

SECTION IV — ENGINE COOLING SYSTEM

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1. DESCRIPTION OF SYSTEM

The engine cooling system includes the water pump, radiator, water inlet manifold, engine oil cooler, torque converter fluid heat exchanger, thermostats, cooling fan, engine temperature gage, water outlet manifolds, and the water passages in the cylinder block and cylinder heads. The water pump draws the coolant from the bottom of the radiator and circulates it through the engine oil cooler, torque converter fluid heat exchanger, and through the water passages in the engine. **NOTE:** *On tractors without a torque converter, the heat exchanger core is omitted and the heat exchanger bonnet is secured to the water inlet manifold on tractors prior to Serial No. 4001 or to the oil and water manifold on tractors Serial No. 4001 and above.* The coolant is discharged from the cylinder heads into the water outlet manifold and passes through the thermostats and the radiator inlet elbow to the upper part of the radiator. The cool-

ant is cooled as it passes from the top to the bottom of the radiator core by air forced through the radiator core by the cooling fan. The two thermostats, located in the water outlet front manifold of the engine, operate automatically to maintain a normal coolant operating temperature of 160° to 185° F.

A double acting valve is provided in the radiator cap for relieving pressure due to expansion (from heating of coolant) and allows air, at atmospheric pressure, to enter when contraction (due to cooling of coolant) occurs. As this is a pressure type cooling system it is necessary to keep the radiator cap screwed on tightly. **CAUTION: DO NOT REMOVE THE PRESSURE TYPE RADIATOR CAP WHILE THE COOLANT IS ABOVE 212° F., as the coolant will break into a boil and may splash onto the person removing the cap.**

2. GENERAL MAINTENANCE

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

Drain and flush the cooling system with clean water before adding an anti-freeze solution for cold weather operation. In winter weather, use a permanent type (glycol base) anti-freeze solution in the system to protect against damage from freezing.

After any addition of water or anti-freeze compound, test the solution after the added quantity has become thoroughly mixed to make certain it will withstand the prevailing or anticipated temperature. A mixture of 64% permanent type (glycol base) anti-freeze and 36% water is recommended. The use of more than 64% permanent

type anti-freeze in the solution will raise the freezing point and provide less protection against freezing. **IMPORTANT:** *The quantity of anti-freeze to be added to the cooling system to provide adequate protection must be in accordance with the anti-freeze manufacturer's directions.*

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

All leaks in the cooling system must be corrected as soon as they are evident. The fan drive belts must be kept properly adjusted. The most efficient

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

Maintaining the normal coolant operating temperature (160° to 185° F.) depends mostly on proper functioning of the thermostats. If the coolant temperature remains consistently below normal, the thermostats should be removed, checked for proper operation, and replaced if necessary.

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3. DRAINING AND FILLING OF SYSTEM

A. Draining of Cooling System

Remove the radiator filler cap. Remove the water drain access cover from the bottom of the crankcase guard, then reaching through the opening in the crankcase guard, open the cooling system drain cock located in the bottom of the water pump. Open the cylinder block drain cock located on the right side of the cylinder block (Fig. 1). **NOTE:** On tractors Serial No. 1508 to 4001 (tractors with torque converter) open the water drain cock located in the fluid heat exchanger rear bonnet (Fig. 2).

On tractors Serial No. 4001 and above (tractors with torque converter) the water in the fluid heat

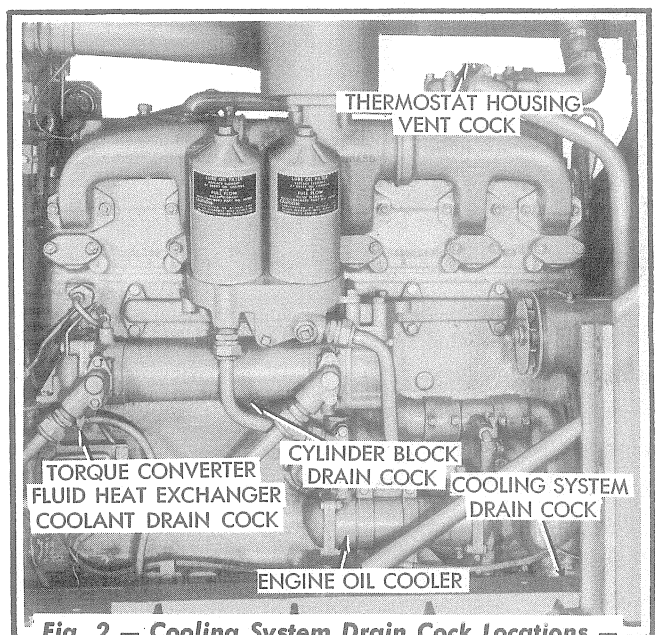


Fig. 2 — Cooling System Drain Cock Locations — Tractors with Torque Converter (Tractors Serial No. 1508 to 4001)

exchanger will drain back into the water pump and out the drain cock located in the bottom of the water pump assembly (Fig. 3). Open the water manifold vent cock located in the top of the water outlet manifold cover (Figs. 1 and 2) or in the top of the manifold front section (Fig. 3).

NOTE: *This vent cock and the fluid heat exchanger water drain cock were not used on early model engines. When draining the cooling system in freezing weather, make certain that the coolant flows freely from all drain cocks and that the system drains completely.*

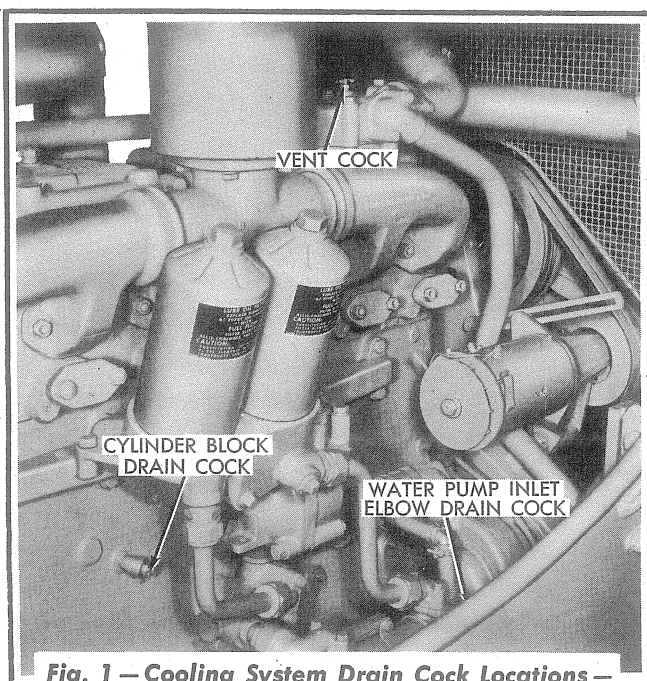


Fig. 1 — Cooling System Drain Cock Locations — Tractors Without Torque Converter (Tractors Serial No. 1508 to 4001)

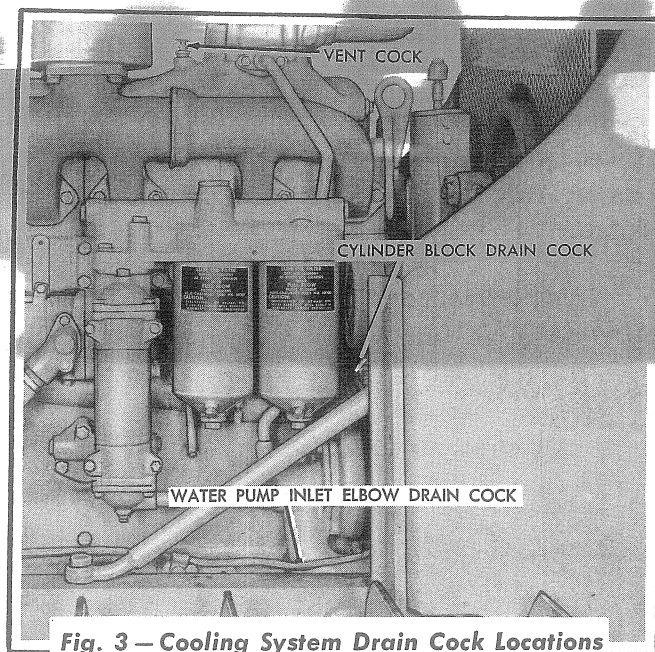


Fig. 3 — Cooling System Drain Cock Locations
(Tractors Serial No. 4001 and Above)

B. Filling of Cooling System

Close all the drain cocks which were opened to drain the system in Paragraph A above; do not close the vent cock in the top of the water outlet manifold. Install the water drain access cover in position on the bottom of the crankcase guard. Fill the cooling system through the radiator filler tube until coolant flows from the water outlet manifold vent cock, then close the vent cock and complete the filling until the coolant level is approximately $1\frac{1}{2}$ inches below the bottom of the radiator filler tube. Install and tighten the radiator filler cap. **NOTE:** On early model engines which do not have the water outlet manifold vent cock, fill the cooling system and operate the engine at part throttle for about ten minutes with the radiator cap removed, stop the engine, add coolant if necessary, and install the radiator cap.

4. CLEANING OF SYSTEM

It is recommended that the cooling system be cleaned at least twice a year, usually at the beginning of cold weather (before adding an anti-freeze solution) and again after the anti-freeze solution is drained for warm weather operation. 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 heads. 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, will eventually clog these passages. It is also important that the air passages through the radiator be kept free of obstructions and the exterior of the engine be kept free from thick deposits of dust and oil.

A. Cleaning Materials

Sal Soda is a very effective and safe solvent for the removal of lime, scale, and other foreign deposits from the cooling system. It should be used in the proportions indicated and according to the directions printed on the container in which it is

purchased. Many other good cleaning solvents for this purpose are available; these should be used according to the manufacturer's directions. After the solvent has been in the cooling system the prescribed length of time, the system should be completely drained, and after the engine has cooled sufficiently, thoroughly flushed with clean water. The use of certain cleaning compounds requires the use of a neutralizer solution, which is usually packed and sold with the cleaning compound, and should be used as directed. **CAUTION: NEVER MIX ANTI-FREEZE SOLUTIONS OR RUST INHIBITORS WITH ANY CLEANING, NEUTRALIZING, OR FLUSHING COMPOUNDS.**

B. Flushing

If the tubes in the radiator become clogged, the obstructions may sometimes be removed by reverse flushing of the radiator. When the clogging is caused by leaves or other trash, this material is usually deposited at the tops of the radiator tubes. Disconnect the radiator lower hose, and using a suitable adapter, connect a pressure water hose to the radiator water outlet elbow. Remove the radiator upper hose 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.**

C. Inspect for Leaks After Cleaning or Flushing

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

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

as directed on the container.

D. Cleaning Exterior of Radiator

Cleaning the fins of the radiator can best be accomplished by means of an air blast carrying a grease solvent, such as Oleum spirits or carbon tetrachloride. To prevent the loosened debris from packing between the radiator screen and the radiator, direct the cleaning spray from the rear side (fan side) on tractors with a pusher type cooling fan; direct the cleaning spray from the front side on tractors with a suction type fan. The engine should be covered before performing the flushing operation. **CAUTION: Provide adequate ventilation of the working area during this operation to avoid toxic effects of the cleaning spray.**

5. RADIATOR AND RADIATOR GUARD

A. Description

The radiator is of the conventional tubular type, consisting basically of a core, top and bottom tanks, and side members. The radiator support (Fig. 7) is a heavy steel weldment attached to the tractor main frame and is braced with two radiator support bracing rods. The radiator support also serves as a fan shroud. The radiator is supported on the radiator support by rubber vibration snubbers, located at the bottom of the radiator as shown in Figs. 4 and 5. A rubber cushion ring and a radiator support ring (Fig. 7) are used to secure the top of the radiator to a bracket welded to the top of the radiator support. A double acting valve is provided in the radiator cap for relieving pressure due to expansion (from heating of the coolant) and to allow air, at atmospheric pressure, to enter when contraction occurs (due to cooling of the coolant). A small hole is provided in the radiator cap, above the pressure valve, for venting and overflowing.

A wrap around type radiator guard is provided to protect the radiator.

Two radiator guard mounting trunnions, one attached to each side of the main frame, are provided for attaching and supporting the radiator guard. Each side of the radiator guard is also attached to the front fender attachment bracket.

B. Lowering of Radiator Guard

The radiator guard must be removed or lowered, as shown in Fig. 4, in order to remove the radiator.

1. Remove the engine hood. Remove the radiator guard lower front plate with the lower air baffle attached. Remove the bumper.
2. Remove the capscrews attaching the headlight cable clips and the air baffle to the right side of the radiator and remove the air baffle. Remove the capscrews attaching the air baffle to the left side of the radiator and remove the air baffle.
3. Remove the capscrews and high nuts attaching each side of the radiator guard to the front fender and fender attachment bracket.
4. Remove the bottom front and rear closure plates from each side of the guard (at trunnion locations). Remove the radiator guard top closure plate, located to the rear of the radiator filler tube.
5. Loosen but do not remove the capscrews attaching the guard pivot cap to each side of the radiator guard, and using a suitable hoist attached near the top of the guard, push the top of the guard forward and

allow it to pivot on its trunnions until it is lowered as shown in Fig. 4.

C. Removal of Radiator

1. Drain the engine cooling system (refer to Topic 3 in this Section). Remove the radiator cap. Remove the capscrews attaching the radiator support ring (Fig. 7) to the bracket welded to the top of the radiator support and remove the support ring, shims, and the cushion ring.
2. Loosen the front hose clamp on the radiator inlet hose (upper hose) and the front hose clamp on the radiator outlet hose (lower hose).
3. Loosen and remove the radiator mounting capscrews, lockwashers, plain washers, lower vibration snubbers, and snubber spacing tubes from each lower corner of the radiator.
4. Using a suitable hoist as shown in Fig. 5, raise and remove the radiator. *NOTE: An old radiator cap may be used for removing the radiator as shown in Fig. 5, by drilling a hole through the center of the cap and inserting a lifting eye bolt through the cap. Retain the eye bolt by the use of a heavy plain washer and nut.*
5. After the radiator is removed, remove the remaining radiator vibration snubbers.

D. Removal of Radiator Support

1. Remove the capscrews and washers securing the radiator support to the main frame.
2. Remove the fan guard from the radiator support. Disconnect the cowl bracing rod from the top of the radiator support.
3. Disconnect the headlight cable from the main wiring harness at the cable connector located near the water pump. Pull the cable free of the radiator support.

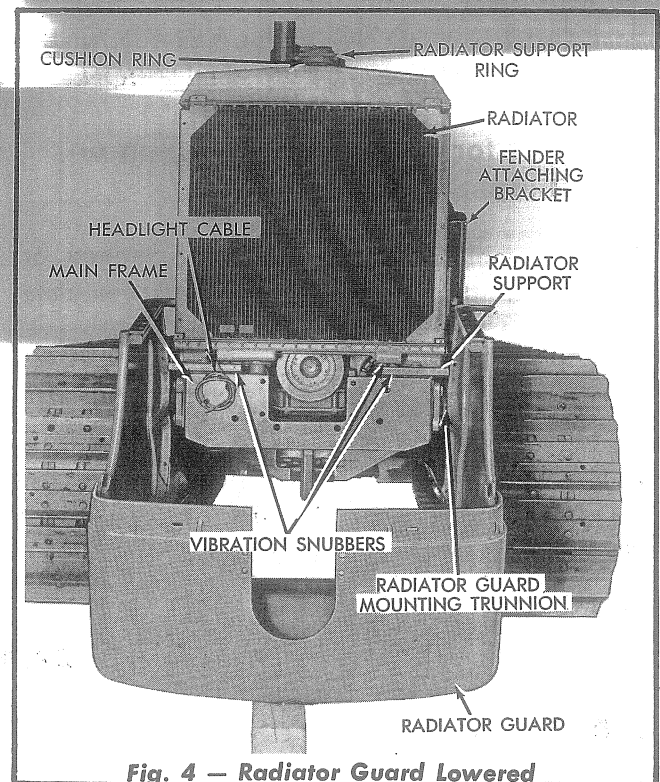


Fig. 4 — Radiator Guard Lowered

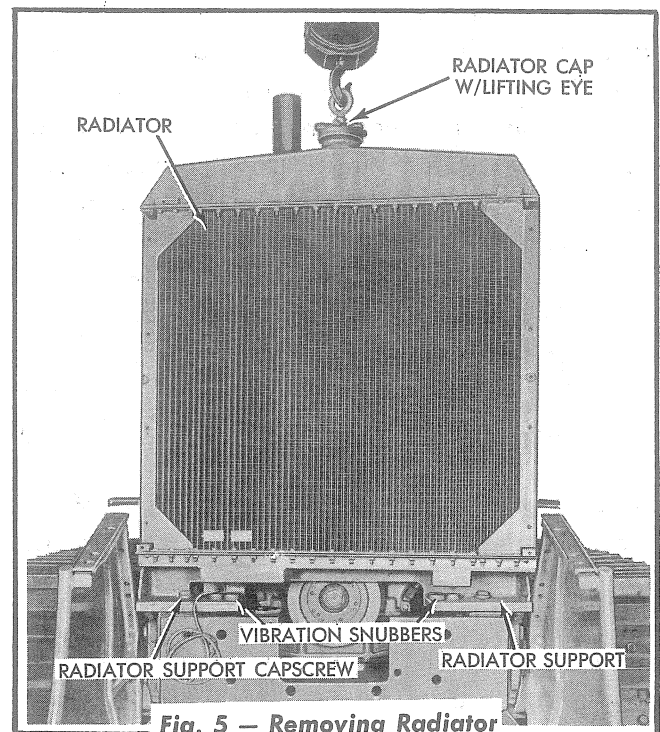


Fig. 5 — Removing Radiator

4. Remove the capscrews from the radiator support bracing rods at the lower (main frame) end and using a suitable hoist, remove the radiator support and the support bracing rods as an assembly.

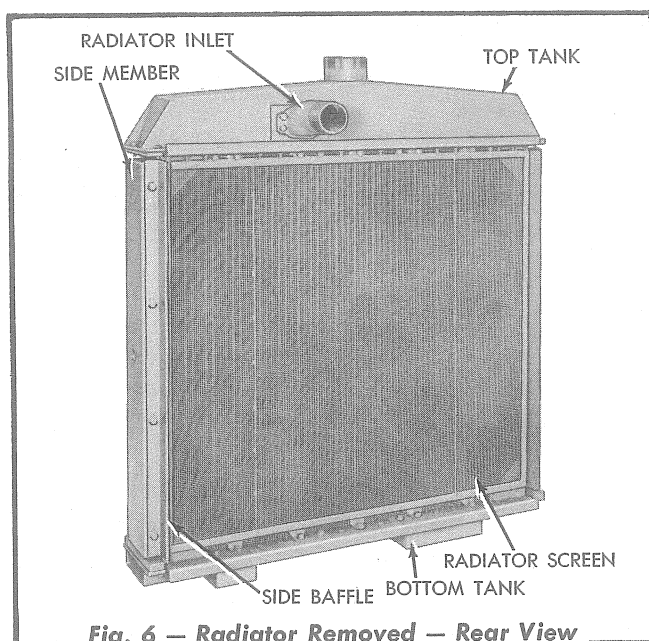


Fig. 6 — Radiator Removed — Rear View

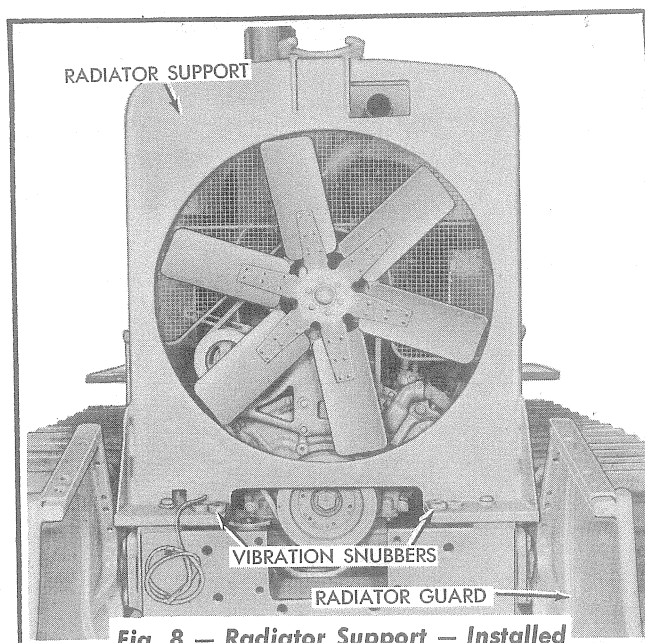


Fig. 8 — Radiator Support — Installed

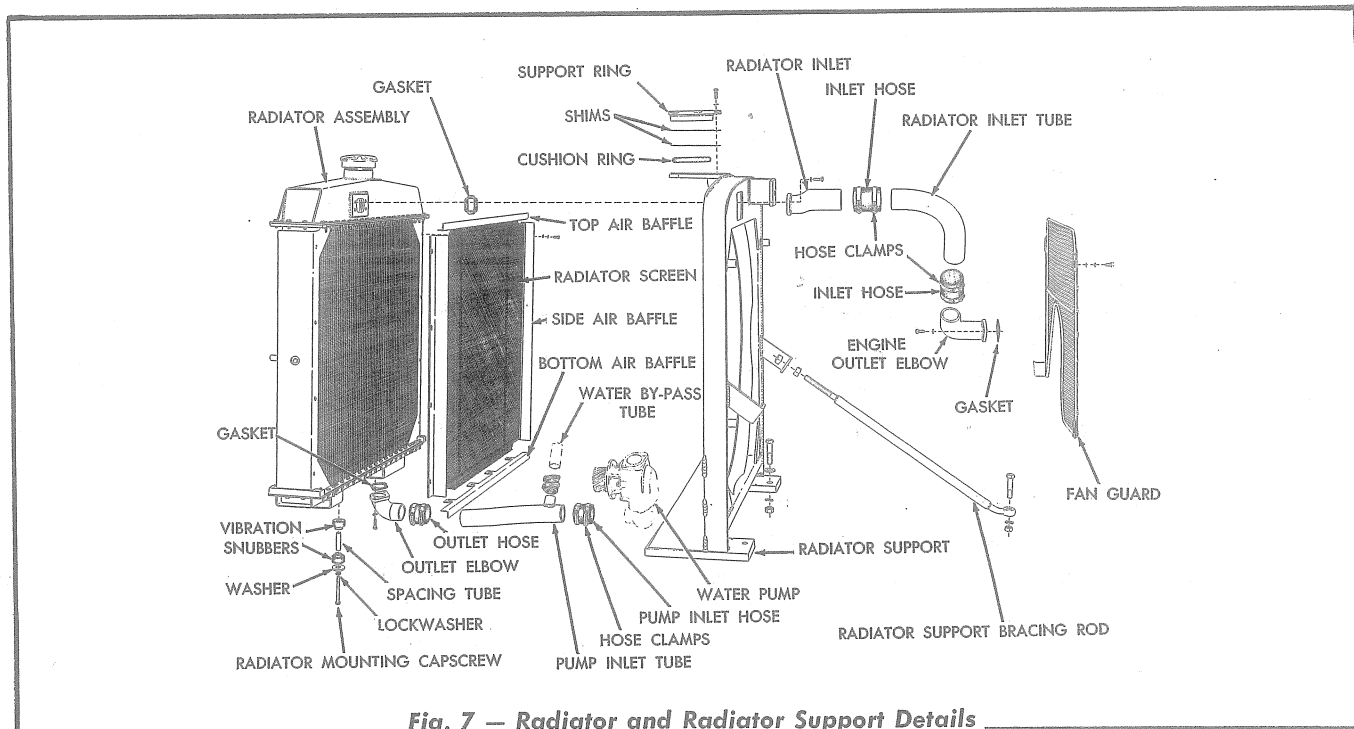


Fig. 7 — Radiator and Radiator Support Details

E. Inspection and Repair of Radiator

1. Remove the radiator screen from the radiator to clean the air passages in the radiator core and test the core for clogging or leaks. Clean the core if clogging is evident and repair any leaks found. The top and bottom tanks may be removed from the radiator

core for cleaning and repairs, if necessary. Install the radiator screen after cleaning and testing.

2. Straighten all bent cooling fins. Replace all damaged radiator hoses. **NOTE: Do not paint the radiator core.**

F. Installation of Radiator and Radiator Support

1. Install the radiator support by a direct reversal of the removal procedure (refer to Paragraph D above).
2. Install the vibration snubbers in position on the lower corners of the radiator support as shown in Fig. 8.
3. Using a suitable hoist and lifting device (Fig. 5) install the radiator in position on the radiator support, inserting the radiator inlet and radiator outlet elbows into the radiator upper and lower hoses.
4. Install a lockwasher, plain washer, spacing tube, and vibration snubber in position on each radiator mounting cap screw and secure the radiator to the radiator mounting support with the cap screws and their components. Tighten the hose clamps on the radiator inlet and outlet hoses.
5. Install the cushion ring, shims, and radiator support ring (Figs. 4 and 7) in position and install the cap screws (with lockwashers) to secure the support ring to the bracket welded to the top of the radiator support.
6. Fill the engine cooling system (refer to Topic 3 in this Section). Check the hoses and connections for leaks and correct any

leaks found.

G. Positioning of Radiator Guard

1. Using a suitable hoist, raise the radiator guard, allowing it to pivot on its mounting trunnions, until it contacts the fender attachment brackets.
2. Install the cap screws and high nuts attaching each side of the radiator guard to the front fender and fender attachment bracket and tighten securely.
3. Tighten the radiator guard pivot cap cap screws securely. Install the front and rear bottom closure plates on the radiator guard and secure with attaching cap screws, plain washers, and lockwashers.
4. Install the two side air baffles, making certain that the headlight cable clips are properly positioned and secure. Insert the headlight cable through the hole in the lower right corner of the radiator mounting support and connect the cable to the main wiring harness at the connector below the water pump.
5. Install the bumper.
6. Install the radiator guard lower front plate, with the lower air baffle attached, and tighten the attaching cap screws securely.
7. Install the engine hood.

6. WATER PUMP

A. Description

A centrifugal type water pump assembly is provided for circulating the coolant through the engine and radiator. The water pump is flange mounted in the lower right rear corner of the timing gear housing and is gear driven by the idler gear of the engine gear train.

The pump shaft in the first type water pump (Fig. 9) used on engines in tractors prior to Serial No. 2734, is supported in the pump housing by two ball bearings. The bearings are splash lubricated by oil thrown by the engine gear train. A "lip type" oil seal is used to prevent the lubricating oil from entering the impeller housing of the pump. A spring loaded seal assembly and ceramic seat are used to prevent the engine coolant from entering the bearing compartment of the pump body. The impeller is a splined fit on the rear of the pump shaft and is retained by a washer and a self locking nut. The pump driving gear is pressed on and keyed to the front end of the pump shaft and is retained by a washer, slotted nut, and a cotter pin.

Effective with tractor Serial No. 2734, a second type water pump (Fig. 10) was used. The pump shaft in the second type water pump is supported in the housing by a ball bearing on the gear end and by a roller bearing on the impeller end of the shaft. The bearings are splash lubricated by oil thrown by the engine gear train. A "lip type" oil seal is used to prevent the lubricating oil from entering the impeller compartment of the pump body. A spring loaded seal assembly, water flinger, and a ceramic seat are used to prevent the engine coolant from entering the bearing compartment of the pump body. The impeller is pressed on and "pinned" to the rear of the pump shaft and is retained by a slotted nut and cotter pin. The pump driving gear is pressed on and keyed to the front of the pump shaft and is retained by a washer, slotted nut, and a cotter pin.

NOTE: A change over kit, consisting of the second type pump and the necessary attachment parts, is available for tractors having engines equipped with the first type water pump.

