TECHNICAL MANUAL

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

PUMP, CENTRIFUGAL, SELF-PRIMING,

GASOLINE ENGINE DRIVEN, WHEEL MOUNTED,

6-INCH, 1500 GPM CAPACITY AT 60 FOOT HEAD

(PEABODY BARNES, INC. MODEL US90CCG-1)

NSN 4320-00-490-1859

HEADQUARTERS, DEPARTMENT OF THE ARMY

AUGUST 1975

WARNING

POISONOUS GASES

are contained in the exhaust fumes expelled by this equipment.

DEATH

or serious illness may result if exhaust fumes are not properly expelled from enclosed areas.

FLAMMABLE GAS

is generated in the battery of this equipment while the battery is being charged. Keep fire or flame away while servicing battery or explosion may result.

FIRE HAZARD

is created by filling fuel tank while engine is running. Shut off engine before servicing fuel tank.

EXPLOSION HAZARD

exists when welding repairs are attempted on fuel tank.

DEATH

may result unless all gasoline fumes are purged from tank before making any repairs involving heat or flame.

SEVERE INJURY

may result from contact with the rotating cooling fan. When it is necessary to make governor adjustments or any other adjustments in the fan area, remove the cooling fan drive belt before making the adjustment.

HEALTH AND SAFETY HAZARD

exists when cleaning solvents are used. Clean all parts in a well ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100F. to 138F. (38 C to 59 C).

Technical Manual
No. 5-4320-234-34

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., *29 August 1975*

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

PUMP, CENTRIFUGAL, SELF-PRIMING, GASOLINE ENGINE DRIVEN, WHEEL MOUNTED, 6-INCH, 1500 GPM CAPACITY AT 60 FOOT HEAD (PEABODY BARNES, INC. MODEL US9OCCG-1) NSN 4320-00-490-1859

LIST OF ILLUSTRATIONS

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual is for your use while providing direct support and general support maintenance of the Pump, Centrifugal, Self-priming, Gasoline Engine Driven, Wheel Mounted, 6-Inch, 1500 GPM Capacity at 60 Foot Head (Peabody Barnes, Inc. Model US9OCCG-1).

1-2. Maintenance Forms and Records

Maintenance forms, records, and reports that you are required to use are DA Form 2400, 2401, 2402, 2404 and 314 (see TM 38-750).

1-3. Reporting of Errors

You can help to improve this manual by calling attention to errors and by recommending improvements. Your letter, DA Form 2028 (Recommended Changes to Publications), or DA Form 2028-2 (Recommended Changes to Equipment Technical Manuals), may be used. Copies of DA Form 2028-2 are attached in the back of the manual for your use. Please mail your recommended changes directly to Commander, U. S. Army Troop Support Command, ATTN: AMSTS-MPP, 4300 Goodfellow Blvd, St. Louis, MO 63120. A reply will be furnished directly to you.

1-4. Equipment Serviceability Criteria

This equipment is not covered by an ESC.

1-5. Destruction of Army Material to Prevent Enemy Use

a. Priority for Destruction. When lack of time or personnel prevents complete destruction of the equipment, the following priority will be used in demolition of essential parts.

(1) Using an axe, pick, mattock, sledge, or any other heavy implement, damage all vital elements such as controls, water, or fuel pumps, cooling systems, switches, and any other major assemblies or components.

(2) Place 1/2 pound (0.22 kg) charges on the following for demolition with explosives.

(*a*) Charge located at carburetor, governor, fuel pump and flywheel area.

(b) Charge located at cylinder head and crankcase.

(*c*) Charge located at intake and exhaust manifold.

(3) Demolition by misuse. Add sand to oil in engine and drop nuts and bolts into pump case. Run engine until pump fails.

(4) Demolition by burning. Pack rags, clothing, or canvas under or around the engine and pump. Saturate this packing with gasoline, oil, or diesel fuel and ignite.

1-6. Administrative Storage

Prepare the pumping assembly for storage according to procedures given in TM 740-90-1.

Section II. DESCRIPTION AND DATA

1-7. Description

a. Centrifugal Pump, Model US90CCG-1, consists primarily of a gasoline engine and a centrifugal pump mounted on a two-wheel chassis. The torque from the engine is transferred to the pump through an intermediate shaft and flexible coupling.

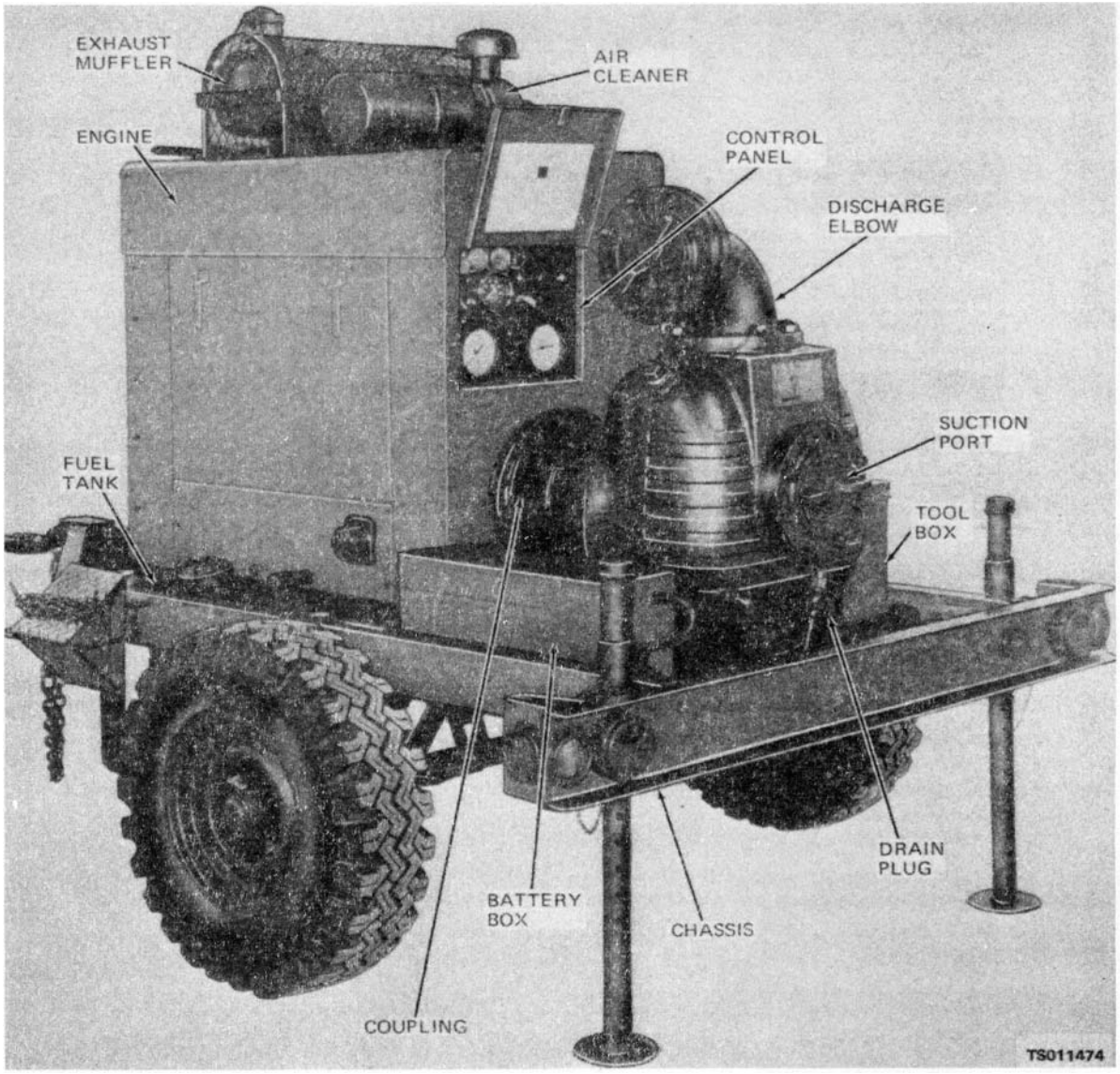


Figure 1-1. Centrifugal pump, left rear view.

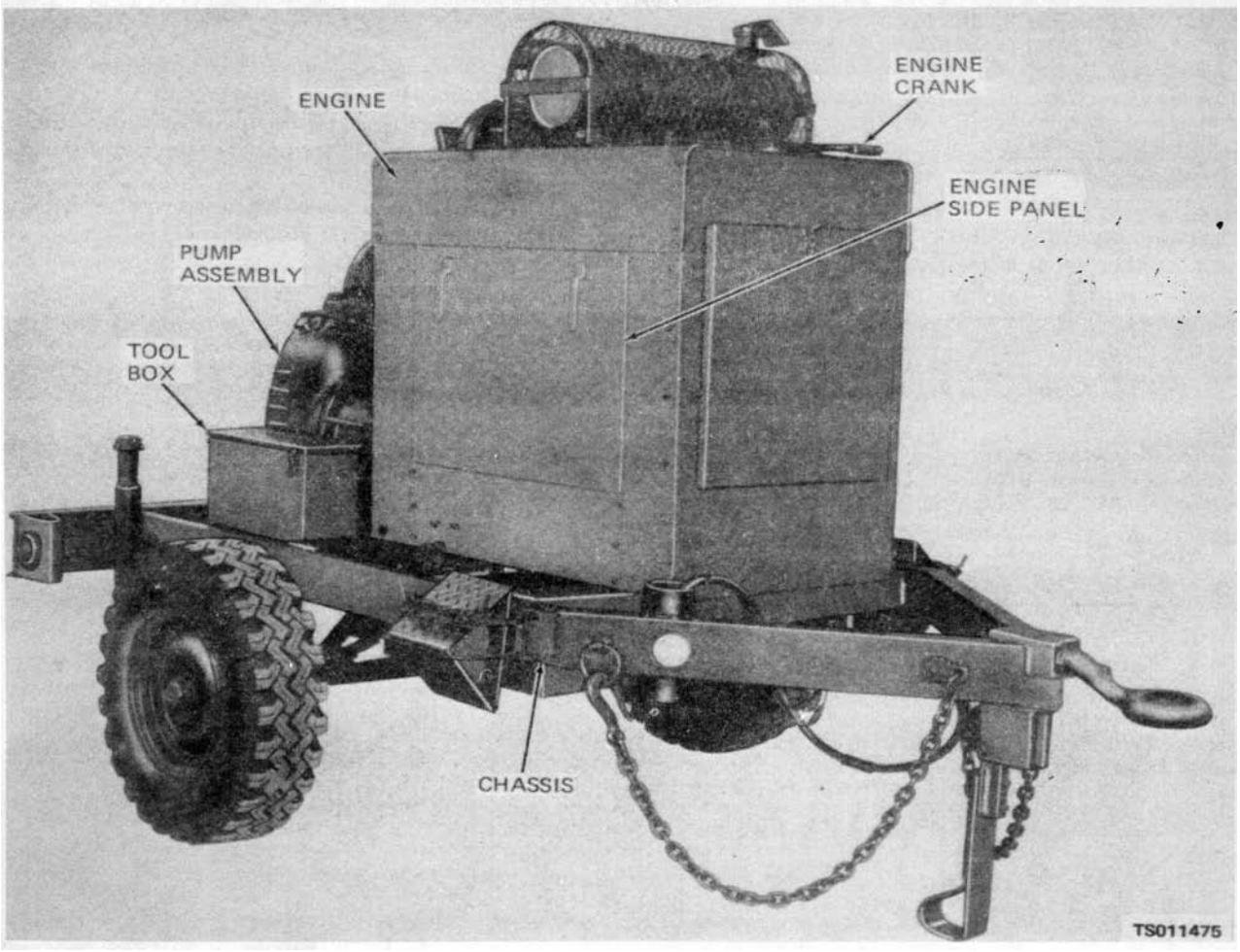


Figure 1-2. Centrifugal pump, right front view.

b. The centrifugal pump has a 6-inch suction flange secured to the front of the pump body, and a 6inch discharge elbow secured to the top of the pump body. The bearing housing (13, fig. 5-2) joins the flywheel housing of the engine with the pump body, providing correct spacing and proper alinement of the parts. The bearing housing also provides the bearing seats for the ball bearings that support the impeller shaft. The impeller is keyed to the end of the impeller shaft and is secured with a locking cone. The impeller is inclosed in a close fitting volute to provide efficient pumping operation. A replaceable wear plate at the front of the impeller is subjected to most of the internal pump wear.

c. The engine is a six-cylinder, water-cooled, pressure-lubricated, four-stroke-cycle, L-head type. Engine speed is governed by a flyball-type governor and is protected by an over-speed governor that shuts off the engine when the engine speed reaches a : preset maximum speed. The engine is inclosed in a housing that has coolant and oil drains ported to the outside of the housing for easy access. The engine uses an electrical starting motor, has magneto ignition and uses an alternator to restore the charge of the battery as it is depleted by operation of the starting motor. The conventional radiator-type cooling system uses a pusher-type cooling fan which forces cooling air through the radiator from the inside out. The fan also maintains a flow of air around the engine to provide proper cooling.

d. The engine and pump are secured to a two-wheeled chassis. The chassis consists primarily of hub assemblies, pneumatic tires, welded frame, and axle.

e. You will find detailed descriptions of centrifugal pump components in the repair paragraphs of this manual.

1-8. Differences Between Models

This technical manual covers only Centrifugal Pump, Peabody Barnes Model US9OCCG-1. No known differences exist for this model number.

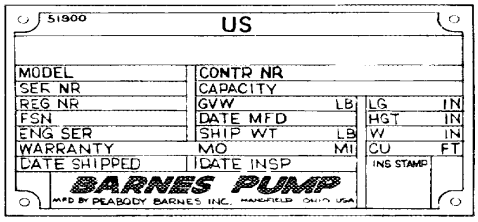
1-9. Tabulated Data

a. Identification. The pumping assembly has three identification plates, as follows:

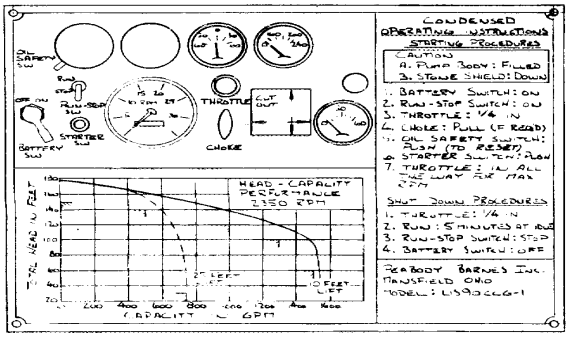
(1) *Pump data plate.* The pump data plate (A, fig. 1-3) is located on front of the pump above the suction flange. It indicates the pump identification number, serial number, dimensions, weight, and shipping information.

(2) *Engine data plate.* The engine data plate (B, fig. 1-3) is located on alternator side of the engine block. It indicates engine identification numbers, serial number, valve tappet clearance information, and patent information.

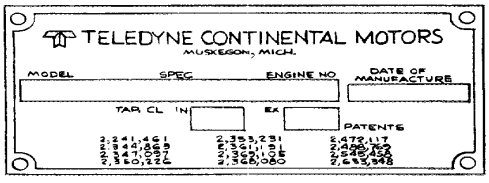
(3) *Instruction plate.* The pump instruction plate (C, fig. 1-3) is located in the cover of the control panel. It identifies the controls and provides basic operating instructions.



A PUMP DATA PLATE



C INSTRUCTION PLATE



B ENGINE DATA PLATE

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Figure 1-3. Data plates.

b. Tabulated Data. Tabulated data applicable to the centrifugal pump and its components is given in table 1-1.

Table 1-1. Tabulated Data

Manufacturer	Peabody Barnes, Inc.
Model number	US9CCG-1
Serial number range	56751-001 thru 56751-024
Type	Self-priming, centrifugal
Output (at maximum rated speed)	1500 gpm at 60 feet head
Rated driven speed	2450 rpm

Table 1-1. Tabulated Data - Continued

Suction port size	6 in., No. 6-8 NPT
Discharge port size	6 in., No. 6-8 NPT
Engine	
Manufacturer	Continental Motors Corp.
Model	FS244-6100P
Type	Four stroke cycle
Number of cylinders	6
Displacement	244 cu in.
Compression ratio	6.9:1
Coolant	Water
Cooling system capacity	18 qt (17.10 L)
Crankcase oil capacity	5-1/2 qt (5.22 L)
Valve clearance (warm)	
Intake	0.014 in. (0.035 cm)
Exhaust	0.016 in. (0.040 cm)
Spark plug gap	0.025 in. (0.063 cm)
Breaker point gap	0.015 in. (0.037 cm)
Firing order	1-5-3-6-2-4
Governed speed	2450 rpm
Overspeed cutout	2700 rpm
Alternator	
Manufacturer	Motorola
Part number	MA24-900G
Voltage	24
Amperage output	35
Voltage regulator	
Manufacturer	Motorola
Part number	70C44707B
Starting motor	
Manufacturer	Delco-Remy
Part number	1108271
Voltage	24
Magneto	
Manufacturer	Fairbanks-Morse
Part number	FMZE6B16P
Fuel pump	
Manufacturer	AC Spark Plug
Part number	6440314
Carburetor	
Manufacturer	Zenith
Part number	12334
Air cleaner	
Manufacturer	Donaldson
Part number	FWG06-66032
Oil filter	
Manufacturer	Fram
Part number	C7407
Military standard number	MS35343-1
Overall dimensions and weight	
Overall length	119 in. (297.5 cm)
Overall width	68.5 in. (171.2 cm)
Overall height	71 in. (177.5 cm)
Overall weight	2630 lbs (1183.5 kg)
Shipping weight	2630 lbs (1183.5 kg)
Shipping volume	343 cu ft
Ground clearance	13.25 in. (33.12 cm)
Engine torque specifications	

Table I-I. Tabulated Data - Continued

	Torque (ft-lb)
Cylinder head capscrews	35 to 40 (4.84 to 5.53 kgm)
Main bearing capscrews	85 to 95 (11.75 to 13.13 kgm)
Connecting rod nuts	40 to 45 (5.53 to 6.22 kgm)
Flywheel nuts	35 to 40 (4.84 to 5.53 kgm)
Manifold nuts	25 to 30 (3.45 to 4.14 kgm)
Gear cover bolts and nuts	
3/8 in	25 to 30 (3.45 to 4.14 kgm)
7/16 in	50 to 55 (6.91 to 7.60 kgm)
Oil pan bolts	12 to 16 (1.65 to 2.21 kgm)
Flywheel housing bolts	50 to 55 (6.91 to 7.60 kgm)
Filler block bolts	15 to 20 (2.07 to 2.76 kgm)
Front end plate bolts	
3/8 in.	25 to 30 (3.45 to 4.14 kgm)
7/16 in	50 to 55 (6.91 to 7.60 kgm)
Camshaft thrust plate bolts	15 to 20 (2.07 to 2.76 kgm)
Water pump bolts	25 to 30 (3.45 to 4.14 kgm)
Magneto bolts	25 to 30 (3.45 to 4.14 kgm)
Governor bolts	25 to 30 (3.45 to 4.14 kgm)

CHAPTER 2
DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS, AND EQUIPMENT

2-1. Special Tools and Equipment

No special tools or equipment is required for the repair and maintenance of the pumping assembly.

2-2. Maintenance Repair Parts

Repair parts and equipment are listed and illustrated in the repair parts and special tools list covering direct support and general support maintenance for this centrifugal pump. Refer to TM 54320-234-34P when you need replacement parts information.

Section II. TROUBLESHOOTING

2-3. General

a. This section contains troubleshooting information for locating and correcting most of the operating troubles which may develop in the pumping assembly. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. You should perform the tests/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections, or corrective actions. If you experience a malfunction which is not listed or is not remedied by listed corrective actions, notify your supervisor.

c. Only those functions which are solely within the scope of direct and general support maintenance are listed. For troubleshooting procedures which are within the scope of operator/crew and organizational maintenance, you should refer to TM 5-4320-234-12.

2-4. Direct Support and General Support Maintenance Troubleshooting

Refer to table 2-1 for troubleshooting which is allocated to direct support and general support maintenance levels.

NOTE

Before you use the troubleshooting table, be sure you have performed all applicable operating checks.

Table 2-1. Troubleshooting

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
ENGINE
1. LOW OR UNEVEN COMPRESSION
Step 1. Check for damaged cylinder head gasket or loose cylinder head by listening for hissing noise on compression stroke. Replace head gasket or tighten cylinder head bolts to proper torque. (1) Remove the cylinder head and gasket as shown in figure 2-1. When removing the cylinder head screws, loosen each a small increment until all are started. This will help prevent cylinder head distortion.

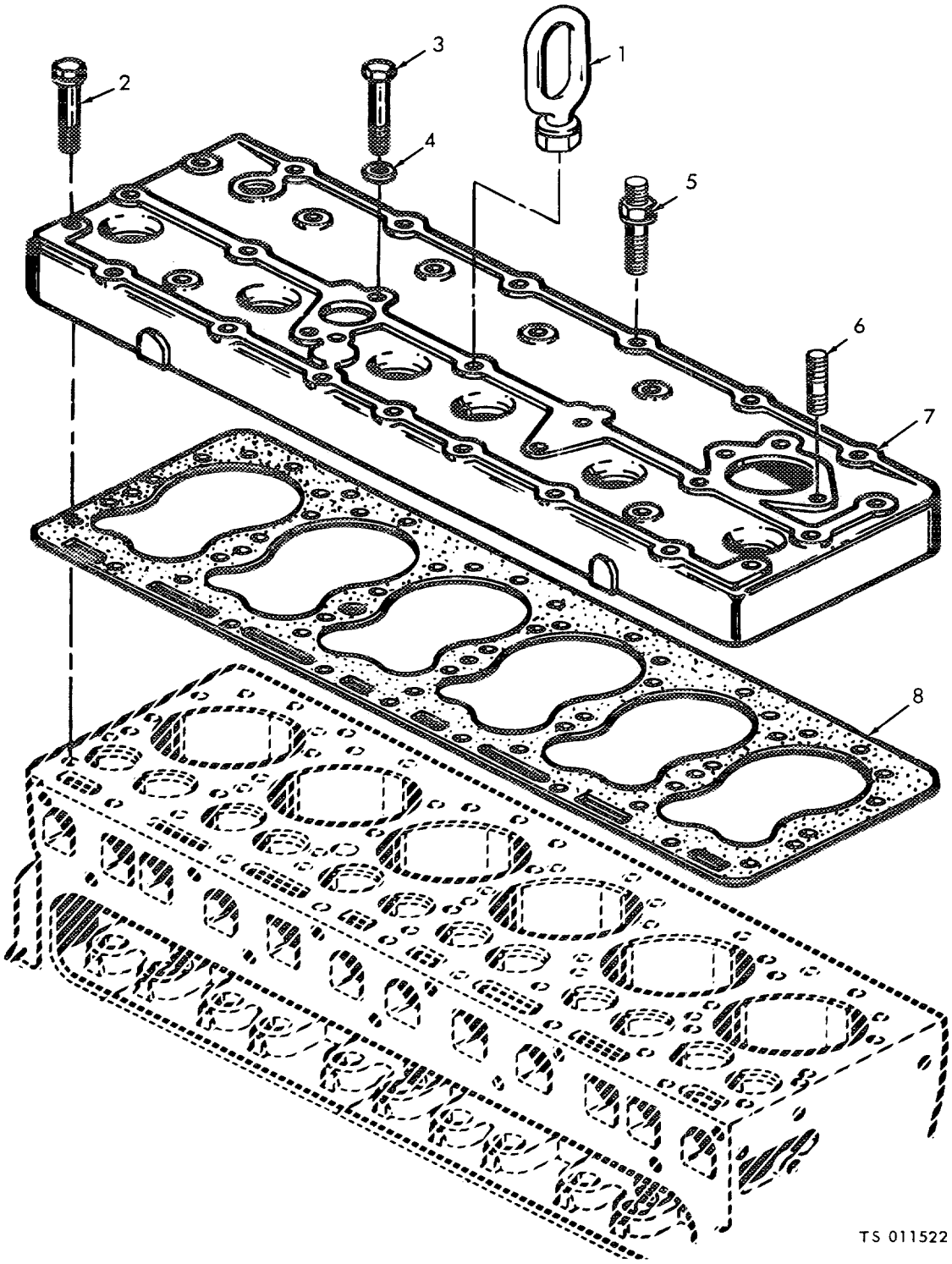

Figure 2-1. Cylinder head.

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
ENGINE CONTINUED
(2) Using a new head gasket, install cylinder head as shown in figure 2-1. Tighten the cylinder head screws according to the sequence shown in figure 2-2. Torque to 35 to 40 foot-pounds (4.84 to 5.53 kgm).

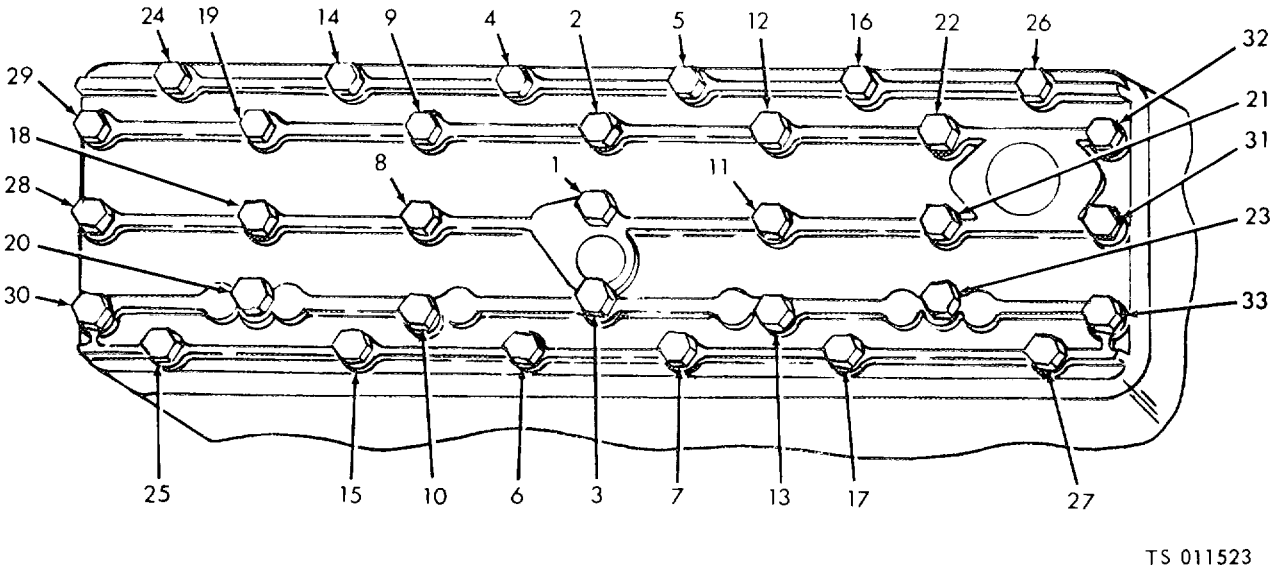

Figure 2-2. Cylinder head capscrew tightening sequence

Step 2. Check for bad piston rings or burned or warped valves.
a. Follow step-by step procedures listed on figure 2-3 and perform compression test.

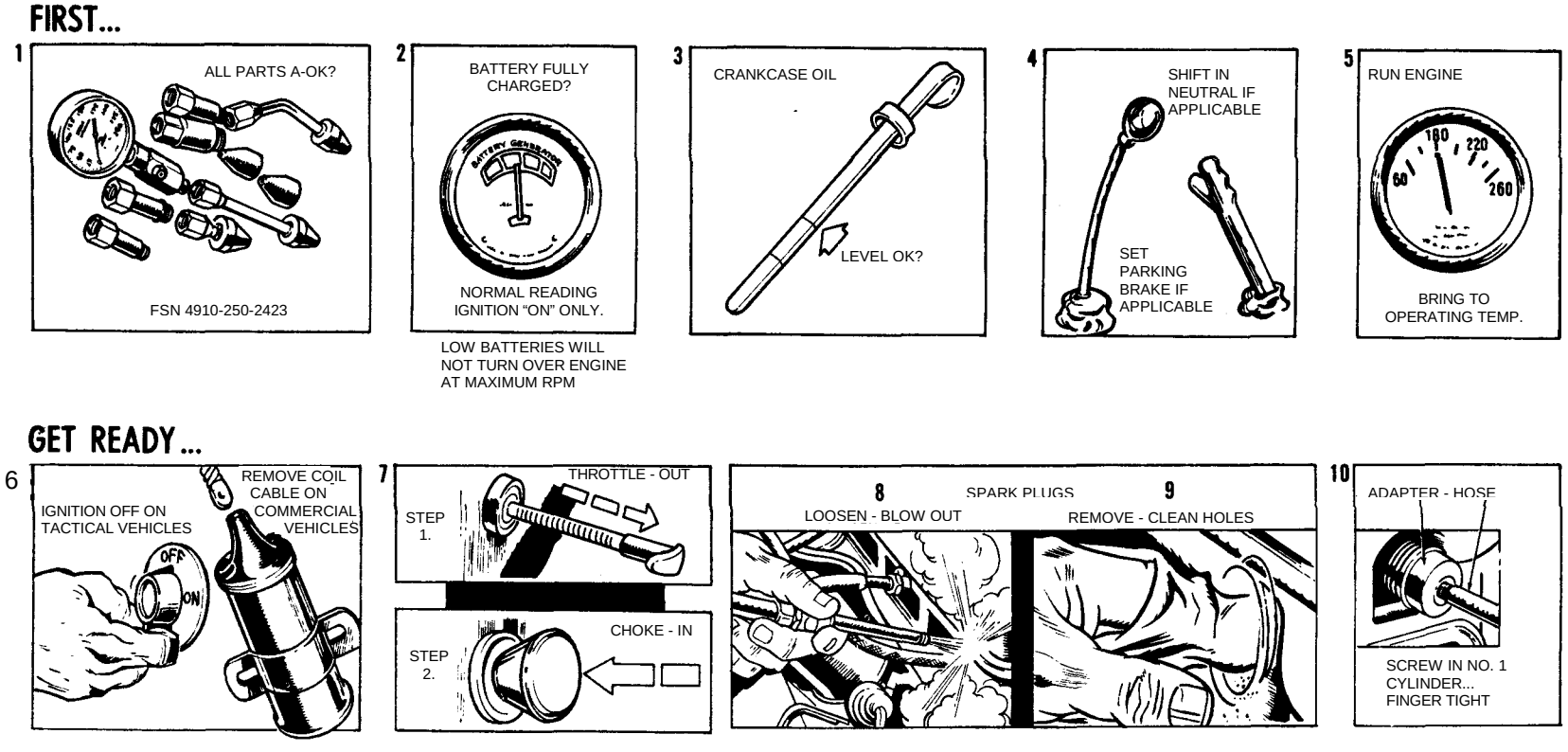

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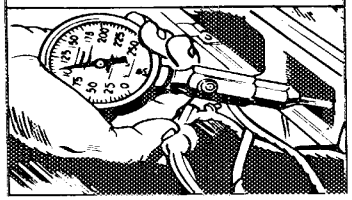
Figure 2-3. Compression test.

COMPRESSION TEST (CONT.)

3. BAD OR MISADJUSTED VALVES

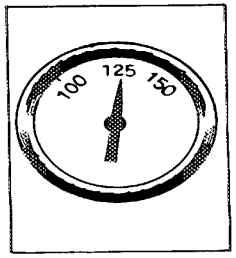
11 WITH GAGE ATTACHED TO NO. 1 CYLINDER....



12 HAVE HELPER TURN OVER ENGINE ABOUT 10 REVS.

DON'T OVERHEAT STARTER

13



14 DO ALL OTHER CYLINDERS THE SAME.
****

ZERO GAGE AND CLEAN TIP AFTER EACH CYLINDER TEST.

SAMPLE READING

CYL	1	2	3	4	5	6
PSI	115	125	120	100	125	115

READINGS BELOW MINIMUM OR BEYOND MAXIMUM ALLOWABLE VARIATION. . .

CAUSE & CURE:

1. HEAD GASKET BLOWN — LOOK FOR SIGNS OF LEAKAGE. IF ANY, REPLACE GSKET IF MAC SAYS SO.

2. BAD RINGS — WET TEST EACH CYLINDER. DO THE SAME FOR A DRY TEST. BUT BEFORE SCREWING IN THE GAGE, SQUIRT A LITTLE OIL ON THE CYLINDER WALL— ALL AROUND. IF THE PSI GOES TO ALLOWABLE MINIMUMS (STEP 15) OR ABOVE, THE RINGS ARE BAD. NOTIFY YOUR NEXT HIGHER LEVEL OF MAINTENANCE.

3. BAD OR MISADJUSTED VALVES

OVERHEAD — IF WET TEST DID NOT IMPROVE READINGS ADJUST VALVE CLEARANCES. IF COMPRESSION IS STILL BAD, REFER TO NEXT HIGHER LEVEL OF MAINTENANCE...PRE YOUR MAC CHART.

FLATHEAD TYPE — IF WET TEST DID NOT IMPROVE READINGS AND GASKET IS OK, NOTIFY NEXT HIGHER LEVEL OF MAINTENANCE.

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

ENGINE CONTINUED

b. If test indicates compression is low, report to next higher level of maintenance.

Step 3. Check for improperly adjusted valve tappets.

a. Operate engine until it reaches operating temperature.

b. Disconnect the positive crankcase ventilation valve and fittings from the valve cover.

c. Remove the nuts and washers that secure the valve chamber cover to the cylinder block. Remove the valve chamber cover and gasket.

d. With the engine running at operating temperature and at idle speed, check the valves for proper clearance. Intake valves should be set for 0.014 inch (0.035 cm) clearance and exhaust valves 0.016 inch (0.04 cm) clearance.

(1) Alternately pass a 0.013 inch (0.032 cm) and 0.015 inch (0.037 cm) flat feeler gage between the head of the intake valve adjusting screw of the tappet (13, fig. 2-4), and stem of valve (2 fig 2-4).

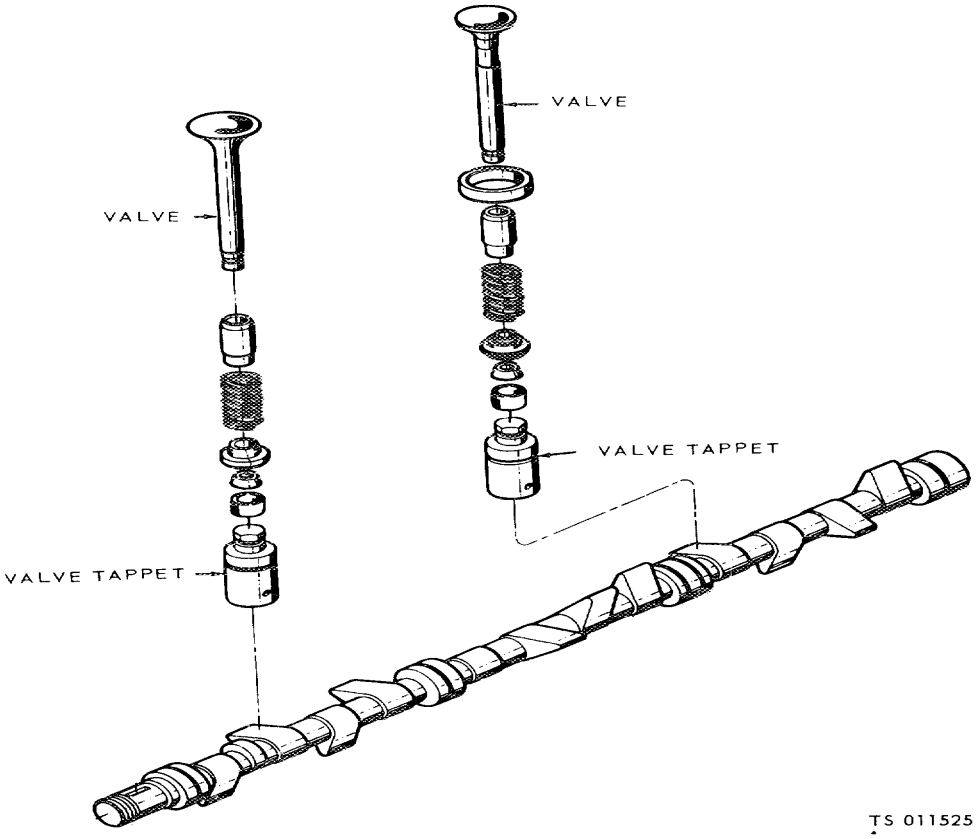


Figure 2-4. Valve adjustment.

