SERVICE MANUAL

FOR

MODEL HD9 TRACTOR

1955

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FOREWORD

This manual is prepared to provide the customer and the maintenance personnel with complete information and instructions on the maintenance of the Model "HD-9B" Tractor (standard model). Extreme care has been exercised in the designing, selection of materials, and the building of the tractor. By proper maintenance and skillful operation of the tractor, the utmost satisfaction in performance and service will be obtained.

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

All information and photographs shown throughout this manual are of the "Standard" Model "HD-9B" 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 of 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. General information on the availability of Special Tools is given in Section XXIV.

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

SUBJECT INDEX

SECTION I—DESCRIPTION AND SPECIFICATIONS

1. GENERAL DESCRIPTION

The description given herein and the information contained in this manual pertains to the Model "HD-9B" Tractor (Standard Model), unless otherwise stated.

The Model "HD-9B" Tractor is an 18,800 pound track-type tractor powered with a 4-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 drive shaft universal joint assembly. From the transmission, the power is transmitted to the bevel gear, and from the bevel gear through two multiple disc steering clutches (one on each side of the bevel gear shaft) to the final drives and the track drive sprockets.

The transmission provides 6 forward speeds ranging from 1.4 M.P.H. in low gear to 5.7 M.P.H. in high gear and 3 reverse speeds ranging from 1.6 M.P.H. in low reverse to 4.4 M.P.H. in high reverse, under full governed engine speed of 1600 R.P.M.

Mechanical "Booster-Type" steering clutch controls, mechanical self energizing brakes, adjustable and wide operator's seat, and unobstructed view of the front of both tracks assure easy, positive control of the tractor at all times.

The tractor is equipped with electric starting and lighting equipment, muffler, full width crankcase guard, front pull hook, bumper, hinged type radiator grille, suction type fan, and 16-inch integral grouser shoes. The truck wheels, track idlers, and support rollers have positive type seals and are protected by guards.

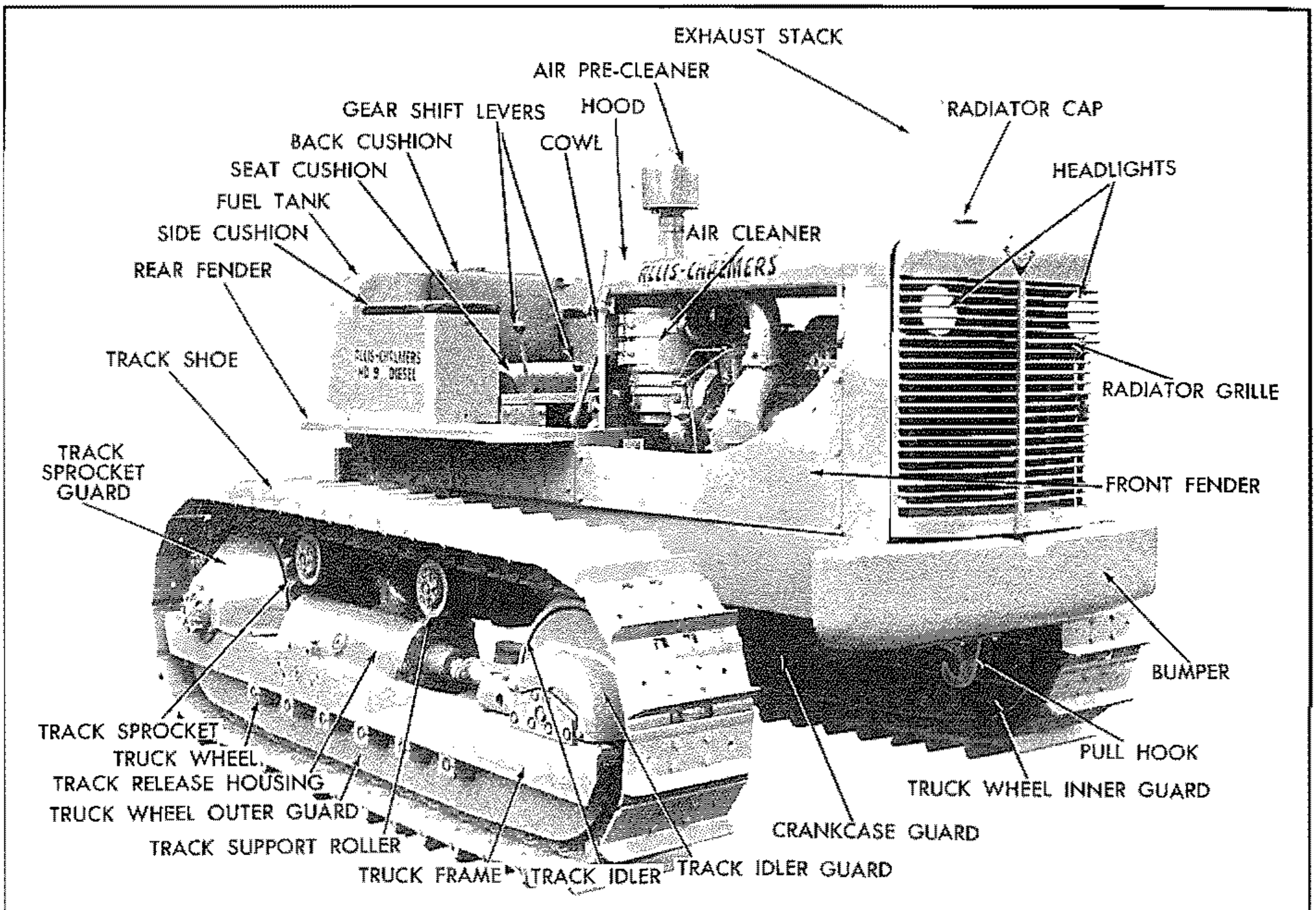

Fig. 1 — Model HD-9B Tractor

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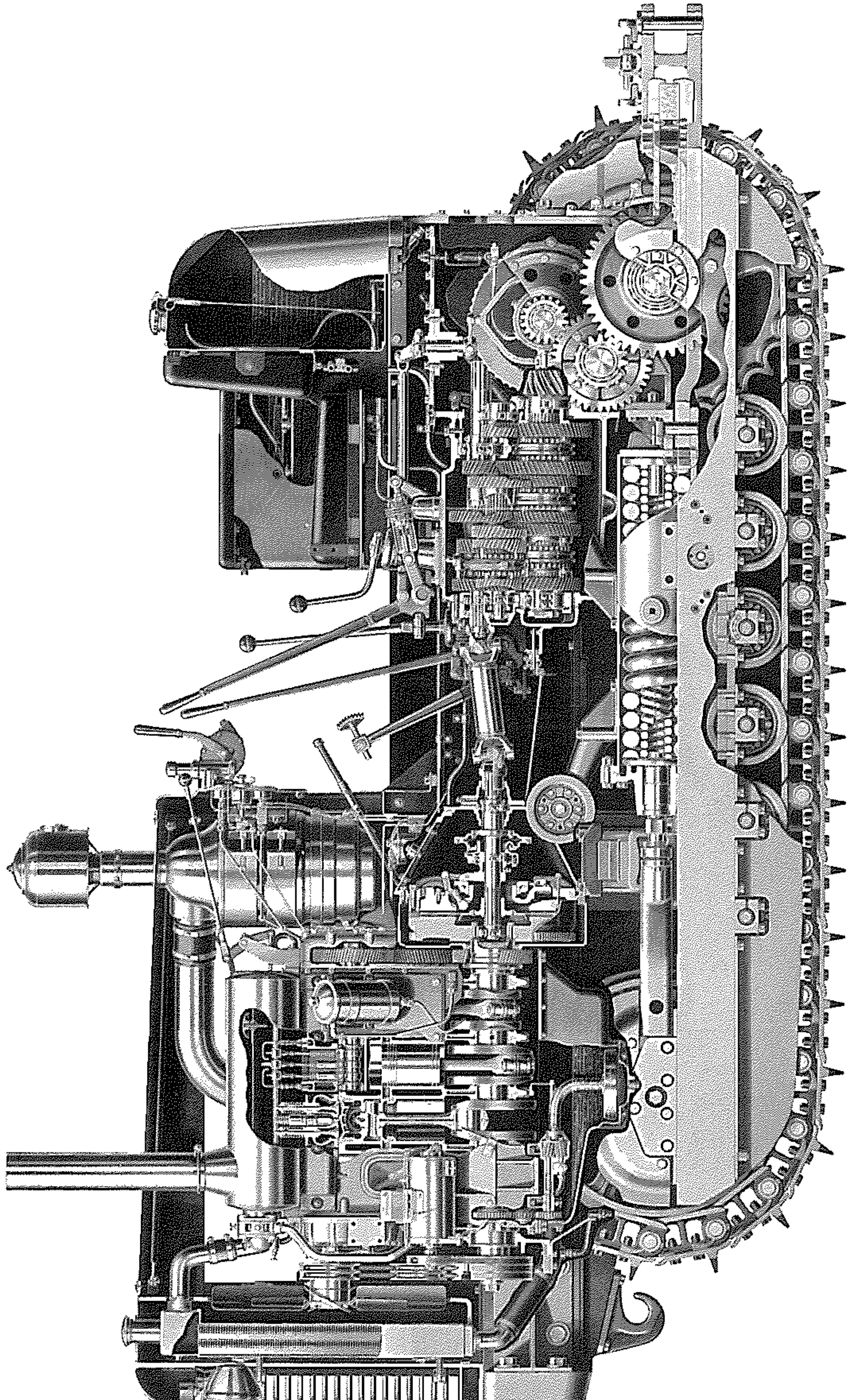

Fig. 2 — HD-9B Tractor (Sectional View)

2. GENERAL SPECIFICATIONS

(STANDARD TRACTOR)

GENERAL SPECIFICATIONS:

Overall Length	12 ft. 6 in.
Overall Height (without stacks)	6 ft. 1⅛ in.
Overall Width (standard shoes)	7 ft. 11-1/16 in.
Turning Radius	8 ft. 7⅝ in.
Ground Clearance	13-5/16 in.
Drawbar Height (center line of jaw)	16-17/32 in.
Lateral Drawbar Movement	26⅝ in.
Shipping Weight (approximate)	18,800 lbs.
Length of Track on Ground	7 ft. 1¾ in.
Width of Standard Track Shoes	16 in.
Maximum Width Track Shoes Available	22 in.
Ground Contact Area (standard shoes)	2744 sq. in.
Number of Track Shoes per Track	38
Ground Pressure per Sq. In. (standard shoes)	6.85 lbs.
Tread width (center-to-center of tracks)	74 in.

TRACTOR SPEEDS (at Rated Engine Speed):

GEAR RANGE	SPEED
1st Gear	1.4 M.P.H.
2nd Gear	2.1 M.P.H.
3rd Gear	2.9 M.P.H.
4th Gear	3.8 M.P.H.
5th Gear	4.4 M.P.H.
6th Gear	5.7 M.P.H.
1st Reverse	1.6 M.P.H.
2nd Reverse	3.5 M.P.H.
3rd Reverse	4.4 M.P.H.

ENGINE:

Make	"General Motors" Diesel
Type	Two Cycle
Number of Cylinders	4
Bore	4¼ in.
Stroke	5 in.
Piston Displacement	284 cu. in.
Engine Speed (governed at full load)	1600 R.P.M.
Lubrication	Forced Feed
Fuel Used	No. 1 or No. 2 Diesel Fuel
Fuel Supplied by	55 cu. mm. Unit Injectors

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

Cooling System	7¼ Gals.
Crankcase and Filter	4 Gals.
Transmission Case	6¾ Gals.
Final Drives (each)	3¼ Gals.
Fuel Tank	55 Gals.
Track Release Housing (each)	2 Gals.
Air Cleaner	1 Gal.

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 viscosities:

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

Manufacturers of lubricants recognize the importance of the qualities required for use in our equipment and they are cooperating fully to assure the use of only those oils which fulfill these requirements. The oil distributor and oil manufacturer are to be held responsible for the results obtained from their products.

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

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

B. Transmission and Final Drive Lubricant

Lubricate these assemblies with any good grade of engine lubricating oil purchased from a reputable oil company.

Use oils of the following viscosities:

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

C. Track Release Housing Lubricant

Lubricate these assemblies with SAE 50 engine lubricating 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 for use by the Allis-Chalmers Manufacturing Company. A revised list of approved greases is issued every six months. Ask your nearest "Allis-Chalmers" authorized Dealer for the latest list.

E. Pressure Gun Lubricant

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

F. Air Cleaner

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

4. SPECIFICATIONS OF FUEL

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

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

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

Physical cleanliness means freedom from water, dirt, and other incombustible ingredients. Since all present day high speed "DIESEL" fuels are completely distilled, they leave the refinery in clean condition.

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

Proper burning characteristics are dependent upon ignition quality and volatility.

All fuels meeting the requirements of the No. 1-D and also the lighter types of fuel in the No. 2-D grade of ASTM-D975 "DIESEL" Fuel Oil Specifications are satisfactory. *The more 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.*

Prolonged use of fuels combining low ignition quality (less than 45 Cetane Number) with high boiling temperature (more than 675° F. end point) should be avoided, particularly in cold weather.

CAUTION: *The sulphur content of "DIESEL" fuel should be as low as possible. For warm weather conditions, the fuel should contain not more than ½ of 1% sulphur. For cold weather operation, fuel with not more than 3/10 of 1% sulphur is preferable.*

5. FUEL STORAGE

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

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

Fuel should be allowed to settle at least 48 hours in the storage container before it is added to the fuel tank of the tractor. It is advisable to use a pump and draw the fuel from the container rather than to drain it from the bottom of the container.

Where conditions are such that drums must be used to supply fuel, it is advisable to have enough drums to allow sufficient time for the fuel to settle. The fuel should be used only to within about three (3) inches from the bottom of the drums. The fuel thus left in a number of drums can be collected into one drum and used after the usual time allowed for settling. In this manner, the sediment and foreign matter will be disposed of and no fuel will be wasted. Whenever drums are used for fuel storage, they should be covered or placed under shelter to avoid contamination of the fuel by water, which will enter through the filler plugs when it rains, even though the plugs are tight.

The fuel tank of the tractor should be filled at the end of the day's run rather than at the start; this will reduce the water content, as a full tank is less subject to condensation. The tractor fuel tank is provided with a drain elbow and drain cock, for draining accumulated water and sediment.

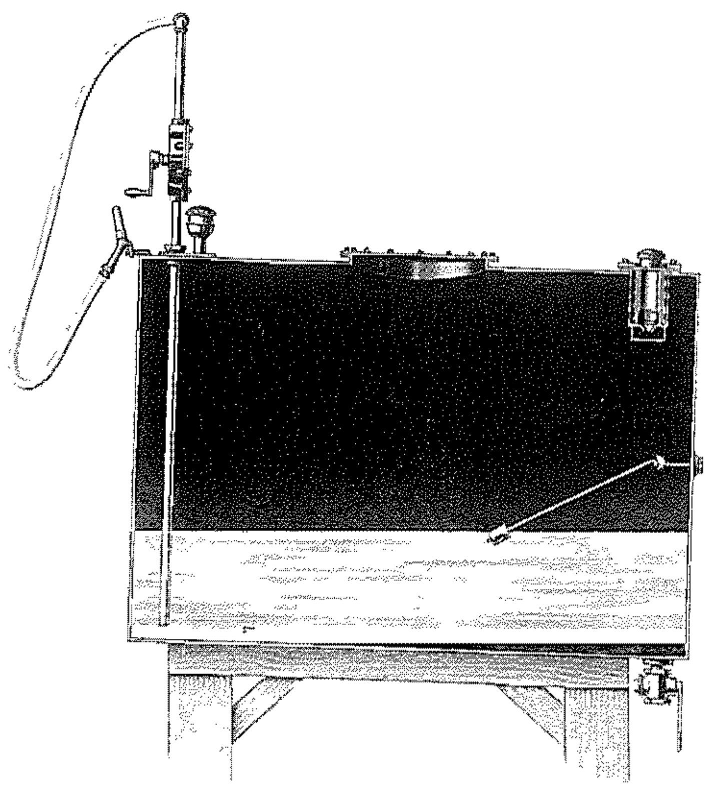

Fig. 3 — Fuel Storage Tank

6. TRACTOR AND ENGINE SERIAL NUMBERS

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

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

The engine serial number is stamped on the upper right side of the cylinder block, below the governor control housing.

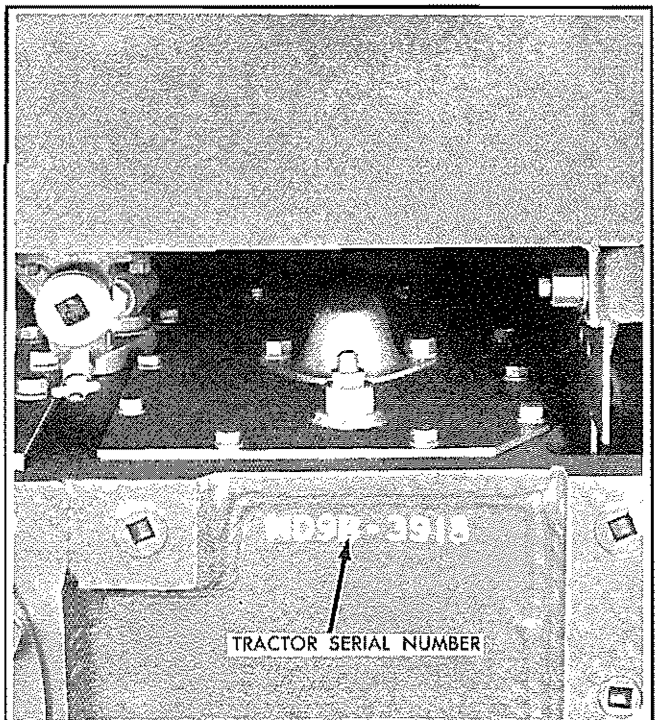

Fig. 4—Tractor Serial Number Location

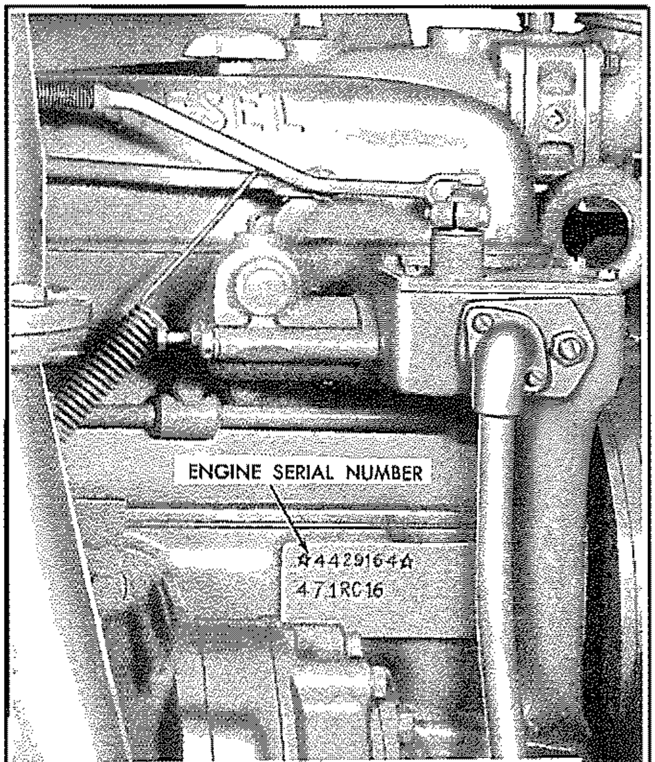

Fig. 5—Engine Serial Number Location

SECTION II—ENGINE FUEL SYSTEM

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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 pressure 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, fuel inlet 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, enters the return fuel manifold and is returned to the fuel tank. A pressure of 20 to 55 pounds is maintained within the fuel system by a restricted fitting located in the rear of the return fuel manifold. The continuous circulation of fuel helps to cool the injectors and eliminates the possibility of air pockets in the fuel system.

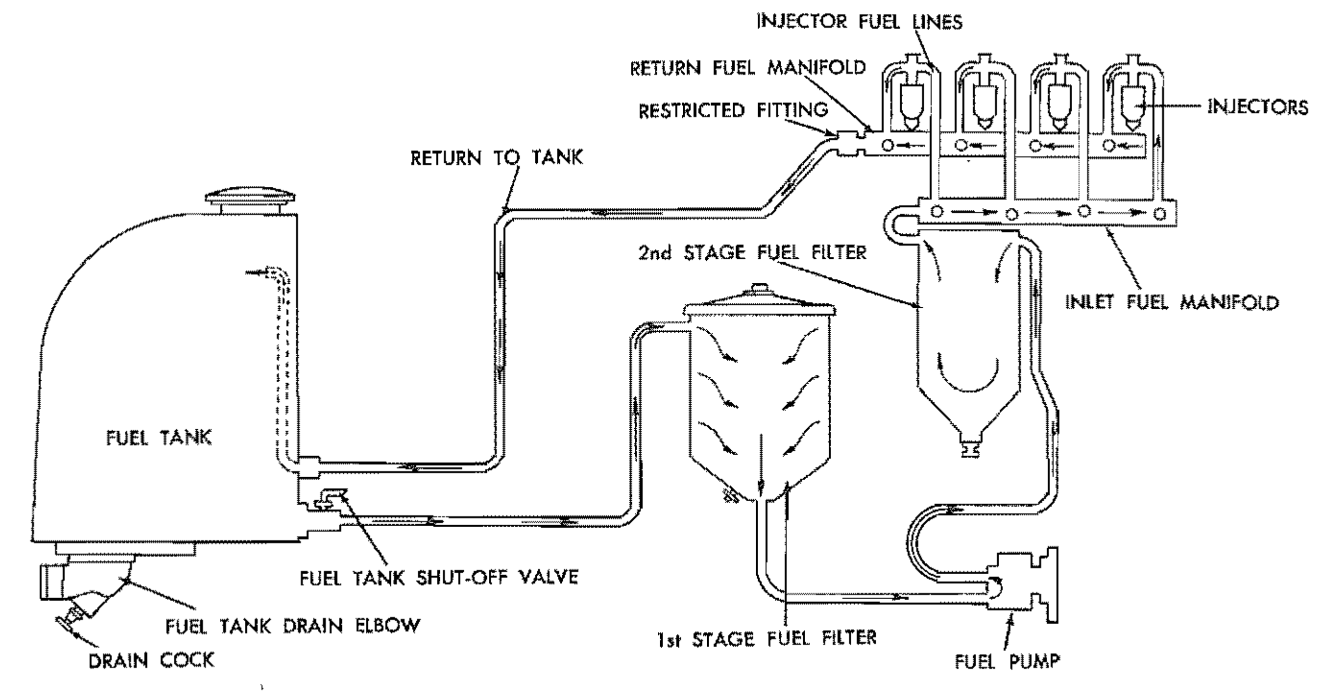


Fig. 1—Schematic Fuel Flow Diagram

2. CHECKING FUEL SUPPLY SYSTEM

A. General

Under normal conditions, with the engine running at full throttle, 20 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:

1. Air being drawn into fuel system on the suction side of the fuel pump.
2. Clogged fuel filter elements and fuel lines.
3. Clogged injector fuel filters.
4. Inoperative fuel pump.

B. Check for Full Flow of Fuel Through System

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

C. Check for Admission of Air into System, Clogged Fuel Filter Elements, and Clogged Fuel Lines

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

If the fuel lines or filters are clogged, clean the first stage or second stage fuel filter, or both, install new elements, and blow out the lines while they are disconnected. This should eliminate the difficulty. Check for full flow of fuel after engine is again started.

D. Check for Clogged Fuel Injector Filters

If the engine still runs "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 low idle speed and cut out each injector in turn by holding the injector follower down with a screwdriver or small block of wood. CAUTION: *Do not allow the screwdriver to slip off the injector follower as damage to the valve assemblies can easily result.* A decrease in engine speed with the injector follower held down will indicate that the injector for that cylinder is functioning properly. 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 line that connects the injector to the return fuel manifold. Hold a finger over the injector fuel outlet and crank the engine with the starter. If fuel gushes from the injector fuel outlet while the starter is cranking the engine, an ample fuel supply is indicated.

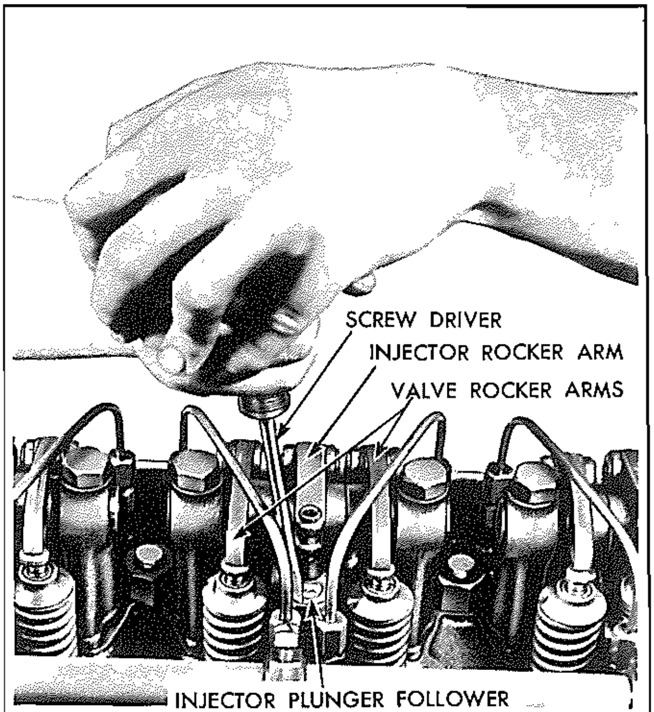


Fig. 2 — Locating Faulty Injector

E. Check for Inoperative Fuel Pump

Assuming that there is a sufficient supply of fuel in the fuel tank, and that fuel is reaching the fuel pump, loosen the vent screw located in the top of the second stage fuel filter. The fuel should gush from the vent screw opening in the filter with the engine running at low idle. If fuel does not gush from this opening, the fuel pump will be considered inoperative and must be repaired or replaced.

F. 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, the restricted fitting installed in the rear of the return fuel manifold, and all the fuel lines should be inspected for clogged passages.

Continued operation with excessively high pressure (over 55 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 55 gallons. The drain elbow at the bottom of the fuel tank provides a means for draining the tank when flushing and also acts as a sediment sump. Open the drain cock in 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 and flush the fuel tank if a large accumulation of rust and scale is evident.

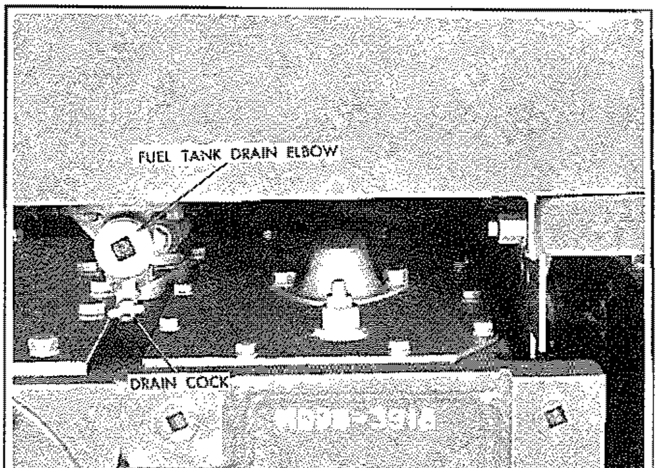


Fig. 3—Fuel Tank Drain Elbow

B. Maintenance

If a large accumulation of rust or scale in the fuel tank becomes apparent, remove the drain plug from the fuel tank drain elbow, disconnect the fuel lines from the fuel 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 cushion. Remove the side cushion from the top of each battery box. Remove the bolt attaching each battery box to the front of the fuel tank (one bolt on each side).

2. Remove the capscrew attaching the battery cable supporting clip to the fuel tank.

3. Close the fuel tank shut-off valve located at the lower front side of the fuel tank. Disconnect the fuel supply line from the fuel tank shut-off valve and disconnect the fuel return line from the fuel tank.

4. Remove the bolts attaching each side of the fuel tank to the rear fenders.

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

D. Installation

Install the fuel tank by a direct reversal of the removal procedure (refer to C. above).

4. FUEL FILTERS

A. Description

The engine is equipped with two (2) fuel filters, each containing a replaceable filter element. The first stage fuel filter is mounted at the left rear side of the engine and the second stage fuel filter is mounted on the right side of the engine. A drain cock is provided in the bottom of each filter for draining of water and sediment.

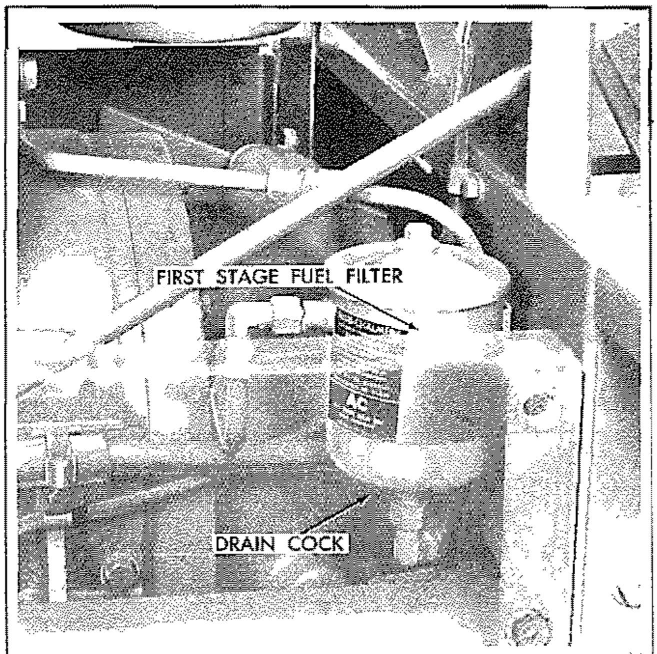


Fig. 4—First Stage Fuel Filter Location

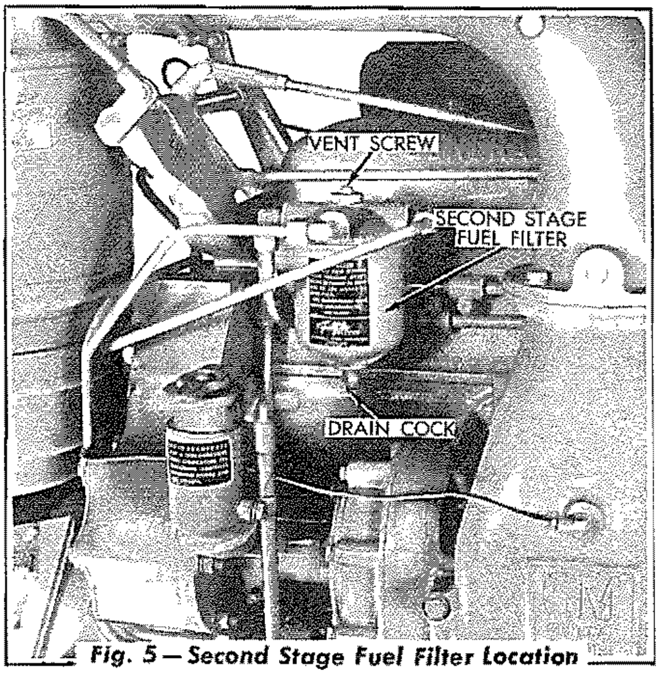


Fig. 5—Second Stage Fuel Filter Location

B. Service

The service of each fuel filter is the same. To service the fuel filters proceed as follows:

Open the filter drain cock daily, before the engine is started at the beginning of the day's operation in warm weather or shortly after the end of the day's operation in freezing weather, and allow the water or sediment to drain. Close the drain cock as soon as clean fuel runs out. Remove and discard the old element and install a new element after every 300 to 500 hours of operation (more often if conditions warrant) or when the filter element becomes clogged. A clogged filter element is usually indicated by irregular engine performance.

C. Replacement of First Stage Fuel Filter Element

1. Close the fuel tank shut-off valve.

2. Thoroughly clean the filter cover and the surrounding area. Loosen the drain cock, located in the bottom of the filter shell, and allow the filter to drain.

3. Loosen the cover screw and remove the cover screw, cover screw gasket, cover, cover gasket, and spring as a unit. Remove the cover gasket from the cover and discard the gasket.

4. Remove and discard the element washer, element gasket, and the filter element.

5. Reaching inside the filter shell, remove the element gasket and element washer from the shell centerbolt and discard.

6. Thoroughly wash and dry the interior of the filter shell. Close and tighten the drain cock located in the bottom of the filter shell.

7. Install a new element washer in position on the shell centerbolt, then install a new filter gasket and press the gasket down firmly onto the element washer.

8. Install a new element in position in the filter shell. Place a new element gasket and an

element washer in position on the shell centerbolt and press the gasket down firmly onto the top of the filter element.

9. Install a new cover gasket in position in the cover.

10. Open the fuel tank shut-off valve and allow the filter to fill with fuel, then install the cover in position on the filter shell and tighten the cover screw securely.

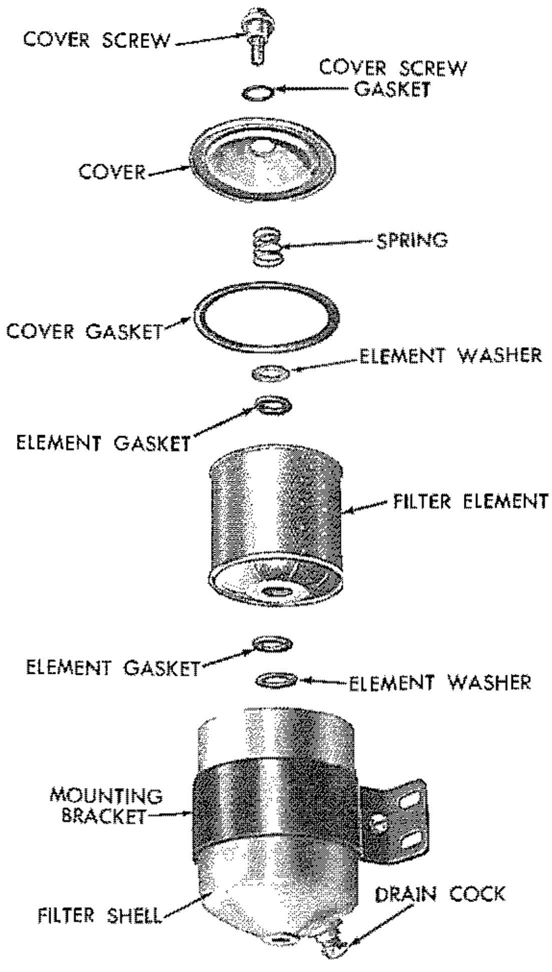


Fig. 6 — First Stage Fuel Filter Details

D. Replacement of Second Stage Fuel Filter Element

1. Thoroughly clean the fuel filter head and the surrounding area. Loosen the drain cock, located in the bottom of the filter shell, and allow the filter to drain.

2. Remove the filter shell (with its components) from the fuel filter head by loosening the shell retaining nut.

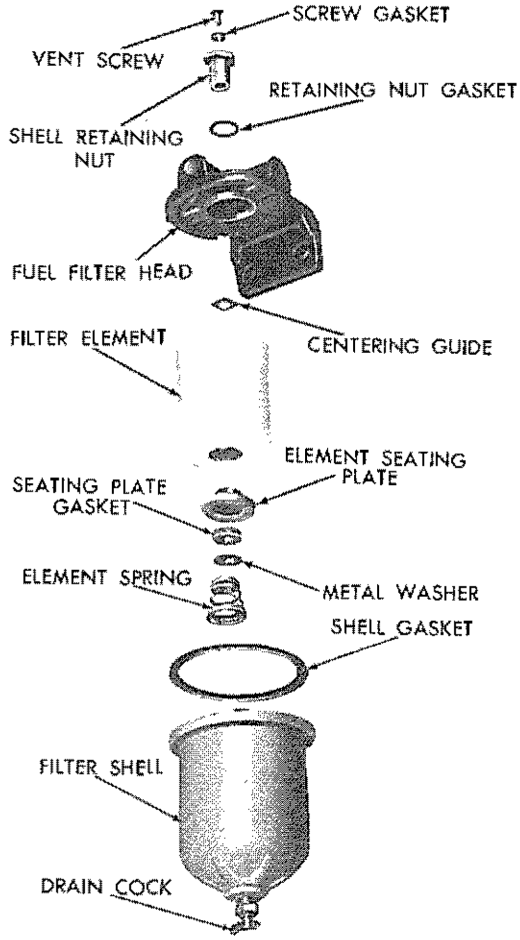


Fig. 7 — Second Stage Fuel Filter Details

3. Remove and discard the filter element. Remove the centering guide, element seating plate, seating plate gasket, metal washer, and element spring from the shell centerbolt. Discard the seating plate gasket, metal washer, and shell gasket.

4. Thoroughly wash and dry the interior of the filter shell. Close and tighten the drain cock located in the bottom of the filter shell.

5. Place the element spring (large end downward) in position on the shell centerbolt and install a new metal washer over the shell centerbolt and down against the element spring.

6. Install a new seating plate gasket in position in the element seating plate, then install the gasket and element seating plate in position on the shell centerbolt.

7. Install the centering guide in position on the

shell centerbolt and install a new filter element in position in the filter shell. Install a new shell gasket in position in the filter shell.

8. Hold the filter shell in position under the fuel filter head and tighten the shell retaining nut. Remove the vent screw and screw gasket from the shell retaining nut.

9. With the engine shut-off knob pulled back (stop position), crank the engine momentarily with the starter until fuel emerges from the vent screw opening in the shell retaining nut. Install the vent screw and screw gasket and tighten the vent screw securely.

10. Start the engine and observe for fuel leaks; correct any leaks found.

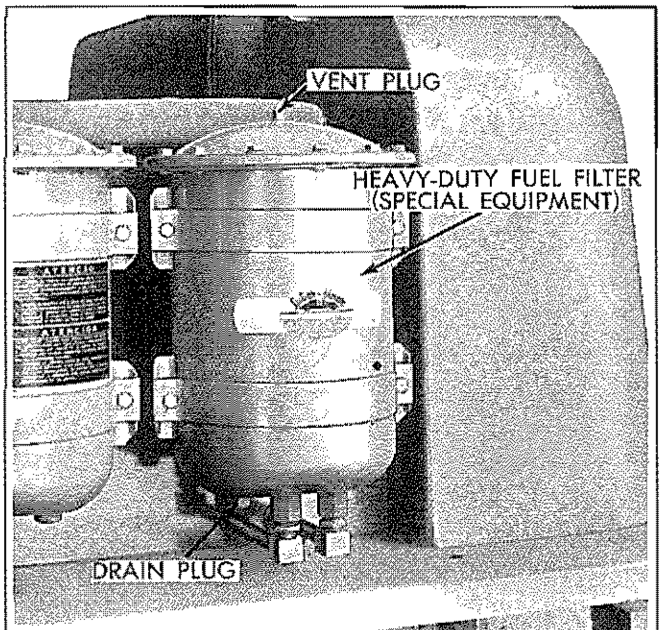


Fig. 8 — Heavy-Duty Fuel Filter Location

E. Heavy-Duty Fuel Filter (Special Equipment)

On tractors equipped with a Heavy-Duty Fuel Filter, service as follows:

Loosen the drain plug located in the bottom of the fuel filter housing, before the engine is started at the beginning of the day's operation in warm weather or shortly after the end of the day's operation in freezing weather and allow the water or sediment to drain. Tighten the drain plug when clean fuel runs out. Remove and discard the old filter element and install a new one after every 300 to 500 hours of operation or when the fuel pressure drops below 20 pounds per square inch.

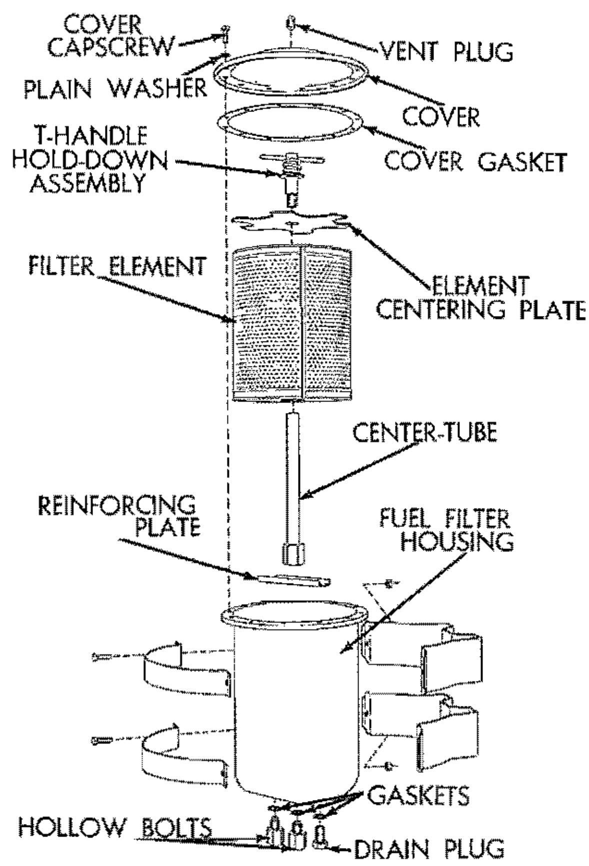


Fig. 9 — Heavy-Duty Fuel Filter Details

F. Replacement of Heavy-Duty Fuel Filter Element

1. Close the fuel tank shut-off valve.

2. Remove the drain plug from bottom of the fuel filter housing and then allow the fuel to drain from the filter. Remove the cover capscrews and lift the cover from the housing.

3. Unscrew the T-handle hold-down assembly from the center tube and remove the T-handle hold-down assembly and the element centering plate. Remove the filter element from the housing by lifting with the pull-out bail. Discard the filter element and the cover gasket.

4. Clean the interior of the fuel filter housing thoroughly and install the drain plug.

5. To assure leak-proof sealing, examine the

center-tube seal at each end of the new filter element to see that the seals are in good condition and clean. Insert the new filter element into position in the filter housing and press the filter element down firmly.

6. Place the element centering plate in position on the top of the filter element and install the T-handle hold-down assembly and tighten securely.

7. Install a new cover gasket in position in the cover and place the cover in position on the filter housing. Install the cover capscrews and tighten evenly and securely.

8. Fill the fuel tank so that there will be sufficient fuel in the tank to fill the fuel filter by gravity. Open the fuel tank shut-off valve.

9. Remove the vent plug from the filter cover and allow the filter to fill with fuel by gravity. Install and tighten the vent plug when fuel emerges from the vent plug opening.

CAUTION: *Use only a "DIESELPAK" filter element in the Heavy-Duty Filter.*

5. FUEL PUMP

A. Description

The fuel pump is a constant flow gear type pump, having a delivery capacity of approximately 35 gallons per hour at 1000 engine R.P.M. with a pump discharge pressure of 40 pounds per square inch. The pump is bolted to the rear end of the blower end plate cover, and is driven by the lower blower rotor shaft through a self-aligning, U-shaped, steel coupling. Two steel gears revolve inside the pump housing to create a vacuum in the intake chamber, thus drawing the 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 pump driving gear is mounted on a free-floating type driving gear shaft and is attached to the shaft by a shear pin. The pump driven gear is supported in the bore of the pump housing by its supporting journal, which is an integral part of the driven gear.

Two pump shaft oil seals are used inside the stator at the coupling end. The sealing edge of one oil seal faces the pump housing and retains the fuel within the pump, the sealing edge of the other oil seal faces the coupling end of the stator and prevents engine lubrication oil from entering the pump. 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 pump housing end), is provided to by-pass fuel back to the inlet side when the outlet pressure exceeds 47 to 60 P.S.I. This valve normally does not open since its purpose is to relieve excessive pressure in case clogging occurs in the fuel lines or filters.

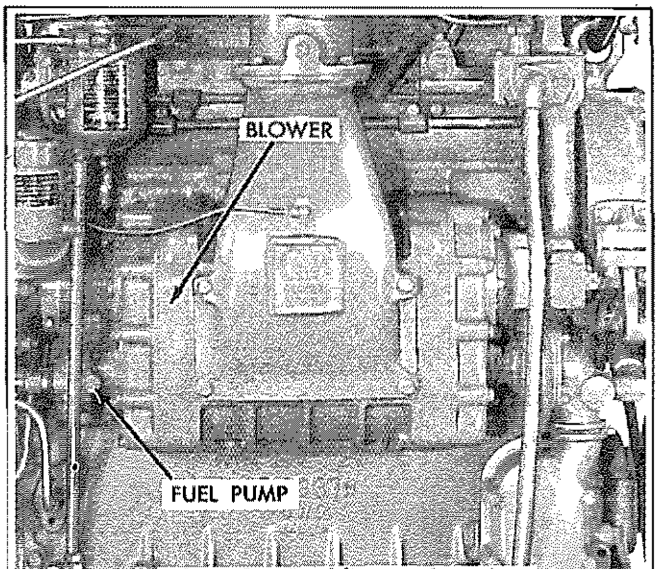


Fig. 10 — Fuel Pump Location

B. Service

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

C. Removal of Fuel Pump

1. Close the fuel tank shut-off valve.

2. Disconnect the two fuel lines from the pump.

3. Remove the three (3) capscrews attaching the fuel pump to the blower end plate cover.

(Use the special fuel pump wrench to remove the capscrew nearest the cylinder block.) Remove the fuel pump and the drive coupling as a unit, withdrawing the pump straight from the blower end plate cover.

4. Rotate the pump driving gear shaft by hand to see if the internal parts of the pump rotate freely. If binding or sticking is evident, disassembly and inspection of the pump will be necessary.

D. Disassembly of Fuel Pump

When repairing the pump, if an oil seal expanding tool is not available there is considerable danger in damaging the oil seals when the pump driving gear shaft is again installed. When installing the shaft, it is very essential to install it without damage to the oil 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 valve plug and jarring the valve parts from the pump stator.

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

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

1. Remove the eight screws attaching the pump housing to the stator. Install four (4) capscrews ¼ x 20 NC x 3 in four of the capscrew holes so that the heads of the screws can be tapped with a hammer to separate the pump stator and the pump housing.

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

3. Remove the driven gear from the pump housing.

4. Remove the pump driving gear shaft and driving gear from the pump stator carefully, to prevent damage to the oil seals.

5. Remove the dowel pins if necessary.

6. If it is necessary to remove the oil seals from the pump stator, a tool of the proper design should be used to prevent damage to the seals.

E. Inspection of Fuel Pump Parts

1. Wash the fuel pump parts in clean fuel or solvent and inspect carefully. The oil seals, once removed from the pump, should be replaced with new seals. If the sealing edges of the oil seals are damaged in any way, so

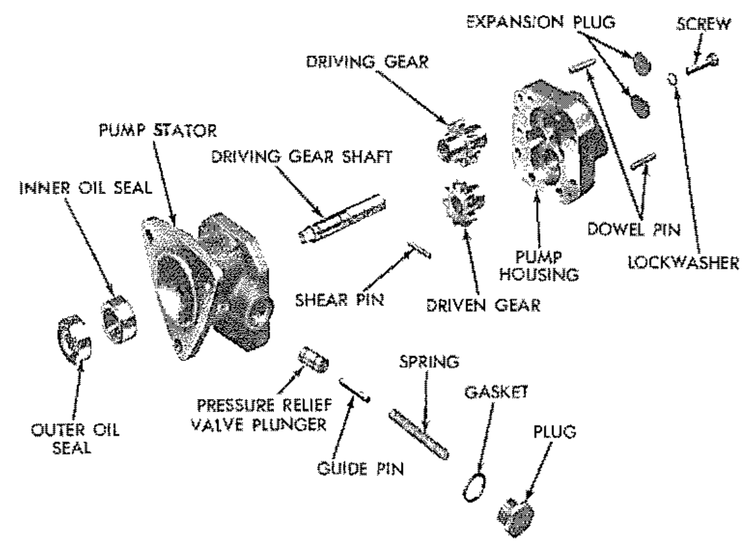


Fig. 11 — Fuel Pump Details

that they do not form a perfect seal around the driving gear shaft, either a fuel leak or a lubricating oil leak will result.

2. Inspect the pump gears. If the gears are slightly worn on the involute surfaces, they should be replaced as an appreciable amount of wear on the gears will affect the delivery capacity of the pump.

3. Inspect the driving gear, located on the driving gear shaft. The shear pin securing the driving gear to the shaft must be tight. Replace parts if necessary.

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

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

6. When the fuel pump is overhauled, it is recommended that the pressure relief valve plunger 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 inner oil seal in position in the pump stator, with the sealing edge of the oil seal toward the pump housing.

2. Install the outer oil seal in position in the pump stator, with the sealing edge of the oil seal toward the coupling end of the pump.

3. Lubricate the driving gear shaft and the oil seals and install the shaft (with driving gear in place) in the pump stator. Push the shaft through the oil seals being careful not to cause damage to the oil seals. Use an oil seal pilot tool on the drive end of the shaft if tool is available.

4. Place the driven gear in position in the pump housing. Lubricate the gears with engine oil.

5. Coat the machined attaching surfaces of the pump 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 pump stator, turn the driving gear shaft to mesh the gear teeth, and push the pump stator and the pump housing together. Install the attaching screws and lockwashers and tighten securely.

6. Turn the pump driving gear 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 pressure relief valve parts, making certain that the parts are installed properly in their respective positions.

8. Install the fuel pump on the engine by direct reversal of the removal procedure.

6. FUEL INJECTORS

A. General

A fuel injector is provided for each cylinder. Each fuel injector combines in a single unit all 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 and 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 and forms a tight seal to withstand the high pressure inside the combustion chamber.

The Model "HD-9B" and "HD-9F" Tractors are equipped with 55 cu. mm. fuel injectors. The Model "HD-9G" Tractors prior to Serial No. 2698 are also equipped with 55 cu. mm. fuel injectors. The 55 cu. mm. injectors are identified by an orange colored injector identification tab marked "55." However, effective with "HD-9G" Tractor Serial No. 2698, all "HD-9G" Tractors are equipped with 70 cu. mm. fuel injectors. The 70 cu. mm. injectors are identified by a black colored injector identification tab marked "70" or "HV7." The primary difference between the injectors marked "70" and the injectors marked "HV7" is that the "HV7" injectors incorporate a "high valve" arrangement.

B. Operation

The operation of the 55 and the 70 cu. mm. fuel injectors is basically the same. The cross section of the unit fuel injector (55 cu. mm.) illustrated in Figure 13, 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

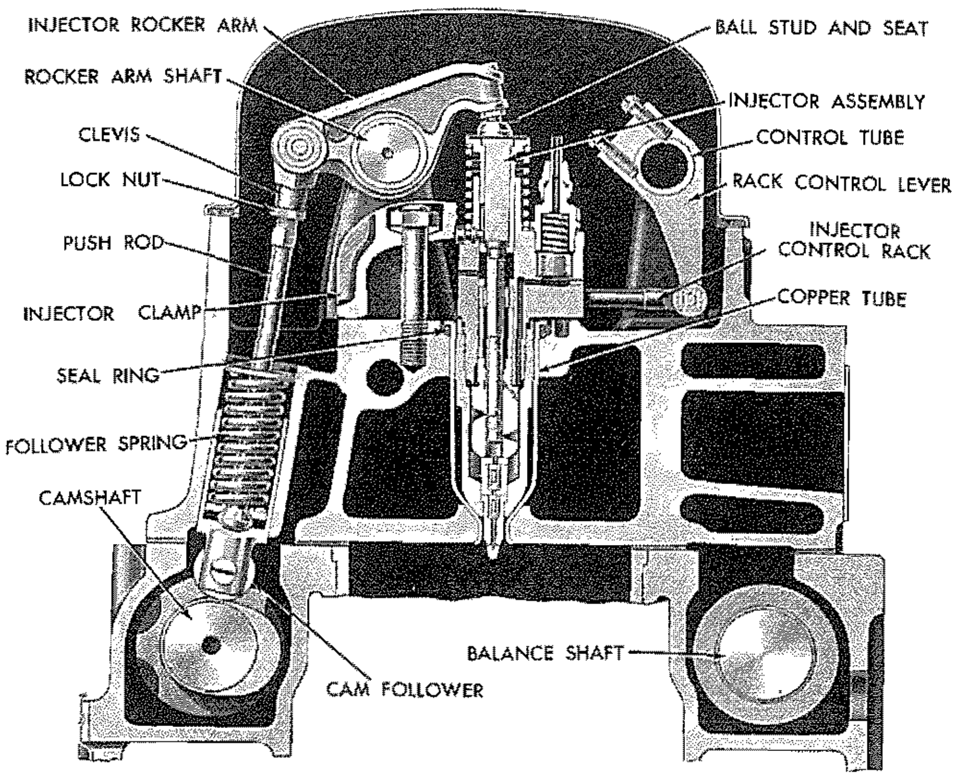


Fig. 12—Fuel Injector Mounting

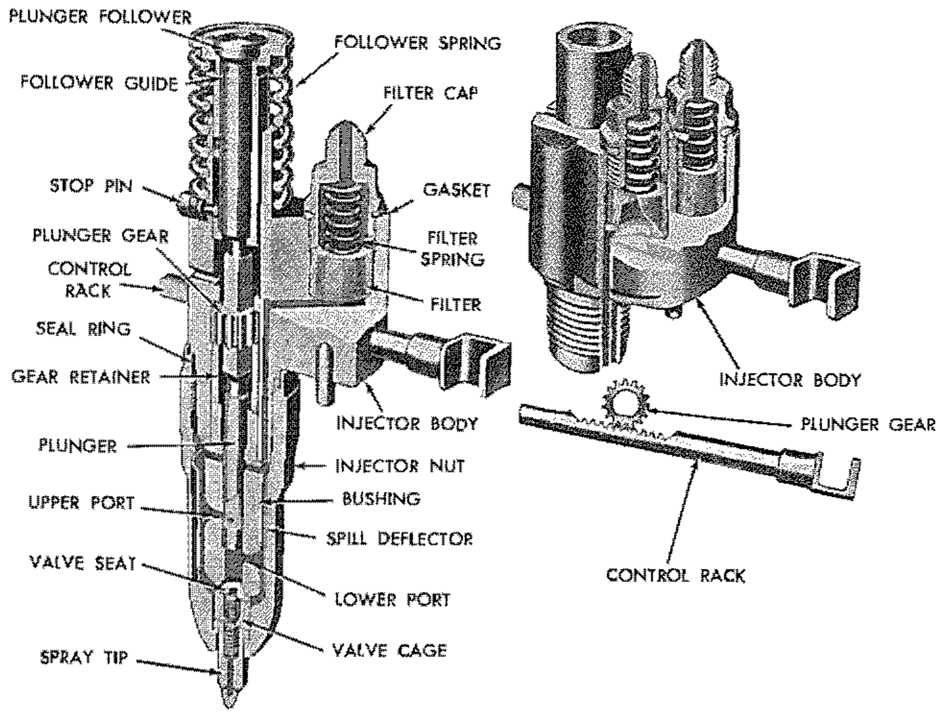


Fig. 13 — Fuel Injector Assembly

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

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

On the upward movement of the injector plunger, the high pressure chamber 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 material by a porous metal filter, exactly like the one on the inlet side.

C. Fuel Injector Service

Because of the important part the fuel 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 the fuel system.

2. After an injector has been operated in an engine, the injector filter caps and filters should not be removed from the injector while the injector is installed in the engine. If the filter caps and the 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 must be tested before it is installed in an engine. Refer to "TESTING INJECTOR" in this section.

D. Fuel Injector Removal

1. Remove the air pre-cleaner and the engine hood. Clean off the rocker cover and remove the cover from the cylinder head.

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

3. If necessary, crank the engine with the starter until the rocker arm clevis pins (at push rod end of arms) are in line, then turn the rocker shaft bracket bolts out of the cylinder head and swing the rocker arm assembly away from the injector and valves. CAUTION: *Push rods may be bent if the upper ends are not aligned when swinging the rocker arm assembly away from the injector and valves.*

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

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

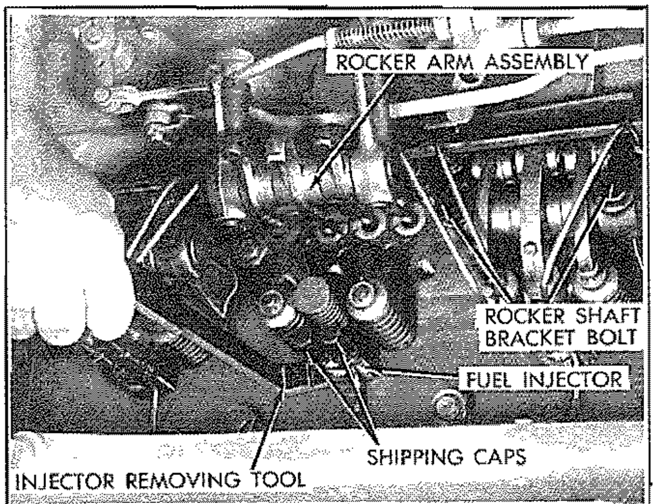


Fig. 14 — Removing Fuel Injector From Engine

E. Fuel Injector Disassembly

Before starting to disassemble a fuel injector, it is necessary to have an extremely clean work bench on which to work and to store the parts. Cleanliness for the injector and its parts is emphasized because practically all injector service troubles are directly due to dirt, or other foreign material, entering the injectors. Use clean paper on the work bench, and, after the injector has been disassembled, place the loose parts in a pan of clean fuel as protection against dirt and corrosion. Leave the parts in the clean fuel until needed for reassembly. When more than one injector is disassembled, 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 valve seats may be removed, cleaned, or 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 in the injector by its own weight. If binding of the plunger or the 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.

The following procedure for disassembly, inspection, reconditioning, and assembly pertains to the 55 cu. mm. fuel injectors and will basically apply for the 70 cu. mm. injectors. However, the injector valve arrangement for the 70 cu. mm. injectors differs from the valve arrangement for the 55 cu. mm. injectors. When rebuilding an injector, refer to the proper illustrations for the particular injector being rebuilt and assemble the valve parts in their proper sequence.

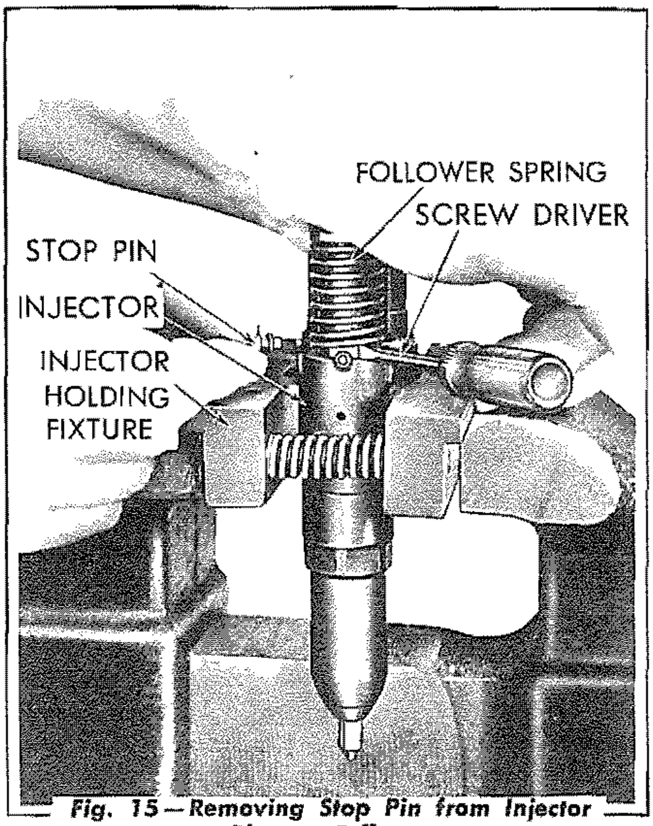


Fig. 15—Removing Stop Pin from Injector Plunger Follower

Disassemble the fuel injector as follows, placing all parts in a pan of clean fuel as they are removed. IMPORTANT: *Before disassembly, refer to preceding paragraph.*

1. Place the injector in an injector holding fixture and place the fixture in a vise, with the spray tip end of the injector down. Make sure the injector control rack is not bound or bent when clamped in the fixture. Loosen, but do not remove the two injector filter caps.

2. Using a screwdriver as shown in Fig. 15, raise the follower spring, and at the same time hold down on the top of the plunger follower, and withdraw the stop pin. Allow the follower spring to raise to its free length position after the stop pin is removed.

3. Raise the plunger follower until the plunger is withdrawn from the injector body. Remove the follower spring and separate the plunger from the plunger follower.

4. Clamp the injector in the holding fixture, with the spray tip end of the injector up, as shown in Fig. 16. Using an injector nut wrench, loosen the injector nut. Unscrew the injector nut from the injector body, then carefully raise the nut from the spray tip so that the spray tip and the other small parts resting on the end of the bushing will not be dislodged. If the injector has been in use for some time, the spray tip will possibly be removed with the injector nut. In this event, drive the spray tip from the injector nut using a hollow steel rod. CAUTION: DO *NOT DRIVE DIRECTLY ON THE END OF THE SPRAY TIP AS DAMAGE TO THE TIP WILL RESULT.*

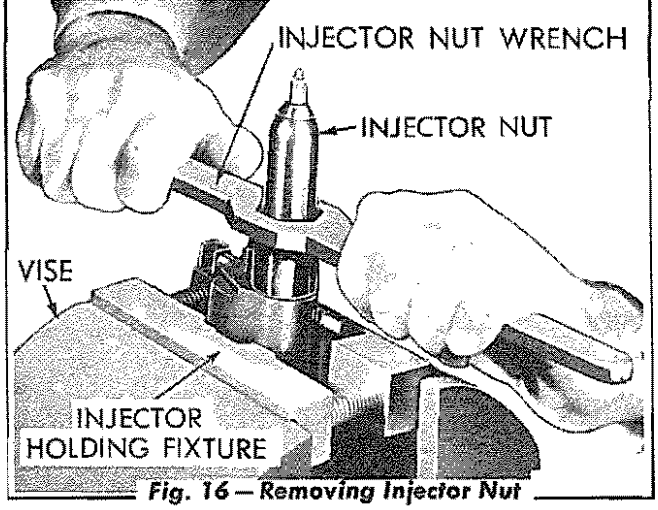


Fig. 16—Removing Injector Nut

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

6. "Jar" the spill deflector from the injector 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 holding fixture and "jar" the gear retainer and plunger gear from the injector body. Pull the control rack from the injector body.

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

F. Cleaning, Inspection, and Reconditioning of Fuel Injector Parts

Wash the hands thoroughly and clean all the injector parts in clean fuel or carbon tetrachloride. Dry the parts with compressed air that is free from dust and 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 the parts of the injector when assembled. Toilet tissue is a good and inexpensive material for wiping injector parts after cleaning.

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

After the injector has been disassembled and all the parts carefully cleaned in carbon tetrachloride or fuel, they should be protected from dirt by storing in clean fuel until the injector is reassembled.

1. Reaming Injector Spray Tip

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

The 55 cu. mm. fuel injectors have six (6) and the 70 cu. mm. fuel injectors have seven (7) .006 inch fuel holes in the spray tip. Clean these fuel holes with the .006" wire and holder furnished with the injector kit. Before using the wire, remove any sharp burrs from the wire by honing it on the stone included in the injector tool kit.

After the spray tip has been reamed and the fuel holes in the spray tip cleaned, blow out loose particles with compressed air. Then again ream the spray tip, clean the fuel holes, wash the tip with carbon tetrachloride, and blow out with compressed air. Discard the spray tips if the diameter of the fuel holes exceeds .008".

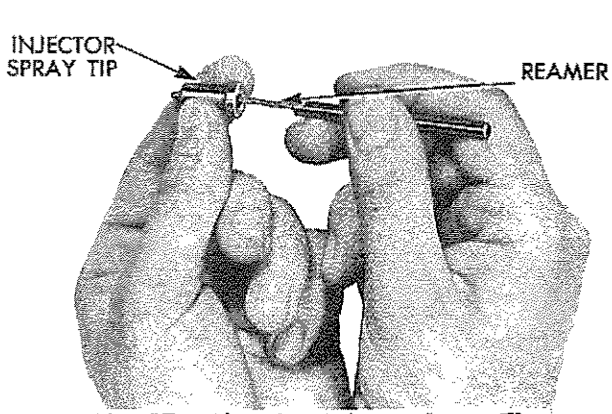


Fig. 17 — Cleaning Injector Spray Tip

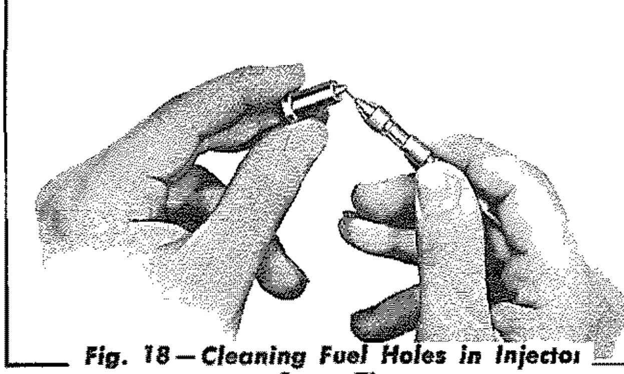
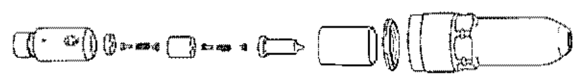


Fig. 18 — Cleaning Fuel Holes in Injector Spray Tip

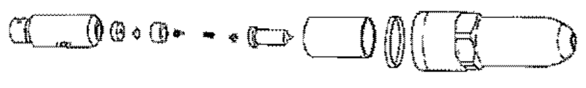
2. Valves and Seats

Thoroughly wash the injector valve components and inspect. If the valve components are chipped, pitted, or otherwise damaged, they must be replaced.

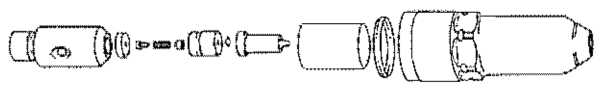
If the flat sealing surfaces of the injector valve components and the lower end of the bushing show discoloration only, they may be lapped on a piece of plate glass or on a lapping block. Use "Carborundum H-40" medium lapping cream, "Norton Alundum 600" grain size, or equivalent. Before lapping the valve components, refer to Fig. 19 showing the parts which may require lapping for the 55 cu. mm. and the 70 cu. mm. injectors.



55 CU. MM. INJECTOR
Identified by ORANGE tab marked "55"



70 CU. MM. INJECTOR
Identified by BLACK tab marked "70"



70 CU. MM. INJECTOR
Identified by BLACK tab marked "HV7"

Fig. 19 — Surface of Injector Valve Components Which May Require Lapping

Spread the lapping cream on the lapping block, 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, 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 or kerosene, and dried with compressed air.

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

3. **Injector Plunger and Bushing**

Clean the injector bushing by immersing it in a container of carbon tetrachloride or fuel and working a brush through the bushing. Clean the plunger with compressed air and again wash it in clean carbon tetrachloride or fuel. For final cleaning, wrap toilet tissue around an injector bushing cleaner tool, or similar rod, and rotate this rod in and out through the bushing. The injector plunger should move freely in the bushing. Worn, scored, or scratched injector plungers and bushings MUST be replaced. The plunger and bushing are serviced only in matched sets.

4. **Injector Nut**

Clean the seat and the bore in the injector nut (for the spray tip) with a spray tip reaming tool. The tool does not cut but merely cleans the seat in the injector nut and also removes carbon or other deposits from the bore at the lower end of the nut. Clean the inside of the injector nut thoroughly with one of the brushes provided in the injector tool kit.

5. **Injector Filters**

Cleaning of the injector filters is not recommended. If the injector has not been in use over an extended period and the filters are removed, they can possibly be used again if they are reinstalled in the same opening in the injector body from which they were removed. CAUTION: *Do not switch the inlet filter to the outlet side or vice versa.*

6. Injector Control Rack and Gear

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

G. Injector Assembly

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 be clean. The cleaned injector parts should remain in a pan of clean fuel until reassembly, then each part should be taken from the pan and assembled in the injector. Care must be used when assembling. NOTE: *The following procedure for assembly pertains to the 55 cu. mm. fuel injectors and will basically apply for the 70 cu. mm. injectors. However, the injector valve arrangement for the 70 cu. mm. injectors differs from the valve arrangement for the 55 cu. mm. injectors. When assembling the injector, refer to the proper illustration for the particular injector being rebuilt and assemble the parts in their proper sequence.*

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

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

b. Place the inlet filter in the fuel cavity of the injector body that has the timing gage hole located near its edge and place the outlet filter in the other fuel cavity. Place a filter spring on each filter and a new copper gasket in position on each filter cap. Lubricate the threads, install, and tighten the filter caps to a torque of 65 to 75 pounds feet.

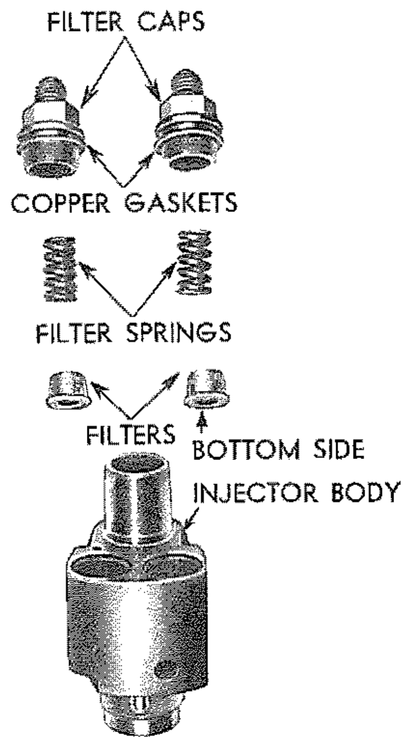


Fig. 20 — Injector Filters, Springs, and Caps

2. Install Injector Control Rack and Gear

Observe the injector control rack and gear and note that two of the teeth of the control rack have a punch mark; also, one tooth of the gear is similarly marked. When the control rack and the gear are properly installed, the marked tooth on the gear is engaged between the two marked teeth on the control rack. This relation of the control rack and the gear MUST be maintained for proper timing of the injector.

a. Hold the injector body, bottom end up, and insert the control rack into the hole in the injector body so that the two marked teeth on the control rack can be seen when looking into the gear bore in the injector body.

b. Holding the control rack in position so the marked teeth can be seen, drop the gear into the injector body so that the marked tooth on the gear is between the two marked teeth on the control rack.

c. Insert the gear retainer down on top of the gear and place the bushing in position on the gear retainer, with the locating pin in the bushing inserted into the slot in the injector body.

d. Place the injector body in an injector holding fixture and clamp in a vise, with the bottom end of the injector up. Use care and do not bind or bend the control rack in the injector body when placing in the vise. Install the spill deflector over the bushing then place a new seal ring over the bushing and down against the shoulder of the injector body.

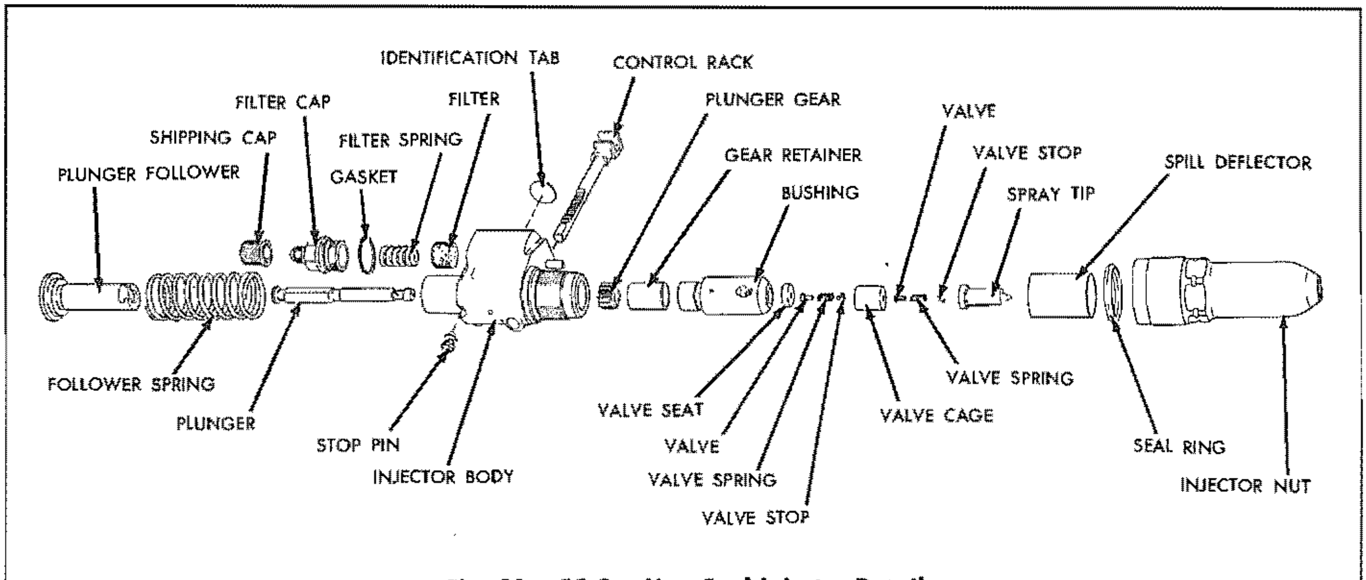


Fig. 21 — 55 Cu. Mm. Fuel Injector Details
(Injector Identified by ORANGE Tab Marked "55")

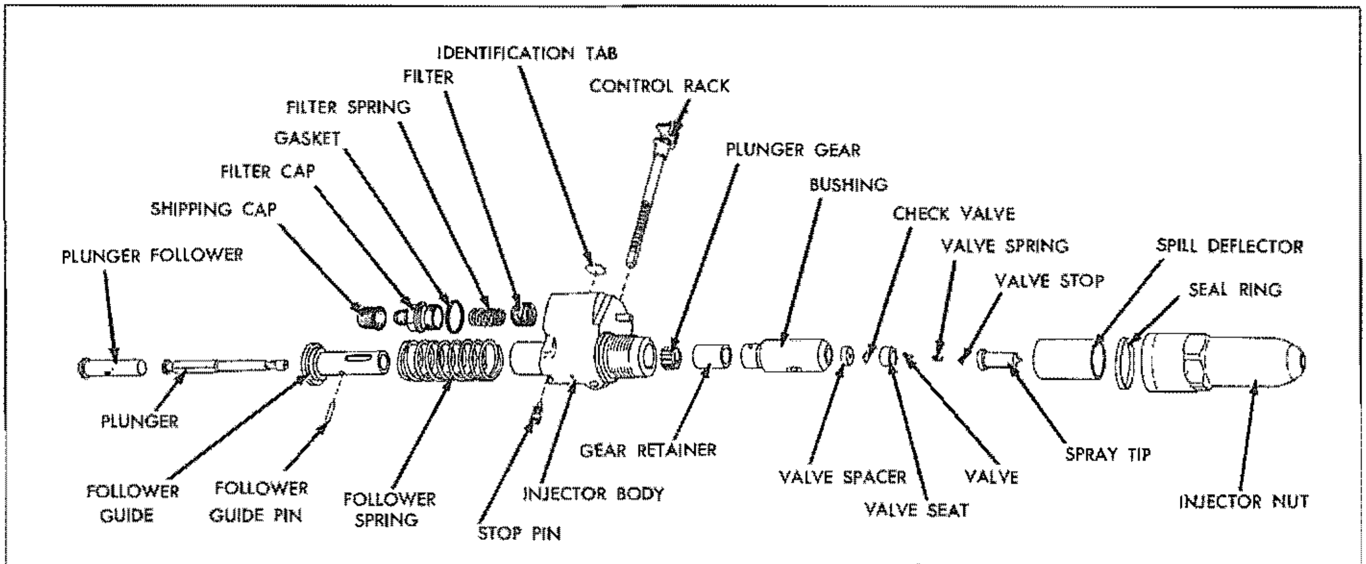


Fig. 22 — 70 Cu. Mm. Fuel Injector Details
(Injector Identified by BLACK Tab Marked "70")

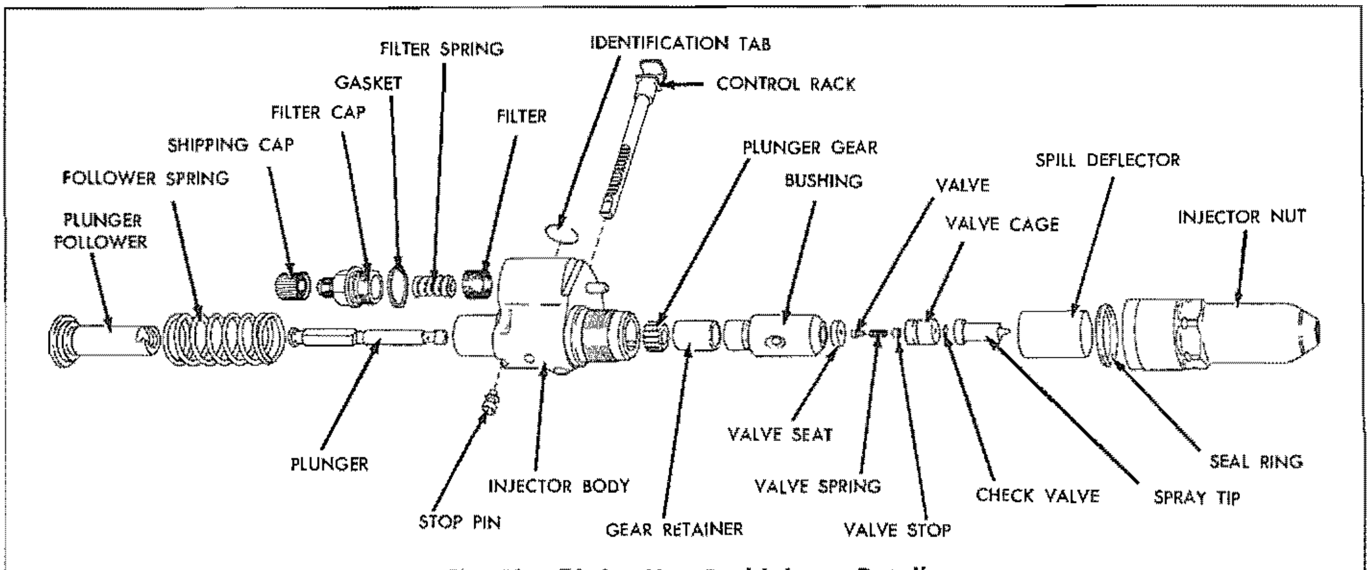


Fig. 23 — 70 Cu. Mm. Fuel Injector Details
(Injector Identified by BLACK Tab Marked "HV7")

3. **Assembly of Injector Spray Tip and Valves**

NOTE: *The following procedure for assembly of the injector spray tip and valves pertains to the 55 cu. mm. fuel injectors and will basically apply for the 70 cu. mm. injectors. However, the injector valve arrangement for the 70 cu. mm. injectors differs from the valve arrangement for the 55 cu. mm. injectors. When assembling the injectors refer to the proper illustration for the particular injector being rebuilt and assemble the parts in their proper sequence.*

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

b. Place the valve seat in position over the valve, which was installed in the valve cage, and place this assembly in position on the bushing.

c. Holding the other valve spring with the fingers, insert a valve in one end of the spring, and insert a 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 valve) in position on the valve cage.

d. With the injector body still positioned 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 bushing with the other hand, lower the injector nut down over the spray tip.

e. With the valves and the spray tip held in position with the tool, screw the injector nut onto the injector body, making certain that the valve assembly has not shifted. Do not force the injector nut, even by hand, while screwing it onto the injector body. The injector nut can be turned down within 1/16" of the shoulder of the injector body with the thumb and finger, if the valve assembly is lined up properly. If the shoulder inside the injector nut strikes the edge of the valve cage and the nut does not screw on easily, shift the valve assembly slightly by turning the spray tip. If the injector nut and the valve assembly cannot be brought into line in this manner, the nut will have to be removed and the valve assembly again centrally located on the end of the bushing. Tighten the injector nut to a torque of 55 to 65 pounds feet. CAUTION: *DO NOT OVERTIGHTEN.*

4. **Install Plunger and Plunger Follower Assembly**

NOTE: *The following procedure for assembly of the plunger and plunger follower pertains to the 55 cu. mm. fuel injectors and will basically apply for the 70 cu. mm. injectors. When assembling these parts, refer to the proper illustrations for the particular injector being rebuilt and assemble the parts in their proper sequence.*

a. Invert the injector in the holding fixture so that the injector is right side up. Place the follower spring down over the follower neck of the injector body. Insert the top of the plunger into position in the slot in the lower end of the plunger follower.

b. Notice the position of the flat on the inside of the plunger gear, and turn the plunger so that the flat of the plunger will register with the flat in the plunger gear when the plunger is inserted into position in the injector.

c. With the flat of the plunger aligned with the flat of the plunger 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 stop pin. Insert a screwdriver, or a follower spring lifter tool, beneath the lower end of the follower spring, push down on the top of the plunger follower, and, raising the follower spring at the same time with one hand, insert the stop pin with the other hand (refer to Fig. 15). The stop pin can be inserted into place as soon as the slot in the plunger follower and the hole in the injector body align. When the follower spring is released, the spring 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 the injector has been properly assembled and the parts are not binding, the control rack will move back and forth by its own weight.

H. Testing Injector

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

1. Place the injector in an injector holding fixture and clamp in a vise. Screw the bolt of the popping tool into the tapped hole in the holding fixture and tighten the lock nut. Introduce clean fuel 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. Place a glass beaker under and surrounding the injector spray tip so that fuel injected from the spray tip is caught by the beaker. CAUTION: *Always use a beaker and keep the hands away from the spray tip when "popping" an injector, as the finely atomized fuel from the spray tip is ejected with such force that it will penetrate the skin and may cause blood poisoning.*

Push the injector control rack all the way in to the full open position and work the injector plunger follower up and down several times with the popping tool. Observe if fuel is discharged from all six (6) fuel holes in the spray tip of the 55 cu. mm. injectors or seven (7) fuel holes in the 70 cu. mm. injectors. Keep the injector filled with fuel from the oil can and press the handle of the popping tool down on the plunger follower with quick motions. It may require a few minutes of this operation before the injector valves will seat and a "chirping" sound will be heard.

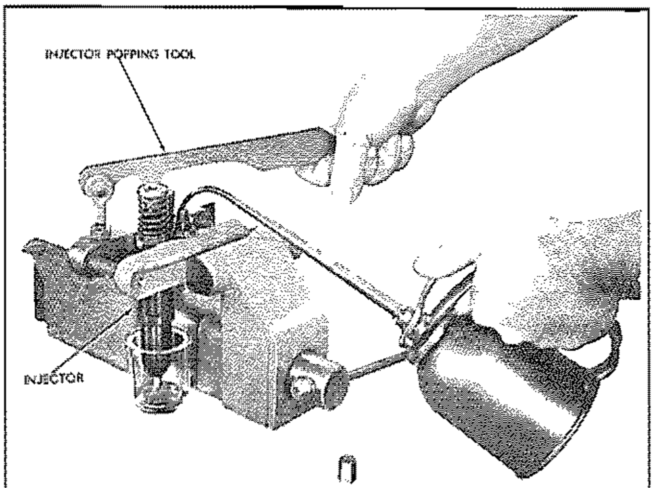


Fig. 24—"Popping" the Injector

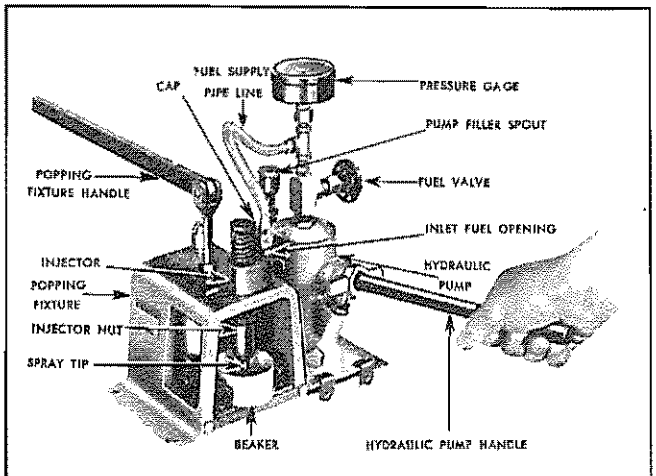


Fig. 25—Pressure Testing Injector

2. Pressure test of the injector requires the use of a test fixture similar to that shown in Fig. 25. The injector is installed in the stand of the fixture and a fuel line from the hydraulic pump is connected to the injector. A pressure gage of the fixture registers the pressure required to spray fuel from the injector spray tip. Check the injector "popping" pressure by working the hydraulic pump handle up and down with smooth even strokes, at the same time observe the pressure gage and note at what pressure the injector valves open. This pressure should be between 1000 and 1500 pounds per square inch for the 55 cu. mm. injectors and between 750 and 900 pounds per square inch for the 70 cu. mm. injectors.

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

   Fuel leaking from around 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 of the injector by pumping the hydraulic handle and "popping" the injector sharply, then close the fuel valve between the pump and the pressure gage, and note the pressure drop indicated by the gage. When checking the pressure drop for a 55 cu. mm. injector, 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. When checking the pressure drop for the 70 cu. mm. injectors, a drop not to exceed 200 pounds (from 750 to 550) 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, disassemble and inspect.

I. Injector Installation

1. With the engine hood and the rocker cover removed, inspect the injector copper tube located in the cylinder head to be sure that no dirt, grit, or oil is present which will prevent the injector from making a tight seal in the copper tube. Insert the injector into the copper tube in the cylinder head, aligning the dowel in 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 injector control rack with the control rack lever.

2. Place the injector clamp on the injector clamp stud and center the side arms of the clamp in the machined recesses of the injector body. Drop the injector clamp washer over the stud, with the "dished out" side of the washer down. Tighten the injector clamp nut to a torque of 20 to 25 pounds feet.

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

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 from the fuel pipe connectors and install the injector fuel lines. Check the

adjustment of the valve rocker arms (refer to "VALVE ADJUSTMENT" in Section IX). Start the engine and inspect the fuel line connections to be sure that there are no fuel leaks.

5. Install the rocker cover, engine hood, and the air pre-cleaner.

J. Injector Timing

1. General

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

The model HD-9B and HD-9F tractors are equipped with 55 cu. mm. fuel injectors which require that the top of the injector plunger follower be set 1.484 inches above the injector body so that the fuel will be injected into the cylinders at the proper time.

The model HD-9G tractors prior to Serial No. 2698 are also equipped with 55 cu. mm. fuel injectors which require the same setting as given above for the HD-9B and HD-9F tractors. However, effective with HD-9G Serial No. 2698, all HD-9G tractors are equipped with 70 cu. mm. fuel injectors which require that the top of the injector plunger follower be set 1.460 inches above the injector body so that the fuel will be injected into the cylinders at the proper time.

2. To Time Fuel Injectors

a. With the engine stopped, remove the air pre-cleaner, engine hood, and rocker cover.

b. Make certain that the engine shut-off knob is pulled back to the "OFF" position. Rotate the engine with the starter until the two exhaust valve rocker arms for the same cylinder are down and the valves are fully opened.

c. Use the correct timing gage (gage stamped 1.484 for 55 cu. mm. injectors and stamped 1.460 for 70 cu. mm. injectors) and place the timing gage in the hole in the injector body. Make certain that the shoulder at the bottom end of the gage rests on the injector body and that the gage is not held up by dirt in the hole. Turn the gage so that the extended head (flat portion) of the gage is toward the injector plunger follower.

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

e. Tighten the injector push rod lock nut and recheck to be sure the timing was not changed by tightening the lock nut. Install the rocker cover, engine hood, and the air pre-cleaner.

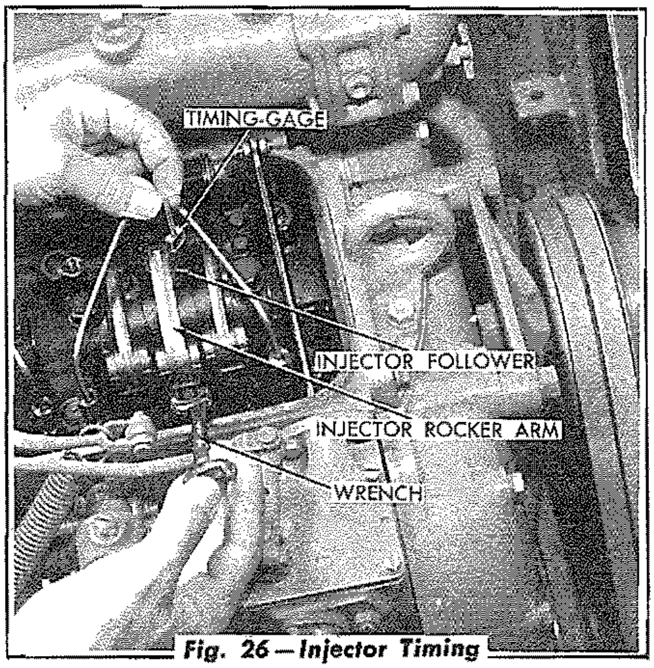


Fig. 26 — Injector Timing

K. Injector Equalizing

1. General

Equalizing of the fuel injectors consists of adjusting the injector rack control levers so that an equal amount of fuel is delivered to each cylinder. The greatest amount of fuel is injected into the cylinders when the injector control 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.

2. To Equalize Fuel Injectors

a. With the engine stopped, remove the air pre-cleaner, engine hood, and the rocker cover.

b. Make certain that the injectors are properly timed and that the linkage for the governor and the engine controls are properly adjusted (refer to "ENGINE CONTROLS AND GOVERNOR" in Section VI).

c. Loosen both adjusting screws on all of the rack control levers. Be sure the screws do not bind, that the levers are free on the rack control tube, and the tube rotates freely in its bearings.

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

e. Push the control tube lever toward the water manifold as far as possible and hold it firmly in that position.

f. Use a medium sized screwdriver and turn down the inner adjusting screw on the No. 1 rack control lever until the No. 1 injector control rack moves in as far as it will go. At this point a slight pressure will be felt on the control tube lever. Roll the screwdriver back and forth with the finger tips to set the screw at the exact point where pressure starts (control rack just "bottoming" in injector — full open position).

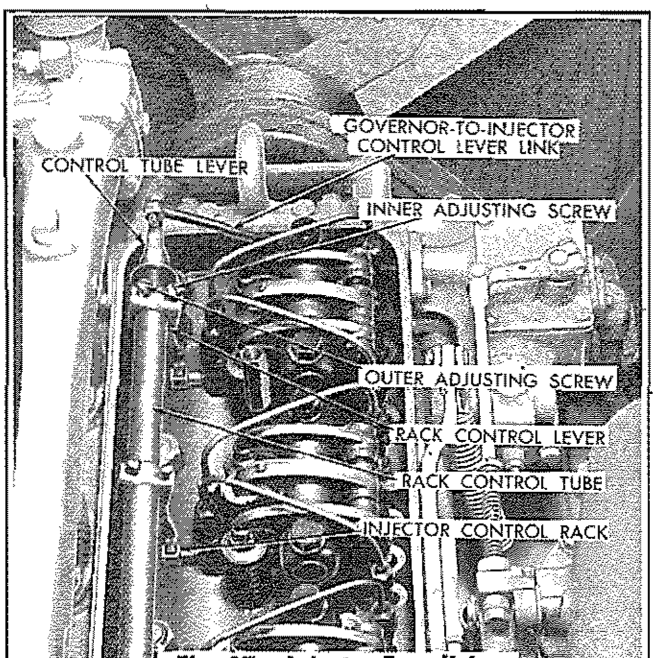


Fig. 27 — Injector Equalizing

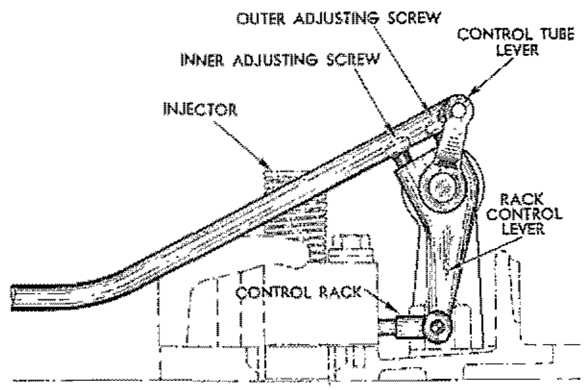


Fig. 28 — Injector Control Rack

g. Repeat this process on the remaining injector control racks.

h. Still holding the control tube lever firmly, as in step e., check each injector control rack to see that none have been missed in making the adjustments and that each rack is gently held in the full open position.

i. Now tighten each outer adjusting screw to lock the rack control levers in place on the control tube. This will also move the injector control racks outward a few thousandths of an inch to prevent "bottoming" of the injector control racks in the injectors during full load operation of the engine.

j. Install the rocker cover, engine hood, and the air pre-cleaner.

7. INJECTOR COPPER TUBES

A. Description

As will be seen by referring to Fig. 12, the bore in the cylinder head for each injector is directly through the water jacket of the head. To prevent the engine coolant from contacting the injector, a copper tube, shaped to receive the injector, is installed in the injector bore of the cylinder head. This tube is sealed at the top with a 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. Injector Copper Tube Removal

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

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

2. Remove the rocker shafts, rocker shaft brackets, and unscrew the rocker arms from the push rods. Remove the exhaust valves (refer to "EXHAUST VALVES AND OPERATING MECHANISM" in Section IX).

3. Remove the fuel 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 special tap down into the upper end of the copper tube as shown in Fig. 30. Remove the tap.

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

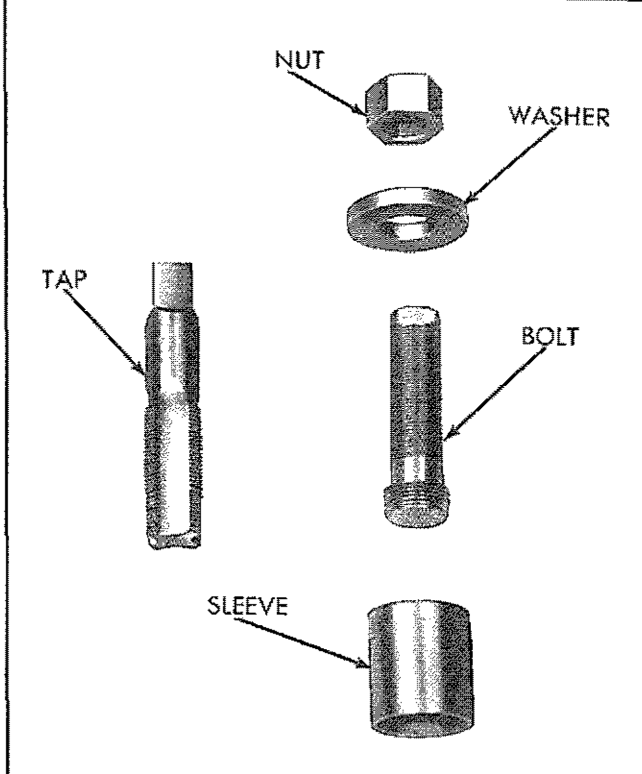


Fig. 29 — Remover Tools for Injector Copper Tube

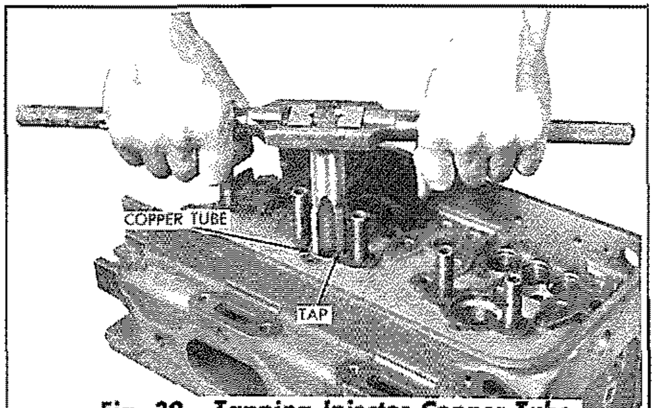


Fig. 30 — Tapping Injector Copper Tube

C. Injector Copper Tube Installation

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

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

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

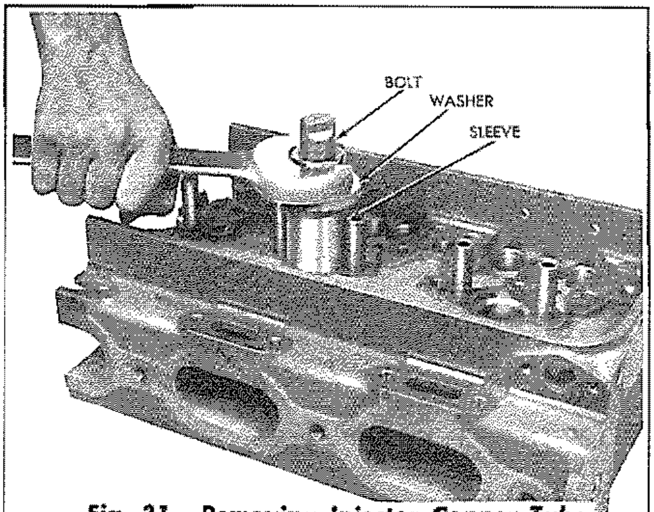


Fig. 31 — Removing Injector Copper Tube

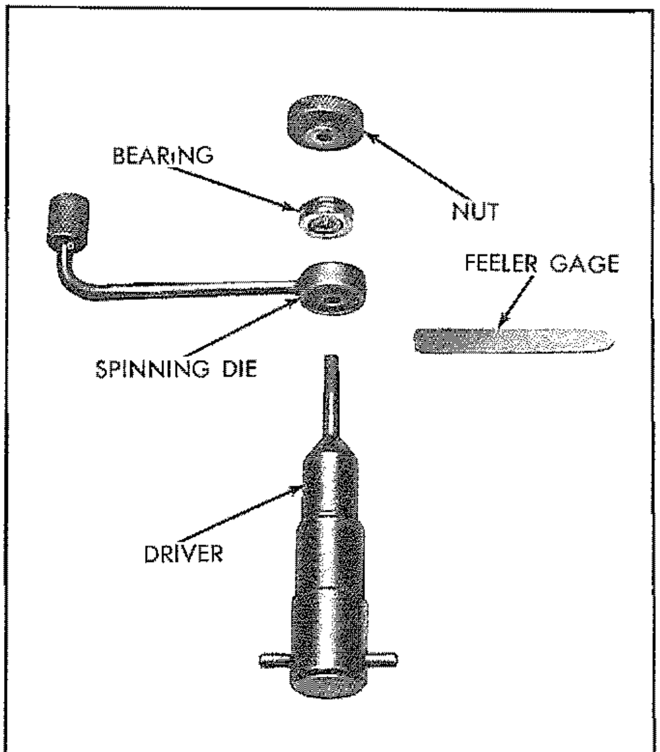


Fig. 32 — Injector Copper Tube Flaring Tool

4. After the copper tube has been driven into place, the lower end of the tube must be flared out to lock in place. Use the driver, spinning die, and nut for this operation 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 driver 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. 33.

   c. Install the bearing above the spinning die and start the nut.

   d. While maintaining 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. 33, then, with 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. Remove the copper tube flaring tools.

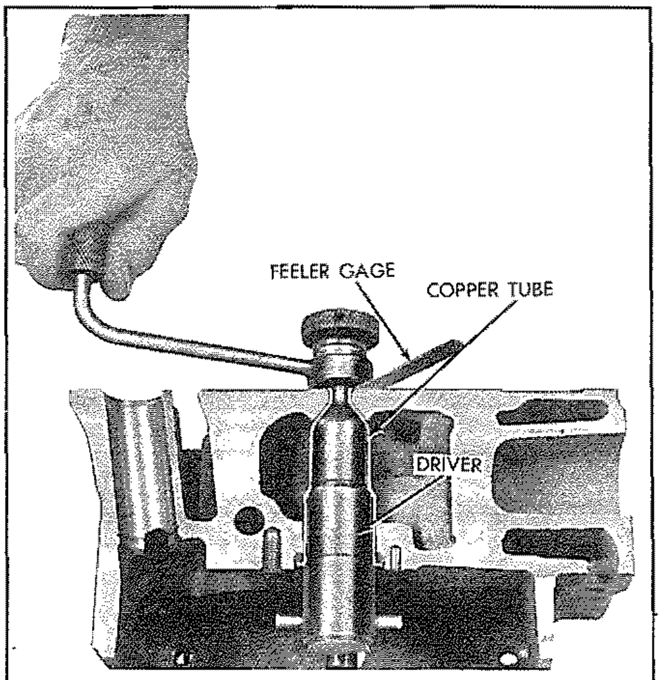


Fig. 33 — Flaring End of Injector Copper Tube

5. The injector copper tube must now be reamed; first, to receive the injector nut and the spray tip; and second, for good seating of the bevel on the lower end of the injector nut. Reaming the copper tube to its proper

size for the injector nut and the spray tip is accomplished by the use of the reamer illustrated in Fig. 34. Reaming the bevel seat in the copper tube is accomplished by use of the bevel seat reamer shown in Fig. 35 as follows:

a. Insert the injector copper tube bevel seat reamer into the tube and place the reamer feed plate and the block in position on the cylinder head as illustrated in Fig. 35. Install the feed screw of the tool directly over the center of the reamer.

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

c. Using cutting compound consisting of equal parts of cutting oil and kerosene, ream the bevel seat in the copper tube for the injector nut so that the shoulder of the injector spray tip will be flush with the bottom surface of the cylinder head (Fig. 36). Check the depth of the cut during the reaming operation by installing an injector in the copper tube and taking measurements.

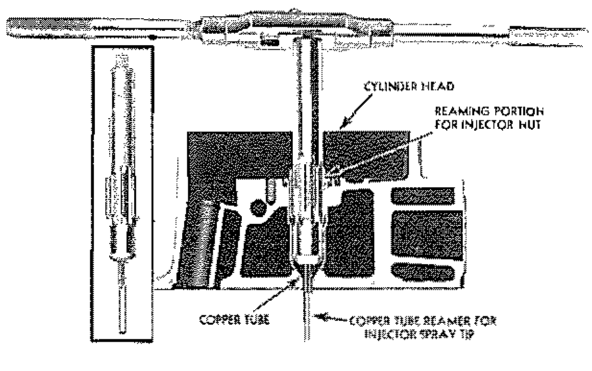


Fig. 34 — Reaming Copper Tube for Injector Nut and Spray Tip

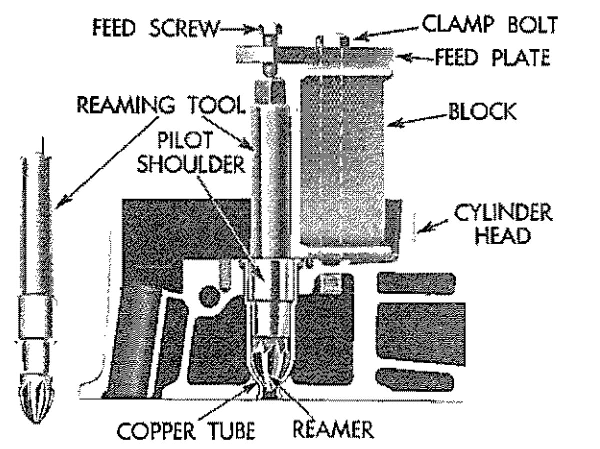


Fig. 35 — Reaming Bevel Seat in Injector Copper Tube

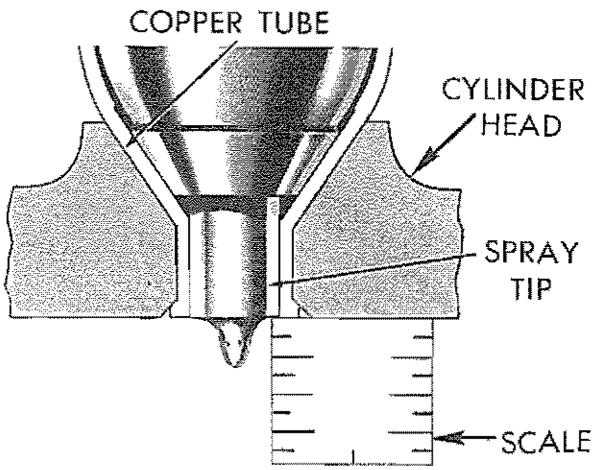


Fig. 36 — Checking Location of Injector Spray Tip.

8. FUEL MANIFOLDS

A. Description

Fuel is supplied to the fuel 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 fuel return manifold (upper of the two manifolds) returns the excess fuel from the injectors through tubing back to the fuel tank. Pressure is maintained in the fuel system by a restricted fitting, located at the rear of the fuel return manifold. Both manifolds are locked in position in the cylinder head by fuel connectors which assemble into tapered seats in the manifold fittings.

B. Service

Since the fit of the tapered lower ends of the fuel connectors in the fuel manifold fittings is the only connection between these parts, prevention of fuel leaks at this point depends on good contact surfaces, and on the fuel 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 fuel leak occurs, remove the injector fuel lines in line with the leaking fuel connector, then loosen the lock nut on the fuel connector and test it to see if the connector is tight.

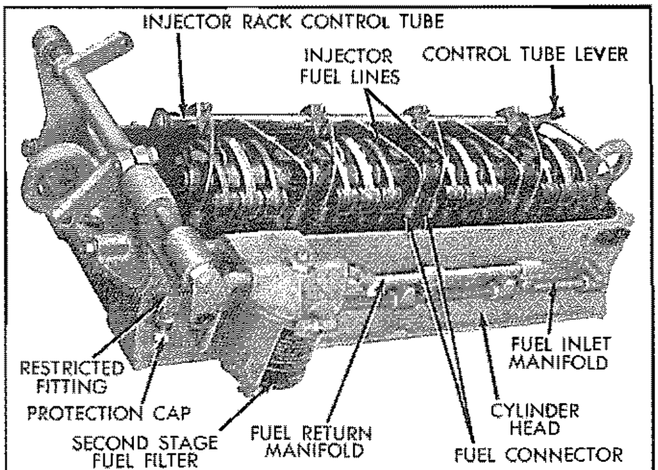


Fig. 37 — Cylinder Head and Fuel Manifolds

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

C. Removal of Fuel Manifolds

Refer to Fig. 38 for relative location of parts. Either manifold may be removed separately and without removing the cylinder head from the engine.

1. Remove the air pre-cleaner and the engine hood.
2. Clean off the rocker cover, right side of the cylinder head, and the governor control housing.
3. Remove the rear fuel line of each pair of injector fuel lines if the fuel return manifold is to be removed, or the front fuel lines if the fuel inlet manifold is to be removed. Remove all injector fuel lines if both fuel manifolds are to be removed. Cover the injector fuel fittings with shipping caps to prevent the entrance of dirt while lines are removed.
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 fuel manifold to be removed.
6. Loosen the lock nuts on the fuel connectors in contact with the fuel manifold to be removed and remove the fuel connectors.
7. Remove the fuel manifold, being careful not to bind the tee connectors of the manifold in the cylinder head.