B. Service

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

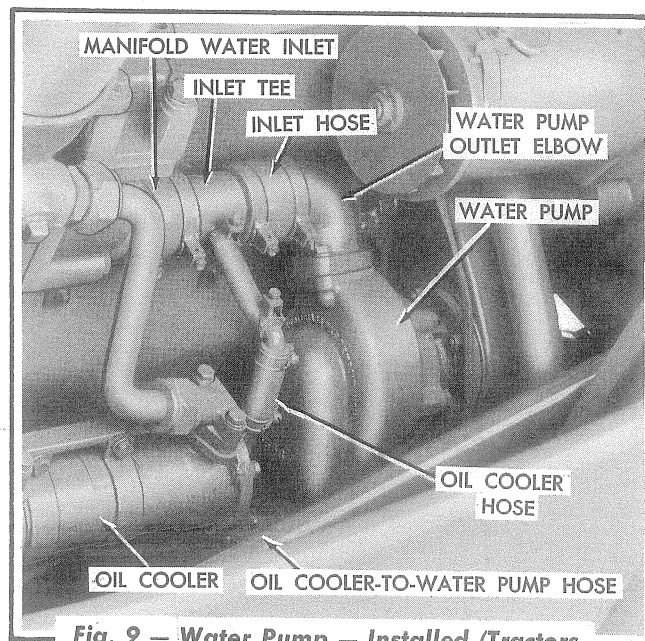


Fig. 9 — Water Pump — Installed (Tractors Prior to Serial No. 2734)

C. Removal of Water Pump

1. On tractors prior to Serial No. 2734 (refer to Figs. 1, 2, and 9).
 - a. Drain the engine cooling system (refer to Topic 3 in this Section).
 - b. Disconnect the water pump inlet hose from the water inlet elbow (lower elbow) of the water pump. Loosen the hose clamps attaching the oil cooler-to-water pump hose and remove the hose.
 - c. Loosen the hose clamp attaching the water drain hose to the water drain cock at the bottom of the water inlet elbow. Remove the capscrews and lockwashers attaching the water inlet elbow to the water pump and remove the inlet elbow.

- d. Loosen the hose clamps on the manifold water inlet tee and remove the tee.
- e. Remove the nuts and lockwashers securing the water pump to the timing gear housing. Move the pump to the rear until the pump is free of the mounting studs, turn the pump as necessary and remove the pump assembly and gasket.

2. On tractors Serial No. 2734 to 4001 (refer to Figs. 1, 2, and 10).

- a. Drain the cooling system (refer to Topic 3 in this Section).
- b. Loosen the hose clamps on the manifold water inlet tube and remove the tube.
- c. Loosen the hose clamps securing the oil cooler-to-water pump hoses and remove the hoses and the elbow. Loosen the rear hose clamp on the water pump inlet hose.
- d. Loosen the hose clamp securing the water drain hose to the water drain cock in the bottom of the water pump inlet cover. Loosen the hose clamps on the water by-pass line and slide the hose up on the water by-pass line.
- e. Remove the nuts and lockwashers securing the water pump assembly to the timing gear housing. Move the pump to the rear until it is free of the mounting studs and the inlet hose, turn the pump as necessary, and remove the pump assembly and gasket.

3. On tractors Serial No. 4001 and above (refer to Figs. 3 and 11).

- a. Drain the cooling system (refer to Topic 3 in this Section).
- b. Loosen the hose clamps on the water by-pass line hose and slide the hose up on the water by-pass line. Loosen the hose clamps attaching the bonnet pipe

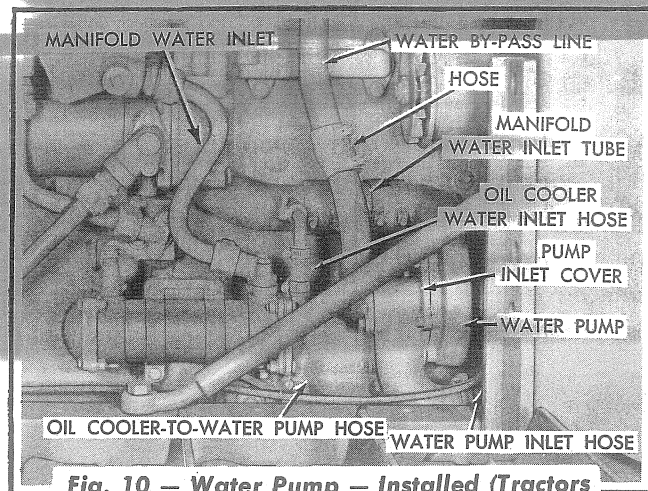


Fig. 10 — Water Pump — Installed (Tractors Serial No. 2734 to 4001)

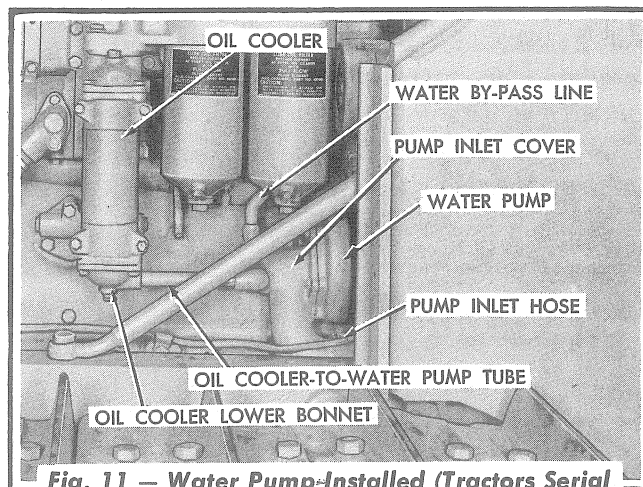


Fig. 11 — Water Pump-Installed (Tractors Serial No. 4001 and Above)

to the water pump and move the hose to the rear on the bonnet pipe. Loosen the hose clamp securing the water drain hose to the water drain cock in the bottom of the water pump and free the hose from the drain cock. Loosen the rear hose clamp on the water pump inlet hose.

- c. Remove the capscrews and lockwashers securing the engine oil cooler lower bonnet to the oil cooler core and remove the lower bonnet. Remove the oil cooler-to-water pump tube from the water pump.
- d. Remove the nuts and lockwashers securing the water pump assembly to the timing gear housing and remove the pump assembly and gasket.

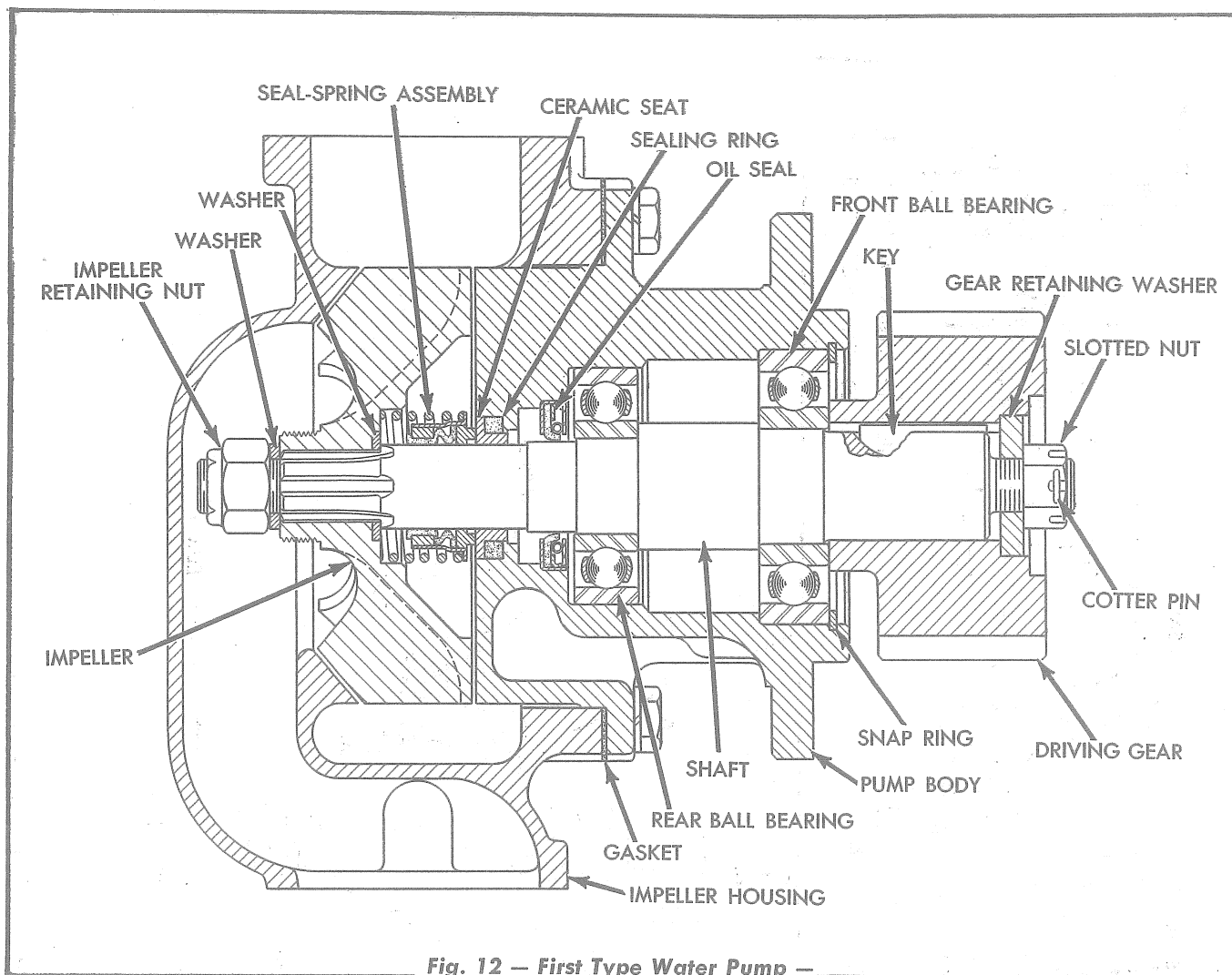


Fig. 12 — First Type Water Pump —
Sectional View

D. Disassembly, Inspection, and Assembly of Water Pump

1. First Type Pump (Figs. 12 and 13)

a. Disassembly

- (1) Remove the capscrews and lockwashers attaching the impeller housing to the pump body and remove the impeller housing.
- (2) Remove the impeller retaining nut and washer from the rear end of the pump shaft. The hub of the impeller is threaded to facilitate removal of the impeller from the pump shaft. Using an impeller puller as shown in Fig. 14, pull the impeller from the shaft.
- (3) The coolant seal assembly is now accessible. If a seal assembly replacement only is to be made, it will not be necessary to remove the shaft assembly from the pump housing.
- (4) Remove the impeller washer and the seal spring assembly from the pump shaft. Remove the ceramic seat and the sealing ring from the pump body and the shaft.
- (5) Remove the cotter pin, slotted nut, and the gear retaining washer from the front end of the pump shaft. Using a suitable puller, pull the pump driving gear from the pump shaft. Remove the key from the shaft.

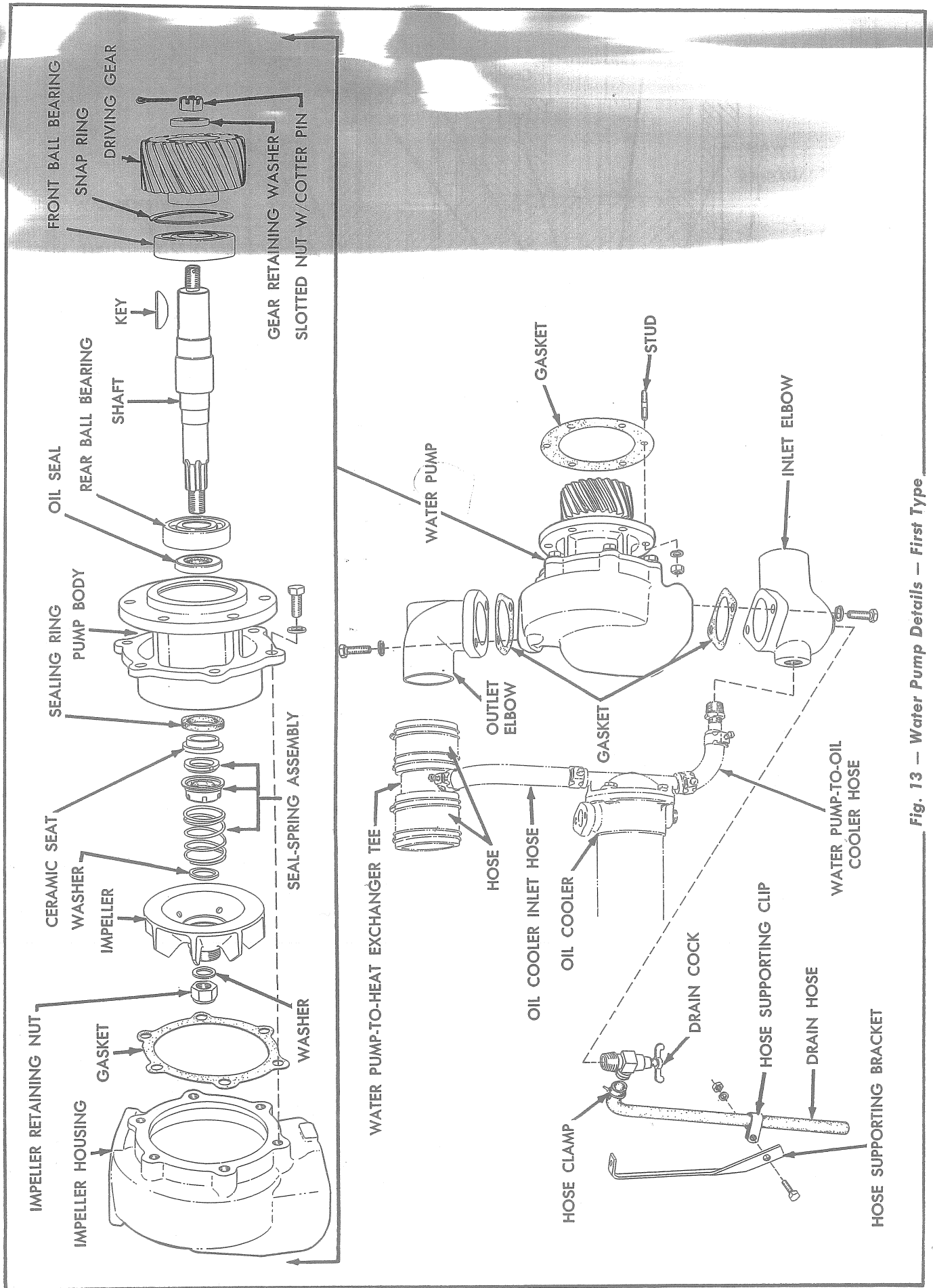


Fig. 13 — Water Pump Details — First Type

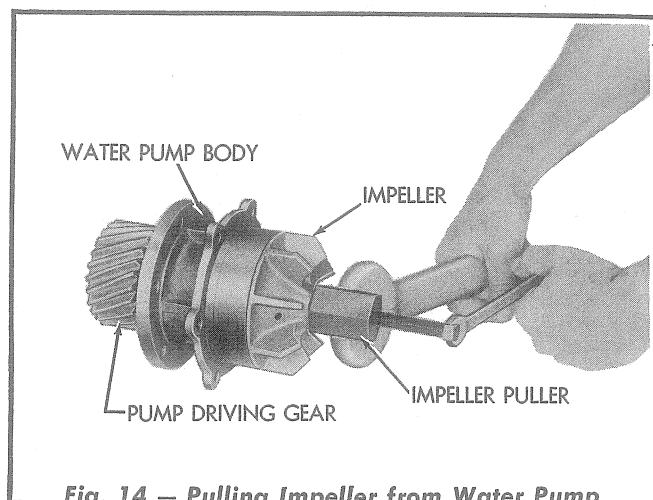


Fig. 14 — Pulling Impeller from Water Pump Shaft — First Type

- (6) Remove the bearing retaining snap ring from its groove in the front of the pump body. Using a soft hammer, drive on the impeller end of the pump shaft to remove the shaft and bearings from the pump body. Press the shaft from the bearings.
- (7) Using a suitable driver, remove the oil seal from the pump body.

b. Inspection

- (1) A new oil seal and coolant seal components should be installed when the pump is reassembled.
- (2) Clean the bearings by washing in cleaning solvent. Check the bearings for looseness, roughness, bind, or pitting and replace if necessary.
- (3) Thoroughly clean the pump body and check the condition of the bearing bores in the body; replace the body if necessary.
- (4) Check the shaft for wear at the point contacted by the lip of the oil seal and check the splines of the shaft for signs of impeller looseness. Replace the shaft if necessary.
- (5) Inspect the impeller for spline wear. Make certain the impeller vanes are not damaged or cracked. Replace the im-

PELLER if necessary.

c. Assembly (Figs. 12 and 13)

- (1) Using a suitable tool, install the oil seal in the pump body with the sealing lip of the seal directed toward the gear end of the pump. Lubricate the lip of the seal.
- (2) Press the front and rear ball bearings onto the shaft, making certain they are pressed tightly against the shoulders of the shaft. Lubricate the bearings and install the shaft, with bearings, in the pump body using care to prevent damage to the lip of the oil seal.
- (3) Install the bearing retaining snap ring in the groove in the front end of the pump body. Insert the key in the shaft and install the driving gear on the shaft. Install the gear retaining washer and slotted nut. Tighten the slotted nut securely and install the cotter pin.
- (4) Install the sealing ring and the ceramic seat in position on the shaft and in the pump body. Lubricate the sealing face of the seat with clean light oil.
- (5) Install the seal spring assembly on the shaft followed by the impeller washer and the impeller. *NOTE: When installing the seal spring assembly, make certain the parts are in their proper positions as shown in Fig. 12.* Install the impeller retaining washer and the impeller retaining nut. Tighten the nut securely.
- (6) Using a new gasket, install the impeller housing in position on the pump body and secure with capscrews and lockwashers.

2. Second Type Pump (Figs. 15 and 16)

a. Disassembly

- (1) Remove the capscrews and lockwashers securing the pump inlet cover to the

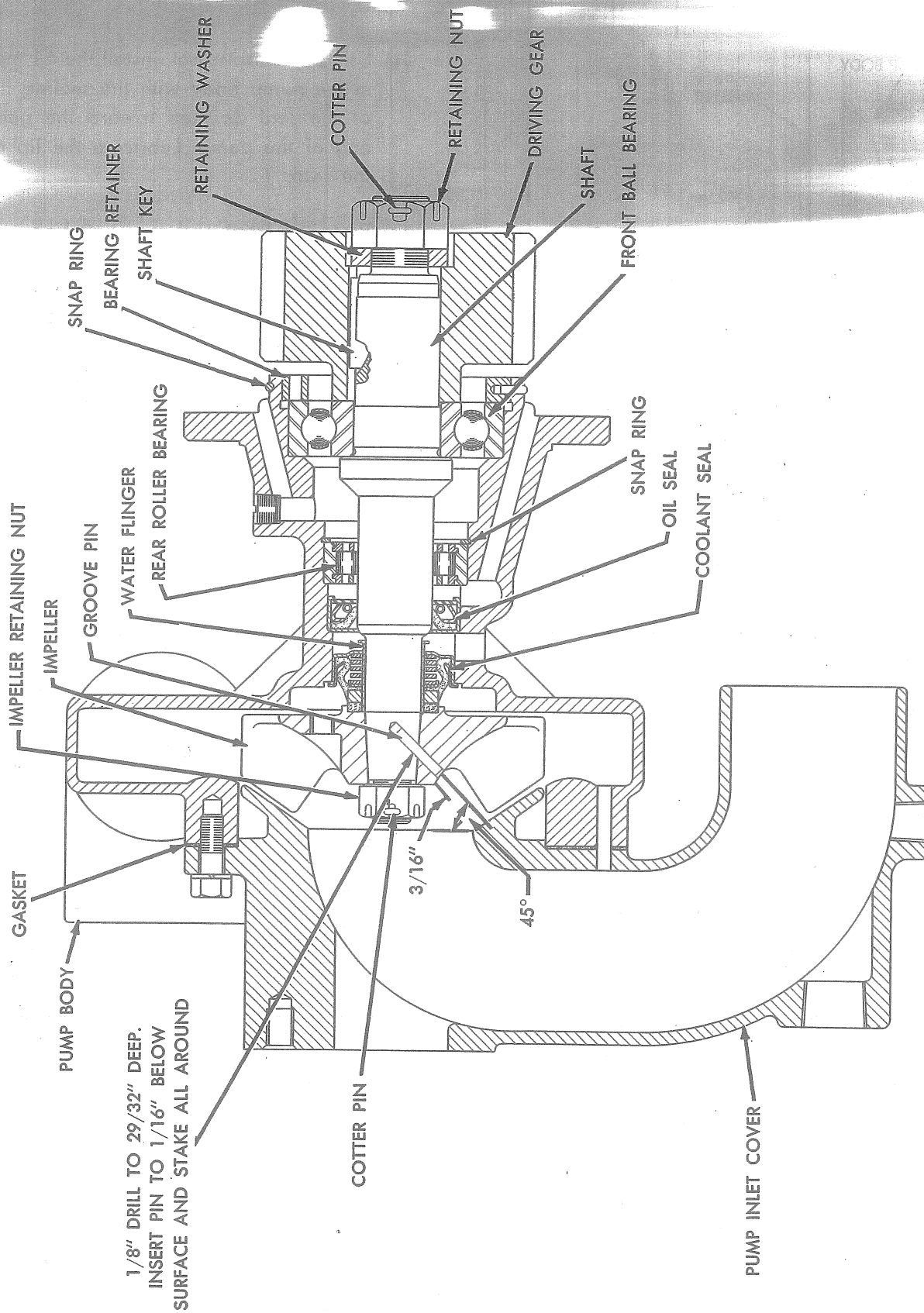


Fig. 15 — Second Type Water Pump —
 Sectional View

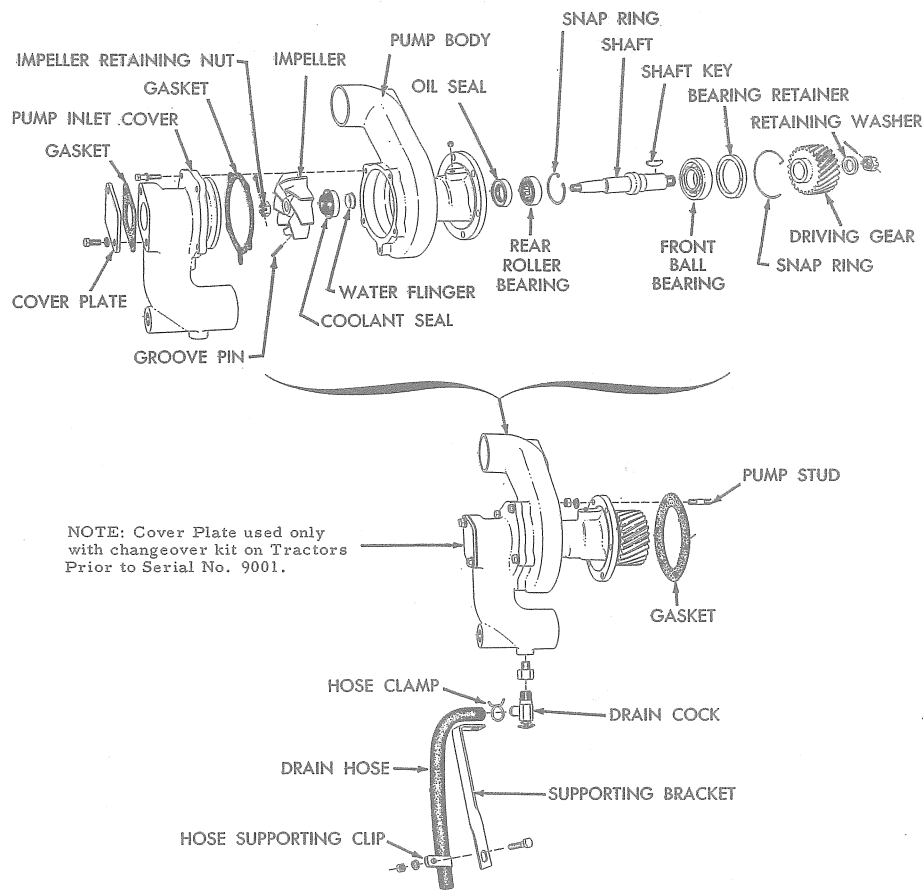


Fig. 16 — Water Pump Details — Second Type

pump body and remove the pump inlet cover.

- (2) Remove the cotter pin and the impeller retaining nut from the shaft. Using a suitable bar type puller, pull the impeller from the shaft. *NOTE: Two $\frac{5}{16}$ " — 18 NC tapped holes are provided in the impeller for the use of a puller to remove the impeller from the shaft. A shaft protector must be used with the cross bar type puller to protect the end of the pump shaft, because of the amount of force required to shear the impeller retaining groove pin; this pin cannot be removed and must be sheared when removing the impeller. Extreme care should be taken to prevent damage to the ceramic sealing ring bonded to the impeller. This ring is an integral part of the impeller and is not serviced separately. The seal assembly is now accessible. If a seal*

assembly replacement only is to be made, it will not be necessary to remove the shaft assembly from the pump body.

- (3) Using seal removing tools similar to the ones shown in Figs. 17 and 18, pry the seal assembly from its position in the pump body and remove the seal assembly. Remove the water flinger from the shaft.
- (4) Remove the cotter pin, retaining nut, and gear retaining washer from the driving gear end of the water pump shaft. Using a suitable puller, pull the driving gear from the pump shaft and remove the key from the shaft.
- (5) Remove the bearing retainer snap ring from the threaded bearing retainer. Turn the bearing retainer out of the pump body.

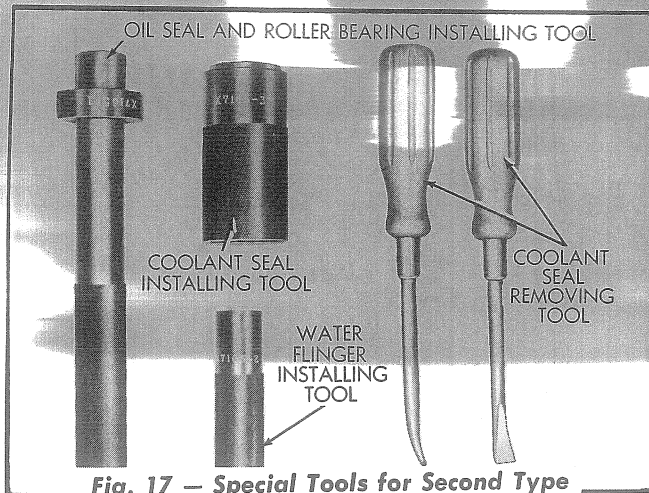


Fig. 17 — Special Tools for Second Type Water Pump

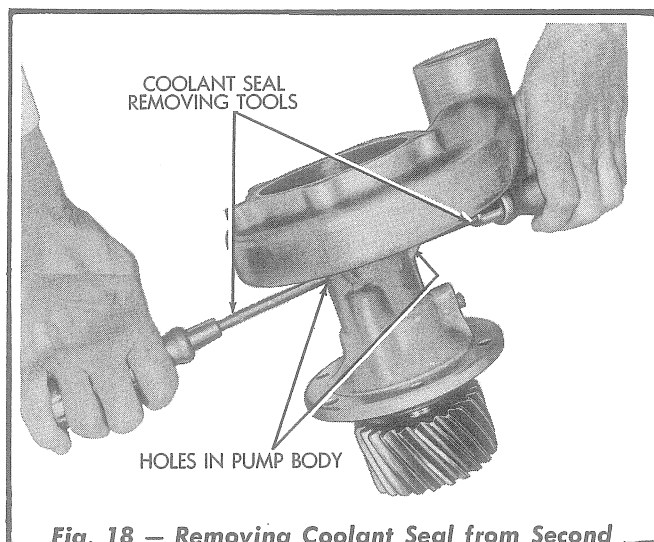


Fig. 18 — Removing Coolant Seal from Second Type Water Pump

- (6) Using a soft hammer, drive on the impeller end of the shaft to remove the shaft and the front ball bearing from the pump body. Press the shaft from the bearing.
- (7) Remove the roller bearing retaining snap ring from the inside of the pump body. Using a suitable driver, remove the roller bearing from the pump body. Drive or press the oil seal from the pump body. **NOTE:** The roller bearing and the oil seal must be removed through the gear end of the pump body.

b. Inspection

- (1) Clean and inspect all parts thoroughly.