Table 2-1. Troubleshooting - Continued

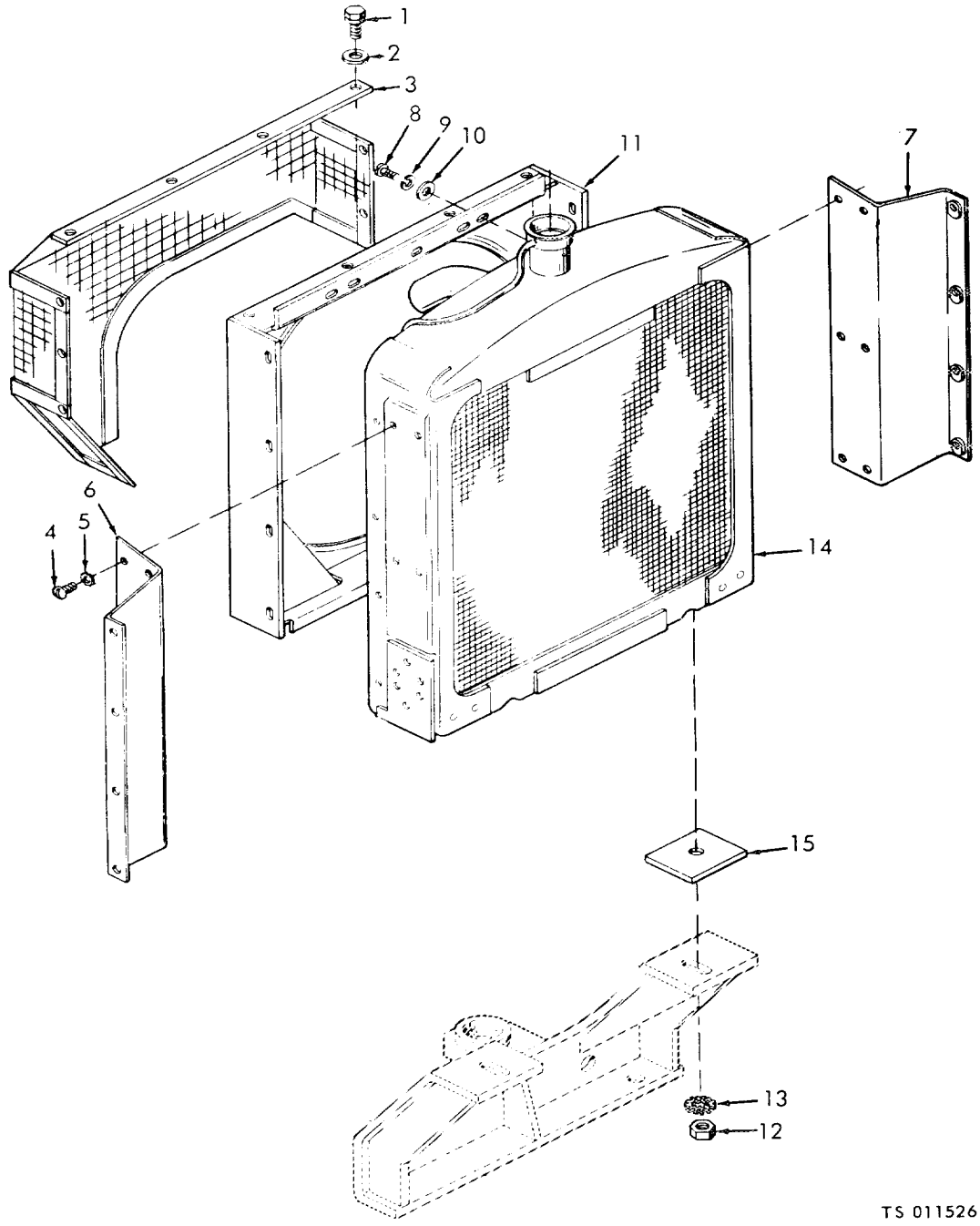
MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

ENGINE CONTINUED

(2) If a 0.013 inch (0.032 cm) feeler gage moves back and forth in gap when the valve is not being lifted, and a 0.015 inch (0.037 cm) feeler gage binds at all times, the clearance requires no adjustment.
(3) Check the exhaust valve clearance in the manner described above, using 0.015 (0.37 cm) and 0.017 inch (0.042 cm) feeler gages
(4) If a 0.013 (0.032 cm) or 0.015 inch (0.037 cm) feeler gage is gripped at all times, the clearance is insufficient.
Adjust valves as follows:
(1) Hold valve lifter with an open end wrench while using a second wrench to turn adjusting screw one-quarter to one-half turn clockwise. Repeat clearance cheek and adjustment until you obtain the proper clearance. The adjustable type valve lifters have self-locking adjusting screws that require no lock nuts.
(2) Install valve chamber cover and gasket Secure valve chamber cover to cylinder block with nuts and washers.
(3) Install positive crankcase ventilation valve and fittings in valve chamber cover.

2. WATER TEMPERATURE SAFETY SWITCH STOPS ENGINE OPERATION

Step 1. Test the radiator for leaks.
a. Remove the radiator from the unit.
(1) Drain the radiator and oil cooler and remove the coolant and oil cooler lines from the radiator.
(2) Remove the engine housing as necessary to provide access to the radiator for removal.
(3) Remove screws (1, fig. 2-5), fiatwashers (2), and fan guard (3). Remove screws (4), lockwashers (5) and remove supports (6 and 7). Remove screws (8), lockwashers (9), fiat washers (10), and fan shroud (11).



1. Screw
2. Flatwasher
3. Fan guard
4. Screw
5. Lockwasher
6. Support
7. Support
8. Screw
9. Lockwasher
10. Flatwasher
11. Fan shroud
12. Nut
13. Lockwasher
14. Radiator
15. Liners

Figure 2-5. Radiator removal.

Table 2-1. Troubleshooting - Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

ENGINE CONTINUED

(4) Use a rope sling and a hoist to support the weight of the radiator before removing nuts (12), lockwashers (13), that secure the radiator to the engine supports Remove nuts (12), lockwashers (13), and remove radiator (14) and liners (15).

b. Inspect all parts for cracks, leaking tubes or gasket.

CAUTION

Do not exceed 10 psi air pressure for radiator testing. Excess pressure will damage the radiator. Make sure that you completely drain the radiator core before testing. When testing at low pressure, it is possible that water within the core could prevent air from passing out of small holes, and the leaks could remain undetected.

c. Make sure the radiator is completely drained of coolant. Plug all openings, except one through which compressed air can he applied. Immerse the radiator in a tank of water and apply 10 psi air pressure to the interior of the radiator. Check for air bubbles that could indicate leak. If leaks are found, mark the areas for repairs.

Repair radiator.

(1) Repair leaks by soldering. Be sure that you **d** not block or retard circulation through any tubes. There shall be no blocked tubes upon completion of repairs.

(2) Use a rope sling and a hoist and install lines (15, fig. 2-5), and radiator (14). Secure radiator to engine supports with lockwashers (13) and nuts (12).

(3) Install fan shroud (11), and secure with flatwasher (10), lockwashers (9), and screws (8). Install supports (7 and 9) and secure with lock-washers (5) and screws (4). Install fan guard (3) and secure with flatwashers (2) and screw (1).

(4) Install engine housing and oil cooler and coolant on the radiator. Service the engine coolant system.

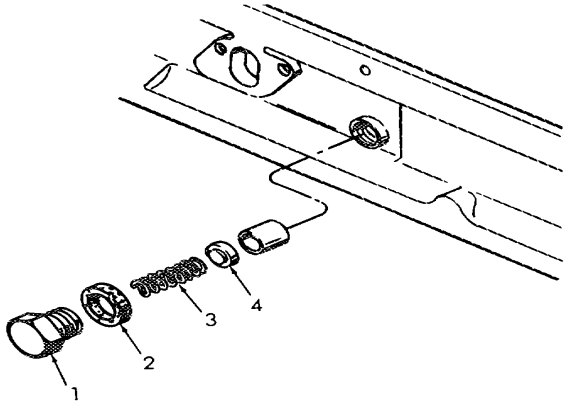
3. OIL PRESSURE SAFETY SWITCH STOPS ENGINE OPERATION

Step 1. Check for improperly adjusted oil pressure regulator valve.

Start the engine and allow it to warm to operating temperature,. Check the engine oil pressure indicated on the oil pressure gage. At idle speed the pressure must exceed 7 psi; at governed speed, it must be between 20 and 30 psi.

If the engine oil pressure is no within the required range, shut off the engine and adjust the oil pressure regulator valve.

(1) Remove plug (1, fig. 2-6) and gasket (2) from the carburetor side of the engine. Remove the valve spring (3) and pressure adjusting washers (4).



1. Plug
2. Gasket
3. Valve spring
4. Washer

Figure 2-6. Oil pressure adjustment

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

ENGINE CONTINUED

(2) To increase oil pressure, add a washer between spring and oil pressure regulator valve. More than four washers should not be used. If four washers do not fulfill the required range, either the spring is faulty or other engine troubles exist.

(3) After you make the adjustments, check that the oil pressure remains In the required ranges during operation.

4. ENGINE LOCKS POWER, SMOKES, OR OPERATES ERRATICALLY

Step I. Check for incorrect engine timing

With the engine running at 600 rpm, use a timing light connected to the rear spark plug and check that the IGN-M indication on the fiywheel is alined with the timing pointer.

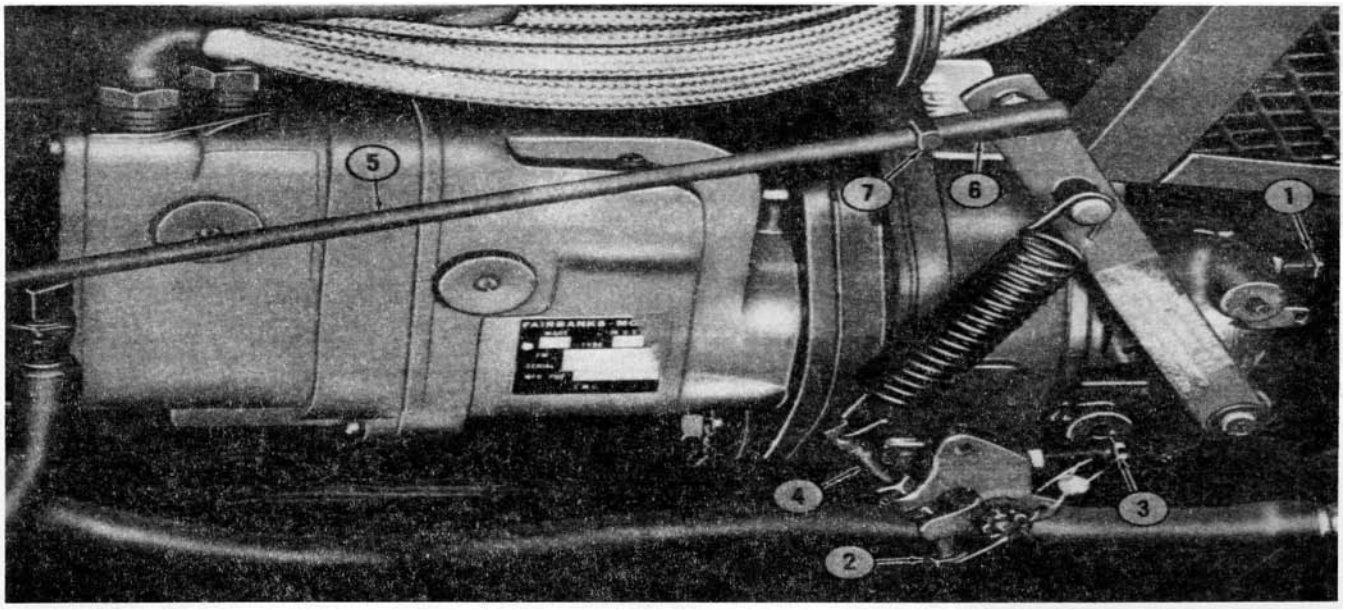
If timing pointer and IGN-M indication on the flywheel are not aligned, the engine timing must be adjusted.

Loosen the magneto mounting hardware slightly and rotate the magneto slightly until the correct indication Is attained. Tighten the magneto mounting hardware firmly.

6. ENGINE SPEED VARIES OR ENGINE SURGES

Check for a defective governor.

a. Start the engine and allow it to warm to operating temperature. While it is warming up, back out the surge adjusting screw (1, fig. 2-7) so that it will not influence the governor setting.



1. Surge adjusting screw
2. Speed adjusting screw
8. Speed adjusting lockscrew
4. Sensitivity adjusting
5. Throttle rod
6. Nut
7. Ball joint

Figure 2-7. Governor adjustment.

b. With the engine warmed up and with the pump not under load adjust the engine idle speed to approximately 150 rpm higher than the required idle speed under load. Make this adjustment by turning the adjusting screw (2, fig. 2-7). Back out speed adjusting lockscrew (3) so that it will not influence the adjustment.

c. The governor's range of action is the differential between the engine speed under load and the engine speed without load. To broaden the range of action use the sensitivity adjusting screw (4). Lengthen the Sensitivity adjusting screw to broaden the range of action of the engine. To narrow the range of action, shorten the sensitivity adjusting screw (4) and compensate for seed change with the speed adjusting screw (3).

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

ENGINE CONTINUED

d. When the governor range of action is properly adjusted, allow the engine to run at governed seed, no load, and check for surging. If surging is noted, turn in the surge adjusting screw (1) just far enough to eliminate the surging.

e. The surge adjustment can also be made by using the tachometer. With the engine running at governed speed, no load, turn in the surge adjusting screw (1) until the engine speed increases 10 to 20 rpm and tighten the lock nut. If the carburetor and linkage are properly adjusted, surge will disappear

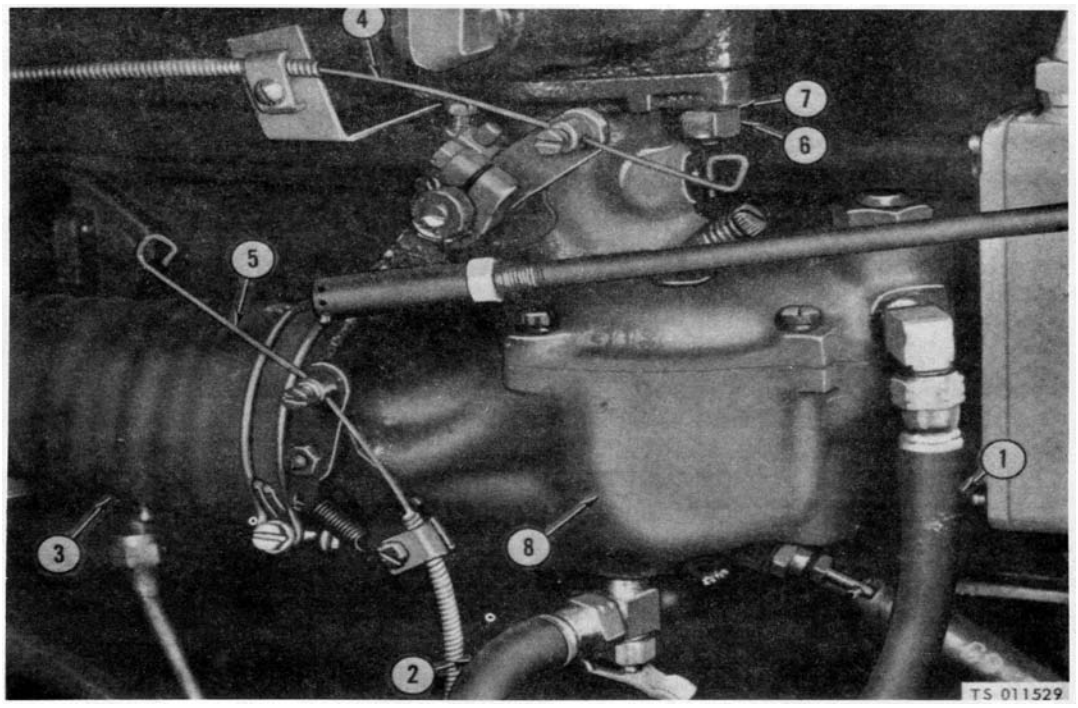
f. If the governor cannot operate the throttle lever on the carburetor through the full operator range, it will be necessary to adjust the length of the throttle rod (5) by loosening the nut (6) and adjusting the position of the ball joint (7).

g. When the governor adjustment is completed, tighten the speed adjusting lockscrew (2) to lock the cam in position. Make sure all locking nuts are tightened.

If the governor cannot be adjusted, replace it.

(1) Disconnect the ball joint on governor to carburetor control rod from the lever on the governor.

(2) Disconnect fuel hoses (1 and 2, fig. 2-8) from the carburetor. Remove air cleaner hose (3) from the carburetor.



1. Fuel hose
2. Fuel hose
3. Air cleaner hose
4. Throttle control cable
5. Choke control
6. Nut
7. Lockwasher
8. Carburetor

Figure 2-8. Carburetor removal.

(3) Disconnect the ends of the throttle control cable (4) and choke control (5) from their respective levers on the carburetor.

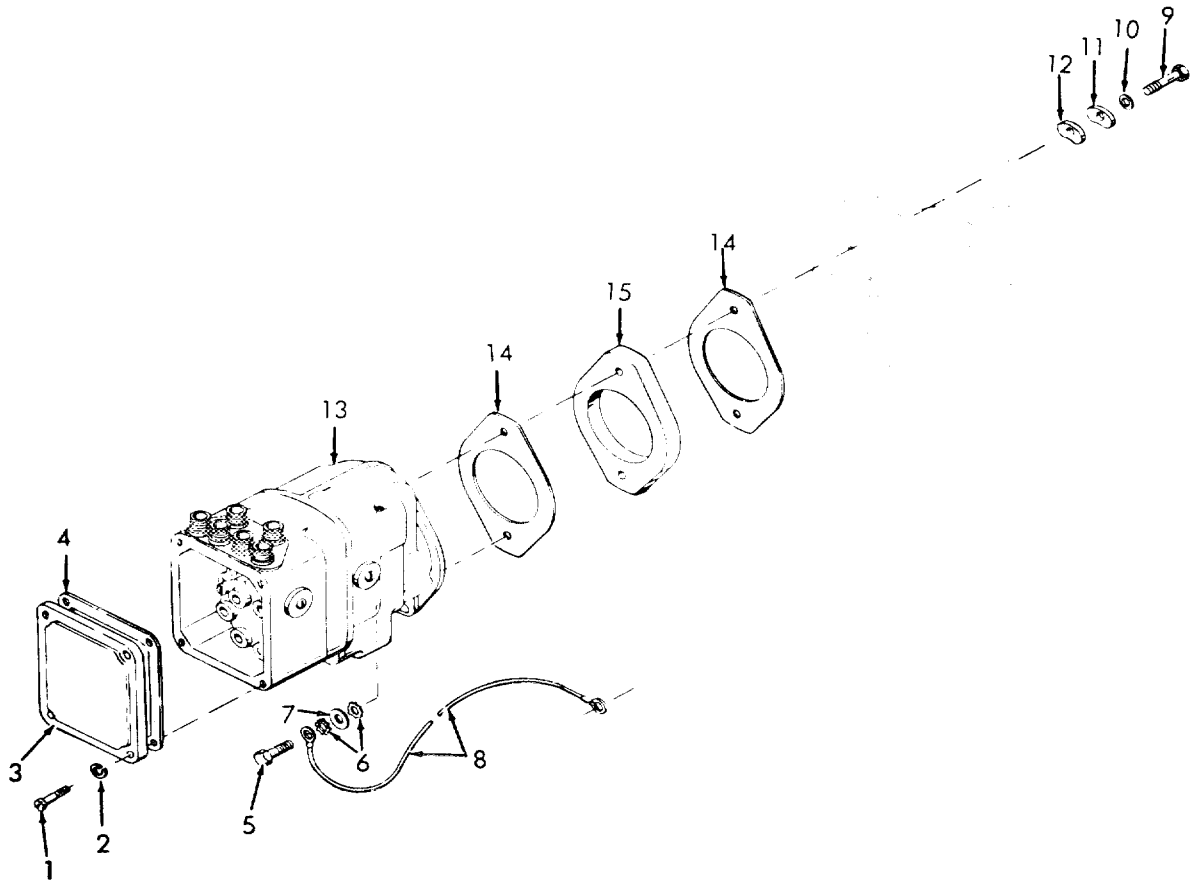
(4) Remove nuts (6), lockwashers (7), and remove carburetor (8).

(5) Remove four screws (1, fig. 2-9) and lockwashers (2) that secure the cover (3) on the magneto; remove the cover and gasket (4).

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

ENGINE CONTINUED



1. Screws
2. Lockwasher
3. Cover
4. Gasket
5. Screw
5. Lockwasher
7. Flatwasher
8. Ground lead
9. Bolt
10. Flatwasher
11. Gasket plate
12. Gasket
13. Magneto
14. Gasket
15. Spacer

Figure 2-9. Magneto removal.

(6) Disconnect the shielded spark plug cables from the magneto end cap by unscrewing the shield connectors. Disconnect the ends of the leads from the distributor cap in the magneto end cap.
(7) Remove the lower screw (5), lockwashers (6), and flatwasher (7) that secure the bottom of the magneto and ground lead (8) to the engine front end plate. Remove bolt (9), flatwasher (10), gasket plate (11), and gasket (12) that secure the top of the magneto and governor to the gear cover; remove magneto (13), gaskets (14) and spacer (15).
(8) Remove screw (1, fig. 2-10). governor (2) and gasket (3).

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

ENGINE CONTINUED

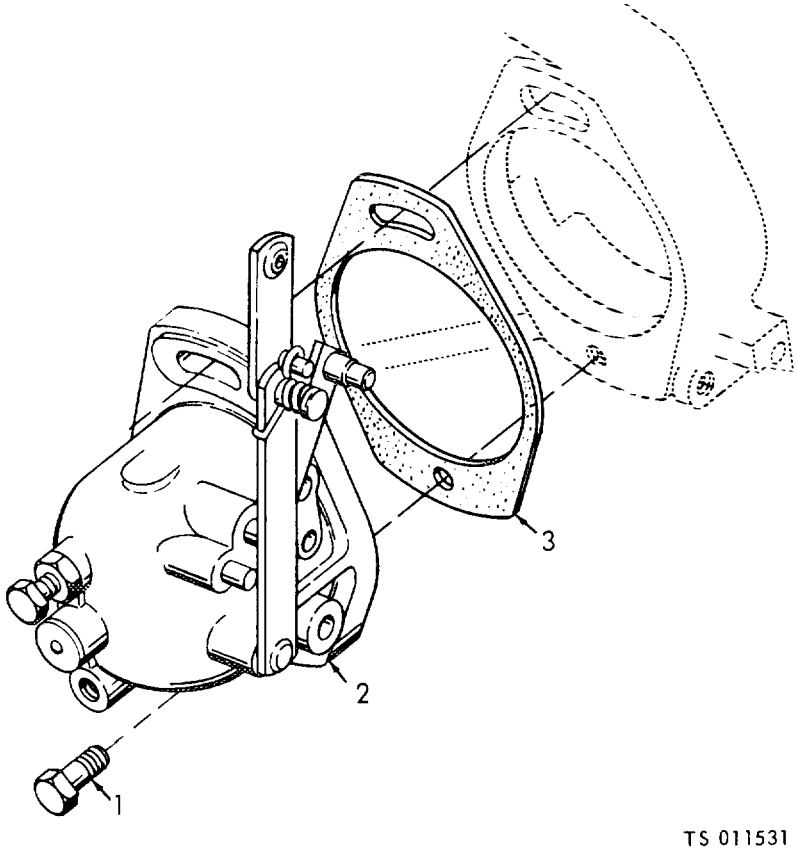


Figure 2-10. Governor removal.

(9) Install gasket (3, fig. 2-10) and governor (2) on gear cover. Sight through the magneto mounting hole to check that the two marked teeth of the governor drive gear engage the single marked tooth of the cam gear as shown in figure 2-11. Ignitor timing is dependent upon this relationship because the magneto is driven by the governor drive gear. Install gasket (12, fig. 2-9), gasket plate (11), flatwasher (10) and bolt (9). Tighten the mounting bolt moderately.

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

ENGINE CONTINUED

ENGINE CONTINUED

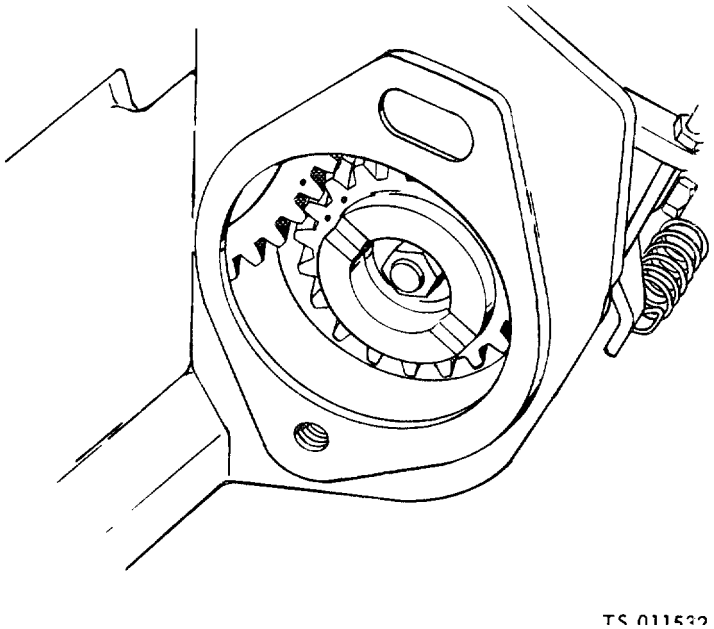


Figure 2.11. Engine timing marks.

(10) Remove the rear spark plug from the engine. Put your thumb over the spark plug hole and crank the engine until no. 6 cylinder starts on the compression stroke. This is indicated by air being compressed against your thumb as the piston rises In the cylinder.

(11) Set the piston on top-dead center by slowly cranking until the DC mark on the flywheel {2, fig 2-12), visible through the timing hole (1) In the housing, is aligned with the timing mark pointer. Hold the engine at this setting.

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

ENGINE CONTINUED

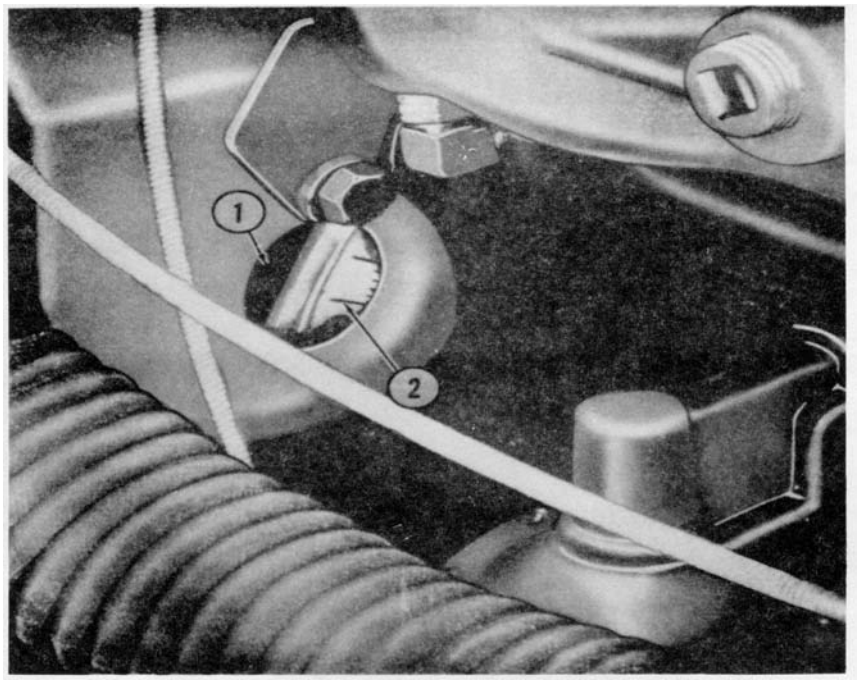


Figure 2-12. Engine timing mark pointer.

(12) Mount the magneto In a vise thoroughly lined with soft cloths. Insert a spark plug cable into distributor block hole for spark plug no. 6. Refer to figure 2-13. Turn the drive lugs clockwise while holding the high tension cable for no. 6 cylinder close to the magneto frame so that a spark will are when the no. 6 cable is energized. When no. 6 cable arcs, the magneto is at the no.6 firing position. Hold the magneto drive shaft at this position.

Table 2-1. Troubleshooting - Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

ENGINE CONTINUED

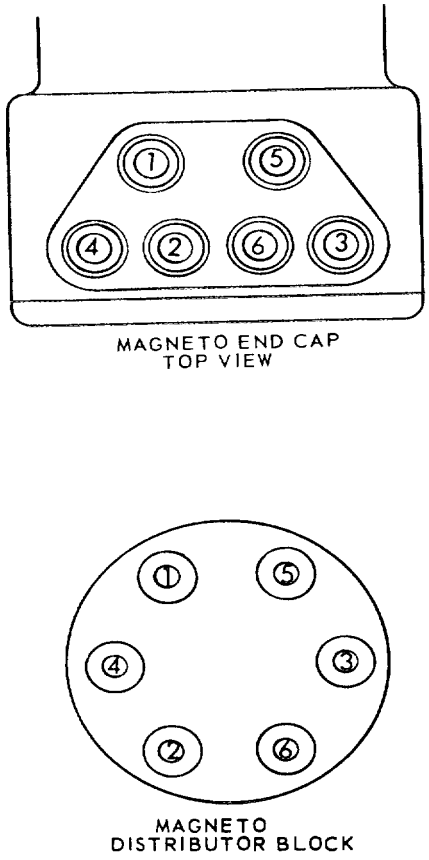


Figure 2-13. Magneto-to-spark plug connections.

(13) Remove the magneto from the vise. Turn the magneto drive lugs of the impulse coupling counterclockwise about one quarter turn so that the lugs will mash with the drive members of the governor drive gear. Position the magneto (13 fig. 9) gaskets (14) and spacer (14), on the engine with the magneto lugs engaged. Install screw (5), lockwashers (6), flatwasher (7) and ground lead (8). Tighten mounting screw modestly. Install and connect the spark plug cables to the magneto end cap.

(14) Start the engine and idle at 600 rpm. If the engine fails to start, it is probably due to faulty ignition, timing. Recheck timing as directed in paragraph (9).

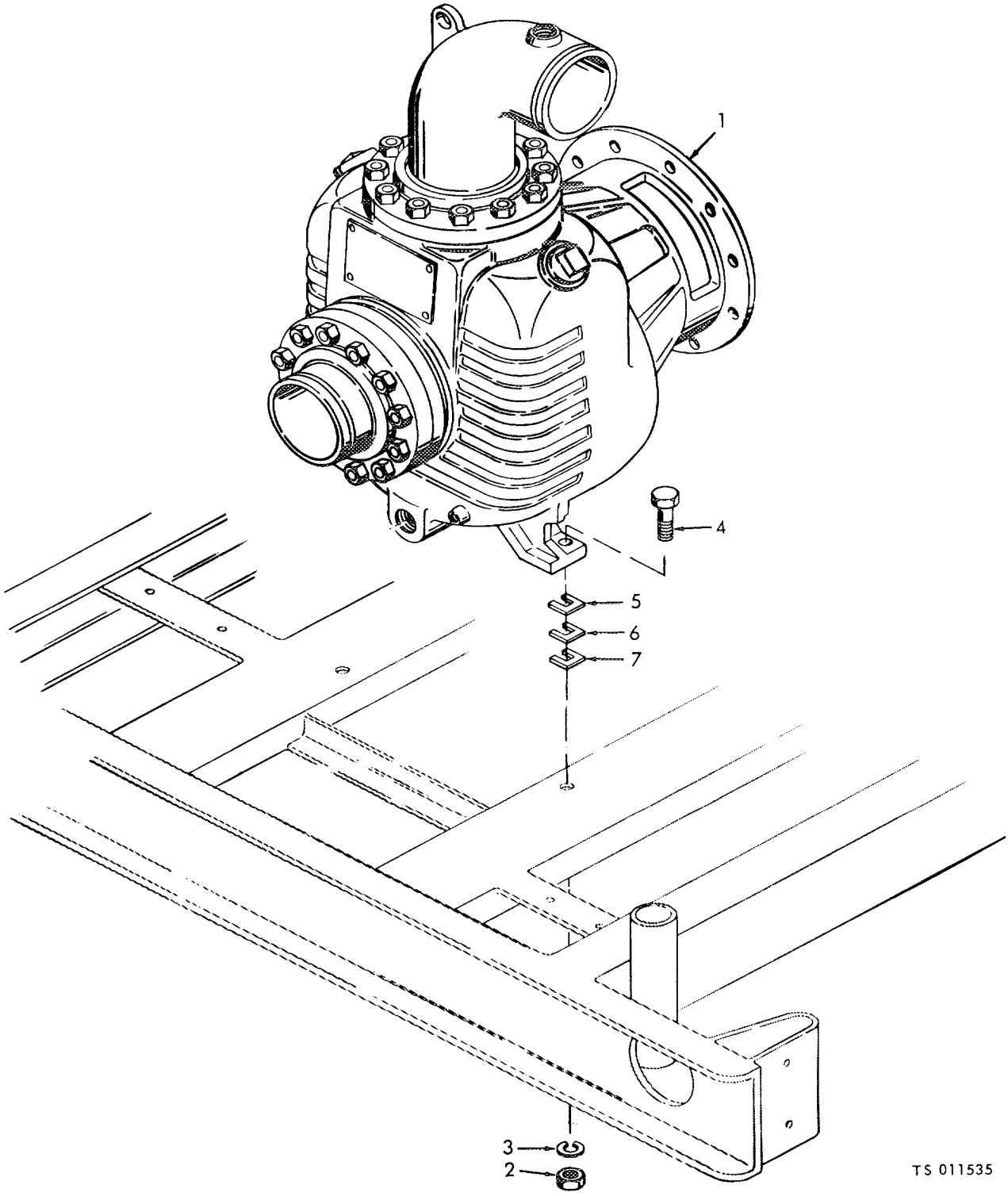
(15) With the engine running at 600 rpm, use a timing light connected to the rear spark plug and check that the IGN-M indication on the flywheel is aligned with the timing pointer. If it is not exactly alined, loosen the magneto mounting hardware slightly and rotate the magneto slightly until the correct Indication is attained. Tighten the mounting hardware firmly..

(16) Refer to Step 1, para a through g and adjust the governor.

6. PUMP RUNS WITH NO DISCHARGE OR WITH LOW PRESSURE

Step 1. Check for a broken, worn, or damaged impeller.

a. Use a hoist or other lifting devices to support the weight of the pump (1, fig. 2-14). Remove nuts (2), lockwashers (3) and screws (4) that secure the pump to the chassis frame.



1. Pump
2. Nut
3. Lockwasher
4. Screw

Figure 2-14. Centrifugal pump removal and installation.

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
ENGINE CONTINUED
b. Remove nuts and lockwashers that secure pump body to the bearing housing;: slide the pump body straight out to disengage it from the remainder of the pump which is secured to the engine. e. Disassemble the pump following the sequence of index numbers in figure 2-15.

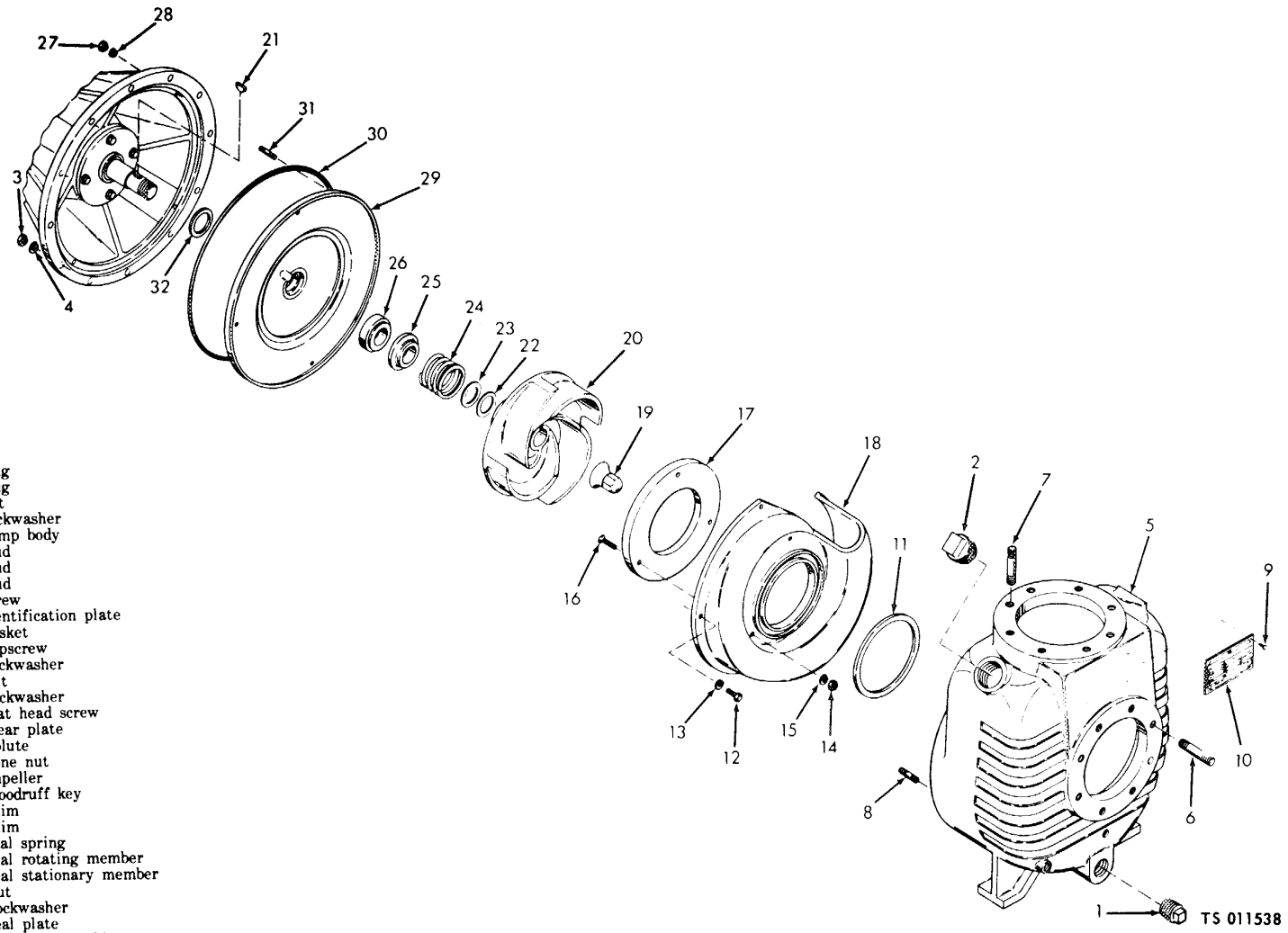


Figure 2-15. Centrifugal pump disassembly and reassembly.

Table 2-1. Troubleshooting - Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

CENTRIFUGAL PUMP CONTINUED

d. Inspect the impeller for cracked, chipped, worn or broken vanes, damaged or distorted bore or keyway.
Replace a damaged impeller.

(1) Reassemble the pump by reversing the disassembly sequence in figure 2-15. Note the following.

a. Press the seal stationary member (26) into seal plate (29) before installing the plate. Lubricate the impeller shaft lightly with oil and slide the seal rotating member (25) and spring into place on the shaft

b. If the same impeller (20) and wear plate (17) are reassembled and no clearance change is indicated, use shims (22 and 23) of the same thickness as those removed. If a new impeller and/or wear plate is installed, determine the shim thickness required to obtain a clearance of 0.010 to 0.020 inch (0.025 to 0.05 cm) between the impeller and wear plate as follows:

c. Install impeller (20) on shaft without shims. Be sure that Impeller is seated firmly against the shaft shoulder.

d. Install volute (18) with wear plate (17) assembled, and secure with screws (12) and lockwashers (13).

e. Insert a feeler gage into the front opening of the volute and measure from the face of the impeller (20) to the face of the wear plate (17)

f. Select shims (22 and 23) to equal the dimension obtained less 0.010 to 0.020 inch (0.025 to 0.05 cm) clearance.

