain hose from the bottom of the cooler housing.

4. Remove the capscrews attaching the oil cooler housing to the adapter assembly. The housing and the cooler core may now be removed from the engine.

C. Cleaning of Oil Cooler

If the oil passages in the cooler core are allowed to become clogged, the oil flow will be restricted or stopped, and the oil temperature will rise. When this occurs the viscosity of the oil decreases, with a resulting drop in oil pressure. *IT IS ABSOLUTELY NECESSARY THAT THE OIL COOLER UNIT BE KEPT CLEAN FOR PROPER OIL COOLING.*

If live steam is available, a jet of steam, mixed with a soapy substance, is a very effective cleaner. After cleaning, remove all traces of water by heating the cooler core.

If steam is not available, place the cooler core in a vessel and fill with carbon tetrachloride, or with any other suitable cleaner, to a level of at least one inch above the openings in the core. A force pump is suggested as a means of forcing the cleaning solution back and forth through the core. This operation should be continued until the core is clean. *CAUTION: Cleaning with carbon tetrachloride is to be done in the open air, or with adequate ventilation, due to the toxic qualities of the chemical.*

Other solvents which have been found effective when used according to their manufacturer's directions are as follows:

Excello Floor Cleaning Compound

Turco Cleaning Compound

Mixture of 3 parts Oakite No. 7 and 5 parts Fuel oil

Bendix Cleaning Compound

To use the last named solvent, merely submerge the core in the solution for a sufficient length of time to allow the chemical action of the solvent to dissolve or loosen the sludge or other foreign matter from the core.

Flush the core thoroughly with live steam or spirits after cleaning, regardless of the type of cleaner used.

Cement the gaskets to both sides of the flange of the cooler core and coat both sides of the gaskets with cement when the core and housing are again installed after cleaning.

D. Installation

1. Cement a new gasket to the rear face of the adapter assembly, coat the other side of the gasket with gasket cement, then attach the adapter assembly to the cylinder block with three (3) 3/8" x 1 1/8" and three (3) 3/8" x 1 3/8" N.C. capscrews. Use lockwashers on all the capscrews.

2. Cement a new gasket to the outer face of the adapter and coat the other side of the gasket with gasket cement. Cement a new gasket to the outer face of the attaching flange of the core, then coat the other side of the gasket with gasket cement. Place the core in the cooler housing and attach the housing and core to the adapter.

3. Connect the water pump and oil cooler housing with the water pump to oil cooler seal and tighten the hose clamp.

4. Use a new attaching gasket and connect the oil cooler water inlet elbow (from radiator) to the bottom of the cooler housing with two (2) capscrews and lockwashers. Connect the water drain hose to the bottom of the cooler housing.

5. Install the governor breathing pipe and the right front fender.

6. Fill the engine cooling system (refer to "FILLING AND DRAINING OF SYSTEM" in Section IV). Start the engine and check for leaks.

6. LUBRICATING OIL FILTER

A. Description

The lubricating oil filter is mounted on a common base with the two fuel filters, at the left side of the engine.

The filter contains a replaceable element. A drain cock in the bottom of the filter base allows draining of the filter for replacement of the element. A new element must be installed each time the oil in the crankcase is changed, or more often if conditions warrant.

B. To Remove Element

1. Open the air vent on top of the filter. Clean all dirt thoroughly from around the filter and base. Open the drain cock and allow the oil to drain from the filter base.

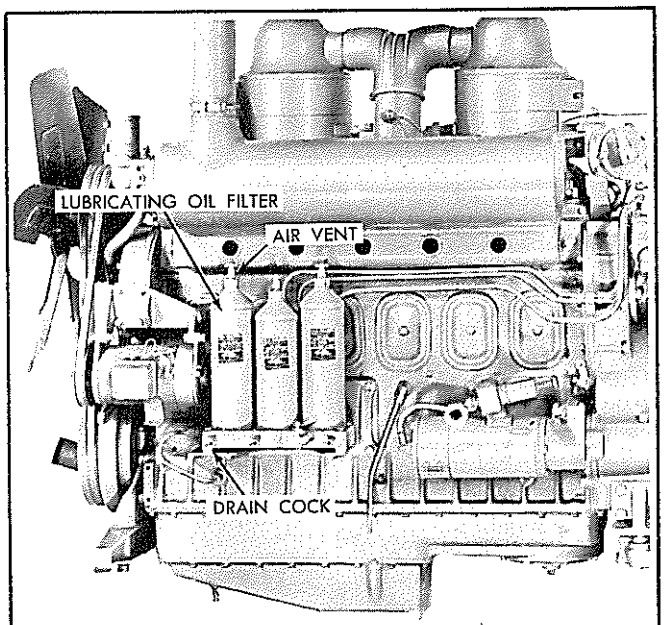


Fig. 5—Lubricating Oil Filter Location

2. Unscrew the stud and lift the filter shell from the filter base.

3. Lift out and discard the filter element, gasket, and top and bottom seals, leaving the compression spring and cup in position.

4. Clean out the filter shell, stud, and filter base.

5. Keep all parts clean when changing the filters.

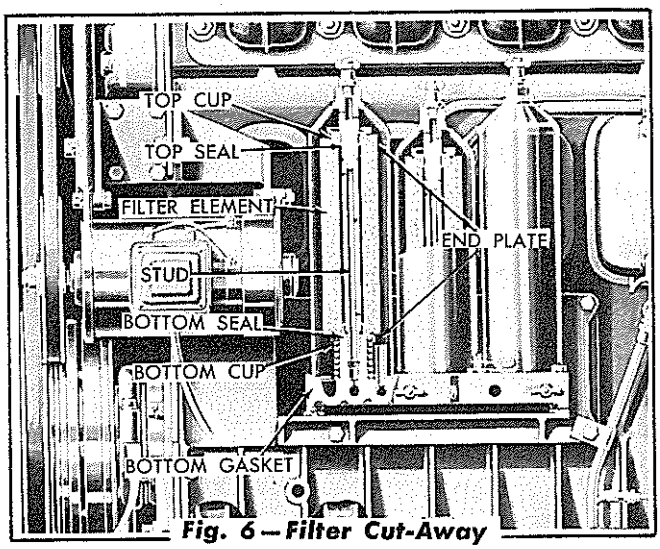


Fig. 6—Filter Cut-Away

C. To Install Element

1. Install a new bottom gasket in the filter base. Then install new seals in the end plates. Install the end plates, complete with seals into the top and bottom openings of the filter element.

2. Place the washer on the stud, followed by the filter shell. Turn this assembly bottom up and install the top cup and filter element complete with end plates and seals. Make sure that the compressing spring and cup are in position on the filter base and install the complete assembly in its proper position on the filter base.

3. Tighten the stud securely, making sure that the filter shell is in the counterbore of the filter base. *NOTE: Use precaution in pulling the stud down tight, as a side pull may break the stud.*

4. Close the drain cock in filter base. Run the engine until oil runs out of the air vent. Tighten the air vent valve. Check for leaks around the filter base, top copper washer, and oil lines.

   NOTE: To insure maximum protection, replace filter elements at every oil change or more often if conditions warrant.

7. OIL COOLER PRESSURE RELIEF VALVE

A. Description

The valve assembly consists of a hollow piston type valve, a compression spring, and a plug to retain the spring.

The valve is held in its seat by the spring, which is compressed by the plug screwed into the valve opening in the oil cooler adapter. The valve assembly is contained in the oil cooler adapter. When conditions are such that the oil pressure at the valve becomes approximately 25 to 30 pounds per square inch greater than the pressure at the oil cooler outlet, due to clogging or restriction of the cooler core, the valve is lifted from its seat and oil from the engine gallery is by-passed around the cooler into the engine. Refer to Fig. 4.

B. Service

Under normal conditions, the valve should require very little attention. If the lubricating system has been allowed to sludge, the valve may not work freely, thereby remaining open or failing to open at the normal operating pressure.

Whenever the lubricating oil cooler is removed for inspection the valve and spring assembly should be removed also, thoroughly cleaned in fuel oil and inspected.

NOTE: The valve used in the bottom of the adapter plate need not be serviced as it is not used in the tractor application.

C. Removal of Oil Cooler Pressure Relief Valve

1. Remove the right front fender.

2. Remove the pressure relief valve plug from the oil cooler adapter, then withdraw the spring and the valve.

D. Inspection

The valve and all the parts should be thoroughly cleaned in clean solvent or fuel oil, dried with compressed air, and inspected before reassembly.

The valve must be smooth and free of score marks and must move freely in its bore in the cooler adapter.

E. Installation of Oil Cooler Pressure Relief Valve

1. Lubricate the valve with clean engine oil and position it in the cooler adapter with the open end of the valve towards the threaded end of the valve opening.

2. Insert the valve spring inside the valve, and while compressing the spring, start the plug into the cooler adapter. Tighten the plug securely.

3. Install the right front fender.

SECTION VI—ENGINE CONTROLS AND GOVERNOR

1. THROTTLE AND ENGINE SHUT-OFF CONTROLS

A. Description

The throttle control lever is used to regulate the speed of the engine. A throttle control rod and linkage connects the throttle control lever with the variable speed control lever on the governor. The engine runs at full governed speed when the throttle control lever is pulled all the way back, and runs at idling speed when the throttle control lever is pushed all the way forward.

The throttle control lever is mounted on a bracket with the steering clutch control levers, and is connected to the throttle control assembly by a rod with an adjustable yoke.

The throttle control assembly consists of a shaft and drum, friction band assembly, housing, and covers. The friction band assembled around the drum acts as a brake and holds the throttle lever in any desired position, therefore, an infinite range of engine speed is obtained between idle and wide open. The friction band assembly is provided with an adjusting screw to adjust the tightness of the band on the drum for ease of throttle operation. The distance the throttle lever travels (from idle to wide open) is controlled by the governor variable speed lever.

The engine shut-off control rod opens and closes an air valve in the blower air inlet elbow and also moves the governor fuel shut-off lever to its open and closed positions. When the engine shut-off control rod is pushed in (forward) as far as it will go (running position), the air valve and the governor fuel shut-off lever are moved to their full open position. When the engine shut-off control rod is pulled out (back) as far as it will go, the air valve and the governor fuel shut-off lever are moved to their closed position. Refer to Figs. 1 and 2.

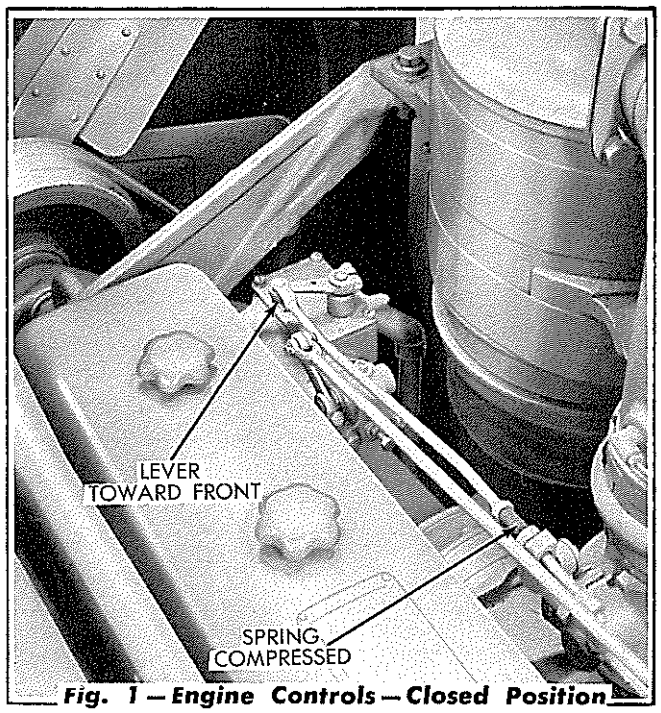


Fig. 1—Engine Controls—Closed Position

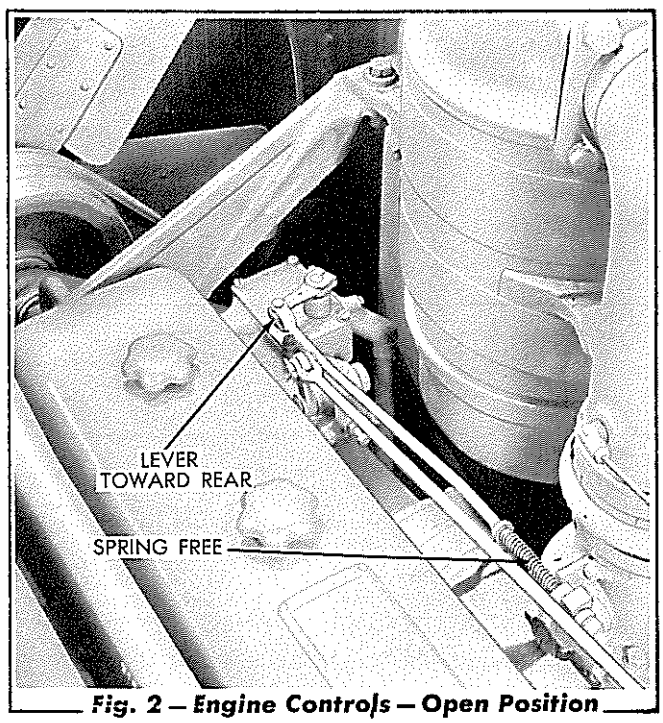


Fig. 2—Engine Controls—Open Position

B. Adjustment of Engine Shut-Off Controls

If the shut-off controls fail to operate properly, first make certain that the linkage and the levers are properly lubricated and the condition is not due to binding in the linkage or broken springs.

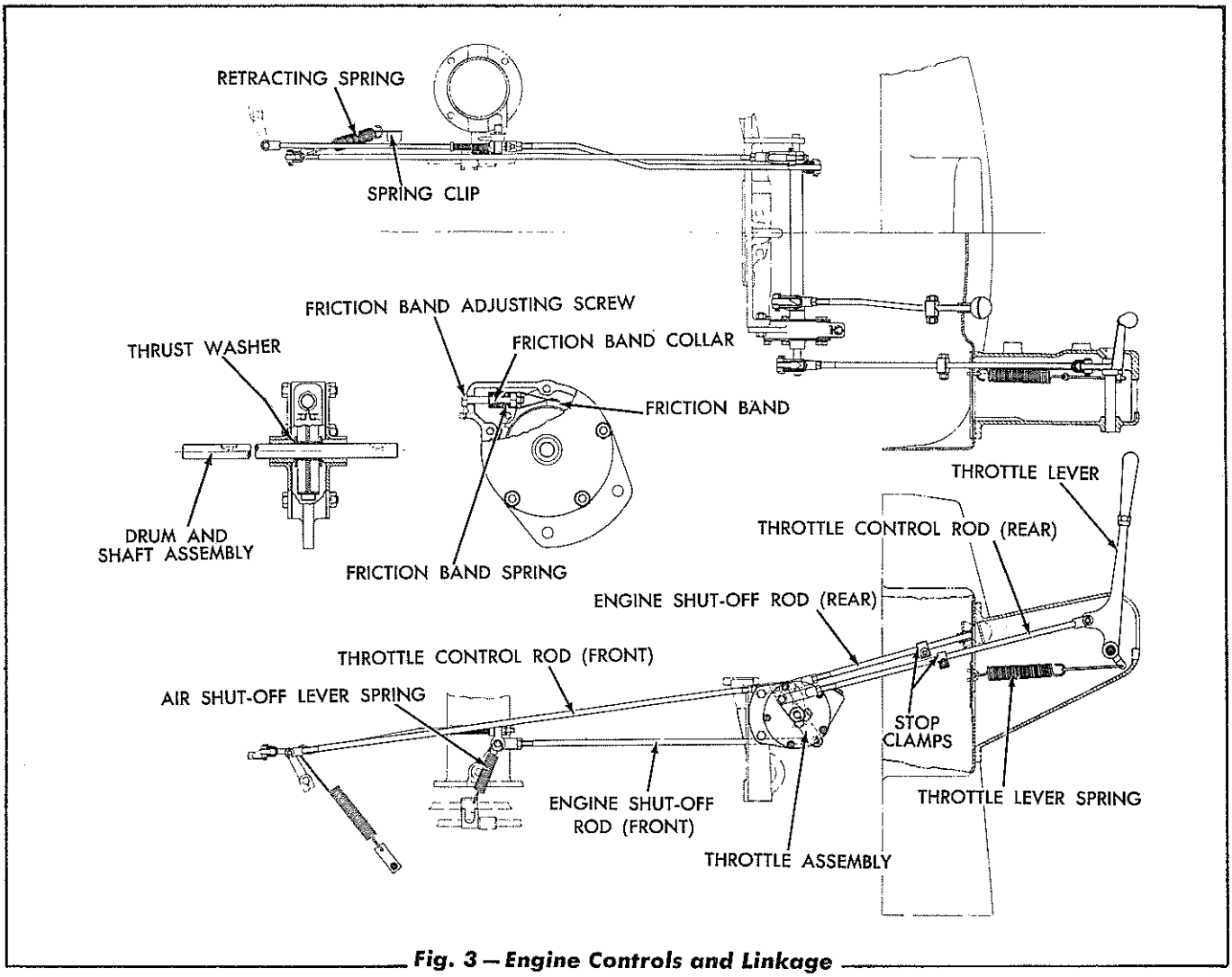


Fig. 3 — Engine Controls and Linkage

Make adjustment as follows:

1. Push the engine shut-off control rod into running position (all the way in) and check the air shut-off valve swivel lever to see if it is moved back and contacts its stop (boss) on the blower air inlet elbow. If not, check and make certain the shut-off rod knob is not striking the cowl. If the knob is striking, adjust the rear shut-off rod by turning it out of the yoke. If the air shut-off valve swivel lever still does not contact its stop, shorten or lengthen the front shut-off rod by turning it in or out of the yoke as necessary. Loosen the stop clamp bolt in the clamp on the rear shut-off rod and pull the rod back as far as it will go. Push the shut-off rod forward 1/16", move the stop clamp back on the rear rod so that it contacts the cowl, and tighten the clamp bolt. With the clamp in this position, it will prevent the air shut-off valve from bottoming in the air inlet elbow when the shut-off control rod is pulled out to stop the engine.

2. To adjust the governor fuel shut-off control, push the engine shut-off control rod into the running position (all the way in) and remove the pin connecting the governor fuel shut-off rod to the governor fuel shut-off lever. Hold the governor fuel shut-off lever all the way back (towards the cowl) as far as it will go and check to see of the hole in the fuel shut-off rod lines up with the hole in the fuel shut-off lever. If not, loosen the capscrew clamping the governor fuel shut-off lever to the shaft, and move the position of the lever on the shaft so that the holes line up when the lever is all the way back. Tighten the capscrew used to clamp the lever to the shaft securely, then install the control rod pin and the cotter pin.

2. GOVERNOR

A. Description

The governor, mounted to the front of the blower, consists of four (4) sub-assemblies. The sub-assemblies are: the weight and carrier assembly, control shaft housing assembly, the variable speed spring housing assembly, and the cover assembly.

A pair of weights are carried on a horizontal shaft inside the governor weight housing. The weight carrier shaft is mounted on a ball bearing at the front end of the shaft and the rear end of the shaft is supported inside of, and driven by, the splines of the upper blower rotor shaft.

The control mechanism transmits motion of the governor weights to the injector racks. This mechanism consists of a vertical shaft mounted inside of a housing with a fork fixed at the lower end, and an operating lever fixed at the upper end, and a speed governing spring with adjustments. The vertical shaft is mounted in a ball bearing at the upper end and in a needle roller bearing at the lower end.

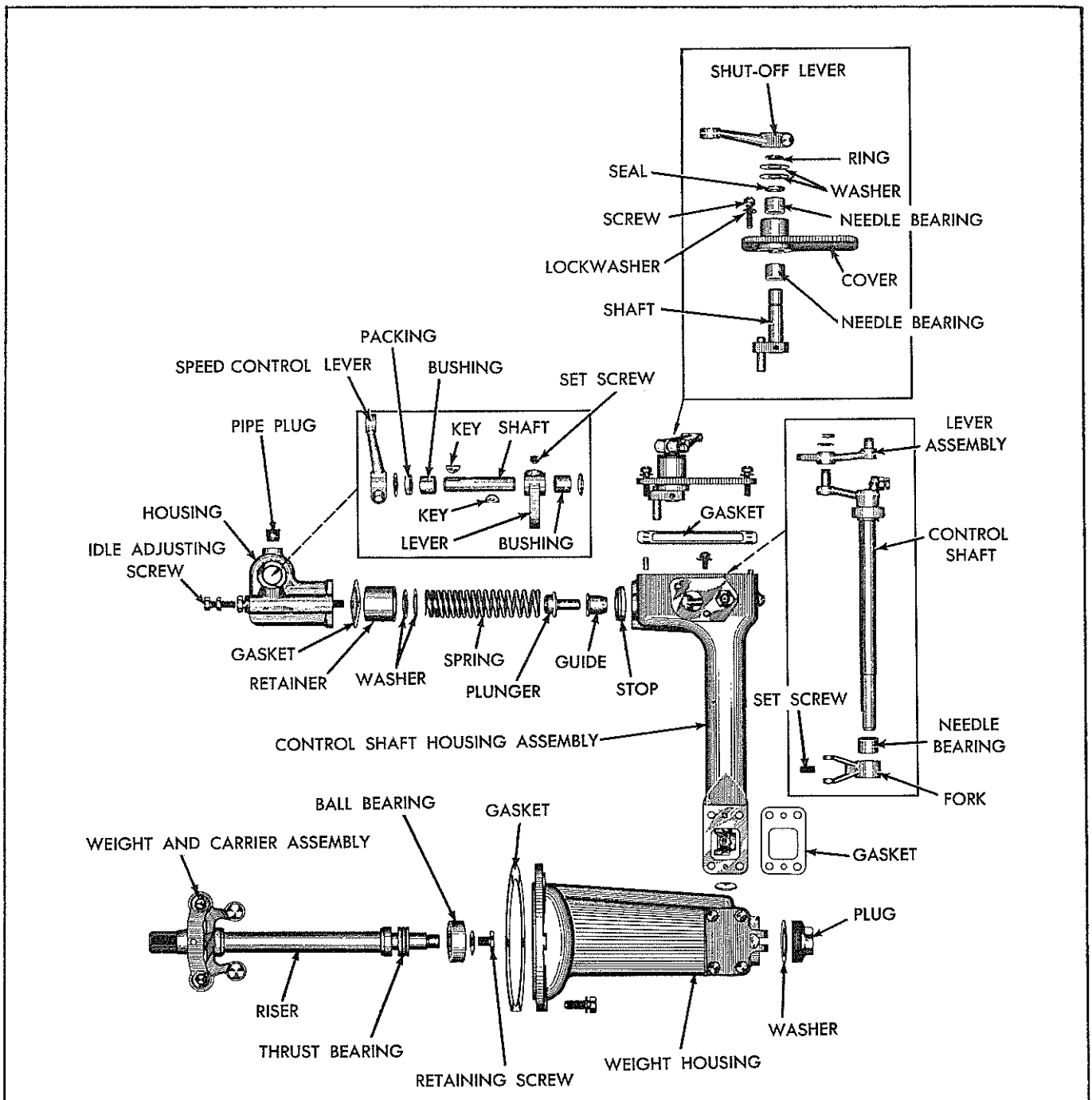


Fig. 4 — Governor Details

The centrifugal action of the governor weights is transmitted to the vertical operating shaft through a movable riser and thrust bearing on the weight carrier shaft and the fork on the lower end of the vertical shaft. This motion is, in turn, transmitted to the injector control tube by the operating and differential levers on the upper end of the vertical shaft.

The governor cover assembly serves as a carrier for the governor fuel shut-off lever. It is a stamped cover and the manual movement of the governor fuel shut-off lever is limited by a slot in the under side of the cover.

The plunger at one end of the variable speed spring, in the top of the governor control housing, bears against the operating lever on the vertical operating shaft. The opposite end is retained and guided inside a spring retainer which in turn bears against a variable speed spring lever controlled by the variable speed control lever and by the linkage to the throttle control lever. The governor is designed to control the engine at any constant speed (within the limits of the governor spring), that the operator may desire. Such control is made possible by the idle adjusting screw for the low engine speeds; and by imposing more or less tension on the spring by means of the throttle linkage and variable speed spring lever for high speeds. The greater the tension on the spring, the higher the engine speed.

For starting, the engine shut-off control rod is moved to running position (pushed all the way in). This moves the injector control racks to "FULL FUEL" position and also opens the engine air shut-off valve in the blower air inlet elbow. As soon as the engine starts, the governor moves the injector racks OUT to the position required for idling. The engine can then be brought up to any desired operating speed, within the limitations of the variable speed spring, by opening the throttle and increasing the tension on the spring. The engine speed control is entirely automatic from this point on, depending upon the spring tension.

B. Governor Inspection and Service

The governor was adjusted at the factory to provide the full governed engine speed (under load) of 1600 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 oil. If 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 aligning the shaft brackets with the control tube. The control tube must turn freely to the "NO FUEL" position by the action of the return spring only. *CAUTION: Never stretch or tamper with the rack control 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 engine does not reach its maximum rated speed of 1725 R.P.M. at high idle with engine clutch disengaged, inspect as follows:

a. Wear on the governor variable speed lever shaft, lever, and a loose setscrew in the lever will cause loss of engine speed and new parts should be installed if wear is excessive.

b. Make certain the engine shut-off control rod moves the governor fuel shut-off lever all the way back against the lever stop (run position).

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 right front fender. Remove the oil cup from the front air cleaner.

2. Clean off the rocker arm 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 breather pipe to the governor housing and the capscrew attaching the breather pipe clip to the engine oil cooler.

6. Remove the capscrews attaching the governor control housing to the cylinder head and to the governor weight housing, then remove the governor control housing. Pull the top of the governor housing away from the engine and push the lower end of the housing toward the engine to disengage the fork, then lift the assembly out.

7. Loosen the capscrew in the adjusting arm of the fan belt tightening idler and loosen the two (2) fan belt idler hinge bolts. Release the tension on the fan belts, then remove the belts from the tightening idler pulley. Remove the three (3) capscrews attaching the tightening idler assembly to the engine front cover (balance weight cover) and remove the assembly from the engine.

8. Remove the capscrews attaching the weight housing to the blower, then remove the weight housing by pulling the assembly forward until the splines are free from the blower rotor.

9. After removing the governor assembly from the engine, it should be thoroughly washed in clean solvent, dried with compressed air, and inspected for worn, damaged parts, or bind in any of the parts. The governor should be disassembled only far enough to correct the difficulties which interfere with proper operation.

D. Disassembly of Variable Speed Spring Housing

1. Remove the capscrews attaching the variable speed spring housing to the governor control housing.

2. Remove the variable speed spring housing; hold the variable speed spring in place in the spring retainer so that the adjusting washers in the spring retainer will not fall out when removing, also, do not lose the spring retainer stop.

3. Remove the variable speed spring, stop, adjusting washers, and spring retainer from the housing. Do not lose the adjusting washers. Remove the low idle screw and jam nut.

4. Remove the variable speed control lever

and its key from the variable speed lever shaft. Remove the pipe plug from the top of the variable speed spring housing. Insert an "ALLEN" setscrew wrench through the pipe plug hole and remove the "ALLEN" setscrew holding the governor variable speed spring lever in place on the shaft. Remove the variable speed lever shaft, spring lever, washer, and shaft packing. *NOTE: A "WOODRUFF" key is used in addition to the "ALLEN" setscrew to attach the variable speed spring lever to the shaft.* To remove the shaft, drive the shaft out towards the expansion plug end of the housing.

5. Remove the variable speed shaft bearings from the housing.

E. Removal and Disassembly of Weight and Carrier Assembly

1. Remove the cap and the cap gasket from the end of the weight housing. Remove the capscrew and the lockwasher retaining weight shaft bearing (ball bearing).

2. Press or drive the weight shaft out of the bearing, use care and do not damage the threads in the weight shaft, then remove the weight shaft, riser, and riser thrust bearing (three piece bearing) from the weight housing.

3. Lift the riser thrust bearing and the riser from the weight shaft.

4. Press or drive the weight shaft bearing out of the weight housing.

F. Removal and Disassembly of Control Shaft

1. Remove the variable speed spring plunger and plunger guide from the control housing.

2. Using an "ALLEN" setscrew wrench, remove the "ALLEN" setscrew holding the governor control shaft fork in place on the lower end of the control shaft.

3. Loosen the buffer screw jam nut and remove the buffer screw assembly from the control housing.

4. Remove the round head machine screw, lockwasher, and plain washer used to hold the governor control shaft upper ball bearing in place in the governor housing.

5. Remove the expansion plug, located under the lower end of the control shaft, from the governor housing. Insert a punch through the expansion plug hole and drive the control shaft out of the control shaft lower fork, then, remove the control shaft assembly.

6. Remove the differential lever from the control shaft lever, then, press the control shaft out of the shaft lever and the control shaft upper ball bearing.

7. Remove the control shaft lower needle bearing from the governor housing.

G. Disassembly of Governor Control Housing Cover

1. Remove the governor shut-off lever from the shut-off shaft, then remove the snap ring and the flat washer from the shaft.

2. Remove the shut-off shaft assembly from the cover.

3. Remove the shut-off shaft packing and remove the bearings from the cover.

H. Inspection of Governor Parts

Clean the parts thoroughly, using clean fuel oil or solvent, inspect the parts for wear, and replace with new parts where needed.

When bearings and moving parts in the governor become worn, new parts must be installed to insure proper functioning of the governor.

I. Assembly of Governor

To assemble the governor, reverse the disassembly procedure. Refer to Fig. 4 showing the parts in their relative position. When assembling the variable speed spring, make certain to install the close coils of the spring in the spring retainer and the same total thickness of variable speed spring washers as were removed at the time of disassembly. These washers are installed to obtain the

correct high idle speed. *CAUTION: When assembling make certain that the control shaft fork on the lower end of the control shaft is installed in front of all three pieces of the three (3) piece riser thrust bearing (ball bearing).*

J. Governor Installation

1. INSTALL GOVERNOR WEIGHT HOUSING.

   Using gasket cement, cement the weight housing to blower gasket in place on the weight housing. Slide the weight housing assembly against the front end of the blower, with splined end of weight carrier shaft entering the hollow upper blower rotor shaft. Install the attaching capscrews, finger tight only.

2. INSTALL GOVERNOR CONTROL HOUSING.

   Coat a new gasket with gasket cement and place in position on the mounting surface at the upper end of the control housing. Place a new gasket on the dowels at the lower end of the control housing. Set the control housing in position against the weight housing; then place the weight housing cover and gasket in position, and attach the cover, gasket, and the two housings together with the four (4) capscrews, then tighten the capscrews securely. *IMPORTANT: Make certain that the control shaft fork is assembled so that the rounded machined faces of the fork bear against the thrust bearing outer race, and not between the outer race and the balls.* With gasket in place, attach the upper end of the control housing to the cylinder head with the attaching capscrews. Pour ½ pint of SAE 10 engine oil, into the top of the control housing for initial lubrication of the parts. Tighten the capscrews attaching the weight housing assembly to the blower securely.

3. CONNECT GOVERNOR CONTROL LINK.

   Insert the short bent end of the control link through the hole in the cylinder head and into the governor control housing, then place the end of the link on the pin of the differential lever. Secure the link with a washer and a spring clip. Connect the other end of the link to the injector control tube lever with the pin and a cotter pin. Coat a new breather pipe gasket with gasket cement and place in position on the control housing. Place the breather pipe into position on the control housing and secure with the attaching screws. Install the capscrew attaching the breather pipe clip to the oil cooler.

4. INSTALL CONTROL HOUSING COVER ASSEMBLY.

   NOTE: Before installing the control housing cover and the rocker arm cover, check the governor adjustment as outlined in "GOVERNOR ADJUSTMENT," in this section. Equalize injectors (refer to "INJECTOR EQUALIZING" in Section II).

   Place a new cover gasket in position on the dowel pins in the control housing, then install the cover assembly in position on the control housing and make certain the pin in the shut-off lever engages the fork on the differential lever. Install the cover attaching screws and tighten the screws securely. Connect the fuel shut-off rod to the fuel shut-off lever with a pin and cotter pin. Check the travel of the shut-off lever. Connect the front throttle control rod to the variable speed spring lever with a pin and cotter pin.

5. Install the right front fender and the front air cleaner oil cup.

6. Install the fan belt tightening idler and adjust the belts as outlined in Section IV.

K. Governor Adjustment

If the governor has been dismantled for repairs, or if a new governor is installed, certain adjustments should be checked and engine speed adjustments made if necessary.

Proceed as follows to check the governor adjustment:

1. CHECKING ENGINE SPEED.

   Operate engine until normal operating tem-

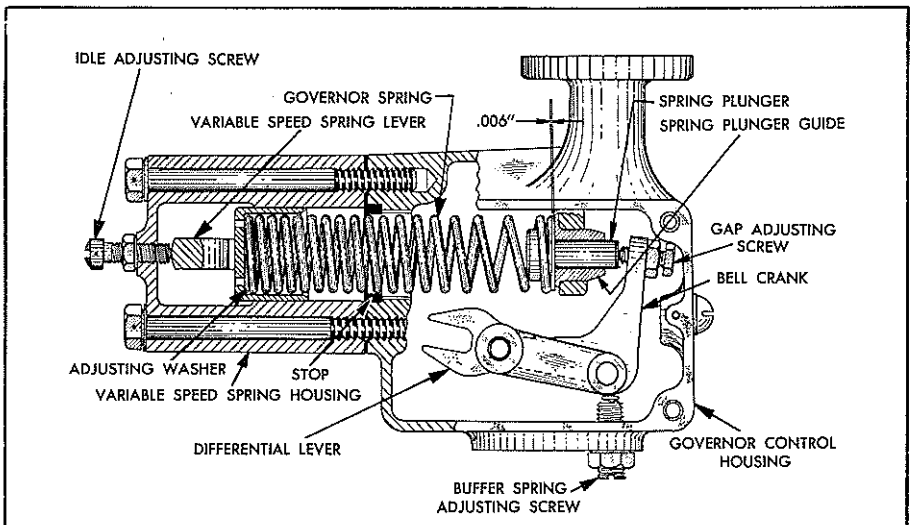


Fig. 5 — Governor Adjustment

perature (160° to 185° F.) is indicated on temperature gage. Hold a tachometer against the front end of the crankshaft. With the throttle lever all the way back (wide open) the engine speed should be 1725 R.P.M.

NOTE: If equipment on the tractor prevents the use of a tachometer at front end of crankshaft, remove the capscrews attaching the flywheel housing cover to the flywheel housing (at rear of the camshaft) and remove the cover and gasket. The tachometer may now be used on the camshaft to record the R.P.M. of the engine. The camshaft runs the same speed as the crankshaft.

2. SPRING PLUNGER GAP ADJUSTMENT.

A clearance of .006" must be maintained between the variable speed spring plunger and the plunger guide. To adjust, remove control housing cover and pull throttle lever half way back. Loosen the lock nut on the adjusting screw and turn the screw in or out until a .006" gap is obtained between the spring plunger and guide. Use a .006" feeler gage to measure this gap. Tighten lock nut after proper adjustment has been made and replace the cover.

3. HIGH IDLE SPEED ADJUSTMENT.

In most cases, the cause for the engine not reaching the proper high idle speed (1725 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, before changing the adjustment of the governor, check the following:

a. Be sure that the governor fuel shut-off lever on the governor control housing moves to its rear position (as far back as it will go) when the engine shut-off control rod is pushed into running position.

b. If the injectors have been properly timed and equalized and all adjustments and inspections listed above have been made, and the engine still fails to attain its proper high idle speed of 1725 R.P.M., addition of adjusting washers between the variable speed spring and the spring retainer will be required.

The adjusting washers are installed by removing the variable speed spring housing from the governor control housing, lifting the spring from the spring retainer and inserting additional adjusting washers in the spring retainer. Each .010" thick washer will increase the high idle engine speed approximately 20 R.P.M. To decrease the high idle speed, remove the necessary amount of adjusting washers.

4. LOW IDLE SPEED ADJUSTMENT.

After adjusting the governor for the correct

high idle engine speed, the low idle speed should be checked and adjusted if necessary to obtain the speed of 500 R.P.M. Loosen the lock nut on the buffer spring adjusting screw and back the screw out (away from the differential lever) so that there is approximately ⅛" clearance between the spring and the differential lever. With the throttle control lever in "low idle" position, loosen the lock nut on the idle adjusting screw and turn the screw in to raise the low idle speed or out to lower the low idle speed. Tighten the lock nut when the correct low idle speed is obtained.

With the engine running at low idle (500 R.P.M.), turn the buffer spring adjusting screw in until a very slight increase (not to exceed an increase of 20 R.P.M.) in the low idle speed is noted, then tighten the adjusting screw lock nut.

SECTION VII—ELECTRICAL SYSTEM

1. DESCRIPTION OF SYSTEM

The electrical system, which includes the starter, generator, generator regulator, batteries, headlights, and wiring, is a 12-volt system throughout. Current for the operation of the system is supplied by two 12-volt wet cell storage batteries connected in parallel and located in compartments at the ends of the seats.

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 located on the side of the generator.

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

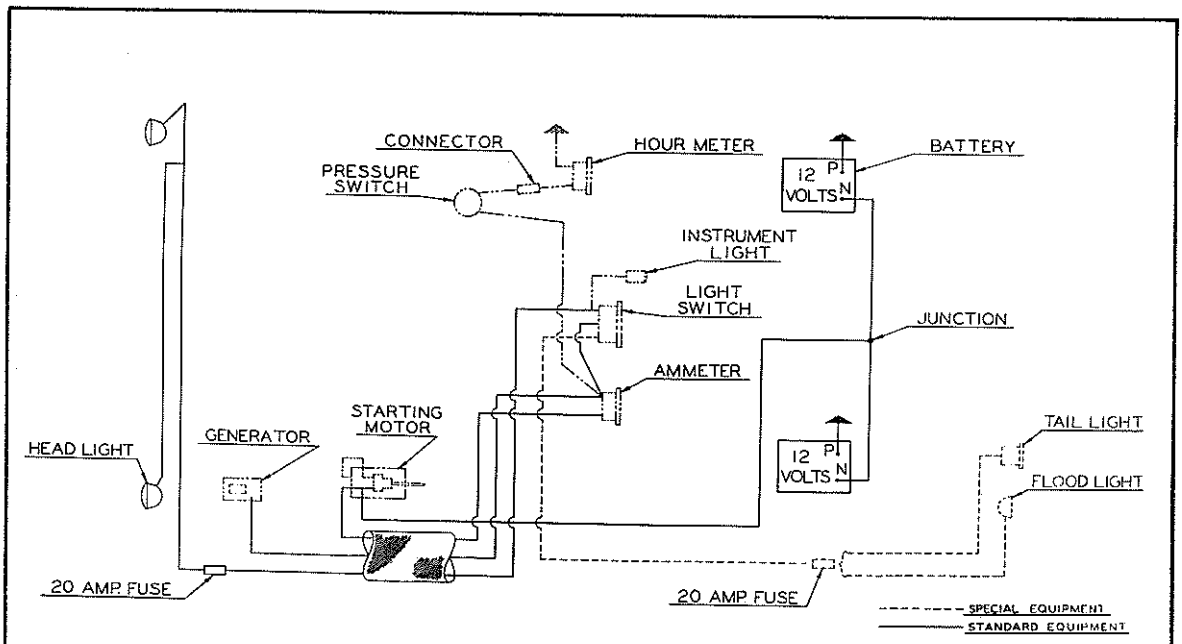


Fig. 1 — Wiring Diagram

Heavy cables connect the batteries and the starter. A wiring harness is used to connect the generator, ammeter, and headlight switch to the electrical system. Ten (10) 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 left corner of the radiator, prevents burning out the lights in event of a short-circuit. An additional 20-ampere fuse is provided when the tractor is equipped with a rear flood light or tail light.

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 parallel to provide 12-volt current.

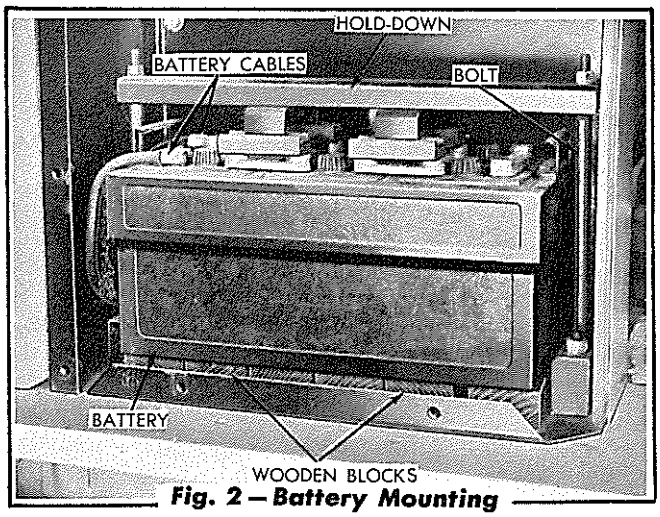


Fig. 2 — Battery Mounting

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. 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 regulator requires attention. If these units prove satisfactory, inspect the system for short circuits, loose connections 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.

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

A. Description

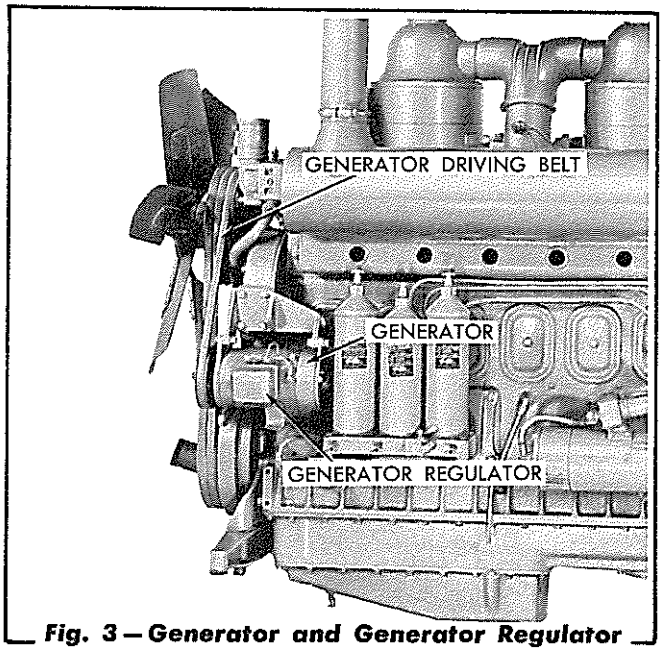


Fig. 3—Generator and Generator Regulator

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 left side of the cylinder block, and is driven by a V-belt from the fan pulley. The generator revolves at approximately 1.55 times engine crankshaft speed.

The output of the generator is approximately 18 amperes when cold and 12-13 amperes when hot at 2400 armature R.P.M. (approximately 1550 engine R.P.M.). As a steady charging rate of 12-13 amperes would soon destroy the storage batteries, an output controlling device becomes necessary. To accomplish this, a step-voltage control together with a cut-out relay is wired to the generator circuit.

1. Step-Voltage Control

This unit is mounted on the generator field frame as shown in Fig. 3 and connected into the circuit as shown in the wiring diagram Fig. 4.

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 5 to 7 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 belt in proper adjustment. It is correctly adjusted when the top side of the belt can be pressed inward approximately 1¼" at a point halfway between the generator and fan pulleys.

To adjust the belt, loosen the capscrew in the adjusting arm at the front of the generator and loosen the generator hinge bolts, then move the generator in or out until the correct tension on the belt is obtained. Tighten the capscrew and the generator hinge bolts. Excessive belt tension causes rapid wear on the drive belt and on the generator 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 Generator and Regulator

Testing and adjustment of the generator or regulator should not be attempted without dependable testing equipment. If such equipment is not available, it is recommended that these units be taken to a United Motors Service Station, or other dependable electrical repair shop. To check the generator, an accurate 0-10 or 0-20 ammeter, an accurate 0-20 voltmeter, and a 20-ohm variable resistance of sufficient capacity to carry 10 amperes continuously, are needed.

DO NOT RUN OR TEST THE GENERATOR ON AN OPEN CIRCUIT. TO DO SO MAY DESTROY THE GENERATOR OR THE GENERATOR REGULATOR.

1. Generator Step-Voltage Control Checks

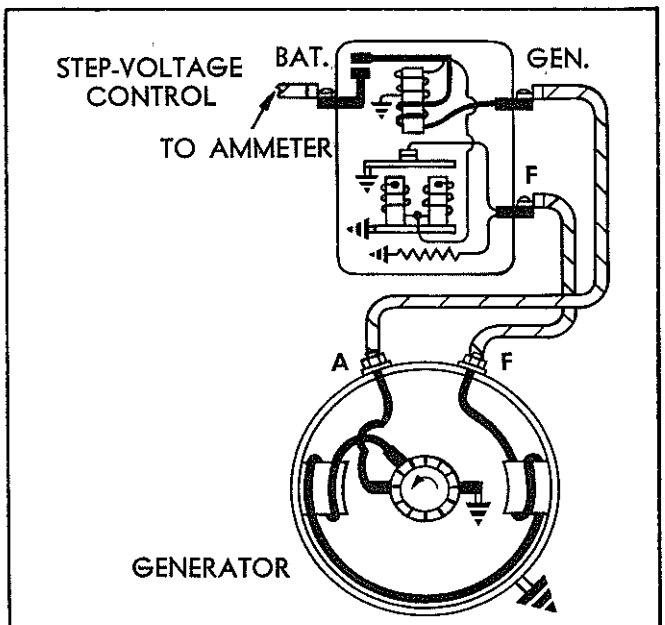


Fig. 4 — Wiring Diagram — Generator and Voltage Control Units

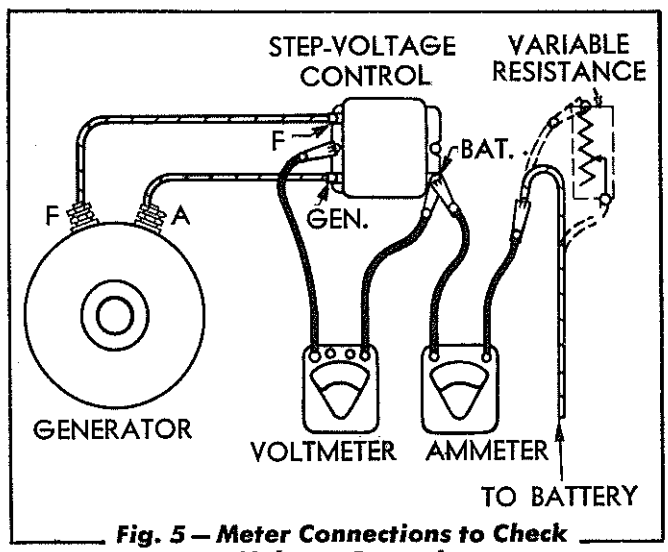


Fig. 5 — Meter Connections to Check Voltage Control

A low charging rate indicated on the ammeter when the batteries are fully charged indicates proper operation of the voltage control. Excessive gassing of the batteries indicates overcharge. The voltage control is designed to reduce the generator charging rate to approximately 2 amperes at 2400 generator R.P.M. (approximately 1550 engine R.P.M.) when the batteries have approached a fully charged condition. Check the voltage control action by stopping the engine and connecting the ammeter into the charging circuit, as shown in Fig. 5. Disconnect the lead from the "BATTERY" terminal of voltage control and connect the negative ammeter lead to the disconnected lead. With the ammeter connected and the engine running, there should be 10 to 13 amperes charge for a short time (up to 30 minutes with charged batteries). As the current used in starting the engine is replaced in the batteries, the batteries will come up in voltage until the voltage control operates. This will reduce the charging rate to about two amperes. Failure of the units to operate in this manner will necessitate their being taken off the engine for further checking and adjustment as described in "Checking Generator Output."

Low batteries and low or no charging rate, indicate either the third brush of the generator or the voltage control is out of adjustment. Loose connections in the charging circuit, particularly at the battery terminals, may also cause a low charging rate. Connect the ammeter in the charging circuit as described above. With the generator operating at about 2400 R.P.M. (approximately 1550 engine R.P.M.) and low batteries, the output should be 10 to 13 amperes. If less than 8 amperes is obtained, connect a jumper lead from the "F" terminal of the voltage control to the ground (base of voltage control is satisfactory). If the output increases to 10 to 13 amperes, the trouble is in the voltage control. If the output does not increase to 10 to 13 amperes with the jumper lead connected from the "F" terminal of the voltage control to the ground, the generator is at fault, and it must be checked further, as discussed under "Checking Generator Output."

Refer to Fig. 5 and disconnect the lead from "BATTERY" terminal of the voltage control and connect it to one terminal of the variable resistance. Connect the positive ammeter lead to "BATTERY" voltage control terminal. Connect the negative ammeter lead to the other terminal of the variable resistance. Connect the negative voltmeter lead to the "BATTERY" voltage control terminal and the positive lead to the ground (base of voltage control or generator frame). Connect a jumper lead (not shown in dia-

gram) between the "F" terminal of the voltage control unit and the ground to eliminate the voltage-control resistance.

Set the engine speed for the maximum generator output (approximately 2400 generator R.P.M. or 1550 engine R.P.M.).

Adjust the variable resistance until the voltmeter reads 15.1 to 15.5 volts. The output should be approximately 10 to 13 amperes with the generator at operating temperature. Adjust the generator output by shifting the third brush in the direction of rotation to increase the output, and in the opposite direction to decrease the output. Adjust the variable resistance after shifting the third brush to maintain 15.1 to 15.5 volts before taking the ampere reading.

Before moving the third brush, it is necessary to loosen the clamp screw on the face of the commutator and frame. Do not loosen this screw more than one or two turns. Considerable force may be required to move the third brush due to the construction of its mounting. *CAUTION: Never under any circumstances, set the generator output above 13 amperes at 15.1 to 15.5 volts.*

If unable to obtain 10 to 13 amperes by shifting the third brush, remove the generator and voltage control and service them in the manner described in the following pages of this section.

2. Checking Cut-Out Relay

Connect the test leads of an ammeter and voltmeter into the electrical system as shown in Fig. 6. Start the engine, gradually increase the engine speed, and note the relay closing voltage. The reading must be 13.2 to 14.0 volts.

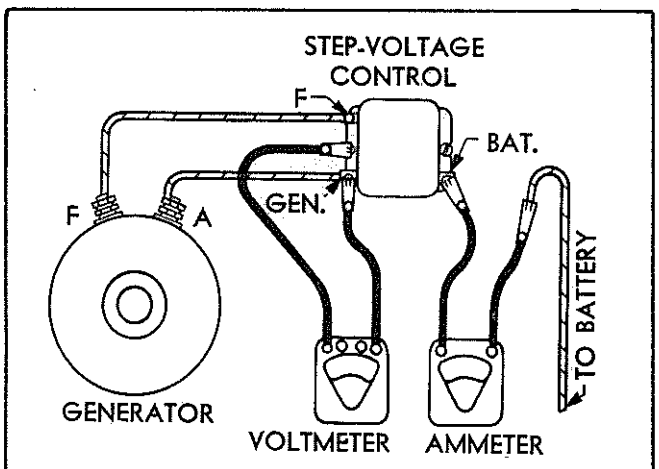


Fig. 6 — Meter Connections to Check Cut-Out Relay

Decrease the engine speed and note on the ammeter the reverse current necessary to open the points, this reading must be from 0 to 4.0 amperes. If any adjustments are necessary, disconnect the regulator, remove the cover and make the adjustments as describe under "CUT-OUT RELAY ADJUSTMENTS."

3. Cut-Out Relay Adjustments

a. AIR GAP (.020"). With the contact points held closed, check the air gap between the armature and the center of the core. To adjust, loosen the two screws at the back of the relay and raise or lower the armature as required. Tighten the screws securely after adjustment.

b. POINT OPENING (.020"). Measure the contact point gap with the points open. Adjust by bending the upper armature stop.

c. CLOSING VOLTAGE (13.2 to 14.0 volts). Connect the voltage control to the generator and batteries in the normal manner to check the relay closing voltage. Connect the voltmeter from the "GENERATOR" terminal to the voltage control base. It is not necessary to connect the ammeter into the circuit unless it is desired to measure the generator output. Gradually increase the generator speed and note the voltage at which the points close. Adjust by bending up on the spring post to increase the spring tension and raise the closing voltage. Bend down on the spring post to lower the closing voltage.

4. Step-Voltage Control Adjustments

a. CONTACT SPRING TENSION (0.5 to 1.1 oz.). The flat contact spring tension is

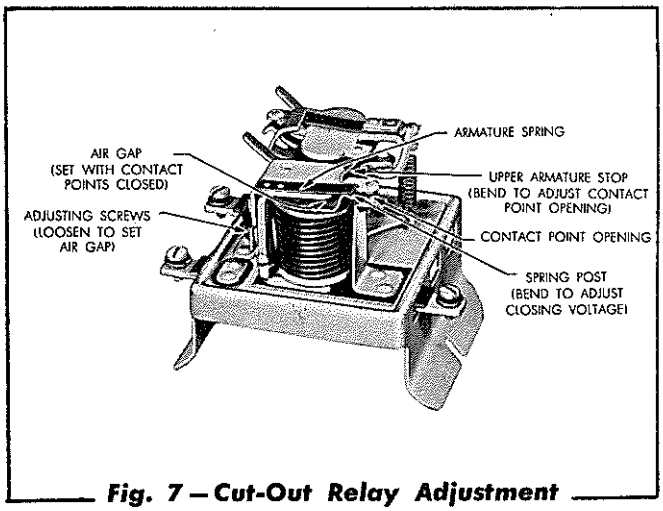


Fig. 7 — Cut-Out Relay Adjustment

measured at the contacts with the armature and the spring just separated from the upper stop. The pull required to separate the points should be carefully measured with a spring gage. Adjust the tension by slightly bending the flat spring.

Contact points which are pitted, rough, dirty, or burned may be cleaned with a stroke or two of a clean, fine-cut point file. Blow out all dust. Be careful not to bend or distort the flat armature spring.

b. AIR GAP (.033″). The air gap is measured between the center of the core and the armature with the armature held down against the lower armature stop. Bend the lower armature stop to adjust.

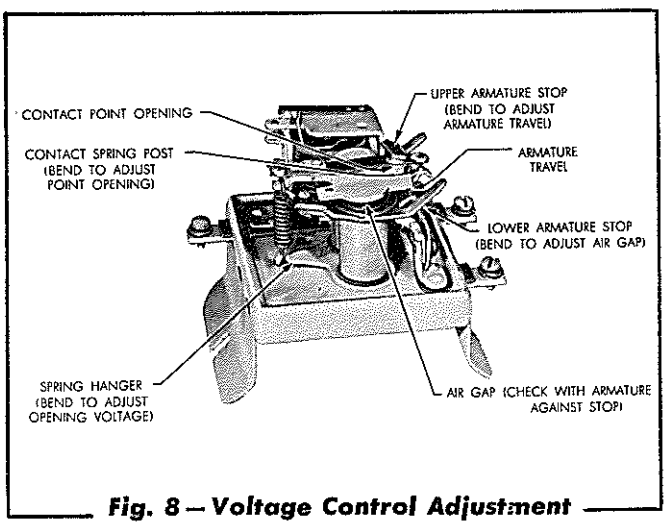


Fig. 8 — Voltage Control Adjustment

c. ARMATURE TRAVEL (.030″). Release the armature and gage the distance between the armature and the lower armature stop. Adjust by bending the upper armature stop.

d. POINT OPENING (.010″). With the armature held down against the lower armature stop, measure the contact point opening. Adjust by bending the contact spring post.

e. VOLTAGE SETTING. The opening voltage (13.5 to 14.2 with the unit hot — 180° F.) of the contact points is checked by connecting the meters and a ¼ ohm variable resistance, as illustrated in Fig. 5, to the voltage control, generator, and batteries. Increase the generator speed slowly and note the voltage at which the contact points of the voltage control unit open. The moment at which the contact points open will be indicated by a sudden drop in the charging rate as shown by the ammeter. *STEP-VOLTAGE CONTROL MUST BE AT OPERATING TEMPERATURE AND COVER MUST BE IN PLACE WHEN MAKING THIS CHECK.*

If the batteries are low, the voltage control may not operate. To obtain sufficient voltage to cause the voltage control points to open, operate the generator at medium speed and slowly cut in the resistance until the voltage control points open. Note voltage. To adjust, bend the spiral spring hanger down to increase the opening voltage setting and bend it up to lower the setting.

The closing voltage (12.2 maximum volts) is checked by reducing the generator speed or cutting out the resistance so that the voltage drops to the value at which the points close. Adjust by adjusting the air gap, as described above. Increase the air gap to raise the closing voltage, or decrease the air gap to lower the closing voltage. After adjusting the air gap, adjustment of the contact point opening may be required.

D. Generator Removal and Installation

1. **Removal**

Disconnect and tape the lead from the "BATTERY" terminal of the regulator. Remove the belt-adjusting capscrew and the two hinge bolts and lift the generator away from the engine.

2. **Installation**

Hang the generator on the mounting bracket with the two hinge bolts. Fasten the belt adjusting link to the bottom extension of the drive and frame and adjust the drive belt tension for approximately 1¼" deflection of the belt at a point half-way between the generator and fan pulleys. Attach the battery wire to the "BATTERY" terminal of the generator regulator.

INSTALLATION CAUTION: After the generator has been installed, or at any time after the leads have been disconnected and then reconnected to the generator, a jumper lead should be connected momentarily between the "BATTERY" and armature "GENERATOR" terminals of the voltage control unit before starting the engine.

This allows a momentary surge of current from the batteries to the generator which correctly polarizes the generator with respect to the batteries it is to charge.

6. STARTER

A. Description

The starter is an 8-brush, 4-pole, heavy-duty unit, with the armature suported 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 and pedal. 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. Starter Service

Field service on the starter will be limited to cleaning of the starter, cleaning and adjustment of the drive assembly, cleaning of the commutator, and replacement of the brushes, brush springs, or starter 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 an authorized United Motors Service Station, or other dependable electrical repair shop, if repair or adjustment is necessary. With fully charged batteries and normal temperatures 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, of course, 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. *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:

   a. Disconnect the battery ground cables, then 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 of 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 ⅛" 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 ¾" 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 light engine oil.

D. Starter Removal and Installation

1. Disconnect the starting motor operating rod from the starter shift lever.

2. Remove the seats and rear floor plate. Disconnect the two (2) battery ground cables and tape the loose cable ends 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 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 the tractor, consist of the engine oil pressure gage, engine temperature gage, fuel pressure gage, and the ammeter, and are mounted on the instrument panel of the cowl.

The hour meter, which may be obtained as special equipment, is mounted in the instrument panel.

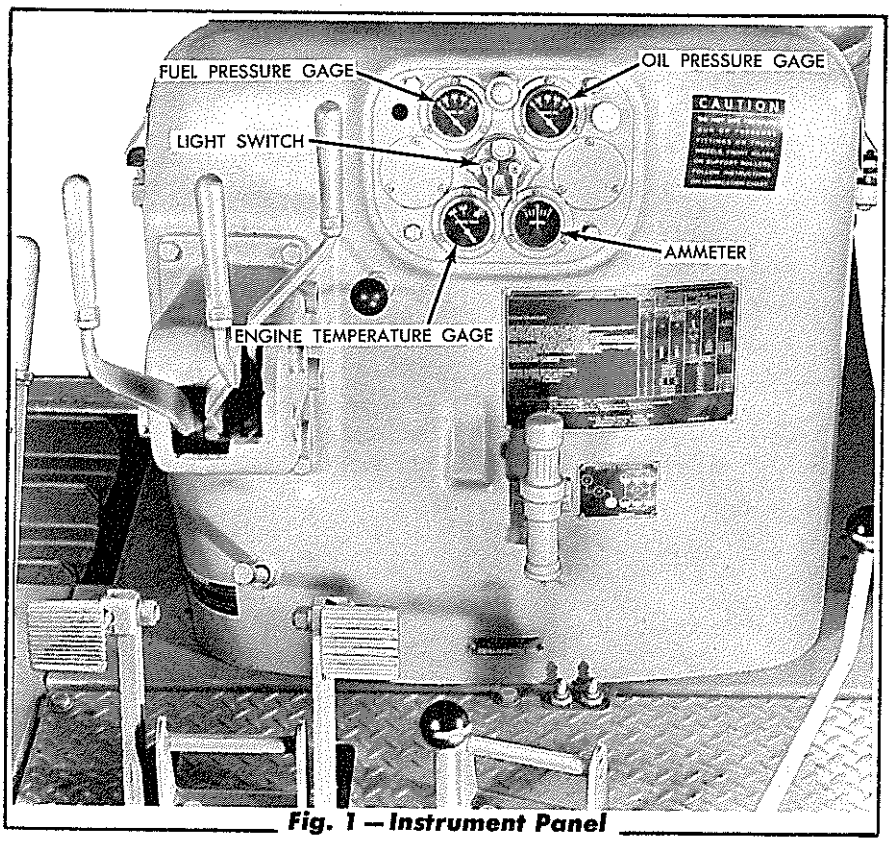


Fig. 1—Instrument Panel

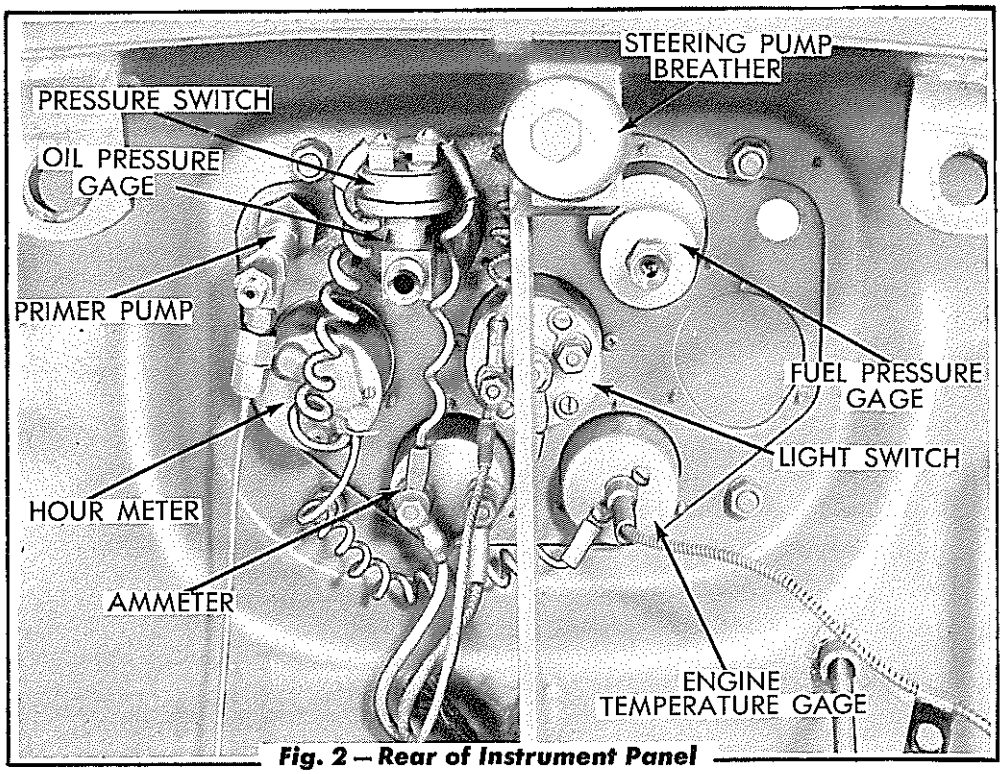


Fig. 2 — Rear of Instrument Panel

2. ENGINE OIL PRESSURE GAGE

This gage registers the pressure at which the oil is circulated through the engine. With the engine running at high idle, the engine oil pressure should be between 30 and 45 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 must 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 a bellows type thermostat 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 conected into the fuel manifold tube at the rear of the engine block.

The fuel pressure gage indicates the pressure at which the fuel oil is circulated through the fuel system. Under normal conditions, with the engine operating at full governed speed, this pressure should be 25 to 55 pounds. *DO NOT OPERATE ENGINE WITH FUEL PRESSURE ABOVE OR BELOW THIS RANGE.* Investigate for clogged filters, clogged or leaking fuel lines or connections, or improper fuel pump and pump regulator valve operation.

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, hoses, etc., to which they are connected.

Limited service on any of the instruments with the exception of the hour meter, is available at any United Motors Service Station.

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. The Diesel Principle

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.

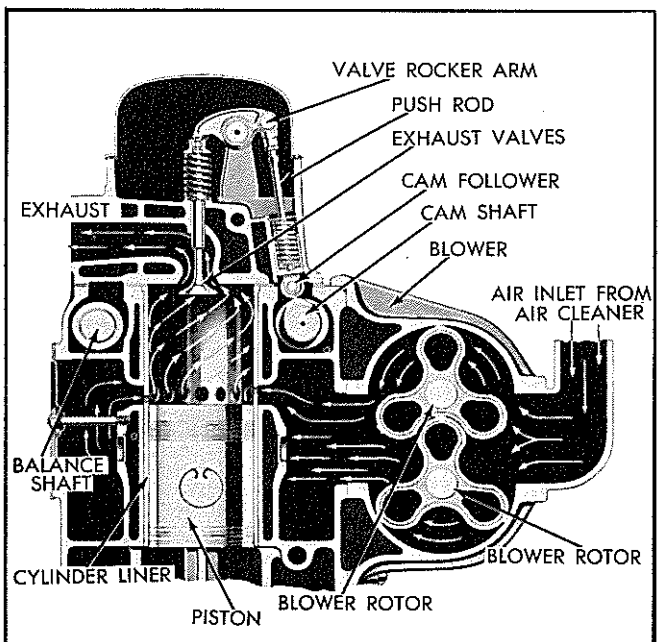


Fig. 1 — Air Flow Through Engine

The engine in the Model HD-15A Tractor is a water-cooled, 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 right 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 Fig. 1.

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 as shown in Fig. 2. The flow of air towards the exhaust valves produces 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.

