

SECTION 11A

ENGINE

(ROLLS ROYCE/CONTINENTAL)

(THRU 1971)

1972 AND ON, REFER TO SECTION 11

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11A-1. ENGINE COWLING. Refer to paragraph 11-1.

11A-2. DESCRIPTION. Refer to paragraph 11-2.

11A-3. REMOVAL AND INSTALLATION. Refer to paragraph 11-3.

11A-4. CLEANING AND INSPECTION. Refer to paragraph 11-4.

11A-5. REPAIR. Refer to paragraph 11-5.

11A-6. ENGINE.

11A-7. DESCRIPTION. An air-cooled, wet-sump, horizontally-opposed, direct-drive, six-cylinder Continental O-300-D series engine is used to power the F172 aircraft through the 1971 model year. The cylinders, numbered from rear to front are staggered to permit a separate throw on the crankshaft for each connecting rod. The right rear cylinder is number 1 and cylinders on the right side are identified by odd numbers 1, 3 and 5. The left rear cylinder is number 2 and cylinders on the left side are identified by even numbers 2, 4 and 6. Refer to paragraph 11A-8 for detailed engine data. For repair and overhaul of the engine, accessories and propeller, refer to the applicable publications issued by their manufacturers.

11A-8. ENGINE DATA.

MODEL Rolls-Royce (Continental)

O-300-D

Rated Horsepower at RPM

145 at 2700

Number of Cylinders

6-Horizontally Opposed

Displacement

301.37

Bore

4.0625

Stroke

3.875

Compression Ratio

7.0:1

Magnetos

Slick No. 664

Right Magneto

Fires 26° BTC Upper Plugs

Left Magneto

Fires 28° BTC Lower Plugs

Firing Order

1-6-3-2-5-4

Spark Plugs

18 MM (Refer to Current Continental Active
Factory Approved Spark Plug Chart)

Gap

330 ± 30 Lb-In.

Torque

Carburetor (Marvel-Schebler)

MA-3-SPA

Oil Sump Capacity

8 U.S. Quarts

With External Filter

9 U.S. Quarts

Tachometer

Mechanical

Oil Pressure (psi)

5

Minimum Idling

30-60

Normal

100

Maximum (Starting & Warm-Up)

Oil Temperature

Within Green Arc

Normal Operating

Red Line

Maximum

Cylinder Head Temperature

Within Green Arc

Normal Operating

Red Line

Maximum

Direction of Propeller Shaft

Clockwise

Rotation (viewed from rear)

Dry Weight - With Accessories

298 lb (Weight is approximate and
will vary with optional equipment
installed.)

11A-9. TROUBLE SHOOTING. Refer to paragraph 11-9.

11A-10. REMOVAL. Refer to paragraph 11-10.

11A-11. CLEANING. Refer to paragraph 11-11.

11A-12. ACCESSORIES REMOVAL. Refer to paragraph 11-12.

11A-13. INSPECTION. Refer to paragraph 11-13.

11A-14. BUILD-UP. Refer to paragraph 11-14.

11A-15. INSTALLATION. Refer to paragraph 11-15 for engine installation procedures. Use figure 11A-1 as reference for shock-mount installation.

11A-16. FLEXIBLE FLUID HOSES. Refer to paragraph 11-16.

11A-17. LEAK TEST. Refer to paragraph 11-17.

11A-18. REPLACEMENT. Refer to paragraph 11-18.

11A-18A. STATIC RUN-UP PROCEDURES. In a case of suspected low engine power, a static RPM run-up should be conducted as follows:

a. Run-up engine, using take-off power and mixture settings, with the aircraft facing 90° right and then left to the wind direction.

b. Record the RPM obtained in each run-up position.

NOTE

Daily changes in atmospheric pressure, temperature and humidity will have a slight effect on static run-up.

c. Average the results of the RPM obtained on 1969 thru 1971 models should be within 50 RPM of 2280 RPM.

d. If the average results of the RPM obtained are lower than stated above, the following recommended checks may be performed to determine a possible deficiency.

1. Check carburetor heat control for proper rigging. If partially open it would cause a slight power loss.

2. Check magneto timing, spark plugs and ignition harness for settings and conditions.

3. Check condition of induction air filter. Clean if necessary.

4. Perform an engine compression check. (Refer to engine Manufacturer's Manual).

11A-19. ENGINE BAFFLES. Refer to paragraph 11-19.

11A-20. DESCRIPTION. Refer to paragraph 11-20.

11A-21. CLEANING AND INSPECTION. Refer to paragraph 11-21.

11A-22. REMOVAL AND INSTALLATION. Refer to paragraph 11-22.

11A-23. REPAIR. Refer to paragraph 11-23.

11A-24. ENGINE MOUNT. Refer to paragraph 11-24.

11A-25. DESCRIPTION. Refer to paragraph 11-25.