(2) After reassembly, when using either new or used parts, recheck the clearance; it must be 0.010 to 0.020 Inch (0.025 to 0.05 cm). Check the impeller shaft for free rotation. It must turn freely without catching or binding. If binding is evident, disassemble the pump and correct the condition.

(3) Use a hoist or other lifting device and install the pump on the chassis. Install nuts and lockwashers that secure the pump body to the bearing housing.

(4) Install screws (4, fig.-14), lockwashers (3) and nuts (2) that secure pump (1) to the chassis.

NOTE

If you are installing the same pump you removed, use shims (5, 6 and 7, fig. 2-14) having the same thickness as the ones removed. If a different pump is being installed, provide shims having proper thickness for as long the bearing housing with the flywheel housing of the engine.

Step 2. Check for incorrect impeller-to-wear plate clearance.

a. Insert a feeler gage into the front opening of the volute and measure from the face of the impeller (20, fig. 2-15) to the face of the wear plate (17).

b. The correct clearance should be 0.010 to 0.020 inch (0.(25 to 0.05 cm).

If the clearance between the face of the impeller and the face of the wear plate is not 0.010 to 0.020 inch (0.025 to 0.05 cm) the pump must be disassembled and shims added to obtain the correct clearance.

Refer to malfunction one to remove, disassemble, reassemble and install the pump.

Step 3. Check for excessively worn wear plate.

a. Refer to malfunction one to remove and disassemble the pump.

b. inspect the wear plate for wear, scoring, and distortion.

If any damage to the wear plate is evident, replace it. Refer to Malfunction 1 and reassemble and install the pump.

Step 4. Check for defective shaft seal.

a. Use a hoist or other lifting device to support the weight of the pump (1, fig. 2-16). Remove nuts (2), lockwasher (3), and screws (4) that secure the pump to the chassis frame.

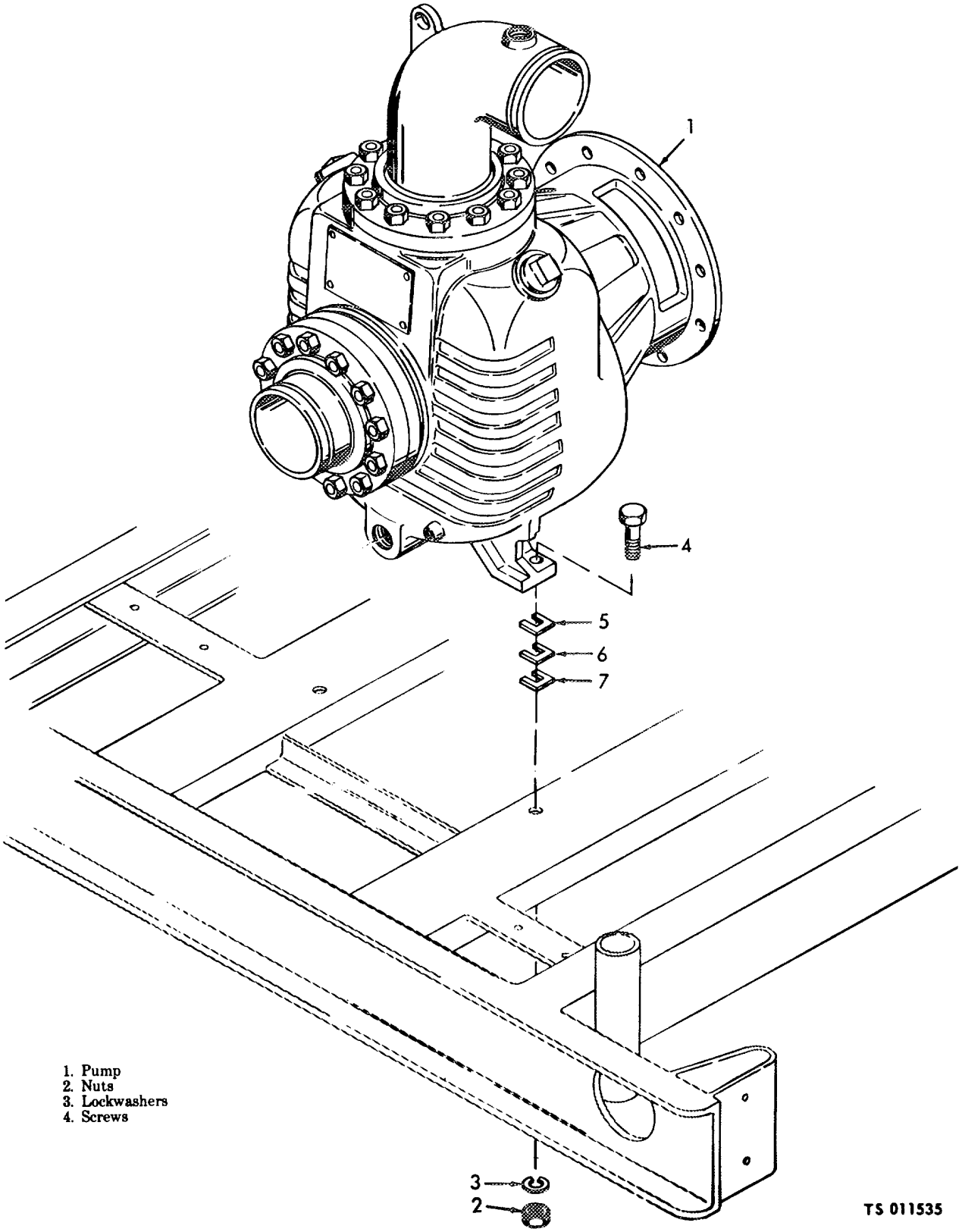
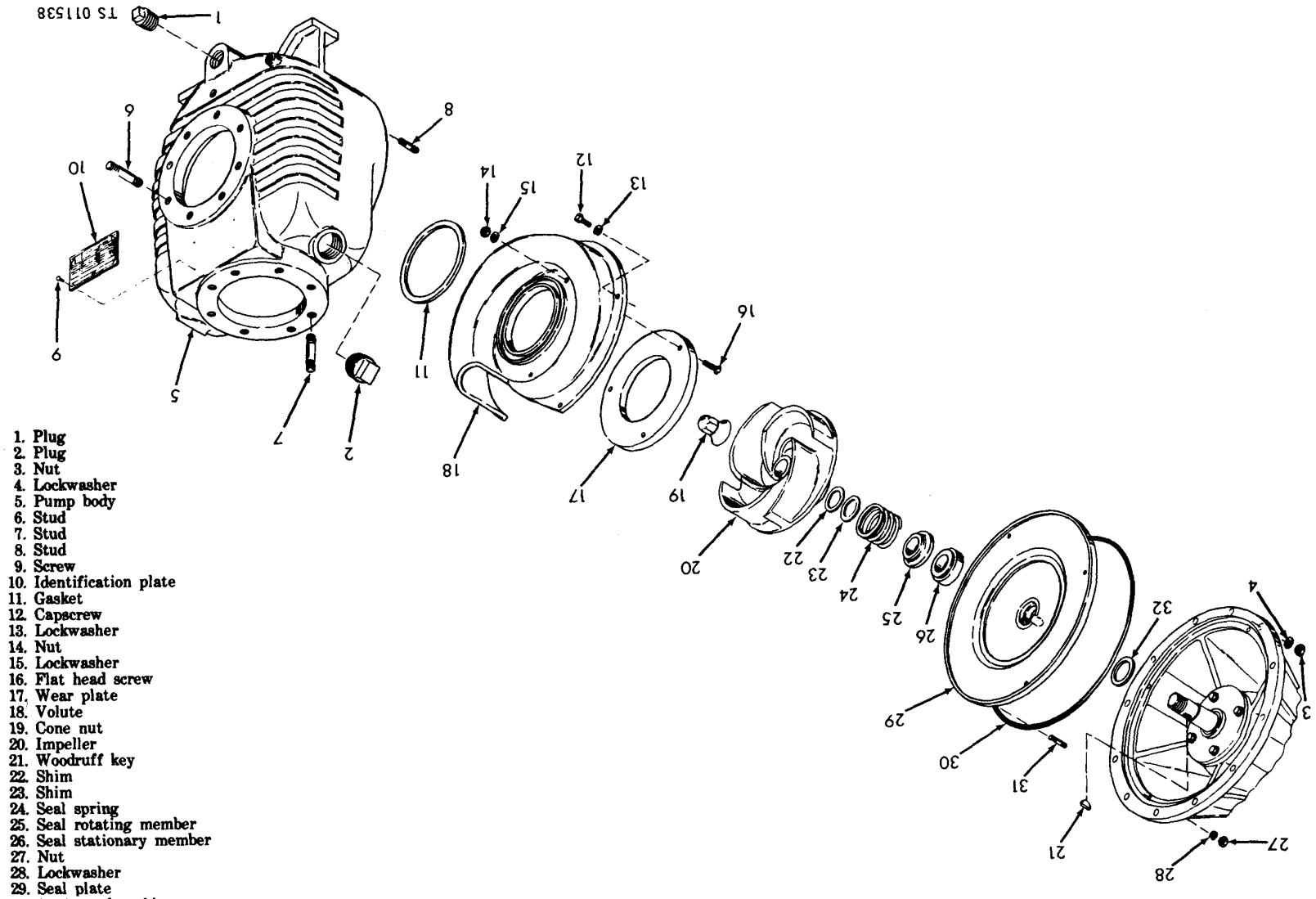


Figure 2-16. Centrifugal pump removal and installation.

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
CENTRIFUGAL PUMP CONTINUED
b. Remove nuts and lockwashers that secure pump body to the bearing housing; slide the pump body straight out to disengage it from the remainder of the pump which is secured to the engine.
c. Disassemble the pump following the sequence of index numbers in figure 2-17.



1. Plug
2. Plug
3. Nut
4. Lockwasher
5. Pump body
6. Stud
7. Stud
8. Stud
9. Screw
10. Identification plate
11. Gasket
12. Capscrew
13. Lockwasher
14. Nut
15. Lockwasher
16. Flat head screw
17. Wear plate
18. Volute
19. Cone nut
20. Impeller
21. Woodruff key
22. Shim
23. Shim
24. Seal spring
25. Seal rotating member
26. Seal stationary member
27. Nut
28. Lockwasher
29. Seal plate
30. Preformed packing
31. Stud
32. Slinger

Figure 2-17. Centrifugal pump disassembly and reassembly.

Table 2-1. Troubleshooting - Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

CENTRIFUGAL PUMP CONTINUED

d. Inspect shaft seal for cracks and excessive wear.

Replace a damaged shaft seal.

NOTE

The seal members are replaceable individually. When replacing the seal, be sure to replace all parts that are provided in the seal kit.

(1) Reassemble the pump by reversing the disassemble sequence In figure 2-17. Note the following:

(a) Press the seal stationary member (28) into seal plate (29) before installing the plate. Lubricate the impeller shaft lightly with oil and slide the seal rotating member (25) and spring into place on the shaft.

(b) If the same impeller (20), and wear plate (17) are reassembled and no clearance change is indicated, use shims (22 and 23) of the same thickness as those removed. If a new impeller and/or wear plate is installed, determine the shim thickness required to obtain a clearance of 0.010 to 0.020 inch between the impeller and wear plate as follows.

(c) Install impeller (20) on shaft without shims. Be sure that Impeller is seated firmly against the shaft shoulder.

(d) Install volute (18, with wear plate (17) assembled, and secure with screws (12) and lockwasher (13).

(e) Insert a feeler gage into the front opening of the volute and measure from the face of the impeller (20) to the face of the wear plate (17).

(f) Select shims (22 and 23) to equal the dimensions obtained less 0.010 to 0.020 inch (0.025 to 0.05 cm) clearance.

(2) After reassembly, when using either new or used parts, recheck the clearance; it must be 0.010 to 0.020 inch (0.025 to 0.05 cm). Check the impeller shaft for free rotation. It must turn freely, without catching or binding. If binding is evident, disassemble the pump and correct the condition.

(3) Use a hoist or other lifting device and install the pump on the chassis. Install nuts and lockwashers that secure the pump body to the bearing housing.

(4) Install screws (4, fig. 2-16), lockwashers (3) andnuts (2) that secure pump (1) to the chassis.

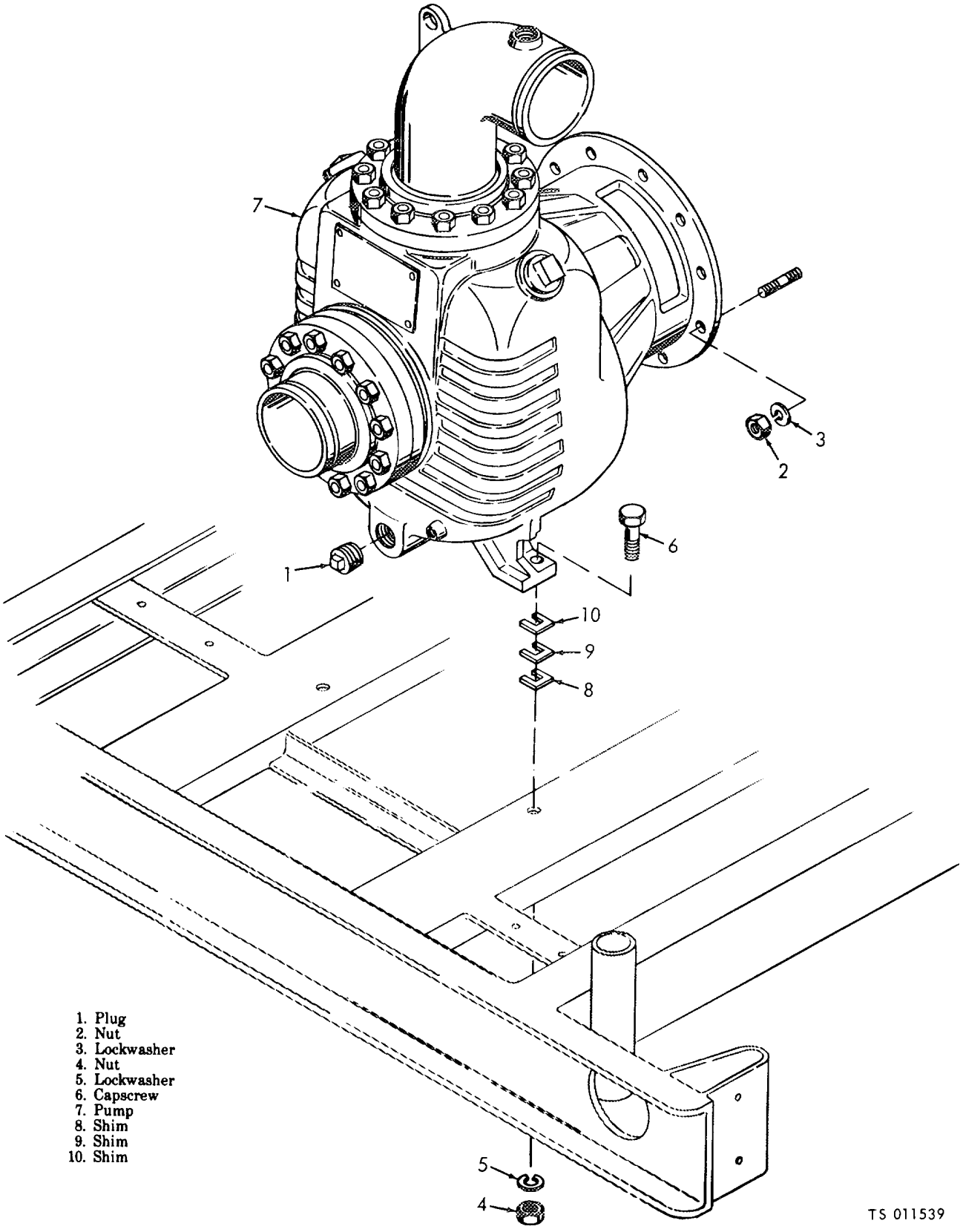
NOTE

If you are installing the same pump you removed, use shims (5, 6, and 7, fig. 2-16) having the same thickness as the ones removed. If a different pump is being installed, provide shims having proper thickness for sling the bearing housing with the flywheel housing of the engine.

7. PUMP MAKES EXCESSIVE NOISE

Step 1. Check for defective impeller shaft bearings.

a. Remove drain plug (1, fig2-18) from the centrifugal pump.



1. Plug
2. Nut
3. Lockwasher
4. Nut
5. Lockwasher
6. Capscrew
7. Pump
8. Shim
9. Shim
10. Shim

Figure 2-18. Centrifugal pump removal and installation.

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

CENTRIFUGAL PUMP CONTINUED

b. Disconnect all suction and discharge piping from the pump. Disconnect the suction and pressure gage piping from the pump.

c. Place a rope sling around the pump and support the weight of the pump with a hoist or crane.

d. Remove the nuts (2) and lockwashers (3) that secure the bearing housing of the pump (7) to the flywheel housing of the engine.

e. Remove nuts (4), lockwashers (5) and capscrews (6) that secure the pump to the chassis. Operate the hoist or crane so that pump fast barely clear the chassis frame. Pull the pump straight out to disengage the pump half of the flexible coupling from the engine half of the coupling. Be careful not to lose the cushions that are installed between the coupling halves. Remove the pump and shims (8, 9 and 10).

f. Remove sleeves (1, fig. 2-19) to release the cushions (2) from the coupling halves (7 and 13). Remove setscrew (3) that secures the coupling half (7) to the impeller shaft; remove the coupling and key.

g. Remove lockwire (4) and retaining ring (5) that secure the collar (6) to the coupling half; remove the collar.

h. Remove capscrews (8) and lockwashers (9) that secure the drive plate (12) to the engine flywheel; remove the assembled coupling half (13) and drive plate.

i. Remove the capscrews (10) and lockwashers (11) that secure the coupling half (13) to the drive plate (12): remove the coupling half.

j. Remove nuts and lockwashers that secure pump body to the hearing housing. Separate the bearing housing and pump body.

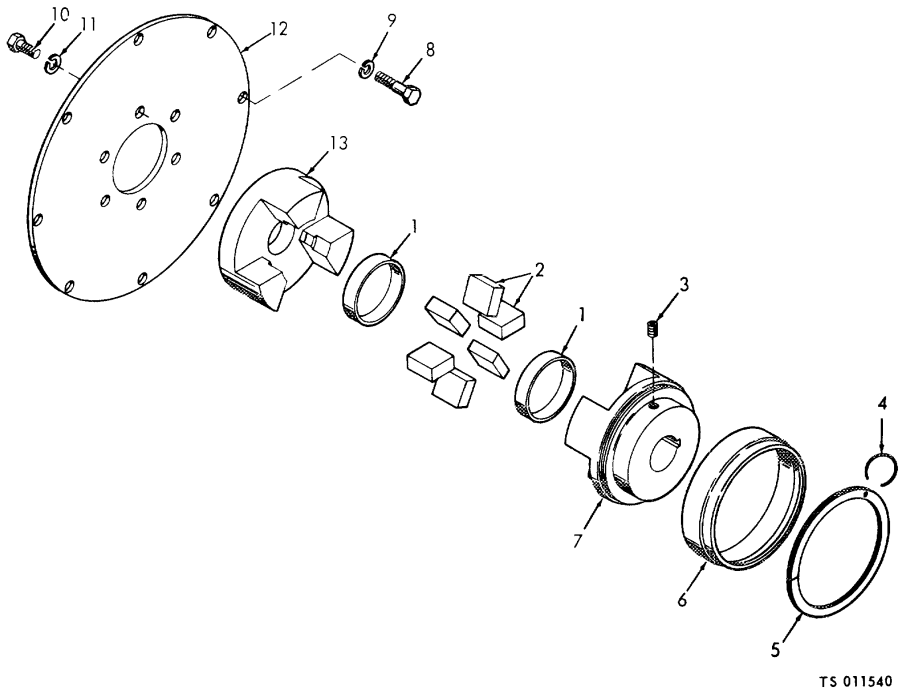


Figure 2-19. Pump coupling.

k. Disassemble the bearing housing in the sequence indicated in figure 2-20.

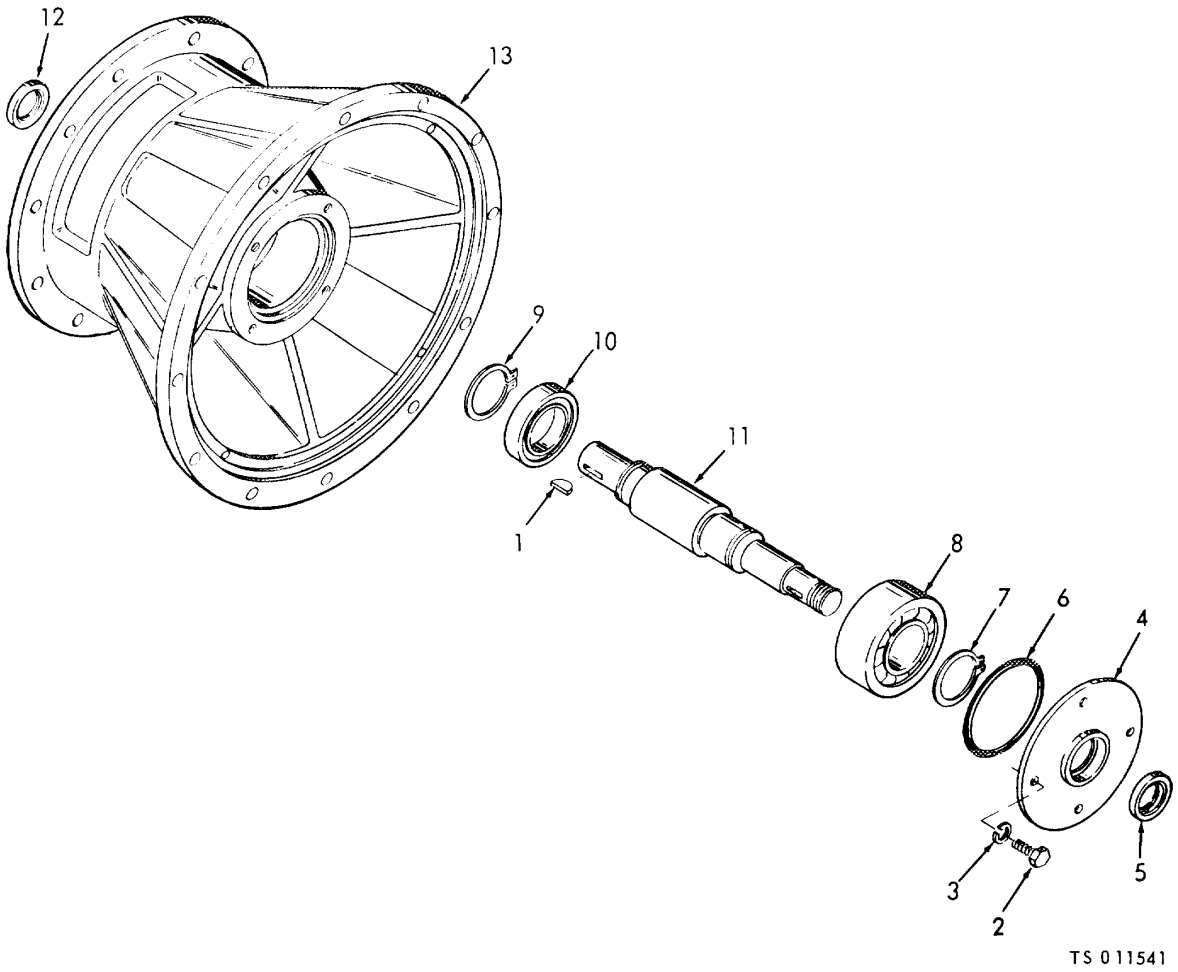


Figure 2-20. Bearing housing.

Table 2-1. Troubleshooting - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

CENTRIFUGAL PUMP CONTINUED

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Dry cleaning solvent, P-D-680 or P-S-661, used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. - 138 F. (38 C.- 59 C.).

l. Clean ball and roller bearings by replacing them into a wire basket and then immersing them into a container of fresh cleaning solvent (Fed. Spec. P-D-680). Agitate the bearings in the solvent to remove all traces of old lubricants. After the bearings are cleaned, allow them to air dry.

m. Inspect the bearings for signs of scoring, cracked races, signs of overheating, and binding operation.

Table 2-1. Troubleshooting -- Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

CENTRIFUGAL PUMP CONTINUED

Replace all bearings that are damaged.

(1) Press bearings (8 and 10, fig. 2-20) onto the Impeller shaft (11). Secure bearings to the shaft with retaining ring (7 and 9).

(2) Press grease seal (12) into the bearing housing (13) and grease seal (5) Into the bearing cap (4) before installing the shaft and bearings in the bearing housing.

(3) Pack the bearings and bearing cap with MIL-G-10924 grease; pack the area between the bearings in the bearing housing three-fourths full of the same grease.

(4) Press the shaft and assembled bearings into the housing until the bearings are seated. Install the preformed packing (6) and bearing cap (4). Secure the bearing cap with the capscrews (2) and lockwashers (3), tightening them evenly In increments until all are secure.

(5) Install coupling half (13, fig. 2-19) on the drive plate (11); secure with six capscrews (10) and lockwashers (11).

(6) Install drive plate (12) on the engine flywheel and secure with capscrews (8) and lockwashers (9).

(7) Install collar to coupling half and secure with retaining ring (5) and lockwire (4).

(8) Install coupling half (7) and collar (6) on the end of the impeller shaft so that the keyway engages the key on the shaft. Secure with setscrew (3).

(9) Install three cushions (2) on each coupling half; secure each with sleeve (1).

(10) Place a sling around the pump and install pump onthe chassis. Install shims (8. 9, and 10) having die same thickness as the ones removed. Slide the pump into engagement with the engine so that the coupling halves are properly alined.

(11) Secure the bearing housing to the flywheel housing with nuts (2) and lockwashers (3). Secure the pump feet to the chassis frame with capscrews (6), lockwashers (5) and nuts (4).

Section III. GENERAL MAINTENANCE

2-5. General

This section contains general maintenance procedures which are the responsibility of direct support and general support maintenance personnel. The paragraphs contained herein describe general practices you will find applicable to several assemblies or components of the pumping assembly which would otherwise have to be repeated in each section of the manual assigned to those assemblies and components.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (fed. spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 to 138 F (38 to 59 C).

2-6. Cleanliness

a. Take care to ensure that your work area is clean before starting to disassemble the engine or pump parts.

b. Clean the exterior of the engine or pump before starting disassembly to prevent dirt from entering the bearings or the other critical contact surfaces. Clean the exterior of engine components with a cloth dampened with cleaning solvent (fed. spec. P-D-680).

c. If you clean the parts with compressed air, make sure the air is free from dirt and contaminants.

d. Protect disassembled parts from blowing sand and dust which could later cause rapid wear of the gears, bearings, and machined surfaces.

2-7. Care of Bearings

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (fed. spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 to 138 F (38 to 59 C).

a. Clean ball and roller bearings by placing them into a wire basket and then immersing them into a container of fresh cleaning solvent (fed. spec. P-D-680). Agitate the bearings in the solvent to remove all traces of old lubricants.

b. After the bearings are cleaned, allow them to air dry.

c. Dip the cleaned and dried bearings in clean engine oil and immediately wrap them in lint-free paper to prevent the entry of dust and dirt.

2-8. Seals-and Gaskets

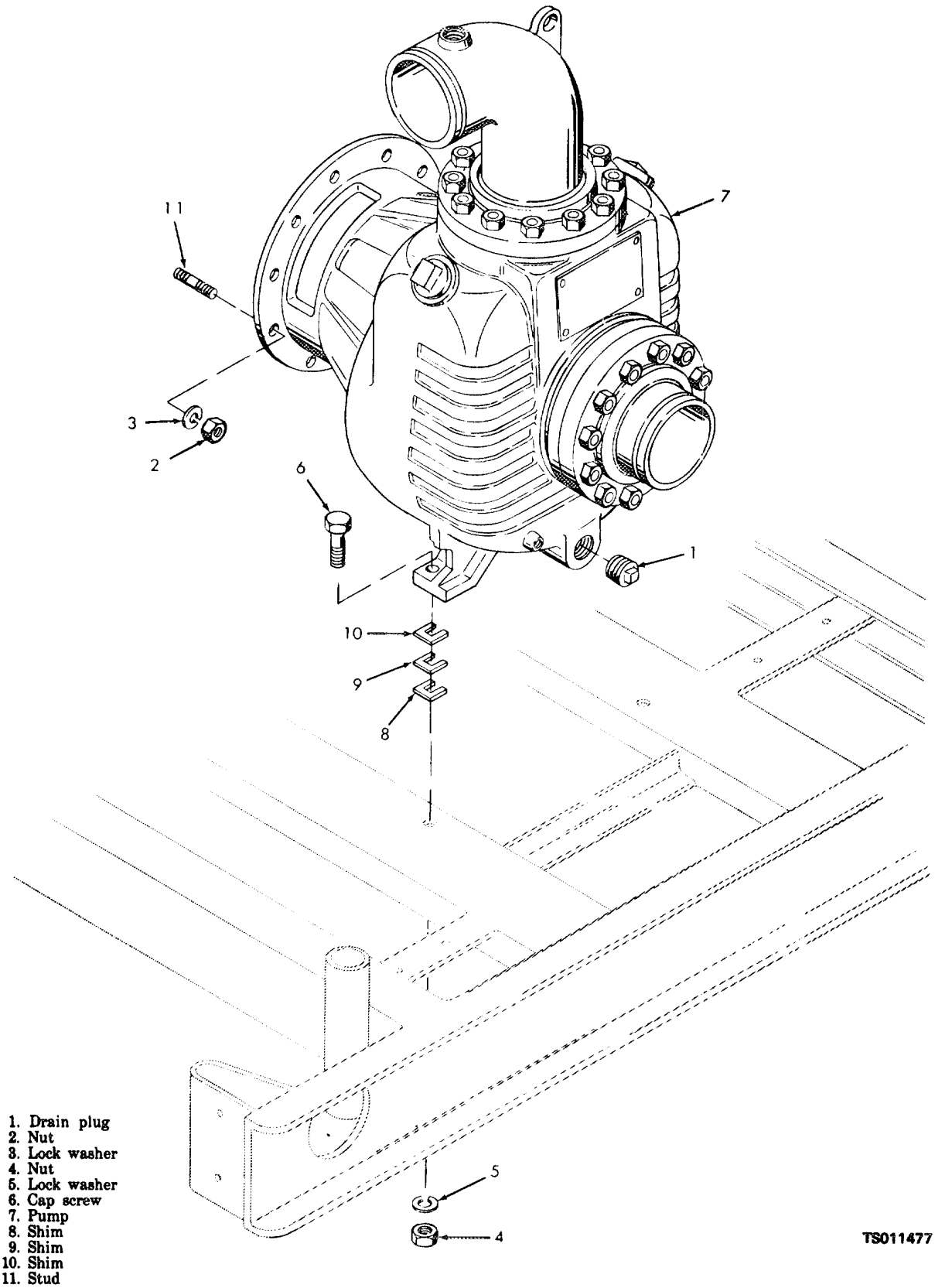
Replace seals and gaskets of all components you disassemble. The use of new gaskets and seals will greatly reduce the possibility of leaking and will help prevent the entry of dust and dirt after reassembly.

Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS AND ASSEMBLIES

2-9. Centrifugal Pump

a. Removal.

(1) Remove the drain plug (1, fig. 2-21) from the centrifugal pump.



1. Drain plug
2. Nut
3. Lock washer
4. Nut
5. Lock washer
6. Cap screw
7. Pump
8. Shim
9. Shim
10. Shim
11. Stud

Figure 2-21. Centrifugal pump, removal and installation.

(2) Disconnect all suction and discharge piping from the pump.

(3) Disconnect the suction and pressure gage piping from the pump (TM 5-4320-234-12, para 4-47).

(4) Place a rope sling around the pump and support the weight of the pump with a hoist or crane.

(5) Remove the nuts (2) and lockwashers (3) that secure the bearing housing of the pump (7) to the flywheel housing of the engine.

(6) Remove the cap screws (6), nuts (4), and lock washers (5) that secure the pump to the chassis. Operate the hoist or crane so that the pump feet barely clear the chassis frame. Pull the pump straight out to disengage the pump half of the flexible coupling from the engine half of the coupling. Be careful not to lose the cushions that are installed between the coupling halves. Remove the pump and shims (8, 9, and 10).

(7) Remove the flexible coupling (para 2-10).

b. Installation.

(1) Install the flexible coupling (para 2-10).

(2) If you are installing the same pump you removed, use shims (8, 9, and 10, fig. 2-21) having the same thickness as the ones removed. If a different pump is being installed, provide shims having proper thickness for aligning the bearing housing with the flywheel housing of the engine. Slide the pump into engagement with the engine so that the coupling halves are properly alined.

(3) Secure the bearing housing of the pump to the flywheel housing of the engine with nuts (2) and lock washers (3). Secure the pump feet to the chassis frame with cap screws (6), nuts (4) and lock washers (5), making sure the shims are in place.

(4) Connect the suction and pressure gage piping (TM 5-4320-234-12, para 4-47).

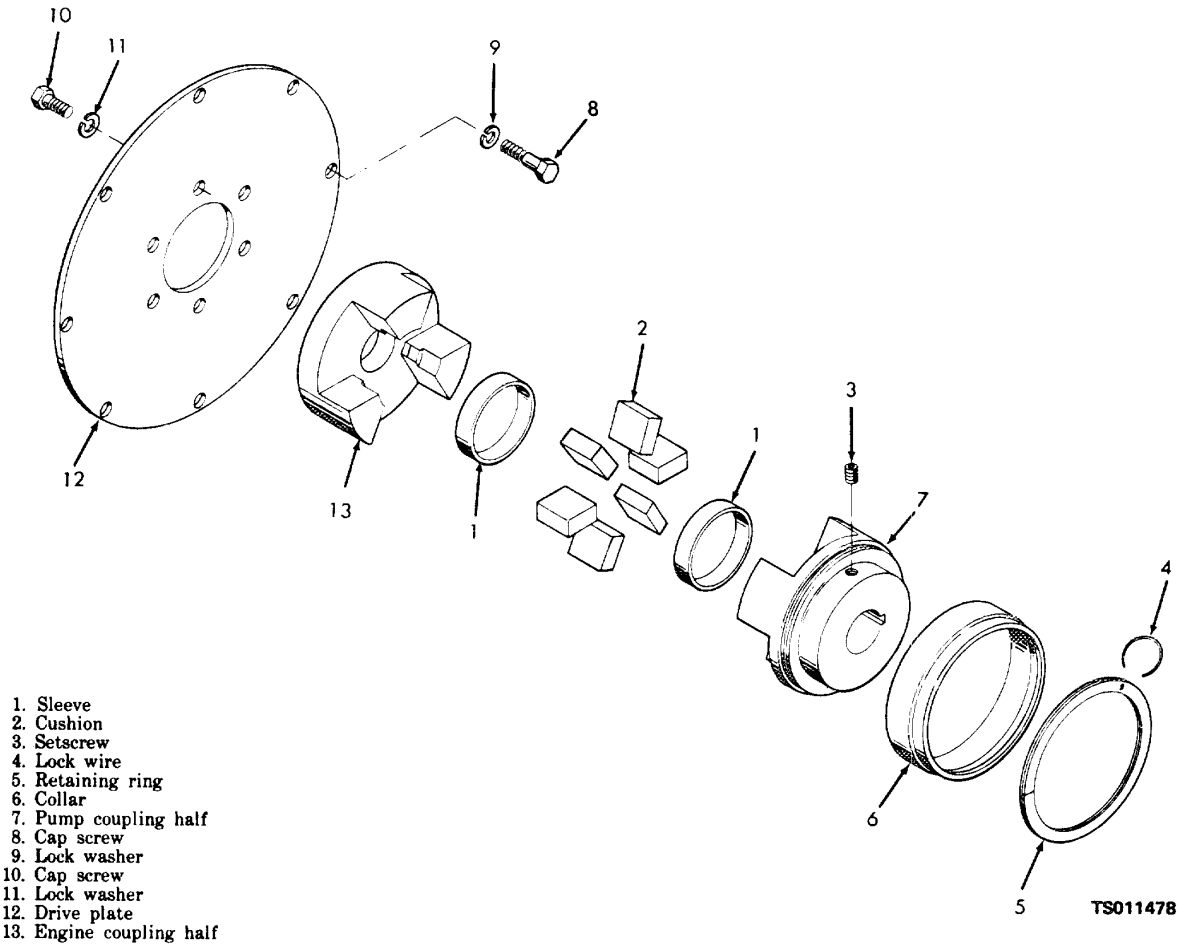
(5) Install the drain plug (1, fig. 2-21).

2-10. Flexible Coupling

a. Removal and Disassembly.

(1) Remove the assembled pump and bearing housing from the engine and chassis frame as directed in paragraph 2-9. The one half of the coupling assembly will remain with the engine; the other half will remain with the pump.

(2) Remove the sleeves (1, fig. 2-22) to release the cushions (2) from the coupling halves (7 and 13).



1. Sleeve
2. Cushion
3. Setscrew
4. Lock wire
5. Retaining ring
6. Collar
7. Pump coupling half
8. Cap screw
9. Lock washer
10. Cap screw
11. Lock washer
12. Drive plate
13. Engine coupling half

Figure 2-22. Pump coupling, exploded view

(3) Remove the setscrew (3) that secures the coupling half (7) to the impeller shaft; remove the coupling half and key.

(4) Remove the lock wire (4) and the retaining ring (5) that secure the collar (6) to the coupling half; remove the collar.

(5) Remove the cap screws (8) and lock washers (9) that secure the drive plate (12) to the engine flywheel; remove the assembled coupling half (13) and drive plate.

(6) Remove the cap screws (10) and lock washers (11) that secure the coupling half (13) to the drive plate (12); remove the coupling half.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash ex posed skin thoroughly. Dry cleaning solvent (fed. spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 to 138 F (38 to 59 C).

b. Cleaning and Inspection.

(1) Clean the six cushions by wiping them with a clean, dry cloth.

(2) Wash all remaining parts with cleaning solvent (Fed. spec P-D-680); dry thoroughly.

(3) Inspect the cushions for cracks, wear, brittleness, and deterioration; replace damaged cushions.

(4) Inspect the coupling halves for cracks, worn teeth, worn bores, damaged threads, and other damage; replace damaged coupling halves.

