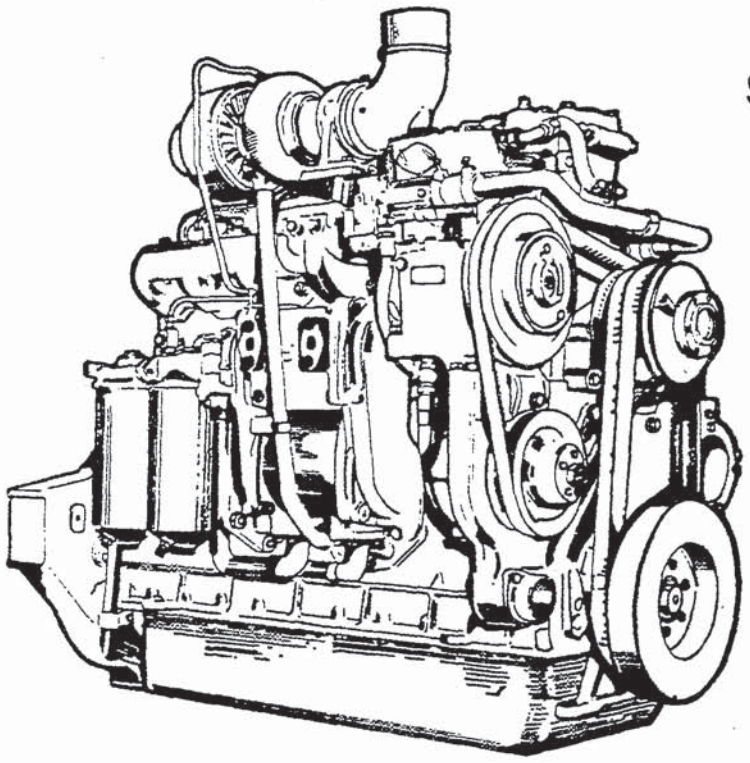
FIATALLIS®

2800
2800 MK1
2900
2900 MK1

ENGINES



service manual

Form 73110787 English
8-89

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SAFETY RULES

Never use gasoline or solvent or other flammable fluid to clean parts. Use authorized commercial, non-flammable, non-toxic solvents.

Never place gasoline or diesel fuel in an open pan.

Shut off engine and be sure all pressure in system has been relieved before removing panels, housings, covers, and caps. See Operation and Maintenance Instruction Manual.

Do not remove hoses or check valves in the hydraulic system without first removing load and relieving pressure on the supporting cylinders. Turn radiator cap slowly to relieve pressure before removing. Add coolant only with engine stopped or idling if hot. See Operation and Maintenance Instruction Manual.

Fluid escaping under pressure from a very small hole can almost be invisible and can have sufficient force to penetrate the skin. Use a piece of card board or wood to search for suspected pressure leaks. *DO NOT USE HANDS.* If injured by escaping fluid, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

Never use any gas other than dry nitrogen to charge accumulators. See Operation and Maintenance Instruction Manual.

When making pressure checks use the correct gauge for expected pressure. See the Operation and Maintenance Instruction Manual or Service Manual for guidance.

For field service, move machine to level ground if possible and block machine. If work is absolutely necessary on an incline, block machine and its attachments securely. Move the machine to level ground as soon as possible.

Brakes are inoperative when manually released for servicing. Provision must be made to maintain control of the machine by blocking or other means.

Block all wheels before bleeding or disconnecting any brake system lines and cylinders.

Never use make shift jacks when adjusting track tension. Follow the Undercarriage Service Manual.

Know your jacking equipment and its capacity. Be sure the jacking point used on the machine is appropriate for the load to be applied. Be sure the support of the jack at the machine and under the jack is appropriate and stable. Any equipment up on a jack is dangerous. Transfer load to appropriate blocking as a safety measure before proceeding with service or maintenance work according to local or national requirements.

Always block with external support any linkage or part on machine that requires work under the raised linkage, parts, or machine per local or national requirements. Never allow anyone to walk under or be near unblocked raised equipment. Avoid working or walking under raised blocked equipment unless you are assured of your safety.

When servicing or maintenance requires access to areas that cannot be reached from the ground, use a ladder or step platform that meets local or national requirements to reach the service point. If such ladders or platforms are not available, use the machine hand holds and steps as provided. Perform all service or maintenance carefully.

Shop or field service platforms and ladders used to maintain or service machinery should be constructed and maintained according to local or national requirements.

Lift and handle all heavy parts with a lifting device of proper capacity. Be sure parts are supported by proper slings and hooks. Use lifting eyes if provided. Watch out for people in the vicinity.

In lifting and handling heavy parts, slings must be of adequate strength for the purpose intended and must be in good condition.

Handle all parts with extreme care. Keep hands and fingers from between parts. Wear authorized protective equipment such as safety glasses, heavy gloves, safety shoes.

When using compressed air for cleaning parts use safety glasses with side shields or goggles. Limit the pressure to 207 kPa (30 psi) according to local or national requirements.

Wear welders protective equipment such as dark safety glasses, helmets, protective clothing, gloves and safety shoes when welding or burning. Wear dark safety glasses near welding. *DO NOT LOOK AT ARC WITHOUT PROPER EYE PROTECTION.*

Replace seat belts every two years on open canopy units and every three years on machines with cabs or at change of ownership.

Wear proper protective equipment such as safety goggles or safety glasses with side shields, hard hat, safety shoes, heavy gloves when metal or other particles are apt to fly or fall.

Use only grounded auxiliary power source for heaters, chargers, pumps and similar equipment to reduce the hazards of electrical shock.

Keep maintenance area *CLEAN* and *DRY.* Remove water or oil slicks immediately.

Remove sharp edges and burrs from reworked parts.

Be sure all mechanics tools are in good condition. *DO NOT* use tools with mushroomed heads. Always wear safety glasses with side shields.

Do not strike hardened steel parts with anything other than a soft iron or non-ferrous hammer.

Do not rush. Walk, do not run.

Know and use the hand signals used on particular jobs and know who has the responsibility for signaling.

IMPORTANT: MODEL 2800 MKI. Even though only one belt may need replacement because of damage or excessive wear, it is imperative that both belts be replaced to obtain satisfactory belt life. After replacement, approximately 24 hours operating time is required to properly seat a new pair of belts. Readjust the belts after this period.

3. Install fan belt by a direct reversal of the removal procedure and adjust the belt; refer to "FAN BELT ADJUSTMENT" in this section.