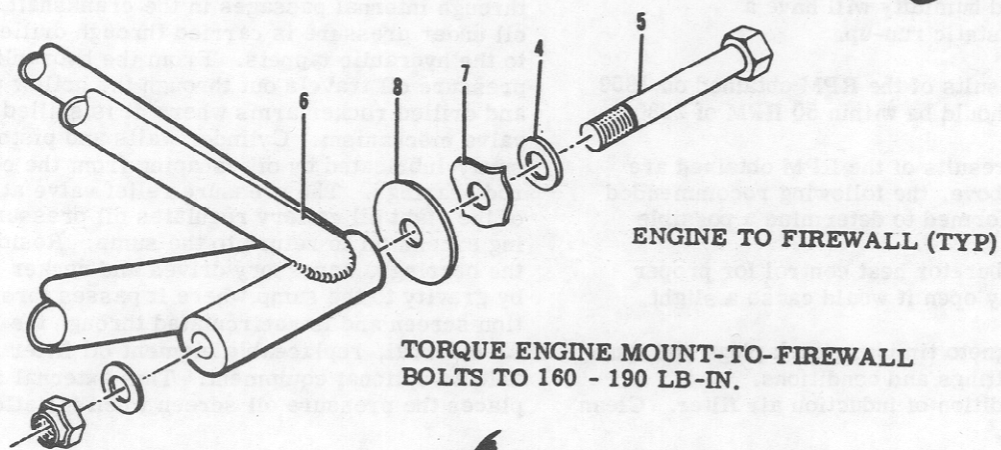
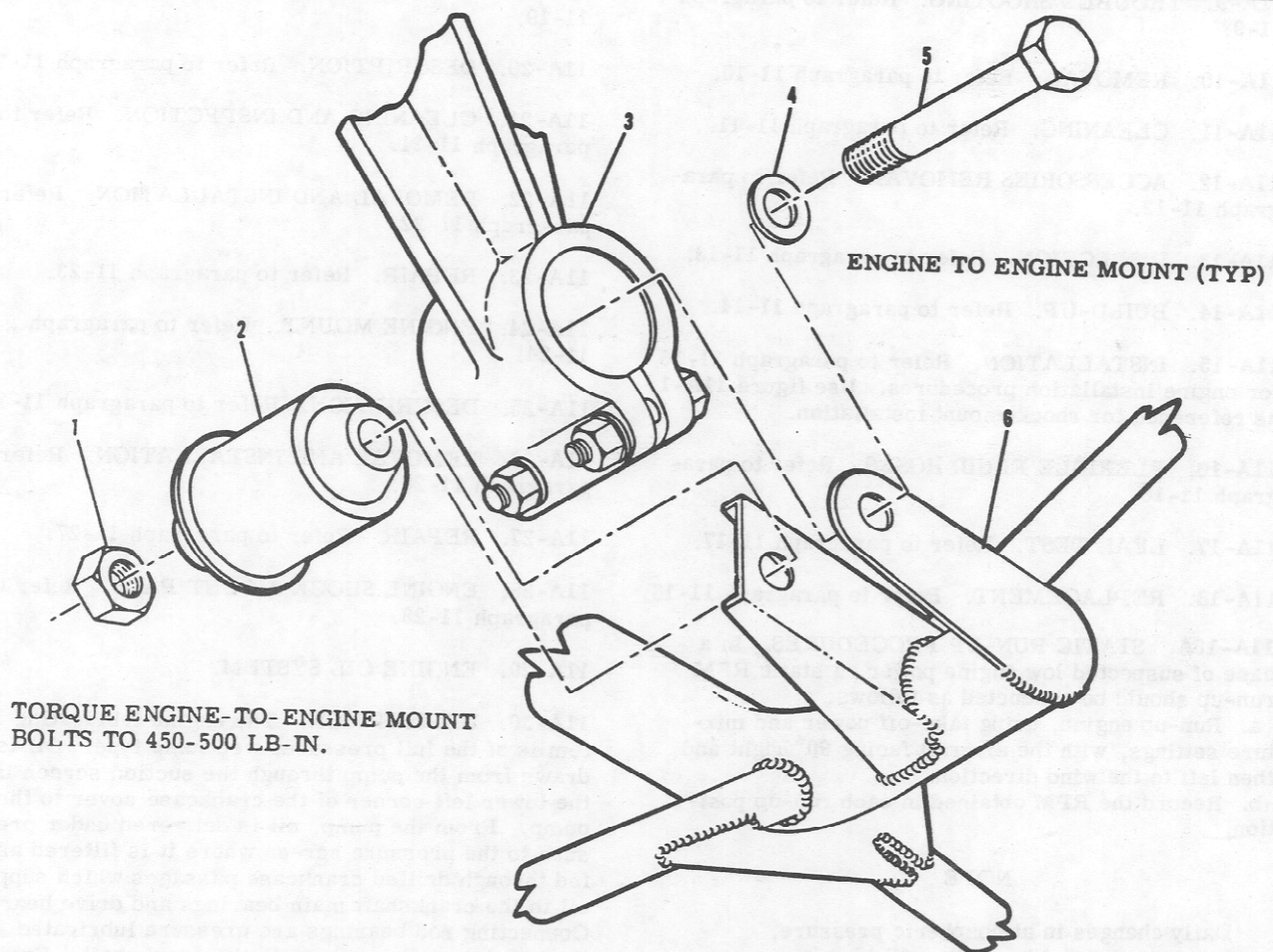
11A-26. REMOVAL AND INSTALLATION. Refer to paragraph 11-26.

11A-27. REPAIR. Refer to paragraph 11-27.

11A-28. ENGINE SHOCK-MOUNT PADS. Refer to paragraph 11-28.

11A-29. ENGINE OIL SYSTEM.

11A-30. DESCRIPTION. The engine lubricating system is of the full pressure, wet sump type. Oil is drawn from the sump through the suction screen in the lower left corner of the crankcase cover to the pump. From the pump, oil is delivered under pressure to the pressure screen where it is filtered and fed through drilled crankcase passages which supply oil to the crankshaft main bearings and drive bearings. Connecting rod bearings are pressure lubricated through internal passages in the crankshaft. Engine oil under pressure is carried through drilled passages to the hydraulic tappets. From the hydraulic tappets, pressure oil travels out through the hollow push rods and drilled rocker arms where it is spilled over the valve mechanism. Cylinder walls and piston pins are spray-lubricated by oil escaping from the connecting rod bearings. The pressure relief valve at the aft end of the right oil gallery regulates oil pressure by allowing excess oil to return to the sump. Residue oil from the bearings, accessory drives and rocker boxes flows by gravity to the sump where it passes through a suction screen and is recirculated through the engine. An external, replaceable element oil filter is available as optional equipment. This external filter replaces the pressure oil screen when installed.



