T. O. 38G2-39-3

HANDBOOK
OVERHAUL INSTRUCTIONS

PACKETTE
MODEL PE 150-6

(CONTINENTAL MOTORS CORPORATION)

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

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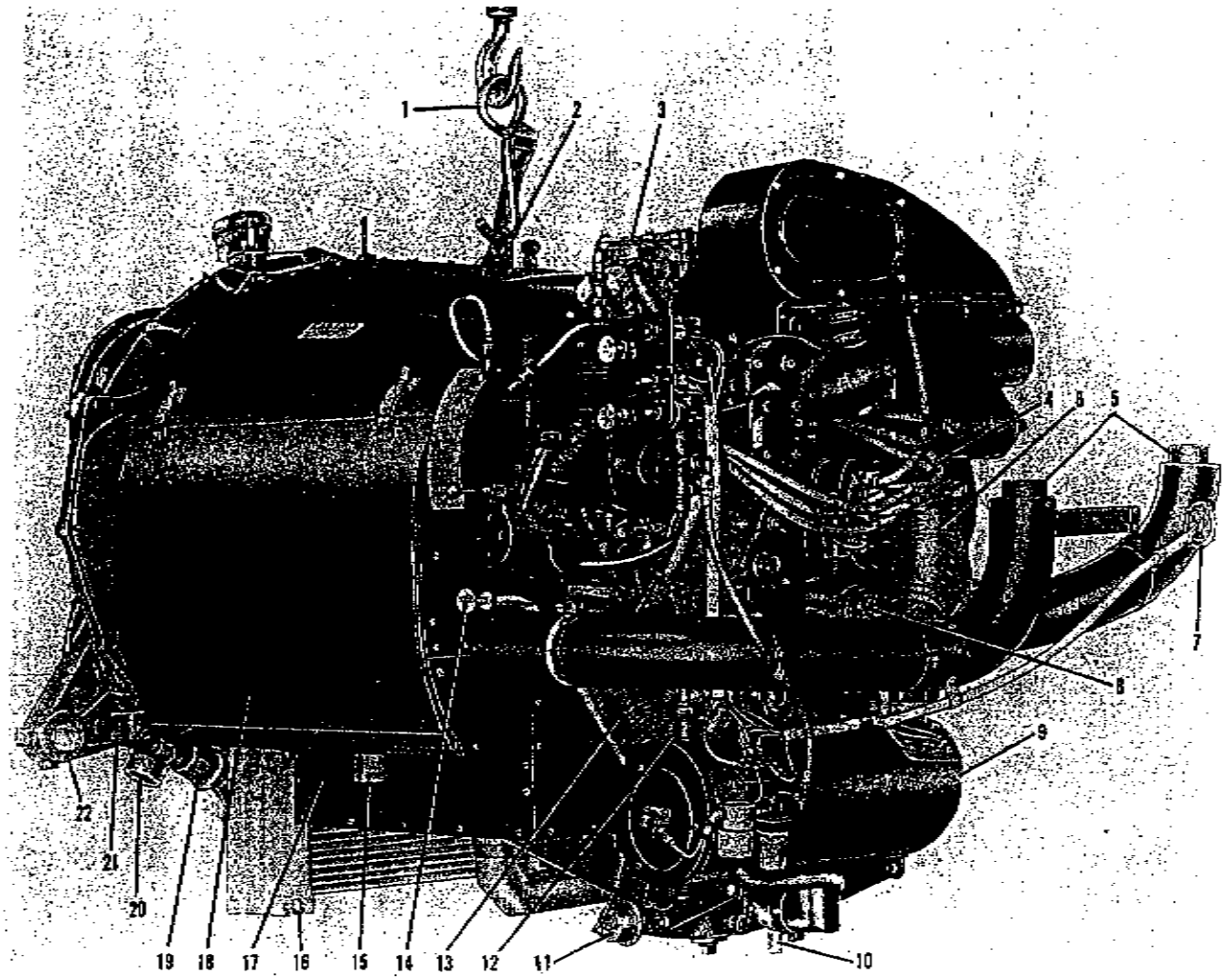
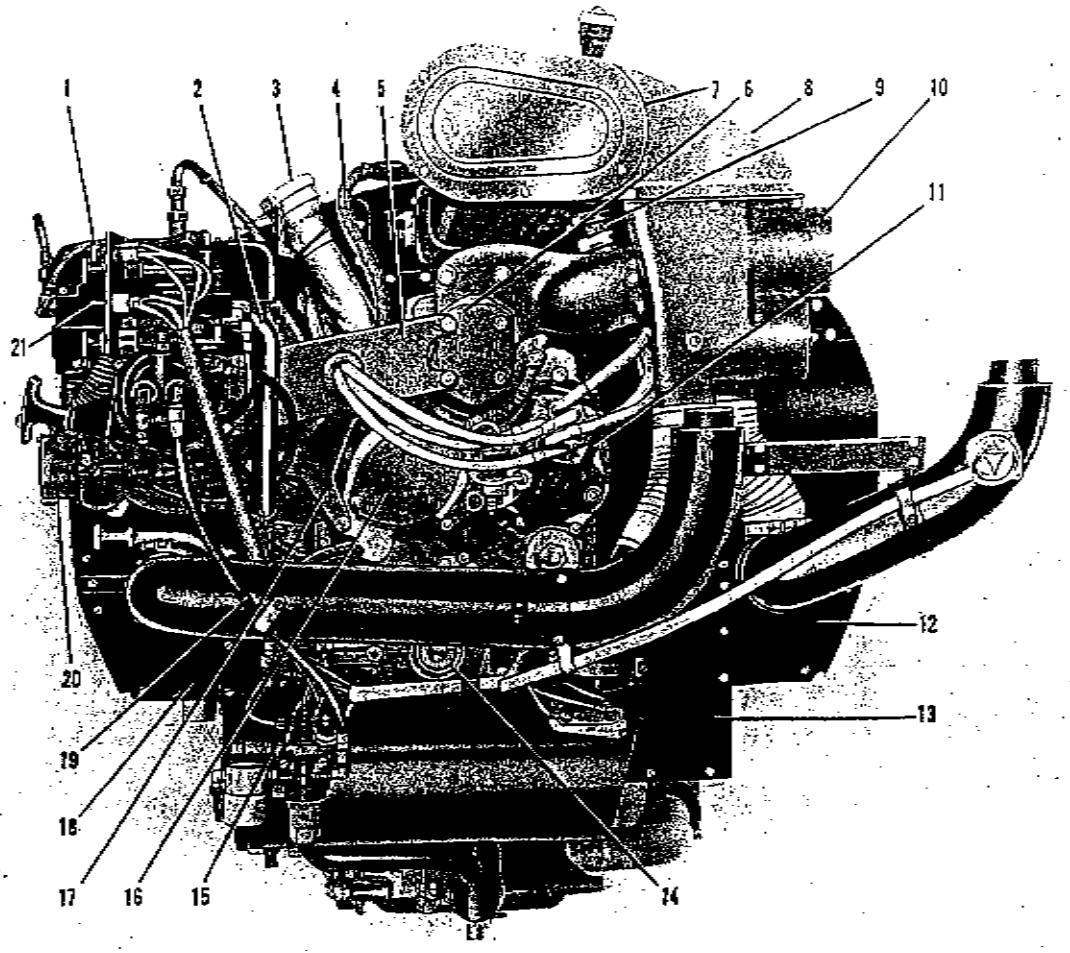


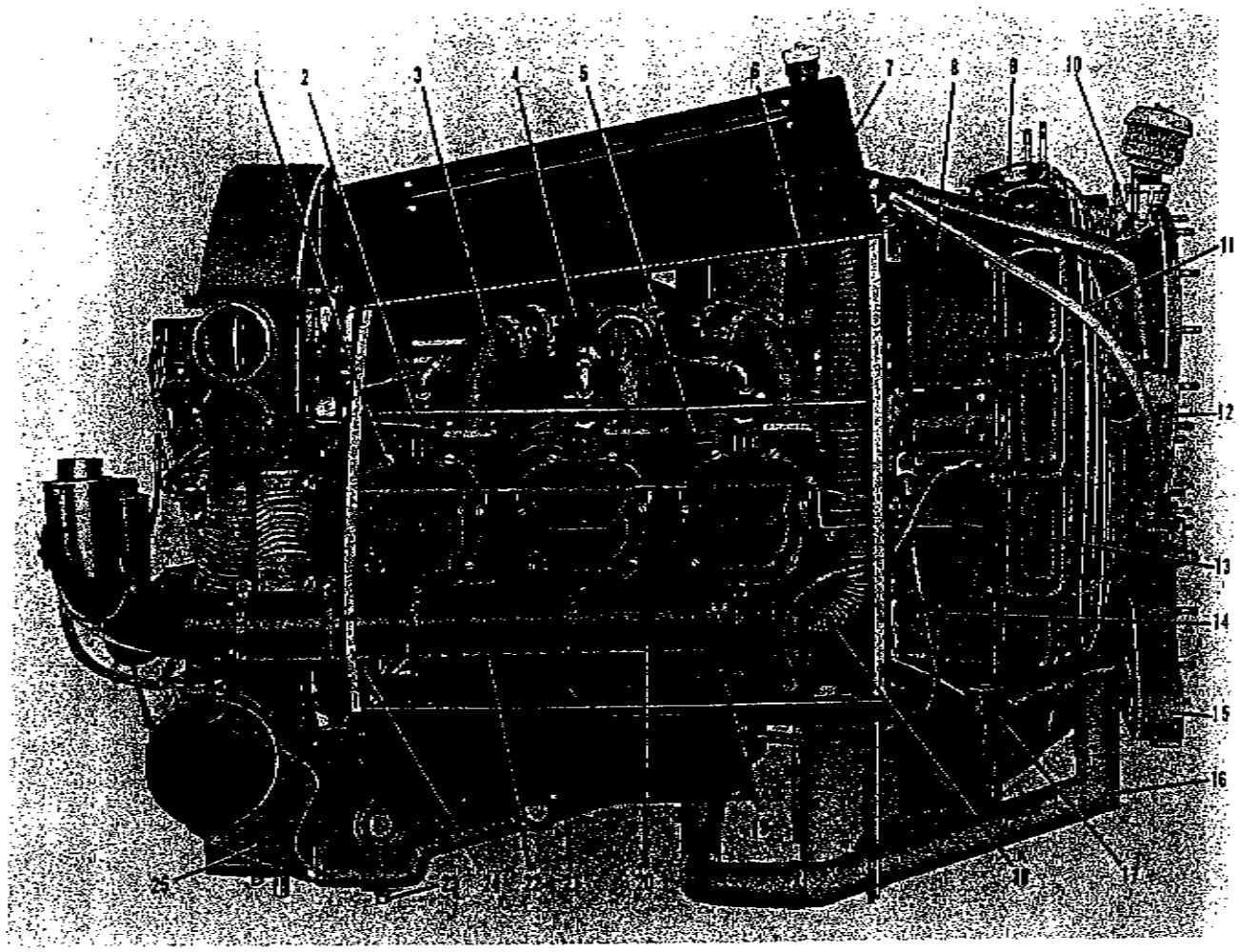
1. Hook
2. Eye
3. Carburetor
4. Conduits
5. Pipes and jackets
6. Duct
7. Switch
8. Oil filter
9. Heater
10. Tube
11. Switch
12. Plug
13. Duct
14. Oil level gauge
15. Duct connection
16. Oil cooler
17. Panel
18. Panel
19. Unit
20. Exhaust gas outlet
21. Boss
22. Boss

Figure 1-1. Three-Quarter Left Rear View of Model PE150-6 Packette



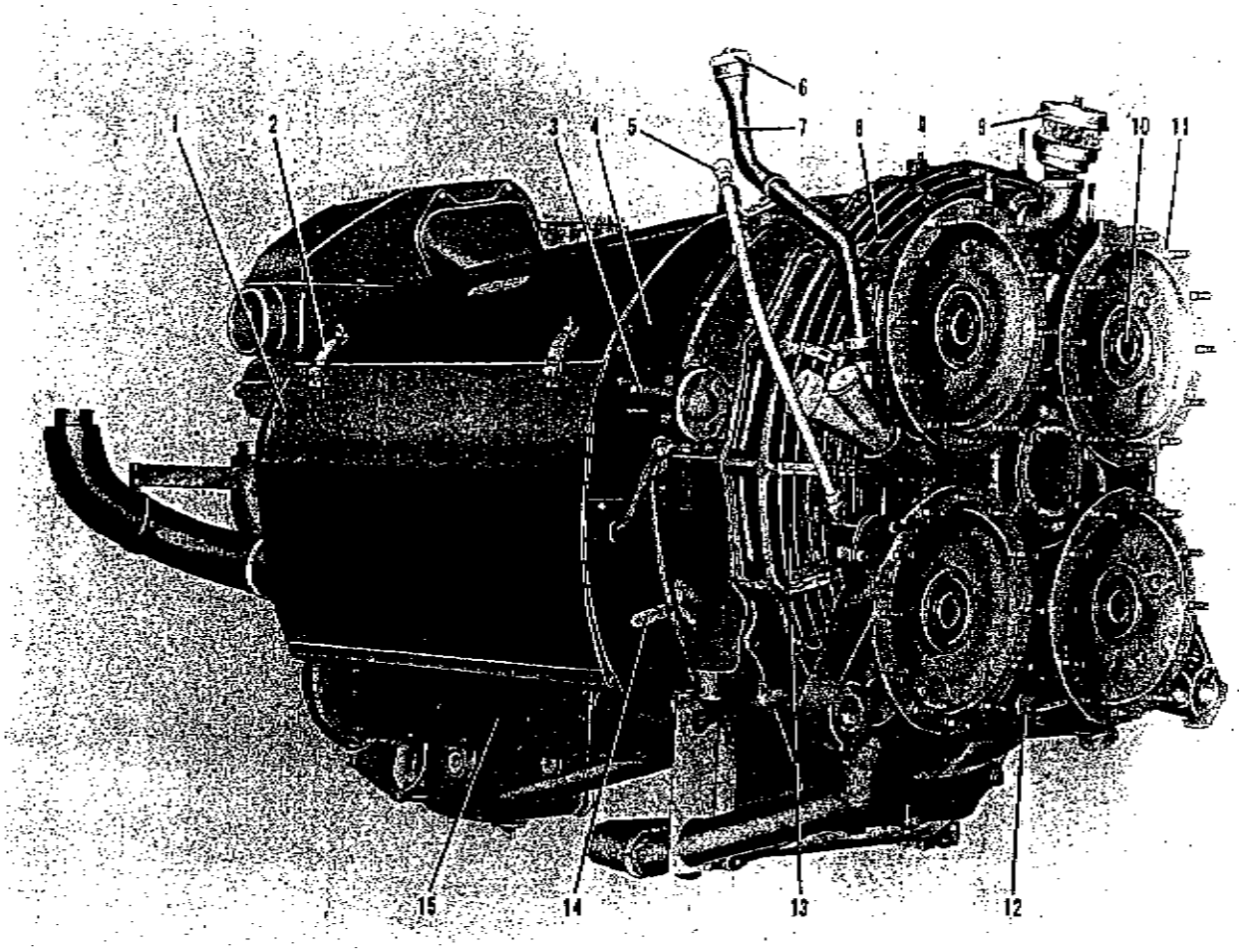
1. Lamp
2. Exhaust pipe
3. Oil filler cap
4. Fuel hose
5. Bracket
6. Cover
7. Air filter
8. Housing
9. Hose connector
10. Housing
11. Magneto
12. Panel adapter
13. Panel
14. Adapter
15. Terminal block
16. Adapter
17. Bracket
18. Adapter
19. Hose
20. Blower engine
21. Heater switch

Figure 1-2. Rear View of Model PE150-6 Packette



1. Cover
2. Rod
3. Intake Tube
4. Intake manifold
5. Cylinder
6. Flexible duct
7. Top panel and access door assembly
8. Housing
9. Inlet and gear housing
10. Housing
11. Gauge support tube
12. Adapter
13. Cable
14. Cable
15. Boss
16. Tube assembly
17. Boss
18. Duct
19. Starter
20. Jacket
21. Oil sump
22. Cap
23. Oil sump drain plug
24. Strip
25. Bracket

Figure 1-3. Right Side View of Model PE150-6 Packette



1. Detachable panel
2. Latch
3. Magnetic switch
4. Panel
5. Oil gauge knob
6. Oil filler cap
7. Oil filler tube
8. Shield
9. Gear case heat outlet filter
10. Splined shaft
11. Generator mount pads
12. Oil drain plug
13. Flywheel and fan assembly
14. Detent lever
15. Bottom side panel

Figure 1-4. Three-Quarter Right Front View of Model PE150-6 Packette

SECTION I
INTRODUCTION

1-1. SCOPE.

1-2. This publication comprises the overhaul instructions for the model PE150-6 packettes manufactured by Continental Motors Corporation, Muskegon, Michigan.

1-3. TERMS.

1-4. Terms used in these instructions are as follows:

a. After Top Center (A.T.C.): Positions of piston and crankpin after passing outward end of stroke.

b. Backward Rotation: In direction opposite normal operation.

c. Before Top Center: Piston and crankpin positions on outward stroke, before reaching Top Dead Center.

d. Bottom (or lower side): Normally refers to positions on downward side of engine or part in installed position. Also, toward open (skirt) end of cylinder.

e. Forward Rotation: Normal operation direction.

f. Front: Flywheel end of engine.

g. Outward (or outer): Positions and directions away from the center of the engine and its assemblies, when in operating position.

h. Rear: Accessory drive end of engine.

i. Right Side: Determined when the engine is viewed from the rear.

j. Top: Normally positions on upward side of engine and its assemblies when in normal operating position. Also indicates outer, or head end of cylinders.

k. Top Dead Center: Piston and crankpin position at outward end of stroke.

l. Clockwise: Same direction of rotation as hands of clock when rotating part is viewed from rear end of engine. Counterclockwise direction is opposite.

1-5. CUSTOMERS' STOCKLISTS.

1-6. In order to adapt them to the control and construction requirements of the various vehicles and other machines in which they may serve as primary or auxiliary power plants, model PE150-6 packettes are supplied to manufacturers of such equipment and to the Air Force with different combinations and extent of engine driven accessories, instruments, controls and/or shipping equipment. Each such combination of optional equipment is described in a "customer's stocklist", which is numbered by the packette manufacturer and used by his assembly and shipping personnel. The appropriate customer's stocklist number is stamped, at the factory, on each packette identification plate in a space immediately above the Air Force acceptance stamp. *(See figure 1-5.)* The customer's stocklist number provides a means of identification of packettes (and their shipping crates if stenciled thereon after each overhaul) and of determination of their suitability for installation in specific machines. This system is followed, in preference to differentiation by model number, because any basic packette can be converted to any customer's stocklist by addition, removal or exchange of externally attached accessories and shipping equipment.

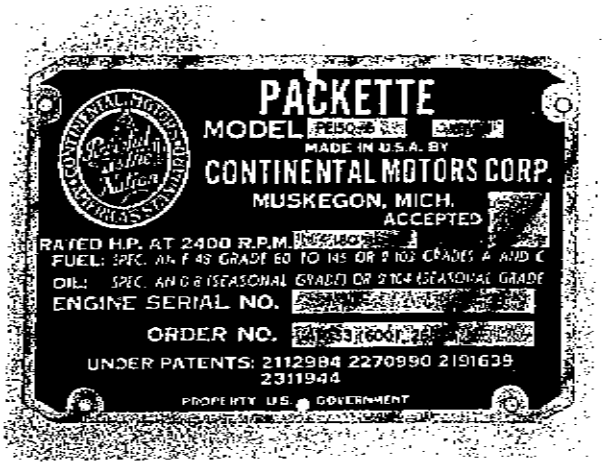


Figure 1-5. Identification Plate

1-7. The packette manufacturer recommends that the appropriate customer's stocklist number be stamped on the identification plate and the original number obliterated whenever a packette is rebuilt to a different customer's stocklist. He further recommends that shipping boxes of rebuilt packettes be marked for identification purposes by stenciling the model number and the appropriate customer's stocklist number on the side panels in a standard location. To enable such marking, the following table summarizes the distinguishing features of each customer's stocklist and its application.

Customer's Stocklist No.	*Equipment Added*	*Equipment Omitted*	*Product for Which Packette is Equipped*
1	*Generator Gear case (Equip. 5506) Shipping kit (Equip. 5510)	None	MD-3 mobile generator set

*Also supplied separately as a spare assembly. (Refer to Illustrated Parts Breakdown, T. O. 38G2-39-4.)

1-8. CYLINDER ARRANGEMENT.

1-9. Numbers 1, 3 and 5 cylinders are attached to the right side of the crankcase and numbers 2, 4 and 6 to the left side. The cylinder positions, as seen from above, are illustrated in figure 1-6.

1-10. MEASUREMENT.

1-11. In these instructions frequent reference is made to Table of Limits, Section XII. Use the tables in that section to determine whether any clearance or tightness measured with a micrometer, dial gauge or thickness gauge is acceptable.

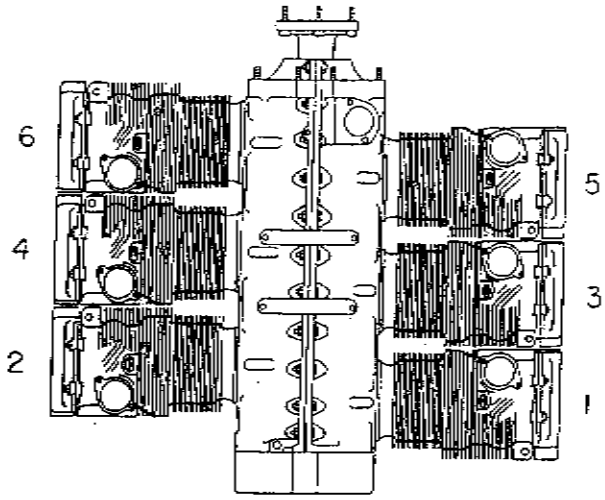


Figure 1-6. Cylinder Arrangement Diagram (Top View)

SECTION II
GENERAL DESCRIPTION

2-1. CONSTRUCTION.

2-2. The PE150-6 packette is a compact power unit built around a standardized type of light weight, air cooled, internal combustion engine with horizontally opposed cylinders and an integral (wet sump) lubrication system. This model has a high degree of parts interchangeability with other models in the "PE" series. It is adapted specifically for the type MD-3 air portable generating plant by a special fan inlet and gear housing at the front end with mount pads for four electric generators. The fan outlet housing and shroud enclose the crankcase, cylinders and the upper part of the oil sump. The two front mount bosses are part of the fan inlet and gear housing, and two rear mounting brackets are attached to the sides of the crankcase. The lifting eye is attached to the crankcase upper flange ahead of the intake manifold. The crankcase is split vertically through the crankshaft and camshaft bearings and the halves are held together by through bolts and top and bottom flange bolts. Cylinders are attached to crankcase through bolts and studs. Overhead valves are seated by two springs each and turned slightly each cycle by roto caps which are depressed by rockers pivoted on full floating shafts. Pushrods are enclosed in removable housings below the cylinders and actuated by zero lash hydraulic valve lifters in the crankcase.

2-3. GEAR TRAINS. *(See figure 2-1.)*

2-4. The accessory drive gear (20) is attached to the rear end of the crankshaft by unequally spaced screws to position its timing marks (22) in relation to No. 1 crankpin. It drives the camshaft gear (11), which is attached to the rear flange of the camshaft by unequally spaced screws to position its timing mark (19) in relation to the cam lobes. The magneto drive gear (10) has a bushing which bears on a pivot attached to the crankcase. The magneto coupling retainer and rubber bushings (9) are centered by a sleeve in a rear slot of the gear (10). These bushings form a slot for the driving lugs of the magneto impulse coupling. The accessory drive gear also drives the governor drive gear (21) which bears in a bushing in the governor adapter casting attached to the accessory case. The splined governor shaft meshes in the splined gear shaft. For starting, the crankshaft is turned either by a ring gear (1) on the flywheel which can be driven by a Bendix drive pinion in the electric starter (8), or by a hand crank inserted in the jaw (15) at the rear end of the hand crank and fuel pump shaft (14), which is splined to its drive gear (13). After starting, the latter gear drives its shaft, on which an eccentric (16) is machined to actuate the fuel pump operating lever. The oil pump driving impeller (12) has a squared front shaft end which is driven at camshaft speed by a squared hole centered in the camshaft gear. It drives the oil pump driven impeller (18) at the same speed. The slotted rear end (17) of the driven impeller receives and drives the tachometer flexible shaft. Proportional speeds of all gears (crankshaft = 1) are stated in the legend.

2-5. COOLING SYSTEM. *(See figure 2-2.)*

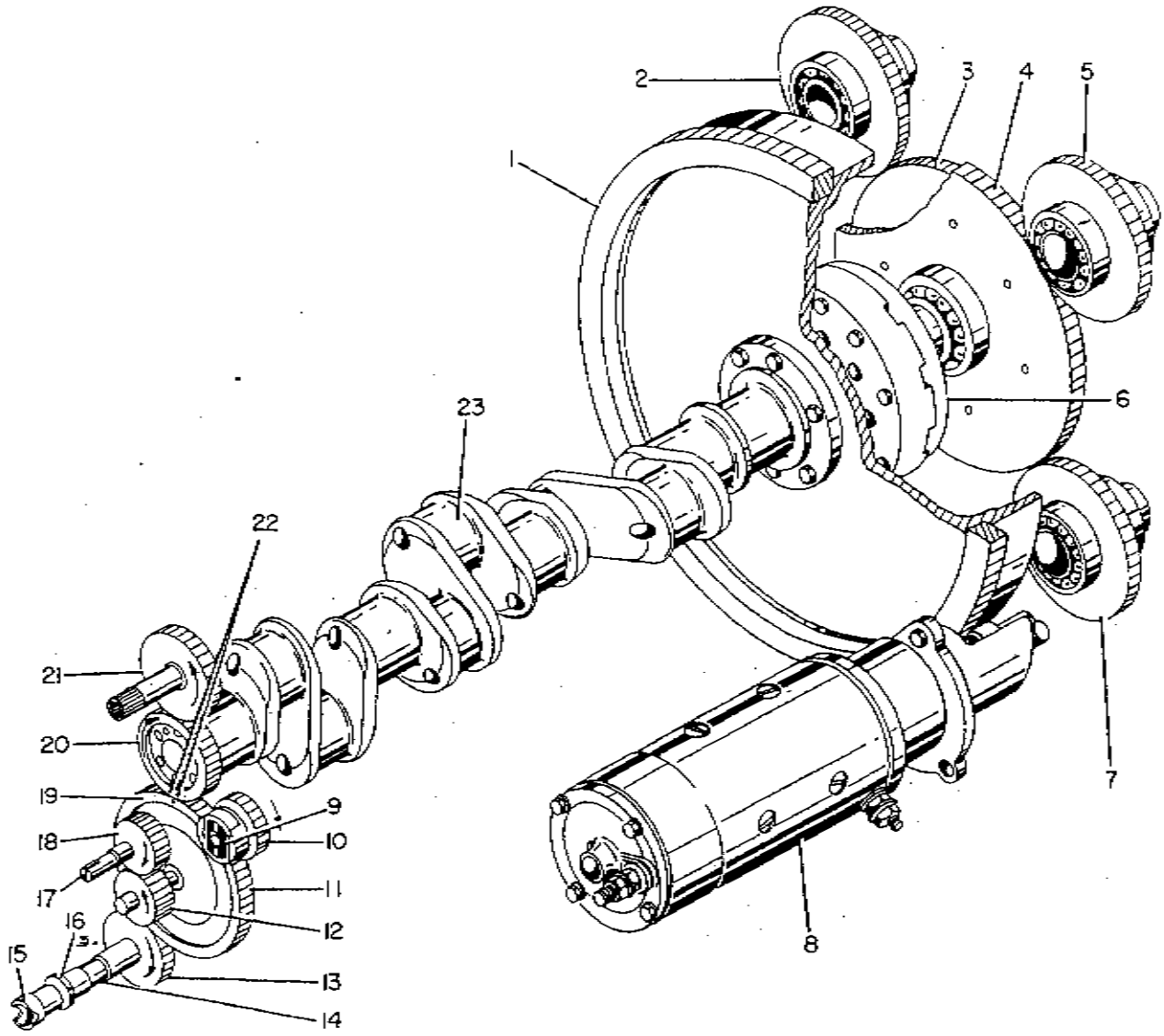
2-6. The fan (3) on the flywheel is driven by the crankshaft and forces air backward and around its outlet housing (4). The turning vanes (5, 6) catch the whirling air stream and force it to pass to the rear above the cylinders. The shroud and cylinder baffles (7, 8, 10, 11, 14) form a tight compartment, excepting the spaces between cylinder fins (9), and the cooling air must pass through those spaces to escape downward and through the shutters (19), absorbing, as it does so, unusable combustion heat. Other baffles (11) force cooling air to pass between cylinder head fins (12) for the same purpose. The shutters are held shut by a spring (18) when air temperature is low and opened, as the temperature in the shroud rises, by a bellows actuator (16) mounted on top of the left side shutter, thus allowing the engine to warm up quickly. Other turning vanes (21) direct a part of the air stream in the fan housing backward and through the openings of the oil cooler (20) to absorb heat from the engine lubricating oil passing through the cooler core.

2-7. FUEL AND INDUCTION SYSTEM.

2-8. Fuel is delivered by the AC diaphragm pump through a hose to the carburetor float chamber inlet and needle valve seat, which is opened or closed by a needle valve whose position is changed by the float and its lever in response to the fuel level in the chamber. Through the carburetor high speed and idling jets, fuel is drawn from the float chamber into the air stream passing through the carburetor throat. Air enters the carburetor through a cast aluminum adapter from the air filter which covers the exit of its housing attached to the outlet of the preheat and mixing valve. The carburetor is mounted on the rear flange of the intake manifold attached to the top of the crankcase and delivers its fuel-air mixture to fill the volume continually evacuated by engine pistons on their intake strokes. The manifold is connected to the cylinder intake ports by tubes and hose connectors. Each tube is sealed to its cylinder by a flange and a rubber seal ring. The carburetor choke control cable is attached to the choke valve lever at the right of the carburetor throat rear inlet. The throttle control cable is connected to the right side throttle valve lever near the carburetor front flange. The governor control rod is connected to the lever at the left end of the carburetor throttle valve shaft.

2-9. EXHAUST SYSTEM.

2-10. Tubular steel exhaust manifolds are attached to

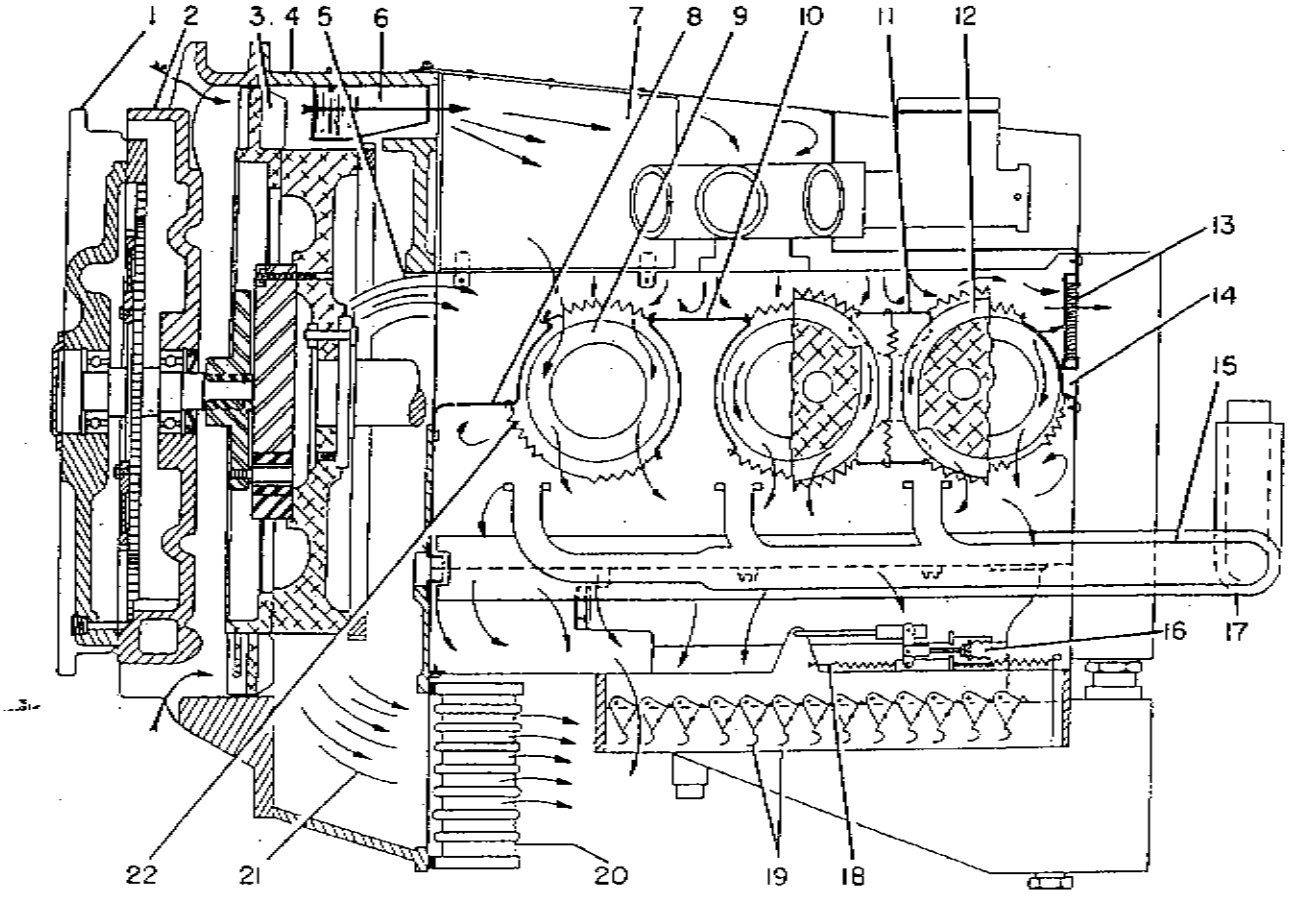


Index No.	Nomenclature	No. of Teeth	Speed Ratio (Crankshaft = 1)
1.	Flywheel ring gear	158	1 : 1
2.	Alternator driven gear	36	1 : 2.666
3.	Alternator drive gear	96	1 : 1
4.	Generator driver gear	126	1 : 1
5.	Generator drive gear	50	1 : 2.52
6.	Flexible coupling		1 : 1
7.	Generator drive gear	50	1 : 2.52
8.	Starter	13	1 : 12.153
9.	Coupling		1 : 1.5
10.	Magneto drive gear	20	1 : 1.5
11.	Camshaft gear	60	1 : 0.5

Figure 2-1. Schematic Diagram of Gear Trains

Legend for Figure 2-1. (Cont)

Index No.	Nomenclature	No. of Teeth	Speed Ratio (Crankshaft=1)
12.	Oil pump driver impeller	9	1 : 0.5
13.	Hand crank and fuel pump drive gear	27	1 : 1.111
14.	Hand crank and fuel pump shaft		1 : 1.111
15.	Jaw		1 : 1.111
16.	Eccentric		1 : 1.111
17.	Tachometer drive		1 : 0.5
18.	Oil pump driven impeller	9	1 : 0.5
19.	Timing mark		
20.	Accessory drive gear	30	1 : 1
21.	Governor drive gear	30	1 : 1
22.	Timing marks		
23.	Crankshaft		1



1. Gear case housing
2. Fan inlet and gear housing
3. Flywheel fan
4. Fan outlet housing
5. Lower turning vanes
6. Upper turning vanes
7. Shroud divider
8. Shroud to No. 6 cylinder baffle
9. Cylinder barrel fin
10. Inter barrel baffle
11. Inter head baffle
12. Cylinder head fin
13. Heater blower air screen
14. Shroud to No. 2 cylinder baffle
15. Exhaust manifold
16. Sealed bellows actuator
17. Exhaust manifold jacket
18. Shutter spring
19. Shutter vanes
20. Oil cooler
21. Oil cooler turning vanes
22. Baffle spring

Figure 2-2. Schematic Diagram of Cooling System

the bottom exhaust ports of left and right side cylinders by flanges and nuts. A cross pipe from the left side manifold brings its outlet adjacent to that of the right side manifold, both being directed upward.

2-11. IGNITION SYSTEM.

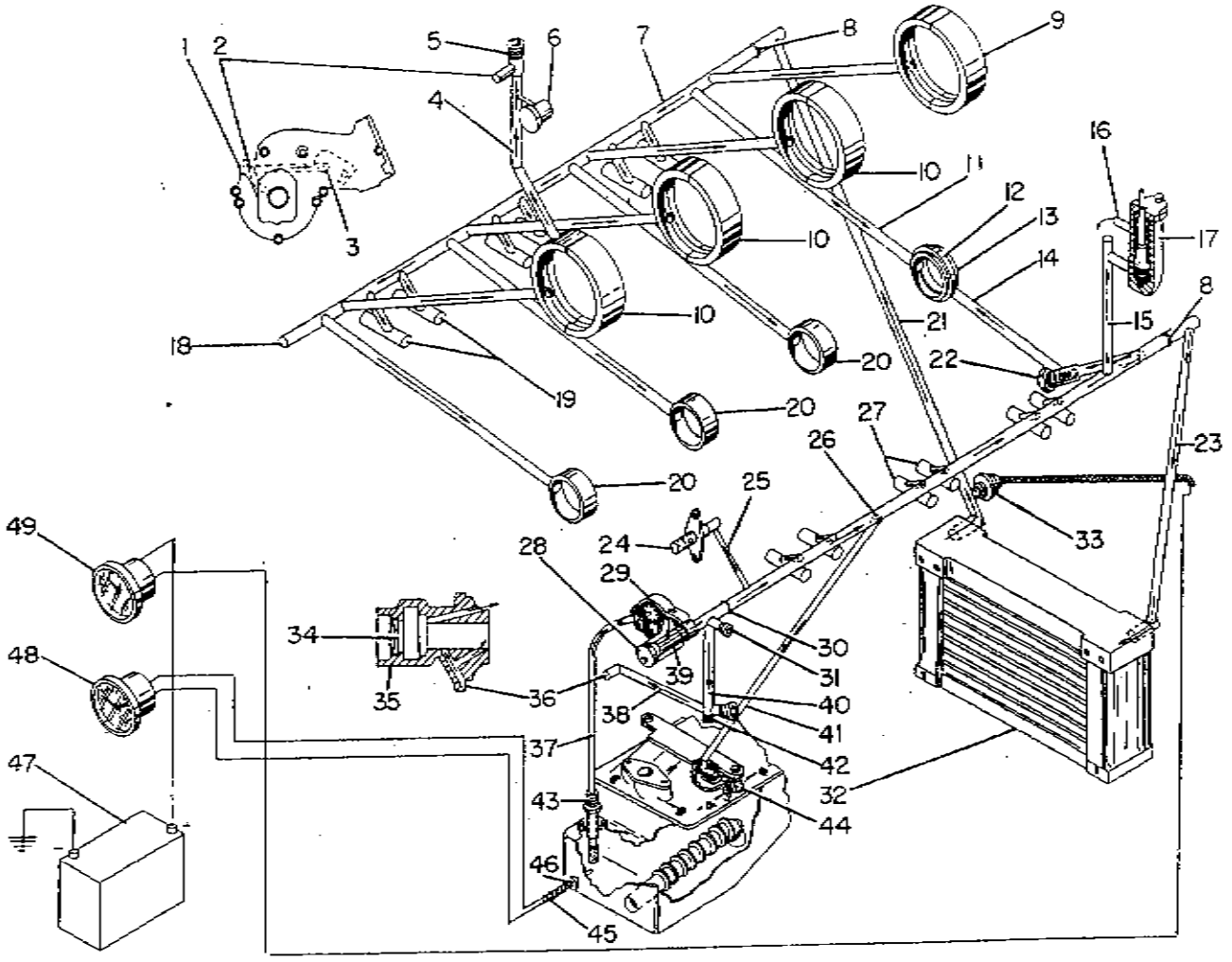
2-12. Ignition spark current is generated by a magneto which has its own spark distributor and is connected to the spark plugs through high tension cables surrounded by flexible radio shielding conduits. The magneto and spark plugs are also radio shielded. All cable conduits pass through rubber grommets in the shroud upper rear panel. The cable conduits are attached to spark plugs by shielded elbows and union nuts, and the cables have ceramic spark plug terminal contact sleeves. The cable conduits are attached to the magneto outlet plate by elbows and coupling nuts. The cables terminate in a rubber grommet which holds their end washers in place behind the distributor rotor. Each magneto has an impulse coupling which engages only at cranking speed to retard spark impulses and provide a rapid spin of the rotor shaft through its firing positions to produce hot sparks. The impulse coupling latch is released by centrifugal force after starting and the magneto is driven at full advance by the coupling spring.

2-13. GOVERNOR SYSTEM.

2-14. The governor is not supplied by the packette manufacturer, hence a detailed description of the governor and its operating principle is beyond the scope of this publication. The packette manufacturer supplies a control rod assembly with each new packette. This consists of a 1/4 inch steel rod (which is threaded at each end), a ball swivel fitting for attachment to the tapped lever on the left end of the carburetor throttle shaft, a rod end clevis for attachment to the governor lever and two lock nuts for the end fittings. The lever at the left end of the carburetor throttle valve shaft is not clamped on the shaft. Its hub contains a helical spring which is engaged to the lever at one end and to a knurled ring cotter pinned to the shaft at the other end. The lever hub is shouldered on the carburetor side, and the hub spring tends to hold the shoulder against a pin driven into the shaft. When acting to close the throttle, the governor lever pushes on the pin to move the throttle shaft positively, but when acting to open the throttle the lever moves away from the shaft pin and can operate the shaft only through the helical spring in its hub. The spring tension is such as to cause the shaft to move toward the open valve position, keeping the shaft pin against the lever hub shoulder as the lever moves, however the manual control can be used to override the spring and close the throttle valve regardless of governor control lever position. When properly installed on a rebuilt carburetor, the spring loaded lever at the left end of the throttle valve shaft lies above the shaft and can move through an angle of 37-1/2 degrees each side of the vertical. Rearward movement of the lever opens the throttle valves, and movement to the forward extreme position closes them. The manual throttle control lever on the right end of the shaft is freely pivoted and hangs downward but moves against its retaining clamp when pulled rearward to close the throttle positively. This lever must be in its forward position to allow the governor to control through the spring loaded lever on the left side.

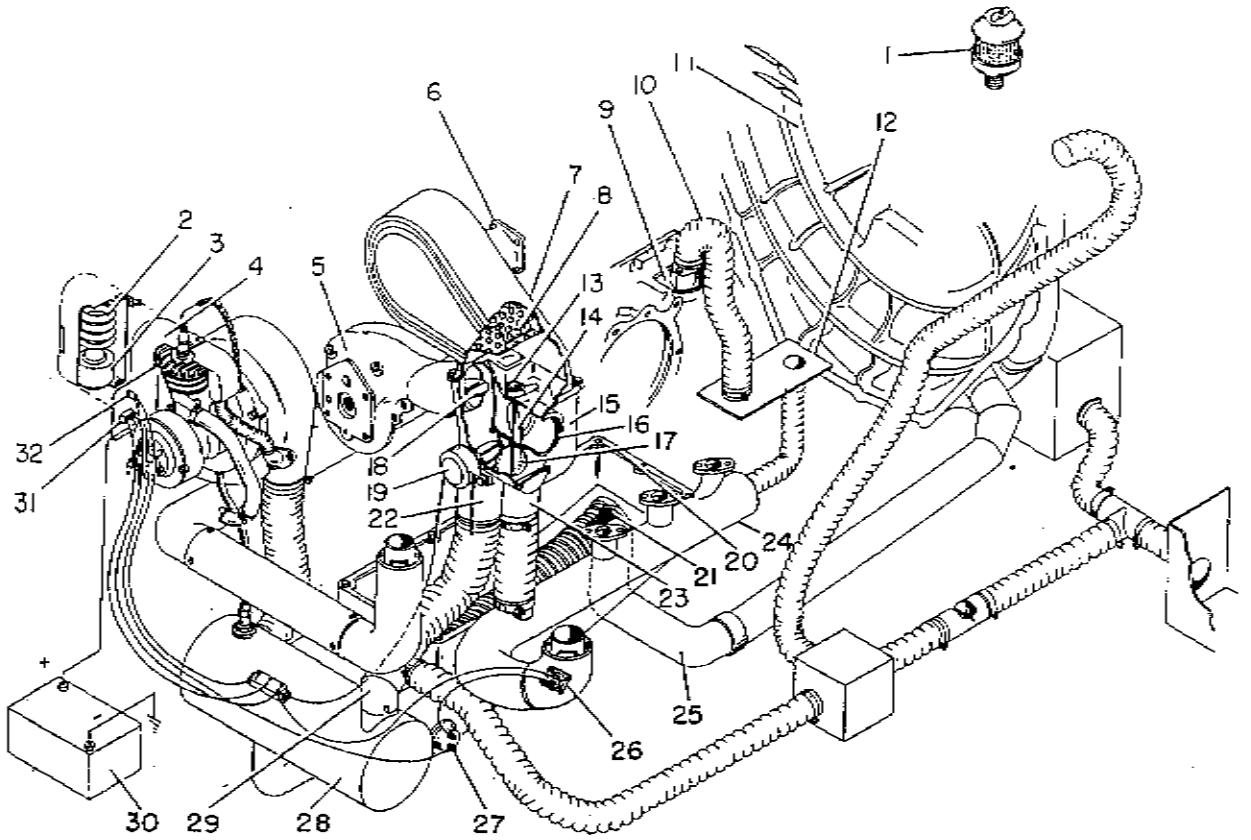
2-15. LUBRICATION SYSTEM. *(See figure 2-3.)*

2-16. PRESSURE LUBRICATION SYSTEM. Oil in the sump is forced, by atmospheric pressure on its surface, to rise through the oil pump section tube (37) to fill the volume continually displaced by rotation of the oil pump impellers (29). Oil carried around the pump chamber in impeller tooth spaces is forced into the tachometer and oil screen housing (39). The oil filter (28) is sealed to its housing by a copper-asbestos gasket and fits closely into the accessory case outlet from the cavity, so that pumped oil must pass through the screen to escape into the right oil gallery (26) at point 30, leaving on the screen any solid particles. From the forward end of the right gallery the oil stream may enter the oil cooler (32) through a fan housing passage (23) unless it is so cold and viscous as to require a higher than normal pressure to force it through the core. In the latter event a rise in back pressure opens the by-pass valve (22), allowing the oil to by-pass directly to the left gallery (7). Normally the oil flows through the cooler and through a second fan housing passage (21) to the left gallery and rearward to the blind end (18). The oil pressure relief valve (44) in the oil sump adapter is opened by any rise above normal system pressure due to an excess of pumpage over loss through bearings, dumping the excess into the oil sump. Hydraulic valve lifters, their guides, (19, 27) and their valve trains are fed from both galleries through holes drilled to register only in the valve open positions to prevent "pumping up" of the lifter hydraulic units. Drilled lifter sockets and hollow pushrods carry oil to the rocker passages to lubricate their bearings and spray the exhaust valves. Main and camshaft bearings (9, 10, 13, 20) are fed from the left gallery through drilled holes. The crankshaft is drilled and has tubes permanently installed to conduct oil from main bearings to crankpins. From the rear main bearing oil is fed through holes (4, 2, 3) in the crankcase, accessory case and governor adapter to the governor drive gear bushing and to the oil pressure valve located on the governor adapter. The magneto drive gear support is fed from the right oil gallery through a passage (25). The hand crank and fuel pump drive shaft bushing is lubricated by oil leaving the screen exit cavity through a vertical hole (40) to the bottom of the accessory case, thence through a horizontal drilled hole (38) to the hand crank and pump adapter (35) which has an oil inlet hole (36) drilled to register with the gasket and case oil holes. Cylinder walls are lubricated by spray from crankpin bearings and accessory gears are lubricated by spray from the rear main bearing and gear bushings. Oil is returned to the crankcase from rocker boxes through the pushrod housings. Crankcase drainage oil returns to the sump through three sump adapter holes sealed to the crankcase by gaskets. Oil drains from the accessory case to the sump through a large tube (43) which is



1. Pipe plug
2. Oil outlet and inlet
3. Oil outlet and inlet to rear oil pressure valve
4. Governor oil supply passage
5. Pipe plug
6. Governor drive gear thrust plug
7. Oil gallery
8. "O" ring packing
9. Front main-thrust bearing
10. Center and rear main bearings
11. Oil supply and bypass hole
12. Groove around bearing
13. Front camshaft bearing
14. Oil cooler bypass hole
15. Crankcase oil hole
16. Air vent hole
17. Front oil pressure valve
18. Blind end of oil gallery
19. Valve lifter guides
20. Center and rear camshaft bearings
21. Oil passage on left side of fan outlet housing
22. Oil cooler bypass valve
23. Oil passage on right side of fan outlet housing
24. Magneto gear support
25. Oil hole
26. Oil gallery
27. Valve lifter guides
28. Oil filter
29. Oil pump
30. Entrance to oil gallery
31. Pipe plug
32. Oil cooler
33. Oil pressure gauge engine unit
34. Oil seal
35. Hand crank and fuel pump adapter
36. Oil outlet and inlet
37. Oil pump suction tube
38. Accessory case oil hole
39. Tachometer and oil screen housing
40. Accessory case oil hole
41. Crankcase passage
42. Pipe plug
43. Accessory case oil drain tube
44. Oil pressure relief valve
45. Thermocouple connector
46. Thermocouple
47. 24 volt storage battery
48. Cylinder head and oil temperature gauge
49. Oil pressure gauge

Figure 2-3. Schematic Diagram of Lubrication System



1. Filter
2. Fuel heating coil
3. Gasoline burner and wick
4. Blower engine
5. Governor adapter
6. Carburetor to air filter adapter
7. Carburetor air filter housing
8. Air filter
9. Crankcase heater air valve assembly
10. Flexible duct
11. Fan inlet and gear housing
12. Cylinder to shroud baffle
13. Bimetal spiral
14. Mixing valve vane
15. Preheat and mixing valve housing
16. Cold air inlet port
17. Hot air valve vane
18. Hot air butterfly valve
19. Rotary solenoid and hot air butterfly valve
20. Engine oil sump
21. Oil sump heat exchanger
22. Preheat air inlet port
23. Warm air inlet port
24. Exhaust manifold jacket
25. Tube
26. Thermo switch
27. Thermo switch
28. Heater
29. Outlet tube and duct
30. 24 volt storage battery
31. Heater switch
32. Heater indicator lamp

Figure 2-4. Schematic Diagram of Preheat and Warm-up System

screwed into the case surrounding the oil pump suction tube and is sealed to the sump by a separate plate and rubber ring.

2-17. PREHEATING AND WARM-UP SYSTEM.

(See figure 2-4.)

2-18. To permit starting in extremely cold weather, air is warmed by the heater (28) and is forced by a gasoline engine driven blower (4) through a tube and duct (29) to the rear inlet port (22) at the bottom of the preheat and air mixing valve housing (15) located behind No. 1 cylinder. This valve housing has a cold air inlet (16) at the right side and a second inlet (23) at the bottom which is connected by a duct to the exhaust manifold jacket (24), in addition to the inlet connected to the heater. The exhaust manifold jacket front ends are connected to receive air from the flywheel fan. The heater burner exhaust gases are passed through a tube to the entrance of a finned heat exchanger passage (21) cast inside the oil sump (20) to warm the oil supply. The exhaust gases pass from the sump through a tube (25) to the inlet of an oil sump heat exchanger in the bottom of the fan inlet and gear housing (11). They are exhausted through a port on the left of the housing. The preheat air passage through the mixing valve housing to the crankcase is not obstructed when the engine is not running, but the passage connecting it to the carburetor is controlled by a solenoid operated butterfly valve (19), which is normally held shut by a spring. The rotary solenoid is actuated by 24 volt battery current in a circuit controlled by a thermo sensitive switch

(27) screwed into the oil sump, another (26) attached to the right exhaust jacket outlet elbow, the heater switch (31) and the ignition switch, as diagrammed in figure 10-2. The sump switch is closed at temperatures below 149°C (300°F) and open at higher temperatures. The exhaust jacket switch is closed below 38°C (100°F) and open at higher temperatures. When both thermo switches and the ignition switch are closed the current flows through the solenoid, overcoming its spring and holding the butterfly valve open to admit warm air from the heater to the carburetor. This occurs only during the engine warm-up period. Exhaust jacket air is controlled by a butterfly valve (17) below, and on the same shaft with the cold air entrance butterfly valve (14). These two valves are at right angles so that when one is wide open the other is closed. Cold air and warm jacket air passing valves 14 and 17 are mixed in the top of the mixing valve housing, where the resulting air temperature affects a bimetal spiral (13) fastened to the valve shaft and causes it to expand or contract in response to temperature changes and to position the jacket air and cold air valves to maintain 60°F air temperature when the atmospheric temperature is 60°F or lower. Air mixed by these valves is drawn by manifold vacuum through the air filter housing (7) and filter element, thence through an adapter into the carburetor. Before the engine is started the governor adapter valve (18) is held open by a spring in its oil pressure (actuating) valve (not illustrated), allowing warm air from the heater to pass through the governor adapter (5), on which the mixing valve is mounted, and into the accessory case, thence into the crankcase to warm it. This warm air is exhausted through the crankcase heater outlet valve (9) and through its connecting duct (10) to the space below the cylinders. Preheated air dumped below the cylinder baffles rises between the cylinder fins and is recirculated by the blower engine. The governor adapter and crankcase outlet butterfly valves (18 and 9) are closed by oil pressure valves (with connections to the pressure oil system) when the engine is running. This opens the breather tube in the governor adapter to the air filter housing. After the engine starts, cylinder heat causes the sealed bellows actuator to open the shutters, as described in paragraph 2-6.

SECTION III
SPECIAL OVERHAUL TOOLS

Fig. No.	*Index No.*	*Kent-Moore Tool No.*	*Nomenclature*
			DISASSEMBLY AND REASSEMBLY TOOLS
3-1	1	J-2839	Compressor—Piston ring
3-1	2	J-2838	Compressor—Valve spring
3-1	3	J-2882	Wrench—Cylinder base nut
3-1	4	J-2858	Fixture—Cylinder and valve holding
3-2	1	J-5003	Stand—Engine, transportation
			CLEANING TOOLS
3-3	1	KMO-122	Cleaner—Valve guide
3-3	2	J-5009	Polishing Tool—Crankshaft
			INSPECTION TOOLS
3-4	1	J-2844	Gauge—Camshaft bearing
3-4	2	J-2848-1	Gauge—Intake valve guide
3-4	3	J-2848-2	Gauge—Exhaust valve guide
3-4	4	J-2849-1	Gauge—Cylinder head valve guide bore, 0.005 in. oversize
3-4	5	J-2849-2	Gauge—Cylinder head valve guide bore, 0.010 in. oversize
3-4	6	J-2850	Gauge—Piston ring, standard and 0.005 in. oversize
3-4	7	J-2851-1	Gauge—Rocker arm bushing, standard
3-4	8	J-2852	Gauge—Magneto drive gear bushing
3-4	9	J-2853-1	Gauge—Piston pin hole, standard
3-4	10	J-2854-1	Gauge—Connecting rod bushing
3-4	11	J-2859	Gauge—Valve lifter guide

Note: Tool numbers listed in this section are those assigned by the tool manufacturer, Kent-Moore Organization, Inc., General Motors Bldg., Detroit 2, Michigan. These tools are not carried in stock by the manufacturer.

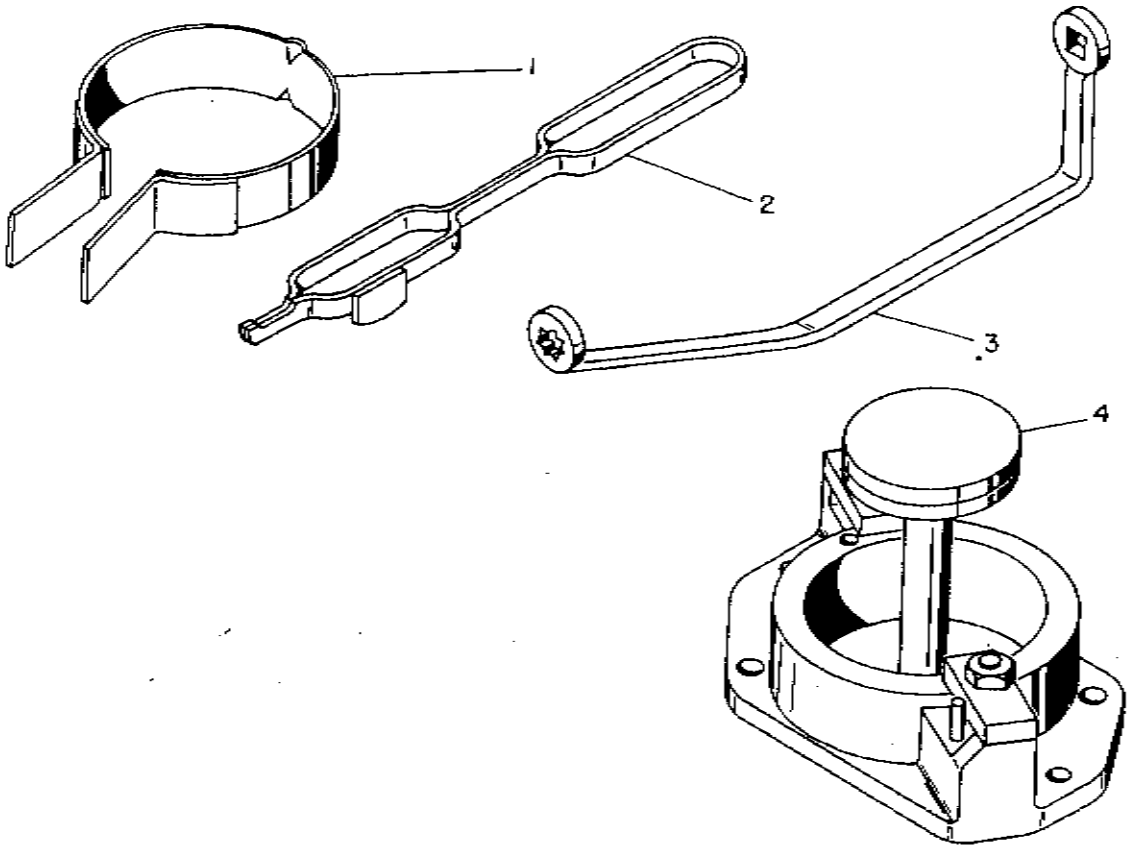


Figure 3-1. Disassembly and Reassembly Tools

Fig. No.	*Index No.*	*Kent-Moore Tool No.*	*Nomenclature*
3-4	12	J-2860	Gauge—Cylinder head rocker shaft bore
3-4	13	J-1297-B	Fixture—Hydraulic valve lifter leakdown rate checking
			REPAIR AND REPLACEMENT TOOLS
3-5	1	J-2842	Driver—Valve guide installing
3-5	2	J-2847-1	Broach—Intake valve guide stem hole
3-5	3	J-2847-2	Broach—Exhaust valve guide stem hole
3-5	4	J-2874	Remover—Valve guide
3-5	5	J-2887-A	Gauge—Exhaust valve seat blueing
3-5	6	J-2887-B	Gauge—Intake valve seat blueing
3-5	7	J-2861	Fixture—Cylinder head holding
3-6	1	J-2879	Remover and Replacer—Connecting rod bushing

Note: Tool numbers listed in this section are those assigned by the tool manufacturer, Kent-Moore Organization, Inc., General Motors Bldg., Detroit 2, Michigan. These tools are not carried in stock by the manufacturer.

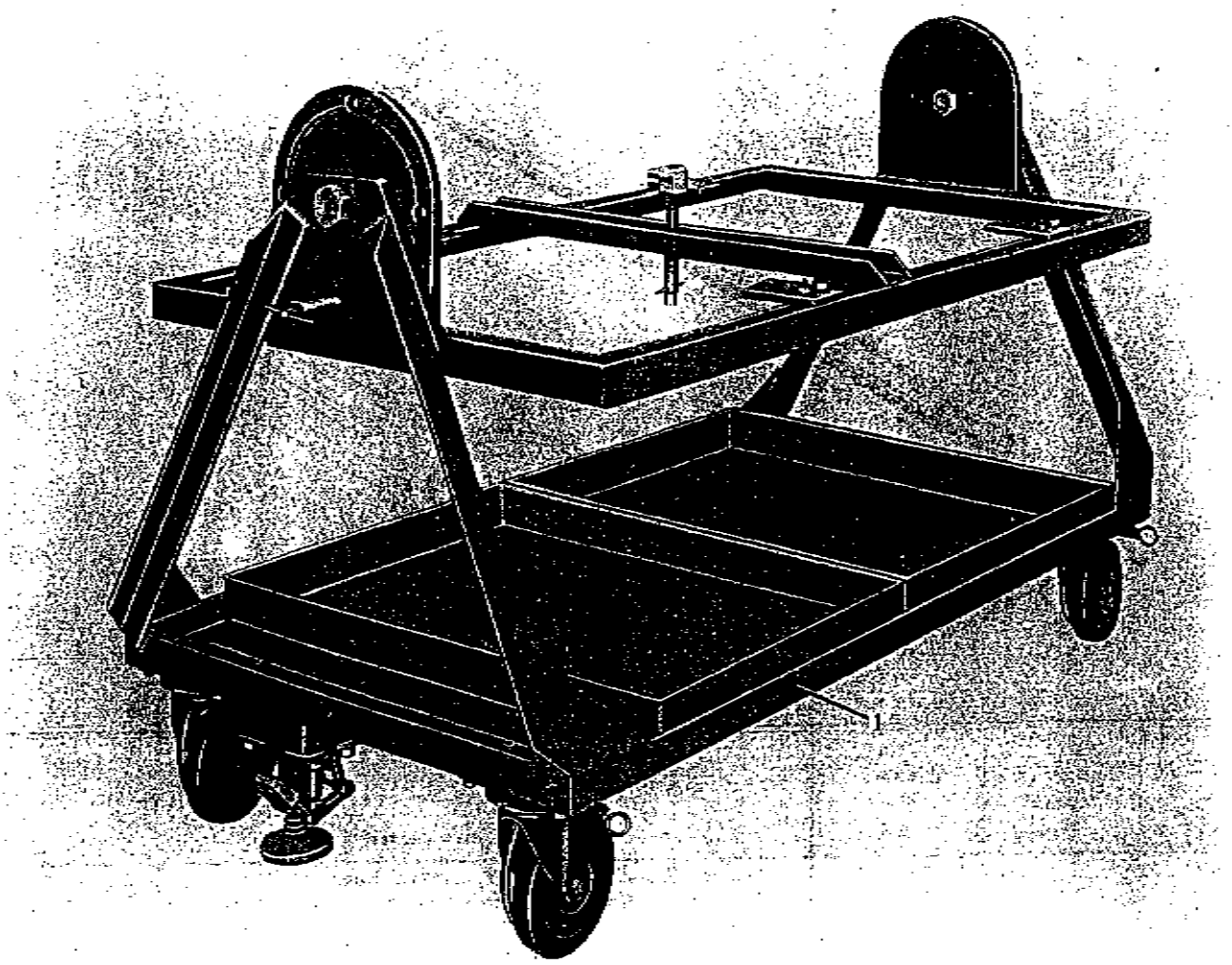


Figure 3-2. Disassembly and Reassembly Tools

Fig. No.	*Index No.*	*Kent-Moore Tool No.*	*Nomenclature*
3-6	2	J-5008	Reamer—Connecting rod bushing
3-6	3	J-2881	Remover and Replacer—Rocker arm bushing
3-6	4	J-2892-1	Reamer—Rocker arm bushing, standard
3-6	5	J-2846	Broach—Cyl head valve guide hole, 0.005 in. oversize
3-6		J-7201	Broach—Cyl head valve guide hole, 0.010 in. oversize
3-6		J-7202	Broach—Cyl head valve guide hole, 0.020 in. oversize
3-6	6	J-5007	Remover and Replacer—Rocker shaft support bushing
3-7	1	J-5010-1	Remover and Replacer—Oil pump and accessory case bushings
3-7	2	J-5010-2	Fixture—Remover and Replacer, oil pump and accessory case bushings
3-7	3	J-5047-1	Remover—Hand crank and fuel pump adapter oil seal
3-7	4	J-5047-2	Replacer—Hand crank and fuel pump adapter oil seal
3-7	5	J-5048-1	Remover and Replacer—Governor adapter bushing
3-7	6	J-5048-2	Fixture—Governor adapter bushing reaming and spot facing

Note: Tool numbers listed in this section are those assigned by the tool manufacturer, Kent-Moore Organization, Inc., General Motors Bldg., Detroit 2, Michigan. These tools are not carried in stock by the manufacturer.

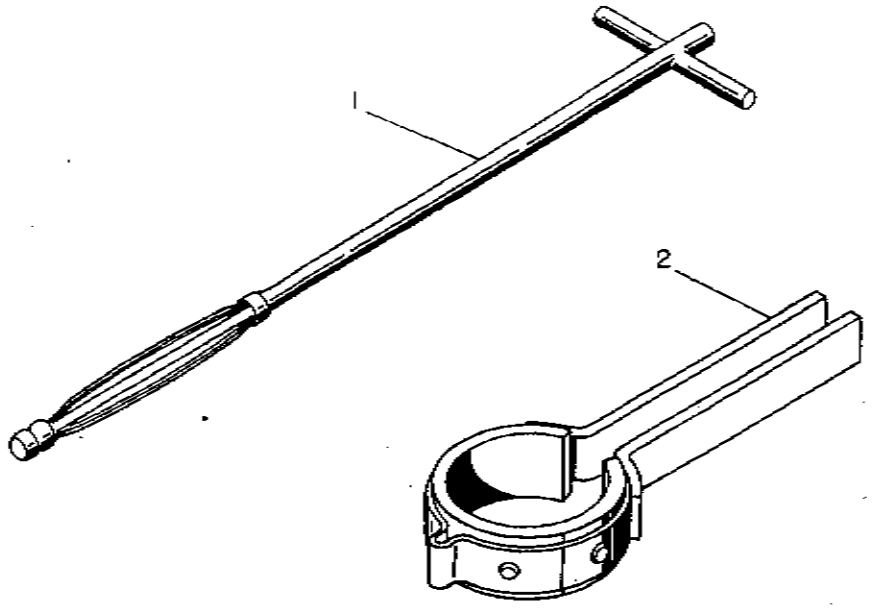


Figure 3-3. Cleaning Tools

Fig. No.	*Index No.*	*Kent-Moore Tool No.*	*Nomenclature*
3-7		J-5129	Reamer Set—Rocker shaft support boss
3-7	7	J-5129-1	. Reamer—Rocker shaft support boss, 1st cut
3-7		J-5129-2	. Reamer—Rocker shaft support boss, 2nd cut
3-7		J-5129-3	. Reamer—Rocker shaft support boss, 3rd cut
3-7	8	J-5129-4	. Kit—Cloth, rocker shaft support reamers
3-7	9	J-5130	Reamer—Rocker shaft support bushing

Note: Tool numbers listed in this section are those assigned by the tool manufacturer, Kent-Moore Organization, Inc., General Motors Bldg., Detroit 2, Michigan. These tools are not carried in stock by the manufacturer.

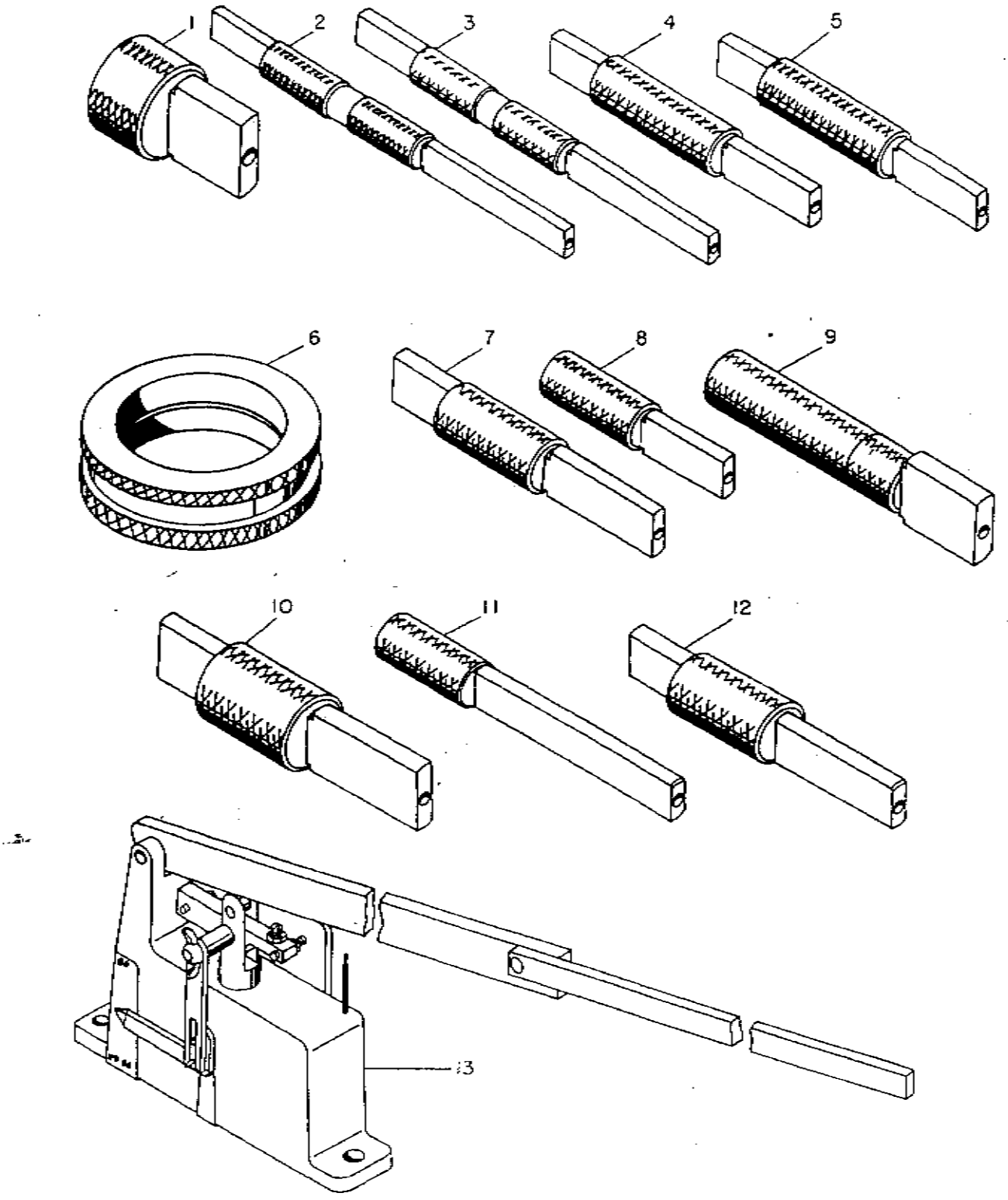


Figure 3-4. Inspection Tools

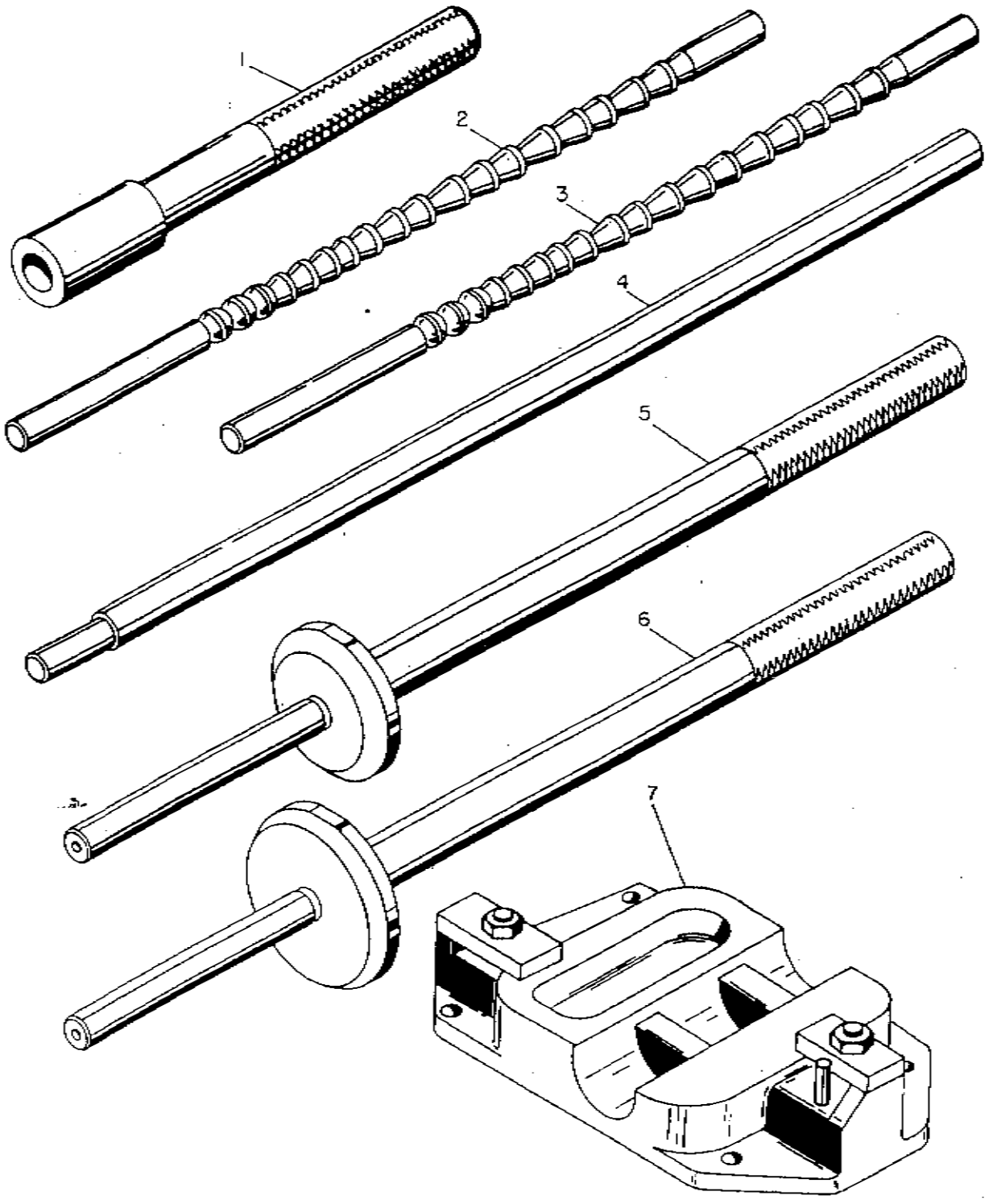


Figure 3-5. Repair and Replacement Tools

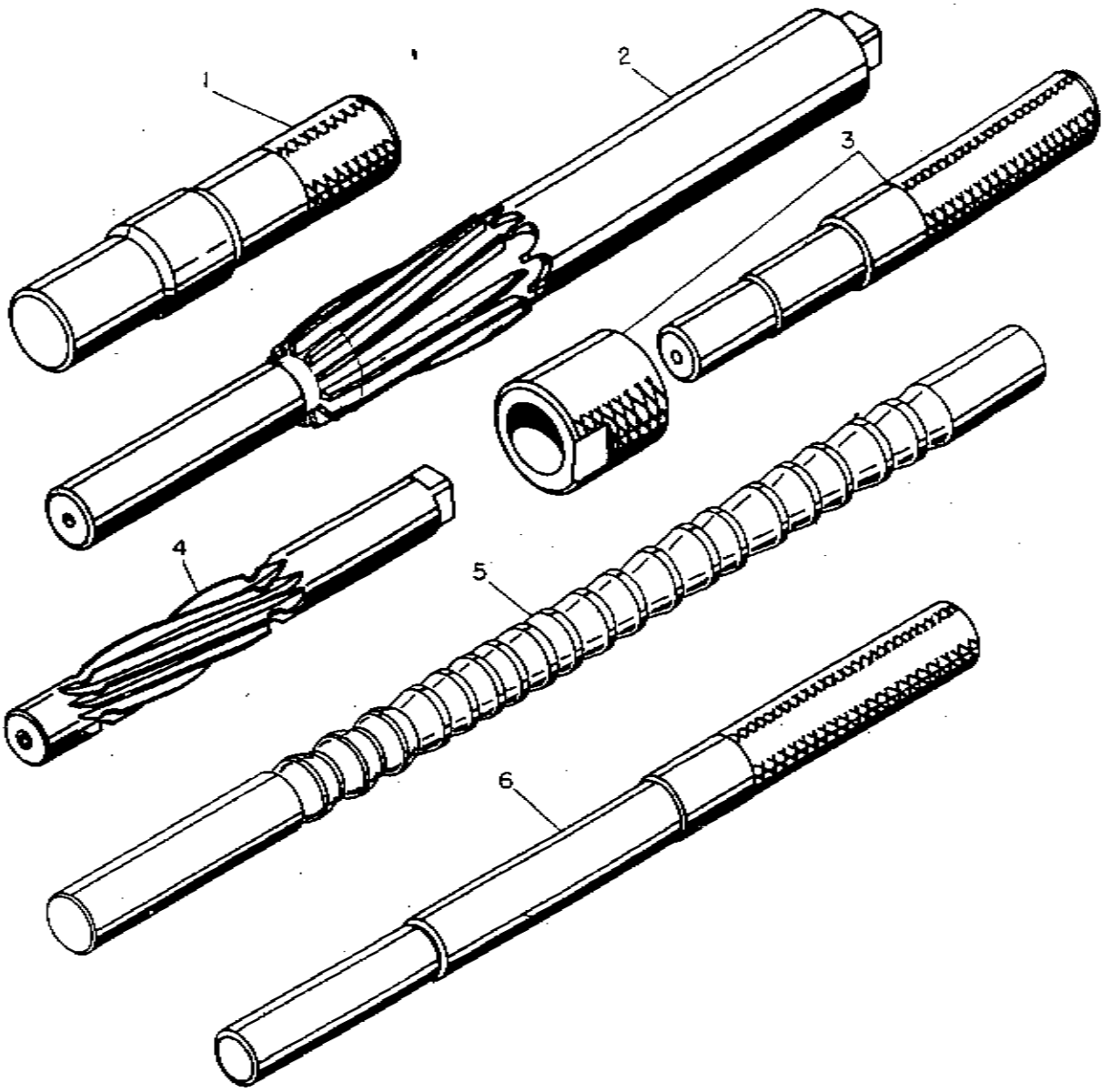


Figure 3-6. Repair and Replacement Tools

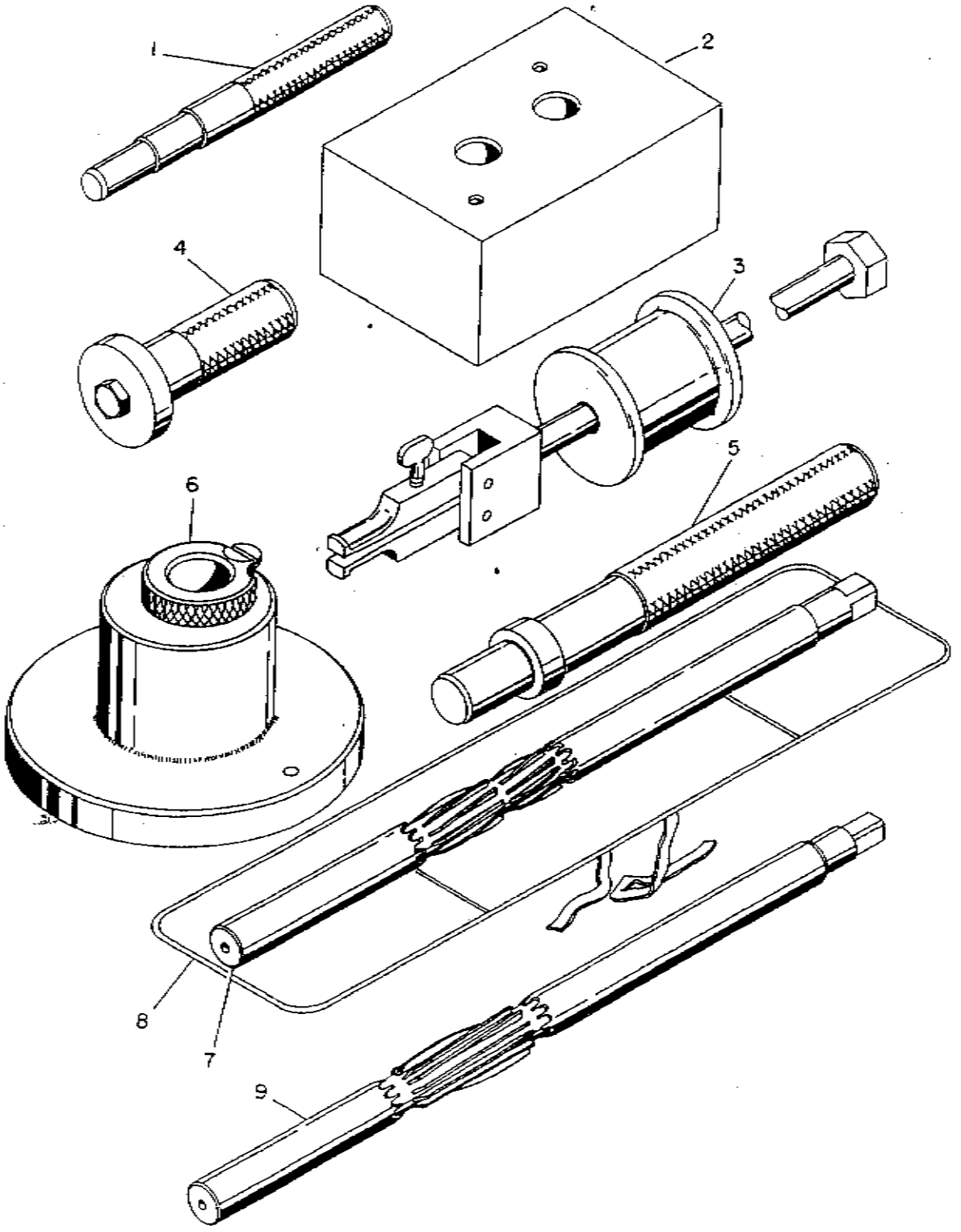


Figure 3-7. Repair and Replacement Tools

SECTION IV
DISMANTLING AND ASSEMBLY

4-1. PRELIMINARY OPERATIONS.