- (2) If the ceramic insert (bonded to the rear face of the impeller) is scored or cracked, a new impeller assembly must be installed.
- (3) Inspect the carbon sealing face of the seal assembly, if roughness or cracks are evident, the seal assembly must be replaced. A new water finger should be used when reassembling the water pump.
- (4) Check the bearings for looseness, roughness, bind, or pitting and replace if necessary.
- (5) Make certain the impeller vanes are not damaged or cracked. Replace the impeller if necessary.
- (6) Check the pump shaft for wear at the point contacted by the lip of the oil seal. Replace the shaft if necessary.

c. Assembly (Figs. 15 and 16)

- (1) Install the oil seal and roller bearing in their respective bores through the gear end of the pump body, using a tool similar to the one shown in Figs. 17 and 18. **IMPORTANT:** When installing the oil seal, make certain the sealing lip of the seal is directed toward the gear end of the pump body.

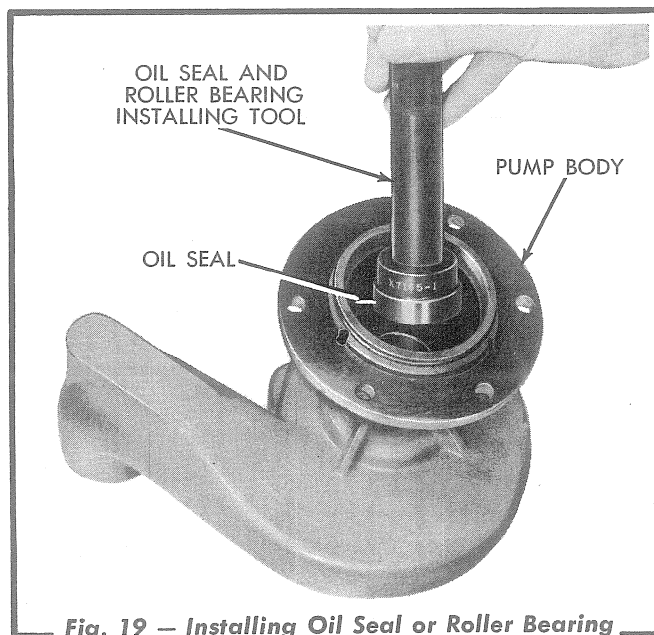


Fig. 19 — Installing Oil Seal or Roller Bearing in Second Type Water Pump

- (2) Install the roller bearing retaining snap ring in its groove in the pump body. Lubricate the roller bearing with clean oil.
- (3) Install the ball bearing on the shaft making certain it is pressed against the shoulder on the shaft. Lubricate the ball bearing with clean oil and install the shaft and bearing assembly into the pump body.
- (4) Screw the threaded bearing retainer into the pump body until the hole in the retainer is aligned with the hole in the body for the retainer snap ring and install the retainer snap ring.
- (5) Install the shaft key in the driving gear end of the pump shaft. Install the driving gear, gear retaining washer, and retaining nut and tighten the nut to 50 lbs. ft. torque. Secure with the cotter pin.
- (6) Start a new water flinger on the shaft, with the flanged end next to the oil seal. Install the water flinger so that the flanged end is located $2\frac{7}{16}$ " from the rear end (impeller end) of the pump shaft. The special tool shown in Fig. 17 is available for this operation and is bored the proper depth to locate the flinger at the correct position on the shaft.
- (7) Install the coolant seal assembly in position on the impeller end of the shaft and using a special tool similar to the one shown in Figs. 17 and 18, drive the coolant seal into its bore in the pump body, using care to prevent damage to the seal assembly. **NOTE: Coat the brass lip on the outside diameter of the seal with a small amount of sealing compound before installing.**
- (8) If the original impeller is to be re-used, install the impeller as follows:
 - (a) Drive the old retaining groove pin

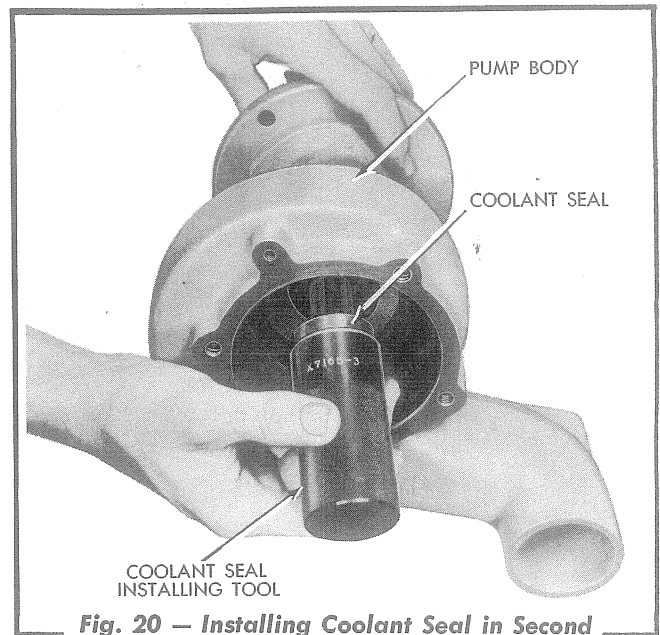


Fig. 20 — Installing Coolant Seal in Second Type Water Pump

from the hub of the impeller. Use a $\frac{1}{8}$ " diameter drill and clean the hole in the impeller from which the groove pin was removed.

- (b) Start the impeller on the pump shaft so that the drilled hole in the impeller is turned 180° from its original position and install the impeller retaining nut; tighten the nut to 30 lbs. ft. torque and install the cotter pin.
- (c) Using a $\frac{1}{8}$ " diameter drill inserted into the drilled hole in the impeller, drill the groove pin hole in the pump shaft until the total depth of the hole is $\frac{29}{32}$ " (Fig. 15). Install the groove pin so that the outer end of the pin is $\frac{1}{16}$ " below the surface of the impeller and stake the pin in place.
- (9) If a new impeller is to be installed, refer to Fig. 15 and install the impeller as follows:
 - (a) Drill a $\frac{1}{8}$ " diameter hole $\frac{3}{16}$ " from the front face of the impeller at an angle of 45° to the front face.
 - (b) Remove any burrs from the shaft

bore of the impeller and start the impeller on the pump shaft so that the drilled hole in the impeller is turned 180° from the old groove pin location. Install the impeller retaining nut and tighten to a torque of 30 lbs. ft.

- (c) Using a $\frac{1}{8}$ " drill inserted into the drilled hole in the impeller, drill the groove pin hole in the pump shaft until the total depth of the hole is $\frac{29}{32}$ ". Install the groove pin so that the outer end of the pin is $\frac{1}{16}$ " below the surface of the impeller and stake the pin in place.

- (10) Place the pump inlet cover in position on the pump body, using a new gasket. Install the capscrews and lockwashers and tighten securely.

E. Installation of Water Pump

- 1. On tractors prior to Serial No. 2734 (refer to Figs. 9 and 13).

- a. Place a new water pump mounting gasket in position on the timing gear housing. With the water outlet elbow installed on the impeller housing, install the water pump in position on the timing gear housing and secure with nuts and lockwashers.
- b. Install the manifold water inlet tee and hoses and secure with hose clamps.
- c. Install the water inlet elbow (with drain cock) in position on the impeller housing, using a new gasket, and secure with capscrews and lockwashers. Place the upper end of the water drain hose in position on the drain cock and secure with the hose clamp.
- d. Place the pump inlet hose in position on the water inlet elbow of the pump and secure with the hose clamp.
- e. Install the oil cooler-to-water pump hose and secure with the hose clamps.

- f. Fill the engine cooling system (refer to Topic 3 in this Section). Check all connections for coolant leaks and correct any leaks found.

- 2. On tractors Serial No. 2734 to 4001 (refer to Figs. 10 and 16).

- a. Place a new water pump mounting gasket in position on the timing gear housing. Install the water pump in position on the timing gear housing and secure with nuts and lockwashers.
- b. Place the upper end of the water drain hose in position on the drain cock and secure with the hose clamp. Properly position the water by-pass line hose and secure with the hose clamps.
- c. Place the water pump inlet hose in position on the water pump and tighten the hose clamps.
- d. Install the manifold water inlet tube and hoses and secure with the hose clamps.
- e. Fill the engine cooling system (refer to Topic 3 in this Section). Check all connections for coolant leaks and correct any leaks found.

- 3. On tractors Serial No. 4001 and above (refer to Figs. 11 and 16).

- a. Place a new water pump mounting gasket in position on the timing gear housing. Install the water pump assembly in position on the timing gear housing and secure with nuts and lockwashers.
- b. Install new "O"-rings in position in the grooves (2 at each end) machined in the O.D. of the oil cooler-to-water pump tube and install one end of the tube in position in the rear end of the water pump.
- c. Install the oil cooler lower bonnet in position on the oil cooler-to-water

pump tube and the oil cooler core and secure the bonnet to the oil cooler core with capscrews and lockwashers.

- d. Properly position the bonnet pipe-to-water pump hose and secure with hose clamps. Position the water by-pass tube hose and secure with hose clamps.

- e. Place the upper end of the water drain hose in position on the drain cock and secure with the hose clamp.
- f. Fill the engine cooling system (refer to Topic 3 in this Section). Check all connections for coolant leaks and correct any leaks found.

7. THERMOSTATS

A. Description

The two thermostats, located in the water outlet front manifold of the engine, operate automatically to maintain normal coolant operating temperature of 160° to 185° F. The thermostats are so positioned, that when they are closed, the flow of the coolant from the engine water outlet manifold to the radiator inlet is shut off. The flow of coolant is then directed from the water outlet manifold through the water by-pass line and back to the inlet side of the water pump.

Before the thermostats open (below coolant temperature of approximately 165° F.), the coolant

circulates through the engine circulating system only. When the thermostats open (fully opened at approximately 185° F.), the coolant circulates through the radiator and the entire system.

Engines prior to Serial No. 2753 are equipped with "blocking" type thermostats, which block off the flow of coolant through the by-pass line when the engine has attained a temperature which fully opens the thermostats. Engines serial No. 2753 and above are equipped with "full choke" type thermostats, which allow coolant to circulate through the by-pass line and into the inlet side of the water pump even when the thermostats are fully opened. Tractors Serial No. 4001 and above

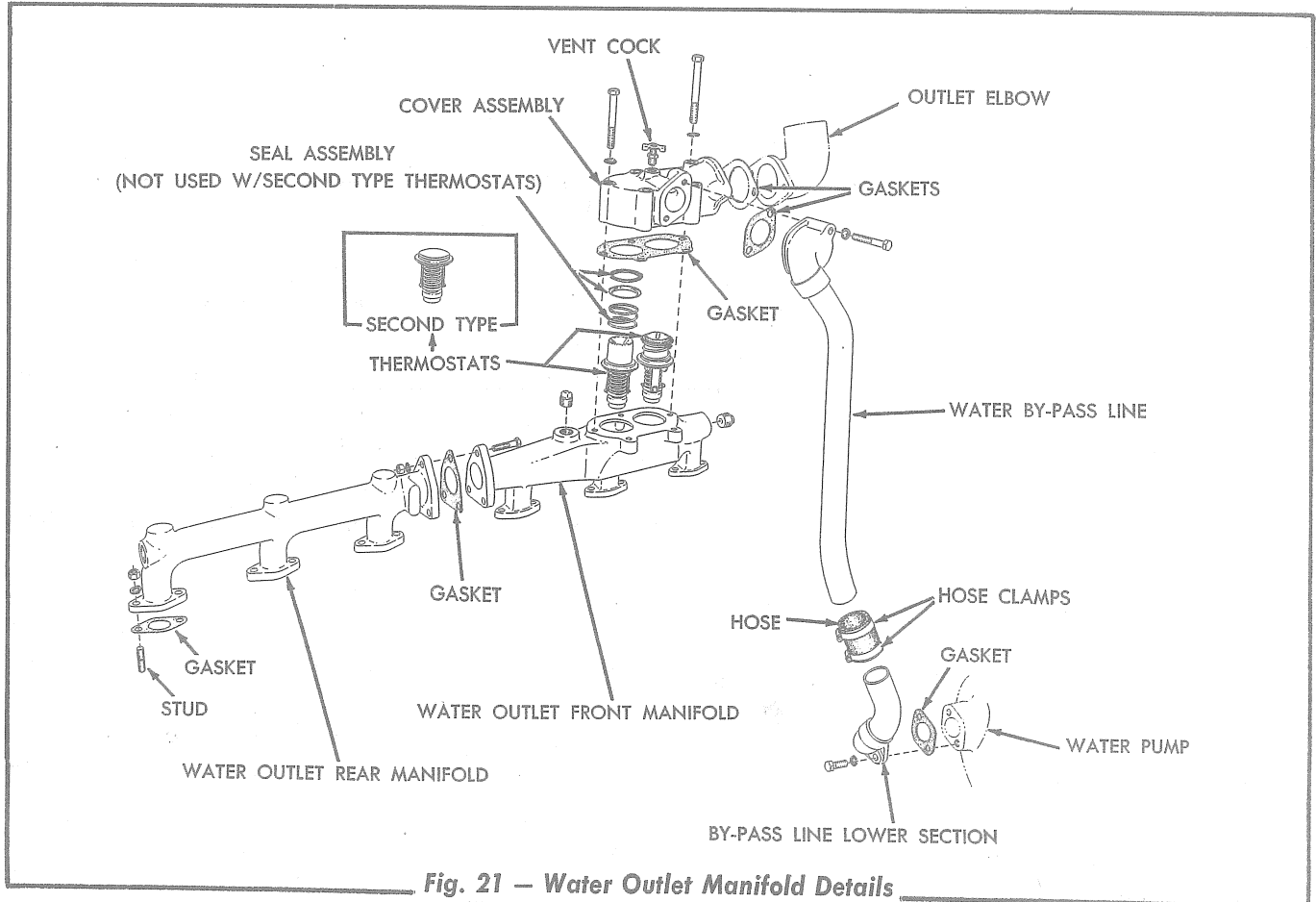


Fig. 21 — Water Outlet Manifold Details
(Tractors Prior to Serial No. 4001)

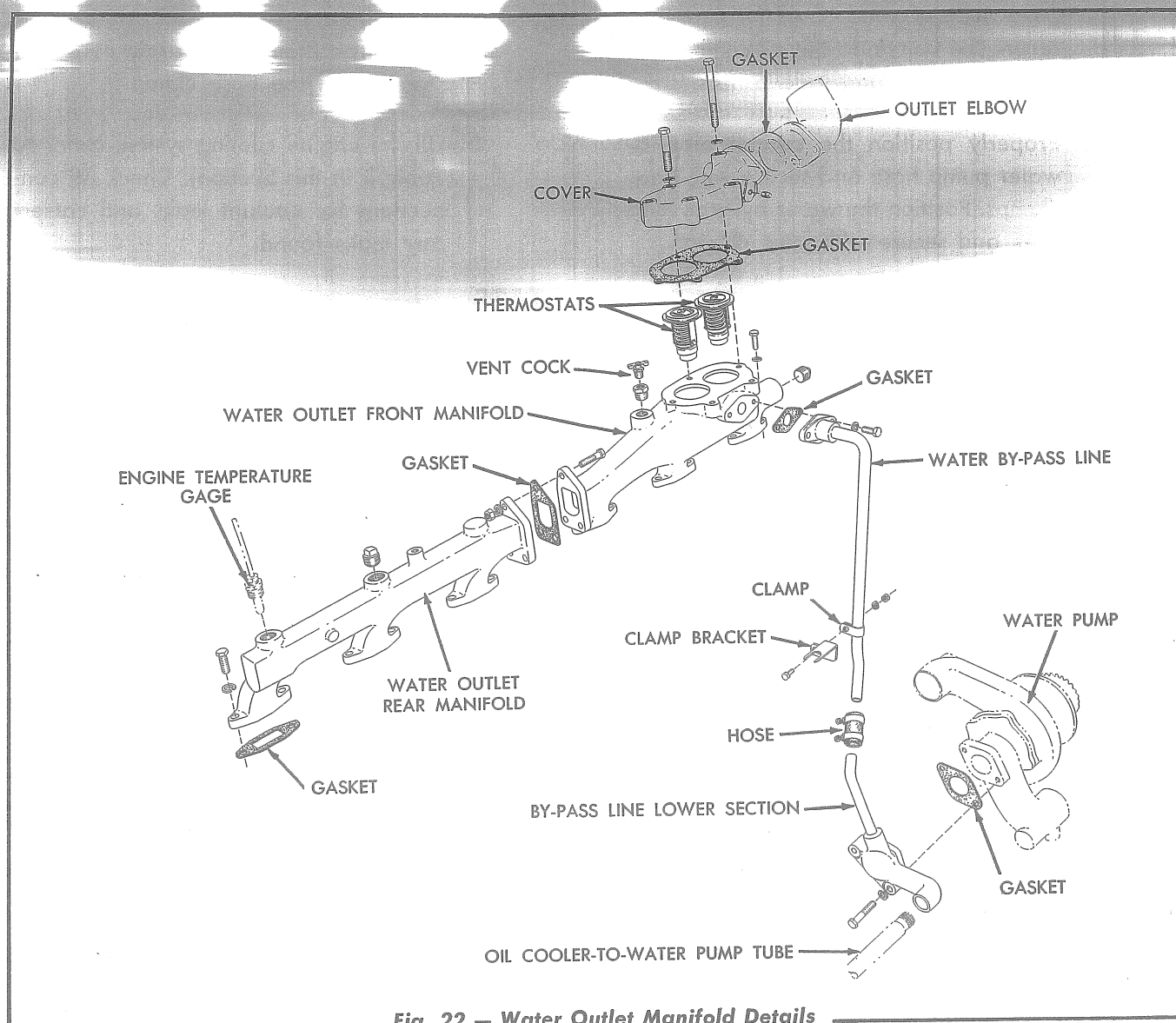


Fig. 22 — Water Outlet Manifold Details
(Tractors Serial No. 4001 and Above)

are equipped with two "full choke" type thermostats; each thermostat has a different opening temperature. One thermostat has an opening temperature of 170° F. and the other an opening temperature of 180° F.

B. Service

Replacement of thermostats will become necessary when the thermostats become corroded or sticking in the open or closed position. If the engine overheats or does not reach and maintain normal operating temperature (160° to 185° F.), the thermostats should be removed and tested for the possible cause of the trouble.

The two 170° thermostats used in tractors prior to

Serial No. 4001 and the one 170° thermostat used in tractors serial No. 4001 and above are designed to start to open at 165° F. and to be fully opened at 180° F., a variation of plus or minus 5° is permissible. The one 180° thermostat used in tractors Serial No. 4001 and above is designed to start to open at 175° F. and to be fully opened at 190° F., a variation of plus or minus 5° is permissible. Sus-

pend the thermostats in a pan of clean water so that the thermostats are completely immersed. While stirring the water, use an accurate thermometer to check the water temperature and gradually heat the water. As the temperature of the water approaches 165° F., observe the thermostats. If the thermostats are functioning properly, the 170° F. thermostats should start to open at

165° F. and be fully opened at 180° F., plus or minus 5°. The 180° thermostat should start to open at 175° F. and be fully opened at 190° F., plus or minus 5°. The thermostats are not adjustable and if they do not open or close within the above limits, they must be replaced.

The "full choke" type (second type) thermostats may be installed in engines prior to Serial No. 2753. The "full choke" type thermostats provide improved cooling and temperature control and better engine warm-up characteristics. To install the "full choke" type thermostats in these engines, it is necessary to install the late type water manifold cover and gaskets, it is also necessary to remove the water outlet front manifold and drill a $\frac{5}{8}$ " diameter hole in the top deck of the manifold as shown in Fig. 23.

C. Thermostat Replacement (Figs. 21 and 22)

1. Drain the cooling system (refer to Topic 3 in this Section).
2. Loosen the lower hose clamp at the engine water outlet elbow and remove the two capscrews and lockwashers securing the water outlet elbow to the water manifold cover. Remove the water outlet elbow and gasket.
3. Remove the capscrews and lockwashers securing the water by-pass line to the water manifold cover or manifold front section and move the line out of the way.
4. Remove the capscrews and lockwashers securing the water manifold cover to the water outlet front manifold and remove the cover. Remove the thermostats, gasket, and if the tractor is equipped with the first type

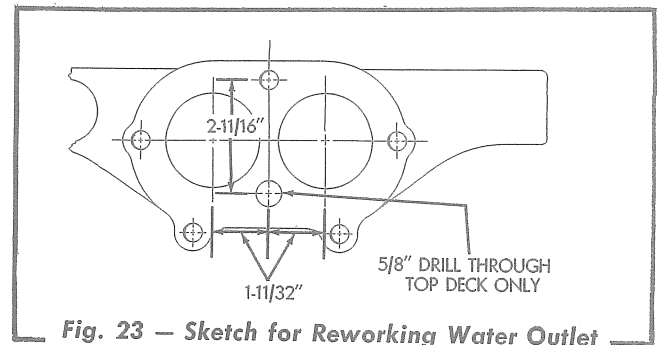


Fig. 23 — Sketch for Reworking Water Outlet Manifold (Engines Prior to Serial No. 2753)

thermostats, remove the seal assemblies.

5. Clean and inspect the water manifold cover. Examine the gasket and replace if necessary. On engines prior to Serial No. 2753 examine the thermostat seal assemblies (serviced only as a unit) and replace if necessary.
6. Place a gasket in position on the water outlet manifold, and install the thermostats and the seal assemblies as shown in Fig. 21 or 22. Place the water manifold cover in position on the manifold and secure with capscrews and lockwashers.
7. Place the water by-pass line and gasket in position on the cover or manifold front section and secure with capscrews and lockwashers.
8. Place the water outlet elbow and gasket in position on the water manifold cover and into the radiator inlet hose. Secure the water outlet elbow to the cover with capscrews and lockwashers. Tighten the hose clamps on the radiator inlet hose securely.
9. Fill the cooling system with coolant (refer to Topic 3 in this Section).

8. FAN, FAN PULLEY, AND FAN BELTS

A. Description

The standard fan on the models HD 16A and HD 16D tractors is a six blade, suction type fan, 34 inches in diameter. The standard fan on the models HD 16AC, HD 16DC, HD 16FC and HD 16GC tractors is a six blade, pusher type fan, 34 inches in diameter. The fan pushes or pulls (according to the type used) air through the radiator and helps cool the engine coolant as it is circulated from the top to the bottom of the radiator core.

The fan is bolted to the fan pulley which rotates on two ball bearings mounted on the fan spindle. The entire assembly is supported by the fan mounting bracket, bolted to the front of the timing gear housing cover, and is driven by the two belts from the crankshaft pulley, the generator drive is used as an idler for adjusting the fan drive belts.

B. Removal of Fan Pulley Assembly

1. Drain the cooling system (refer to Topic 3 in this Section).
2. Loosen the hose clamps securing the radiator inlet tube (Fig. 7) and remove the tube. Remove the capscrews, lockwashers, and plain washers securing the fan guard to the radiator support, then remove the fan guard.
3. Remove the capscrews and lockwashers attaching the fan to the fan pulley assembly. Move the fan forward and lower it onto the fan shroud of the radiator support.
4. Loosen the tension on the fan and generator drive belts and remove the belts.
5. Remove the roll pin used to lock the slotted nut in position on the rear end of the fan spindle. Loosen the slotted nut and remove the nut and the plain washer from the rear end of the fan spindle. Remove the fan pulley assembly from the fan mounting bracket. Remove the fan.

C. Disassembly of Fan Pulley (Fig. 24)

1. Remove the pulley cap retaining snap ring and pulley cap from the fan pulley assembly.
2. Remove the retainer snap ring and turn the spindle sealing washer retainer out of the fan pulley; remove the retainer, spindle sealing washer (cork), rear bearing retaining washer, and the bearing retaining washer gasket.
3. Place the fan pulley assembly in a suitable press, with the fan end of the pulley up, and press the spindle and bearings from the fan hub.
4. Remove the cotter pin and the fan spindle nut from the spindle and press the spindle from the bearings.

D. Inspection of Fan Pulley Assembly

Wash all parts thoroughly in clean solvent or fuel and inspect for wear or damage. Rotate the

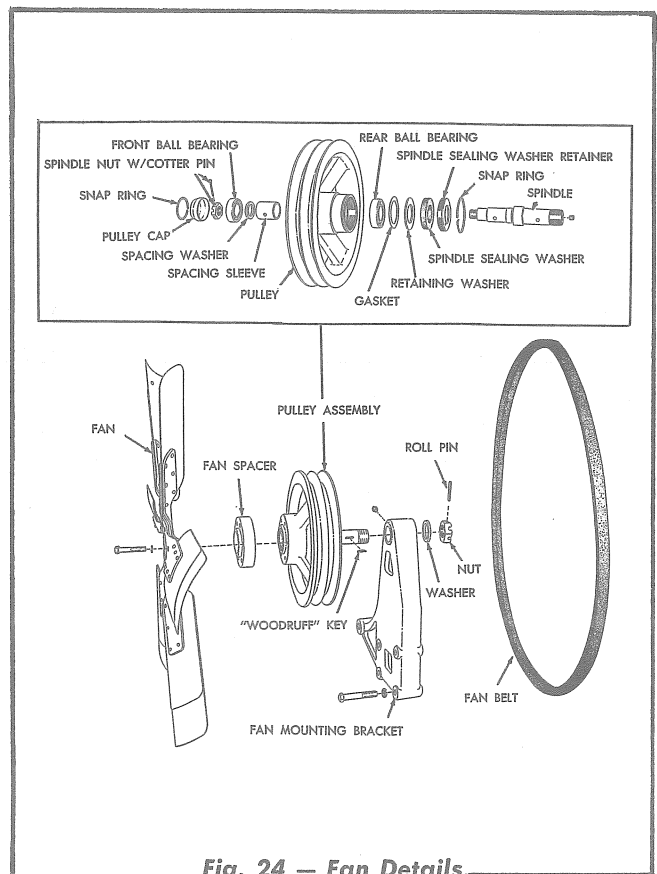


Fig. 24 — Fan Details

bearings by hand and check for looseness, roughness, and binding, and replace if necessary. Inspect the spindle and make certain it is not bent or worn and that the threads are not damaged beyond repair. Inspect the fan pulley for wear and make certain that the pulley grooves are smooth and that the pulley is not chipped or cracked. Discard the spindle sealing washer and the bearing retaining washer gasket and install new ones when assembling. Replace the fan and generator drive belts if they are worn or frayed.

E. Assembly of Fan Pulley (Fig. 24)

1. Press the rear ball bearing onto the spindle. Place the spindle bearings spacing sleeve and the front bearing spacing washer in position on the front end of the spindle. Press the front ball bearing onto the spindle.
2. Install the fan spindle nut, tighten securely, and install the cotter pin.
3. Place the pulley in position on a press, with the fan end of the pulley down. Start the spindle (with bearings) into position in the pulley. Pressing on the rear end of the spindle, press the spindle (with bearings) into position in the pulley. *NOTE: While pressing the spindle into the pulley, hand pack the area between the bearings with clean ball and roller bearing lubricant.*
4. Install a new bearing retaining washer gasket and the rear bearing retaining washer in position on the spindle. Insert a new spindle sealing washer into the spindle sealing washer retainer and turn the washer retainer into the pulley until the hole in the retainer is aligned with the hole in the pulley for the retainer snap ring. Install the retainer snap ring.
5. Install the pulley cap, and if the fan pulley was equipped with a snap ring to retain the cap, install the snap ring.