D. Installation of Fuel Manifolds

The fuel manifolds are installed by reversing the sequence of operations for their removal. Refer to Fig. 38 and note that the tee connectors on the fuel manifolds which are inserted into the cylinder head are on the top side of the fuel inlet manifold and on the bottom side of the fuel return manifold. The fuel manifolds are not interchangeable, due to

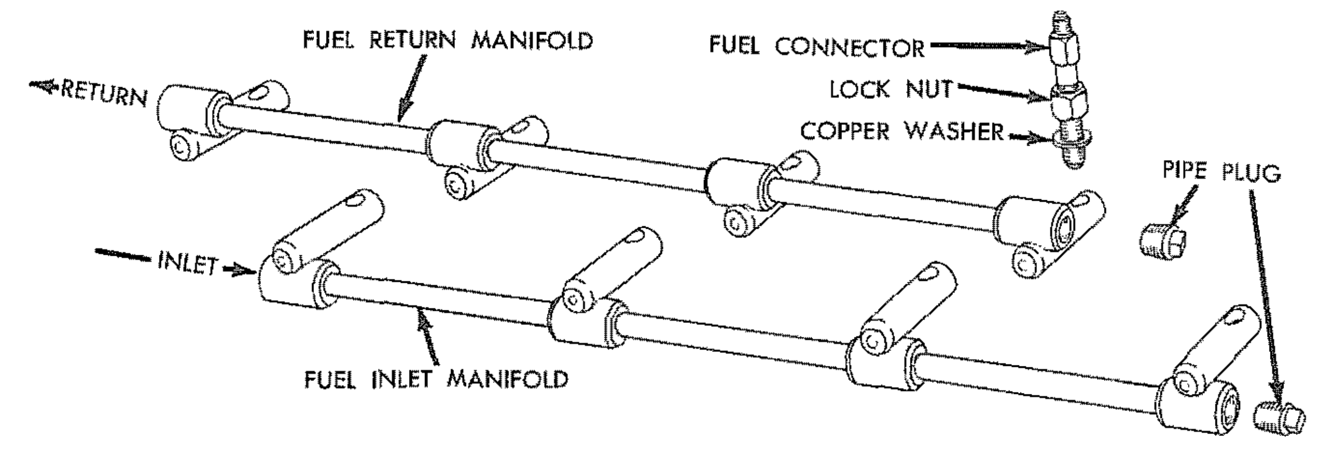


Fig. 38 — Fuel Manifold Details

the location of the tapered seats in the tee connectors. To install, proceed as follows:

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

2. Guide the tee connectors of the fuel manifolds into the openings in the side of the cylinder head, so that the tapered seats are in approximate alignment with the holes in the top of the cylinder head for the fuel connectors.

3. Centralize the tee connectors of the manifolds with fuel connectors by alternately turning the connectors and moving the manifold. This is an important operation and is necessary to assure 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 onto 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 fuel 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 of the fuel manifolds and install the governor control housing.

7. Before installing the rocker cover, run the engine and check all fuel line connections for leaks. Correct any leaks that are evident. Install the rocker cover, engine hood, and the air pre-cleaner.

SECTION III—ENGINE AIR INTAKE SYSTEM

1. DESCRIPTION OF SYSTEM

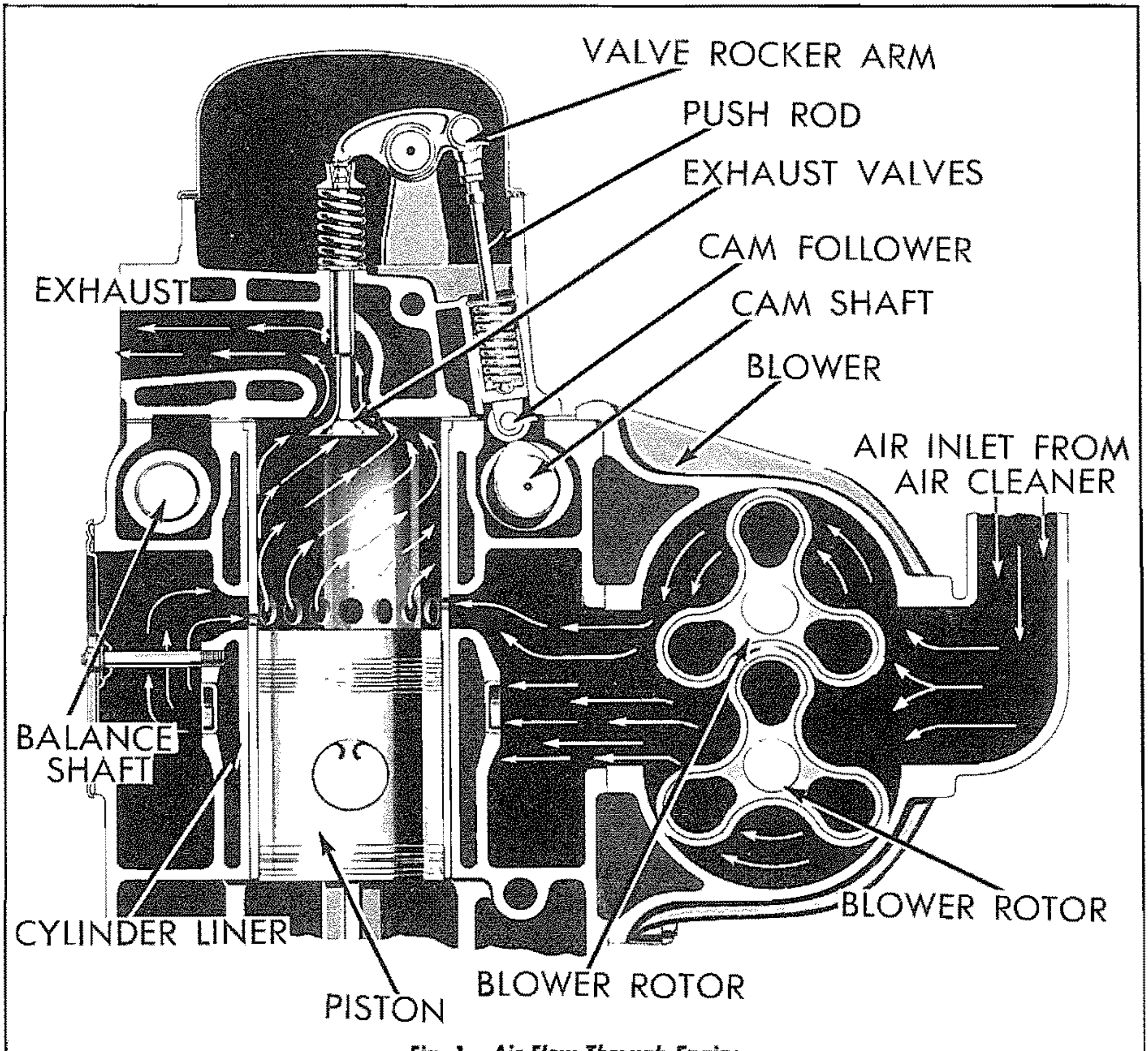


Fig. 1 — Air Flow Through Engine

The engine air intake system includes the air pre-cleaner, air cleaner, air shut-off valve, cylinder block air box, and the blower. The blower supplies the fresh air needed for combustion of fuel in the cylinders and for scavenging burned gases from the cylinders. The air, drawn from the atmosphere by the blower, passes through the air pre-cleaner and the air cleaner 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 was delivered to the engine uncleaned, the dust particles would cause rapid wear on pistons, cylinder liners, and other engine 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 in the cylinder liners are uncovered by the pistons and the exhaust valves are opened, fresh air rushes through the ports and into the cylinders to scavenge the exhaust gases and to supply the cylinders 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 within the cylinders is absorbed by the pistons and the cylinder walls. This heat loss and the reduced cranking speed may reduce the temperature of the air in the cylinders to a point too low to ignite the fuel. A Cold Weather Engine Primer is provided as an aid for starting the engine in cold weather. The Cold Weather Engine Primer is provided to inject starting fluid (ethyl ether) into the blower air intake housing. The starting fluid injected into the blower air intake housing is then picked up by the blower and is blown into the cylinders. Since the starting fluid is highly combustible, and has a low ignition point, it is easily ignited by the compression in the cylinders.

An air box drain tube is provided for drainage of fuel that might leak into the cylinder block air box and would otherwise be drawn into the cylinders with the air. The drain tube is located approximately in the center of the left hand side of the cylinder block.

2. AIR PRE-CLEANER

A. Description and Purpose

The air pre-cleaner is of the centrifugal type and consists of a body and shell assembly. Fins in the air pre-cleaner body are located at an angle to give the incoming air a swirling motion; this causes the heavy particles of dust to be thrown to the outside of the air pre-cleaner shell and deposited therein. All large particles of dust, as well as leaves and other like material, are thus removed from the air before it enters the air cleaner. The level of the dust collected in the air pre-cleaner shell is visible through an inspection glass, located in the shell assembly.

B. Air Pre-Cleaner Service

The air pre-cleaner shell must be emptied whenever the dust level reaches half-way up on the inspection glass. Remove and clean as follows:

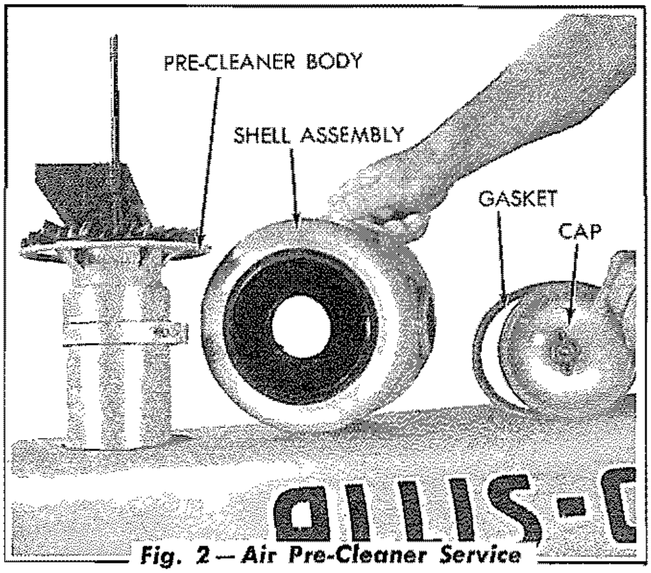


Fig. 2—Air Pre-Cleaner Service

1. Unscrew the wing nut and remove the cap from the shell. Lift the shell from the pre-cleaner body.

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

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

3. AIR CLEANER

A. Description

The air cleaner consists of a cylindrical body packed to a prescribed density with rust-proof metallic matting and has an oil cup suspended on the lower end of the body. This oil cup is filled to a specified level with engine lubricating oil. A pipe extends down through the center of the cleaner body and into the oil cup. The air pre-cleaner is mounted on the upper end of this pipe. After passing through the air pre-cleaner, the air enters the air cleaner through the pipe extending down through the center of the air cleaner body and into the oil cup. As the air is drawn through the air cleaner, a portion of the oil in the oil cup is drawn up into the screen mats and the air passes on through the mats to the blower. The oil with which the mats are saturated, collects the dust from the air, and, in dripping back into the oil 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, the oil cup must be removed, cleaned, and refilled with new oil and the air cleaner pipe swabbed out. Dirt mixed with the oil will collect inside the pipe and if it is not removed, will in time restrict the flow of air, resulting in an insufficient supply of air to the engine. A damaged hose, loose hose clamp, damaged blower gasket, or leak of any kind that allows air to enter the cylinders without first passing through the air cleaner, will defeat the purpose of the air cleaner, and MUST be corrected at once. Periodic inspection of the above parts and of the air cleaner body for dents, cracks, loosened solder connections, etc., should be made frequently. If any of the above mentioned

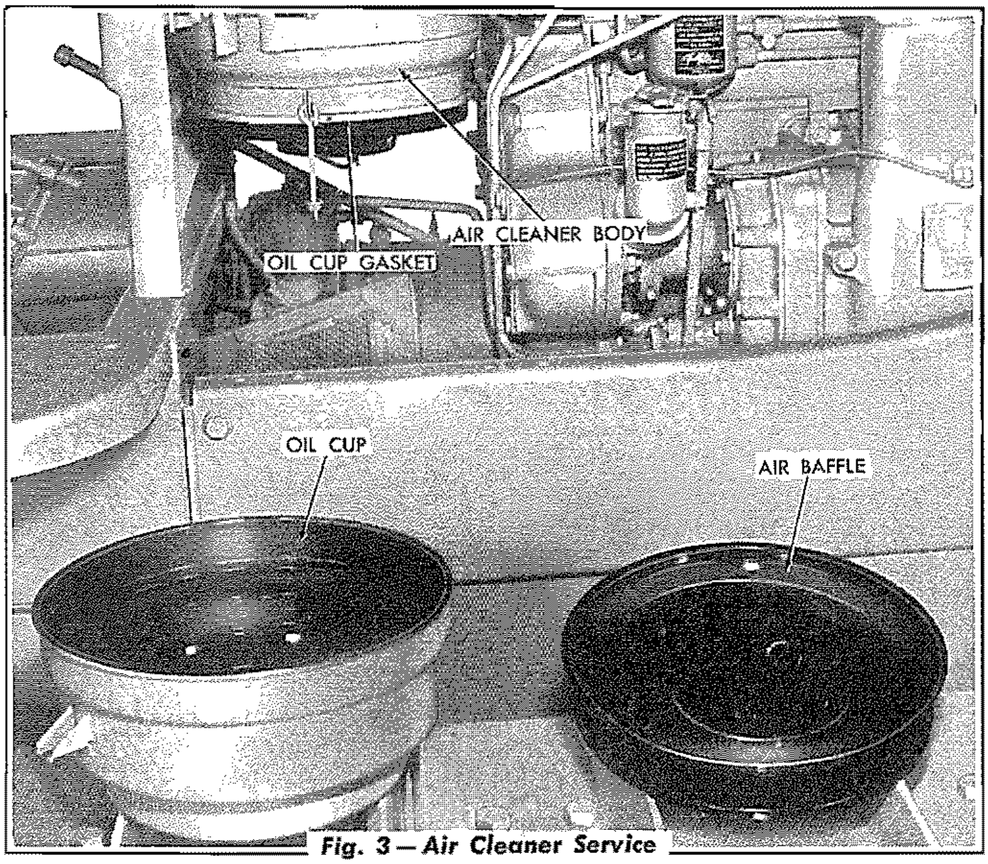


Fig. 3 — Air Cleaner Service

conditions are found they MUST be corrected immediately.

Remove the oil cup daily (more often if operating in extremely dusty conditions) to check the oil level in the cup and to determine the condition of the oil. Empty and wash the oil cup whenever the oil becomes discolored, indicating a quantity of dirt has collected, then refill with clean oil. Keep the oil cup filled to the top of the cone in the center of the air baffle in the cup. CAUTION: *DO NOT OVERFILL.* Use the same viscosity oil in the air cleaner as is used in the engine crankcase at prevailing temperatures (refer to "SPECIFICATIONS OF LUBRICANTS," Section I). 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.*

Service the Air Cleaner as Follows:

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

2. Wash the air baffle and the oil cup thoroughly with clean fuel or solvent. Remove the air pre-cleaner from the top of the air cleaner and swab out the air cleaner pipe. Install the air pre-cleaner assembly.

3. Install the air baffle in the oil cup and fill the cup to the proper level with clean oil. Be sure that the gasket above the oil cup is in good condition. Install the cup on the bottom of the air cleaner body.

4. Once or twice a year remove the air cleaner from its mounting. Remove the oil cup and immerse the cleaner in a tub of clean fuel, or non-combustible cleaning solvent, and rinse the dirt from the air cleaner filter mats. Allow the air cleaner to dry thoroughly before installing.

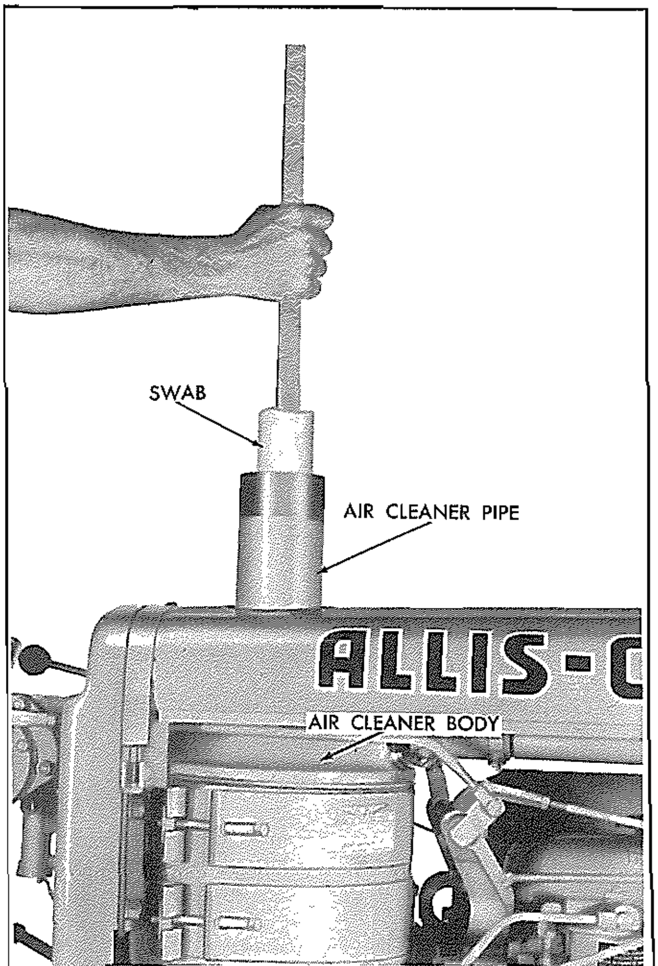


Fig. 4 — Swabbing Air Cleaner Pipe

C. Air Cleaner Removal

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

2. Loosen the hose clamps on the air cleaner hose attaching the air inlet elbow to the air cleaner. Move the hose forward onto the air inlet elbow.

3. Loosen and remove the air cleaner mounting bands and remove the air cleaner.

D. Air Cleaner Installation

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

4. AIR INLET ELBOW AND AIR SHUT-OFF VALVE

A. Description

The air inlet elbow, located above the blower air intake housing (Fig. 5), contains an engine air shut-off valve assembly. This is a butterfly type valve and is manually controlled by the engine shut-off control rod. When the engine shut-off rod knob is pushed all the way in, the air shut-off valve is opened and the air can pass through the air inlet elbow to the blower. When the engine shut-off rod knob is pulled all the way back, the air shut-off valve is closed and the air supply to the engine is shut off. This air shut-off valve also serves as an emergency engine shut-off device. If for some reason fuel collects in the cylinder block air box, speeding up of the engine will cause this fuel to be drawn from the air box and 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 shut-off valve which shuts off the supply of air necessary for combustion of fuel.

B. Removal, Disassembly, and Inspection

1. Remove the air shut-off lever spring and spring hook. Remove the cotter pin and the plain washer from the air shut-off valve swivel lever pin, located at the front end of the engine shut-off front rod. This swivel lever attaches the engine shut-off front rod to the air shut-off valve lever. Push the engine shut-off front rod toward the engine rocker cover to uncouple the swivel lever pin from the air shut-off valve lever.

2. Loosen the two (2) hose clamps on the air cleaner hose and move the hose onto the air inlet elbow.

3. Remove the capscrews attaching the air inlet elbow to the blower air intake housing. Remove the air inlet elbow. NOTE: *Cover the opening in the blower air intake housing after removing the air inlet elbow.*

4. Remove the bolt used to clamp the air shut-off valve lever to the air shut-off valve shaft and remove the lever. Remove the locking wire from the screws used to attach the air shut-off valve in place in the shaft, then remove the screws and the air shut-off valve.

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

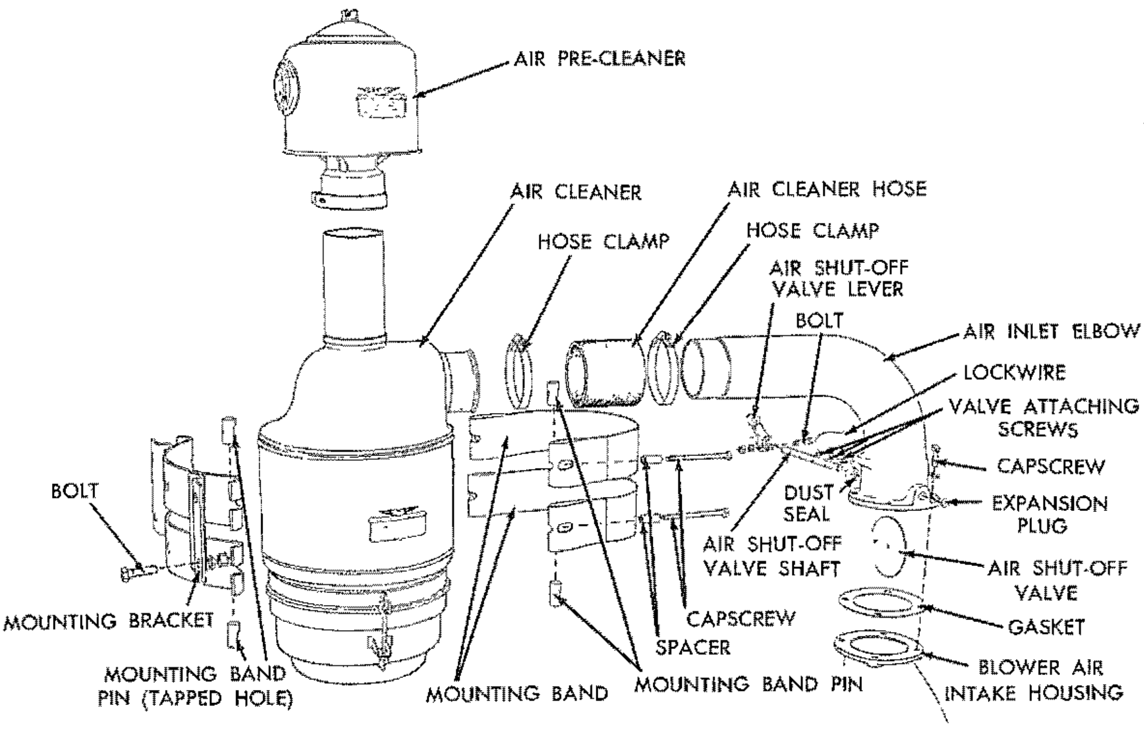


Fig. 5 — Air Cleaner, Air Inlet Elbow, and Air Shut-Off Valve Details

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

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 position in the slot of the shaft and install the attaching screws. Lock the screws with a lockwire.

3. Install a new shaft dust seal in the air inlet elbow, with the lip of the seal toward the lever end of the shaft. Install the air shut-off valve lever on the shaft and install and tighten the bolt securely.

4. Install the expansion plug in the outer side of the air inlet elbow if the plug has been removed. Make certain that the expansion plug fits tightly in the elbow.

5. Examine the air inlet elbow gasket and make certain that it is in good condition. Coat each side of the gasket with gasket cement or sealing compound, and install it in place on the blower air intake housing.

6. Place the air inlet elbow in position on the blower air intake housing and install the attaching capscrews and lockwashers.

7. Move the air cleaner hose into its proper position on the air cleaner and the air inlet elbow and secure the hose with the hose clamps. CAUTION: *It is of the utmost importance that the air cleaner hose forms a tight seal and is not crimped when installed, otherwise, air will be drawn into the system without first passing through the air precleaner and the air cleaner.*

8. Insert the air shut-off valve swivel lever pin, located on 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. Install the air shut-off lever spring and the spring hook.

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

10. Install the engine hood and the air precleaner.

5. BLOWER

A. Description

The blower supplies the air needed for combustion and for scavenging the cylinders 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 the blower 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 air intake housing from the air cleaner is picked up by the rotor 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 box of the cylinder block, when the engine is operating at its maximum speed. As the piston uncovers the air ports of the cylinder liner, the air sweeps through the air ports and into the cylinder. The angle of the air ports in the cylinder liner imparts a swirling motion to the air as it enters the cylinders.

Two timing gears on the drive ends of the blower rotor shafts space the rotor lobes with a slight clearance. Thus, because the rotor lobes do not touch each other at any time, they require no lubrication. Lip type oil seals prevent air leakage at the ends of the rotor shafts and also prevent oil, used for lubricating the timing gears and the rotor shaft bearings, from entering the rotor compartment 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 the 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 by the doweled end plates of the blower housing by a roller bearing at the front end, and a two-row, pre-loaded, radial and thrust ball bearing at the rear end.

The blower timing 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 camshaft pockets, it overflows through a hole at each end of the blower housing, providing lubrication for the blower 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 crankcase 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 rotor lobes and also between rotors 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 located on 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 after every 1,000 engine operating 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 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 material having been drawn through the blower, thereby scoring the rotor lobes and the 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, between rotors and the end plates, and between the rotors and the 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, 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 intake 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 will raise burrs around such abrasions. If such burrs cause interference between the rotors, or between the rotors and the housing, the blower should be removed and the parts dressed to eliminate the interference. The rotors must be replaced if they are badly scored.

2. LEAKY OIL SEALS. Leaky rotor shaft oil seals are usually indicated by the presence of oil on the blower rotors or on the inside of the rotor housing. Oil on the rotors can also be a result of oil pull-over from the air cleaner; 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 blower end plates for a thin film of oil which will radiate away from a leaky oil seal. (Refer to Fig. 10 for location of rotor shaft oil seals). CAUTION: *Do not attempt this inspection when there is excessive dust in the air as there will be no air cleaner protection with the blower air intake housing removed.*

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 should have a springing action. When released, the rotors should move back at least 1/4". The blower drive coupling should be inspected if the rotors cannot be moved as above, if the rotors move freely without a springy feel, or if they can be rattled. If the inspection shows the blower drive coupling to be worn, the blower drive must be removed for repairs or replacement (refer to "BLOWER DRIVE ASSEMBLY" in this Section).

4. LOOSE ROTOR SHAFTS OR WORN ROTOR SHAFT 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 blower end plates, or between the rotors and the housing. Usually a combination of these conditions exists.

   A loose rotor shaft usually causes contact between the rotors and the blower end plates. Worn rotor shaft bearings will cause contact between the mating rotor lobes at some point, or may allow the rotors to contact the blower housing. This condition will usually be noted on the end of the rotors at which the rotor shaft bearing has failed. Excessive backlash in the blower timing gears usually results in the rotor lobes contacting throughout their entire length.

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

C. Blower Removal

1. Remove the right front fender. Drain the engine cooling system.

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

3. Remove the breathing pipe 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 elbow located in the water pump body cover.

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

6. Close the fuel tank shut-off valve and disconnect the two (2) 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 intake housing. Disconnect the engine primer line from the primer elbow, located in the blower air intake housing.

9. Remove the capscrews attaching the blower air intake 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) toward 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, then pull the covers from the dowels. CAUTION: *Do not pry between the end plate covers and the end plates as damage to the gasket surfaces may result.*

2. Remove the socket-head capscrew from the center of the water pump drive coupling, located at the front end of the lower rotor shaft, and withdraw the water pump drive coupling from the rotor shaft.

3. Remove the three (3) capscrews attaching the blower rotor driving hub plate assembly to the gear on the upper rotor shaft and remove the rotor driving hub and plate assembly as a unit.

4. Unlock and remove the capscrew and washers at the center of each blower gear. NOTE: *The fuel pump coupling disc will be removed with the lower capscrew.*

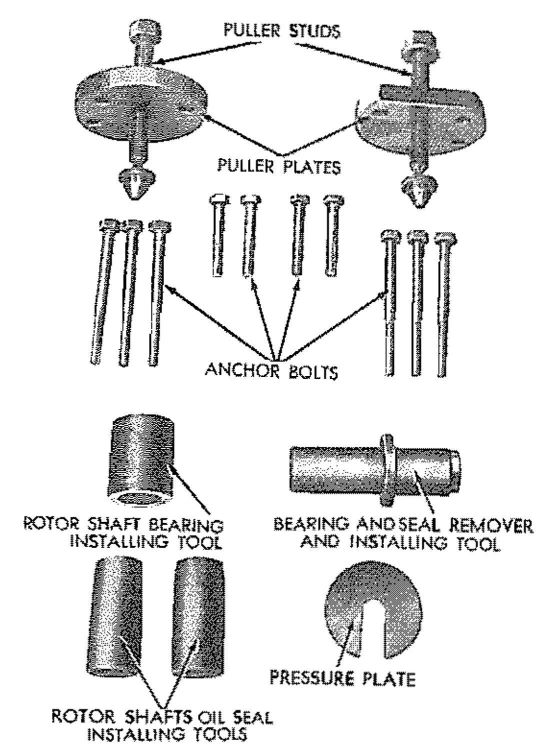


Fig. 6 — Blower Special Tools

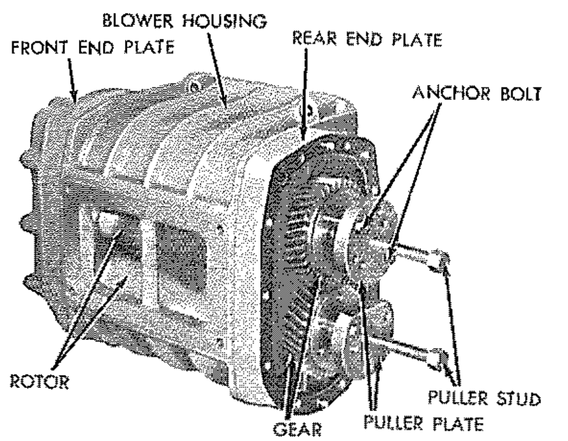


Fig. 7 — Pulling Blower Gears from Rotor Shafts

5. Pull the blower gears from the rotor shafts. NOTE: *These two gears must be pulled from the rotor shafts at the same time, using the special puller studs and plates as shown in Figs. 6 and 7.*

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

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

   c. Place a cloth between the gears to prevent them from turning. Turn the two puller studs clockwise uniformly until the gears are withdrawn from the rotor shafts. In most cases, shims will be found on each rotor shaft in back of the gears. Wire these shims (removed from each shaft) to their respective gears so that they may be reinstalled in their respective location when the blower is reassembled.

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

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 rotor shaft rear bearings, then withdrawing the rotors (still assembled in the other end plate) from the housing.

   a. Remove the two (2) fillister-head screws from the front end plate. Loosen the two (2) fillister-head screws in the rear end plate about one turn.

   b. Use the same puller studs and puller plates as used to pull the gears. Install three anchor bolts in the three equally spaced holes in each puller plate (as shown in Fig. 8) and turn the anchor bolts into the holes from which the rear bearing retainer capscrews were removed. Turn the anchor bolts into the end plate so that the faces of the puller plates are parallel with the face of the blower.

   c. Turn the two (2) puller studs clockwise and uniformly until the rotor shafts are free from the rotor shaft rear bearings.

   d. Remove the puller plates from the rear end plate, remove the two (2) fillister-head screws, and remove the rear end plate. Withdraw the rotors and the front

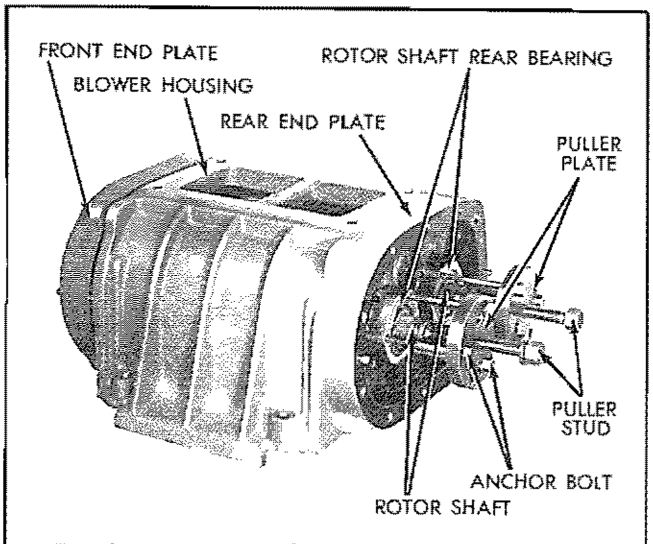


Fig. 8 — Removing Blower End Plates and Rotors

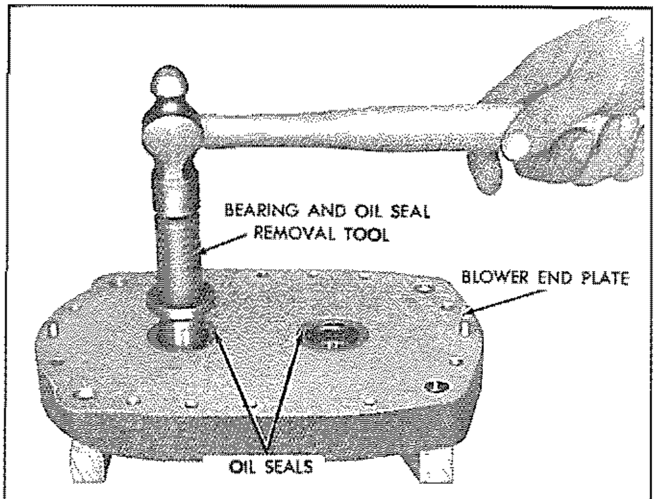


Fig. 9 — Removing Rotor Shaft Bearing from End Plate

end plate assembly as a unit from the blower housing. Assemble the puller plates on the front end plate and press the rotor shafts out of the rotor shaft front bearings in the same manner as the shafts were pressed out of the rotor shaft rear bearings.

8. Remove the rotor shaft bearings from the blower end plates by using a bearing remover tool as shown in Fig. 9. Insert the bearing remover 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 (2) inches high and drive the bearing out of the end plate. Follow the same procedure and remove all four (4) bearings.

9. Remove the rotor shaft oil seals from the blower end plates. The oil seals may be removed from the end plates at the same time that the bearings were removed by continuing to drive down on the remover tool shown in Fig. 9; the collar of the remover tool will contact the oil seal and drive it out of the end plate.

E. Inspection of Blower Parts

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

1. Wash the rotor shaft bearings by rotating them in a pan of clean solvent or fuel until they are free from grease and oil. Blow the dirt and fuel from the bearings with dry compressed air, while rotating the bearings by hand. CAUTION: *Do not spin the bearings with air pressure.* Repeat the cleaning operation until all foreign substance has been removed. After cleaning, thoroughly lubricate the bearings with clean engine oil and rotate them by hand to inspect for roughness. The double-row bearings used at the rear of the rotors are pre-loaded and have no end play; in fact a new double-row bearing will seem to have considerable resistance to motion when revolved by hand. Due to blower rotor expansion and contraction in relation to temperature during engine operation, the roller bearings used at the front of the 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 rotor shaft bearings are discolored instead of having brightly polished surfaces, the bearings have probably been overheated 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 the rotor shaft oil seals in the end plates, with the en-

gine running, was described previously in "LEAKY OIL SEALS." If the sealing lip of the oil seal is scored or damaged so that a tight seal on the rotor shaft cannot be obtained, or the sealing lip of the seal 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 rotor lobes for smoothness and the bearing surfaces for wear and burrs. The serrations in the ends of the rotor 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 with a file and emery paper and reinstalled, provided 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 (refer to "BLOWER CLEARANCE CHART," Fig. 16).

5. As stated in the preceding paragraph and shown in Fig. 16, the rotors must revolve inside 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 ROTOR SHAFT OIL SEALS IN END PLATES. Lubricate the oil seals with engine oil and install the oil seals in the end plates, with the flat face of the oil seals flush with the inner face of the end plates and with the

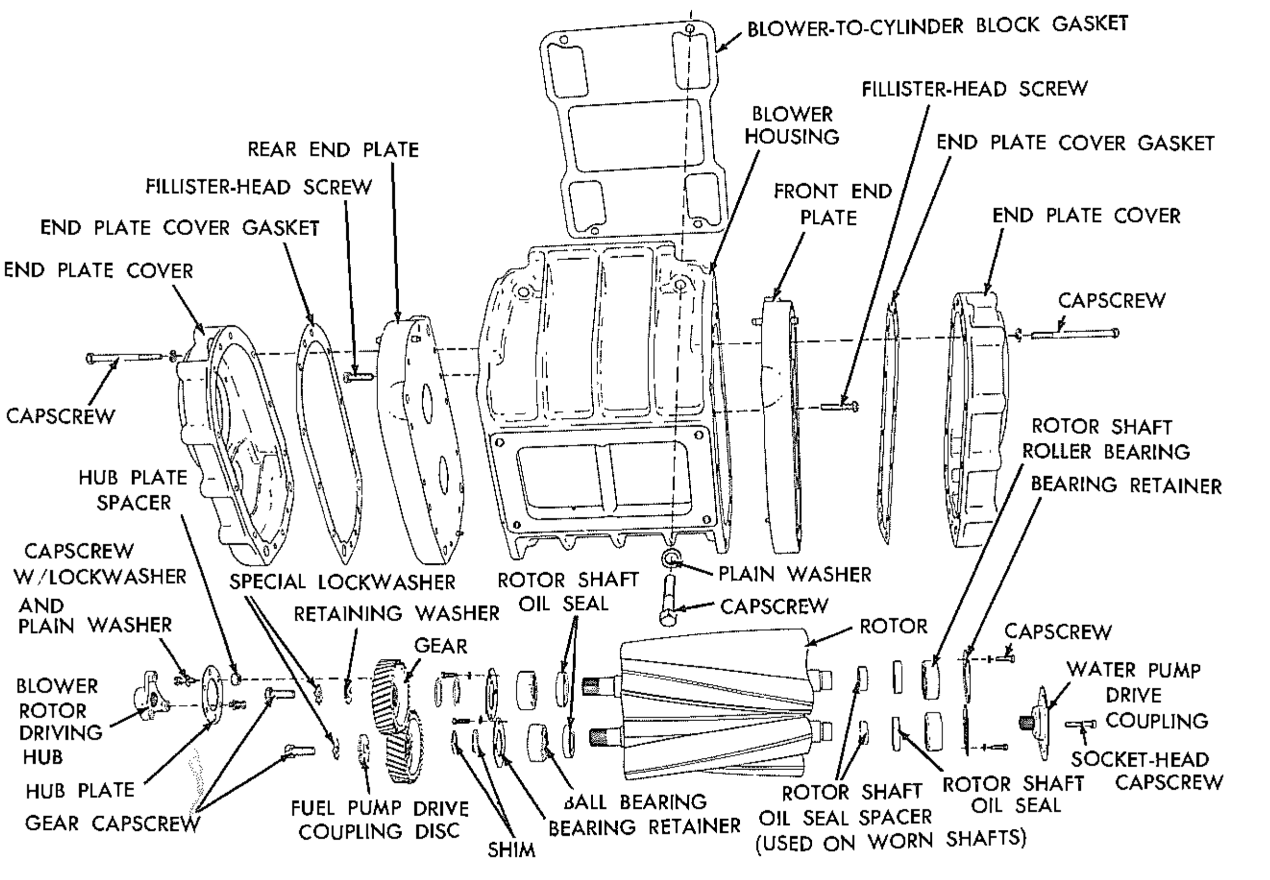


Fig. 10 – Blower Details

sealing lips of the seals pointing away from the inner faces of the end plates. Install each of the four (4) oil seals as follows:

a. Clamp the end plate between soft jaws in a vise. Use one of the puller plates and a puller stud used in disassembling the blower, and a slotted pressure plate to press the oil 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 an oil seal in position to enter the end plate, and install the slotted pressure plate over the puller stud and against the oil seal. Turn the puller stud clockwise to force the oil seal into the end plate.

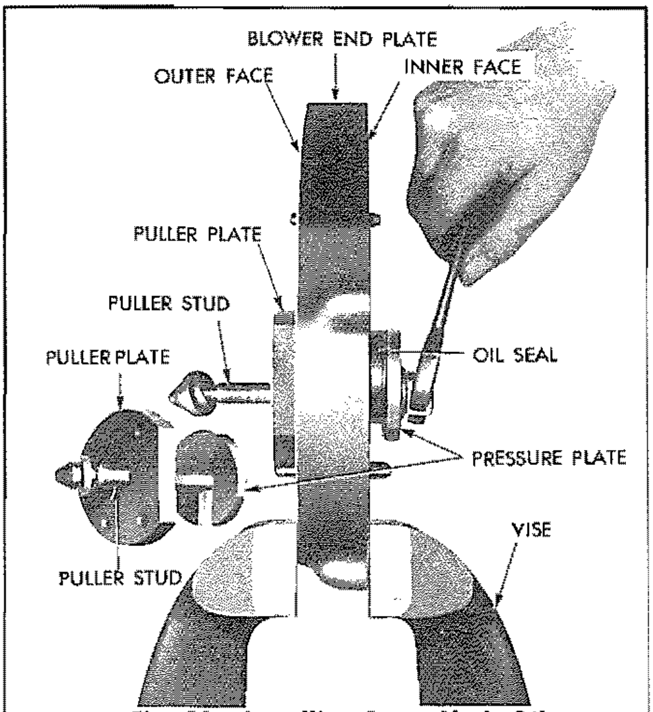


Fig. 11—Installing Rotor Shaft Oil Seal in Blower End Plate

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 extending across the entire length of the housing. 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 front end plate to the front end of the blower housing as follows:*

   a. Start the dowels, located in the front 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 is no gasket used between the end plate and the blower housing, the mating surfaces must be perfectly flat, smooth, and clean.

   b. Fasten the front end plate securely to the blower housing with the two (2) fillister-head screws, using no lockwashers. The dowels must project ⅜" beyond the outer face of the end plate after it is installed.

3. INSTALL ROTORS IN BLOWER HOUSING. Note that the lobes on one of the rotors and the teeth on one of the 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-hond helix must be used with the gear having the right-

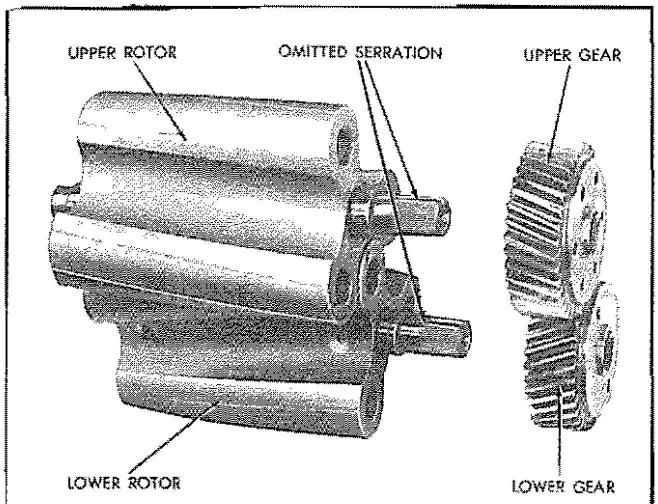


Fig. 12—Upper and Lower Rotors and Gears

hand helical teeth and these parts must be installed in the upper position in the blower housing. The left hand rotor and gear must be installed in the lower position in the blower housing. The rotors and gears are marked "UPPER" and "LOWER" on the rear faces of the gears and on one lobe of each rotor. Note also that one serration is omitted from the gear 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.

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

b. Place the rotors together, with the right-hand rotor on top and with the rotors in mesh and turned so that the omitted serration in the gear end of each rotor shaft is facing up as shown in Fig. 12. Slide the rotors into the blower housing, using an oil seal installing tool on the front end of each rotor shaft, to expand the oil seals in the front end plate and to guide the ends of the rotor shafts into the end plate.

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

4. INSTALL BLOWER REAR END PLATE. With the rotors installed in the blower housing and with the omitted serrations in each rotor

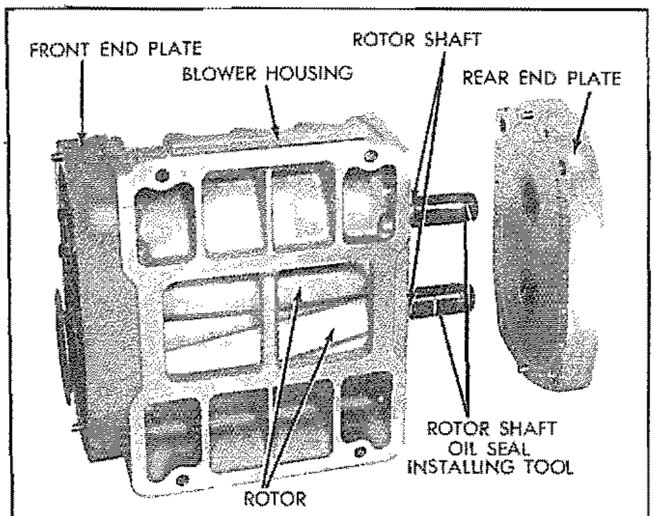


Fig. 13—Installing Blower Rear End Plate

shaft facing the top of the blower housing, as explained previously in step 3, place a rotor shaft oil seal installing tool on the gear end of each rotor shaft, then install the rear end plate in the same manner as the front end plate was installed. Fasten the rear end plate to the blower housing with two (2) fillister-head screws, using no lockwashers. The dowels in the rear end plate must project ⅜" beyond the outer face of the plate. Remove the oil seal installing tools from the rotor shafts.

5. INSTALL ROTOR SHAFT BEARINGS. The rotor shaft roller bearings must be installed on the front ends of the rotor shafts and the rotor shaft ball bearings on the rear ends (gear end) of the rotor shafts. The bearing number is stamped on one side of the ball bearing race of each bearing; when installed, these numbers must face the outer face of the end plates.

a. Start each rotor shaft bearing into the end plate and tap the bearings into place with the rotor shaft bearing installing tool shown in Fig. 14. After the rotor shaft bearings have been installed, check the rotor-to-housing and the rotor-to-end plate clearances as described in "BLOWER TIMING."

b. Place the bearing retainers for the rotor shaft bearings in position and install the attaching capscrews and lockwashers. NOTE: *The bearing retainers used at the*

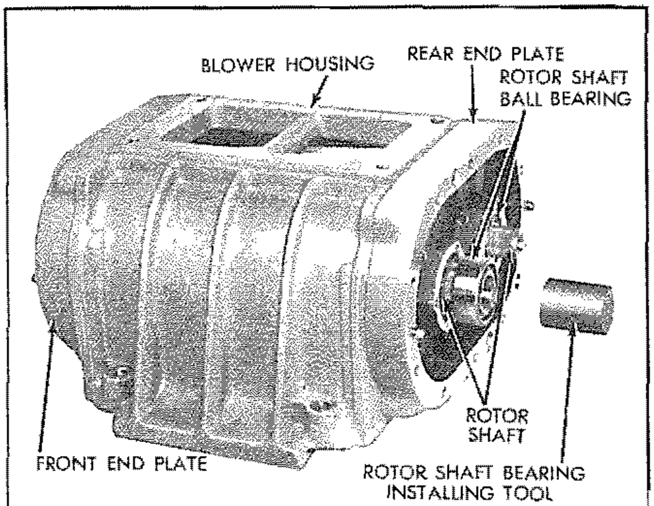


Fig. 14 — Rotor Shaft Bearing Installing Tool

front and at the rear positions are identical.

6. PRESS GEARS ONTO ROTOR SHAFTS. If a used blower is being reassembled with the original parts, shims were probably used in back of one or both blower gears. These shims, removed when the blower was disassembled, must be placed on the respective rotor shaft from which they were removed. If new gears or rotors are being installed, install the new parts without shims, and use shims later, if necessary, when timing the rotors. NOTE: *The blower gears are matched, and when replacement is necessary they must be replaced as a set.*

   a. Be sure that the omitted serrations on the ends of the rotor shafts are at the top. The gear that has six (6) tapped holes in its hub (right-hand helix) must be installed on the upper rotor shaft. Lubricate the serrated ends of the rotor shafts with engine oil, then install the gears as follows:

   b. With the original shims installed on the rotor shafts, start the gears onto 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 rotor shafts at the location of the omitted serrations, to assist in locating the gears on the shafts.

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

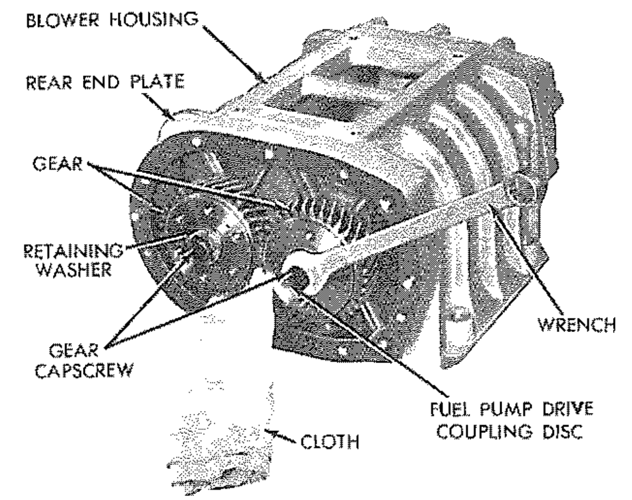


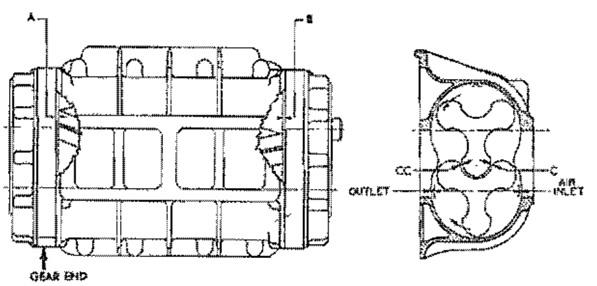
Fig. 15 — Pressing Blower Gears Onto Rotor Shafts

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

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 blower hous-

ing, 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 hub of a gear and the rotor shaft ball bearing located in back of the gear. The shims used to make this adjustment are of .002", .003", .005" and .010" thickness.

When the upper gear is moved out, the upper rotor will be moved in a counter-clockwise direction as viewed from the gear end; when the lower gear is moved out, the lower rotor will be moved in a clockwise direction as viewed from the gear end. The clearance between the upper and the lower rotor lobes must be taken at both ends and at the mid-section, while revolving the rotors with the upper rotor turning in a counter-clockwise direction (viewed from the gear end). Always determine the 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 ribbon and a more accurate measurement will be obtained.



SER.		A	B	C	CC	INLET	OUTLET
4-71	MIN.	.007	.009	.014	.002	.016	.004
	MAX.				.006		

Fig. 16 — Diagram of Blower Clearances

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 blower housing and

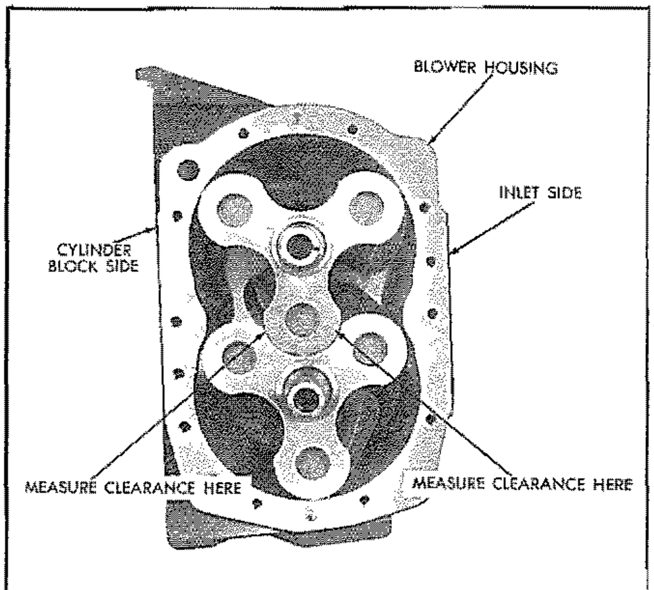


Fig. 17 — Measuring Points for Clearance Between Rotor Lobes

down between the lobes at this point ("CC" Fig. 16). Turn the rotors and take measurements at the mid-section and at the opposite end of the lobes. Record the minimum clearance obtained. Measure the clearance between the second and the third pair 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 is specified as .002" to .006". Therefore, this clearance must be decreased to within that range. This can be accomplished by adding shims in back of the lower gear or removing shims from behind the upper gear. A .003" adjusting shim in back of a gear will affect the rotor clearance .001". The clearance must again be checked after the addition or removal of shims, to make certain that the clearance obtained is correct. Add or remove shims as necessary 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 reinstalled together whenever addition or removal of shims is necessary.*

After the clearance between the rotor lobes has been measured through the cylinder block side (outlet side) of the blower housing 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, as shown in Fig. 19. The specified minimum clearance

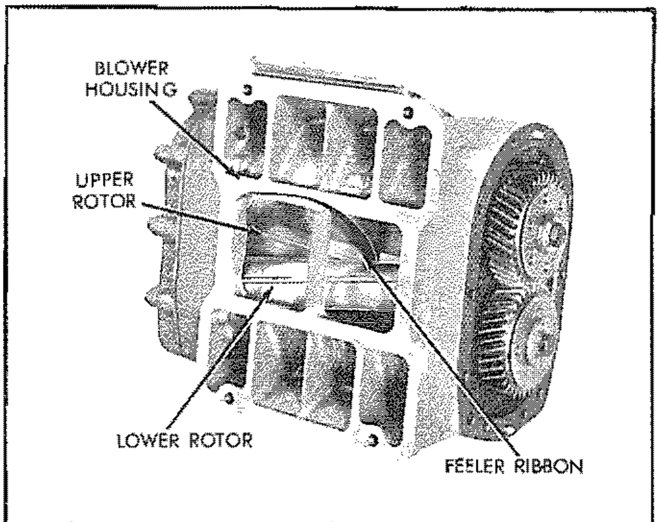


Fig. 18—Measuring Clearance Between Rotor Lobes from Outlet Side

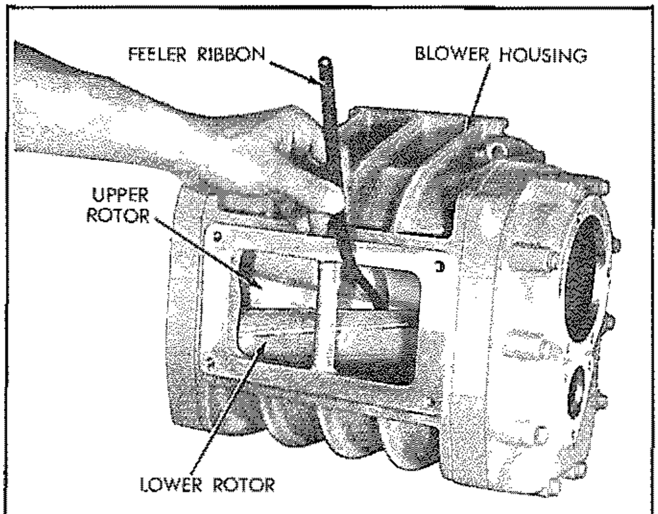


Fig. 19—Measuring Clearance Between Rotor Lobes from Inlet Side

between the rotor lobes is .014". When it is impossible to obtain a minimum clearance of .014" between the rotor 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 and the rotors must be replaced.

The clearance between the ends of the rotor lobes and the end plates of the blower ("A" and "B," Fig. 16) and between the rotor lobes and the blower housing must also be checked. Measure the rotor-to-end plate clearance at the ends of each rotor lobe, as shown in Fig. 20, taking twelve measurements in all. As specified on the chart in Fig. 16, there must be a minimum clearance of .007" at "A" and .009" at "B." Next, insert feeler ribbons between the rotor lobes and the inside of the blower housing, from both the inlet and outlet sides of the blower. A minimum running clearance of .004"

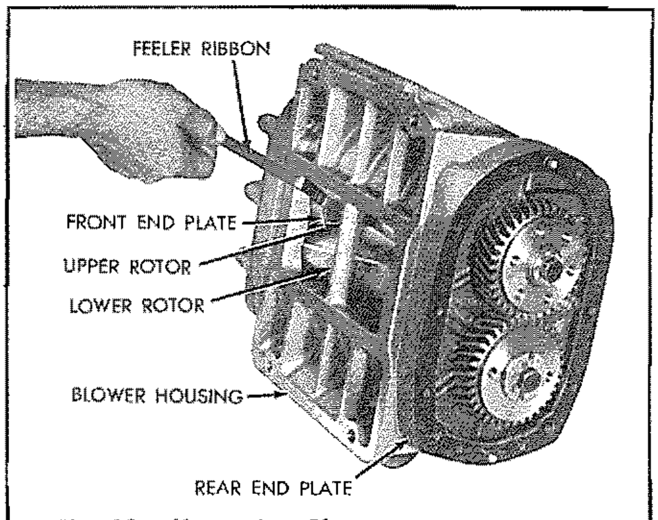


Fig. 20—Measuring Clearance Between End of Rotor and End Plate

is required between the rotor lobes and the inside of the housing when measuring from the outlet side and a minmum clearance of .016" is required when measuring from 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, refer to Fig. 10 and install the rotor driving hub plate assembly in position on the upper gear as follows:

   a. Place the two hub plates in position on the blower rotor driving hub and install the three (3) capscrews (5/16" NF x ¾") with lockwashers and plain washers. Tighten the capscrews to a torque of 25 to 30 pounds feet.

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

9. Insert the splined end of the water pump drive coupling into the front end of the lower rotor shaft. Install the socket-head capscrew, used to attach the water pump

drive coupling to the rotor shaft, and tighten the capscrew to a torque of 25 pounds feet.

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

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 gear shaft, install the fuel pump in position at the rear of the lower rotor, inserting the ends of the fork coupling into the slots in the fuel pump drive coupling disc. Install the fuel pump attaching capscrews and lockwashers and tighten securely.
2. Install the blower drive shaft cover and gasket (Fig. 22) in position on the rear end plate cover of the blower, but do not tighten the capscrews at this time. Place the hose clamp for the drive shaft cover seal on the drive shaft cover and install the blower drive shaft cover seal in place on the drive shaft cover.
3. Install the water pump and gasket in position on the front end plate cover of the blower. Place the water pump outlet packing flange and the pump outlet packing in position on the water pump. Place the water pump-to-oil cooler seal and the seal clamp in position on the engine oil cooler housing.
4. Install the governor weight housing assembly and gasket in position on the front end plate cover of the blower.
5. Insert the rear end (end having the shortest serrations) of the blower drive shaft (Fig. 22) into the serrations of the blower drive gear coupling cam. Cement a blower-to-cylinder block gasket to the cylinder block. Install the blower assembly in position on the cylinder block, inserting the front end of the blower drive shaft into the blower rotor driving hub. Rotate the rotors by hand until the serrations of the blower drive shaft can be felt entering the serrations in the blower drive gear coupling cam.
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 pounds feet.
7. Position the blower drive shaft cover seal and the hose clamp, then tighten the clamp securely. Tighten the capscrews attaching the blower drive shaft cover to the rear end plate cover of the blower.
8. Position the water pump outlet packing flange and packing, then install the attaching capscrews. Position the water pump-to-oil cooler seal and the seal clamp then tighten the seal clamp securely.
9. Install the water by-pass tube hose and the hose clamps in position on the by-pass tube and the elbow in the water pump body cover, then tighten the hose clamps.
10. Place the blower screen and the blower air intake housing in position on the blower housing and secure with capscrews and lockwashers. Place the blower air inlet elbow gasket and the air inlet elbow in position on the blower air intake housing and secure with capscrews and lockwashers. Connect the engine primer line to the primer elbow, located in the blower air intake housing.
11. Connect the two 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, then install the fan belts on the fan belt tightening idler pulley. Adjust the fan belts (refer to "FAN BELT ADJUSTMENT" in Section IV).
14. 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 drive shaft and flexible type coupling, mounted to the hub of the blower drive gear located in the upper right side of the flywheel housing. The blower drive gear is driven by the engine camshaft gear. This drive transmits power to the blower, governor, water pump, and the fuel pump. The drive is cushioned by two banks of coupling springs which dampen engine torque fluctuations to the blower and the other driven assemblies. The blower drive shaft engages in the serrations of the coupling cam at the rear end and in serrations of the blower rotor driving hub at the front end. The hub for the blower drive gear turns in a bushing in the blower drive support assembly.

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 assembly has been removed, the end clearance between the blower drive support assembly and the hub thrust washer should be checked before the blower drive assembly is removed from the engine (refer to Fig. 21). A clearance of .005" to .008" is specified at this point. When this clearance exceeds .010", the blower drive support assembly must be replaced. Remove the blower drive assembly as follows:

1. Disconnect each end of the oil pipe, extending from the cylinder block to the blower drive support. The oil pipe will be freed from the elbows when the support is withdrawn from the flywheel housing. Remove the engine crankcase oil level dipstick and the oil level dipstick tube.

2. Remove the nuts and lockwashers from the four bolts that extend through the flange of the blower drive support and through the flywheel housing. Remove the two capscrews at the front of the flange of the blower drive support.

3. Tap the blower drive support assembly loose

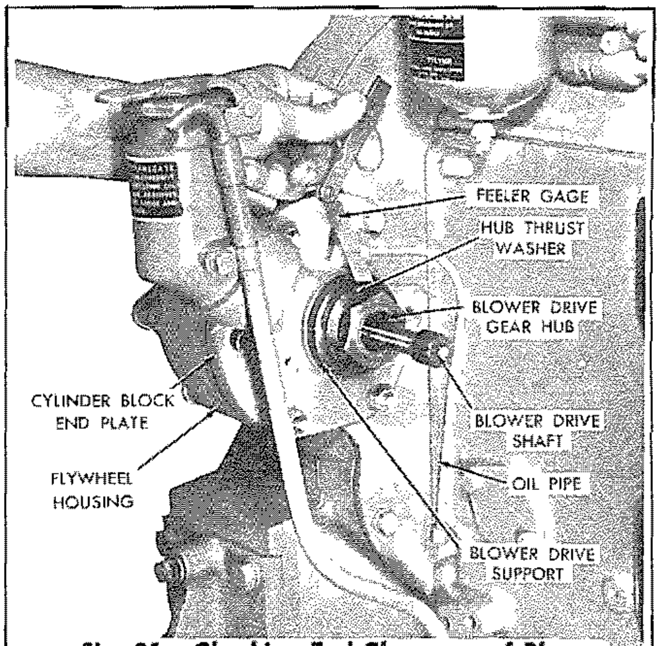


Fig. 21 — Checking End Clearance of Blower Drive Gear Hub

from the cylinder block end plate and withdraw the support assembly from the flywheel housing and the end plate.

C. Blower Drive Disassembly

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

2. Remove the six (6) capscrews attaching the coupling retainer, coupling support, and the blower drive gear to the blower drive gear hub and remove the coupling retainer and the coupling support.

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

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

5. If the coupling spring assemblies, coupling spring seats, or the coupling cam are to be

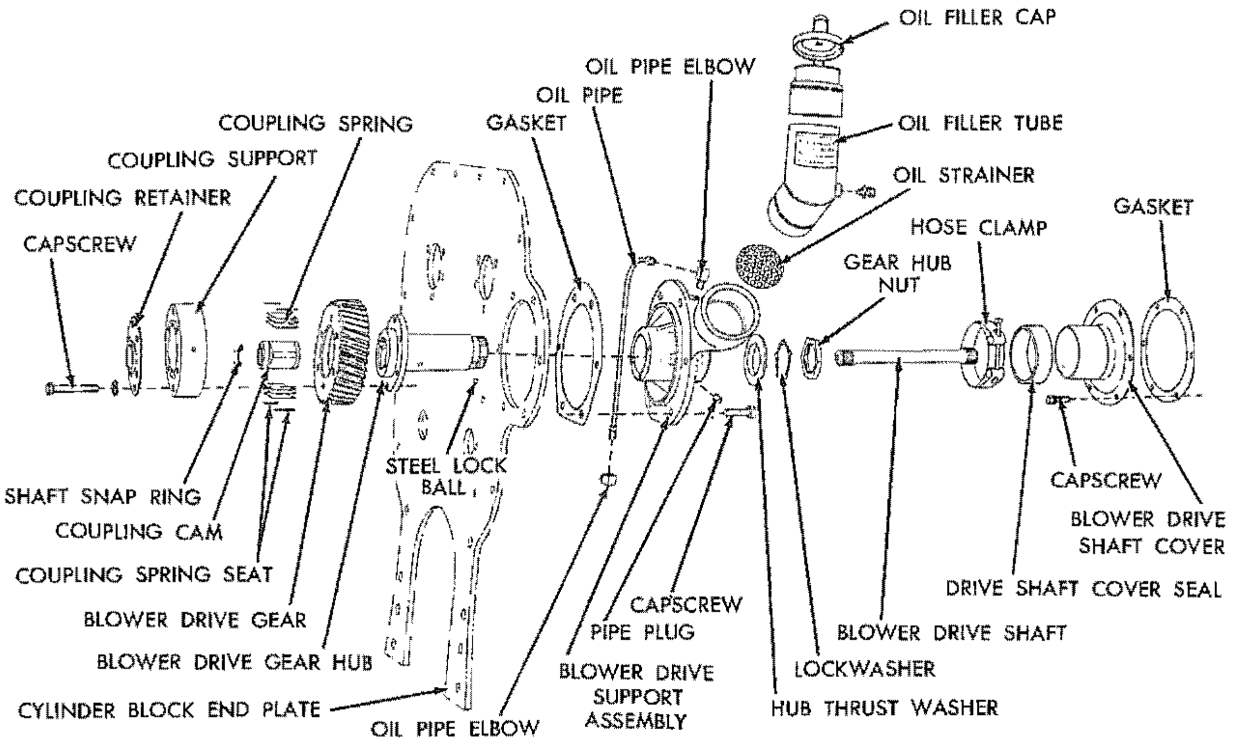


Fig. 22—Blower Drive Details

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

D. Inspection of Blower Drive Parts

Inspect the bore and the thrust faces of the bushing located inside the blower drive 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 blower drive support assembly must be replaced.

Check the inside diameter of the bushings for wear and roundness, and the outside diameter of the blower drive gear hub for wear. The proper clearance between the bushings and the hub is .001″ to .002″ and must not exceed .005″. If measurements show that the bushings or the hub are worn to exceed .005″ clearance, install a new blower drive support assembly, or blower drive gear hub, or both.

Inspect the serrations of the blower drive shaft; if they are worn so that excessive backlash is evident between the shaft and the coupling cam, or between the shaft and the blower rotor driving hub (in blower), a new blower drive shaft or its mating parts must be installed.

Inspect the coupling springs, spring seats, and the coupling cam 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.

E. Assembly of Blower Drive

1. Clamp the blower drive support assembly in a vise. Coat the outer side of the blower drive gear hub and the bushings in the support assembly with engine oil. Insert the blower drive gear hub into the support assembly.

2. Hold the blower drive gear hub in positior in the support assembly and place the stee

lock ball in the hole in the front end of the gear hub. Install the hub thrust washer on the gear hub and over the steel lock ball, with the large diameter of the thrust washer facing the bushing in the support assembly.

3. Prevent the blower drive gear hub from turning by inserting bolts in two holes in the gear hub and holding the bolts with a bar. Install a new lockwasher on the front end of the gear hub, next to the hub thrust washer, then install and tighten the gear hub nut. Check the end clearance between the support assembly and the hub thrust washer; this clearance must be between .005" and .008". Bend the ears of the lockwasher over the flat sides of the gear hub nut to lock the nut.

4. Remove the bolts from the blower drive gear hub and install the blower drive gear on the flange of the gear hub, with the flat side of the gear away from the support assembly. When installing the gear, line up the holes in the gear with the holes in the flange of the gear hub.

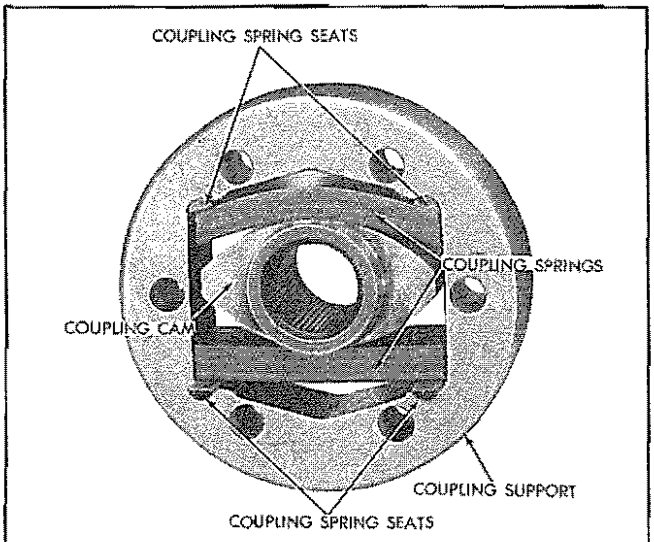


Fig. 23 — Blower Drive Flexible Coupling

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

6. Place the coupling support (with cam and springs) in position on the blower drive gear so that the lobes of the coupling cam are located over the 5/32" oil groove slots in the face of the blower drive gear hub. Make certain that the counterbore in one end of the coupling cam is positioned away from the blower drive gear when installed.

7. Place the coupling retainer against the coupling support, with the center flange of the retainer away from the coupling cam. Install the attaching capscrews and lockwashers and tighten securely.

8. Install the shaft snap ring in position in the coupling cam.

F. Installation of Blower Drive Assembly

1. Cement a new gasket to the rear side of the blower drive support assembly. Place the oil pipe, for the blower drive, in position against the oil pipe elbow in the cylinder block and the elbow in the support assembly as the support assembly is inserted into the flywheel housing. The blower drive gear must mesh with the engine camshaft gear as the support assembly is inserted into the flywheel housing. Secure the support assembly, using four (4) ⅜" NF x 5" bolts and two ⅜" NF 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 oil pipe elbows.

2. Insert the rear end of the blower drive shaft (end of shaft with shortest serrations) through the blower drive gear hub and into

position in the serrations 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. Cylinder Block Air Box and Drain Tubes

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

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. An air box drain tube, located approximately in the center of the left side of the cylinder block, is provided for drainage. IMPORTANT: *It is important that the drain tube be kept open at all times.*

When the drain tube is open and functioning properly, a stream of air can be felt emerging from the end of the tube when the engine is running. If the drain tube becomes clogged, the drain tube must be removed and cleaned.

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 air ports, must be kept open to allow free passage of air into the cylinders. Inspection for the condition of the air ports should be made at frequent intervals (at least ever 500 hours of engine operation), as hard carbon or sludge will build up in the air ports and restrict the passage of air. Remove the hand hole covers from the left side of the cylinder block to inspect the air ports.

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

1. Remove the cylinder head assembly (refer to "CYLINDER HEAD REMOVAL," Section IX).

2. Rotate the engine crankshaft 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 the air ports from the inside of the cylinder liner.

4. After all the air ports 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 air ports with fine emery paper to be sure that no burrs or nicks are left on the inside of the cylinder liner. Again clean the cylinder with compressed air, before rotating the engine crankshaft to work on another cylinder.

NOTE: *With the cylinder liners removed from the engine, the air ports may be cleaned by*

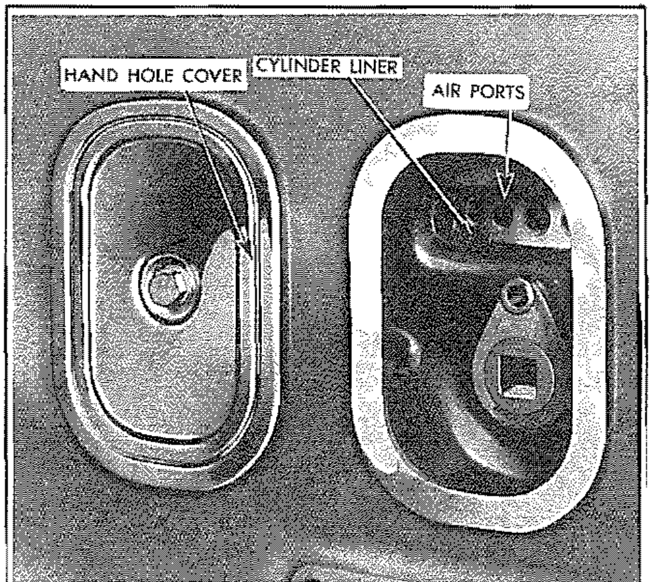


Fig. 24—Cylinder Liner Air Ports

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.

5. After the air ports in all the cylinder liners have been cleaned, clean all the carbon from the cylinder block air box. Remove the air box hand hole covers, air box drain tube, and the drain tube elbow while cleaning the air box.

6. Be sure that the air box drain tube is open and the drain tube elbow is clean before reinstalling the tube.

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 reduce the temperature of the air in the cylinders to a point too low to ignite the fuel. A starting aid must then be used in starting the engine.

B. Description

The cold weather engine primer consists of a dispenser assembly, which holds and punctures a capsule containing ethyl ether starting fluid, a primer pump to force the fluid through a small nozzle and into the blower air intake housing, a primer elbow assembly, and the necessary lines to complete the system. The primer pump is mounted in the left side of the instrument panel and the dispenser assembly is attached to the cowl, to the right of the instrument panel.

The starting fluid is forced through the primer elbow assembly and into the blower air intake housing, where it is picked up by the engine blower and is blown into the cylinders.

Since the starting 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 cranks the engine at a low cranking speed.

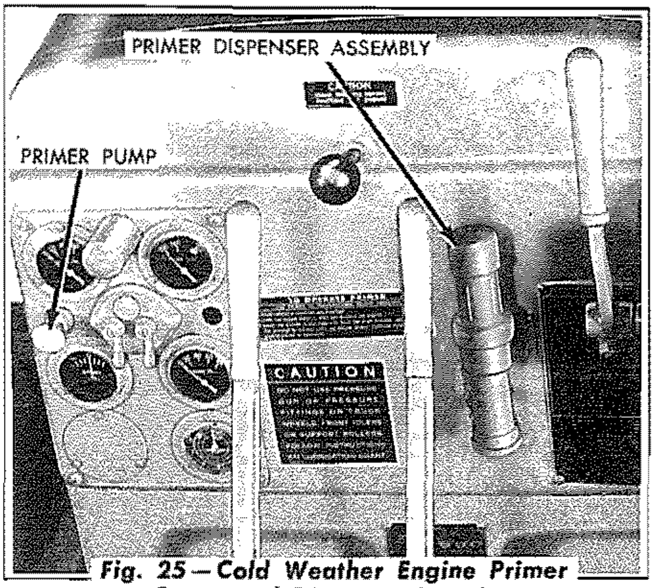


Fig. 25—Cold Weather Engine Primer Pump and Dispenser Location

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

C. Operation

1. Unscrew the upper chamber of the engine 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 or 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 onto the dispenser body.

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

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

6. Depress the starter pedal to crank the engine, and at the same time operate the primer pump to force the starting fluid into the engine air system. Continue pumping, after the engine starts and runs on regular fuel, until all of the fluid in the dispenser has been injected into the engine.

7. While the engine is warming up, unscrew the upper chamber of the primer dispenser and remove the empty capsule. Reinstall the upper chamber.

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 the hand by barbs on the 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 (all the way forward) and with the throttle lever pulled all the way back, and does not start after two or three strokes of the primer pump, it is advisable to stop cranking and inspect the primer system for possible causes of failure.

Check the primer system as follows:

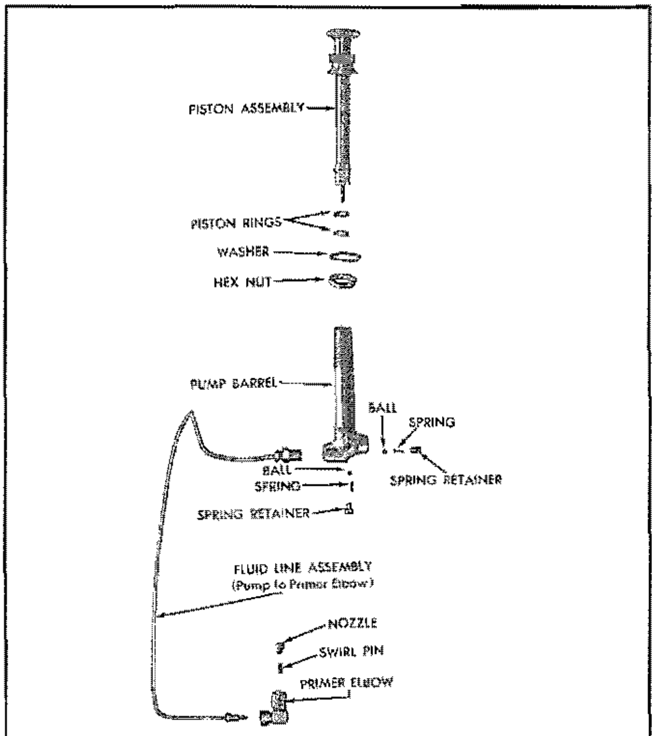


Fig. 26 — Primer Pump and Primer Elbow Details

1. Primer Elbow Assembly Clogged

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

2. Inoperative Primer Pump

Failure of the primer pump to function properly may be due to worn or damaged pump piston rings, a clogged dispenser filter screen, clogged fluid lines, or "frozen" or worn check valve balls. The piston rings on the piston are made of a special rubber composition and must be replaced by duplicate parts if worn or damaged.

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

3. **Ball Check Valves**

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

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

4. **Clogged Dispenser Strainer**

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

To clean the strainer, unscrew the plug from the dispenser body and wash the strainer and plug in hot water. The strainer may be removed for replacement if necessary by removing the strainer screw attaching the strainer to the plug. The dispenser body may be washed without removing it from the cowl by removing the upper chamber, the line connector, and the plug.

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

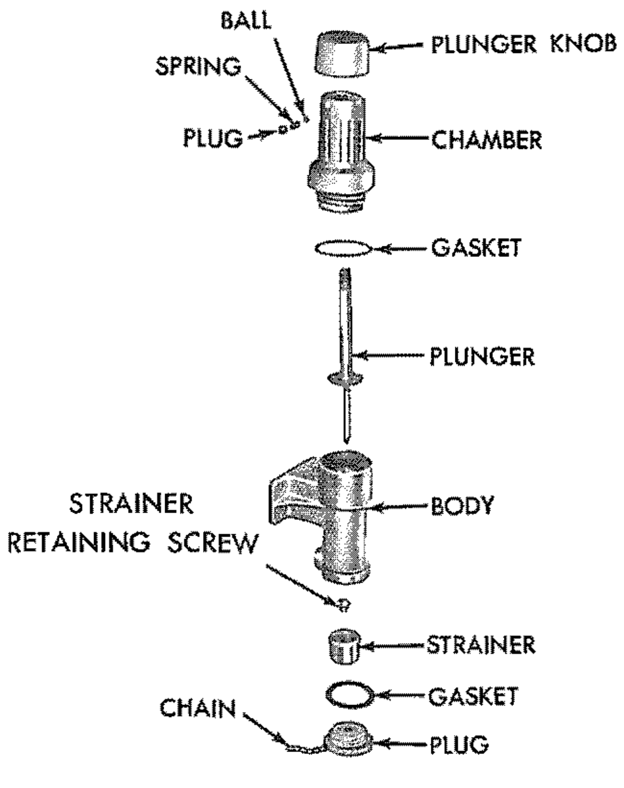


Fig. 27 — Primer Dispenser Details

SECTION IV—ENGINE COOLING SYSTEM

1. DESCRIPTION OF SYSTEM

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

The water pump draws the coolant from the bottom of the radiator and circulates it through the engine oil cooler housing and the water passages in the engine. The coolant is discharged from the cylinder head into the water manifold and passes through the thermostat housing and the upper radiator hose to the upper part of the radiator. The coolant 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 the water manifold of the engine, operates automatically to maintain a normal engine coolant operating temperature of 160° to 185° F.

2. GENERAL MAINTENANCE

Keep the cooling system filled with clean soft water or rain water whenever possible. If soft water is not available and hard water must be used, the hard water should first be treated with a water softener. A commercially reliable rust inhibitor should be added to the cooling system for warm weather operation. A rust inhibitor (soluble oil) is available from "Allis-Chalmers" Dealers and should be added in proportions of one pint of soluble oil to every 15 quarts of water. The use of water containing lime will result in lime deposits in the cylinder head and cylinder block, causing hot spots in the engine and eventually restricting the water passages. Alkali in the water will cause a corrosive action detrimental to the engine. CAUTION: *NEVER ADD ANTI-FREEZE SOLUTION TO A COOLING SYSTEM THAT CONTAINS A RUST INHIBITOR.* Drain, flush, and refill the system with clean water before adding an anti-freeze solution for cold weather operation.

In winter weather, use an ethylene glycol anti-freeze solution in the system to protect against damage from freezing. This type of anti-freeze has a much higher boiling point than water. After any addition of water or anti-freeze solution, test the solution after the added quantity has become thoroughly mixed to make sure it will withstand the prevailing or anticipated temperature. 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 from leaves, trash, and other material which will restrict the flow of air through the radiator. All leaks in the cooling system must be corrected as soon as they are evident and the fan belts must be kept properly adjusted. The most efficient engine operation is obtained with the coolant temperature held within a range of 160° to 185° F. Operating the engine with coolant temperature below this range will result in incomplete combustion of fuel, higher fuel consumption with less power, and will cause harmful deposits within the engine.

Maintaining the normal engine coolant temperature (160° to 185° F.) depends mostly on the proper functioning of the thermostat. If the engine coolant temperature remains consistently below normal, the thermostat should be removed and inspected. If the thermostat is corroded or stuck, 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 coolant operating temperature.

3. FILLING AND DRAINING OF SYSTEM

A. Filling Cooling System

The engine is equipped with a water by-pass tube extending from the water manifold to the water pump. When the engine coolant is below normal operating temperature (thermostat closed), this by-pass tube allows the coolant to pass directly from the water manifold 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 engine oil cooler. When the coolant within the engine reaches approximately 160° F., the thermostat opens and allows the coolant to circulate through the radiator.

Air in the cooling system is vented through a vent cock, located 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 engine oil cooler housing are provided to drain the system.

Remove the radiator cap and fill the cooling system through the radiator cap opening, after first closing all three drain cocks. IMPORTANT: *Open the vent cock located in the top of the thermostat housing then 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 system.*

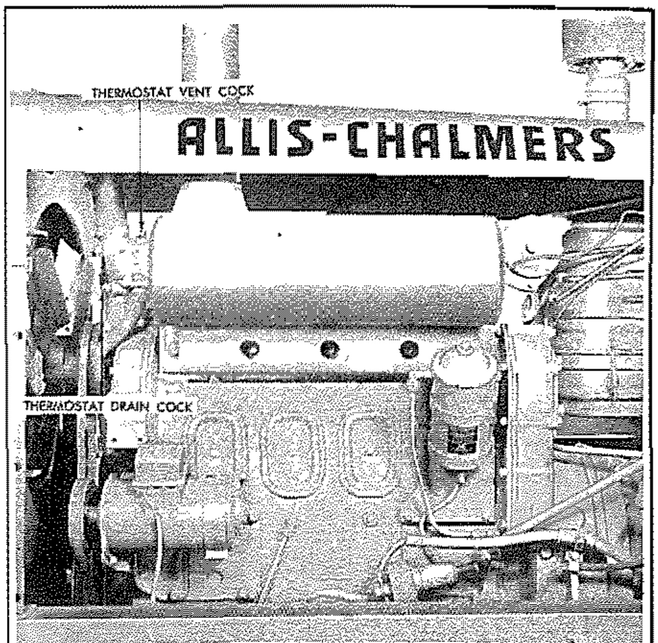


Fig. 1 — Thermostat Housing

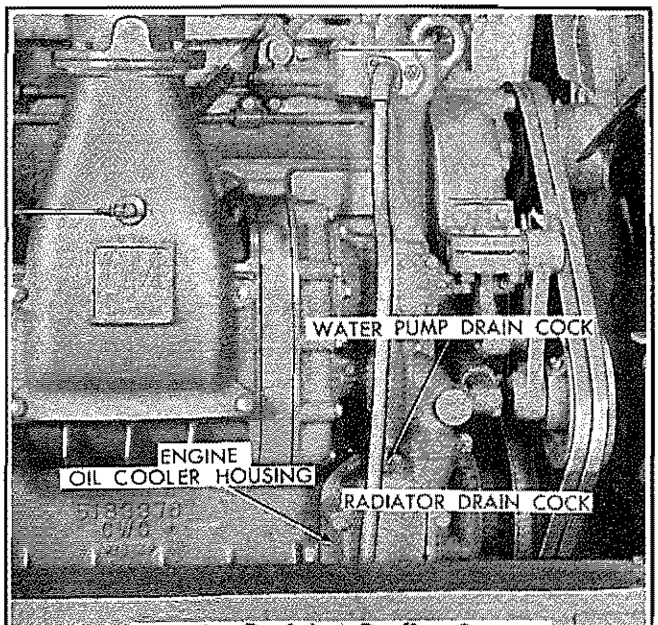


Fig. 2 — Draining Cooling System

B. Draining Cooling System

Open the drain cocks in the bottom of the water pump housing, engine oil cooler housing, and the bottom of the thermostat housing. Open the vent cock in the top of the thermostat housing and allow the coolant to drain. CAUTION: *When draining the cooling system in freezing weather, make certain the coolant flows freely from all the drain cocks and that the system drains completely.*

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 adding an anti-freeze solution) and again after the anti-freeze solution is removed. Cleaning at these intervals will reduce clogging and overheating and will minimize the necessity of removing the radiator for cleaning.

If hard water has been used, the necessity for cleaning is greater, since lime deposits, or scale, will form in the radiator, cylinder block, and the cylinder head. This lime deposit is detrimental to the engine and the radiator core.

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

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

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 is usually deposited at the tops of the radiator tubes.

   Disconnect the radiator outlet hose (lower hose), and using a suitable adapter, connect a pressure water hose to the lower radiator outlet elbow. Remove the radiator inlet elbow (upper elbow) and plug the inlet opening of the radiator. Remove the radiator cap and force water upward through the radiator. The trash will be loosened from the top of the tubes and will flow out through the top of the radiator with the water. CAUTION: *Do not use over 5 pounds pressure in this flushing operation as excessive pressure may cause the radiator tubes or tanks to rupture.*

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

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

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

5. RADIATOR AND RADIATOR SHELL

A. Description

The radiator shell is a heavy steel weldment consisting of a shell and fan shroud. Brackets, welded to the back side of the shell, are incorporated in the design for attaching a fan guard. A heavy, bar type, hinged grille is attached to the front of the shell for protection of the radiator. The radiator is of the conventional tubular type and is mounted in the radiator shell.

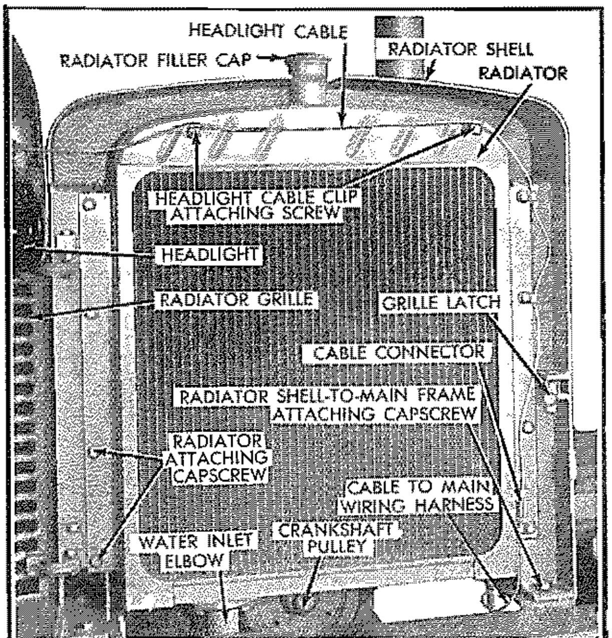


Fig. 3 — Radiator and Radiator Shell Assembly

B. Removal of Radiator and Radiator Shell

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

2. Open the radiator grille. Remove the two (2) screws and plain washers attaching the headlight cable clips to the top of the radiator. Disconnect the headlight cable fróm the main wiring harness at the cable connector, located at the lower left front corner of the radiator.

3. Remove the capscrews attaching the radiator inlet elbow and the radiator outlet elbow to the radiator.

4. Support the radiator and remove the four (4) capscrews and plain washers attaching each side of the radiator to the radiator shell. Remove the radiator from the shell as shown in Fig. 4.

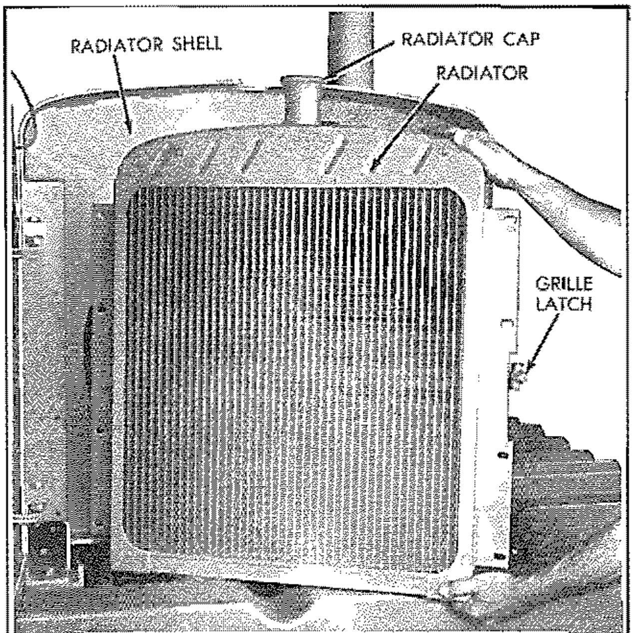


Fig. 4 — Removing Radiator from Shell

5. If it is necessary to remove the radiator shell, proceed as follows:

   a. Remove the air pre-cleaner and the engine hood. Remove the bolts attaching the right and left front fenders to the radiator shell.

   b. If the tractor is equipped with radiator shell-to-cowl bracing rods, loosen the front of the bracing rods from the radiator shell. Remove the two bolts attaching each lower corner of the radiator shell to the main frame and remove the radiator shell and grille as an assembly.

C. Inspection and Repair

Clean the air passages in the radiator 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 and Radiator Shell

1. If the radiator shell is removed from the tractor, place the radiator shell in position

on the main frame; install two (2) bolts, plain washers, lockwashers, and nuts to secure each lower corner of the radiator shell to the main frame. Do not tighten the bolts at this time.

2. Install three (3) bolts, plain washers, lockwashers, and nuts to secure each front fender to the radiator shell. Tighten the front fender attaching bolts and the bolts attaching the radiator shell to the main frame.

3. Place the radiator in position in the radiator shell and install the capscrews and plain washers to secure the radiator to the radiator shell. When installing these attaching capscrews, be sure they are inserted through the corresponding headlight cable clips. Install the two screws and plain washers to secure the headlight cable to the front top of the radiator.

4. Using gasket cement, cement a new gasket in position on the radiator inlet elbow (upper elbow) and on the radiator outlet elbow (lower elbow). Secure these elbows to the radiator with capscrews and lockwashers.

5. Install the engine hood and the air precleaner. Connect the headlight cable to the main wiring harness at the cable connector, located at the lower left front corner of the radiator.

6. Close and fasten the radiator grille. Fill the cooling system (refer to "FILLING AND DRAINING OF SYSTEM" in this Section).

6. WATER PUMP

A. Description

A centrifugal type water pump is used for circulating the coolant through the engine and radiator. A bronze impeller is pressed on, and pinned to, one end of a case-hardened steel pump shaft and a pump shaft coupling, with an oil slinger, is pressed on the opposite end. The oil slinger shrouds the inner end of the pump body flange to prevent oil from creeping along the pump shaft and through the pump shaft bearing. The pump shaft is supported at the drive end by 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. The pump shaft and the bearing constitute one assembly and are serviced only as a unit. Water is prevented from creeping along the pump shaft from the impeller end by means of a spring-loaded "NEOPRENE" seal, retained in the impeller by a seal retaining cup.

B. Water Pump Lubrication

The water pump shaft bearing is of the "shielded" type and is 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 only clean water is added to the cooling system. Water containing alkali is especially harmful to the water pump as alkali 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. Remove the breathing pipe from the governor.

3. Loosen the seal clamp on the water pump-to-oil cooler seal and the hose clamp attaching by-pass tube hose to the elbow in the water pump body cover. Remove the two (2) capscrews attaching the pump outlet packing flange to the cylinder block.

4. Remove the three (3) capscrews attaching the water pump to the blower; use the special fuel pump and water pump wrench to remove the inner capscrew.

5. Free the water 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 body cover from the pump body.

2. Using a small punch, drive the 3/16" x ⅞" groove pin out of the pump shaft and the impeller.

   Place the pump in a press as shown in Fig. 5, and press the pump shaft from the impeller. The pump shaft and shaft bearing will be removed from the pump body in this operation. If replacement of the seal assembly or of the pump body insert is the only repair necessary, no further disassembly of the pump is necessary as the seal assembly and the body insert may now be removed.

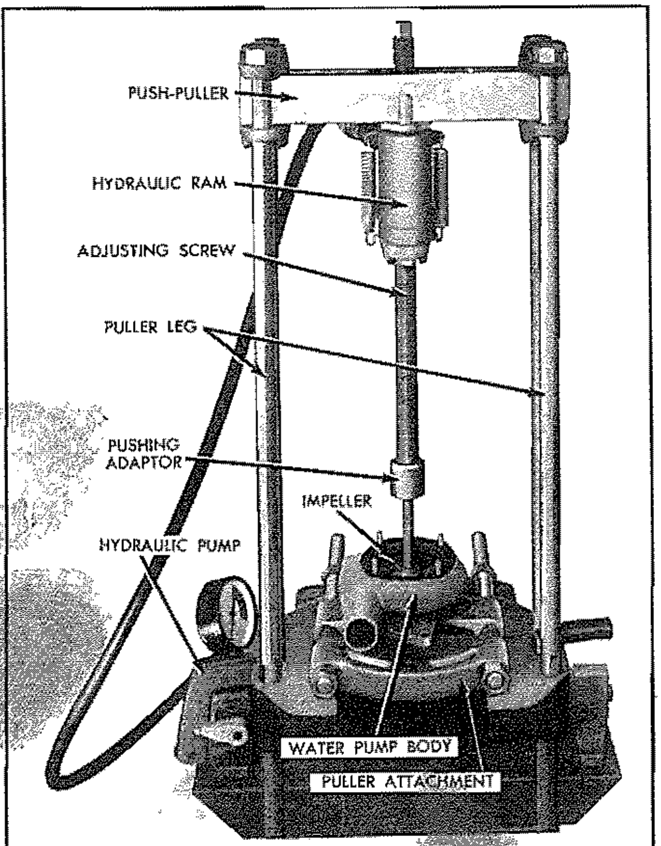


Fig. 5 — Pressing Water Pump Shaft from Impeller

3. If further disassembly is necessary, place the pump shaft in a press as shown in Fig. 6, and press the pump shaft from the pump shaft coupling. The pump shaft coupling is pressed on the pump shaft and is driven solely through the press fit. The metal stretches when the coupling is pressed onto the shaft and, if the coupling is repeatedly removed and installed, the bore coupling will become enlarged, causing a loose fit of the coupling on the pump shaft. This fit should be checked and a new coupling should be installed if necessary.

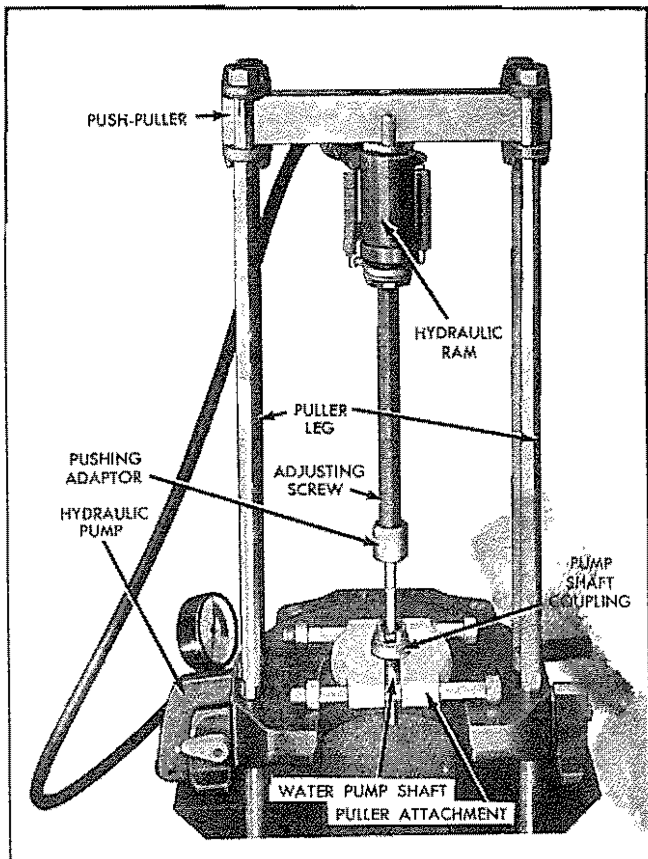


Fig. 6 — Pressing Water Pump Shaft from Pump Shaft Coupling

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 body insert are scored or are rough, replace the seal assembly and the body insert. NOTE: *The seal assembly is serviced only as a unit.*

1. Remove the body insert by driving it from the pump body.

2. Install a new pump body insert by pressing it into position in the counterbore of the pump body. CAUTION: *Be sure the polished*

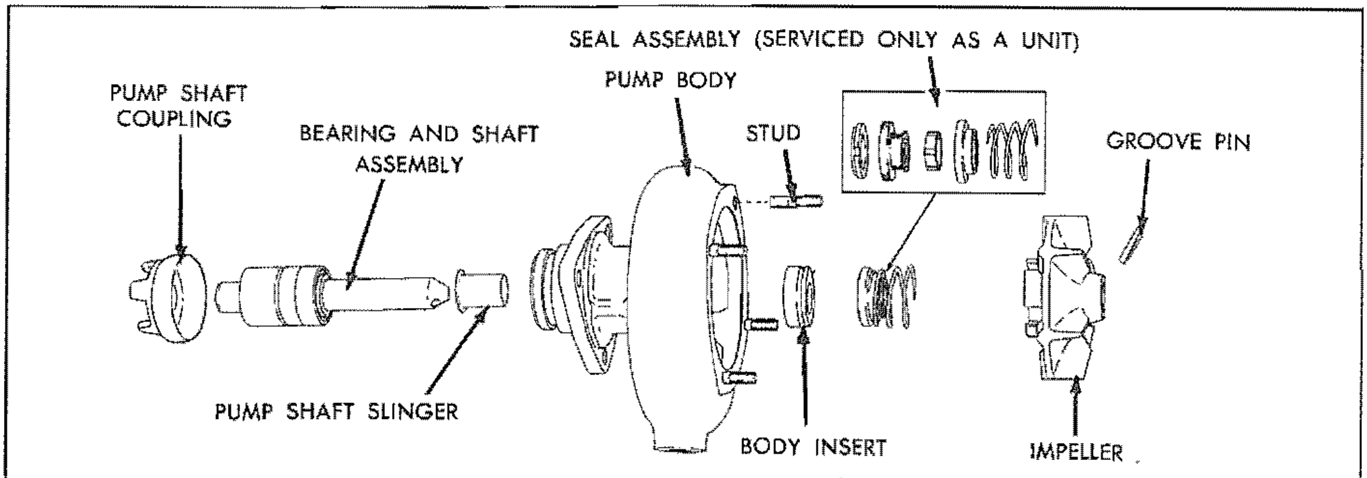


Fig. 7 — Water Pump Details

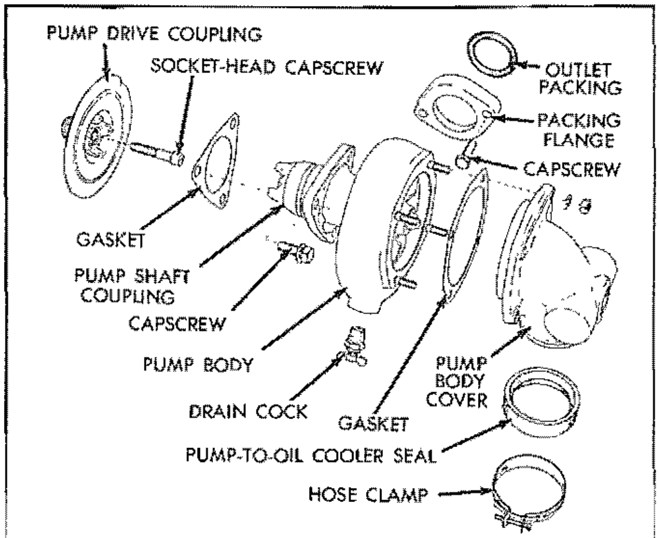


Fig. 8 — Water Pump Attaching Parts

surface of the body insert is up when installing and the counterbore of the pump body is clean, so the body insert will seat squarely in the pump body.

G. Assembly of Water Pump

When assembling the water pump refer to Figs. 7 and 8, which show the relative location of all parts, and assemble as follows:

1. Place the pump body on a bench (cover end down). With the slinger in position on the pump shaft, insert the shaft and the bearing assembly into position in the pump body and press the bearing into 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 flange of the pump body against the end of the bearing outer race in three or four places, to prevent the bearing from moving endwise in the pump body.

2. Install the seal assembly in position on the pump shaft. Start the impeller on the end of the pump shaft; position the impeller so 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 onto the shaft so that it is located 11/32" past the end of the shaft (or until the holes are aligned). Drive the groove pin into place and stake the impeller against the end of the groove pin to prevent the pin from working out.

3. Support the impeller end of the pump shaft on a suitable press and press the pump shaft coupling onto the inner end of the shaft, flush with the end of the shaft.

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

5. Place a gasket on the pump body and install the pump body cover over the studs so that the elbow end will align with the engine oil cooler housing when the pump is installed on the engine. Secure the pump body cover to the pump body with four nuts and lockwashers. Again turn the pump shaft by hand to check for clearance between the impeller and the pump body cover.

H. Installation of Water Pump

1. If the pump drive coupling was removed from the blower rotor shaft, insert the splined end of the coupling into the mating splines of the blower rotor shaft, and install the 5/16" N.F. x 1½" socket-head capscrew to secure the coupling to the rotor shaft.

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 outlet.

3. Place the hose clamp and the water pump-to-oil cooler seal in position on the engine oil cooler.

4. Hold the water pump in place at the front end of the blower, so that the lugs on the two drive couplings are in line and the pump outlet points down. Secure the pump to the blower with three (3) capscrews and copper washers.

5. Slide the outlet packing and the outlet packing flange over against the cylinder block and secure the flange to the cylinder block with two (2) capscrews.

6. Make certain the pump-to-oil cooler seal is properly positioned and tighten the hose clamp, located on the seal.

7. Connect the water by-pass tube hose to the elbow, located in the water pump body cover.

8. Install the breathing pipe in position 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).

7. WATER MANIFOLD AND THERMOSTAT

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 end of the manifold where the thermostat housing is attached.

Unrestricted flow of coolant 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 is shut off. The flow of coolant is then directed from the water manifold to the water by-pass tube and then back to the inlet side of the water pump.

Before the thermostat opens (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 system.

B. Service

Replacement of the thermostat will be necessary when the thermostat becomes corroded, sticking in the open or closed position.

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 outlet elbow.

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

4. Clean the seat for the thermostat in the outlet elbow. Examine the outlet elbow attaching gasket, and the gasket used between the thermostat housing and the water manifold, and replace if necessary. Using gasket cement, cement the gaskets in position on their respective components.

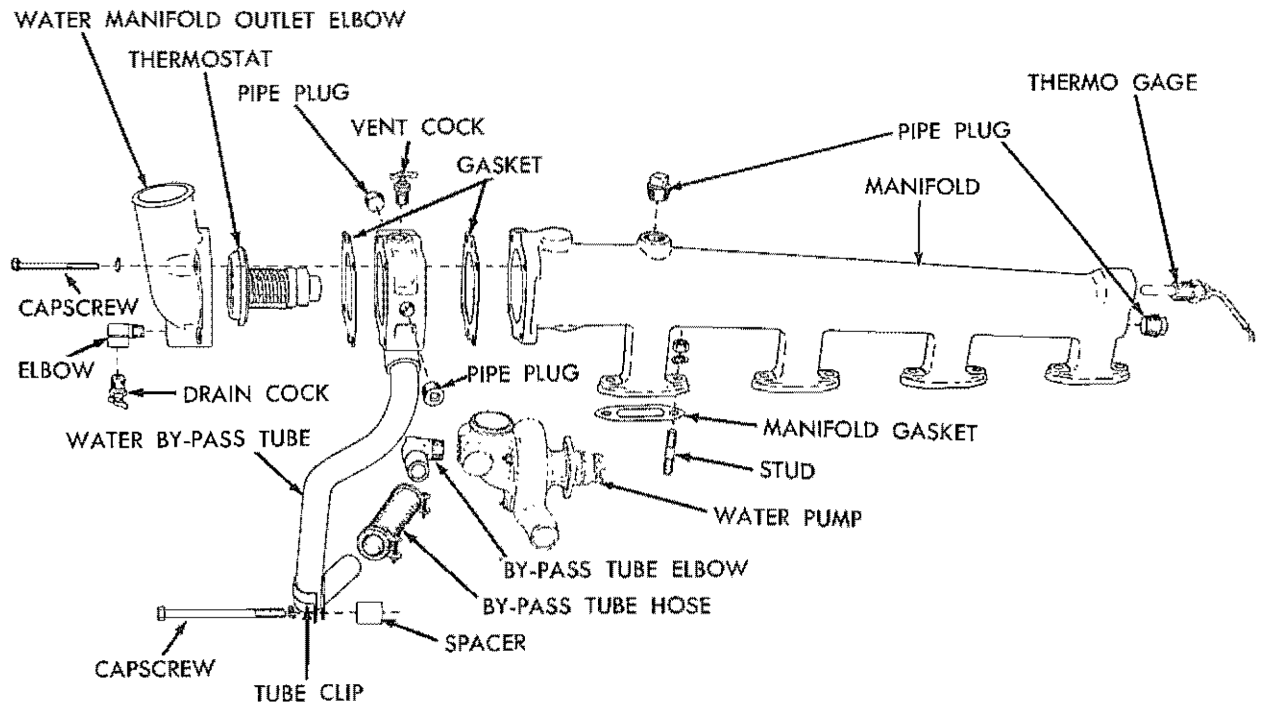


Fig. 9 — Water Manifold Details

5. Insert the thermostat in position in the thermostat housing (large end toward the front), then install the outlet elbow. Secure the outlet elbow to the water manifold and thermostat housing with four (4) capscrews and lockwashers.

6. Coat the inside of the radiator inlet hose with sealing compound and connect it to the water manifold outlet elbow. Tighten the hose clamp.

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-cleaner, engine hood, and the exhaust muffler.

3. Disconnect the thermo gage from the rear of the water manifold. Remove the four (4) capscrews attaching the water manifold outlet elbow to the front of the water manifold and remove the elbow and the thermostat.

4. Remove the nuts and lockwashers attaching the water manifold to the cylinder head and remove the manifold. Remove the manifold 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 manifold gasket in position around each opening in the cylinder head and install the manifold in position on the cylinder head. 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 water manifold outlet elbow and the thermostat as described in "THERMOSTAT REPLACEMENT" in this Section.

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

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

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

A. Description

The fan draws air through the radiator and helps to cool the engine coolant as the coolant 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 located on the front end of the engine crankshaft. A fan belt tightening idler assembly, mounted on a bracket bolted to the right side of the engine balance weight cover, is provided for adjusting the fan belts.

B. Lubrication

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

C. Fan Belt Adjustment

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

To Adjust the Fan Belts

1. Loosen the 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 on the belts is obtained, then tighten the capscrew in the adjusting arm and the fan idler hinge bolts.

D. Removal of Fan Assembly

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

2. Loosen the tension of the fan belts. Remove the four capscrews attaching the fan to the fan pulley and lower the fan into the fan shroud.

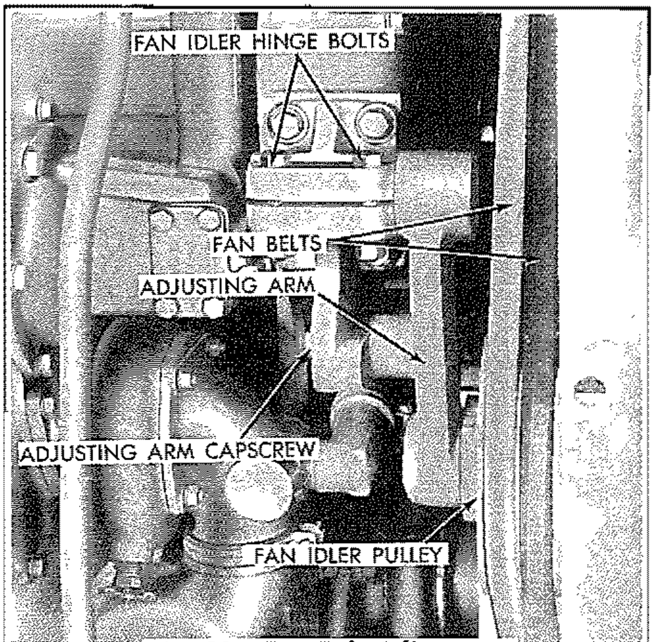


Fig. 10 — Fan Belt Adjustment

3. Remove the three (3) capscrews attaching the fan mounting bracket to the engine balance weight cover, then remove the two (2) fan belts from the fan pulley. Remove the fan pulley assembly and remove the fan.