4-2. UNCRATING.

a. Unscrew and remove the machine bolts which attach the side panels to the crate base, and lift off the assembly of crate top and side panels.

b. If a waterproof shroud is installed over the packette remove it carefully. Clean, fold and store it for future use if it is intact.

c. In order to uncover the rear mounting bolt nuts and to permit removal of any bags of desiccant inside the shroud it will be necessary to remove the detachable panels at the sides of the packette cooling shroud. The easiest way of removing each panel is to disengage the two latches on the access door above and to open the door then push down on the upper edge of the detachable side panel until the hook member along its bottom edge is disengaged from the hook member on the panel below and swing out the bottom of the side panel so that it can be lifted clear. Alternately, the spring hooks at the top of the side panel may be disengaged by lifting them and the side panel lowered to disengage its bottom hook member, however, this method requires holding the top of the panel inward against the webbing seal strips on the end panels if it should tend to spring outward due to insufficient curvature.

d. Remove any bags of desiccant found inside the shroud or placed around the packette. If any exterior component is not installed, look for a small bag of desiccant in the engine opening of its mount pad, if any. If dehydrator plugs are installed in place of spark plugs, remove them and substitute old spark plugs or vent plugs, and temporarily attach ignition cables to them. Look for and remove any other dehydrator plugs installed in engine openings. Dispose of all bags of desiccant and dehydrator plugs in accordance with applicable Technical Orders.

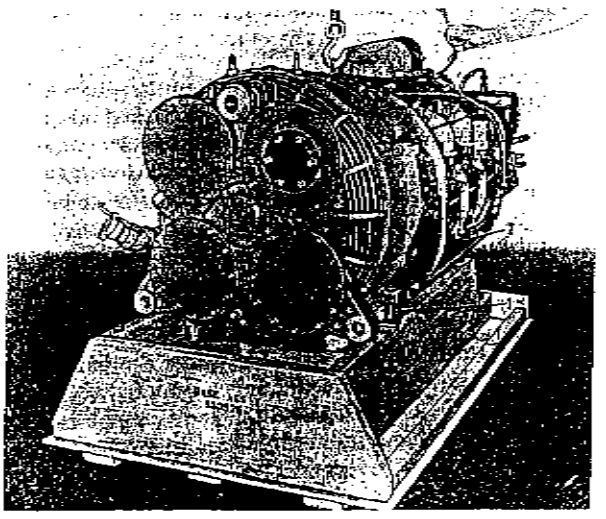
e. Loosen and unscrew the nuts on the two front and two rear mounting bolts and remove plain washers beneath them. The rear nuts are located inside the packette shroud. *(See 2, figure 4-1.)*

f. Hoist the packette by its lifting eye (2, figure 4-1), with the hoist hook engaged either directly in the eye or through an adapter hook (1, figure 4-1), until the shroud bottom side panels are at waist level. *(See also figure 4-1.)*

g. Remove all trash and other foreign matter from the crate base. Reassemble and store the crate.

4-3. REMOVAL OF SHROUD BOTTOM SIDE PANELS. Bottom side panels of the shroud are attached to front and rear panels by type "J" speed nuts and hex head sheet metal screws and to the shutters by the same type of screws and flat speed nuts. The type "J" nuts are not removed at this stage. Remove the seven hex head sheet metal screws from each panel. The bottom side panels are attached to the front panel and to the front bottom panel by fillister head screws, lock washers and Tinnerman "cage type" lock nuts. The latter will remain in place at this stage. Remove the fillister head screws to complete detachment of each bottom side panel; then shift the panels forward to clear the rear mount brackets, and lay them aside.

4-4. MOUNTING PACKETTE ON STAND. *(See figure 4-2.)* Roll a No. J-5003 engine transportation stand under the suspended packette, and slack off the hoist until the packette mounts are just clear of the four adapter plates attached to the slotted side rails of the pivoted cradle. Adjust the adapters lengthwise on the cradle until they are properly spaced to match the packette mounting bolt holes, and tighten their attaching bolt nuts. Insert ma-



1. Front mounting bolt
2. Rear mounting bolt hole in bracket

Figure 4-1. Hoisting Typical Packette from Shipping Crate

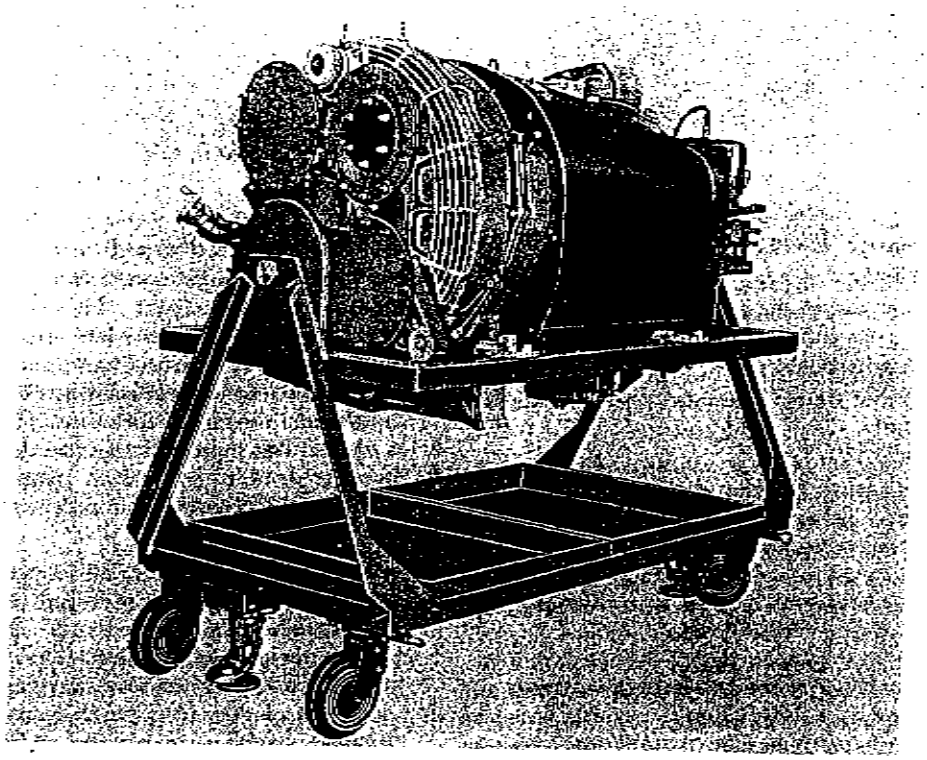


Figure 4-2. Typical Packette Mounted on No. J-5003 Transportation Stand

chine bolts through the four stand adapters and packette bolt holes. Lower the packette until it rests on the cradle, and attach it with plain washers and nuts.

Note

Use machine bolts in the front mounting bosses of such length that the nuts can be backed off at least 1/2 inch of bolt length to permit clearance for removal of the fan housing, as described later in this section. Space the packette about equally from both ends of the cradle to permit working space for removal of parts forward and rearward. This should be done before the packette rests entirely on the cradle.

4-5. PRELIMINARY CLEANING. Use a suitable pressure spray cleaning nozzle to apply an approved mineral spirit solvent. The nozzle should be long enough to reach inside the shroud and into all crevices while the operator stands well away. Pay particular attention to nuts and the heads of all bolts and screws. If necessary, use a clean paint brush to loosen caked dirt. Do not use wire brushes or scrapers.

4-6. GENERAL DISASSEMBLY INSTRUCTIONS.

4-7. SAFETY DEVICES. Without further instructions, remove all lockwires before attempting to loosen the bolts, plugs, etc., which they secure. Do not pry lockwires; use diagonal cutters and pliers, taking care to remove all of the wire. Loosen and unscrew nut locks before attempting to loosen plain nuts which they secure. Attempts to loosen or unscrew both nuts at once may result in backing out studs. Be sure that cotter pins are removed completely if they break. Small pieces of cotter pin remaining in stud holes may lock the nuts and cause studs to back out with them. Discard all lockwires, nut locks and tooth lock washers immediately after removal and in such a manner as to preclude inadvertent reinstallation.

4-8. DISASSEMBLY INSPECTION. During each step of dismantling and disassembly look for evidence of burning, scoring, seizure, discoloration and dryness which would indicate lack of lubrication. Also note any evidence of careless handling, such as breakage of external parts, of improper operation, of improper maintenance or lack of maintenance and of work improperly performed during a previous overhaul. Report all such evidences in accordance with current orders on that subject.

4-9. OPERATION OF TRANSPORTATION STAND. After the stand is rolled into position preparatory to any step of the dismantling procedure, set the floor brakes, located between the wheels at both ends, by stepping down on the bronze levers. *(See figure 4-2 for brake in set position.)* Release the floor brakes by lifting the levers until they snap to their up positions. Each brake release spring is strong enough to inflict pain when the bronze lever passes the toggle reverse position on the up stroke if operated by hand and allowed to kick the lever against the hand. When it is desired to turn the pivoted cradle to a new position, first make sure that the floor brakes are

set; then one man, standing beside the end of the cradle nearest the pivot lockpin (visible in figure 4-3) can pull out the crossbar and pin to release the lock and hold it out until he has shifted the cradle angle slightly. The pin may be released then and the cradle rotated by hand and foot pressure through an angle of 90 degrees. The pin will spring into the cradle plate lock hole. If the cradle must be turned to the next 90 degree position the pin is again pulled out, after adjusting the operator's hand grip and foot position on the side rails as necessary, and the cradle is turned on until the lockpin springs into the next lock hole. The packette balances rather well if mounted directly on the bed adapters without spacers of any kind, so that only moderate force is required to turn it to any position.

4-10. ILLUSTRATIONS IN THIS SECTION. Major subassemblies are illustrated by means of line drawings, and certain parts and operations are represented by photographs to aid the reader in visualizing the parts and the work described. The line drawings illustrate "exploded" subassemblies in upright positions, though it will be necessary to invert the packette in order to facilitate removal of those attached to the bottom, as described in the text. Index numbers connected by "leader" lines to illustrations of parts are duplicated in the legend for each figure and there listed in numerical order, together with correct nomenclature. The order of listing is the recommended order of removal. This is not the same order as that in which the same parts are listed in the Parts Catalog.

CAUTION

Since catalog drawings are reprinted herein to describe dismantling and disassembly operations, it is obvious that all sub-assemblies are "exploded" in these drawings, although assemblies of gears and bushings, castings with bushings, dowels and studs installed and certain other sub-subassemblies should not be disassembled. The appearance of such parts in "exploded" positions in these illustrations does not constitute authority to disassemble them unless such disassembly operations are described in the text.

4-11. REFERENCES TO ILLUSTRATIONS. When instructions throughout any paragraph apply to the parts illustrated in a photograph or line drawing, a reference to that figure appears in parentheses immediately following the paragraph head. In such paragraphs, index numbers placed in parentheses immediately after the nomenclature of parts, and not accompanied by figure numbers, all refer to the figure named at the beginning of that paragraph. When additional references to other figures are made in the same paragraph they also appear in parentheses following the part nomenclature, but in such instances the index number is followed by a comma and the figure number. Thus, "(10, figure 1-1)" refers to index number 10 in figure 1-1, but "(10)" refers to the

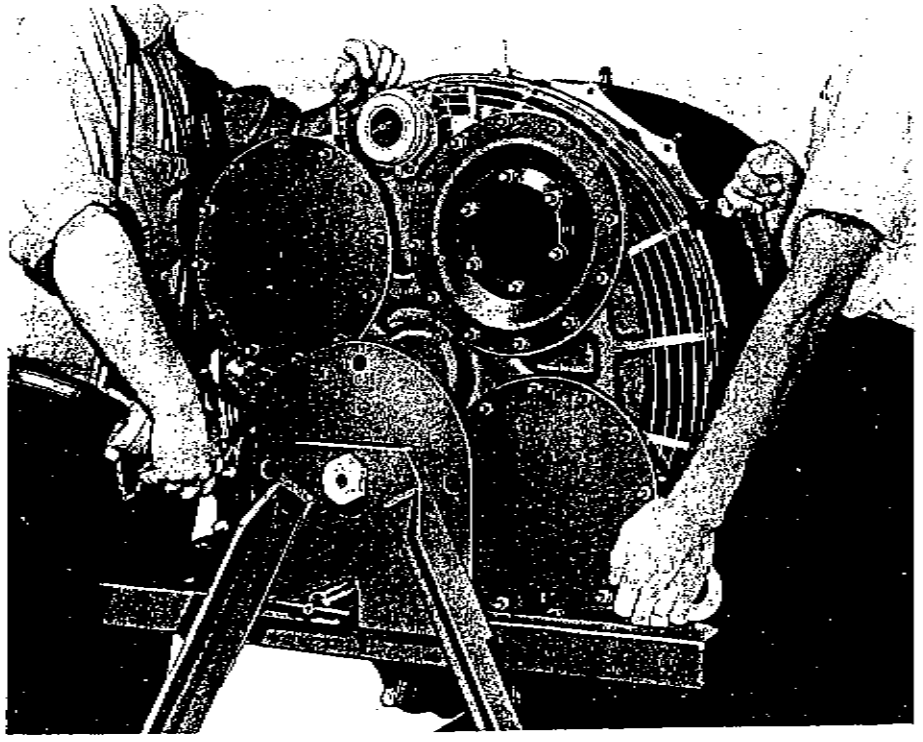


Figure 4-3. Lifting Off Complete Fan Inlet and Gear Housing Assembly

figure indicated at the beginning of the paragraph, whether it appears before or after an expression such as "(10, figure 1-1)". Throughout the dismantling procedure such references to illustrations of parts and assemblies in figures 1-1 through 1-4 are intended to indicate the locations and appearance of such parts as supplements to drawings of the assemblies or in lieu of such drawings when dismantling work is not complex. To assist the reader in locating instructions on specific parts, Table I lists in the first column the sequence of dismantling operations and in the following columns references to pertinent text and illustrations.

4-12. HANDLING OF PARTS. Normally, moving parts will be covered with enough oil to protect them from corrosion while awaiting cleaning operations. If dry at disassembly, all unplated steel parts should be coated with lubricating oil or a mixture of one part corrosion preventive compound, MIL-C-6529, type 1, and three parts engine lubricating oil. Wooden racks should be used for storage of crankshaft and connecting rods assemblies. The same racks will serve for stripped crankshafts. If steel racks are used for this purpose they must be padded with canvas, felt or other nonabrasive material. Crankshafts

TABLE I. DISMANTLING AND DISASSEMBLY PROCEDURE

Sequence No.	Dismantling Procedure: Illustration Figure No.	Dismantling Procedure: Illustration Index No.	Dismantling Procedure: Text Paragraph No.	Disassembly Procedure: Illustration Figure No.	Disassembly Procedure: Text Paragraph No.	Part or Subassembly
1	1-1	18	4-2	—	—	Shroud left detachable panel
2	1-4	1	4-2	—	—	Shroud right detachable panel
3	1-1	17	4-3	—	—	Shroud left bottom side panel
4	1-4	15	4-3	—	—	Shroud right bottom side panel
5	1-1	14	4-19	—	—	Engine oil gauge
6	1-4	5	4-19	—	—	Gear case oil gauge
7	1-4	6	4-19	—	—	Gear case oil filler cap
8	1-3	23	4-19	—	—	Engine oil sump drain plug
9	1-4	12	4-19	—	—	Gear case oil drain plug
10	1-3	16	4-20	—	—	Sump to gear case tube assembly
11	1-3	9, 10 11, 12	4-20	4-24	4-58	Fan inlet and gear housing assembly
12	1-4	13	4-21	—	4-59	Flywheel and fan assembly
13	1-2	19	4-22	—	—	Pump to heater fuel hose
14			4-22	—	—	Heater spark plug cable
15	1-2	2	4-22	4-5	—	Blower engine exhaust pipe
16	1-1	13	4-22	4-5	—	Blower to heater flexible duct
17	1-2	1	4-22	—	—	Heater indicator lamp
18	4-5	25	4-22	—	—	Blower engine
19	4-5	23	4-22	—	—	Blower to governor bracket
20	4-5	22	4-22	—	—	Blower to accessory case bracket
21	1-1	5	4-23	4-6	4-23	Rear exhaust pipes and jackets
22	4-7	1, 2, 3, 4	4-24	—	—	Heater to mixing valve duct and tube
23	4-7	8	4-24	—	—	Stewart-Warner heater
24	4-7	9, 10, 11 12, 13	4-24	—	—	Heater to sump tube assembly
25	1-2	7	4-25	4-25	4-60	Carburetor air filter element
26	1-2	8, 9	4-25	4-25	4-60	Air filter housing and adapter
27	1-2	10	4-26	4-26	4-61	Preheat and mixing valve
28	1-2	4	4-27	—	—	Pump to carburetor fuel hose
29	1-1	3	4-27	—	—	Zenith-Stromberg carburetor
30	1-1	4	4-28	11-3	11-21	Ignition assembly
31	4-8	All	4-28	—	—	Magneto, coupling and noise filter
32	4-9	All	4-29	4-27	4-62	Governor drive and oil pressure valve assembly
33	1-2	14	4-30	4-28	4-63	Fuel pump and drive assembly
34	4-10	2, 3, 4, 5	4-31	—	—	Engine oil gauge support
35	1-3	2	4-32	—	—	Shroud brace rods
36	4-14	7, 8	4-33	—	—	Oil sump thermocouple
37	4-14	9	4-33	—	—	Oil sump thermoswitch
38	1-3	25	4-33	—	—	Heater mount brackets

TABLE I. DISMANTLING AND DISASSEMBLY PROCEDURE (Cont)

Sequence No.	Dismantling Procedure: Illustration Figure No.	Dismantling Procedure: Illustration Index No.	Dismantling Procedure: Text Paragraph No.	Disassembly Procedure: Figure No.	Disassembly Procedure: Text Paragraph No.	Part or Subassembly
39	4-11	All	4-34	—	4-64	Shroud shutters
40	4-12	1-8	4-35	—	—	Starter detent control
41	1-3	13	4-35	—	—	Starter power cable
42	1-3	14	4-35	—	—	Starter ground cable
43	1-4	3	4-35	—	—	Starter magnetic switch
44	1-1	16	4-36	—	—	Oil cooler
45	—	—	4-37	—	—	Shroud bottom front panel
46	1-3	1	4-38	—	—	Valve rocker covers
47	1-3	19	4-39	—	—	Delco-Remy starter
48	4-18	11	4-40	—	—	Shroud lower rear panel adapters
49	4-18	45	4-40	—	—	Webbing seal strips
50	1-3	18	4-40	—	—	Flexible duct
51	1-3	20	4-40	4-13	—	Exhaust manifolds and jackets
52	4-14	26	4-41	4-14	4-65	Oil sump assembly
53	1-2	13	4-42	—	—	Shroud lower rear panels
54	—	—	4-43	4-16	4-66	Oil sump adapter assembly
55	4-17	1	4-44	—	—	Bottom cylinder attachments
56	4-17	2-5	4-45	—	—	Front crankcase support
57	4-17	10	4-46	—	—	Accessory case oil drain tube
58	1-1	8	4-46	11-1	11-2	Engine oil filter
59	1-2	16	4-46	—	—	Governor oil drain adapter
60	4-17	—	4-46	4-29	4-67	Accessory case assembly
61	4-18	All	4-47	—	—	Shroud top and upper rear panels
62	4-19	4-8	4-48	—	—	Shroud to rear cylinder baffles
63	1-3	6	4-49	—	—	Flexible duct
64	4-20	—	4-49	4-30	4-69	Fan outlet housing
65	1-4	4	4-49	—	4-68	Shroud front panel and baffles
66	1-3	3, 4	4-50	—	4-70	Induction system
67	4-19	16, 18	4-51	—	—	Inter head and inter barrel baffles
68	4-21	1-7	4-52	4-31	4-71	Crankcase heater air valve
69	4-21	8-11	4-52	4-32	4-72	Oil pressure valve
70	4-22	—	4-53	4-33	4-73	Cylinder assemblies
71	—	—	4-53	—	4-74	Piston assemblies
72	—	—	4-54	—	—	Timing gears
73	4-23	All	4-55	4-23	4-57	Crankcase
74	—	—	4-55	4-34	4-75	Crankshaft and connecting rods
75	—	—	4-55	—	—	Camshaft

should be supported horizontally on front and rear main journals. Camshafts should be stored in nearly vertical positions on partitioned wooden racks. Cylinders and cylinder assemblies should be stored in the vertical position on wooden racks consisting of horizontal planks with holes into which the cylinder pilot skirts will fit loosely. Do not place serviceable cylinders on concrete floors or other abrasive surfaces. Suitable wooden racks should be provided for storage of hydraulic valve lifters. Such a rack should accommodate one engine set of 12 lifters and should have holders arranged in straight rows for lifter bodies, hydraulic units, sockets and retainer rings so that the parts of each lifter will be identified by their relative positions in the rack, since it is advisable to reassemble worn parts in their original relationships. The rack should be designed to minimize the possibility of lifter parts being spilled and intermixed. Other subassemblies, before and after disassembly, and parts removed from the packette individually should be placed on wood, linoleum, masonite of other suitable rack shelves or in specially constructed racks designed to prevent falling, bumping, stacking and other dangerous conditions.

4-13. PRESERVATION OF ORIGINAL ASSEMBLY RELATIONSHIPS. It is important to preserve the identity of subassemblies and parts by packette serial and model numbers (found on the identification plate attached to the top of the fan outlet housing) in order to insure their reassembly in original relationships. This precaution is particularly applicable to the relation of fan outlet housing and crankcase. Observe match mark numerals stamped on top of crankcase front mounting flange and on fan housing.

4-14. Crankshaft counterweights should be marked by acid etching (but not by electric etching or stamping) immediately after disassembly to assure reassembly on the same side of the shaft and with the same sides forward as originally assembled. This precaution is necessary, because the crankshaft is dynamically balanced after original assembly. The acid etched numerals or letters and their locations should be standardized to avoid errors in reassembly.

4-15. If cylinders, pistons or connecting rods are interchanged the following procedures will be necessary at reassembly. Unless these can be accomplished accurately with available equipment, and unless shop procedures are set up to assure their accomplishment, pooling or interchanging of these parts should not be allowed.

a. A balanced set of connecting rods and a balanced set of pistons must be selected for each engine to be assembled by weighing each part and grouping them within weight limits specified in Section VIII.

b. The position numbers stamped on piston heads and on connecting rod and cap bolt bosses must be obliterated if they duplicate those on other parts in the same set, and correct position numbers (1 through 6) must be stamped adjacent to the original numbers.

c. The pistons to be installed in reconditioned cylinders should be measured across the skirts and matched to cylinder bores to provide, as nearly as possible, uniform piston side clearance in each engine.

Note

The foregoing precautions relative to handling and marking of parts are given at this point, since these considerations will affect disassembly work, as well as subsequent operations.

4-16. PARTS TO BE DISCARDED.

4-17. Without further instructions, discard immediately upon removal all rubber packings, copper-asbestos gaskets, soft composition gaskets, tooth lock washers, AN356 nut locks, cotter pins, lockwire and piston rings. As an exception to this procedure it is advisable to save cylinder base packing rings for use as retainers during dismantling and during reassembly, as described in the text, unless special retainers are available. *(See figure 8-13.)*

4-18. DISMANTLING PROCEDURE.

4-19. DRAINING OIL. Withdraw the engine oil level gauge (14, figure 1-1) and the generator gear case oil gauge (5, figure 1-4) from their support tubes. Remove the gear case oil filler cap (6, figure 1-4) by turning to the left to release the bayonet lock. After placing suitable receptacles under the oil sump drain plug (23, figure 1-3) and the gear case oil drain plug (12, figure 1-4), unscrew these plugs and allow the sumps to drain thoroughly. (The engine sump has a capacity of 12 quarts and the gear case sump a capacity of 2 quarts.)

4-20. FAN INLET AND GEAR HOUSING ASSEMBLY. *(See figure 4-3.)* Loosen two clamps; detach the tube bracket from the oil cooler, and remove the two-piece sump to gear case heat tube assembly (16, figure 1-3). Remove the parts (5, 6 and 7, figure 4-24) which hold the oil filler tube and oil level gauge support tube clamps on a bracket attached to the fan outlet housing. Remove two hose clamps, and withdraw the gear case oil filler tube (7, figure 1-4). Discard the connector hose. Unscrew the gauge support tube coupling nut, and lift off the tube. Detach the rubber lined clamps from the filler tube and gauge tube. Remove 16 sets of attaching nuts and washers around the rear flange of the inlet and gear housing (9, figure 1-3); then two men can lift off the entire assembly, as illustrated, moving it straight forward until the coupling is separated, or a hoist may be attached by means of the vertical studs on top to facilitate this operation.

4-21. FLYWHEEL AND FAN ASSEMBLY. *(See figure 4-4.)*

a. Detach and remove the driving flange and bushing assembly of the Ajax coupling from the center of the flywheel.

b. Loosen and remove six flywheel attaching nuts and three lock plates (previously covered by the coupling flange). Pry the bent lock plate corners away from the nuts and flatten them before attempting to loosen nuts.

c. Pull the flywheel and fan assembly by screwing two machine bolts into the tapped puller holes and tightening them as illustrated.

d. Lift off the flywheel and fan assembly (2 men).

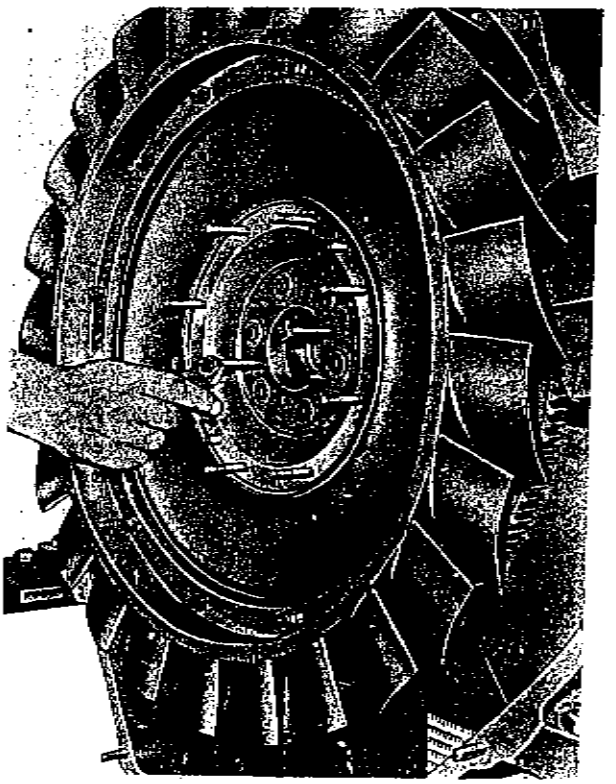
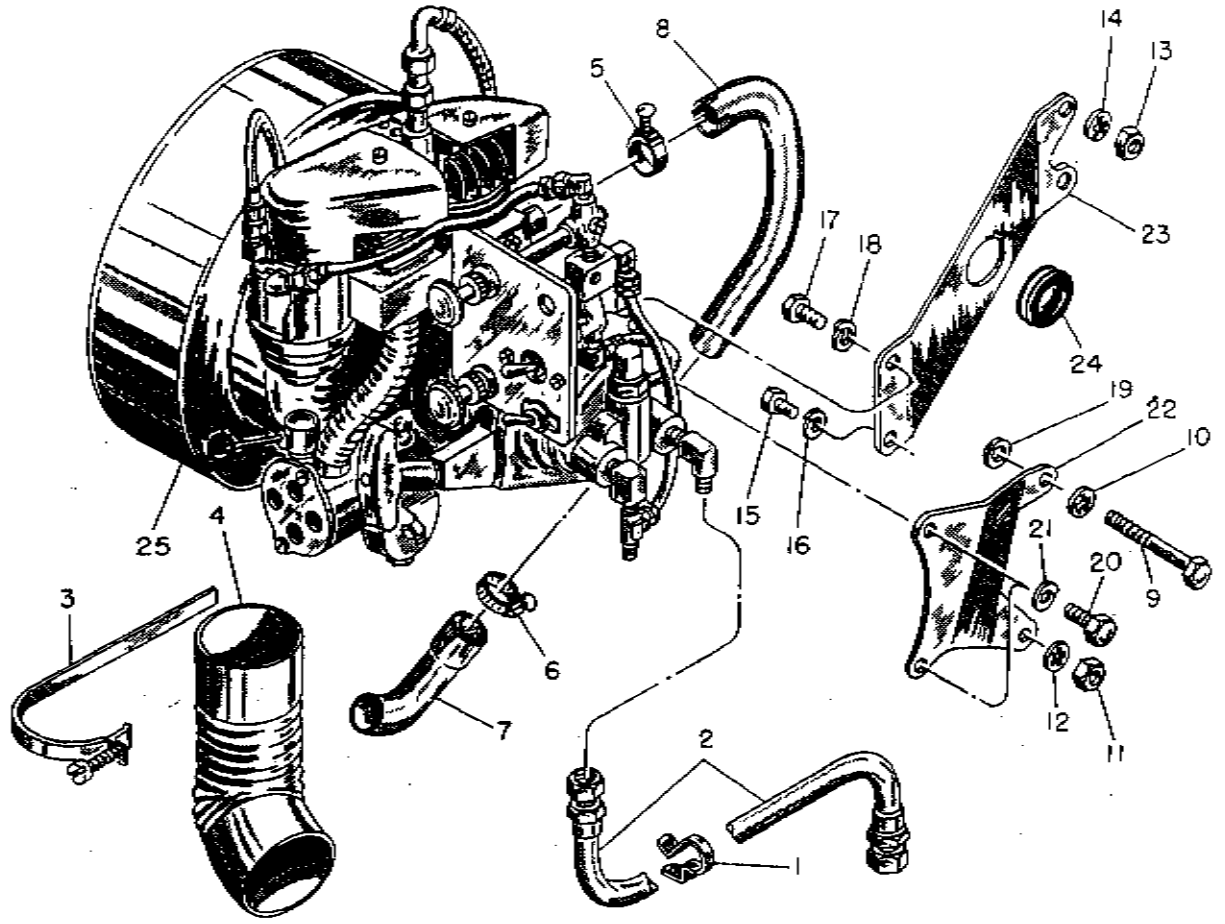


Figure 4-4. Pulling Flywheel



1. Bracket
2. Hose assembly
3. Hose clamp
4. Duct
5. Clamp
6. Clamp
7. Tube
8. Tube
9. Bolt
10. Washer
11. Nut
12. Washer
13. Nut
14. Washer
15. Bolt
16. Washer
17. Screw
18. Washer
19. Washer
20. Screw
21. Washer
22. Bracket
23. Bracket
24. Grommet
25. Engine

Figure 4-5. Heater Blower Engine and Connections

4-22. BLOWER ENGINE. *(See figure 4-5.)*

a. Detach the bracket (1) from the exhaust manifold jacket and couplings of the hose assembly (2) from the heater and blower engine elbows.

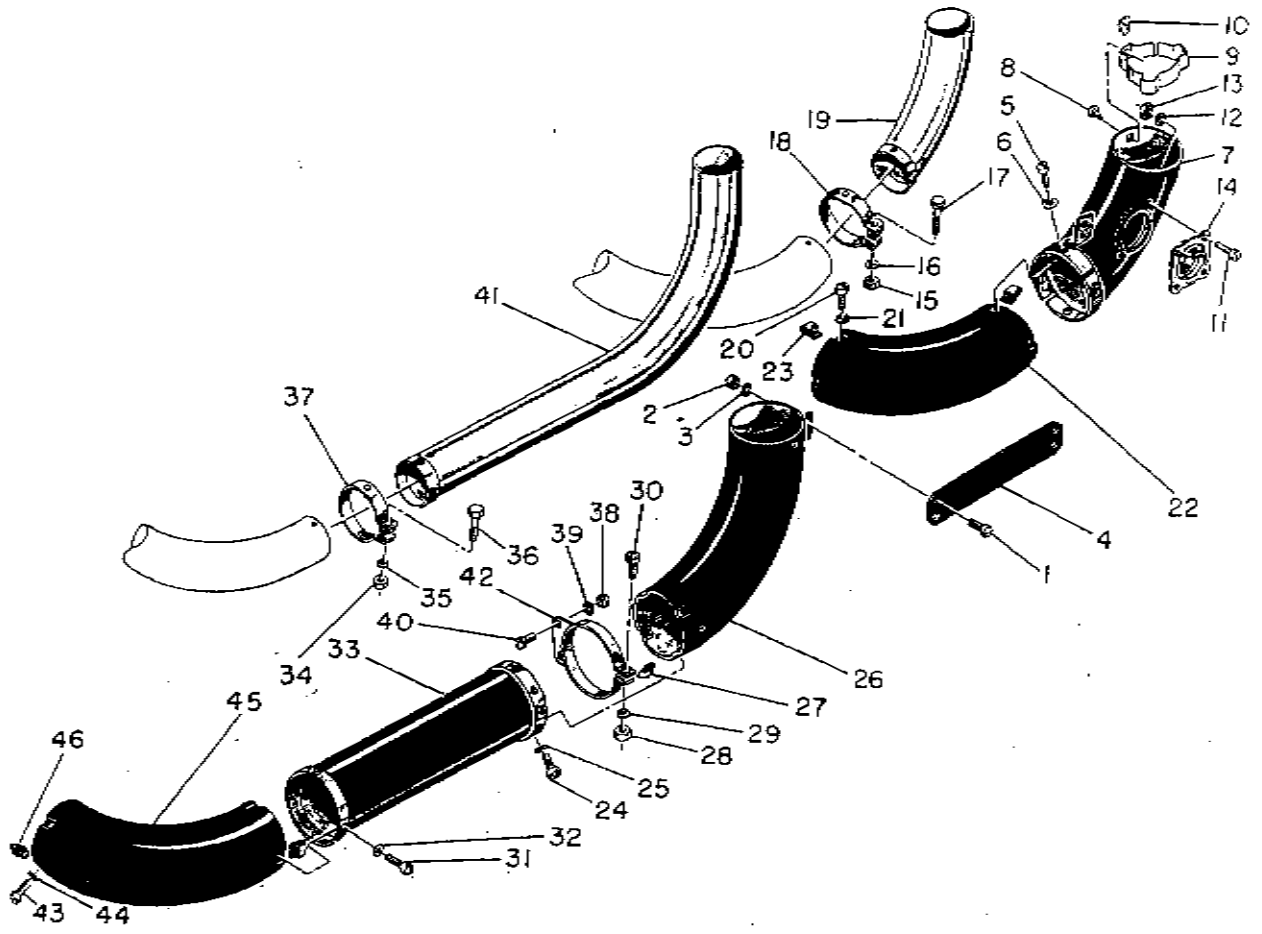
b. Loosen two clamps (3), and pull the duct (4) from the blower engine and heater.

c. Loosen two clamps (5) at upper and lower ends of the blower engine exhaust pipe assembly (5, 6, 7, 8), and pull the assembly from its connectors.

d. Disconnect all ignition cables from packette engine spark plugs. Install AN4060-1 plastic projectors in the elbow coupling nuts. Push left side ignition cable grommets from the shroud left rear panel, and feed the left cable and conduit assemblies out through the holes. Push the large grommet (24) from the blower engine to governor adapter bracket (23), and feed the left cables out through the hole.

e. Detach and remove the ignition cable assembly from the heater spark plug, leaving it connected to the blower engine.

f. Unscrew the cap and lock nut from the heater indicator lamp assembly at the upper right corner of the blower engine control panel, and withdraw the lamp assembly from the panel. Reassemble its parts, leaving it soldered to the harness. Detach and remove the heater switch from its position below the indicator lamp, leav-



1. Nut
2. Washer
3. Screw
4. Brace
5. Screw
6. Washer
7. Elbow
8. Screw
9. Spacer
10. Nut
11. Screw
12. Washer
13. Nut
14. Thermoswitch
15. Nut
16. Washer
17. Bolt
18. Clamp
19. Elbow
20. Screw
21. Washer
22. Elbow
23. Nut
24. Screw
25. Washer
26. Elbow assembly
27. Nut
28. Nut
29. Washer
30. Screw
31. Screw
32. Washer
33. Jacket
34. Nut
35. Washer
36. Bolt
37. Clamp
38. Nut
39. Washer
40. Screw
41. Pipe
42. Bracket assembly
43. Screw
44. Washer
45. Elbow
46. Nut

Figure 4-6. Rear Exhaust Pipes, Jackets and Brackets

ing it connected to the harness. Lay that branch of the heater wiring harness back over the exhaust jacket.

g. Remove attaching parts (9, 10) from the accessory case and attaching parts (11, 12) from the case stud below. The spacer (19) will fall out when the lower engine is removed. Leave the lower bracket (22) attached to the blower engine. Remove two sets of left side governor (or cover) attaching parts (13, 14). While supporting the blower engine, remove the lower attaching screw and lock washer (17, 18) then the upper set (15, 16), and lift off the engine and its lower bracket.

h. Detach the bracket (22) from the blower engine by removing two sets of parts (20, 21).

i. If a governor is installed and does not provide enough clearance to permit removal of the upper bracket (23), remove its two sets of right side attaching parts, and withdraw governor and bracket together from the adapter studs. If a cover (6, figure 1-2) is installed on the governor pad it may be left in place.

4-23. REAR EXHAUST PIPES, JACKETS AND BRACKETS. *(See figure 4-6.)*

a. Remove four sets of attaching parts (1, 2, 3) and the cross brace (4).

b. Disconnect the two heater wiring harness cables from the thermo disc switch (14). Remove four sets of attaching parts (5, 6) and the first jacket elbow (7).

c. Remove two screws (8), and lift out the spacer (9). Remove from it the two speed nuts (10). Remove two screws, washers and nuts (11, 12, 13) and the thermoswitch (14).

d. Remove the clamping parts (15, 16, 17) and spread the clamp assembly (18) enough to disengage its rivet from the right manifold; then take off the exhaust elbow (19).

e. Remove four sets of attaching parts (20, 21), and slide off the second jacket elbow (22). Remove eight cage nuts (23) from it.

f. Remove four sets of attaching parts (24, 25) from the right end of the cross pipe jacket (33). This will also detach the first heater wiring harness bracket. Remove it from the harness. Slide off the third jacket elbow (26). Remove its four cage nuts (27) and, from each end, a spacer assembly (same as 8, 9, 10).

g. Remove clamping parts (28, 29, 30) and four sets of cross pipe jacket attaching parts (31, 32), and slide the jacket to the right to expose a clamp (37). This will also detach a third wiring harness bracket. Remove it.

h. Remove clamping parts (34, 35, 36) and spread the clamp (37) to disengage its rivet from the left manifold. Slide the cross pipe (41) out slightly to prevent the rivet from engaging (or rotate the clamp).

i. Remove two sets of attaching parts (38, 39, 40) from the bracket (42) and its support. Removal of the lower set will also detach a heater wiring harness support clip. Lift off the cross pipe and jacket assembly. Remove the clamp (37) from the cross pipe (41); then slide off the jacket (33). Remove the bracket (42), and remove a spacer and attaching parts (same as 8, 9, 10).

j. Remove four sets of attaching parts (43, 44), and slide the last jacket elbow (45) from the left manifold. Remove its eight cage nuts (46).

4-24. HEATER. *(See figure 4-7.)*

a. Loosen three hose clamps (1) on the duct (2) (also 6, figure 1-1) and tube assembly (4). Remove the retaining screw (3). Pull the duct from the preheat and mixing valve housing inlet boss and the tube assembly from the heater outlet collar.

b. Remove the screw which holds a short cambric insulating sleeve to a clip welded near the top of the heater about midway along its jacket. Detach all electrical cables from the heater terminal block, excepting the one connected to the heater fuel valve. Pass those connected to thermoswitches on the heater out through the cambric sleeve, and reconnect them to the terminal block screws. Disconnect the Burndy connector on one cable from a white cable permanently attached to the rotary solenoid on the front side of the preheat and mixing valve housing. Disconnect two cables from the thermoswitch installed on the left side of the packette oil sump near the rear, and detach the clip supporting their cambric sleeve from an oil sump stud. Lift off the heater wiring harness assembly.

c. Remove four sets of attaching parts (5, 6, 7) to detach the heater (8) from its two mounting brackets (17). Withdraw the heater rearward.

d. Loosen the clamp screw nut (9) at the rear end of the tube assembly (12) (also 10, figure 1-1), and pull the tube from the heater exhaust elbow. Slide off the clamp and its attached parts.

e. Unscrew the elbow (14) from the heater fuel filter.

4-25. CARBURETOR AIR FILTER, HOUSING AND ADAPTERS. The filter, housing and breather hose (7, 8 and 9, figure 1-2) and a cast aluminum alloy adapter attached to the front side of the housing may be removed as a unit after loosening the lower hose clamp, removing four sets of adapter-to-carburetor attaching nuts and washers and removing six sets of housing-to-preheat and mixing valve attaching fillister head screws and washers. Lift the housing until the hose is clear of the breather tube on the governor adapter, then withdraw it rearward from the carburetor. Remove two gaskets.

4-26. PREHEAT AND MIXING VALVE ASSEMBLY.

a. Detach the short spring holding the No. 1 cylinder head baffle to a tab washer under the rear flange attaching screw of the No. 1 cylinder intake tube.

b. Remove the screw mentioned in the preceding step.

c. Remove two fillister head screws, lock washers and plain washers, and remove the mixing valve support (flat end tube) and the heat valve cover under it from the mixing valve housing (10, figure 1-2). Pull the support tube out through the shroud grommet.

d. Loosen its upper and lower hose clamps, and pull the flexible duct from the mixing valve housing (forward bottom inlet) and from the right exhaust manifold jacket collar just behind the shroud.

e. Remove two sets of attaching nuts and washers inside the upper cavity in the mixing valve housing and withdraw the valve assembly to the right from the governor adapter studs.

4-27. CARBURETOR AND HOSE.

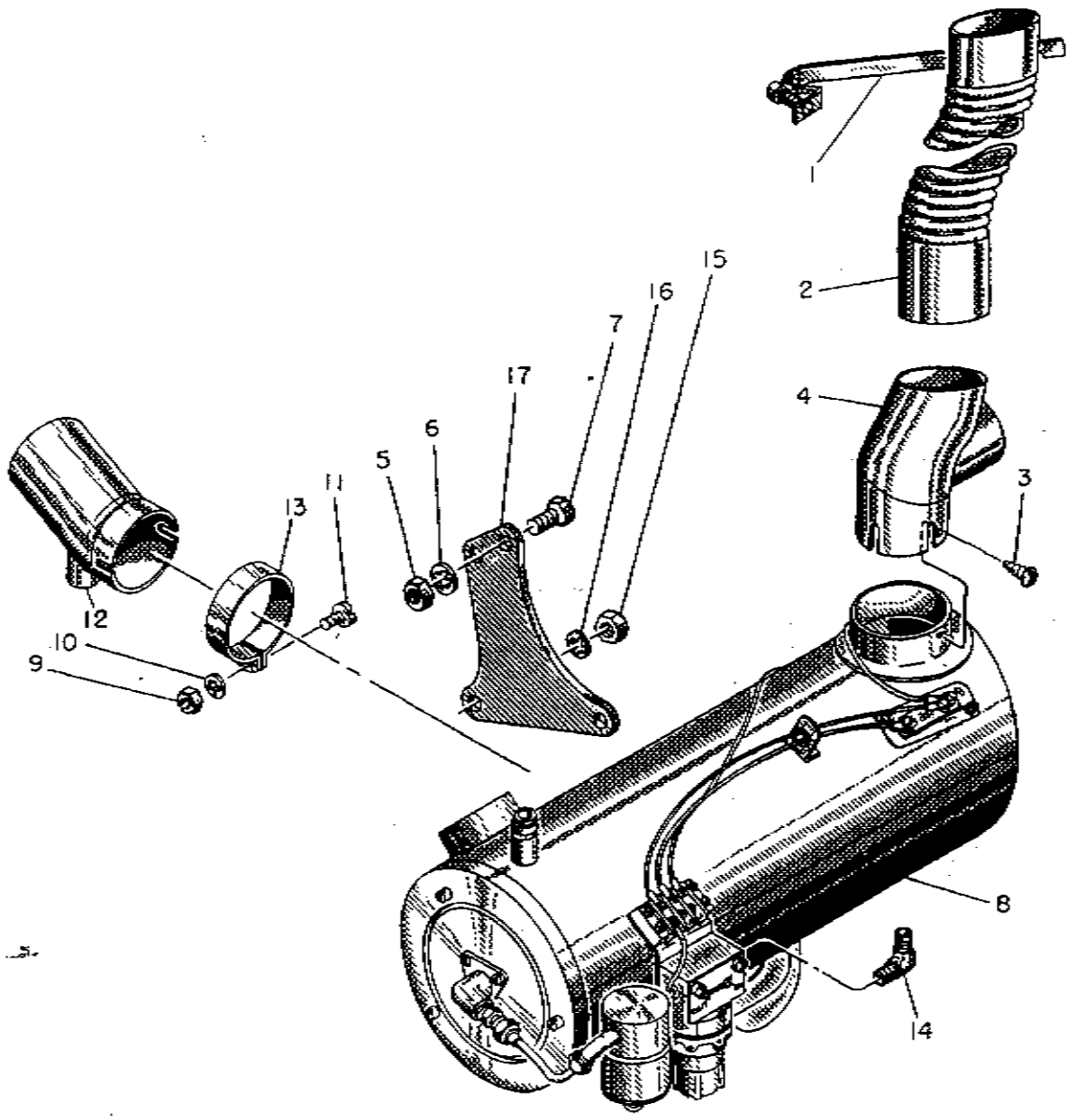
a. Unscrew the end connectors of the pump to carburetor fuel hose assembly (4, figure 1-2), and detach the hose bracket from the governor adapter to remove the hose assembly.

b. Loosen the fuel pump outlet elbow enough to permit removal by hand later, and loosen the carburetor inlet elbow and extension adapter for the same purpose.

c. Loosen and remove four sets of carburetor attaching nuts and washers from the intake manifold studs, and lift off the carburetor (3, figure 1-1).

4-28. IGNITION SYSTEM. *(See figure 4-8.)*

a. Remove four fillister head screws which attach the high tension cable outlet plate to the rear side of the



1. Clamp
2. Duct
3. Screw
4. Outlet tube assembly
5. Nut
6. Washer
7. Screw
8. Heater
9. Nut
10. Washer
11. Screw
12. Tube assembly
13. Clamp
14. Elbow
15. Nut
16. Washer
17. Bracket

Figure 4-7. Heater, Brackets and Ducts

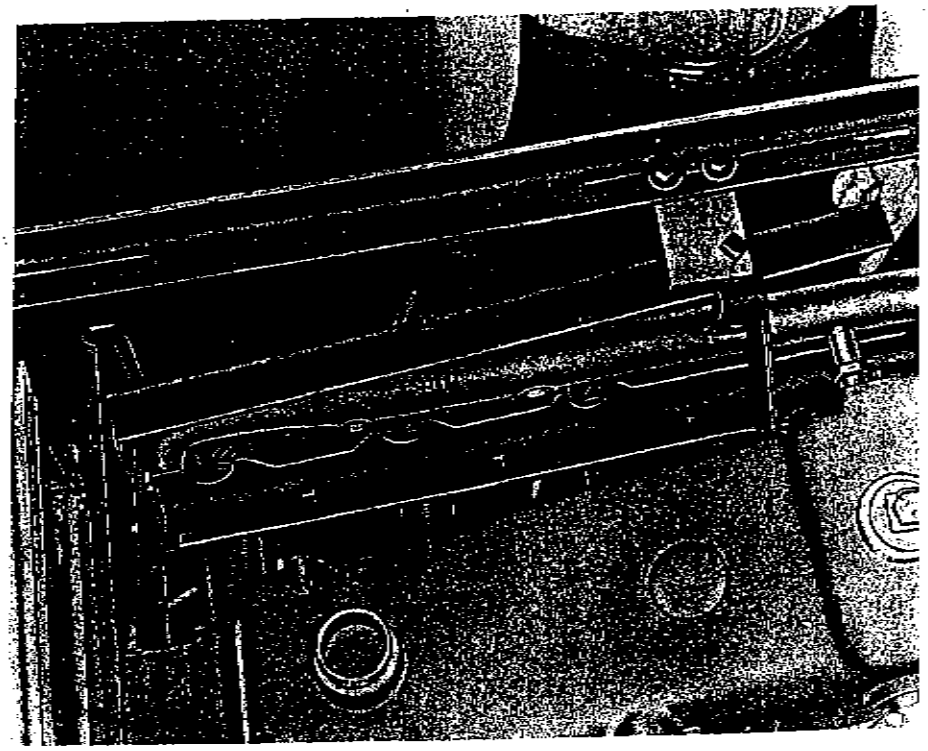


Figure 4-13. Removing Left Side Outer Exhaust Manifold Jacket

and lift it straight up over the oil pump suction tube. *(See figure 4-15.)*

d. Remove the sump gasket (27) from the flange to which it adheres.

e. Slide the plate (29) off the accessory case drain tube. Remove the "O" ring packing (28).

Note

Parts indicated by index numbers 16 through 20 in figure 4-14 will be removed at a later stage.

4-42. SHROUD LOWER REAR PANELS. Remove the two fillister head screws which attach the lower rear panels to the upper rear panels and the screw which attaches the two lower panels where they overlap at the center; then slide out both lower panels (13, figure 1-2 and opposite).

4-43. OIL SUMP ADAPTER. *(See figure 4-16.)*

a. Loosen the square head plug (13) slightly to facilitate removal later.

b. Loosen the oil pressure relief valve cap (9) slightly.

c. Detach the sump adapter (15), by removing four cotter pins (1) from castle nuts (2) inside the casting cavity and unscrewing those four nuts, then removing two sets of attaching parts (3, 4, 5) and six sets of parts (6, 7, 8) from crankcase studs.

d. Lift off the adapter assembly, and strip off the three short and two long gaskets (16, 17, 18). Make sure that no gasket material remains across the crankcase parting line.

Note

Parts indicated by index numbers 9 through 14 in figure 4-16 will be removed at a later stage.

4-44. PRELIMINARY CYLINDER WORK. *(See figure 4-17.)*

a. Remove three sets of attaching parts from each push-rod housing flange (1).

b. *(See figure 4-19.)* The springs (1, 2, 3) which connect the lower inter head baffles and the lower ends of inter cylinder baffles together and to the shroud to front cylinder baffles are now above the cylinders. Detach and remove these only. Do not remove springs indicated by index numbers 4, 5 or any higher numbers at this stage.

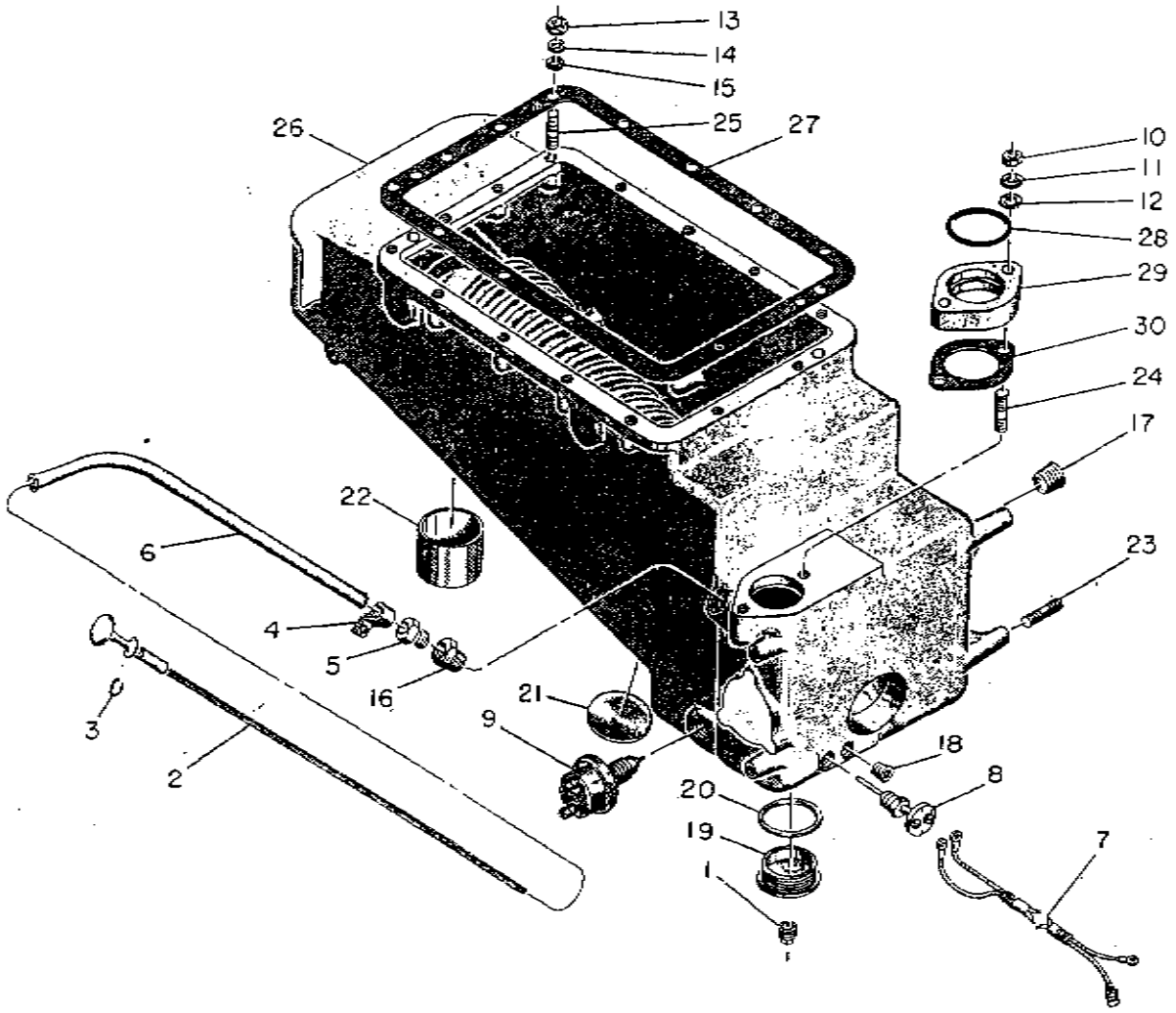
c. Loosen and unscrew four bottom side nut locks, then four flanged nuts (now on top) from attaching studs and through bolts at each cylinder base flange.

4-45. INSTALLATION OF FRONT CRANKCASE SUPPORT. *(See figure 4-17.)*

a. Insert the support assembly (2) between the crankcase and the engine cradle somewhat ahead of the illustrated position, and hook the welded clip over one rail, as shown. Slide the clamp (3) over the other rail.

b. Back out the jack screw (4) until the bottom side of the swivel (5) is flush with the toes of the beam flanges. Slide the beam into the illustrated position, and run the jack screw down so that the hole in the swivel passes over the long stud in the left crankcase casting.

c. Tighten the two screws which lock the clamp (3) to the bed.



1. Plug	7. Thermocouple lead	13. Nut	19. Plug	25. Stud
2. Engine oil gauge	8. Thermocouple	14. Washer	20. Gasket	26. Oil sump
3. Circlip	9. Thermoswitch	15. Washer	21. Plug	27. Gasket
4. Support bracket	10. Nut	16. Connector	22. Bushing	28. Packing
5. Nut	11. Washer	17. Plug	23. Stud	29. Plate
6. Support tube	12. Washer	18. Plug	24. Stud	30. Gasket

Figure 4-14. Exploded View of Oil Sump and Oil Gauge

Legend for Figure 4-16

1. Cotter pin	7. Washer	13. Plug
2. Nut	8. Washer	14. Gasket
3. Nut	9. Relief valve cap	15. Oil sump adapter
4. Washer	10. Gasket	16. Gasket
5. Washer	11. Relief valve spring	17. Gasket
6. Nut	12. Relief valve plunger	18. Gasket

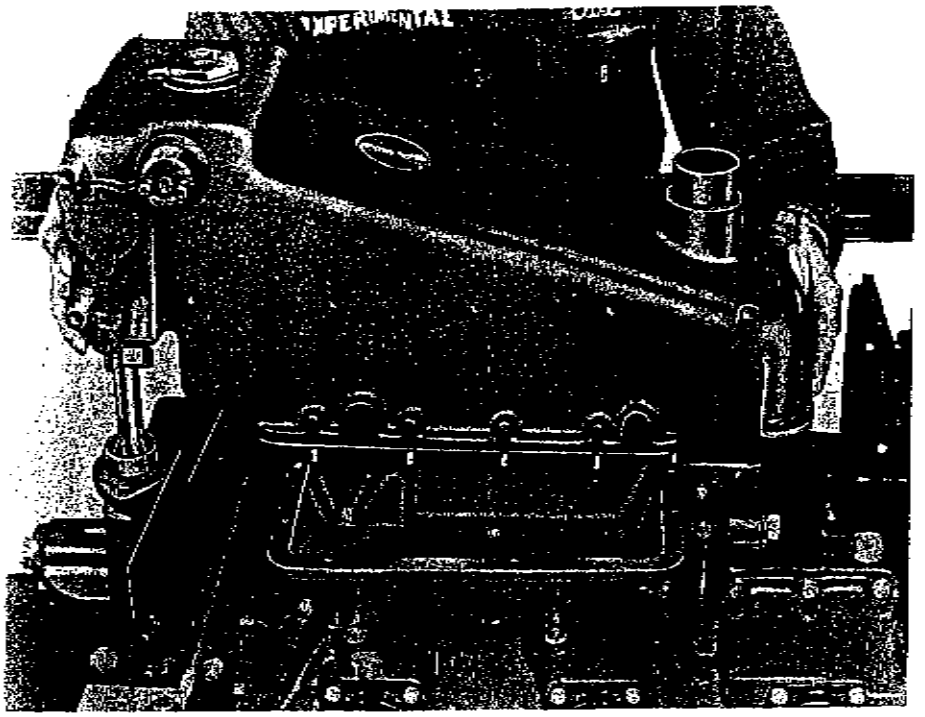


Figure 4-15. Lifting Off Oil Sump

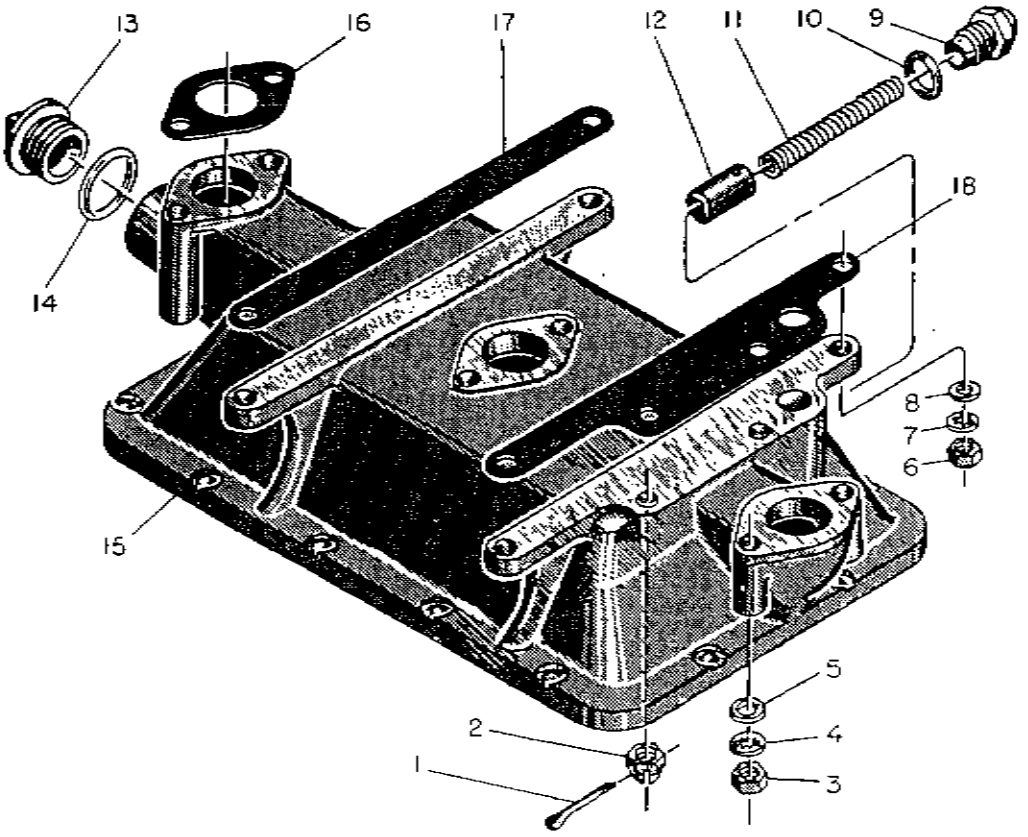
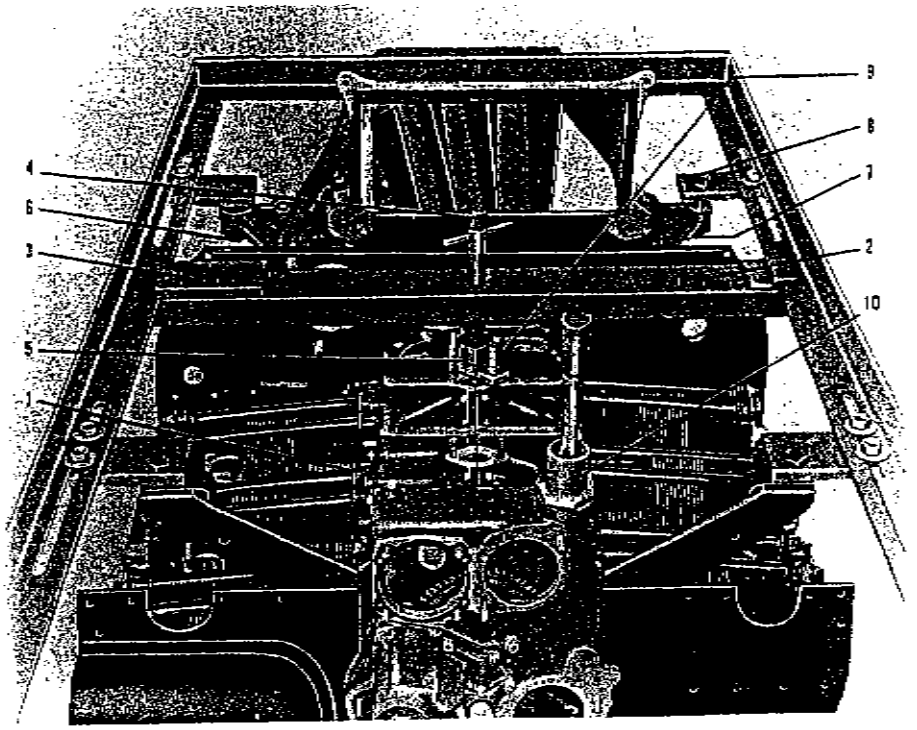


Figure 4-16. Oil Sump Adapter Assembly



1. Pushrod housing flange
2. Crankcase front support
3. Clamp block
4. Jack screw
5. Swivel block
6. Nut
7. Nut
8. Engine stand adapter
9. Pipe spacer, washer, nut
10. Oil drain tube

Figure 4-17. Front Crankcase Support Installed on Engine Cradle

d. Loosen the two front packette mounting bolt nuts (6 and 7) as far as possible without beginning to disengage them. From 1/2 to 1 inch mount boss clearance from the adapters (8) is preferable.

e. Tighten the jack screw (4) until the swivel (5) is in contact with the crankcase. Install on the long case stud, over the swivel, a pipe spacer, a plain washer and a nut (9), and tighten the nut.

CAUTION

Do not remove the front mount bolts or nuts while the packette is inverted. The crankcase stud to which the support swivel is attached is not designed to support more than the crankcase.

4-46. ACCESSORY CASE ASSEMBLY.

a. Loosen slightly the accessory case oil drain tube (10, figure 4-17) and the oil filter (8, figure 1-1) to facilitate their removal at a later stage.

b. Remove one short and three long special hex head screws which attach the accessory case to the bottom edge of the crankcase rear surface. These are located between the crankcase ends of the rear mount brackets visible at the bottom of figure 4-17.

c. Turn the engine cradle over so that the crankcase will be upright. (Refer to paragraph 4-9.)

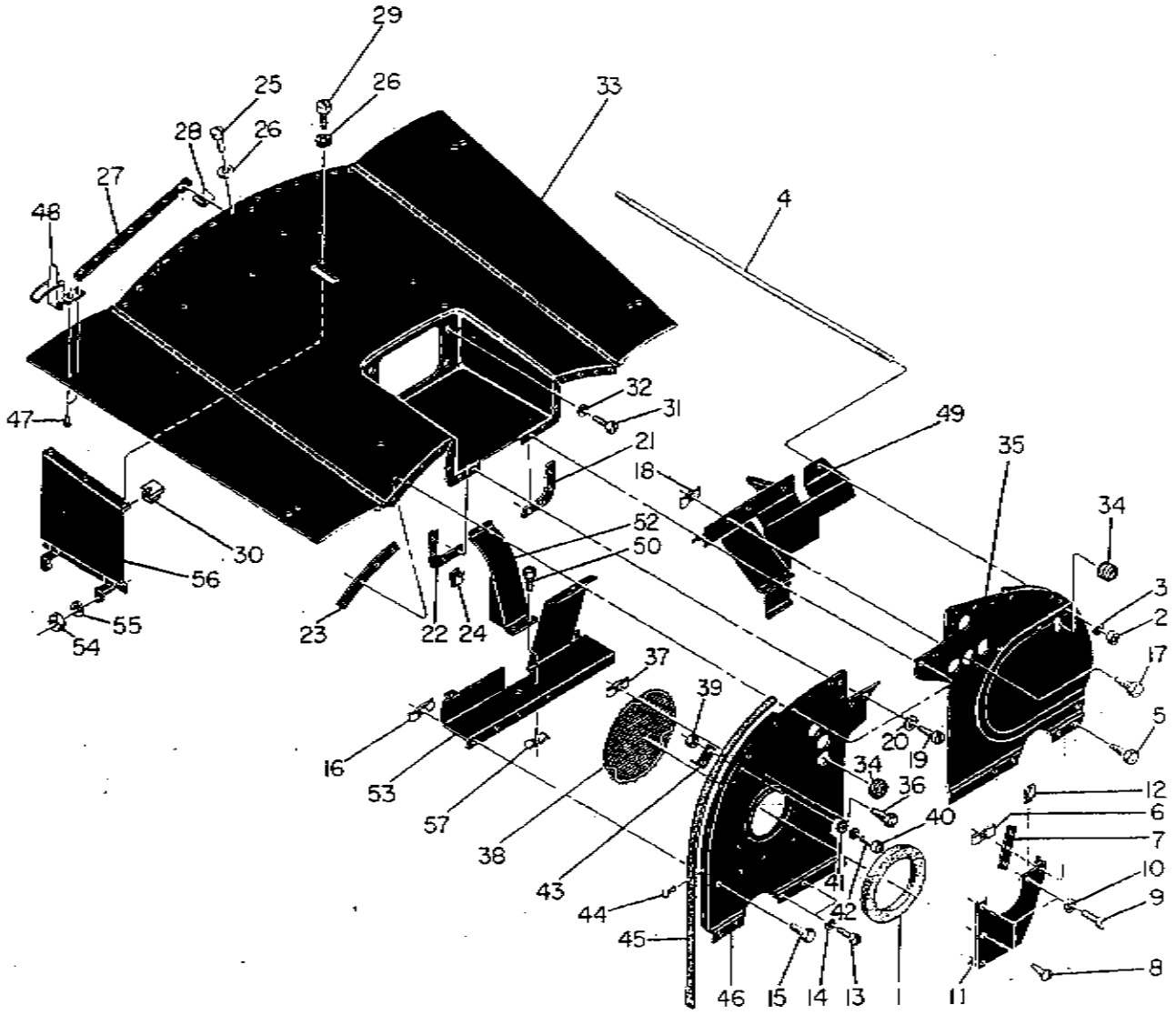
d. Detach and remove the governor oil drain adapter (16, figure 1-2) and its gasket from the accessory case.

e. Inside the opening uncovered in the preceding step and inside the magneto pilot opening to the right of it will be found two hex head screws secured by tab washers. Bend down the tabs, and back out the screws.

f. Remove the long hex head bolt and washers above the magneto mount pad to complete the detachment of the accessory case.

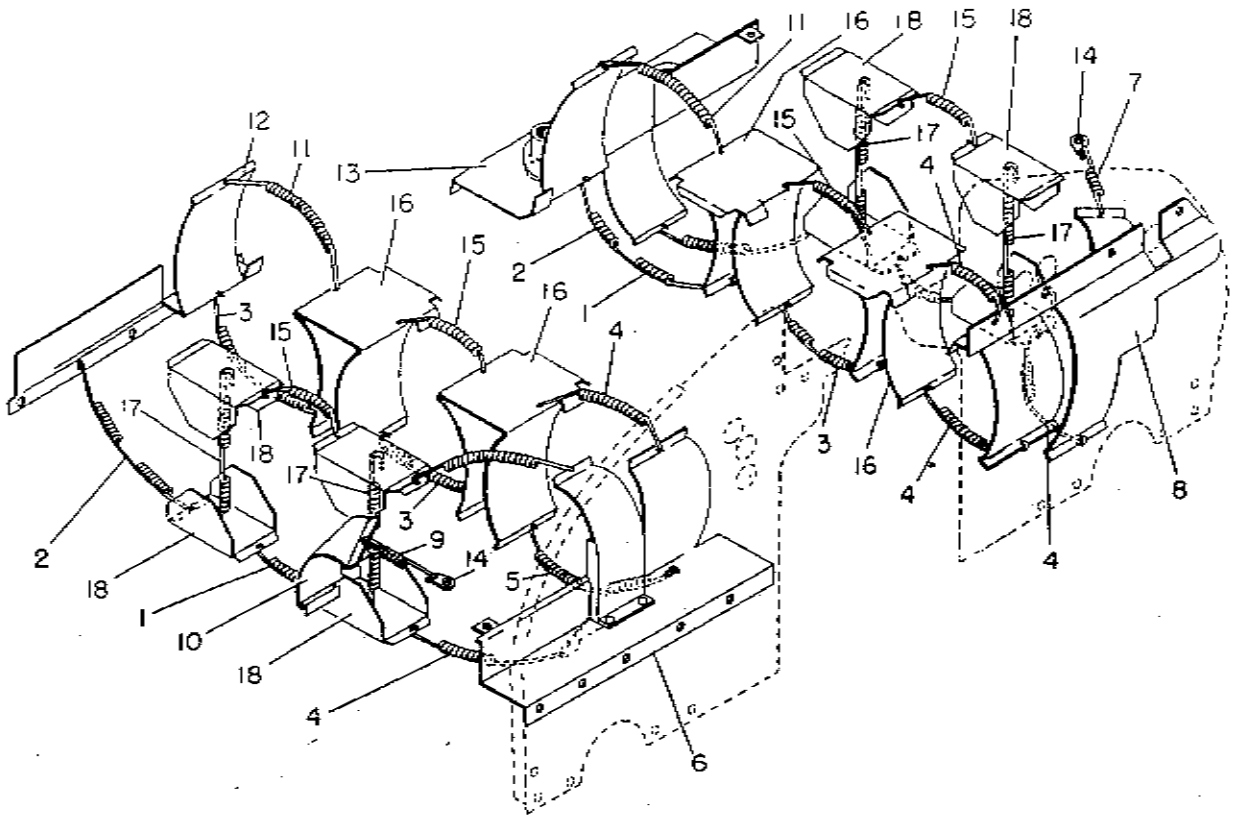
g. Tap the side of the accessory case, if necessary, with a rawhide mallet to break loose the gasket. Tilt the top of the case to the rear, and lower it clear of the camshaft gear.

4-47. SHROUD TOP AND UPPER REAR PANELS. *(See figure 4-18.)* The brace rods and attaching parts (2, 3, 4) and the rear panel adapters and attaching parts (5 through 11 and opposite) were removed earlier. The shroud to rear cylinder baffles (49 and 53) may remain on the cylinders. The shroud divider (56) will remain on the crankcase. Detach the upper rear panels from the



1. Felt packing ring
2. Nut
3. Washer
4. Rod
5. Screw
6. Nut
7. Brace angle
8. Screw
9. Screw
10. Washer
11. Adapter
12. Nut
13. Screw
14. Washer
15. Screw
16. Nut
17. Screw
18. Nut
19. Screw
20. Washer
21. Nut strip
22. Nut strip
23. Nut strip
24. Nut
25. Screw
26. Washer
27. Nut strip
28. Nut
29. Screw
30. Nut
31. Screw
32. Washer
33. Shroud top panel and access doors assembly
34. Grommet
35. Right upper rear panel
36. Screw
37. Nut
38. Screen assembly
39. Nut
40. Screw
41. Washer
42. Washer
43. Hook angle
44. Rivet
45. Weatherstrip webbing
46. Left upper rear panel
47. Rivet
48. Latch toggle and bail assembly
49. Shroud to No. 1 cylinder baffle assembly
50. Screw
51. Nut
52. No. 2 cylinder intake side baffle
53. Shroud to No. 2 cylinder baffle
54. Nut
55. Washer
56. Shroud divider

Figure 4-18. Shroud Top and Upper Rear Panels



1. Baffle spring
2. Baffle spring
3. Baffle spring
4. Baffle spring
5. Baffle spring
6. Shroud to No. 2 cylinder baffle
7. Baffle spring
8. Shroud to No. 1 cylinder baffle assembly
9. Baffle spring
10. No. 2 cylinder exhaust side head baffle
11. Baffle spring
12. Shroud to No. 6 cylinder baffle
13. Shroud to No. 5 cylinder baffle
14. Tab washer
15. Baffle spring
16. Inter barrel baffle
17. Baffle spring
18. Inter head baffle

Figure 4-19. Cylinder Baffles and Springs

baffles by removing screws and speed nuts (15, 16, 17, 18) and from the top panel by removing 16 fillister head screws and lock washers (19, 20), two curved nut strips (23) and two angle strips (21, 22). The cage nuts (24) may remain on the nut strips if in good condition. Take off the upper rear panels (35, 46). Discard the grommet (34), and detach the blower inlet screen (38). If the felt blower seal ring (1) adheres to the left panel discard it. Hook angles (43) need not be detached from the upper rear panels. To detach the top panel, remove four screws and washers (31, 32) at the rear side of the intake manifold, 14 screws and washers (25, 26) and two strip and cage nut assemblies (27, 28) at the front end and three screws and cage nuts (29, 30) along the center line. Tilt the front end up, and slide the top panel to the rear to clear the manifold studs, then lift off the top panel and access doors assembly.

