Foreword

IT is the purpose of Caterpillar Tractor Co., to build into its products the capability of a long life of useful work. The records of tens of thousands of users testify to success in the achievement of that purpose. It is natural, however, that length of life and cost of operation and maintenance will vary — top records are the reward of the owners and operators who are diligent and conscientious in the care, operation and maintenance of their machines.

The Operator's Instruction Book, a copy of which is supplied with each machine, tells what to do, and how and when to do it, with regard to the day-to-day lubrication, operation and maintenance of the machine. It is urged that these instructions be studied carefully and reread frequently until the operator is thoroughly familiar with them. By following the instructions, the operator is best assured of obtaining maximum life and performance from his machine and of minimizing the frequency, number and cost of repairs.

Even the best of care will not eliminate the necessity, in course of time, of making minor repairs or complete reconditioning.

Your "Caterpillar" dealer has exceptionally complete facilities for such work. He carries a stock of genuine replacement parts and has in his employ competent factory trained servicemen. For work that cannot be done in the field, dealers have well equipped shops. Both the shop and the field servicemen have many special tools, designed and developed by "Caterpillar", that make easier and quicker the disassembly and assembly operations.

Though most "Caterpillar" owners prefer to make use of the excellent service and shop facilities of their dealers, some are themselves skilled mechanics or have such mechanics in their employ for reconditioning their equipment. To those owners this book, issued as a guide for "Caterpillar" dealer servicemen, will be of equal value.

The special tools pictured in various operations throughout are among the many which can be purchased from dealers. These tools are illustrated and listed in the Catalog for Service Tools, a copy of which is available on request.

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SPECIFICATIONS

DIESEL ENGINE

Bore and stroke	4¼ x 5½ in.
Firing order	1-3-4-2

Camshaft

Bearing, journal diameter	2.495 - 2.496 in.
Clearance	.003 - .006 in.
Maximum permissible clearance	.010 in.
End clearance	.003 - .007 in.
Maximum permissible end clearance	.025 in.

Crankshaft

Main journal, diameter	2.999 - 3.000 in.
Main bearing clearance (Aluminum)	.006 - .0085 in.
Main bearing clearance (Babbitt)	.003 - .0055 in.
Maximum permissible clearance	.015 in.
End clearance (center main)	.009 - .015 in.
Maximum permissible end clearance	.020 in.
Main bearing stud nuts, torque wrench	1450 lb. in.
Connecting rod, journal diameter	2.624 - 2.625 in.
Maximum permissible wear of journal	.006 in.
Maximum permissible out of roundness	.007 in.

Connecting Rod

Connecting rod bearing clearance (Aluminum)	.0055 - .008 in.
Connecting rod bearing clearance (Babbitt)	.0035 - .006 in.
Maximum permissible clearance	.013 in.
Connecting rod bolt nuts, torque wrench	700 lb. in.

Cylinder Liner

Diameter	4.250 - 4.251 in.
Maximum permissible liner wear (at top of ring travel)	.015 in.

Piston Pins

Clearance in rod bushings	.001 - .0018 in.
Maximum permissible clearance in rod	.006 in.
Maximum permissible clearance in piston	.006 in.

Piston Rings

Piston ring clearance in groove	
Top ring	.003 - .004 in.
Second and third ring	.0015 - .0025 in.
Oil control ring	.0015 - .0035 in.
Maximum permissible clearance (new ring)	.010 in.

Valves

Tappett clearance (hot)	.010 in.
Exhaust valves	
Stem clearance in bushing	.005 - .007 in.
Maximum permissible clearance in bushing	.012 in.
Valve seat angle	45°
Inlet valves	
Stem clearance in bushing	.004 - .006 in.
Maximum permissible clearance in bushing	.012 in.
Valve seat angle	45°

Valve Timing

Exhaust opens	50° BBC
Exhaust closes	22° ATC
Inlet opens	12° BTC
Inlet closes	30° ABC

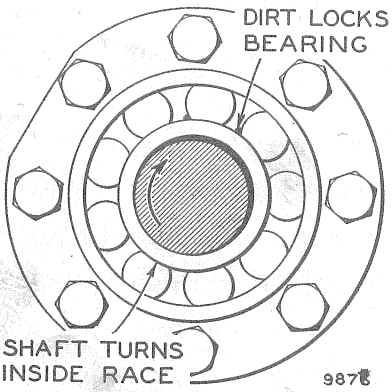
Valve Spring	
Outer	57.50 - 62.50 lbs. pressure when compressed to 2⅞".
Inner	9 - 11 lbs. pressure when compressed to 2 13/32".
Rocker Arm Bushings	
Clearance between shaft and bushing	.001 - .003 in.
Oil Pump	
Clearance between gears and separator plates	.002 - .004 in.
STARTING ENGINE	
Bore and stroke	2¾ x 3 in.
Brake horsepower	10 @ 3000 RPM
Camshaft	
Bearings, journal diameter front and rear	1.496 - 1.497 in.
Bearing clearance	.0025 - .004 in.
End clearance	.007 - .015 in.
Crankshaft	
Main journal, diameter	1.8120 - 1.8125 in.
Main Bearing clearance (Aluminum)	.005 - .0085 in.
Main bearing clearance (Babbitt)	.002 - .0055 in.
Maximum permissible clearance	.015 in.
End clearance front main bearing	.010 - .015 in.
Maximum permissible end clearance	.025 in.
Connecting rod journal diameter	1.7495 - 1.7500 in.
Maximum permissible out of roundness (journal)	.003 in.
Connecting Rod	
Connecting rod bearing clearance	.002 - .0035 in.
Maximum permissible clearance	.009 in.
Cylinder Bore	
Diameter	2.751 - 2.752 in.
Cylinder bore wear limit (out of round)	.004 in.
Cylinder bore wear (taper)	.006 in.
Piston Pins	
Clearance in rod bushing	.0008 - .0013 in.
Maximum permissible clearance between pin and bushing	.003 in.
Clearance in pin	.0004 - .001 in.
Maximum permissible clearance between piston and pin	.0025 in.
Piston Rings	
Compression ring gap	.012 - .022 in.
Oil ring gap	.012 - .020 in.
Compression ring groove clearance	.0015 - .003 in.
Oil ring groove clearance	.001 - .0025 in.
Maximum permissible groove clearance (new ring) compression and oil rings	.009 in.
Valves	
Exhaust and inlet	
Tappett clearance (cold)	.007 - .010 in.
Face angle	45°
Bushing clearance (Exhaust)	.003 - .005 in.
(Inlet)	.0015 - .003 in.
Valve timing	
Exhaust opens	40° BBC
Exhaust closes	5° ATC
Inlet opens	10° BTC
Inlet closes	35° ABC
Valve spring	35 - 38 lb. pressure when compressed 1 29/32 in.

GENERAL INSTRUCTIONS

THESE general instructions will be extremely helpful in following the detailed instructions in the main sections of the book. They should be read and then kept in mind while assembling or disassembling the engine.

KEEP DIRT OUT

The most important single item in preserving the long life of the tractor is to keep dirt out of vital working parts. Caterpillar Tractor Co. has taken precautions to safeguard against dirt entering working parts. Enclosed compartments, seals and filters have been provided to keep the supply of air, fuel, and lubricants clean. It is highly important that the effectiveness of these safeguards be maintained. Filters should be replaced or cleaned regularly. Worn seals or broken gaskets should be quickly replaced.



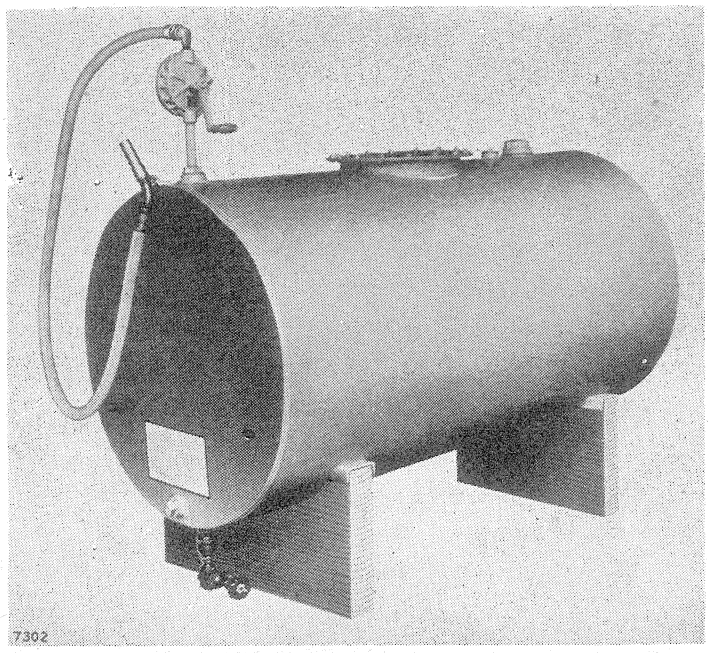
EFFECT OF DIRT IN BEARING

Anti-friction bearings, properly lubricated with clean lubricant, will last indefinitely. Abrasives in the lubricant will cause rapid wear on the extremely hard races and balls or rollers. Dirt in an anti-friction bearing can cause the bearing to lock, with the result that the shaft will turn in the inner race or the outer race will turn within the cage. Dirt and abrasives in lubricants will embed in bronze or babbitt bearings and act like fine sandpaper against the shaft, causing extremely rapid wear.

Lubricant must be changed at recommended intervals. Use clean containers. Before removing a filler cap, brush away the dirt with the brush provided in the tool kit.

Wear on fuel injection pumps and other parts of the fuel system will be almost negligible if the fuel is perfectly clean. Adequate fuel filters have been provided to safeguard fuel injection equipment. However, dirty fuel caused by careless handling or improper storage facilities will cause wear on the fuel transfer pump, prematurely clog the fuel filter, and eventually result in improper operation of the Diesel engine.

Since natural settling is an effective method of cleaning Diesel fuel, allow the fuel to stand as long as possible after delivery before using. The storage and settling tank of 500 gallons capacity or greater, similar to the one shown in the accompanying illustration, provides one of the



FUEL STORAGE TANK WITH PUMP

most satisfactory methods of handling Diesel fuel. Such a tank allows continuous settling and even though some dirt might accidentally get into the fuel during its delivery, the fuel will be clarified considerably as the dirt settles out in the tank. If other methods become necessary at times, use containers which are absolutely clean and reduce agitation to a minimum. Always plan on transferring fuel directly from the storage tank to the fuel tank by means of a pump similar to the one shown in the illustration.

INSPECT FREQUENTLY AND CORRECT MINOR TROUBLES

"A stitch in time saves nine" applies to engine maintenance.

A bearing changed in time will save a crankshaft. A water leak corrected prevents loss of coolant and an overheated engine. A nut tightened in time will prevent the loss or breakage of an associated part.

SAFETY AND WORKMANSHIP SUGGESTIONS

There are certain practices which should be followed in the interest of safety and good workmanship when working around machinery.

Always show proper respect for weight. Do not attempt to lift heavy parts where a hoist should be used. Never leave heavy parts in an unstable position. When jacking up a machine make sure that it is blocked securely. Then block it up so that the weight will be supported by the blocks rather than the jack.

TOOLS

All service tools should be kept in first class condition. Use the proper tool for the job at hand. Special service tools are available for specific jobs and they should be used when recommended. The use of these tools will save time and prevent damage to parts.

In the following pages puller arrangements are illustrated for separating tightly fitted parts. However, if the machine is being repaired in a shop, it may in many cases be easier and faster to use a press. When pulling a bearing or gear from a shaft, always use a centering spacer between the forcing screw and the end of the shaft.

DISASSEMBLY

If a part offers unexpected resistance to removal, check carefully to see that all nuts and capscrews have been removed before using force. Possibly some other part is interfering and should be removed first. Parts which are fitted together with tapered splines are always very tight. If they are not tight when disassembled, inspect the tapered splines and discard the part if the splines are worn.

Identical parts, such as pistons and valves, should be kept in order or marked so they can be reinstalled in the same place from which they were removed.

Where shims are used, be sure to remove them all. Tie the shims together and identify them as to their location. Then keep them clean and flat until they are reinstalled.

Whenever fuel injection lines are disconnected the ends of the lines should be capped with the fittings supplied in the tool kit. Also cap the pumps and valves. This will prevent dirt and other foreign matter from entering the fuel injection system.

CLEANING AND INSPECTION

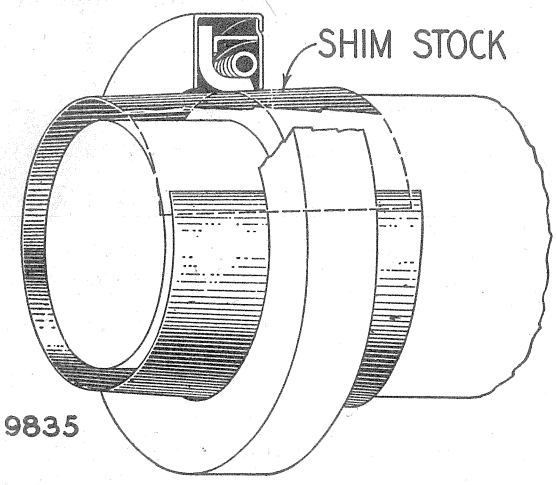
Clean all parts thoroughly after they are removed and inspect them. Be sure all lubricant passages and oil holes are open. Badly worn or damaged parts should not be put back in the machine. Cover all parts to keep them clean until they are installed.

Anti-friction bearings should receive special handling. As soon as a bearing is removed, cover it to keep out dirt and abrasives. Wash bearings in non-inflammable cleaning solution and inspect the races and balls or rollers. Discard the bearings if they are pitted, scored, or burned. If the bearing is serviceable, coat it with light oil and wrap it in clean paper. Do not unwrap new bearings until ready to install them.

ASSEMBLY

Clean the rust preventive compound from all machined surfaces of new parts before installing them. Be sure to install parts in the proper location and position.

When one part is pressed into another, use white lead or a suitable prepared compound to lubricate the mating surfaces. Tapered parts, however, should be assembled dry. Before assembling parts with tapered splines, be sure the splines are clean, dry and free from burrs. Then press the parts together tightly.

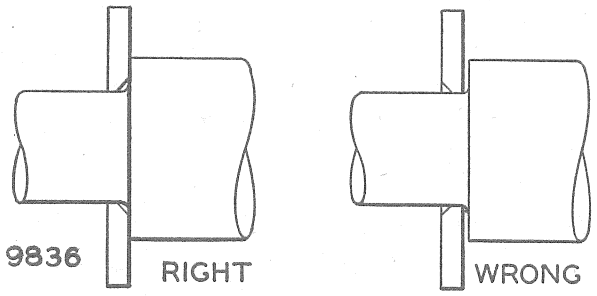


PROTECTING SEAL
DURING INSTALLATION

When possible, soak new rawhide seals in warm oil for a half hour before installing. Install the seal with the wiping edge turned in the direction recommended. Be careful not to cut the leather seal as it is installed or when installing a shaft through the seal. Use shim stock if necessary to protect the seal from shoulders or sharp edges during installation. Packing-type seals should always be renewed if the contacting part is removed.

When installing a bearing, spacer, or washer against a shoulder on a shaft, be sure the chamfered side is toward the shoulder. If the washer is turned in the wrong direction the radius may interfere and prevent the washer from seating against the shoulder.

Do not install bushings by driving them in with a hammer. Use a press if possible and be sure to apply the pressure directly in line with the bore. If a bushing must be driven in, use a bushing driver or a bar with a smooth flat end. If the bushing has an oil hole, be sure it is lined up with the oil hole in the part in which it is assembled.



HOW TO INSTALL SPACER AGAINST SHOULDER ON SHAFT

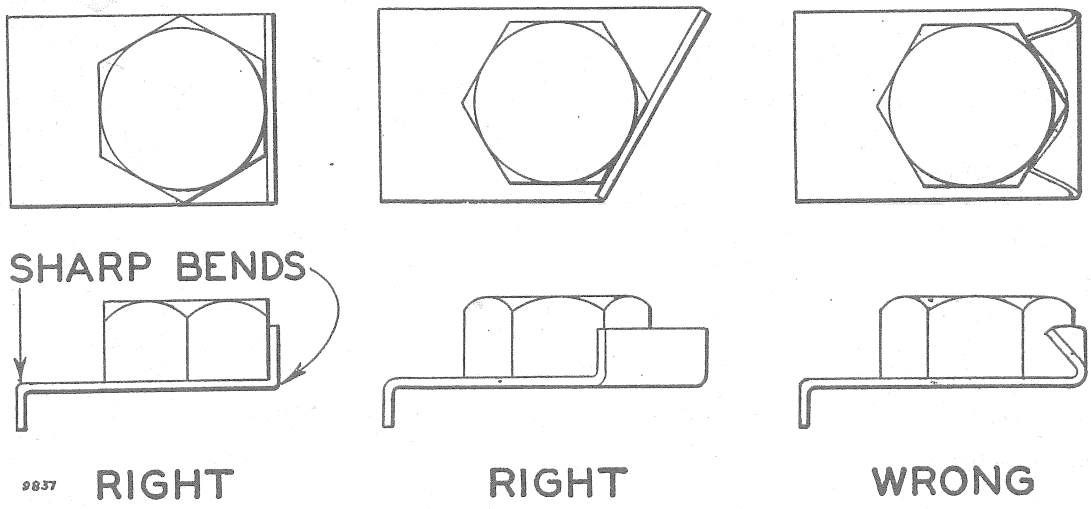
Install gaskets where required and use new ones if necessary. Never use cork or felt gaskets or seals a second time. Be sure the holes in the gaskets correspond with the lubricant passages in the mating parts. If it is necessary to make gaskets, select stock of the proper type and thickness and be sure to cut sufficient holes in the right places. Blank gaskets can cause much damage.

Use capscrews of the correct length. A capscrew which is too long may "bottom" before the head is tight against the part it is to hold, and in addition the threads may be damaged when the capscrew is removed.

If a capscrew is too short, there will not be enough threads to hold the part securely.

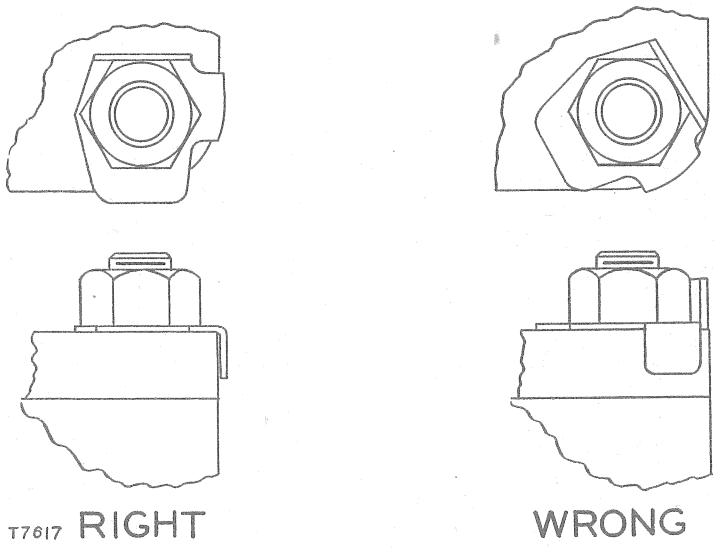
Lock washers, cotter pins, or flat metal locks should be used to lock each nut and capscrew. Flat metal locks must be installed properly to be effective. Bend one end of the lock sharply around the edge of the part. Bend the other end sharply against one flat surface of the nut or capscrew head. Do not bend the lock against more than one side of the nut.

When assembling a machine complete each step in turn. Do not leave one part partially assembled and start assembling some other part. Make all adjustments as recommended. Always check the job after it is completed to see that nothing has been overlooked.



HOW TO INSTALL FLAT METAL LOCKS

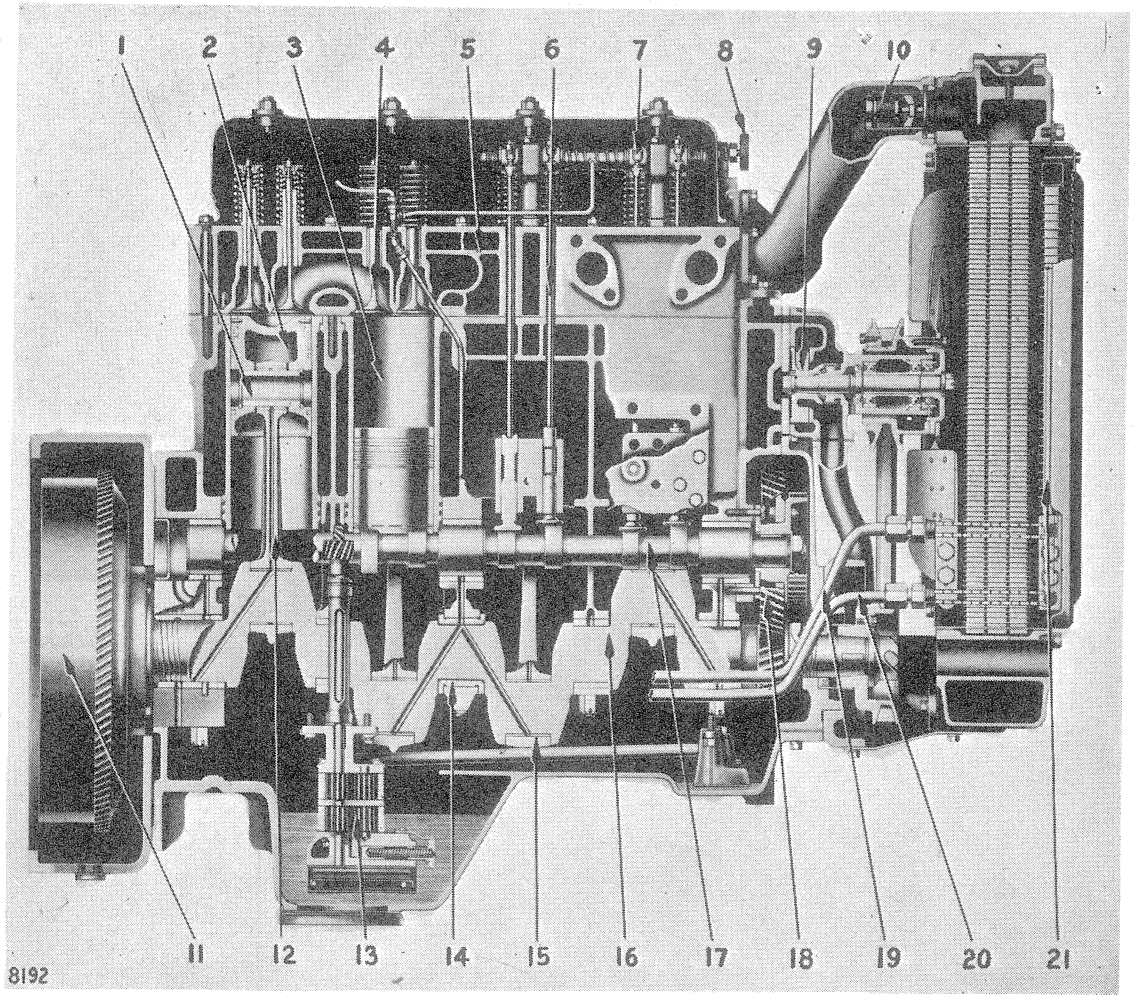
HOW TO INSTALL CLOVER LEAF LOCKS



PREPARATION FOR STARTING

After assembling a machine, lubricate it thoroughly. Fill the various gear compartments with the type and grade of lubricant recommended in the Operator's Instruction Book. Fill the crankcases of both the Diesel engine and starting engine with the grade of oil recommended for the prevailing temperature. Fill the cooling system with water or anti-freeze solution.

Recheck the various adjustments by operating the machine before returning it to the job. If a machine has been completely rebuilt, it should be run-in gradually before subjecting it to a full load.

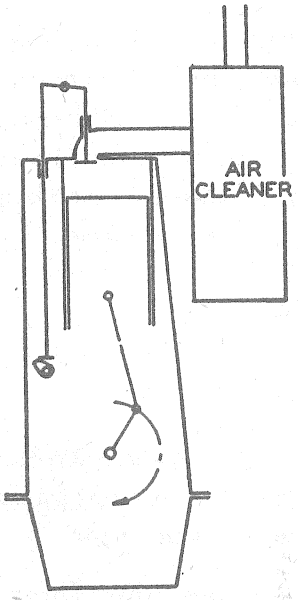


ENGINE CROSS SECTION

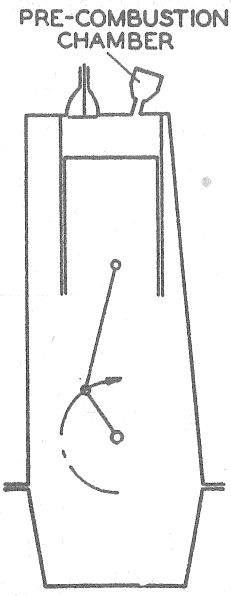
1. Piston Pin
2. Piston
3. Cylinder Liner
4. Valve
5. Cylinder Head
6. Valve Push Rod
7. Valve Rocker Arm Assembly
8. Fuel Filter Housing Vent
9. Water Pump
10. Temperature Regulator
11. Flywheel
12. Connecting Rod
13. Lubricating Oil Pump
14. Center Thrust Main Bearing
15. Connecting Rod Bearing Shell
16. Crankshaft
17. Camshaft
18. Timing Gears
19. Oil Line to Cooler
20. Oil Line from Cooler
21. Oil Cooler

DIESEL ENGINE

THE "Caterpillar" Diesel engine is a relatively simple piece of machinery and is easy to maintain and service. Its simplicity is more evident if one understands thoroughly the principles underlying Diesel engine operation.



INLET STROKE



COMPRESSION STROKE

THE WORKING PROCESS

The "Caterpillar" Diesel engine operates on the 4-stroke cycle and burns commercial Diesel fuels without the assistance of spark plugs or externally heated surfaces.

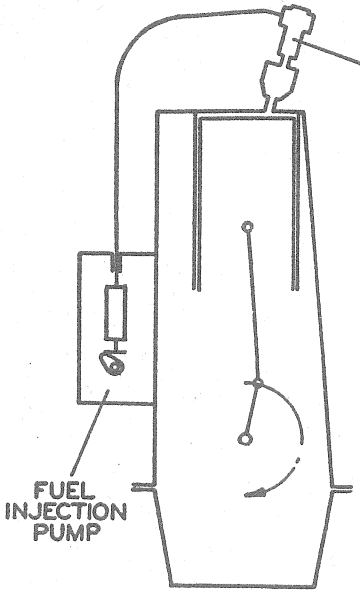
Let's spend a minute looking into the working process of the Diesel engine. The inlet stroke is the most convenient point for us to begin.

STROKE ONE

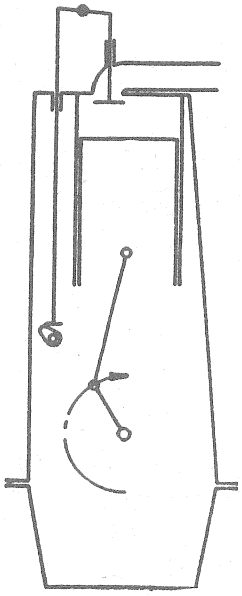
As the piston moves down on the inlet stroke, air is drawn through the air cleaner, through the inlet valve opening, and then into the combustion chamber. The Diesel engine always takes in a full charge of air on each inlet stroke regardless of whether it is operating at idling speed or at full load.

STROKE TWO

On the compression stroke, both the inlet and exhaust valves are closed, and the piston moves up, crowding the air into a very small space. The high compression in the main and precombustion chambers raises the temperature of this air to over 1000°F.



POWER STROKE



EXHAUST STROKE

STROKE THREE

Near the end of the compression stroke and during the beginning of the power stroke, the fuel injection pump forces a measured quantity of fuel through the fuel line to the fuel injection valve. The fine spray from the fuel injection valve passes into the precombustion chamber, where it heats quickly and ignites.

As fuel injection continues, burning fuel passes through the opening in the precombustion chamber into the main combustion chamber where additional air is available to complete its combustion. Expansion is thus obtained and the piston is forced down by the pressure.

STROKE FOUR

As the piston moves up on the exhaust stroke, the exhaust valve opens, and the burned gases are forced out through the exhaust pipe.

The exhaust stroke completes the Diesel cycle; as the piston moves downward on its next stroke, the working process is started over again.

Cylinder Head and Valve Mechanism

THE cylinder head is equipped with copper water directors to conduct the flow of cooling water around the valve ports and precombustion chambers.

Rubber seals and copper ferrules installed in the water passages between the cylinder head and block relieve the cylinder head gasket of any water sealing function.

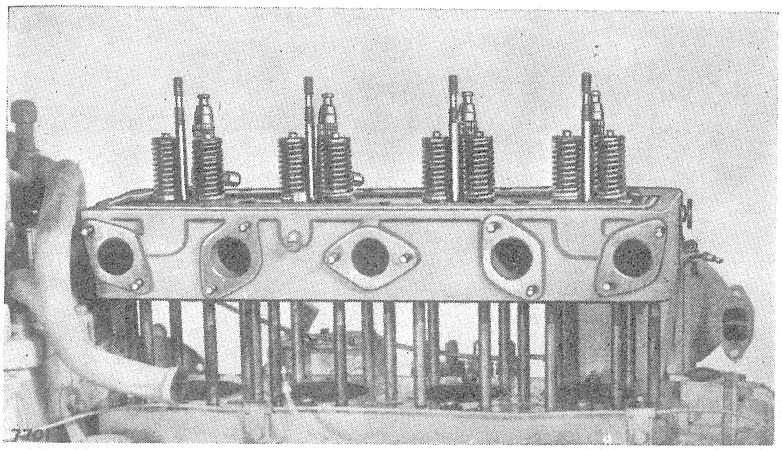
CYLINDER HEAD REMOVAL

Remove the hood and then the following items from the right side of the engine:

1. Inlet and exhaust manifold assembly
   The inlet manifold assembly and air cleaner will come off as a unit after disconnecting the starting engine exhaust pipe from the inlet manifold.
2. Valve cover
3. Oil tubes to valve rocker arm assemblies

The following items should be disconnected from the left side of the engine:

1. Cooling system outlet pipe for the engine
2. Fuel injection lines

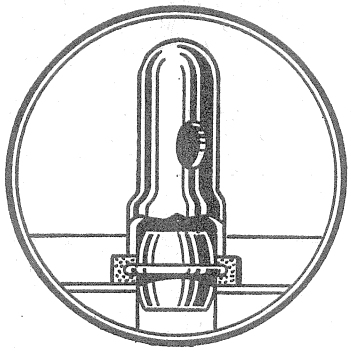


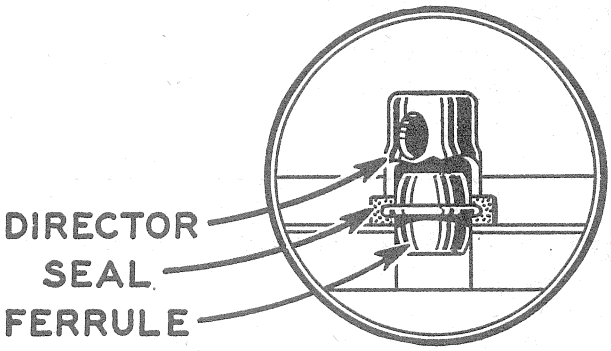
After removing the valve rocker assemblies, push rods and cylinder head nuts, the head may be lifted off.

WATER DIRECTORS

The short water directors are located on the manifold side of the engine and the long directors on the fuel injection valve side of the head as seen with the head in place on the block.

Water directors should be replaced only if they are damaged. Press the director into place in the head after aligning the notch on the director with the V mark on the head.



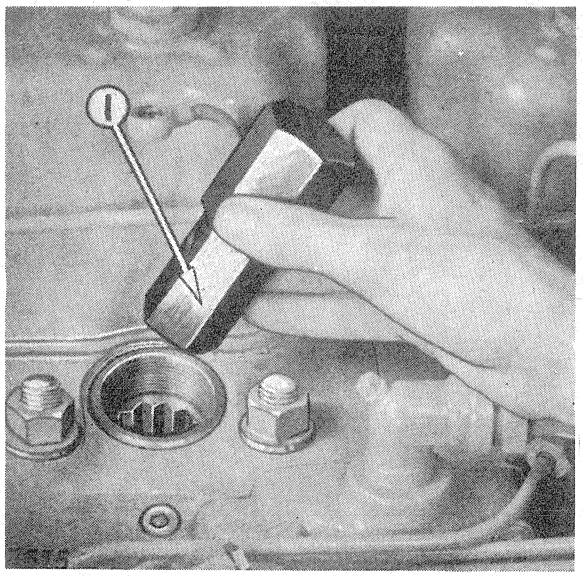


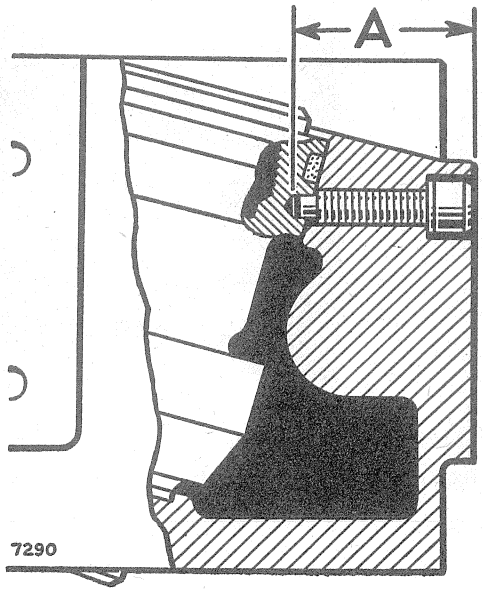
The director should be pressed into the cylinder head until the open end is flush with the counterbore.

Care should be taken when installing the ferrules and seals to see that the ridge on the ferrule is in the central groove of the seal. Installation of the seal on the ferrule can be facilitated if the inner surface of the seal is first coated with soap.

PRECOMBUSTION CHAMBERS

The precombustion chambers are screwed into the cylinder head and locked with a set screw (A). The injection valve is secured in the precombustion chamber by a retaining nut on the injection valve body. Remove the retaining nut and injection valve.





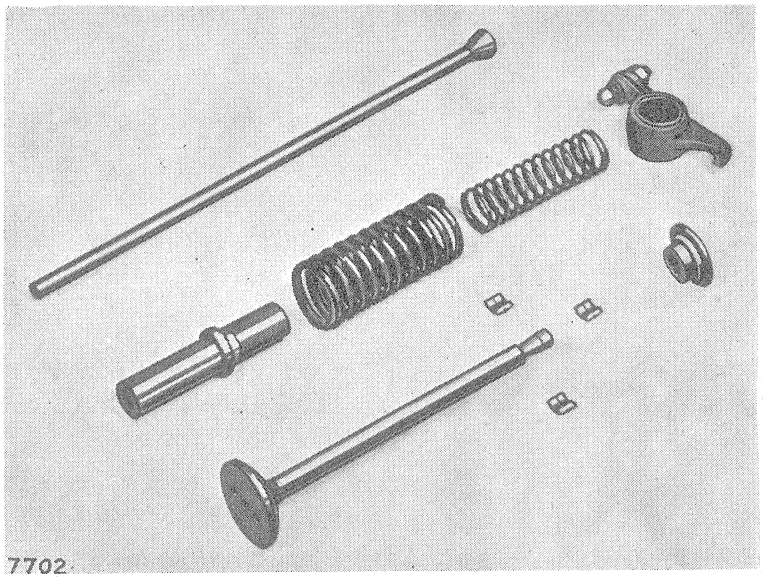
After removing the set screw, the precombustion chambers should be removed with the Precombustion Chamber Removing and Installing Tool 1F479. When installing a new precombustion chamber, place a new copper gasket at the bottom of the precombustion chamber bore in the cylinder head and fit a new rubber seal in position around the outside of the chamber. Coat the chamfered portion of the cylinder

head and the rubber seal with soap. Insert the precombustion chamber into the cylinder head and tighten with the precombustion chamber tool.

Using the set screw hole in the cylinder head as a guide, drill a $^{19}/_{64}$" hole in the precombustion chamber to a depth (A) of $1^{7}/_{32}$" from the outer surface of the cylinder head. Use a new copper washer with a locking set screw. Tighten the set screw with a 1D5343 Wrench.

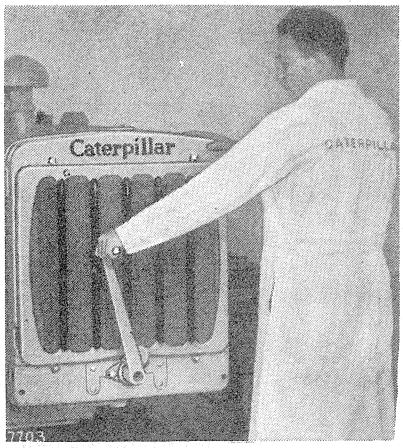
NOTE: If a used precombustion chamber is installed, check to see that the original hole in the chamber either coincides with the hole in the cylinder head or is completely out of view, in order to be sure that the new hole will not overlap or break into the edge of the original hole.

VALVES AND VALVE MECHANISM



Properly adjusted valves will operate for many hours before they need to be serviced.

Eventually, however, the valve faces and seats may become slightly pitted which ultimately allows compression pressure losses.



CHECKING COMPRESSION

It is well to check the valves occasionally for proper seating. This may be done by "rocking" the engine against compression with the Diesel engine hand crank. If the engine does not "rock back" against compression, it is quite likely that the valves and valve seats should be refaced and reground. Valve leakage often can be heard distinctly in the manifolds.

NOTE: Worn pistons and piston rings, improperly adjusted valves or a damaged cylinder head gasket will keep the engine from "rocking" against compression; therefore, these items should be checked before concluding that the valves are at fault. Worn pistons and rings can usually be detected without dismantling the engine as considerable oil vapor will come out of the breather while the engine is running. In addition, this condition will probably be accompanied by high oil consumption.

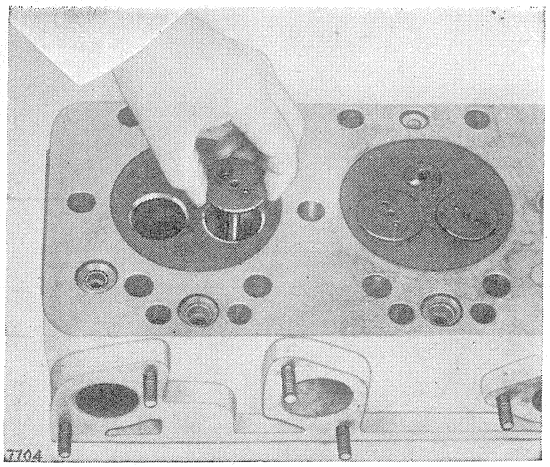
It is not always necessary to put on a new gasket when the cylinder head is removed since a cylinder head gasket can often be used several times. Damaged cylinder head gaskets can usually be determined by inspection. Gaskets showing blow-by marks or cracks should be replaced with new gaskets.

CLEANING

After removing the cylinder head from the Diesel engine and the valve assemblies from the head, carefully scrape all carbon accumulations from the parts. Be sure to clean the valves thoroughly, as well as the valve stems, valve stem bushings and valve ports.

VALVE STEM BUSHINGS

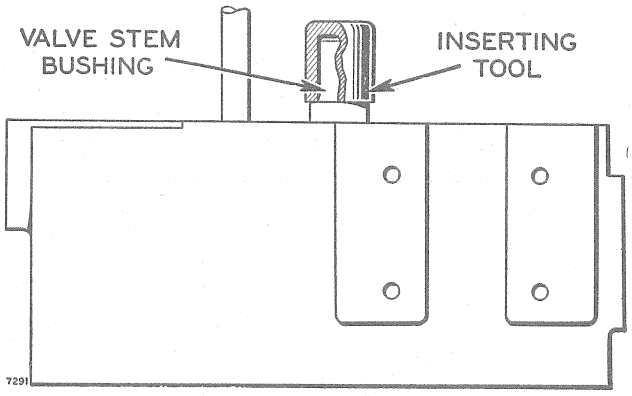
The valve stems operate in replaceable bushings. A valve stem bushing can be roughly checked for wear by cleaning the inside of it and inserting a new valve stem in the bushing. If the valve stem bushing is worn, an excessive amount of side play will be present.



CHECKING VALVE STEM CLEARANCE

Normal valve stem clearance in a valve stem bushing is from .004" to .006" for an inlet valve and from .005" to .007" for an exhaust valve. If excessive valve stem clearance is present, the valve will not seat properly.