F. Installation of Fan Pulley

1. Place the fan in position in the shroud of the radiator support.

2. Insert the "Woodruff" key in the keyway of the fan spindle if it was removed. Insert the spindle into the bore of the fan mounting bracket, then install the plain washer and slotted nut. Tighten the nut securely and install the roll pin to lock the nut.
3. Install and adjust the fan and generator drive belts (refer to Paragraph G in this Topic).
4. Install the fan on the fan pulley and secure with capscrews and lockwashers. *NOTE: If the tractor has a suction type fan, install the fan spacer.*
5. Attach the fan guard to the radiator support and secure with capscrews, plain washers, and lockwashers.
6. Install the radiator inlet tube and secure with the hose clamps.
7. Fill the cooling system (refer to Topic 3 in this Section).

G. Adjustment of Fan and Generator Drive Belts

The fan and generator drive belts are properly adjusted when the straight side (left side) of the belts can be pressed inward approximately 1 inch by hand at a point half way between the crankshaft and fan pulleys.

To adjust the fan and generator drive belts loosen the generator adjusting arm capscrew (Fig. 25) and move the generator in or out until the proper belt tension is obtained, then tighten the adjusting arm capscrew.

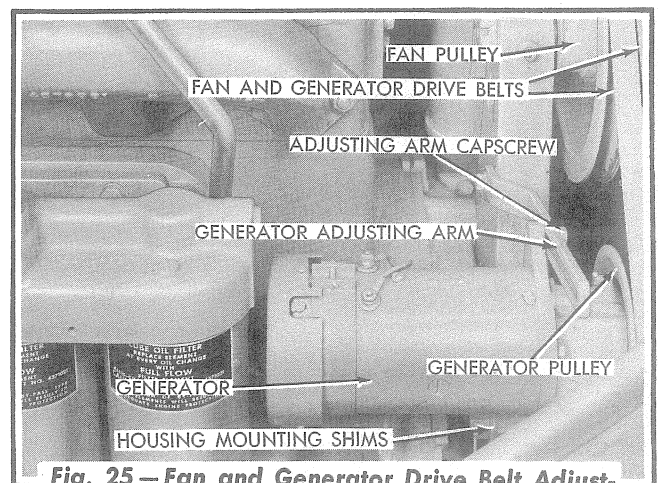


Fig. 25 — Fan and Generator Drive Belt Adjustment Location (Tractors Serial No. 4001 and Above Shown — Tractors Prior to Serial No. 4001 Similar)

SECTION V — ENGINE LUBRICATING SYSTEM

Topic Title	Topic No.	Page No.
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Oil Pressure Regulating Valve	4	100
Lubricating Oil Cooler and Oil By-Pass Valve	5	101
Lubricating Oil Filters	6	106

1. DESCRIPTION OF SYSTEM

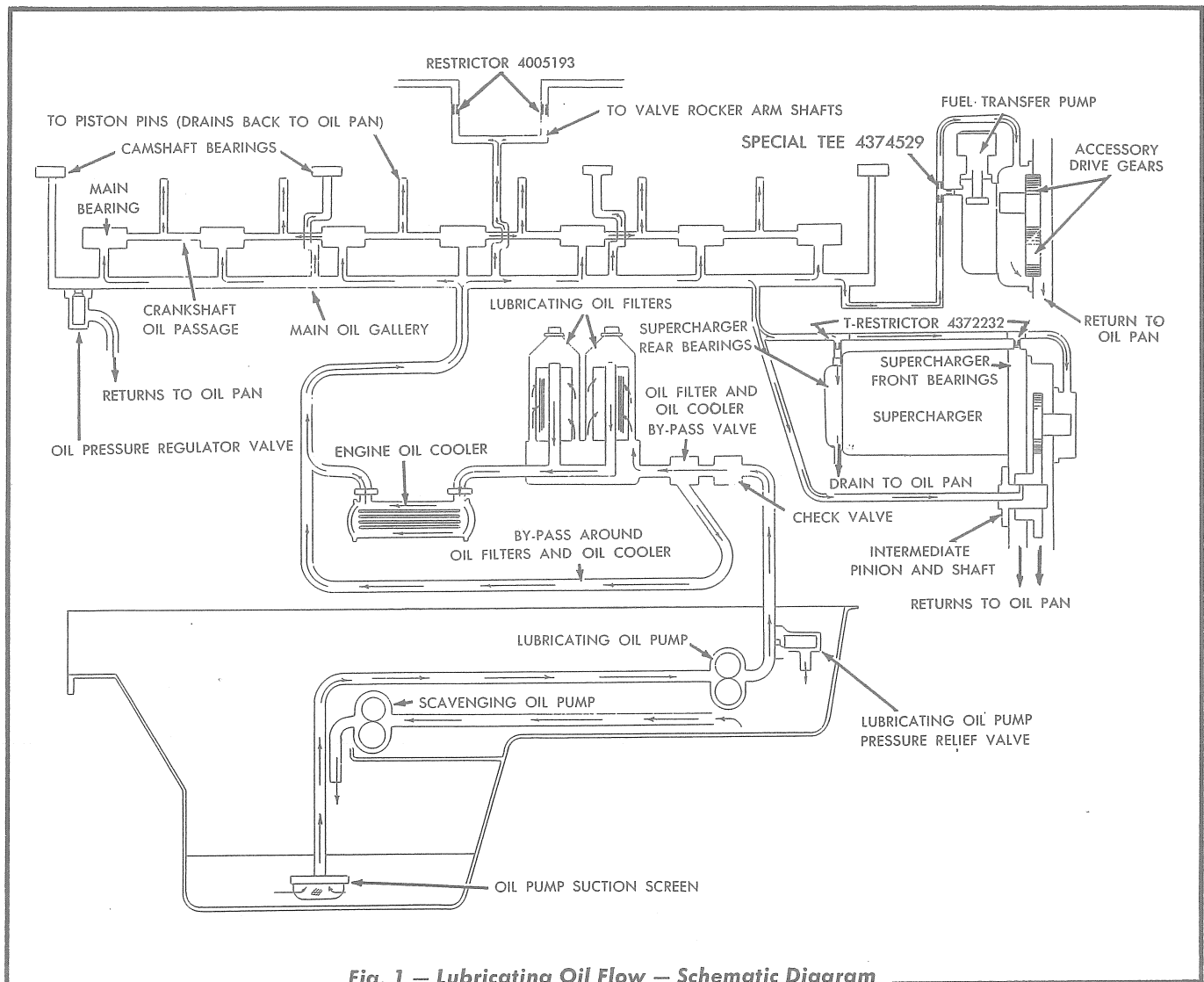


Fig. 1 — Lubricating Oil Flow — Schematic Diagram
(Tractors Prior to Serial No. 4001)

The engine is pressure lubricated throughout by a gear type lubricating oil pressure pump driven by a gear in mesh with the crankshaft gear, located on the front end of the crankshaft. A pump pres-

sure relief valve, located in the lubricating oil pump discharge line, is provided and is set to relieve when pressure in the engine oil passages and lines exceeds 180 P.S.I.

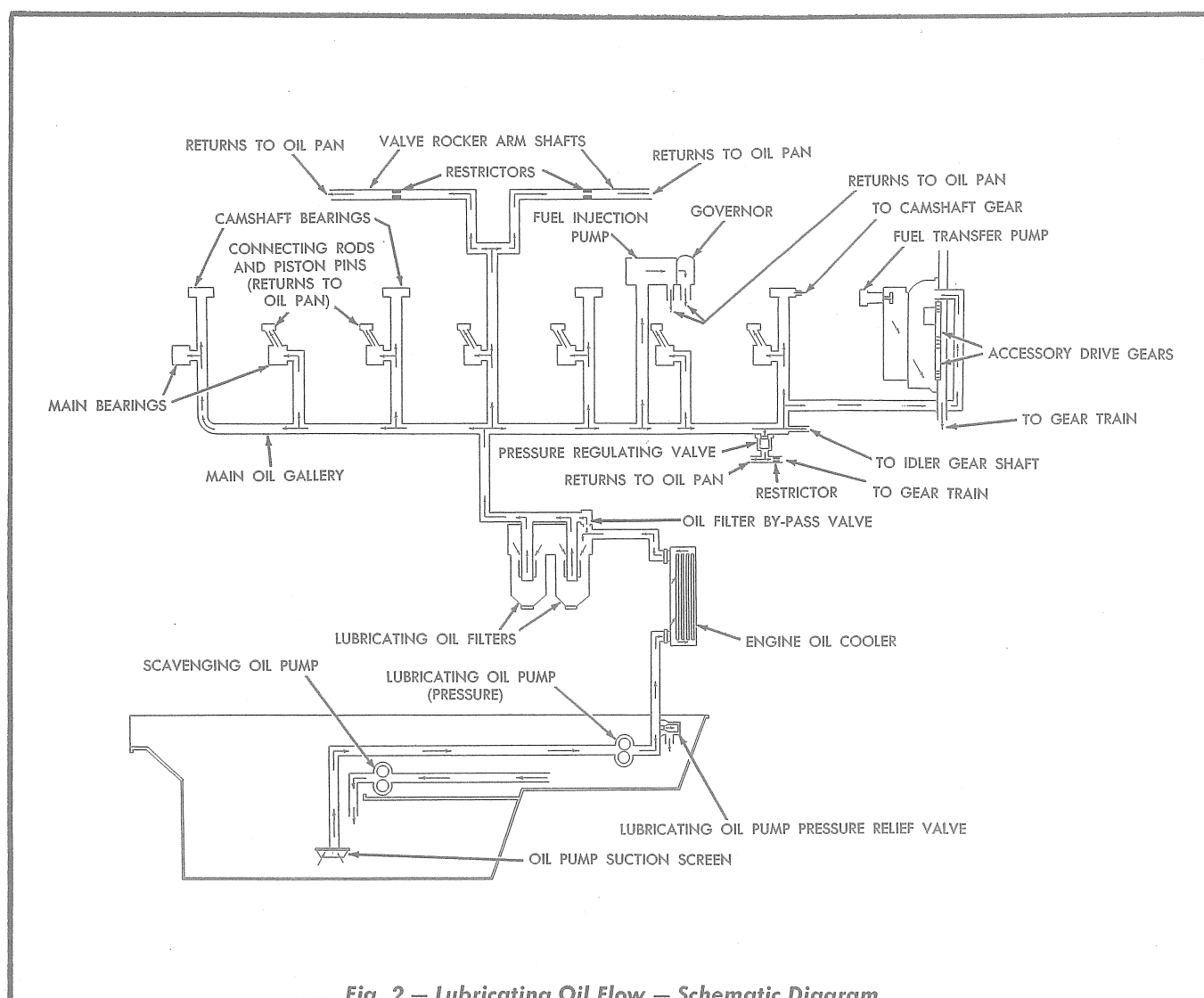


Fig. 2 — Lubricating Oil Flow — Schematic Diagram
(Tractors Serial No. 4001 and Above)

A scavenging oil pump, driven from the rear of the lubricating oil pressure pump by a drive shaft connecting the upper shaft of the scavenging oil pump to the lower shaft of the lubricating oil pressure pump, is also provided. The scavenging oil pump serves as a transfer pump, transferring oil from the front portion of the oil pan to the main oil sump in the rear of the oil pan, keeping the inlet end (suction screen) of the lubricating oil pressure pump submerged at all times. A pressure relief valve is not provided for the scavenging oil pump.

The lubricating oil pressure pump draws the oil from the rear oil sump in the oil pan through the oil pump suction screen, which is submerged in the lubricating oil. The pump then circulates the oil under pressure through the engine oil cooler and lubricating oil filters, and then to the main oil

gallery of the engine which extends lengthwise through the cylinder block and parallel to the camshaft. Oil passages direct the oil from the main oil gallery to the camshaft and main bearings and through rifle drilled connecting rods to the piston pins.

A horizontal oil passage through the center of the cylinder block extends from the main oil gallery to a cavity in the left side of the cylinder block. From this cavity there are two vertical openings which extend to the rocker arm assemblies.

On tractors Serial No. 923 and above, a drilled passage at the front of the main oil gallery provides lubrication to the idler gear through a drilled passage in the idler gear shaft.

On tractors prior to Serial No. 4001, an external-

oil line, extending from the main oil gallery to the accessory drive cover and housing, provides lubrication for the fuel transfer pump drive shaft gear and the accessory drive gears.

On tractors Serial No. 4001 and above, the accessory drive is lubricated by an oil line connected into the cross drilled oil passage between the main oil gallery and the camshaft front bearing; this oil line is located inside the timing gear housing.

On tractors Serial No. 4001 and above, an engine lubricated fuel injection pump and governor is also used. On these engines, a fitting is installed in the oil cavity in the left side of the cylinder block and an external oil line, connected to this fitting and to the fuel injection pump mounting bracket, provides lubrication to the fuel injection pump and governor assembly, through a drilled passage in the pump mounting bracket. Oil is returned directly to the engine oil pan from the fuel injection pump and governor assembly through drilled passages in the pump mounting bracket.

On tractors prior to Serial No. 4001, an oil by-pass valve consisting of two valves, an oil filter and oil cooler by-pass valve and a check valve (Fig. 10) located in the by-pass valve housing on the right side of the cylinder block, are incorporated in the

lubricating oil passage to the engine lubricating oil filters and the engine oil cooler. Oil delivered under pressure by the oil pressure pump holds the check valve in the open position, allowing the oil to circulate; whenever the engine is stopped, the check valve closes, preventing the oil in the lubricating oil filters from draining back to the crankcase. The lubricating oil filter and oil cooler by-pass valve by-passes oil directly to the engine lubricating system if either the oil filters or the oil cooler become clogged, or if in cold weather the oil is too thick to circulate freely through the oil filters and the oil cooler.

A check valve is not used on tractors Serial No. 4001 and above and an oil filter by-pass valve is incorporated in the lubricating oil filter head. The by-pass valve by-passes oil directly to the engine lubricating system if the oil filters become clogged, or if in cold weather the oil is too thick to circulate freely through the oil filters.

Stabilized oil pressure is maintained within the lubricating system by an oil pressure regulating valve (Fig. 9) located in the main oil gallery at the right front corner of the cylinder block. Excess oil by-passed through this valve returns to the oil pan.

2. LUBRICATING OIL PRESSURE PUMP

A. Description

The full pressure engine lubricating system permits operation of the engine at an angle of 45° in any direction. Oil pressure at normal operating temperature should be 30 to 55 P.S.I. at high idle engine speed.

The gear-type oil pressure pump is mounted on the front main bearing cap as shown in Fig. 3. The oil pressure pump driving gear is a helical gear which meshes directly with the crankshaft gear. The pump driving gear is pressed on and keyed to the front end of the upper shaft and gear assembly (Figs. 5 and 6) and is retained by a roll pin. The upper shaft and gear assembly of the pump drives the lower shaft and gear assembly.

The rear end of the lower shaft is slotted and extends through the rear of the pump body and is connected to the upper shaft and gear assembly of the scavenging oil pump by means of a drive shaft (Fig. 3). On tractors prior to Serial No. 4001 the upper shaft and gear assembly is supported at each end by bushings located in the pump body and the pump cover. The lower shaft and gear assembly is supported by bushings located in the pump body as shown in Fig. 5. On tractors Serial No. 4001 and above the upper and lower shaft and gear assemblies are supported by plain bushings and flanged bushing located in the pump body and pump cover as shown in Fig. 6. The gears of both the upper and lower gear and shaft assemblies are keyed and pressed onto their respective shafts and are not serviced separately.

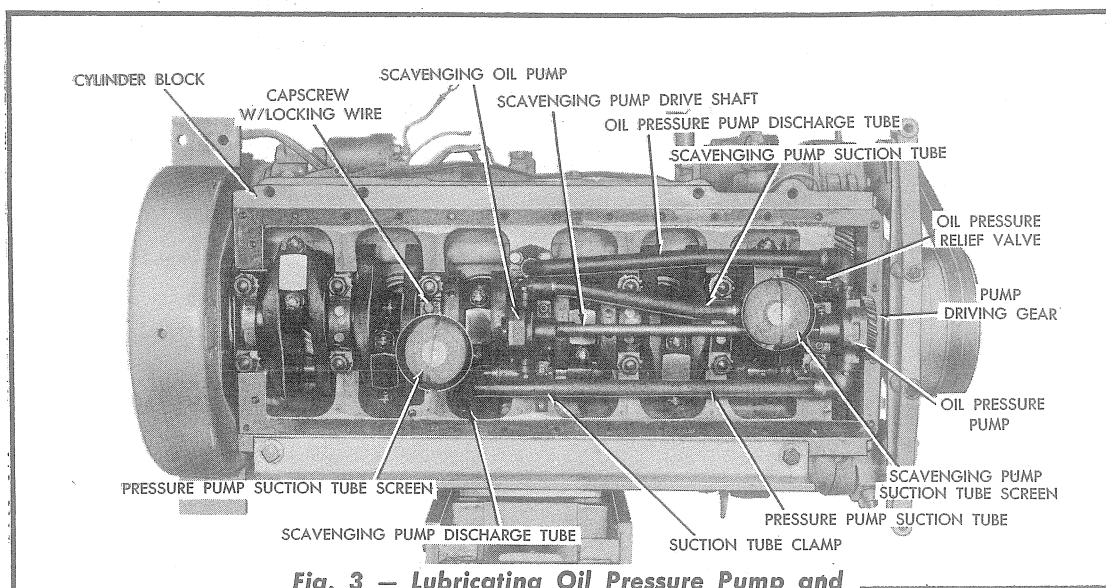


Fig. 3 — Lubricating Oil Pressure Pump and Scavenging Oil Pump — Installed (Tractors Serial No. 4001 and Above Shown — Tractors Prior to Serial No. 4001 Similar)

A plunger type pressure relief valve (Fig. 3) located in the oil pressure pump discharge tube, by-passes excess oil back to the oil pan when the discharge pressure exceeds 180 P.S.I. To protect the oil pump gears, a suction screen is attached to the oil pump suction tube.

B. Removal of Oil Pressure Pump (Figs. 3 and 8)

1. Remove the engine crankcase guard.
2. Drain the engine lubricating oil and remove the oil pan.
3. Remove the locking wire, capscrews, and lockwashers attaching the oil pressure pump discharge tube and remove the tube and oil pressure relief valve as an assembly.
4. Remove the locking wire, capscrews, and lockwashers attaching the pressure pump suction tube to the pressure pump and to the number 5 main bearing cap. Remove the locking wire, capscrew, lockwasher, and plain washer attaching the suction tube clamp bracket to the scavenging pump and remove the suction tube and the suction tube clamp bracket as an assembly.
5. Remove the locking wires, capscrews, lockwashers, and plain washer from the scav-

enging pump suction tube supporting bracket and remove the bracket. Remove the locking wire, capscrews, and lockwashers attaching the oil pressure pump to the front main bearing cap. The oil pressure pump may now be removed as a unit by lowering and moving toward the front of the engine to free the pump from the scavenging pump drive shaft. Remove the scavenging pump drive shaft.

C. Disassembly of Oil Pressure Pump (Figs. 5 and 6)

Inspection of the pump is advisable when the engine is overhauled, or after a long period of service. To disassemble the pump, proceed as follows:

1. Thoroughly wash the pump assembly and remove the roll pin from the hub of the driving gear. Using a puller as shown in Fig. 4, pull the driving gear from the pump shaft. Remove the "Woodruff" key from the shaft, and using a hone or file, remove any burrs from the shaft.
2. Remove the locking wire and capscrews securing the pump cover to the pump body. Tap the cover lightly to loosen it from the dowel pins and remove the cover and gasket.

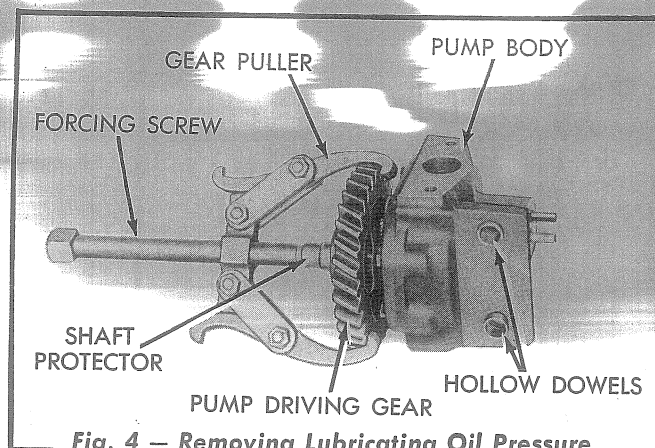


Fig. 4 — Removing Lubricating Oil Pressure Pump Driving Gear

3. Remove the upper shaft and gear assembly.
4. Remove any burrs from the drive end of the lower shaft and remove the shaft and gear assembly from the pump body.

D. Cleaning and Inspection of Oil Pressure Pump Parts

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

The principal wearing parts of the oil pump are the upper and lower shaft and gear assemblies, pump cover bushing(s) and pump body bushings. If dirt and sludge have been allowed to accumulate in the lubricating system, oil pump gear wear may be rather pronounced in a comparatively short time. When the oil has been kept clean and the oil filters have been properly serviced, the wear on these parts should be very slight.

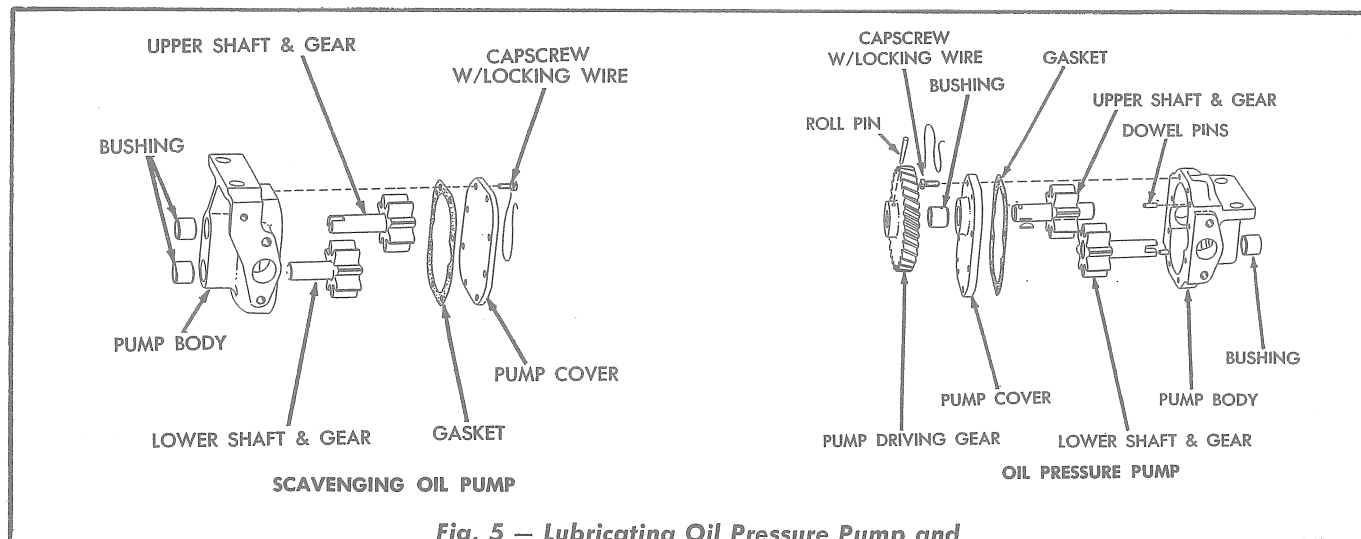


Fig. 5 — Lubricating Oil Pressure Pump and Scavenging Oil Pump Details (Tractors Prior to Serial No. 4001)

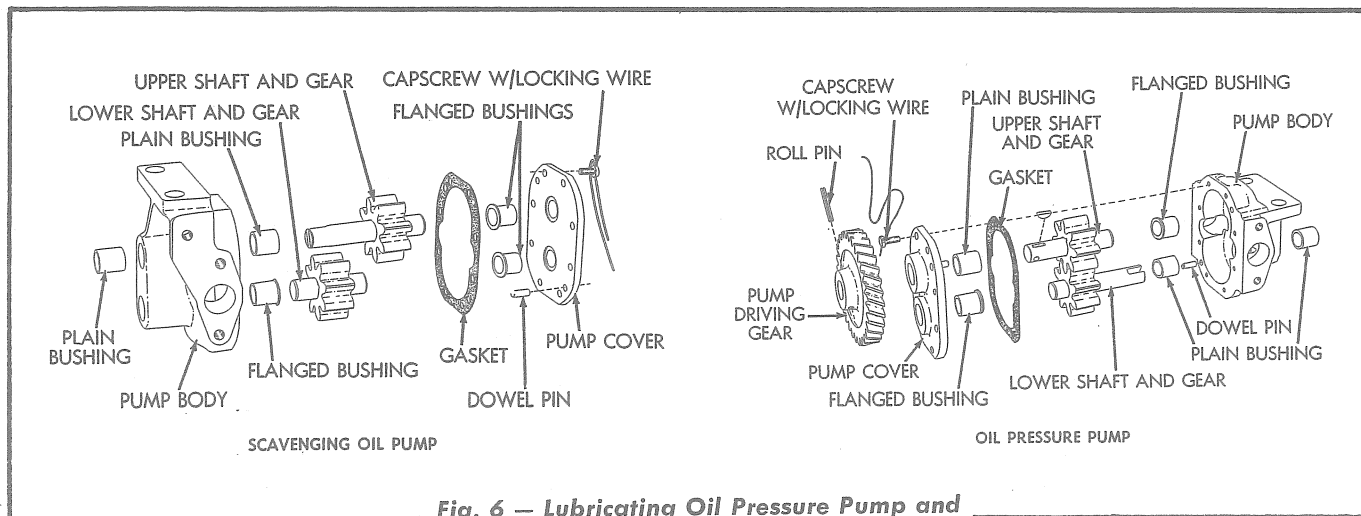


Fig. 6 — Lubricating Oil Pressure Pump and Scavenging Oil Pump Details (Tractors Serial No. 4001 and Above)

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

The radial clearance between the pump gears and the pump body should be .0022" to .0032". When the pump is assembled, the side clearance of the gears in the pump should be .005" to .007". When these clearances are exceeded, it will be necessary to replace the worn parts. The upper shaft and gear and the lower shaft and gear are available only as assemblies.

3. Inspect the pump cover bushing(s) and the pump body bushings for excessive wear or scoring and replace if necessary. The specified clearance between the upper and lower shafts and the bushings is .0015" to .003". After installing new bushings in the pump body and in the pump cover, the bushings should be reamed to .7495" to .7505". The specified diameter of the upper and lower shafts at the bushing locations is .7475" to .7480".