4-48. CYLINDER BAFFLES AND SPRINGS.
(See figure 4-19.)

a. Detach springs (4, 5) on the left side to release the No. 2 cylinder baffle (6), and remove it; then disconnect springs (4) on the right side to detach the No. 1 cylinder baffle (8).

b. Remove the short spring (9) above No. 2 cylinder to detach the small baffle (10), and slide it out from its position between No. 2 and 4 cylinder heads.

c. Detach springs (11) from shroud to front cylinder baffles (12, 13) and from the front inter barrel baffles on each side. The springs illustrated below these should have been removed earlier (paragraph 4-44, step "b") so that the front baffles will not interfere with removal of the panel and housing assembly to which they remain attached.

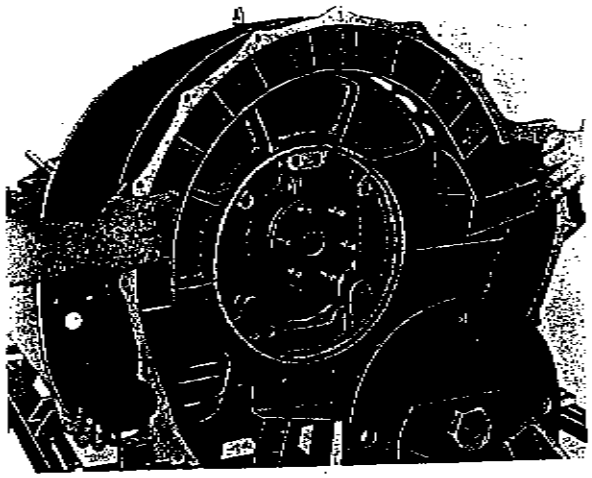


Figure 4-20. Lifting Off Assembly of Fan Outlet Housing and Shroud Front Panel

4-49. FAN OUTLET HOUSING AND SHROUD FRONT PANEL. *(See figure 4-20.)*

a. Loosen the two hose clamps which hold the flexible duct (6, figure 1-3) to the crankcase heater air valve and to the shroud to No. 5 cylinder baffle. Remove the duct and clamps.

b. Remove the two front mount bolts and nuts. If the fan outlet housing mount bosses are not 1/2 inch or more above the stand adapters, raise the front end of the packette with the jack screw of the crankcase front support assembly.

c. Remove seven nuts and washers which attach the fan outlet housing to crankcase studs. Two men will be required to lift off the housing and panel assembly. Store it in such a position as to avoid bending the panel.

4-50. INDUCTION SYSTEM. *(See figure 1-3.)*

a. Loosen all hose connector clamp screws, and push all hose connectors outward until clear of the manifold.

b. Remove four sets of intake manifold attaching nuts and washers and lift off the manifold casting (4).

c. From each of the aluminum flanges which hold down the six intake tubes remove two hex head screws and lock washers. The two tab washers (14, figure 4-19) will be removed in the same operation. Lift off the intake tubes (3).

CAUTION

The soft aluminum tubes must be lifted out of cylinder ports without cocking to prevent distortion of their bottom ends and scuffing of the ports.

4-51. INTER HEAD AND INTER BARREL BAFFLES. *(See figure 4-19.)*

a. Detach two springs (15) on each side from adjacent inter head and inter barrel baffles.

b. Lift out two inter barrel baffles (16) on each side.

c. Use a stiff wire hook to lift the upper end hook of each vertical spring (17), in turn, until the spring hook can be passed down through the larger hole in the upper inter head baffle. Lift off each of these baffles when detached.

d. In the same manner as in the preceding step, detach the lower inter head baffles, and remove them.

e. If the vertical springs are difficult to remove leave them in place until the cylinders are taken off.

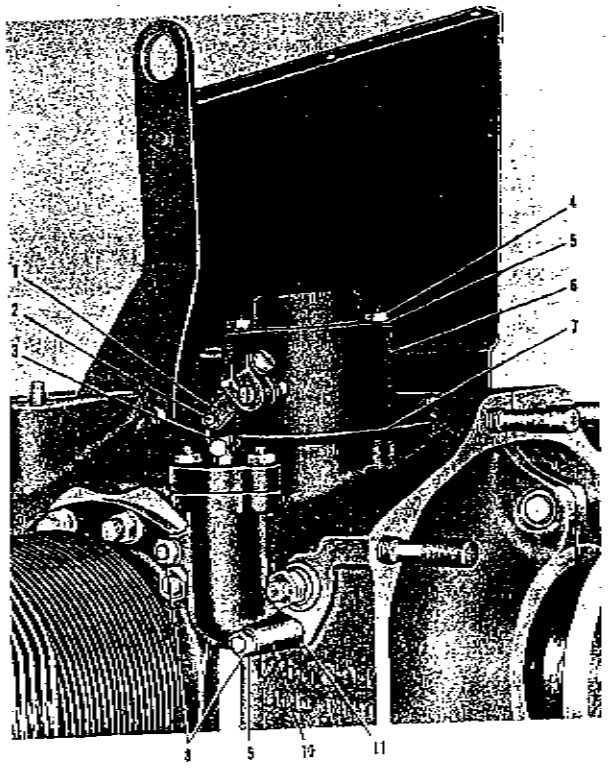
4-52. CRANKCASE HEATER AIR VALVE AND FRONT OIL PRESSURE VALVE. *(See figure 4-21.)*

a. Pull out the upper cotter pin (1) and the upper flat head pin (2).

b. Swing back the spring link (3) clear of the lever.

c. Remove attaching parts (4, 5) from two studs, and lift off the air valve assembly (6). Peel off all parts of the gasket (7).

d. Remove two nuts (8) and washers (9). Slide the oil pressure valve assembly (10) off the case studs, and peel off its gasket (11).



1. Cotter pin
2. Pin
3. Spring link
4. Nut
5. Washers
6. Air valve assembly
7. Gasket
8. Nut
9. Washers
10. Oil pressure valve assembly
11. Gasket

Figure 4-21. Removal of Crankcase Heater Air Valve and Oil Pressure Valve

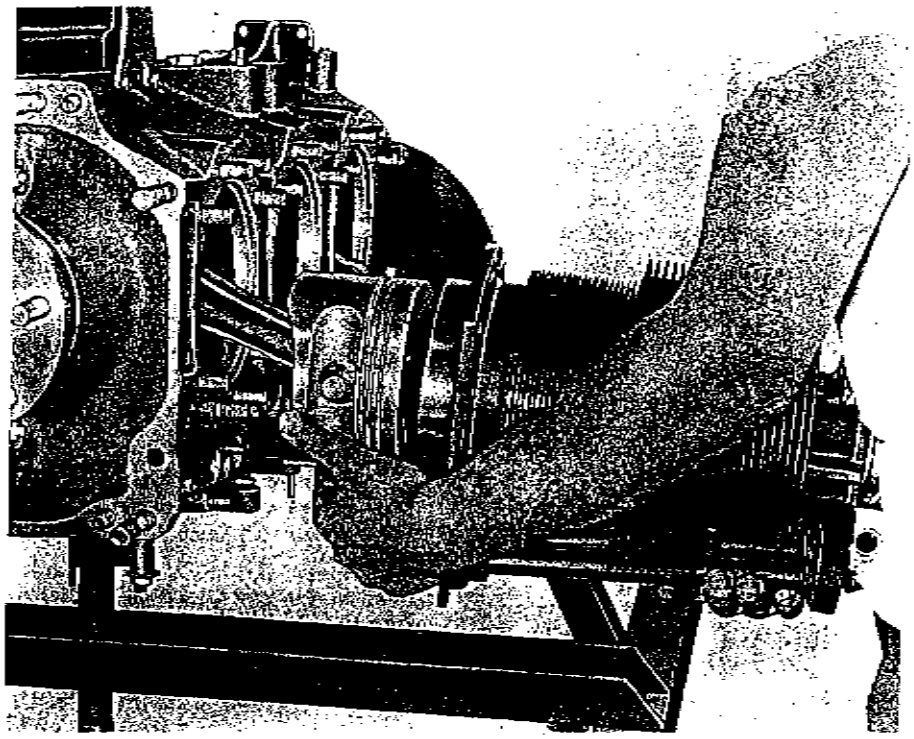


Figure 4-22. Removing Cylinder Assembly

4-53. CYLINDERS.

a. Unscrew all six spark plugs.

b. Turn the crankshaft until any piston is at top dead center with both valves completely closed (T.D.C. compression stroke). (A right handed operator will find it easier to start with either No. 1 or No. 6 cylinder and proceed in such an order that the left side of the cylinder being removed is exposed.)

c. Having positioned the first piston, as in the preceding step, remove the remaining four base nuts (now on top) to detach the base flange of the cylinder containing that piston.

d. Cradle the detached cylinder in one arm, and withdraw it straight outward. Catch the piston in the other hand as the cylinder skirt clears it, and lower it gently until it rests on the crankcase chamfer. *(See figure 4-22.)* Keep the pushrods in place in their housings until the cylinder is laid down.

e. Immediately after laying down each cylinder, push out the pin of the exposed piston until it clears the connecting rod bushing, and remove the piston assembly. Push the pin back into place, and lay the piston with its cylinder. Do not drop the connecting rod end.

f. When all cylinders have been removed as in the preceding steps, pull out the pushrods. Store the cylinder and piston assemblies so as to preserve their relationship.

Note

If a piston pin cannot be pushed out easily by hand, use a fiber drift and hammer to tap it out, supporting the piston sidewise against the blows, or — preferably — heat the piston head with a steam jet or by pouring hot oil over it to expand the pin hole.

4-54. TIMING GEARS. Cut and remove the lockwires, and remove the four screws which attach the large gear to the rear flange of the camshaft. Take off the gear. Similarly detach the small gear from the rear end of the crankshaft. If it is difficult to remove, screw two bolts into the tapped puller holes in the gear web, and tighten them evenly to push the gear from the shaft.

4-55. CRANKCASE AND SHAFTS. *(See figure 4-23.)*

a. Detach the shroud divider (56, figure 4-18) and the lifting eye (11) from the crankcase upper parting flanges.

b. Turn the engine bed 90 degrees so that the right side (No. 1, 3, 5 cylinders) is on top.

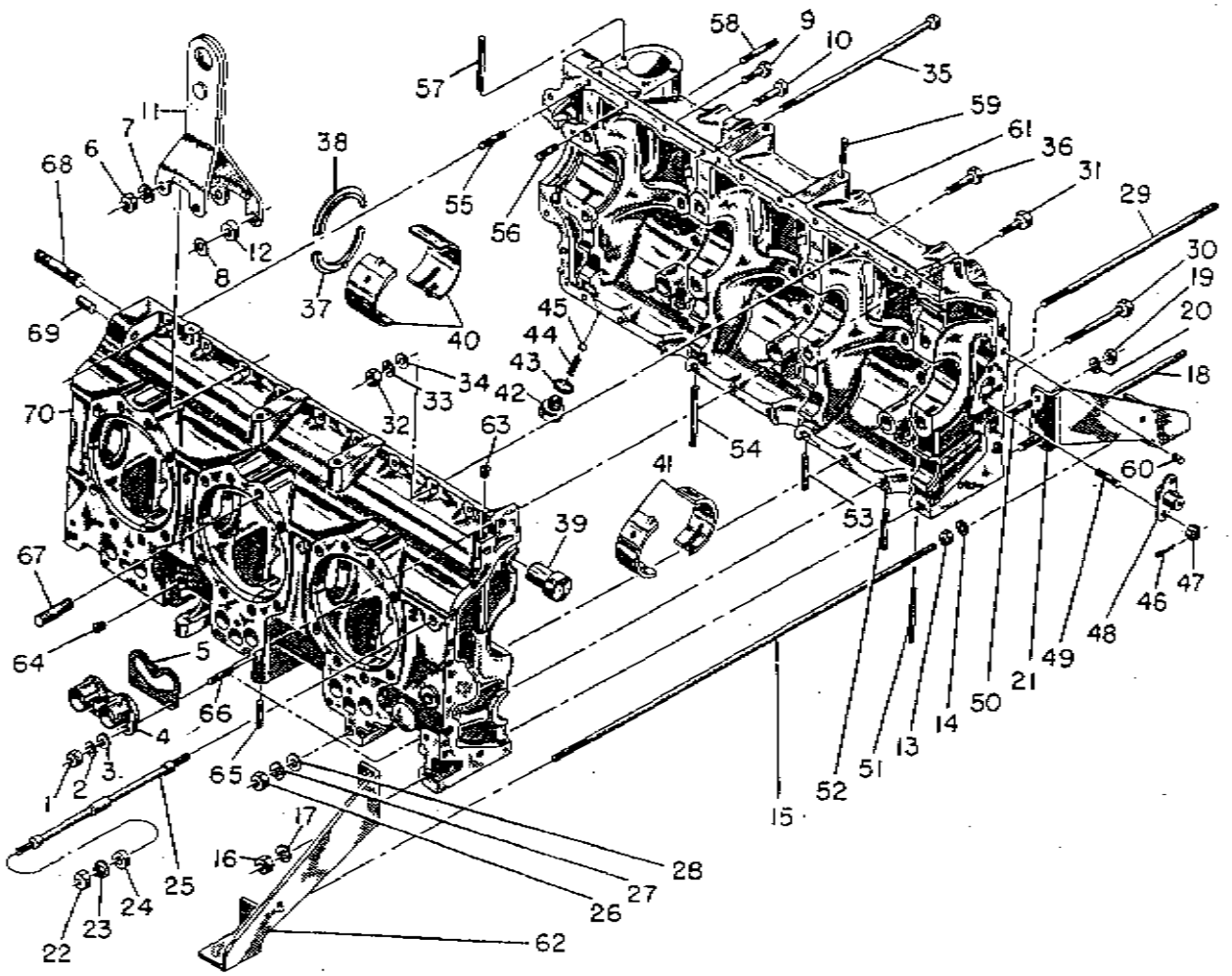
c. Remove the four nuts and lock washers and the rear mount rod (13, 14, 15) from the rear mount brackets.

d. Detach the right rear mount bracket (21) from the stand. Remove its attaching parts (16 through 20) in numerical order, and lift off the bracket.

e. Tap out the eight crankcase through bolts (25), using a smaller bolt or preferably a brass drift. Remove the four remaining nuts and spacers (22, 23, 24).

f. Remove all attaching nuts, washers and bolts (26 through 36) from the crankcase upper and lower parting flanges.

g. Install used cylinder base packings to retain right side valve lifters. *(See figure 8-13.)*



1. Nut
2. Washer
3. Washer
4. Pushrod housing flange
5. Gasket
6. Nut
7. Washer
8. Washer
9. Bolt
10. Bolt
11. Lifting eye assembly
12. Washer
13. Nut
14. Washer
15. Rod
16. Nut
17. Washer
18. Bolt
19. Nut
20. Washer
21. Right rear mount bracket
22. Nut lock
23. Nut
24. Spacer
25. Bolt
26. Nut
27. Washer
28. Washer
29. Bolt
30. Bolt
31. Bolt
32. Nut
33. Washer
34. Washer
35. Screw
36. Bolt
37. Thrust washer with pin
38. Thrust washer without pin
39. Thrust plug
40. Front main-thrust bearing
41. Intermediate and rear main bearings
42. Plug
43. Gasket
44. Spring
45. Ball
46. Cotter pin
47. Nut
48. Magneto drive gear support
49. Stud
50. Stud
51. Stud
52. Stud
53. Stud
54. Stud
55. Stud
56. Stud
57. Stud
58. Stud
59. Stud
60. Dowel
61. Right crankcase
62. Left rear mount bracket
63. Plug
64. Plug
65. Stud
66. Stud
67. Stud
68. Stud
69. Dowel
70. Left crankcase

Figure 4-23. Crankcase Assembly

h. Before removing the right crankcase, turn the crankshaft to such a position that the upper connecting rods in the No. 3 and 5 cylinder holes can be placed in the vertical position and will remain there without touching the case. During the next step a second person should grasp the No. 1 rod as soon as the right case is lifted high enough to reach under and should keep it from dropping against the left case parting flange.

i. Lift off the right crankcase (61), and store it, open side upward.

j. Rotate the two complete thrust washers until the pins are on top; then lift off the halves with pins (37). Rotate the plain halves (38) until they are on top, and remove them.

k. Lift out the thrust plug (39).

l. Lift out the camshaft, then the crankshaft and rods assembly, and store them on suitable racks.

m. Detach the left rear mount bracket from its stand adapter and the front support swivel from the long crankcase stud, and place the left crankcase on the work bench, open side up.

n. Remove attaching parts identical to index numbers 19 and 20 from the left rear mount bracket attaching stud, and take off the bracket. Store the left crankcase, open side up.

o. From each crankcase subassembly lift out the six hydraulic valve lifters, and store them in a suitable rack.

4-56. DISASSEMBLY OF SUBASSEMBLIES.

4-57. CRANKCASE. *(See Figure 4-23.)*

a. Push the plain end of each bearing insert (40, 41) in each crankcase casting until the tang end rises far enough to grip; then lift out all bearings, and discard them.

b. From the right crankcase (61) unscrew the plug (42). Discard the gasket (43), and tilt the case until the spring (44) and ball (45) drop out. Store these valve parts together in a small container.

c. With Allen wrenches unscrew the pipe plug (64) and the plug (63) from illustrated locations. Similarly remove a pipe plug (not illustrated) from the bottom end of the oil feed hole to the front oil pressure valve in the right crankcase.

Note

Do not remove the magneto gear support (48) or its attaching parts (46, 47). Do not remove any of the studs or dowels from either casting.

4-58. FAN INLET AND GEAR HOUSING ASSEMBLY. *(See figure 4-24.)* The drain plug (1) and the oil gauge and oil filler parts (2 through 20) were removed during the dismantling operation. The bracket (21) for the oil filler and gauge support clamps is attached to the fan outlet housing. The parts remaining on the subassembly may be removed in the following manner.

a. Use an open end wrench on the hex below the lower cup of the air filter (22) to loosen the pipe thread, and unscrew the filter. Unscrew the street elbow (23) from the inlet and gear housing.

b. Remove attaching parts (24, 25, 26) around the four generator pad covers, if installed, and remove the covers (27) and their gaskets (28).

c. Remove the attaching parts, center cover and gasket (29 through 33).

d. Remove attaching parts, cover and gasket (34 through 38).

e. Remove 12 nuts, lock washers and plain washers from studs inside the four generator mounting flanges at the front of the assembly and the single group of attaching parts from the stud between the two bottom flanges.

Legend for Figure 4-24

1. Plug
2. Oil gauge
3. Circlip
4. Oil filler cap
5. Nut
6. Washer
7. Screw
8. Clamp
9. Hose
10. Oil filler tube assembly
11. Nut
12. Washer
13. Screw
14. Clamp
15. Nut
16. Washer
17. Screw
18. Clamp
19. Nut
20. Support tube
21. Bracket
22. Air filter
23. Elbow
24. Nut
25. Washer
26. Washer
27. Cover
28. Gasket
29. Nut
30. Washer
31. Washer
32. Gear housing cover
33. Gasket
34. Nut
35. Washer
36. Washer
37. Oil filler hole cover
38. Gasket
39. Retaining ring
40. Coupling flange assembly
41. Bearing
42. Screw
43. Alternator driver gear
44. Generator driver gear
45. Bearing
46. Generator drive gear
47. Alternator driven gear
48. Retaining ring
49. Retaining ring
50. Seal
51. Seal
52. Connector
53. Gear case housing
54. Cover plate
55. Screw
56. L.H. fan inlet shield assembly
57. R.H. fan inlet shield assembly
58. Fan inlet and gear housing

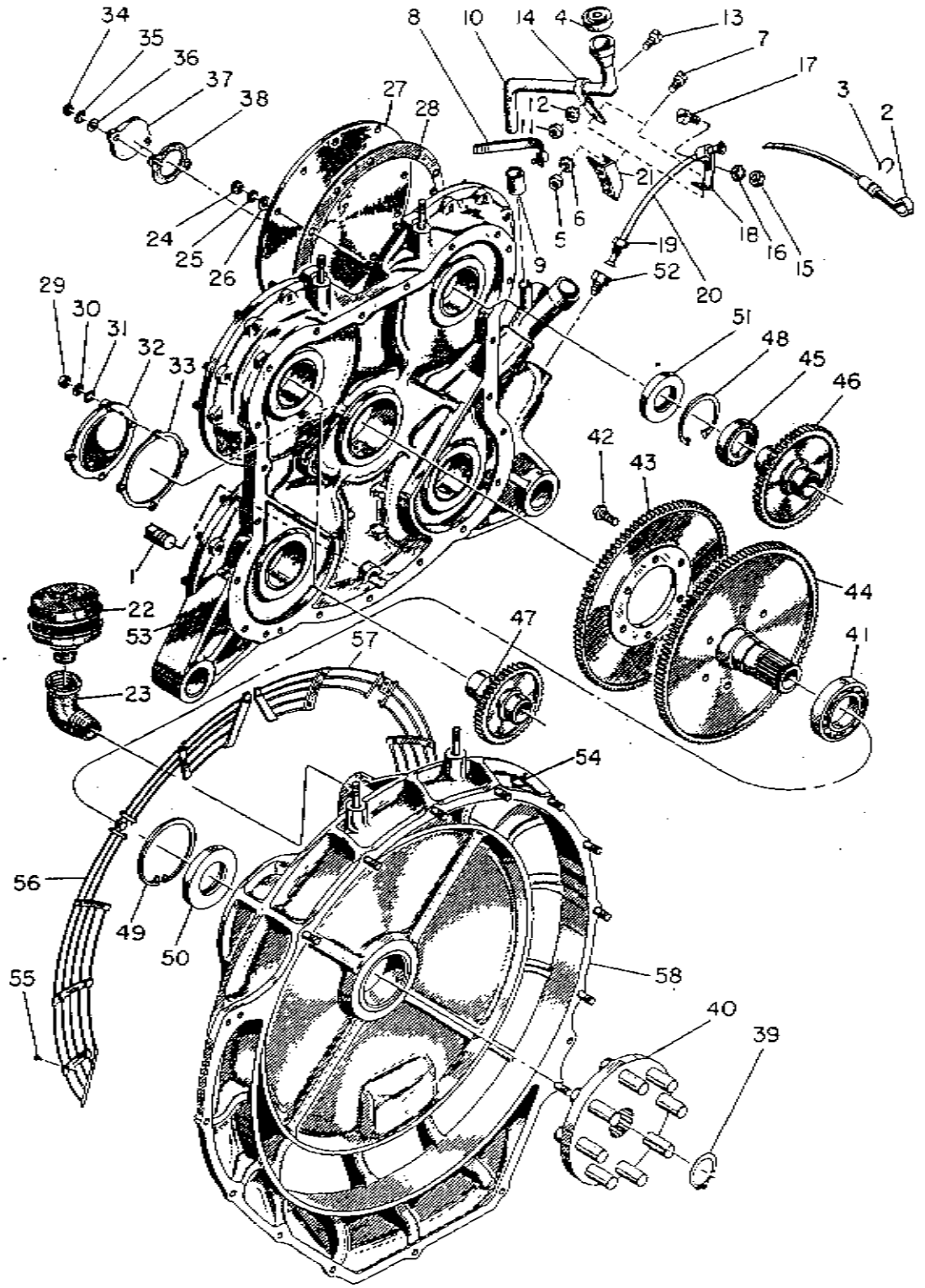


Figure 4-24. Fan Inlet and Gear Housing

f. Turn the assembly, front side downward, holding the two castings together; then lift off the inlet and gear housing (58) and driver gear assembly.

g. Use Truarc No. 6 or No. 26 pliers to expand and remove the external retaining ring (39) from the driver gear shaft groove. Lift off the coupling driven flange assembly (40); then lay the casting rear side down, and lift out the driver gear assembly (41, 42, 43, 44).

h. Lift out of the gear case housing three gears (46) and one gear (47), each with two ball bearings (45) pressed on.

i. With Truarc No. 5 or No. 25 pliers, compress and withdraw four retaining rings (48), and remove two retaining rings (49) with Truarc No. 7 pliers.

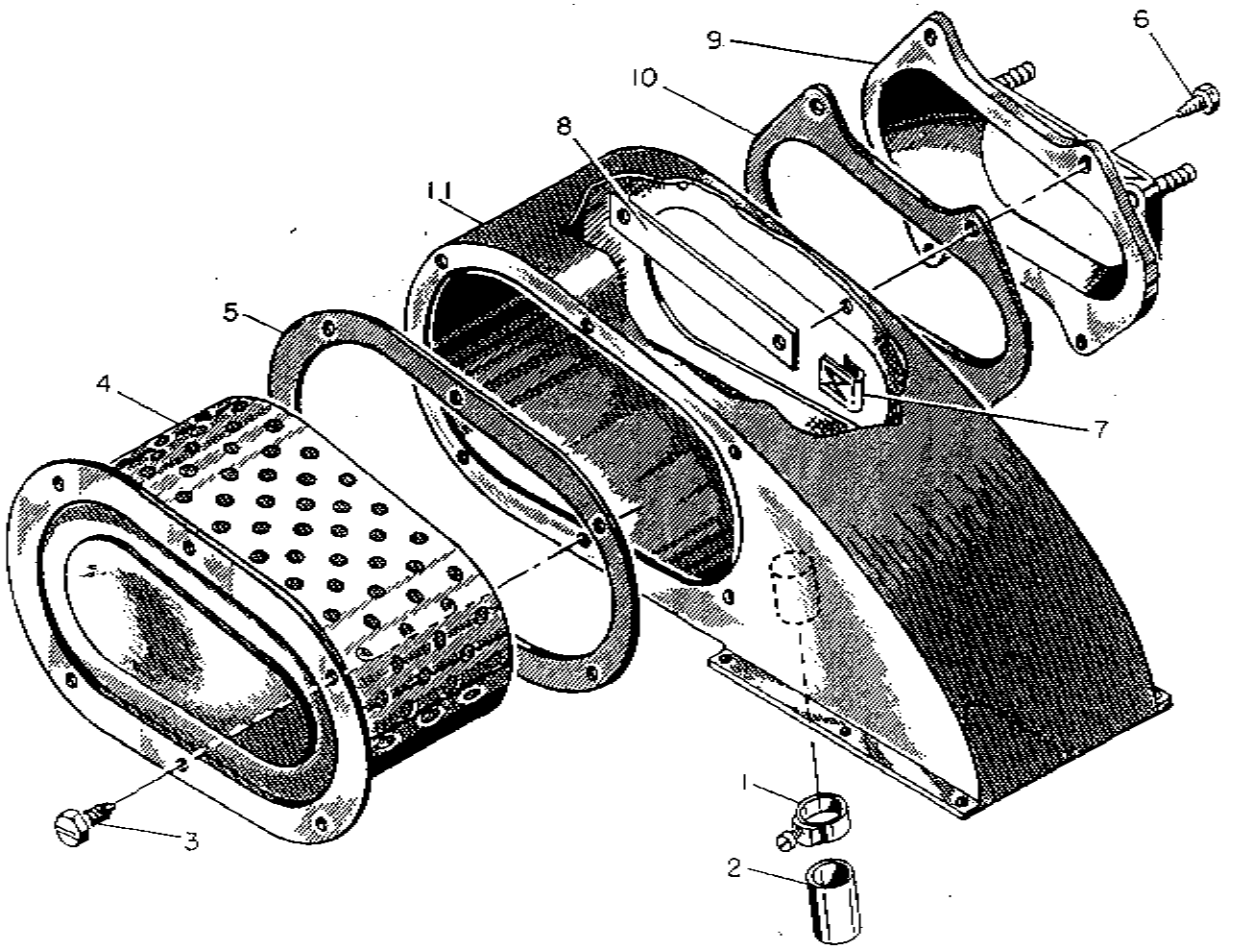
j. With suitable drifts drive or press four oil seals (51) from the gear case housing and one seal (50) from the fan outlet and gear housing.

k. Remove the cover plate (54).

Note

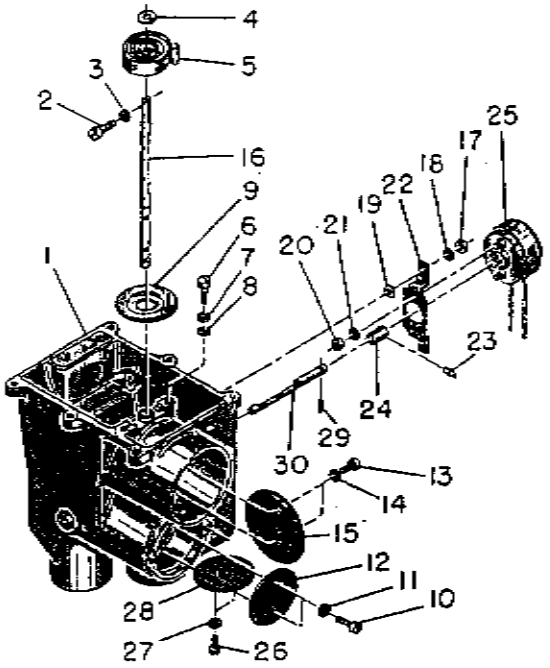
Do not remove the fan inlet shields (56, 57), unless they are damaged. If the screws must be removed it is preferable to pull them intact, rather than grinding off the heads, since that will permit installation of larger drive screws at the same locations for replacement.

4-59. FLYWHEEL AND FAN ASSEMBLY. Do not disassemble the assembly of flywheel, fan and ring gear. (Refer to Section VII for ring gear replacement.) The flywheel and fan are dynamically balanced after assembly. The small balancing weights must not be disturbed.



1. Clamp
2. Hose
3. Screw
4. Filter element
5. Gasket
6. Screw
7. Nut
8. Nut strip
9. Adapter assembly
10. Gasket
11. Air filter housing assembly

Figure 4-25. Carburetor Air Filter and Adapter



1. Preheat and mixing valve housing
2. Screw
3. Washer
4. Washer
5. Bimetal spiral
6. Screw
7. Washer
8. Washer
9. Mixing valve adjustment plate assembly
10. Screw
11. Washer
12. Hot air valve vane
13. Screw
14. Washer
15. Mixing valve vane
16. Mixing valve shaft
17. Nut
18. Washer
19. Washer
20. Nut
21. Washer
22. Solenoid bracket
23. Pin
24. Solenoid coupling
25. Solenoid
26. Screw
27. Washer
28. Hot air valve vane
29. Pin
30. Air heater shut off shaft

Figure 4-26. Preheat and Mixing Valve Assembly

4-60. AIR FILTER AND ADAPTER ASSEMBLY. *(See figure 4-25.)*

a. If still attached to the breather tube on the bottom of the filter housing (11), remove the two clamps (1) and discard the hose connector (2).

b. Remove six screws (3), and withdraw the filter element (4). Discard its gasket (5). Take necessary precautions to prevent damage to the filter during storage.

c. Remove four screws (6) and the two assemblies of speed nut (7) and nut strip (8) inside the housing to detach the adapter assembly (9). Discard its gasket (10).

4-61. PREHEAT AND MIXING VALVE ASSEMBLY. *(See figure 4-26.)*

a. Clamp the housing (1) lightly between aluminum shielded vise jaws, or otherwise support it in an upright position.

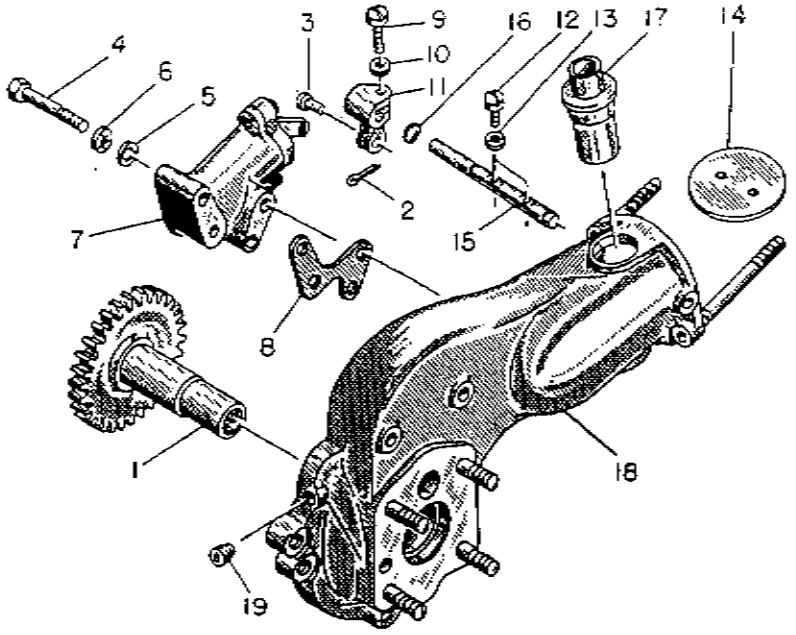
b. Remove a screw and lock washer (2, 3) from the upper end of the shaft (16), and lift off the plain washer (4). Carefully pry the outer end loop of the bimetal spiral (5) upward and off the pin attached to the adjustment plate (9), simultaneously raising the inner end of the spiral from the shaft slot (which may have to be spread slightly to prevent binding, but not more than necessary) and taking care to avoid bending the pin. Lift off the spiral, and store it in a safe place.

c. Back out the two clamping screws (6) and remove washers (7, 8). Lift off the adjusting plate (9).

d. Remove attaching parts (10, 11) and the smaller butterfly valve (12) from the shaft (16) in the lower valve barrel. Similarly remove the larger valve (15) from the shaft inside the upper barrel, and lift out the shaft.

e. Remove two sets of attaching parts (17, 18) and take off the solenoid and bracket assembly. Removal of the bracket (22) from the solenoid (25) is optional. Do not remove the coupling (24) or its retaining pin (23) from the solenoid shaft.

f. Remove attaching parts (26, 27) and take the solenoid operated valve (28) from its shaft far inside the lower barrel. Withdraw the shaft and pin assembly (29, 30). Do not remove the pin.



1. Governor drive gear
2. Cotter pin
3. Pin
4. Bolt
5. Washer
6. Washer
7. Oil pressure valve assembly
8. Gasket
9. Screw
10. Washer
11. Hot air valve lever
12. Screw
13. Washer
14. Hot air butterfly valve
15. Butterfly valve shaft
16. Packing
17. Breather bushing
18. Adapter assembly
19. Plug

Figure 4-27. Governor Adapter and Oil Pressure Valve Assembly

4-62. GOVERNOR DRIVE AND OIL PRESSURE VALVE. *(See figure 4-27.)*

a. Withdraw the gear (1) from the adapter.

b. Remove the cotter pin (2) and the flat head pin (3) from the lever. Disengage the spring link on the pressure valve stem from the lever fork; then detach the valve assembly by removing two screws and washers (4, 5, 6), and remove the valve (7) and its gasket (8).

c. Hold the butterfly valve (14) shut with the lever while its attaching screws and washers (12, 13) are removed; then withdraw the butterfly and the shaft and lever assembly. Discard two "O" rings (16).

d. Unscrew the pipe plug (19) to permit flushing of the oil passages.

Note

It is not necessary to remove the lever (11) from the butterfly valve shaft, unless one part is damaged and the other serviceable. Leaving these parts assembled will simplify reassembly of the group.

4-63. FUEL PUMP AND DRIVE. *(See figure 4-28.)*

a. Unscrew the elbow (1) from the pump outlet port.

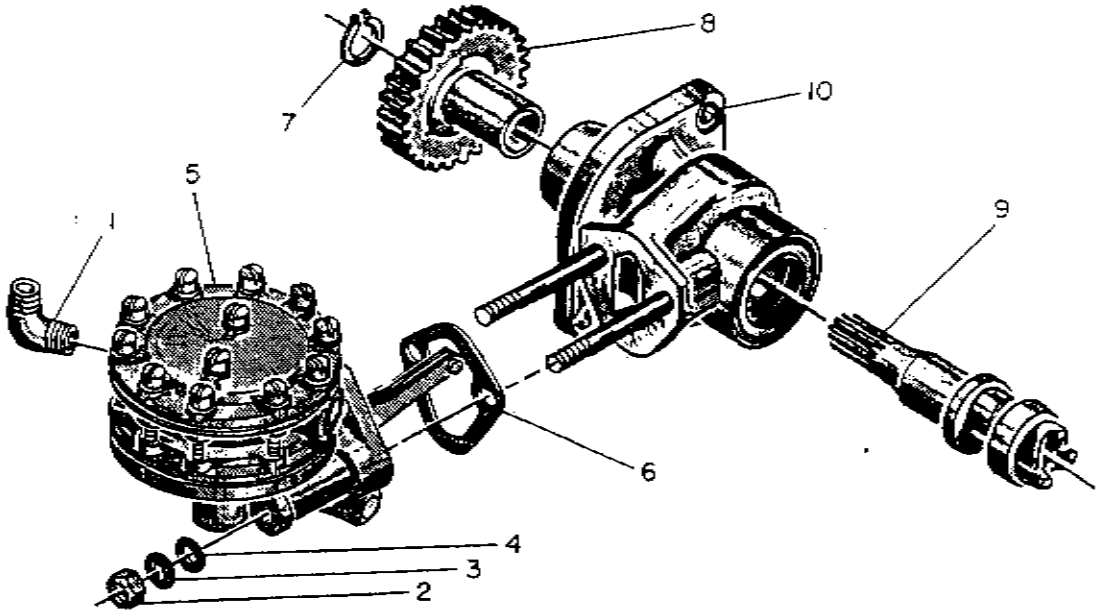
b. Remove attaching parts (2, 3, 4), and withdraw the pump (5) from the adapter studs. Peel off its gasket (6).

c. With Truarc pliers, expand and remove the retaining ring (7).

d. Withdraw the drive gear (8) from the adapter, and push the shaft (9) out through the oil seal to the rear.

e. With a suitable puller, remove the steel cased oil seal from the rear end of the adapter bore. In the absence of a special seal puller this can be done by drilling and tapping two opposite holes for No. 8-32 screws in the flange of the seal case and turning into them two screws whose heads are supported on a bridge plate drilled to match the tapped case holes and with a slide hammer attached to a tapped hole centered in the bridge plate.

4-64. SHROUD SHUTTERS. Do not remove the bellows assembly or its linkage from the left side shutter. These parts should be removed only by repair personnel when replacements are found necessary.



1. Elbow
2. Nut
3. Washer
4. Washer
5. Fuel pump
6. Gasket
7. Retaining ring
8. Hand crank and fuel pump drive gear
9. Hand crank and fuel pump shaft
10. Hand crank and fuel pump adapter assembly

Figure 4-28. Fuel Pump and Drive Assembly

4-65. OIL SUMP ASSEMBLY. *(See figure 4-14.)*

a. Loosen and unscrew the flared tube connector (16).

b. With Allen wrenches, loosen and unscrew the two pipe plugs (17, 18).

c. Loosen and unscrew the square head flanged plug (19). Remove and discard its gasket (20).

d. Remove and discard the packing (28) in the connection plate bore groove.

Note

Unless the Hubbard plug (21) is loose, do not remove it. Do not remove the bushing (22) unless it is damaged. Do not remove any of the studs (23, 24, 25).

4-66. OIL SUMP ADAPTER ASSEMBLY. *(See figure 4-16.)*

a. Unscrew the oil pressure relief valve cap (9). It will be forced outward vigorously by the spring when its thread is disengaged. Do not allow it to drop. Remove from the plug and discard the gasket (10).

b. Turn the adapter, left side up, and the spring (11) and plunger (12) will fall into the hand. Do not drop the plunger. Store the cap, spring and plunger together in a small container.

c. Unscrew the square head flanged plug (13) and discard its gasket (14).

4-67. ACCESSORY CASE ASSEMBLY. *(See figure 4-29.)* The case (21) may be clamped lightly between aluminum shielded vise jaws or laid flat on the work bench for the following operations, as preferred. If laid on the bench, start disassembly with the open front side down.

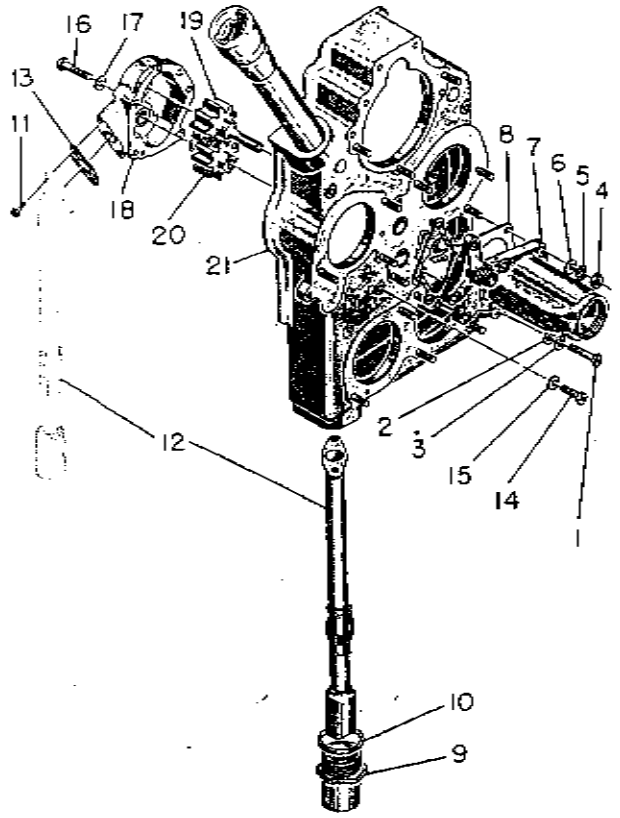
a. Unscrew and lift the oil filter (not illustrated) out of the housing (7).

b. Remove three sets of attaching bolts and washers (1, 2, 3) and four sets of nuts and washers (4, 5, 6) to detach the housing (7). Take off the housing and its gasket (8).

c. Unscrew the oil drain tube (9), and slide it off the suction tube (12). Remove and discard its copper-asbestos gasket (10).

d. Turn the case over, and remove lockwire from two bolts (11). Unscrew these bolts to detach the suction tube (12). In order to withdraw the tube from the case bottom opening it will be necessary to turn it to the illustrated (lower) position and swing the tube out of line about 30 degrees so that the flange will pass. Remove and discard the tube gasket (13).

e. Turn the case up on edge, and remove pump attach-



1. Bolt
2. Washer
3. Washer
4. Nut
5. Washer
6. Washer
7. Tachometer and oil screen housing
8. Gasket
9. Accessory case oil drain tube
10. Gasket
11. Bolt
12. Oil pump suction tube assembly
13. Gasket
14. Bolt
15. Washer
16. Bolt
17. Washer
18. Oil pump housing assembly
19. Oil pump driven impeller
20. Oil pump driver impeller
21. Accessory case

Figure 4-29. Accessory Case Assembly

ing parts (14, 15) from the rear side, then lay it open side up, on the bench, and remove the last pump housing attaching bolt and washer (16, 17).

f. Turn the case, open side down, holding the pump housing (18) in the hand, and carefully work the housing downward until it is free of the two case dowels. Keep the two impellers in the pump housing as it is lowered and lay the assembly on the bench.

g. Do not remove the pressed-in oil filler neck from the accessory case. Store the case so as to protect the neck from contact with other parts.

h. Lift the driven impeller (19) from the pump housing bushing; then invert the housing, and catch the driver impeller (20) in the other hand.

4-68. SHROUD FRONT PANEL AND BAFFLES. Remove the sheet metal screws and flat speed nuts and the fillister head screws and lock washers which attach the front baffles to the front panel and the panel and baffles to the horizontal rib of the fan outlet housing. Take off the baffles. Remove the rear row of hex nuts (inside), fillister head screws and lock washers (heads outside) around the upper half of the outlet housing to detach the curved flange of the front panel and the oil filler tube bracket (21, figure 4-24). Lift off the panel assembly, and remove the exhaust jacket adapter (flanged short tube) under its left side.

4-69. FAN OUTLET HOUSING ASSEMBLY. *(See figure 4-30.)*

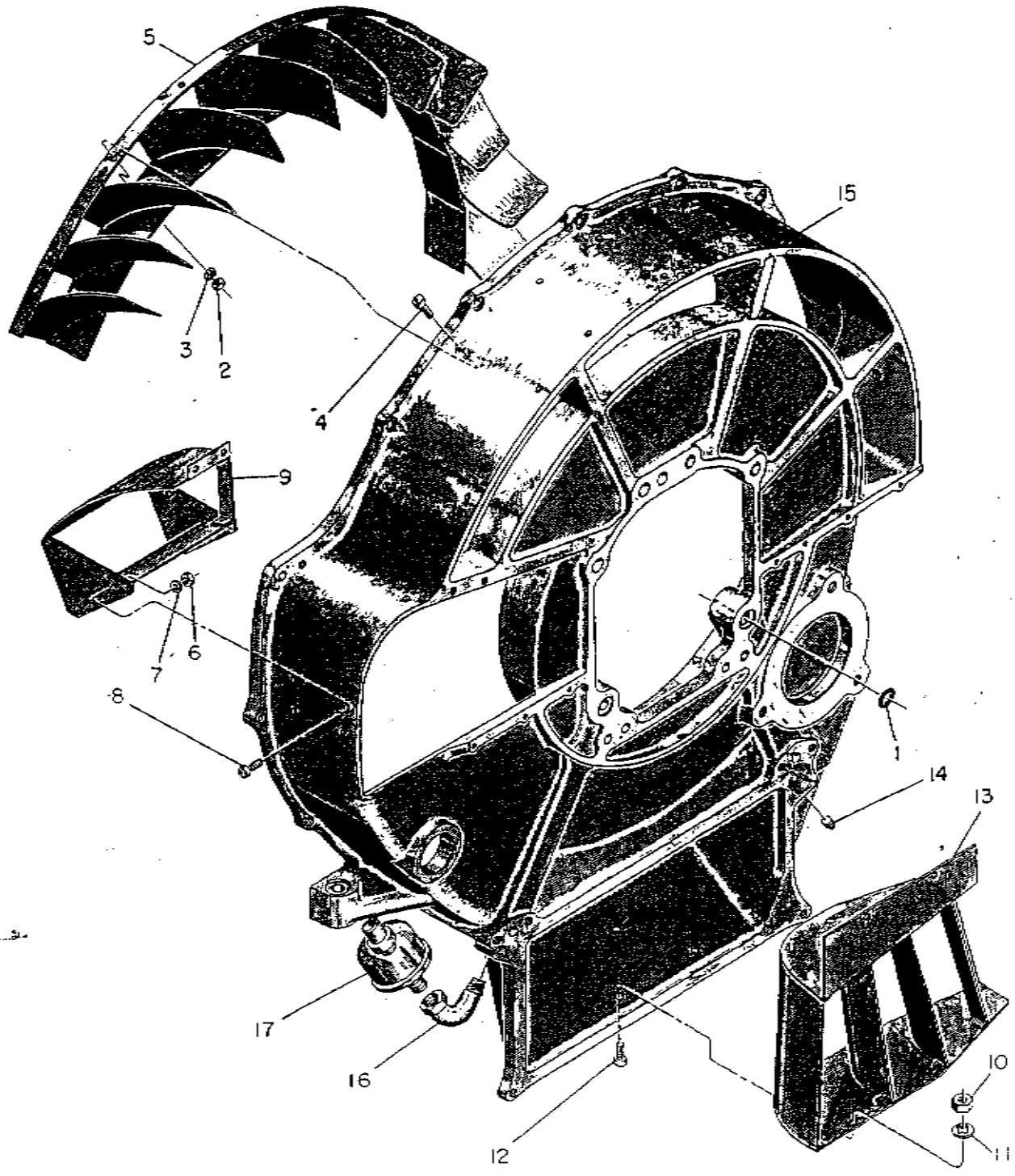
a. Remove and discard two "O" rings (1) from the small counterbores.

b. Turn the housing, front side up on the bench, and remove the row of nuts (inside), lock washers and fillister head screws (2, 3, 4) which attach the upper turning vane assembly (5). Lift out the vane assembly.

c. Remove two sets of nuts, lock washers and fillister head screws (6, 7, 8) from the forward holes of the lower turning vane end plate, and remove two fillister head screws and lock washers from the upturned flange of the oil cooler turning vane assembly (13).

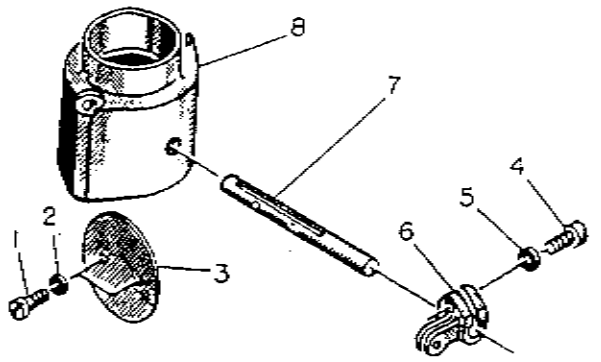
d. Turn the housing over. Remove the third set of attaching parts (6, 7, 8) from the lower turning vane end plate and two fillister head screws and lock washers which attach the small, upturned flange of the outer vane to the rear side of the housing. Lift the housing left side, and remove the lower turning vane assembly (9).

e. Remove three sets of attaching parts (10, 11, 12) and



1. Packing
2. Nut
3. Washer
4. Screw
5. Upper turning vane assembly
6. Nut
7. Washer
8. Screw
9. Lower Turning vane assembly
10. Nut
11. Washer
12. Screw
13. Oil cooler turning vane assembly
14. Plug
15. Fan outlet housing studding assembly
16. Elbow
17. Oil pressure gauge engine unit

Figure 4-30. Fan Outlet Housing Assembly



1. Screw
2. Washer
3. Hot air outlet valve
4. Screw
5. Washer
6. Lever
7. Butterfly valve shaft
8. Crankcase heater outlet valve body

Figure 4-31. Crankcase Heater Air Valve Assembly

the oil cooler turning vane assembly (13).

f. In order to permit thorough flushing of housing oil holes, loosen with an Allen wrench and unscrew the pipe plug (14).

4-70. INDUCTION SYSTEM ASSEMBLY.

a. Slide off the two hose clamps, then the hose connector from each intake tube.

b. Push up the flange on each intake tube. Remove and discard the tube seals; then remove the flanges.

4-71. CRANKCASE HEATER AIR VALVE ASSEMBLY. *(See figure 4-31.)*

a. Remove attaching parts (1, 2), and pull the valve (3) from the slotted shaft (7) inside the barrel.

b. Slide the shaft and lever assembly (4, 5, 6, 7) from its bearings in the body (8). It is not necessary to remove the lever (6) from the shaft unless it is broken or worn in the pin hole or unless the shaft is so badly worn as obviously to require replacement.

4-72. OIL PRESSURE VALVES. *(See figure 4-32.)* Disassemble both the front and rear valve assemblies in the following steps, and store the parts of each in a small container.

a. Pull the cotter pin (1), and remove the flat head pin (2) from the stem to release the spring link (3).

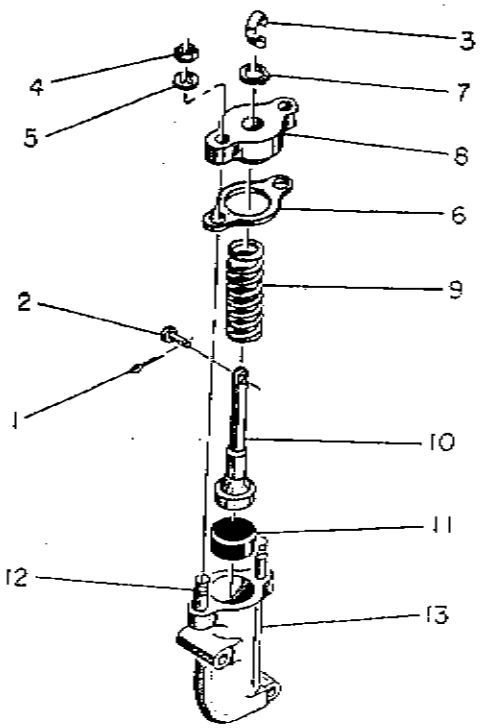
b. Remove two sets of attaching parts (4, 5) from cylinder studs, and lift off the cover and piston subassembly. Peel off the gasket (6).

c. With Truarc pliers, spread and remove the retainer ring (7) from the stem groove, while holding down the cover (8) against the spring (9). Release the cover and remove it and the spring from the piston (10).

d. Invert the cylinder (12) and tap it on a wood block to force out the seal (11).

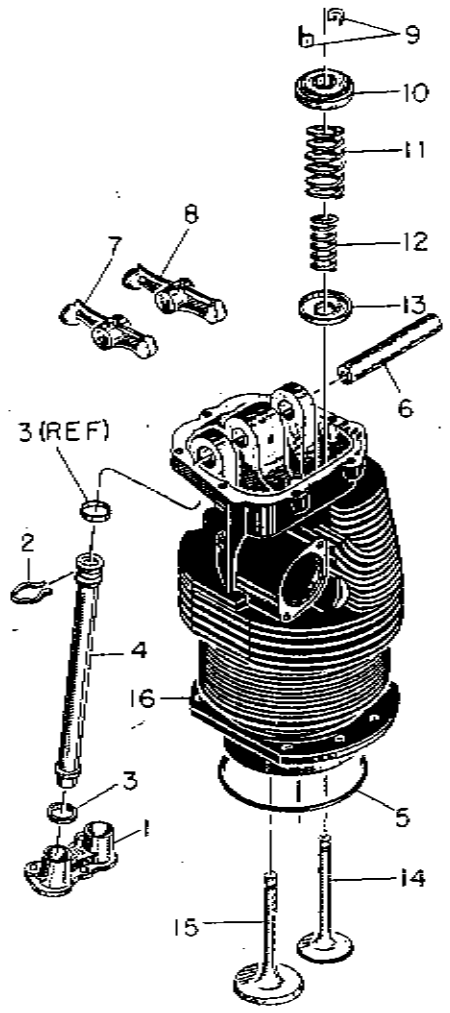
4-73. CYLINDERS. *(See figure 4-33.)*

a. Pull free the flange (1), and pull from the cylinder head the two pushrod housing assemblies. Pull off the retainers (2) and the rubber ring seals (3) from the two housings (4).



1. Cotter pin
2. Pin
3. Spring link
4. Nut
5. Washer
6. Gasket
7. Retaining ring
8. Cylinder cover
9. Spring
10. Oil pressure valve piston
11. Oil pressure valve seal
12. Stud
13. Oil pressure valve cylinder

Figure 4-32. Oil Pressure Valve Assembly



1. Pushrod housing flange
2. Pushrod housing retainer
3. Packing
4. Pushrod housing
5. Packing ring
6. Rocker shaft
7. Intake valve rocker
8. Exhaust valve rocker
9. Valve spring retainer key
10. Roto cap
11. Outer valve spring
12. Inner valve spring
13. Inner valve spring retainer
14. Exhaust valve
15. Intake valve
16. Cylinder and head assembly

Figure 4-33. Cylinder Assembly

b. Remove the packing ring (5) from the cylinder skirt and save it for use as a retainer (paragraph 4-55).

c. Slide out the shaft (6) enough to clear both valve rockers (7, 8). Remove the two rockers, and return the shaft to its original position.

d. Place the valve support (pedestal) in a cylinder and valve holding fixture (tool No. J-2358), and lower the open end of the cylinder over the valve support until the base flange rests on the fixture solidly. Swing the two plate clamps over the base flange and tighten clamp nuts.

e. Use the valve spring compressor (tool No. J-2838) to compress either set of valve springs by hooking its narrow end under the rocker shaft and bearing down on the handle. If the stem keys (9) do not loosen strike the compressor with a rawhide mallet directly over the roto cap (10). The keys should fall apart far enough to permit removal when the springs and roto cap are depressed without moving the valve stem. Do not depress the roto cap further than necessary, because any upward motion of the keys before they are removed may cause them to nick the valve stem and bind the assembly.

CAUTION

The roto caps must not be cocked by the compressor so as to touch the valve stems, since they will gouge stems, making them unserviceable.

f. While holding down the roror cap, as in the preceding step, lift out the two keys (9); then release the roto cap. Remove the compressor, and lift off the roto cap (10), outer and inner springs (11, 12) and retainer (13).

g. Disassemble parts from the second valve stem in the manner described in the preceding two steps (e, f); then push out the rocker shaft (6). Release the fixture clamps, and swing them back.

h. Lift the cylinder assembly by the valve stems, or while holding them in place, and lay cylinder on its side.

i. In turn, remove carefully the two valves (14, 15) from their guides, through barrel, and store with others.

j. Store the cylinder and head assembly on a suitable wooden rack. Springs, retainers, roto caps and keys may be interchanged and, so, may be stored according to type.

4-74. PISTON ASSEMBLIES. Use the fingers or a standard type of piston ring expanding tool to spread, in turn the rings of all six pistons, and lift them off, working downward from the top rings, while the pistons stand upright. Do not permit the ring ends to scratch the piston lands as they pass over. Piston and pin assemblies should be left intact if they can be cleaned by a spray process which does not require separation of parts, however, if grit blasting or immersion in a carbon solvent bath will be required, the pin assemblies should be stored in marked containers or rack compartments so that they may be mated again with the same pistons after cleaning.

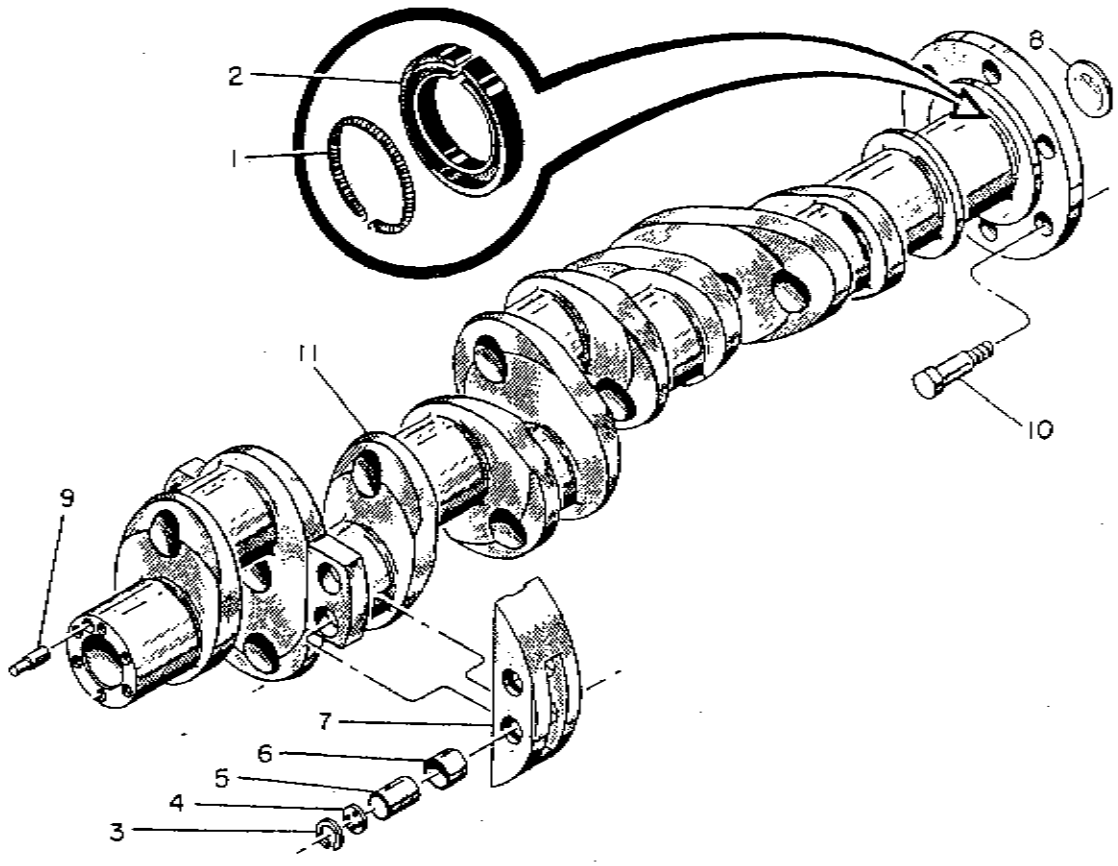
4-75. CRANKSHAFT AND CONNECTING RODS ASSEMBLY. *(See figure 4-34.)*

a. Support the crankshaft front and rear journals on notched 2 x 4 inch wood blocks (on edge) or on other suitable supports.

b. Remove cotter pins from all connecting rod bolts.

c. Hold each connecting rod, in turn, in the most convenient position while the cap bolt nuts are loosened and run off. Withdraw the rod and take the cap and bolts from the crank pin. Place the rod with its mating cap.

d. Remove and discard all bearing inserts. Reassemble loosely the rods, caps, bolts and nuts, placing the position mark numerals on the bolt bosses together.



1. Oil seal spring
2. Crankshaft oil seal
3. Retaining ring
4. Pin retaining plate
5. Counterweight pin
6. Counterweight bushing
7. Crankshaft counterweight
8. Plug
9. Dowel
10. Flywheel bolt
11. Crankshaft

Figure 4-34. Crankshaft Assembly

e. Lift the spring (1) out of the recess in the oil seal (2) with a hook made of stiff wire or by spreading the seal at the split far enough to grasp the spring, then working it out by hand. Unhook the spring end loops and save the spring for a spare if it appears to be undamaged. Twist and pull off the seal.

f. With Truarc internal retaining ring pliers compress the pin and plate retaining rings (3) at both ends of each bottom counterweight pin, and withdraw them. Remove the retaining plates (4), if necessary, with the aid of a hook, and push out the two bottom pins (5). In the same manner remove the top pin retaining rings, plates and pins from each counterweight, and slide off the two counterweights (7).

g. Drill and tap a hole of suitable size to accept a threaded slide hammer in the center of the Hubbard plug (8). Screw in the hammer stem and operate the slide weight to pull the plug. This is necessary to permit thorough removal of magnetic inspection material before reassembly.

Note

It is essential that crankshaft counterweights be identified as to the crankshaft and the blade on which they were originally installed and as to the side originally toward the flywheel end so they can be reinstalled in their original positions on the shaft. This is due to dynamic balance requirements. Do not remove the dowel (9), the flywheel bolts (10) or the counterweight bushings (6).

SECTION V
CLEANING

5-1. GENERAL INSTRUCTIONS.

Note

Air Force personnel will follow procedures specified and described in T. O. 2R-1-84 in all instances in which such instructions are applicable. Adequate precautions for personal protection will be taken, as directed in applicable technical orders. Refer to T. O. 2R-1-84, and other applicable technical orders and specifications for specific formula, mixing and applicable procedures for cleaning compounds and operation instructions for washing machines, spray booths, blasting cabinets and other cleaning equipment. Refer to T. O. 2R-1-11 for corrosion preventive procedures to be followed.

5-2. MATERIALS AND PROCESSES. Wherever in this section dry cleaning solvent is mentioned use material conforming to Federal Specification P-S-661. Where instructions call for the use of mineral spirit, use Federal Specification TT-T-291 in tanks and spray booths. For inhibited, mild alkaline cleaner use a water solution of a mild alkaline powder containing a suitable inhibiting agent to retard its chemical attack on aluminum alloys. Suitable materials for this purpose are in general use in hot dip tanks and are considered most effective when kept in the temperature range of 82.22°C to 93.33°C (180°F to 200°). The solution should be agitated vigorously and continuously to permit satisfactory cleaning without prolonged immersion of parts. Caustic stripper solution may be used as a hot bath for cleaning steel parts. It is made up as a water solution of caustic soda (sodium hydroxide) according to the applicable Federal Specification. Carbon solvent is a general term applied to a number of cresol base liquids. References herein to such material and its application should be understood to mean the solvent and method of application currently used for loosening adhesive carbon deposits. Vapor condensation plants, using trichloethylene for degreasing and paint removal, may be used as for similar parts of other engines when available. Pressure blasting of packette parts should be used only to remove stubborn carbon deposits. Machined surfaces must be suitably protected from blast grit. If the vapor grit process is employed, refer to specific cleaning instructions in this section for permissible grades of blast grit. Sand and coarse steel blast grit shall not be employed. Use soft grit (processed grain, fruit pits or shells), whenever possible, in preference to more abrasive materials.

5-3. REMOVAL OF CLEANING COMPOUND RESIDUES. Immediately after soaking parts in a caustic or inhibited, mild alkaline bath, remove all traces of the alkali by spraying the parts with a jet of wet steam, if possible, and by brushing vigorously with a mineral spirit solvent. All alkaline residues must be removed from crevices, recesses and holes, as well as from other surfaces, to prevent the formation of a foaming emulsion in the engine lubricating oil after reassembly. Remove carbon solvent liquid from engine parts and wash away loosened carbon deposits by flushing or spraying and by brushing, when necessary, with a mineral spirit solvent.

5-4. DRYING CLEANED PARTS. Use a jet of dry compressed air to remove solvent liquid from parts after cleaning. All moisture must be removed from the air stream by suitable traps in the air line to prevent corrosion of bare steel.

5-5. CORROSION PREVENTION. After bare steel parts have been cleaned and dried, spray them with, or dip in, corrosion preventive compound, Specification MIL-C-6529, Type II, or a mixture of one part Type I compound and three parts engine lubricating oil. Discard and replace the mixture whenever it becomes diluted by carry-over of solvent liquid.

5-6. DANGEROUS CLEANING METHODS. Scraping, abrasion with wire brushes, sandpaper or abrasive cloth and buffing with charged buffing wheels are dangerous methods to use on soft metals such as magnesium and aluminum. Gouging with a scraper reduces the fatigue resistance of a highly stressed part and removal of metal by other named methods may render a part dimensionally unserviceable. Do not use scrapers to clean piston ring grooves, regardless of their design.

5-7. SPECIFIC CLEANING INSTRUCTIONS.

5-8. MAGNESIUM CASTINGS. Such parts may be cleaned safely in alkaline solutions, which do not attack this metal. Removal of residues must be thorough. (Refer to paragraph 5-3.) Degreasing may be accomplished with any high flash point petroleum solvent, such as dry cleaning solvent, Specification P-S-661.

5-9. ALUMINUM ALLOY PARTS. Such parts may be degreased by spraying with any Service Approved mineral spirit solvent or with dry cleaning solvent or by brush application of the same liquids. Fortified mineral spirits are more effective when the parts are immersed in them and allowed to remain for a short time to permit solvent action to loosen caked deposits. Use a paint brush to remove loosened material in the absence of a high pressure nozzle. Carbon deposits and gum (oil varnish) may be removed most easily by immersing these parts in a hot bath of an inhibited, mild alkaline cleaning compound. Immersion time should be only as long as necessary to remove

the deposits. Remove all traces of alkali as described in paragraph 5-3. Carbon solvents should be employed only when carbon deposits are too hard and thick for removal by other solvents. Give special attention to cleaning studs, tapped holes and drilled holes.

TABLE II. LIGHT WEIGHT CASTING METALS

Part Name	*Material*
Pushrod housing flange	Aluminum
Cylinder head	Aluminum
Oil pressure valve cylinder	Aluminum
Valve rocker cover	Aluminum
Tachometer and oil screen housing	Aluminum
Hand crank and fuel pump adapter	Aluminum
Flywheel	Aluminum
Oil sump	Aluminum
Fan outlet housing	Aluminum
Fan inlet and gear housing	Aluminum
Oil drain connection plate	Aluminum
Crankcase hot air outlet valve body	Aluminum
Flywheel fan	Aluminum
Flexible coupling driving flange	Aluminum
Gear housing cover	Aluminum
Oil pump housing	Aluminum
Accessory case	Magnesium
Carburetor to air filter adapter	Aluminum
Intake manifold	Aluminum
Oil sump adapter	Aluminum
Right crankcase	Aluminum
Left crankcase	Aluminum
Piston	Aluminum
Preheat and mixing valve housing	Aluminum
Governor adapter	Aluminum
Governor oil drain adapter	Aluminum
Gear case housing	Aluminum

TABLE III.—WROUGHT ALUMINUM ALLOY PARTS

Part Name
Intake tube attaching flange
Heat valve cover
Intake tube
Governor adapter butterfly valve
Crankcase hot air outlet valve
Piston pin plug
Oil cooler

5-10. CYLINDERS. Precautions applicable to both aluminum and steel must be exercised in cleaning and storing these assemblies. An inhibited, mild alkaline cleaner may be used. If stubborn deposits of carbon remain on cylinder heads the areas affected may be vapor blasted, using No. 50 Vapor Blast grit. All machined surfaces must be protected from abrasive action during the blasting operation. Vapor condensation plants are not recommended for cleaning these parts, because their extreme degreasing action leaves carbon deposits harder and more difficult to remove.

5-11. PISTONS. Chemical carbon solvents may be employed to loosen heavy carbon deposits. Following immersion in a carbon solvent bath, the pistons should be flushed immediately with a mineral spirit and a paint brush used to remove loosened material. Deposits which cannot be loosened in that manner may be removed by soft grit blasting or by vapor grit blasting, using No. 80 Vapor Blast grit, with appropriate blasting equipment. No. 80 grit is suitable for cleaning piston heads and interiors. It must not be applied to piston skirts, ring grooves or pin bores. These surfaces should not require blasting, but, if they are to be cleaned in this way, a much finer Vapor Blast grit must be employed so as to leave a very smooth surface. Narrow strips of crocus cloth or binder twine may be pulled through piston ring grooves to remove loosened deposits. Do not buff pistons. Discoloration of the metal need not be removed. Vapor condensation plants are not recommended for cleaning these parts, because their extreme degreasing action leaves carbon deposits harder and more difficult to remove.

5-12. PISTON PINS AND ROCKER SHAFTS. Degrease these parts by brushing on a mineral spirit or dry cleaning solvent. Prior to magnetic inspection polish the steel bearing surfaces with crocus cloth moistened with kerosene, then with dry crocus cloth, preferably while the pins are rotated in a polishing head or lathe collet.

5-13. VALVES. After degreasing valves, inspect them and discard any whose head is warped excessively or which has insufficient stock to permit refacing within specified limits or whose stem is burned, scored, eroded or nicked. (Refer to paragraph 7-33.) Carbon deposits may be loosened by chemical carbon solvent action or they may be scraped off while the valve is rotated in a polishing head or lathe collet. Apply crocus cloth moistened in mineral spirit, and polish the stems with dry crocus cloth.

5-14. CRANKSHAFT. All parts may be degreased by brushing or spraying with mineral spirit or dry cleaning solvent. Pay particular attention to threads, oil holes and recesses. Before magnetic inspection, the crankpins, main journals and oil seal race must be smoothed with crocus cloth moistened in a mineral spirit and polished with dry crocus cloth. If possible, this should be accomplished while the shaft is rotated in a high speed lathe (about 100 rpm). Do not remove cadmium plating on the fly wheel mounting flange. All gum (varnish) deposits must be removed to permit reliable magnetic indications.

5-15. PUSH RODS, VALVE ROCKERS AND OTHER SMALL STEEL PARTS. Degrease these parts with mineral spirit, paying special attention to removal of sludge from all oil passages.

5-16. OIL SUMP. Soak heavy sludge deposits by filling the sump with a mineral spirit solvent. After the sump is emptied, spray the interior with a high pressure nozzle supplied with a mineral spirit solvent or dry cleaning solvent to remove loosened material. If an alkaline cleaning bath is employed the instructions in paragraph 5-3 are applicable.

5-17. GEARS. Gears without bushings may be freed of hard deposits by immersion in a caustic stripping bath

when cold solvents are not effective. Bushings are discolored by such treatment, hence bushed gears should be cleaned by other methods, such as spraying and/or brushing with a mineral spirit solvent and brushing with a brass wire brush.

5-18. FLYWHEEL AND FAN ASSEMBLY.

CAUTION

Do not disassemble the parts. Any shifting or interchanging of parts or any loss of metal by chipping will destroy the balance of the assembly and make it unserviceable. Take particular care to avoid nicking surfaces and cracking fan blades.

5-19. SHROUD AND OTHER SHEET METAL PARTS. Clean these parts with a mineral spirit spray or by brushing with the same liquid, or use a cold emulsion type cleaner and flush with water to rinse. Shutters are made of aluminum and require careful handling to avoid distortion which would make them inoperative. Avoid damage to the shutter actuator in handling, either by crushing or by puncturing the bellows. Take care to prevent deformation of fan housing turning vanes, cylinder baffles and shroud panels by rough handling.

5-20. ACCESSORIES. Engine accessories discussed in Section XI should be cleaned only during the overhaul procedures described there and in accordance with those instructions, except that the exterior of enclosed mechanism may be degreased, without immersing the assemblies, during the general cleaning operation. Do not degrease hydraulic valve lifters prior to disassembly.

SECTION VI
INSPECTION

6-1. DEFINITIONS.

6-2. Terms used in this section to describe the various types of damage for which parts should be inspected are as follows:

a. Abrasion: Scratching of a surface, either by contact with another part or by mechanical cleaning or resurfacing with abrasive materials.

b. Burrs: Sharp, rough, upstanding edges.

c. Corrosion: Deterioration of a surface. This term usually refers to fretting or oxidation of a metal.

d. Deformation: Any departure from correct shape or surface finish, such as bends, bulges, twists, elongation, crushing, flattening, peening, indentation, and gouging.

e. Elongation: Stretching or increase in length.

f. Fretting: Deterioration of a metal surface caused by vibration or chattering of or against another part.

g. Galling: Excessive friction between two metals resulting in particles of the softer metal being torn away and "welded" to the harder.

h. Indentation: Dents or depressions in a surface caused by severe blows.

i. Pitting (or spalling): Small, deep cavities in a metal surface.

j. Oxidation: Chemical combining of a metal, usually steel or iron, with atmospheric oxygen. Surface oxide films formed on aluminum alloy parts serve to prevent further oxidation and are not harmful. Iron oxides do not form protective film and allow oxidation to continue in the underlying metal, roughening the surface and progressing inward.

k. Scoring: Deep grooves or scratches in the surface of a part caused by abrasion, resulting in increased friction and temperature in the absence of adequate lubrication.

l. Run out: Eccentricity or wobble, expressed in decimal parts of an inch, as indicated by the full deflection of an indicator needle.

6-3. VISUAL INSPECTION.

6-4. All parts should be examined for visible defects, such as cracks, deformation, elongation and corrosion, which would render them unserviceable, before they are subjected to dimensional and other time consuming inspections. A magnifying glass may be employed to advantage for examination of suspected cracks. Parts should be checked for cleanliness of all surfaces, including cavities and oil passages and for complete removal of residues of cleaning materials. Critical machined surfaces should be examined for nicks, deep scratches, galling, burning and excessive scoring. Threads should be examined for deformation, such as nicks, pulling, cracking, crossed threads, peening and stripping.

6-5. MAGNETIC INSPECTION.

6-6. Stressed steel parts listed in Table IV shall be inspected for fatigue cracks by the "Magnaflux" process indicated. All parts must be clean and free of carbon and oil varnish deposits and oil before inspection. The crankshaft journals, rocker shafts and piston pins must be polished smooth before being magnetized. In the wet continuous process Red Magnaflux Paste No. 9 is used in a mineral spirit vehicle. The suspension is maintained at a ratio of 1 to 1-1/2 ounces of paste to 1 gallon of liquid. Springs will not be inspected by the magnetic process.

Note

All parts shall be checked carefully for other indications such as grinding cracks, forging laps and seams. If the crankshaft is suspected of any defect it shall be demagnetized and magnetized longitudinally for further inspection.

CAUTION

All small openings, such as oil holes, leading to inaccessible cavities must be plugged with hard wood or fiber plugs or with hard grease or a similar nonabrasive material which is readily soluble in engine lubricating oil before magnetization to prevent the accumulation of magnetic particles where they cannot be removed readily by washing and air blasting.

Note

All parts must be completely demagnetized after inspection and between successive magnetizing operations. Parts which are irregular, and therefore difficult to demagnetize should be withdrawn from the coil at a rate of not over 12 feet per minute. The magnetic substance must be removed completely from all parts after inspection. Remove all plugs from small holes, and inspect for cleanliness of all visible surfaces.

* After cleaning slush serviceable parts in the corrosion preventive mixture specified in paragraph 6-31.

6-7. FLUORESCENT PARTICLE INSPECTION.

6-8. The packette manufacturer recommends inspection for cracks in all stressed steel parts by the "Magnaglow"

TABLE IV. MAGNETIC INSPECTION DATA

Part Name	*Method of Magnetization*	*Amps*	*Method of Inspection*	*Possible Defects and Critical Areas*
CRANKSHAFT	Circular	2500	Wet Continuous	All journals, fillets, dowel holes, bolt holes, counterweight pin holes and oil holes, and No. 1 and 2 crankpins—Fatigue cracks. Thrust flanges at front journal — Heat cracks. Deep, sharp indications across cheeks.
CONNECTING RODS	Circular	1800	Wet Continuous	All areas—Fatigue cracks, opened inclusions. Fatigue cracks at end bosses and at bolt spot face areas.
CAMSHAFT	Circular	1500	Wet Continuous	All areas—Fatigue cracks.
PISTON PINS	Circular	1800	Wet Continuous	Inside and outside—Longitudinal fatigue cracks. Continuous inclusions running over ends of pin.
PISTON PINS	Longitudinal	1800	Wet Residual	Inside and outside at shear planes — transverse Fatigue cracks.
ROCKER ARMS	Circular	1800	Wet Residual	Valve contact face—Fatigue cracks. (Intake rocker only—squirt nozzle.)
CAMSHAFT GEAR	Circular	1800	Wet Continuous	Teeth—Fatigue cracks. Square hole—Fatigue cracks.
ACCESSORY DRIVE GEAR	Circular	1800	Wet Continuous	Teeth—Fatigue cracks. Screw holes—Fatigue cracks.
ALL OTHER GEARS	Circular	1800	Wet	Teeth—heat cracks and fatigue cracks.
CYLINDER BARREL	*Circular	1800	Wet Continuous	All flange areas, especially fillets and spot faced areas—Fatigue cracks.

*Clamp base flange between magnetizer poles.

process and inspection for suspected cracks in all aluminum alloy and magnesium castings by the "Zyglo" process wherever these processes are in use. Standard operating techniques for the respective processes are suitable for inspection of packette parts.

Note

For instructions relative to fluorescent particle ("Magnaglow") inspection, refer to AMC Manual 74-15. For fluorescent penetrant ("Zyglo") inspection procedure and data, refer to AMC Manual 74-4.

6-9. DIMENSIONAL INSPECTION.

6-10. MAINTENANCE OF FITS. All tight fits, clearances, spring pressures and tightening torques shall be maintained within the limits specified in the Table of Limits, Section XII.

6-11. DISPOSITION OF REJECTED PARTS. Parts whose critical dimensions have worn beyond allowable limits shall be replaced if they cannot be returned to serviceable condition by one of the following methods:

a. Replacement of studs and other inserts of standard or available oversize.

b. Grinding or honing to fit standard size mating parts within the "Replacement Maximum" limits.

c. Grinding, honing, boring or reaming to fit available oversize mating parts within limits specified for new parts.

d. Installation of available inserts to provide fit specified for new parts with standard or oversize mating parts.

6-12. FIT OF NEW AND OVERSIZE PARTS. In the Table of Limits, Section XII, figures in the "Minimum" and "Maximum" columns under the heading "New Parts" indicate—in decimal parts of an inch—the values of clearances and interference (tight) fits at room temperature obtained when new mating parts are properly installed together. These values also apply to fits to be obtained when the female part is honed, ground, bored or reamed to the proper size to fit a new oversize male part or when a female insert is installed and reamed or broached to the proper size to fit a new, standard size or serviceable (worn) male part.

6-13. FIT OF USED PARTS. Clearances between running parts which do not exceed the values specified in the "Replacement Maximum" column of Section XII permit the parts to be reinstalled in the engine. If the limit is exceeded the part which is further from the original size shall be replaced. The replacement part must fit the mating part within the "Replacement Maximum" limit.

6-14. FIT OF INSERTS. Replacement inserts installed in place of worn inserts must have the same interference, at room temperature, with the recess in which they are screwed or pressed as that specified for new parts. If an interference within the prescribed limits cannot be secured with a standard size replacement, or if the recess was damaged in removal of the original insert, the smallest oversize insert which can be installed with proper fit in the enlarged recess shall be specified by inspection personnel.

6-15. BACKLASHES. Backlash, or clearance, between mating gear teeth must be determined at reassembly.

6-16. PARTS TO BE MEASURED FOR WEAR. Features of parts indicated in Table V shall be measured at each overhaul. If no limit is placed on allowable increase or reduction in dimension the measured value shall be recorded for comparison with the corresponding dimension of the mating part to determine serviceability of the fit, as defined in paragraph 6-13. All dimensions given in Table V are stated in inches.

6-17. SPECIAL GAUGES.

6-18. The special gauges listed in Section III were designed for inspection of worn bearing bores, worn and replacement bushings, oversize holes for inserts and gaps of new piston rings. The flat shape of plug gauges permits the determination of out-of-roundness sufficient to warrant rejection. They should be tried in several radial positions. If the appropriate "NO GO" plug gauge for a worn part will enter the hole, even though snug, in any radial position the hole is larger than the manufacturer's recommended limit, and the part must be rebushed, reamed or broached to oversize or discarded, as determined by the availability of bushings, inserts or oversize mating parts. The appropriate "GO" gauge should enter a finished replacement bushing or oversized hole, but the "NO GO" gauge should not enter at all. Holes which pass such inspection are within the limits specified for new parts or of correct diameters to fit oversize inserts, as the case may be. When a worn hole "NO GO" gauge is combined with a finished bushing "GO" and "NO GO" pair in one tool, the latter two are machined in tandem on one end, forming a step gauge which permits inspection in a single operation. Table VI shows the purpose and characteristics of each special plug gauge.

6-19. Each worn hole "NO GO" gauge was calculated to allow for permissible wear of the male part which bears in the hole which the gauge is used to inspect. If the hole does not admit the gauge plug the running clearance will be within specified limits, unless the male part is extensively worn. Usually male parts such as valves, lifters and shafts are discarded because of surface roughness or other damage if they are worn excessively, however, if any such part shows considerable wear (compared to dimensions given in Table V or in Section XII) and is otherwise serviceable, an accurate measurement of both male and female diameters should be made to determine whether the clearance is excessive. Thus, the special plug gauges will reduce inspection time in all but border line instances.

6-20. Tool numbers and sizes are stamped on the special plug gauges. Those of identical appearance and very small dimensional difference are also marked to indicate their applicability to parts. For instance, tool No. J-2848-1 is marked "INTAKE", while No. J-2848-2 is marked "EXHAUST". Tools No. J-2849-1 and J-2849-2 are marked with the oversizes indicated in Table VI. Gauge dimen-

TABLE V. PARTS TO BE MEASURED FOR WEAR

Name of Part	Description of Measurement	Reference Number in Section XII	Special Gauge No. or Tool No.	Dimension New (inches) Minimum	Maximum
CYLINDER ASSEMBLY:					
Cylinder and Head Assembly	Bore dia (lower 4-1/4 in.)	1			
	Bore dia (top of bore)	2, 3			
	Bore (out of round)	4			
	Bore (reground)	1, 2, 3, 5			
	Rocker shaft bearing bore		J-2860	0.7182	0.7192
	Valve seat widths	10, 11			
	Valve seat angle (reground)	12			
Valves	Intake valve guide bore		J-2848-1	0.4352	0.4362
	Exhaust valve guide bore		J-2848-2	0.4370	0.4380
	Intake valve stem dia			0.433	0.434
	Exhaust valve stem dia			0.433	0.434
	Intake valve length	21			
	Exhaust valve length	22			
	Valve face angle	19, 20			
	Valve head warp	23			
Valve Springs	Valve spring force	106, 107			
Rocker shaft	Shaft dia (standard)			0.7177	0.7182
	Shaft dia (oversize)			0.7227	0.7237
Valve rockers	Bushing diameter		J-2851-1	0.7192	0.7202
PISTON ASSEMBLY:					
Piston	Skirt dia at bottom			4.994	4.995
	Skirt dia below 3rd ring groove			4.985	4.986
	Pin bore dia in piston		J-2853-1	1.1250	1.1255
Piston rings	Side clearance of new ring in top groove	26			
	Side clearance of new ring in 2nd groove	27			
	Side clearance of new ring in 3rd groove	28			
	Ring gap (standard ring in 5.000 in. dia gauge; 0.005 in. OS ring in 5.005 in. gauge)	29, 30, 31	J-2850		
Piston pin assembly	Pin dia			1.1243	1.1245
	Pin assembly in barrel	37			
CONNECTING ROD ASSY:	Piston pin bushing bore dia		J-2854-1	1.1257	1.1261
	Bushing and bearing twist convergence	42			
	Bolt length			2.240	2.260
CRANKSHAFT ASSY:	Main journal dia	44			
	Crankpin dia	46			
	Damper pin bushing dia			0.624	0.626
	Damper pin dia			0.5554	0.5574
	Run out at center journals (shaft supported at front and rear journals)	44			
	Run out at front end on perimeter and face of flywheel flange (shaft supported at front and rear journals	47			
	End clearance of shaft in front main-thrust bearing (fully assembled)	45			

TABLE V. PARTS TO BE MEASURED FOR WEAR (Cont)

Name of Part	Description of Measurement	Reference Number in Section XII	Special Gauge No. or Tool No.	Dimension New (inches) Minimum	Maximum
CAMSHAFT ASSY:	Run out at center journals (shaft supported at front and rear journals)	61			
	End clearance in assembled crankcase	60			
	Journal diameters			1.249	1.249
	Intake cam lobes (lift measured at center of width)			0.352	0.356
	Exhaust cam lobes (lift measured at center of width)			0.352	0.356
VALVE LIFTER:	Body dia			0.7177	0.7182
	Hydraulic unit leakdown		*J-1297-B		
GENERATOR GEAR CASE:	Driver gear bearings in liners	68			
	Driven gear bearings in liners	69			
	Driver gear bearings end clearance	74			
CRANKCASE:	Valve lifter guide dia		J-2859	0.7187	0.7191
	Camshaft bearings dia		J-2844	1.250	1.251
	Magneto drive gear supports dia			0.6845	0.6855
ACCESSORY CASE:	Oil pump impeller shaft bushings dia			0.8120	0.8130
OIL PUMP:	Impeller end clearance	77			
	Impeller shafts dia			0.8095	0.8105
	Housing bushings dia			0.8120	0.8130
	Driving impeller square across flats			0.427	0.429
HAND CRANK AND FUEL PUMP DRIVE:	Adapter bearing bore dia			0.968	0.969
	Drive shaft dia			0.966	0.967
	Gear shaft dia			0.966	0.967
MAGNETO DRIVE GEAR:	Bushing bore dia		J-2852	0.687	0.688
GOVERNOR DRIVE:	Gear bushing bore dia			0.8745	0.8755
	Gear shaft dia			0.8726	0.8736
	Butterfly valve bearing diameters			0.375	0.376
	Butterfly valve shaft diameters			0.372	0.374
CRANKCASE HEATER AIR VALVE:	Body shaft bore dia			0.374	0.376
	Butterfly valve shaft dia			0.372	0.374
OIL PRESSURE VALVES:	Cylinder bore diameter			1.000	1.002
	Piston head dia			0.997	0.998

*Use 3 to 6 second leakdown master hydraulic unit with fixture. Specify when ordering from Wilcox-Rich Div., Eaton Mfg Co., Detroit, Mich.

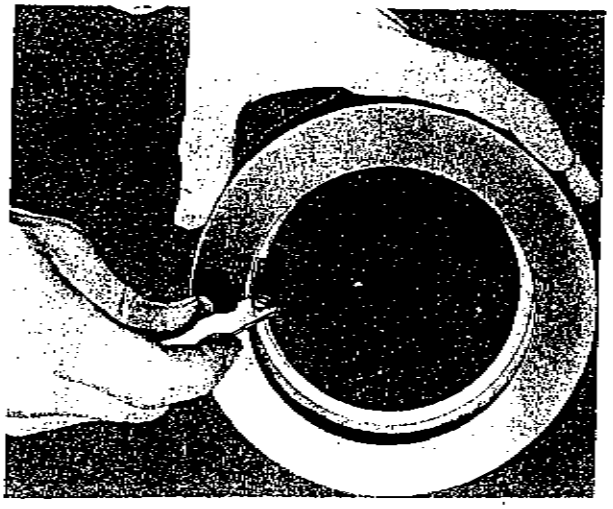


Figure 6-1. Measuring Piston Ring Gap

sions are intended only for checking the gauges themselves, and the stamped figures should not be used for any other purpose.

6-21. The piston ring gauge (tool No. J-2850) has a 5.000 inch bore on one end and a 5.005 inch bore on the other end. If the cylinder bores are within new parts limits the gaps of new standard piston rings in the cold barrels can be determined more easily by placing the rings, one at a time, in the 5.000 inch gauge bore and measuring their gaps with a thickness gauge. *(See figure 6-1.)* In the same manner, the gaps of 0.005 inch oversize rings in barrels of the same oversize can be measured, using the other end of the ring gauge. The tool also will enable the inspector to determine definitely whether a new piston ring is of standard size or 0.005 inch oversize, provided that it has not been filed. New rings may be checked also for proper circular shape in inspection in the proper gauge bore over a strong light. A new ring should be approximately 95% light tight in the gauge. The faces of the gauge are marked to indicate the sizes of adjacent gauging bores.

6-22. SPECIFIC INSPECTIONS.

6-23. PISTONS AND RINGS. Inspect the following features of each piston, and fit a set of new rings in the manner indicated in the following steps:

a. Inspect the piston skirt for heavy scoring and galling.

b. Inspect all surfaces for necessary cleanliness. Stains may be permitted, though all carbon deposits, oil "varnish" and loose material should be removed. Inspect oil drain holes at the bottom of the third ring groove for cleanliness.

c. Inspect the piston pin bore for excessive wear, using piston pin hole gauge, tool No. J-2853-1. The gauge is marked "Standard" (for pistons fitted with standard size pins). The gauge has a worn hole "NO GO" end only.

d. Measure the piston skirt diameters below the third ring groove and at the bottom in a direction at right angles to the pin bore. The skirt is tapered, its larger diameter being at the bottom. The measured diameters should be recorded for comparison with cylinder bore diameters to determine whether cylinders require regrinding.

e. Obtain the new set of rings to be used with each piston. Place each ring, individually, in the piston ring gauge, tool No. J-2850, and measure the gap. *(See figure 6-1.)* The gauge ring has a center groove separating the standard size diameter side from the 0.005 inch oversize diameter side. If the cylinder bore has been or is to be, honed to 0.005 inch oversize use 0.005 inch oversize rings, and check them in the oversize side of the gauge. Gaps must be within new part limits specified for ring in cylinder barrel. *(See limits No. 29, 30, 31, Section XII.)*

f. Install the set of rings in the piston. Using a standard thickness gauge, measure the piston ring side clearances, and compare measured values with limits No. 26, 27, and 28 in Section XII. *(See figure 6-2.)*

Note

Place the side of each piston ring on which the part number is etched toward the piston head. After a set of rings has been inspected for correct fit in each piston, they should remain in place to avoid mixing. If cylinder barrels are to be honed or reground, the piston rings for each

Figure 6-2. Measuring Piston Ring Side Clearance

should be checked for gap (in the refinished barrel at a point even with the base flanges) against the "Replacement Maximum" value. It is preferable that gaps remain within the "New Parts" limits. It is for this reason that 0.005 inch oversize rings are supplied for installation with standard pistons in honed barrels. It is not necessary to coat piston rings or pistons with the corrosion preventive mixture after inspection, although piston pins must have such protection. Rings are protected by Parko Lubrite coating (top) and by tin plating (second and third). Wrap the assembly of piston, pin and rings to keep out grit.

TABLE VI. CHARACTERISTICS OF SPECIAL PLUG GAUGES

Tool Number	*Parts to be Gauged*	*Worn Hole "NO GO"*	*New or Refinished Hole "GO" and "NO GO"*
J-2844	Camshaft Bearing in crankcase	Standard	None
J-2848-1	Intake Valve Guide (Stem Hole)	Standard	Standard
J-2848-2	Exhaust Valve Guide (Stem Hole)	Standard	Standard
J-2849-1	Cyl Head (Valve Guide Bore)	None	0.005 in. oversize
J-2849-2	Cyl Head (Valve Guide Bore)	None	0.010 in. oversize
J-2851-1	Rocker (Bushing Bore)	Standard	Standard
J-2852	Magneto Drive Gear (Bushing Bore)	Standard	None
J-2853-1	Piston (Pin Bore)	Standard	None
J-2854-1	Connecting Rod (Bushing Bore)	Standard	Standard
J-2859	Crankcase (Valve Lifter Guide Bore)	Standard	None
J-2860	Cyl Head (Rocker Shaft Support Bore)	Standard	Standard

TABLE VII. CYLINDER INSPECTIONS AND REPAIRS

Name of Part	*Feature to be Inspected*	*Inspect For*	*Inspection Method*	*Reference*	*Available Repair Method*	*Available Oversizes*	*Remarks*
Cylinder Head	Fins	Cracks, broken	fluorescent Visual	—	Drill Vee notch. File edges smooth	—	Not over 10% of total fin area may be removed.
	Exhaust flange	Burning roughness	Visual	—	None	—	Flange must provide seal area all around.
	Rocker shaft supports	Cracks	Visual, fluorescent	—	None	—	No cracks are permissible.
	Studs	Looseness, bends thread condition	Visual, ring or toolmaker's square	Paragraph 7-5 and Note	Replace	0.003, 0.006, 0.009	Specify next larger oversize if tapped hole is undamaged.
	"Heli-Coil" inserts	Looseness Deformation	Visual	Paragraphs 7-7, -8, -9, -10, -11, -15, -17 Table XI	—	Replace	Outer end must lie in last full thread of hole.

TABLE VII. CYLINDER INSPECTIONS AND REPAIRS (Cont)

Name of Part	*Feature to be Inspected*	*Inspect For*	*Inspection Method*	*Reference*	*Available Repair Method*	*Available Oversizes*	*Remarks*
Cylinder Head (Cont)	Valve guides	Wear	Plug Gauges J-2848-1, J-2848-2	Table VI	Replace	0.015, 0.010, 0.020	Refer to limits No. 8 and 9, Section XII for interference fit.
	Valve seats	Looseness, burning excess width	Visual, bluing gauge, depth gauge	Table VIII	Regrind	—	Measure seat width, depth, concentricity after grinding with bluing gauges J-2887-A, J-2887-B.
	Rocker support bores	Sharp edges at ends of bores, wear	Visual, plug gauge J-2860	Figure 7-12 paragraph 7-35	Ream for oversize or install repair bushings	Refer to "Valve Rocker Shaft"	After reaming or installation of bushings, measure alignment position of bores.
Cylinder Barrel	Base flange parting surface	Bending	Dial indicator	—	None	—	Must not be more than 0.002 in. out of flat or square.
	Fins	Bending	Visual	—	Straighten	—	Inspect for cracks after straightening.
	Cylinder bore wall	Pitting, surface roughness, choke diameter	Visual, dial indicator bore gauge	Section XII, limits 1, 2, 3, 4, 5	Roughen with Aloxite cloth, hone (local), Regrind, rebarrel (factory)	0.005 0.015	Inspect refinished bores for surface roughness of 30-40 micro inches rms.
Valve Rockers	Valve contact face	Wear, scoring	Visual	—	None	—	—
	Socket	Wear	Visual	—	None	—	Worn socket area should be highly polished by wear.
	Bearing	Looseness, wear	Plug gauge No. J-2851-1	Table V	Replace	—	Inspect new bearings for alignment, bore, clear oil passages, fit on shaft.
Valve Rocker Shaft	Exterior surface	Wear	Micrometer caliper (0-1 in.)	Table V	None	None	Measure for correct clearance in reamed supports or bushings.
	Ends	Tools, marks chamfers	Visual	Paragraph 6-29	None	—	Discard shafts with tool marks on ends.

TABLE VII. CYLINDER INSPECTIONS AND REPAIRS (Cont)

Name of Part	*Feature to be Inspected*	*Inspect For*	*Inspection Method*	*Reference*	*Available Repair Method*	*Available Oversizes*	*Remarks*
Valves	Stems	Cracks, wear roughness	Visual	—	None	—	Specify polishing of stems. Measure after polishing.
	Lock grooves	Nicks, cracks, wear, scoring	Visual fit to stems	—	None	—	Keys should fit on valve stems snugly with no appreciable end movement.
	Faces	Excessive grinding, angle, concentricity	Visual, protractor, dial indicator	Section XII, limits 19, 20	Regrind	—	Face must not be cut into rounded edge of head or below depth of Stellite.
	Head flats	Warp	Dial indicator	Section XII, limit 23	None	—	—
Valve Springs	Surfaces	Cracks, corrosion	Visual	—	None	—	—
	Ends	Broken ends	Visual	—	None	—	Spring ends must be square with axis.
	Strength	Loads at specified lengths	Spring tester	Section XII, limits 106, 107	None	—	—
Valve Spring Retainers	Wearing surfaces	Excessive wear, cracks	Visual	—	None	—	—
	Holes	Wear, roughness	Visual	—	None	—	—
Valve Stem Keys	Wearing surfaces	Nicks, cracks, wear, scoring	Visual, fit to stems	—	None	—	Keys should fit snugly on valve stems with no appreciable end play.
Pushrods	Ball ends	Wear, scoring, cracks	Visual	—	None	—	Worn areas should be highly polished by wear.
	Tubes	Bending	Roll on surface plate	—	Tap with rawhide mallet	—	Inspect for clear oil passages.
Pushrod Housings	Flanges	Cracks	Visual	—	None	—	—
	Straight ends	Cracks, distortion	Visual	—	None	—	—
	Tube wall	Deformation	Visual	—	Tap over mandrel	—	Inspect for cracks after straightening.

6-24. CYLINDER ASSEMBLIES. Inspect all parts for damage which would place them in the unrepairable category. Dispose of all unrepairable cylinder parts in accordance with current orders on that subject, keeping the others in such locations, or maintaining such identifying tags attached to them as will be necessary to assure reassembly of originally mated parts in their former relations. Pushrods, valve rockers and rocker shafts are the parts which should not be interchanged. Inspect the remaining group of parts for repairable damage and wear, and specify necessary repair operations on appropriate repair tags attached securely to any parts which will require such attention. Refer to Table VII for descriptions of detail inspections before repair and available repair methods. Inspect all repair work for correct dimensions, alignment, fits and surface finish, as applicable.

Note

Due to the necessity of maintaining the length of valve trains (cam lobes to valve seats) within the range of compensation provided by the hydraulic lifters, it is essential that valve regrinding be limited to the extent specified in Section XII, limits No. 21 and 22 and that reground seats be maintained within the depth limits specified in Table VIII.

TABLE VIII. VALVE SEAT GAUGING DIMENSIONS

Valve Seat	**GAUGE DEPTH (Inches)*				*Gauge Diameter (Inches)*
	New Seat		*Reground Seat*		
	Minimum	*Maximum*	*Minimum*	*Maximum*	
Intake	6.455	6.465	6.455	6.495	2.250
Exhaust	6.474	6.485	6.475	6.515	1.781

*Measured from parting surface of cylinder base flange.

6-25. CRANKSHAFT ASSEMBLY. Before magnetic inspection is conducted inspect the crankshaft for unrepairable conditions such as burned or scored journals, worn counterweight pin holes, bending and severe indentation, and specify polishing of crankpins and main journals. Inspect serviceable crankshafts after magnetic inspection for repairable damage such as cross threaded flywheel bolts, lightly scored counterweight pin holes or a damaged dowel. Inspect for residual magnetism and residues of magnetic particles. Specify demagnetization and recleaning if necessary and any needed repair work, including installation of a new Hubbard plug.

6-26. CONNECTING RODS. Inspect bearing cap bolts for elongation and for thread condition. Check fit of nut threads on bolt ends and positions of cotter pin holes when nuts are tightened to specified torque on the assembled rods. Cotter pin holes must lie within the nut slots. Test alignment of the connecting rod big end bore (without inserts) with piston pin bushings which have passed dimensional inspection or have been installed as replacements. This inspection may be performed by inserting push fit arbors in the big end and bushing and placing the big end arbor in Vee blocks on a surface plate so that the bushing arbor rests on two parallel blocks, accurately ground to uniform height. A thickness gauge may be used to test for clearance under either end of the bushing arbor, indicating twist or bushing misalignment. The rod may be swung to the upright position in the Vee blocks and a surface gauge and dial indicator passed over the bushing arbor to test for bushing and bearing convergence. (Refer to Ref. No. 42, Section XII and to figure 7-14 for dimensional limits.) Use the plug, gauge, tool No. J-2854-1 to check the bore diameter of any new connecting rod bushing. Also check for approximately 0.015 in. x 45 degree chamfers at ends of new bushing bores. Inspect bored or reamed holes in new bushings for tool marks. If available, a profilometer should be used to spot check a percentage of new bushing bores for surface roughness resulting from tool condition and operation. *(See figure 7-14.)*

6-27. CAMSHAFT. Measure journal diameters with an outside micrometer caliper. (Refer to "dimension new", Table V.) Measure eccentricity at each of the two center journals with a dial indicator while the shaft is mounted between bench centers. In the same manner measure lift at the center of width of each cam lobe and test for measurable slope along the toe line of each lobe. The toe line taper is necessary in order to rotate the valve lifters. (Refer to lift limits for new shafts in Table V.) In order to measure the lobe lift and journal eccentricity accurately, the indicator stem axis must be perpendicular to and in the same plane as the camshaft axis, e.g., the two axes must intersect at right angles. For the lift measurement use an indicator capable of 1/2 inch stem travel, such as Federal model No. D81S. The foregoing dimensional inspection need be performed only if there are no visible and unrepairable defects, such as heavily scored journals, pits along the lobe toe lines or deformed threads in the gear flange holes.

6-28. OIL PRESSURE RELIEF VALVE CAP. Inspect the bronze cap bore wall for roughness or wear resulting in a measurable step. Discard any cap with either type of damage, since it will cause erratic oil pressure.

6-29. VALVE ROCKER SHAFTS AND COVERS. Shafts will be serviceable if not heavily scored or excessively worn on the exterior surfaces and if the flat ends are smooth and free from tool marks or other roughness. If the shaft ends have worn deeply into the associated valve rocker cover, both parts must be discarded. To reduce wear in the covers, current production rocker shafts are polished on the flat ends, and the end surface areas are increased by a reduction in the chamfer dimensions. These are identified by a length of 4.44 inches.

6-30. PROTECTION OF PARTS FROM CORROSION FOLLOWING INSPECTION.

6-31. Parts which have passed visual and dimensional inspection, whether awaiting assembly or repair, must be

protected from oxidation if atmospheric conditions are conducive to such damage. Aluminum parts may require protection in atmospheres having a high salt content. Steel parts must be protected in all instances.

6-32. The corrosion preventive mixture shall be composed on one part corrosion preventive compound MIL-C-6529, Type I, thoroughly mixed with three parts engine lubricating oil, MIL-O-2104, grade 50. This mixture must be kept clean and must be discarded when it becomes diluted. Parts should be sprayed or dipped in such a manner as to leave a protective film on all surfaces.

SECTION VII
REPAIR OR REPLACEMENT

7-1. STUD REPLACEMENT.

7-2. AVAILABLE OVERSIZES. All studs listed in the Illustrated Parts Breakdown under the packette manufacturer's part numbers are available in oversizes of 0.003, 0.006 and 0.009 inch, as measured on the pitch diameter of the coarse thread end. The fine thread is always of standard pitch diameter. Oversizes may be identified by the shape of the coarse threaded end, as shown in Table IX.

TABLE IX. STANDARD AND OVERSIZE STUD IDENTIFICATION

Typical Part No.	Oversize on Pitch Dia of Coarse Thread (inches)	Optional Identification Marks on Coarse Thread End		Identification Color Code
		Stamped	Machined	
XXXXXX	Standard	None		None
XXXXXXP003	.003			
XXXXXXP006	.006			
XXXXXXP009	.009			
XXXXXXP007	.007			
XXXXXXP012	.012			

7-3. REMOVAL OF STUDS. Whole studs may be removed by turning to the left with any standard type of gripping stud remover. Broken studs may be removed with a splined stud extractor after drilling the proper size hole on the stud axis to accommodate the extractor shank. Center punch exactly in the center of the broken stud end to avoid damage to the casting threads. Use the correct size of twist drill to assure a snug fit and good grip of the extractor. Hold the drill in line with stud and as steady as possible. Turn the stud out slowly to avoid heating and galling of the casting threads. Before discarding the damaged stud, examine the inner end to determine its size.

7-4. RETAPPING. Ordinarily it will not be necessary to clean out stud holes with taps. First, clean a vacated hole with a solvent, and blow it dry with compressed air; then examine the threads for smoothness. Usually, a stud of the oversize next larger than the stud removed will enter the vacated hole with correct tightness. Run in a worn tap to clean out the hole threads only if they are damaged. If a new tap is used the hole will be enlarged, requiring a larger oversize.

TABLE X. STUD SETTING HEIGHTS

Location of Stud	*Stud Thread Sizes*	*Total No. of Studs*	*Setting Height (inches)*
CRANKCASE			
Magneto gear support pad	5/16–18 x 5/16–24	2	0.50
Mounting bracket pads (2)	5/16–18 x 5/16–24	2	0.66
Upper parting flange (front)	1/4–20 x 1/4–28	1	1.00
Upper parting flange (second)	1/4–20 x 1/4–28	1	0.69
Oil sump adapter pads			
Rear drain hole	1/4–20 x 1/4–28	2	1.75
Center drain hole (drilled)	5/16–18 x 5/16–24	2	0.90
Front drain hole	5/16–18 x 5/16–24	2	2.62
Rear arm mount pad, inner (drilled)	5/16–18 x 5/16–24	2	1.50
Arm mount pads (2)	5/16–18 x 5/16–24	4	0.81
Pushrod housing flange pads (6)	1/4–20 x 1/4–28	18	0.62
Cylinder pads (6)	7/16–14 x 7/16–20	36	0.87
Fan housing flange	1/2–13 x 1/2–20	7	1.88
Heater outlet valve pad	1/4–20 x 1/4–28	2	2.31
Intake manifold pads (2)	3/8–16 x 3/8–24	4	0.94
Oil pressure valve pad	1/4–20 x 1/4–28	2	1.56
GEAR CASE HOUSING			
Lifting eye pads (2)	7/16–14 x 7/16–20	2	1.94
Gear housing cover pad	1/4–20 x 1/4–28	4	0.75
Generator pads (4)	3/8–16 x 3/8–24	40	1.12
Oil filter adapter pad	5/16–18 x 5/16–24	2	0.75
FAN INLET AND GEAR HOUSING			
Lifting eye pads (2)	7/16–14 x 7/16–20	2	1.94
Front parting flange, bottom hole	3/8–16 x 3/8–24	1	2.55
Front parting flange, through generator pads (4)	3/8–16 x 3/8–24	8	3.25
Front parting flange, through gear case housing	3/8–16 x 3/8–24	12	1.05
Rear parting flange	5/16–18 x 5/16–24	9	0.78
FLYWHEEL AND FAN ASSEMBLY			
Ring gear shoulder (rear)	1/4–20 x 1/4–28	12	0.75
Drive coupling mounting face (front)	5/16–18 x 5/16–24	8	1.62
FAN OUTLET HOUSING			
Front parting flange	5/16–18 x 5/16–24	7	1.00
Starter mount pad	1/2–13 x 1/2–20	3	1.12
Magnetic switch mount pad	1/4–20 x 1/4–28	4	0.38
CYLINDERS			
Exhaust flange (stud part No. 21463, 1-3/8 in. lg)	5/16–18 x 5/16–24	12	0.88

TABLE X. STUD SETTING HEIGHTS (Cont)

Location of Stud	*Stud Thread Sizes*	*Total No. of Studs*	*Setting Height (inches)*
INTAKE MANIFOLD			
Carburetor mount flange	3/8-16 x 3/8-24	4	0.91
OIL SUMP			
Mounting flange	1/4-20 x 1/4-28	14	0.74
Oil drain connection plate pad	1/4-20 x 1/4-28	2	0.81
Heater bracket pads (4)	5/16-18 x 5/16-24	4	0.56
ACCESSORY CASE			
Exhaust manifold bracket pad	5/16-18 x 5/16-24	4	0.54
Hand crank and fuel pump drive adapter mount pad	5/16-18 x 5/16-24	2	0.81
Tach. and oil screen pad	1/4-20 x 1/4-28	4	0.75
Magneto pad	5/16-18 x 5/16-24	2	0.94
Governor oil drain adapter	1/4-20 x 1/4-28	1	0.56
Governor adapter pad	5/16-18 x 5/16-24	3	0.81
Left accessory pad	5/16-18 x 5/16-24	2	0.81
Blower engine to accessory case bracket pad	5/16-18 x 5/16-24	1	0.62
HAND CRANK AND FUEL PUMP ADAPTER			
Pump pad	3/8-16 x 3/8-24	2	2.93
GOVERNOR ADAPTER			
Governor pad	5/16-18 x 5/16-24	4	1.00
Mixing valve mount pad, upper (stud part No. 532505)	5/16-18 x 5/16-24	1	2.25
Mixing valve mount pad, lower (stud part No. 532522)	5/16-18 x 5/16-24	1	2.81
OIL PRESSURE VALVE			
Cylinder	1/4-20 x 1/4-28	2	0.865
PREHEAT AND MIXING VALVE HOUSING			
Solenoid bracket pad	1/4-20 x 1/4-28	2	0.41

7-5. STUD INSTALLATION. Drive studs supplied under packette manufacturer's part numbers with a stud driver designed for spherical end studs if the replacement parts have this shape. For installation of any AN bolt stud and some of those produced by the packette manufacturer, use a stud driver designed for flat end studs. A worn stud driver may damage the end thread, making it necessary to use a chasing die before a nut can be screwed on. This procedure will remove the cadmium plating and allow corrosion, which will make future disassembly difficult or cause the stud to be backed out with the nut. Before driving a stud, always inspect the hole for chips and liquid. Blow out any foreign matter. Start the stud by hand. If it will not start into the hole it is too large or has a defective end thread. Before final insertion coat the coarse thread with a thin film of anti-seize compound, MIL-T-5544, if the stud hole is blind, or with a non-hardening sealing paste if the hole enters a cavity subject to oil spray. Turn the stud in slowly to prevent overheating and galling of the casting metal. Drive the stud to the proper "setting height", as specified in Table X. The setting height is the total projecting length. While driving, observe the torque required. This must be greater than nut tightening torque for the same size, but not enough to damage the casting, as the stud approaches its correct engagement depth.

Note

If any cylinder base attaching stud in the crankcase must be replaced because of breakage, it will be necessary to replace all six studs in that same cylinder pad and the two through bolts originally installed there, because such breakage indicates that looseness existed and may have fatigued the remaining studs and through bolts, creating the danger of failure if they are used in the rebuilt packette. In this event, the parting surface of the base flange of the cylinder previously mounted on that pad should be tested for bending, and, if it is bent, the cylinder must be discarded.

7-6. HELI-COIL THREAD INSERTS.

7-7. GENERAL. With the exception of cylinder mount

pad stud holes in the crankcase, all tapped holes may be repaired, if stripped, cross-threaded, corroded or worn, by installation of "Heli-Coil" screw thread inserts. As their name implies, "Heli-Coil" inserts are helical coils of wire whose cross section is diamond-shaped to form external and internal threads. They are screwed into specially retapped holes. Stud holes repaired in this manner will provide the required tight fit for standard size studs and screw hole inserts will accept bolt and cap screw threads with a Class 3 fit. The retapped holes for "Heli-Coil" inserts and the pitch diameters of installed inserts are the same for stud holes and screw holes. The difference in fit is due to the corresponding difference in pitch diameters of studs and bolt threads of the same nominal size. Thus only one "Heli-Coil" roughing tap and one finishing tap are required for each nominal thread size.

7-8. LENGTHS. "Heli-Coil" inserts are supplied in five standard lengths. Expressed in terms of nominal diameter, these are 1, 1-1/2, 2, 2-1/2 and 3. For aluminum castings use lengths equal to 1-1/2 diameters and for magnesium castings use 2 diameter lengths of "Heli-Coil" inserts. (Refer to Table II, Section V.) "Heli-Coil" part numbers are stated in Table XI without reference to length of insert.

7-9. MATERIALS. "Heli-Coil" inserts are made of carbon steel, stainless steel and phosphor bronze. Part numbers in Table XI do not include the symbols used to specify material. These are "C" for stainless steel and "B" for bronze. They are added to the listed part numbers.

7-10. NOTCHING. "Heli-Coil" thread inserts for through holes (as in casting flanges) are notched just above the driving tang (end bent diametrically across the coil) to facilitate breaking off the tang after installation. The symbol "N" added to the part size number designates a notched insert. The part size numbers in Table XI do not include this symbol, since parts are supplied with or without the notch.

7-11. PART NUMBER. To determine the complete part number for any "Heli-Coil" insert, add the material symbol "B" or "C" and notching symbol "N", if applicable, to the type and size number, then add "X" and the required length in inches, expressed as a fraction. Thus, the complete part number for a notched 5/16-18 stainless steel insert of 1-1/2 dia length is "1185-5CN x 15/32", and a 1/4-20 x 1-1/2 dia bronze insert without notch is numbered "1185-4B x 3/8". A carbon steel insert of the latter size would be numbered "1185-4 x 3/8".

7-12. METHOD OF INSTALLATION. The six normal operations required to install and inspect a Heli-coil insert in a damaged tapped hole are: Drill out hole, rough tap, finish tap, gauge retapped hole, wind insert into hole, break off tang (through holes only). Special finishing operations applicable to spark plug hole thread inserts are described in paragraph 7-29.

7-13. DRILLING. Use a twist drill of a diameter equal to that of the stud or bolt body (nominal) to drill out torn threads of the original tapped hole. Drill to the depth of the original threads in blind holes. Do not make them deeper. Keep the drill perfectly square with the machined surface of the casting. Use a drill coolant made up of one part Lard Oil and two parts Kerosene for soft metals. Blow out all liquid and chips from blind holes with dry compressed air.

7-14. TAPPING. Special "Heli-Coil" roughing taps, for which tool numbers are listed in Table XI, are used to cut threads in drilled out holes, leaving a small amount of stock to be removed with the finishing taps. If roughing taps are not available, the proper size of finishing tap may be used immediately after drilling, however, this practice will cause more rapid wear and will necessitate earlier replacement of the finishing tap. Both roughing and finishing taps may be turned by hand with standard pattern tap chucks and tap wrenches. (Refer to AF Supply Catalog, Class 17-B.) Use the coolant specified in the preceding paragraph to lubricate the tap before turning it into the hole. The depth of the full thread in a blind hole must be 0.02 to 0.06 inch greater than the length of the insert to be installed. After tapping, blow out all liquid and chips with dry compressed air.

Note

When both roughing and finishing taps are employed, always perform the first operation with the roughing tap and the second with the finishing tap.

7-15. GAUGING. The "Heli-Coil" thread gauges, for which tool numbers are listed in Table XI, are used to gauge the finish tapped holes for "Heli-Coil" inserts. The "GO" plug end is screwed into the finish tapped hole first. It must enter to the depth indicating shoulder to assure an adequate pitch diameter. If it does not the finishing tap is worn excessively, and the hole must be retapped with a serviceable tool. If the "NO GO" plug enters the tapped hole more than 1/2 turn the finishing tap is cutting oversize, probably due to side forces applied to the tool in tapping. Standard size studs cannot be tightened if the "Heli-Coil" inserts are oversize on pitch diameter.

7-16. INSTALLING. Four types of installing tools are supplied by the "Heli-Coil" Corporation. The simplest type is a plain "T" driver with a slot in the end of its mandrel to drive the "Heli-Coil" tang. The insert is placed over the mandrel, open end first, and the tank engaged in the slot in the mandrel. The drive end of the insert is then placed at the tapped hole entrance and turned into the hole thread with the installing tool until the outer end of the insert lies in the first full thread (slightly below the surface). The tool is then withdrawn. In through holes only, the tank is broken off by a hammer blow on a bar which will just pass through the thread or by bending it back and forth across the hole with long nose pliers. An "improved" type of installing tool consists of a "T" driver with a sliding sleeve on the mandrel. The sleeve is used to push the insert against the hole

TABLE XI. AF STOCK NUMBERS AND MANUFACTURER'S NUMBERS OF "HELI-COILS" AND SPECIAL TOOLS

Size	Inserts			Taps		GAGES (Thread Plug)	INSERTING TOOLS (Prewinding Type)	EXTRACTORS
	"Heli-Coil" Part No.	Basic Lengths		Roughing	Finishing			
		1-1/2 dia	2 dia					
10–24	*1185-3	9/32	3/8	*186-3	†7900-757070	*188-3	†7900-273987-2	†7900-278510
1/4–20	*1185-4	3/8	1/2	*186-4	†7900-757090	*188-4	†7900-273987-6	†7900-278510
5/16–18	*1185-5	15/32	5/8	*186-5	†7900-757110	*188-5	†7900-273988	†7900-278510
3/8–16	*1185-6	9/16	3/4	*186-6	†7900-757130	*188-6	†7900-273988-4	†7900-278510
7/16–14	*1185-7	21/32	7/8	*186-7	†7900-757150	*188-7	†7900-273988-8	†7900-278515
1/2–13	*1185-8	3/4	1	*186-8	*187-8	*188-8	*528-8N	†7900-278515
18 mm	*C2-52	.343 (special)		*2-22	†7900-759915	†7900-373080	†7900-373989-4	†7900-278515

* "Heli-Coil" Corporation numbers.
† Air Force stock numbers.

thread. The "pre-winding" type of installing tools, for which Air Force stock numbers are listed in Table XI, operate in essentially the same manner as the simpler tools. A sliding sleeve on the mandrel is recessed at the side, and its lower end is tapped so that the "Heli-Coil" insert can be inserted into the side recess and wound into the tapped end with the slotted mandrel, thus compressing it so that it will enter the tapped hole in the work more easily. To install a "Heli-Coil" insert with a pre-winding tool, coat it with an anti-seize compound, MIL-T-5544, and place it in the side recess of the sleeve with the tang next to the tapped hole in the driving end. Push the mandrel through the insert and engage the tang in the mandrel slot. Slowly wind the insert into the sleeve thread. Place the insert and tool at the end of the hole to be repaired, and slowly turn the insert into place, keeping the sleeve in line with the hole and against it. *(See figure 7-1.)* After the insert leaves the tool turn further until its end lies in the first full thread of the tapped hole; then withdraw the tool. The power installing tools operate in the same manner as the hand driven pre-winding tools, but they are driven by a portable electric drill, an air tool, or a drill press. These are intended for manufacturing operations and are not described or listed herein.

Note

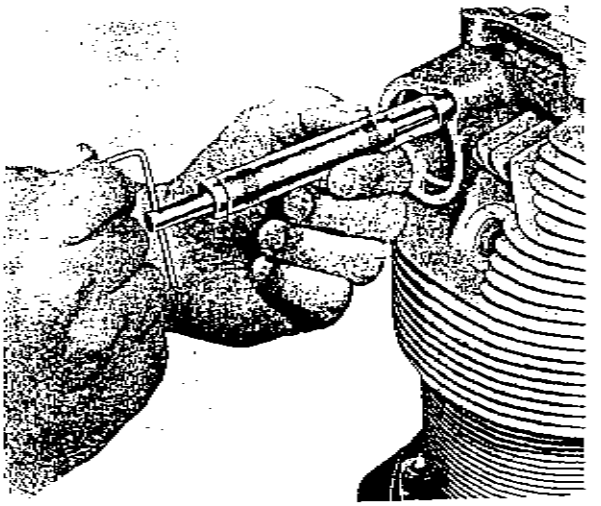
Do not drive a "Heli-Coil" insert deeper than necessary to place its outer end in the first full thread of the hole. Make sure that the proper length of insert is used for the depth of hole and kind of casting metal (paragraph 7-8).

7-17. INSPECTION. Installed "Heli-Coil" inserts may be checked for correct pitch diameter with National Coarse Thread Class 3 or 3B plug gauges. (Refer to AF Supply Catalog, Class 17-B for NC-3 "GO" and "NO GO" gauges.)

7-18. REMOVAL. Damaged "Heli-Coil" inserts may be removed with the applicable sizes of extracting tool listed in Table XI. Tap the tool shank with a hammer sharply to drive the tapered square into the insert until it gets a good "bite"; then turn the tool handle to the left to unscrew the insert. Removal of spark plug hole inserts requires a preliminary operation. *(See paragraph 7-29.)*

7-19. THREAD CHASING.

7-20. Chasing nuts designed for the purpose may be run on damaged stud threads to remove burrs and nicks. Usually it will not be possible to employ a standard die and stock because of interference of other studs nearby. Also, threading dies can be adjusted to cut down the entire



7-1. Installing Typical "Heli-Coil" Insert With "Pre-Winding" Type Tool

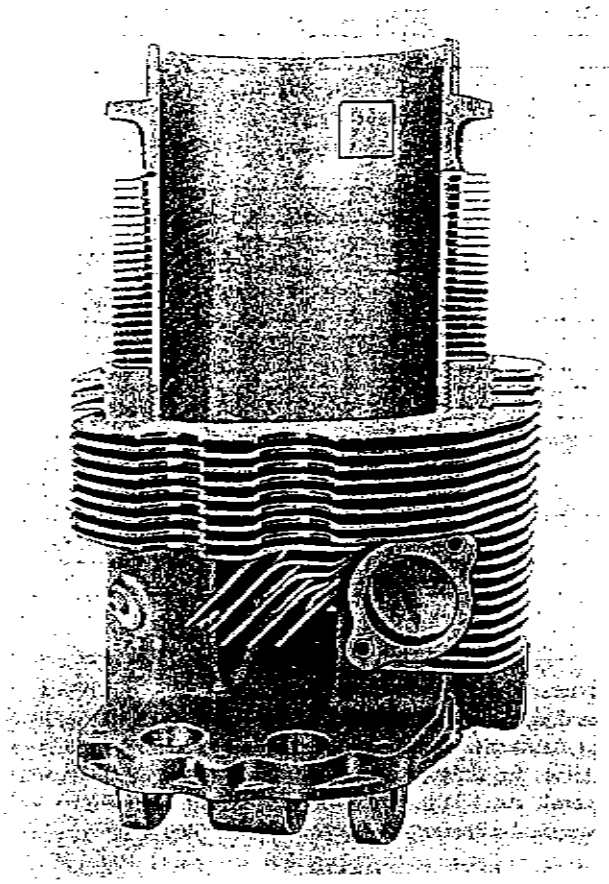


Figure 7-2. Finish Pattern of Correctly Honed Cylinder Bore

thread, and this must be avoided. If a stud is more than slightly damaged it should be replaced, since removal of the cadmium plating by thread chasing will permit corrosion, making the stud nut difficult to remove. Bolts and screws with slightly nicked or burred threads may be repaired also with thread chasing nuts of proper sizes. They should be discarded if their threads are badly deformed, because of strength and assembly considerations.

7-21. STONING.

7-22. Nicks and light scores may be smoothed by the use of an Arkansas hard stone or a fine India stone. A film of oil on the stone prevents loading of the surface and increases the cutting action. When an India stone is employed, care must be exercised to avoid cutting of the finished surface. Stoning should aim only to remove projecting burrs and raised edges of nicks and scores. A triangular stone may be used to smooth large, external threads.

7-23. WELDING AND BRAZING.

7-24. These processes may be employed for the repair of cracks in internal steel parts, such as brackets and shroud panels, however the time required, the difficulty of the work on thin metal and the chance of embrittlement and subsequent failure make such repairs of questionable value, hence they should be attempted only when replacement parts are not available. Welding and brazing of castings and running parts are not permissible.

7-25. CYLINDER ASSEMBLIES.

7-26. CYLINDER HEAD FIN REPAIR. Removal of fin area not in excess of 10 percent of the original total area by breakage or drilling to stop cracks is permissible. Round broken edges with a file, removing only enough metal to smooth the edges. A Vee notch with a rounded apex may be cut out to stop a crack. Round the corners of the cut edges. If a crack extends radially the full width of a fin it cannot be arrested, and the assembly should be discarded.

7-27. CYLINDER BORE. Dimensional inspection information should indicate whether the bore and choke of the cylinder barrel are within limits which allow installation of standard pistons and standard rings or standard pistons and 0.005 inch oversize rings or if the bore is sufficiently worn to require grinding to the permissible 0.015 in. oversize for oversize pistons and rings. If standard pistons and rings will be installed it will be necessary only to remove the glaze on the bore wall either with aluminum oxide cloth, Specification No. P-C-451, grit No. 100, or with a cylinder honing machine with No. 400 grit stones mounted in the honing head. In either event, the resurfaced wall must have a roughness of 30-40 micro inches, rms, and the scratch pattern must conform to that illustrated in figures 7-2 and 7-3. "Replacement Maximum", Ref. No. 1, 2, 3 and 4, Section XII, limits allow for reduction of choke and enlargement of the straight bore

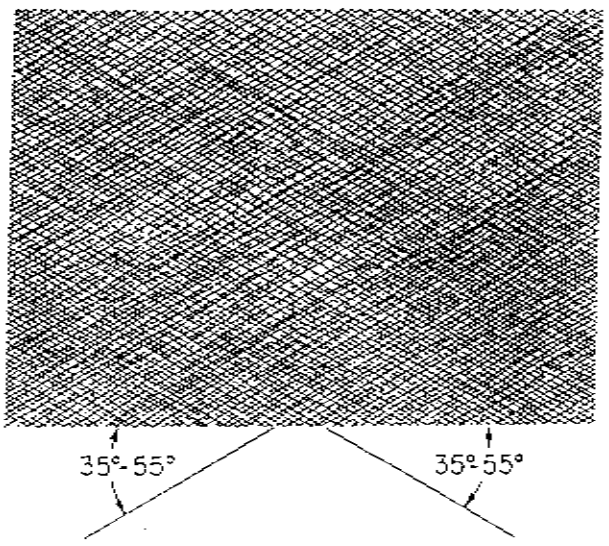


Figure 7-3. Magnified Pattern of Honing Scratches (Black Outline in Figure 7-2)

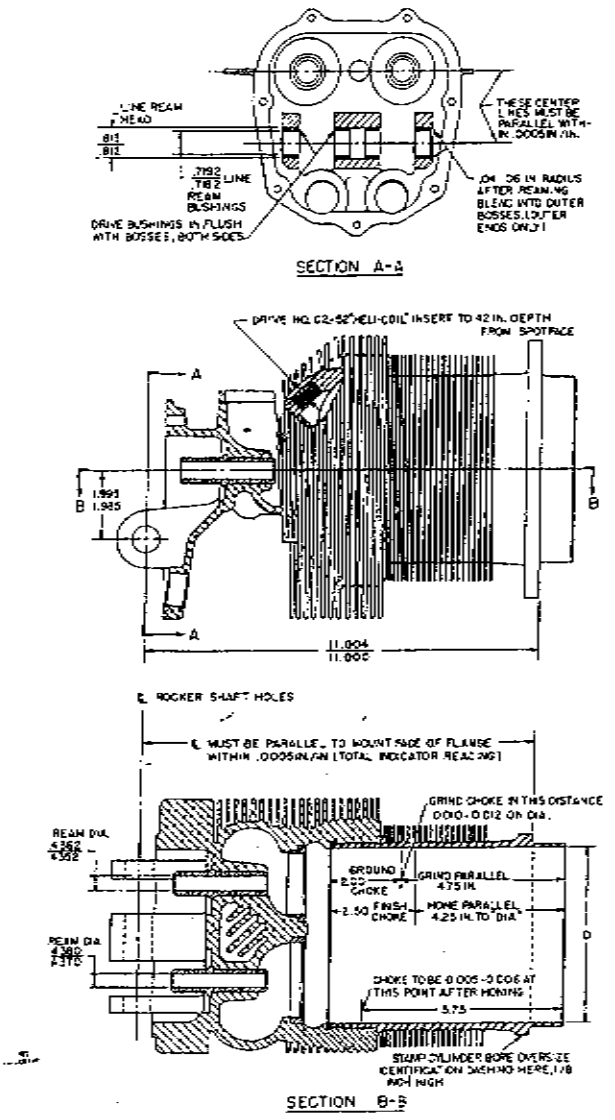


Figure 7-4. Dimensions of Cylinder Assembly

to approximately 0.005 in. over the minimum standard dimensions so that 0.005 in. oversize rings can be installed on standard pistons when these limits are reached, thus allowing the cylinder to remain in service. If the bore dimensions are further enlarged by wear the barrel must be reground to 0.015 in. oversize, with original choke dimensions. Refer to figure 7-4 for bore and choke dimensions of both standard and oversized barrels. If the barrel is not to be ground oversize it will be necessary to grind or hone to remove any ring step at the top end in excess of 0.002 in. on the diameter. Such work must not reduce the choke below the minimum value specified in the "Replacement Maximum" column, Ref. No. 3, Section XII.

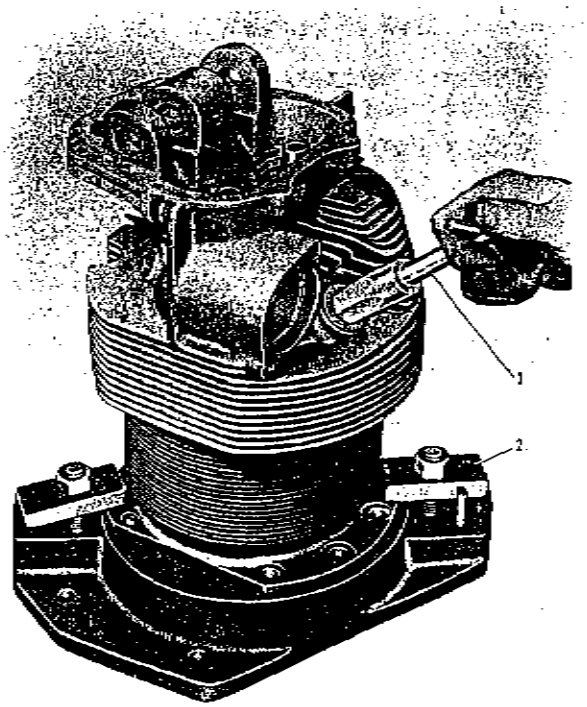
Observe in figure 7-4 that the ground choke is slightly blended into the seraight bore by honing but is not otherwise affected by that operation.

7-28. IDENTIFICATION OF OVERSIZE CYLINDERS. After grinding and honing a cylinder assembly to the oversize dimensions specified in Table XII, the barrel base flange should be stamped on the edge, as indicated in the illustration, in accordance with factory rebuilding practice, to provide a uniform method of identifying such assemblies.

TABLE XII. CYLINDER BORE DIMENSIONS

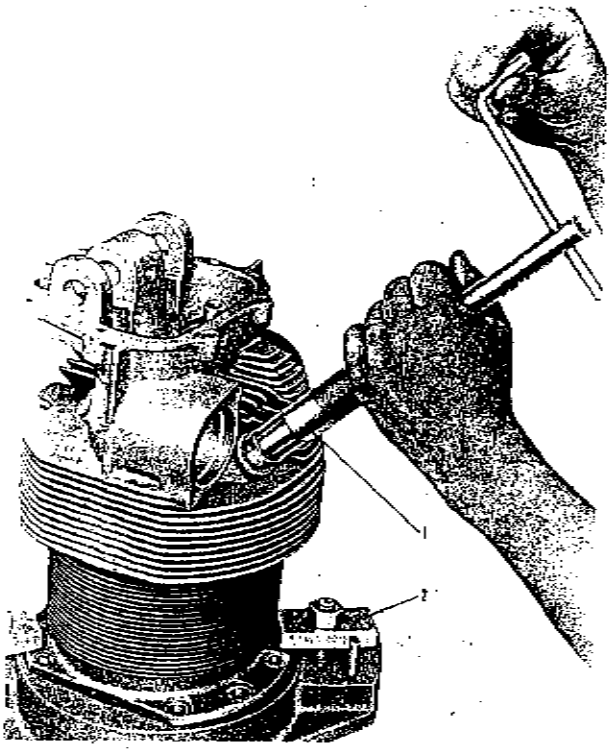
Cylinder Part No.	*Bore Status*	*"D" Diameter in Figure 7-4 (inches)*
534893	Standard	5.001 - 5.003
534893P015	0.015 in. oversize	5.016 - 5.018

7-29. REPLACEMENT OF SPARK PLUG "HELI-COIL" INSERTS. If the original "Heli-Coil" has been damaged, without damage to the tapped hole in the cylinder head, replacement may be accomplished as follows:



1. "Heli-Coil" extracting tool
2. Cylinder and valve holding fixture, tool No. J-2858

Figure 7-5. Removing Spark Plug Hole "Heli-Coil" Insert



1. "Heli-Coil" "Pre-Winder" type inserting tool
2. Cylinder and valve holding fixture, tool No. J-2858

Figure 7-6. Installing Spark Plug Hole "Heli-Coil" Insert

a. With a sharp pointed instrument, pry the outer end of the "Heli-Coil" away from the tapped hole. This end has a series of teeth which are forced into the cylinder head metal when the "Heli-Coil" is installed. The teeth must be clear of the hole.

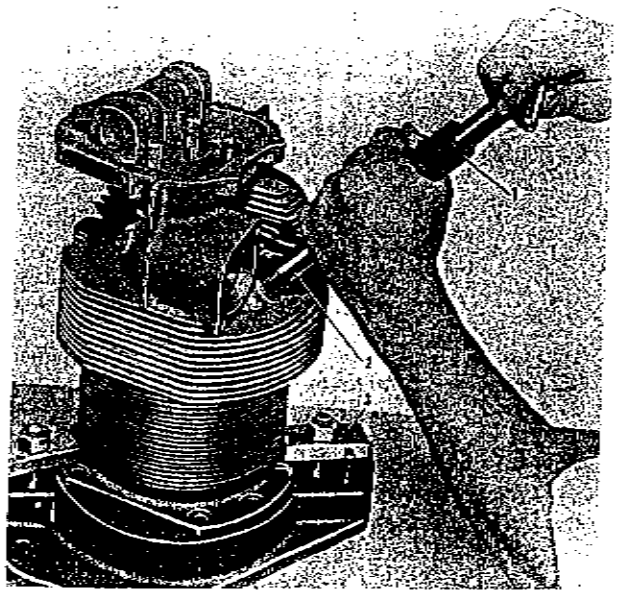
b. Use a "Heli-Coil" removing tool to unscrew the original "Heli-Coil". (Refer to Table XI.) Tap the square, tapered end of the tool into the "Heli-Coil" so that it will get a good "bite". Unscrew the "Heli-Coil" by turning to the left. *(See figure 7-5.)*

c. Inspect the tapped hole for thread condition. Slight damage may be repaired by chasing with an 18 mm "Heli-Coil" tap, however it is not advisable to repair the assembly if the damage is severe.

d. Use the special 18 mm "Heli-Coil" installing tool listed in Table XI to install the replacement "Heli-Coil" in the manner described in paragraph 7-16. *(See figure 7-6.)* The toothed end of the "Heli-Coil" goes toward the turning handle, so that it will enter the hole last, the stem driving slot will engage the bent driving end of the "Heli-Coil". Notice that the "Heli-Coil" is notched near the bent end to permit easy breaking of the end after installation. Drive the insert in slowly until the locking teeth lie in the first full thread of the tapped cylinder head hole; then remove the installing tool, and measure the depth of the driving tang. It must lie 0.420 (slightly more than 13/32) below the spotface on the head. This measurement should be made from spotface to a smooth hardwood or aluminum block inserted from the combustion chamber side against the insert tang. The installing tool may be used to drive the insert slightly deeper if necessary. If driven too deep so that its tang emerges in the combustion chamber, screw the insert on through the hole, and discard it.

e. To break off the "Heli-Coil" driving end, grip the bent end with a pair of long nose pliers, and bend back and forth several times.

f. Attach the expanding and staking tool (Heli-Coil Corp. tool No. 520-2) to a suitable Tee handle drive; coat the tool thread with anti-seize compound, Specification No. MIL-T-5544, or a paste composed of white lead and lard oil, and turn it into the "Heli-Coil". *(See figure 7-7.)* The tool will expand the "Heli-Coil" tightly into the tapped hole, and the final threads of the tool will force the teeth of the "Heli-Coil" into the cylinder head metal



1. Tap Chuck
2. Heli-Coil Corp No. 520-2 expanding tool
3. Cylinder and valve holding fixture, tool No. J-2858

Figure 7-7. Expanding Spark Plug Hole "Heli-Coil" Insert

to prevent accidental removal. Back out the expanding tool, and inspect the new "Heli-Coil" with an 18 mm thread plug gauge. (Refer to AF Supply Catalog, Class 17-B.)

7-30. REPLACEMENT OF INTAKE FLANGE "HELI-COIL". If either of the 1/4–20 "Heli-Coils" installed in the cylinder head intake flange is damaged it may be replaced in the manner described in paragraphs 7-16 through 7-18. *(See figure 7-1.)*

7-31. VALVE GUIDE REPLACEMENT.

CAUTION

Before removing a worn valve guide, make sure that all carbon deposits have been removed from its outer surface on the end which projects slightly into the valve port. Carbon will score the cylinder head boss hole if forced through.

Note

The cylinder assembly illustrated in figures 7-2, 7-8, and 7-11 was "sectioned" to enable the reader to see the parts and tools discussed in the related text. This was a scrap assembly. Do not section serviceable cylinders.

a. Place the cylinder and head holding fixture, tool No. J-2861, on the table of a deep throat arbor press, and install on it the cylinder and head assembly, with the rocker box flange resting on the fixture. Secure the cylinder head with hold-down clamps provided on the fixture.

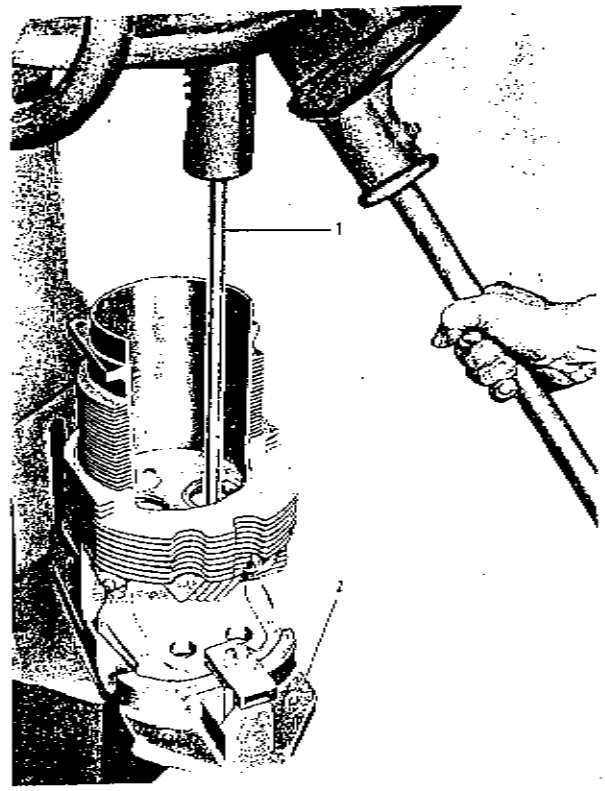
b. *(See figure 7-8.)* Through the cylinder barrel, insert the valve guide remover (1) into the worn valve guide. Shift the fixture to align the remover under the press arm, and see that one of the press table slots is positioned to admit the guide as it is pressed out. Holding the remover parallel with the cylinder, apply pressure with the ram steadily to press out the worn guide. Catch the remover as the guide drops out. Remove the cylinder assembly from the fixture (2).

c. Inspect the vacant bore in the cylinder head guide boss for possible scoring and other damage. If the hole is smooth it will be possible to install a new standard size guide with correct tight fit and without measuring the hole.

d. If the vacant guide hole in the cylinder head is scored, or if measurement shows too little interference with a new standard size replacement guide, enlarge the hole to 0.005 inch oversize with a broach (tool No. J-2846) of that oversize to receive a 0.005 inch oversize guide. If the guide removed was 0.005 inch oversize and if the hole was scored, or if measurement indicates insufficient interference with a new guide of the same oversize, enlarge the hole to 0.010 inch oversize with a broach of that oversize (tool No. J-7201) to receive the next larger oversize guide. The largest oversizing broach (tool No. J-7202) will refinish the hole to receive a 0.020 inch oversize guide. Standard guides are 0.6265 to 0.627 inch in diameter on the inserting end, and oversizes are based on those limiting dimensions. To determine correct hole diameter deduct the interference specified in Section XII from the measured replacement guide diameter if gauges described in the following step are not available.

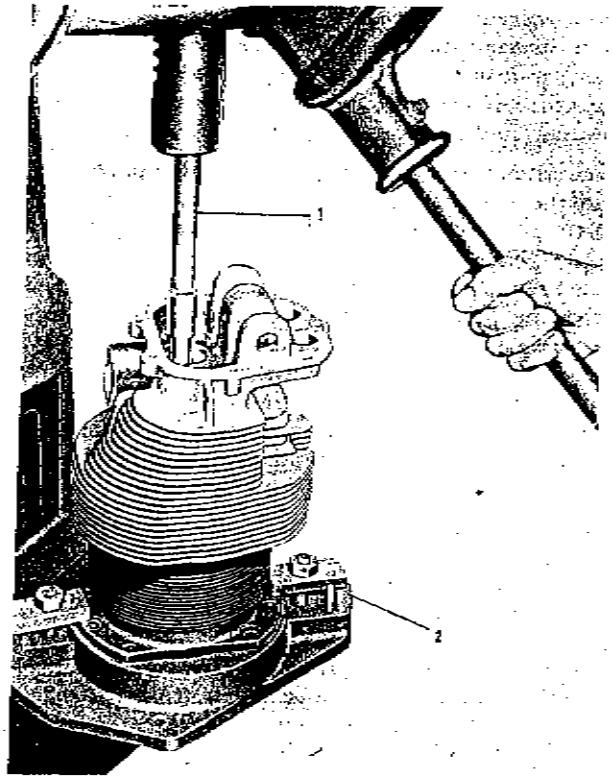
e. Check a 0.005 inch oversize cylinder head boss hole with the standard size plug gauge, tool No. J-2849-1 or a 0.010 inch oversize hole with tool No. J-2849-2. The "GO" gauge of the proper tool must enter the reamed hole fully to assure no excessive interference with the replacement guide, while the "NO GO" gauge plug must not enter at all. If the feel of the gauge indicates that a new reamer has cut slightly oversize or a worn reamer slightly undersize, it may be possible to select a guide from stock which will give an interference within limits specified in Section XII by measuring the reamed hole and comparing its exact diameter with diameters of the press fit ends of available guides.

f. Place the cylinder and valve holding fixture, tool No. J-2858, without the valve support piece, in a deep throat arbor press. Place the cylinder in the fixture, and secure its base flange with the fixture clamps. Align the vacant guide hole under the press ram. Adjust the table height to admit the new guide and its driver between the cylinder and the retracted ram.



1. Valve guide remover, tool No. J-2874
2. Cylinder head holding fixture, tool No. J-2861

Figure 7-8. Pressing Out Worn Valve Guide



1. Valve guide installing driver, tool No. J-2842
2. Cylinder and valve holding fixture, tool No. J-2858

Figure 7-9. Pressing in Replacement Valve Guide

g. *(See figure 7-9.)* Insert the end of the replacement valve guide toward which the fillet side of its seating flange faces into the driver (1). It will be observed that the driver hole end is rounded to match the guide flange fillet. Coat the exposed end of the replacement guide with the engine lubricating oil, MIL-L-2104, grade 30.

h. Place the driver and replacement guide in position at the entrance to the vacant cylinder head boss hole and align them with the cylinder axis by eye. Bring the press ram into contact with the driver, and adjust the lever position. Apply a steady force to drive the guide into place, meanwhile watching for misalignment indicated by peeling of metal. After the driver alignment to correct such a condition if it should occur. Press the guide in until its flange is seated firmly on the rocker box surface.

i. Select the proper broach, tool No. J-2847-1 or J-2847-2 for the stem hole of the guide just installed. Make sure that the correct broach is used, since the difference in clearance of intake and exhaust valve stem is important.

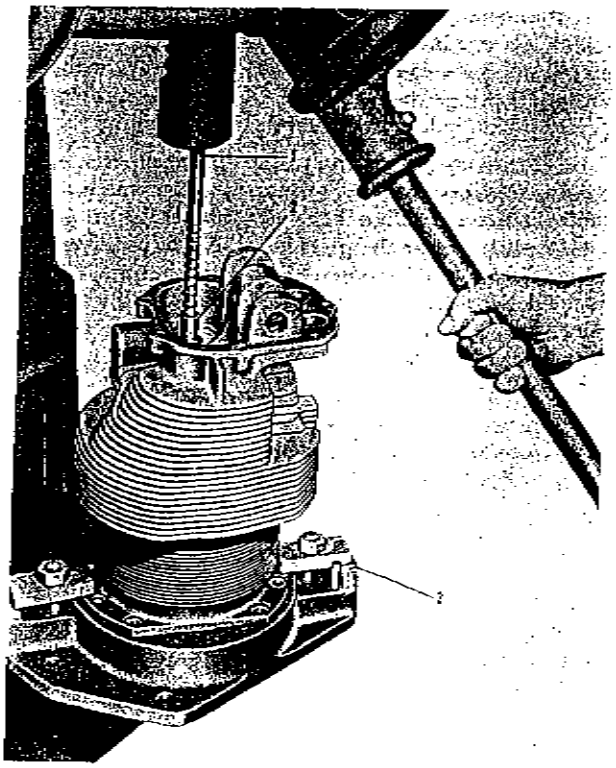
j. *(See figure 7-10.)* Adjust the press table height to admit the broach between valve guide and retracted ram. Insert the broach into the new guide so that the cutters face it, the burnishing balls following. Bring the ram into contact with the broach and check its alignment. Apply a steady force to push the broach entirely through the guide, and catch it as it falls from the open cylinder end.

k. Gauge the broached stem hole of the new guide with either tool No. J-2848-1 or J-2848-2, depending on which guide was installed. It is important to be sure that the correct gauge is used, since it is possible to employ the wrong broach or one which is worn excessively. Use only the step gauge intended for new parts, since the stem clearance must be within "New Parts" limits. If the hole diameter passes gauge inspection it will provide the proper clearance with any valve of that type whose stem has not been worn or otherwise reduced excessively. Stem holes shall not be undersized to compensate for non-standard valve stem diameters.

7-32. REFACING VALVE SEATS.

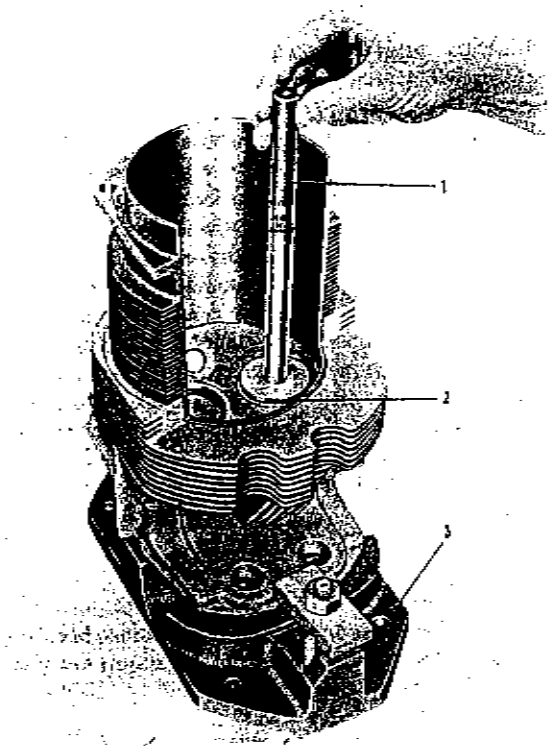
a. If a valve guide is to be replaced, that operation must be performed and the guide broached before the corresponding valve seat is faced.

b. Keep stones of the valve seat grinder true to the angle specified in Section XII for valve seat to stem axis angle. (Refer to limit No. 12.)



1. Intake valve guide stem hole broach, tool No. J-2847-1
2. Replacement intake valve guide
3. Cylinder and valve holding fixture, tool No. J-2858

Figure 7-10. Broaching New Valve Guide



1. Exhaust valve seat bluing gauge, tool No. J-2887-A
2. Flat to define limiting OD of finished seat
3. Cylinder head holding fixture, tool No. J-2861

Figure 7-11. Testing Finished Exhaust Valve Seat With Bluing Gauge

c. Remove no more metal than necessary to produce true seats.

d. Direct a stream of coolant liquid on the grinding stone continuously while cutting is in progress.

e. To test concentricity and angle of the finished seat, spread on the cone gauge surface of the proper bluing gauge, tool No. J-2887-A or J-2887-B, a very thin film of oil base Prussian blue pigment and rotate the gauge on the seat. *(See figure 7-11.)* Remove the gauge, and examine the seat for uniform transfer of pigment. Low spots will have none. To test for excessive seat O.D., wipe off, and spread new pigment on the seat. Rotate the gauge on the seat again; then examine its cone surface for transfer of pigment. A maximum serviceable seat width will leave a color ring just tangent to the gauge flat (2). If seat widths exceed the limits specified in Section XII, reduce their outside diameters with a 70° stone one time only.

f. After resurfacing valve seats, return the cylinder assemblies to inspection personnel for dimensional inspection, as described in paragraph 6-24 and Table VIII.

7-33. REFACING VALVES. Worn valves may be refaced to a true surface and with the face angle specified in limits No. 19 and 20, Section XII, provided that maximum warp specified in limit No. 23 is not exceeded. Excessively warped valves must be discarded. Valve refacing will be performed in accordance with established procedures and with valve refacing equipment in general use, subject to the following restrictions and precautions:

a. Depth of the tip regrinding and valve length must not exceed the "Maximum Replacement" values of limits No. 21 and 22, Section XII.

b. The outer edge of the reground valve face must not cut into the rounded edge of the valve head.

c. Refinished faces of exhaust valves must not go deeper than the 0.031 inch original stellite facing. (Refer to T. O. 2R-1-18 for etching test.)

d. The valve face must be flooded with a stream of coolant liquid throughout the regrinding operation to prevent overheating.

e. Lap valves to seats in which they will operate. Obtain only line contact. Use fine grade lapping compound. Remove all traces of compound after lapping.

7-34. VALVE STEM TIP GRINDING. Guide stems in the proper machine attachment to assure flat ends, square with axis. Leave no tool marks. (Surface roughness should not exceed 16 micro in., rms.)

7-35. ROCKER SHAFT SUPPORT BOSS BUSHING INSTALLATION. If rocker shaft supports on the cylinder head are excessively worn in the bores, as determined with the "Worn Hole No Go" plug of gauge J-2860, the holes may be bored out to the diameter limits specified in figure 7-12, maintaining the hole location limits also specified in that figure, and repair bushings may be installed in each end of the center support and in each of

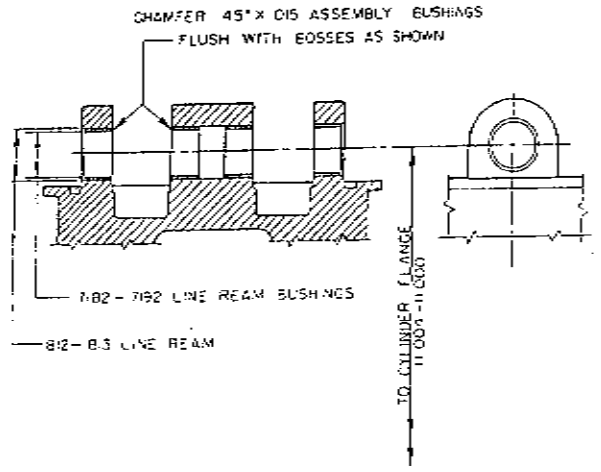


Figure 7-12. Dimensions of Rocker Shaft Support Bushings

the end supports. The bushings may be line bored or line reamed to the proper inside diameter to fit the rocker shaft within the clearance limits specified for new parts, as indicated by inspection with the step gauge end of tool No. J-2860. The finished bushing holes must center within the locating dimension limits specified in figure 7-12 and the center line must not be askew, in any direction, with respect to the original hole center line. Finished holes must have no tool marks. Break sharp bushing edges with 45° chamfers 1/64 in. across faces.

7-36. VALVE ROCKER BUSHING REPLACEMENT.

a. Place the support ring of the rocker bushing remover and replacer, tool No. J-2881, on the table of an arbor press, and lay the rocker on the ring so that its worn bushing is centered.

b. Insert the driving (reduced) end of the bushing driver into the worn bushing, and bring the press ram into contact with its upper end. Align the driver so that it bears on the bushing all around while the rocker contacts the support ring all around. Apply force with the press to push out the worn bushing.

c. Clean and inspect the rocker bore, and check the oil passages with a fine wire, taking care not to enlarge the squirt nozzle if it is an intake valve rocker.

d. Dip the replacement bushing in clean engine oil, and place it on the driver of the remover and replacer set.

e. Place the valve rocker on the support ring and the bushing and driver in position on the bore end. Make sure that the rocker is centered on the ring. Bring the ram into contact with the driver, and align the latter. Apply force to the ram to press in the bushing until it projects equally from both sides of the rocker.

f. Face the bushing ends flush with sides of the rocker. Do not cut into the rocker. Use a piloted end mill if possible.

g. Ream the new bushing with the rocker bushing reamer, tool No. J-2892-1, maintaining the original hole alignment. Break sharp corners very slightly.

h. Gauge the finished bushing hole with the New Bushing "GO and NO GO" step gauge end of tool No. J-2851-1. Make sure that there are no tool marks in the hole.

Note

To prevent bronze chips from entering the oil passages the two bushing wall oil holes should be plugged with bee's wax before reaming. Be sure to remove the wax afterward.

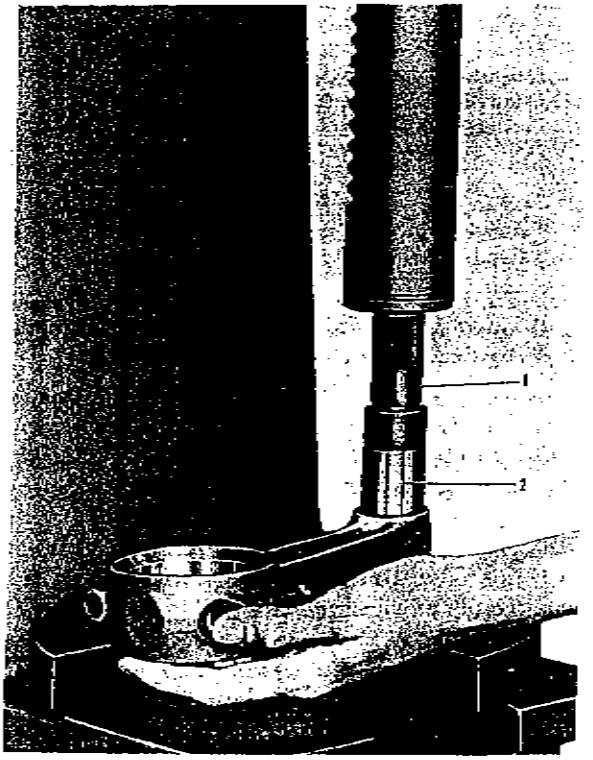
7-37. VALVE ROCKER COVERS. Test the parting surfaces of all valve rocker covers on a surface plate by attempting to insert a 0.0015 inch thickness gauge at various points. Lap any warped cover surface on a lap plate, using fine grade lapping compound and working in a figure 8 stroke pattern. When the entire surface shows a grey matte finish, wash the cover in a mineral spirit solvent to remove all traces of compound.

7-38. PISTONS.

7-39. Before any repair work is done ascertain that the piston has passed dimensional inspection, including measurement of side clearances of new rings. If the ring lands are bent or the grooves excessively worn the piston cannot be repaired. Pistons whose heads are battered, gouged or severely nicked, or whose walls are burned or heavily scored should be discarded. If the fit of a piston pin in the piston in which it was originally installed is excessively loose, refer to dimensions in Table V, Section VI to determine which part requires replacement. Stone small nicks and scores with a hard Arkansas stone, removing only the upstanding metal. Round the edges of small nicks on the piston heads with a burnishing tool. Do not polish pistons or use any type of wire brush or abrasive compound. Discoloration need not be removed, though all carbon deposits should have been removed in the cleaning process.

CAUTION

Weigh all replacement pistons and original pistons, and make sure that the difference between the lightest and heaviest in the engine set does not exceed 1/2 ounce.



1. Connecting rod bushing remover and replacer, tool No. J-2879
2. Bushing split line

Figure 7-13. Pressing in Replacement Connecting Rod Bushing

7-40. CRANKSHAFT.

7-41. UNDERSIZE AND OVERSIZE PARTS. Crankshafts reconditioned by the manufacturer may have any one or all of the following nonstandard size features:

a. Crankpins and main journals may be 0.010 in. undersize. The crankshaft part No. is then 536369M010. Such shafts are identified by the designation ".010" acid etched on the front face of the flywheel mount flange.

b. The accessory drive gear locating dowel in the rear end may be 0.005 in. oversize on the pressed-in end. Its presence will be indicated by the numeral "5" stamped adjacent to it. The exposed end of the dowel will always be standard size.

c. Damper pin bushings in the counterweights may be 0.003 inch oversize on the outside diameter. Their presence will be indicated by the designation "P003" stamped on the counterweight between them and each bushing will be marked with the designation "P003" on the exposed face.

7-41A. Before discarding a crankshaft which has no type of damage or wear other than those repairable by means enumerated in the preceding paragraph, check current Air Force policy regarding return of the assembly to the manufacturer for reconditioning.

7-42. FLYWHEEL BOLT REPLACEMENT. If the threads of a flywheel bolt in the crankshaft flange are damaged severely, remove upstanding metal by stoning, and smooth the shank with crocus cloth moistened in a mineral spirit solvent. Press out the damaged bolt with an arbor press. Inspect the vacant flange hole for galling, and smooth any roughness with a hard Arkansas stone of round section. Cool the replacement bolt in dry ice or in a deep freeze unit. Place the crankshaft flywheel flange on a suitable support in an arbor press or, preferably, a pneumatic press. Place the cold bolt in the vacant flange hole so that the head flat will be tangent to the flange shoulder, and quickly press the bolt into place.

7-43. CONNECTING ROD.

7-44. GENERAL. Stone nicks on machine surfaces. Replace bearing cap bolts or nuts which are defective in any way.

7-45. PISTON PIN BUSHING REPLACEMENT.

a. Obtain a suitable support ring of the proper diameter to pass the bushing and to support the connecting rod boss. Center it on the nearest size slot of the arbor press table.

b. Insert the connecting rod bushing remover and replacer, tool No. J-2879, in the worn bushing, and lay the rod boss end on the support ring. Bring the ram down on the tool end, and apply force to push the bushing out.

c. Inspect the connecting rod bore for cleanliness, and remove any bronze chips. It is not possible to compare the hole diameter with the split bushing diameter, due to the spring of the bushing.

d. Coat the replacement bushing with engine lubricating oil, Specification MIL-L-2104, grade 30 and place it on the removing and replacing tool end.

e. *(See figure 7-14.)* Place the bushing and tool on the rod boss so that the split line will be in the illustrated position, and center the boss on the support ring in the press.

f. *(See figure 7-13.)* Bring the ram down on the tool (1) and square the bushing and replacing tool with the rod bore. Apply pressure to drive the bushing into place. Watch for possible misalignment which will peel off bushing metal on one side. Correct any misalignment. Drive the bushing in flush with the end of the rod boss.

g. Ream the new bushing with a No. J-5008 spiral fluted reamer or equivalent, or bore it to a diameter within limits specified in figure 7-14. If a boring machine is used, mount the big end of the rod on a suitable arbor supported firmly and indicated parallel in all planes to the boring axis. To maintain surface roughness of the bore wall within the 30 micro inch, rms, limit specified in figure 7-14 the reamer or boring tool must leave no visible marks. The center to center distance specified in the drawing must be maintained, and will be if the bushing bore is concentric with the rod hole. Do not face the ends of a new bushing. If the original internal chamfers are completely removed in the boring or reaming operation, break the resulting sharp edges only 0.015 inch depth x 45 degrees.

h. Return rebushed connecting rods to inspection personnel for dimensional inspection.

7-46. BEARING INSERTS. All connecting rod crankpin bearing inserts must be replaced at each overhaul. The part number of each insert is lightly stamped on the back side near one end. The inserts will be installed during assembly or subassemblies.

CAUTION

If any connecting rod assembly is replaced all connecting rods for the engine must be weighed. The permissible difference in weight between the lightest and heaviest rod assemblies in any engine set is 1/4 ounce.

7-47. CRANKCASE.

7-48. GENERAL. Replace any damaged studs with next larger oversizes of the same basic part numbers. Dress down the upstanding edges of any nicks in machined parting flanges and mounting pads, using a small, flat, hard Arkansas stone. Remove only the upstanding edges of any scores in valve lifter guides and camshaft bearings and of any nicks in main bearing seats, using a round stick of hard Arkansas stone or a strip of crocus cloth wound on a hardwood dowel. Wet the abrasive with a mineral spirit solvent to prevent loading of its surface. Wash the castings thoroughly after such abrasive repair work, using a mineral spirit or dry cleaning solvent spray. Dry the repaired castings with a jet of dry compressed air, and blow out all oil passages and tapped holes.

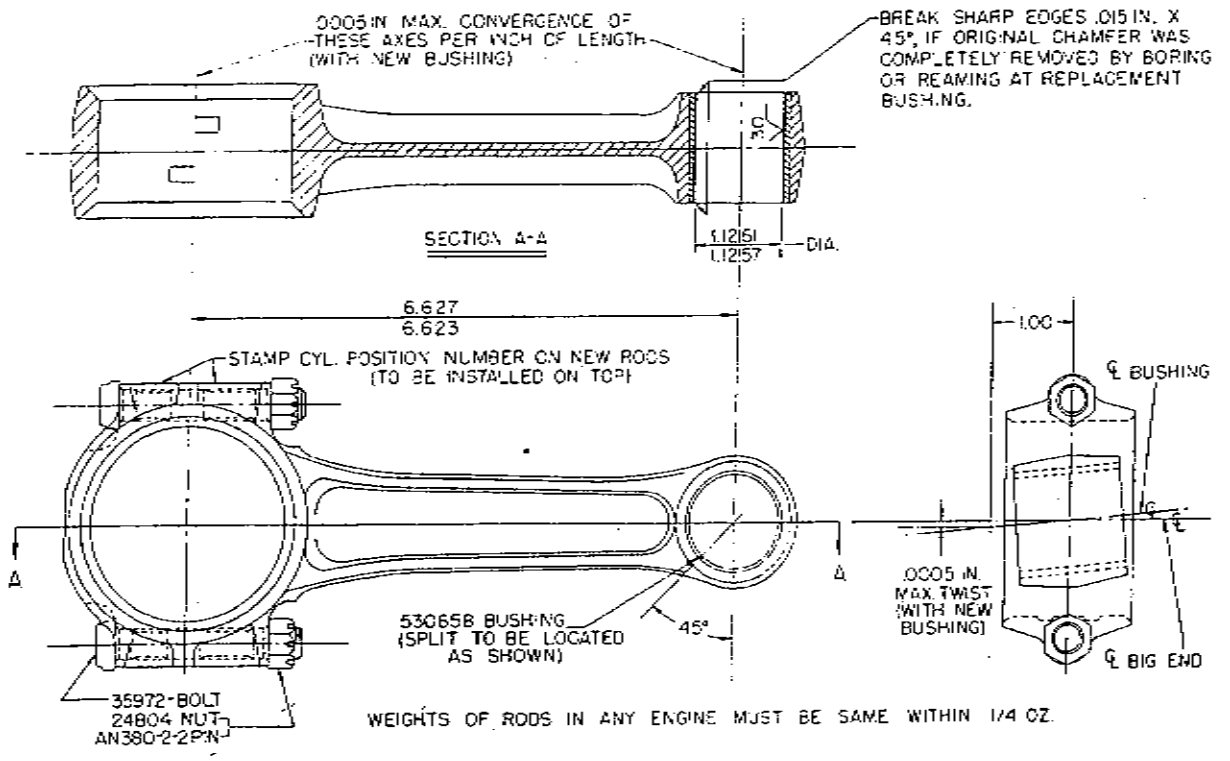


Figure 7-14. Connecting Rod and Bushing Dimensions

7-49. If the magneto gear support bearing surface is badly worn, remove the support attaching parts and pull the support with the type of puller illustrated in figure 7-15. The set screws engage the support oil holes and exercise the pulling force on the support. Use a plastic nonmarring hammer or a rawhide mallet to tap a new support into the crankcase pilot hole, and reinstall the attaching parts.

7-50. PUSHROD HOUSING FLANGES. Place the four flange castings on a surface plate and test their parting surfaces for warpage by attempting to insert a 0.0015 inch thickness gauge. Lap any warped casting on a lap plate, using only a film of fine grade lapping compound and moving the flange in a figure 8 stroke pattern without rocking. When the surface shows a uniform grey matte finish, wash the flange thoroughly with either a mineral spirit solvent or a dry cleaning solvent spray to flush away all traces of the compound.

7-51. REAR ENGINE MOUNT BRACKETS. Straighten any bracket which is slightly twisted. Heat may be applied with a torch for this purpose. Cracked brackets may be repaired by welding if replacements are not available, however the difficulty of maintaining shape makes this a time consuming operation. If a weld covers any part of either a mounting face or the contact area of attaching nuts, the surface must be spotfaced or ground in that area to assure correct fitting. If machining would reduce the weld strength dangerously the part must be discarded.

7-52. MAIN BEARING INSERTS. Draw from stock a set of new crankshaft main bearing inserts and a set of new crankshaft thrust washers. Keep these parts in dustproof wrappings pending installation.

7-53. CRANKCASE HEATER AIR VALVE.

7-54. If the vane is bent or otherwise damaged it should be replaced. Replace the shaft if it is bent, its bearing areas worn noticeably or the tapped holes damaged. While it is possible to bore out the body shaft holes and to install locally manufactured bronze bushings, the necessary accuracy of hole locations makes it advisable to discard the body when the shaft holes are excessively worn, unless no replacement part is available. Stone down the raised edges of any nicks in the valve parts. Check for warpage of the body parting surface, and lap it, if necessary, to restore flatness. Discard the lever if its tapped hole is stripped, the clamp deformed or the pin hole worn noticeably. Collect a complete set of parts for the valve assembly in a small container after drawing any necessary replacements from stock.

7-55. INDUCTION SYSTEM.

7-56. AIR FILTER ASSEMBLY. Small dents in the filter housing may be straightened with a sheet metal hammer and dolly. Cracks may be repaired by brazing, prior to which all enamel must be removed. Replacements of loose

or missing speed nuts may be attached by spot welding or brazing. Tap out any irregularities in the filter element attaching flange, while supporting it on a flat steel plate.

7-57. INTAKE TUBES. The bent aluminum tubes may be placed on a round mandrel and tapped with a non-marring hammer or a rawhide mallet to straighten any dents. Both ends of each tube must be perfectly round to prevent air leaks. Do not expand the end diameters in an attempt to restore roundness. Do not reduce the depth of seal ring grooves in the cylinder ends or distort them. The grooves must be perfectly round and smooth. After any straightening operation, the gray enamel coating must be stripped off the tube by a chemical solvent, if this was not already done, and the repaired areas must be inspected for possible cracks by either the standard aluminum etching process or the fluorescent penetrant ("Zyglo") inspection process. Discard any cracked tubes.

7-58. INTAKE TUBE FLANGES. These aluminum alloy parts must fit perfectly on the cylinder ports. Test each of the six flanges for flatness of the counterbored side on a surface plate, using a 0.0015 inch thickness gauge. Lap any warped flange to restore flatness of the contacting surface. Remove any nicks or roughness from the seal ring grooves with crocus cloth.

7-59. INTAKE MANIFOLD. Remove the upstanding edges of any nicks in machine surfaces with a small, flat, hard Arkansas stone. Replace any damaged stud.

Note

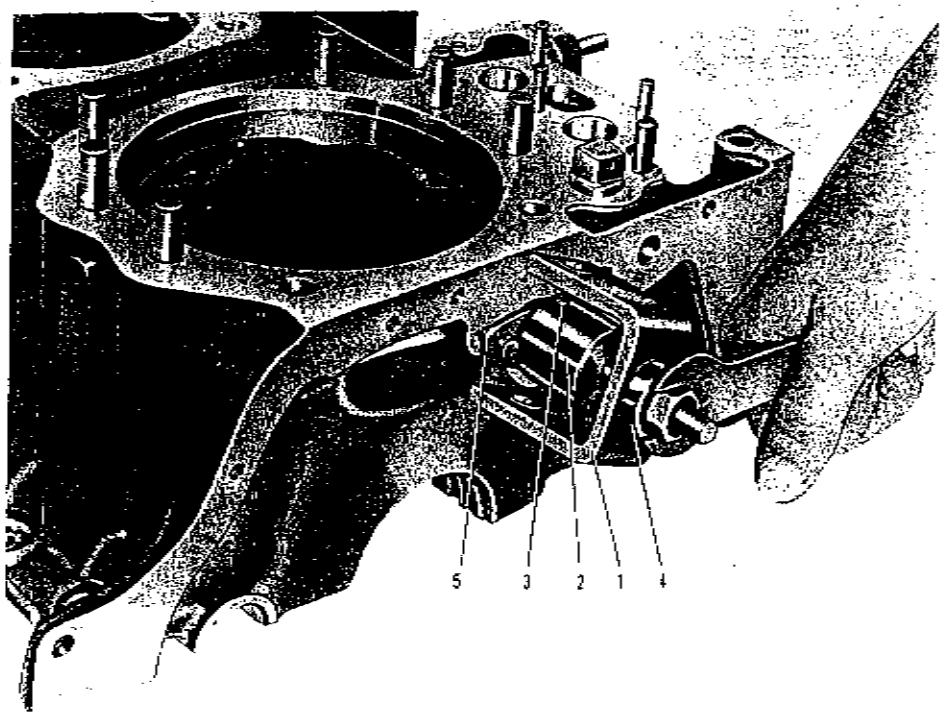
Before applying primer and enamel to the manifold and tubes, mask the machined surfaces, including the seal grooves and the short tube areas beyond these grooves.

7-60. FAN INLET AND GEAR HOUSING ASSEMBLY.

7-61. INLET AND GEAR HOUSING. Replace any damaged stud with the next oversize of the same basic part number. (Refer to Table X.) Straighten the fan inlet shields if the bars are not badly bent. If the shields are seriously damaged, grind off the heads of the attaching drive screws, and remove them; then pull out the screw shanks with old diagonal cutters. Lay replacement shields on the entrance housing with the screw holes over those ribs used to attach the original parts. Use a No. 33 twist drill to drill new screw holes to a depth of 11/32 inch. Blow out chips, and drive in 21 new flat head drive screws (Parker-Kalon type 21, No. 4) to attach two new shields. Stone down any nicks in the casting parting flange.

Note

If previous replacements have cause two sets of screw holes in the housing ribs, match the holes in the new guard with original housing holes, and drill them to a depth of ½ inch from the guard surface with a No. 29 twist drill to enlarge the holes for No. 6 (Parker-Kalon type 21) drive screws.



1. Puller bridge
2. Screw and bell
3. External cone point set screw (2 req'd)
4. Nice thrust bearing
5. Magneto gear support

Figure 7-15. Pulling Magneto Drive Gear Support

7-62. BEARING LINERS. Replacement of worn liners for drive gear ball bearing pilot bores in the inlet and gear housing and in the gear case (front) housing should be attempted only when an accurate boring machine of sufficient size is available. The liners in the two castings must be line bored, and the axis of each pair must be parallel in all planes to the others and square with the rear parting flange of the housing assembly. Figure 7-16 provides machining dimensions. Old liners may be bored out to thin shells and collapsed for safe removal. Old liner dowels must be removed or tapped in flush without damaging the castings.

7-63. FAN OUTLET HOUSING. Replace any damaged stud with the next larger oversize of the same basic part number. (Refer to Table X.) Check the small tapped holes with a No. 10-24 machine screw. If any of the threads are damaged so as to bind, run in a No. 10-24 tap. Stone down the raised edges of any nicks or scratches on machined surfaces of the casting.

Note

Before discarding a damaged fan outlet housing carefully grind off the heads of six round head drive screws which attach the identification plate. Using the plate as a template in the corresponding location on the replacement casting, drill new screw holes with a No. 45 twist drill to a depth of 3/16 inch into the casting. Attach the plate with six round head drive screws. It is best to attach the plate with a screw in the first hole drilled and another immediately after drilling the second hole to prevent shifting and misalignment.

7-64. FLYWHEEL, FAN AND RING GEAR ASSEMBLY.

CAUTION

Do not remove the fan from the flywheel or remove the flywheel counterweights for any reason. These parts are assembled before the dynamic balancing operation and must not be shifted. If the fan is cracked or any blade chipped or broken off, replace the entire flywheel, fan and ring gear assembly.

7-65. RING GEAR REPLACEMENT.

a. Lay the flywheel, fan and ring gear assembly on a suitable bench, with the ring gear upward.

b. Remove the 12 ring gear attaching nut locks and plain nuts or Marsden lock nuts and lock washers.

c. Lift off the damaged ring gear. If necessary use a hardwood block and a hammer to tap it from the flywheel shoulder.

d. Smooth any roughness on the flywheel with crocus cloth.

e. Place a new ring gear on the flywheel with stud hole counterbores outward. Tap it onto the shoulder.

f. Attach the gear with twelve internal tooth lock washers and Marsden lock nuts. Tighten the nuts to a uniform torque within limits specified in Section XII.

7-66. ACCESSORY CASE ASSEMBLY.

7-67. OIL FILTER NECK AND CAP RETAINER. A damaged oil filter neck may be removed most easily by sawing it off about 1/2 inch from the case and collapsing the remaining tube with pliers. The replacement tube should be driven into the case hole with a hardwood block and a mallet after other repair work on the casting has been finished. If the cap retainer chain is damaged, shear off the rivet which holds it to the filler cap, and punch the rivet end out. Insert a new rivet from the inside of the cap lug and support its head on a suitable mandrel. Place a new chain on the rivet, and peen the rivet shank over to hold it firm. Spread the retainer ring eye, and slip over it the last link of the new chain; then close the eye with pliers.

7-68. TACHOMETER AND OIL SCREEN HOUSING. Remove the oil seal assembly from the mounting side of the tachometer and oil screen housing with a standard oil seal puller. If the casting parting surface is warped, lap it to restore perfect flatness before installing a new oil seal, and wash the casting thoroughly with a mineral spirit solvent; then dry it with a compressed air jet. Before installing the new oil seal soften its leather lip with a suitable oil. (The manufacturer recommends Neate's Foot Oil.) Coat the metal case of the new oil seal with engine lubricating oil. Support the casting in an arbor press (not on the tachometer adapter), and position the new seal at the counterbore mouth so that its leather sealing lip is outward. Place on the seal a suitable round, flat block of slightly smaller diameter than the seal case, but larger enough to bear on it. Press the seal in squarely against the bottom of the counterbore. Dress damaged tachometer adapter threads with a Swiss thread file or a chasing nut.

7-69. OIL PUMP AND ACCESSORY CASE BUSHINGS. If replacement of these bushings for the pump impellers was specified by inspection personnel, drive out the two bushings in the pump housing and the corresponding pair in the accessory case with the bushing remover and replacer, tool No. J-5010-1 while the casting is supported on the fixture, tool No. J-5010-2. Dip the replacement bushings in engine lubricating oil immediately before driving them into place with the same tools. The bushings must be installed with their chamfered faces toward and flush with the gear chamber surfaces. Bore or ream the new bushings to a diameter within the limits specified in Table V, Section VI. For this operation the pump housing must be assembled to the accessory case, and the bushings must be line bored or line reamed so that the axis of each pair in line is square with the pump parting surface in all directions. Break sharp edges at the square ends approximately 0.015 inch.

7-70. ACCESSORY CASE STUDDING ASSEMBLY. Replace any damaged stud with the next larger oversize

metal. Gears with such serious damage and any whose teeth are pitted deeply, corroded, chipped or worn in profile noticeably must be discarded.

7-83. GEAR SHAFTS. Polish gear shafts with crocus cloth moistened with a mineral spirit solvent, then with dry crocus cloth. Moderate polishing should remove any roughness on the bearing areas. If severe scoring or groove wear remains the gear should not be reinstalled.

7-84. EXHAUST MANIFOLDS.

7-85. Test the manifold attaching flange surfaces for warpage on a surface plate by attempting to insert a 0.0015 inch thickness gauge. If necessary to restore flatness, the surfaces may be lapped, provided that a large lap plate is available. They should show a uniform matte finish to assure flatness and perfect alignment. Dented manifolds are difficult to repair and may burn through if dents remain, hence they should not be reinstalled when replacements are available. Ends of the manifolds may be returned to circular shape with sheet metal tools.

7-86. SHEET METAL PARTS. Straighten dented or bent shroud parts and exhaust jackets with normal sheet metal repair tools. Cracks and broken joints may be repaired by brazing if the damage is not excessive.

Note

Efficient operation of the air heating and engine cooling systems depends on close fitting shroud parts and exhaust jackets. Parts which cannot be returned to correct shape should be discarded.

7-87. OIL SUMP ASSEMBLY.

7-88. Replace any damaged stud with the next larger oversize. (Refer to Table X.) Stone down the raised edges of any nicks on the sump machined surfaces and the oil drain connecting plate. Smooth any nicks in plug threads with a Swiss thread file. If the oil gauge support is dented or bent, saw off the flared end, and insert a replacement tube through the original coupling nut, if serviceable. Flare the new tube with a tube flaring tool. Replace the oil gauge rod if it is damaged.

7-89. OIL SUMP ADAPTER ASSEMBLY. Stone down the raised edges of nicks in machined surfaces with a flat hard Arkansas stone dipped occasionally in kerosene. Smooth any nicks or roughness on the threads of the square head flanged plug and screw it into the front adapter tapped hole to check for binding. If necessary, use a 1–1/4–18 tap to smooth the hole thread. In the same manner, repair the oil pressure relief valve cap and its tapped hole in the adapter, using a 7/8–18 NF tap if necessary. If gasket seating surfaces around these two plug holes are roughened they must be machined smooth with a suitable end mill, maintaining their squareness with the holes. Test seating of the oil pressure relief valve plunger in the adapter with oil base Prussian blue pigment on the plunger cone. If the plunger face is imperfect discard the plunger. If the seat is imperfect but not seriously damaged lap it to a serviceable plunger, using fine grade lapping compound, and clean both parts thoroughly before rechecking.

7-90. PREHEAT AND AIR MIXING VALVE.

7-91. Smooth any nicks in the machined surfaces of the housing, butterfly valve shafts and vanes. If either of the solenoid bracket attaching studs is damaged replace it. Repair any damaged screw hole in the top housing flange with a No. 1185-4BN x 3/8 "Heli-Coil" insert. Use a No. 1185-3BN x 9/32 "Heli-Coil" to repair either of the retaining screw holes for the bimetal spiral adjustment plate and break off the tang after installation or install a No. 1185-3B x 3/8 insert, and leave the driving tang in place. Either procedure may be followed, using the same optional parts, to repair the rear attaching screw hole for the heat valve cover at the right end of the housing, however the opposite screw hole should be repaired by installation of a No. 1185-3BN x 3/16 insert, since it is a through hole of only 1/4 inch depth.

7-92. OIL PRESSURE VALVES.

7-93. Replace damaged cylinder studs with the next larger oversize. (Refer to Table X for setting height.) Smooth any roughness on the machined surfaces of the cylinder, its bore wall, the piston and the cover, using a flat hard Arkansas stone on flat surfaces and crocus cloth on curved surfaces. If the pin hole in the piston stem is worn out of round enough to cause noticeable lash in the linkage or if the flat head pin is noticeably worn, discard such parts and draw replacements from stock. Collect sets of parts for two complete valve assemblies in small containers, and keep them covered to exclude dust and grit pending reassembly.

7-94. CORROSION PREVENTION.

7-95. During all stages of repair operations and following such work, bare steel surfaces shall be protected from oxidation when not actually undergoing repair work, i.e., while awaiting any repair step, reinspection or reassembly. Such protection shall be accomplished by dipping the parts in, or spraying them with corrosion preventive compound, MIL-C-6529, Type II, or a mixture of one part Type I compound and three parts engine lubricating oil, MIL-L-2104, grade 30. The same protective coating shall be applied to other metals if necessary to prevent oxidation under climatic or atmospheric conditions prevailing in the workshop.

Note

Piston rings and other plated steel parts do not require protection. The foregoing instruction is applicable at all times to polished and machined steel parts not protected by cadmium, tin, copper, or other plating or surface treatment. In order to make the corrosion preventive film effective the bare metal surfaces must be free of moisture when it is applied. Acid present in perspiration and skin oils may attack steel surfaces if finger prints are not removed. Dip parts in finger print remover solutions available from Air Force stock after handling to prevent such attack.

7-96. REPLACEMENT OF PROTECTIVE COATING.

7-97. Before repainting, magnesium castings must be treated by brush application of the chrome pickle process, Specification MIL-M-3171, Type I, if their surfaces have been machined, scratched or otherwise altered so as to remove the protective film from small areas. For dip treatment refer to Table XIII.

7-98. Table XIII provides information for proper application of protective coatings of primer and/or enamel, to replace packette parts. Refer to the listed specifications for colors and properties of the coating materials and for intended drying methods and times.

CAUTION

Masking tape should be applied carefully, in order to exclude primer and enamel. If any small areas of over spray are found when the masking material is removed it must be dislodged without gouging or scratching the finished surfaces. No primer or enamel is permissible on interior surfaces of the fan inlet and gear housing, gear case housing, crankcase, accessory case, oil sump and other castings contacted by engine lubricating oil after assembly.

TABLE XIII. PROTECTIVE COATINGS
CODING EXPLANATION

Code	*Protective Coating Designation*	*Spec. No.*	*Type*	*Color*	*Color No.*	*No. of Coats*
a	Primer—Zinc-chromate	MIL-P-6889	I	—	—	1
b	Primer—Zinc-chromate	MIL-P-6889	I	—	—	2
c	Primer—Synthetic	TT-P-636	—	—	—	1
d	Enamel—Heat-resisting	MIL-E-5557	II	Black	515	2
e	Enamel—Gloss	MIL-E-7729	II	Gray	513	2
f	Enamel—Gloss	MIL-E-7729	II	Orange	506	2
g	Cadmium plate	AMS-2400	(SAE)	—	—	—
h	Parkerize	—		—	—	—
i	*Dichromate treatment	MIL-M-3171, Type III	—	—	—	—

Part. No.	*Description*	*Material*	*Code*
A17189	Filter—Gear case air	Steel	ce
1551457	Filter—Carburetor air	Steel	ce
M 1251	Shutter Assembly—Left	Aluminum	ad
M 1252	Shutter—Right	Aluminum	ad
36181	Cover—Gov. adapter	Aluminum	ae
531183	Housing—Pushrod	Steel	g
531186	Flange—Pushrod housing	Aluminum	ae
532450	Cover—Valve rocker	Aluminum	ae
532741	Cover—Heat valve	Aluminum	ae
532754	Jacket—Exhaust cross pipe	Steel	hd
532758	Elbow—Exhaust jacket	Steel	hd
532787	Baffle—Shroud to No. 2 cyl	Steel	cd
532868	Housing—Tach. & oil screen	Aluminum	ae
532915	Tube—Intake	Aluminum	ae
532989	Adapter—Fuel pump	Aluminum	ae
533132	Baffle—Shroud to No. 5 cyl	Steel	cd
533159	Sump Oil	Aluminum	ae
533169	Housing—Fan outlet	Aluminum	ae
533179	Housing—Fan inlet & gear	Aluminum	ae
533184	Plate—Oil drain connect	Aluminum	ae
533187	Baffle—Inter head	Steel	cd
533189	Baffle—Inter barrel	Steel	cd
533215	Jacket—Exhaust manifold	Steel	hd
533228	Jacket—Exhaust manifold	Steel	hd
533231	Valve body—Air outlet	Aluminum	ae

Note: Apply finishes to unmachined exterior surfaces only.

*Applicable only when entire casting has been stripped of paint and any previous chrome pickle treatment. For touch up refer to paragraph 7-97.

TABLE XIII. PROTECTIVE COATINGS (Cont)

Part No.	Description	Material	Code
533256	Flywheel and Fan Assembly	Aluminum	ae
533262	Adapter—Oil filler neck	Aluminum	ae
533268	Jacket—Exhaust manifold	Steel	hd
533274	Rod Assembly—Oil gauge	Steel	cf
533291	Jacket—Exhaust manifold	Steel	hd
533298	Cover—Gear housing	Aluminum	ae
533324	Turning Vane	Steel	ce
533352	Filter—Gear case air	Steel	ce
533382	Turning Vane—Oil cooler	Steel	ce
533401	Filter—Heater blower air	Aluminum	ad
533419	Turning Vane—Lower	Steel	ce
533448	Bracket—Heater	Steel	ce
533453	Cap—Oil filler	Steel	cf
533454	Tube—Heater to sump	Steel	g
533519	Bracket—Blower engine	Steel	ce
533591	Cover—Oil press. valve cyl	Cast iron	ce
533659	Accessory Case	Magnesium	ibe
533715	Elbow—Exhaust jacket	Steel	hd
533718	Elbow—Exhaust jacket	Steel	hd
533732	Bracket—Blower engine	Steel	ce
533824	Tube—Heater air outlet	Steel	cd
533853	Support—Mixing valve	Steel	cd
533938	Brace Angle—Shroud	Steel	cd
533952	Housing—Carb air filter	Steel	ce
533993	Adapter—Carb to filter	Aluminum	ae
534018	Bracket—Exhaust jacket	Steel	cd
534019	Cross Brace—Exhaust jackets	Steel	cd
534027	Elbow—Exhaust manifold jacket	Steel	hd
534223	Bracket—Rear engine mount	Steel	cd
534224	Bracket—Rear engine mount	Steel	cd
534342	Divider—Shroud	Steel	g
534359	Baffle—No. 2 cylinder	Steel	cd
534412	Manifold—Intake	Aluminum	ae
534427	Oil Filler Body	Steel	g
534563	Baffle—Shroud to No. 6 cyl	Steel	cd
534593	Baffle—No. 2 cyl head	Steel	cd
534601	Baffle—No. 1 cyl to shroud	Steel	cd
534717	Adapter—Oil sump	Aluminum	ae
534736	Crankcase—Right	Aluminum	ae
534770	Crankcase—Left	Aluminum	ae
534893	Cylinder and Head Assy	Al & Steel	d
535069	Lifting Eye	Steel	cd
535584	Bracket—Exhaust jacket	Steel	cd
535665	Housing—Preheat and mixing valve	Aluminum	ae
535713	Adapter—Governor	Aluminum	ae
535714	Housing—Air filter	Steel	ce
535857	Strip—Nut	Steel	cd
535858	Strip—Nut	Steel	cd
535859	Strip—Nut	Steel	cd
535860	Strip—Nut	Steel	cd
535870-1	Panel Assy—Shroud front	Steel	cd
535870-2	Panel—Shroud upper rear	Steel	cd
535870-3	Panel—Shroud lower rear	Steel	cd
535870-4	Panel—Shroud lower rear	Steel	cd
535870-5	Panel—Shroud upper rear	Steel	cd
535870-6	Panel Assy—Shroud top	Steel	cd

TABLE XIII. PROTECTIVE COATINGS (Cont)

Part No.	Description	Material	Code
535870-8	Panel—Shroud bottom side	Steel	cd
535870-9	Panel—Shroud bottom side	Steel	cd
535870-10	Panel—Shroud bottom front	Steel	cd
535870-11	Panel—Shroud detachable	Steel	cd
535870-12	Panel—Shroud detachable	Steel	cd
535870-13	Adapter—Shroud rear panel	Steel	cd
535870-14	Adapter—Shroud rear panel	Steel	cd
535870-30	Angle—Shroud hook	Steel	g
535959	Jacket—Exhaust manifold cross pipe	Steel	hd
536161	Adapter—Governor oil drain	Aluminum	ae
537262	Cover—Oil filler hole	Steel	ce
538726	Rod—Governor control	Steel	g
538737	Tube—Oil filler	Steel	ce
538742	Bracket—Oil filler tube	Steel	g
538758	Housing—Gear case	Aluminum	ae
538805	Cap—Oil filler	Steel	cf
538960	Tube—Oil gauge rod support	Steel	ce
8521969	Cooler—Engine oil	Aluminum	a

SECTION VIII
ASSEMBLY OF SUBASSEMBLIES

8-1. CLEANLINESS.

8-2. In order to prevent scoring of bearings and contamination of the lubricating oil supply, it is essential that all parts be free of dust and grit when they are assembled or installed. The prevalence of abrasive particles in the atmosphere makes it advisable to wash case parts, internal parts and cylinder in dry cleaning solvent immediately before final lubrication and assembly. If more than a few minutes must elapse between final cleaning and assembly, the part or parts should be covered during the waiting period. This precaution also should be applied to partial and completed subassemblies.

8-3. LUBRICATION.

8-4. Unless the packette is to be completed and tested within 24 hours after the assembly procedure is begun, it will be necessary to lubricate the moving parts, all bare steel parts and all bushings and bearings—immediately before installation—with corrosion preventive compound, MIL-C-6529, Type II, or a mixture made of one part Type I compound and three parts aircraft engine lubricating oil, MIL-L-6082. If rapid assembly and immediate testing are scheduled, it will be permissible to lubricate the moving parts and bearings at assembly, with aircraft engine lubricating oil and the special lubricants mentioned in the specific assembly instruction in this section, however, should a waiting period develop between assembly and testing of any packette so lubricated, it will become necessary to preserve the packette for temporary storage in accordance with current Technical Orders covering that subject. Apply lubricating oil and corrosion preventive oil mixture with a spray nozzle, a squirt can or clean brush. Keep supplies of lubricants in dustproof and waterproof containers.

8-5. NEW SMALL PARTS REQUIRED.

8-6. All parts of the following types used in reassembly shall be new parts: lockwire, nut locks, lock washers, tab washers, nut lock plates, cotter pins, copper-asbestos gaskets, rubber seal rings, rubber hose connectors, soft gaskets, speed nuts and piston rings.

8-7. LOCK DEVICES.

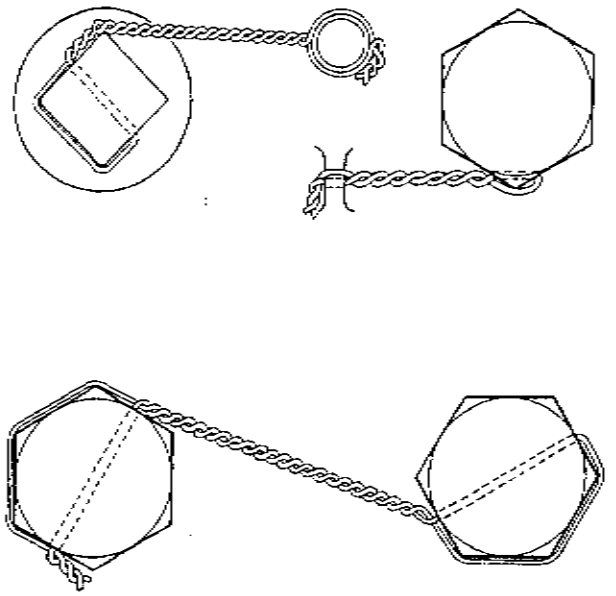


Figure 8-1. Installation of Lockwires

8-8. LOCKWIRES. In figure 8-1 are illustrated three typical lockwire installations. Notice that the end loops are held inward by the direction of twist to prevent loosening. Twist wires snug, and pull moderately tight when twisting the anchor ends. Bend down the twisted ends, as illustrated. Always lead the wire in the direction which will hold the threaded part which it secures against loosening. (Only right hand threads are employed.)

8-9. INTERNAL TOOTH LOCK WASHERS. Install on screws with undrilled heads in all instances and on studs before installing plain hex nuts, except where instructions call for nut locks. When the part secured by the screw or nut is made of aluminum alloy or magnesium, install a plain steel washer between that part and the internal tooth lock washer to prevent the sharp washer teeth from digging into the soft metal.

8-10. NUT LOCKS. Use only where specified. After tightening a plain nut to specified torque, screw a nut lock on the stud with the fingers until it is snug, then tighten it only about 1/6 turn (never more than 1/4 turn) with a wrench. Excessive tightening will permanently distort the spring teeth of the nut lock, making it useless as a locking device.

8-11. COTTER PINS. Cotter pin holes in bolts and studs must lie within the slots of the nuts which the cotter pins are intended to secure. If they do not conform to this requirement, substitute another bolt or another washer, as required, to correct the hole position. This situation usually is the result of installing incorrect types of attaching part. Tap the cotter pin head into the nut slot as far as it will go without flattening. Bend cotter pin legs snug against nut sides and stud or bolt ends. If necessary, cut off the pin ends with diagonal cutters until they will lie flat. *(See figure 8-2.)*

8-12. TIGHTENING TORQUES.

8-13. In the Table of Tightening Torques in Section XII, special torques are specified for tightening certain bolts, screws and nuts. Tighten all others to the values specified in Section XII for general use with the thread size in question. After extensive practice with various sizes of attachment the assembler will know, from the force required on various wrenches, when proper torque has been applied. Unless specifically noted, tightening torques specified in these instructions are intended for use without thread lubricant. Tighten straight thread plugs enough to compress their copper-asbestos gaskets. Tighten pipe plugs with about the same torques applied to straight threads of similar diameters.

8-14. GASKET PASTE AND SHELLAC.

8-15. The application of gasoline and oil resistant grease, MIL-L-6032, to both surfaces of soft gaskets immediately before they are installed will aid in preventing oil leaks which sometimes result when dry gaskets take a permanent "set", or compression, under the combined effect of heat, vibration and compressive force of attaching parts. Gasket shellac should be used only where specified in the text. It forms a thin seal when soft gaskets cannot be used between case parting surfaces.

CAUTION

When gasket shellac or paste or any gasoline and oil-resistant semisolid material is applied to a soft gasket or to a case parting surface, use only a thin, uniform film. Any excess of such material which is squeezed into the engine case may be carried by the lubricating oil to the oil filter or a small passage, where it will lodge and cause a restriction or stoppage of the oil flow with resultant damage to moving parts of the engine.

8-16. ASSEMBLY FIGURES AND LEGENDS.

8-17. Operations required to assemble the subassemblies are described in this section, with frequent reference to exploded views in Section IV. Such references are made in the same manner as in Section IV. (Refer to paragraph 4-11.)

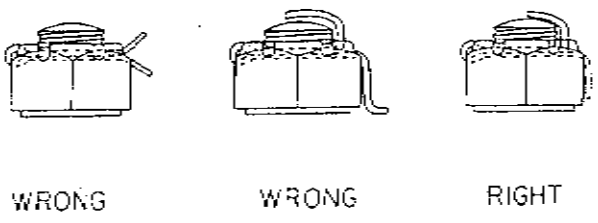


Figure 8-2. Cotter Pin Installation

8-18. COMPLETE FAN INLET AND GEAR HOUSING.

8-19. FAN INLET AND GEAR HOUSING. *(See figure 4-24.)*

a. Lay the housing and guard assembly (56, 57, 58) on its front studs.

b. With Truarc No. 7 pliers compress the drive gear bearing retaining ring (49), and insert it into its groove in the central bearing liner.

c. Lay a new oil seal (50) on the end of the bearing bore liner with its sealing lip downward, and tap it into place against the retaining ring with a flat end block and a mallet. The seal lip must be toward the gear compartment.

d. Attach the timing inspection hole cover (54) with a lock washer and a screw so that it will close the housing inspection hole.

e. Turn the housing over. Spread on the external pipe thread of a street elbow (23) a film of gasoline and oil resistant grease, MIL-L-6032, and screw the elbow into the pipe tapped hole between the upper generator mount pads. Similarly lubricate the pipe thread of an air filter (22). Tighten the elbow to such a position that the filter nipple thread axis will lie parallel to the vertical center line of the housing (in working position); then screw the filter into the elbow, and tighten it so that it is inclined toward the generator end, as illustrated in figure 1-3.

8-20. GEAR CASE HOUSING. *(See figure 4-24.)*

a. With Truarc No. 7 pliers compress a second retaining ring (49), and install it in the central bearing bore liner groove of the gear case housing (53).

b. With Truarc No. 5 or No. 25 pliers compress, in turn, the four driven gear bearing retaining rings (48), and install them in the gear case housing driven gear bearing bore liner grooves.

c. Lay the gear case housing on its rear surface. In turn, lay four new oil seals (51) on the driven gear bearing bore liners with seal lips downward, and tap them into the liners with a suitable flat end block and mallet until they are seated against the retaining rings. The sealing lips must be toward the gear compartment.

d. Install and tighten a square head plug (1) in the oil drain hole.

e. Attach a new gasket (38) and the oil filler hole cover (37) on the two-stud pad adjacent to the lower left generator mount pad with two sets of parts (36, 35, 34).

f. Apply a film of gasoline and oil resistant grease, MIL-L-6032, to the external pipe threads of a nut (52), and screw it tightly into the tapped hole behind the oil filler hole cover (for connection of the oil gauge support tube).

8-21. GEARS AND BEARINGS. *(See figure 4-24.)*

a. If the ball bearings (41, 45) were removed from the driving and driven gears (44, 46, 47), install two serviceable bearings on each gear. A support ring and a driving ring of correct diameters and flat ends must be procured. Both rings should be sized to bear on the bearing inner races, with clearance holes to pass the gear shafts; and those for the driving gear bearings must be long enough to project beyond the shafts when the bearings are in place.

b. Lay a support ring on the arbor press table and center one of the bearings on top of it. Place the gear on the bearing, and align it in all directions; then bring the ram down on the gear shaft and press the gear into the first bearing.

c. Place the second bearing on the gear shaft and the driving ring on the bearing. Bring the ram into contact. Square up the bearing, and center the ring, then press the bearing onto the shaft until it is seated.

d. If new gears are being installed make sure that they are equipped with cupped oil plugs in the shaft bores. If the plugs are not in place procure one for each gear, and drive them in with a drift and mallet until they seat on the shaft bore shoulders.

8-22. ASSEMBLY OF HOUSINGS, GEARS AND COVERS. *(See figure 4-24).*

a. Lubricate the driver gear and its bearings. Place a cone of stiff oilproof paper (such as stencil paper in the central bore oil seal to guide the gear shaft through the seal lip, and carefully push the gear assembly into place in the housing (58). Withdraw the paper cone from the opposite side. The cone is made of a rectangular piece of paper curled up and slipped into the seal opening. Its overlapping ends are not attached.

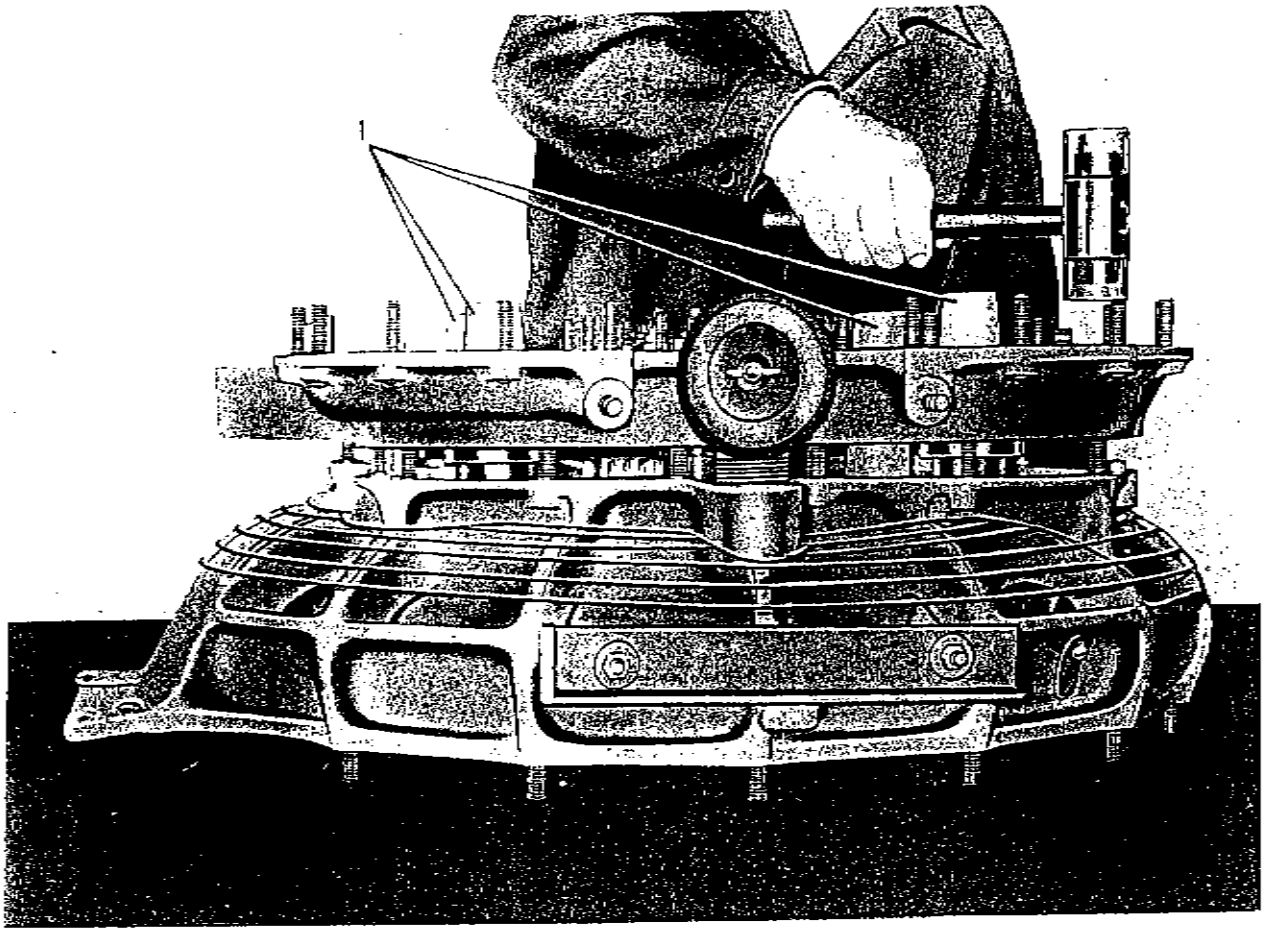
b. Lubricate the gear shaft splines with Gredag No. 44 grease. Push the flexible coupling driven flange (40) over the gear shaft. With No. 6 or No. 26 Truarc pliers spread the retaining ring (39), and seat it in the gear shaft groove.

c. Lay the inlet and gear housing (58) and gear assembly on the housing rear studs. *(See figure 8-3.)* Lubricate the four driven gear and bearing assemblies, and insert the bearings on the plain shaft sides into the inlet and gear housing liners so that the splined gear shaft ends are upward. Install the 36 tooth gear assembly in the position which will be at upper left of the housing assembly in its operating position (left foreground in figure 8-3).

d. Place four stencil paper cones (1, figure 8-3) in the driven gear shaft oil seals in the gear case housing (53) with the large cone ends toward the gear compartment. Make these cones as described in step "a" of this paragraph.

e. On the front parting flange of the inlet and gear housing (58) spread a thin, uniform film of lightweight Tite Seal. Lay a loop of No. 50 silk thread around the flange outside of the studs (but inside when it is wider there). The ends of the loop should lie side by side at the top of the flange and touching but not crossed over.

f. Turn the gear case housing, front side up, and lower it carefully onto the gears in the inlet and gear housing, watching the paper cones to see that the gear shafts enter them safely. Tap the gear case housing down into posi-



1. Stencil paper cones in gear case housing oil seals

Figure 8-3. Installing Gear Case Housing on Fan Inlet and Gear Housing

tion with a nonmarring hammer, keeping it level; then withdraw the paper cones.

g. Attach the gear case housing to the inlet and gear housing studs projecting into the generator pad cavities and to the stud between the two bottom pads with 13 washers, internal tooth lock washers, and plain hex nuts.

h. Place four new gaskets (28) on the generator mount pads. Install the four covers (27), and attach each with 21 sets of parts (26, 25, 24).

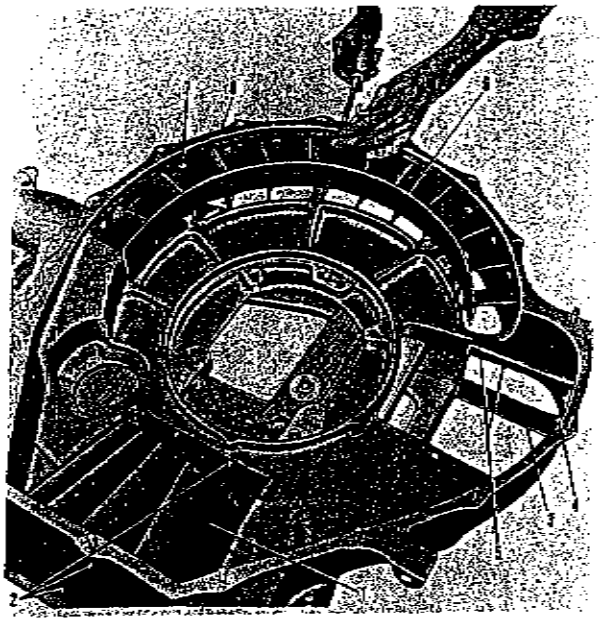
i. Place a new gasket (33) on the studded center pad of the gear case housing, and place a cover (32) over it. Install and tighten four sets of attaching parts (31, 30, 29).

8-23. FAN OUTLET HOUSING AND SHROUD FRONT PANEL.

8-24. OUTLET HOUSING AND ATTACHED PARTS. In figure 8-4 the outlet housing studding assembly is illustrated as mounted on a rotatable work stand to permit turning it to the most convenient working position for attachment of the three turning vane assemblies (2, 3, 6). If such a support is not available, lay the casting on a work bench. Attach the vane assemblies with parts listed in the accompanying legend. The two screws (5) at the top of the lower turning vane assembly are more clearly visible in figure 8-5.

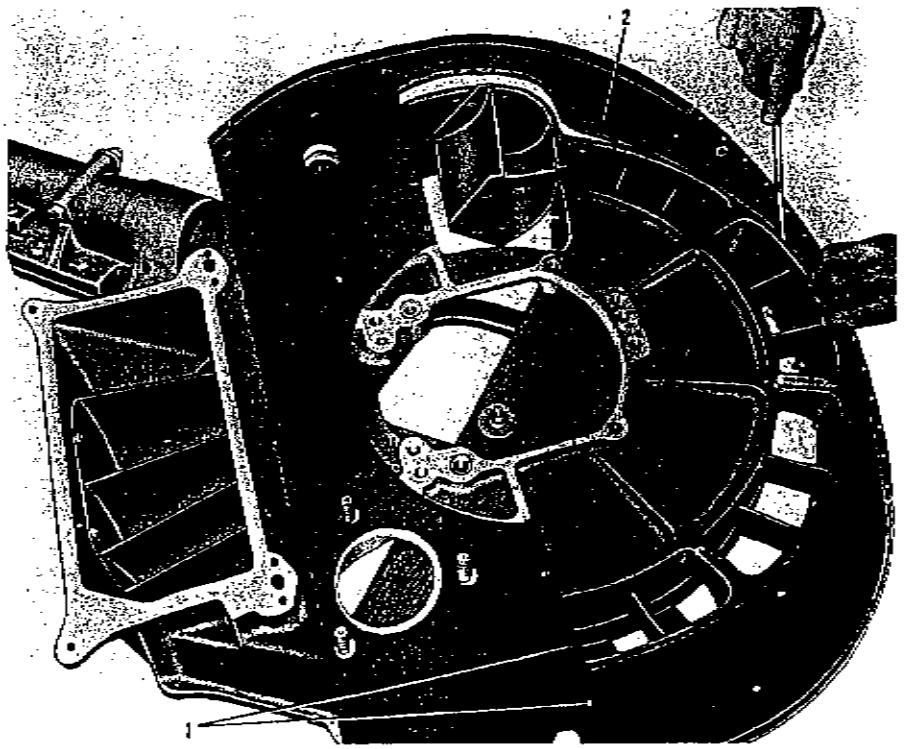
8-25. In figure 8-5 the fan outlet housing and turning vane subassembly is shown after it has been turned over, and the shroud front panel assembly has been attached to it temporarily with fillister head screws (1) in the cylinder to shroud baffle attaching holes. A new felt sealing strip (2) has been cemented inside the front panel attaching flange with SC No. 1551 adhesive (liquid) and allowed to dry prior to this operation. It must be firmly attached to the panel flange to prevent shifting as it is tucked in with a screwdriver, starting at one end, while the panel is pushed down over the housing. Excessive thickness of the felt will make this a difficult operation, while insufficient thickness will prevent a perfect seal at this important joint. The correct strip is 0.09 inch thick, 1 inch wide and 47-3/8 inches long.

8-26. In figure 8-6 the operator is punching a screw hole



1. Oil cooler turning vane assembly
2. Screw, lock washer and nut
3. Lower turning vane assembly
4. Screw, lock washer and nut
5. Screw and lock washer
6. Upper turning vane assembly
7. Screw, lock washer and nut
8. Fan outlet housing

Figure 8-4. Installing Turning Vales



1. Screws
2. Felt sealing strip

Figure 8-5. Installing Shroud Front Panel and Sealing Strip

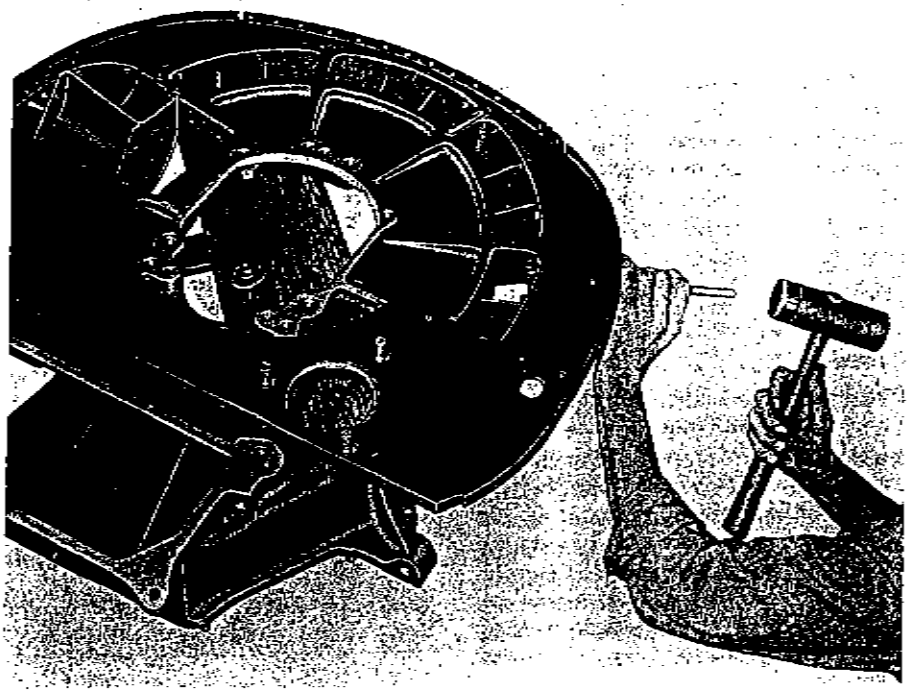


Figure 8-6. Aligning Screw Holes and Punching Sealing Strip

through the shroud front panel sealing strip with a long, tapered punch which has been ground to a sharp point on the business end. Screws, lock washers and nuts have already been installed in other holes around the panel flange, with nuts on the inside of the housing and the lock washers under the screw heads. The longer screws are near the ends of the attaching flange where the casting is slightly thicker. With two of the screws (4th and 5th from right end) and a bracket (21, figure 4-24) for the gear case oil filler and oil gauge support tubes is attached on top of the front panel flange, as shown in figures 1-3 and 1-4. When all shroud panel flange attaching screws have been installed, remove those at the baffle positions.

8-27. *(See figure 8-7.)*

Legend for Figure 8-7

1. Fan outlet housing and turning vanes assembly
2. Shroud front panel assembly
3. Exhaust manifold connector
4. Shroud to No. 5 cylinder intake side baffle
5. Shroud to No. 6 cylinder exhaust side baffle
6. Packings
7. Grommet
8. Grommet
9. Hook angle

a. Before installing the shroud to cylinder baffles pull the shroud panel (2) away from the housing (1) only enough to admit the exhaust manifold jacket connector (3), and slide the latter part between so that its collar

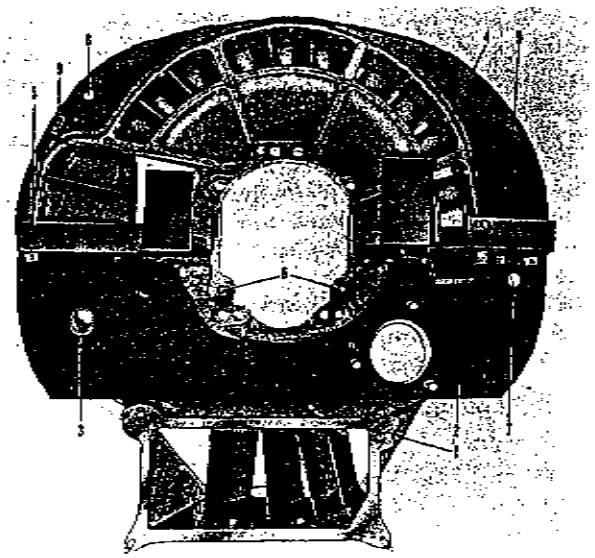


Figure 8-7. Fan Outlet Housing, Shroud Panel and Baffles Assembly

projects through the panel hole. The adapter is loose in the hole to permit self-alignment with the exhaust manifold jacket.

b. Attach the shroud to No. 5 cylinder intake side baffle assembly (4) to the panel and housing assembly with four screws and lock washers and to the panel only with two screws and nuts. With parts of the same kinds, attach the shroud to No. 6 cylinder baffle (5) on the left side. New baffles are illustrated. Baffles previously installed may be curved more nearly to the cylinder shape.

c. Insert two new "O" rings (6) in the oil passage counterbores.

d. Insert new grommets (7, 8) in the shroud panel holes where illustrated.

e. Attach a webbing strip to the outside of the narrow flange which surrounds the shroud front panel on the left side in a position such that it will lie between the installed positions of the bottom side panel and the top panel. Attach another identical strip on the right side in a corresponding position. The webbing strips may be attached with split rivets or tubular rivets. If holes were not originally drilled in the panel flanges, it will be necessary to drill about five holes through each webbing strip and flange at evenly spaced positions while the webbing is held firmly in place.

f. Install 14 cage lock nuts in holes in the outturned flange along the bottom edge of the shroud front panel with the threaded inserts on top. Make sure that the retaining lip of each cage nut is engaged in the panel hole to assure alignment when the bottom front panel is attached later.

g. If removed for repair work, attach two hook angles (9) (same as 43, figure 4-18).

8-28. SHROUD UPPER REAR PANELS AND BAFFLES.

8-29. Refer to figure 4-18 for identification and locations of the blower inlet screen, felt sealing ring and grommet to be installed on the upper rear panels. Use illustrated types of attaching part for the screen. A new felt ring may be stuck to the rear side of the left panel by coating one side with SC No. 1551 adhesive (a rubber compound cement), or equivalent, and allowing the cement to dry while the felt ring lies in place. If the weatherstrip webbing (45, figure 4-18) has been removed from the side flanges it should be replaced with new strips after completion of the rear panel during final assembly of the packette. Do not attach the baffles (49 and 53, figure 4-18) to the upper rear panels at this stage.

8-30. INDUCTION SYSTEM.

8-31. AIR FILTER AND ADAPTER ASSEMBLY. *(See figure 4-25.)* Attach a new gasket (10) and an adapter casting (9) to the front side of the filter housing (11) with four shroud attaching screws (6), while holding two assemblies of nut strip and speed nuts (7, 8) inside the housing. The speed nut teeth must be away from the housing surface, as illustrated. Place a new gasket (5) on the filter element (4), and slide the filter into the rear housing opening. Attach its flange with six shroud attaching screws (3). Equip a new connector hose (2) with two clamps (1), and slide one end onto the breather connector on the bottom of the filter housing. Turn so that both clamp screws will be accessible from the rear (filter) side; then tighten the upper clamp. *(See figure 1-2 for position.)*

8-32. INTAKE TUBES. *(See figure 8-8.)* On each of the intake tubes (3) slide one of the flanges (4) with its counterbored side toward the grooved end of the tube. In the groove of each tube, place a new special seal (5), and slide the flanges down over the seals. On the plain end of each intake tube, slide a new hose (6) and over it two hose clamps (7). Push the hoses on until flush with the tube ends.

8-33. INTAKE MANIFOLD. *(See figure 8-8.)* The only part to be installed in the intake manifold casting (1) at this stage is the pipe plug (2). Coat the plug threads with anti-seize compound, MIL-T-5544, before screwing it into the tapped hole on top of the manifold.

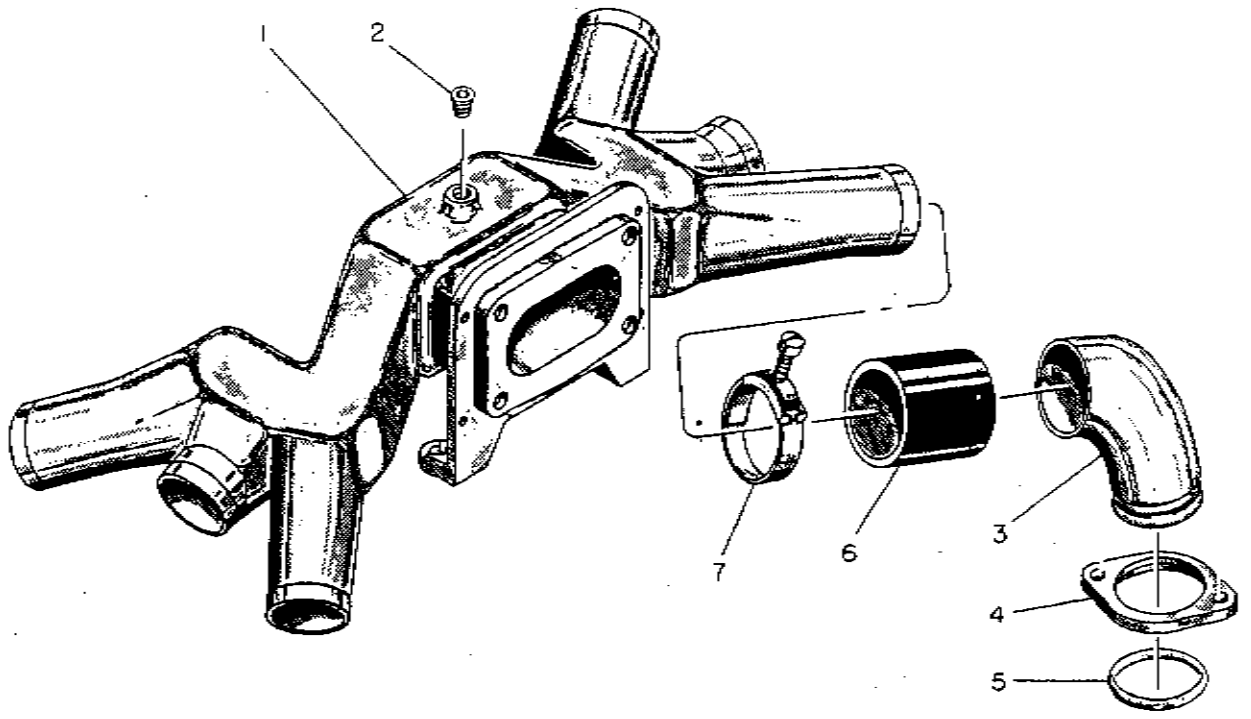
8-34. PREHEAT AND MIXING VALVE.

8-35. ASSEMBLY. *(See figure 4-26.)*

a. Assemble the parts illustrated in figure 4-26 without lubrication. If desired the housing (1) may be clamped lightly between lead shielded vise jaws while the other parts are installed. If the solenoid valve shaft (30) is an original part, the pin (29) should be in place already. If this shaft is a new part, tap a new pin into the hole provided near the plain end of the shaft until it projects equally from both sides. Insert the shaft and pin assembly into the horizontal bearings of the housing and attach a butterfly valve (28) with two screws and lock washers (26, 27). Test by turning the valve and shaft assembly from the open to the closed position to make sure that there is no binding. Also move the shaft sidewise to make sure that it is not excessively loose in its bearings.

b. Insert the mixing valve shaft (16) through the vertical holes in the housing, and test it for looseness. If the shaft fits satisfactorily and does not bind, insert the smaller butterfly valve (12) into the lower valve throat, and attach it to the flat side of the shaft with two screws and lock washers (10, 11). In the same manner, install and attach the larger butterfly valve (15) in the upper valve throat. Test the valves and shaft assembly for free rotation through their full range.

c. If the solenoid (25) is a new part, install on it a new coupling (24). The solenoid scroll spring tends to hold the shaft in the valve closed position. In this position, the driving slot in the outer end of the coupling must be vertical, i.e., in line with the two mounting studs. Slide the coupling on the shaft in this position so that its outer end is exactly 0.91 inch from the face of the solenoid housing. Drill through the coupling pin holes and shaft with a 1/8 inch twist drill, and secure the coupling by driving in a new pin (23). Attach the mounting bracket (22) to the solenoid studs with two self locking nuts and washers



1. Intake manifold
2. Pipe plug
3. Intake tube
4. Intake tube flange
5. Seal
6. Hose
7. Clamp

Figure 8-8. Three-Quarter Left Rear View of Exploded Intake Manifold and Tubes Assembly

(20, 21). Turn the horizontal valve shaft (30) until its driving pin (29) is vertical as illustrated. Install spacer washers (19) on two housing studs, then the solenoid and bracket assembly with the coupling slot engaged to the shaft pin. Attach the bracket with two nuts and lock washers (17, 18).

d. Place a serviceable adjusting plate assembly (9) over the vertical valve shaft, and attach it loosely with two sets of attaching parts (6, 7, 8). Turn the adjusting plate until its anchor pin is in position to fit into the outer end loop of the bimetal spiral (5) when the bent inner end of the spiral is in position to fit into the vertical valve shaft slot, and push the spiral carefully into position over the valve shaft and anchor pin. Place a washer (4) on the shaft over the spiral, and secure it with lock washer (3) and a screw (2).

Note

The spiral must travel counterclockwise from the anchor pin loop to the bent inner end, as seen from above.

e. Turn the adjusting plate until the hot air valve (12) is just held in the closed position; then tighten the adjusting plate retaining screws (6) enough to hold the position.

8-36. TESTING AND ADJUSTMENT. A slot in the end of the horizontal valve shaft (30) opposite the solenoid indicates the position of the butterfly valve (28). The slot should be nearly vertical when the valve is closed, and it should be horizontal when the solenoid is actuated to open the valve. Test the solenoid action by connecting its leads across a 24 volt storage battery. If the current does not open the valve, reverse the leads and repeat the test. Do not apply current longer than a few seconds at a time. If the current will not actuate the solenoid it will be necessary to discard the assembly and substitute a new one.

8-37. FUEL PUMP AND DRIVE.

8-38. HAND CRANK AND FUEL PUMP ADAPTER ASSEMBLY. *(See figure 4-28.)*

a. Apply a film of general purpose aircraft lubricating grease, MIL-L-7711, to the oil seal lip in the adapter (10) and to the seal race (adjacent to crank jaws) on the shaft. Lubricate the shaft journal and splines as specified in paragraph 8-4; then push the shaft slowly into the adapter.

b. Slide the drive gear (8) over the shaft splines. Spread the retaining ring (7) with Truarc pliers No. 2 or No. 22 just enough to pass over the shaft end and seat it in the groove ahead of the gear.

c. Measure the end clearance between the gear and the adapter with a thickness gauge. (Refer to Ref. No. 90, Section XII.)

8-39. FUEL PUMP. *(See figure 4-28.)*

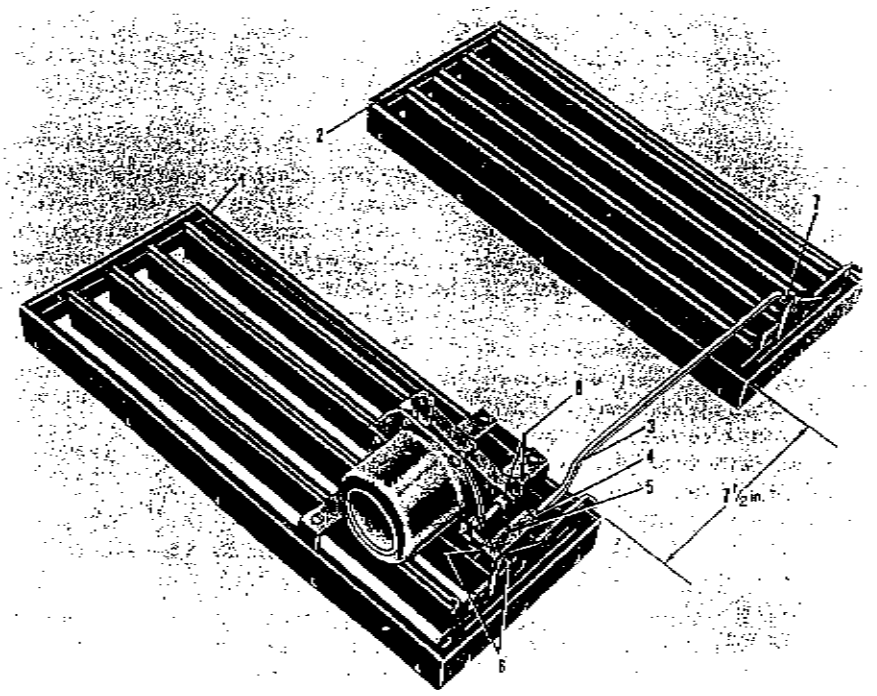
a. Before installing the pump (5), turn the drive gear until the shaft eccentric is at its lowest position. Place a new gasket (6) and the fuel pump on the two long adapter studs, and slide the pump into seated position, compressing the pump lever springs as the lever passes above the shaft eccentric. Attach the pump with two sets of attaching parts (4, 3, 2 in that order).

b. Turn the drive gear through at least one complete revolution to test the action of the pump lever.

c. Lubricate the pipe threads of an elbow (1) with gasoline and oil-resistant grease, MIL-L-6032, before installing it in the fuel pump port marked "OUT". When the elbow is tightened it must point straight up, as illustrated.

8-40. SHROUD SHUTTERS. *(See figure 8-9.)*

8-41. In order to avoid the necessity of adjusting the shutter control rod after final installation of shutters on the packette, it is advisable to attach the two shutter assemblies temporarily to the sides of the oil sump or to space them as indicated in figure 8-9 and to assemble and adjust the control rod parts with both shutters wide open. The left shutter assembly (1), if in good operating condition, will be held wide open by the bellows actuating mechanism installed on it at room temperatures of 21°C (70°F) and higher. The right shutter assembly (2) must be kept in the open position by some suitable means during this procedure. If necessary, the left shutter may be adjusted to the open position by loosening lock nuts (8) and turning them to move the bent rod further into the swivel nut in the forked operating lever. Tighten the lock nuts again to hold the shutter vanes in this position. This adjustment must be carried out at a room temperature of at least 70°F. Screw a nut (4) and a rod end (5) on the threaded end of the control rod (3). Install the rod end on the bent rod and insert the latter through the hole on the vane control plate, as illustrated. Install two cotter pins (6) in the bent rod where illustrated. Place the eyelet end of a spring clip (7) astride the control plate of the right shutter and push the bent end of the control rod (3) through the clip and the plate. Snap the clip down over the control rod to hold it in place. Observe the positions of the right shutter vanes. The angle of these vanes should be identical to that of the left shutter vanes when the control rod is adjusted to the correct length. If the right vanes are not held at the correct angle, remove the spring clip (7) and the bent end of the control rod (3), and turn the rod to change its effective length as required; then reinstall the bent end in the right shutter, as before. When the correct rod length has been



1. Left shroud shutter
2. Right shroud shutter
3. Shutter control rod
4. Lock washer and nut
5. Shutter control rod end
6. Washers and cotter pins
7. Spring clip
8. Adjustment lock nuts

Figure 8-9. Adjustment of Shutter Control Rod

obtained, tighten the hex nut (4) against the rod end (5) to maintain the length adjustment. Detach the control rod from the right shutter, but leave it attached to the left shutter assembly.

8-42. OIL SUMP. *(See figure 4-14.)*

8-43. All studs (23, 24, 25) should be found in place in the sump. The gasket (27), the thermoswitch (9), the oil gauge and its support (2 through 6) and sump attaching parts (13, 14, 15) will not be installed in the sump at this stage. Install the other parts in the following steps:

a. Slide a spring wire circlip (3) on the gauge. If it is necessary to install a new support (6), slide over the plain end of the tube a bracket (4)—in the illustrated orientation—and a coupling nut (5), with the nut thread facing the plain end of the tube. Flare the tube end with a standard flaring tool.

b. Before installing threaded parts (16, 17, 18) spread on their threads a thin film of gasoline and oil resistant grease, Specification MIL-L-6032.

c. Place the new copper-asbestos gasket (20) on the flanged plug (19), and screw the plug into the drain opening in the bottom of the sump. Spread a film of gasoline and oil resistant grease on threads of the drain plug (1), and screw this plug into the tapped hole in the larger plug. Do not install lockwire in either plug, since the oil must be drained following the run-in test after overhaul.

d. Fit a new packing (28) into the groove around the large bore centered in the drain connection plate (29). The plate assembly, its gasket and its attaching parts need not be installed at this time. They may be loosely attached to the sump studs (24) if desired.

e. If the bushing (22) is not in place obtain a replacement part which will fit tightly into the hole toward the forward end of the sump bottom surface, and tap it squarely into place with a wood block and hammer.

f. If the Hubbard plug (21) has been removed, install a new part in the counterbore near the center of the sump bottom surface, and tighten it with two or three firm blows of a hammer, taking care not to dent the convex surface.

8-44. OIL SUMP ADAPTER. *(See figure 4-16.)*

8-45. Place a new copper-asbestos gasket (14) on the square head plug (13) and screw the plug into the tapped hole in the front spout of the adapter casting. Place a new copper-asbestos gasket (10) on the relief valve cap (9). Lubricate a serviceable spring (11) and insert one end into the cap. Place the relief valve plunger (12) over the other end of the spring. Hold the adapter casting so that its right side is downward, and insert the relief valve assembly upward into the tapped hole in the right side boss. Holding the relief valve cap inward, invert the adapter and rest its left edge on the work bench; then push the cap (9) in against the spring, and screw it into the tapped hole. It will be easier to tighten the front plug and the relief valve cap after installation of the adapter on the engine. Attaching parts (1 through 8) and gaskets (16, 17 and 18) are not to be installed at this stage.

8-46. CRANKCASE HEATER AIR VALVE. *(See figure 4-31.)*

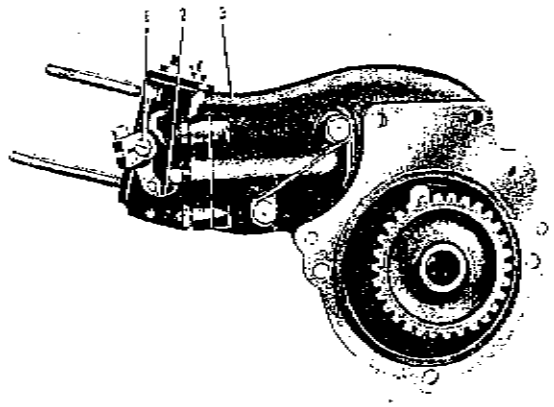
8-47. If the lever (6) was removed from the valve shaft (7) assemble two serviceable parts and install a lock washer (5) and a screw (4), but do not tighten the screw fully at this stage. The lever should be flush with the slotted end of the valve shaft. Insert the shaft (7) into the valve body (8), and push a butterfly valve (3) through the shaft slot until the screw holes are aligned. Attach the valve with two screws and lock washers (1, 2). Test for free rotation of the valve and shaft assembly, and inspect for leakage around the valve in the closed position by holding the assembly between the eye and an illuminated 100 watt lamp. Correct leakage by shifting the valve slightly. The position of the lever (6) will be adjusted at final assembly.

8-48. OIL PRESSURE VALVES. *(See figure 4-32.)*

8-49. Assemble the parts illustrated to make up each of two oil pressure valve assemblies required for one packette. Lubricate the cylinder wall with a film of general purpose grease, MIL-L-7711. Insert the cupped side of the synthetic rubber piston seal (11) into the cylinder and push it inward a short distance, keeping it square. Place a serviceable spring (9) on the piston (10). Set the piston on the work bench, and compress the spring by pushing the cylinder cover (8) down over the stem. While holding the cover downward to expose the snap ring groove in the stem, expand a retaining ring (7) with Truarc No. 2 or No. 22 pliers only enough to permit it to pass over the stem, and install the ring in the groove. Place a new gasket (6) on the cylinder studs, and install the piston, spring and cover assembly on top of it. Attach the cover with two sets of attaching parts (4, 5). This method of assembly avoids possible damage to the bottom edge of the rubber seal, since the seal cannot be pushed too far into the cylinder when the parts are installed in this manner. Attach one end loop of a spring link pin (3) with a flat head pin (2) so that the link is free to swing within the slot at the top of the piston stem. Secure the flat head pin with a cotter pin (1).

8-50. GOVERNOR DRIVE. *(See figure 4-27.)*

8-51. Push two new packings (16) over the ends of the shaft (15), and seat them in the grooves in the bearing areas. Slide the shaft assembly into the adapter bearings, with its notched end toward the gear side. Insert the butterfly valve (14) through the shaft slot, and attach it with two sets of parts (13, 12). Hold the valve in the closed position, and inspect its fit in the adapter throat. If necessary, shift the valve slightly to assure the best possible seating. Attach one of the oil pressure valve assemblies (7) with two sets of bolts and washers (6, 5, 4) over a new gasket (8) placed on the two valve mount pads on the gear side of the adapter. After tightening, secure the bolt heads together with lockwire, as in figure 8-10. Turn the spring link to the position illustrated in figure 8-10. Assemble loosely a lever and clamping parts (9, 10, 11), and slide the lever over the protruding valve shaft. Align the



1. Alignment groove in butterfly valve shaft end
2. Spring link
3. Adapter

Figure 8-10. Governor Adapter Assembly and Oil Pressure Valve Assembly

open eye of the spring link with the lever pin hole and attach the two parts with a flat head pin and cotter pin (3, 2). Hold the butterfly valve against the breather bushing (wide open), and rotate the lever until the resulting tension in the spring link just begins to lift the oil pressure valve piston stem. (The stem retaining ring should be at the point of breaking contact with the cylinder cover). While holding the lever thus, tighten its clamp screw. Test the valve action by pulling out the oil pressure valve piston stem until the butterfly valve is fully closed and the piston stem fully extended. The spring link will flex slightly to compensate for piston overtravel. Make sure that there is no interference between the end of the piston stem and the lever on the valve shaft. *(See figure 9-10.)* If interference occurs, the lever is improperly positioned or the link is deformed and must be replaced. Lubricate a pipe plug (19) with anti-seize compound, Specification MIL-C-5544, and install it tightly in the adapter. Lubricate the shaft of the drive gear (1), and slide the gear into the adapter bushing. It is not retained in any manner.