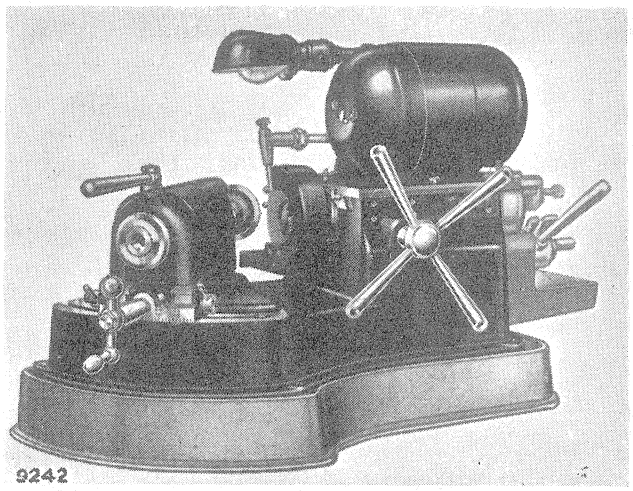
The valve stem bushings can be driven out from the inside of the head with a suitable drift.



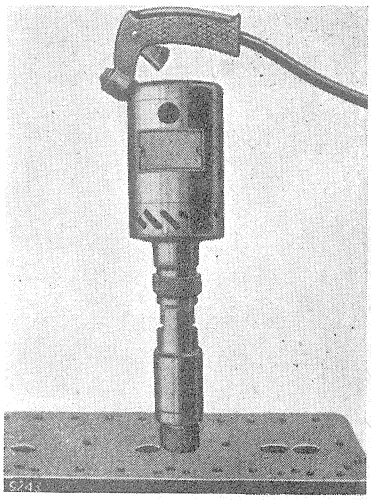
The bushings should be *pressed* into place carefully with the type of inserting tool shown in the accompanying illustration to prevent damage to their ends.

VALVE INSPECTION AND RECONDITIONING

The valves should always be carefully inspected. If the valve faces are pitted or making poor contact with the valve seat, they can be refaced in a valve refacing machine. If the valves are deeply pitted, badly warped or worn, they should be replaced.



VALVE REFACING TOOL



VALVE SEAT TOOL

The 45° valve seats can be ground with a valve seat grinding tool. Care should be exercised in its use to prevent removal of too much material. After the valve seats have been ground until they are smooth and concentric with the valve guides, all parts should be cleaned thoroughly.

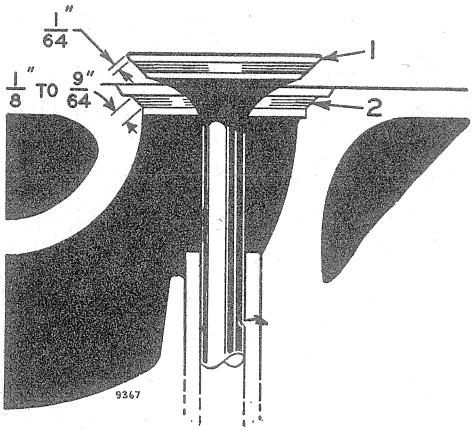
Minor imperfections in the valve face and valve seat can be corrected by "lapping in" the valve.

CAUTION: *Never turn valves one complete revolution while lapping as the compound is likely to create grooves in the valve seats.*

If the valve seat (2) contacts the valve face $\frac{1}{64}$" from the top of the valve face (1), the width of the seat should be reduced to $\frac{1}{8}$"-$\frac{9}{64}$". Narrow the seat with a 15° stone or fly cutter.

VALVE INSTALLATION

When installing valves in the head, care should be taken to see that the valves are installed in the same port from which they were removed. Exhaust valves marked "EX" on the valve head should be installed in the exhaust ports. Inlet valves marked "IN" on the valve head should be installed in the inlet ports.

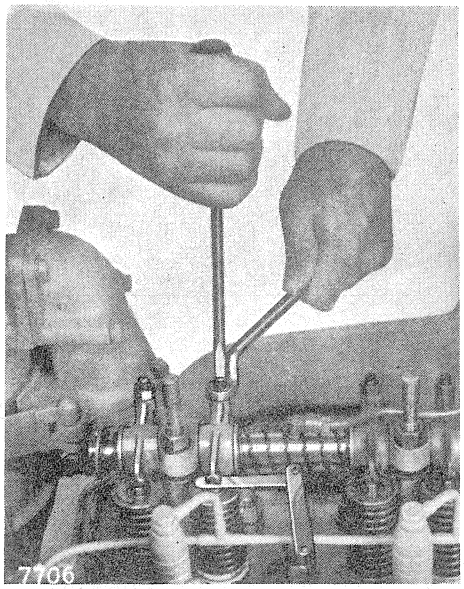


VALVE CLEARANCE ADJUSTMENT

The valve clearance adjustment should be made while the engine is hot; that is, after the engine has been stopped ten minutes and before it has been stopped twenty minutes. If the adjustment is not completed during this ten minute interval, start the engine and allow it to warm up. The valve clearance adjustment must be made or checked with the compression release lever in the RUN position.

NOTE: *Check the cylinder head nuts and rocker arm assembly hold-down nuts to see that they are tight before adjusting the valves.*

TO ADJUST: Adjust the valves in the firing order of the engine (1-3-4-2). Crank the engine in the direction of normal rotation until the inlet valve closes on No. 1 cylinder, then give the engine one-half additional turn and adjust both valves on No. 1 cylinder at the same time.



SETTING VALVE CLEARANCE

Loosen the valve adjusting screw lock nut on the valve rocker arm. Insert the feeler gauge between the valve stem and valve rocker arm. Turn the screw to obtain the correct clearance between the top of the valve stem and the end of the valve rocker arm.

Set the clearance at 0.010" for the exhaust and inlet valves. Recheck the adjustment after the adjusting screw lock nut is tightened.

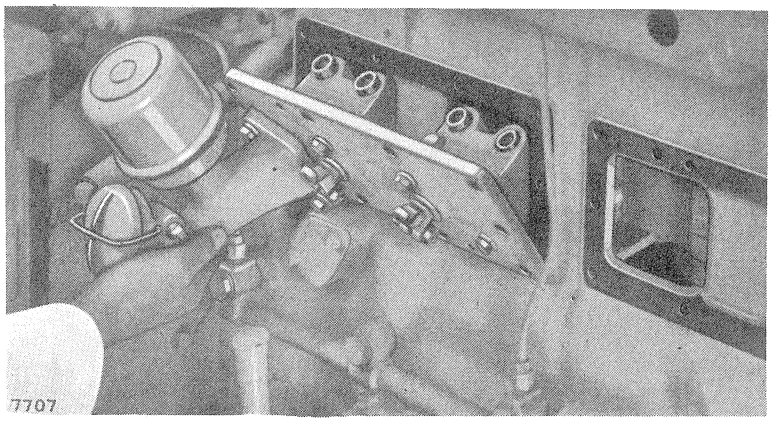
Turn the engine another half turn and adjust the valves on the next cylinder in the firing order.

VALVE TIMING

The valve timing is controlled by the setting of the timing gears. Corresponding marks on the crankshaft, camshaft, fuel injection pump and idler gears must be in line before installing the timing gear cover. Timing is discussed in the topic, TIMING GEAR ASSEMBLY.

VALVE LIFTER ASSEMBLIES

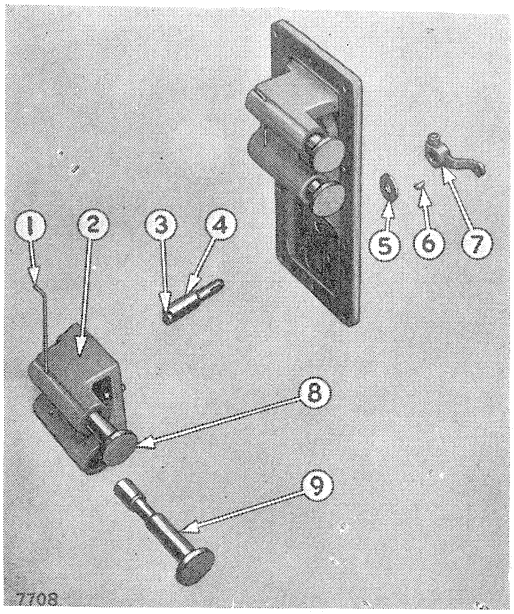
Two valve lifter assemblies are attached to each valve lifter cover. After loosening the valve rocker arm assemblies, remove the valve push rods and compression release lever connecting bar. Drive the dowel



pins in each valve lifter cover in flush with the block and then remove the cover as shown after taking out the capscrews holding the cover in place. Drive the dowel pins on through the block, catching them as they come out inside the block.

COMPRESSION RELEASE

A non-adjustable compression release mechanism is included in each lifter assembly and acts on the inlet valve lifter to lift the valve off its seat. Remove the lever (7), key (6), washer (5), capscrews which hold the guide assembly (2) to the cover and then slide out the cam shaft (4). The cam (3) fits into the groove of the inlet valve lifter (8). If leakage occurs around the cam shaft, replace the seal in the cover.



LIFTERS AND GUIDE ASSEMBLY

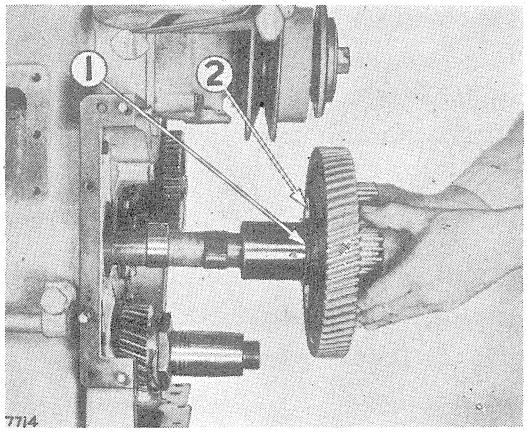
The exhaust valve lifter (9) may be removed after the wire lock (1) has been withdrawn. To remove the inlet valve lifter (8) remove either the cam shaft (4) or the guide assembly (2). The guide assembly (2) may be removed by taking out the capscrews which hold it to the cover. If the clearance between the lifters and valve guide is excessive, the worn parts should be replaced. The clearance between a new valve lifter and the bore of a new valve guide is .0015″ to .003″.

Camshaft

REMOVAL

REMOVE the lubricating oil filter housing, loosen the valve rocker arm assemblies and remove the valve push rods and valve lifter assemblies. Remove the oil pan, oil pump, radiator and oil cooler, fan spider, fan belt, cranking jaw, belt pulley, radiator bracket, the cover on right-hand side of the timing gear housing, the timing gear cover and then the idler gears as described in the topics, CRANKSHAFT and TIMING GEAR ASSEMBLY.

By working through the holes in the camshaft gear, remove the thrust plate capscrews from the cylinder block. Slide out the camshaft gears, thrust plate and camshaft. Care should be taken when removing and installing the camshaft not to damage the camshaft bearing bores. After removing the nut and lock, the camshaft gear may be pressed off the camshaft or pulled with the cross arm and screw of the 8B7554 Bearing Cup Pulling Attachment and two ½″—20 capscrews 4½″ long. Use a 4B8267 Nut and 4B8268 Stud to replace the camshaft gears as described in the topic, TIMING GEAR ASSEMBLY. When installing the camshaft gear, do not drive it into place as this will dislodge the plug in the camshaft rear bearing bore and allow oil to leak into the flywheel clutch compartment.



REMOVING CAMSHAFT

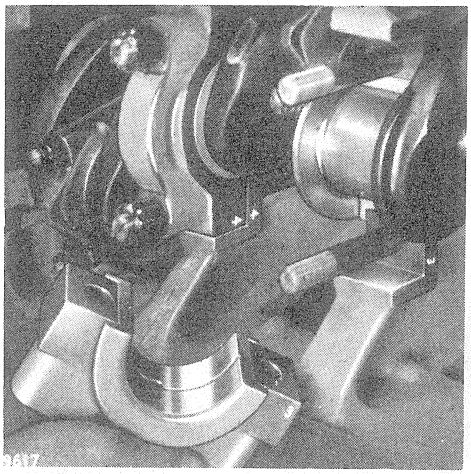
END PLAY

If the end play of the camshaft exceeds .025″, the thrust washer (1) and thrust plate (2) should be replaced. Be sure the chamfered side of the thrust washer is against the cylinder block.

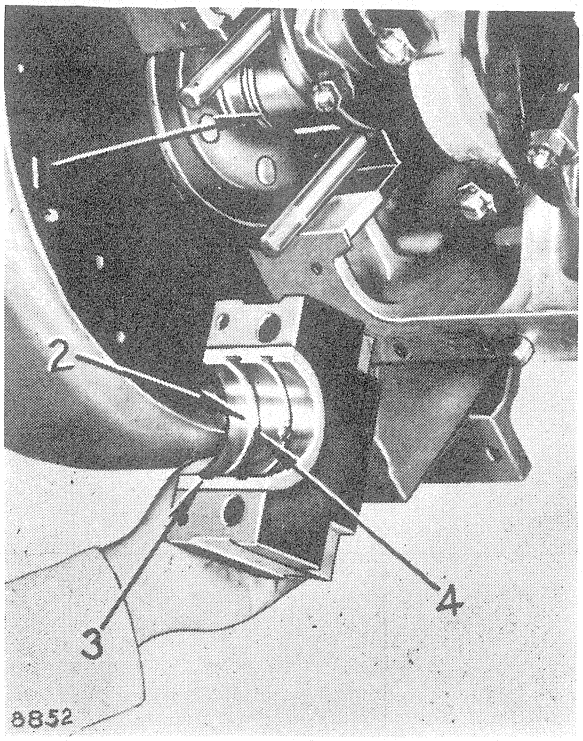
Main Bearings

THE main bearings are precision type, babbitt-lined shells. The upper shells are located in ribs in the crankcase. The lower shells are located in the main bearing caps which are secured to the crankcase by studs and nuts. In current tractors, the lower shells are held in position by dowels in the bearing caps, with the upper shells doweled to the lower shells. This construction makes it possible to remove and replace the main bearings with the crankshaft in place.

The center main bearing takes the end thrust of the crankshaft. NOTE: On machines built before serial number 7J2813, the end thrust is taken by a thrust plate and washer at the front end of the crankshaft.



CENTER MAIN BEARING



REAR MAIN BEARING

The flywheel end of the rear main bearing is bored .003″ to .005″ larger in diameter at (2) and consequently, the crankshaft does not touch this part of the bearing. This section of the bearing provides for oil control by permitting the oil return threads (1) on the crankshaft to deliver oil to the oil groove (3). From the groove, the oil returns to the crankcase through the drilled passage (4).

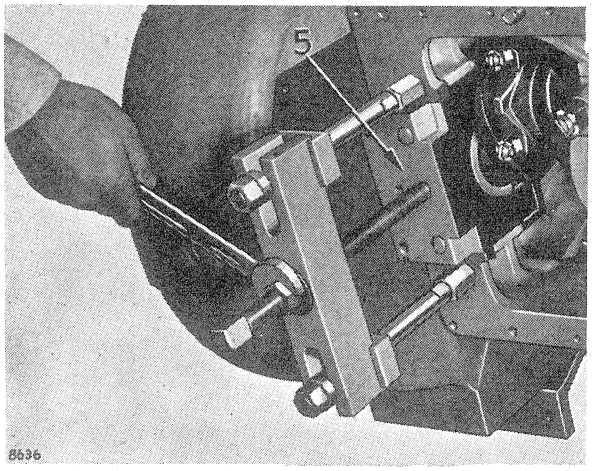
REMOVING MAIN BEARINGS

NOTE: In earlier machines with serial numbers below 2T337 (including all machines in the 7J series), the upper shells of all the main bearings except the center main are doweled to the crankcase.

Only the center main bearing can be removed from those machines without first removing the crankshaft.

On machines with serial numbers above 2T336, the main bearings can be removed in the following manner.

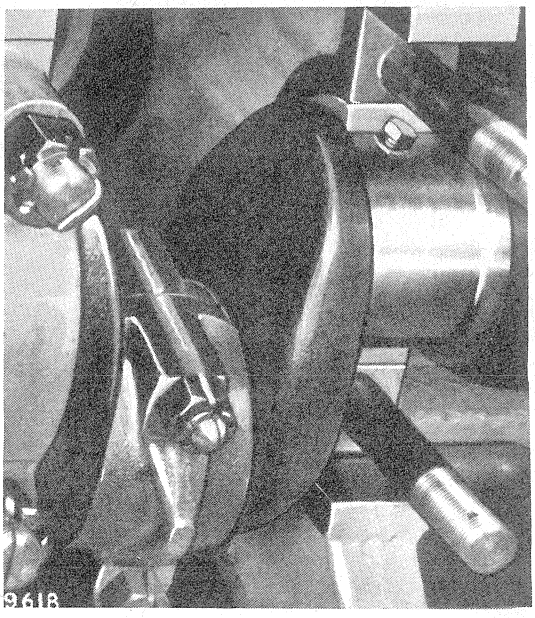
Remove the oil pan, lubricating oil pump and suction bells. Take off only one bearing cap at a time unless the crankshaft is to be removed. Take off the nuts and remove the bearing cap. The rear main bearing cap (5) has two hollow head capscrews holding it in place in addition to the studs. If the rear main bearing cap is tight, it can be pulled with the 8B7548 Push Puller by using a stud or bolt and nut in place of the forcing screw. The other main bearing caps are recessed to permit the use of a prybar if they offer resistance to removal.



PULLING REAR MAIN BEARING CAP

After removing the bearing cap, the upper shell can be rotated out.

On those bearings where the crankshaft is drilled, the upper shells can be rotated out by inserting a small capscrew in the oil hole and turning the crankshaft. If the bearing shell seems tight, it is advisable to place a short piece of key stock between the edge of the shell and the capscrew to prevent damaging the shell. On the bearings where the crankshaft is not drilled, rotate the shell out by driving on the edge of the shell with a small curved rod.

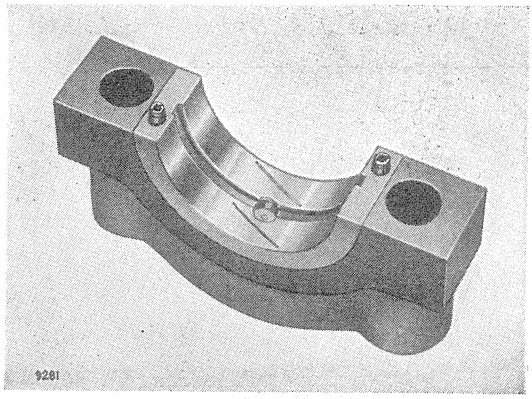


REMOVING MAIN BEARING SHELL

INSPECTION

Replace the center main bearing if the crankshaft end clearance exceeds .020".

Check the bearing clearance by placing soft lead wire between the lower shell and the crankshaft. Coat two one inch lengths of the wire with soft grease and place them diagonally on the bearing as shown. The soft grease will keep the wires in position while installing and tightening the cap. Turn the crankshaft one complete revolution during the final tightening. Remove the bearing cap and measure the thickness of the compressed wire with a 0″ to 1″ micrometer to determine the bearing clearance.



CHECKING BEARING CLEARANCE

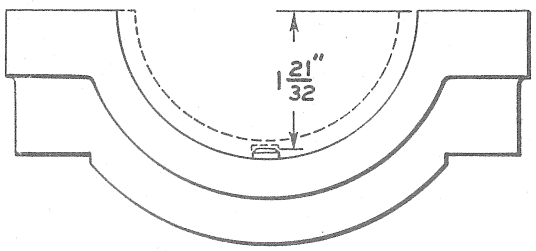
Main bearing clearance in a new engine is .003″ to .0055″. Maximum permissible clearance is .015″. If the clearance exceeds .015″ replace either the bearings or the crankshaft, depending upon which part is worn. For crankshaft wear limits, see the topic, CRANKSHAFT.

REPLACEMENT BEARING SHELLS

Precision main bearing shells, machined to provide proper clearance, are obtainable in complete sets and should be installed without fitting, scraping, filing or reaming. Single replacement bearings, upper and lower shell, may also be obtained and installed without special fitting. As a rule, however, it is good practice to replace the complete set if any one of the bearings needs to be replaced. If only one new bearing is installed and the other bearings are worn to any extent, the new bearing will carry more than its normal share of load and might be damaged as a result.

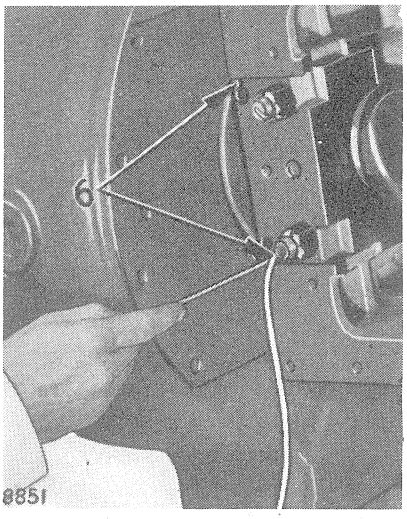
Precision main bearings are also obtainable for use with crankshafts reground to .030″ undersize.

NOTE: All replacement bearing shells are the later type with upper and lower shells doweled together. When installing these bearings in older machines, it is first necessary to remove the hollow dowels from the bearing supports in the crankcase. Also check the dowel in the bearing cap to see that it does not protrude too far. The end of the dowel should be not less than $1\frac{21}{32}$″ from the parting surface of the cap as illustrated. The dowel may be driven in farther or filed off if necessary.



INSTALLING MAIN BEARINGS

Before installing a bearing shell, wash it thoroughly and wipe the outer surface dry. Rotate the upper shell into position in the same manner by which it was removed. Remove the capscrew, if used, from the oil hole in the crankshaft. Place the lower shell in the cap and install the cap. Tighten both nuts securely and evenly, and install cotter pins.



PACKING REAR MAIN BEARING CAP

NOTE: If a torque wrench is used, tighten the nuts to 1450 inch pounds.

REAR MAIN BEARING

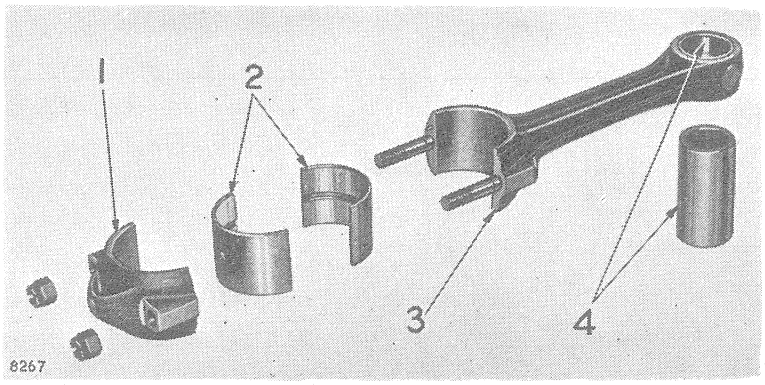
After tightening the nuts and hollow head capscrews in the rear main bearing cap, seal the cap by installing new 2B2414 Packing in the grooves (6). Feed the packing into the grooves as shown, tamping it in tightly with a hammer and long thin punch until the grooves are filled.

Connecting Rod

CONNECTING rod bearings are located in the crankshaft end of the connecting rod. The bearing caps and rods are numbered consecutively, 1 to 4, from the front of the engine on the left side so that the numbers can be seen through the inspection openings on the left side of the cylinder block. The rods should be reassembled with the numbers in this position.

REMOVAL

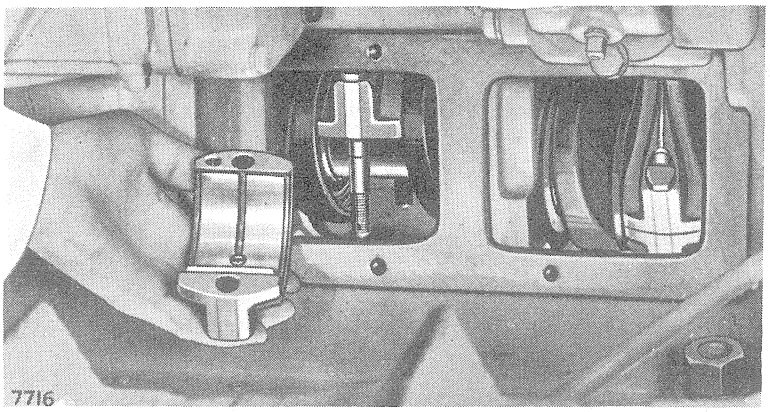
Connecting rod bearings are the precision type and are to be installed without fitting, reaming or scraping the rod (3), cap (1) or shells (2).



CONNECTING ROD ASSEMBLY

The bearing shells may be removed, inspected and replaced through the inspection openings without removing the rod from the engine.

To remove a connecting rod bearing through the inspection opening, remove the cover and turn the crankshaft until the bearing to be removed is in the position shown in the photograph. Remove the cotter



REMOVING CONNECTING ROD BEARING CAP

pins and nuts from the connecting rod bolts and take out the cap (1) and lower shell. To remove the upper shell, turn the crankshaft or push the rod up slightly.

INSPECTION

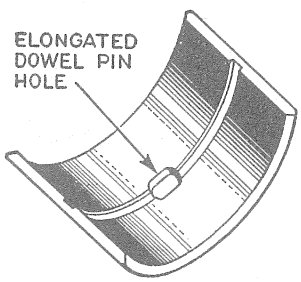
Babbitt lined bearing shells rarely need to be replaced because of wear. If dirt is allowed to get into the engine, this material will embed itself in the babbitt and act as an abrasive against the crankshaft bearing journals. Bearings having a gray color, a sandy surface or foreign material embedded in the babbitt should be replaced.

New standard connecting rod bearing shells are 2.6285 - 2.630″ in diameter, giving a clearance of .0035 -.006″ between the bearing and crankshaft. Bearing shells .030″ undersize are serviced for reground crankshafts.

Bent rods are not suitable for service and should be discarded. Do not attempt to align connecting rods by bending them.

INSTALLATION

The dowel pin hole in the lower shell is oblong to assure proper alignment of the bearing in the connecting rod.



If a tension wrench is used to tighten the nuts, a torque of 700 inch pounds should be exerted. It is permissible to exceed this value by the amount necessary to turn the nut to the next slot for alignment with the cotter pin hole.

PISTON PIN BUSHING

It is not always necessary to replace piston pin bushings when new precision bearing shells are installed in a connecting rod. In many cases, bushings may be serviceable even though the second replacement of bearing shells has been made.

After the oil has been cleaned from the pin and bushing (4), it is possible to feel the clearance between them. This normal oil clearance must not be mistaken for wear.

A new bushing should be installed only when the clearance between the bushing and a new piston pin exceeds .006". This clearance can be checked with a feeler gauge.

New connecting rods have the piston pin bushing bored in a special machine which maintains the proper center-to-center distance and parallelism of the connecting rod bearing and piston pin bore. Reconditioned rods should be machined in the same manner. A new connecting rod makes the best templet for center-to-center distance.

After pressing a new bushing into place, it should be machined accurately from .0005" to .001" larger than the new piston pin diameter.

Crankshaft

THE crankshaft main bearing journals are 2.999-3.000" in diameter and the connecting rod bearing journals are 2.624-2.625" in diameter.

A crankshaft should not be put in an engine if the wear on the main bearing or connecting rod bearing journals exceed .006" or if the connecting rod bearing journals are more than .007" out of round.

If a reground crankshaft is installed, it will be necessary to install new undersize main bearings and connecting rod bearings. Crankshafts should be ground .030" undersize. Rawhide oil seal surfaces on all reground crankshafts should be finished .050" undersize and a new .050" undersize seal installed.

Connecting rod and main bearings .030" undersize are serviced for use with reground crankshafts.

REMOVAL

Remove the engine from the tractor as outlined in the topic, REMOVING DIESEL ENGINE. Disconnect the oil cooler lines and water pipes between the radiator and the engine. Remove the radiator, fan belt, belt pulley, radiator support bracket and timing gear cover as described in the topics, RADIATOR REMOVAL and TIMING GEAR ASSEMBLY.

Inspect the crankshaft oil seal in the timing gear housing. If it is worn or leaking, a new seal should be installed with the wiping edge out. Use a 7B7918 Driver.

Remove the starting engine as described in the topic, STARTING ENGINE. Then remove the flywheel and flywheel housing. Take off the oil pan and remove the oil pump and suction bells. Remove all the main bearing caps and connecting rod bearing caps and lift out the crankshaft.

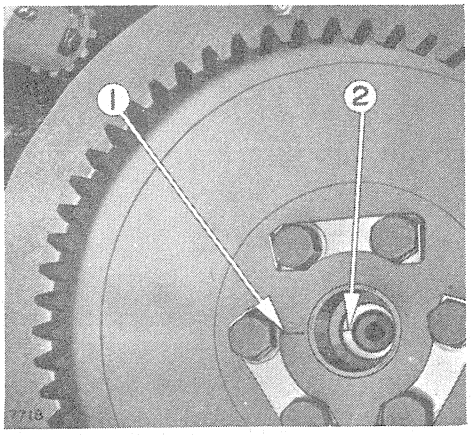
CRANKSHAFT END-PLAY

The crankshaft end-play is controlled by the center main bearing. When the engine leaves the factory, the crankshaft end-play is from .009″ to .015″.

Should the end-play of the crankshaft exceed .020″, the center main bearing should be replaced.

FLYWHEEL

If the flywheel is removed from the crankshaft, the marks (1) and (2) should be aligned when the flywheel is replaced. This will insure that the timing marks on the flywheel will be in their correct location with respect to the crankshaft.



ALIGNING MARKS

When installing the flywheel, care should be taken to center the flange on the crankshaft in the counterbore of the flywheel before tightening the capscrews. The capscrews should be drawn down evenly and tightly before securing the locks.

RING GEAR

The starter pinion of the starting engine engages with the ring gear on the flywheel when starting the Diesel engine.

Before installing the ring gear, carefully clean and remove all burrs from the contact surfaces of the ring gear and flywheel. Heat the ring gear in oil and slip it into position. Install the capscrews and pull them down evenly and tightly before securing the locks.

Cooling System

THE cooling system should be kept clean and free from scale deposits. The use of soft water in the cooling system will reduce the formation of scale deposits. If soft water is not available, clean rain water or hard water treated with water softener should be used. The fan belt tension should be adjusted as recommended in the Operator's Instruction Book.

CLEANING COOLING SYSTEM

If difficulty is experienced in cooling, the oil cooler and radiator should be checked and cleaned of any accumulation of debris between the fins and tubes. Such accumulations decrease the efficiency of the cooling system and may cause the engine to overheat. If enough coolant is boiled out of the system, the cylinder head may be cracked when cold water is added.

Some of these accumulations may be removed from the radiator and oil cooler cores by flushing with water or compressed air from the engine side. It may be necessary eventually to remove the radiator guard and oil cooler to clean out the accumulation effectively.

A further check should be made to see that the cooling efficiency is not being affected by lime or sediment deposits in the radiator and cylinder block. If it is necessary to use hard water in the cooling system, periodic checks should be made for lime deposits in the system, to avoid overheating the engine.

If such deposits are present, the cooling system should be filled with a mixture consisting of five parts of commercial hydrochloric (muriatic) acid, one part of formaldehyde and forty-eight parts of water. Mix the formaldehyde and water, and then add the acid to the solution.

Operate the engine for three hours and then drain the cleaning solution. Thoroughly flush the system and refill with soft water.

WINTER CONDITIONING

The cooling system should be prepared for cold weather operation and a suitable anti-freeze used to prevent damage to the engine. Various anti-freeze mixtures such as ethylene glycol (Prestone, G. M., Permaguard, Zerex, etc.), denatured ethyl alcohol, methanol (synthetic wood or methyl alcohol) and glycerine are all suitable for use.

Because the boiling point of alcohol is low (approximately that of the normal operating temperature of the engine), some of this mixture is being evaporated practically every moment that the engine is running, especially since the cooling system is controlled by a water temperature regulator and held at a relatively high temperature. This loss by evaporation is objectionable *but the regulator should not be removed.* Doing so might make the solution run cooler and save the alcohol, but it would greatly reduce the efficiency of the engine. It is essential, therefore, that the coolant be tested frequently to assure adequate protection.

Other anti-freezes such as salt solutions of calcium chloride, magnesium chloride, sodium silicate, etc., may cause serious corrosion of cooling system metals and for this reason are not recommended. Honey, glucose and sugar solutions likewise are not satisfactory for use as an anti-freeze.

The use of light fluid oils, such as kerosene, saw oil, Diesel fuel, etc. should also be discouraged because their poor heat conducting qualities may cause overheating of the engine under certain conditions. Oil is also destructive to rubber seals and connections in the system.

SERVICING THE COOLING SYSTEM

Before adding anti-freeze, regardless of the type used, the cooling system should be inspected to be sure that it is clean, leak-proof and in proper working order. If cleaning is necessary refer to the topic, CLEANING COOLING SYSTEM.

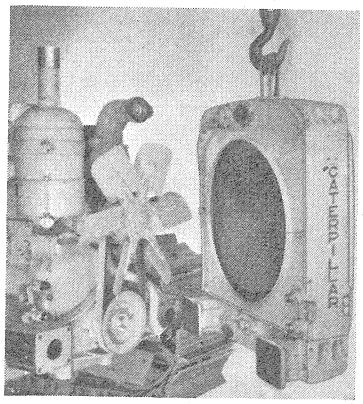
After the anti-freeze is added, the system should be inspected regularly to be sure that no leaks have developed. To avoid overflow loss of solution, care should be exercised to see that the radiator is not overfilled. Make necessary additions only when the cooling system is warmed up to operating temperature so a correct coolant level is indicated.

The cylinder head should be tightened or the gasket replaced to avoid the possibility of the solution leaking into the engine. Anti-freeze or water mixed with engine oil in large quantities will form heavy sludge that may cause lubrication failure, gumming and serious damage to the engine. The water pump should be inspected for leaks and corrections made if necessary. This will not only avoid loss of coolant but also prevent air from being drawn into the cooling system which may cause foaming, rust, overheating and similar difficulties.

Anti-freeze should be used in accordance with the instructions and in the proportions recommended by the anti-freeze manufacturer. It should be tested frequently (especially alcohol) to avoid the possibility of a freeze-up through undetected loss. An inexpensive hydrometer, graduated for testing the kind of anti-freeze in the system, should be used.

Proper sheltering is an aid to cold weather starting, insures longer engine life through immediate oil circulation, and helps to prevent freezing of the cooling system when unexpected temperature "drops" occur.

RADIATOR REMOVAL



Remove the engine hood and side plates. Then, disconnect the oil cooler tubes and the upper and lower water pipe connection to the radiator.

Take out the capscrews that hold the radiator assembly to the radiator support and remove the radiator and oil cooler assembly as shown in the accompanying illustration.

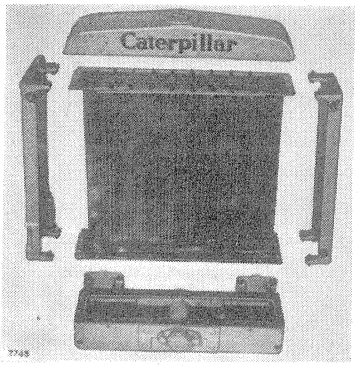
Remove the oil cooler core as recommended under the topic, OIL COOLER.

RADIATOR CORE

If difficulty is experienced in cooling, the radiator core should be cleaned of any accumulation of debris between the fins and tubes. Such accumulations decrease the efficiency of the cooling system and may cause the engine to overheat.

A fine mesh screen covering the front end of the radiator and oil cooler may be necessary in severe conditions. The finer mesh screen is easily cleaned and under extreme conditions, may have to be cleaned several times daily. Such a screen will keep much of the larger material from accumulating on the core where it is not readily accessible for cleaning.

To remove the radiator core, remove the overflow tube, take off the top tank and side plates and remove the capscrews that hold the radiator core to the bottom tank. Remove the radiator core.



Clean the radiator core of all accumulations of debris by flushing with water or compressed air from the engine side. The outer row of tubes on each side of the radiator core carry no coolant and serve only as supports.

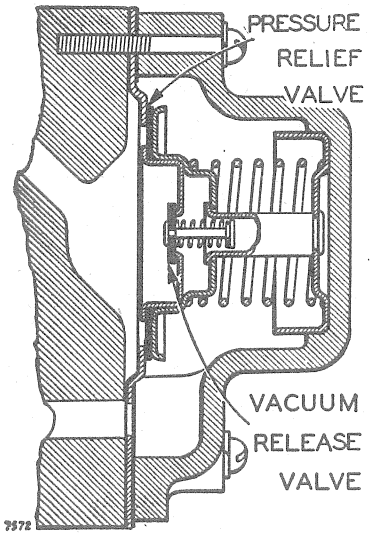
The inside of the radiator core, bottom tank and top tank should be cleaned of any accumulation of sediment with a solution of sal-soda.

Care should be taken, when assembling the radiator, to see that a perfect seal exists between the top and bottom tanks and the radiator core.

Narrow strips are used in front of the radiator core while wide strips are used on the engine side of the radiator core to aid in securing a perfect seal between the core and the top and bottom tanks.

SEALED PRESSURE OVERFLOW

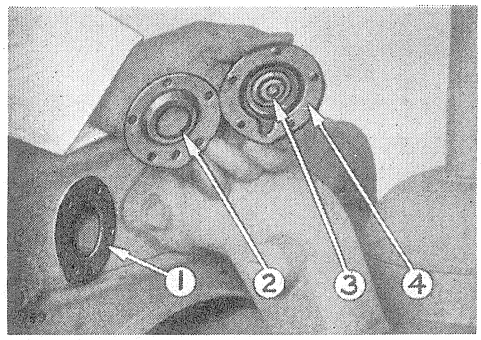
As shown in the accompanying sketch, a sealed pressure overflow assembly is used to prevent the loss of coolant through the radiator overflow tube when the tractor is operating at an angle. Under such operating conditions, coolant will flow down the top tank overflow passage to the seal assembly.



If there is no pressure in the cooling system, the coolant will not escape through the radiator overflow tube.

When a pressure in excess of 6 lbs. per square inch does exist, due to expansion of the coolant by rising temperature, the pressure relief valve will be forced away from its seat and coolant will flow out of the radiator overflow tube. As the pressure decreases, the valve will begin to close, being fully closed when the pressure reaches 6 lbs. per square inch.

When a vacuum of 1 lb. per square inch exists in the cooling system due to contraction of the coolant by a decreasing temperature, the vacuum release valve will open, permitting air to enter the cooling system until the vacuum becomes less than 1 lb. per square inch.



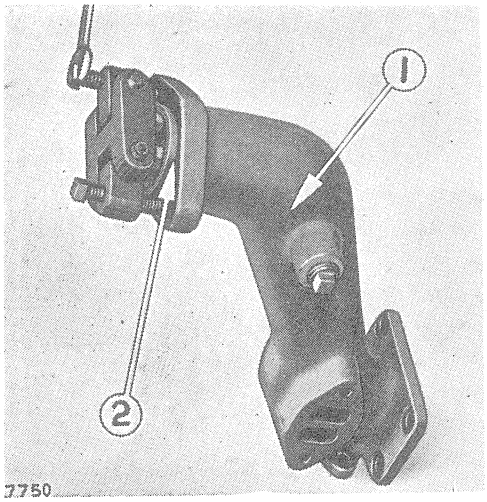
The seal assembly (3) may be removed by taking out the machine screws that hold the housing (4) in place and removing the housing and seal plate (2). The gaskets between the radiator tank (1) and the seal plate, and between the seal plate and the housing should be replaced if leaking. To remove the seal assembly, pry under opposite edges of the pressure relief valve. To install a new seal assembly, place the seal assembly in position in the housing and press down evenly with the thumbs on the seal of the pressure relief valve. The edge of the cup on the end opposite the pressure relief valve should be firmly seated in the recess in the housing.

WATER TEMPERATURE REGULATOR

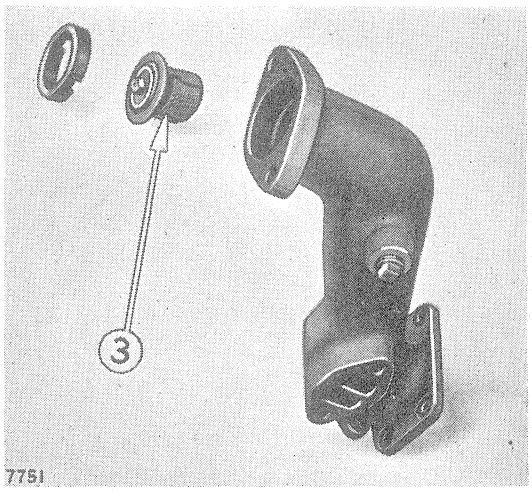
A water temperature regulator is used to restrict the flow of coolant through the radiator until the engine has warmed up. These regulators are so constructed that if the element should be punctured accidentally, they will immediately open to a position of safety.