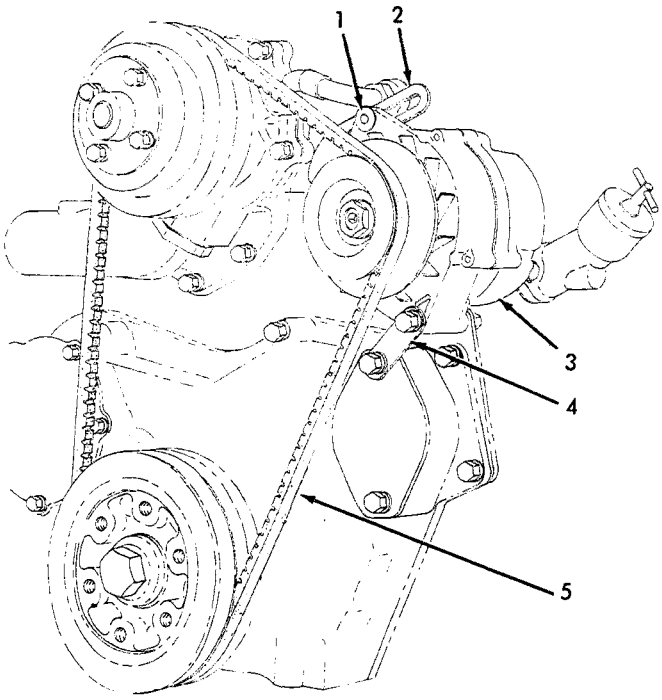

FIG. 1 FAN BELT ADJUSTMENT LOCATION (MODEL 2900 SHOWN) (T-74681)

1. Adjusting bracket capscrew
2. Adjusting bracket
3. Alternator
4. Alternator supporting bracket
5. Belt

D. FAN, FAN SPACER, AND FAN PULLEY REMOVAL, INSPECTION, AND INSTALLATION

Fan blades seldom require service. However, bent blades are conducive to inefficient cooling and will affect the balance of the fan causing water pump bearing damage. In case of damage, the fan should be removed and the blades restored to their original contour (check by comparing with a new or undamaged fan) or replace with a new fan. For removal of the fan, fan spacer, and fan pulley, proceed as follows:

1. Remove capscrews and lockwashers securing fan and fan spacer to pulley hub; remove fan and fan spacer.

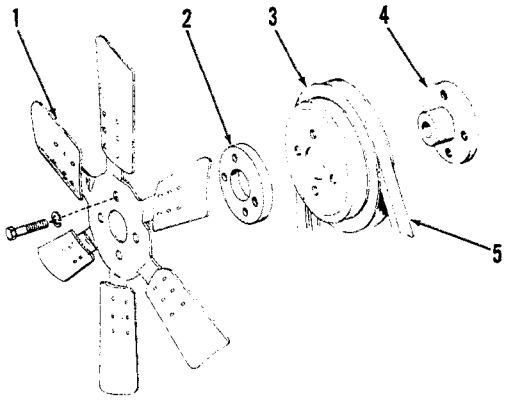

FIG. 2 FAN AND FAN PULLEY PARTS (T-54408)

1. Fan
2. Fan spacer
3. Pulley
4. Pulley hub
5. Belt

2. Loosen capscrew securing alternator to adjusting brace and push alternator in far enough so the belt can be removed from the fan pulley.

3. Slip the belt off the fan pulley and remove the pulley from the water pump hub.

4. Inspect fan for cracks, loose rivets, or bent blades. Repair or replace if necessary.

5. Inspect fan spacer and fan pulley for wear or damage. Replace if necessary.

6. Position fan pulley on water pump hub; position belt in fan pulley groove.

7. Install fan spacer and fan, securing with capscrews and lockwashers. Tighten capscrews to a torque of 30 to 35 lbs. ft. (4.14 - 4.83 kg – m).

8. Adjust fan belt; refer to "FAN BELT ADJUSTMENT" in this section.

2. Mark alternator lead wires for later identification and disconnect lead wires.

3. Remove capscrew and plain washer attaching alternator to adjusting brace. Push alternator in and remove drive belts from pulley.

4. Remove capscrew and lockwasher attaching alternator to supporting bracket and remove alternator.

5. Install alternator in reverse order of removal.

C. ALTERNATOR SERVICE

Complete information regarding servicing the alternator is contained in Electrical System Service Manual.

TOPIC 5 - VOLTAGE REGULATOR

A. DESCRIPTION

The regulator is a two-unit regulator consisting of a voltage regulator unit and field relay unit. The voltage regulator unit operates to limit alternator voltage to a preset value; the field relay unit connects the alternator field winding and regulator winding directly to the battery.

The two-unit regulator has 4 slip-connection type terminals. A projection on the connector body serves to latch the assembly together and prevent disconnections due to vibration. The assembly can be disconnected by lifting slightly on the latch.

IMPORTANT: Polarities of the regulator, alternator, and battery must be the same. Instant damage will result if polarities are mismatched. Do not short across or ground regulator terminals. Do not operate without a battery.

B. VOLTAGE REGULATOR REMOVAL AND INSTALLATION

1. Mark regulator lead wires for subsequent identification. Disconnect lead wires.
2. Remove attaching capscrews, nuts, and lockwashers and remove regulator.
3. Install regulator in reverse order of removal.

C. VOLTAGE REGULATOR SERVICE

Complete information regarding servicing the voltage regulator is contained in Electrical System Service Manual.

TOPIC 6 - STARTER

A. DESCRIPTION

The starter is an enclosed shift lever starting (cranking) motor. The shift lever mechanism and solenoid plunger are enclosed in the drive housing. Thus the shifting mechanism is protected from exposure to dirt, splash, and icing conditions. The drive is operated by means of the shift lever and linkage from the solenoid switch mounted on the starter drive housing. Closing the control switch energizes the cranking circuit starter solenoid which shifts the starter pinion into mesh with the engine flywheel ring gear, and simultaneously closes the main circuit contacts located inside the solenoid housing. The starting motor does not require lubrication except during overhaul. For service replacement, the starting motor has a universal type mounting flange which may be rotated, if necessary, for proper fit.

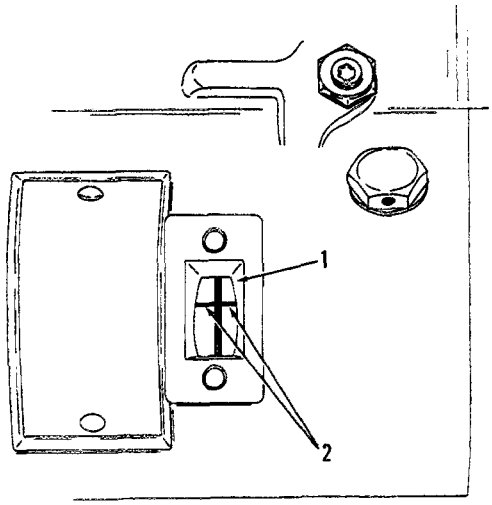

FIG. 6 FUEL PUMP TIMING MARKS - MODEL 2900, First Type Shown (T-50586)

1. Timing window 2. Timing marks

IMPORTANT: To prevent internal damage to the fuel injection pump, WIRE THE GOVERNOR SPEED CONTROL LEVER IN THE "FULL FUEL" POSITION.

8. Remove the pump retaining stud nuts and serrated washers. Remove pump by pulling it to the rear (off shaft). Use care to prevent damaging drive shaft seals.