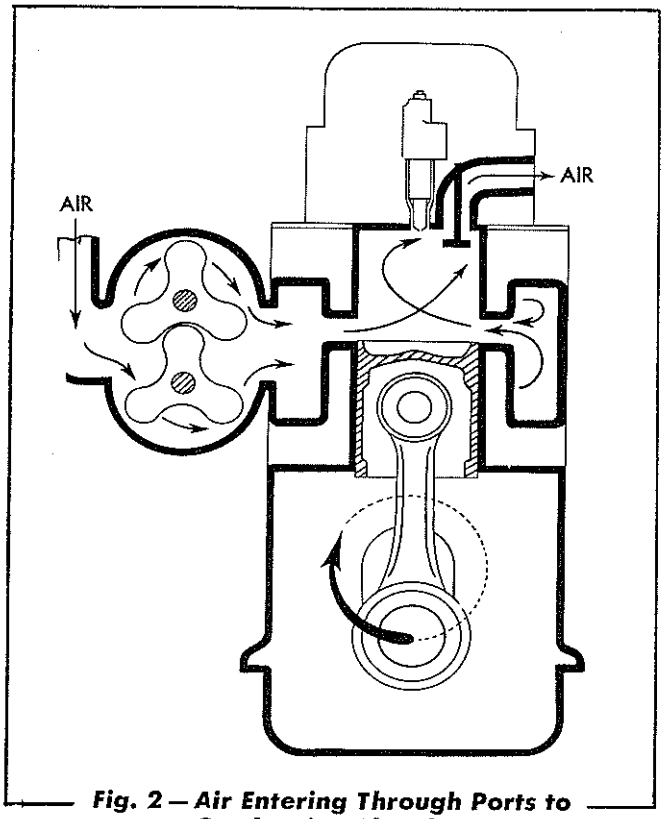


Fig. 2 — Air Entering Through Ports to Combustion Chamber

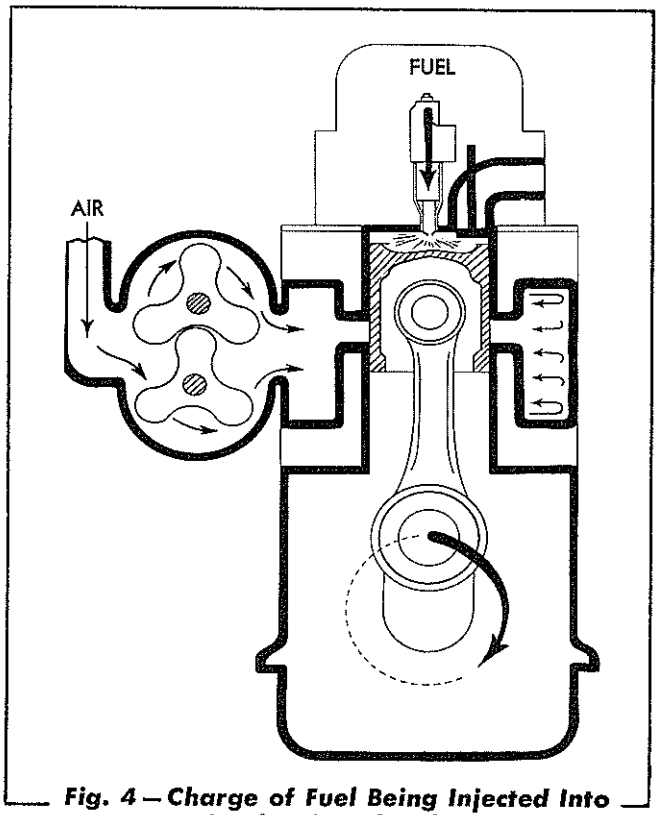


Fig. 4 — Charge of Fuel Being Injected Into Combustion Chamber

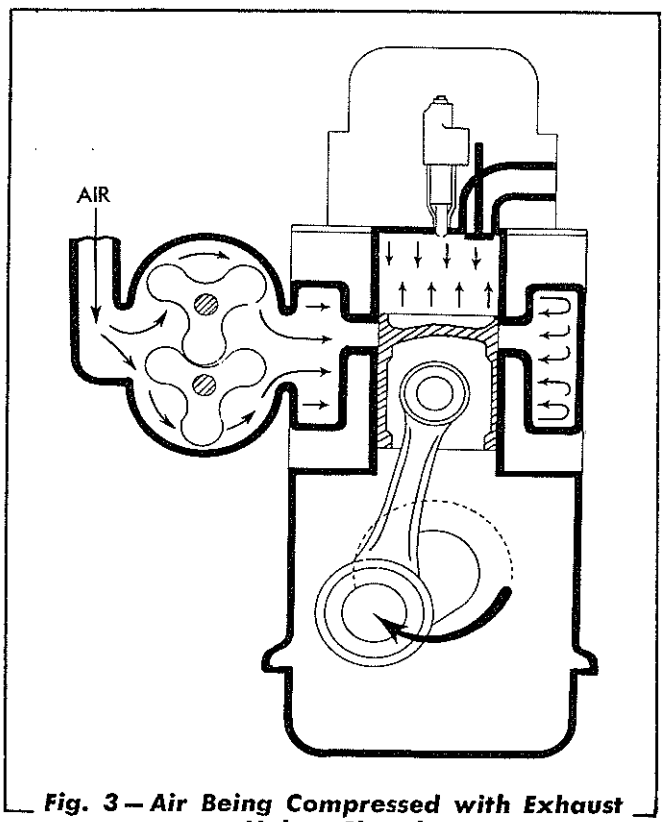


Fig. 3 — Air Being Compressed with Exhaust Valves Closed

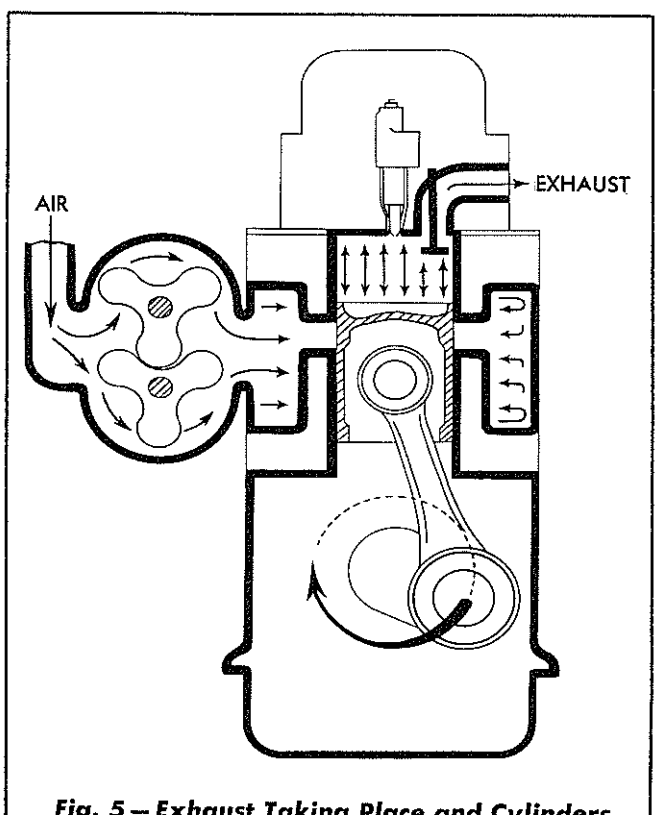


Fig. 5 — Exhaust Taking Place and Cylinders About to Be Swept with Clean Scavenging Air

3. This engine is designed for a highly efficient 16 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. 4. 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. 5, 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. 2. 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."

2. CYLINDER HEAD

A. Description

The cylinder head is a one-piece alloy iron 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 held to the upper part of the cylinder block by heat-treated alloy steel studs.

Located in the head are two exhaust valves, two valve seats, two valve guides, a fuel injector, and three rocker arms, for each cylinder. One 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 space in 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 of the exhaust muffler. The exhaust passages, exhaust valve seats, and injector seats are completely surrounded by cooling water.

To seal compression within the cylinders in tractors having engines prior to Serial No. 6A-16283, a flat laminated gasket is installed between the cylinder head and the cylinder block. A flat gasket (4 piece cork type) is used between the cylinder head and the cylinder block at the outer rim to provide an oil seal.

In tractors having engines Serial No. 6A-16283 and above, the cylinder block and cylinder head were revised to provide a metal to metal contact between the cylinder block and the cylinder head. The top of the cylinder block is recessed to retain individual compression gaskets for each cylinder and rubber seal rings for sealing the oil and the water passages.

The top of the cylinder head, containing the fuel injectors and the exhaust valve assemblies, is completely enclosed by a pressed steel valve rocker cover, which is held in place by screws fitted with hand knobs. The cover is sealed at the bottom against the top of the cylinder head by a gasket which is held in place by the flanged edge of the cover.

B. Service of Parts Contained in Cylinder Head

Service on some of the parts contained in the 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.

e. Replacement of fuel manifolds or fuel connectors.

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 engine pre-cleaners from the air cleaner tubes, then remove the engine hood.

2. Drain the engine cooling system (refer to "FILLING AND DRAINING OF SYSTEM" in Section IV). Wash all dirt off the upper part of the engine.

3. Remove the exhaust muffler.

4. Remove the engine thermo gage from the rear of the water outlet manifold.

5. Remove the yoke pin connecting the throttle operating rear rod to the throttle assembly. Remove the yoke pin connecting the engine shut-off rear rod to the engine shut-off lever.

6. Disconnect the engine primer tube from the primer elbow assembly located in the engine air inlet elbow. Unhook the upper end of the air shut-off lever spring and disconnect the engine shut-off swivel lever from the air shut-off valve lever. Remove the yoke pins connecting the rear of the throttle control front rod and the rear of the engine shut-off front rod to the intermediate levers.

7. Remove the capscrews attaching the lower end of the air inlet elbow to the blower air inlet housing. Remove the capscrews, nuts, and washers attaching the air cleaners to the front and the rear mounting brackets. Make certain that the air shut-off valve lever is in its closed position, then remove the air cleaner assemblies as a unit. Cover the opening in the blower air inlet housing.

8. Disconnect the fuel lines from the rear of the fuel manifolds located on the right side of the cylinder head.

9. Remove the four (4) capscrews attaching the outlet manifold elbow and the water by-pass tube assembly to the front of the water outlet manifold and remove the thermostat from the manifold.

10. Remove the valve rocker arm cover and the governor control housing cover, then disconnect the governor to injector control link from the governor and the injector control tube lever, and remove the link.

11. Remove the two (2) capscrews attaching the governor control shaft housing to the cylinder head. Loosen but do not remove the four (4) capscrews attaching the lower end of the governor control shaft housing to the governor weight housing.

12. Remove the two (2) capscrews that attach each front and rear mounting bracket for the air cleaners to the flywheel housing and the front balance weight cover. Remove one of the radiator shell to cowl bracing rods.

13. Remove the capscrews attaching the injector control tube brackets to the cylinder head and remove the control tube assembly.

14. Remove all the injector fuel pipe assemblies and cover the fuel openings with shipping caps. Remove the injectors from the cylinder head using an injector removing tool.

15. Remove all the cylinder head stud nuts and by means of the front and rear mounting brackets for the air cleaners, lift and remove the cylinder head from the engine.

16. If the cylinder head is to be completely stripped as for head replacement, proceed as follows: Remove the fuel manifold connector assemblies, fuel manifolds, front and rear mounting brackets for the air cleaners, water outlet manifold, exhaust muffler studs, injector clamp studs, and the exhaust valve mechanism and exhaust valves.

D. Inspection

In case of a cylinder head change, the working parts removed from the old head must be thor-

oughly inspected before installing them in a new head. The proper procedure to be followed in making the inspection and installation of the various parts will be found under "EHAUST VALVES AND OPERATING MECHANISM" in this section and in "ENGINE FUEL SYSTEM," in Section II.

E. Cylinder Head Installation

To seal compression within the cylinders in tractors having engines prior to Serial No. 6A-16283, a flat laminated gasket is installed between the cylinder head and the cylinder block. A flat gasket (4 piece cork type) is used between the cylinder head and the cylinder block at the outer rim to provide an oil seal.

In tractors having engines Serial No. 6A-16283 and above, the cylinder block and cylinder head were revised to provide metal to metal contact between the cylinder block and the cylinder head. The top of the cylinder block is recessed to retain individual compression gaskets for each cylinder and rubber seal rings for sealing the oil and water passages.

The cylinder heads used on engines Serial No. 6A-16283 and above are approximately 7/32" wider than those used on engines prior to this Serial Number. The cylinder blocks used on engines Serial No. 6A-16283 and above are approximately 1/16" higher than those used on engines prior to this Serial Number. The added 1/16" in the height to the top of the new type cylinder block is to compensate for the thickness of the gasket used with the old type cylinder blocks. Blowers and exhaust mufflers are interchangeable between the old and the new types.

The cylinder head stud holes in the new type blocks are ⅝" deeper than the stud holes in the old style blocks and are counterbored ½" instead of being countersunk. The studs used in the new type block are 6⅜" in length and those used in the old type block are 5¾" in length.

Summary:

1. The cylinder head gasket usage is entirely dependent on which cylinder block is being used. If the Engine Serial No. is 6A-16283 or above (having new type block) the new type gasket set must be used. If the Engine Serial Number is below 6A-16283 (having old type block) the old type gasket set must be used.

2. The new type cylinder heads may be used on old type blocks provided the old type gasket set is used.

3. The old type cylinder heads may be used on the new type blocks provided the new type gasket set is used.

Proceed as follows for installation:

1. On engines prior to Serial No. 6A-16283, remove all traces of the old oil gasket from the top of the cylinder block and from the bottom of the cylinder head. With both surfaces clean, install a new cylinder head compression gasket on the top of the block with the side of the gasket marked "TOP" up. Place the cylinder head oil gasket (4 piece) in position on the top of the cylinder block.

   On engines Serial No. 6A-16283 and above, remove the six (6) old compression gaskets, all the oil hole and water hole seal rings, and the large cylinder head oil seal from the cylinder block. Clean the recesses for the seal rings and the oil seal, also the surface for the compression gaskets, thoroughly. Clean the top surface of the cylinder block and the bottom surface of the cylinder head. Install a new gasket set as the old gasket should not be used again. Install six (6) compression gaskets in place on top of the cylinder liners. Install the oil hole and water hole seal rings, and the cylinder head oil gasket in position in their recesses in the top of the cylinder block.

2. Attach the air cleaner mounting brackets, without their gaskets, to the cylinder head. Install the cylinder head in place on the cylinder block, then remove the air cleaner mounting brackets from the cylinder head. Install and draw the cylinder head stud nuts down evenly, rotating from one nut to another. Tighten the nuts to a torque of 165 to 175 ft. lbs. by starting at the center nuts and working toward each end, tightening each nut a little at a time. Refer to Fig. 6.

3. Coat the gaskets for the air cleaner mounting brackets with gasket cement and place them in position, then install the front and rear air cleaner mounting brackets in place on cylinder head. Install the capscrews and lockwashers that attach brackets to the cylinder head, flywheel housing, and the balance weight cover. Tighten the capscrews to a torque of 55 to 60 ft. lbs.

4. Install the injectors in the cylinder head (refer to "INJECTOR INSTALLATION" in Section II). Install the injector fuel pipes.

5. Install the injector control tube assembly in position in the cylinder head, then install the capscrews attaching the control tube brackets to the cylinder head and tighten to a torque of 10 to 12 ft. lbs.

6. Install a new gasket between the governor control shaft housing and cylinder head, and install the two (2) attaching capscrews. Tighten the four (4) capscrews attaching the lower end of the governor control shaft housing to the governor weight housing.

7. Install the governor to injector control link, then install the governor control housing cover.

8. Connect the fuel lines to the rear of the fuel manifolds located on the right side of the cylinder head.

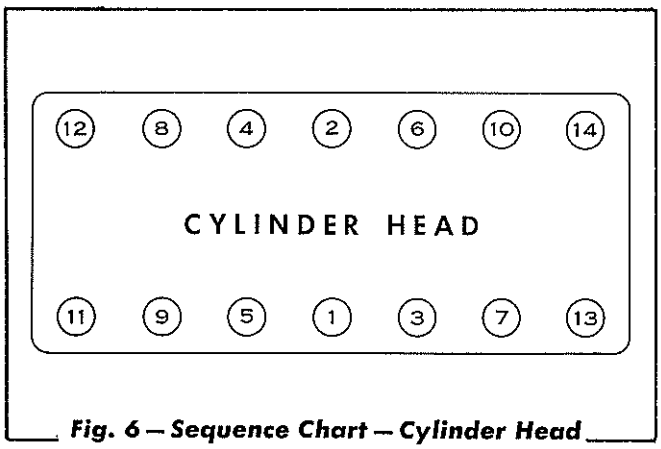


Fig. 6 — Sequence Chart — Cylinder Head Stud Nuts

9. Examine the gasket used between the blower air inlet housing and the air inlet elbow and replace it if necessary. Coat the gasket with gasket cement, then install the air cleaner assemblies in place on the mounting brackets. Install the bolts attaching the air cleaner mounting band brackets to the front and rear mounting brackets, then install the capscrews used to attach the lower end of the air inlet elbow to the blower air inlet housing. Connect the engine primer tube to the primer elbow assembly located in the engine air inlet elbow.

10. Connect the engine shut-off swivel lever to the air shut-off valve lever. Install the yoke pin and cotter pin used to connect the rear of the throttle control front rod and the rear of the engine shut-off front rod to the intermediate levers.

11. Install the yoke pin and cotter pin used to connect the throttle operating rear rod to the throttle control assembly. Install the yoke pin and cotter pin used to connect the engine shut-off rear rod to the engine shut-off lever.

12. Install the engine thermo gage in the rear of the water manifold. Install the radiator shell to cowl bracing rod.

13. Examine the gaskets used between the water outlet manifold and the upper end of the water by-pass tube and between the water outlet manifold elbow and the upper end of the water by-pass tube and replace it if necessary.

    Coat the gaskets with gasket cement, install the thermostat with the thermostatic element end towards the manifold, then install the four capscrews used to attach the elbow and the by-pass tube to the water manifold.

14. Install the exhaust muffler using new exhaust muffler gaskets.

15. Fill the engine cooling system (refer to "FILLING AND DRAINING OF SYSTEM" in Section IV).

16. 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.).

17. Start the engine and inspect the connections to be sure that there are no fuel leaks from the injector fuel pipes.

18. Examine the valve rocker arm cover gasket and replace if necessary, then install the rocker arm cover. Install the engine hood and the engine 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 seat inserts in 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 and then reamed for the desired fit. A cylindrical valve spring, made of alloy steel, is held in place by a retainer (spring cap) and a tapered two-piece lock.

Three drop-forged rocker arms are provided for each cylinder; the two outer arms operating the exhaust valves, and the center one the fuel injector as shown in Fig. 7. Each rocker arm assembly operates on a separate shaft supported by two cast-iron brackets.

The injector end of each injector rocker arm is fitted with a hardened ball stud and a ball seat which form a flexible joint. The ball seat transmits the rocker arm motion to the fuel injector. The valve end of each valve rocker arm is hardened and ground to a cylindrical surface, which bears directly on the end of the valve stem. The rocker arms are operated from the camshaft through short push rods.

Contact between the cam roller follower and the cam is made by a plain bearing that rotates on a pin which attaches the roller to the roller follower. The cam rollers are held squarely with the cam surfaces by steel follower roller guides bolted to the bottom side of the cylinder head. A separate coil spring, located inside of the hollow cam follower, is held in place in the cylinder head by a retaining washer (upper spring seat) and wire locking ring.

Oil for the valve operating mechanism is pumped through a longitudinal oil passage in the cylinder head, entering the hollow rocker arm shafts through an oil passage in the shaft bracket bolts. Excess oil from the rocker arms, returning to the oil pan, lubricates the valves, injectors, cam followers, blower gears, and the governor.

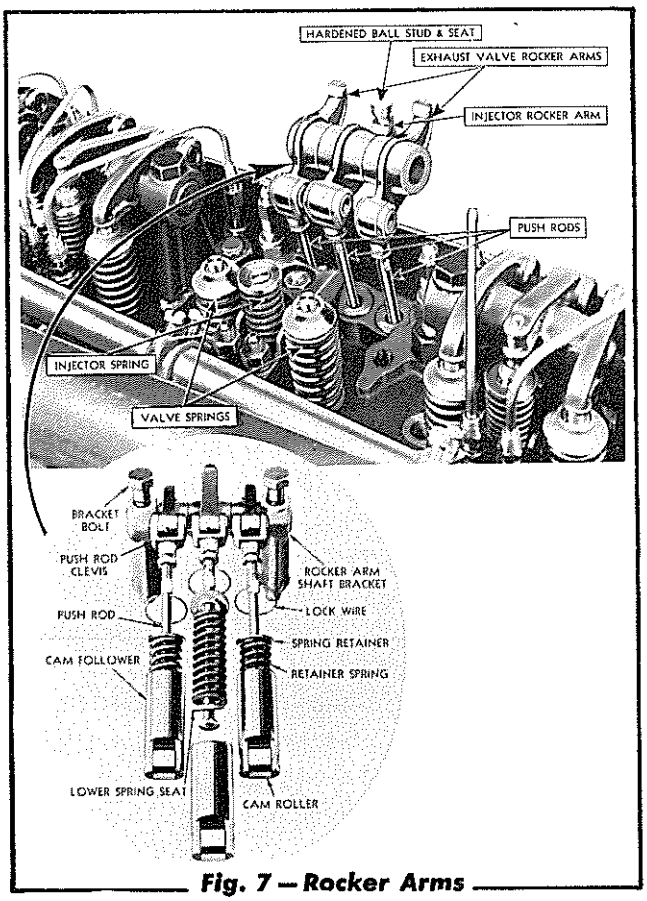


Fig. 7 — Rocker Arms

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 valve spring.

3. Removal or replacement of a rocker arm, cam follower, and follower spring.

4. Removal or replacement of a rocker arm shaft or shaft bracket and push rod.

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. Removal or replacement of a valve or a seat insert.

2. Removal or replacement of a valve guide.

3. Grinding of valves or valve seats.

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 seat inserts. Excessive valve clearance will result in 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 will then be closed and the valve rocker arms raised off the valve stems.

3. Check clearance between the valve stems and the rocker arms. When adjusted properly, a .009" thickness gage should pass between them with a slight drag when the engine is at normal operating temperature. With the engine at ambient temperature, a .012" thickness gage may be used and the valves adjusted to .012" clearance—cold.

   Adjust each valve by loosening the lock nut and turning the push rod into the push rod clevis to increase the clearance or out of the push rod clevis to decrease the clearance. When proper clearance is obtained, tighten the lock nut. Recheck the clearance to be sure it was not changed by tightening the lock nut.

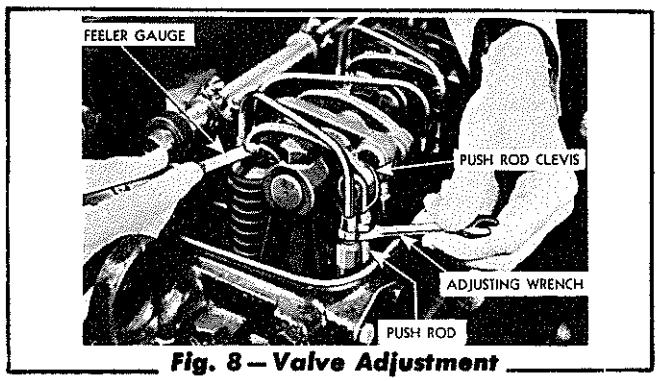


Fig. 8—Valve Adjustment

4. Rotate the engine with the starter and repeat the above operations on the valves for the other cylinders. Replace the rocker arm cover and the hood. *CAUTION: If a push rod is disconnected from a rocker arm, be sure that when it is re-installed, the clevis on the rocker arm is screwed on the upper end of the push rod until the end of the push rod is flush with the inside of the clevis yoke. Otherwise, the valves will open too far when the engine is turned, and the piston will strike the head of the valve causing damage to the valve, piston, or push rod.*

D. Rocker Arm Removal, Inspection, and Installation

1. Clean the dirt off the rocker arm cover and remove the cover. If the cylinder head is on the engine, turn the engine until the push rod ends of all three of the rocker arms for one cylinder are in line.

2. Disconnect and remove the injector fuel pipes. Place caps on the fuel connectors to prevent dirt entering the fittings.

3. Remove the two bolts from the rocker arm shaft brackets. Remove the brackets from the shaft and remove the shaft from the rocker arms.

4. Loosen the lock nuts at the upper ends of the push rods and unscrew the rocker arms from the push rods.

5. 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 the new bushings to allow .001" to .0025" clearance with the shaft. Clean out the oil holes in the rocker arms, hollow 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.

6. 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. The center (injector) rocker arm can be identified by the ball stud and ball seat. Install each valve rocker arm on the shaft with the longest boss of each toward the injector rocker arm (toward the inside of the rocker arm assembly). Place the shaft brackets on the shaft with the machined side of each bracket toward the valve rocker arms.

7. Before tightening the bolts in the rocker arm shaft brackets, hold the three rocker arms and the two brackets together so that, when the bolts are tightened, a total of .004" to .006" end clearance will be allowed between the rocker arms and the brackets. Excessive clearance between these parts will allow too much oil to emerge from between the rocker arms instead of being forced through the drilled oil passages in the rocker arms to lubricate the push rod and cam follower assemblies. Tighten the rocker arm shaft bracket bolts to a torque of 90 to 100 ft. lbs.

8. *CAUTION: After a rocker arm has been disconnected from a push rod, be sure that, when reinstalled, the clevis on the rocker arm is screwed on the upper end of the rod until the end of the rod is flush with the inside of the clevis yoke. Otherwise, the valves will open too far when the engine is turned and the piston will strike the valve, and damage to the valve, push rod, or piston will result.*

E. Removal, Inspection, and Installation of Cam Follower Assemblies

1. Remove the injector fuel pipes, the rocker arm shaft and the brackets (see "ROCKER ARM REMOVAL, INSPECTION, AND INSTALLATION"). Loosen the push rod lock nut and unscrew the rocker arm from the push rod that is to be removed.

2. Depress the follower spring by pushing down on the upper spring retainer with a screwdriver, and use another screwdriver to remove the retainer lock wire from the groove in the cylinder head above the spring retainer. Lift the push rod and spring assembly from the cylinder head. Insert a finger into the cam follower and slide the cam follower up out of the head.

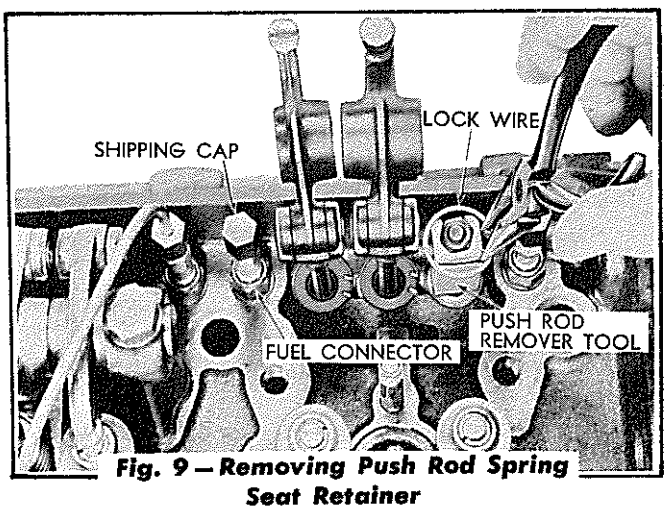


Fig. 9 – Removing Push Rod Spring Seat Retainer

3. If the cylinder head is removed, the follower assemblies may be removed from the cylinder head by unscrewing the rocker arms from the push rods, then removing the retainer screws from the cam follower guides

on the lower side of the cylinder head, and removing the complete assembly out through the bottom of the head.

4. 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.

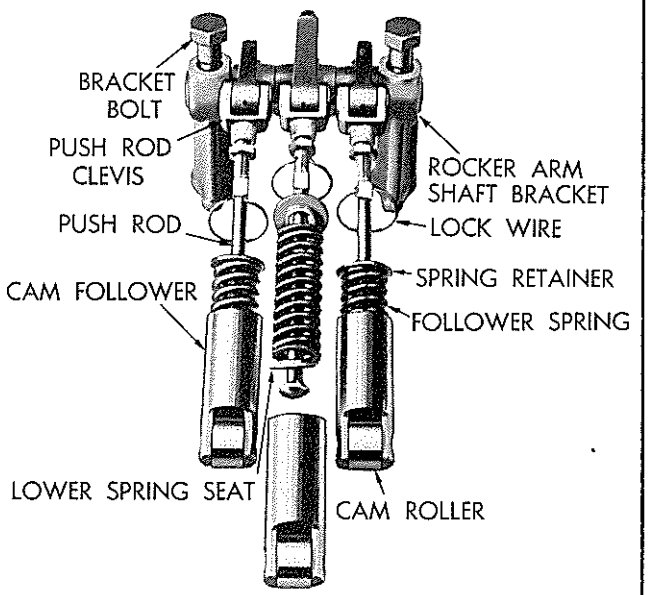


Fig. 10 — Cam Follower and Push Rod Assembly

5. 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 engine operation and, therefore, all of 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 installing the follower assemblies into the cylinder block. This will insure initial lubrication of the follower assemblies which is essential to satisfactory follower performance.*

6. When installing the cam follower and push rod assembly with the cylinder head not removed, proceed as follows:

   a. Lubricate the roller and follower. Insert the cam follower into the cylinder head (roller end down) with the oil hole in the lower end of the follower pointing away from the valves. The roller must engage the slot in the follower guide.

   b. With the retainer lock wire removed, and with the lower spring seat, follower spring, and upper spring seat installed on the push rod, insert the push rod assembly into the head and follower.

   c. Depress the follower spring with a screwdriver and install the retainer lock wire in the groove in the cylinder head above the upper spring seat.

   d. Screw the push rod lock nuts down on the push rod, then install the rocker arms and shaft as explained in "ROCKER ARM REMOVAL, INSPECTION, AND INSTALLATION."

7. When installing the cam follower and push rod assembly with the cylinder head removed, proceed as follows:

   a. Install the retainer lock wire in the groove in the cylinder head.

   b. With the spring seats and spring installed on the push rod, place the push rod assembly in the cam follower and insert the assembly up through the cylinder

head, with the oil hole in the follower toward outer side of the head.

c. Insert the retaining capscrews through the cam follower guide, then place the guide in position against the cylinder head, with the main body of the guide toward the center of the head and with the cam rollers engaged in the slots in the guide. Tighten the capscrews to a torque of 12 to 15 ft. lbs.

F. Exhaust Valve Spring Removal and Installation

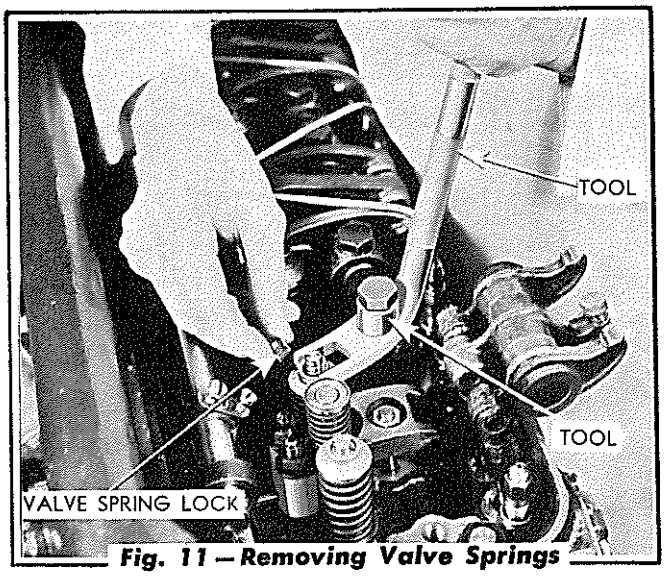


Fig. 11 — Removing Valve Springs

Removal of the cylinder head is not necessary if disassembly 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 crank the engine with the starter until the piston is at the top of its stroke, which is indicated when the injector rocker arm is down (injector plunger at the bottom of its stroke).

2. Disconnect and remove the injector fuel pipes. Install the caps on the fittings to prevent entrance of dirt.

3. Remove the two bolts from the rocker arm shaft brackets, and remove the brackets and the shaft.

4. Insert one of the bracket bolts through the valve lifter bushing and the valve spring compressor tool as shown in Fig. 11, and insert the bolt into the tapped hole of the cylinder head nearest the valve spring to be removed.

5. Depress the valve spring and remove the valve spring locks. Lift the spring cap, spring, and spring seat from the valve and valve guide.

6. Inspect the spring, cap, and seats for wear or damage. Replace any worn parts. The valve spring when compressed to a length of 2-3/16" should have an approximate load of 44 lbs. When the spring is compressed to a length of 1-51/64" it should have a load of 140 lbs. (plus or minus 4½ lbs.). Replace the spring when it has a loading of less than 122 lbs. when compressed to a length of 1-51/64."

7. Install the spring by reversing the sequence of operations for its removal. Refer to "ROCKER ARM REMOVAL, INSPECTION, AND INSTALLATION" to install the rocker arms. Adjust the valve lash and check for fuel leaks from the injector fuel pipe connections after starting the engine.

G. 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 same order.

3. Clean the carbon from the valve and seat inserts and ream the carbon from the valve

guides with a valve guide cleaner.

4. Replace the valves if they are bent or worn. the valve stem diameter is from .3415" to .3425"; the clearance of the stem in the guide is from .002" to .004" and should not exceed .006".

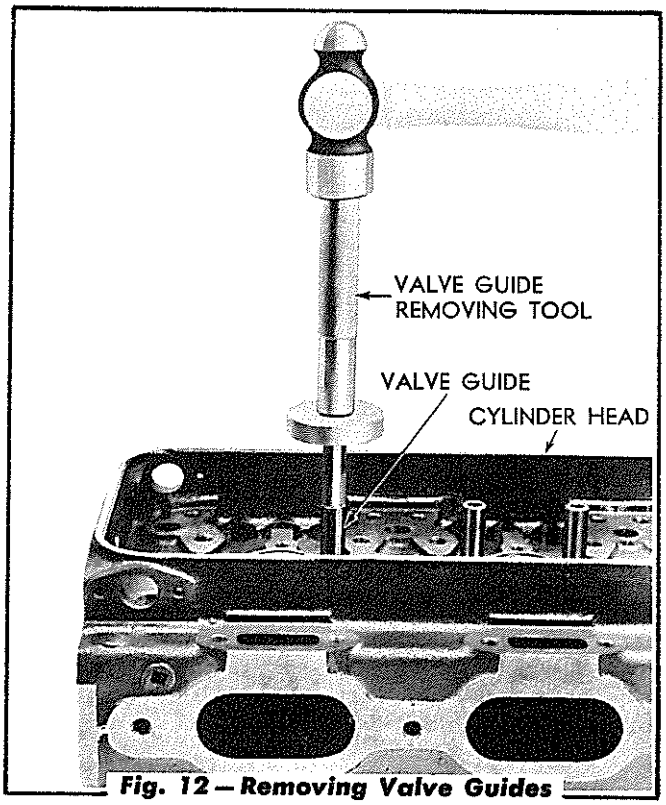


Fig. 12 — Removing Valve Guides

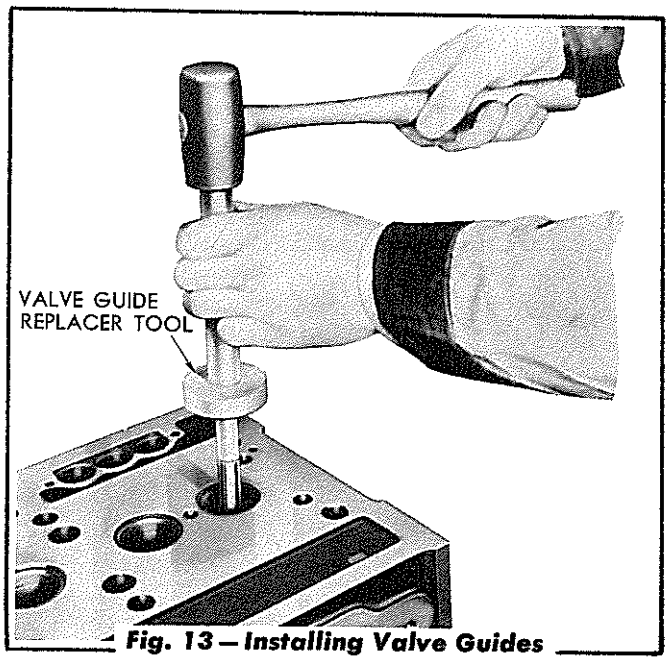


Fig. 13 — Installing Valve Guides

5. Remove the guides by driving them out from the top of the cylinder head with the special valve guide tool shown in Fig. 12.

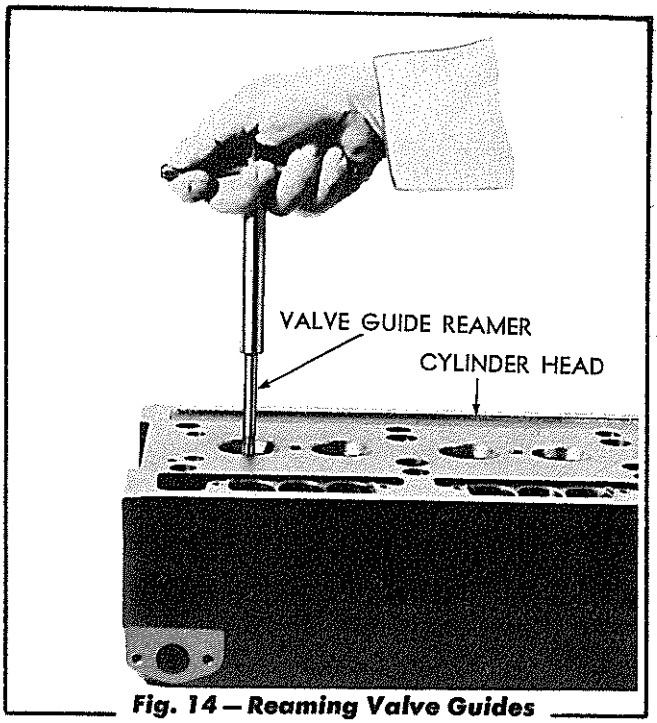


Fig. 14 — Reaming Valve Guides

New guides are installed by placing the machined collar on the tool, and driving each guide into the head from the bottom until the collar is against the surface of the head. This will locate the guides for proper height (flush with the top edges of the head).

6. After the valve guides have been installed, insert the valve stems into the guides to check for the proper clearance of .002" to .004" between the stems and the guides. If the clearance is less than .002", the guides must be reamed to size by use of the reamer as shown in Fig. 14.

7. Inspect the valve seat inserts. If they are loose, cracked, or pitted, new ones should be installed. The seat inserts are hardened and shrunk into the cylinder head. In order not to damage the head, they must be removed with a special tool provided for that purpose; also, unless the new seat inserts are installed with care, and according to the following instructions, the results will be unsatisfactory.

8. Remove the inserts as follows:

   a. Lay the cylinder head on a bench and insert the collet of the remover tool inside of the valve seat insert so that the lip at the bottom of the collet flange is flush with the bottom side of the valve seat

insert. While holding the collet in this position, expand the collet by turning the nut at the top of the tool. Be sure that the flange of the collet is firmly entered just below valve seat insert.

b. Slide the tool body over the top of the collet, with the "Allen" screw of the body in line with the slot below the threads on the collet. Turn the "Allen" screw IN to engage the slot and lock the screw on the collet.

c. Put the thrust bearing over the top of the collet and on top of the body.

d. Start the screw thread of the tool head on the collet and continue to turn it until the valve seat insert is pulled from the cylinder head.

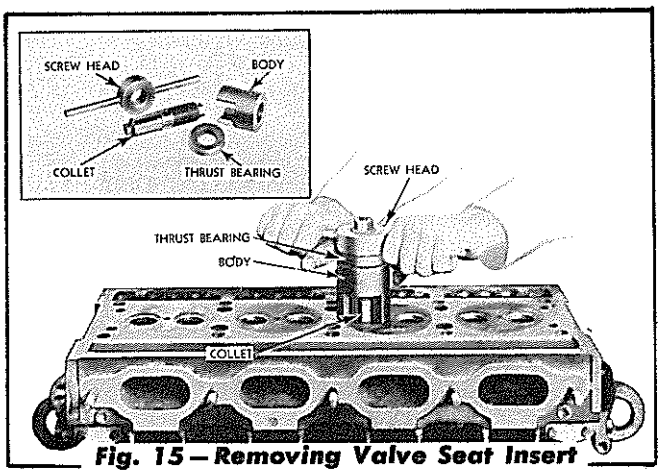


Fig. 15—Removing Valve Seat Insert

9. Particular care must be exercised when replacing the valve seat inserts. The seat inserts are installed into the cylinder head with a .0025" to .005" press fit, and must be started in place "true" with the counterbore in the head.

IMPORTANT: REFER TO "VALVE AND VALVE SEAT GRINDING" IN THIS SECTION, TO DETERMINE THE PROPER VALVE SEAT INSERT TO BE INSTALLED IN THE CYLINDER HEAD.

To install the valve seat inserts, proceed as follows:

a. See that the cylinder head is perfectly clean, particularly the counterbore for the seat inserts.

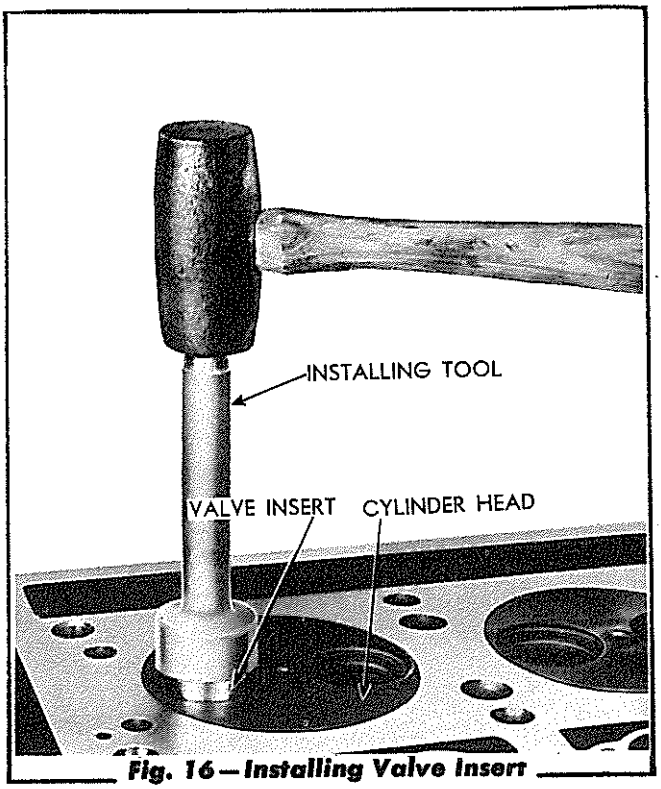


Fig. 16—Installing Valve Insert

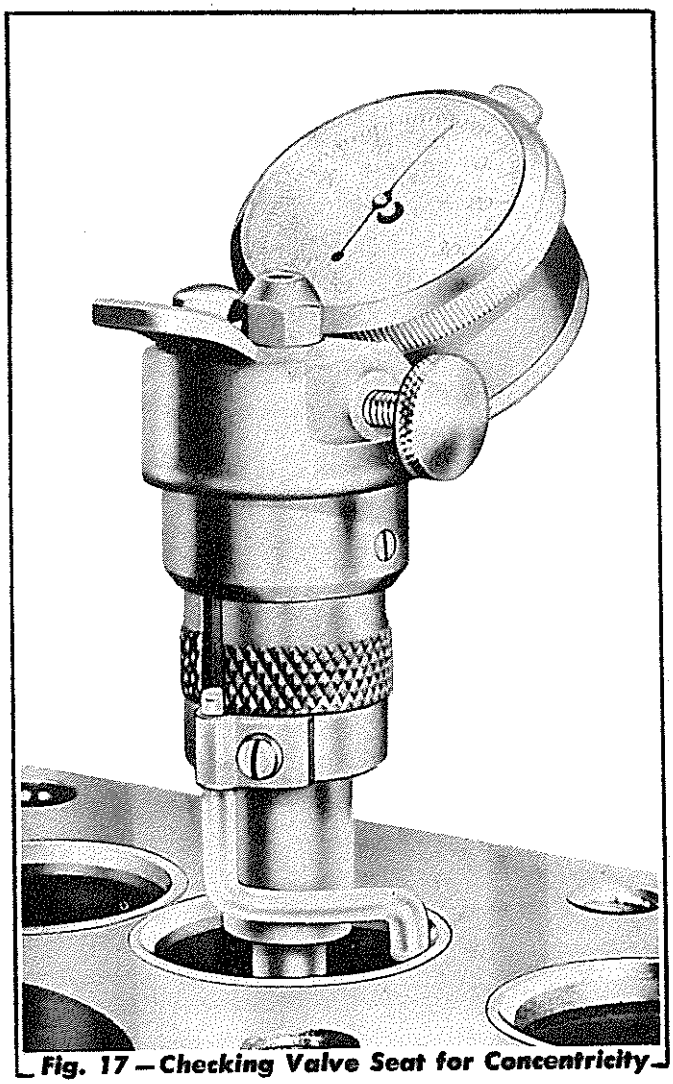


Fig. 17—Checking Valve Seat for Concentricity

b. Immerse the cylinder head for approximately 30 minutes in water heated to boiling temperature, 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 seat insert counterbores with air, and lay a seat insert in the counterbore (valve side up).

d. Using the valve seat insert installing tool, shown in Fig. 16, insert the pilot end of the tool into the valve guide and drive the seat 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 (see Fig. 17) and, if necessary, recondition the seat or seats as directed in "VALVE AND VALVE SEAT GRINDING" in this section.

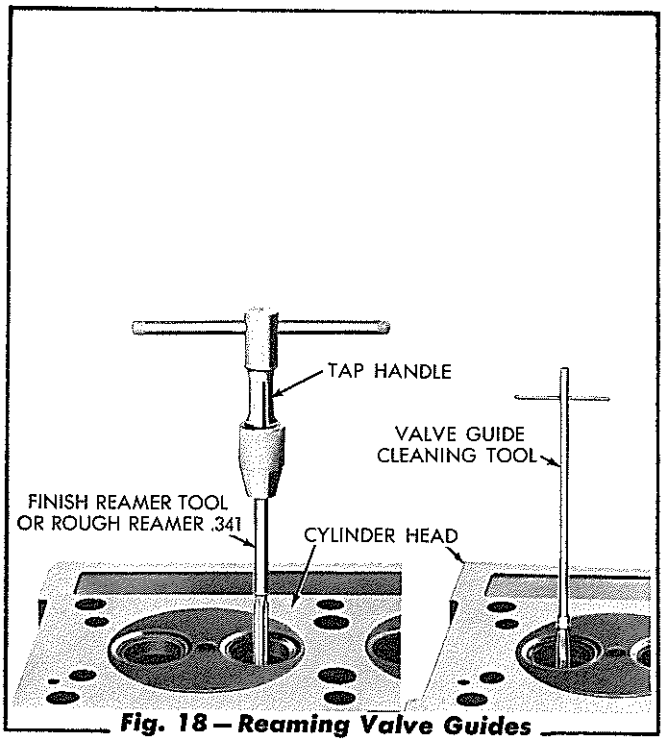


Fig. 18 — Reaming Valve Guides

H. Valve and Valve Seat Grinding

In tractors having Engine Serial No. 6A-16283 and above, the cylinder block and the cylinder head were revised to provide "metal to metal" contact between the cylinder block and the cylinder head. The new type cylinder head is approximately 7/32" wider than the cylinder head used previous to this Serial Number. In conjunction with this cylinder head and block change, a new type cylinder head to block gasket set was included (refer to "CYLINDER HEAD INSTALLATION" in this Section).

The new type cylinder head is equipped with 30° exhaust valves and valve seat inserts, whereas, 45° exhaust valves and valve seat inserts are used in the previous type cylinder head (used on engines prior to Serial No. 6A-16283). This change affects only the exhaust valve and valve seat insert; the valve guide, valve spring, caps, and the locks were not changed.

The 30° valve seat inserts are approximately .042" thinner than the 45° seat inserts, and the counterbore for the seat inserts in the new type head is approximately .042" less. The valve head of the 30° exhaust valve in the new cylinder head may protrude a maximum of .014" past the cylinder head fire deck (bottom flat surface of the head) or it may set in the fire deck a maximum of .005". The 45° valve head used in the former cylinder head may protrude .017" or set in .004" from the flat surface of the cylinder head fire deck.

The new type 30° exhaust valve and 30° valve seat insert may be used in the former type cylinder head. The 30° valve head, when installed in the former cylinder head, may protrude a maximum of .017" past the fire deck or set in a maximum of .004" below the cylinder head fire deck (same as the former 45° valve installed in the former cylinder head). When the 30° valve insert is installed in the former type cylinder head, the seat insert will not extend to the edge of the countersink in the counterbore for the seat insert. Under these conditions, a standard width 30° grinding stone might strike the edge of the cylinder head countersink, thus removing some of the metal from the head. This will not injure the head in any way, but will increase the amount of time required to grind the valve seats. To eliminate the necessity of grinding away part of the countersink in the head, the 30° grinding stone diameter may be reduced, thus reducing the amount it cuts into the head.

NOTE: DO NOT INSTALL THE 45° EXHAUST VALVE AND 45° VALVE SEAT INSERT IN THE

NEW TYPE CYLINDER HEAD. The 45° valve seat insert is .042" thicker than the 30° valve seat insert, therefore the valve seat insert, being .042" thicker than the depth of the counterbore in the new type cylinder head, would protrude from the counterbore and would be subject to burning out very rapidly.

Summary

1. The 30° exhaust valves and 30° seat inserts may be used in *EITHER* the *NEW TYPE* or the *FORMER TYPE* cylinder heads.

2. The 45° exhaust valves and 45° seat inserts may be used *ONLY* in the *FORMER* type cylinder head.

Before installing either a new or used exhaust valve, the valve seat insert in the cylinder head should be examined for proper valve seating. Furthermore, if an exhaust valve once used is to be installed again, the valve stem should be cleaned and the seat ground to the recommended angle (30° or 45°, depending on whether it is the new type or the former type valve as described above). The valve guide should be thoroughly cleaned with the valve guide cleaner tool. If the bore in the valve guide is worn oblong, or if the valve heads are warped relative to the valve stem, the parts must be replaced.

The width of the valve seats of the new type 30° exhaust valves and seat inserts must be between 1/16" and 3/32" regardless of which type cylinder head is used.

The width of the valve seats of the former 45° exhaust valves and seat inserts must be between 5/64" and 7/64".

When new valve inserts are installed, or used inserts refaced, the work must be done with a valve seat grinding set. The ordinary method of grinding valve seats is ineffective for this operation because of the very hard valve insert material.

The usual equipment furnished with the valve grinder set includes the following items:

1. Valve seat grinder.
2. Dial gage.
3. Pilot.
4. Four grinding wheels—30°-45°-60°-and 70°.

When refacing the new type 30° valve seat, use a 30° grinding wheel for refacing the valve seat and a 70° grinding wheel for opening the throat of the insert below the valve seat and for narrowing the seat to the recommended seat width of 1/16" to 3/32".

When refacing the former type 45° valve seat, use a 45° grinding wheel for refacing the valve seat and the 30° and 60° wheels for narrowing the seat to the recommended width of 5/64" to 7/64".

After the valve seats have been dressed with the grinding wheel, the dial gage, shown in Fig. 17, 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: All the valve seat inserts must be ground so that the width of the seat falls within the recommended width of 1/16" to 3/32" for the new type 30° seat valves, and 5/64" to 7/64" for the former 45° seat valves. Also, it may be necessary to grind the seats of the inserts to prevent the valve head from extending too far from the face of the cylinder head (fire deck) as explained above.

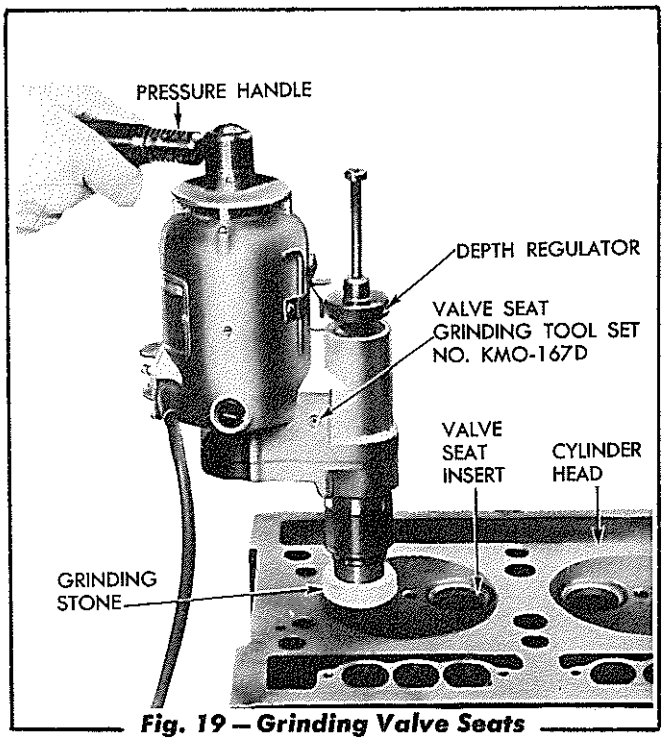


Fig. 19—Grinding Valve Seats

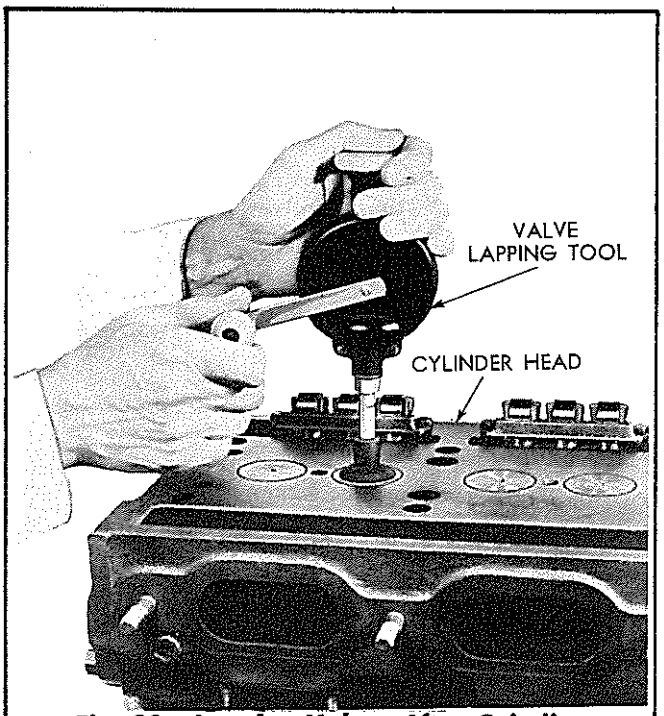


Fig. 20—Lapping Valves After Grinding

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.

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. 20. 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 manual.

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 of the block opposite 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. Even temperature and minimum distortion are assured by water cooling each liner over its entire length 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, ⅝" in diameter, are drilled into the circumference of each liner as shown in Fig. 21.

In order to obtain proper sealing of the individual compression gaskets, and still maintain the "metal-to-metal" contact between the top of the cylinder block and the bottom of the cylinder head, in tractors having Engine Serial No. 6A-16283 and above (having the new type cylinder block), the top surface of the cylinder liner flange must be .046" to .050" *below* the top flat surface of the cylinder block. In addition, the distance from the top of the cylinder block must not exceed .002" on any two adjacent cylinders. If upon inspection, the top surface of any cylinder liner flange does not fall within the .046" to .050", or the difference between any two adjacent liners exceeds .002", the neces-

Fig. 21 — Cylinder Liner

sary cylinder liner shims must be installed between the bottom of the cylinder liner flange and the top of the cylinder liner supporting insert. The shims are available in two sizes; .0015" and .003" thick.

In order to obtain proper sealing of the cylinder head compression gasket in tractors having engines prior to Serial Number 6A-16283 (having the former type cylinder block), the top surface of the cylinder liner flange must protrude .002" to .006" *above* the top flat surface of the cylinder block. In addition, the difference in protrusion between any two adjacent cylinder liners should not exceed .002". If upon inspection, the top surface of any cylinder liner flange is not .002" to .006" above the top flat surface of the cylinder block, or the difference between any two adjacent liners exceeds .002", the necessary cylinder liner shims must be installed between the bottom of the cylinder liner flange and the shoulder in the cylinder block. (Cylinder liner inserts are not used in engines prior to Serial Number 6A-16283.)

The shims are available in two sizes; .0015" and .003" thick. If the engine is being overhauled, the shim can be installed by merely slipping it over the bottom of the cylinder liner. However, to facilitate the installation of the shim and to minimize the time required for its installation when only the cylinder head is removed from the engine, it is recommended that the shim be cut so that it can be inserted under the cylinder liner flange without completely removing the cylinder liner from the cylinder block. Before installing the shim, make sure that its surfaces are smooth and entirely free from burrs and wrinkles.

When only the cylinder head is removed, it is desirable to raise the cylinder liner only enough to permit the installation of the liner shim under the cylinder liner flange.

B. Cylinder Liner Service

The cylinder liners will render satisfactory service 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 "AIR INTAKE SYSTEM," in 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 cylinder liner.

An alternate method of cleaning the cylinder liner ports is to soak the cylinder 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 cylinder liners will, in most cases, slide out of the block when the pistons are removed. Cylinder 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.

D. Cylinder Liner Cleaning and Inspection

1. Remove all dirt, carbon, or grease from the cylinder liners and the liner bores in the cylinder block. Discard the cylinder liners if they are scored, cracked, or worn beyond the allowable limits. Slightly scuffed cylinder liners, if not worn, may sometimes be made usable by polishing or lapping to remove the surface irregularities. Clean the cylinder liner 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 inside of the cylinder liners can result in the early failure of an engine.

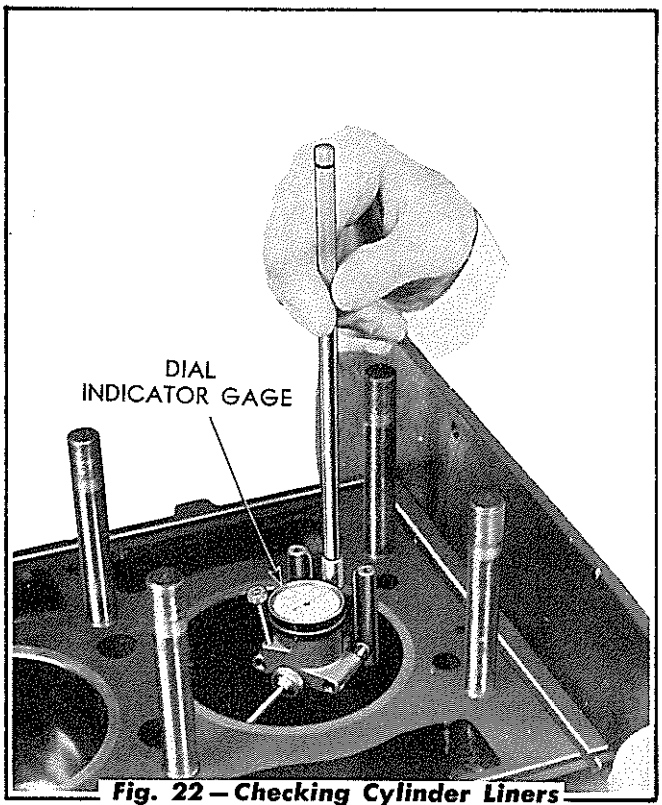


Fig. 22 — Checking Cylinder Liners for Roundness

2. Check the cylinder liners for roundness, taper, and the amount of wear by means of a gage similar to the one shown in Fig. 22. Measure each cylinder liner as outlined in the diagram in Fig. 23. Do not install cylinder liners that have more than .0015" taper or that are more than .0015" out of round when installed. Be sure that the cylinder liners slide into the cylinder block bores freely to insure a loose fit. If 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.

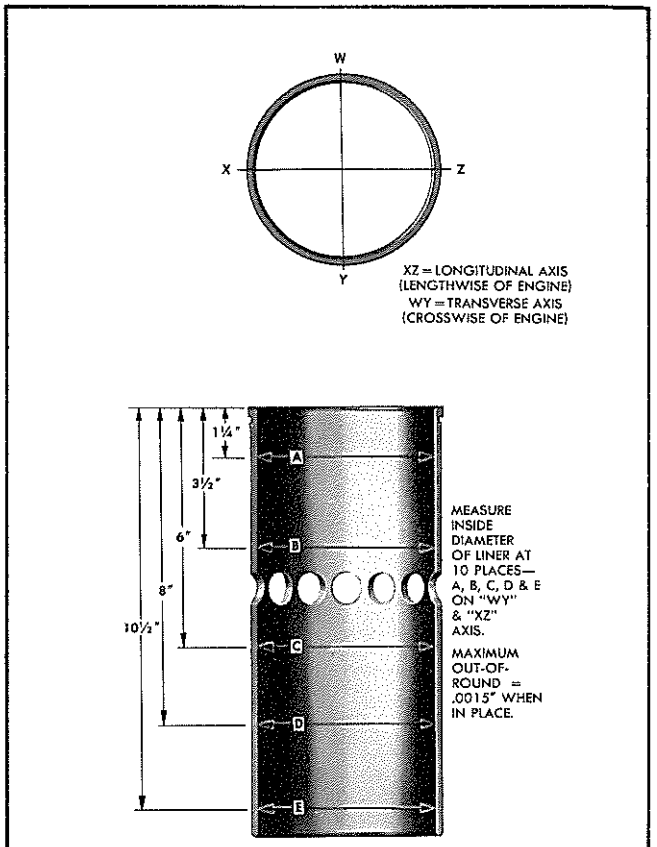


Fig. 23 — Measuring Cylinder Liners

3. Measure the new cylinder liners after they are installed, in the manner described above. Due to their thin walls, it is possible for the cylinder 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 cylinder liners.

E. Cylinder Liner Installation

1. Clean the cylinder liner and the bore in the cylinder block thoroughly and make sure that the bottom surface of the cylinder liner flange and the counterbore in the cylinder block are clean and not damaged.

   On tractors having Engine Serial No. 6A-16283 and above, examine the cylinder liner supporting insert that is used in the counterbore of the cylinder block beneath the flange of the liner. Be sure that all surfaces of the insert are clean, flat, and smooth so that the insert rests perfectly in the counterbore and will allow the cylinder liner to

slide freely through when the cylinder liner is installed. *NOTE: This cylinder liner supporting insert is not used in tractors having engines prior to Serial No. 6A-16283. In these engines, the cylinder liner flange rests directly on the flat surface of the counterbore in the cylinder block.*

2. Keeping the above information in mind, install the cylinder liner supportng insert in position in the counterbore of the cylinder block if the engine is of the serial number requiring the insert. Insert the cylinder liner in position and check the locaton of the top of the cylinder liner flange in relation to the top flat surface of the cylinder block. In tractors having Engine Serial No. 6A-16283, and above, the top surface of the cylinder liner flange must be .046" to .050" *below* the top surface of the cylinder block and the difference between any two adjacent cylinder liners should not exceed .002".

   In tractors having engines prior to Serial No. 6A-16283, the top surface of the cylinder liner flange must be .002" to .006" *above* the top flat surface of the cylinder block and the difference between any two adjacent cylinder liners should not exceed .002".

   CAUTION: These dimensions must be held in order to obtain proper sealing of the gasket set, between the cylinder head and the cylinder block, when the cylinder head is tightened in place.

3. In tractors having Engine Serial No. 6A-16283 and above, if the top surface of any cylinder liner flange is not .046" to .050" below the top surface of the cylinder block, or the difference between any two adjacent cylinder liners exceeds .002", the necessary cylinder liner shims must be installed between the bottom of the cylinder liner flange and the top of the cylinder liner insert. The shims are available in two sizes; .0015" and .003" thick.

   In tractors having engines prior to Serial No. 6A-16283, if the top surface of any cylinder liner flange is not .002" to .006" above the top flat surface of the cylinder block, or the difference between any two adjacent liners exceeds .002", the necessary cylinder liner shims must be installed between the bottom of the cylinder liner flange and the shoulder in the cylinder block. The shims are available in two sizes; .0015" and .003" thick.

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 cylinder block and it has been thoroughly cleaned with live steam or a suitable solvent and dried with compressed air.

Inspect the entire cylinder block for cracks or damage. If the cylinder liners are not to be changed and are left in the cylinder block, clean all the air ports in the cylinder liners as explained in "AIR INTAKE SYSTEM," in 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 cylinder block with clean water under pressure to remove all traces of the solvent.

To clean the water jacket of the cylinder block, remove the plugs from the jacket. Apply high pressure steam and water through these openings; turn the block in various positions while this is being done so that the loose scale will be washed out.

IMPORTANT: Note the location of the plugs removed for cleaning of the oil and water passages in the cylinder block and be sure 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 insure 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

Three (3) 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. One drain tube is located approximately in the center on the left hand side of cylinder block; the other two tubes are located on the right hand side at the front and rear 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.

5. CRANKSHAFT, FLYWHEEL, AND MAIN BEARINGS

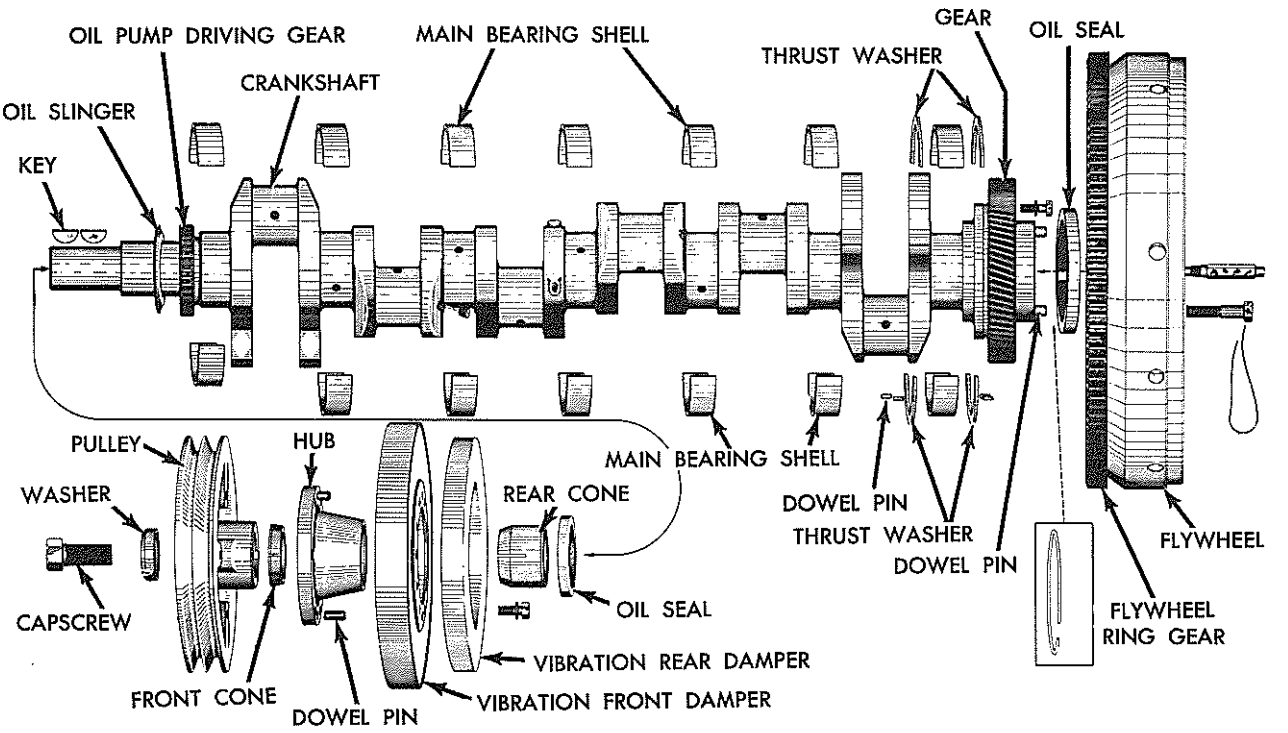


Fig. 24 -- Crankshaft and Flywheel Details

A. Description

1. CRANKSHAFT. The rigid crankshaft is a high alloy steel drop forging, carefully heat treated to insure utmost strength and durability. All the main and connecting rod bearing journals are hardened and ground to a smooth finish. 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.