REMOVAL

Drain the cooling system until the coolant level is below the cylinder head. Remove the heat indicator element from the water outlet pipe (1) and remove the water outlet pipe. The regulator is located in the upper end of the pipe. Use a 3B7184 Regulator Retainer Puller to remove the retainer (2). The hooks of the puller fit in the slots of the retainer. Lift out the regulator (3).



PULLING REGULATOR RETAINER



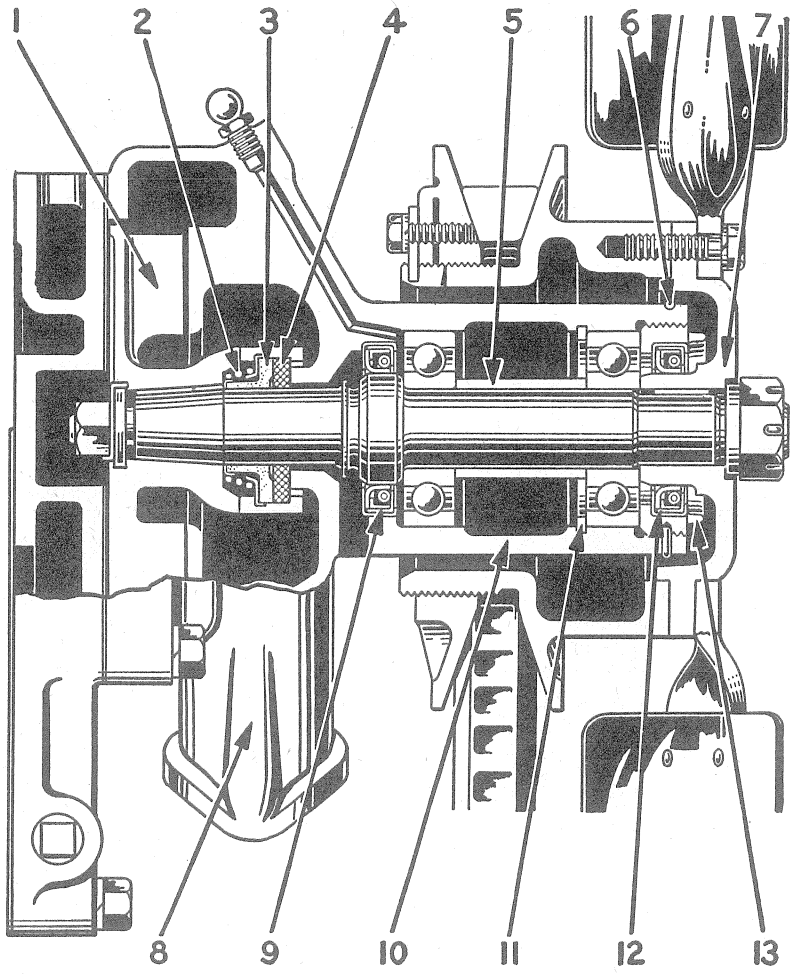
REGULATOR ASSEMBLY

A regulator should be fully open at 180° F. plus or minus 5°. To check a water temperature regulator, suspend it in an open pan of water so the regulator is completely covered. Gradually heat the water until the regulator reaches its "fully opened" position. Use an accurate thermometer to note the temperature. Stir the water to obtain a more accurate check. The regulator is non-adjustable and, if not properly calibrated, should be replaced.

FAN AND WATER PUMP

The fan and water pump impeller are mounted on opposite ends of the same shaft. The shaft is supported by two ball bearings in the water pump housing and is driven by the fan belt.

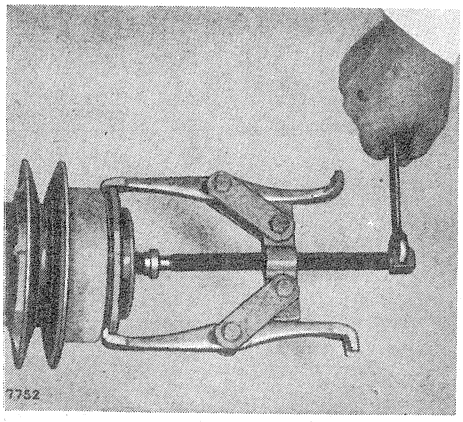
After the radiator is removed as described in the topic, RADIATOR REMOVAL, the fan and water pump may be removed from the front end of the engine as a unit by disconnecting the water pump pipe and removing the capscrews holding the water pump housing to the timing gear housing.



WATER PUMP CROSS SECTION

FAN

With the radiator removed, all parts of the fan may be replaced without removing the water pump housing from the engine.



PULLING FAN HUB

To replace the seal (12), the following procedure is recommended: Loosen the fan belt adjustment. Remove the fan spider and fan blades by taking out the capscrews that pass through the fan hub (7) and into the fan pulley hub (10). After the cotter pin, nut and lock are removed, pull the fan hub (7) using an 8B7546 Puller as shown. Remove the snap ring (6) and screw out the retainer (13).

Clean the fan pulley hub and ring of any accumulations of dirt and grease. Such accumulations act as a grinding compound and cause excessive wear of the fan belt, hub and ring.

When adjusting the fan belt tension, be sure that the flat locks fit into the notches in the ring and hub and that the capscrews are securely tightened.

WATER PUMP

The water pump circulates water through the cooling system. The seal assembly is self-adjusting thus eliminating the necessity for an adjusting nut.

SEAL ASSEMBLY

If water is leaking from the drain opening on the underside of the pump, the seal assembly should be replaced. With the radiator removed, the water pump and fan can be taken off the engine. Removal of the fan will facilitate the disassembly of the water pump.

Pull the impeller (1) with the cross bar and screw from 8B7554 Bearing Cup Pulling Attachment and two ¼"—20 capscrews 3½" long (3B1798). Remove the key, coat the pump shaft with soap and then remove the spring (2), seal (3) and washer (4).

The new seal assembly can be installed in the reverse order of disassembly. Check to see that the spring (2) is installed with the smaller end toward the impeller (1).

Slip the impeller onto the shaft and in mesh with the lugs of the carbon washer. Observe through the pump inlet port (8) the proper mesh of the impeller and washer. Then rotate the impeller on the shaft until the keyways line up and insert the straight key.

BEARING AND SHAFT ASSEMBLY

Before removing the bearing and shaft assembly, the impeller and seal assembly should be removed as previously recommended. Then, remove the nut from the front end of the shaft and the capscrews that hold the fan spider to the hub (7). Remove the fan spider assembly and pull the hub with an 8B7546 Puller.

Remove the lock ring (6) and then the retainer (13).

Press the shaft forward until the front bearing protrudes from the bearing housing. The bearing can be pulled with an 8B7547 Puller.

Remove the retainer ring (11). The spacer (5) and rear bearing can be removed with the shaft from the front of the pump body assembly.

Before reassembling any of the parts, the seals (9 and 12) should be inspected and replaced if necessary. It should be noted that each seal is installed with the wiping edge toward the fan spider assembly.

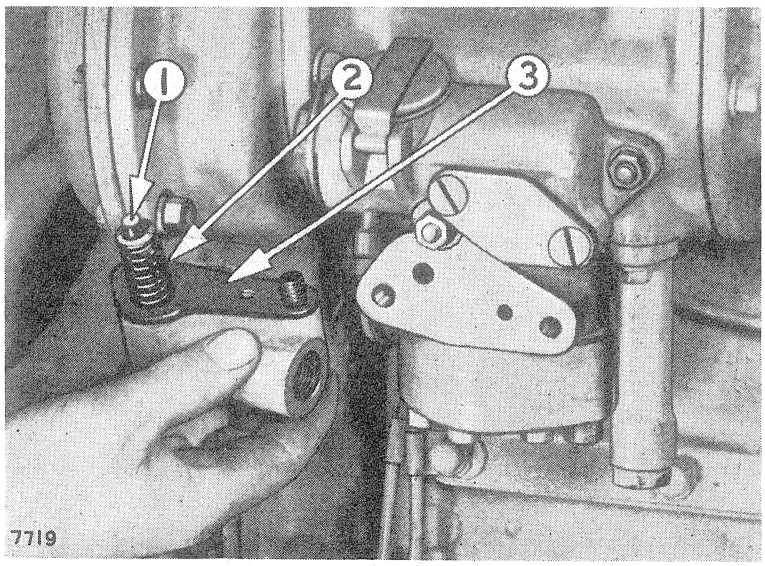
Fuel System

MAXIMUM efficiency of the fuel system can be expected only when clean fuel is used. Dirty fuel, caused by careless handling or improper storage facilities, will cause wear to the fuel transfer pump and fuel injection equipment and eventually result in improper operation of the Diesel engine.

It is important to clean the fuel tank and fuel lines when new fuel injection equipment is installed. This will prevent former dirt and sediment accumulations from damaging the newly installed equipment.

FUEL TRANSFER PUMP

The fuel transfer pump is directly under the fuel filter housing and is driven by the accessory shaft. This pump is self-priming. An adapter (3) is mounted on the side of the transfer pump and contains a plunger



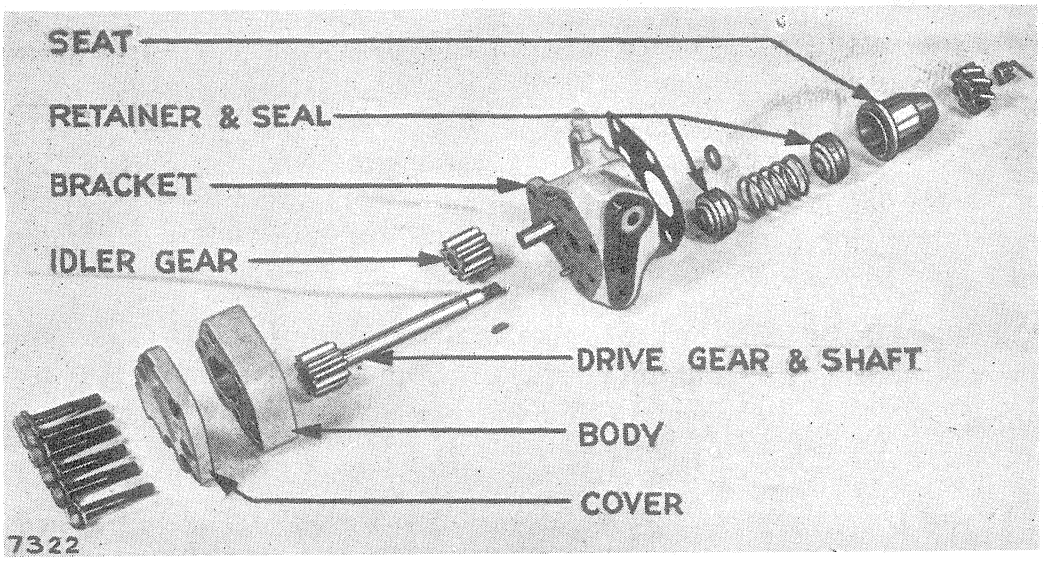
TRANSFER PUMP ADAPTER

(1) and spring (2) which regulates the fuel pressure to the fuel filters and fuel injection pumps. The plunger opens when the fuel injection pumps do not use all the fuel or when the fuel filters become clogged. The spring pressure is such that the excess fuel is by-passed within the pump and adapter, thus preventing excessive pressure that might cause damage to the fuel filter housing or fuel filter pressure gauge mechanism.

The plunger may fail to function properly if dirt gets between the seat and the plunger. This may cause the fuel filter pressure gauge needle to show low fuel pressure or a wide variation in pressure between low idle and high idle speed. After cleaning the contact surfaces, check to see that the seat is smooth and flat, and that the sealing surface of the plunger is in good condition. If this plunger is functioning properly the gauge needle should vary only slightly.

The transfer pump and adapter may be removed as a unit or either the adapter or the cover, body and one gear may be removed without taking out the entire unit.

Wear in the pump gears is caused by dirty fuel. A worn pump may be made serviceable by installing new gears if the bracket and cover are not worn. The clearances are small between the moving and stationary parts of the pump, and for this reason ground joints instead of gaskets are used between the body and the cover, and the body and the bracket.



FUEL TRANSFER PUMP

FUEL PUMP SHAFT SEALS

The fuel transfer pump shaft seals keep fuel and lubricant from leaking along the shaft.

The seat assembly can be removed and the seals replaced after the gear is pulled from the end of the shaft. The spring between the two seal assemblies makes the seals self-adjusting. Should fuel leak past the seals, the pump should be dismantled and the seals replaced.

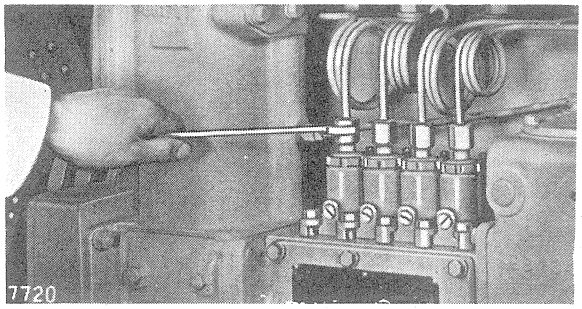
FUEL INJECTION EQUIPMENT

The most likely causes for faulty fuel injection are: insufficient fuel transfer pump pressure, low fuel supply, clogged fuel filters, water in the fuel or air in the fuel system. If these conditions are checked and corrected and the engine still does not operate as it should, it is well to check the fuel injection equipment.

CHECKING FUEL INJECTION EQUIPMENT

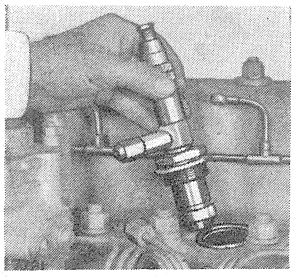
Before removing a fuel injection valve or pump from an engine that is operating irregularly, a simple check may be made to determine which cylinder is not firing properly.

With the engine running at a speed that makes the irregularity most pronounced, momentarily loosen the fuel line nut just above the fuel pump sufficiently to "cut-out" the cylinder. Check each cylinder in the same manner. If one is found where loosening the nut makes no difference in the operation of the engine, probably the valve and pump for that cylinder *only* need be tested.



LOOSENING FUEL LINE NUT

The function of the fuel injection valves is to properly inject and atomize the fuel from the fuel injection pumps into the pre-combustion chambers of the engine cylinders.



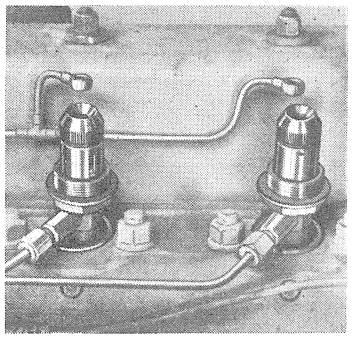
REMOVING VALVE

The function of the fuel injection pumps is to measure or meter the fuel to be injected, to produce the necessary fuel pressure for injection into the particular cylinder and to properly time such injection.

Irregular engine operation and smoking may be caused by an improperly operating injection valve. Hard starting and irregular operation may be the result of an injection pump not supplying sufficient fuel.

TESTING A FUEL INJECTION VALVE

Before removing a fuel injection valve, clean all dust and dirt from the valve and adjacent areas; then disconnect the fuel injection line



TESTING FUEL INJECTION VALVES

and fuel drain line and remove the hold-down nut that keeps the valve in place. Turn the valve in a horizontal position if possible or upside down, and connect the fuel line again.

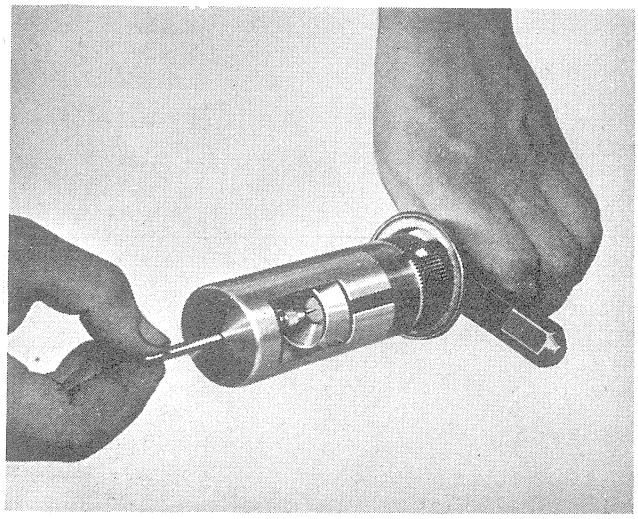
Before testing the valve, loosen the line nut above each pump not being tested to prevent fuel being injected into the cylinders.

Start the starting engine, and with the Diesel engine compression release lever in the START position, engage the starter pinion and clutch. If the starting engine is operated slightly above its low idle speed, the Diesel engine will be turned sufficiently fast to insure an accurate check on the spray characteristics of the injection valve.

With the starting engine cranking the Diesel engine, open the Diesel engine throttle wide and notice the fuel spray that comes from the injection valve. If the injection valve emits a fine, even spray in the form of a mist, it indicates that the injection valve is in good condition.

If the spray characteristics of an injection valve do not come up to standard, the fuel discharge hole in the nozzle end should be cleaned. This may be done with a 5B1401 Cleaning Tool as illustrated.

The fuel discharge hole in the nozzle end will not clog completely with carbon accumulations, but may under some conditions collect a small amount of carbon on the inner diameter of the fuel discharge opening. If a slightly greater amount of carbon forms on one side of the opening than on the other, the spray will have a tendency to shoot off to one side.



CLEANING FUEL DISCHARGE HOLE

Often, cleaning of the fuel discharge opening in the fuel injection valve nozzle end is all that is necessary to make a valve operate the way it should.

If after cleaning, the valve shows the following spray characteristics it should be replaced:

1. Fuel discharged in a solid stream or jet.

2. Fuel spray emitted on one side of the nozzle.

A valve should not be rejected, however, unless it fails to spray properly when the starting engine is operated at full governed speed. This speed is only about half the slowest speed at which the Diesel engine is required to run.

NOTE: *Always keep in mind that the quality of the spray is determined by the condition of the injection valve, while the quantity of the spray in a properly operating valve is determined by the condition of the injection pump.*

When installing injection valves, the hold-down nut should be drawn down only tight enough to prevent leaks between the valve and valve seat. Excessive tightening will cause distortion of the injection valve.

FUEL INJECTION PUMPS

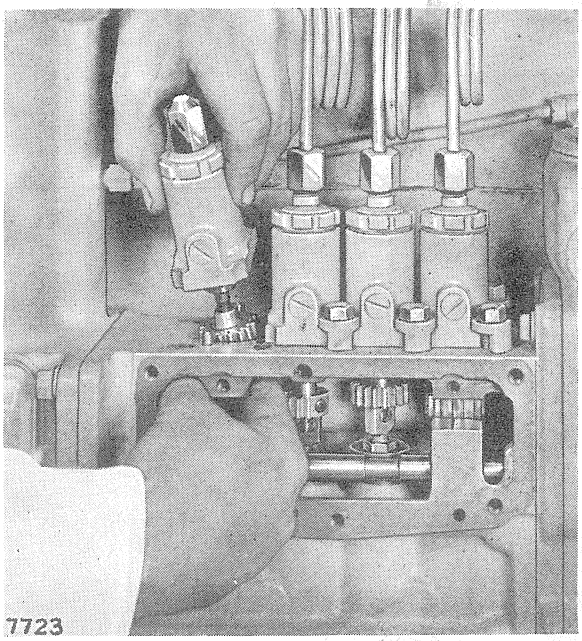
The indication of a worn fuel pump is an insufficient quantity of spray emitted by the fuel valve when tested with the starting engine operating at full governed speed as outlined in the preceding topic, TESTING A FUEL INJECTION VALVE.

Ordinarily, if one injection pump on an engine is not supplying sufficient fuel, it will be found that all of the injection pumps are worn and need replacing.

Failure to replace all of the worn injection pumps may result in an erratically and irregularly operating engine.

PUMP REMOVAL

Due to the small clearance between the plunger and barrel of each individual pump, a plunger should not be changed from one pump to another. To do so will affect the efficiency of the pump and thus cause unsatisfactory engine operation.



REMOVING FUEL INJECTION PUMP

After cleaning the top of the housing and around the inspection plate, disconnect the fuel injection lines from the pumps and immediately cap the openings with covers. Remove the inspection plate and then the coupling that fastens the rack to the slide bar. Remove the capscrews and retaining plates that hold the rack in place and pull the rack out of the housing.

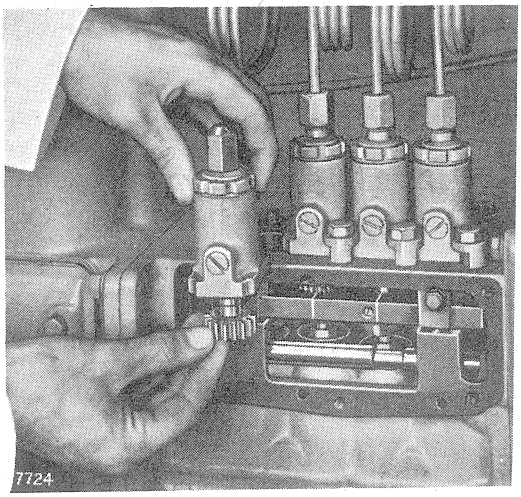
Remove the capscrews and clamps that hold the pump to the housing and lift the pump straight up only enough to clear the dowel pins. Reach through the inspection opening to prevent the plunger from dropping out of the pump. Shift the pump to free the end of the pump plunger from the slot in the pump lifter and remove the pump and plunger assembly from the housing. Always cap the fuel outlet on the top of the housing with a rubber nipple to keep out dirt.

PUMP INSTALLATION

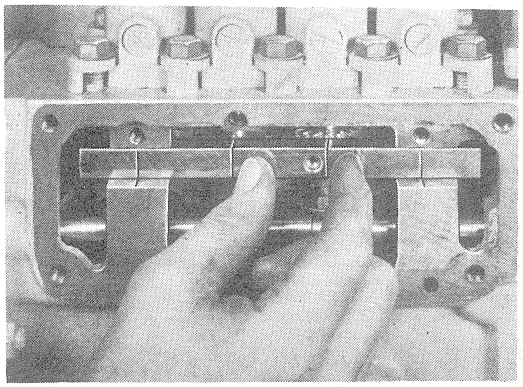
Remove the rubber nipple from the fuel outlet on the top of the housing and lower the pump assembly into the housing, taking care that the pump plunger does not slide out of the pump. Slide the end of the plunger into the slot in the pump lifter and lower the pump body onto the dowel pins. Always check to see that the pump plunger is free by rotating the gear segment on the end of the plunger with the finger. Then fasten the pump in place.

If the pump plunger does accidentally fall out, wash the plunger thoroughly with clean Diesel fuel, and then replace it in the pump barrel.

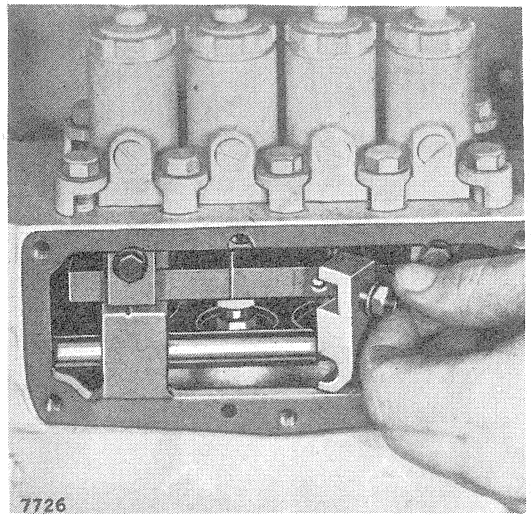
1 Turn the gears on the pump plungers until the marked tooth of each gear faces toward the pump rack. The end pumps can be aligned with the marks on the fuel injection pump housing.



2 The top side of the rack is indicated by the half moon marks adjacent to the teeth of the rack. Engage the marked tooth on the pump rack with the marked tooth of the plunger gear segment. The other pumps can be aligned as the rack is slid into position.



3 Install the capscrews and rack retaining plates. Open the throttle and fasten the coupling in place. Replace the inspection cover and connect the fuel lines. Then prime the fuel system as recommended in the Operator's Instruction Book.



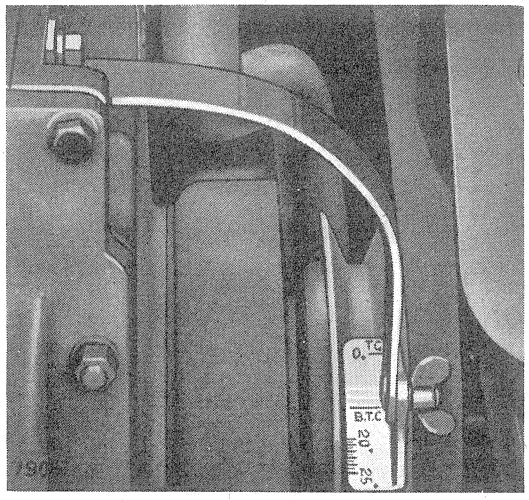
FUEL INJECTION PUMP LIFTER ADJUSTMENT

Ordinarily, adjustment is required only if the pump lifter assembly is taken apart. On machines that have seen considerable service, it may be advisable to check the adjustment at the time of engine reconditioning and, if necessary, to correct the adjustment to compensate for wear that may have occurred in the pump lifter assembly.

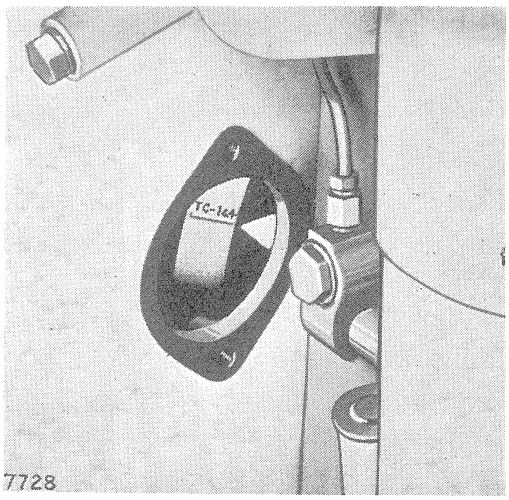
The following tools are required for making the pump lifter adjustments:

1—4B6059 Gauge Assembly
1—4B7617 Lifter Screw Wrench
1—4B7618 Lock Nut Wrench
1—1F7313 Indicator
1—1F7312 Bracket
1—3B723 Wing Nut
1—4B4277 Washer

Remove the fan belt. Install the 1F7313 Indicator on the timing gear housing so the indicator arc lines up with the arc of the crankshaft pulley.

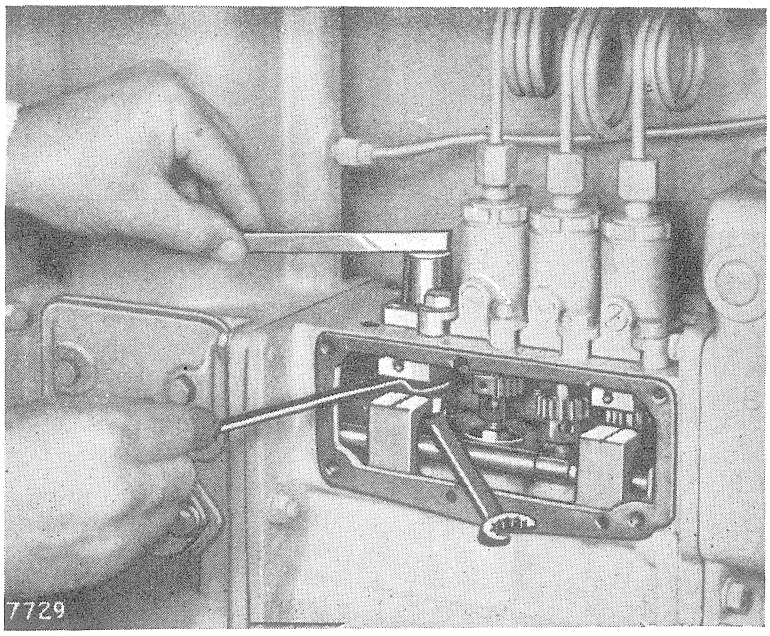


TIMING INDICATOR



FLYWHEEL TIMING MARKS

Remove the cover from the side of the fuel injection pump housing and then the coupling, rack and fuel injection pump. Place the 4B7617 Lifter Screw Wrench over the pump lifter yoke and install the 4B6059 Gauge Assembly as shown.



SETTING LIFTER ADJUSTMENT

Place the compression release lever in the START position and turn the Diesel engine crankshaft with the hand crank until the lifter to be checked begins to rise.

Continue to turn the crankshaft until the piston corresponding to the lifter to be checked is coming up on the compression stroke. The T.C. (top center) mark on the flywheel for the lifter to be checked should be lined up with the pointer on the flywheel bell housing. Fuel injection pumps are numbered consecutively from the timing gear end of the engine.

Place a mark on the crankshaft pulley circumference directly opposite the 0° or T.C. mark on the indicator arc. Turn the crankshaft back approximately 60° and then forward until the mark previously made on the crankshaft pulley returns to the 25° mark on the indicator arc. Place a straight edge across the top of the gauge. If the fuel pump lifter is set correctly, the top of the plunger will be flush with the top of the gauge.

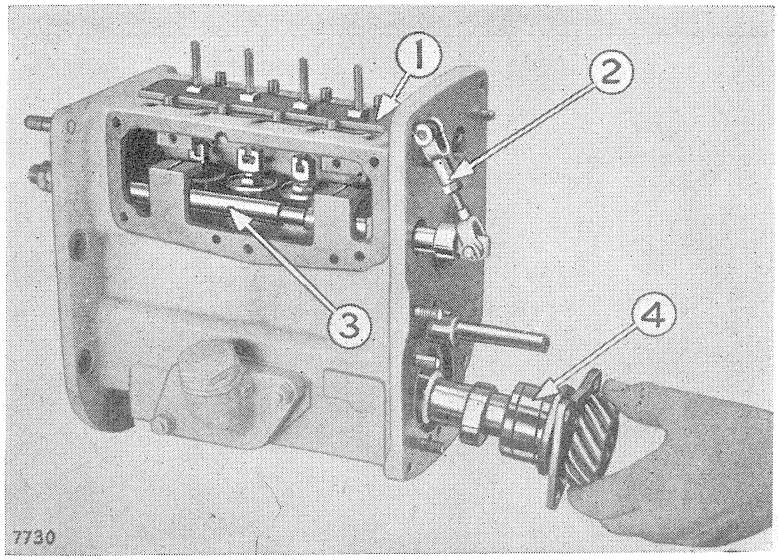
If the variation is greater than .002", loosen the lifter lock nut with the lock nut wrench and reset the pump lifter adjustment using the 4B7617 Lifter Screw Wrench. Recheck the lifter setting with the straight edge after the adjustment has been made and the lock nut tightened to be sure that the setting has not been changed.

Remove the gauge before turning the crankshaft to the proper position for the next pump lifter to be checked.

Checking each pump lifter will insure proper fuel injection timing.

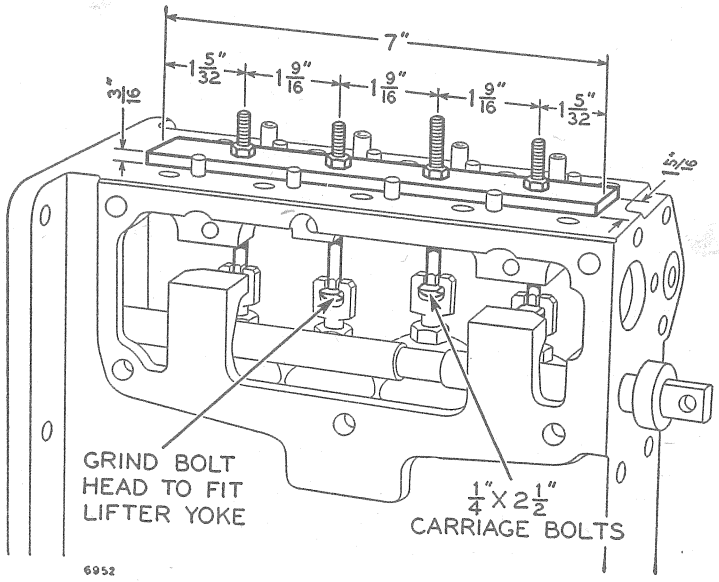
FUEL INJECTION PUMP LIFTER SPRINGS

In the event a lifter spring is broken, it can be replaced after the fuel injection pump housing has been removed from the engine.



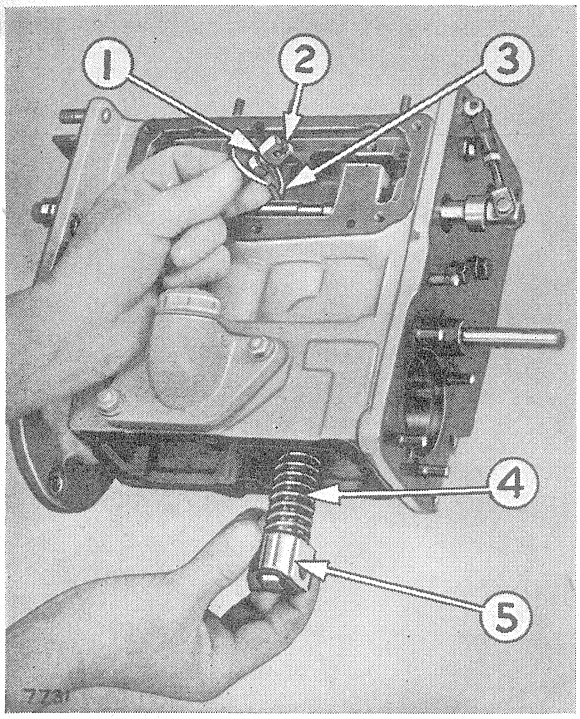
REMOVING PUMP CAMSHAFT

Drain the oil from the fuel injection pump housing and remove the covers from the side and the bottom of the housing. Disconnect the fuel injection lines and remove the injection pumps. Remove the rear cover from the governor, disconnect the connecting rod (2) from the governor lever and remove the governor from the rear of the fuel injection pump housing. Remove the coupling between the slide bar (3) and rack and then remove the rack. With a plate (1) constructed as shown, having holes spaced to correspond with the center-to-center



distance of the pumps, hold up the pump lifter assemblies with carriage bolts, or wire the lifters in position.

Remove the nuts and locks which hold the thrust plate of the fuel injection pump camshaft in position. Slide out the camshaft (4) as shown.

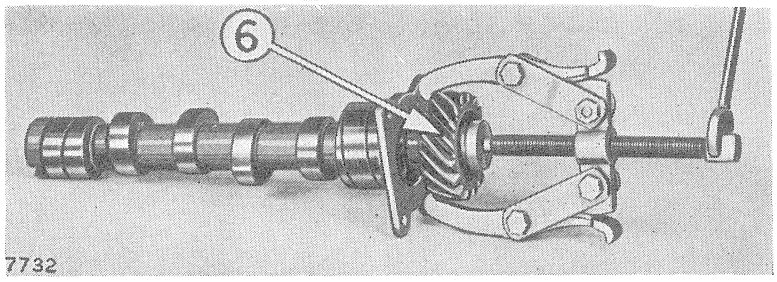


REMOVING LIFTER ASSEMBLY

Remove the yoke (2), lock nut (1) and oil trough (3) from the top of the housing and the spring (4) and lifter (5) from the bottom of the housing. The lifter spring can then be installed and the unit reassembled in the housing.

The gear (6) may be pulled with an 8B7547 Puller after the nut and lock have been removed. The thrust plate and washer may now be slipped off the shaft. If the end play of the camshaft exceeds .035", the thrust washer and thrust plate should be replaced. Be sure to install the chamfered edge of the thrust washer against the camshaft.

After the fuel injection pump housing has been reassembled to the engine, the pump lifters can be adjusted as described previously.



PULLING PUMP CAMSHAFT GEAR

Governor

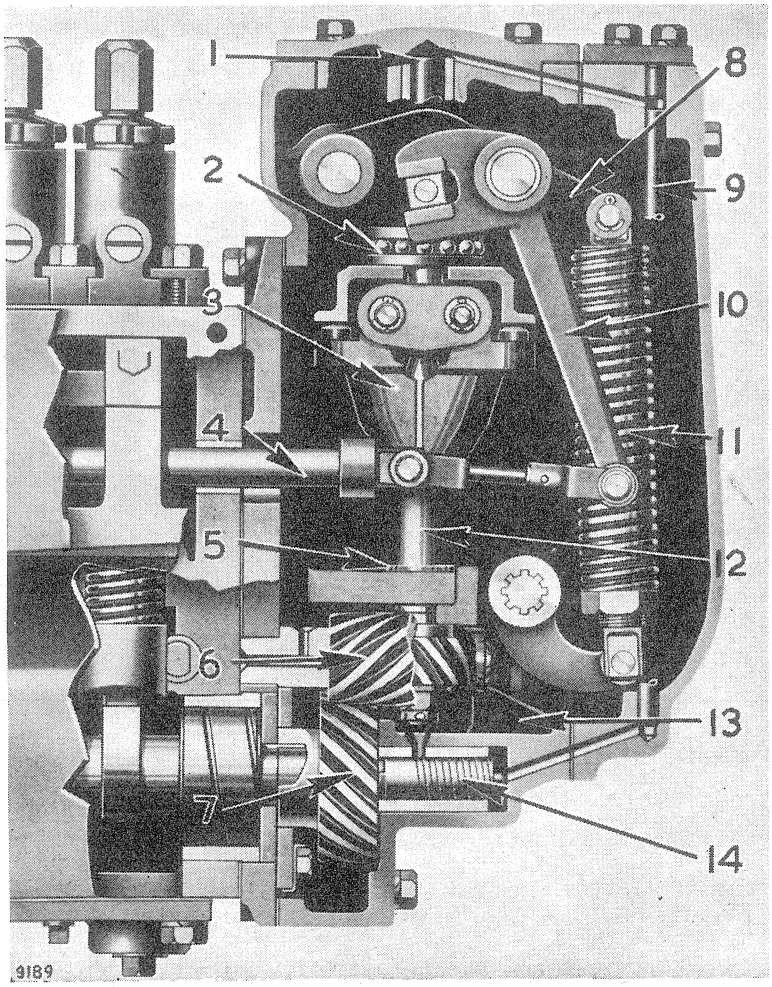
OPERATION

THE vertically mounted governor shaft (12) is driven from the rear end of the fuel injection pump camshaft through gears (7 and 6).

The forces of the governor weights (3) and governor spring (11) act upon the slide bar (4) to govern the speed of the engine in accordance with the tension placed on the governor spring by the setting of the hand throttle control. As the governor weights vary in position with the speed of the engine, their vertical travel is transmitted through the thrust bearing (2) and levers (8 and 10) to the fuel injection pump slide bar (4).

LUBRICATION

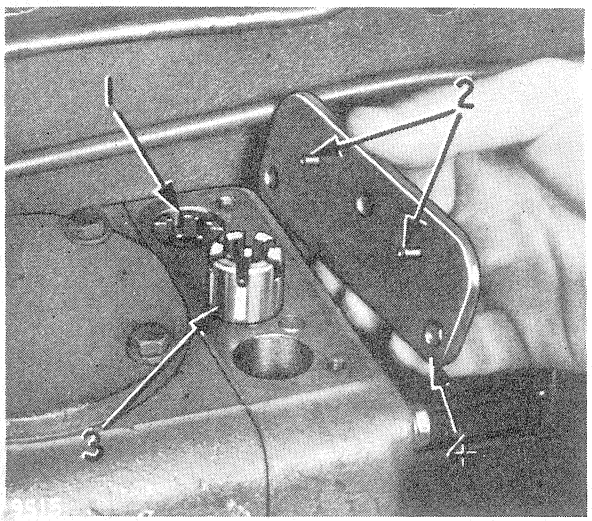
Oil from the fuel injection pump housing flows into the governor housing where it is picked up by the gears (7 and 6) and transferred into the reservoir (13). The oil then flows into the screw-type pump (14) which forces it through drilled passages and the tube (9) into the upper bearing (1). From the upper bearing, the oil passes through the drilled governor shaft (12) to the thrust bearing (2) and governor weights (3). Oil spray thrown off the governor weights and shaft lubricates the lower bearing (5).



GOVERNOR CROSS SECTION

ADJUSTMENTS

Engine R.P.M. can be checked at the tachometer drive connection on the hour meter after removing the cover. The shaft turns at one half engine speed.