E. Disassembly of Fan Pulley Assembly

1. Remove the fan spacer from the pulley.

2. Remove the retaining nut and the spindle washer from the rear end of the fan spindle, then using a suitable puller, remove the fan mounting bracket. Remove the "WOODRUFF" key from the spindle.

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

4. Install the retaining nut on the rear end of the fan spindle, place the assembly in a vise by clamping the retaining nut, then drive the pulley off the fan spindle.

5. Remove the cotter pin and the jam nut from the front end of the spindle, place the spin-

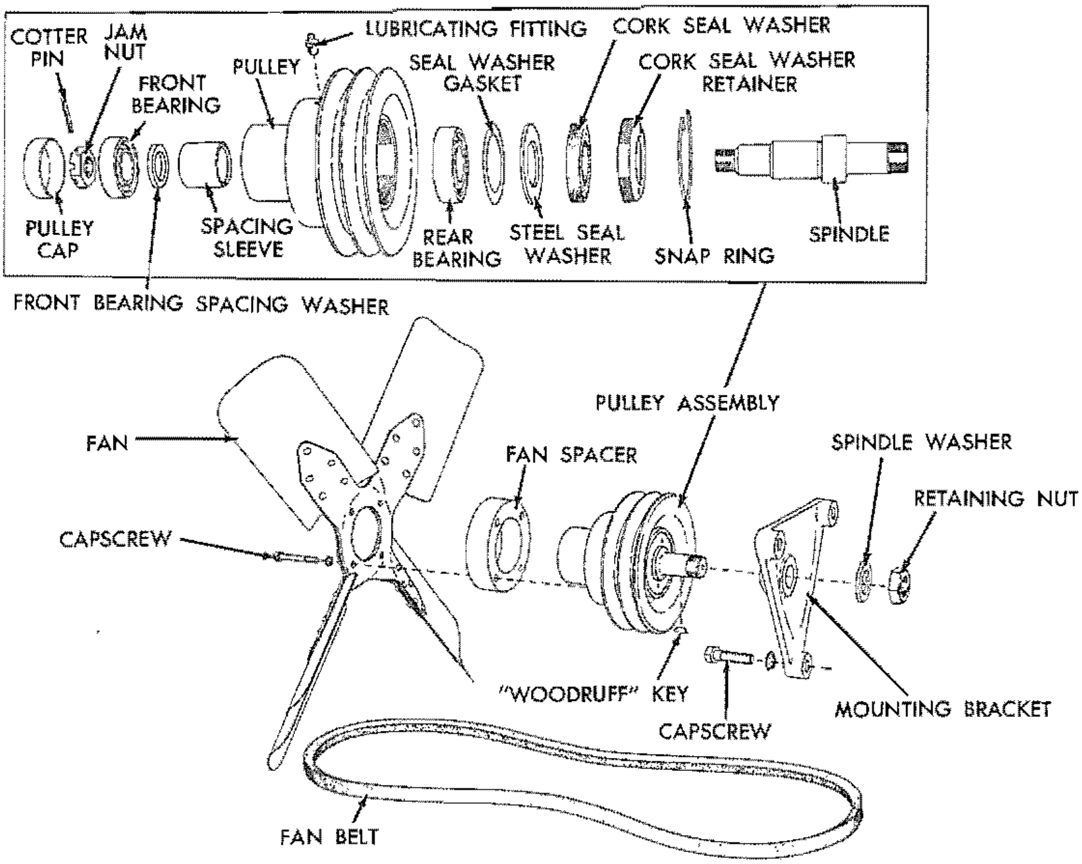


Fig. 11 — Fan Details

dle in a press, and press the spindle out of the bearings.

F. Inspection of Fan Parts

Wash all the parts in clean solvent or fuel and inspect them for wear or damage. Lubricate the bearings with engine oil and rotate them by hand to check for binding or wear and replace if they do not roll easily or if they are worn. The bearings must fit snug in the pulley and on the fan spindle. Replace the spindle if it is bent or worn, or if the threads are damaged beyond repair. Discard the cork seal washer 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

When assembling the fan, refer to Fig. 11 which shows the relative location of the parts.

1. Press the rear bearing in position on the fan spindle. Place the spacing sleeve and the front bearing spacing washer in position on the spindle. Press the front bearing in position on the spindle, making certain it is pressed tight against the spacing washer. Install the jam nut on the front end of the spindle, tighten the nut securely, and install the cotter pin.

2. Start the spindle into the rear of the pulley and press or drive it into position.

3. Place the seal washer gasket and the steel seal washer in position on the spindle. Install a new cork seal washer in position in the cork seal washer retainer. Before installing the 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 cork seal washer retainer and tighten it securely. Install the snap ring around the hub of the pulley, with the prong of the snap ring inserted through the hole in the pulley hub and into the hole in the cork seal washer retainer.

4. Install the pulley cap in position in the front of the pulley if the cap was removed. Install the "WOODRUFF" key in the rear of the spindle. Install the fan mounting bracket in position on the spindle. Install the spindle washer, retaining nut, and tighten the nut securely.

5. Install the lubricating fitting in the pulley if the fitting was removed; fill the bearing compartment of the pulley with lubricant through this fitting.

6. Install the fan spacer in position on the pulley.

H. Installation of Fan Assembly

1. Insert the fan into the fan shroud of the radiator shell. Hold the fan pulley assembly in position at the front of the engine, then place the fan belts in position in the grooves of the pulley. Attach the fan mounting bracket to the engine balance weight cover with three (3) capscrews and lockwashers. Tighten the capscrews securely.

2. Raise the fan from the shroud, install it in position on the front of the fan pulley assembly, and secure the fan to the pulley with four capscrews and lockwashers.

3. Adjust the fan belts (refer to "FAN BELT ADJUSTMENT" in this Section).

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

I. Removal of Fan Belt Tightening Idler

1. Remove the right front fender. Loosen the capscrew in the adjusting arm of the idler pulley and loosen the two (2) fan idler hinge bolts.

2. Move the fan idler pulley toward the engine to loosen 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 fan idler assembly from the engine.

J. Disassembly of Fan Belt Tightening Idler

1. Remove the mounting bracket from the adjusting arm.

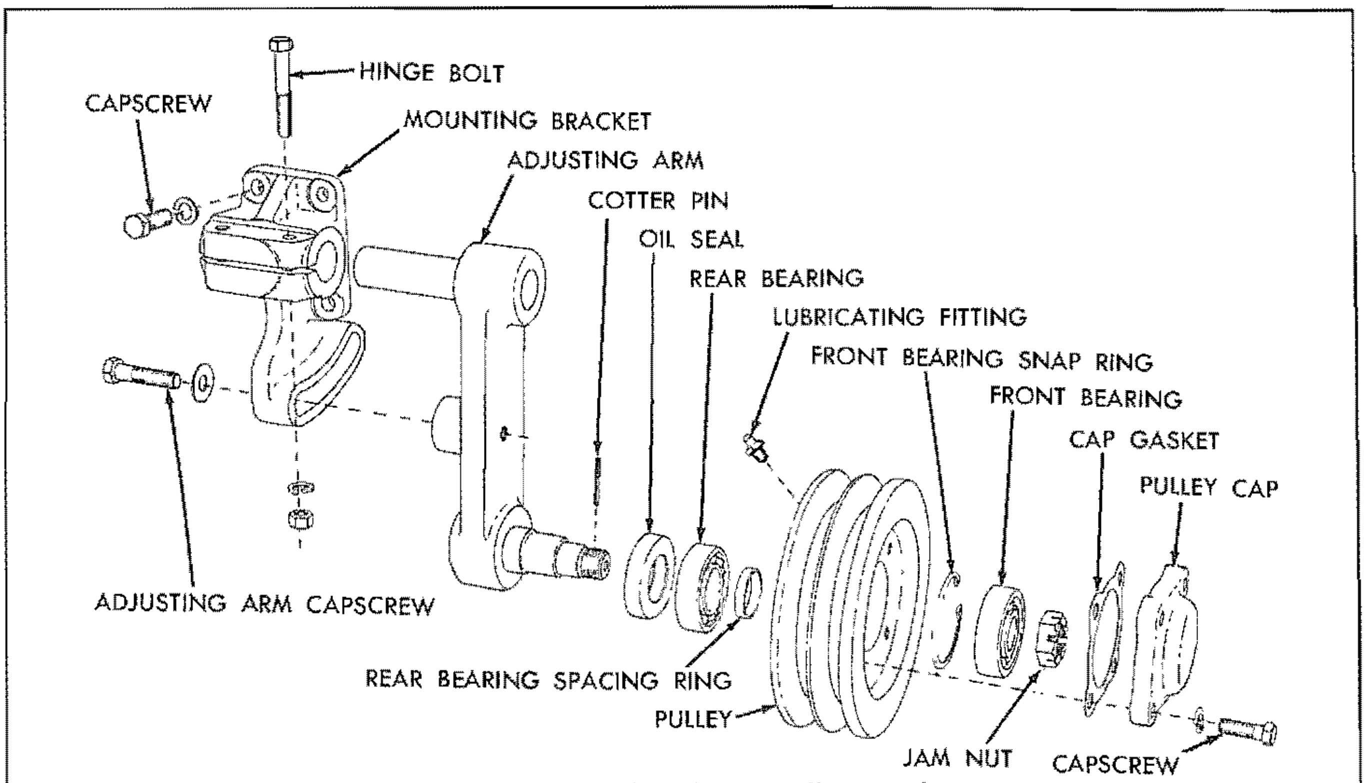


Fig. 12—Fan Belt Tightening Idler Details

2. Remove the capscrews attaching the pulley cap to the pulley and remove the cap and the cap gasket. Remove the cotter pin and the jam nut from the adjusting arm.

3. Place the arm assembly in a suitable press and press the adjusting arm out of the pulley assembly. Remove the front bearing and the snap ring from the pulley. Remove the rear bearing spacing ring, rear bearing, and the oil seal from the adjusting arm.

K. Inspection of Fan Belt Tightening Idler Parts

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

L. Assembly of Fan Belt Tightening Idler

When assembling the fan belt tightening idler, refer to Fig. 12 which shows the relative location of the parts.

1. Install the snap ring in position in the bore of the pulley. Place the pulley on the bed of a press, with the rear face of the pulley down. Press the front bearing into the pulley until the bearing is tight against the snap ring. Install the pulley cap to hold this bearing in position.

2. Place the pulley on the press so that the pulley cap is resting on the bed of the press. Place the rear bearing spacing ring in position on the inner race of the front bearing and press the rear bearing into the pulley until the rear bearing is tight against the spacing ring. Press the oil seal into the pulley, with the lip of the seal pointing away from the bearing.

3. Remove the pulley cap. Using a suitable tool (sleeve) to support the inner and outer race of the front bearing, place the pulley and the tool on the press so that the arm may be installed. Lubricate the oil seal with engine oil and press the arm into position in the pulley bearings.

4. Install and tighten the jam nut and secure with a cotter pin. Place the cap gasket and pulley cap in position on the pulley and secure with four (4) capscrews and lockwashers.

5. Install the lubricating fitting in the pulley if the fitting was removed; fill the bearing compartment of the pulley with lubricant through this fitting.

6. Install the mounting bracket in position on the arm assembly but do not tighten the hinge bolts.

M. Installation of Fan Belt Tightening Idler

1. Place the idler assembly in position on the engine and secure the mounting bracket to the engine balance weight cover with three (3) capscrews and lockwashers.

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

3. Move the idler pulley out until the correct tension on 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 adjusting arm capscrew and the fan idler hinge bolts (refer to Fig. 10).

4. Install the right front fender.

SECTION V—ENGINE LUBRICATING SYSTEM

1. DESCRIPTION OF SYSTEM

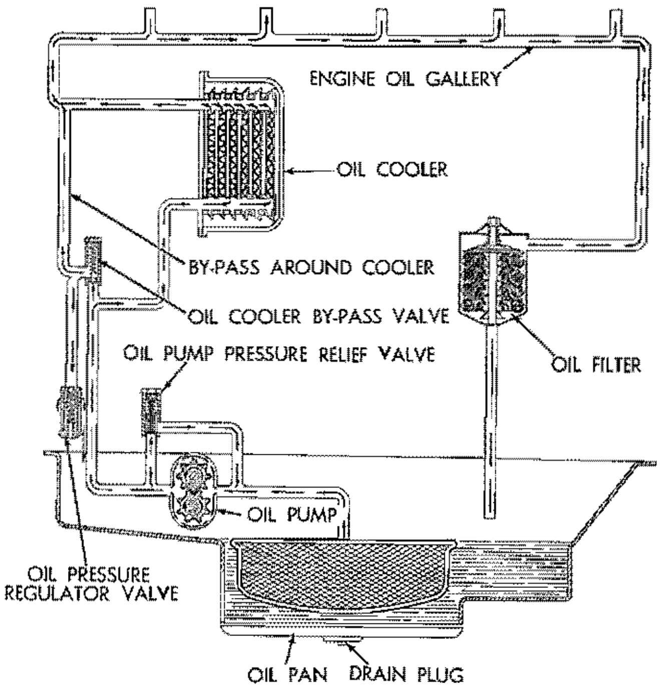


Fig. 1—Schematic Diagram Showing Oil Flow

The engine lubrication system shown schematically, includes the gear driven oil pump, oil pump pressure relief valve, oil cooler, oil cooler by-pass valve, oil pressure regulator valve, oil filter, and the oil passages in the engine block and the cylinder head.

The oil pump draws the oil from the engine crankcase and circulates it under pressure through the oil cooler, engine, and the oil filter. An oil pump pressure relief valve, located in the oil pump body, limits the oil pump discharge pressure. An oil cooler by-pass valve, located in the engine oil cooler adapter, by-passes the oil directly from the oil pump to the lubrication system in the engine if the oil passages in the oil cooler core become clogged, or if in cold weather the oil is too thick to circulate freely through the oil cooler core. Stabilized oil pressure is maintained within the engine by an oil pressure regulator valve, located in the oil gallery at the front end of the engine block.

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

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

Oil for the lubrication of the connecting rod bearings, piston pins, and for cooling 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. The blower drive gear bearing is lubricated through an external pipe connected to 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 oil galleries at each end of the cylinder block. Oil from longitudinal 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 the push rods. The oil then 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. This provides lubrication for the blower drive gears at the rear end, and for the governor, drive assembly at the front end. A partition in the blower housing cover maintains an oil level which submerges the teeth of the lower gear of the blower. An oil slinger, located on the front end of the lower rotor shaft, throws oil into the governor weight assembly. Surplus oil passes from the blower to the engine crankcase 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 driving gear located on the front end of the engine crankshaft. The oil pump intermediate gear support is doweled and bolted to the front of the oil pump body.

The oil pump body gears are enclosed in a pump body which is bolted to the No. 1 and No. 2 main bearing caps. A plunger-type pressure 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 pump discharge pressure exceeds approximately 100 pounds per square inch. To protect the oil pump body gears, and to prevent the pump from losing its prime, a screen is attached to the pump oil inlet. The oil screen is partially immersed in the lubricating oil contained in the oil pan.

B. Oil Pump Removal

1. Remove the crankcase guard.

2. Drain the oil from the engine crankcase and remove the oil pan from the engine.

3. Remove the capscrew and lockwasher attaching the pump oil inlet to the inlet supporting bracket. Remove the two (2) capscrews and lockwashers attaching the oil inlet to the pump body and remove the oil inlet and its attaching gasket. Remove the two (2) capscrews and lockwashers attaching the pump-to-regulator pipe (Fig. 3) to the oil pressure regulator.

4. Remove the four (4) capscrews attaching the oil pump assembly to the front two (2) main bearing caps, then remove the pump assembly from the engine, using care not to lose the oil pump adjusting shims. Tie the adjusting shim packs to their respective positions on the pump body.

C. Disassembly of Oil Pump

1. Remove the two (2) capscrews and lockwashers attaching the pump-to-regulator pipe (Fig. 3) to the oil pump body and remove the pipe and its attaching gasket.

2. Remove the oil pump pressure relief valve plugs and gaskets from each side of the pump body, then jar the pressure relief

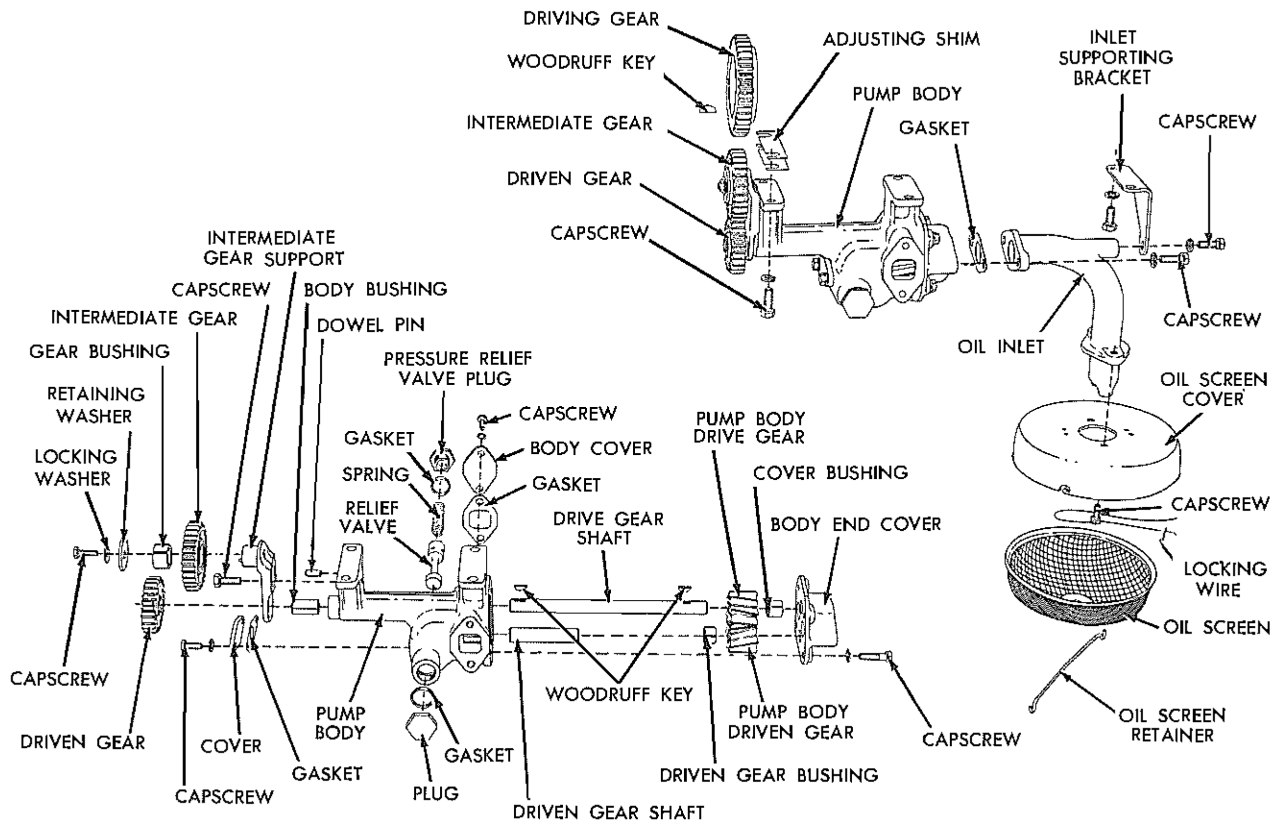


Fig. 2—Oil Pump Details

valve and the spring from the body.

3. Remove the four (4) capscrews and lockwashers attaching the body end cover to the pump body and remove the cover.

4. Remove the pump body driven gear (lower gear) from the driven gear shaft.

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

6. Pull the drive gear shaft (including the pump body drive gear) from the pump body. Place the drive gear shaft in an arbor press and press the shaft from the pump body drive gear. Remove the "WOODRUFF" key from the shaft.

7. Remove capscrew, locking washer, and retaining washer securing the intermediate gear to the intermediate gear support and remove the intermediate gear.

D. Cleaning and Inspection of Oil Pump Parts

1. Wash the oil pump parts in clean solvent or fuel and thoroughly inspect before reassembly.

   The principal wearing parts of the oil pump are the pump body gears. If dirt or sludge have been allowed to accumulate in the lubricating system, the oil pump body gear wear may be rather pronounced in a comparatively short time.

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

The radial clearance between the pump body 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 for excessive wear or scoring and replace the necessary parts.

4. Inspect the pressure relief valve and its bore in the pump body for wear and scoring and replace the relief valve and pump body if necessary.

E. Assembly of Oil Pump

When assembling, refer to Fig. 2 which shows the relative location of the pump parts.

1. Install the "WOODRUFF" key in the rear keyway of the drive gear shaft and start the pump body drive gear in position on the shaft and the key. Press the shaft into the gear so that the distance from the rear face of the gear to the rear end of the shaft is ¾".

2. Lubricate the drive gear shaft with engine oil and insert the drive gear shaft into position in the pump body. Install the "WOODRUFF" key in the front keyway of the shaft. Stand the pump body and the drive gear shaft in a press so that the rear end of the shaft is supported by the press. Make certain the flat face of the driven gear is toward the pump body and start the gear onto the front end of the shaft. Press the driven gear onto the shaft to within .004" to .006" of the pump body.

3. Lubricate the driven gear shaft and the bushings in the pump body driven gear with engine oil. Install the pump body driven gear in position on the driven gear shaft.

4. Place the body end cover in position on the pump body and secure with capscrews and lockwashers.

5. Lubricate the bushing in the intermediate gear and install the gear in position on the intermediate gear support, with the flat face of the intermediate gear facing the gear support. Place the retaining washer and the locking washer in position on the gear support and install the capscrew. Tighten the capscrew and secure with the locking washer.

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

7. Place the oil inlet in position on the pump body, using a new attaching gasket. Secure the oil inlet to the pump body with capscrews and lockwashers.

8. Install the oil screen in position in the oil screen cover and secure the oil screen with the screen retainer.

F. Oil Pump Installation

1. Place the oil pump assembly in position on the front two (2) main bearing caps, placing the adjusting shims in their original positions, and install the attaching lockwashers and capscrews.

   NOTE: *The backlash between the oil pump driven gear and the intermediate gear should be .005" to .008". This backlash is NOT adjustable. If the backlash between these two gears exceeds .010", the gears must be replaced.*

   The backlash between the intermediate gear and the driving gear (gear on front end of crankshaft) should be .005" to .020". The backlash between these two gears is adjustable by the use of adjusting shims between the mounting pads of the pump body and the main bearing caps. The addition of a .005" adjusting shim will increase the backlash between the two gears approximately .0035".

The above clearance measurements must always be taken with the pump tightened securely to the main bearing caps.

2. Install the capscrew and lockwasher used to secure the oil inlet to the inlet supporting bracket. Install the pump-to-regulator pipe (Fig. 3), using new attaching gaskets, and secure the pipe to the pump body and to the oil pressure regulator with capscrews and lockwashers.

3. Install the oil pan on the engine, using a new oil pan gasket, and secure with capscrews and lockwashers. Make certain the oil pan drain plug is tightened securely. Fill the engine crankcase to the proper level with the specified lubricant.

4. Install the crankcase guard.

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 an oil pressure regulator assembly, located at the right front corner of the engine crankcase and in registration with the vertical oil gallery.

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

B. Service of Oil Pressure Regulator

Under normal conditions, the oil pressure regulator should require little or no attention. If the lubricating system has been allowed to sludge up, the valve of the regulator may not work freely, causing sticking in the opened or the closed position.

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

C. Removal of Oil Pressure Regulator

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

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

2. Strike the lower end of the regulator body lightly to separate the regulator body from the gasket and the cylinder block. Remove the regulator assembly and gasket.

D. Disassembly and Inspection of Oil Pressure Regulator

1. Clamp the regulator body in a vise and remove the plug.

2. Remove the spring and valve from the regulator body.

3. Thoroughly clean the parts in clean solvent or fuel, dry with compressed air, and inspect. All oil passages must be open and the valve must be smooth and free from scoring. Lubricate the valve with engine oil, insert it into place in the bore of the regulator body, and make certain the valve moves freely in its bore.

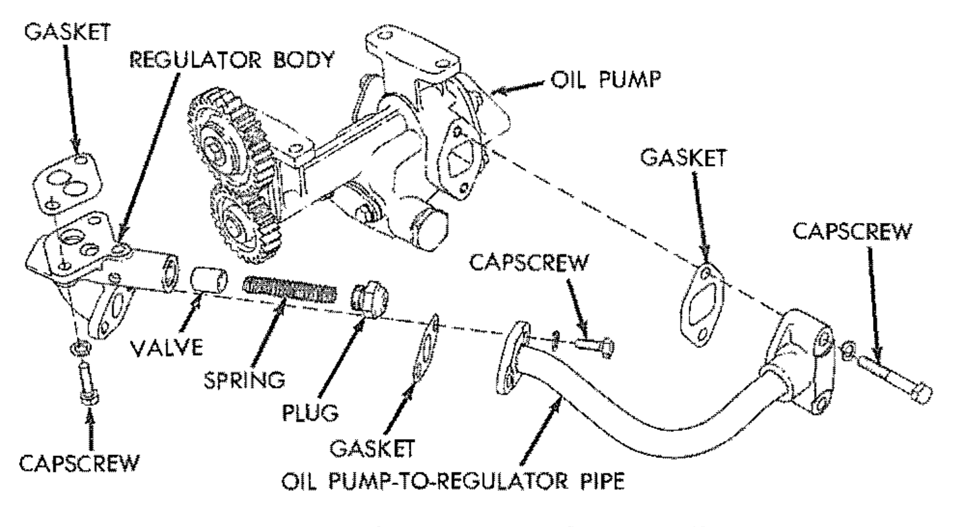


Fig. 3—Oil Pressure Regulator Details

E. Assembly and Installation of Oil Pressure Regulator

When assembling, refer to Fig. 3 which shows the relative location of all parts.

1. Lubricate the valve with engine oil and insert it into position in the regulator body, with opened end of valve toward the threaded end of the bore.

2. Insert the spring into the regulator body and the valve, then install the plug and tighten securely.

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

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

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

4. OIL PUMP DRIVING GEAR AND INTERMEDIATE GEAR

A. Description

The oil pump intermediate gear is mounted on a support which is doweled and bolted to the front of the lubricating oil pump body as shown in Fig. 2. With this type mounting, the intermediate gear may be inspected or replaced when the lubricating oil pump is removed from the engine.

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

B. Removal of Oil Pump Driving Gear and Intermediate 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 gear and the driving gear. The minimum backlash is .005" and the maximum is .020"; the backlash between these two gears is controllable by the use of adjusting shims between the pump and the main bearing caps.

If replacement of the pump intermediate gear is necessary, the oil pump must be removed to replace the gear (refer to "LUBRICATING OIL PUMP" in this Section).

To replace the oil pump driving gear, proceed as follows:

1. Remove the air pre-cleaner, engine hood, and the radiator assembly (refer to "RADIATOR AND RADIATOR SHELL" in Section IV).

2. Remove the crankshaft pulley from the front of the crankshaft (refer to "CRANKSHAFT, CRANKSHAFT PULLEY, FLYWHEEL, AND MAIN BEARINGS" in Section IX).

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

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

5. Remove the capscrews attaching the crankshaft front cover to the cylinder block and remove the cover.

6. Remove the front oil seal spacer, oil slinger, and the oil pump driving gear from the front end of the crankshaft.

C. Installation of Oil Pump Driving Gear

1. Insert the "WOODRUFF" key in the crankshaft and push the oil pump driving gear in

position on the crankshaft, with the hub of the gear facing the main bearing. Install the oil slinger, with the convex side of the slinger next to the gear.

2. Inspect the front oil seal and replace if necessary. Install the crankshaft front cover in position on the engine and secure with the attaching capscrews. Lubricate the oil seal, start the front oil seal spacer on the crankshaft and push it back through the oil seal and against the oil slinger.

3. Examine the cushion ring (rubber ring) for the engine front support cap and make certain that it is in good condition. Install the engine front support and the support cap in position on the crankshaft front cover and start the cap attaching capscrews but do not tighten.

4. Lower the front end of the engine so that the front support rests on the main frame and install and tighten attaching capscrews.

5. Tighten the capscrews attaching the engine front support cap to the front support.

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

7. Install the two (2) "WOODRUFF" keys in the crankshaft and install the crankshaft pulley, retaining washer, and the crankshaft capscrew.

8. Install the radiator assembly, engine hood, and the air pre-cleaner (refer to "INSTALLATION OF RADIATOR AND RADIATOR SHELL" in Section IV).

5. LUBRICATING OIL COOLER

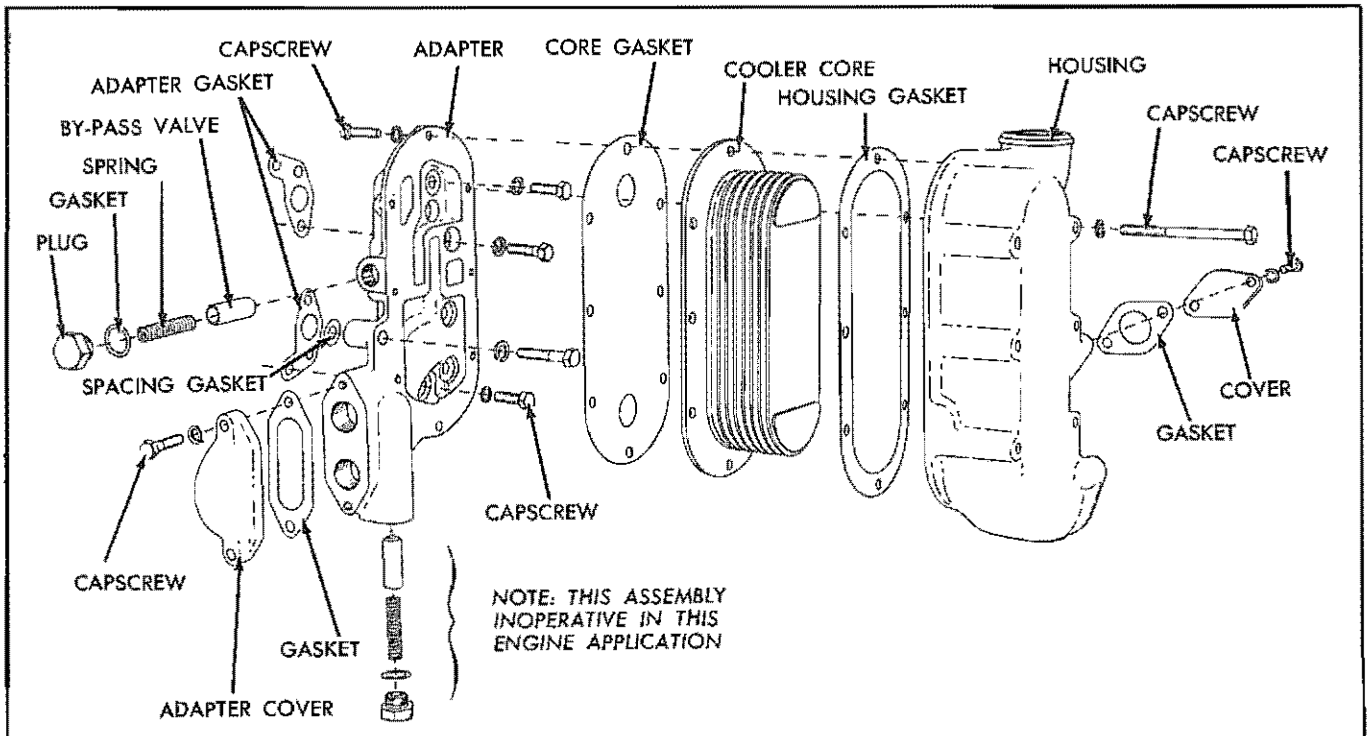


Fig. 4—Lubricating Oil Cooler Details

A. Description

The oil cooler, located on the right front corner of the engine, consists of a multiple plate, corrosion resistant, cooling core contained in a cast iron housing. The engine lubricating oil pump circulates oil through the cooler core and the water pump circulates water through the housing, around the outside of the plates of the core, thereby controlling the oil temperature. The oil enters the cooling core at the bottom, flows through the inside passages, and is discharged at the top into an oil gallery in the cylinder block.

B. Removal of Lubricating 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-oil cooler seal. Disconnect the oil cooler water connection elbow from the bottom of the oil cooler housing by removing two (2) capscrews from the elbow attaching flange.

3. Remove the capscrews attaching the oil cooler housing to the adapter. The housing, cooler core, and the gaskets may now be removed from the engine.

C. Cleaning of Oil Cooler

The oil cooler is lined with small fins which dissipate heat from the oil to the cooling water. If proper lubricating oil maintenance procedure is followed, the cooler will function efficiently. However, if the oil in the engine is not changed at the recommended intervals, impurities will be deposited in the cooler core; consequently causing restriction or clogging of the oil passages in the cooler core. Clogging of the oil cooler core is usually indicated by a drop in oil pressure. If this occurs, the core must be cleaned or a new one installed.

IMPORTANT: *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, 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 cooler 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 material from the core.

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

D. Installation of Lubricating Oil Cooler

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

2. Connect the water pump to the top of the oil cooler housing with the water pump-to-oil cooler seal and tighten the hose clamp.

3. Use a new attaching gasket and install the oil cooler water connection elbow on the oil cooler housing and secure with two (2) capscrews and lockwashers.

4. Install the governor breathing pipe. Fill the engine cooling system (refer to "FILLING AND DRAINING OF SYSTEM" in Section IV). Start the engine and check for leaks at the oil cooler.

5. Install the right front fender.

6. OIL COOLER BY-PASS VALVE

A. Description

The oil cooler by-pass valve is located in the oil cooler adapter and consists of a hollow piston type valve, spring, and plug. The by-pass valve is held on its seat by the spring, which is compressed by the plug screwed into the valve opening in the 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 forced from its seat and oil from the engine oil gallery is by-passed around the cooler core and into the engine (refer to Fig. 1).

B. Service

Under normal conditions, this valve should require very little attention. If the lubricating system has been allowed to sludge the valve may not work freely, sticking in the opened or closed positions.

Whenever the lubricating oil cooler is removed for inspection, this valve assembly should be removed, cleaned, and inspected.

NOTE: *The valve assembly located in the bottom of the oil cooler adapter need not be serviced as it is inoperative in this engine application.*

C. Removal of Oil Cooler By-Pass Valve

1. Remove the right front fender.
2. Remove the by-pass valve plug from the oil cooler adapter, then withdraw the spring and valve.

D. Inspection

The valve and the bore in the oil cooler adapter should be thoroughly cleaned, dried with compressed air, and inspected.

The valve must be smooth and free from scoring. Lubricate the valve with engine oil, insert it into place in the bore of the adapter, and make certain the valve moves freely in its bore.

E. Installation of Oil Cooler By-Pass Valve

When assembling, refer to Fig. 4 which shows the relative location of all parts.

1. Lubricate the valve with engine oil and insert it into position in the cooler adapter, with the opened end of the valve toward the rear of the engine.
2. Insert the valve spring. Install the gasket on the plug, start the plug into the cooler adapter, and tighten securely.
3. Install the right front fender.

7. LUBRICATING OIL FILTER

A. Description

The lubricating oil filter, mounted on the left side of the engine, is of the by-pass type and contains a replaceable type element. A drain plug in the bottom of the filter shell permits draining of the filter for replacement of the element. A new element kit must be installed each time that the oil in the engine crankcase is changed, or more often if conditions warrant.

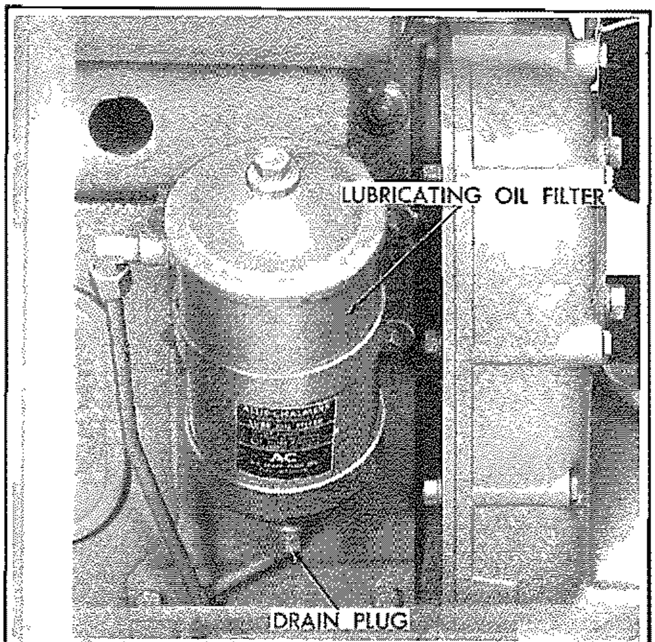


Fig. 5 — Lubricating Oil Filter Location

B. To Change Filter Element

1. Thoroughly clean the filter cover and the surrounding area. Remove the drain plug from the bottom of the filter shell and allow the filter to drain.
2. Loosen the cover screw and remove the cover screw, cover screw gasket, cover, cover gasket, and spring as a unit. Remove the cover gasket from the cover and discard the gasket.
3. Remove and discord the element washer, element gasket, and the filter element.
4. Reaching inside the filter shell, remove the element gasket and element washer from the shell center-tube and discard.
5. Thoroughly wash and dry the interior of the filter shell. Install and tighten the filter drain plug.
6. Install a new element washer in position on the shell center-tube, then install a new element gasket and press the gasket down firmly onto the element washer.
7. Install a new filter element in position in the filter shell. Place a new element gasket and element washer in position on the shell center-tube and press the gasket down firmly onto the top of the filter element.
8. Install a new cover gasket in position in the cover. Install the cover in position on the filter shell and tighten the cover screw securely.
9. Start the engine and observe for oil leakage at the filter cover.

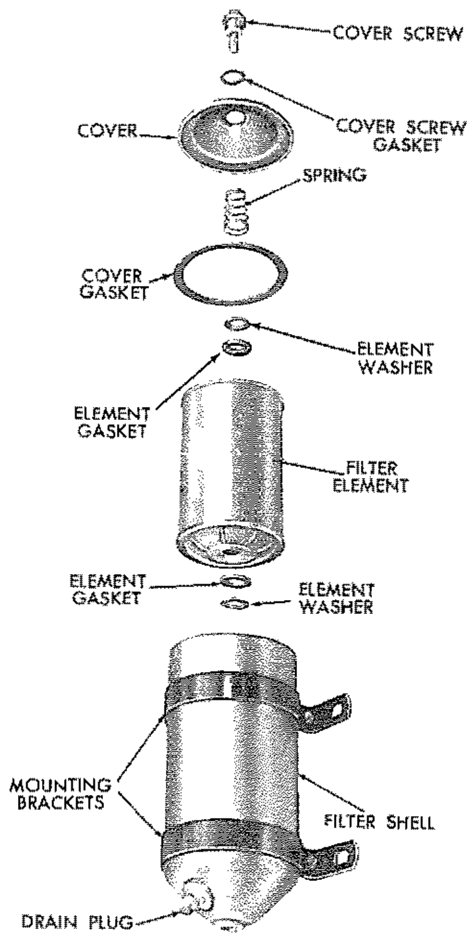


Fig. 6 — Lubricating Oil Filter Details

C. Heavy-Duty Lubricating Oil Filter

On tractors equipped with a Heavy-Duty Lubricating Oil Filter, the filter element must be changed at each engine oil change.

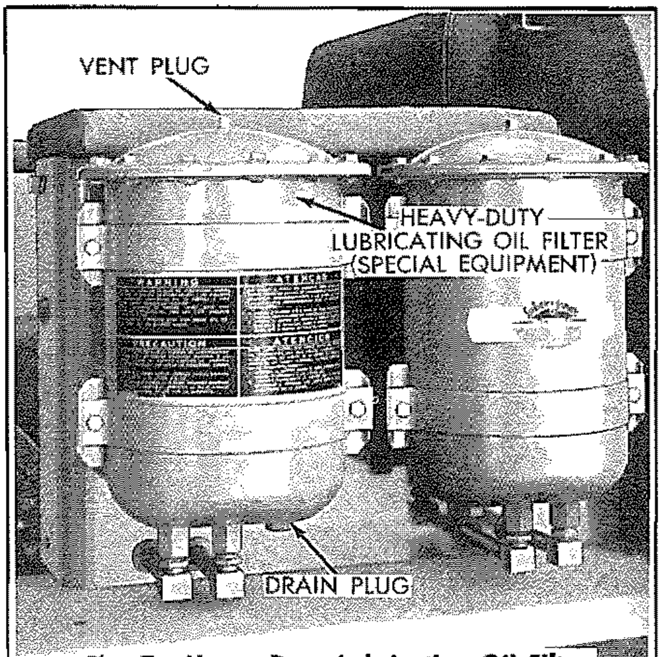


Fig. 7 — Heavy-Duty Lubricating Oil Filter Location

D. To Change the Heavy-Duty Lubricating Oil Filter Element

1. Thoroughly clean the filter cover and the surrounding area. Remove the drain plug, located in the bottom of the filter housing, and allow the filter to drain. Remove the cover capscrews and lift the cover from the housing.

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

3. Clean the interior of the filter housing thoroughly and install the drain plug.

4. To assure leak-proof sealing, examine the center-tube seal at each end of the new filter element to see that the seals are in good condition and clean. Insert the new filter element into position in the filter housing and press the filter element down firmly.

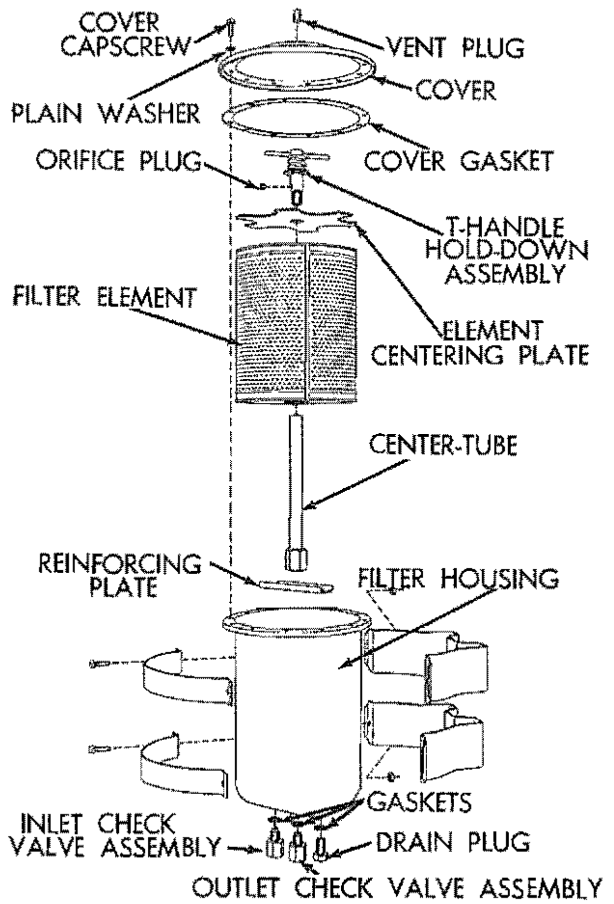


Fig. 8 — Heavy-Duty Lubricating Oil Filter Details

5. Place the element centering plate in position on the top of the filter element. Make certain that the hole in the orifice plug, located in the T-handle hold-down assembly, is open. Install the T-handle hold-down assembly and tighten securely.

   CAUTION: *When servicing the Heavy-Duty Filters, make certain that the T-handle hold-down assemblies are reinstalled in their respective filter as the T-handle hold-down assembly for the engine lubricating oil filter contains an orifice plug. The T-handle hold-down assembly for the fuel filter does not contain an orifice plug.*

6. Install a new cover gasket in position in the cover and place the cover in position on the filter housing. Install the cover capscrews and tighten evenly and securely.

7. Fill the engine crankcase to the proper level with the specified lubricating oil.

8. Remove the vent plug from the filter cover.

9. Start the engine and operate it at low idle speed until oil emerges from the vent plug opening in the filter cover, then stop the engine. Install and tighten the vent plug.

10. Check the oil level of the engine crankcase and add oil as necessary to raise the oil level to the "FULL" mark on the oil level gage rod.

CAUTION: *Use only a "DIESELPAK" filter element in the Heavy-Duty Filter.*

SECTION VI—ENGINE CONTROLS AND GOVERNOR

1. THROTTLE AND ENGINE SHUT-OFF CONTROLS

A. Description

The throttle operating lever is used to regulate the speed of the engine. Throttle control rods and linkage connect the throttle operating lever with the variable speed control lever on the governor. The engine runs at full governed speed when the throttle operating lever is pulled all the way back and runs at idling speed when the throttle operating lever is pushed all the way forward.

The throttle operating lever is located on the shaft of the throttle assembly, which is mounted on a bracket welded to the cowl. The throttle assembly is connected to the governor variable speed control lever by two (2) control rods having adjustable yokes. The throttle assembly consists of a shaft and drum, friction band assembly, housing, and covers. The friction band, which is assembled around the drum, acts as a brake and holds the throttle operating lever in any desired position, therefore, an infinite range of engine speed can be obtained between idle and wide open. The friction band assembly is provided with an adjusting capscrew for adjusting the tightness of the band on the drum for ease of throttle operation.

The engine shut-off rod opens and closes an air shut-off 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 knob is pushed in (forward) as far as it will go (running position), the air shut-off valve and the governor fuel shut-off lever are moved to their full open position. When the engine shut-off control knob is pulled out (back) as far as it will go, the air shut-off valve and the governor fuel shut-off lever are moved to their closed position.

B. Adjustment of Engine Shut-Off Controls

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

1. Push the engine shut-off control knob 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 control knob

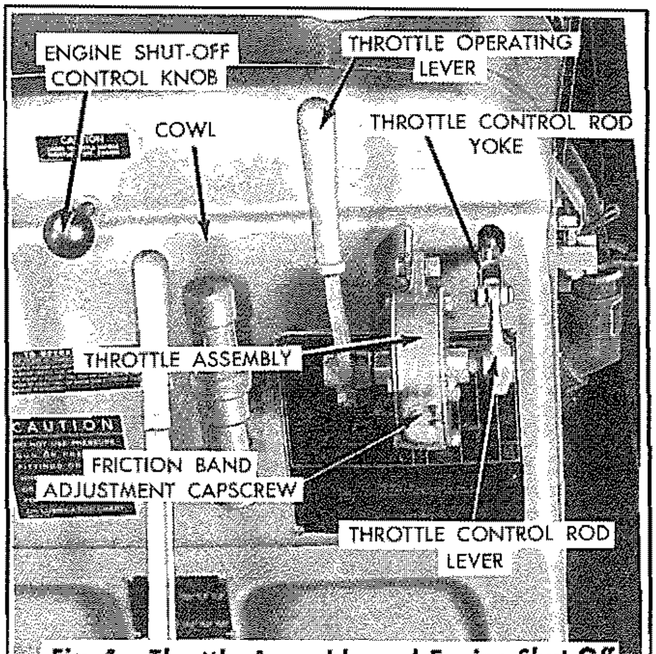


Fig. 1—Throttle Assembly and Engine Shut-Off Control Knob Location

is not striking the cowl. If the knob is striking, adjust the shut-off rear rod by turning it out of the yoke as necessary. If the air shut-off valve swivel lever still does not contact its stop, shorten or lengthen the shut-off front rod by turning it in or out of the yoke as necessary. Loosen the bolt in the stop clamp on the shut-off rear 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 stop clamp bolt. With the stop clamp in this position, it will prevent the air shut-off valve from bottoming in the blower air inlet elbow when the shut-off control knob is pulled back to stop the engine.

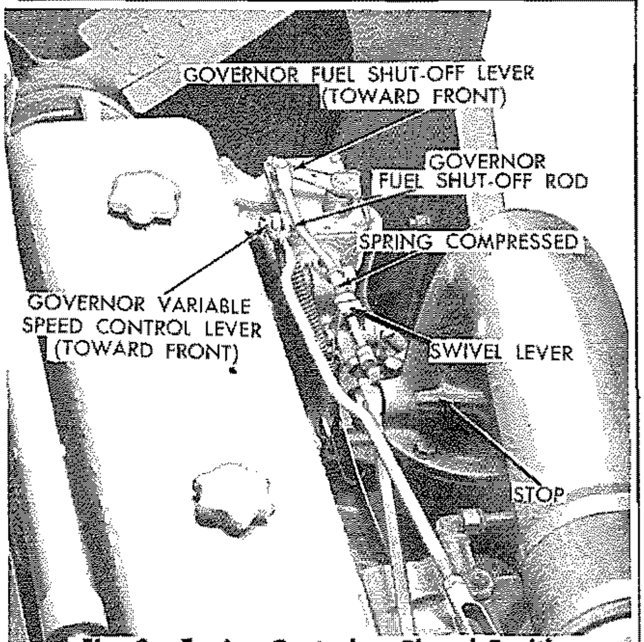


Fig. 2 — Engine Controls — Closed Position

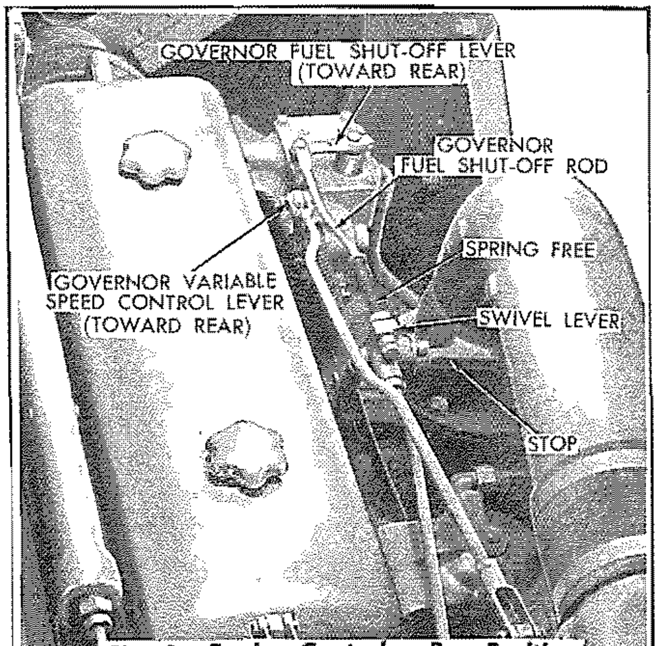


Fig. 3 — Engine Controls — Run Position

2. To adjust the governor fuel shut-off control, push the engine shut-off control knob forward 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 (toward the cowl) as far as it will go and check to see if the hole in the fuel shut-off rod lines up with the hole in the governor fuel shut-off lever.

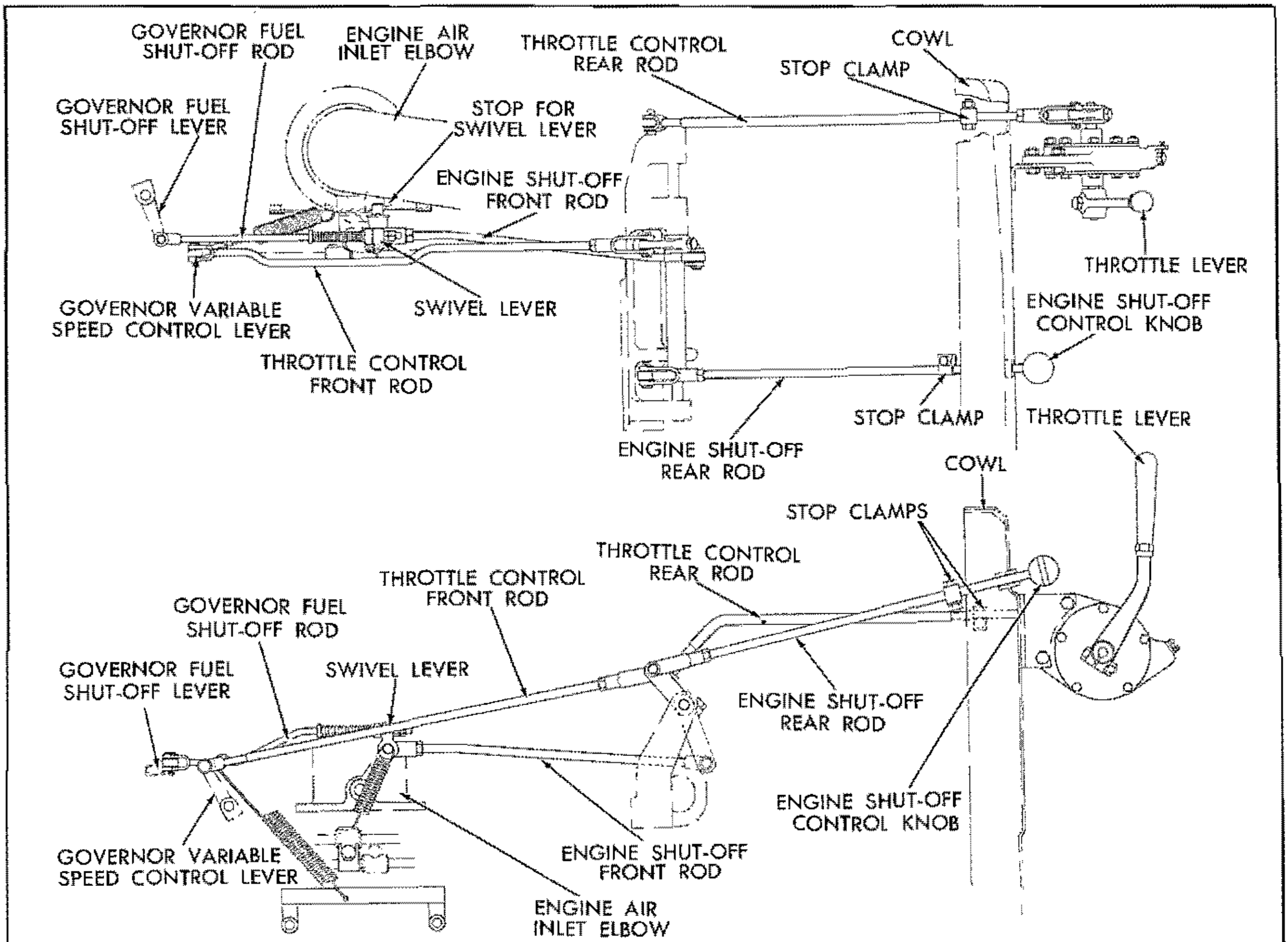


Fig. 4 — Engine Controls and Linkage

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 held all the way back. Tighten the capscrew used to clamp the fuel shut-off lever to the shaft, then install the control rod pin and cotter pin.

3. Loosen the bolt in the stop clamp on the throttle control rear rod. Pull the throttle operating lever all the way back (wide open) and make certain the throttle linkage pulls the governor variable speed control lever back as far as it will go (high idle position); shorten or lengthen the throttle control front and rear rods by turning the control rod yokes, if necessary. Push the throttle operating lever forward 1/16", move the stop clamp back on the throttle control rear rod so that it contacts the cowl, and tighten the stop clamp bolt. With the stop clamp in this position, the clamp will serve as a stop when the throttle operating lever is pulled back to the high speed position.

4. To adjust the throttle assembly for proper operation, remove the cotter pin from the friction band adjustment capscrew (refer to Fig. 1). Turn the adjustment capscrew as necessary (in to tighten or out to loosen) so that the throttle operating lever will remain in any desired position (from idle to wide open) and for ease of lever operation. Install the cotter pin to secure the adjustment capscrew.

2. GOVERNOR

A. Description

The governor, mounted to the front end 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 front end of the weight carrier shaft is mounted on a ball bearing and the rear end of the shaft is supported inside of, and driven by, the upper rotor shaft of the blower.

The governor control mechanism transmits the motion of the governor weights to the injector racks. This control mechanism consists of a vertical control shaft mounted inside a control shaft housing. The vertical control shaft is mounted in a ball bearing at the upper end and in a needle bearing at the lower end. The control shaft has a fork fixed to the lower end and a control shaft lever and a differential lever at the upper end.

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

The spring plunger at one end of the variable speed spring, located in the top of the governor control shaft housing, bears against the control shaft lever of the vertical control shaft. The opposite end of the variable speed spring is retained and guided inside a spring retainer, which in turn bears against a variable speed spring lever. The variable speed spring lever is controlled by the variable speed control lever, which is connected by linkage to the throttle operating lever. The governor is designed to control the engine at any constant speed (within the limits of the variable speed spring) that the operator may desire.

When the engine shut-off control rod is moved to the run position (pushed forward) for starting the engine, this in turn moves the injector control racks to the "FULL FUEL" position and also opens the 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 moving the throttle operating lever toward the rear, thus increasing the tension on the variable speed spring. The control of the engine speed is entirely automatic from this point on, depending upon the tension imposed on the variable speed spring.

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 seldom fails to function properly. 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 the injector control rack tube is not binding in its mounting brackets. The injector control mechanism must move freely throughout the entire travel of the injector racks. Should binding exist in the mechanism, it may be located and eliminated as follows:

   a. If the injector racks stick or move too hard, inspect the racks for an accumulation of gum or sludge. Sticking from this cause can usually be corrected by washing the parts in clean solvent or fuel. If 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 injector control tube until the lever does not cramp the injector rack. After this trouble has been remedied, adjust the lever to equalize the affected injector with the others (refer to "INJECTOR EQUALIZING," Section II).

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

   c. Remove the bind from the control link, connecting the governor differential lever to the injector control lever, if 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 for the following:

a. Wear on the governor variable speed lever shaft, variable speed spring lever, or a loose setscrew in the variable speed spring lever will cause loss of engine speed. Install new parts if wear is excessive.

b. Make certain the engine shut-off control rod moves the governor fuel shut-off lever all the way back (as far as the lever will go) when the control rod knob is moved to the 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.

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

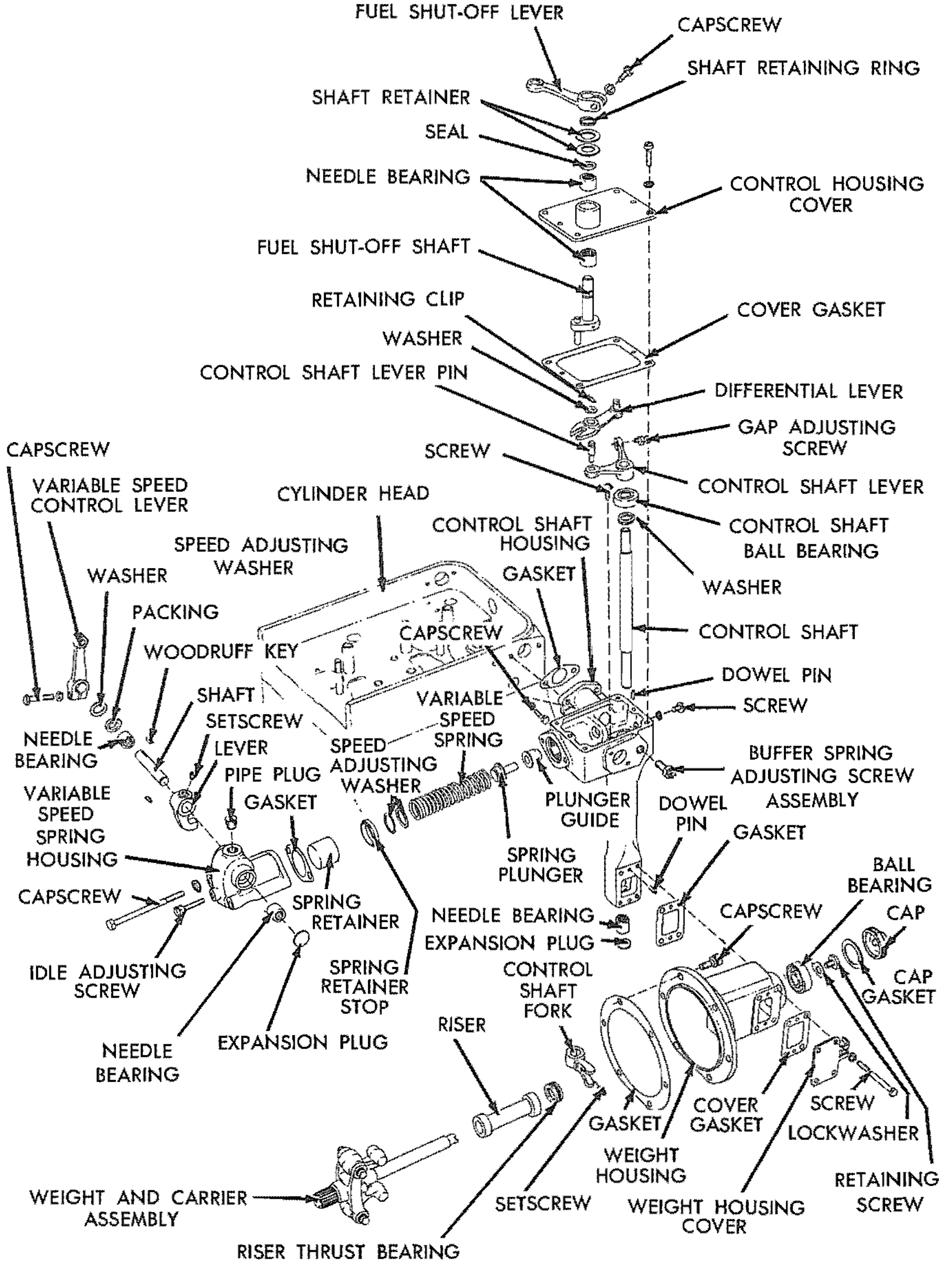


Fig. 5 — Governor Details

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

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

5. Remove the screws attaching the breathing pipe to the governor control shaft housing and the capscrew attaching the breathing pipe clip to the engine oil cooler housing.

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

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 of the fan belts and remove the belts from the idler pulley. Remove the three (3) capscrews attaching the fan belt tightening idler mounting bracket to the engine front cover and remove the idler assembly.

8. Remove the capscrews attaching the governor weight housing to the blower. Remove the weight housing by pulling the assembly forward until the weight shaft is free from the rotor shaft of the blower.

9. After removing the governor assembly, it should be thoroughly washed in clean solvent, dried with compressed air, and inspected for worn and damaged parts, and for 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 control shaft housing.

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

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

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 variable speed spring lever in place on the shaft. Remove the shaft, variable speed spring lever, washer, and packing. NOTE: *A "WOODRUFF" key is used in addition to the setscrew to attach the variable speed spring lever to the shaft. To remove the shaft, drive the shaft out toward the expansion plug end of the housing.*

5. Remove the variable speed shaft needle bearings from the housing. NOTE: *The needle bearing which the shaft and "WOODRUFF" key was driven through to remove the shaft will be damaged by the key. Replacement of the needle bearing will be necessary.*

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 retaining screw and the lockwasher retaining the shaft in the ball bearing.

2. Press or drive the weight shaft out of the ball bearing, using care to prevent damage to the threads in the weight shaft, then remove the weight shaft, riser, and riser thrust bearing (three piece bearing) from the weight housing.

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

4. Press or drive the ball 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 shaft housing.

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

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

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

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

6. Remove the differential lever from the control shaft lever. Press the control shaft out of the control shaft lever and the control shaft ball bearing.

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

G. Disassembly of Governor Control Housing Cover

1. Remove the fuel shut-off lever from the fuel shut-off shaft, then remove the shaft retaining ring and the shaft retainers from the shaft.

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

3. Remove the fuel shut-off shaft seal and remove the needle bearings from the cover.

H. Inspection of Governor Parts

Clean all components thoroughly using clean fuel 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 assure proper functioning of the governor.

I. Assembly of Governor

To assemble the governor, reverse the disassembly procedure. Refer to Fig. 5 showing the parts in their relative position. When assembling the variable speed spring, make certain to install the close coil end of the spring in the spring retainer and the same total thickness of speed adjusting washers as were removed at the time of governor disassembly; these washers are installed to obtain the desired high idle speed. CAUTION: *When assembling, make certain the control shaft fork at the lower end of the control shaft is installed in front of all three pieces of the riser thrust bearing.*

J. Installation of Governor

1. INSTALL GOVERNOR WEIGHT HOUSING.

   Using gasket cement, cement the weight housing-to-blower gasket in place on the weight housing. Install the weight housing assembly against the front end of the blower, inserting end of weight carrier shaft into the front end of the upper rotor shaft of the blower. Install the attaching capscrews but do not tighten at this time.

2. INSTALL GOVERNOR CONTROL SHAFT HOUSING.

   Coat a new gasket with gasket cement and install it in position on the mounting surface at the upper end of the control shaft housing. Install a new gasket on the dowels at the lower end of the control shaft housing. Place the control shaft housing in position against the weight housing, place the weight housing cover and gasket in position, and attach the two housings together with the four (4) capscrews. Do not tighten the capscrews at this time. IMPORTANT: *Make certain the control shaft fork is properly inserted so that the rounded machined face of the fork bears against the outer race of the riser thrust bearing, and not between the outer race and the bearing balls.* With gasket in place, attach the upper end of the control shaft housing to the cylinder head with the attaching capscrews. Tighten all the attaching capscrews of the governor. Pour ½ pint of SAE 10 engine oil into the top of the control shaft housing for initial lubrication of the governor components.

3. CONNECT GOVERNOR CONTROL LINK.

   Insert the offset end of the governor-to-injector control lever 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 to the differential lever with a washer and a retaining clip. Connect the other end of the link to the injector control tube lever with a pin and cotter pin. Coat a new breathing pipe gasket with gasket cement and place it in position on the control housing. Place the breathing pipe in position on the control shaft housing and secure with the attaching screws. Install the capscrew attaching the breathing pipe clip to the oil cooler.

4. INSTALL GOVERNOR CONTROL HOUSING COVER ASSEMBLY.

   NOTE: *Before installing the control housing cover and the engine rocker cover, check the governor adjustment as outlined in "GOVERNOR ADJUSTMENT" in this Section. Equalize the injectors (refer to "INJECTOR EQUALIZING," Section II).* Place a new cover gasket in position on the dowel pins in the control shaft housing. Install the control housing cover in position on the control shaft housing and make certain the pin in the lower end of the fuel shut-off shaft engages the fork on the differential lever. Install the cover attaching screws and tighten securely. Connect the fuel shut-off rod to the fuel shut-off lever and check the travel of the fuel shut-off lever. Connect the throttle control front rod to the variable speed control lever.

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

6. Install the right front fender.

K. Governor Adjustment

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

1. CHECKING ENGINE SPEED.

   Operate the engine until normal operating temperature (160° to 185° F.) is indicated on the engine temperature gage. Hold a tachometer against the front end of the crankshaft. With the throttle operating lever all the way forward (idling position) and with the engine clutch disengaged, the engine speed should be 500 R.P.M. With the throttle operating lever all the way back (wide open position) 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. GOVERNOR SPRING PLUNGER GAP ADJUSTMENT.

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

c. The speed adjusting washers are installed by removing the variable speed spring housing from the control housing, lifting the spring from the spring retainer, and inserting additional adjusting washers in the spring retainer. Each adjusting washer of .010" thickness will increase the high idle engine speed approximately 20 R.P.M. To decrease the high idle speed, remove the necessary amount of adjusting shims. NOTE: *If the proper high idle engine speed cannot be obtained by the addition of adjusting washers, this may be due to the governor spring retainer contacting the spring retainer stop. If this condition is found, remove the spring retainer stop and all speed adjusting washers. After the above parts have been removed, reassemble the governor, start the engine, and check the high idle speed. Add speed adjusting washers as necessary to obtain the specified high idle speed.*

4. LOW IDLE SPEED ADJUSTMENT.

After adjusting the governor for the correct high idle engine speed, the low idle engine speed should be checked and adjusted if necessary to obtain a 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 there is approximately ⅛" clearance between the spring and the differential lever. With the throttle operating lever in "LOW IDLE" position, loosen the lock nut on the idle adjusting screw and turn the screw in as necessary to raise the low idle speed or out as necessary to lower the low idle speed. Tighten the

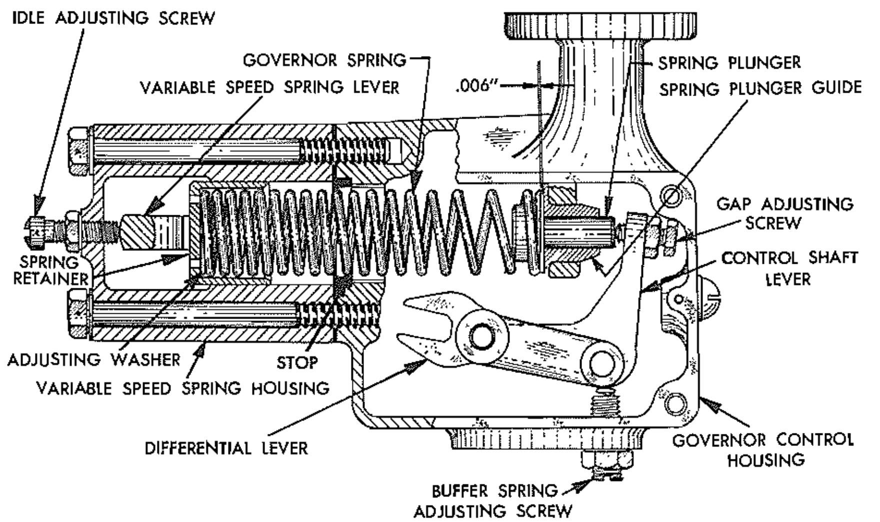


Fig. 6 — Governor Adjustment

lock nut when the correct low idle engine speed is obtained.

With the engine running at low idle speed, turn the buffer spring adjusting screw in until a very slight increase (not to exceed an increase of 20 R.P.M.) is noted in the low idle speed, 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 is supplied by two 6-volt, wet cell, storage batteries carried in compartments at the ends of the seat.

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

2. WARRANTY AND ADJUSTMENT POLICY

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

3. WIRING SYSTEM

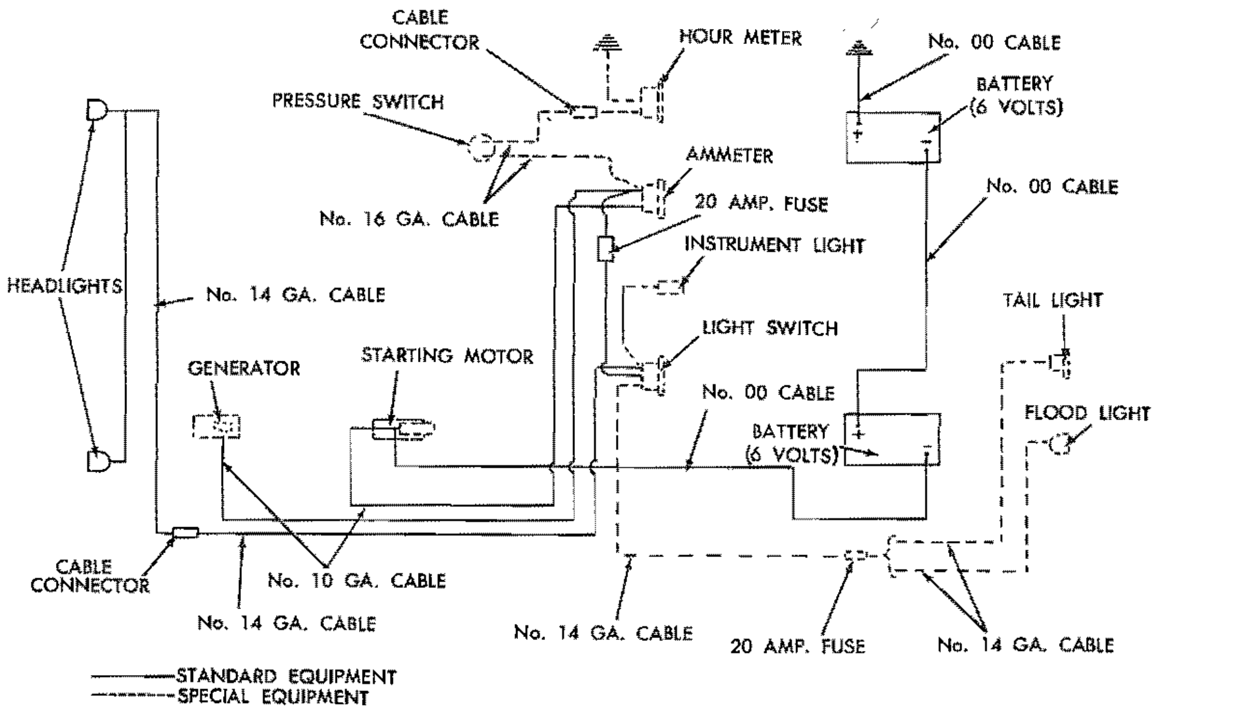


Fig. 1 — Wiring Diagram

Heavy cables connect the batteries and the starter, 10 gage cables connect the ammeter and generator, and 14 gage cables connect the remaining units. A 20-ampere fuse, connected into the cable extending from the ammeter to the light switch, prevents burning out of the lights in the event of a short-circuit. An additional fuse is provided in the electrical cable, near the rear of the tractor, for protection of special lighting equipment.

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 6-volt, wet cell type, located in compartments at the ends of the seat (under the arm rests), and are held in position by special hold-down assemblies. The batteries are connected in series to provide 12-volt current.

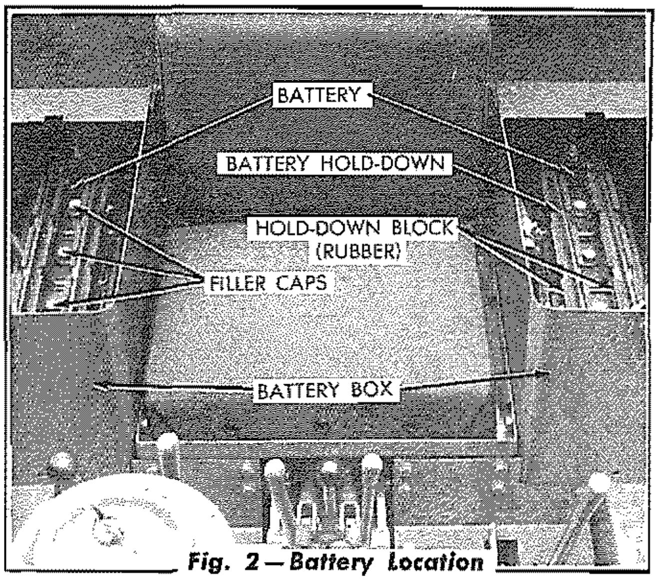


Fig. 2—Battery Location

B. Service

Check the level of the electrolyte in the batteries every 75 hours of operation, or as often as operating conditions prove it necessary. Maintain the level of the solution ⅜" above the battery plates by the addition of clean distilled water. NOTE: *DO NOT OVERFILL.* Keep the battery and cable terminals tight and clean. If corrosion occurs, clean the battery posts and terminals with a strong soda solution and coat the terminals lightly with vaseline before connecting them again. The vaseline will prevent further corrosion.

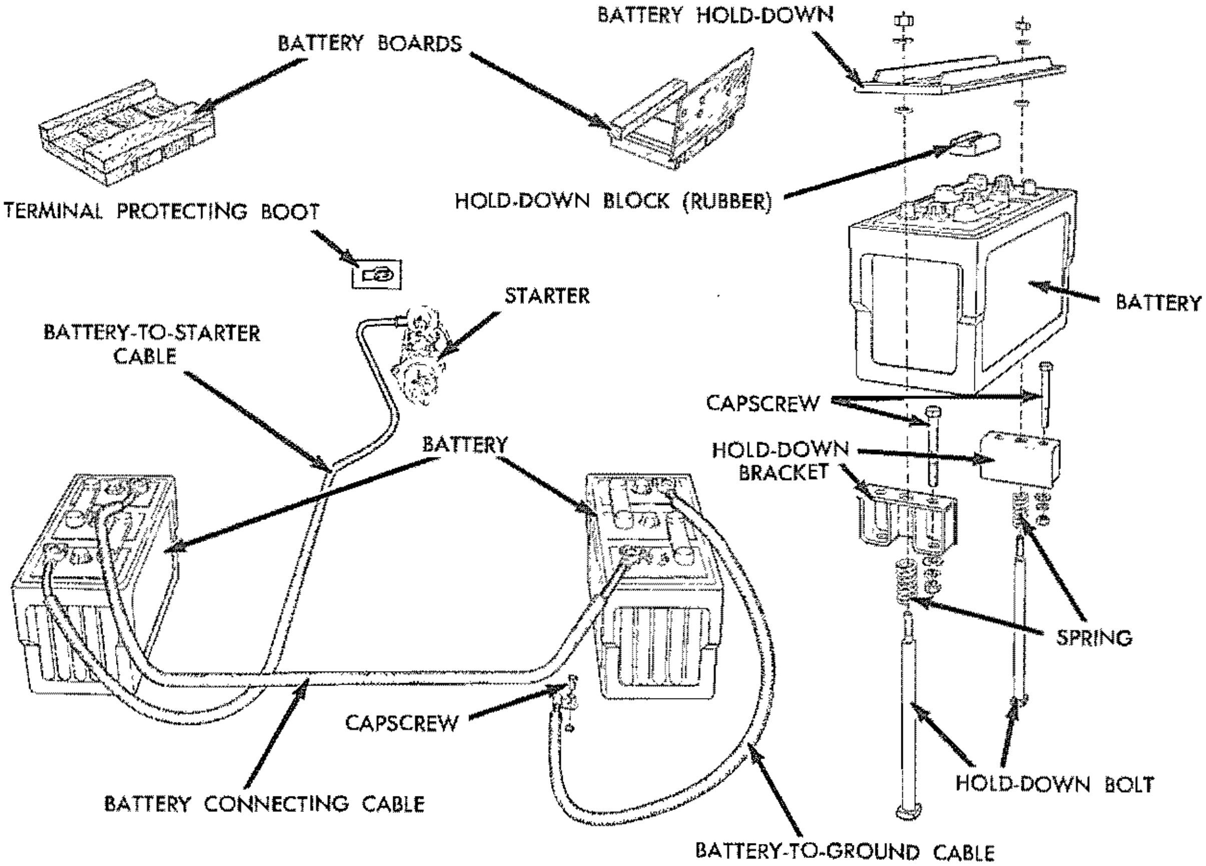


Fig. 3—Batteries, Cables, and Battery Hold-Down Assembly

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 obtain 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 generator regulator requires attention. If these units prove satisfactory, inspect the system for short circuits and for loose or corroded connections. In zero weather there is danger of the 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 battery cells should be made after the engine is started at the beginning of an operating period to make certain the water and electrolyte solution will be thoroughly mixed; otherwise, it may freeze. The battery 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

The generator is a bi-polar unit, controlled internally by an adjustable third brush and externally by the generator regulator. 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 by a mounting bracket attached to the left side of the cylinder black, and is driven by a V-belt from the crankshaft pulley. The generator armature is driven at approximately 1.7 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 1425 engine R.P.M.). As a steady charging rate of 12-13 amperes would soon destroy the batteries, an output controlling device is necessary. To accomplish this, a generator regulator with a cut out relay is wired to the generator circuit.

1. **Generator Regulator**

The generator regulator is mounted on the generatar field frame as shown in Fig. 4, and is connected inta the generator circuit. The purpose of the generator regulator is to increase or decrease the generatar 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 generator regulator 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 generator regulator close, removing the resistance from the field circuit, and the generator output increases to its maximum.

The generator regulator 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 generator regulator 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 generatar regulator unit, closes the circuit between the generator and the batteries only when the generatar 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 flaw 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 securely to the brush holders.

2. Commutator

The commutator must be smooth and round, without excessive roughness, dirt, gum, or burned areas. The slots between the segments must be open and not filled with carbon or copper dust. The 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 generator drive belt properly adjusted. The belt is correctly adjusted when one side of the belt can be pressed inward approximately 1¼" at a point half-way between the crankshaft and the generator driving pulleys.

To adjust the belt, loosen the adjusting arm capscrew at the front end of the generator and loosen the generator hinge bolts, then move the generator in or out until the correct tension of the belt is obtained. Tighten the adjusting arm capscrew and the generator hinge bolts.

4. Connections

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

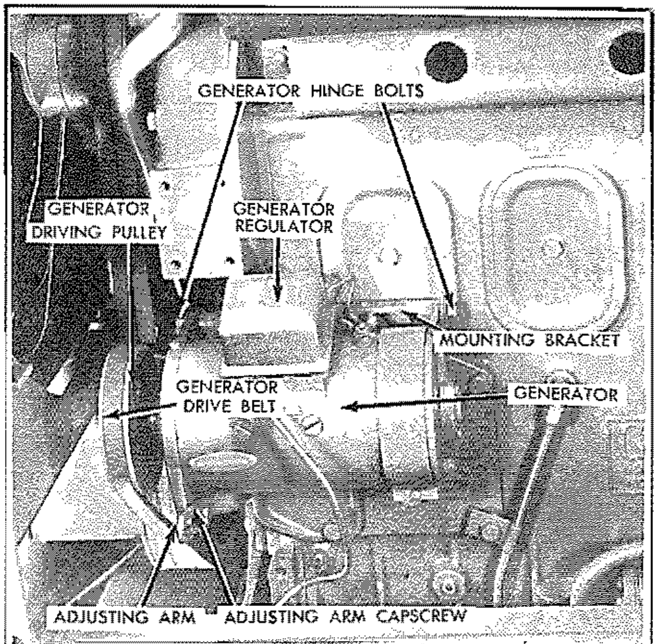


Fig. 4—Generator Drive Belt Adjustment

C. Testing and Adjusting of Generator and Regulator

Testing and adjustment of the generator and the generator regulator should not be attempted without dependable testing equipment; therefore, it is recommended that these units be taken to a dependable electrical repair shop. NOTE: *DO NOT RUN OR TEST THE GENERATOR ON AN OPEN CIRCUIT.*

D. Removal and Installation of Generator

1. Removal

Disconnect and tape the lead from the "BATTERY" terminal of the generator regulator. Remove the adjusting arm capscrew, the two generator hinge bolts, and remove the generator from the engine.

2. Installation

Install the generator on the mounting bracket with the two hinge bolts but do not tighten the bolts at this time. Attach the belt adjusting arm to the generator and adjust the drive belt tension for approximately 1¼" deflection of the belt at a point half-way between the crankshaft and the generator driving pulleys. Tighten the adjusting arm capscrew and the generator hinge bolts. 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 generator regulator 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.

6. STARTER

A. Description

The starter is an 8-brush, 4-pole, heavy-duty unit, with the armature supported by bushings at the drive end, center, and commutator end. The unit is equipped with a heavy duty starting motor switch. A "Dyer" drive is used at the rear end of the starter and provides positive engagement of the starter pinion with the engine flywheel ring gear before the starter switch contacts are closed or the armature is rotated. The pinion is thrown out of mesh with the flywheel ring gear by the reversal of the torque when the engine starts. A shift lever in the starter drive housing is connected to the starter pedal rod. Operation of the shift lever first moves the starter drive pinion into mesh with the flywheel ring gear; completion of the shift lever movement closes the starter switch, so that current can flow from the batteries to the starter.

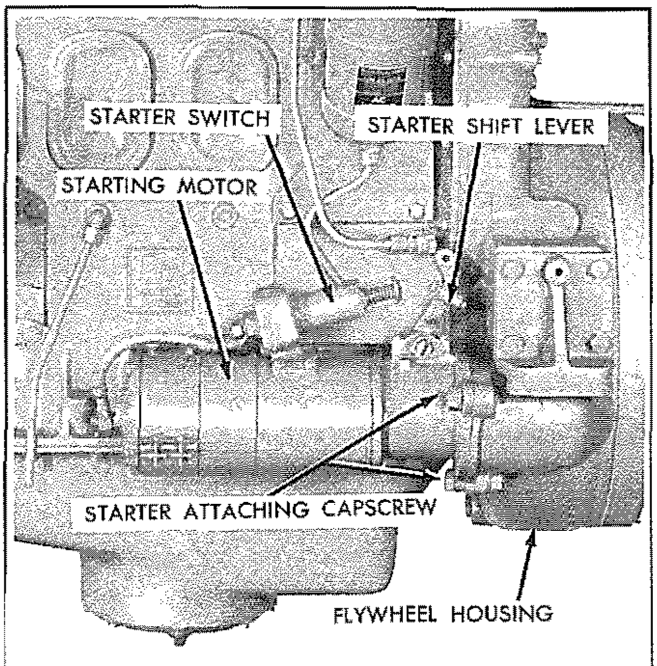


Fig. 5—Starter Location

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 a dependable electrical repair shop, if repair or adjustment is necessary. With fully charged batteries and an ambient temperature of 70° F., the starter will engage promptly and crank the engine at an adequate cranking speed. However, in cold weather the "drag" caused by cold oil between the pistons and cylinder walls and in the bearings, causes the engine to crank harder and the cranking speed will naturally be decreased. IMPORTANT: *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 failure of the starter.*

1. If the starter fails to operate properly, remove the cover band from the starter and inspect the commutator and brush connections. The commutator should be clean, not out of round or excessively worn, and without high mica or burned bars. A glazed or blued commutator does not indicate a condition requiring service, as this is a normal and satisfactory condition on a used unit. All electrical connections should be kept clean and tight, the brush spring tension should be from 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. *IMPORTANT: NEVER USE EMERY PAPER.* 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 starting motor 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 the batteries charged may indicate a faulty starting motor switch. The switch is easily disassembled for reconditioning of burned or corroded surfaces.

   To recondition the starting motor switch:

   a. Disconnect the battery ground cable, then disconnect the battery-to-starter cable from the switch.

   b. Remove the switch from the starter and 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 starter drive mechanism, the drive may "seize" to the shaft, lock, or the starter pinion may fail to mesh properly with the flywheel ring gear. If the pinion "seizes" while it is in mesh with the flywheel ring gear, damage to the starter may result. The drive assembly must be disassembled for cleaning or adjustment.

a. Remove the starter. Refer to "REMOVAL AND INSTALLATION OF STARTER" in this Section.

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

c. Remove the cotter pin from the pinion stop and 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.

e. Reassemble as follows: Place the parts, in the following sequence, 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 in the slots in the pinion. Install the pinion stop, with the cotter pin hole toward the end of the shaft. When the lugs on the stop enter the groove in the shaft, rotate the stop until the cotter pin holes align and install the cotter pin.

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 starter drive was properly adjusted at the factory and seldom requires readjustment. Failure of the drive to operate properly will usually be caused by dirt or damaged parts. When the starter shift lever is moved to where the starting motor 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. Therefore, 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 bushings with light oil.

D. Removal and Installation of Starter

1. Disconnect the starter pedal rod from the starter shift lever.

2. Remove the seat cushion. Disconnect the battery ground cable and tape the disconnected end of the cable to prevent a short circuit in the electrical system when removing the battery-to-starter cable from the starting motor switch.

3. Disconnect the battery-to-starter cable and the wire leading to the wiring harness from the starting motor 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 engine hour meter, which may be obtained as special equipment, is mounted in the instrument panel as shown in Fig. 1.

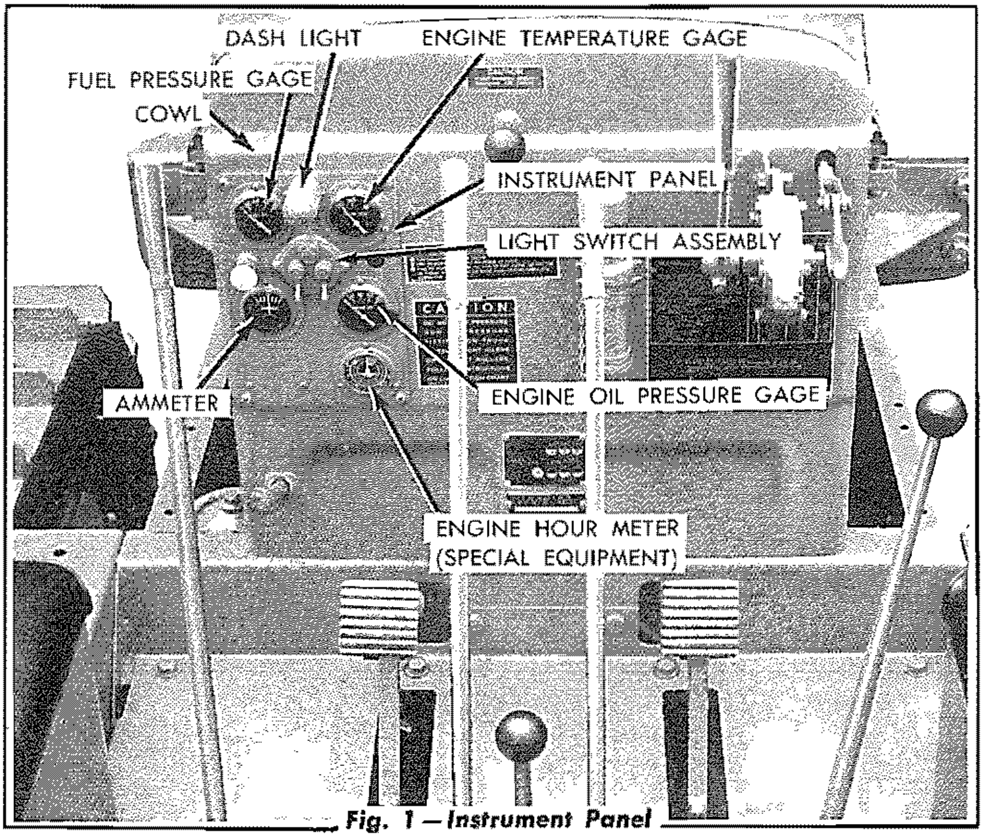


Fig. 1—Instrument Panel

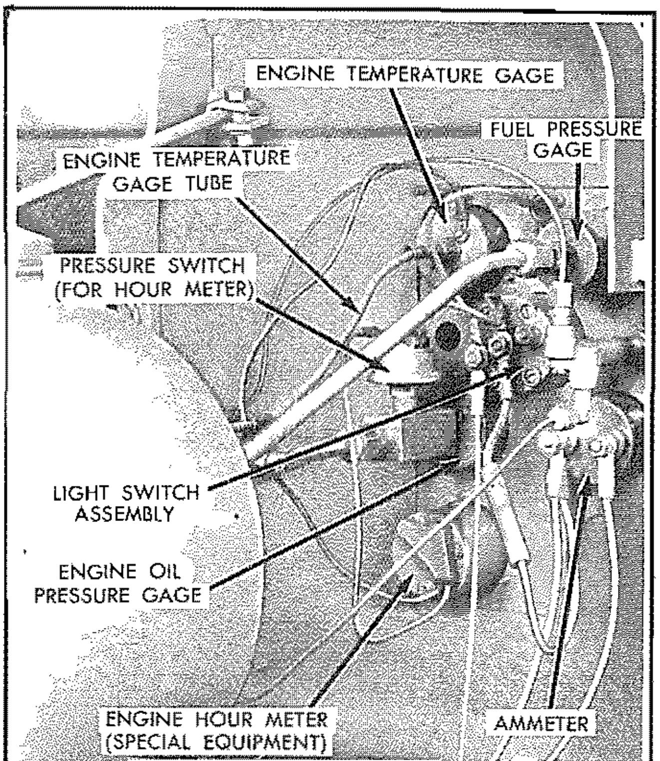


Fig. 2—Rear of Instrument Panel

2. ENGINE OIL PRESSURE GAGE

This gage indicates the pressure at which the oil is circulated through the engine. At full throttle, the engine oil pressure should be between 25 and 45 pounds at normal engine operating temperature (160°-185° F.) CAUTION: *If no pressure is indicated by 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 of the engine. This gage indicates the engine coolant operating temperature, which should be maintained between 160° and 185° F. at all times. The coolant temperature is controlled by a thermostat, located in a thermostat housing mounted on the front of the water outlet manifold of the engine.

4. AMMETER

The ammeter indicates the charging rate of the generator. When the batteries are in a discharged condition, the ammeter should indicate from 4 to 8 amperes until the batteries approach a fully charged condition. When the batteries are fully charged, the ammeter will indicate 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. The fuel pressure gage tube is connected to an elbow located in the front of the second stage fuel filter head.

The fuel pressure gage indicates the pressure at which the fuel is circulated through the fuel system. Under normal conditions, with the engine operating at full governed speed, the fuel pressure should be from 25 to 55 pounds. IMPORTANT: *Do not operate the engine when the fuel pressure is above or below this range. Investigate for clogged fuel filters, clogged or leaking fuel lines or connections, or improper fuel pump and pump pressure relief valve operation (refer to "FUEL SYSTEM," Section 2).*

6. ENGINE HOUR METER (SPECIAL EQUIPMENT)

The engine hour meter registers the number of hours the engine has operated. For instructions on how to read the hour meter refer to "ENGINE HOUR METER" in Section XX.

7. INSTRUMENT SERVICE

Any one of the various instruments can be removed from the instrument panel for replacement by removing the attaching screws and disconnecting the instruments from the wiring, tubes, etc., to which they are connected.

Do not attempt to repair an engine 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 mechanical energy in the cylinders of the engine.

The engine in the Model HD9B Tractor is a water-cooled, 4-cylinder, 2-cycle, "DIESEL" engine. In this "DIESEL" engine, air is supplied to the cylinders by the engine blower and is compressed within the cylinders by the pistons. While the air is compressed within the cylinders, fuel is injected into the cylinders by unit fuel injectors and is ignited by the heat of the compressed air.

B. The Two-Cycle "DIESEL" Engine

In the 2-cycle "DIESEL" engine, intake and exhaust take place during part of the compression and power strokes; 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 to expel the exhaust gases and fill the cylinders with fresh air for combustion as shown in Fig. 1.

A series of air inlet ports cut into the circumference of each cylinder liner wall, above the piston (in its lowest position), admits 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 air inlet ports on its compression stroke.

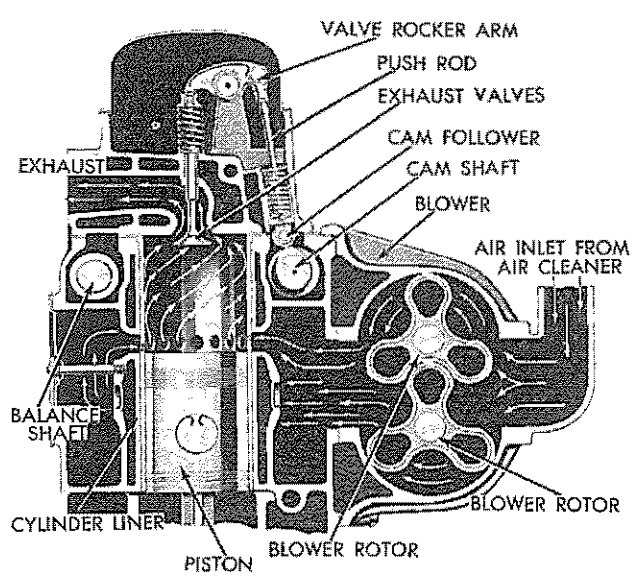


Fig. 1—Air Flow Through Engine

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. 3. This engine is designed for a highly efficient 16 to 1 compression ratio.

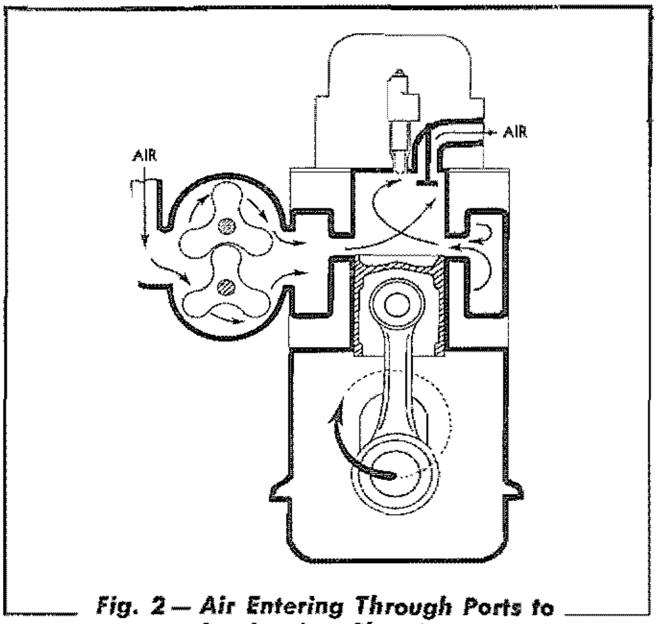


Fig. 2 — Air Entering Through Ports to Combustion Chamber

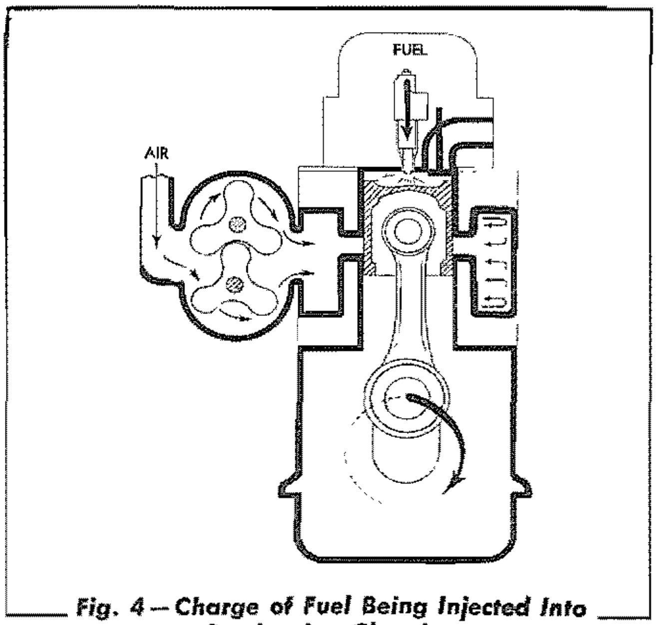


Fig. 4 — Charge of Fuel Being Injected Into Combustion Chamber

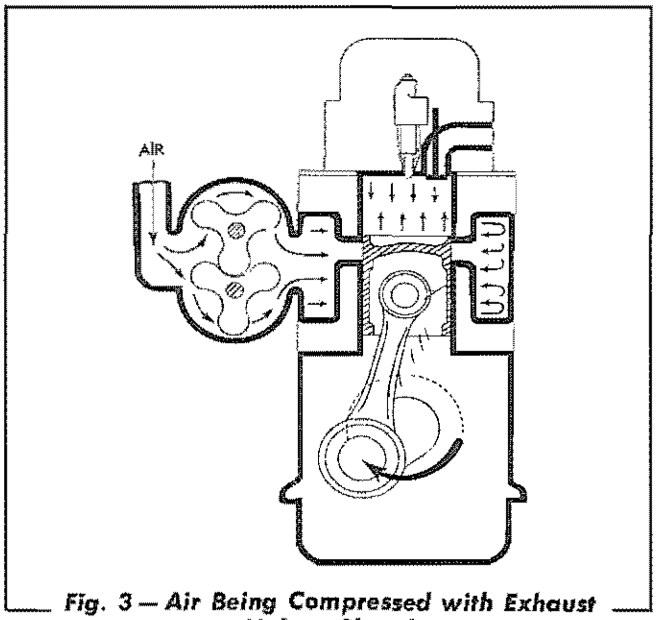


Fig. 3 — Air Being Compressed with Exhaust Valves Closed

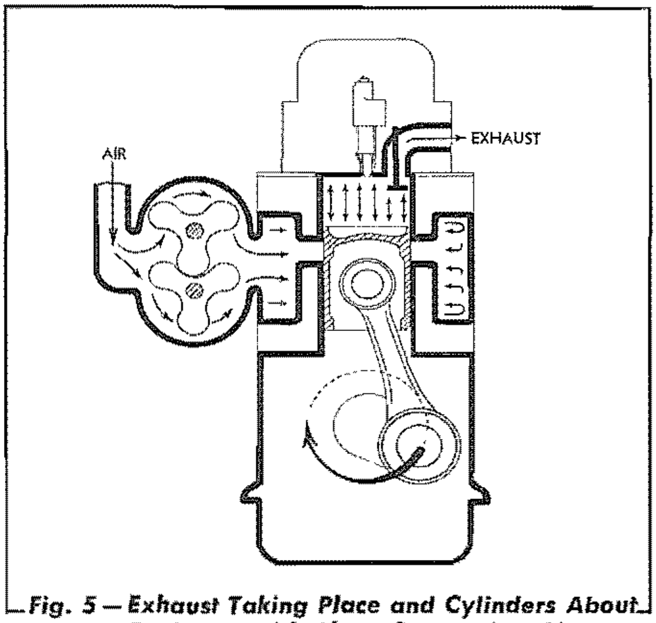


Fig. 5 — Exhaust Taking Place and Cylinders About to Be Swept with Clean Scavenging Air

Shortly before the piston reaches its highest position, the required amount of fuel is sprayed into the combustion chamber 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 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 uncovers the air 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 during 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, fuel manifolds, cam followers, guides, rocker arms, and valves. The cylinder head is held securely to the upper part of the cylinder block by heat-treated alloy steel studs.

Provided in the cylinder head are two exhaust valves, two valve seat inserts, two valve guides, a fuel injector, and three rocker arms, for each cylinder. The center rocker arm operates the injector plunger; the other two rocker arms operate the exhaust valves. The exhaust valve guides are pressed into the cylinder head and hold the valve heads in accurate alignment with the valve seat inserts which are also pressed into the head.

To provide efficient cooling, each fuel injector is inserted into a thin wall copper tube passing through the water space in the cylinder head. To prevent water leaks around the copper tube, the tube is pressed into the cylinder head and the lower end is spun over; the upper end is flanged and sealed with a "NEOPRENE" seal.

Two exhaust passages from each cylinder lead through a single port of the exhaust muffler. The exhaust passages, exhaust valve seat inserts, and injector copper tubes are completely surrounded by the engine coolant.

Engines prior to Serial No. 4A-19529 contain a flat laminated gasket installed between the cylinder head and the cylinder block to seal the compression within the cylinders. 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.

On engines Serial No. 4A-19529 and above, the cylinder block and cylinder head were modified 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 rocker cover retaining bolts fitted with hand knobs. The cover is sealed at the bottom, against the top of the cylinder head, by a gasket 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 cylinder head can be accomplished with the cylinder head installed; on others, the cylinder head must first be removed from the engine.

1. **Operations not requiring the removal of the cylinder 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 cylinder head**

   a. Grinding, reseating, or replacement of the valves and valve seat inserts.

   b. Replacement of the valve guides.

   c. Replacement of the injector copper tubes.

C. Cylinder Head Removal

1. Remove the engine air pre-cleaner from the air cleaner and remove the engine hood.

2. Drain the engine cooling system (refer to

"FILLING AND DRAINING OF SYSTEM" in Section IV). Wash all dirt from the upper part of the engine.

3. Remove the exhaust muffler.

4. Disconnect the engine temperature gage from the rear of the water outlet manifold.

5. Remove the pins connecting the engine shut-off front and rear rods to the engine shut-off rod lever, located at the rear of the engine.

6. Remove the pins connecting the throttle control front and rear rods to the throttle control lever, located at the rear of the engine.

7. Unhook the throttle control retracting spring from the throttle control front rod. Remove the pin connecting the throttle control front rod to the governor variable speed control lever and remove the throttle control front rod.

8. Unhook the upper end of the air shut-off lever spring from the engine shut-off swivel lever and remove the spring and spring hook.

9. Remove the pin connecting the fuel shut-off rod to the governor fuel shut-off lever.

10. Remove the cotter pin securing the engine shut-off swivel lever to the air shut-off valve shaft lever and remove the swivel lever, fuel shut-off rod, and the engine shut-off front rod as an assembly.

11. Loosen the hose clamp attaching the air cleaner hose to the air inlet elbow. Remove the capscrews attaching the air inlet elbow assembly to the air intake housing and remove the elbow assembly.

12. Disconnect the fuel lines from the rear of the fuel manifolds, located on the right side of the cylinder head. Remove the capscrews attaching the second stage fuel filter to the cylinder head.

13. Remove the capscrews attaching the water outlet elbow and the water by-pass tube assembly to the front of the water outlet manifold and remove the thermostat from the manifold.

14. Remove the rocker cover and the governor control housing cover. Disconnect the governor to injector contral lever link from the governor and the injector control tube lever, and remove the link.

15. 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.

16. Remove the two (2) capscrews attaching the throttle shaft and the engine lifting bracket to the flywheel housing. Remove the two (2) capscrews attaching the engine front lifting bracket to the balance weight cover.

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

18. Remove 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. NOTE: *The cylinder head may be removed with the injectors installed in the head, however, care must be used to avoid striking the injector tips when removing.*

19. Remove all the cylinder head stud nuts and by means of the engine front and rear lifting brackets, lift and remove the cylinder head from the engine.

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

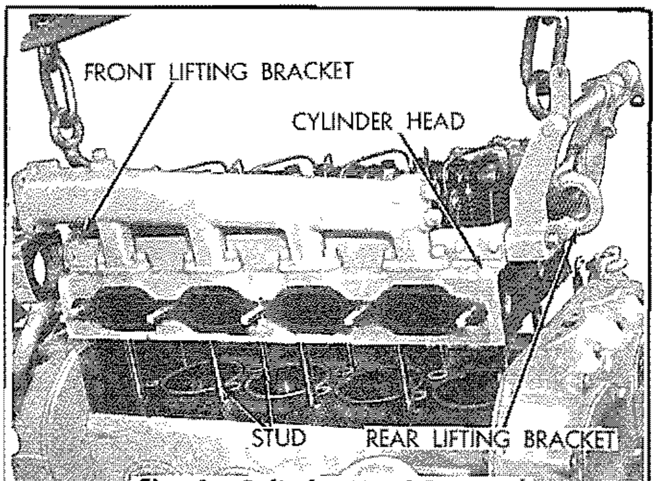


Fig. 6 — Cylinder Head Removal

D. Inspection

If the cylinder head is to be replaced, the working parts removed from the old head must be thoroughly 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 "EXHAUST VALVES AND OPERATING MECHANISM" in this Section and in "ENGINE FUEL SYSTEM," in Section II.

E. Cylinder Head Installation

Engines prior to Serial No. 4A-19529 have a flat laminated gasket installed between the cylinder head and the cylinder block to seal compression within the cylinders. A flat gasket (4 piece type) is used between the cylinder head and the cylinder block at the outer rim to provide an oil seal.

On engines Serial No. 4A-19529 and above, the cylinder block and cylinder head were modified 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. 4A-19529 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. 4A-19529 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 cylinder 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 type of cylinder head gasket set to be installed depends on which type cylinder block is being used. If the Engine Serial No. is 4A-19529 or above (having new type block) the new type gasket set must be used. If the Engine Serial No. is below 4A-19529 (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. 4A-19529, 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" upward. Place the cylinder head oil gasket (4 piece) in position on the top of the cylinder block.

   On engines Serial No. 4A-19529 and above, remove the four (4) old compression gaskets, all the oil hole and water hole seal rings, and the cylinder head oil seal ring (rubber) from the recess in the cylinder block. Thoroughly clean the recesses for the seal rings and the oil seal, and also the surface for the compression gaskets. 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 set should not be reused. Install four (4) 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 engine lifting brackets, without their gaskets, to the cylinder head. Install the cylinder head in place on the cylinder block, then remove the engine lifting 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 lbs. ft. by starting at the center nuts and working toward each end, tightening each nut a little at a time. Refer to Fig. 7.