   A lubricating oiling wick and wick holder is installed in the rear of the crankshaft for lubricating the engine clutch shaft front bearing (pilot bearing).

2. MAIN BEARINGS. Seven main (crankshaft) bearings are used in the engine. The bearings are 3½" in diameter x 1-3/16" long and are of the precision type, replaceable without machining. The main bearing caps are attached to the crankcase and line bored in position to receive the precision bearing

shells. Each bearing cap is numbered and when removed should always be replaced in its respective position and with the numbers of the bearing caps located towards the blower side of the engine.

The upper halves of the main bearing shells are seated in the lower part of the cylinder block. The lower halves are held in place by the main bearing caps, each of which is attached to the crankcase by two special bolts. 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. Each bearing cap is locked from sidewise movement by a line-to-line fit between the bearing cap and bolt.

A spring loaded, lip type oil seal, placed in the bore of the flywheel housing at the rear, is used to seal the crankcase oil from the flywheel compartment. The sealing lip of the seal is held against the crankshaft journal by a coil spring to prevent oil from creeping along the crankshaft journal into the flywheel compartment.

A spring loaded, lip type oil seal is also used used at the front main bearing. This seal is pressed into the crankshaft front cover; and the lip of the seal bears against a removable sleeve (vibration damper rear cone) on the end of the crankshaft, next to the driving gear for the oil pump.

3. FLYWHEEL. The even torque of the engine permits the use of a relatively light, cast iron flywheel, which ensures 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 offset and the flywheel can be attached to the crankshaft flange in only one position. A starter ring gear made from heat-treated steel is shrunk on the rim of the flywheel.

The engine clutch shaft front ball bearing (clutch shaft pilot bearing), located in the center of the flywheel, is lubricated by crankcase oil through an oil wick and holder assembly installed in the rear of the crankshaft.

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 sign 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, do not discard the crankshaft. An oil seal spacer is available and may be installed in front of the oil seal to change the contact position of the seal lip on the crankshaft.

   If the surface of the crankshaft is found to be badly worn and scored at the location of contact with the rear oil seal so that the use of the oil seal spacer will not present a smooth contact surface for the seal lip, a special sleeve is available and may be installed on the crankshaft to provide a new seal surface. When the sleeve is installed on the crankshaft, an oil seal having a larger I.D. (for a 4-13/16" shaft diameter) is available and must be installed instead of the oil seal having an I.D. for a 4-11/16" shaft diameter previously used.

4. Measure the crankshaft 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 3.499" to 3.500"; the connecting rod journals are 2.749" to 2.750".

5. All main and connecting rod bearing surfaces of the crankshaft are hardened to a depth of approximately .0625". If regrinding of the crankshaft becomes necessary, the work should be done by a reputable machine shop that has suitable equipment to handle precision work of this type. Main bearing inserts and connecting rod bearing inserts of .002", .010", .020", and .030" undersize are available, and if the crankshaft is ground, the diameter of the journals should be reduced in steps of .010", .020", or .030" below 3.500" to fit the undersize main bearing shells, and below 2.750" to fit the undersize connecting rod 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 .002" to .003" in a new engine. New

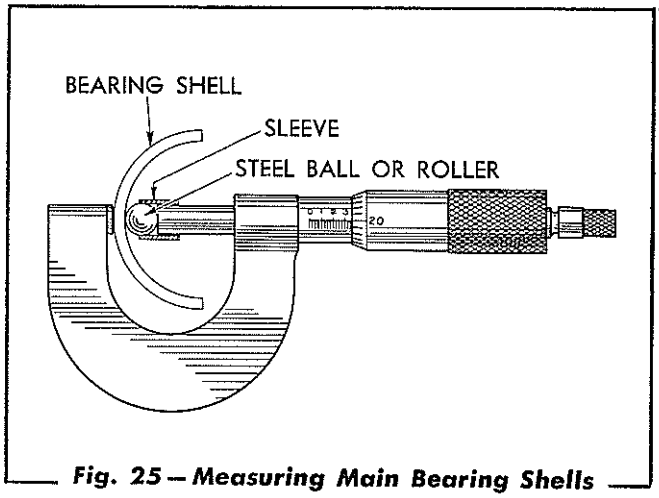


Fig. 25 — Measuring Main Bearing Shells

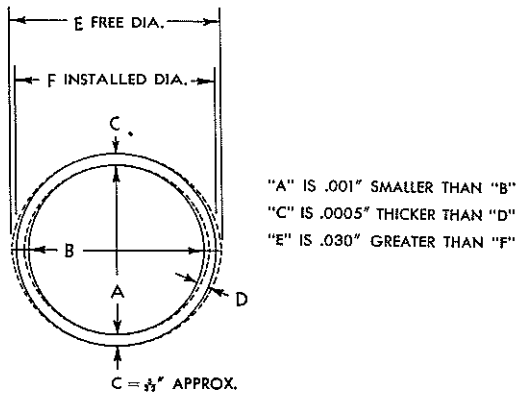


Fig. 26 — Measuring Inside Diameter of Main Bearing Shell

bearing shells must be installed when this clearance exceeds .006". The amount of wear on the bearing shells may be determined by measuring each shell with micrometers as shown in Fig. 25. New shells, measured at the point shown (C, in Fig. 26) are .155" thick, and any variation from .155" will show the amount of wear on the particular shell being measured. Those less than .153" are worn beyond the allowable limits and must be replaced.

3. As will be seen from Fig. 26, the bearing shells (when in place) are .001" larger in diameter at the parting line than they are 90° from the parting line. The 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 2 halves of the shells have a squeeze fit in the seat and cap, and must be tight when the cap is drawn down.

Tighten each cap to a torque of 180 to 190 ft. lbs. using 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 shells and the crank journals. Remove the lead shims and measure them for thickness; the clearance between the shells and the journals should be from .002" to .006".

5. Check the end thrust of the crankshaft, which is taken on the rear main bearing. The minimum end play is .004" and should not exceed .018"; replace the thrust washers if the play exceeds .018".

   Thrust washers of .005" oversize (thickness) are also available.

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. Replacement of Engine Clutch Shaft Pilot Bearing Oiling Wick

If the pilot bearing in the flywheel shows lack of lubrication or if the wick has allowed too much oil to pass through (which can be determined by inspecting the engine clutch compartment for oil accumulation due to the wick allowing too much oil to pass through), a new oiling wick must be installed.

Turn the wick holder out of the flywheel, pull the wick out of the flywheel, and remove it from the holder.

Install the oiling wick as follows:

1. Coat the threads of the wick holder with a sealing compound, then install the holder in place in the crankshaft and tighten securely.

2. Push a fine wire through the wick about ½" back from the end. Lap the end of the wire back and twist over. Soak the wick thoroughly in clean engine oil.

3. Insert the end of the wire into the wick hole at the front (front end of hole starting at the rear cheek of the No. 6 connecting rod throw). Push the wire through the hole until it can be reached at the rear of the wick holder.

4. Start the end of the wick into the hole in the crankshaft and pull on the end of the wire until the front end of the wick extends out ¼" from the rear cheek of the No. 6 connecting rod throw. Remove the wire from the rear end of the wick and cut the rear end of the wick off so that ⅜" extends out from the wick holder.

   CAUTION: It is important that the oiling wick fits tightly in the hole in the crankshaft and in the wick holder. Do not twist the wick when installing as this will leave a groove around the wick and will allow too much oil to pass through and also may cause the wick to slip.

G. Flywheel, Ring Gear, and Engine Clutch Shaft Pilot Bearing 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 surface 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.

3. ENGINE CLUTCH SHAFT PILOT BEARING. Replace the bearing in the flywheel if the balls or the races are worn, corroded, or rough, or if the bearing does not roll freely and smoothly. Remove the bearing with an ordinary bearing puller; install the bearing by starting it into place, then using a driver or tube that will provide for driving against the outer race, drive the bearing into place.

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 damper assembly is made up of a front and rear damper unit, a hub, an inner cone, and an outer cone. Each damper unit consists of an inertia mass (metal disc) enclosed in a fluid-tight outer case but separated from contact with the case by a thin wall of viscous liquid. This liquid is not affected by temperature changes. Any movement of the inertia mass or weight inside the outer case, therefore, is resisted and cushioned by the friction of the viscous liquid. This tends to dampen excessive torsional vibrations in the crankshaft. The dampers are bolted and doweled to the vibration damper hub. Refer to Fig. 24.

B. Service

No service should be required on the vibration damper if the unit is not abused. *CAUTION: The damper should never be struck with a hammer or similar tool when removing or installing as to do so would upset the static balance of the inertia mass in its fluid.*

C. Removal of Vibration Damper (Engine in Tractor)

1. Remove the radiator and shell 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. 27, remove the crankshaft pulley from the crankshaft, then remove the two (2) "WOODRUFF" keys.

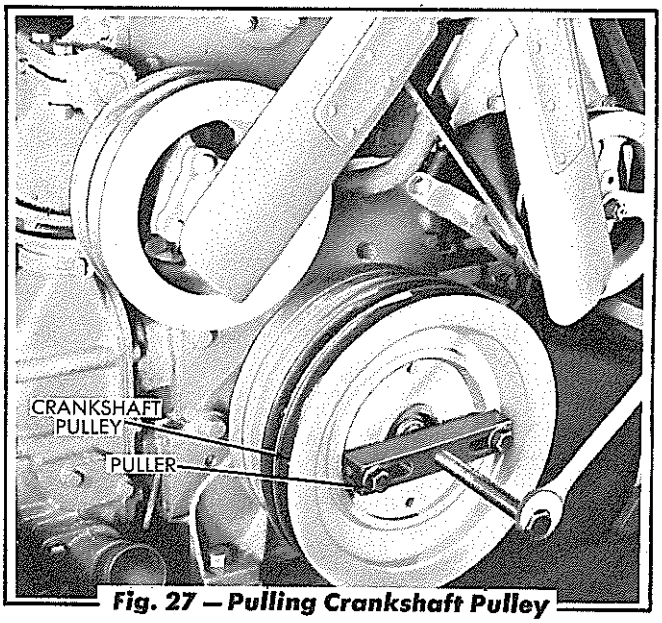


Fig. 27 — Pulling Crankshaft Pulley

4. Using a puller (similar to the one shown in Fig. 27) inserted in the two tapped holes of the hub, pull the damper and hub assembly, together with the outer cone, from the crankshaft. *CAUTION. Do not drive on the damper when removing.*

5. If necessary, the rear cone may now be removed by sliding it off the crankshaft.

D. Inspection of Vibration Damper

After removal of the vibration damper, inspect the damper units for leaks. A leak in the outer case, that allows the fluid to leak out, will render the damper useless and a new unit must be installed.

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. 24 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. When assembling the vibration damper units on the hub, place the two flat faces of the dampers against each other, position them on the locating dowels of the hub, with the larger of the two units next to the hub, then install the attaching capscrews and lockwashers and tighten securely.

3. Slide the damper and hub assembly on the crankshaft (end with the smaller damper towards the rear) until the hub contacts the inner cone. *CAUTION. Do not pound the damper assembly into place on the crankshaft.*

4. Install the front cone on the crankshaft, with the tapered end of the cone next to the hub.

5. Install the two (2) "Woodruff" keys in the crankshaft, then install the crankshaft pulley, pulley retaining washer, and the retaining capscrew. Tighten the capscrew to a torque of 180 to 200 ft. lbs.

6. Place the fan belts in the grooves of the crankshaft pulley, then adjust the belts (refer to "FAN BELT ADJUSTMENT" in Section IV).

7. Install the radiator assembly and shell (refer to "INSTALLATION OF RADIATOR" in Section IV).

7. PISTONS AND CONNECTING RODS

A. Description of Pistons

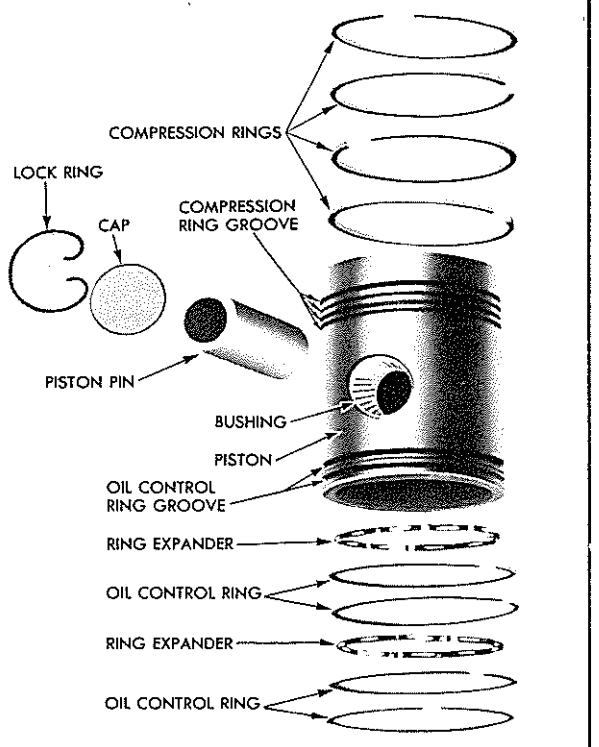


Fig. 28 — Piston Assembly Details

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 four (4) compression rings and four (4) oil control rings of the conventional cut-joint type. The four (4) ⅛" wide compression rings are installed in the four (4) grooves in the piston above the piston pin and the four (4) oil control rings, with two (2) expanders, are installed in the two (2) grooves in the piston below the piston pin.

The pistons in the early model tractors are equipped with one (1) "Chromium Plated" compression ring installed in the uppermost groove of each piston and three (3) "Tin Plated" compression rings in the other grooves. The pistons in later tractors are equipped with two (2) "Chromium Plated" compression rings installed in the two (2) uppermost grooves and two (2) "Tin Plated" compression rings in the other grooves. The latest model tractors are now equipped with four (4) "Chromium Plated" compression rings, one (1) installed in each groove above 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.

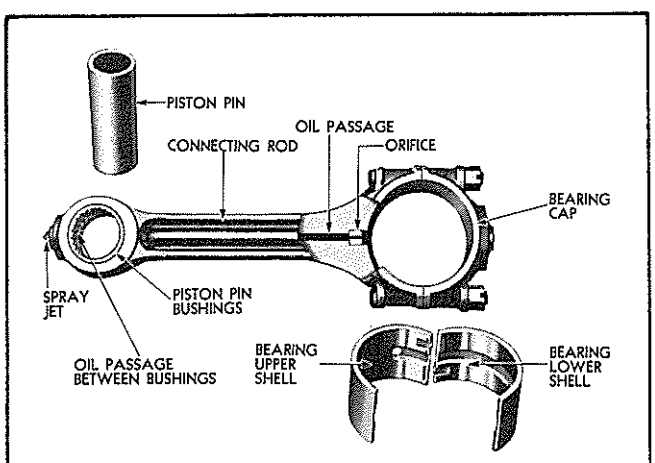


Fig. 29 — Connecting Rod Assembly

The connecting rod bearings are precision type, without shim adjustments. The upper and the lower halves of the connecting rod bearing shells are different; therefore, 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 bearing 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 hollow 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. Scored liners may be detected in this manner 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 tin 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 lock rings at each end of the piston pin.

2. Tap the piston on a wood block and remove the cap and piston pin through the open piston pin hole. If the steel cap lodges in the groove for the lock ring, 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 tin-plated piston is thin and the presence of this coating will, therefore, indicate the absence of wear. If, however, the tin 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 piston and the cylinder liner. The standard clearance is from .004" to .0072". The piston skirt diameter of a new piston is 4.2433" to 4.2455"; the inside diameter of a new cylinder liner is 4.2495" to 4.2505". Deviations from these measurements will indicate the amount of wear on the piston or cylinder liner. The piston or the cylinder liner or both must be replaced if the clearance exceeds .010".

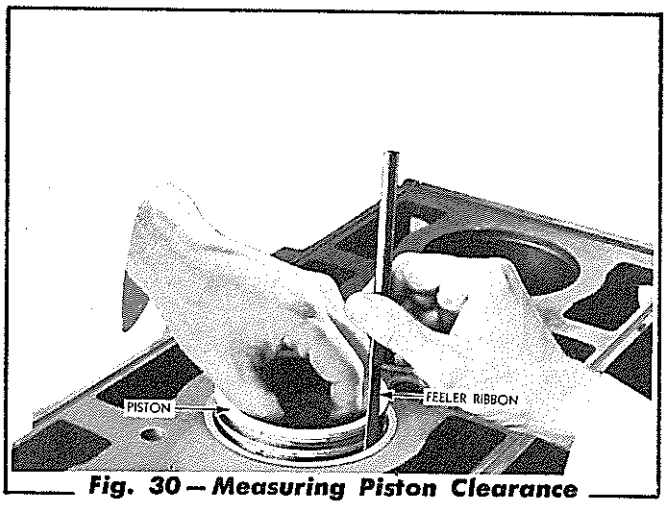


Fig. 30 — Measuring Piston Clearance

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 not serviced. 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 diameter is 1.500" to 1.4996".

2. The standard inside diameter of the bushings in the connecting rod is 1.5025" to 1.503". These dimensions of the pin and bushings provide a clearance of .0025" to .0032". 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 bearing shells should also be inspected for bright spots, and discarded if any bright spots are found as this condition indicates that the bearing 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 bearing shells when installed in the rod is 2.752" to 2.753". The bearing 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). Bearing shells that measure less than .153" at the center should be discarded and new ones installed

in their place. Bearing shells .002", .010", .020", and .030" undersize are available in the event that the crankshaft is worn or has been damaged and must be reground.

G. Fitting Pistons with Liners

Measurements of the pistons and the cylinder liners and running clearances between the pistons and the cylinder liners should be taken at room temperature (70° F.). PISTONS MUST BE FITTED TO THEIR RESPECTIVE CYLINDER LINERS TO PROVIDE A RUNNING CLEARANCE OF NOT LESS THAN .004". Insufficient clearance will result in premature failure of these parts.

Measure the cylinder liners as described in "CYLINDER LINER CLEANING AND INSPECTION" in this section. The bore of the cylinder liners must be round within .0015" and the pistons must also be round within .001". Measure each piston its full length both crosswise and parallel with the pin. Measure each cylinder liner over its entire length at corresponding points.

Use a .003" feeler ribbon 12" to 18" long to measure the clearance between the pistons and the cylinder 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 cylinder liner in running position. With a .004" clearance between the piston and the cylinder liner, the .003" feeler ribbon can be withdrawn with a slight pull (not to exceed 6 pounds). Refer to Fig. 30. Test 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 cylinder 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 cylinder 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.

Pistons and cylinder liners are available in standard size only.

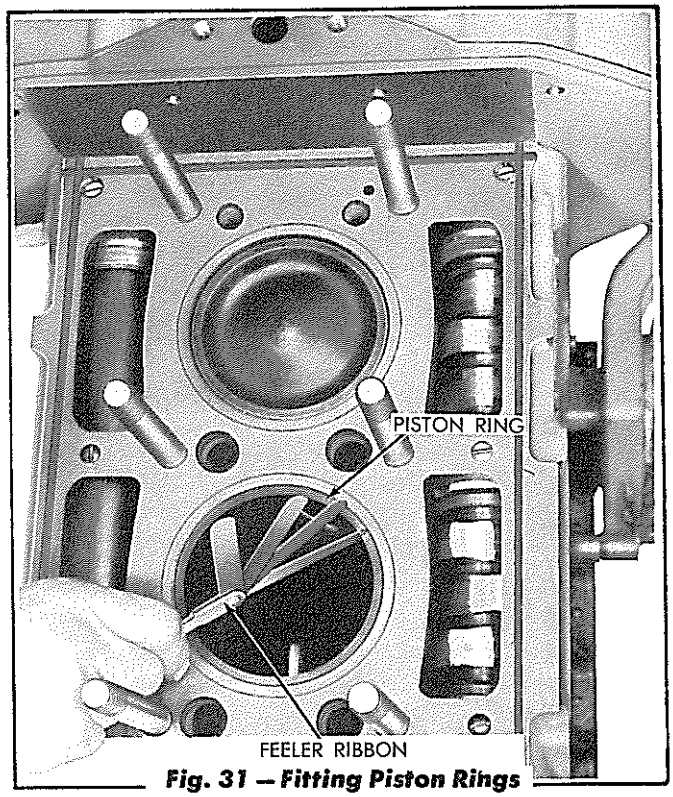


Fig. 31 — Fitting Piston Rings

H. Fitting Piston Rings

The gap between the ends of the piston rings should be measured before the rings are installed on the pistons. Select the rings that are to be used on each piston and insert them one at a time into the cylinder liner in which they are to operate. Use a piston to push the ring squarely into the cylinder liner 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 gage as shown in Fig. 31.

The pistons in the early model tractors are equipped with one (1) "Chromium Plated" compression ring installed in the uppermost groove of each piston and three (3) "Tin Plated" compression rings in the other grooves. The pistons in the later model tractors are equipped with two (2) "Chromium Plated" compression rings installed in the two (2) uppermost grooves and two (2) "Tin Plated" compression rings in the other grooves. The latest model tractors are now equipped with four (4) "Chromium Plated" compression rings, one (1) installed in each groove above the piston pin. It is recommended when the engine is overhauled that

four (4) "Chromium Plated" compression rings be installed on each piston.

The specified gap of the "Chromium Plated" piston compression rings is .025" to .040". *CAUTION: The "Chromium Plated" rings should never be filed to open the gap because the plating might be loosened by the file and later distributed through the engine causing damage, or might cause scoring of the piston and the cylinder liner.*

The specified gap of the "Tin Plated" piston compression rings when used in the 3rd and 4th grooves from the top of the piston is .025" to .035". The ends of these rings (Tin Plated) may be filed with a flat mill file if necessary to obtain the correct gap. Remove any burrs made by filing.

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 (chromium plated)	.010" to .0125"
2nd Ring (chromium plated)	.008" to .0105"
3rd and 4th Ring	.006" to .0085"

The piston oil control ring gap specification is .010" to .020". The oil control ring-to-groove clearance (top of ring to top of groove) 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. 28. 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 the pistons before installing them in the cylinder liners.

IMPORTANT: When installing the rings on the pistons, the rings should not be spread so that 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.

I. Replacement and Reaming of Piston Pin Bushings in Connecting Rod

1. Remove the bushings from the connecting rod

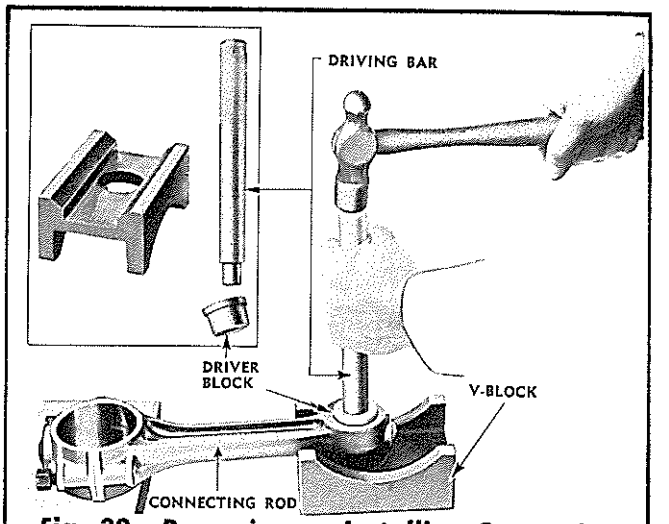


Fig. 32 — Removing or Installing Connecting Rod Bushings

with the driving bar and driver block as shown in Fig. 32.

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.

3. After the bushings have been installed, they must be reamed. The special reaming fixture and reamer shown in Fig. 33 must be used to insure 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 facing the slot in the fixture for 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 reamer 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

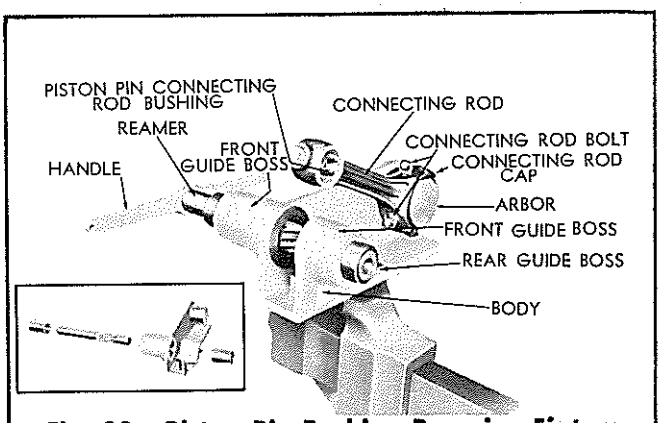


Fig. 33 — Piston Pin Bushing Reaming Fixture

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 bushing will be .0025".

J. Assemble Connecting Rods and Pistons

1 Install one of the piston pin retainers and a retainer 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 engine oil and slide the piston pin through the piston and rod. The piston pin will slip easily into place without forcing if it has been correctly fitted.

3. Install the second piston pin retainer and the retainer lock ring at the opposite end of the piston 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 BALANCE SHAFT

A. Description

The camshaft is a one-piece drop forging, case-hardened at the cams and journals, and is located near the top of the cylinder block on the right hand side. The balance shaft, running parallel to the camshaft, and at the same distance from the crankshaft, is located on the left-hand side of the cylinder block. A bearing assembly with copper-lead, steel backed bushings, at each end, and intermediate bearings, between each set of cams, pro-

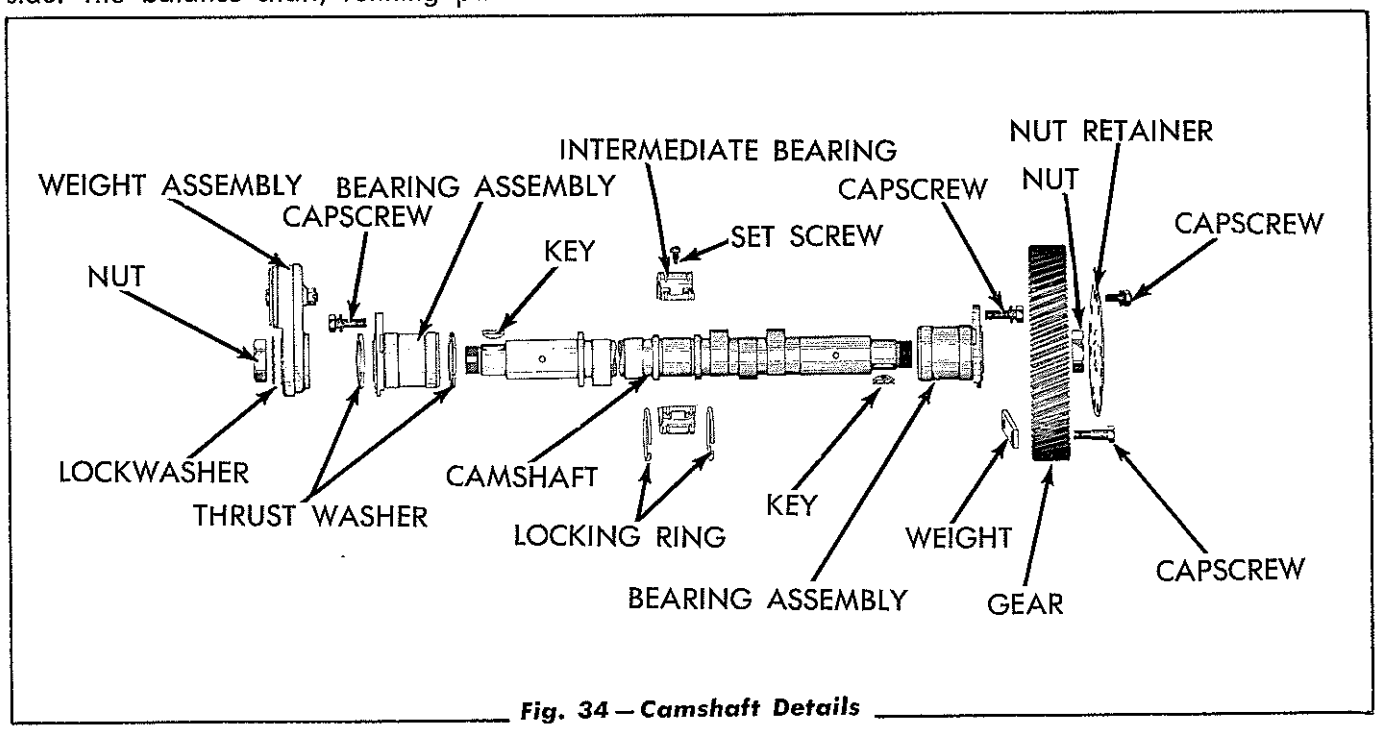


Fig. 34 — Camshaft Details

vide rigid support of the camshaft. The balance shaft is supported in the same manner as the camshaft, except that no intermediate bearings are used. Steel backed bronze replaceable thrust washers are used on the thrust ends (front) of the shafts.

As will be seen from Fig. 34, 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 cylinder block.

The cams are ground with parallel surfaces to insure efficient quiet roller action. Heat-treatment provides hard, wear-resistant cam lobes.

The function of the balance shaft, as its name implies, is to counterbalance the rotation of the weighted camshaft and thus effect a stabilizing action upon oscillatory impulses set up within the engine. Eccentrically positioned weights, at the front and rear ends of both shafts, are designed to dampen out these forces.

In addition to the counterweighted gears at the rear end, balance weights are used at the front end of both the camshaft and balance shaft as shown in Figs. 34 and 35. The balancing weights are known as balance-weight and hub-assemblies. The hub of each assembly is securely fastened to the front ends of both the camshaft and balance shaft by means of a "Woodruff" key, nut, and lockwasher. The weight incorporates a bushing, bearing on the hardened surface of the hub, which permits the weight to oscillate (rock) on the hub. Torque variations, developed in the shafts during speed or load changes, are transmitted from the hubs to the weights leaves. The bolt, retainer, and nut maintain relation between the weights and the hubs.

B. Lubrication

Lubrication is supplied to the camshaft and balance shaft end bearings from four vertical oil passages in the cylinder block which are in line with the main oil gallery. The camshaft intermediate bearings are lubricated by oil from the drilled camshaft.

C. Service

If service on the camshaft gear or the balance 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 and Installation of Camshaft and Balance Shaft Assemblies

Removal of either shaft requires that the engine be removed from the tractor. The procedure given in disassembly and assembly of the engine may be used to remove and install these assemblies with the engine removed from the tractor.

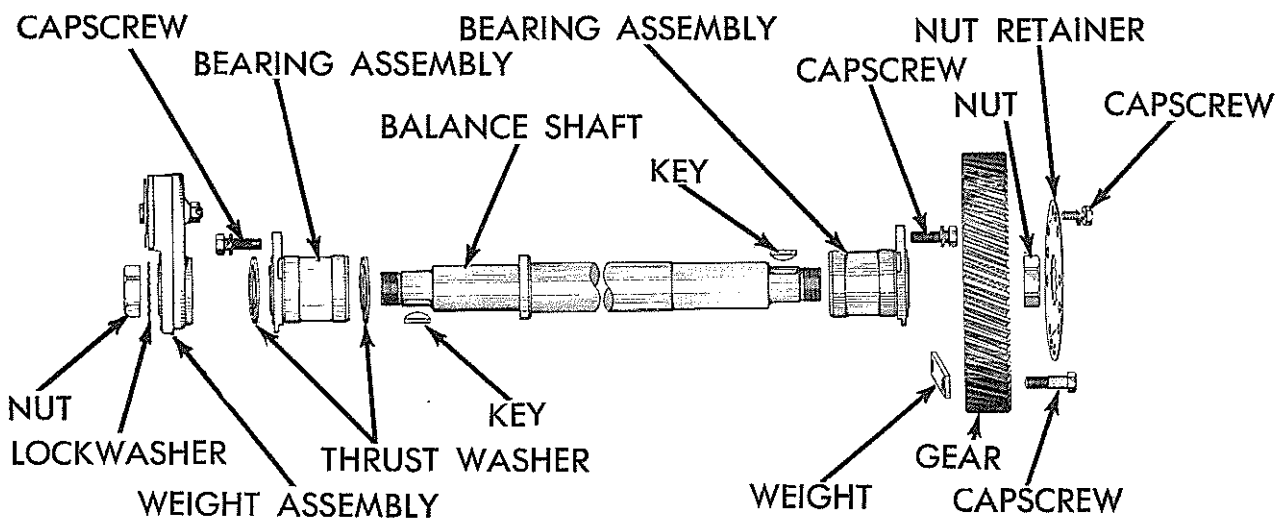


Fig. 35 — Balance Shaft Details

E. Removal of Parts from Camshaft and Balance Shaft

1. Remove the inner thrust washers from the ends of the shafts opposite the gears. Remove the capscrews attaching the nut retainers to the gears and remove the nut retainers, then remove the nuts from the gear ends of the shafts. Using a puller or a press remove the gears from shafts. Remove the "Woodruff" key and the rear bearing assembly from each shaft.

2. Remove the locking rings from the intermediate camshaft bearings and remove the two halves of each bearing.

F. Disassembly of Balance Weight Assemblies

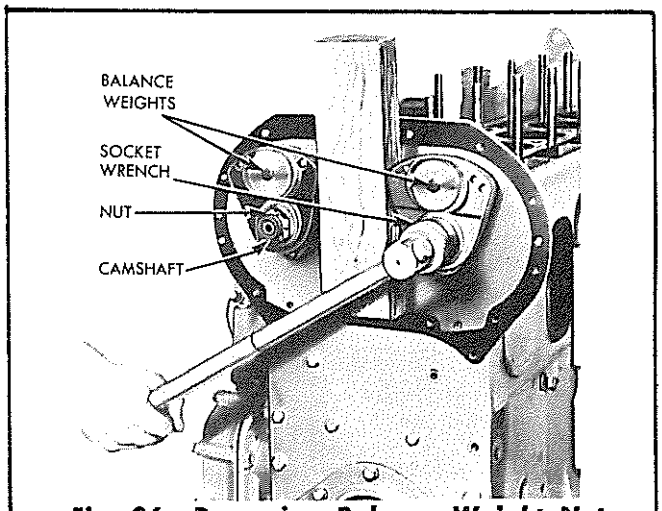


Fig. 36 — Removing Balance Weight Nuts

Refer to Fig. 38 showing the relative location of the parts.

1. Remove the cotter pin from the nut and remove the nut. Remove the bolt and the retainer.

2. Separate the balance weight from the hub, then remove the springs and spacer from the balance weight.

NOTE: The balance weight assemblies are serviced only as a unit; individual parts are not available.

G. Inspection of Camshaft and Balance Shaft Parts

After all the parts have been cleaned with solvent or fuel oil and dried by air, inspect all the bearings and shaft journals for wear before reinstalling the parts in the engine. The original diameter of the bearing journals of the camshaft and the balance shaft is 1.4980" to 1.4985". If the bearing journals of the camshaft and the balance shaft are found to be badly worn or scored making regrinding necessary, the work should be done by a reputable machine shop that has suitable equipment to handle precision work of this type. Camshaft and balance shaft end bearing assemblies of .010" and .020" undersize and camshaft intermediate bearings of .010" undersize are available. If the camshaft or balance shaft end bearing journals are ground, the diameter of the end journals should be reduced in steps of .010" or .020" below 1.4985" to fit the respective undersize end bearing assemblies. If the camshaft intermediate bearing journals are ground, the diameter of the intermediate journals should be reduced .010" below 1.4985" to fit the .010" undersize intermediate bearings.

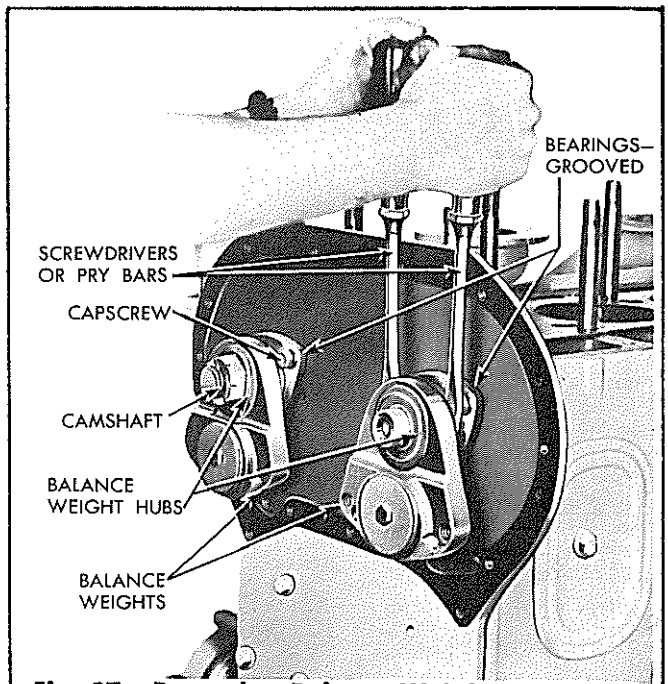


Fig. 37 — Removing Balance Weight Assemblies

Examine both faces of the cam and the balance 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.

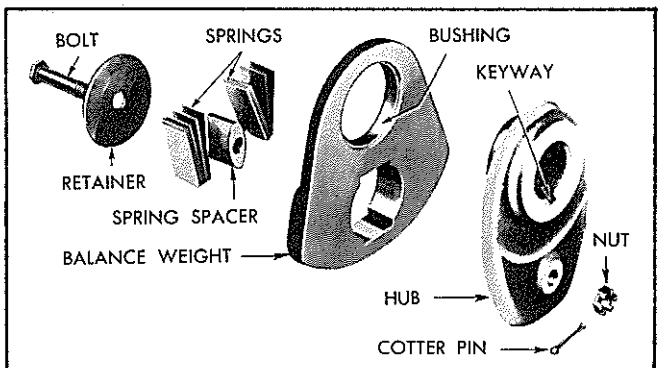


Fig. 38 — Front Balance Weight Details

When the thrust surfaces (side facing the loose thrust washer) of the balance weight hub is damaged, it will be necessary to install a new balance weight assembly as the parts of the weight assembly are not serviced separately. The close limits of the balance maintained in this assembly necessitate the use of mated parts, measured and machined as an assembled unit.

The specified radial clearance on the camshaft and balance shaft end bearings is .0015" to .003" and should not exceed .006", the specified radial clearance of the camshaft and the camshaft intermediate bearings is .0025" to .005" and should not exceed .009". If the clearance is not within the above specifications, refer to information above concerning regrinding of the camshaft and balance shaft journals and the installation of undersize bearings.

The end play of the cam and balance shafts should not be less than .004" and should not exceed .018".

The radial clearance between the balance weight bushing and balance weight hub is from .001" to .0035" and should not exceed .006". The end clearance between the weight and the hub should be from .010" to .016". If the balance weight bushing to balance weight hub clearance exceeds the limits given above, it will be necessary to replace the balance weight assembly as the parts are not serviced separately.

Examine the cam surfaces of the camshaft for wear or scoring. A shaft with scored cams should not be used. Allowable backlash between the driving gears is .003" to .008". Replace worn or damaged driving 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 the shaft. Sludge accumulations which might restrict the oil flow, should be removed.

H. Assembly of Balance Weight and Hub

Refer to Fig. 38 showing the parts in relative position.

1. Separate the springs into four (4) packs (17 or 18 per pack) so that each pack is .253" to .255" thick. The springs are of the following thicknesses: .0135" to .0145"; .015" to .016". The thickness of each pack should be determined while the springs are clamped tightly together. *IMPORTANT: Wash the springs clean, and dry with compressed air before making the above measurements.*

2. Place the balance weight, machined face down, on a clean work bench. Dip the spring packs into lubricating oil, completely coating all the springs.

3. Arrange two (2) spring packs, one on each side of spring cavity, in the balance weight. Place the spacer on blade of a screwdriver, then enter the spring spacer, tapered end first, between the spring packs. As the spacer becomes fully enclosed, tilt the spacer into the upright position, bolt hole up. Press the spacer into place.

4. Place the journal of the weight hub into the bushing of the balance weight. The weight should swing freely on the hub. Burnish the bushing if the required clearance of .001" to .0035" is not present.

5. Place the retainer on the spring spacer and insert the bolt through the retainer spacer, and the hub. Fasten with the castellated nut.

6. Check the clearance between the weight and the hub, as shown in Fig. 39. The clearance should be .010" to .016". Adjust the clearance by tightening or loosening the castellated nut, then lock the nut in position with the cotter pin.

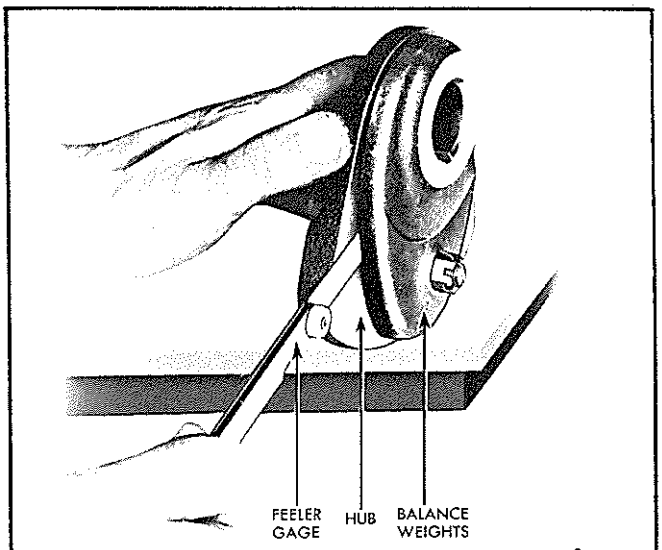


Fig. 39 – Measuring Clearance Between Balance Weight and Hub

I. Installation of Parts on the Camshaft and Balance Shaft

Assembly at this time will consist of installing the gears and the bearing assemblies on the rear end of both shafts, installing the intermediate bearings on the camshaft, and installing the shafts in the engine block. The remaining parts will be assembled as the engine is assembled (refer to "ASSEMBLY OF ENGINE" in this section).

Weights are attached to the camshaft and the balance shaft gears for balancing purposes. Before installing the gears, make certain that the weights are attached.

The teeth of the gear to be installed on the camshaft form a left-hand helix and the gear is marked on the machined side of the gear with an "L"; the teeth of the gear to be installed on the balance shaft form a right-hand helix and carry a timing mark "R." With these identifications in mind and referring to Figs. 34 and 35, install the parts as follows:

1. Lubricate two (2) of the end bearing assemblies with oil and slip them on the end of each shaft (ends of the shafts that have no thrust shoulders) so that the flanged end of the bearing assemblies will face the gears when installed. Install a "Woodruff" key in the slot of each shaft and press the gears on the shafts with the flat finished face of the gears away from the end bearings.

2. After the gears are installed on the shafts, screw the retaining nuts on the shafts against the gears. These nuts are to be tightened and the nut retainers are to be installed later when the shafts are installed in the engine.

3. Lubricate the camshaft intermediate bearings with light engine oil and install the bearings in position on the camshaft journals. Install the locking rings in grooves of the bearings to hold them in place.

NOTE: Tractors having Engine Serial No. 6A-16283 and above have the new style cylinder block in which individual compression gaskets are used instead of the laminated one-piece type compression gasket used on engines prior to this Serial Number.

The new style cylinder blocks are approximately 1/16" higher than the former cylinder blocks in order to compensate for the thickness of the gasket which was used with the former cylinder blocks, but is not used with the new type cylinder blocks. As a result of heightening the new type cylinder block, the camshaft bearing bores are 1/16" lower in relation to the top surface of the cylinder block; thus, the use of longer camshaft intermediate bearing setscrews is required.

The camshaft intermediate bearings used at the upper position in the new type cylinder blocks have a hole for each bearing setscrew drilled all the way through the bearing, whereas, the hole for each setscrew in the intermediate bearing used in the former cylinder block is drilled only partially through the bearing. The threaded portion of the new type intermediate bearing setscrews, as well as the tip, are longer than the setscrews used in the former cylinder blocks.

As the new type camshaft intermediate bearings used in the upper position in the new type cylinder blocks are drilled all the way through and the former intermediate bearings were not, the former bearings can not be used in the upper position in the new cylinder blocks since the new setscrews would bottom in the former bearings and not allow the setscrews to clear the top surface of the cylinder block. If the former setscrews were used in the new type cylinder block, the setscrews would not

provide sufficient engagement with the holes in the new upper intermediate bearings to lock the bearings securely.

New type lower camshaft intermediate bearings used with the new type upper intermediate bearings, are simply the former intermediate bearings without a setscrew hole, and must be used only in the lower position as a setscrew is not used at the lower position.

Summary:

1. The new type camshaft bearings may be used in the former type cylinder blocks provided that they are installed in their respective positions (upper in the upper, and lower in the lower positions), and that the former type setscrews are used to lock the upper bearings in place.

2. The former type camshaft intermediate bearings may be used in the new type cylinder blocks in the LOWER position ONLY.

3. The new type upper camshaft intermediate bearings MUST NEVER be installed in the LOWER position as the lower position is that which takes the load of the camshaft and the oil film of the lower bearings would be disrupted as a result of the setscrew holes piercing the bearing contact surfaces.

J. Installation of Balance Shaft in Cylinder Block

(Balance Shaft Gear and Rear End Bearing Assembled on Shaft)

1. Start the balance shaft, including the rear end bearing and gear assembly, into position in its bore at the rear end of cylinder block. Push the shaft into position to the point where the gear teeth are about to engage, then position the crankshaft, idler, and balance shaft gears so that the timing marks ("R") are adjacent, as shown in Fig. 40, and slide the balance shaft gear into mesh.

2. Secure the balance shaft rear end bearing to the cylinder block with three (3) lockwashers and capscrews. Tighten the capscrews to a torque of 35 to 40 ft. lbs. The capscrews are accessible through the web of the balance shaft gear.

3. Apply grease to the steel side of one of the thrust washers and place the washer in position on the rear face of the end bearing assembly which is to be installed in the front position. Make certain that the steel side of the thrust washer is next to the end bearing assembly. Lubricate the end bearing assembly with engine oil and insert it into position in the cylinder block and onto the balance shaft. Use care when inserting the end bearing assembly so that the thrust washer will not be dislodged. Secure the end bearing assembly to the cylinder block with three (3) capscrews and lockwashers. Tighten the capscrews to a torque of 35 to 40 ft. lbs.

4. Apply grease to the steel side of the thrust washer to be used in the front position, then place the washer in position on the front face of the end bearing assembly. Make certain that the steel side of the thrust washer is next to the end bearing assembly.

5. Install the "Woodruff" key in slot in the front end of the balance shaft, then install the balance weight assembly on the balance shaft, with the weight and spring retainer away from the engine. Place the lockwasher on the balance shaft, then start the retaining nut, but do not tighten the nut at this time as it will be tightened after the installation of the camshaft.

K. Installation of Camshaft in Cylinder Block

(Camshaft Gear, Rear End Bearing, and Intermediate Bearings Assembled on Shaft)

1. Start the camshaft, including the gear assembly, rear end bearing, and intermediate bearings, into position at the rear end of the cylinder block. Push the shaft into position to the point where the gear teeth are about to engage the balance shaft gear, then revolve the gears if necessary so that the "O" timing marks on the cam and balance shaft gears will match, as shown in Fig. 40, and

slide the camshaft gear into mesh.

2. Secure the camshaft rear bearing to the engine block with three (3) lockwashers and capscrews. Tighten the capscrews to a torque of 35 to 40 ft. lbs. The capscrews are accessible through the web of the camshaft gear.

3. Revolve the camshaft intermediate bearing assemblies so that the setscrew holes in the bearings align with the holes in the top of the cylinder block, then install the setscrews and tighten securely. *IMPORTANT: Refer to the NOTE in Step 3 of "INSTALLATION OF PARTS ON THE CAMSHAFT AND BALANCE SHAFT" in this Section and make certain that the correct setscrews and the proper intermediate bearings are installed in their correct positions.*

4. Apply grease to the steel side of one of the thrust washers and place the washer in position on the rear face of the end bearing assembly which is to be installed in the front position. Make certain that the steel side of the thrust washer is next to the end bearing assembly. Lubricate the end bearing assembly with engine oil and insert it into position in the cylinder block and onto the camshaft. Use care when inserting the end bearing assembly so that the thrust washer will not be dislodged. Secure the end bearing assembly to the cylinder block with three (3) capscrews and lockwashers. Tighten the capscrews to a torque of 35 to 45 ft. lbs.

5. Apply grease to the steel side of the thrust washer to be used in the front position, then place the washer in position on the front face of the end bearing assembly. Make certain that the steel side of the thrust washer is next to the end bearing assembly.

6. Install the "Woodruff" key in the slot in the front end of the camshaft, then install the balance weight assembly on the camshaft, with the weight and spring retainer away from the engine. Place the lockwasher on the camshaft, then start the retaining nut.

7. Wedge a block of wood between the balance weights, as shown in Fig. 36, and tighten the retaining nuts on both the cam and balance shafts to a torque of 300 to 325 ft. lbs.

   CAUTION: When tightening the retaining nuts for the balance weights and gears, DOUBLE CHECK and MAKE SURE that the thrust washers are in their proper position over the extended bearings.

8. Check the end play of the balance shaft and the camshaft by inserting a feeler gage between the thrust washer and the balance weight assembly, with the shaft pushed to its forward position. The end play should not be less than .004" and should not exceed .018". If the end play exceeds .018", it is recommended to install oversize thrust washers. Thrust washers of .010" oversize in thickness are available for service. These washers are identified by a "10" stamped on the steel back.

9. Wedge a clean cloth between the balance shaft gear and the camshaft gear, then tighten the retaining nuts to a torque of 300 to 325 ft. lbs. Install the nut retainers on the gears and tighten the attaching capscrews securely.

9. GEAR TRAIN

A. Description

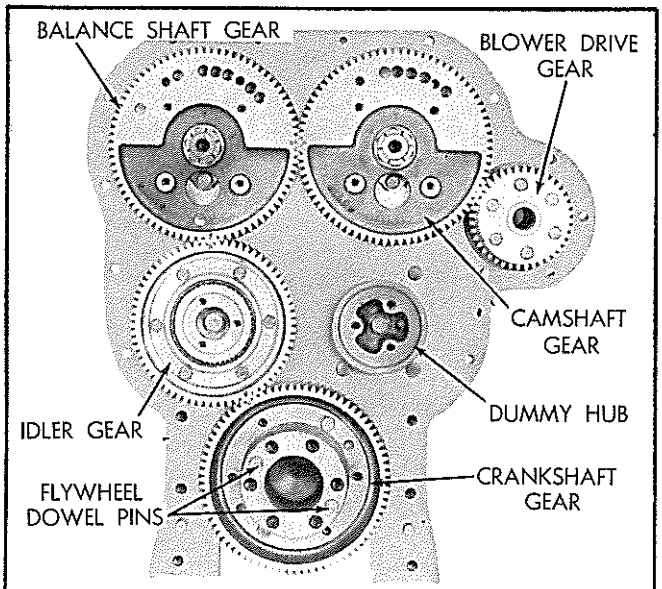


Fig. 40 — Timing Marks and Gears

Located at the rear end of the engine is a completely enclosed train of five (5) helical gears (19° helix angle), as shown in Fig. 40. A gear bolted to the crankshaft flange drives the camshaft and the balance shaft gears, as well as the blower and accessory drive gear, through an idler gear mounted between the crankshaft and the balance shaft gear.

The camshaft gear and the balance shaft gear mesh with each other and run at the same speed as the crankshaft. They are keyed to their respective shafts, each gear being held securely against a shoulder on the shaft by a retaining nut and nut retainer.

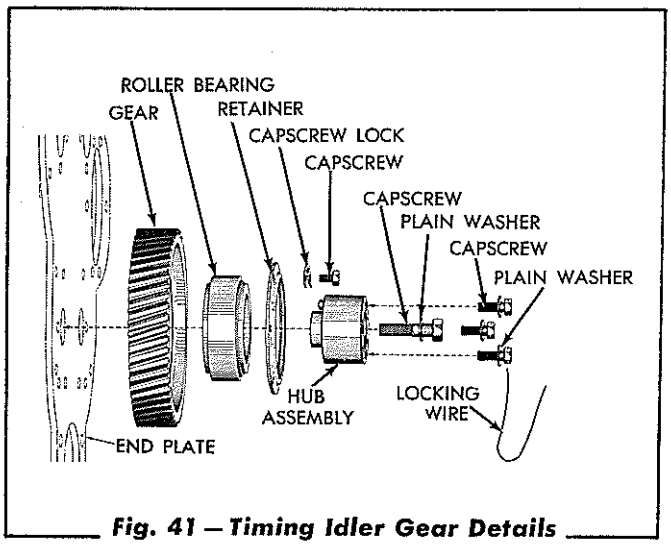


Fig. 41 — Timing Idler Gear Details

The idler gear rotates on a double row tapered, roller bearing and is mounted on a stationary idler gear hub assembly, located at the rear left side of the engine. A "dummy" hub is used to cover the opening at the rear right side of the cylinder block (opposite the idler gear hub location) that is not used for the idler gear mounting. The blower drive gear, in mesh with the camshaft gear, transmits power to drive the blower, governor, water pump, and the fuel pump. The idler gear bearing is lubricated through a hollow dowel, communicating with the left rear vertical oil passage in the cylinder block.

B. Service

Whenever the flywheel housing is removed for inspection or repairs of the gear train, the idler gear assembly should be removed and inspected.

The idler gear roller bearings in engines in the later model tractors are different from the idler gear bearings used in the early models.

The inner races, tapered rollers, and bearing retainers of the later type 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 and the ring holding the two inner races together. When the snap ring is removed as is necessary for removing and 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 roller bearing assembly and it is found necessary to replace the roller bearing assembly, the later type bearing assembly may be installed as the early and late type bearing assemblies are interchangeable.*

The gear train will run quietly if the gears and bearings are in good condition. The backlash between the various mating gears in the train ranges from .003" to .008" on a new engine. 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 cylinder block and end plate.

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 hub assembly out of the inner races of the bearing. *IMPORTANT: When pressing the hub assembly 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 assemblies 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. Unlock and remove the capscrews and the capscrew locks attaching the retainer to the gear. Remove the 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 flat face of the gear down, then using a suitable round hardwood plug, or similar 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 may be used to drive the outer race from gear by inserting the drift into the notches (push-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 in clean solvent.

b. Press the hub assembly out of the inner races of the bearing. *IMPORTANT: When pressing the hub assembly 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 and capscrew locks. Tighten the capscrews to a torque of 24 to 29 ft. lbs. Lock the capscrews in position by bending the ends of the locks against the capscrew heads.

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 workbench.

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 round hardwood plug, or similar 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 workbench 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 and capscrew locks. Tighten the capscrews to a torque of 24 to 29 ft. lbs. Lock the capscrews in position by bending the ends of the locks against the capscrew heads.

3. Preliminary Test of Idler Gear Assembly

Before the idler gear assembly is installed on the engine, the idler gear bearings should be checked to make certain that the idler gear may be rotated on its roller bearings without exceeding the maximum torque specifications, and also to make certain that the bearings are not too loose allowing the gear to be moved in relation to the hub by tilting, wobbling, or shaking the gear.

Test the idler gear assembly as follows:

a. Before installing the camshaft gear, balance shaft gear, and the crankshaft gear, or with these gears removed from the engine, install the idler gear assembly in position on the cylinder block. Install the capscrew and plain washer in the center of the idler gear hub and tighten the capscrew to a torque of 80 to 90 ft. lbs.

b. Lubricate the idler gear bearing with clean, light, engine oil and rotate the gear on its bearings before subjecting the gear assembly to the preliminary test.

Tie one end of a piece of 1/8" lintless cord around a 1/8" round piece of wood (or soft metal stock) about 3/4" in length, place the round piece of wood between two teeth of the idler gear, then wrap the cord around the outside diameter of the gear several times. Position the loose end of the cord so that it can be reached through the opening in the flywheel housing for the camshaft gear.

NOTE: The idler gear roller bearings can be tested by either of two (2) methods. The flywheel housing can be installed in position on the cylinder block over the idler gear, or a "FLAT" piece of 3/8" thickness steel plate, cut to 4" x 4", and with three (3) 5/16" holes drilled through the plate to match with the bolt holes in the idler gear hub, may be installed on the rear of the idler gear hub instead of installing the flywheel housing.

c. If the flywheel housing is to be used to test the idler gear bearings, install the cylinder block spacer assembly ("dummy" hub) in position on the cylinder block, opposite the location of the idler gear hub. Install the capscrew and plain washer in the center of the "dummy" hub and tighten the capscrew to a torque of 80 to 90 ft. lbs. *NOTE: This step is not necessary if the 3/8" thickness steel plate is used to test the bearings instead of installing the flywheel housing.*

d. Install the flywheel housing gasket in position on the cylinder block and install the flywheel housing. Install and tighten the six (6) capscrews (three (3) on each side) near the crankshaft. Install and tighten two (2) bolts in the top of the flywheel housing. Make certain that the loose end of the cord on the idler gear can be reached through the opening in the flywheel housing for the camshaft gear. *Note: This step is not necessary if the 3/8" thickness steel plate is used instead of installing the flywheel housing.*

e. Install the six (6) drilled head capscrews and the plain washers used to attach the flywheel housing to the idler gear hub and the "dummy" hub (three (3) capscrews in each). Tighten these capscrews to a torque of 30 to 35 ft. lbs.

If the 3/8" thickness steel plate is used instead of the flywheel housing, install the plate in position on the rear of the idler gear hub and install the three (3) drilled head capscrews and plain washers to attach the plate to the hub. Tighten the capscrews to a torque of 30 to 35 ft. lbs.

f. Make a loop in the loose end of the cord

on the idler gear and attach it to the hook of an ordinary pull scale (fish scale). Maintain a straight, steady pull on the scale and read the figure on the scale (in pounds) required to rotate the idler gear on its bearings. *NOTE: If the flywheel housing is installed, hold the scale when pulling on the cord so that the cord does not rub against the housing.*

If the idler gear bearing is of the late type as explained above, the specified pull on the scale should be ½ to 6¾ lbs. If the idler gear bearing is of the early type as explained above, the specified pull on the scale should be ½ to 15 lbs. If the running friction of the idler gear is within these specifications, the assembly is satisfactory for use. If the running friction of the idler gear is above or below this range, the assembly should be removed and the bearing inspected. Replace the bearing assembly if necessary.

g. After the preliminary test of the idler gear has been made and the assembly is found satisfactory, remove the flywheel housing, or the plate, so that the other gears in the gear train can be installed.

h. After the assembly of the gear train has been completed, install the flywheel housing on the engine. Tighten the capscrews used to attach the flywheel housing to the idler gear hub and the "dummy" hub to a torque of 30 to 35 ft. lbs. Install the lockwires through the capscrew heads and lock the capscrews in position.

CAUTION: Special care must be taken to protect the idler gear assembly against entry of dirt. Keep the parts clean before and during installation on the engine.

10. REPAIR OF ENGINE WHILE INSTALLED

A. General Information

Repair or replacement of the crankshaft, camshaft and bearings, balance 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 engine and parts clean and free from dust or foreign material if the repair work is performed in the open.

2. Failure of the parts needing replacement, may be due to clogged or restricted oil passages or gritty substances in the engine. If the oil passages are not properly cleaned or if all abrasive material is not removed by thorough cleaning, failure may again occur within a short period of operation after the new parts are installed.

3. If some parts have become worn or damaged to the point where replacement of these parts is required, it is only reasonable to assume that other parts may also be worn and, if not replaced at the same time, will result in further shut-down within a short time.

4. When new main and connecting rod bearings are required, the idler gear bearing, camshaft bearings and balance shaft bearings must also be inspected at this time, 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 balance 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, 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 bearing shell inserts one at a time. Do not fully tighten the caps until all the bearing shells have been installed. The lower bearing shell can be removed from the bearing cap after the cap is removed. Remove the upper bearing shell as follows:

   a. Insert a ¼" x 1" capscrew with a head 7/16" 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. 42.

   b. The upper half of the rear main bearing shell 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. 43.

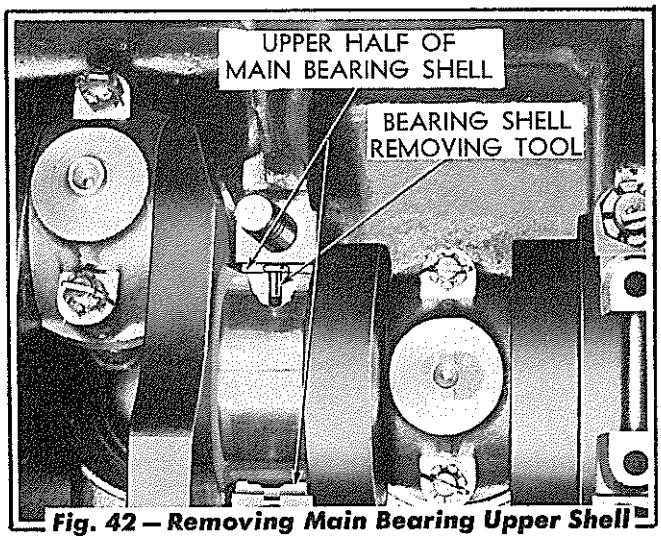


Fig. 42 — Removing Main Bearing Upper Shell

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.

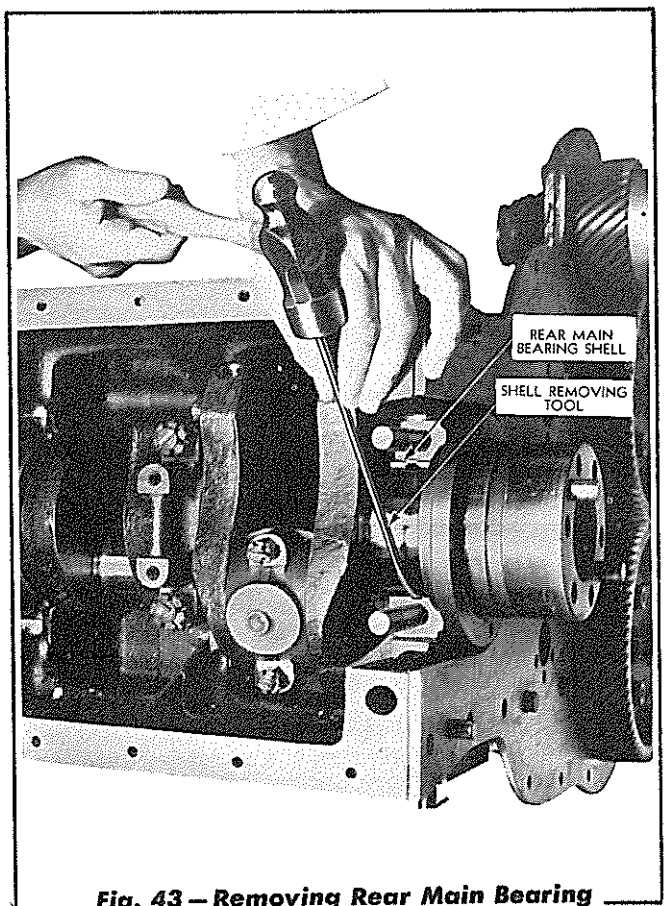


Fig. 43 — Removing Rear Main Bearing Upper Shell

7. Install the upper (grooved) half of each main bearing as follows: Lubricate the bearing shell and start the end of the bearing shell having no tang around the crankshaft bearing journal, so that when the bearing shell is in place, the tang will fit into the groove in the shell seat.

8. After the upper bearing shell has been installed, place the lower (non-grooved) bearing 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 must be replaced in their original positions with marked side toward the blower side of cylinder block.*

9. After all of the bearing shells have been installed, draw the bearing caps tight. Use a torque indicating wrench and tighten the bolts to 180 to 190 foot pounds torque. Do not overtighten the main bearing bolts as the bearings will be distorted out of round. If the bearings have been installed properly, the crankshaft will turn freely with all of the main bearing caps tightened.

10. Install the oil pump, the upper and lower oil pans and the crankcase guard. 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. Open the fuel tank shut-off valve.

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 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.

A. Engine Removal

1. Remove the engine air pre-cleaners, engine hood, and front fenders. Remove the ball from the upper end of each gear shift lever and remove 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 hose connecting the radiator inlet elbow to the water outlet manifold on the engine and to the radiator inlet elbow at the top rear of the radiator. Remove the inlet elbow from the engine. Loosen the hose clamp connecting the radiator outlet hose (lower hose) to the oil cooler elbow.

3. Remove the nuts from the front ends of the radiator to cowl bracing rods. Disconnect the head light wire at the fuse connection located at the left rear side of the radiator and remove the fuse. Remove the capscrew attaching the headlight wire clip to the lower left corner of the radiator shell.

4. Using a suitable chain, cable, or rope to lift the radiator and shell assembly, remove the two (2) bolts attaching each lower corner of the radiator shell to the main frame. Raise the radiator and shell assembly slightly and move it forward to clear the engine fan, and remove it from the main frame.

5. Remove the capscrews attaching both battery grounds (one each side) to the top of the steering clutch housing. Tape the ends of each ground cable to prevent a ground when disconnecting other wiring. Close the fuel tank shut-off valve located under the fuel tank.