(5) Inspect the drive plate for cracks, distortion, and worn mounting holes; replace a damaged drive plate.

(6) Inspect all other parts for cracks, distortion and other damage; replace damaged parts.

c. Reassembly and Installation.

(1) Position the coupling half (13, fig. 2-22) on the drive plate (12); secure with six cap screws (10) and lock washers (11).

(2) Position the assembled drive plate and coupling half on the engine flywheel; secure with eight cap screws (8) and lock washers (9).

(3) Position the collar (6) on the coupling half (7); secure with the retaining ring (5). Make sure the retaining ring is fully seated in the ring groove and install the lock wire (4) into the retaining ring.

(4) Position the assembled coupling half (7) and collar (6) on the end of the impeller shaft so that the keyway engages the key on the shaft. Secure with the setscrew (3).

(5) Install three cushions (2) on each coupling half; secure each with a sleeve (1).

(6) Install the assembled pump and bearing housing onto the engine and chassis frame (para 2-9).

2-11. Engine

a. Removal. Remove the engine from the centrifugal pump and chassis frame as follows:

(1) Remove the centrifugal pump (para 2-9).

(2) Disconnect the fuel lines connecting the fuel pump to the fuel tank (TM 5-4320-234-12, para 4-21).

CAUTION

Although this engine is equipped with a reverse polarity protector to prevent alternator damage due to reverse-polarity connections, you should always take special precautions when connecting and disconnecting electrical leads and cables. Do not ground the field terminal between the alternator and regulator. Do not operate the alternator in an open circuit with the rotor winding energized. Do not ground the alternator output circuit. You should take care to prevent reversing polarity of the electrical system. When you use a battery booster or fast charge, make sure the leads are connected with the correct polarity. Failure to follow these instructions may damage the rectifiers, voltage regulator, and wiring.

(3) Disconnect the battery cables at the battery, taking care to prevent shorting, grounding, or reverse-polarizing the electrical system. Disconnect the battery cable from the engine.

(4) Remove the bolts (3 and 4, fig. 2-23), flat washers (5), nuts (1), and lock washers (2) that secure the engine to the chassis frame. Use a suitable lift truck to raise the engine from the chassis, taking care to insert the forks under structural members only.

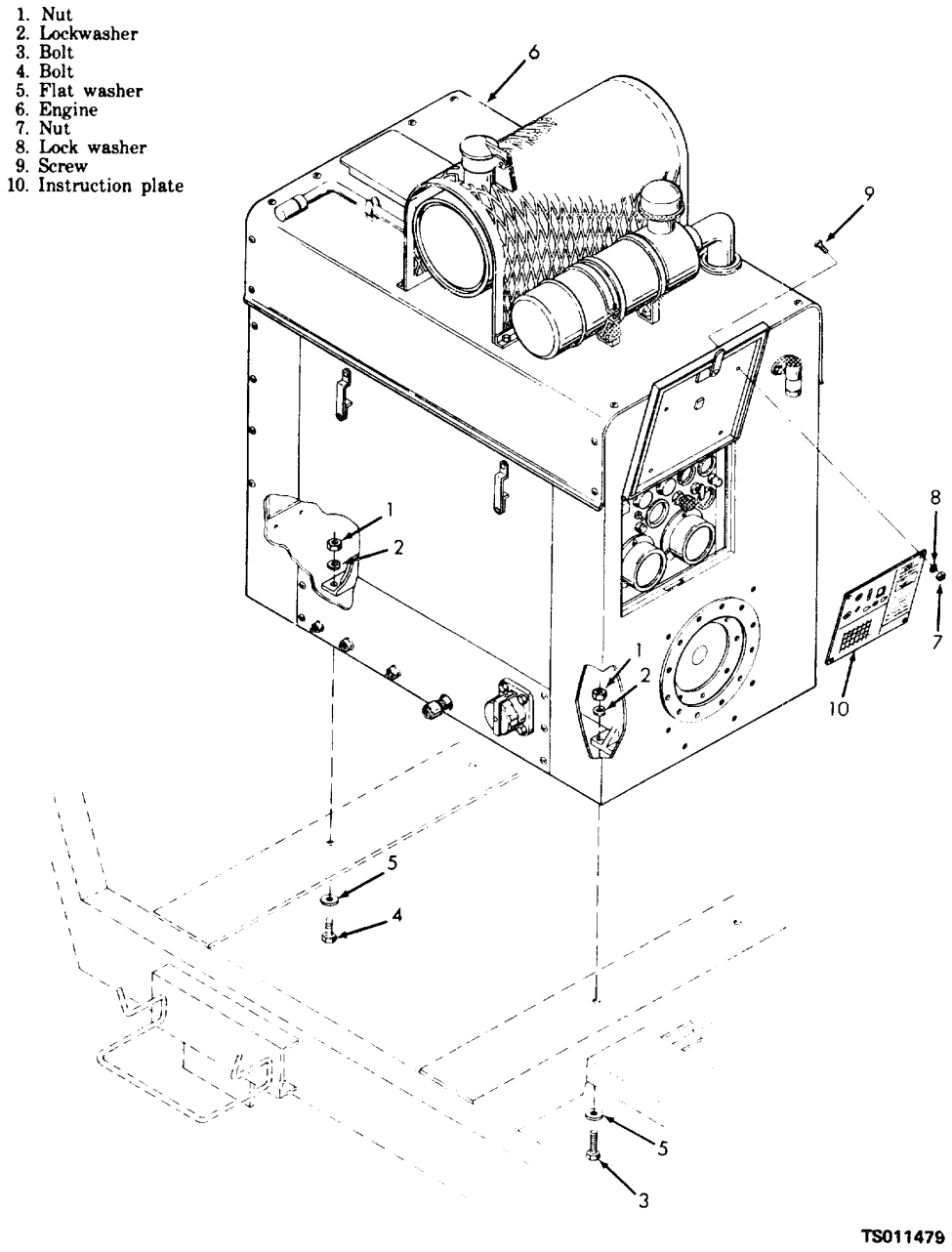


Figure 2-23. Engine, removal and installation

b. Installation

(1) Use a lift truck to position the engine on the chassis frame. Take care to insert the forks under ; structural members only. Secure the engine to the frame with bolts (3 and 4, fig. 2-23), nuts (1, block washers (2), and flat washers (5).

(2) Connect the battery cables to the battery and to the engine. Reread the caution in subparagraph a above to prevent damage to the components of the electrical system before you connect the battery cables.

(3) Install the fuel lines connecting the engine to the fuel tank (TM 5-4320-234-12, para 4-21).

(4) Install the centrifugal pump (para 2-9b).

CHAPTER 3

REPAIR OF ENGINE COMPONENTS

Section I. GENERAL

3-1. Introduction

This chapter provides you with repair and overhaul instructions for various engine components. It includes information regarding disassembly, inspection of parts, repair, and overhaul.

3-2. Scope

Only those components which are solely within the scope of direct and general support maintenance are covered. For repair of components which are within the scope of operator/crew and organizational maintenance, refer to TM 5-4320-234-12.

Section II. REPAIR OF GOVERNOR

3-3. Description

Engine speed is controlled by the inter-operation of the governor and the carburetor. The governor is a variable-speed type and is driven by the timing gear on the end of the camshaft. The driver on the drive shaft of the centrifugal flyball governor engages four hardened steel balls. As the engine runs, centrifugal force throws the balls outward. As the engine speed increases, the centrifugal force increases. This causes the balls to exert pressure against a dished race, forcing the race to move axially away from the rotating balls. The movement of the dished race is transferred to a drive fork through a thrust bearing. The fork is pinned to the governing shaft which pivots as the drive fork moves. An external governing lever on the end of the control shaft is connected to the throttle control on the carburetor and as the engine speed tends to increase, the throttle is closed slightly, decreasing the engine speed. The decrease in engine speed decreases the centrifugal force of the balls, and the dished race moves axially toward the balls. This movement is sensed by the fork which, in turn, transfers the movement to the external governing lever. The governing lever opens the carburetor throttle, increasing the engine speed. In this manner, a balanced condition is reached, and the engine speed remains constant at the level determined by the throttle control setting. Adjustment of the governor is made by changing the tension of the spring which applies tens ion to the external governing lever and tends to keep the dished race against the flyballs. Tightening the spring raises engine speed at any particular throttle control setting. Decreasing spring tension lowers the speed.

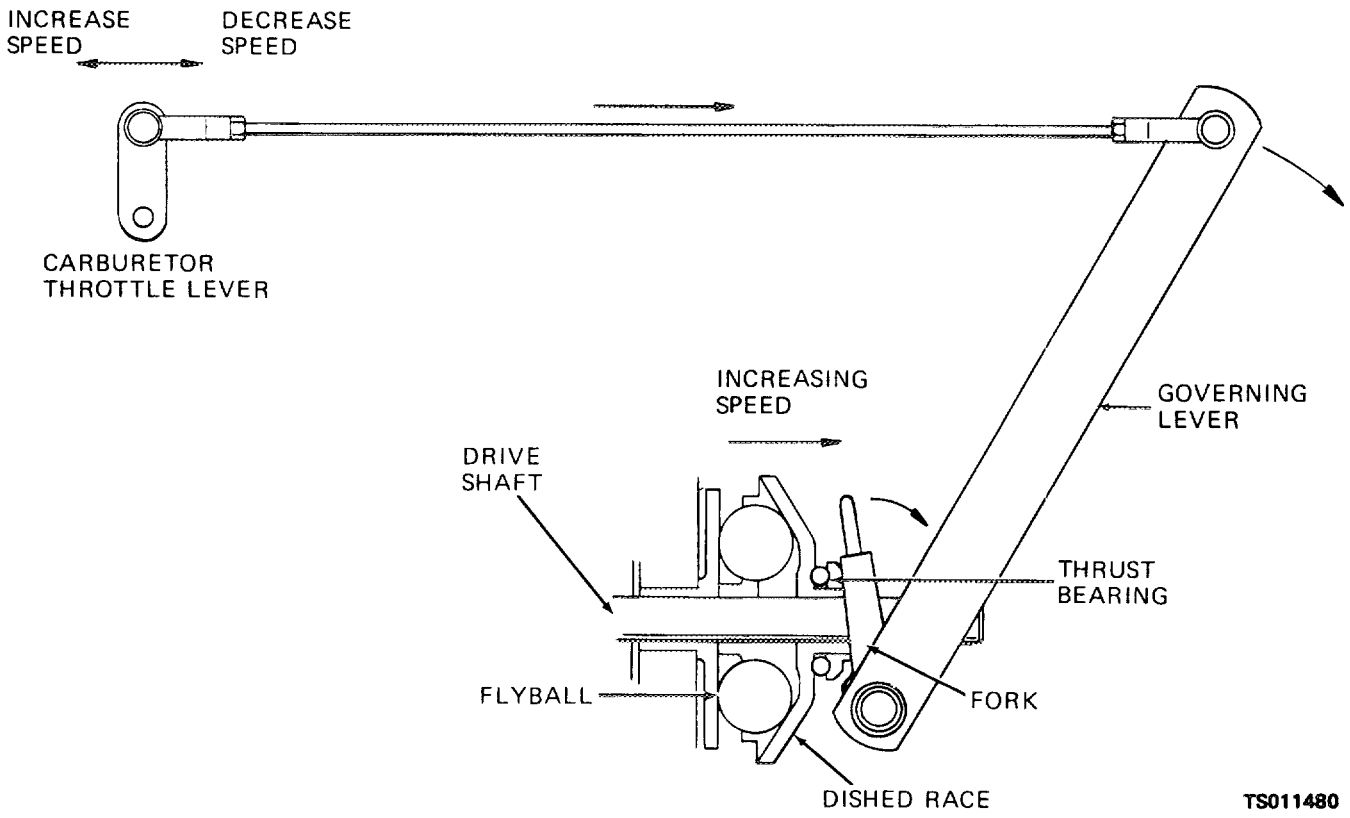


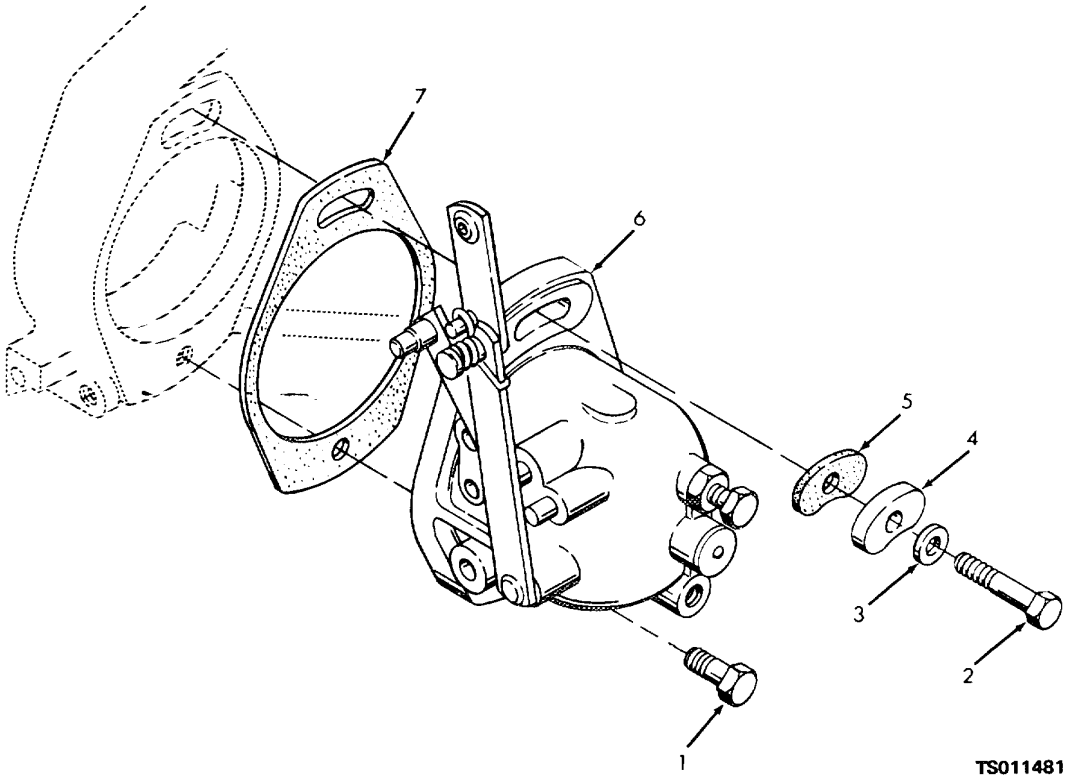
Figure 3-1. Operation of engine speed regulating system.

3-4. Removal

a. Disconnect the ball joint on governor-to-carburetor control rod from the lever on the governor.

b. Remove the magneto (TM 5-4320-234-12, para 4-35).

c. Remove the governor and related parts as shown in figure 3-2.



1. Assembled washer screw
2. Bolt
3. Flat washer
4. Gasket Plate
5. Gasket
6. Governor
7. Gasket

Figure 3-2. Governor removal, exploded view

3-5. Cleaning and Inspection

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (fed. spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 to 138 F (38 to 59 C).

a. Clean the exterior of the governor with a cloth dampened with cleaning solvent (fed. spec. P-D-680). Wipe dry.

b. Clean all remaining parts with cleaning solvent; dry thoroughly.

c. Inspect the governor for cracks, missing parts, wear and other obvious damage. Check the rotation of the governor drive shaft. It must turn freely without catching or binding. Check the movement of the governor lever shaft in its needle bearings. It must pivot freely without catching or binding and without excessive play. Replace a damage governor.

3-6. Installation

a. Install the governor by reversing the removal procedure. Refer to figure 3-2 and note the following:

(1) The magneto must be removed to enable proper timing of the governor drive gear with the timing gear.

(2) Sight through the magneto mounting hole to check that the two marked teeth of the governor drive gear engage the single marked tooth of the cam gear as shown in figure 3-3. Ignition timing is dependent upon this relationship because the magneto is driven by the governor drive gear.

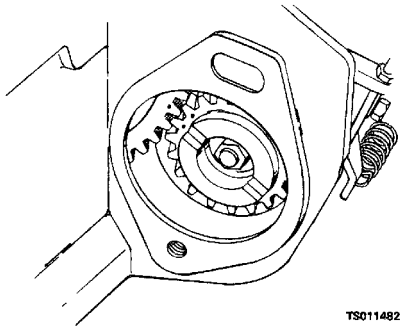


Figure 3-3. Timing marks on governor drive gear and cam gear.

b. Install the magneto (TM 5-4320-234-14, para 4-35).

c. Adjust the governor (TM 5-4320-234-12, para 4-27).

Section III. REPAIR OF RADIATOR

3-7. Description

Liquid coolant is pumped through passages in the engine to remove the heat of combustion. As the hot coolant is pumped from the engine, it enters the radiator, which is a large heat exchanger consisting of tubes and fins that dissipate the heat to the atmosphere. The fluid passes into the top of the radiator and out through the bottom. The cooling fan maintains a blast of air through the radiator to help dissipate the heat. The coolant from the radiator is recirculated through the engine to complete the cycle.

3-8. Removal

Remove the radiator (TM 5-4320-234-12, para 4-32).

3-9. Cleaning

a. You may clean the exterior of the radiator by flushing in a reverse-flow direction with a stream of water to remove all bugs and debris. Remove any greasy or oil deposits with cleaning solvent (Fed. Spec. P-D-680).

b. Reverse-flush the interior of the radiator, using a flushing gun.

c. If flushing fails to remove scale from the interior of the radiator, boil it out in accordance with current directives.

3-10. Inspection and Testing

a. Inspect all parts for cracks, leaking tubes or gaskets, damaged threads, or other obvious damage.

CAUTION

Do not exceed 10 psi air pressure for radiator testing. Excess pressure will damage the radiator. Make sure that you completely drain the radiator core before testing. When testing at low pressure, it is possible that water within the core could prevent air from passing out of small holes, and the leaks could remain undetected.

b. Make sure the radiator is completely drained of coolant. Plug all openings, except one through which compressed air can be applied. Immerse the radiator in a tank of water and apply 10 psi air pressure to the interior of the radiator. Check for air bubbles that could indicate leaks. If leaks are found, mark the areas for repairs.

c. Inspect all hardware for cracks and for worn or stripped threads.

d. Replace all parts damaged beyond repair.

3-11. Repair

a. Repair leaks by soldering. Be sure that you do not block or retard circulation through any tubes. There shall be no blocked tubes upon completion of repairs.

3-12. Installation

Install the radiator (TM 5-4320-234-12, para 4-32).

Section IV. REPAIR OF OIL SYSTEM COMPONENTS

3-13. Description of Engine Oil System

a. The engine oil system provides lubrication for the working surfaces within the engine. The oil is retained in the oil pan under the engine and is circulated through the engine by the oil pump mounted on one of the main bearing caps of the engine. Internal components of the engine lubrication system are covered in Chapter 4, which describes basic engine repair and overhaul.

b. An oil filter with its related piping is mounted

on the exterior of the engine to remove from the engine oil any impurities and particles that could cause engine wear. This filter has a replaceable cartridge.

c. The engine oil pressure is regulated by a relief valve mounted in the engine cylinder block. The valve consists mainly of a spring-loaded, spool-type valve which is seated in a bore in the block. The greater the spring pressure is which loads the valve, the greater the oil pressure in the system. The pressure is increased by adding pressure-adjusting washers between the spring and the valve to increase spring force against the valve. Oil pressure adjustment is described in paragraph 3-15.

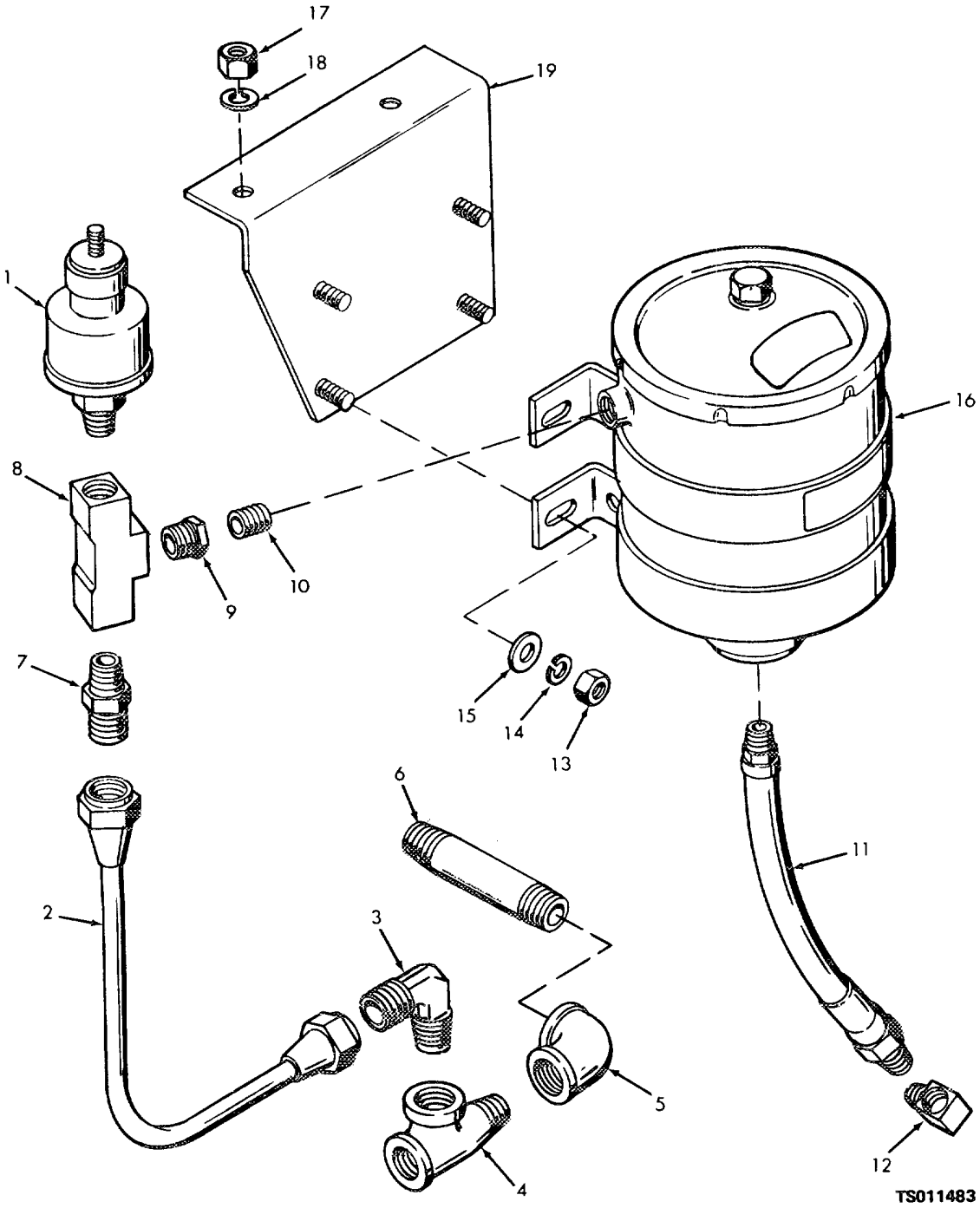
3-14. Engine Oil Filter

a. Removal.

(1) Drain the oil from the engine (TM 5-4320-234-12, para 3-3).

(2) Disconnect the electrical lead from the oil pressure sender on the filter piping.

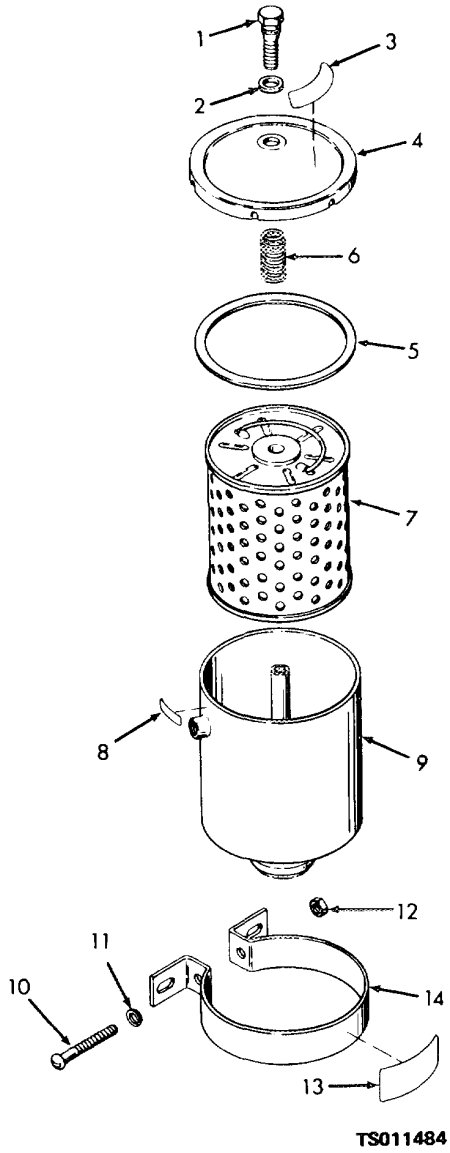
(3) Remove the oil filter and related parts from the engine as shown in figure 3-4.



1. Oil pressure sender
2. Tube
3. Elbow
4. Tee
5. Elbow
6. Nipple
7. Connector
8. Tee
9. Bushing
10. Nipple
11. Hose
12. Elbow
13. Nut
14. Lock washer
15. Flat washer
16. Oil filter assembly
17. Nut
18. Lock washer
19. Oil filter bracket

Figure 3-4. Engine oil filter mounting, exploded view.

b. Disassembly. Disassemble the oil filter as shown in figure 3-5.



1. cove screw
2. Screw gasket
3. Decal
4. Cover
5. Cover gasket
6. Spring
7. Filter element
8. Decal
9. Oil filter body
10. Screw
11. Lock washer
12. Nut
13. Decal
14. Oil filter clamp

Figure 3-5. Oil filter assembly, exploded view

c. Cleaning and Inspection.

(1) Discard and replace the oil filter element and gaskets.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 to 138 F (38 to 59 C).

(2) Clean all remaining parts with cleaning solvent (Fed. Spec. P-D-680). Use compressed air to blow debris from tubes and hoses.

(3) Inspect the hose for abrasion, cracks, deterioration, damaged threaded ends, and collapsed walls; replace a damaged hose.

(4) Inspect the tube for dents, cracks, damaged tube nuts, and collapsed walls; replace a damaged tube.

(5) Inspect the filter body and cover for cracks, distortion, dents, damaged threads, and other damage; replace a defective body or cover.

(6) Inspect the oil pressure sender for cracks, dents, and damaged threads. Check the sender in series with a 12-volt battery and the oil pressure gage mounted on the control panel. Use a low pressure, calibrated air supply when you run the test. The sender must provide proper resistance at various pressures to register the required readings on the associated gage. Replace damage or inaccurate parts.

(7) Inspect all other parts for cracks, distortion and damaged threads. Replace damaged parts.

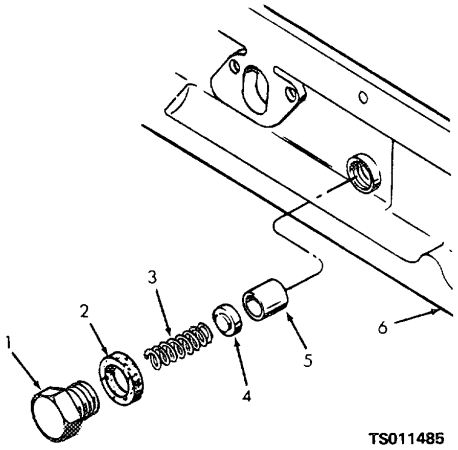
d. Reassembly and Installation. Reassembly and installation are the reverse of removal and disassembly. Refer to figure 3-4 and 3-5. After filling the engine lubricating system with oil per LO 5-4320-234-12, start the engine and check for oil leaks. Correct any leaks.

3-15. Engine Oil Pressure Adjustment

If oil pressure is consistently low, youcan make the necessary pressure adjustment as follows:

a. Start the engine and allow it to warm to operating temperature. Check the engine oil pressure indicated on the oil pressure gage. At idle speed the pressure must exceed 7 psi; at governed speed it must be between 20 and 30 psi.

b. If the engine oil pressure is not within the required range, shut off the engine and remove the plug (1, fig. 3-6) and gasket (2) from the carburetor side of the engine block. Remove the valve spring (3) and pressure adjusting washer (4).



1. Plug
2. Gasket
3. Valve spring
4. Pressure adjusting washer
5. Oil pressure regulator valve
6. Engine block

Figure 3-6. Oil pressure adjustment.

c. To increase oil pressure, add a washer between the spring and oil pressure regulator valve. More than four washers should not be used. If four washers do not fulfill the required range, either the spring is faulty or other engine troubles exist.

d. After you make the adjustments, check that the oil pressure remains in the required ranges during operation.

Section V. REPAIR OF ELECTRICAL SYSTEM COMPONENTS

3-16. Description of Engine Electrical System

a. The alternator and regulator are typical automotive types in which the alternator output is controlled through the voltage regulator, depending upon the state of charge of the battery. When the battery charge is low, the voltage regulator increases the strength of the alternator field to increase the output of the alternator. When the battery charge is normal, the output of the alternator decreases to near zero.

b. Reversed polarity connections in the charging system can severely damage the alternator. To prevent this damage, the system is protected by a reverse polarity protector mounted on the voltage regulator bracket.

c. The engine starter is a solenoid-operated type in which the solenoid switch is mounted on the top of the starter. The solenoid switch uses electrical energy to pull the starter drive into engagement with the flywheel ring gear and to form the electrical circuit which energizes the starter after the drive is engaged. When the engine starts, the starter drive is disengaged, preventing the engine from driving the starter since engine operating speeds could severely damage the starting motor. Reengagement of the starter while the engine is running is prohibited by the starter disengage relay.

3-17. Alternator

CAUTION

Disconnect the battery cable from the positive battery terminal before disconnecting any other leads from the engine components. This precaution will prevent shorts which could damage the alternator, voltage regulator, or other parts.

a. Removal. Remove the alternator as directed in TM 5-4320-234-12, para 4-38.

b. Alternator Brush Replacement.

(1) Remove the two assembled washer screws (4, fig. 3-7) that secure the brush cover (5) to the alternator; carefully pull the cover away from the alternator.

1. Nut
2. Lock washer
3. Cable
4. Screw
5. Cover
6. Gasket
7. Screw
8. Nut
9. Insulating washer
10. Bushing
11. Washer
12. Lead
13. Screw
14. Insulator
15. Brush assembly
16. Nut
17. Lock washer
18. Pulley
19. Fan
20. Kay
21. Spacer
22. Nut
23. Lock washer
24. Nut
25. Insulating washer
26. Isolation diode assembly
27. Insulating sleeve
28. Nut
29. Bolt
30. Retainer
31. Bearing
32. Front housing
33. Stator assembly
34. Nut
35. Insulating washer
36. Positive diode assembly
37. Negative diode assembly
38. Insulating sleeve
39. Insulating washer
40. Retainer
41. Rear housing
42. Screw
43. Lock washer
44. Slip ring assembly
45. Bearing
46. Rotor assembly

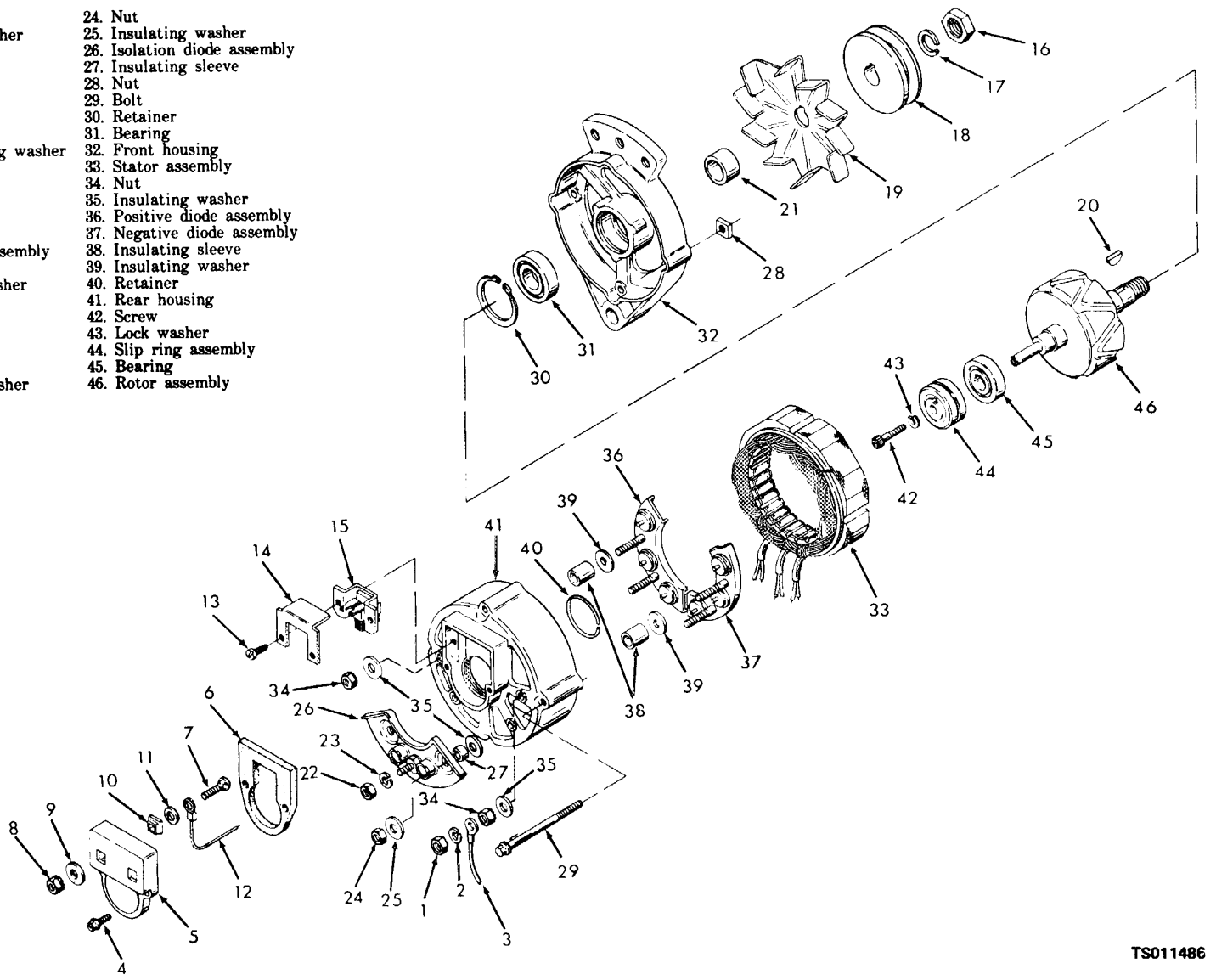


Figure 3-7. Alternator assembly, exploded view.

(2) Remove the two terminal screws (7), nuts (8), insulating washers (9), leads (12), washers (11), and bushings (10) from the brush cover.

(3) Remove the two screws (13) that secure the insulator (14) and brush assembly (15) to the alternator; remove the brush assembly with the attached electrical leads (12).

(4) Inspect the brush assembly for cracks, signs of over-heating, and distortion. Check that the brushes slide freely in the brushholders and that the brush springs provide sufficient brush tension. Inspect the brushes for cracks, oil saturation, and wear. If you find that the brushes are worn to less than 3/16 inch (0.468 cm), oil soaked, or cracked, replace the brush assembly.

(5) If the brush assembly passes your visual inspection, check the electrical condition of the assembly. Refer to figure 3-8. Check that continuity exists between points A and B and between points C and D, but that no continuity exists between point E and points A or C.

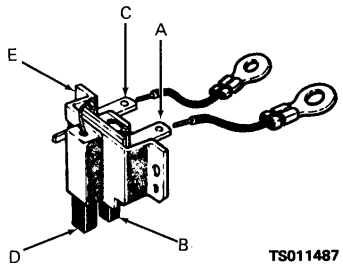


Figure 3-8. Alternator brush assembly, showing continuity paths.

(6) Use a new brush assembly if the inspection indicates faults.

(7) Position the brush assembly (15, fig. 3-7) and insulator (14) on the alternator; secure with two machine screws (13).

(8) Connect the electrical leads (12) from the brush assembly to the brush cover (5) with the terminal screws (7), nuts (8), insulating washers (9), and washers (11). Make sure you have the bushings (10) in place.

(9) Position the brush cover (5) on the alternator; secure with two assembled washer screws (4).

c. Disassembly. Disassemble the alternator following the sequence indicated in figure 3-7. Note the following:

(1) To remove the pulley (18), wrap the alternator drive belt around the pulley and clamp it in a vise so that the belt protects pulley edges. Strike the end of the rotor shaft with a soft mallet or plastic hammer to jar loose the pulley.

(2) Remove the isolation diode assembly (26). When removing the diode assemblies, note the positions of the insulating sleeves and washers to ensure reassembly in proper positions.

(3) Remove the square nuts (28) and through bolts (20) that secure the front housing (32) to the rear housing (41).

(4) Using a small bladed screwdriver, pry at several points around the stator to remove the assembled rotor and front housing. Do not insert the screwdriver blade more than 1/16 inch, or damage to the stator windings may occur while you are separating the front housing from the stator.

(5) Clamp the front housing lightly in a vise and, using long nose pliers, reach through the front housing (32) to compress the ears of the bearing retainer (30) and lift it free of its recessed seat.

(6) With the bearing retainer free of the recess, you can remove the assembled rotor and bearings by tapping the end of the rotor shaft on a block of wood while holding the housing.

(7) Place the assembled stator (33) and rear housing (41) on a clean, smooth working surface that is free of metal chips. Remove the lock nuts (34) and insulating washers (35) that secure the studs of the diode assemblies (36 and 37) to the rear housing (41). Carefully push the studs out of the housing and separate the assembled diode assemblies and stator (33) from the rear housing.

(8) Do not disassemble the rotor unless the bearings or slip rings are damaged and must be replaced. If you must remove the bearings and slip rings, proceed as follows:

(a) Use a bearing puller to remove the front bearing from the rotor shaft.

(b) Remove any sealant retaining the rotor winding leads to the slip ring.

(c) Unsolder the rotor leads from the slip ring terminals. Unwind the leads from the terminals, taking care you do not bend or stress leads excessively.