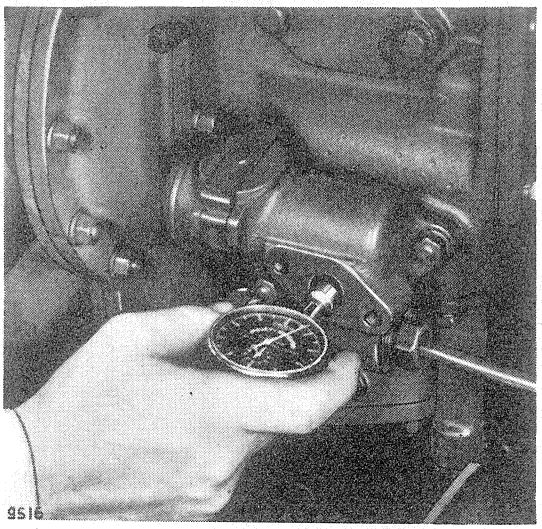


GOVERNOR ADJUSTMENTS

The low idle and full load engine speeds can be adjusted by removing the cover (4) from the top of the governor and turning the adjusting sockets (1 and 3). The socket (1), nearest the engine adjusts the low idle speed and the socket (3) adjusts the full load speed. The adjustment can be made by using a screwdriver or the socket may be removed as shown and a socket wrench used in place of the socket. The dowels (2) in the cover fit into the slots in the sockets to prevent them from turning after the adjustment is made.

LOW IDLE SPEED ADJUSTMENT

Remove the cover and turn the socket (1) clockwise to decrease the low idle speed or counter clockwise to increase the speed. Push the throttle control lever forward and check the speed at the tachometer drive connection on the hour meter. Adjust the low idle speed to 550 R.P.M., or 225 R.P.M. at the tachometer drive connection.



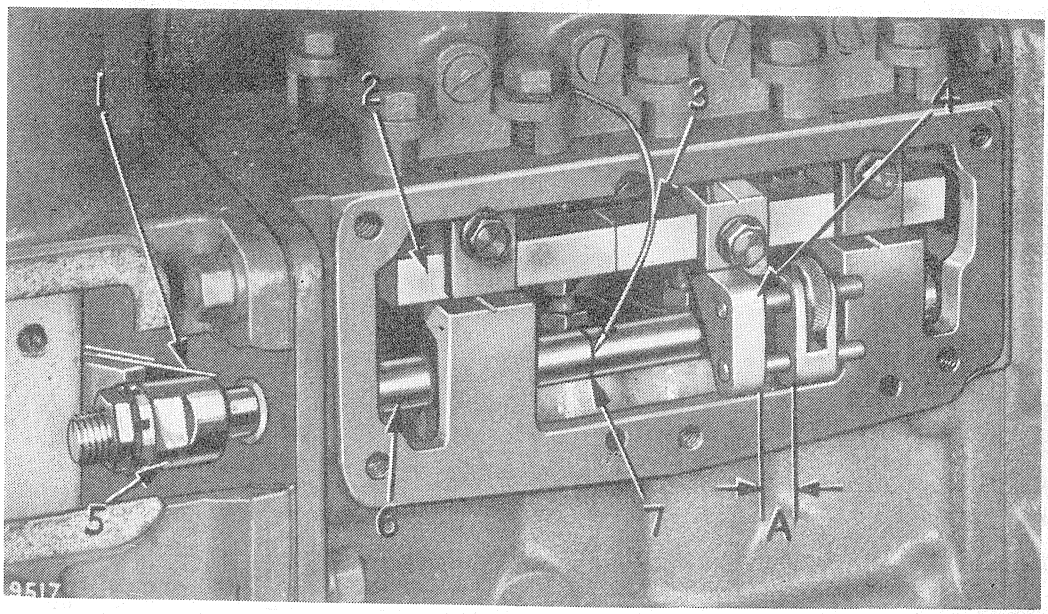
CHECKING ENGINE SPEED

FULL LOAD SPEED ADJUSTMENT

Pull the throttle control lever all the way back and check the engine speed which should be 1550 R.P.M. Turn the full load speed adjusting socket clockwise to decrease the speed or counter clockwise to increase the speed. Push the throttle control lever forward, then pull it back and

recheck the engine speed after each adjustment. A high idle speed of 1550 R.P.M. will result in a full load speed of approximately 1400 R.P.M.

To adjust the full load speed more accurately, the 9B2532 Governor Setting Fixture should be used. By using this fixture the engine speed, while still controlled by the governor, is made independent of the normal position of the fuel pump slide bar. In this way the full load speed can be adjusted accurately without loading the engine.

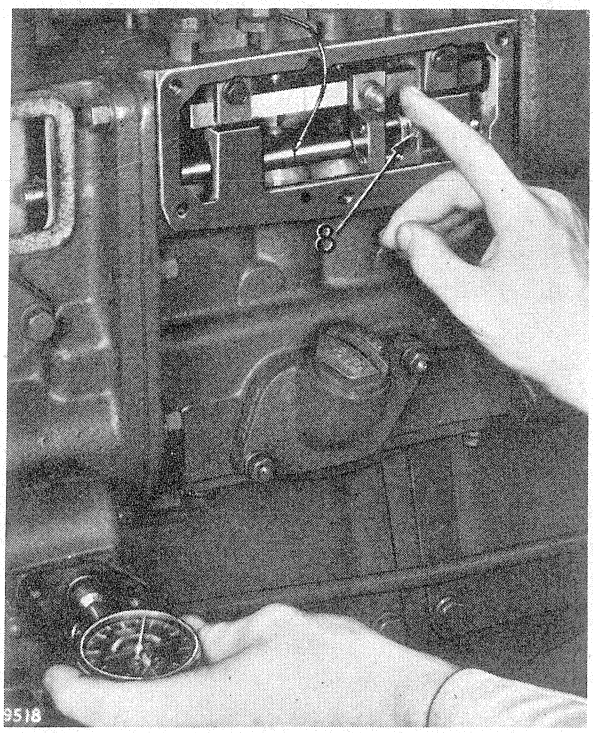


GOVERNOR SETTING FIXTURE

Remove the coupling between the fuel injection pump slide bar (6) and the fuel injection pump rack (2). Place the rack adjusting bracket (4) between the rack and the slide bar, making sure the bracket fits down into the relief for the coupling on the slide bar. The rack adjusting bracket makes it possible to vary the speed of the engine independently of the hand throttle by rotating the knurled nut to change the position of the rack relative to the slide bar. Rotating the nut to close the gap (A) will increase the speed of the engine while widening the gap will decrease the speed.

The slide bar stop nut (5) just contacts but does not compress the torque spring (1) when the engine is operated at full load. Since it is rather inconvenient to observe the stop nut while the engine is running, it is advisable to attach a pointer (3) as shown to check the position of the slide bar. Before starting the engine, move the slide bar to where the stop nut (5) just touches the torque spring (1) and make a sharp mark (7) on the slide bar exactly at the end of the pointer (3).

With the gap of the adjusting bracket set at its widest position, start the Diesel engine and pull the hand throttle all the way back. Increase the engine speed by turning the knurled nut (8) until the pointer coincides with the mark on the slide bar and check the engine speed. If the speed is above or below 1400 R.P.M., turn the adjusting socket, reset the hand throttle, adjust the knurled nut until the pointer coincides with the mark on the slide bar, and recheck the speed. The governor is properly adjusted when the engine speed is 1400 R.P.M. This insures the maximum horsepower output of the engine at 1400 R.P.M. although the high idle speed may be above or below 1550 R.P.M.



CHECKING FULL LOAD SPEED

SERVICE

The governor may be removed as a unit or it may be inspected and most parts replaced without removing it from the engine.

REMOVAL

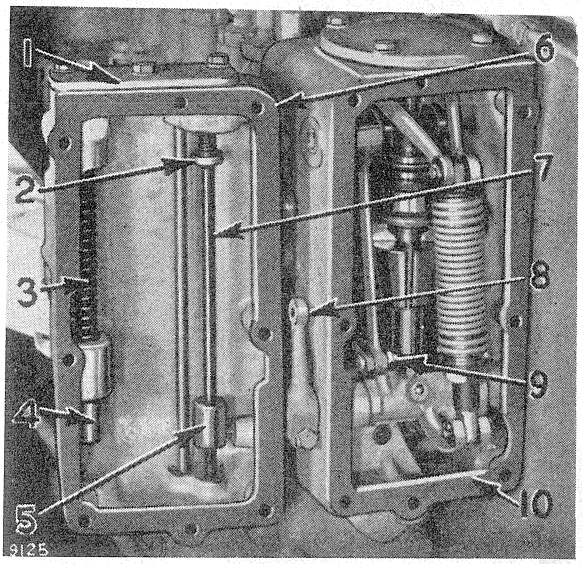
Before removing the governor, drain the lubricating oil from the fuel injection pump housing. Remove the rear cover (6), and disconnect the clevis (9) from the crank and the control rod from the lever (8). Take out the capscrews holding the governor housing (10) to the fuel injection pump housing and remove the governor. The oil pump screw and the idler gear which drives the governor shaft may now be removed. These parts are discussed later in the topic, DISASSEMBLY.

DISASSEMBLY

The following disassembly procedure can be followed with the governor mounted on the engine. However, for better illustration, the governor is shown removed.

SPEED ADJUSTING SCREWS

Remove the plate (1) from the cover (6). Turn the low idle adjusting screw (counter-clockwise) out of the stop (4) and remove the screw and spring (3) from the cover.



Lift up the washer (2) and remove the pin through the full load speed adjusting screw (7). The screw can then be turned (counter-clockwise) out of the stop (5) and removed from the cover.

Assemble the screws in the reverse order of disassembly and refer to the topics, FULL LOAD SPEED ADJUSTMENT and LOW IDLE SPEED ADJUSTMENT for information on setting the screws.

LINKAGE

Take out the pin and separate the crank (14) from the clevis (9). The clevis is screwed on the end of a rod and pinned in place so the overall length of the rod will not be changed.

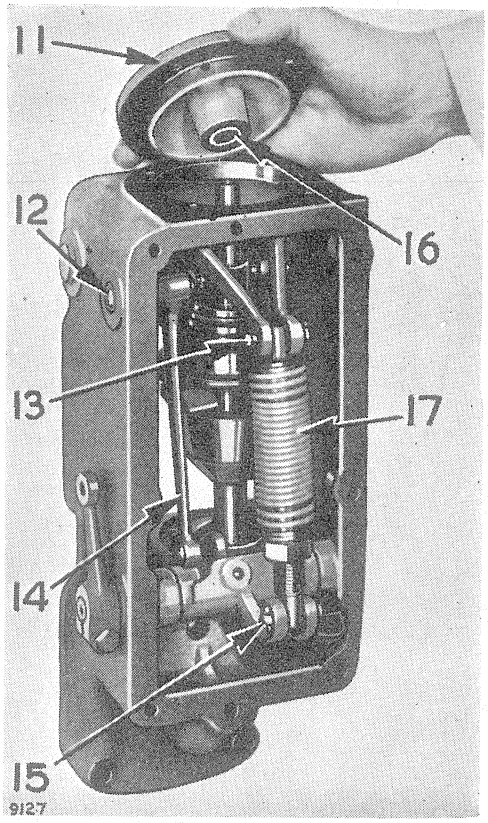
When the clevis and crank are reconnected, check to see that there is no binding as this will affect the operation of the governor.

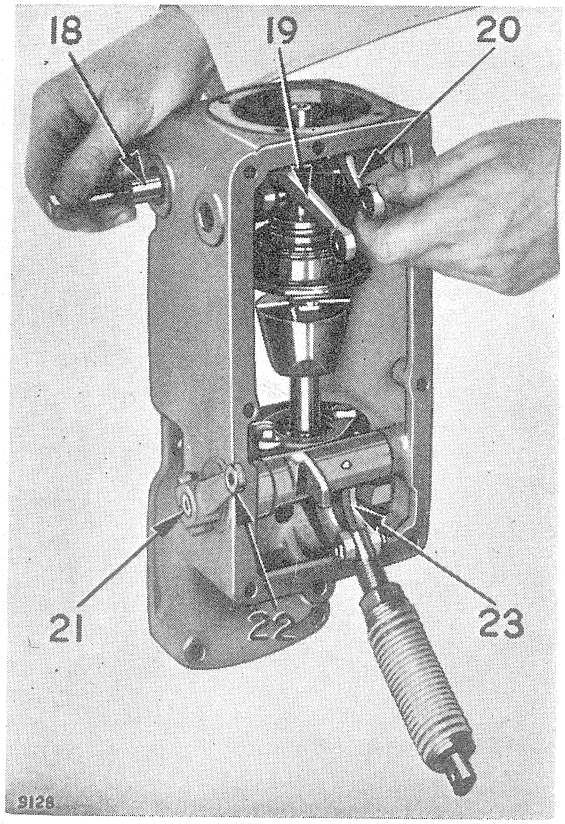
UPPER BEARING

Take out the capscrews which hold the cover (11) to the housing and remove the cover. The bushing (16) should be replaced if the clearance between it and the shaft exceeds .010". Cut the bushing to facilitate removal. Press in the new bushing.

GOVERNOR SPRING

Remove the pin (13) and swing the spring assembly (17) downward about the lower pin (15). Or, take out the lower pin as well and remove the spring assembly. Do not change the overall length of the spring





assembly by screwing the plugs into or out of either end. Any change in the overall length of the spring assembly will change the relation of the full load and high idle speeds and may affect the stability. The spring is serviced only as a calibrated assembly which includes both connections to the spring.

CRANKS AND LEVERS

Pull the shaft (12) and remove the crank (14). The end of the shaft is drilled and tapped for a $\frac{5}{16}$"—18 capscrew to assist in removal. Press the needle bearing out of the crank if it is worn or damaged and install a new bearing. Examine the shaft for wear or roughness and replace it if necessary.

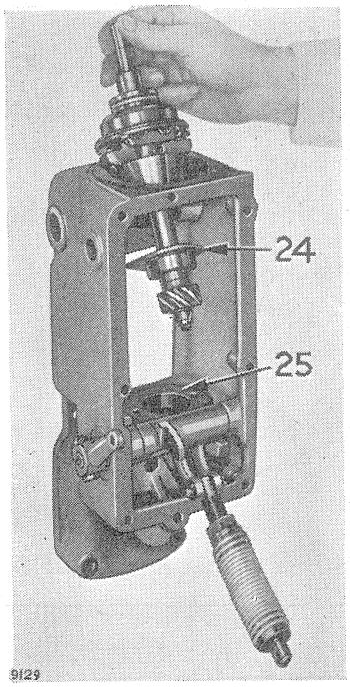
Remove the plug over the end of the shaft (18) and pull the shaft with a $\frac{5}{16}$"—18 capscrew as shown. Take out the levers (19 and 20). Press the needle bearings out of the bore from which the shaft (18) was removed. If the bearings or shaft are worn or damaged, new parts should be installed. The rollers on the levers (19 and 20) may be replaced if necessary. Remove them by taking out the cotterpins and pressing out the pins which attach them to the levers. The block on the lever (19) is mounted on the same pin which passes through the roller. Replace the block if it is worn.

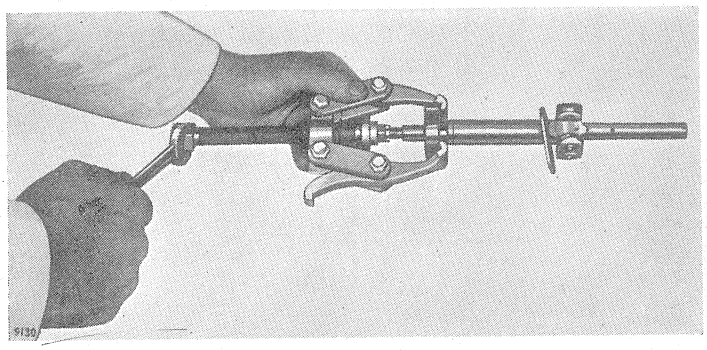
Loosen the clamping bolt and pull the lever (22) off the shaft. Remove the key. The seal can be removed after pressing out the shaft. The governor housing must be removed from the engine in order to press out the shaft. Drive out the taper pin which locates the lever (23) on the shaft. Press on the end of the shaft at (21) to remove the plug at the opposite end. The shaft and lever (23) may then be removed from the housing.

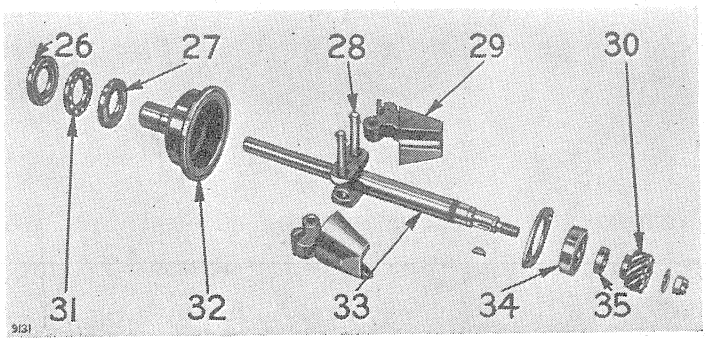
When reinstalling the shaft and lever, be sure the holes for the taper pin will line up. If a new shaft and lever are installed, it is necessary to ream the hole through both parts before installing the taper pin. Install a new plug in the bore at the end of the shaft and install the seal with the wiping edge toward the inside of the housing.

GOVERNOR SHAFT GROUP

Unlock and remove the capscrews which secure the retainer plate (24) to the housing at (25). The governor shaft group can then be taken out of the housing as shown.





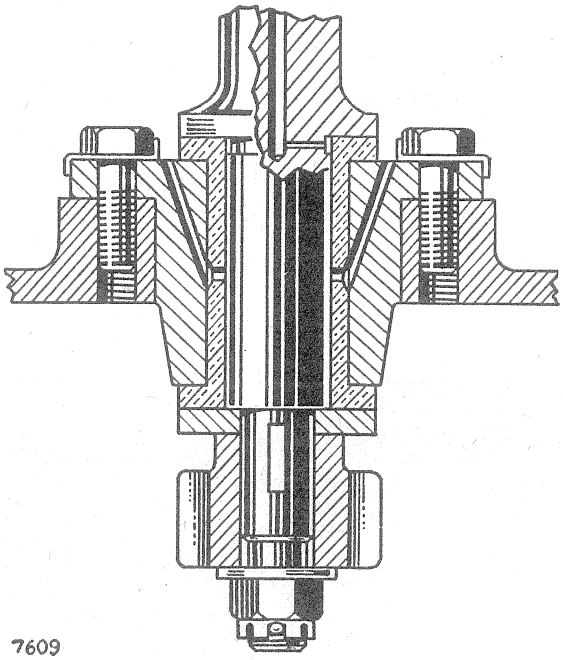


Slide the race (26) and bearing (31) off the retainer assembly (32), and the retainer assembly off the shaft (33). Remove the race (27) from the retainer assembly by installing the 8B7551 Attachment and pressing the retainer through the race. The bushing should be pressed out of the retainer and a new one pressed in if the clearance exceeds .010".

Remove the governor balls (29) from the shaft by pressing out the pins (28). The pins fit tightly in the balls and care should be taken not to bend the shaft when pressing them out.

Remove the cotter pin, nut and washer from the end of the shaft and pull the gear (30) using the 8B7547 Puller.

CAUTION: *When pulling the gear, it is advisable to install a nut flush with the end of the shaft. This will prevent the force of the puller screw from spreading the end of the shaft.*



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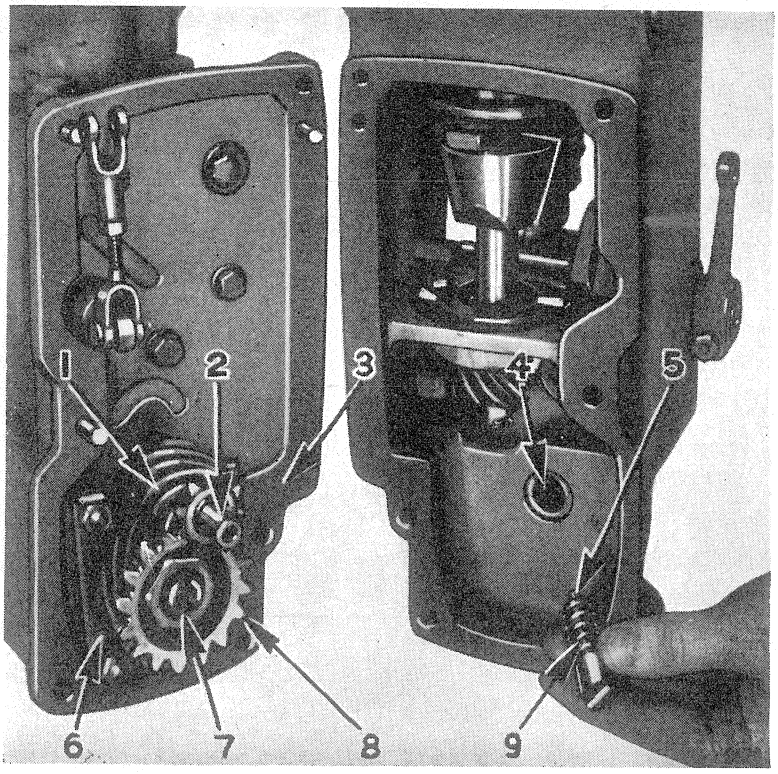
LOWER BEARING

Slide off the spacer (35) and pull the bearing (34) in the same manner as the gear was pulled. NOTE: Tractors built prior to 7J8687 had a bearing assembly with two bronze bushings in place of the ball bearing. Procedure for disassembling the governor remains the same. Replace the bushings if they are worn more than .010".

OIL PUMP

Remove the governor housing as described previously for access to the oil pump. Slide the oil pump screw (9) out of the housing. Normal clearance between the screw and bushing (4) is .004" to .0055". If the clearance exceeds .007", the screw or bushing should be replaced depending upon which is worn. Cut the bushing to facilitate removal. Press the new bushing in flush with the housing, making sure the oil hole in the bushing and in the housing are in alignment. Make sure the plunger (5) and the spring back of it are in place when the screw is installed in the housing.



DRIVING GEAR AND IDLER

Remove the governor housing from the engine as described previously. The idler gear (1) may then be slipped off the shaft (2). If the clearance exceeds .010", replace the shaft or the bushing in the gear. The shaft can be pressed out of the plate (3) after removing the plate from the fuel injection pump housing.

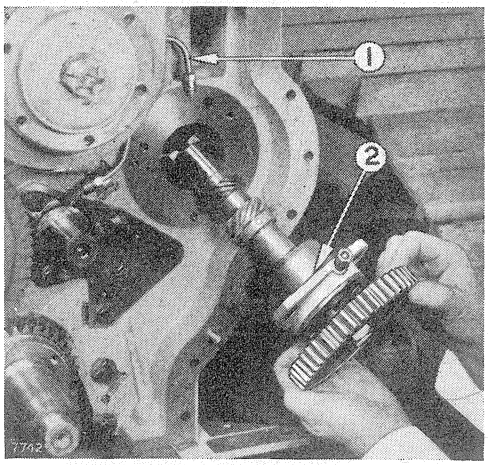
Unlock and remove the nut (7) from the end of the fuel injection pump camshaft. Pull the gear (8) using the 8B7547 Puller. Take off the nuts and remove the thrust plate (6). The plate (3) may then be removed after taking out the capscrews which hold it to the fuel injection pump housing.

ASSEMBLY

Assemble the governor in the reverse order of disassembly. Parts should be replaced if they are worn sufficiently to allow movement of the governor operating mechanism without this motion being transmitted to the fuel injection pump rack. Make sure there is no binding between operating parts.

Accessory Gear and Shaft

THE accessory shaft extends from the accessory gear to the fuel injection pump housing and drives the fuel transfer pump and hour meter. An off-center tongue and groove connection at the fuel injection pump housing drives the fuel injection pump camshaft and governor. The rear end of the accessory shaft is supported by the front bushing for the injection pump camshaft in the injection pump housing.

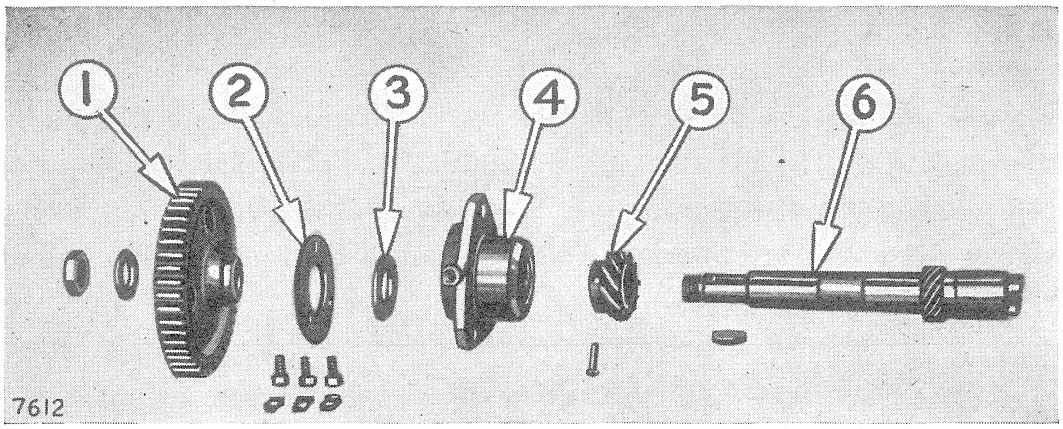


ACCESSORY SHAFT REMOVAL

Disconnect the oil line (1) and remove the capscrews which hold the bearing assembly (2) to the block. The entire assembly may then be removed as shown.

Remove the nut and lock on the end of the shaft and pull the gear (1) using an 8B7546 Puller. Remove the thrust plate (2) and washer (3). The shaft (6) will then slide out of the bearing (4). The fuel transfer pump gear (5) may be pressed off the shaft after the pin has been driven out. NOTE: In tractors above serial number 7J7576 the fuel transfer pump gear (5) is forged integral with the accessory shaft.

If the bushing to shaft clearance in the bearing assembly exceeds .010", the bushing should be pressed out and a new one installed.

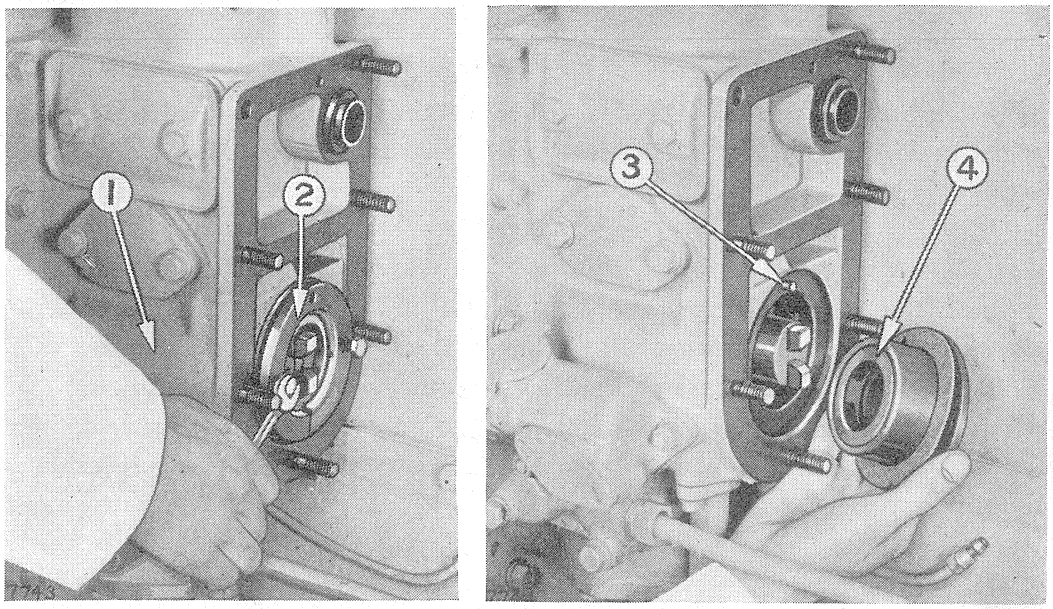


ACCESSORY SHAFT ASSEMBLY

ACCESSORY SHAFT SEAL

If the fuel injection pump housing requires frequent additions of lubricating oil, the seal on the rear of the accessory shaft should be inspected and replaced if necessary.

To do this, remove the fuel injection pump housing and governor as a unit by taking off the nuts on the studs at the rear of the fuel filter housing (1). Using two ¼"—20 capscrews (2A758) from the rear

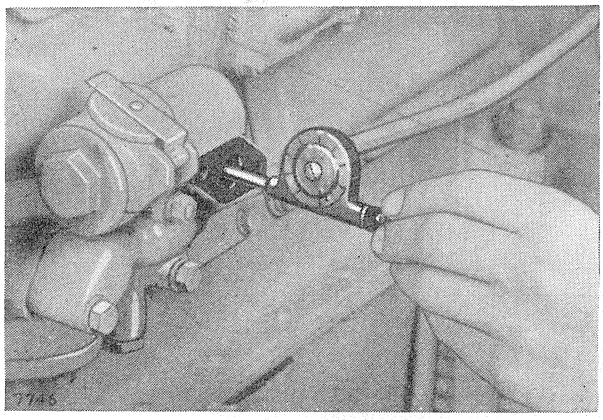


ACCESSORY SHAFT SEAL ASSEMBLY

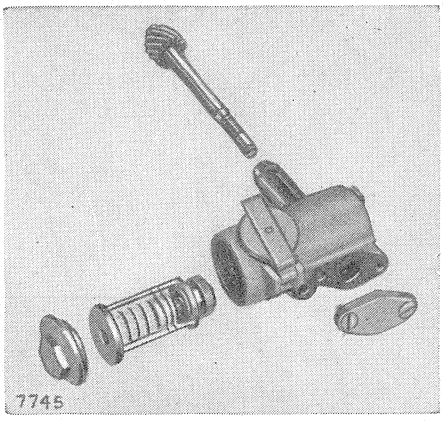
cover of the governor, pull the retainer (2) as shown. The retainer is kept from rotating by the dowel pin (3). The seal (4) may be pried out and replaced.

Hour Meter

THE hour meter is located below the inspection cover on the fuel filter housing and is driven by the accessory shaft.



CHECKING SPEED



HOUR METER ASSEMBLY

The drive shaft of the hour meter has the end grooved so that a tachometer may be installed after the cover has been removed. Engine speed may be obtained at this point by using a speed indicator. This drive shaft rotates at one-half engine speed.

COUNTER ASSEMBLY

Replacement counter assemblies (2) are available and can be installed as follows: Remove the retainer assembly (1). The counter retaining spring will come out with the retainer. Remove the counter assembly.

DRIVE SHAFT

Slide out the drive shaft (4). After removing the pin, pull the gear with an 8B7547 Puller. Remove the bearing assembly (3).

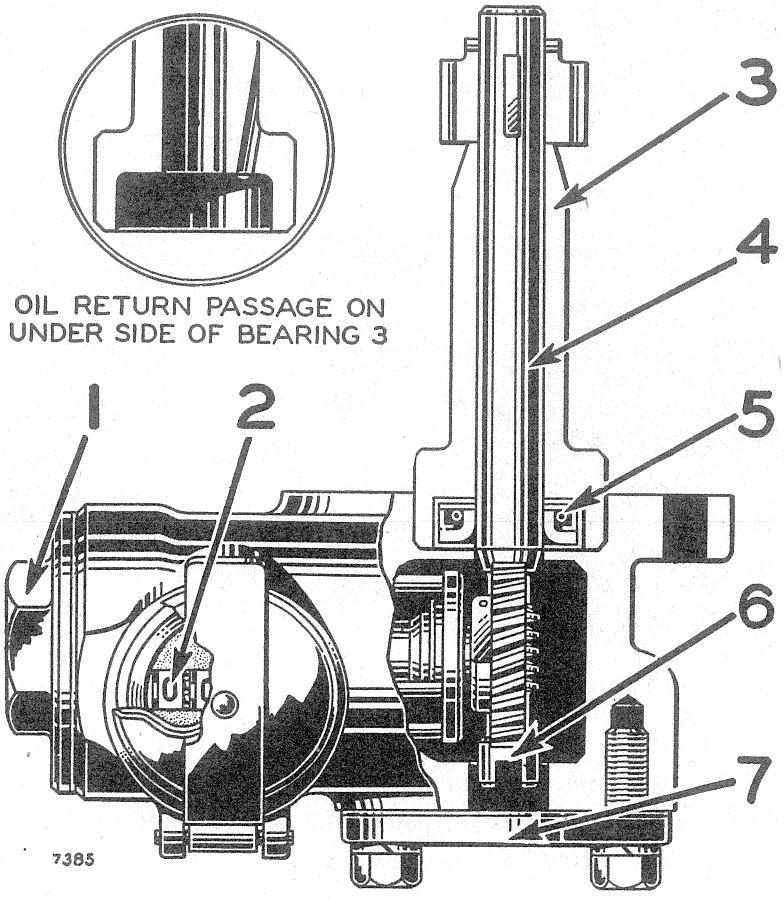
BEARING ASSEMBLY

An oil seal (5) keeps oil out of the counter assembly. If this seal is replaced, the wiping edge should be installed toward the bearing (3). The bearing should be replaced if the clearance exceeds .012″. The bearing is lubricated through the holes in the bearing (3) and oil is returned through a drilled passage just behind the rawhide seal. This drilled passage should be on the bottom when the bearing is installed.

LUBRICATION

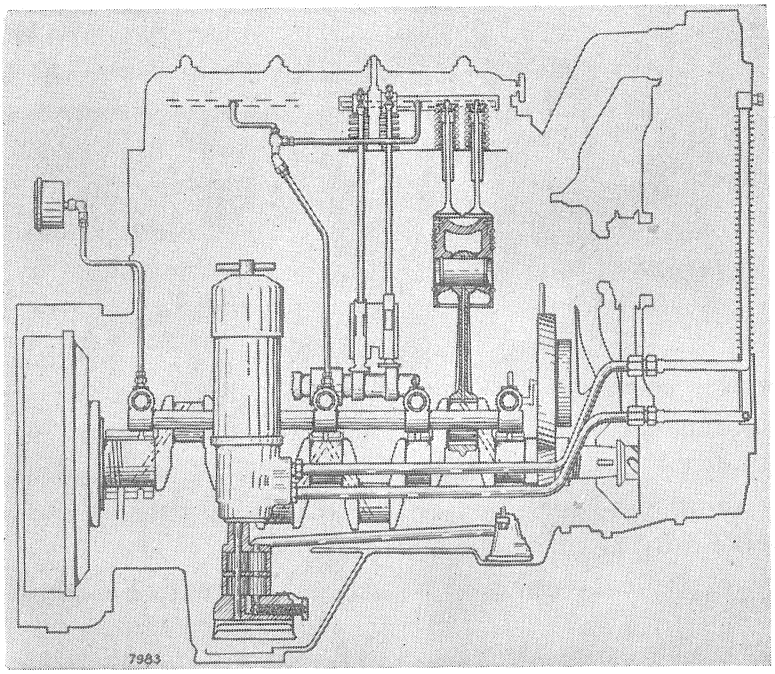
When reassembling, place high melting point grease on tne counter assembly drive gear.

The drive gear and shaft are lubricated by oil from the accessory shaft bearing.



Lubricating System

ONE of the most important items contributing to the long life of an engine is proper lubrication. The lubricating system has been designed to meet all working conditions, but it should be inspected occasionally to see that everything is functioning properly.

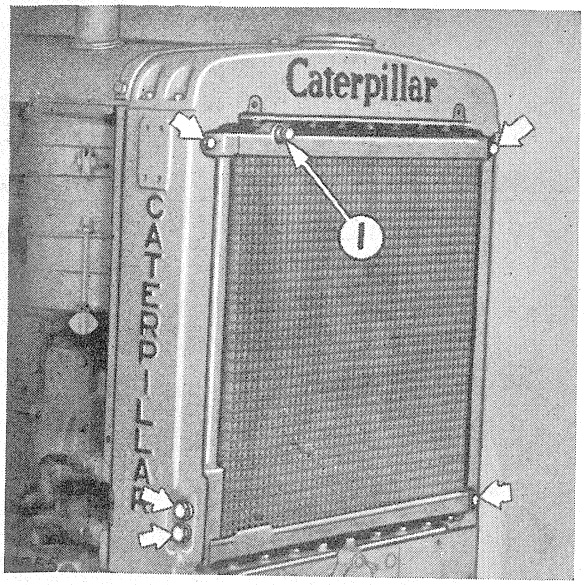


OIL PRESSURE GAUGE

The oil pressure with the engine operating at normal load and operating temperature is about thirty pounds. This pressure brings the gauge needle approximately midway across the pressure scale on the gauge dial. As long as the needle stays within the "operating range" under normal working conditions, it may be assumed that the oil pump is operating correctly.

OIL COOLER

Lubricating oil flows from the oil pump to the oil cooler before it passes through the oil filter. The oil cooler is located just ahead of the



OIL COOLER

water radiator and can be removed separately or as a unit with the radiator assembly.

OIL COOLER REMOVAL

Remove the screen guard assembly. Drain the oil from the oil cooler by loosening the vent plug (1) and removing the drain plug in the bottom of the oil filter. Remove the cap-screws shown by the arrows and lift out the oil cooler.

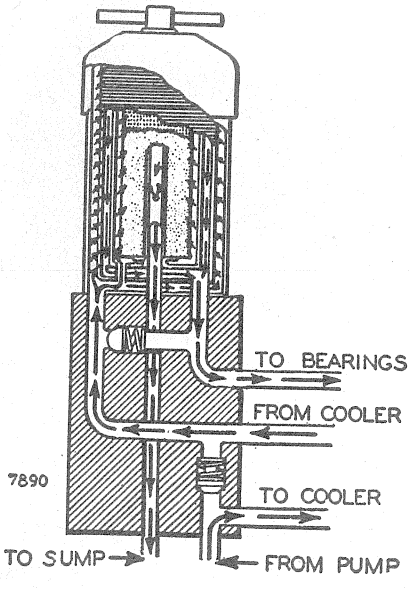
SERVICE

Clean the oil cooler of any accumulation of debris between the fins and tubes. Such accumulations decrease the efficiency of the oil cooler. Cleaning may be done by flushing the outside of the core with water or by using compressed air. The outside tubes of the oil cooler carry no oil and serve only as oil cooler core supports.

The inside of the cooler should be washed out with kerosene.

OIL FILTER

The oil filter has an edge-type metal element surrounding an absorbent-type element. As shown in the following sketch, the oil filtered by the outer element goes to the bearings while the oil filtered by the inner element is returned through the metering hole in the stud to the oil pan.



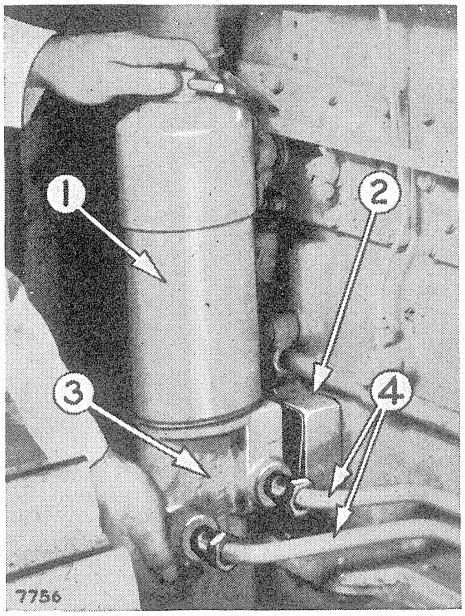
OIL FLOW

If the oil is cold and viscous, a by-pass valve in the filter base opens to permit the oil to flow directly to the filters from the pump without passing through the oil cooler.

If the outer element becomes clogged, another by-pass valve opens to permit the oil to flow directly to the bearings without passing through the element. These by-pass valves should be checked to insure that they are functioning properly.

The outer element may be clogged internally even when the outside surface has been carefully cleaned. To check the internal condition, plug the holes in the bottom of the element in question

and a new element and then immerse both elements to the top rim in some non-inflamable fluid such as Diesel fuel. Compare the rate at which the fluid level rises in each element. Discard the used element if its flow rate is less than three-fourths the flow rate of the new element. In other words, if the used element is not at least three-fourths full in the time required to fill a new element, the used element should be discarded.