6. Disconnect the wiring harness from the starter and the generator. Remove the capscrews attaching the wiring clips to the base of the filters on the left side of the engine.

7. Disconnect the front of the fuel supply tube from the elbow in the filter base. Remove the capscrew attaching the clip mounting bracket to the rear of the starter, then move the bracket towards the main frame so that it will clear when the engine is moved forward for removal.

8. Disconnect the upper end of the engine primer tube from the primer pump.

9. Disconnect the lower end of the fuel pressure gage tube from the "tee" connection located to the rear of the cylinder head. Disconnect the lower end of the engine oil pressure gage tube from the tube connector located to the rear of the cylinder head. Disconnect the lower end of the hydraulic steering pump reservoir breather tube from the elbow in the top of pump reservoir cover.

10. Disconnect the lower end of the fuel return front tube from the tube connector at the lower right side of the engine flywheel housing.

11. Disconnect the front end of the engine thermo gage tube from the rear of the engine water outlet manifold. Remove the two (2) capscrews attaching the tube clips for the thermo gage tube to the hydraulic steering pump reservoir cover. Position the end of the thermo gage tube back over the top of the cowl.

12. Remove the yoke pin connecting the starter operating rod to the starter lever. Remove

the yoke pin connecting the engine shut-off rear rod to the engine shut-off lever located just to the right of the throttle assembly. Remove the yoke pin connecting the throttle operating rear rod to the lever located to the left of the throttle assembly.

13. Remove the two (2) jam nuts attaching the lubricating hoses for the clutch shaft rear bearing and the clutch shifting sleeve bearing to the base of the cowl.

14. Remove the capscrews attaching the steering clutch control lower cross shaft bracket to the rear of the engine clutch housing and pull the loose end of the lubricating hose out through the opening in the center of the bracket.

15. Disconnect the rear ends of the three (3) hydraulic steering fluid front tubes from the rear tubes at the tube connectors located to the left rear of the engine clutch housing. Remove the bolts used to clamp these three (3) tubes in position in the front tube clamp, then remove the tube clamp bracket attaching capscrews and remove the bracket from the engine clutch housing.

16. Remove the yoke pin connecting the front end of the shifting lock plunger rod (left rod) to the engine clutch shifting yoke shaft lever. Remove the cotter pin and plain washer from the rear end of the shifting lock plunger rod (right rod) and disconnect it from the shifting lock plunger at the front of the transmission. Tie the rod up to the clutch housing so that it will not be damaged when the engine is removed.

17. Remove the yoke pin connecting front end of the engine clutch operating lever control rod to the engine clutch shifting yoke shaft lever. *NOTE: It is not necessary to remove the capscrews attaching the clutch to transmission universal joint assembly as the front yoke assembly will slip off the rear end of the clutch shaft as the engine is moved forward for engine removal.*

18. Remove the nuts from the rear ends of the radiator to cowl bracing rods and remove the rods from the cowl.

19. Remove the bolt attaching each end of the engine supporting front hanger to the brackets welded to the main frame. Remove the two (2) bolts attaching each engine supporting rear bracket (one bracket on each side) to the main frame.

20. The engine is now ready for removal from the tractor. Using an engine lifting bar, similar to the one shown in Fig. 44, and with the proper lifting facility, raise the engine enough so that the weight is off the engine supports. Move the engine forward and raise it as necessary until the clutch housing is clear of the cowl and then raise and remove it from the main frame. *CAUTION: Use care when removing the engine and make certain that all the necessary wiring, tubing, linkage, etc. is disconnected and that no parts are smashed or damaged by careless handling.*

B. Engine Installation

The installation of the engine is practically a reversal of the removal procedure, *except that certain inspections and adjustments must be made when installing.*

1. Using an engine lifting bar, silimar to the one shown in Fig. 44, and with suitable hoisting equipment, install the engine in position in the main frame of the tractor. As the engine is lowered and is moved towards the rear of the tractor, align the splines in the front yoke on the clutch to transmission universal joint assembly with the splines on the rear of the engine clutch shaft so that the front yoke engages properly with the clutch shaft. Install the attaching bolts in the front and the rear engine supporting mountings and tighten the bolts securely.

2. Connect the engine clutch operating lever control rod to the engine clutch shifting yoke shaft lever. Check the edjustment of the engine clutch linkage and of the engine clutch and clutch brake (refer to "ENGINE CLUTCH AND CLUTCH BRAKE" Section X).

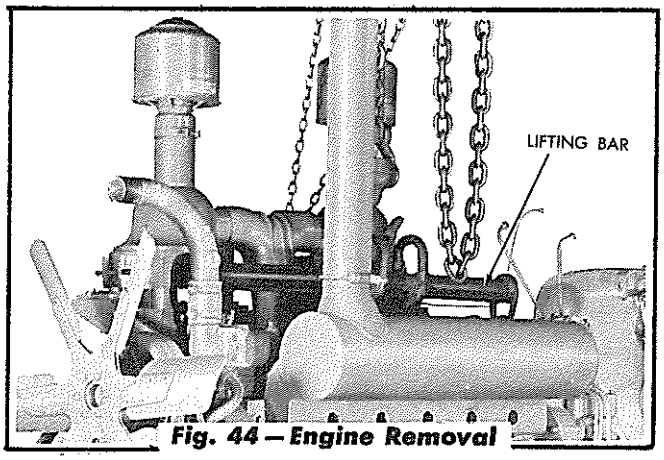


Fig. 44—Engine Removal

3. Connect the front end of the shifting lock plunger rod (left rod) to the engine clutch shifting yoke shaft lever. Insert the rear end of the shifting lock plunger rod (right rod) into position in the shifting lock plunger at the front of the transmission and install the plain washer and the cotter pin in the end of the rod.

4. Connect the rear ends of the three (3) hydraulic steering front tubes to the rear tubes at the tube connectors located to the left rear of the engine clutch housing. Tighten the connections securely. Install the clamp bracket for these tubes in position on the rear of the engine clutch housing. Install the tube clamp for these tubes in position on the clamp bracket.

5. Place the steering clutch lower cross shaft bracket in position at the rear of the engine clutch housing and install the attaching capscrews. Insert the end of the lubricating hose for the engine clutch shaft rear bearing through the opening in the steering clutch lower cross shaft bracket and then insert the end of the lubricating hose into position in the left of the two (2) holes at the base of the cowl. Insert the end of the lubricating hose for the engine clutch shifting sleeve bearing in the other hole at the base of the cowl. Install a lockwasher and jam nut on the end of each lubricating hose and tighten the jam nut securely making certain that the hoses do not twist when tightening.

6. Insert the starter operating rod into position and connect it to the starter lever. Connect the engine shut-off rear rod to the engine shut-off lever located just to the right of the throttle assembly. Connect the throttle operating rear rod to the lever located to the left of the throttle assembly.

7. Insert the end of the engine thermo gage tube into position in the rear of the engine water outlet manifold and tighten the connecting nut. Hold the thermo gage tube in position and install the capscrews used to attach the tube clips for the thermo gage tube to the hydraulic steering pump reservoir cover.

8. Connect the lower end of the fuel return front tube to the tube connector at the lower right side of the engine flywheel housing.

9. Connect the lower end of the hydraulic steering pump reservoir breather tube to the elbow in the top of the pump reservoir cover. Connect the lower end of the engine oil gage tube to the tube connector located to the rear of the cylinder head. Connect the lower end of the fuel pressure gage tube to the "tee" connection located to the rear of the cylinder head.

10. Connect the upper end of the engine primer tube to the primer pump.

11. Connect the front of the fuel supply tube to the elbow in the filter base. Place the clip mounting bracket in position at the rear of the starter and install the attaching capscrew.

12. Connect the wiring harness to the starter and the generator. Hold the wiring clips in position at the base of the filter and install the attaching capscrews.

13. Remove the tape from the ends of the battery ground cables (one each side) and install the capscrews, lockwashers, and internal teeth lockwashers used to attach the cables to the steering clutch housing. Install the internal teeth lockwashers between the cable end and the housing. Open the fuel tank shut-off valve.

14. Place the radiator to cowl bracing rods in position in the holes in the cowl and install the nuts on the rods. Coat the inside of the engine cooling system hoses, used to connect the radiator to the engine, with gasket cement or sealing compound. Using a suitable chain, cable, or rope, lift the radiator and shell assembly and install it in position on the main frame. When installing the radiator, insert the front ends of the radiator to cowl bracing rods into their respective holes at the top of the radiator shell. Install and tighten the two (2) bolts attaching each lower corner of the radiator shell to the main frame. Install and tighten the nuts on the radiator to cowl bracing rods.

15. Insert the fuse into position in the fuse connection, located at the left rear side of the radiator, and connect the two (2) wires together. Install the capscrew in the headlight wire clip and clip the wire in position to the lower left corner of the radiator shell.

16. Make certain that the radiator outlet hose (lower hose) is properly located on radiator outlet elbow and on the oil cooler elbow, then tighten the hose clamps. Install the radiator inlet elbow in position in its respective hoses and tighten the hose clamps.

17. Fill the engine cooling system (refer to "FILLING AND DRAINING OF SYSTEM" in Section IV).

18. Check the adjustment of the engine control linkage (refer to "ENGINE CONTROLS AND GOVERNOR" in Section VI).

19. Check the exhaust valve lash (refer to "VALVE LASH ADJUSTMENT" in this section).

20. Time and equalize the injectors (refer to "INJECTOR TIMING" and "INJECTOR EQUALIZING" in Section II).

21. 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 insure initial lubrication of the various components within the engine.

22. 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. Turn the filter base by-pass valve to the on position (handle away from filters) and allow the second stage filter to fill with fuel. Close the filter air vent when fuel runs out, then, turn the filter base by-pass valve to the off position (handle positioned next to the first stage filter shell).

23. 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).

24. Install the front and center floor plates, front fenders, engine hood, and air pre-cleaners.

25. 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

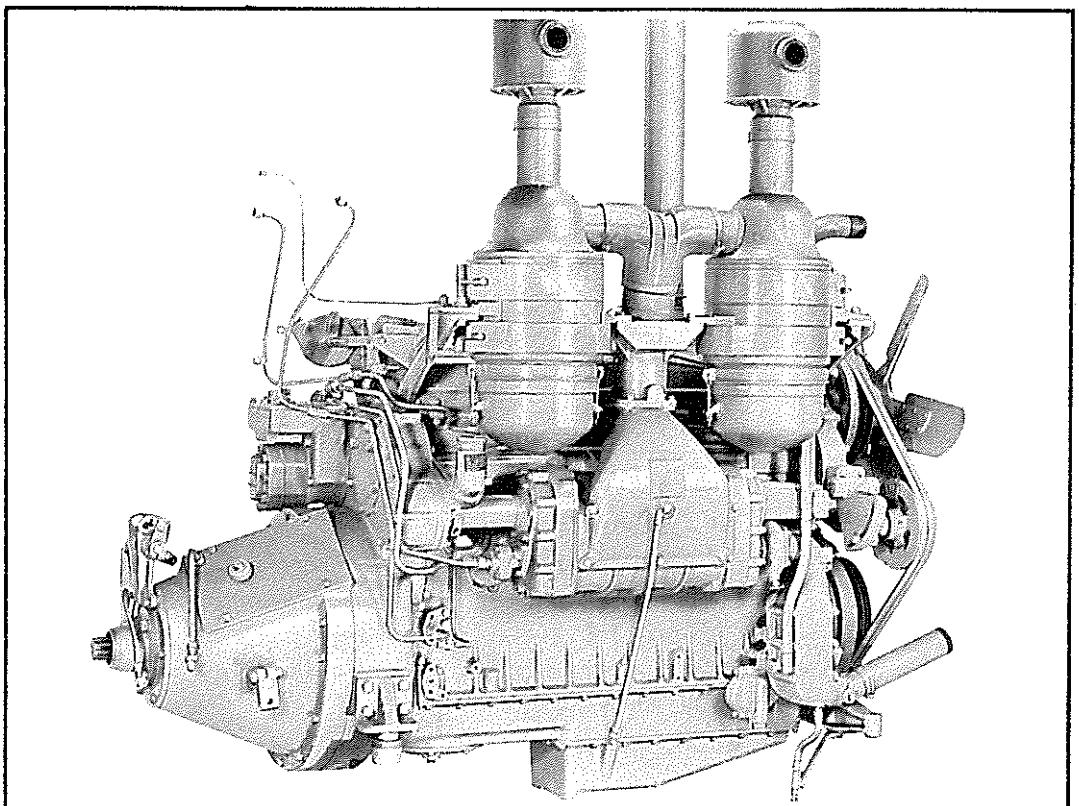


Fig. 45 — Right Side of Engine

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.

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 Figs. 44 and 45 when removing the accessories.

1. With the engine suspended from a hoist or supported on blocks, remove the following parts from the left side of the engine so that the engine can be mounted to an engine stand if one is available:

   Remove the muffler, generator, generator mounting bracket, lubricating oil and fuel oil filter assembly including the filter base, starter, and engine air box drain tube. Remove the capscrews attaching the clips on the fuel tubes extending from the filters around the rear of the engine to the fuel pump and the fuel manifold, then disconnect these tubes and remove them from the engine. Remove the air box handhole covers from the side of the cylinder block.

2. Remove the upper lubricating hose for the engine clutch shifting sleeve bearing and remove the jam nut and lockwasher attaching the upper end of the hose to the clutch housing. Push the end of the lubricating hose down into the clutch housing.

3. Remove the capscrews attaching the engine clutch housing to the engine flywheel housing and properly supporting the clutch housing, move it towards the rear until the clutch shaft has moved free of the shifting sleeve bearing carrier assembly, then remove it from the engine.

4. Loosen the hose clamps on the rubber tee connecting the air cleaners to the air inlet elbow, and remove the rubber tee. Remove the capscrews, washers, and nuts attaching the air cleaner mounting band brackets to the air inlet elbow and to the front and rear

air cleaner mounting brackets. Raise the air cleaners and remove from the engine.

5. Disconnect the engine primer tube from the air inlet elbow. Remove the cotter pin and plain washer from the swivel pin in the front end of the engine shut-off front rod, used to connect the shut-off rod to the air shut-off valve lever. Remove the capscrews attaching the air inlet elbow to the blower air inlet housing and remove the inlet elbow from the engine. *IMPORTANT: Cover the opening in the blower inlet housing after removing the inlet elbow.*

6. With the above accessories removed, the engine can be mounted on a stand similar to the one shown in Fig. 46. With this stand, the engine is held by a heavy mounting plate provided with screw clamps to fasten to the left side of the cylinder block. The engine may be rotated on the stand for convenience in assembly or disassembly.

7. Loosen the tension on the fan belts and remove the three (3) capscrews attaching the fan mounting bracket to the engine balance weight cover, then remove the fan assembly from the engine.

8. Remove the crankshaft pulley and the vibration damper assembly (refer to "REMOVAL OF VIBRATION DAMPER" in this section).

9. Remove the fan belt tightening idler assembly.

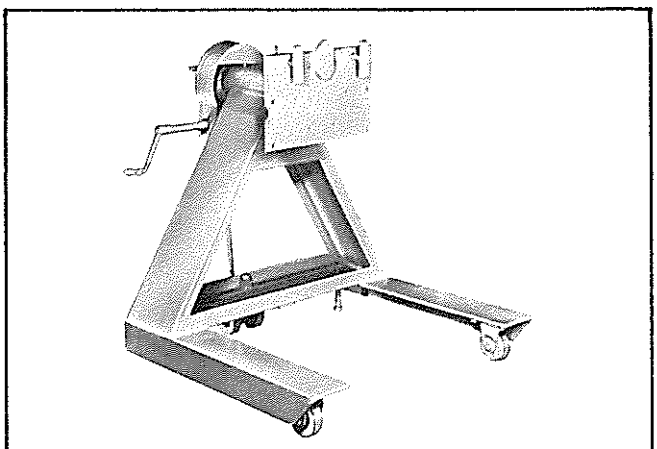


Fig. 46 — Engine Stand

10. Drain the engine lubricating oil. Loosen the hose clamp on the water pump to oil cooler seal and slip the seal up on the pump inlet.

    Remove the capscrews attaching the oil cooler housing to the adapter assembly and remove the housing and the cooler core. Remove the capscrews attaching the oil cooler adapter to the cylinder block and remove the adapter.

11. Disconnect the throttle and engine shut-off control rods, located on the upper right side of the engine, and remove the rod assemblies. Do not disturb the adjustment of the control rods.

12. Remove the governor breathing tube. 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 and to the governor weight housing, then remove the governor control housing assembly. Pull the top of the housing away from the engine and push the lower end of the housing towards the engine to disengage the fork, then lift the assembly out.

13. Remove the water manifold and the water by-pass tube.

14. Remove the two (2) capscrews used to attach the water pump outlet packing flange to the cylinder block. Loosen the hose clamp used on the blower drive shaft cover seal. Remove the oil level gage rod and the gage rod tube. Remove the capscrews attaching the blower to the cylinder block, then move the blower assembly (including accessories) towards the front, leaving the blower drive shaft in the drive gear housing, and remove the blower assembly.

15. Remove the five (5) capscrews attaching the hydraulic steering pump adapter assembly to the engine flywheel housing, then remove

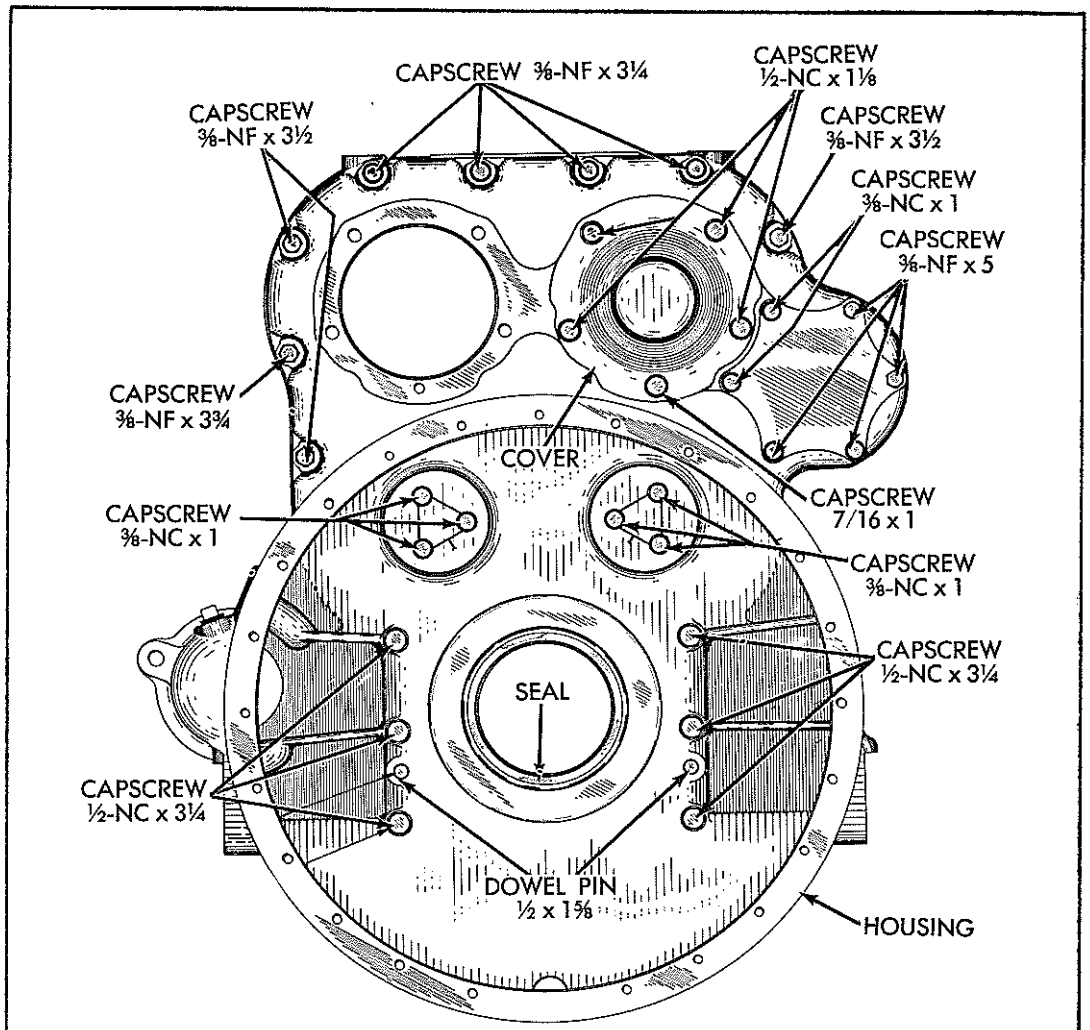


Fig. 47 — Flywheel Housing

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 balance shaft gear and remove the coupling disc.

16. Remove the capscrews attaching the engine clutch assembly to the flywheel and remove the clutch assembly, including the driven disc.

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" N.C. capscrews into the two (2) tapped holes in the flywheel and use them as puller studs to force the flywheel from the crankshaft hub.

3. Remove the lower and the upper crankcase oil pans.

4. Remove the bolts and capscrews attaching the flywheel housing to the cylinder block rear end plate and to the cylinder block. Remove the capscrews inside the flywheel compartment that attach the housing to the idler gear hub and the spacer ("dummy" hub). Tap and pry the housing off the two (2) dowels located on each side of the crank-

shaft and remove the housing.

5. Remove the capscrews attaching the balance weight cover to the cylinder block front end plate and remove the cover. Remove the retaining nuts and lockwashers holding the balance weight assemblies on the camshaft and the balance shaft. Pry the weight assemblies from the shafts by using two (2) heavy screwdrivers or pry bars between the heads of the bearing retaining capscrews and the balance weight hubs as shown in Fig. 37. Remove the "Woodruff" keys from the shafts. When removing the balance weight retaining nuts from the shafts, the shafts may be held from turning by "wedging" a block of wood between the weights. Remove the front thrust washer from each shaft.

6. Remove the set screws that hold the intermediate camshaft bearings from turning. *NOTE: A good practice to prevent loss of these set screws is to install them in similar tapped holes above the balance shaft as they are removed from the camshaft side.*

7. After removing the set screws, remove the three (3) capscrews attaching each rear bearing of the camshaft and the balance shaft to the rear end of the cylinder block. To reach these capscrews, insert a socket wrench through the holes in the webs of the camshaft and balance shaft gears and turn the gears until the holes aline with the capscrews. Remove the camshaft and the balance shaft out of the cylinder block by pulling out on the gears. The rear bearings of both shafts and the intermediate bearings on the camshaft will remain on the shaft and be removed with them. Slide the front bearings out of the front end of the cylinder block after removing the three (3) attaching capscrews from each.

8. Remove the capscrew in the center of the idler gear hub and the flywheel housing-to-cylinder block spacer ("dummy" hub) and remove the assemblies.

9. Remove the capscrews attaching the crankshaft rear gear to the crankshaft hub. Install two (2) ⅜" N.F. capscrews in the tapped holes in the crankshaft gear and push the gear off the end of the crankshaft.

10. Remove the capscrews attaching the crankshaft front cover and slide the vibration damper rear cone, front oil seal, and the cover assembly off the crankshaft.

11. Disconnect each end of the oil pipe for the blower drive support assembly, then remove the capscrews attaching the blower drive support to the cylinder block rear end plate and remove the support assembly and the oil pipe.

12. Remove the capscrews attaching the cylinder block rear end plate to the cylinder block and remove the end plate. Remove the capscrews attaching cylinder block front end plate to the cylinder block and remove the end plate.

13. Remove the oil pump (refer to "OIL PUMP REMOVAL" in Section V). Remove the oil pressure regulator from the cylinder block.

14. 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 if out through the top of the cylinder. Install each bearing cap on its respective connecting rod as they are removed.

15. Remove all the main bearing caps and lift the crankshaft from the cylinder block. If necessary, remove the oil pump driving gear and "Woodruff" key from the front end of the crankshaft.

16. Remove the cylinder liners from the cylinder block. Remove all the plugs from oil and water passages so that the cylinder block can be thoroughly cleaned.

    CAUTION: Note the location of all plugs removed so that they can be re-installed in their correct position.

17. 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 that all the 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 coated with gasket cement.

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 that all the plugs that have been removed to clean the oil and water passages in the cylinder 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 cylinder 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 position in the crankshaft bearing seats of the cylinder block. The upper bearing 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 main 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 main 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 main bearing cap. The bearing caps are numbered 1, 2, 3, etc., indicating their respective positions. Install the caps with the numbered side toward the blower side of the cylinder block and install the main bearing cap bolts and lockwashers. Tighten the bolts to a torque of 180 to 190 ft. lbs. The use of a torque wrench is recommended for this purpose.

   CAUTION: DO NOT OVERTIGHTEN THE BOLTS. 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 bolts are tight. Never file or shim a bearing 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. Install the engine clutch shaft pilot bearing oiling wick if it was removed for replacement, (refer to "REPLACEMENT OF ENGINE CLUTCH SHAFT PILOT BEARING OILING WICK" in Topic 5 of this Section).

5. Turn the cylinder block on end, or lay it on its side, for installation of the cylinder liners. On Tractors having Engine Serial No. 6A-16283 and above (having the new type cylinder block as explained in "CYLINDER BLOCK AND LINERS," Topic 4 in this section), make certain that the cylinder liner inserts, used in the counterbores of the cylinder block beneath the flange of the liners, are clean, flat, and smooth so that the inserts rest perfectly in the counterbores and will allow the cylinder liners to slide freely through when the liners are installed. *NOTE: These cylinder liner inserts are not used in tractors having engines prior to Serial No.*

6A-16283. In these engines, the flange at the top of the cylinder liners rest directly on the flat surface of the counterbores in the cylinder block.

6. Keeping the information in mind in Step 5 above, install the cylinder liner inserts in position in the counterbores of the cylinder block if the cylinder block is of the new type requiring the inserts. Install the cylinder liners in position and check to location of the top of each cylinder liner flange in relation to the top flat surface of the cylinder block. In tractors having the new type cylinder block (requiring the cylinder liner inserts), the top surface of each cylinder liner flange must be .046" to .050" below the top flat surface of the cylinder block and the difference between any two adjacent cylinder liners should not exceed .002".

   In tractors having the first type cylinder blocks (blocks not requiring the cylinder liner inserts), the top surface of each cylinder liner flange must be .002" to .006" above the top flat surface of the cylinder block and the difference between any two adjacent cylinder liners should not exceed .002".

   These dimensions mentioned above must be held in order to obtain proper sealing of the gasket set, between the cylinder head and the cylinder block, when the cylinder head is tightened in place.

7. In tractors having the new type cylinder block (requiring the cylinder liner inserts), if the top surface of any cylinder liner flange is not .046" to .050" below the top flat surface of the cylinder block, or the difference between any two adjacent cylinder liners exceeds .002", the necessary cylinder liner shims must be installed between the bottom of the cylinder liner flange and the top of the cylinder liner insert. The shims are available in two sizes: .0015" and .003" thick.

   In tractors having the first type cylinder block (blocks not requiring the cylinder liner inserts), if the top surface of any cylinder liner flange is not .002" to .006" above the top flat surface of the cylinder block, or the difference between any two adjacent cylinder liners exceeds .002", the necessary cylinder liner shims must be installed between the bottom of the cylinder liner flange and the surface that the flange of the cylinder liner contacts in the cylinder block. The shims are available in two sizes: .0015" and .003" thick.

   CAUTION: When installing cylinder liner shims, make certain that the shims are smooth and entirely free from burrs and wrinkles.

8. Install the piston and connecting rod assemblies. The lower end of each rod, as well as the bearing caps, are numbered 1, 2, 3, etc. on one side. These numbers identify the bearing caps with the rods and show the particular cylinder with which each rod is used; the numbered side of the rod always faces 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 tool over the lower end of the piston skirt, with flared end of the tool toward the top of the piston. Turn the piston connecting rod so that the identification mark on the lower end of the rod is toward the blower side of the cylinder block. Aline the lower end of the connecting rod with the crankshaft before pushing the piston in the cylinder. By tapping on the upper end of piston, with the wooden handle of a hammer, drive the piston into the cylinder bore. Be sure that the piston ring compressor tool is down tight on the top of the cylinder liner so that the piston rings cannot snap out of the ring compressor before entering the cylinder liner bore.

   b. Lubricate and install the connecting rod 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 connecting rod lower bearing shell, with one continuous groove from parting line to parting line, into the bearing cap with the tang of the shell in the groove of the cap, and install the cap and shell in place.

d. Tighten the connecting rod nuts to a torque of 65 to 75 ft. lbs. and secure the nuts with cotter pins. *NOTE: Never file or shim the bearing caps to make the bearings fit. Install new bearing shells if the fit is unsatisfactory. The crankshaft must turn freely after all of the connecting rod nuts have been tightened.*

e. Hold the cylinder liners in place while turning the crankshaft. Since the cylinder liners are a loose fit in the bores, the drag of the piston rings on the cylinder liners is sufficient to pull them out of the cylinder block.

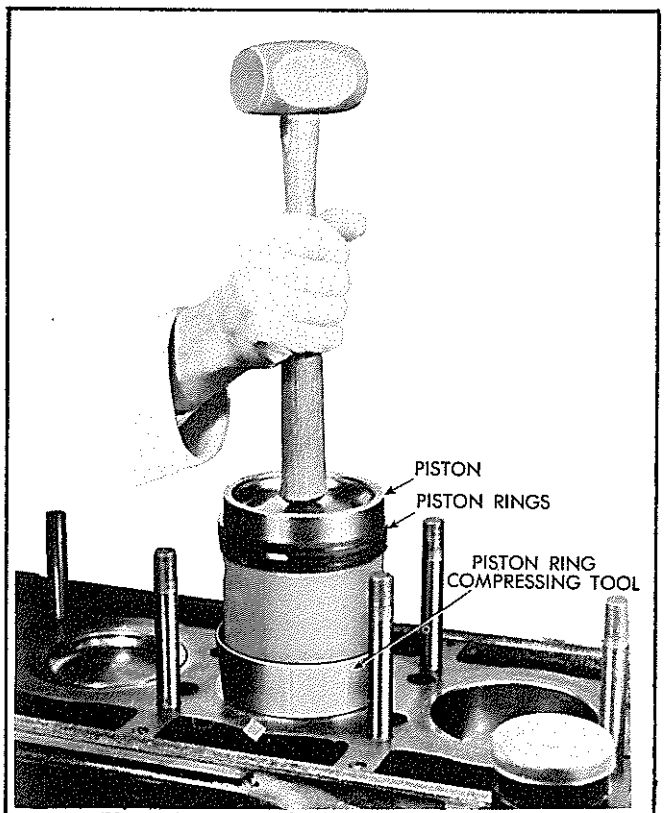


Fig. 48 — Use of Ring Compressor Tool

9. Cement a new end plate gasket to the front end of the cylinder block and coat the outer surface of the gasket with gasket cement. Install the front end plate, first making sure that both surfaces are free of nicks or burrs. Attach the end plate using two (2) ½" N.C. x 1⅛" capscrews, five (5) ⅜" N.C. x 1" capscrews, and one (1) ⅜" x 3" capscrew. The ⅜" N.C. x 3" capscrew should be inserted through the generator belt adjusting link when installing. Use lockwashers on all the capscrews when installing. *NOTE: Before tightening the end plate capscrews, insert the camshaft front bearing in the hole in the end plate and the cylinder block (on blower side of engine) to accurately aline the hole in the end plate with the bore in the cylinder block.* The holes in the end plate for the camshaft and the balance shaft are not the same size. The hole for the camshaft is accurately machined to 2.187" diameter while the hole for the balance shaft measures 2.250" in diameter. For this reason, it is important that the camshaft bearing be inserted in the camshaft opening for alinement purposes.

10. Install the rear end plate and gasket on the rear end of the cylinder block in the same manner, with the hole in the end plate for the blower drive support toward the blower side of the cylinder block. Attach this plate with six (6) capscrews; the capscrews to be installed in the holes just above and below the idler gear hub and the spacer ("dummy" hub) bores. Use the same method as explained in step 9 to aline the holes in the end plate with the camshaft and the balance shaft bores in the cylinder block before tightening the capscrews.

11. Install the rear bearings and the gears on the camshaft and the balance shaft as explained in "INSTALLATION OF PARTS ON THE CAMSHAFT AND BALANCE SHAFT" in this Section.

a. Start the balance shaft, including the rear end bearing and gear assembly, into position at the rear end of the cylinder block (in the left bore when viewed from the rear of the engine). Secure the balance shaft rear end bearing with three (3) lockwashers and capscrews; tighten the capscrews to a torque of 35 to 45 ft. lbs. Apply grease to the steel

side of one of the thrust washers and place the washer on the rear face of the end bearing assembly which is to be installed in the front position. Make certain that the steel side of the thrust washer is next to the end bearing assembly. Lubricate the end bearing assembly with engine oil and insert it into position in the cylinder block and onto the balance shaft. Use care when inserting the end bearing so that the thrust washer will not be dislodged. Secure the end bearing assembly to the cylinder block with three (3) capscrews and lockwashers; tighten the capscrews to a torque of 35 to 45 ft. lbs.

b. Apply grease to the steel side of the thrust washer to be used in the front position on the balance shaft, then place the washer in position on the front face of the end bearing assembly. Make certain that the steel side of the thrust washer is next to the end bearing assembly. Install the "Woodruff" key in the slot in the front end of the shaft, then install the balance weight assembly on the balance shaft, with the weight and spring retainer away from the engine. Place the lockwasher on the balance shaft, then start the retaining nut, but do not tighten the nut at this time as it will be tightened after the installation of the camshaft.

c. Refer to "INSTALLATION OF PARTS ON THE CAMSHAFT AND BALANCE SHAFT" in this Section and make certain that the correct camshaft intermediate bearings are installed on the camshaft. Start the camshaft, including the rear end bearing, intermediate bearings, and the gear assembly, into position at the rear end of the cylinder block (in the right bore when viewed from the rear of the engine). Push the shaft into position to the point where the camshaft gear teeth are about to engage with the balance shaft gear, then revolve the gears if necessary so that the "O" timing marks on the cam and balance shaft gears will match, as shown in Fig. 40, and slide the camshaft gear into mesh. Secure the camshaft rear bearing assembly to the engine block with three (3) lockwashers and capscrews. Tighten the capscrews to a torque of 35 to 45 ft. lbs.

d. Revolve the camshaft intermediate bearings so that the set screw holes in the bearings aline with the holes in the top of the cylinder block, then install the set screws and tighten securely. *IMPORTANT: Refer to NOTE in Step 3 of "INSTALLATION OF PARTS ON THE CAMSHAFT AND BALANCE SHAFT" in this Section and make certain that the correct set screws and intermediate bearings are installed in their correct position.*

e. Apply grease to the steel side of one of the thrust washers and place the washer in position on the rear face of the end bearing assembly which is to be installed in the front position. Make certain that the steel side of the thrust washer is next to the end bearing assembly. Lubricate the end bearing assembly with engine oil and insert it into position in the cylinder block and onto the camshaft. Use care when inserting the end bearing assembly so that the thrust washer will not be dislodged. Secure the end bearing assembly to the cylinder block with three (3) capscrews and lockwashers; tighten the capscrews to a torque of 35 to 45 ft. lbs.

f. Apply grease to the steel side of the thrust washer to be used in the front position, then place the washer in position on the front face of the end bearing assembly. Make certain that the steel side of the thrust washer is next to the end bearing assembly. Install the "Woodruff" key in the slot in the front end of the camshaft, then install the balance weight assembly on the camshaft, with the weight and spring retainer away from the engine. Place the lockwasher on the camshaft, then start the retaining nut.

g. Wedge a block of wood between the balance weights, as shown in Fig. 36, and

tighten the retaining nuts on both the cam and balance shafts to a torque of 300 to 325 ft. lbs.

CAUTION: When tightening the retaining nuts for the balance weights and gears, DOUBLE CHECK and MAKE SURE that the thrust washers are in their proper position over the extended bearings.

h. Check the end play of the balance shaft and the camshaft by inserting a feeler gage between the thrust washer and the balance weight assembly, with the shaft pushed to its forward position. The end play should not be less than .004" and should not exceed .018". Thrust washers of .010" oversize in thickness are available for service.

i. Wedge a clean cloth between the balance shaft and the camshaft gear, then tighten the retaining nuts to a torque of 300 to 325 ft. lbs. Install the nut retainers on the gears and tighten the attaching capscrews securely.

12. Install the idler gear assembly (refer to "GEAR TRAIN" Topic 9 in this Section).

13. 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 rear end plate, meshing the drive gear with the camshaft 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). *CAUTION: Two (2) ⅜" N.F. x 13/16" capscrews must be used at this point as longer capscrews will strike the camshaft gear.*

14. Install the flywheel housing as follows:

a. Press a new crankshaft rear oil seal into the housing (the lip of the seal must face the engine when the housing is installed).

b. Cement the flywheel gasket to the rear end plate. Using the oil seal expander tool placed on the dowels in the crankshaft as shown in Fig. 49 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 using the correct length and size bolts and capscrews as shown in Fig. 47.

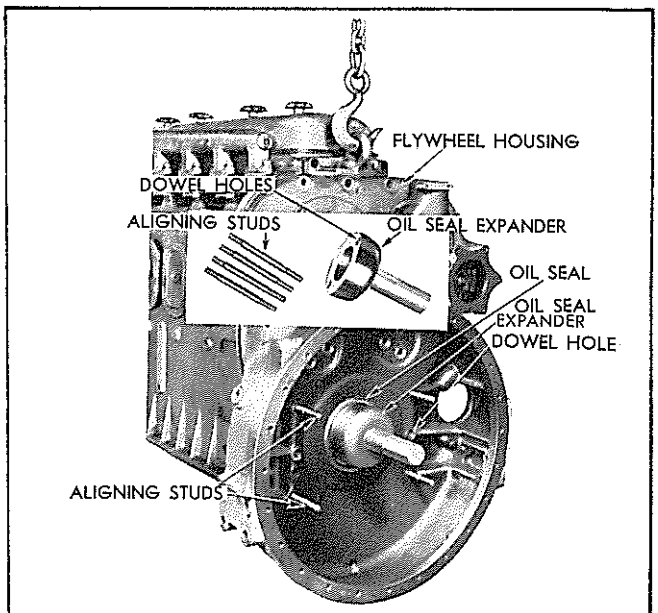


Fig. 49 — Use of Oil Seal Expander Tool

c. Cement a gasket to the flywheel housing at the camshaft gear opening, and install the flywheel housing star cover.

d. 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.

15. Insert the "Woodruff" key in the slot in the crankshaft next to the front main bearing. Then install the oil pump driving gear on the front end of crankshaft, with the hub of the gear facing the main bearing. Install the oil slinger with the dished outer diameter away from the gear.

16. Install the crankshaft front oil seal in the crankshaft front cover in the same manner as was used in installing the rear oil seal in the flywheel housing (the lip of the seal should face the gear when the cover is in-

stalled). Cement a new gasket to the crankshaft front cover and install the cover in position on the crankshaft and onto the dowel pins in the cylinder 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.

17. Install the vibration damper assembly and the crankshaft pulley. Refer to "VIBRATION DAMPER" in this Section.

18. Turn the engine upside down, and after checking to be sure that cotter pins have been installed in all the 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.

19. Install the upper and lower crankcase oil pans using new attaching gaskets. Install the oil pan handhole cover, using a new gasket, if it was removed. Install and tighten the oil pan drain plugs.

20. Turn the engine right side up. Cement a new gasket to the balance weight cover and install the cover. Attach the cover with the capscrews and lockwashers removed at disassembly.

21. Install the cylinder head (refer to "CYLINDER HEAD INSTALLATION" in this Section).

22. 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).

23. Install the flywheel on the rear end of the crankshaft and install the 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 crankshaft flange. Tighten the flywheel attaching capscrews to a torque of 150 to 160 ft. lbs. and install the locking wires in the heads of the capscrews and twist the ends of the wires.

24. Install the engine clutch shaft pilot bearing in the flywheel if it was removed.

25. Cement the two (2) small oil cooler adapter-to-cylinder block gaskets to the attaching pads on the block. Attach the adapter to the block with the capscrews and lockwashers which were removed when disassembling the engine. Cement a new gasket to each side of the bolting flange of the oil cooler core, coat the outer surfaces of the gaskets with cement, then place the core in the cooler housing and attach the housing and core to the adapter. Tighten the attaching capscrews securely.

26. Install the engine blower (refer to "BLOWER INSTALLATION" in Section III).

27. Install the governor control shaft housing assembly (refer to "GOVERNOR INSTALLATION" in Section VI).

28. Using new gaskets, install the water manifold and water by-pass tube assembly.

29. Install the fan, fan belt tightening idler, and the fan and generator drive belts and adjust the fan belts. Refer to "FAN, FAN BELTS, AND FAN BELT TIGHTENING IDLER" in Section IV.

30. If the engine was mounted on an engine stand it must now be removed in order to install various parts on the left side of the engine.

31. Place the hydraulic steering pump coupling

plate in position on the engine balance shaft gear, then install the attaching capscrews and tighten the capscrews securely. Install the capscrew locking wires. Make certain the locking wires are bent away from the internal teeth of the coupling plate far enough to clear the small internal teeth of the driven coupling gear (refer to Fig. 15 in Section XII). Clearance for the installation of the driven coupling gear may be checked by installing the gear into the coupling plate before installation of the hydraulic steering pump is made. The internal teeth of the driven coupling gear must engage the teeth in the coupling plate without touching the locking wires on the coupling plate. Attach the hydraulic steering pump to the engine (refer to "INSTALLATION OF HYDRAULIC PUMP" in Section XII).

32. 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.

33. Install the lubricating oil and fuel filter assembly, including the filter base, and connect the fuel and lubricating oil lines. *IMPORTANT: New filter elements should be installed after overhauling the engine.*

34. Install the air box drain tube assembly on the left side of the engine.

35. Install the engine clutch and clutch housing (refer to "ENGINE CLUTCH AND BRAKE" in Section X).

36. Install the throttle and engine shut-off control rods. Using new gaskets, install the muffler.

37. Using new gaskets, install the handhole covers on the cylinder block. Install the engine air cleaners making certain that the hose clamps on the rubber connecting tee form a tight seal.

38. 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 overhall, inspect engine oil level, fuel oil, hydraulic steering system oil 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 in a new engine, or one which has just been overhauled, is OPERATING TEMPERATURE. The thermostat must function properly to maintain a normal operating temperature of 160° F. 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, THEREFORE, EVER IN THE LIFE OF A TRACTOR, ALLOW IT 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 should be engaged 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 CLUTCH BRAKE

1. ENGINE CLUTCH

A. Description

The engine clutch is a single plate, dry clutch with an over-center, cam-engaging action. A shifting sleeve and release bearing carrier assembly, carried on the clutch shaft and connected by linkage to the clutch camshafts, is operated by the clutch operating lever to engage and disengage the clutch. A threaded adjusting ring provides a means of maintaining the necessary adjustment to compensate for normal wear on the clutch facings.

The clutch operating lever and clutch operating yoke shafts are assembled on needle bearings that are sealed and grease packed for life. The clutch camshafts, shifting sleeve, shifting sleeve ball bearing (throwout bearing), and the clutch shaft rear bearing require periodic lubrication.

The clutch back plate is bolted to the rear face of the engine flywheel and carries most of the clutch weight, thus adding to the flywheel effect. The clutch driven disc assembly, which is splined to the clutch shaft, is engaged between the pressure plate and the rear face of the flywheel when the clutch camshafts are moved by the links connected to the clutch shifting sleeve assembly. The facings on both sides of the driven disc are cemented directly to the disc. When the clutch is disengaged, the friction between the pressure plate, clutch driven disc, and flywheel is relieved and the clutch brake stops the rotation of the driven disc and the clutch shaft. The other clutch parts continue to turn with the engine flywheel, and the clutch shifting sleeve bearing turns on its sleeve.

The front end of the engine clutch shaft is mounted in the clutch shaft front bearing (pilot bearing) located inside the engine flywheel and the rear end of the shaft in a ball bearing inside the rear of the clutch housing. The clutch shaft is connected to the transmission top shaft (input shaft) by a universal joint assembly. By removal of the universal joint assembly, the engine clutch can be removed without disturbing the engine or the transmission.

The engine clutch brake assembly consists of two (2) brake plates or discs. One plate with two (2) small brake facings is attached to the clutch shifting bearing sleeve carrier. This plate is stationary and is adjustable by means of an adjusting ring. The other plate, or disc, has no facings and is bolted to the clutch shaft. This plate rotates with the clutch shaft. As the engine clutch is disengaged, the brake plate, mounted to the clutch shifting sleeve is moved back and contacts the brake disc, thus stopping the rotation of the clutch shaft. The clutch brake is applied by pressing forward on the clutch operating lever after disengaging the engine clutch.

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 a maximum of 55 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 30 pounds, an adjustment is necessary. *IMPORTANT: Do not operate the tractor when the pull on this lever is less than 30 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 cemented to the driven plate and cannot be serviced in the field.

IMPORTANT: SINCE MOST CLUTCH FAILURES ARE THE RESULT OF IMPROPER MAINTENANCE, IT IS VERY IMPORTANT THAT THE CLUTCH AND CLUTCH BRAKE ARE KEPT IN PROPER ADJUSTMENT AT ALL TIMES AND THAT THE CLUTCH COMPONENTS ARE LUBRICATED AS RECOMMENDED. DO NOT SLIP THE CLUTCH EXCESSIVELY WHEN ENGAGING.

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 55 pounds is required 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 30 pounds, an adjustment is necessary. Do not operate the tractor when the pull on this lever is less than 30 pounds.

IMPORTANT: Before checking the pounds pull required to engage the clutch, make certain that the clutch cams are well lubricated and that the clutch linkage is not binding, or a false reading will be obtained.

The clutch will engage with a distinct over center snap when it is properly adjusted.

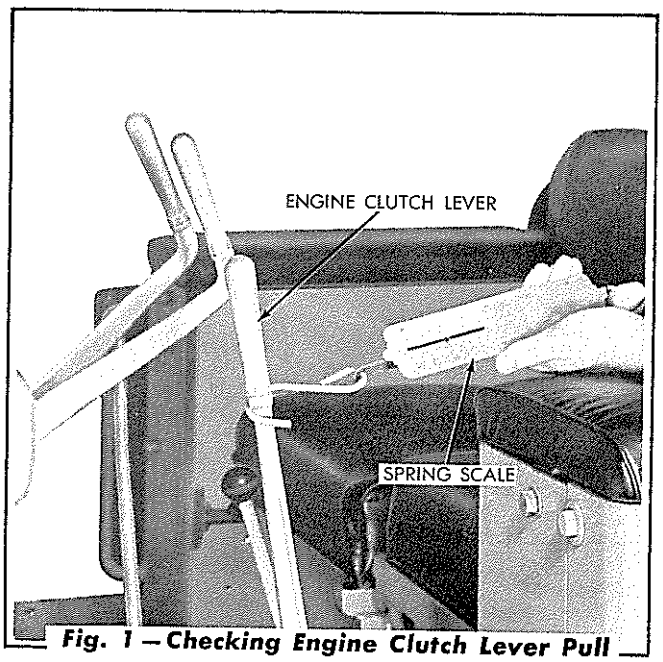


Fig. 1 — Checking Engine Clutch Lever Pull

To Adjust the Clutch

1. Remove the clutch inspection cover from the top of the clutch housing by removing the two lower capscrews and loosening the two upper capscrews. The upper 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 clutch adjusting lock can be reached through the inspection hole (refer to Fig. 2). Disengage the adjusting lock from the slot in the back plate.

3. Using a suitable pry bar or a hammer and a small driving bar, pry or tap on the lugs of the adjusting ring to tighten or loosen the clutch. Turn the adjusting ring clockwise to tighten or counter clockwise to loosen.

4. When the proper adjustment has been made, (53 to 55 pounds pull on lever with engine stopped), lock the adjusting ring in place by engaging the adjusting lock into the nearest slot in the back plate. Install the clutch inspection cover.

D. Engine Clutch Brake Adjustment

After each adjustment of the engine clutch, the setting of the clutch brake should be checked. Proper setting of the clutch brake must be maintained for ease of gear shifting. The clutch brake is properly set when there is a clearance of 1-3/16" between the clutch brake plate facings and the clutch brake disc when the engine clutch is in its engaged position.

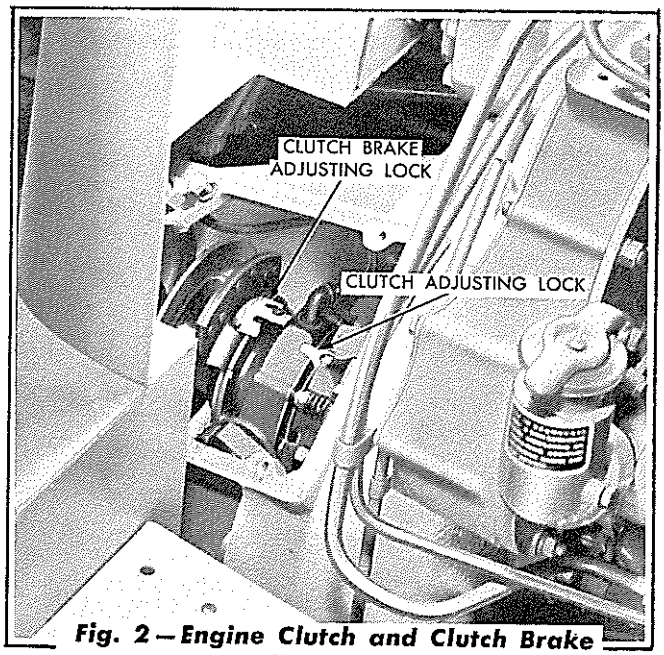


Fig. 2 — Engine Clutch and Clutch Brake Adjusting Locks

Inspect the clutch brake facings periodically and replace the facings when badly worn.

To Adjust Clutch Brake

1. Engage the engine clutch.

2. Turn the notched adjusting ring (refer to Fig. 2) in or out to obtain 1-3/16" clearance between the clutch brake plate facings and the clutch brake disc. *NOTE: It is not necessary to remove the clutch brake adjusting lock when making the adjustment.*

E. Clutch Linkage Adjustment

The engine clutch lever control 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 lever control 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.

F. Washing Engine Clutch

Oil leaks or over-lubrication of the clutch components 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. If a drain plug is installed in the bottom (front) of the engine flywheel housing, remove the plug and drain the clutch and flywheel housing. If a drain plug has not been installed in the housing, this step is unnecessary.

2. Install the drain plug in the bottom of the flywheel housing. Remove the clutch inspection cover from the upper right side of the clutch housing.

3. Pour cleaning solvent into the housing until the level is 1¼" below the clutch shaft. Install the inspection cover and operate the engine at low idle speed for approximately 5 minutes with the clutch disengaged.

4. Stop the engine, remove the drain plug, and drain the solvent. If the solvent is excessively "oily," refill the housing and repeat the washing process. *CAUTION: LUBRICATE THE CLUTCH SHIFTING BEARING, THE SHIFTING SLEEVE, THE CLUTCH SHAFT REAR BEARING, AND THE THREE CAMSHAFTS THOROUGHLY AFTER THE CLUTCH HAS BEEN WASHED AND THE HOUSING DRAINED AS THE LUBRICANT MAY HAVE BEEN WASHED FROM THESE PARTS DURING THE WASHING PROCESS.*

5. Operate the tractor 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 facings.

G. Clutch Removal

The engine clutch may be removed from engine with the cowl in place on the tractor, or if desired, the cowl may be loosened and placed on the track as shown in Fig. 3. The following procedure for clutch removal is with the cowl mounted in place.

1. Remove the front and center floor plates and the supporting channel for the front and center floor plates.

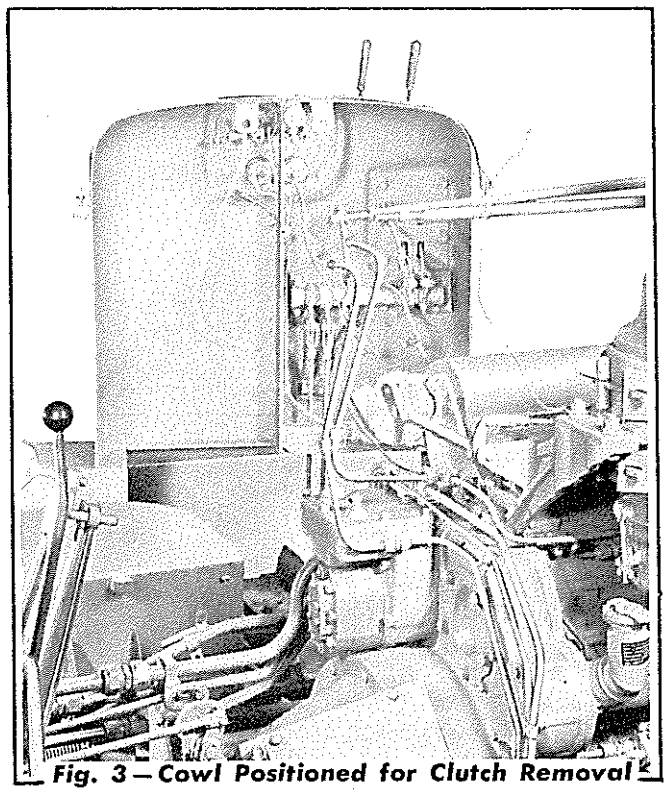


Fig. 3 — Cowl Positioned for Clutch Removal

2. Remove the two (2) jam nuts attaching the lubricating hoses for the clutch shaft bearing and the clutch shifting sleeve bearing to the base of the cowl.

3. 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 steering control rods to the lower cross shaft levers. Remove the capscrews attaching the lower cross shaft bracket to the rear of the engine clutch housing and remove the bracket and lower control rods as an assembly.

4. Unclamp the hydraulic steering fluid tubes (front sections), remove the capscrews attaching the tube clamp supporting bracket to the rear of the clutch housing, and remove the bracket.

5. Disconnect and remove the right brake pedal retracting spring. Remove the yoke pin connecting the right brake front control rod to the right brake pedal shaft lever. Remove the capscrews attaching the right brake pedal shaft bracket to the main frame and remove the bracket, right pedal lever shaft, and pedal lever as an assembly.

6. Remove the engine clutch inspection cover plate from the housing. Remove the upper lubricating hose for the engine clutch shifting sleeve bearing and remove the jam nut and lockwasher attaching the lower lubricating hose, for the clutch shifting sleeve bearing, to the clutch housing. Push the end of the lower lubricating hose down into the clutch housing.

7. Unlock and remove the four (4) capscrews attaching the rear of the universal joint to the transmission shaft yoke. Lower the loosened end of the universal joint, pull towards the rear until the front yoke on the universal joint assembly is free of the clutch shaft, and remove the universal joint. *IMPORTANT: Straighten the capscrew lock and remove the capscrew, lock, and retaining washer attaching the yoke to the transmission top shaft. Remove the yoke seal and the yoke from the transmission top shaft.*

8. Engage the engine clutch, then remove the yoke pin connecting the front end of the clutch operating lever control rod to the shifting yoke shaft lever at the left side of the clutch housing.

9. Remove the capscrews attaching the clutch shaft rear bearing retainer to the rear of the clutch housing. Pry out on the clutch shaft rear bearing retainer until it is free of the clutch housing, then pull back on the clutch shaft complete with its components and remove the assembly from the housing.

10. Remove the capscrew, nut, and lockwasher attaching the gear shifting plunger operating lever to the end of the clutch operating yoke shaft (right side of clutch housing). Pry the operating lever off the end of the shaft, then disconnect the rear end of the plunger rod from the lock plunger and remove the assembly. Remove the yoke pin connecting the front end of the shifting lock plunger rod to the clutch shifting yoke shaft lever (left side of clutch housing), then disconnect the rear end of the plunger rod from the lock plunger and remove the assembly.

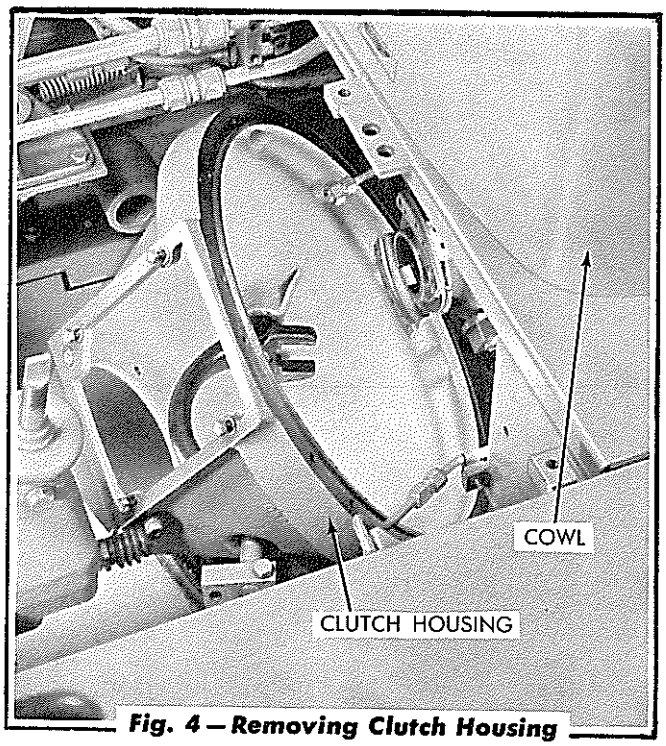


Fig. 4—Removing Clutch Housing

11. Remove the capscrews attaching the clutch housing to the engine flywheel housing and remove the clutch housing, leaving the clutch assembly attached to the engine.

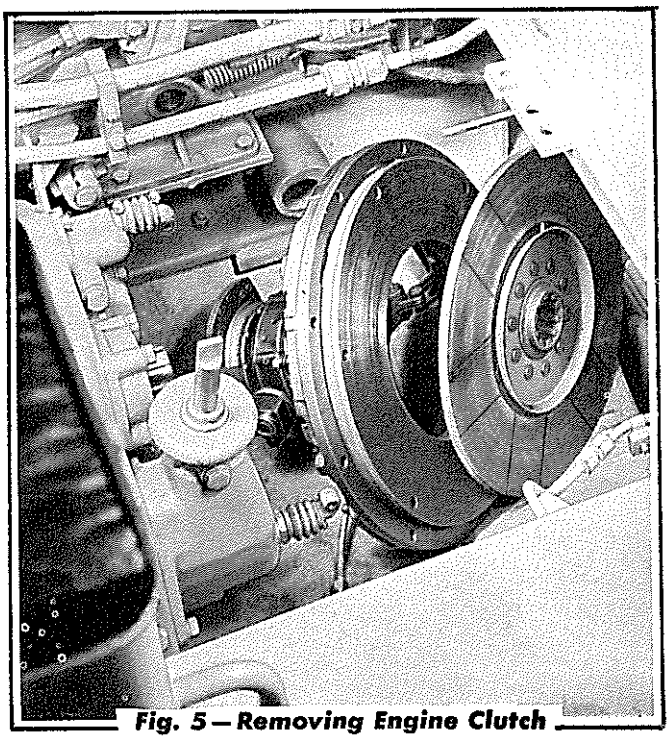


Fig. 5 — Removing Engine Clutch

12. Remove the capscrews attaching the clutch assembly to the engine flywheel and remove the clutch assembly. *CAUTION: When removing the clutch assembly use care and do not drop or damage the clutch driven disc assembly. Remove the driven disc assembly.*

H. Clutch Disassembly

Refer to Fig. 6 and disassemble the clutch as follows:

1. Place the engine clutch assembly on a clean work bench, with the pressure plate down.

2. Turn the clutch brake adjusting ring off the shifting sleeve bearing carrier.

3. Remove the three (3) pins used to connect the connecting links to the shifting sleeve assembly and remove the shifting sleeve assembly and the shifting sleeve bearing carrier assembly as a unit. Remove the capscrews attaching the shifting sleeve bearing retaining plate to the front of the shifting sleeve bearing carrier, then using a soft hammer, drive the shifting sleeve bearing carrier off the shifting sleeve bearing.

4. Remove the retaining ring from the shifting sleeve (retaining ring used next to bearing) and press the shifting sleeve out of the bearing. Remove the bearing retaining plate from the shifting sleeve.

5. Unlock the clutch adjusting ring and turn it out (turn counter clockwise) of the clutch back plate. Remove the adjusting ring then remove the adjusting ring plate. Remove the three (3) clutch camshafts.

6. Remove the nuts from the six (6) retracting spring screws and remove the pressure plate retracting springs.

7. Lift the clutch back plate off the pressure plate. Remove the six (6) retaining spring screws from the pressure plate.

8. Remove the capscrews attaching the clutch brake disc to the clutch shaft and remove the disc. Remove the four (4) capscrews attaching the clutch shaft rear bearing cap to the clutch shaft rear bearing retainer and remove the bearing cap and the cap gasket.

9. Unlock the clutch shaft rear bearing locknut and remove the locknut and the locknut lockwasher from the clutch shaft.

10. Drive or press the clutch shaft out of the rear bearing then remove the rear bearing from the rear bearing retainer.

I. Clutch Inspection and Repair

1. Wash all the clutch components thoroughly and inspect them to see if they are in good condition.

2. Inspect the facings on the driven disc for wear and looseness of the facings on the plate. Also check the splines in the hub of the disc for wear. The specified thickness of the driven disc when new is .463", plus or minus .008". Measure the thickness of the clutch disc being inspected and if it is worn to approximately .250", a new driven disc should be installed. *NOTE: The facings are cemented to the plate and therefore the facings are not serviced separately.*

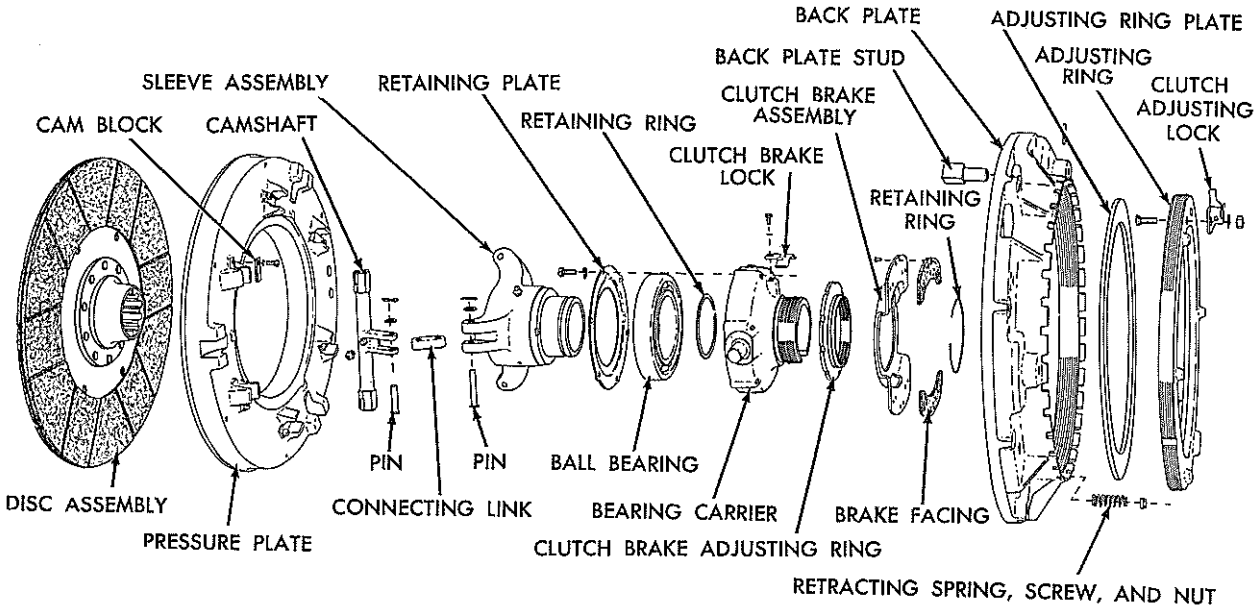


Fig. 6 — Engine Clutch Details

3. Inspect the facing of the pressure plate for roughness, heat cracks, and warpage. If the face of the pressure plate is in a rough 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 camshafts and the rollers in the camshafts for wear and make certain that the rollers are free to rotate. Also check to see if the lubricant when applied to the lubricating fitting in each camshaft emerges from around the camshaft rollers. Inspect the six (6) camshaft blocks, attached to the back of the pressure plate, for wear and replace if necessary. *NOTE: If it is necessary to replace any of these small blocks, it is recommended that all six (6) of them be replaced at the same time.*

5. Inspect the bushings in the shifting sleeve for wear and roughness and replace the sleeve assembly if necessary.

6. Check the clutch back plate for cracks and replace if cracks are evident.

7. Inspect the shifting sleeve bearing for wear and roughness. Replace the bearing if it is worn excessively or if it does not turn smoothly when rotated by hand.

8. Remove the two (2) operating shifting blocks used on the shifting sleeve bearing carrier. Inspect the needle bearings, needle bearing inner races, and dust seals for wear and damage and replace the necessary parts.

9. Inspect the six (6) pressure plate retracting springs for breakage and replace if necessary.

10. Inspect the clutch wearing surface of the flywheel and make certain 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.

11. Inspect the clutch shaft front bearing (pilot bearing) for wear and lubrication. In case the bearing shows signs of improper lubrication, install a new oiling wick in the pilot bearing oiling wick holder. Refer to "REPLACEMENT OF ENGINE CLUTCH SHAFT PILOT BEARING OILING WICK," in Topic 5, Section IX.

12. Inspect the holes in the clutch shifting sleeve and in the connecting links for the connecting link pins and if the holes show excessive wear, replace the necessary parts. If the connecting link pins are worn, they must also be replaced.

13. Inspect the clutch shaft rear bearing for wear

and roughness. Replace the bearing if it is worn excessively or if it does not turn smoothly when rotated by hand.

14. Inspect the clutch shaft. If the shaft is excessively worn at the location of the clutch shifting sleeve, or if the splines show excessive wear, the shaft must be replaced.

15. Inspect the lubricating hoses for the clutch shaft rear bearing and for the shifting sleeve bearing and replace if they are not in good condition.

16. Inspect the clutch brake discs. If the brake facing is worn down close to the rivet heads, the facing must be replaced. Inspect the rear brake disc for wear and scoring. Slight scoring of uneven wear can be removed by machining, however, if the disc is worn or scored excessively, replacement is necessary.