C. FUEL INJECTION PUMP INSTALLATION AND STATIC TIMING

When the fuel injection pump has been serviced and is ready to be reinstalled, or if a new pump is to be installed on the engine, follow the procedure outlined below:

1. Remove timing window cover from the fuel injection pump. Two fuel pump timing marks are used for timing injection of fuel into Number 1 cylinder. One mark is located on governor weight retainer hub and one is located on the cam ring. Insert screwdriver, or other suitable tool, into drive shaft end of pump and turn distributor rotor until timing marks are aligned as viewed through the timing window.
2. Rotate engine flywheel until Number 1 piston approaches top dead center on its compression stroke. This is determined by observing valves of Number 1 cylinder. With both valves closed (valve push rods at bottom of travel), continue to rotate flywheel until pointer on front of timing gear housing cover is aligned with BTDC mark stamped on crankshaft pulley, Fig. 5. Engine is now properly positioned for installation of the fuel injection pump.
3. Inspect pump drive shaft seals and pilot seal. Replace if necessary.
4. Lubricate seals with engine oil or grease. Slide pump over drive shaft and on to pump mounting studs using care to prevent damage to seals. Install serrated washers and the pump stud nuts but do not tighten nuts at this time.
5. Turn pump until timing marks are aligned. Tighten attaching stud nuts securely to a torque of 18 to 21 lbs. ft. (2.48-2.90 kg-m).

NOTE: Mounting holes in pump housing are elongated so pump can be turned to align timing marks within the timing window.

6. Install timing window cover and gasket.
7. Install and connect the fuel injection lines to their corresponding openings in the fuel injection pump and fuel injection nozzles.

   Make sure that a copper gasket is used on both sides of the injection line fitting at the fuel injection pump opening. Tighten the fuel injection line nuts and connecting screws securely.

8. Complete the installation by reversing the removal procedure.

D. CHECKING AND ADJUSTING AUTOMATIC TIMING ADVANCE

The function of the automatic advance, is to advance the timing automatically as the engine speed increases.

The specified advance, as the engine speed increases, is 2° at 1000-1200 rpm and 8° at 1600-1800 rpm for the Model 2900 engine; 12° for the Model 2800 MKI engine. A plastic timing window, Fig. 7 (1), Roosa Master tool number 13366, is required to test and adjust the automatic timing advance. Test and adjust as follows:

1. Make certain the fuel injection pump static timing (engine stopped) is set at the specified B.T.D.C. Refer to "FUEL INJECTION PUMP INSTALLATION AND STATIC TIMING" in this Topic.
2. Remove timing window cover and install plastic timing window, Fig. 7 (1).
3. Run engine until coolant reaches normal operating temperature.

IMPORTANT: When setting or checking the automatic advance, it must always be done after reducing the engine speed from high idle to the specified rpm.

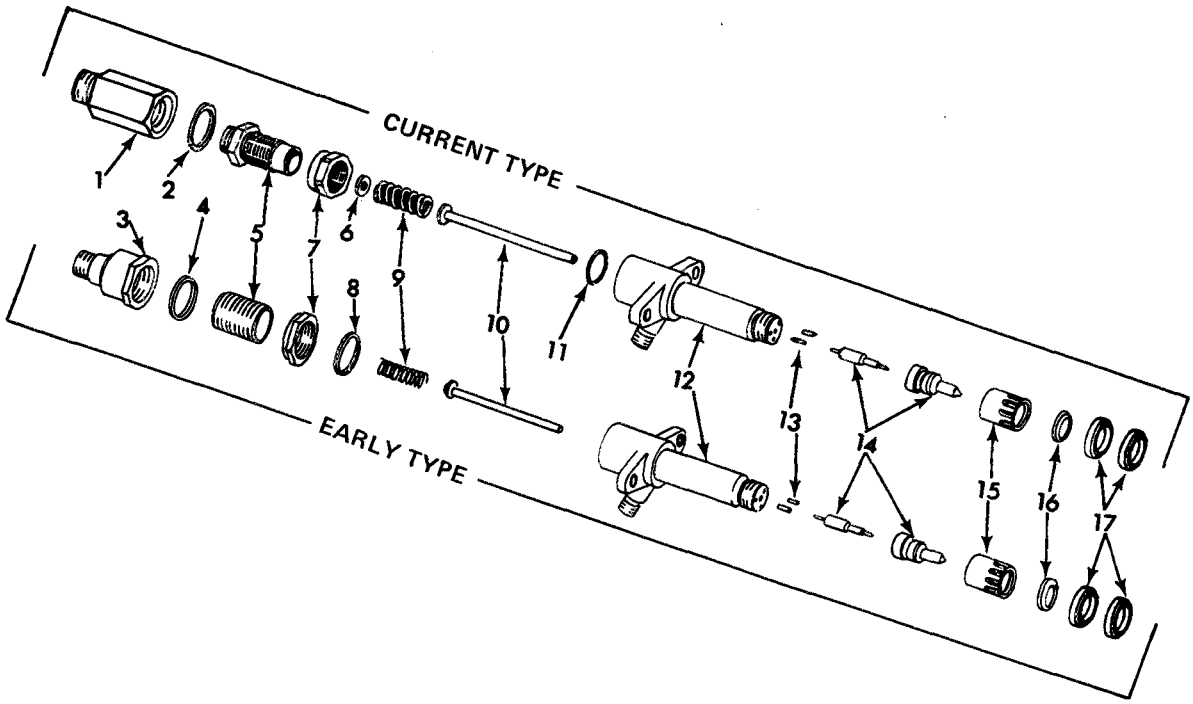

FIG. 20 NOZZLE HOLDER ASSEMBLY
(T-80057)

1. Adaptor
2. Gasket
3. Cap nut
4. Gasket
5. Adjusting screw
6. Wear washer
7. Locking nut
8. Gasket
9. Spindle spring
10. Spindle rod
11. O-ring
12. Holder body
13. Dowel pins
14. Nozzle body & needle valve
15. Retaining nut
16. Gasket
17. Nozzle holder dust shields

and castor oil used on tissue paper. The valve may be held by its stem in a revolving chuck for this cleaning operation. An orange stick or round toothpick will be helpful in cleaning the valve.

Hard or sharp tools, emery cloth, crocus cloth, jeweler's rouge, grinding compounds, or other abrasives should never be used in cleaning.

l. Thoroughly rinse the valve in clean diesel fuel before installing it in the valve body.

m. Examine the flat sealing surface of the valve body (surface which contacts lower end of the holder body) and make certain surface is clean and free of scratches. This surface may be lapped, if necessary, using Allis-Chalmers 1000G lapping compound, castor oil, and a lapping block as shown in Fig. 21. After lapping, remove all traces of lapping compound with clean diesel fuel.

n. Make certain the bottom flat sealing surface of nozzle holder body is clean and in good condition. Rinse the valve and valve body in clean diesel fuel, then insert valve into position in body.

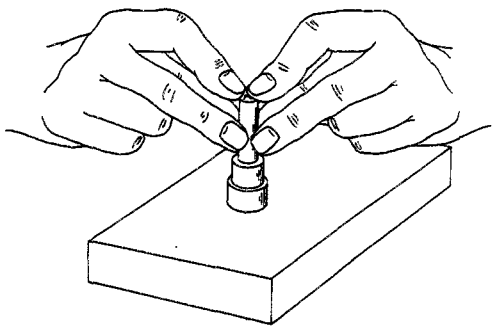

FIG. 21 LAPPING FUEL INJECTION NOZZLE VALVE BODY
(T-51416)

Place the valve body and valve in position on the end of the nozzle holder body, and center the valve body with the holder body. Install and tighten the nut to a torque of 40 to 60 lbs. ft. (5.53-8.29 kg-m).