4. For installation of oil pressure pump bushings:

- a. On tractors prior to Serial No. 4001, refer to Figs. 5 and 7, and install the bushing in the bore of the pump cover so that the outer end (driving gear end) of the bushing is $\frac{1}{64}$ " in from the front machined surface of the cover. Three bushings are provided in the pump body bores; one bushing in the upper shaft bore and two bushings in the lower shaft bore. The upper shaft bushing is to be installed in the pump body so that the inner end (gear end) of the bushing is $\frac{1}{32}$ " in from the inner machined face of the body. The bushings for the pump lower shaft are to be installed so that the inner end (gear end) of the inner bushing is $\frac{1}{32}$ " in from the inner machined face of the body and the outer end of the outer bushing

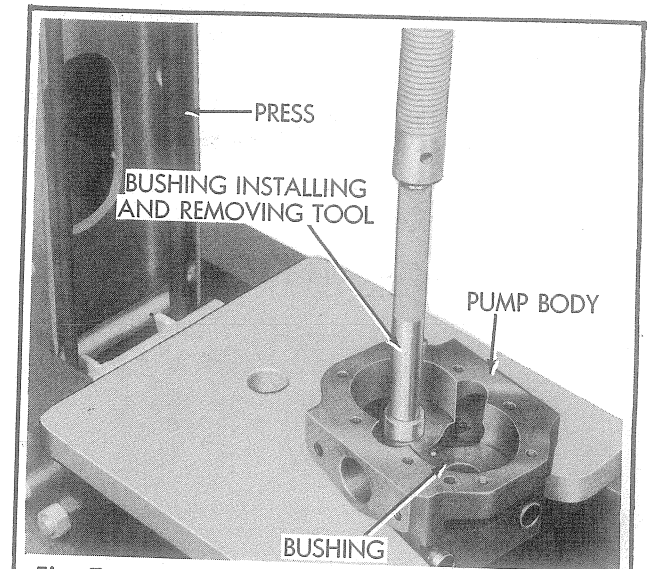


Fig. 7 — Installing Lubricating Oil Pressure Pump Body Bushings (Tractors Prior to Serial No. 4001 Shown — Tractors Serial No. 4001 and Above Similar)

should be located $\frac{1}{32}$ " in from the outer face of the pump body.

- b. On tractors Serial No. 4001 and above, refer to Figs. 6 and 7 and install the plain bushing in the upper shaft bore and the flanged bushing in the lower shaft bore in the pump cover. The two bushings are to be flush with or below the machined inner surface of the pump cover. Three bushings are provided in the pump body bores; the flanged bushing in the upper shaft bore and the two plain bushings in the lower shaft bore. The upper shaft bushing is to be installed in the pump body so that the top of the flange is flush with or below the inner face of the body. The bushings for the pump lower shaft are to be installed so that the inner end (gear end) of the inner bushing is $\frac{1}{32}$ " in from the inner machined face of the body and the outer end of the outer bushing should be located $\frac{1}{32}$ " in from the outer face of the pump body.
5. Remove the pressure relief valve from the pressure pump discharge tube. Disassemble and inspect the pressure relief valve. The piston must slide smoothly in the bore of the valve body. When the piston or the bore

of the valve body show excessive wear or roughness, a new valve assembly must be installed.

6. Remove the oil screen from the pressure pump suction tube, thoroughly clean, and reinstall.

E. Assembly of Oil Pressure Pump

(Figs. 5 and 6)

Lubricate the bushings, and shaft and gear assemblies, with clean oil. Assemble the oil pump as follows:

1. Install the lower shaft and gear assembly in the pump body, inserting the slotted end of the shaft through the pump body bushings.
2. Install the upper shaft and gear assembly in the pump body, with the end of the shaft containing the keyway facing toward the cover end.

3. Install the pump cover and gasket in position on the pump body and dowel pins and secure with drilled-head capscrews and locking wires.

4. Install the "Woodruff" key in the upper shaft. Heat the pump driving gear in oil to a temperature of approximately 240° F. then press the gear into position on the shaft. **NOTE:** When installing the driving gear onto the shaft, press the gear onto the shaft only far enough to align the holes for the roll pin. The specified clearance between the driving gear and the front machined face of the cover is .010" to .029". Install the roll pin in position in the driving gear and shaft and secure by peening the gear hub over each end of the pin.

F. Installation of Oil Pressure Pump

(Figs. 3 and 8)

1. Place the scavenging pump drive shaft in

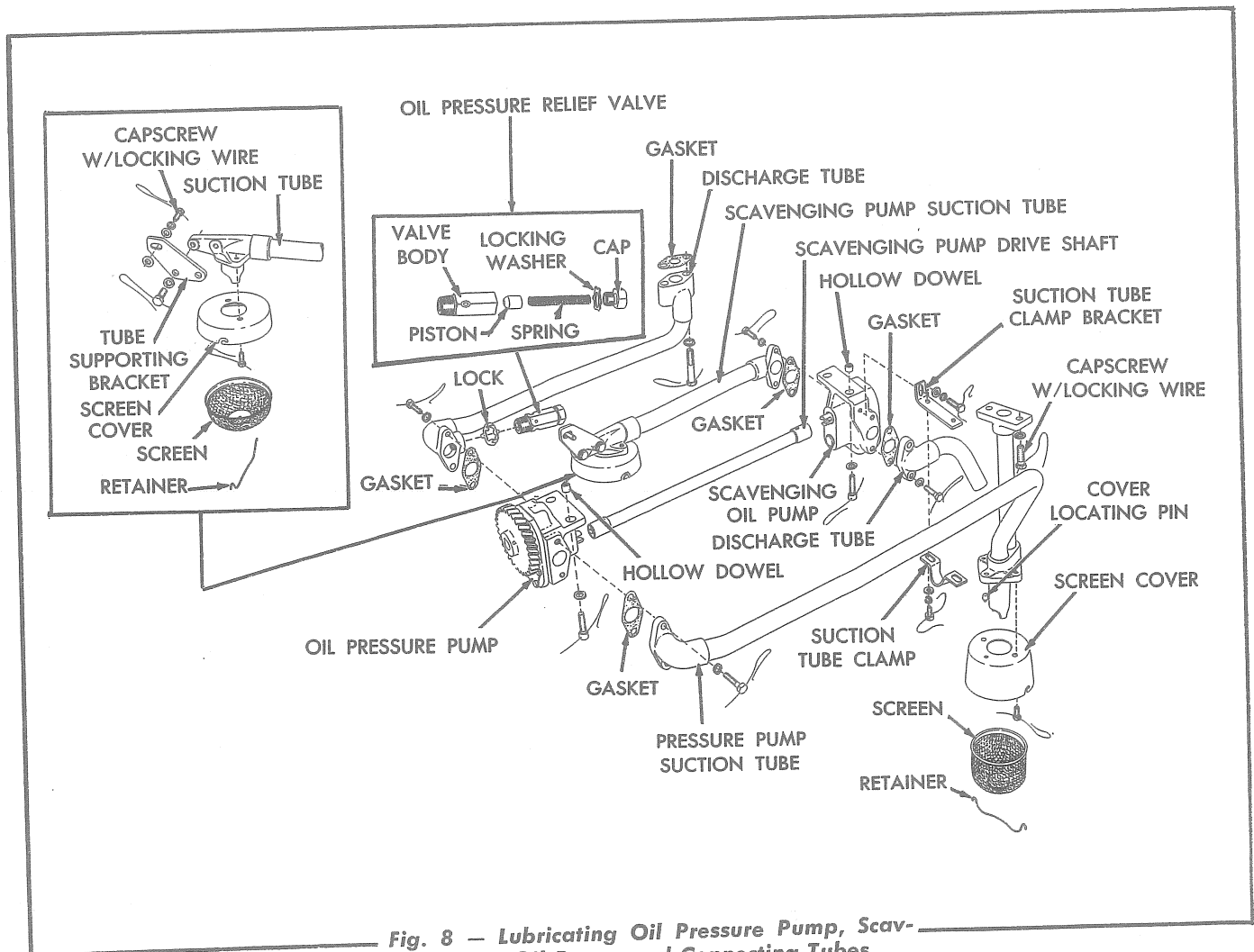


Fig. 8 — Lubricating Oil Pressure Pump, Scavenging Oil Pump, and Connecting Tubes
(Tractors Serial No. 2734 to 4001
Shown — Other Tractors Similar)

position on the lower shaft of the oil pressure pump and place the rear end of the drive shaft against the upper shaft of the scavenging pump. Turn the pump driving gear until it meshes with the crankshaft gear and the scavenging pump drive shaft is properly engaged with the upper shaft of the scavenging pump. This will allow the two hollow dowels, located in the pressure pump body, to position in the holes in the front main bearing cap. Attach the pressure pump to the front main bearing cap with socket-head capscrews and lockwashers and secure the capscrews with a locking wire.

NOTE: *The specified backlash between the oil pump driving gear and the crankshaft gear is .002" to .008" on tractors prior to Serial No. 4001 and .003" to .011" on tractors Serial No. 4001 and above.*

2. Place the pressure pump suction tube in position on the pressure pump, using a new gasket between the suction tube and the pump. Attach the suction tube to the pressure pump with capscrews and lockwashers and secure the capscrews with a locking wire. Attach the rear end of the suction tube to the number 5 main bearing cap with capscrews and lockwashers. Secure the capscrews with a locking wire. Attach the pressure pump suction tube clamp bracket to the scavenging pump with a cap-screw, lockwasher, and plain washer. Secure the capscrow with a locking wire.
3. Place the oil pressure pump discharge tube in position on the pressure pump and the cylinder block, using a new gasket at each end of the discharge tube. Attach the discharge tube to the pressure pump and to the cylinder block with capscrews and lockwashers. Secure the capscrews with locking wire.
4. Install the scavenging pump suction tube

supporting bracket in position on the oil pressure pump and secure with a capscrew, lockwasher, and two plain washers. Secure the capscrew with a locking wire. Secure the scavenging pump suction tube to the supporting bracket with two capscrews and lockwashers and secure the capscrews with locking wire.

5. Place a new pressure relief valve lock in position on the pressure relief valve and install the pressure relief valve in the pressure pump discharge tube. Tighten the pressure relief valve and secure with the pressure relief valve lock.

NOTE: *In early model engines (engines in tractors prior to Serial No. 2734) plain socket-head capscrews and lockwashers were used to secure the oil pressure pump and the scavenging pump in position on the main bearing caps. Plain capscrews and lockwashers were used to secure the suction tubes and the discharge tubes to the pumps and mounting brackets. In late model engines (engines in tractors Serial No. 2734 and above) drilled socket-head capscrews, lockwashers, and locking wires are used to secure the oil pressure pump and the scavenging pump in position on the main bearing caps. Drilled head capscrews, lockwashers, and locking wires are used to secure the suction tubes and the discharge tubes to the pumps and mounting brackets. It is suggested that when overhauling an early model engine, drilled head capscrews, lockwashers, and locking wires be installed as a precautionary measure.*

6. Install the engine oil pan, using a new oil pan gasket set, and tighten the attaching capscrews to a torque of 45 to 50 lbs. ft. Fill the engine crankcase to the proper level with the specified lubricant (refer to Section I, Topic 3).
7. Install the engine crankcase guard.

3. SCAVENGING OIL PUMP

A. Description

The scavenging oil pump, mounted on the number 4 main bearing cap, serves as an oil transfer pump. The scavenging oil pump transfers oil from the front portion of the oil pan to the main oil sump in the rear of the oil pan, keeping the inlet end (oil screen) of the oil pressure pump suction tube submerged in oil at all times. The scavenging oil pump is driven from the rear of the oil pressure pump by a drive shaft connecting the upper shaft of the scavenging oil pump to the lower shaft of the oil pressure pump. No pressure relief valve is provided for the scavenging oil pump.

B. Removal of Scavenging Oil Pump

(Figs. 3 and 8)

1. Remove the engine crankcase guard.
2. Drain the engine lubricating oil and remove the oil pan.
3. Remove the locking wire, capscrews, and lockwashers attaching the scavenging pump suction tube to the scavenging oil pump.
4. Remove the locking wire, capscrew, plain washers, and lockwasher attaching the scavenging pump suction tube supporting bracket to the oil pressure pump and remove the suction tube and supporting bracket as an assembly.
5. Remove the locking wire, capscrew, and flat washer attaching the pressure pump suction tube clamp bracket to the scavenging oil pump.
6. Remove the locking wire, socket-head capscrews, and lockwashers attaching the scavenging oil pump to the number 4 main bearing cap and remove the scavenging oil pump and scavenging pump discharge tube as an assembly. Remove the discharge tube from the scavenging oil pump.

C. Disassembly of Scavenging Oil Pump

(Figs. 5 and 6)

1. Using a hone or file, remove any burrs from the shaft of the upper shaft and gear assembly before removing the cover.
2. Thoroughly wash the pump assembly before disassembly. Remove the locking wire and capscrews attaching the pump cover to the pump body and remove the cover and cover gasket.
3. Remove the upper shaft and gear assembly.
4. Remove the lower shaft and gear assembly.

D. Cleaning and Inspection of Scavenging Oil Pump Parts

1. Wash all the pump components in clean solvent and thoroughly inspect all the parts before reassembling the pump. The principal wearing parts of the scavenging oil pump are the upper and lower shaft and gear assemblies and the pump body bushings. If dirt and sludge have been allowed to accumulate in the lubricating system, oil pump gear wear may be rather pronounced in a comparatively short time. When the oil has been kept clean and the oil filters have been properly serviced, the wear on these parts should be very slight.
2. Inspect the pump gear teeth, the inside of the pump body, and the inner face of the cover for wear or scoring. The gear teeth, the inside of the pump body, and the inner face of the cover must be smooth, with no scratches, score marks, or rough spots.

The radial clearance between the pump gears and the pump body should be .0022" to .0032". When the pump is assembled the side clearance of the gears in the pump should be .005" to .007". When these clearances are exceeded, it will be necessary to replace the worn parts. The upper and lower shafts and gears are not serviced separately and if either the shafts or the gears are to be replaced, the shaft and gear must be replaced as an assembly.

3. Inspect the pump shafts and bushings for excessive wear or scoring and replace if necessary. The specified clearance between the shafts and the bushings is .0015" to .003". After installing new bushings in the pump body, the bushings should be reamed to .7495" to .7505". The specified diameter of the shafts is .7475" to .7480".

4. For installation of scavenging oil pump bushings:

- a. Tractors prior to Serial No. 4001 have two bushings in each shaft bore in the pump body. Refer to Figs. 5 and 7 and install the inner bushing in each shaft bore of the pump body so that the inner end (gear end) of each bushing is $\frac{1}{32}$ " in from the inner machined face of the body. Install the outer bushing in each shaft bore of the pump body so that the outer end of each bushing is $\frac{1}{32}$ " in from the outer face of the pump body. Ream the bushings to .7495" to .7505".
- b. On tractors Serial No. 4001 and above, refer to Figs. 6 and 7 and install the two flanged bushings in the pump cover. The bushings are to be installed so that the top of the flange is flush with, or below, the inner machined face of the pump cover. Three bushings are provided in the pump body bores; the flanged bushing in the lower shaft bore and the two plain bushings in the upper shaft bore. The flanged bushing is to be installed in the pump body so that the top of the flange is flush with, or below, the inner machined face of the pump body. The plain bushings are to be installed so that the inner bushing is $\frac{1}{32}$ " in from the inner machined face of the pump body, and the outer bushing is $\frac{1}{32}$ " in from the outer face of the pump body. Ream the bushings to .7495" to .7505".

5. Remove the oil screen from the scavenging pump suction tube, thoroughly clean, and reinstall.

E. Assembly of Scavenging Oil Pump (Figs. 5 and 6)

Lubricate the bushings, and shaft and gear assemblies, with clean oil. Assemble the pump as follows:

1. Install the lower shaft and gear assembly in position in the pump body.
2. Install the upper shaft and gear assembly in position in the pump body, inserting the slotted end of the shaft through the pump body bushings.
3. Place the pump cover and cover gasket in position on the pump body and secure with drilled-head capscrews and locking wires.

F. Installation of Scavenging Oil Pump (Figs. 3 and 8)

1. Place the scavenging pump in position on the number 4 main bearing cap, inserting the end of the scavenging pump drive shaft into position on the end of the upper shaft of the scavenging oil pump. Install drilled socket-head capscrews and lockwashers to attach the scavenging pump to the main bearing cap and secure the capscrews with locking wire.
2. Place the scavenging pump discharge tube in position on the scavenging pump, using a new gasket between the tube and pump. Install drilled-head capscrews and lockwashers to attach the discharge tube to the pump and secure the capscrews with locking wire.
3. Place the scavenging pump suction tube in position on the scavenging pump, using a new gasket between the pump and tube. Install drilled-head capscrews and lockwashers to attach the suction tube to the pump and secure the capscrews with locking wire. Secure the scavenging pump suction tube supporting bracket to the lubricating oil pressure pump with a drilled-head capscREW, lockwasher, plain washer, and locking wire.

NOTE: On tractors Serial No. 2734 and above, drilled-head capscrews and locking wires were incorporated instead of the

plain head capscrews to mount the oil pressure pump, scavenging oil pump, and suction and discharge tubes. It is suggested that when overhauling an engine that does not have drilled-head capscrews and locking wire, that the plain capscrews be replaced with drilled-head capscrews as a precautionary measure.

4. Install the engine oil pan, using a new oil pan gasket set, and tighten the capscrews to a torque of 45 to 50 lbs. ft. Fill the engine crankcase to the proper level with the specified lubricant (refer to Section I, Topic 3).

5. Install the engine crankcase guard.

4. OIL PRESSURE REGULATING VALVE

A. Description

Stabilized oil pressure is maintained within the lubricating system by an oil pressure regulating valve Fig. 9 located in the main oil gallery at the right front corner of the cylinder block. When conditions are such that the oil pressure at the regulating valve exceeds approximately 55 P.S.I., the valve piston is raised off the valve piston seat and the excess oil is by-passed.

On tractors prior to Serial No. 4001 the excess oil is by-passed into the timing gear housing through a drilled passage in the front of the cylinder block. The oil returns to the engine oil pan through the timing gear housing. On tractors Serial No. 4001 and above the excess oil is by-passed into a drilled passage in the cylinder block. Part of the oil is sprayed onto the idler gear through a restricted opening in the front of this passage and returns to the engine oil pan through the timing gear housing; the remainder of the oil is returned directly to the engine oil pan through the rear of the drilled passage.

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

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

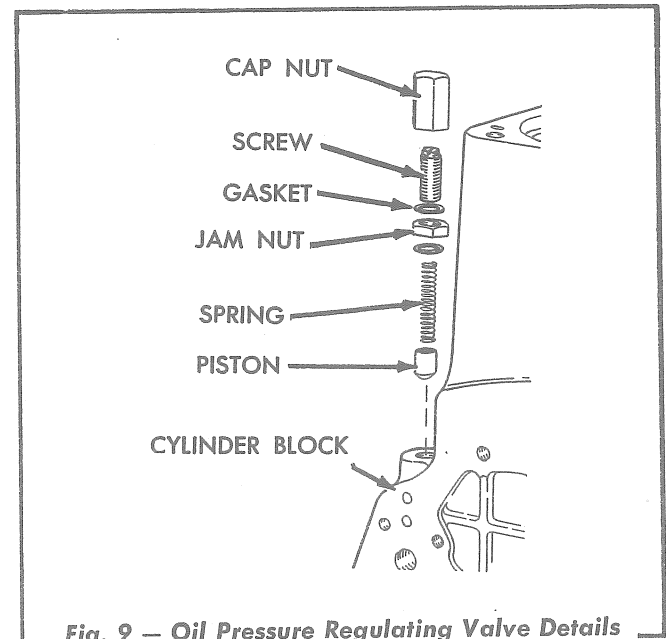


Fig. 9 — Oil Pressure Regulating Valve Details

B. Disassembly of Oil Pressure Regulating Valve

1. Refer to Fig. 9 and remove the pressure regulating valve cap nut and valve nut gasket.
2. Remove the jam nut and gasket.
3. Remove the pressure regulating valve screw, noting the number of turns required for removal. Withdraw the valve spring and valve piston.
4. Wash all parts thoroughly and inspect. Replace all necessary parts.

C. Assembly of Oil Pressure Regulating Valve

1. Lubricate the valve piston with clean oil. Install the oil pressure regulating valve

piston and valve spring (Fig. 9) in position in the cylinder block.

2. Install the pressure regulating valve screw.
NOTE: *Turn the valve screw into the cylinder block the same number of turns as required for removal.*
3. Place the valve nut gasket in position over the pressure regulating valve screw and install the jam nut.
4. After the engine has been reassembled and

is running, operate the engine until normal operating temperature (160° to 185° F.) is indicated by the engine temperature gage. Adjust the oil pressure regulating valve screw to obtain a maximum oil pressure of 55 P.S.I. at high idle engine speed, then tighten the jam nut. No further adjustment should be necessary.

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

5. LUBRICATING OIL COOLER AND OIL BY-PASS VALVE

A. Description

The lubricating oil cooler (Figs. 10 and 11) located on the right side of the engine, consists of a corrosion resistant cooling core and tank. The water pump circulates coolant through the cooling core tubes and the engine lubricating oil pressure pump circulates oil through the tank, around the outside of the tubes of the cooling core, thereby controlling the oil temperature. The cooling core consists of small brass tubes which dissipate heat from the oil to the engine coolant. If proper lubricating oil maintenance procedure is followed, the oil 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 and will restrict the flow of oil around the tubes of the cooling core. Restriction of the flow of oil around the tubes of the cooling core is usually indicated by a drop in oil pressure, due to the oil overheating. If this occurs, the oil cooler 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.*

On tractors prior to Serial No. 4001, two valves, an oil filter and oil cooler by-pass valve, and a check valve (Fig. 10), located in the oil by-pass valve housing on the right side of the cylinder block, are incorporated in the lubricating oil passage to the engine lubricating oil filter and the engine oil cooler. Oil delivered under pressure by the lubricating oil pressure pump holds the check valve in the open position, allowing the oil to pass through the oil filters and the oil cooler. Whenever

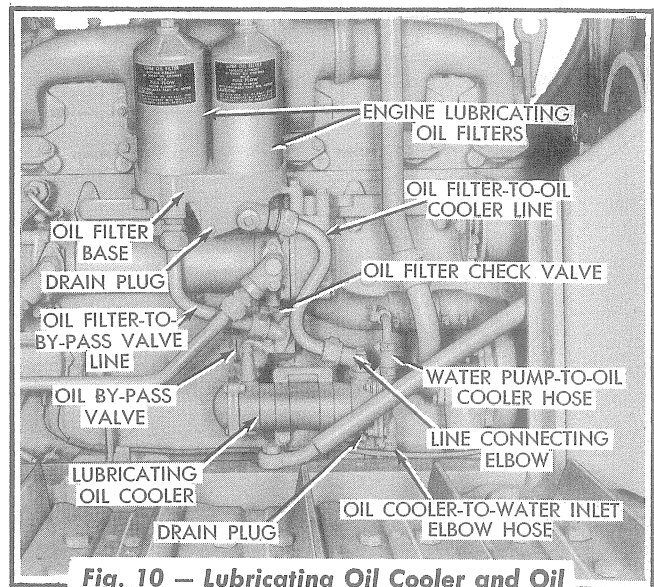


Fig. 10 — Lubricating Oil Cooler and Oil By-Pass Valve Location (Tractors Prior to Serial No. 4001)

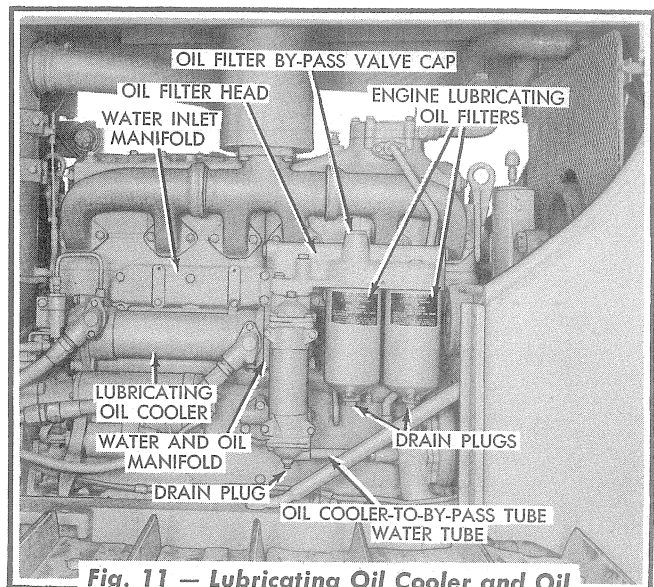


Fig. 11 — Lubricating Oil Cooler and Oil By-Pass Valve Location (Tractors Serial No. 4001 and Above)

the engine is stopped, the check valve closes, preventing the oil in the lubricating oil filter from draining back to the crankcase. The lubricating oil filter and oil cooler by-pass valve, by-passes oil directly from the lubricating oil pressure pump to the engine lubricating system if either the oil filter or the oil cooler becomes clogged, or if in cold weather the oil is too thick to circulate freely through the oil filter and the oil cooler.

On tractors Serial No. 4001 and above, a by-pass valve located in the lubricating oil filter head permits oil to pass directly to the engine lubricating system if the oil filters become clogged or if in cold weather the oil is too thick to flow freely through the oil filters.

B. Removal of Oil Cooler

1. Tractors prior to Serial No. 4001:

- a. Drain the cooling system (refer to Section IV, Topic 3).
- b. Loosen the hose clamps on the water pump-to-oil cooler hose and free the hose from the oil cooler.
- c. Loosen the hose clamps on the oil cooler-to-water inlet elbow hose and free the hose from the oil cooler.
- d. Remove the oil filter drain plug (Fig. 10) from the lubricating oil filter base and drain the oil from the oil filters. Reinstall and tighten the drain plug.
- e. Loosen the nut on the oil filter-to-oil cooler line at the line connecting elbow.
- f. Remove the capscrews and lockwashers attaching the line connecting elbow to the oil cooler and remove the elbow and gasket.
- g. Loosen the male nut connecting the oil cooler-to-by-pass valve line to the oil cooler. Remove the capscrews and lockwashers attaching the oil cooler-to-by-pass valve line to the oil cooler and remove the line and gasket.

- h. Remove the capscrews and lockwashers from the oil cooler clamps and remove the oil cooler.

2. Tractors Serial No. 4001 and above:

- a. Drain the cooling system (refer to Section IV, Topic 3).
- b. Remove the capscrews and lockwashers attaching the oil cooler to the water and oil manifold.
- c. Refer to Fig. 13 and move the top of the oil cooler outward from the manifold to free the oil cooler-to-manifold water tube, move the bottom of the oil cooler to the rear of the engine to free the tube between the oil cooler and the water by-pass tube lower section and remove the oil cooler from the engine.

C. Disassembly of Oil Cooler

Remove the capscrews and lockwashers or capscrews, lockwashers, and nuts attaching the bonnets to the oil cooler core and remove the bonnets and gaskets. (Figs. 12 and 13).

D. Cleaning of Oil Cooler

Thorough cleaning of the oil cooler may require the use of special solvents. Several solvents for this purpose are available and must be used according to the manufacturers' directions. Some of the solvents are as follows:

Excello Floor Cleaning Compound.

Turco Cleaning Compound.

No. 70 Stripper.

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

Bendix Cleaning Compound.