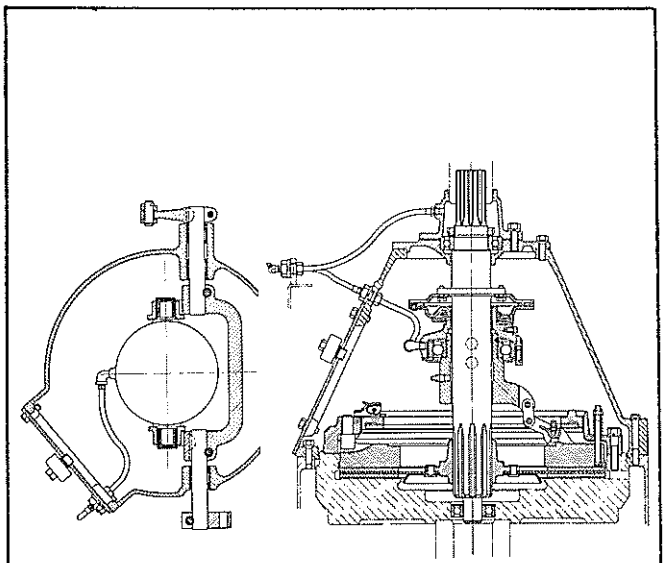


Fig. 7 — Engine Clutch Sectional View

J. Assembly of Clutch

Refer to Figs. 6 and 7 and assemble the clutch by direct reversal of the disassembly procedure. *IMPORTANT: When installing the three (3) pins used to connect the connecting links to the clutch camshafts, install them so that the heads of the pins are to the right when the pin is located at the top and viewed from the rear of the clutch. When installing the three (3) pins used to connect the connecting links to the shifting sleeve, install them so that the heads of the pins are to the left when the pin is located at the top and viewed from the rear of the clutch.*

When installing the six (6) retracting spring nuts, tighten the nuts against the retracting springs so that the assembled length of each spring is 1-3/16" (measure to bottom of recess in clutch back plate). Pack the needle bearings in the two (2) operating sliding blocks with grease when assembling the blocks in position on the shifting sleeve bearing carrier. Lubricate the clutch camshafts, clutch shifting sleeve, shifting sleeve bearing, and the clutch shaft rear bearing thoroughly when assembly of the clutch is completed. Lubricate the connecting link pins sparingly.

K. Inspection and Replacement of Clutch Operating Yoke

1. With the engine clutch removed, place the operating sliding blocks in position in the clutch operating yoke. If there is excessive looseness between the parts due to wear, replacement of both the yoke and the operating sliding blocks is necessary.

2. Replace the clutch operating yoke as follows:

   a. Remove the two (2) bolts clamping the operating yoke to the yoke shafts.

   b. Spread the shaft opening in each end of the yoke open using a broad face chisel, or similar tool, to free the yoke on the shafts.

   c. Pull the shafts out of the yoke and remove the "Woodruff" key from the inner end of each shaft.

   d. Pull the shafts out of the needle bearings and inspect the bearings, shafts, and dust seals for wear. Replace the necessary parts.

   e. Lubricate the yoke shaft needle bearings with grease and start the shafts in place.

f. Install a "Woodruff" key in position in the inner end of each shaft, hold the operating yoke in position with the shafts, and drive the shafts into position in the operating yoke.

g. Install the capscrews, lockwashers, and nuts used to clamp the yoke to each shaft and tighten the nuts securely.

L. Installation of Clutch

1. Make certain that the flat surface of the flywheel is clean. Place the clutch driven disc assembly in position on the flywheel making certain that the side of the disc having the oil slinger, is next to the flywheel.

2. Place the engine clutch assembly in position on the flywheel. Start all the attaching capscrews, with their lockwashers, then tighten the capscrews evenly so that the clutch back plate enters the recess in the flywheel.

3. Install the engine clutch housing in position, inserting the operating yoke sliding blocks in position in the operating yoke as the housing is moved forward into position. Use two (2) ⅜" NC guide bolts, approximately 5½" to 6" in length, with the heads cut off to line up and hold the housing in place when installing. Make certain that the needle bearings in the operating sliding blocks are packed with grease before installing the housing. Tighten the housing attaching capscrews securely.

NOTE: With the engine clutch adjusting ring backed out far enough so that the clutch can be engaged by hand, or by use of a pry bar, engage the clutch so that the engine clutch shaft assembly may now be installed.

4. Install the clutch shaft assembly (complete with its components) into the clutch housing and the clutch. To install, insert the front end of the shaft through the shifting sleeve assembly until it contacts the hub of the driven disc. Push in on the shaft and turn to engage the shaft splines with the splines in the driven disc hub. Tap lightly on the rear end of the shaft to drive the front end of the shaft into position in the clutch shaft front bearing (pilot bearing). Position the clutch shaft rear bearing retainer so that the lubricating hose is to the top, then install the capscrews used to attach the rear bearing retainer to the clutch housing.

5. Reaching through the clutch inspection plate opening, insert the upper end of the lower lubricating hose for the clutch shifting sleeve bearing into hole in the clutch housing and install the lockwasher and jam nut on the end of the hose to hold it in position. Connect the lower end of the upper lubricating hose for this bearing to the lower lubricating tube, then insert the upper end of this hose into the outer hole (outer of the two holes) at the base of the cowl. Install the lockwasher and jam nut on the upper end of the hose to hold it in position.

6. Hold the front end of the gear shift plunger operating rod assembly in position at the right side of the clutch housing and aline the plunger operating lever on the end of the rod with the clutch operating yoke shaft. drive or pry the operating lever onto the shaft and install the capscrew, lockwasher, and nut used to attach the lever to the shaft. Connect the rear end of this plunger operating rod to the transmission shifting lock plunger using a plain washer and cotter pin.

7. Hold the other gear shift plunger operating rod assembly in position at the left side of the clutch housing and install the yoke pin and cotter pin used to connect the front end of the rod to the clutch shifting yoke shaft lever. Connect the rear end of this rod (end with spring) to the transmission shifting lock plunger using a yoke pin and cotter pin.

8. Connect the front end of the clutch operating lever control rod to the clutch shifting yoke shaft lever, at the left side of the clutch housing, using a yoke pin and cotter pin.

9. Install the universal joint rear yoke in position on the front end of the transmission top shaft. Install the rear yoke seal (neoprene) and the rear yoke retaining washer in posi-

tion in front of the rear yoke, then install the rear yoke retaining capscrew lock and capscrew. Tighten the retaining capscrew securely and lock with the capscrew lock.

10. Install the universal joint front yoke, attached to the universal joint assembly, in position on the rear of the clutch shaft, then raise the rear end of the universal joint assembly and connect it to the rear yoke using the attaching capscrews and capscrew locks. Tighten the capscrews securely and lock with the capscrew locks.

11. Install the right brake pedal lever shaft with its components in position and install the capscrews used to attach the right brake pedal shaft bracket to the main frame. Connect the parking brake lock bar in position on its corresponding lever. Connect the right brake pedal retracting spring. Connect the right brake front control rod to the right brake pedal shaft lever using a yoke pin and cotter pin.

12. Install the clamp bracket for the front sections of the hydraulic steering fluid tubes and install the tube clamp in position on the tubes. Tighten the attaching capscrews securely.

13. Install the hydraulic steering lower cross shaft bracket (with the lower control rods attached) in position on the rear of the engine clutch housing. Connect the rear of the lower control rods to the spool valves using yoke pins and cotter pins. Connect the vertical steering control rods to the lower cross shaft levers using yoke pins and cotter pins.

14. Insert the upper end of the lubricating hose for the clutch shaft rear bearing up through the opening in the center of the steering lower cross shaft bracket and insert the upper end of the hose into the inner hole (inner of the two holes) at the base of the cowl. Install the lockwasher and jam nut on the upper end of the hose to hold it in position.

15. Adjust the engine clutch and clutch brake (refer to "CLUTCH ADJUSTMENT" and "CLUTCH BRAKE ADJUSTMENT" in this section). Install the clutch inspection cover plate.

16. Install the supporting channel for the front and center floor plates and install the floor plates.

17. Make certain that the clutch and clutch shaft components are lubricated thoroughly before the tractor is put into operation.

2. CLUTCH BRAKE

A. Description

The clutch shaft brake is designed to stop rotation of the clutch shaft when the clutch is disengaged to permit easier shifting of the transmission gears. The clutch brake is applied by exerting forward pressure on the clutch control lever after the clutch has been disengaged.

The brake assembly is attached to the rear of the clutch shifting sleeve bearing carrier. This portion of the brake assembly has a friction material facing that contacts the rear brake disc (attached to the flange on the clutch shaft) when the brake is applied.

Adjustment of this brake assembly is provided through an adjusting ring which carries the brake front plate.

B. Service, Inspection, and Repair

Keep the clutch operating lever control rod adjusted to give a clearance of ¼" between the front of the clutch operating lever (lever in its disengaged position) and the center floor plate. If the control rod is not adjusted properly, the front of the clutch operating lever, when in the disengaged position, will strike the floor plate and will not allow the clutch brake plate to move back far enough to contact the clutch brake disc. Keep the clutch brake properly adjusted (refer to "ENGINE CLUTCH BRAKE ADJUSTMENT" in Topic 2, this section).

In event that the clutch brake does not function properly when shifting gears, remove the clutch inspection cover plate from the clutch housing and inspect the clutch brake assembly. Whenever the facings on the clutch brake plate are worn down to the rivet heads, the facings must be replaced. Inspect the brake disc (rear) for wear and scoring. Slight scoring or uneven wear can be removed by machining, however, if the disc is worn or scored excessively, it should be replaced.

C. Clutch Brake Removal

1. Remove the front and center floor plates and the supporting channel for the front and center floor plates.

2. Remove the jam nut and lockwasher attaching the lubricating hose for the clutch shaft rear bearing to the base of the cowl.

3. 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 steering control rods to the lower cross shaft levers. Remove the capscrews attaching the lower cross shaft bracket to the rear of the engine clutch housing and remove the bracket and lower control rods as an assembly.

4. Unclamp the hydraulic steering fluid tubes (front sections), remove the capscrews attaching the tube clamp supporting bracket to the rear of the clutch housing, and remove the bracket.

5. Disconnect and remove the right brake pedal retracting spring. Remove the yoke pin connecting the right brake front control rod to the right brake pedal shaft lever. Remove the capscrews attaching the right brake pedal shaft bracket to the main frame and remove the bracket, right pedal lever shaft, and pedal lever as an assembly.

6. Unlock and remove the four (4) capscrews attaching the rear of the universal joint to the transmission shaft yoke. Lower the loosened end of the universal joint, pull towards the rear until the front yoke on the universal joint assembly is free of the clutch shaft, and remove the universal joint.

   IMPORTANT: Straighten the capscrew lock and remove the capscrew, lock, and retaining washer attaching the yoke to the transmission top shaft. Remove the yoke seal (neoprene) and the yoke from the transmission top shaft.

7. Engage the engine clutch. Remove the capscrews attaching the clutch shaft rear bearing retainer to the rear of the clutch housing and pry out on the clutch shaft rear bearing retainer until it is free of the clutch housing, then pull back on the clutch shaft complete with its components and remove the assembly from the housing.

8. The clutch brake plate (front) may now be removed from the clutch shifting sleeve bearing carrier by turning the brake adjusting ring. Remove the capscrews attaching the brake disc (rear) to the clutch shaft.

D. Clutch Brake Installation

The clutch brake may be installed by direct reversal of the removal procedure. When installing the clutch shaft assembly and universal joint assembly, refer to "INSTALLATION OF CLUTCH" in this section (steps 4, 9, and 10). After installation of the clutch brake assembly is complete, adjust the clutch brake (refer to "ENGINE CLUTCH BRAKE ADJUSTMENT" in Topic 1, this section).

SECTION XI—TRANSMISSION AND BEVEL GEAR

1. GENERAL DESCRIPTION

Power from the engine is delivered through the engine clutch and the universal joint assembly to the transmission, then through the transmission to the bevel gear, and 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 obtained by shifting the transmission gears.

2. TRANSMISSION

A. Description

The transmission is a constant mesh, helical gear, speed reduction unit designed to provide the proper ratio for the required speed or power for operation of the tractor. The various speed changes, six (6) forward and three (3) reverse, are obtained by the use of shifting collars on the intermediate shaft and the bevel pinion shaft gears.

The shifting collars are shifted into mesh with the various gears by shifter forks actuated by gear shifting levers. They are located for proper mesh by detent notches in the shifter shafts and detent balls (steel balls) encased in a housing attached to the transmission case.

The shifting collars are locked in mesh by two locking mechanisms, each consisting of a plunger connected to the engine clutch operating yoke shaft by linkage. The locks are designed so that the gear shifting levers can not be moved from any engaged position without first disengaging the engine clutch.

The transmission shafts are supported on one end by ball bearings and on the other end by roller bearings. The power input to the transmission is applied to the transmission top shaft.

B. Transmission Removal

1. Remove the oil drain plugs from the transmission case and from the bottom of the bevel gear compartment and allow the oil to drain.

2. Remove the seat cushions, seat adjusting frame, floor plates, and the rear section of the bottom shield.

   NOTE: The bottom shield must be removed to provide clearance for the drain plug boss when detaching transmission from steering clutch and final drive housing.

3. Disconnect the right brake pedal retracting spring from the spring anchoring angle and remove the spring, then remove the two (2) ½" capscrews from the right pedal shaft bracket and remove the bracket, pedal lever shaft, and pedal lever assembly as a unit by sliding it to the right until it is free of the left pedal shaft bracket. It is not necessary to disturb the left bracket.

4. Remove the extension levers from the gear shifting levers by loosening the ½" hex nuts on the clamping capscrews.

5. Remove the yoke pins from the spool valve ends of both lower steering control rods, swing the rods upward and fasten them to the cowl to provide clearance. Remove the tube supporting bracket from transmission and from rear section of steering control fluid tubes.

6. Disconnect both shifting lock plunger rods at the transmission end and allow rods to drop down to provide clearance.

7. 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 from falling off. Place a small pry-bar between the spider assembly and the rear yoke, and 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 from the engine clutch shaft splines.

8. Refer to Fig. 1 and install a lifting chain as shown. With the lifting chain installed in this position, the transmission will balance properly for removal.

9. Clean thoroughly around top of transmission case and at junction of transmission case and steering clutch housing, then remove the attaching capscrews.

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 in alinement (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)

1. Clean the transmission thoroughly before disassembly.

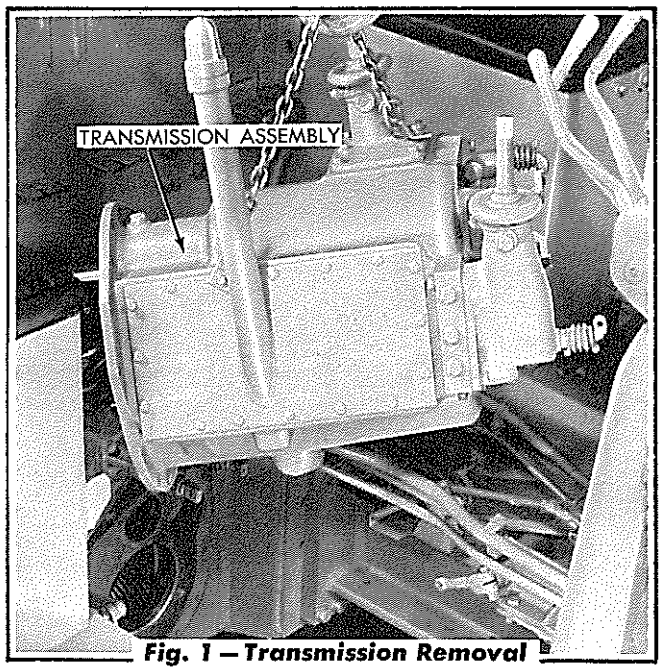


Fig. 1 — Transmission Removal

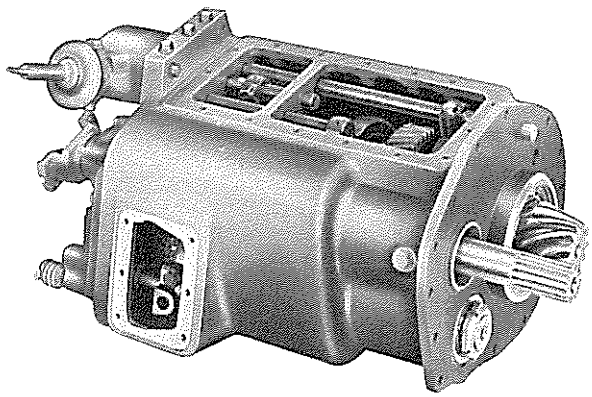


Fig. 2 — Transmission on Bench

2. Place the transmission on a clean work bench with the right side up and the cover removed as shown in Fig. 2.

3. Remove the capscrews attaching the gear shifter and range selector housings to the transmission case and remove the housings from the case.

4. Loosen the clamp screws and the "Allen" set screws used to secure the shifting forks to the shifting shafts, then loosen the interlock spring capscrews and remove the lower of the three (3) shifting shafts from the case. Be sure to catch the three (3) steel balls which will drop from position when the shaft is removed. Remove the shifting fork from the slot in the shifting collar.

5. Remove the center shifting shaft and interlock pin from the transmission case, catching the four (4) steel balls which will drop from position when this shaft is removed. Remove the shifting fork from the slot in the shifting collar.

6. Remove the upper shifting shaft from the transmission case, catching the one (1) steel ball which will drop from position when this shaft is removed. Remove the remaining shifting fork from the bottom (pinion) shaft. *NOTE: The three (3) shifting forks are identical but the shifting shafts differ and must be installed in their correct positions when reassembling the transmission.*

7. Remove the pinion shaft cover and tie the (narrow) bearing adjusting shims to cover to prevent loss of shims.

8. On early model tractors, unlock the locking washer and remove the pinion nut from the front of the bevel pinion shaft. On later model tractors, unlock the pinion locknut before loosening it for removal from the bevel pinion shaft. Do not remove the snap ring from the double row ball bearing on the front of the pinion shaft or the adjusting shims at this time.

9. Drive or use a combination cross bar puller, and push the bevel pinion shaft back out of the double row ball bearing.

10. Turn the transmission assembly on the bench so that the bottom of the case is up, and pull the pinion shaft out of the gears and transmission case.

11. Place a rope around the center cluster of gears (3rd, 4th, 6th forward), and remove the gear cluster and the spacing washers, on each side of the cluster, from the case as an assembly.

12. The front gear cluster (2nd reverse, and 3rd and 5th forward) must be disassembled inside the case as there is not sufficient space to permit removal as an assembly. To disassemble this gear cluster, slide the rear gear (3rd and 5th) from the gear hub and remove from case. Slide the shifting collar from the hub and the hub from the front gear (2nd reverse) and remove these items and the 2nd reverse gear from the case.

13. The rear gear cluster (1st reverse and 1st and 2nd forward) may now be removed if desired by following the disassembly procedure as outlined in item 12 above. However, it is suggested that the rear gear cluster be left in the transmission case until the top and intermediate shafts have been removed. The cluster can then be removed as an assembly.

14. Again turn the transmission on the bench so that the right side of transmission faces upward as in Fig. 2. Remove the rear (universal joint) yoke and the retainer from the front of the top shaft and the sleeve locking screw from the bearing retaining sleeve at the rear end of the top shaft. Remove the retaining sleeve and shims from the transmission case.

15. Drive the top shaft toward the rear until the shaft is free of the front bearing spacing sleeve and front roller bearing, then pull the shaft out of the trainsmission case and remove the three (3) gears, three (3) spacing sleeves, and the spacer from the case.

16. Clamp the top shaft in a vise, protecting the splines of the shaft by use of copper jaws or similar measure. On early model tractors, unlock the lockwasher and remove the nut, lockwasher, bearing, and the low reverse gear from the top shaft. On later model tractors, unlock the locknut and remove the locknut, bearing, and the low reverse gear from the top shaft.

17. Remove the cover from the front end of the intermediate shaft. If the oil seal in the cover is removed for replacement, the new oil seal must be installed in the cover so that the lip of the seal is toward the front when the cover is installed.

18. Loosen the clamp bolt on the high-low shifting fork and remove the two (2) capscrews securing the upper interlock housing to the transmission case, then remove the interlock

assembly and shifting shaft from the transmission case as a unit. Remove the high-low shifting fork from the slot in the shifting collar.

19. On early model tractors, unlock the lockwasher and remove the nut and the lockwasher from the front end of the intermediate shaft. On later model tractors, unlock the locknut and remove it from the front end of the intermediate shaft toward the rear to free it from the front ball bearing and from the high range gear bearing inner race. Remove the shaft from the transmission case and remove the gears, spacers, etc. from the transmission case.

20. If the rear gear cluster of the pinion shaft was left intact in the case, remove it at this time.

21. Clamp the intermediate shaft in a vise, protecting the splines of the shaft by use of copper jaws or similar measure. On early model tractors, unlock the lockwasher and remove the nut and the lockwasher from the rear of the shaft. Remove the bearing and the 1st and 2nd speed gear from the shaft.

22. Remove the ball bearings from the bores in the front of the transmission case.

D. Cleaning and Inspection of Parts

Clean and inspect all the transmission parts thoroughly as described in pertinent parts of "GENERAL MAINTENANCE INSTRUCTIONS" in Section XXI. Replace or recondition the worn or damaged parts.

E. Assembly of Transmission

1. Installation of Intermediate Shaft Assembly

NOTE: Before installing the components of the intermediate shaft in the transmission case, the pinion shaft rear gear cluster (1st reverse and 1st and 2nd forward) should be assembled and placed in position inside the transmission case. This will make the installation of the pinion shaft much easier when the pinion is installed.

a. Place the transmission case on a bench as shown in Fig. 2.

b. Install the 1st and 2nd speed gear (19 teeth) on the rear end of the intermediate shaft, with the hub of the gear facing the rear of the shaft, then press the rear bearing inner race in position on the shaft.

c. Place the spacing sleeve (4½" long) on the shaft against the face of the gear and insert the assembly in the transmission case from the rear just far enough to install the rest of the gears.

d. Start the 4th and 6th speed gear (40 teeth) on the splines of the shaft, with the hub of the gear toward the front of the shaft. Install the spacing sleeve (1¾" long) on the shaft against the hub of the gear followed by the 3rd and 5th speed gear (36 teeth), with hub of the gear against the spacing sleeve.

e. NOTE: On early model tractors, the low range gear (35 teeth) contained a bushing and on later model tractors the bushing in this gear was discontinued. This gear in the later model tractors is assembled in position on the low range gear hub on two (2) roller bearings.

On early model tractors, lubricate the bushing in the low range gear (35 teeth) and install the gear in position on the low range gear hub. Install this assembly on the shaft with the gear located next to the 3rd and 5th speed gear. Install the shifting collar in position on the low range gear hub.

On later model tractors, install the two (2) low range gear roller bearings in position on the low range gear hub and lubricate the bearings. Install the low range gear (35 teeth) in position on the roller bearings. Install this assembly in position on the shaft with the gear located next to the 3rd and 5th speed gear. Install the shifting collar in position on the low range gear hub.

f. NOTE: On early model tractors, the high range gear (28 teeth) contained a bushing and on later model tractors the bushing in this gear was discontinued. This gear in the later model tractors is assembled on two (2) roller bearings.

On early model tractors, lubricate the bushing then install the bearing inner race in position in the bushing of the gear. Install the bearing spacing washer in the bore of the high range gear with the chamfer on the I.D. of the washer toward the rear of the assembly as installed. Install the assembly on the shaft with the large diameter of the gear located next to the low range gear hub.

On later model tractors, install the two (2) high range gear roller bearings in position in the high range gear (28 teeth) and lubricate the bearings. Install the bearing inner race in position in the roller bearings and install the bearing spacing washer in the bore of the gear with the chamfer on the I.D. of the washer toward the rear of the assembly as installed. Install the assembly on the shaft with the large diameter of the gear located next to the low range gear hub.

g. Install the front bearing spacing washer on the shaft with the flat face of the washer located next to the high range gear. With the snap ring installed in the rear roller bearing, install the rear roller bearing in position on the shaft and into the rear bore of the transmission case. On early model tractors, install the lockwasher and the rear nut on the shaft. On later model tractors, install the rear locknut on the shaft.

h. Install the ball bearing in position on the front end of the shaft and into the bore of the transmission case. On early model tractors, install the lockwasher and the front nut on the shaft. On later model tractors, install the front locknut on the shaft. Do not tighten the shaft nuts at this time as they will be tightened when assembly of the transmission is completed.

i. Install a new oil seal in position in the intermediate shaft front cover with the lip of the seal towards the front when the cover is installed. Place the cover and its attaching gasket in position but do not tighten the attaching capscrews at this time.

2. Installation of Top Shaft Assembly

a. Place the top shaft in a vise with the rear end of the shaft up. Protect the splines of the shaft by use of copper jaws in the vise. Install the 1st reverse gear (18 teeth) on the shaft with the hub of the gear towards the rear of the shaft. Install the ball bearing on the rear of the shaft. On early model tractors, install the lockwasher and the rear nut on the shaft. On later model tractors, install the rear locknut on the shaft. Tighten the rear nut or locknut and lock in position.

b. Insert the front end of the shaft into the top shaft bore of the transmission case from the rear. Install a spacing sleeve (4⅛" long) on the shaft followed by the 3rd reverse gear (40 teeth), with the hub of the gear facing the front of the shaft.

c. Install the low range gear (30 teeth) on the shaft next to the 3rd reverse gear, with the hub of the gear facing the front of the shaft, then install a spacing sleeve (1¾" long) against this gear.

d. Install the high range and 2nd reverse gear (36 teeth) on the shaft, with the hub of the gear facing the rear against the spacing sleeve.

e. Install the 5 16" chamfered spacer, the front bearing spacing sleeve and the roller bearing inner race on the shaft in the order named, then install the roller bearing and snap ring assembly on the shaft. Install the spacer (½" long) on the shaft against the inner bearing race.

f. Install an oil seal in the front bearing re-

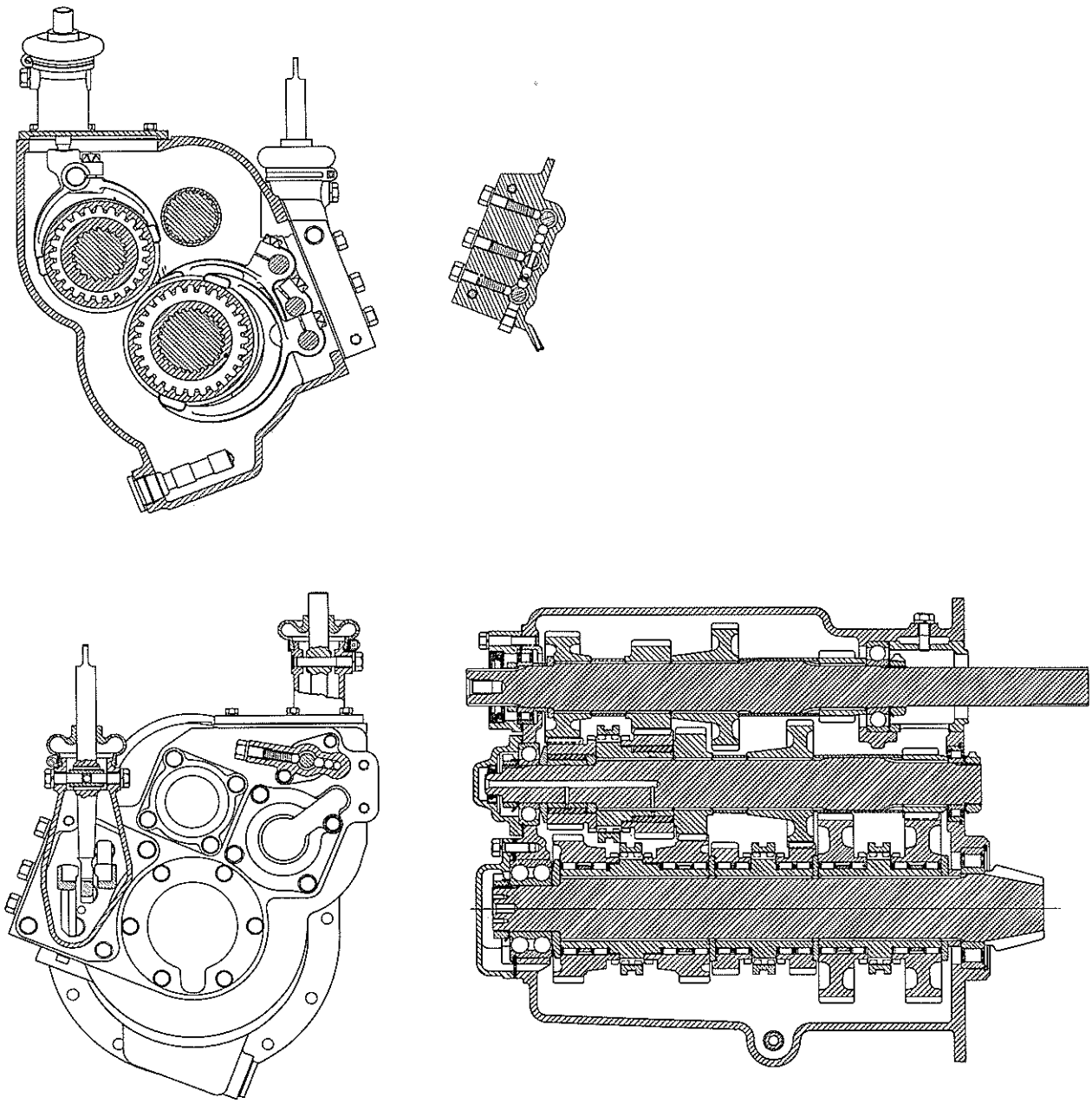
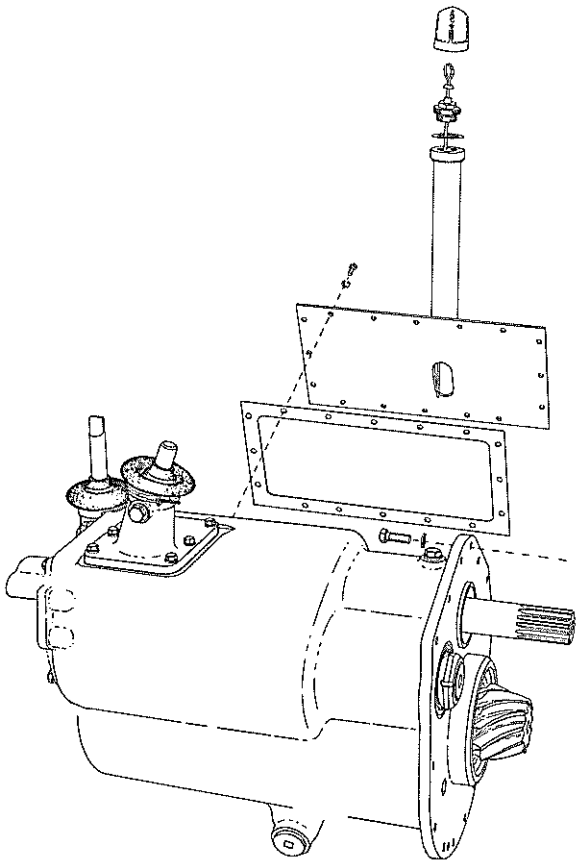
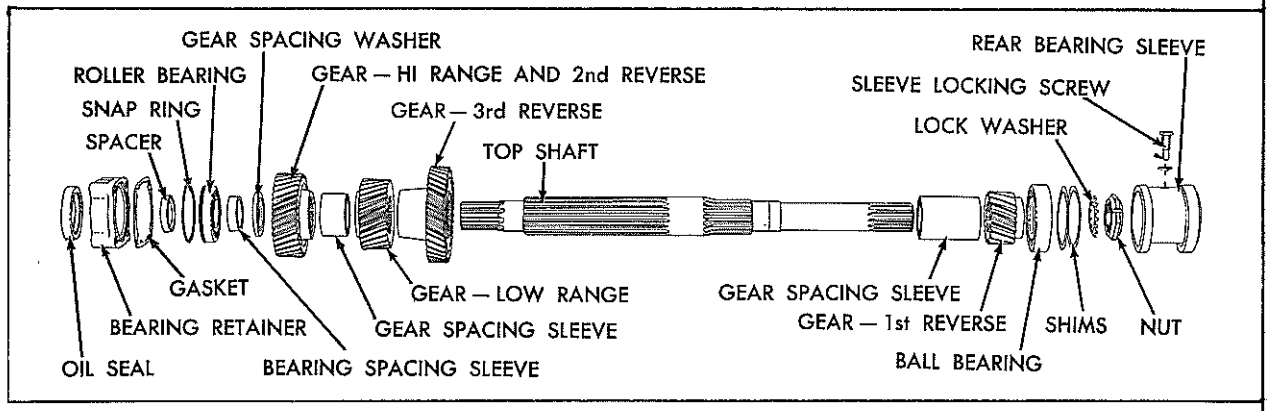
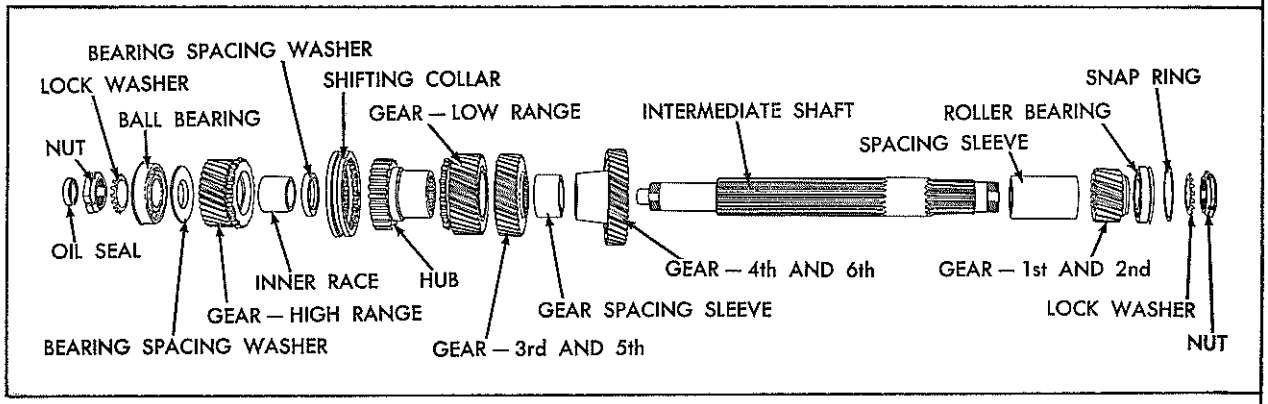


Fig. 3 — Transmission Sectional View







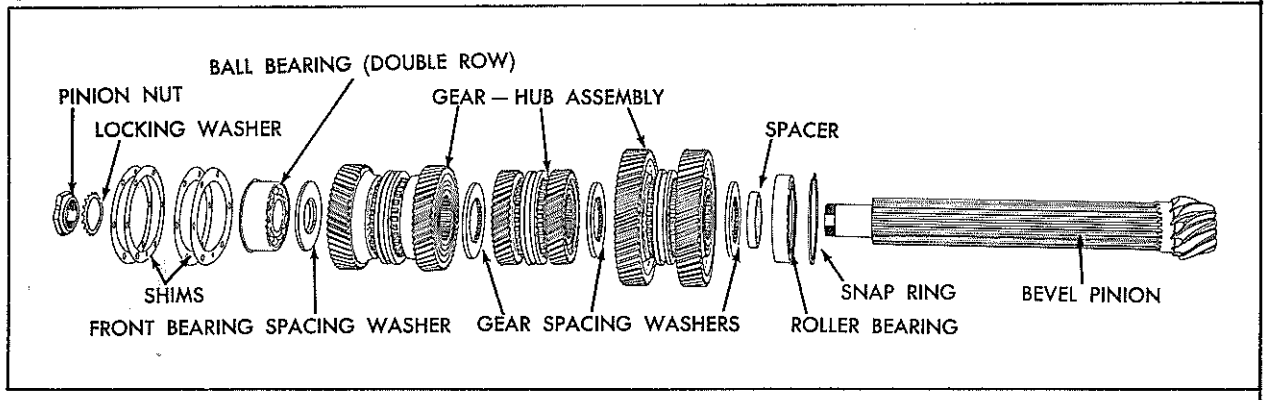


Fig. 4 — Transmission Details

tainer, with the sealing lip of the seal facing toward the rear, to seal the oil in the transmission.

g. Cement a gasket to the transmission case and attach the front bearing retainer to the case with four (4) ½" x 2½" cap-screws and four (4) ½" lockwashers.

h. Insert the ball bearing retaining sleeve into the rear top shaft bore being sure to aline the holes for the retaining screw. Use sufficient shims between the rear of the ball bearing and the front of the sleeve so that the sleeve has .000" to .005" standout from the rear face of the case.

i. after the retaining sleeve has been properly set as outlined above, fasten it in position with a ⅝" sleeve locking screw and a ⅝" lockwasher.

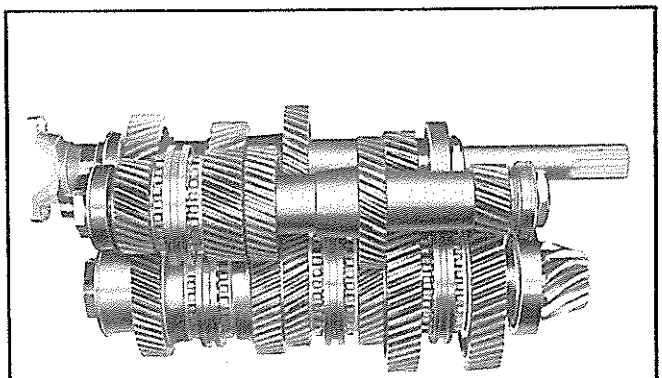


Fig. 5 — Transmission Gear Cluster Left Side View

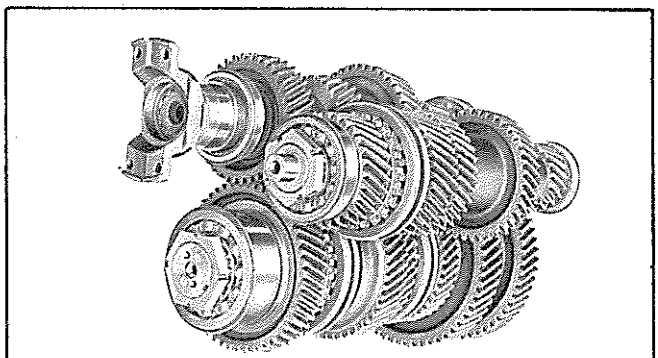


Fig. 6 — Transmission Gear Cluster — Left Front View

3. Installation of Pinion Shaft

a. Install the roller bearing in the rear pinion bore of the transmission case and secure in position with the snap ring.

b. With the rear pinion shaft gear cluster in position in the transmission case as outlined in E, 1 above, refer to Fig. 7 and assemble the front gear cluster (2nd reverse gear—48 teeth, and 3rd & 5th speed gear—48 teeth), inside the case in the same manner in which the rear gear cluster was assembled. Note that the hub for the 2nd reverse and the 3rd & 5th speed gears used in the front gear cluster has two different width bearing shoulders. The hub must be installed with the long shoulder toward the rear of the case.

c. After the pinion shaft front gear cluster has been assembled, push it as far forward as possible in the case and allow it to mesh with the mating gears on the top and intermediate shafts.

d. Referring to Fig. 7, assemble the pinion shaft center gear cluster (consisting of two (2)—3rd reverse and 4th & 6th speed gears each having 41 teeth), on a bench, then place the assembled cluster in the transmission case between the front and rear gear clusters, allowing the gears of the center gear cluster to mesh with the mating gears on the top and intermediate shafts.

e. With the three gear clusters in position in the transmission case, check to be sure that all gears are on the proper ends of their respective hubs so that the helixes of the gear teeth will mesh with their mating gears.

f. Press the roller bearing inner race in position on the shoulder of the bevel pinion shaft and install the chamfered spacer on the pinion shaft with the chamfer of the spacer toward the rear.

g. Enter the pinion shaft into the rear roller bearing, pushing the shaft through the bearing far enough to install a splined flat washer on the shaft.

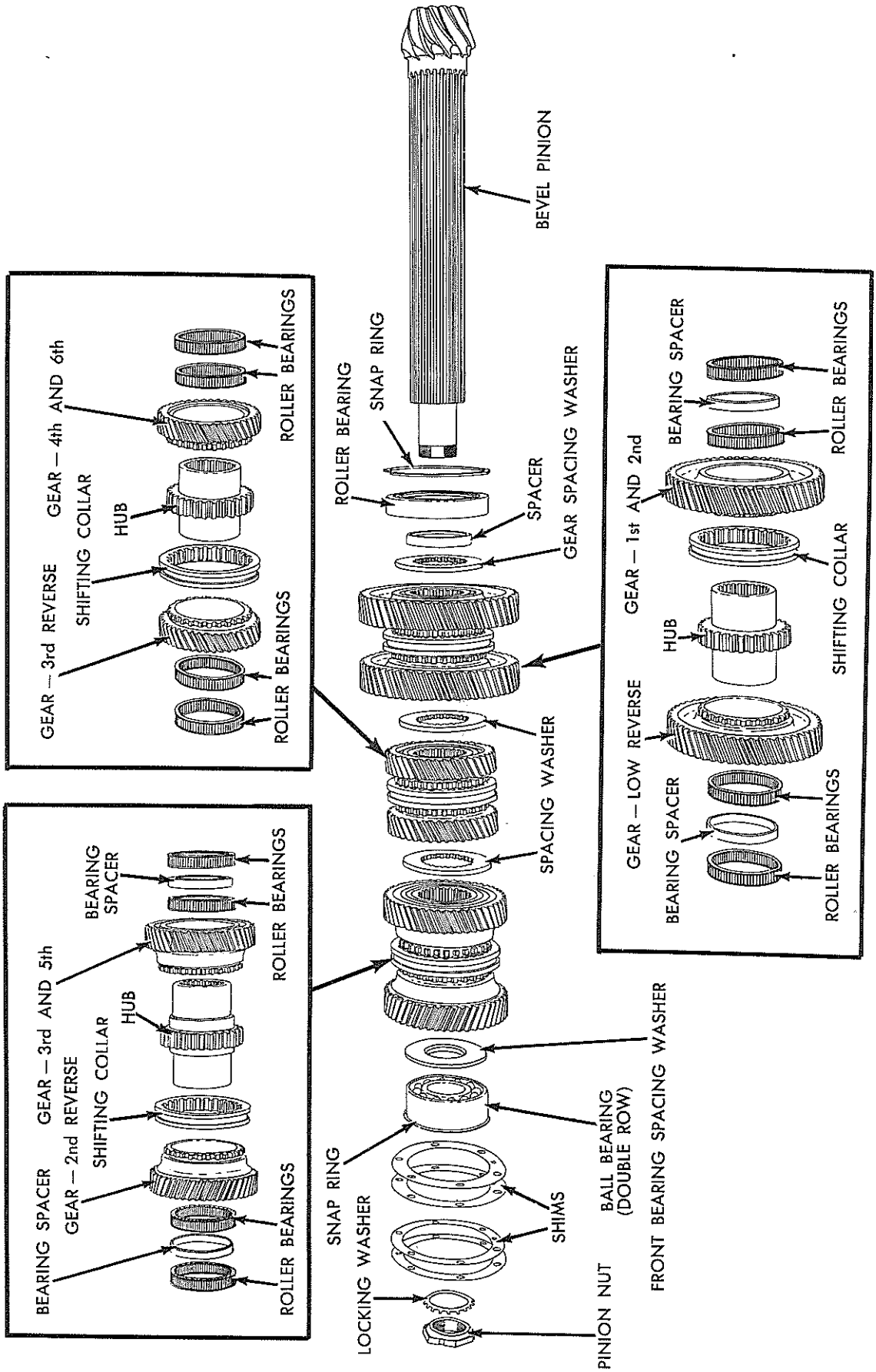


Fig. 7 – Bevel Pinion Shaft Details

h. Continue pushing the pinion shaft through the bearing, lining up the splines of the pinion shaft and the hub of the rear gear cluster. Push the shaft through the hub of the rear gear cluster and install another splined flat washer on the shaft.

i. Install the center and front gear clusters in the same manner, using another splined flat washer between the two gear clusters.

j. When reaching the point where the inner race on the rear of the bevel pinion shaft starts to enter the rear roller bearing, care must be exercised to prevent damage to the bearing. When the roller bearing and inner race are alined, push the shaft forward into the bearing as far as it will go.

k. Place the front pinion bearing spacing washer in position on the pinion shaft with the flat face of the washer next to the front gear cluster. Remove the snap ring from the double row ball bearing and start the bearing in position on the pinion shaft. On early model tractors, install the lockwasher and the front nut on the shaft. On later model tractors, install the front locknut on the pinion shaft. Tighten the nut or locknut using it to pull the double row ball bearing into position on the pinion shaft and into the bore of the transmission case. Lock the nut or locknut in position.

l. Remove the front cover from the intermediate shaft, then tighten and lock the front and rear intermediate shaft nuts. Replace the cover and secure it to the case with the capscrews provided.

m. Place the snap ring in its groove in the bevel pinion front bearing and tap the pinion shaft toward the rear until the snap ring is up against the face of the transmission case, then hold the bearing cover firmly against the bearing, and, using a feeler gage, measure the gap between the bearing cover and the face of the transmission case. Make up a shim pack approximately .001" thicker than the feeler gage measurement. This will provide .000" to .002" bearing end play in cover when cover is bolted to case.

n. Drive the bevel pinion shaft forward approximately 1/16" and remove the snap ring from the front ball bearing. Install the pinion depth adjusting shims, removed at disassembly, in place on the front pinion bearing, install the snap ring, and drive the pinion shaft back until the snap ring is tight against the shims.

o. Install the front bearing cover with the correct amount of bearing cover shims as determined in step (m) above. Install the attaching capscrews and tighten securely.

p. The initial bevel pinion depth, (controlled by shims between the front bearing snap ring and the transmission case) should be set so that the rear face of the pinion extends 4" from the rear face of the transmission case.

q. If the bevel pinion has a mounting distance dimension marked on the face of the pinion, subtract this dimension from 9.865", which is the specified dimension from the rear 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 the pinion should extend from the rear mounting face of the transmission case without the mounting gasket in place. Refer to Fig. 8.

r. Occasionally, after a bevel pinion and gear have been adjusted in the above manner, it is necessary to add or remove adjusting shims to obtain a good tooth pattern. Always use a marking compound to check the tooth pattern after making an adjustment. Refer to Fig. 15 in this section for proper tooth pattern.

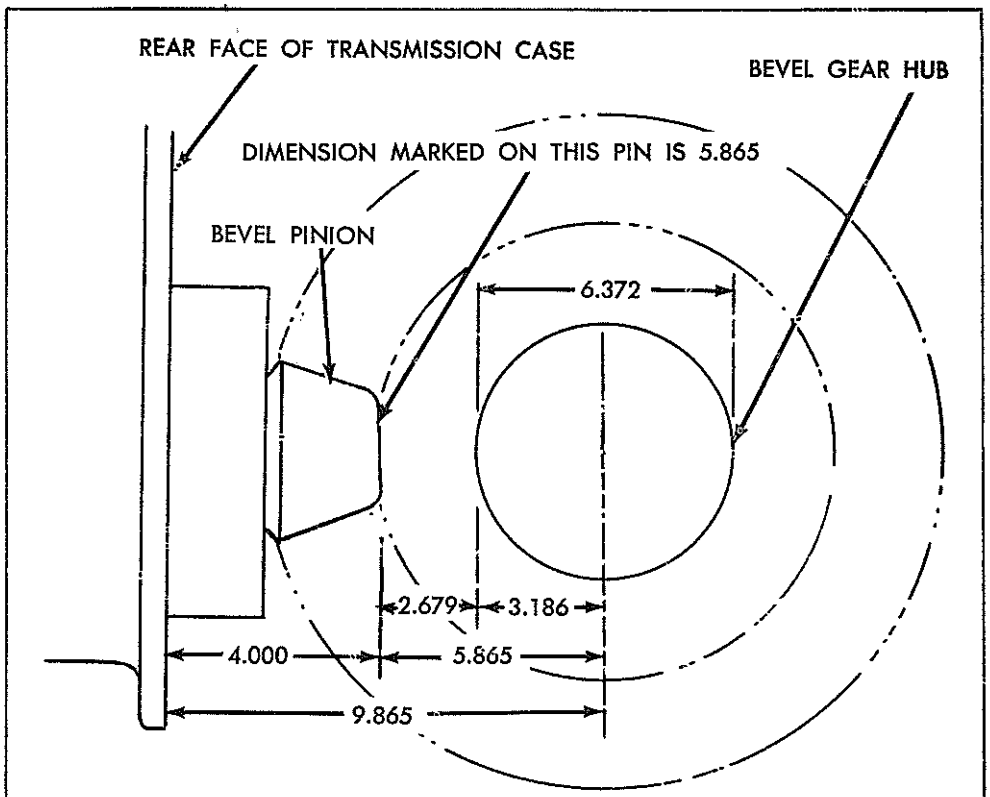


Fig. 8 — Bevel Pinion Adjustment

4. Installation of Gear Shift

Refer to Fig. 3 and assemble the shifting shafts and their components as follows:

a. Install the three shifting forks in the slots of the shifting collars on the pinion shaft. The forks must be installed with the bosses for the clamp screws facing upward.

b. The shifting shafts are of three different lengths; the lower shaft being the longest, the upper shaft being next in length and the center shaft being the shortest of the three. Install the lower (longest) shifting shaft through the lower bore in the transmission case and into the shifting fork on the rear gear cluster. Place two (2) steel balls into the vertical hole above the lower shaft and move the lower shifting shaft so that the bottom ball enters the detent of the shaft. Install a steel ball in the lower of the three horizontal holes and secure in position with an interlock spring and a capscrew.

c. Install the interlock pin in the center (shortest) shifting shaft and install the shaft through the center bore of the transmission case and into the shifting fork on the front gear cluster. Place three (3) steel balls in the vertical hole above the center shifting shaft and move the shaft until the lower of the three balls enters the detent in the shaft. Insert a steel ball into the center hole of the three horizontal holes and secure in position with an interlock spring and a capscrew.

d. Install the upper shifting shaft through the upper bore of the transmission case and into the shifting fork on the center gear cluster. Insert a steel ball in the remaining horizontal hole and secure in position with an interlock spring and a capscrew.

e. Center the three shifting collars on the gear hubs, then center the shifting forks in the slots of the shifting collars. Install the capscrew locks and the clamping capscrews in the shifting forks. Tighten the capscrews only enough to hold the forks in position on the shafts. Tighten the

"Allen" setscrews in the shifting forks securely and peen the edge of the tapped holes, then tighten the clamping capscrews to 90-100 ft. lbs. torque. Lock the capscrews with capscrew locks.

f. Attach the gear shifter housing to the front of the transmission case with the capscrews removed at disassembly. Install the shifting lever.

g. Install the remaining shifting fork on the range selector collar, with the clamping slot of the fork facing toward the center of the transmission. Insert the shaft, assembled in place in the shift interlock housing, into the bore of the transmission case and into the shifting fork.

h. Center the shifting collar on the gear hub and center the fork in the collar. Install a capscrew lock and a clamping capscrew in the fork. Tighten the capscrew to 90 - 100 ft. lbs. torque and lock with the capscrew lock.

i. Install the shifting lever extension on the lower shift lever. Install the drain plug in the transmission case. Inspect the inside of the transmission thoroughly for foreign objects and to determine if all capscrews inside the transmission have been securely tightened and locked. Using a small pry bar, or similar tool, move each shifting shaft into its various detent positions, and check to see if the shifting forks are properly located on the shafts so that the shifting collars are in proper engagement with their corresponding gears. Install transmission cover plate. Recheck the bevel pinion depth setting by referring to Fig. 14.

j. Install the rear yoke (universal joint) to the top transmission shaft using a new "Neoprene" washer between the top shaft and the yoke retaining washer. Secure the yoke in position with a capscrew and capscrew lock.

k. Install the lower shifting rod plunger and boot in position with the yoke of plunger turned up.

l. Install the upper shifting rod plunger and boot in position with the yoke of plunger turned down. The transmission is now ready to be installed in the tractor.

F. Installation of Transmission Assembly

1. Use a new mounting gasket between the transmission case and the steering clutch and final drive housing and install the transmission case by a direct reversal of the removal procedure. Check the adjustment of the bevel pinion and bevel gear and adjust if necessary as explained in "ASSEMBLY OF BEVEL GEAR" in this section.

2. Attach the rear yoke to the rear spider of the universal joint with four (4) capscrews and locks.

3. Attach the steering control fluid tube bracket to the transmission case and fluid tubes.

4. Remove the lower steering control rods from the cowl, where they were fastened for removal, and attach them to the hydraulic valve spool ends with yoke pins and cotter pins.

5. Install the right brake pedal shaft bracket in position on the right pedal lever shaft and install this assembly in position inserting the left end of the right pedal lever shaft into position in the left brake pedal shaft bracket. Install the capscrews and lockwashers used to secure the right brake pedal shaft bracket in position. Install the right brake pedal retracting spring. Connect the right brake front rod to the pedal shaft lever.

6. Install the yoke pins and cotter pins used in connecting the control rods to the two locking plungers. Adjust the locking plungers as follows:

   a. The gear shifting (lower) locking plunger, on right side of transmission, is properly adjusted when there is ⅛" travel remaining in the plunger with the engine clutch operating lever in the *ENGAGED*

position, i.e., plunger lacking ⅛" of bottoming in the housing. The adjustment is made by turning the nuts on the forward end of the locking plunger control rod.

b. The range shifting (upper) locking plunger, on left side of transmission, is properly adjusted when there is ⅛" clearance between the stop shoulder on the plunger and the housing with the engine clutch operating lever in the *DISENGAGED* position. The adjustment is made by turning the adjustable yoke on the forward end of the locking plunger control rod.

c. After the locking plungers have been properly adjusted, install the pin in the adjustable yoke and secure with a cotter pin. Lock the adjusting nut on the other control rod with the jam nut provided.

7. Install the floor plates, seat adjusting frame, and seat cushions. Install the drain plug in the bevel gear compartment and install the rear section of the bottom shield.

8. Fill the transmission and bevel gear compartments to the proper level with 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 on the bevel gear shaft. The shaft is supported on each end by tapered roller bearings contained in removable bearing cages. The bevel gear is driven by the transmission bevel pinion. An approximate 4.5 to 1 speed reduction is made through the bevel gear and pinion. Power from the bevel gear is delivered through the steering clutches to the final drives.

B. Bevel Gear Removal

With the transmission removed from the steering clutch and final drive housing, the bevel gear may be removed as follows:

1. Remove both steering clutches (refer to "CLUTCH REMOVAL" in Section XII, Topic 2). Remove the steering clutch throwout yoke and bearing assemblies (refer to "STEERING CLUTCH THROWOUT BEARING ASSEMBLIES" in Section XII, Topic 3).

2. Remove the drain plug in the hydraulic steering control housing and drain the oil. Remove the steering control housing (refer to "HYDRAULIC STEERING CONTROL HOUSING" in Section XII, Topic 5).

3. Remove the high nuts and locking plates used in securing the bevel gear to the bolting flange of the bevel gear shaft.

4. Remove the bolts used in fastening the bevel gear shaft bearing cage assemblies to the inner walls of the steering clutch compartments and pull the bearing cages out of their bores.

5. Install a puller similar to that as shown in Figs. 10 and 11, using the split spacer sleeve between the bevel gear and the inner wall on the right side of the bevel gear compartment. Tighten the hex nut on the puller screw to pull the bevel gear shaft from the gear.

6. Remove the nut on the puller screw, remove the sleeve plate and the sleeve, then tilt the bevel gear shaft and remove the puller screw from the shaft. Remove the shaft and the right bearing cone through the right steering clutch compartment.

7. Remove the bevel gear through the top of the bevel gear compartment.

8. Remove the bearing cone from the right end of the bevel gear shaft and the bearing cups from the bearing cage assemblies. Tie the bearing adjusting shims to the bearing cage assemblies from which they were removed so that the initial bearing setting will be close to the desired setting when the bevel gear is reinstalled.

C. Cleaning and Inspection of Parts

Clean and inspect all the parts thoroughly as de-

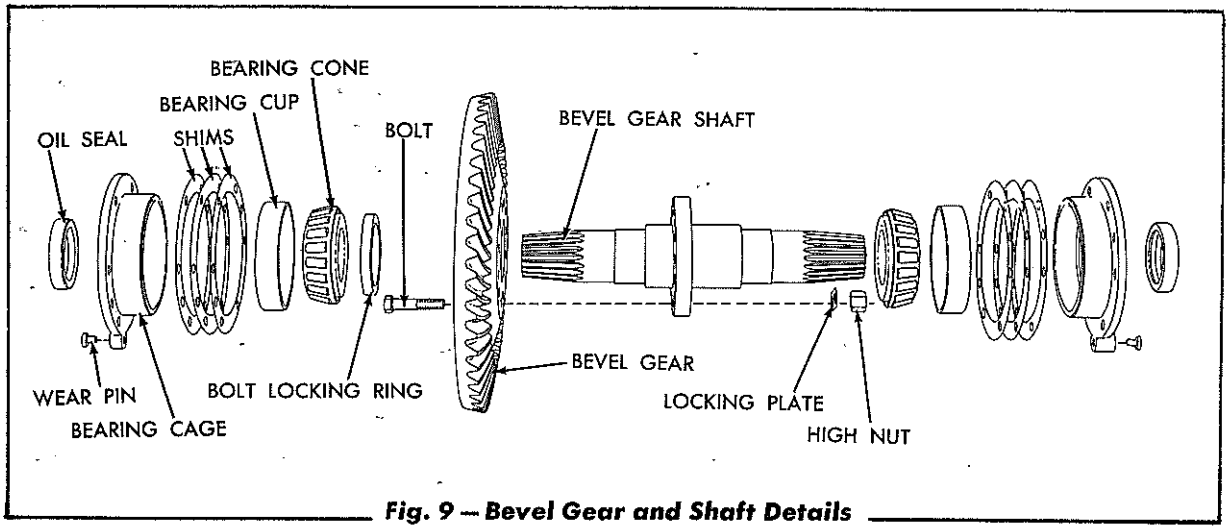


Fig. 9 — Bevel Gear and Shaft Details

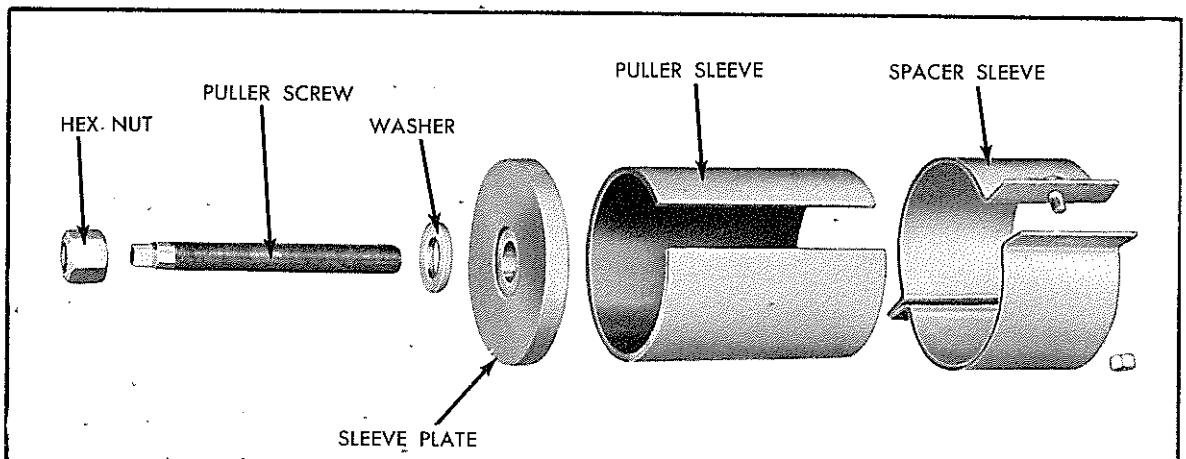


Fig. 10 — Bevel Gear Shaft Puller Details

scribed in pertinent pages in "GENERAL MAINTENANCE INSTRUCTIONS," in Section XXI. Replace or recondition any damaged parts. Use new oil seals when assembling.

D. Bevel Gear Installation

1. Install the bearing cone on the right hand (long) end of the bevel gear shaft, with the large diameter of the bearing against the shoulder of the shaft. Install the bevel gear attaching bolts in the gear. When installing the bolts, position the bolt heads so that the bolt locking ring may be installed.

2. Place the bevel gear in position in the housing, with the teeth of the gear to the right side when viewed from the rear. Start the bevel gear shaft into the gear and start the shaft on the bevel gear attaching bolts. Bump or drive the shaft into the gear until the locking plates and the high nuts may be started on the attaching bolts. Place the locking plates in position on the attaching bolts and start the high nuts. Tighten several of the high nuts evenly until the gear is properly located on the shaft. Install the bolt locking ring in position making certain that the heads of the bolts are positioned so that the locking ring will contact the bevel gear.

3. Lubricate the other bearing cone and start it on the left hand end of the bevel gear shaft, with the large diameter of the bearing toward the bevel gear. Using a tool similar to that shown in Fig. 12, install the puller screw (used in removal) in the tapped hole in the left hand end of the bevel gear shaft. Place a bearing installing sleeve, (having an O.D. the size of the inner race of the bearing cone) over the puller screw and against the bearing cone race. Install a sleeve plate

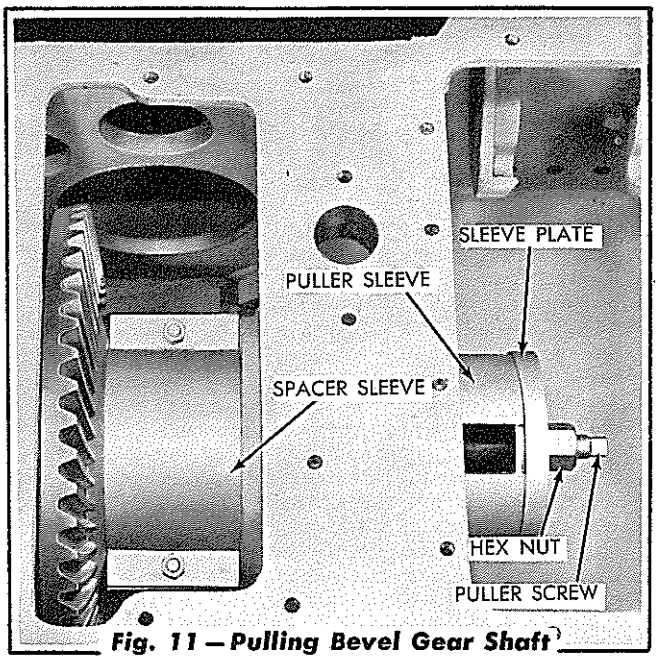


Fig. 11 — Pulling Bevel Gear Shaft

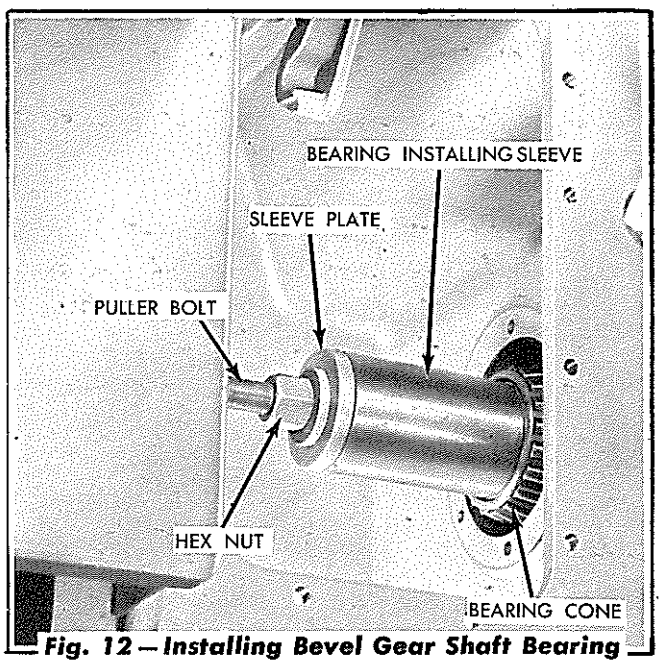


Fig. 12 — Installing Bevel Gear Shaft Bearing

against the sleeve and install a puller screw nut. Tighten the nut to press the bearing cone tight against its seat on the shaft. Remove the installing tool.

4. Press the bearing cups into the bearing cage assemblies. Lubricate the bearings with clean engine oil and insert one cage and cup assembly into each bore of the housing, using the shims removed at disassembly between each cage and the wall of the case.

5. Make certain that the wear pin in the bottom of each cage is to the bottom, then start the attaching capscrews but do not tighten.

6. Tighten all of the bevel gear high nuts to 165-175 ft. lbs. torque and lock the high nuts in position with the locking plates.

7. Tighten the bearing cage attaching capscrews and bump the bearing cages to make certain the bearings are properly seated, then check the bearing pre-load. *NOTE: The bearing pre-load is checked without the oil seals in position in the bearing cages.*

8. The bevel gear shaft bearings are properly adjusted when they have a pre-load of 10 to 15 inch pounds or when they are adjusted .002" to .004" tight. If an inch pound torque wrench is available, install a steering clutch driving hub retaining capscrew in the shaft, then using the torque wrench, turn the shaft to check the bearing pre-load. Add or remove bearing adjusting shims as necessary to obtain the correct 10 to 15 inch pounds pre-load.

9. Install the transmission in position on the steering clutch and final drive housing and tighten the attaching capscrews securely.

10. To adjust the bevel pinion depth or mounting distance with the transmission installed in the tractor, refer to Fig. 13 ,and proceed as follows:

    a. Using a telescoping gage or an inside caliper, measure the distance from the flat surface on the toe end of the pinion to the narrow machined surface on the bevel gear shaft attaching flange. Lock the telescoping gage in position, then use an outside micrometer and measure the telescoping gage.

    b. To calculate this distance, divide the diameter of the bevel gear shaft attaching flange by two (2) and subtract this distance from the mounting distance marked on the toe end of the bevel pinion.

    EXAMPLE: The diameter of the attaching flange on the bevel gear shaft is 6.372"

and the mounting distance marked on the end of the pinion is 5.865."

6.372" ÷ 2 = 3.186", 5.865" – 3.186" = 2.679".

Therefore, 2.679" is the distance the toe end of the bevel pinion should be from the front surface of the bolting flange on the bevel gear shaft. Refer to Fig. 8.