SECTION 6 - EXHAUST MANIFOLD AND TURBOCHARGER

⚠ WARNING

⚠ Observe all start up and shut down procedures and ⚠ WARNINGS listed in the Operation and Maintenance Instruction Manual.

⚠ Never use gasoline, solvent or other flammable fluids to clean parts.

TOPIC 1 - EXHAUST MANIFOLD

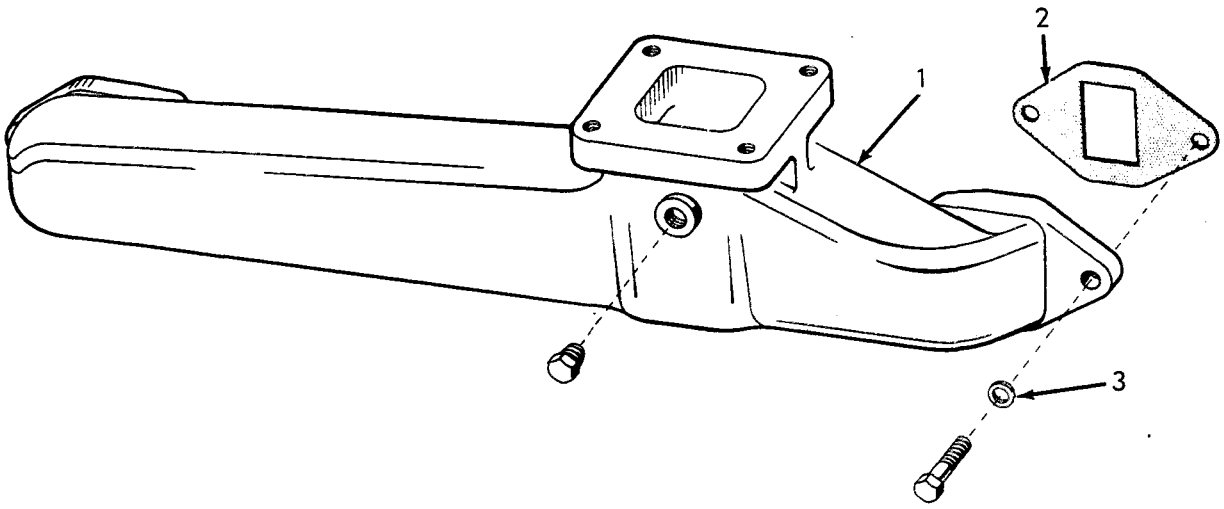

FIG. 1 EXHAUST MANIFOLD - MODEL 2900 SHOWN
(T-70765)

1. Manifold
2. Gasket
3. Capscrew and tab washer

A. GENERAL

The cast alloy exhaust manifold is sealed to the exhaust ports of the cylinder head with steel asbestos gaskets and secured in place with capscrews and tab washers. The manifold is designed to provide the most efficient expulsion of exhaust gases from the cylinder head and into the turbocharger.

NOTE: The turbocharger is used on Model 2900 engines only.

Nothing should be attached to the exhaust manifold which might upset its heat balance characteristics.

B. EXHAUST MANIFOLD REMOVAL

The exhaust manifold can be removed from or installed on the engine in or out of the unit. To remove the exhaust manifold from the engine, use the following procedure:

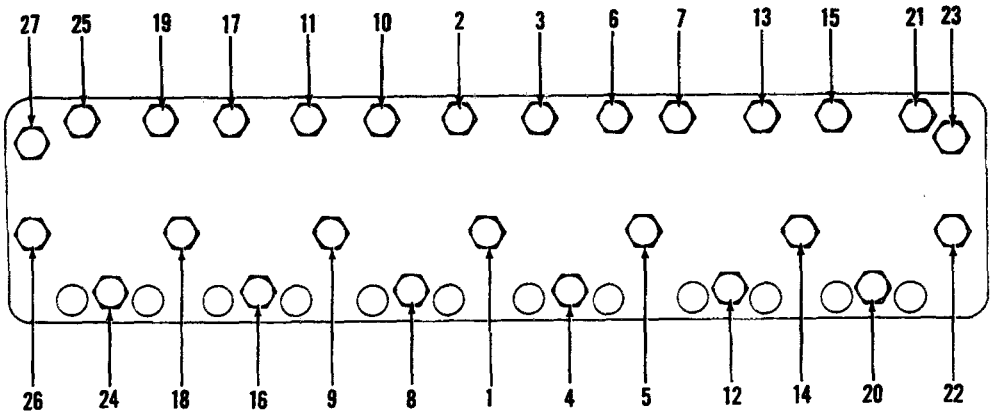

FIG. 4 CYLINDER HEAD CAPSCREW TORQUING SEQUENCE
(T-51815)

TOPIC 4 - VALVES

⚠ WARNING

- ⚠ Observe all start up and shut down procedures ⚠ WARNINGS listed in the Operation and Maintenance Instruction Manual.
- ⚠ Wear proper protective equipment such as safety goggles or safety glasses with side shields, hard hat, safety shoes, heavy gloves when metal or other particles are apt to fly or fall.
- ⚠ Never service or adjust with the engine running except as called for in the Operation and Maintenance Instruction Manual or Service Manuals to keep from being caught in moving parts or by a moving machine.
- ⚠ It is unsafe to strike hardened steel parts with anything other than a soft iron or non-ferrous hammer. When installing or removing such parts wear safety glasses with side shields and heavy gloves gloves, etc., to reduce the possibility of injury.
- ⚠ Wear safety glasses with side shields or goggles when using compressed air for cleaning to reduce the danger of personal injury from flying particles. Limit the pressure to 30 psi (2.1 kg/cm^2) according to OSHA requirements.

A. VALVE LASH ADJUSTMENT

Correct clearance (valve lash) between end of intake valve stem, exhaust valve stem, and related rocker arms, is very important in diesel engine performance because of high compression developed within the cylinders. Insufficient valve lash will cause loss of compression, misfiring, and eventually lead to burning of valves and valve seats. Excessive valve lash will result in faulty engine operation, valve lifter noise, and cause rapid wear on the valve operating mechanism. With engine coolant temperature at a minimum of 160°F. (71°C) specified valve lash for both intake and exhaust valves is 0.015" (0.38mm). After any mechanical work has been done that may have disturbed the valve lash adjustment, set valves "cold" at 0.018" (0.457mm) clearance so engine can be run and allowed to warm to normal operating temperature. After engine coolant temperature has reached a minimum of 160°F. (71°C), check valve lash again for proper clearance.

IMPORTANT: After any mechanical work has been done that may have disturbed the valve lash adjustment, make certain the rocker arm adjusting screws are turned upward (counterclockwise) high enough to prevent rocker arms and push rods from opening too far. If rocker arms and push rods open too far, the pistons will strike the valves when the engine is cranked.

Valve lash must be adjusted when the piston is near top dead center on its compression stroke and intake and exhaust valves are closed. Number 1 and number 6 pistons move up and down in their respective cylinders simultaneously. When one piston is on its compression stroke, the other is on its exhaust stroke, and vice versa. Observe valves for number 6 cylinder; when the exhaust valve is almost closed and the intake valve starts to open, number 6 piston is near top dead center on its exhaust stroke and number 1 piston is in the same position on its compression stroke. At this point, both valves for number 1 cylinder are closed and valve lash can be adjusted. Engine firing order is 1-5-3-6-2-4, and if this sequence is followed, the lash for all valves can be checked and adjusted in 2 complete revolutions of the crankshaft. Check valve clearance periodically. When adjustment is necessary, proceed as follows to obtain specified clearance:

1. Run engine until coolant temperature of 160°F (71°C) minimum is reached. Stop the engine.
2. Thoroughly clean cylinder head cover and surrounding area.
3. Remove breather tube, capscrews, washers, and cylinder head cover.

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be removed and all gaskets be replaced. If the timing gear cover is to be removed without removing the engine, proceed as follows:

a. Loosen the front and side-rail oil pan capscrews about .25" (6.35mm) (or enough to slightly lower the front of the oil pan).

IMPORTANT: Do not damage the oil pan gasket.

b. Remove the fuel pump drive gear inspection plate, and remove the thrust button with spring from the fuel pump drive shaft.

c. Remove all capscrews and nuts on front and back side securing timing gear cover to cylinder block and engine front plate. Jar cover loose with a soft headed hammer; pry cover from locating dowels, and remove it from engine. Do not damage front portion of oil pan gasket.

6. Place the cover on a flat surface with the front of cover down; support cover solidly with wooden blocks, and drive seal out of cover. Clean the seal bore in the cover.

NOTE: The O.D. of the new front oil seal has a layer of red-colored sealant which forms a seal between the O.D. of the seal and the bore in the cover, eliminating the need of using a sealing compound prior to driving or pressing the seal into the cover. The I.D. of the seal has a layer of rubber compound to prevent oil leakage between the seal and the crankshaft.

7. Position the cover (front of cover up) solidly on wooden blocks, and position a new seal (open side down) squarely in the bore. Drive or press the seal into the cover bore until it bottoms, Fig. 3; use of the illustrated tool will properly place the driving force on the outer edge of seal.

8. After seal is installed in the cover, insert fingers into inner part of seal and check for rotation. If seal was installed properly, the inner part will turn with a firm feel.

C. TIMING GEAR COVER INSTALLATION

1. Carefully remove nicks or burrs from keyway in crankshaft, using a fine-cut mill file or stone.

2. Coat the crankshaft with engine oil.

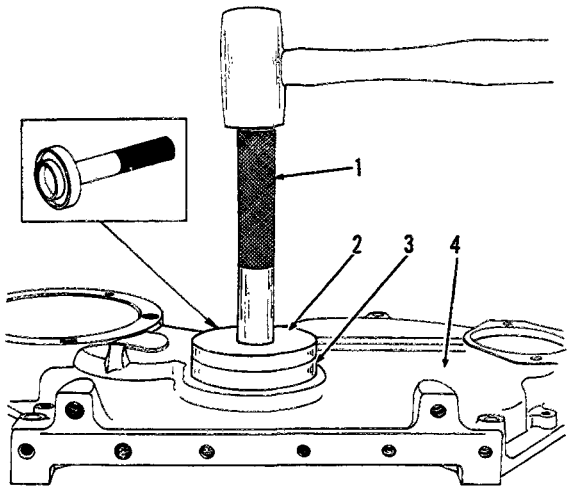

FIG. 3 INSTALLING CRANKSHAFT FRONT OIL SEAL
(T-52154)

1. Handle
2. Installing tool
3. Oil seal
4. Timing gear cover

3. Position a new gasket on the front support plate; wedge the front edge of the oil pan down until the gear cover will clear as it is positioned on the dowel pins and pushed into place.

NOTE: Be sure the oil pan gasket is in good condition.

4. Install and tighten the timing gear cover capscrews to a torque of 28-33 lbs. ft. (3.87-4.56 kg-m). Install the balance of capscrews to secure the oil pan, and torque them to 18-20 lbs. ft. (2.48-2.76 kg-m).

5. Install the spring and thrust button into the injection pump drive shaft; install the injection pump drive gear inspection plate with a new gasket.

6. Install the crankshaft pulley, and secure the engine to the engine front mounting bracket.

7. Install the drive belts, and install and fill the radiator and cooling system (refer to "COOLING SYSTEM").

SECTION 10 — LUBRICATING SYSTEM

TOPIC 1 — GENERAL

The engine is pressure lubricated by gear-type oil pressure pump. Early Model 2900 engines use two types of the bayonet type pump mounted near the bottom center of the engine block and driven by the oil pump driving gear in constant mesh with an integral gear on the camshaft. The main difference between the two bayonet type pumps was the mounting of the suction screen. The first type had the screen attached to the lower cover of the oil pump. The second type had a separate suction screen and tube assembly that bolted into the suction side of the pump.

Current Model 2900 engines use the externally front mounted gear-type lubricating oil pressure pump mounted on the engine front cover and driven by a splined shaft engaged into an oil pump drive which is driven by a gear in mesh with the camshaft gear.

The engine oil pressure on the Model 2900 oil pumps should be between 30 and 55 psi (2.10-3.86 kg/cm^2) when the engine is operating at full throttle and with the engine coolant at normal operating temperature. An oil pump pressure relief valve is set to relieve between 70-90 psi (4.92-6.32 kg/cm^2), to protect the system from excessive pressures when the oil is cold. The oil pressure relief valve is located in the oil pump cover for the bayonet and crankshaft gear driven type pumps and on the rail of the cylinder block inside the engine, if the engine uses the external front mounted type oil pump.

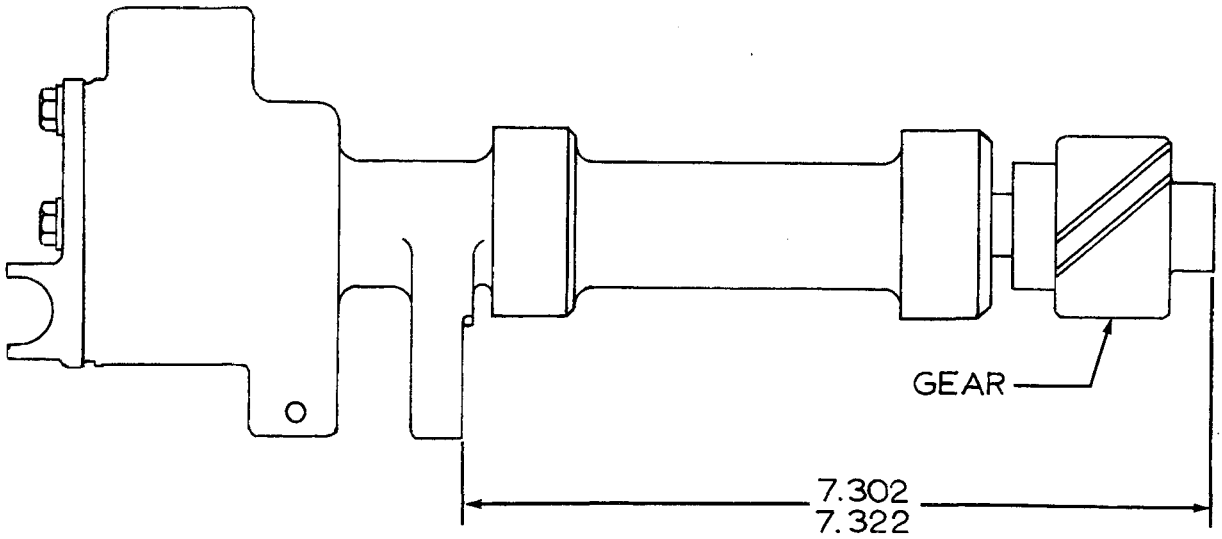

FIG. 11 PUMP MOUNTING SURFACE-TO-GEAR RELATIONSHIP
(T-74744)