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

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 to attach the control tube brackets to the cylinder head and tighten to a torque of 10 to 12 lbs. ft.

6. Install a new gasket between the governor control shaft housing and the 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 lever 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. Install the two (2) capscrews to attach the second stage fuel filter to the cylinder head.

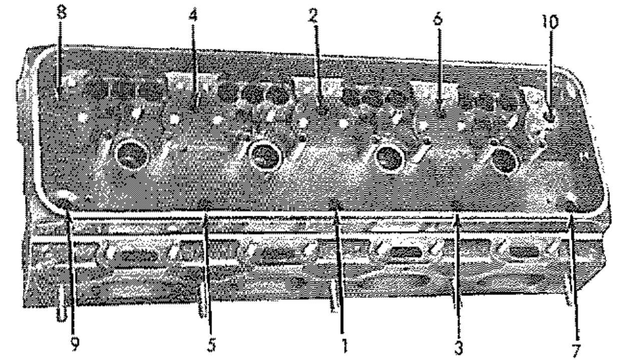


Fig. 7 — Sequence Chart for Tightening Cylinder Head Stud Nuts

9. Install a new air inlet elbow gasket in position on the air intake housing. Place the air inlet elbow in position on the air intake housing and secure with the attaching capscrews. Place the air cleaner hose in position on the air cleaner and the air inlet elbow and tighten the hose clamps.

10. Install the air shut-off lever spring and its hook on the air shut-off swivel lever. Install the throttle control retracting spring.

11. Connect the engine temperature gage tube to the rear of the water manifold.

12. Examine the gaskets used between the water outlet manifold and the upper end of the water by-pass tube and between the water outlet elbow and the upper end of the water by-pass tube and replace if necessary. Coat the gaskets with gasket cement. Install the thermostat, with the element end towards the manifold, then install attaching capscrews to secure the elbow and the by-pass tube to the water manifold.

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

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

15. 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).

16. Start the engine and inspect for fuel and oil leaks. Correct any leaks found.

17. Examine the rocker cover gasket and replace if necessary, then install the rocker cover. Install the engine hood and the engine air pre-cleaner.

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 valve spring cap lock.

Each cylinder is provided with a rocker arm assembly consisting of, three (3) rocker arms, rocker arm shaft, two (2) rocker arm shaft brackets, and two (2) bracket attaching bolts. The two outer rocker arms of each assembly operate the exhaust valves and the center rocker arm operates the fuel injector as shown in Fig. 8.

Engines prior to Serial No. 4A-29209 were provided with injector rocker arms with the injector end of the rocker arms fitted with a hardened ball stud and a ball seat which forms a flexible joint. The ball seat transmits the rocker arm motion to the fuel injector. Engines Serial No. 4A-29209 and above were provided with injector rocker arms with the injector end of the rocker arm hardened and ground to a cylindrical surface, which bears directly on the injector plunger follower. The valve contact end of each valve rocker is also 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 by push rods. Contact between the camshaft followers and the corresponding camshaft lobes is made by a roller containing a bushing type bearing. The roller rotates on a pin which attaches the roller to the camshaft follower. The camshaft follower rollers are held squarely with the corresponding camshaft lobe surfaces by camshaft follower roller guides, bolted to the bottom side of the cylinder head. Each camshaft follower spring, located inside the hollow camshaft follower, is held in place in the cylinder head by a spring upper seat and a spring upper seat retainer (wire locking ring).

Lubricating oil for the valve operating mechanism is supplied by the engine oil lubricating oil pump 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 crankcase oil pan, lubricates the valves, injectors, cam followers, blower gears, and the governor.

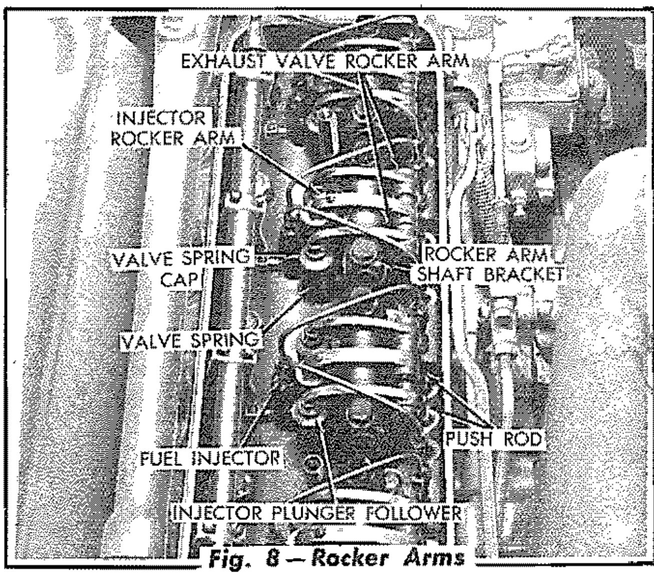


Fig. 8 — Rocker Arms

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 an exhaust valve spring.

3. Removal or replacement of a rocker arm, rocker arm shaft and rocker shaft bracket.

4. Removal or replacement of a camshaft follower assembly, camshaft follower spring, and push rod.

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 inserts.

C. Valve Lash Adjustment

Correct clearance between the valve stem ends and the rocker arms is very important in a "DIESEL" engine. Insufficient valve clearance will cause loss of compression, "missing," and eventual burning of the exhaust valves and the valve inserts. Excessive exhaust valve clearance will result in noisy engine operation and rapid wear on the valve operating mechanism. Valve adjustment should be made to allow .009" clearance (lash) with engine at normal operating temperature (160° — 185° F.).

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 for the final correct adjustment.

1. Remove the air pre-cleaner, engine hood, and the rocker cover.

2. Crank the engine with the starter until the injector rocker arm of the cylinder to be adjusted is down and the injector plunger follower is at the bottom of its stroke. The exhaust valves for that cylinder will then be closed and the valve rocker arms will be raised off the valve stems.

3. Check the clearance between the valve stems and the rocker arms. When adjusted properly, a .009" thickness gage will pass between them with a slight drag when the engine is at normal operating temperature (160° to 185° F.). 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 as necessary. When proper clearance (lash) is obtained, tighten the lock nut. Recheck the clearance to be sure it was not changed by tightening the lock nut.

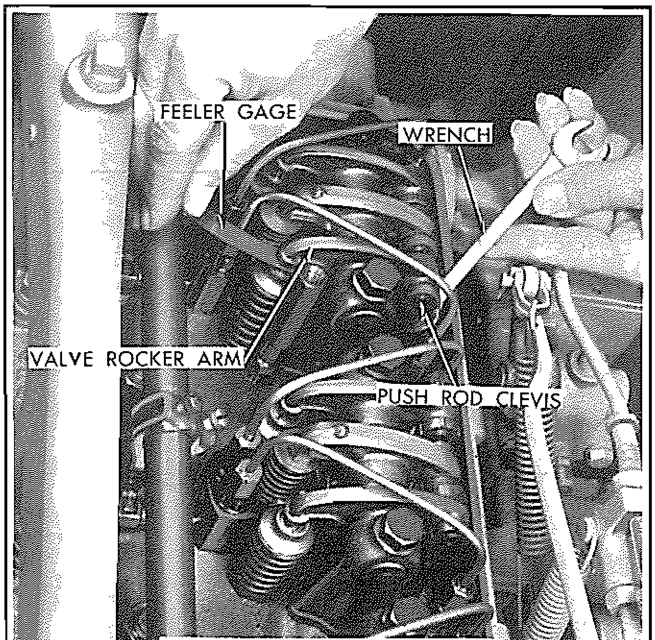


Fig. 9 — Valve Adjustment

4. Crank the engine with the starter and repeat the above operation on the valves for the other cylinders. Install the rocker cover, engine hood, and the air pre-cleaner. CAUTION: *If for any reason a push rod was disconnected from a rocker arm, be sure when it is reinstalled, that the upper end of the push rod is flush with the inside of the clevis yoke before cranking the engine. If it*

is not, it is possible that the valve will be opened too far and the piston will strike the valve and damage the valve or piston.

D. Rocker Arm Removal, Inspection, and Installation

1. Thoroughly clean the rocker cover and remove the cover. If the cylinder head is installed on the engine, crank 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 shipping caps on the fuel connectors to prevent dirt entering the fittings.

3. Remove the 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 rocker arm shaft with engine oil and install the rocker arms and the rocker arm shaft by reversing the sequence of operations for removal. Install the injector (center) rocker arm on the rocker arm shaft. On early model engines the injector rocker arm can be identified as the rocker arm fitted with ball stud and ball seat. On late model engines the injector rocker arm can be identified as the rocker arm having two bosses of equal length. Install each valve rocker arm on the shaft, with the longest boss of each toward the injector rocker arm. 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 pasages in the rocker arms to lubricate the push rod and camshaft follower assemblies. Tighten the rocker arm shaft bracket bolts to a torque of 90 to 100 lbs. ft.

   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 push 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 cranked 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, rocker arm shaft brackets, and the rocker shaft (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 spring upper seat with a screwdriver, and use another screwdriver to remove the spring upper seat retainer (lock wire) from the groove in the cylinder head, above the spring seat. *NOTE: Use a tool similar to the one shown in Fig. 10 for this operation, if tool is available.* Lift the push rod and spring assembly from the cylinder head. Insert a finger into the cam follower and pull the cam follower up out of the cylinder head.

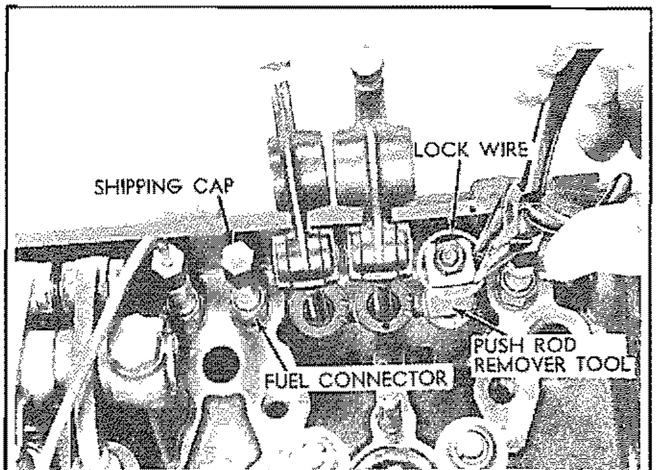


Fig. 10 — Removing Push Rod Spring Upper Seat Retainer

3. If the cylinder head is removed, the follower assemblies may be removed from the cylinder head by removing the capscrews attaching the camshaft follower roller guides to the lower side of the cylinder head and removing the guides. Remove the complete follower assemblies through the bottom of the cylinder head.

4. After the camshaft follower assemblies have been removed, they should be cleaned in solvent, blown dry with compressed air, and inspected before they are again assembled in the cylinder head.

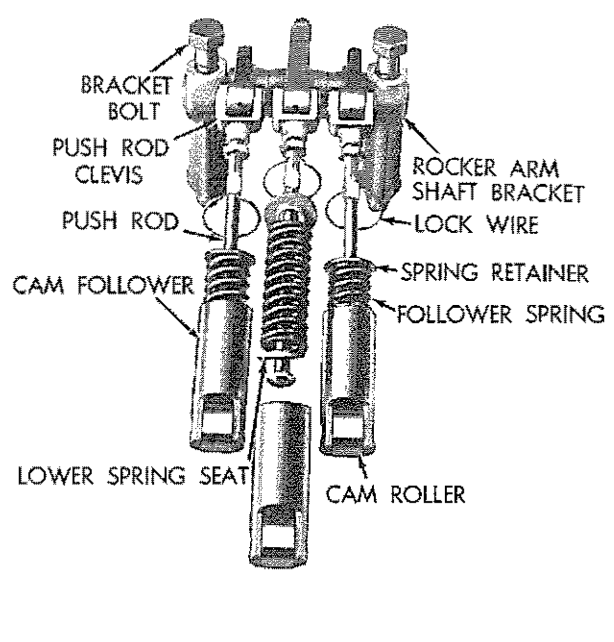


Fig. 11 — Camshaft Follower and Push Rod Assembly

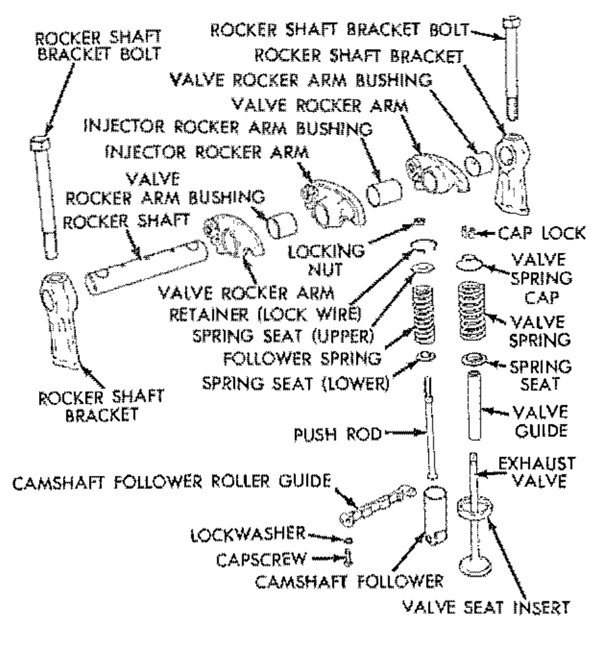


Fig. 12 — Valve Mechanism

5. The camshaft follower rollers must rotate smoothly and freely. Measure the total clearance between the camshaft follower roller bushing and the pin. Since the camshaft lobe forces the camshaft 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 camshaft follower body. By measuring the clearance in this manner, a better measurement of bushing wear can be 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 necessary. The camshaft follower 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 camshaft lobes on which the rollers have operated. Replace the camshaft if the camshaft lobes are worn or scuffed.

NOTE: New, or solvent-cleaned, camshaft follower assemblies must be immersed in clean lubricating oil for at least five minutes before installing the follower assemblies in the cylinder head. This will assure initial lubrication of the follower assemblies which is essential to satisfactory follower performance.

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

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

   b. With the spring upper seat retainer (lockwire) removed, and with the spring lower seat, follower spring, and spring retainer (upper seat) installed on the push rod, insert the push rod assembly into the head and the camshaft follower.

   c. Depress the camshaft follower spring with a screwdriver and install the spring upper seat retainer (lockwire) in the groove in the cylinder head above the spring retainer.

   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 camshaft follower and push rod assembly with the cylinder head removed, proceed as follows:

   a. Install the spring upper seat retainer (lockwire) in the groove in the cylinder head.

   b. With the spring retainer, spring, and lower spring seat installed on the push rod, place the push rod assembly in the camshaft follower and insert the assembly up through the cylinder head, with the oil hole in the follower toward the outer side of the head.

   c. Insert the attaching capscrews through the camshaft follower roller 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 camshaft rollers engaged in the slots in the guide. Tighten the attaching capscrews to a torque of 12 to 15 lbs. ft.

F. Exhaust Valve Spring Removal and Installation

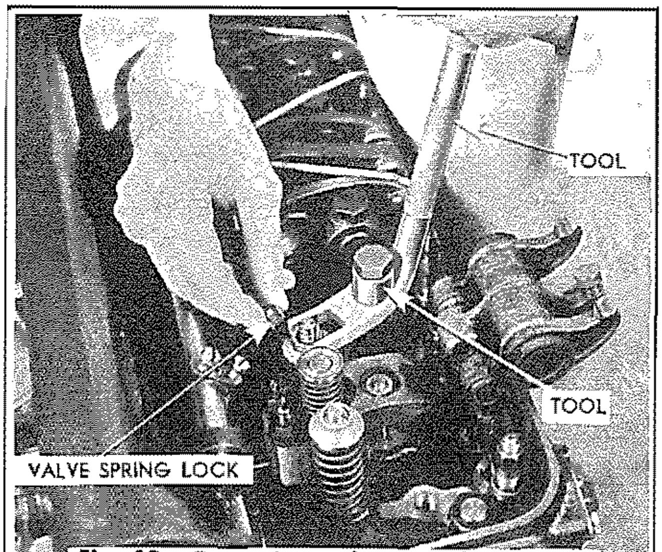


Fig. 13 — Removing Exhaust Valve Springs

Removal of the cylinder head is not necessary if removal 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 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 follower at the bottom of its stroke).

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

3. Remove the bolt from each rocker shaft bracket 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. 12, and screw the bolt into the tapped hole of the cylinder head nearest the valve spring to be removed.

5. Using precaution to prevent the exhaust valve from falling into the cylinder, depress the valve spring and remove the valve spring cap locks. Lift the valve spring cap, spring, and spring seat from the valve and valve guide.

6. Inspect the valve spring, cap, and seat for wear or damage. Replace any worn parts. The exhaust 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 exhaust valve 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 Seat Inserts

1. Remove the cylinder head from the engine (refer to "CYLINDER HEAD REMOVAL" in this Section). Place 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 camshaft follower rollers which project through the bottom of the head.

2. Remove the exhaust valve springs as described in "EXHAUST VALVE SPRING REMOVAL AND INSTALLATION." Turn the cylinder head on its side and remove the exhaust valves from the head. Place the valves in a rack as they are removed from the head so they can be identified and reinstalled in the head in their original positions.

3. Clean the carbon from the valves 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 specified diameter of the valve stem is .3415" to .3425"; the clearance of the stem

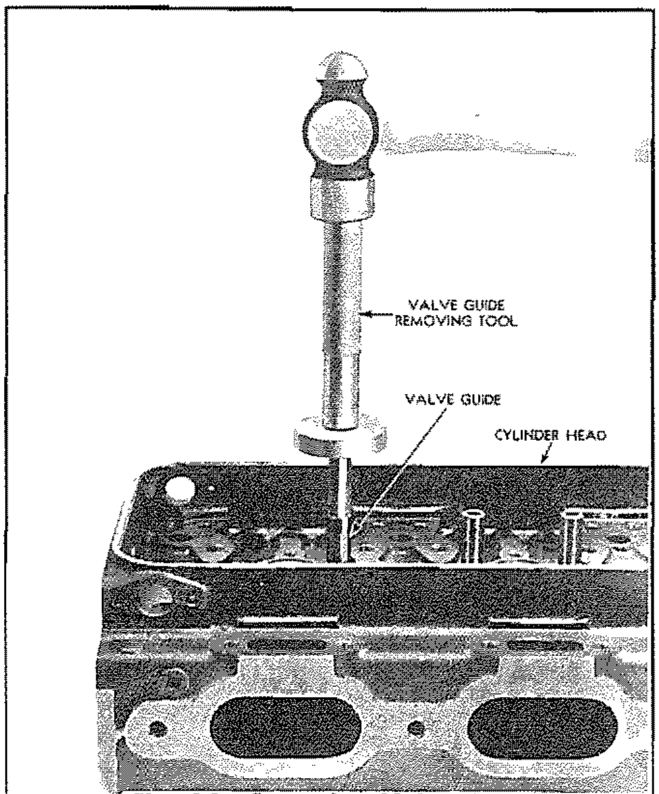


Fig. 14—Removing Valve Guides

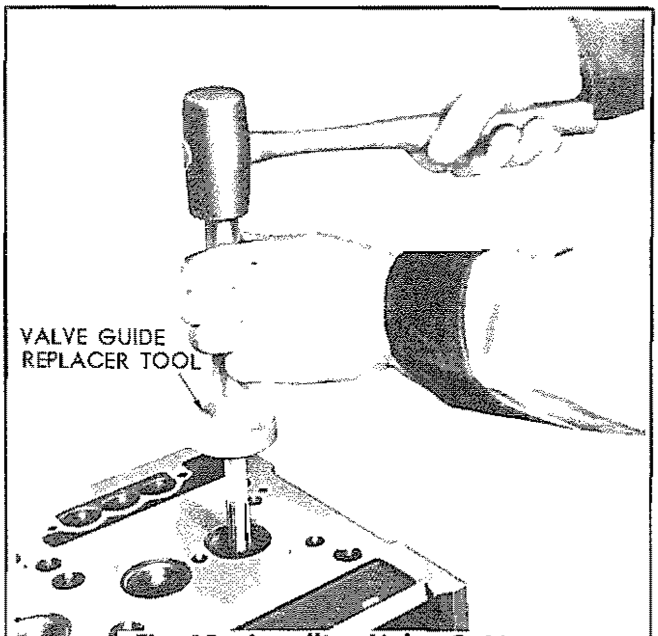


Fig. 15—Installing Valve Guides

in the guide is .002" to .004" and should not exceed .006".

5. Remove the guides by driving them out from the top of the cylinder head, using a valve guide removing tool similar to the one shown in Fig. 14.

   New valve guides are installed by placing the machined collar on the tool, and driving each guide into the cylinder head from the bottom until the collar of tool is against the surface of the head. This will locate the valve guides for the 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 obtain proper clearance with a reamer as shown in Fig. 16.

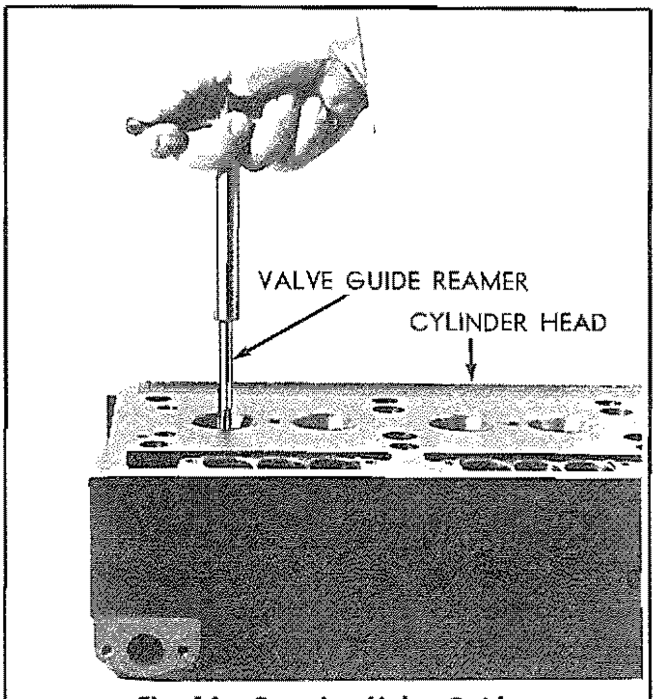


Fig. 16—Reaming Valve Guides

7. Inspect the valve seat inserts. If they are loose, cracked or pitted, new ones should be installed. The valve seat inserts are a press fit into the cylinder head and should be removed with special tool as shown in Fig. 17.

8. Remove the valve seat inserts as follows:

   a. Place the cylinder head on a bench and insert the collet of the remover tool inside the valve seat insert so that the lip at 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 the valve seat insert.

   b. Place 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. Place the thrust bearing over the top of the collet and on top of the body.

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

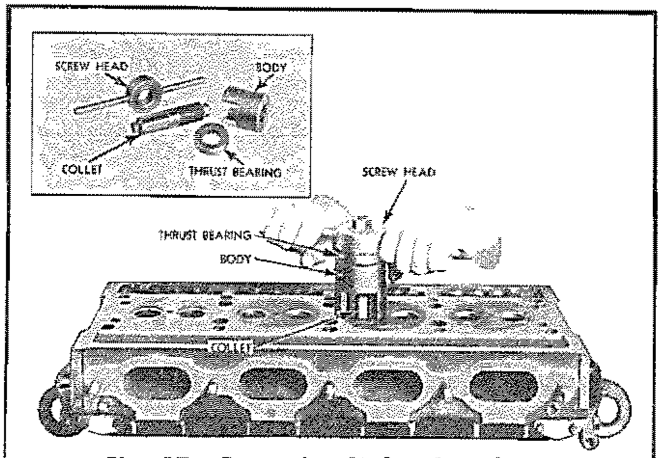


Fig. 17 — Removing Valve Seat Insert

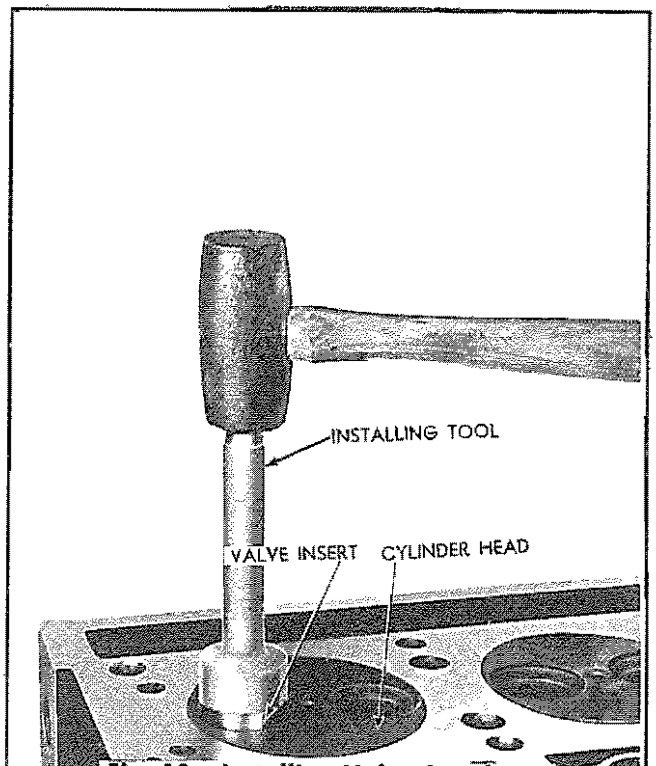


Fig. 18 — Installing Valve Seat Insert

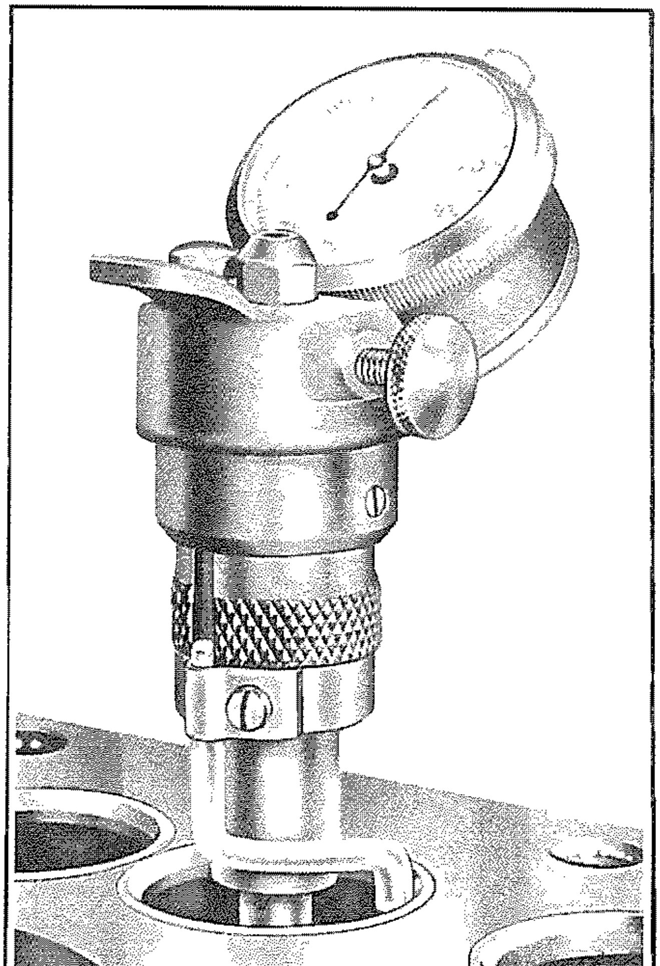


Fig. 19 — Checking Valve Seat for Concentricity

9. Particular care must be exercised when replacing the valve seat inserts. The 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.

Install the valve seat inserts as follows:

a. Make certain the valve seat counterbores in the cylinder head are clean and free of burrs.

b. Immerse the cylinder head for approximately 30 minutes in water heated to near boiling temperature, or chill the seat inserts with dry ice for approximately 45 minutes.

c. Place the cylinder head bottom-side up on a bench. Clean out the seat insert counterbores with compressed air and start a seat insert into the counterbore (valve side up).

d. Using the valve seat insert installing tool similar to the one shown in Fig. 18, insert the pilot end of the tool into the valve guide and drive the seat insert down tightly into the counterbore. This operation must be done quickly, while the valve seat insert is cold.

e. Check each valve seat for concentricity with its valve guide (refer to Fig. 19) and, if necessary, recondition the seat or seats as directed in "VALVE AND VALVE SEAT GRINDING" in this Section.

H. Valve and Valve Seat Grinding

In tractors having Engine Serial No. 4A-19529 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

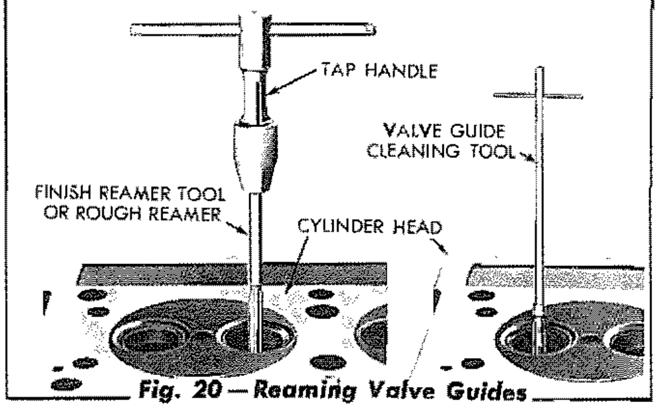


Fig. 20 — Reaming Valve Guides

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. 4A-19529). 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° valve seat inserts, and the counterbore for the seat inserts in the late type cylinder heads is approximately .042" less. The valve head of the 30° exhaust valve in the late type 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 early type cylinder head may protrude .017" or set in .004" from the flat surface of the cylinder head fire deck.

The late type 30° exhaust valve and 30° valve seat insert may be used in the early type cylinder head. The 30° valve head, when installed in the early type 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 early type cylinder head). When the 30° valve insert is installed in the early 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 cylinder head. This will not injure the cylinder 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 cylinder head, the 30° grinding stone diameter may be reduced, thus reducing the amount it cuts into the cylinder head.

NOTE: DO NOT INSTALL THE 45° EXHAUST VALVE AND 45° VALVE SEAT INSERT IN THE LATE 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 late 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° valve seat inserts may be used in EITHER the LATE TYPE or the EARLY TYPE cylinder heads.

2. The 45° exhaust valves and 45° valve seat inserts may be used ONLY in the EARLY TYPE cylinder heads.

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 late type or the early 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 necessary parts must be replaced.

The width of the valve seats of the late type 30° exhaust valves and valve 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 early type 45° exhaust valves and valve seat inserts must be between 5/64" and 7/64".

When new valve seat 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 seat 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 late 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 early 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. 19 should be 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 late type 30° seat valves, and 5/64" to 7/64" for the early type 45° seat valves. Also, it may be necessary to grind the seats of the inserts to pre-

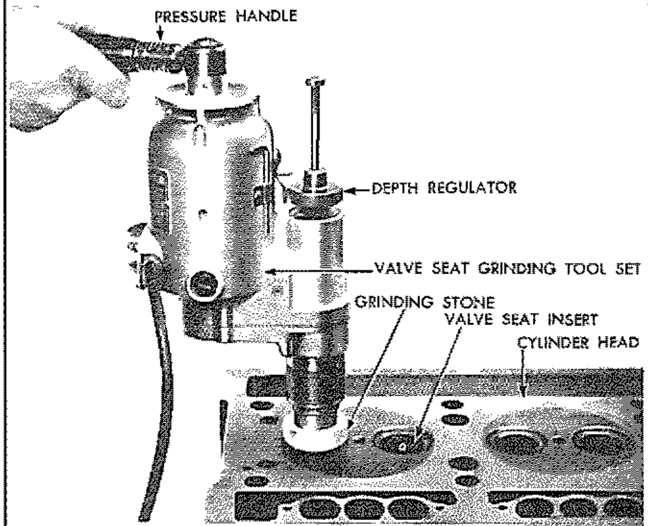


Fig. 21 — Grinding Valve Seats

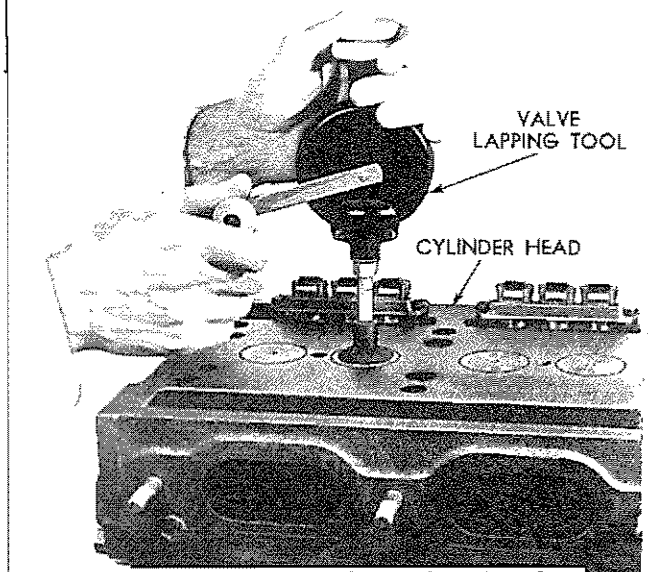


Fig. 22 — Lapping Valves After Grinding

vent the valve heads from protruding too far from the bottom face (flat surface) of the cylinder head as explained above.

After a grinding wheel has been used several times, the cutting angle of the stone must be reground and made true to obtain the proper seat angle. 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 in perfect seats in the regular manner, as shown in Fig. 22. 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 of 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, assuring perfect alignment of the bores and bearings under all loads. The cylinder block is bored to receive the cylinder liners.

The water jackets extend the full length of the cylinder 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 type 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, assuring 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 cylinder 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. 23.

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. 4A-19529 and above (having the late 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. If upon inspection, the top surface of any cylinder liner flange does not fall within the .046" to .050", the necessary 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.

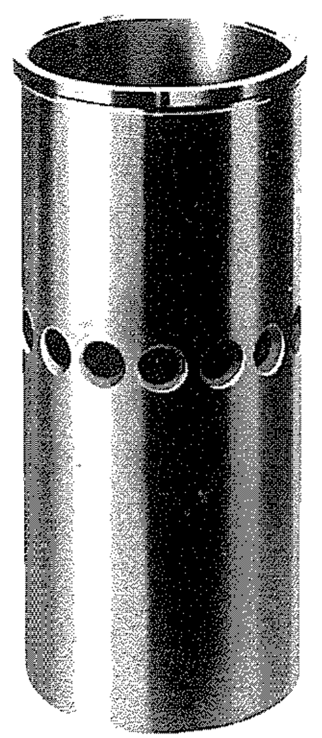


Fig. 23—Cylinder Liner

To obtain proper sealing of the cylinder head compression gasket in tractors having engines prior to Serial No. 4A-19529 (having the early 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 supporting inserts are not used on engines prior to Serial No. 4A-19529.)

The cylinder liner 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 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 a lapping compound. To avoid such a condition, the air cleaner, 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," 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. Failure to remove all the burrs from the inside of the cylinder liners can result in the early failure of an engine.

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. 24. Measure each cylinder liner as outlined in the diagram in Fig. 25. 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 assure 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.

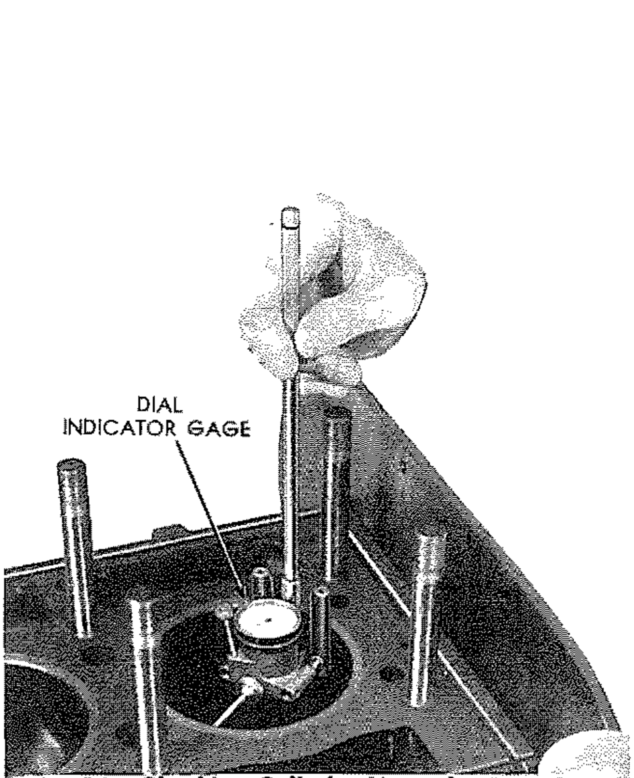


Fig. 24 — Checking Cylinder Liners for Roundness

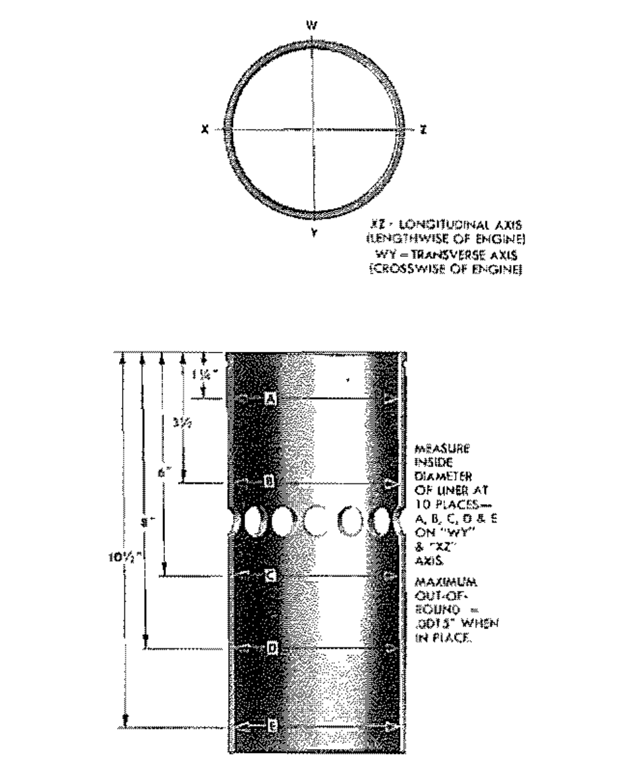


Fig. 25 — Measuring Cylinder Liners

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. 4A-19529 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 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 engines prior to Serial No. 4A-19529. 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 supporting 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 location of the top of the cylinder liner flange in relation to the top flat surface of the cylinder block. On tractors having Engine Serial No. 4A-19529 and above, the top surface of the cylinder liner flange must be .046" to .050" *below* the top flat surface of the cylinder block.

   On tractors having engines prior to Serial No. 4A-19529, 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. On tractors having Engine Serial No. 4A-19529 and above, if the top surface of any cylinder liner flange is not .046" to .050" below the top surface of the cylinder block, 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.

   On tractors having engines prior to Serial No. 4A-19529, 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 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," 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 assure a tight seal. The plugs must be installed so that they do not project from the block to interfere with the fit of the attached parts.

G. Air Box Drain Tube

Three (3) air box drain tubes are provided for drainage of fuel and engine oil that might accumulate 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 the cylinder block; the other two (2) 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, CRANKSHAFT PULLEY, FLYWHEEL, AND MAIN BEARINGS

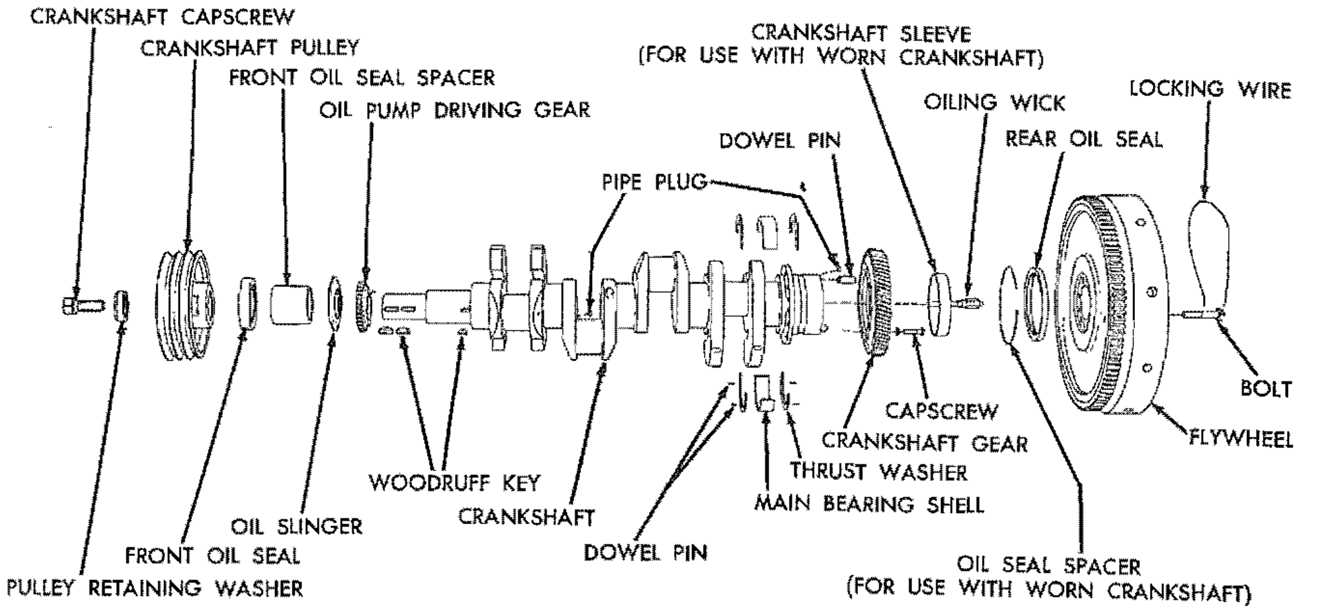


Fig. 26 —Crankshaft and Flywheel Details

A. Description

1. CRANKSHAFT. The rigid crankshaft is a high alloy steel drop forging, carefully heat-treated to assure utmost strength and durability. All the main and connecting rod bearing journals are hardened and ground to a smooth finish. Complete static and dynamic balance of the rotating parts has been achieved by counter-weights incorporated on the crankshaft.

   The end thrust of the crankshaft is taken by two (2) 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 assembly is installed in the rear of the crankshaft for lubricating the engine clutch shaft front bearing (pilot bearing).

2. MAIN BEARINGS. Five 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 cylinder block 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 cylinder block by two (2) 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 shell. 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 and into the flywheel compartment.

   A spring loaded, lip type oil seal is also used at the front main bearing. This seal is pressed into the crankshaft front cover. The sealing lip of the seal bears against the front oil seal spacer installed on the crankshaft, next to the crankshaft front oil slinger.

3. FLYWHEEL. The even torque of the engine permits the use of a relatively light, cast iron flywheel, which assures exceptional operating flexibility. The flywheel is bolted securely to a flange on the rear end of the crankshaft and is 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 oil pan 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 journals 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 sealing 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 special 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 sealing 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 journals 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 shells and connecting rod bearing shells 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.

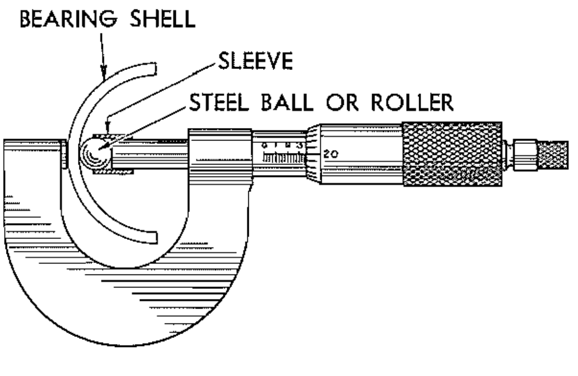


Fig. 27 — Measuring Main Bearing Shells

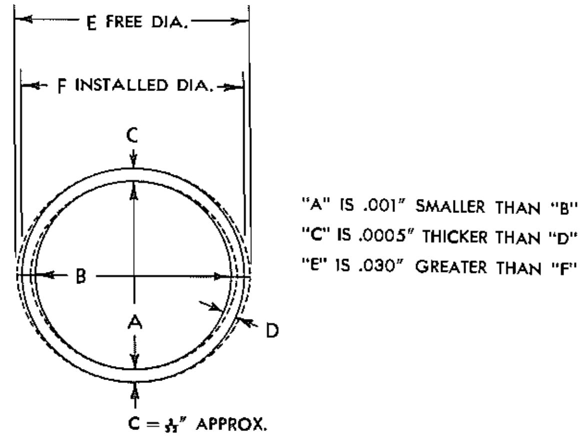


Fig. 28 — Measuring Inside Diameter of Main Bearing Shell

C. Main Bearing Inspection

1. Any bearing shells 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. Bearing shells which are worn beyond the specified limits 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 replaced. 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 .002" to .004" in a new engine; new 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. 27. New shells, measured at the point "C" in Fig. 28 are .155" thick, and any variation from .155" will show the amount of wear on the particular shell being measured. Bearing shells less than .153" thick are worn beyond the allowable limits and must be replaced.

3. As will be seen in Fig. 28, the bearing shells (when in place) are .001" larger in diameter at the parting line than they are 90° from the parting line. The two (2) shells do not form a true circle when not installed and, when measured for inside diameter, they should be installed in the cylinder block and the bearing caps bolted tightly in place (crankshaft removed). The two (2) halves of the shells have a squeeze fit in the seat and bearing cap, and must be tight when the cap is drawn down. Tighten each bearing cap to a torque of 180 to 190 lbs. ft. using a torque wrench.

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 lbs. ft. torque, thus "crushing" the wire or foil to shim thickness between the shells and the crankshaft 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 thrust washers at the rear main bearings. The minimum end play is .004" and should not exceed .018"; replace the thrust washers if the end play exceeds .018". *NOTE: 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 the engine is disassembled. Use a flat piece of metal to press the new seals into place to prevent damaging the seal; the sealing lip side of each seal should be toward the inner side of the housing or the cover. The sealing lips must face each other when the housing and the cover are installed on the engine.

F. Replacement of Engine Clutch Shaft Front Bearing Oiling Wick

If the clutch shaft front bearing (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 assembly must be installed.

Turn the wick holder out of the crankshaft and remove the oiling wick assembly.

Install the oiling wick assembly as follows:

1. Saturate the wick with clean engine oil. Coat the threads of the wick holder with a sealing compound.

2. Insert the end of the wick into the hole in the crankshaft and engage the threads of the wick holder with the threads in the crankshaft. Tighten the wick holder securely.

   CAUTION: The wick was carefully installed in the holder without twisting. When a new wick assembly is received, do not twist the wick in the holder as this will leave a groove around the wick and will allow too much oil to pass through.

G. Flywheel, Ring Gear, and Engine Clutch Shaft Front 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 this surface is not smooth and true, the flywheel may 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 ring gear if it is not in good condition. Remove the ring gear from the flywheel by grinding a notch through the ring at the root of one of the teeth, then expand the ring and drive it from its position. Do not attempt to remove the ring gear without first expanding it. To install a flywheel ring gear, proceed as follows:

   a. The ring gear is shrunk on the flywheel by uniformly heating the gear to 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 the 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 with the pinion of the starter. Drive the ring gear down tight against the shoulder on the flywheel. Allow the ring gear to cool slowly; do not cool it by using water.

3. ENGINE CLUTCH SHAFT FRONT 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.

H. Removal of Crankshaft Pulley

1. Remove the radiator and shell assembly (refer to "RADIATOR REMOVAL," Section IV).

2. Release the tension on the fan belts and remove the belts from the crankshaft pulley.

3. Remove the crankshaft capscrew and washer used to retain the crankshaft pulley. Using a puller similar to the one shown in Fig. 29, remove the crankshaft pulley from the crankshaft.

I. Installation of Crankshaft Pulley

1. Install the two (2) "WOODRUFF" keys in

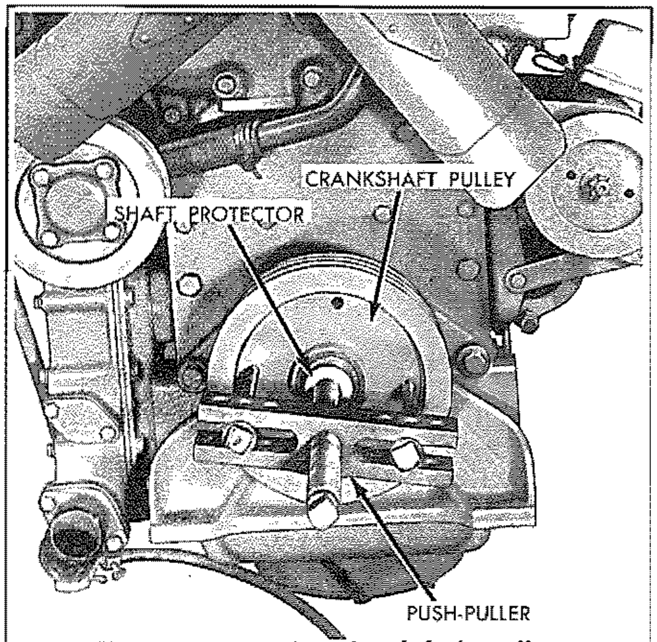


Fig. 29 — Removing Crankshaft Pulley

the crankshaft, then install the crankshaft pulley, pulley retaining washer, and the crankshaft capscrew. Tighten the crankshaft capscrew to a torque of 180 to 200 lbs. ft.

2. Place the fan belts in the grooves of the crankshaft pulley, then adjust the belts (refer to "FAN BELT ADJUSTMENT," Section IV).

3. Install the radiator assembly and shell (refer to "INSTALLATION OF RADIATOR," Section IV).

6. PISTONS AND CONNECTING RODS

A. Description of Pistons

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.

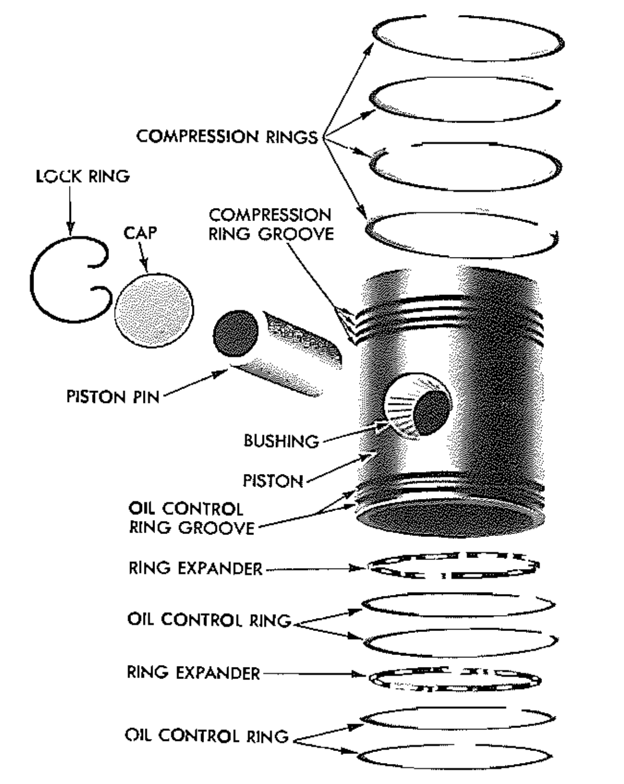


Fig. 30 — Piston Assembly Details

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 nozzle in 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 type 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 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 late 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 nozzle 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.

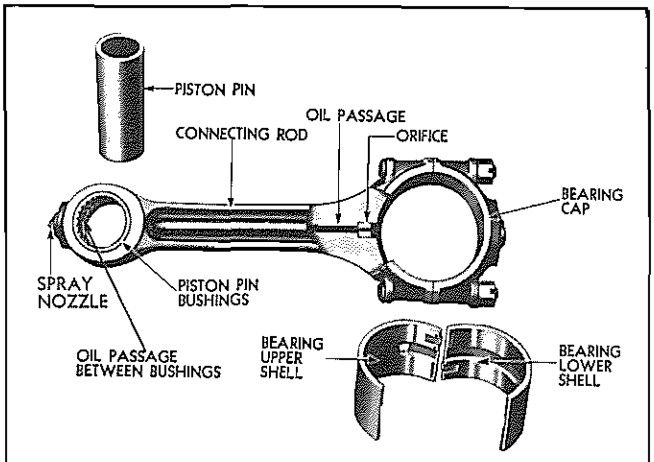


Fig. 31 — Connecting Rod Assembly

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 shells are 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 shells have 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 piston 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 the 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 bearing shells 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 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 ring 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, 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 thin 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".

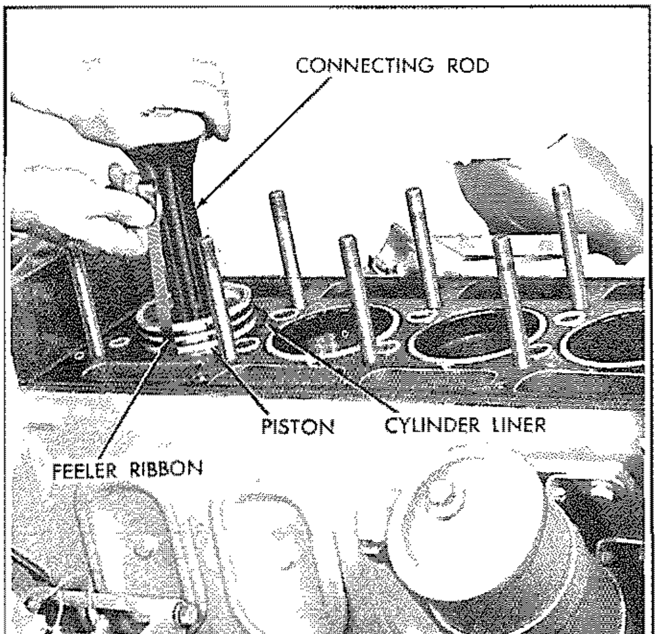


Fig. 32 — Measuring Piston Clearance

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 piston 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, 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 1.4996" to 1.500".

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 .0034". 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 nozzle at the upper end of the connecting rod and blow dry compressed air through the oil passage in the rod. *IMPORTANT: BE SURE THAT ALL OIL PASSAGES ARE OPEN.*

4. Inspect the connecting rod bearing shells for scoring, chipping, corrosion, cracking, or signs of over-heating; discard the bearing 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 load is on the upper half of the connecting rod bearing 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 thickness of connecting rod bearing shells may be measured for wear in the same manner as the main bearing shells (refer to "CRANKSHAFT,

CRANKSHAFT PULLEY, FLYWHEEL, AND MAIN BEARINGS" in this Section). Connecting rod bearing shells that measure less than .153" at the center should be discarded and new ones installed. 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.). *IMPORTANT: 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 (cylinder liner installed in the cylinder block). 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. 32). 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 cylinder 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 all burrs with a honing stone or fine emery paper.

If, after removing any 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.

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 of the cylinder liner 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. 33.

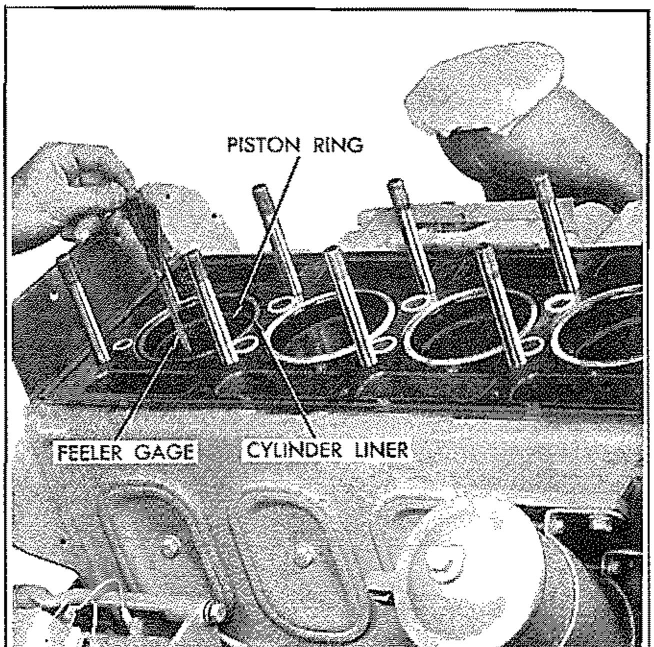


Fig. 33 — Fitting Piston Rings

The pistons in early 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 late model tractors are 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" 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 compression ring-to-groove clearances (top of ring to top of groove in piston) using a new piston and new rings are as follows:

Top Ring	.010" to .0125"
2nd Ring	.008" to .0105"
3rd and 4th Ring	.006" to .0085"

The oil control ring gap specification is .010" to .020". The oil control ring-to-groove clearance (top of ring to top of groove in piston) 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. 30. The ring expanders must be installed first, then the rings, with the scraper edges down and the chamfered edges toward the top of the pistan. 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 with the driving bar and driver block as shown in Fig. 34.

2. Install the new bushings, pressing one into each side of the connecting rod, with outer end of each bushing flush with the outer edge of the rod and with the joints of the bushings toward the top of rod. This will leave an oil space of approximately 3/16" between the bushings.

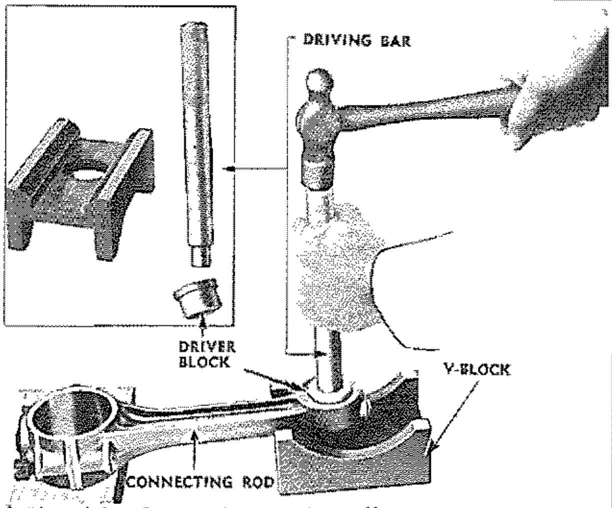


Fig. 34—Removing or Installing Connecting Rod Bushings

3. After the bushings have been installed, they must be reamed. The special reaming fixture and reamer, shown in Fig. 35, must be used to assure proper alignment of the piston with the rod and to obtain proper clearance of the piston pin with the bushings.

   a. Place the bore at the lower end of the rod over the arbor on the fixture and draw the bearing cap up tight.

   b. Slide the fixture 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 obtained by moderate pressures when turning.

   e. After reaming, inspect the clearance between the connecting rod bushings and the piston pin. If the bushings have been properly reamed, the clearance between

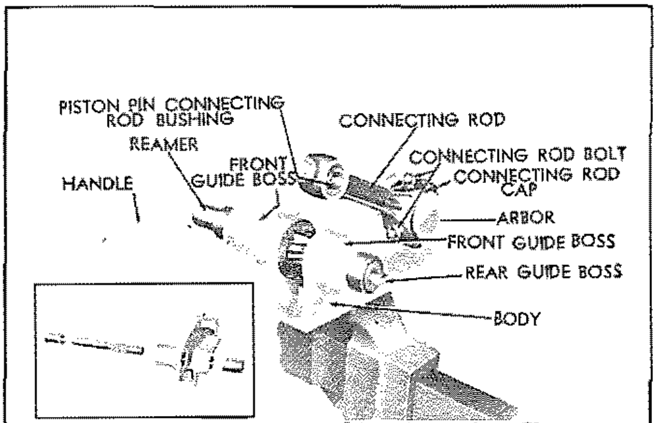


Fig. 35 — Piston Pin Bushing Reaming Fixture

the piston pin and the bushings 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 in the piston.

2. Insert the upper end of the connecting rod into the piston. Lubricate the piston pin with engine oil and insert the piston pin into position in the piston and the connecting rod. The piston pin will slip easily into place without forcing if it has been correctly fitted.

3. Install the other 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.

7. CAMSHAFT AND BALANCE SHAFT

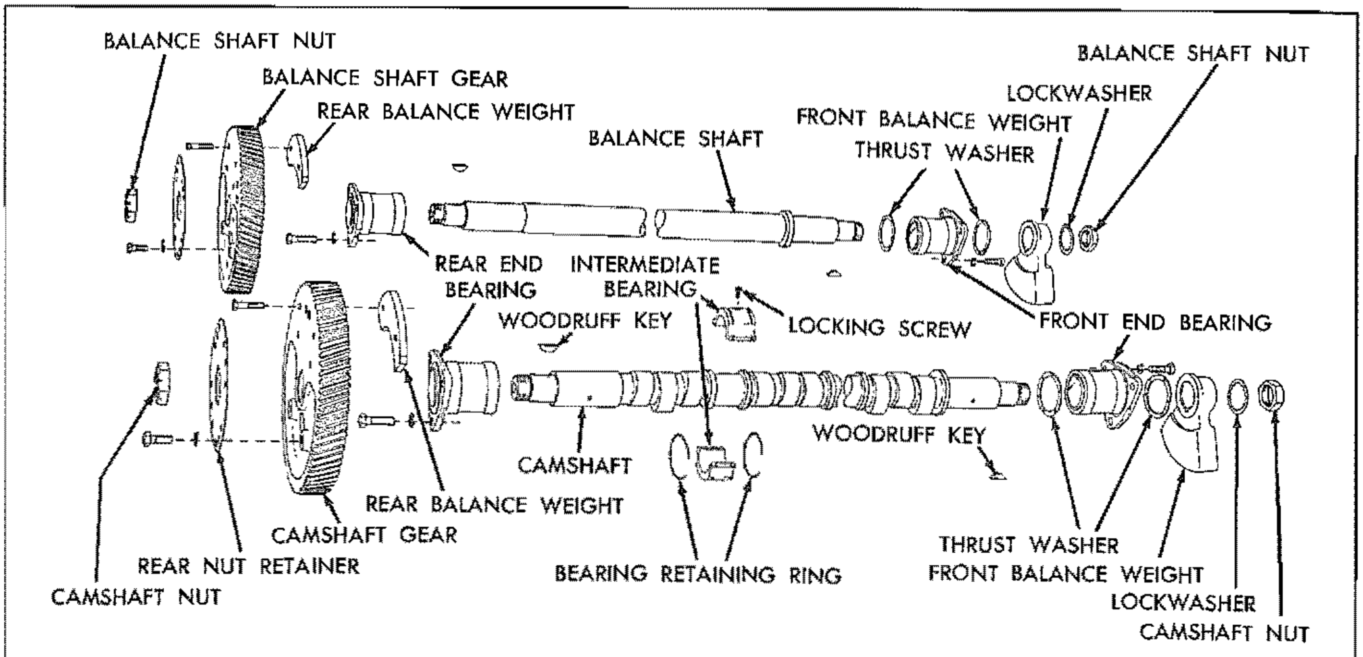


Fig. 36 — Camshaft and Balance Shaft Details

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, located 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, provide 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 type, thrust washers are used at the thrust ends (front) of the shafts.

As will be seen from Fig. 36, the camshaft intermediate bearings are two-piece and are held together by retaining rings. Each bearing assembly is located and locked in position in the cylinder block by a shouldered locking screw which is installed into a counterbore at the top of the cylinder block.

The cams are ground with parallel surfaces to assure efficient quiet camshaft follower 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. Balance weights, at the front and rear ends of both the camshaft and the balance shaft, 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 the balance shaft as shown in Fig. 36. The balance weights are securely fastened to the front ends of both the camshaft and the balance shaft by means of a "WOODRUFF" key, nut, and lockwasher.

B. Lubrication

Lubrication is supplied to the camshaft and the 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 the removal of the engine 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.

E. Removal of Parts from Camshaft and Balance Shaft

Refer to Fig. 36 showing the relative location of the parts.

1. Remove the inner thrust washers from the front ends of the shafts. Remove the cap-screws attaching the rear nut retainers to the gears and remove the nut retainers, then remove the nuts from the gear ends of the shafts. Using a suitable puller, or a press, remove the gears from shafts. Remove the "WOODRUFF" key and the rear bearing assembly from each shaft.

2. Remove the bearing retaining rings from the camshaft intermediate bearings and remove the bearings.

F. Inspection of Camshaft and Balance Shaft Parts

After all the parts have been cleaned with solvent or fuel and dried by air, inspect all the bearings and shaft journals for wear. 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 to be reground, 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 to be reground, the diameter of the intermediate journals should be reduced to .010" below 1.4985" to fit the .010" undersize intermediate bearings.

Examine both faces of the cam and the balance shaft bearing thrust washers and if either face is scored, replace the thrust washers. Examine the surfaces against which the thrust washers contact and if the surfaces are scratched, but not severely scored, they may be smoothed with an oil stone. However, score marks too deep to be removed, or parts badly worn, necessitate the use of new parts.

The specified clearance of the camshaft and balance shaft journals with the end bearings is .0015" to .003" and should not exceed .006". The specified clearance of the camshaft journals with the camshaft intermediate bearings is .0025" to .004" 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".

Examine the cam surfaces of the camshaft for wear or scoring. A shaft with scored cams should not be reinstalled. 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 and any sludge accumulations which might restrict the oil flow should be removed.

G. 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 cylinder 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 to the gears.

The teeth of the gear to be installed on the camshaft form a left-hand helix and the teeth of the gear to be installed on the balance shaft form a right-hand helix. Refer to Fig. 36 and install the parts as follows:

1. Lubricate the two (2) rear end bearing assemblies with oil and slip one on the rear 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 shaft nuts on the rear ends of shaft and against the gears. The shaft 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 engine oil and install the bearings in position on the camshaft intermediate bearing journals. Install the intermediate bearing retaining rings in the grooves of the bearings.

NOTE: Tractors having Engines Serial No. 4A-19529 and above have the late type cylinder block in which individual compression gaskets are used instead of the laminated one-piece type compression gasket which was used on engines prior to this serial number.

The late type cylinder blocks are approximately 1/16" higher than the early type cylinder blocks, in order to compensate for the thickness of the gasket which was used with the early type cylinder blocks. As a result of heightening the late 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 locking screws is required in the late type cylinder blocks.

The camshaft intermediate bearings used at the upper position in the late type cylinder blocks have a hole for each bearing locking screw drilled all the way through the bearing, whereas, the hole for each locking screw in the intermediate bearings used in the early type cylinder blocks is drilled only partially through the bearing. The threaded portion of the late type intermediate bearing locking screws, as well as the tip, are longer than the locking screws used in the early type cylinder blocks.

As the late type camshaft intermediate bearings used in the upper position in the late type cylinder blocks are drilled all the way through and the early type intermediate bearings were not, the early type bearings cannot be used in the upper position in the late type cylinder blocks, as the new locking screws would bottom in the early type bearings and would not allow the locking screws to clear the top surface of the cylinder block. If the early type locking screws were used in the late type cylinder block, the locking screws would not provide sufficient engagement with the holes in the late type intermediate bearings to lock the bearings securely.

Late type camshaft lower intermediate bearings used with the late type intermediate upper bearings, are simply the early type intermediate bearings without a locking screw hole, and must be used only in the lower position as a locking screw is not used at the lower position.

Summary:

1. The late type camshaft intermediate bearings may be used in the early type cylinder blocks provided they are installed in their respective positions (upper in the upper, and lower in the lower positions), and that the early type locking screws are used to lock the upper bearings in place.

2. The early type camshaft intermediate bearings may be used in the late type cylinder blocks in the LOWER position ONLY.

3. The late type camshaft upper 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 locking screw holes piercing the bearing contact surfaces.

H. 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 of the 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. 37. Push the balance shaft gear into mesh.

2. Secure the balance shaft rear end bearing to the cylinder block with three (3) lockwashers and capscrews and tighten the capscrews to a torque of 35 to 40 lbs. ft. 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 inner face of the front end bearing assembly; make certain that the steel side of the thrust washer faces the front end bearing assembly. Lubricate the front end bearing assembly with engine oil and insert it into position in the cylinder block and on to the balance shaft. Use care when inserting the front end bearing assembly so that the thrust washer will not be dislodged. Secure the front end bearing assembly to the cylinder block with three (3) capscrews and lockwashers. Tighten the capscrews to a torque of 35 to 40 lbs. ft.

4. Apply grease to the steel side of the thrust washer to be used in the front position on the balance shaft. Place the washer in position on the outer face of the front end bearing assembly. Make certain that the steel side of the thrust washer faces the front end bearing assembly.

5. Install the "WOODRUFF" key in slot in the front end of the balance shaft. Install the front balance weight in position on the balance shaft. Place the lockwasher on the balance shaft and start the balance shaft nut, but do not tighten the nut at this time as it will be tightened after the installation of the camshaft.

I. 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 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 turn the gear as necessary so that the "0" timing marks on the camshaft and the balance shaft gears will match as shown in Fig. 37, and push the camshaft gear into mesh.

2. Secure the camshaft rear end bearing to the cylinder block with three (3) lockwashers and capscrews and tighten the capscrews to a torque of 35 to 40 lbs. ft. The capscrews are accessible through the web of the camshaft gear.

3. Turn the camshaft intermediate bearings so that the locking screw holes in the bearings align with the holes in the top of the cylinder block. Install the locking screws 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 locking screws and the proper intermediate bearings are installed.*

4. Apply grease to the steel side of one of the thrust washers and place the washer in position on the inner face of the front end bearing assembly; make certain that the steel side of the thrust washer faces the front end bearing assembly. Lubricate the front end bearing assembly with engine oil and insert it into position in the cylinder block and onto

the camshaft. Use care when inserting the front end bearing assembly so that the thrust washer will not be dislodged. Secure the front end bearing assembly to the cylinder block with three (3) capscrews and lockwashers. Tighten the capscrews to a torque of 35 to 45 lbs. ft.

5. Apply grease to the steel side of the thrust washer to be used in the front position on the camshaft. Place the washer in position on the outer face of the end bearing assembly. Make certain that the steel side of the thrust washer faces the end bearing assembly.

6. Install the "WOODRUFF" key in the slot in the front end of the camshaft. Install the front balance weight in position on the camshaft. Place the lockwasher on the camshaft and start the camshaft nut.

7. Wedge a block of wood between the balance weights as shown in Fig. 45, and tighten the nuts on both the camshaft and the balance shaft to a torque of 300 to 325 lbs. ft.

   CAUTION: When tightening the nuts for the balance weights and gears, DOUBLE CHECK and MAKE SURE that the thrust washers are in their proper position.

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, with the corresponding 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 thrust 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 and tighten the nuts to a torque of 300 to 325 lbs. ft. Install the rear nut retainers on the gears and tighten the attaching capscrews securely.

8. GEAR TRAIN

A. Description

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. 37. A crankshaft gear bolted to the crankshaft flange drives the camshaft and the balance shaft gears, as well as the blower 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. The gears are keyed to their respective shafts, each gear being held securely against a shoulder on the shaft by a retaining nut and nut retainer.

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

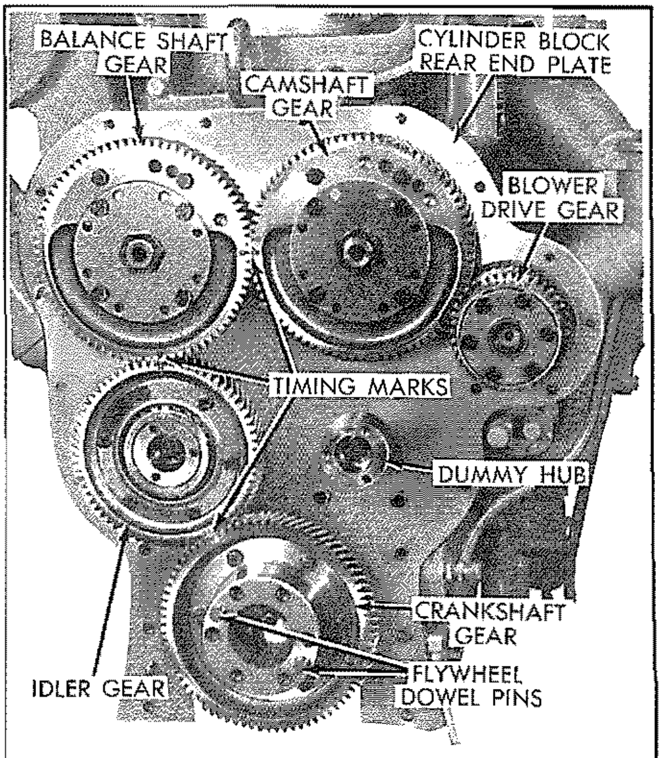


Fig. 37 — Timing Marks and Gears

(opposite the idler gear hub location). The idler gear bearing is lubricated through a hollow dowel, communicating with the left rear vertical oil passage in the cylinder block. The blower drive gear, in mesh with the camshaft gear, transmits power to drive the blower, governor, water pump, and the fuel pump.

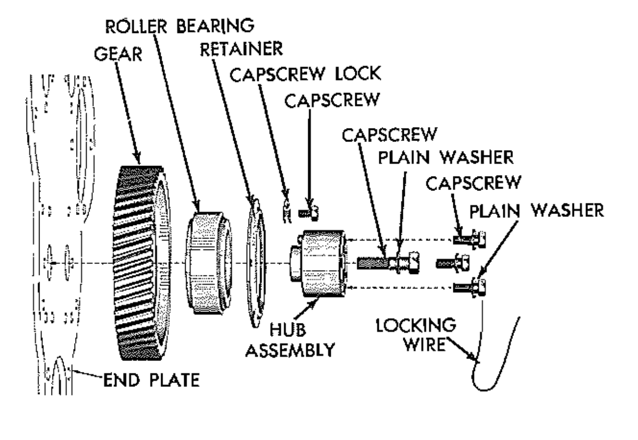


Fig. 38 — Idler Gear Details

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 inner races, tapered rollers, and bearing retainers of the 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 assembly 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 idler gear, hub assembly, and roller bearing are available as an assembly or the individual parts can be obtained for service.

The gear train will run quietly if the gears and bearings are in good condition. The specified backlash between the various mating gears in the train is .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.

C. Inspection and Disassembly of Idler Gear, Hub, and Bearing Assembly

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.

With the idler gear assembly removed from the engine, proceed as follows:

1. Thoroughly wash the idler gear assembly in clean solvent.

2. 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.*

3. 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. The spacer used between the inner races is not replaceable due to it being specifically ground for the inner races used with it.

4. Inspect the outer bearing race and if necessary remove it from the idler gear. Unlock and remove the capscrews and the capscrew locks attaching the retainer to the gear and remove the retainer.

5. 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 idler gear in a press (with the 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 driver may be used to drive the outer race from the gear by inserting the drift into the notches (push-out slots) in the shoulder of the gear.

6. Coat the parts with clean engine oil and store them in a suitable place which will protect them against damage 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 Idler Gear Roller Bearing Into Idler Gear

a. Thoroughly clean all parts 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.

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 lbs. ft. Lock the capscrews in position by bending the ends of the locks against the capscrew heads.

2. 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 lbs. ft.

b. Lubricate the idler gear bearing with clean 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 ⅛" lintless cord around a ⅛" round piece of wood (or soft metal stock) about ¾" 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 ⅜" 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 lbs. ft. *NOTE: This step is not necessary if the ⅜" 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.

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 lbs. ft.

If the ⅜" 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 lbs. ft.

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; the specified pull on the scale is ½ to 6¾ lbs.*

If the running friction of the idler gear is within the above 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 so that the other gears in the gear train can be installed.

h. Install the idler gear as follows:

1. Position the balance shaft and the camshaft gears so that the "0" timing marks align (refer to Fig. 37).

2. Position the "R" timing mark on the crankshaft and the "R" timing mark on the balance shaft gears so that they will align with the two (2) "R" timing marks on the idler gear (refer to Fig. 37).

3. With these timing marks in alignment, start the idler gear into mesh with the crankshaft gear and the balance shaft gear and simultaneously rotate the gear hub, which is pressed into the roller bearing inner race, so that the hollow dowel pin at the inner end of the idler gear hub nearly registers with the oil hole in the cylinder block end plate.

4. Install the idler gear in position, aligning the hollow dowel pin with the hole in the cylinder block end plate. The hollow dowel pin in the hub is used to conduct oil through the end plate and into the idler gear hub, where it flows through a drilled passage to the idler gear roller bearing.

5. After making sure that the idler gear hub is tight against the cylinder block end plote, secure the idler gear assembly in place with the plain washer and capscrew. Tighten the capscrew to a torque of 80 to 90 lbs. ft.

6. Lubricate the idler gear and bearing with clean engine oil.

i. 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 lbs. ft. Install the lockwires through the capscrew heads to lock the capscrews in position.

CAUTION: Special care must be taken to protect the idler gear assembly against the entry of dirt. Keep the parts clean before and during installation on the engine.

9. REPAIR OF ENGINE WHILE INSTALLED

A. General

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. *IMPORTANT. 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 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 bear-

ings 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 oil pan.

3. Remove the oil pump from the engine block (refer to "OIL PUMP REMOVAL," 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 oil pan (refer to "OIL PUMP INSTALLATION," Section V). Fill the engine crankcase to the proper level with the specified oil.

9. Install the cylinder head and the engine 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 air pre-cleaner, engine hood, and the valve rocker cover.

2. Close the fuel tank shut-off valve, and remove the fuel injectors (refer to "INJECTOR REMOVAL," Section II). Removal of the injectors is necessary to relieve the compression and allow free turning of the crankshaft.

3. Remove the engine crankcase guard. Drain the oil from the crankcase and remove the oil pan.

4. Remove the oil pump assembly from the engine block (refer to "OIL PUMP REMOVAL," Section V).

5. Remove the main bearing caps one at a time and install new bearing shells. Do not fully tighten the bearing caps until all the bearing shells have been installed. The lower bearing shell can be removed from the bearing cap after the cap is removed. Remove the upper bearing shell as follows:

    a. Insert a ¼" x 1" capscrew, with a head 7/16" in diameter and with the head ground down to a thickness of 1/16", into the crankshaft main bearing oil hole, then revolve the crankshaft in the

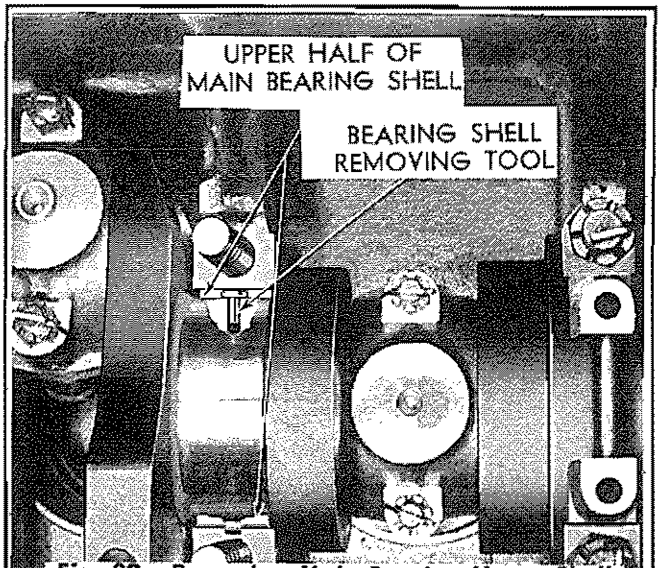


Fig. 39—Removing Main Bearing Upper Shell

direction that will turn the head of the bolt against the end of the bearing shell that has no locking tang. Continue turning the crankshaft until the shell has been pushed out of position as shown in Fig. 39.

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 as shown in Fig. 40, while revolving the crankshaft.

6. Inspect the crankshaft and each bearing shell as explained in "CRANKSHAFT, FLYWHEEL, AND MAIN BEARINGS" in this Section. If the crankshaft is unfit for use, it must be reconditioned or replaced before new bearings are installed.

7. Install the upper (grooved) half of each main bearing shell 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 clean engine oil, and install the bearing cap. *NOTE: The main bearing caps are marked 1, 2, 3, etc. Whenever the bearing caps are removed, they must be reinstalled in their original positions and with the marked side toward the blower side of cylinder block.*

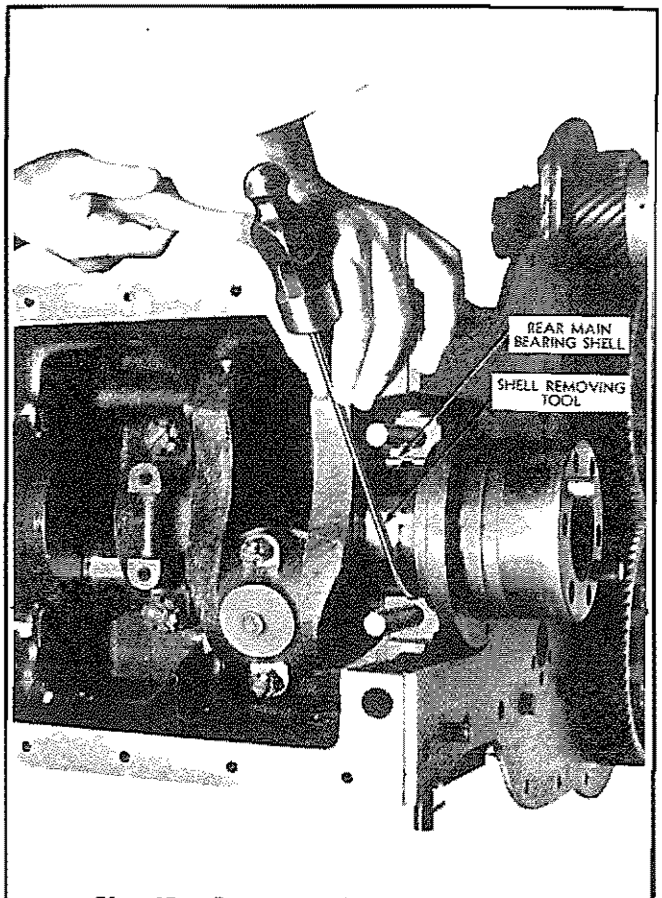


Fig. 40—Removing Rear Main Bearing Upper Shell

9. After all of the bearing shells have been installed, tighten the bearing caps. Use a torque indicating wrench and tighten the bolts to a torque of 180 to 190 lbs. ft. *CAUTION: 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, oil pan, and the crankcase guard (refer to "OIL PUMP INSTALLATION," Section V). Fill the engine crankcase to the proper level with the specified oil.

11. Install the fuel injectors and make the proper adjustments as explained in "INJECTOR TIMING" and "INJECTOR EQUALIZING," Section II. Adjust the valve lash as explained in "VALVE LASH ADJUSTMENT" in this Section.

12. Install the valve rocker cover, engine hood and the air pre-cleaner. 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.

10. ENGINE REMOVAL AND INSTALLATION

A suitable hoist, cable or chain and a sling spacing bar, 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, clean 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 at disassembly, but will make the work much quicker and more easily done.

A. Engine Removal

1. Remove the engine air pre-cleaner, engine hood, and the front fenders. Remove the brake pedal pads, gear shift lever guide, gear shift lever extension, and the floor plate.

2. Drain the engine cooling system (refer to "FILLING AND DRAINING OF SYSTEM," Section IV). Remove the capscrews attaching the water inlet elbow to the radiator and loosen the hose clamps on the radiator outlet hose.

3. Disconnect the headlight cable at the cable connector located at the left front side of the

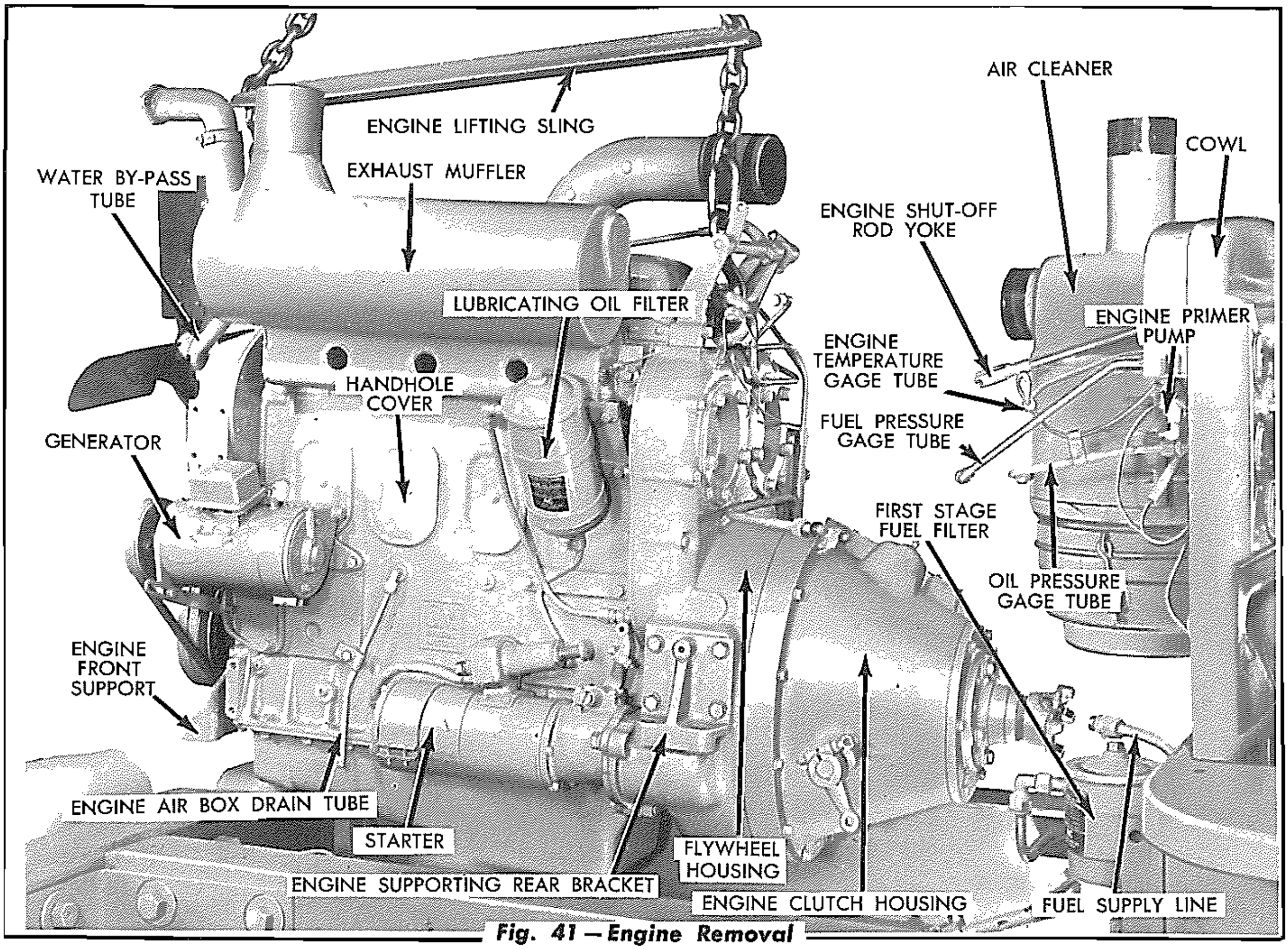


Fig. 41 — Engine Removal

radiator. Remove the capscrews attaching the headlight cable clips to the left front and the top of the radiator.

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 the radiator and shell assembly from the main frame.

5. Remove the capscrew attaching the battery ground to the top of the steering clutch housing. Tape the end of the ground cable to prevent a ground when disconnecting other electric cables. Close the fuel tank shut-off valve, located at the front side of the fuel tank.

6. Disconnect the wiring harness from the starter and the generator. Remove the cap-screw attaching the cable clip to the left rear engine supporting bracket.

7. Disconnect the fuel supply line at the sealastic union located at the left rear corner of the engine.

8. Disconnect the engine primer line from the primer pump. Loosen the hose clamps on the air cleaner hose and free the hose of the air cleaner body.

9. Disconnect the fuel pressure gage tube and the engine oil pressure gage tube at the sealastic unions, located at the rear of the engine.

10. Disconnect the fuel return line at the sealastic union, located at the lower right side of the engine flywheel housing.

11. Disconnect the front end of the engine temperature gage tube from the rear of the engine water outlet manifold.

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 on the rear of the engine. Remove the yoke pin connecting the throttle operating rear rod to the lever located on the rear of the engine.

13. Remove the yoke pin connecting the front end of the transmission shifting lock plunger rod (left rod) to the engine clutch shifting yoke shaft lever. Remove the cotter pin from the front end of the transmission shifting lock plunger rod (right rod) and disconnect it from the shifting lock lever at the right side of the engine clutch housing.

14. Remove the yoke pin connecting the 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 front yoke to transmission universal joint assembly as the front yoke will slip off the rear end of the clutch shaft as the engine is moved forward for engine removal.*

15. Remove the bolt attaching each end of the engine front support 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.

16. The engine is now ready for removal from the tractor. Using an engine lifting sling assembly similar to the one shown in Fig. 41, and with the proper lifting facility, raise the engine enough so that the weight is off the engine supports. Move the engine forward, raise it as necessary until the clutch housing is clear of the cowl, and 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 sling similar to the one shown in Fig. 41, 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 splined clutch shaft with the front yoke of the transmission universal joint assembly so that the front yoke engages properly with the clutch shaft. Install the attaching bolts in the engine front and the rear supports and tighten the bolts securely.

2. Connect the engine clutch operating lever control rod to the engine clutch shifting yoke shaft lever. Check the adjustment of the engine clutch linkage and of the engine clutch and clutch brake (refer to "ENGINE CLUTCH AND CLUTCH BRAKE," Section X).

3. Connect the front end of the transmission shifting lock plunger rod (left rod) to the engine clutch shifting yoke shaft lever. Connect the front end of the transmission shifting lock plunger rod (right rod) to the clutch shaft lever located on the right side of the engine clutch housing.

4. 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 on the rear of the engine. Connect the throttle operating rear rod to its corresponding lever located on the rear of the engine.

5. Insert the end of the engine temperature gage tube into position in the rear of the engine water outlet manifold and tighten the connecting nut. Position the air cleaner hose on the air cleaner body and the air inlet elbow and tighten the hose clamps.

6. Connect the fuel return line to the sealastic union at the lower right side of the engine flywheel housing.

7. Connect the engine oil pressure gage tube and the fuel pressure gage tube to their corresponding lines.

8. Connect the upper end of the engine primer line to the engine primer pump.

9. Connect the fuel supply line to the sealastic union at the left rear of the engine.

10. Connect the wiring harness to the starter and the generator. Install the cable clip in position at the left rear engine supporting bracket and install the attaching capscrew.

11. Remove the tape from the end of the battery ground cable and install the capscrew, lockwasher, and internal tooth lockwasher used to attach the cable to the steering clutch housing. Install the internal tooth lockwasher between the cable and the housing. Open the fuel tank shut-off valve.

12. Using a suitable chain, cable, or rope, lift the radiator and shell assembly and install it in position on the main frame. Install and tighten the two (2) bolts attaching each lower corner of the radiator shell to the main frame.

13. Connect the headlight cable at the cable connector located at the front side of the radiator. Clip the headlight cable to the left front side and top of radiator.

14. Make certain that the radiator outlet hose (lower hose) is properly positioned on the radiator outlet elbow, and tighten the hose clamps. Using a new gasket, install the radiator inlet elbow in position on the radiator.

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

16. Check the adjustment of the engine control linkage (refer to "ENGINE CONTROLS AND GOVERNOR," Section VI).

17. Check the exhaust valve lash (refer to "VALVE LASH ADJUSTMENT" in this Section).

18. Time and equalize the fuel injectors (refer to "INJECTOR TIMING" and "INJECTOR EQUALIZING," Section II).

19. Fill the engine crankcase to the proper level with the specified lubricant. If the engine has been rebuilt, or a new engine has been installed, remove the valve rocker cover and pour approximately 1 gallon of oil over the rocker arm assemblies and cylinder head components when filling the crankcase. This will assure initial lubrication of the various components within the engine.

20. Loosen the vent screw in the top of the second stage fuel filter. With the engine shut-off control knob pulled back to the "STOP" position, crank the engine with the starter several times and allow the second stage filter to fill with fuel. Tighten the filter vent screw when fuel emerges from around the loosened vent screw.

21. Install the floor plate, brake pedal pads, gear shift lever extension, geor shift lever guide, front fenders, engine hood, and air pre-cleaner.

22. 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.

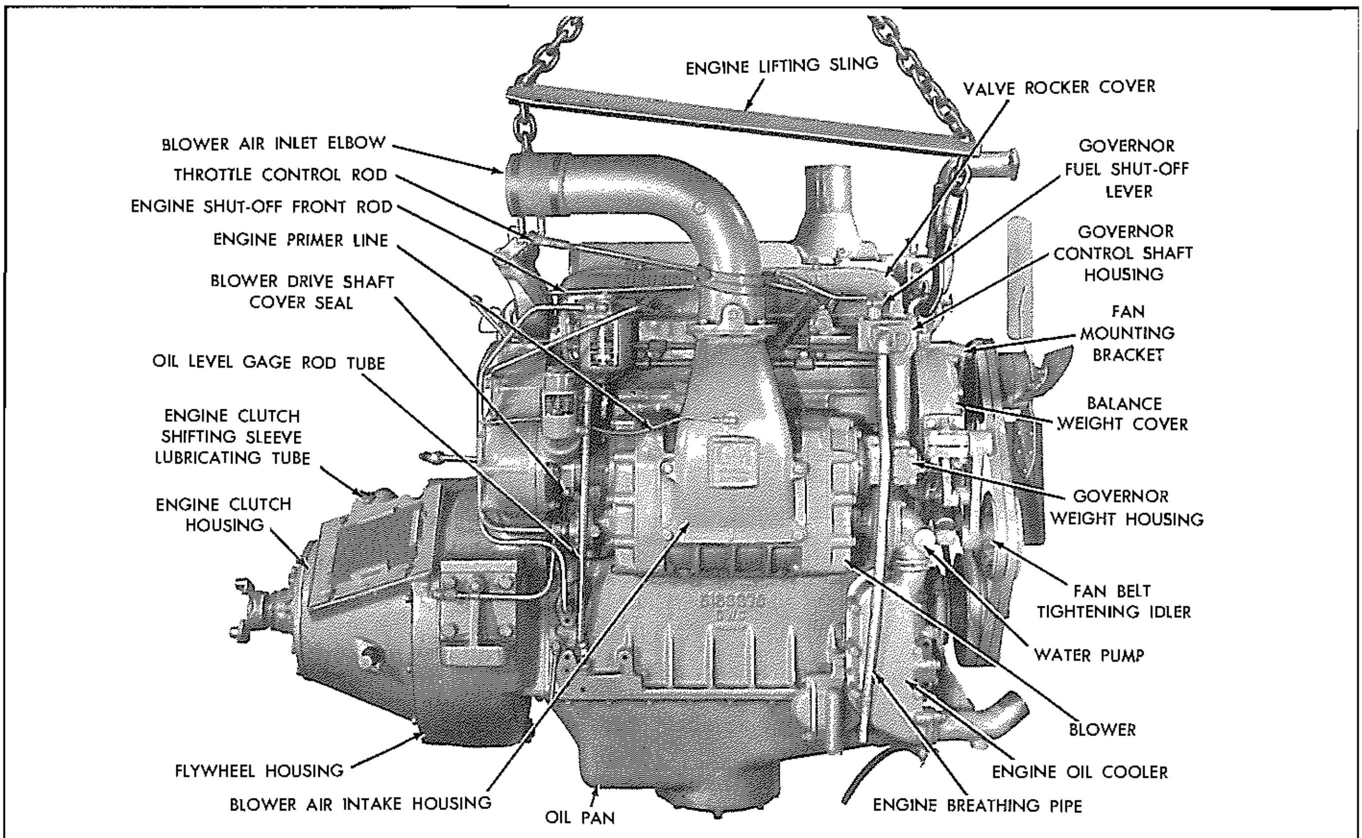


Fig. 42—Right Side of Engine

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. 41 and 42 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 a stand is available:

   Remove the muffler, generator and mounting bracket, lubricating oil filter and filter base, starter, and engine air box drain tube. Remove the air box handhole covers from the side of the cylinder block.

2. Remove the jam nut and lockwasher attaching the engine clutch shifting sleeve bearing lubricating tube to the engine clutch housing. Push the end of the lubricating tube down into the clutch housing.

3. Remove the capscrews attaching the engine clutch housing to the engine flywheel housing. Support the clutch housing and move it towards the rear until the clutch shaft has moved free of the clutch shifting sleeve yoke assembly, then remove it from the engine.

4. Remove the yoke pin connecting the fuel shut-off rod to the governor fuel shut-off lever. Remove the yoke pin connecting the engine shut-off front rod to the engine shut-off lever located at the rear of the engine. Remove the air shut-off valve lever spring and hook from the fuel manifold. Disconnect the engine primer line from the elbow located in the blower air inlet housing. Remove the capscrews attaching the blower air intake housing to the blower and remove the housing and the blower air inlet elbow in one assembly. *IMPORTANT: Cover the opening in the blower housing after removing the blower air intake housing.*

5. With the above accessories removed, the engine can be mounted on a stand similar to the one shown in Fig. 43. 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.

6. 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.

7. Remove the crankshaft pulley (refer to "REMOVAL OF CRANKSHAFT PULLEY" in this Section).

8. Remove the fan belt tightening idler assembly with its mounting bracket.

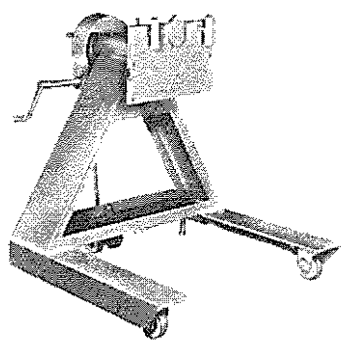


Fig. 43 — Engine Stand

9. Drain the engine lubricating oil. Loosen the hose clamp on the water pump to oil cooler seal. Remove the engine breathing pipe. Remove the capscrews attaching the oil cooler housing to the oil cooler 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.

10. Disconnect the throttle control rod, located on the upper right side of the engine, and remove the rod assembly. Do not disturb the adjustment of the control rod.

11. Remove the valve rocker cover and the governor control shaft housing cover. Disconnect the governor-to-injector control tube lever link from the injector tube lever. Disconnect the link from the governor differential lever and remove the link. Remove the capscrews attaching the governor control shaft housing to the cylinder head and to the governor weight housing. 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 and remove the housing assembly.

12. Remove the water outlet manifold and the water by-pass tube.

13. 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 position in the blower drive gear, and remove the blower assembly.

14. Remove the capscrews attaching the engine clutch assembly to the flywheel and remove the clutch assembly and the driven plate.

B. Disassembly of Engine into Sub-Assemblies

Refer to pertinent sections of this manual for detailed information on the various engine subassemblies. 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 bolts 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 crankcase oil pan.

4. Remove the bolts and capscrews attaching the flywheel housing to the cylinder block rear end plate and to the cylinder block. Unlock and remove the capscrews from the inside of the flywheel cômpartment which attaches the housing to the idler gear hub and the spacer ("dummy" hub). Tap and pry the flywheel housing off the two (2) dowels located on each side of the crankshaft and remove the housing.

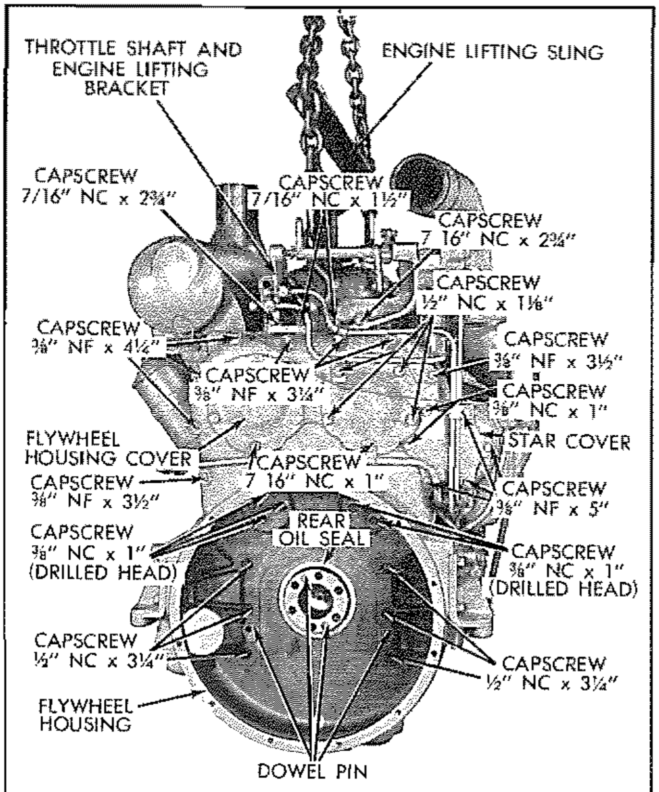


Fig. 44 — Flywheel Housing

5. Remove the capscrews attaching the balance weight cover to the cylinder block front end plate and remove the cover. Refer to Fig. 45, and remove the camshaft and the balance shaft nuts and lockwashers retaining the balance weights on the shafts. When removing the camshaft and the balance shaft nuts from the shafts, the shafts may be held from turning by "wedging" a block of wood between the balance weights. Pry the balance weight from the shafts by using two (2) heavy screwdrivers or pry bars between the heads of the front end bearing retaining capscrews and the balance weights as shown in Fig. 46. Remove the "WOODRUFF" keys from the shafts. Remove the front thrust washer from each shaft.

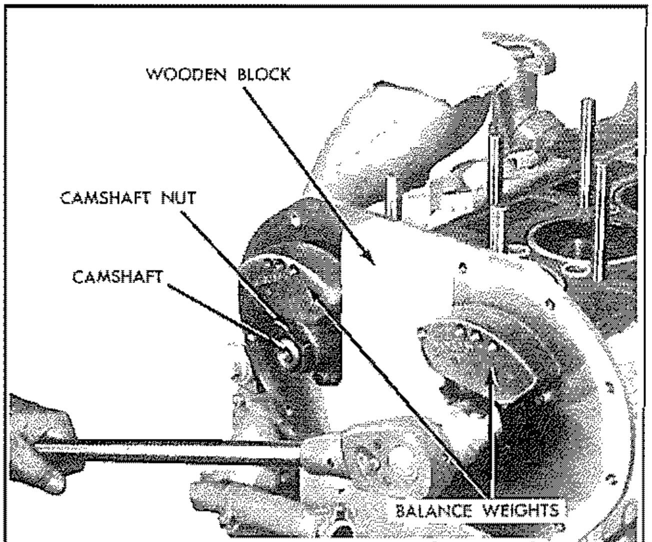


Fig. 45 — Removing Camshaft and Balance Shaft Nuts

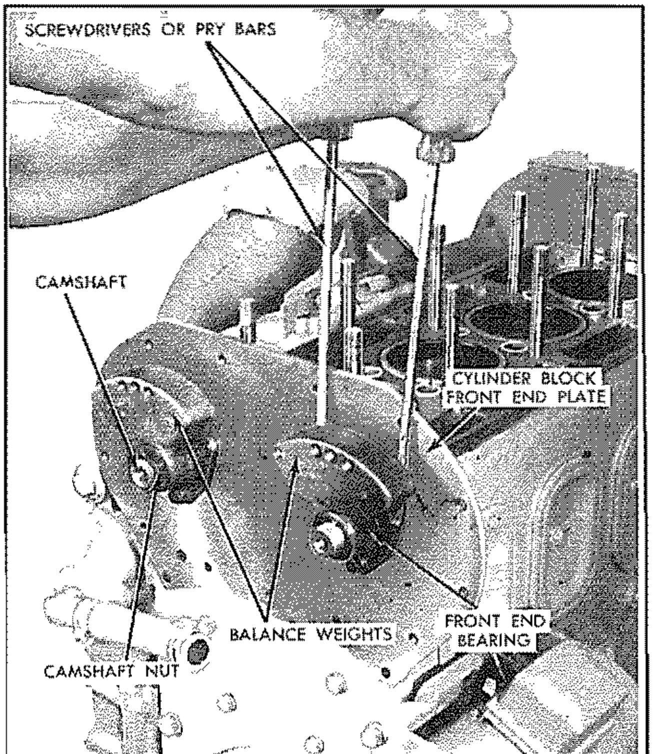


Fig. 46 — Removing Balance Weight

6. Remove the locking screws that hold the camshaft intermediate bearings from turning. *NOTE: A good practice to prevent loss of these locking 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 camshaft intermediate bearing locking screws, remove the three (3) capscrews attaching each rear end bearing of the camshaft and the balance shaft to the rear 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 align with the capscrews. Remove the camshaft and the balance shaft from the cylinder block by pulling back on the gears. The rear end bearings of both shafts and the intermediate bearings on the camshaft will remain on the shaft and be removed with the shafts. Remove the front end bearings from the front of the cylinder block after removing the three (3) attaching capscrews from each.

8. Remove the capscrew located in the center of the idler gear hub and the flywheel housing-to-cylinder block end plate spacer ("dummy" hub) and remove the assemblies.

9. Remove the capscrews attaching the crankshaft 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 crankshaft.

10. Remove the capscrews attaching the crankshaft front cover and slide the front oil seal spacer, front oil seal, and the cover assembly off the crankshaft.

11. Disconnect each end of the oil pipe for the blower drive support assembly. Remove the capscrews attaching the blower drive support assembly 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 the cylinder block front end plate to the cylinder block and remove the end plate.

13. Remove the oil pump (refer to "OIL PUMP REMOVAL," 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. Remove each piston and connecting rod assembly from the engine by pushing the assembly out through the top of the cylinder. Install each bearing cap on its respective connecting rod as they are removed.

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 reinstalled in their original positions.*

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 from the engine.

12. ASSEMBLY OF ENGINE

A. General

Make sure that all the parts are thoroughly cleaned before they are installed in the engine. Use new gaskets where gaskets are required. It is not necessary to cement gaskets used to seal against water leaks; on the other hand, BOTH SIDES of gaskets used to seal against oil or air leakage must be coated with gasket cement.

Lubricate all bearings or bearing surfaces with clean engine oil as the parts are assembled.

Before any parts are installed in the cylinder block, be sure that all the plugs which were removed to clean the oil and water passages in the cylinder block have been coated with sealing compound, installed, and securely tightened.

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. Refer to the various illustrations in this Section when assembling the engine.

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 corresponding slots in the bearing seats. Install the upper-halves of the two-piece thrust washers in position on each side of the rear main bearing.

2. Lubricate all the crankshaft main bearing journals and lower the crankshaft into the position in the cylinder 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 position in the main bearing caps. Place the lower halves of the two piece thrust washers in position on the dowels of 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. Use a torque wrench and tighten the bolts to a torque of 180 to 190 lbs. ft.

   CAUTION: DO NOT OVERTIGHTEN THE MAIN BEARING CAP BOLTS. If these bolts are overtightened, 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 tightened. Never file or shim a bearing cap to make the bearing shell fit; install new bearing shells if the fit on the crankshaft is unsatisfactory.

4. Install the crankshaft gear in position on the rear end of the crankshaft and install and tighten the attaching capscrews securely. Install the engine clutch shaft front bearing oiling wick assembly if it was removed for replacement (refer to "REPLACEMENT OF ENGINE CLUTCH SHAFT FRONT BEARING OILING WICK" in Topic 5 of this Section).

5. Turn the cylinder block on end, or lay it on its side, for the installation of the cylinder liners. On Tractors having Engine Serial No. 4A-19529 and above (having the late type cylinder block as explained in "CYLINDER BLOCK AND LINERS" in Topic 4 in this Section), make certain that the cylinder liner supporting inserts, used in the counterbores of the cylinder block beneath the flange of the liners, are clean, flat, and smooth so that the liner supporting inserts rest perfectly in the counterbores and will allow the cylinder liners to be inserted freely. *NOTE: Cylinder liner supporting inserts are not used in tractors having engines prior to Serial No. 4A-19529. 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 step 5 above in mind, install the cylinder liner supporting inserts in position in the counterbores of the cylinder block if the cylinder block is of the late type requiring the supporting inserts. Install the cylinder liners in position in the cylinder block. Measure the distance from the top of each cylinder liner flange to the top flat surface of the cylinder block. In Tractors having the late type cylinder block (requiring cylinder liner supporting inserts), the top surface of each cylinder liner flange must be within .046" to .050" below the top flat surface of the cylinder block.
In tractors having the early type cylinder block (blocks not requiring cylinder liner supporting 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".