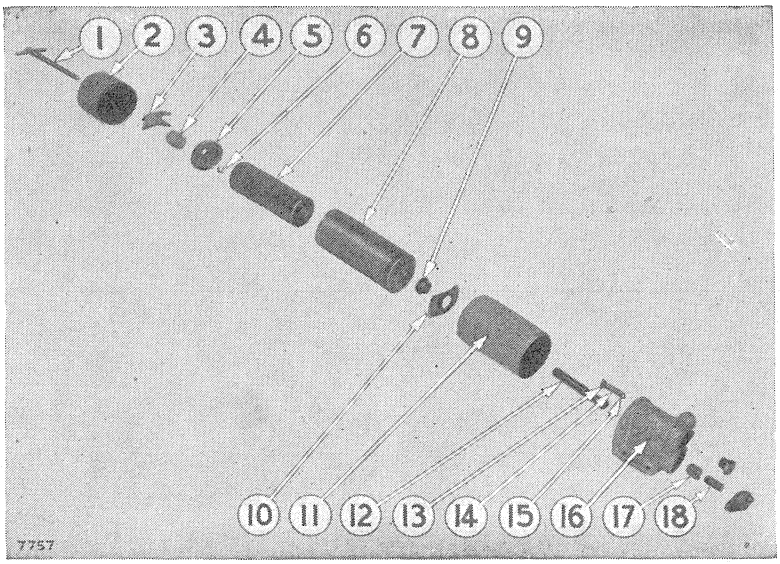
OIL FILTER AND MANIFOLD

The oil filter housing (1) and base (3) can be removed from the side of the engine after taking off the nuts from the studs that hold the base against the oil manifold (2) and disconnecting the oil cooler lines (4) at the base of the filter.

The oil filter manifold (2) should be removed and cleaned. This can be done after removing the studs and the capscrews that hold the manifold in place.

DISASSEMBLY

The accompanying photograph shows the filter housing and base completely disassembled.



OIL FILTER ASSEMBLY

The screw assembly (1), gasket, springs (3 and 4), and plate assembly (5) in the top cover (2) that hold the filter elements (7 and 8) in position are held in place by a snap ring (6) that fits in a groove on the screw.

Socket wrench 8B2444 should be used to remove the nut (9) at the bottom of the filter stud (12). This nut holds the retainer (10) that secures the filter element case (11) to the base (16). Remove the filter stud with a pipe wrench taking care not to damage the metering hole in the stud.

The plunger (17) and spring (18) should be removed and cleaned whenever the filter assembly is taken apart. The plunger permits oil to flow directly to the oil filters when the oil in the system is too cold or viscous to flow through the oil cooler.

Remove the plug (13) adjacent to the stud and take out the spring (14) and ball check (15). This ball check and spring permit oil to by-pass the outer element of the filter if the element is clogged. If the ball check and spring are corroded, replace them. Smooth the seat if rough.

Clean the oil passages in the filter base (16) and stud (12) thoroughly.

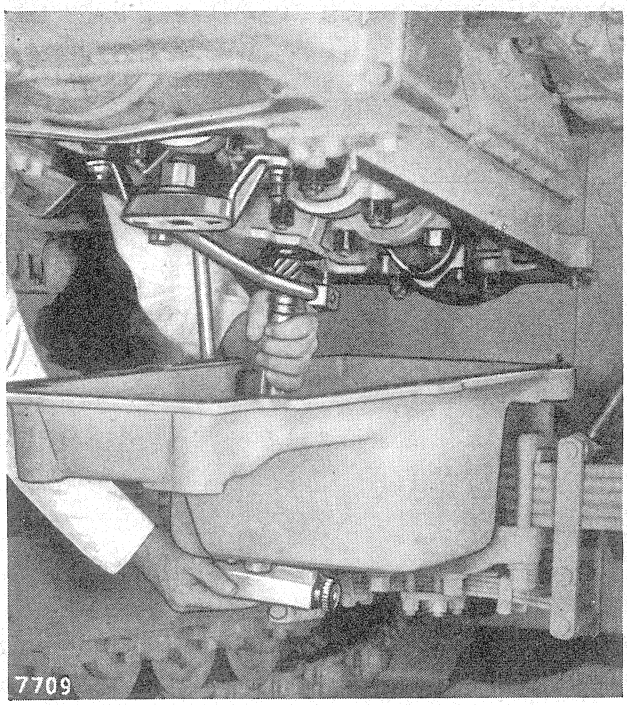
OIL PUMP

The oil pump is driven from a spiral gear on the camshaft through the vertically mounted drive shaft of the oil pump. It circulates oil under pressure to the oil cooler, oil filter, engine bearings and piston pins. If the oil pressure gauge indicates a low pressure or no pressure at all, check for the following in order.

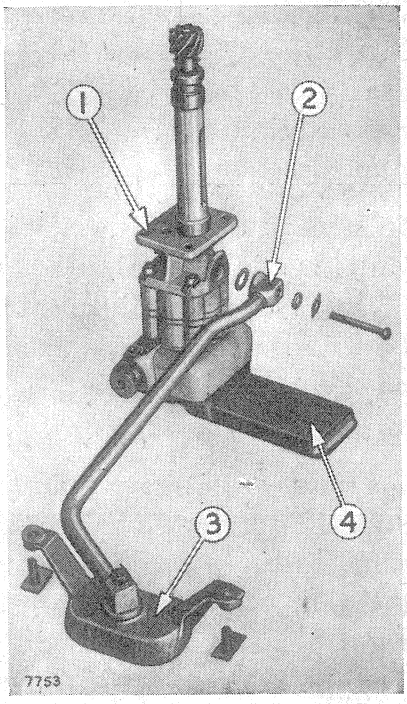
1. Clogged oil filter.
2. Defective oil gauge or gauge line.
3. Clogged oil pump screen.
4. Sticking oil pump plunger.
5. Leaking connections.
6. Loose bearings.
7. Worn oil pump gears.
8. Improper adjustment of oil pressure relief valve adjust ing screw.

REMOVAL

The oil pump assembly can be removed by jacking up the front of the engine and dropping the oil pan as shown. Remove the oil pump suction bell (4) and the capscrew that holds the auxiliary pump bell tube (2) to the oil pump. Remove the capscrews which hold the oil pump (1) to the block and lower the oil pump through the bottom opening in the oil pan.



REMOVING OIL PUMP

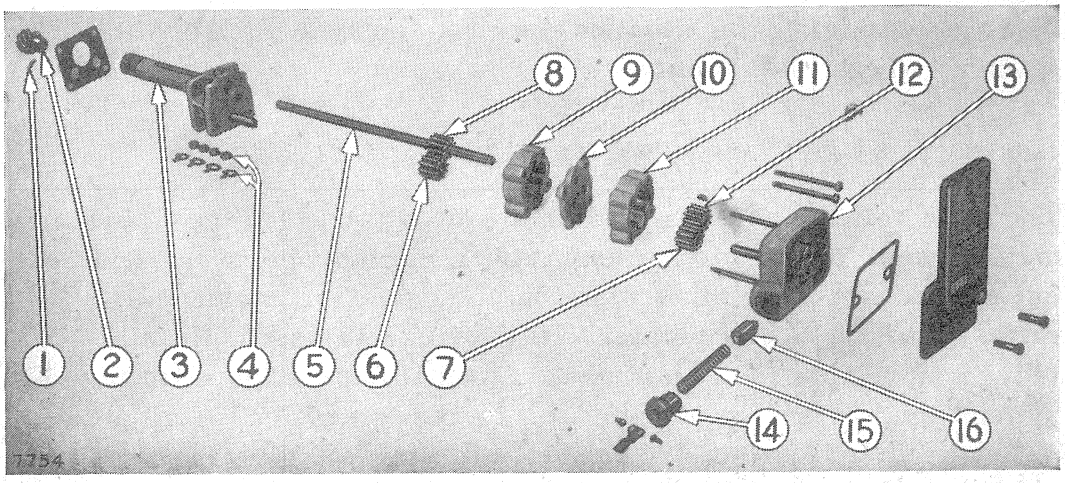


OIL PUMP

The oil pump assembly contains a pressure pump section which circulates the lubricant under pressure to the engine parts. It also has an auxiliary pump section connected to a screened suction bell (3) located at the front end of the oil pan. On steep downhill operation, the auxiliary pump returns accumulated oil from the front end of the oil pan to the sump in which is located the pressure pump suction bell.

PUMP GEARS

Ordinarily, oil pump drive gears should not be replaced unless they have worn sufficiently to cause a considerable drop in oil pressure.



OIL PUMP ASSEMBLY

To check the pump gears, remove the nuts and locks (4) and then the lower case assembly (13). Remove the body (11). Slide off the idler gear (7). The drive gear (12) is keyed to the drive shaft and must be carefully pulled from the shaft. These two gears constitute the pressure pump section.

Remove the pin (1) that holds the drive gear (2) to the shaft (5). Pull the drive gear with an 8B7547 Puller. The separator (10), pump body (9) and auxiliary pump gears (6 and 8) and shaft (5) can now be withdrawn as a unit from the bracket (3). Remove the separator (10) and body (9). The idler gear (6) and the drive gear (8) constitute the auxiliary pump section.

To remove the drive gear (8) from the shaft, drill out the gear at both ends of the pin and drive out the pin. Press the gear off the shaft and remove the key. When installing a new gear, replace the key and press the gear on the shaft, aligning the holes in the gear and shaft. Using these holes as a guide, drill a ⅛" hole through the shaft and opposite side of the gear. Install a new pin and peen the gear over both ends of the pin. CAUTION: *The ends of the pin should not protrude beyond the surface of the gear. Any roughness caused by drilling or peening should be removed from the gear teeth.*

The clearances are small between the moving and stationary parts of the pump, and for this reason, ground joints instead of gaskets are used between pump body sections.

SUCTION BELL

Remove the oil pump suction bell through the opening in the bottom of the oil pan. Wash and clean the bell assembly in kerosene or some non-inflammable washing fluid before replacing. The bell assembly should be cleaned at least twice a year or more frequently if necessary.

New gaskets should be installed between the bell assembly and case assembly when reassembling.

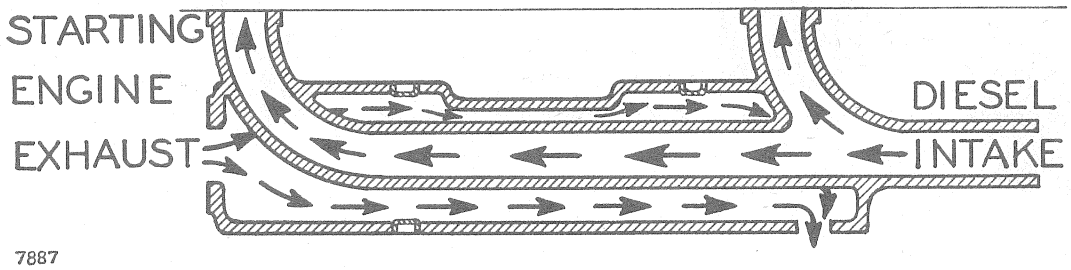
OIL PRESSURE RELIEF VALVE

The relief valve arrangement provides a means by which the oil pressure may be kept reasonably constant under normal operating conditions unless excessive wear takes place in the pump or engine parts. This valve, consisting of the plunger (16), spring (15) and adjusting screw (14), is accessible for adjustment, without draining the crankcase oil, by removing the rear inspection cover on the crankcase. The oil pressure is increased by turning IN on the adjusting screw or decreased by turning OUT on the adjusting screw.

The plunger may fail to function properly if foreign material gets between it and the seat. After cleaning the contact surfaces, check to see that the seat is smooth and flat, and that the sealing surface of the plunger is in good condition. If this plunger is functioning properly, the gauge needle should vary only slightly.

Manifold Group

THE inlet manifold for the Diesel engine is heated for starting by the starting engine exhaust gases. This manifold is of one piece construction with a cored outer passage for the starting engine exhaust gases. This construction minimizes the possibility of starting engine exhaust gases, dust or dirt getting into the Diesel engine through the inlet manifold.



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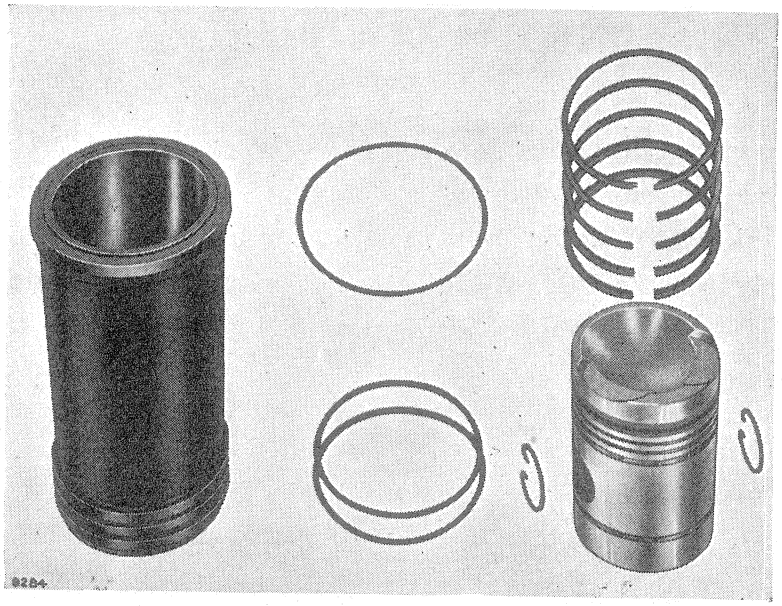
Copper-asbestos gaskets form a seal for the starting engine exhaust pipe at the rear of the inlet manifold and for the Diesel engine air cleaner pipe at the front of the inlet manifold.

The inlet manifold may be tested for leaks or cracks permitting the entrance of unfiltered air into the Diesel engine by holding a lighted match in the starting engine exhaust opening on the front of the inlet manifold. With the Diesel engine operating at high idle speed, leaks or cracks will be indicated by a suction of the match flame.

The Diesel engine exhaust manifold is also of one piece construction. Copper-asbestos gaskets form a seal between the manifold and cylinder head. If the tractor is parked without shelter, cover the exhaust pipe to prevent the entrance of rain, snow or dust.

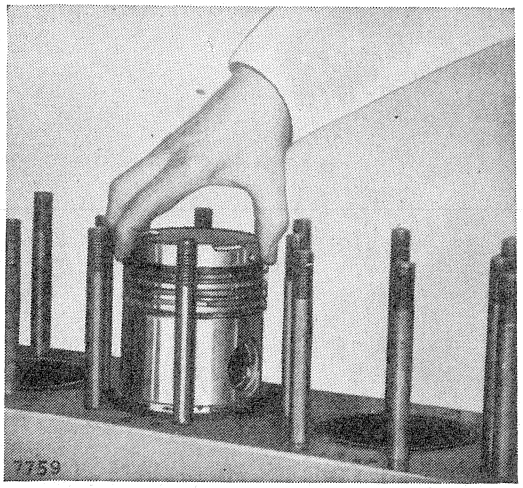
Pistons, Rings and Cylinder Liners

THE first noticeable symptoms of worn piston rings and cylinder liners are increased oil consumption and excessive vapor from the crankcase breather. Extreme wear may result in poor compression, loss of power and hard starting.



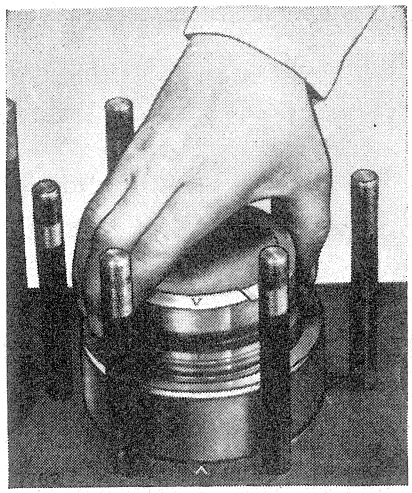
PISTONS

Drain the lubricating oil and water and remove the cylinder heads as described in the topic, CYLINDER HEAD REMOVAL. Take off the cylinder block inspection covers or the oil pan and remove the connecting rod bearing caps as shown in the topic, CONNECTING ROD. Rotate the crankshaft until the piston to be removed is at top center. Push the connecting rod up until the piston is above the top of the cylinder block and then lift out the piston and connecting rod assembly.



REMOVING PISTON

To reinstall a piston, place the piston ring compressor 3B5241 over the cylinder into which the piston is to be placed. Lower the piston and connecting rod assembly through the compressor tool and into the cylinder. The piston rings will be compressed as the piston is pushed through the compressor tool. NOTE: As the piston is lowered into the cylinder, it should be rotated so that the V mark on the top of the piston lines up with the V mark on top of the cylinder block. This will place the crater of the piston directly under the precombustion chamber opening and line up the connecting rod bearing with the crankpin.



INSTALLING PISTON

Pistons which are not badly scored should be cleaned and used again, providing the ring grooves are square and not damaged and there is not too much clearance between the ring and groove. The side clearance between a new ring and ring groove should not exceed .010". Pistons with ring grooves worn beyond this limit should be replaced or reworked as described in the topic, REWORKING PISTONS. The cast iron ring band in which is cut the groove for the top compression ring is not replaceable. Slight surface cracks or checks on the top of pistons are not detrimental.

CLEANING PISTONS

A number of commercial solvents are available for cleaning pistons. A good solvent should loosen the carbon deposits in the bottom of each ring groove and thus eliminate detrimental scraping. A final check should be made to see that the bottom of each ring groove is clean. Never scrape the sides of the ring grooves or the contact surfaces of the piston. The area above the top ring may be filed smooth but pistons badly scored below the ring grooves should be replaced.

REWORKING PISTONS

Pistons with a clearance of more than .010" between a new top ring and the ring land can be reworked to use a wider ring 1F8964 in the top groove if the remainder of the piston is in good condition.

After chucking the piston in a lathe, first remove just enough material to clean up the lower surface of the top ring groove.

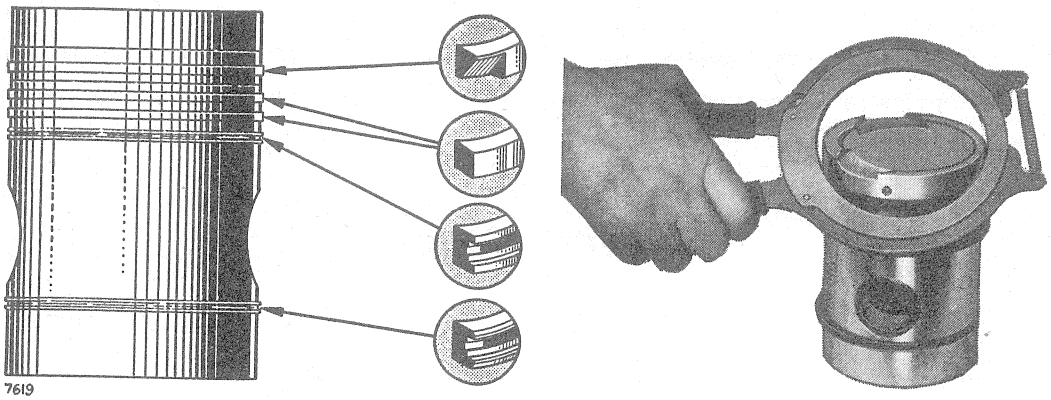
Additional material should then be removed from the top of the groove to provide a ring side clearance of .003″ to .004″. A radius of .020″ to .025″ should be left in the inside corners of the groove. The corners next to the clyinder liner should be chamfered .025″ to .030″ at a 45° angle.

If reworked pistons and wide rings are used in worn liners, the ridge in the liner should be raised as described in the topic, CYLINDER LINERS.

PISTON RINGS

Piston rings seal compression and control the oil on the cylinder walls. If oil consumption is not excessive and compression is satisfactory, pistons should not be removed nor new rings installed when the engine is dismantled for some other reason.

To avoid damage to the piston, remove the rings with a ring expander 7B7976.



INSTALLING PISTON RINGS

When installing the rings, care should be taken that the correct ring is installed in each groove and that the upper compression ring is installed correctly.

Four different piston rings are used. As shown in the accompanying sketch, the upper compression ring has a special overlap type joint and the next two compression rings have a butt-joint. The oil ring above the piston pin is of conventional design while the oil ring below the piston pin has chamfered edges to reduce the contact area of the ring.

RUNNING-IN SCHEDULE

The following is a reproduction of the label that accompanies pistons and rings sent out from the "Caterpillar" Parts Department.

CAUTION

Whenever new rings, piston assemblies or liners are installed be sure to run-in the engine on at least a 4-hour conditioning schedule before operating at normal load and speed. Avoid operating the engine at high speed idle at any time during the conditioning process. The following schedules are indicated as safe procedures to follow:

	DIESEL TRACTOR	DIESEL POWER UNITS
Period 1: 1/2 hour	Operate the engine at low idle speed.	Operate the engine at low idle speed.
Period 2: 1/2 hour	Operate the tractor in 4th gear without load at 3/4 rated speed.	Operate the engine on work approximating 1/4 maximum load at 3/4 rated speed.
Period 3: 2 hours	Operate the tractor at 3/4 rated speed on light work.	Operate the engine on work approximating 1/2 maximum load at 3/4 rated speed.
Period 4: 1 hour	Operate the tractor at full rated speed on medium work.	Operate the engine on work approximating 3/4 maximum load at full rated speed.

These periods may be impractical to maintain in all cases; however, at least three hours should be accumulated before operating at full rated speed. Do not run the engine idle for a long period after installing new rings or liners. Rings will not seat during idle operation. Place some load on the engine after 1/2 hour of operation and put a full load on the engine if at all possible, after 4 hours of operation.

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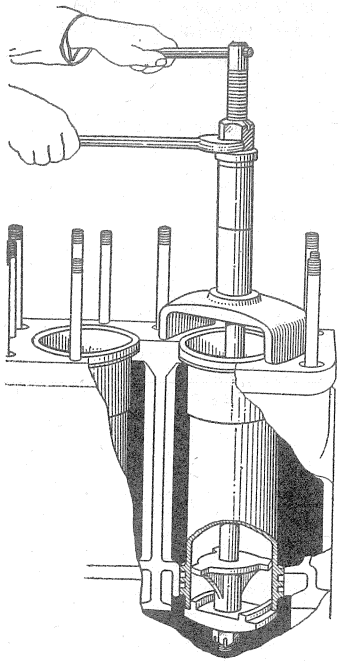
Use the piston ring expander 7B7976 when placing the rings in the grooves. The ring expander is not only a time saver but will also prevent breaking or distorting rings and damaging ring grooves.

When new piston rings are to be used in worn cylinder liners, the ridge at the top of the liner should be raised and the liner etched as recommended in the topic, CYLINDER LINERS.

CYLINDER LINERS

Cylinder liners need to be replaced only when they are worn at the top of the ring travel more than .012″- .015″ or when they are scratched or scored.

Cylinder liner surfaces are machined, hardened, ground and finally honed to a mirror finish and chemically treated. The resultant surface is so hard that ordinary boring tools will not machine it. Also, cylinder liners and pistons are priced at the factory so that it is not economical to grind worn cylinder liners oversize.

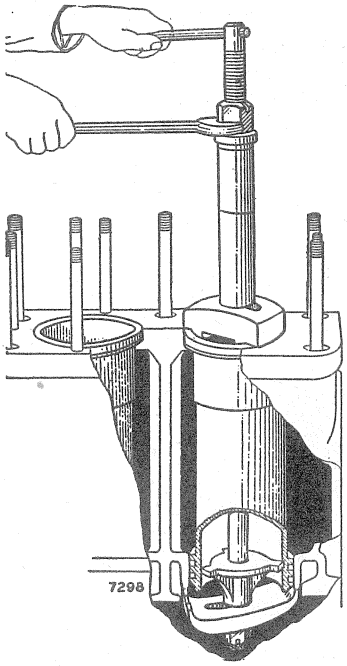


LINER REMOVAL

Liners, pistons and rings are available from the factory in standard sizes only and require no fitting when they are installed.

REMOVING CYLINDER LINERS

Cylinder liner tools are available for removing and installing cylinder liners. Always protect the crankshaft and bearings with clean cloths when changing liners to prevent water jacket sediment from entering the oil passages and bearings.



LINER INSTALLATION

REPLACING CYLINDER LINERS

Each liner installed should have a new copper gasket at the top between the flange on the liner and the cylinder block and new rubber seals in the grooves at the bottom of the liner to prevent water leaks.

Thoroughly clean the upper and lower sealing surfaces of the block.

To avoid damaging the seals, coat the exposed portion of the rubber seals with a mixture of soapstone and glycerine or soap and water before installing the liner. Then lower the liner carefully into the block and use the service tool to press it into place. The liner is a light press fit and if resistance is felt, alternately apply and relieve pressure until the rubber sealing rings slip into place.

Properly installed liners should extend slightly above the face of the cylinder block. This insures proper holding and sealing of the cylinder liner against the cylinder head gasket when the cylinder head is drawn down.

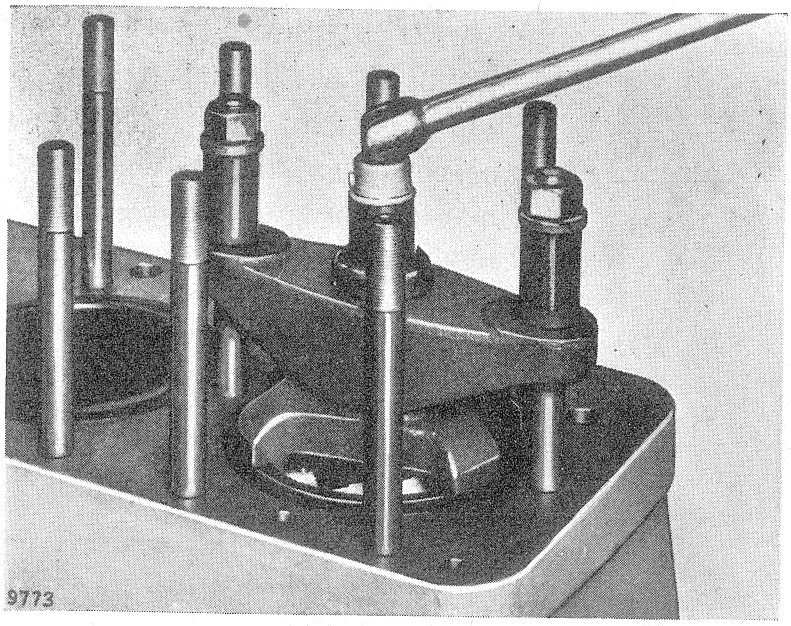
Liners may be slightly loose in the bore at the bottom, yet serve satisfactorily without water or anti-freeze leaking past the rubber seals.

REMOVING RIDGE FROM WORN CYLINDER LINERS

When new piston rings are to be used in worn cylinder liners, the ridge in the liner at the top of the ring travel should be raised to provide clearance for the new top ring. Since the liners are too hard for ordinary tools, the 2F6397 Liner Ridge Boring Tool and 2F6394 Bit should be used. The illustration shows how the tool is installed.

The tungsten carbide tool bit is spring loaded and specially ground so that it will follow the worn contour of the liner and will not cut deeper than the worn surface.

Instructions for its use accompany the tool.



RIDGE BORING TOOL

ETCHING CYLINDER LINERS

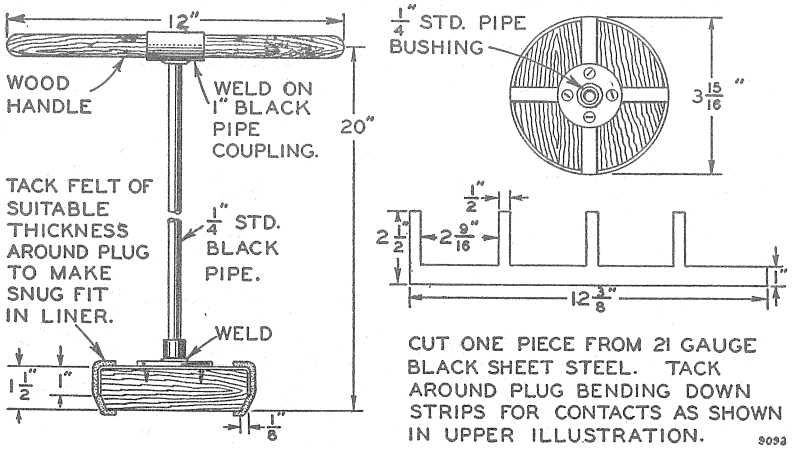
An inexpensive etching fixture can be made similar to the one shown. Use an etching solution composed of:

Oxalic Acid (commercial grade) — 10 ounces

Acetic Acid (Glacial) — ¾ fluid ounce

Denatured Alcohol (Industrial) — 7 fluid ounces

Add sufficient water to make one gallon.



CYLINDER LINER ETCHING TOOL

To prepare the etching solution, dissolve the oxalic acid crystals in approximately one-half gallon of water in a glass container. Add the acetic acid and stir until well mixed. Add the denatured alcohol and water to make one gallon. The solution can be kept indefinitely in a tightly closed glass container.

Clean the liner with cleaning solvent and flush with carbon tetrachloride to remove all traces of oil. Cover the crankshaft beneath the liner to protect it from the etching solution.

Saturate the felt on the fixture with the etching solution and place the fixture in the liner bore and force it to the bottom.

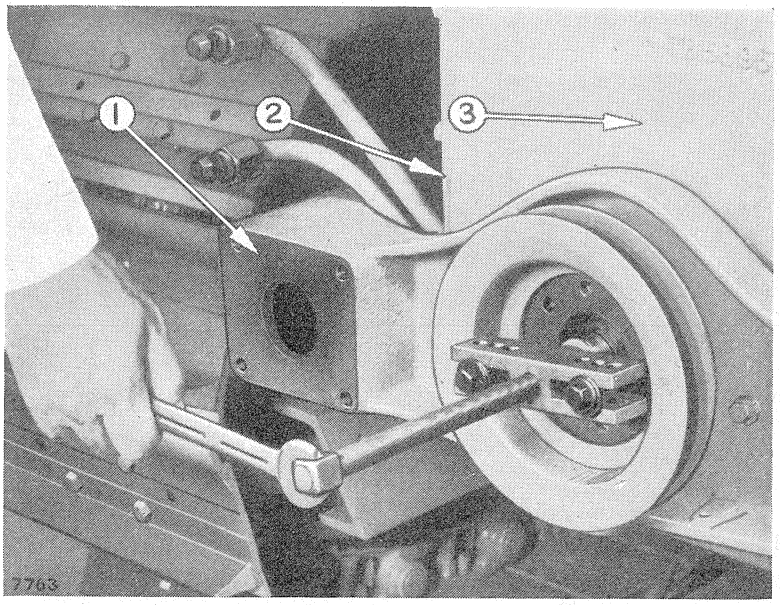
Connect the positive (+) terminal of a 6 volt storage battery to one of the cylinder block studs and the negative (—) terminal to the shank of the fixture using wires and battery clips. Move the fixture up and down the liner bore with a spiral movement for eight or ten minutes with the current at 15 to 20 amperes. Etching solution should be added while the fixture is in the liner to keep the felt well saturated.

Care should be taken to see that the fixture is kept in motion while the electrical circuit is complete.

After the etching process, remove the fixture from the liner, wipe the liner clean and dry and coat it with oil. Flush out the crankcase before assembling the engine.

Timing Gear Assembly

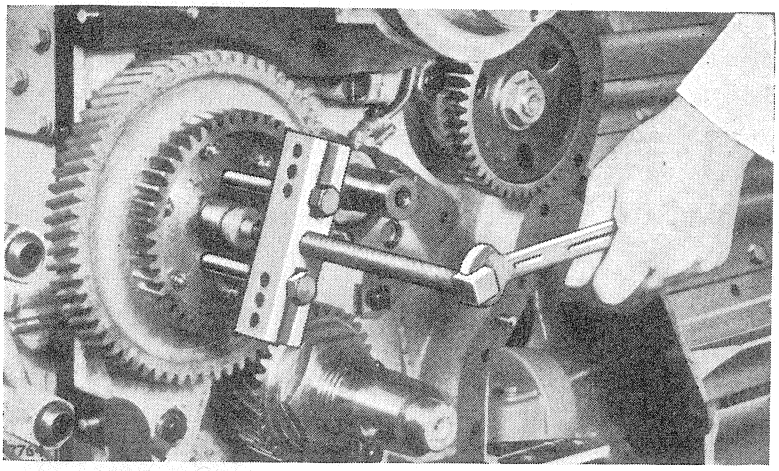
REMOVE the hood, radiator, fan spider, fan belt, water pump pipe, and cranking jaw. Pull the crankshaft pulley as shown with the cross arm and screw of 8B7554 Bearing Cup Pulling Attachment and two $\frac{3}{8}$" —16 capscrews 4" long. Remove the radiator bracket (1), the cover (2) and then the timing gear cover (3). The idler gear will slide off the stub shaft.



REMOVING CRANKSHAFT PULLEY

CAMSHAFT GEAR

Remove the nut and lock from the end of the camshaft and then pull the camshaft gears as shown using the cross arm and screw of 8B7554 Bearing Cup Pulling Attachment and two ½"—20 capscrews 4½" long.



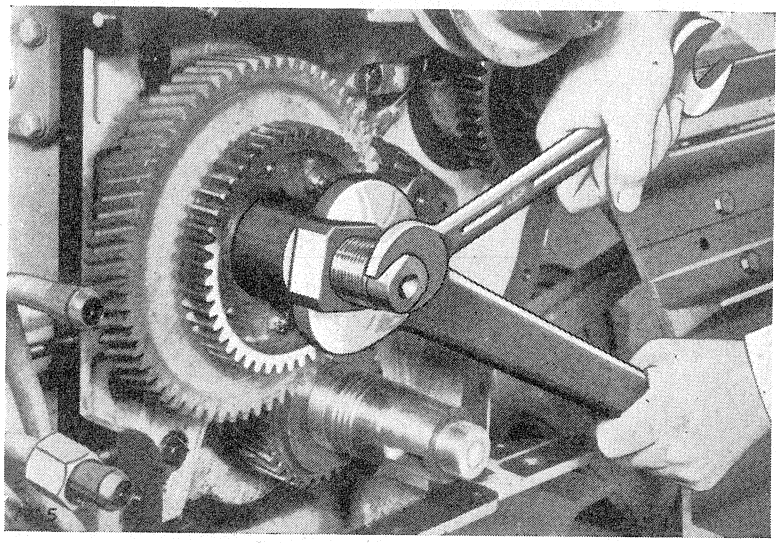
REMOVING CAMSHAFT GEARS

Remove the thrust plate and then slip the thrust washer off the end of the camshaft. If the end-play of the camshaft exceeds .025", the thrust washer and thrust plate should be replaced. Be sure the chamfered side of the thrust washer is toward the cylinder block.

The camshaft gears can be reinstalled with the camshaft in place using:

1—4B8267 Nut 1—4B8268 Stud

Use wrench V456 on the nut.

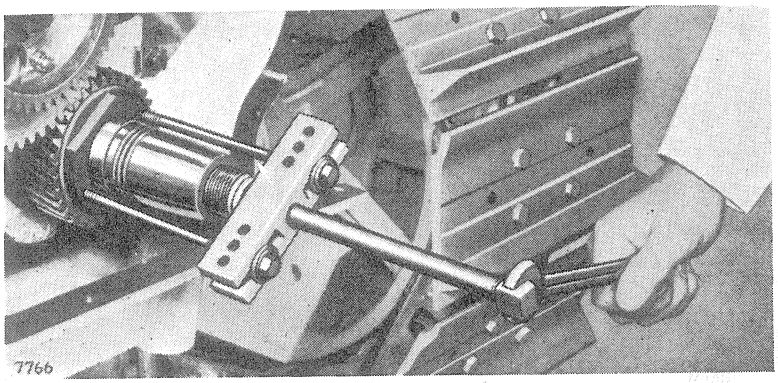


INSTALLING CAMSHAFT GEARS

The stud screws on the end of the camshaft and the nut forces the gear into position. Do not drive on the end of the camshaft as this will dislodge the plug in the camshaft rear bearing bore and allow oil to leak into the flywheel compartment.

CRANKSHAFT GEAR

To remove the crankshaft gear, first remove the nut and lock and then pull the gear with the crossarm and screw of 8B7554 Bearing Cup Pulling Attachment and two $\frac{3}{8}$"—24 capscrews $8\frac{1}{2}$" long (1B1284).



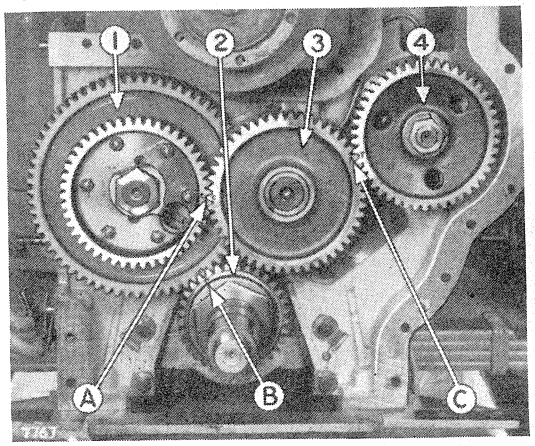
REMOVING CRANKSHAFT GEAR

The crankshaft gear can be easily reinstalled after heating it in oil. The end thrust of the crankshaft is taken by the center main bearing and should not exceed .020".

TIMING GEAR TRAIN

The timing gear train is as shown. The crankshaft gear (2) is timed to the camshaft gear at (B). The idler gear (3) is timed to the camshaft gear (1) at (A). The accessory shaft gear (4) is timed to the idler gear at (C).

Since the idler gear (3) has an odd number of teeth, the timing marks will line up only periodically. To line up the timing marks, time the crankshaft and camshaft gears and then rotate the accessory shaft gear until the marks line up when the idler gear is slipped into position.

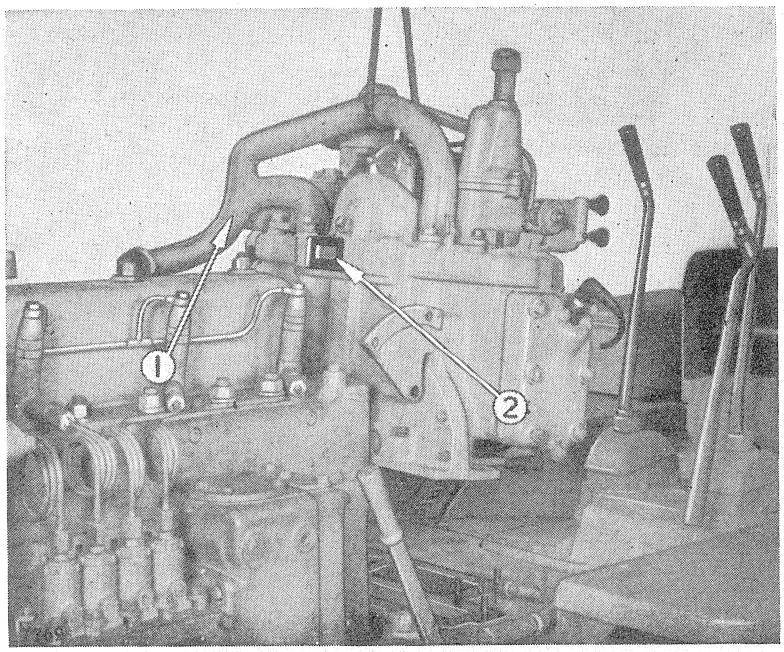


TIMING GEAR TRAIN

STARTING ENGINE

REMOVING THE STARTING ENGINE

DRAIN the Diesel engine cooling system and the oil from the starting engine. Then, remove the compression release control, the starting engine air cleaner and the dash. Disconnect the gasoline fuel line and the starting engine exhaust manifold (1) from the Diesel engine air inlet manifold. Remove the capscrews and nuts at the base



of the starting engine block. Grasp the tab of the brass insert of the manifold seal located at (2), pull the starting engine away from the Diesel engine and remove the seal. The starting engine can then be lifted off as shown.

REPLACING THE STARTING ENGINE

Clean the gasket surfaces on the top of the Diesel engine flywheel housing and on the bottom of the starting engine block. Cement the gasket in place on the flywheel housing and allow it to set. Coat the outside surface of the gasket with grease. Install the starting engine, exercising care to avoid damage to the gasket. Install the water manifold seal by pulling the starting engine away from the Diesel engine and inserting the seal in position after coating it with soap. Tighten the capscrews and nuts at the base of the starting engine evenly and securely.

If the seal only is to be replaced it can be taken out and a new one installed without removing the starting engine. Coat the new seal with soap and force into position.