5. Install the relief valve piston, spring and retainer, and secure with roll pin.
6. Install screen and wire retainer.
7. Lubricate the pump gears, and make certain the pump turns without binding.
8. Install the discharge tube onto the pump, and lubricate the drive gear with "Molycote G" lubricant.
9. Install the pump assembly as shown in Fig. 3; install the lock-bolt and torque it to 44-49 lbs. ft. (6.08-6.77 kg-m). Position the discharge tube and tighten it securely.
10. Install the oil pan (refer to "OIL PAN" in this Section), and fill the crankcase to the proper level with the specified lubricant.
11. Install the engine (refer to "ENGINE REMOVAL AND INSTALLATION").

TOPIC 4 - OIL PRESSURE PUMP MODEL 2900 - CURRENT TYPE

⚠ WARNING

Never use gasoline, solvent or other flammable fluids to clean parts

A. GENERAL

The gear-type pump is externally mounted on the engine front cover just below the alternator and is driven through a splined shaft by the oil pump drive gear which is driven by the camshaft gear, when pump pressure exceeds 75-85 psi (5.26-5.96 kg/cm2) a relief valve, located on the rail of the cylinder block inside the oil pan, allows excess oil to flow back into the oil sump.

B. PUMP REMOVAL AND DISASSEMBLY

1. Loosen the pump suction and discharge tubing nuts connected to the connectors at the bottom of the pump body; retain the O-rings.
2. Loosen alternator; slip off fan belts.
3. Remove one short and one long capscrew with lockwasher securing oil pump and alternator mounting bracket to front cover; slide the oil pump out of the oil pump drive gear and remove from front cover. Remove the gasket, Fig. 12 (4).

IMPORTANT: When withdrawing the camshaft with a first or second type thrust plate, be careful the thrust plate does not fall and become damaged. Use extreme care not to scratch or mar camshaft bearings while withdrawing camshaft from cylinder block.

9. Remove the valve lifters.

IMPORTANT: Identify the original location of each valve lifter so it can be re-installed in its original location.

10. After removing the camshaft and gear, check the thrust plate clearance by inserting a feeler gauge between the thrust plate and camshaft journal, Fig. 5. The specified clearance is .003" to .009" (0.076-0.228mm). If clearance exceeds .015" (0.381mm) with a new thrust plate, the camshaft gear must be replaced.

11. Press the camshaft from the gear.

C. CAMSHAFT AND THRUST PLATE INSPECTION

1. If the engine has been operated with clean oil and the correct quantity in the oil pan, the camshaft bearing journals seldom wear to the extent that is necessary to replace the shaft. The specified O.D. of all camshaft bearing journal diameters is 2.130"to 2.131" (54.10-54.12mm). The specified inside diameter of the camshaft standard bearings installed is 2.133" to 2.135"(54.17-54.23mm). The specified running clearance between the camshaft journals and bearings is .002" to .005" (0.050-0.127mm) and must not exceed .008" (0.203mm). If the installation of new standard bearings will not reduce the running clearance below .008" (0.203mm), grind the camshaft journals to accommodate .010" (0.254mm) undersize bearings. Likewise, if the journals are worn or scored to the extent that they will not accommodate .010" (0.254mm) undersize bearings, the camshaft must be replaced.

2. Inspect the camshaft lobes for roughness, scoring or excessive wear. Replace the camshaft if any of these conditions are found. These conditions can be caused by inferior quality of lubricating oil, excessive valve lash adjustment, contaminated oil or the valve lifters not rotating.

3. Replace camshaft gear if the teeth are nicked, scored or broken.

4. Before reusing a camshaft gear, check the bore size at the center and near each end. The first and second type should measure 1.374"-1.375" (34.89-34.92mm); the third type should measure 1.373"-1.374" (34.87-34.89mm). Failure to maintain the specified .0015"-.003" (0.038-0.076mm)

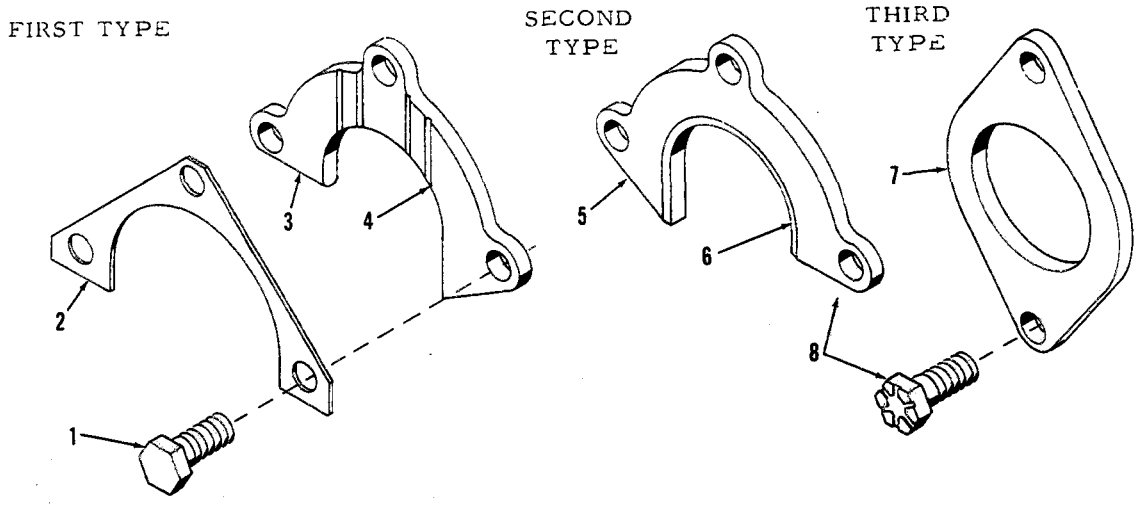

FIG. 4 THRUST PLATES
(E-1141)

1. Capscrew (grade 5)
2. Lock plate (first type)
3. Thrust plate (first type)
4. Oil grooves
5. Thrust plate (second type)
6. Chamfer
7. Thrust plate (third type)
8. Lock bolt (second and third type)

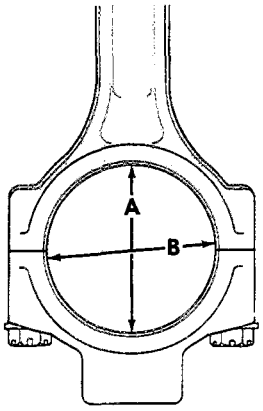

FIG. 9 CONNECTING ROD MEASURING POINTS (E-1006)

mension from the larger, the remainder must not exceed .0015" (0.038mm) which is the maximum allowable out-of-roundness. If either of the above limits are exceeded, the connecting rod must be replaced.