   The dimensions given 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 installed.

7. In tractors having the late type cylinder block (requiring cylinder liner supporting inserts), if the top surface of any cylinder liner flange is not within .046" to .050" below the top flat surface of the cylinder block, the necessary cylinder liner shims must be installed between the bottom of the cylinder liner flange and the top of the cylinder liner supporting insert. The cylinder liner shims are available in two sizes: .0015" and .003" thick.

   In tractors having the early type cylinder block (blocks not requiring cylinder liner supporting 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 contacts in the cylinder block. The cylinder liner 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 connecting rods MUST be installed with the numbered side of the rod towards the blower side of the cylinder block.

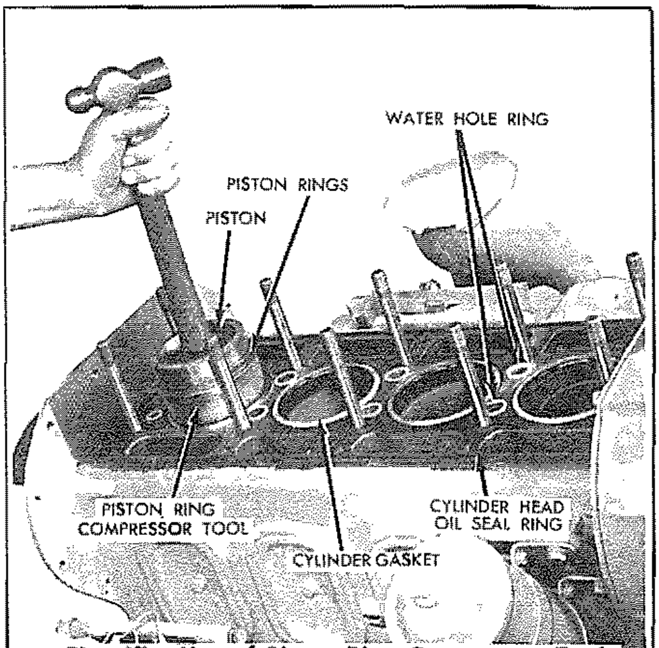


Fig. 47 — Use of Piston Ring Compressor Tool

   a. Stagger the piston ring gaps evenly around the piston, apply clean engine oil to the pistons and rings. Install a piston ring compressor tool over the lower end of the piston skirt, with flared end of the compressor tool toward the top of the piston. Turn the connecting rod so that the identification mark on the lower end of the rod is toward the blower side of the cylinder block. Align the lower end of the connecting rod with the crankshaft before pushing the piston into the cylinder. By tapping on the upper end of piston, with the wooden handle of a hammer, drive the piston into the cylinder liner. Be sure that the piston ring compressor tool is down tight against the top of the cylinder liner, so that the piston rings cannot snap out of the ring compressor before entering the cylinder liner.

b. Lubricate and install the connecting rod upper bearing shell (bearing shell with one short groove at each parting line) in position in the connecting rod and position the rod on the crankshaft journal.

c. Lubricate and install the connecting rod lower bearing shell in position in the bearing cap, with the tang of the shell in the corresponding groove of the cap. Install the bearing cap and shell.

d. Use a torque wrench and tighten the connecting rod nuts to a torque of 65 to 75 lbs. ft. 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 slip fit in the bores, the drag of the piston rings on the cylinder liners is sufficient to push the liners out of the cylinder block.

9. Using gasket cement, cement a new cylinder block end plate gasket to the front end of the cylinder block and coat the outer surface of the gasket with gasket cement. Install the cylinder block front end plate in position on the cylinder block, making sure that both surfaces are free of nicks or burrs. Attach the front end plate to the cylinder block using two (2) ½" N.C. x 1⅛" capscrews and six (6) ⅜" N.C. x 1" capscrews; use lockwashers on all the capscrews when installing. *NOTE: Before tightening the front end plate capscrews, insert the camshaft front bearing into position in the hole in the end plate and the cylinder block (on blower side of engine) to accurately align the hole in the end plate with the bore in the cylinder block.* The holes in the front end plate for the camshaft and the balance shaft front end bearings are not the same size. The hole for the camshaft front end bearing is machined to 2.187" diameter while the hole for the balance shaft front end bearing is 2.250" in diameter. For this reason, it is important that the camshaft front end bearing be inserted in the camshaft opening for alignment purposes.

10. Install the cylinder block rear end plate and gasket in position on the rear of the cylinder block in the same manner, with the hole in the rear end plate for the blower drive support toward the blower side of the cylinder block. Attach this plate to the cylinder block 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 align the holes in the rear end plate with the camshaft and the balance shaft rear end bearing bores in the cylinder block.

11. Install the rear end bearings and the gears in position 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, with the rear end bearing and balance shaft gear, into position at the rear of the cylinder block (in the left bore when viewed from the rear of the engine). 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 45 lbs. ft. Apply grease to the steel side of one of the thrust washers and place the thrust washer in position on the inner face of the front end bearing to be installed on the front of the balance shaft. Make certain that the steel side of the thrust washer faces the front end bearing. Lubricate the front end bearing with clean engine oil and insert it into position in the cylinder block and onto the balance shaft. Use care when inserting the front end bearing so that the thrust washer will not be dislodged. Secure the front end bearing to the cylinder block with three (3) capscrews and lockwashers; tighten the capscrews to a torque of 35 to 45 lbs. ft.

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 thrust washer in position on the front face of the front end bearing. Make certain that the steel side of the thrust washer faces to the front end bearing. Install the "WOODRUFF" key in position in the slot in the front end of the balance shaft, then install the balance weight on the balance shaft. Install the lockwasher on the balance shaft and start the shaft nut. 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, with the rear end bearing, intermediate bearings, and the camshaft gear into position in the rear 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, turn the gears as necessary so that the "O" timing marks on the cam and balance shaft gears will match as shown in Fig. 37, then push the camshaft gear into mesh. Secure the camshaft rear end bearing to the engine block with three (3) lockwashers and capscrews; tighten the capscrews to a torque of 35 to 45 lbs. ft.

d. Turn the camshaft intermediate bearings so that the locking screw holes in the bearings align with the holes in the top of the cylinder block, then install the locking screws 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 locking 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 thrust washer in position on the inner face of the front end bearing to be installed on the front of the camshaft. Make certain that the steel side of the thrust washer faces the front end bearing. Lubricate the front end bearing with clean engine oil and insert it into position in the cylinder block and onto the camshaft. Use care when inserting the front end bearing so that the thrust washer will not be dislodged. Secure the front end bearing to the cylinder block with three (3) capscrews and lockwashers; tighten the capscrews to a torque of 35 to 45 lbs. ft.

f. Apply grease to the steel side of the thrust washer to be used in the front position on the camshaft, then place the washer in position on the front face of the front end bearing. Make certain that the steel side of the thrust washer faces the front end bearing. Install the "WOODRUFF" key in position in the slot in the front end of the camshaft, then install the balance weight on the camshaft. Install the lockwasher on the camshaft and start the shaft nut.

g. Wedge a block of wood between the balance weights as shown in Fig. 45, and tighten the camshaft and the balance shaft nuts to a torque of 300 to 325 lbs. ft. *CAUTION: When tightening the nuts for the balance weights and gears, DOUBLE CHECK and MAKE SURE that the thrust washers are in their proper position.*

h. Check the end play of the balance shaft and the camshaft by inserting a feeler gage between the front thrust washer and the balance weight, 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 gears, then tighten the shaft nuts to a torque of 300 and 325 lbs. ft. Install the rear nut retainers in position on the gears and install and tighten the attaching capscrews securely.

12. Install the idler gear assembly and the flywheel housing-to-end plate spacer ("Dummy" hub) (refer to "GEAR TRAIN" Topic 8 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 cylinder block rear end plate, meshing the blower drive gear with the camshaft gear. No timing of this gear is required. Attach the drive 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. Install a new crankshaft rear oil seal in position in the flywheel housing (the sealing lip of the seal must face the engine when the housing is installed).

b. Using gasket cement, cement the flywheel housing gasket to the cylinder block rear end plate. Using an oil seal expander tool placed on the dowels in the crankshaft as shown in Fig. 48 to expand the oil seal, lubricate the seal and slide the flywheel housing on the crankshaft and against the cylinder block rear end plate. Remove the oil seal expander tool and attach the flywheel housing using the correct length and size of bolts and capscrews as shown in Fig. 44.

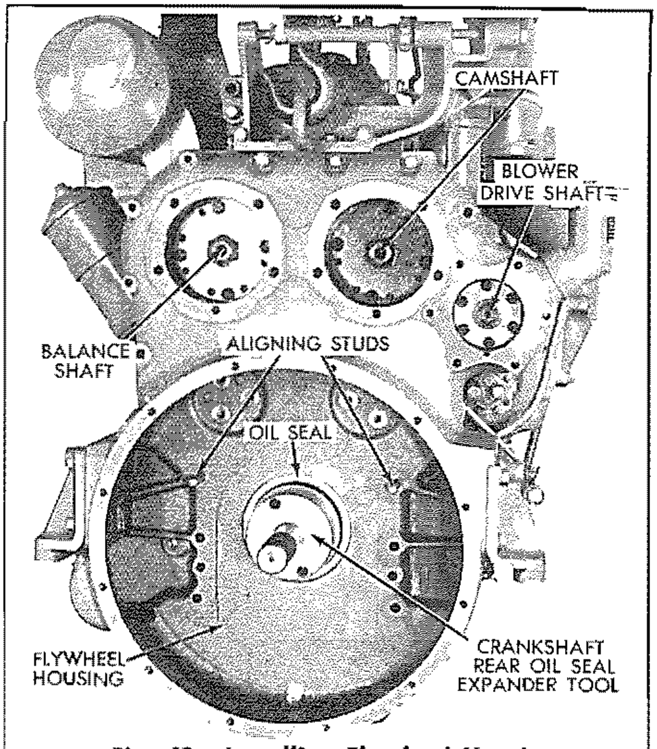


Fig. 48 — Installing Flywheel Housing

c. Using gasket cement, cement a gasket to the flywheel housing at the camshaft and the balance shaft openings, and install the flywheel housing covers.

d. Install the blower drive shaft snap ring in position in the groove of the coupling cam located in the blower drive gear (if it was removed). Install the gasket and the star cover in position at the rear of the blower drive gear.

15. Install the "WOODRUFF" key in position in the slot in the crankshaft, next to the front main bearing. Install the oil pump driving gear in position 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 position in the crankshaft front cover (the sealing lip of the seal should face the oil pump driving gear when the cover is installed).

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 front oil seal. Install the front oil seal spacer in position on the crankshaft and through the oil seal and against the oil slinger. Make certain that the outside diameter of the oil seal spacer is smooth where it contacts the oil seal. Attach the crankshaft front cover with lockwashers and capscrews, making certain that the proper length capscrews are installed.

17. Install the crankshaft pulley, pulley retaining washer, and the crankshaft capscrew.

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," Section V).

19. Install the crankcase oil pan, using a new attaching gasket. Install the oil pan handhole cover, using a new gasket. Install and tighten the oil pan drain plug.

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 fuel injectors in the cylinder head (refer to "INJECTOR INSTALLATION," Section II). Install the valve rocker arm assemblies if they were removed (refer to "EXHAUST VALVES AND OPERATING MECHANISM" in this Section).

23. Make certain that the contacting surfaces of the flywheel and the bolting flange of the crankshaft are smooth and free of nicks or burrs that would prevent the flywheel from fitting up tight against the crankshaft flange. Install the flywheel in position on the rear of the crankshaft and install the six (6) drilled head bolts. Due to one offset hole in the flange of the crankshaft and in the flywheel, the flywheel can be located in only one position. Tighten the flywheel attaching bolts to a torque of 150 to 160 lbs. ft. and install the locking wire.

24. Install the engine clutch shaft front bearing (pilot bearing) in position in the flywheel if it was removed.

25. Cement the two (2) oil cooler adapter-to-cylinder block gaskets to the attaching pads on the cylinder block. Attach the oil cooler adapter to the cylinder 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 install the cooler core in position in the cooler housing and attach the housing and the core to the oil cooler adapter. Tighten the attaching capscrews securely.

26. Install the engine blower (refer to "BLOWER INSTALLATION," Section III).

27. Install the governor control shaft housing assembly (refer to "GOVERNOR INSTALLATION," 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," Section IV).

30. If the engine is mounted on an engine stand it must now be removed in order to install the various parts on the left side of the engine.

31. Install the generator and adjust the generator drive belt (refer to "GENERATOR REMOVAL AND INSTALLATION," Section VII).

Install the starter in position on the flywheel housing.

32. Install the lubricating oil filter, including the filter base, and connect the oil lines. *IMPORTANT: New elements should be installed in the lubricating oil and the fuel filters when overhauling the engine.*

33. Install the engine air box drain tube assembly in position on the left side of the engine.

34. Install the engine clutch and the clutch housing (refer to "ENGINE CLUTCH AND CLUTCH BRAKE," Section X).

35. Install the throttle and engine shut-off control rods. Using new gaskets, install the exhaust muffler.

36. Using new gaskets, install the handhole covers on the cylinder block.

37. The engine may now be installed in the tractor (refer to "ENGINE INSTALLATION" in this Section).

B. Engine Run-In Schedule

After the 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 the 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 the engine after it has been rebuilt, inspect the engine crankcase oil level, fuel, and the cooling system, and see that the air cleaner has been properly serviced. Start the engine and allow it to run at ½ throttle; see that all the gage readings are normal.

The most important factor in running in a new engine, or one which has just been rebuilt, is OPERATING TEMPERATURE. The thermostat must function properly to maintain a normal operating temperature of 160° to 185° F. Temperatures of 150° F. and below are conducive to the formation of gum and sludge, both highly detrimental to an engine.

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 the run-in, inspect the engine crankcase oil level and all points of adjustment, making any necessary corrections.

The tractor can then be put to work but should be operated under light load for the next 24 hours. After another examination and rechecking all of the 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 having an over-center engaging action. A shifting sleeve and bearing mechanism, carried on the clutch shaft and connected by linkage to the clutch actuating levers, is operated by the engine clutch operating lever to engage and disengage the clutch. An adjusting ring provides a means of maintaining the necessary adjustment to compensate for wear of the facing on the clutch driving disc. *NOTE: The tractor may be equipped with an "AUBURN" or a "ROCKFORD" engine clutch.*

A clutch brake assembly, consisting of a stationary lined plate, attached to the clutch shifter bearing carrier, and a plain brake disc bolted to the clutch shaft, is provided for stopping the rotation of the transmission gears for shifting. The clutch brake is applied by pushing forward on the engine clutch operating lever after disengaging the clutch. The clutch shifting sleeve, clutch shifting 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 driving disc assembly, which is splined to the clutch shaft, is engaged between the clutch pressure plate and the rear face of the flywheel when the clutch actuating levers are moved by the actuating lever links, which are connected to the clutch shifting sleeve assembly. The facings on both sides of the driving disc are cemented to the disc.

When the clutch is disengaged, the friction between

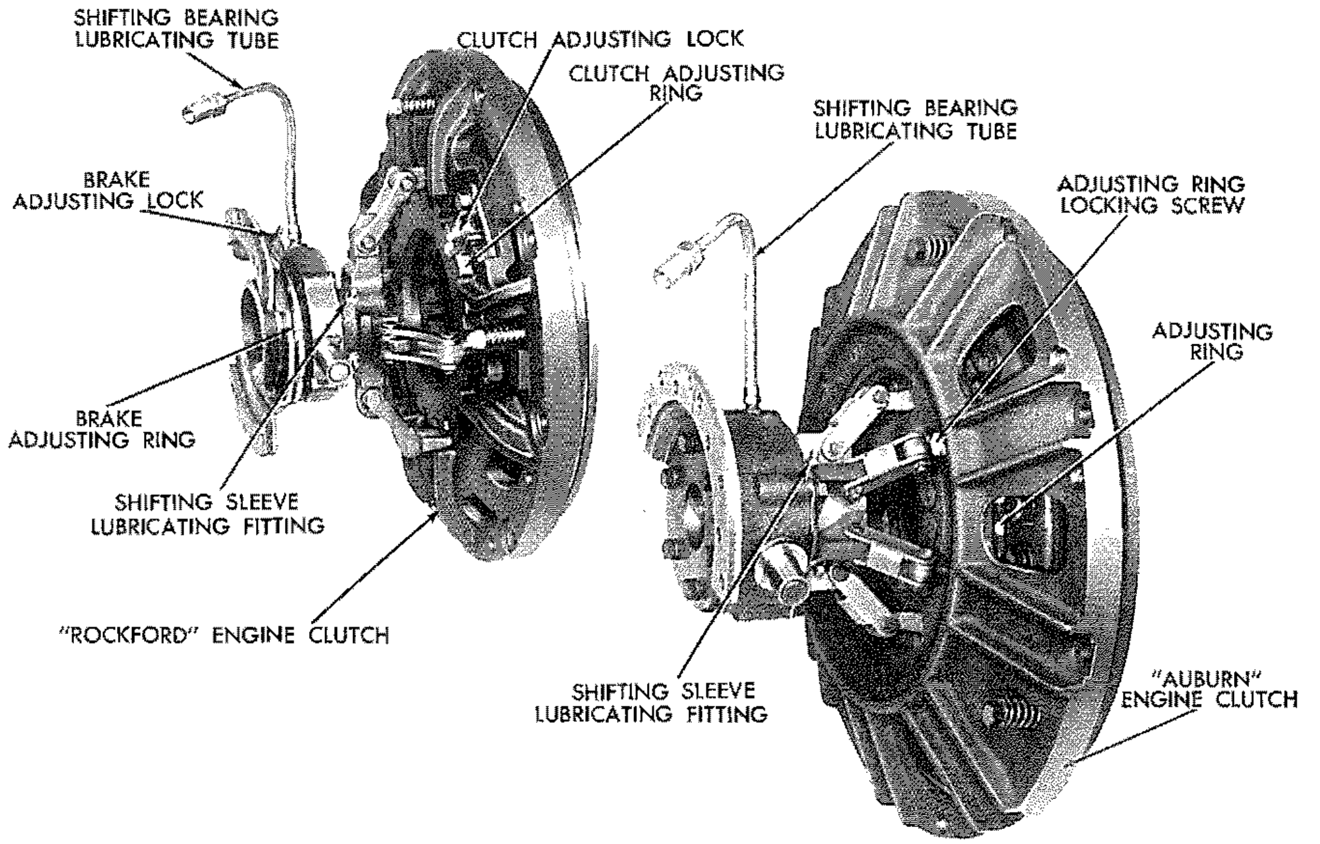


Fig. 1—Engine Clutches ("Rockford" and "Auburn")

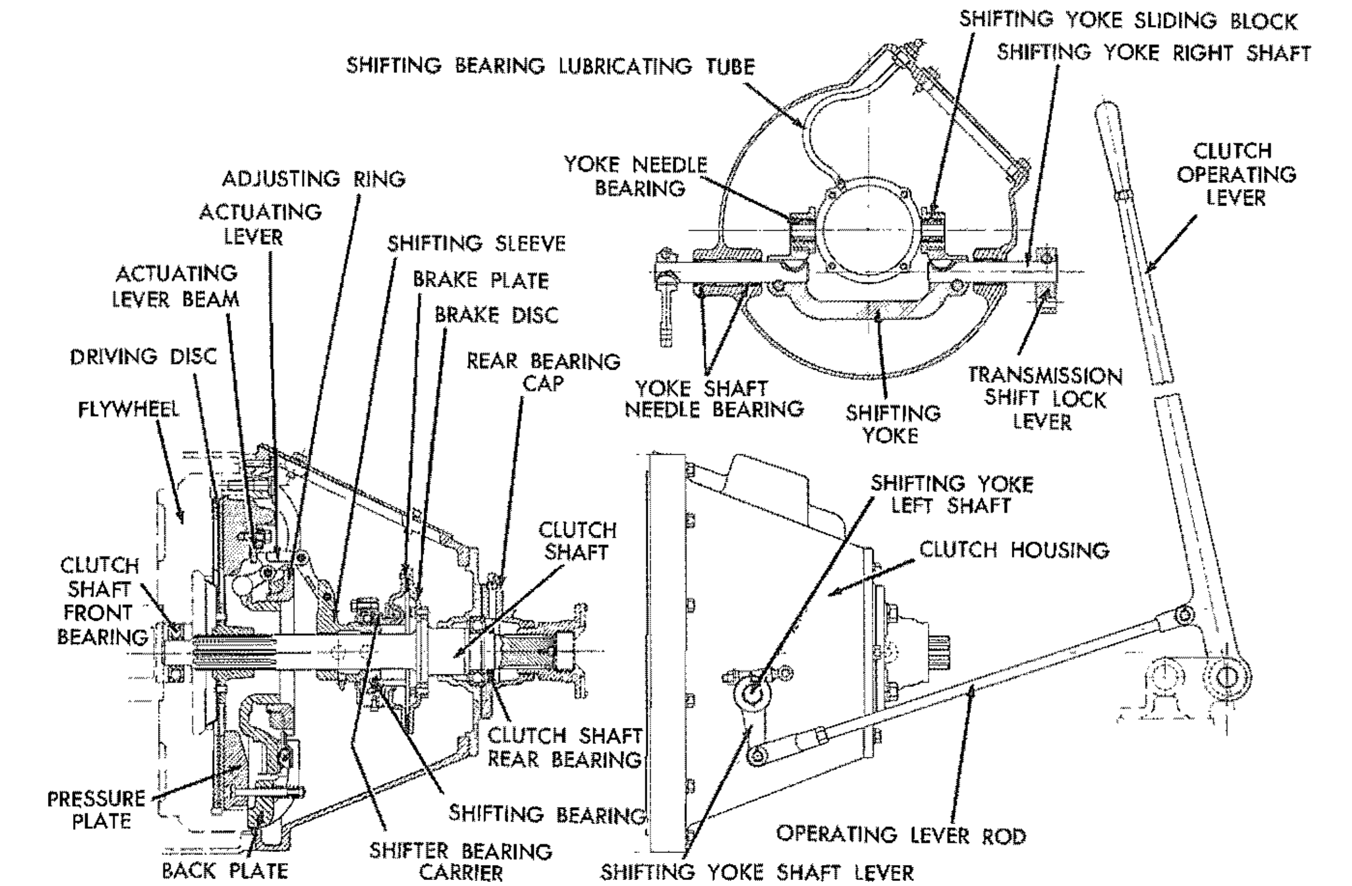


Fig. 2—Engine Clutch Sectional View ("Rockford")

the clutch pressure plate, clutch driving disc, and the flywheel is relieved, and the clutch brake assembly stops the rotation of the clutch driving disc and the clutch shaft. The other components of the clutch continue to turn with the engine flywheel and the inner race of the clutch shifting bearing turns with the clutch shifting sleeve.

The clutch shaft is supported by two (2) ball bearings. The front end of the clutch shaft is supported by the clutch shaft front bearing (pilot bearing) installed in the counterbore of the engine flywheel; the rear end of the clutch shaft is supported by the clutch shaft rear bearing, installed in 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 consists of a clutch brake plate assembly and a brake disc. The clutch brake plate assembly on the "ROCKFORD" clutch is stationary and is adjustable by means of a brake disc adjusting ring; the clutch brake plate assembly on the "AUBURN" clutch is attached to the shifting sleeve yoke assembly with capscrews and is not adjustable. The brake disc has no facings and is bolted to and rotates with the clutch shaft. As the engine clutch is disengaged, the clutch brake plate assembly, mounted on the clutch shifting sleeve assembly, is moved back and contacts the brake disc, thus stopping the rotation of the clutch shaft. The clutch brake is applied by pushing forward on the clutch operating lever after disengaging the engine clutch.

B. Clutch Service

Specified time intervals between clutch adjustments can not be established due to variable operating conditions. Keep the clutch adjusted so that a maximum pull of 50 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. *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 driving disc are worn excessively and the driving disc should be replaced. A new driving disc assembly must be installed as the facings are cemented to the driving disc 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 PROPERLY ADJUSTED AT ALL TIMES AND THAT THE CLUTCH COMPONENTS ARE LUBRICATED AS RECOMMENDED. DO NOT SLIP THE CLUTCH EXCESSIVELY WHEN ENGAGING.

C. Engine Clutch Adjustment

Attach a spring scale to the engine 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 50 pounds is required on the engine clutch operating lever for its engagement (engine stopped). The clutch should engage with a distinct over-center snap.

As the clutch wears, the pull on the engine clutch operating lever diminishes. When the pull on the

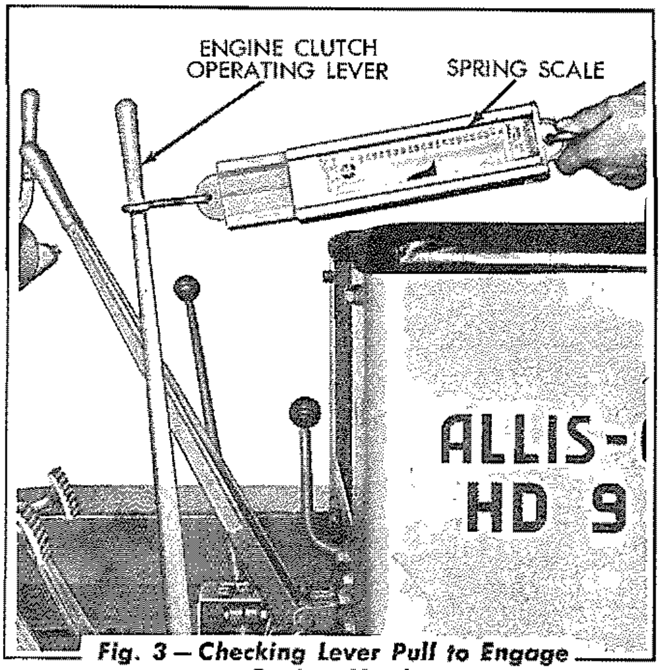


Fig. 3 — Checking Lever Pull to Engage Engine Clutch

lever diminishes to 30 pounds, an adjustment is necessary. *CAUTION: Do not operate the tractor when the pull on this lever is less than 30 pounds.*

D. To Adjust the "ROCKFORD" Clutch

1. Remove the clutch inspection plate from the upper right side of the clutch housing.

2. Disengage the clutch and crank the engine with the starter until the clutch adjusting lock may be reached through the inspection hole. Disengage the adjusting lock from the slot in the clutch adjusting ring (refer to Fig. 1).

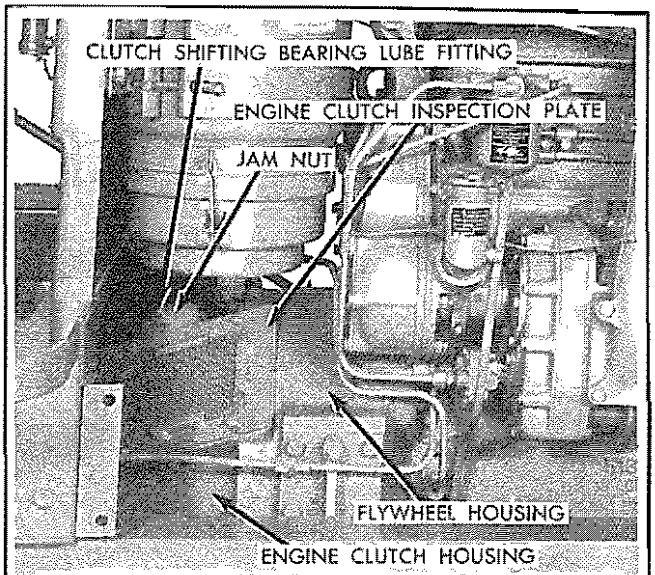


Fig. 4 — Engine Clutch Inspection Plate Location

3. Using a hammer and punch, or a short pry bar, turn the clutch adjusting ring to tighten or loosen the clutch as necessary. Turn the clutch adjusting ring clockwise to tighten or counter-clockwise to loosen. Moving the clutch adjusting ring 2 or 3 notches is generally sufficient.

4. Lock the clutch adjusting ring in place by engaging the adjusting lock into the nearest slot in the adjusting ring. Attach a spring scale to the engine clutch operating lever (just below lever hand grip) and weigh the pull required to engage the clutch. When the clutch is properly adjusted, a pull of 48 to 50 pounds is required on the operating lever for its engagement.

5. After each adjustment of the "ROCKFORD" clutch, the adjustment of the clutch brake should be checked. The proper adjustment

of the clutch brake must be maintained to avoid gear clashing when shifting. The clutch brake is properly adjusted when there is a clearance of 1⅜" between the clutch brake plate facing and the clutch shaft brake disc with the engine clutch engaged. Inspect the clutch brake plate facing periodically and replace the facing when badly worn. Check and adjust the clutch brake as follows:

a. Engage the engine clutch and disengage the brake adjusting lock.

b. Turn the "notched" brake adjusting ring in or out as necessary to obtain 1⅜" clearance between the brake facing and the clutch shaft brake disc (engine clutch engaged).

c. Lock the brake adjusting ring in place by engaging the brake adjusting lock into the nearest slot in the brake adjusting ring.

6. Clean and install the clutch inspection plate in position on the clutch housing.

E. To Adjust the "AUBURN" Clutch

1. Remove the clutch inspection plate from the upper right side of the clutch housing.

2. Disengage the clutch and crank the engine with the starter until the adjusting ring locking screw can be reached through the inspection hole (refer to Fig. 1).

3. Loosen the adjusting ring locking screw just enough so that the adjusting ring can be turned. *CAUTION: DO NOT REMOVE THE ADJUSTING RING LOCKING SCREW.*

4. Tighten the clutch by turning the "notched" adjusting ring with a screwdriver, or a short pry bar, until the proper adjustment is obtained. Moving the adjusting ring 1 or 2 notches is generally sufficient.

5. Tighten the adjusting ring locking screw securely. Attach a spring scale to the engine clutch operating lever (just below lever hand grip) and weigh the pull required to engage the clutch. When the clutch is properly adjusted, a pull of 48 to 50 pounds is required on the operating lever for its engagement.

6. Inspect the clutch brake plate facing and replace the facing when badly worn.

7. Clean and install the clutch inspection plate in position on the clutch housing.

F. Engine Clutch Linkage Adjustment

The engine clutch operating lever rod should be adjusted to provide a clearance of approximately ¼" between the front of the engine clutch operating lever (lever in its disengaged position) and the floor plate.

Adjust the engine clutch operating lever rod by turning the operating rod front yoke, to lengthen or shorten the rod as necessary, to obtain ¼" clearance between the front of the engine clutch operating lever and the floor plate.

G. Washing Engine Clutch

Over-lubrication of the clutch components may cause the clutch facings to become coated with grease. This will cause the clutch to slip even though it is properly adjusted. In this event, the clutch must be washed.

1. Install the drain plug in the bottom of the flywheel housing. Remove the engine clutch inspection plate from the upper right side of the engine clutch housing.

2. Pour cleaning solvent into the engine clutch housing until the level is approximately 1¼" below the clutch shaft. Install the clutch inspection plate and operate the engine at low idle speed for approximately 5 minutes with the clutch disengaged.

3. Stop the engine, remove the drain plug to drain the solvent and if the solvent is excessively "oily," repeat the washing process. *CAUTION: LUBRICATE THE CLUTCH SHIFTING BEARING, SHIFTING SLEEVE, AND THE CLUTCH SHAFT REAR BEARING THOROUGHLY AFTER THE CLUTCH HAS BEEN WASHED AND THE HOUSING DRAINED AS*

THE LUBRICANT MAY HAVE BEEN WASHED FROM THESE COMPONENTS DURING THE WASHING PROCESS.

4. 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 parts.

H. Engine Clutch Removal

The engine clutch and engine clutch housing can be removed from the tractor without removing the cowl. The engine clutch may be removed from the tractor as follows:

1. Remove the brake pedal pads, gear shift lever guide, gear shift lever, floor plate, and the right front fender.

2. Remove the U-bolts connecting the drive shaft universal joint assembly to the front and rear yokes and remove the universal joint assembly. Tape the journal needle bearing assemblies to the universal joint assembly to prevent loss.

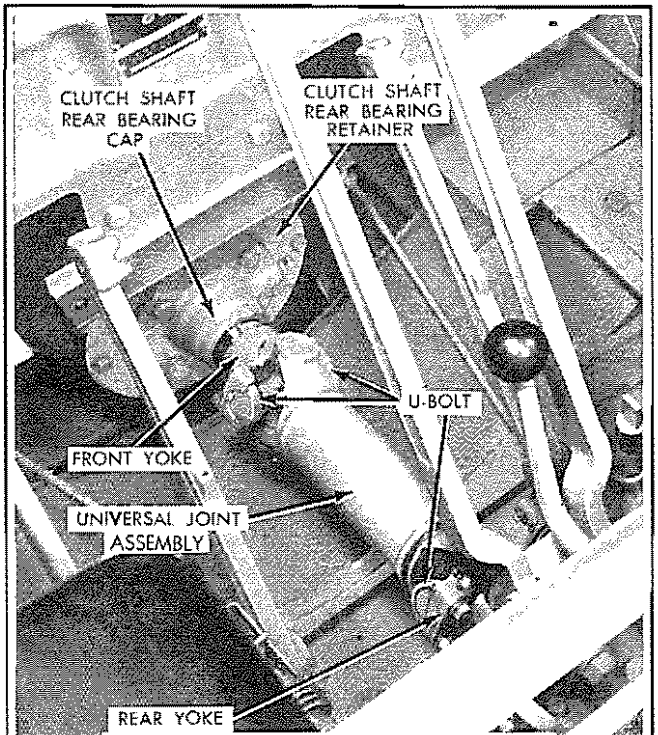


Fig. 5 — Drive Shaft Universal Joint Assembly Location

3. Remove the six (6) capscrews attaching the clutch shaft rear bearing retainer to the clutch housing and remove the clutch shaft and clutch shaft rear bearing retainer as an assembly.

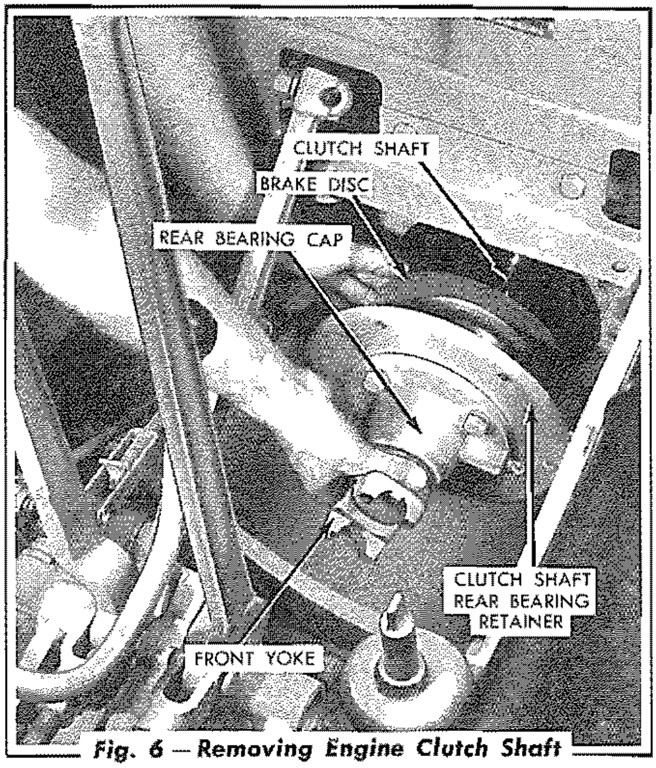


Fig. 6 — Removing Engine Clutch Shaft

4. Remove the engine clutch inspection plate from the clutch housing. Remove the jam nut from the clutch shifting bearing lubricating tube (refer to Fig. 4). Push the outer end of the lubricating tube into the clutch housing.

5. Disconnect the front end of the clutch operating lever rod from the shifting yoke shaft lever by removing the yoke pin. Disconnect the front ends of the two (2) transmission shifting lock plunger rods from their corresponding levers, located at the sides of the clutch housing. Remove the bolt, nut, and washer attaching the shifting lock lever to the clutch shifting yoke right shaft, and remove the lever from the shaft. Remove the brake pedal levers from the brake pedal shafts.

6. Remove the capscrews, attaching the engine clutch housing to the flywheel housing and remove the engine clutch housing (refer to Fig. 7). As the clutch housing is removed, the clutch shifting yoke will disengage from the shifting yoke sliding blocks and will be removed with the clutch housing.

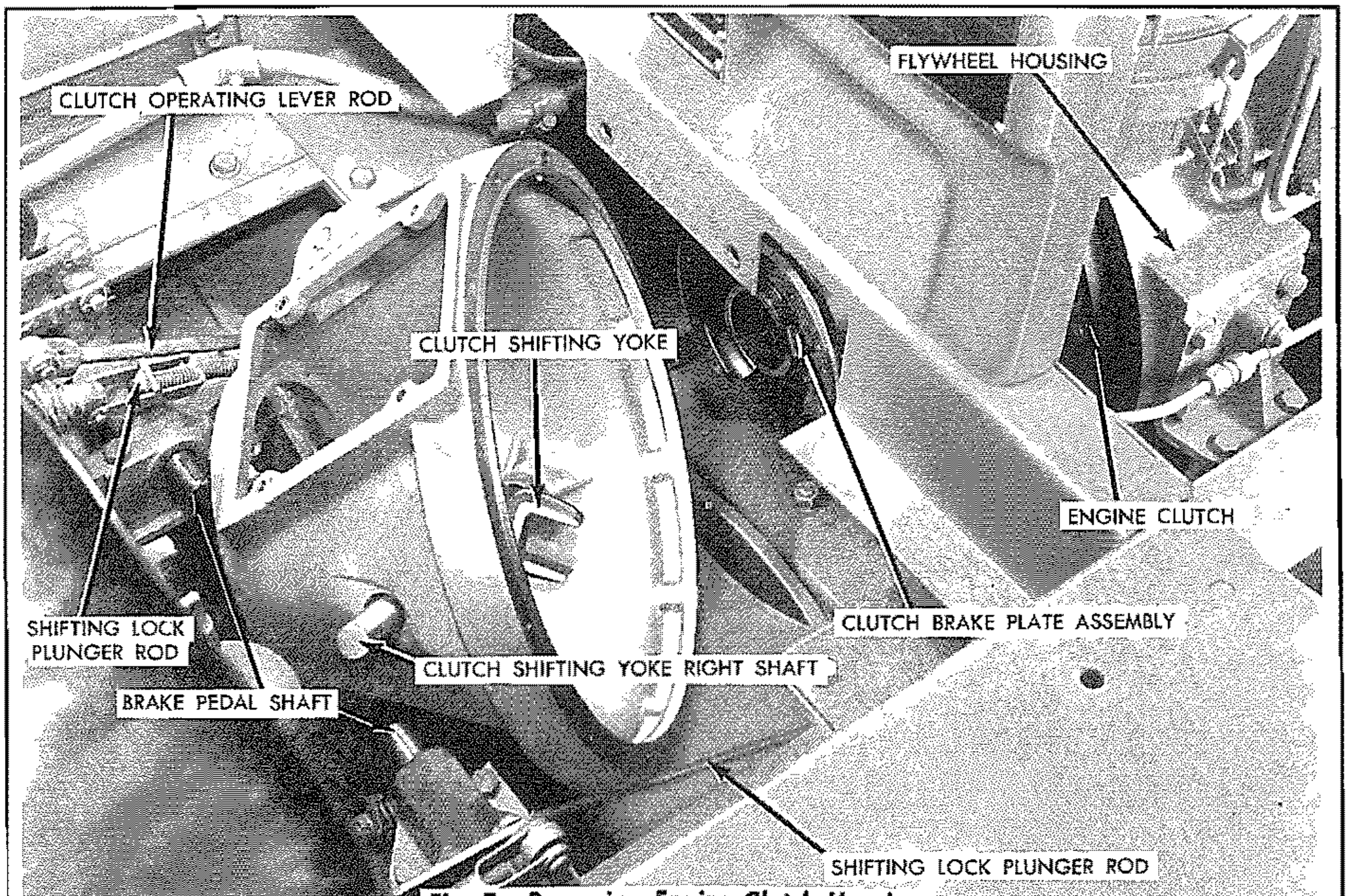


Fig. 7—Removing Engine Clutch Housing

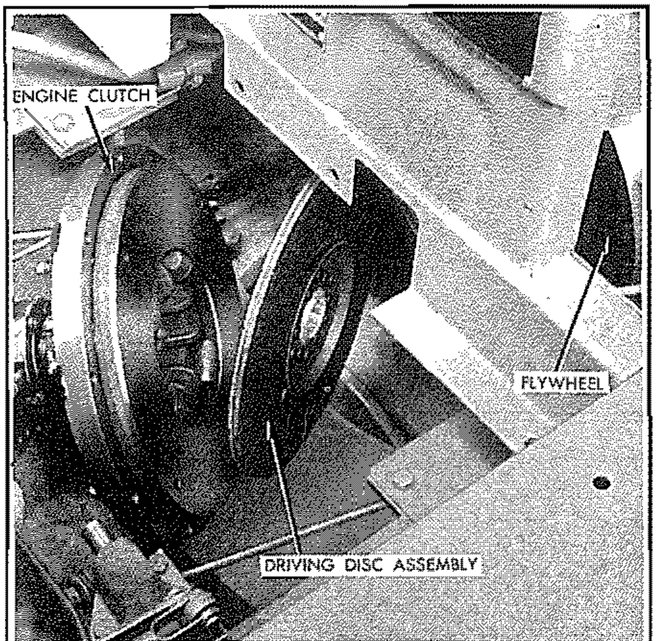


Fig. 8—Removing Engine Clutch

7. Remove the capscrews, attaching the engine clutch to the engine flywheel, and remove the engine clutch (refer to Fig. 8). The clutch driving disc can now be removed. CAUTION: *When removing the clutch assembly use care and do not drop or damage the clutch driving disc.*

I. Disassembly of Engine Clutch

1. "ROCKFORD" Clutch

Refer to Fig. 11 and disassemble the clutch as follows:

a. Place the engine clutch assembly on a clean work bench, with the pressure plate side of the clutch downward.

b. Remove the brake disc retaining snap ring and turn the brake adjusting ring off the shifter bearing carrier.

c. Remove the four (4) pins connecting the actuating lever links to the shifting sleeve and remove the shifting sleeve and the shifter bearing carrier as a unit. Remove the capscrews attaching the bearing retaining plate to the front of the shifter bearing carrier. Using a soft hammer, drive the shifter bearing carrier off the clutch shifting sleeve ball bearing.

d. Remove the bearing retaining snap ring from the shifting sleeve and press the shifting sleeve out of the bearing. Remove the bearing retaining plate from the shifting sleeve.

e. Unlock the clutch adjusting ring and turn the adjusting ring off the back plate. Remove the adjusting ring plate from the back plate.

f. Remove the self locking nuts from the four (4) retracting spring screws and remove the pressure plate retracting springs.

g. Remove the back plate from the pressure plate. Remove the four (4) retracting spring screws from the pressure plate.

h. Remove the capscrews attaching the brake disc to the clutch shaft and remove the disc (refer to Fig. 10). 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 gasket.

i. Unlock the clutch shaft nut and remove the nut and the locking washer from the clutch shaft.

j. Drive or press the clutch shaft out of the rear bearing and remove the rear bearing from the rear bearing retainer.

2. **"AUBURN" Clutch**

Refer to Fig. 12 and disassemble the clutch as follows:

a. Place the engine clutch on a clean work bench, with the pressure plate side of the clutch downward. Remove the capscrews holding the pressure plate retracting springs and remove the retracting springs. Remove the pressure plate and pressure ring as a unit from the clutch assembly.

b. Remove the capscrews, lockwashers, and plain washers attaching the pressure ring to the pressure plate. Remove the pressure ring from the pressure plate. Remove the pressure springs, spring cups, and insulating washers.

c. Remove the pins connecting the actuating lever links to the actuating levers.

d. Remove the adjusting ring locking screw and the adjusting ring locking plate. Remove the two (2) adjusting ring spacer capscrews and adjusting ring spacers, then remove the adjusting ring from the back plate.

e. Remove the pins attaching the actuating lever links to the shifting sleeve.

f. Remove the capscrews attaching the grease shield and the clutch brake plate to the shifting sleeve yoke and remove the shield and the brake plate.

g. Remove the capscrews attaching the bearing retainer to the front of the shifting sleeve yoke. Press the shifting sleeve and the ball bearing out of the shifting sleeve yoke.

h. Remove the snap ring from the shifting sleeve and remove the bearing, bearing retainer, and sealing ring.

i. Remove the front yoke from the rear end of the clutch shaft. Remove the rear bearing cap from the clutch shaft rear bearing retainer (refer to Fig. 10). Unlock and remove the clutch shaft nut and locking washer. Drive or press the clutch shaft out of the rear bearing and bearing retainer.

j. Remove the clutch shaft rear bearing from the bearing retainer.

J. Engine Clutch Inspection and Repair

1. Thoroughly wash all clutch components and inspect for worn or damaged parts.

2. Inspect the facings of the driving disc for wear and looseness of the facings on the disc. The specified thickness of the driving

disc when new is .458" to .486". Measure the thickness of the clutch driving disc being inspected and if it is worn to a thickness of approximately .250", a new driving disc must be installed. *NOTE: The clutch facings are cemented to the disc and therefore the facings are not serviced separately.* Check the splines in the hub of the disc for wear.

3. Inspect the face 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.

4. Inspect the actuating lever links, actuating lever link pins, actuating levers, and shifting sleeve for wear. Inspect the link pin holes in the clutch shifting sleeve for wear. Inspect the actuating levers for wear at the contact points.

   NOTE: When the actuating lever beams ("ROCKFORD" clutch only) are worn at the point where the actuating levers contact the actuating lever beams, the beams may be turned 180° to provide a new wear point. The actuating lever beams may also be turned over to provide two (2) additional wear points. Check the actuating lever beams for flatness and if the beams are "dished" they should be replaced.

5. Inspect the bushings in the shifting sleeve for wear and roughness and replace the sleeve if necessary.

6. Check the clutch back plate for cracks and replace if cracks are evident.

7. Inspect the shifting sleeve ball 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) shifting yoke sliding blocks (refer to Fig. 9). Inspect the shifting yoke needle bearings, needle bearing inner races, dust seals, and the shifting yoke for wear and damage and replace the necessary parts.

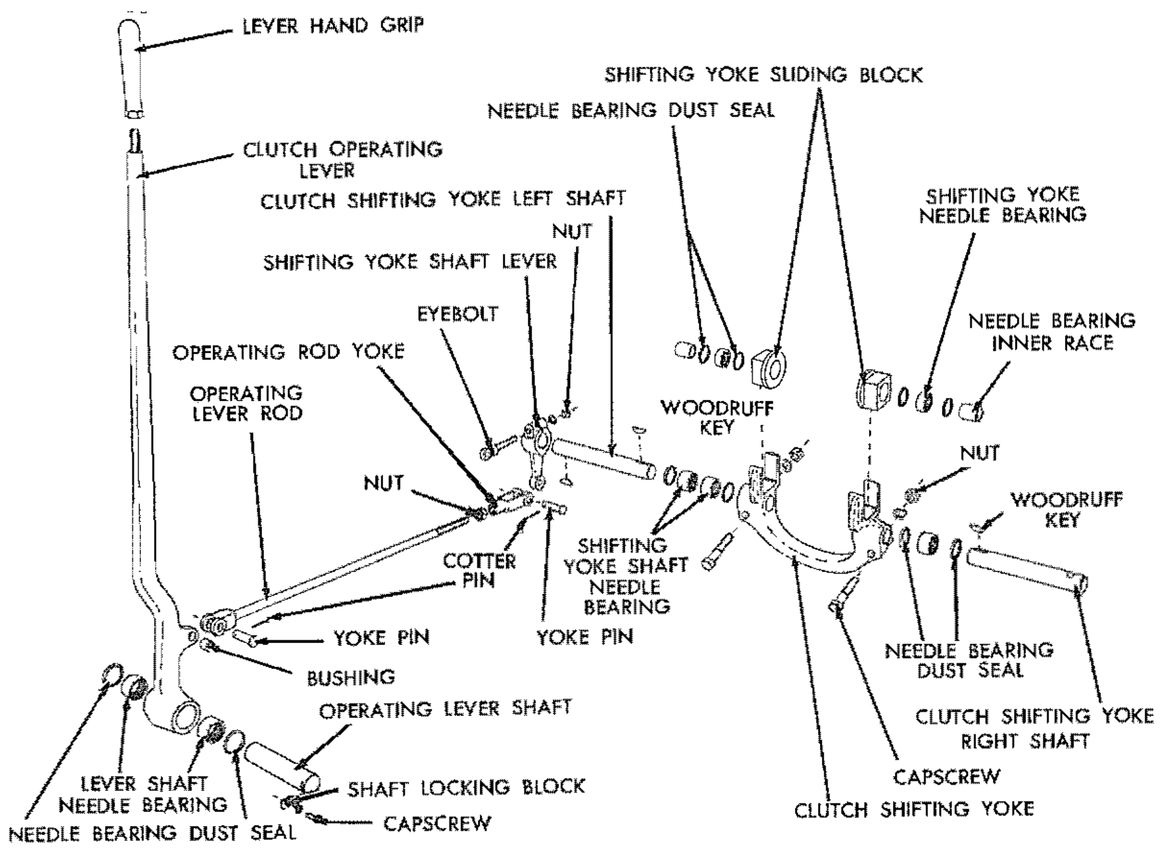


Fig. 9 — Engine Clutch Shifting Yoke Details

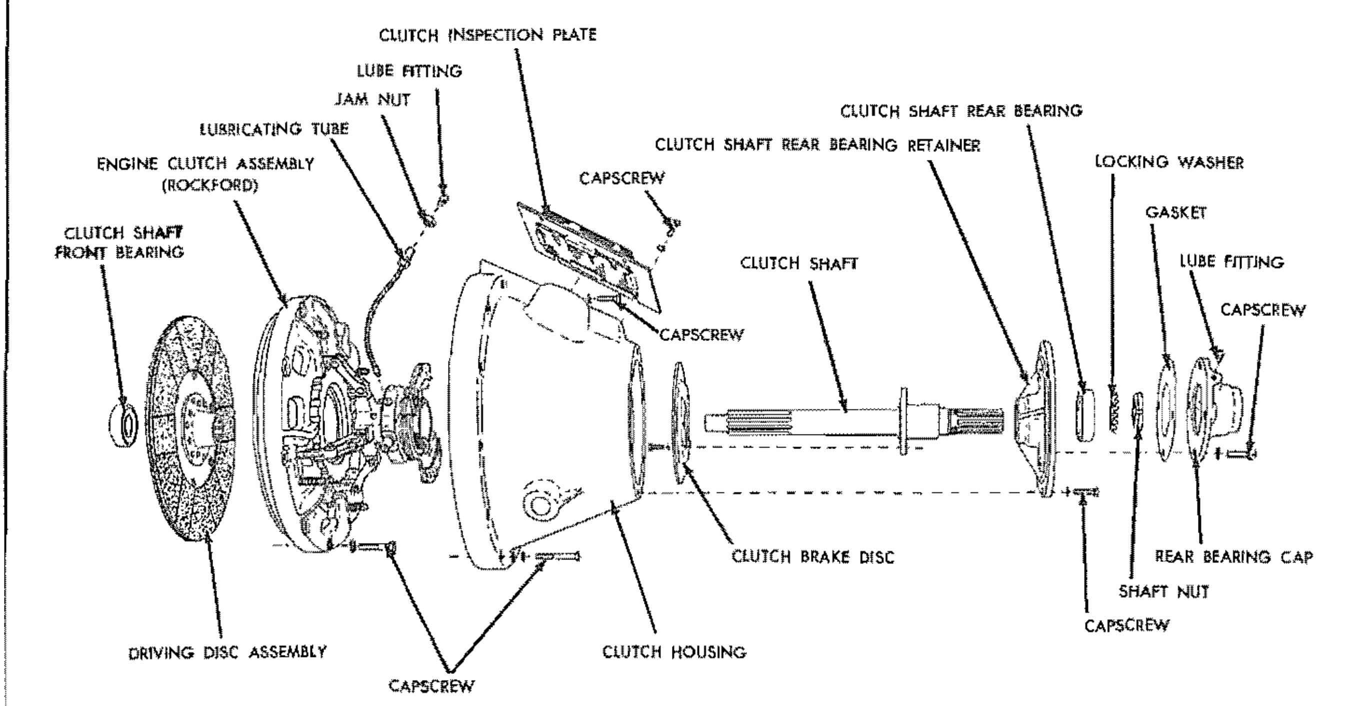


Fig. 10—Engine Clutch Shaft Details

9. Inspect the four (4) pressure plate retracting springs for breakage and replace if necessary.

10. Inspect the face of the flywheel and make certain the surface is flat and smooth. If the face is scored and "heat checked" the flywheel may be machined smooth; replace the flywheel if more than 1/16" stock must be removed.

11. Inspect the clutch shaft front bearing (pilot bearing) for wear and lubrication. If the bearing shows signs of improper lubrication, install a new oiling wick assembly, refer to "REPLACEMENT OF ENGINE CLUTCH SHAFT FRONT BEARING OILING WICK," in Topic 5, Section IX).

12. 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.

13. Inspect the clutch shaft. If the shaft is excessively worn at the location of the clutch shifting sleeve, or if the splines of the shaft show excessive wear, the shaft must be replaced.

14. Inspect the lubricating tube for the clutch shifting bearing and replace the tube if necessary.

15. Inspect the clutch brake plate assembly. If the brake plate facings are worn to the extent that the rivet heads may score the clutch brake disc, the facings must be replaced. Inspect the clutch brake disc for wear and scoring. Slight scoring or uneven wear can be removed by machining, however, if the disc is worn or scored excessively, replacement of the disc is necessary.

K. Assembly of Engine Clutch

1. "ROCKFORD" Clutch

Refer to Figs. 1 and 11 and assemble the engine clutch by direct reversal of the disassembly procedure. *IMPORTANT: When installing the pins used to connect the actuating lever to the adjusting ring plate, make certain the pins fit tightly in the plate. If the holes in the adjusting ring plate are worn, the plate and pins should be replaced with new parts. After the pins are installed in the adjusting ring plate, stake the plate at the pin locations so that the pins cannot*

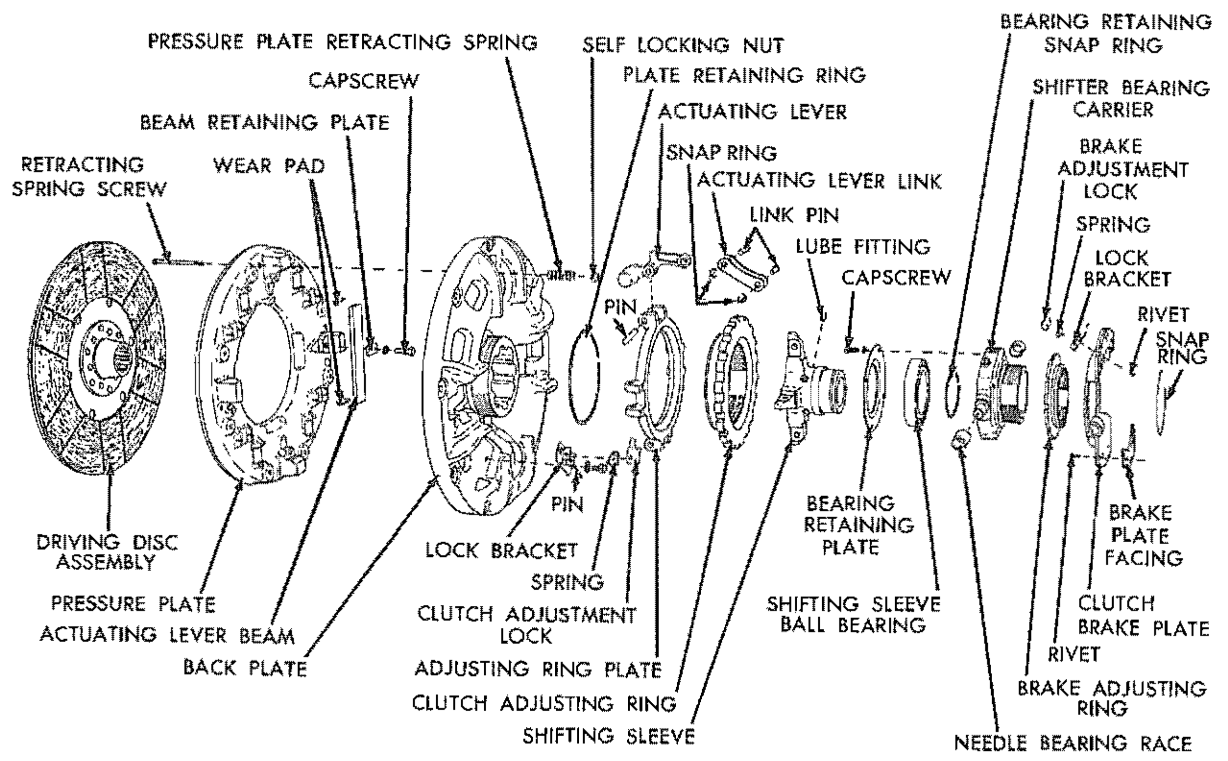


Fig. 11 — Engine Clutch Details ("Rockford")

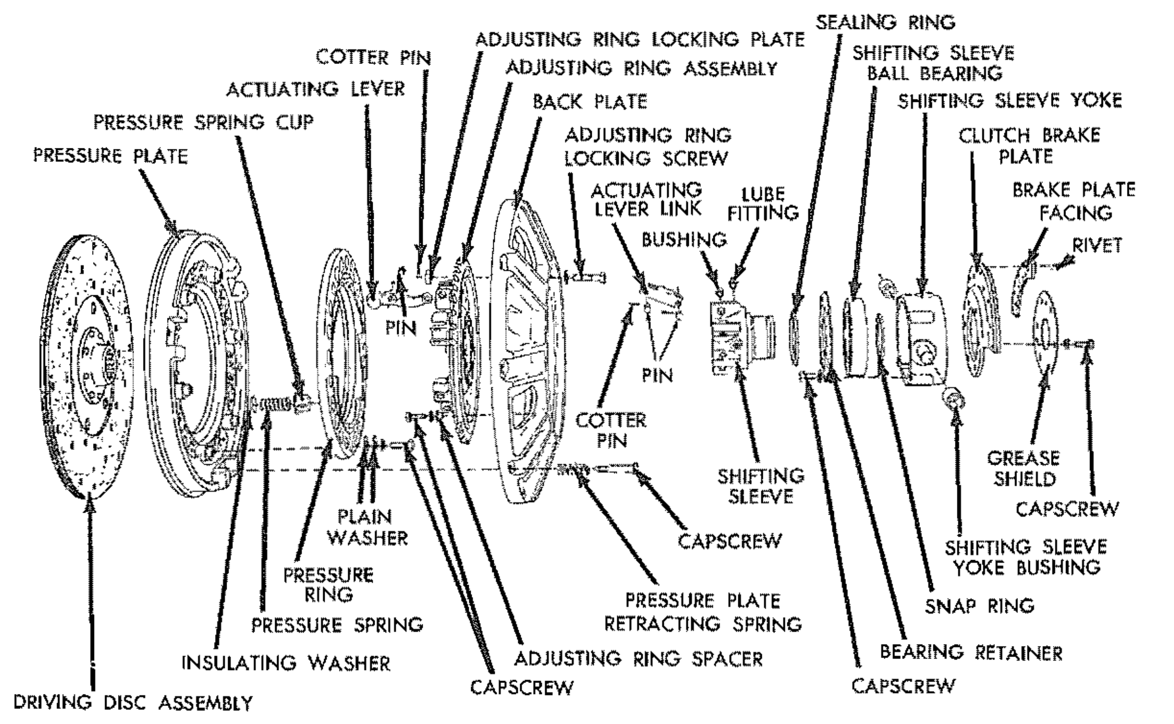


Fig. 12 — Engine Clutch Details ("Auburn")

work loose. When installing the pins used to connect the actuating lever links, install the pins so that the head of each pin is to the left, with the pin located at the top of the clutch and when viewed from the rear.

When installing the self locking nuts on the retracting spring screws, tighten the nuts against the retracting springs so that the assembled length of each spring is 1-3/16" (measured to bottom of recess in clutch back plate). Pack the shifting yoke needle bearings with grease when assembling the shifting yoke sliding blocks. Lubricate the clutch shifting sleeve, shifting sleeve ball bearing, and the clutch shaft rear bearing thoroughly when assembly of the clutch is completed. Lubricate the clutch linkage sparingly when assembling the clutch.

2. **"AUBURN" Clutch**

Refer to Figs. 1 and 12 and assemble the engine clutch by direct reversal of the disassembly procedure.

IMPORTANT: When assembling the pressure ring to the pressure plate, position the pressure ring so that the "XX" identification marks on the pressure ring correspond with the lug on the pressure plate that lines up with the tapped hole used to secure the ring to the plate. When installing the shifting sleeve ball bearing in position in the shifting sleeve yoke, install the bearing so that the shielded side of the bearing is toward the rear. When installing the pins used to connect the actuating levers and actuating lever links, make certain the pins are installed so that the head of each pin is to the left, with the pin located at the top of the clutch and when viewed from the rear. Lubricate the clutch linkage sparingly when assembling the clutch.

L. Inspection and Replacement of Clutch Shifting Yoke

1. With the engine clutch removed, place each shifting yoke sliding block in position in the clutch shifting yoke (refer to Fig. 9). If there is excessive looseness between the parts due to wear, replacement of both the yoke and the shifting yoke sliding blocks is necessary.

2. Replace the clutch shifting yoke as follows:

   a. Remove the two (2) capscrews, nuts, and lockwashers clamping the clutch shifting yoke to the shifting yoke shafts.

   b. Spread the opening in each end of the shifting yoke, using a broad face chisel or similar tool, to free the yoke on the shafts.

   c. Pull the shifting yoke shafts out of the yoke and remove the "WOODRUFF" key from the inner end of each shaft.

   d. Pull the shafts out of the shaft needle bearings and inspect the bearings, shafts, and dust seals for wear. Replace the necessary parts.

   e. Pack the shifting yoke shaft needle bearings with grease. Start the shifting yoke shafts into position in the clutch housing. Install a "WOODRUFF" key in position in the inner end of each shaft, hold the shifting yoke in position, and drive the shafts into position in the shifting yoke.

   f. Install the capscrews, lockwashers, and nuts used to clamp the shifting yoke to each shaft and tighten the nuts securely.

M. Installation of Engine Clutch

1. Make certain that the face of the flywheel is clean. Place the clutch driving disc assembly in position against the flywheel, making certain the side of the driving 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 lockwashers, and tighten the capscrews evenly so that the clutch back plate enters the recess in the flywheel. *NOTE: The tractor may be equipped with an "AUBURN" or a "ROCKFORD" engine clutch. The "AUBURN" engine clutch is attached to the flywheel with ½" NC x 1½" capscrews; the "ROCKFORD" engine clutch is attached to the flywheel with ½" NC x 2" capscrews. Make certain the proper length capscrews are used when installing the engine clutch.*

   Make certain the needle bearings in the shifting yoke sliding blocks are packed with grease before installing the clutch housing.

3. Install two (2) ⅜" NC x 6" guide studs in the flywheel housing to align and to hold the clutch housing when the clutch housing is being installed. Start the engine clutch housing in position on the guide studs. Start the shifting yoke sliding blocks in position in the clutch shifting yoke, then push the clutch housing forward against the flywheel housing. Install and tighten the clutch housing attaching capscrews.

4. Turn the clutch adjusting ring counter-clockwise as necessary so that the clutch driving disc is free. Install the clutch shaft assembly (complete with its components) into the clutch housing and the clutch. To install, insert the front end of the clutch shaft through the shifting sleeve until the front end of the shaft contacts the hub of the driving disc. Push in on the shaft and turn as necessary to engage the shaft splines with the splines in the hub of the driving disc. Tap lightly on the rear end of the shaft to drive the shaft into position in the clutch shaft front bearing (pilot bearing). Position the clutch shaft rear bearing retainer so that the lubricating fitting is to the top, then install the attaching capscrews to secure the rear bearing retainer to the clutch housing.

5. Reaching through the clutch inspection plate opening in the clutch housing, insert the end of the lubricating tube for the clutch shifting sleeve ball bearing into the hole in the clutch housing. Install the lockwasher and jam nut on the end of the lubricating tube to hold the tube in position.

6. Install the transmission shifting lock lever in position on the outer end of the clutch shifting yoke right shaft and secure the lever to the shaft with a capscrew, lockwasher, and nut. Connect the front end of the transmission shifting lock plunger rod to this shifting lock lever. Connect the front ends of the clutch operating lever rod and the other transmission shifting lock plunger rod to the clutch shifting yoke shaft lever, located on the outer end of the clutch shifting yoke left shaft.

7. Install the universal joint front yoke in position on the rear of the clutch shaft. Place the universal joint assembly in position and connect the assembly to the front and the rear yokes using the attaching U-bolts, nuts, and lockwashers.

8. Adjust the engine clutch and clutch brake (refer to "ENGINE CLUTCH ADJUSTMENT" in this Section). Install the clutch inspection plate.

9. Install the brake pedal levers, floor plate, brake pedal pads, gear shift lever, gear shift lever guide, and the right front fender.

10. Make certain the clutch and clutch shaft components are lubricated thoroughly before the tractor is operated.

2. ENGINE CLUTCH BRAKE

A. Description

The engine clutch brake is designed to stop the rotation of the engine clutch shaft when the engine clutch is disengaged; stopping the rotation of the clutch shaft permits easier shifting of the transmission gears. The engine clutch brake is applied by pushing forward on the engine clutch operating lever after the clutch has been disengaged.

The engine clutch brake plate is attached to the rear of the engine clutch shifting bearing assembly. This brake plate has a friction material facing that contacts the clutch brake disc (attached to the flange on the clutch shaft) when the brake is applied.

The brake assembly of the "ROCKFORD" clutch can be adjusted by means of a brake adjusting ring which carries the clutch brake plate assembly. The brake assembly of the "AUBURN" clutch is not adjustable.

B. Service, Inspection, and Repair

Keep the clutch operating lever rod properly adjusted to provide a clearance of ¼" between the front of the clutch operating lever (lever in its disengaged position) and the floor plate. If the 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 ADJUSTMENT" in this Section).

In event that the clutch brake does not function properly when shifting gears, remove the clutch inspection 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 for wear and scoring; slight scoring or uneven wear can be removed by machining, however, if the disc is worn or scored excessively, it must be replaced.

C. Removal of Engine Clutch Brake

1. Remove the brake pedal pads, gear shift lever guide, gear shift lever, floor plate, and the right front fender.

2. Remove the U-bolts connecting the universal joint assembly to the rear yoke. Raise the rear end of the universal joint assembly, pull back on the universal joint assembly until the front yoke is free of the clutch shaft, and remove the assembly. Tape the needle bearings to the universal joint assembly to prevent loss.

3. Engage the engine clutch. Remove the capscrews attaching the clutch shaft rear bearing retainer to the clutch housing and pry out on the clutch shaft rear bearing retainer until it is free of the clutch housing. Pull back on the clutch shaft (complete with its components) and remove the assembly from the housing.

4. The clutch brake plate of the "ROCKFORD" clutch may now be removed from the shifting sleeve bearing carrier by removing the snap ring. The "AUBURN" clutch brake plate is attached to the shifting sleeve yoke with six (6) capscrews; remove the capscrews to remove the plate. Remove the capscrews attaching the brake disc to the clutch shaft and remove the brake disc.

D. Installation of Engine Clutch Brake

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 ENGINE CLUTCH" in this Section. After installation of the clutch brake assembly is complete, adjust the clutch brake (refer to "ENGINE CLUTCH ADJUSTMENT" in this Section).

SECTION XI—TRANSMISSION AND BEVEL GEAR

1. GENERAL DESCRIPTION

Power from the engine is transmitted through the engine clutch and the universal joint assembly to the transmission. From the transmission, power is transmitted to the bevel gear, and from the bevel gear through the steering clutches, to the final drives and the track drive sprockets.

The transmission case is attached to the front of steering clutch and final drive housing with capscrews. The transmission is piloted into the steering clutch and final drive housing by a boss, located on the rear of the transmission case. This boss also serves as a bearing retainer for the transmission bevel pinion shaft rear bearing.

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 gear ratio for the required speed or power for the operation of the tractor. The various speed changes (six (6) forward and three (3) reverse) are obtained by the use of shifting collars, located on hubs assembled on the intermediate shaft and the transmission bevel pinion.

The shifting collars are shifted into mesh with their corresponding gears by the use of shifting forks. The shifting forks are actuated by shifting fork shafts engaged with the gear shifting levers. The shifting movement of each shifting fork shaft is controlled by detent notches in the shifting shafts and steel balls (detent balls) located in the transmission case. Each shifting fork is so positioned and clamped to its shifting shaft so that when each shifting shaft is shifted to the desired speed range, the detent balls enter the detent notches in the shifting shafts and properly locate the shifting collar with its corresponding gear.

The shifting collars are locked in mesh with their corresponding gears by locking mechanisms consisting of two (2) shifting lock plungers attached to, and actuated by, two (2) shifting lock plunger rods. The front end of each shifting lock plunger rod is connected to a lever located on the outer ends of the engine clutch shifting yoke shafts. When the engine clutch operating lever is pulled back to engage the clutch, the shifting lock plunger rods move the shifting lock plungers to a position between the detent balls and lock the shifting shafts in the desired position. *NOTE: The shifting shaft locking mechanisms are so designed that the transmission shifting shafts can be shifted only when the engine clutch operating lever is in the disengaged position.*

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 of the steering clutch and final drive housing and allow the oil to drain.

2. Remove the seat cushion, seat adjusting frame, brake pedal pads, gear shift lever guide, speed selection shift lever, floor plate, and the main frame bottom rear shield.

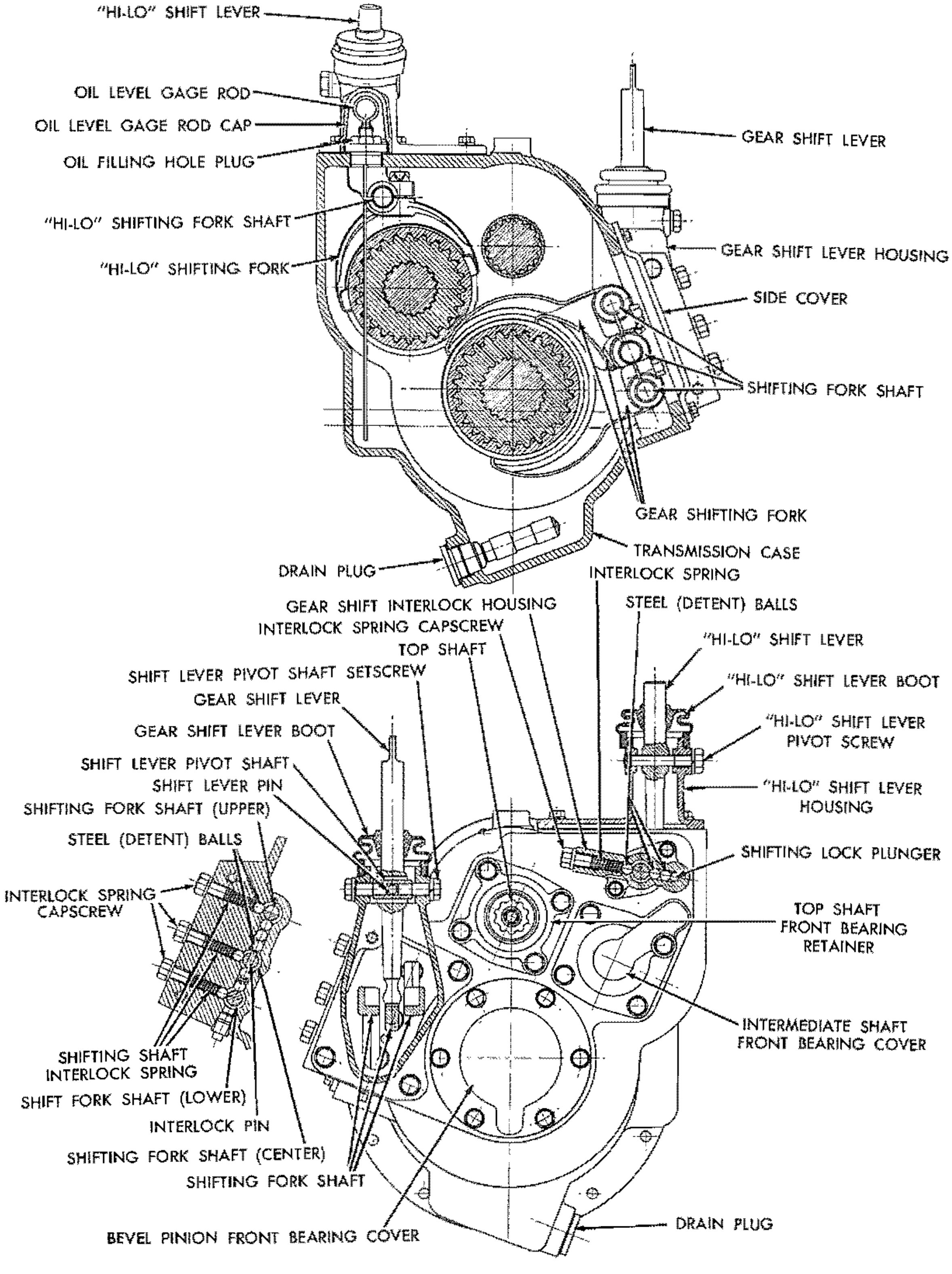


Fig. 1—Transmission Sectional View

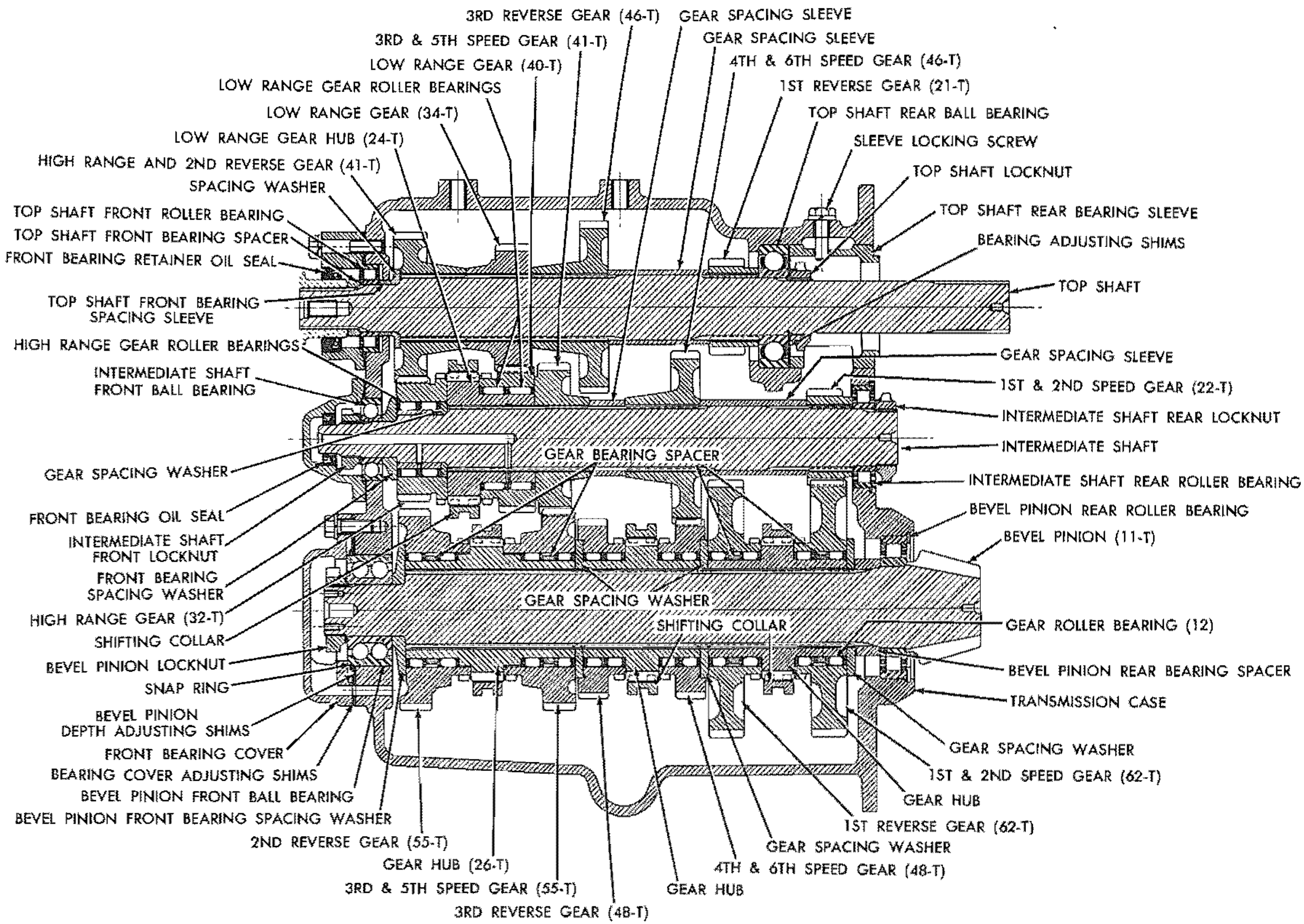


Fig. 1 — Transmission Sectional View

3. Remove the four (4) capscrews from the right brake pedal lever bracket and move the bracket assembly to provide clearance for removal of the transmission.

4. Remove the "HI-LOW" gear shift lever from the high-low shift lever of the transmission.

5. Disconnect the steering clutch control rods from the steering levers. Remove the capscrews attaching the steering lever bracket to the transmission case and remove the steering levers and bracket as an assembly.

6. Disconnect both shifting lock plunger rods at the transmission end and allow the rods to drop down to provide clearance.

7. Remove the two (2) U-bolts attaching the universal joint to the rear yoke. Hold the two (2) universal joint bearing assemblies to prevent them from falling off. Place a small pry-bar between the universal joint and the rear yoke and pry the universal joint assembly forward to clear the rear yoke. Tie or tape the bearing assemblies in place on the universal joint journal. Remove the universal joint assembly by pulling the front yoke from the engine clutch shaft splines.

8. Thoroughly clean the top of the transmission case and the surrounding area.

9. Install a ⅝" NC eye bolt in the tapped hole of the transmission case as shown in Fig. 2. Using a suitable chain and hoist, support the weight of the transmission assembly and remove the capscrews attaching the transmission to the steering clutch and final drive housing.

10. Move the transmission forward until the rear boss of the transmission case is free of its bore in the steering clutch and final drive housing, then raise and remove the transmission.

NOTE: Keep the transmission in alignment (straight) when removing to prevent the boss on the transmission case from binding in the bore of the steering clutch and final drive housing.

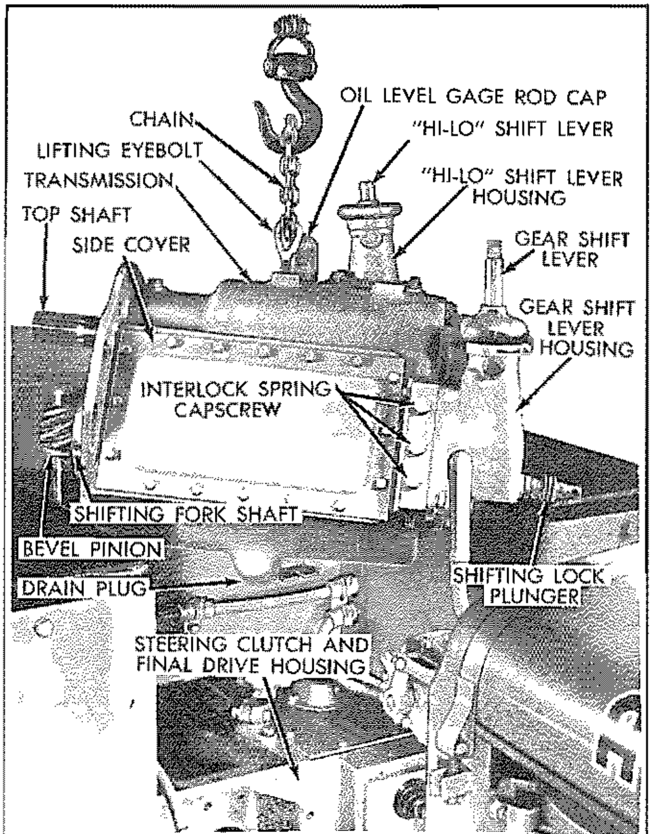


Fig. 2—Removing Transmission

C. Disassembly of Transmission

1. Thoroughly clean the transmission case before disassembly.

2. Place the transmission assembly on a clean work bench, with the right side upward, and remove the side cover.

3. Remove the capscrews attaching the gear shift lever housing and the "HI-LO" gear shift housing to the transmission case and remove the housings.

4. Loosen the shifting fork capscrews attaching the shifting forks to the shifting fork shafts. Loosen the interlock spring capscrews and pull the lower of the three (3) shifting fork shafts from the transmission case; catch the three (3) steel balls (detent balls) which will drop from position when the shaft is removed. Remove the shifting fork from the shifting collar.

5. Pull the center shifting fork shaft and interlock pin from the transmission case, catching the four (4) steel balls (detent balls) which

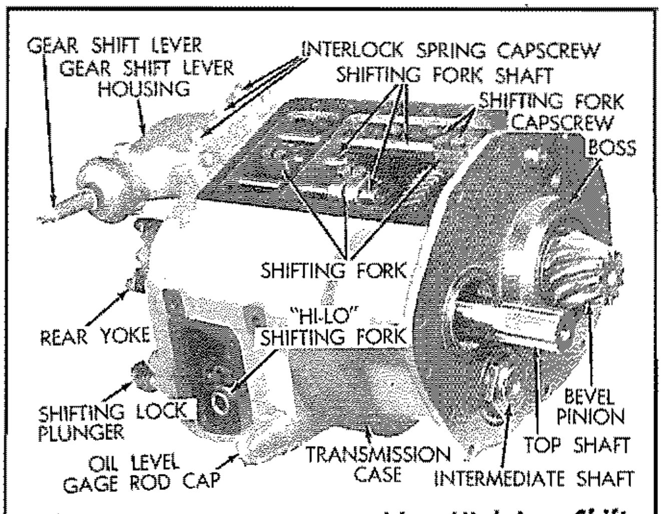


Fig. 3 — Transmission Assembly — High-Low Shift Lever Housing and Side Cover Removed

will drop from position when this shaft is removed. Remove the shifting fork from the shifting collar.

6. Pull the upper shifting fork shaft from the transmission case, catching the steel ball (detent ball) which will drop from position when this shaft is removed. Remove the shifting fork from the shifting collar. *NOTE: The three (3) shifting forks which were removed above are identical but the shifting shafts differ and must be installed in their correct positions when reassembling the transmission.*

7. Remove the bevel pinion front bearing cover and tie the cover shims to the cover to prevent loss of the shims.

8. On early model tractors, unlock the lockwasher and remove the nut from the front of the transmission bevel pinion. On later model tractors, unlock the bevel pinion locknut before loosening it for removal from the transmission bevel pinion. Do not remove the snap ring from the bevel pinion front ball bearing or the bevel pinion depth adjusting shims at this time.

9. Turn the transmission case on the work bench so that the top of the case is downward and block the case in this position. Using special tools similar to the ones shown in Fig. 4, push the bevel pinion from the bevel pinion front ball bearing. Pull the bevel pinion from the gears and the transmission case.

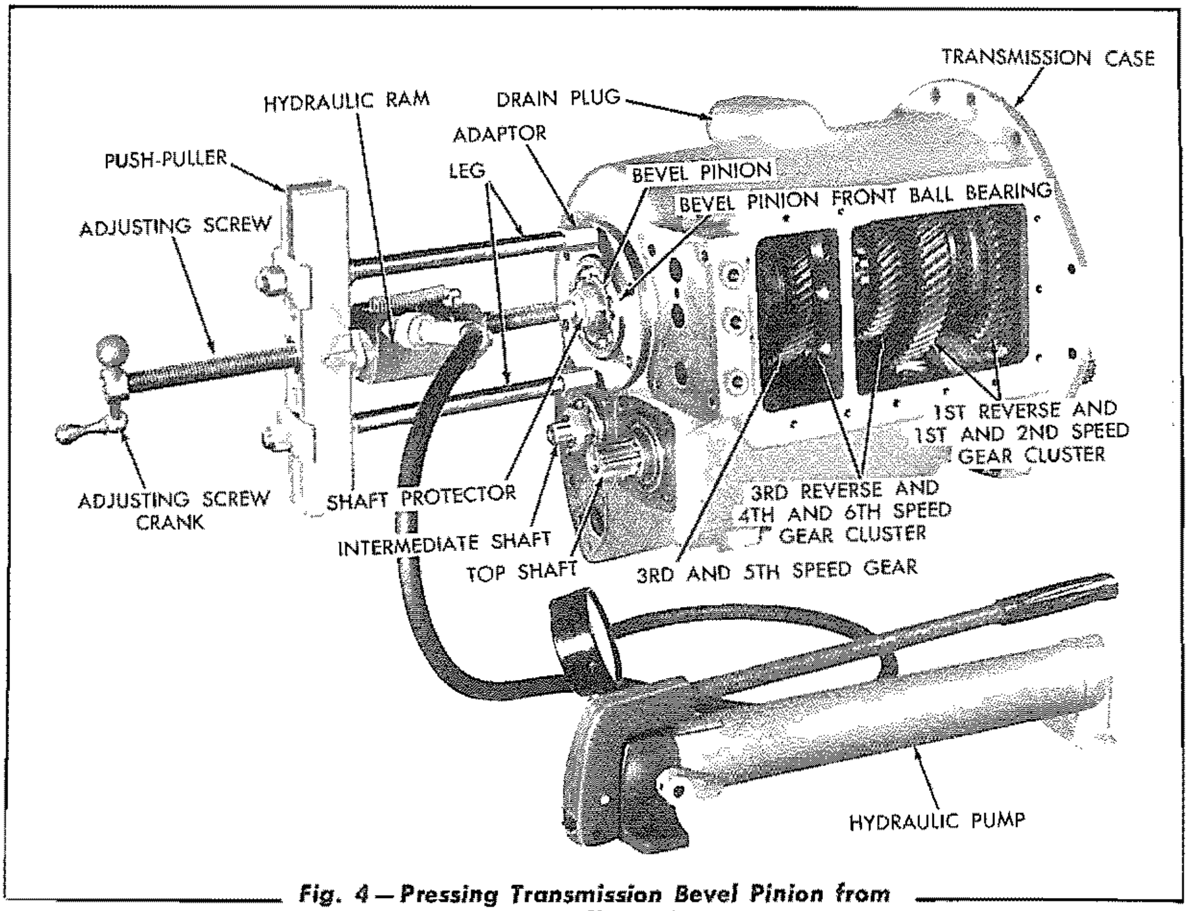


Fig. 4 — Pressing Transmission Bevel Pinion from Front Ball Bearing

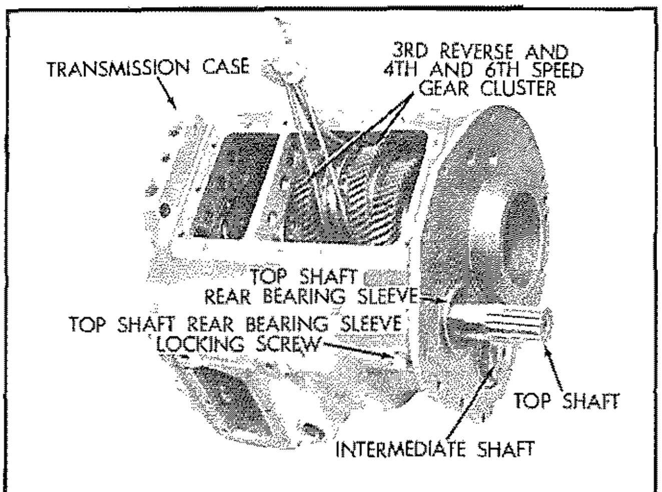


Fig. 5 — Removing 3rd Reverse and 4th and 6th Speed Gear Cluster

10. Place a rope around the center cluster of gears (3rd reverse and 4th and 6th speed gears) and remove the gear cluster and the gear spacing washers from the transmission case as an assembly (refer to Fig. 5).

11. The front gear cluster (2nd reverse and 3rd and 5th speed gears) must be disassembled inside the transmission case as there is not sufficient space to permit removal as a cluster. To disassemble this gear cluster, slide the rear gear (3rd and 5th) from the hub and remove the gear 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.

12. The rear gear cluster (1st reverse and 1st and 2nd speed gears) may now be removed if desired by following the disassembly procedure as outlined in step 11 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.

13. Turn the transmission case on the bench so that the right side of the transmission case faces upward. Remove the capscrew and retainer washer attaching the universal joint rear yoke to the front end of the transmission top shaft and remove the yoke. Remove the capscrews attaching the top shaft front bearing retainer to the transmission case and remove the retainer. Remove the top shaft rear bearing sleeve locking screw (refer to Fig. 5) and remove the rear bearing sleeve and shims from the transmission case.

14. Drive the top shaft toward the rear of the case until the shaft is free of the front bearing spacing sleeve and front roller bearing. Pull the shaft from the transmission case and remove the three (3) gears, bearing spacing sleeve, and the bearing spacer from the case.

15. 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 1st reverse gear from the top shaft. On later model tractors, unlock the locknut and remove the locknut, bearing, and the 1st reverse gear from the top shaft.

16. Remove the intermediate shaft front bearing cover from the front end of the transmission case. *NOTE: If the oil seal in the bearing cover is removed for replacement, the new oil seal must be installed in the bearing cover so that the sealing lip of the seal is toward the front when the cover is installed.*

17. Loosen the clamp bolt on the high-low shifting fork and remove the two (2) capscrews securing the interlock housing to the transmission case. Remove the interlock assembly and shifting fork shaft from the transmission case as a unit. Remove the high-low shifting fork from the shifting collar.

18. 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. Drive the intermediate shaft toward the rear of the case to free it from the front ball bearing and from the high range gear bearing inner race. Remove the shaft from the transmission case. Remove the gears, spacers, etc., from the transmission case.

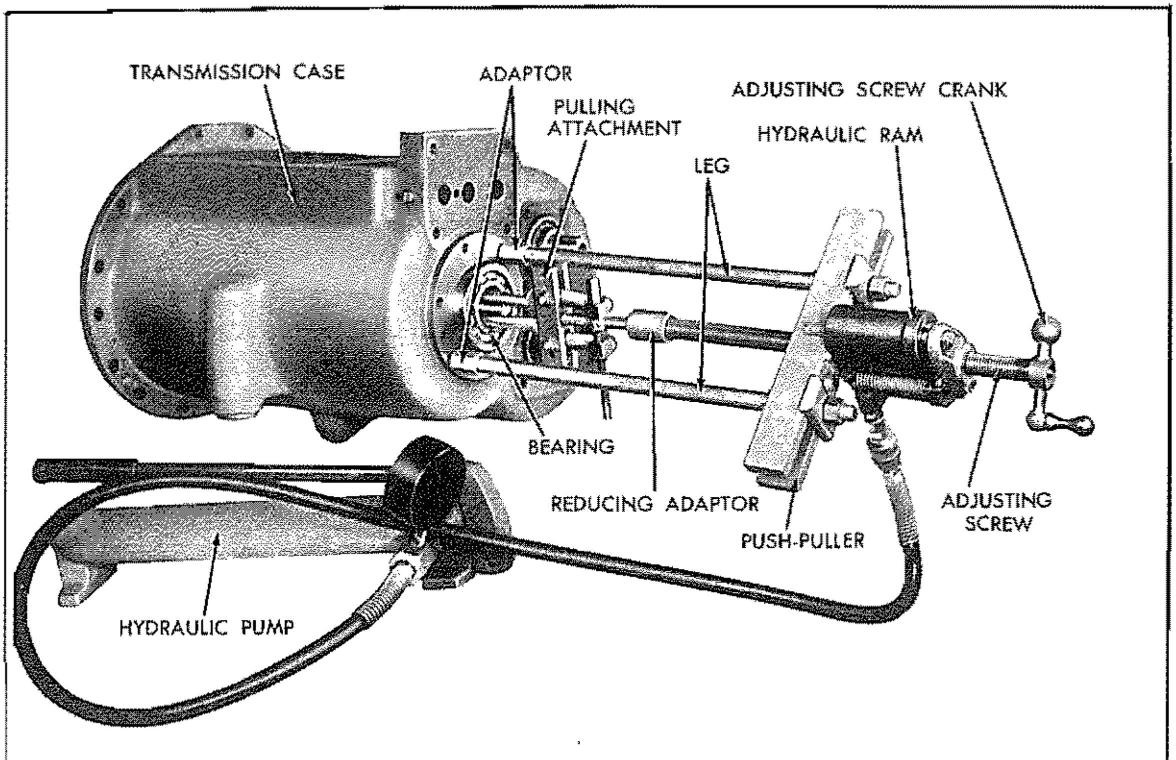


Fig. 6—Removing Bearing from Transmission

19. If the rear gear cluster of the bevel pinion was left in the transmission case, remove the cluster at this time.

20. Clamp the intermediate shaft in a vise, protecting the splines of the shaft by use of copper jaws or similar measure. Unlock and remove the nut from the rear of the shaft. Remove the bearing and the 1st and 2nd speed gear from the shaft.

21. Using special tools similar to the ones shown in Fig. 6, 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.

The transmissions in Tractors Serial No. 2939 through 3895 have shifting collars, hubs and corresponding gears with wide engaging teeth which require shifting fork shafts with elongated detent grooves for the detent balls. However, the transmissions in Tractors prior to Serial No. 2939 and in Tractors Serial No. 3896 and above, have shifting collars, hubs, and corresponding gears with narrow engaging teeth and have shifting fork shafts with equally spaced detent grooves.

NOTE: The wide tooth type shifting collars, hubs, and gears, and the shifting fork shafts with the elongated detent grooves for the detent balls (as used in transmissions in Tractors Serial No. 2939 thru 3895) were discontinued. Whenever the transmissions in these tractors are disassembled for repairs, new shifting collars, hubs, and gears having the narrow type engaging teeth, and new shifter fork shafts with equally spaced detent grooves, should be installed.

Effective with Tractor Serial No. 3749, heavier transmission shifter forks were installed. The heavier shifter forks contain two (2) capscrews for clamping the fork to its respective shifter shaft instead of one (1) clamping capscrew as used in transmissions in Tractors prior to this Serial Number. Whenever the transmissions in Tractors prior to Serial No. 3749 are disassembled for repairs, the heavier shifter forks should be installed.

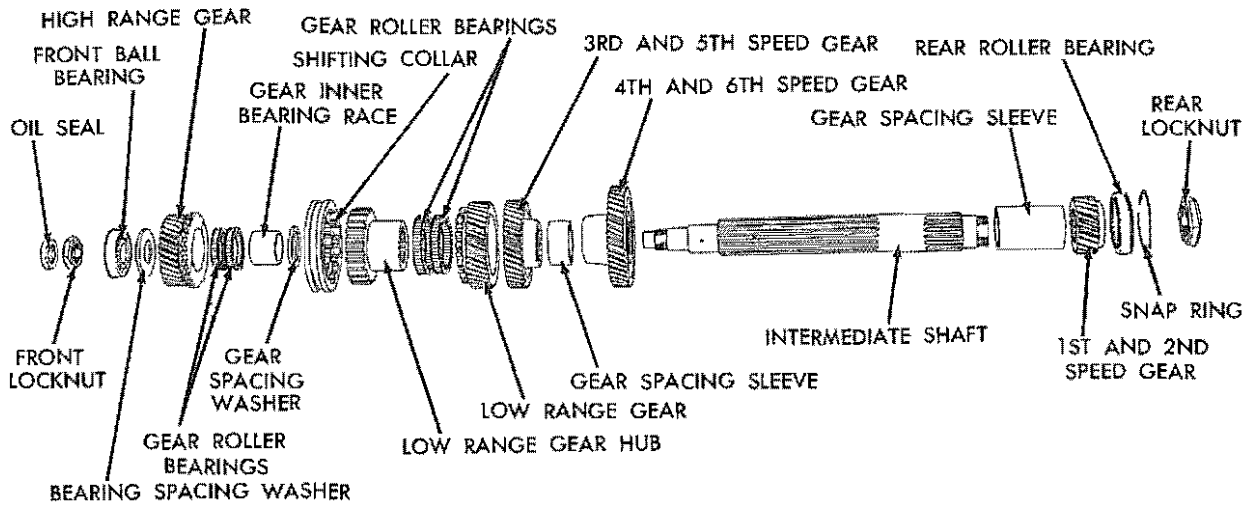


Fig. 7 — Transmission Intermediate Shaft Details

E. Assembly of Transmission

1. Installation of Intermediate Shaft Assembly

NOTE: Before installing the components of the intermediate shaft in the transmission case, the bevel pinion rear gear cluster (1st reverse and 1st and 2nd speed gears) should be assembled and placed in position inside the transmission case. This will make the installation of the transmission bevel pinion easier.

a. Place the transmission case on a bench with the side cover opening in the case upward.

b. Install the 1st and 2nd speed gear (22 teeth) on the rear end of the intermediate shaft, with the hub end of the gear facing the rear of the shaft. Press the inner race of the rear roller bearing in position on the shaft.

c. Place the gear spacing sleeve (4⅛" long) on the shaft and against the front face of the gear and insert the assembly in the transmission case from the rear just far enough to start the remaining components onto the shaft.

d. Start the 4th and 6th speed gear (46 teeth) on the splines of the shaft, with the hub end of the gear toward the front of the shaft. Install the gear spacing sleeve (1- 5/16" long) on the shaft against the hub of the gear. Install the 3rd and 5th speed gear (41 teeth) on the shaft, with the hub end of the gear against the spacing sleeve.

e. *NOTE: On early model tractors, the low range gear (40 teeth) contained a bushing and on later model tractors the bushing in this gear was discontinued. The low range gear in the later model tractors is supported on the low range gear hub by two (2) roller bearings.*

On early model tractors, lubricate the bushing in the low range gear (40 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 (40 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 (32 teeth) contained a bushing and on later model tractors the bushing in this geor was discontinued. The high range geor in the later model troctors is supported by two (2) roller beorings.*

On eorly model tractors, lubricote the bushing then install the bearing inner race in position in the bushing of the gear. Install the gear spacing washer in the bore of the high range gear, with the chamfer on the ID of the washer toward the rear of the assembly as installed. Start this assembly in position on the shaft, with the large diameter of the gear located next to the low range gear hub, and drive the bearing inner race into position on the shaft.

On later model tractors, install two (2) high range gear roller bearings in position in the high range gear (32 teeth) and lubricate the bearings. Install the roller bearings and the gear spacing washer in the bore of the gear, with the chamfer on the ID 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, and push the shaft forward into position. Start the gear inner bearing race onto the front end of the shaft and drive it into position on the shaft and against the gear spacing washer.

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 into position in the rear bore of the transmission case and onto the inner race of the bearing which was installed on 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.

h. Install the front ball bearing into position in the bore of the transmission case and onto the shaft. On early model tractors, install the lockwasher and the front nut on the shaft. On loter model troctors, instoll 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 bearing cover, with the sealing lip of the seal toward the front when the cover is installed. Install the bearing cover and its attaching gasket in position on the case but do not tighten the attaching capscrews at this time.

2. Installation of Transmission Top Shaft Assembly

a. Place the top shaft in a vise, with the rear end of the shaft upward; protect the splines of the shaft by use of copper jaws in the vise. Install the 1st reverse gear (21 teeth) on the shaft, with the hub end of the gear towards the rear of the shaft. Install the rear ball bearing in position on 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, to a torque of 175 to 200 lbs. ft. and lock in position.

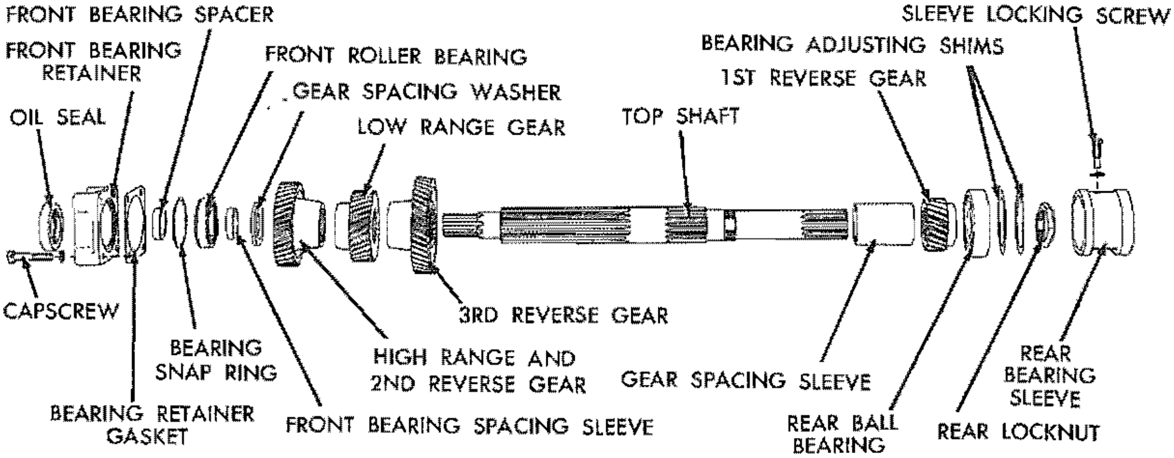


Fig. 8 — Transmission Top Shaft Details

b. Start the front end of the shaft into the top shaft rear bore of the transmission case. Install a gear spacing sleeve (3⅞" long) on the shaft followed by the 3rd reverse gear (46 teeth), with the hub end of the gear facing the front of the shaft.

c. Install the low range gear (34 teeth) on the shaft and next to the 3rd reverse gear, with the hub end of the gear facing the front of the shaft.

d. Install the high range and 2nd reverse gear (41 teeth) on the shaft, with the hub end of the gear facing the rear and against the hub of the low range gear.

e. Install the ⅜" thick high range and 2nd reverse gear spacing washer (chamfer toward the gear), front bearing spacing sleeve, and the inner race of the front roller bearing on the shaft in the order named. Install the roller bearing (with its snap ring) into position in the front bore of the case and on the shaft. Install the front bearing spacer (½" thick) on the shaft and against the inner race of the front roller bearing.

f. Install an oil seal in the front bearing retainer, with the sealing lip of the seal toward the rear.

g. Using gasket cement, cement a front bearing retainer gasket to the transmission case and attach the front bearing retainer to the case with four (4) ½" x 2½" capscrews and lockwashers.

h. Insert the rear bearing sleeve into the transmission top shaft rear bore, aligning the hole for the sleeve locking screw. Use sufficient bearing adjusting 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 positioned as outlined above, secure it in position with the sleeve locking screw and lockwasher.

3. Installation of Transmission Bevel Pinion

a. With the bevel pinion rear gear cluster in position in the transmission case as outlined in E, 1 above, refer to Fig. 9 and assemble the front gear cluster (2nd reverse gear [55 teeth] and 3rd and 5th speed gear [55 teeth]), inside the transmission case in the same manner in which the rear gear cluster was assembled. When assembling, coat the rear face of the front bearing spacing washer with grease to hold it in position against the 2nd reverse gear. *NOTE: The gear hub for the 2nd reverse and the 3rd and 5th speed gears, of the front gear cluster, has two different width bearing journals;*

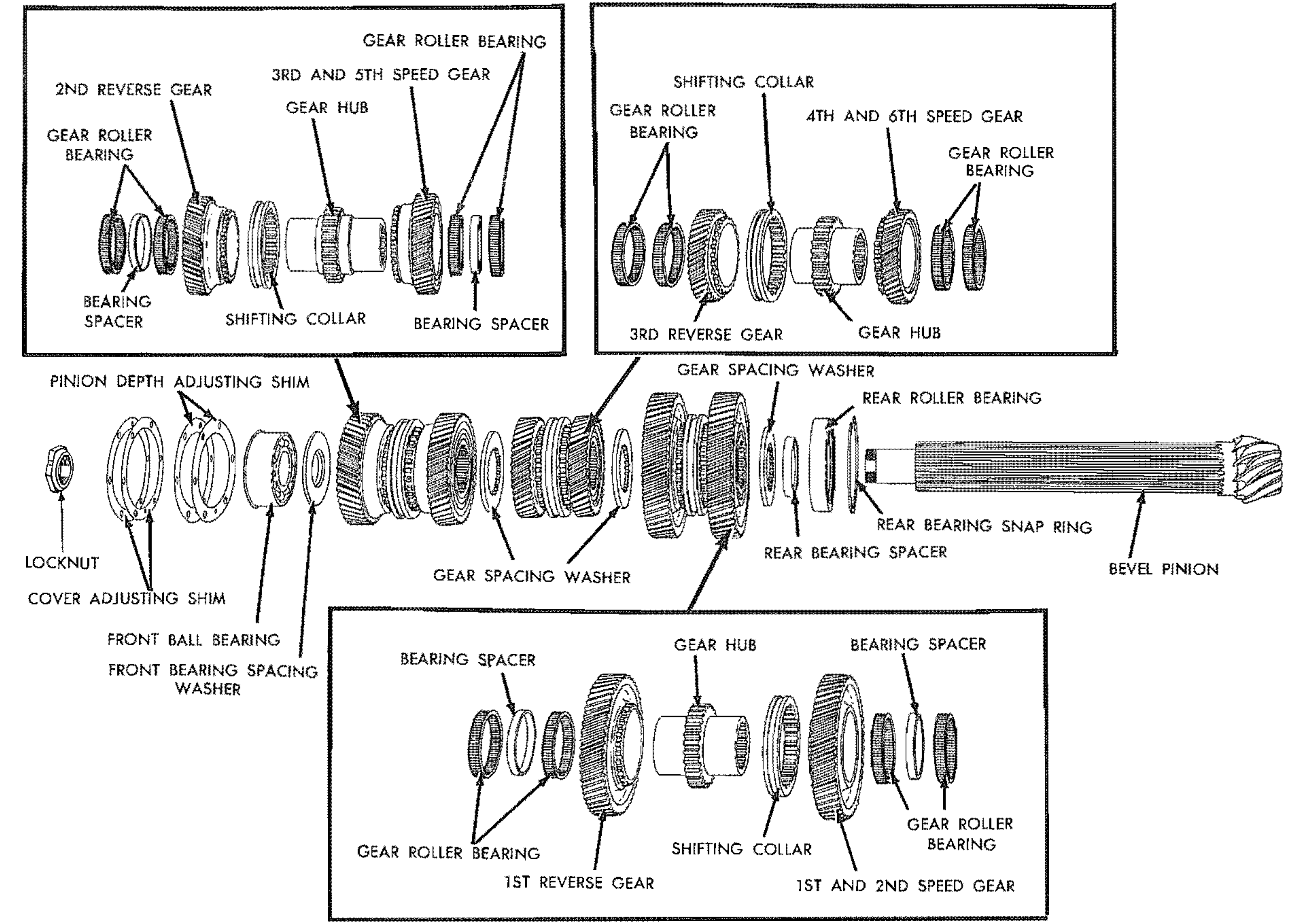


Fig. 9 — Transmission Bevel Pinion Shaft Details

this gear hub must be installed with the longer journal toward the rear of the case.

b. After the bevel pinion front gear cluster has been assembled, push it as far forward as possible in the transmission case and into mesh with the mating gears on the top and intermediate shafts.

c. Assemble the transmission bevel pinion center gear cluster (3rd reverse and 4th and 6th speed gears each having 48 teeth), on a work bench. When assembling, coat the two (2) gear spacing washers with grease to hold them in position against their corresponding gears. Install the assembled cluster in position in the transmission case, between the front and rear clusters. Make certain the gear spacing washers are in their proper position and that the gears of the center gear cluster mesh properly with the mating gears on the top and intermediate shafts.

d. 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 gear hubs, so that the helixes of the gear teeth will mesh with their mating gears (refer to Fig. 1).

e. Press the inner race of the rear roller bearing into position on the bevel pinion and install the rear roller bearing in position on the inner race. Install the rear bearing spacer (1" long) on the bevel pinion, with the chamfered end of the spacer toward the bearing. Place a gear spacing washer in position on the bevel pinion and against the rear bearing spacer.

f. Turn the transmission case so that the top of the case rests on the work bench as shown in Fig. 10. Make certain the three (3) shifting collars are in their neutral position. Start the bevel pinion into the case from the rear. While pushing on the pinion, turn the gears and position the bevel pinion as necessary to align the splines of the pinion with the corresponding splines in the gear spacing washers and the gear hubs, and push the pinion into the gear hubs until the rear bearing is started into the bore of the case. Drive the rear bearing into the bore of the case and install the rear bearing snap ring in position in the case.

g. Remove the snap ring from the double row ball bearing and start the bearing into position on the bevel pinion. On early model tractors, install the lockwasher and the front nut on the bevel pinion. On later model tractors, install the front locknut on the bevel pinion. Tightening of the nut or locknut will pull the double row ball bearing into position on the bevel pinion and into the bore of the transmission case. Tighten the nut or locknut to a torque of 480 to 520 lbs. ft. and lock in position.