- 1. Nut
- 2. Shock Mount
- 3. Engine Mount Leg

- 4. Washer
- 5. Bolt

- 6. Engine Mount
- 7. Firewall
- 8. Spacer

Figure 11A-1. Engine Mount Details

CODE



PRESSURE OIL FROM
GEAR TYPE OIL PUMP



SUMP OIL, SUCTION OIL, AND
RETURN OIL FROM RELIEF
VALVE

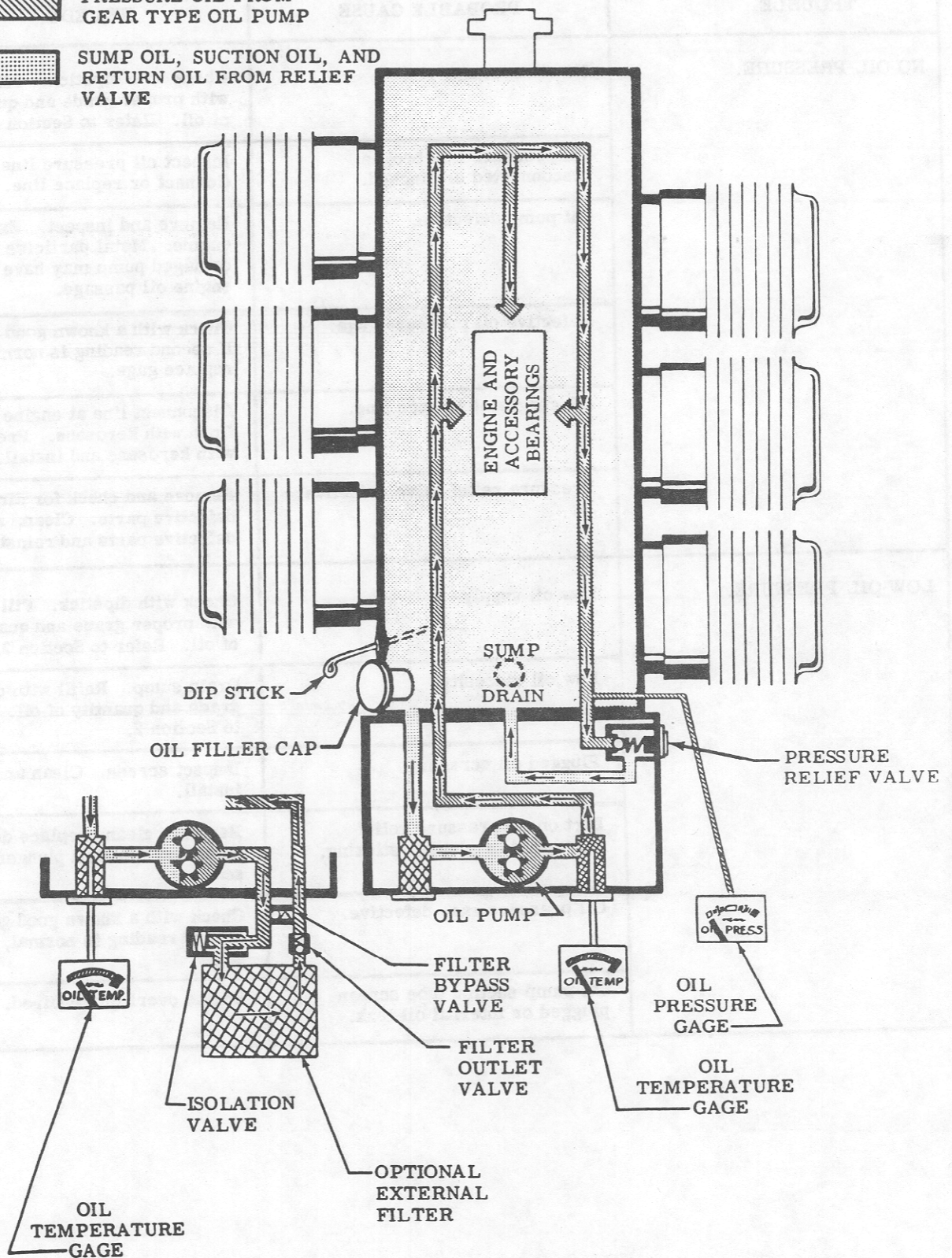


Figure 11A-2. Engine Oil Schematic

CODE



PRESSURE OIL FROM
GEAR TYPE OIL PUMP



SUMP OIL, SUCTION OIL, AND
RETURN OIL FROM RELIEF
VALVE

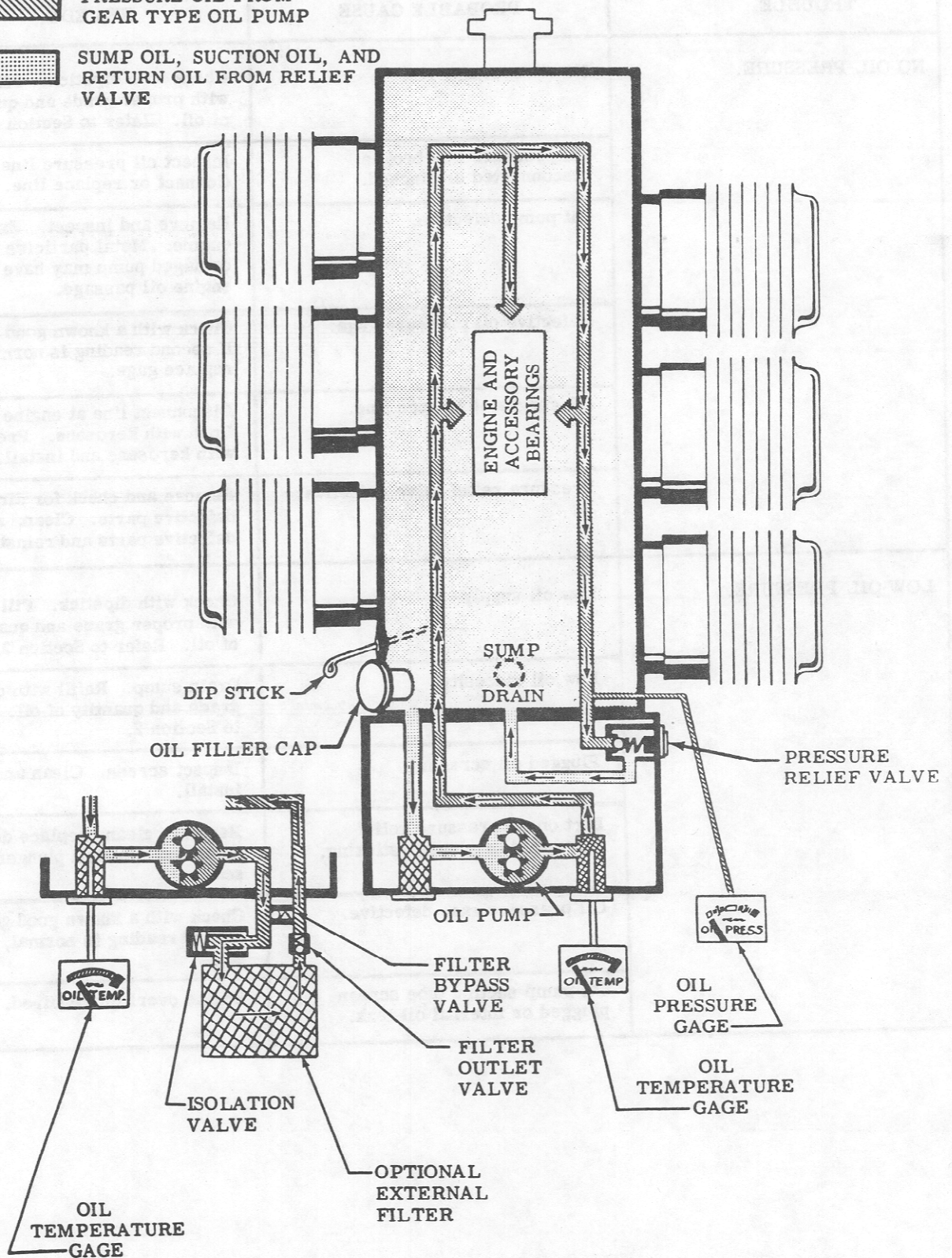


Figure 11A-2. Engine Oil Schematic

11A-31. TROUBLE SHOOTING.

TROUBLE	PROBABLE CAUSE	REMEDY
NO OIL PRESSURE.	No oil in sump.	Check with dipstick. Fill sump with proper grade and quantity of oil. Refer to Section 2.
	Oil pressure line broken, disconnected or pinched.	Inspect oil pressure line. Connect or replace line.
	Oil pump defective.	Remove and inspect. Examine engine. Metal particles from damaged pump may have entered engine oil passage.
	Defective oil pressure gage.	Check with a known good gage. If second reading is normal, replace gage.
	Oil congealed in gage line.	Disconnect line at engine and gage; flush with kerosene. Pre-fill line with kerosene and install.
	Pressure relief valve defective.	Remove and check for dirty or defective parts. Clean, replace defective parts and reinstall.
LOW OIL PRESSURE.	Low oil supply.	Check with dipstick. Fill sump with proper grade and quantity of oil. Refer to Section 2.
	Low oil viscosity.	Drain sump. Refill with correct grade and quantity of oil. Refer to Section 2.
	Plugged oil screen.	Inspect screen. Clean and re-install.
	Dirt on oil pressure relief valve seat or plunger sticking.	Remove, clean, replace defective parts and reinstall plunger and seat.
	Oil pressure gage defective.	Check with a known good gage. If second reading is normal, replace gage.
	Oil pump suction tube screen plugged or internal oil leak.	Engine overhaul required.

11A-31. TROUBLE SHOOTING (Cont).

TROUBLE	PROBABLE CAUSE	REMEDY
HIGH OIL PRESSURE.	High viscosity oil.	Drain sump. Refill with correct grade and quantity of oil. Refer to Section 2.
	Oil pressure gage defective.	Check with a known good gage. If second reading is normal, replace gage.
HIGH OIL TEMPERATURE.	Low oil supply.	Check with dipstick. Fill sump with proper grade and quantity of oil. Refer to Section 2.
	Dirty or diluted oil.	Check with dipstick. Drain sump and fill with proper grade and quantity of oil. Refer to Section 2.
	Prolonged ground operation at high engine speed.	Avoid prolonged running on the ground.
	Excessive rate of climb.	Avoid low airspeed.
	Lean fuel-air mixture.	Avoid excessive lean mixture operation.
	Oil temperature gage defective.	Check with a known good gage. If second reading is normal, replace gage.
	Winter baffles installed.	Check and remove winter baffles.
	Defective oil temperature bulb.	Check oil temperature gage with a known good gage. If second reading is the same, replace bulb.