Bearings

MAIN BEARINGS

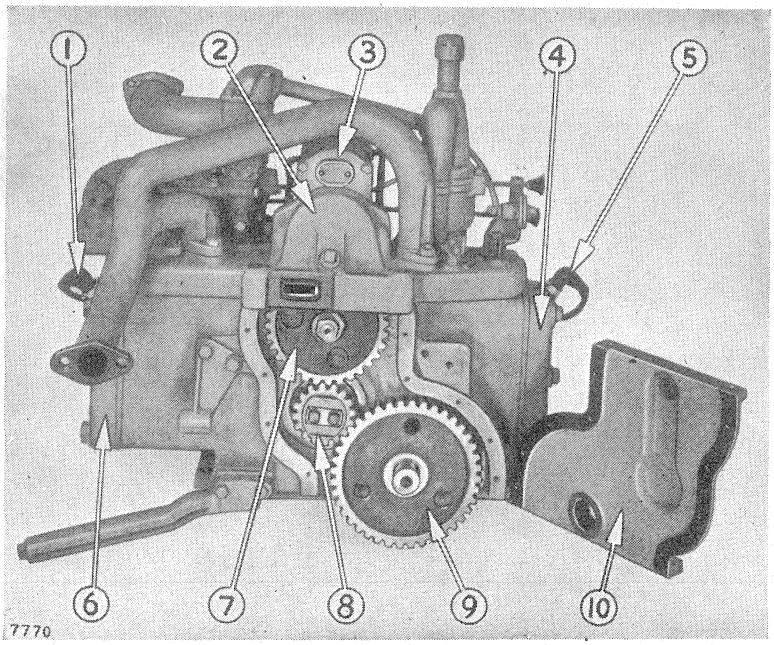
THE main bearings are babbitt-lined, bushing-type bearings. They are not adjustable and each bearing is held in position and kept from rotating by a dowel pin which protrudes through the bearing support into the bearing shell. After removing the piston and connecting rod assemblies and crankshaft, the main bearings can be taken out.

REMOVING MAIN BEARINGS

To remove the main bearings, remove the ignition wires (1 and 5) from the spark plugs and magneto.

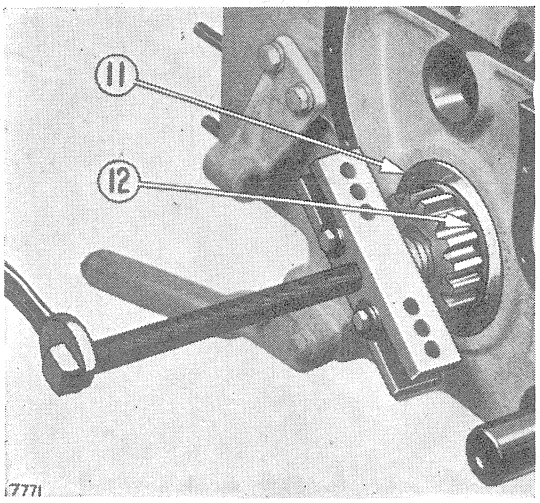
Then remove:

1. Manifold assembly (2) and magneto (3) as a unit and the cylinder heads (4) and (6)

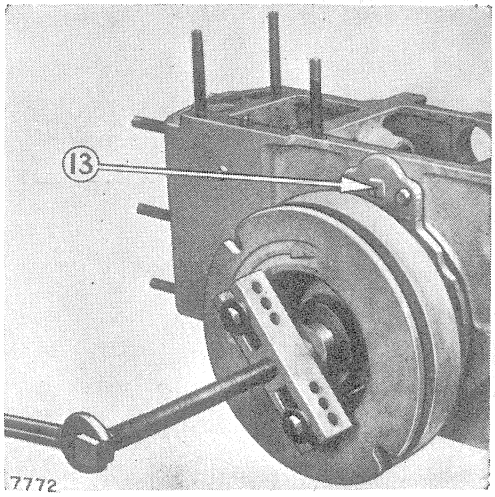


REMOVING TIMING GEAR COVER

2. Timing gear cover assembly (10)
3. Camshaft (7) as described in the topic, CAMSHAFT AND CAMSHAFT GEAR
4. Idler gear (9).

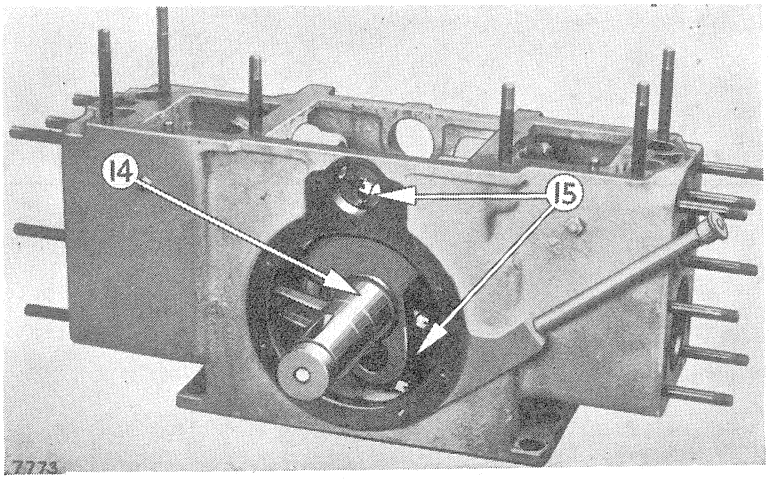


PULLING CRANKSHAFT GEAR



PULLING FLYWHEEL

5. Crankshaft gear (8)
   Take out the capscrews, lock and washer which hold the crank shaft gear in place. Pull the gear from the crankshaft as shown. The puller assembly consists of two 1/4"—20 capscrews 3 1/4" long and an 8B7554 Bearing Cup Pulling Attachment Cross Arm with a screw from an 8B7546 Puller.
6. Slip the washer (12) off the crankshaft. If the seal (11) or washer (12) is worn or damaged, it should be replaced.
7. Flywheel
   Pull the flywheel using two 3/8"—16 capscrews 4 1/2" long (1A5964) and the same pulling arrangement as for the crankshaft gear as shown
8. Flange Assembly (13)
   The bearing can be pressed out of the flange assembly after the dowel is driven out.



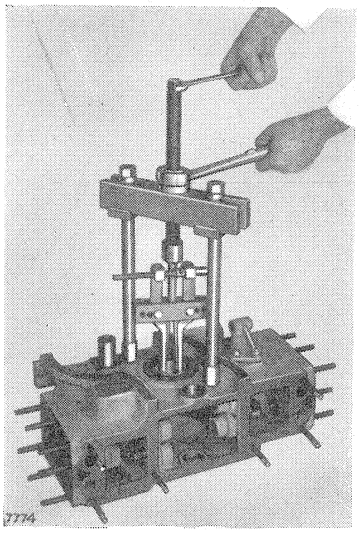
CRANKSHAFT REMOVAL

9. Piston and connecting rods

Take off the bearing caps (15), push the piston and connecting rod into the cylinder and remove as a unit from the cylinder head end of the bore.

10. Crankshaft (14)

To remove the bearing in the block, drive out the dowel and then pull the bearing as shown, using an 8B7554 Bearing Cup Pulling Attachment and an 8B7548 Push Puller.



PULLING BEARING

REPLACING MAIN BEARINGS

When replacing the main bearings, line up the drilled hole in the bearing shell as closely as possible with the drilled hole in the cylinder block or flange and press the bearing flush with the inner face of the bearing bore. Using the hole in the block or flange as a guide, drill through the bearing shells with a $^{15}/_{64}$" drill. Finish ream the dowel pin hole to .249-.250".

It is not necessary to ream, scrape or fit new bearings as they are machined to provide the correct clearance between the bearings and the crankshaft. After assembling, check to see that the crankshaft turns freely. Always be sure the dowel pin is installed in each bearing before installing the crankshaft and check to see that the timing marks are lined up correctly as outlined in the topic CAMSHAFT AND CAMSHAFT GEAR.

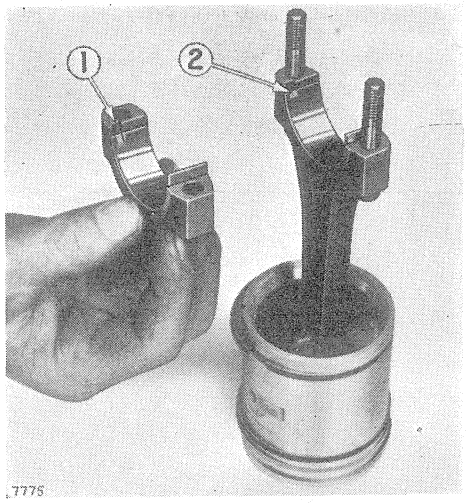
CONNECTING ROD BEARINGS

Precision babbit-lined bearing shells are used. These bearings do not require fitting and may be removed and replaced after the manifold assembly, timing gear cover, and camshaft and gear are removed. See the topic CAMSHAFT AND CAMSHAFT GEAR.

It is only necessary to remove the bearing cap to replace the bearing shells. The cap half of the bearing can be lifted out and the connecting rod half rotated out.

Always check the crankshaft bearing surface to see that it is not scored or damaged before putting in a new bearing.

When replacing the bearings, check to see that the protruding portion (2) on the back of each bearing half lines up with its corresponding groove (1) in the connecting rod and bearing cap. This locks the bearing in place and keeps it from rotating.



BEARING SHELLS

CRANKSHAFT

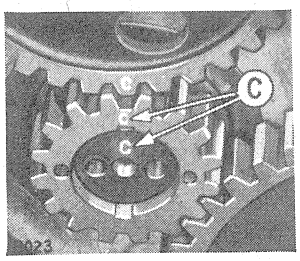
The starting engine crankshaft main bearing journals are 1.8125-1.8120″ and the connecting rod bearing journals are 1.7495-1.7500″.

The crankshaft may be removed as described in the topic, BEARINGS.

A crankshaft should not be used if the wear on the main bearing or connecting rod bearing journals exceed .005 or if the connecting rod bearing journal is more than .003″ out-of-round.

If the crankshaft bearing journals are reground, standard main bearings and connecting rod bearings .020″ undersize can be obtained.

The washer and rawhide seal behind the crankshaft timing gear should be replaced if leaking or damaged.



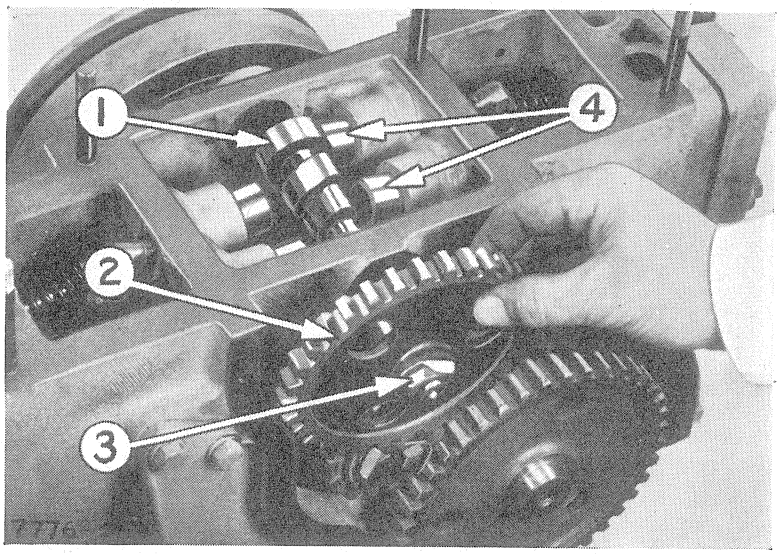
ALIGNING MARKS

When installing the crankshaft gear, be sure to align the timing marks (C) on the crankshaft and crankshaft gear. As the crankshaft gear is prevented from rotating on the crankshaft by two keys, it is possible to install the gear 180° out of the proper position.

Camshaft and Camshaft Gear

TO REMOVE the camshaft and camshaft gear, disconnect the ignition wires at the magneto, remove the manifold and then the timing gear cover. The end play of the camshaft is taken by a boss on the timing gear cover. Remove the valve stem bushing retainers by

inserting a screwdriver into the valve port opening and prying against the valve stem bushing (toward the camshaft) until the retainer can be slipped out of the groove in the bushing. Push the lifters (4) away from the camshaft and then remove the camshaft (1).



REMOVING CAMSHAFT

After the nut (3) and lock are removed, the camshaft (1) may be pressed out of the camshaft gear (2).

When installing the camshaft and gear, be sure the correct timing mark on the camshaft gear is lined up with the timing mark on the crankshaft gear. After the valve stem bushing retainers are installed, check to see that the retainer is correctly and completely installed in the groove of the valve stem bushing. With the manifold in place, check the timing of the camshaft gear with the magneto drive gear through the opening in the manifold.

Carburetor

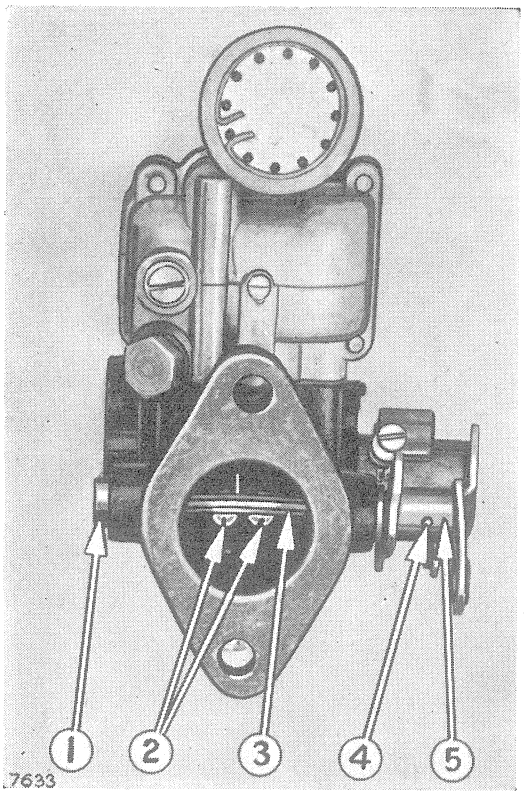
A ZENITH TU-4C Series Carburetor of the downdraft type is used.

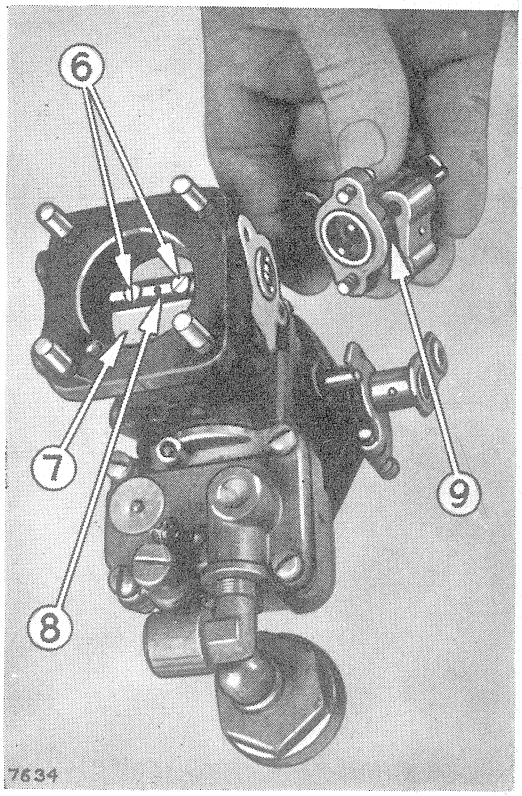
REMOVAL

Remove the air cleaner pipe and the adapter mounted above the carburetor. Disconnect the fuel inlet line, the choke control rod and governor control rod. Remove the nuts at the base of the carburetor and remove the carburetor.

THROTTLE VALVE

Remove the screws (2) and then the throttle valve (3). Drive the taper pin (4) out of the stop assembly (5). The stop assembly will now come





off the shaft. The shaft packing in the housing should be replaced. To remove the shaft, take out the plug (1) and drive the shaft out of the shaft retaining ring.

AIR SHUTTER OR CHOKE CONTROL

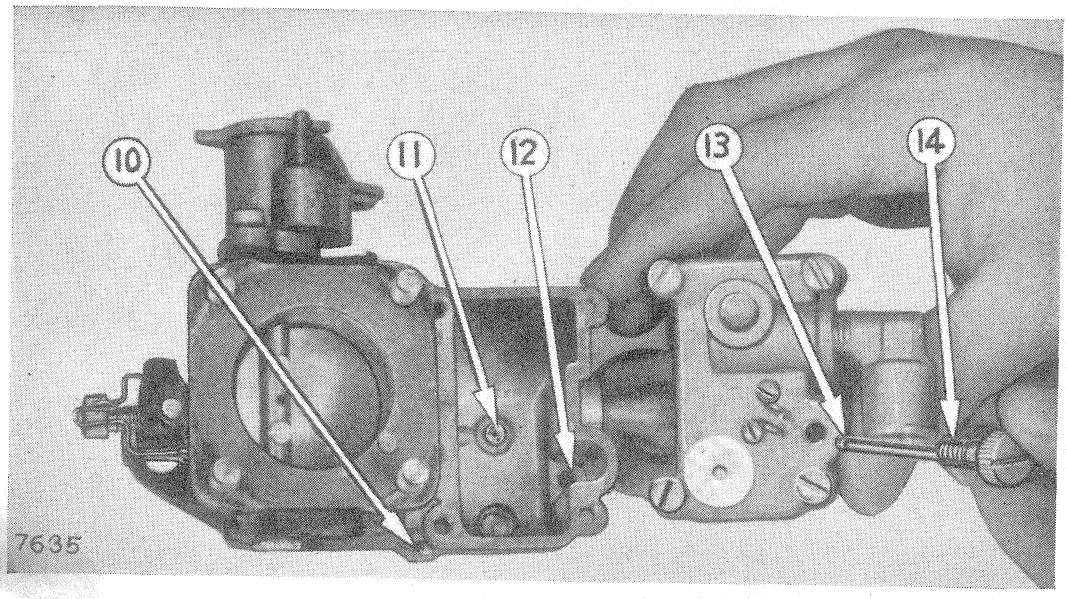
Remove the air shutter lever assembly (9). This lever assembly provides a positive connection between the control rod and the air shutter so that when the control rod is pulled out three-fourths of the way, the shutter is completely closed mechanically. In pulling the lever the last fourth of its travel, the positive control is tripped and the shutter is held closed by the spring. In this position, the shutter will be opened by the force of the air stream as soon as the engine starts. This permits the engine to continue running without flooding until the choke control rod can be pushed in. When the choke is released, the control should be pushed all of the way in which again engages the mechanical control and assures proper functioning of the choke the next time the engine is started.

To remove the air shutter shaft, melt the solder around the screw heads and take out the screws (6). Slip out the shutter plate (7) and then the air shutter shaft assembly (8). Replace the shaft bushings in the housing if worn.

MAIN OR HIGH SPEED SCREW

Remove the main jet adjusting screw (14). This screw regulates the amount of fuel in excess of the fuel from the compensator (11). The

amount of fuel is reduced by turning the screw clockwise thus varying the seating of the tip of the screw in the hole (12) and changing the effective size of the hole (13).



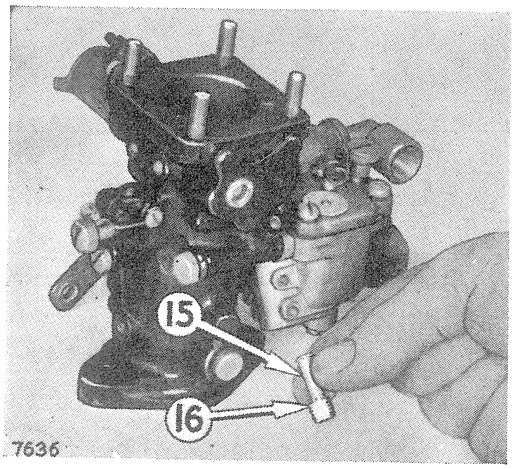
The compensator jet (11) which admits the fuel for the idling jet and also for the high speed metering well may be removed with a screw-driver.

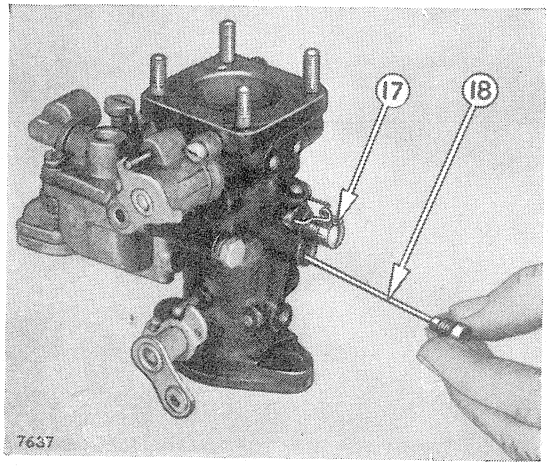
HIGH SPEED METERING WELL

The high speed metering well may be removed by taking out the plug (10) and screwing out the well (15). The fuel flow is regulated by the hole (16).

IDLING JET

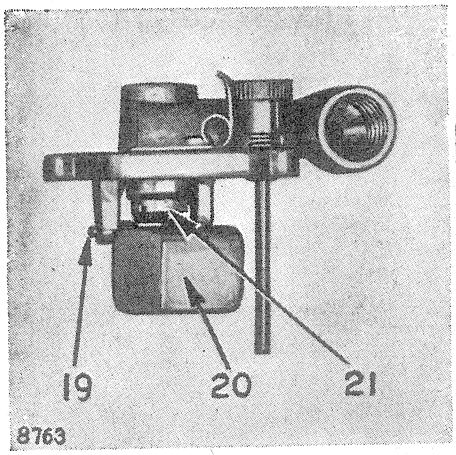
The idle adjusting screw (17) regulates the amount of air to be mixed with the fuel at the idling jet. The non-adjustable jet (18) controls the amount of fuel taken from the high speed metering well. The fuel and air pass through the priming plug located in the carburetor throat adjacent to the idling position of the throttle valve.

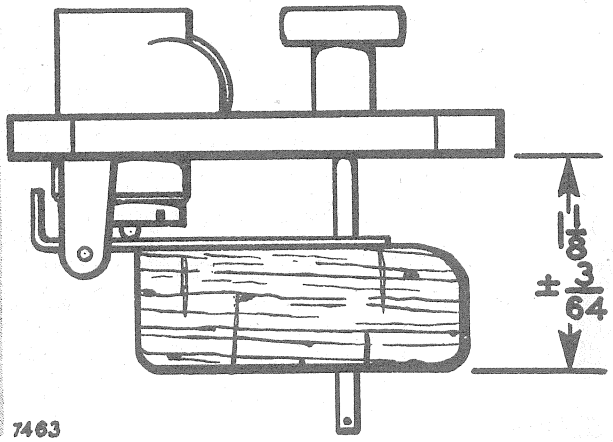




CLEANING JETS

All jets should be cleaned thoroughly before replacing. Blow out the passages and openings in the opposite direction of normal fuel flow. Never use drills or wire to clean the jets as this will enlarge the openings and cause improper operation of the carburetor.





FLOAT ASSEMBLY

If the float valve (21) leaks as evidenced by fuel leaking out of the breather on the fuel bowl or the engine performance does not respond to normal carburetor adjustment, inspect the seat of the valve assembly after removing the pin (19) and float assembly (20). Clean any foreign material from the seat, or if worn, replace the valve assembly. The float level is correct when a measurement of $1\frac{1}{8}$" plus or minus $\frac{3}{64}$" exists between the face of the cover of the fuel bowl (without gasket) and the float as shown.

Governor

THE governor is mounted on top of the starting engine under the air cleaner pipe. It is driven from the starting engine flywheel by the vee belt. Adjustment of the vee belt is provided by slots in the governor bracket.

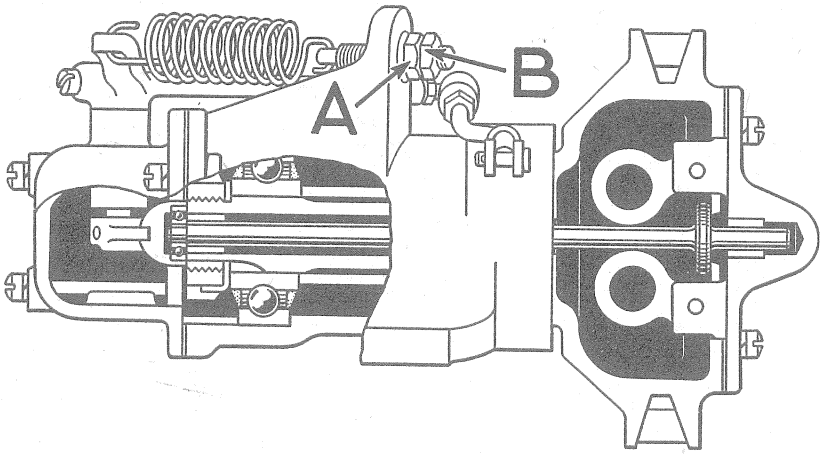
Through linkage operated by the throttle control lever, the forces of the governor weights and spring act upon the carburetor throttle valve to govern the speed of the engine.

LOW IDLE SPEED

The low idle speed is controlled by an adjusting screw on the carburetor throttle shaft lever assembly. This screw should be set to give a low idle speed of 800 R.P.M.

HIGH IDLE SPEED

The high idle speed is controlled by the governor spring. Increasing the tension on the spring increases the high idle speed and decreasing the tension decreases the speed. Loosen lock nut (B) and turn the adjusting nut (A) until the correct high idle speed of 3350 R.P.M. is



GOVERNOR CROSS-SECTION

obtained. If the starter pinion latches disengage before the Diesel engine starts, adjust the starter pinion latches as outlined in the topic, STARTING MECHANISM.

REMOVAL

Disconnect the control rod from the governor to the carburetor. Take off the nuts holding the governor assembly to the starting engine manifold. Slip the belt from the governor pulley and remove the governor assembly.

DISASSEMBLY

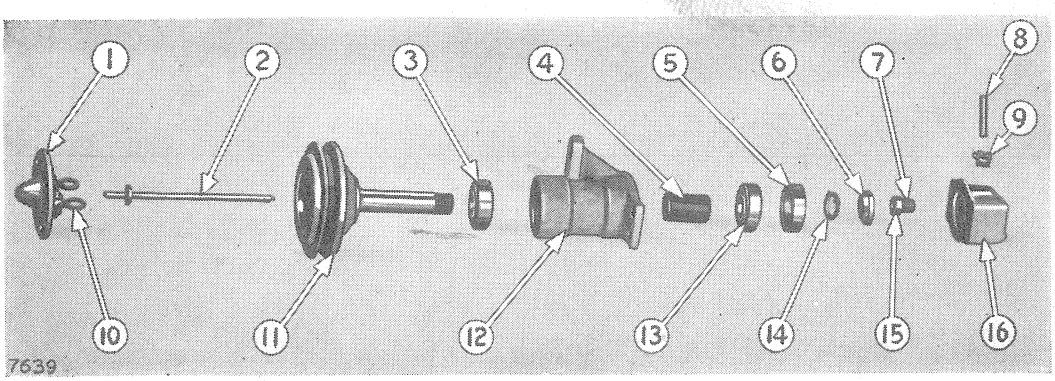
Remove the governor spring and then the control rod and lever as a unit from the shaft (8). Remove the screws holding the body (16) to the bracket (12).

Slip the bearing (15) and cap (7) from the plunger (2). The lever (9) fits into the notch in the cap (7).

Replace the bearing (15) if it is worn.

Remove nut (6), lock (14), spacer (5), bearing (13), and spacer (4); withdraw the remainder of the pulley assembly from the other end of the bracket (12) and slip out the bearing (3).

Remove the cover (1) and governor weights (10) from the pulley (11). Examine the governor weights and pins. Install new governor weights and pins if they are damaged or worn or if there is any binding action. Remove the plunger (2) and install a new one if it is bent or scored.



GOVERNOR DISASSEMBLED

When reassembling the governor cover, install three of the four screws. Then add oil until it will just run out of the screw hole when the governor is in a horizontal position and the hole is at its lowest point.

When installing the governor on the manifold, locate it so that ½" slack remains in the vee belt. The slots in the governor bracket provide the means by which this adjustment may be made.

Magneto

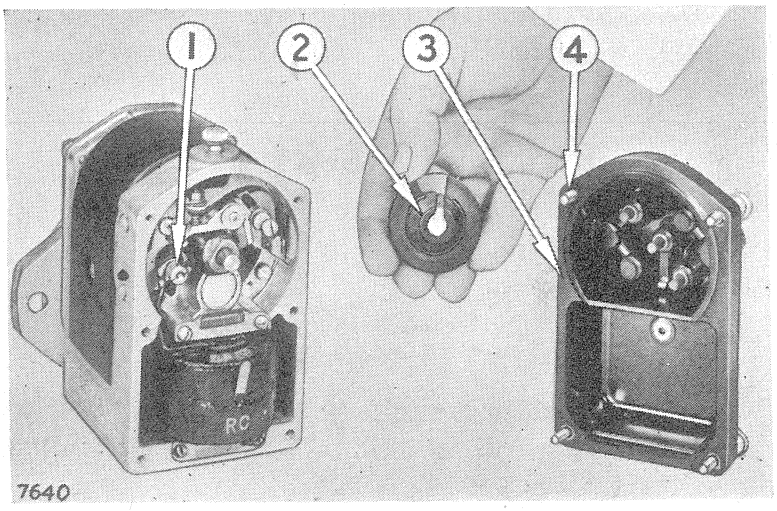
AN Eisemen Magneto Model RC-2H is used on the starting engine.

REMOVAL

Pull the ignition wires out of the distributor plate, disconnect the wire to the switch, take out the capscrews that hold the magneto in place and remove the magneto from the engine.

DISTRIBUTOR PLATE

Remove the distributor plate by loosening the screws (4). Using a clean soft cloth dampened with gasoline or some other evaporating



solvent, carefully clean the inside of the plate of carbon dust. The gasket (3) should be replaced if damaged.

BRUSHES

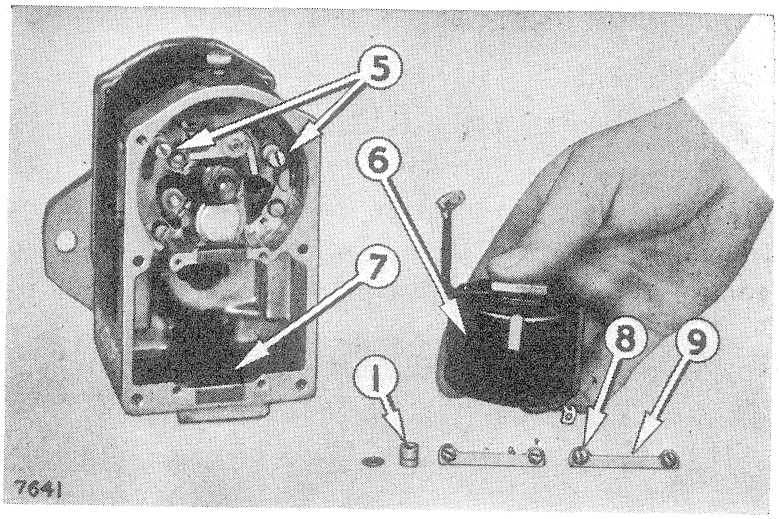
To install a new brush after the old ones have been pulled out of their sockets, place the small end of the coil spring on the brush, press the spring straight into the socket and twist the brush a few turns clockwise and again compress the spring by pressing the carbon brush into the socket. The brushes should move freely and protrude uniformly from their sockets.

ROTOR

Pull the rotor (2) from the shaft and clean both sides. Replace the rotor if the brass insert is burned, the rotor cracked or the face grooved.

WINDING OR COIL

The winding (6) may be removed by taking off the slotted nut (1) and washer and removing the winding lead. Remove the screws (8) holding the straps (9) in position and slide out the winding. Check the wind-



ing or coil on an Eisemann Winding Tester or other suitable device. When replacing, press firmly on the winding to seat the core ends in the tapered pole-shoe (7) before replacing the clamps.

BREAKER ASSEMBLY

Remove the slotted head screws (5), and pull out the breaker assembly (13) after removing the lead (11) from the condenser post. Do not disturb the adjustment (10).

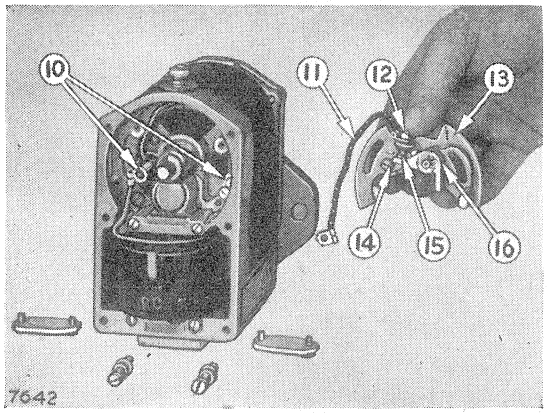
CONTACT POINTS

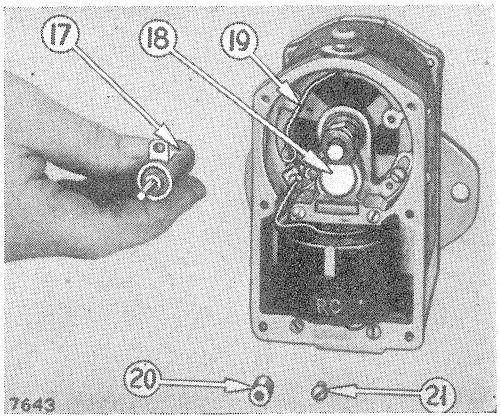
If the contact points wear unevenly or become pitted, a fine carborundum stone instead of a steel file should be used to smooth them. Replace

the contact points if badly pitted or worn. Remove all dust particles with a clean, dry cloth.

ADJUSTMENT

Insert a .020″ feeler gauge between the contact points (15) after positioning the breaker lever bumper block on a high point of the cam. To adjust the gap, loosen the screw (14) which secures the adjustable contact point bracket and move the bracket by inserting a

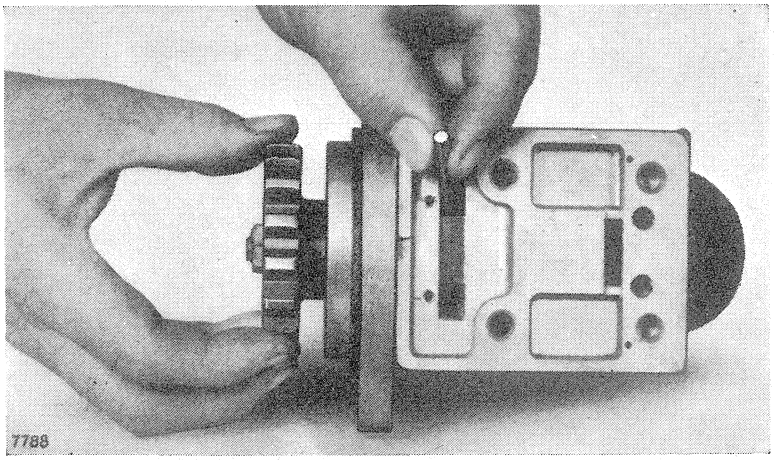




screwdriver in the space between the head of the screw and the lip on the bracket. Move the bracket to obtain .020″ gap. Tighten the screw (14). The upper contact point may be replaced after the nut (12) is removed and the point taken out. It is necessary to replace the lever (16) if the lower point is to be replaced.

TIMING

To obtain maximum spark intensity when the breaker points separate and to insure proper timing, the rotor should be properly positioned with respect to the breaker plate and contact points.

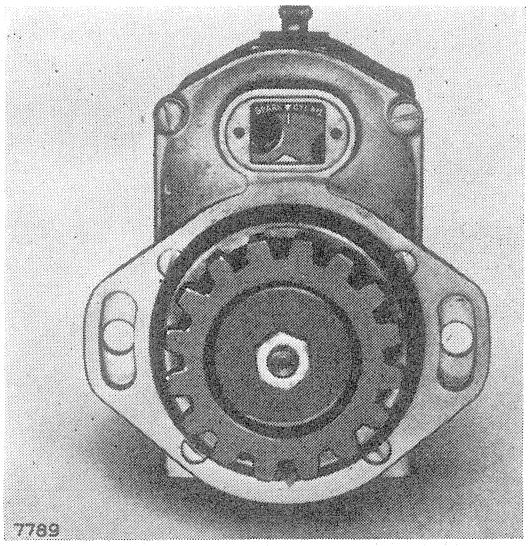


Remove the plate and gasket covering the inspection holes on the underside of the magneto. With the magneto on its side so the top is toward the operator and the drive gear is to the left, insert the shank of a No. 40 drill (.098″ diameter) through the upper hole. Turn the drive gear the reverse of the normal operating direction until the drill is locked lightly between the induction rotor and lower pole-shoe. Loosen the fork stop screws (10) and shift the breaker plate until the contact points just start to separate. To check this, use a 6 volt "split lamp circuit" or pull on a piece of cigarette paper placed between the contact points. This is the maximum spark advance position. Lock the fork stops against the breaker plate.

CONDENSER

To replace the condenser, remove the breaker assembly as outlined. Slip off the spacer (20) and remove the lead (19) from the condenser post. Remove the screw (21) and slide out the condenser (17). To check the condenser, use the post as one terminal and the condenser case as the other terminal in series with a lamp on a 110 volt circuit. If the lamp lights, the condenser is burned out. A 6 volt battery circuit may be used if 110 volt current is not available.

DRIVE GEAR



The drive gear may be pulled with an 8B7547 Puller after the nut and lockwasher are removed.

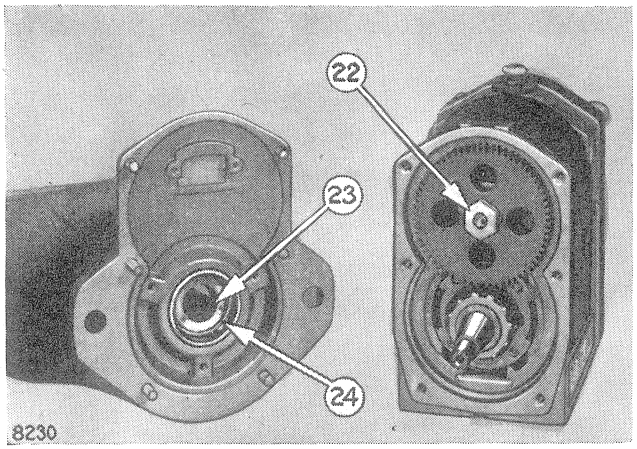
DISTRIBUTOR GEAR AND SHAFT

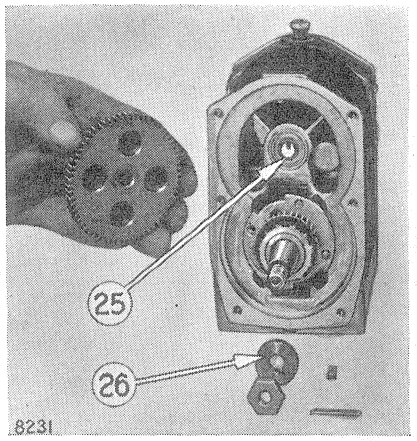
Pry out the plug (18) holding the oil wick which lubricates the breaker cam and remove the oil wick. Use non-corrosive aluminum stearate No. 2 grade grease to impregnate the oil wick.

Remove the cotter pin and nut (22) on the shaft and gently tap the shaft out of the gear. Be sure to align the timing marks on the rotor gear (31) and distributor gear when reassembling. The shaft will now slide out of the magneto. The spacer (26) is used to properly locate the distributor gear bearing (25). If damaged, this bearing should be tapped out and replaced, using drift 19984. The breaker cam bearing

(27) may be removed after the pin in the brass bushing (28) has been driven out. If the cam is scored, replace the shaft and cam assembly. Line up the slot in the outer race with the pin (29) in the housing before pressing the bearings into position. Before installation, pack the bearings with acid-free, high melting point grease.

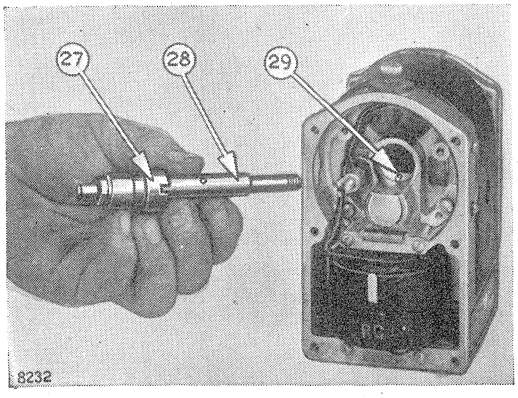
The seal (23) should be replaced, if damaged, to prevent starting engine oil fumes from entering the magneto.