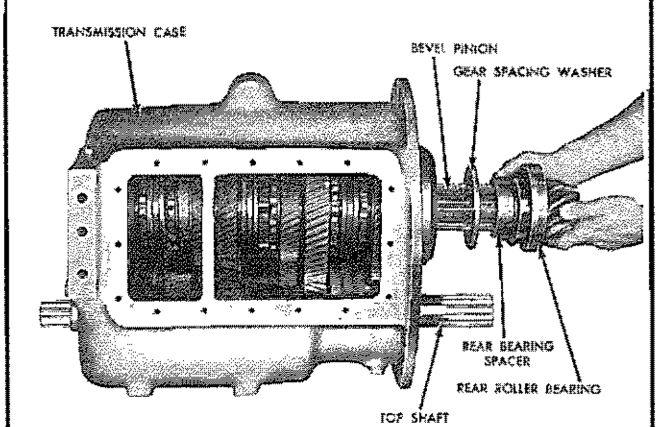


Fig. 10 — Installing Bevel Pinion in Transmission

h. Remove the front bearing cover from the intermediate shaft, tighten the intermediate shaft front and rear nuts to torque of 180 to 220 lbs. ft., and lock the nuts in position. Install the intermediate shaft front bearing cover and gasket and secure the cover to the case with the attaching capscrews.

i. Place the snap ring in its groove in the bevel pinion front bearing and tap the bevel pinion toward the rear until the snap ring is against the face of the transmission case. Hold the front bearing cover firmly against the front 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 of cover adjusting shims approximately .001″ thicker than the feeler gage measurement; this will provide .000″ to .002″ bearing end play in the bearing cover when the bearing cover is attached to the case. Keep the shim pack with the bearing cover.

j. Drive the transmission bevel pinion forward approximately 1/16″ and remove the snap ring from the front bearing. Install the pinion depth adjusting shims (approximately .080″), which were removed at disassembly, in place on the front bearing. Install the snap ring and drive the bevel pinion toward the rear until the snap ring is tight against the adjusting shims.

k. Install the bevel pinion front bearing cover with the correct amount of cover adjusting shims, as determined in step (i) above, and secure with the attaching capscrews.

l. The initial transmission bevel pinion depth (controlled by depth adjusting shims located between the transmission bevel pinion front bearing snap ring and the transmission case) should be set so that the rear face of the bevel pinion extends 4.149″ from the rear face of the transmission case.

m. If the bevel pinion has a mounting distance dimension marked on the rear face of the pinion, subtract this dimension from 9.521″, 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 case mounting gasket in place (refer to Fig. 11).

n. Occasionally, after a transmission bevel pinion and gear have been adjusted in the above manner, it is necessary to add or remove pinion depth adjusting shims to obtain the desired tooth bearing pattern. Always use a marking compound

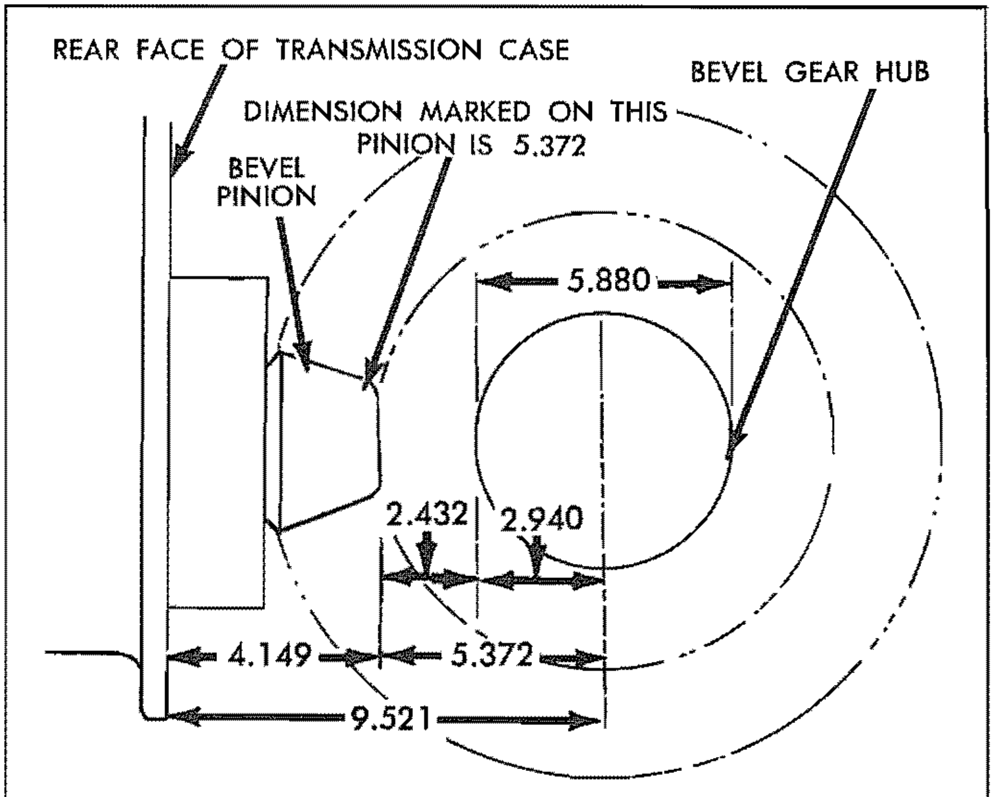


Fig. 11 — Transmission Bevel Pinion Adjustment

to check the tooth bearing pattern after making an adjustment (refer to Fig. 18 in this Section for proper tooth pattern).

4. Installation of Gear Shift Mechanism

Turn the transmission case on the work bench so that the case rests on its left side. Refer to Figs. 1 and 3 and install the shifting fork shafts and their components as follows:

a. Install the three shifting forks in position in the slots of their corresponding shifting collars. The forks must be installed with the bosses for the fork attaching capscrews positioned as shown in Fig. 3.

b. The three (3) shifting fork shafts are of different lengths; the lower shaft being the longest, the upper shaft being next in length, and the center shaft being the shortest.

   Insert the upper shifting fork shaft through the upper shifting shaft bore in the case and into the shifting fork located on the center cluster of gears. Refer to Fig. 1 and insert three (3) steel balls (detent balls) in position in the case and make certain that the ball contacting the upper shifting fork shaft is located in the center detent notch of the shifting fork shaft.

c. Install the interlock pin in position in the center shifting fork shaft and insert the shaft through the center shifting shaft bore in the case and into the shifting fork located on the front cluster of gears. Refer to Fig. 1 and insert two (2) steel balls (detent balls) in position in the case and make certain that the ball contacting the center shifting fork shaft is located in the center detent notch of the shifting fork shaft.

d. Insert the lower shifting fork shaft through the lower shifting shaft bore in the case and into the shifting fork located on the rear cluster of gears. Make certain the center detent notch of the shifting fork shaft is in line with the steel balls (detent balls).

e. Insert a steel ball (detent ball) and an interlock spring into each hole over each shifting fork shaft, then install the three washers and interlock spring capscrews. Tighten the capscrews securely.

f. Make certain that the shift lever notches in the front ends of the shifting fork shafts are properly aligned. Center the three shifting collars on the gear hubs and center the shifting forks in the slots of the shifting collars. Tighten the shifting fork capscrews (½" capscrews) to a torque of 85 to 95 lbs. ft. *NOTE: The shifting forks in Tractors Serial No. 1945 thru 3748 contained ⅝" capscrews; the ⅝" capscrews in these forks (if these forks are reinstalled) should be tightened to a torque of 170 to 180 lbs. ft.*

g. Install the gear shift lever housing and gasket in position on the front of the transmission case, inserting the lower end of the gear shift lever into position in the notched ends of the shifting fork shafts. Install the attaching capscrews and tighten securely.

h. Install the high-low shifting fork in position in the shifting collar of the intermediate shaft, with the clamping slot of the fork facing toward the center of the transmission (refer to Fig. 3). Insert the high-low shifting fork shaft, assembled in the gear shift interlock housing, into the bore of the transmission case and into the shifting fork.

i. Center the shifting collar of the gear hub and center the shifting fork in the shifting collar. Tighten the shifting fork capscrews (½" capscrews) to a torque of 85 to 95 lbs. ft.

   NOTE: The shifting fork in Tractors Serial No. 1945 thru 3748 contained a ⅝" capscrew; the ⅝" capscrew in this fork (if this fork is reinstalled) should be tightened to a torque of 170 to 180 lbs. ft.

j. Install the high-low shifting lever in position on the high-low shift lever. Install the drain plug in the transmission case. Thoroughly inspect the inside of the transmission for foreign objects. Check all capscrews inside the transmission and make certain they have been tightened securely. Using a small pry bar, or similar tool, move each shifting fork 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 properly engaged with their corresponding gears. Install the transmission side cover and gasket.

k. Install the rear yoke (universal joint) in position on the front of the transmission top shaft, using a new yoke seal between the top shaft and the yoke retaining washer (refer to Fig. 20). Secure the rear yoke in position with a capscrew and locking wire.

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 transmission bevel pinion and bevel gear and adjust if necessary as explained in "ASSEMBLY OF BEVEL GEAR" in this Section.

2. Connect the universal joint assembly to the rear yoke with the two (2) U-bolts.

3. Install the capscrews to attach the right brake pedal lever bracket. Install the steering levers and bracket in position on the transmission case and secure with the attaching capscrews. Connect the steering clutch control rods to the steering levers.

4. Install the yoke pins and cotter pins used to connect the shifting lock plunger rods to the two (2) shifting lock plungers and check the adjustment of the rods when connecting as follows:

   a. To adjust the shifting lock plunger rod on the right side of the transmission, pull the engine clutch operating lever to its "ENGAGED" position. Measure the compressed length of the plunger rod rear spring and record this measurement. Push the engine clutch operating lever to its "DISENGAGED" position. Turn the nuts on the front end of the plunger rod as necessary to compress the plunger rod front spring to obtain the same compressed length as recorded for the rear spring. When the correct adjustment is obtained, tighten the jam nut.

   b. The shifting lock plunger located on the left side of the transmission, is properly adjusted when there is ⅛" clearance between the shoulder of the plunger and the shifting lock plunger sleeve with the engine clutch operating lever in its "DISENGAGED" position. The correct adjustment can be made by turning the adjustable yoke at the forward end of the shifting lock plunger rod as necessary.

5. Install the floor plate, brake pedal pads, seat adjusting frame, speed selection shift lever, gear shift lever guide, and seat cushion. Install the drain plug in the bevel gear compartment and install the main frame bottom rear shield.

6. 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 center compartment of the steering clutch and final drive housing, is bolted to the flange of the bevel gear shaft. The bevel gear shaft is supported at 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. Removal of Bevel Gear

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," Section XII). Remove the steering clutch throwout yoke and bearing assemblies (refer to "STEERING CLUTCH THROWOUT BEARING ASSEMBLIES," Section XII).

2. Remove the bevel gear compartment cover.

3. Remove the high nuts and nut locking plates securing the bevel gear to the bolting flange of the bevel gear shaft.

4. Remove the bolts attaching the bevel gear shaft bearing cage assemblies to the inner walls of the steering clutch compartments and remove the bearing cages.

5. Install a puller similar to the one shown in Fig. 12. Place suitable wooden blocks between the right side of the bevel gear and the compartment wall to hold the bevel gear stationary. Tighten the puller screw hex nut and pull the bevel gear shaft from the gear.

6. Remove the hex nut from the puller screw and remove the wooden blocks which were installed in step 5. 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 cover opening. Remove the bevel gear.

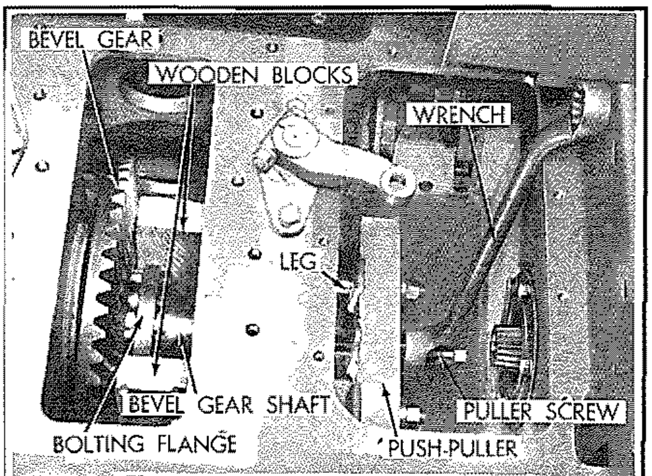


Fig. 12—Pulling Bevel Gear Shaft

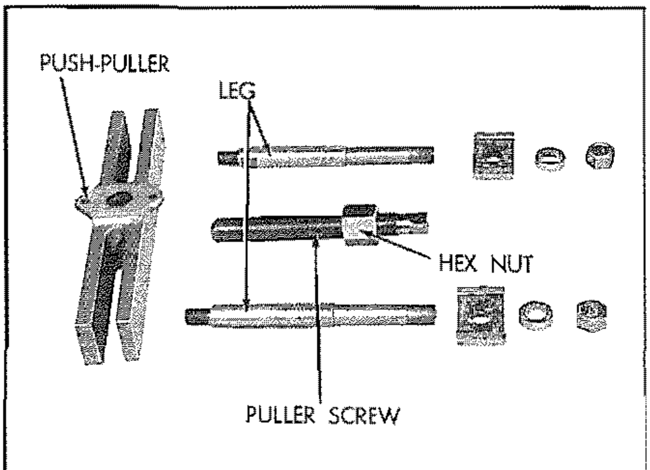


Fig. 13—Special Tool Details for Pulling Bevel Gear Shaft

7. Remove the bearing cone from 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.

C. Cleaning and Inspection of Parts

Clean and inspect all the parts as described in pertinent pages in "GENERAL MAINTENANCE INSTRUCTIONS," Section XXI. Replace or recondition any damaged parts. Replace the bevel gear shaft oil seal sleeves if necessary and install new oil seals when assembling.

D. Installation of Bevel Gear

1. Press the bearing cone into position on the right end (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 position in the

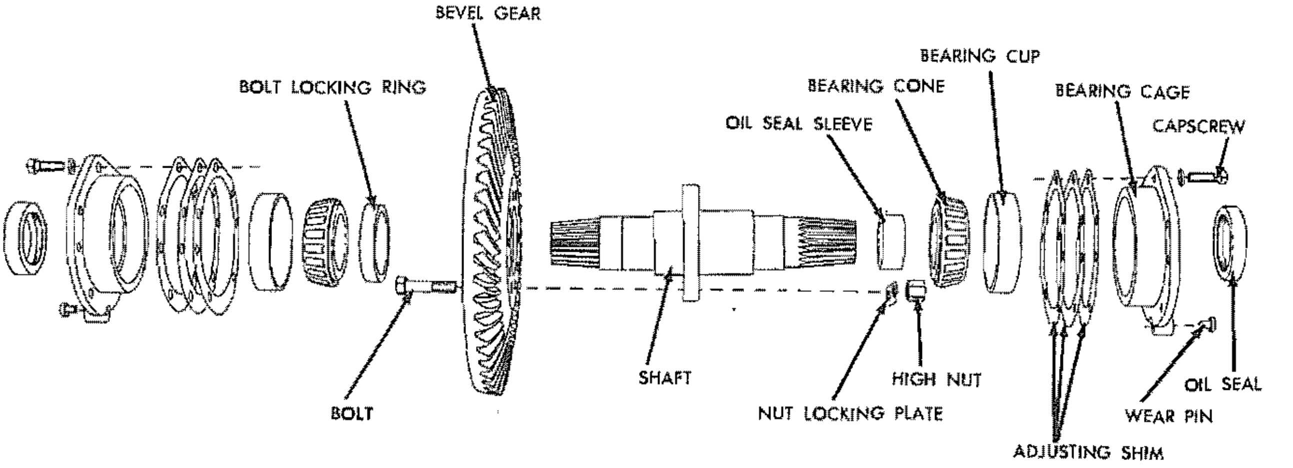


Fig. 14 — Bevel Gear and Shaft Details

gear. *NOTE: 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 toward the right side when viewed from the rear. Start the bevel gear shaft into the bevel gear and start the flange of the shaft onto the attaching bolts. Bump or drive the bevel gear 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 when installed.

3. Lubricate the other bearing cone and start it on the left end of the bevel gear shaft, with the large diameter of the bearing toward the bevel gear. Using special tools similar to the ones shown in Fig. 15, install the puller screw (used in removal) in the tapped hole in the left end of the bevel gear shaft. Place a bearing installing sleeve (having an OD the size of the inner race of the bearing cone) over the puller screw and

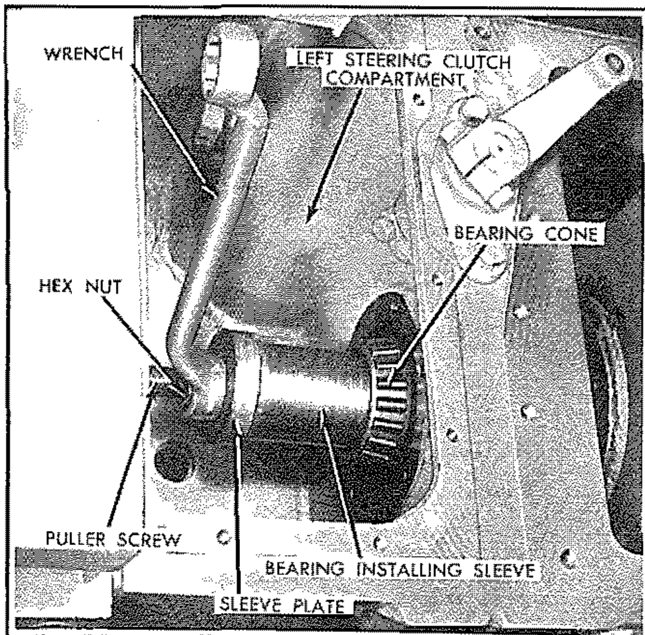


Fig. 15 — Installing Bevel Gear Shaft Bearing Cone

against the inner race of the bearing cone. Install a sleeve plate against the installing sleeve and install a hex nut on the puller screw. Tighten the hex nut to press the bearing cone tight against its seat on the shaft, then remove the installing tools.

4. Press the bearing cups into position in the bearing cage assemblies. Lubricate the bearing cones 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 housing.

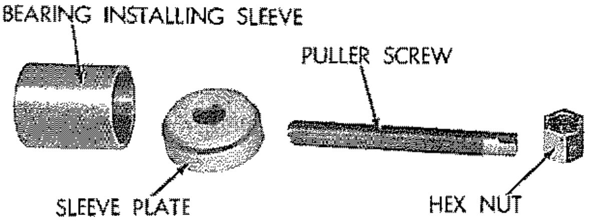


Fig. 16 — Special Tool Details for Installing Bevel Gear Shaft Bearing Cone

5. Make certain that the wear pin in each cage is toward the bottom as installed, then start the attaching capscrews but do not tighten.

6. Tighten all of the high nuts of the bevel gear attaching bolts to a torque of 165 - 175 lbs. ft. and lock the high nuts in position with the nut locking plates.

7. Tighten the bearing cage attaching capscrews and bump the bearing cages to make certain the bearing cones are properly seated, then check the bearing pre-load. *NOTE: THE BEARING PRE-LOAD MUST BE 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 25 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 25 inch pounds pre-load.

9. Install the transmission assembly in position on the steering clutch and final drive housing and tighten the attaching capscrews.

10. To adjust the bevel pinion depth (or mounting distance) with the transmission installed in the tractor, refer to Fig. 17 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 bevel pinion to the machined surface of the bevel gear shaft flange. Lock the telescoping gage in position, use an outside micrometer to measure the telescoping gage, and record this measurement.

    b. To calculate this distance (refer to Fig. 11), divide the diameter of the bevel gear shaft 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 bevel gear shaft flange is 5.880" and the mounting distance marked on the end of the bevel pinion is 5.372".

    $$5.880'' \div 2 = 2.940''$$
    $$5.372'' - 2.940'' = 2.432''$$

    Therefore, 2.432" is the proper mounting distance from the toe end of the bevel pinion to the machined surface of the flange of the bevel gear shaft.

    NOTE: If the bevel pinion has no mounting distance marked on the toe end, the pinion should be adjusted so that the rear face (toe end) of the bevel pinion stands out approximately 4.149" from the rear face of the transmission case.

11. Check the backlash between the bevel gear and the bevel pinion teeth; the specified backlash is .006" to .012". If the 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 .006"; if the run out exceeds .006", the mounting of the bevel gear on the shaft should be rechecked.

12. Adjustment of the backlash between the bevel gear and the bevel pinion teeth 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 from under the bearing cage on the left side and add these shims to those under the bearing cage on the right side. If the backlash is insufficient, remove adjusting shims from under the bearing cage on the right side and add them to

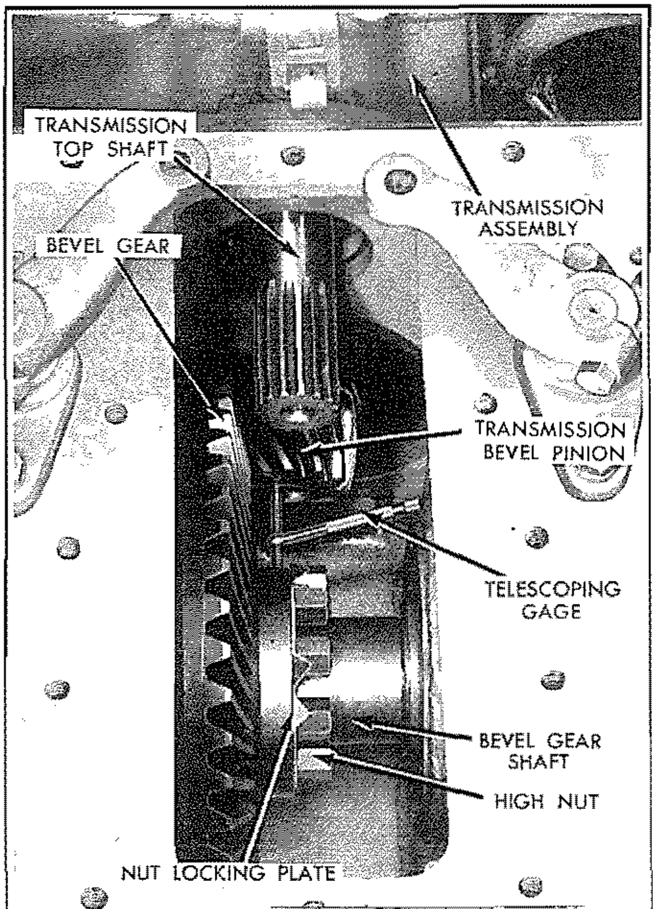


Fig. 17 — Checking Transmission Bevel Pinion Adjustment

the shims under the bearing cage on the left side. In this manner, the bevel gear is moved without disturbing the bevel gear shaft bearing pre-load adjustment. Transferring a .005" adjusting shim will change the 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. Rotate the gear by hand and the tooth bearing will show plainly (refer to Fig. 18 showing the correct and incorrect tooth bearings).

13. After the backlash of the bevel gear and pinion has been properly adjusted, remove the bevel gear shaft bearing cages (keep adjusting shims with their respective cages) then lubricate and install the oil seals in position in the bearing cages; install the oil seals in the bearing cages so that the sealing lips of the seals are toward the bevel gear when installed. Lubricate bevel gear shaft and reinstall the bearing cages, using care so that the lips of the seals are not crimped or damaged. *IMPORTANT: When installing the bearing cages, make certain they are positioned so that the wear pin for the clutch throwout yokes are located at the bottom when installed.*

14. Install the steering clutch throwout bearings, throwout yokes, and steering clutch driving hubs in position on the bevel gear shaft as an assembly. Install the steering clutch driving hub retaining washers, locks, and retaining capscrews and tighten the retaining cap-

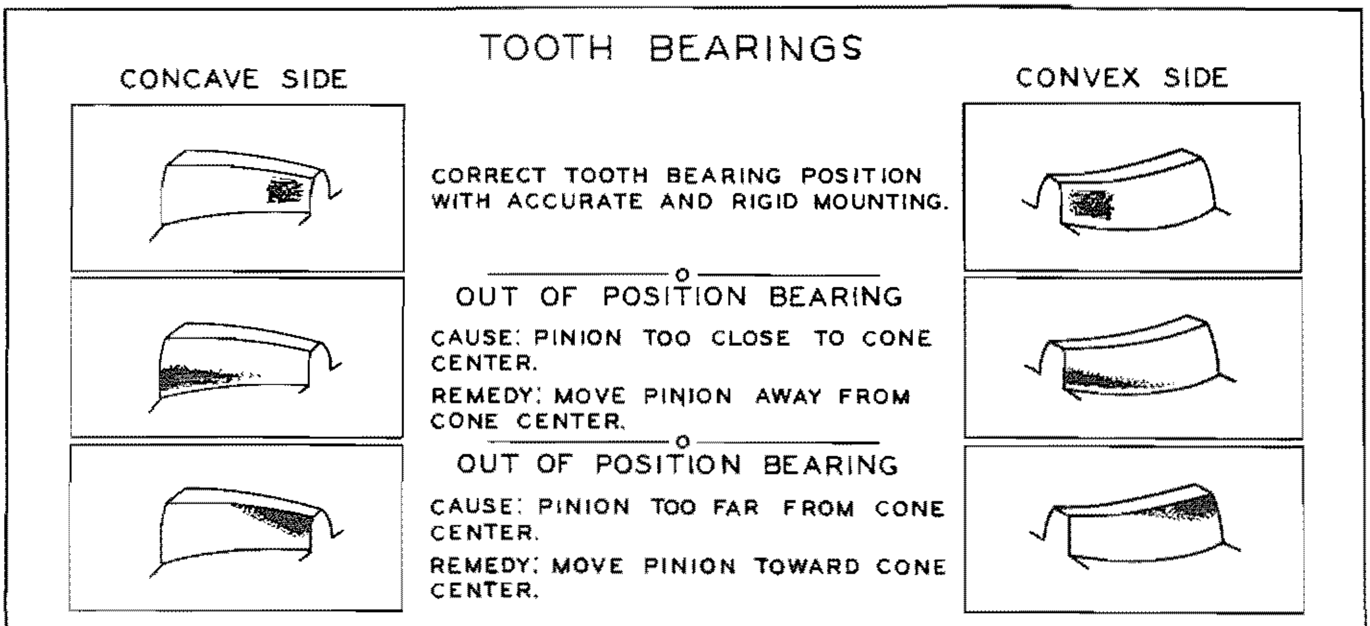


Fig. 18 — Tooth Bearings

screws to a torque of 300 lbs. ft. Lock the capscrews in position with the capscrew locks. Connect the upper ends of the lubricating tubes (right and left) for the steering clutch throwout bearings.

15. Install the bevel gear compartment cover, using a new gasket.

16. Install both steering clutches and brake assemblies (refer to "CLUTCH INSTALLATION," Section XII).

17. Install the oil drain plug in the bevel gear compartment, then fill the transmission and the bevel gear compartment to the proper level using the specified lubricant.

4. DRIVE SHAFT UNIVERSAL JOINT

A. Description

Power is transmitted from the engine through the engine clutch and to the transmission by the drive shaft universal joint assembly. The main parts of the universal joint assembly are: front and rear yokes, center shaft, and the journals and bearing assemblies. By disconnecting the universal joint at the front or rear yoke, either the transmission or the engine clutch can be removed without disturbing the bevel gear and steering clutch assembly or the engine.

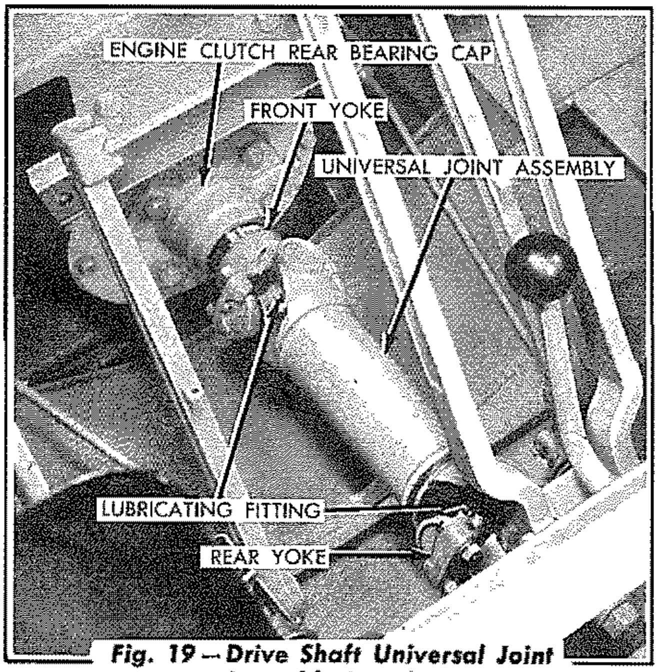


Fig. 19 — Drive Shaft Universal Joint Assembly Location

B. Service

The universal joint assembly is provided with two (2) lubricating fittings one in each journal assembly. After each 400 to 1000 hours of operation, remove the floor plate and lubricate the universal joint assembly.

C. Removal, Disassembly, and Inspection

1. Remove the brake pedal pads, gear shift lever guide, speed selection shift lever, and the floor plate.

2. Remove the two (2) U-bolts attaching the rear journal assembly to the rear yoke. Use a small pry bar and pry the universal joint assembly forward on the clutch shaft splines to free the journal assembly from the rear yoke. Tape or tie the two (2) bearing assemblies to the rear journal. Pull the universal joint assembly toward the rear to free the front yoke from the clutch shaft and remove the universal joint assembly.

3. Remove the bearing assemblies from the journals and remove the gaskets and gasket retainers.

4. Wash the parts thoroughly in clean solvent. Inspect the components for damage and wear and replace the necessary parts.

D. Assembly and Installation

1. The universal joint assembly may be reassembled and installed by direct reversal of the removal and disassembly procedure. When installing the journal assemblies, install them so that both lubricating fittings are in line. Install the rollers in position in the bearing retainers (thirty-four (34) rollers in each). Pack with grease to hold the rollers in position and install the bearing assemblies in position on the journals.

2. Install the floor plate, speed selection shift lever, gear shift lever guide, and the brake pedal pads.

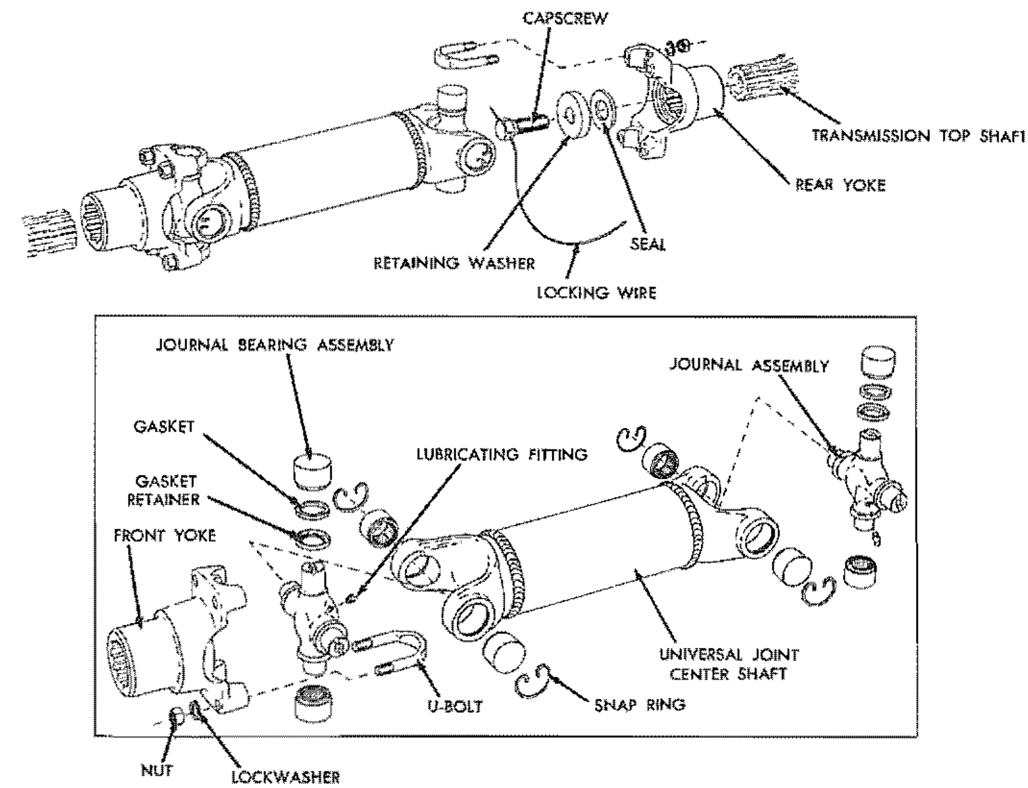


Fig. 20 — Drive Shaft Universal Joint Assembly Details

SECTION XII—STEERING CLUTCHES AND CONTROLS

1. GENERAL DESCRIPTION

Two steering clutch assemblies, one located at each end of the bevel gear shaft, are used for steering the tractor. Each steering clutch assembly is enclosed in a brake drum which acts in conjunction with the steering clutch for steering. Each steering clutch is actuated by a steering lever connected by linkage to the steering clutch throwout yoke assembly. An over-center, spring loaded type steering lever booster assembly is attached to the lower end of each steering lever to assist in disengaging the respective clutch.

2. STEERING CLUTCHES

A. Description

The two steering clutch assemblies, one on each side, are of the multiple disc type having seventeen (17) friction discs and seventeen (17) steel discs assembled alternately. Pressure springs hold the steering clutch discs tightly together, between the steering clutch pressure plate and the steering clutch throwout plate, in assembly.

Power is transmitted from the bevel gear shaft through the steering clutches to the final drive pinions. The steering clutches are manually disengaged by pulling back on the steering levers, located directly in front of the operator. Pulling back on a steering lever mechanically forces the corresponding steering clutch throwout sleeve against the steering clutch throwout plate and compresses the pressure springs, thereby allowing

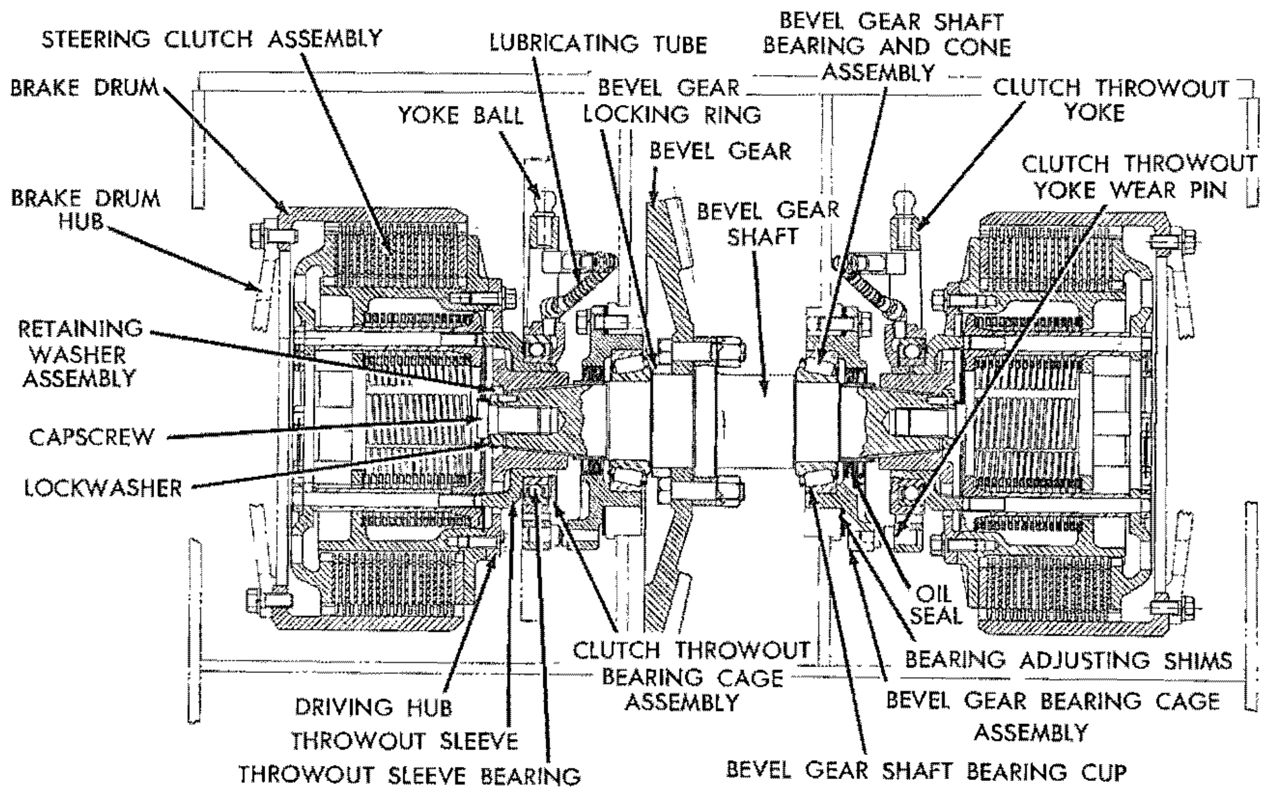


Fig. 1—Steering Clutch and Bevel Gear Assembly

the steel discs and friction discs of the clutch to separate.

When either steering clutch is disengoged, the bevel gear shaft turns without driving or supplying power to the final drive pinion shoft on the side in which the steering clutch is disengoged.

B. Steering Clutch Service

Specified time intervals between steering clutch linkage adjustments can not be established because of the variable operating conditions which determine the amount of steering clutch disc wear.

The steering clutch linkage is properly adjusted when the steering levers each have 3" of free travel, measured at the tops of the steering levers. As the steering clutch discs wear, the steering lever free trovel becomes less and an adjustment is required when the free travel has decreased to less than 1". Free travel of the steering levers is necessary to assure proper clearance between the steering clutch throwout sleeve and the steering clutch throwout plate and to assure full engagement of each steering clutch (refer to "STEERING LEVERS AND LINKAGE" in this Section).

C. Washing Steering Clutches

If the steering clutches slip due to oil getting on the clutch discs as a result of oil leaking into the steering clutch compartments, wash the steering clutches with cleaning solvent in the following manner:

1. Install a drain plug in the drain hole located in the bottom of each steering clutch compartment.

2. Remove the brake band adjustment hole covers from the top of the steering clutch housing and pour about three gallons of solvent into each steering clutch 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 steering clutches and brakes will be washed off in this operation.

3. Drain the steering clutch compartments and refill with the same amount of clean solvent, then drive the tractor back and forth for another five minutes, disengaging one steering clutch and then the other continuolly during this period. Disengaging the steering clutches allows the steering clutch discs to separate so that the solvent can get between them to wash the oil from their friction surfaces.

4. Drain the steering clutch compartments and allow the steering clutches to dry a short time. Operate the tractor with a light load in low gear until the steering clutches become thoroughly dry, otherwise they may slip due to the presence of solvent on the discs.

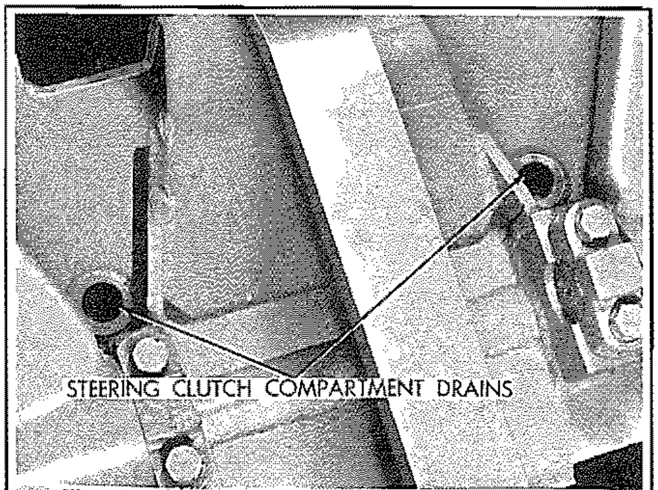


Fig. 2—Steering Clutch Compartment Drains

D. Steering Clutch Removal

NOTE: The following removal procedure applies to either steering clutch.

1. Remove the fuel tank (refer to "FUEL TANK REMOVAL," Section II).

2. Remove the seat cushion, tool box, seat cushion frame, brake pedal pads, floor plate, and the floor supporting plates. Loosen the lower end of the battery ground cable and tape the end. Remove the copscrews attaching the battery box to the fender and move the battery box forward on the fender to provide clearance for the removal of the steering clutch.

3. Remove the jam nut and the brake band support 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 yoke.

6. Remove the yoke pin connecting the rear end of the brake control 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 which is located in the brake band adjusting yoke. Using a suitable ⅜" NC capscrew inserted through the hole, turn the capscrew into the tapped hole in the end of the brake band end pin. Pull out on the capscrew and remove the brake band end pin as shown in Fig. 3.

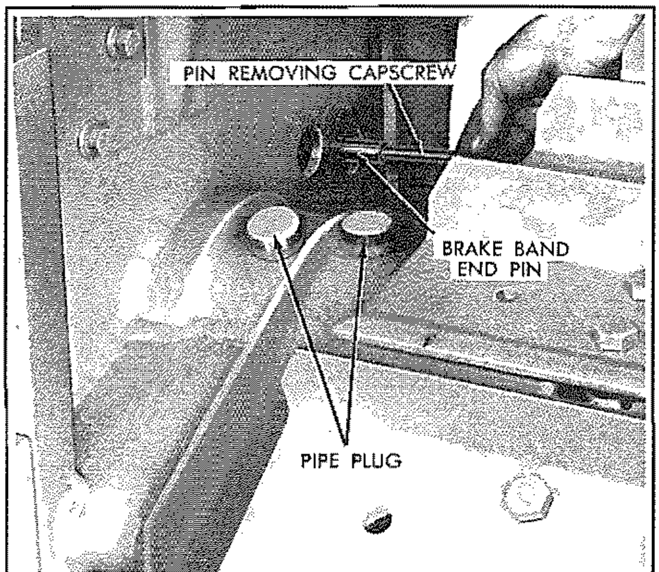


Fig. 3 — Removing Brake Band End Pin

7. Remove the brake band adjusting yoke. 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. 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 from the clutch compartment.

8. Remove the capscrews attaching the steering clutch assembly to the driving hub and to the brake drum hub. This will necessitate turning the steering clutch assembly and brake drum, which can be accomplished by using a jack placed under the rear of the track and moving the tractor, or by turning the track sprocket by the use of a pry bar.

9. Attach a chain to the brake band as shown in Fig. 4 and lift the steering clutch assembly from the steering clutch 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.* With the brake band turned in this position, the brake band 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 steering clutch is lifted from the steering clutch compartment.

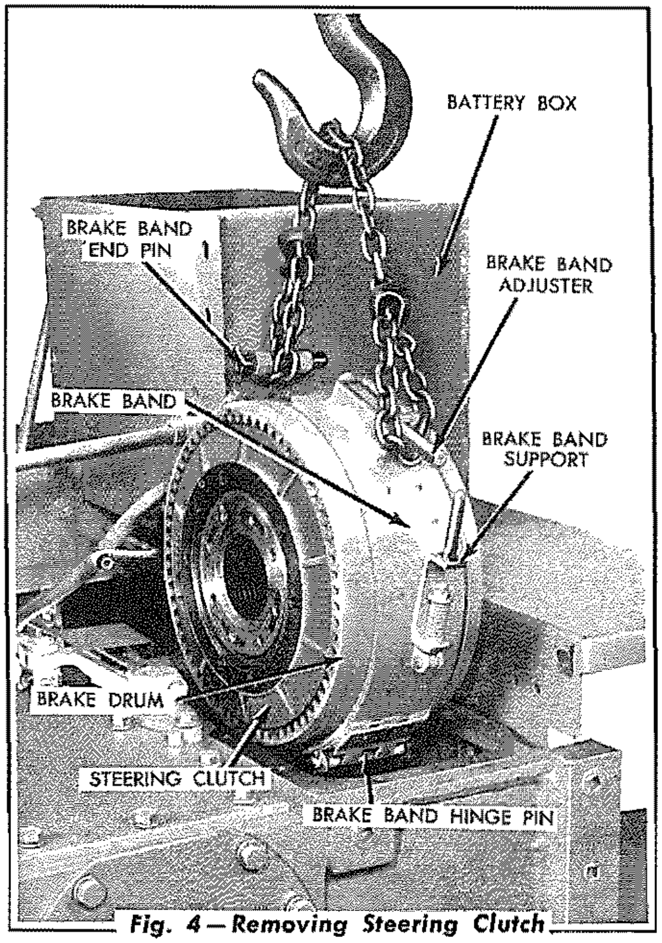


Fig. 4 — Removing Steering Clutch

E. Disassembly of Steering Clutches

NOTE: The following disassembly procedure applies to either steering clutch.

1. Remove the brake drum from the steering clutch assembly, using care to prevent dam-

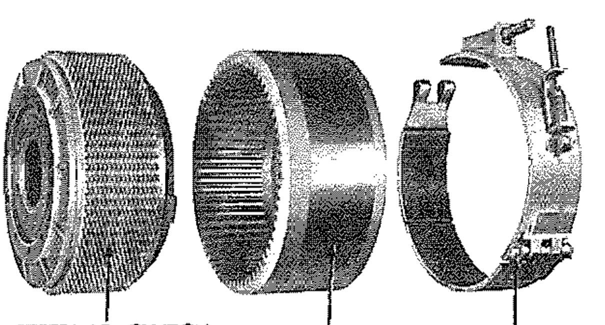


Fig. 5 — Steering Clutch, Brake Drum, and Brake Band

age to the clutch friction disc teeth.

2. Before disassembling the steering clutch, refer to Fig. 8 and center punch or mark the clutch pressure plate, back plate, hub, and the throwout plate so that they can be reassembled in their same relative position.

3. Remove the lockwire from the eight (8) drilled-head capscrews used in holding the steering clutch assembly together. Compress the steering clutch pressure springs using special tools similar to the ones shown in Figs. 6 and 7 and remove drilled-head capscrews. Release the pressure from hydraulic ram, allowing the assembly to separate until all tension is taken off of the steering clutch pressure springs. The clutch throwout plate, discs, springs, etc. can now be separated.

F. Steering Clutch Inspection and Repairs

When the steering clutch has been disassembled, inspect the following items:

1. **Steel Discs**

   The specified thickness of a steel disc when new is .083" to .096". Inspect the discs for wear and scoring. The discs must be flat within .015".

2. **Friction Discs**

   The specified thickness of a friction disc when new is .152" to .157". Inspect the discs for wear, condition of teeth, and scoring. If the thickness of the friction discs is less than .125", or the teeth are in a damaged condition, new discs must be installed.

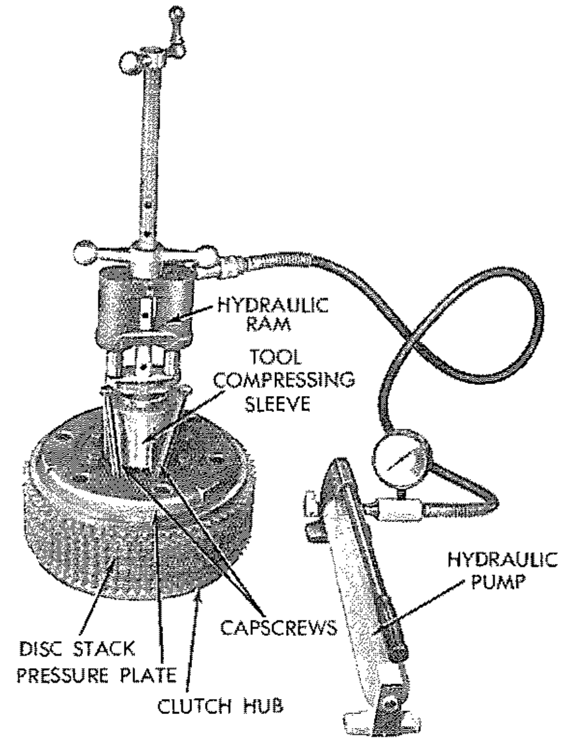


Fig. 6 — Steering Clutch Springs Compressed to Remove Capscrews

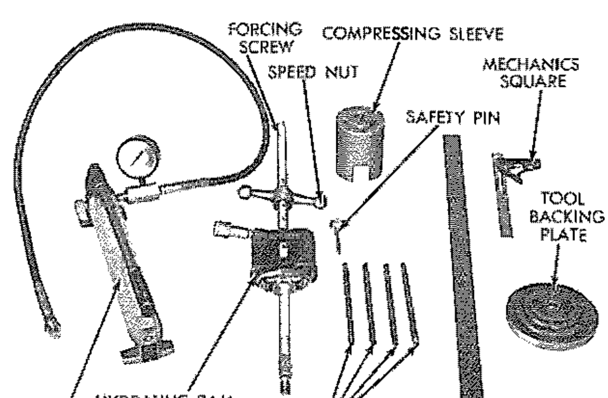


Fig. 7 — Special Tool Details for Disassembly and Assembly of Steering Clutch

3. **Pressure Springs**

   Each pressure spring of the steering clutch when new exerts a pressure of 275 to 305 pounds when compressed to 3-11/16". If a pressure spring does not check reasonably close to this tolerance, it is an indication that the spring has lost its tension and a new spring must be installed.

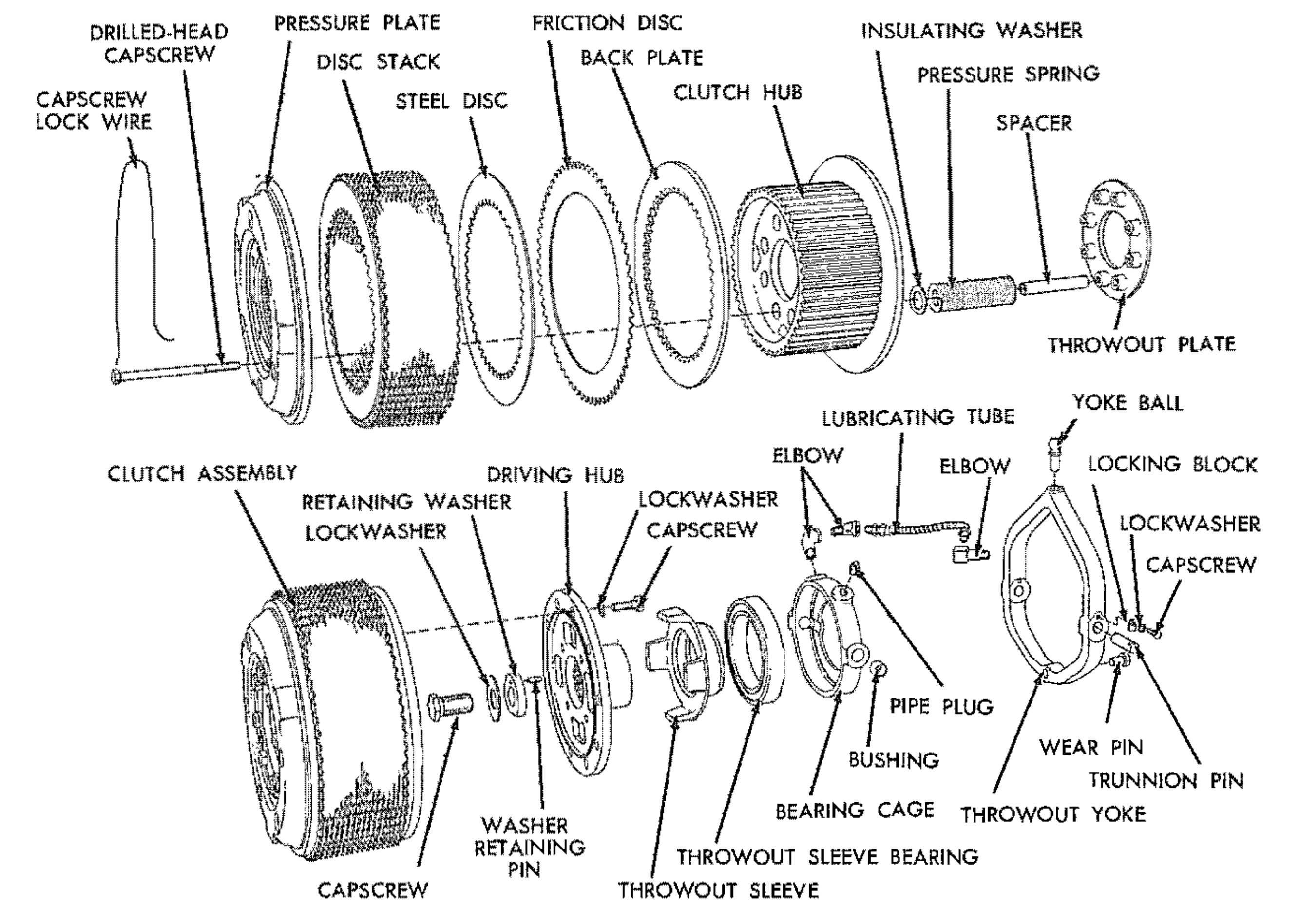


Fig. 8 — Steering Clutch and Throwout Yoke Details

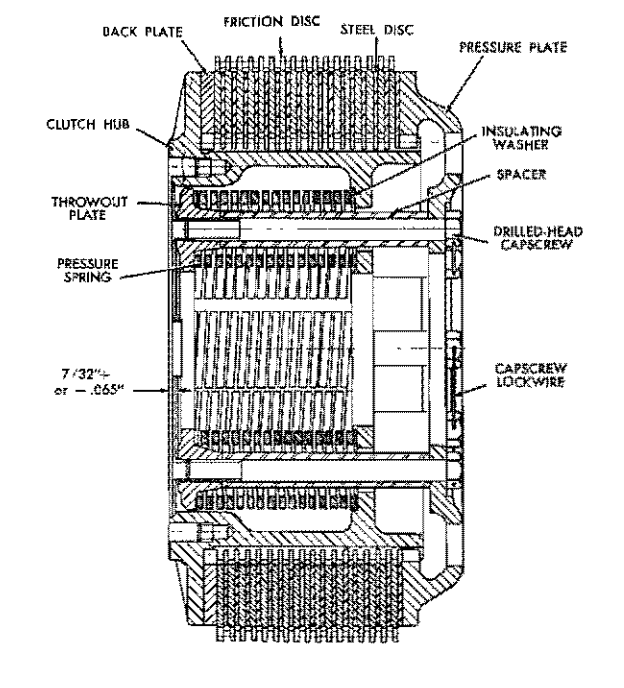


Fig. 9 — Steering Clutch Assembly

4. **Clutch Hub**

Inspect the teeth of the steering clutch hub for wear, as heavy grooving may cause binding with the teeth of the steel discs.

G. Assembly of Steering Clutch

Refer to Figs. 8 and 9 showing the steering clutch components in their relative position.

1. Lubricate the teeth of the steering clutch hub and the outer diameter of the steering clutch throwout plate sparingly with a graphite base lubricant.
2. Place the special tool backing plate (shown in Figs. 7 and 10) on a work bench and place the clutch throwout plate, with the pressure spring boss side up, in position on the tool backing plate.
3. Place one pressure spring over each pressure spring boss of the throwout plate and insert

a throwout plate spacer into each spring.

4. Place an insulating washer on the top of each pressure spring.

5. Install the clutch hub in position over the pressure springs and the insulating washers.

6. Insert four (4) aligning studs (shown in Figs. 7 and 11) through four (4) of the throwout plate spacers and screw the studs into the throwout plate.

7. Place the brake drum down over the clutch hub, with the throwout plate side of the brake drum down. Place ½" blocks under brake drum to hold it up off of work bench. This will position the brake drum so that all of the clutch discs can be aligned when they are installed on the clutch hub.

8. Install the back plate in position on clutch hub.

9. Stack the clutch discs (17 each — Friction and Steel) alternately on the clutch hub, beginning with a friction disc next to the back plate. Check the stack height of the discs as shown in Fig. 10; the top disc should be 9/16" + or — 1/16" below the top of the steering clutch hub.

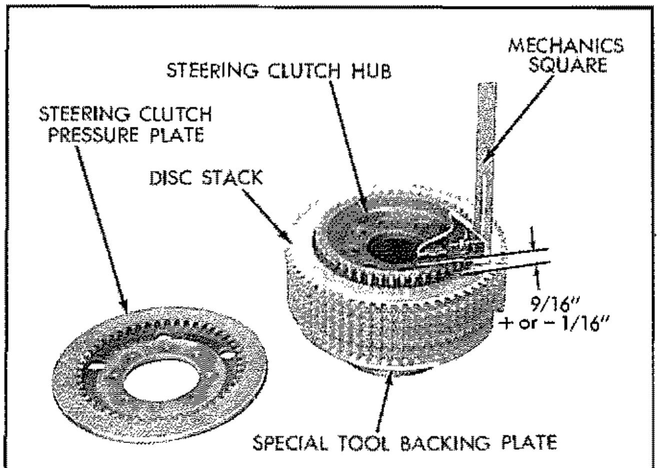


Fig. 10 — Measuring Steering Clutch Disk Stack Height

10. Place the clutch pressure plate in position, making certain the punch marks are aligned, and place the tool compressing sleeve through the center of the pressure plate and down on the clutch hub as shown in Fig. 11.

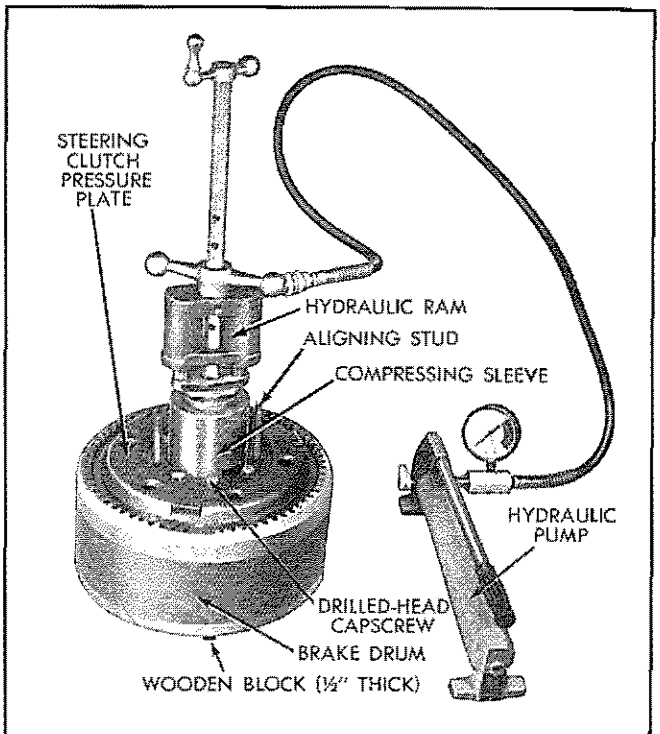


Fig. 11 — Compressing Steering Clutch Pressure Springs to Install Capscrews

11. Insert the tool forcing screw through the tool compressing sleeve and down through the clutch pressure plate and turn the screw into the tool backing plate.

12. Install the hydraulic ram as shown in Fig. 11 and compress the clutch pressure springs. Insert four (4) drilled-head capscrews and tighten the capscrews securely.

13. Remove the aligning studs and install the remaining four (4) drilled-head capscrews. Tighten all eight (8) capscrews securely.

14. Release the pressure from hydraulic ram and remove the special tools. Remove the brake drum from the clutch.

15. Measure the distance between the face of the clutch hub and the flat face of the throwout plate as shown in Fig. 12. This measurement should be 7/32" + or — .065". In case the distance is not within this specification, add a steel disc to correct; placing the added steel disc next to the pressure plate.

H. Steering Clutch Installation

The installation of either steering clutch may be made by the direct reversal of the procedure outlined under "STEERING CLUTCH REMOVAL" in this Section. Adjust the steering 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 sleeve ball bearing, bearing cage, throwout sleeve, throwout yoke assembly, and a throwout bearing lubricating tube. The throwout sleeve bearing is a press fit in the throwout bearing cage and on the hub of the throwout sleeve. The assembly of the throwaut sleeve and bearing is carried by the steering clutch driving hub. The bore in the throwout sleeve is machined to allow a sliding fit of the throwout sleeve on the driving hub. The clutch throwout yoke is attached to the throwout bearing cage with two (2) trunnion pins. Both the throwout sleeve bearing and the bore of the throwout sleeve are lubricated from the bevel gear compartment by the means of a lubricating tube and wick assembly.

B. Removal

The steering clutch throwout bearing assemblies should be removed and the parts inspected whenever the steering clutches are removed.

NOTE: The following removal procedure applies to either throwout bearing assembly. Refer to Fig. 8 showing the components in their relative position.

1. Remove the steering clutch (refer to "STEERING CLUTCH REMOVAL" in this Section).

2. Disconnect the upper end of the lubricating tube for the clutch throwout sleeve bearing.

3. Unlock the capscrew, retaining the steering clutch driving hub to the bevel gear shaft, and remove the capscrew, lockwasher, and the retaining washer. Using puller tools similar to the ones shown in Fig. 13, pull the driving hub from the bevel gear shaft. Remove the driving hub, throwout sleeve, throwout sleeve bearing, and throwout yoke as a unit.

4. Remove the driving hub from the throwout yoke assembly.

5. Remove the capscrews, lockwashers, locking blocks, and the throwout yoke trunnion pins and remove the throwout yoke.

6. Remove the throwout sleeve bearing lubricating tube.

7. Place the bearing cage assembly in a press and press the throwout sleeve and throwout sleeve bearing from the bearing cage.

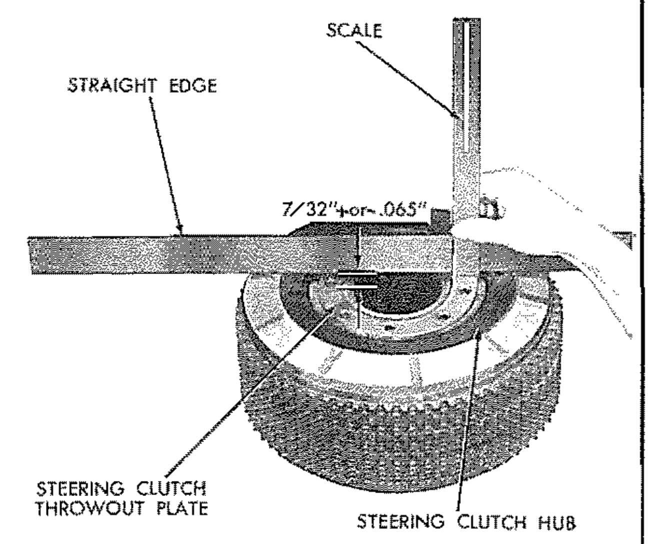


Fig. 12—Measuring Distance Between Steering Clutch Hub and Throwout Plate

C. Inspection and Repairs

1. Check the steering clutch throwout sleeve bearing for wear, indicated by looseness.

2. Check the components for abnormal wear and the lubricating tube for oil leakage; replace the necessary parts. If the lubricating oiling wicks, in the wick holder, have become hard they should be replaced.

3. Effective with Tractor Serial No. 4729, a revision was made in the wick assembly to

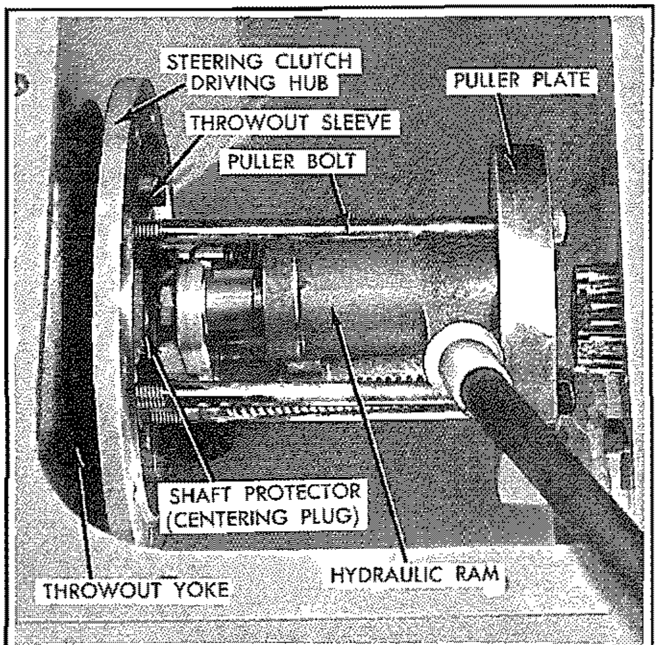


Fig. 13—Pulling Steering Clutch Driving Hub

provide improved lubrication to the steering clutch throwout sleeve bearing assemblies. A 25/32" diameter oiling wick was inserted in the upper end of the wick holder and about ½ of this wick is exposed above the wick holder. This wick accumulates oil from the bevel gear compartment and feeds oil to the smaller oiling wick, located in the lower end of the wick holder. When repairs are being made to the tractor and the wick assembly is accessible, it is recommended to install the late type oiling wick. Install the wick as follows:

a. Soak the wicks in light oil until they are completely saturated; heat the oil if necessary.

b. Work the lower wick into the wick holder until 5/16" of the wick protrudes from the lower end of the holder. CAUTION: *If the lower wick is inserted into the holder by twisting, be sure to untwist after the wick has been inserted.*

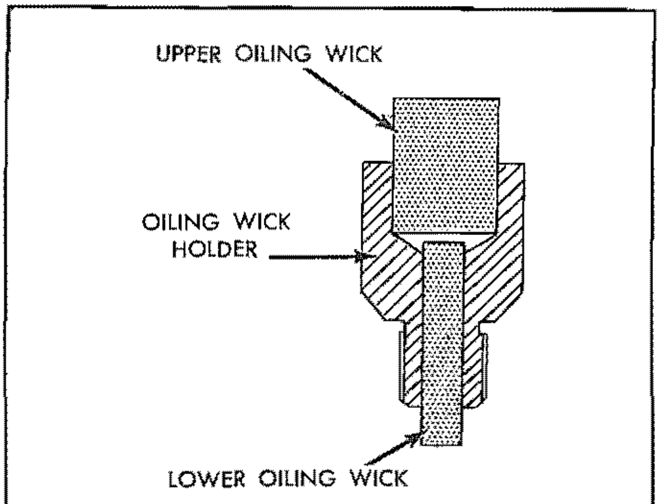


Fig. 14—Steering Clutch Throwout Sleeve Bearing Oiling Wicks and Wick Holder

c. Start the upper wick into the wick holder and push the wick down until the lower end bottoms in the hole of the wick holder.

D. Assembly and Installation of Steering Clutch Throwout Bearing Assemblies

Assembly and installation of the steering clutch throwout bearing assemblies can be accomplished by direct reversal of the procedure explained under "REMOVAL" in this Section; refer to Figs. 1 and 8 when assembling. When assembling, pack the throwout sleeve bearing with grease. Before installing the throwout bearing assembly in position on the driving hub, lubricate the bore in the throwout sleeve with light engine oil. The capscrew, used to retain the driving hub on the bevel gear shaft, must be tightened to a torque of 300 lbs. ft. Lock the capscrew by bending the lockwasher. Adjust the steering clutch linkage as explained in "STEERING LEVERS AND LINKAGE" in this Section.

4. STEERING LEVERS AND LINKAGE

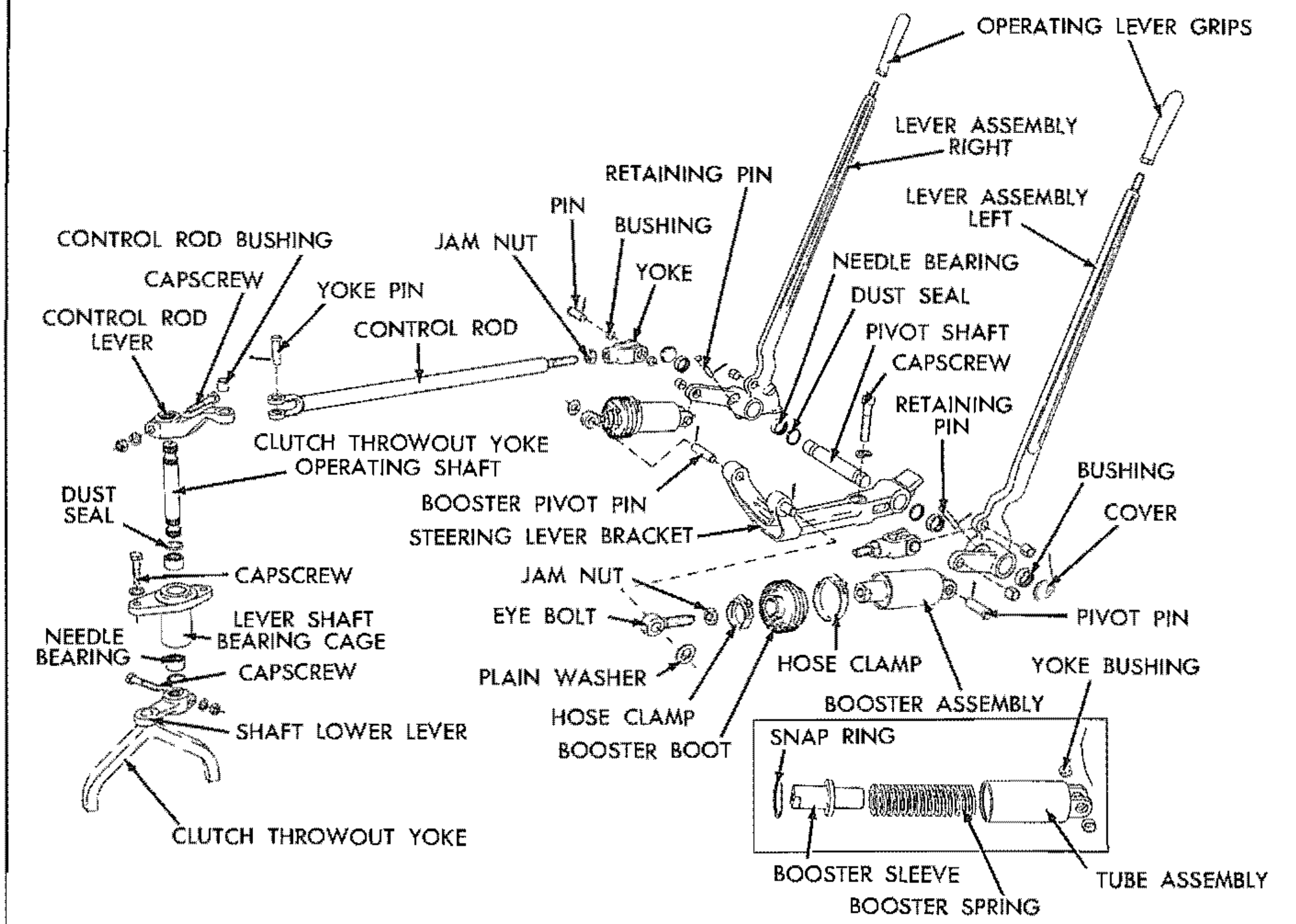


Fig. 15—Steering Levers and Linkage Details

A. Description

The steering lever booster assemblies are of the spring loaded, over-center type, pivoting from the steering lever bracket assembly attached to the top of the transmission case. Each booster assembly consists of a booster spring and a booster sleeve encased in a tube assembly. The booster spring is compressed to a given height inside the tube assembly and is held in position by a snap ring. The steering lever booster assemblies assist in decreasing the steering lever pull when steering. When either steering lever is pulled back to disengage a steering clutch, the action of the booster spring trying to reach its free height, exerts pressure against the lower end of the steering lever and decreases the manual pull required to disengage the steering clutch.

Each steering lever is connected by linkage to the corresponding control rod lever, located on the upper end of the clutch throwout yoke operating shaft. The clutch throwout yoke operating shaft is assembled in the lever shaft bearing cage installed in the steering housing, over the clutch throwout yoke. A lever, located on the lower end of the throwout operating shaft, connects the shaft to the upper end of the clutch throwout yoke.

B. Steering Clutch Control Linkage Adjustment

The steering clutch linkage is properly adjusted when the steering levers each have 3" of free travel, measured at the tops of the levers. As the steering clutch discs wear, this free travel becomes less and an adjustment is required when the free travel has decreased to less than 1". Free travel of the steering levers is necessary to assure clearance between the clutch throwout sleeve and the clutch throwout plate and to assure full engagement of each steering clutch.

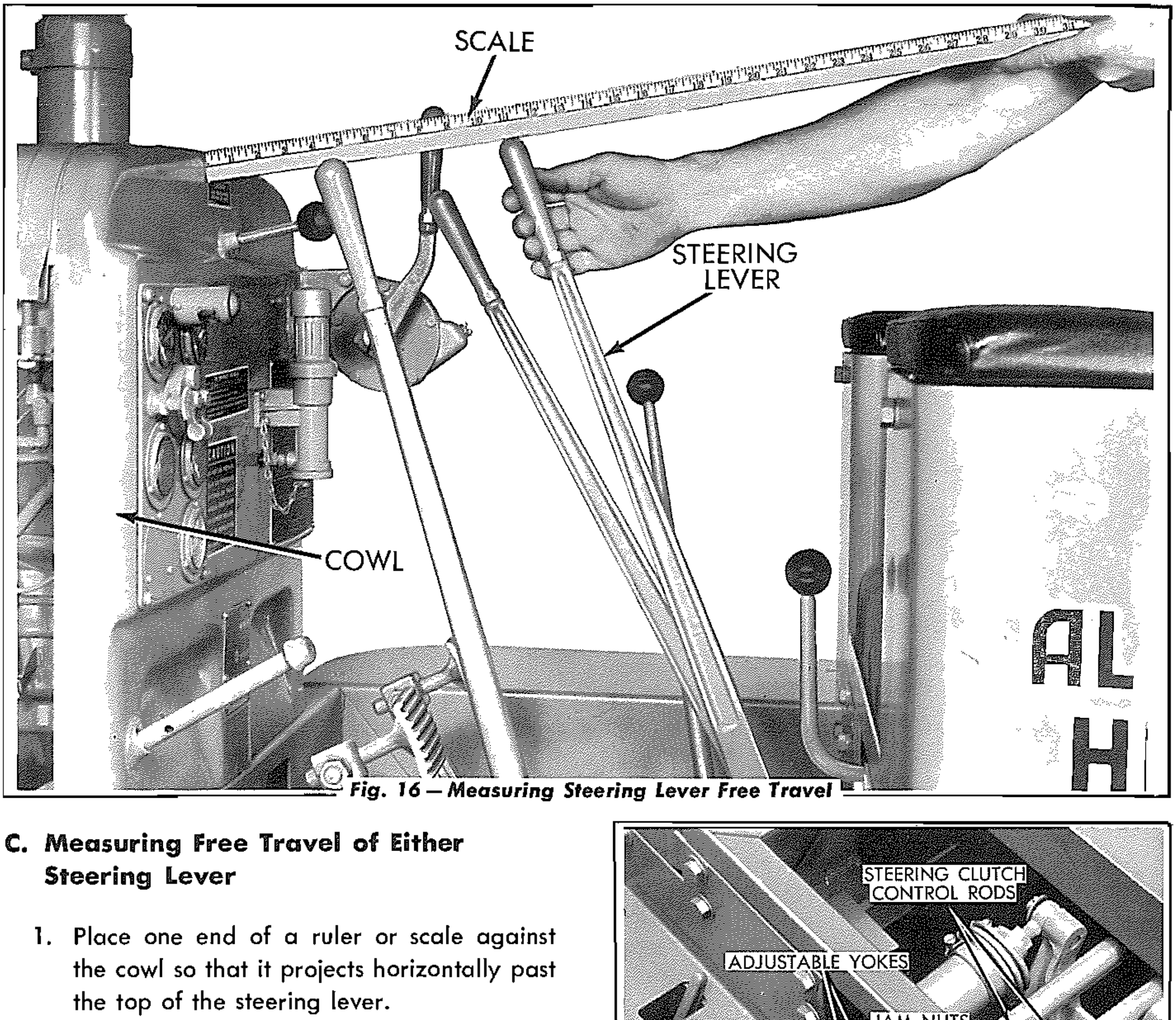


Fig. 16 — Measuring Steering Lever Free Travel

C. Measuring Free Travel of Either Steering Lever

1. Place one end of a ruler or scale against the cowl so that it projects horizontally past the top of the steering lever.

2. With the steering lever forward against its stop, measure the distance from the cowl to the top of the lever.

3. Pull the steering lever back until pressure is felt, which is the point where disengagement of the clutch begins. Note the distance between the cowl and the top of the steering lever. The difference between the two measurements is the free travel of the steering lever. If this distance is less than 1″ or more than 3″, an adjustment must be made.

D. Adjustment of Linkage for Either Clutch

1. Remove the seat cushion.

2. Loosen the jam nut of the adjustable yoke on the front end of the steering clutch control rod, extending from the steering lever to the control rod lever on the clutch throwout yoke operating shaft.

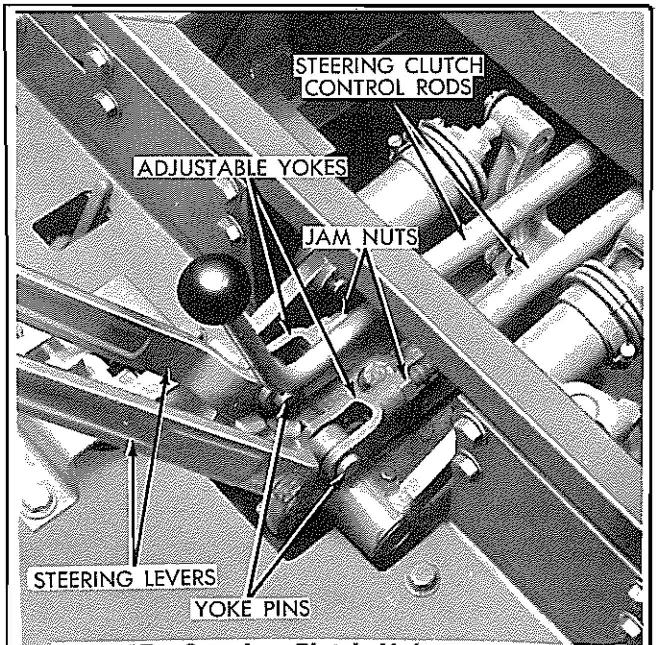


Fig. 17 — Steering Clutch Linkage Adjustment

3. Remove the yoke pin connecting the steering clutch control rod to the steering lever. Turn the yoke to lengthen or shorten the rod as

necessary to obtain 3" of free travel at the top of the steering lever. When the correct adjustment is obtained, connect the control rod to the steering lever and tighten the jam nut.

4. Adjust the steering lever booster for proper booster action. Refer to Fig. 15 and loosen the hose clamp at the rear of the booster boot. Loosen the jam nut on the eye bolt. Turn the booster sleeve as necessary to obtain the proper booster action. Tighten the jam nut on the eye bolt and tighten the hose clamp on the booster boot.

SECTION XIII—STEERING BRAKES

1. GENERAL DESCRIPTION

The two (2) steering brakes are of the foot operated, mechanically controlled, self-energizing type. The brake band assemblies are of the wrap around, two-piece type with removable linings. The brake band assemblies operate on brake drums which enclose the steering clutches.

Foot pressure applied on the brake pedals is transmitted through linkage to the brake band lever assembly. Action of the brake band lever assembly pulls the ends of the brake band assembly together, causing the brake band assembly to tighten around the brake drum.

The steering brakes are used as an aid in steering when use of the steering clutches alone will not provide adequate steering. Do not attempt to use a steering brake for steering without first 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 assembly is provided with a parking brake lock lever for holding the brake pedal in the applied position for parking purposes.

Brake pedal pads, clamped to the brake pedal levers with eyebolts, are adjustable within limits. The brake pedal lever shafts are supported by sealed needle bearings in the pedal lever bracket. The needle bearings are grease packed at time of assembly. Adjustable brake control rods connect the brake pedal levers to the brake band lever

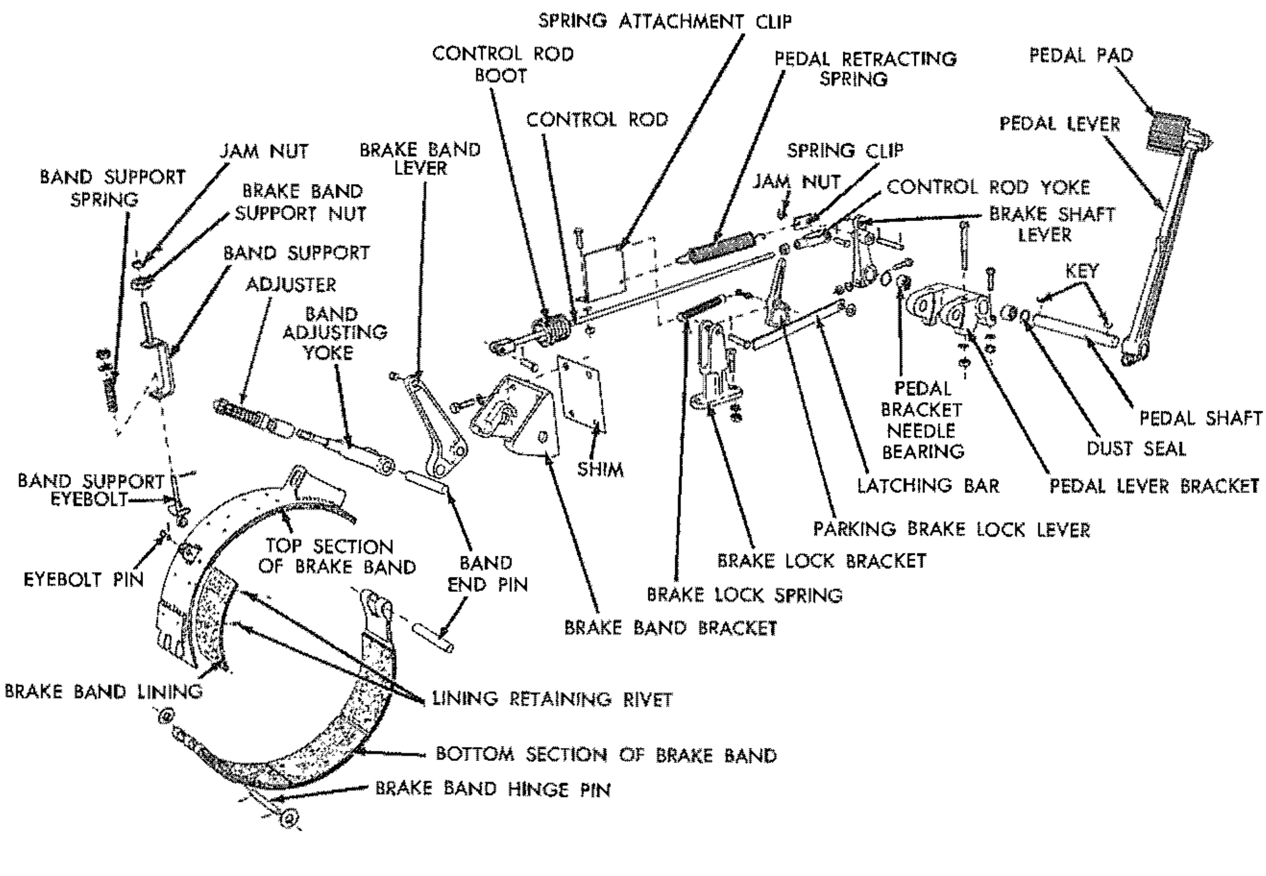


Fig. 1—Steering Brake Details—Left Brake

assemblies. Each brake band lever assembly is attached to both ends of the brake band. A brake pedal lever retracting spring is attached to the brake control rod to return the brake pedal lever to the normal (released) position.

The brake band assembly is made up of two (2) sections to permit easy removal and installation. Each section of the brake band is serviced separately with lining attached, or the lining alone may be replaced.

2. STEERING BRAKE SERVICE

Due to variable operating conditions, specific time intervals for brake service are not given. Each brake will require adjusting before the brake is loose enough to allow the brake pedal lever to strike the floor plate when the brake is fully applied. The needle bearings for the brake pedal lever shafts do not require lubrication service as they are grease packed and sealed. The brake linkage pins should be lubricated with oil for ease of operation.

Where frequent brake adjustments have been necessary, periodically remove the steering clutch compartment cover, located over each brake, and inspect the brake band linings for wear. The linings must be replaced before they are worn to a point where the lining retaining rivets will contact and score the brake drum.

A. Steering Brake Adjustment

The steering brakes are properly adjusted when each brake pedal lever has 1¾" to 2" of free travel. Brakes require adjustment before they are loose enough to allow the brake pedal levers to strike the floor plate when the brakes are fully applied. Brakes adjusted too tightly 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 each of the steering brakes, proceed as follows:

1. Remove the brake adjusting hole cover from the steering clutch compartment cover.

2. Adjust the brakes by turning the brake adjuster clockwise until the brake pedal lever has 1¾" to 2" of free travel. NOTE: *When adjusting the brakes it is necessary to turn the brake adjuster in ½ turn increments so that the lobes on the adjuster will center in the grooves of the spring loaded locking block.*

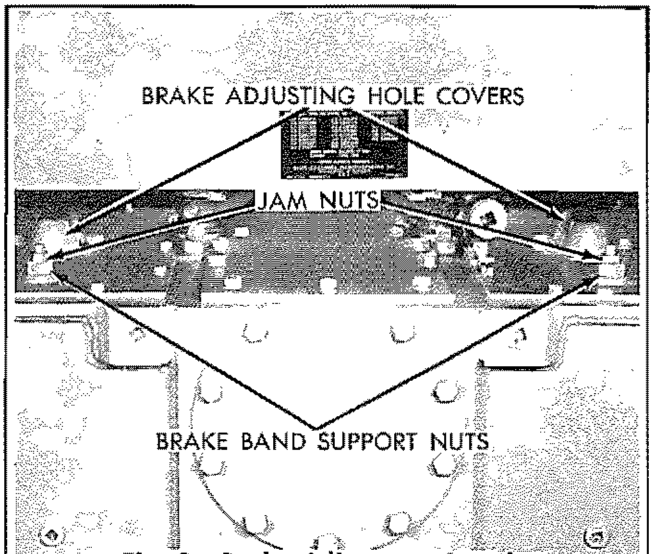


Fig. 2 — Brake Adjustment Location

3. With the brake pedal lever free (pedal all the way back), loosen the jam nut on the brake band support, then back off the band support nut from its seat in the steering clutch compartment cover. Turn the support nut down until it contacts the seat in the cover and give the nut an additional ½ turn; this centers the brake band on the brake drum. Lock the support nut in this position with the jam nut. Install the brake adjusting hole cover.

B. Brake Linkage Adjustment

1. Remove the steering clutch compartment cover.

2. Hold the brake band lever back against the elongated stops in the brake band bracket. Adjust the control rod, between the brake band lever and the brake shaft lever, to provide 1/16" clearance between the stop on the brake pedal lever and the floor plate.

3. Install the steering clutch compartment cover. Adjust the brakes as described in "STEERING BRAKE ADJUSTMENT" in this Section.

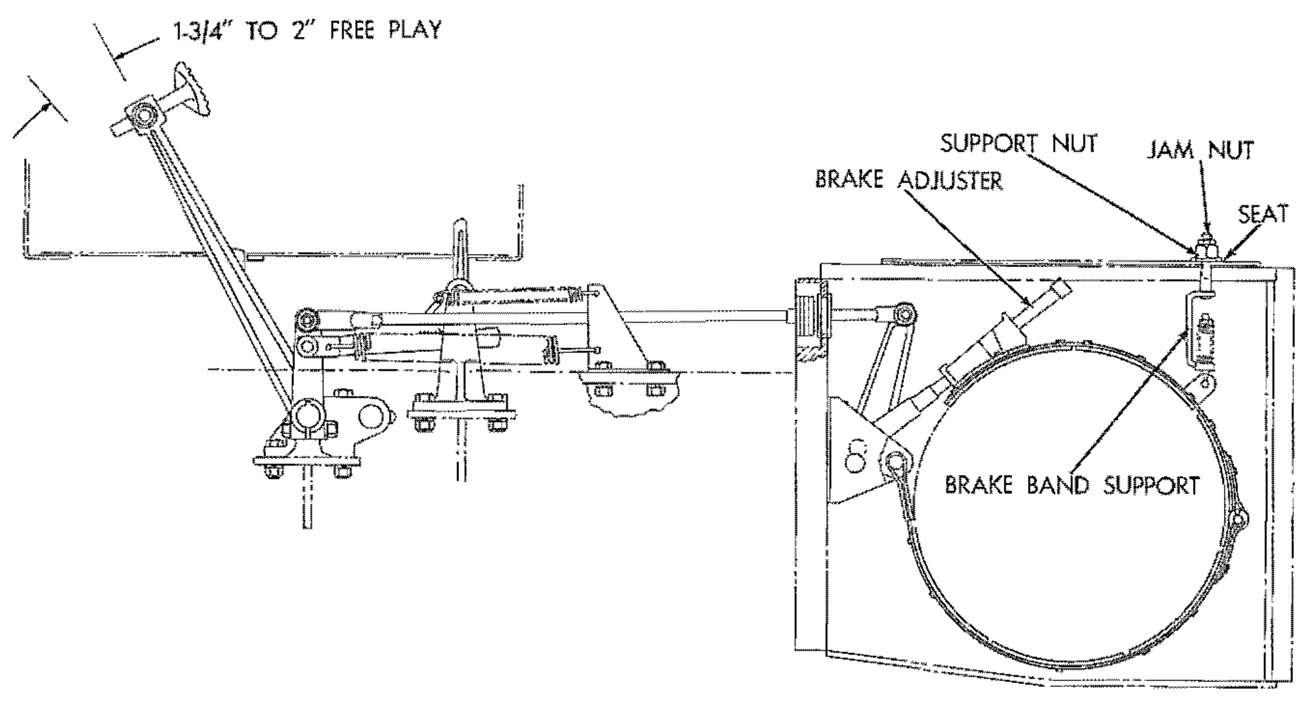


Fig. 3 — Steering Brake Adjustment

C. Washing Steering Brakes

When the steering brakes do not hold properly due to oil on the brake linings, the brakes may be washed as outlined in "WASHING STEERING CLUTCHES," Section XII.

D. Brake Band Removal

NOTE: The following removal procedure applies to either brake band.

1. Remove the seat cushion and the tool box.
2. Remove the jam nut and the brake band support nut.
3. Remove the steering clutch compartment cover.
4. Turn the brake adjuster counter-clockwise until it is loosened from the brake band adjusting yoke.
5. Remove the yoke pin connecting the rear end of the brake control rod to the top of the brake band lever.
6. Remove the pipe plug from the side of the steering clutch compartment, in line with the brake band end pin which is located in the brake band adjusting yoke. Using a suitable ⅜" NC capscrew inserted through the opening for the pipe plug, turn the capscrew into the tapped hole in the end of the brake band end pin. Pull on the capscrew and remove the pin (refer to Fig. 3, Section XII). Remove the brake band adjusting yoke.
7. 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. Remove the brake band lever.
8. Move the brake band assembly toward the

bevel gear compartment and turn the band assembly on the brake drum so that the brake band hinge pin can be reached for removal.

9. Remove the cotter pin and the plain washer from the inner end of the brake band hinge pin and remove the hinge pin.

10. Remove the top section of the brake band as shown in Fig. 4. Remove the bottom section of the brake band.

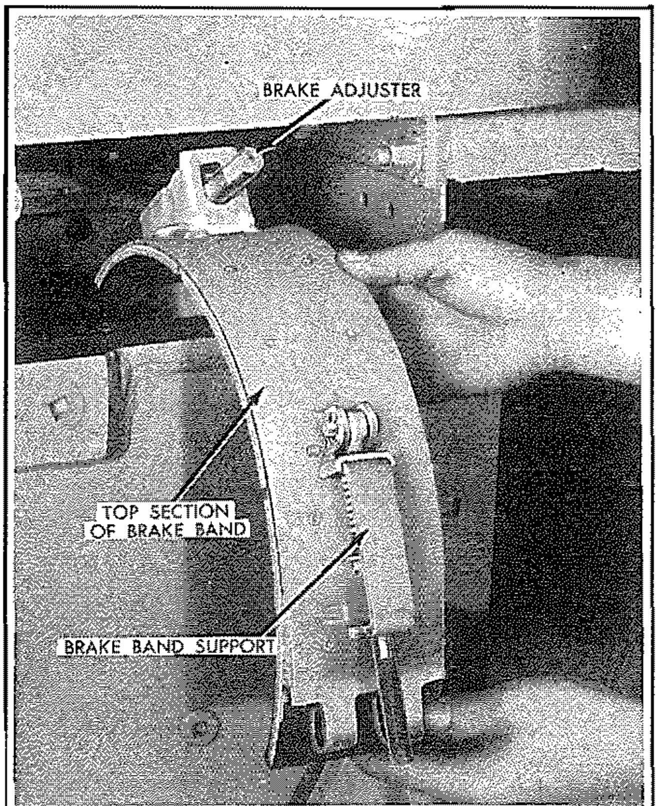


Fig. 4—Steering Brake Band Removal

E. Steering Brake Inspection and Repair

1. If the brake band linings are worn down to the rivets, each section of the brake band must be relined or replaced.

2. If the steering brake drum is worn, scored, or grooved excessively, it must be removed and replaced (refer to "STEERING CLUTCH REMOVAL," Section XII).

3. Inspect the brake band end pins, linkage yokes, yoke pins and bushings for wear. Replace the necessary parts.

4. Actuate each brake pedal lever to make certain that the pedal bracket needle bearings are in good condition.

5. Observe the pedal bracket dust seals, located at each end of the pedal bracket needle bearings, for signs of excessive grease linkage and replace the seals if necessary.

6. Before installing the steering brake band, particularly after relining, the brake band should be checked for roundness. Place the steering brake band on the steering brake drum and form the band, 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 steering brake removal procedure and must be properly adjusted. Refer to "STEERING BRAKE ADJUSTMENT" and "STEERING BRAKE LINKAGE ADJUSTMENT" in this Section.

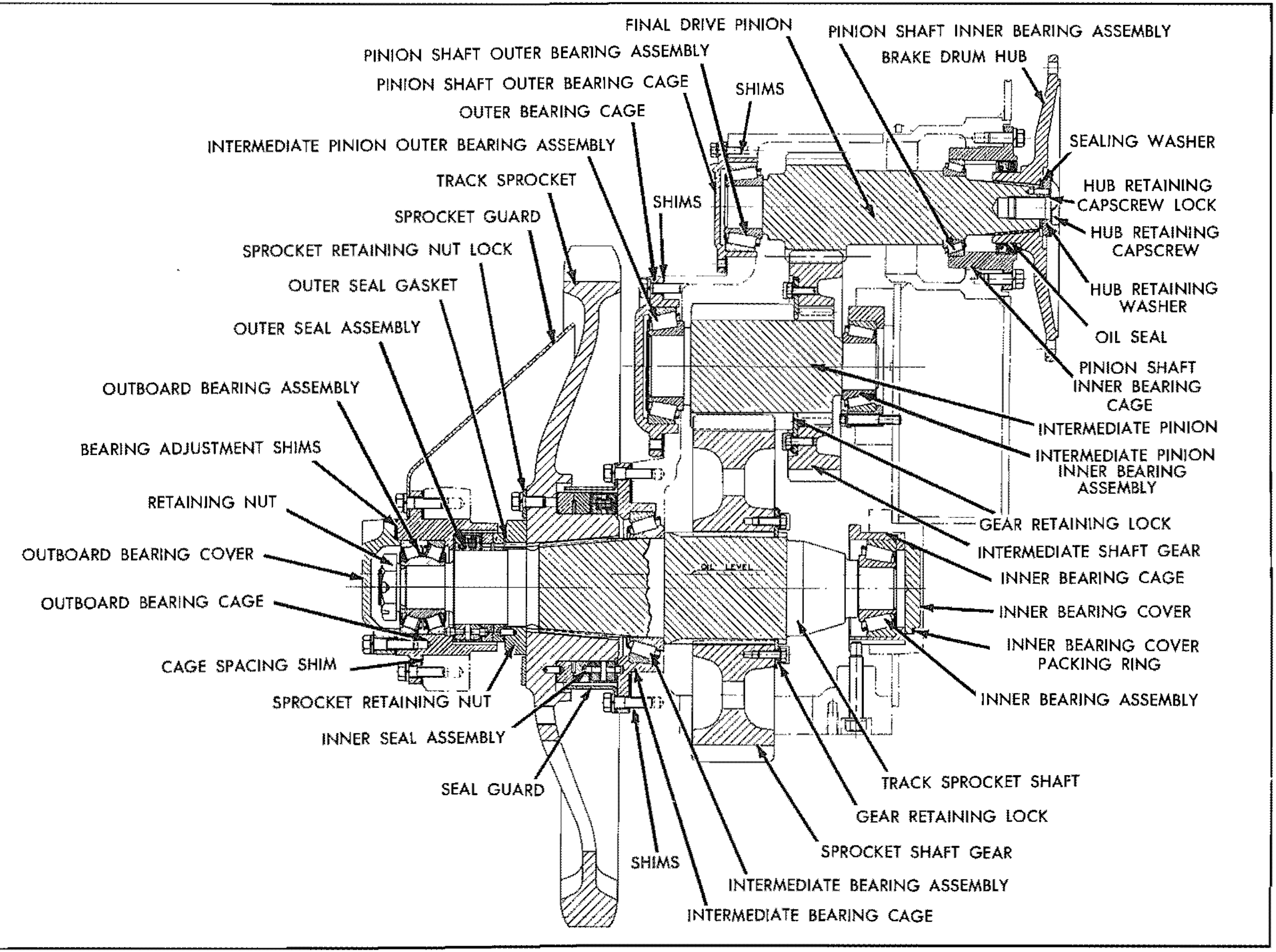


Fig. 1 — Final Drive Assembly

1. DESCRIPTION

The final drives are of the double reduction type, consisting of a pinion and shaft, intermediate pinion and gear, track sprocket shaft and gear, and their component parts. They are assembled in a combination "one-piece" fabricated steel, steering clutch and final drive housing. The final drive housings are an integral part of the steering clutch housing and misalignment of the bores is eliminated by the use of line boring.

The final drive pinions, intermediate pinions, and track 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 pinion bearings, are lubricated by oil thrown by the gears.

Replaceable type bearing cages are provided for the bearing cups of the final drive pinion bearings, intermediate pinion bearings, and for the inner and the intermediate bearings of the track sprocket shafts.

The final drive outboard bearings of the track sprocket shafts are located in cages which attach to the truck frames. The outboard bearings absorb thrust in both directions.

The two (2) oil 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 through the steering clutches; the pinions drive the intermediate shaft gears; the intermediate pinions drive the sprocket shaft gears, which in turn drive the track sprockets.

2. DISASSEMBLY

NOTE: The disassembly procedure for each final drive is the same.

A. Removal of Track Sprocket Shaft

1. Uncouple the track by removing the track master pin (refer to Section XVII). Move the tractor backward until the top of the track is off the track sprocket.

2. Drain the oil from the final drive compartment.

3. Remove the track sprocket guard, truck frame pivot shaft caps, and the two (2) capscrews attaching the truck frame outboard bearing clamping cap. Remove the three (3) remaining capscrews attaching the final drive outboard bearing cage to the truck frame. Remove the two (2) capscrews attaching the equalizing spring seat to the truck frame.

4. Use a jack and suitable cribbing under the drawbar supporting plate and the equalizing spring and raise the tractor off the truck frame. Raise the tractor high enough so that the track sprocket can be tipped to clear the truck frame when removing.

5. Remove the final drive outboard bearing cover and the bearing adjustment shims; tie the shims to the cover so that they will not be lost. Remove the cotter pin and the outboard bearing retaining nut.

6. Using puller tools similar to the ones shown in Fig. 3, pull the final drive outboard bearing cage and bearing from the track sprocket shaft. Use care in handling and prevent damage to the oil seal rings.

7. Remove the two (2) capscrews attaching the sprocket retaining nut lock to the sprocket and remove the nut lock and the sprocket retaining nut. Use care when removing the sprocket retaining nut and prevent damage to the oil seal ring cemented to the nut. Using puller tools similar to the ones shown in Fig. 4, pull the track sprocket and remove it from the track sprocket shaft. Use care and do not damage or scratch the seal ring cemented to the sprocket, and do not damage the threads of the track sprocket shaft.

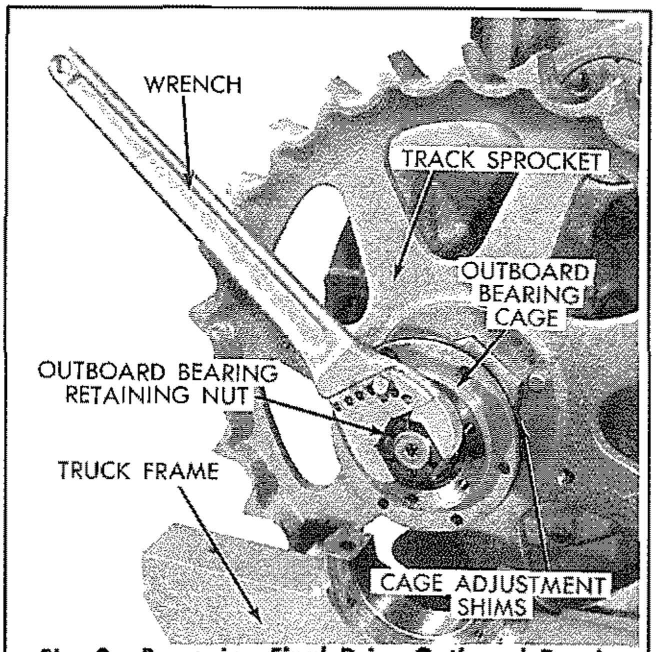


Fig. 2 — Removing Final Drive Outboard Bearing Retaining Nut

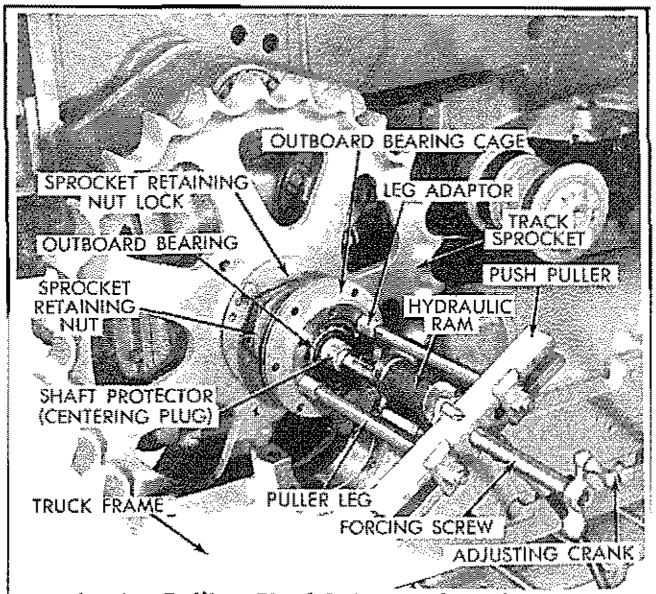


Fig. 3 — Pulling Final Drive Outboard Bearing from Track Sprocket Shaft

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 retaining locks and remove the capscrew locks and the gear retaining locks. *NOTE: To rotate the track sprocket shaft to the correct position for removal of the gear retaining locks, it is necessary to tie the corresponding steering*

lever back in the disengaged position. This will hold the steering clutch in the disengaged position and the sprocket shaft gear may then be rotated to the desired position

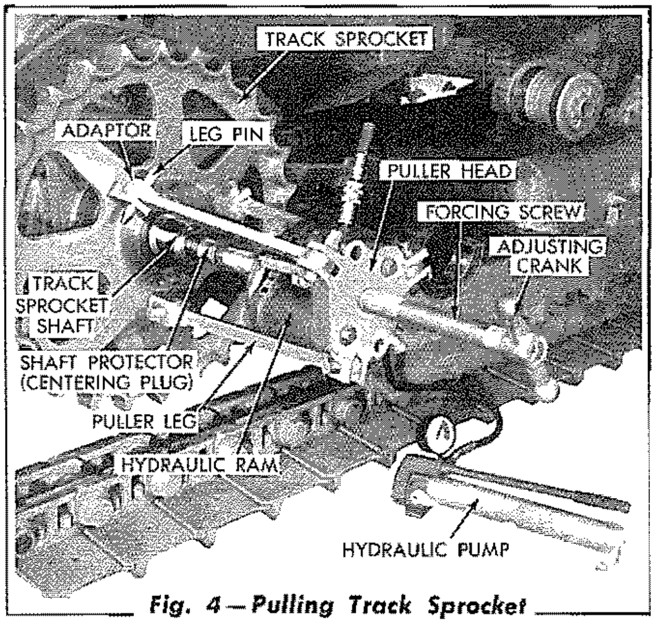


Fig. 4—Pulling Track Sprocket

for removal of the gear retaining locks.

9. Place suitable blocking under the sprocket shaft gear as shown in Fig. 5, to prevent the gear from dropping when the sprocket shaft intermediate bearing cage is removed.

10. Remove the capscrews attaching the sprocket shaft intermediate bearing cage and the seal guard to the final drive housing, then remove the seal guard, bearing cage, and bearing adjustment shims. Tie the adjustment shims to the intermediate bearing cage so that they will not be lost. Pull the track sprocket shaft from the sprocket shaft gear and remove the gear.

11. If it is necessary to remove the sprocket shaft inner bearing cup, the bearing cup and the inner bearing cage may be removed as a unit using tools similar to the ones shown in Fig. 6. Press (towards the final drive compartment) on the track sprocket shaft inner bearing cover until the inner bearing cage is free of its bore in the housing, then remove the inner bearing cup, inner bearing cage, inner bearing cover, and cover packing ring.