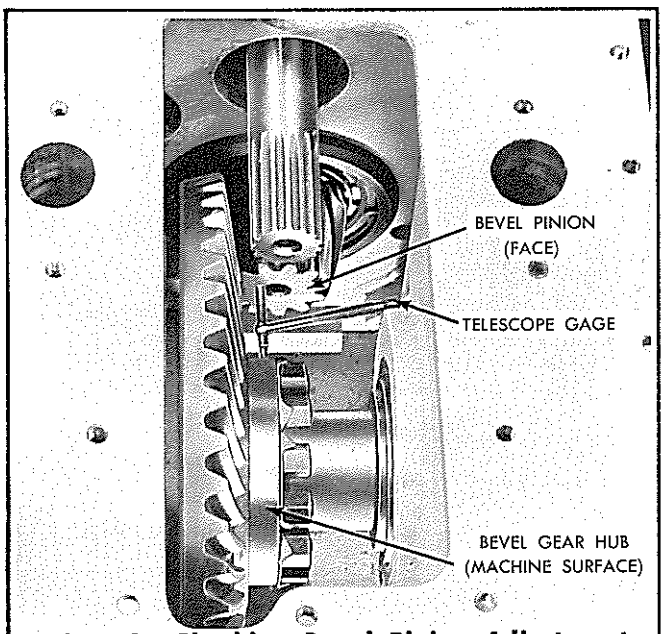


Fig. 13 – Checking Bevel Pinion Adjustment

NOTE: If the bevel pinion has no mounting distance marked on the toe end, the pinion should be adjusted so that the face of the bevel pinion stands out approximately 4.000" from the rear face of the transmission case.

11. Check the backlash between the bevel gear and bevel pinion teeth. The specified backlash is .008" to .014". If the gear backlash is not within the above limits, the bevel gear "run out" (wobble) should be checked with a dial indicator. The bevel gear run-out should not exceed .012". If the bevel gear run-out exceeds .012", the mounting of the bevel gear on the shaft should be rechecked.

12. Adjustment of the gear backlash is accomplished by changing the bevel gear bearing adjusting shims from one bearing cage to the other. If the backlash is excessive, remove adjusting shims under the bevel gear shaft bearing cage on the left and add these shims to those under the bearing cage on the right side. If the backlash is insufficient, remove adjusting shims from the right side and add them to the left side. In this manner, the bevel gear is moved without disturbing the adjustment of the bevel gear shaft bearings.

    Moving a .005" shim will change the gear backlash approximately .0035".

    IMPORTANT: After the backlash has been adjusted, the tooth bearing MUST 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. 14 showing the correct and incorrect tooth bearings.

13. 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 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, be certain that they are positioned so that the wear pin for the clutch throwout yokes are to the bottom.

14. 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 300 foot pounds torque, then lock the capscrews in position with the capscrews locks. Connect the upper ends of the lubricating tubes (right and left) for the steering clutch throwout bearings.

15. Install both steering clutches and brake assemblies, refer to "CLUTCH INSTALLATION" in Section XII.

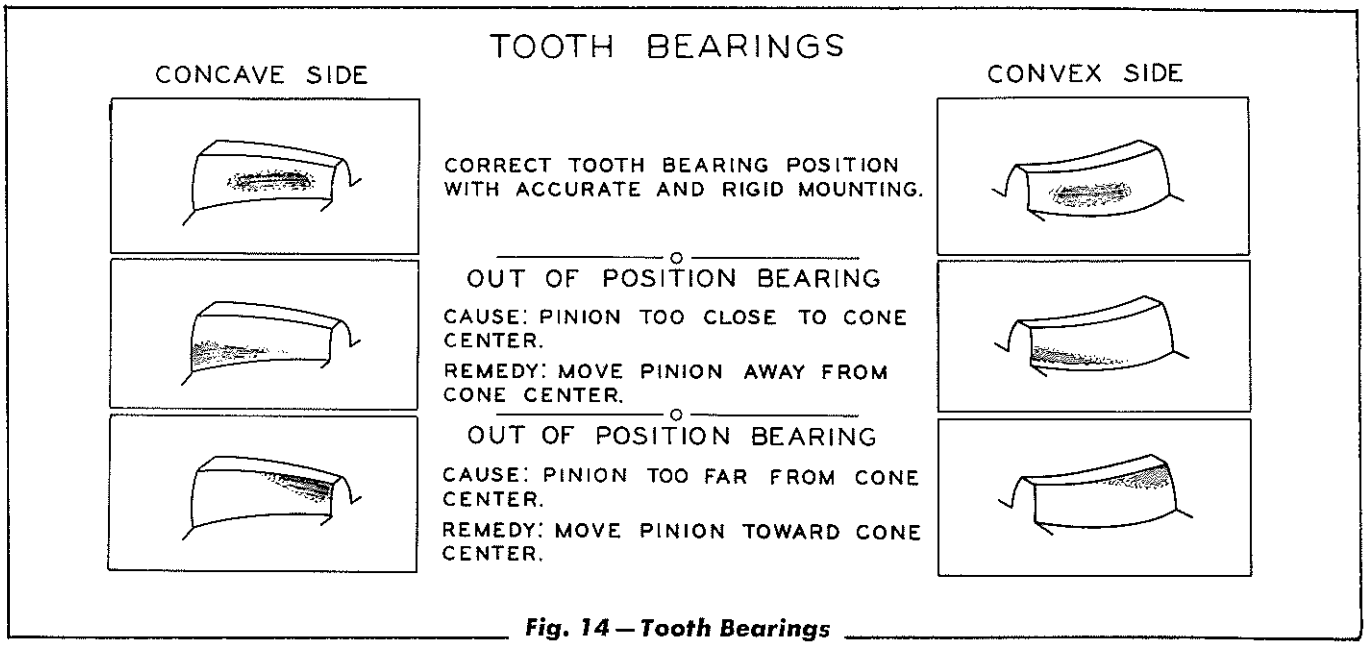


Fig. 14 — Tooth Bearings

16. 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.

17. 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 steering control housing in position as outlined in "STEERING CLUTCHES AND CONTROLS" in Section XII.

4. UNIVERSAL JOINT

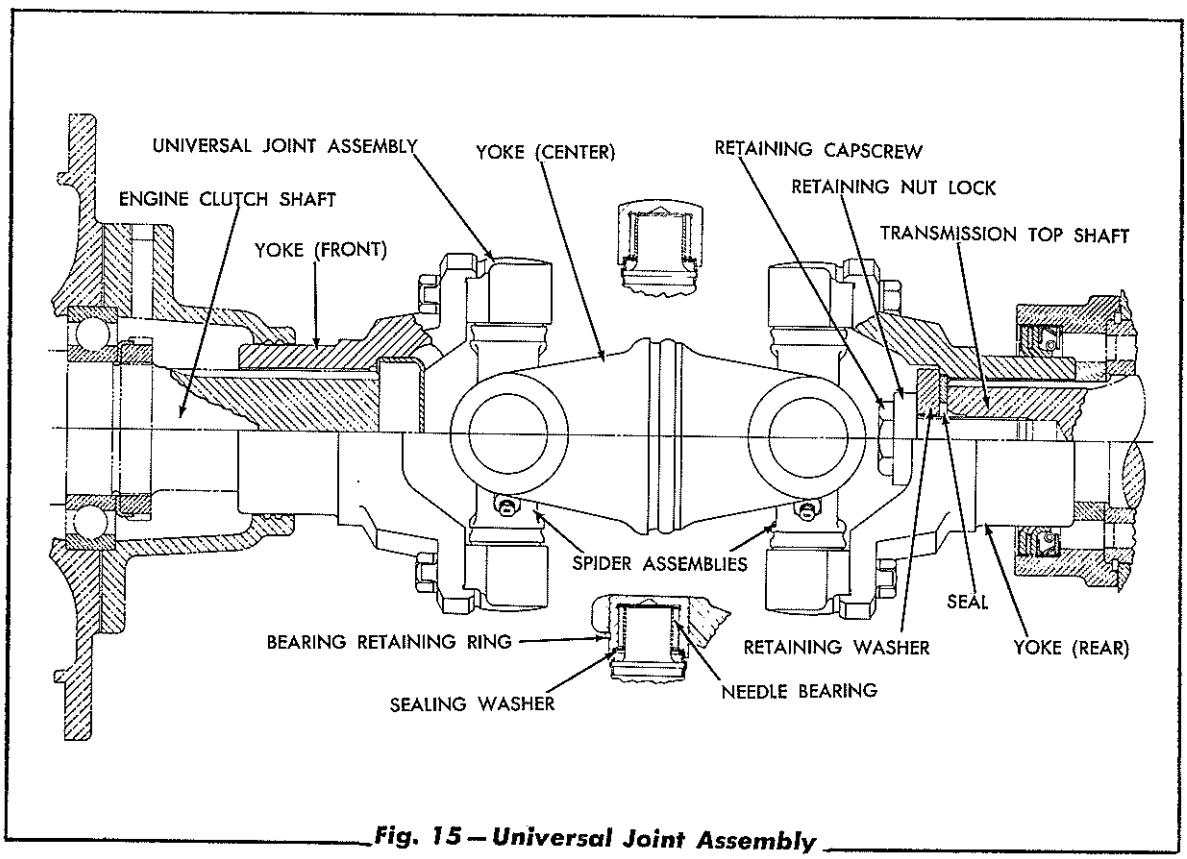


Fig. 15 — Universal Joint Assembly

A. Description

Power from the engine is transmitted through the engine clutch and to the transmission by a universal joint assembly. The main parts of the assembly are: the front, center, and rear yokes and the spiders and bearing assemblies. By removing the front or rear yoke, either the transmission or engine clutch can 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 lubricate these points, remove the front floor plates. Replace the front floor plates after the universal joints have been lubricated.

The universal joint assemblies should be lubricated after each 1000 hours of operation. Whenever the transmission or engine clutch are removed, the universal joint assembly should be inspected.

C. Removal, Disassembly, and Inspection

1. Remove the front floor plates.
2. Remove the four (4) capscrews attaching the rear yoke to the bearing assemblies. Use a small pry bar to pry the universal joint assembly forward on to the clutch shaft splines. Do not drop the rollers from the bearing retainers. Tape or tie the two (2) bearing assemblies to the spider, then remove the front yoke retaining screws and pull the universal joint free of the front yoke.
3. 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 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, 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-one (31) in each race, and pack them with grease to hold them in position. Install the retainers.

MEMO

SECTION XII—STEERING CLUTCHES AND CONTROLS

1. GENERAL DESCRIPTION

Two steering clutches, one at each end of the bevel gear shaft, are employed for steering the tractor. Each steering clutch is enclosed in a brake drum which serves in conjunction with the steering clutch for steering, by braking the rotating action of the final drive.

Each steering clutch is actuated by a hand lever which controls a spool valve of the hydraulic piston arrangement. The piston arrangement actuates the steering clutch throwout yoke assembly which in turn disengages the steering clutch.

2. STEERING CLUTCHES

A. Description

The two steering clutches, one on each side, are of the multiple disc type having fourteen (14) friction discs and fourteen (14) 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 the corresponding clutch throwout sleeve against the clutch throwout plate in the clutch and compresses the springs, thereby allowing the steel discs and friction discs to separate.

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 levers is necessary to insure proper clearance between the clutch throwout sleeve and the clutch throwout plate and to insure 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 adjustor covers from the top of the steering clutch 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

Remove either steering clutch as follows:

1. Remove the fuel tank (refer to "FUEL TANK REMOVAL" in Section II).
2. Remove the center and rear floor plates. Remove the two (2) bolts attaching the right and left supporting channels for the center and rear floor plates to the supporting channel (cross channel) for the front floor plate. Remove the capscrew attaching the cable clip to the left rear corner of the left supporting channel and remove the channel assembly from the tractor.
3. Remove the jam nut and the brake band support adjusting nut.
4. Remove the steering clutch compartment cover.
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 control rear rod to the brake band lever. Remove the pipe plug located in the side of the steering clutch housing, in line with the brake band end pin in the band adjusting fork, and using a suitable 3/8" N.C. capscrew inserted through the hole, turn it into the tapped hole in the end of the brake band end pin. Pull on the capscrew and remove the brake band end pin out through the hole for the pipe plug, then remove the brake band adjusting fork. Lift up on the brake band lever until the pin attaching the lower end of the brake band to the brake band 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 using a jack under the rear of the track and moving the tractor, or by turning the track sprocket by using a suitable pry bar.
8. Using a small chain hooked around the brake band adjuster and around a suitable 3/8" bolt or rod inserted in the lower end of the brake band as shown in Fig. 1, lift the steering clutch assembly out of the compartment: *NOTE: Before lifting the clutch in this manner, turn the brake band on the brake drum so that the brake band adjuster is as far forward as possible, then place the lifting hook on the small chain as near to the adjuster as possible.* With the band turned in this position, the brake band adjustment support (at the rear of the band) will be turned forward far enough so that it will clear the top rear of the clutch housing as the clutch is lifted from the compartment.

E. Disassembly of Steering Clutches

1. Remove the brake drum from the clutch assembly, being careful not to bend the clutch friction 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.

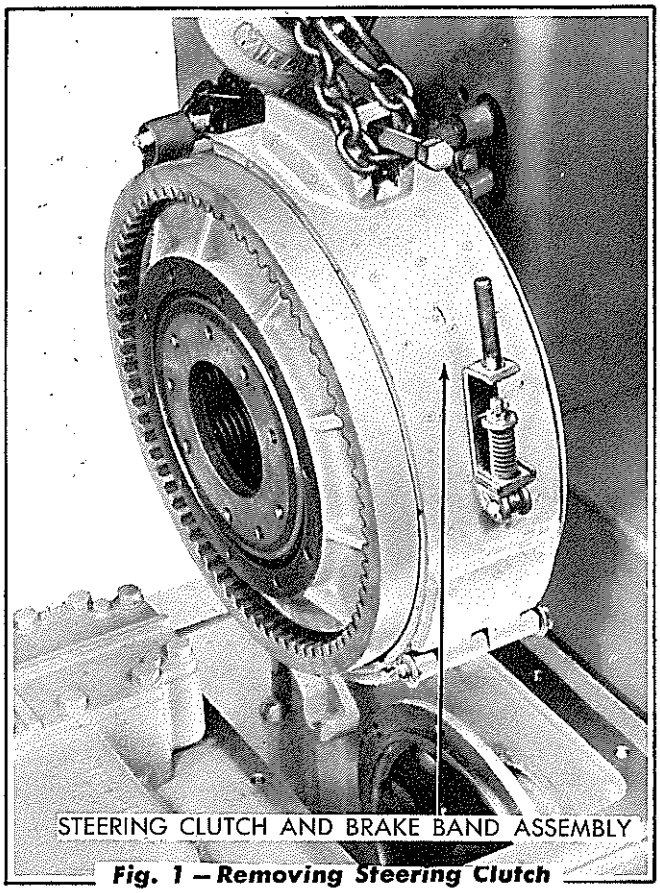


Fig. 1 — Removing Steering Clutch

3. Remove the lockwire and five (5) of the nine (9) drilled head capscrews used in holding the clutch together. *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" N.F. for a distance of approximately 1". The other end should be machined square for a wrench hold and threaded ½" N.F. for a distance of approximately 8½" (refer to Fig. 3).*

4. Install the five studs with the short threaded end into the throwout plate, followed by flat washers and hex nuts. Turn 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 separated.

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."

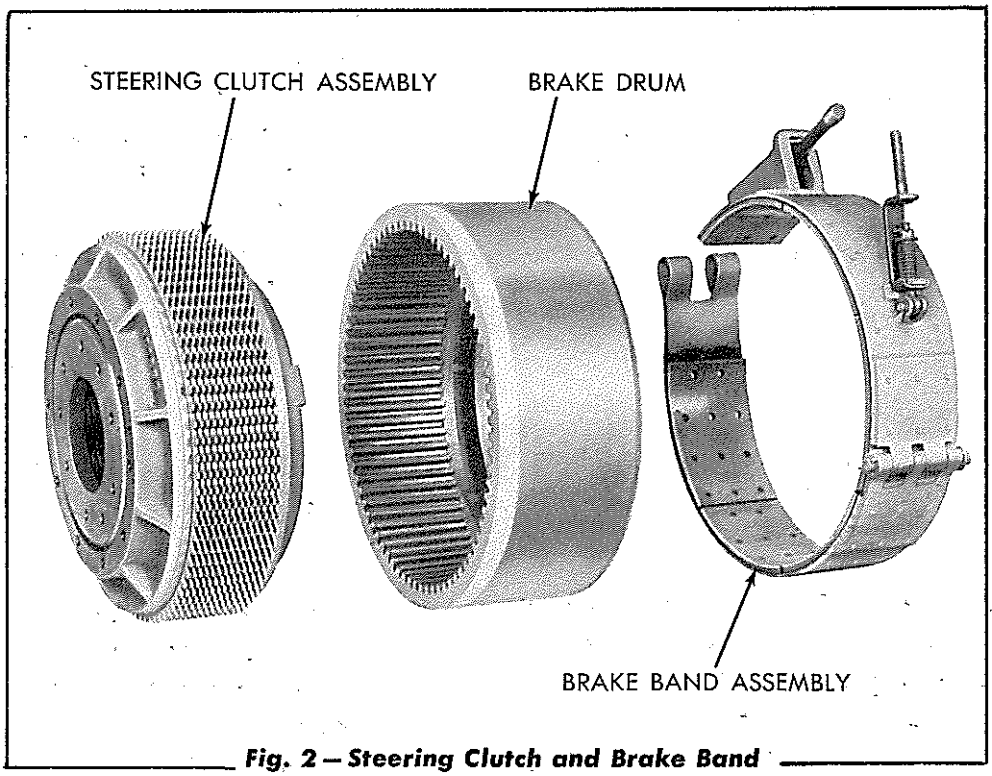


Fig. 2 — Steering Clutch and Brake Band

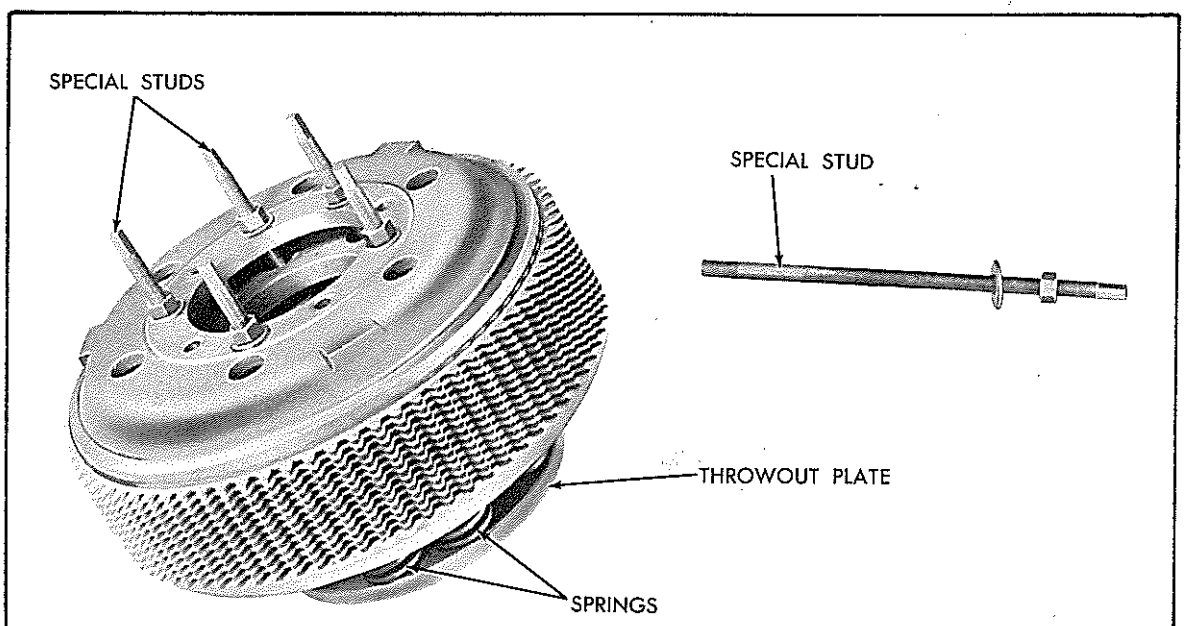


Fig. 3—Disassembly of Steering Clutch

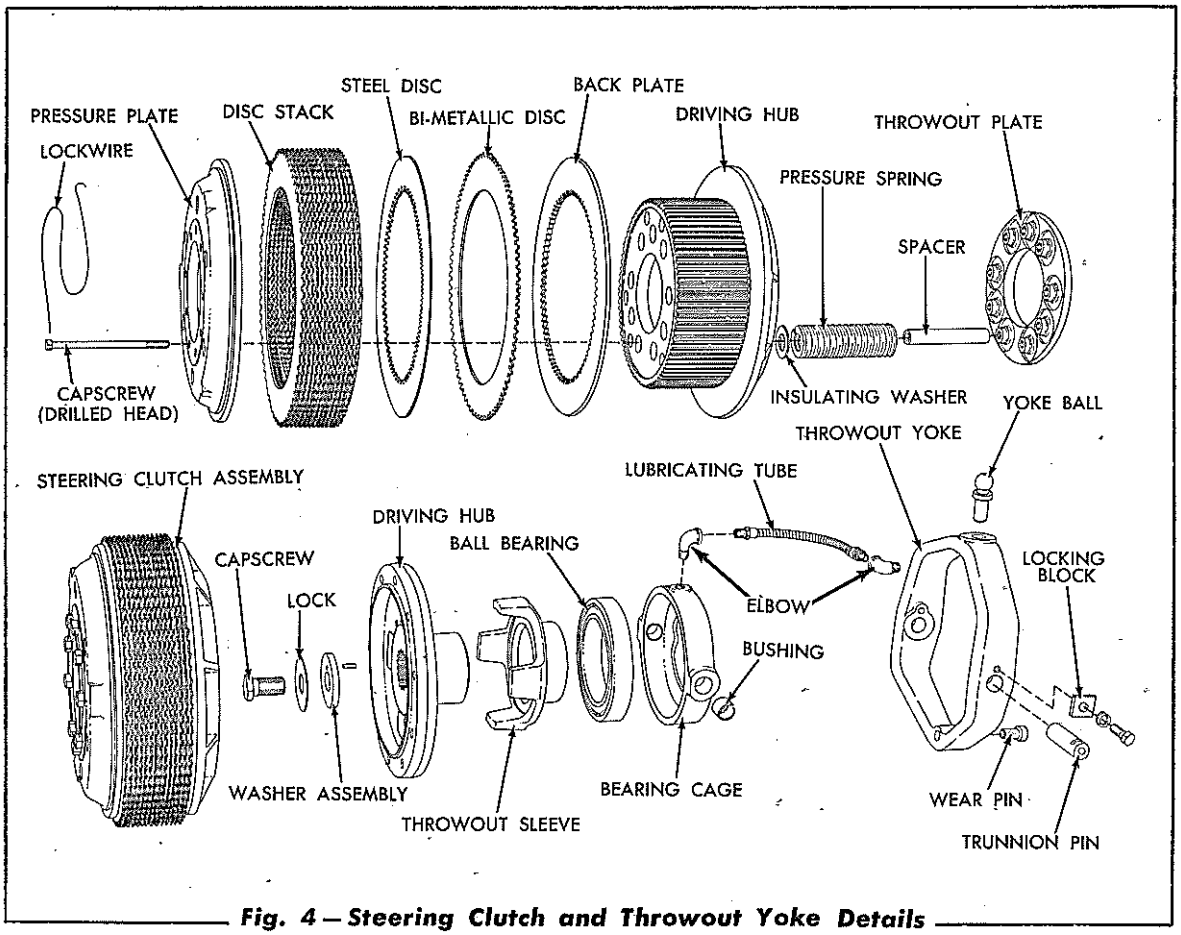


Fig. 4—Steering Clutch and Throwout Yoke Details

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 380 to 420 pounds when compressed

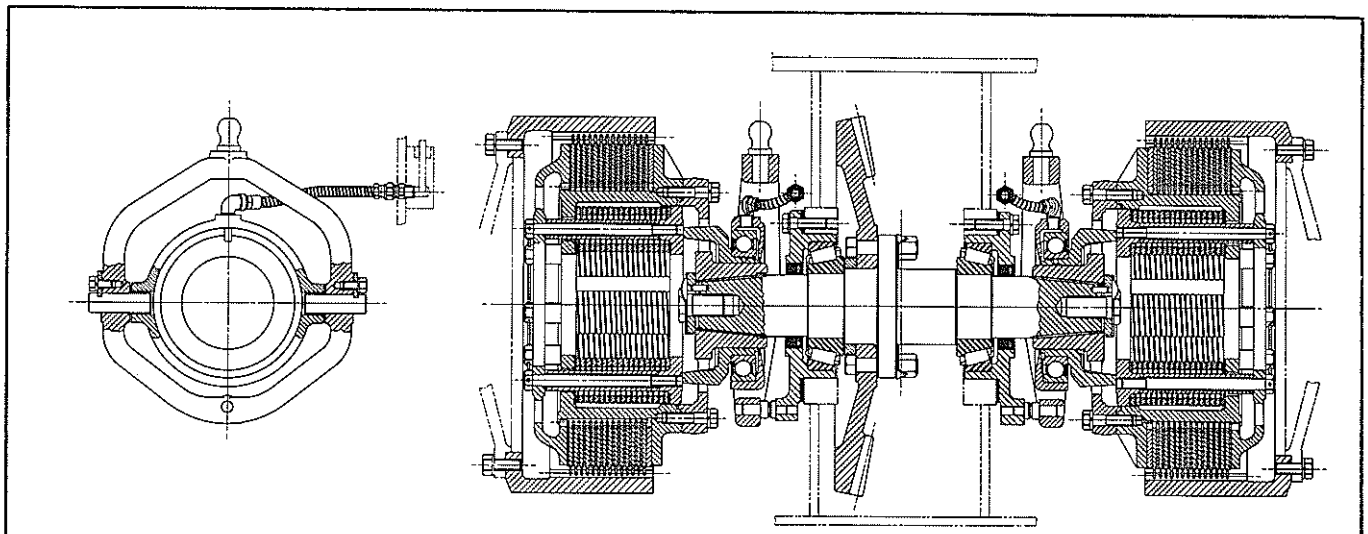


Fig. 5 — Steering Clutch and Throwout Yoke Sectional View

to 4-17/64". 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 Figs. 4 and 5 showing the parts in their relative position.

1. Lubricate the hub teeth and the extreme outer surface of the throwout plate sparingly with "Supremalube" or its equivalent.

2. Place the throwout plate on a bench with the spring bosses up.

3. Install a spring over each boss and install a throwout plate spacer in each spring.

4. Place an insulating washer on each spring.

5. Place the hub over the springs. Be certain that the center punch marks on the hub and throwout plate are in line.

6. Place the back plate on the hub. Be certain that the center punch marks on these parts are in line.

7. Stack the discs (14 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, being 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. Remove the brake drum from the clutch, then turn the clutch to a vertical position. *CAUTION: Use care and do not damage the clutch disc teeth when standing the clutch on its teeth.*

10. Using a suitable scale or straight edge, measure the distance between the machined end face of the clutch hub (throwout plate end) and the machined flat face of the throwout plate. These faces must be flush within plus or minus .065". If necessary, use steel discs to obtain the proper relation of the hub with the throwout plate; placing the added steel disc next to the pressure plate.

11. Install four (4) attaching capscrews and tighten them, then remove the five (5) special studs and install the five (5) remaining capscrews. Tighten the nine (9) 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 throwout bearing lubricating tube. 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 tube and wick assembly.

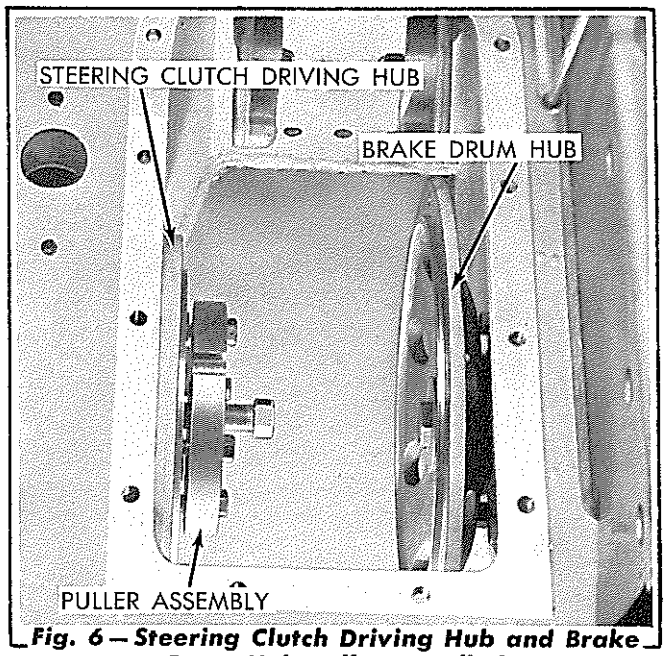


Fig. 6—Steering Clutch Driving Hub and Brake Drum Hub Puller Installed

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 capscrew and remove the capscrew, lock, and retaining washer. Using a puller plate similar to the one shown in Fig. 6, pull the driving hub from the shaft. Remove the driving hub, throwout bearing, and throwout yoke assembly.

4. Remove the driving hub from the yoke 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 ¼" of wick protrudes above the holder. *CAUTION: Do not twist the wick as this will put a spiral in the wick, thus chang-*

ing 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 capscrew to a torque of 300 ft. lbs. and lock with the capscrew lock.

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 oil by-pass opening 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 sets of 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. 7, before the linkage is adjusted.

To Adjust Linkage

1. Remove the upper yoke pin from the vertical control rod, then raise the steering lever up

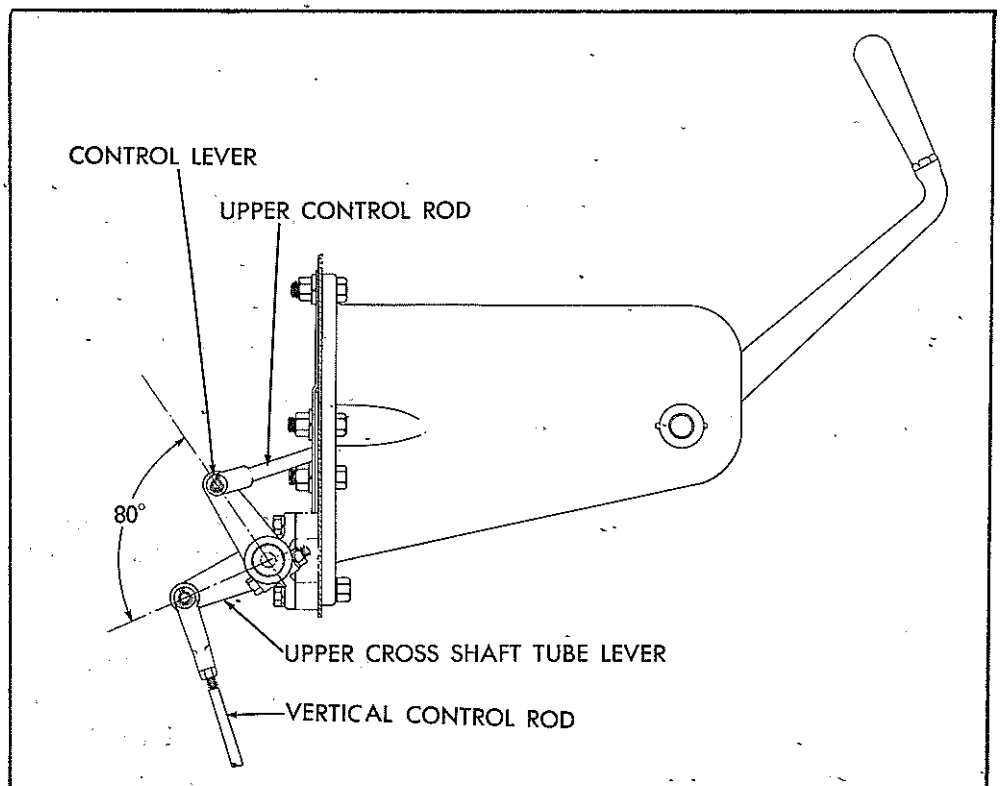


Fig. 7 — Steering Levers and Linkage

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 front yoke 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.

2. Adjust the other steering lever linkage using the same procedure as outlined above.

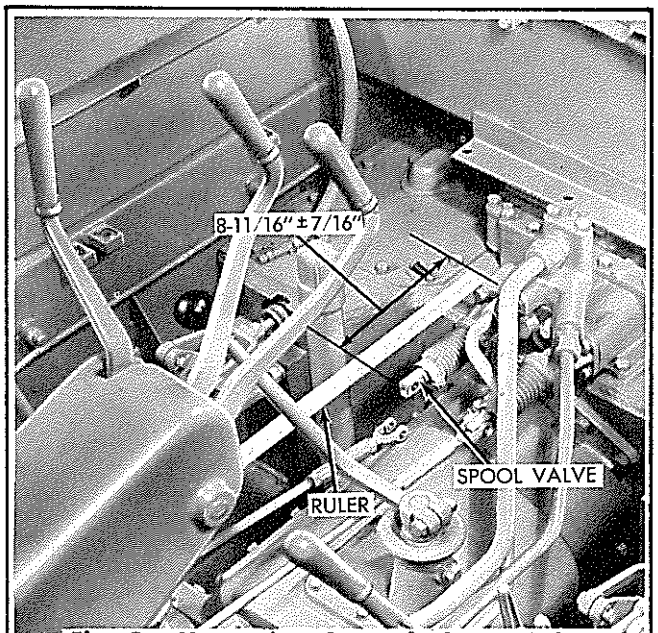


Fig. 8 — Measuring Control Piston Linkage

To Adjust Steering Linkage for Control Piston

1. Remove the steering clutch compartment cover on the side that the linkage is to be adjusted.

2. With the engine stopped, remove the yoke pin connecting the steering clutch lower control rod to the spool valve. Push the spool valve back against the control piston as far as it will go, and then check to make certain that the steering clutch throwout yoke has moved towards the steering clutch so that the shifting sleeve is contacting the clutch throwout plate, then holding back on the spool valve, 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. 8).

   When the hydraulic piston control linkage is correctly adjusted this measurement should be 8-11/16" plus or minus 7/16."

3. If this measurement is not correct, thoroughly clean the outside of the control housing cover so that no dirt will enter when the control housing cover is removed. Remove the capscrews attaching the control housing cover to the control housing, then remove the cover and the cover gasket. Remove the steering clutch compartment cover on the side to be adjusted.

4. Remove the clamping bolt attaching the lower actuating lever (at the top of steering clutch throwout yoke) to the actuating lever shaft. Determine which direction the upper actuating lever should be moved to obtain the correct measurement (8-11/16" plus or minus 7/16"), and approximately how far the lever should be moved. Raise the upper actuating lever and the shaft just far enough to free the lower actuating lever, then rotate the upper lever and shaft to the correct position and push the shaft back into the lower actuating lever. Install the clamping bolt in the lower actuating lever, and when tightening the bolt, make certain that the lower lever is flush with the lower end of the shaft.

   IMPORTANT: This measurement is important as it provides the necessary movement of the actuating lever to properly operate the steering clutch throwout yoke assembly for disengagement and engagement of the steering clutch. This measurement also provides for pressure relief in the hydraulic system. The spool valve should never be actuated, with the engine running, by any method other than the lever control linkage or damage to the hydraulic system may result.

   When the proper adjustment of the steering linkage for the spool valve is obtained, coat the steering control housing cover gasket with gasket cement and install it and the housing cover in position. Install and tighten the cover capscrews securely.

5. Install the steering clutch compartment cover and tighten the cover capscrews securely. With the brake pedal free (pedal all the way back), turn the adjusting nut down on the brake band adjustment support until the nut contacts the seat in the cover, then give the nut an additional ¼ turn. Install the jam nut on the brake band adjustment support to lock the adjusting nut in position.

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, and adjustment is required when the free travel has decreased to less than 1". Free travel of the levers is necessary to insure clearance between the clutch throwout sleeve and the 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 (refer to Fig. 9).

2. Holding the lever forward, measure the distance from the cowl to the top of the lever.

3. With the engine stopped, 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", or greater than 2", an adjustment must be made.

To Adjust the Steering Lever Free Travel

1. Remove the seat cushions and the rear floor plate.

2. Loosen the jam nuts from the adjusting nut, located at the rear end of the lower control rod extending 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. 10).

   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 steering lever using the same procedure as outlined above.

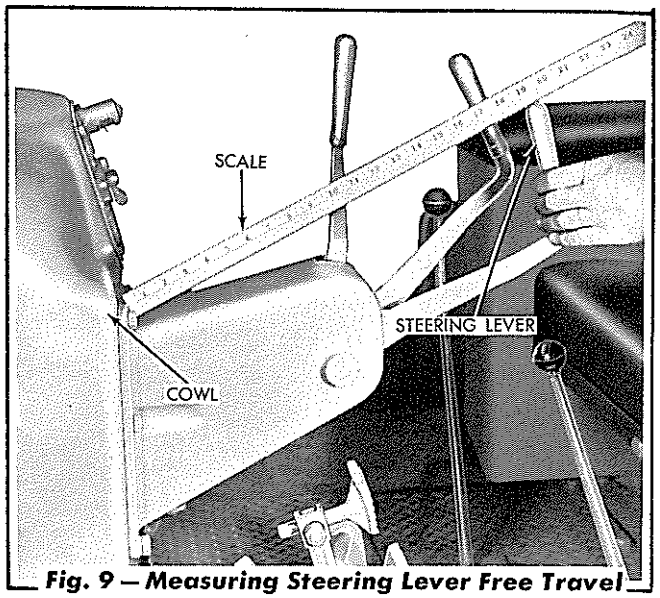


Fig. 9 — Measuring Steering Lever Free Travel

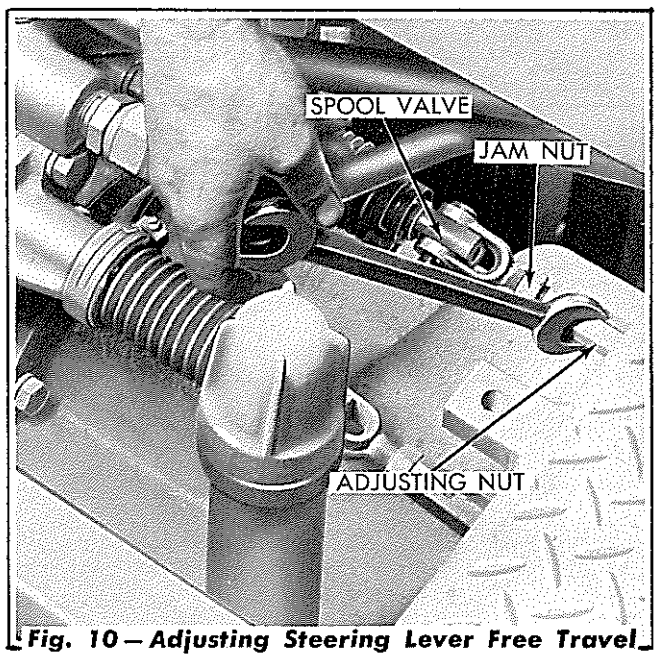


Fig. 10 — Adjusting Steering Lever Free Travel

5. HYDRAULIC STEERING CONTROL HOUSING

A. Description

The hydraulic steering control housing is mounted on top of 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, and the brackets 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 balance 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 return tube. When the spool valve is actuated (by the steering lever), the spool valve moves back and closes the opening 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 actuating levers and the throwout yoke assembly. 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 in needle bearings. The needle bearings and the lip type oil seals are mounted in bearing retainers, which are attached to the control housing by capscrews and lockwashers. Each bearing retainer has a groove machined around the O.D., close to the top, for a sealing ring to prevent an oil leak between the bearing retainer and the control housing.

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 1.

Drain the hydraulic system by removing the drain plug located at the rear of the control housing. Open the air vent cock located in the top of the housing cover when draining (refer to Fig. 11).

REFILL WITH NEW OIL AS FOLLOWS:

1. Re-install the oil drain plug.
2. Remove the oil filler plug located in the top of the tube connection manifold attached to the control housing (refer to Fig. 11). With the air vent cock open, fill the housing, through the filler plug opening, with the specified lubricant.
3. Close the air vent cock and install the oil filler plug.
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. Re-install the oil filler plug.
5. Operate the engine at low idle speed and open the air vent cock in the control housing cover until all the air in the system is bled through the air vent cock, then close the air vent cock.
6. Stop the engine and add oil if necessary to bring the oil level to the "FULL" mark on the oil level gage rod of the hydraulic steering pump adapter.
7. Repeat, items 5 and 6 above, until further operation does not lower the oil level in hydraulic steering pump adapter. *IMPORTANT: Make certain that the hydraulic system is kept clean when servicing.*

C. Removal of Control Housing

1. Remove the seat cushions and the seat back cushions. Remove the seat adjusting frame.
2. Remove the fuel tank (refer to "FUEL TANK REMOVAL" in Section II).
3. Remove the center and the rear floor plates. Remove the two (2) bolts attaching the right

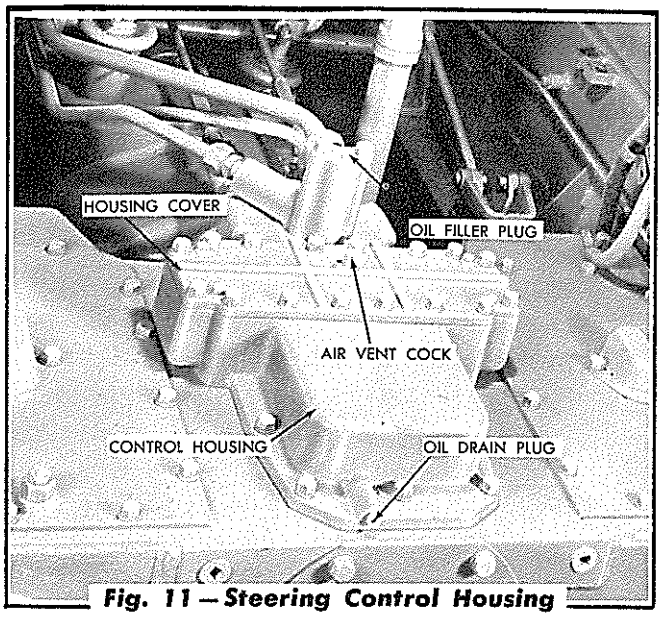


Fig. 11 — Steering Control Housing

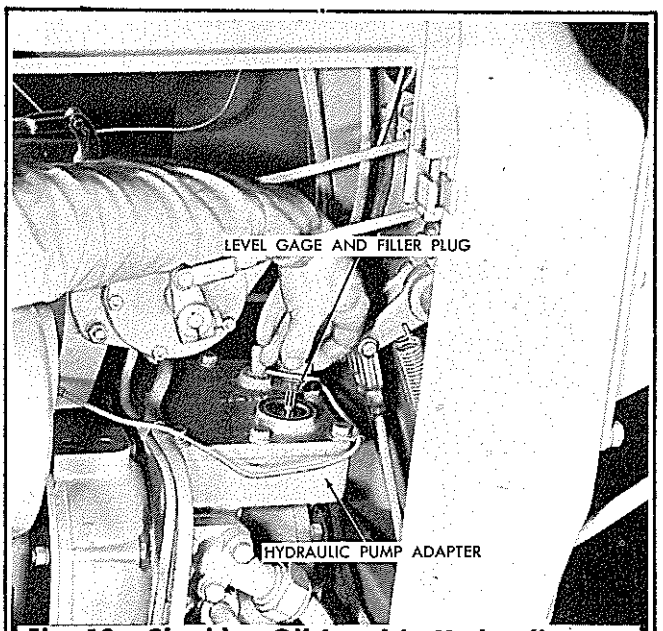


Fig. 12 — Checking Oil Level in Hydraulic Pump Adapter

and left supporting channels for the center and rear floor plates to the supporting channel (cross channel) for the front floor plate. Remove the capscrew attaching the cable clip to the left rear corner of the left supporting channel and remove the channel assembly from the tractor.

4. Remove the oil drain plug from the rear of the hydraulic steering control housing and open the air vent cock located in the top of the housing cover.

5. Disconnect the three (3) hydraulic steering tubes from the tube connection manifold attached to the top of the control housing. Remove the capscrews attaching the tube connection manifold to the control housing and remove the manifold and the manifold gasket.

6. Remove the two (2) yoke pins connecting the rear ends of the lower steering control rods to the front of the spool valves. Remove the capscrews attaching the control housing cover to the control housing and remove the cover and cover gasket.

7. Remove the cover from the top of each steering clutch compartment. Remove the two (2) bolts (one in each steering clutch compartment) clamping the steering clutch lower actuating levers to the actuating lever shafts.

8. Remove the capscrews attaching the control housing to the top of the steering clutch housing, then raise the control housing and free the lower actuating levers from the shafts. Remove the control housing and its attaching gasket.

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 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.

3. 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. Push the control pistons towards the front and remove them from the control housing. *IMPORTANT: Protect the surface of each piston after removing.*

4. Remove the upper actuating levers and the actuating lever shafts by raising them out of the control housing. If replacement of the upper actuating levers is necessary, clamp the levers in a vise, remove the capscrews clamping the levers to the shafts, then remove the shafts from the levers.

5. To remove the actuating lever shaft bearing retainers, remove the capscrews attaching the retainers to the control housing, then push the retainers up and remove them from the control housing. If the actuating lever shaft oil seals and needle bearings are to be replaced, press the components out of the bearing retainers.

E. Inspection and Repair

1. Clean all parts thoroughly in clean solvent or fuel oil. Inspect the actuating lever shafts and their needle bearings. If they are worn excessively, they must be replaced.

2. Inspect the bearing roller used in each upper actuating lever. If the roller is excessively worn or does not turn freely on its needle bearing, remove the retaining pin and inspect the bearing and replace the roller and bearing if necessary.

3. Inspect the spool valves, control pistons, and the bores for the valves and pistons. If the parts show excessive wear or scoring, replace the necessary parts.

4. Inspect the oil seals, gaskets, and bearing retainer sealing rings for damage 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. Refer to Fig. 13 and assemble as follows:

1. If the needle bearings and the oil seals for the actuating lever shafts were removed from the bearing retainers, lubricate the bearings and press one bearing into position at the top and one bearing into position

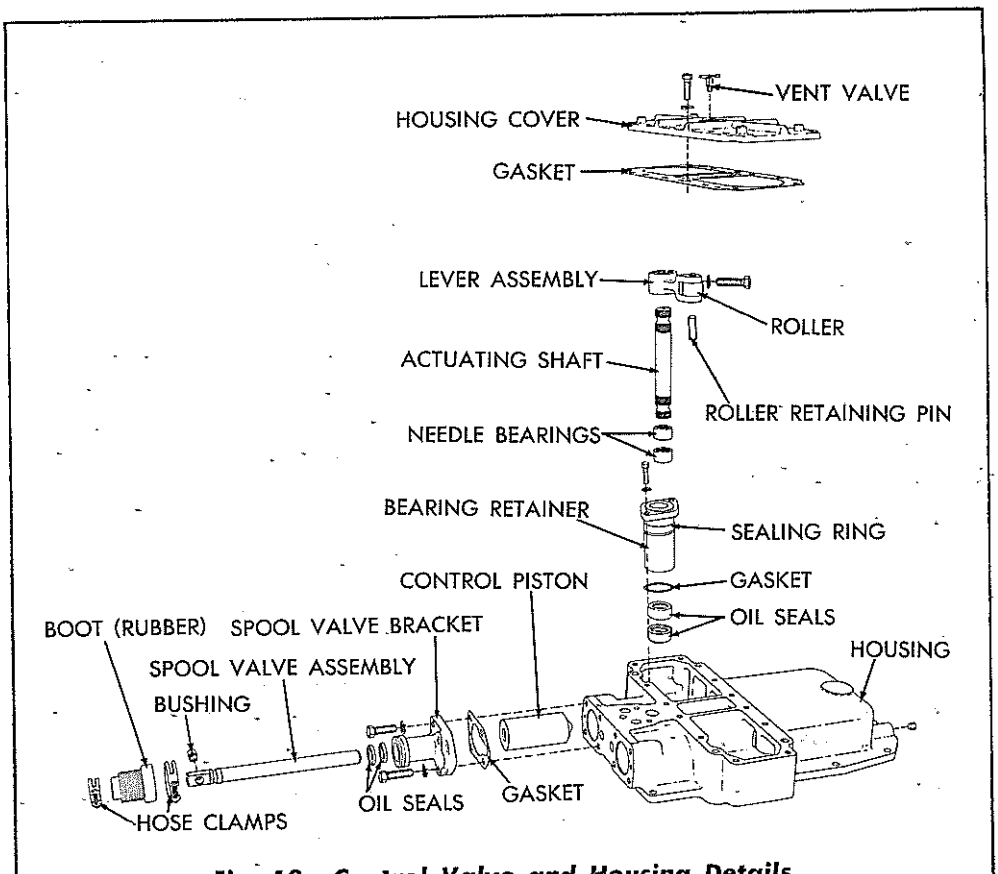


Fig. 13 — Control Valve and Housing Details

at the bottom of each bearing retainer. Press an actuating lever shaft oil seal into position in the counterbore at the lower end of each bearing retainer making certain that the seal is installed with the lips of the seal up (towards the bearing).

2. Place a lever shaft bearing retainer gasket in position on each bearing retainer. Install a sealing ring in position in the groove near the top of each bearing retainer. Install the retainers into position, from the top side of the control housing, making certain that the sealing rings are not damaged. Install and tighten the capscrews used to attach each retainer to the control housing.

3. Install the upper actuating levers in position on the lever shafts if they were removed. *NOTE: Install the upper actuating levers on the shafts so that the chamfered edge, around the hole for the shaft, is down (towards the bearings when installed).* Install and tighten the capscrews used to clamp the levers in position on the shafts.

4. Lubricate the actuating lever shafts and oil seals and insert the shafts into position, from the top side of the control housing. Use care when inserting the shafts so that the lips of the oil seals are not crimped and damaged.

5. Lubricate each control piston and push them into position in the bores in the control housing from the front. Make certain that the cone shaped end of each piston is towards the rear when installing.

6. If the oil seals were removed from the spool valve brackets, lubricate the oil 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.

7. 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.

8. 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 oil 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 in position on the steering clutch housing and tighten the attaching capscrews securely.

2. Place the lower actuating levers of the actuating lever shafts in position on the ball at the top of each steering clutch throwout yoke. *IMPORTANT: When installing each lower actuating lever, make certain that the chamfered edge around the hole for actuating lever shaft is up, (towards the control housing).*

3. Raise each upper actuating lever and shaft only far enough to start the bottom end of the shaft into the lower actuating lever. Install the clamping bolts in the lower actuating levers and hold the levers up when tightening so that the lower end of the shafts are flush with the bottom of the levers. Tighten the clamping bolts securely.

4. Hold the top of each steering clutch throwout yoke over towards the corresponding steering clutch as far as it will go, then push each hydraulic spool valve back as far as it will go so that the control pistons are tight against the bearing rollers in the upper actuating levers. Holding back on each spool valve in turn, measure the distance from the front of the spool valve back to the machined

surface on the control housing, where the spool valve bracket attaches to the control housing (refer to Fig. 8). This measurement should be 8-11/16" plus or minus 7/16". If this measurement is not correct, adjust. Refer to "TO ADJUST STEERING LINKAGE FOR CONTROL PISTON" in this Section.

5. When the proper adjustment of the steering clutch control linkage is obtained, make certain that the clamping bolts in the actuating levers are tightened securely. Connect the rear ends of the steering clutch lower control rods to the spool valves. Inspect the control housing cover gasket and replace if necessary. Coat the cover gasket with gasket cement and install the cover and tighten the attaching capscrews securely.

6. Install each steering clutch compartment cover and tighten the cover capscrews securely.

7. With each brake pedal free (pedal all the way back), turn the adjusting nut down on the brake band adjustment support until the nut contacts the seat in the cover, then give the nut an additional ¼ turn. Install the jam nut on the brake band adjustment support to lock the adjusting nut in position. This adjustment centers the brake band on the brake drum.

8. Inspect the tube connection manifold gasket and replace if necessary. Coat the manifold gasket with gasket cement and install it and the tube connection manifold in position on the control housing. Tighten the attaching capscrews securely.

9. Connect the hydraulic fluid tubes to the tube connection manifold. Tighten the tube fitting nuts securely.

10. Install the floor plate supporting channel assembly. Install the fuel tank and connect the fuel lines. Open the fuel tank shut-off valve.

11. Adjust the steering lever free travel (refer to "MEASURING AND ADJUSTING FREE TRAVEL OF STEERING CLUTCH LEVERS" in this Section).

12. Install the oil drain plug in the control housing and open the air vent cock located in the top of the control housing cover. Remove the oil filler plug in the top of the tube connection manifold (refer to Fig. 11). Fill the control housing, through the filler plug opening, with the specified lubricant. Close the air vent cock and install the oil filler plug in the tube connection manifold.

13. Remove the oil filler plug located in the top of the hydraulic steering pump adapter assembly and fill the adapter to the proper level. Install the oil filler plug.

14. Operate the engine at low idle speed and open the air vent cock in the control housing cover until all the air in the system is bled through the air vent cock, then close the air vent cock. Stop the engine and add oil if necessary to bring the oil level to the "FULL" mark on the oil level gage rod of the hydraulic steering pump adapter.

15. Install the center and the rear floor plates. Install the seat adjusting frame, seat cushions, and seat back cushions.

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 balance shaft through a gear and coupling plate. 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 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 by disengaging one or the other of the steering clutches. Disengagement of the clutches is accomplished "hydraulically" by operating the steering levers. When either of the steering levers are pulled back, the lever 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 and disengages 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 connected by a tube to the pump adapter cover.

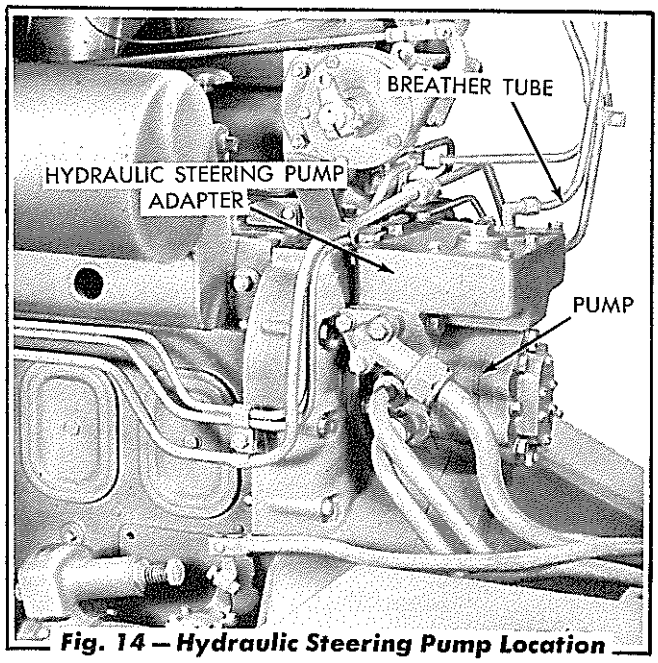


Fig. 14 — Hydraulic Steering Pump Location

B. Removal of Hydraulic Pump and Adapter Assembly

1. Remove the front floor plate. Disconnect the rear ends of the hydraulic steering fluid tubes (front sections) from the rear sections at the tube connectors. Remove the tube supporting clamp from the front section fluid tubes.

2. Disconnect the fluid tubes from the hydraulic steering pump and remove the front section fluid tubes. Tape or otherwise seal the ends of the rear section fluid tubes to prevent dirt or foreign material from entering while they are disconnected.

3. Remove the capscrews attaching the fuel tube supporting clip and the engine temperature gage tube clips to the pump adapter cover. Disconnect the breather tube from the pump adapter cover.

4. 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. 15).

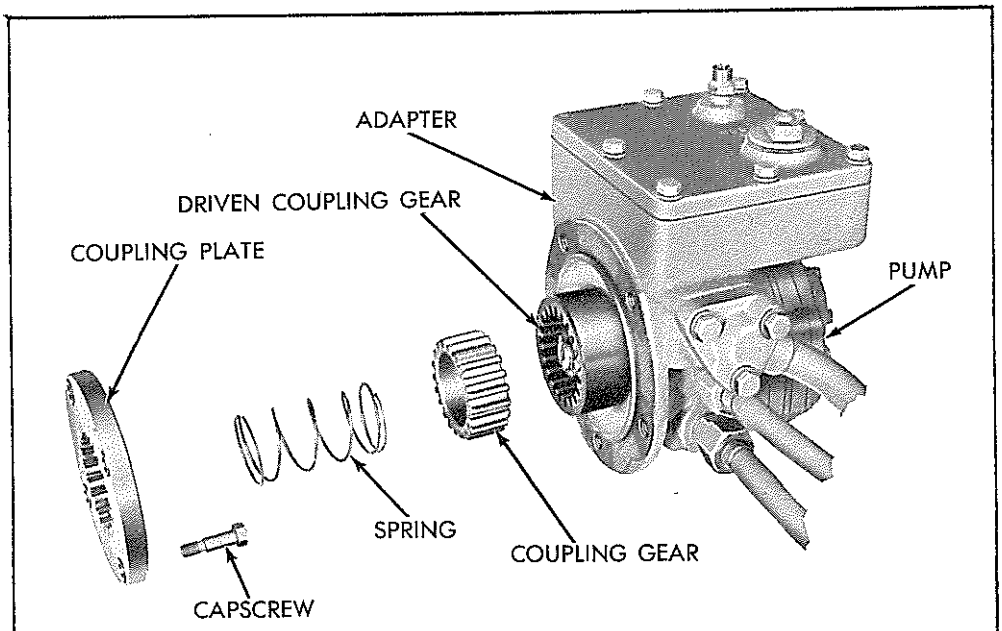


Fig. 15—Hydraulic Pump and Adapter Assembly

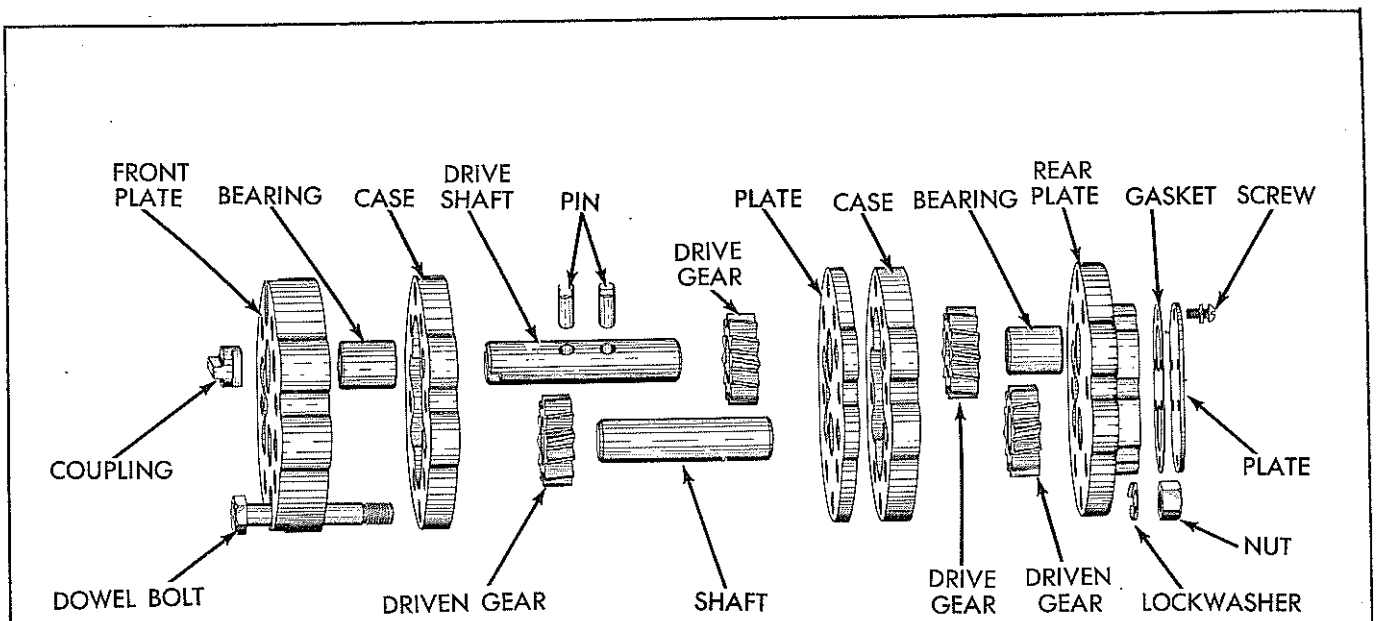


Fig. 16—Roper Hydraulic Pump Details

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 driven coupling gear 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 driven coupling gear 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 driven coupling gear. 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.

6. If the pump adapter bushing and oil 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 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. 16 and 17).

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 of 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 dowel bolt nuts attaching front plate to the dowel bolts, then remove the dowel bolts.

D. Inspection of Hydraulic Pump Parts

1. 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

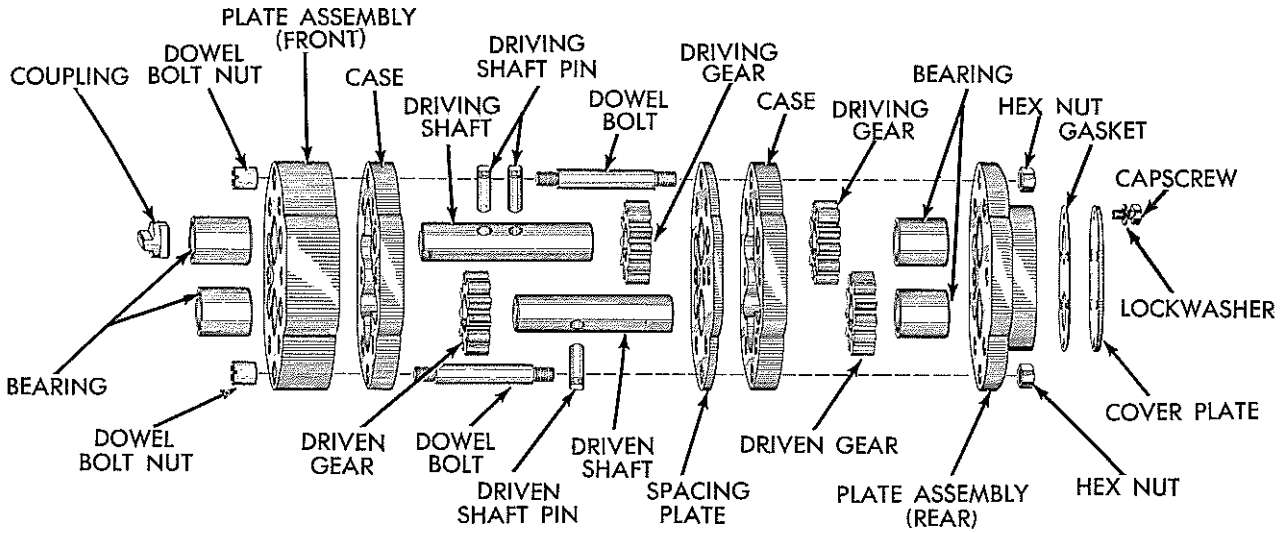


Fig. 17 — Sunstrand Hydraulic Pump Details

time. Before assembling the pump, examine the gear teeth, the inside of both gear cases, the shaft bearings, and the shafts for wear. If the gear teeth are scored or excessively worn they should be replaced. If the 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 16 and 17 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 drive 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 from the front of the plate assembly approximately 3/32", which 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") are 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 aline 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 lower shaft of the "ROPER" pump is held stationary in the front plate and the driven gear revolves on the shaft, whereas in the "SUNDSTRAND" pump, the lower 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 front set of gears. Be certain the case is installed with marks in line. If replacement of the cases or plates was necessary, aline 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 pump adapter bushing in the adapter assembly if it was removed. Lubricate a new oil seal and install it in position in the adapter, with the lip of the oil 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 registration 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 engine balance shaft gear. If the gear teeth are worn excessively, replacement of the plate is necessary. If the coupling plate is to be replaced, remove the capscrew locking wires from the four (4) capscrews attaching the coupling plate to the engine balance shaft gear and remove the capscrews and the coupling plate. Place a new coupling plate in position on the engine balance shaft gear, then install the attaching capscrews and tighten the capscrews securely. Install the capscrew locking wires. Be 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 driven coupling gear. This may be determined by placing the coupling gear in position in the driven coupling gear and inserting the coupling gear into the coupling plate. The driven coupling gear should contact the coupling plate with no interference from the locking wires.

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 necessary.

3. Inspect the teeth in the driven coupling gear for wear If the teeth are worn excessively, replacement of the coupling is necessary. Inspect the pump drive shaft for scoring or wear and replace if necessary.

4. Install the driven coupling gear in position on the pump drive shaft, alineing the key way in the coupling gear with the key in the drive shaft. The internal teeth of the coupling gear should be toward the threaded end of the drive shaft. Install the retaining nut. When tightening the retaining nut, hold the drive shaft by placing the driving slot in the shaft on a flat piece of metal clamped in a 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 driving shaft and place the thrust washer in position on the shaft, then place the small metal driving shaft coupling in the slot of the driving shaft. Place the driving shaft and coupling into the pump adapter housing, and rotate the driven coupling gear to engage the small metal shaft coupling into the slot in the pump shaft.

2. Coat a new gasket with gasket cement and place it in position on the front of the pump adapter assembly. Place the coupling gear in position in the driven coupling gear, then place the coupling spring in position inside the coupling gear. Hold the drive assembly in this position and install the adapter and pump assembly on the flywheel housing of the engine. Be certain that the spring enters the coupling plate and the teeth of the coupling gear enter the internal teeth of the coupling plate. Install the capscrews attaching the pump 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 pump adapter cover and the attaching capscrews. *NOTE: Two (2) of the cover attaching capscrews are used to attach the fuel tube supporting clip and the engine temperature gage tube clip to the adapter cover.*

4. Connect the breather tube to the pump adapter cover. Install and connect the three (3) hydraulic steering fluid tubes (front sec-

tions) to the hydraulic pump and to the rear section fluid tubes. Tighten the tube fitting nuts securely.

5. Install the fluid tube supporting clamp in position on the front section fluid tubes and install and tighten the clamp attaching bolts. Install the front floor plate.

6. Remove the oil filler plug from the hydraulic steering pump adapter cover and fill the system with the specified lubricant (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 adapter. Each fluid supply tube and the fluid return tube are made in two (2) sections (front and rear) for ease of assembly and disassembly. The fluid supply tubes and the fluid return tubes are supported by two (2) clamp supporting brackets and clamps. One of the brackets is attached to the rear of the engine clutch housing and the other is attached to the left front corner of the transmission case (refer to Fig. 18).

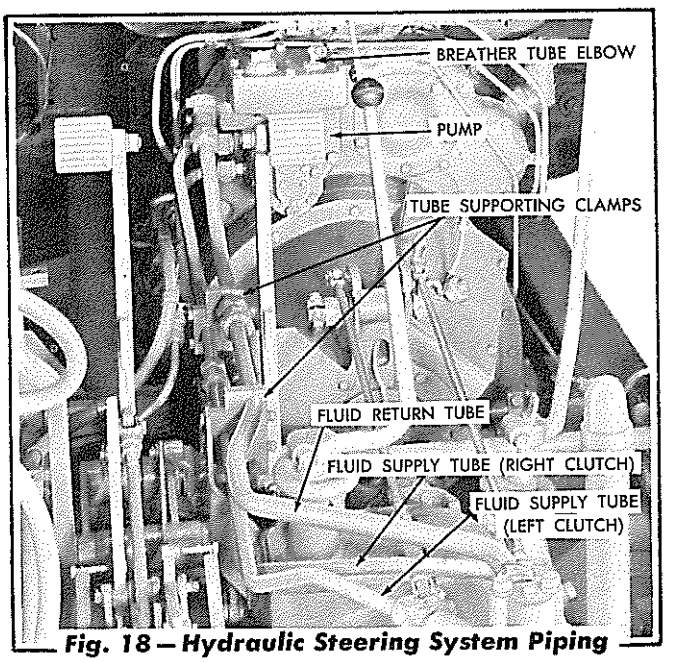


Fig. 18 — Hydraulic Steering System Piping

B. Service and Inspection of Piping

The fluid supply tubes and the fluid return tube clamps, and the clamp supporting brackets, should be kept tight to prevent damage to the tubes. Maintain a tight connection where tubes connect to the control housing, the pump, pump adapter, and at the connections where the front sections connect to the rear sections.

In the event of a failure in 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 of the foot operated, mechanically controlled, self-energizing type. Brake bands are of the wrap around, two-piece type with replaceable linings. The bands 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 lever assembly. Action of the brake band lever assembly pulls the ends of the brake band together and causes the brake band to close on 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. Each steering brake is provided with a brake lock on the floor plate, to provide a means of holding the brake in the applied position for parking purposes.

The brake pedal pads are clamped to the pedal levers with eyebolts which make the pedal length adjustable. The brake pedal levers are mounted on sealed needle bearings that are grease packed at time of assembly. Adjustable brake operating rods connect the brake pedal lever to the brake band operating lever. The brake band operating lever is attached to both ends of the brake band. A brake pedal lever retracting spring is attached to the brake operating rod to return the lever to the normal (released) position after application.

The brake band is made up of two (2) steel segments to permit 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 will require adjusting before they are loose enough to allow the brake pedal to strike the floor plate. The brake pedal lever 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 pedal levers 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, it will cause heating, 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.

To Adjust the Steering Brakes

1. Remove the small oval cover from the steering clutch compartment cover.

2. Adjust the brakes by turning the brake adjuster clockwise until the pedal has 3" of free travel.

   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.

3. With the brake pedal free (pedal all the way back), loosen the jam nut on the brake band adjusting support, then turn the adjusting

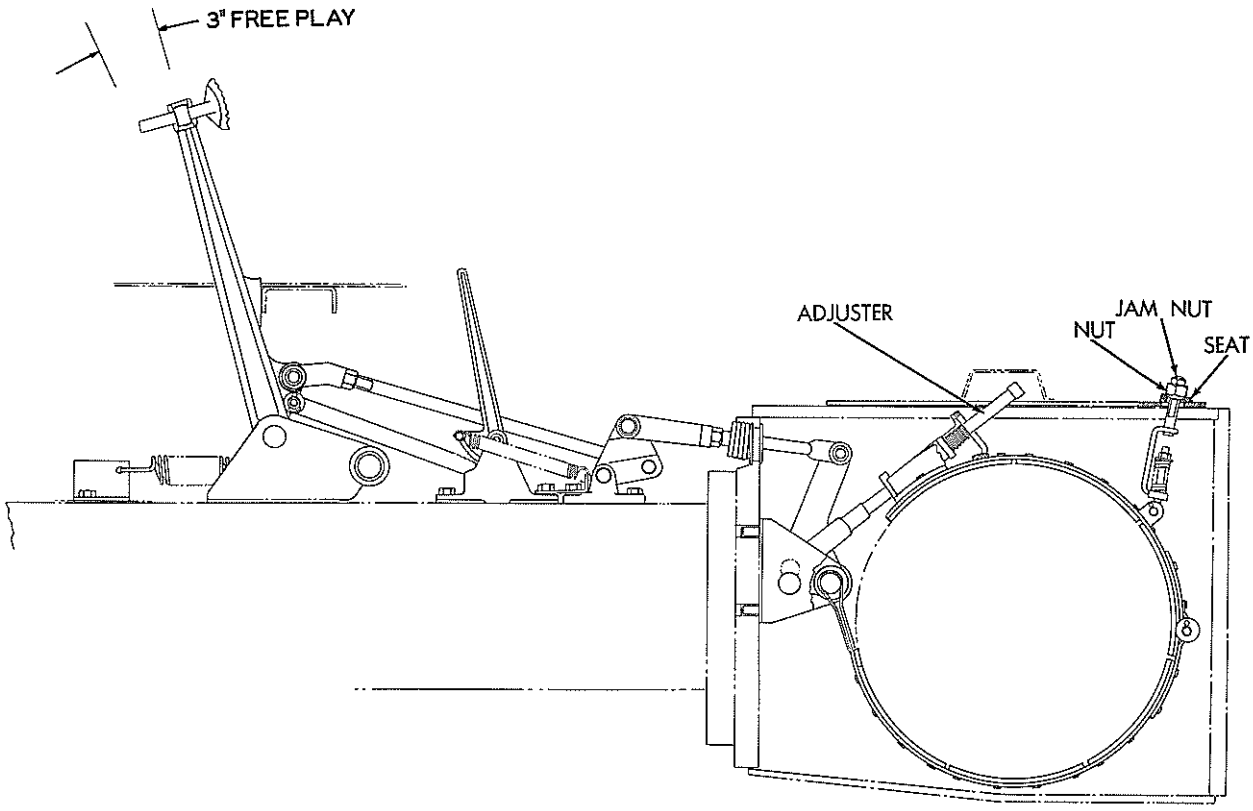


Fig. 1 — Brake Assembly

support nut up out of seat in the cover. Turn the adjusting nut back down until it contacts the seat in the cover and give the nut an additional ¼ turn, then lock the adjusting nut in position with the jam nut. This centers the brake band on the brake drum. Replace the small oval cover.

B. Brake Linkage Adjustment

1. Adjust the rod assembly, connecting the brake band actuating lever to the bellcrank so that the distance between the centers of the lower rear pin holes in the bell crank is 2" from the top of the main frame.

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 bell-crank and the foot pedal lever, to provide 1/16" clearance between the stop on the foot pedal lever and the floor plate.

3. Turn the brake adjuster clockwise until the brake pedal has 3 inches 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 the small oval cover.

   NOTE: This adjustment is to be made each time an adjustment for brake pedal free travel is made.

C. 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.

D. 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 lever.

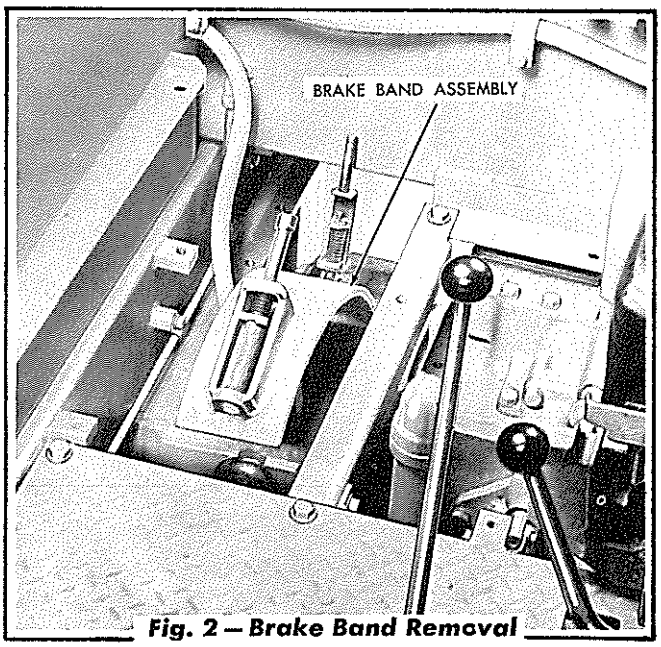


Fig. 2 — Brake Band Removal

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 3/8" N.C. 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 and the brake band adjuster. 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.

7. Move the brake band toward the bevel gear compartment and remove as shown in Fig. 2.

E. 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 foot brake pedal to be 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 and make it fit uniformly around the brake drum.

7. All pins and bushings should be lubricated sparingly when reinstalled.

F. Brake Band Installation

Steering brakes may be installed by a direct reversal of the removal procedure and must be properly adjusted. Refer to "BRAKE ADJUSTMENT" and "BRAKE LINKAGE 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 misalinement 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.

Bearing cages are provided for the bearings on the final drive pinions, for the bearings on the intermediate pinions, and for the inner and the intermediate bearings on the sprocket shafts.

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) used in each final drive are of the positive type.

The final drive pinions are driven by the bevel gear and steering clutches. The pinions drive the gears splined to the intermediate shafts, 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 three (3) remaining capscrews attaching the outboard bearing cage 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 sprocket shaft outer bearing adjusting cap and adjusting shims. Tie the adjusting shims to the cap so that they will not be lost. Remove the cotter pin, then remove 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

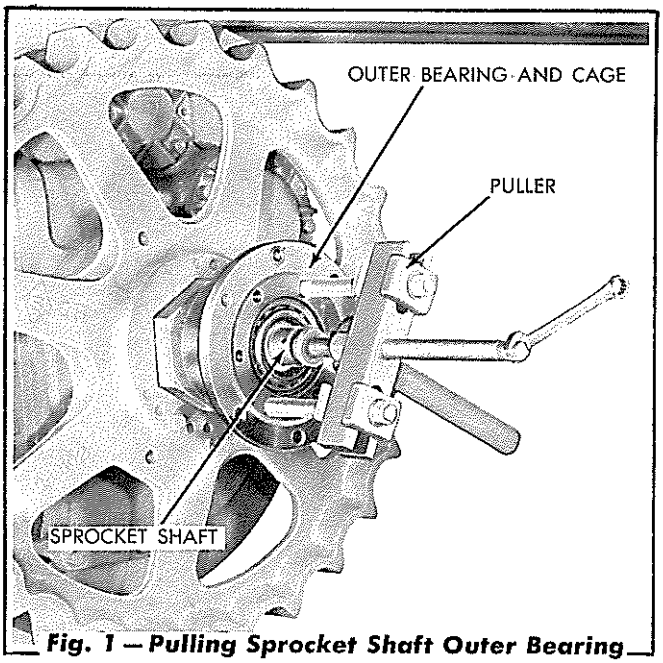


Fig. 1 — Pulling Sprocket Shaft Outer Bearing

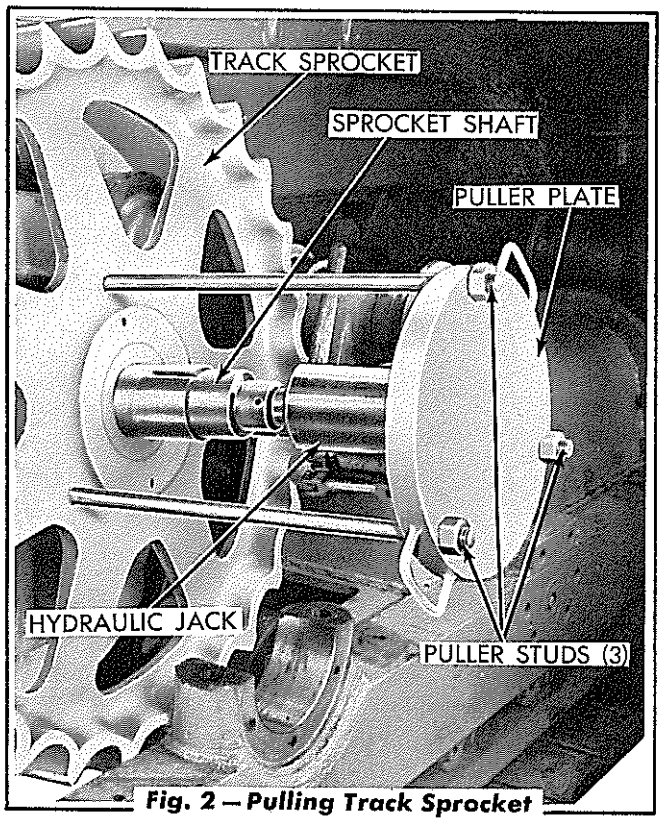


Fig. 2 — Pulling Track Sprocket

nut, is not damaged or scratched. Using a puller similar to the one show in Fig. 2, and with a hydraulic jack having approximately 20 ton capacity, pull track sprocket and remove it from the shaft. Use care and not damage or scratch the seal ring cemented to the sprocket, and do not damage the threads on the sprocket shaft.

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 locks, then remove the capscrew locks and the gear locks. *NOTE: To rotate the sprocket shaft to the correct position for removal of the gear 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 inch material 3½ inches in length and 2½ inches in width, in back of the corresponding steering clutch throwout yoke. With the steering clutch cover removed, start the engine and disengage 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 locks. Refer to Fig. 3.

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 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.

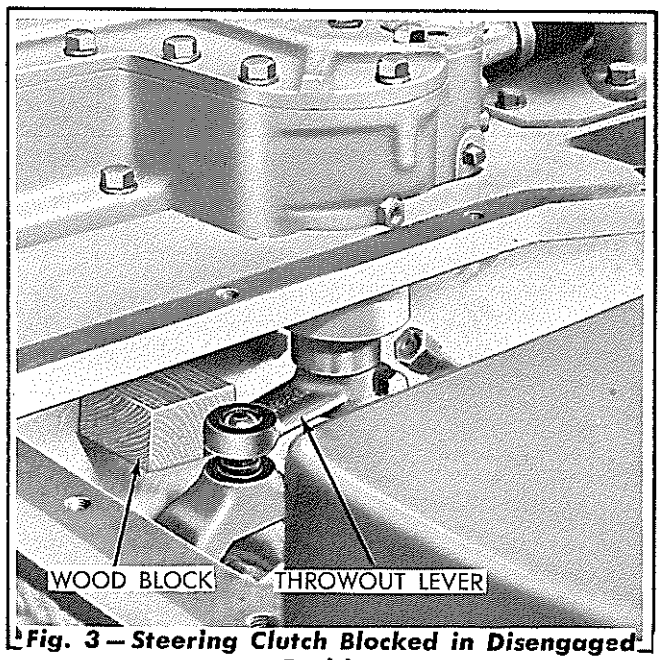


Fig. 3 — Steering Clutch Blocked in Disengaged Position

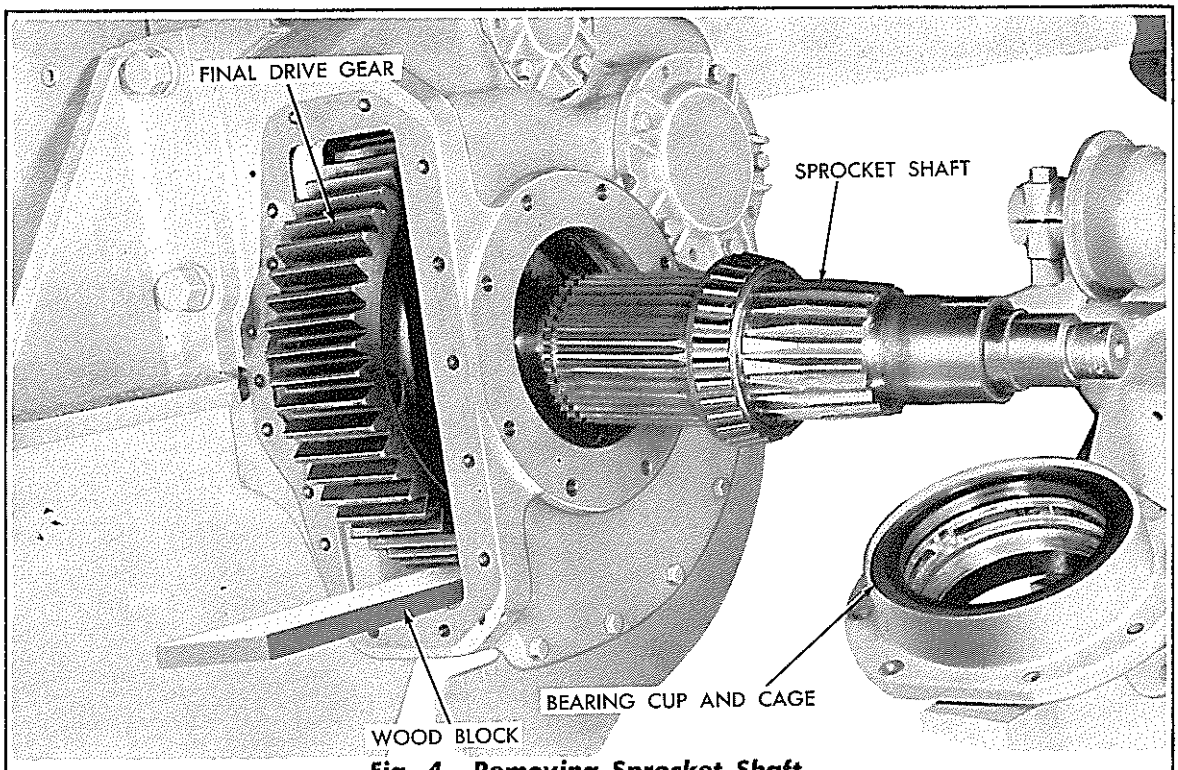


Fig. 4 — Removing Sprocket Shaft

10. Using a sliding hammer type puller and an adapter nut turned onto the sprocket shaft threads, pull the sprocket shaft and bearings. *IMPORTANT: Avoid damaging the bearing by holding the shaft out as far as possible when pulling so that the bearing is tight against the bearing cup. Remove the sprocket shaft gear using a suitable hoist.*

11. If it is necessary to remove the sprocket shaft inner bearing cup, the bearing cup may be removed by driving out (towards the final drive gears) on the sprocket shaft inner cover. Remove the bearing cup, inner cover, and cover seal ring.

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 capscrew locks. *NOTE: The intermediate locks cannot be removed at this time.*

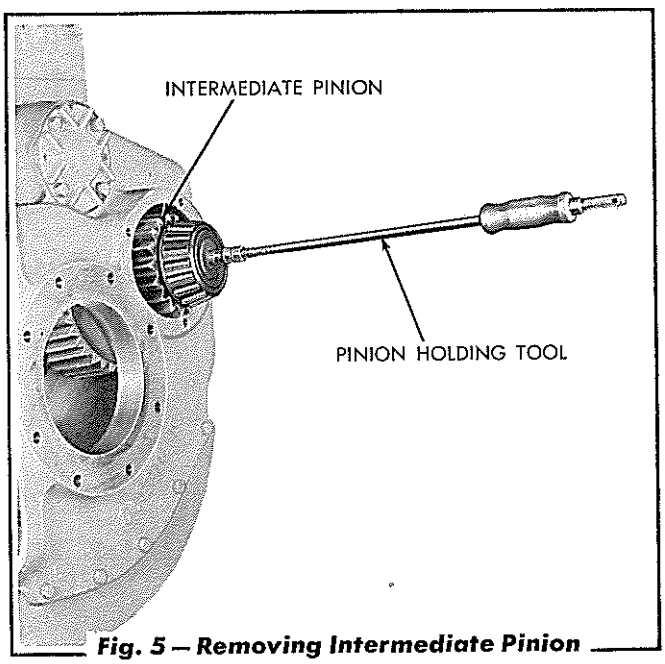


Fig. 5 — Removing Intermediate Pinion

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, to support and remove the intermediate pinion. Screw the threaded end of

the tool into the 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, remove the capscrews attaching the inner bearing cage to the housing. Remove the bearing cage by using ⅜" N.C. pusher capscrews in the tapped holes in the bearing cage. Remove the bearing cup from the cage.

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.

2. Remove the final drive pinion:

   a. Unlock and remove the brake drum hub retaining screw, then remove the lock and retaining washer. Use three (3) pusher screws having ¾" N.C. threads in the tapped holes in the brake drum hub, to push the hub off the final drive pinion. Remove the brake drum hub.

   b. Remove the capscrews attaching the inner bearing cage to the housing. Use three (3) ½" pusher screws having N.C. threads, in the tapped holes in the cage, to 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 through the steering clutch compartment using care so that the bearings are not damaged.

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 inner bearing cup in its cage. Install the cage in the housing and install the attaching capscrews and capscrew locks. Install the bearing cones on 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) in position in the housing. Install the outer bearing cup in the outer bearing cage, then install the outer bearing cage in the housing using the original amount of bearing adjusting shims. Install the attaching capscrews.

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 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," Step B. 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 ring (Neoprene) in the inner bore of the steering clutch and final drive housing, then install the sprocket shaft inner cover and the assembly.

2. Install the inner and the center bearing cones on the sprocket shaft if they were removed. Make certain the bearing cones are pressed tightly against their seats on the shaft. Lubricate the bearings and insert the sprocket shaft (without the gear) in position in the housing. Install the center bearing cup in the bearing cage, then install the bearing cage using the original amount of bearing adjusting shims. Install the attaching capscrews.

3. 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 sprocket shaft to make certain the bearings are seated when adjusting.

4. Remove the sprocket shaft center bearing cage and bearing adjusting shims. Keep the bearing adjusting shim pack with the cage.

   Remove the sprocket shaft using a sliding hammer type puller. *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. To Install the Inner Seal Assembly

a. Place the sprocket shaft center bearing cage on a clean bench with the flat face of the cage up.

b. Make certain the spring follower assembly, rubber 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 cage with "Neoprene" cement. Immediately place the boot and spring follower assembly on 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 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 nearest "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 dowels 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. **To Install the Outer Seal Assembly**

a. Place the sprocket shaft outboard 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 spring assembly, rubber boot, and the seal ring are clean and dry. Install the rubber boot on the spring assembly, lining up the holes in the boot with the protruding pins in the spring assembly. Hold each lip of the boot out and coat the inside of the lips and the sides of the spring assembly with "Neoprene" cement. Press the lips back in place against the spring assembly.

c. Coat the outer face of one lip of the rubber boot and the machined face in the bottom of the counter bore in the bearing cage with "Neoprene" cement. Immediately place the boot and spring 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 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.

f. Coat one side of the seal ring gasket and the outer face of the track 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 nut, 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.

D. Installation and Bearing Adjustment of Final Drive Pinion

1. Install inner and outer bearing cones on the pinion shaft. Make certain the bearing cones are pressed against their seats on the shaft.

2. Install the outer bearing cup in its cage and install the cage in the outer bore of the housing, using the original amount of bearing adjusting shims between the cage and the housing. Do not tighten the cage retaining capscrews securely at this time.

3. Lubricate the bearing cones on the pinion and install the pinion in the outer bearing

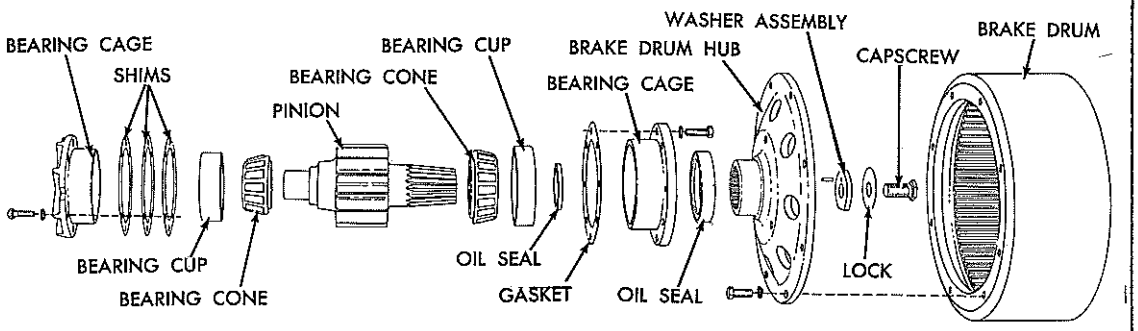


Fig. 6 — Final Drive Pinion Details

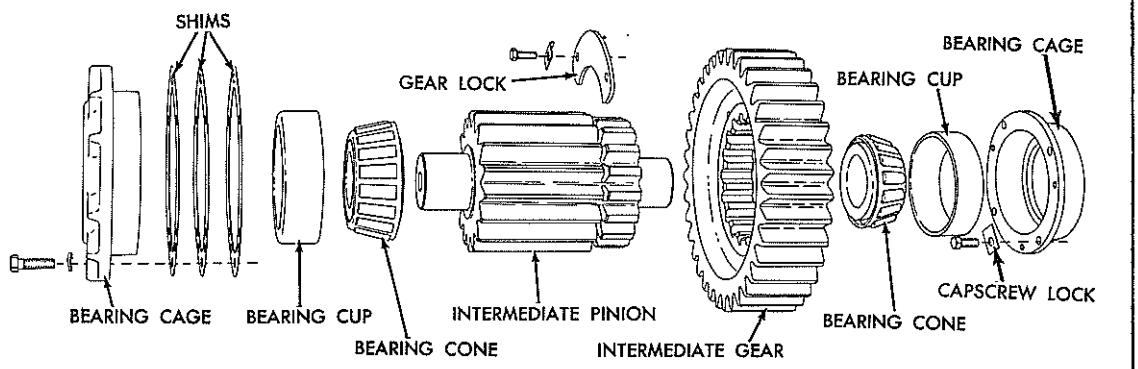


Fig. 7 — Final Drive Intermediate Pinion and Gear Details

cup from the steering clutch compartment side.

4. Install a brake drum hub oil seal in the seal recess of the inner bearing cup cage, with the lip of the seal towards the pinion as installed. Install the inner bearing cup in the cup recess of the bearing cage.

5. Use a new gasket and install the inner bearing cage in position. Tighten the capscrews securely. Then tighten the retaining capscrews of the outer bearing cage. Bump the outer bearing cage to make certain the bearings are properly seated. Turn the pinion to determine the bearing pre-load.

6. 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.

7. 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 lock, and hub retaining capscrew. Tighten capscrew to 300 ft. lbs. torque. Lock the capscrew securely with the capscrew lock.

8. Install the steering clutch and steering brake (refer to "STEERING CLUTCH INSTALLA-

TION," in Section XII).

E. Installation of Final Drive Intermediate Pinion and Gear

1. Place the final drive intermediate gear in 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. Aline 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 in 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 lock attaching capscrews towards the inner bearing cup) in the housing and block the gear in position.

2. Lubricate the bearings and insert the sprocket shaft into the bore in the housing and into the gear. Push the sprocket shaft in so that the inner bearing is in position in the inner bearing cup, then install the sprocket shaft center bearing cage, with the seal assembly attached, and the seal dirt guard in place on the housing, using the correct amount of bearing adjusting shims as determined previously in "SPROCKET SHAFT BEARING ADJUSTMENT." Tighten the attaching capscrews securely.

3. Position the sprocket shaft gear so that the gear locks may be installed on the gear and into the machined groove in the shaft. Install the gear 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.

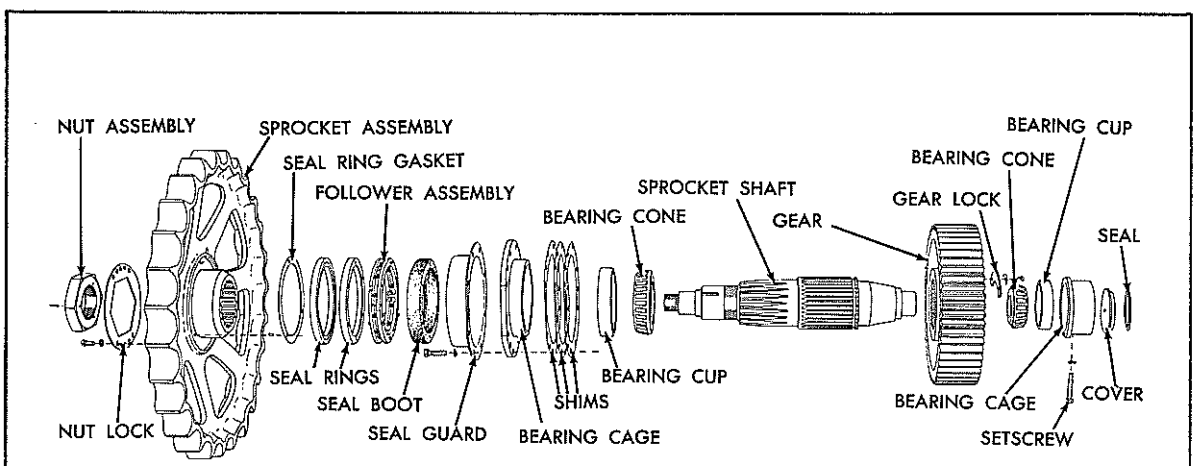


Fig. 8 — Sprocket Shaft Details

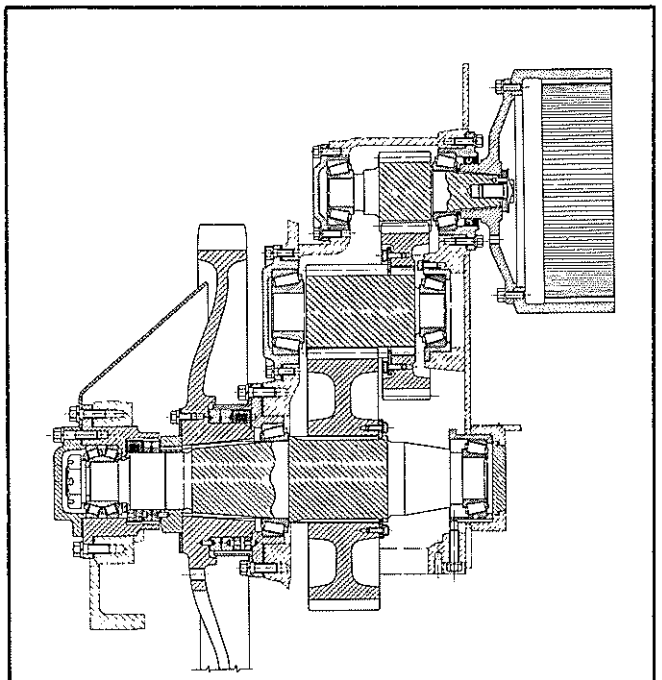


Fig. 9 — Final Drive Sectional View

4. Lubricate the mating surfaces of the inner seal rings, then install the track sprocket (with the seal ring in place) on the sprocket shaft. Coat the back face of the sprocket retaining nut (face which contacts the sprocket) with gasket cement or sealing compound. Make certain the oil holes in the track sprocket retaining nut are not obstructed with the gasket cement or sealing compound, then install the nut. Tighten the sprocket retaining nut to 4500 to 5000 ft. lbs. 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 on the 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 24 inch pipe wrench or chain wrench to turn the universal joint or use a bar in the universal joint. With a spring scale (sometimes called a fish scale) hooked on the end of the wrench handle, turn the universal joint counterclockwise (viewed from the operator's seat) to tighten the right track drive sprocket retaining nut. Turn the universal joint clockwise (viewed from the operator's seat) to tighten the left track drive sprocket retaining nut. Turn the universal joint until a pull of 19 to 22 pounds is indicated on the spring scale; this will impose 4500 to 5000 ft. lbs. torque on the track drive sprocket retaining nut.

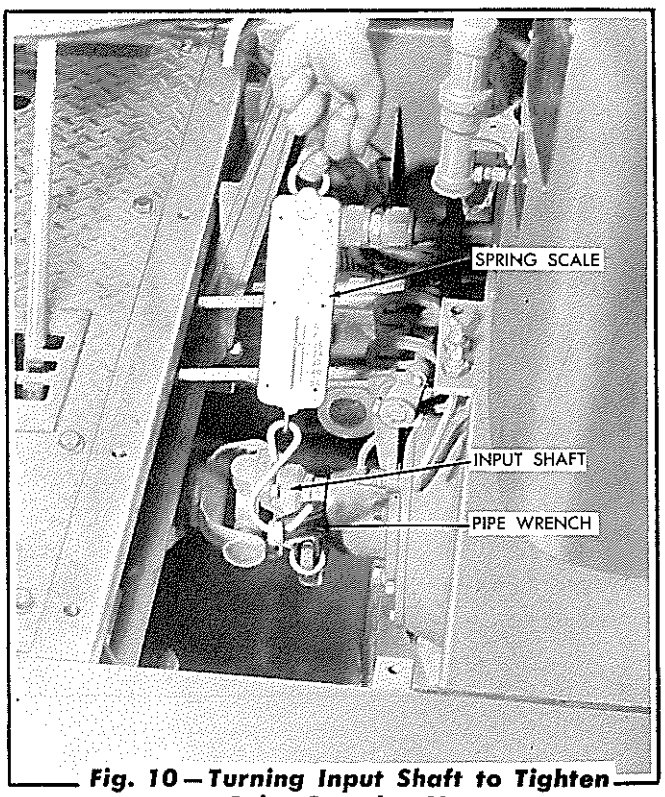


Fig. 10 — Turning Input Shaft to Tighten Drive Sprocket Nut

NOTE: During this procedure, strike the sprocket with a sledge hammer as near to the hub as possible, to make certain the sprocket is firmly seated on the shaft serrations.

The following is the approximate pounds pull required on the spring scale, when using various length wrenches or bars.

Wrench-Feet*	Pounds-Pull
1	39-44
1½	29-33
2	19-22

*NOTE: Distance from center of universal joint 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 block used to hold the steering clutch in the disengaged position.

G. Install Sprocket Shaft Bearing 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. 12. Press the cage and bearing assembly on the shaft to a position allowing .050" to .060" clearance between the sealing surfaces of the two (2) outer seal rings.

   The tool mentioned above and shown in Fig. 12 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. 12. 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 light 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.

3. The sprocket shaft outer bearing is correctly adjusted when it has 19 to 25 inch pounds pre-load. A spring scale, sometimes called a fish scale, may be used to weigh the bearing pre-load. Refer to Fig. 13.

4. To weigh the sprocket shaft outer bearing pre-load proceed as follows:

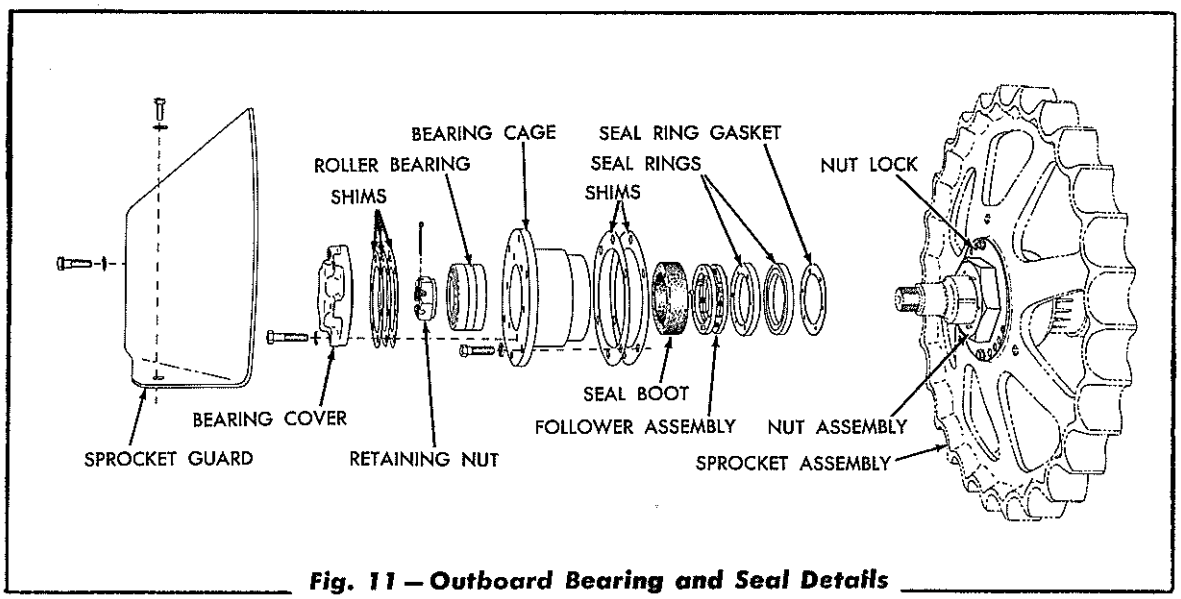


Fig. 11 — Outboard Bearing and Seal Details

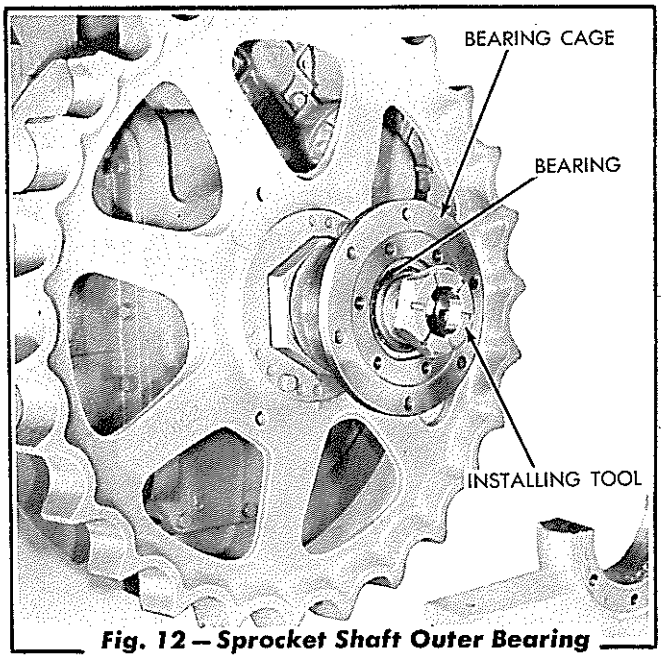


Fig. 12 — Sprocket Shaft Outer Bearing Installation

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 sprocket shaft to the point of pull on the bearing cage is 4", therefore, to obtain the desired 19 to 25 inch pounds pre-load, a pull of 5 to 6 pounds is required on the spring scale. EXAMPLE: 4 inches x 6 pounds = 24 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 on the remaining distance. Install the cotter pin to lock the retaining nut.

6. Install the sprocket shaft outer bearing cap and the correct amount of bearing adjusting shims. Tighten the attaching capscrews securely.

7. Install the original amount of adjusting shims used between the outer bearing cage and the truck frame, then place the outer bearing cage clamping cap in position on the cage, and start three (3) of the outer bearing cage attaching 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, being 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 be certain that the sprocket shaft outer bearing cage enters the truck frame. The outer bearing clamping cap will serve as a guide to aline the holes in the outer bearing cage with the holes in the truck frame. Be certain the holes are in alinement by inserting the attaching capscrews. Do not tighten the capscrews at this time.

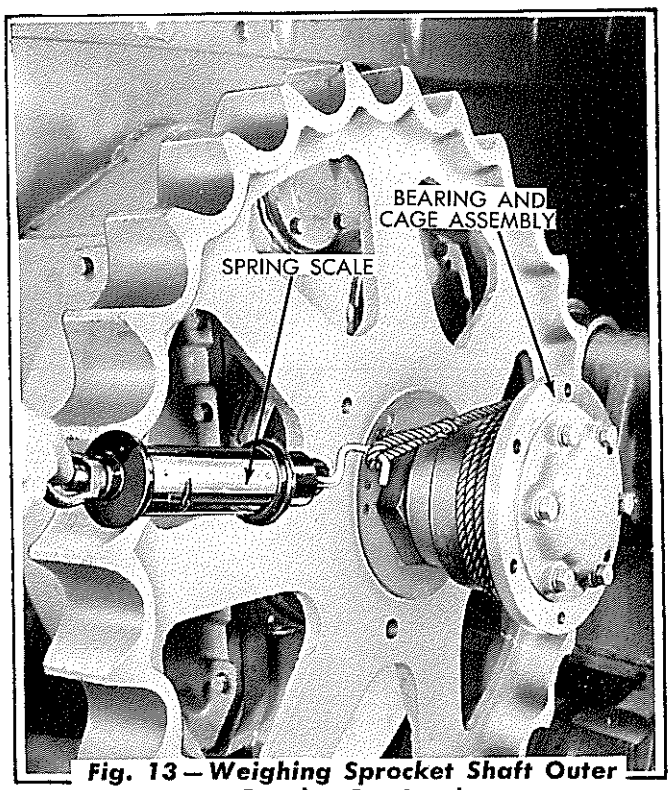


Fig. 13 — Weighing Sprocket Shaft Outer Bearing Pre-Load

8. Start the two (2) outer bearing clamping cap attaching capscrews but do not tighten at this time.

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 installed 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 attachng capscrews to 450 ft. lbs. 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 cage to the outer bearing cage clamping cap, then install the sprocket guard. Tighten all the outer bearing cage attaching capscrews 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 FRAMES

1. DESCRIPTION

The major components of a truck frame assembly are: The truck frame, the truck wheels, the track support rollers, the 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 outer bearing cage and outer bearing. The truck frames support the main frame by the use of an equalizing spring except on the HD-15F and HD-15G. These two (2) models are supported by a rigid beam in place of the equalizing spring.

Each truck frame assembly on the HD-15A incorporates six (6) truck wheel assemblies; (four (4) single flange wheels and two (2) double flange wheels). The double flange wheels are used in the numbers 2 and 5 positions and the single flange wheels in the numbers 1, 3, 4, and 6 positions.

Each truck frame assembly on the HD-15F and HD-15G (long track models) incorporates seven (7) truck wheel assemblies; (four (4) single flange wheels and three (3) double flange wheels). The double flange wheels are used in the numbers 2, 4, and 6 positions and the single flange wheels in the numbers 1, 3, 5, and 7 positions.

The truck wheels revolve on tapered roller bearings, have positive grease seals, and 1000 hour recommended lubrication periods. The brackets of the truck wheels are attached to the truck frames by capscrews threaded into replaceable tapped blocks.

Both the support rollers and the track idlers contain tapered roller bearings, positive type grease 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 replacable slide bars and guide plates.

The track release mechanism consists of a yoke, adjustment screw, bellcrank, two (2) push rods, push rod pins, and a 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 obtain proper operating conditions. Truck frames sprung or twisted "out of line" will contribute to rapid wear of the truck wheels, track idlers, support rollers, track sprockets, and track assemblies and should be repaired or replaced. Excessively worn pivot shafts and pivot shaft bushings or excessively worn sprocket shaft outer bearings may also cause misalinement of the truck frames and should be replaced immediately.

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 sprocket shaft outer bearing cage 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 ten (10) inches off the truck frame. Block under the equalizing spring with suitable cribbing. Remove the capscrews attaching the front support roller to the truck frame and remove the support roller and bracket assembly.

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 lubricated by an oil wick assembly from the bevel gear compartment. No maintenance is necessary other than periodic checks to be certain that the pivot shaft attaching caps are tight and that the bushing and the shaft are not excessively worn.

2. Removal of Pivot Shaft, Bushing, and Dirt Seals

a. With the track uncoupled, the sprocket shaft outer bearing cage loosened from the truck frame, and the pivot shaft caps removed, 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 or drift.

b. The pivot shaft bushing may be removed by using tools similar to, and as shown in

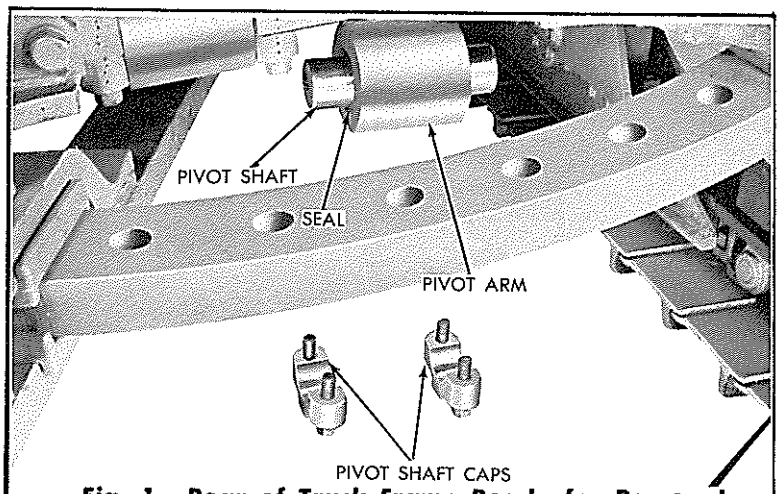


Fig. 1 — Rear of Truck Frame Ready for Removal

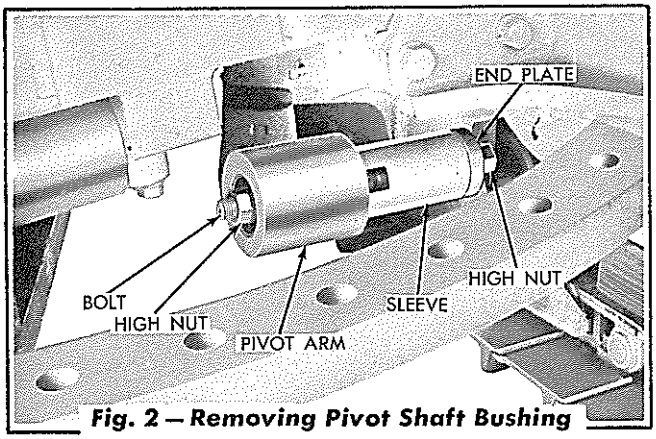


Fig. 2 — Removing Pivot Shaft Bushing

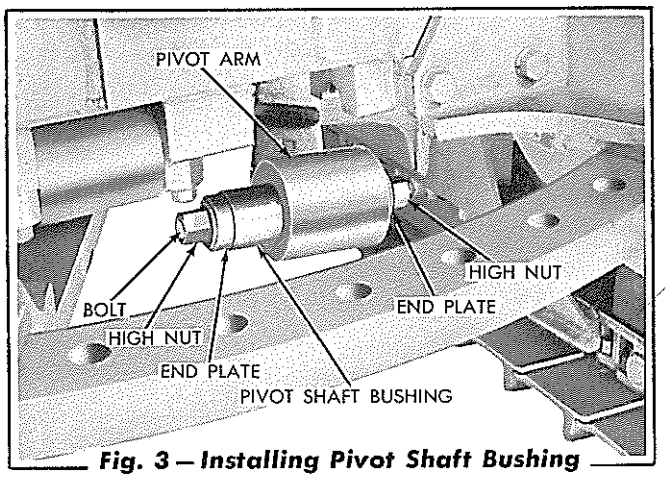


Fig. 3 — Installing Pivot Shaft Bushing

Fig. 2. Refer to Fig. 4 showing the tool details.

3. Installation of Pivot Shaft Bushing, Pivot Shaft, 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 being certain that the bore and the bushing are smooth and free of burrs.

b. Using a tool similar to the one shown in Fig. 3, which is made up 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 being an equal distance 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. 5. The outside diameter of the driver should be 3-5/16". The inside diameter should be 2½" and should be machined to a depth of 2¼". 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 direct reversal of

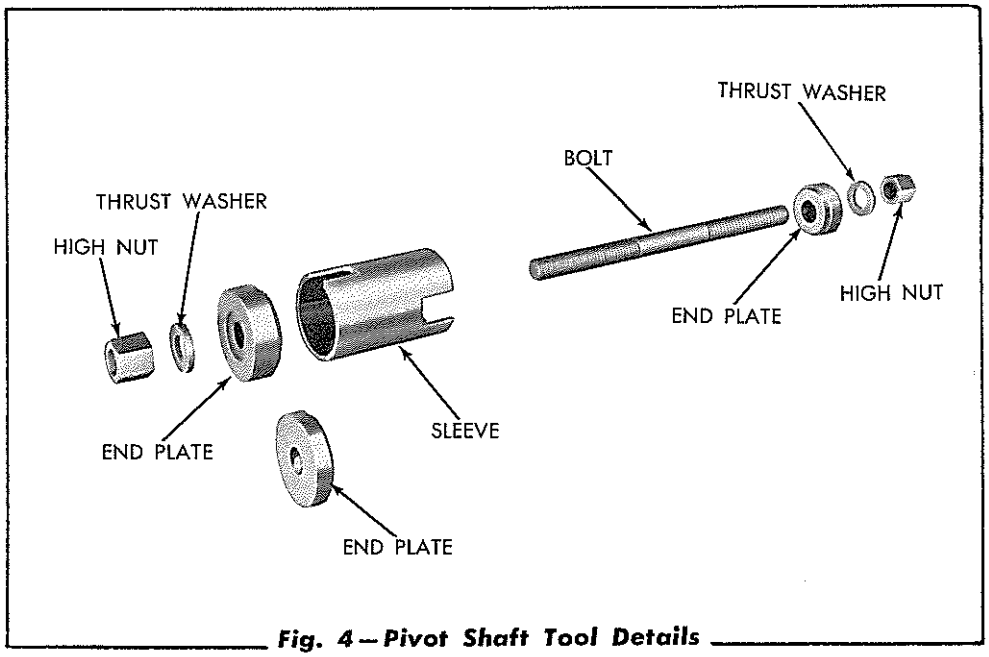


Fig. 4 — Pivot Shaft Tool Details

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 the pivot shaft, care should be used to prevent damaging of the lubricating wick holder. Misalinement of the truck frame and abnormal wear of the pivot shaft and bushing will result from damaging the lubricating wick assembly.*

The truck frame pivot shaft caps are center punched 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 a torque of 450 ft. lbs.

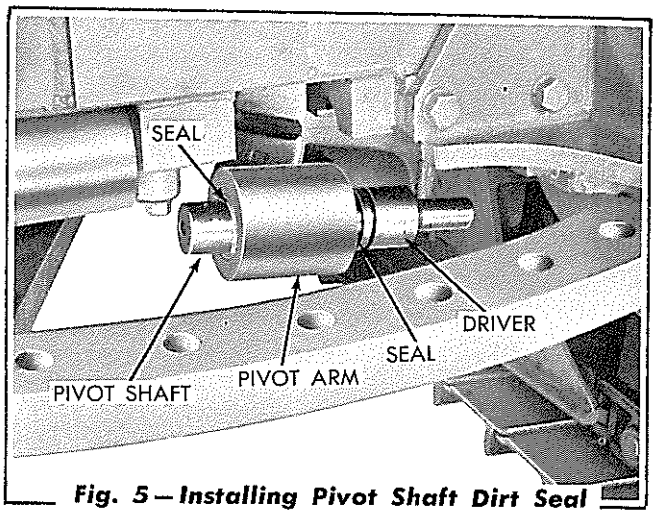


Fig. 5—Installing Pivot Shaft Dirt Seal

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, just to the rear of the track and move the tractor backward until the weight is being carried by the track drive sprocket and the track idler. In this position the slack should be in the bottom of the track. Lock the brakes in the applied position, and check the truck wheels for bearing end play. 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 truck wheels. *NOTE: Truck wheels are attached to the truck frames by capscrews threaded into replaceable tapped blocks.*

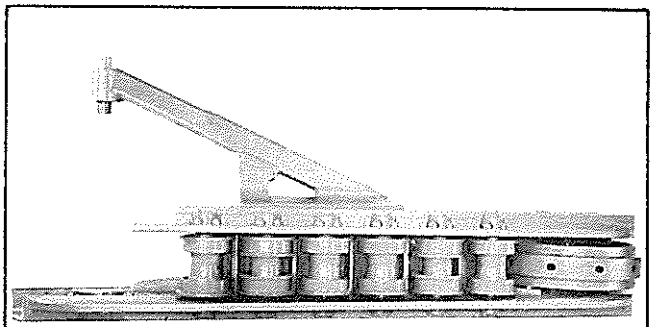


Fig. 6—Truck Wheels Mounted to Truck Frame

C. Disassembly of Truck Wheels

1. With the tractor placed on blocks as explained above, remove the inner and outer truck frame guards. Remove the capscrews attaching the truck wheel to the truck frame and remove the truck wheel from the tractor.

2. Place the truck wheel in a vice by clamping on the truck wheel attaching bracket. Remove the attaching 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 attaching 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 attaching 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 as a means of removal. Using three (3) ⅜" N.C. puller bolts in these holes, turn the bolts in evenly to push the bearing retainers, including the seal retainers and the seal assemblies, off the shaft. *CAUTION: Use care when removing the bearing retainers so that the steel ball, used for holding the inner seal ring in position in the bearing retainer, is not lost. 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 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 seal spring rubber boot in each seal 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 rubber 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 seal retainer, and the outer face of the other lip should be firmly cemented to the outer seal ring. No cement is used on the I.D. or the O.D. of the rubber 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

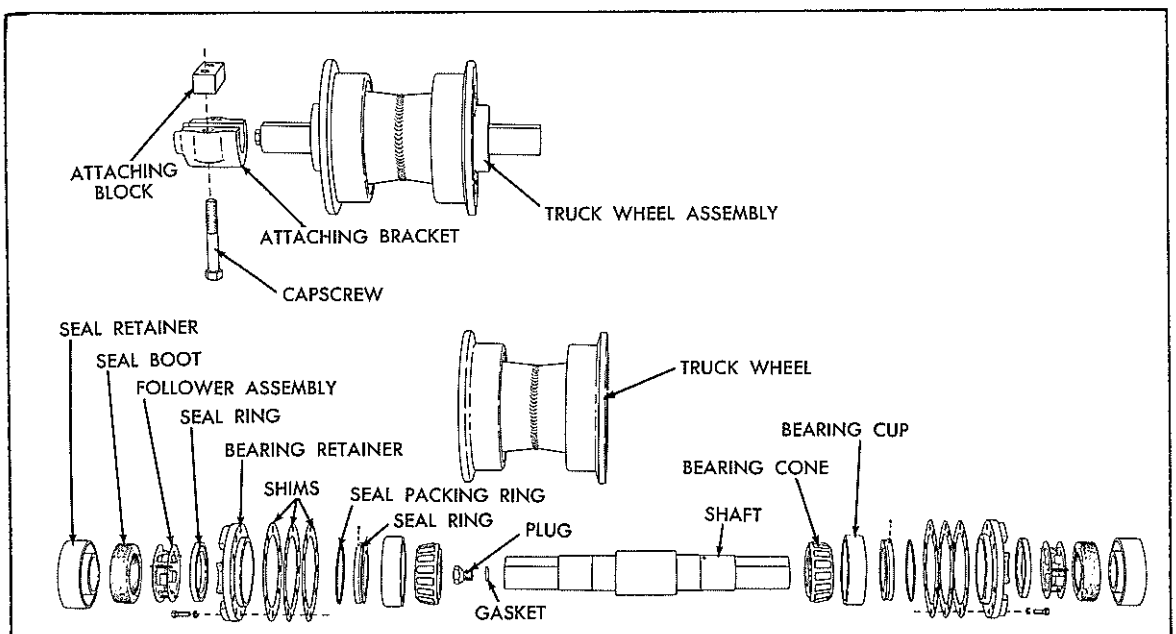


Fig. 7 — Truck Wheel Details

place, do not remove.

5. Remove the inner seal rings from the bearing retainers and examine the seal packing rings. Replace the seal packing rings if they are not in good condition.

E. Assembly and Installation of Truck Wheels

Each truck frame on the HD-15A tractor is equipped with four (4) single flange and two (2) double flange truck wheels. The two (2) double flange wheels are used in the numbers 2 and 5 positions and the single flange wheels in the numbers 1, 3, 4, and 6 positions.

1. Make certain that all parts are clean.

2. If a new seal assembly is to be installed in the seal 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.

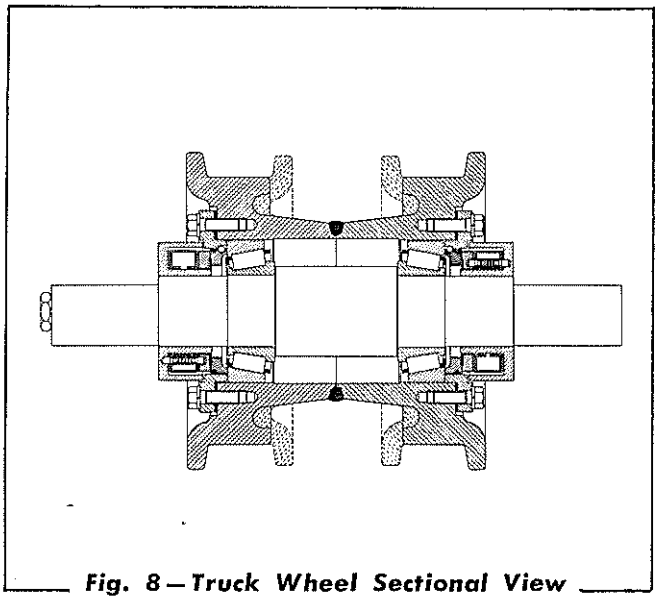


Fig. 8—Truck Wheel Sectional View

To Install the Seal Assembly

Refer to Figs. 7 and 8 and assemble as follows:

a. Place each seal retainer, flat face down, on a clean work bench.

b. Make certain the seal spring assembly, seal spring rubber boot, and the outer 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.

c. Coat the outer face of one lip of the rubber boot and coat the machined face in the seal retainer (face that the rubber boot contacts) with "Neoprene" cement. Immediately place the boot and spring assembly in the seal retainer inserting the ends of the pins into the corresponding holes in the seal retainer.

d. Coat the face of the outer lip of the rubber boot and the back face of the outer seal ring with "Neoprene" cement. Immediately place the outer 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 outer 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.

f. Install the seal packing ring in position in the ring groove of the inner seal ring. When installing, make certain that the seal packing ring is not "rolled" into position, thus twisting the ring in its groove.

g. Clean the bore in the bearing retainer. Place the steel ball in the ball recess in the seal ring, hold the steel ball in position, and install the inner seal ring (with the seal packing ring) in position in the bearing retainer. When installing the inner seal ring into the bearing retainer, start the side with the packing ring into

the bore first, and aline the steel ball with the ball slot in the bearing retainer.

3. Press the bearings on the shaft until they are seated against the shoulders on the shaft.

4. Install a bearing cup in one end of the truck wheel. Insert the shaft, with the bearings in place, in the truck wheel and install the other bearing cup. Lubricate the bearings with clean engine oil.

5. Install one of the bearing retainers, complete with inner seal ring assembly, and the original amount of shims, on the truck wheel and tighten the attaching capscrews securely.

6. Install the other bearing retainer, complete with inner seal ring 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 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 engine oil. Press the seal retainers (with outer seal ring assemblies cemented in place), on each end of the shaft. Press each seal retainer onto the shaft until the outer face of the seal retainer is flush with the shoulder on the shaft (this positions the outer face of the seal retainer 3.260" to 3.265" from the end of the shaft).

8. 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.

9. 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 1¾ pounds of grease is required to fill the truck wheel. Install and tighten the shaft plug and plug gasket.

10. Install the truck wheel in its proper location on the truck frame, making certain the lubricating plug in the end of the truck wheel shaft is to the outside.

11. Install the truck frame guards.

12. 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. Adjust the track by turning the track adjusting screw out of the track release yoke, 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 pry 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 every 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 move the tractor back 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 two (2) lower capscrews attaching the crosshead guide to the housing.

4. Loosen the remaining five (5) 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 spring pressure against the guide is not relieved after loosening these bolts approximately ⅜", it may be 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 spring pressure from the crosshead guide and remove 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 from the bellcrank.

7. The spring assembly may be disassembled by compressing the spring 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." Refer to Figs. 9 and 10 showing the parts in their relative position and assemble as follows:

1. Install the spring plunger and the spring seat in position in the spring. Insert the spring adjusting capscrew through the hole in the spring seat and start the threads into the spring plunger. Compress the spring assembly by use of a press, or if no means of compressing is available, clamp the spring to hold it from turning, then tighten the spring adjusting capscrew. Tighten the adjusting capscrew to compress the spring to the assembled length of 26-23/32" (measured from the ends of spring coils). Insert the spring adjusting capscrew lock in position in the spring seat.

2. Install the spring assembly in position in the spring housing with the spring seat end towards the rear. Use care when installing so that the spring adjusting capscrew lock is not "jarred" from position.

3. Place the push rods in position in the bellcrank if they were removed and install the push rod pins. Place the bellcrank (stop side down) in position in the crosshead guide and install the bellcrank pivot pin.

4. Install the crosshead seal in the groove of the crosshead, lubricate the crosshead and the seal with light engine oil, then install the crosshead in position in the crosshead guide, with the seal of the crosshead towards the front. Make certain that the end of the push rod is centered in the seat of the crosshead when installing.

5. Using gasket cement, cement the crosshead

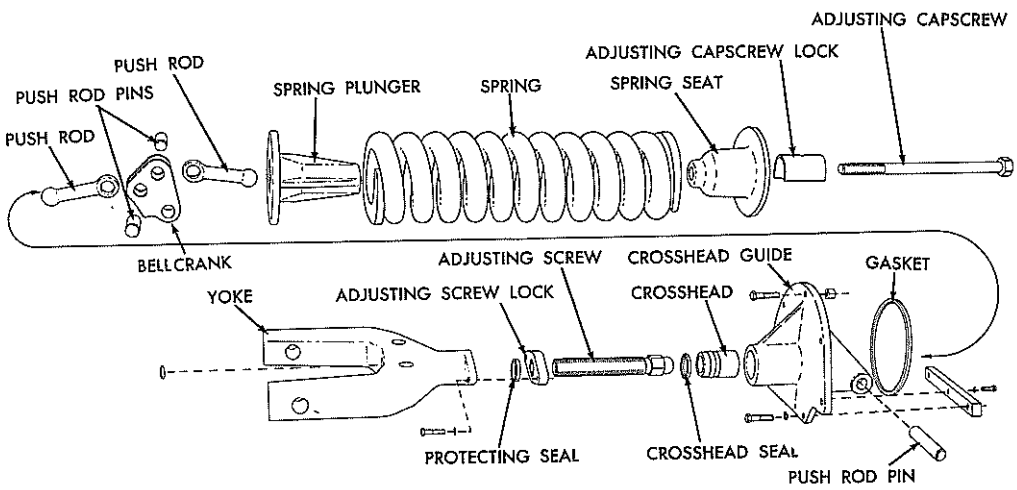


Fig. 9 — Track Release Details

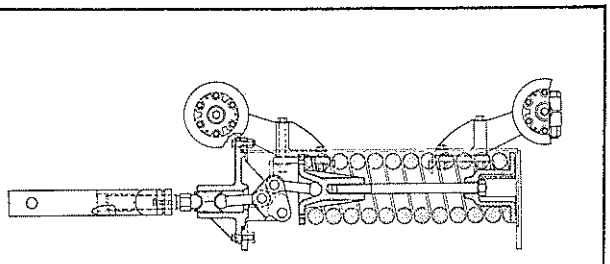


Fig. 10 — Track Release Sectional View

guide gasket in position in the counterbore of the spring housing. Place the crosshead guide assembly in position, making certain that the ends of the push rods are properly seated in the spring plunger and the crosshead. Install the attaching bolts and tighten uniformly so that the crosshead guide enters the counterbore of the spring housing.

6. Install the track release yoke assembly, couple the track, and adjust (refer to "TRACKS" in Section XVII).

7. Fill the track release housing to the proper level with the specified lubricant.

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 off of the supporting rollers.

2. Grasp each 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 seal assembly is noted at any time, the supporting roller should be removed and checked for bearing end play and the seal assembly inspected. Grease leakage is one indication of loose bearings.

B. Removal of Support Roller

1. Raise and block the track so that it clears the support roller to be removed.

2. Remove the bolt used to clamp the support roller shaft in position in the upper bore of the support roller bracket. Drive a broad faced chisel, or similar tool, into the clamping slot of the bracket to open the bracket thus freeing the support roller shaft. Remove the support roller assembly.

C. Disassembly of Support Roller

1. Wash and clean the outside of the support roller assembly thoroughly.

2. Remove the capscrews attaching the outer bearing retainer to the support roller. Place the support roller in a press (outer bearing retainer down), and supporting the support roller by the flanges, press on the inner end of the shaft until the outer bearing retainer is free and remove the retainer and its adjusting shims. Tie the shims to the bearing retainer.

3. Continue pressing on the inner end of the shaft until the seal retainer is free and the outer bearing cup is pushed out of the bore of the roller, then remove the shaft.

4. Remove the capscrews attaching the inner bearing retainer to the roller and remove it and its adjusting shims. Tie the shims to the bearing retainer. *CAUTION: Use care when removing the inner bearing retainer so that the steel ball, used for holding the inner seal ring in position, is not lost. Remove the inner bearing cup from the bore of the roller. When disassembling the roller, keep the parts separated so that they can be installed again in their original positions.*

D. Inspection of Support Roller

1. Wash and clean the parts thoroughly before inspecting. Make certain that the grease passages in the shaft are 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 support roller, replace the necessary parts.

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 seal spring rubber boot in outer seal retainer and make certain that it is firmly cemented in place. The inner face of the rubber boot lips should be firmly cemented to the ends of the seal spring assembly. The back face of the outer seal ring should be firmly cemented to the inner lip of the boot and the outer lip of the boot should be firmly cemented to the seal retainer. No cement is used on the O.D. or the I.D. of the rubber boot since it is neces-

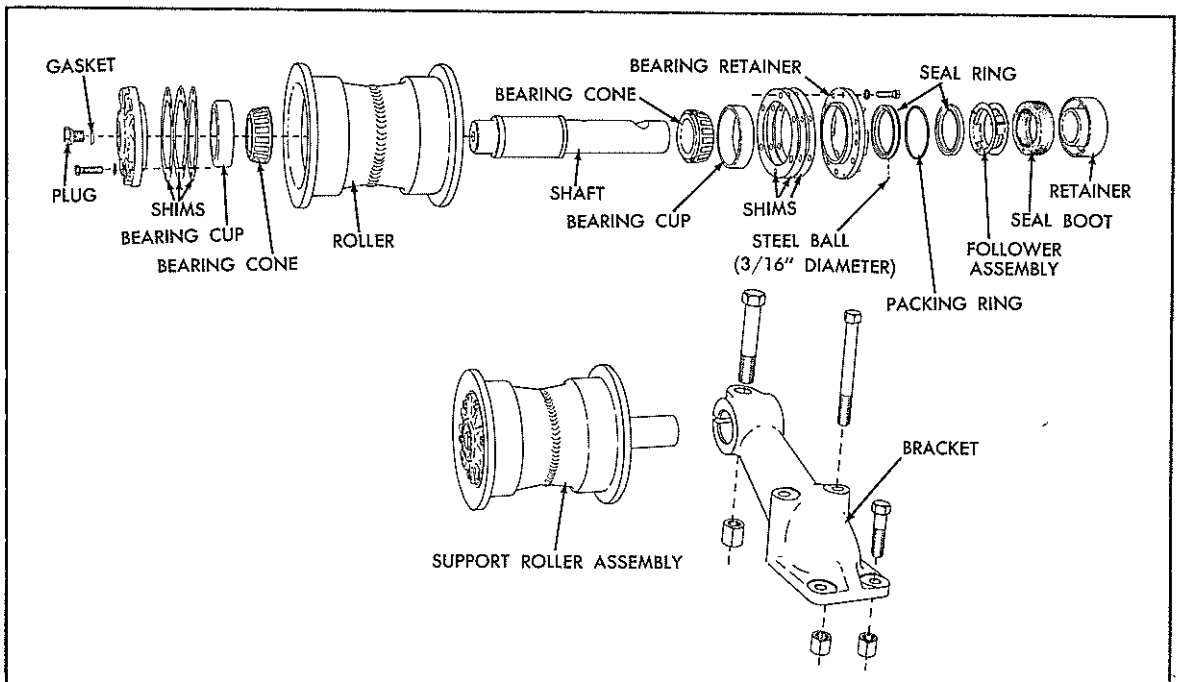


Fig. 11 —Track Support Roller Details

sary 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. Remove the inner seal ring from the bearing retainer and examine the seal packing ring. Replace the seal packing ring if it is not in good condition.

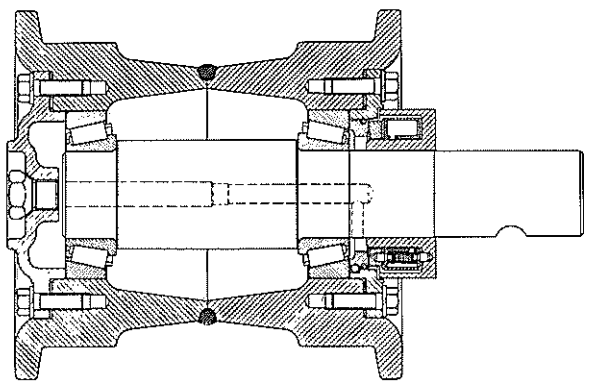


Fig. 12 — Track Support Roller Sectional View

E. Assembly of Support Roller

Refer to Figs. 11 and 12 and assemble as follows:

1. Make certain all the parts are clean.

2. If a new seal assembly is to be installed in the seal retainer, 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 on the shaft until they are seated against the shoulders on the shaft.

4. Install a bearing cup in one end of the support roller. Insert the shaft, with the bearings in place, in the support roller and install the other bearing cup. Lubricate the bearings with clean engine oil.

5. Install the inner bearing retainer, complete with the inner seal ring assembly and the original amount of shims, on the support roller and tighten the attaching capscrews securely.

6. Install the outer bearing retainer, with its original amount of shims, on the support roller. 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 retainer (with the outer seal ring assembly cemented in place), on the inner end of the support roller shaft. Press the seal retainer onto the shaft until the outer face of the seal retainer is flush with the shoulder on the shaft (this positions the outer face of the seal retainer 3.435" to 3.440" from the inner end of the shaft).

8. 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 2 pounds of

grease is required to fill the support roller assembly. Install and tighten the shaft plug and plug gasket.

9. 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 to take the load off the idler.

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 any end play. If any end play is found, the idler assembly should be removed from the tractor for disassembly and inspection and then be 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 bottom side up or end for end to present an unworn surface to the idler brackets. 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 track pins (standard), protruding approximately ⅛" beyond the boss in the side bars.

2. Loosen the adjustment 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.

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 alinement of the track idler when re-assembling. 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 shaft.

3. Remove the capscrews attaching the bearing retainers to the track idler. The track idler bearing retainers are each provided with three (3) equally spaced tapped holes as means of removal. Using three (3) ⅜" N.C. puller bolts in these holes, turn the bolts in evenly to push the bearing retainers, in-

cluding the seal retainers and the seal assemblies, off the shaft. *CAUTION: Use care when removing the bearing retainers so that the steel ball, used for holding the inner seal ring in position in the bearing retainer, is not lost. Keep all parts separated so that the track idler may be re-assembled with the parts in their original positions. Keep the parts clean and use care so that the seals are not scratched or damaged.*

4. Remove the idler 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 bearing retainers, 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 seal spring rubber boot in each seal retainer and make certain that it is firmly cemented in place and forms an oil proof bond between mating parts. The inner faces of the rubber 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 seal retainer and the outer face of the other lip should be firmly cemented to the outer seal ring. No cement is used on the I.D. or O.D. of the rubber 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. Remove the inner seal rings from the bearing retainers and examine the seal packing rings. Replace the seal packing rings if they are not in good condition.

F. Assembly of Track Idler

Refer to Figs. 13, 14, and 15 and assemble as follows:

1. Make certain all parts are clean.

2. If a new seal assembly is to be installed in the seal 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 on the shaft until they are seated against the shoulders on the shaft.

4. Install a bearing cup in each bearing retainer. Insert the shaft with the bearings in place into the idler hub and lubricate the bearings with clean engine oil.

5. Install one of the bearing retainers, complete with inner seal ring assembly, and the original amount of shims, on the idler hub and tighten the attaching capscrews securely.

6. Install the other bearing retainer, complete with inner seal ring assembly, and the original amount of shims, on 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.

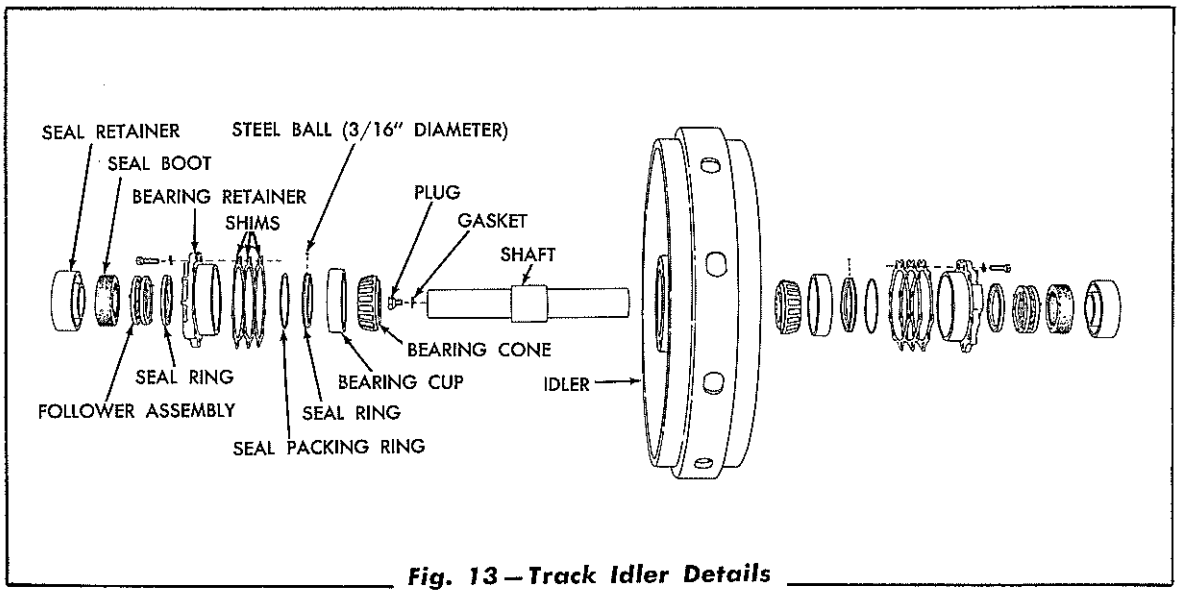


Fig. 13—Track Idler Details

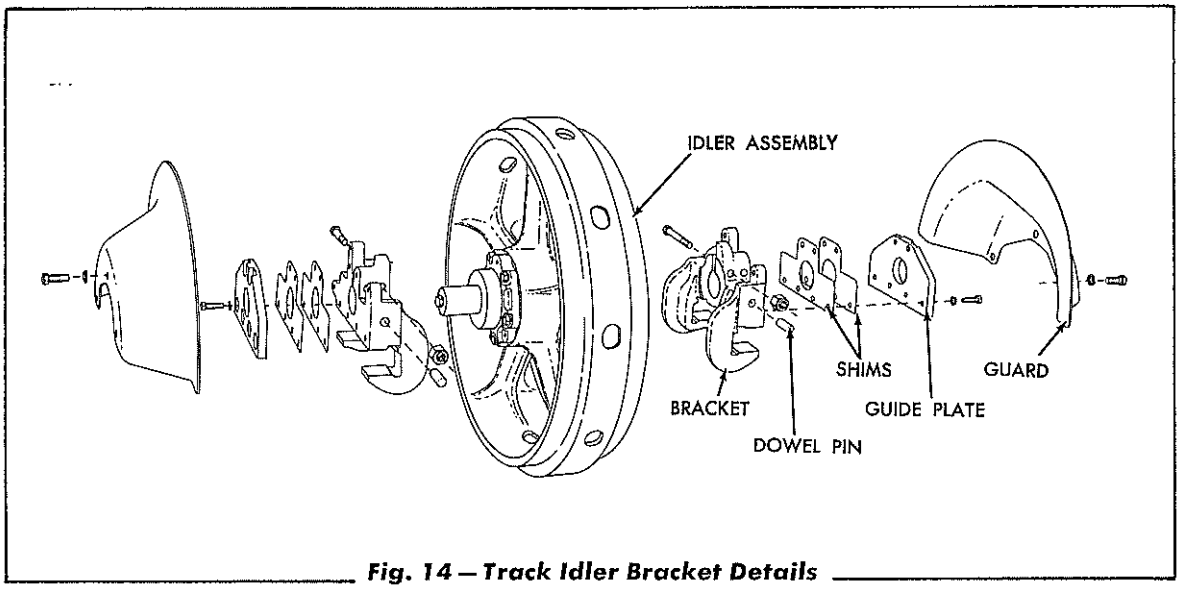


Fig. 14—Track Idler Bracket Details

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. Lock the bearing retainer capscrews in position with locking wire.

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 engine oil. Press the seal retainers (with outer seal ring assemblies cemented in place), on each end of the shaft. Press each seal retainer onto the shaft until the outer face of the seal retainer is flush with the shoulder on the shaft (this positions the outer face of the seal retainer 3.094" to 3.098" from the end of the shaft).

8. Spread the track idler brackets using a broad faced chisel. Drive or press the brackets on 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 in 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 4 pounds of grease is required to fill the idler. Install and tighten the shaft plug and plug gasket.

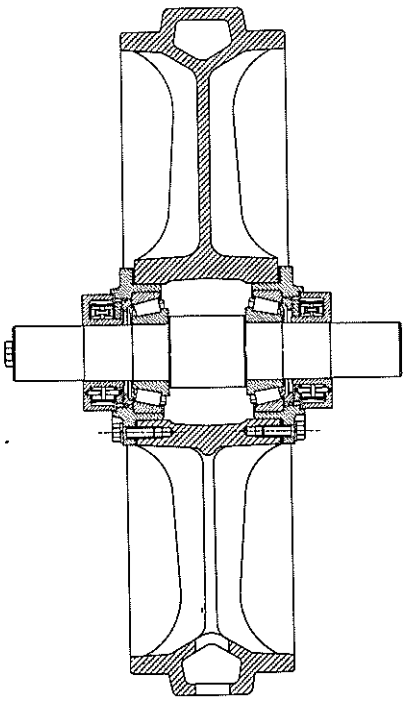


Fig. 15 — Track Idler Sectional View

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 the original shim pack. Sufficient shims should be added or removed to provide a sliding fit between the track idler brackets and slide bars. If necessary, the track idler may be alined with the track by moving shims from one track idler guiding plate to the other guiding plate as explained in "IDLER SLIDE BARS AND ALINEMENT" 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 of the drawbar, 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 lockpin and the coupling pin are held in position by the lock shaft and arm assembly.

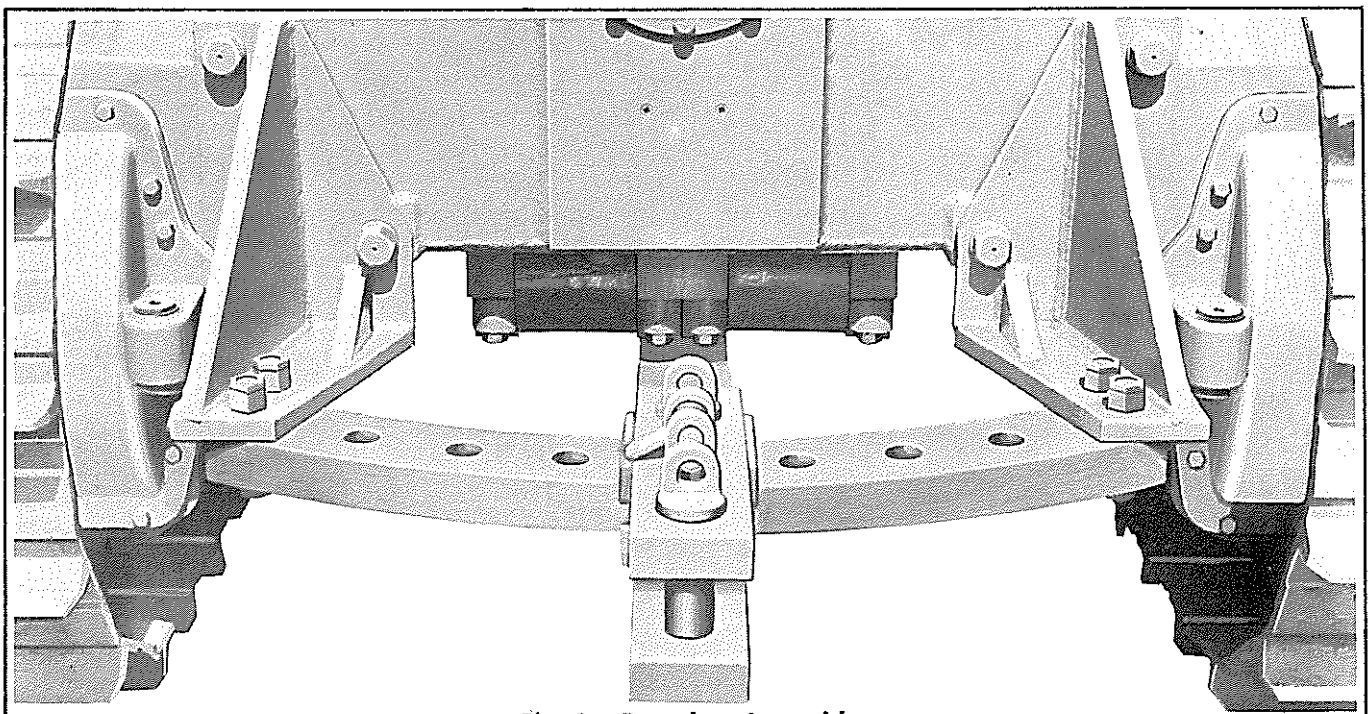


Fig. 1 — Drawbar Assembly

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.

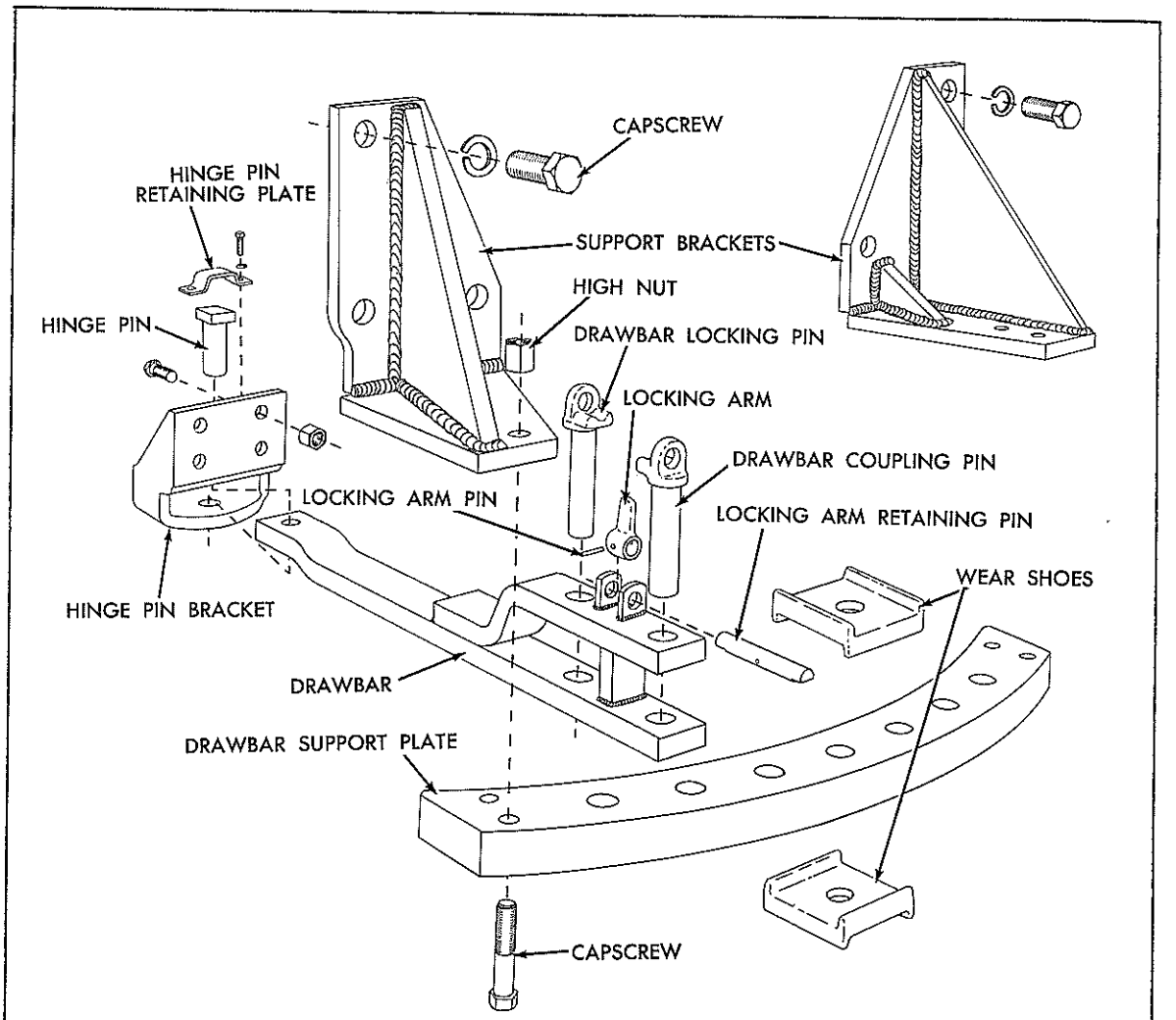


Fig. 2 — Drawbar Details

SECTION XVII—TRACKS

1. DESCRIPTION

The standard (Model HD-15A) track rail assembly consists of thirty-eight (38) links. Track rail assemblies for the Models HD-15F and HD-15G Tractors consist of forty-two (42) links each. Each track rail assembly is made up of side bars (right and left), pins, bushings, and grouser shoes. The master link, for coupling the track together, has a shorter master bushing with a ½" spacer at each end; a master pin, which is 5/16" longer and smaller in diameter than the other pins, has been provided to facilitate the coupling and uncoupling of the track.

Several different types and widths of track shoes, are available, each adapted to a particular application. 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 width.

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 300 to 310 ft. lbs. 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 casual 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

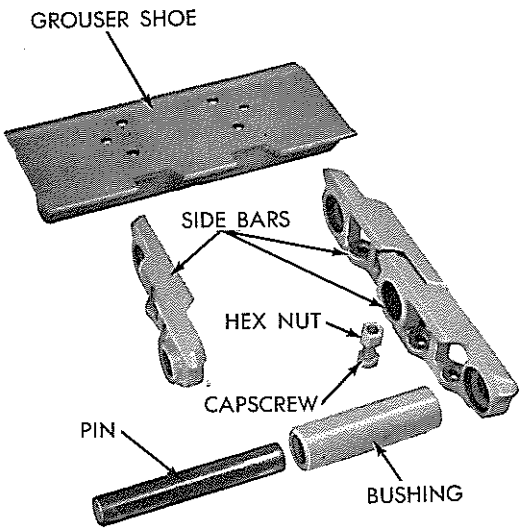


Fig. 1 — Track Details

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 degrees and installed, new contact surfaces are brought into play 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, the wear on the track increases its pitch length. As a result, the bushing is inclined to ride higher on the sprocket tooth. In such case, the sprocket will finally spin in the track. Under no condition should the combined wear of the sprocket and track be allowed to reach the stage where such spinning of the sprocket can occur. This causes extremely severe repeated shock to the tractor and may result in serious breakage. While it is always preferable to install new sprockets with new tracks, it may not be possible, and in this case the right and left sprocket should be interchanged, thus presenting the better side of the sprocket teeth to the bushings.

The pitch length (distance between centers of pins) of a new track is 7-27/32", and the maximum allowable pitch length for a used track is 8-1/32."

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 will be so far out of pitch that the increased wear on the sprocket will more than counteract the saving that may be obtained by further life on the track.

Occasionally, under extreme 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. 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. Then check the adjustment of the track. When correct adjustment of the track is obtained, tighten the capscrews in the locknut.

B. Track Removal

1. Move the tractor until the master pin is at the lower front face of the track idler. The

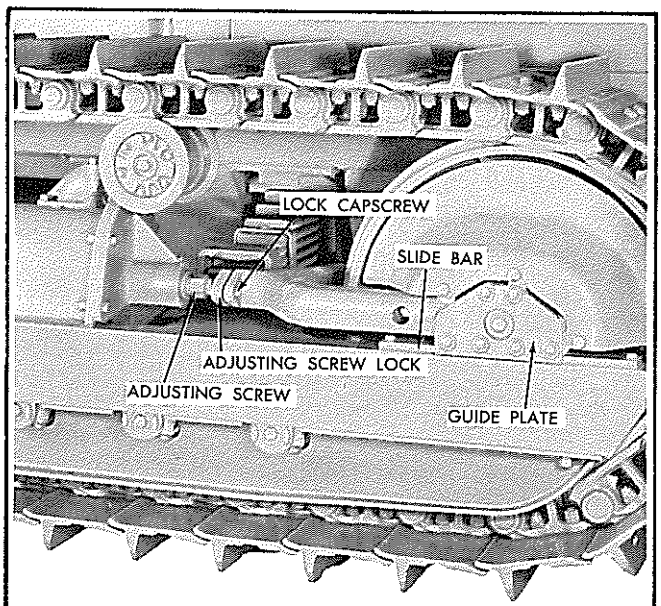


Fig. 2—Track and Track Idler Adjustment

master pin can be identified as being longer than the standard pins and protrudes approximately 1/8" 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 tractor.

2. Place an 8" block under the grouser 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 on a sprocket tooth 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 1/2" spacers, at each end of the master bushing, are in position with the chamfered side of the spacer toward the counterbore.

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

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 crackcase guard is a pressed steel plate bolted to the main frame for protection of the engine crackcase and the underside of the tractor. Removable plates in the guard are provided for draining the engine oil and the coolant.

C. Equalizer Spring

The equalizer spring is a leaf type spring which pivots on a pin attached to the bottom of the main frame. The weight of the front end of the tractor is transmitted to the truck frames through the equalizer spring.

The spring stabilizes the tractor and its mounted equipment by permitting the truck frames to oscillate. Oscillating truck frames provide more uniform traction and minimize the shock imposed on the tractor when operating over rough terrain.

D. Rigid Beam

The rigid beam is used in place of the equalizer spring on Models HD-15F and HD-15G tractors which have longer truck frames and are specially designed for mounting front end equipment. The rigid beam tends to stabilize the tractor and is used where track oscillation is not required.

The rigid beam assembly consists of a welded beam, a saddle, a pivot pin, and the necessary hardware to complete the assembly. Each end of the beam welded assembly is bolted securely to the truck frame top channels of the tractor. Shims are provided for use between the top of the rigid beam and the bottom of the main frame side members.

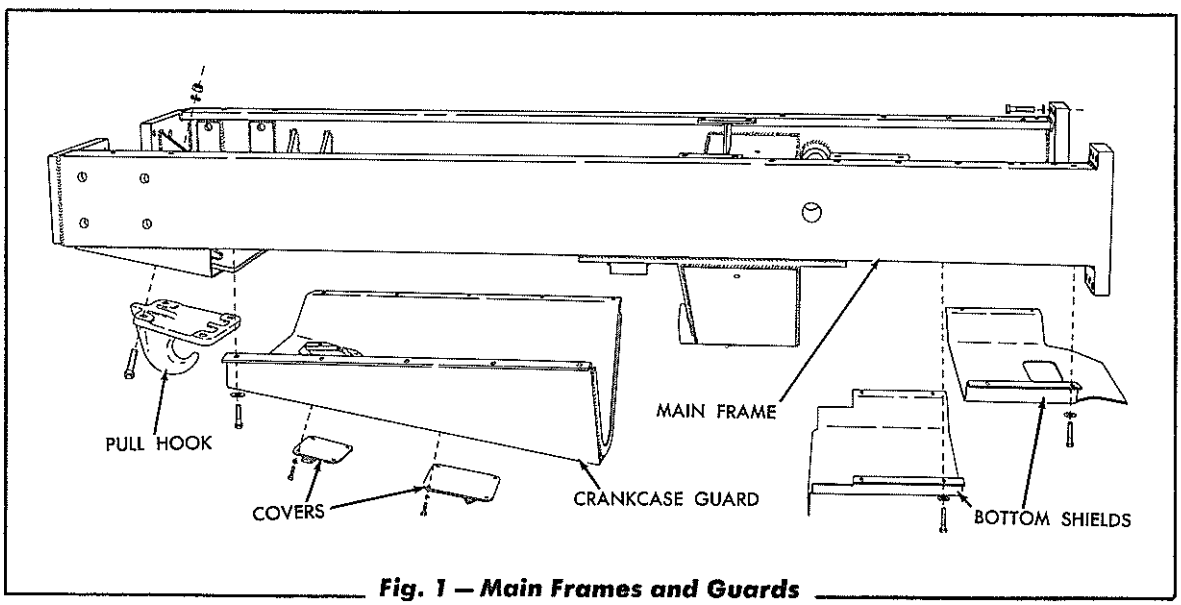


Fig. 1 — Main Frames and Guards

2. MAIN FRAME

A. Maintenance and Inspection

The main frame should be checked periodically for loose bolts, cracked welds, bending and misalinement. 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 alinement 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.

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 bolts 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.

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 retaining plate and the pivot pin washer from the front and rear of the equalizer spring pivot pin.

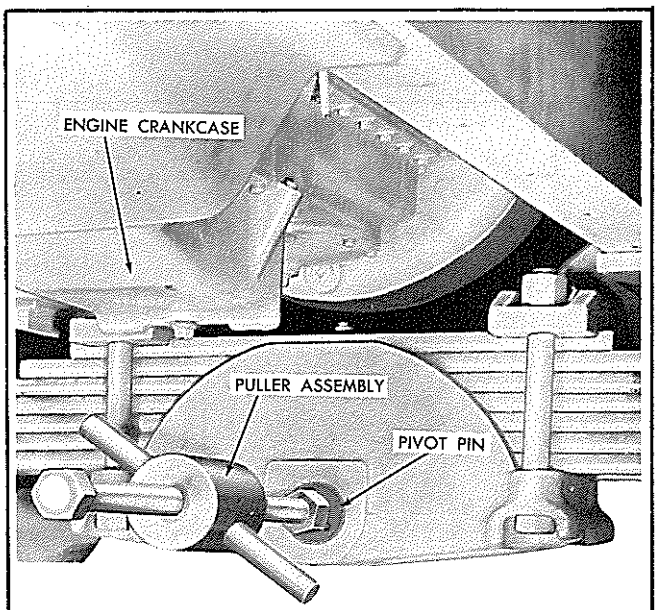


Fig. 2 — Spring Pivot Pin Puller Installed

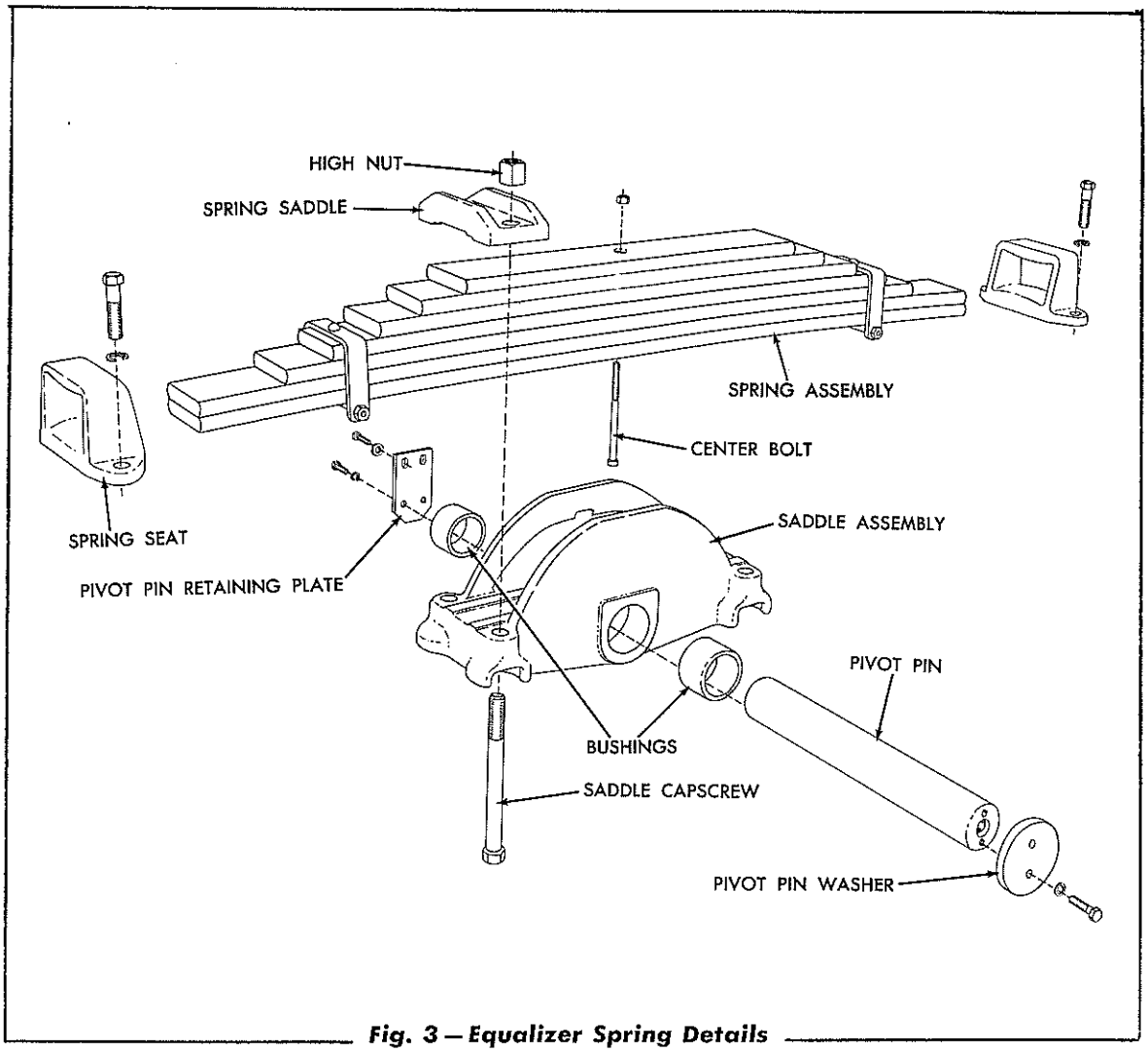


Fig. 3 — Equalizer Spring Details

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 bolts.

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 bolt 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 bolt 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 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 aline the pivot pin holes. Install the pivot pin and the spring seat.

5. Install the pivot pin retaining plate and the pivot pin washer, 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.

5. RIGID BEAM

A. Maintenance and Inspection

The rigid beam must be checked periodically for loose bolts, cracked welds, bending, and misalignment. Should any of the above conditions exist, they must be corrected as soon as possible.

B. Removal

1. Remove the crankcase guard. Refer to "CRANKCASE GUARD REMOVAL" in this Section.

2. Remove the eight (8) capscrews used in bolting the rigid beam to the truck frames.

3. Remove the pivot pin washer and the retainer plate from the front and rear of the pivot pin.

4. Using a suitable hoist or jack, raise the front end of the tractor and block the main frame securely so that the rigid beam is raised approximately 4" off the truck frame. Using suitable blocks between the tops of the truck frames and the rigid beam mounting pads, lower the front end of the tractor sufficiently so that the weight of the rigid beam is imposed on the blocks. Do not lower the tractor to the point where the tractor weight is resting on the blocks.

5. Use a sliding hammer type puller similar to the one shown in Fig. 2 to pull the pivot pin.

6. Push the rigid beam to one side and allow it to fall to the ground then pull it out from beneath the tractor.

C. Disassembly

Remove the saddle assembly from the rigid beam if it presents interference with any straightening or welding operations on the rigid beam.

D. Assembly and Installation

Assemble and install the rigid beam by a direct reversal of the removal and disassembly procedure.

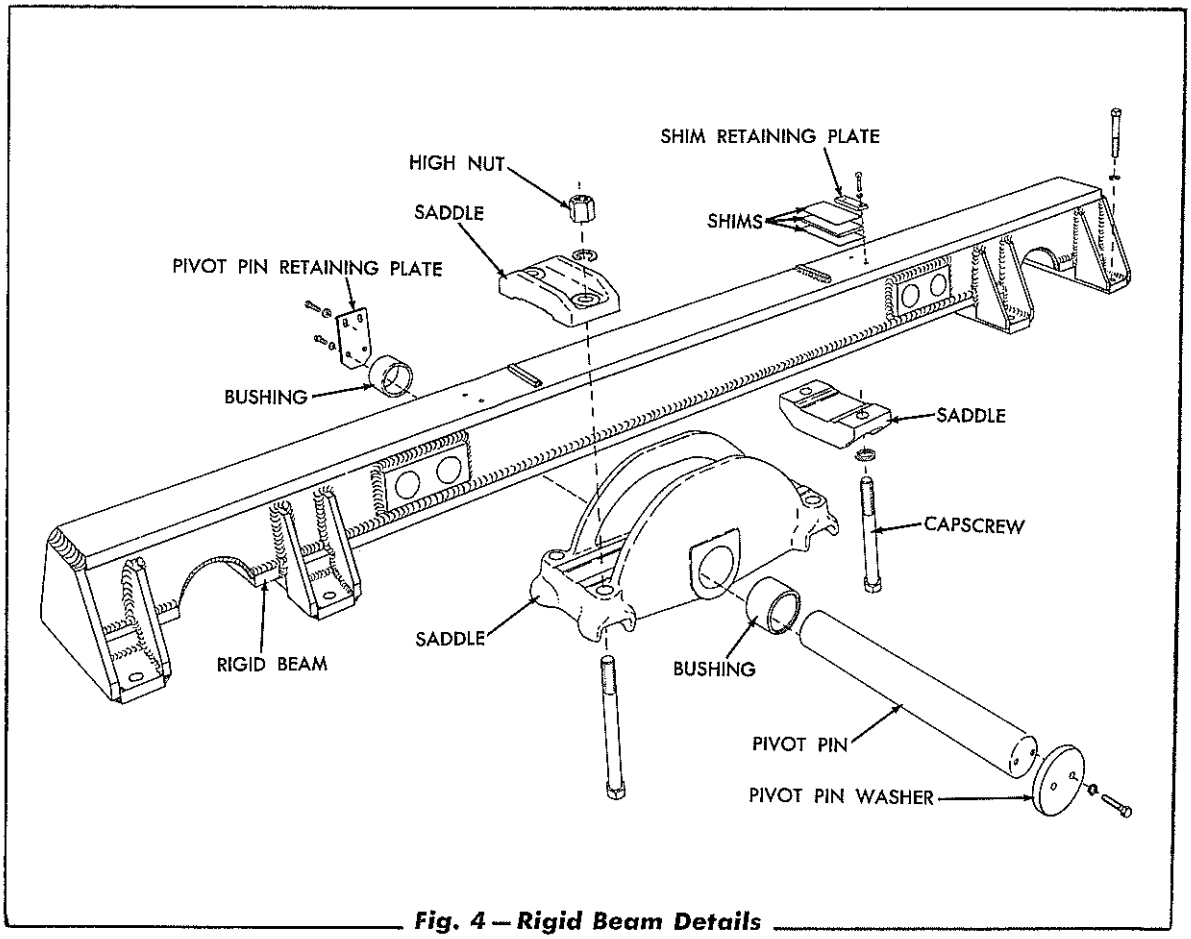


Fig. 4 — Rigid Beam Details

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 installing 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.

The rear fenders may be removed after removing the fuel tank, with or without the battery boxes attached, or, the rear fender group, battery boxes and fuel tank may be removed as a unit after removing the attaching capscrews.

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 cloth.

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, refer to your "Allis-Chalmers" Dealer.

2. GUARD EQUIPMENT

The standard tractor is equipped with a full width crankcase guard, a bumper, hinged radiator grille, 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. This equipment is to be used on the Model HD-15A only.

1. 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.

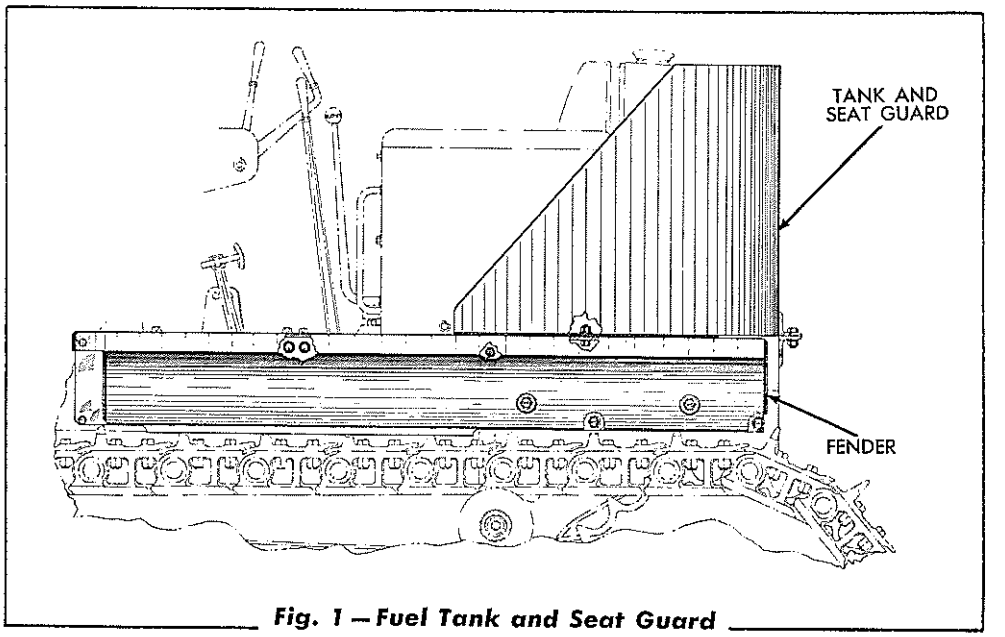


Fig. 1—Fuel Tank and Seat Guard

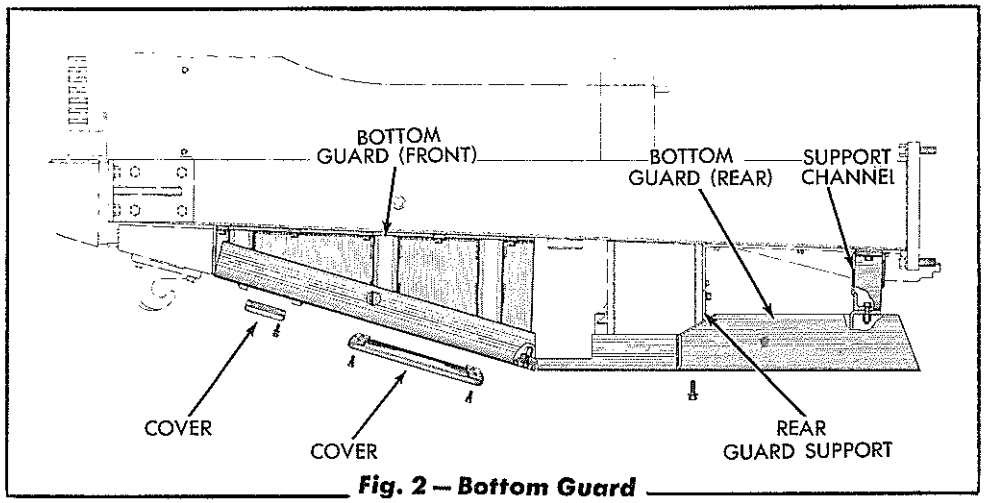


Fig. 2 — Bottom Guard

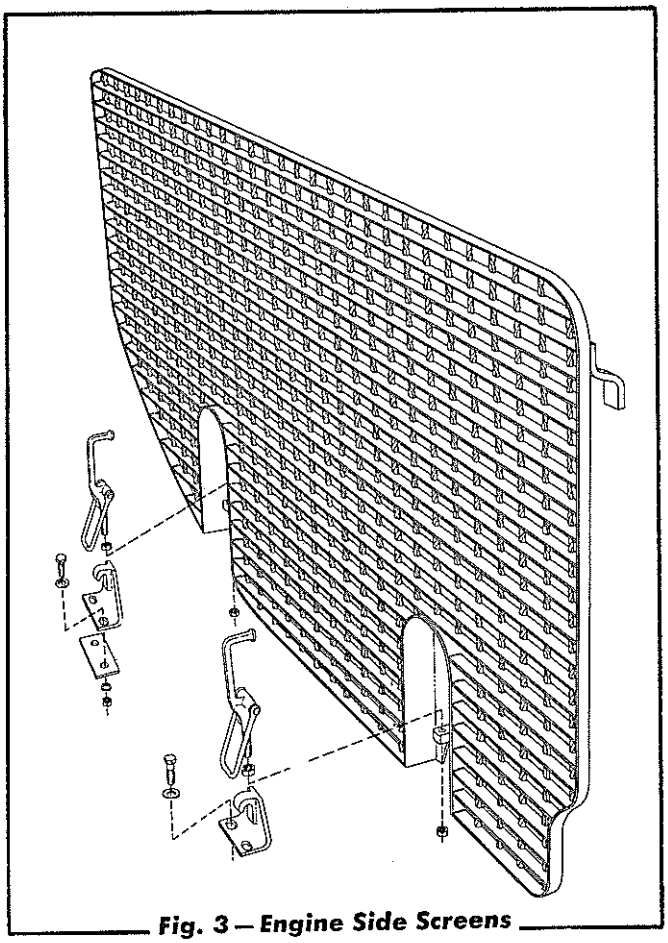


Fig. 3 — Engine Side Screens

2. Fuel Tank and Seat Guard Group

The fuel tank and seat guard group consists of a heavy guard and reinforcing angle designed to protect the fuel tank. The guard is mounted on the heavy fenders (special equipment) and to the rear of the steering clutch and final drive housing. Refer to Fig. 1.

3. Bottom Guard Group

The bottom guard group consists of a heavy front section, which replaces the standard crankcase 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. Refer to Fig. 2.

4. Heavy Mesh Grille Screen

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. Refer to Fig. 3.

3. HOOD SIDE PLATES

Hood side plates with louvers are available for cold weather use. They hook to the hood and fasten to the fenders with over center spring loaded snap fasteners. The side plates can not be used on tractors equipped with hydraulic dozers.

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. CAB GROUP

The cab group is an all steel enclosure with rubber mounted, safety glass windows. The cab is to be used with the Model HD-15A Tractor only. When installing a cab on the tractor it is recommended that heavy fenders be used.

6. HOUR METER

A. Description

The hour meter records the number of hours the engine has operated and is spring driven, and electrically wound. The switch, controlled by the engine oil pressure closes the clock-winding circuit whenever the oil pressure is above 3 pounds. Therefore, the clock 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. The clock 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:

Use number passed on 1,000 hour (inner) track here. — 1
Use number passed on 100 hour (middle) track here. — 9
Use number passed on 10 hour (outer) track here. — 5
Use number of marks passed beyond last figure on 10 hour track here. — 5

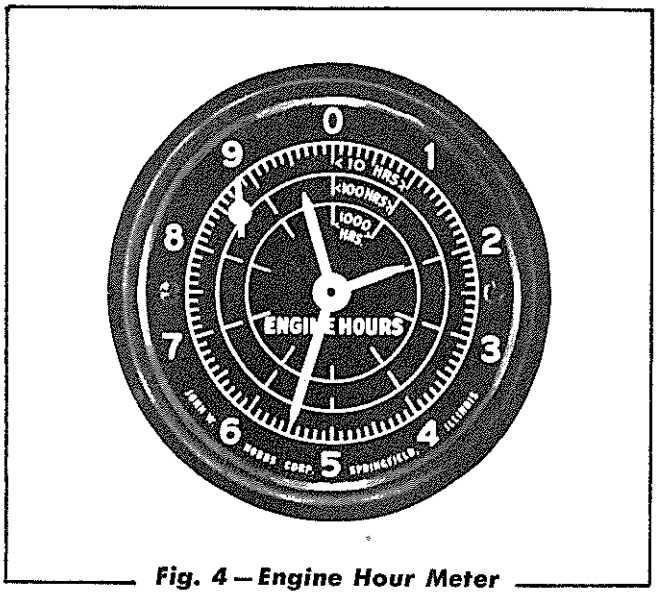


Fig. 4—Engine Hour Meter

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 hour meter pressure switch in the Tee fitting, connecting the oil pressure line and the lubricating oil pressure gage. The Tee fitting is located on the oil pressure gage.

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.

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 12-volt test lamp (a 12-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

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.

To Install 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 on 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 eight (8) 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 eighteen (18) inches in diameter and has a fifteen (15) inch face.

The power pulley rotates clockwise at 693 R.P.M. at 1600 R.P.M. engine speed. 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. Aline 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.

9. MISCELLANEOUS

In addition to the above special equipment, several other items, as described below, are available.

A. Radiator Screen — Fine Mesh

This screen is designed to prevent fine particles of moss, bark, leaves, and etc. from entering the radiator cooling passages and restricting air flow through the radiator. It can not be used when the tractor is equipped with a pusher type fan.

B. Radiator Curtain

The radiator curtain is used with other special equipment for cold weather operation. Its purpose is to help raise the engine operating temperature. It can not be used when the tractor is equipped with a pusher type fan.

C. Engine Pre-Heater

The pre-heater is a portable fuel oil torch equipped with an electric blower. It is used to pre-heat the engine internally under conditions of extreme cold.

D. Pre-Cleaner Extension

Pre-cleaner extensions are used when the tractor is operated under extremely dusty or sandy conditions.

E. Heavy Duty Filters

This special equipment consists of large capacity fuel oil or lubricating oil filters. The required attaching brackets for field installation must be ordered separately from repair stock.

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 setup 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 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.

C. Detents

1. On shifting shaft containing detents, be sure that the detent balls have been entering the detent notches on the shaft. Remove any burrs or roughness on the detent ball path with a stone or mill file.

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. Also check the shifting grooves or slots in the shifting collars in which the forks operate. Remove any roughness with a stone or mill file. 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.

6. When a new lip type seal is to be installed, always soak it in warm lubricating oil for about 1 hour before installing. This will lubricate the lip expanding spring and make the lip pliable.

B. Positive Type

1. The sealing surfaces of the seal rings (positive type) must be smooth and flat; and 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.

2. Check the rubber boot for cracks and be sure that it is securely cemented to the spring follower assembly or seal ring.

3. Check the spring follower to make certain all springs are in good condition and that the follower is exerting an even pressure on its entire periphery.

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.

2. Check the internal splines for galling or roughness.

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.
3. Periodically clean the battery terminals and apply a light coating of vaseline to the terminals.

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.

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.
3. Check all filter connections for leaks after an element has been replaced.

12. PIPING

1. Tighten the "Sealastic" fittings on the hydraulic steering control tubes only tight enough to prevent leakage. If the fittings are drawn up too tight they will be damaged and must be replaced.
2. Always be sure that the ferrules and nuts are clean before tightening.

13. FASTENERS

1. Keep all nuts, bolts, hose clamps, etc., tight at all times.

   A periodic check of these parts does not take long and may prevent the occurrence of a major failure.
2. 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. Make all adjustments as specified in this manual.
3. Use only genuine "Allis-Chalmers" parts for replacement. Make substitutions in case of emergency only.

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	4.2495" to 4.2505"	
2. Diameter of piston skirt	4.2433" to 4.2455"	
3. Clearance of piston with liner	.004" to .0072"	.010"
4. Allowable taper	.0015"	
5. Allowable out of round (when installed)	.0015"	
6. Clearance liner with block	Slip fit	
7. Height of cylinder liner above cylinder block—Prior to Engine Serial No. 6A-16283	.002" to .006"	
8. Height of cylinder block above cylinder liner— Effective with Engine Serial No. 6A-16283	.046" to .050"	
9. Allowable difference between any two adjacent cylinder liners measured from top of liner to top flat surface of cylinder block	.002"	
B. Pistons		
1. Piston length	6.00"	
2. Piston pin length	3.610" to 3.620"	
3. Inside diameter of piston pin bushing	1.5025" to 1.503"	
4. Outside diameter of piston pin	1.4996" to 1.500"	
5. Clearance—pin and piston bushing	.0025" to .0034"	.010"

Description	Size of New Parts	Install New Parts When Clearance Exceeds
C. Piston Rings—Compression		
1. Number of rings and width	4—⅛"	
2. Gap between ends — fitted		
1st and 2nd rings from top (chromium plated)	.025" to .040"	
3rd and 4th rings from top (tin plated)	.025" to .035"	
3rd and 4th rings from top (chromium plated)	.025" to .040"	
3. Clearance in groove		
Upper ring (chromium plated)	.010" to .0125"	.022"
2nd ring from top (chromium plated)	.008" to .0105"	.015"
3rd and 4th rings from top (tin plated)	.006" to .0085"	.013"
3rd and 4th rings from top (chromium plated)	.006" to .0085"	.013"
D. Piston Rings—Oil Control		
1. Number of rings and width	2 — 3/16" three piece ring	
2. Gap between ends — fitted	.010" to .020"	.040"
3. Clearance in grooves	.0015" to .0055"	.0095"
E. Crankshaft		
1. Diameter of crank pin journals	2.750" + .000", — .001"	
2. Width between cheeks	2.125" + .002", — .002"	
3. Diameter of main bearing journals	3.500" + .000", — .001"	
4. Width between cheeks	1.500" + .005", — .005"	
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	.004" minimum	.018"
8. Oversize rear main thrust washers available for service	.005"	
F. Main Bearings		
1. Number of main bearings in engine	7	
2. Diameter — inside of shell	3.502" + .001", — .000"	
3. Diameter of crankshaft main bearing journals	3.500" + .000", — .001"	
4. Clearance — shell and journal	.002" to .004"	.006"
5. Width of shell	1-3/16"	
6. Undersize bearings available for service	.002", .010", .020", and .030"	
G. Connecting Rod Bearings		
1. Width of shell	1-7/8"	
2. Diameter — inside of shell	2.752" + .001", — .000"	
3. Diameter of crankshaft connecting rod journals	2.750" + .000", — .001"	
4. Clearance — shell and journal	.002" to .004"	.006"
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. Length	10.125"	
2. Diameter — inside of connecting rod bearing shell	2.752" + .001", — .000"	
3. Clearance — connecting rod bearing shell and journal	.002" to .004"	.006"
4. Width of rod — lower end	2.115" to 2.117"	
5. End play — lower end on journal	.006" to .012"	
6. Diameter of piston pin	1.4996" to 1.500"	
7. Diameter inside connecting rod bushing	1.5025" to 1.503"	
8. Clearance — pin and bushing	.0025" to .0034"	.010"
I. Exhaust Valve		
1. Valve lift	.375"	
2. Angle of valve seat	30°	
3. Width of valve face	3/16"	
4. Valve lash	.009" at Operating Temperature	
5. Diameter of valve head	1-9/16"	
6. Diameter of valve stem	.3425" + .000", — .001"	
7. Diameter — inside of valve guide	.3445" + .001", — .000"	
8. Clearance — stem and guide	.002" to .004"	.006"
9. Valve standout — with bottom of head	—.005" to + .014"	
J. Exhaust Valve Insert		
1. Seat angle	30°	
2. Seat width	1/16" to 3/32"	
K. Exhaust Valve Guide		
1. Outside diameter	.5632" to .5637"	
2. Inside diameter	.3445" to .3455"	
3. Clearance — valve stem and guide	.002" to .004"	.006"
L. Rocker Arms		
1. Outside diameter of rocker arm shaft	.8740" + .000", — .0005"	
2. Inside diameter of rocker arm bushing	.875" + .001", — .000"	
3. Clearance — shaft and rocker arm	.001" to .0025"	.004"
4. Total end clearance — rocker arm assemblies	.004" to .006"	
M. Cam Followers		
1. Outside diameter of cam followers	1.061" + .000", — .001"	
2. Inside diameter of follower bore in cylinder head	1.062" + .001", — .000"	
3. Clearance — follower and cylinder head	.001" to .003"	.006"
4. Clearance — follower roller bushing and pin	.0005" to .0016"	.015"
N. Gear Train		
1. Backlash of gears in gear train	.003" to .008"	.010"

Description	Size of New Parts	Install New Parts When Clearance Exceeds
O. Idler Gear (Double Row Tapered Roller Bearing)		
1. Backlash of gears in gear train	.003" to .008"	.010"
P. Balance Shaft		
1. Inside diameter — end bearings	1.500" + .001", — .000"	
2. Outside diameter — shaft journals	1.498" + .0005", — .000"	
3. Clearance — bearing with shaft	.0015" to .003"	.006"
4. End clearance — thrust washer with thrust shoulder on shaft	.004" to .018"	.018"
5. Clearance — balance weight bushing with balance weight hub	.001" to .0035"	.006"
6. End clearance — balance weight bushing with balance weight hub	.010" to .016"	
7. Oversize thrust washers available for service	.010"	
Q. Camshaft		
1. Inside diameter — end bearings	1.500" + .001", — .000"	
2. Inside diameter — intermediate bearings	1.501" + .001", — .000"	
3. Outside diameter — shaft journals	1.4980" + .0005", — .000"	
4. Clearance — end bearings with shaft	.0015" to .003"	.006"
5. Clearance — intermediate bearings with shaft	.0025" to .004"	.009"
6. End clearance — thrust washer with thrust shoulder on shaft	.004" to .018"	.018"
7. Clearance — balance weight bushing with balance weight hub	.001" to .0035"	.006"
8. End clearance — balance weight bushing with balance weight hub	.010" to .016"	
9. Oversize thrust washers available for service	.010"	
10. Undersize end bearings available for service	.010", .020"	
R. Blower		
1. Clearance — rotors to front end plate (governor end)	.014" minimum	
2. Clearance — rotors to rear end plate (gear end)	.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"
6. Clearance between lobes and housing	.004" minimum	

S. Blower Drive

Description	Size of New Parts	Install New Parts When Clearance Exceeds
1. Inside diameter of support assembly bushings	1.626" + .0005", — .000"	
2. Outside diameter of drive gear hub	1.625" + .000", — .0005"	
3. Clearance — support assembly bushing with drive gear hub	.001" to .002"	.005"
4. End clearance — support assembly bushing with drive gear hub	.003" to .006"	.010"
5. Backlash — blower drive gear with camshaft gear	.003" to .008"	.010"

T. Lubrication Oil Pump

1. Radial clearance — gears with pump body	.002" minimum	.0045"
2. End clearance — gears with pump body	.002" minimum	.0045"
3. Backlash — pump driven gear with intermediate gear	.002" to .006"	.006"
4. Backlash — intermediate gear with crankshaft gear	.002" to .006"	

U. Torque Wrench Specifications

Application	Torque - Foot Pounds
Injector clamp nuts	20 - 25
Exhaust Muffler studs	15 - 30
Exhaust muffler nuts	20 - 25
Control shaft bracket bolts	10 - 12
Cam follower guide bolts	12 - 15
Hand hole cover bolts	10 - 15
Air intake tube to blower housing bolts	16 - 20
Flywheel housing bolts	90 - 100
Injector clamp nuts	20 - 25
Blower to block bolts size — 7/16" N.C.	55 - 60
Lifter bracket bolts	55 - 60
Connecting rod nuts	65 - 75
Rocker shaft bracket bolts	90 - 100
Flywheel bolts	150 - 160
Cylinder head nuts	165 - 175
Main bearing bolts	180 - 190
Blower rotor gear bolts	55 - 65
Crankshaft end bolt	180 - 200
Cam and balance shaft nuts	300 - 325
Bearing retainer to idler gear capscrews	24 - 29
Flywheel housing to idler gear hub capscrews	30 - 35
Water pump drive coupling capscrew	25 - 30
Blower drive coupling bolts	20 - 25
Cam and balance shaft end bearing bolts	35 - 40
Water manifold nuts	25 - 30

3. ENGINE CLUTCH

Description	Size of New Parts	Install New Parts When Clearance Exceeds
Thickness of driven plate assembly	15/32"	

4. TRANSMISSION

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 cover	.000" to .002"
3. Backlash between bevel pinion teeth and bevel gear teeth	.008" to .014"
4. Width of shifter fork grooves in all shifting collars of transmission	.432" to .442"
5. Thickness of all shifter fork prongs in transmission	.417" to .422"
6. Clearance of shifter fork prongs in grooves of shifting collars	.010" to .025"

5. 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	300
4. Foot pounds torque specified for tightening bevel gear attaching nuts	168 - 178
5. Specified standout — face of steering clutch hub flange to face of clutch throwout plate in assembly	+ or –.065"
6. Specified thickness of steering clutch internal tooth friction disc	.084" to .096"
7. Specified thickness of steering clutch external tooth friction disc	.152" to .157"
8. Assembled height of steering clutch pressure spring	4-17/64"
9. Pounds load of steering clutch pressure spring at 4-17/64" height	380 to 420 per spring

6. 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	19 to 25 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	300

7. TRUCK WHEELS

1.	Pre-load of truck wheel bearings	15 to 45 in. lbs.
2.	Standout — each end of shaft to face of seal retainer	3.260" to 3.265"
3.	Foot pounds torque specified for tightening truck wheel bracket capscrews	290 to 300

8. TRACK SUPPORT ROLLERS

1.	Pre-load of bearings in track support roller	15 to 45 in. lbs.
2.	Standout — end of shaft to face of seal retainer	3.435" to 3.440"

9. TRACK IDLERS

1.	Pre-load of track idler bearings	15 to 45 in. lbs.
2.	Standout — each end of shaft to face of seal retainer	3.094" to 3.098"

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 the 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 "SPECIFICATIONS OF LUBRICANTS" 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 valve, 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 No. 3 of this Section.

4. **Blower Not Turning**

Refer to "ENGINE AIR INTAKE SYSTEM" in Topic No. 4 of this Section.

5. **Water in Air Box**

(Possible after a disassembly of the cylinder head.) Dry the air box through the hand holes 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. **Injectors 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 arm 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 a screwdriver or a wood block. 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 arm 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.

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 385 pounds per square inch 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	370 lbs./sq. in.
2	400 lbs./sq. in.
3	395 lbs./sq. in.
4	405 lbs./sq. in.
5	410 lbs./sq. in.
6	400 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 compression gaskets 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 385 lbs. sq. in. unless the gage is known to be accurate. 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 No. 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 No. 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 No. 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 thermostat, replace the thermostat 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 Oil Filters, Air in Fuel System, or Unsatisfactory Injectors**

Refer to "CHECKING OF FUEL SUPPLY SYSTEM," in Topic No. 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 No. 3 in this section.

3. "Hunting" Governor

Check adjustment of governor buffer spring and the control 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° to 185° F. Check the thermostat, replace the thermostat if necessary.

6. Cylinder Cutting Out

Refer to sub-topic C, paragraph 3 of this section.

7. Vibration Damper Loose

Tighten attaching capscrews.

8. Crankshaft Broken

Replace crankshaft, refer to "ENGINE" in Section IX.

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 drains, leaky blower housing gasket, or leaky blower oil seals.

G. Black Smoke Exhaust

1. Poor Grade of Fuel

Refer to "DESCRIPTION AND SPECIFICATIONS" in Section I for fuel oil specifications.

2. Unsatisfactory Injectors or Incorrect Timing or Equalizing

Refer to "CHECKING OF FUEL SUPPLY SYSTEM," in Topic No. 3 in 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 Exhaust

1. Engine Temperature Too Low

Inspect the thermostat and test it 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 No. 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 core.

J. Excessively Fast Wear on Engine Parts

1. **Oil of Unsuitable Grade, Composition, or Viscosity**

Change to suitable oil. Refer to "DESCRIPTION AND SPECIFICATIONS" 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. **Oil Used Longer Than Recommended Time**

Change oil 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 inlet 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 No. 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 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 25 to 55 pounds per square inch in the engine fuel system. 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. 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 valve in the air inlet elbow, 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 Valve 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 Cylinder Liners 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" in Section III.

C. Difficult Stopping of Engine

1. Air Shut-Off Valve Does 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 inlet 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 thermostat being stuck in the closed position. In some cases, lime will be deposited in the water passages of the radiator, cylinder block, and cylinder 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 or 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, leaking cylinder head gasket, or a ruptured oil cooler core 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. The water pump body is provided with an opening above and below the pump shaft, in the event of pump seal leakage the water will drain through the opening, where it will be visible. If however, this opening should become clogged with dirt or foreign material and the pump seal is leaking, the water will follow along the shaft, into the blower where it enters the engine crankcase, with no visible indication of the pump leaking. Inspect for a cracked cylinder head or block, or a damaged cylinder head gasket.

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 Temperatures

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 thermostat unit, when operating properly, closes when the engine temperature goes down and causes the water to circulate through the engine only until it again reaches a temperature of approximately 158° F., at which time it begins to open and is fully opened at 185° F. When the thermostat opens, the water is allowed to circulate through the radiator and is thus cooled. If the thermostat sticks open, normal temperature may not be attained. Refer to "ENGINE COOLING SYSTEM" in Section IV. If the 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 crackcase 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**

   Loose main or connecting rod bearings 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 core. 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 core 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 Balance Shaft Bushings**

    Replace the worn parts. Refer to "ENGINE" in Section IX.

12. **Excessive End Clearance of Rocker Arms on Rocker Arm Shafts**

    Adjust. Refer to "ENGINE" in Section IX.

13. **Blower Drive Bearings Loose**

    Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

14. **Oil Gaskets Between Cylinder Head and Block Leaking**

    Replace gaskets.

B. Excessive Oil Pressure

1. **Oil Pressure By-Pass Valve Stuck**

   This valve is designed to open and relieve excessive pressure due to cold heavy oil, clogged oil cooler core, or clogged oil passages. Refer to "ENGINE LUBRICATING SYSTEM" in Section V.

2. **Inoperative Oil Pressure Gage**

   Test the accuracy of the gage by installing a tested gage.

C. Oil Too Hot

1. Oil Cooler Core Clogged

This causes the oil cooler 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 core 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 of 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 plates, 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 with oversize 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 Drive Belt Loose or Broken

Tighten or replace the belt.

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 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 reflectors or 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. Replace any inoperative instruments.

9. ENGINE STARTING AID (COLD WEATHER ENGINE PRIMER)

(Refer to "ENGINE AIR INTAKE SYSTEM" in Section III, for full details on this unit.)

A. Cold Weather Engine Primer

1. Inoperative Pump

Repair pump.

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 CLUTCH BRAKE

(Refer to "ENGINE CLUTCH" in Section X, for full details of the clutch group.)

A. Clutch Slips

1. In Need of Adjustment

Adjust clutch.

2. Clutch Facings Worn Out

Replace the driven disc. *NOTE: The facings are bonded to the driven disc and are not serviced separately.*

3. Clutch Worn Out

Replace the clutch. Refer to "ENGINE CLUTCH" in Section X.

B. Clutch Hard to Engage

1. Clutch Improperly Adjusted

Clutch adjusted too tight. Adjust clutch.

2. Clutch Linkage Binding

Unless due to bent or broken parts, binding will in most cases be relieved by lubricating the clutch components as recommended.

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.

3. **Clutch Brake Too Loose or Brake Facings Worn**

Adjust clutch brake or replace the brake facings if necessary.

D. Engine Fails to Turn when Towing Tractor to Start the Engine

1. **Engine Clutch Slips**

Adjust clutch.

E. Engine Fails to Aid in Slowing the Speed of Tractor when Descending a Steep Grade

1. **Engine Clutch Slips**

Adjust clutch.

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 and Shifting Collars**

Repair or install new gears and shifting collars.

4. **Rough or Worn Splines**

Smooth the splines or replace the worn or rough parts.

5. **Gear Shifting Lock Plunger Rods Out of Adjustment**

Adjust control linkage for plungers.

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 misalinement 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 correct 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.

5. **Improper Use of Brakes**

   Refer to "OPERATORS MANUAL" for instructions on proper use of brakes.

C. Lining Wears Excessively

1. **Improper Adjustment**

   Adjust brakes.

2. **Linkage Binding**

   Free linkage and lubricate.

3. **Improper Use of Brakes**

   Refer to "OPERATORS 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 Contacts**

   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 300 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 "OPERATORS 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 follower 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 to 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 "OPERATORS MANUAL" for instructions on servicing.

4. **Improper Lubricator Used**

   Use proper lubricator furnished with tractor. Refer to "OPERATORS 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 rail 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 Spring Broken

Replace spring.

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. Capscrews Attaching Sprocket Shaft Outer Bearing Cage to Frame Loose

Tighten capscrews.

4. Sprocket Shaft Outer Roller Bearing Badly Worn or Broken

Replace the necessary parts. Refer to "FINAL DRIVES" in Section XIV.