11A-32. FULL-FLOW OIL FILTER. (Refer to figure 11A-3.)

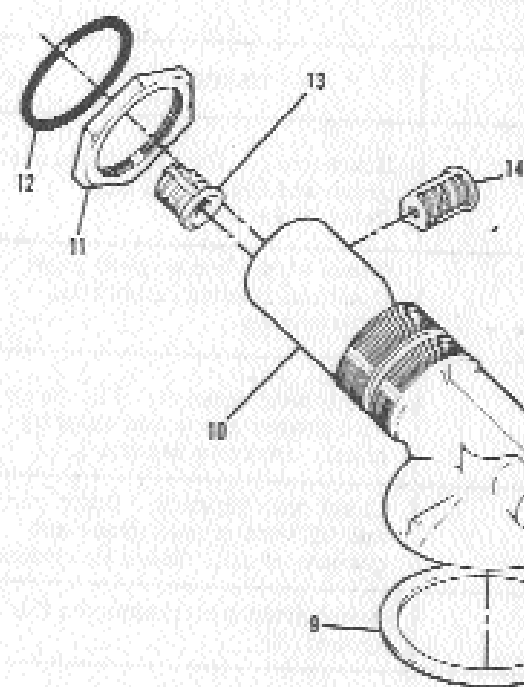
11A-33. DESCRIPTION. An external oil filter may be installed on the engine. The filter and filter adapter replaces the regular internal oil pressure screen. In some filter installations, the filter adapter incorporates a bypass valve, outlet valve and isolation valve. Normally, oil from the oil pump flows through the isolation valve, through the filter element, through the outlet valve, to the engine oil passages. If the filter element should become blocked, the bypass valve and outlet valve will open, allowing pressure oil to flow to the engine oil passages. The isolation valve blocks off the filter assembly and oil then flows through the bypass valve, if excessive oil pressure should occur. In some filter installations the filter adapter incorporates only a bypass valve.

11A-34. REMOVAL AND INSTALLATION. (Refer to figure 11A-3.)

NOTE

New filter element kits are available from the Cessna Service Parts Center.

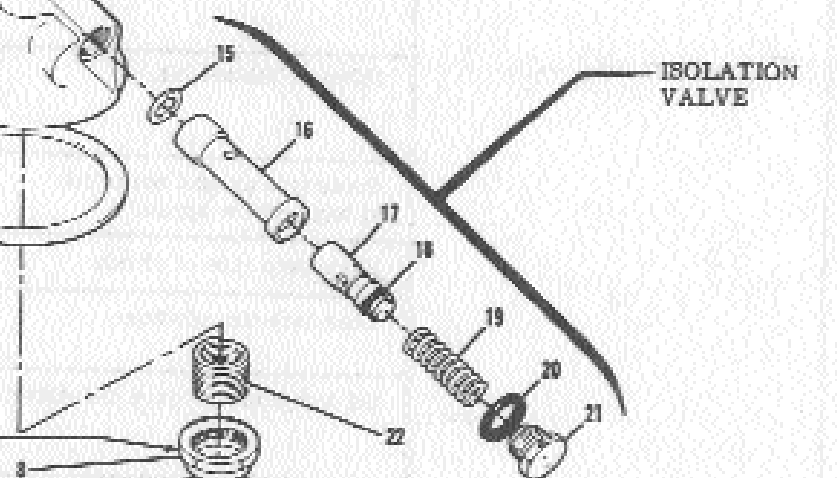
- Remove engine cowling in accordance with paragraph 11-3.
- Remove safety wires from filter can and unscrew hollow stud (1) to detach filter assembly from adapter (10) as a unit. Remove filter assembly from aircraft discarding upper gasket (9). Oil will drain from filter as assembly is removed from adapter.
- Press downward on stud (1) to remove from filter element (5) and can (4). Discard metal gasket (2) on stud (1).
- Lift lid (7) from can (4) and discard lower gasket (6).
- Pull filter element (5) from can (4) and discard.



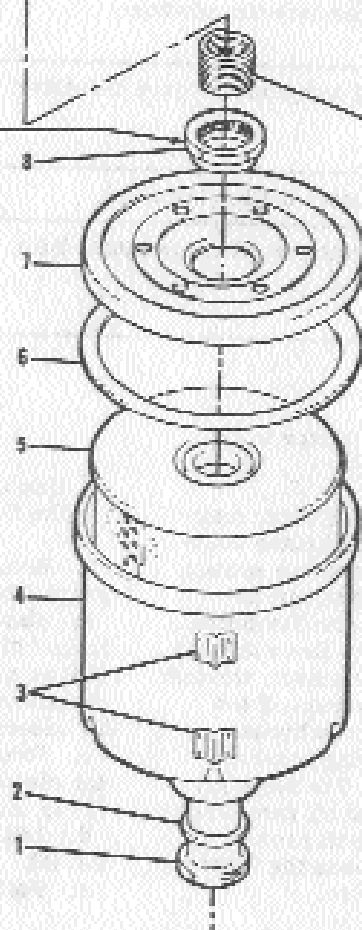
NOTE

Do NOT substitute automotive gaskets for any gasket used in this assembly. Use only approved gaskets listed in the Parts Catalog.

NUT DELETED ON CURRENT INSTALLATIONS (DISCARD AT NEXT FILTER ELEMENT CHANGE)



1. Hollow Stud
2. Metal Gasket
3. Safety Wire Tab
4. Filter Can
5. Filter Element
6. Lower Gasket
7. Lid
8. Nut
9. Upper Gasket
10. Filter Adapter
11. Adapter Nut
12. O-Ring
13. Outlet Valve
14. Bypass Valve
15. Countersink Washer
16. Sleeve
17. Piston
18. O-Ring
19. Spring
20. O-Ring
21. Plug
22. Thread Insert



NOTE

When installing plug (21), tighten to dimension shown.

Figure 11A-3. Full-Flow Oil Filter

NOTE

Before discarding removed filter element, remove the outer perforated paper cover; using a sharp knife, cut through the folds of the filter element at both ends. Then carefully unfold the pleated element and examine the material trapped in the filter element for evidence of internal engine damage such as chips or particles from bearings. In new or newly overhauled engines, some small particles or metallic shavings might be found. These are generally of no consequence and should not be confused with particles produced by impacting, abrasion or pressure. Evidence of internal engine damage found in the oil filter element justifies further examination to determine the cause.

- f. Wash lid (7), hollow stud (1) and can (4) in cleaning solvent and dry with compressed air.

NOTES

When installing a new filter element, it is important that all gaskets are clean, lubricated and positioned properly, and that the correct amount of torque is applied to filter hollow stud. If the stud is under-torqued, oil leakage will occur. If the stud is over-torqued, the filter can may be deformed, again causing oil leakage.