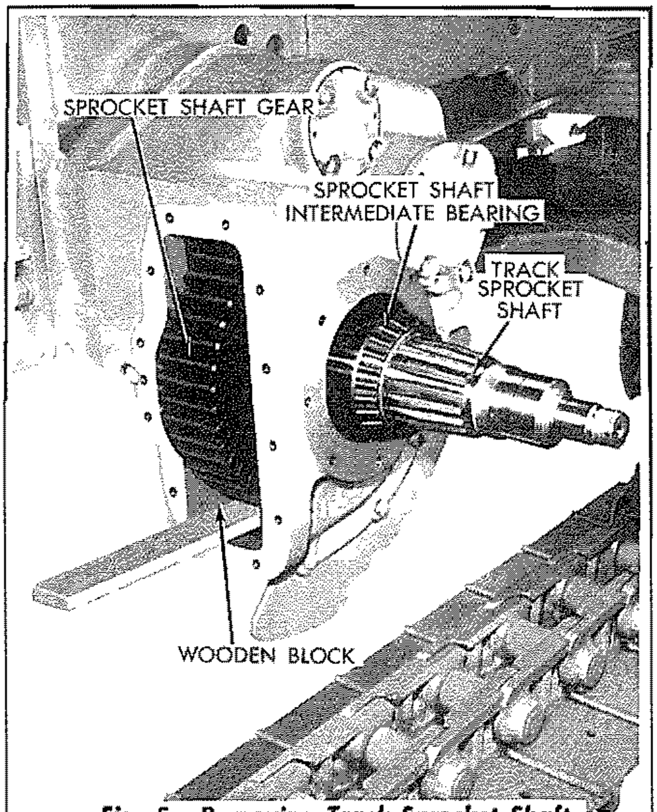


Fig. 5—Removing Track Sprocket Shaft

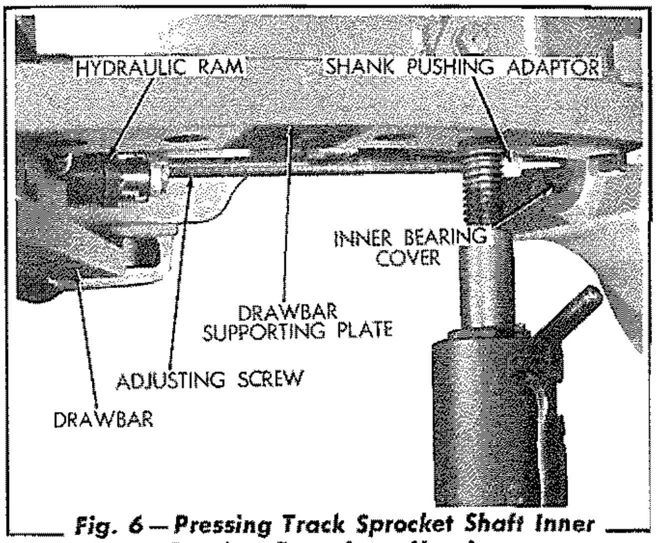


Fig. 6—Pressing Track Sprocket Shaft Inner Bearing Cage from Housing

B. Removal of Final Drive Intermediate Pinion and Gear

To remove the intermediate shaft gear lock capscrews, it will be necessary to turn the intermediate shaft gear; this is accomplished by tying the corresponding steering clutch lever in the disengaged position as outlined previously under track sprocket shaft removal in this Section.

1. Unlock the capscrews attaching the two (2) intermediate shaft gear retaining locks to the gear. Remove the capscrews and the

capscrew locks. *NOTE: The intermediate shaft gear retaining locks cannot be removed at this time.*

2. Remove the capscrews attaching the intermediate pinion outer bearing cage to the final drive housing. Remove the outer bearing cage by using two (2) ½" NC pusher screws in the two (2) tapped holes in the bearing cage. Tie the bearing adjustment shims to the outer bearing cage so that they will not be lost.

3. Use a sliding hammer (holding tool), similar to the one shown in Fig. 7, to support and to remove the intermediate pinion. Screw the tool adaptor into the tapped hole in the end of the intermediate pinion and pull the pinion out far enough to remove the intermediate shaft gear retaining locks. Remove the intermediate shaft gear retaining locks. Block the intermediate shaft gear in position and pull the intermediate pinion from the gear and remove the gear from the final drive housing.

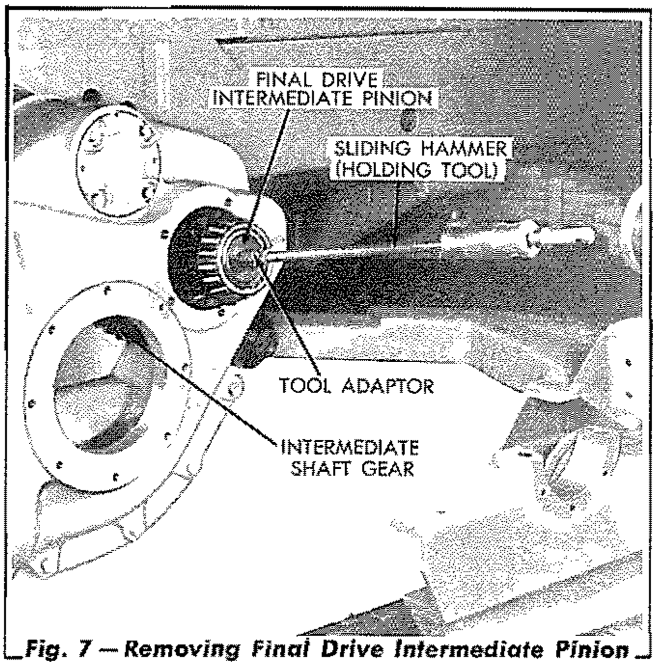


Fig. 7 — Removing Final Drive Intermediate Pinion

4. If it is necessary to remove the intermediate pinion inner bearing cup, unlock and remove the capscrews attaching the intermediate pinion inner bearing cage to the housing. Remove the inner bearing cage and the inner bearing cup as a unit.

C. Removal of Final Drive Pinion

With the track sprocket shaft and gear and the intermediate pinion and intermediate shaft gear removed, the final drive pinion may be removed as follows:

1. Remove the steering clutch from the side on which the final drive is being disassembled (refer to "STEERING CLUTCH REMOVAL," Section XII).

2. Remove the final drive pinion:

   a. Unlock the brake drum hub retaining capscrew. Remove the retaining capscrew, capscrew lock, and hub retaining washer. Use tools similar to the ones shown in Fig. 8 and pull the brake drum hub from the final drive pinion. Remove the brake drum hub.

   b. Remove the capscrews attaching the pinion shaft inner bearing cage to the housing. Use three (3) ½" NC pusher screws in the tapped holes in the bearing cage, and pull the bearing cage from the housing as shown in Fig. 9. Remove the pinion shaft outer bearing cage and

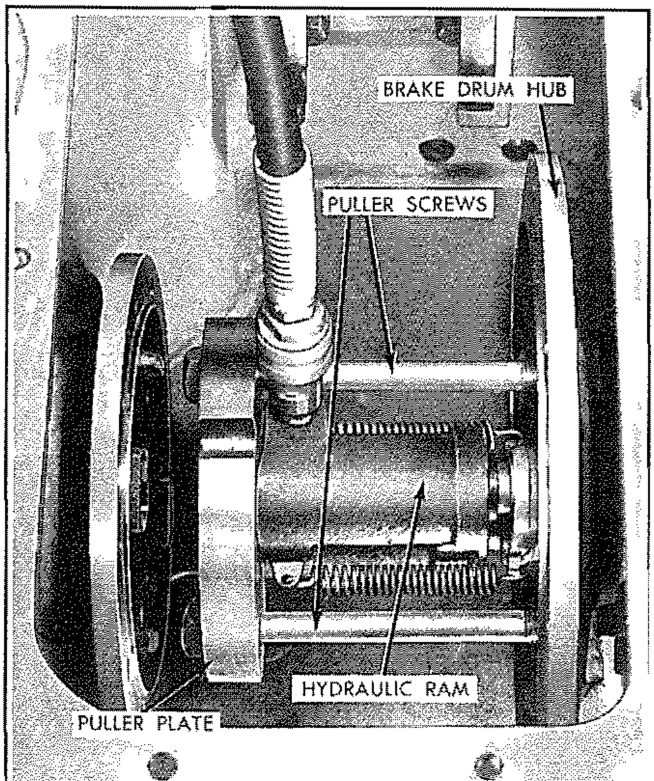


Fig. 8 — Pulling Brake Drum Hub

the bearing adjustment shims. Tie the adjustment shims to the outer bearing cage so that they will not be lost.

c. Pull the final drive pinion into the steering clutch compartment and remove.

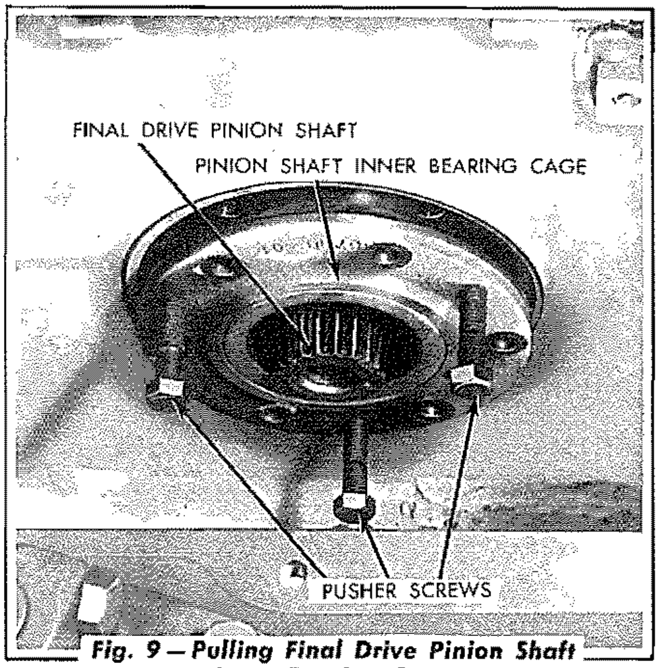


Fig. 9 — Pulling Final Drive Pinion Shaft Inner Bearing Cage

3. CLEANING AND INSPECTION

Clean and inspect all the parts thoroughly as described in pertinent pages in "GENERAL MAINTENANCE INSTRUCTIONS," Section XXI. Replace or recondition any damaged parts before assembling the final drive.

If replacement of the final drive outboard bearing is necessary, use tools similar to the ones shown in Fig. 10 to pull the bearing from the bearing cage.

If replacement of the bearings on the final drive pinion or the intermediate pinion is necessary, use tools similar to the ones shown in Figs. 12 and 13 to remove and install the bearings.

If replacement of the track sprocket shaft inner and intermediate bearings is necessary, use tools similar to the ones shown in Figs. 14 and 15 to remove and install the bearings on the shaft.

If the track sprocket shaft inner bearing cage and cover were removed for replacement of the inner bearing cup, use tools similar to the ones shown in Fig. 11 to install the inner bearing cage and cover in the final drive housing.

IMPORTANT: When installing the final drive bearings on their respective shafts, make certain the bearings are pressed tightly against the shoulders on the shafts.

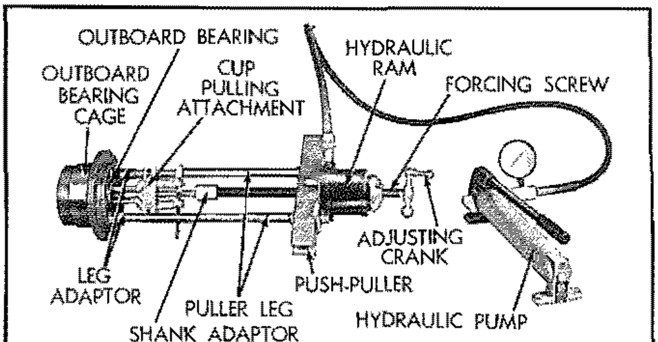


Fig. 10 — Pulling Final Drive Outboard Bearing from Outboard Bearing Cage

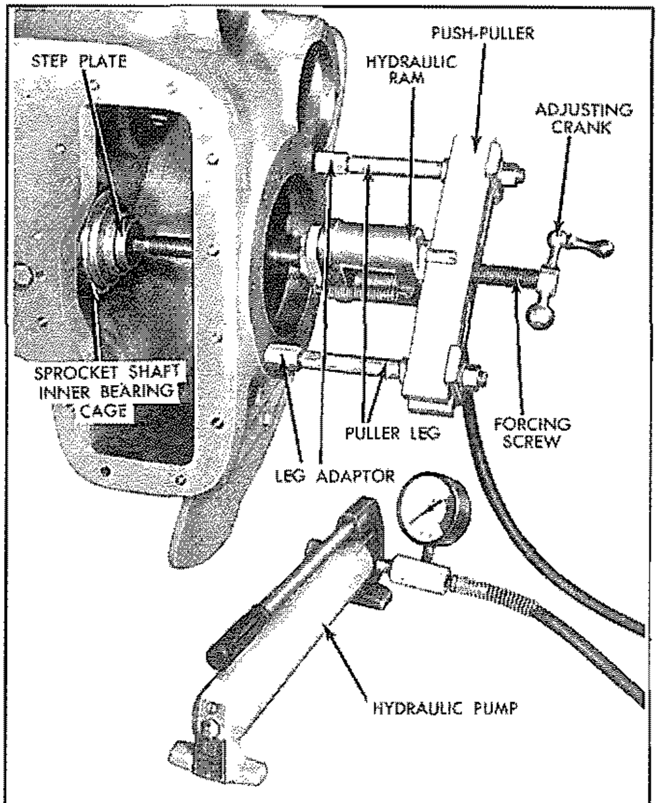


Fig. 11 — Installing Track Sprocket Shaft Inner Bearing Cage and Cover

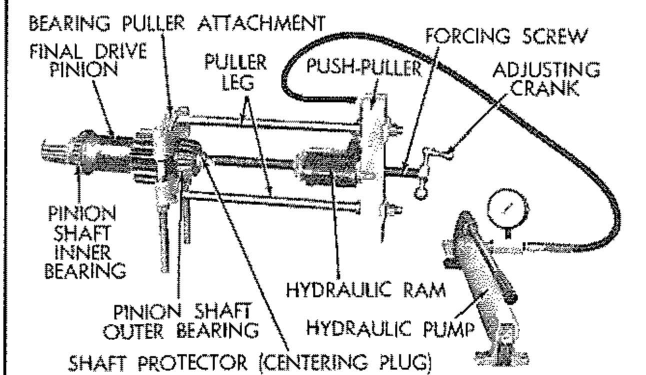


Fig. 12 — Pulling Pinion Shaft Outer Bearing from Final Drive Pinion

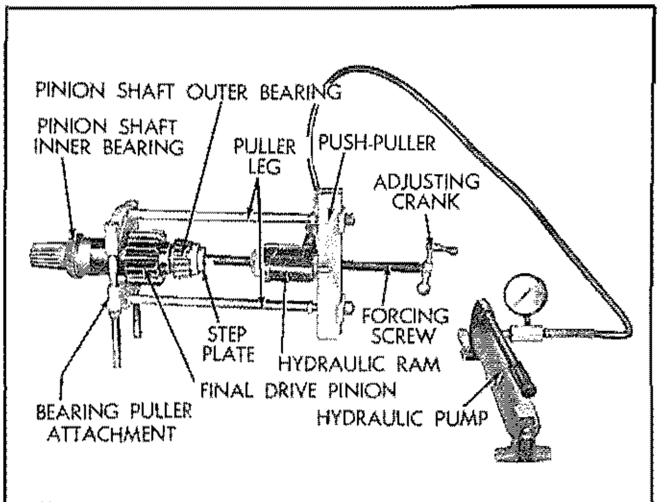


Fig. 13 — Installing Pinion Shaft Outer Bearing on Final Drive Pinion

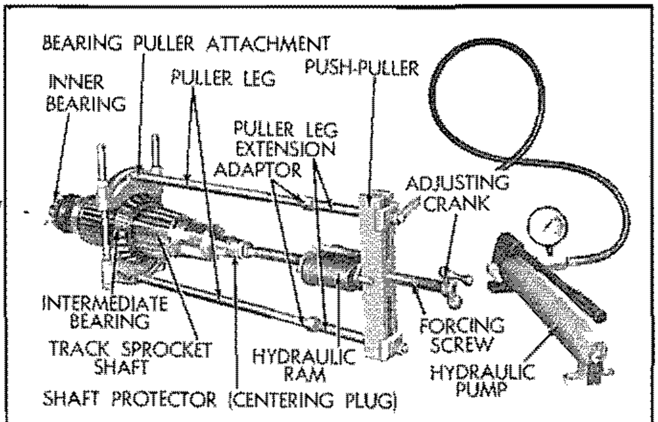


Fig. 14 — Pulling Intermediate Bearing from Track Sprocket Shaft

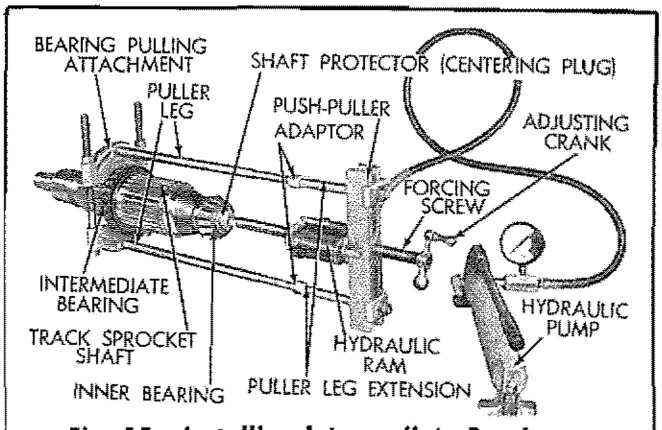


Fig. 15 — Installing Intermediate Bearing on Track Sprocket Shaft

4. ASSEMBLY

NOTE: The assembly procedure for each final drive is the same. Refer to Figs. 16, 17, and 18 when assembling the final drive.

Before assembling the final drive, the track sprocket shaft and the intermediate pinion bearings should be adjusted correctly without the gears installed. Proceed as follows:

A. Adjustment of Final Drive Intermediate Pinion Bearing

1. Install the intermediate pinion inner bearing cup in position in the inner bearing cage. Install the inner bearing cage in the housing and install the attaching capscrews and capscrew locks. Lock the capscrews securely with the capscrew locks.

2. Lubricate the intermediate pinion bearings and insert the intermediate pinion (without the intermediate shaft gear) into position in the housing. Install the outer bearing cup in the outer bearing cage. Install the outer bearing cage in the housing, using the original amount of bearing adjustment shims. Install the outer bearing cage attaching capscrews.

3. The intermediate pinion bearings are correctly adjusted when they have .002" to .004" pre-load. Add or remove bearing adjustment shims until a very slight pre-load (start of pre-load) is noted when turning the intermediate pinion, then substitute the combination of shims to reduce the total shim pack thickness .002" to .004" to obtain the proper pre-load. When adjusting, bump the outer bearing cage to make certain the bearings are properly seated.

4. Remove the outer bearing cage, as described previously in "REMOVAL OF FINAL DRIVE INTERMEDIATE PINION AND GEAR." Keep the bearing adjustment shims with the outer bearing cage. Remove the intermediate pinion using a tool similar to the one shown in Fig. 7. *IMPORTANT: Keep the bearings clean.*

B. Adjustment of Track Sprocket Shaft Bearings

1. Install the inner bearing cover packing ring (Neoprene) in position on the sprocket shaft inner bearing cover. Start the inner bearing cover and packing ring in position in the bore of the final drive housing. Install the inner bearing cup in position in the sprocket shaft inner bearing cage and press the inner bearing cage and cover into position in the final drive housing using tools similar to the ones shown in Fig. 11.

2. Lubricate the track sprocket shaft bearings and insert the track sprocket shaft (without the sprocket shaft gear) into position in the housing. Install the intermediate bearing cup in the sprocket shaft intermediate bearing cage. Install the intermediate bearing cage and cup, using the original amount of bearing adjustment shims. Install the intermediate bearing cage attaching capscrews.

3. The sprocket shaft bearings (inner and intermediate) are correctly adjusted when they have .002" to .003" pre-load. Add or remove bearing adjustment shims until a very slight pre-load (start of pre-load) is noted when turning the track sprocket 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 track sprocket shaft to make certain the bearings are properly seated.

4. Remove the track sprocket shaft intermediate bearing cage and bearing adjustment shims. Keep the bearing adjustment shims with the intermediate bearing cage. *IMPORTANT: Keep the bearings clean.*

C. Installation of Track Sprocket Shaft Seal Assemblies

If the seal assemblies for the track sprocket shaft were removed, the seal assemblies (Figs. 18 and 20) should be installed at this time so that the "NEOPRENE" cement, used for cementing the seal assemblies in place, will have sufficient time to dry.

1. **To Install the Inner Seal Assembly** (Fig. 18)

    a. Place the track sprocket shaft intermediate bearing cage on a clean bench, with the flat face of the bearing cage up.

    b. Make certain the inner seal follower assembly, inner seal boot, and the inner seal ring (stationary ring) are clean and dry. Install the inner seal boot on the inner seal follower, lining up the holes in the seal boot with the protruding pins of the follower assembly. Hold each lip of the seal boot out and coat the inside of the lips and the sides of the inner seal follower assembly with "NEOPRENE" cement. Press the boot lips back in place against the inner seal follower assembly.

    c. Coat the outer face of one lip of the inner seal boot and the machined face of the intermediate bearing cage with "NEOPRENE" cement. Immediately place the seal boot and inner seal follower assembly in position on the intermediate bearing cage, inserting the ends of the follower pins into the corresponding holes in the intermediate bearing cage.

    d. Coat the face of the outer lip of the seal boot and the back face of the inner seal ring with "NEOPRENE" cement. Immediately place the inner seal ring on the seal boot and follower assembly, inserting the ends of the follower pins into the corresponding holes in the inner seal ring.

    e. Place a weight on the inner 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 other inner seal ring thoroughly. Coat the machined surface of the track sprocket with "NEOPRENE" cement and immediately install the inner seal ring gasket in position on the track sprocket. Coat the outer surface of the inner seal ring gasket with "NEOPRENE" cement and immediately install the inner seal ring (rotating ring) on the track sprocket, inserting the seal driving dowels in the sprocket into the corresponding holes in the inner seal ring. Place a weight on the inner 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** (Fig. 20)

    a. Place the track 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 outboard bearing cage, the outer seal follower assembly, outer seal boot, and the outer seal rings are clean and dry. Install the outer seal boot on the outer seal follower assembly, lining up the holes in the boot with the protruding pins of the follower assembly. Hold each lip of the seal boot out and coat the inside of the lips and the sides of the outer seal follower assembly with "NEOPRENE" cement. Press the boot lips back in place against the outer seal follower assembly.

    c. Coat the outer face of one lip of the outer seal boot and the machined face in the bottom of the counterbore in the outboard bearing cage with "NEOPRENE" cement. Immediately place the seal boot and outer seal follower assembly into position in the outboard bearing cage, inserting the ends of the follower pins into the corresponding holes in the outboard bearing cage.

d. Coat the face of the outer lip of the outer seal boot and the back face of the outer seal ring with "NEOPRENE" cement. Immediately place the outer seal ring on the seal boot and follower assembly, inserting the ends of the follower pins into the corresponding holes in the outer seal ring.

e. Place a weight on the outer 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 outer seal ring gasket and the outer face of the sprocket retaining nut with "NEOPRENE" cement. Install the outer seal ring gasket in position on the sprocket retaining nut. Coat the outer side of the outer seal ring gasket and the back face of the other outer seal ring with "NEOPRENE" cement, and place the outer seal ring on the sprocket retaining nut, lining up the holes in the seal ring with the dowels in the nut.

g. Place a weight on the outer 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 the pinion shaft outer bearing cup in position in the outer bearing cage. Install the outer bearing cage in the bore of the housing, using the original amount of bearing adjustment shims between the bearing cage and the housing. Do not tighten the outer bearing cage retaining capscrews at this time.

2. Lubricate the pinion shaft bearings, lower the pinion into the steering clutch compartment, and insert it into position in the final drive housing.

3. Install a brake drum hub oil seal in position in the pinion shaft inner bearing cage, with the sealing lip of the oil seal toward the pinion. Install the pinion shaft inner bearing cup in position in the inner bearing cage.

4. Use a new gasket and install the pinion shaft inner bearing cage in position in the housing and tighten the capscrews for both bearing cages. Bump the outer bearing cage to make certain the bearings are properly seated. Turn the final drive pinion to determine the bearing pre-load.

5. The pinion shaft bearings are correctly adjusted when they have .002" to .003" pre-load. Add or remove bearing adjustment shims until a very slight pre-load (start of pre-load) is noted when turning the pinion, then substitute the combination of shims to reduce the total shim pack thickness .002" to .003" to obtain the proper pre-load.

6. Install the brake drum hub, sealing washer, hub retaining washer, hub retaining capscrew lock, and the hub retaining capscrew. Tighten the retaining capscrew to a torque of 300 lbs. ft. and lock the capscrew securely with the capscrew lock.

7. Install the steering clutch and steering brake (refer to "STEERING CLUTCH INSTALLATION," Section XII).

E. Installation of Final Drive Intermediate Pinion and Gear

1. Place the intermediate shaft gear in the housing, with the gear lock attaching holes in the gear toward the outer side of the housing. Block the gear in place with suitable blocking. Lubricate the intermediate pinion bearings and insert the intermediate pinion into position in the housing and the inter-

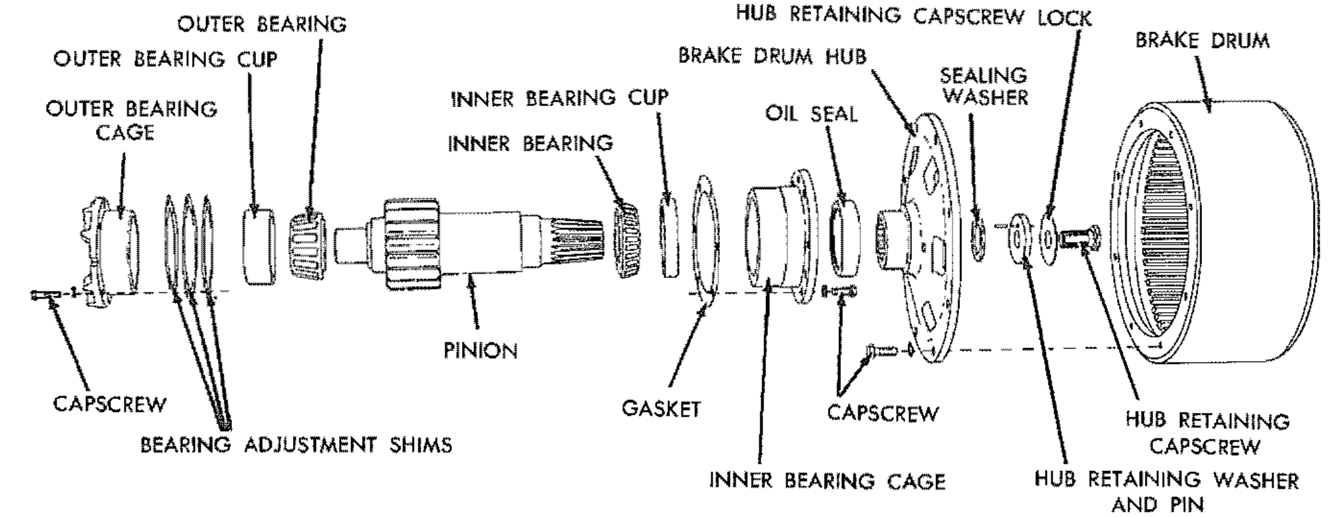


Fig. 16 — Final Drive Pinion Shaft Details

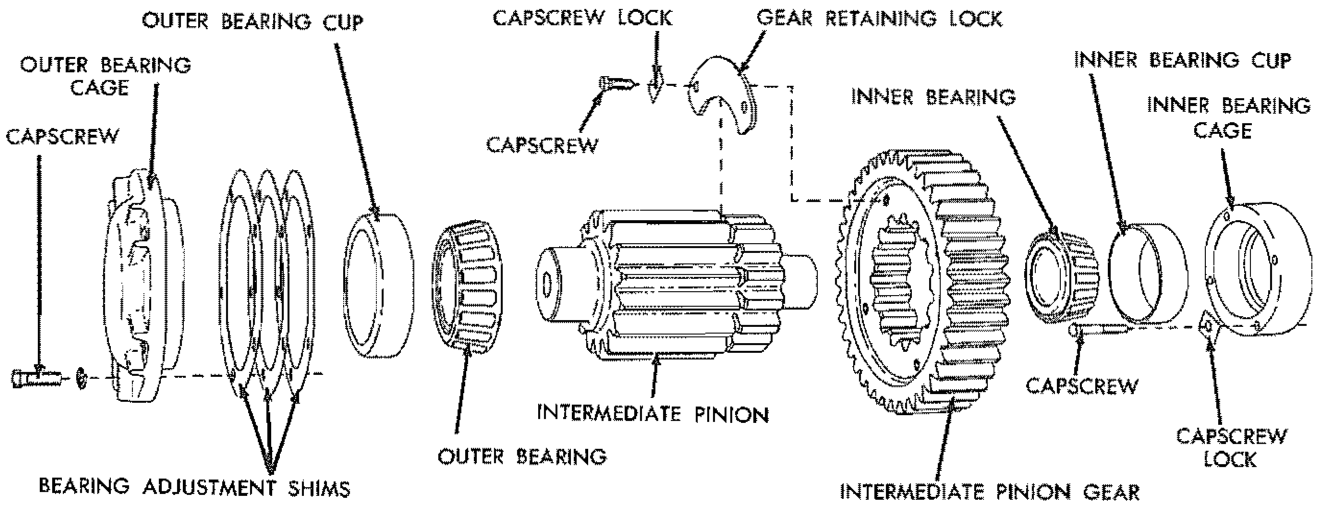


Fig. 17 — Final Drive Intermediate Pinion and Gear Details

mediate shaft gear.

2. Working through the opening in the rear of the final drive housing, use a bar and raise the intermediate pinion and gear so that the outer bearing cage can be installed. Install the outer bearing cage in the housing, using the correct amount of bearing adjustment shims as determined previously in "INTERMEDIATE PINION BEARING ADJUSTMENT." When installing the outer bearing cage, install it in the housing just far enough to start the attaching capscrews. Use a bar and move the intermediate pinion out against the outer bearing cage. Insert the two (2) gear retaining locks in place in the groove in the pinion, then move the pinion back until the locks are against the gear and install capscrews and capscrew locks to secure the gear retaining locks to the gear. Tighten the capscrews securely and lock the capscrews with the capscrew locks.

3. Tighten the capscrews to secure the outer bearing cage to the housing.

F. Installation of Track Sprocket Shaft

1. Install the sprocket shaft gear (with the tapped holes for the gear retaining lock attaching capscrews toward the inner bear-

ing cup) in the housing and block the gear in position.

2. Lubricate the track sprocket shaft bearings and insert the track sprocket shaft into the bore in the housing and the gear. Push the track sprocket shaft in so that the inner bearing is in position in the inner bearing cup. Install the track sprocket shaft intermediate bearing cage, with the seal assembly attached, and the seal dirt guard in place on the housing, using the correct amount of bearing adjustment shims as determined previously in "TRACK SPROCKET SHAFT BEARING ADJUSTMENT." Tighten the capscrews to secure the intermediate bearing cage to the housing.

3. Position the sprocket shaft gear on the shaft so that the gear retaining locks may be installed. Install the gear retaining locks, capscrews, and capscrew locks. Tighten the capscrews and secure with the capscrew locks. Install the final drive compartment rear cover gasket, cover, and tighten the attaching capscrews.

4. Lubricate the mating surfaces of the oil seal rings of the inner seal assembly, then install the track sprocket (with the seal ring in place) on the track 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 a torque of 3500 to 4000 lbs. ft. This may be accomplished by using the reduction of the transmission and final drive when tightening. With the opposite steering clutch lever held in the disengaged position, proceed as follows:

   a. Remove the floor plate.

   b. When tightening the left sprocket retaining nut, place a wrench on the retaining nut and place a block of wood between the wrench handle and the top of the truck frame to hold the wrench in position. When tightening the right sprocket retaining nut, place a wrench on the retaining 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. Make certain the engine clutch operat-

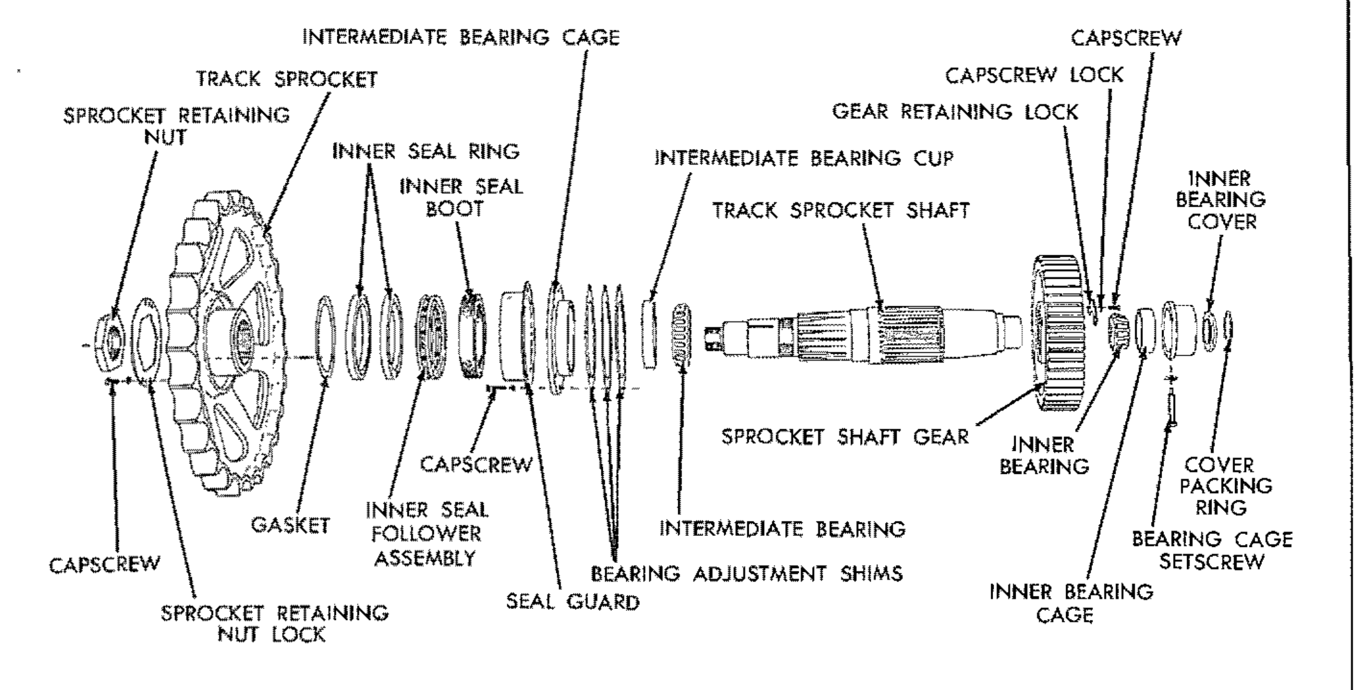


Fig. 18—Track Sprocket Shaft Details

ing lever is in the disengoged position.

d. Use a 24-inch pipe wrench, chain wrench, or a suitoble bar to turn the drive shaft universal joint assembly. Use a spring scale attached to the end of the wrench handle, turn the universal joint counter-clockwise (viewed from seat) to tighten the right sprocket retaining nut. Turn the universal joint clockwise (viewed from seat) to tighten the left sprocket retaining nut. Turn the universal joint until a pull of 17 to 19 pounds is indicated on the spring scale attached to the end of the 24-inch pipe wrench as shown in Fig. 19. This will impose a torque of 3500 to 4000 lbs. ft. on the sprocket retaining nut. *NOTE: During this tightening procedure, strike the sprocket, as near to the hub as possible, with a sledge hammer to make certain the sprocket is properly seated on the shaft.*

The following is the approximate pounds pull required on the spring scale when using various length wrenches or bars to turn the universal joint to tighten the sprocket retaining nut.

Wrench-Feet*	Pounds-Pull
1	34–38
1½	25–28
2	17–19

**NOTE: Distance from center of universal joint to point on wrench to which spring scale is attached.*

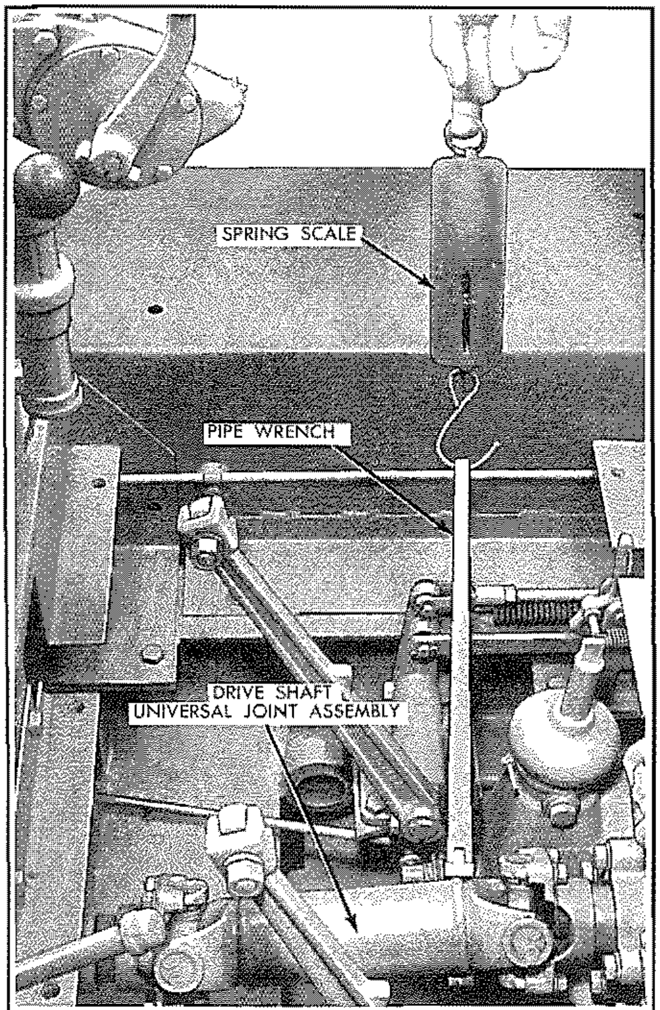


Fig. 19—Turning Drive Shaft Universal Joint Assembly to Tighten Track Sprocket Retaining Nut

e. Install the sprocket retaining nut lock and the lock attaching capscrews.

f. Install the floor plate.

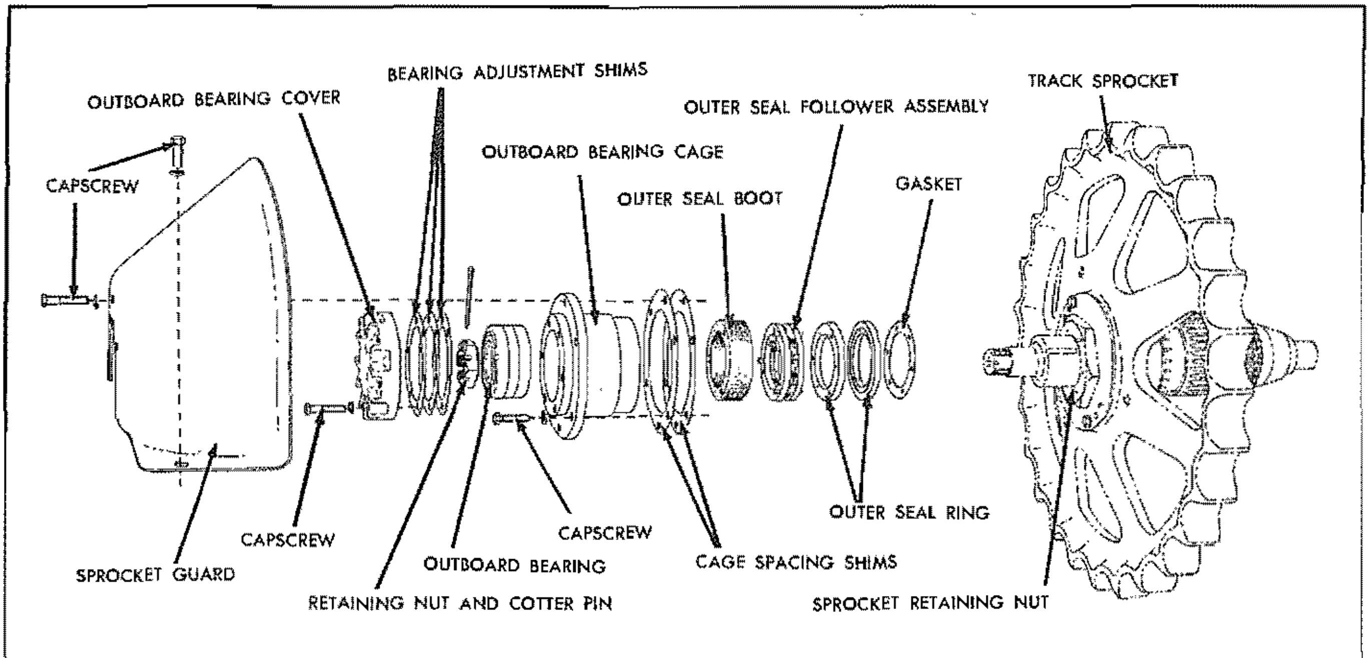


Fig. 20—Sprocket Shaft Outboard Bearing and Outer Seal Details

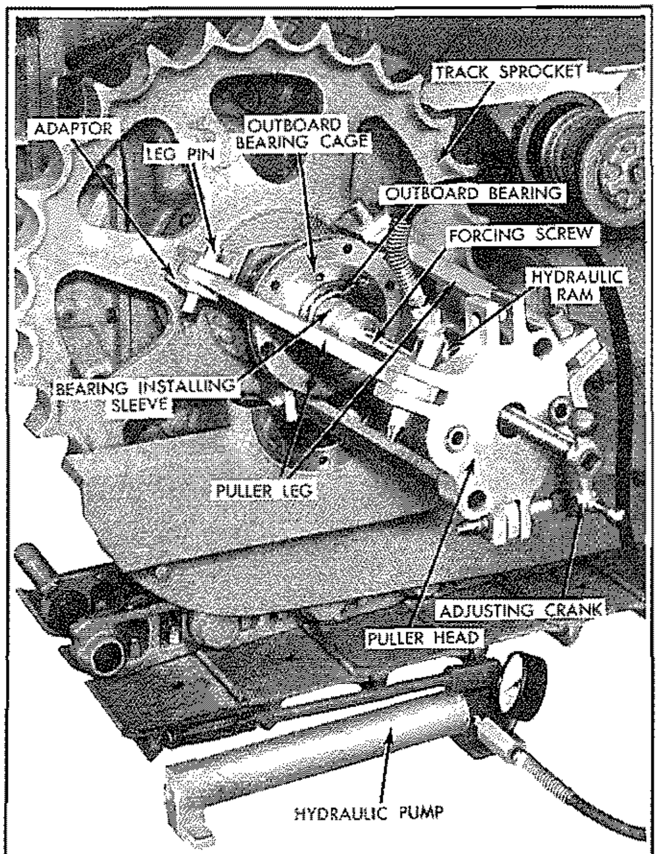


Fig. 21—Installing Outboard Bearing on Track Sprocket Shaft

G. Installation of Sprocket Shaft Outboard Bearing

1. With the outer seal assembly and the outboard bearing in place in the outboard bearing cage, install the bearing cage on the track sprocket shaft using special tools similar to the ones shown in Fig. 21. *NOTE: The bearing installing sleeve shown in Fig. 21 is machined from a piece of steel tubing to the following dimensions: I.D. 2-1/16", O.D. 2½", length 2½".* Press the outboard bearing cage and bearing assembly onto the sprocket shaft to a position allowing .050" to .060" clearance between the two (2) outer oil seal rings. *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 outboard bearing.*

2. Lubricate the outboard bearing with clean oil. Install the outboard bearing cover, using the original amount of bearing adjustment shims.

3. The outboard bearing must be adjusted for a pre-load of 8 to 13 inch pounds. A spring scale may be used to weigh the bearing pre-load, as shown in Fig. 22.

4. To check the outboard bearing pre-load proceed as follows:

   a. Use a length of small rope and wind the rope around the outboard 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 3⅛", therefore, to obtain the desired 8 to 13 inch pounds pre-load, a pull of approximately 3 to 4 pounds is required on the spring scale.

b. Add or remove bearing adjustment shims to obtain the correct bearing pre-load.

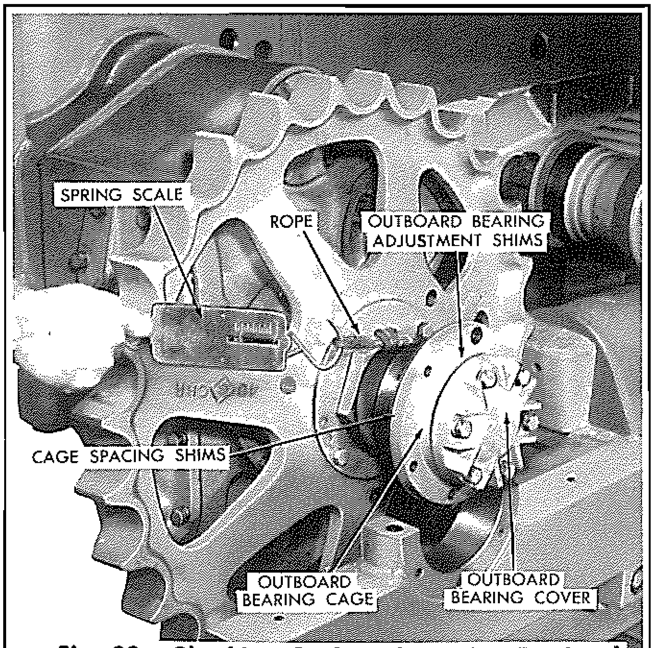


Fig. 22—Checking Outboard Bearing Pre-Load

5. After the correct amount of bearing adjustment shims has been determined, remove the outboard bearing cover and the adjustment shims. Lubricate the sealing surfaces of the outer seal rings, then install the outboard bearing retaining nut and tighten it securely. When tightening the nut, the outboard bearing cage assembly will be pressed onto the shaft the remaining distance. Secure the retaining nut with the cotter pin.

6. Install the outboard bearing cover and the correct amount of bearing adjustment shims. Tighten the cover attaching capscrews securely.

7. Install the original amount of cage spacing shims, used between the outboard bearing cage and the truck frame, then place the truck frame outboard bearing upper clamping cap in position on the outboard bearing cage. Start three (3) of the outboard bearing cage attaching capscrews to hold the clamping cap in position on the bearing cage; do not tighten the capscrews at this time. Move the truck frame assembly back into position under the tractor. Remove the blocking and lower the tractor onto the truck frame, making certain that the truck frame is positioned correctly under the tractor so that the hollow dowel for the truck frame pivot shaft enters the hole in the pivot shaft. Also make certain that the sprocket shaft outboard bearing cage seats properly on the truck frame. The truck frame outboard bearing upper clamping cap will serve as a guide to align the holes in the outboard bearing cage with the corresponding holes in the truck frame. Install the capscrews to attach the truck frame to the outboard bearing cage but do not tighten at this time.

8. Start the two outboard bearing upper clamping cap attaching capscrews but do not tighten at this time.

9. The truck frame pivot shaft caps and the pivot shaft brackets (welded to the housing) are center punched on the rear side for identification so that the caps may be re-installed in their original positions. Install each pivot shaft cap in its original position and tighten the cap attaching capscrews to a torque of 300 lbs. ft.

10. Tighten all capscrews used to attach the outboard bearing cage to the truck frame.

11. Check the clearance between the truck frame pivot arm and the pivot shaft outer cap; a clearance of 1/16" should be obtained at this point. If the proper clearance is not obtained at this point, add or remove cage spacing shims, between the outboard bearing cage and the truck frame, to obtain the desired 1/16" clearance.

12. Remove the capscrews from the outboard bearing cage so that the sprocket guard may be installed. Install the sprocket guard and tighten the attaching capscrews securely.

13. Install the two (2) capscrews to attach the equalizing spring seat to the truck frame and tighten the capscrews securely.

14. Install the oil drain plug in the final drive housing. Fill the final drive to the proper level with the specified lubricant.

15. Install the fuel tank and connect the fuel lines.

16. Couple the track and adjust (refer to "TRACK INSTALLATION," Section XVII).

SECTION XV—TRUCK FRAMES

1. DESCRIPTION

The major components of a truck assembly are: Truck frame, truck wheels, track support rollers, track release, and track idler.

The truck frame is made of steel sections welded into a rigid "A" frame assembly. Each truck frame pivots on a pivot shaft and a sprocket shaft outboard bearing. The pivot shaft is secured to the bottom of the steering clutch and final drive housing by pivot shaft caps and the sprocket shaft outboard bearing is installed in the sprocket shaft outboard bearing cage, which is attached by capscrews to the truck frame. The truck frames support the main frame by the use of an equalizing spring except on the HD-9F and HD-9G; these two (2) models are supported by a rigid beam in place of the equalizing spring.

Each truck frame assembly on the HD-9B incorporates six (6) truck wheel assemblies (four (4) single flange wheels and two (2) double flange wheels). The double flange truck wheels are used in the number 2 and 5 positions and the single flange wheels in the number 1, 3, 4, and 6 positions as shown in Fig. 1.

Each truck frame assembly on the HD-9F and HD-9G (long track models) incorporates seven (7) truck wheel assemblies (four (4) single flange wheels and three (3) double flange wheels). The double flange truck wheels are used in the number 2, 4, and 6 positions and the single flange wheels in the number 1, 3, 5, and 7 positions.

The truck wheels revolve on tapered roller bearings, have positive type grease seals, and 1000 hour recommended lubrication periods. The attaching brackets of the truck wheels are secured to the truck frames by capscrews, which are threaded into replaceable tapped blocks.

The track support roller and track idler assemblies 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 full length truck wheel guards, track idler inner and outer guards, and track sprocket inner and outer guards. Truck frame

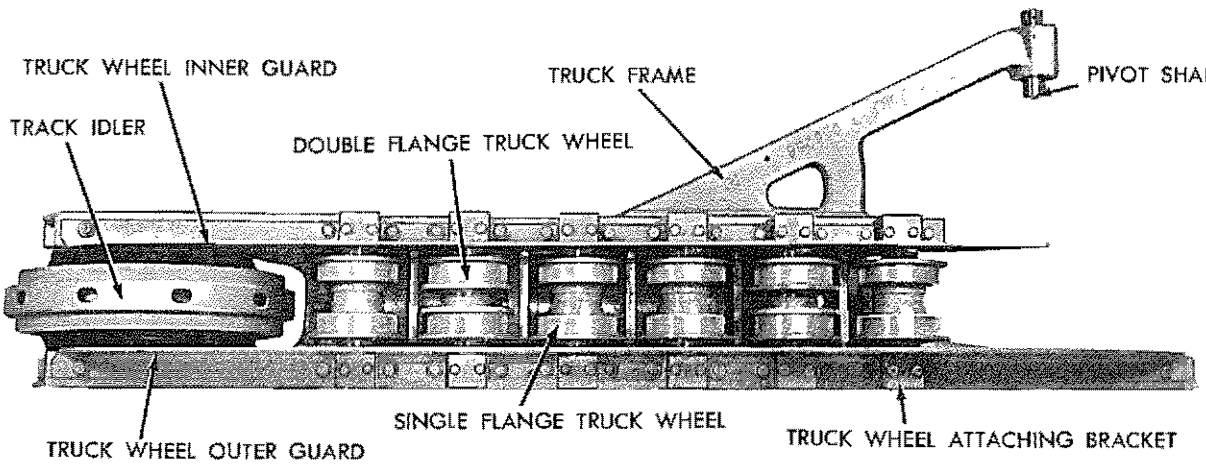


Fig. 1—HD-9B Truck Frame Assembly

guard equipment is attached to the truck frames by capscrews and is readily removable.

The track idlers are guided on the truck frames by replaceable slide bars and guide plates.

Each track release mechanism consists primarily of a yoke assembly, track adjustment screw, crosshead, and an inner and an outer track release spring. The release springs are enclosed in an oil tight housing which is an integral part of the truck frame.

2. TRUCK FRAME

A. Maintenance

Maintenance of the truck frames consist 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 outboard bearings may also cause misalignment of the truck frames and should be replaced immediately.

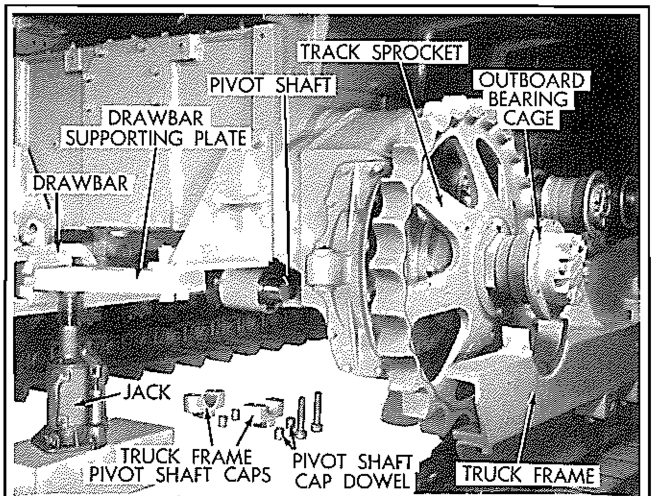


Fig. 2 — Truck Frame Assembly Ready for Removal

B. Truck Frame Removal

1. Uncouple the track (refer to Section XVII).
2. Remove the track idler, track release yoke, truck frame pivot shaft caps, track sprocket guard, and the track sprocket outboard bearing clamping cap. Remove the three (3) capscrews attaching the sprocket shaft outboard bearing cage to the truck frame.
3. Remove the bolts attaching the equalizing spring seat to the truck frame. Using a suitable hoist or jack, raise the free end of the equalizing spring approximately ten (10) inches off the truck frame and block under the spring with suitable cribbing. Remove the capscrews attaching the front support roller bracket to the truck frame and remove the support roller assembly.
4. Raise the rear of the tractor approximately ten (10) inches and block under the drawbar supporting plate with suitable cribbing.
5. Move the truck frame assembly forward on the track until it contacts the equalizing spring. Tip the truck frame assembly outward until it clears the equalizing spring, then roll it forward on the track.

C. Pivot Shaft, Pivot Shaft Bushing, and Pivot Shaft Seals

1. Maintenance

The pivot shaft and pivot shaft bushing are lubricated with oil from the bevel gear compartment by a lubricating wick assembly. No maintenance is necessary other than periodic checks to be certain that the truck frame pivot shaft caps are tight and that the bushing and the shaft are not excessively worn.

2. Removal of Pivot Shaft, Pivot Shaft Bushing, and Pivot Shaft Seals

a. With the track uncoupled, the sprocket shaft outboard bearing cage loosened from the truck frame, and with the truck frame pivot shaft caps removed, the pivot shaft may be removed by using special tools similar to the ones shown in Fig. 3. When removing the pivot shaft, one of the pivot shaft seals will be removed with the shaft; using a suitable punch, remove the other seal from the truck frame.

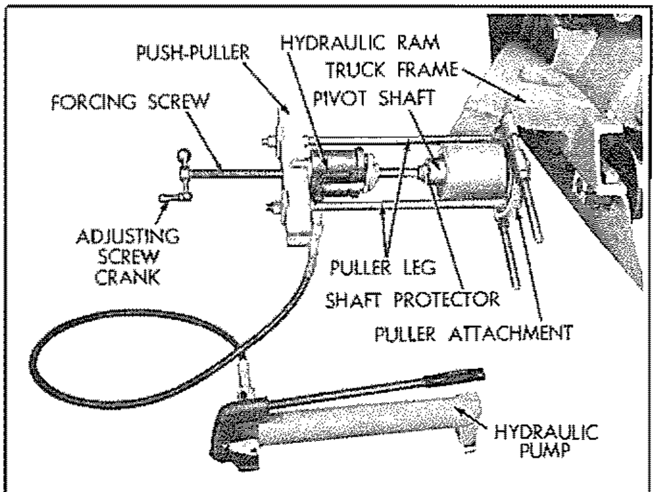


Fig. 3 — Removing Pivot Shaft

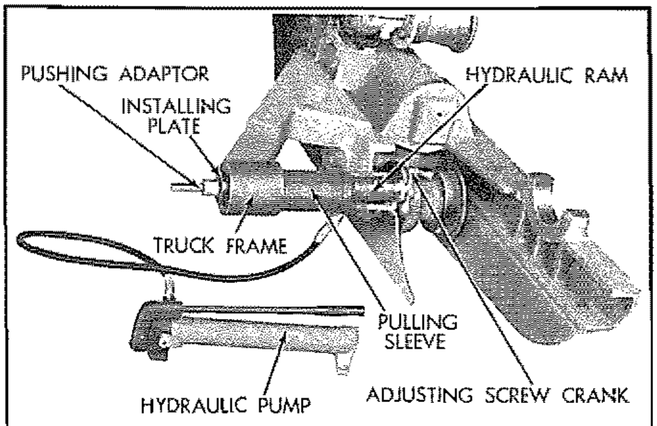


Fig. 4 — Removing Pivot Shaft Bushing

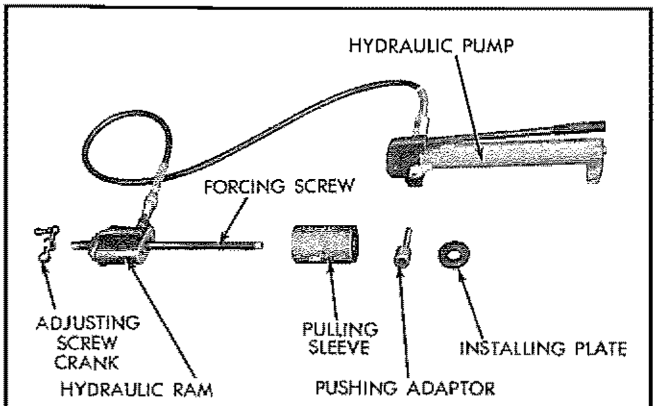


Fig. 5 — Special Tool Details for Removing and Installing Pivot Shaft Bushing

b. The pivot shaft bushing may be removed by using special tools similar to the ones shown in Figs. 4 and 5.

3. Installation of Pivot Shaft Bushing, Pivot Shaft, and Pivot Shaft Seals

a. Coat the outer diameter of the pivot shaft 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 special tools similar to the ones shown in Fig. 6, 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).

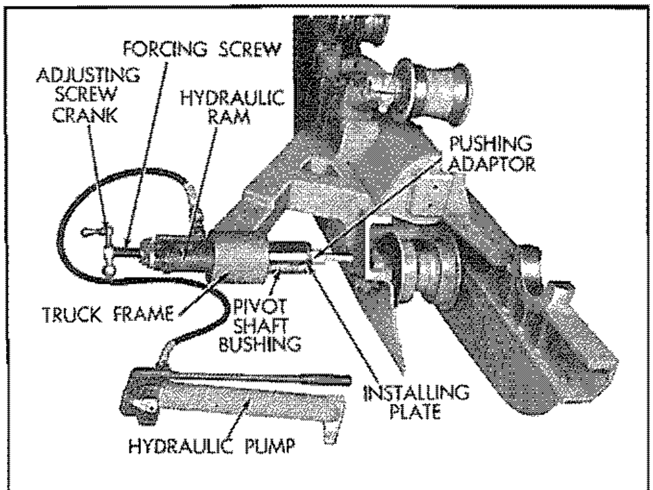


Fig. 6 — Installing Pivot Shaft Bushing

c. Install a new pivot shaft seal, using another pivot shaft bushing as a seal installing sleeve as shown in Fig. 7. Lubricate the pivot shaft and start it into the bushing; make certain the oil hole in the shaft will be to the inside of the tractor and positioned on the top as installed. Using special tools similar to the ones shown in Fig. 8, press the shaft into position. Start the other pivot shaft seal into position and while "bucking" the opposite end of the shaft, press the seal into position in the bore.

4. Installation of Truck Frame

Install the truck frame assembly by direct reversal of the removal procedure. CAUTION: *The truck frame pivot shaft and bushing are lubricated by a wick assembly that also serves as a dowel pin for locating the pivot shaft to the steering clutch and final drive housing. When lowering the tractor*

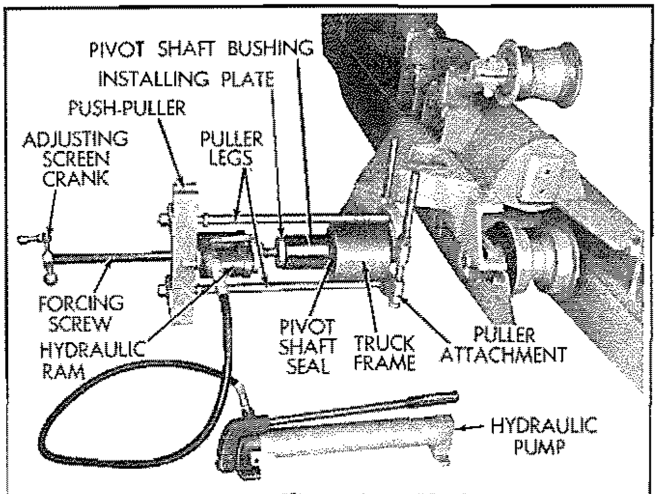


Fig. 7 — Installing Pivot Shaft Seal

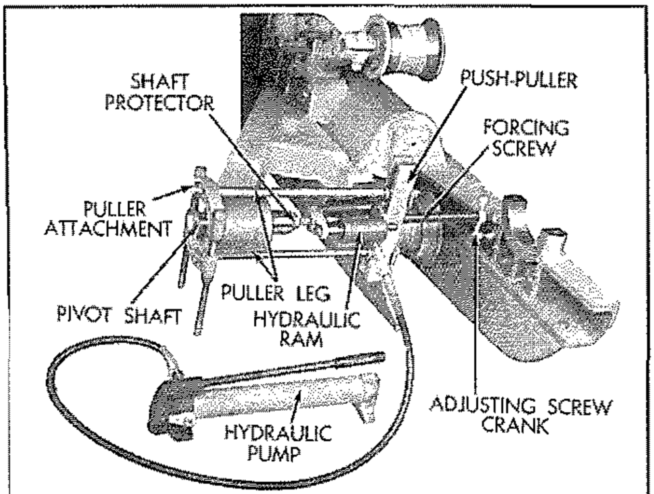


Fig. 8 — Installing Pivot Shaft

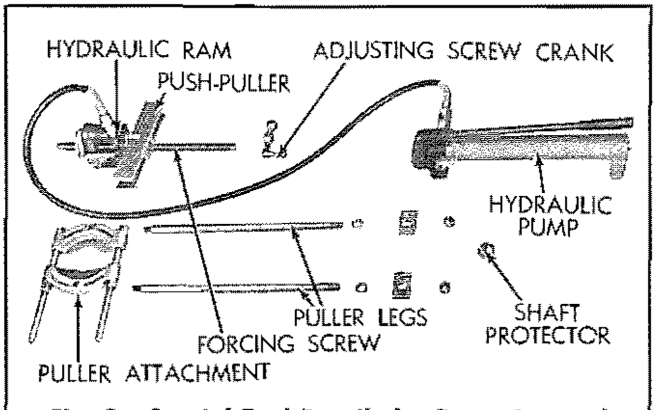


Fig. 9 — Special Tool Details for Removing and Installing Pivot Shaft

onto the pivot shaft, care MUST be used to prevent damaging the lubricating wick holder. Misalignment of the truck frame and abnormal wear of the pivot shaft and bushing will result from a damaged lubricating wick assembly.

The truck frame pivot shaft caps and the pivot shaft brackets (welded to the housing) are center punched on the rear side for identification as the caps MUST be installed in their original positions.

Install each pivot shaft cap in its original position, making certain the pivot shaft cap dowels are properly inserted, then tighten the cap attaching capscrews to a torque of 300 ft. lbs.

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 assembly without uncoupling the track; loosen the capscrews in the track adjustment screw lock and turn the adjustment screw into the track release yoke assembly 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 sprocket assembly and the track idler assembly. Lock the brake pedals in their applied position, with the tractor in this position the slack should be in the bottom of the track (refer to Fig. 10). Check the truck wheels for bearing end play; if there is 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 the removal of truck wheels. NOTE: *The truck wheels are attached to the truck frames by capscrews inserted through the attaching bracket and threaded into replaceable tapped blocks.*

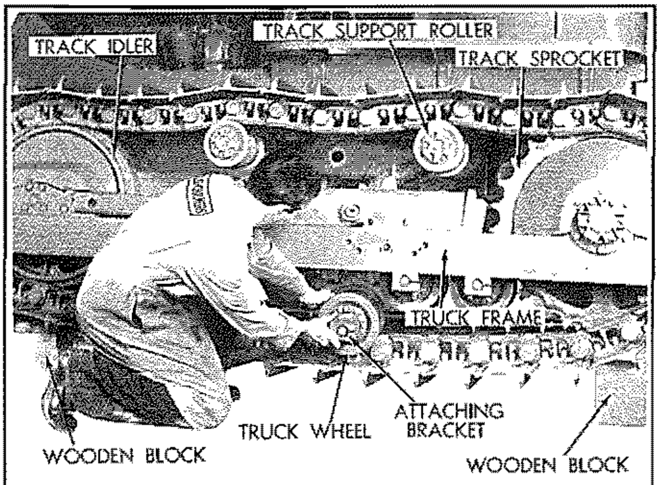


Fig. 10 — Removal of Truck Wheel with Track Installed

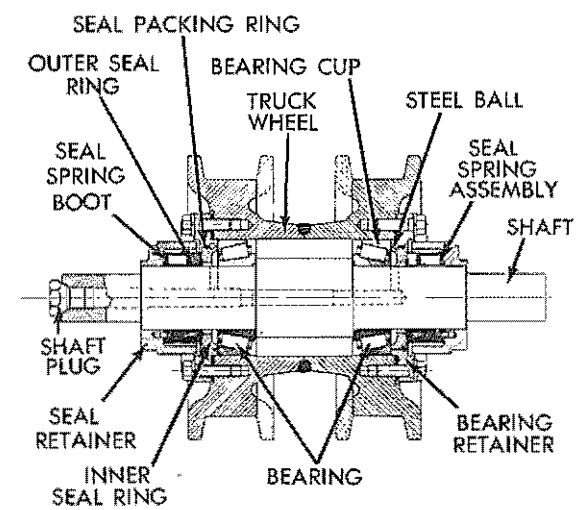


Fig. 11 — Truck Wheel Sectional View

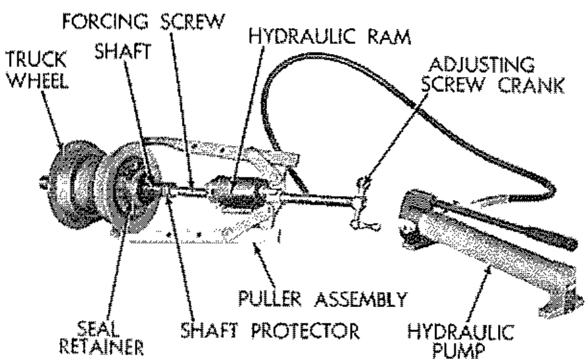


Fig. 12 — Removing Shaft from Truck Wheel

C. Disassembly of Truck Wheels

1. With the tractor placed on blocks as explained above, remove the truck wheel inner and outer guards. Remove the capscrews attaching the truck wheel to the truck frame and remove the truck wheel from the tractor. *NOTE: Do not remove the tapped blocks from the truck frame.*

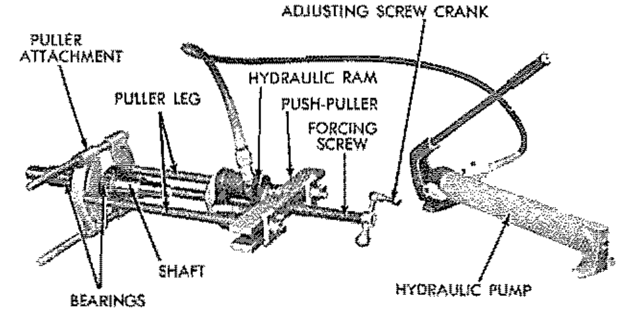


Fig. 13 — Removing Bearings from Truck Wheel Shaft

2. To remove the attaching bracket from each end of the truck wheel shaft, use a hammer and a chisel to spread the slot in the bracket, then pull the bracket from the shaft.

3. Wash the outside of the truck wheel thoroughly.

4. *IMPORTANT: When disassembling the truck wheel, keep the parts separated so that they can be reassembled in their original positions.* Remove the capscrews attaching each bearing retainer to the truck wheel.

5. Using special tools similar to the ones shown in Fig. 12, press on the shaft, removing one bearing cup, seal retainer, and bearing retainer from the wheel. Place the shaft back into position in the wheel and press on the opposite end of the shaft to remove the other bearing cup, seal retainer, and bearing retainer from the wheel. *CAUTION: DO NOT SCRATCH OR DAMAGE THE SEAL RINGS.*

6. Using special tools similar to the ones shown in Fig. 13, remove the bearings from the shaft.

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 seal rings for scratches, nicks, or burrs, as these surfaces *MUST* be smooth and flat. If the sealing surfaces are scratched or damaged, both mating seal rings must be replaced.

4. Examine the seal spring 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 boot lips should be firmly cemented to the ends of the seal spring assembly. The outer face of one boot lip should be firmly cemented to the seal retainer; 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 boot, as it is necessary that the outer part remain flexible to follow the action of the springs in the seal spring assembly.

   Examine the seal spring boot and make certain that the rubber is pliable and the boot is in good condition. If the boot and the seal ring are in good condition and are firmly cemented in place, do not remove.

5. 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-9B 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 number 2 and 5 positions and the single flange wheels in the number 1, 3, 4, and 6 positions. When assembling, refer to Fig. 14 which shows the parts in their relative positions.

1. Make certain that all parts are clean.

2. If a new seal spring 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.

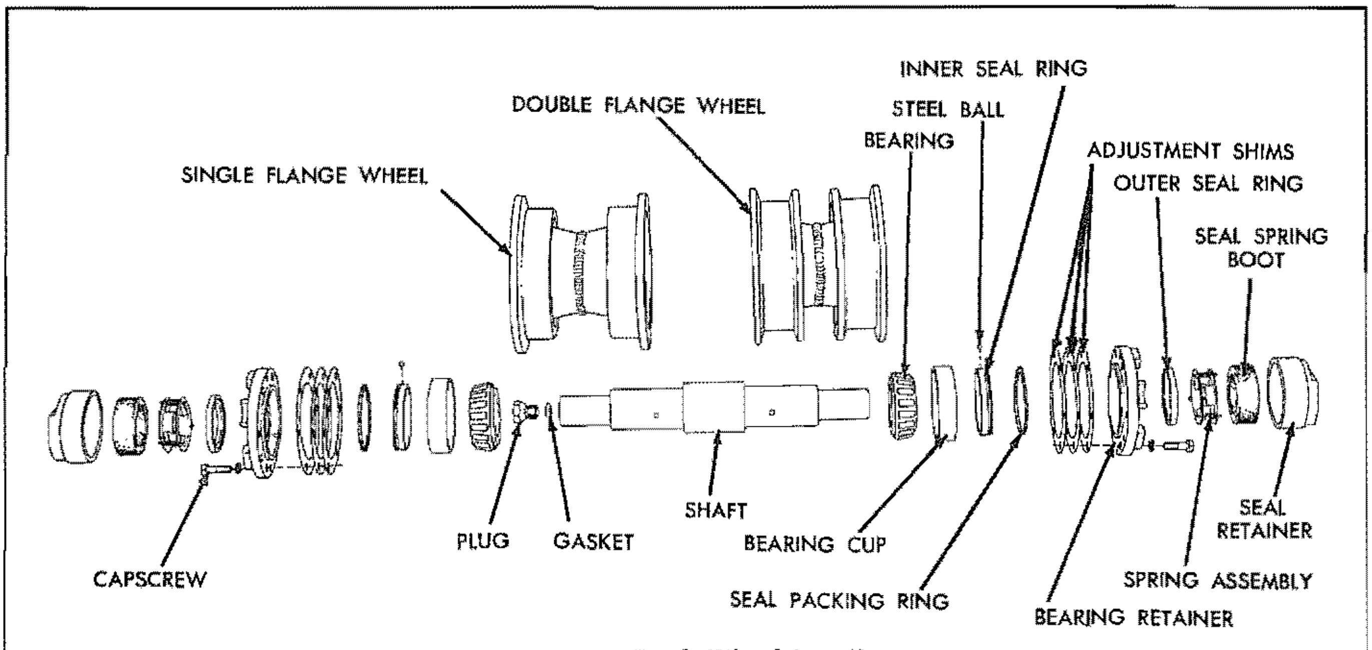


Fig. 14—Truck Wheel Details

To Install the Seal Assembly

a. Place each seal retainer, flat face down, on a clean work bench.

b. Make certain the seal spring assembly, seal spring boot, and the outer seal ring are clean and dry. Install the 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 seal spring boot and coat the machined face in the seal retainer (face that the boot contacts) with "NEOPRENE" cement. Immediately place the boot and spring assembly in the seal retainer, inserting the ends of the seal spring assembly pins into the corresponding holes in the seal retainer.

d. Coat the face of the outer lip of the seal spring 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 seal spring assembly 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 align the steel ball with the ball slot in the bearing retainer.

3. Press the bearings onto the shaft until they are seated against the shoulders on the shaft.

NOTE: The ends of the shaft are marked with a chisel mark in alignment with the cross drilled grease holes in the shaft. If a new shaft is installed, mark the location of the grease holes in a similar manner so that their location can be determined after the shaft is installed in the truck wheel.

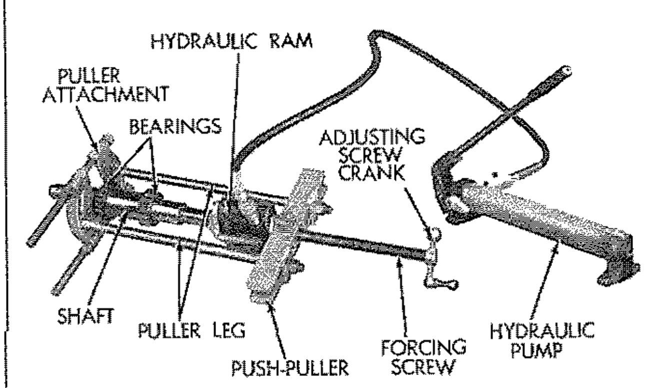


Fig. 15 — Installing Bearings on Truck Wheel Shaft

4. Install a bearing cup in one end of the truck wheel. Insert the shaft (with bearings) into 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 adjustment 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 adjustment shims, on the truck wheel. When tightening the bearing retainer 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 adjustment shims as needed. To do this, remove the bearing retainer, add or remove the estimated number of adjustment 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. Using an installing sleeve similar to the one shown in Fig. 16, having dimensions of 1-17/32" I.D. × 2-7/16" deep, 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 of the shaft. *NOTE: When installing the seal retainers on the shaft, be sure that the flat portion of each retainer is facing the chisel mark on each end of the shaft. The chisel marks identify the top of the shaft and are in alignment with the cross drilled grease holes in the shaft.*

8. Insert a chisel or wedge in the split of the truck wheel attaching bracket to spread the bracket for easier installation onto the shaft.

9. Install an attaching bracket on each end of the shaft, with the splits of the two brackets facing in opposite directions and the counter-bored side of the brackets toward the outside. Drive the brackets onto the shaft until the inner faces of the brackets contact the outer faces of the seal retainers. *NOTE: The shaft bore in the bracket is offset 1/16" from the center of the bracket. The brackets must be installed with the narrow part upward and in line with the flat portion of the corresponding seal retainer.*

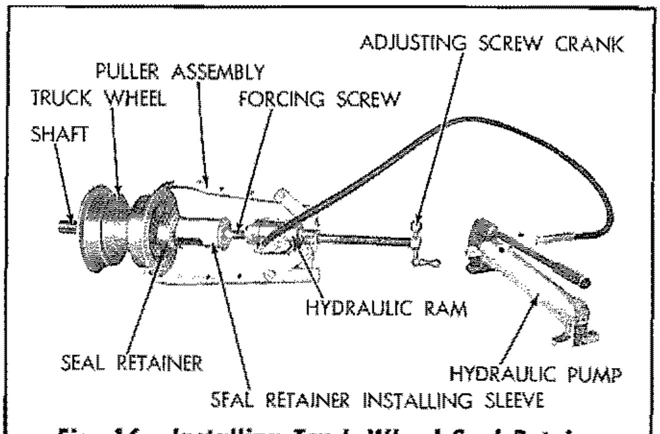


Fig. 16 — Installing Truck Wheel Seal Retainer

10. Using a hand lubricator and special lubricating nozzle as shown in Fig. 17, 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 one (1) pound of grease is required to fill the truck wheel. Install the shaft plug and gasket in the end of the shaft and tighten the plug securely.

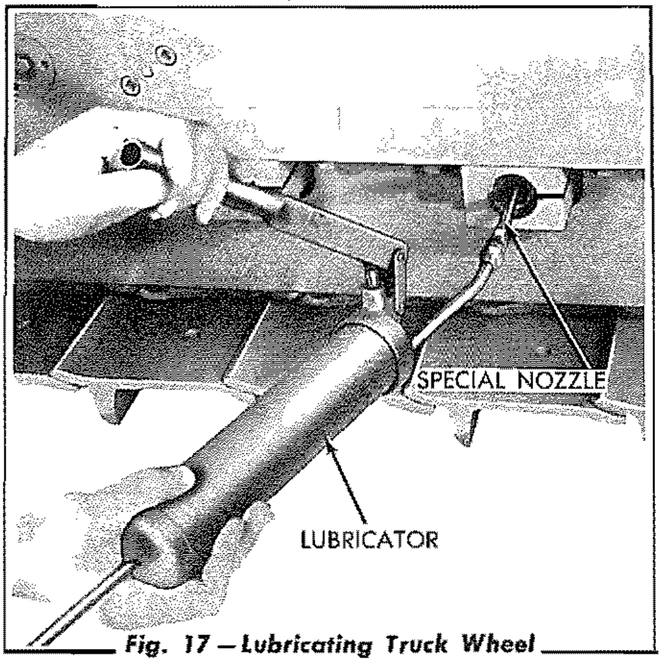


Fig. 17 — Lubricating Truck Wheel

11. Install the truck wheel in its proper location on the truck frame, making certain the shaft plug in the end of the truck wheel shaft is to the outside. *IMPORTANT: The completed assembly of the truck wheel must be installed on the truck frame so that the cross drilled grease holes in the shaft (indicated by the chisel marks on ends of shaft) are on the top of the shaft when the wheel is in the installed position.*

12. Install the truck wheel inner and outer guards.

13. 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 adjustment screw out of the track release yoke as necessary, thus forcing the track idler ahead. The track is properly adjusted when the top of the track can be lifted 1½" to 2" off the track 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 adjustment screw lock.

4. TRACK RELEASE

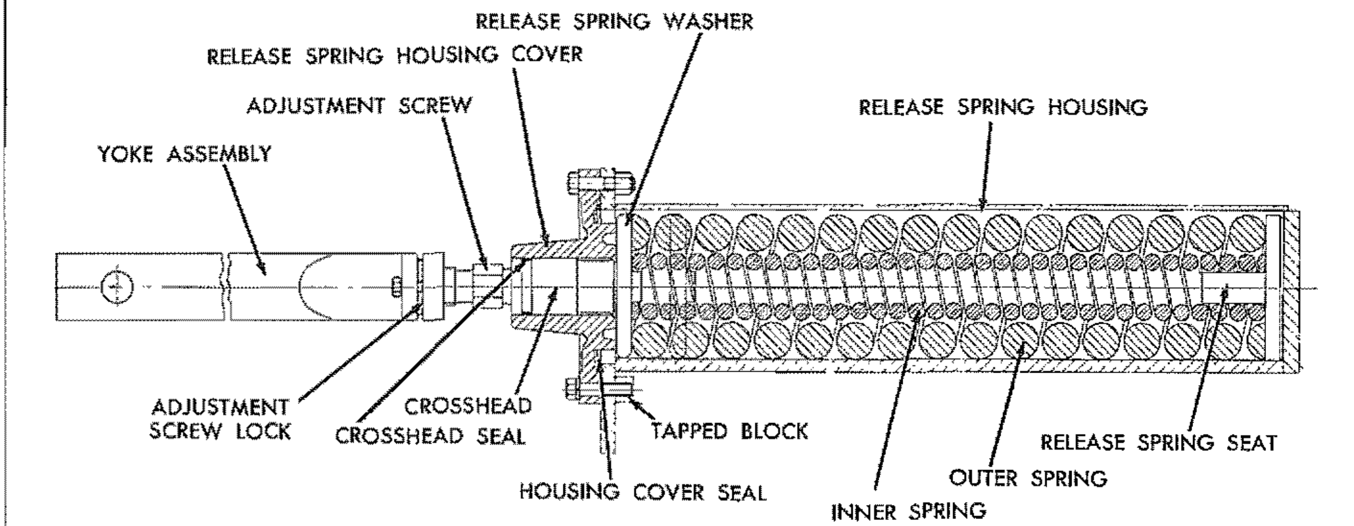


Fig. 18—Track Release Sectional View

A. Maintenance

Remove the oil filler plug from 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 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. Using a jack or hoist, raise the truck frame assembly approximately 4" and remove the truck wheel inner and outer guards. Remove the bracket attaching bolts from the truck wheel in the No. 2 position from the front of the tractor. *NOTE: This is necessary to provide clearance for the removal of the track release spring housing cover.*

4. Remove the crosshead by welding a small rod into the countersunk end of the crosshead and pull the crosshead and seal from

the track release spring housing cover.

5. Insert a 1" bolt 32½" long, and having 4" of NC threads, through the track release spring housing cover, release spring washer, inner spring, and screw it into the release springs seat for the purpose of compressing the springs. A washer ½" thick, with an O.D. of 2¼", should be used between the head of the bolt and the release spring washer.

6. Compress the springs to the limit of the bolt, which will compress the springs to the overall length of approximately 32".

7. Remove the eight (8) capscrews attaching the track release spring housing cover to the housing and remove the cover.

8. Remove the springs from the housing for inspection.

C. Inspection

1. Clean and inspect all parts thoroughly.

2. If the crosshead or the bore in the cover for the crosshead show excessive wear, replace the necessary parts.

3. Inspect the release springs seat, spring washer, release spring housing cover seal and the inner and outer springs for cracks and replace the necessary parts.

D. Installation of the Track Release

1. Install the track release by a direct reversal of the removal procedure, using new seals where necessary.

2. Install the truck wheel, the truck wheel inner and outer guards, and lower the truck frame onto the track.

3. Install the track release yoke assembly. Couple and adjust the track (refer to "TRACKS," Section XVII).

4. Fill the track release spring housing to the proper level with the specified lubricant.

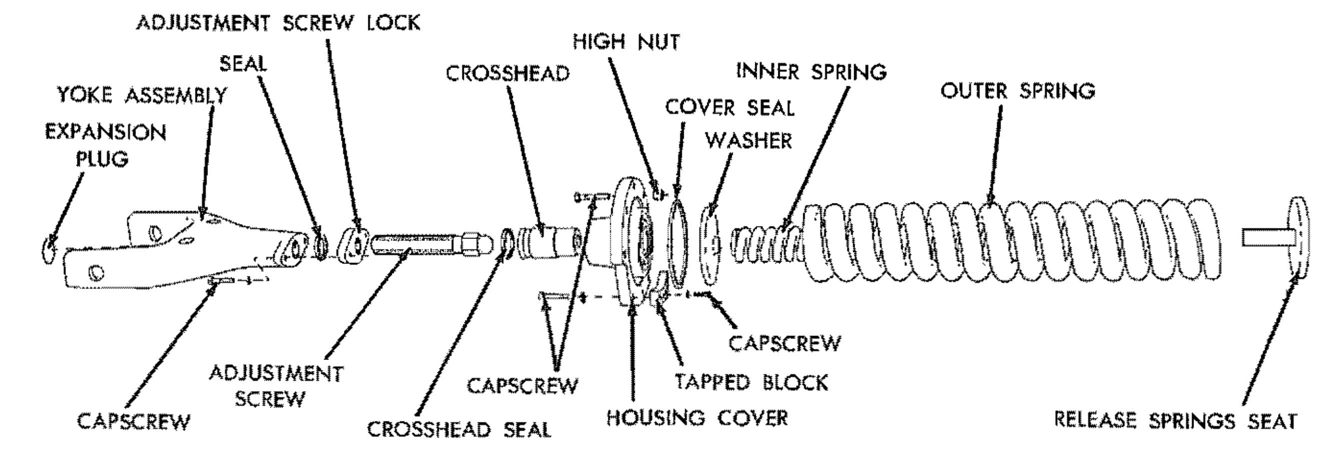


Fig. 19—Track Release Details

5. TRACK SUPPORT ROLLERS

A. Maintenance

Maintenance of track 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 the support rollers.

2. Grasp each roller and check for end play. If end play is found, the roller assembly should be removed immediately and disassembled, inspected, and rebuilt.

   NOTE: If grease leakage through the seal assembly is noted, the support roller should be removed, disassembled, and inspected. Grease leakage is an indication of loose bearings.

B. Removal of Track Support Roller

1. Raise and block the track so that it clears the support roller to be removed.

2. Remove the bolt clamping the support roller shaft in position in the 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.

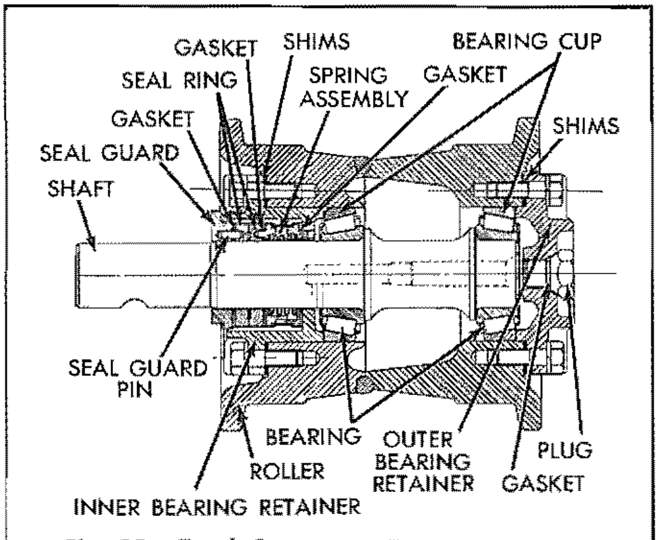


Fig. 20 — Track Support Roller Sectional View

C. Disassembly of Track Support Roller

1. Thoroughly wash and clean the outside of the support roller assembly.

2. Remove the capscrews attaching the inner bearing retainer to the roller. Using special tools similar to the ones shown in Fig. 21, pull the inner bearing retainer and seal guard from the shaft. Tie the adjustment shims to the retainer.

3. Remove the capscrews attaching the outer bearing retainer to the roller. Using special tools similar to the ones shown in Fig. 22, press on the inner end of the shaft to remove the outer bearing retainer and outer bearing cup. Tie the adjustment shims to the bearing retainer.

4. Place the shaft back into position in the roller and press on the outer end of the shaft to remove the inner bearing cup. Remove the shaft from the roller.

   CAUTION: When disassembling the track support roller, keep the parts separated so they can be reinstalled in their original positions.

5. Using tools similar to the ones shown in Fig. 13, remove the bearings from the shaft.

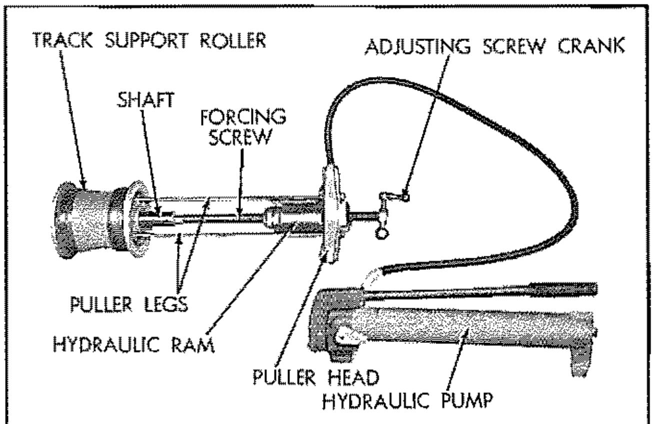


Fig. 21 — Removing Inner Bearing Retainer and Seal Guard from Track Support Roller

D. Inspection of Track Support Roller

1. Thoroughly wash and clean the track support roller components before inspecting. Make

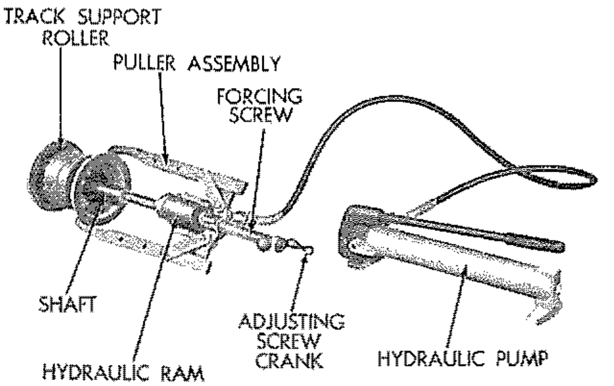


Fig. 22—Removing Outer Bearing Retainer and Outer Bearing Cup from Track Support Roller

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 or chipped, 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 seal rings for scratches, nicks, or burrs, as these faces *MUST* be smooth and flat. If the sealing surfaces are scratched or damaged, both mating seal rings must be replaced.

4. Examine the seal spring assembly and seal ring, located in the inner bearing retainer, and make certain that they are firmly cemented in place. Inspect the seal spring assembly and make certain the rubber is pliable and in good condition. If the seal spring assembly and seal ring are in good condition and are firmly cemented in place, do not remove.

E. Assembly of Track Support Roller

1. Make certain all the parts are clean.

2. If a new seal spring assembly and seal ring is to be installed in the inner bearing retainer, they should be installed at this time so that the "NEOPRENE" cement, used for cementing the assembly in place, will have sufficient time to dry.

3. Make certain the seal spring assembly and the seal ring gaskets are clean and dry. Coat one face of the seal spring assembly with "NEOPRENE" cement and immediately place a seal ring gasket in position on the seal spring assembly, inserting the pins through the holes in the gasket. Coat the other side of the seal ring gasket and the machined surface in the inner bearing retainer with "NEOPRENE" cement and immediately install the seal spring assembly in the inner bearing retainer, inserting the ends of the pins into the corresponding holes in the retainer.

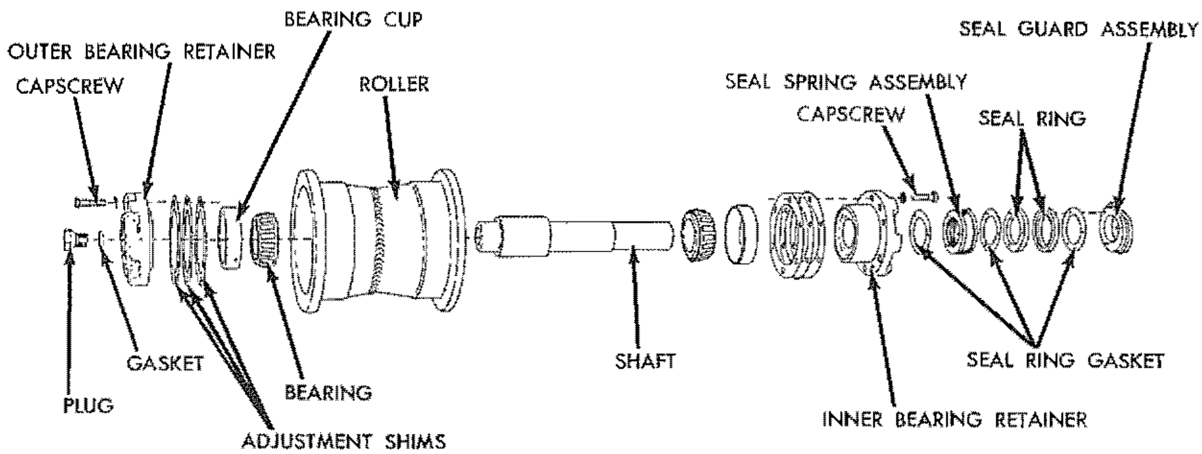


Fig. 23—Track Support Roller Details

4. Coat the outer face of the seal spring assembly with "NEOPRENE" cement and immediately install a seal ring gasket in position on the seal spring assembly. Coat the back face of a seal ring and the seal ring gasket with "NEOPRENE" cement and immediately install the seal ring on the seal spring assembly, inserting the pins into the corresponding holes in the seal ring.

5. Place a weight on the seal ring, using a clean cloth between the weight and seal ring, and allow the "NEOPRENE" cement to dry and set thoroughly.

6. Coat the pin side of the seal guard with "NEOPRENE" cement and immediately install a seal ring gasket on the seal guard. Coat the back face of the seal ring with "NEOPRENE" cement and immediately install the seal ring in position on the seal guard, inserting the pins into the corresponding holes in the seal ring.

7. 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.*

8. Using special tools similar to the ones shown in Fig. 15, press the bearings onto the shaft until they are seated against the shoulders of the shaft.

9. Install a bearing cup into one end of the bore of the track support roller. Insert the shaft (with the bearings) into the support roller and install the other bearing cup. Lubricate the bearings with clean oil.

10. Install the inner bearing retainer and the original amount of adjustment shims in position on the support roller and tighten the attaching capscrews securely.

11. Install the outer bearing retainer and the original amount of adjustment shims in position on the track 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 adjustment 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 adjustment shims, do not add or remove shims on one side only. The total thickness of the adjustment shims required to adjust the bearings should be divided as evenly as possible between the two sides.*

12. Coat the mating surfaces of the seal rings with clean oil. Using tools similar to the ones shown in Fig. 16, press the seal guard (with the outer seal ring cemented in place) onto the shaft until the outer face of the seal guard is flush with the shoulder of the shaft.

13. Use the hand lubricator and special lubricating nozzle as shown in Fig. 17, 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 one (1) pound of grease is required to fill the track support roller assembly. Install the shaft plug and gasket and tighten the plug securely.

14. The track 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 adjustment screw lock and turn the adjustment screw into the track release yoke to loosen the track.

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 assure that no load is being carried on the track idler, other than the section of track which it supports.

3. Using a bar approximately five (5) feet long, pry against the track idler bearing retainer and check for any end play. If any end play is found, the idler assembly should be removed from the tractor, disassembled, inspected, and rebuilt.

NOTE: If at any time grease is noted leaking from the seals, the track idler should be removed, disassembled, inspected, and rebuilt. Grease leakage is an indication of loose bearings.

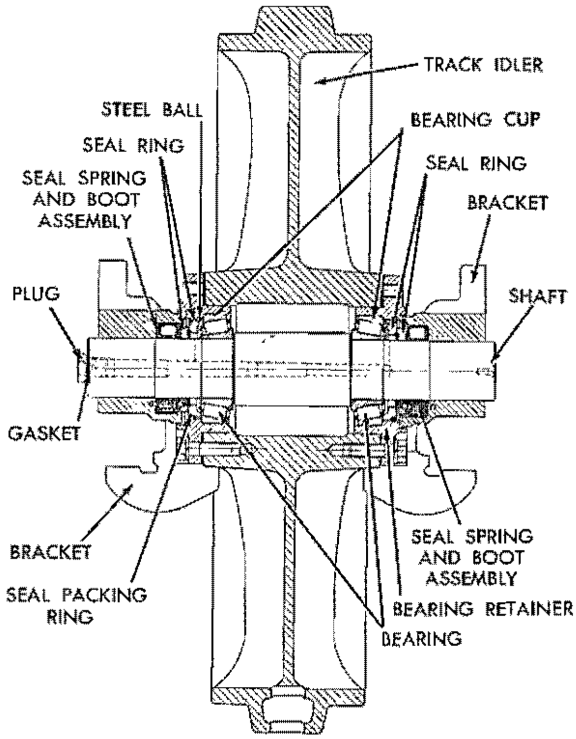


Fig. 24—Track Idler Sectional View

B. Track Idler Slide Bars and Alignment

1. Inspect the upper and lower track idler slide

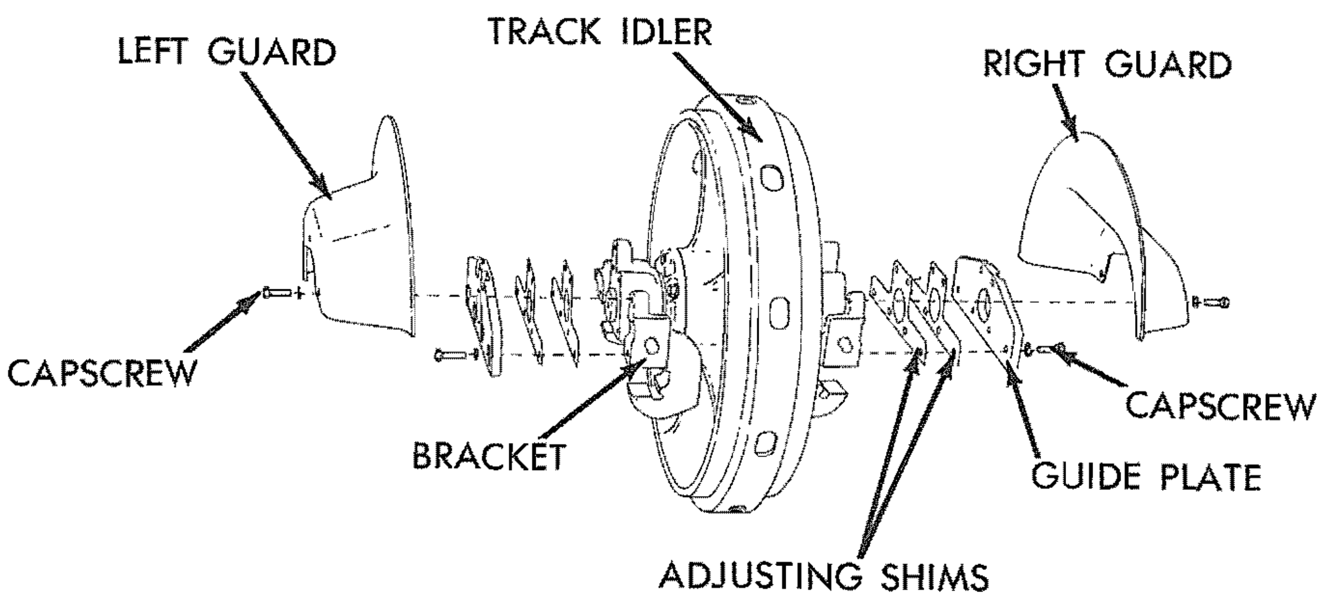


Fig. 25—Track Idler Guide Plate Details

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 track idler brackets. Add or remove adjusting 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, adjustment is necessary. Remove the track idler guide plates and move sufficient shims from the side which shows no wear to the side which shows excessive wear. Reinstall the guide plates.

C. Removal of Track Idler

1. Move the tractor until the track master pin is at the lower front face of the track idler. The track master pin can be identified as being longer than the track pins (standard), protruding approximately ⅛" beyond the boss in the track side bar.

2. Loosen the adjustment of the track and uncouple the track (refer to "TRACKS," Section XVII). 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 thoroughly clean the track idler.

2. Remove the track idler guide plates and tie the guide adjusting shims to the plates to facilitate alignment of the track idler when it is reinstalled.

3. Place the track idler assembly in a horizontal position on blocks. Using special tools similar to the ones shown in Fig. 26, pull the bracket from the track idler shaft. Turn the track idler over and remove the other bracket in the same manner.

4. Remove the attaching capscrews from each bearing retainer, and using a soft hammer, tap on the end of the idler shaft to remove the shaft and bearing retainers from the track idler. Tie the bearing adjustment shims to their respective retainers. Keep all parts separated so that the parts may be installed in their original position when assembling the track idler.

5. Using tools similar to the ones shown in Fig. 27, remove the bearings from the track idler shaft.

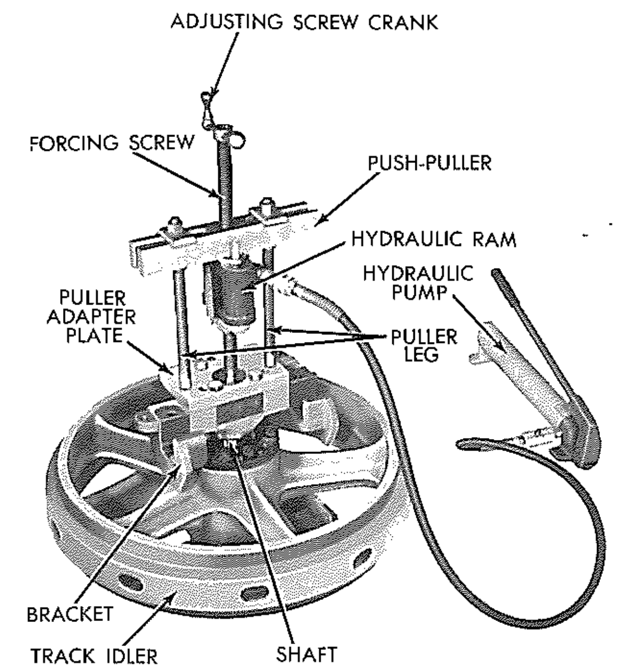


Fig. 26 — Removing Track Idler Bracket

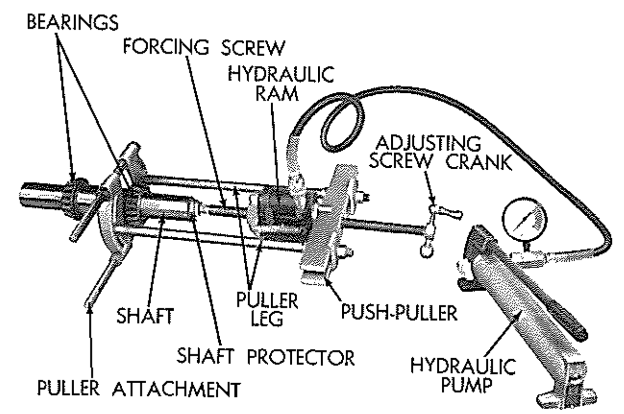


Fig. 27 — Removing Bearings from Track Idler Shaft

E. Inspection of Track Idler

1. Thoroughly wash all parts before inspection.

Make certain that the grease passage in the track 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 seal rings for scratches, nicks, or burrs, as these surfaces *MUST* be smooth and flat. If the sealing surfaces are scratched or damaged, both mating seal rings must be replaced.

4. Examine the seal spring boot in each bracket and make certain that it is firmly cemented in place and forms an oil proof bond between mating parts. The inner faces of the seal spring boot lips should be firmly cemented to the ends of the seal spring assembly. The outer face of one boot lip should be firmly cemented to the bracket 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 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 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

1. Make certain all parts are clean.

2. If a new seal assembly is to be installed in the idler brackets, 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. Using special tools similar to the ones shown in Fig. 29, press the bearings onto the shaft until they are seated against the shoulders of the shaft. *NOTE: The ends of the shaft are marked with a chisel mark in alignment with the cross drilled grease holes in the shaft. If a new shaft is installed, mark the location of the grease holes in a similar manner so*

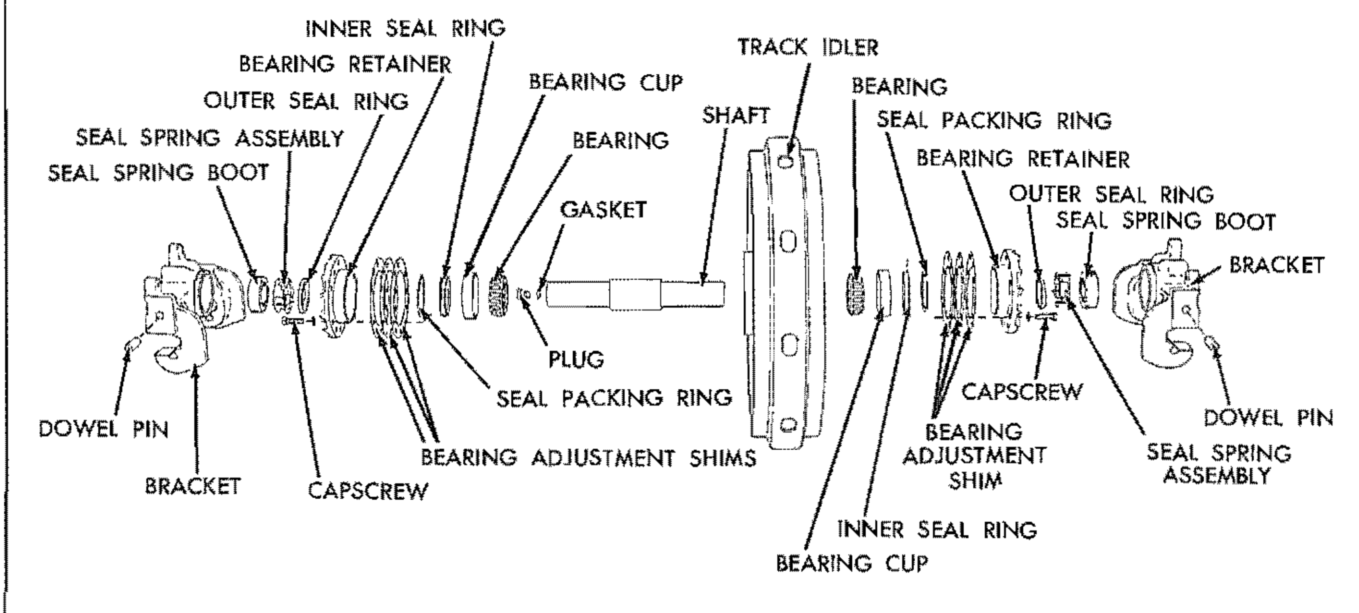


Fig. 28 — Track Idler Details

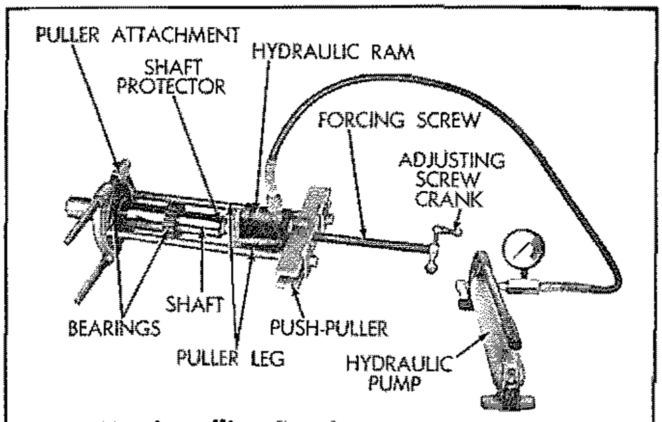


Fig. 29 — Installing Bearings on Track Idler Shaft

that their location can be determined after the shaft is installed in the track idler.

4. Install a bearing cup in each bearing retainer. Insert the track idler shaft (with the bearings) into place in the track idler hub and lubricate the bearings with clean oil.

5. Install one of the bearing retainers, complete with the inner seal ring assembly and the original amount of bearing adjustment shims, on the track idler hub and tighten the attaching capscrews securely.

6. Install the other bearing retainer, complete with the inner seal ring assembly and the original amount of bearing adjustment 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.

   If the bearings are too tight or too loose, it will be necessary to remove or add the necessary adjustment shims. To do this, remove the bearing retainer, 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 bearing adjustment shims, do not add or remove shims on one side only. The total thickness of the shims required should be divided as evenly as possible between the two sides.