(d) Remove the screw (42) from end of shaft. Thread a 1/4-28 x 1-1/4-inch long screw into the slip ring hub; this process will back the slip ring assembly (44) off the shaft.

(e) Use a bearing puller to remove the rear bearing (45), taking care you do not damage the rotor leads.

d. Cleaning and Inspection.

(1) Discard and replace gaskets.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent

fumes and prolonged exposure of skin to cleaning-solvent. Wash exposed skin thoroughly. Dry cleaning solvent (fed. spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 to 138 F (38 to 59 C).

(2) Use a cloth dampened with cleaning solvent (fed. spec. P-D-680) to clean the diode assemblies, stator, and rotor. Wipe dry.

(3) Wipe the bearings with a cloth, taking care that you do not disturb the bearing seals.

(4) Clean all remaining parts with cleaning solvent; dry thoroughly.

(5) Inspect and test the brush assembly as directed in sub-paragraph b above.

(6) Inspect the pulley for cracks, groove wear, and damage to the keyway. Replace a damaged pulley.

(7) Check the fan for bent or missing fins and mounting hole wear. Replace if damaged.

(8) Inspect all insulating sleeves and washers for cracks, separations and other damage. Replace as necessary.

(9) Inspect the front and rear housings for cracks, bearing bore wear, distortion, damaged threads, and other obvious damage. You should remove any burrs with a fine stone or file. Replace either housing if not reparable.

(10) Inspect the stator for gouged or discolored windings. Discoloration of the winding insulation is an indication of an overheated stator that may result in shorted or grounded windings.

(11) Inspect the slip rings for cracks, wear grooves, damaged or loose lead connections, or other damage. You can restore a smooth surface to the slip rings with fine crocus cloth. Wipe all residue from slip rings. Replace the slip rings if they are too worn to be reused.

(12) Inspect the rotor bearings for wear, catching or binding operation, or missing or damaged seals. Replace the bearings if defective. While the bearings are off the rotor shaft, you should inspect the shaft bearing surfaces for wear.

(13) Inspect the rotor shaft and body for stripped threads, worn key slot, cracked or marred pole fingers and shaft. Replace a damaged rotor.

(14) Inspect all other parts for cracks, distortion, or damaged threads. Replace all damaged parts.

e. Testing.

NOTE

Use only rosin core solder to solder diodes to the stator leads. If you use acid core solder, the connection will corrode, resulting in an open circuit and damage to the components.

(1) Test the diodes with a diode tester according to the instructions of the equipment manufacturer. To test, it will be necessary for you to unsolder the leads from the stems of the positive and negative diode assemblies for individual testing. When you solder and unsolder leads from the diodes, use long nose pliers to grasp the diode stem between the diode and the stator lead to be removed. This will give better heat dissipation and protect the diode from damage. You should make note of the diode to stator lead connections to facilitate reassembly. If one diode is bad, you must replace the entire diode assembly. The positive diode assembly has red printing on the diode body; the negative diode assembly has black printing. Refer to figure 3-9.

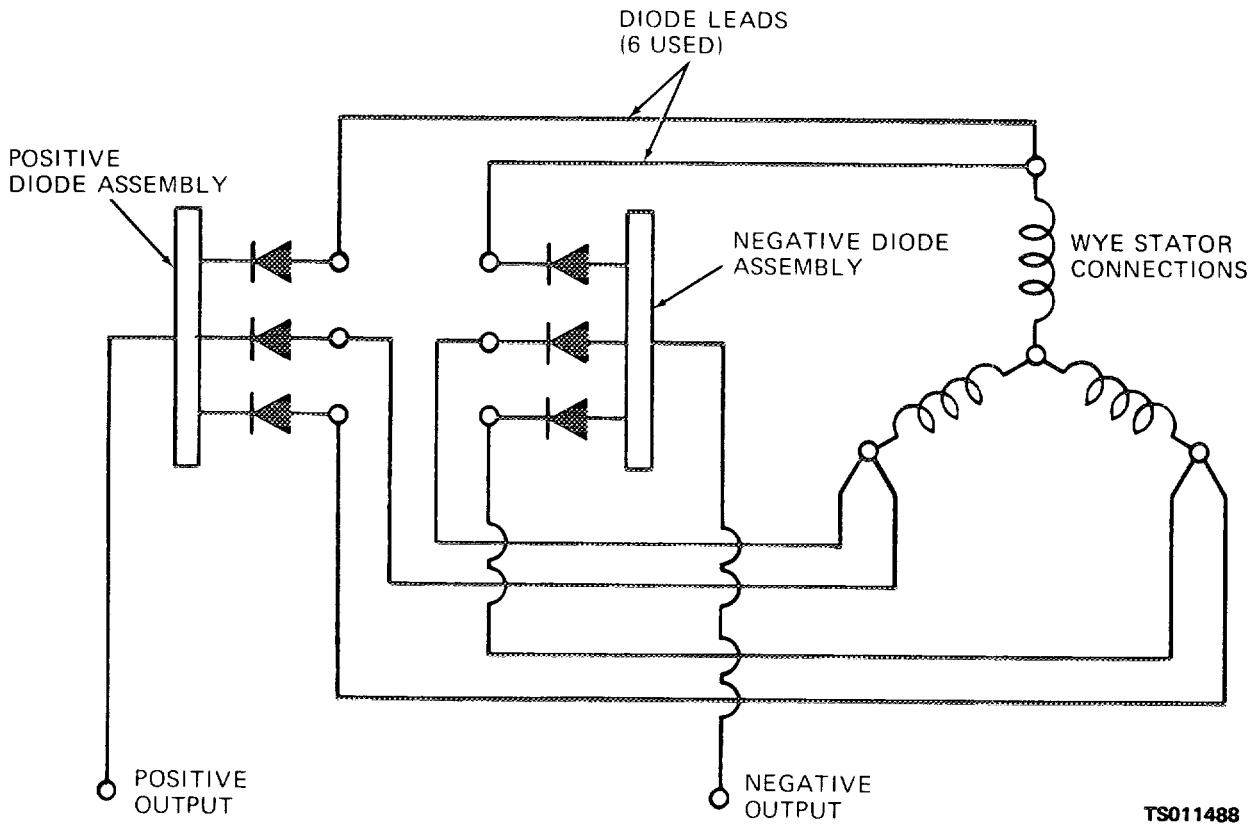


Figure 3-9. Stator winding and connections.

(2) With the stator disconnected from the diode assemblies, test it for leakage and continuity. You can use either a good quality ohmmeter or test lamp (12 volts or 120 volts) to test the stator. Refer to figure 3-10. Unsolder and separate the common leads; pull back the insulating sleeves exposing the opposite end leads. Connect the ohmmeter or test lamp probes to each pair of the following test points:

Point A to point B
Point A to point C
Point B to point C
Point A to point D
Point B to point D
Point C to point D

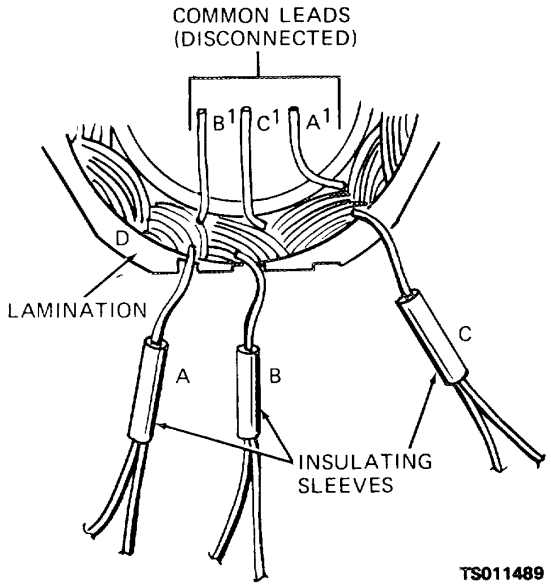


Figure 3-10. Stator test points.

(3) The resistance should be infinite or test lamp should not light in all of the above tests. If the resistance reading is not infinite or in the test lamp lights in any test, high leakage or a short exists between stator windings, or between a stator winding and the lamination. Replace the stator.

(4) Test for stator continuity by connecting the ohmmeter or test lamp probes to each pair of the following test points:

Point A to point A
Point B to point B
Point C to point C

You should have a reading of approximately 0.1 ohm or the test lamp should light in each test. Infinite resistance or an unlighted test lamp indicates an open winding. Replace the stator if it fails any of the above tests or, if the alternator has been disassembled because of an electrical malfunction, replace the stator after all other components have been checked and found to be satisfactory.

(5) Use a multimeter to test the rotor and slip ring assembly. Connect the slip rings in series with a multimeter and a 20-volt supply. There should be a 1.20- to 2.5-amp current draw. Your multimeter should indicate 11 to 14 ohms resistance across the slip rings. Connect one of the multimeter or test lamp probes to the rotor body and the other on either slip ring. You should have an infinite resistance reading or the test lamp should not light. If this does not occur, then either the slip rings, ring connecting leads, or rotor winding is grounded. Replace a faulty rotor.

f. Reassembly. Reassembly is essentially the reverse of disassembly. Refer to figure 3-7. Pay particular attention to the following:

(1) Make certain that all positive and negative rectifier diodes are soldered to the proper stator leads and that the stator common leads have been resoldered together after testing.

(2) Press the bearing (31) into the front housing (32), using a driver tool that exerts pressure on the outer bearing race only. Place the bearing retainer (30) in recess, making certain the retainer ears line up with openings in the housing. Use a wooden dowel to exert pressure on the retainer when you seat its edge in the recess.

(3) With the rotor leads in position on the rotor assembly (46), carefully press the rear bearing (45) onto the rotor shaft, exerting pressure on the inner race only.

(4) Guide the rotor winding leads through the square passage in the slip ring hub. Hand press the slip rings (44) onto the shaft while you maintain alinement of rotor leads and passage. Install screw (42) and washer (43) and tighten to 45 inch-pounds. Before soldering the rotor winding leads to the slip rings, make certain that fiber insulating washers are in place on the inner slip ring terminals. Wrap leads around the terminals and solder with rosin core solder. Secure wires to the end of the rotor and slip rings with a synthetic rubber sealer. Retest the rotor circuits to ensure that a short or ground did not develop during repair. Refer to subparagraph e(5) above.

(5) With the rotor properly supported on an arbor press, use a driver sleeve on the inner bearing race and press the front housing (32) onto the rotor.

(6) Position the spacer (21), fan (19), and pulley (18) in place on the rotor shaft. Secure with the lock washer (17) and nut (16). Tighten to 35 foot-pounds torque.

(7) Position the insulating washers (39) and sleeves (38) on the studs of the diode assemblies (36 and 37). Position the diode assemblies in the rear housing so that the washers and sleeves electrically insolate the diode assemblies. Secure with insulating washers (35) and nuts (34).

(8) With rear bearing retainer (40) in place, position the rear housing (41) over the slip ring end of the rotor and hand press the housings together. Aline the slots in the stator with the openings in the housings and install the through bolts (29). Install nuts (28) and tighten to 50 to 60-inch pounds (6.9150 to 8.2980 kgm) torque. Turn the rotor by hand to check for binding of bearings. Rotor must rotate freely.

(9) Install the isolation diode (26), noting the proper position of the plate insulators (25, 27, and 35).

Secure the diode with nuts (24).

g. Bench Test. The following test will determine the current producing capability of the repaired alternator.

(1) Mount the alternator in a test fixture capable of providing 3000 rpm.

(2) Connect fixture circuit leads and instruments to the alternator terminals as shown in figure 3-11.

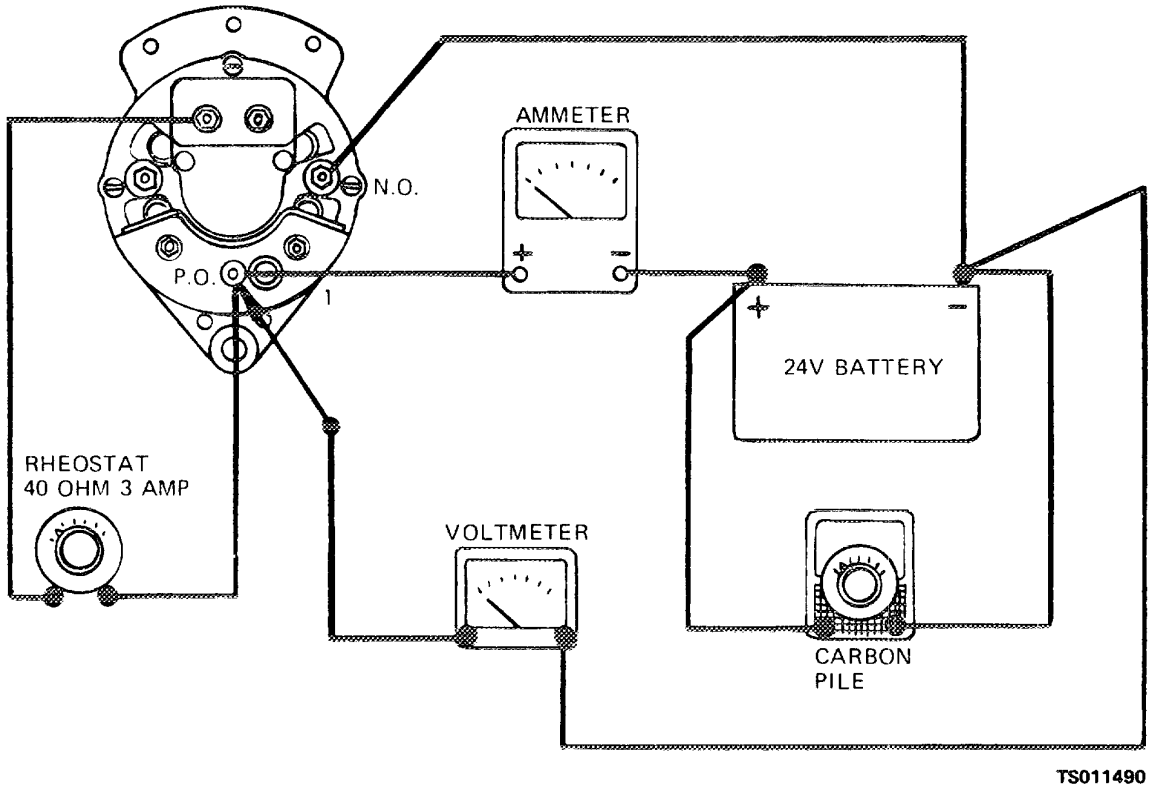


Figure 3-11. Alternator bench test circuit.

(3) With the carbon pile turned off to avoid discharging the battery, set the field rheostat in maximum resistance position.

(4) Start the test fixture, and operate at 1500 rpm for a few minutes to normalize operating temperature.

(5) Increase the alternator speed to 3000 rpm and, at the same time, apply the carbon pile load to the battery to keep the charging voltage below 28.0 volts. At 3000 rpm, the alternator should provide a minimum current output of 28 amperes.

(6) The charging voltage can be adjusted by the voltage regulator when the alternator is installed on the engine.

h. Installation. Install the alternator following procedures given in TM 5-4320-234-12, para 4-38.

3-18. Voltage Regulator Adjustment

If you have determined by testing (TM 5-4320-234-12, para 4-39) that the voltage regulator should be adjusted to suit your operating conditions, proceed according to either of the following methods.

a. You can change the voltage approximately 0.6 volt higher or lower by using a metal strap provided on the underside of the regulator case. Raise the voltage 0.6 volt by placing the metal strap across the terminals marked HI. Secure strap with the terminal nuts. Lower the voltage 0.6 volt by placing the metal strap across the terminals marked LO.

b. If the step adjustment described above did not give the exact system voltage you desire, follow this procedure:

(1) With the engine off, connect a voltmeter to the battery and connect an ammeter in series with output of the alternator as shown in figure 3-12.

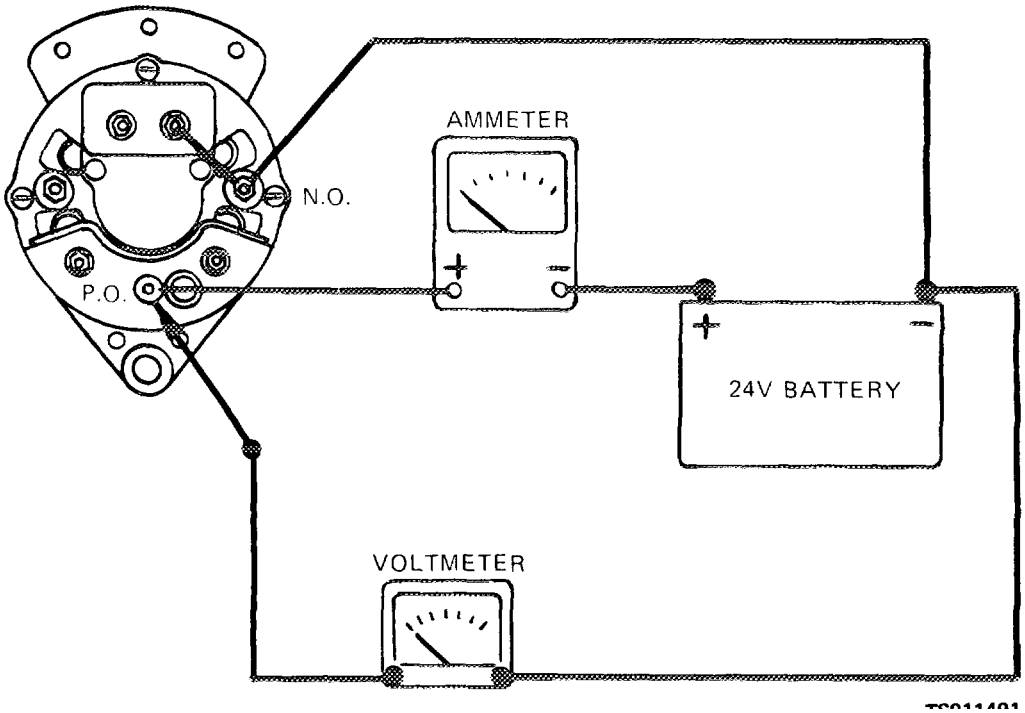


Figure 3-12. Voltage regulator adjustment circuit.

(2) Operate the engine at fast idle (700 to 1000 rpm) to stabilize the electrical system until the voltmeter stops showing a charge. This should occur between 5 to 15 minutes.

(3) Leave the engine running and remove bakelite covered field connector on back of alternator. Remove the four cover screws and remove cover from voltage regulator. Reconnect the field to the alternator.

CAUTION

The variable voltage control is connected to alternator output and is electrically hot. Do not let adjustment tool touch anything but voltage control.

(4) Use a No. 2 Phillips screwdriver to adjust the voltage control. Turn the control a few degrees counterclockwise if you want to reduce voltage, or turn it clockwise to increase voltage. Stops are provided in the control to limit rotation to less than 1/2 turn total. Do not try to force control beyond stops.

(5) After adjustment, remove field connector on back of alternator. Reinstall the regulator cover and screws. Reconnect the field, and operate for no more than 5 minutes to ensure that you have obtained the desired change in voltage.

3-19. Starting Motor

CAUTION

Disconnect the battery cable from the positive battery terminal before disconnecting any other electrical leads from the engine components. This will prevent shorts which could damage the alternator, voltage regulator, and other parts.

a. Removal. Remove the starting motor (TM 5-4320-12, para 4-42).

b. Pinion Clearance Check. After removing the starting motor, check pinion clearance. The clearance cannot be adjusted, but improper clearance will indicate worn parts and the need for starting motor replacement. To check the pinion clearance, refer to figure 3-13 and proceed as follows:

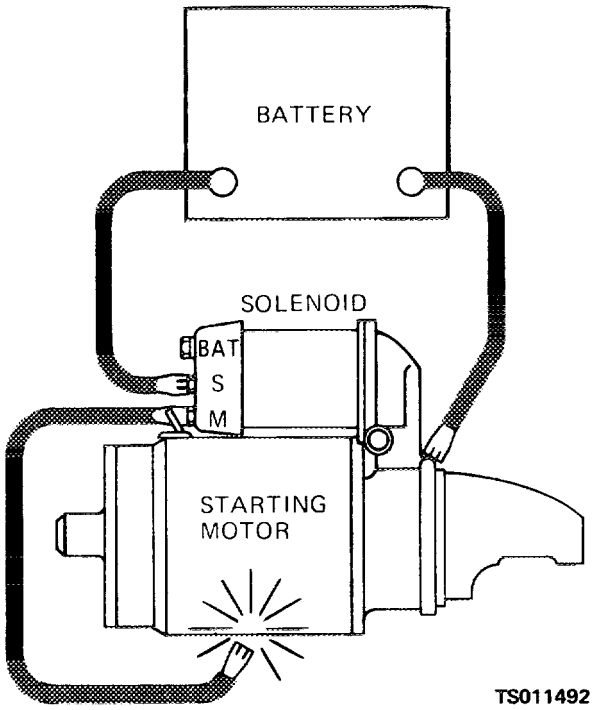


Figure 3-13. Circuit for checking pinion clearance.

(1) Disconnect the motor field coil connector from the solenoid motor terminal and insulate it carefully.

(2) Connect a 24-volt battery from the solenoid switch terminal to the solenoid frame.

(3) With one end of jumper connected to the solenoid motor terminal, momentarily strike the other end against the starter frame. This will shift the drive assembly pinion into the cranking position where it will remain until the battery is disconnected.

(4) Push the pinion back toward the commutator end to eliminate slack movement. Using a feeler gage, measure the distance between pinion and pinion stop (fig. 3-14). The clearance shall be 0.010 to 0.140 inch (0.0250 to 0.3500 cm).

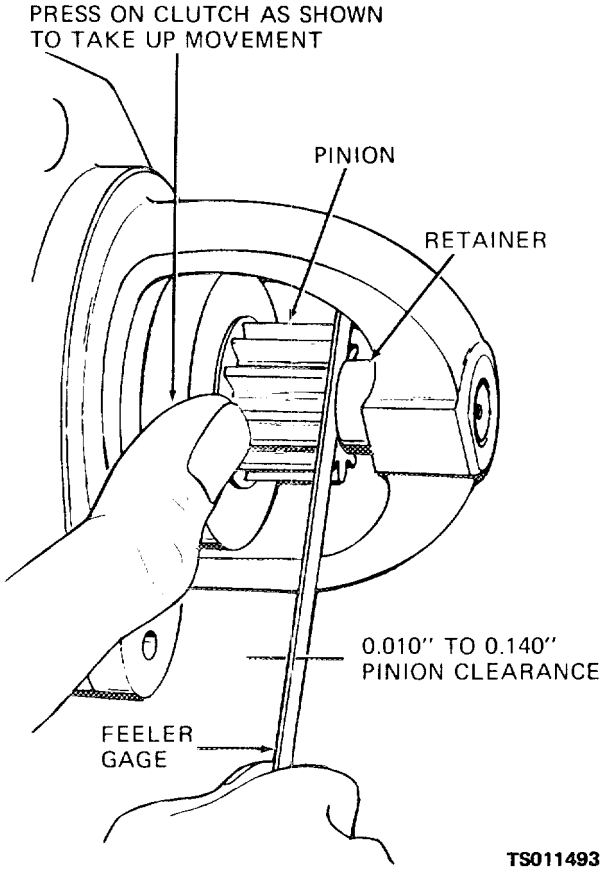


Figure 3-14. Checking pinion clearance.

c. Starter Brush Replacement.

(1) Remove the through bolts (3, fig. 3-15) that secure the commutator end frame (4) to the starting motor. Pull straight out on the end frame to disengage the end frame bushing from the rotor shaft.

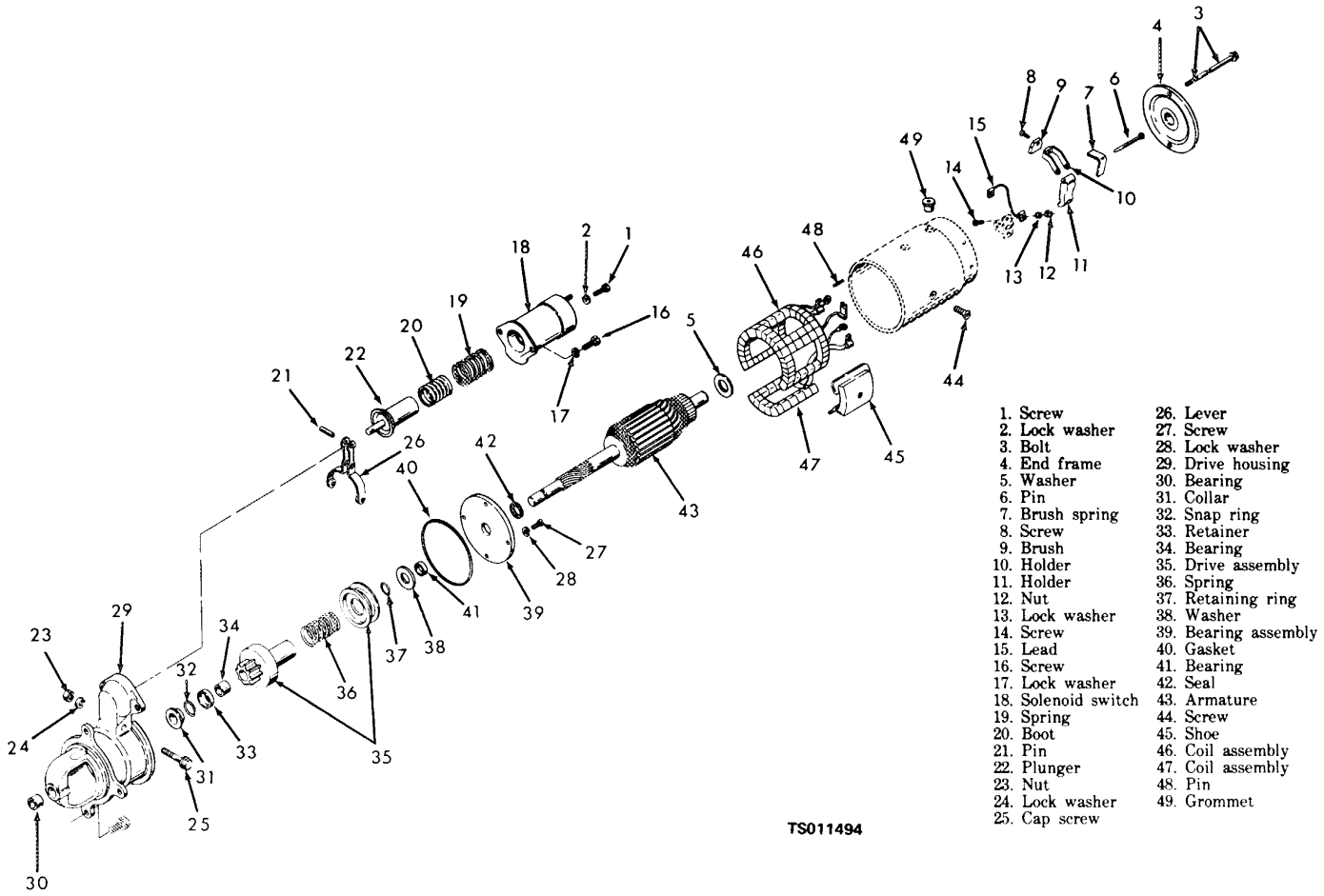


Figure 3-15. Starting motor, exploded view.

(2) Remove the support pins (6) to release the grounded brush holders (10), insulated brush holders (11), and brush springs (7) from the brush supports. Remove the brush screws (8) that secure the brushes (9) to the brush holders; you can now remove the brushes.

(3) Remove the screws (14), nuts (12), and washers (13) that secure the brush leads (15) to the brush support; remove the brush leads.

(4) Replace the brushes if you find them chipped, oil soaked, or worn to less than 5/16 inch (0.7812 cm). Replace any other parts that are cracked, worn, or distorted.

(5) Install the brushes and related parts as shown in figure 3-15. Before installing the commutator end frame (4), seat the brushes on the commutator using 00 sandpaper.

NOTE

Thecommutator on the armature shaft must be smooth and concentric, free from burrs, scoring, high segments, burned segments, or other damage. You should replace the starting motor if the commutator is damaged.

(6) Install the commutator end frame (4) with the through bolts (3).

d. *Testing.* To perform a no-load test, connect the starting motor in series with a fully charged 24-volt battery, an ammeter of 0to 500-ampere range and a large variable carbon pile resistor as shown in figure 3-16. Also connect a voltmeter into the circuit. You will also need a tachometer to measure armature speed. Energize the starting motor and adjust the variable resistor until you have a reading of 20 volts. Armature rotation should be within the range of 3300 to 5600 rpm with a current draw between 40 and 75 amperes. Interpret the results as follows:

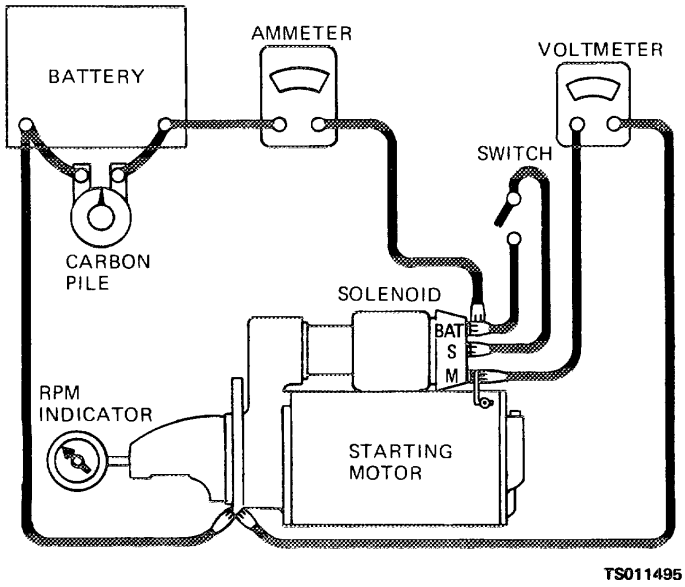


Figure 3-16. Starting motor no-load test setup.

(1) Current draw and no-load armature speed within the above limits indicate normal condition of the starting motor.

(2) Low free speed or high current draw indicates too much friction, caused by damaged bearings or a bent shaft, a shorted armature, or a grounded armature or field.

(3) No rotation with high current draw indicates a grounded field terminal or frozen bearings.

(4) Failure to operate with no current draw in dicates an open field circuit, open armature coils (this condition is normally accompanied by badly burned commutator bars), or lack of continuity between brushes and commutator.

(5) Low free speed with low current draw indicates high internal resistance due to poor connections, defective leads, or a dirty commutator.

(6) High free speed with high current draw indicates a shorted field.

e. *Disassembly*. Disassemble the start motor

following the sequence indicated in figure 3-15. Note the following.

(1) If you have already removed the brushes, be sure to remove screw (1) and lock washer (2) to disconnect the field coil connections from the solenoid motor terminal.

(2) Before removing the pinion drive assembly (35), you must remove the retainer (33). To do this, slide a metal cylinder on the shaft that will make contact with the retainer edge only. Drive the retainer toward the armature core and off the snap ring (32). Remove the snap ring from the groove in the armature shaft and continue disassembly.

(3) Do not remove the sleeve bearing (30) from the pinion housing (29) unless inspection indicates bearing is damaged.

(4) Do not disassemble the field coils (45 and 47) from frame unless tests indicate they are damaged and must be replaced.

f. Cleaning and Inspection.

(1) Discard and replace gasket and oil seal.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (fed. spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 to 138 F (38 to 59 C).

CAUTION

Saturating electrical parts with cleaning solvent will damage them.

(2) Clean the solenoid switch, armature, field frame and coil assembly, and drive assembly with a cloth dampened lightly in cleaning solvent (fed. spec. P-D-680). Blow dry with clean, dry compressed air.

(3) Clean all other metal parts thoroughly in cleaning solvent. Dry thoroughly with compressed air.

(4) If necessary, you may clean the armature commutator with No. 00 sandpaper. Do not use emery cloth.

(5) Inspect the brushes as directed in subparagraph c above.

(6) Inspect the armature for damaged insulation, worn or out-of-round commutator, and damaged bearing surfaces on shaft. Revarnish damaged insulation, allowing the varnish to soak into the windings. You can smooth damaged bearing surfaces with crocus cloth. Replace armature if damaged beyond repair.

(7) Use a growler to test the armature for shorted windings. Shorts can sometimes be corrected by removing metal particles imbedded between commutator bars. Replace armature if short cannot be located and corrected.

(8) Use a 110-volt test lamp and check for continuity between adjacent commutator bars. If continuity does not exist, then the armature windings are open. Check for loose connections between the conductors and the commutator. Poor connections will cause arcing and burning of the commutator.

(9) Use the test lamp to check for continuity between commutator bars and armature shaft. If continuity exists between commutator bars and armature shaft, the armature windings are grounded. Replace a grounded armature.

(10) Inspect the field coil windings in the frame for damaged insulation, broken wires, and damaged terminals. Revarnish damaged insulation. Replace frame and field assembly if badly damaged.

(11) Disconnect the field coil ground connections and, using the test lamp, check for grounds between each winding lead and frame. Check for open windings by connecting test lamp probes to the winding leads. Continuity must exist. Replace field windings that are open or grounded.

(12) Inspect the pinion housing sleeve bearing for scoring and wear. Press a damaged bearing from the housing, and press a new bearing into the housing.

g. Reassembly. Reassembly is essentially the reverse procedure of disassembly refer to figure 3-15. Pay particular attention to the following:

(1) After you install the drive assembly (35) and bearing (34) onto the armature shaft, place the retainer (33) onto the shaft with the cupped surface facing the snap ring groove. Place the snap ring (32) onto the shaft. Force the snap ring over the shaft end by placing a block of wood on it and lightly tapping with a hammer. Slide the ring into the groove. To force the retainer over the snap ring, place a suitable washer over the shaft, and squeeze retainer and washer together with pliers. Remove the washer and install the collar (31).

(2) After you install the solenoid, apply a sealing compound between the field frame, flange and solenoid junction.

h. Installation. Install the starting motor (TM 5-4320-234-12, para 4-42).

3-20. Radio Interference Suppression

a. Description. Essentially, suppression is attained by providing a low resistance path to ground for stray currents. The methods used include shielding the ignition and high frequency wires and grounding the frame with bonding straps.

b. Replacement of Suppression Components. This equipment uses no primary radio suppression com-

ponents. You can replace the secondary radio suppression components as follows: (1) Replace the shielded spark plug cables as directed in TM 5-4320-234-14, para 4-35. (2) Replace the magneto ground strap as directed in TM 5-4320-234-12, para 4-35.

Section VI. REPAIR OF ENGINE MOUNTING

3-21. Description

The engine is mounted on the radiator support assembly at the front, and on the feet of the flywheel housing at the rear. The resilient support at the front of the engine helps cushion engine vibration, preventing it from being transmitted to the associated equipment. The radiator support is connected to the flywheel housing by an adjustable tie rod.

3-22. Engine Support

a. Removal.

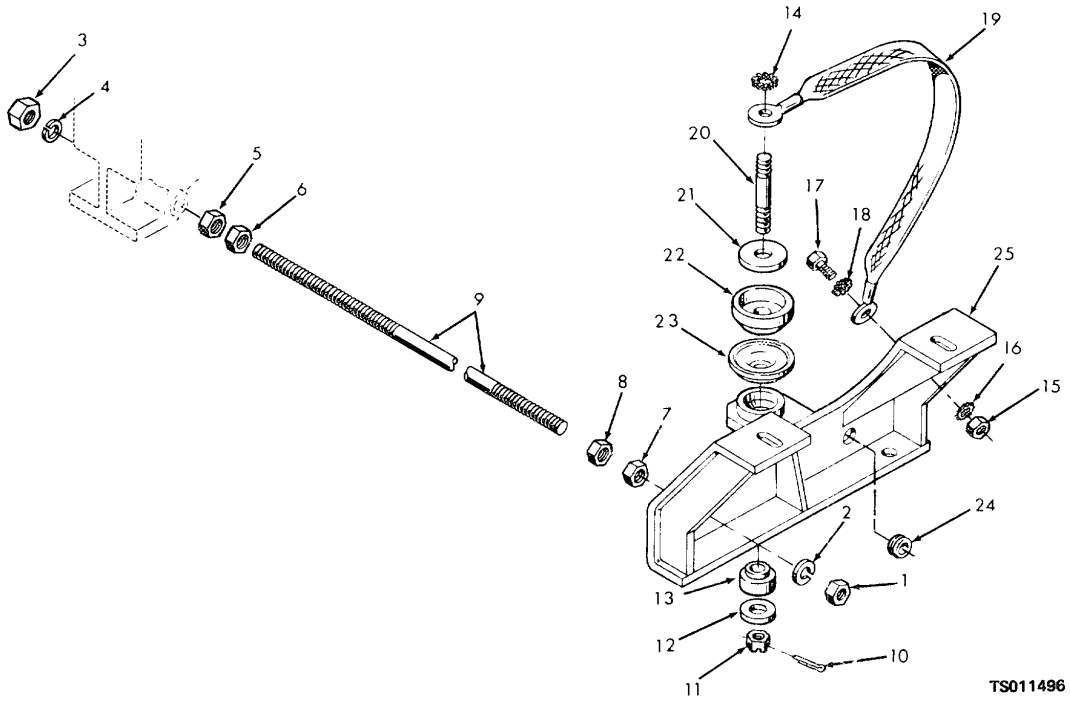
(1) Remove the engine from the centrifugal pump assembly (para 2-9).

(2) Remove the engine housing from the engine (TM 5-4320-234-12, para 4-19).

(3) Remove the radiator (TM 5-4320-234-12, para 4-32).

(4) Support the engine with a hoist engaged in the lifting eye at the top of the engine.

(5) Remove the tie rod and related parts (items 1 through 9, fig. 3-17) that connect the radiator support (25) with the flywheel housing.



1. Nut
2. Lockwasher
3. Nut
4. Lockwasher
5. Nut
6. Nut
7. Nut
8. Nut
9. Support tie rod
10. Cotter pin
11. Nut
12. Flatwasher
14. Lockwsher
15. Nut
16. Lockwasher
17. Capscrew
18. Lockwasher
19. Ground strap
20. Gear cover stud
21. Flatwasher
22. Support mount
23. Mount retainer
24. Grommet
25. Radiator support

Figure 3-17. Engine mounting parts, exploded view.

CAUTION

Do not rest the engine on its oil pan. This may damage the oil pan.

(6) Remove the cotter pin (10), nut (11), flat washer (12), and support mounting (13) from the end of the gear cover stud (20). Raise the engine out of engagement with the radiator support. Mount the engine on an overhaul stand, or provide proper blocking to rest it on the floor.

(7) Remove the flat washer (21), support mount (22), and mount retainer (23) from the radiator support.

b. Cleaning and Inspection.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(1) Clean the rubber mounting parts with a cloth dampened with cleaning solvent (Fed. Spec. P-D-680). Wash all remaining parts in solvent.

(2) Inspect the rubber mounting parts for cracks, deterioration, cuts, loss of resiliency, and other damage; replace damaged mounting parts.

(3) Inspect the support tie rod for damaged threads and distortion; replace damaged rod.

(4) Inspect the radiator support for cracks, broken weldments, distortion, and other damage; reweld, straighten, or replace a damaged support.

(5) Inspect the ground strap for rust, corrosion, and other damage. If necessary, sandpaper the end terminals to ensure a good electrical contact between the radiator support and engine at installation.

c. Installation.

(1) Install the engine on the radiator support as shown in figure 3-17. Make sure the ground strap (19) is making good electrical contact between parts.

(2) When you install the tie rod (9) that connects the radiator support (25) with the flywheel housing, position the inner nuts so that they prevent excessive strain on the radiator support when the outer nuts are tightened. The bottom of the radiator support must be horizontal when the tie rod is installed.

(3) Install the radiator (TM 5-4320-234-12, para 432).

(4) Install the engine housing (TM 5-4320-234-12, para 4-19).

(5) Install the engine on the centrifugal pump assembly (para 2-11).

CHAPTER 4

REPAIR OF ENGINE

Section I. INTRODUCTION

4-1. Description

The engine is a six-cylinder, four-stroke-cycle, L-head, in-line, water-cooled unit which is designed to run on gasoline. It is pressure lubricated by a pump located in the oil pan. It uses magneto ignition and an electrical starter. Engine speed is controlled by a variable speed flyball governor. The engine is protected by an overspeed governor which grounds the magneto to shut down operation if engine speed exceeds a preset limit.

4-2. Fits, Tolerances, and Wear Limits

Table 4-1 lists the fits and tolerances applicable to the engine. Refer to the table to determine if you must replace parts or if continued serviceability of the parts is possible.

Table 4.1. Engine fits tolerances, and wear limits.

Component points of measurement	Manufacturers dimensions in inches		Design clearances in inches		Allowable wear or clearance
	Min.	Max.	Min.	Max.	
Valve and valve guides.					
Intake valves					
Cylinder block face-to-guide distance				1-15/32 (3.6717 cm)	
Outside diameter	0.6565 (1.6412 cm)	0.6575 (1.6437 cm)			
Inside diameter	0.3422 (0.8555 cm)	0.3432 (0.8580 cm)			0.3447 (0.8617 cm)
Valve stem diameter	0.3406 (0.8515 cm)	0.3414 (0.8535 cm)			0.3386 (0.8465 cm)
Step to guide clearance			0.0008 (0.0020 cm)	0.0026 (0.0065 cm)	0.0046 (0.0115 cm)
Valve-to-tappet clearance					0.0140 (0.0350 cm)
Exhaust valves					
Cylinder block face-to-guide distance				1.15/32 (3.6717 cm)	
Outside diameter	0.6565 (1.6412 cm)	0.6575 (1.6437 cm)			
Inside diameter	0.3422 (0.8555 cm)	0.3432 (0.8580 cm)			0.3447 (0.8617 cm)
Valve stem diameter	0.3377 (0.8442 cm)	0.3385 (0.8462 cm)			0.3357 (0.8392 cm)
Stem-to-guide clearance			0.0037 (0.0092 cm)	0.0055 (0.0137 cm)	0.0075 (0.0187 cm)
Valve-to-tappet clearance					0.0160 (Hot) (0.0400 cm) 0.0170 (Cold) (0.0425 cm)
Valve tappets					
Outside diameter		0.9990 (2.4975 cm)			
Tappet bore diameter		1.0000 (2.5000 cm)			
Maximum bore-to-tappet clearance					0.0050 (0.0125 cm)
Camshaft and bushings					
Bearing journal diameter					
No. 1	1.8715 (4.6787 cm)	1.8725 (4.6812 cm)			1.8705 (4.6762 cm)
No. 2	1.8085 (4.5212 cm)	1.8095 (4.5237 cm)			1.8075 (4.5187 cm)
No. 3	1.7457 (4.3642 cm)	1.7465 (4.3662 cm)			1.7447 (4.3617 cm)

Table 4-1. Engine fits, tolerances, and wear limits - Continued

Component points of rneasurement	Manufacturer's dimensions in inches		Design clearances in inches		Allowable wear or clearance
	Min.	Max.	Min.	Max.	
Bearing journal diameter (cont.)					
No. 4	1.2465 (3.1162 cm)	1.2475 (3.1187 cm)			1.2455 (3.1137 cm)
Camshaft bushing diameter					
No. 1	1.8745 (4.6862 cm)	1.8755 (4.6887 cm)			
No. 2	1.8115 (4.5287 cm)	1.8125 (4.5312 cm)			
No. 3	1.7495 (4.3737 cm)	1.7502 (4.3755 cm)			
No. 4	1.2495 (3.1237 cm)	2.2505 (5.6262 cm)			
Journal-to-bushing clearance					
No. 1			0.002 (0.0050 cm)	0.004 (0.0100 cm)	
No. 2			0.002 (0.0050 cm)	0.004 (0.0100 cm)	
No. 3			0.002 (0.0050 cm)	0.004 (0.0100 cm)	
No. 4			0.002 (0.0050 cm)	0.004 (0.0100 cm)	
Camshaft end play			0.005 (0.0125 cm)	0.009 (0.0225 cm)	
Connecting rod					
Bushing hole diameter	0.9130 (2.2825 cm)	0.9140 (2.2850 cm)			
Bearing hole diameter	2.1865 (5.4662 cm)	21870 (5.4675 cm)			
Side play			0.0060 (0.0150 cm)	0.0100 (0.0250 cm)	
Connecting rod bearing					
Bearing hole diameter	2.1865 (5.4662 cm)	2.1870 (5.4675 cm)			
Bearing thickness	0.0613 (0.0407 cm)	0.0616 (0.1540 cm)			0.0608 (0.1520 cm)
Crank pin diameter	2.0619 (5.1547 cm)	2.0627 (5.1567 cm)			20609 (5.1522 cm)
Bearing to crankshaft clearance			0.0006 (0.0015 cm)	0.0022 (0.0055 cm)	0.0032 (0.0080 cm)
Crankshaft					
End thrust			0.0030 (0.0075 cm)	0.0080 (0.0200 cm)	
Main bearing journal diameter	2.3744 (5.9360 cm)	2.3752 (5.9380 cm)			2.3734 (5.9335 cm)
Crank pin diameter	2.0619 (5.1547 cm)	2.0627 (5.1567 cm)			2.0609 (5.1522 cm)
Main bearings					
Case hole	2.5615 (6.4037 cm)	2.5622 (6.4055 cm)			
Bearing thickness	0.0925 (0.2312 cm)	0.0928 (0.2320 cm)			0.0920 (0.2300 cm)
Crankshaft journal diameter	2.3744 (5.9360 cm)	23752 (5.9380 cm)			2.3734 (2.3734 cm)
Journal-to-bearing clearance			0.0007 (0.0017 cm)	0.0028 (0.0070 cm)	
Piston					
Ring groove width					
1st	0.1275 (0.3187 cm)	0.1285 (0.3212 cm)			0.1305 (0.3262 cm)

Table 4-1. Engine fits, tolerances, and wear limits - Continued

Component points of measurement	Manufacturer's dimensions in inches		Design clearances in inches		Allowable wear or clearance
	Min	Max.	Min.	Max	
Ring groove width (cont.)					
2nd and 3rd	0.1275 (0.3187 cm)	0.1285 (0.3212 cm)			0.1305 (0.3262 cm)
4th	0.2520 (0.6300 cm)	0.2530 (0.6325 cm)			0.2550 (0.6375 cm)
Cylinder bore diameter	3.4375 (8.5937 cm)	3.4395 (8.5987 cm)			3.4475 (8.6187 cm)
Piston fit in bore. Check by pull on 1/2-inch wide x 0.003-inch feeler gage					5 to 10 lb (2.250 to 4.500 kg)
Piston rings					
Width					
No. 1	0.1230 (0.3075 cm)	0.1240 (0.3100 cm)			0.1210 (0.3025 cm)
No. 2 and 3	0.1230 (0.3075 cm)	0.1240 (0.3100 cm)			0.1210 (0.3025 cm)
No. 4	0.2485 (0.6212 cm)	0.2490 (0.6225 cm)			0.2465 (0.6162 cm)
Gap					
No. 1			0.007 (0.0175 cm)	0.017 (0.0425 cm)	
No. 2 and 3			0.007 (0.0175 cm)	0.017 (0.0425 cm)	
No. 4			0.007 (0.0175 cm)	0.017 (0.0425 cm)	
Side clearance					
No. 1			0.0035 (0.0087 cm)	0.0050 (0.0125 cm)	
No. 2 and 3			0.0035 (0.0087 cm)	0.0055 (0.0137 cm)	
No. 4			0.0030 (0.0075 cm)	0.0045 (0.0112 cm)	
Piston pin					
Length	2.805 (7.012 cm)	2.815 (7.037 cm)			
Pin diameter	0.8591 (2.1477 cm)	0.8593 (2.1482 cm)			0.8588
Piston pin bushing diameter	0.8595 (2.1487 cm)	0.8597 (2.1492 cm)			0.8067
Piston pin fit in piston			Light push		
Piston pin fit in rod			0.0002 (0.0005 cm)	0.0006 (0.0015 cm)	
Valve spring					
Weight required to compress to 1-45/64 in. (valve closed)			47 lb (21.15 kg)	53 lb (23.85 kg)	42 lb (18.19 kg)
Weight required to compress to 1-27/64 in. (valve open)			96 lb (43.20 kg)	104 lb (46.80 kg)	86 lb (34.40 kg)

Section II. ENGINE REPAIR AND OVERHAUL

NOTE

You can do some engine repair with the engine in the engine housing. More extensive repair will require removal of the engine from the housing. Major repair or overhaul requires that the engine be mounted on an engine overhaul stand. Remove the engine housing (TM 5-4320-234-12, para 4-19). Remove the engine from its mounting parts if necessary (para 3-22). Remove accessories from the engine as required.

4-3. Cylinder Head

a. Removal. Remove the cylinder head and gasket as shown in figure 4-1. When removing the cylinder head screws, loosen each a small increment until all are started. This will help prevent cylinder head distortion. Repeat for several more small increments until all are loose.

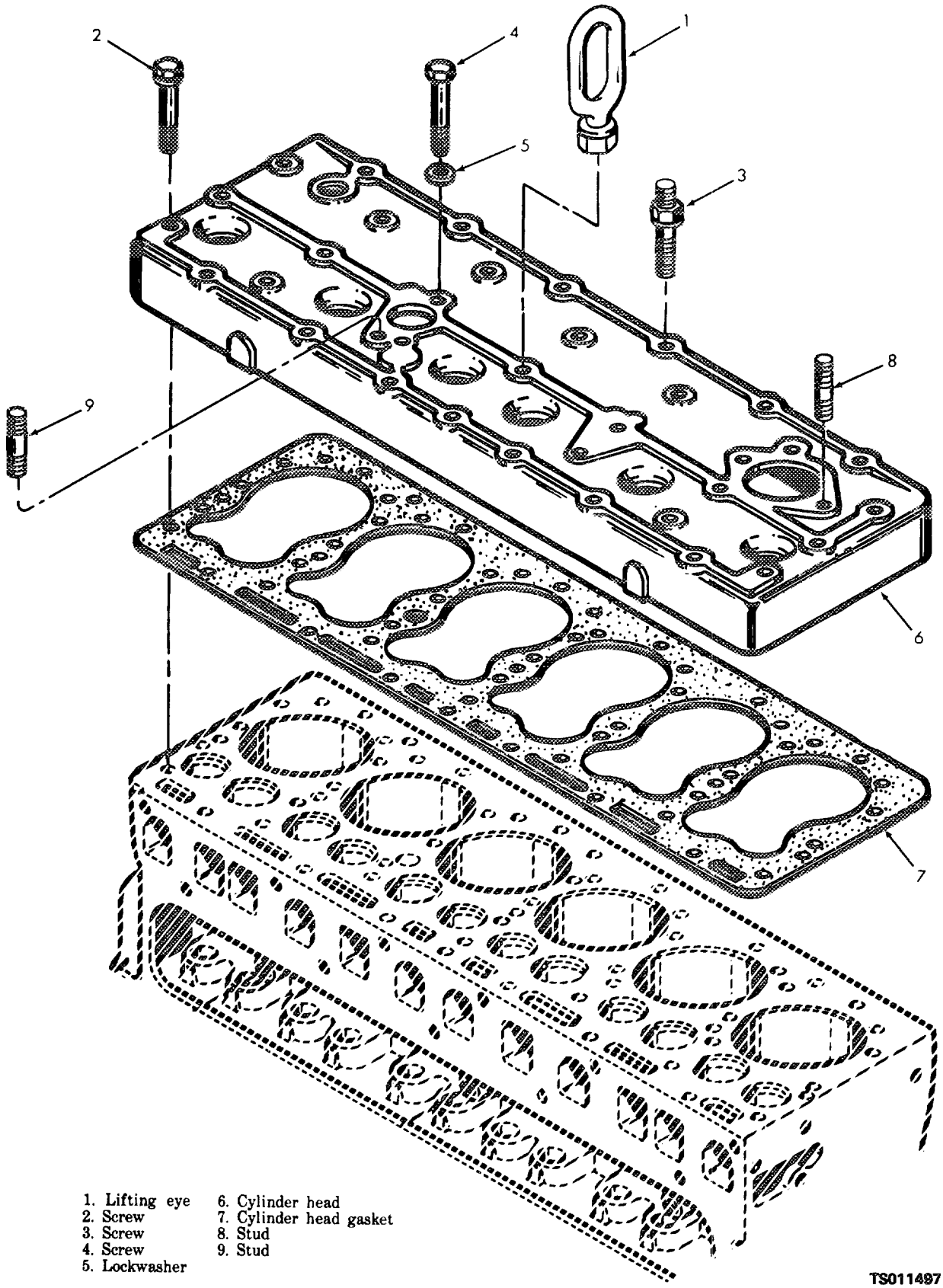


Figure 4-1. Cylinder head, exploded view.

b. Cleaning and Inspection.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(1) Remove all carbon from combustion areas with a scraper and wire brush. Clean all remaining residue from the cylinder head with cleaning solvent (Fed. Spec. P-D-680). Dry with clean, dry, compressed air.

(2) Clean the top of the cylinder block with a scraper and a cloth dampened in cleaning solvent. Be careful that you do not get dirt in the cylinders or water jacket.

(3) Inspect the cylinder head for cracks, corrosion, damaged threads, plugged water ports, or other defects.

(4) Check flatness lengthwise with a straightedge and feeler gage. The maximum permissible low spot is 0.012 inch (0.0300 cm) in the center, gradually decreasing toward the ends. Check flatness lengthwise at each edge and in the middle of the head.

(5) Check flatness crosswise with a straightedge and a feeler gage. The maximum permissible low spot is 0.003 inch (0.0075 cm) in localized areas. Check flatness crosswise at each end and between each combustion chamber.

(6) Inspect cylinder head studs for looseness or damaged threads.

(7) Replace the gasket, hoses, and defective parts.

c. Installation. Using a new head gasket, install head in reverse order of removal. Tighten the cylinder head screws according to the sequence shown in figure 4-2. Torque to 35 to 40 foot-pounds (4.840 to 5.532 kgm).

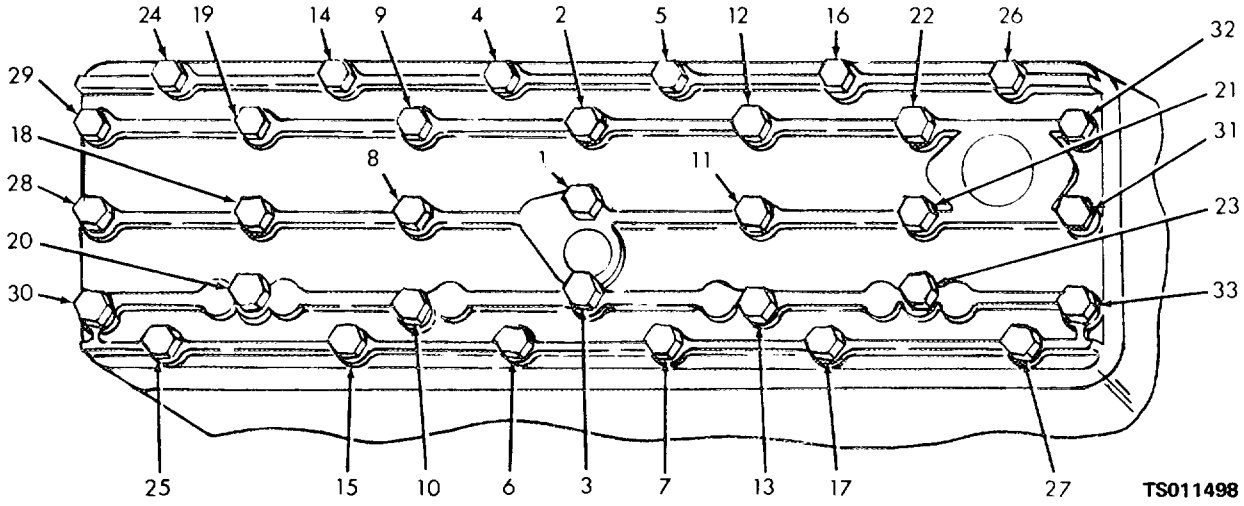


Figure 4-2. Cylinder head capscrew tightening sequence.

4-4. Intake and Exhaust Valves

a. General. The intake and exhaust valves of this L-head engine are mounted in the cylinder block. They are opened by operation of the camshaft through adjustable valve tappets. They are closed by the valve springs. The valve stems ride in valve guides which are pressed into the block. The intake valves seat directly in the block. The exhaust valves seat in shrink-fit valve seat inserts in the block.

b. Removal.

(1) Remove the cylinder head (para 4-3).

(2) Remove the valve chamber cover (7, fig. 4-21).

(3) Using a spring lifter, compress the valve spring (5 or 10, fig. 4-3) at each valve (2 or 7) and remove the valve lock (1 or 6) from each valve that is in the closed position. Rotate the engine crankshaft to close the remaining valves and remove the remaining locks.

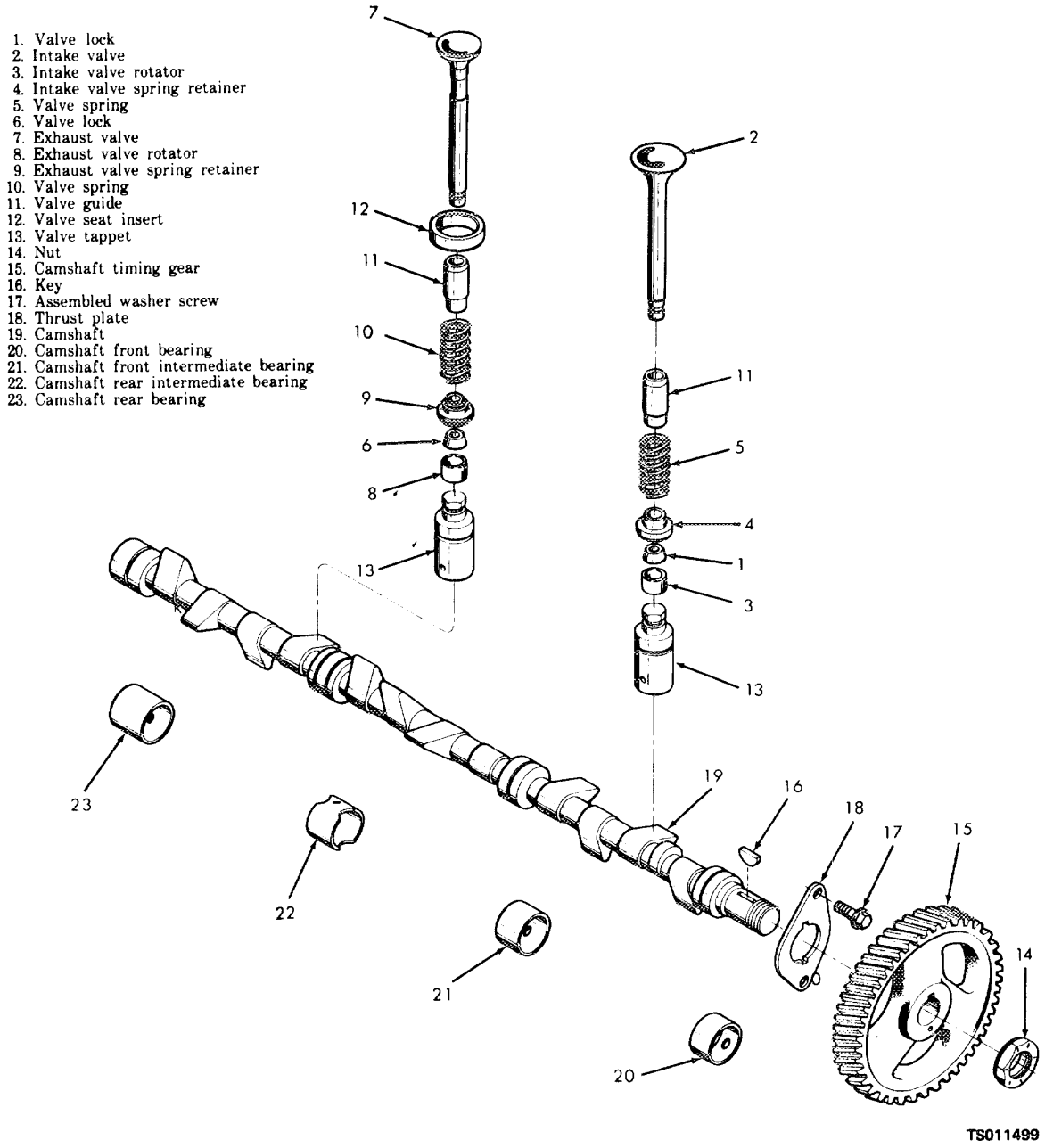


Figure 4-3. Valves and camshaft, exploded view.

(4) Lift each valve from the top of the block. Place valves in order in a rack to ensure that you will reassemble each in the same valve guide from which it was removed.

(5) Remove the valve rotator (3 or 8), spring retainer (4 or 9), and valve spring (5 or 10). Remove the valve tappet assembly (13).

(6) Do not remove the valve guide (11) or valve seat insert (12) unless inspection indicates that it is faulty.

c. Cleaning, Inspection, and Repair.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(1) Clean the valves, valve springs, and valve tappet assemblies with cleaning solvent (Fed. Spec. P-D680); dry thoroughly. Remove carbon deposits with a wire brush.

(2) Clean the valve guides installed in the block with a valve guide cleaner or wire brush. Remove all lacquer and other deposits.

(3) Clean the valve seats with a wire brush.

(4) Inspect the valves for cracks, bent stems, distortion, and wear (table 4-1). If the valves are not seriously damaged, regrind them. After grinding, the valve head thickness must be at least 50 percent of a new valve's thickness. You must replace the valves if they are ground to less than this amount. Check the reground valves on V-blocks with an indicator. The contact face must be true with the stem to within 0.002 inch (0.0050 cm).

(5) Check for loose or worn valve guides. Check the internal diameter of the valve guide with a telescope gage and a micrometer. Replace guides that are worn to a bell-mouthed shape or guides that have a maximum diameter of more than 0.3447 inch (0.8617 cm).

CAUTION

Do not attempt to ream the valve guides after seating them. Guides are pre-reamed and coated. Further reaming will remove the coating.

(6) If the valve guides are worn or damaged, press out the guides from the combustion side, using a driver that is slightly smaller than the external diameter of the guide. With the driver, press in new guides from the combustion side. When properly seated, valve guide tops will be 1-13/32 inches (3.5155 cm) from the top of the block (fig. 4-4).

(7) Check the exhaust valve seat inserts for cracks or loose mountings. Pull out faulty valve seat inserts. Replace original valve seats with new 0.010 inch (0.0250 cm) oversized valve seats. Counterbore the original valve seats to a diameter of 1.3535 to 1.3545 inches (3.3837 to 3.3862 cm). This will provide the required press fit. If valve seats had been counterbored previously, rebore to 0.01 inch (0.0250 cm)

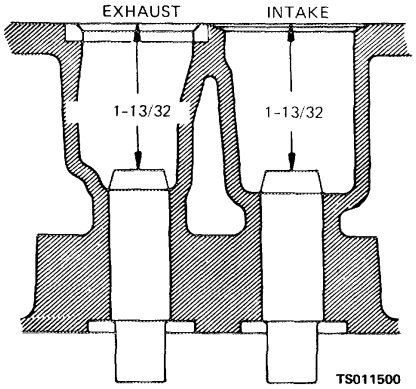


Figure 4-4. Valve guide installation dimensions.

oversize to provide a 0.003 to 0.005 inch (0.0075 to 0. 0125 cm) press fit. Counterbore deeply enough so that the boring tool will clean up the bottom of the bore to ensure proper heat conduction from the valve insert. Chill the valve seats in dry ice for 20 minutes. Install the valve seat in place with a piloted driver, by using an arbor press or by applying light blows with a hammer until the valve seat is resting against the bottom of the bore. Roll or peen the valve seat into place.

(8) Check the valve springs for cracks and distortion. Test compression strength with a spring tester. Compression strength must be as follows:

Length	Load (minimum)
1-45/64 inches (closed) (4.2577 cm)	42 pounds (18.90 kg)
1-27/64 inches (open) (3.5547 cm)	86 pounds (38.70 kg)

(9) Grind the valve seats. The seat angle of the intake valve is 30°. The seat angle of the exhaust valves is 45°. Use a dial indicator to check the valve seat for runout. The total indicator reading must not exceed 0.002 inch (0.0050 cm). Clean the valve seat and surrounding area thoroughly after grinding.

(10) After you have refaced and reground the valves and seats, coat each seat lightly with Prussian blue and drop the valve into place, oscillating it slightly to transfer the blue pattern to the valve face. This should show a contact width of 1/16 to 3/32 inch (0. 1562 to 0.2342 cm), and should fall well within the width of the valve face, leaving at least 1/64 inch on either side of the contact area. If the contact area is greater than 3/32 inch (0.2342 cm), narrow the contact area by grinding the outside diameter of the seat with a 15° stone or by grinding the inside diameter of the seat with a 60° or 75° stone (fig. 4-5). After the

seat area is corrected, touch the seat lightly with the original grinding stone to remove the burred or feathered edge.

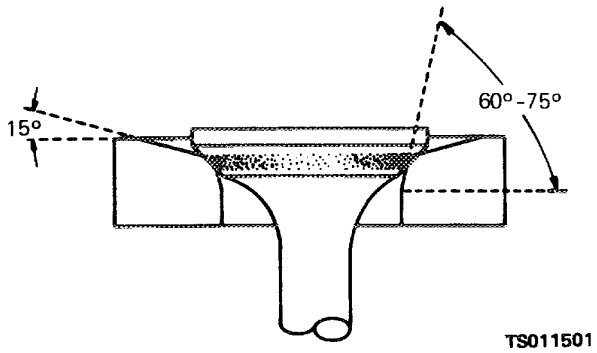


Figure 4-5. Narrowing valve seat.

(11) Inspect the spring retainer seats, spring retaining locks, valve stem caps, and valve tappet assemblies for cracks, scoring, overheating, and wear. Replace damaged parts.

d. Installation.

(1) Position the valve tappet assemblies (13, fig. 4-3) in the engine block.

(2) Assemble the valves (2 and 7), valve springs (5 and 10), spring retainers (4 and 9), valve rotators (3 and 8), and valve locks (1 and 6). Compress the valve springs with a spring compressor to install the valve locks. Turn the engine over as necessary to allow each valve to move to the closed position before attempting to install the valve parts. Make sure that you install each valve into the guide from which it was removed.

(3) With the engine stopped, temporarily set the intake valve-to-tappet clearance to 0.014 inch (0.0350 cm) and the exhaust valve-to-tappet clearance to 0.017 inch (0.0425 cm) (cold).

(4) Install the cylinder head (para 4-3).

(5) Operate the engine until it reaches operating temperature. Adjust valve-to-tappet clearance as directed in subparagraph e below.

(6) Install the valve chamber cover (7, fig. 4-21).

e. Valve Adjustment.

(1) Operate engine until it reaches operating temperature.

(2) Disconnect the positive crankcase ventilation valve and fittings from the valve chamber cover.

(3) Remove the nuts and washers that secure the valve chamber cover to the cylinder block. Remove the valve chamber cover and gasket.

(4) With the engine running at operating temperature and at idle speed, set the intake valves for 0.014-inch (0.0350 cm) clearance as follows:

(a) Alternately pass a 0.013-inch (0.0325 cm) and a 0.015-inch (0.0375 cm) flat feeler gage between the head of the adjusting ,;crew of the tappet (13, fig. 4-3) and stem of valve (2).

(b) If a 0.013-inch (0.0325 cm) feeler gage moves freely back and forth in gap when the valve is not being lifted, and a 0.0015-inch (0.0375 cm) feeler gage binds at all times, the clearance requires no adjustment.

(c) If a 0.013-inch (0.0325 cm) feeler gage is gripped at all times, the clearance is insufficient.

(d) Hold valve lifter with an open end wrench while using a second wrench to turn adjusting screw one-quarter to one-half turn clockwise. Repeat clearance check and adjustment until you obtain the proper clearance. The adjustable-type valve lifters have self-locking adjusting screws that require no lock nuts.

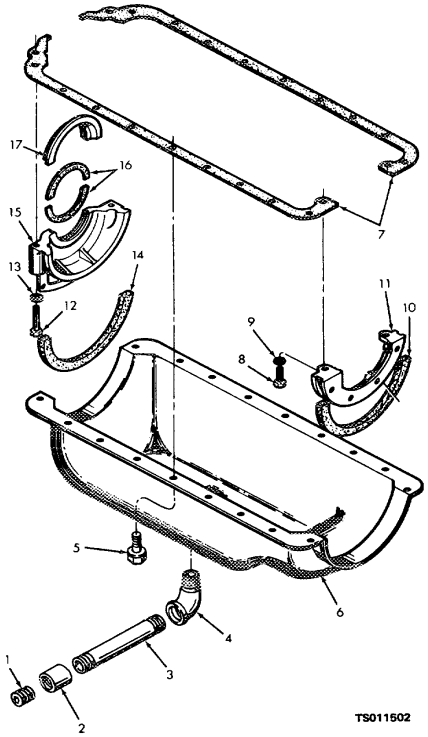
(e) If a 0.015-inch (0.0375 cm) feeler gage moves freely when valve is not being lifted, the clearance is too great. Hold valve lifter with an open end wrench while using a second wrench to turn valve lifter adjusting screw counterclockwise one-quarter to one-half turn. Repeat the clearance check and adjustment until proper clearance is obtained.

(5) Adjust the exhaust valves to a 0.016-inch (0.0400 cm) (hot) clearance in the manner described above, using 0.015 (0.0375 cm) and 0.017 inch (0.0425 cm) feeler gages.

4-5. Oil Pan and Filler Blocks

a. Removal.

(1) Remove the drain plug (1, fig. 4-6) and drain the engine oil into a suitable container. Remove the oil drain piping (items 2 through 4).



1. Oil drain plug
2. coupling
3. Nipple
4. Elbow
5. Assembled washer screw
6. Oil pan
7. Oil pan gasket
8. Capscrew
9. Lockwasher
10. Front filler block seal
11. Front filler block
12. Capscrew
13. Lockwasher
14. Rear filler block seal
15. Rear filler block
16. Oil guard seal
17. Rear oil guard

Figure 4-6. Oil pan and filler blocks, exploded view.

(2) Remove the 18 assembled washer screws (5) that secure the oil pan (6) to the block; remove the oil pan and gaskets (7).

(3) Remove the two capscrews (8) and lockwashers (9) that secure the front filler block (11) to the block; remove the filler block and seal (10).

(4) Remove the two capscrews (12) and lockwashers (13) that secure the rear filler block (15) to the block; remove the filler block and seal (14), oil guard seal (16) and oil guard (17).

b. Cleaning and Inspection.

(1) Discard and replace gaskets and seals.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(2) Clean all remaining parts with cleaning solvent (Fed. Spec. P-D-680); dry thoroughly.

(3) Inspect the oil pan for cracks, severe dents, holes, damaged threads, and other damage; replace a defective oil pan.

(4) Inspect the filler blocks for cracks, distortion, and other damage; replace damaged filler blocks.

c. Installation.

(1) Install the seal (16, fig. 4-6) into the rear filler block (15) and oil guard (17) as follows:

(a) Flatten the jute seal in a vise or with a hammer until the seal fits into the groove in the filler block or oil guard.

(b) Roll the seal into the oil guard or filler block groove with a round object.

(c) Trim the seal 0. 020 to 0. 030 inch (0. 0500 to 0. 0750 cm) above the flat surface of the oil guard or filler block, using a sharp knife or razor blade. Make sure the cut is parallel to the flat surface of the casting.

(2) To replace the neoprene seals (10 and 14) on the filler blocks (11 and 15), make sure the contact surface is free of cement, dirt, and oil. To hold the seal in place for assembly, use a small spot of nonhardening cement in the center of the contacting surface before you insert the seal into the groove. No other cement is required.

(3) Lubricate all seals with engine oil. With the crankshaft in place, the assembled rear oil guard (17) and jute seal (16) can be rolled into place around the crankshaft. Position the assembled rear filler block (15) and seal (14) on the engine block; secure with the two capscrews (12) and lockwashers (13). Tighten the capscrews to 15 to 20 foot-pound torque.

(4) Position the front filler block (11) and seal (10) on the engine block; secure with the two capscrews (8) and lockwashers (9). Tighten the capscrews

to 15 to 20 foot-pounds torque.

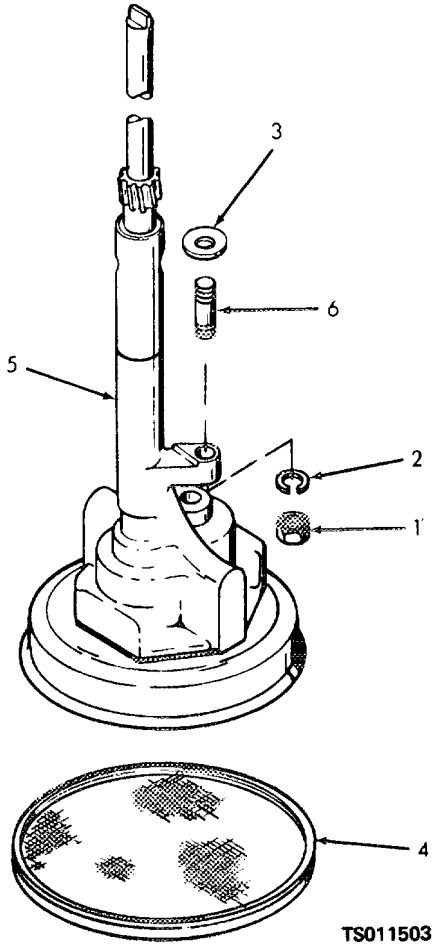
(5) Position the gaskets (7) on the oil pan (6). Install the oil pan and gaskets on the engine block; secure with the 18 assembled washer screws (5). Tighten the screws to 12 to 16 foot-pounds torque.

(6) Coat the male threads of the elbow (4) with thread sealing compound and install the elbow in the drain pan. Coat the male threads of the nipple (3) with thread sealing compound and install the nipple in the elbow. Install the coupling (2) on the nipple, and install the oil drain plug (1) in the coupling.

4-6. Engine Oil Pump

a. Removal.

(1) Remove the engine oil pan (para 4-5).



1. Nut
2. Lockwasher
3. Flat washer
4. Screen
5. Engine oil pump
6. Stud

Figure 4-7. Engine oil pump installation.

(2) Remove the nut (1, fig. 4-7) and lockwasher (2) securing the engine oil pump to the bearing cap. Remove the oil pump and flat washer (3).

(3) Remove the screen (4) from the bottom of the oil pump (5).

b. Cleaning and Inspection.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.)..

(1) Clean all parts with dry cleaning solvent (Fed. Spec. P-D-680). Allow all parts to dry thoroughly before reinstallation.

(2) Inspect the screen for holes, clogging, and distortion. Replace a damaged screen.

(3) Check the fit of the drive shaft in the pump body. There shall be no excessive play. Replace the oil pump if the shaft is damaged, or if the play is excessive.

c. Installation.

(1) Install the screen (4, fig. 4-7) on the bottom of the oil pump (5).

(2) Position the washer (3) and oil pump (5) on the main bearing so that the drive gear engages the toothed portion of the camshaft. Secure the pump with the nut (1) and lockwashers (2).

(3) Install the oil pan (para 4-5).

4-7. Gear Cover

a. Removal and assembly.

(1) Remove the governor from the engine (para 34).

(2) Remove the water pump from the engine (TM 5-4320-234-12, para 4-31).

(3) Remove the starting jaw (1, fig. 4-13) and collar (2) that secure the pulley (3) to the front end of the crankshaft; remove the pulley and key (4) from the crankshaft.

(4) Remove the capscrews (1, 3, 6, and 10, fig. 4-8), assembled washer screws (5), nuts (8 and 11), lockwashers (2, 9, and 12), and copper washers (4 and 7) that secure the gear cover (14) to the engine block; remove the gear cover and gear cover housing gasket (15) from the front end plate (19).

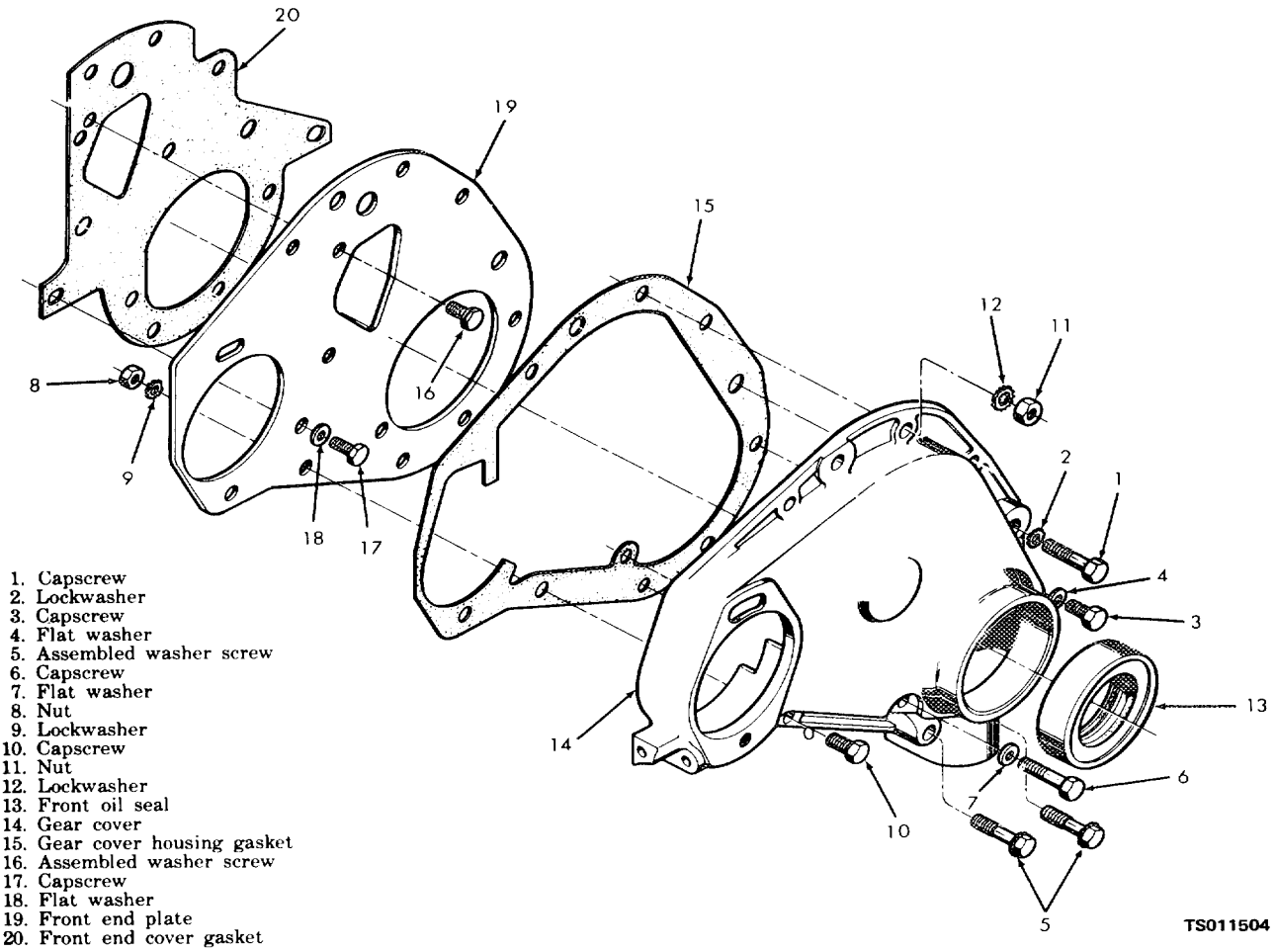


Figure 4-8. Gear cover and front end plate, exploded view.

(5) Press the seal (13) from the gear cover.

(6) Remove the assembled washer screw (16), capscrews (17) and flat washers (18) that secure the front end plate (19) to the cylinder block; remove the front end plate and gasket (20).

b. Cleaning and Inspection.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(1) Discard and replace all gaskets and seals.

(2) Clean all parts with cleaning solvent (Fed. Spec. P-D-680); dry thoroughly.

(3) Inspect the gear cover for cracks, distortion, damaged sealing surfaces, and other damage; replace a damaged gear cover.

(4) Inspect all other parts for cracks, distortion, worn or damaged threads, and other damage; replace damaged parts.

c. Reassembly and Installation.

(1) Refer to figure 4-8, items 1 through 15, and install the gear cover.

(2) Secure the crankshaft pulley (3, fig. 4-13) to the crankshaft, using the starting jaw (1) and collar (2).

(3) Install the governor on the engine (para 3-6). Time the magneto (TM 5-4320-234-12, para 4-35).

4-8. Flywheel and Flywheel Housing

a. Removal. Remove the flywheel and flywheel housing as follows:

(1) Remove the six nuts (5, fig. 4-13) and lock washers (6) that secure the flywheel (7) and ring gear (8) to the crankshaft (36); remove the flywheel.

(2) Remove the capscrews (11, fig. 4-21), shoulder screws (13), and lockwashers (12 and 14) that secure the flywheel housing (15) to the block (41); remove the flywheel housing and gasket.

b. Cleaning, Inspection, and Repair.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(1) Clean the flywheel and flywheel housing with cleaning solvent (Fed. Spec. P-D-680); dry thoroughly.

(2) Inspect the flywheel housing for cracks, distortion, and damaged threads; replace a damaged flywheel housing.

(3) Inspect the flywheel for chipped, cracked, or broken teeth on the ring gear, distortion, worn or out of-round bolt holes, and other damage. If the ring gear is damaged, replace as follows:

CAUTION

When you heat the ring gear, be careful not to damage the flywheel.

(a) Heat the ring gear with a torch and remove the ring gear from the flywheel.

(b) Heat the replacement ring gear and cool the flywheel.

(c) Position the replacement ring gear on the flywheel. As the ring gear and flywheel approach the same temperature, the ring gear will contract to achieve a tight fit on the flywheel.

c. Installation.

(1) Position the flywheel housing (15, fig. 4-21) on the block (41); secure with shoulder screws (13), capscrews (11), and lockwashers (12 and 14).

(2) Position the flywheel (7, fig. 4-13) on the crankshaft (36); secure with six bolts (9), lockwashers (6), and nuts (5). Tighten the nuts to 35 to 40 footpounds (4.8405 to 5.5320 kgm) torque.

(3) Check flywheel runout by mounting a dial indicator so that it indicates the flat vertical surface of the flywheel (fig. 4-9); rotate the crankshaft through one full revolution. Hold pressure against the flywheel to eliminate crankshaft end play. If flywheel runout exceeds 0.008 inch (0.0200 cm), remove the flywheel and clean the crankshaft flange and flywheel seat. Install the flywheel and recheck runout. If runout still exceeds 0.008 inch (0.0200 cm) replace the flywheel.

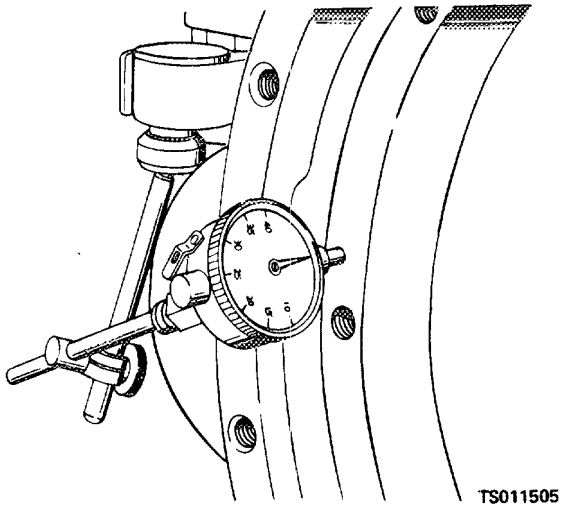


Figure 4-9. Checking flywheel runout.

(4) Check flywheel eccentricity by mounting a dial indicator so that it indicates the inside diameter of the flywheel counterbore (fig. 4-10); rotate the crankshaft through one revolution. If the flywheel is eccentric more than 0.008 inch (0.0200 cm), loosen and retighten the flywheel mounting bolts and recheck eccentricity. If eccentricity still exceeds 0.008 inch (0.0200 cm), replace the flywheel.

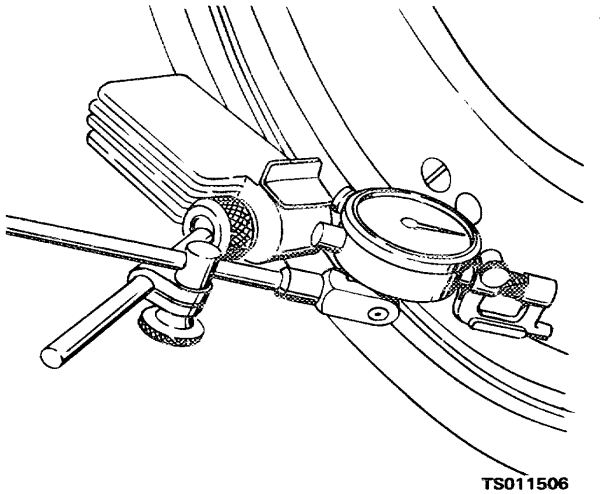


Figure 4-10. Checking flywheel eccentricity.

(5) Check runout of the flywheel housing face by mounting a dial indicator so that it indicates the housing face (fig. 4-11); rotate the crankshaft through

one revolution. Hold pressure against the flywheel to eliminate end play. If runout exceeds 0.008 inch (0.0200 cm), clean the mounting surfaces of the flywheel housing and the block. Recheck flywheel housing runout. If the runout is still not within limits, replace the flywheel housing.

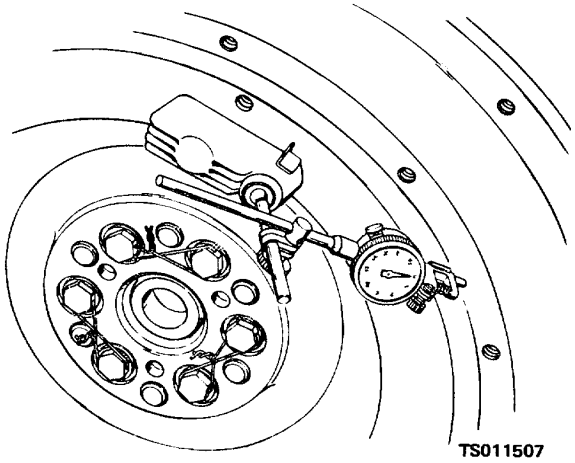


Figure 4-11. Checking flywheel housing runout.

(6) Check eccentricity of the flywheel housing bore by mounting a dial indicator so that it indicates

4-9. Pistons and Connecting Rods

a. Removal and Disassembly. With the engine mounted on an engine overhaul stand, proceed as follows:

(1) Remove the cylinder head (para 4-3a).

(2) Remove the engine oil pan (para 4-5a) and oil pump (para 4-6a). the bore (fig. 4-12); rotate the engine through one revolution. If the housing bore is eccentric more than 0.008 inch (0.0200 cm), loosen the flywheel housing mounting bolts and tap the housing into its proper position with a soft hammer. Tighten the bolts and recheck eccentricity of the housing bore. If the housing cannot be brought into true position, replace the housing.

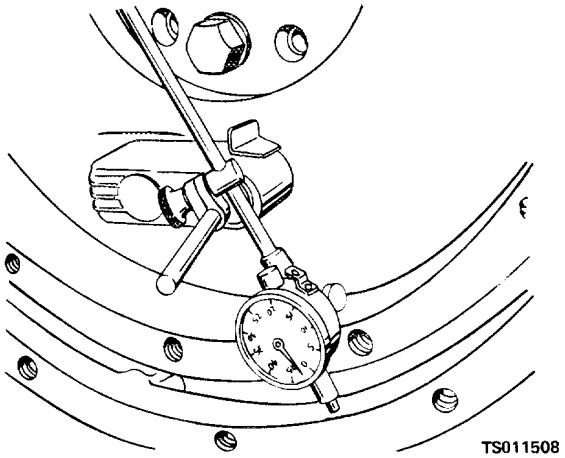


Figure 4-12. Checking flywheel housing eccentricity.

(3) Ream the ridge of the top of each cylinder bore with a standard ridge reamer. Blow metal fragments from the cylinder with compressed air.

(4) Remove the two cotter pins (10, fig. 4-13) and nuts (11), that secure a bearing cap (13) to a connecting rod (20); remove the cap and bearing shells (14).

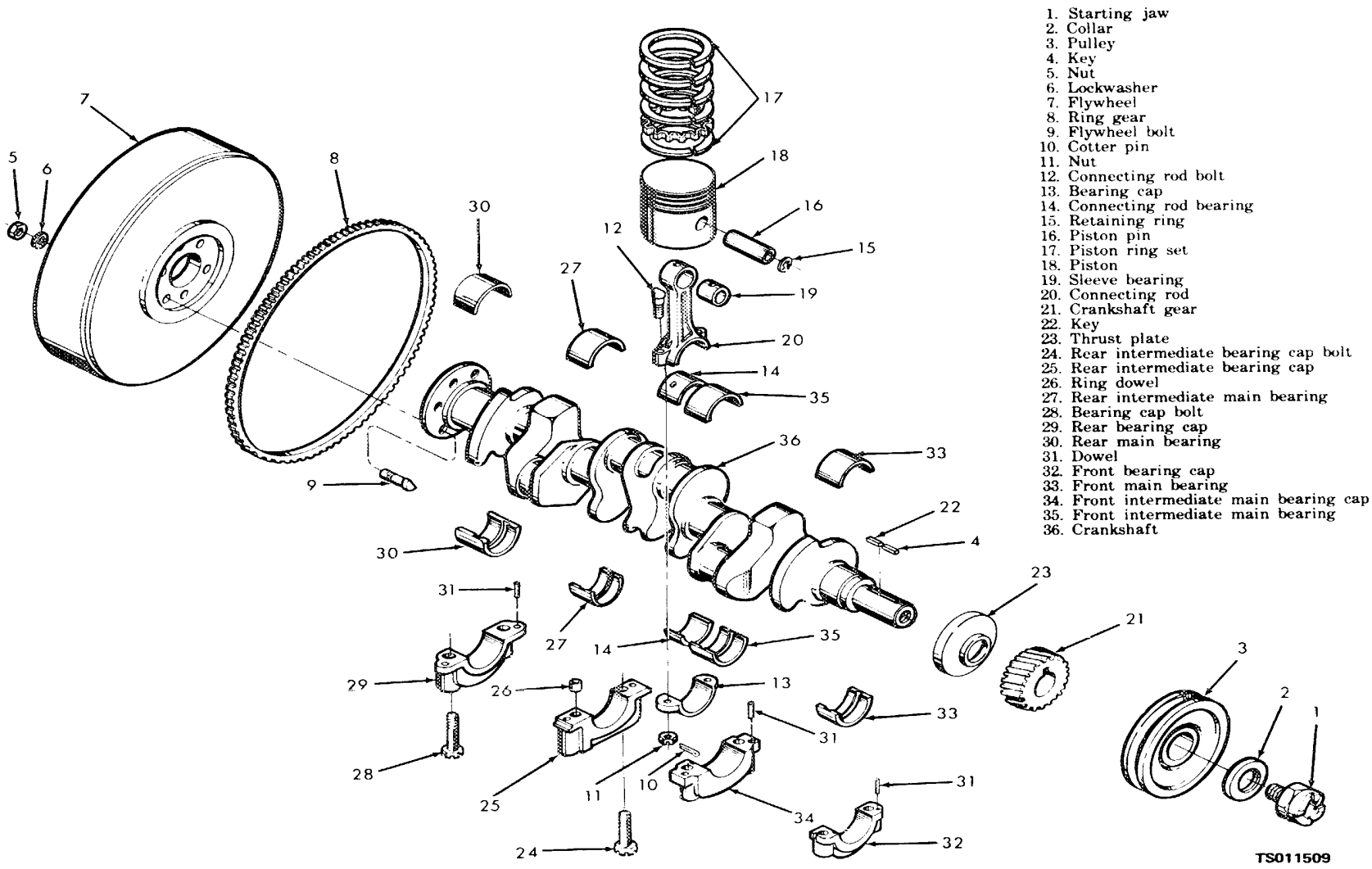


Figure 4-13. Piston, crankshaft, and flywheel, exploded view.

CAUTION

When you push the piston and rod from the block, be careful the connecting rod does not scratch the cylinder wall.

(5) Push assembled piston (18), rings (17), and connecting rod (20) up through the top of the block.

NOTE

Disassemble the pistons and piston rods in sets, and keep the sets together. Also, be sure that you install each piston and piston rod set into the cylinder from which it was removed.

(6) Refer to figure 4-13 (items 15 through 20) and disassemble the piston and connecting rod.

b. Cleaning and Inspection.

WARNING

Dry cleaning solvent, P-D-680 or P-S-661, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100 F.138 F. (38 C.-59 C.).

(1) Discard and replace the piston rings.

(2) Clean all parts with cleaning solvent (Fed. Spec. P-D-680); dry thoroughly.

(3) Inspect the pistons for cracks, distortion, broken ring lands and distorted grooves, loose piston pin-to-piston fit, and other damage; replace damaged pistons. Refer to table 4-1 for wear limits.

(4) Check the piston ring groove side clearance, using new piston rings. If side clearance exceeds the limits cited in table 4-1, replace the piston.

NOTE

Pistons and bearings are individually checked and fitted to the cylinders at reassembly. Before reassembly, check the cylinder bores as directed in paragraph 4-12c.

(5) Inspect the connecting rods for cracks, distortion, and other damage; replace damaged connecting rods. Refer to table 4-1 for wear limits.

(6) Inspect the bearing shells for scoring, wear, cracks, and other damage. Check bearing thickness, using a ball micrometer. Thickness must not be less than 0.0608 inch (0.1520 cm) micrometer. Thickness must not be less than 0.0608 inch (0.1520 cm) in all areas.

NOTE

New bearing shells are smooth and highly polished. After a few hours of operation the bearing surface becomes a leaden grey and develops minute craters so that the bearing surface has an almost cellular appearance. This is normal and is not an indication of impending bearing failure.

(7) Inspect all other parts for cracks, scoring, damaged threads, and other damage; replace damaged parts.

c. Reassembly and Installation.

(1) Check piston fit in the cylinder bore (fig. 4-14), using a piece of 0.003-inch (0.0075 cm) feeler stock cut 1/2 inch wide. Dress the edges of the feeler stock with a stone to remove burrs and feathered edges. The block and pistons must be at room temperature when you check the piston fit. Position the feeler stock midway between the piston pin bosses. With the piston inserted about 2 inches into the block, the feeler stock must pull from the block with 5 to 10 pounds pull. If the feeler stock does not offer enough resistance, perform the same test with a new standard size piston. If sufficient resistance is still not obtained, the cylinders are worn oversize, and the block must be replaced.

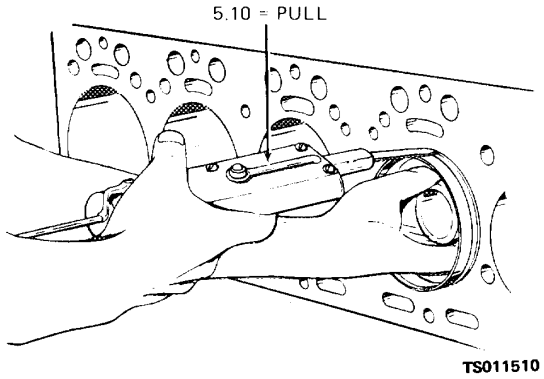


Figure 4-14. Checking piston fit in cylinder bore.

(2) If new pistons (18, fig. 4-13) and piston pins (16) are being used, press a new sleeve bearing (19) into each connecting rod (20). Ream and hone the sleeve bearings to 0.8595 to 0.8597 inch (2.1487 to 2.1492 cm) diameter. Make sure the final operation is done with a hone so that 75 percent or more of bearing surface contacts the piston pin.

(3) If the pistons and pins are not being replaced, check the clearance between the piston pins and the sleeve bearings. Clearance must be between 0.0002 (0.0005 cm) and 0.0006 (0.0015 cm) inch. If clearance is not within this tolerance, press new sleeve bearings into the connecting rods and ream and hone to provide the proper clearance. After honing, 75 percent of the sleeve bearing surface must contact the piston pin.

(4) Select pins, bushings and pistons of the proper size. Heat the pistons and connecting rods and position the connecting rod in its piston. Install the piston pin; secure with the piston pin retaining ring (15, fig. 4-13).

(5) Slide the piston rings (17) squarely into the cylinders in which they will be used. Check the ring gap with feeler gage. If the ring gap is not at least 0.007 inch (0.0175 cm), you can file the rings to provide the required gap. If the ring gap with a new

ring exceeds 0.017 inch (0.0425 cm), the cylinder is worn oversize and the cylinder block must be replaced.

(6) Install the oil ring in the bottom ring groove of each piston as follows: (a) Place stainless steel expander spacer in groove with ends butted.

(b) Install steel segment on top side of expander spacer with gap of segment approximately 90° beyond gap of stainless steel expander spacer, making certain that the expander spacer ends are still in a butted position.

(c) Install second segment on bottom side of the expander spacer with segment gap approximately 90° from the expander gap in opposite direction from which the top segment has been installed.

(d) Recheck assembly. Rings should be free to move in the groove; however, you will notice a slight drag because of the side sealing action of the ring assembly. Be sure expander spacer ends remain butted.

(7) Install the remaining piston rings on the piston with a standard ring expander tool.

(8) Assemble the remaining pistons, connecting rods, and piston rings.

(9) Install the assembled pistons and connecting rods in the same cylinders from which they were originally removed. Use a ring compressor to compress the piston rings. Lubricate the pistons and cylinder walls with engine oil before installing the pistons. Wrap the bottom ends of the connecting rods with cloths to prevent damage to the cylinder walls during installation.

(10) Check the crank pin bearing journal-to connecting rod bearing clearance with plastigage. Lay a piece of plastigage material on the crankshaft journal and install the connecting rod bearing cap. Torque the nuts to 40 to 45 foot-pounds (5.532 to 6.223 kgm). Remove the bearing cap and compare the width of the flattened plastigage material with the scale markings on the plastigage package to determine the clearance. The bearing-to-journal clearance shall be 0.006 to 0.0022 inch (0.0015 to 0.0055 cm). If clearance is beyond these limits, replace the bearing and/or the crankshaft as required.

(11) As an alternate method of checking crank pin bearing journal-to-connecting rod bearing clearance, install a 1/2 inch (1.250 cm) piece of 0.0022inch (0.0055 cm) thick feeler stock between the bearing and journal, and install the bearing cap. Tighten the connecting rod cap bolts to 40 to 45 footpounds (5.532 to 6.223 kgm) torque. Rotate the crankshaft to determine the amount of drag. If clearance is within tolerance, you will feel a definite drag. Disassemble the rod cap and remove the shim stock. If clearance is not within tolerance, replace the connecting rod bearings and recheck the clearance. If clearance is still not within tolerance, replace the crankshaft.

(12) Lubricate the crank pin bearing journals and the sleeve bearings with engine oil. Install the cap (13, fig. 4-13) onto its connecting rod (20) and crank pin bearing journal; secure with the two bolts (12) and nuts (11). Tighten the nuts to 40 to 45 footpounds (5.532 to 6.223 kgm) torque. Install the cotter pins (10).

(13) Secure the remaining connecting rods to the crank pin bearing journals.

(14) Install the engine oil pan (para 4-5c) and oil pump (para 4-6c).

(15) Install the cylinder head (para 4-3r).

4-10. Main Bearings and Crankshaft

a. Removal and Disassembly. With the engine mounted on an engine overhaul stand, proceed as follows: (1) Remove the cylinder head (para 4-3a).

(2) Remove the oil pan (para 4-5a) and oil pump (para 4-6a).

(3) Remove the gear cover (para 4-7a).

(4) Remove the flywheel and flywheel housing (para 4-8a).

(5) Remove the pistons and connecting rods (para 4-9a).

(6) Remove the bolts (24 and 28, fig. 4-13) that secure the main bearing caps (25, 29, 32, and 34) to the cylinder block. Loosen the bearing caps by tapping them with a plastic hammer. Remove the bearing caps and lower bearings (27, 30, 33, and 35).

NOTE

Upper main bearing shells can be removed without removing the crankshaft. To remove the upper shell, remove the main bearing cap at the defective bearing and remove the lower bearing shell. Insert a pin with an angular head into the oil hole of the crankshaft as shown in figure 4-15. Rotate the crankshaft and roll the bearing shell from the cylinder block.

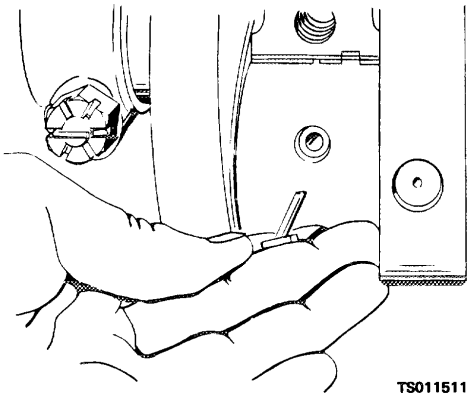


Figure 4-15. Removing upper bearing shell with angular pin.

(7) Pull the gear (21, fig. 4-13) from the crankshaft (36). Remove the key (22) and the thrust plate (23).

b. Cleaning and Inspection.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(1) Clean all parts with cleaning solvent (Fed. Spec. P-D-680). Clean oil passages in the crankshaft with a rifle cleaning brush. Make sure all passages are open.

(2) Inspect the crankshaft for cracks, worn or scored journals, damaged threads, and burred keyways. Refer to table 4-1 for wear limits. If magnetic particle inspection equipment is available, you should use it to check the crankshaft for hidden flaws. Replace a damaged crankshaft.

(3) Inspect the gear for cracked, chipped and broken teeth; replace a damaged gear.

(4) Inspect the bearing shells for cracks and scoring. New bearings are smooth and highly polished. After a few hours of operation, the bearing surfaces become leaden grey in color and develop minute craters which give the bearing surfaces an almost cellular appearance. This is a natural characteristic of the bearing and does not indicate bearing failure. Replace bearings if they are scored or damaged. Check the bearing thickness with a ball micrometer. Check several locations on the bearing. If thickness is less than 0.0920 inch (0.2300 cm), replace the bearing.

(5) Inspect the bearing caps for cracks and distortion and for burrs and gouges of the seating surfaces. Clean up any burrs with a fine stone to ensure proper seating of the bearing cap on the block.

c. Reassembly and Installation.

(1) Install the rear oil seal and oil guard as directed in paragraph 4-5c.

(2) Position the thrust plate (23, fig. 4-13) on the crankshaft and install the key (22) in the keyway of the crankshaft, after you make sure that the keyway is free of burrs. Press the gear (21) onto the crankshaft.

CAUTION

When you install the crankshaft, make sure that you aline the timing marks on the crankshaft with the timing marks on the camshaft gear. See paragraph 4-11.

(3) Position the upper half of the main bearings (27, 30, 33, and 35) in the seats in the crankcase. Position the crankshaft in the bearing shells.

(4) Install the lower half of the main bearings into the bearing caps (25, 29, 32, and 34).

(5) Check the clearance between the crankshaft bearing journals and bearings as follows:

(a) Place a piece of plastigage near the oil hole of the bearing cap.

(b) Position the cap on the block and secure with the two screws and lockwashers. Tighten the screws to 85 to 95 foot-pounds (11.75 to 13.13 kgm) torque.

(c) Remove the bearing and bearing cap. Check the bearing journal-to-bearing clearance indicated by the plastigage (fig. 4-16).

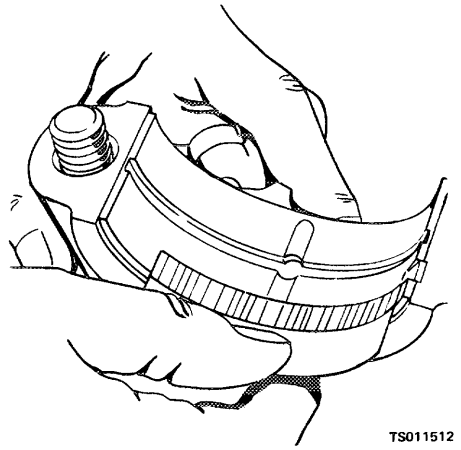


Figure 4-16. Checking bearing clearance with plastigage.

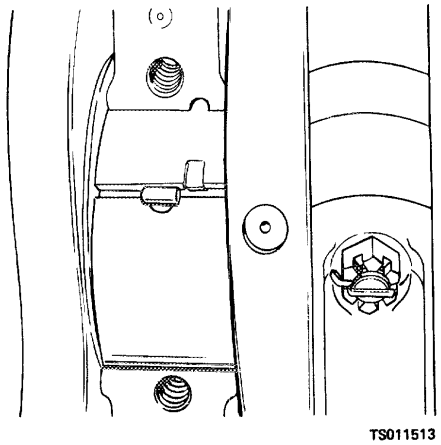


Figure 4-17. Installing upper bearing half, using angular pin.

(6) Clearance must be between 0.0007 (0.0017 cm) and 0.0028 inch (0.0070 cm). If the clearance is not within these limits, replace the bearings and recheck the clearance.

(7) Remove and replace the bearings as follows:

(a) Remove the bearing cap; remove the bearing from the cap.

(b) Install a pin with an angular head into the oil hole in the crankshaft bearing journal (fig. 4-15).

(c) Rotate the crankshaft by hand. The pin will force the top bearing half out of its seat.

(d) Position the replacement bearing on the crankshaft bearing journal. Rotate the crankshaft by hand. The pin will force the bearing half into position as shown in figure 4-17.

(e) Install the replacement bearing half into the cap. Install the cap.

(8) Check the remaining bearing-to-bearing journal clearances and replace bearings as necessary.

(9) An alternate method of checking bearing clearance is as follows:

(a) Oil the bearing and bearing journal with engine oil.

(b) Position a strip of 0.003-inch (0.0075 cm) feeler gage, 1/2 inch (1.250 cm) long, on the bearing cap (fig. 4-18).

(c) Install the cap onto the block; secure with the screws and lockwashers. Tighten the screws to 85 to 95 foot-pounds (11.75 to 13.13 kgm) torque.

(d) Try to turn the crankshaft by hand. If you cannot turn the crankshaft or if a very definite drag is felt, bearing-to-bearing journal clearance is within

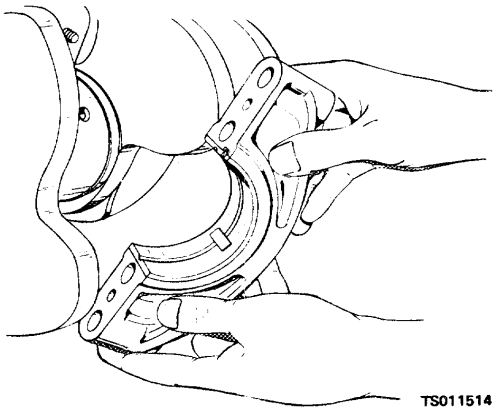


Figure 4-18. Checking bearing clearance with shim stock.

tolerance. Remove the shim stock and reinstall the bearings caps.

(10) After you have installed all main bearings, use a dial indicator to check crankshaft end play. If end play is not between 0.003 (0.0075 cm) and 0.008 inch (0.0200 cm), replace the thrust plate (23, fig. 4-13) which controls the shaft end play.

(11) Install the pistons and connecting rods (para 4-9c).

(12) Install the flywheel housing and flywheel (para 4-8c).

(13) Install the gear cover (para 4-7c).

(14) Install the oil pan (para 4-5c) and oil pump (para 4-6c).

(15) Install the cylinder head (para 4-3c).

4-11. Camshaft.

a. Removal. With the engine removed from the pump assembly and mounted on an engine stand, proceed as follows:

(1) Remove the cylinder head (para 4-3a).

(2) Remove the valves and valve tappets (para 44b).

(3) Remove the gear cover (para 4-7a).

(4) Remove the nut (14, fig. 4-3) from the camshaft (19), and pull the gear (15) from the camshaft. Remove the key (16).

(5) Remove the two assembled washer screws (17) that secure the plate (18) to the block; remove the thrust plate.

(6) Pull the camshaft (19) from the block.

b. Cleaning and Inspection.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(1) Clean all parts with cleaning solvent (Fed. Spec. P-D-680); dry thoroughly.

(2) Inspect the camshaft for cracks, worn or scored cams, worn or scored bearing surfaces, chipped or cracked keyway, and clogged oil passages. Use compressed air to check oil passages for clogging. Refer to table 4-1 for wear limits. Replace a damaged camshaft.

(3) Inspect the thrust washer for scoring and wear. Replace the thrust washer if you find any signs of wear.

(4) Inspect the cam gear for cracked, chipped, or broken gear teeth, damaged shaft bore, or worn thrust surface. The cam gear and the mating gear on the crankshaft must be replaced as a pair. Do not attempt to replace these gears singly.

(5) Inspect the plug (34, fig. 4-21) in the cylinder block. Replace plug if any leaking is evident from its circumference.

(6) Inspect the camshaft bearings in the cylinder block for scoring or visible damage; replace damaged bearings if necessary. Check the camshaft-to-bearing clearance and, if necessary, replace bearings as follows:

CAUTION

Do not insert the camshaft too far into the block. If the camshaft bumps the expansion plug on the drive end of the engine, an oil leak could result.

(a) Temporarily insert the camshaft (19, fig. 43) into the block. Check the clearance between the camshaft bearing journals and camshaft bearings (20, 21, 22, and 23) with feeler stock cut in strips 1/4 inch (0.6250 cm) wide. Dress the feeler stock with a stone to eliminate burrs or feathered edges. Clearance between bearings and journals must be between 0.002 (0.0050 cm) and 0.004 (0.0100 cm) inch.

(b) If clearance exceeds tolerances, remove the camshaft and replace the camshaft bearings. New bearings are pre-reamed. Install new bearings, taking care that you aline the oil holes with the passages in the block. Be careful that you do not damage the bearings during installation.

c. Installation.

(1) Lubricate the camshaft bearings with engine oil and install the camshaft into the block. Position the thrust plate (18, fig. 4-3) on the camshaft; secure with two assembled washer screws (17).

CAUTION

When installing the camshaft gear, do not attempt to seat the gear by tightening the retaining nut. This procedure may break threads on the camshaft, requiring camshaft replacement.

(2) Hold the camshaft toward the front of the engine with a bar inserted into the fuel pump hole. Aline the timing marks on the camshaft and crankshaft gears (fig. 4-19), and drive the gear (15, fig. 4-3) onto the camshaft.

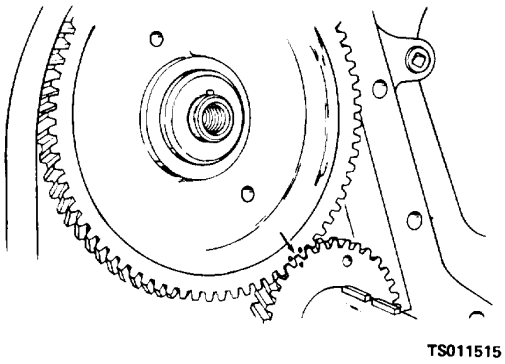


Figure 4-19. Timing gears showing alinement marks.

(3) Check camshaft end play with a dial indicator. If end play is not between 0.005 (0.0125 cm) and 0.009 (0.0225 cm) inch, remove the camshaft timing gear and replace the thrust plate (18, fig. 4-3).

(4) Check the clearance between the camshaft and crankshaft gears as follows:

(a) Force the teeth of the gears apart with a screwdriver. Attempt to insert a 0.002 inch (0.0050

cm) feeler gage into the gap between the gears. If the gage will enter, the clearance is excessive.

(b) If the gage will not enter, place a finger at the junction of the two gears as shown in figure 4-20 and tap the camshaft gear with a hammer. If vibrations can be felt in the large gear, the clearance is sufficient.

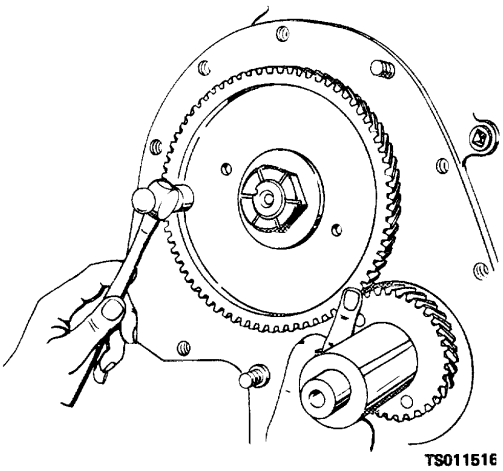


Figure 4-20. Checking for insufficient timing gear clearance.

(5) If gear clearance is too great or too small, the gears must be replaced. Replace the gears only in sets. Gear sets are available in standard size (marked S), 0.002 (0.0050 cm) and 0.004-inch (0.0100 cm) undersize (marked U), and 0.002 (0.0050 cm) and 0.004inch (0.0100 cm) oversize (marked 0). Install a gear set marked the same as the set you removed. Check the clearance as directed in (4) above. If clearance is too great, install the next smaller size gear set. If clearance is insufficient, install the next larger size set.

(6) Install the gear cover (para 4-7c).

(7) Install the valves and valve tappets (para 4-4c).

(8) Install the cylinder head (para 4-3c).

4-12. Cylinder Block

a. *Removal and Disassembly*. With the engine mounted on an engine overhaul stand, proceed as follows:

(1) Remove the cylinder head (para 4-3a).

(2) Remove the intake and exhaust valves (para 4-4b).

(3) Remove the oil pan (para 4-5a) and oil pump (para 4-6a).

(4) Remove the gear cover (para 4-7a).