To use the last named solvent, merely submerge the oil cooler in the solution for sufficient length of time to allow the chemical action of the solvent to dissolve or loosen the sludge or other foreign matter. Flush the oil cooler thoroughly with live steam or spirits after cleaning, regardless of the type of cleaner used. *NOTE: If the oil cooler core is badly clogged, a new oil cooler core must be*

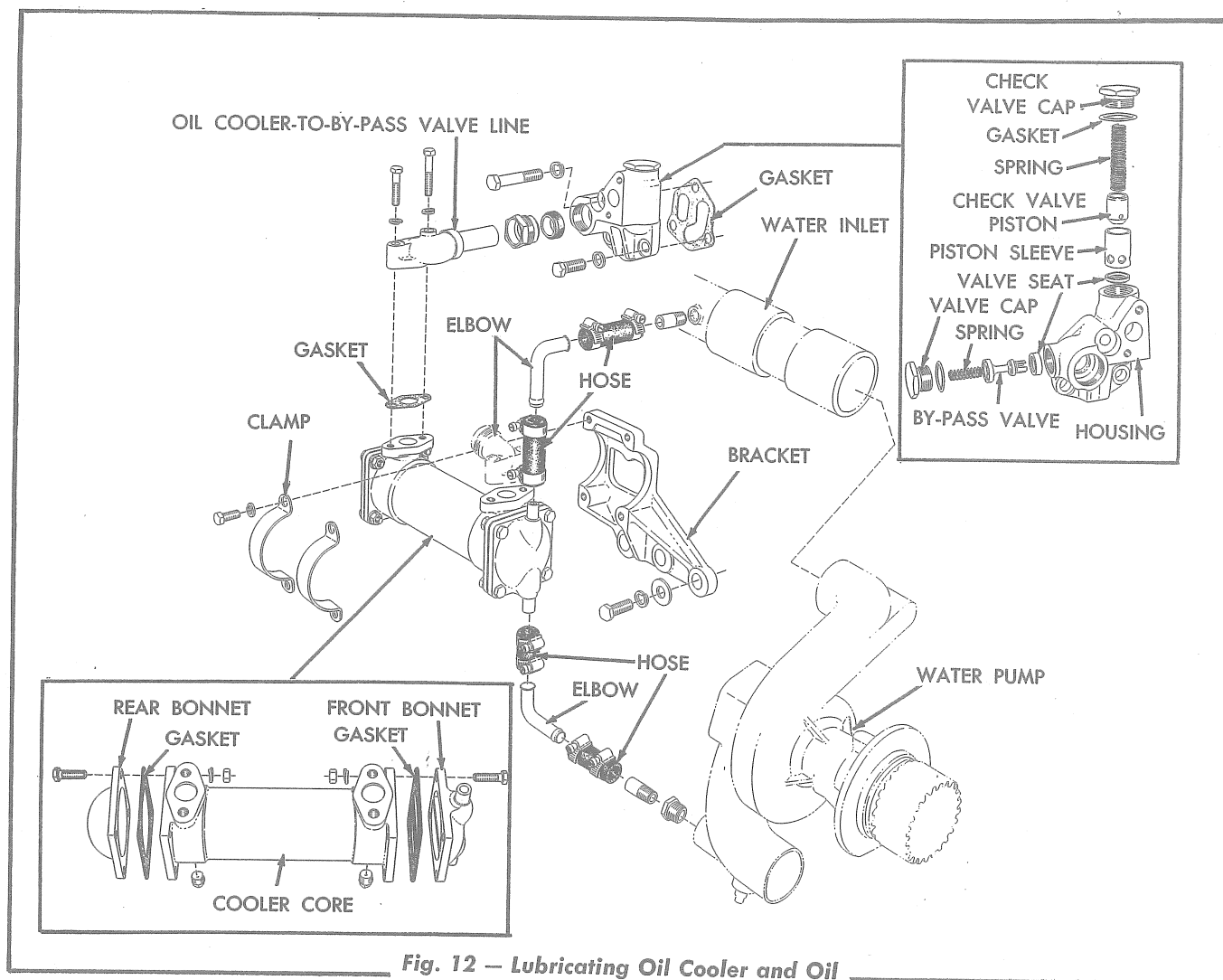


Fig. 12 — Lubricating Oil Cooler and Oil By-Pass Valve Details (Tractors Prior to Serial No. 4001)

installed.

E. Assembly and Installation of Oil Cooler

1. Using gasket cement, cement a new bonnet gasket to one face of the oil cooler. Coat the outer side of the gasket with gasket cement, then place the bonnet in position on the oil cooler and secure with capscrews and lockwashers or capscrews, lockwashers, and nuts.
2. Cement a new bonnet gasket to the other face of the oil cooler. Coat the outer side of the gasket with gasket cement, then place the other bonnet in position on the oil cooler and secure with capscrews and lockwashers or capscrews, lockwashers, and nuts. **NOTE:** Refer to Figs. 12 and 13 and make certain the water inlet and outlet openings in the
3. Installation of oil cooler (tractors prior to Serial No. 4001).
 - a. Place the oil cooler in position on the mounting bracket. Place the oil cooler clamps in position on the oil cooler and install the capscrews and lockwashers to attach the clamps to the oil cooler mounting bracket, but do not tighten the capscrews at this time.
 - b. Place the oil cooler-to-by-pass valve line in position on the oil cooler, using a new gasket, and install the capscrews and lockwashers to secure the line to the oil cooler. Tighten the capscrews

oil cooler bonnets are properly positioned in relation to each other and to the oil cooler core.

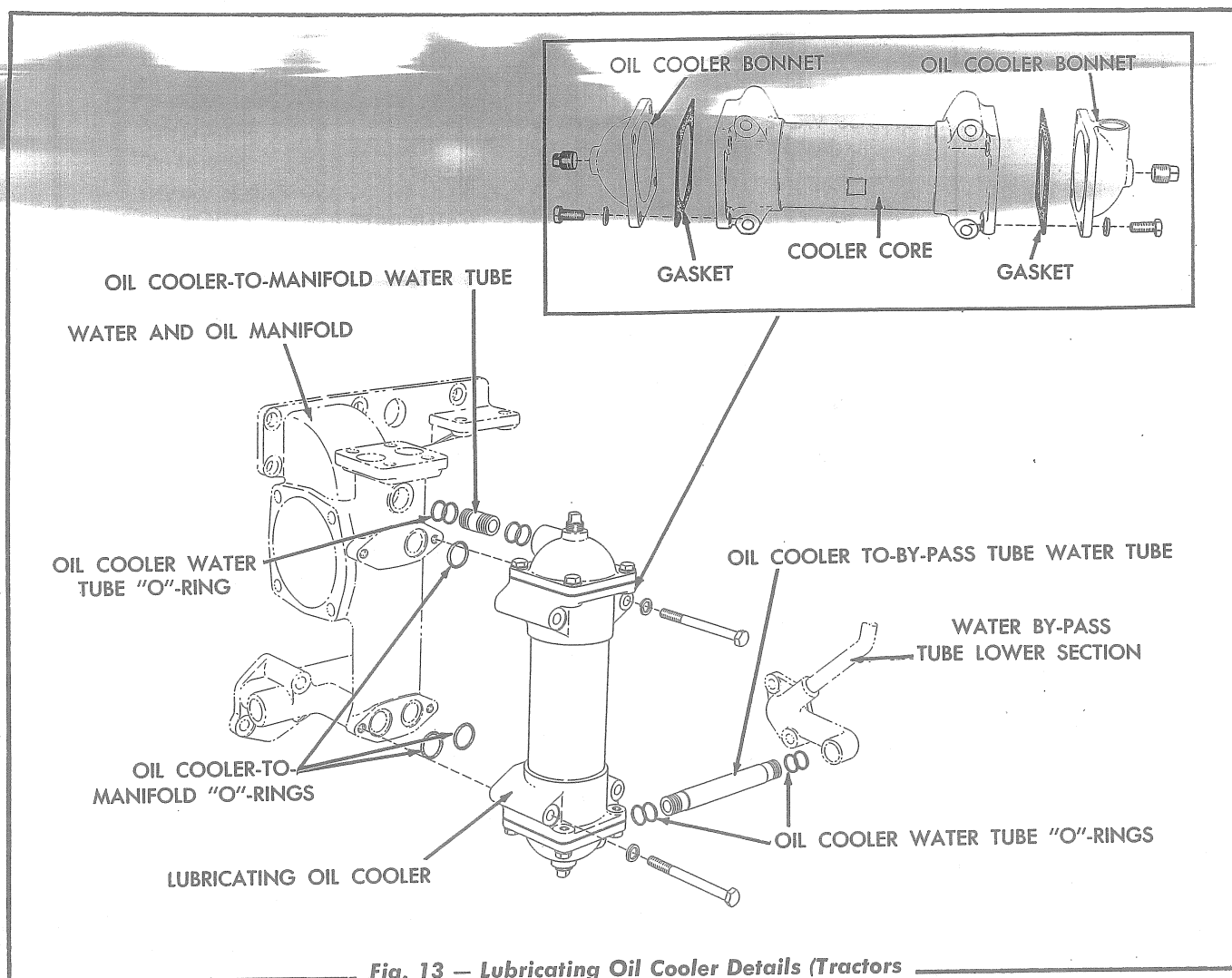


Fig. 13 — Lubricating Oil Cooler Details (Tractors Serial No. 4001 and Above)

- c. Place the line connecting elbow and gasket in position on the oil cooler. Install the capscrews and lockwashers to attach the elbow to the oil cooler and tighten the capscrews securely. Start the nut to secure the oil filter-to-cooler line to the line connecting elbow but do not tighten at this time.
 - d. Place the water pump-to-oil cooler hose on the inlet side of the front bonnet and the oil cooler-to-water inlet hose on the outlet side of the front bonnet, but do not tighten the hose clamps at this time.
 - e. Move the oil cooler on the mounting bracket as necessary to eliminate all binds and tighten the oil cooler clamp capscrews securely.
 - f. Tighten the male nut attaching the oil cooler-to-by-pass valve line to the oil by-pass valve. Tighten the nut attaching the oil filter-to-oil cooler line to the line connecting elbow. Tighten the hose clamps on the oil cooler-to-water inlet hose and on the water pump-to-oil cooler hose.
4. Installation of oil cooler (tractors Serial No. 4001 and above).
 - a. Refer to Fig. 13 and install new "O"-rings in position in the grooves machined in the O.D. of the oil cooler-to-by-pass

tube water tube and insert the water tube into the counterbore in the water by-pass tube lower section.

- b. Refer to Fig. 13 and install "O"-rings in position in the grooves machined in the O.D. of the oil cooler-to-manifold water tube.
 - c. Position "O"-rings in the three counterbores in the water and oil manifold (Fig. 13).
 - d. Install the oil cooler in position on the water and oil manifold and secure with capscrews and lockwashers.
5. Fill the cooling system (refer to Section IV, Topic 3).
 6. Operate the engine and check for oil and water leaks at the oil cooler connections and correct any leaks found. Stop the engine and check the crankcase oil level; add oil as necessary, to raise the oil level to the "FULL" mark on the oil level gage rod.

F. Removal of Oil By-Pass Valve (Tractors Prior to Serial No. 4001) Figs. 10 and 12

1. Remove the oil filter drain plug from the lubricating oil filter base and allow the filters to drain. Install and tighten the oil drain plug.
2. Thoroughly clean the oil by-pass valve housing and the surrounding area.
3. Loosen the upper nut on the oil filter-to-by-pass valve line. Remove the two capscrews and lockwashers attaching the line connecting elbow to the by-pass valve housing and remove the line and elbow as a unit.
4. Remove the two capscrews and lockwashers attaching the oil cooler-to-by-pass valve line to the oil cooler. Loosen the male nut attaching the oil cooler-to-by-pass valve line to the by-pass valve and remove the line and gasket.

5. Remove the capscrews and lockwashers attaching the oil by-pass valve assembly to the cylinder block and remove the oil by-pass valve assembly and gasket.

G. Disassembly of Oil By-Pass Valve

1. Tractors prior to Serial No. 4001 (Fig. 12).
 - a. Remove the check valve cap and gasket.
 - b. Remove the spring, check valve piston, and the piston sleeve.
 - c. Remove the by-pass valve cap and gasket.
 - d. Remove the spring and the by-pass valve.
2. Tractors Serial No. 4001 and above (Fig. 15).

NOTE: On tractors Serial No. 4001 and above, the oil by-pass valve is located in the lubricating oil filter head and may be disassembled as follows:

- a. Remove the by-pass valve cap and gasket.
 - b. Remove the spring and by-pass valve piston.
 - c. Remove the piston sleeve and piston seat.
3. Wash all parts thoroughly in fuel oil and inspect for wear or damage and replace the necessary parts. Inspect the valve seats and if the seats are worn or damaged, replace the valve seats.
 4. Assemble the oil by-pass valve assembly by a direct reversal of the disassembly procedure.

H. Installation of Oil By-Pass Valve (Tractors Prior to Serial No. 4001) Figs. 10 and 12

1. Place the oil by-pass valve assembly in position on the cylinder block, using a new

by-pass valve-to-cylinder block gasket, and secure with capscrews and lockwashers.

2. Place the oil cooler-to-by-pass valve line in position, using a new gasket between the line and the oil cooler. Install the capscrews and lockwashers to attach the line to the oil cooler, then tighten the male nut to attach the line to the by-pass valve.
3. Place the oil filter-to-by-pass valve line in position, using a new gasket between the by-pass valve and the connecting elbow.

Install the capscrews and lockwashers to attach the elbow to the by-pass valve, then tighten the nut to attach the line to the oil filter.

4. Start the engine and operate at approximately $\frac{1}{4}$ throttle and check for oil leaks, correct any leaks found.
5. Stop the engine and check the crankcase oil level and add oil, as necessary, to raise the oil level to the "FULL" mark on the oil level gage rod.

6. LUBRICATING OIL FILTERS

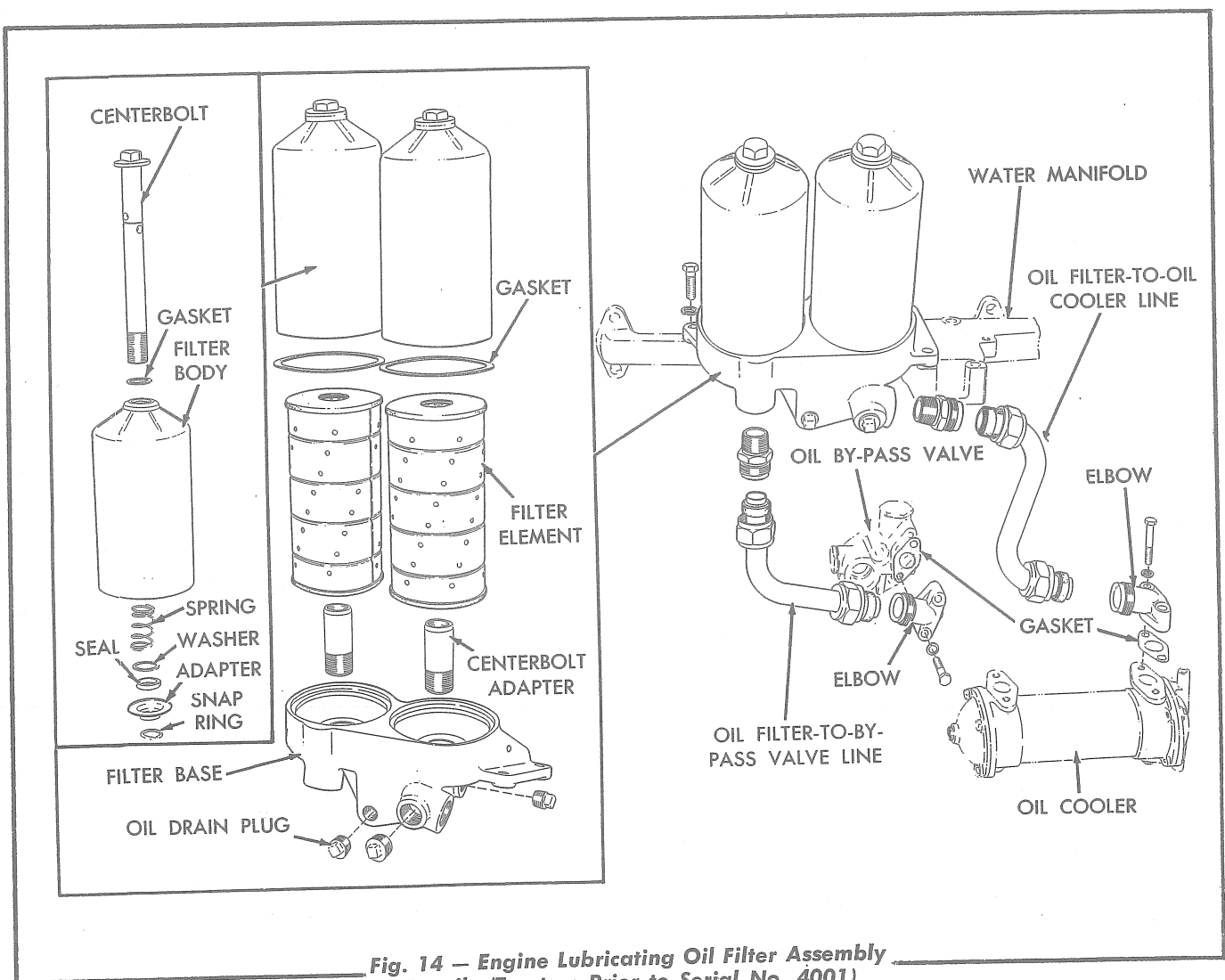


Fig. 14 — Engine Lubricating Oil Filter Assembly
Details (Tractors Prior to Serial No. 4001)

A. Description

The engine lubricating oil filters (Figs. 10 and 11) located on the right side of the engine, are of the

full-flow type and contain replaceable type elements. New elements must be installed each time the oil in the crankcase is changed, or more often if conditions warrant.

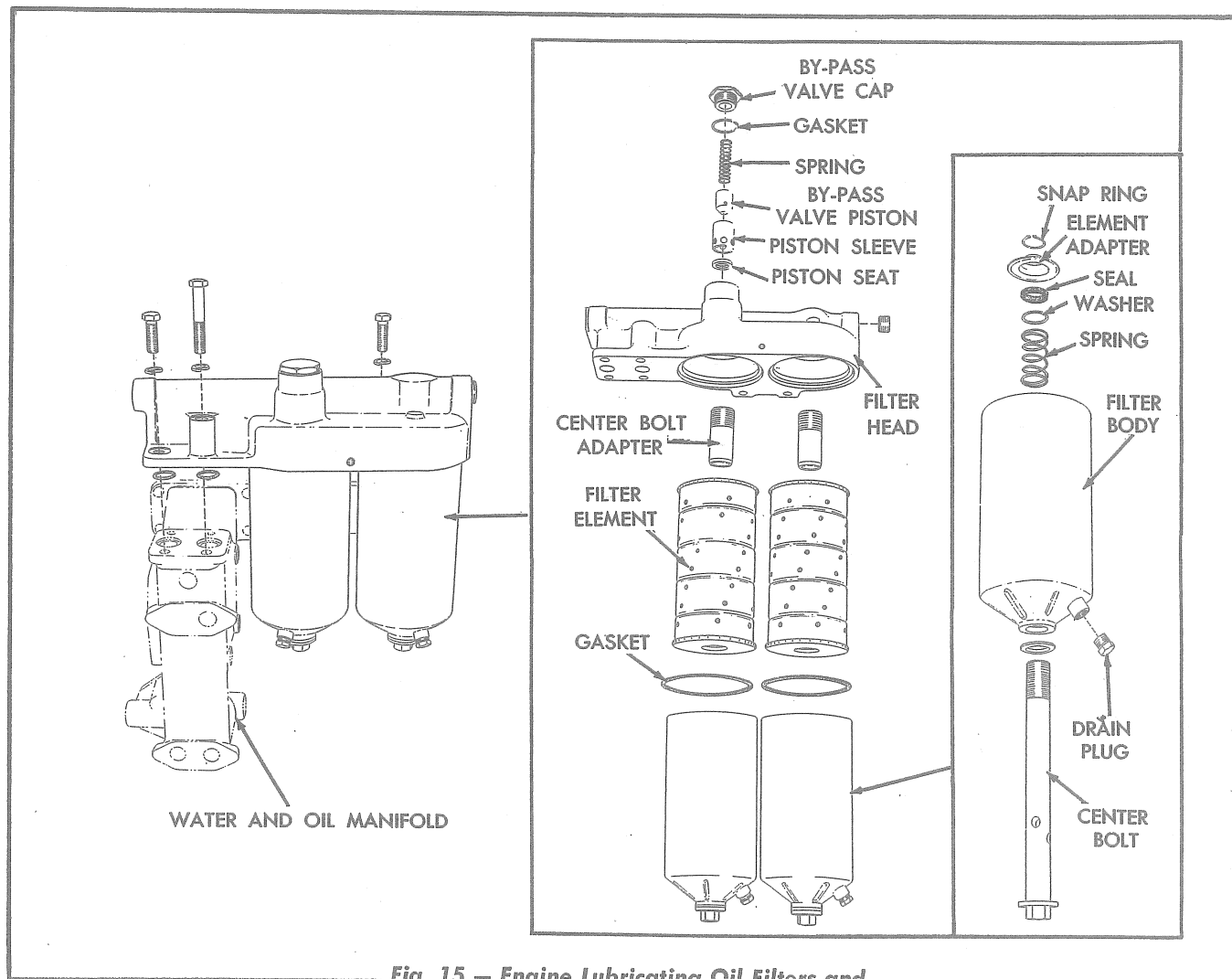


Fig. 15 — Engine Lubricating Oil Filters and By-Pass Valve Assembly Details (Tractors Serial No. 4001 and Above)

B. Removal and Installation of Engine Lubricating Oil Filters

1. Removal and Installation of Engine Lubricating Oil Filters (Tractors Prior to Serial No. 4001) Fig. 14.

- a. Remove the oil filter drain plug from the oil filter base and allow the oil to drain. Install the oil drain plug and tighten securely.
- b. Loosen the nut connecting the oil filter-to-by-pass valve line to the oil filter base. Loosen the nut connecting the oil filter-to-oil cooler line to the oil filter base.
- c. Remove the two capscrews and lockwashers and one nut and lockwasher

attaching the lubricating oil filter base to the water manifold and remove the oil filter base and oil filters as an assembly.

- d. Install the lubricating oil filter base and oil filters as an assembly by a direct reversal of the removal procedure.
- ### **2. Removal and installation of engine lubricating oil filters (tractors Serial No. 4001 and above, Fig. 15).**
- a. Remove the oil filter drain plugs from the oil filter bodies and allow the oil to drain. Install the oil filter drain plugs and tighten securely.
 - b. Remove the capscrews and lockwashers attaching the oil filter head to the water

and oil manifold and remove the oil filter head and oil filters as an assembly.

- c. Install the lubricating oil filter head and oil filters as an assembly by a direct reversal of the removal procedure. **NOTE:** *Make certain the "O"-rings in the top of the water and oil manifold are in good condition and properly installed before securing the oil filter head to the water and oil manifold — refer to Fig. 15.*

C. To Change Engine Lubricating Oil and to Service Oil Filters

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

1. Remove both drain access covers from the bottom of the crankcase guard.
2. Loosen and remove the rear oil drain plug from the crankcase oil pan and allow the oil to drain. Loosen and remove the front oil drain plug from the crankcase oil pan and allow the oil to drain.
3. Install and tighten both drain plugs, making certain the drain plug gaskets are in good condition. Install both drain access covers in position on the bottom of the crankcase guard.
4. Service the engine lubricating oil filters as follows:
 - a. Thoroughly clean the filter bodies and the surrounding area. On tractors prior to Serial No. 4001 remove the oil filter drain plug from the oil filter base and allow the filters to drain. On tractors Serial No. 4001 and above, remove the oil filters drain plugs from the filter bodies and allow the filters to drain.

- b. Loosen the filter centerbolts and remove the centerbolts, filter bodies, and the filter elements as assemblies.
- c. Remove the filter elements from the filter bodies and discard the elements.
- d. Thoroughly wash and dry the interior of the filter bodies.
- e. Install new body gaskets. Install new elements in position in the filter bodies.
- f. Install the filter body assemblies, making certain the body gaskets are properly installed (Figs. 14 and 15), then tighten each filter centerbolt to a torque of 75 to 80 lbs. ft. Install the oil filter drain plug(s) and tighten securely.

5. Fill the engine crankcase, through the crankcase oil filler pipe, with $7\frac{1}{2}$ gallons of the specified lubricant.
6. Check the oil level after filling as follows:
 - a. Pull the throttle control lever back so that the engine will run at about $\frac{1}{4}$ speed. Start the engine and operate it at this speed ($\frac{1}{4}$ throttle) for about 5 minutes.
 - b. Stop the engine and allow several minutes for the oil to drain back before checking the oil level.
 - c. Using the oil level gage rod, check the oil level and add oil as necessary to raise the oil level even with the "FULL" mark on the gage rod.
 - d. Observe the engine lubricating oil filters for oil leakage and make certain that the filter body gaskets are properly installed.

D. Engine Heavy-Duty Lubricating Oil Filter (Special Equipment)

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

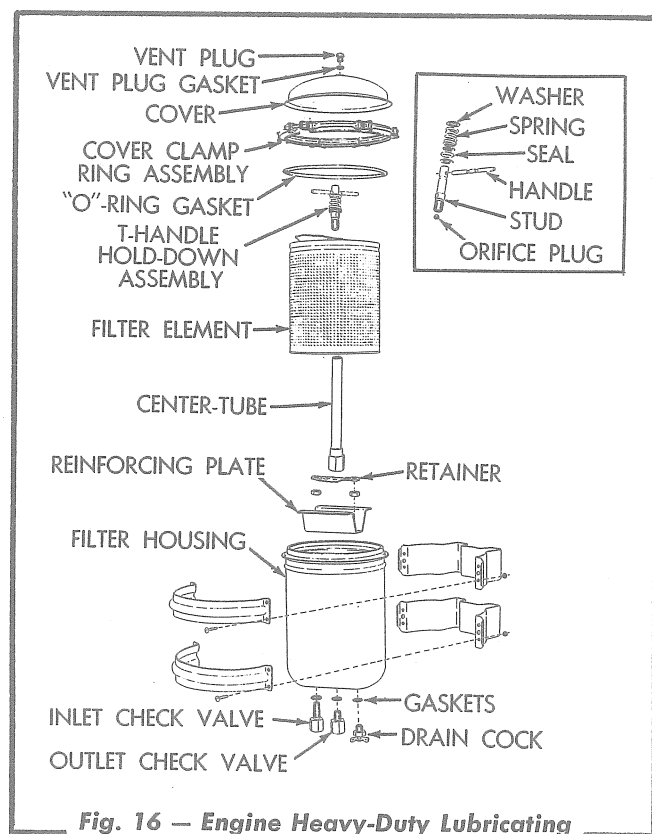


Fig. 16 — Engine Heavy-Duty Lubricating Oil Filter Details

E. To Replace Heavy-Duty Lubricating Oil Filter Element

1. Thoroughly clean the filter cover and the surrounding area. Open the drain cock on late models, or remove the drain plug on early models, located at the bottom of the filter housing and allow the oil to drain. Remove the cover clamp ring and lift the cover from the filter housing. Do not damage the "O"-ring gasket.
2. Unscrew the T-handle hold-down assembly from the center-tube and remove the T-handle hold-down assembly. Remove the filter element from the housing by lifting with the pull-out bail. Discard the filter element.
3. Thoroughly clean the interior of the filter housing and close the drain cock on late models, or install the drain plug on early models.

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

5. 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. Reversing the T-handle hold-down assemblies can result in serious damage to the engine.

6. Install the cover gasket and place the cover in position on the filter housing. Install the cover clamp ring and tighten securely.

7. Fill the engine crankcase with $7\frac{1}{2}$ gallons of the specified lubricating oil.

8. Remove the vent plug from the filter cover.

9. Start the engine and operate it at $\frac{1}{4}$ throttle until oil flows 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 "DIESELPAC" filter element in the Heavy-Duty Filter.

SECTION VI — ELECTRICAL SYSTEM

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Generator and Generator Regulator	5	114
Starter	6	119

1. DESCRIPTION OF SYSTEM

The electrical system, which includes the starter, generator, generator regulator, batteries, ammeter, headlights, instrument panel light, and wiring, is a 24-volt system throughout. Current is supplied by two 12-volt, wet cell, storage batteries carried in the compartments at the end of the seats.

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

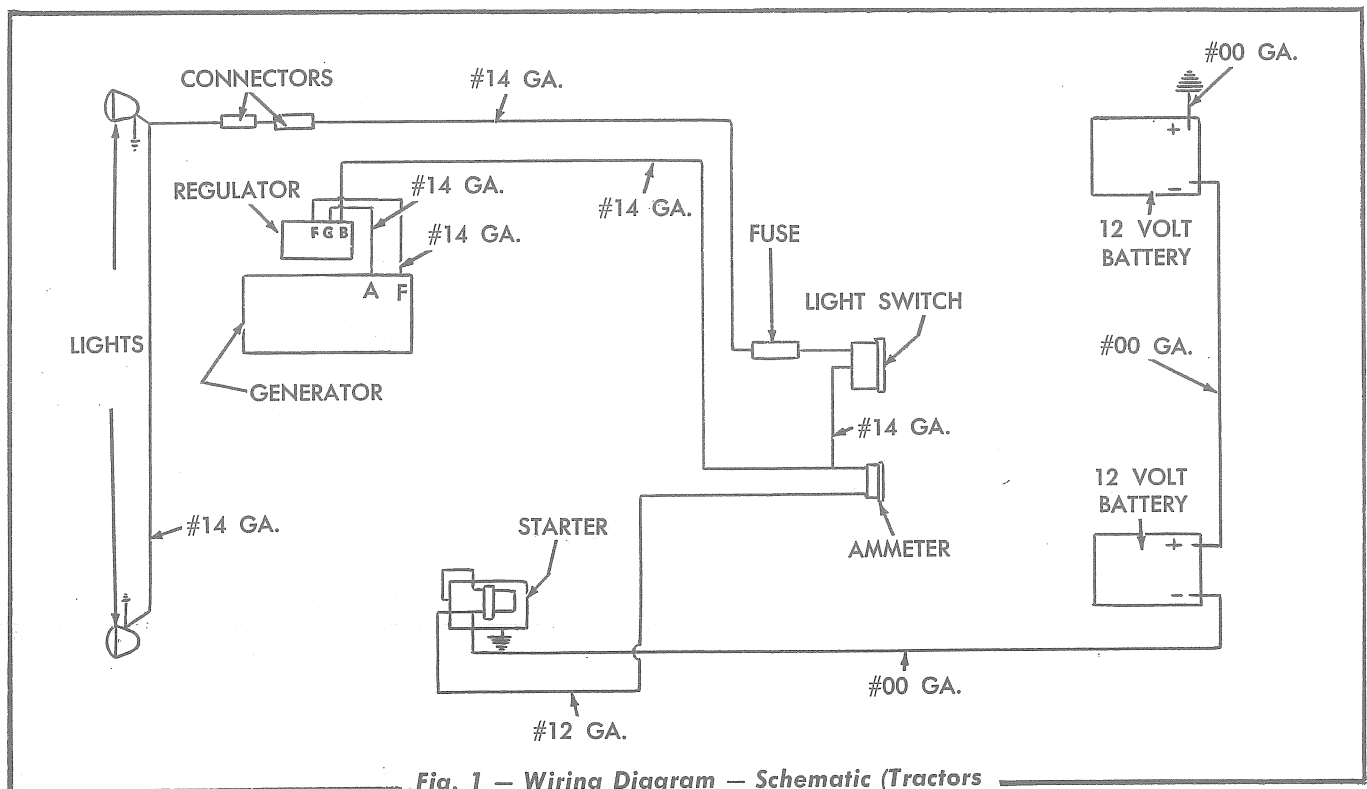
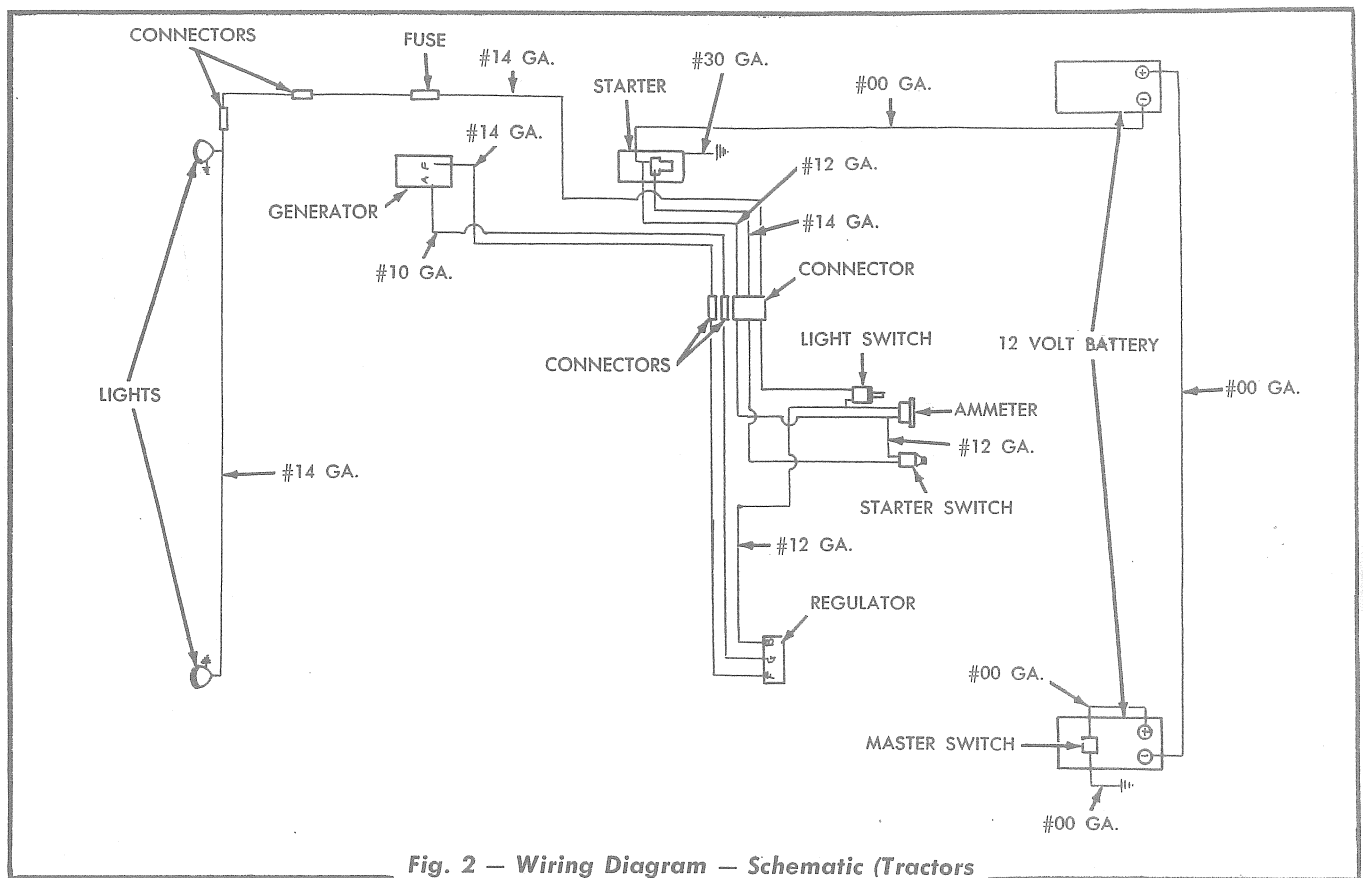


Fig. 1 — Wiring Diagram — Schematic (Tractors Prior to Serial No. 4001)



4. BATTERIES

A. Description

The two batteries are 12-volt, wet cell type, located in compartments at the end of the seats (under the arm cushions), and are held in position by special hold-down assemblies. The batteries are connected in series by the battery connecting cable to provide 24-volt current. On tractors prior to Serial No. 4001, the positive terminal post of the right battery is grounded to the steering clutch and final drive housing by the battery-to-ground cable. On tractors Serial No. 4001 and above, the positive terminal of the left battery is grounded to the steering clutch and final drive housing by the battery-to-ground cable. An electrical system master switch is provided in the battery-to-ground cable (Figs. 5 and 6).

B. Service of Batteries

Check the level of the electrolyte in the batteries after every 10 hours of operation, or as often as operating conditions prove it necessary. Maintain the level of the solution $\frac{3}{8}$ " above the battery plates by the addition of clean distilled water. **NOTE: DO NOT OVERFILL.** Keep the battery cable terminals tight and clean. If corrosion occurs, clean the battery terminal posts and terminals with a strong soda solution and coat the terminals lightly with petroleum jelly before connecting them again, the petroleum jelly will prevent further corrosion.

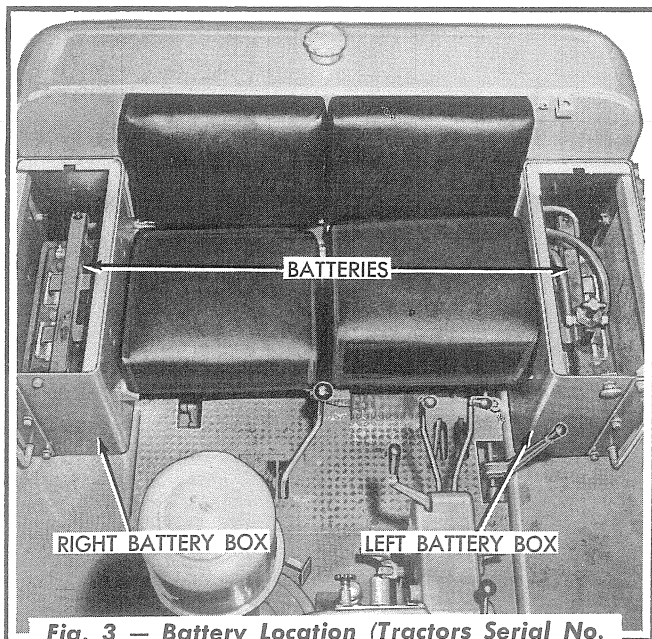


Fig. 3 — Battery Location (Tractors Serial No. 4001 and Above Shown — Tractors Prior to Serial No. 4001 Similar)

When the atmospheric temperature is below the freezing point, special attention should be given to hydrometer readings of the batteries. A specific gravity of 1.270 to 1.215 at 80° F. is considered satisfactory for continued use. Specific gravity readings without correction for temperature are practically meaningless. For each 10 degrees that the temperature of the electrolyte is above 80° F., add 4 points to the hydrometer reading and for each 10 degrees below 80° F., subtract 4 points to obtain the true specific gravity. For example, if the hydrometer reading is 1.250 and the electrolyte temperature is 20° F. (60 degrees below 80° F.), 1.250 minus 24 points equals 1.226 — the true specific gravity. If the corrected readings are below 1.215, the batteries are not receiving sufficient charge. This might indicate that the generator or the generator regulator requires attention. If these units prove satisfactory, inspect the system for short circuits and for loose or corroded connections. In cold weather there is danger of batteries freezing if the specific gravity is below 1.100. Batteries with a specific gravity of 1.100 will freeze at 18° F.; batteries with a specific gravity of 1.220 will freeze at 31° F. below zero. During freezing weather, any addition of water to the cells should be made after the engine is started at the beginning of an operating period to make certain that the water and electrolyte solution will be thoroughly mixed; otherwise it may freeze. The filler plugs must be kept tight at all times and the tops of the batteries kept clean and dry.

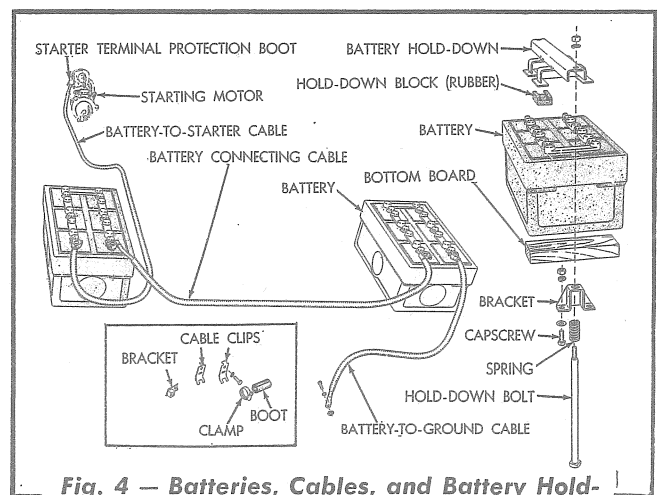


Fig. 4 — Batteries, Cables, and Battery Hold-Down Details (Tractors Prior to Serial No. 4001)

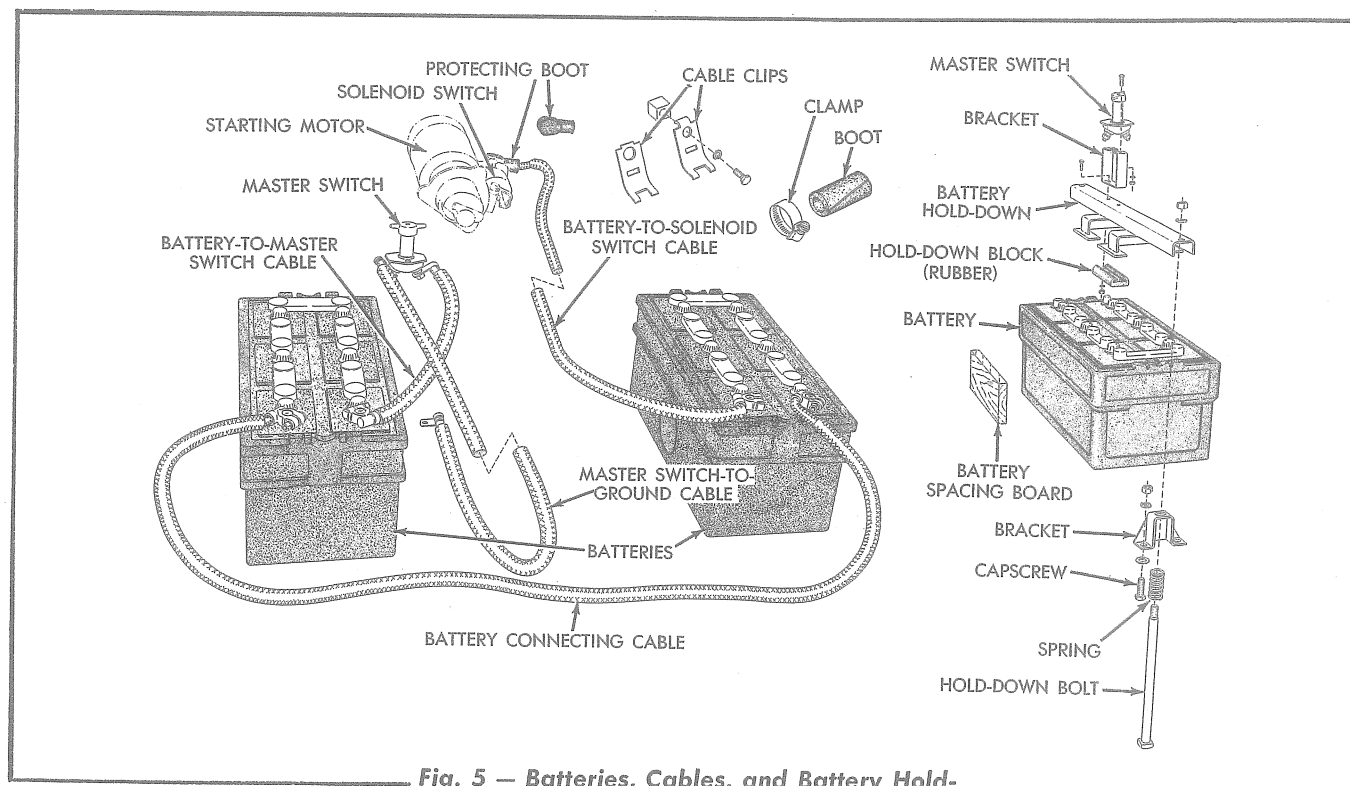


Fig. 5 — Batteries, Cables, and Battery Hold-Down Details (Tractors Serial No. 4001 and Above)

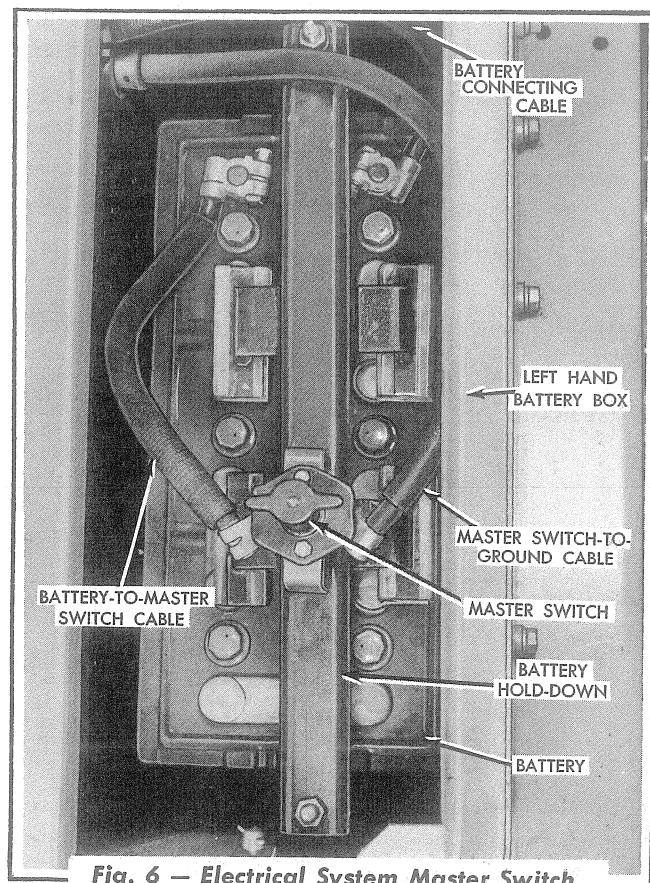


Fig. 6 — Electrical System Master Switch Location (Tractors Serial No. 4001 and Above)

5. GENERATOR AND GENERATOR REGULATOR

A. Description

1. Generator

The generator is a two-brush, shunt wound unit, designed with two openings in the field frame and with a cover band. The brush holders are mounted directly to the end frame. The brushes are mounted in reaction type brush holders and can be inspected through the openings in the field frame by removing the cover band. The spring tension on the brushes is set at 28 ounces. The armature shaft is supported at both ends by ball bearings. A ventilating fan draws air through the generator to prevent overheating. The generator is attached to the generator drive housing which is hinged to the right side of the fan mounting bracket. The generator and the engine fan are driven from the crankshaft pulley by two drive belts. The generator is driven at approximately 1.6 times engine crankshaft speed.

2. Generator Regulator

The generator regulator is a three unit regulator designed for use with generators which have the field circuit insulated in the generator, but grounded in the regulator. A field connection of this type is designated as Circuit "A." The regulator consists of a cutout relay, a voltage regulator, and a current regulator unit. The cutout relay closes the generator-to-battery circuit when the generator voltage is sufficient to charge the batteries and opens the circuit when the generator slows down or stops. The voltage regulator unit is a voltage limiting device that prevents the system voltage from exceeding a specified maximum and thus protects the batteries and other voltage sensitive equipment. The current regulator unit is a current limiting device that limits the generator output so as not to exceed its rated maximum. On tractors prior to Serial No. 4001, the generator regulator is mounted on a generator regulator mounting bracket bolted to the flywheel housing (Fig. 11). On tractors Serial No. 4001 and above, the generator regulator is mounted on the left front side of the cowl (Fig. 12).

B. General Maintenance and Inspection of Generator

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

1. Brushes

A stop is provided to prevent the brush arm from touching and scoring the commutator. The brush should never be allowed to wear down until the brush arm actually touches the stop. The brush spring tension (28 ounces) must be sufficient to give good clean contact of the brushes on the commutator and the brushes must be free to slide in their brush holders. The pig tail leads in the brushes must be tight and the lead clips fastened securely to the brush holders.

2. Commutator

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

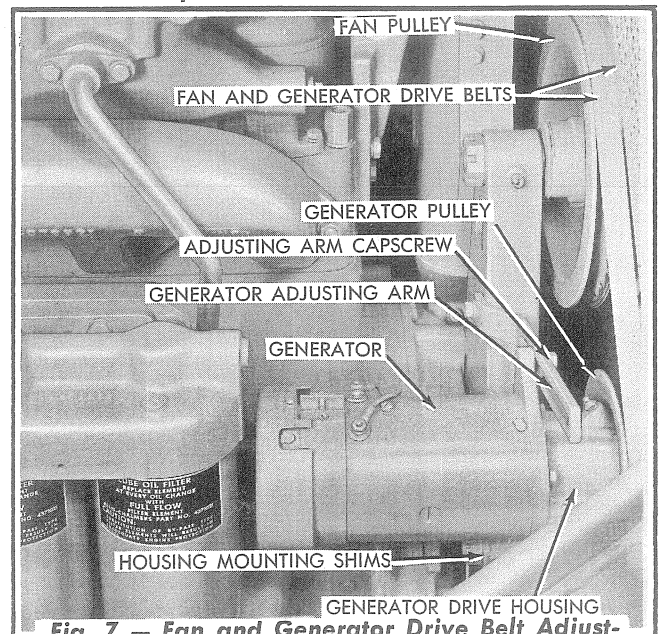


Fig. 7 — Fan and Generator Drive Belt Adjustment Location (Tractors Serial No. 4001 and Above Shown — Tractors Prior to Serial No. 4001 Similar)

3. Fan and Generator Drive Belt Adjustment

Keep the fan and generator drive belts properly adjusted. The belts are properly adjusted when the straight side of the belts (left side) can be pressed inward (by hand pressure) approximately 1 inch at a point half-way between the crankshaft and fan pulleys. To adjust the belts, loosen the generator adjusting arm capscREW and move the generator in or out until the correct tension on the belts is obtained, then tighten the adjusting arm capscREW.

4. Connections

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

C. Testing and Adjustment of Generator and Generator Regulator

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

D. Removal and Installation of Generator

1. Removal of Generator (Fig. 7)

Disconnect the wiring harness from the generator; identify the cables so that they may be reinstalled on the terminal from which they were removed. Remove the capscREWS and lockwashers attaching the generator to the generator drive housing and remove the generator and coupling sleeve (Fig. 8) from the housing.

2. Installation of Generator

Place the coupling sleeve in position on the generator shaft pinion (Fig. 8) and place the generator in position on the generator drive housing making certain that the splines in the coupling sleeve engage with the splines on the generator drive shaft. Install the capscREWS and lockwashers attaching the generator to the drive housing and tighten the capscREWS securely. Connect the wiring harness to the generator making certain each cable is connected to the terminal from which it was removed. Before starting the engine refer to Paragraph G in this Topic and polarize the generator.

E. Removal and Disassembly of Generator Drive

1. Removal of Generator Drive (Fig. 7)

Disconnect the wiring harness from the generator; identify the cables so that they may be reinstalled on the terminal from which they were removed. Remove the adjusting arm capscREWS, lockwasher, and plain washer. Remove the cotter pin and slotted nut from the generator drive housing capscREW and remove the capscREW and housing mounting shims. Remove the generator and generator drive as an assembly.

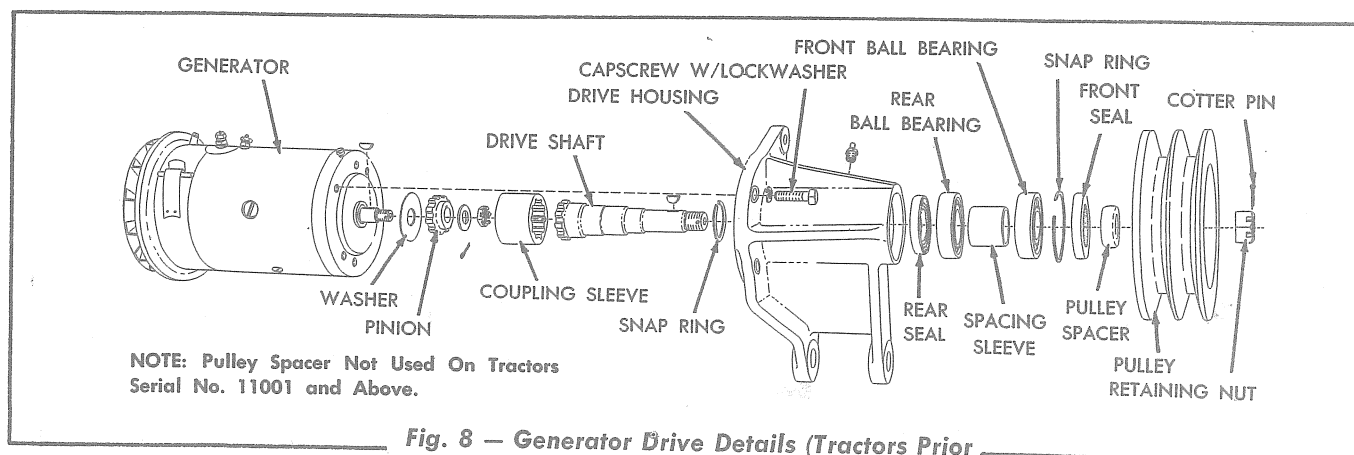


Fig. 8 — Generator Drive Details (Tractors Prior to Serial No. 4001 Shown — Tractors Serial No. 4001 and Above Similar)

2. Disassembly of Generator Drive

- a. Remove the capscrews and lockwashers attaching the generator to the generator drive housing and remove the generator and coupling sleeve.
- b. Remove the cotter pin and slotted nut from the pulley end of the generator drive shaft and using a suitable puller, pull the pulley from the shaft. Remove the "Woodruff" key from the shaft.
- c. Pressing on the pulley end of the shaft as shown in Fig. 9, press the shaft from the generator drive housing.

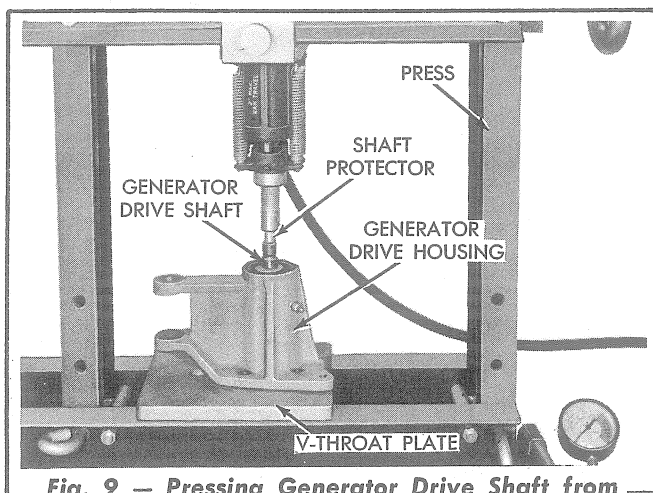


Fig. 9 — Pressing Generator Drive Shaft from Generator Drive Housing (Tractors Prior to Serial No. 4001 Shown — Tractors Serial No. 4001 and Above Similar)

- d. Remove the pulley spacer (pulley spacer not used on tractors Serial No. 4001 and above) from the front end of the housing and pry out the front grease seal. Remove the bearing retaining snap ring and using a suitable press, press on the rear grease seal and press the grease seal, front and rear ball bearings, and the bearing spacing sleeve from the drive housing.

F. Assembly and Installation of Generator Drive

1. Assembly of Generator Drive

- a. Lubricate and install the rear grease seal in the generator drive housing, with the sealing lip of the seal directed toward the front (pulley end) of the housing.

- b. Lubricate the rear ball bearing and press it into position in the housing. Place the bearing spacing sleeve in position on the inner race of the rear ball bearing. Press the front ball bearing into position in the housing and install the bearing retaining snap ring.
- c. Lubricate and install the front grease seal in the generator drive housing, with the sealing lip of the seal directed toward the front (pulley end) of the housing.
- d. Make certain the snap ring is installed in position next to the splines on the generator drive shaft and press the generator drive shaft into position in the bearings. Install the pulley spacer (pulley spacer not used on tractors Serial No. 4001 and above) on the front end of the drive shaft with the chamfered side of the spacer next to the front ball bearing.
- e. Install the "Woodruff" key in the generator drive shaft. Install the pulley in position on the shaft and install the pulley retaining nut; tighten the retaining nut securely and lock with the cotter pin. Lubricate the generator drive, through the lubricating fitting, with a good grade of ball and roller bearing lubricant.

- f. Place the coupling sleeve in position on the generator shaft pinion and place the generator in position on the generator drive housing, making certain that the splines in the coupling sleeve engage with the splines on the generator drive shaft. Install the capscrews and lockwashers attaching the generator to the housing and tighten the capscrews securely.

2. Installation of Generator Drive (Fig. 7)

- a. Place the generator drive and generator, as an assembly, in position on the fan mounting bracket and install a sufficient number of housing mounting shims in position as shown in Fig. 7 to eliminate all end play between the generator drive housing and the fan mounting bracket. Install the generator drive housing capscrew and the

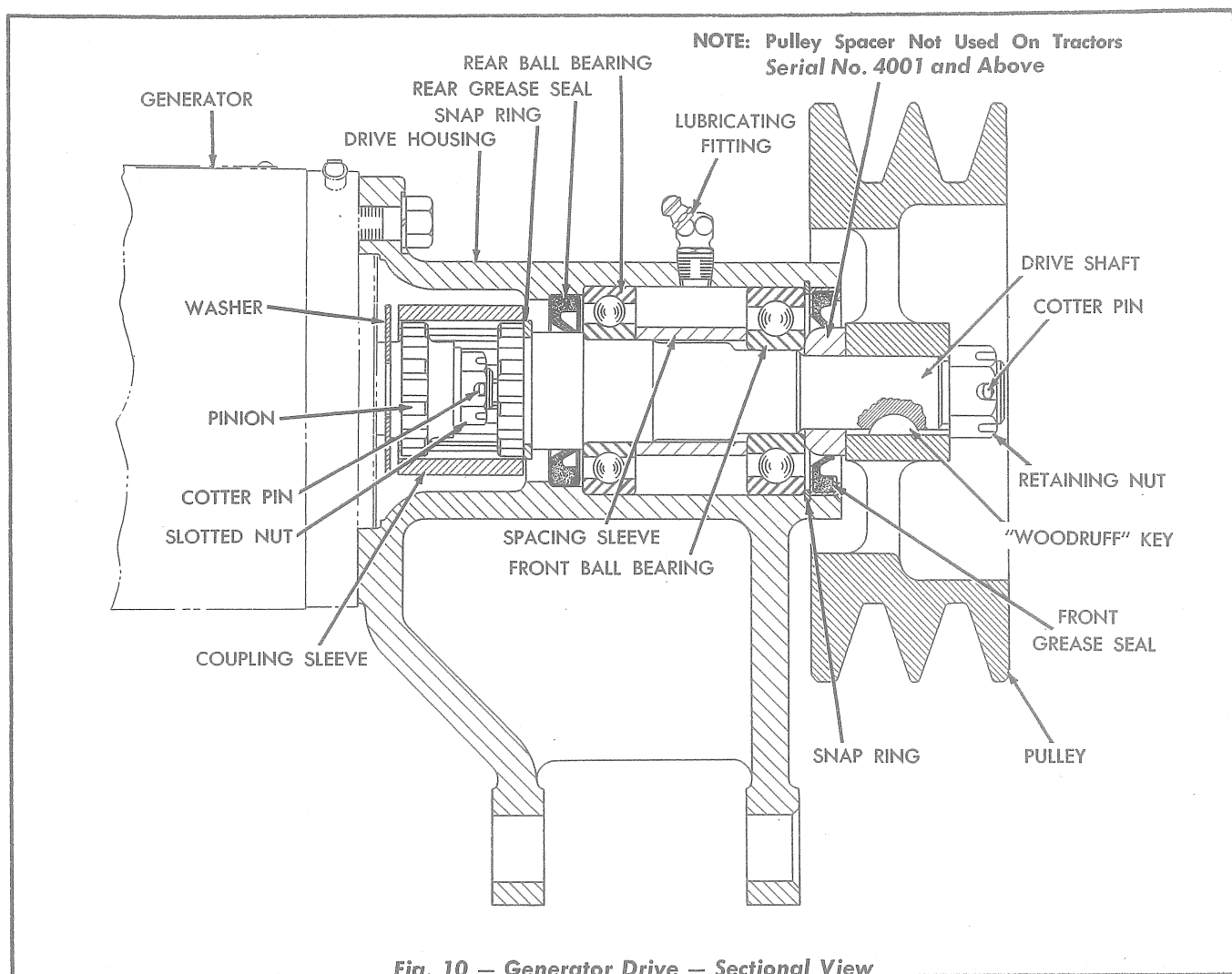


Fig. 10 — Generator Drive — Sectional View
*(Tractors Prior to Serial No. 4001 Shown —
 Tractors Serial No. 4001 and
 Above Similar)*

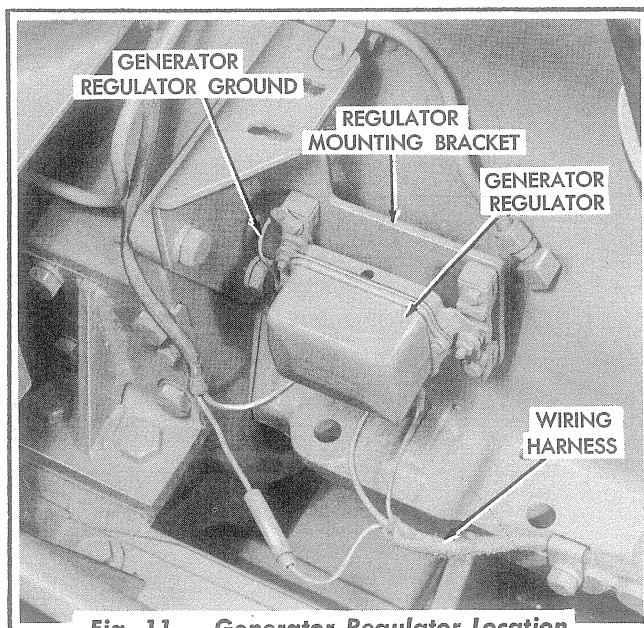


Fig. 11 — Generator Regulator Location
(Tractors Prior to Serial No. 4001)

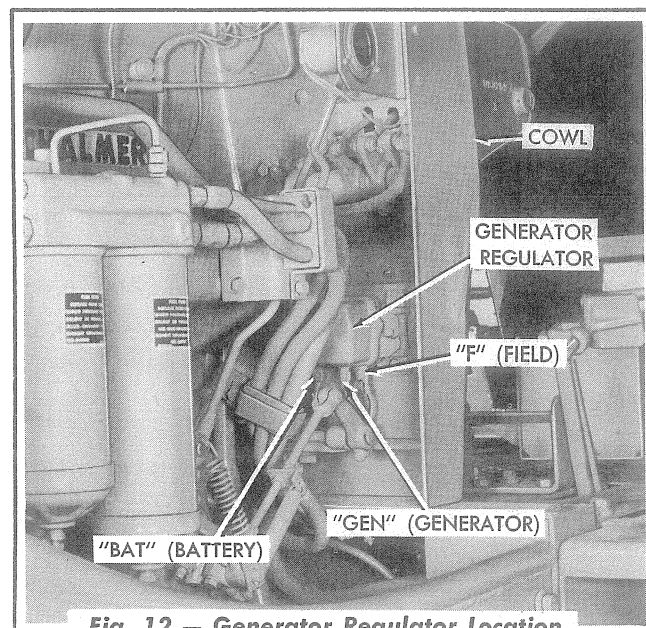


Fig. 12 — Generator Regulator Location
(Tractors Serial No. 4001 and Above)

slotted nut. Tighten the slotted nut snugly to allow a stiff hinge action with the fan mounting bracket and lock the nut with the cotter pin.

- b. Connect the wiring harness to the generator making certain that each cable is connected to the terminal from which it was removed. Install the adjusting arm cap-screw, plain washer, and lockwasher and adjust the drive belt tension for approximately 1 inch deflection at a point half-way between the crankshaft and fan pulleys. Before starting the engine, refer to Paragraph G in this Topic and polarize the generator.

G. Removal and Installation of Generator Regulator

Refer to Fig. 11 or 12 for location of the generator regulator.

1. Removal of Generator Regulator

Remove the two generator-to-regulator leads and the ammeter-to-regulator lead from the generator regulator and identify them so that they can be reinstalled in their original positions. Remove the capscrews, lockwashers, and nuts attaching the generator regulator to the regulator mounting bracket and remove the regulator.

2. Installation of Generator Regulator

Attach the generator regulator to the regulator mounting bracket with capscrews, lockwashers, and nuts. Make certain that the generator regulator ground is attached to one of the regulator mounting capscrews. Connect the ammeter-to-regulator lead to the post on the regulator marked "BAT" (battery). Connect the two generator-to-regulator leads to the proper posts on the regulator marked "GEN" (generator) and "F" (field).

IMPORTANT: Whenever the generator has been removed for repairs or replacement, or when the

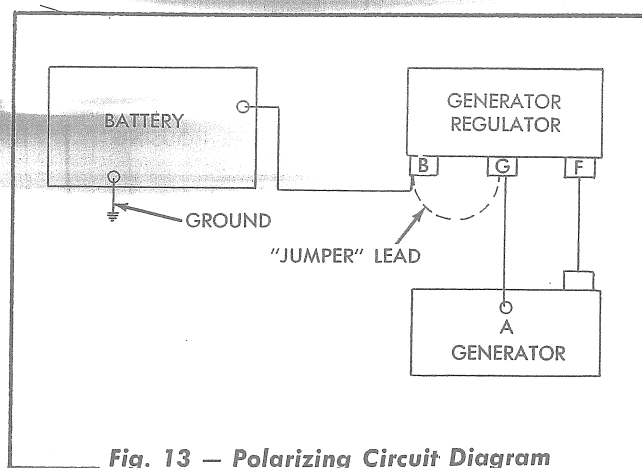


Fig. 13 — Polarizing Circuit Diagram

generator regulator leads have been disconnected and reconnected, the generator must be polarized before the engine is started. Polarizing causes the current to flow in the normal direction through the field coils and will prevent vibration, arcing, burning, and sticking of the regulator points.

3. Polarize the Generator as Follows:

- a. Remove the cover band from the generator and insulate the generator brushes from the armature by using a piece of cardboard between the brushes and the armature.
- b. Using a short "jumper" lead, momentarily touch the "jumper" lead to the "BAT" (battery) and to the "GEN" (generator) terminals of the generator regulator.
- c. Remove the cardboard from under the generator brushes and install the cover band.

CAUTION: Do not operate or test the generator on an open circuit.

If it should become necessary to operate the generator without it being connected to the batteries, it should be short circuited. This can be done by disconnecting the lead connected to the "GEN" (generator) terminal of the regulator and connecting the end of the lead to a convenient ground.

6. STARTER

A. Description

The starter is an 8-brush, 4-pole, 24-volt, heavy-duty unit. The armature is supported by bushings at the drive end, center, and commutator end. A "DYER" type drive is used to mesh the drive pinion of the starter with the flywheel ring gear for cranking the engine and to automatically disengage the drive pinion when the engine has started.

For location of the starter on tractors prior to Serial No. 4001, refer to Fig. 14; for location of the starter on tractors Serial No. 4001 and above refer to Fig. 15.

On tractors prior to Serial No. 4001, the starter is equipped with a heavy-duty starting motor switch which is actuated manually. The shift lever in the drive housing of the starter is connected by linkage to the starter rod. When the starter rod is depressed, the shift lever moves the drive pinion of the starter into mesh with the flywheel ring gear and then closes the starting motor switch which connects the batteries directly to the starter.

On tractors Serial No. 4001 and above, the starter is equipped with a solenoid switch which is actuated by the starter switch button, located on the instrument panel. The shift lever in the drive housing of the starter is connected, by linkage, to the solenoid plunger. When the starter switch button is depressed, current from the batteries energizes the solenoid. The current passes through windings in the solenoid plunger, causing the starter shift lever to move the drive pinion of the starter into mesh with the flywheel ring gear. As the solenoid plunger continues to move in, it closes the main switch in the solenoid which connects the batteries directly to the starter.

B. Service of Starter

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 or brush springs. 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 depend-

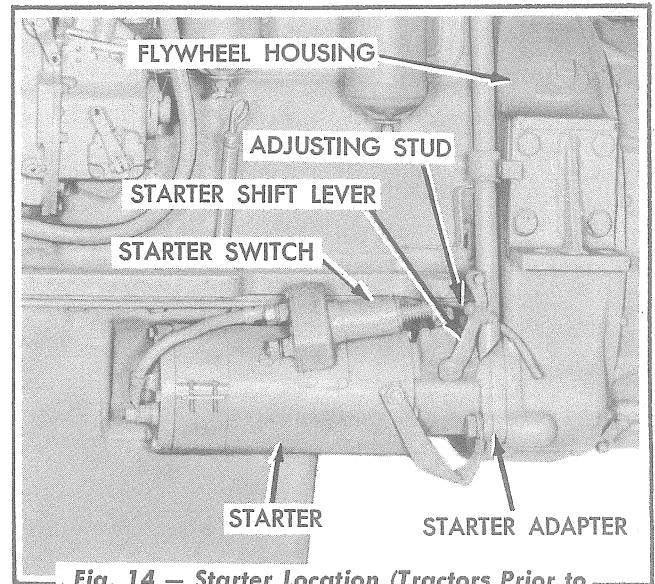


Fig. 14 — Starter Location (Tractors Prior to Serial No. 4001)

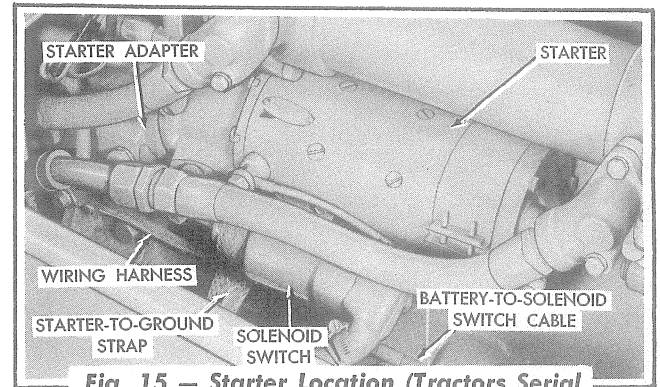


Fig. 15 — Starter Location (Tractors Serial No. 4001 and Above)

able electrical repair shop, when repair or adjustment is necessary. With fully charged batteries and an ambient temperature of 70° F., the starter will engage promptly and crank the engine at an adequate cranking speed. However, in cold weather the "drag" caused by cold oil between the pistons and cylinder walls and in the bearings reduces the cranking speed of the engine. **IMPORTANT:** The starter must never be used for more than 30 seconds at any one time without a pause to allow it to cool. The starter must NEVER be used to move the tractor. 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. **NOTE:** On tractors prior to Serial No. 4001 it will be necessary to first remove

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

2. A dirty commutator should be cleaned with No. 00 sandpaper. **IMPORTANT: NEVER USE EMERY PAPER.** If dust and dirt have accumulated in the starter, it should be cleaned with compressed air, as such accumulations are likely to interfere with the operation of both the starter and the starter drive assembly.
3. On tractors prior to Serial No. 4001, the contact surfaces of the starter switch may become burned or corroded so that insufficient current is transmitted to the starter. A slow cranking speed or difficulty in keeping the batteries charged may indicate a faulty starter switch.

The switch may be disassembled for reconditioning of burned or corroded surfaces as follows:

- a. Disconnect the battery-to-ground cable from the battery. Remove the starter protecting cover when disconnecting 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.

4. On tractors Serial No. 4001 and above, continued cranking of the starter, after the starter switch button has been released indicates shorted turns in the solenoid switch windings or that the solenoid switch is mounted out-of-line causing binding of the solenoid plunger. Chattering of the solenoid switch indicates shorted turns in the windings or run-down batteries. It is recommended that the solenoid switch be taken to a dependable electrical repair shop when repair or adjustment is necessary.

C. Starter Drive Assembly

Disassembly, Cleaning, and Reassembly of Starter Drive

If hard dirt or grease has accumulated on the splined part of the armature shaft or in the starter drive mechanism, the drive may "seize" while it is in mesh with the flywheel ring gear and damage to the starter may result.

The drive assembly may be disassembled for cleaning or adjustment as follows:

1. Remove the starter (refer to Paragraph D in this Topic).
2. Separate the drive housing from the starter field frame by removing the attaching cap-screws; mark both housings before they are separated to establish relationship of one with the other. **NOTE: On tractors Serial No. 4001 and above, it will be necessary to disconnect the starter shift lever from the solenoid plunger.**
3. Remove the cotter pin from the pinion stop and remove the pinion stop, pinion, spring, pinion guide, shift sleeve, cup washer, and the spacer washer from the armature shaft.
4. Clean all parts thoroughly and inspect for worn or damaged parts.

5. Reassemble as follows: Place the parts, in the following sequence, on the drive end of the armature shaft; plain spacer washer, cup washer (cup side away from field frame), and shift sleeve. Place the spring inside of the hollow pinion, with the drive pinion guide next to the spring and the ears on the outside diameter of the guide, facing the pinion. Start the ears into the slots in the pinion and hold the guide approximately half the distance down the slots, then start the pinion guide and the spring assembly on the splines of the armature shaft. The pinion and guide assembly cannot be started on the shaft unless the ears on the guide are held in the slots in the pinion. Install the pinion stop, with the cotter pin hole toward the end of the shaft. When the lugs on the stop enter the groove in the shaft, rotate the stop until the cotter pin holes align and install the cotter pin.
6. 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, and install the attaching capscrews. *NOTE: On tractors Serial No. 4001 and above, connect the starter shift lever to the solenoid plunger.*

D. Removal and Installation of Starter

1. Removal and Installation of Starter on Tractors Prior to Serial No. 4001

- a. Disconnect the battery-to-ground cable from the battery located in the battery box on the right hand side of the seat. 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 starter switch.

- b. Remove the starter protecting cover.
- c. Disconnect the starter rod from the starter shift lever.
- d. Disconnect the battery-to-starter cable and starter-to-ammeter cable from the starter switch. Disconnect the starter-to-ground strap from the starter.
- e. Remove the crankcase guard.
- f. Remove the capscrews and lockwashers attaching the starter to the flywheel housing and remove the starter and starter adapter by lowering the assembly down and out from under the tractor.
- g. Install the starter by a direct reversal of the removal procedure.

2. Removal and Installation of Starter on Tractors Serial No. 4001 and Above

- a. Turn the electrical system master switch, located above the left hand battery, to the off position.
- b. Disconnect the starter-to-ground strap from the starter. Disconnect the wiring harness from the solenoid switch.
- c. Remove the capscrews and lockwashers attaching the starter to the flywheel housing and remove the starter and the starter adapter.
- d. Install the starter by a direct reversal of the removal procedure.

SECTION VII — INSTRUMENTS

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1. GENERAL 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 mounted in the instrument panel

located on the cowl. The engine hour meter (special equipment) is mounted in a shock resistant mounting bracket which is attached to the front side of the cowl as shown in Fig. 2.

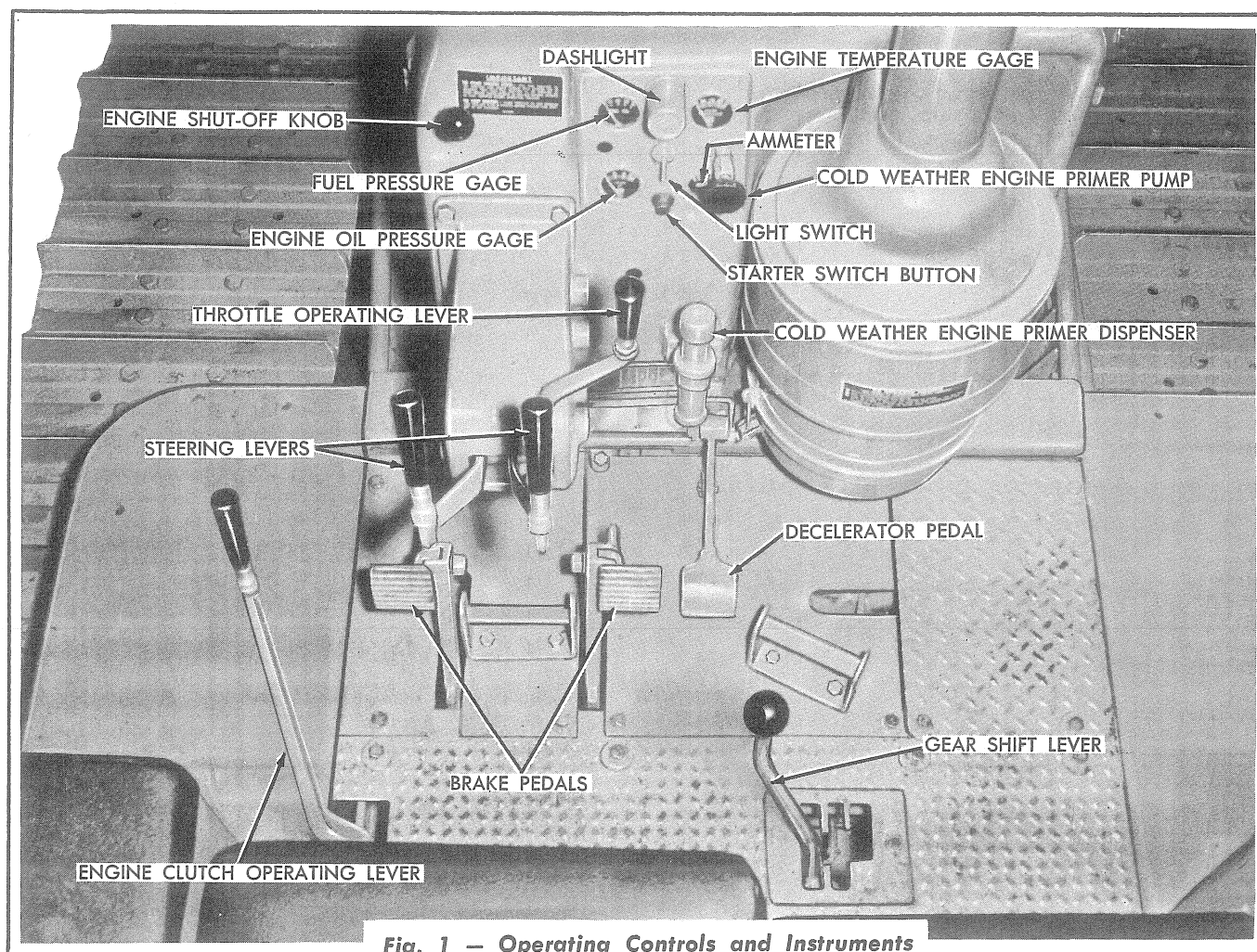


Fig. 1 — Operating Controls and Instruments
(Tractors Serial No. 4001 and Above Shown —
Tractors Prior to Serial No. 4001 Similar)

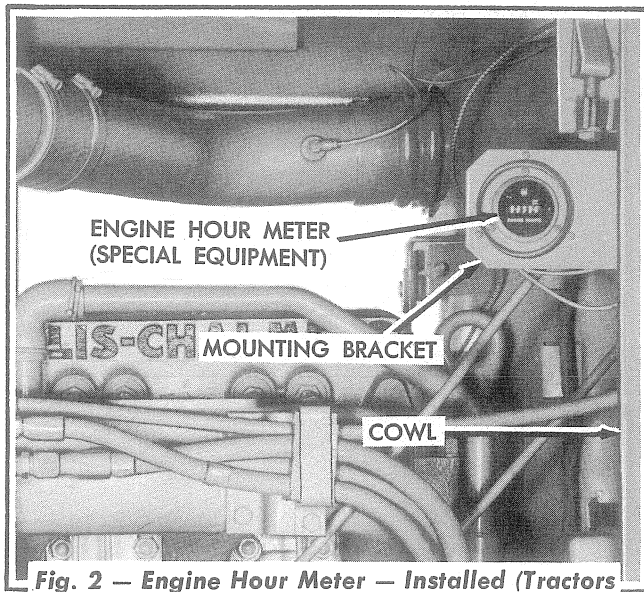


Fig. 2 — Engine Hour Meter — Installed (Tractors Serial No. 4001 and Above Shown — Tractors Prior to Serial No. 4001 Similar)

2. ENGINE OIL PRESSURE GAGE

The engine oil pressure gage indicates the pressure at which the engine lubricating oil is circulated through the engine. With the engine running at full throttle, the engine oil pressure should be between 30 and 55 pounds at normal engine operat-

ing temperature (160° to 185° F.). **CAUTION:** *If no oil pressure is indicated by the gage, the engine must be stopped immediately and the cause determined and corrected.*

3. ENGINE TEMPERATURE GAGE

The engine temperature gage indicates the engine coolant operating temperature, which should be

maintained between 160° to 185° F. at all times.

4. AMMETER

The ammeter indicates the charging rate of the generator. When the batteries are in a discharged condition, the ammeter should indicate a good rate of charge until the batteries approach a fully

charged condition. When the batteries are fully charged, the ammeter will indicate nearly zero, except for a short time after the starter has been used.

5. FUEL PRESSURE GAGE

The fuel pressure gage indicates the pressure at which the fuel is circulated through the low pressure fuel system. Under normal conditions, with the engine operating at full governed speed, the fuel pressure should be between 30 and 60 pounds. **CAUTION:** *Do not operate the engine when the fuel pressure is above or below this range. Check*

for clogged fuel filters, clogged or leaking fuel lines or connections, worn fuel transfer pump, or inoperative fuel transfer pump pressure relief valve and on tractors with a torque converter check for leaks at the fluid heat exchanger, torque converter or converter lines.

6. ENGINE HOUR METER (SPECIAL EQUIPMENT)

The engine hour meter is an electrically-energized clock which records the number of hours the engine has operated. Starting and stopping of the clock is controlled by the engine oil pressure through a pressure switch, therefore, the meter records only when the engine is operating. The engine hour meter is a direct reading type and records up to 10,000 hours and repeats. The four figures of the hours are read directly. The red figure indicates 10ths of an hour. The small indicator (upper left) visibly turns when the meter is recording.

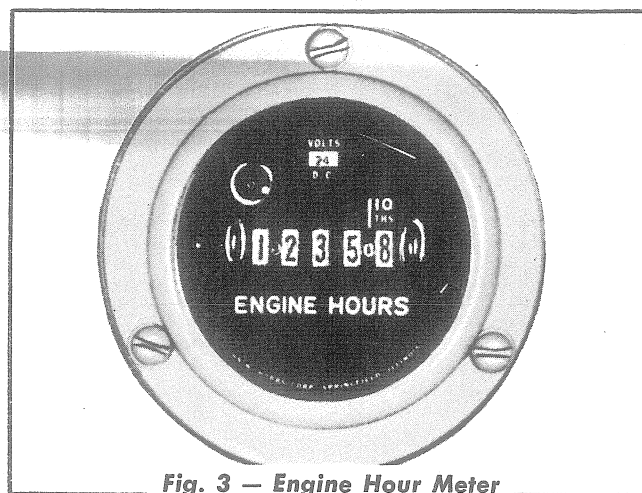


Fig. 3 — Engine Hour Meter
(Reading 1235.8 Hours)

7. INSTRUMENT SERVICE

Any of the various instruments may be removed for replacement by removing the attaching screws and disconnecting the instrument from the wiring, tubes, etc., to which it is connected. Do not attempt to

repair an engine hour meter; return it to your "Allis-Chalmers" Construction Machinery Dealer for trade-in allowance on a new engine hour meter.