4. Measure the outside diameter of the piston pin to determine wear. The specified O.D. of a new pin is 1.2515"-1.2517" (31.78-.31.79mm); specified I.D. of the connecting rod bushing is 1.2527" -1.2532" (31.81-31.83mm). These dimensions of pin and bushings provide a running clearance of .001"-.0017" (0.025-0.043mm). Replace the connecting rod bushing if clearance exceeds .003" (0.076mm).

5. Whenever connecting rods are removed from an engine it is recommended to check alignment of the piston pin bushing end with the large bore end. Alignment, length, and twist can be checked with an alignment gauge checking fixture similar to the one illustrated in Figs. 10 and 11. The following procedure covers details of this inspection using the correct crank and pin mandrels, indicator adapter and alignment checking fixture.

NOTE: Initial checking of crank mandrel is recommended to establish the accuracy of checking fixture. Installing mandrel end-for-end in the same connecting rod must give identical gauge readings. If not, the mandrel must be corrected before satisfactory checking of connecting rod can be accomplished.

a. Calibrating Rod Checking Fixture

(1) Select a new connecting rod that has been checked for correct nominal length of 7.250" (184.15mm). Specified length of a

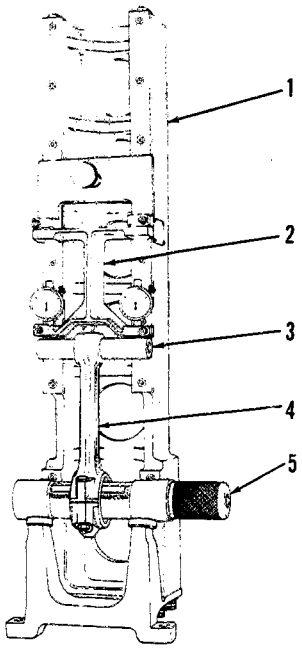

FIG. 10 CHECKING CONNECTING ROD ALIGNMENT (T-53981)

1. Checking fixture
2. Indicator adapter
3. Pin mandrel
4. Connecting rod
5. Crank mandrel

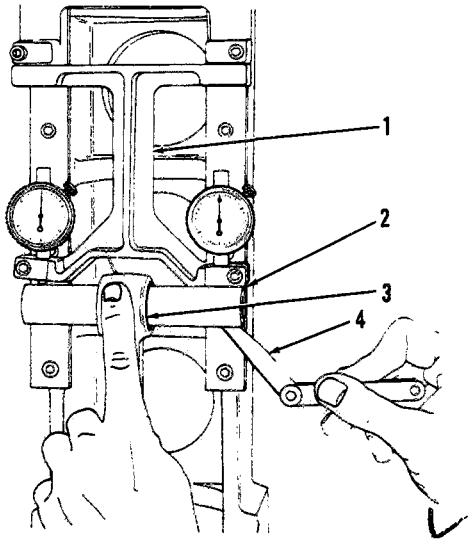

FIG. 11 CHECKING CONNECTING ROD TWIST (T-53982)

1. Indicator adapter
2. Pin mandrel
3. Connecting rod
4. Feeler gauge

TOPIC 2 — MAIN BEARINGS

A. GENERAL

The precision type main bearings are replaceable without machining. The front and intermediate bearings are 1.287"-1.317" (32.68-33.44mm) long; the rear bearing is 1.524"-1.554"(38.70-39.46mm)long, and the center (thrust) bearing is 2.054"-2.057" (52.16-52.24mm) long. The inside diameter of the bearings measure 2.7496"-2.7513" (69.83-69.88mm) after they are installed and the lock bolts are tightened to their specified torque of 130-140 lbs. ft. (17.97-19.35 kg-m).

The upper halves of the main bearing shells are seated in the cylinder block. The lower halves are held in place by the main bearing caps, each of which is attached to the cylinder block by lock bolts. The bearing shells are prevented from radial movement by a tang on the bearing shell which locates in a slot in the bearing seat of the cylinder block and/or the bearing cap. The upper bearing shells have an oil hole in them and must be installed in the cylinder block; the lower bearing shells do not have an oil hole and are installed in the bearing caps.

B. MAIN BEARING REMOVAL, INSPECTION, AND INSTALLATION

1. MAIN BEARING REMOVAL

   a. Remove crankshaft (refer to CRANKSHAFT REMOVAL AND INSPECTION in this Section).

   b. Remove the main bearing shells from the cylinder block and bearing caps.

IMPORTANT: Identify bearing shells as to their original location in the cylinder block and main bearing caps in the event inspection proves they can be reused.

2. MAIN BEARING INSPECTION

   a. Any bearing shells that are scored, chipped, pitted, or worn beyond specified limits given below must be replaced. Inspect backs of shells for bright spots. Bright spots on backs of shells indicate shells have shifted in their supports and are unfit for further use.

   b. Specified clearance between main bearing shells and crankshaft journals is .0016"-.0048" (0.040-0.111mm). New bearing shells must be installed when this clearance exceeds .008" (0.203mm).

      With crankshaft removed, measure inside diameter of the bearing at a point 90° from the parting line, with bearing cap installed and tightened to the specified torque of 130-140 lbs. ft. (17.97-19.35 kg-m). Bearing shells when in place are .0004"-.001" (0.010-0.025mm) larger in diameter for a distance of .38" (0.965mm) each side of the parting line than they are 90° from the parting line. The two halves of the shells have a crush fit in their bore in the block and must be tight when the cap is secured in place. Do not measure inside diameter at the parting line.

      The specified inside diameter of new main bearings installed is 2.7496"-2.7513" (69.83-69.88 mm) and any readings above 2.7513" (69.88mm) indicates the amount of bearing wear. Measure diameter of the crankshaft journal at the corresponding bearing location, and subtract this dimension from inside diameter measurement of the bearing (as determined above); the difference between these two measurements is the crankshaft-to-bearing clearance.

   c. Another method for determining amount of wear on bearing shells is by measuring each shell with a micrometer at a point 90° from the parting line as shown in Fig. 6. New shells, measured as shown, are .0931"-.0936" (2.36-2.37mm) thick. Bearing shells less than .092" (2.33mm) thick

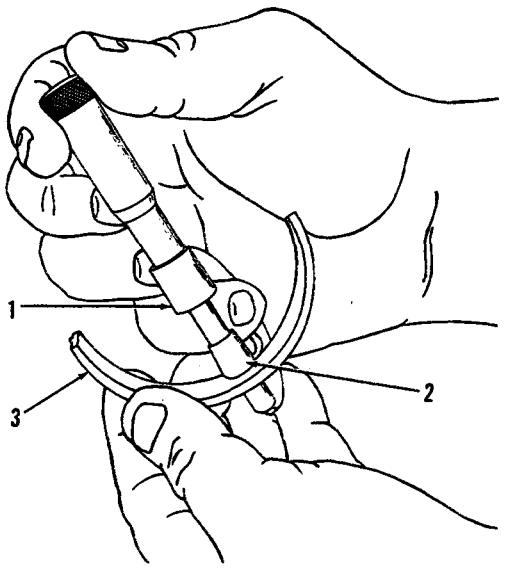

FIG. 6 MEASURING BEARING SHELL THICKNESS (T-19046)

1. Micrometer
2. Sleeve with steel ball
3. Bearing shell

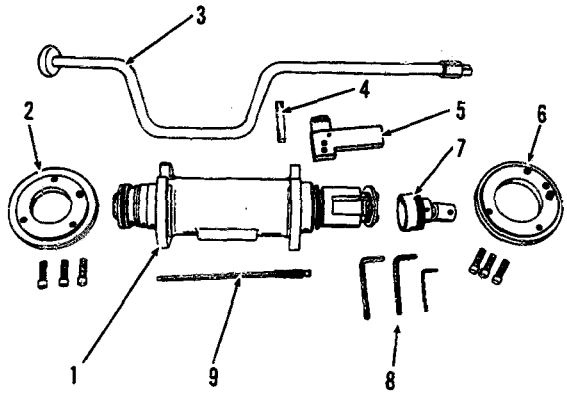

FIG. 11 CYLINDER SLEEVE RESEATING TOOL (T-53647)

1. Tool housing
2. Lower adapter plate
3. Speed handle
4. Carboloy tool bit
5. Tool holder
6. Upper adapter plate
7. Locking nut
8. Allen wrenches
9. Spring loaded extension

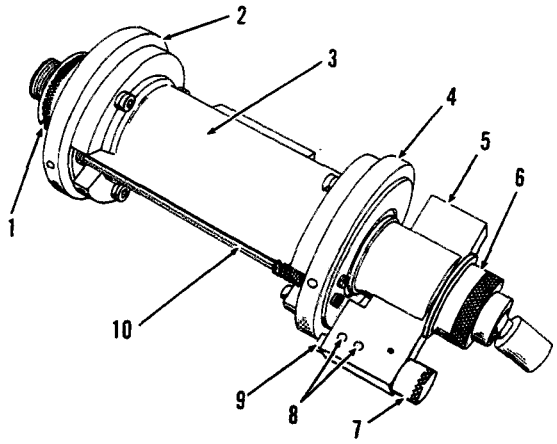

FIG. 12 CYLINDER SLEEVE RESEATING TOOL ASSEMBLED (T-53648)

1. Bottom knurled nut
2. Lower adapter plate
3. Tool housing
4. Upper adapter plate
5. Tool holder
6. Locking nut
7. Adjusting knob
8. Set screws
9. Tool bit
10. Spring loaded extension

remove shaft end play. Re-tighten setscrew when desired adjustment is obtained.

e. Install the tool holder and tool bit, Fig. 12.

2. PREPARATION OF CYLINDER BLOCK FOR CHECKING AND RESEATING SLEEVE COUNTERBORE

a. Thoroughly clean the top deck of the cylinder block.

b. Thoroughly clean upper and lower sleeve bores in block; remove all scale, rust and carbon so upper and lower tool adapter plates and their adjusting pins contact original bore diameters.

IMPORTANT: Failure to thoroughly clean bores can cause tool misalignment and cut untrue seats.

c. Measure the present depths of the sleeve counterbores with a depth micrometer at the front and rear of each counterbore, and record. The specified original depth of the counterbore for standard cylinder sleeve is .3150"-.3165" (8.00 -8.03mm).

NOTE: Cylinder block top decks, especially on older engines are not necessarily square with the sleeve bores.

3. INSTALLATION OF TOOL IN BLOCK

a. Loosen the two small setscrews, Fig. 12, that secure the tool bit in the tool holder. Turn the tool bit adjusting knob counterclockwise as far as possible by hand, and raise the tool bit to a safe position so the cutting edge cannot be damaged while installing tool assembly in block.

b. Retract the centralizing pins in the lower and upper adapter plates.

c. Insert the tool assembly into the cylinder block so the upper adapter plate is between .03" and .06" (0.793-1.587mm) below the sleeve counterbore seat in the block, Figs. 13 and 15.

d. Secure the upper and lower adapter plates in the bores by tightening the setscrews, Fig. 14.

4. ADJUSTMENT AND OPERATION OF TOOL

a. To adjust the tool for cutting the correct diameter in the counterbore, loosen the knurled nut securing the tool holder; move the tool holder enabling the tool bit to be extended into the counterbore about half way. Slide the tool holder until

SECTION 17 — FITS AND TOLERANCES, TORQUE SPECIFICATIONS, AND STUD GAUGE HEIGHTS

TOPIC 1 — FITS AND TOLERANCES

Description	Size of New Parts	
A. CYLINDER SLEEVE	Inches	Millimeters
1. Inside diameter	3.8755-3.877	98.44-98.48
2. Diameter of sleeve at machined area just below flange	4.436-4.438	112.67-112.72
3. Diameter of cylinder sleeve at packing ring location	4.374-4.376	111.09-111.15
4. Sleeve flange outside diameter	4.624-4.628	117.44-117.55
5. Cylinder block-to-sleeve clearance at sleeve lower diameter	.001-.005	0.025-0.127
6. Cylinder block-to-sleeve clearance at machined area just below flange	.0005-.0045	0.012-0.114
7. Cylinder block-to-sleeve clearance at sleeve flange	.003-.012	0.076-0.304
8. Clearance of piston skirt with sleeve	.0045-.007	0.114-0.177
9. Fire wall height above cylinder sleeve flange	.0445-.0475	1.13-1.20

SECTION 18 — TROUBLE SHOOTING

⚠ DANGER

- FLAMMABLE VAPORS: Extinguish all smoking materials or open flames before checking and filling batteries. DO NOT check battery by sparking.
- Do not use matches, lighters, or torches for a light source on the machine due to the presence of flammable fluids.
- Extinguish all smoking materials, or open flames before checking and filling fuel tanks, changing filters and before opening sediment drain due to the presence of flammable fluid.

⚠ WARNING

- No unauthorized person should be allowed to service or maintain this machine. Study the Operation and Maintenance Instruction Manual before starting, operating, maintaining, fueling, or servicing this machine.
- Always disconnect the batteries before cleaning, repairing, or servicing the machine.
- Never use gasoline, solvent or other flammable fluids to clean parts.
- DO NOT check or adjust belts when engine is running. Be especially alert around a pusher fan.
- Never attempt to operate machine or attachment except when seated in the operator's seat. Keep head, body, limbs, hands and feet inside the operator's compartment to reduce exposure to hazards outside the operator's compartment.
- Do not run the engine of this machine in closed areas without proper ventilation to remove deadly exhaust gases.
- Use only grounded auxiliary power source for heaters, chargers, pumps and similar equipment to reduce the hazard of electrical shock.
- Never service or adjust with the engine running except as called for in the Operation and Maintenance Instruction or Service Manuals to keep from being caught in moving parts or by a moving machine.
- Before moving machine or attachments be sure exposed people in the area are clear of the unit. Walk completely around machine before mounting. Sound horn.
- Keep people clear of attachments and tools while in raised position to prevent possible injury.
- Warn all people who may be servicing or working around machine before starting machine.
- Use lifting eyes, if provided, for handling by lifting devices.
- DO NOT USE HANDS to search for pressure leaks. Fluid escaping under high pressure can penetrate skin.
- Place protection over air inlet openings before operating engine.
- Wear safety glasses with side shields or goggles when using compressed air for cleaning to reduce the danger of personal injury from flying particles. Limit the pressure to 30 psi (2.1 kg/cm^2) according to OSHA requirements.

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