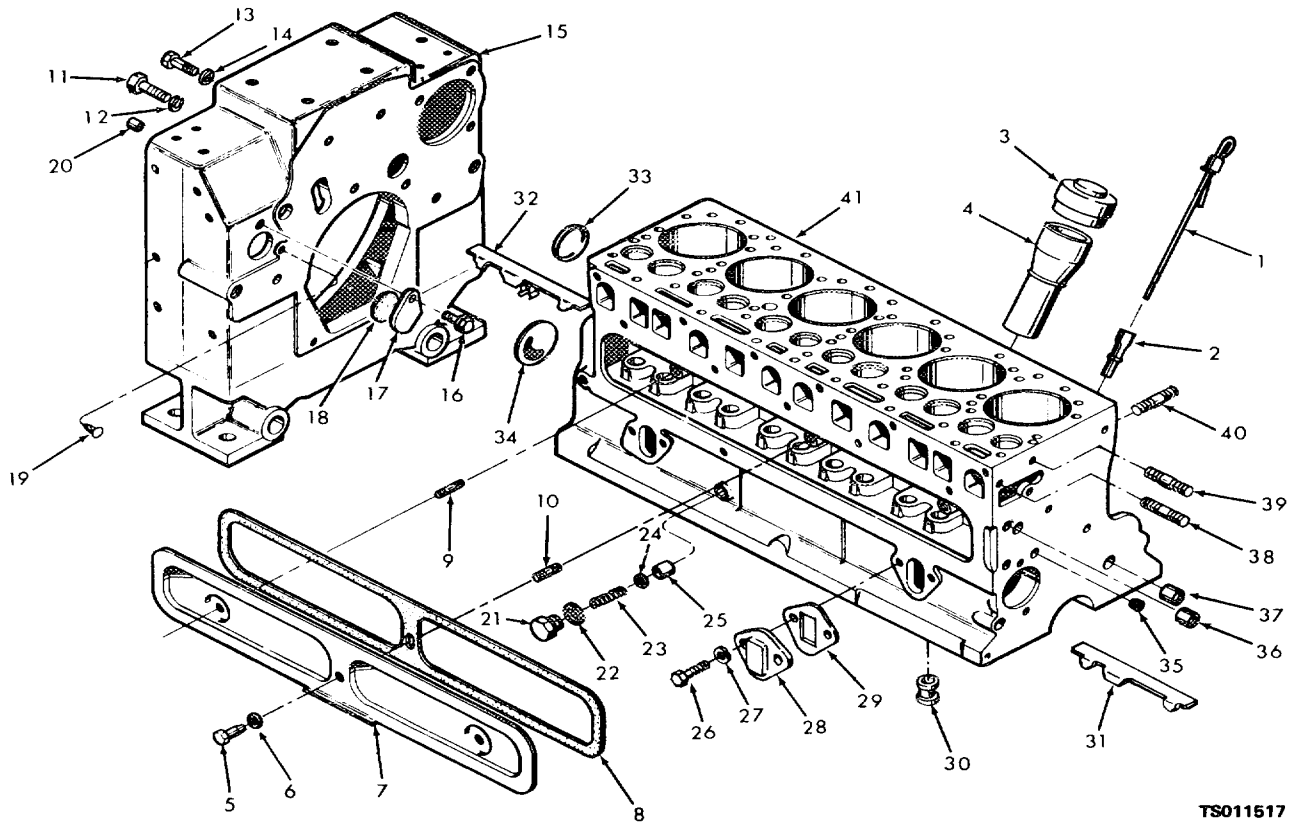
(5) Remove the flywheel and flywheel housing (para 4-8a).

(6) Remove the pistons and connecting rods (para 4-9a).

(7) Remove the crankshaft and main bearings (para 4-10a).

(8) Remove the camshaft (para 4-11a).

(9) Remove the oil gage rod (1, fig. 4-21) from the cylinder block, and remove the oil filler cap (3) from the oil filler nipple (4). If the oil gage rod support (2) or oil filler nipple is damaged, pull these parts from the cylinder block.



1. Oil gage rod
2. Oil gage rod support
3. Oil filler cap
4. Oil filler nipple
5. Cover nut
6. Gasket
7. Valve chamber cover
8. Gasket
9. Stud
10. Stud
11. Capscrew
12. Lockwasher
13. Shoulder screw
14. Lockwasher
15. Flywheel housing
16. Assembled washer screw
17. Timing hole cover
18. Felt
19. Drive screw pointer
20. Ring dowel
21. Plug
22. Gasket
23. Relief valve spring
24. Pressure adjusting washer
25. Oil pressure relief valve
26. Capscrew
27. Lockwasher
28. Cover
29. Gasket
30. Sleeve bearing
31. Baffle
32. Baffle
33. Core hole plug
34. Core hole plug
35. Oil header plug
36. Ring dowel
37. Ring dowel
38. Stud
39. Stud
40. Stud
41. Cylinder block

(10) Remove the cover nuts (5) and gaskets (6), from the studs (9 and 10). Remove the valve chamber cover (7) and gasket (8).

(11) Remove the screws (11 and 13) and lockwashers (12 and 14) that secure the flywheel housing (15) to the cylinder block; remove the flywheel housing. If the timing hole cover (17) or felt (18) is damaged, remove the attaching screw (16) and remove these pieces. Press out the drive screw pointer (19) and ring dowel (20) if they are damaged.

(12) Remove the plug (21) and gasket (22); remove the spring (23), washers (24), and oil pressure relief valve (25). Remove the two screws (26) and lockwashers (27) securing the cover (28) to the cylinder block. Remove the cover and gasket (29).

(13) Press out the sleeve bearing (30) if it is worn or damaged. Remove the baffles (31 and 32), plugs (33, 34, and 35), ring dowels (36 and 37), and studs (38,

39, and 40) to ensure that the cylinder block oil and coolant passages will be properly cleaned.

b. Cleaning

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(1) Remove dirt and grease deposits and all traces of old gasket material from flywheel housing (15, fig. 4-21), valve chamber cover (7) and cylinder block (41), using a putty knife, gasket scraper or wire brush and dry cleaning solvent (Fed. Spec. P-D-680). Steam-clean these pieces and boil out the block to remove deposits from the coolant passages. Blow out oil passages in the cylinder block and check that they are not restricted.

(2) Clean all other metal pieces with dry cleaning solvent (Fed. Spec. P-D-680), and allow all pieces to dry thoroughly before reassembly.

c. Inspection.

(1) Inspect the block for cracks, damaged sealing surfaces, scored or damaged bearing seats, scored or scratched cylinder walls, damaged threads, loose or damaged studs, corrosion in the water jacket, or other defects.

(2) Check piston fit in the cylinder bores (para 49c).

(3) Check cylinder bore wear with an inside micrometer. Measure the cylinder bore at 45° intervals below the travel of the lowest piston ring where the cylinder is not worn. Compare this measurement with a measurement taken about 1/4 inch (0.625 cm) below the top of the cylinder. The maximum allowable cylinder wear (the difference between these two measurements) is 0.008 inch (0.0200 cm).

(4) Replace the block if it is cracked, or if defects cannot be repaired. Replace loose or damaged studs. Retap damaged threads. If a proper piston fit cannot be attained (para 4-9c), the cylinders are scratched or scored, or cylinder wear exceeds 0.008 inch, replace the cylinder block.

(5) Inspect the front end plate for cracks and distortion. Remove any burrs with a fine stone.

(6) Inspect the oil pressure relief valve for scoring, wear, and other damage. Inspect the spring for cracks and misalined coils. Replace damaged oil pressure regulator parts.

d. Reassembly.

(1) Reassembly is the reverse of removal and disassembly. Refer to figure 4-21.

(2) When installing the front end plate (19, fig. 48), tighten the 3/8-inch bolts to 25 to 30 foot-pounds (3.457 to 4.149 kgm) torque and tighten the 7/16-inch bolts to 50 to 55 foot-pounds (6.915 to 7.606 kgm) torque.

(3) Install the camshaft (para 4-11c).

(4) Install the crankshaft and main bearings (para 4-10c).

(5) Install the pistons and connecting rods (para 4-9c).

(6) Install the flywheel and flywheel housing (para 4-8c).

(7) Install the gear cover (para 4-7c).

(8) Install the oil pump (para 4-6c) and oil pan (para 4-5c).

(9) Install the intake and exhaust valves (para 44d).

(10) Install the cylinder head (para 4-3c).

(11) See paragraph 3-15 for oil pressure adjustment procedure.

CHAPTER 5
REPAIR OF CENTRIFUGAL PUMP ASSEMBLY

5-1. Description

a. The centrifugal pump assembly consists of the pump, bearing housing, and flexible coupling. The centrifugal pump is driven by the engine through a coupling which is secured to the impeller shaft. The impeller shaft is ball bearing mounted in the bearing housing. The impeller shaft extends into the pump housing which is bolted to the bearing housing. The open-type impeller is keyed to this end of the shaft so that it rotates with the shaft.

b. The impeller is enclosed in a close-fitting volute to provide efficient operation. The pump housing provides the suction and discharge ports. The pump housing has a replaceable wear plate. This wear plate is subjected to most of the internal pump wear.

c. Repair consists primarily of replacing the shaft seal and other damaged parts. Overhaul consists of complete teardown to allow inspection and, if necessary, replacement of all operating parts, including bearings, impeller, and wear plate. Repair can be done without removal of the entire pump assembly from the engine and chassis. Overhaul requires removal of the unit to a workbench.

5-2. Shaft Seal Replacement

Replace a leaking shaft seal as follows:

a. Remove the drain plug (1, fig. 5-1), and drain all fluid from the pump body.

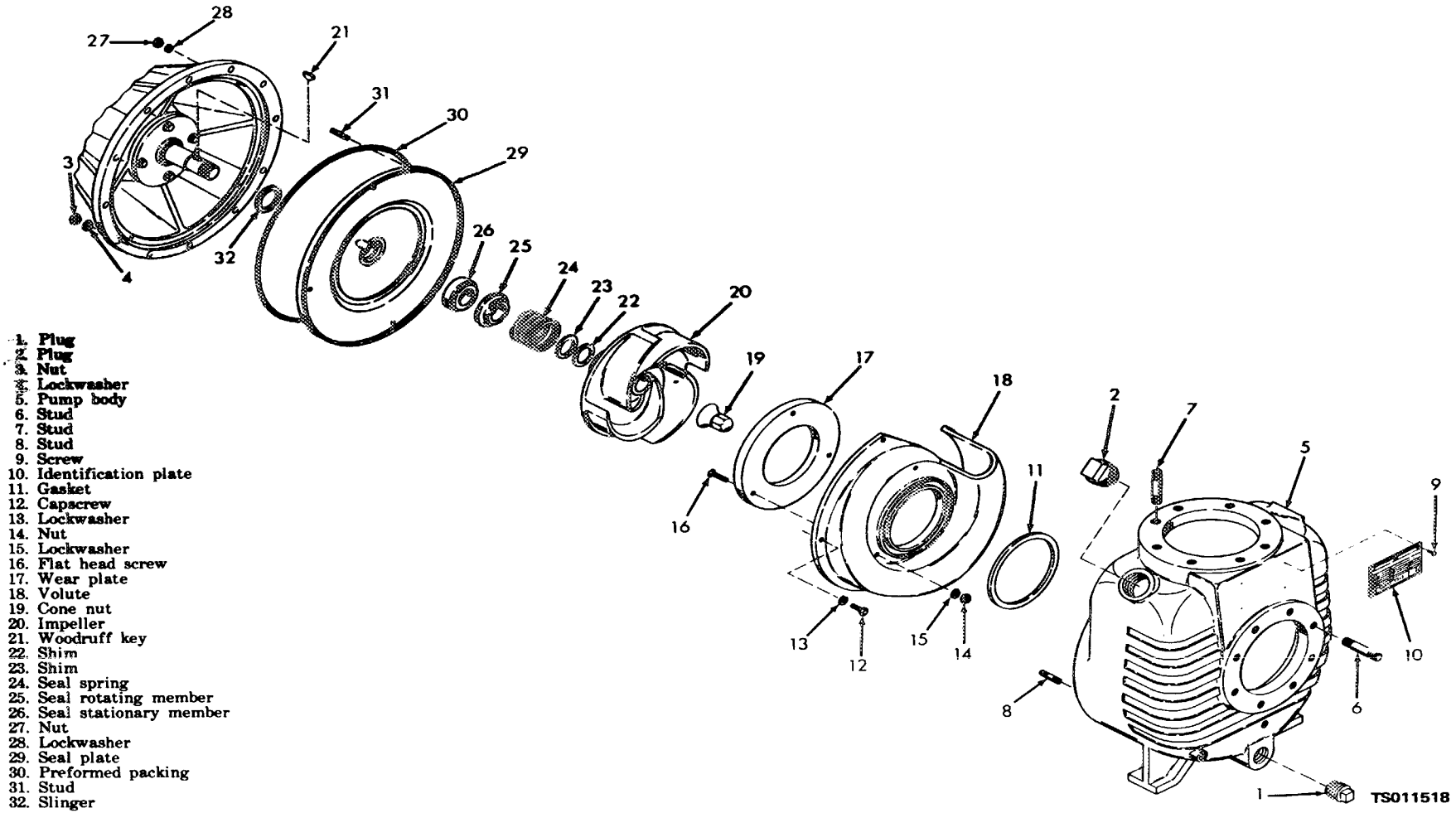


Figure 5-1. Centrifugal pump, exploded view.

b. Use a hoist or other lifting device to support the weight of the pump body (5). Remove the capscrews (6, fig. 2-1), nuts (4), and lockwashers (5), that secure the feet of the pump body to the chassis frame.
c. Remove the nuts (3, fig. 5-1) and lockwashers (4) that secure the pump body (5) to the bearing housing; slide the pump body straight out to disengage it from the remainder of the pump which is secured to the engine.
d. Remove the capscrews (12), and lockwashers (13), that secure the assembled volute (18) and wear plate (17) to the seal plate (29); remove the assembled parts.
e. Remove the cone nut (19) that secures the impeller (20) to the impeller shaft. Use a puller to pull the impeller from the shaft and remove the key (21). Temporarily install a plain hexagonal nut on the impeller shaft to protect the threads while pulling the impeller. Remove the shims (22 and 23), seal spring (24), and seal rotating member (25) from the shaft.
f. Remove the nuts (27) and lockwashers (28) that secure the seal plate (29) to the bearing housing; remove the seal plate with the assembled seal stationary member (26). Remove the seal stationary member from the seal plate.

NOTE

The seal members are not replaceable individually. When replacing the seal, be sure to replace all parts that are provided in the seal kit.

g. Install the seal stationary member (26) into the seal plate (29); install the seal plate on the bearing housing with nuts (27) and lockwashers (28).
h. Lubricate the inside diameter of the seal rotating member (25). Install the rotating member onto the shaft, and install the seal spring (24). Take care to prevent damage to the interior of the seal member during assembly, or premature failure will result. Also use extreme care to prevent damage to the contact faces, both the stationary and rotating seal members.
i. When installing the impeller (20), be sure you install shims (22 and 23) of the same thickness as those removed.
j. Reassemble the remainder of the pump by reversing the disassembly procedure. When installing the impeller nut (19) onto the impeller shaft, tighten the nut to 95 to 110 foot-pounds (13,138 to 15.213 kgm) torque. Block the impeller with a block of wood to prevent its rotation when you install the nut (19).

5-3. Centrifugal Pump Overhaul

a. *Disassembly*. Disassemble the pump following the sequence of index numbers in figure 5-1.
b. *Cleaning and Inspection*.

(1) Discard and replace all seals, gaskets, and packings.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(2) Clean all parts with cleaning solvent (Fed. Spec. P-D-680) and wipe dry.

(3) Inspect the pump body for cracks, loose or damaged studs, and for damaged threads. Clean up damaged threads with a thread die Replace any damaged studs. Replace the housing if damaged beyond repair.

(4) Inspect the wear plate for wear, scoring, and distortion. If any damage is evident, replace the wear plate.

(5) Inspect the volute for cracks, distortion, internal scoring, and wear; replace if damaged.

(6) Inspect the impeller for cracked, chipped, worn or broken vanes, damaged or distorted bore or keyway, and other damage; replace a defective impeller.

c. *Reassembly*. Reassemble the pump by reversing the disassembly sequence. Refer to figure 5-1. Note the following:

(1) Press the seal stationary member (26) into seal plate (29) before installing the plate. Lubricate the impeller shaft lightly with oil and slide the seal rotating member (25) and spring into place on the shaft.

(2) If the same impeller (20) and wear plate (17) are reassembled and no clearance change is indicated, use shims (22 and 23) of the same thickness as those removed. If a new impeller and/or wear plate is installed, determine the shim thickness required to obtain a clearance of 0.010 to 0.020 inch (0.025 to 0.050 cm) between the impeller and wear plate as follows:

(a) Install impeller (20) on shaft without shims. Be sure that impeller is seated firmly against the shaft shoulder.

(b) Install volute (18) with wear plate (17) assembled, and secure with screws (12) and lockwashers (13).

(c) Insert a feeler gage into the front opening of the volute and measure from the face of the impeller (20) to the face of the wear plate (17).

(d) Select shims (22 and 23) to equal the dimension obtained less 0.010 to 0.020 inch (0.025 to 0.050 cm) for clearance.

(3) After assembly, when using either new or used parts, recheck the clearance; it must be 0.010 to 0.020 inch (0.025 to 0.050 cm). Check the impeller shaft for free rotation. It must turn freely without catching or binding. If binding is evident, disassemble the pump and correct the condition.

(4) Install the assembled pump and bearing housing onto the engine and chassis (para 2-9).

5-4. Bearing Housing

a. Disassembly.

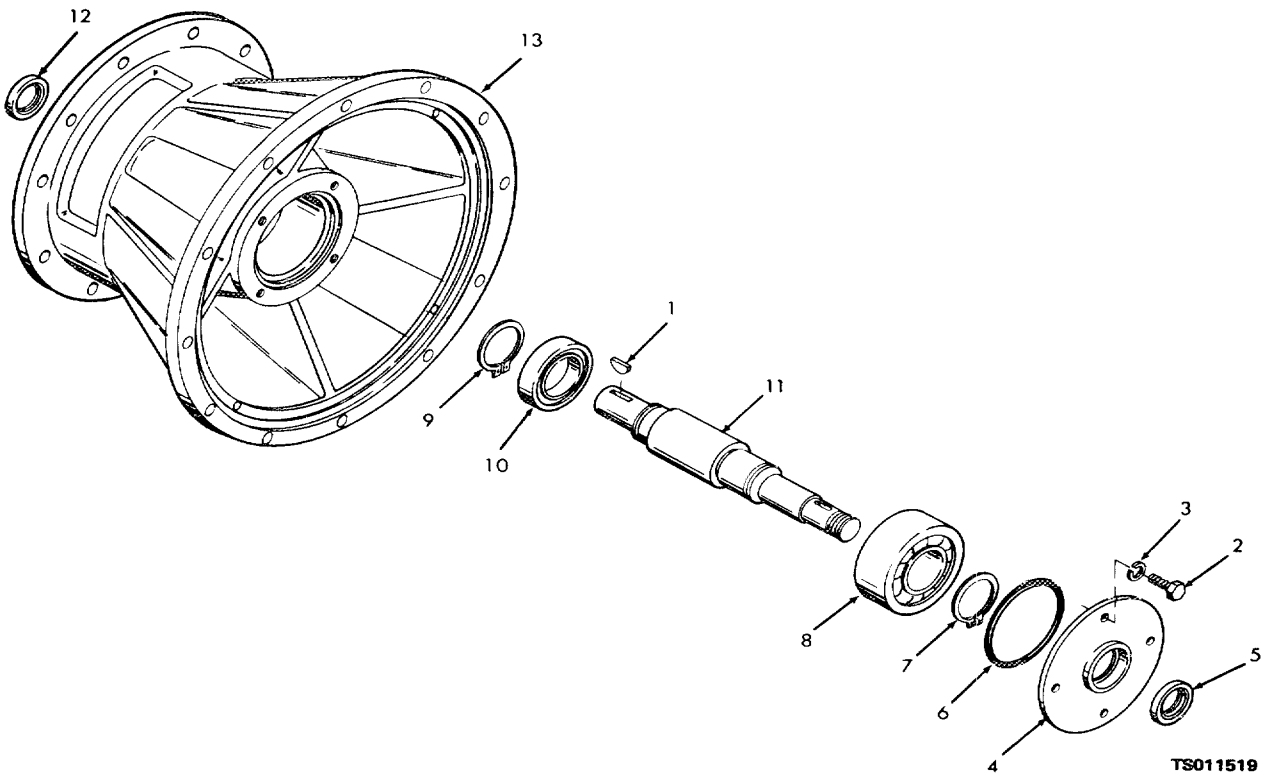
NOTE

It is easier to disassemble the pump parts from the engine than it is to remove the entire pump assembly before starting disassembly. If the pump is mounted on the engine, disassemble it per paragraph 5-2 for seal replacement. Then remove the bearing housing from the engine and disassemble it. If the pump assembly was removed from the engine per paragraph 2-9, proceed as directed below.

(1) Remove the assembled pump and bearing housing from the engine and chassis (para 2-9).

(2) Disassemble the centrifugal pump from the bearing housing (para 5-3).

(3) Disassemble the bearing housing assembly in the sequence indicated in figure 5-2.



1. Woodruff key
2. Capscrew
3. Lockwasher
4. Bearing cap
5. Grease seal
6. Preformed packing
7. Retaining ring
8. Ball bearing
9. Retaining ring
10. Ball bearing
11. Impeller shaft
12. Grease seal
13. Bearing housing

Figure 5-2. Bearing housing, exploded view.

b. Cleaning and Inspection.

(1) Discard and replace all seals, gaskets, and packings.

(2) Clean the ball bearings as directed in paragraph 2-7.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use

near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(3) Clean all remaining parts with cleaning solvent (Fed. Spec. P-D-680); dry thoroughly.

(4) Inspect the ball bearings for scored balls or races, cracked races, signs of overheating, and binding operation; replace damaged bearings.

(5) Inspect the impeller shaft for distortion, worn or damaged bearing seats, and damaged retaining ring grooves, keyways, and threads. You can clean up damaged retaining ring grooves or keyways with a fine stone. Repair damaged threads with a thread chaser. Replace the shaft if it is damaged beyond repair.

(6) Inspect the bearing housing for cracks, distortion, and scored or burred bearing seats. Remove nicks or burrs from the bearing seats with a fine stone. Clean up damaged threads with a thread die. Replace a damaged bearing housing.

c. Reassembly. Reassemble the bearing housing assembly by reversing the disassembly sequence. Refer to figure 5-2. Note. the following:

(1) Press bearings (8 and 10, fig. 5-2) onto the impeller shaft (11). If bearings slide onto the shaft by hand, they are too loose and the bearings and/or shaft must be replaced. Secure bearings to the shaft with retaining rings (7 and 9).

(2) Press grease seal (12) into the bearing housing (13) and grease seal (5) into the bearing cap (4) before installing the shaft and bearings in the bearing housing.

(3) Pack the bearings and bearing cap with MIL-G-10924 grease; pack the area between the bearings in the bearing housing three-fourths full of the same grease.

(4) Press the shaft and assembled bearings into the housing until the bearings are seated. Install the preformed packing (6) and bearing cap (4). Secure the bearing cap with the capscrews (2) and lockwashers (3), tightening them evenly in increments until all are secure.

(5) If the pump is to be mounted onto the engine immediately, it is easier to first mount the assembled bearing housing onto the engine, and then assemble the remaining pump parts to the bearing housing. If pump assembly is to be assembled completely for later mounting onto the engine, proceed as directed in steps (6) and (7) below.

(6) Reassemble the centrifugal pump on the bearing housing (para 5-3).

(7) Install the assembled pump and bearing housing on the engine and chassis (para 2-9).

5-5. Pump Performance Test

After the centrifugal pump has been repaired or overhauled, connect the pump into a petroleum products pump flow test setup to check pump output. Provide adequate supply and discharge facilities. Install a flowmeter in the discharge line. Fill the pump body with pumping fluid. With the engine warmed up and operating at 2600 rpm, the centrifugal pump must meet the following performance requirements:

a. The pump shall prime in not more than 1 minute when subjected to a static suction lift equivalent to 10 feet using 15 feet of suction line and one elbow.

b. The pump shall deliver not less than 980 to 1000 GPM at 60 feet total head.

c. After conducting tests a and b above, test the pump check valve. Shut off the pump and allow it to set for not less than 30 minutes. Restart the pump and determine if the pump immediately primes. Immediate prime is an indication that the valve prevents siphoning of fluid from the pump case and is, therefore, in good condition.

d. Check the suction and pressure gages against master gages to verify their accuracy. Output gage reading must correspond with master gage readings to within 5 percent of scale reading.

CHAPTER 6
REPAIR OF CHASSIS

6-1. Description

a. The chassis assembly is primarily a welded frame consisting of two longitudinal channels separated by a series of angle and channel crossmembers. The angles and channels provide support for mounting the pump, engine, fuel tank, storage boxes, and remaining components of the pumping assembly. A drop-down front leg and two adjustable rear stands provide rigid support for the chassis. Chock blocks are also stored on the chassis frame.

b. The axle and suspension system is mounted to the underside of the chassis frame. The suspension system consists of two shock absorbers and leaf springs.

6-2. Axle and Suspension System

a. Removal and Disassembly.

(1) Jack up and block the chassis frame so that the tires barely touch the floor.

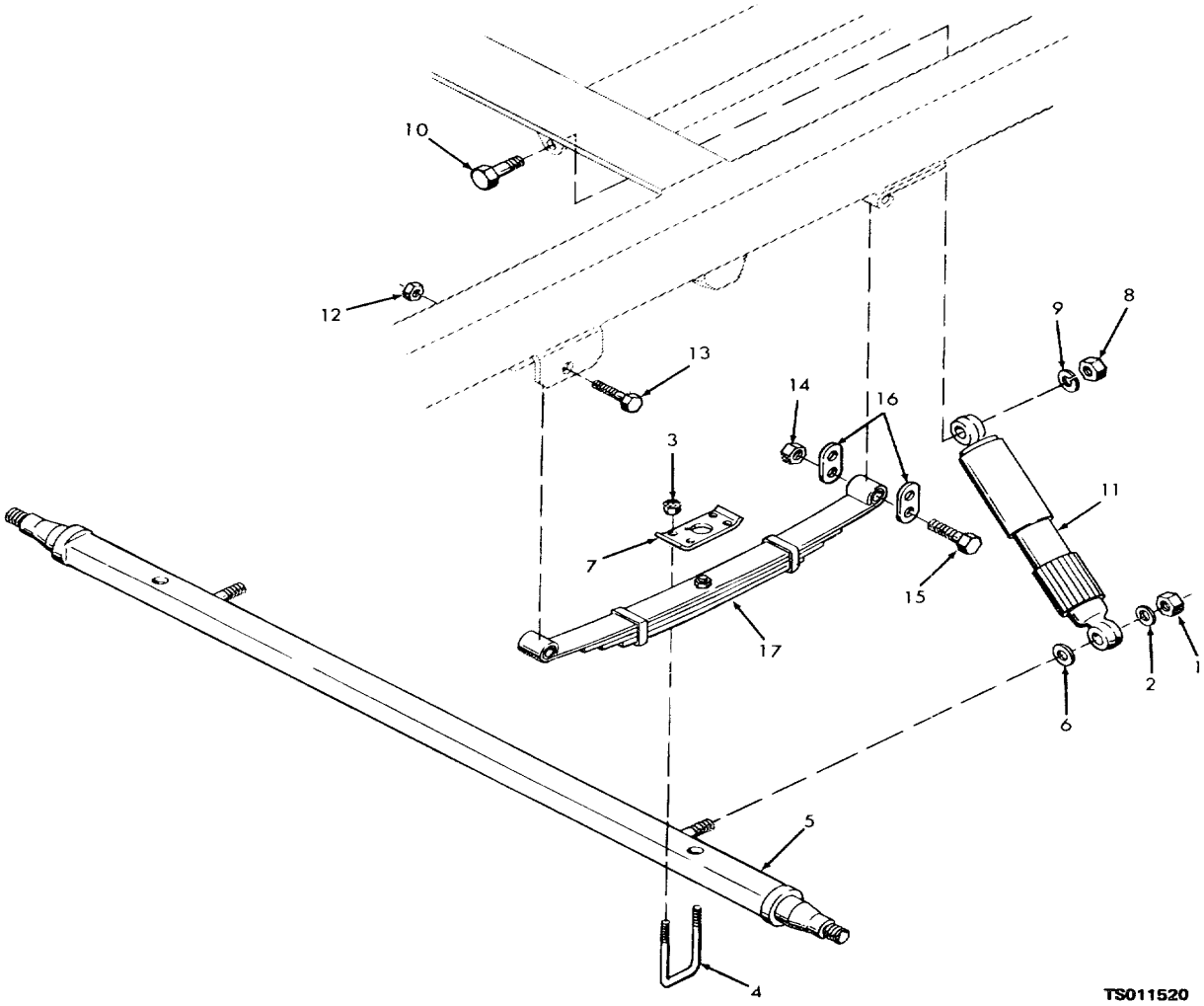
(2) Remove the tires and tubes (TM 5-4320-234-12, para 4-51).

(3) Remove the wheel and hub assemblies (TM 5-4320-234-12, para 4-52).

WARNING

Make sure that you support the axle properly before removing the securing hardware, or injury to personnel may result.

(4) Remove the nuts (1, fig. 6-1) and washers (2) securing the axle to the shock absorbers (11).



1. Nut
2. Washer
3. Nut
4. U-bolt
5. Axle
6. Washer
7. Plate
8. Nut
9. Lockwasher
10. Capscrew
11. Shock absorber
12. Nut
13. Capscrew
14. Nut
15. Capscrew
16. Shackle links
17. Spring

Figure 6-1. Axle and suspension system, exploded view.

(5) Remove the nuts (3) and U-bolts (4) securing the axle (5) to the leaf springs; remove the axle.

(6) Remove the nuts (8), lockwashers (9), and capscrews (10) that mount the upper ends of the shock absorbers to the chassis frame; remove the shock absorbers.

(7) Remove the leaf springs (17) by removing nuts (12 and 14), capscrews (13 and 15), and shackle links (16).

b. Cleaning and Inspection.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of

skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(1) Clean the shock absorbers with a cloth dampened with cleaning solvent (Fed. Spec. P-D-680). Wipe dry.

(2) Steam-clean the axle and springs. If steam cleaning equipment is not available, flush the parts with a water-pressure hose. Remove greasy and gummy deposits with cleaning solvent.

(3) Clean all remaining parts with cleaning solvent; dry thoroughly.

(4) Inspect all parts for rust, corrosion, chipped paint, and distortion. Remove rust and corrosion with a metal scraper and wire brush. Prime and paint bare surfaces.

(5) Inspect the axle for cracks, distortion, or damaged threads. Inspect the axle spindle ends for scored or damaged bearing surfaces. Replace a damaged axle.

(6) Inspect the springs for cracked or broken leaves, distortion, or fatigue. Replace damaged or weak springs.

(7) Inspect the shock absorbers for distortion, missing or damaged bushings, leaking, and other damage. Check that the compression stroke resistance is sufficient. Replace worn or damaged shock absorbers.

c. Reassembly and Installation. Reassembly and installation is essentially the reverse of removal and disassembly. Refer to figure 6-1. Note the following:

(1) The leaf spring can be installed with either end toward the front of the chassis.

(2) Make sure you install the shock absorbers with the proper end up.

(3) Remove blocking and lower unit to the ground. Rock the unit on its springs to check for free spring movement and for proper dampening of spring movement by the shock absorbers.

6-3. Chassis Frame

a. Removal and Disassembly.

(1) Remove the pump and bearing housing assembly (para 2-9).

(2) Remove the engine (para 2-11).

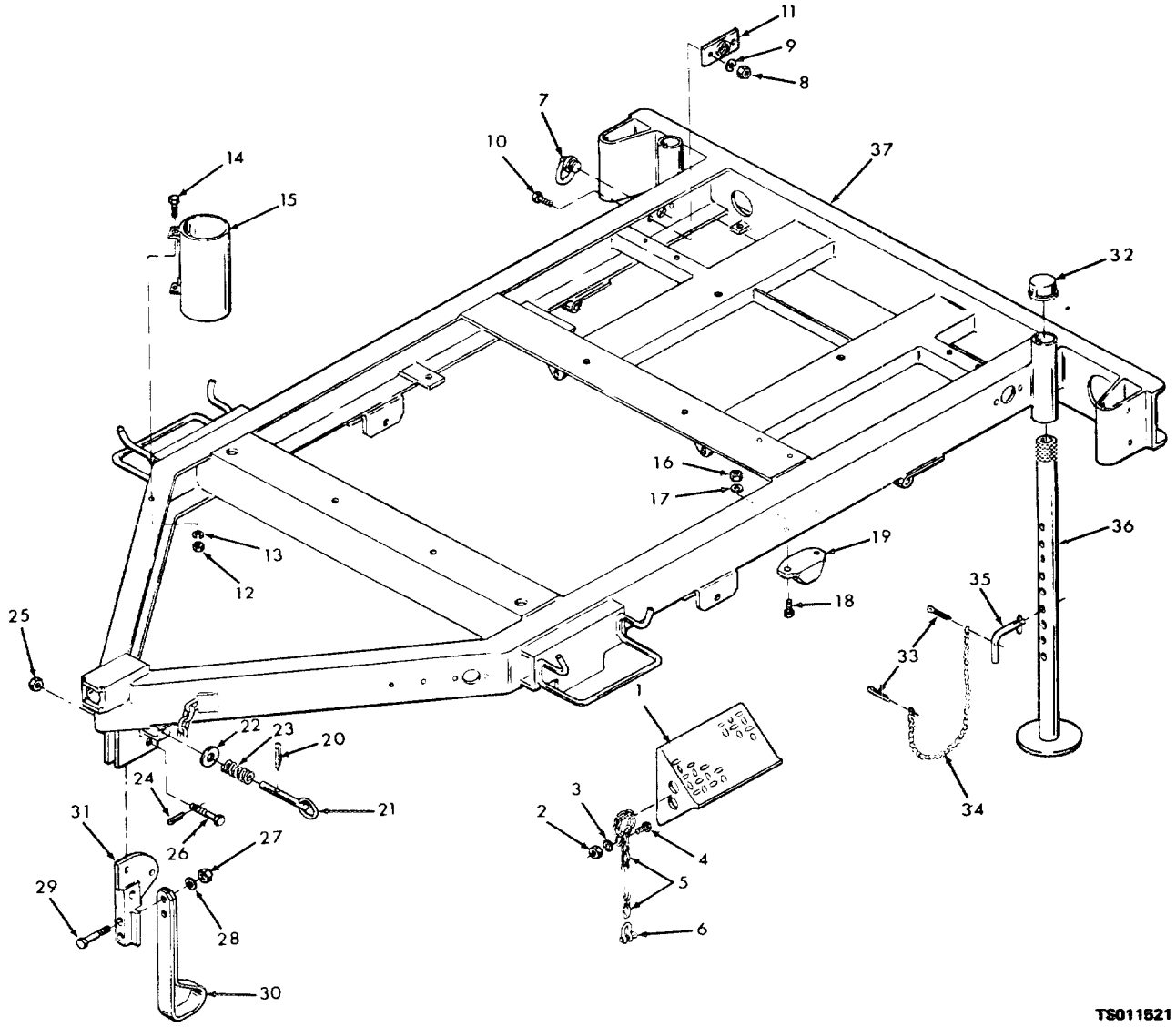
(3) Remove the battery box and tool box (TM 5-4320-234-12, para 4-54).

(4) Remove the fuel tank (TM 5-4320-234-12, para 4-22).

(5) Remove the wheel and hub assemblies (TM 5-4320-234-12, para 4-52).

(6) Remove the axle and suspension system (para 6-2).

(7) With the chassis frame supported on blocks, disassemble the chassis in the sequence indicated in figure 6-2.



1. Chock block
2. Nut
3. Lockwasher
4. Capscrew
5. Chain
6. Shackle
7. Tie down ring
8. Nut
9. Lockwasher
10. Capscrew
11. Plate nut
12. Nut
13. Lockwasher
14. Capscrew
15. Plug holder
16. Nut
17. Lockwasher
18. Capscrew
19. Bumper
20. Cotter pin
21. Locking pin
22. Washer
23. Spring
24. Cotter pin
25. Nut
26. Capscrew
27. Nut
28. Lockwasher
29. Capscrew
30. Leg
31. Bracket
32. Cap
33. Cotter pin
34. Chain
35. Locking pin
36. Stand
37. Frame

Figure 6-2. Chassis frame, exploded view.

b. Cleaning and Inspection.

WARNING

Clean all parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. to 138 F. (38 C. to 59 C.).

(1) Steam-clean the chassis frame and its related parts. If steam-cleaning equipment is not available, flush off the chassis frame with a water-pressure hose. Remove greasy and gummy deposits with cleaning solvent (Fed. Spec. P-D-680).

(2) Inspect spring bumpers (19, fig. 6-2) for cracks, wear, and deterioration; replace if defective.

(3) Check the fit of the stands (36) in the sleeves mounted on the frame. The stands must slide easily through the sleeves.

(4) Inspect the front leg (30) and related parts for distortion, cracks, and damage. Minor straightening of the leg is permitted. Replace defective parts and parts damaged beyond repair.

(5) Be sure that all remaining parts are present and in good condition. Replace any missing or damaged parts.

(6) Inspect the chassis frame for cracks, distortion, or broken weldments. Minor straightening of the frame is permitted. Repair cracked weldments using arc welding methods. Replace the frame if it is severely damaged.

(7) If paint is damaged in any way, remove damaged paint and sand the areas smooth. Prime and repaint the bare areas.

c. Reassembly and Installation.

(1) Reassemble the chassis frame as shown in figure 6-2.

(2) Install the axle and suspension system (para 6-2).

(3) Install the wheel and hub assembly (TM 5-4320-234-12, para 4-52).

(4) Install the engine (para 2-11).

(5) Install the pump and bearing housing (para 2-9).

(6) Install the battery box and tool box (TM 5-4320-234-12, para 4-54).

(7) Install the fuel tank (TM 5-4320-234-12, para 4-22).

APPENDIX A
REFERENCES

A-1. Fire Protection

TM 5-4200-200-10	Hand Portable Fire Extinguishers for Army Users

A-2. Lubrication

C91001L	Fuel, Lubricants, Oils and Waxes
LO 5-4320-234-12	Pumping Assembly and Engine Lubrication Order

A-3. Painting

TM 9-913	Painting Instructions for Field Use

A-4. Radio Suppression

TM 11-483	Radio Interference Suppression

A-5. Maintenance

TM 9-1870-1	Care and Maintenance of Pneumatic Tires
TM 5-4320-234-20P	Organizational Maintenance Repair Parts and Special Tools List, Centrifugal Pump
TM 5-4320-234-12	Operator and Organizational Maintenance Manual, Centrifugal Pump
TM 5-4320-234-34P	Direct Support and General Support Maintenance Repair Parts and Special Tools List, Centrifugal Pump
TM 38-750	Army Equipment Record Procedures

A-6. Shipment and Storage

TM 740-90-1	Administrative Storage

A-7. Destruction to Prevent Enemy Use

TM 750-244-3	Procedures for Destruction of Equipment to Prevent Enemy Use

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