7. Coat the mating surfaces of the seal rings with clean oil. Determine on which side of the tractor the idler is to be used so the idler shaft lubricating plug will be to the outside and the doweled end of the idler brackets will be toward the rear when the idler is installed on the tractor.

8. Start one of the idler brackets in position on the shaft, making certain the chisel mark on end of the shaft is toward the top of the idler when the bracket is installed. Using a suitable installing sleeve (made from steel tubing having a minimum I.D. of 2⅜") and special tools similar to the ones shown in Fig. 30, press the bracket onto the shaft so that the distance from the end of the shaft to the outer face of the bracket (at shaft location) is .395" to .400". CAUTION: *The bracket MUST not be pressed on the shaft more than the specified distance of .400" as damage to the seal rings will result.*

9. Install the other idler bracket on the shaft in the same manner as above. *IMPORTANT: When installing this bracket, make certain the lower machined surfaces of the brackets are parallel to each other.*

10. Using the hand lubricator and special lubricating nozzle as shown in Fig. 17, fill the

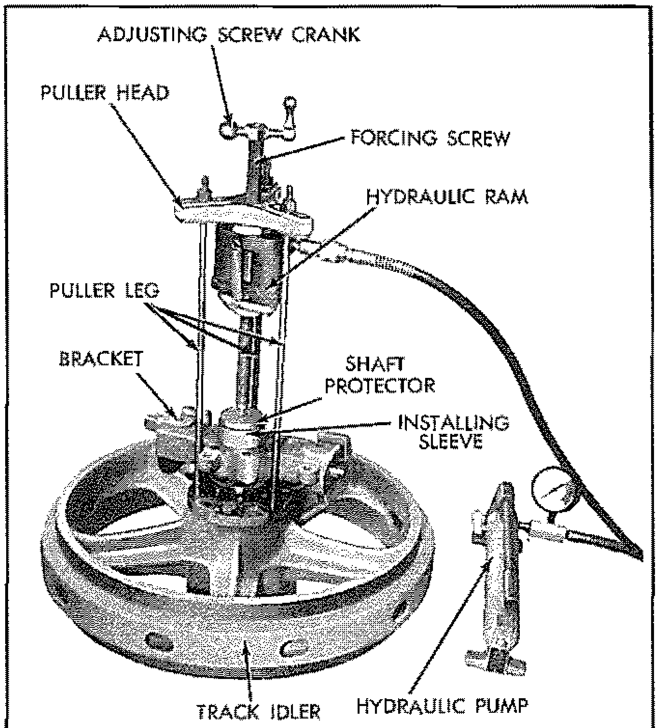


Fig. 30 — Installing Track Idler Bracket on Shaft

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 track idler is full. Approximately two (2) pounds of grease is required to fill the track idler. Install the shaft plug and gasket and tighten the plug securely.

G. Installation of Track Idler

1. Install the track idler on the truck frame.
2. Install the track idler guide plates in their original positions using the original adjusting shim pack. Sufficient adjusting shims should be added or removed to provide a sliding fit between the track idler brackets and the slide bars. If necessary, the track idler may be aligned with the track by moving adjusting shims from one track idler guide plate to the other guide plate as explained in "TRACK IDLER SLIDE BARS AND ALIGNMENT" in this Section.
3. Install the track idler guards.
4. Couple the track and adjust (refer to "TRACKS," Section XVII).

SECTION XVI—DRAWBAR

1. DESCRIPTION

The drawbar assembly consists of a drawbar, hinge pin, hinge pin bracket, locking pin, coupling pin, locking arm shaft and locking arm assembly, two (2) wear shoes, supporting plate, and two (2) supporting plate brackets.

The front 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 rear end of the drawbar, which incorporates the locking pin, coupling pin, locking arm shaft and locking arm assembly, and wear shoes is supported by a supporting plate. The supporting plate is attached to supporting plate brackets, which are attached to the rear face of the steering clutch and final drive housing.

The drawbar is of the swinging type (equipped with wear shoes) and can be swung from side to side on the supporting plate, or can be held stationary in various positions, by a series of holes provided in the supporting plate and the use of the drawbar locking pin. Both the drawbar locking pin and the coupling pin are held in position in the drawbar by the locking arm shaft and arm assembly.

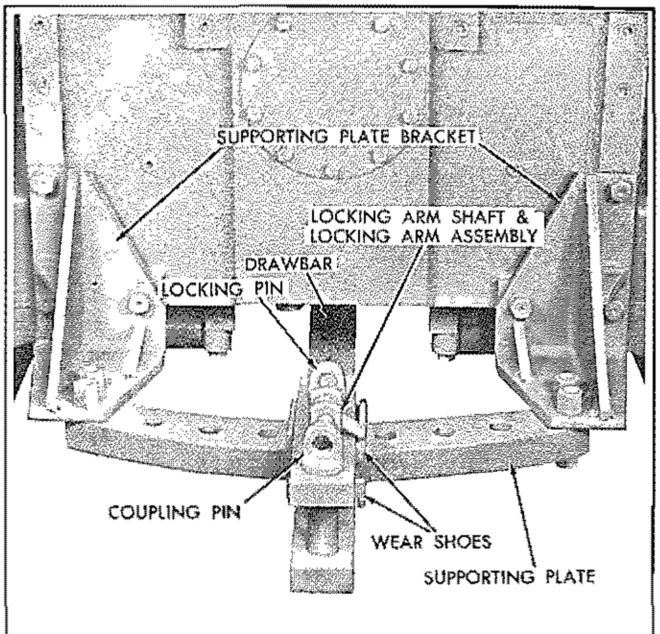


Fig. 1—Drawbar Assembly

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2. SERVICE

The bolts and capscrews attaching the hinge pin bracket and the supporting plate brackets should be checked periodically and tightened securely.

A. Removal and Inspection

1. Disconnect the drawbar from the hinge pin bracket by removing the hinge pin retaining plate and the hinge pin.

2. Remove the drawbar and supporting plate by removing the capscrews attaching each end of the supporting plate to the brackets. 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."

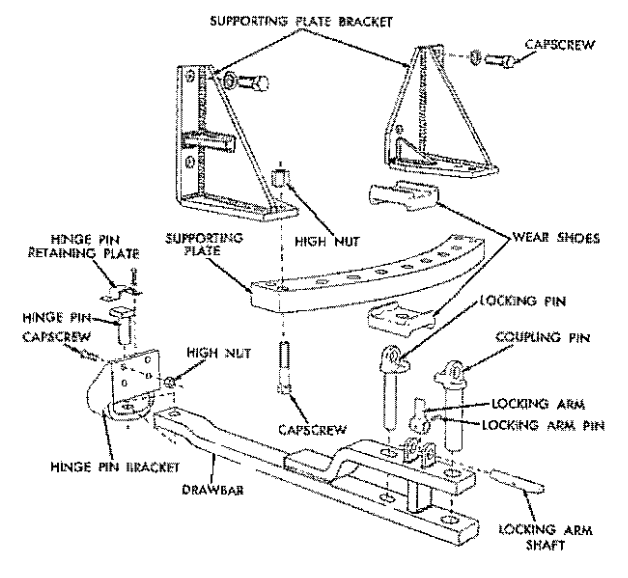

Fig. 2 — Drawbar Details

SECTION XVII—TRACKS

1. DESCRIPTION

The standard (Model HD-9B) track rail assemblies consist of thirty-eight (38) links each. Track rail assemblies for the Models HD-9F and HD-9G Tractors consist of forty-one (41) 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 bushing with a ½" spacer at each end; a master pin, which is ¼" 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 grouser shoes are available, each adapted to a particular application. The most common or standard grouser 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 grouser shoe bolts properly tightened; the bolts should be tightened to a torque of 250 to 260 lbs. ft.

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 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 the 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 the bushings.

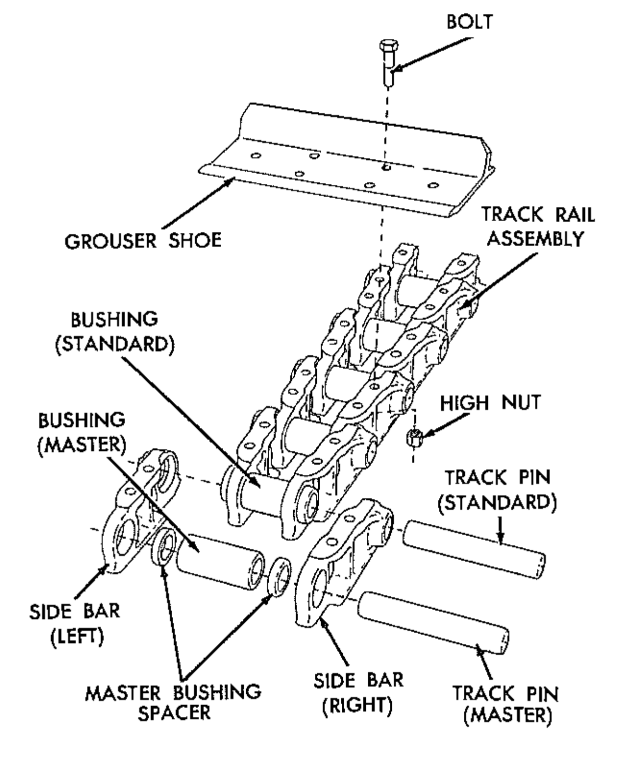

Fig. 1 — Track Details

When the pins and bushings are pressed out of the track, turned 180 degrees and reinstalled, new contact surfaces are brought into play between the pin and the 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 (distance between centers of adjacent track pins) 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 track bushings.

The pitch length (distance between centers of pins) of a new track is 7-1/16", and the maximum allowable pitch length for a used track is 7-3/16".

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 teeth may wear deep enough into the bushings to justify turning the pins and bushings before any appreciable wear shows on the inside of the bushings 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.

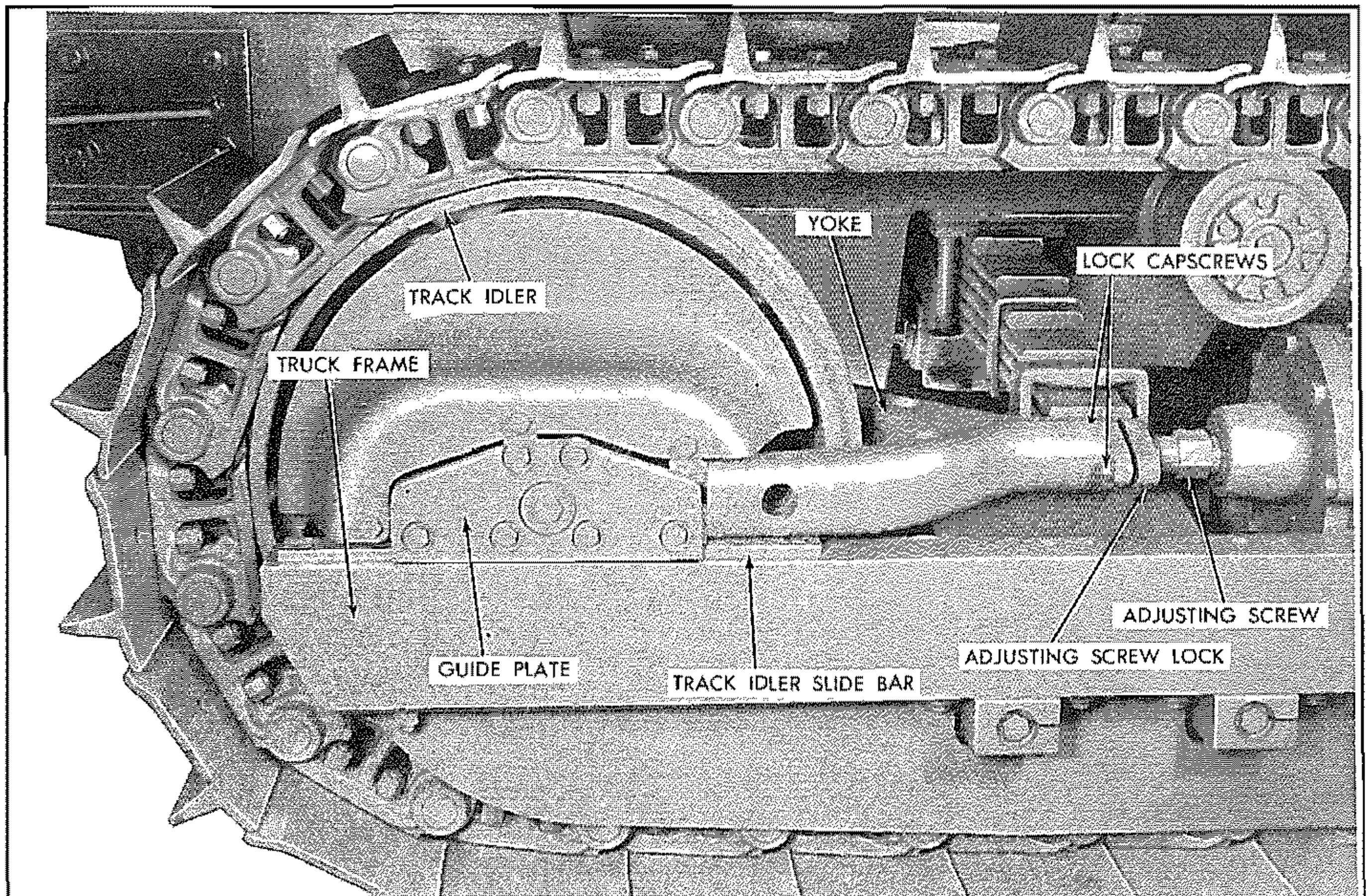

Fig. 2—Track and Track Idler Adjustment

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, then turn the adjusting screw out of the idler yoke as necessary to force the track idler ahead and tighten the track, or turn the screw into the yoke as necessary to loosen the track. Drive 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 adjusting screw lock.

B. Track Removal

1. **Uncoupling of Track Using Special Tools**

   a. Move the tractor until the master pin is at the lower front face of the track idler. The master pin can be identified as being longer than the standard pins and protrudes approximately ⅛" beyond the boss in the side bar.

   b. Loosen the capscrews in the adjusting screw lock and turn the adjusting screw into the track release yoke until the track is loose.

   c. Using special tools similar to the ones shown in Figs. 3 and 4, remove the master pin from the track as follows:

      1. Attach the two (2) puller legs to the push-puller with two (2) nuts.

      2. Insert the push-puller with one leg through the idler and one leg to the outside of the track as shown in Fig. 3.

      3. Insert the press plate aligning bushing into the end of the press plate. Install the press plate on the inner end of the two puller legs and attach with two (2) nuts, making certain the aligning bushing is centered around the inside end of the master pin.

      4. Attach the hydraulic ram to the push-puller with the two (2) attaching capscrews.

      5. Install the adaptor on the inner end of the forcing screw and insert the end of the press pin into position in the adaptor.

      6. Using the adjusting crank, turn the forcing screw in until the press pin contacts the end of the master pin. Support the outer end of the press assembly on blocks as shown in Fig. 3.

      7. Connect the hydraulic pump to the hydraulic ram and actuate the pump handle until the ram has extended its full length. Slowly release the pres-

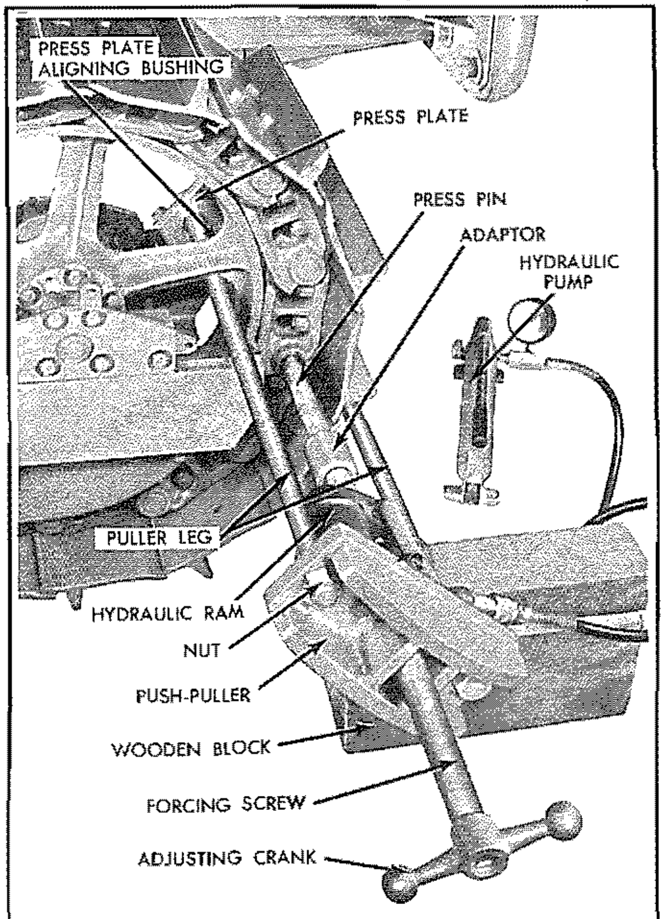

Fig. 3 — Pressing Master Pin from Track

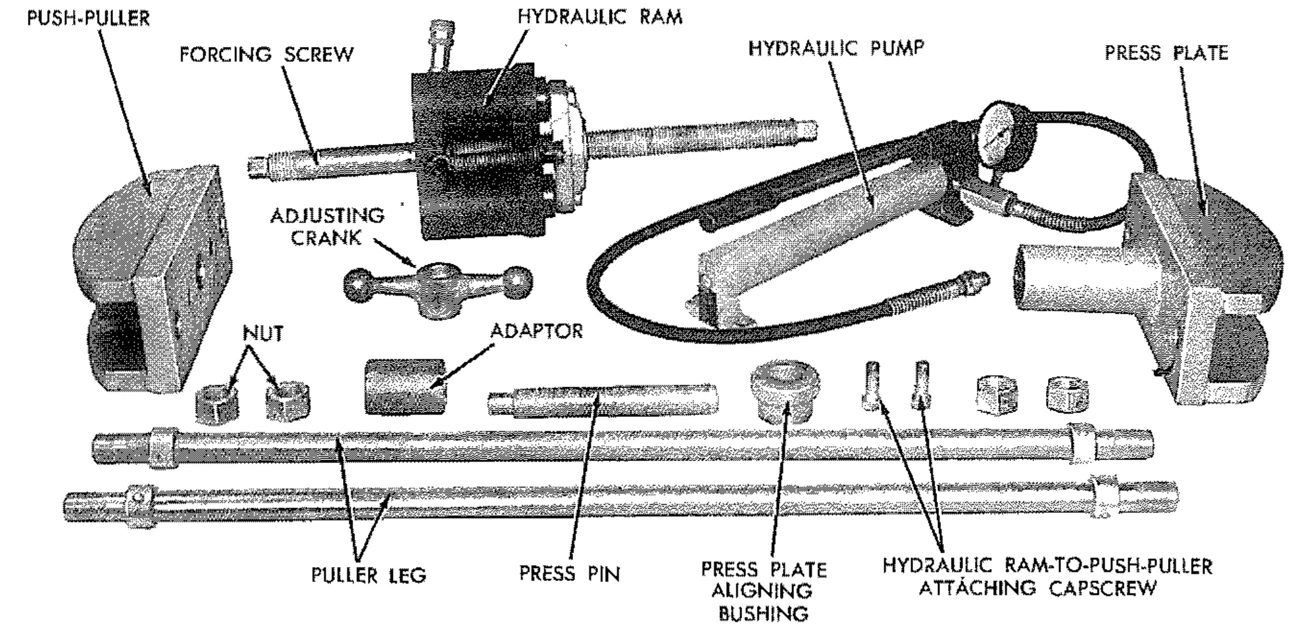

Fig. 4—Track Master Pin Press Details

sure from the hydraulic pump and at the same time, turn the adjusting crank to move the forcing screw forward until the pistons are fully retracted into the ram cylinders. Close the actuating valve on the hydraulic pump and continue this operation until the master pin is pressed out of the track rail assembly. Remove the press assembly.

2. **Uncoupling of Track Without Use of Special Tools**

If special tools are not available, follow steps a and b in the preceding paragraph and proceed as follows:

a. Hold a "bucking bar" against the inner side bar, close to the master pin.

b. Drive the master track pin out using a sledge hammer and a suitable driving bar. *CAUTION: Necessary precaution should be taken to protect the eyes from chips of steel, which might occur when striking the master pin.*

3. **Removal of Track from Under Truck Frame**

a. Uncouple the track and move the tractor backward until the track is free of the track sprocket.

b. Raise the truck frame free of track and pull the track out from under the truck frame.

C. Track Installation

1. Place the track under the truck frame with the bushing end of the track links to the front of the tractor.

2. Place an 8" block under the first grouser shoe.

3. Place a bar through the track pin hole in the rear end of the track.

4. Move the tractor backward until the bar may be hooked over a tooth of the track sprocket. Move the tractor forward, holding the bar firmly in place on a sprocket tooth so the track will roll around the sprocket.

5. Hold the end of the track up so it will pass over the support rollers and the track idler as the tractor is moved forward.

6. Remove the bar and line up the track pin holes in both ends of the track; make certain that the master bushing spacers (used at

each end of the master bushing) are in position with the chamfered side of the spacer toward the counterbore in the side bars.

7. Using special tools similar to the ones shown in Figs. 5 and 6, install the master pin as follows:

   a. Attach the two (2) puller legs to the push-puller with two (2) nuts.

   b. Insert the push-puller with one leg through the idler and one leg to the outside of the track as shown in Fig. 6.

   c. Insert the press plate aligning bushing (Fig. 4) into the end of the press plate. Install the press plate on the inner end of the two puller legs and attach with two (2) nuts, making certain the hole in the aligning bushing is aligned with the hole in the side bar.

   d. Attach the hydraulic ram to the push-puller with the two (2) attaching capscrews.

   e. Hold a shaft protector in position on the inner end of the forcing screw. Using the adjusting crank, turn the forcing screw in until the shaft protector contacts the end of the master pin, making certain that the master pin is properly positioned for installation. Support the outer end of the press assembly on blocks as shown in Fig. 5.

   f. Connect the hydraulic pump to the hydraulic ram and actuate the pump handle until the ram has extended to its free length. Slowly release the pressure from the hydraulic pump, and at the same time, turn the adjusting crank to move the forcing screw forward until the pistons are fully retracted into the ram cylinders. Close the actuating valve on the hydraulic pump and continue this operation until the master pin is pressed into position with an equal amount of the master pin extending from each side bar. Remove the press assembly.

8. If special tools are not available, drive the master pin into place using a sledge hammer and a suitable driving bar, allowing an equal amount of the master pin to extend from each side bar. CAUTION: *Necessary precaution should be taken to protect the eyes from chips of steel, which might occur when striking the master pin.*

9. Adjust the track. Refer to "TRACK ADJUSTMENT" in this Section.

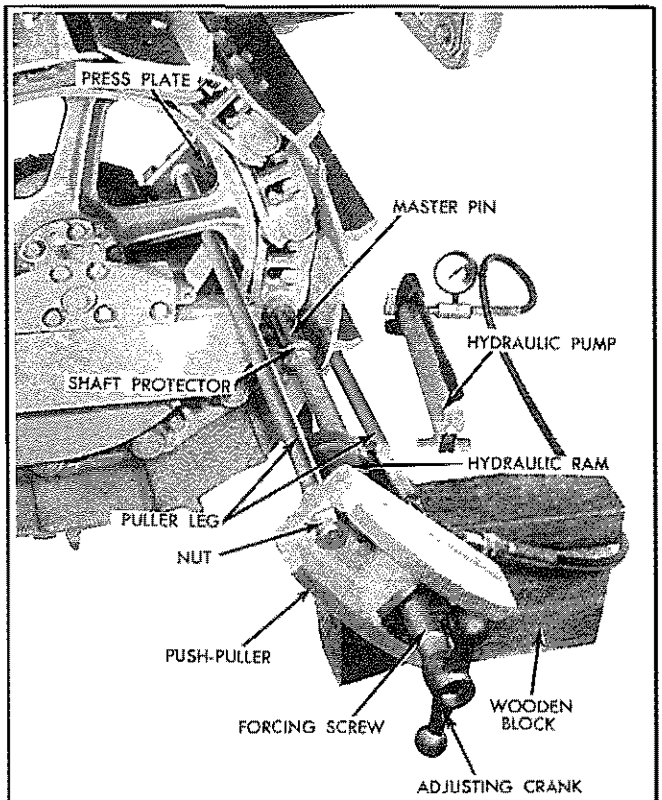

Fig. 5—Pressing Master Pin Into Track (Side View)

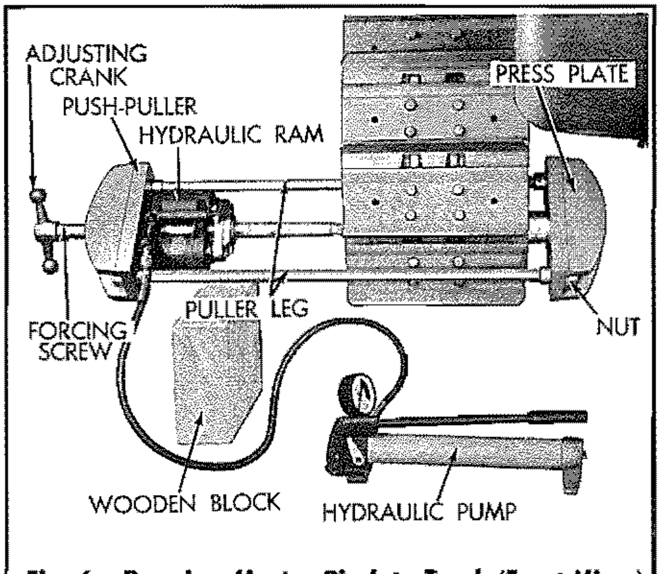

Fig. 6—Pressing Master Pin Into Track (Front View)

SECTION XVIII—MAIN FRAME AND EQUALIZER SPRING

1. GENERAL DESCRIPTION

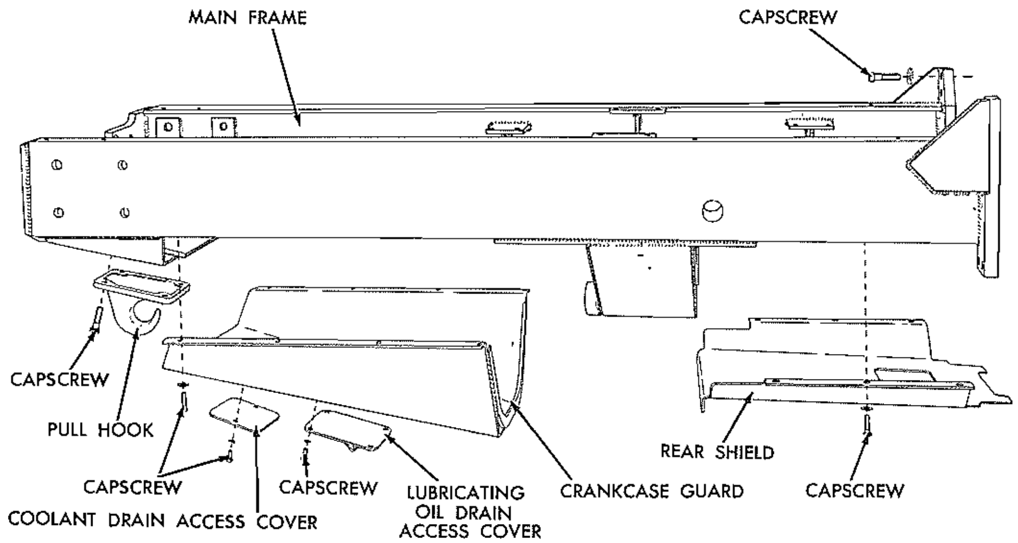

Fig. 1 —Main Frame and Guards

A. Main Frame

The main frame is a one piece welded steel structure. The rear end of the main frame is bolted to the steering clutch and final drive housing, and is attached to, and supported by, an equalizer spring.

B. Crankcase Guard

The engine crankcase guard is a pressed steel plate bolted to the main frame for protection of the engine crankcase and the underside of the tractor. Removable covers in the guard are provided for draining the engine lubricating 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

A rigid beam is used in place of the equalizer spring on Models HD-9F and HD-9G 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, saddle, pivot pin, and the necessary hardware to complete the assembly. Each end of the beam welded assembly is bolted securely to the top of the truck frames. Shims are provided for use between the top of the rigid beam and the bottom of the main frame side members.

2. MAIN FRAME

A. Maintenance and Inspection

The main frame should be checked periodically for loose bolts, cracked welds, bending and misalignment. Any of the above conditions should be corrected immediately.

B. Repair

If the main frame becomes cracked or broken because of unusually rough work, it may be practical to weld the cracks and reinforce the frame with suitable steel plates. Before welding the frame it should be checked for alignment and straightened if necessary.

If it is not practical or desirable to straighten or weld the frame, it may be replaced.

3. CRANKCASE GUARD

A. Maintenance and Inspection

The crankcase guard should be checked periodically for loose bolts and dents which may cause damage to the engine crankcase. If the crankcase guard becomes dented it should be removed and straightened or replaced. Never operate the tractor without the crankcase guard in place, as it is essential that the crankcase oil pan be guarded at all times against obstructions.

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, plain washers, lockwashers, 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 the 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 capscrews and the retaining plate from the rear of the spring saddle. Unlock and remove the capscrew, capscrew lock, and the cover plate from the front of the pivot pin.

5. Using a 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. Support the front end of the main frame on suitable cribbing.

6. Support the free end of the equalizer spring on a suitable block. Using special tools similar to the ones shown in Figs. 2 and 3, pull the pivot pin from the main frame and the equalizer spring saddle.

7. Push the spring assembly to the side and allow it to fall on the ground. Remove the spring from beneath the tractor.

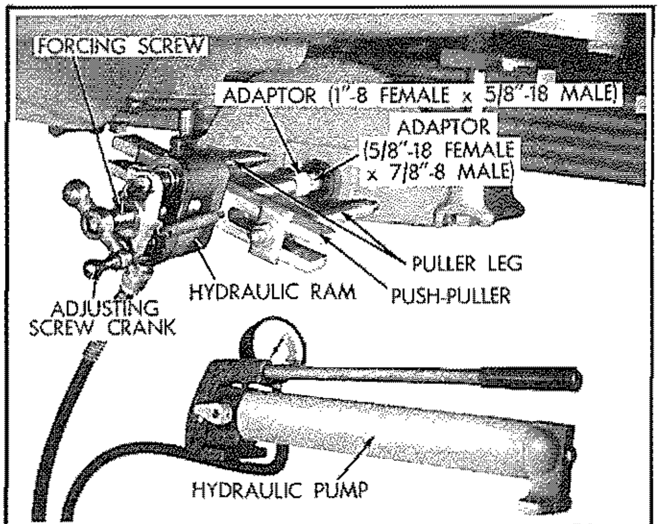

Fig. 2 — Removing Equalizer Spring Pivot Pin

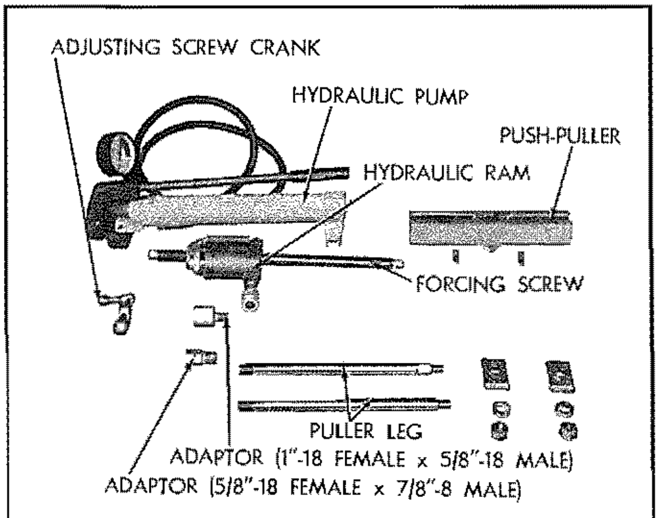

Fig. 3 — Special Tool Details for Removing Equalizer Spring Pivot Pin

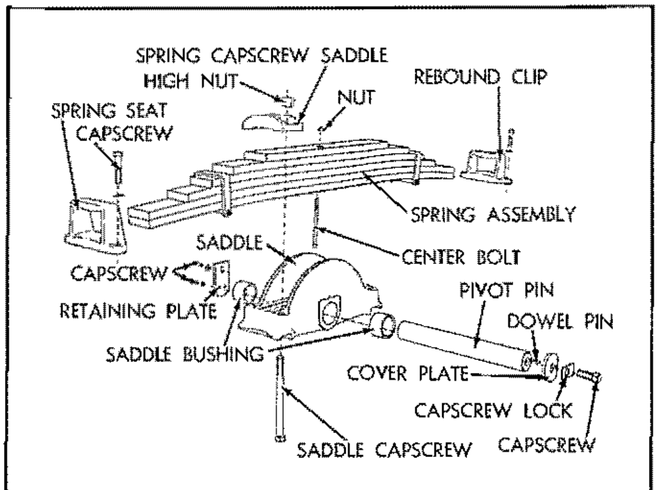

Fig. 4 — Equalizer Spring Details

C. Disassembly

1. Remove the bolts from the rebound clips.

2. Remove the spring saddle capscrews.

3. Remove the spring from the saddle and place the spring in a suitable vise or press.

4. Compress the spring and remove the centerbolt. Disassemble the spring.

5. Clean all the mating surfaces of the spring leaves, seats, saddle assembly with a wire brush. Clean all new parts before assembling. Do not lubricate the spring leaves.

D. Assembly

1. Using a guiding pin in place of the centerbolt, assemble the spring leaves in a suitable vise or press. Compress the spring leaves fully.

2. Remove the guiding pin and install the centerbolt 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 capscrews 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 and place one end of the spring on the truck frame having the spring seat removed. Chain the end of the spring to the truck frame and push the spring around into position under the main frame.

3. Use a hoist and 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. Place end of spring in position in the spring seat. Lubricate the pivot pin hole and the pivot pin.

4. Move the hoist to the other end of the spring and raise the spring to align the holes for the pivot pin. Drive the pivot pin into position

in the spring saddle and the main frame.

5. Install the pivot pin retaining plate. Install the pivot pin cover plate, capscrew lock, and the capscrew. Tighten the capscrew and lock with the capscrew lock.

6. Place the spring seat in position on the end of the spring. Remove the cribbing from under the tractor, and lower the tractor. Install the capscrews to attach the spring seat to the truck frame.

7. 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 capscrews attaching the rigid beam to the truck frames.

3. Remove the pivot pin cover plate and the retaining 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. Place blocks between the tops of the truck frames and the rigid beam mounting pads.

5. Using special tools similar to the ones shown in Figs. 2 and 3, pull the pivot pin from the main frame and the saddle.

6. Remove the capscrews attaching the rigid beam to the main frame and remove the beam capscrew saddles. Remove the spacing shims, located between the top of the rigid beam and the main frame.

7. Push the rigid beam to one side and allow it to fall to the ground then pull it out from beneath the tractor.

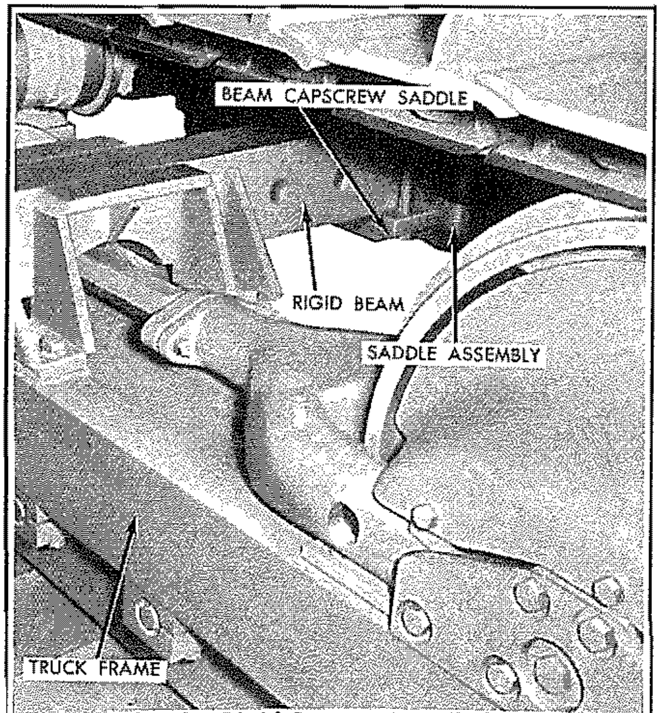

Fig. 5 — Rigid Beam — Installed View

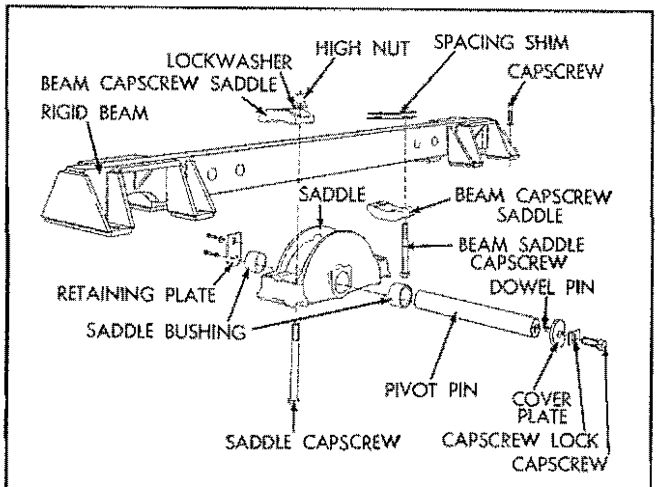

Fig. 6 — Rigid Beam Details

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.

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 or hood side screens which may be obtained as special equipment. The front fenders may be removed by removing the bolts attaching the fenders to the cowl and the radiator shell.

B. Rear Fenders

The rear fender group protects the operator, seat, fuel tank, and battery boxes from debris carried by the tracks. The fenders serve as a mounting for the cowl, battery boxes, fuel tank, and seat.

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 the fuel tank may be removed as a unit after removing the attaching capscrews.

2. SEAT

The tractor is provided with an adjustable and removable seat. Arm rest cushions are provided which also serve as battery box covers. The seat cushion, back cushion, and arm rest cushions are replaceable and are covered with weather resistant cloth.

The seat cushion frame is adjustable for three (3) height positions by removing the attaching capscrews and moving the frame to the position desired.

Reasonable care should be taken to avoid damaging the cushions with sharp or heavy objects, unnecessary exposure, battery acids, oil, and greases.

SECTION XX—SPECIAL EQUIPMENT

1. GENERAL

Special equipment, mentioned in this section, may be purchased separately for field installation, or the tractor may be ordered with the equipment factory installed. For a more complete list of available special equipment, contact your "Allis-Chalmers" Dealer.

2. GUARD EQUIPMENT

The standard tractor is equipped with a full width crankcase guard, bumper, hinged type 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 (for the Model HD-9B only) includes a fuel tank and seat guard group, heavy rear fenders, bottom guard group, grille screen, and engine side screens. This equipment may be ordered as separate items if desired.

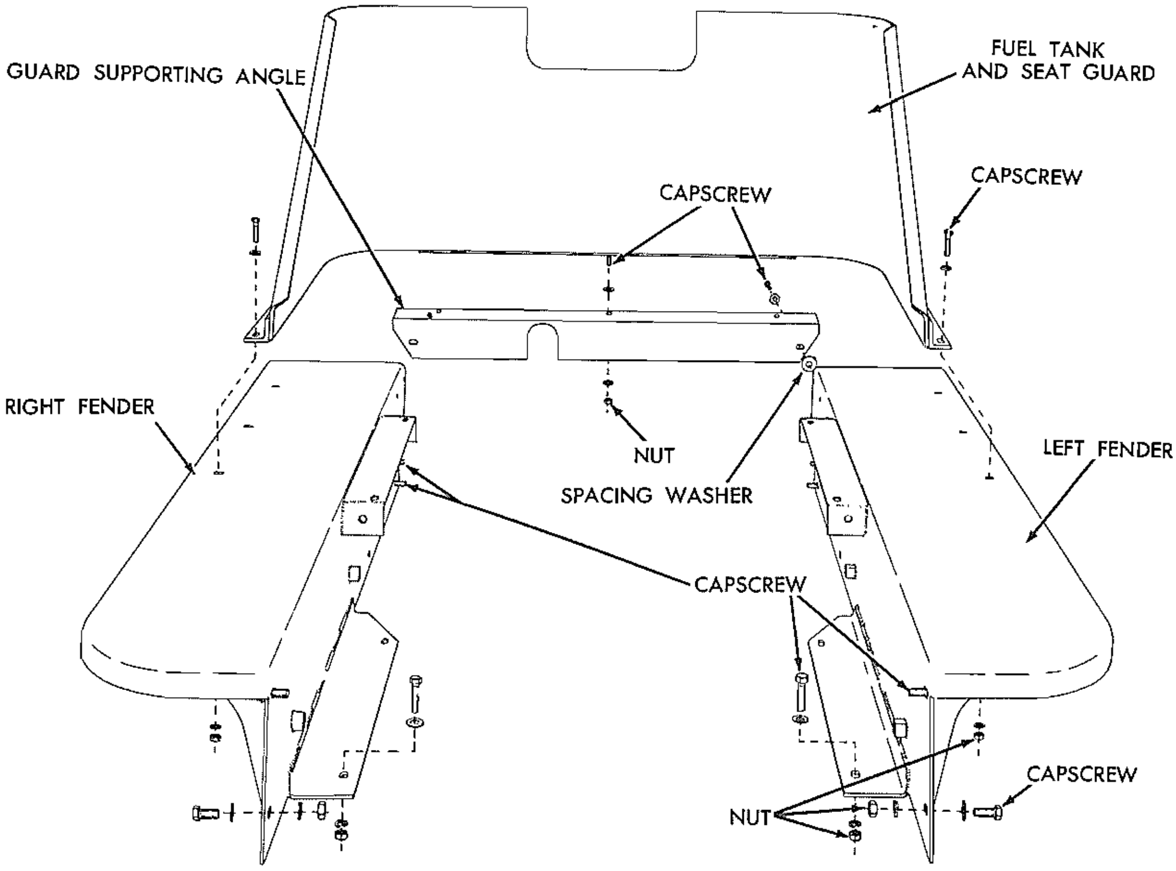

Fig. 1 —Fuel Tank and Seat Guard

1. Heavy Fenders

Heavy rear fenders replace the standard rear fenders and serve as mountings for the battery boxes, fuel tank, and the fuel tank and seat guard.

2. Fuel Tank and Seat Guard Group

The fuel tank and seat guard group consists of a heavy guard and supporting 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.

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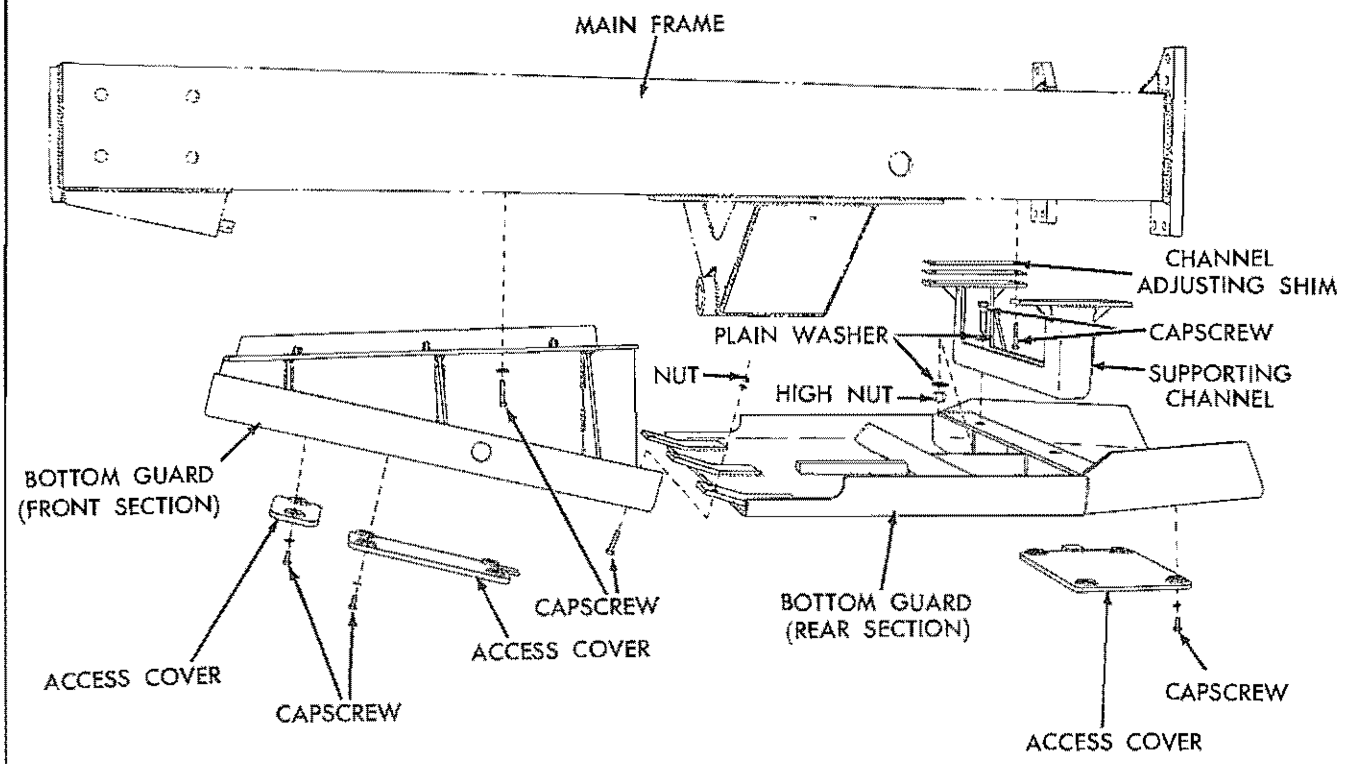

Fig. 2 — Bottom Guards

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 transmission 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; the attaching capscrews should be kept tight (refer to Fig. 2).

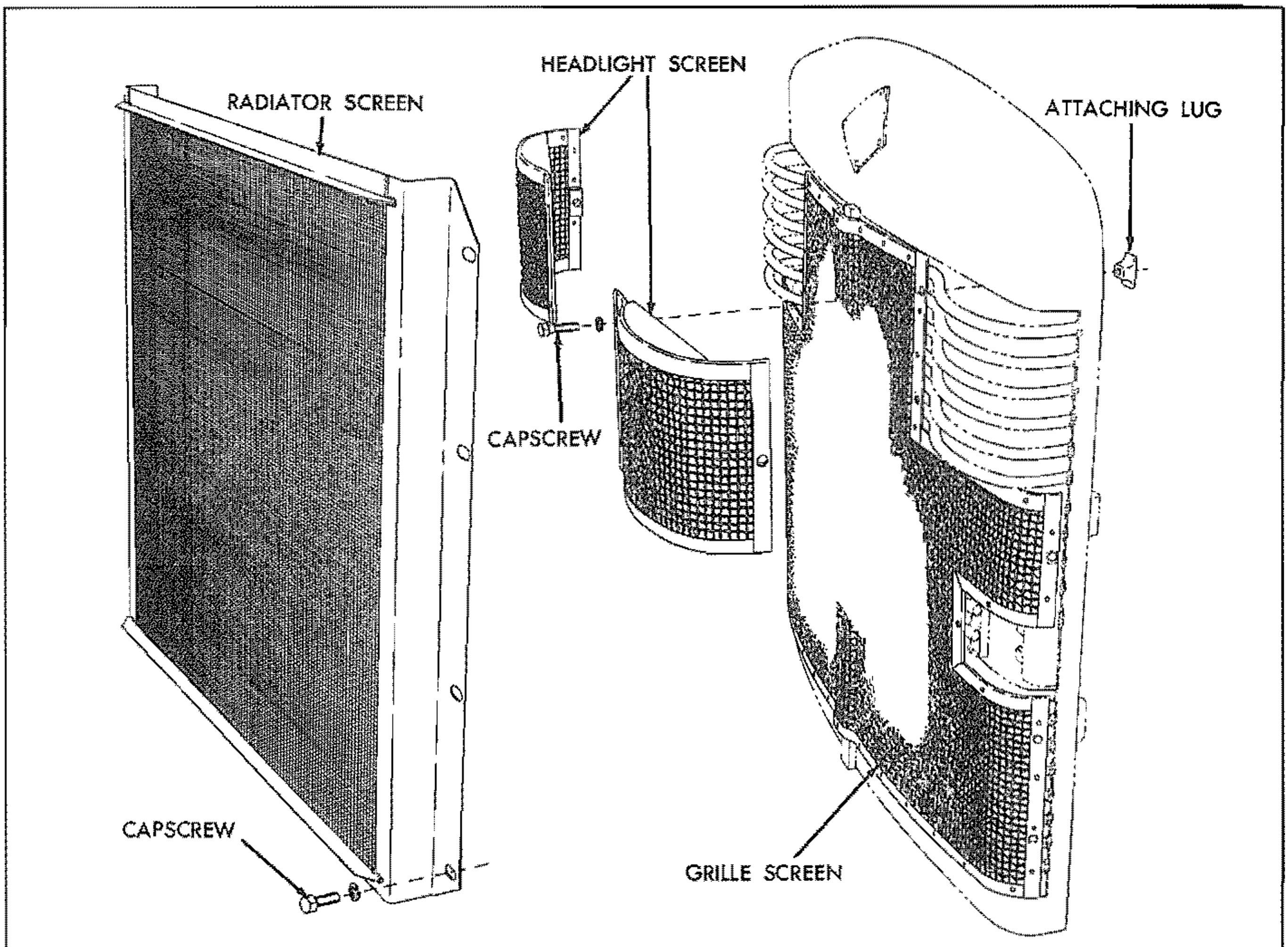

Fig. 3 — Radiator and Grille Screens

4. Grille Screen — Heavy Mesh

The heavy mesh grille screen (for Models HD-9B and HD-9F) is attached to the outside of the hinged type radiator grille and does not interfere with the opening and closing of the grille. NOTE: *This screen is not to be used on tractors equipped with a push type fan.*

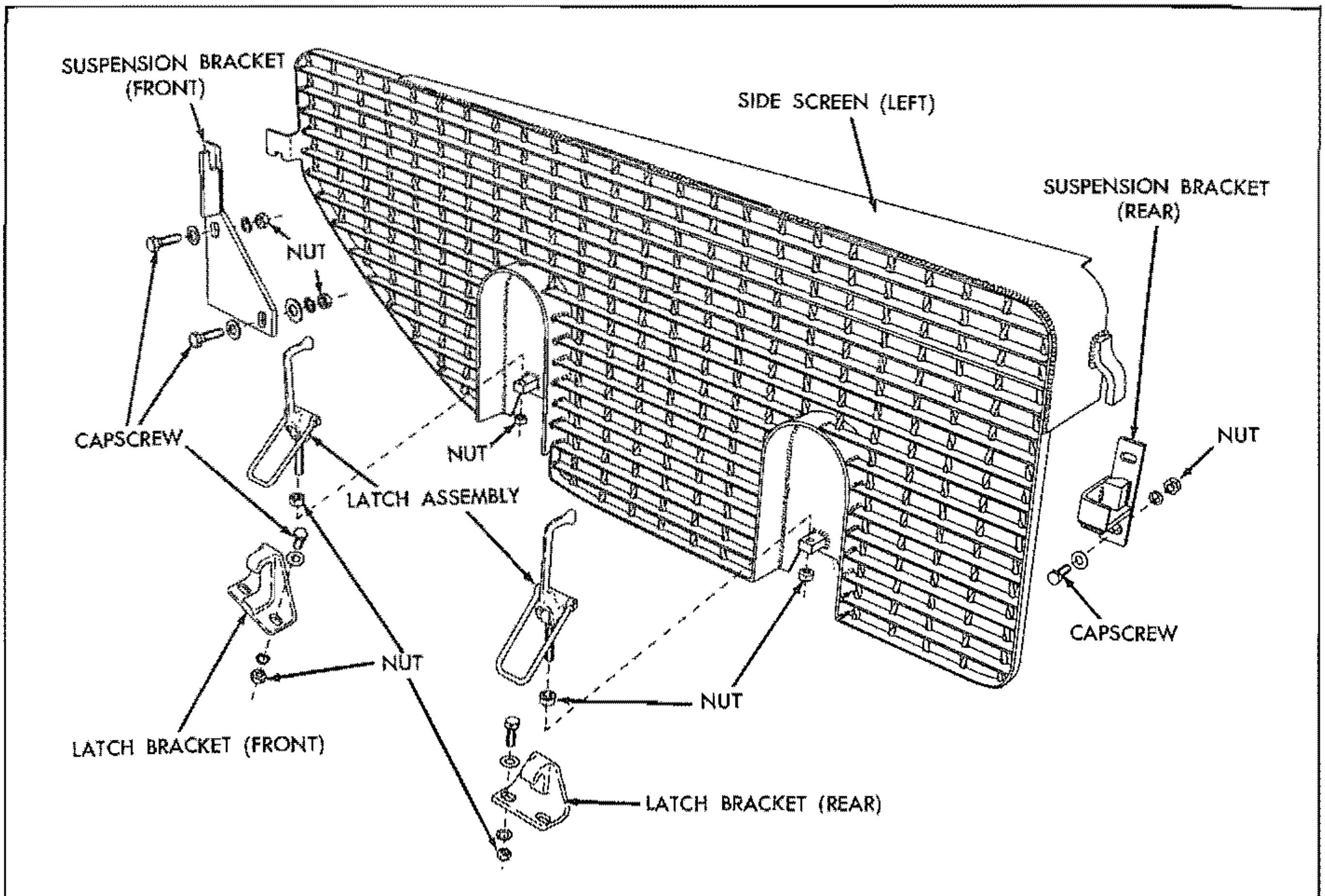

Fig. 4 — Engine Side Screens

5. **Engine Side Screens**

The engine side screens (for the Model HD-9B only) fasten to the front fenders, radiator shell, and the cowl. The screens protect the engine from debris with a minimum of air restriction. *NOTE: The side screens cannot be used on tractors equipped with hydraulic dozers.*

B. Radiator Screen — Fine Mesh

The fine mesh radiator screen (for Models HD-9B and HD-9F) is attached to the front of the radiator shell, along with the radiator assembly. *NOTE: This screen is not to be used on tractors equipped with a push type fan.*

3. HOOD SIDE PLATES

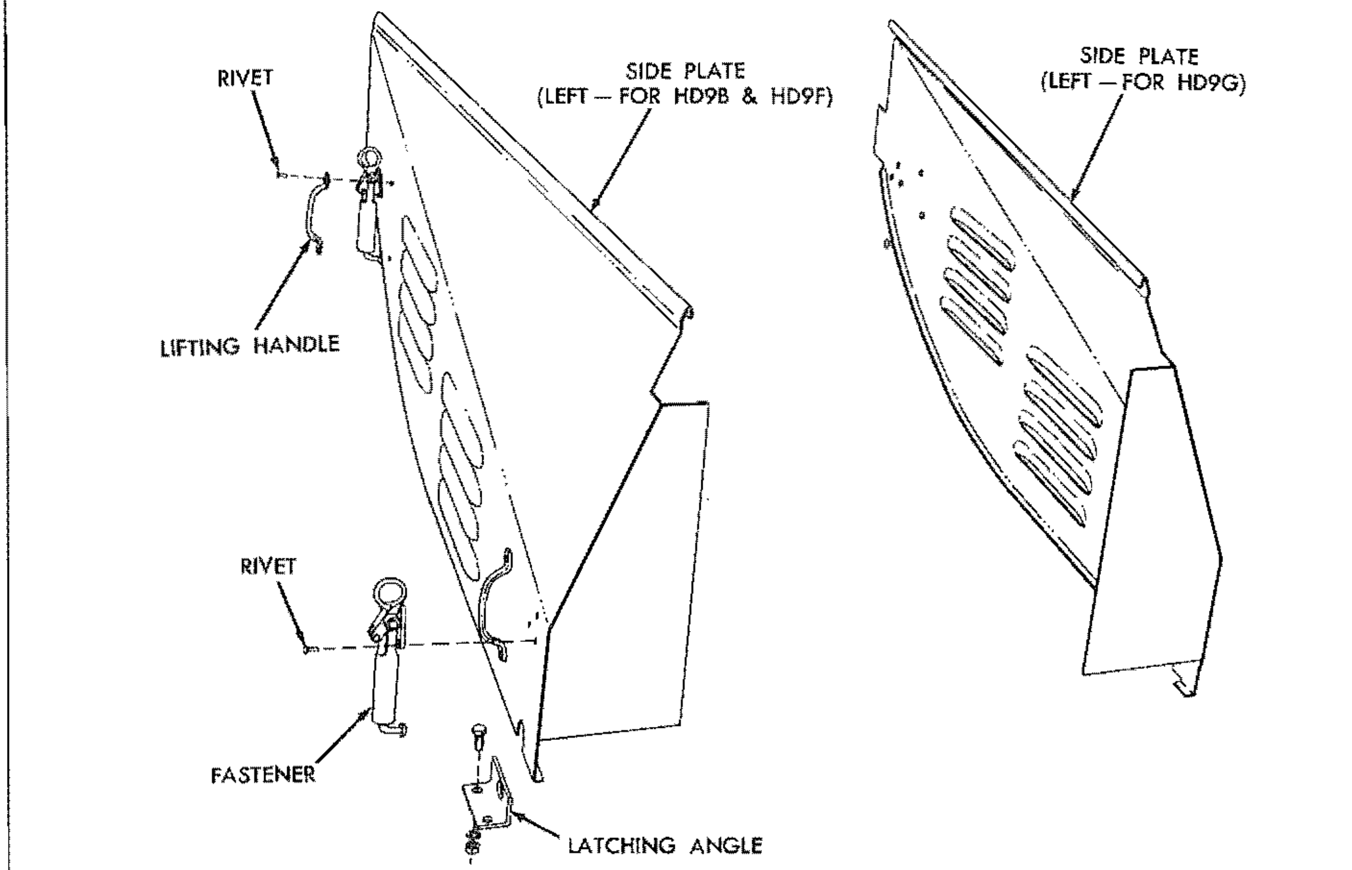

Fig. 5—Hood Side Plates

Hood side plates with louvers are available for cold weather use. The hood side plates hook to the engine hood and fasten to the front fenders with over-center spring loaded snap fasteners. *NOTE: The side plates cannot 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. *NOTE: All Model HD-9G tractors Serial Nos. 554 and above are equipped with the pusher type fan.*

Installation

Remove the suction fan and fan spacer (refer to "REMOVAL OF FAN," Section IV). Discard the fan spacer and suction fan attaching capscrews. Install the pusher type fan and secure with four (4) 5/16" NC x 1" capscrews and lockwashers.

5. CAB GROUP

The cab group is an all steel enclosure with rubber mounted, safety glass windows. The cab is for use on the Model HD-9B Tractor only. When installing a cab on the tractor it is recommended that heavy fenders be used.

A. Description

The hour meter is a spring driven, electrically energized clock which records the number of hours the engine has operated. The pressure switch, controlled by the engine oil pressure, closes the clock-winding circuit whenever the engine oil pressure is above 3 pounds. Therefore, the clock cannot wind when the engine is not running; the clock may continue to run as much as 3 minutes after the engine stops. 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:

1 9 5 5

Used 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

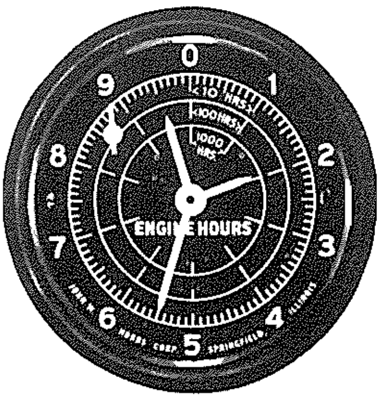

Fig. 6 — Engine Hour Meter (Reading — 1955 Hours)

B. Installation

1. Remove the instrument hole cover from the lower right corner of the instrument panel. Install the hour meter in the opening and secure with three (3) thread-cutting screws and lockwashers.

2. Remove the pipe plug from the oil pressure gage tee and install the hour meter pressure switch.

3. Refer to Fig. 7 and connect the hour meter ground cable to the screws attaching the dash light base to the instrument panel. Connect the other cable of the hour meter to the pressure switch terminal. Connect the pressure switch-to-ammeter cable to the other terminal of the pressure switch and to the left terminal of the ammeter.

C. Inspection

Periodically, inspect the hour meter cables for poor connections, broken cables, and frayed or oil soaked cable insulation and make the necessary repairs.

D. Checking of Pressure Switch

Disconnect the pressure switch-to-hour meter cable from the terminal of the pressure switch. Connect one cable of a 12-volt test lamp (a 12-volt tail light may be used) to the pressure switch terminal from which the hour meter cable was disconnected. Ground the other end of the test lamp cable to the engine or main frame. Start the engine. If the test lamp fails to light (with engine oil pressure between 25 and 45 psi) the pressure switch is inoperative, and must be replaced.

If the pressure switch and cables 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 your nearest "Allis-Chalmers" Industrial Dealer for a trade-in allowance on a new meter.

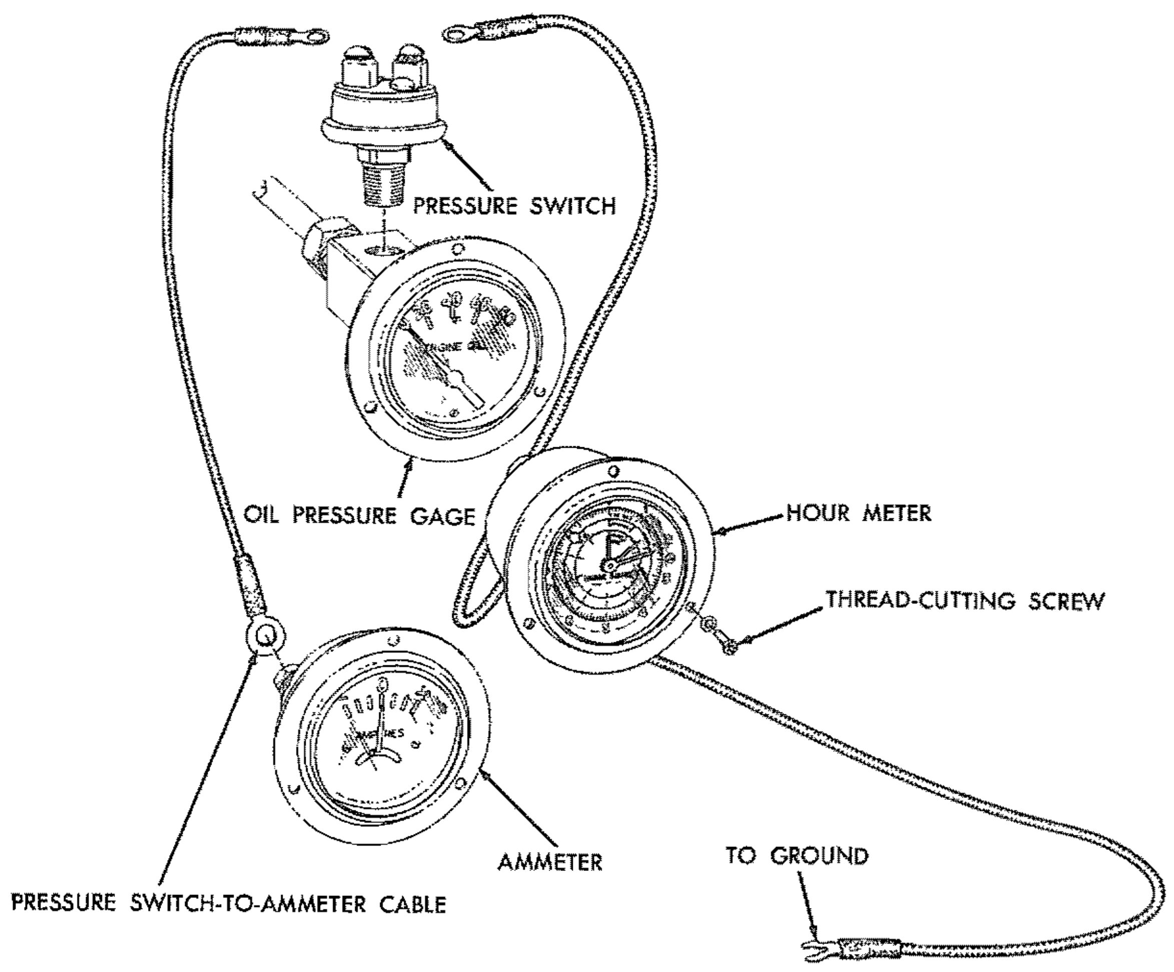

Fig. 7 — Engine Hour Meter, Pressure Switch, and Cables

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 the flood light and tail light use the same mounting bracket on the fuel tank, both cannot be installed at the same time.

To Install Tail Light or Rear Flood Light

1. Install light mounting plate, mounting bracket, and light in position on the welded bracket located on the front of the fuel tank, near the upper left hand corner.

2. Connect the terminal end of the rear section cable to the terminal connection of the light.

3. Remove the floor plate. Thread the front section cable along the inside of the left fender and main frame (terminal end toward the front) and through the bottom of the cowl to the tractor light switch. Attach the terminal of the cable to the terminal of the light switch. Install the fuse in the fuse holder and connect the two cables together at the fuse holder. Install the cable clips and attach the clips to the cowl, main frame, and left rear fender.

4. Install the floor plate.

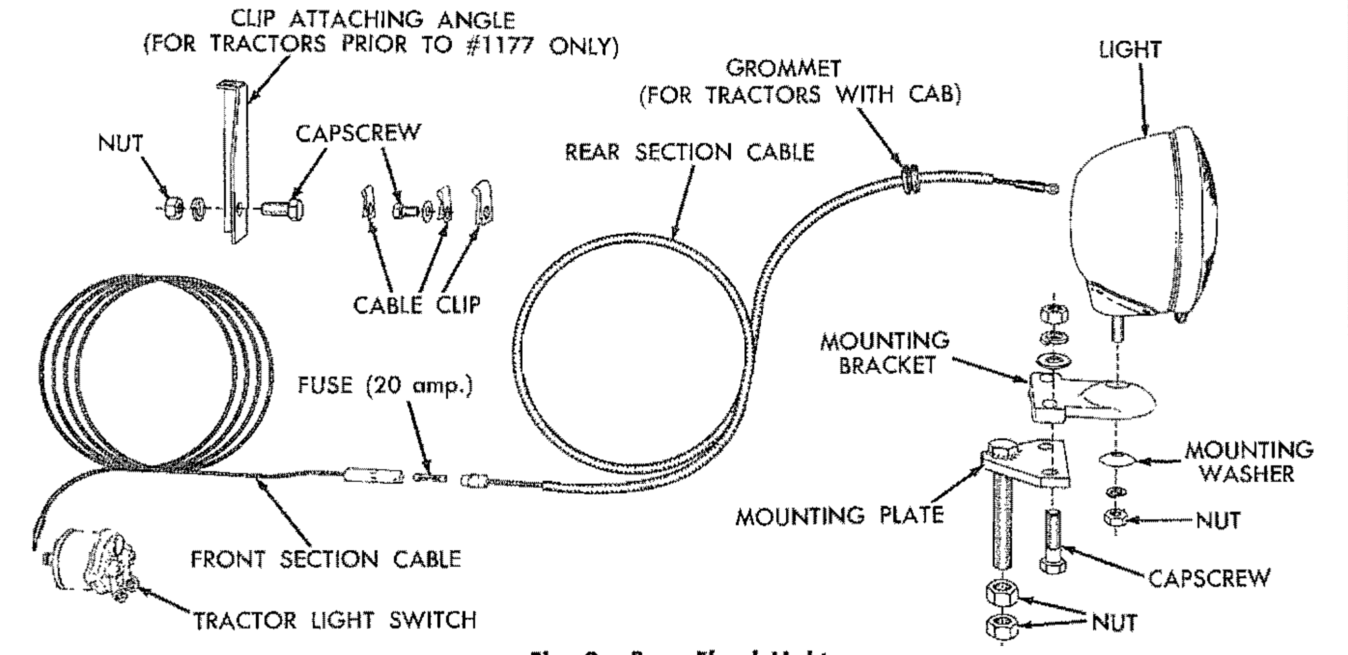

Fig. 8 — Rear Flood Light

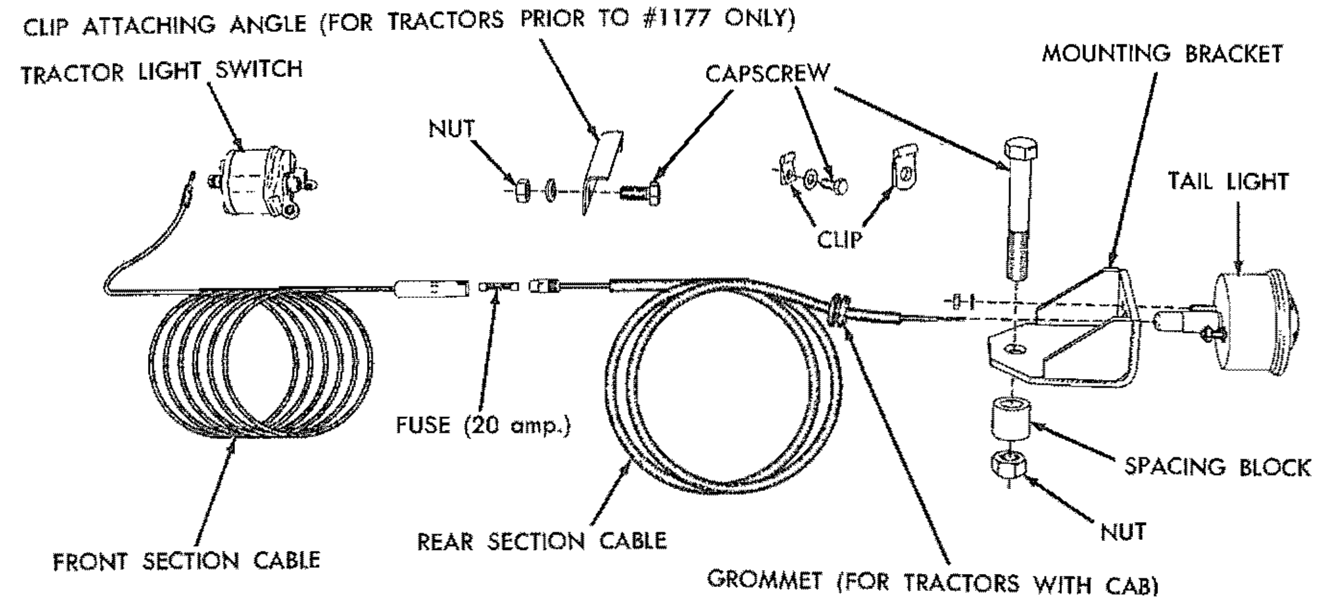

Fig. 9—Tail Light

8. POWER PULLEY AND POWER TAKE-OFF

A. Power Pulley

The power pulley is mounted to the rear of the steering clutch and final drive housing and is driven by the transmission top shaft. The pulley is 13⅜ inches in diameter and rotates clockwise (viewed from left side of tractor) at 929 R.P.M. at 1600 R.P.M. engine speed.

B. Straight Rear Power Take-Off

The straight rear power take-off is mounted to the rear of the steering clutch and final drive housing and is driven by the transmission top shaft. The output shaft rotates counterclockwise (viewed from rear of tractor) at the same speed as the engine.

C. Reversible Reduction Power Take-Off

The reversible reduction power take-off is mounted to the rear of the steering clutch and final drive housing and is driven by the transmission top shaft. The output shaft rotates clockwise at 430 R.P.M. and counterclockwise at 335 R.P.M. at 1600 R.P.M. engine speed.

9. MISCELLANEOUS

In addition to the above special equipment, several other items, as described below, are available.

A. Radiator Curtain

The radiator curtain is used with other special equipment for cold weather operation. Its purpose is to help control the engine operating temperature. The curtain cannot be used when the tractor is equipped with a pusher type fan.

B. Engine Pre-Heater

The pre-heater is a portable "DIESEL" fuel torch equipped with an electric blower. It is used to pre-heat the engine internally under conditions of extreme cold.

C. Engine Air Pre-Cleaner Extension

The pre-cleaner extension is for use when the tractor is operated under extremely dusty or sandy conditions.

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 and pitted rollers and races.

2. Inspect the outside of the bearing cup (outer race) and the inside of the cone (inner race) for marks which indicate creepage.

3. Always set up a tapered roller bearing in accordance with the specifications. *IMPORTANT: DO NOT EXPERIMENT.* A properly set up tapered roller bearing will give satisfactory service for a very long time, while a bearing pre-loaded too much or set up too loose may fail in a comparatively short time.

4. Lubricate the bearings at assembly with clean lubricant.

C. Needle Bearings

Needle bearings are used primarily in place of bushings where an oscillating motion is present. They are seldom used on a revolving part.

1. Thoroughly clean and inspect the rollers for wear or damage.

2. Inspect the needle retaining cage for dents which may interfere with the free rolling of the needles.

3. Be sure that the needles or rollers are not "cocked" in the cage and rotate each needle individually to be sure that it will turn.

4. Lubricate or pack the bearings at assembly with clean lubricant.

D. General

1. Do not use a bearing which is in bad con-

dition except in emergencies.

2. Keep all bearings spotlessly clean and well lubricated to prevent rusting.

3. Use a press and a suitable sleeve or driver when installing bearings. If these are not available, a cold rolled soft steel rod and hammer may be used to drive the bearings into position.

4. When installing a bearing on a shaft, drive or press on the inner race; when installing it in a bore, drive or press on the outer race.

5. Be careful not to strike the shield, snap ring, or balls when using a rod and hammer to install the bearings.

6. When using a sliding hammer type puller to remove or install an assembly containing tapered roller bearings, be sure that the pull is evenly distributed on the bearing. Do not allow the cup and the cone of the bearings to become separated, as each blow of the sliding hammer, with the cup and cone separated, would cause the cup and the cone to be rammed together and damage to the bearing would result.

E. Bushings

1. Do not remove the bushings for inspection unless the bushings are loose in their bores or are excessively worn, then they must be removed and replaced.

2. Use a press and a suitable sleeve or driver to install the bushings. Ream the bushings to the specified dimensions when reaming is required.

2. SHAFTS AND SPLINES

A. Shafts

Inspect all shafts for worn areas and make certain they are not twisted or bent.

B. Splines

1. Inspect the splines of all shafts for roughness, burrs, and wear. Remove all burrs and slight roughness, from the splines with a stone or mill file.

2. Be sure the splines of all shafts are smooth and try all the sliding gears on their respective shafts to be sure that they slide freely on the splines.

C. Detents

Inspect the detent notches in the transmission shifting fork shafts. Make certain the detent balls have been entering the detent notches. Remove any burrs or roughness on the shifting fork shafts with a stone or mill file.

3. SHIFTING FORKS

Check the transmission shifting forks for tightness and proper location on the shifting fork shafts and make certain the forks are not bent as indicated by uneven wear. Observe the side faces of the forks for wear and roughness; also, check the shifting grooves in the shifting collars in which the forks operate. Remove any roughness on these parts with a stone or mill file. Refer to "FITS AND TOLERANCES," Section XXII, for tolerances when new.

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4. OIL SEALS

A. Lip Type

1. When any work has been done which involves the removal of a shaft from an oil seal or the removal of an oil seal from its bore, the sealing lip of the seal must be carefully examined.

2. The sealing lip must not be scratched, folded over, torn, or charred from heat. The lip must be flexible and the spring, located inside the lip, must have the proper tension to return the lip to its proper position when the lip is pressed in by hand.

3. Be sure that the surface of the shaft contacted by an oil seal is smooth and free from tool marks or burrs.

4. When installing an oil seal on a shaft, or a shaft through an oil seal, be sure to protect the sealing lip from damage which might be caused from a keyway, splines, threads, or a hole through the shaft. A small scratch or cut, or a fold in the lip of the seal, will render the seal useless.

   Use an oil seal installing bushing, or a thin sheet of stiff paper wrapped around the sharp portion of the shaft, then slide the seal over the bushing or paper.

5. Use an oil seal installing tool or a press when installing seals into their bores, to prevent damage to the outer case of the seals. If the proper installing tools are not available, a smooth piece of 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 oil seal is to be installed, always soak it in warm engine oil for about 1 hour before installing. This will lubricate the sealing lip and make the lip pliable.

B. Positive Type

1. The sealing surfaces of the seal rings (positive type) must be smooth and flat. 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 clean engine oil.

2. Check the seal boot (rubber) for cracks and be sure that it is securely cemented to the seal spring follower assembly and the seal ring.

3. Check the seal spring follower assembly and make certain the 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 the gasket and inspect it for damage. If it is in good condition, and is to be used again, immerse it in a container of oil and keep it in the container until it is needed.

2. Do not use a gasket which is torn, hardened, or shrunken out of shape.

6. GEARS

1. Thoroughly clean and inspect all gears for worn, pitted, chipped, or cracked teeth.

2. Check the internal splines for galling, roughness, and wear.

7. HOSES

Inspect all water and air hoses, fuel lines, and lubricating oil lines for leaks and signs of collapsing and deterioration of the rubber on the inside of the hoses. Replace if necessary.

8. WIRING

1. Do not allow the insulation of the cables to become soaked with fuel or lubricating oil.
2. Wrap all frayed spots of the insulation with tape.
3. Keep all terminals and connections clean and tight.

9. BATTERIES

1. Keep the batteries clean and maintain the level of the electrolyte solution ⅜" above the battery plates by the addition of clean distilled water.
2. Be sure that the battery hold-down assemblies are tight so that the botteries do not shift around in their compartments.
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) anti-freeze solution should be used in freezing weather.
2. Remove all leaves and other debris from the air passages of the radiator. *IMPORTANT: DO NOT PAINT THE RADIATOR CORE.*
3. Keep the radiator and the radiator shell mounting bolts properly tightened.

11. FILTERS

1. Fuel filter elements should be changed after every 300 to 500 hours of operation or when the filters become clogged and a pressure of less than 20 pounds is indicated by the fuel pressure gage. Engine oil filter elements should be changed each time the oil in the crankcase is changed, or more often if conditions warrant.
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 "Sealastic" fittings only tight enough to prevent leakage. If the fittings are drawn up too tight they will be damaged and must be replaced.
2. Always be sure that the 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 and tighten 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.

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. 4A-19529	.002″ to .006″	
8. Height of cylinder block above cylinder liner—Effective with Engine Serial No. 4A-19529	.046″ to .050″	
9. Allowable difference between any two adjacent cylinder liners measured from top of liner to top flat surface of cylinder block—Prior to Engine Serial No. 4A-19529	.002″	

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Description	Size of New Parts	Install New Parts When Clearance Exceeds
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″
C. Piston Rings — Compression		
1. Number of rings and width	4 — ⅛″	
2. Gap between ends — fitted	.025″ to .040″	
3. Clearance in groove		
Upper ring	.010″ to .0125″	.022″
2nd ring from top	.008″ to .0105″	.015″
3rd and 4th rings from top	.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″	.008″
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	5	
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″	

Description	Size of New Parts	Install New Parts When Clearance Exceeds
G. Connecting Rod Bearings		
1. Width of shell	1⅞″	
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″	
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		
Prior to Engine Serial No. 4A-19529	45°	
Effective with Engine Serial No. 4A-19529	30°	
3. Width of valve face	3/16″	
4. Valve lash	.009″ at normal 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 cylinder head		
Prior to Engine Serial No. 4A-19529	— .004″ to + .017″	
Effective with Engine Serial No. 4A-19529	— .005″ to + .014″	
J. Exhaust Valve Insert		
1. Seat angle		
Prior to Engine Serial No. 4A-19529	45°	
Effective with Engine Serial No. 4A-19529	30°	
2. Seat width		
Prior to Engine Serial No. 4A-19529	5/64″ to 7/64″	
Effective with Engine Serial No. 4A-19529	1/16″ to 3/32″	

Description	Size of New Parts	Install New Parts When Clearance Exceeds
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 when installed	.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 (transverse movement)	.0005″ to .0016″	.015″
N. Gear Train		
Backlash of gears in gear train	.003″ to .008″	Replace gears that have excessive backlash and that are pitted or scored
O. Balance Shaft		
1. Inside diameter — end bearings	1.500″ + .001″, — .000″	
2. Outside diameter — shaft journals	1.4980″ + .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. Oversize thrust washers available for service	.010″	
P. 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. Oversize thrust washers available for service	.010″	
8. Undersize end bearings available for service	.010″, .020″	
9. Undersize intermediate bearings available for service	.010″	

Description	Size of New Parts	Install New Parts When Clearance Exceeds
Q. Blower		
1. Clearance — rotors to front end plate (governor end)	.009″ minimum	
2. Clearance — rotor to rear end plate (gear end)	.007″ minimum	
3. Clearance of rotors — between leading side of upper rotor and trailing side of lower rotor	.014″ 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 rotor lobes and inside of housing (outlet side)	.004″ minimum	
7. Clearance between rotor lobes and inside of housing (inlet side)	.016″ minimum	
R. Blower Drive		
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	.005″ to .008″	.010″
5. Backlash — blower drive gear with camshaft gear . .	.003″ to .008″	Replace gears that have excessive backlash and that are pitted or scored
S. 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	.005″ to .008″	.010″
4. Backlash — intermediate gear with crankshaft gear . .	.005″ to .020″ (adjustable by shims)	

Description	Size of New Parts	Install New Parts When Clearance Exceeds

T. Torque Wrench Specifications (Engine)

Application	Torque — Lbs. Ft.
Injector clamp nuts	20 - 25
Exhaust muffler nuts	30 - 35
Injector control tube bracket bolts	10 - 12
Camshaft follower roller guide bolts	12 - 15
Cylinder block hand hole cover bolts	12 - 15
Air intake housing-to-blower housing bolts	16 - 20
Flywheel housing bolts	
⅜" N.F.	25 - 30
½" N.C.	90 - 100
Blower-to-cylinder bolts — size — 7/16" N.C.	55 - 60
Engine lifting bracket bolts	55 - 60
Connecting rod nuts	65 - 75
Rocker shaft bracket bolts	90 - 100
Flywheel-to-crankshaft bolts	150 - 160
Cylinder head nuts	165 - 175
Main bearing bolts	180 - 190
Blower rotor gear retaining bolts	25 - 30
Crankshaft end bolt	180 - 200
Cam and balance shaft nuts	300 - 325
Bearing retainer-to-idler gear bolts	24 - 29
Flywheel housing-to-idler gear hub and dummy hub bolts	25 - 30
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
Crankshaft front cover bolts	25 - 30

3. ENGINE CLUTCH

Thickness of driven plate assembly	
HD-9B and HD-9F Tractors	.458" to .486"
HD-9G Tractors (serial No. 5127 and above — "CERAMIC" type)	.458" to .470"

Description	Size of New Parts	Install New Parts When Clearance Exceeds

4. TRANSMISSION

Description	Size of New Parts	Install New Parts When Clearance Exceeds
1. Fit of transmission case pilot in bore of steering clutch housing	.002" to .005" loose	
2. Clearance between bevel pinion shaft front bearing and bearing cover	.000" to .002"	
3. Backlash between bevel pinion teeth and bevel gear teeth	.006" to .012"	
4. Width of shifter fork grooves in all shifting collars of transmission	.432" to .442"	
5. Thickness of all shifter fork prongs in transmission	.412" to .422"	
6. Clearance of shifter fork prongs in grooves of shifting collars	.010" to .030"	
7. Specified torque for tightening transmission bevel pinion front bearing retaining nut	480 to 520 lbs. ft.	
8. Specified torque for tightening transmission top shaft nut	175 to 200 lbs. ft.	
9. Specified torque for tightening transmission intermediate shaft nuts	180 to 220 lbs. ft.	

5. BEVEL GEAR AND STEERING CLUTCHES

Description	Size of New Parts	Install New Parts When Clearance Exceeds
1. Pre-load of steering clutch and bevel gear shaft bearings	10 to 25 in. lbs. or .002" to .004" tight	
2. Backlash between bevel gear teeth and bevel pinion teeth	.006" to .012"	
3. Specified torque for tightening steering clutch driving hub retaining capscrew	300 lbs. ft.	
4. Specified torque for tightening bevel gear attaching nuts	168 - 178 lbs. ft.	
5. Specified standout of face of steering clutch hub flange to face of clutch throwout in assembly	7/32" + or — .065"	
6. Specified thickness of steering clutch internal tooth friction disc	.083" to .096"	
7. Specified thickness of steering clutch external tooth friction disc	.152" to .157"	
8. Assembled height of steering clutch pressure spring	3-11/16"	
9. Pounds load of steering clutch pressure spring at 3-11/16" height	275 to 305 per spring	

Description	Size of New Parts	Install New Parts When Clearance Exceeds

6. FINAL DRIVES

1. Pre-load of final drive pinion shaft bearings	10 to 20 in. lbs. or .002" to .003" tight	
2. Pre-load of final drive intermediate pinion bearings ..	10 to 20 in. lbs. or .002" to .004" tight	
3. Pre-load of final drive sprocket shaft bearings	10 to 20 in. lbs. or .002" to .003" tight	
4. Pre-load of final drive sprocket shaft outer bearing ..	8 to 13 in. lbs. or .001" to .002" tight	
5. Specified torque for tightening drive sprocket retaining nut	3500 to 4000 lbs. ft.	
6. Specified torque for tightening brake drum hub retaining capscrew	300 lbs. ft.	

7. TRUCK WHEELS, TRACK SUPPORT ROLLERS, AND TRACK IDLERS

1. Pre-load of shaft bearings	15 to 45 in. lbs.	
2. Standout — each end of track idler shaft to outer face of idler bracket in assembly	.395" to .400"	

8. TRACKS

Specified torque for tightening track shoe bolts	250 to 260 lbs. ft.	

SECTION XXIII—TROUBLE SHOOTING

This section contains trouble shooting information and outlines tests which can be made to determine some of the troubles that may develop in the tractor when the tractor is used under average working conditions. Each symptom of trouble is recorded under the individual unit or system of the tractor 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 or seized. Broken piston rings, gears, etc., may also be the cause of the locking. The engine should be disassembled to determine the cause and the necessary parts replaced.

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 (refer to "ELECTRICAL SYSTEM" in Section VII).

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 starter 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

Make certain the throttle lever is pulled all the way back (high speed position). Check the adjustment of the engine shut-off controls and governor linkage (refer to "GOVERNOR AND ENGINE CONTROLS" in Section VI).

3. Insufficient Supply of Fuel to Injectors

Refer to "ENGINE FUEL SYSTEM" in Topic 3 of this Section.

4. Blower Not Turning

Refer to "ENGINE AIR INTAKE SYSTEM" in Topic 4 of this section.

5. Water in Air Box

(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. Cylinder Cutting Out

Locate a "missing" cylinder as follows:

a. Remove the engine hood and the 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 fuel 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 functioning properly. If no decrease in engine speed is noted, the injector is inoperative and should be removed for inspection.

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. If fuel flows from the injector while the starter is cranking the engine, this indicates that fuel is reaching the injector but is not being injected into the cylinder. Remove the injector for inspection (refer to "ENGINE FUEL SYSTEM" in Section II).

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 suitable compression tester and check each cylinder as follows:

a. Remove the engine hood and rocker arm cover.

b. Start with No. 1 cylinder when checking the compression. Remove the fuel lines from both the injector and the fuel connectors for that cylinder.

c. Remove the injector and install the compression tester 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 compression tester, start the engine, run it at approximately 500 R.P.M., and take a reading on the tester gage. *NOTE: Do not check the compression by cranking the engine with the starter.*

e. Perform this same operation on the remaining cylinders. The compression pressure of any one cylinder should not be below 385 psi 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	410 lbs./sq. in.
4	405 lbs./sq. in.

Note that the compression pressure in No. 1 cylinder falls considerable below the pressure in the other cylinders, indicating a compression leak in No. 1 cylinder. In this case, the cylinder head must be removed, the exhaust valves and seats inspected for leaks, the valve stems for wear and sticking, and check 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 tester 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 "ENGINE FUEL SYSTEM," in Topic No. 3 of this section.

6. Air Cleaner Restricted

Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

7. Clogged Fuel Filters

Refer to "ENGINE FUEL SYSTEM," in 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, refer to "ENGINE FUEL SYSTEM," in 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. Fuel Injector Controls Sticking

Remove all bind from the injector control tube and linkage. Make certain that the injector racks move freely without bind (refer to "ENGINE FUEL SYSTEM" in Section II).

3. **Restricted Fuel Filters, Air in Fuel System, or Malfunctioning Injectors**

Refer to "ENGINE FUEL SYSTEM," in Topic No. 3 of this Section.

E. UNEVEN RUNNING AND EXCESSIVE VIBRATION

1. **Faulty Fuel Injector Equalizing or Timing**

Refer to "ENGINE FUEL SYSTEM" in Section II.

2. **Fuel Supply Erratic or Insufficient**

Refer to "ENGINE FUEL SYSTEM," in Topic No. 3 of this Section.

3. **"Surging" Governor**

Check the adjustment of governor buffer spring and the control linkage (refer to "ENGINE CONTROLS AND GOVERNOR" in Section VI).

4. **Exhaust Valves in Bad Condition**

Recondition exhaust valves (refer to "ENGINE" in Section IX).

5. **Engine Temperature Too Low**

An operating temperature of 160° to 185° F. should be maintained. Check the thermostat and replace if necessary.

6. **Cylinder Cutting Out**

Refer to "LOSS OF POWER," Paragraph C, sub-topic 3 in this Section.

7. **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 fuel injectors, incorrectly timed fuel injectors, leaking fuel connections in the cylinder head with accompanying crankcase dilution, oil pull over from the air cleaner, clogged cylinder block 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 specifications.

2. **Malfunctioning Fuel Injectors or Incorrect Timing or Equalizing**

Refer to "ENGINE FUEL SUPPLY SYSTEM" in Section II.

3. **Air Box Handhole Cover Plate Gasket Ruptured**

Install a new gasket.

4. **Air Ports in Cylinder Liners Restricted**

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 Pipe Restricted**

Remove the air cleaner oil cup and the pre-cleaner. Swab out the inside of the air cleaner pipe (refer to "ENGINE AIR INTAKE SYSTEM" in Section III).

6. **Engine Shut-Off Controls Out of Adjustment**

Refer to "GOVERNOR AND ENGINE CONTROLS" in Section VI.

H. BLUE SMOKE EXHAUST

1. Engine Temperature Too Low

Inspect the thermostat, test it for proper action, and replace if necessary.

2. Fuel Injector Racks Improperly Positioned

Refer to "ENGINE FUEL SYSTEM" in Section II.

3. Cylinder Cutting Out

Refer to "LOSS OF POWER," Paragraph C, sub-topic 3 in 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 cleaner, or oil level being above "FULL" mark on crankcase oil level 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 (refer to "ENGINE COOLING SYSTEM" in Section IV).

3. Fan Drive Belts Loose

Adjust the drive belts (refer to "ENGINE COOLING SYSTEM" in Section IV).

4. Water Pump Inoperative

Repair or replace the water pump (refer to "ENGINE COOLING SYSTEM" in Section IV).

5. Tractor Overloaded

Lighten load on tractor.

6. Oil Cooler Clogged

Clean or replace the oil cooler core (refer to "ENGINE LUBRICATING SYSTEM" in Section V).

J. EXCESSIVELY FAST WEAR ON ENGINE PARTS

1. Oil of Unsuitable Grade, Composition, or Viscosity

Change to a 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 "OPERATORS MANUAL."

4. Insufficient Oil

Maintain the crankcase oil level to the "FULL" mark on the oil level gage rod.

5. Air Cleaner Not Serviced Properly or Damaged

Inspect the air cleaner body and the air cleaner inlet pipe for cracks. Make certain all hose connections are tight and that air cannot enter the blower without passing through the filtering oil in the air cleaner. Service the cleaner as instructed in the "OPERATORS MANUAL."

2. ENGINE STARTING SYSTEM

A. STARTER WILL NOT CRANK THE ENGINE

1. Batteries Weak

Inspect and test the batteries.

2. Cables or Connections Loose or Corroded

Make certain that the 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.

5. 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 7 below.

6. 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 the 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.

7. 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.

8. Armature Burned Out

Replace the armature.

9. Starter Switch Inoperative

Contact surfaces may be burned out or not making contact. Disassemble, clean the contacts, reassemble, and adjust the switch lever (refer to "ELECTRICAL SYSTEM" in Section VII).

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 "ELECTRIC SYSTEM" in Section VII.

3. Broken Parts

Replace broken or excessively worn parts.

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 20 to 55 P.S.I. 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. Insufficient supply of fuel may be due to any of the following conditions:

a. Insufficient fuel in fuel tank.

b. Air being drawn into the system on the suction side of the fuel pump.

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.)

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 Pipe 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 air ports (refer to "ENGINE AIR INTAKE SYSTEM" in Section III).

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

This condition is due to the air shut-off valve not closing properly. Adjust the air shut-off control linkage (refer to "ENGINE AIR INTAKE SYSTEM" in Section III).

D. OIL IN AIR BOX OF CYLINDER BLOCK

1. Blower Housing Gasket Leaks

Install new gasket (refer to "ENGINE AIR INTAKE SYSTEM" in Section III).

2. Blower Oil Seals Leak

Install new oil seals (refer to "ENGINE AIR INTAKE SYSTEM" in Section III).

3. Air Box Drains Clogged

Remove the obstructions from the drain tubes (refer to "ENGINE AIR INTAKE SYSTEM" in Section III).

4. Oil Level in Air Cleaner Oil Cup Too High

Fill air cleaner oil cup to the proper level.

E. RAPID WEAR ON ENGINE PARTS

1. Dirt Admitted with Air

Inspect the air cleaner body and the air cleaner pipe and connections *THOROUGHLY*, to detect any cracks or openings which would allow air to pass into blower and enter the engine, without first passing through the air cleaner.

2. Dirty Lubricating Oil

Change engine oil and lubricating oil filter elements regularly. Keep oil clean when filling engine.

3. Improper Fuel

Use the proper fuel (refer to "SPECIFICATIONS OF FUEL" 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

Inspect the radiator for debris in the air passages, for clogged water passages, inoperative water pump, loose or broken fan drive belts. Check the thermostat for proper operation. 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 and for repair or replacement of inoperative units.

2. Overheating Due to Loss of Coolant

a. After the engine has been allowed to cool down to normal operating 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 for loss of coolant. If oil is present in the coolant of the cooling system, remove and inspect the oil cooler core and the cylinder head. If water is present in the engine crankcase oil, inspect the water pump. The water pump body is provided with an opening below the pump shaft; in the event of pump seal leakage, the water will drain through this opening. 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 seal leakage.

c. Seals on injector copper tubes leaking (refer to "ENGINE FUEL SYSTEM" in Section II).

B. ENGINE DOES NOT REACH NORMAL OPERATING TEMPERATURE

1. Operation in Arctic Temperatures

It is very important that the operating temperature of the engine 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, when operating properly, closes when the engine temperature decreases and allows the coolant to circulate through the engine only; when the temperature of the coolant again reaches approximately 158° F., the thermostat begins to open and is fully opened at 185° F. When the thermostat opens, the coolant is allowed to circulate through the radiator and is thus cooled. If the thermostat sticks in the open position, normal operating temperature may not be attained and a new thermostat should be installed. If the thermostat is not at fault, check the accuracy of the engine 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 in Crankcase

Maintain the oil level to the "FULL" mark on the oil level gage rod.

2. Crankcase Oil Diluted by Fuel

Inspect for fuel leaking into the crankcase and correct the cause (refer to "ENGINE FUEL SYSTEM" in Section II).

3. Improper Lubricant

Refer to the "DESCRIPTION AND SPECIFICATIONS" in Section I, for the correct viscosity of oil for the prevailing atmospheric temperature.

4. Worn Bearings

Worn main or connecting rod bearings will cause oil pressure to drop; replace the bearings (refer to "ENGINE" in Section IX).

5. Lubricating Oil Pump Relief Valve or Oil Pressure Regulator Valve Stuck Open

Inspect these valves (refer to "ENGINE LUBRICATING SYSTEM" in Section V).

6. Engine Oil Cooler Core Clogged

Inspect and clean the oil cooler core (refer to "ENGINE LUBRICATING SYSTEM" in Section V).

7. Lubricating Oil Pump Screen Clogged

Remove the oil pan. Remove the oil pump screen and clean the screen (refer to "ENGINE LUBRICATING SYSTEM" in Section V).

8. Lubricating 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. Clogged 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 Cooler 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 is found 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 Bearings

Replace the worn parts (refer to "ENGINE" in Section IX).

12. **Excessive End Clearance of Rocker Arms on Rocker Arm Shafts**

Check and adjust (refer to "ENGINE" in Section IX).

13. **Blower Drive Bearings Loose**

Refer to "ENGINE AIR INTAKE SYSTEM" in Section III.

B. EXCESSIVE OIL PRESSURE

1. **Oil Pressure Regulator 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. **Insufficient Oil in Crankcase**

Maintain the oil to the "FULL" mark on the oil level gage rod.

2. **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. Clean or replace the oil cooler core (refer to "ENGINE LUBRICATING SYSTEM" in Section V).

D. EXCESSIVE OIL CONSUMPTION

1. **Pistons, Rings, and Cylinders Worn**

Examine the engine to determine if these parts are worn, or if the rings are stuck or have excessively wide gaps. Blue smoke, loss of power, and hard starting are indications of this condition.

2. **Oil Leaks**

Inspect for loose connections, damaged gaskets, and loose cylinder block end plates. 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 crankshaft front oil seal can then be seen. Inspect to see if oil drips out of the engine clutch housing; this indicates that the crankshaft rear oil seal is leaking (refer to "ENGINE" in Section IX).

4. **Blower Gasket or Oil Seals Leaking**

Inspect the gaskets and 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 piston pins. Correct this condition by removing the pistons and bending the ends of the retainer snap rings in to exert more pressure against the pin retainers. If the pin retainers are worn, replace with oversize retainers (refer to "ENGINE" in Section IX).

6. **Oil Too Light**

Change to oil of proper viscosity for the prevailing atmospheric 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. **Exhaust Valve Guides Worn**

Replace valve guides (refer to "ENGINE" in Section IX).

7. GENERATOR, GENERATOR REGULATOR, LIGHTS, AND WIRING

(Refer to "ELECTRICAL SYSTEM" in Section VII, for full details on the electrical system.)

A. GENERATOR NOT CHARGING

1. Generator Drive Belt Loose or Broken

Tighten or replace the drive belt.

2. Cables Broken or Loose

Repair or replace the cables or tighten the connections.

3. Generator 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, and 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 generator regulator.

B. LIGHTS AND WIRING

1. Lights

If the headlight switch is turned to the on position 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 to the on position.

2. Wiring

Refer to "ELECTRICAL SYSTEM" in Section VII, for a wiring diagram of the tractor. When replacing any cables, connect them as shown in 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 (refer to "ENGINE CLUTCH" in Section X).

2. Clutch Facings Worn Out

Replacing the driving disc. *NOTE: The facings are bonded to the driving 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 (refer to "ENGINE CLUTCH" in Section X).

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 transmission input shaft to stop turning. The affected parts cannot be inspected unless removed (refer to "ENGINE CLUTCH" in Section X).

2. Clutch Will Not Release Completely

Adjust clutch and clutch linkage (refer to "ENGINE CLUTCH" in Section X).

3. Clutch Brake Too Loose or Brake Facings Worn

Adjust clutch brake or replace the brake facings if necessary (refer to "ENGINE CLUTCH" in Section X).

11. TRANSMISSION AND GEAR SHIFT

(Refer to "TRANSMISSION AND BEVEL GEAR" in Section XI, for further detailed instructions on repairs.)

A. TRANSMISSION HARD TO SHIFT

1. Transmission Oil Too Heavy

Refer to "DESCRIPTION AND SPECIFICATIONS" in Section I for correct viscosity of oil for prevailing atmospheric temperatures.

2. Worn Shifting Control

Remove gear shift mechanism, inspect for worn parts, and repair or replace any worn parts (refer to "TRANSMISSION AND BEVEL GEAR" in Section XI).

3. Burred Gears and Shifting Collars

Repair or install new gears and shifting collars (refer to "TRANSMISSION AND BEVEL GEAR" in Section XI).

4. Rough or Worn Splines

Smooth the splines or replace the worn or rough parts (refer to "TRANSMISSION AND BEVEL GEAR" in Section XI).

5. Gear Shifting Lock Plunger Rods Out of Adjustment

Adjust plunger control linkage (refer to "TRANSMISSION AND BEVEL GEAR" in Section XI).

B. SHIFTING COLLARS SLIP OUT OF MESH IN OPERATION

1. Shifting Lever Locking Mechanism Worn

Inspect for worn or broken shifting lock plungers, broken or weak springs, or edges rounded off detent notches in shifter shafts (refer to "TRANSMISSION AND BEVEL GEAR" in Section XI).

2. Incorrect Positioning of Shifting Forks on Shafts

Reset forks (refer to "TRANSMISSION AND BEVEL GEAR" in Section XI).

3. Shifting Forks Worn

Remove and repair or replace shifting forks (refer to "TRANSMISSION AND BEVEL GEAR" in Section XI).

4. Worn Gears, Bearings, or Shafts

This condition will allow misalignment of gears and cause the shifting collars to slip out of mesh. Remove and repair or replace worn parts (refer to "TRANSMISSION AND BEVEL GEAR" in Section XI).

C. NOISE IN TRANSMISSION

1. Broken or Worn Gears, Bearings, or Shafts

Replace worn or broken parts (refer to "TRANSMISSION AND BEVEL GEAR" in Section XI).

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 proper level on the oil level 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 (refer to "STEERING BRAKES" in Section XIII).

2. Improper Adjustment

Adjust the brakes (refer to "STEERING BRAKES" in Section XIII).

3. Oil on Brakes

Wash brakes and repair oil leak (refer to "STEERING BRAKES" in Section XIII).

4. Brake Band Broken

Install new band and adjust (refer to "STEERING BRAKES" in Section XIII).

5. Broken Controls

Install new parts (refer to "STEERING BRAKES" in Section XIII).

B. BRAKE OVERHEATING

1. Brakes Adjusted Too Tight

Adjust brakes (refer to "STEERING BRAKES" in Section XIII).

2. Steering Clutches Not Disengaging

Adjust steering clutches (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

3. Oil on Brakes

Wash brakes and repair oil leak (refer to "STEERING BRAKES" in Section XIII).

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 (refer to "STEERING BRAKES" in Section XIII).

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. Brake Drum Hub to Brake Drum Bolts Loose

Tighten bolts (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

2. Erratic Brake Band Contact

Adjust brakes (refer to "STEERING BRAKES" in Section XIII).

3. Final Drive Pinion Shaft Bearings Worn or Broken

Install new bearings (refer to "FINAL DRIVES" in Section XIV).

4. Brake Drum Hub Loose on Pinion Shaft

Tighten and lock hub retaining capscrew (refer to "FINAL DRIVES" in Section XIV).

5. Warped Brake Drum Hub

Repair or install new parts (refer to "FINAL DRIVES" in Section XIV).

6. Worn or Damaged Brake Drums

Repair or install new drums (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

13. STEERING CLUTCHES

(Refer to "STEERING CLUTCHES AND CONTROLS" in Section XII, for adjustments and repairs of the steering clutches.)

A. CLUTCHES SLIP

1. Friction Discs Worn

Install new discs (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

2. Steel Discs Warped

Install new discs (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

3. Oil on Discs

Wash clutches (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

4. Improper Adjustment

Adjust control linkage (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

5. Springs Weak

Install new springs (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

B. CLUTCHES SHIFT SIDEWAYS

1. Clutch Driving Hub Retaining Capscrew Loose

Tighten capscrew (refer to "TRANSMISSION AND BEVEL GEAR" in Section XI).

2. Bevel Gear Bearings Loose

Adjust bearings (refer to "TRANSMISSION AND BEVEL GEAR" in Section XI).

C. UNABLE TO DISENGAGE CLUTCHES

1. Improper Adjustment

Adjust linkage (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

2. Throwout Yoke Ball Broken or Lost

Install new ball or new yoke assembly (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

3. Throwout Yoke Trunnion Pin Broken or Out of Yoke

Replace pin (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

D. 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 (refer to "STEERING CLUTCHES AND CONTROLS" in Section XII).

14. EQUALIZING SPRING

(Refer to "MAIN FRAME AND EQUALIZER SPRING" in Section XVIII, for repairs on the spring.)

FRONT END OF TRACTOR TOO LOW

1. **Spring Leaves Broken**

   Replace broken leaves (refer to "MAIN FRAME AND EQUALIZER SPRING" in Section XVIII).

2. **Spring Pivot Pin Worn Badly or Broken**

   Replace pivot pin (refer to "MAIN FRAME AND EQUALIZER SPRING" in Section XVIII).

3. **Spring Pivot Pin 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 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 (refer to "FINAL DRIVES" in Section XIV).

3. **Insufficient Oil Supply**

   Check oil level and fill to the proper level.

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 (refer to "TRACKS" in Section XVII).

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 (refer to "TRUCK FRAMES" in Section XV).

6. **Sprocket Shaft Bearings Out of Adjustment or Damaged**

   Replace or adjust bearings (refer to "FINAL DRIVES" in Section XIV).

7. Sprocket Loose on Shaft

Tighten retaining nut to 3500 to 4000 lbs. ft. 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 (refer to "TRUCK FRAMES" in Section XV).

3. Track Rail Assembly Badly Worn

Repair or install new track (refer to "TRACKS" in Section XVII).

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" aproved 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 (refer to "TRUCK FRAMES" in Section XV).

C. LUBRICANT LEAKAGE

1. Damaged or Worn Seals

Install new seals and other necessary parts (refer to "TRUCK FRAMES" in Section XV).

2. Loose or Badly Worn Bearings

Remove and inspect and 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 (refer to "TRUCK FRAMES" in Section XV).

2. Badly Worn Truck Wheels, Support Rollers, or Track Idlers

Repair or replace (refer to "TRUCK FRAMES" in Section XV).

3. Truck Frames Out of Line

Repair or replace (refer to "TRUCK FRAMES" in Section XV).

4. Track Sprocket Teeth Badly Worn

Replace sprocket (refer to "FINAL DRIVES" in Section XV).

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. Bady Worn Pins, Bushings, and Rails

Install new track rail assembly (refer to "TRACKS" in Section XVII).

18. TRACK RELEASE

RELEASE MECHANISM DOES NOT FUNCTION PROPERLY

1. Release Spring Broken

Replace spring (refer to "TRUCK FRAMES" in Section XV).

2. 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).

3. Tracks Out of Adjustment

Adjust (refer to "TRACKS" in Section XVII).

19. TRUCK FRAMES

TRUCK FRAMES OUT OF LINE

1. Bent or Twisted Frames

Repair or install new frames (refer to "TRUCK FRAMES" in Section XV).

2. Truck Frame Pivot Shaft and Bushing Worn

Install new parts (refer to "TRUCK FRAMES" in Section XV).

3. Capscrews Attaching Sprocket Shaft Outer Bearing Cage to Truck Frame Loose

Tighten capscrews.

4. Sprocket Shaft Outer Bearing Badly Worn or Broken

Replace the necessary parts (refer to "FINAL DRIVES" in Section XIV).

SECTION XXIV—SPECIAL TOOLS

In most cases, the use of special tools for disassembly, repairs, and assembly are required to perform the particular operation and to obtain the best results. The use of special tools also helps the serviceman, or mechanic, to make the necessary repairs in the least amount of time.

Special tools similar to the ones illustrated in this manual are manufactured by various tool manufacturers. Contact your local "Allis-Chalmers" Dealer for information regarding availability of the special tools.