- Lubricate rubber grommets in each end of new filter element, rubber gaskets (6 and 9) and metal gasket (2) with clean engine oil or general purpose grease before installation. Dry gaskets may cause false torque readings, again resulting in oil leakage.
- Before assembly, place a straightedge across bottom of filter can. Check for a distortion or out-of-flat condition greater than .010 inch. Replace if either of these conditions exist.
- Before assembly, cut adapter nut safety wire and try to rotate adapter by hand. If adapter can be moved, check for thread deformation in engine and adapter.
- After installing a new gasket on lid (7), turn it upside down. If gasket falls, try a different gasket and repeat test. If this gasket falls off, install a new lid.
- g. Inspect adapter gasket seat for gouges, deep scratches, wrench marks and mutilation. If any of these conditions are found, install a new adapter.
- h. Place new element in can and insert stud (1) with a new metal gasket (2) in place, through the can and element.
- i. Position a new gasket (6) inside lower flange of lid (7). Position new gasket (9) around upper flange of lid (7). Place the lid in position.
- j. Install filter assembly on adapter. Holding can to prevent it from turning, tighten stud (1) and torque to 20-25 lb-ft (240-300 lb-in), using a torque wrench.

k. Reinstall parts removed for access and service the engine with proper grade and quantity of oil. One additional quart of oil is required each time the element is replaced.

- l. Start engine and check for proper oil pressure. Check for oil leakage after warming up engine.
- m. Again check for oil leakage after engine has been run at a high power setting (preferably a flight around the field).
- n. Check to make sure that the filter has not been in contact with adjacent parts due to engine torque.
- o. While engine is still warm, recheck torque on stud (1), then safety stud to lower tab (3) on filter can and safety adapter to upper tab (3) on filter can.

11A-35. FILTER ADAPTER.

11A-36. REMOVAL. (Refer to figure 11A-3.)

- a. Remove filter assembly as outlined in paragraph 11A-34.
- b. Note angular position of adapter, then remove safety wire and loosen adapter nut (11).

NOTE

A special wrench adapter for adapter nut (11) (Part No. SE-709) is available from the Cessna Service Parts Center, or one may be fabricated as shown in figure 11A-4. Remove any engine accessory that interferes with removal of the adapter.

- c. Unscrew adapter and remove from engine. Discard adapter O-ring.

11A-37. DISASSEMBLY, INSPECTION AND RE-ASSEMBLY. Figure 11A-3 shows the relative position of the internal parts of the filter adapter and may be used as a guide during installation of parts. The bypass and outlet valves are to be installed as complete units, with the valves being staked three places. The detail parts which form the isolation valve may be replaced individually. Also use new seals, lubricate parts with engine oil and replace any part that shows signs of excessive wear. Note that washer (15) is installed with its countersunk side toward outlet valve (13). Tighten plug (21) to a maximum of .40 inch as shown in figure 11A-3. The heli-coil type insert (22) in the adapter may be replaced, although special tools are required. Follow instructions of the tool manufacturer for their use. If the isolation valve should become defective, remove plug (21) and parts (15 through 20). Weld shut vent hole in plug (21). Reinstall washer (15), sleeve (16), O-ring (20) and plug (21) in the adapter. Inspect threads on adapter and in engine for damage. Clean adapter in solvent and dry with compressed air. Ascertain that all passages in the adapter are open and free of foreign material. Also, check that bypass and outlet valves are seated properly.

11A-38. INSTALLATION.

- a. Assemble adapter nut (11) and new O-ring (12) on adapter (10) in sequence illustrated in figure 11A-3.
- b. Lubricate O-ring on adapter with clean engine oil. Tighten adapter nut until O-ring is centered in

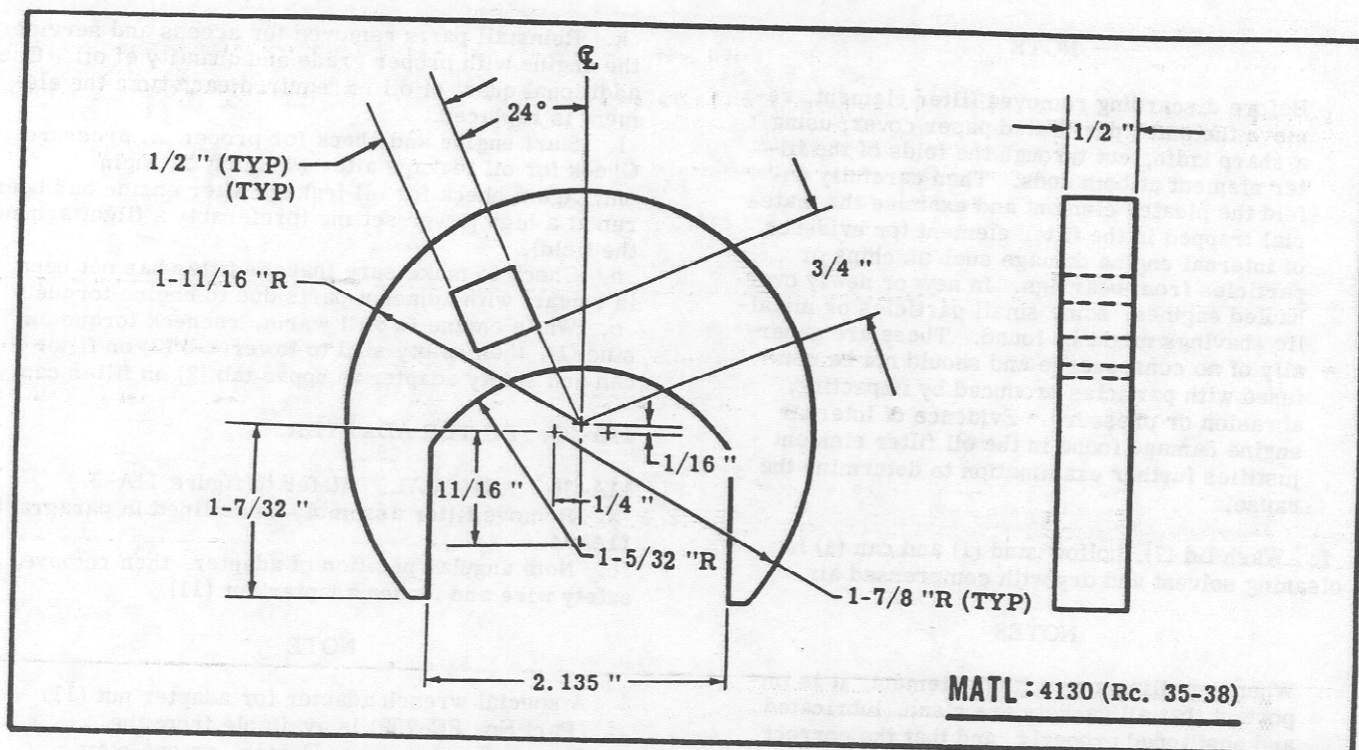


Figure 11A-4. Oil Filter Adapter Wrench Fabrication

its groove on the adapter.

c. Apply an anti-seize compound sparingly to the adapter threads, then simultaneously screw adapter and adapter nut into engine until O-ring seats against engine boss without turning adapter nut (11). Rotate adapter to approximate angular position noted during removal. Do not tighten adapter nut at this time.

d. Temporarily install filter assembly on adapter, and position so adequate clearance with adjacent parts is attained. Maintaining this position of the adapter, tighten adapter nut to 50-60 lb-ft (600-700 lb-in) and safety. Use a torque wrench, extension and adapter as necessary when tightening adapter nut.

e. Using new gaskets, install filter assembly as outlined in paragraph 11A-34. Be sure to service the engine oil system.