CAUTION

Do not attempt to pull out the oil pressure valve piston by moving the butterfly valve or the lever since this may distort the spring link. The function of the spring link is to prevent jamming of the butterfly valve due to overtravel of the oil pressure valve piston stem, hence it is important that it maintain its original curvature. Do not grasp the piston stem with any tool which might scratch or nick it. Take care not to break or dislodge the snap ring, removal of which would allow the piston to jam its oil seal.

8-52. ACCESSORY CASE. *(See figure 8-11.)*

8-53. Clamp the accessory case (1) between soft shielded vise jaws, as illustrated. During the assembly process, turn the case as necessary to provide the best visibility and access to the parts being installed. Install the parts in the following steps:

a. Lubricate the impellers (2, 3), and insert them in the pump housing (4). Notice the location of the driving impeller square.

b. Install the pump assembly in the case, and tap it home over the two case dowels. The pump mounting flange must be perfectly flat and clean to seat properly.

c. Attach the pump housing with a steel washer and bolt (5) and a copper washer and screw (6), but do not tighten these fully.

d. Place a new gasket on the mounting pad for the tachometer and oil screen housing. Insert into the tachometer cable slot of the oil pump driven impeller a fiber strip which will fill it out to the shaft contour throughout its entire length and will project enough to grip for removal.

e. Spread on the oil pump driven impeller shaft a film of general purpose aircraft lubricating grease, MIL-L-7711.

f. Push the oil seal up carefully over the impeller shaft and seat the housing (7) on its gasket.

g. Install three sets of attaching parts (8) and four sets of parts (9); then remove the fiber strip from the tachometer drive slot.

h. Test the pump impellers for free rotation while all attaching parts (5, 6, 8 and 9) are tightened evenly. Any binding or drag must be corrected by disassembly and repair or replacement of parts. The case dowels prevent misalignment of impellers unless a bushing is replaced and improperly bored or faced.

i. Install the oil pump suction tube (11) over a new gasket (10), and attach it to the oil pump housing with two screws (12). The tube must be cocked 30° off the vertical and 135° from the case rear surface (approximately) to allow its flange to enter.

j. With lockwire (13) tie the pump housing bolt (5) and the two suction tube attaching screws (12) together in the manner illustrated in the lower example of figure 8-1.

k. Place a new gasket (14) on the drain tube (15), and screw the latter into the accessory case. Tighten it securely.

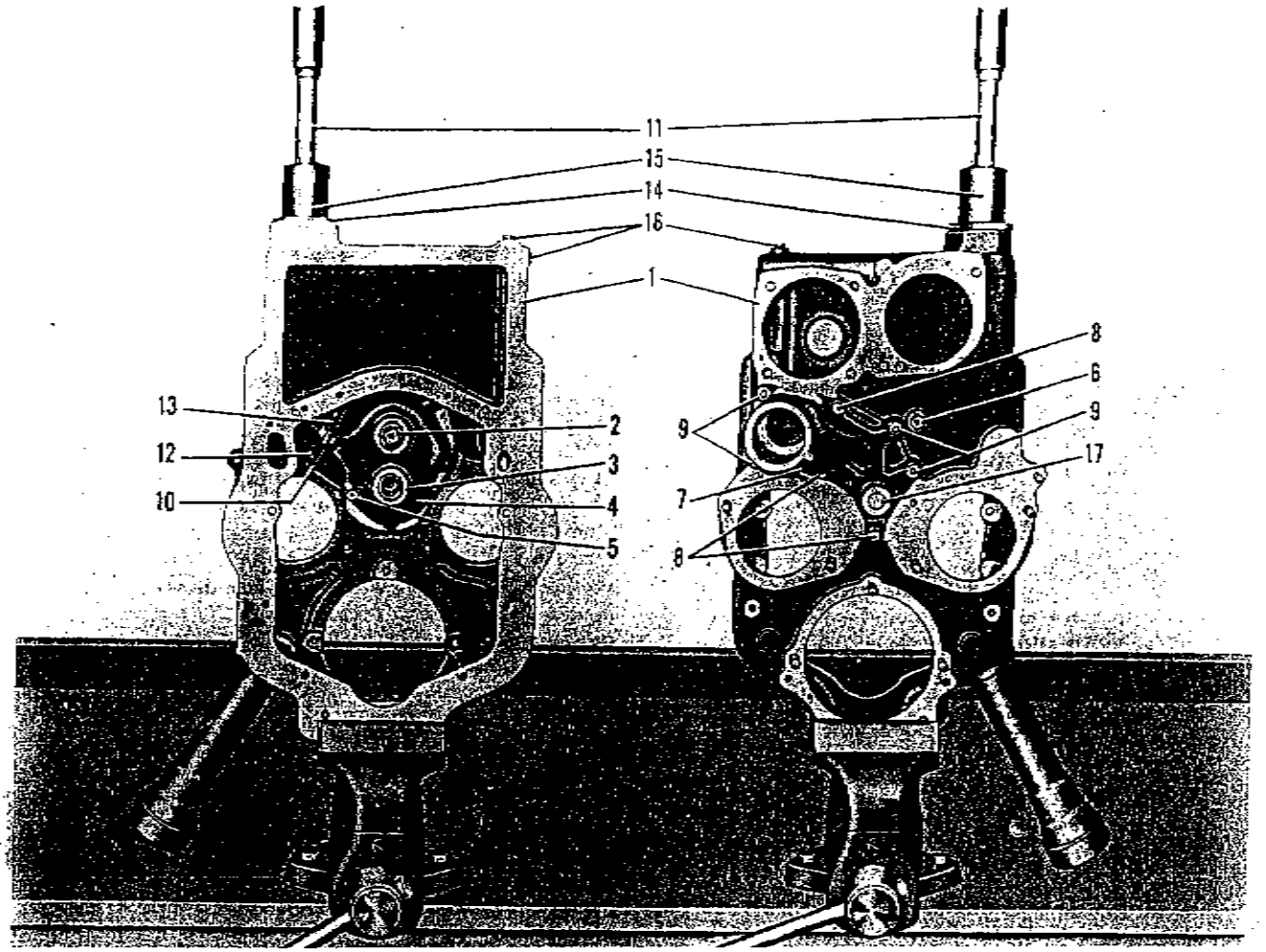
l. Install three pipe plugs (16), and tighten them with a 1/8 inch Allen wrench.

m. If available, install a shipping cover nut (17) on the tachometer adapter thread.

8-54. BLOWER ENGINE. *(See figure 8-12.)*

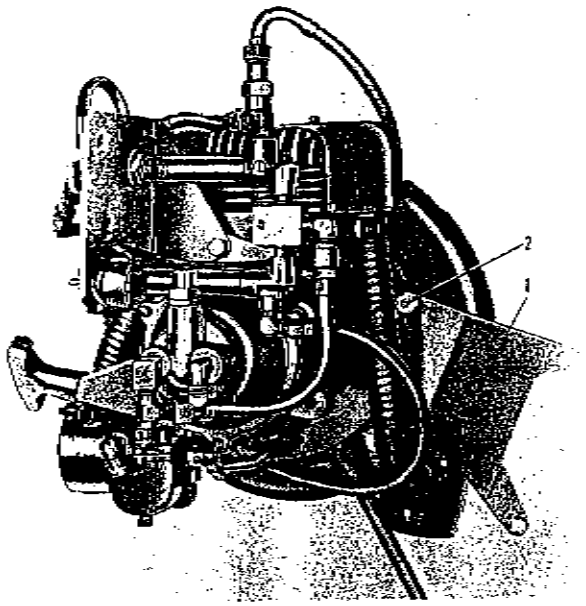
8-55. Attach the blower mounting bracket (1) with two sets of parts (2). Notice the position of the blower bracket on the engine.

8-56. CRANKCASE HALVES. *(See figure 8-13.)*



1. Accessory case studding assembly
2. Oil pump driving impeller
3. Oil pump driven impeller
4. Oil pump housing
5. Washer and bolt
6. Washer and bolt
7. Tachometer and oil screen housing
8. Washer, lock washer and bolt
9. Washer, lock washer and nut
10. Gasket
11. Oil pump suction tube assembly
12. Bolt
13. Lockwire
14. Gasket
15. Oil drain tube
16. Pipe plug
17. Tachometer drive shipping cover nut

Figure 8-11. Accessory Case Assembly



1. Blower to accessory case bracket
2. Screw and lock washer

Figure 8-12. Blower Engine With Blower to Accessory Case Bracket Installed

8-57. Screw a pipe plug (1) into the machined bottom surface of the right crankcase, and tighten it. Nearby is the oil cooler bypass valve hole (oblique). Assemble parts of the bypass valve (42, 43, 44 and 45, figure 4-23), balancing the ball on the spring. With the casting tipped slightly forward of its position in figure 4-23, insert the valve assembly upward into the case hole, and screw in the plug. Lay the case down, and tighten the plug. Thoroughly clean all bearing seats in both crankcase castings and clean a set of new bearing inserts. Push the inserts (2, 3) into their seats in the castings so that their tangs engage the case notches and their ends project equally from the case parting surface. Lay the right side casting on the bench, open side up, and install a set of reassembled hydraulic valve lifters (4) which have been lubricated on the exterior surfaces only. Retain the hydraulic lifters in the right crankcase casting with used cylinder base packings (5), installed as illustrated and looped around the three short pushrod housing flange studs on the outside of the casting below each cylinder opening. If desired, the right crankcase casting assembly may be inverted and attached to the left crankcase casting with two bolts and nuts in upper and lower parting flange holes. The purpose of the cylinder base packings is to prevent the right side valve lifters from dropping out when the right casting is held open side down for final assembly. Valve lifters will be installed in the left side crankcase at final assembly.

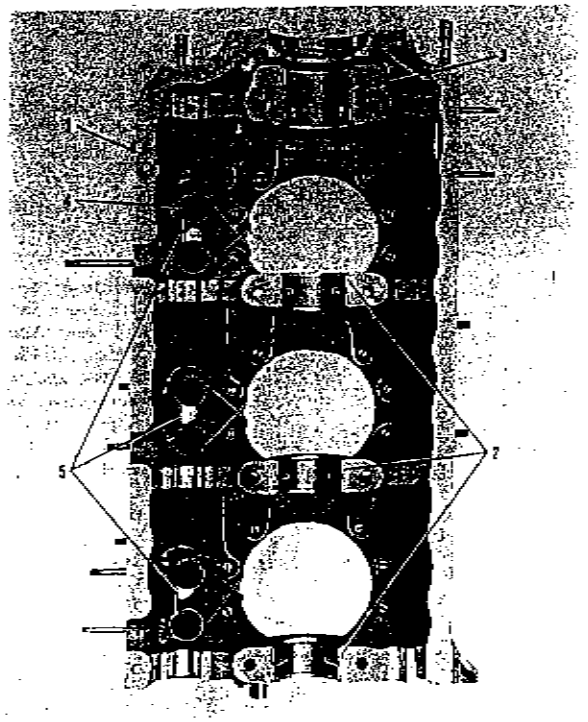
Note

Before installation of new main and connecting rod bearing inserts, inspect the front face of the flywheel mount flange of the crankshaft to be installed in the packette. If an acid etched symbol ".010" is found there the shaft journals and crankpins have been reground to 0.010 in. undersize, and will require undersize bearing inserts. Install undersize intermediate and rear main bearings, main-thrust bearings and connecting rod bearings to accommodate a reground crankshaft. The bearing part numbers are lightly stamped in small numerals on the outside surfaces near one end for identification. Examine these numbers in any event to assure installation of correct parts.

8-58. CRANKSHAFT AND CONNECTING RODS.

(See figure 4-34.)

8-59. As received from repair personnel, the crankshaft (11) should be equipped with a dowel (9) and six flywheel bolts (10), however it may be necessary to install a new Hubbard plug (8) in the center bore at the front end. Do this by laying the new plug on the counterbore shoulder and striking one or two firm blows with a hammer, but not enough to dent the plug. The convex side of the plug needs to be flattened only slightly to expand it



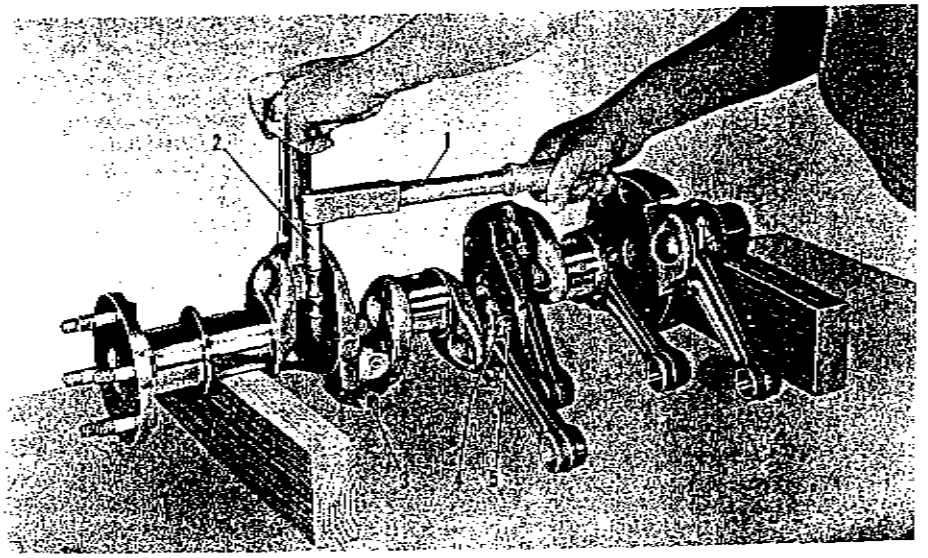
1. Pipe plug
2. Intermediate and rear main bearings
3. Front main-thrust bearing
4. Hydraulic valve lifter
5. Used cylinder base packings

Figure 8-13. Right Crankcase Assembly

firmly in place. Check the identification attached to the two loose counterweights (7) to determine their original positions on the crankshaft. These counterweights must be reinstalled in the same positions as in the original assembly, i.e., on the same blades and with same sides forward. In turn, place each of the counterweights on the correct blade, and insert the two loose-fitting pins (5). Insert a retaining plate (4) at each end of each pin and install a retaining ring (3) to retain each plate. Use Truarc pliers to compress the retaining rings, and seat the rings firmly in the grooves provided in the counterweights. Check the pendulum action of each counterweight to see that there is no binding. Place the crankshaft and counterweights assembly in notched 2 x 4 inch wood blocks, illustrated in figure 8-14. Lay out the connecting rods and caps in numerical order beside the shaft. Thoroughly clean the bearing seats of all rods and caps, and press into each piece a new connecting rod bearing insert, with its tank engaged in the notch provided for it, and with its ends projecting equally from the parting surface. Install each connecting rod and its cap, with their position numbers together and all facing the side which will be on top when the shaft and rods are positioned as they will be in the assembled engine. Attach caps to rods with special hex head bolts and castle nuts. The rod and cap position numbers are found on one of the bolt bosses of each piece. The nuts must go toward the small end of each rod. When all rods and caps have been installed, hold each, in turn, in a convenient working position and tighten the castle nuts with a torque indicating wrench and a deep socket, as shown in figure 8-14. When the nuts have been tightened to the correct torque, as specified in Section XII, cotter pin holes in the bolts must align with nut slots and lie within them. If they do not, substitute other nuts or bolts of correct part numbers, as necessary. Secure all connecting rod bolt nuts with cotter pins. When all connecting rods have been installed, obtain a new crankshaft oil seal assembly, and remove the spring from the seal groove. Unhook the ends of the spring. Lubricate the crankshaft just behind the flywheel flange and the lip and ends of the oil seal with a film of Gredag No. 44 grease or equivalent. Twist the oil seal and pass it over the crankshaft, as illustrated in figure 8-15, with its spring recess toward the rear end of the shaft. Bring the seal ends together and seat the lip on the shaft surface. Loop the oil seal spring around the crankshaft, just behind the seal, and hook its ends together. Turn the spring loop so that its joint is approximately opposite the seal split; then, starting at any point, push the spring into the seal recess, and, working in both directions, push the entire seal spring into the deepest part of the recess. *(See figure 8-16.)* Make sure that the ends of the seal are flush and the seal lip in contact with the crankshaft all around. Square up the seal with the shaft and locate it so that it will fit properly into the counterbore at the front end of the crankcase when the shaft is installed.

Note

Before installing connecting rod assemblies, their bearing inserts must be lubricated copiously with corrosion preventive oil mixture, or, if final assembly and testing will follow immediately, it is permissible to use castor oil, Specification JJJ-C-86.



1. Torque indicating wrench
2. Deep socket
3. Bolt
4. Nut
5. Cotter pin

Figure 8-14. Tightening Connecting Rod Cap Bolt Nut

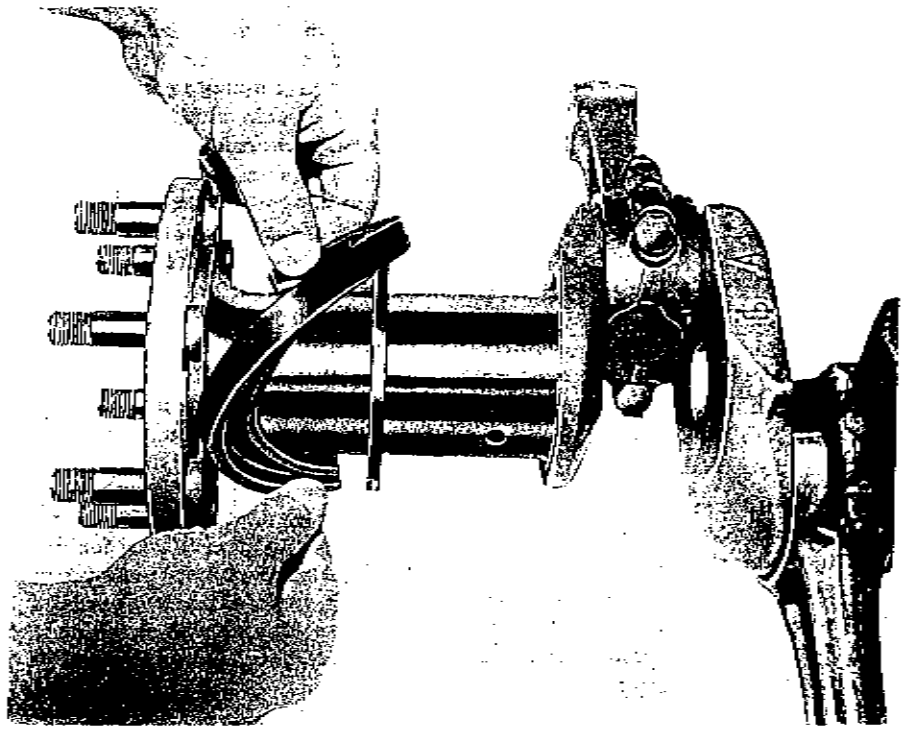


Figure 8-15. Installing Crankshaft Oil Seal

CAUTION

If connecting rod assemblies are not reinstalled on their original crankshaft or if new rods are to be installed, each rod assembly must be weighed. The maximum permissible weight difference between rods in any engine is 1/4 ounce.

8-60. CYLINDERS. *(See figure 4-33.)*

8-61. Assemble the necessary parts to make up each of the six cylinder assemblies in the following manner:

a. Spread only a film of Lubriplate No. 707 (Fiske Bros. Refining Co., Toledo, Ohio) on the stems of the two valves which were lapped to the seats of the cylinder to be assembled, and install them in their respective guides. Then, holding the valve stems, lift the cylinder and place it on the cylinder and valve holding fixture, tool No. J-2858, with the valve holding pedestal in position. Secure the cylinder base flange with the fixture clamps. Again apply Lubriplate No. 707 to the valve stems above the guides, including the stem tip surfaces.

b. Install the inner spring retainers (13) over the two valve guides, then the inner and outer vave springs (12, 11) and, on top of these, the two roto-caps (10).

c. Temporarily slide into position the rocker shaft (6), and use this as a fulcrum for the valve spring compressor, tool No. J-2838. Place the narrow end of the compressor under the rocker shaft, and push down on the handle until the roto-cap on either valve is depressed enough to admit the two stem keys (9). Place the keys in the tapered center hole of the roto-cap with their smaller ends inward, and carefully release pressure until the ribs inside the keys engage in the valve stem groove, and the keys seat firmly in the roto-cap. Do not permit the keys to become cocked and nick the valve stem. Remove the compressor and install stem keys on the other valve in the same manner.

CAUTION

Do not allow the roto-caps to be cocked by the spring compressor so as to touch the valve stems and score them. The intake valve stems are particularly susceptible to such damage.

d. Release the cylinder flange clamps, and remove the cylinder and valve assembly from the fixture. Stand it upright on the work bench, and strike each valve stem tip firmly with a rawhide mallet or plastic hammer to seat the stem keys.

e. Push the rocker shaft from its supports. Lubricate the bushings of two valve rockers, one intake and one exhaust, with corrosion preventive oil mixture and the rocker surfaces which will contact the valves with Lubriplate No. 707 grease. Place the rockers in position between cylinder head supports. Lubricate a rocker shaft with corrosion preventive oil mixture, and start it in one end support. Align the first rocker, and push the shaft through, then the second, and push the shaft in to centered position.

f. When all cylinders have been assembled as in the preceding steps, lay them out in numerical order on the work bench on the sloped cylinder head fins, so that the intake ports are downward and the open cylinder skirt projecting upward diagonally.

g. Over the open end of each cylinder, stretch a new cylinder base packing (5), and work it against the cylinder base flange so that it is not twisted.

h. Push a new pushrod housing seal (3) over each end of each pushrod housing (4), and push a housing retainer (2) between the beads provided for it at one end of each housing to make up twelve housing assemblies.

i. Push the retainer end oil seal of each pushrod housing into one of the rocker box holes until the retainer seats against the box surface. When all twelve housings are in place in the cylinders, push over the open end of each pair a pushrod housing flange (1) with its bolt flange projecting away from the cylinder.

j. Although pushrods may be installed dry, it is preferable to immerse the entire engine set in light mineral oil or castor oil, Specification JJJ-C-86, in a clean pan with one end of each rod slightly elevated to permit air to escape. The hollow pushrods will require some time to fill, hence they should be placed in the oil bath well in advance of completion of the other cylinder assembly work. To install each pair of pushrods, select two in the bath, and plug the elevated end holes with thumbs; then remove them, and, without draining, insert them into the installed pushrod housings of any cylinder. Seat the inner ball ends in the valve rocker sockets.

k. Lubricate the walls of all cylinders copiously with castor oil if final assembly and testing are scheduled immediately, otherwise use corrosion preventive oil mixture.

8-62. PISTONS.

8-63. Place the six pistons upright on the work bench in front of their respective cylinders, according to the position numbers stamped on the rims of their heads. If piston rings were not installed earlier, obtain a new set of rings of the correct part numbers for this engine model and for the standard or oversize status of the cylinder bores. Expand the rings with the fingers or with a standard ring installing tool and lower them into their respective grooves, starting with the center slotted oil control rings in the bottom grooves, then the compression rings in the second and top grooves, respectively. Install all rings with their marked part numbers toward the piston head. (Refer to Section VI for instructions regarding inspection of ring clearances.)

Note

If pistons are not installed in their original cylinders for any reason, or if new pistons are installed, it will be necessary to weigh each piston in the engine set, and to make sure that the difference in weight of the heaviest and lightest does not exceed ½ ounce.

Lubricate pistons and rings copiously with the same lubricant applied to the cylinder bores; then lubricate each

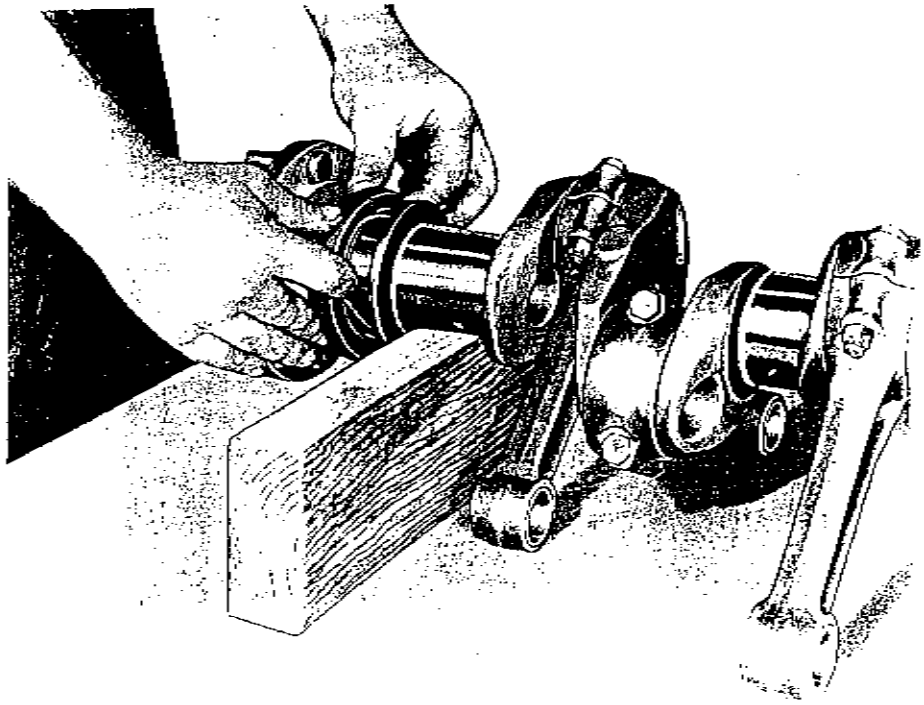
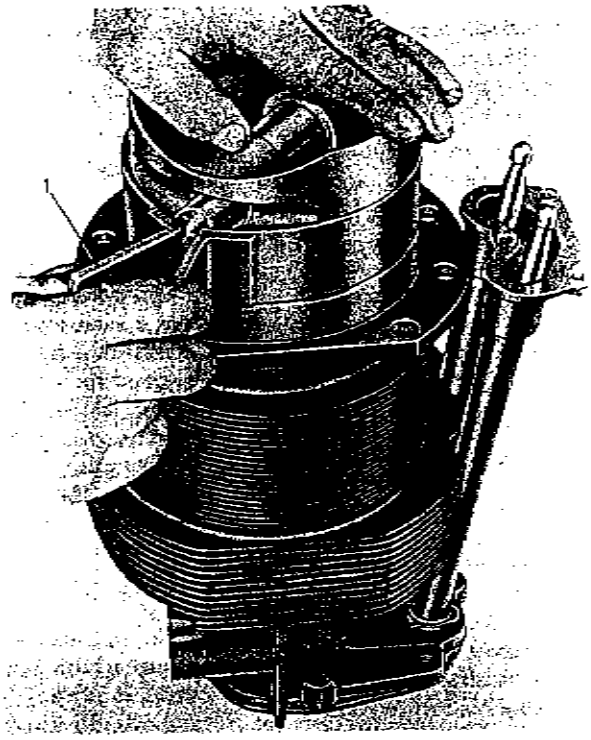


Figure 8-16. Installing Crankshaft Oil Seal Spring



1. No. J-2839 piston ring compressor

Figure 8-17. Installing Piston Assembly in Cylinder

piston pin assembly and insert it into the original piston. Space the ring gaps of each piston so that the oil control ring gap will be downward and the other two ring gaps spaced equally from it (120° apart) when the piston is installed in the cylinder with its part number in the direction which will be toward the flywheel (toward intake port of cylinders No. 1, 3, and 5 and opposite intake ports No. 2, 4 and 6). Starting with No. 1 piston, compress the rings with the piston ring compressor and push the piston into the No. 1 cylinder, which should be held upright, as illustrated in figure 8-17. Push the piston in only until the rings are within the cylinder barrel and the piston pin free to move endwise. Return the cylinder and piston assembly to its original position on the bench. In the same manner, install all other piston and ring assemblies in their respective cylinders.

Note

Pistons are installed in cylinders at this stage in order to facilitate final assembly by eliminating the use of the ring compressor at that stage.

SECTION IX
FINAL ASSEMBLY

9-1. GENERAL INSTRUCTIONS.

9-2. CLEANLINESS. Final assembly operations shall be conducted in such a manner as to exclude, as nearly as possible, all dust and abrasive air-borne particles from the packette interior. Individual parts shall be sprayed with dry cleaning solvent, when necessary, to remove all dust, grit, and gritty films of corrosion preventive oil, and such cleaning shall be followed by complete drying with a jet of dry compressed air. These final cleaning operations shall be carried out immediately prior to final lubrication and installation. Do not clean lubricated subassemblies with any petroleum solvent. Such assemblies must be protected from abrasive particles by suitable covers until they are installed.

9-3. LUBRICATION. Instructions in paragraph 8-4 are applicable to final assembly operations except where special lubricants are mentioned in this section.

9-4. NEW SMALL PARTS REQUIRED. Refer to paragraph 8-6 for a list of type of connecting, attaching and sealing parts which must be new.

9-5. LOCKING DEVICES. Instructions for the correct installation of lockwires, lock washers, nut locks and cotter pins are contained in paragraphs 8-8 through 8-11.

9-6. TIGHTENING TORQUES. The instructions in paragraph 8-13 also apply to tightening of threaded parts during final assembly. In addition, observe the following precautions:

a. Use a torque indicating wrench whose scale includes the torque (in inch lb or its equivalent in ft lb) specified in Section XII, for the specific nut or bolt, or, if no specific tightening torque is listed for that part, use the value specified for general use with the size of thread to be tightened.

b. Tightening torques listed in Section XII are not applicable when thread lubricant is applied to the nut or bolt except when the use of such lubricant is specified in the table for that part and torque.

c. Keep the socket extension used with a torque indicating wrench in line with the bolt or stud to avoid false indications and damage to parts and tools. This precaution is especially important when the cylinder base nut wrench, tool No. J-2882, or any very thin wall socket is employed.

d. Do not jerk a torque indicating wrench. Apply the tightening force steadily until the desired torque is indicated. Do not use a torque indicating wrench to loosen a nut or bolt.

e. If a nut must be backed up to meet alignment requirements or if either a nut or bolt must be backed up to correct excessive tightness, loosen the part with a socket or end wrench; then tighten it with a torque indicating wrench. Do not merely back up the part to the desired position, because tightness cannot be measured in that manner.

9-7. PREPARATION OF ASSEMBLY STAND.

(See figure 9-1.)

9-8. The engine transportation stand, tool No. J-5003, is used to support the engine during final assembly operations described in this section. Clean the drip pans thoroughly so that any parts dropped into them may be retrieved and installed without further cleaning. Locate the four adapter plates along the slotted side rails of the pivoted cradle so that the engine mounting bolt holes are toward the center of the stand sidewise and endwise and spaced as dimensioned in the illustration. Allow space at each end for installation or subassemblies. Install the crankcase front support (2) on the cradle side rails in approximate position and tighten the clamp bolts enough to hold it. The final position of the support will have to be adjusted when the crankcase is mounted. Turn the cradle to the illustrated position. Lock the floor brakes.

9-9. CRANKCASE.

9-10. LEFT CRANKCASE. *(See figure 4-23.)*

a. Attach the left rear mount bracket (62) to the left crankcase (70) with a lock washer and nut (20, 19), keeping the lower through bolt hole in the bracket aligned with that in the case.

b. Mount the left crankcase on the transportation stand as illustrated in figure 9-1, and attach the swivel on the front support jack screw to the long sump adapter attaching stud, using a pipe spacer, a washer and a nut (9, figure 4-17). Clamp the front support firmly to the cradle with its clamp bolts.

c. Run the jack screw in so that the front end of the crankcase will be slightly elevated when assembled and turned upright.

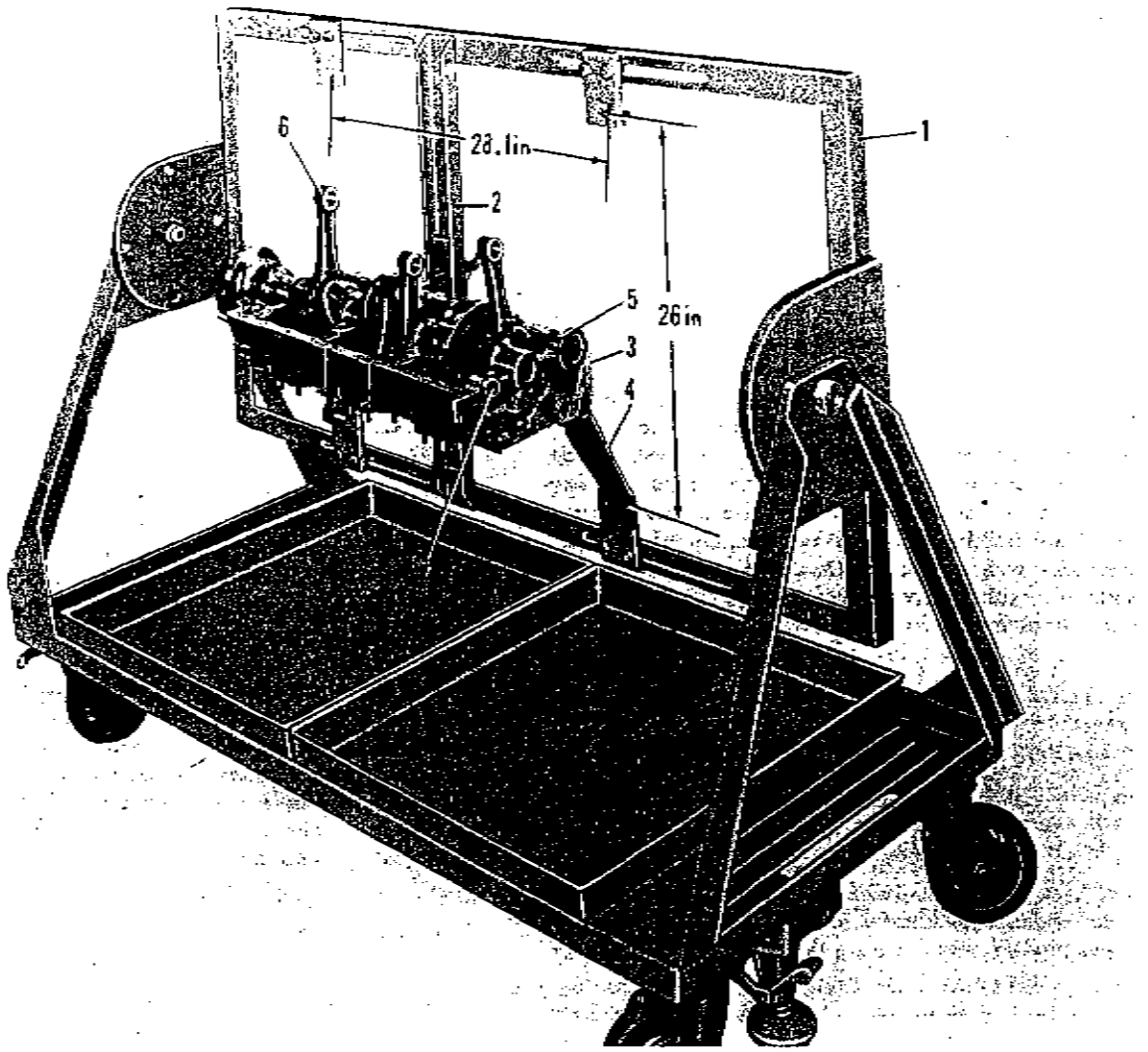
9-11. SHAFTS. *(See figure 9-1.)*

a. Lubricate the exterior surfaces of six hydraulic valve lifters, and install them in the left crankcase guides.

b. Lubricate the camshaft (5), and lay it in the left crankcase bearings. Measure the end clearance at either end of the rear camshaft journal with a thickness gauge, and compare it with limits specified in Section XII.

c. Spread only a film of gasoline and oil resistant grease, MIL-L-6032, in the oil seal counterbore at the front end of each crankcase casting.

d. Lubricate the left crankcase bearings and the crankshaft journals with a heavy coat of corrosion preventive



1. No. J-5003 transportation stand
2. Front crankcase support
3. Left crankcase subassembly
4. Left rear mount bracket
5. Camshaft
6. Crankshaft and connecting rods subassembly
7. Governor drive gear thrust plug

Figure 9-1. Left Crankcase Ready for Installation of Right Crankcase

TABLE XIV. FINAL ASSEMBLY SEQUENCE

Sequence No.	Illustration: Figure No.	Illustration: Index No.	Text Paragraph	Part or Subassembly
1	9-1	3	9-10	Left crankcase
2	9-1	4	9-10	Left rear mount bracket
3	—	—	9-11a	Left side valve lifters
4	9-1	5	9-11b	Camshaft
5	9-1	6	9-11c, d, e	Crankshaft and connecting rods
6	9-2	2, 3	9-12	Crankshaft thrust washers
7	9-2	6	9-13	No. 50 silk thread
8	9-1	7	9-14	Governor drive gear thrust plug
9	8-13	All	9-14	Right crankcase
10	4-23	25	9-14	Crankcase through bolts
11	4-23	*	9-14	Crankcase attaching parts
12	4-23	21	9-14	Right rear mount bracket
13	9-4	1	9-15	Engine lifting eye
14	9-4	2	9-15	Shroud divider
15	9-5	1*	9-16	Accessory drive gear
16	9-5	5*	9-16	Camshaft gear
17	9-6	—	9-18	Cylinders and pistons
18	9-9	2*	9-21	Front oil pressure valve
19	9-9	5*	9-21	Crankcase heater air valve
20	4-19	*	9-25	Inter cylinder baffles
21	9-11	1, 3*	9-27	Intake manifold and tubes
22	9-11	10	9-32	Valve rocker covers
23	9-11	12, 14	9-33	Shroud to rear cylinder baffles
24	9-11	17	9-34	Fan outlet housing and shroud panel
25	9-11	18	9-37	Flexible duct
26	4-18	33	9-39	Shroud top panel
27	4-18	35	9-40	Shroud upper right rear panel
28	4-18	46	9-40	Shroud upper left rear panel
29	—	—	9-42	Accessory case
30	1-1	8	9-43	Oil filter
31	—	—	9-44	Oil filler cap retainer assembly
32	1-2	16	9-45	Governor oil drain adapter
33	4-19	1, 2, 3	9-48	Bottom baffle springs
34	9-13	2	9-50	Oil sump adapter
35	9-13	7, 8	9-52	Shroud lower rear panels
36	9-13	11	9-55	Starter
37	4-12	*	9-56	Starter detent control
38	9-16	5	9-57	Oil cooler sealing strips
39	9-14	1, 2	9-59	Oil pressure gauge engine unit
40	9-14	3, 7*	9-61	Exhaust manifolds
41	9-14	8	9-63	Oil sump subassembly
42	9-15	1, 2, 3*	9-65	Exhaust manifold jackets
43	4-18	11	9-67	Shroud adapters
44	4-18	45	9-67	Webbing seal strips
45	4-12	10	9-69	Starter magnetic switch
46	1-3	13	9-72	Starter power cable
47	9-16	13, 14	9-73	Shroud bottom side panels
48	9-16	3	9-74	Shroud bottom front panel
49	9-16	10, 11	9-76	Shroud shutters
50	9-16	14, 15	9-76	Heater brackets
51	9-16	6*	7-79	Oil cooler
52	9-17	1	9-83	Oil sump thermocouple

*Refer to text for several index numbers.

TABLE XIV. FINAL ASSEMBLY SEQUENCE (Cont)

Sequence No.	Illustration: Figure No.	Illustration: Index No.	Text Paragraph	Part or Subassembly
53	4-10	*	9-84	Engine oil gauge and support
54	9-17	5, 6	9-86	Heater
55	—	—	9-89	Exhaust jacket bracket
56	—	—	9-91	Fuel pump and drive
57	9-18	1-7	9-93	Ignition assembly
58	4-9	11*	9-95	Governor drive subassembly
59	9-19	—	9-98	Flywheel and fan assembly
60	—	—	9-99	Flexible coupling drive half
61	9-21	—	9-100	Magneto
62	—	—	9-105	Spark plugs
63	4-8	4	9-107	Noise filter
64	4-18	4	9-108	Shroud brace rods
65	9-23	1	9-109	Complete fan inlet and gear housing
66	—	—	9-112	Carburetor and fuel hose
67	4-6	All	9-114	Rear exhaust pipes and jackets
68	4-5	25*	9-117	Blower engine
69	4-5	*	9-118	Blower connections
70	9-22	All	9-119	Sump to gear case tube assembly
71	1-2	14	9-122	Preheat and mixing valve
72	1-2	12, 13*	9-124	Carburetor air filter and adapter subassembly
73	9-24	All	9-126	Heater electrical wiring
74	—	—	9-128	Oil pressure engine unit cable
75	—	—	9-130	Shroud detachable panels

*Refer to text for several index numbers.

oil mixture (paragraph 8-4) or with castor oil, Specification JJJ-O-318, if testing will follow assembly immediately.

e. Lift the crankshaft and rods assembly by the No. 1 and 5 rods and lay it in the left crankcase bearings with the crankshaft oil seal (1, figure 9-2) fully seated. Locate the seal split line about 5/8 inch below the case parting surface toward the top flange (near side in figure 9-1).

9-12. CRANKSHAFT THRUST WASHERS. *(See figure 9-2.)*

a. Coat the crankshaft sides of two plain half washers (2) with Gredag No. 44 grease or equivalent, and lay them inside the crankshaft thrust flanges; then rotate them fully into the case recesses.

b. After coating the thrust side with Gredag No. 44 grease, lay a thrust washer and pin assembly (3) on each of the plain half washers, and rotate the complete washers until the pins (4) lie in the crankcase notches. The pins must not project above the parting surface.

c. Push the crankshaft fully back, and use a thickness gauge to measure the end clearance (5). Compare the measured values with limits in Section XII.

9-13. PARTING FLANGE THREAD. *(See figure 9-2.)* Thoroughly clean and dry the parting flanges of both crankcase castings. On the top and bottom flanges of the left crankcase and on the small flange area between the rear main bearing and the governor gear thrust plug recess spread a thin, uniform film of No. 3 Aviation Permatex or equivalent. When it has dried to a tacky consistence, lay on the coated flanges lengths of No. 50 silk thread (6) inside the bolt holes but clear of the edges. The short thread on the rear flange must lie parallel to the plug recess. The thread should overhang at both ends of each flange. Cut it off flush after completion of the crankcase.

9-14. RIGHT CRANKCASE. *(See figure 4-23.)*

a. Lubricate all main and camshaft bearings in the right crankcase. Stand up the No. 1, 3 and 5 connecting rods.

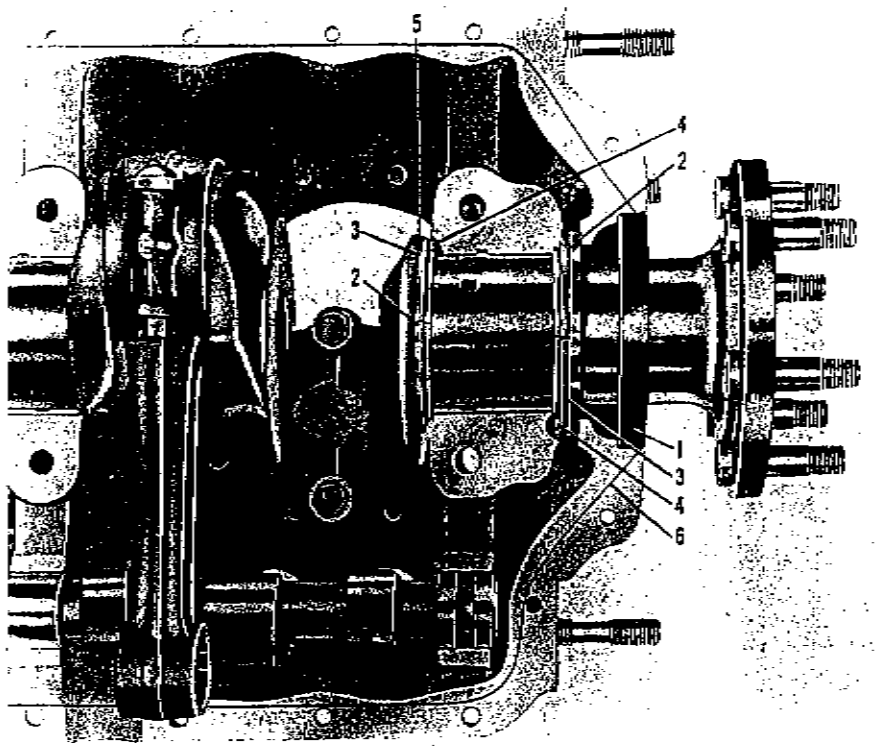
b. Lay a governor gear thrust plug (39) in the recess provided for it in the left crankcase. Its rear face only should be lubricated.

c. Lay the right crankcase subassembly on the left crankcase, guiding its front bearing between the thrust washers.

d. Remove the rubber band retainers from valve lifters.

e. With a rawhide mallet top eight through bolts (25) through the case holes each side of the main bearings until they project equally from both sides. Install one each of the attaching parts (24, 23) on the bottom ends of the rear bolts and on the top ends of the front pair.

f. Install other case attaching parts (26 through 36) in the top and bottom parting flanges, and tighten the



1. Crankshaft oil seal
2. Plain half thrust washer
3. Thrust washer with pin
4. Thrust washer pin in case notch
5. Crankshaft end clearance
6. No. 50 silk thread

Figure 9-2. Installation of Crankshaft Oil Seal and Thrust Washers

nuts evenly to the torques specified in Section XII.

g. Install the right rear mount bracket (21) and attaching parts (20, 19, 18, 17, 16 in that order). With a suitable machine bolt and nut attach the bracket to the stand adapter.

h. Run a hex nut (13) on each end of the mount rod (15) as far as possible, and place over each nut a lock washer (14). Insert the rod into the hole provided for it in the bent up end of either rear mount bracket; then push it through the opposite bracket hole, and place on each end a second lock washer and a second nut. Run the inner and outer nuts against the brackets, and tighten them without deflecting the brackets. (Bracket mounting bolt holes must be spaced 26 in. apart.)

CAUTION

Before turning the engine bed to any other position it is advisable to install short lengths of split rubber hose on the connecting rods or provide some other protection against scuffing and nicking the cylinder hole chamfers. Irregularities in these surfaces may allow oil leakage.

9-15. LIFTING EYE AND SHROUD DIVIDER. *(See figure 9-4.)*

a. Turn the pivoted bed to place the crankcase upright. Observe the operator's position and method of control illustrated in figure 9-3. This method makes it very easy for one man to turn the packette over at any stage of assembly, since the unbalance is very slight at all times.

b. Install the lifting eye (1) with a spacer (12, figure 4-23) between each bolt hole and the case, excepting the front one (4), where the shroud divider bracket takes the place of a spacer.

c. Place the shroud divider (2) in the illustrated position, and install attaching parts (3, 4, 5, 6).

9-16. TIMING GEARS. *(See figure 9-5.)*

a. Tap the accessory drive gear (1) over the crankshaft dowel and firmly against the shaft end with a nonmarring hammer. Attach it with six screws (2), and secure these in two groups of three with lockwires (3), as illustrated. (Refer to torque limit No. T8, Section XII.)

b. Turn the crankshaft until the tooth space between the two timing marks (4) points to the camshaft.

c. Hold the camshaft gear (5) behind and close to its mounting flange on the camshaft with its timing mark (6) aligned as illustrated, and turn the camshaft until all four gear and shaft screw holes are aligned. One of these in each part is unequally spaced so that the two parts can be assembled only in the one correct relation. Install the

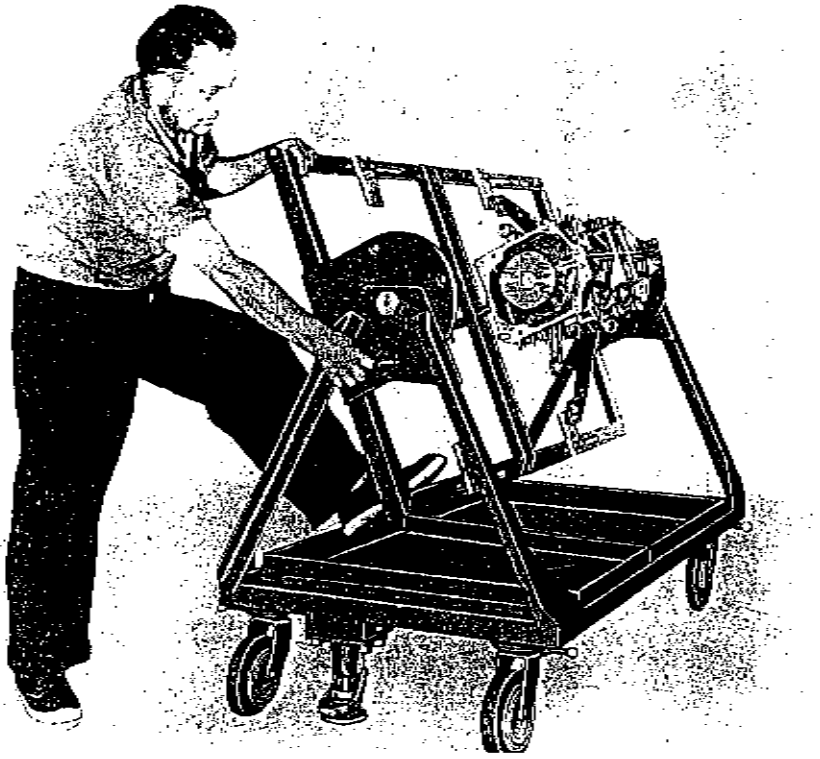
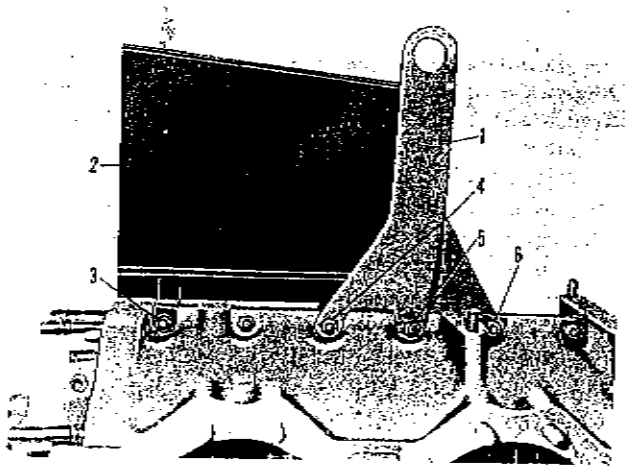


Figure 9-3. Turning Engine Bed



1. Lifting eye
2. Shroud divider
3. Washer and nut
4. Bolt, washer and nut
5. Bolt, two spacers, washer and nut
6. Bolt, spacer, washers and nut

Figure 9-4. Installation of Lifting Eye and Shroud Divider

gear, and attach it with four screws (7), tightened to the torque specified at T9, Section XII. Install two lockwires (8). The end loops must not pass over the screw heads and must be held down as shown in the lower example of figure 8-1.

9-17. CYLINDER AND PISTON SUBASSEMBLIES.

9-18. INSTALLATION. The following instructions assume that all parts, including pushrods, housings and flanges were installed in all cylinders, as described in Section VIII. Install and check these subassemblies as described in the following steps, observing the position numbers stamped on the base flanges. The pistons were installed in their working positions. Do not rotate them.

a. Place six new pushrod housing flange gaskets on the crankcase studs.

b. Turn the crankshaft until the connecting rod for the first cylinder to be installed is at the outer end of its stroke and both of the corresponding valve lifters are at their innermost positions. Remove the protector from that connecting rod.

c. Cradle the first cylinder in the right arm, and push out the piston pin. Dip the pin in corrosion preventive oil. (Use castor oil if testing will follow assembly without delay.)

d. With the left hand lift the proper connecting rod, and move the cylinder inward until the rod bushing is aligned with the piston pin. Push the pin through the rod bushing and the piston to its working position. *(See*

figure 9-6). Push the cylinder inward until its flange is seated, taking care to guide the pushrods into the valve lifters and their housing flange over the three case studs.

e. Immediately after installing each cylinder run eight flanged hex nuts on the six base attaching studs and two through bolts. Tighten nuts on the studs, as described in the following paragraph. Adjust those on the through bolts so that the bolts will project equally from opposite flanges. Tighten only the last nut installed on each through bolt.

f. Install all cylinders in the same manner. The order is optional, since the stand will not tip over due to unbalance. It is important to have no cylinder to the left of the one being installed. The sequence: 2, 5, 4, 3, 6, 1 is suggested.

9-19. ATTACHMENT. *(See figure 9-7.)*

a. Use the cylinder base nut wrench (1) and a torque indicating wrench (2) of at least 500 inch pounds capacity to tighten the cylinder flange attaching nuts. Refer to Limits T4 and T5, Section XII.

Legend for Figure 9-5

1. Accessory drive gear
2. Screw
3. Lockwire
4. Accessory drive gear timing marks
5. Camshaft gear
6. Camshaft gear timing mark
7. Screw
8. Lockwire

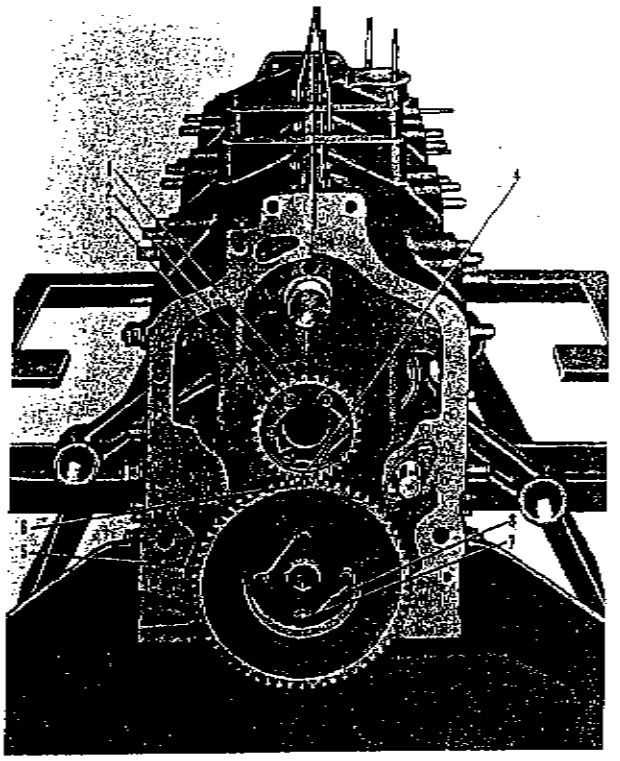


Figure 9-5. Timing Gears

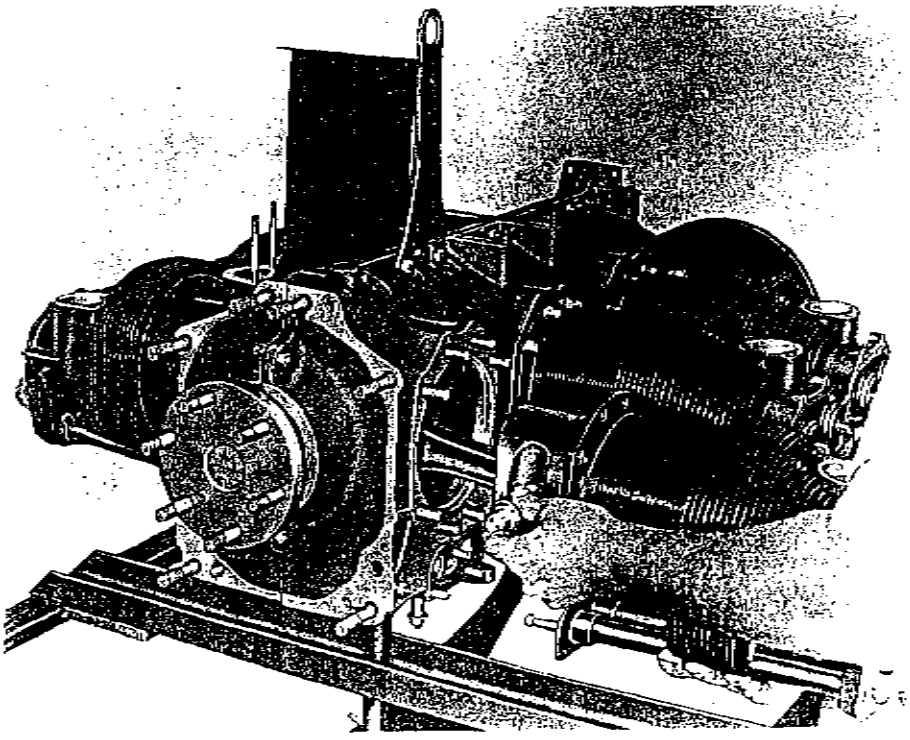
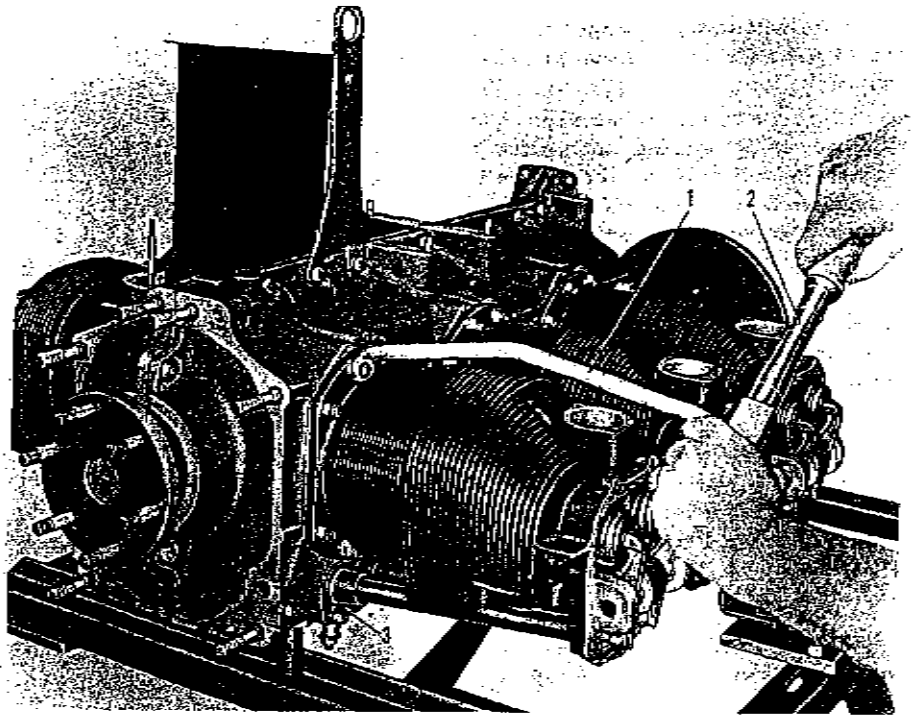
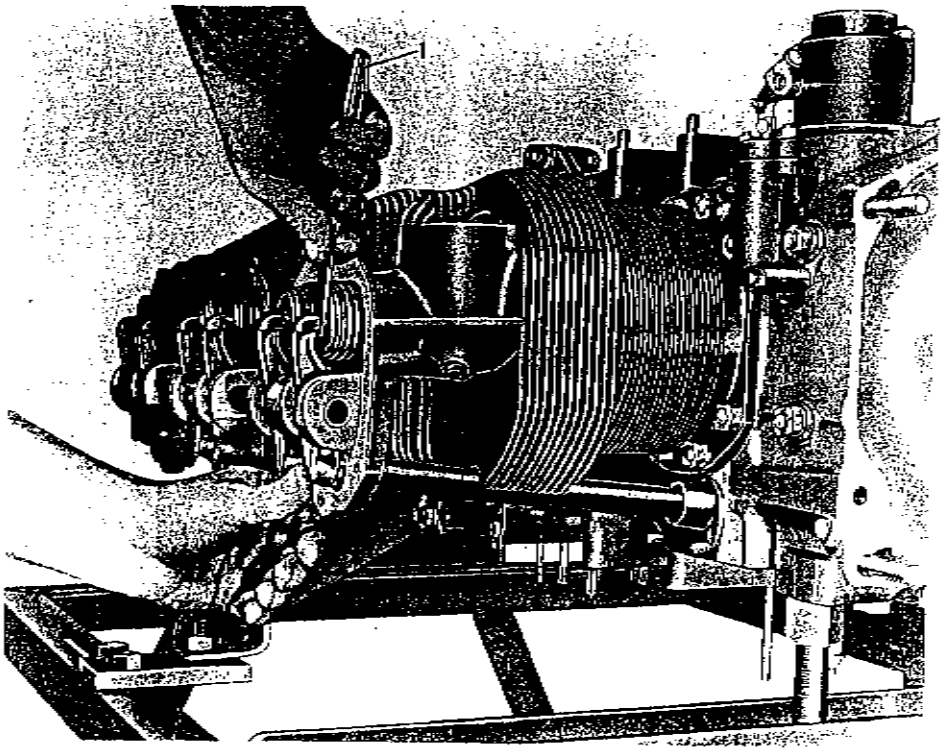


Figure 9-6. Installing Piston and Cylinder Subassembly



1. No. J-2882 cylinder base nut wrench 2. Torque indicating wrench 3. Pushrod housing flange

Figure 9-7. Tightening Cylinder Base Nut



1. Thickness gauge

Figure 9-8. Measuring Dry Valve Lash

b. When all cylinders have been installed and their base nuts tightened, install a nut lock over each base nut. Install nut locks on the right ends of the front through bolts and the left ends of the rear pair.

CAUTION

There must be no enamel or other foreign material on the cylinder base flange nut seats. Disintegration of such material when nuts are tightened will allow them to loosen after operation of the engine and may result in breakage of studs and/or through bolts.

Note

It will be easier to attach the pushrod housing flanges after the packette is inverted at a later stage.

CAUTION

From this stage onward do not turn the pivoted engine bed to any other position until the fan outlet housing has been installed and attached to the cradle. The crankcase stud to which the front support is attached is not considered strong enough to support the weight of more than the crankcase.

9-20. MEASUREMENT OF VALVE LASH. When the hydraulic valve lifters are filled with oil there will be no lash in any valve train unless it is defective, however if the lifters were installed with only exterior lubrication it will be possible to turn the crankshaft until both valves are fully closed and then to measure the lash in each valve train by depressing the rockers and attempting to insert various thickness gauge combinations between the rockers and valve stems. *(See figure 9-8.)* The measured value should be 0.030 to 0.110 inch if all parts of the train are in serviceable condition, however it may exceed the high limit in rare instances.

Screw a set of new or reconditioned spark plugs loosely into all cylinder spark plug holes, or install a set of vent plugs to exclude dust.

9-21. CRANKCASE HEATER AIR VALVE AND OIL PRESSURE VALVE.

9-22. INSTALLATION. *(See figure 9-9.)*

a. Place a new gasket (1) on the pressure valve pad studs ahead of No. 5 cylinder.

b. Slide the remaining oil pressure valve assembly (2) over the two crankcase studs and against the gasket.

c. Attach the pressure valve body with two sets of parts (3).

d. Place a new gasket (4) on the crankcase top pad over the two long vertical studs.

e. Slide the heater air valve subassembly (5) down over the crankcase studs, and see that it seats perfectly on its gasket.

f. Attach the air valve body with two sets of parts (6).

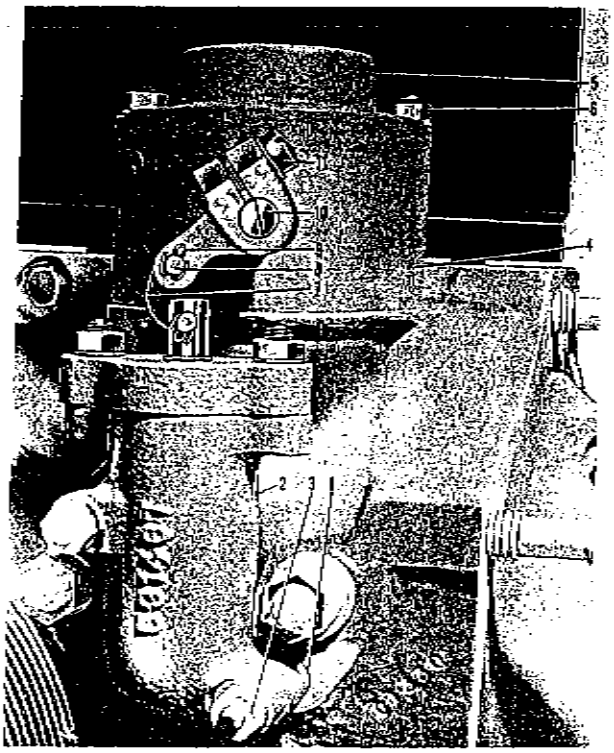
g. Swing the spring link (7) into the air valve lever fork, and align its end loop with the lever pin holes. Install a flat head pin (8), and secure it with a cotter pin (9).

9-23. ADJUSTMENT. *(See figure 9-9.)*

a. If the butterfly valve and shaft cannot be turned easily loosen the lever clamp screw (11).

b. Turn the butterfly valve so that the groove (10) in the end of its shaft (which is aligned with the butterfly) is in the illustrated position—not quite vertical. This adjustment should permit a full 90 degrees of valve movement to the closed position.

c. Tighten the clamp screw (11) with the shaft groove



1. Oil pressure valve gasket
2. Oil pressure valve assembly
3. Washers and nut
4. Gasket
5. Crankcase heater air valve assembly
6. Washers and nut
7. Spring link
8. Pin
9. Cotter pin
10. Groove in end of butterfly valve shaft
11. Screw

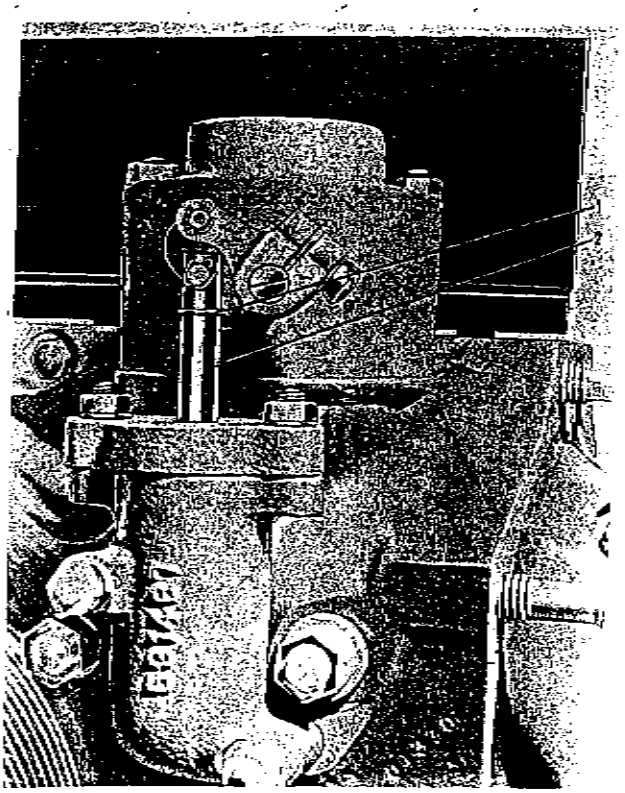
Figure 9-9. Installation and Adjustment of Crankcase Heater Air Valve and Oil Pressure Valve

in the illustrated position. If the pressure valve piston is not fully retracted or has any end play the assembly must be removed and repaired.

9-24. TESTING. *(See figure 9-10.)* Pull up the oil pressure valve piston (2) as far as it will go. Make sure that there is a small clearance between the edge of the piston stem and the air valve lever when the butterfly in the air valve body is fully closed and the piston stem fully extended. (Observe position of air valve shaft groove in illustration.) Return the stem slowly to its home position. If the lever and stem interfered, inspect the spring link for correct arch. If the spring link is deformed, replace it with a new part. If the spring link is satisfactory but allows interference, loosen the lever clamp screw, and turn the butterfly valve slightly counterclockwise; then tighten the screw and repeat the test. The spring link should flex slightly before the piston reaches its highest position.

CAUTION

Do not turn the butterfly or its shaft lever to lift the pressure valve piston. This would stretch the spring link. Adjustment of the lever to correct for an excessively arched spring link can cause the interference mentioned in paragraph 9-24. The function of the spring link is to absorb pressure valve piston travel beyond the point at which it closes the butterfly valve so as to prevent jamming of the elliptical butterfly. Do not scratch or nick the piston stem or distort its retaining ring during this test.



1. Retaining ring
2. Oil pressure valve piston

Figure 9-10. Test for Interference of Oil Pressure Valve Piston

9-25. INTER CYLINDER BAFFLES. *(See figure 4-19.)*

9-26. Slip the four inter barrel baffles (16) down between the fins of adjacent barrels. Connect the adjacent lower ends of the two baffles on each side with short springs (3). These will pass between the barrel fins and the pushrod housings. Connect the tops of the two baffles on each side with short springs (15). Install between each two adjacent cylinder heads an upper and a lower head baffle (18) and a long spring (17). First insert all of the springs between cylinder heads with the shorter helix of each above the fins; then hold a head baffle below any of the springs and insert a long, stiff wire hook through its larger spring hole (center flat side). Hook the bottom spring loop. Slide the head baffle up into position with its inner flange next to the end of the inter barrel baffle. (Head baffles do not span all head fins. Keep their flanges parallel.) Pull the spring loop through, and hook it into the smaller baffle hole; then remove the hook carefully. Engage the upper loop of the same spring with the wire hook; then slide a second inter head baffle down over the wire (through large hole), and seat it directly above the lower one. Pull the spring end loop through the upper baffle hole, and hook it into the small hole; then unhook the wire. Join adjacent upper inter head baffles with short springs (15). Attach shroud to rear cylinder baffles (6, 8) to inter cylinder and inter head baffles with springs (4, 5) where illustrated.

9-27. INDUCTION SYSTEM. *(See figure 9-11.)*

9-28. INTAKE MANIFOLD. Place the manifold assembly (1) on the studded crankcase pads, as illustrated, and attach it with four sets of parts (2).

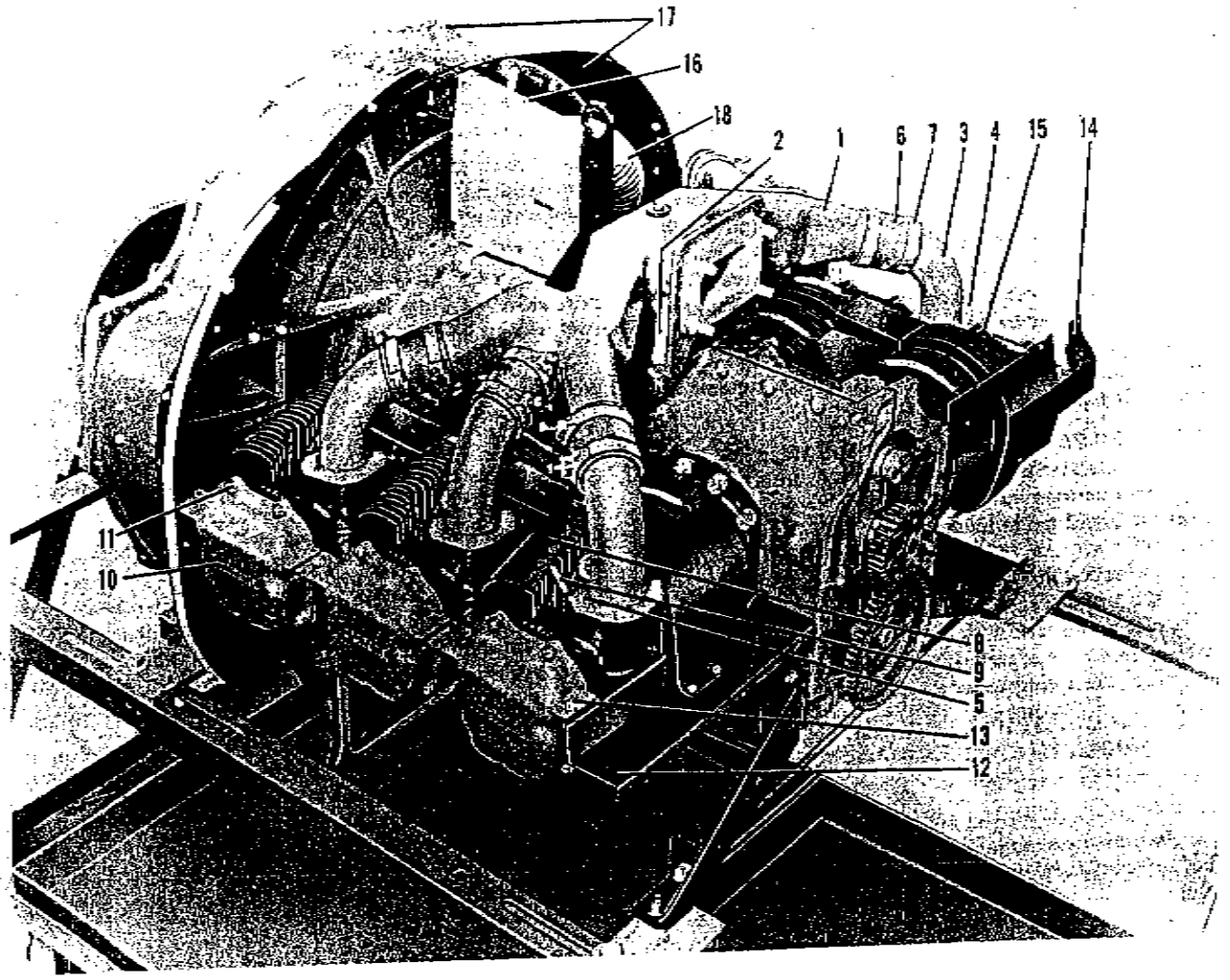
9-29. INTAKE TUBES.

a. Push the hose connectors (6) on the intake tube subassemblies (3) back over the tubes until they will clear the manifold.

b. Set each intake tube, in turn, straight downward on a cylinder intake port so that the unpainted tube end enters and the aluminum flange can be pushed almost into contact. Align the tube and manifold outlet.

c. Attach each intake tube flange with two sets of parts (4, 5) excepting the tab washers which are installed only at the two pistons indicated.

d. Push the hose connectors (6) over the manifold outlets until they cover an equal tube length at each end. Tighten their hose clamps (7) in the illustrated positions so that they will not project above the hoses.



1. Intake manifold
2. Washer, lock washer and nut
3. Intake tube assembly
4. Screw, lock washer, tab washer and plain washer
5. Screw, lock washer, tab washer and plain washer
6. Intake tube hose connector
7. Hose clamp
8. No. 2 cylinder exhaust side head baffle
9. Spring
10. Valve rocker cover
11. Screw, lock washer and plain washer
12. Shroud to No. 2 cylinder baffle assembly
13. Screw, washer and speed nut
14. Shroud to No. 1 cylinder baffle assembly
15. Spring
16. Cage lock nut
17. Fan outlet housing and shroud front panel assembly
18. Duct

Figure 9-11. Induction System, Valve Rocker Covers and Fan Outlet Housing Installed

9-30. CYLINDER BAFFLES AND VALVE ROCKER COVERS. *(See figure 9-11.)*

9-31. HEAD BAFFLE. Slide the No. 2 cylinder head baffle (8) between fins of No. 2 and 4 cylinders to the illustrated position, and attach it to the tab washer (5) with a short spring (9).

9-32. VALVE ROCKER COVERS. Install a new gasket and a rocker cover (10) on each cylinder head, and attach each with seven sets of parts (11). The covers installed on No. 2 and No. 5 cylinders, at least, must have holes in the horizontal baffle flanges (short end) to accept shroud to cylinder baffle tab attaching screws (13). Tighten the seven screws around each cover in several steps until a uniform torque within limits specified in Section XII has been applied to each.

9-33. SHROUD TO REAR CYLINDER BAFFLES. Attach the rear baffle assemblies (12 and 14) to inter cylinder baffles with springs indicated in figure 4-19. Attach the shroud to No. 2 baffle to the valve rocker cover with a screw and speed nut (13). Connect the head baffle piece on the shroud to No. 1 cylinder baffle to the tab washer at Index No. 4 with a short spring (15) if desired, however the washer and attaching screw will have to be removed later to connect the preheat and mixing valve support tube, hence the spring need not be installed at this stage.

9-34. FAN OUTLET HOUSING AND SHROUD PANEL.

9-35. INSTALLATION.

a. Two men, one on each side, can lift the subassembly onto the crankcase studs just as it was lifted off (figure 4-20). The crankcase and outlet housing parting flanges must be absolutely clean and dry and free of nicks so that they will fit together perfectly, otherwise the housing will be misaligned. Before installing the subassembly, check it for completeness, including all parts illustrated in figure 8-7.

b. Attach the outlet housing to seven crankcase studs with washers, lock washers and nuts. Tighten the nuts around the circle in steps until all have been subjected to a torque within the limits specified in Section XII.

c. Back out the jack screw in the crankcase front support until the outlet housing mounting bosses rest on the two stand adapters.

d. Install two washers, machine bolts and nuts to attach the outlet housing to the stand adapters.

Note

It will be easier to remove the crankcase support after the packette is inverted.

9-36. BAFFLES. *(See figure 4-19.)* With springs (2, 3, 11) connect the shroud to front cylinder baffles to the forward inter head and inter barrel baffles, first the bottom ends, then the upper parts, as illustrated. Attach the tab on the shroud to No. 5 cylinder baffle to the valve rocker cover with parts as indicated at index No. 13, figure 9-11.

9-37. CRANKCASE HEAT OUTLET DUCT. If the original hose clamps are serviceable, install one on each end of a flexible duct (18, figure 9-11). Position the clamp screws for accessibility, and push one end of the duct over the heat outlet valve body. Tighten the clamp screw; then bend the duct down, and clamp its other end over the collar on top of the shroud to No. 5 cylinder baffle. If new clamps must be installed refer to figure 9-12 for instructions.

9-38. SHROUD TOP AND UPPER REAR PANELS. *(See figure 4-18.)*

9-39. TOP PANEL AND ACCESS DOORS ASSEMBLY.

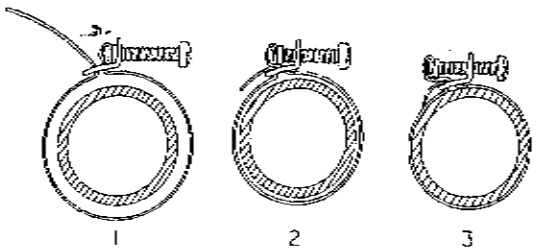
a. Push three cage type lock nuts (30) over the top flange of the shroud divider (56) so that their retaining lips engage the screw holes and thread inserts are downward.

b. Lower the top panel and access doors assembly onto the packette, and slide forward so that the rear studs and mount pad of the intake manifold pass through the opening in the front end of the depressed center portion of the top panel. A slot in the top panel will then fit over the lifting eye, allowing the front end of the panel to rest on the narrow flange around the front panel.

c. Attach the top panel to the intake manifold rear side with four screws and washers (31, 32).

d. Attach the top panel to the shroud divider cage nuts with three screws and lock washers (29, 26).

e. Equip two nut strips (27) with cage type lock nuts (28), and hold each strip in position under the front panel top flange to cover half of the top panel screw holes while screws and lock washers (25, 26) are installed. (Thread inserts on all cage nuts must be on bottom side.)



1. Loop clamp around jacket or duct. Insert strap through slot in clamp bracket.
2. Pull clamp strap snug; bend back sharply, and cut off about ½ inch from bracket. Bend strap end down firmly.
3. Tighten clamp screw moderately to seal joint.

Figure 9-12. Installation of Wraplock Hose Clamp

9-40. UPPER REAR PANELS. Equip two angular nut strips (21, 22) and two curved strips (23) with cage type lock nuts (24), with the threaded inserts on the sides which will be forward. The upper left rear shroud panel should be equipped with a screen (38) and felt ring (1) already. The upper right rear panel should be equipped with a grommet (34); if not, install one in the hole for the mixing valve support tube. Both panels should be equipped with hook angles (43); if not, attach one to each panel with two sets of parts (39 through 42). Attach the upper rear panels, in turn, to the top panel with one angular and one curved nut strip and eight screws and washers (19, 20) each; then attach the panels to the shroud to rear cylinder baffles (49, 53) with screws and speed nuts (15, 16). If weatherstrip webbing (45) was removed from the outturned flanges of the upper rear panels it should not be replaced until the adapters (11) are installed at a later stage.

9-41. ACCESSORY CASE.

9-42. INSTALLATION.

a. Coat a new accessory case gasket with a film of gasoline and oil resistant grease, MIL-L-6032. Stick it to the crankcase rear flange. See that the gasket fits properly over the two dowels and that screw holes and oil gallery holes align. The gasket should adhere all around.

b. Turn the oil pump driving square in the accessory case assembly until it will align with the squared hole in the camshaft gear when the case is installed.

c. Lubricate the timing gears, pump drive square and magneto gear supports.

d. Lift the case assembly into position, holding the top slightly to the rear until its lower front wall passes up between the camshaft gear and the case gasket; then push the pump square into mesh with the gear hole and the case over the crankshaft dowels. Make sure that the gasket is not displaced at the bottom.

e. Install a bolt and washers in the accessory case bolt hole above the right magneto mount pad. Install two screws with tab washers in the accessory case interior attaching bolt holes near the magneto drive gear support and opposite. Washer tabs should fit inward beside the edge of the accessory case flange. Do not tighten these parts fully.

f. Invert the engine bed (to position shown in figure 9-13), and remove the crankcase front support.

g. Install the short screw and the three longer screws (1, figure 9-13) in the bottom crankcase and accessory case screw holes. Tighten in steps these, the inside screws and the long bolt at the rear. Bend up the twin tabs of the inside tab washers against the screw heads.

9-43. OIL FILTER. Place a new copper-asbestos gasket on a serviceable oil filter, and screw the latter into its housing at the rear of the accessory case. Tighten the filter cap, and secure it to the housing lug with lockwire.

9-44. OIL FILLER CAP RETAINER ASSEMBLY. Place the cap on the end of the oil filler neck of the accessory case, and lock it with a twist to the right. If the cap does not lock securely replace it with a serviceable part. Snap the cap retaining (wire) ring around the filler neck.

9-45. GOVERNOR DRAIN ADAPTER. Place a new gasket and an adapter and pipe plug assembly (16, figure 1-2) on the left accessory pad studs, and attach with plain and internal tooth lock washers and plain hex nuts.

9-46. PUSHROD HOUSING FLANGES. *(See figure 9-13.)*

9-47. Attach each of the six flanges with three sets of parts (1).

9-48. BOTTOM BAFFLE SPRINGS. *(See figure 4-19.)*

9-49. Connect the unattached bottom ends of inter barrel baffles and the unattached ends of lower inter head baffles with springs (1 and 3). The former pass under the pushrod housings and the latter springs above them.

9-50. OIL SUMP ADAPTER. *(See figure 9-13.)*

9-51. INSTALLATION.

a. Coat a new sump adapter gasket of each type (16, 17 and 18, figure 4-16) with only a film of gasoline and oil resistant grease, MIL-L-6032, and place them on the crankcase bottom pads—now on top.

CAUTION

Make sure that the oil passage hole of the rear gasket is located in register with the case oil hole for the relief valve.

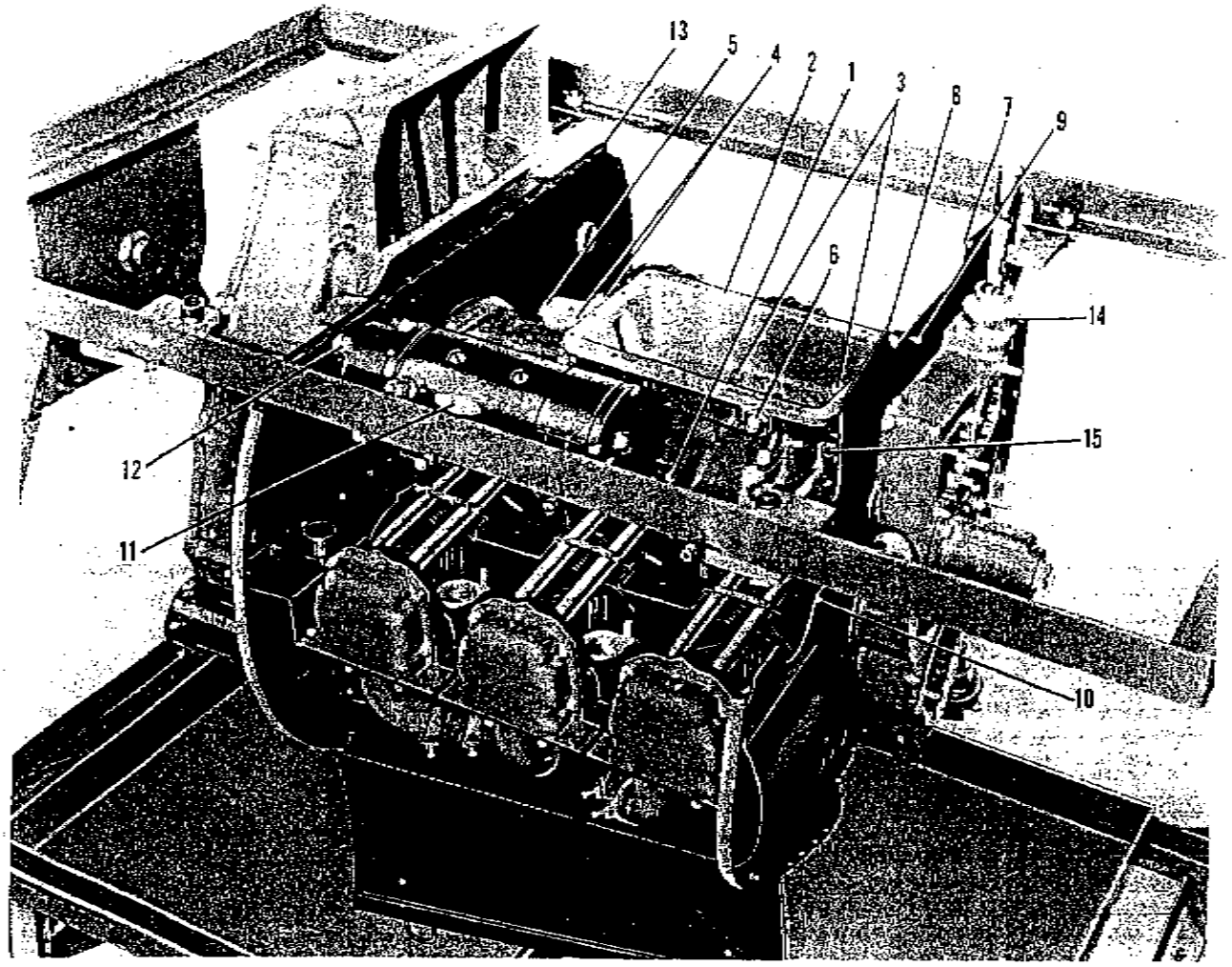
b. Place the sump adapter subassembly (2) on the pad gaskets, and attach it with four sets of parts (3), six sets of parts (4) at the front and sides and two sets of nuts and washers at the rear. Tighten all nuts evenly in several steps to final torques within limits in Section XII before installing cotter pins on the studs inside the adapter cavity.

c. Tighten the square head plug (5) at the front end of the adapter, and secure it with lockwire anchored to the nearest attaching nut.

d. Tighten the oil pressure relief valve cap (6) and install lockwire to anchor it to the crankcase through bolt immediately below.

9-52. SHROUD LOWER REAR PANELS. *(See figure 9-13.)*

9-53. Install cage lock nuts (13, 15) where illustrated on the front panel and on each lower rear panel. Also install the same type of nut on the overlapping edge of the left lower rear panel (7) to receive the screw (9) and on the outside vertical edge (3 required) and top edge (1 required) of each lower rear panel. Notice that screw holes are enlarged (0.34 in. dia) wherever this type of cage nut is required. Make sure to push each cage nut inward until its retaining lip fits into the screw hole so as to align the tapped hole with the corresponding screw hole in the panel to be attached later. The tapped part must always be toward the interior of the shroud. Place the two lower rear panels in position, and install one set of attaching parts (9) at the overlapping edge.



1. Washer, lock washer and nut
2. Oil sump adapter subassembly
3. Washer, nut and cotter pin
4. Washer, lock washer and nut
5. Plug
6. Oil pressure relief valve cap
7. Shroud lower left rear panel
8. Shroud lower right rear panel
9. Lock washer and screw
10. Lock washer and screw
11. Starter
12. Lock washer and nut
13. Cage lock nut
14. Oil drain tube connection plate and packing
15. Cage lock nut

Figure 9-13. Oil Sump Adapter, Starter and Shroud Lower Rear Panels Installed

9-54. STARTER AND DETENT CONTROL.

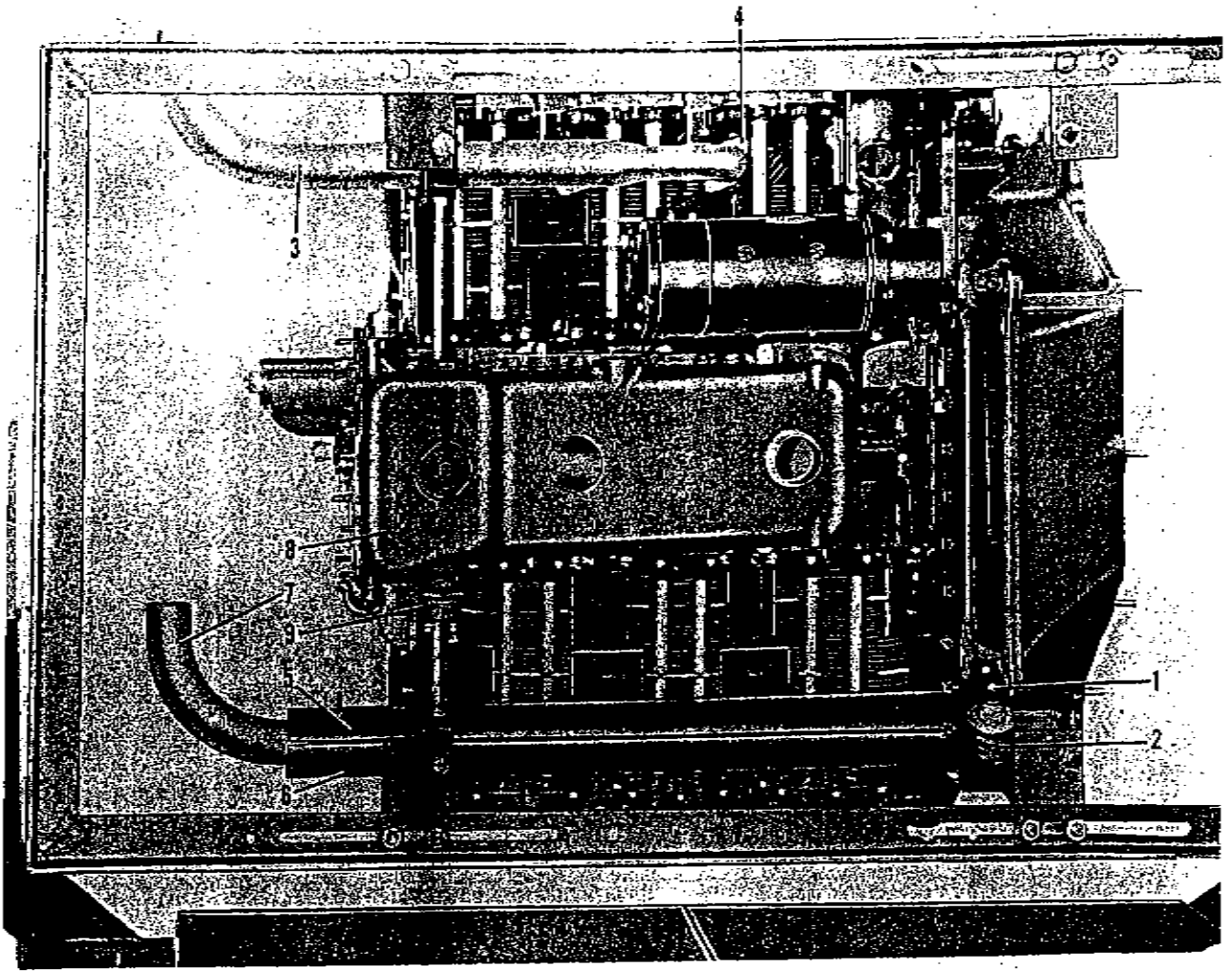
9-55. STARTER.

a. Lower the starter to a position in line with its pilot bore in the fan outlet housing and with the cutout in its pinion housing facing the flywheel ring gear. Slide the Bendix pinion housing through the pilot bore and the flange over the fan housing studs. Attach the starter flange with three sets of parts (12, figure 9-13).

9-56. DETENT CONTROL. *(See figure 4-12.)* Screw the support (8) into the fan outlet housing tapped hole ahead of No. 5 cylinder. Align its slot parallel to the shroud front panel. Push a retaining ring (7) into the groove in the detent pin (5). Attach the pin to the lever (4) with a flat head pin (3) and a cotter pin (1). Slide the spring (6) over the detent pin, and insert the pin into the plain fan housing hole. Insert the lever hub into the support slot, and attach it with a second flat head pin (2) and a cotter pin. Check the lever operation to make sure that it will turn the starter pinion through a small angle. If it does not the support must be screwed in further.

9-57. OIL COOLER SEALING STRIPS.

9-58. Pull the protective fabric from the adhesive coated surface of each strip just before pressing the sponge rubber part in place, either on the cooler mounting flange of the fan outlet housing or on the mounting face of the



1. Street elbow
2. Oil pressure gauge engine unit
3. Right exhaust manifold (cyl. 1, 3, 5)
4. Brass hex nut
5. Left inner exhaust manifold jacket
6. Left outer exhaust manifold jacket
7. Left exhaust manifold (cyl. 2, 4, 6)
8. Oil sump subassembly
9. Hour meter pressure switch

Figure 9-14. Oil Sump, Exhaust Manifolds and Pressure Gauge Unit Installed

oil cooler. Notice that the top strip is shorter than the bottom strip (5, figure 9-16). If pressed on the outlet housing, their positions must be just right to fit between the headers, and the end strips must fit against the edges of the headers between mount pads. It will probably be found easier to press these seal strips onto the cooler for that reason.

9-59. OIL PRESSURE GAUGE ENGINE UNIT. *(See figure 9-14.)*

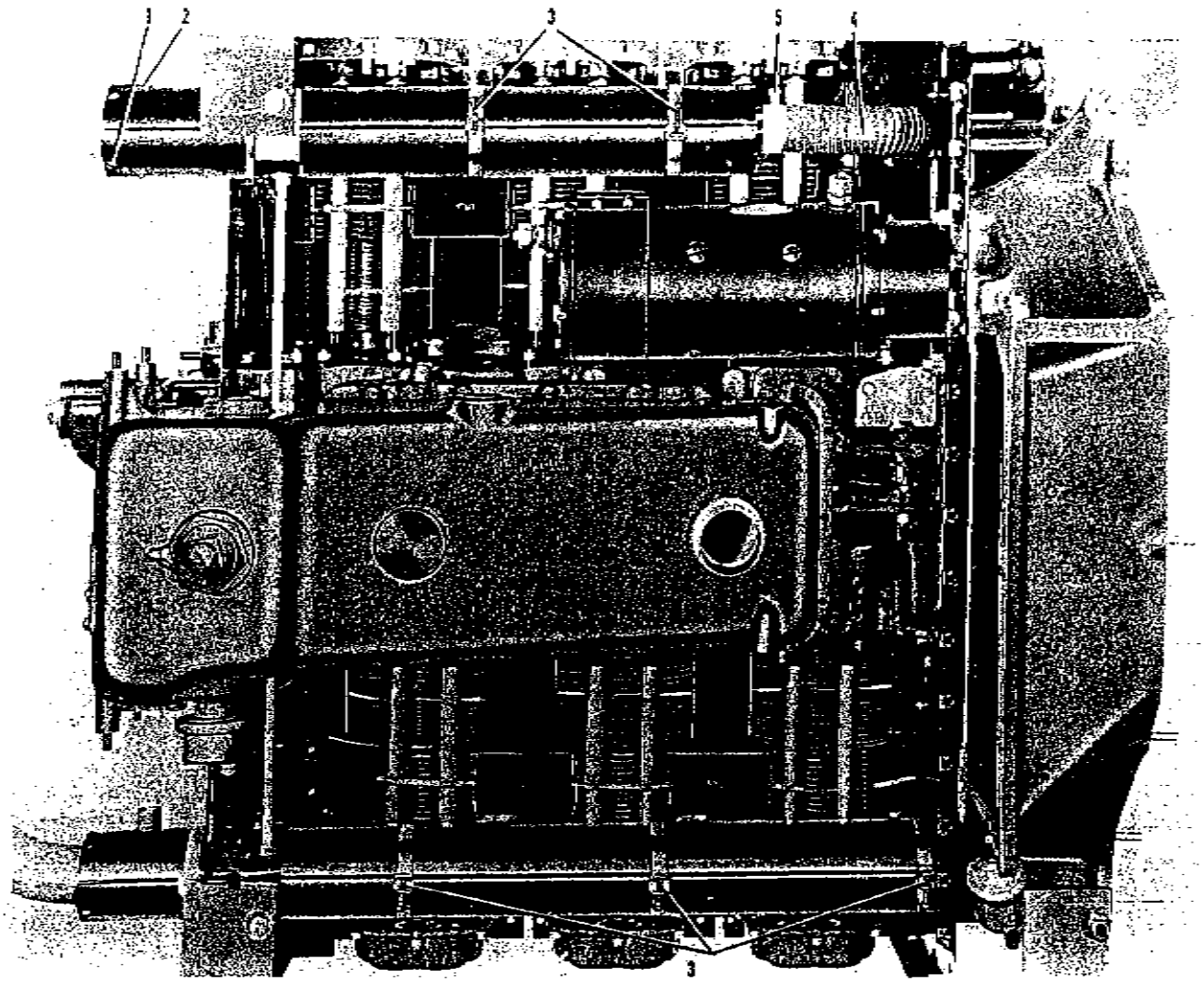
9-60. Spread only a film of anti-seize compound, MIL-T-5544, on the male pipe threads of a street elbow (1) and a serviceable oil pressure gauge unit (2). Tighten the elbow to the illustrated position; then screw the gauge unit into its female thread, and tighten it.

Note

The opposite 1/4 in. pipe tapped hole in the outlet housing must be plugged.

9-61. EXHAUST MANIFOLDS. *(See figure 9-14.)*

9-62. Place six new copper-asbestos gaskets on the cylinder exhaust flange studs. Lay the inlet flanges of the right manifold (3) on the gaskets, and run on the cylinder studs six brass hex nuts (4). Place the two halves of the left manifold jacket (5, 6) on the manifold, and place the assembly in position on the No. 2, 4 and 6 cylinder gaskets. Attach it the same as the other manifold. Tighten all attaching nuts with the same torque. Do not tighten enough to warp the manifold flanges and cause exhaust leakage.



1. Right inner exhaust manifold jacket
2. Right outer exhaust manifold jacket
3. Hose clamp
4. Flexible duct
5. Hose clamp

Figure 9-15. Exhaust Manifold Jackets Installed

9-63. OIL SUMP SUBASSEMBLY.

9-64. Ascertain that a new packing has been installed in the bore groove of the oil drain connection plate (14, figure 9-13); then lubricate it with a film of gasoline and oil resistant grease, and push the assembly down over the accessory case oil drain tube, as illustrated, with the machined face of the plate upward. Place a new gasket on the plate. Spread a film of the same grease on both faces of a new oil sump gasket, and work it well into the material. Press the treated gasket onto the upper flange of the oil sump subassembly over the attaching studs. Invert the sump, and lower it over the oil pump suction tube in the accessory case to seated position on the sump adapter, holding it level as illustrated in figure 4-15. Attach the sump with 14 sets of plain washers, internal tooth lock washers and plain hex nuts. Tighten these progressively around the flange in several stages until correct torque has been applied to all of them. Push the oil drain connection plate up over the two studs in the rear flat of the sump, and attach it with the same kind of parts installed on the sump attaching studs. Install the thermoswitch (9, figure 9-14) and tighten it and the plugs installed during subassembly work.

9-65. EXHAUST MANIFOLD JACKETS.

(See figure 9-15.)

9-66. Place the right side inner jacket (1) in position on the manifold. Rotate this jacket piece downward to assist in placing the outer jacket (2) in its position. The outer jacket will have to be forced into the rear shroud panel cutout and the pair turned back to the illustrated position to fit properly together. Install four hose clamps (3) on the left side jacket and two on the right jacket. *(See figure 9-12 for procedure.)* Push a flexible duct (4) over

the front collar of the right side jacket, and secure it with a clamp (5); then attach it in the same manner to the collar on the shroud No. 5 cylinder baffle.

9-67. SHROUD ADAPTERS AND WEBBING. *(See figure 4-18.)*

9-68. Install one cage lock nut (12) where illustrated and at the corresponding hole in the opposite adapter. The threaded inserts must be toward the interior of the shroud. Install the adapters with their upper edges under the offset bottom edges of the upper rear panels. Attach the right adapter and the lower rear panel next to it with a total of five sets of parts (9, 10, 13, 14). When attaching the left adapter, omit one screw (2, figure 4-10). Before tightening the screws, align the outermost holes where the adapters and upper rear panels overlap (for screws at index No. 5). Attach a webbing strip (45) with split rivets (44) if the original strips were removed. Hold the new strips in position, and drill rivet holes through webbing and panel flange, starting near the top and installing a rivet after each hole is drilled. The strips will extend to a point near the bottom of each adapter but will clear both the top panel and (when installed) the bottom side panel. Install a brace angle and attaching parts (5, 6, 7) on each side, with the unattached flange of the angle next to the flange on which the webbing was installed. In one remaining screw hole of each adapter install a sheet metal screw (8), which will pass through a hole in the rear mount bracket, and a speed nut (same as index No. 6).

9-69. STARTER MAGNETIC SWITCH. *(See figure 4-12.)*

9-70. Attach the Delco-Remy magnetic switch (10) in the illustrated position on the fan outlet housing with four sets of parts (9).

9-71. SHROUD BOTTOM PANELS, STARTER CABLES AND SHUTTERS. *(See figure 9-16.)*

9-72. STARTER POWER CABLE. The terminal lug with a 1/2 inch diameter hole is to be installed on the terminal stud at the side of the starter coil housing. This cable assembly is 17 inches long between terminal lug holes. From the front side of the shroud front panel insert the proper terminal through a grommet installed in the cable hole below the cylinder baffle, and connect it to the starter stud with a spring lock washer and brass terminal nut. Connect the other terminal lug to the lower terminal of the magnetic switch on the fan outlet housing with the screw on the bottom of the switch housing. *(See figure 1-3.)*

9-73. SHROUD BOTTOM SIDE PANELS. Before installing these panels, push a speed nut on the clip angle at each end of each panel to receive screws which will attach it to the front and rear panels, and in the four holes of each side panel to which the bottom front panel will be attached install cage lock nuts with threaded inserts to inside of shroud. The rear end of each panel is notched to clear the rear mount bracket. Slide the notched end of each under a mount bracket so that the front ends rest on the shroud front panel bottom flange. Attach each to the front panel with screws and lock washers and to the lower rear panels with parts of the same kinds; then attach the clip angle speed nuts to front and rear panels with hex head shroud attaching screws. It is advisable to install all of these screws before tightening any of them.

9-74. SHROUD BOTTOM FRONT PANEL. Lay the "L" shaped panel in place with the cutout at the front of the oil sump, and attach it to the flange there with three screws inserted from the panel side and secured by speed nuts on top of the sump flange. Leave these loose until 10 screws and lock washers have been installed through holes at the front end and run into cage nuts on the front panel and eight sets of identical parts have been installed in the holes at each side and run into cage nuts on the bottom side panels. After all of these have been installed, tighten them.

9-75. STARTER GROUND CABLE. Push one terminal lug through a grommet installed in the cable hole near the right end of the vertical leg of the bottom front shroud panel, and attach it with a lock washer and brass hex nut to the terminal stud at the rear end of the starter coil housing.

9-76. SHROUD SHUTTERS. If the shutter control rod was installed and adjusted as described in paragraph 8-40 and figure 8-9 it will be attached to the left shutter assembly. Install this assembly (11) where shown and the other shutter (10) on the opposite side of the sump. Install attaching parts (12) to hold each shutter loosely to the sump; then install shutter to shroud panel attaching parts (15) at outer sides and both ends (to make alignment easier) before tightening the screws. Hold a spring clip over the right shutter operating plate in line with the rod hole, and insert the control rod bent end through both parts; then snap the spring legs of the clip down over the rod. If the rod was correctly adjusted at assembly the blades of both shutters should assume the same angle, and both should be nearly wide open at room temperature.

9-77. HEATER BRACKETS. *(See figure 9-16.)*

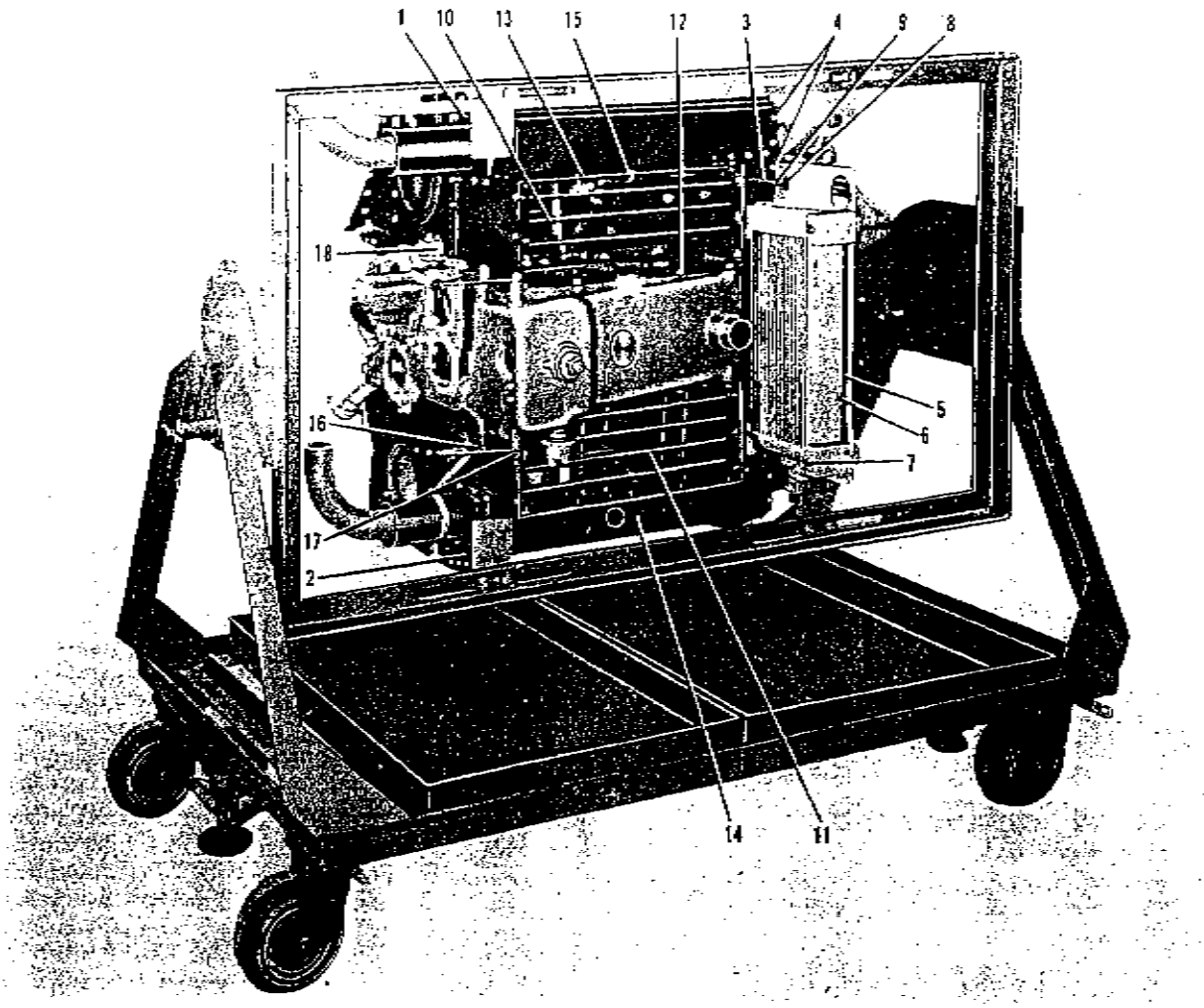
9-78. Attach two mounting brackets (16) for the heater to side studs at the rear of the oil sump, each with two sets of parts (17).

9-79. OIL COOLER. *(See figure 9-16.)*

9-80. Install six sets of attaching bolts and washers (7) in the header holes of the oil cooler, with bolt heads on the side opposite the end flanges. Place new gaskets on the attaching bolt ends, and install the cooler on the fan outlet housing, making sure that the gaskets and sealing strips (5) are not displaced in the process. Tighten the attaching bolts to specified torque. Install a grommet (8) in the cooler right end flange cable hole. Pass the unattached terminal lug of the starter ground cable through the grommet, and secure it with lockwire. *(See figure 1-3.)*

9-81. ENGINE OIL GAUGE, THERMOCOUPLE AND PRESSURE SWITCH.

9-82. PREPARATION. Invert the pivoted engine bed to place the packette upright.



1. Shroud right rear panel adapter
2. Shroud left rear panel adapter
3. Shroud bottom front panel
4. Screw and lock washer
5. Adhesive rubber seal strip
6. Oil cooler
7. Bolt, lock washer and plain washer
8. Grommet
9. Starter ground cable
10. Right shroud shutter
11. Left shroud shutter and control rod assembly
12. Bolt and lock washer
13. Shroud right bottom side panel
14. Shroud left bottom side panel assembly
15. Screw and speed nut
16. Heater bracket
17. Lock washer and nut
18. Oil pressure switch

Figure 9-16. Bottom View of Packette with Shroud Bottom Panels, Oil Cooler, Shutters and Heater Brackets Installed

9-83. THERMOCOUPLE. Screw the thermocouple (1, figure 9-17) into the left hand one of two 1/8 inch pipe tapped holes at the rear of the oil sump, and tighten it. See that a pipe plug is tightly installed in the adjacent hole.

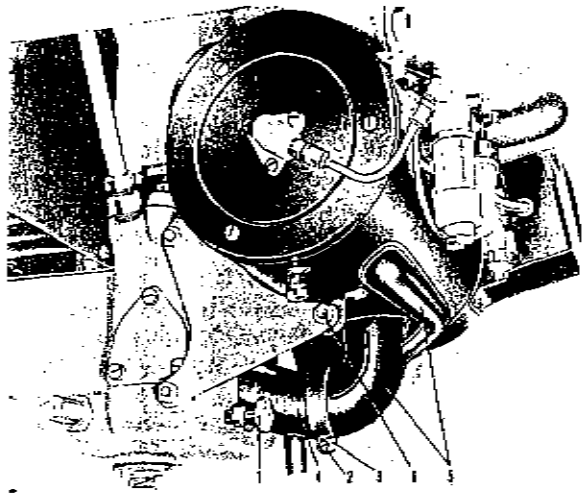
9-84. ENGINE OIL GAUGE. *(See figure 4-10.)* Screw the coupling nut on the support tube (5) into the sump connector (4) tightly, holding the tube bent end parallel to the shroud panel. Attach the support bracket (3) to the shroud panel with parts (2). Insert the bayonet oil gauge and circlip assembly (1) into the support as far as it will go.

9-85. HOUR METER PRESSURE SWITCH. Screw a pressure switch (18, figure 9-16) into the hole in the right side of the accessory case about level with the oil filter housing, and tighten it.

9-86. HEATER. *(See figure 9-17.)*

9-87. HEATER TO SUMP TUBE. Assemble parts of the clamp (2, 3) on the tube (4), and push the tube over the exhaust outlet elbow at the bottom of a new or rebuilt unit (5).

9-88. INSTALLATION. Install the heater and tube assembly in the illustrated position, with the tube fully



1. Oil sump thermocouple
2. Screw, lock washer and nut
3. Clamp
4. Heater to sump tube assembly
5. Heater
6. Screw, lock washer and nut

Figure 9-17. Thermocouple and Heater Installed

entering the sump heat exchanger passage, and attach the four brackets on the heater housing to the two brackets attached to the oil sump with four sets of parts (6). Tighten the heater to sump tube clamp screw (2).

9-89. EXHAUST MANIFOLD TO ACCESSORY CASE BRACKET.

9-90. Attach a new gasket and the bracket assembly to four studs around the accessory mount pad in the lower right corner at the rear side of the accessory case. The projecting arm of the assembly must be vertical and its outer end slightly higher than the mounting plate.

9-91. FUEL PUMP AND DRIVE SUBASSEMBLY.

9-92. Place a new gasket on the two-stud pad near the bottom center rear of the accessory case, and insert the drive gear and pilot of the subassembly through the case bore. Turn the hand crank jaw as necessary to mesh the gear; then seat the adapter on its gasket and attach it. Check for gear backlash by attempting to turn the crank jaw both ways.

9-93. IGNITION ASSEMBLY.

9-94. Install a new grommet on each ignition conduit. Pass the No. 1, 3 and 6 spark plug terminals and conduits through the three holes in the shroud upper right rear panel, with No. 1 on the outside, No. 3 in the center and No. 5 in the inner hole. Push the conduit grommets into the shroud holes. The No. 2, 4 and 6 conduits are inserted in the same way after passing them through a grommet installed in the large center hole of a blower engine to governor bracket (23, figure 4-5). Make sure that the bracket is located on the conduits so as to assume the correct position when attached. *(See figures 1-2 and 4-5.)* Lay the cable terminals on the cylinders to which they will be attached later. The magneto outlet plate will

1. 22 inch conduit and connector assembly
2. 30 inch conduit and connector assembly
3. 30 inch conduit and connector assembly
4. 34 inch conduit and connector assembly
5. 36 inch conduit and connector assembly
6. 40 inch conduit and connector assembly
7. Shielded high tension cable outlet plate
8. Spark plugs
9. Magneto (rear view)
10. Noise filter bracket
11. Noise filter
12. Magneto switch wire (not installed on packette)
13. Ignition switch (not installed on packette)
14. Switch ground strap (not installed on packette)

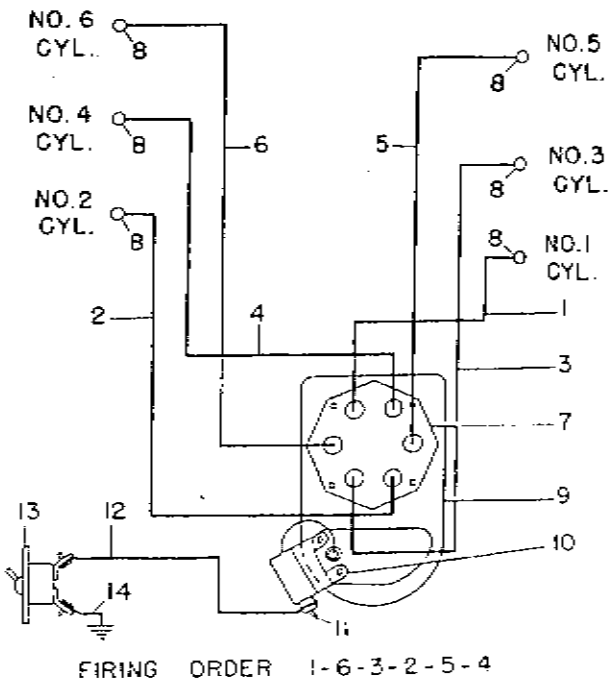


Figure 9-18. Ignition Wiring Diagram

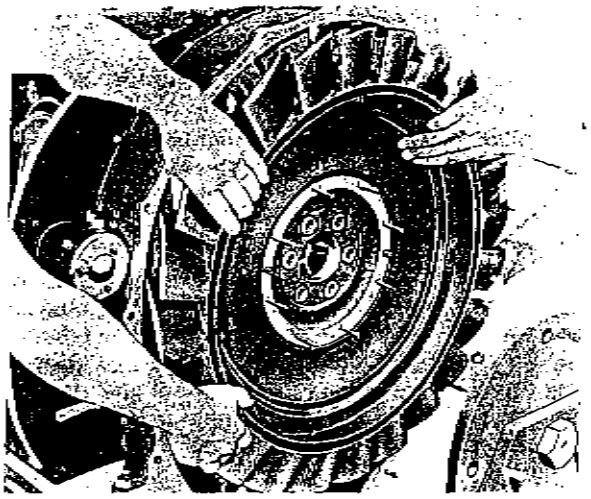


Figure 9-19. Installing Flywheel and Fan Assembly

hang down at the right side of the accessory case until the magneto is installed later. Check cables for correct length to reach the proper cylinders in accordance with the wiring diagram in figure 9-18. The No. 1 cable is attached to the outlet plate spigot which will be uppermost when installed on the magneto. A figure "1" is molded on the plate adjacent to this outlet. Notice that the upper plate attaching screw holes are more widely separated than the lower holes.

9-95. GOVERNOR DRIVE SUBASSEMBLY.

(See figure 4-9.)

9-96. Place a new gasket (12) on the three-stud pad at upper rear center of the accessory case, and install the lubricated gear and adapter subassembly over it, meshing the gear by turning its splined shaft end. Attach the adapter with two sets of parts (7, 6, 5) and two sets of bolts and washers (10, 9, 8). Omit the nut and washers (7, 6, 5) from the left side stud, since the fuel hose bracket will be attached there later. Install the upper pair of bolts, washers and nuts (4, 3, 2, 1). Test—by pushing, pulling and attempting to oscillate its splined shaft—for end clearance and backlash in the drive gear. Measurement of these values would require special tools which are not available. As long as there is a noticeable backlash and a sensible end clearance the gear will operate without danger.

9-97. FLYWHEEL AND FAN ASSEMBLY AND COUPLING.

9-98. INSTALLATION. Before lifting the flywheel and fan assembly into position obtain three new lock plates. Match the shorter plate to the two closely spaced flywheel bolts, and notice their positions. With the same plate locate the two closely spaced flywheel bolt bushings; then turn the flywheel and fan assembly until these bushings are in the same angular positions as the corresponding bolts. Two men can easily lift the assembly onto the bolts, as illustrated in figure 9-19, if it does not have to be turned in mid air. Take care to avoid scuffing or breaking fan blades. Install the three nut lock plates and run six nuts on the flywheel bolts. Tighten these evenly in several steps, progressing around the circle, with a torque indicating wrench, a socket and an extension bar about six inches long until the torque specified in Section XII has been applied to each nut. With pliers bend up the corners of all lock plates flat against the nut sides.

9-99. FLEXIBLE COUPLING DRIVER HALF. Hold the driver half—an aluminum slab with rubber bonded bronze bushings—in front of the circle of eight studs in the flywheel, with the counterbored ends of the stud holes facing outward. Turn the coupling until its two opposite dowel holes align with flywheel dowels; then push it home over the studs. Attach it with eight washers and nuts. After tightening these, install eight nut locks (paragraph 8-10).

9-100. MAGNETO INSTALLATION AND TIMING.

9-101. DRIVE GEAR AND COUPLING. *(See figure 4-8.)* Insert two new rubber bushings (17) into the retainer (18) with their rounded outside edges entering first. The gear parts (19, 20, 21) should be assembled already. Snap the coupling bushings and retainer assembly into the gear hub slot so that the bushings will be exposed. Lubricate the gear's bronze bushing (20) and teeth.

9-102. MAGNETO INSTALLATION.

a. Remove all six spark plugs or vent plugs from the cylinders.

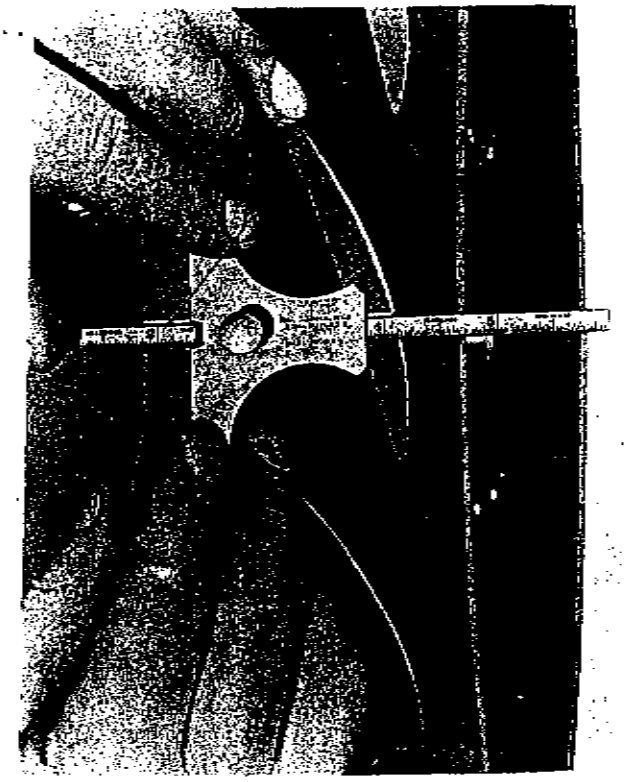
b. Turn the flywheel fan until the "TC" mark on the tip of one fan blade is near the index mark (1, figure 9-20). While plugging No. 1 cylinder spark plug hole with a thumb, turn the fan clockwise (facing it). If no suction is felt by the thumb in the first quarter revolution, turn the fan one full revolution from the starting point and onward another quarter revolution. This will place the No. 1 piston midway on its compression stroke. Now turn the fan counterclockwise (facing it) until the "30°" mark on another fan blade tip aligns with the fan housing mark. A sliding depth gauge may be used for exact alignment, as shown in figure 9-20.

c. Place a new magneto gasket on the magneto mounting pad.

d. Unscrew the hex head inspection plug from the hole in the top of the magneto case.

e. Turn the magneto impulse coupling backward (clockwise facing drive end) until the white distributor gear tooth is in line with the pointer seen through the plug hole. The magneto is now approximately in position to fire No. 1 cylinder spark plug.

f. Without moving the magneto impulse coupling, the drive gear and coupling assembly may be pushed onto its driving lugs and the entire magneto gear assembly installed as a unit, or the position of the impulse coupling lugs may be determined while holding the magneto at the approximate mounting angle behind the accessory case, the gear and coupling assembly installed on its support



1. Fan outlet housing timing mark

Figure 9-20. Placing Flywheel in Ignition Timing Position

inside the case and meshed so as to align the slot between the rubber bushings with the magneto lugs; then the magneto may be installed and engaged to the coupling bushings.

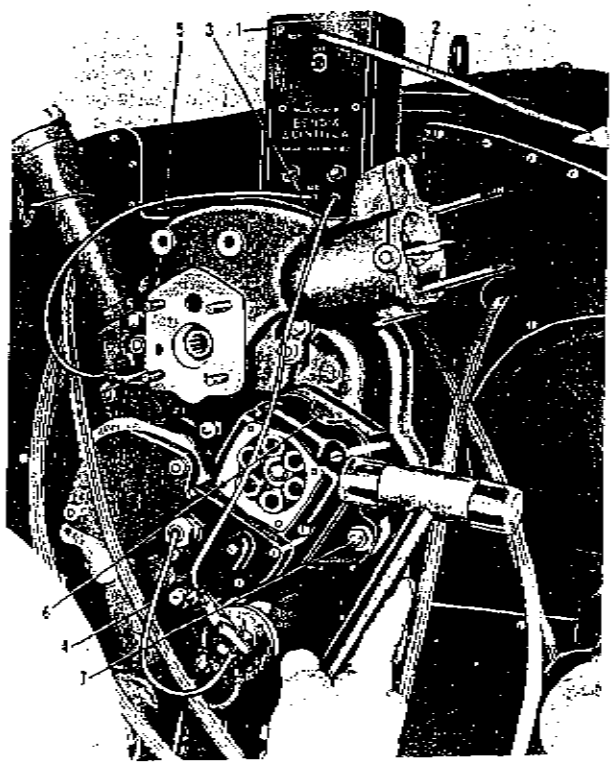
g. Attach the magneto with two sets of parts (14, 13 and 12, figure 4-8). Be sure to use the correct plain washers. Tighten the nuts with the fingers only.

h. Rotate the magneto clockwise (rear view) as far as its flange slots permit.

9-103. TIMING. *(See figure 9-21.)*

a. Place a Scintilla No. 11-851 or equivalent timing light (1) in the illustrated location. Plug in its power cable (2), if any, to a 110 volt a-c outlet. If the instrument is powered by self contained batteries there will be no power cable. In that event, turn the switch to "ON", and observe whether the unit operates; then test by touching the red and black cable terminals together. If the lamp is not illuminated replace the battery. Connect the "GRD" lead (5) to a bare metal part of the engine. Screw a shop test lead (4) (made up of Scintilla parts 5 through 10, figure 4-8 and a short insulated wire) into the magneto grounding cable terminal socket. Connect it to either of the red wires (3) and coil up the other.

b. The connected lamp in the instrument should be illuminated to indicate a closed primary circuit. If it is not, look into the inspection hole (6), and see if the white gear tooth can be aligned with the pointer by rotat-



1. Scintilla No. 11-851 timing light
2. Timing light power cable
3. Test lead (red) from timing light
4. Scintilla switch terminal and short lead assembly
5. Timing light ground lead (marked "GRD")
7. Special washer, lock washer and nut

Figure 9-21. Timing Magneto

ing the magneto. If it cannot, remove the magneto and repeat steps e, f, g and h, paragraph 9-102.

c. Tap the magneto case counterclockwise with a nonmarring hammer until the timing light lamp is extinguished or illuminated, depending on instrument type, to indicate opening of the breaker points. Tighten the two magneto attaching nuts (7).

d. Check the magneto timing by backing up the flywheel fan (clockwise when facing it) not over 10 degrees about 2/3 of the width of a blade) and tapping it forward until the timing lamp indicates that the breaker points have just opened. At this point the flywheel fan and fan housing timing marks will be aligned if timing is correct.

e. After successful completion of the test replace the magneto plug, and remove the timing light and the magneto switch wire (4).

Note

The magneto impulse latch is under the case stud and cannot stop against it to retard the magneto rotor when the coupling is turned forward if it is so placed by backing up the coupling to the timing position (step e, paragraph 9-102). Excessive backward rotation of the coupling (or of the flywheel after the magneto is installed) will allow the latch to engage the case stud and retard the rotor. If this should occur, back up the flywheel two revolutions to the timing position.

9-104. SPARK PLUGS, CONNECTORS, NOISE FILTER AND BRACE RODS.

9-105. SPARK PLUGS. See that the plugs have serviceable copper gaskets. Install a serviceable washer type thermocouple instead of a gasket under the plug installed in No. 2 cylinder. Before screwing the plugs into the cylinder head "Heli-Coils" coat their 18 mm. threads with only a film of BG mica thread lubricant. Do not allow any of the lubricant to get on the electrodes, plug seat or gasket. Tighten them with a torque indicating wrench, spark plug socket and extension bar to the torque specified in Section XII. *(See Ref. No. T-10.)*

9-106. CONNECTORS. Inspect the spark plug elbow, ceramic sleeve and terminal spring of each connector and conduit assembly before inserting the terminal into the proper spark plug. Screw the elbow coupling nuts on the plugs and tighten them only enough to hold the elbows stationary. Consult the wiring diagram, figure 9-18, for correct connections from plugs to magneto outlet plate. Check the rubber grommet and its wire terminals at the outlet plate. If these appear sound push the grommet into the magneto distributor block, with the outlet plate held in position to match screw holes. Attach the plate with four screws and spring lock washers.

9-107. NOISE FILTER. *(See figure 4-8.)* The noise filter (4) and terminal parts (5 through 10) should be assembled already. Attach the bracket (11) to the filter in the illustrated relationship with two sets of parts (3, 2, 1). Remove the two left side breaker housing screws from the magneto, and use them to attach the filter bracket. Push the shielded wire terminal assembly into the switch wire terminal socket, and screw on the coupling nut (10). Tighten it only moderately.

9-108. SHROUD BRACE RODS. Install the nuts and lock washers which will go inside the shroud before inserting the rods through the front and rear panel holes above the cylinders. Adjust the positions of these nuts to space the panels properly, then install and tighten the outside nuts and lock washers.

9-109. COMPLETE FAN INLET AND GEAR HOUSING SUBASSEMBLY.

9-110. INSTALLATION. Turn the flywheel until two of the bushings in the Ajax coupling driver half lie in a vertical line; then turn the driven half of the coupling (attached to the gear housing subassembly) until two of its pins lie on a vertical line when the housing is held upright. Two men can lift the subassembly into position and onto the fan outlet housing studs without difficulty if the coupling halves are positioned to engage. Alternatively, a lifting eye can be attached to the four vertical studs at the top of the inlet and gear housing and the assembly hoisted into position. Attach the assembly with 16 sets of parts (2, figure 9-23).

9-111. OIL FILTER TUBE, OIL GAUGE AND SUPPORT. *(See figure 4-24.)* Attach tube clamps (14, 28) loosely to the two tubes with attaching parts (11, 12, 13 and 15, 16, 17) so that they will assume the positions illustrated in figure 1-4 when anchored to the bracket (21) on the fan outlet housing. If the gauge tube is a new part, slide on a coupling nut (19); then flare the tube end with a standard flaring tool. Screw the coupling nut into the connector (52) installed in the inlet and gear housing, and tighten it with the support tube in position. Connect the filler tube to the adapter pressed into the inlet and gear housing with a hose connector (9) and two clamps (8). *(See figure 9-12 for clamp installation.)* Before installing the clamps, attach both tube clamps (14, 18) to the bracket (21) with the same set of attaching parts (5, 6, 7). Install a cap (4) (painted yellow and marked "2 QTS.") on the filler tube. Push a circlip (3) into the handle groove of the oil level gauge (2); then insert the gauge into its support tube.

9-112. CARBURETOR AND HOSE.

9-113. Place a new carburetor gasket on the studded rear flange of the intake manifold and attach a carburetor over it. Spread on the male threads of an extension adapter a film of anti-seize compound, MIL-T-5544, and screw the adapter tightly into the float chamber inlet port at the left rear corner of the carburetor. Similarly install in the extension adapter a 45 degree pipe thread to flared tube elbow. The elbow must point horizontally to the rear when tightened. Connect a serviceable hose assembly (4, figure 1-2) to the carburetor inlet elbow and to the fuel pump outlet elbow. Place the bracket clamped on the fuel hose on the left side attaching stud for the governor adapter, and attach with a set of parts (7, 6, and 5, figure 4-9).

9-114. REAR EXHAUST PIPES AND JACKETS. *(See figure 4-6.)*

9-115. Install first the jacket elbows which attach to the open ends of jackets already installed on the exhaust manifolds. Before installing each of the first three elbows in this group, equip their dimpled screw holes with cage lock nuts (46, 27, 23). The threaded nuts must be on the inside. Install two speed nuts (10) on each of two spacers (9), and install these assemblies on the upper ends of the final elbows (7, 26) after these have been attached in place. After the first elbow (22) has been installed on the right side, assemble a clamp (15 through 18) on the exhaust elbow (19), and push it onto the right manifold end. Unless the manifold is a new assembly, there will be a hole in it positioned to receive the retaining rivet in the clamp. If no hole is found it will be necessary to drill one to match the rivet hole in the elbow's split end. The same procedure applies to the other clamp (34 through 37), which will be used to attach the exhaust cross pipe (41) to the left manifold after the left jacket elbow (45) has been installed. The cross pipe jacket (33) must be placed loosely on the manifold cross pipe before it is attached. Assemble the bracket (42) and its clamping parts (28, 29, 30) on the cross pipe jacket before installing the last elbow (26) on that side, and attach the bracket with two sets of parts (38, 39, 40) to the support installed earlier on the accessory case. Before installing the last elbow (7) on the right side, attach the thermoswitch (14) to its rear side tubular opening with two sets of parts (11, 12, 13), with the electrical terminals nearest the inside of the curve. Finally, attach the brace (4) between brackets on the two final elbows with four sets of parts (1, 2, 3).

9-116. BLOWER ENGINE. *(See figure 4-5.)*

9-117. INSTALLATION. Hold the blower engine and blower to accessory case bracket subassembly in position against the felt seal installed on the shroud upper left rear panel, with the lower bracket attaching hole engaged on the open stud at the left side on the rear of the accessory case and an attaching bolt, lock washer and spacer (9, 10, 19) in position in the upper hole; then push the bolt through the accessory case hole, and screw it into the crankcase. Install a nut and lock washer (11, 12) on the case stud; then tighten the bracket attaching parts. Install a governor or pad cover (6, figure 1-2) on the governor mount pad, and the blower to governor adapter bracket (hanging on the left ignition cables) on the left side governor attaching studs. If the upper bracket cannot be installed with the governor in place, due to lack of clearance at the stud ends, install governor and bracket at the same time. Install governor or cover attaching parts; then attach the upper bracket to the blower engine crankcase with a coarse thread bolt (17) in the upper hole and a fine thread bolt (15) in the lower hole, each with a spring lock washer.

9-118. BLOWER CONNECTIONS.

a. Slide a clamp (5) onto each end of an exhaust tube assembly (6, 7, 8). The clamp (6) at the center of the tube should not be tightened fully yet and should allow length adjustment of the assembly. Push the upper tube end over the blower engine exhaust outlet and the lower end over the left exhaust manifold side inlet tube. Tighten the top and bottom clamps, then the center clamp on the tube assembly.

b. If original hose clamps (3) are serviceable, push one over each end of a flexible duct (4) before installing it. Push the ends of the duct over the outlet of the blower engine fan housing and the air inlet of the heater. Tighten original clamps, or install new ones as described in figure 9-12.

c. Check condition of the ceramic sleeve and terminal spring of the shielded ignition cable dangling from the blower engine. If these are satisfactory insert the terminal into the heater spark plug (12, figure 1-1), and tighten the coupling nut moderately.

d. Coat the pipe threads of an elbow (14, figure 4-7) with anti-seize compound, MIL-T-5544, and screw it tightly into the heater fuel filter inlet port so that its flared tube connector end points upward. Between this elbow and the elbow in the blower fuel pump "OUT" port connect a hose assembly (19, figure 1-2 or 2, figure 4-5). Install a bracket (1, figure 4-5) on the hose, and attach it to the packette exhaust manifold cross pipe jacket where illustrated in figure 1-2.

9-119. SUMP TO GEAR CASE TUBE ASSEMBLY.

9-120. *(See figure 9-22.)* This assembly includes all of the parts illustrated. Before installing the tubes, peel the protective paper from the adhesive side of a new sponge rubber seal ring, and press the adhesive side against the front face of the oil cooler flange, centering its hole on the flange hole provided for the heat tube. First, install a clamp assembly (1, 2, 3, 4) on the welded elbow split ends of the two tube assemblies. Next, insert the front tube assembly (5) through the cooler flange from the front side, and clamp its split end onto the gear case inlet spout with the clamp installed there. Slide a support clamp (6, 8, 9, 10) over the long radius elbow of the rear tube (7), with the bracket strip toward the tube end; then fit the tube onto the open end of the front tube, and push the welded elbow and clamp onto the sump bushing. Tighten the rear clamp screw. Remove the nearest oil cooler attaching bolt, and use it to attach the support clamp (6) to the cooler. Tighten the clamp screw nut (10) to complete the installation.

9-121. PREHEAT AND MIXING VALVE.

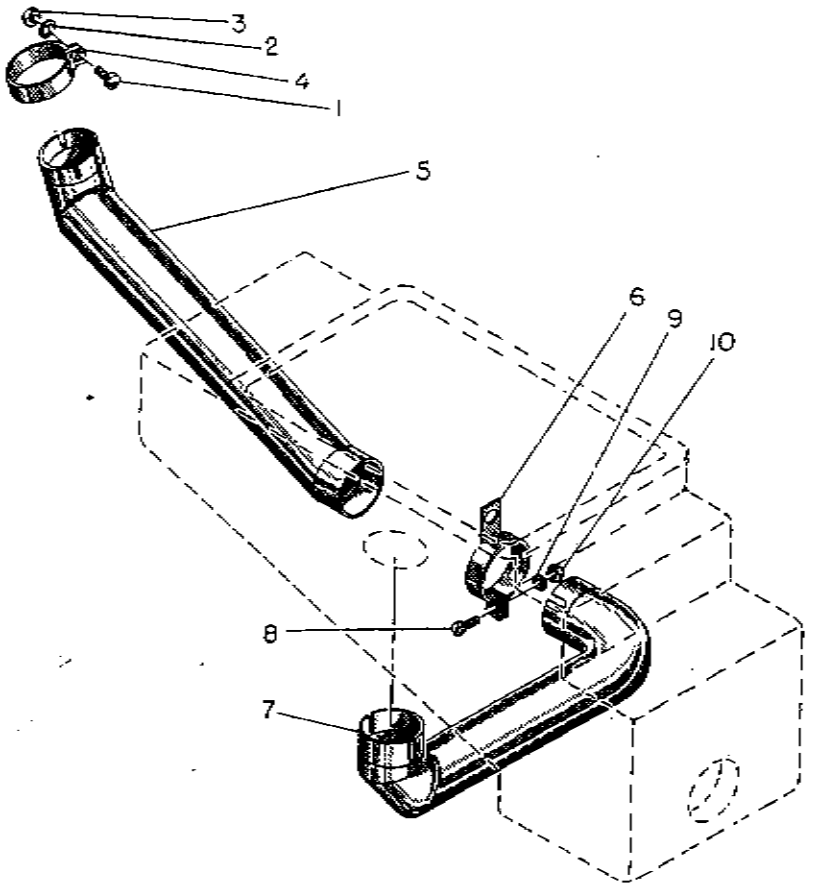
9-122. INSTALLATION.

a. Place a new gasket on the two, long studs projecting from the right end of the governor adapter.

b. Mount the preheat and mixing valve subassembly on the studs, and seat it on its gasket.

c. Attach the valve housing with two plain washers, lock washers and nuts.

d. Remove the rear hex head attaching screw and tab washer (4, figure 9-11) from No. 1 cylinder intake flange. Insert the single hole end of a (flat end, tubular) support



1. Screw
2. Washer
3. Nut
4. Clamp
5. Inlet tube
6. Clamp assembly
7. Outlet tube
8. Screw
9. Washer
10. Nut

Figure 9-22. Sump to Gear Case Tube Assembly

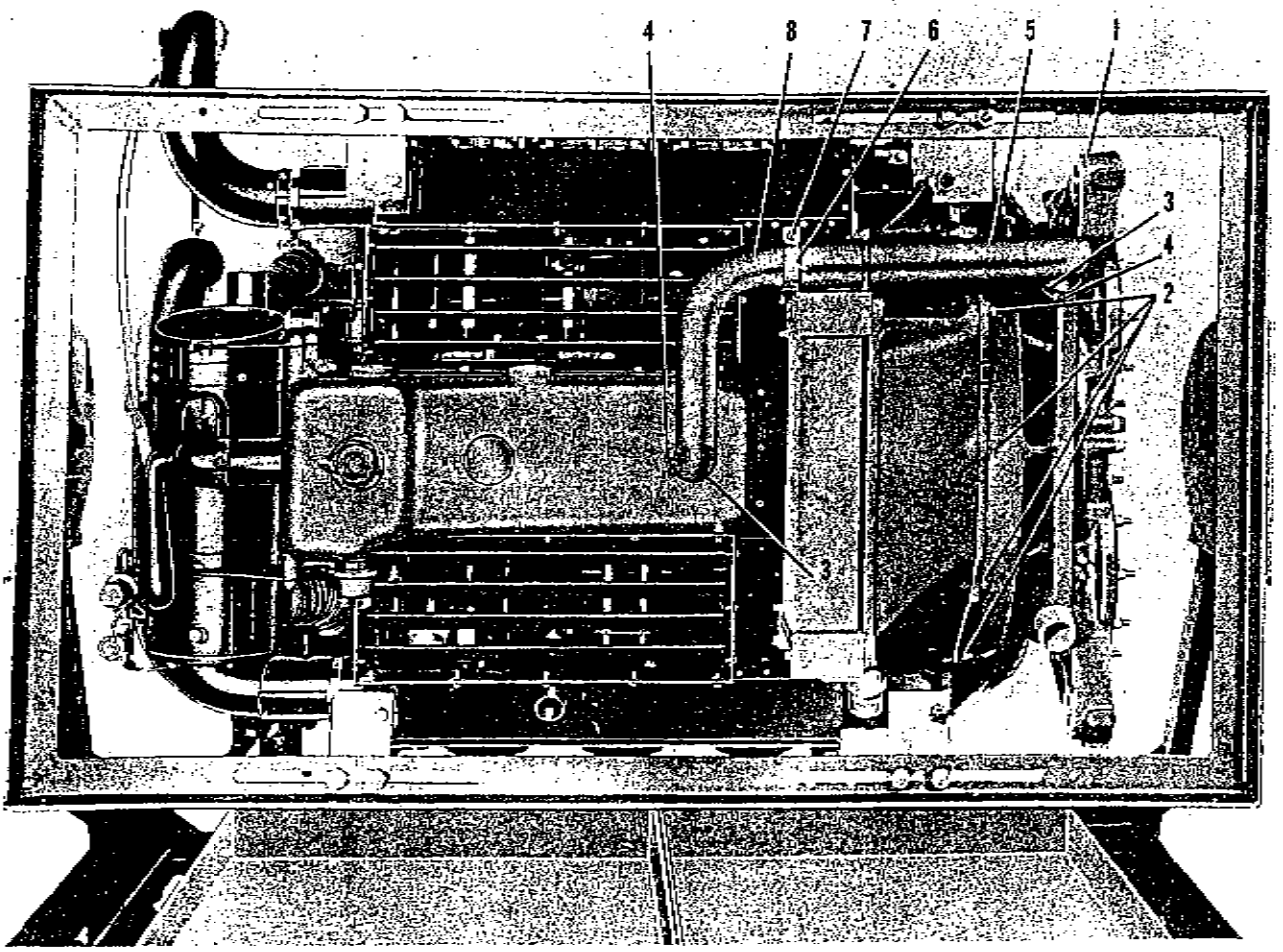
through the grommet at the upper edge of the bulge in the shroud right side upper rear panel, and attach it with the intake flange screw, keeping the tab washer aimed at the head baffle piece on the shroud to No. 1 cylinder baffle assembly. Install a spring (15, figure 9-11) to connect the baffle to the tab washer. Place a heat valve cover over the lower right end opening in the mixing valve housing, and attach it and the two-hole flat on the support tube with two screws and lock washers. Tighten these first, then tighten the intake flange attaching screw.

9-123. DUCTS. *(See figure 4-7.)* Attach a tube assembly (4) to the heater outlet collar with a screw (3). If either assembly has no screw hole in the illustrated screw position, drill a 1/8 inch diameter hole through both; then install the screw. The side outlet of the tube assembly must point straight to the right side of the packette. Install a clamp (1) over the bottom (split) tube end where it overlaps. *(See figure 9-12 for procedure.)* On the upper end of the outlet tube install a heat resistant flexible duct (2) and push its upper end over the rear inlet spout of

the mixing valve housing. On each end of the duct install a clamp (1). Install an identical duct and clamps on the right exhaust manifold jacket outlet just to the rear of the shroud and on the forward inlet spout of the mixing valve housing. (These parts are also visible in figure 1-3.)

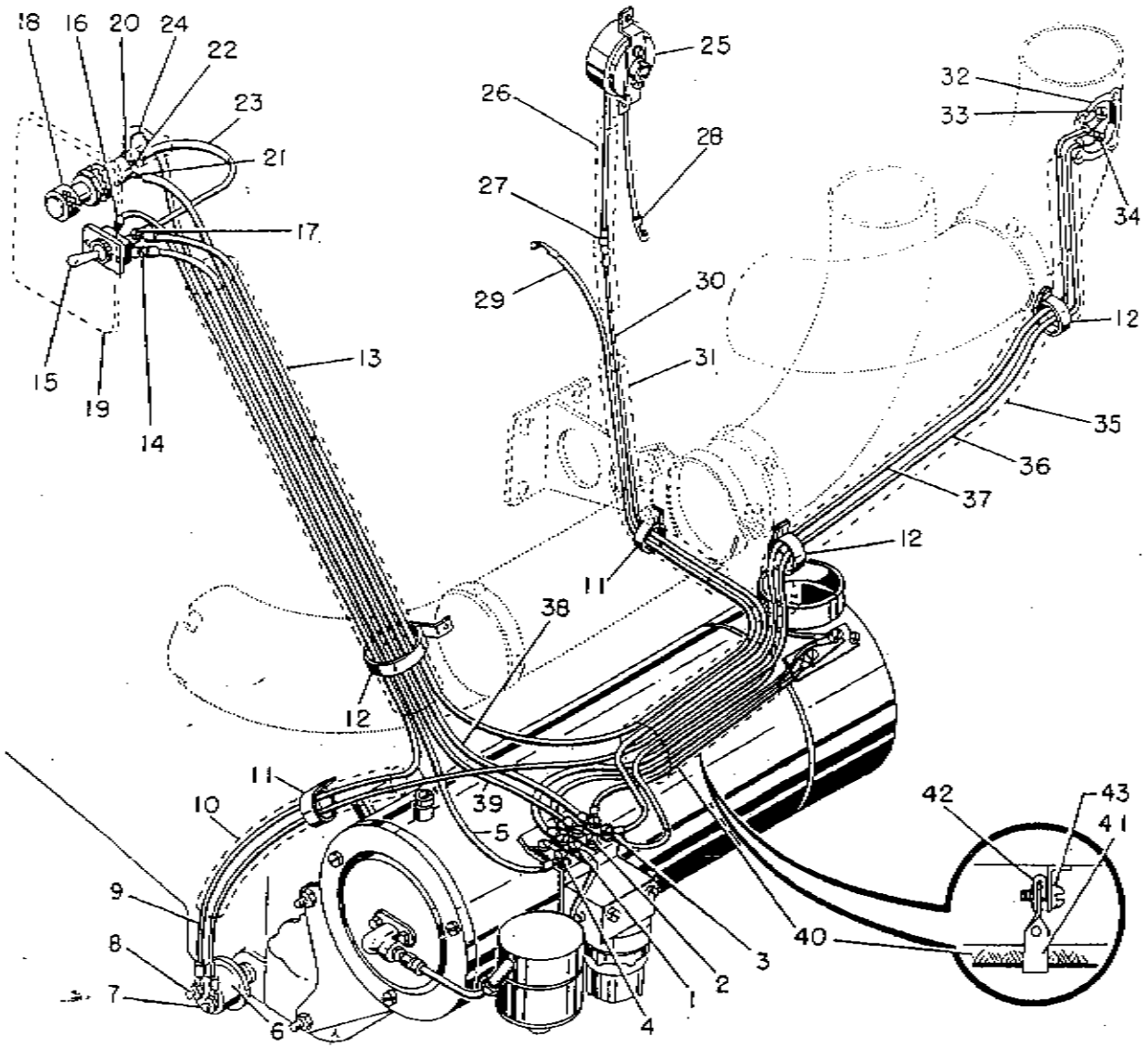
9-124. CARBURETOR AIR FILTER AND ADAPTER SUBASSEMBLY.

9-125. Place a new gasket on the studded front flange of the air filter adapter and a new gasket on the top surface of the preheat and mixing valve housing. The subassembly should include all parts illustrated in figure 4-25. Insert the filter adapter studs into the carburetor rear flange holes; then push the breather connector hose down onto the bushing in the governor adapter. Attach the filter adapter with four sets of washers, lock washers and nuts. Attach the filter housing and its gasket to the mixing valve housing with six sets of plain and internal tooth



1. Complete fan inlet and gear housing assembly
2. Washer, lock washer and nut
3. Clamp
4. Screw, lock washer and nut
5. Gear housing inlet tube
6. Support clamp assembly
7. Screw, lock washer and nut
8. Sump heat outlet tube

Figure 9-23. Bottom View With Sump to Gear Case Tubes Installed



1. No. 1 terminal on heater terminal block
2. No. 2 terminal on heater terminal block
3. No. 3 terminal on heater terminal block
4. Grounding screw on heater terminal block
5. Cable assembly
6. Thermoswitch
7. Rear terminal of thermoswitch
8. Front terminal of thermoswitch
9. Cable Assembly
10. Sleeve
11. Clip
12. Bracket
13. Sleeve
14. Heater switch "MOM. ON" terminal
15. Switch
16. Heater switch "ON" terminal
17. Heater switch power terminal
18. Pilot lamp assembly
19. Blower engine control panel
20. Indicator lamp No. 1 terminal (ground)
21. Indicator lamp No. 2 terminal
22. Indicator lamp No. 3 terminal (test)
23. Cable assembly
24. Sleeve
25. Rotary solenoid on preheat and mixing valve housing
26. Sleeve
27. Rotary solenoid Burndy connector
28. Burndy connector for cable to ignition switch
29. Cable assembly
30. Cable assembly
31. Sleeve
32. Thermoswitch
33. Thermoswitch upper terminal
34. Thermoswitch lower terminal
35. Sleeve
36. Cable assembly
37. Cable assembly
38. Cable assembly
39. Cable assembly
40. Sleeve
41. Bracket and rivet
42. Speed nut
43. Screw

Figure 9-24. Installation of Heater Wiring Harness

lock washers and fillister head screws. Tighten the filter adapter attaching nuts first, then the filter housing screws; then tighten the two hose clamps on the breather hose.

9-126. HEATER ELECTRICAL WIRING.

(See figure 9-24.)

9-127. This harness is made up and connected as indicated in figure 9-24 and Table XV. The circuit is shown in figure 10-2. Consult that diagram only for operation features, not for wiring connections. Figures 1-1 and 1-2 also illustrate the harness and connections. Rubber covered clamps (11) are attached by the regular attaching parts (10, 11 and 12, figure 4-14) of the oil drain tube connection plate on the left side and by attaching parts (38, 39 and 40, figure 4-6) of the exhaust jacket support clamp assembly on the right. Three brackets (12) are held by attaching screws of the jacket sections at the positions illustrated.

9-128. OIL PRESSURE GAUGE ENGINE UNIT CABLE.

9-129. Slide onto the round bayonet connecter terminal of a cable assembly, and in the order named, the following connecting parts: shell, bushing and grommet. The grommet must be forced over the cable terminal, small end first. The bushing goes on the cable, small end first. Push it over the grommet and against its shoulder. Push a connector over the cable terminal as far as it will go. Push the other end of this connector over the bayonet terminal inside the oil pressure gauge engine unit on the fan outlet housing; then push the shell over the grommet and bushing and into the unit locking slots. Turn it to lock the connector assembly. Coil up the cable, and wrap at one point with tape.

9-130. SHROUD DETACHABLE PANEL ASSEMBLIES.

9-131. It is assumed that the hook assemblies, springs and retaining nuts have not been removed from channel members at upper edges of the detachable panels. There should be one such assembly near each end of each panel. Before installing the detachable panel assemblies, swing up the access doors on the top panel. Engage the detachable panel bottom clips under the clip braces on the bottom side panels, and center the detachable panels so that they cover webbing strips on front and rear panels. As each panel assembly is placed in position, lift the spring hooks, and drop their bent ends into the holes in hook angles on the inside of front and rear panels; then lower the access door, and fasten the toggle latches.

TABLE XV. HEATER CABLE INSTALLATION

Cable Assembly Part No.	*Cable Index No. (Fig. 9-24)*	*Cable Length (in.)*	*Terminal Index No. (Fig. 9-24)*	*Type Terminal*
532584-19	39	19	2 14	Eyelet Eyelet
532584-31	9	31	8 16	Eyelet Eyelet
532584-31	36	31	3 34	Eyelet Eyelet
534393-37	29	37	17 Open	Eyelet Burndy connector
532584-45	37	45	7 33	Eyelet Eyelet
532658-6	23	6	17 22	Eyelet None (solder)
532658-20	5	20	4 20	Eyelet None (solder)
532658-21	38	21	3 21	Eyelet None (solder)
534393-18.5	30	18½	3 27	Eyelet Burndy connector

Note

If the packette is to be placed in a shipping crate before the run-in test for any reason, omit the detachable panels until it has been fastened to the crate mount bolts.

SECTION X
TESTING AFTER OVERHAUL

Note

Air Force personnel will follow procedures outlined in Air Force Technical Orders covering this subject. Navy personnel will follow procedures outlined in NavAer 02-1-508.

TABLE XVI. SEA LEVEL POWER RATINGS

Rating Designation	*Net BHP*	*RPM*	*Carburetor Air Temperature*
Max. Continuous Power	140	2400	55°C (131°F)
Max. Continuous Power	180	2400	15.5°C (60°F)
Max. Intermittent Power	170	2900	55°C (131°F)
Max. Intermittent Power	205	2900	15.5°C (60°F)

10-1. TEMPERATURE LIMITS.

10-2. CYLINDER HEAD TEMPERATURE. As measured by a washer type thermocouple installed under any spark plug, cylinder head temperature shall not be allowed to exceed 274°C (525°F).

10-3. CYLINDER BARREL TEMPERATURE. As measured by a cylinder barrel contact thermocouple installed between the bottom barrel fin and the base flange, the temperature of any cylinder barrel shall not exceed 146°C (295°F).

10-4. OIL TEMPERATURE. The temperature of oil in the engine sump shall not exceed 107°C (225°F). The packette engine shall not be started until oil in its sump has been warmed to at least 18°C (0°F).

Note

Excessive oil temperature will indicate that either the oil cooler core or air passage is restricted or that the oil cooler bypass valve in the bottom of the crankcase is leaking, unless it is caused by overheating of running parts.

10-5. MAGNETO TEMPERATURE. The magneto shall not be subjected to temperatures in excess of 82°C (180°F).

10-6. CARBURETOR AIR TEMPERATURE. The packette engine is designed to operate satisfactorily with carburetor air temperatures within the range of 15.5°C to 55°C (60°F to 131°F). At ambient temperatures below 60°F the bimetal spiral located in the top of the preheat and mixing valve housing automatically operates the cold and warm air valves below it to regulate the air stream entering the carburetor to a temperature between 60°F and 70°F. When the ambient temperature is above 60°F the carburetor air temperature will be the same as the ambient temperature if the bimetal spiral was correctly installed and adjusted. Correct operation of the mixing valve should be checked when low ambient temperatures permit, since it is possible to install the bimetal spiral in the inverted position, thus reversing the valve movement.

10-7. COOLING AIR TEMPERATURE. The packette cooling system is designed to maintain all engine temperatures within prescribed limits when operating at ambient temperatures within the range of —54°C to +55°C (—65°F to +131°F).

Note

If cylinder and oil temperatures do not rise normally within a short period of engine operation or if they become excessive at higher speed and power settings check the position of the thermostatically controlled shroud shutters.

10-8. PRESSURE LIMITS.

10-9. OIL PRESSURE. At the recommended idling speed of 800 to 900 rpm the engine oil pressure should be 20 to 40 psi. At normal operating speed (2400 rpm) the oil pressure must be within the range of 40 to 60 psi.

Note

No adjustment is provided in the oil pressure relief valve located in the right side of the engine oil sump adapter. If oil pressure fluctuates or exceeds the specified limits the relief valve may be removed by unscrewing its bronze acorn cap and withdrawing the spring and plunger which it retains. Dirt in the oil may cause fluctuation of pressure or a spring of improper strength may cause high or low pressure. Low or fluctuating pressure also may be caused by a leak in the pump suction tube inside the accessory case and sump or by excessive clearances in the pump or elsewhere.

10-10. FUEL PRESSURE. No provision for measurement of fuel pump discharge pressure is incorporated in the packette.

10-11. ENGINE AND HEATER FUEL.

10-12. SPECIFICATION. During the run-in test the packette engine and heater shall be supplied with gasoline conforming to specification MIL-F-5572, grade 80 to 130 or Specification MIL-G-3056, grade "A" or "C". For blower engine fuel specifications and mixing instructions refer to the applicable Technical Order.

10-13. FUEL SUPPLY CONNECTIONS. Three connections are required. The blower engine is equipped with a fuel distributor system which supplies the two primer

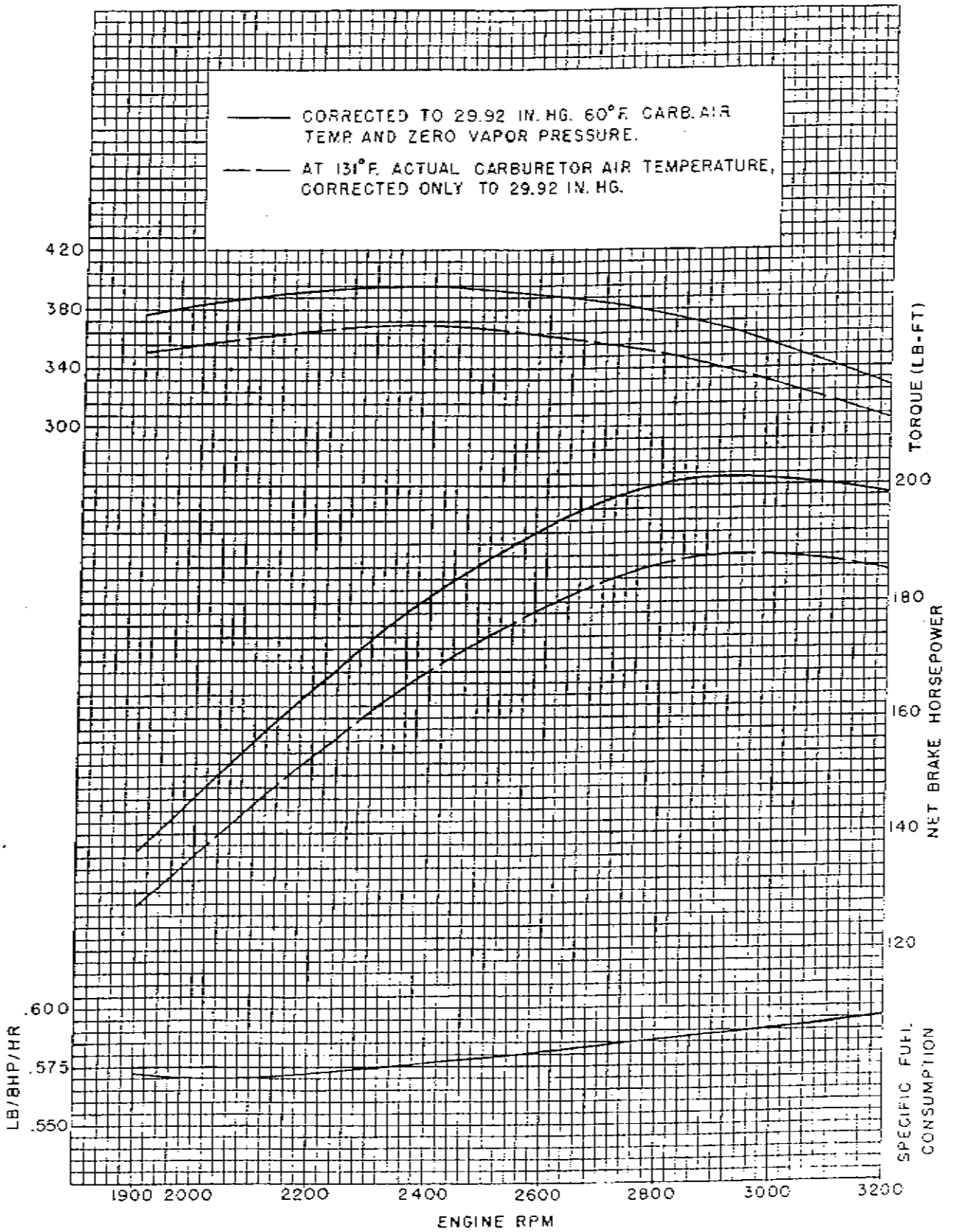


Figure 10-1. Net Brake Horsepower, Torque and Specific Fuel Consumption vs. RPM at Full Throttle

pumps, and the fuel pump which, in turn, feeds fuel to the heater. The inlet to the distributor has a 1/8 inch flared tube fitting (3, figure 10-3). Connect to this fitting a supply line from the same gasoline tank which supplies the packette engine. The blower engine carburetor also has a 1/8 inch flared tube fitting (20, figure 10-3). To this point connect a line from a tank of fuel and oil mixture. The packette engine fuel pump has a 1/4 inch pipe tapped inlet hole at the rear for a pipe to flared tube nipple or elbow. Install such a fitting and connect to it a 3/8 inch fuel supply line.

10-14. FUEL SUPPLY PRESSURE. If a gravity fuel feed system is employed the gravity head shall not exceed the value specified by the packette fuel pump manufacturer. The pump is capable of supplying fuel to the carburetor at a rate adequate for rated power and speed while operating under a suction head of not over four feet.

10-15. ENGINE AND GEAR CASE LUBRICATING OIL.

10-16. SPECIFICATION. During the run-in test the packette engine shall be supplied with aircraft engine lubricating oil conforming to Specification MIL-L-6082 or Specification MIL-L-2104.

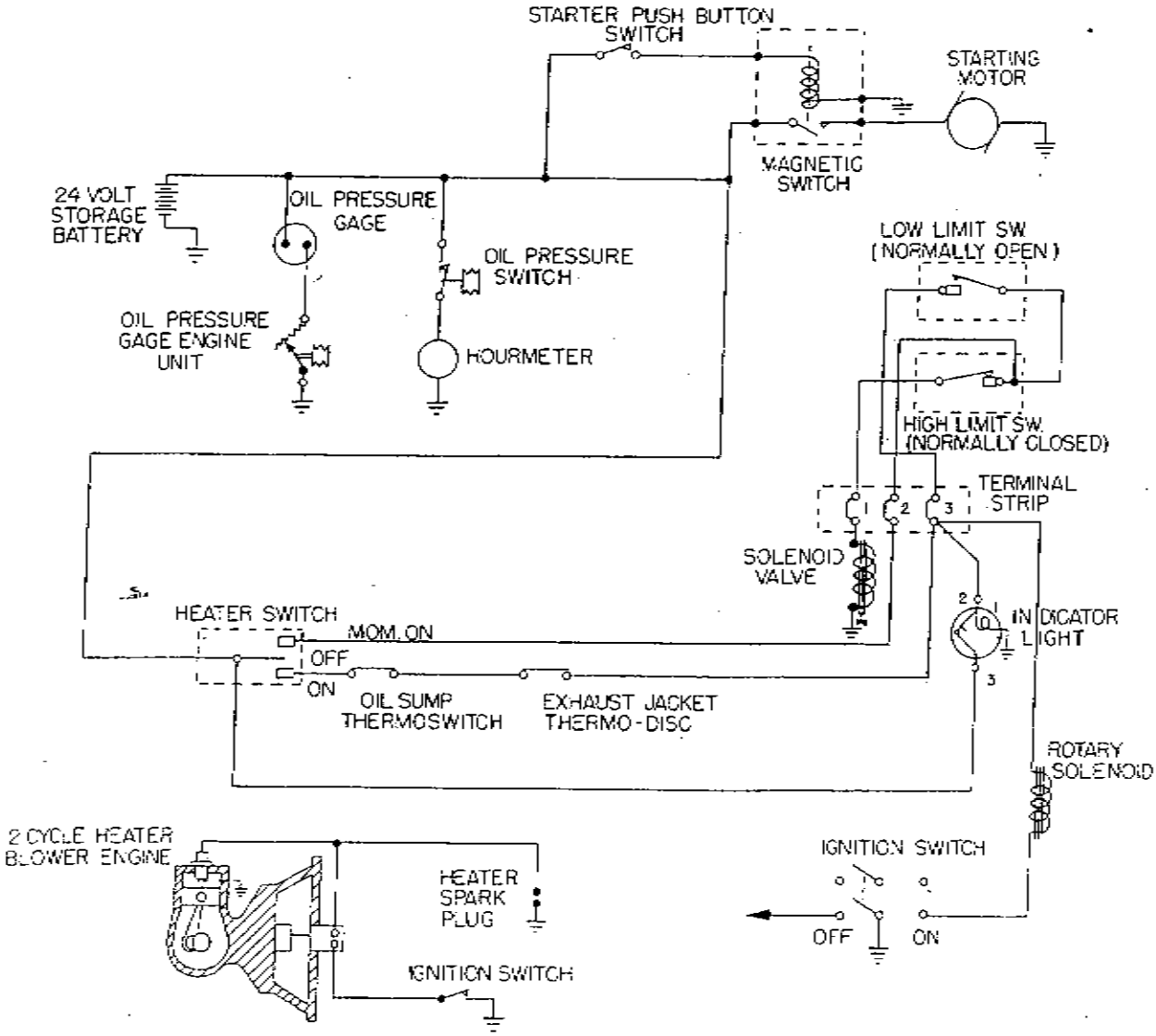


Figure 10-2. Electrical Wiring Diagram

10-17. VISCOSITY GRADES. At ambient temperatures between —54°C (—65°F) and —6.6°C (+20°F) use oil of a viscosity corresponding to SAE No. 10. At ambient temperatures above 20°F use oil of a viscosity equal to SAE No. 30.

10-18. OIL CONSUMPTION. The specific oil consumption at 2400 rpm and 180 net bhp shall not exceed 0.108 lb/bhp/hr.

10-19. PRE-OILING. To assure adequate lubrication of engine bearings and filling of the oil cooler and galleries, remove the 1/4 inch countersunk head pipe plug from the obligue passage at the right side of the fan outlet housing and connect a hose supplied by a source of warm oil at a pressure of 30-60 psi. At this pressure inject approximately three quarts of oil, meanwhile turning the crankshaft with either the electric starter or the hand crank. Replace the plug after disconnecting the pre-oiling hose.

10-20. OIL SUMP FILLING. Loosen the yellow oil filler cap (4, figure 10-3) by turning to the left, and remove it. Pour 12 quarts of oil into the filler neck; then replace the cap, and lock it with a quarter turn to the right. Pull out the oil gauge (18, figure 10-3), and see that the level is at the "FULL" mark; then replace the gauge.

10-21. GEAR CASE FILLING. Remove the gear case oil filler cap (6, figure 10-3), and pour into the case two quarts of oil of the same viscosity grade as in the engine sump. Check the quantity with the gauge located beside the filler neck; then replace the cap and gauge.

Note

Allow 5 or 10 minutes after filling the gear case sump for oil to run through a small hole to the gauge location. If checked too soon the gauge will not show the full amount of oil added.

10-22 .OIL DRAINS. The engine oil sump is drained by removing a hex head plug (23, figure 1-3). After the plug has been replaced secure it to the sump anchor lug with lockwire. The gear case oil sump is drained by removing a square head pipe plug (12, figure 1-4).

10-23. MINIMUM QUANTITY. During the test run the oil levels in the engine sump and the gear case must remain above the "LOW" marks on the respective gauges, as determined by inspection during shut-down periods.

10-24. INSTRUMENTS AND ELECTRICAL WIRING.

10-25. CYLINDER HEAD TEMPERATURE MEASUREMENT. A washer type constantan and iron thermocouple is installed under the No. 2 cylinder spark plug. A grommet in the left side of the shroud front panel provides access for the leads from this thermocouple to a temperature gauge. In the MD-3 portable generator set installation, cylinder head temperature is registered on a combination cylinder head and oil temperature gauge. If this type of gauge is used connect the positive terminal to the short, straight black (iron) wire of the thermocouple and the negative gauge terminal to the long, bent, yellow (constantan) wire.

10-26. OIL TEMPERATURE MEASUREMENT. A protected bayonet thermocouple (16, figure 10-3) has two screws for connection of a short constantan and iron lead assembly. Connect the iron (black) wire to the thermocouple positive (+) terminal and the constantan (yellow) wire to the negative (—) terminal. Support the lead to prevent excessive vibration. Connect the iron and constantan leads to the positive and negative terminals, respectively, of a suitable thermoelectric gauge. (Refer to paragraph 10-25.)

10-27. OIL PRESSURE MEASUREMENT. A 12 inch long lead cable is installed in the electric gauge engine unit at the left side of the fan outlet housing. Its outer end has a Burndy locking connector for a cable leading to the oil pressure gauge. (Refer to the Illustrated Parts Breakdown for a suitable oil pressure gauge and connecting cables.)

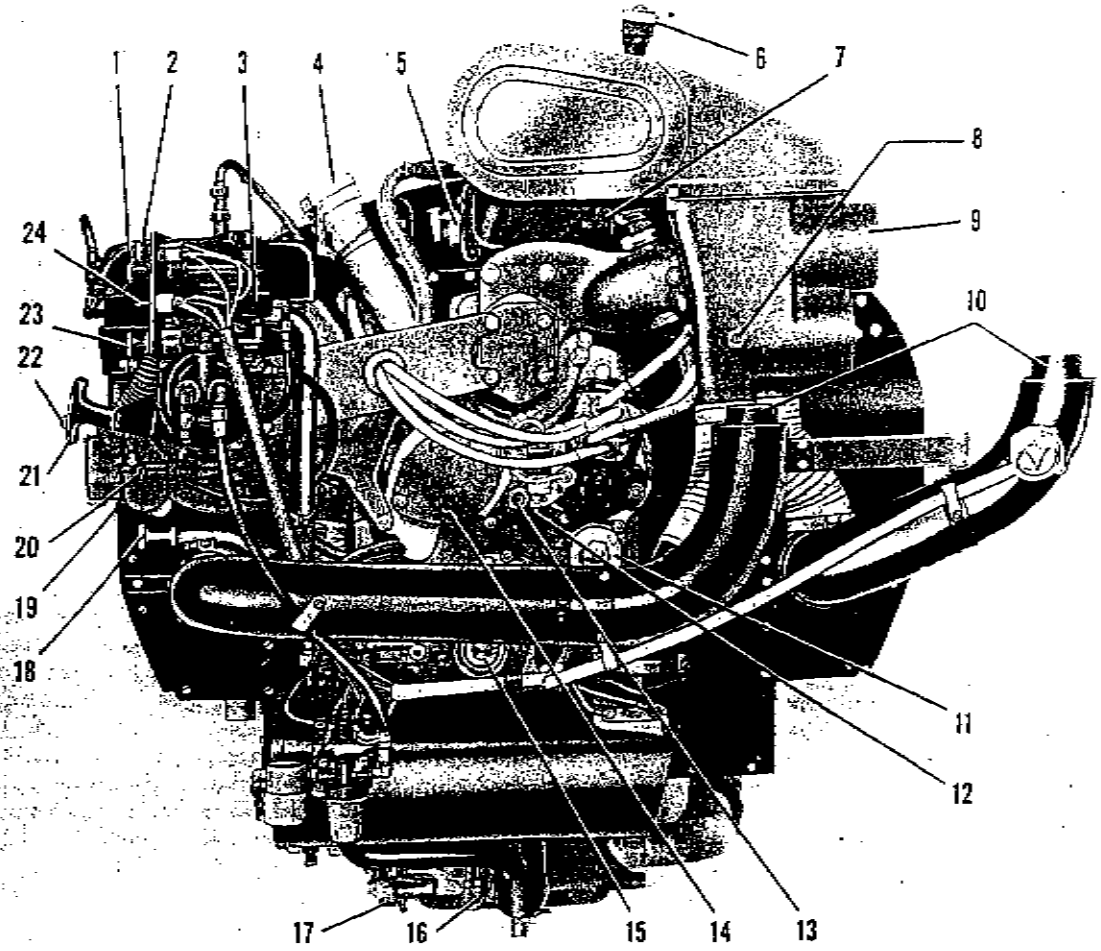
10-28. TACHOMETER. A mechanical tachometer drive (13, figure 10-3) turns clockwise at 1/2 crankshaft speed. The flexible cable of any standard clockwise tachometer designed for this speed ratio and an SAE drive may be connected.

10-29. STARTER AND MAGNETIC SWITCH. Connect the positive terminal of a 24-volt storage battery to the top power terminal of the starter magnetic switch (3, figure 1-4) with No. 0 cable equipped with a terminal equal to Thomas & Betts Co. part No. J-73. Connect the starter ground cable (14, figure 1-3) to the same (ground) conductor as the battery negative terminal. Connect from the battery positive terminal to a push button switch on the control panel and from the other switch terminal to the magnetic switch coil positive terminal stud. Connect from the other magnetic switch coil terminal to battery ground.

10-30. MAGNETO SWITCH. Connect a cable from the switch on the control panel to the terminal stud on the noise filter (12, figure 10-3) bracketed to the magneto case, and make sure that the switch is grounded to the engine test stand. The mixing valve rotary solenoid has an open cable terminal for connection to the center terminal of the DPDT ignition switch. *(See figure 10-2.)* This connection must be made if the heater system is to be operated. If this feature is tested, observe the rotary solenoid valve shaft (8, figure 10-3) when the ignition switch is closed for starting the packette engine. A slot in the shaft end shows when the solenoid opens the valve to admit warm air to the induction system. It should rotate nearly 1/4 turn clockwise from a position near the vertical when actuated.

10-31. HEATER POWER CONNECTION.

10-32. Connect a lead from the battery positive terminal to the center terminal of the heater switch. *(See 29, figure 9-24.)* Unless the engine is mounted on rubber vibration dampeners, the heater will be grounded through the engine and test stand. If necessary to assure grounding, connect a second heater terminal block grounding screw (4, figure 9-24) to the battery negative terminal at the same point where the starter ground cable is connected.



1. Blower engine cylinder primer
2. Heater indicator lamp
3. Gasoline supply line connection on blower engine junction block
4. Packette engine oil filler cap
5. Governor controlled throttle lever
6. Gear case oil filler cap
7. Packette engine carburetor choke lever
8. Rotary solenoid controlled hot air valve shaft
9. Induction system cold air inlet port
10. Packette engine exhaust manifold outlets
11. Air Maze oil filter
12. Ignition grounding switch cable connecting stud on magneto to noise filter
13. Tachometer drive
14. Governor oil drain connection
15. Hand crank jaw
16. Oil sump thermocouple
17. Oil sump thermoswitch
18. Engine oil level gauge
19. Blower engine choke lever
20. Blower engine carburetor connection elbow for fuel and oil mixture
21. Blower engine starter handle
22. Blower engine throttle knob
23. Blower engine preheating wick primer
24. Heater switch

Figure 10-3. Rear View of PE150-6 Packette Showing Controls and Connections

10-33. CONTROLS.

10-34. THROTTLE. Connect a suitable linkage from the operator's hand throttle to the throttle lever located forward on the right side of the carburetor.

10-35. CHOKE. Connect a suitable control to the carburetor choke lever (7, figure 10-3), located to the rear of the throttle lever, if the packette engine is to be started at an ambient temperature of 32°F or lower, otherwise tie the choke lever back to hold the valve open.

10-36. STARTER DETENT. If the packette engine is to be started at an ambient temperature of 0°F or lower, a remote cable control may be connected to the detent lever (14, figure 1-4) to pull the lever upward while the starter switch is energized. This detent prevents rotation of the Bendix drive pinion until it has traveled into mesh with the flywheel ring gear in the event that congealed grease in the Bendix drive resists gear movement. The detent control is not used at higher temperatures.

10-37. BLOWER ENGINE. The control panel, attached to the left side of the blower engine, is equipped with all necessary engine controls (1, 19, 21, 22, 23, figure 10-3). No instruments are required.

10-38. HEATER. The only manually operated control for the heater is the three-position switch (24, figure 10-3) on the right side of the blower engine control panel. The heater pilot light (2, figure 10-3) has a protruding lens collar which may be pushed to test the lamp bulb. The switch "MOM. ON" position is for starting. It is held in this position until the heater low limit switch has closed, causing the indicator lamp to be illuminated. Thereafter the switch may be moved to the "ON" position, where it will remain. Moving the heater switch to the "OFF" position will immediately close the heater fuel valve and cut off the burner. The same effect will occur if the high limit switch is opened by overheating or if the blower engine is stopped, cutting off the burner ignition and allowing the low limit switch to open.

10-39. DUCTS.

10-40. EXHAUST PIPES. If the engine is to be operated in an enclosed space it will be necessary to connect two flexible metal tubes to the exhaust tail pipes (10, figure 10-3) to conduct exhaust gases outside the cell, or to procure and install on them a suitable manifold, and, from it, a single flexible tube.

10-41. CARBURETOR AIR INTAKE. If the exhaust gases are ducted away and if the ambient temperature (in a cell) can be kept below 55°C (131°F), it will not be necessary to duct outside air to the mixing valve inlet port (9, figure 10-3), unless a high dust content makes ground level air unsatisfactory. In the latter event, or if exhaust gases are released at the tail pipes, a tube of at least 3-1/2 inches ID and with an elevated intake should be connected to this port by a flexible duct.

10-42. GEAR CASE HEAT TUBE. Only if the engine is to be started at an ambient temperature of —18°C (0°F) or lower and only if the heater is to be operated, connect a flexible duct between the side outlet of the heater outlet tube and the oil filler tube adapter on the generator gear case housing (right side).

10-43. MAGNETO CHECKS.

10-44. The single ignition system does not permit a drop off check. There is no automatic spark advance. When the engine is being cranked listen for loud clicks at the magneto which indicate that the impulse coupling is working. Immediately after starting the clicks should cease. Thereafter, the magneto is driven at full spark advance. During the warm-up period test the magneto switch circuit by turning the switch to "OFF" for an instant. If the ignition system does not cease firing the circuit to ground is open at some point. In that event stop the engine by turning off the fuel supply, and correct the circuit before starting again.

TABLE XVII. RECOMMENDED RUN-IN SCHEDULE

Period	*RPM*	*Time (Minutes)*	*Elapsed time End of Period (hr:min)*	*Load*		*Checks and Adjustments*
				Torque (lb. ft)	*bhp*	
1	800	10	0:10	0	0	Visual. Adjust idling speed, mixture
2	1200	*10	0:20	94.5	21.6	
3	1400	10	0:30	128.0	34.1	
4	1600	10	0:40	167.0	50.9	
5	1800	15	0:55	212.0	72.6	
6	2000	15	1:10	261.5	99.6	
7	2200	15	1:25	315.5	132.3	
8	2400	15	1:40	†	†	
9						Adjust governor
10	800	**15				Visual

* Extend this period, if necessary, until oil temperature reaches 32°C (90°F).
† Full load at wide open throttle.
** Operate with corrosion preventive and oil mixture in lubricating system.

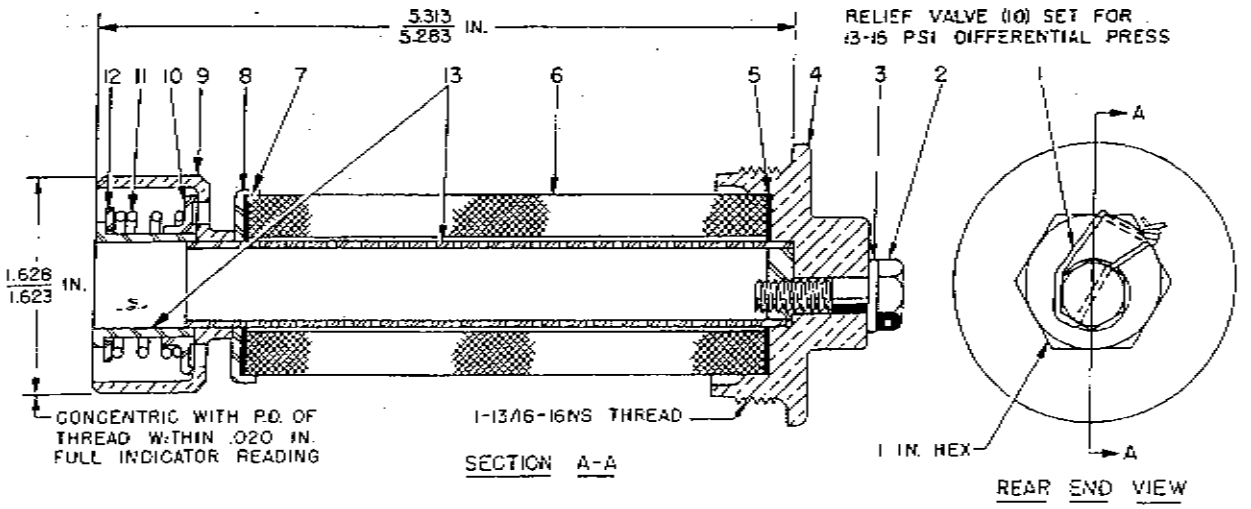
SECTION XI
ACCESSORIES

11-1. OIL FILTER. *(See figure 11-1.)*

11-2. DISASSEMBLY. Remove lockwire (1) from the hex head bolt (2), and remove the bolt and the washer (3). Withdraw from the tube assembly (13), in the order named, the brass plug (4), its gasket (5), the corrugated filter element (6), gasket (7), retainer (8), pilot cup (9), bypass valve (10), spring (11) and washer (12).

11-3. CLEANING. If necessary, soak the filter element in mineral spirit or dry cleaning solvent to loosen sludge. Do not use any forceful method on the part. Clean all other parts with the same solvent, applied by brush or spray. Take particular care to avoid scratching or nicking the valve face and seat. Allow solvent to drain from the element, and blow off the other parts with a jet of dry compressed air.

11-4. INSPECTION. Inspect the corrugated filter element visually for deformation, punctures and sludge. It must be thoroughly clean and undamaged. Discard the element if punctured or deformed or if foreign deposits cannot be removed almost entirely. Inspect threads and gasket seat of the plug (4). Discard the plug if seats are irregular or threads damaged or if the wrench hex is seriously deformed. Look for distortion and wear in the tapped hole of the tube plug. Inspect the retainer (8) for bending and other damage which would prevent it from sealing the element. Inspect the seating surfaces of the bypass valve (10) and pilot cup (9) for wear and roughness. These parts must seal perfectly. Both must slide freely on the tube but without looseness. Inspect the valve spring (11) for distortion and corrosion. Inspect the washer (12) for deep groove wear and visible cracks. Make sure that the tube holes are clear. Inspect the pilot cup's large end for out-of-roundness. It must enter the accessory case counterbore freely when the reassembled filter is screwed into the mounted housing.



1. Lockwire
2. AN102913 drilled hex head bolt
3. Continental Motors Corp. No. 530671 solid copper washer or equivalent
4. Air-Maze No. Q9S471-140 plug
5. Air-Maze No. Q9S471-66 gasket
6. Air Maze No. Q9S552-07 filter element
7. Air-Maze No. Q9S471-66 gasket
8. Air-Maze No. Q9S471-211 retainer
9. Air-Maze No. Q9S552-233 pilot cup
10. Air-Maze No. Q9S471-214 bypass valve
11. Air-Maze No. Q9S471-110 spring
12. Air-Maze No. Q9S471-173 spring seat washer
13. Air-Maze No. Q9S552-218 tube assembly

Note. This data will be superseded by a list to be added to the Illustrated Parts Breakdown.

Figure 11-1. Air-Maze Oil Filter Assembly

11-5. REPAIR. Smooth any nicks in the brass plug threads with a triangular, hard Arkansas stone. Smooth any nicks on other parts, except the sealing lip of the bypass valve, which must be perfect. Normally it will not be economical to attempt repair of more extensive damage. Any parts which are deformed or worn visibly should be replaced.

11-6. ASSEMBLY. Lubricate the large end of the tube assembly (13), and stand it on its flange end. Lubricate and install on the tube, in the order named, a washer (12), a spring (11), a valve (10), a pilot cup (9) and a retainer (8). Place a new gasket (7) in the retainer, and seat an element (6) on it. Place a second gasket (5) on the element and the plug (4) on top of the stack, with its screw hole aligned with the off-center tapped hole in the tube plug. Compress the valve spring by holding the pilot cup down to the bench and install a screw and washer (2, 3). Make sure that the element is seated on both gaskets; then tighten the retaining screw, while holding the assembly by the plug (4) only; then install lockwire (1) as illustrated. Make sure that all visible surfaces are free from foreign matter. Spread a film of general purpose grease, MIL-L-7711, on the plug threads; then dip the valve end and the element into clean engine lubricating oil, MIL-L-6082, grade 1100, up to but not including the brass plug. Drain the assembly, and wrap it in oilproof paper.

11-7. AC THERMOSWITCH.

11-8. TESTING. This switch is designed to break contact at 149°C (300°F) and to remain open at higher temperatures. The manufacturer specifies testing by immersion of the sensitive end to a depth of 3/8-1/4 in. short of the wrench hex in GM No. 4695M, grade H-100, hydraulic oil or equivalent with a flow of 25-35 fpm, and specifies that the unit must be tapped while checking calibration. Connect one terminal to battery positive and the other to battery negative terminal. With the manual circuit switch closed, a test indicator lamp connected in series with the unit will be illuminated until the thermoswitch breaks the circuit. The temperature at which this occurs (while the unit is tapped lightly) should fall within limits given in Table XVIII. Discard any unit which fails to pass the test, since it is a permanent assembly and not subject to repair.

11-9. EXHAUST JACKET THERMOSWITCH.

11-10. TESTING. *(See figure 11-2.)* This switch is designed to close at 26.7°C (80°F) as the temperature of air in contact with its sensitive side (opposite the terminals) is reduced, to open at 37.8°C (100°F) as the air temperature increases and to remain open at higher temperatures.

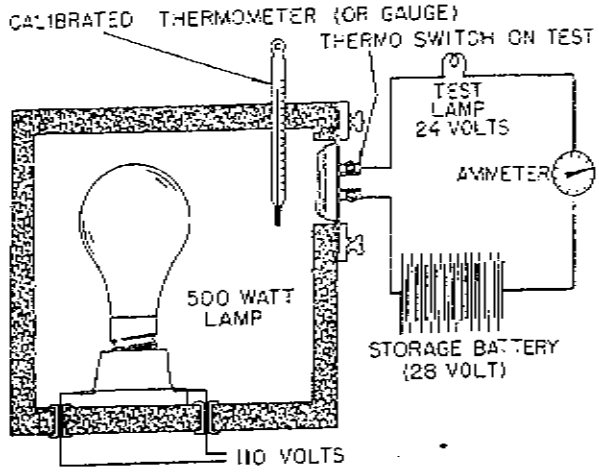


Figure 11-2. Exhaust Jacket Thermoswitch Test Set-up

11-11. *(See figure 11-2.)* A suggested test set-up is illustrated, however alternate equipment may be used, particularly for heating the switch and for measuring the air temperature. It is essential that the thermometer be at the same temperature as the switch surface, hence radiant heat should not be directed against the switch. A liquid (oil or water) may be employed instead of air in the heating compartment. The test should start at a temperature below the minimum closing temperature and end at approximately the same point. Discard any switch unit which fails to open or close within the tolerance ranges specified in Table XIX.

11-12. LEDEX ROTARY SOLENOID.

11-13. TESTING. The solenoid shaft turns from its open circuit stop in the clockwise direction (looking at the shaft end) through an angle of 67-1/2 degrees when a 24-volt current is applied across the lead-in wires. When no current is flowing through the solenoid, its shaft pin hole should lie at right angles to the line of attaching studs and the shaft coupling slot should align with the studs. It is necessary only to test for the approximate angular travel

TABLE XVIII. OPERATING LIMITS OF AC OIL SUMP THERMOSWITCH

Manufacturer's Part No.	*Normal Circuit*	*Switching Function*	*Nominal Switching Temperature*	*Permissible Switching Limits*	
				Minimum	*Maximum*
1512786	Closed	Break	+149°C (+300°F)	+146.1°C (295°F)	—151.7°C (305°F)

TABLE XIX. EXHAUST JACKET THERMOSWITCH TEST DATA

Manufacturer's No.	Battery Voltage	Current (Amperes)	Opening Temp.		Opening Temp.	
			Minimum	Maximum	Minimum	Maximum
4253	28	5	32.2°C (90°F)	37.8°C (110°F)	21.1°C (70°F)	32.2°C (90°F)

of the shaft by connecting the solenoid lead-in wires across the terminals of a 24-volt storage battery. Do not allow the current to flow longer than a few seconds at a time.

11-14. HARRISON OIL COOLER.

11-15. CLEANING.

a. Soak the assembly in a tank of mineral spirit, Federal Specification TT-T-291 or in dry cleaning solvent, Federal Specification P-S-661 to loosen and wash out heavy sludge deposits and oil.

b. Blow out the cooling fins and dry the exterior with a jet of dry compressed air after draining the cooler.

c. For the final cleaning operation a tank of at least 10 gallons capacity with a solution circulating pump system of approximately 35 gallons per minute delivery at 75-150 pounds per square inch pressure should be used to circulate through the cooler core a solution of an inhibited, mild alkaline cleaning compound, such as Oakite No. 61 (6 oz. of Oakite per gallon of water) or materials specified for similar purposes in T. O. 2R-1-84 and T. O. 2R-1-1, maintained at a temperature between (71°C (160°F) and 82.2°C (180°F). A pressure gauge should be installed in the supply line and another in the discharge line to measure the pressure drop through the cooler. Adapters for attachment of the solution hoses to the cooler mounting pad studs must be made locally. Arrange the supply hose to delivery solution from the circulating pump, through a filter, to the normal cooler outlet (left end) and the discharge hose to empty into the supply tank below the liquid surface. The pump inlet port must be connected to the solution tank in such a manner as to prevent recirculation of any large, solid particles.

d. With the oil cooler and flushing equipment set-up as described in the preceding step, circulate the alkaline cleaning solution through the cooler core for a period of 30 minutes, or until the discharged solution appears clean.

e. Flush the cooler core thoroughly with clean, hot water, and drain it as completely as possible. Blow off the exterior with dry compressed air.

CAUTION

Use only a mild, alkaline cleaning solution which is approved for cleaning aluminum parts. Strong alkaline solutions will destroy the assembly by corrosive action. If any such solution has been used in the circulating system it must be washed out thoroughly before this operation. It is essential that all alkaline material be removed from all exterior and interior surfaces of the oil cooler, since alkaline residues will mix with lubricating oil to form an emulsion which will foam and may cause failure of the lubricating system.

After a flushing operation empty the solution filter, and examine the filtering element for metallic particles. If any significant volume of such particles is found the oil cooler from which they came should be destroyed, since there is no method of determining when all such particles have been removed.

11-16. INSPECTION.

a. Look for obstructions between the air fins.

b. Inspect the 16 flat tubes, the air fins and the headers for dents and bending. Any distortion of tubes or headers will indicate the possibility of cracks, broken joints or small holes. The fins must not be bent so as to restrict the cooling air flow.

c. Inspect the mounting pads for deep scratches and cracks. Such defects will prevent the gaskets from sealing the oil passage.

d. To test for leaks block either oil port with a gasket and plate attached over the mounting pad: seal an air pressure hose adapter to the other port and mounting pad: connect to the adapter an air hose equipped with a pressure gauge: lower the oil cooler below the surface of water in a test tank, and apply an air pressure of 100 pounds per square inch. Air bubbles escaping from any point on the cooler will indicate the location of a crack, broken joint or hole. Circle such locations with colored, waterproof crayon marks to identify points which may be repairable.

11-17. REPAIR.

a. Because of the welded construction, repairs are not recommended by the manufacturer, however, emergency repairs may be made to stop leaks in accessible locations, such as tube seams and header surfaces when replacement assemblies are not available. Do not attempt to repair oil coolers with blown or bulged tubes.

b. Clean thoroughly the area surrounding the crack or hole.

c. Apply a thin coat of a solution of Alcoa No. 33 flux in water.

d. To repair tube leaks, heat the metal with an acetylene torch equipped with a No. 3 tip, and apply Alcoa No. 716 welding wire of 1/16 inch diameter.

e. To repair header leaks or mounting pad cracks, heat

the metal with an acetylene or hydrogen torch equipped with a No. 5 tip and apply Alcoa No. 43S welding rod or Alcoa No. 718 welding wire of 3/32 inch diameter.

f. Remove all traces of welding flux by wiping all accessible areas with a clean cloth wet with hot water; then scrub with a stiff bristle brush and hot water, and wipe again with a wet, hot cloth. Flush all inaccessible areas thoroughly with hot water and dry with compressed air several times.

g. Repeat the air test described in paragraph 11-16 step "d".

CAUTION

All aluminum welding fluxes are highly corrosive. Exercise care to prevent the flux from entering the cooler core. Complete removal of the flux residues is essential for the same reason.

11-18. TESTING. Connect to either oil port of the cooler a supply hose leading through a valve from a source capable of supplying a low viscosity lubricating oil at a static pressure of 200 pounds per square inch. Fill the cooler by circulating oil until all air has been displaced; then block the open oil port with a plate fitted with a pressure gauge. Apply a pressure of 200 pounds per square inch, and close the supply line valve. The pressure gauge should indicate no drop in pressure for a test period of 20 minutes.

11-19. LUBRICATION. Prior to storage an oil cooler should be flushed with clean, low viscosity lubricating oil at a temperature of approximately 71.1°C (160°F). Drain the bulk of the flushing oil, leaving a coating inside the passage. Plug the oil ports, and store the cooler in a suitable container.

11-20. TITEFLEX IGNITION HARNESS ASSEMBLY.

11-21. DISASSEMBLY.

a. Pry the brass nail from the spark plug end of each cable.

b. Pull off the ceramic sleeve and spring terminals and the rubber sleeves.

c. Unscrew all six spark plug elbow hex coupling nuts, and pull off the elbows.

d. In turn, loosen with a suitable spanner wrench the slotted nuts which hold the six cable conduits to the high tension outlet plate, and unscrew all of them.

e. Detach the cables from the outlet plate and grommet by straightening the bent wire strands at the ends; then carefully pull apart the plate and its grommet.

f. Pull each cable from the outlet plate grommet and through the plate.

g. Pull the cables from the straight ends of the conduits and discard them. Save only the outlet plate, cable conduit assemblies, spark plug elbows and terminal sleeve which are undamaged.

11-22. CLEANING. Remove dirt and oil from the conduit assemblies, spark plug elbows and ceramic sleeves by brushing with dry cleaning solvent, Specification P-S-661. The ceramic sleeves are extremely fragile. Dry the parts by draining and store them in suitable containers.

11-23. INSPECTION. Inspect ceramic spark plug terminal sleeves for cracks, chipped edges and flattened contact springs. Discard any sleeve with any of these defects. Inspect the elbows for thread condition, cracked, flattened or deformed coupling nuts, deformed elbow tubes and loosened joints. Discard damaged assemblies. Inspect the conduit assemblies for coupling nut condition, loosened or deformed ferrules and elbows and frayed shielding braid. In an emergency, small braid defects may be repaired with half hard solder, however, damaged conduits should not be reinstalled if replacements are available.

11-24. ASSEMBLY. *(See figure 11-3.)*

a. Procure a complete set of parts to make up an assembly as illustrated.

b. From bulk 5 mm. cable, MIL-C-3162, Type I, class B, cut one piece for each of the six conduits to lengths specified in Table XX.

c. Feed the six cables through the shield conduits from the straight ends, until they project approximately three inches from the magneto end elbows.

d. Insert each cable through the proper hole in the cable outlet plate, and screw the slotted elbow coupling nuts into the plate loosely.

Note

In figure 11-3 the outlet plate cable holes are numbered in magneto firing order. Conduits and connectors are listed in the same order in the first column of Table XX. The second column of the table gives numbers of cylinders to which the cables will be connected. The sequence of these numbers is the engine firing order. The outlet plate has a numeral "1" stamped in its central rear side depression adjacent to the No. 1 cable hole. Start with the No. 1 cable, and proceed counterclockwise, turning the elbows in the illustrated directions. (Compare conduit part numbers in figure 11-3 with lengths in Table XX. The two conduits with long elbows are numbered "3" and "6" in the illustration. The others have short elbows.

e. Strip the insulation from 1/2 inch of the magneto end of each cable.

f. Over the stripped cables push new rubber sleeves. (See enlarged view.) Push the sleeved cable through a new outlet plate grommet, guiding the bare strands through its close fitting holes.

g. Place a slotted washer over the bare strands of wire projecting from each grommet cable hole. Separate the strands of each cable into two approximately equal groups and bend them around through the opposite washer slots and in behind the washers, as illustrated in the enlarged view.

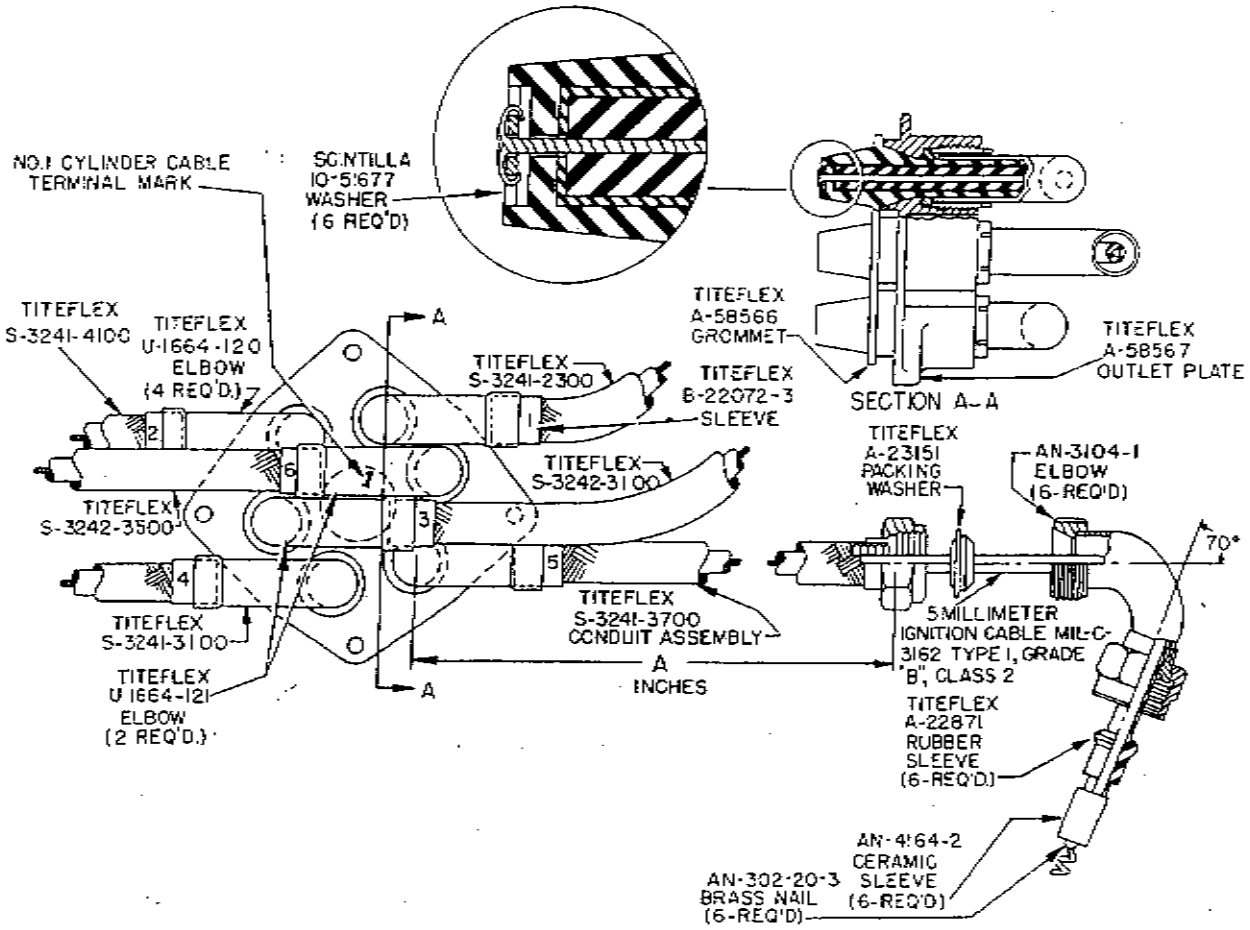


Figure 11-3. Assembly of Titeflex Ignition Harness

h. Push the outlet plate grommet firmly into the recesses provided for it in the front side of the outlet plate, meanwhile pulling the cables back through their conduits, without pulling them from the grommet.

i. Tighten the magneto elbow slotted coupling nuts moderately with a suitable spanner wrench.

j. Push a new packing washer over the spark plug end of each cable with its cone face outward.

k. Slide six spark plug terminal elbows over the exposed cable ends, taking care to avoid damage to the cable insulation ends. Screw on the conduit hex coupling nuts, but do not tighten them.

l. Strip the insulation from a length of 1/4 inch at the exposed end of each cable.

m. Push a new rubber sleeve over the exposed end of each cable, and seat all of them in the elbows.

n. Push a serviceable ceramic terminal sleeve and spring assembly over the exposed end of each cable. Twist the sleeve so as to keep the wire strands twisted, and guide them through the eyelet. If the cable is too long to permit the ceramic sleeve to touch the rubber sleeve when pushed inward with moderate force it must be cut shorter. This should not be necessary if cables were cut to specified lengths.

o. Separate the wire strands, and bend them down around the end of the eyelet so that they are evenly spaced.

p. Insert a brass nail through the eyelet in each ceramic sleeve, and drive it into the cable squarely to pierce the bundle of wire strands.

11-25. WILCOX-RICH HYDRAULIC VALVE LIFTERS.

11-26. DISASSEMBLY. *(See figure 11-4.)* When the lifters are disassembled, it is essential that a suitable rack be available for storage of the parts in their original relations. This is an absolute necessity with regard to parts of hydraulic units. It is advisable to disassembly these units immediately before they are to be cleaned and to carry out the disassembly, cleaning, inspection and re-

TABLE XX. IGNITION HARNESS DATA

Magneto Outlet No.	Cylinder No.	Titeflex Conduit Part No.	Magneto Elbow Type	"A" Dimension	Cable Cutting Length (Inches)
1	1	S-3241-2200	Short	22 in.	27½
2	6	S-3241-4000	Short	40 in.	45½
3	3	S-3242-3000	Long	30 in.	36
4	2	S-3241-3000	Short	30 in.	35½
5	5	S-3241-3600	Short	36 in.	41½
6	4	S-3242-3400	Long	34 in.	40

assembly operations in one continuous process. Use the following disassembly procedure:

a. With a knife point or other sharp instrument, carefully pry the wire snap ring from the groove at the outer end of the shank. In order to do this, it will be necessary to depress the socket slightly. Use a discarded pushrod or other ball end tool for this purpose.

b. Invert the lifter, and the socket and hydraulic unit will fall into the palm of the hand. Place the body and socket in the rack.

c. Usually the hydraulic unit plunger may be removed from the cylinder by pulling it outward, while turning in the direction which tends to "wind up" the spring under its head. If the plunger appears to be "frozen" in the cylinder it may be held tightly between the oil under it and

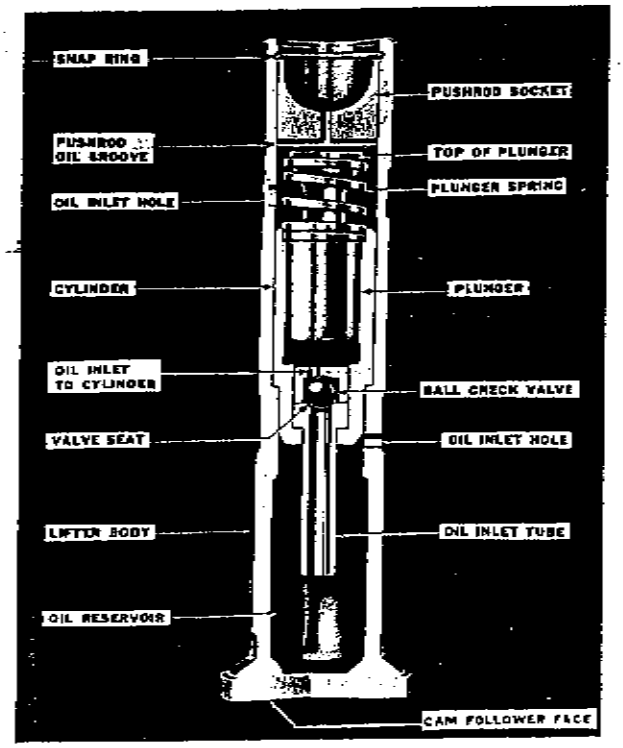


Figure 11-4. Cutaway View of Hydraulic Valve Lifter

Figure 11-5. Releasing Hydraulic Unit Check Valve

a ring of carbon on the cylinder wall. To test for this condition and to release the plunger simultaneously, insert a medical swab stick, or similar hardwood dowel, into the open end of the inlet tube, and depress the ball check valve. *(See figure 11-5.)* This will release oil from the cylinder and the plunger may be depressed, unless it is actually stuck to the cylinder. A ring of carbon may be disintegrated and the plunger may be removed by both turning and pulling outward, in an oscillating fashion, while gripping the plunger head with tape-covered pliers. *(See figure 11-6.)*

11-27. CLEANING. All parts of each lifter assembly should be degreased thoroughly by dipping and brushing in clean, approved solvent in a small cake pan, or similar container which can be placed near the parts rack on a well-lighted bench. All traces of dirt must be removed. Extreme care must be exercised to avoid interchanging parts of the assemblies. The cleaning procedure should be carried out immediately prior to inspection and testing to avoid an additional cleaning and preserving operation. The parts and assemblies must not stand for more than a few minutes without application of a corrosion preventive coating.

11-28. INSPECTION AND TESTING.

a. Inspect the face of the cam follower on the body for any of the types of damage illustrated in figure 11-7. In-

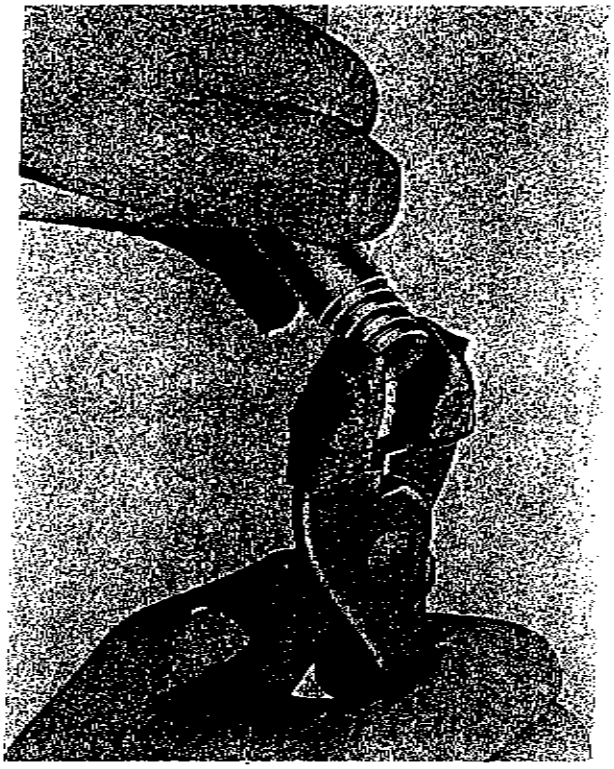


Figure 11-6. Removing Stuck Plunger From Hydraulic Unit

spect the body bearing surface for scoring and corrosion. Discard any lifter body which exhibits any of these faults.

b. Inspect the pushrod socket for excessive wear and roughness in the spherical cavity. Wear is indicated by a polished area at the bottom of the cavity with a sharp boundary. The diameter of the worn area and its apparent depth below the original, smooth contour give a visual indication of the extent of wear, however the appearance is usually deceptive, hence a socket should not be discarded unless there is some evidence of penetration of the hardened surface layer, or unless the unit produces an excessive "dry" lash wherever it is installed in an engine.

c. Test roughly for diametrical clearance and check valve wear in the hydraulic unit by starting the dry plunger into the dry cylinder, then pushing it in and releasing it quickly. For this test hold the cylinder between the thumb and middle finger, and depress the piston with the index finger. The compression of air in the cylinder should make the plunger kick back instantly. If the piston does not return fully, either it is excessively worn, or the check valve is leaking. To check for a leaking valve, repeat the compression test while plugging the end of the oil inlet tube with the other hand. If the plunger does not kick back promptly it and the cylinder are excessively worn. If it does kick back on the second test, either the check valve seat is worn and leaking or it is dirty. In this event clean the cylinder again, and repeat the first test (tube open). If the plunger still does not kick back the valve is defective. Any unit which fails to pass this rough test must be discarded. Discard both the cylinder and the piston since these parts are selectively fitted and are not interchangeable.

11-29. Inspect the hydraulic units which have passed the rough test described in the preceding step for correct leak-down rate with the aid of the hydraulic valve lifter leak-down rate checking fixture tool No. J-1297-B, in the following manner:

a. Wash the tool thoroughly with kerosene to remove all traces of dust and rust. Bolt the tool firmly to a workbench in a convenient location. Do not attempt to operate without bolting it to a solid structure.

b. Fill the reservoir of the tool with kerosene until flush with the top of the sockets which hold the units.

c. Prepare master units, received from the factory, in the following manner: Wash thoroughly in clean kerosene. Handle the units one at a time so as not to mix their parts. Remove the plunger from its cylinder as described in paragraph 11-26. With the plunger removed from its cylinder, move the cylinder back and forth vigorously in the kerosene so that the liquid can enter the bore and the tube. Also wash the plunger before reinserting it in the cylinder. Replace the plunger in the cylinder and be sure that the spring is snapped into the counterbore. To assemble the plunger in the cylinder, the cylinder should be placed on the pin provided on the side of the tool. This pin will push the check ball off its seat and will permit air or kerosene to escape. The plunger then can be pushed into the cylinder with ease.

Note

This pin should be used at all times in replacing the plunger in the bore. To snap the spring into the counterbore, give the plunger a twist while the plunger is pressed all the way down.

d. Fill the master units by placing on the pin in the kerosene reservoir and pumping the plunger several times. Insert units in sockets.

e. Rest the weight of the handle on the beam pilot, set adjusting screw on the beam so that the beam is horizontal, and set the indicator pointer at "0".

f. Press down on the handle with sufficient force to compress the two units. Repeat this operation several times and watch movement of the pointer. If the units are filled, it will be noted that they are rather hard to compress. If the units are not filled, they can be pushed down rather easily. It is essential that they be filled and that the operation is not too easy.

Note

Observe the first movement of the pointer, as this direction is the correct one, because direction of pointer movement will reverse or give a false reading after one unit bottoms.

g. This test checks one master against the other. There should be very little movement of the pointer until one

unit bottoms. If, at any time, one unit checks "no go" against the other, the unit checking "no go" should be replaced by a new master. Master units are identified by a band of red paint around the cylinder.

Note

Master units should have the numeral "6" electric etched in the unmachined surface to identify them as 3-6 second leakdown rate units.

h. After checking the master units, remove the unit from the position marked "test", and leave the one master unit in the position marked "master"

i. Prepare the units taken from the engine in exactly the same manner as outlined for the master units.

j. Insert unit taken from engine in socket marked "test". Follow the procedure outlined above for checking the masters.

k. If the indicator swings down toward "no go", it indicates that the unit is below standard and it should be replaced. If the pointer swings toward "go" or stays on "0", the unit is all right for further use.

Note

Remember that the direction in which the pointer first moves indicates the condition of the unit. The distance the pointer moves is no indication of the unit's condition. Due to slight variations in length of the units, the pointer will not always return to "0". Therefore, it is necessary to watch the direction in which the pointer moves when the handle is first pushed down. Readings should be taken four to five times to make sure that the results are consistent. If results are inconsistent after several trials, the unit being tested should be removed from its socket and washed out thoroughly. Refill the unit by using the pin in the kerosene reservoir and repeat the test. If the results are still inconsistent, the unit should be replaced.

11-30. REPLACEMENT. Hydraulic units (piston, spring and cylinder) may be replaced as assemblies in any valve lifter. The parts of these units are selectively fitted at the factory to produce the desired leakdown rate, and they must never be interchanged. Lifter bodies may be replaced independently of hydraulic units if original parts were damaged. It is advisable to install used lifter bodies in the same engine guides which they originally occupied. New bodies may be installed in any engine guide with new or original hydraulic units in them. Pushrod sockets should be reinstalled in contact with the same ball ends of the same pushrods with which they originally operated, unless either pushrod or socket is a new part. Sockets may be replaced independently of other parts. In order to meet these requirements and to minimize wear on individual parts the lifter parts and units should be kept in their numbered positions in the parts rack except for those which were discarded. Place new parts in the vacant spaces of the rack to make up a complete set of lifters.

11-31.

a. Clean all parts with dry cleaning solvent and drain them immediately before starting assembly work.

b. Lubricate the interior and exterior surfaces of the cylinder and the surface of the piston and spring with only a film of engine lubricating oil and corrosion preventive mixture (paragraph 8-4). Do not lay the parts down after lubricating. Start the piston into the cylinder and twist it to wind up the spring while pushing inward until the spring snaps into the cylinder counterbore.

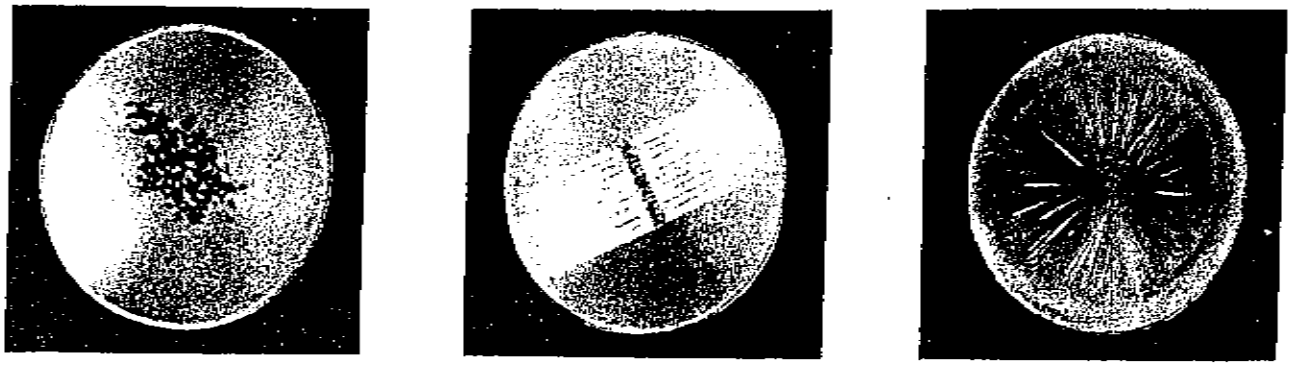
c. See that the valve lifter body is protected with only a film of engine lubricating oil and corrosion preventive mixture inside and out. Insert the hydraulic unit, tube first, against the body inner shoulder.

d. Place the socket, grooved flat side inward, on the piston, and depress it with a pushrod or other ball end tool until the snap ring can be installed in its groove. Seat the snap ring all around.

e. When all valve lifters have been assembled in this manner and replaced in their correct positions in the parts rack, cover them to exclude dust and grit until ready to install them in the engine.

11-32. OIL PRESSURE GAUGE ENGINE UNIT.

11-33. The engine unit is a factory sealed and calibrated



Pitting (or Spalling) Worn in Groove Scoring

Figure 11-7. Defects of Lifter Body Follower

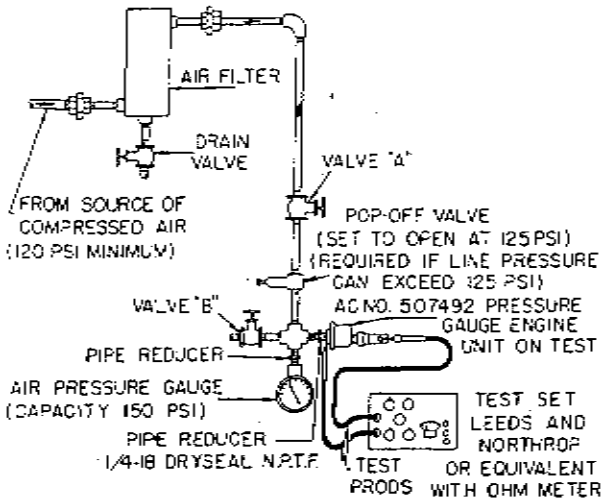


Figure 11-8. Oil Pressure Gauge Engine Unit Test Set Up

rheostat whose resistance coil contactor is operated, against a spring, by a flexible diaphragm sealed by a gasket between the pipe threaded mounting base and the rolled over metal cover. Liquid or gas is admitted to the engine side of the diaphragm through a 0.025 (plus or minus 0.003) inch diameter restriction hole drilled axially through the base. The unit is not repairable or adjustable, and it will be destroyed by disassembly.

11-34. Both mechanical and electrical failures may occur and may not be capable of detection by visual inspection. Possible mechanical defects include looseness of components, punctures, fatigue cracks, damaged mounting threads, plugged restriction hole, and crushing. Electrical failure may be caused by breaks in wiring, burned out resistance coil and damaged insulators. Tests for such defects should be made at each overhaul and whenever a unit is suspected of malfunction. Such tests should be independent of the instrument panel gauge unit, which is not required, since it is only necessary to test for leakage, electrical shorts, burned out coil and deviations from the pressure-resistance relations specified in the following table.

CALIBRATION OF OIL PRESSURE GAUGE ENGINE UNIT

Pressure (psi)	*Resistance Across Unit (in Ohms)*	
	Minimum	*Maximum*
0	0	1.0
10	1.5	3.0
60	14.5	16.5
120	28.0	31.0

11-35. A suggested set-up of equipment for testing these units is illustrated in figure 11-8. These units also may be tested with a pressure oil system in lieu of compressed air.

11-36. Start the test by reading and recording the resistance indicated by the ohmmeter with valve "A" closed and valve "B" open. The data on the first line of the above table is applicable. Tap the unit lightly on either side or end of the cover. The ohmmeter should not indicate any permanent change in resistance. Close valve "B" and open valve "A" slowly until the pressure gauge indicates 10 psi. Again read the ohmmeter and record the reading. Tap the unit and watch the meter for any permanent resistance change. Repeat this test procedure at 60 and 120 psi pressure. Close valve "A" and hold the last test pressure for several minutes, meanwhile tapping the unit periodically to simulate the vibration to which it will be subjected in service and listening for air leaks. A continuous drop in electrical resistance and air pressure will indicate a leak in the unit diaphragm if the test piping, valves and joints are tightly sealed. After completion of the leakage test, open valve "B" slightly and check the indicated resistance at each specified test pressure against those previously recorded. Open valve "B" wide before disconnecting the electrical circuit or unscrewing the unit. Discard any unit which is more than 10% inaccurate or which has a leaking diaphragm or which gives a fluctuating indication.

CAUTION

Since the engine unit's electrical resistance is very low when the unit is not under pressure take care to avoid subjecting it to full battery voltage by unauthorized test procedures.

11-37. ELECTRICAL CABLES.

11-38. All data required for cutting of electrical cables and assembly of terminals are given in Table XXI.

11-39. AC FUEL PUMP.

11-40. Replace worn or damaged parts after disassembling the pump. Replacements for parts subject to the most rapid wear, including a new diaphragm assembly, valves, gaskets and lever spring, are available in a repair kit supplied for maintenance by United Motors Service, General Motors Bldg., Detroit, Michigan.

Note

The rebuilt pump must be capable of delivering at a static pressure of 4-5-3/4 psi, measured at a point of 16 in. above its discharge port, when operated at 1800 cycles per minute.

11-41. OTHER ACCESSORIES.

11-42. For overhaul instructions on accessories not covered in this section, refer to applicable Air Force and Navy handbooks.

TABLE XXI. ELECTRICAL CABLES

Cable Assembly Part No.	Qty. Req'd	Cable Terminals			Wire Size	‡Length (Inches)
		Type	Manufacturer	Part No.		
532584-19	1	Crimped eyelet	Electric Auto-Lite Co.	300158	*16	19
532584-31	2	Crimped eyelet Crimped eyelet Crimped eyelet	Electric Auto-Lite Co. Electric Auto-Lite Co. Electric Auto-Lite Co.	300158 300158 300158	*16	31
532584-45	1	Crimped eyelet Crimped eyelet Crimped eyelet	Electric Auto-Lite Co. Electric Auto-Lite Co. Electric Auto-Lite Co.	300158 300158 300158	*16	45
532658-6	1	Crimped eyelet 1/4 in. of bare wire	Electric Auto-Lite Co.	300158 None	*16	6
532658-20	1	Crimped eyelet 1/4 in. of bare wire	Electric Auto-Lite Co.	300158 None	*16	20
532658-21	1	Crimped eyelet 1/4 in. of bare wire	Electric Auto-Lite Co.	300158 None	*16	21
533386-12	1	Locking connector †Bayonet	Burndy Engineering Co. Douglas Mfg. Co.	YZ-18-HI 51358	*16	12
534393-18.5	1	Crimped eyelet Locking connector	Electric Auto-Lite Co. Burndy Engineering Co.	300158 YZ-18-HI	*16	18½
534393-37	1	Crimped eyelet Locking connector	Electric Auto-Lite Co. Burndy Engineering Co.	300158 YZ-18-HI	*16	37
535163-17	1	†3/8 in. screw eye †1/2 in. screw eye	Thomas & Betts Co. Thomas & Betts Co.	J-73 J-75	†† 0	17
535164-33	1	†1/2 in. screw eye †1/2 in. screw eye	Thomas & Betts Co. Thomas & Betts Co.	J-75 J-75	†† 0	33

* Cable assemblies supplied by packette manufacturer under part Nos. in first column are made of Auto-Lite No. 103510, type 4, silver sheathed, low tension cable with tinned, 16 ga. conductor.
† Terminal swaged on cable.
‡ Overall length, including terminals. Measure to centers of eyes, to ends of others.
†† Cable must conform to Specification MIL-W-5086.

SECTION XII
TABLE OF LIMITS

12-1. PURPOSE.

12-2. The tables of dimensional limits in this section are applicable only to the Continental type PE150-6 packettes. These tables shall be used in connection with inspection, repair and assembly operations described and indicated in the preceding sections of this publication to determine whether worn parts are dimensionally serviceable and to determine the extent of wear, as well as to determine the serviceability of repair and replacement work.

12-3. USE OF TABLES.

12-4. DEFINITIONS OF TERMS AND ABBREVIATIONS. In the following tables loose fits — such as diametrical clearances, side clearances and end plays— are denoted by the letter "L" following the numerical value. Interference (tight) fits, in which the female part is smaller than the male part — when measured at room temperature — are denoted by the letter "T". The abbreviation "Replace. Maximum" indicates the term "Replacement Maximum", defined in paragraphs 12-5 and 12-6. All dimensions are stated in inches.

12-5. SIGNIFICANCE OF LIMITING VALUES. In the following tables dimensional limits are placed in three columns. Values in the two columns under the heading, "New Parts", apply when both mating parts concerned in a specification of fit are new parts, drawn from stock for replacement purposes, or when the dimension in the "Replace. Maximum" column represent the greatest departure from desired fits, sizes and strength permissible in rebuilt engines and apply to worn parts. It will be observed that "Replace. Maximum" dimensions are not always larger in numerical value than corresponding dimensions of new parts.

12-6. DETERMINATION OF SERVICEABILITY. Minimum and maximum values of dimensions applicable to new parts are set up as ideal limits. Measurements which indicate no greater departure from ideal sizes and clearances and strength than the replacement maximum values permit the parts concerned to be continued in service. When no figure appears in the "Replace. Maximum" column, the fit must be within limits stated in the "New Parts" column.

12-7. MEASUREMENT OF PARTS. Use dimensional data in these tables and in Table V to determine the extent of wear on critical dimensions of parts for which special gauges are not provided.

12-8. REJECTION AND REPAIR. Parts and assemblies rejected for excessive wear, but otherwise serviceable, shall be discarded only when no repair procedure is described or indicated in Section VII. Inspection personnel will specify installation of available oversize parts to maintain interference fits within "New Parts" limits.

12-9. TIGHTENING TORQUES. The torque values specified in the table of tightening torques are applicable when threads are coated with a minimum film of engine lubricating oil. When a graphited thread lubricant is applied the torque values should be reduced approximately 20%.

TABLE XXII. TABLE OF LIMITS

Ref. No.	*Chart No.*	*Description*	*New Parts* *Minimum*	*New Parts* *Maximum*	*Replace. Maximum*
		CYLINDER AND HEAD ASSEMBLY			
1	1	Cylinder bore (lower 4-1/4 in. of barrel length).....dia:	5.001	5.003	5.006
2	1	Cylinder bore (at top).....dia:	4.989	4.993	5.000
3	1	Cylinder bore (upper 2-1/2 in. of length).....choke:	.010	.012	.006
4	1	Cylinder bore.....out of round:			.002
5	1	Cylinder bore (reground).....allowable oversize:			.015
6	1	Intake valve seat insert in cylinder head.....dia:	.009T	.012T	
7	1	Exhaust valve seat insert in cylinder head.....dia:	.007T	.010T	
8	1	Intake valve guide in cylinder head.....dia:	.001T	.0025T	
9	1	Exhaust valve guide in cylinder head.....dia:	.001T	.0025T	
10	1	Intake valve seat.....width:	.107	.156	
11	1	Exhaust valve seat.....width:	.120	.171	
12	1	Valve seat to guide axis.....angle:	44°-30'	45°	

TABLE XXII. TABLE OF LIMITS (Cont)

Ref. No.	Chart No.	Description	New Parts Minimum	New Parts Maximum	Replace. Maximum
		VALVE ROCKERS AND SHAFT			
13	1	Rocker shaft in cylinder head bosses....dia:	.000	.0015L	.003L
14	1	Rocker shaft in valve rocker bearing....dia:	.001L	.0025L	.004L
15	1	Valve rocker bearing in rocker....dia:	.0005T	.0025L	
16	1	Valve rocker assembly....side clear.:	.004L	.011L	.015L
		VALVES			
17	1	Intake valve in guide....dia:	.0012L	.0032L	.005L
18	1	Exhaust valve in guide....dia:	.003L	.005L	.008L
19	1	Intake valve face (to axis)....angle:	45°	45°-30′	
20	1	Exhaust valve face (to axis)....angle:	45°	45°-30′	
21	1	Intake valve....length:	4.804	4.824	4.789
		Intake valve....maximum tip regrind:			.015
22	1	Exhaust valve....length:	4.806	4.826	4.791
		Exhaust valve....maximum tip regrind:			.015
23	1	Valve head....warp:			.004
		SPARK PLUGS (AUTO-LITE NO. BR8S)			
23A	2	Spark plug electrodes....gap:	.033	.037	
		PISTON, RINGS AND PINS			
24	1	Piston (bottom of skirt) in cylinder....dia:	.006L	.009L	.021L
25	1	Piston (below third groove) in cylinder....dia:	.015L	.018L	.025L
26	1	Top piston ring in groove....side clear.:	.0065L	.0085L	.013L
27	1	Second piston ring in groove....side clear.:	.005L	.007L	.010L
28	1	Third piston ring in groove....side clear.:	.0035L	.005	.007L
29	1	Top piston ring in cylinder barrel....gap:	.037	.051	.058
30	1	Second piston ring in cylinder barrel....gap:	.037	.051	.058
31	1	Third piston ring in cylinder barrel....gap:	.032	.046	.053
32	1	Top piston ring (std. gap)....tension:	10.5 lbs.	14.5 lbs.	9 lbs.
33	1	Second piston ring (std. gap)....tension:	11.5 lbs.	14.5 lbs.	11 lbs.
34	1	Third piston ring (std. gap)....tension:	11 lbs.	16 lbs.	10 lbs.
35	1	Plug in piston ring (assembly No. 530845)....dia:	.0005T	.0025T	
36	1	Piston pin in piston....dia:	.0005L	.0012L	.002L
37	1	Piston pin and plugs in cylinder....end clear.:	.036L	.058L	.100L
		CONNECTING ROD			
38	1	Piston pin in connecting rod bushing....dia:	.0012L	.0018L	.003L
39	1	Piston pin bushing in connecting rod....dia:	.0025T	.005T	
40	2	Connecting rod bearing on crankpin....dia:	.0014L	.0034L	.006L
41	2	Connecting rod on crankpin....end clear.:	.006L	.010L	.016L
42	1	Connecting rod bearing and bushing (per inch of length)....twist and convergence:	.000	.0005	.001
43	1	Bolt in connecting rod....dia:	.0005T	.001L	
		CRANKSHAFT			
44	2	Crankshaft in main and thrust bearings....dia:	.0008L	.0035L	.0055L
		Main journals....out of round:	.000	.0005	.0015
		Main and thrust journals....dia:	2.374	2.375	2.372
		Center main journal (shaft supported at thrust and rear journals) (full indicator reading)....run-out:	.000	.015	.015
45	2	Crankshaft in thrust bearing....end clear.:	.004L	.014L	.018L
46	2	Crankpins....out of round:	.000	.0005	.0015
		Crankpins....dia:	2.249	2.250	2.247
47	2	Flywheel flange face and perimeter (full indicator readings)....run-out:			.005

TABLE XXII. TABLE OF LIMITS (Cont)

Ref. No.	Chart No.	Description	New Parts Minimum	New Parts Maximum	Replace. Maximum
48	2	Damper pin bushing in crankcheek extension.....dia:	.0015T	.003T	
49	2	Damper pin bushing in counterweight.....dia:	.0015T	.003T	
50	2	Damper pin in bushing.....dia:	.0666L	.0706L	.082L
45	2	Crankshaft in thrust bearing.....end clear:	.011	.033	.050
52	2	Crankcheek in counterweight.....side clear.:	.006	.012	.020
53	2	Accessory drive gear on crankshaft pilot.....dia:	.000	.002L	
		CRANKCASE			
54	2	Crankcase oil seal in crankcase.....dia:	.012T	.016T	
55	2	Through bolt (10–11/16 long) in crankcase.....dia:	.0005T	.001L	
56	1	Hydraulic valve lifter in crankcase guide.....dia:	.0005L	.002L	.0035L
57	3	Magneto drive gear support in crankcase.....dia:	.0005T	.0025T	
58	3	Oil pressure relief valve plunger in cap.....dia:	.002L	.005L	.007L
		CAMSHAFT			
59	2	Camshaft journals in bearings.....dia:	.001L	.003L	.005L
60	2	Camshaft in crankcase.....end clear.:	.005L	.009L	.014L
61	2	Camshaft center journals (shaft supported at front and rear journals) (full indicator reading).....run-out:	.000	.001	.001
62	2	Camshaft gear on flange.....dia:	.0005T	.0015L	
		FLYWHEEL, FAN, RING GEAR AND HOUSING			
63	2	Ring gear on flywheel.....dia:	.002L	.014L	
64	2	Bushing in flywheel.....dia:	.0015T	.003T	
65	2	Flywheel bolt in bushing.....dia:	.0005L	.0035L	
		GENERATOR GEAR CASE			
66	2	Center bearing liners in generator drive housing.....dia:	.004T	.006T	
67	2	Generator drive bearing liners in housing.....dia:	.004T	.006T	
68	2	Generator driver gear bearings in bearing liners.....dia:	.0001T	.0011L	
69	2	Generator driven gear bearings in bearing liners.....dia:	.0001T	.0012L	
70	2	Generator driver gear oil seal in bearing liner.....dia:	.0022T	.0068T	
71	2	Generator driven gear oil seals in bearing liners.....dia:	.001T	.007T	
72	2	Driver gear shaft in ball bearings.....dia:	.0001L	.0009T	
73	2	Driven gear shafts in ball bearings.....dia:	.0001L	.0009T	
74	2	Driver gear between bearings.....side clear.:	.0022L	.0332L	
75	2	Flexible coupling drive flange in flywheel pilot.....dia:	.005L	.013L	
		OIL PUMP			
76	3	Pump impellers in housing.....dia:	.002L	.005L	.007L
77	3	Pump impellers in housing.....end clear.:	.002L	.005L	.007L
78	3	Impeller shafts in housing.....dia:	.0015L	.0035L	.0045L
79	2	Impeller shafts in accessory case.....dia:	.0015L	.0035L	.0045L
80	3	Driveshaft in camshaft gear (across flats).....side clear.:	.008L	.011L	.020L
		TACHOMETER DRIVE			
81	2	Oil seal in housing.....dia:	.001T	.007T	
		STARTER			
82	2	Adapter pilot in case.....dia:	.001L	.007L	
		MAGNETO DRIVE			
83	3	Drive gear bushing on support.....dia:	.0015L	.0035L	.005L
84	3	Bushing in gear.....dia:	.001T	.003T	
85	3	Coupling retainer in gear.....side clear.:	.002T	.028L	.040L
86	3	Coupling bushing on magneto drive lugs.....side clear.:	.010L	.052T	.000
87	3	Magneto pilot in case.....dia:	.001L	.005L	

TABLE XXII. TABLE OF LIMITS (Cont)

Ref. No.	Chart No.	Description	New Parts Minimum	New Parts Maximum	Replace. Maximum
		HANDCRANK AND FUEL PUMP DRIVE			
88	2	Drive gear in adapter.....dia:	.001L	.003L	.005L
89	2	Shaft in adapter.....dia:	.001L	.003L	.005L
90	2	Shaft and gear assembly in adapter.....end clear.:	.003L	.015L	.020L
91	2	Oil seal in adapter.....dia:	.001T	.007T	
92	2	Adapter pilot in case.....dia:	.001L	.005L	
		GOVERNOR DRIVE			
93	2	Valve shaft in governor adapter.....dia:	.001L	.004L	
94	2	Butterfly valve in governor adapter.....dia:	.010L	.022L	
95	2	Shaft gear in adapter bushing.....dia:	.0009L	.0029L	.004L
96	2	Bushing in adapter.....dia:	.001T	.003T	
97	2	Adapter pilot in case.....dia:	.001L	.005L	
98	2	Shaft gear in case.....end clear.:	.018L	.066L	.080L
		GEAR TOOTH BACKLASHES			
99	3	Accessory drive gear to camshaft gear.....	.006	.010	.014
100	3	Accessory drive gear to governor drive gear.....	.007	.011	.015
101	3	Camshaft gear to magneto drive gear.....	.007	.011	.015
102	3	Camshaft gear to fuel pump and handcrank drive gear....	.007	.011	.015
103	3	Generator drive gear to driven gears.....	.012	.016	.020
104	3	Oil pressure pump impellers.....	.009	.013	.015
		SPRING TEST DATA			
105	3	Oil pressure relief valve spring No. 531471 (compressed to 2.22 in. length).....load:	3.75 lbs.	4.75 lbs.	3.00 lbs.
		Oil pressure relief valve spring No. 531471 (compressed to 1.22 in. length).....load:	8.0 lbs.	10.0 lbs.	7.0 lbs.
106	1	Inner valve spring No. 532125 (compressed to 1.269 in. length).....load:	78.0 lbs.	88.0 lbs.	70.0 lbs.
		Inner valve spring No. 532125 (compressed to 1.749 in. length).....load:	43.0 lbs.	49.0 lbs.	37.0 lbs.
107	1	Outer valve spring No. 532126 (compressed to 1.300 in. length).....load:	107.0 lbs.	121.0 lbs.	100.0 lbs.
		Outer valve spring No. 532126 (compressed to 1.780 in. length).....load:	65.0 lbs.	71.0 lbs.	62.0 lbs.

TABLE XXIII. TABLE OF TIGHTENING TORQUES

Ref. No.	Chart No.	Description	Size	Per Engine	Torque (In. Lbs.)
T1	1	Nut—Crankcase flange bolt (top).....	1/4–28	12	100-124
T2	3	Nut—Magneto gear support.....	5/16–24	4	180-220
T3	1	Nut—Crankcase flange bolt (bottom).....	5/16–24	7	180-220
T4	1	Nut—Crankcase through bolt.....	7/16–20	16	490-510
T5	1	Nut—Crankcase to cylinder stud.....	7/16–20	36	490-510
T6	1	Nut—Connecting rod bolt.....	3/8–24	12	340-360
T7	1	Nut—Flywheel assembly to crankshaft.....	1/2–20	6	360-440
T8	2	Screw—Gear to crankshaft.....	5/16–24	6	180-220
T9	2	Screw—Gear to camshaft.....	5/16–20	4	180-220
T10	1	Spark Plug	18MM	6	300-360
		Other nuts and cap screws.....	1/4–28		70-80
		Other nuts and cap screws.....	5/16–24		180-220
		Other nuts.....	3/8–24		270-330
		Other nuts.....	1/2–20		360-440