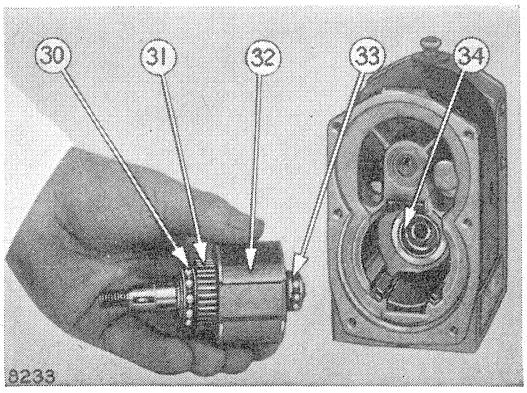




INDUCTION ROTOR AND GEAR

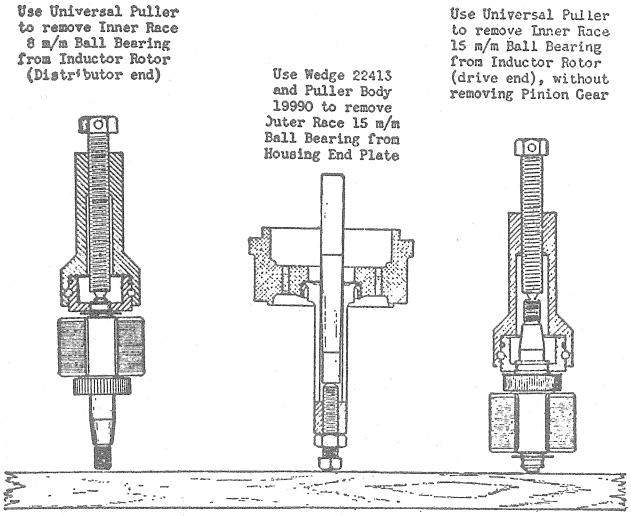
With the distributor gear removed, the rotor (32) will slide out. The rotor gear (31) and bearing (30) may be driven off by using forked drift 19986. The race alone can be removed by pulling with the Universal puller with chuck 19973. Drift 19985 will install either the race or the gear.



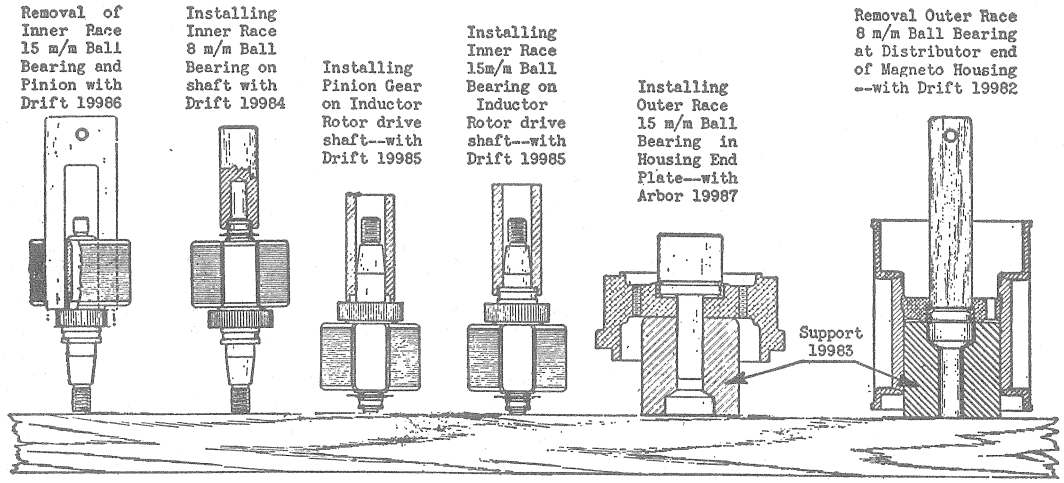


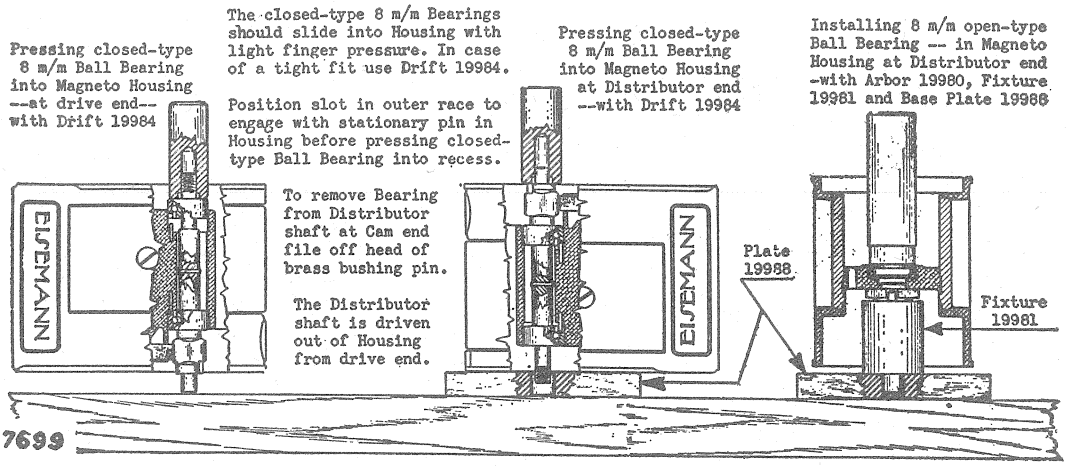
Use wedge 22413 and puller body 19990 to remove the outer race (24) from the housing. Arbor 19987 and support 19983 should be used to install this outer bearing race.

EISEMANN MAGNETO SERVICE TOOLS



The tools shown on this page for servicing the magneto are available from the distributors or service stations handling the products of Jack & Heintz Precision Industries, Inc., Cleveland 1, Ohio.





The bearing (33) and race can be pulled using the Universal puller with chuck 19971. Drift 19984 should be used to install this race. Drift 19982 with support 19983 will remove the outer race (34) from the housing. Arbor 19980, fixture 19981 and base plate 19988 should be used to install the race.

The bearings should be packed with acid-free, high melting point grease upon installation.

MAGNET

Remove the magnet only when replacing the housing by taking out the screws. Reinstall the end-marked "N" on the side of the housing with the cast "N" on it.

TIMING MAGNETO TO ENGINE

When the magneto is removed from the starting engine for any reason, it will be necessary to re-time the magneto to the engine.

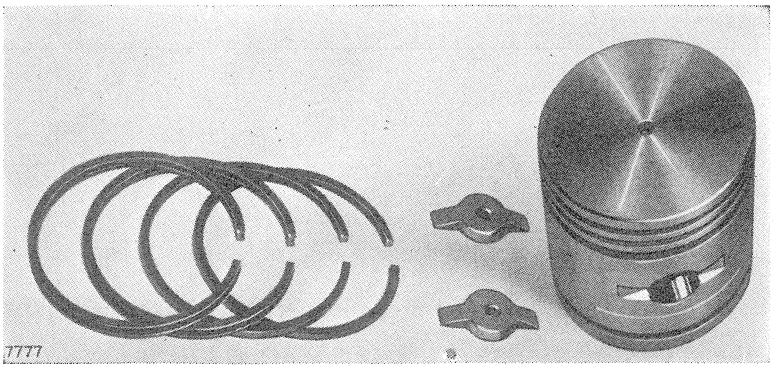
Remove the spark plug from No. 1 cylinder and rotate the flywheel in a clockwise direction until air is forced from the spark plug opening. This indicates that the piston is coming up on the compression stroke. The No. 1 cylinder is located next to the flywheel.

Continue to rotate the flywheel until the "MAG" mark on it lines up with the mark on the starting engine main bearing flange.

Remove the small cover at the end of the magneto. Turn the magneto shaft until the white line on the distributor gear lines up with the pointer in the end plate casting.

Replace the cover and install the magneto.

Pistons and Rings

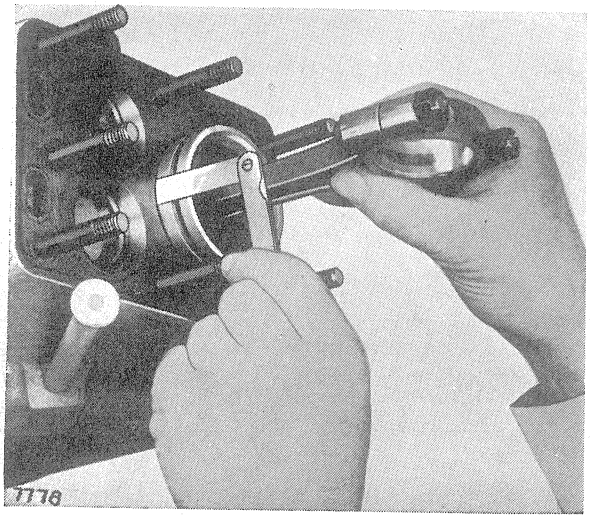


THE piston and connecting rod assembly can be removed from the side of the cylinder block.

An engine that shows a loss of power, excessive oil consumption and loss of compression may need to have the cylinder bores reconditioned.

While the piston is removed, it is a good practice to gauge the cylinder bore for possible out-of-round (eccentricity) and wall taper. If the cylinder bore shows an out-of-round of more than .004″ or a taper of .006″, the cylinder bore should be reconditioned and new pistons and rings installed.

PISTONS



CHECKING PISTON CLEARANCE

Piston clearance should be measured by a thickness gauge on the thrust side of the piston. The piston skirt clearance of a new piston should be .004″ to .006″.

The piston surfaces and ring grooves should be thoroughly cleaned before installing rings or replacing pistons in the cylinder. The most satisfactory method of cleaning pistons is to follow the same recommendations as outlined for cleaning the Diesel engine pistons.

RINGS

New compression rings should have .0015″ to .003″ side clearance in the ring groove and oil rings should have .001″ to .0025″. After the rings have been installed on the pistons, they should be free in the grooves so they can be rotated without binding.

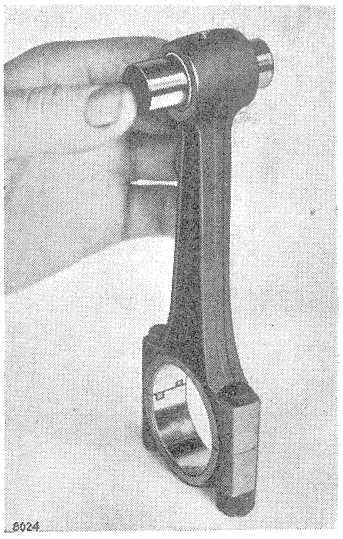
The ring gap for the compression rings should be .012″ to .022″ and the ring gap for oil control rings should be .012″ to .020″. This measurement should be taken at the smallest diameter of the cylinder bore.

PISTON PIN BUSHING

It is not always necessary to replace piston pin bushings whenever new precision bearing shells are installed in a connecting rod. In many cases, bushings may be serviceable even though the second replacement of bearing shells has been made.

After the oil has been removed from the pin and bushing, it is possible to feel the clearance between them. A new bushing should be installed only when the clearance exceeds .003″.

A piston pin bushing furnished from stock must be finished to the correct size after it is pressed into the connecting rod, and the oil hole drilled.



New connecting rods have the piston pin bushing bored in a special machine which maintains the proper center-to-center distance and parallelism of the connecting rod bearing and piston pin bore. Reconditioned rods should be reamed in the same manner. A new connecting rod makes the best templet for center-to-center distance.

The piston pin should be a thumb push fit in the connecting rod bushing and piston at normal room temperature (70° F.). The piston pin or retaining plugs must never be forced into the piston.

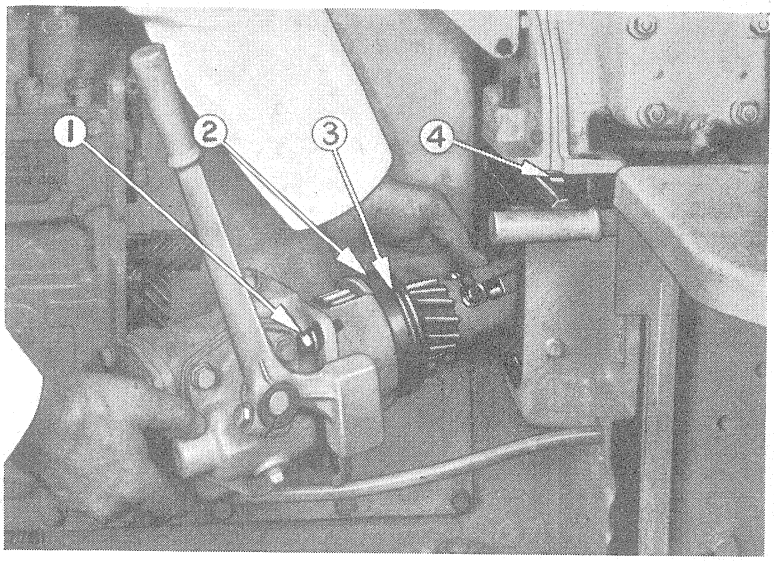
Piston assemblies should be replaced in the same cylinders from which they were removed. Cylinder number one is located next to the flywheel.

Starter Mechanism

THE starting engine transmits its power through a multiple disc clutch to a sliding pinion which is engaged with the Diesel engine flywheel gear by means of a hand lever. The pinion is automatically disengaged by centrifugal force acting on the pinion latches when the Diesel engine begins to operate under its own power.

REMOVAL

Loosen the starting engine and block it up on one side only as shown. This will permit the starting engine idler gear (4) to clear the clutch housing at (2). Remove the capscrews (1) and slide out the starter



REMOVING STARTER MECHANISM

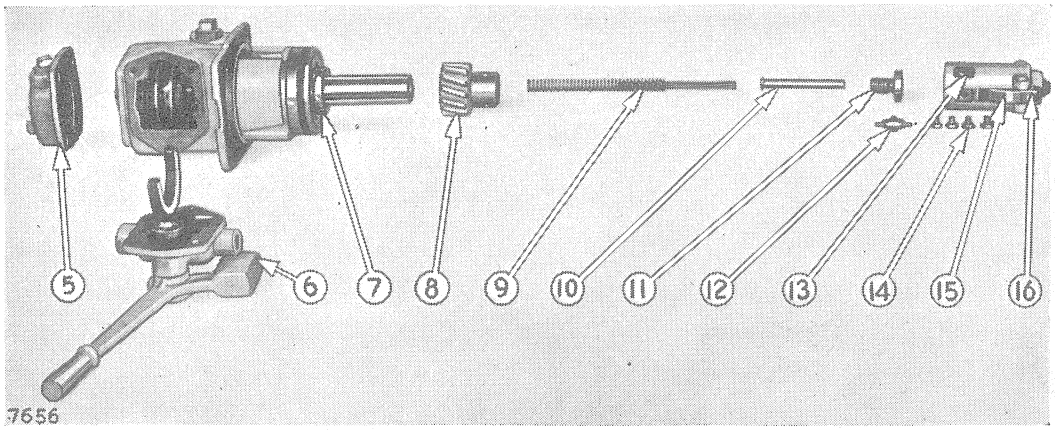
mechanism. The rubber seal (3) should be replaced if damaged. When installing the starter mechanism, coat the rubber seal with soap to facilitate installation.

LATCHES

Remove the capscrews (14) and slide off the sleeve assembly (13). If the sleeve assembly is disassembled, note the exact position of the adjusting screws (16) with reference to the latch face (15). Care should be taken to install the screws again in the same position in order not to raise the latch releasing speed.

ADJUSTMENT

One clockwise turn of the adjusting screw will increase the compression of the spring between the adjusting screws enough to increase the releasing speed of the pinion 100 to 150 R.P.M. Adjust each screw an equal amount. Care should be taken not to raise the releasing speed too high as this may cause over-speeding and damage to the starting engine. Lock the adjusting screws with new cotter pins.

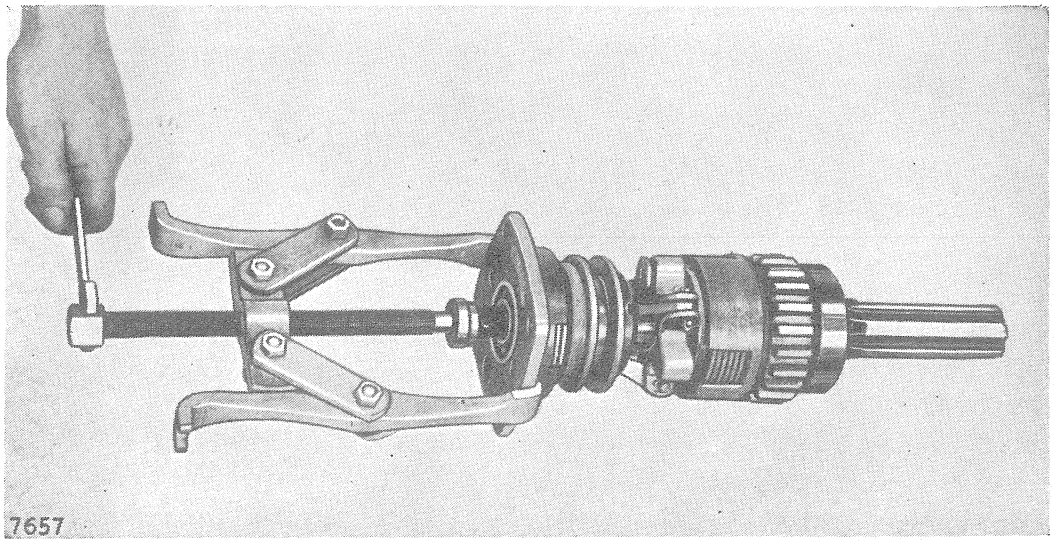


STARTER PINION REMOVAL

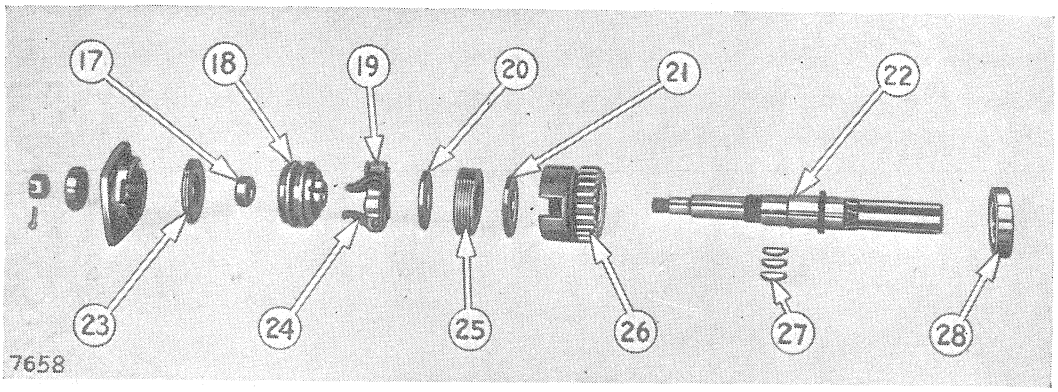
PINION

Unscrew the stop (11), remove the lock (12), plunger (10), springs (9) and pinion (8). This pinion engages the gear on the flywheel. When the latches are disengaged by centrifugal force, the springs (9) and plunger (10) press the sleeve assembly and pinion out of engagement with the flywheel ring gear.

CLUTCH



PULLING BEARING CAGE



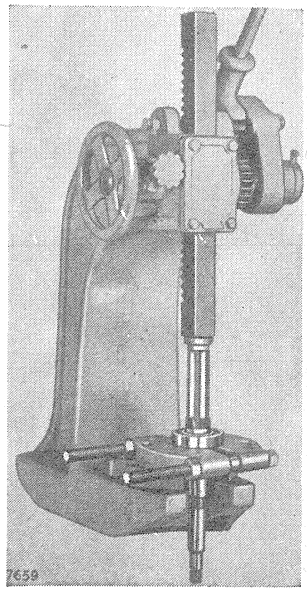
CLUTCH ASSEMBLY

It is important that the starting engine clutch be maintained in proper adjustment as described in the Operator's Instruction Book. This will assure longer clutch disc wear and more satisfactory starting of the Diesel engine.

Remove the clutch fork and cover (6) as a unit, the cover (5) and then the nut (7) and lock. Slide out the clutch assembly. The seal next to the ball bearing in the housing should be replaced if damaged.

Remove the nut and cotter pin from the end of the shaft and pull the bearing cage using an 8B7546 Puller as shown. Remove the clutch brake discs (23). The sleeve (17) which is keyed to the shaft will now slide off. The brake consists of three steel discs locked to the sleeve and two intermediate stationary brass discs which fit into the notches of the bearing cage.

Slide off the collar (18) and clutch adjusting spider assembly (19). The dogs (24) should be replaced if worn.

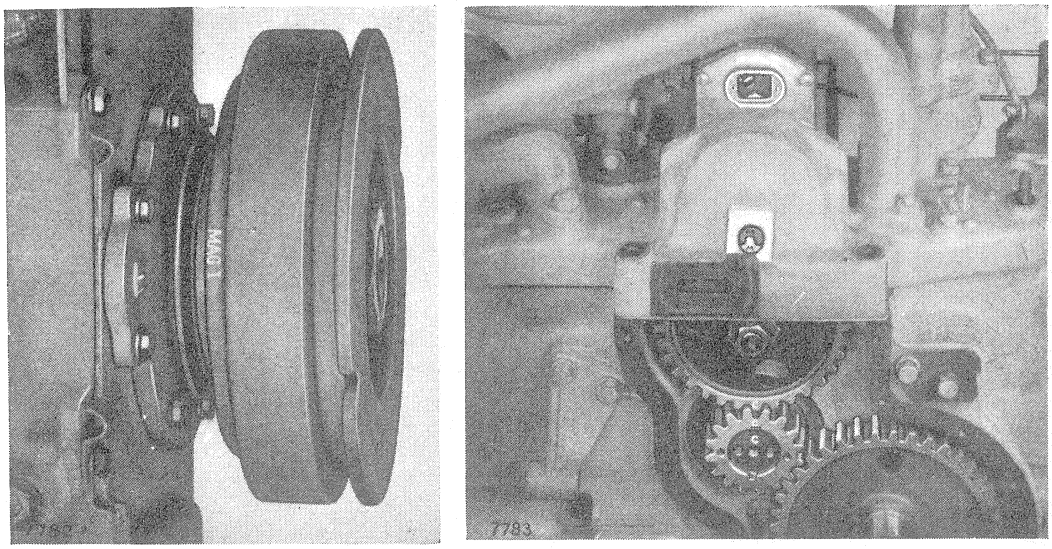


Remove the adjuster plate (20) and then the clutch discs (25). These discs are alternate steel and brass beginning with a steel disc against the adjuster plate (20). The steel discs are locked to the shaft (22) by the keys (27). Remove the plate (21) and slide off the gear (26). The bushing in the gear should be replaced if worn. The bearing (28) may be pressed off the shaft by supporting the inner race with an 8B7551 Bearing Pulling Attachment.

Timing Gear Assembly

WHEN a starting engine is reconditioned or if hard starting and loss of power are experienced, the timing should be checked.

To do this, rotate the flywheel until No. 1 cylinder (No. 1 cylinder is next to the flywheel) is on the compression stroke and the timing mark on the magneto distributor gear lines up with the mark on the magneto housing. Remove the plug and check to be sure that the camshaft gear



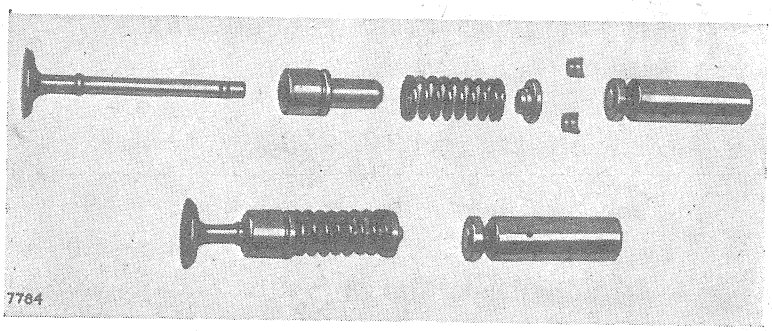
ALIGNMENT OF TIMING MARKS

and magneto drive gear timing marks are aligned. Then check the MAG mark on the flywheel to be sure that it is aligned with the mark on the bearing flange. If these timing gear marks are lined up, the engine is properly timed.

Be sure the timing mark on the crankshaft gear also lines up with the timing mark on the end of the crankshaft. Due to the two keys which prevent the crankshaft gear from rotating on the crankshaft, it is possible to install the crankshaft gear 180° out-of-time with the crankshaft and flywheel.

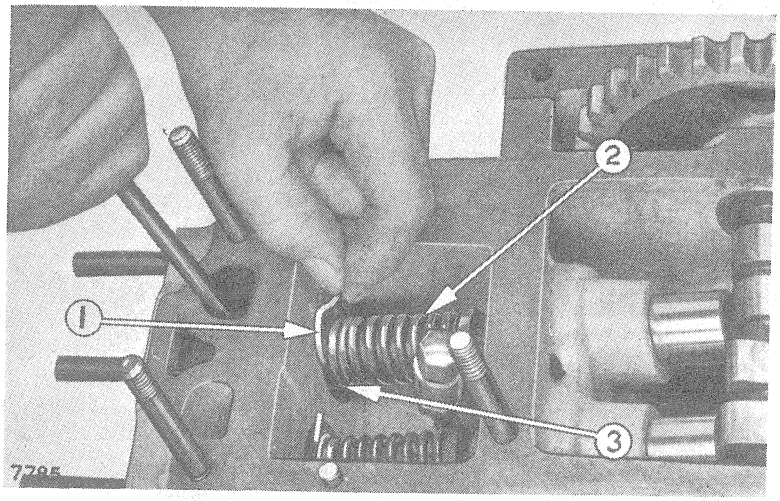
Valves and Valve Mechanism

COMPRESSION pressure losses occur when the valve faces and seats become pitted. Valves should be checked occasionally to see that they are seating properly. This may be done by rocking the starting engine against compression. If the cylinder head gaskets and piston



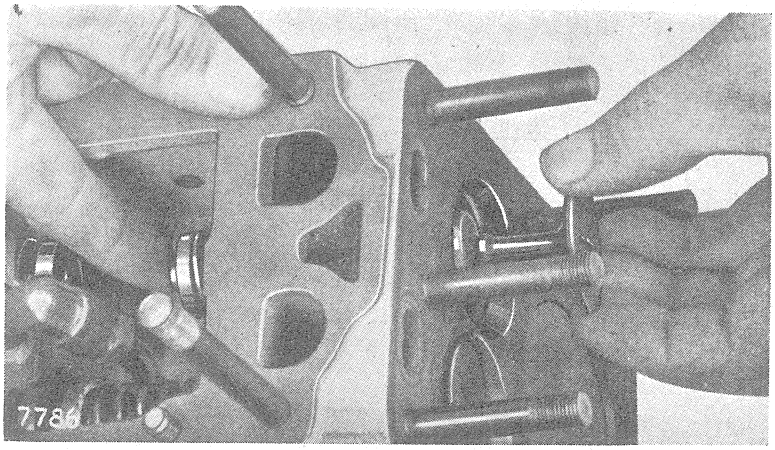
rings are in good condition and the engine does not "rock back" against compression, it is likely that the valves and seats should be refaced and reground.

VALVE INSPECTION AND RECONDITIONING



REMOVING VALVE STEM BUSHING RETAINER

Remove the cylinder heads and then the manifold assembly as outlined in the topic, CAMSHAFT.



REMOVING VALVE ASSEMBLY

Compress the valve spring (2) by inserting a screwdriver in the valve port opening and prying against the valve stem bushing (3) toward the camshaft as shown and remove the valve stem bushing retainer (1). Remove the valve, bushing, spring, retainer and locks as a unit by sliding them out as shown. Press down on the lock retainer to compress the valve spring and remove the locks.

If the bushing is worn, it should be replaced.

Valve stem to bushing clearances are:

	New Clearance	*Worn Limits*
Inlet	.0015-.003″	.005″
Exhaust	.0030-.005″	.007″

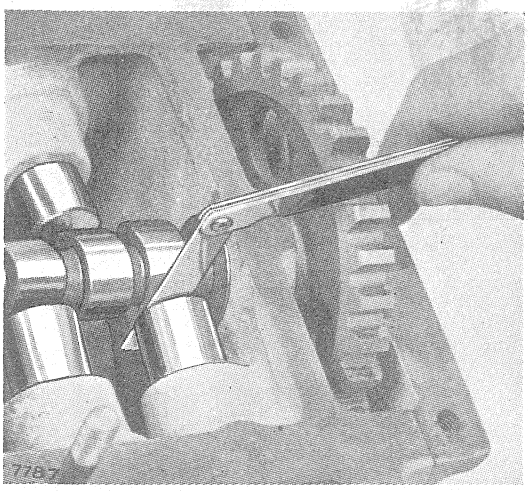
These clearances are obtained with a new valve.

The faces of the valves should always be inspected and refaced if necessary. If the faces are pitted or warped, the valves may need to be replaced.

The valve seats in the cylinder block and faces of the valves should be inspected, reconditioned if necessary, and checked as outlined in the Diesel engine section.

Carefully clean the parts of the valve mechanism before they are reassembled. When reassembling the valve mechanism, check to see that the locks are correctly installed in the lock retainer. Installation can be facilitated by coating the inside of the locks with heavy grease.

When installing the valve stem bushing retainers, check carefully to see that the retainer is correctly and completely installed in the groove of the valve stem bushing.



CHECKING VALVE CLEARANCE

VALVE CLEARANCE ADJUSTMENT

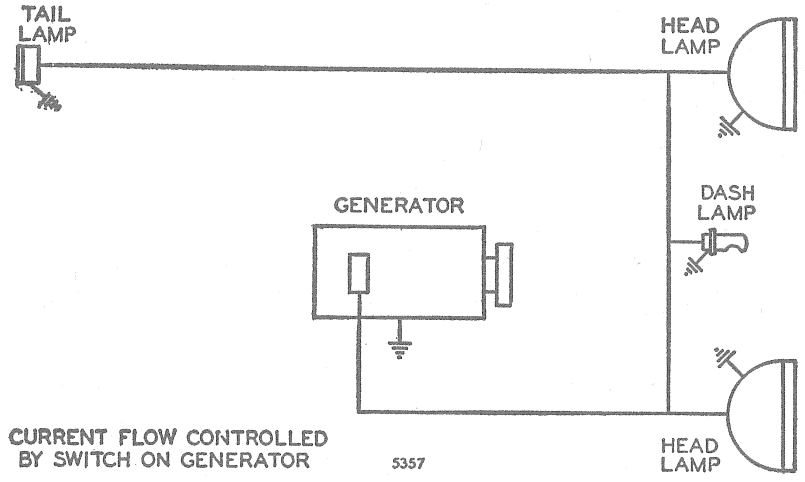
The clearance between the inlet and exhaust valve lifters and the camshaft should be .007″ to .010″ when the engine is cold. The adjustment should be made by grinding the end of the valve stem as required to obtain the proper clearance. Check the clearance with a feeler gauge as shown.

ATTACHMENTS

Lighting Systems

LIGHTING systems may be divided into two groups—those without a battery and those with a battery.

In a lighting system without a battery, the amount of electrical load imposed on the generator should be watched carefully so that a generator will never have a total electrical load greater than its rated output.



WIRING DIAGRAM (WITHOUT BATTERY)

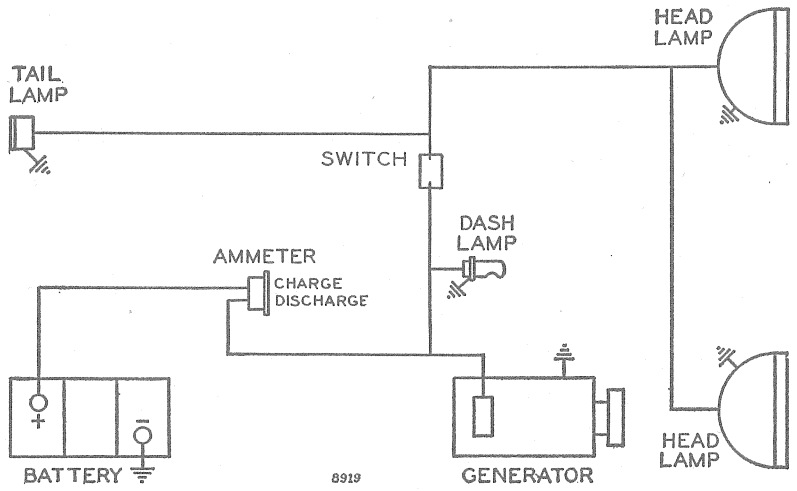
The electrical load can be estimated quite accurately in this manner: Mazda bulbs consume approximately 1 watt per candlepower. In connecting lights to a generator, without batteries, the candlepower of the lamp bulbs used should be calculated in terms of watts and the total maximum power demand kept within the rated capacity of the generator.

EXAMPLE

Lights Used	*Rating per Bulb*	*Total Watts*
2—Head Lamps	32 C.P.	64
1—Dash Light	3 C.P.	3
1—Tail Light	3 C.P.	3
		70

In this case, a 75 watt generator or larger should be used to carry the electrical load. If, however, an additional 32 candlepower light were used, the total load would then be increased to 102 candlepower. This would mean a consumption of approximately 100 watts, thus requiring a generator capacity in excess of the total load.

Lighting systems with a battery have a different type of generator. These generators are rated at 90 to 175 watts. They will take care of an overload for limited use, if run during the day to offset the excess current consumption at night.



WIRING DIAGRAM (WITH BATTERY)

Care should be taken to see that all connections are clean and tight. If the battery ground connection is broken in a lighting system with a battery, the generator voltage will rise rapidly, thus resulting in burned out bulbs and possible damage to the generator itself.

The 6 volt-90 watt generator, and 6 volt-175 watt generator are both used with a battery. These generators are of similar construction and will be discussed together. The 6 volt-130 watt generator is used without a battery and due to different type construction will be handled individually. These generators are all mounted on the right hand side of the engine and are driven by the camshaft gear.

LIGHTS

Prefocused, 32 candlepower, 6-8 volt light bulbs are used in the lamps. The light switch is located on the battery box.

Additional lamps when installed should be connected in the system past the ammeter so the current drawn will be indicated. For information regarding the requirements of the additional lamps and the capacity of the generator, refer to the topic, LIGHTING SYSTEMS.

A 3 candlepower, 6-8 volt light bulb is used in the dash lamp.

All wires should be checked periodically for worn spots on the insulation which might cause a short circuit. All connections should be kept clean and tight.

BATTERY

The electrolyte level in the battery should be checked every other day during the summer and at least once a week during the winter months. The electrolyte in the battery should be maintained at a level $\frac{3}{8}$" above the top of the plates by adding pure distilled water to each cell. Failure to maintain the proper electrolyte level will cause damage to the plates and reduce the capacity of the battery.

When distilled water is added to the battery during freezing weather, operate the generator for ten or fifteen minutes to mix thoroughly the distilled water with the electrolyte in the battery. This will eliminate the possibility of the water freezing and cracking the battery case.

CAUTION: *Never add acid, patent solutions or charging liquids to the battery electrolyte.*

The state of charge of a battery should be checked with a hydrometer every 60 hours. The following hydrometer readings indicate the charge condition:

Full charge	—1.275-1.290
Half charge	—1.225
Dangerously low	—1.150

In order to prevent freezing during cold weather, the hydrometer reading should be at least 1.250.

Keep the battery and its carrier and compartment clean and dry. Clean all accumulations of dust and dirt from the top of the battery. Such dust accumulations on a damp or rainy day may combine with moisture to form an electrical conductor and discharge the battery.

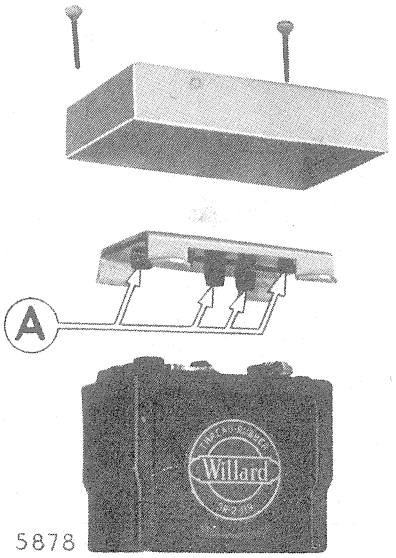
Keep the battery securely fastened in its compartment at all times.

Keep the battery terminals and leads clean and tight. To clean corrosion from the battery terminals, scrub the terminals with a weak solution of bicarbonate of soda (baking soda) and water. Dry the battery thoroughly. Coat the terminals with petrolatum to prevent corrosion.

Disconnect, thoroughly clean and inspect the other terminals of the battery cables periodically to insure good connections. Securely tighten the terminals when finished.

BATTERY BOX

The battery box is mounted on the left hand fender within easy reach of the operator. The electric starting motor switch, ammeter and lighting switch are attached to the rear face of the box. Any of these may be removed by taking out the screws and nuts holding them in position.



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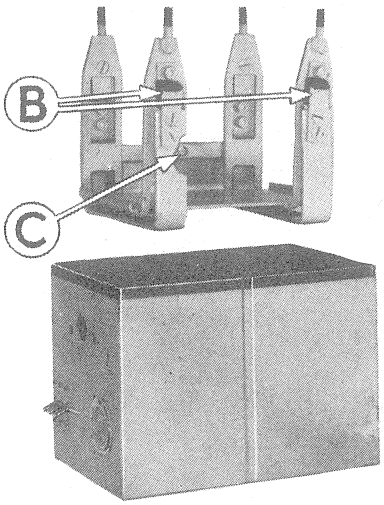

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The battery holder is constructed so as to "float" the battery on rubber.

The rubber bumper blocks (A) in the top of the battery support press against the terminals and battery posts to hold the battery firmly. Remove the nuts holding the top to the inner frame of the bottom battery support and lift off the top. Disconnect the battery cables and lift out the battery.

The rubber blocks (B) form the shock absorbing connecting links between the inner and outer support frames of the bottom battery support. These rubber blocks carry the weight of the battery and absorb vibration. The cross piece on the outer support frame has a capscrew (C) for attaching the battery ground cable. Remove the bolts and nuts holding the bottom support frame and battery box to the fender and lift out the bottom support frame.

Clean the battery box, battery support and battery of all accumulations of dust and dirt. Such accumulations, if present in sufficient quantities, may reduce the shock absorbing qualities of the battery support.

Generators

(90 AND 175 WATT)

THE recommended output of the 90 and 175 watt generators used with battery installations is shown in the following chart:

	Field Current at 6 Volts	Hot Output		
Generator	*(Amps.)*	*Amps.*	*Volts*	*Approx. R.P.M.*
90 Watt	4.0-6.1	11-14	7.5-7.85	1700-1800
175 Watt	1.53-1.67	21-23	7.0	1600

The generator output should be checked and adjusted at the voltage specified in the chart, since the generator output increases with generator voltage. Normally, if the generator is checked with an accurate ammeter and a fully charged battery, the proper voltage will be developed. If a fully charged battery is not available, it will be necessary to cut-in resistance until the proper voltage is obtained. This can be done by inserting into the charging circuit a ¼ ohm variable resistance of sufficient current carrying capacity to handle the load. See the topic, VOLTAGE REGULATOR. Connections for checking the output are shown in the sketch.

The generator output can be varied by moving the third brush as outlined in the topic BRUSHES. The output should never be set higher than recommended. If the battery continually overcharges and the regulator and generator are in proper operating condition, the charging rate should be decreased until a balance exists between the current requirements and the state of charge of the battery. Excessive output will result in an overcharged battery, light bulb failure and burned contact points and generator windings.

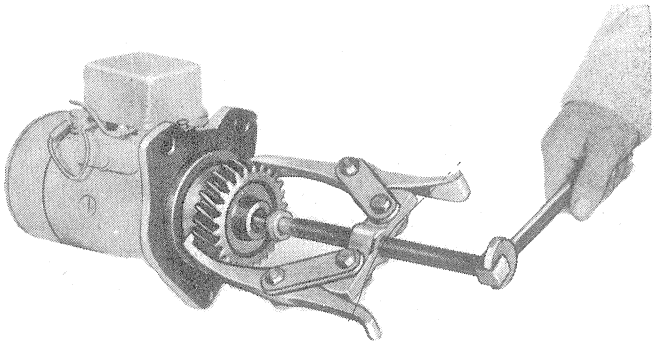
If the brushes are in good condition, the third brush properly adjusted and the regulator functioning as it should, and yet the generator output does not check with the specified current and voltage values, the unit should be disassembled and checked. If the bearings are worn, they should be replaced.

REMOVAL

Disconnect the generator lead, take out the capscrews holding the generator to the housing and remove the generator.

DRIVE GEAR

Remove the cotter pin and nut, and pull the drive gear with an 8B7546 Puller. Remove the key and shield.



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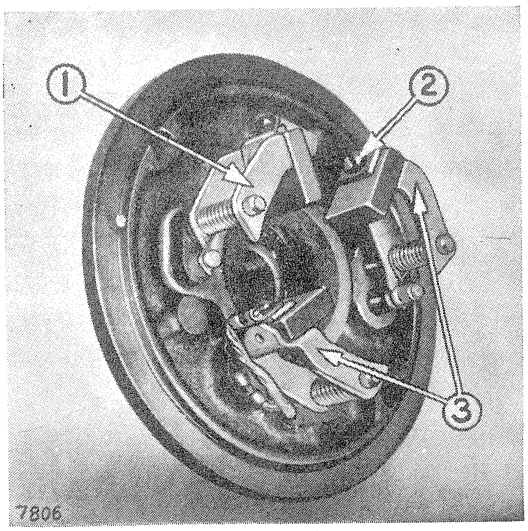
PULLING DRIVE GEAR

BRUSHES

ADJUSTMENT

These generators have an adjustable third brush (1) in addition to two fixed brushes (3). To vary the generator output, loosen the locking screw



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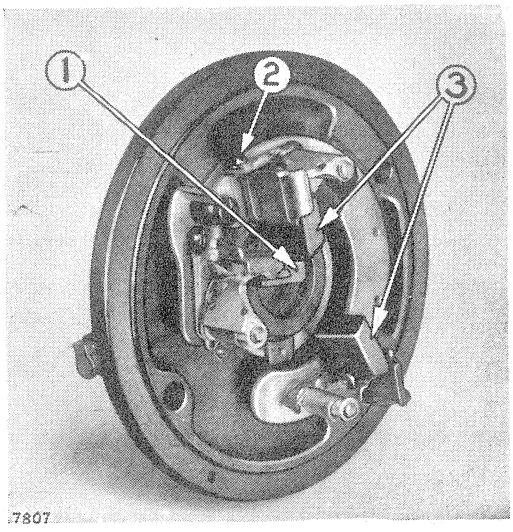

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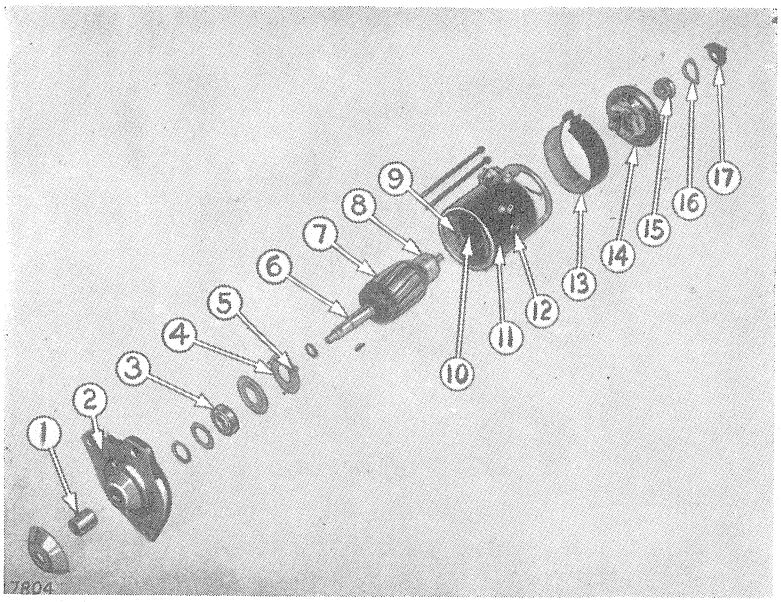
GENERATOR BRUSHES

on the rear cover of the generator and rotate the third brush in the direction of armature rotation to increase the ampere output of the generator or in the reverse direction to decrease the ampere output. Tighten the locking screw securely after making an adjustment.

TESTING: Remove all carbon dust from the brush holders and cover to insure that the brushes are not grounded. Check the lead from each carbon brush for a loose connection in the brush.

REPLACEMENT

If the brushes are worn or covered with oil, they should be replaced. Remove the tie bolts and take off the brush holder plate. Remove the screw (2) and install a new brush. New brushes may be installed through the openings under inspection cover (13).



90 WATT GENERATOR

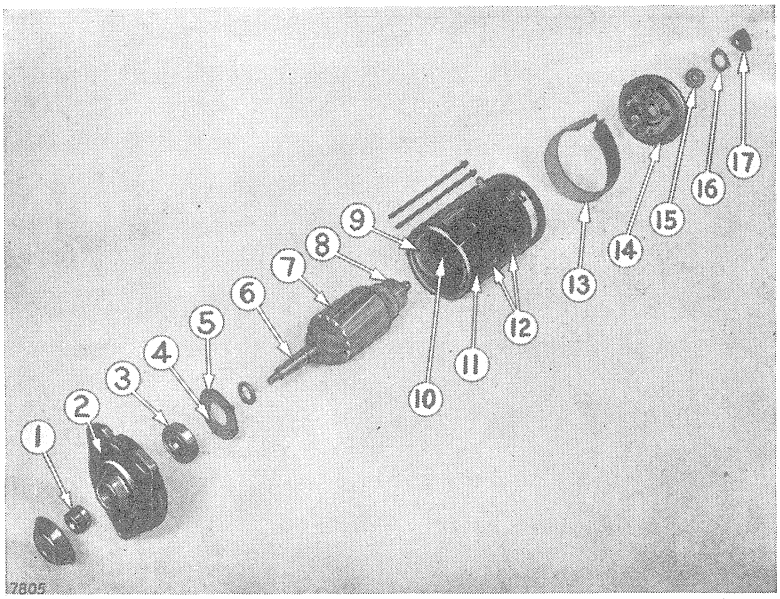
New brushes should not be sanded-in but should be seated using a bedding stone. With the engine operating at low idle speed, press the bedding stone firmly against the commutator and move it back and forth along the commutator to cover the area contacted by the brushes. The brushes should seat in a second or two. Clean the generator with air to remove all particles of abrasive. New brushes on the 90 watt generators may be seated with either "00" sandpaper or a bedding stone.

BRUSH HOLDER SPRINGS

If the brush holder springs have lost their tension, they should be replaced. On 90 watt generators, the spring tension should be 16 oz. while on 175 watt generators, the tension should be 25 oz. The third brush spring tension on both generators should be 17 oz.

BEARINGS

Remove the cover (17) and gasket (16). The bearing (15) will slip out of the end plate (14) and should be replaced if damaged.

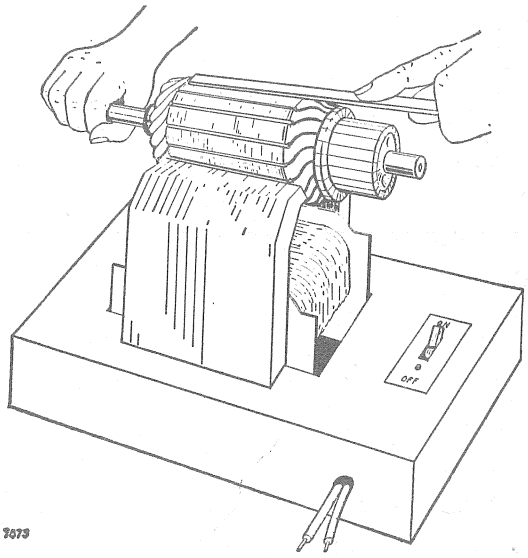


175 WATT GENERATOR

Remove the cover (2). Take out the locking wire through the screws (5), remove the screws (5), plate (4), and gasket. Slide out the bearing (3). A plate holds the felt washer in the cover (2) on 90 watt generators. This plate should be installed with the extended portion toward the drive end of the generator. The 175 watt generator has a felt washer in the cover (2). This washer is secured with a cup retainer pressed into the end cover. The spacer (1) locates the bearing (3) on the armature shaft (6). Pack the bearings with a high melting point grease before installing.

ARMATURE

Slide the armature (7) out of the stator (11). With a battery and 6 volt lamp connected in series, place one lead on the armature shaft and the other lead on each segment of the commutator (8) in succession. If the test lamp lights between any one segment and the shaft, the armature is grounded and should be replaced. If the test lamp does not light, the armature is not grounded.



CHECKING WITH GROWLER

To test the armature for a short, clean out between the commutator bars, place the armature on a growler with a hacksaw blade over the armature core and rotate the armature. If the blade does not vibrate, the armature is not shorted. If the blade vibrates, the armature is short circuited and should be replaced.

COMMUTATOR

Check the commutator (8) for roughness. If rough, it should be turned down in a lathe just enough to remove roughness and then sanded with "00" sandpaper. The commutator should check for concentricity. Undercut the mica between each segment $\frac{1}{32}$" with a hacksaw blade.

If the surface of the commutator is only glazed or darkened, polish with "00" sandpaper. Clean out the generator with air to remove abrasives.

FIELD WINDING OR STATOR

The field windings should be tested for a continuous circuit, ground and coil balance.

CONTINUOUS CIRCUIT: To test for a continuous circuit, connect a battery and a 6 volt lamp in series. Place the lead from the battery on the field (F) terminal of the generator and the lead from the lamp on the brush lead. If the lamp does not light, the field coils are open-circuited and should be replaced.

GROUND: To test for a ground, connect a battery and 6 volt lamp in series. Place the lead from the battery on the field (F) terminal of the generator and the lead from the lamp on the generator case. If the test lamp lights, the fields are grounded and should be replaced.

FIELD COIL BALANCING TEST: Connect a 6 volt battery and ammeter in series. Slide the insulation off the wire connection between the two fields. Connect the lead from the battery to this wire connection. First place the other lead on the field (F) terminal of the generator and note the ammeter reading. Second, place the same lead on the brush terminal of the windings and note the ammeter reading. If one field coil draws more current than the other, there is an internal short in that field coil and the coil should be replaced.

Removal: To replace the field coils (9) remove the screws (12) and pole shoes (10) and take out the coils. Use *rosin flux* in making all soldered connections. Check to make sure that the coils are installed in the same position as the coils which were taken out.

INSTALLATION

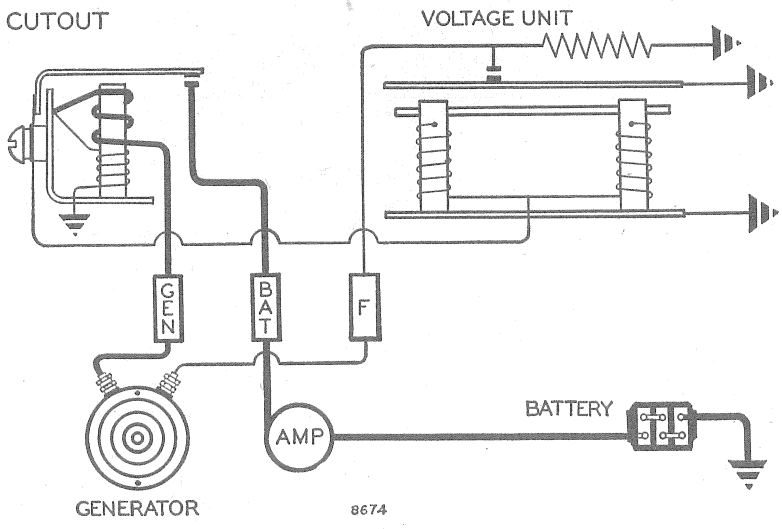
After the generator has been installed on the engine and reconnected, always connect momentarily with a jumper lead between the generator (GEN) terminal and battery (BAT) terminal of the regulator before

starting the engine. This allows a momentary surge of current to pass from the battery to the generator which will automatically give the generator the correct polarity with respect to the battery it is to charge.

Never operate the generator on an open circuit as this will allow the generator voltage to build up dangerously high and result in complete generator failure.

REGULATOR

The regulator for 90 and 175 watt generators consist of a cut-out relay and a voltage regulator.

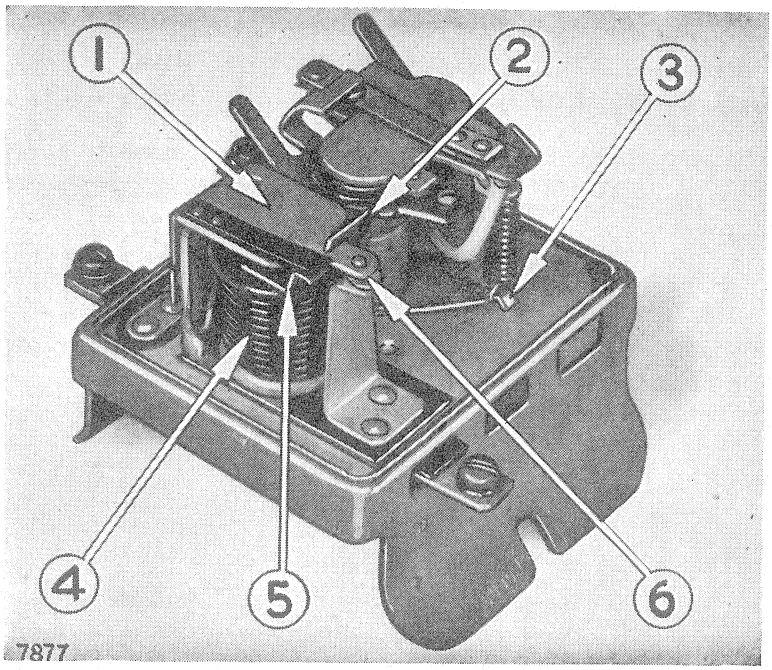


CUT-OUT RELAY

The cut-out relay automatically closes the circuit between the generator and the battery when the generator voltage is sufficient to charge the battery. The cut-out relay also automatically opens the circuit between the generator and battery when the generator voltage is not sufficient to charge the battery thus preventing the battery from discharging back through the generator windings.

TESTING: Disconnect the battery wire from the battery (BAT) terminal of the regulator. Connect an ammeter in series at this point with the positive lead of the ammeter on the battery terminal of the regulator and the negative lead on the battery wire. Connect the positive lead of a voltmeter to the generator (GEN) terminal of the regulator and ground the negative lead of the voltmeter. Start the engine, increase its speed and note the voltage at which the cut-out relay contact points (6) close. This should be 6.3 to 6.9 volts. Decrease the engine speed and note the amperage at which the contact points open. This should be 0 to 3 amperes.

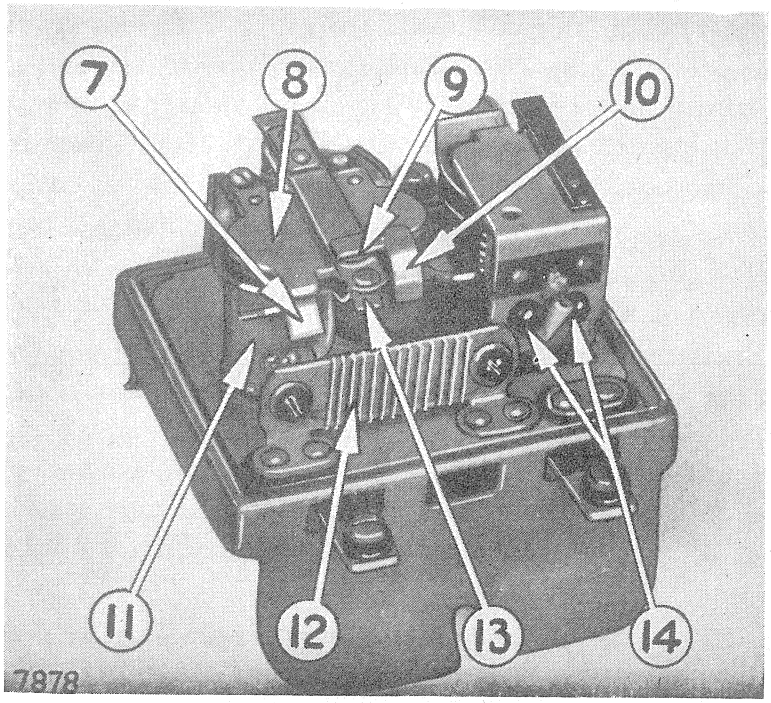
If necessary, adjust the closing voltage of the regulator by bending the spring post (5) up to increase the closing voltage and down to decrease the closing voltage.



Recheck the amperage to open the contact points. If the opening amperage is not between 0 to 3 amperes, check the air gap between the core (4) and the cut-out relay armature (1).

AIR GAP

Press the armature (1) down directly above the center of the core (4) until the points (6) just close. The air gap between the center of the core (4) and the armature (1) should be .020". Adjust the gap by loos-



ening the screws (14) on the back of the armature and raising or lowering the armature (1) as required. Tighten the screws (14) securely after adjustment.

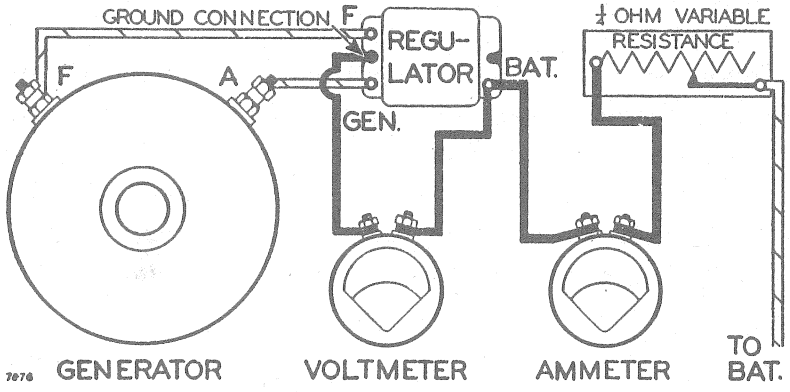
CUT-OUT RELAY POINT GAP: Adjust the contact point gap (6) to .020″ by bending the upper armature stop (2) upward to increase the gap or downward to decrease the gap.

After adjusting the air gap and cut-out relay point gap, recheck and adjust if necessary the closing voltage and opening amperage of the cut-out relay as outlined under the topic, TESTING.

VOLTAGE REGULATOR

The voltage regulator functions to insert resistance into the generator field and thus reduce generator output when the battery becomes fully charged

TESTING: Connect a voltmeter, ammeter, and variable resistance (¼ ohm) as shown. Gradually increase the engine speed and note the voltage at which the voltage control contact points open. Decrease the speed and note the voltage at which the points close. NOTE: Readings should



be taken with the regulator at operating temperature and the cover in place. The contact points (9) should open between 7.75 and 8.2 volts. The points should close between 6.55 and 7.1 volts.

If the battery is in a low state of charge, the voltage will not be sufficient to operate the voltage control contacts. To obtain sufficient voltage, operate the generator at medium speed and slowly cut in resistance until the voltage control contact points open. Then cut out resistance until they close. Adjust the voltage setting by bending the spiral spring hanger (3) down to increase the voltage setting and up to decrease the voltage setting. Recheck the opening voltage of the contact points (9). If the opening voltage is not between a range of 7.75 to 8.2 volts, check the air gap above the cores and the contact point gap.

AIR GAP

Press the armature (8) down until it just contacts the lower stop (7). The air gap between the cores (11) and the armature (8) should measure .035". Adjust the gap by bending the lower stop (7) as required. The armature travel should be .035". The correct amount of travel may be obtained by bending the upper armature stop (10).

CONTACT POINT GAP

Press the armature down until it just rests on the stop (7). The gap between the contact points (9) should be .010". Adjust the gap by bending the stop (13) as required.

After adjusting the air gap and the contact point gap, recheck and adjust if necessary the closing and opening voltage of the voltage regulator contact points as outlined under the topic, TESTING.

CLEANING CONTACT POINTS

Properly cleaning the contact points of the voltage regulator is important. Dirty or oxidized contact points arc and burn and thus cause reduced generator output and run down batteries. If the points are properly cleaned, the regulator will be restored to normal operation. If improperly cleaned, *improvement in performance will be small and only temporary.* The points should be cleaned one at a time with a spoon or riffler file. Loosen the two contact mounting screws so the upper contact bracket can be swung to one side or the contact bracket removed entirely. A flat file cannot be used successfully to clean contact points, since it will not touch the center of the flat point, and will not clean out the slight cavity formed in the point surface during normal operation. Adjust the *air gap* after cleaning the contact points. *Never use sandpaper or emery cloth to clean the contact points.*

Generator

(American Bosch ARKF Series)

NOTE: The numbers given in the following paragraphs are reference numbers only and refer to Figure 1. They should never be used in ordering service parts. Tool numbers refer to special tools available from the American Bosch Corp., Springfield, Mass.

The Generator:

The generator is of the two-brush shunt-wound type with a voltage regulator (32), sealed in the housing (30), located on top of the generator.

The cylindrical generator frame (15) contains the pole shoes (16) and field coils (19). The armature (18) rotates in grease-packed ball bearings (4 and 26) mounted in their respective end plates (2 and 28). Brush holders (25), brushes (27) and brush springs (29) are contained in the

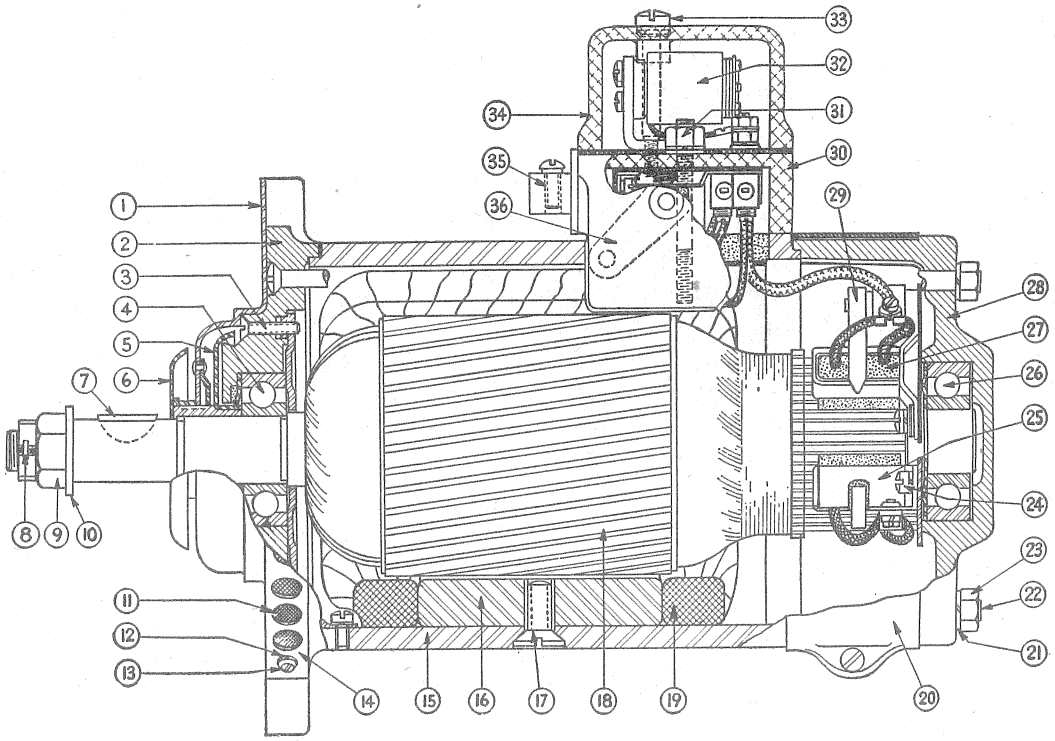


FIGURE 1

commutator end plate (28). A removable brush inspection garter band (20) protects these parts against the entrance of dust, dirt and foreign matter. A terminal block (35) secured to the saddle of the regulator assembly readily permits the attachment of an external load.

The switch mechanism, located in the hollow base (30) of the regulator is operated by the lever (36). The switch positions OFF and ON are engraved in the regulator saddle.

With the switch in the OFF position, only the generator field (19) is connected across the commutator; the external load remains disconnected.

With the switch in the ON position, both the generator field (19) and the external load are connected across the commutator.

DISASSEMBLY

To facilitate the reassembling of the generator and the regulator, it is suggested that the parts be laid on a clean bench or placed in a clean pan in the order in which they are disassembled.

Remove from the regulator the cover fastening screws (33), cover (34) and base holding screws or nuts (31). Loosen the cables in the base (30) and withdraw the complete regulator and base assembly.

1. Remove the cotter pin (8), hexagon nut (9), washer (10), woodruff key (7) and oil thrower (6) from the drive end of the armature.

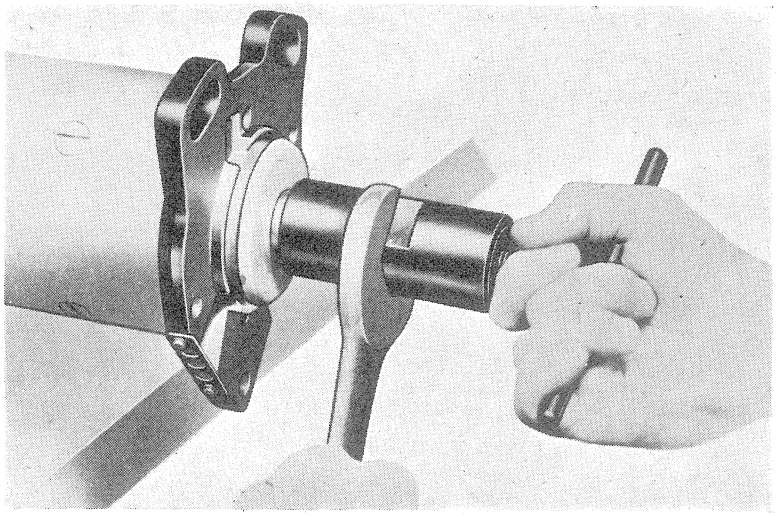


FIGURE 2

2. Withdraw the flange baffle plate fastening screws and remove the baffle plate (1).
3. Remove the oil slinger (5) using tool TSE 602—see Figure 2.
4. Withdraw the bearing retaining plate fastening screws (3).
5. Remove the garter band (20) and loosen the field coil leads from the brush holders.
6. Remove the through bolt hexagon nut (23), lock washer (21) and through bolt (22).
7. Tap end plates (2 and 28) with a mallet to remove them from the generator frame; withdraw armature (18).
8. Remove the bearings using Weidenhoff Puller Press No. 967 or equivalent. See Figure 3.

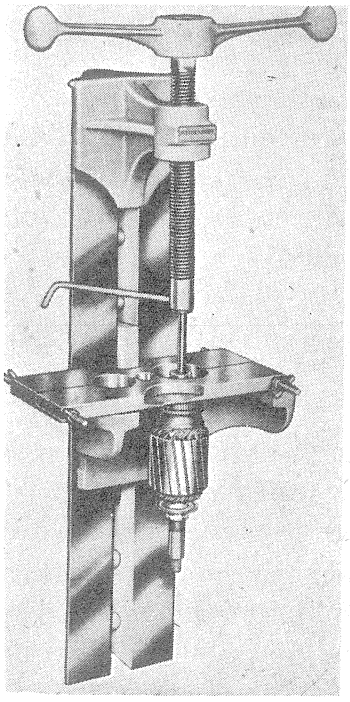


FIGURE 3

INSPECTION AFTER DISASSEMBLY

NOTE: All parts should be washed in *clean* gasoline and dried.

Check brushes (27) to ascertain if they move freely in the brush holders (25). Damaged or excessively worn brushes (27), damaged brush holders (25) and brush springs (29) must be replaced. Check insulation plate under insulated brush holder for possible damage due to heat.

Ball bearings (4 and 26) must be thoroughly cleaned in an approved solution and rough or worn bearings replaced. Repack bearings with high melting point grease.

Refer to the topic on GENERATORS (90 and 175 watt) for additional generator tests.

Visually inspect the armature for possible damage due to overheating; this would be caused by excessive load or speed. Check armature on a growler for ground, short or open circuit. If the commutator is rough, reface and undercut the mica between the commutator bars.

Remove ground connection of resistance B coil in generator frame and check continuity of field coils. A good field coil will show a current draw of 1.6 amperes at 6 volts. Replace coil if grounded or damaged due to overheating.

REASSEMBLY

Prior to positioning the bearings on the armature shaft (use tool TSE 76113 for this operation), insert them in the bore of their respective end plates to check the tolerance between the outer race and the bore. This must be a hand-push fit—under no condition should an arbor press be required.

If the outer race in the end plate is too tight, the bearing bore must be enlarged either by slight scraping or through the use of emery cloth, after which the end plate should be well cleaned.

The bearings must float in the end plates when the generator is completely assembled to allow for armature shaft expansion caused by operating temperature. If the bearings are restricted in this respect, a pressure is exerted on them with the result that they are damaged.

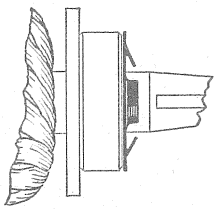


FIGURE 4

It is important that the correct retaining spring washers are properly installed in their respective end plates. Figures 4 and 5 show the right way to install the retaining spring washer at the drive end and the retaining spring washer at the commutator end.

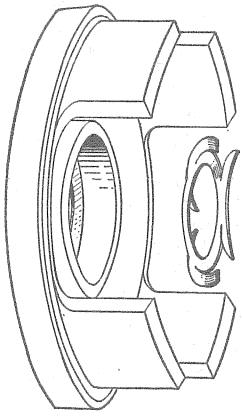


FIGURE 5

Complete the assembly of the generator following the opposite procedure to that outlined under Disassembly and check the end play.

The armature should have an end play of from .010"-.040". This can be checked by backing off about two turns on the bearing retaining plate fastening screws, see Figure 6. Pull the armature drive shaft toward you against the thrust of the spring washer. From this position it should be possible to push the armature toward the commutator end plate in accordance with the dimensions given above. Sufficient force must be exerted to overcome the pressure of the retaining spring washer.

If the unit has adequate end play, re-tighten retaining plate fastening screws. However, if the unit has insufficient end play recheck the assembly, making certain that bearings are properly positioned on the armature shaft. Reassemble the generator and recheck the end play.

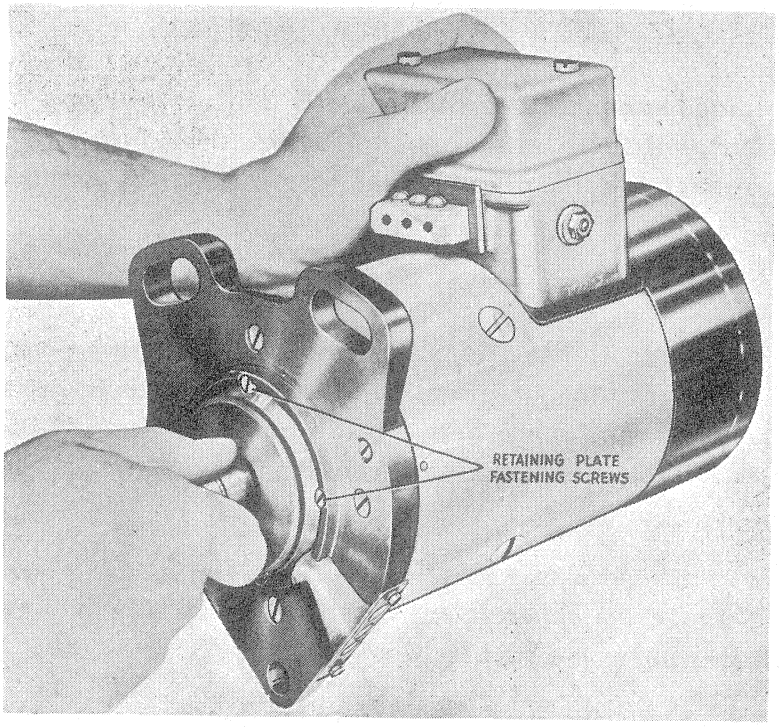


FIGURE 6

CHANGING THE GENERATOR ROTATION

The direction in which the generator must rotate is indicated by an arrow on the generator frame. Figure 7, illustrates the proper connections for anti-clockwise rotation of these units when viewed from the drive end.

To change the direction of rotation it is only necessary to reverse the two leads of the field coil, these can readily be identified since one is red and the other is blue or bluish green.

On SAE flange mounted generators it is also necessary to change the oil slinger (5). The threads on the hub of the oil slinger must correspond to the direction of rotation.

REGULATOR

The regulator unit (32) is of rugged construction, having a high contact pressure and powerful magnet which eliminates the influence of engine vibrations on its performance. The following is a general explanation of the functioning of the regulator, with the switch in the 'ON' position (see Figure 7)..

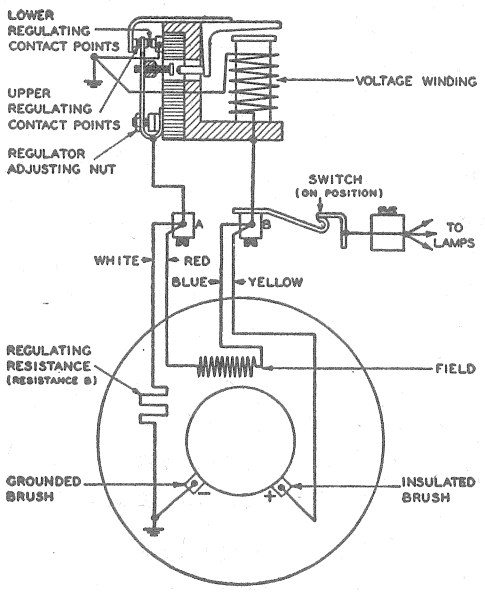


FIGURE 7

The armature (18) rotating in the magnetic field of the generator produces a voltage between the brushes (27), of which one is grounded. Current travels from the insulated positive (+) brush through the switch to the regulator yoke through the voltage coil returning to the negative (—) brush by way of ground.

At medium operating speeds, when the voltage tries to become excessive, the lower regulating contact points open, due to the increased current in the voltage coil, forcing the field current to flow from the terminal post 'A' through regulating resistance 'B' to ground.

At high operating speeds, when the armature (18) tries to develop an excessive voltage which, if not checked, would be detrimental to the current consumers and the generator, the upper regulator contact points close and open in rapid succession. This action, short circuits the generator field for brief intervals, reducing the field current to a comparatively low average value, thus stabilizing the generator voltage within permissible limits.

DISASSEMBLY

IMPORTANT! If the coil of the regulator is damaged due to overheating or the core is loose in the yoke, the unit is beyond field repair and must be replaced.

NOTE: The numbers given in the following paragraphs refer to Figure 8.

1. Withdraw the hold-down bracket fastening screw (3) and lock washer (4).

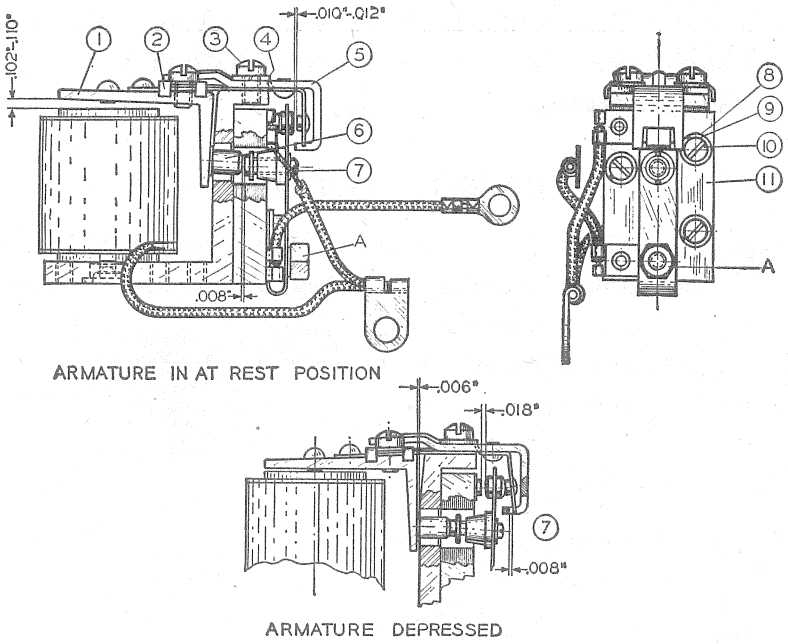


FIGURE 8

2. Remove the armature hold-down bracket (5) and armature assembly (1). Care must be exercised in the removal of the armature assembly (1) to prevent damage to the glass bead.
3. Withdraw the fastening screw (10), plain washer (8), lock washer (9) and contact terminal block (11).

INSPECTION AFTER DISASSEMBLY

1. Check the tension of the hold-down bracket contact point (this must not be less than 11 oz.) using the spring scale as shown in Figure 11.
2. Examine the contact points for signs of wear. Exercise care in dressing the points to assure a flat, square surface. Peaks or craters appearing on the contact surface must be removed. A fine stone is recommended for this operation. Crocus cloth should be used to obtain a mirror finish.
3. Check the riveting of glass bead (6) in the armature assembly (1). If this is loose, the armature must be replaced.

REASSEMBLING THE REGULATOR

1. The assembly must be clean and free from dust, dirt, chips, oil or solder flux. Check all solder joints and connections.

2. All contact point surfaces must be cleaned with carbon tetrachloride and wiped off with a *clean* chamois skin before reassembly.

IMPORTANT! Contact surfaces must not be touched with the hand after they are cleaned. Feeler gauges used to check air gaps and contact openings must be kept scrupulously clean.

3. Reassemble the contact terminal block (11) to the regulator yoke using screws (10), plain washer (8) and lock washer (9).

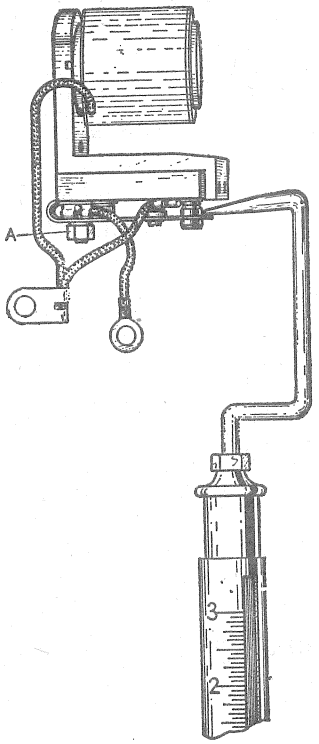


FIGURE 9

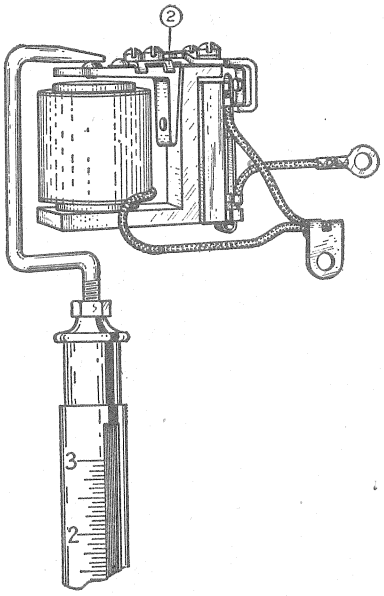


FIGURE 10

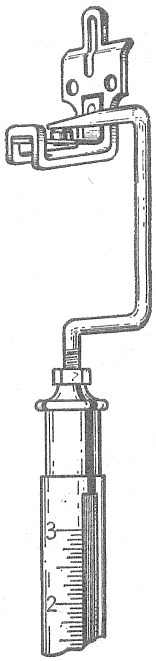


FIGURE 11

4. Adjust the tension of the terminal block movable contact springs —see Figure 9—this must be between 14 to 18 oz. Adjustment is made by tightening or loosening nut (A).

5. Loosely fasten the armature assembly (1) and hold-down bracket (5) to the regulator yoke using screw (3) and lock washer (4).

6. With the armature depressed, adjust the gap between the armature and yoke to .006″—see Figure 8—using a standard feeler gauge. Securely fasten the armature in place.

7. With the armature (1) in the "at rest" position, the gap between the front of the armature and core must be .102″-110″; adjustment is made by bending the tongue end of the hold-down bracket (5) up or down as required.

8. Check the tension of the armature spring—see Figure 10—this must be between 23 oz.-32 oz. Adjustment is made by shifting the spring clamp (2).

9. The gap between the upper regulating points, in the "at rest" position, should be .010"-.012". Adjustment is made by bending the armature hold-down bracket as required. Recheck spring tension —see paragraph 1 under Inspection After Disassembly.

10. With the armature (1) fully depressed, the opening between the lower regulating contacts must be at least .018". This is adjusted by means of the reverse current screw (7). In this position the spring with the upper regulating contact must be raised at least .008" from its "at rest" position.

11. With armature (1) in the "at rest" position, a gap of not less than .008" must exist between reverse current screw (7) and the glass bead (6).

12. Securely set all fastening screws and reassemble the regulator to the generator.

ELECTRICAL ADJUSTMENT

1. Connect a low reading voltmeter (scale 0-10 volts) between the ground and the external terminal block of the regulator base.

2. Adjust the regulating voltage at 1000 generator R.P.M. to 6.0-6.3 volts by turning the nut (A) in or out as required. No external load should be connected during this adjustment.

3. Increase the generator speed to 2500 R.P.M. Adjust the regulating voltage to 6.3-6.6 volts, turning the reverse current screw (7) in or out as required.

4. Connect three 21 candle power lamps in parallel between the terminal block and ground, and recheck the regulating voltage as outlined.

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STARTING ENGINE

ATTACHMENTS

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