11A-39. ENGINE FUEL SYSTEM.

11A-40. DESCRIPTION. The engine is equipped with a carburetor mounted at the lower side of the engine. The carburetor is of the plain-tube fixed-jet type and has such features as an enclosed accelerating pump mechanism, simplified fuel passages to prevent vapor locking, idle cut-off to prevent starting of the engine accidentally and manual mixture control for leaning. For overhaul and repair of the carburetor, refer to the manufacturer's overhaul and repair manual.

11A-41. CARBURETOR.

11A-42. REMOVAL AND INSTALLATION.

- Place fuel selector valve in the OFF position.
- Remove engine cowl in accordance with paragraph 11-3.
- Drain fuel from strainer and lines with strainer drain control.

d. Remove airbox in accordance with paragraph 11A-47.

e. Disconnect throttle and mixture control to control arms on carburetor. Note EXACT position, size and number of washers and spacers for reference on reinstallation.

f. Disconnect and cap or plug fuel line at carburetor.

g. Remove nuts and washers attaching carburetor to intake manifold and remove carburetor and mounting gasket.

h. Reverse the preceding steps for reinstallation. Use new gasket when installing carburetor. Rig controls as outlined in paragraphs 11-64 and 11-65. Check carburetor throttle arm to idle stop arm attachment for security and proper safetying at each normal engine inspection in accordance with figure 11-5. The carburetor and linkage for the Continental engine will be different, but the method of safetying remains the same.

11A-43. IDLE SPEED AND MIXTURE ADJUSTMENTS. Refer to paragraph 11-45.

11A-44. INDUCTION AIR SYSTEM.

11A-45. DESCRIPTION. Ram air to the engine enters the induction airbox through the induction air filter located in the forward part of the lower engine cowl. From the induction airbox the air is directed to the inlet of the carburetor, mounted on the lower side of the engine, through the carburetor, where fuel is mixed with the air, to the intake manifold. From the intake manifold, the fuel-air mixture is distributed to each cylinder by separate intake pipes.

The intake pipes are attached to the intake manifold with hoses and clamps and to each cylinder with a gasket. The induction airbox contains a valve, operated by the carburetor heat control in the cabin, which permits air from an exhaust heated source to be selected in the event carburetor icing or filter icing should be encountered.

11A-46. AIRBOX.

11A-47. REMOVAL AND INSTALLATION.

- a. Remove cowling in accordance with paragraph 11-3.
- b. Disconnect flexible ducts from each side of airbox.
- c. Disconnect carburetor heat control at arm on airbox and remove clamp attaching control to airbox.
- d. Remove bolts attaching airbox to carburetor and screws attaching airbox to engine bracket.
- e. Reverse the preceding steps for reinstallation.

11A-48. IGNITION SYSTEM.

11A-49. DESCRIPTION. The ignition system is comprised of two magnetos, two spark plugs in each cylinder, an ignition wiring harness, an ignition switch mounted on the instrument panel and required wiring between the ignition switch and magnetos.

11A-50. TROUBLE SHOOTING. Refer to paragraph 11-51. All reference to paragraph 11-58 for the Lycoming engine will be paragraph 11A-56 for the Continental engine.

11A-51. MAGNETOS.

11A-52. DESCRIPTION. Engine ignition is supplied by two Slick magnetos (refer to paragraph 11A-8 for model number). The magnetos contain a conventional two-pole rotating magnet (rotor), mounted in ball bearings. Driven by the engine through an impulse coupling at one end, the rotor shaft operates the breaker points at the other end. The nylon rotor gear drives a nylon distributor gear which transfers high tension current from the wedge-mounted coil to the proper outlet in the distributor block. A coaxial capacitor is mounted in the distributor block housing to serve as the condenser as well as a radio noise suppressor. Both nylon gears are provided with timing marks for clockwise or counterclockwise rotation. The distributor gear and distributor block have timing marks, visible through the air vent holes, for timing to the engine. A timing hole is provided in the bottom of the magneto adjacent to the magneto flange. A timing pin or 6-penny nail can be inserted through this timing hole into the mating hole in the rotor shaft to lock the magneto approximately in the proper firing position. The breaker assembly is accessible after removing the screws fastening the magneto halves together and disconnecting the capacitor slip terminal.

NOTE

Thru aircraft F17200804, refer to Cessna Single-engine Service Letter SE74-21 for inspection of the impulse coupling pawl rivets.

11A-53. REMOVAL AND INSTALLATION.

- a. Remove engine cowling in accordance with paragraph 11-3.
- b. Tag for identification and remove high tension wires from the magneto being removed.

WARNING

The magneto is not internally grounded when the switch wire is disconnected. Remove the high tension wires from magneto or disconnect spark plug leads from the spark plugs.

- c. Disconnect switch wire from condenser terminal at magneto. Tag wire for identification so it may be installed correctly.
- d. Rotate propeller in direction of normal rotation until No. 1 Cylinder is coming up on its compression stroke.

NOTE

To facilitate the installation of a replacement magneto, it is good practice to position for crankshaft at the advanced firing angle for No. 1 cylinder during step "d." Any standard timing device or method can be used, or if the magneto being removed is correctly timed to the engine, the crankshaft can be rotated to a position at which the breaker points will be just opening to fire No. 1 cylinder.

- e. Remove nuts and washers and pull magneto from crankcase mounting pad.

NOTE

For replacement of the breaker assembly or where removal of only the distributor half of the magneto is desired, remove the screws fastening the halves together, then pull the rear half aft only far enough to disconnect the capacitor slip terminal. As the halves are separated, be sure that the large distributor gear is not dropped.

CAUTION

When removing the distributor block housing from the engine half of magneto, do not pull it away far enough to break or damage the capacitor lead or slip terminal.

- f. Reverse the preceding steps for reinstallation and time magneto-to-engine in accordance with paragraph 11A-55.

11A-54. INTERNAL TIMING.

- a. Whenever the gear on the rotor shaft or the cam (which also serves as the key for the gear) has been

removed, be sure that the gear and cam are installed so the timing mark on the gear aligns with the "O" etched on the rotor shaft.

b. When replacing breaker assembly or adjusting contact breaker points, place a timing pin (or 0.093 inch 6-penny nail) through the timing hole in the bottom of the magneto next to the flange and into the mating hole in the rotor shaft. Adjusting contact breaker points so they are just starting to open in this position will give the correct point setting. Temporarily assemble the magneto halves and capacitor slip terminal and use a timing light to check that the timing marks, visible through the ventilation plug holes are approximately aligned.

NOTE

The side of the magneto with the manufacturer's insignia has a red timing mark and the side opposite to the insignia has a black timing mark viewed through the vent plug holes. The distributor gear also has a red timing mark and a black timing mark. These marks are used for reference only when installing magneto on the engine. Do not place red and black lines together on the same side.

c. Whenever the large distributor gear and rotor gear have been disengaged, they must be engaged with their timing marks aligned for correct rotation. Align the timing mark on the rotor gear with the "RH" on the distributor gear. Care must be taken to keep these two gears meshed in this position until the magneto halves are assembled.

11A-55. MAGNETO-TO-ENGINE TIMING. The magneto must be installed with its timing marks correctly aligned and with the number one cylinder on its compression stroke with number one piston at its advanced firing position. Refer to paragraph 11A-8 for the advanced firing position of number one piston.

WARNING

The magneto is grounded through the magneto switch, therefore, any time the switch (primary) wire is disconnected from the magneto, the magneto is in a switch ON or HOT condition. Before turning the propeller by hand, remove the high tension wires from the magneto or disconnect all spark plug leads to prevent accidental firing of the engine.

To locate the compression stroke of number one cylinder, remove the lower spark plugs from each cylinder except number one cylinder. Remove the top plug from number one cylinder. Place thumb of one hand over the number one cylinder spark plug hole and rotate the crankshaft in the direction of normal rotation until the compression stroke is indicated by positive pressure inside the cylinder lifting the thumb off the spark plug hole. After the compression stroke is obtained, locate number one piston at its advanced firing position. Locating the advanced firing position

of number one cylinder may be obtained by rotating the crankshaft opposite to its normal direction of rotation until it is approximately 30 degrees before top center (BTC) on the compression stroke of number one cylinder. Then, rotate crankshaft in normal direction of rotation to align the correct timing mark on the outer surface of the crankshaft flange, with the parting surface of the crankcase below the crankshaft as the reference point, making sure the final motion of the crankshaft is in the direction of normal rotation.

NOTE

Various other methods and equipment may be used to arrive at the number one piston advanced firing position. One such method is: An accurate top center indicator which screws into a spark plug mounting hole and a pendulum pointer mounted on a 360-degree timing disc may be used. The timing disc should be adapted to fit over the end of the propeller spinner in such a manner that it may be rotated as necessary.

In all cases, it must be definitely determined that the number one cylinder is at the correct firing position, on the compression stroke, when the crankshaft is turned in its normal direction of rotation. After the engine has been placed in the correct firing position, install and time the magneto to the engine in the following manner.

a. Remove the timing (vent) plug from the bottom of the magneto. The vent plug in the top of the magneto need not be removed.

b. Turn the magneto shaft until the timing marks visible through the ventilation plug holes are aligned (red-to-red or black-to-black) and insert a timing pin (or 0.093 inch 6-penny nail) through the timing hole in the bottom of the magneto next to the flange and into the mating hole in the rotor shaft. This locks the magneto approximately in the firing position while installing on the engine.

c. Establish that the magneto is at number one firing position.

NOTE

Impulse coupling pawls must be depressed to turn magneto shaft in normal direction of rotation.

d. Keep timing mark centered in vent plug hole during installation.

e. Be sure magneto gaskets are in place and that engine is in correct firing position, then install magneto at the angle noted during removal, tighten mounting nuts finger tight.

CAUTION

Remove timing pin from magneto before turning the propeller.

f. Connect a timing light to the capacitor terminal at the rear of the magneto and to a good ground.

g. Turn propeller back a few degrees to close the contact points.

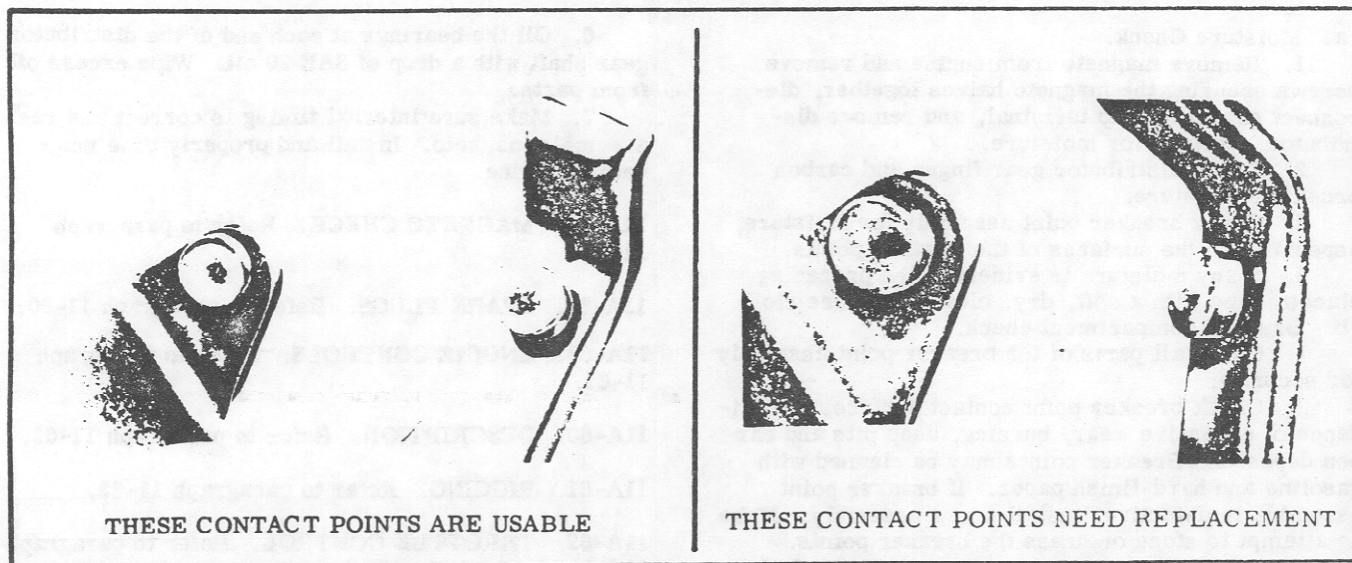


Figure 11A-5. Magneto Contact Breaker Points

NOTE

Do not turn the propeller back far enough to engage the impulse coupling or the propeller will have to be turned in normal direction of rotation until the impulse coupling releases, then backed up to slightly before the firing position.

h. Slowly advance propeller (tap forward with minute movements as firing position is approached) in normal direction of rotation until timing light indicates position at which contact points break. The contact points should break at the advanced firing position of number one cylinder. Loosen mounting nuts slightly and rotate magneto case to make contact points break at the correct position.

- i. Tighten magneto mounting nuts, recheck timing.
- j. Repeat steps "a" through "h" for the other magneto.

k. After both magnetos have been timed, check synchronization of both magnetos. Magnetos must fire at the same time.

- l. Remove timing devices from magneto and engine.

m. Connect spark plug leads to their correct magneto outlets.

NOTE

Beginning with the number one outlet, the magneto fires at each successive outlet in a counterclockwise direction, looking at the outlets. Connect number one magneto outlet to number one cylinder spark plug lead, number two outlet to the next cylinder to fire, etc. Engine firing order is listed in paragraph 11A-8.

n. Connect switch primary lead to the capacitor terminal on the magneto.

- o. Inspect magneto installation and install engine cowlings in accordance with paragraph 11-3.

11A-56. MAINTENANCE. Magneto-to-engine timing should be checked with a timing light at each 100 hour inspection. Magneto-to-engine timing should be within a tolerance of plus zero, minus two degrees. In the event the magneto internal timing marks are off more than plus or minus five degrees when the breaker points open to fire number one cylinder, remove the magneto and check the magneto internal timing. Whenever the magneto halves are separated the breaker point assembly should always be checked. As long as internal timing and magneto-to-engine timing are within the preceding tolerances, it is recommended that the magneto be checked internally only at 500 hour intervals. It is normal for contact points to burn and the cam to wear a comparable amount so the magneto will remain in time within itself. This is accomplished by having a good area making contact on the surface between the points and the correct amount of spring pressure on the cam. The area on the points should be twenty-five percent of the area making contact. The spring pressure at the cam should be 10.5 to 12.5 ounces. When the contact points burn, the area becomes irregular, which is not detrimental to the operation of the points unless metal transfer is too great which will cause the engine to misfire. Figure 11A-5 illustrates good and bad contact points. A small dent will appear on the nylon insulator between the cam follower and the breaker bar. This is normal and does not require replacement.

NOTE

If ignition trouble should develop, spark plugs and ignition wiring should be checked first. If the trouble definitely is associated with a magneto, use the following to help disclose the source of trouble.

a. Moisture Check.

1. Remove magneto from engine and remove screws securing the magneto halves together, disconnect capacitor slip terminal, and remove distributor. Inspect for moisture.

2. Check distributor gear finger and carbon brush for moisture.

3. Check breaker point assembly for moisture, especially on the surfaces of the breaker points.

4. If any moisture is evident in the preceding places, wipe with a soft, dry, clean, lint-free cloth.

b. Breaker compartment check.

1. Check all parts of the breaker point assembly for security.

2. Check breaker point contact surfaces for evidence of excessive wear, burning, deep pits and carbon deposits. Breaker points may be cleaned with gasoline and hard-finish paper. If breaker point assembly is defective, install a new assembly. Make no attempt to stone or dress the breaker points. Clean new breaker points with clean, un-leaded gasoline and hard-finish paper before installing.

3. If the breaker point assembly is equipped with a cam oiler felt, inspect oiler felt, if dry, apply 2 or 3 drops of SAE 70 oil to felt. Remove any excess oil from breaker assembly. Too much oil will result in fouling and excessive burning of the breaker points. The corner of the felt should just barely touch the cam lobe. Newer breaker point assemblies are not equipped with the oiler felt. The cam lobe is lubricated with M-1827 Cam Grease.

4. Check capacitor mounting brackets for cracks or looseness.

5. Check carbon brush on distributor gear for excessive wear. The brush must extend a minimum of 1/32 inch beyond the end of the gear shaft. The spring which the carbon brush contacts should be bent out approximately 20 degrees from vertical, since spring pressure on the brush holds the distributor gear shaft against the thrust bearing in the distributor block.

6. Oil the bearings at each end of the distributor gear shaft with a drop of SAE 20 oil. Wipe excess oil from parts.

7. Make sure internal timing is correct and re-assemble magneto. Install and properly time magneto to engine.

11A-57. MAGNETO CHECK. Refer to paragraph 11-59.

11A-58. SPARK PLUGS. Refer to paragraph 11-60.

11A-59. ENGINE CONTROLS. Refer to paragraph 11-61.

11A-60. DESCRIPTION. Refer to paragraph 11-62.

11A-61. RIGGING. Refer to paragraph 11-63.

11A-62. THROTTLE CONTROL. Refer to paragraph 11-64.

11A-63. MIXTURE CONTROL. Refer to paragraph 11-65.

11A-64. CARBURETOR HEAT CONTROL. Refer to paragraph 11-66.

11A-65. STARTING SYSTEM.

11A-66. DESCRIPTION. The automatically engaged starting system employs an electric starter motor mounted to a 90-degree adapter. A starter solenoid is activated by the ignition key on the instrument panel. When the solenoid is activated, its contacts close and electrical current energizes the starter motor. Initial rotation of the starter motor engages the starter through an overrunning clutch in the starter adapter, which incorporates worm reduction gears. The starter is located just aft of the right rear cylinder.

11A-67. TROUBLE SHOOTING.

TROUBLE	PROBABLE CAUSE	REMEDY
STARTER WILL NOT OPERATE.	Defective master switch or circuit.	Check switch and circuit continuity. Replace switch or wiring as necessary.
	Defective starter switch or switch circuit.	Check switch and circuit continuity. Replace switch or wiring as required.
	Defective starter motor.	Check starter brushes, brush spring tension, thrown solder on brush cover, worn, or dirty commutator. Repair or replace starter motor.

11A-67. TROUBLE SHOOTING (Cont).

TROUBLE	PROBABLE CAUSE	REMEDY
STARTER MOTOR RUNS, BUT DOES NOT TURN CRANK-SHAFT.	Defective overrunning clutch or drive.	Remove and inspect starter and adapter, replace defective parts.
	Damaged starter pinion gear or crankshaft gear.	Remove, inspect and replace defective parts.
STARTER DRAGS.	Low battery.	Check battery. Charge or replace battery.
	Starter switch or relay contacts burned or dirty.	Replace with serviceable parts.
	Defective starter power cable.	Check cable. Replace power cable.
	Defective starter motor.	Check starter brushes, brush spring tension, thrown solder on brush cover, worn, or dirty commutator. Repair or replace starter motor.
STARTER EXCESSIVELY NOISY.	Worn starter pinion gear.	Remove and inspect pinion. Replace starter drive.
	Worn or broken teeth on crankshaft gears.	Remove starter and inspect crankshaft gear. Replace parts as necessary.

11A-68. PRIMARY MAINTENANCE. Refer to paragraph 11-70.

11A-69. STARTER MOTOR.

11A-70. REMOVAL AND INSTALLATION.

a. Remove engine cowling in accordance with paragraph 11-3.

CAUTION

When disconnecting or connecting the starter cable, do not permit starter terminal bolt to rotate. Rotation of the bolt could break the conductor between terminal and field coils causing the starter to be inoperative.

- b. Disconnect electrical cable at starter motor. Insulate the disconnected cable terminal as a safety precaution.
- c. Remove the nuts securing starter motor to adapter and remove starter.
- d. Reverse the preceding steps for reinstallation. Install a new O-ring on the starter, then install the starter. Be sure that starter engages with the drive in the adapter.

11A-71. EXHAUST SYSTEM.

11A-72. DESCRIPTION. The exhaust system consists of two exhaust stack assemblies, one for the left and one for the right bank of cylinders. Each cylinder has a riser pipe attached to the exhaust port. The three risers at each bank of cylinders are attached to a muffler and tailpipe forming an exhaust stack assembly. The mufflers are enclosed in shrouds which capture exhaust heat for cabin and carburetor heating.

11A-73. REMOVAL AND INSTALLATION.

- a. Remove engine cowling in accordance with paragraph 11-3.
- b. Disconnect flexible ducts from shrouds on mufflers.
- c. Disconnect braces from tailpipes.
- d. Remove hardware attaching riser pipes to mufflers.
- e. Loosen nuts attaching riser pipes to cylinders and remove mufflers.
- f. Remove nuts and washers attaching riser pipes to cylinders and remove pipes and gaskets.
- g. Reverse the preceding steps for reinstallation. Use a new copper-asbestos gasket between each exhaust riser and its mounting pad on the cylinder.

11A-74. INSPECTION. Refer to paragraph 11-76.

11A-75. EXTREME WEATHER MAINTENANCE.
Refer to paragraph 11-77.

11A-76. COLD WEATHER. Refer to paragraph 11-78.

11A-77. HOT WEATHER. Refer to paragraph 11-79.

11A-78. DUSTY CONDITIONS. Refer to paragraph 11-80.

11A-79. SEACOAST AND HUMID AREAS. Refer to paragraph 11-81.

11A-80. GROUND SERVICE RECEPTACLE Refer
to paragraph 11-82.

11A-81. HAND CRANKING. Refer to paragraph 11-83.

SHOP NOTES: