Service Instructions for Aircraft Engines R-670-4, R-670-5, R-670-6, R-670-11, and R-670-11A

AN 02-40AA-2

1-July-1945

SERVICE INSTRUCTIONS

FOR

AIRCRAFT ENGINES

MODELS

R-670-4, -5, -6, -11, -11A

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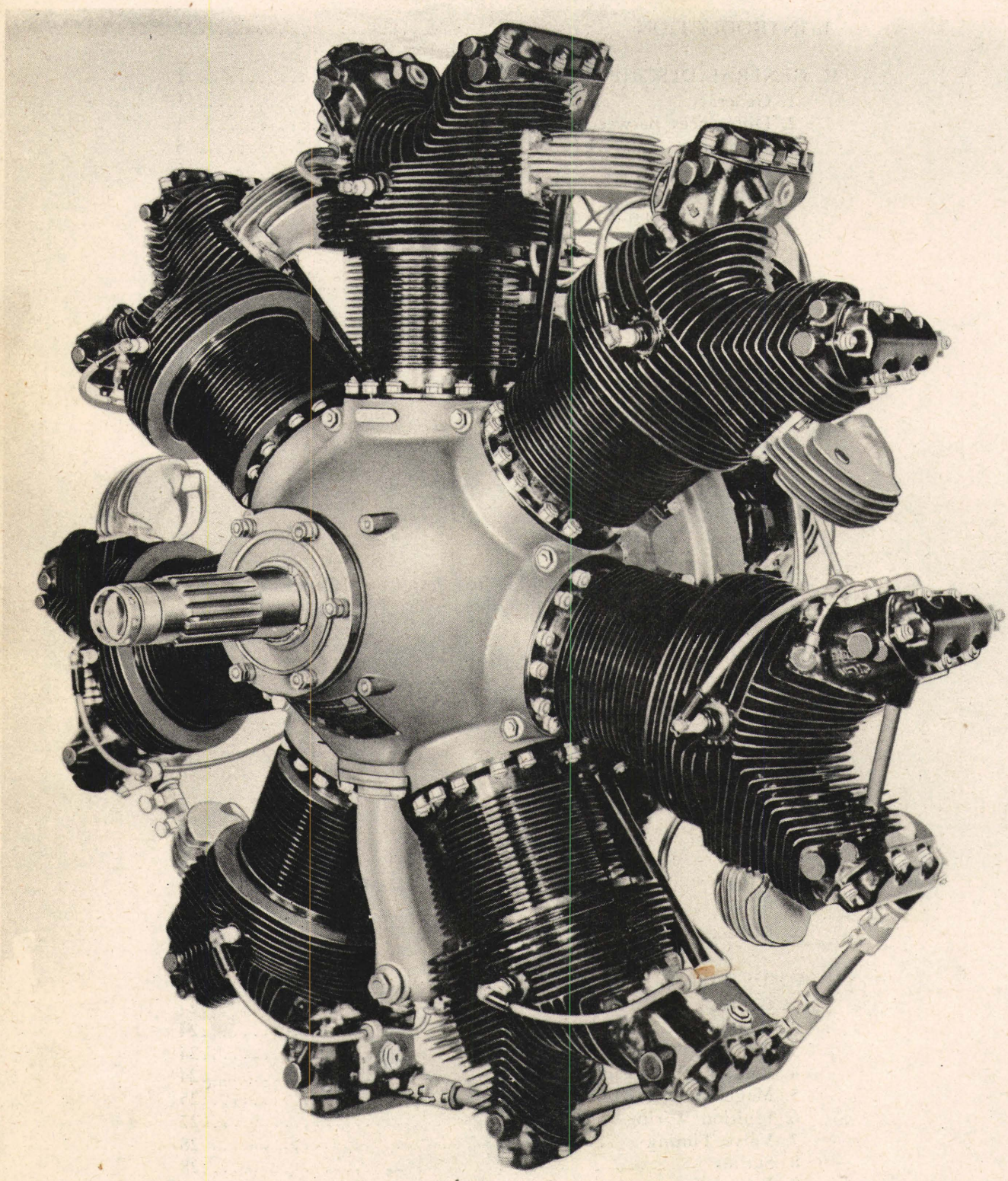


Figure 1—Three-Quarter Left Front View of R-670-4, -5, -11 and -11A Engines

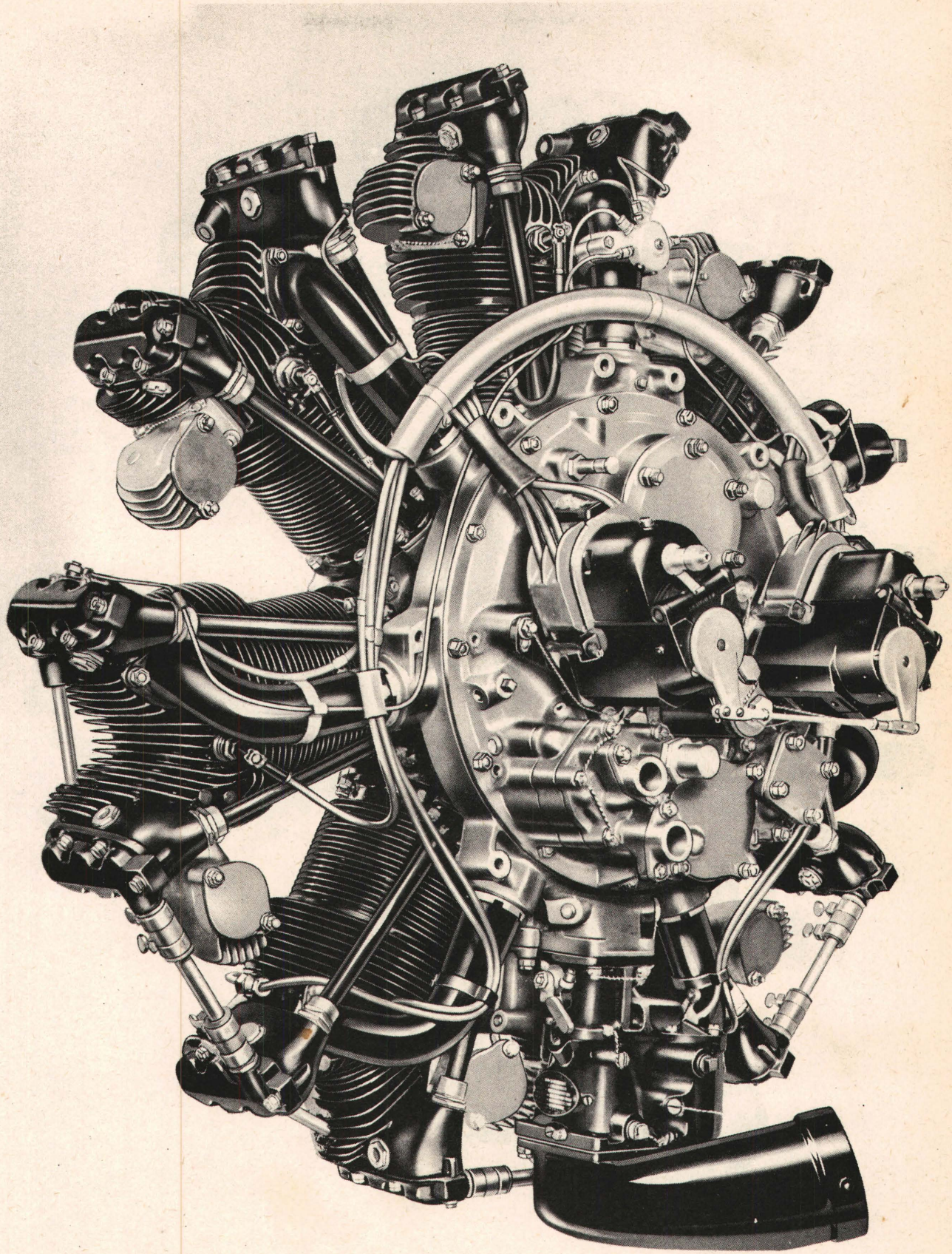


Figure 2—Three-Quarter Left Rear View of R-670-5 Engine

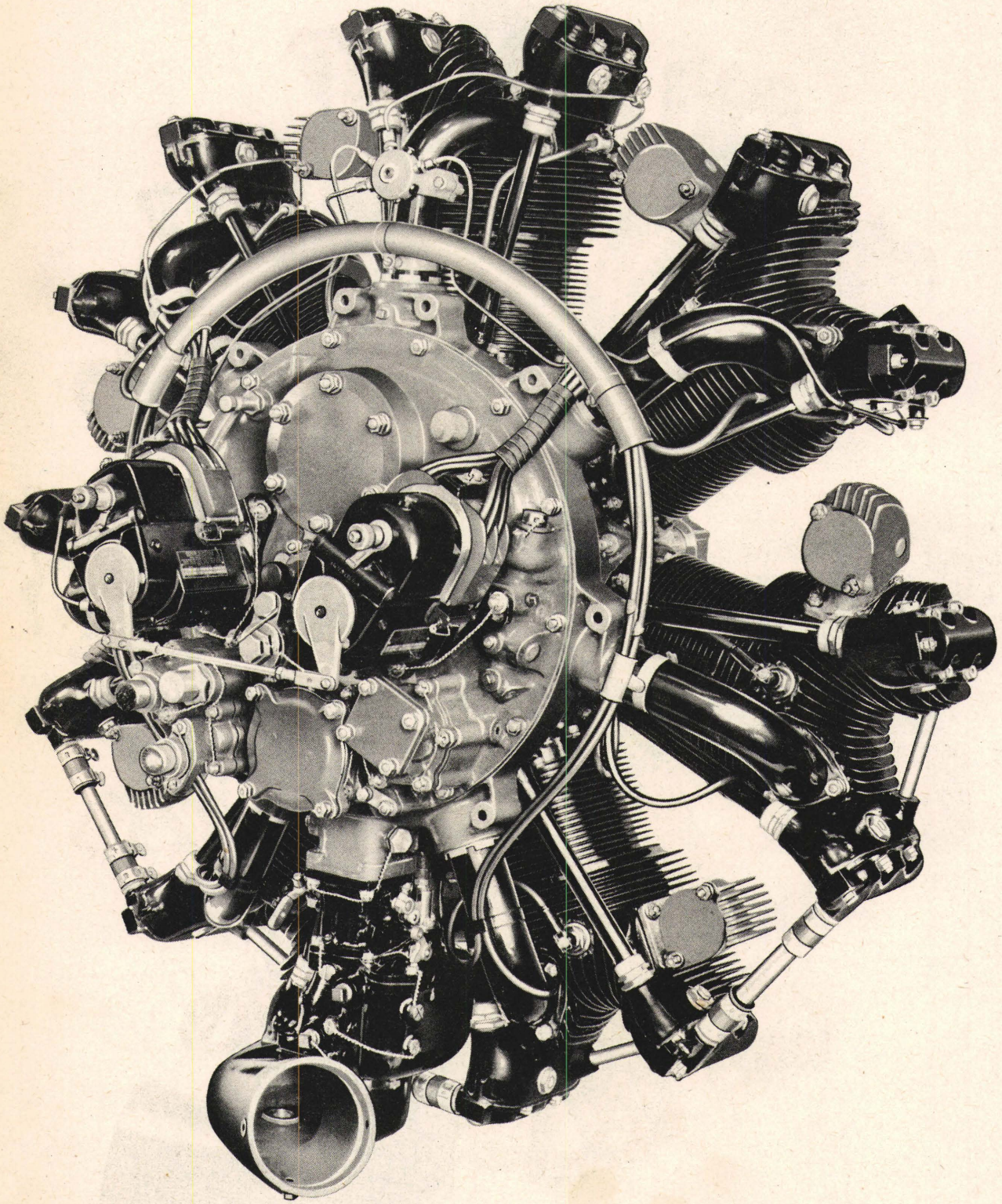


Figure 3—Three-Quarter Right Rear View of R-670-5 Engine

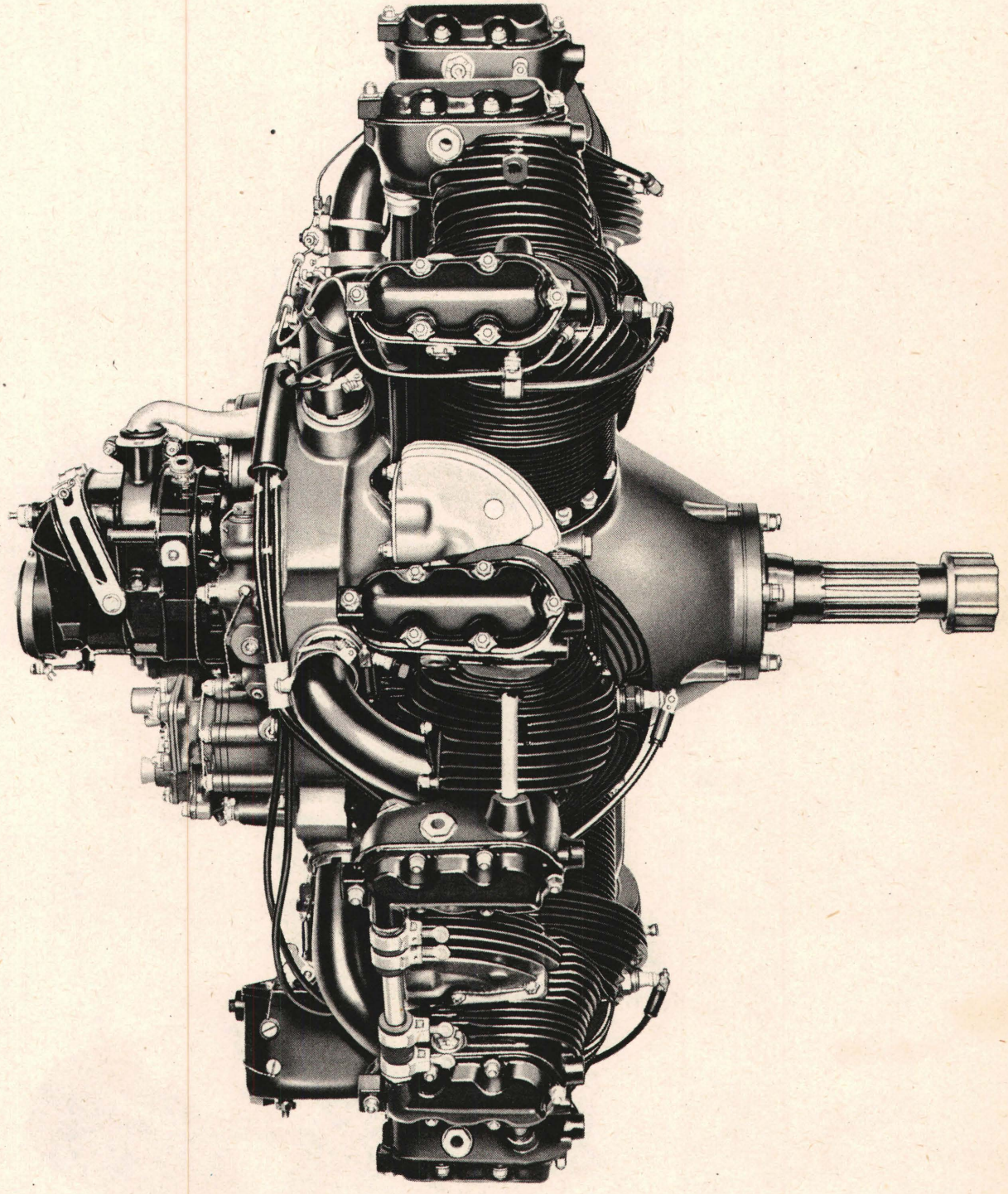
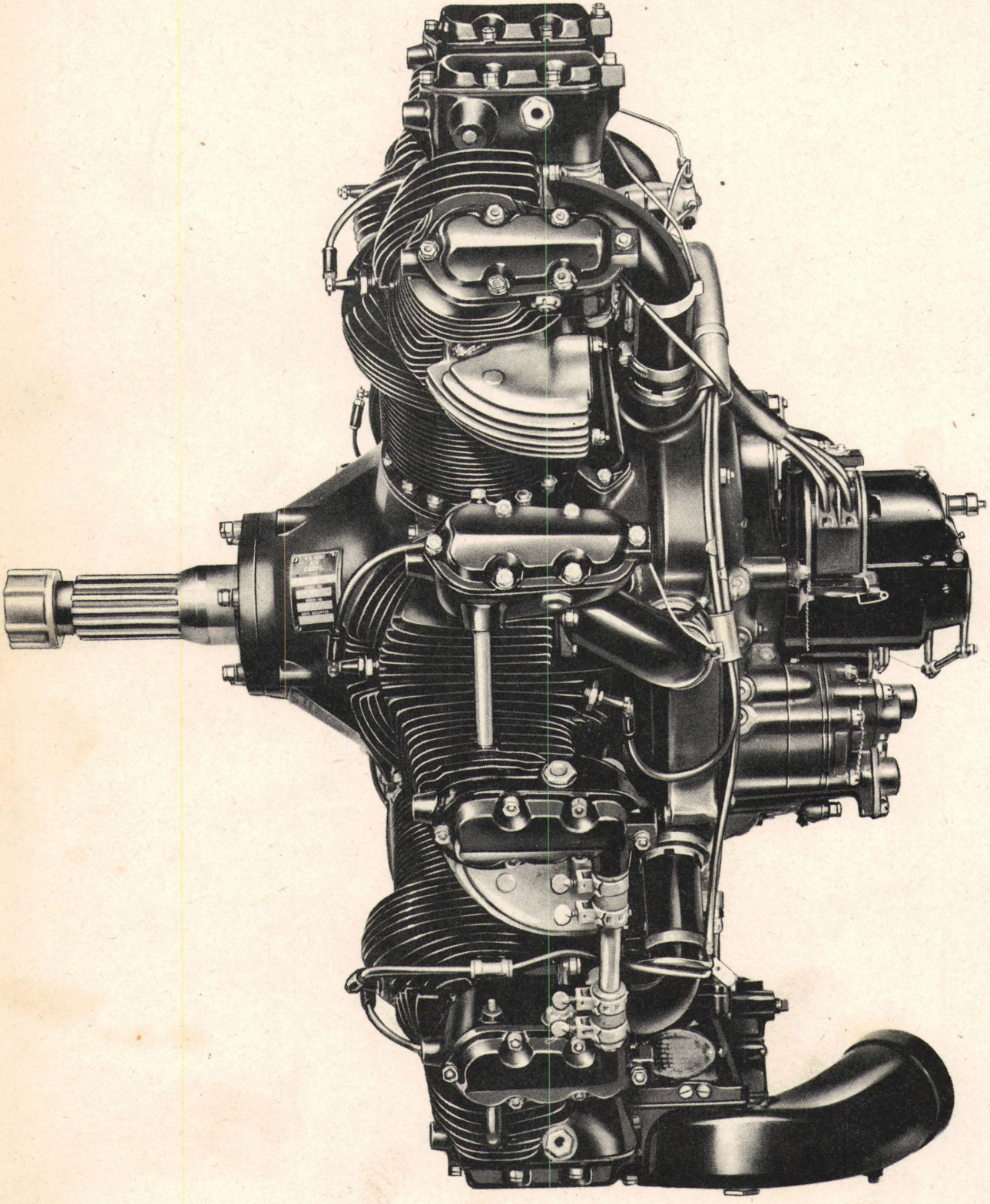


Figure 4—Right Side View of R-670-4, -11 and -11A Engines



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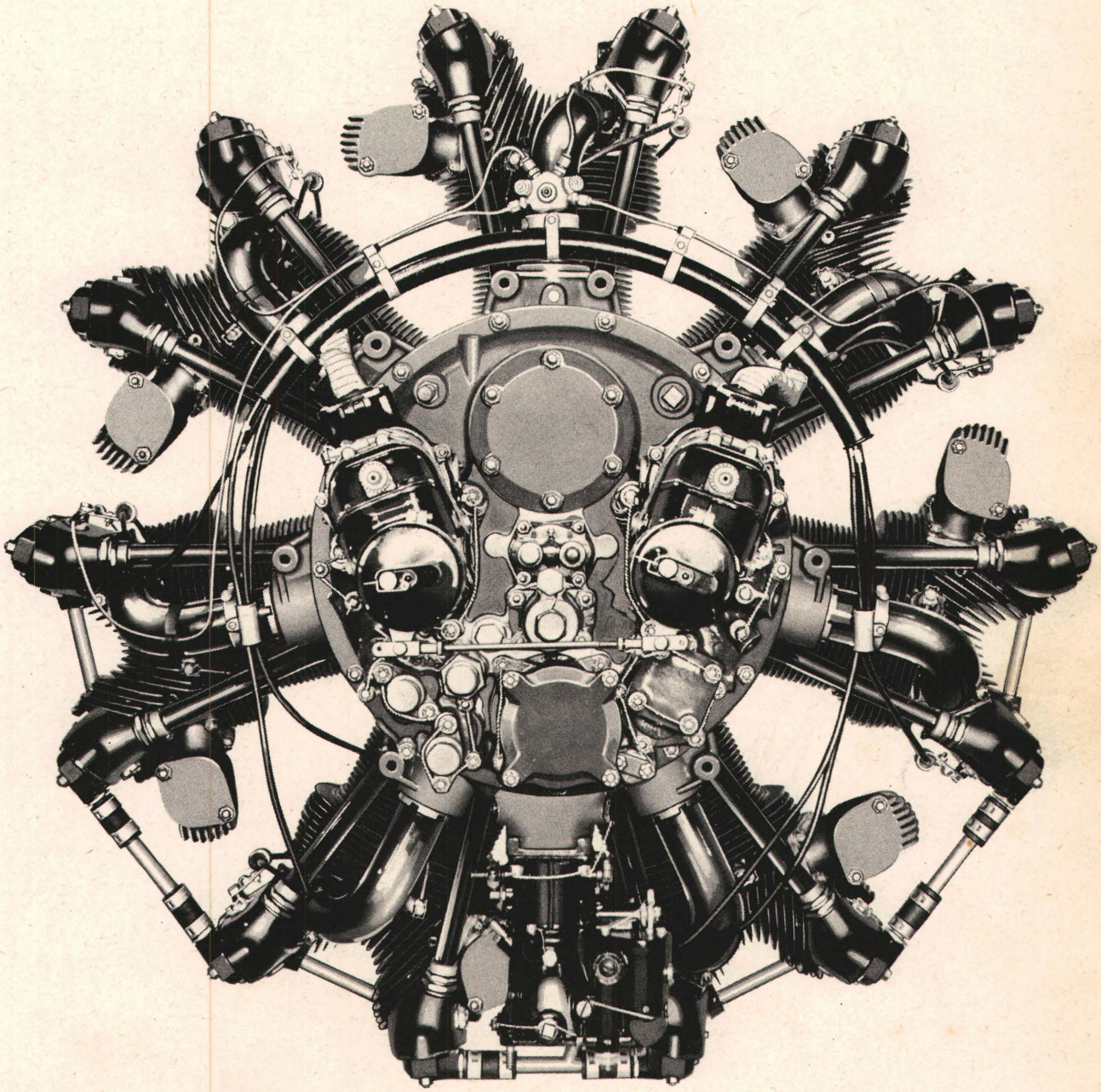


Figure 6—Rear View of R-670-4, -11 and -11A Engines

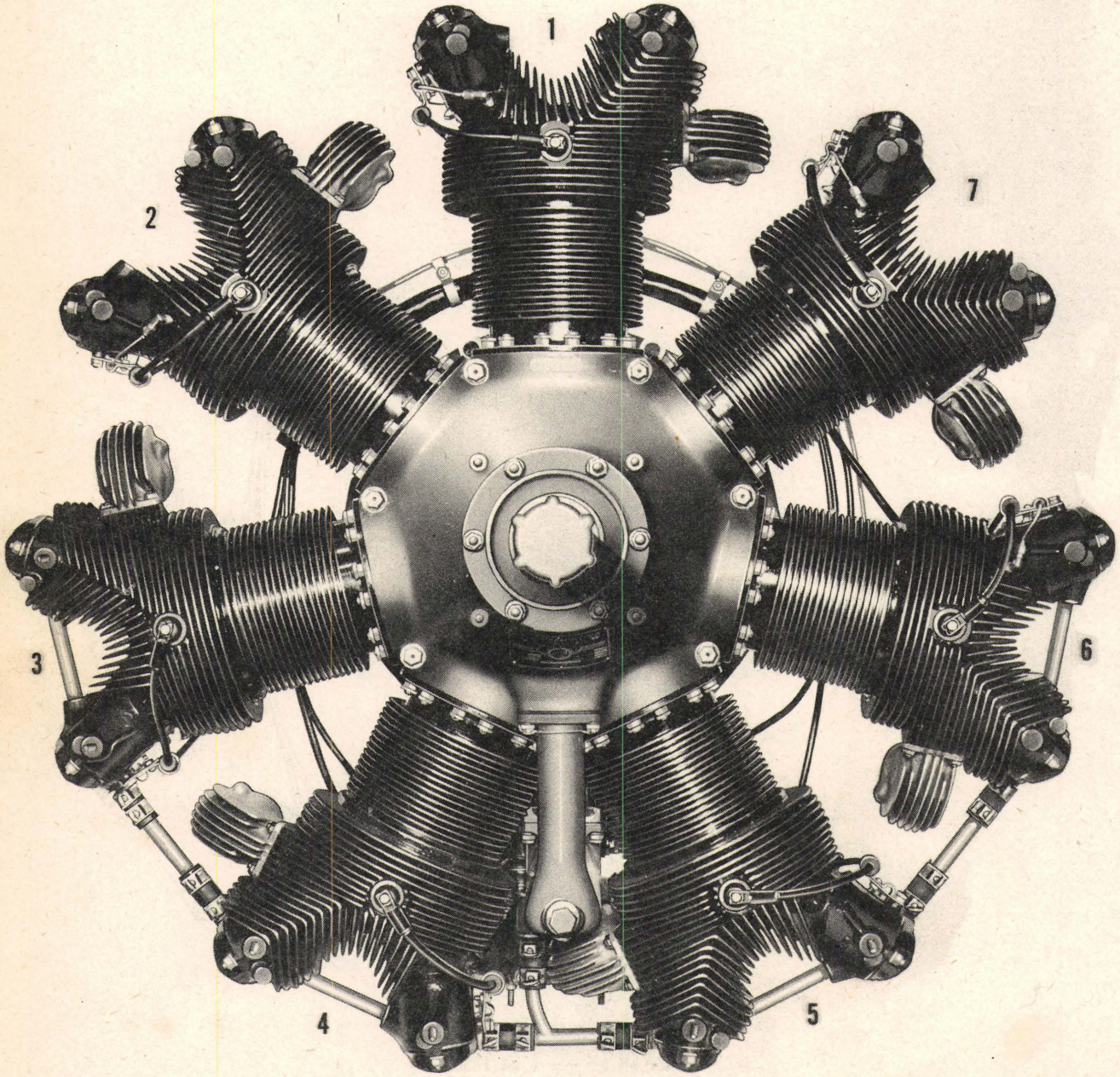


Figure 7—Front View of R-670-4, -5, -11 and -11A Engines with Cylinder Numbering Designations

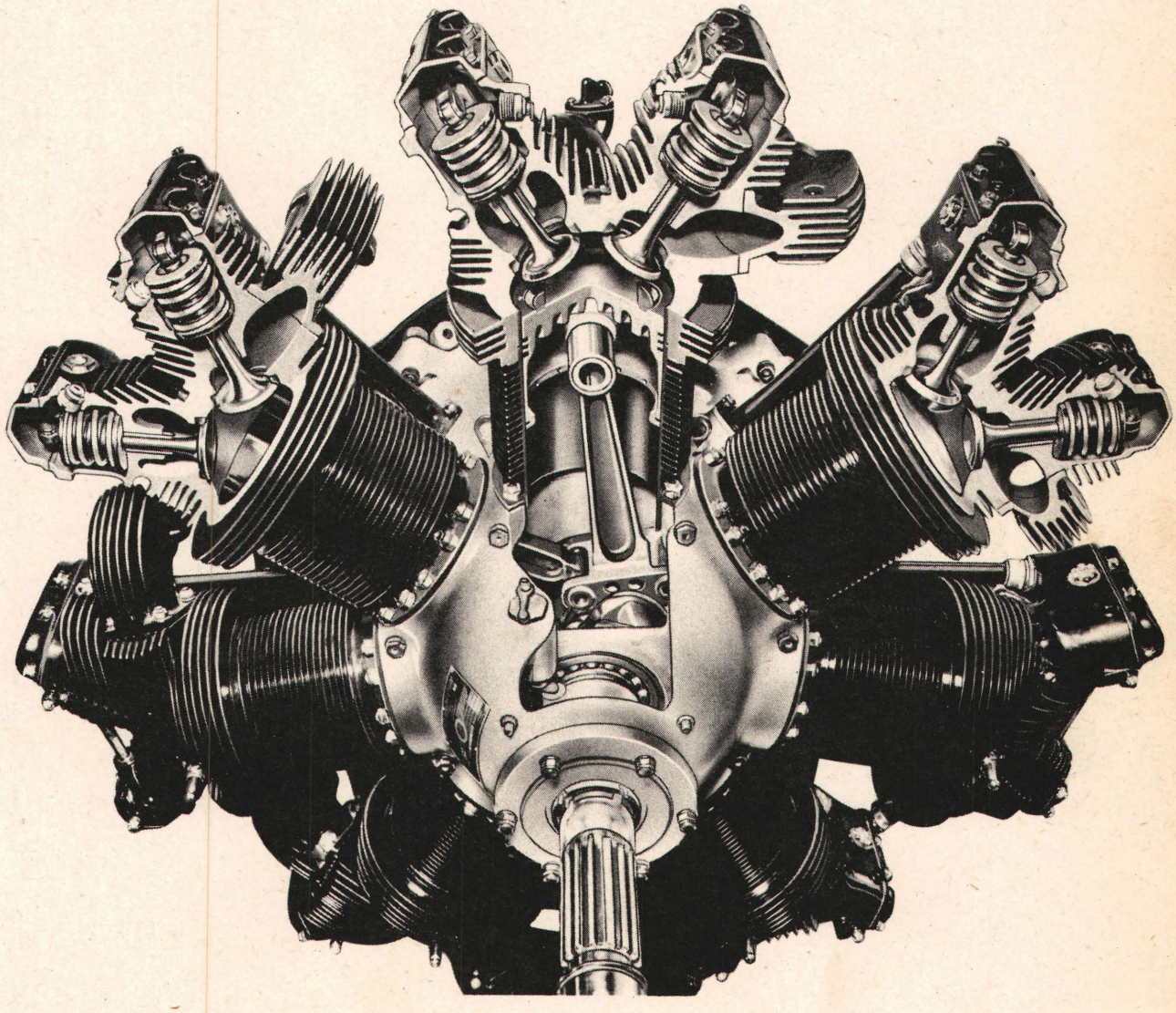


Figure 8—Three-Quarter Top Front Cutaway View of R-670-4, -5, -6 and -11A Engines

SECTION I
INTRODUCTION

1. This publication comprises the Service Instructions for the Model R-670-5 and associated Models -4, -6, -11, and -11A Aircraft Engines, manufactured by Continental Motors Corporation, Muskegon, Michigan.

2. In this publication, the following definitions will be used: The propeller end of the engine will be referred to as the "front" of the engine, and the anti-propeller end will be referred to as the "rear." The terms "right" and "left" are determined by viewing the engine from the rear and looking in the direction in which the propeller shaft points. "Top" and "bottom" are referred to with the engine resting on the base of its carburetor with the propeller shaft extending horizontally to the front. Directions of rotation are determined when looking from the rear toward the front of the engine. The rotation of accessory drives, whose mounting pads are set at an angle, is determined by facing the mounting pad. Cylinders are numbered beginning with the top cylinder, designated as "No. 1," and continuing in numerical order around the engine in a clockwise direction, when looking from rear to front, as indicated in figure 7.

SECTION II
GENERAL DESCRIPTION

1. GENERAL.

a. The R-670 engine is a seven-cylinder, air-cooled, static radial type gasoline engine with 667.86 cubic inches piston displacement, 5.125-inch bore, and 4.625-inch stroke. The compression ratio is 5.4 to 1.

b. Serial numbers will be used exclusively for engine identification. Model designations corresponding to serial numbers may be obtained from the following table:

Manufacturer's Engine Serial Number	*Army Air Forces Engine Serial Numbers*	*Navy Engine Serial Numbers*
	MODEL R-670-4 ENGINES	
8500—9133	.....	8500—9133
15000—16423	42-163386—42-164808	.....
16531	42-164917	.....
16532	42-164918	.....
16533	42-164919	.....
16534	42-164921	.....
16608	42-164994	.....
16689—16724	42-165075—42-165110	.....
16726—16837	42-165112—42-165223	.....
16845	42-165231	.....
16847	42-165233	.....
16848	42-165234	.....
16851	42-165237	.....
16852	42-165238	.....

Manufacturer's Engine Serial Number	*Army Air Forces Engine Serial Numbers*	*Navy Engine Serial Numbers*
16853	42-165239	.....
25000—25599	.....	25560—26159
25600—25770	.....	26160—26330
25776—25779	.....	26336—26339
25781—25797	.....	26341—26337
25801—25806	.....	26361—26366
25810	.....	26370
26201—26227	.....	26761—26787
26229—26341	.....	26789—26901
26362—26561	.....	26922—27121
26607—26677	.....	27167—27237
26709	.....	27269
	MODEL R-670-5 ENGINES	
5500—7970	41-1—41-19183	.....
13000—14837	41-51637—41-53474	.....
	MODEL R-670-6 ENGINES	
27068—27069	.....	27628—27629
27411—27428	.....	27471—27988
27476	.....	28036
T-27477—T-27479	.....	28037—28039
27480	.....	28040
T-27481—T-27482	.....	28041—28042
27483	.....	28043
T-27484—T-27485	.....	28044—28045
	MODEL R-670-11 ENGINES	
16424—16530	42-164810—42-164916	.....
16534	42-164920	.....
16609—16688	42-164995—42-165074	.....
16725	42-165111	.....
16838—16844	42-165224—42-16230	.....
16846	42-165232	.....
16849	42-165235	.....
16850	42-165236	.....
16854—16999	42-165240—42-165385	.....
25771—25775	.....	26331—26335
25780	.....	26340
25798—25800	.....	26358—26360
25807—25809	.....	26367—26369
25811—26200	.....	26371—26760
26228	.....	26788
26342	.....	26902
26361	.....	26921
26562—26606	.....	27122—27166
26678—26708	.....	27238—27268
26710—26999	.....	27270—27559
17000 and up	42-165386 and up	.....
27000 and up	.....	27560 and up
	MODEL R-670-11A ENGINES	
27408—27410	.....	27968—27970
27429—27475	.....	27989—28035

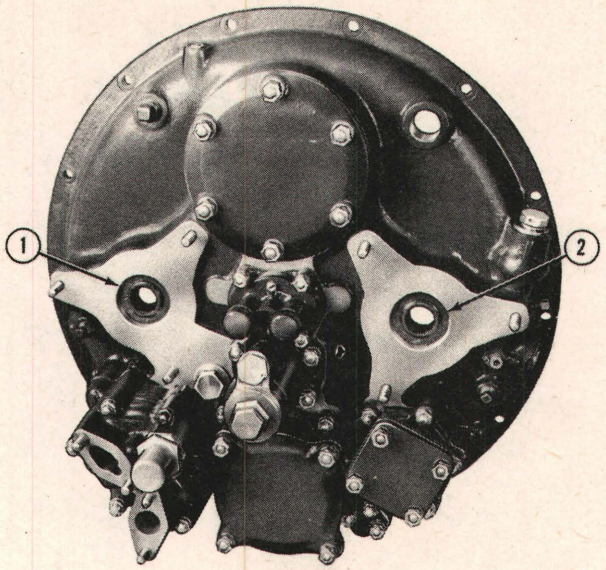


Figure 9—Accessory Case for R-670-5 Engine

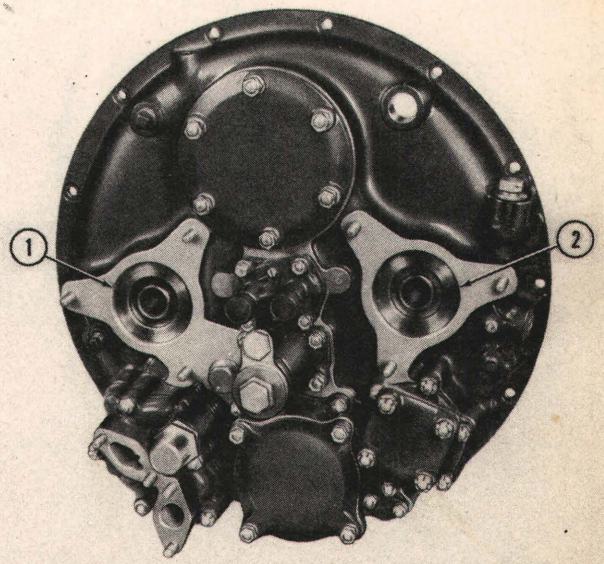


Figure 10—Accessory Case for R-670-4, -6, -11 and -11A Engines

Note

Supplementing the above identification plates, Continental serial numbers will be found stamped on a small machined boss area on the crankcase just under the front side of No. 1 cylinder mounting pad.

2. DIFFERENCES BETWEEN MODELS.

While all models of this engine are essentially the same, the following detailed description of the differences between models is given:

a. DIFFERENCES BETWEEN THE R-670-4 AND R-670-5 ENGINES.

(1) The accessory case on the R-670-5 engine is machined to accommodate a 1.875-inch diameter pilot (1 and 2, figure 9) on the magneto mounting pad. On the R-670-4, the provision for the pilot is machined to a 3.000-inch diameter (1 and 2, figure 10.)

(2) The fuel pump mounting pad is on the body of the rocker scavenge oil pump on all R-670 models. However, the pad on the R-670-5 is an AN standard "Old Type Pad." The R-670-4 has an AN standard "Square Type Pad" (2 inches between center line of mounting studs). The rocker scavenge oil pump drive gear on the R-670-4 has a spline connection for driving the fuel pump and is provided with an oil seal. The R-670-5 has a square coupling for driving the fuel pump, and no oil seal is provided.

(3) The drain hole in the oil sump for the R-670-4 has a 1-20 tapped hole to provide for the dehydrator plug required for storage, while the oil sump for the R-670-5 has a 1-18 tapped drain hole. Extreme care should be taken to see that the correct plug is used. An incorrect plug will cause damage to the threads in the oil sump.

(4) The magnetos used on the R-670-5 are Scintilla Model VMN7DF. (See figure 11.) The ignition drive shafts on the R-670-5 have serrated connections for driving the magneto drive shafts by means of a serrated coupling. The ignition drive gears for the R-670-4, -6, -11, and -11A have spline connections for driving the spline drive shaft on the SF7RN1 magnetos. (See figure 12.)

(5) The individual cable lengths for the ignition wiring assembly on the R-670-5 are slightly shorter than those for the other models because of the difference in magnetos.

b. DIFFERENCE BETWEEN THE R-670-4 AND R-670-11 ENGINES.

(1) Models R-670-4 and R-670-11 are identical in construction, the only difference is the carburetors. The R-670-4 engine is equipped with a Stromberg Model NA-R6D carburetor, for use in gravity-feed systems. The R-670-11 engine is equipped with an NA-R6G carburetor, for use in pressure-feed systems. The NA-R6G carburetor also can be used for gravity systems.

(2) The NA-R6G carburetor has a modified float to give a 5/8-inch fuel level for use on low wing ships requiring fuel pumps which operate at a maximum pressure of 3 pounds per square inch. It also has an inverted flight check valve assembly.

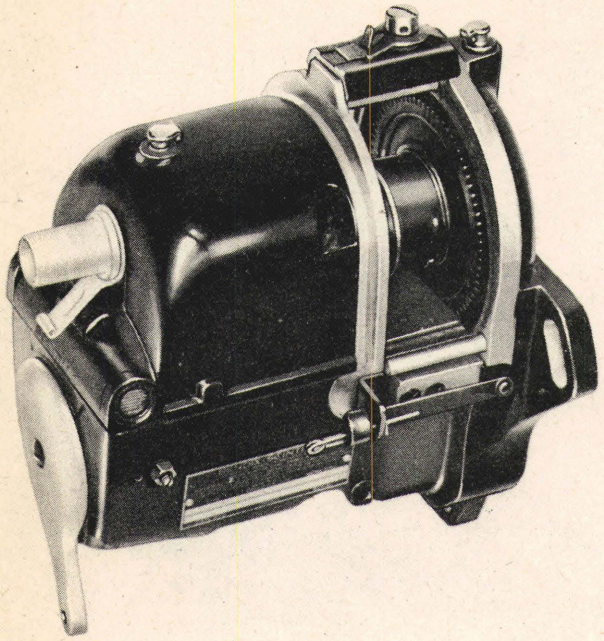


Figure 11—Scintilla VMN7DF Magneto Used on R-670-5 Engine

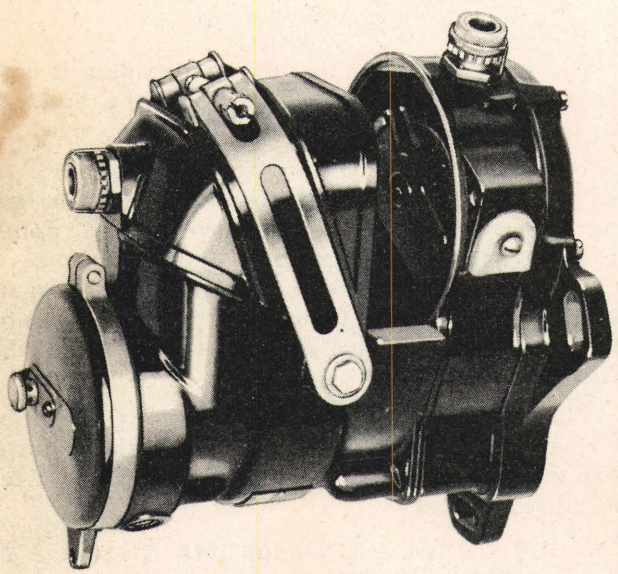


Figure 12—Scintilla SF7RN-1 Magneto Used on R-670-4, -6, -11, and -11A Engines

Note

The R-670-4 engine may be converted to an R-670-11 engine by removing the NA-R6D carburetor and replacing it with an NA-R6G carburetor. However, if this change is made, the engine data plate must be changed from R-670-4 to R-670-11. However, an NA-R6D carburetor *never* should be used with an R-670-11 engine.

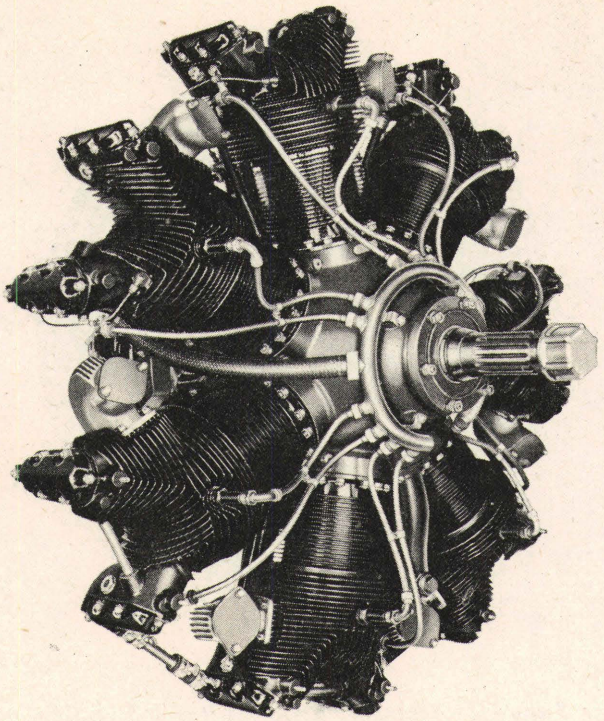


Figure 13—Right Front View of R-670-6 Engine Showing Radio-Shielded Ignition Harness

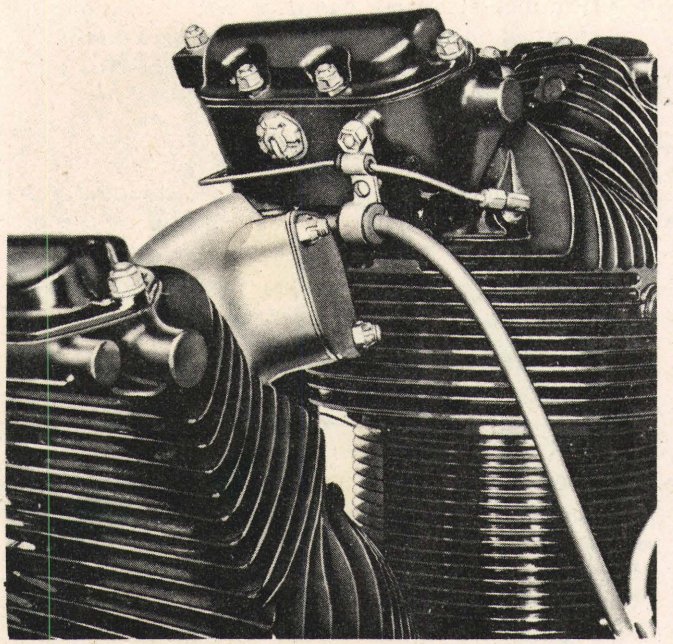


Figure 14—Primer Line and Ignition Wire Clip

c. DIFFERENCES BETWEEN THE R-670-6 AND R-670-11 ENGINES.

(1) The cylinder assemblies on the R-670-6 engine are provided with special studs for adaptation to airship installations.

(2) The R-670-6 engine is equipped with a Breeze radio-shielded ignition harness which is mounted on four studs in the front crankcase and with Champion C26S shielded spark plugs. Special radio-shielded magnetos (with fixed spark) are required. (See figure 13.) The left hand magneto is Scintilla, part No. 10-13900-14; the right magneto is Scintilla, part No. 10-13900-13. Both magnetos are Scintilla type SF7RN1.

(3) The exhaust elbow assemblies are all 90-degree elbows mounted so that the exhaust is directed toward the propeller end, as the R-670-6 is a pusher-type engine.

(4) The primer assembly used on the R-670-6 engine, while basically the same as used on the R-670-11 engine, is secured to the engine by clips attached to the intake pipes. (See figure 14.) The primer assembly for the R-670-11 engine is secured to the ignition cable conduit at the rear of the engine.

d. DIFFERENCES BETWEEN THE R-670-11, AND R-670-11A ENGINES.—The R-670-11A engine has a seventh order torsional vibration damper on the rear crankshaft crank cheek which, with its immediately associated parts on the crankshaft assembly, is the only difference from the R-670-11 engine. (See figure 18.)

Note

If it is necessary to convert a -4 or -5 engine to a -11A engine, first make all changes necessary to convert the -4 or -5 to a -11 engine. (Refer to paragraph 2. *a.* and *b.*, this section.) If it becomes necessary to install a seventh order crankshaft on a -6 engine, such installation should be noted by the addition of a "-A" to the nameplate on the converted engine, which will make it a -6A engine.

3. CRANKCASE.

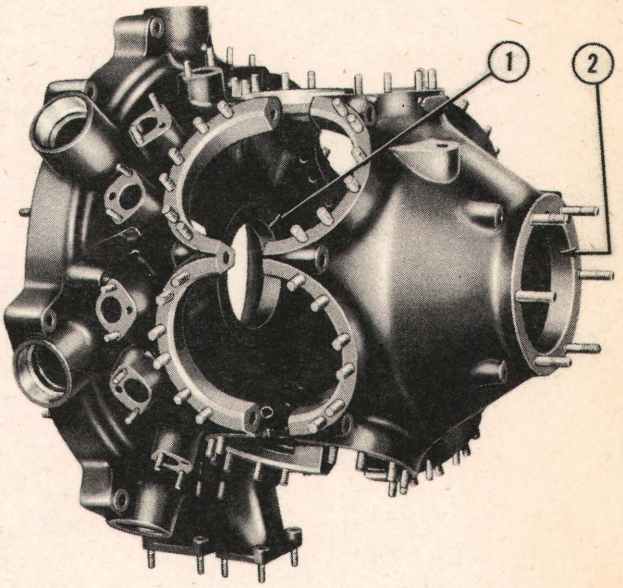
(See figure 15.)

a. The main crankcase section consists of a two-piece assembly bolted together at the cylinder center line with seven 7/16-inch nickel-steel bolts. It is cast from a special aluminum alloy and is reinforced with webs and fillets at all points of high stress. Twelve 3/8-inch studs are sunk at each cylinder port for cylinder mounting, and thirteen 5/16-inch studs are provided for attaching the rear accessory case. Internal webs, with pressed-in bronze liners (1), provide for the crankshaft front and rear main ball bearings.

b. The front end of the front crankcase half is provided with a recess (2) to receive a special steel cage and thrust bearing.

c. The carburetor induction system is cast integral with the rear half of the case. This provides additional internal reinforcement and a heated passage for the fuel from the top of the carburetor to the individual cylinder intake manifold ports.

d. Fourteen bosses are located around the outside diameter of the crankcase rear half where the cam followers and guides are installed. The casting is drilled at several points to provide a lubricating oil path to the cam followers, guides, push rods, and rocker arms. The eight main engine mounting lugs are cast integral with the rear half of the rear crankcase and located adjacent to the accessory case mounting flange. The main oil sump attaches to the front crankcase half between No. 4 and 5 cylinder ports.



1. Main Bearing Liner
2. Thrust Bearing Recess

Figure 15—Crankcase Sections Showing Pressed-In Bronze Main Bearing Liners and Cage and Thrust Bearing Recess

4. ACCESSORY CASE.

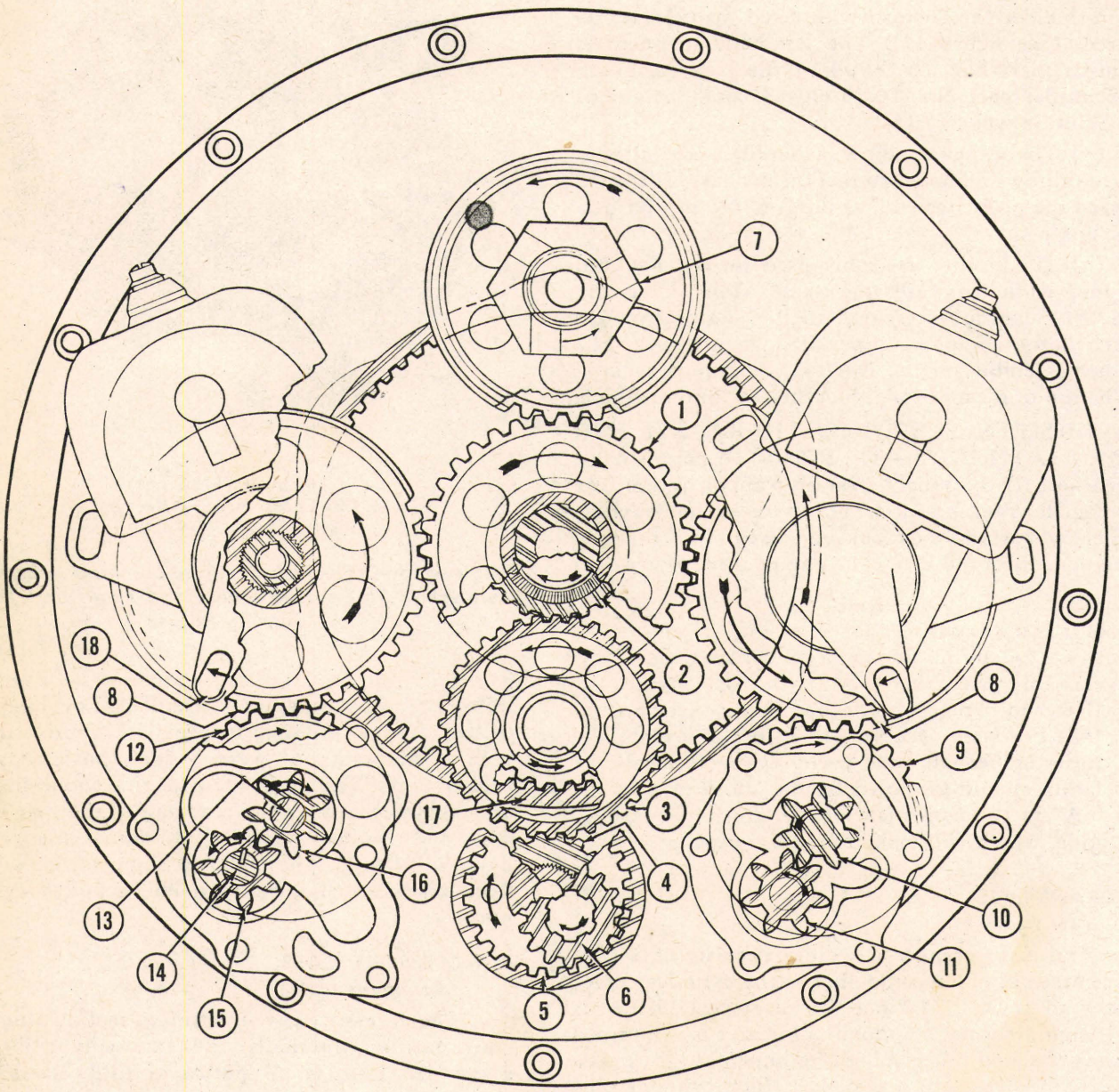
(See figure 16.)

a. The accessory case is a single-section aluminum alloy casting, internally and externally ribbed for greater strength at all points of high stress. It is machined around its entire mounting flange; at all accessory mounting pads; at all accessory gear train support bushings; and is internally drilled for high and low pressure oil passages. An analysis of the gear train follows:

(1) The rear crankshaft starter gear (1) is driven from the crankshaft by a direct-spline connection and turns in a clockwise direction at crankcase speed.

(2) The cam ring bearing gear (2) is driven through serrations on gear (1) at crankshaft speed in a clockwise direction.

(3) The intermediate cam drive gear (3) is driven by gear (2) in a counterclockwise direction at two-thirds crankshaft speed. The intermediate cam drive gear pinion is integral with gear (3), and drives the



1. **Rear Crankshaft Starter Gear**
2. Cam Ring Bearing Gear
3. Intermediate Cam Drive Gear
4. Generator Step Up Drive Gear
5. Generator Drive Gear
6. Generator Final Drive Pinion
7. Starter Gear
8. Right and Left Magneto Drive Gears
9. Rocker Scavenge Oil Pump Driving Gear
10. **Rocker Scavenge Oil Pump Drive Gear**
11. Rocker Scavenge Oil Pump Driven Gear
12. Duplex Oil Pump Driving Gear
13. Duplex Pressure Oil Pump Drive Gear
14. Duplex Pressure Oil Pump Driven Gear
15. Duplex Scavenge Oil Pump Drive Gear
16. Duplex Scavenge Oil Pump Driven Gear
17. Cam Ring Gear
18. Magneto Breaker Assembly Control

Figure 16—Gear Train Analysis

internal cam ring gear in a counterclockwise direction at 1/6 crankshaft speed.

(4) The generator step-up drive (4) meshes with gear (3), and turns in a clockwise direction at 1-1/5 crankshaft speed.

(5) The generator drive gear (5) is attached to gear (4), and turns the generator final drive pinion (6).

(6) The generator final drive pinion (6) turns in a clockwise direction at 1.95 crankshaft speed.

(7) The starter gear (7) turns in a counterclockwise direction at crankshaft speed.

(8) The right and left magneto drive gears (8) turn in a counterclockwise direction at 7/8 crankshaft speed.

(9) The rocker scavenge oil pump driving gear (9) turns in a clockwise direction at 1¼ crankshaft speed.

(10) The rocker scavenge oil pump drive gear (10) is driven by gear (9) through a male-female square coupling, and turns in a clockwise direction at 1¼ crankshaft speed.

(11) The rocker scavenge oil pump driven gear (11) turns in a counterclockwise direction at 1¼ crankshaft speed.

(12) The duplex oil pump driving gear (12) turns in a clockwise direction at 1¼ crankshaft speed.

(13) The duplex pressure oil pump drive gear (13) is driven from gear (12) by a male-female square coupling, and turns in a clockwise direction at 1¼ crankshaft speed.

(14) The duplex pressure oil pump driven gear (14) meshes with gear (13), and turns in a counterclockwise direction at 1¼ crankshaft speed.

(15) The duplex scavenge oil pump drive gear (15) is keyed to the shaft of gear (14), and turns in a counterclockwise direction at 1¼ crankshaft speed.

(16) The duplex scavenge oil pump driven gear (16) meshes with gear (15), and turns in a clockwise direction at 1¼ crankshaft speed.

(17) The cam ring gear (17) meshes with the intermediate cam drive gear pinion and turns in a counterclockwise direction at 1/6 crankshaft speed.

(18) The magneto breaker assembly control rotates in a clockwise direction for advanced position.

b. The entire accessory gear train drive system, with the exception of the cam ring and bearing gear and the crankshaft starter gear, is supported from the accessory case. All engine accessories, except the carburetor, are attached with appropriate mounting studs in a manner to permit maximum ease in installing, removing, inspecting, or maintaining in service.

5. CRANKSHAFT.

(See figures 17 and 18.)

a. The crankshaft is of two-piece, drop-forged, steel-alloy construction. It is carefully machined over its entirety, and is assembled with a single 7/8-inch

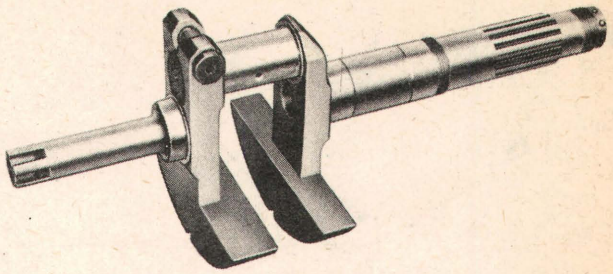


Figure 17—Crankshaft Assembly Part No. A5180

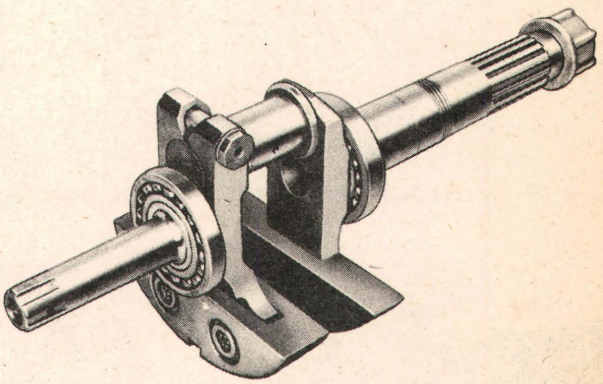


Figure 18—Crankshaft Assembly Part No. A5891 with Seventh Order Torsional Vibration Damper—Showing Front and Rear Main Bearings and Propeller Thread Protection Cap

cap screw at the juncture of the rear crankcheek and the master rod journal. The crankshaft bore provides an oil passage to carry pressure lubrication to its single crank throw journal and articulating rod knuckle pin bearings. The crankshaft of models R-670-4, -5, -6, and -11 is equipped with two fixed counterbalances to offset the weight of the connecting and articulating rod assembly.

b. The damper crankshaft has a single-torsional vibration damper attached to the rear crankshaft cheek by two loose pins. Tolerance on the pin clearances are .074 minimum to .080 maximum. Clearances beyond these limits will result in excessively rough engines and possible crankshaft breakage. A bronze ring is shrunk on the crankpin next to the crankpin's fillet for master rod side thrust.

Note

Crankshaft part No. A5881 is a seventh-order torsional vibration damper crankshaft which uses Master Rod, part No. C5071. This crankshaft was an experimental model of which the Army or Navy have but few. Crankshaft part No. A5891 is a seventh-order vibration damper crankshaft which, with its integral bronze washer, uses Master Rod, part No. A40083. Both are used on -11A engines. (Refer to paragraph 2. *d.*, this section.)

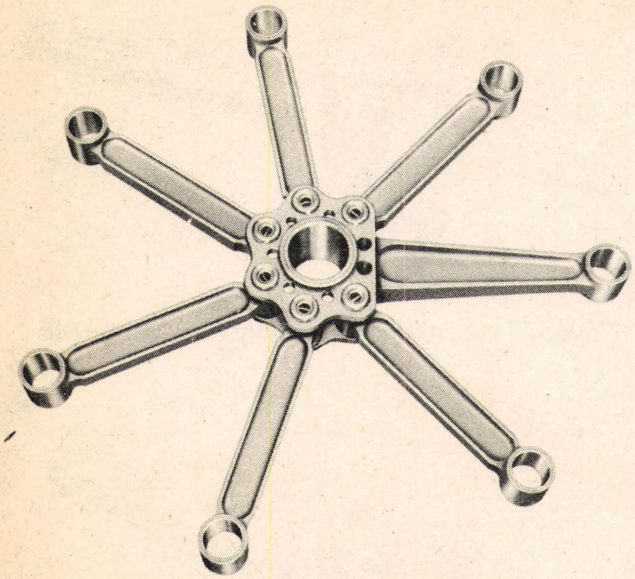


Figure 19—Connecting and Articulating Rod Assembly

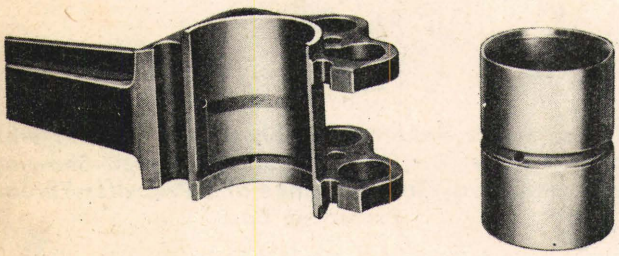


Figure 20—Cutaway of Master Rod with Complete Bearing

c. The propeller shaft is a prolongation of the front half of the crankshaft and is machined with a standard No. 2 spline for receiving the propeller hub. The accessory shaft (tail shaft) is a prolongation of the crankshaft rear half and is provided with a spline and a special female threaded end for power take-off to drive the accessory gear train.

6. CONNECTING AND ARTICULATING ROD ASSEMBLY.

(See figures 19 and 20.)

The connecting and articulating rod assembly is made up of seven separate subassemblies described in detail as follows:

a. The master rod is of single, drop-forged, "H" section special alloy steel and is machined over its entirety. It is provided with a pressed-in, shell-type bronze bushing, reamed to receive the piston pin, and a one-piece steel-backed lead bronze bearing, 1.992 inches inside diameter by 3.288 inches long, pressed in the crank end and diamond bored to size. Wide cheeks are provided on the crank end as an integral part of the master rod. These cheeks are separately machined, bored, and reamed to receive the knuckle pins attaching the six articulating rods.

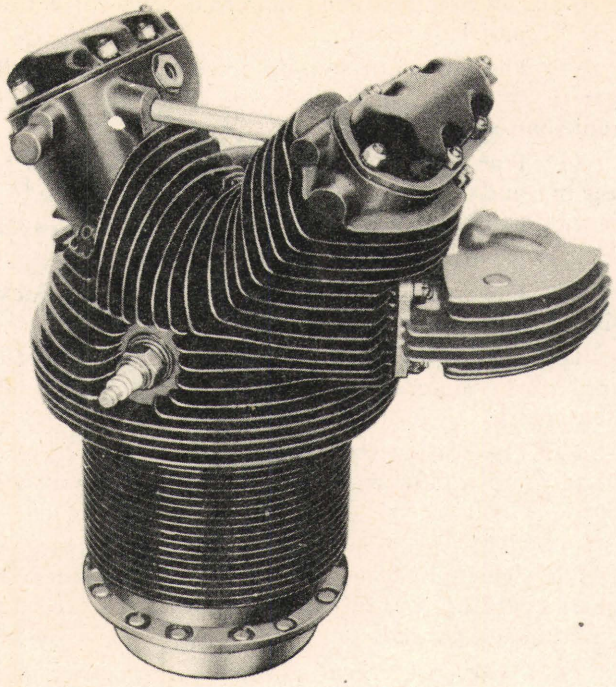


Figure 21—Cylinder Assembly

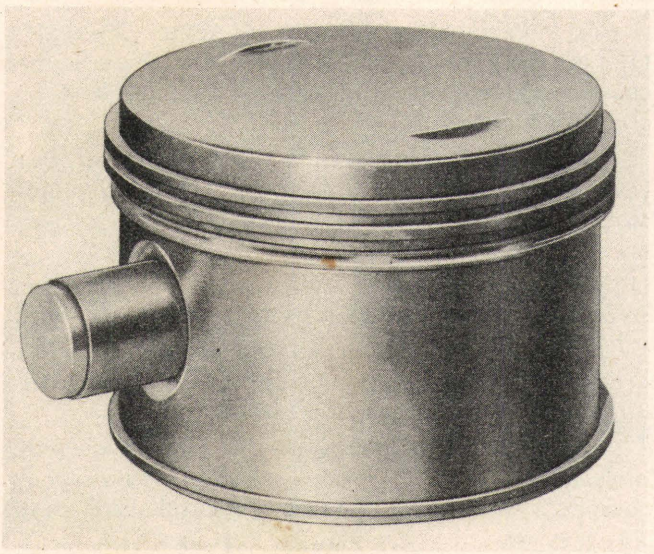
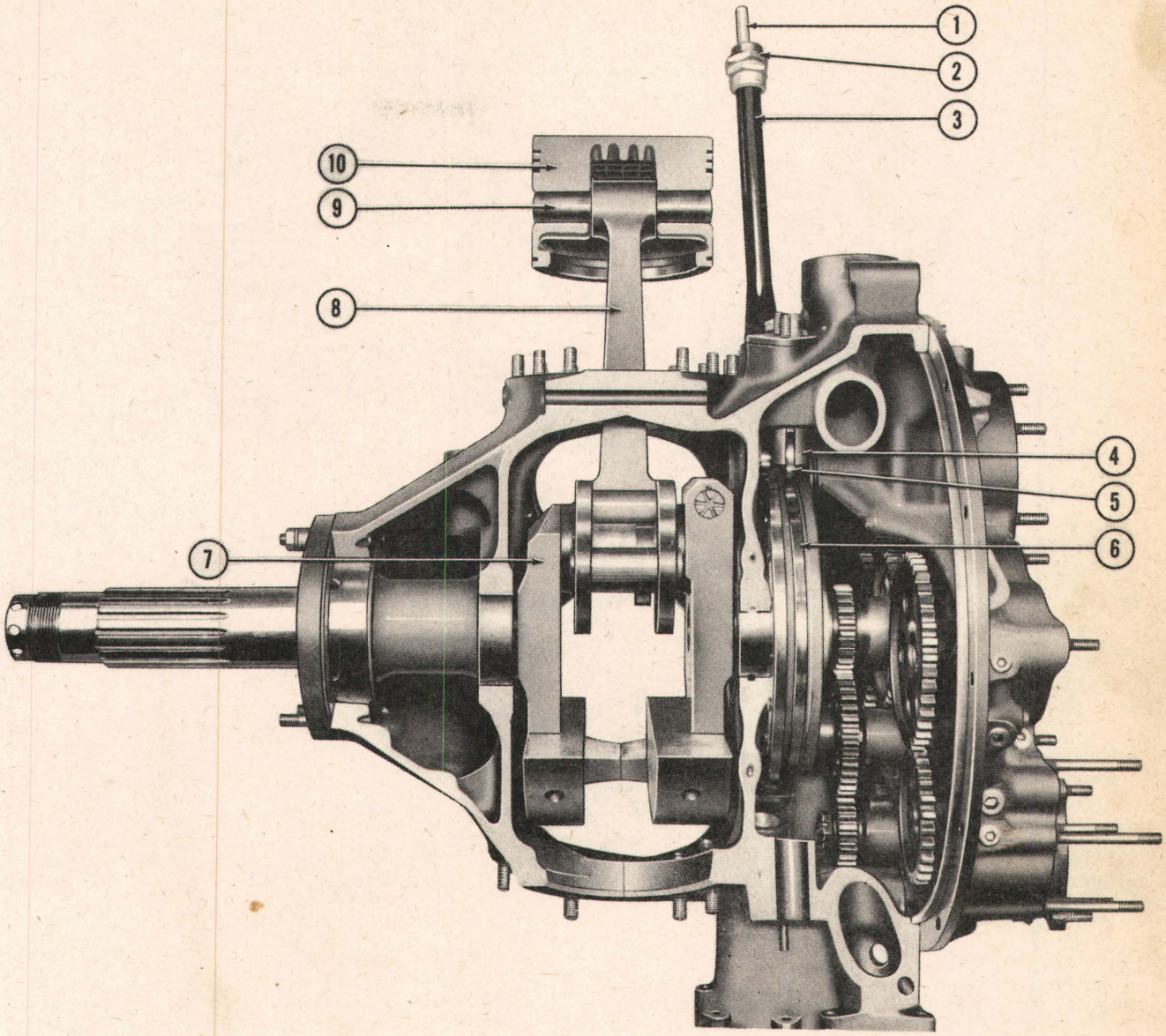


Figure 22—Piston Assembly

b. Each of the six articulating rods is of an "H" section, drop-forged construction of special alloy steel and is machined over its entirety. The piston end of each rod is provided with a pressed-in, shell-type bronze bushing reamed to take the piston pin. The crank end is provided with a shell-type, pressed-in bronze bushing reamed to receive the knuckle pin.

c. The articulating rods are assembled to the master rod by inserting the knuckle pin end between the



1. Push Rod
2. Valve Adjusting Screw
3. Push Rod Housing
4. Cam Follower Guide
5. Cam Follower
6. Cam Ring
7. Crankshaft
8. Connecting Rod
9. Piston Pin
10. Piston

Figure 23—Left Side Cutaway View of Typical R-670 Engine

master rod cheeks, lining up the bores, and installing the knuckle pins.

d. The knuckle pins are machined from seamless alloy steel tubing. They are case-hardened, fitted on their inside bore with a pinned-in oil plug, and ground to size. These pins install with a retaining Woodruff key on one end and a circlip on the other.

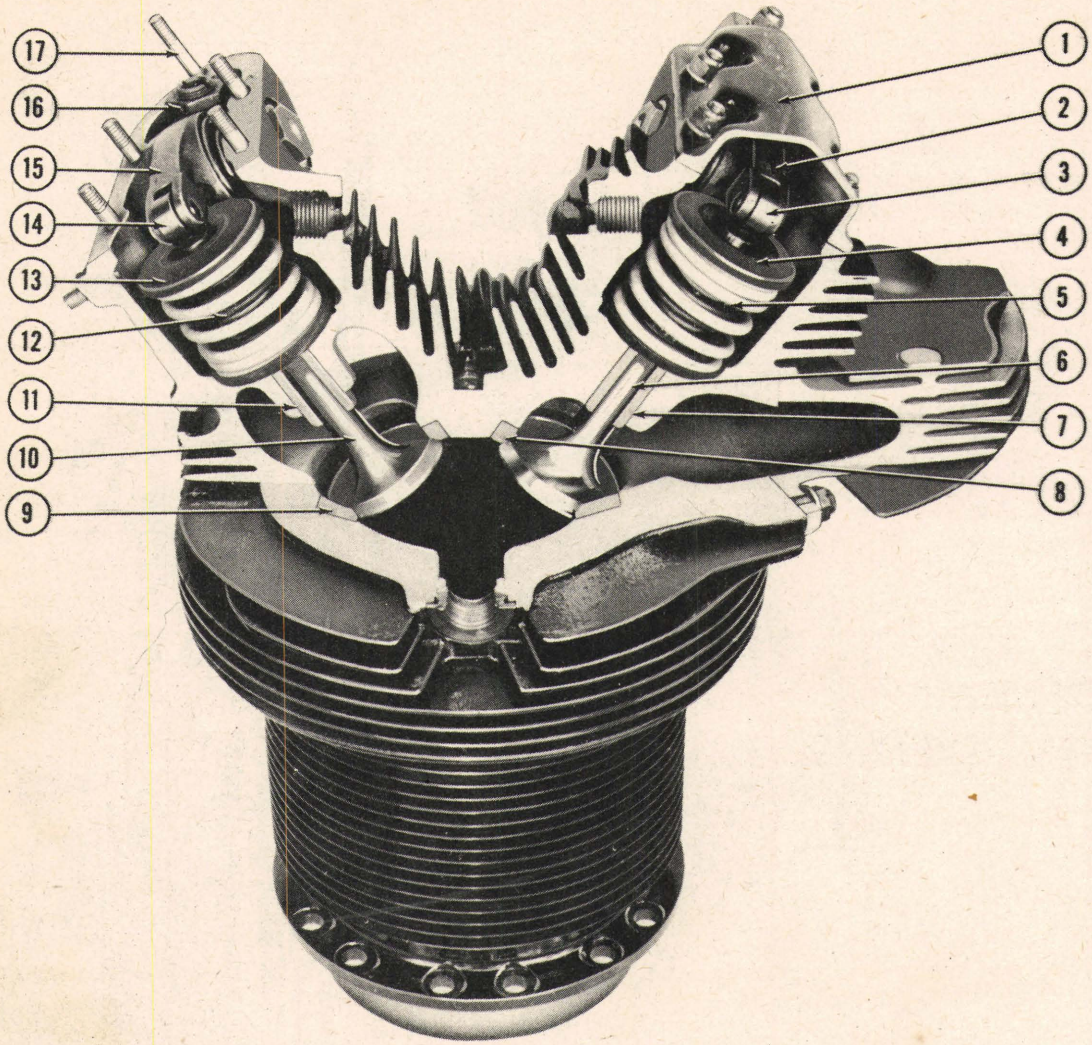
e. The complete master and articulating rod assembly is installed on the crankshaft throw journal prior to the assembly of the two crankshaft halves.

7. CYLINDERS.

(See figure 21.)

The cylinder assembly is composed of two pieces screwed and shrunk together. The following describes the construction:

a. The cylinder barrel is machined from a single drop-forging of special alloy steel. Its mounting flange is provided with 12 holes to receive the attaching studs from the main crankcase, and the top is provided with a special thread where the aluminum head is



1. Rocker Box Cover
2. Rocker Arm
3. Rocker Arm Roller
4. Exhaust Valve Spring Retainer
5. Exhaust Valve Spring
6. Exhaust Valve
7. Exhaust Valve Guide
8. Exhaust Valve Seat Insert
9. Intake Valve Seat Insert
10. Intake Valve
11. Intake Valve Guide
12. Intake Valve Spring
13. Intake Valve Spring Retainer
14. Rocker Arm Roller
15. Rocker Arm
16. Valve Adjusting Screw
17. Rocker Box Cover Studs

Figure 24—Cutaway View of Cylinder Assembly

screwed and shrunk in place. The bore is machined, ground, and polished to a mirror finish, and the cooling fins are machined their entire depth from the original forging.

b. The cylinder head is of a special cast aluminum construction with side exhaust and rear intake ports. Provisions are made in the head to receive intake and exhaust valves and two spark plugs. Bronze valve seats and guides are shrunk in place when the head is shrunk to the barrel. The spark plug inserts are installed after the assembly has cooled. Rocker boxes are cast integral with the head and are machined to receive the necessary valve operating mechanism.

8. PISTONS.

(See figure 22.)

The piston assembly is made up of three subassemblies.

a. The piston is of a special aluminum alloy forging with ribs provided to support the head. The piston is machined over its entire outer surface and is drilled and reamed through its boss to receive the piston pin.

The piston is provided with four ring grooves, three above the pin and one below.

b. The piston pin is machined and ground from a case-hardened, seamless steel alloy tubing, fitted on each end with a special aluminum plug. The pin assembly is of the "full floating" type.

c. There are four rings to each piston. Two compression rings and one oil ring are located above the pin; one compression ring is located below.

9. VALVE OPERATING MECHANISM.

(See figures 23 and 24.)

a. The valves are actuated by means of a double track cam ring revolving on the cam ring bearing gear which is located on the crankshaft in the accessory section of the main crankcase. Lobes, provided on the cam ring track, actuate the cam followers through rollers located on their ends. The cam lift action is transmitted to the one cylinder valve by means of a push rod and rocker arm. The rocker arm is equipped with a center ball bearing secured in place by a rocker arm bolt and two side-thrust washers. It has a valve adjusting screw on the push rod end and a roller on the valve end. The rocker arm acts directly from the push rod to the top of the valve stem.

b. The cam ring is driven by the intermediate cam drive gear pinion meshing with internal teeth around a track near its outside diameter.

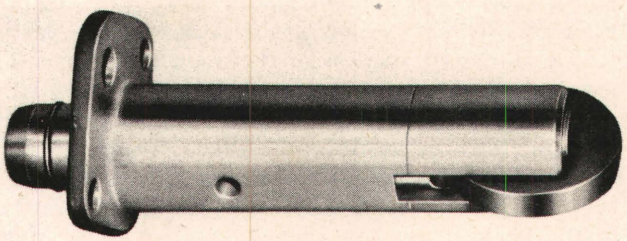


Figure 25—Cam Follower and Guide Assembly

c. The cam follower assembly is composed of two major parts (see figure 25): the "guide," and the "follower" with its assembling pin, roller, and retaining circlip. The assembly is lubricated by the low pressure oil system, and is drilled to provide passage for this oil to the hollow push rod. The cam follower is secured in its guide with a circlip located near the push rod socket. The assembly is secured in the crankcase by two ¼-inch studs extending through the cam follower guide shoulder to the push rod housing mounting flange.

d. The push rod is of three-piece construction with two ball socket ends pressed into a center hollow tube. The socket ends are drilled to permit passage of low pressure oil from the cam follower to the rocker arm. Push rod ball socket ends are machined steel, case-hardened, and ground to fit their cam follower and valve adjusting screw sockets.

e. The rocker arm is a drop-forging of alloy steel, bored and threaded on the rear end to receive the valve adjusting screws. It is provided with a recess in the center for the rocker ball bearings, and is machined and bored at the front end for a roller specially designed to eliminate wear from the valve stem during operation.

f. The intake valve is a special steel forging, machined and ground with a 2.250-inch head and a .464-inch Stellite-tipped stem. The valve is ground to its seat and installed in the cylinder with the conventional valve springs and washers, a safety circlip in its stem, and is retained in place by two split-cone keys.

g. The exhaust valve is a special steel forging, machined and ground with a 2.250-inch head and a .558-inch Stellite-tipped stem that is hollow and filled with sodium. It installs in the same manner as described in the preceding paragraph.

h. The aluminum or magnesium rocker box covers are held in place by six ¼-28 nuts. The covers on cylinders No. 7, 1, and 2 have no external connections. Cylinders No. 3, 4, 5, and 6 are equipped with external piping to scavenge rocker box oil to the oil sump level. There it is picked up by the special low-pressure rocker scavenge oil pump. Inter-cylinder rocker scavenge oil drain lines are installed with oil hose connections.

10. FUEL SYSTEM.

Fuel is furnished by one single-barrel Stromberg Type NA-R6D carburetor (on the R-670-4, -5, and a NA-R6G carburetor on the R-670-6, -11, and -11A) located on a mounting pad at the extreme lower part of the main crankcase. Fuel passes from the carburetor into the intake manifold system, and is distributed to the cylinder manifold ports located around the outside diameter of the main crankcase and to the rear of the cylinder ports. The fuel passes from these ports through external manifold pipes to the cylinder intake valve ports.

11. IGNITION SYSTEM.

(See figure 35.)

a. Ignition is furnished and distributed by two type VMN7DF Scintilla magnetos on the R-670-5 engine, and two type SF7RN-1 Scintilla magnetos on the R-670-4, -6, -11, and -11A engines. One magneto is mounted on the left and one on the right side of the accessory case.

b. Ignition cables, carrying the current from the magnetos to the cylinder spark plugs, pass through a protective ignition cable housing located along the upper diameter of the accessory case on the R-670-4, -5, -11, and -11A engines.

c. Only the spark plugs designated in T. O. No. 03-5E-1 will be used in these engines.

12. LUBRICATION SYSTEM.

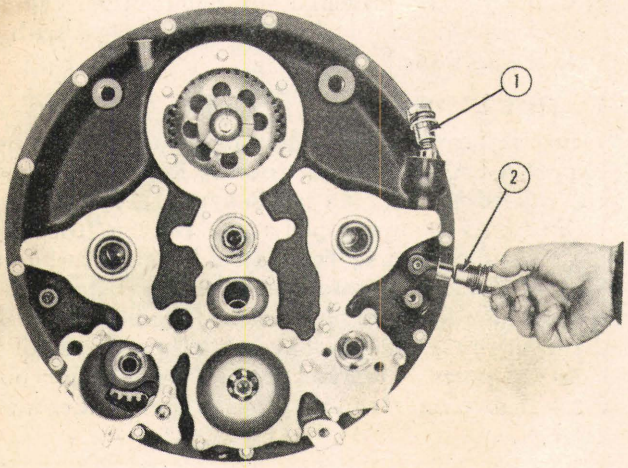
a. GENERAL.—The lubrication system of these engines is divided into four divisions: high pressure

oil; low pressure oil; rocker scavenge oil; and main scavenge oil.

b. THE OIL PUMP.

(1) The main pressure and scavenge oil pump is of duplex construction. The scavenge oil section is located in a separate housing adjacent to the accessory case, and the pressure oil section is superimposed over the scavenge section in another housing. In the R-670-4, -5, and -11 engines the duplex pressure and scavenge sections are separated by two plates with oil seals located between them.

(2) Drive and idling gear shafts extend through the duplex pump body assembly from front to rear. Each shaft supports two gears; the front gears operate in the scavenge section and the rear gears in the pressure section. The entire pump is driven by the left accessory case oil pump drive gear through a square type coupling, the male portion of which is integral with the pressure drive gear shaft. The driving scavenge gear is located on and keyed to the driven pressure gear shaft. The driven scavenge gear is mounted on the pressure gear shaft but is not keyed to it.



1. Low Pressure Relief Valve
2. High Pressure Relief Valve

Figure 26—Location of High and Low Pressure Oil Relief Valves for R-670-4, -5, -6

(3) In the R-670-4, -5, and -11 engines the high pressure oil relief valve is incorporated as an integral part of the duplex pump assembly. (See figure 26.) It is of the spring and plunger type with an adjusting screw regulating the oil pressure. Bypassed oil from this relief valve is admitted directly to the input of the pressure pump by way of a passage in the pump housing.

c. HIGH PRESSURE OIL.—For the purposes of this explanation, the cycle of oil will be "started" at the "oil in" connection on the main duplex oil pump. From this point oil is pumped through the high pressure oil screen into the main oil distributing passages on the front side of the accessory case. All bearings, located on the accessory case, receive pressure lubrication by way of small oil passages in the accessory case casting connecting each individual bearing with this main oil supply line. Oil enters the rear of the crankshaft through a recessed bronze bearing, and passes through a drilled passage in the rear crank cheek into the hollow crankpin. A small hole drilled in this pin lubricates the master rod bearing and passes oil into the master rod which is drilled for oil passage to the knuckle pins in the articulating rods. Oil thrown from ends of the master rod bearing lubricates the piston assemblies and cylinder walls. Front and rear main ball bearings and the thrust ball bearing receive their lubrication from the splash and spray of the main crankcase. Accessory gears receive their lubrication by splash and spray of oil escaping from the pressure lubrication of their respective bearings. When circulating crankcase oil is released from pressure, it falls by gravity to the main oil sump located between No. 4 and 5 cylinders.

d. LOW PRESSURE OIL.—Low pressure oil originates at the end of the main high pressure passage in the accessory case just below the low pressure oil relief valve. High pressure oil passes through a .090-inch orifice to the low pressure relief valve, which maintains a constant pressure of 15 to 18 pounds per square inch in the low pressure rocker system. (See figure 26.) Bypassed oil from this valve empties through a drilled passage in the accessory case casting to the accessory section of the main crankcase. The low pressure oil passes from its valve through drilled passages in the rear crankcase casting to each of the 14 cam follower guides, then through a hole drilled in the center of this guide and cam follower into the push rod, and through the rocker arm adjusting screw to the rocker arm bearing and roller. Valve stems, springs, and washers receive their lubrication by splash. On cylinders No. 7, 1, and 2 the rocker oil scavenges by gravity back to the rear crankcase section by way of the push rod housings and special drain passages provided in the rear half of the main crankcase. Scavenge oil in rocker boxes of cylinders No. 3, 4, 5, and 6 drains by gravity through the external piping provided between the cylinder rocker box covers to the rocker box level of cylinders No. 4 and 5, where it is picked up by the rocker scavenge pump and discharged in the accessory section of the main crankcase. Detailed explanation of this procedure is outlined in the following paragraph.

e. ROCKER SCAVENGE OIL. *(See figure 27.)*—Due to the fact that rocker boxes on cylinders No. 4 and 5 are at a lower level than the main oil sump, it is necessary to provide a separate pump so that these boxes will not be unduly flooded from the main crankcase. As a single-section scavenge pump will not pick up oil from two levels without danger of flooding the lower level, a separate scavenge pump is located on the accessory

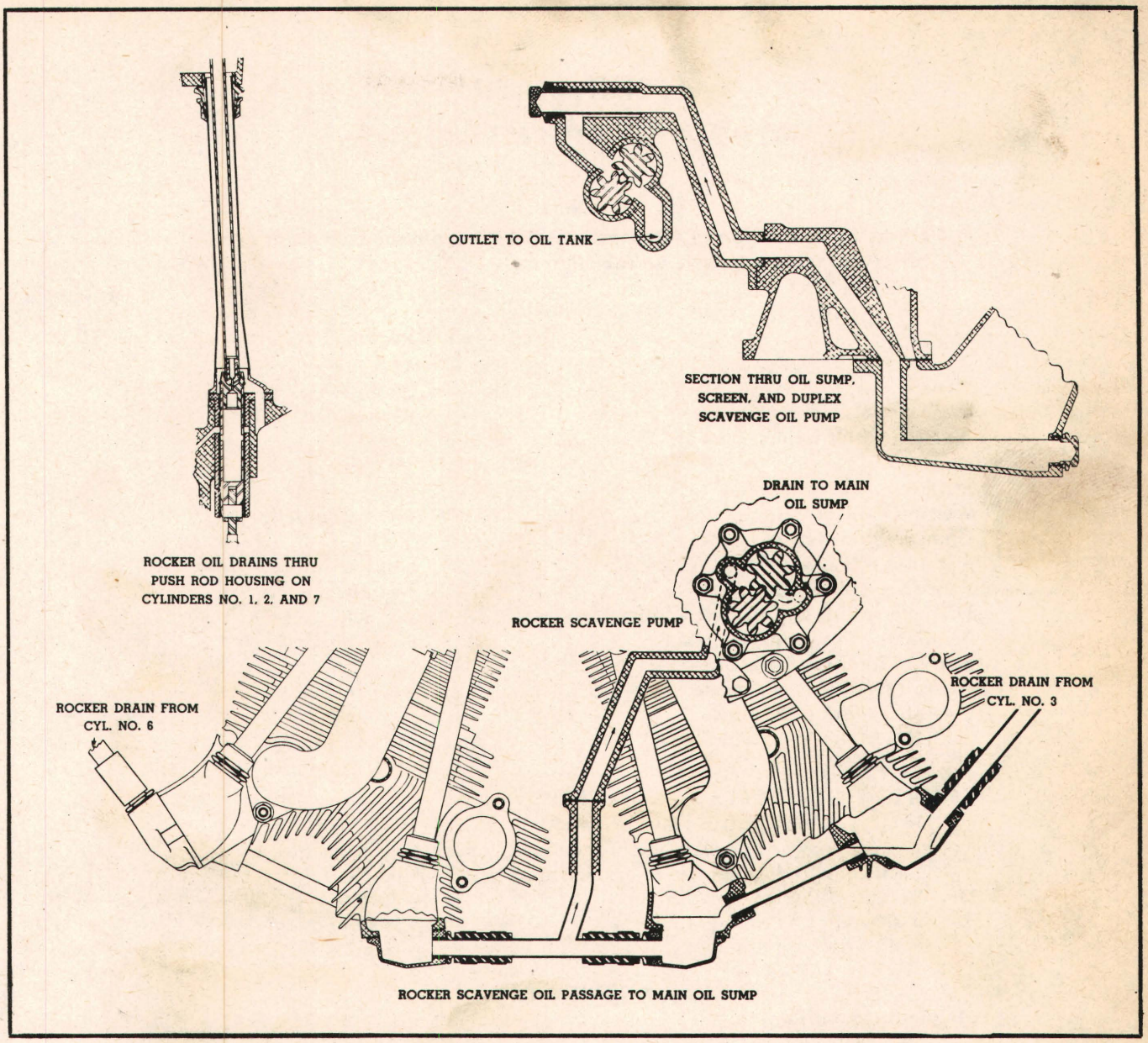


Figure 27—Scavenge Oil System Diagram

case to handle the rocker scavenge oil. This pump picks up its oil by way of a hole through the rear end of the oil sump and drilled passages in the rear crankcase and accessory case housing, and empties it into the accessory case section of the main crankcase.

f. MAIN SCAVENGE OIL. *(See figure 27.)*—Oil draining from all sections of the main crankcase falls into the main oil sump located between cylinders No. 4 and 5 on the front side of the engine. From this sump the duplex scavenge oil pump (a section of the duplex pressure and scavenge oil pump assembly) picks it up through the scavenge oil screen, located adjacent to and a little above the main pressure screen housing, and returns it to the oil supply tank. From this point the duplex pressure pump again picks it up and the oil repeats its circulation throughout the engine.

13. PRIMING SYSTEM.

The models R-670-4, -5, and -11 engines are equipped with a conventional external priming system composed of a primer distributor with four standard ⅛-inch primer lines. These lines attach to the distributor at one end and to primer jets on cylinders No. 6, 7, 1, and 2 at the other. The airplane's main primer line attaches at the center of the engine's primer distributor with a standard ⅛-inch pipe connection. (See figure 36.)

14. COOLING.

The entire engine is air-cooled. At no time during operation will cylinder head temperature exceed +260° C. (+500° F.) or "oil in" temperatures exceed +95° C. (+203° F.)

SECTION III
TABLE OF SPECIFICATIONS

Note

Direction of rotation of accessories is defined from the viewpoint of the observer facing the drive on the engine.

GENERAL

Model	R-670-4, -5, -6, -11, and 11A
Type	Single Row, Static Radial, Air-Cooled
Number of Cylinders	7
Bore	5.125 inches
Stroke	4.625 inches
Piston Displacement	667.86 cubic inches
Compression Ratio	5.4 : 1
Rotation of Crankshaft	Clockwise
Propeller Spline Size	No. 20
Diameter of Mounting Bolt Circle	20 inches
Number of Mounting Bolts	8
Size of Mounting Bolts	3/8 inch
Overall Diameter of Engine	42 1/4 inches
Overall Length of Engine	
(R-670-4, -6, -11, and -11A)	35 5/8 inches
(R-670-5)	34-3/16 inches
POSITION OF CENTER OF GRAVITY:	
Distance to rear of front face of thrust nut	10-13/16 inches
Distance forward of rear face of mounting lugs	6-1/16 inches
Distance below centerline of crankshaft	5/8 inch
Dry Weight of Engine—Maximum	
(R-670-4, -5, -11, and -11A)	485 pounds
(R-670-6)	495 pounds

IGNITION

Magneto—Scintilla	
Type (R-670-4, -6, -11, -11A)	SF7RN-1
Type (R-670-5)	VMN7DF
Magneto Breaker Point Gap	As required
(Scintilla Type SF7RN-1) The contact points of the pivotless breakers must always be adjusted to open at the proper position of the cam in relation to the timing marks at the breaker end of the magneto, and not for any fixed clearance between the contact points.	
Magneto Breaker Point Gap	.010 inch to .014 inch
(Scintilla Type VMN7DF) Breaker in full advance position.	.012 inch most desirable
Spark Plug Gap Clearance	.016 inch plus .002 inch or minus .001 inch
Spark Plug	
Type R-670-4, -11, -5, -11A	Champion M26 or C26
Type R-670-6	Champion C26S or 18A-1
Rotation	Counterclockwise
Speed	0.875:1
Right Magneto Times, Degrees Before Top Center	32
Left Magneto Times, Degrees Before Top Center	29

VALVES AND TIMING

HOT RUNNING VALUES:

Intake Opens, Degrees Before Top Center	8
Intake Closes, Degrees After Bottom Center	45
Intake Remains Open, Crank Angle Degrees	209
Exhaust Valve Opens, Degrees Before Bottom Center	63
Exhaust Valve Closes, Degrees After Top Center	20
Exhaust Remains Open, Crank Angle Degrees	263

VALVE TIMING (Set valve clearance No. 1 cylinder at .124 inch cold):

Exhaust Opens, Degrees Before Bottom Center	49
Exhaust Closes, Top Dead Center	0
Intake Valve Opens, Degrees After Top Center	4
Intake Valve Closes, Degrees After Bottom Center	21
Adjust All Valves for Service—Cold	.010 inch
Valve Lift	.500 inch

FUEL SYSTEM

Carburetor—Stromberg (R-670-4, -5)	Model NA-R6D
(R-670-6, -11, -11A)	Model NA-R6G
Fuel: Minimum Grade	73—Specification No. AN-F-23
Carburetor Connection	3/8-inch Pipe
Priming System Inlet Connecting Thread	1/8-inch Pipe

LUBRICATION SYSTEM

Grade of Oil Required—Specification	AN-VV-O-446
Speed of Oil Pump	1.250:1
Oil Inlet and Outlet Connections, R-670-4, -5, -6, -11, -11A	3/4-inch Pipe Thread

ACCESSORY DRIVES AND INSTRUMENT CONNECTIONS

Oil Pressure—High and Low	1/8-inch Standard Pipe
Crankcase Breather	1/2-inch Hose
Oil Tank Vent Connection on Accessory Case	3/4-inch Standard Pipe

FUEL PUMP MOUNTING PAD AND DRIVE

Type of Drive—R-670-4, -6, -11, -11A	Spline
Type of Drive—R-670-5	Square Shaft
Direction of Rotation	Clockwise
Speed	1.250:1

STARTER MOUNTING—3 Jaw—Type L

Direction of Rotation	Counterclockwise
Speed	1:1
Clutch Torque Setting (As specified in T. O. No. 03-5CA-8.)	

GENERATOR MOUNTING PAD AND DRIVE

Direction of Rotation	Clockwise
Speed	1.95:1

TACHOMETER DRIVE—TWO CONNECTIONS, TYPE 1

Direction of Rotation	Counterclockwise
Speed	0.5:1

SECTION IV
PREPARATION FOR STORAGE OR SERVICE

1. SHIPPING BOXES.

The following shipping box is used for both domestic and overseas shipping of R-670-4, -5, -6, -11, and -11A engines:

Overall length	48 inches
Overall width	48 inches
Overall height	48 inches
Empty weight	430 pounds
Gross weight	930 pounds

2. PACKING AND UNPACKING.

(See figure 28.)

The engines are covered with a moisture-proof, airtight pliofilm bag and placed in a shipping box with the engine resting on its mounting bosses with the crankshaft pointing up. The upper part of the shipping box is merely a cover and is secured to the bottom by four bolts. In unpacking, the first step is to remove the nuts from these four bolts and vertically lift the cover off box, using the chain hoist and sling. Four hooks are provided for this purpose and are located at the top of the cover near its four corners. Remove the shipping cap from the end of the propeller shaft and install the crankshaft lifting eye assembly. Remove the eight hold-down bolts securing the engine mounting plate to the shipping box bed, and lift the engine clear with a hoist. Disassemble the plate from the engine by removing its attaching bolts.

a. This engine was serviced prior to packing and should be prepared for service in accordance with paragraph 5., this section.

b. Attach sling to the crankcase lifting eyes installed on the crankcase assembly bolts on the right and to the left side of No. 1 cylinder, and pick engine up by second hoist, suspending it in horizontal position. Uncouple first chain hoist, remove crankshaft lifting eye assembly, and reinstall shipping cap on propeller shaft threads. (See figure 29.)

c. Attach engine to an assembly stand or install in airplane.

3. SERVICE TOOL KIT.

Each new engine, when shipped from the factory, has the standard service tool kit, part No. B-20964, securely attached to the bottom of the shipping box. Remove this tool kit from the shipping box and attach it to the engine so it will accompany the engine to the airplane in which it belongs. (See figure 30.)

4. TREATMENT OF INSTALLED ENGINES FOR PERIODS OF IDLENESS.

a. SHORT STORAGE.—Engines installed in airplanes which will be inoperative for more than one day but will be operated within seven days, will be treated as follows:

(1) On alternate days the propellers will be rotated at least four complete revolutions by hand.

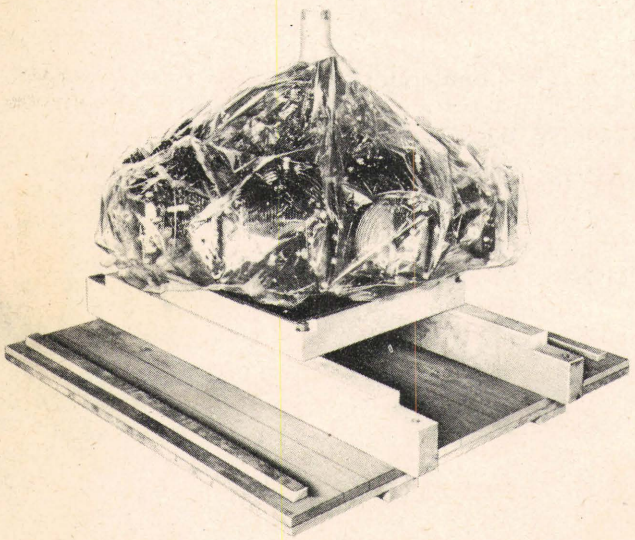


Figure 28—Engine in Moisture-Proof Bag

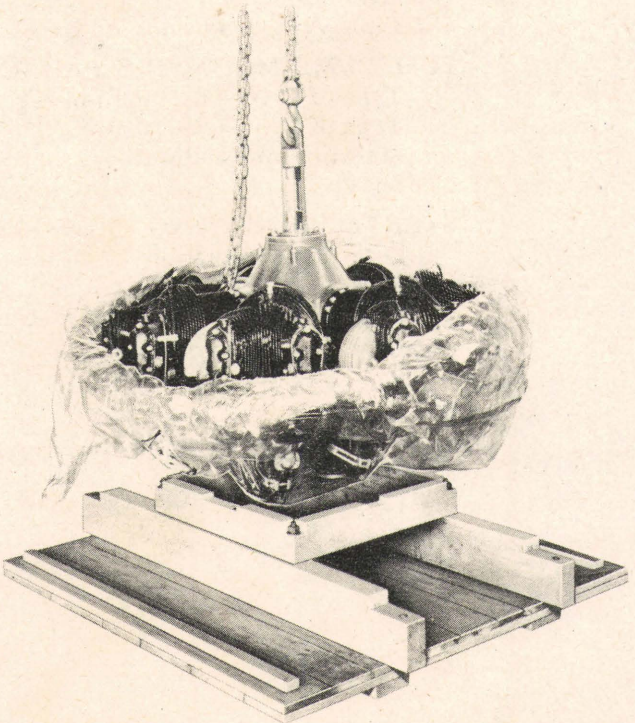
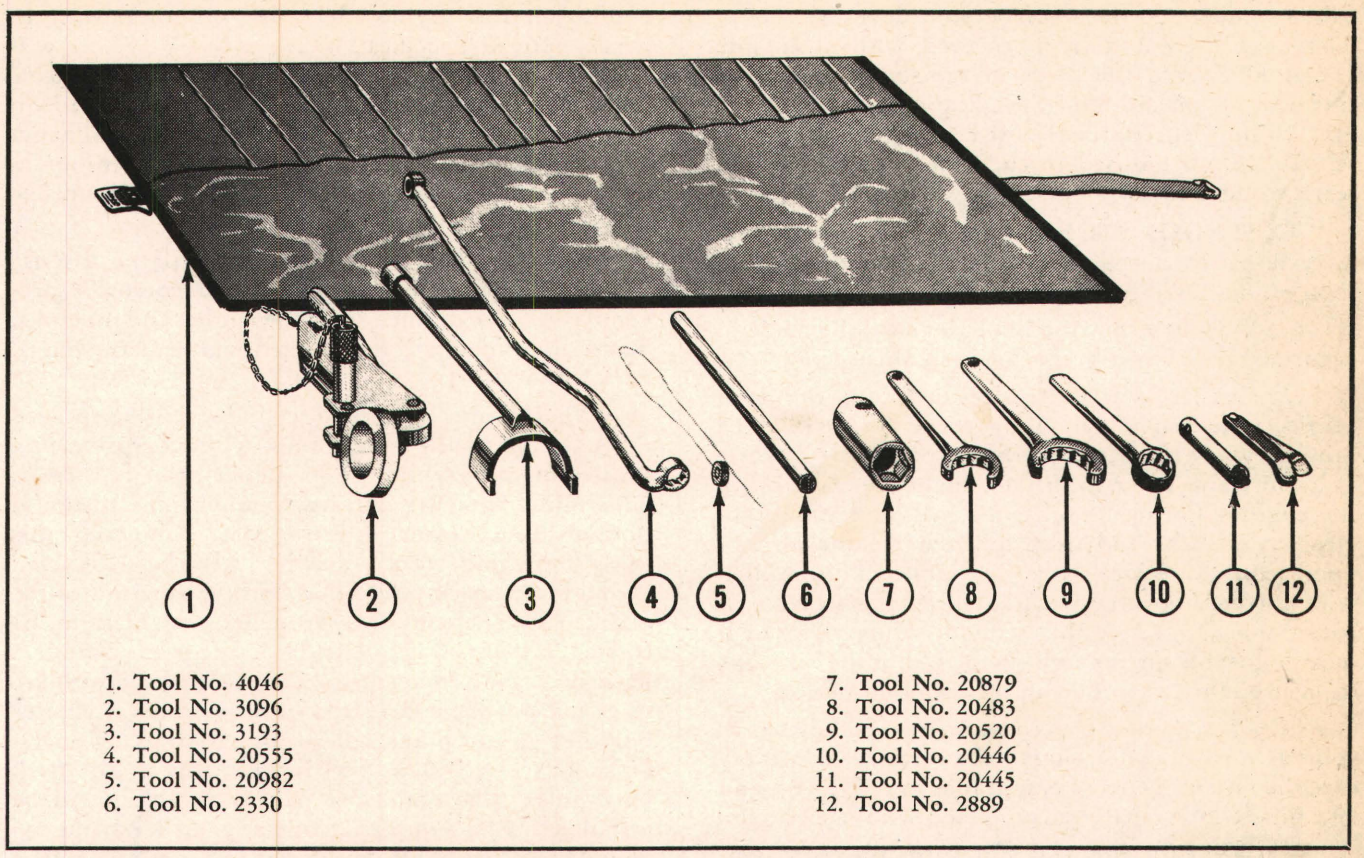


Figure 29—Removing Engine from Moisture-Proof Bag



1. Tool No. 4046
2. Tool No. 3096
3. Tool No. 3193
4. Tool No. 20555
5. Tool No. 20982
6. Tool No. 2330
7. Tool No. 20879
8. Tool No. 20483
9. Tool No. 20520
10. Tool No. 20446
11. Tool No. 20445
12. Tool No. 2889

Figure 30—Service Tool Kit No. B20964

(2) On intervening alternate days the engine will be given a ground run-up until the "oil-in" temperature reaches normal operating temperature for the particular installation. Excessive ground operation other than stated above should be avoided, and sandy, dusty, areas should be avoided, if possible.

b. TEMPORARY STORAGE.—Engines installed in aircraft that are not to be operated for a period of more than one week, but will be operated within 30 days, will be treated as follows as soon as it is known that the equipment will not be operated for the specified period of time:

(1) Engines will be inspected weekly. The dehydrator plugs mounted in the spark plug holes and oil sump will be replaced at any time when they indicate a relative humidity above 20 percent. The seals on these plugs will not be removed until immediately before being installed in their respective positions. The bags of dehydrating agent anchored in the intake and exhaust manifolds will be replaced bi-monthly and the ends of manifolds resealed.

(2) The sump drain plug will be removed, the oil drained, and the plug wired to the engine without being reinstalled. In its place, install a crankcase dehydrator plug. Plug AN4061-1 (1-inch, 20-thread) will be used with sump, part No. A5578A. Plug AN4061-2 (1-inch, 18-thread) will be used with sump, part No. A5522A.

(a) Thoroughly spray the exhaust valves with corrosion-preventive mixture.

Note

This compound can be prepared by mixing one part corrosion preventative compound, Specification No. AN-VV-C-576, with three parts aircraft engine lubricating oil, Specification No. AN-VV-O-446 (Grade 1065 or 1120). Grade 1065 is used for short-term protection. Grade 1120 is used for long-term protection, such as storage.

This spraying will be accomplished through the exhaust port with the exhaust valves fully opened, except in engines having exhaust collectors that are difficult to remove. In that case, the spraying may be done through the spark plug holes with the exhaust valves fully open.

(b) Upon completion of these operations, the crankshaft will be rotated at least four revolutions to thoroughly work the corrosion-preventive mixture into the valve guide. With the piston at the bottom of the stroke, corrosion-preventive mixture then will be sprayed into the cylinder bores in such a manner as to cover all the interior surfaces. Install cylinder bore dehydrator plugs conforming to drawing No. AN4062 into the spark plug holes.

(3) At least one ½-pound bag of silica gel, Specification No. AN-D-6, type V, will be placed in each

exhaust outlet and in the carburetor air-intake scoop. The ends thereof will be covered with a suitable anchored double thickness of moisture-impervious, transparent, plastic film, Specification No. AN-O-P-406. Non-hydroscopic adhesive tape, Specification No. AN-T-12, will be used in anchoring the plastic material to the outlets.

c. EXTENDED STORAGE.—Engines installed in aircraft that are not to be operated for a period of more than 30 days will be treated as follows:

(1) Weekly inspection of engines will be made in accordance with paragraph 4. *b.* (1), this section.

(2) Engines will be run on fuel conforming to service requirements at idling speed for at least 15 minutes while using the corrosion-preventive mixture as a lubricant. Prior to this 15-minute run, the oil in the engines and in the oil tanks will be drained into clean containers and used to reservice the aircraft upon return to service status. The tanks will be refilled with corrosion-preventive mixture. (Refer to Note in paragraph 4. *b.* (2) a. this section.) Only a sufficient quantity of this mixture will be placed in the oil tanks to insure lubrication during this running period.

(3) Preservation procedure will be completed as soon as possible after engine shutdown, but in every case the requirements of paragraphs 4. *c.* (5), (6), and (9), this section, shall be completed within 12 hours.

(4) While the engine is still warm, the corrosion-preventive mixture will be drained from the sump. Screens will be removed, cleaned, and replaced. All drain plugs will be replaced and safetied.

(5) Rocker box covers will be removed and each rocker box cleaned and sprayed with corrosion-preventive mixture to thoroughly coat the valve rocker arms, valve stems, springs, push rods, and interior of boxes. Replace covers and gaskets and screw down to an airtight seal.

(6) Each exhaust port will be sprayed with a sufficient quantity of corrosion-preventive mixture to thoroughly coat the exhaust valve. A ½-pound bag of silica gel, conforming to Specification No. AN-D-6, type V, will be placed in the exhaust opening of exhaust manifold, anchored in place and the opening sealed by covering with an oil and moisture-resistant diaphragm. The silica gel bag will not be removed from its moisture-proof shipping container until immediately before being inserted in the opening.

(7) Carburetors need not be removed. However, all fuel lines will be disconnected, a suitable nipple installed in the carburetor fuel inlet connection, and aircraft engine lubricating oil (grade 1065A), Specification No. AN-VV-O-446, introduced by means of a funnel and a hose. Drain plugs in the bottom of the carburetor will be removed and the carburetor flushed several times with lubricating oil and the throttle and mixture controls moved several times. After this procedure, the carburetor will again be drained of lubricating oil and all connections and plugs will be reinstalled. When fuel pumps are attached to the engine, aircraft engine lubricating oil conforming to grade 1065A, Specification No. AN-VV-O-446, will be injected therein while the shaft of the engine is being rotated to insure complete coverage of oil on the fuel pump parts. The fuel lines of the airplane fuel system will be left disconnected and the openings in the carburetor and fuel lines closed with neoprene plugs, part No. 40A6416.

(8) The oil-in and oil-out line will be disconnected, the sump plug removed, and corrosion-preventive mixture drained from the engine and oil tanks. These lines then will be plugged with suitable plugs, part No. 40A6416.

(9) The interior of each cylinder will be sprayed through the spark plug holes with corrosion-preventive mixture while the propeller shaft is rotated. This initial spraying will be done with the piston at bottom dead center in each case. Following this initial spraying, each cylinder will be resprayed through the spark plug holes without rotation of the crankshaft. Thereafter the propeller shaft will not be rotated. If the shaft is rotated by accident, the cylinders must be resprayed according to the above procedure to insure adequate coverage of all surfaces. Cylinder bore dehydrator plugs, conforming to drawing Specification No. AN4062, will be installed in all spark plug holes. The crankcase dehydrator plug will be installed in the sump plug opening. At least one ½-pound bag of silica gel, Specification No. AN-D-6, type V, will be placed in the exhaust pipe outlet and in the carburetor air intake scoop. The ends thereof will be covered with a suitably anchored, double thickness moisture-impervious, transparent, plastic film, Specification No. AN-O-P-406. Non-hydroscopic adhesive tape, Specification No. AN-T-12, will be used in anchoring the plastic material to the outlets. All other openings in the engine will be sealed with locally manufactured plugs to insure an airtight and moisture-proof engine interior.

(10) Magnetos will be protected by enclosing in a suitable envelope fabricated of moisture-impervious transparent plastic film, Specification No. AN-O-P-406.

(11) If the propellers are to be removed and stored separately, both the interior and exterior of the shaft will be sprayed with corrosion-preventive mixture. This will not be interpreted as requiring a disassembly operation. The threads of the propeller shaft will be protected with a propeller shaft thread cap, drawing Specification No. AN5012, and the shaft wrapped in an oil-saturated cloth. If propellers are to remain installed, all exposed parts of the propeller shaft and the propeller will be sprayed with corrosion-preventive mixture. In adverse climate conditions a propeller cover may be fabricated from the moisture-impervious transparent plastic film, Specification No. AN-O-P-406.

(12) All engines will be covered with engine covers furnished with the airplane and securely fastened.

(13) The condition of the cylinder bore and crankcase dehydrator plugs will be inspected weekly and will be replaced at any time when they indicate a relative humidity above 20 percent. The seals on these plugs will not be removed until immediately before they are screwed into their respective positions.

5. PREPARATION OF ENGINES FOR SERVICE AFTER TREATMENT.

a. SHORT STORAGE.—Engines installed in aircraft which have been prepared for short storage need no preparation for service.

b. TEMPORARY STORAGE.—Engines installed in aircraft which have been prepared for temporary storage will be prepared for service as follows:

(1) All plugs, cover plates, and nipples which have been installed to close lines or other engine openings will be removed and all fuel and oil lines and controls replaced.

(2) Prior to the installation of spark plugs, inspection will be made of the cylinder bores. If excessive corrosion-preventive mixture is found therein, it should be drained.

(3) The propeller then will be rotated slowly by hand to determine if the cylinders are free and the valves operate freely. Any sticking valves will have their stems generously lubricated with a mixture of lead-free gasoline, Specification No. AN-F-22 or 23, and aircraft engine lubricating oil, Specification No. AN-VV-O-446. Continue to turn the engine over by hand until all evidence of sticking valves has been eliminated. If the mixture of gasoline and lubricating oil does not free all the valves, necessary repairs will be made before the engine is placed in service.

c. EXTENDED STORAGE.—Engines installed in aircraft that have been prepared for extended storage will be prepared for service as follows:

(1) All plugs, cover plates, nipples, and wrappings which were installed will be removed. Excess corrosion preventive mixture will be drained from the cylinder bores and the oil sump. The propeller then will be rotated slowly by hand at least four or five revolutions to determine if the cylinders and valves operate freely. If valves stick, treat as directed in paragraph 5. *b.*(3), this section, before operating the engine. Install spark plugs and connect all disconnected fuel and oil lines, and controls.

(2) Clean the propeller hub and propeller if previously treated.

(3) All oil screens shall be removed, cleaned in dry cleaning solvent, Federal Specification P-S-661, dried, reoiled, and reinstalled. Engines started after treatment for storage will be ground tested in accordance with instructions in T. O. 02-1-4.

(4) Prior to ground testing of the engine or engines, sufficient oil will be placed in the oil tank or tanks to insure completion of the ground test. In general, one-half the tank capacity will be adequate for this purpose. The oil level in the tank must be level with, or higher than the oil inlet connection to the engine. (Comply with T.O. No. 02-1-22.) After the engine or engines have been ground tested, the lubricating oil will be drained from the oil system. The oil system then will be filled with new oil and T.O. No. 02-1-22 again complied with. This drained oil is not suitable for further use in aircraft engines, since the corrosion-preventive compound in the oil promotes rapid sludging with consequent sticking of piston rings.

d. NEWLY INSTALLED ENGINES.—Serviceable engines that have been treated for storage will be prepared for service at the time of installation in accordance with the instructions in paragraph 5. *c.*, this section.

SECTION V
ENGINE TROUBLES AND THEIR REMEDIES

1. FAILURE OF ENGINE TO START.

a. INADEQUATE FUEL SUPPLY.

(1) Ascertain that gasoline is turned "on"; that there is a sufficient amount in the tank to permit flow to the carburetor; that there is a definite gasoline flow at the carburetor; and that the carburetor float is not stuck.

(2) Check for vapor lock in the line and for obstruction of fuel flow due to dirty strainers or water in line or carburetor bowl. Inspect gasoline tank for open vent lines.

b. ENGINE UNDERPRIMED OR OVERPRIMED.

(1) If engine is underprimed, check functioning of the primer system and "load" the engine more by turning its propeller in the direction of rotation with the switch "off" and the throttle "closed."

(2) The correct amount of priming required for each individual engine can be determined only by trial and error. Overpriming, and a resultant flooded condition, is more often experienced during warm or hot weather. This condition is easily identified, especially if the engine seems to fire on one or two cylinders with a fizzling "poof" exhaust report and emits black smoke accompanied by a weak "kick" of the propeller with the engine finally dying. If this condition exists, turn the main gasoline supply off; turn the magneto switch off; open the throttle wide, and turn the propeller 15 to 20 revolutions as rapidly as possible in the direction of rotation. This should "unload" the engine and a new attempt can be made to start.

c. MIXTURE CONTROL.—Set mixture control at "FULL RICH" when starting engine.

d. THROTTLE OPERATING.

(1) The engine will start more readily with the throttle cracked open about one-tenth of its range.

(2) If the engine starts but dies after a few explosions and no evidence of overpriming is present, pump the throttle a little when the engine fires again on the next attempt to start. This will permit the accelerating well in the carburetor to pump a small charge of gasoline into the intake manifold with each advance motion of the throttle.

e. DEFECTIVE IGNITION.

(1) Examine the ignition wiring for continuity and for leaks resulting from breaks in the insulation.

(2) Check all spark plugs for correct gap setting (.016 inch, plus .002 to minus .001 inch) and see that they are not fouled by oil or carbon.

(3) Check magneto to breaker points for proper timing as described in paragraphs 3. through 6., section VII.

Note

The VMN7DF magneto timing is checked by measuring point clearance. The SF7RN-1 magneto timing is checked by a timing light and the marks on the rim of the breaker cup.

Also check breaker points for proper gap clearance or adjustment, a possible pitted condition, or evidence that the condenser has burned out.

(4) Check to see that the magnetos are in good working condition and in correct time. Refer to paragraph 2. *c.* (1), section VI, for timing instructions.

(5) Remove booster wire from magneto and hold it about ¼ of an inch from the engine while operating the booster. If a spark fails to jump this gap, the booster or booster wire is defective.

(6) Make sure that the ignition switch is turned "on"; that it is not defective; or that the ground wire insulation is not damaged so as to permit a contact with the metal of the airplane somewhere between the switch and magneto ground terminals.

f. VALVE ACTION.

(1) Check valve stems to be sure that they are not gummed with carbon and sticking open.

(2) See that all valve springs are in good condition and that their assembly to the valve stem is in good order.

(3) Check for free and good working order of all rocker arm assemblies, and especially for evidence of a rocker arm striking the side of a rocker box causing a delayed action.

(4) Check for worn or bent push rods.

(5) Check for correct valve clearance.

g. COLD OIL.—Turn over the propeller by hand 10 to 20 times in the direction of rotation to break the drag created by cold oil. If the engine is excessively stiff, it may be necessary to warm the engine with an engine heater or let the airplane stand for a short while in a heated hangar, or to drain and heat the oil.

h. HOT ENGINE.—In addition to instructions contained in paragraph 1. *b.* (2), this section, the following is important: A hot engine is often easily overprimed and frequently it will start without an additional prime. If the engine is hot and refuses to start for that reason, turn the main gasoline supply "off"; open the throttle wide; turn ignition switch "off"; and allow the engine to cool for 10 or 15 minutes.

i. AIR LEAKS.—Examine intake pipes for cracks and inspect for leaks at all induction system connections. Air leaks sometimes cause a sharp high-pitched whistling noise that is particularly audible at or near idling speeds when the intake manifold vacuum is at its highest.

CAUTION

Be sure new-type gasket is being used between carburetor and carburetor boss.

j. CARBURETOR FLOODING.

(1) If there is a slight leak, it may be due to sticking of the float. A light tapping of the carburetor housing with the hand usually will remedy this condition.

(2) Because of the fire hazard involved, the engine should not be run if the carburetor leaks excessively.

(3) In no case will the carburetor be disassembled to correct leakage. Replace the carburetor.

2. LOW OIL PRESSURE.

a. Determine whether the main oil tank contains a sufficient quantity of lubricating oil.

b. Carefully inspect the main oil line from the tank to the input side of the duplex oil pressure pump for air leaks which will cause the pump to starve for oil.

c. Inspect the oil pressure relief valve to be sure that the plunger is operating smoothly in its guide and is seating well, and that the control spring is functioning properly. Check spring tension to 1⅜ pounds minimum and 1⅝ pounds maximum pressure.

d. Make certain that the oil pump is turning, that its gears and housing have not worn excessively, and that no failure of the drive shaft has occurred.

e. Remove oil pressure screen and examine it for sludge and an excessive deposit of metal particles. If metal particles of an appreciable size and quantity are found, the cause should be determined and the engine drained and cleaned out and repaired if necessary before further operation. Inspect the high pressure oil relief valve plunger and be sure it is not stuck in an open position.

f. If low oil pressure persists after the preceding checks have been made, check every possibility to be sure that the system has not "opened up" somewhere due to a lost oil plug. If it is found that the system has not opened up, remove the No. 2 cylinder and inspect the master rod bearing for excessive clearance or evidence of bearing failure.

g. Insufficient oil pressure in the low pressure rocker oil system could be caused by a leak or opening whereby the capacity of the oil pump would be exceeded. Check the oil inlet orifice below the low pressure oil relief valve for a clogged condition, or for the possibility that the relief valve plunger is stuck open.

3. LOW POWER.

a. Remove the front set of spark plugs and test the compression of each cylinder with a compression gage.

b. Check all valves. Any valve having an appreciable increased clearance will indicate cam ring, push rod, or rocker arm trouble. It is impossible for the engine to jump valve timing.

c. Check engine lubricating oil for conformity to requirements set forth in T.O. No. 01-70A-1.

d. Check ignition system operation, especially for cylinders which cut out periodically, due to failure of spark plugs, ignition wiring, or sticking of magneto points. Be sure that the magneto is functioning in accordance with instructions and specifications set forth in T.O. Nos. 03-5D-7 and 03-5DA-8. Especially under low power conditions, ascertain that the magneto breaker point has minimum clearance *behind* the point arm when points themselves have their required clearance. (This applies to VMN7DF magnetos only.) Be sure magnetos are in full advance. If necessary, check ignition timing in accordance with instructions in section VI.

e. Make sure that the pilot's throttle lever is completely opening the butterfly in the carburetor.

f. Check the carburetor for proper setting and functioning. (See T.O. No. 03-10B-1.)

g. See that an unrestricted flow of gasoline is available at the carburetor.

h. Ascertain that carburetor air heater (if used) is being operated as set forth in T.O. No. 02-1-5, and that there is no evidence of ice.

i. Check the induction system for air leaks.

j. Check propeller for correct model and setting.

4. ROUGH RUNNING.

a. Check propeller for balance, track, and correct installation on the propeller shaft.

b. Remove and check spark plugs.

c. Check magneto operation. Ascertain whether insulation of ignition cables is failing at high engine speeds. Refer to paragraph 3. *d.*, this section.

d. Check valve operation, especially for evidence of sticking or lag in valve operating mechanism.

e. Check engine mounting bolts for tightness.

f. Check engine mount for cracked or broken members.

g. In extreme cases, check possibility of magneto ground wire swinging and periodically grounding, or having damaged insulation at points where they are taped down.

h. Check carburetor low speed idling jet for proper adjustment.

i. Check carburetor mounting flange for distortion;

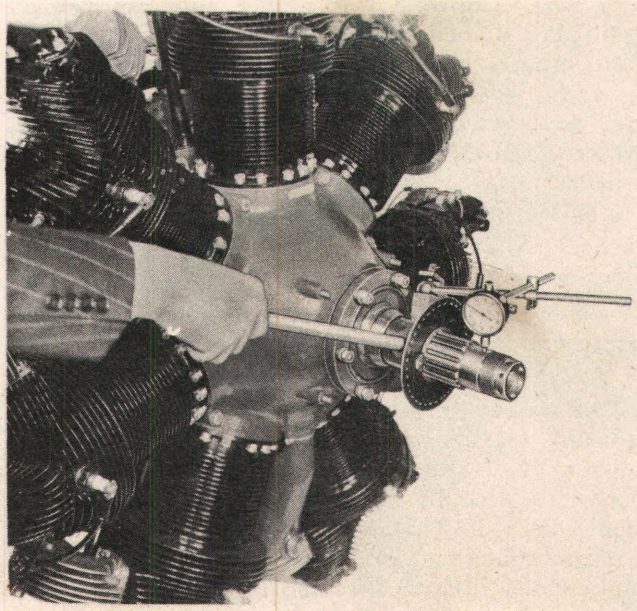


Figure 31—Checking Front Crankshaft Runout

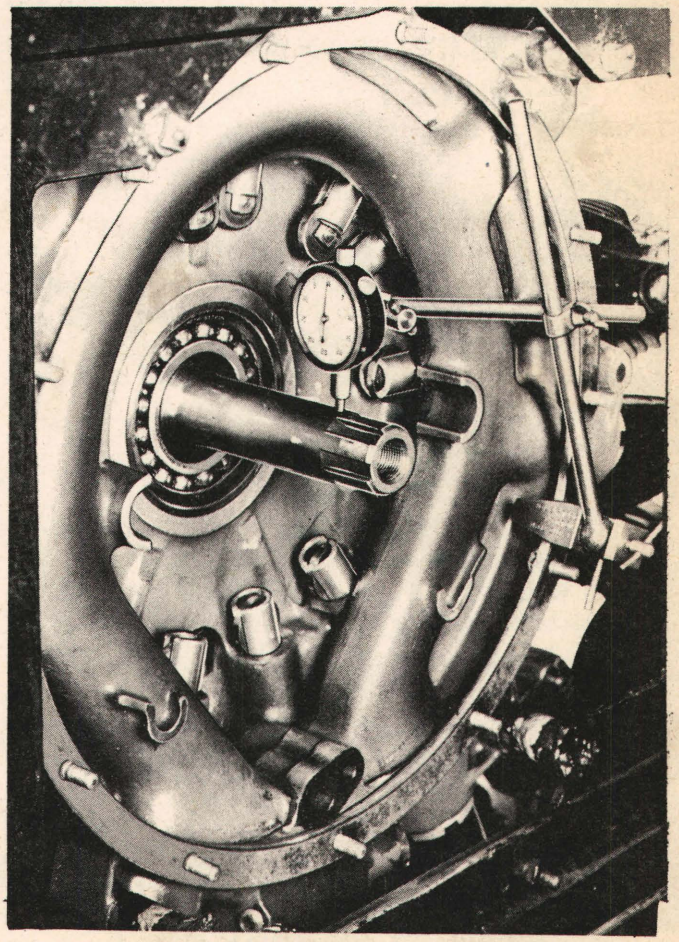


Figure 32—Checking Rear Crankshaft Runout

check bolts for looseness; and check for a shrunken gasket.

5. HIGH OIL TEMPERATURE.

a. Check quantity and quality of supply in the main oil tank. Oil must comply with specifications in T.O. No. 01-70A-1.

b. Check functioning of oil cooler and bypass valves if airplane is so equipped.

c. Check ignition timing. (See section VI for detailed instructions covering ignition timing.)

d. Check compression by pulling the propeller in the direction of rotation to determine that each cylinder has good compression and is about even. Excessive discharge of oil or oil fumes from the crankcase breather or thrust bearing is caused by "blow-by" and increased crankcase pressure, usually due to worn or damaged pistons or piston rings.

e. Check oil strainer for metal deposits indicating failure in the master rod bearing or other internal parts.

f. Check for lean mixture in any or all cylinders. This could result from improper setting of the carburetor of air leaks in the induction system, loose carburetor bolts or bent carburetor mounting pad flange.

6. CARBURETOR.

a. The idle adjustment, located on the front side of the carburetor just to the rear of the oil sump, is set for smoothest idle on the final acceptance run of the engine at the factory. As the engine loosens up during service, this adjustment should be regulated as required to keep the engine idling smoothly.

b. Any further maintenance, service, or adjustments will be accomplished in accordance with T.O. No. 03-10B-1.

7. MAGNETOS.

For information on adjustments and service of magnetos refer to section VII, on Adjustment, Replacement, and Minor Repair.

8. CHECKING CRANKSHAFT RUN-OUT.

(See figures 31 and 32.)

Check front and rear crankshaft run-out in accordance with the provisions and limits of T.O. No. 02-1-15.

SECTION VI
SERVICE INSPECTION AND ASSOCIATED MAINTENANCE

1. GENERAL.

a. The work outlined in this section is a normal function of the operating organizations. It consists of the periodic inspection, cleaning, servicing, lubricating, adjusting, and such maintenance as is associated with the routine inspection system. For preflight inspection, refer to the handbook for the airplane in which the engine is installed.

b. The necessary tools for this work may be found listed in section VIII.

2. INSPECTION AND MAINTENANCE.

a. DAILY INSPECTION.

(1) POWER PLANT.—Inspect for evidence of engine throwing oil.

(2) OILING SYSTEM.—Inspect all oil plugs and drain cocks for proper safetying.

(3) CARBURETOR.

(a) Inspect carburetor and fuel line connections for fuel leakage, paying particular attention to drain plugs, passage plugs, and parting surface between body castings.

(b) Inspect all safety wiring on carburetor.

b. 25-HOUR.

(1) SPARK PLUGS.—Check spark plug terminal connections for security.

(2) FUEL SYSTEM.—Lubricate all visible movable parts, including linkage, with general purpose, low temperature lubricating oil, Specification No. AN-O-6.

(a) Inspect parting surface between body casting for leakage and test parting surface screws for tightness.

(b) Remove float chamber and fuel passage drain plug. Remove fuel strainer plug and strainer, and clean strainer. Flush out water and sediment by allowing fuel to flow through strainer and drain plug opening. Strainer assemblies, strainer plugs, or plugs marked "DRAIN" may be replaced if found unserviceable.

(3) OIL SYSTEM.—Inspect all oil lines for leaks, particularly at connections; security of anchorage; wear, due to chafing or vibration; dents or cracks.

(4) PROPELLER AND ACCESSORIES.—Inspect thrust bearing nut. If necessary, tighten as follows:

(a) The required torque of 7200 inch-pounds will be applied by the use of thrust bearing nut wrench, tool No. 3100, in combination with spline wrench, drawing No. 42B2268. Suitable weights will be hung from the bar handle of the spline wrench to obtain the required torque. The product of the distance in inches from the center line of the crankshaft to the point of application of the weight, and the weight in pounds when the bar of the spline wrench is in a horizontal position, gives the applied tightening torque.

CAUTION

Care will be taken to insure that nuts are not tightened excessively by the use of an extension on the wrench handle or by hammering on the handle.

(b) If difficulty is experienced in holding the wrenches on or against the thrust bearing nut during the tightening or checking operation, a sleeve made of wood or other suitable soft material should be placed over the crankshaft between the wrenches and the propeller hub attaching nut, tightening the nut only enough to hold the wrenches in place. This sleeve, when required, will be manufactured locally.

(c) Tightening of the thrust bearing nut will be accomplished whenever it is loose.

c. 50-HOUR.

(1) MAGNETOS.

(a) GENERAL.—Check magneto, harness connections, and ground wiring for security.

(b) VMN7DF MAGNETO.—Remove magneto breaker cover and check the clearance between the contact points when held wide open by the cam. Clearance should be from .010 inch to .014 inch, the most desirable being .012 inch.

1. To adjust the clearance of the contact points, loosen the lock nut on the long contact screw with Scintilla wrench, tool No. 4-490. Adjust the contact screw so there is .012-inch clearance between the contact points. After adjustment, tighten the lock nut. Check timing and synchronization of magnetos, adjustment for which must be made at the drive end.

2. Put 20 to 30 drops of aircraft engine lubricating oil, Specification No. AN-O-5, grade 1100P, into the oil cup on the magneto front end plate, and five to eight drops in the oil cup on the magneto coil cover. Avoid over-oiling.

3. Examine the felt wick at the bottom of the breaker cup to make sure it is moist with oil. If oil appears on the surface of the felt when it is squeezed with the fingers, no additional lubricant is needed. If the felt is dry, moisten with aircraft engine lubricating oil, grade 1100P, Specification No. AN-O-5.

(c) SF7RN-1 MAGNETO.

1. Remove magneto breaker cover and check the adjustment of the contact points as follows: Place a straight edge on the step-cut in the cam, then turn the crankshaft in the direction of rotation until this straight edge coincides with the timing marks on the rim of the breaker housing. At this position, the contact points should just begin to open as indicated by an Abbot A-100 timing light (AAF stock No. 8042-273875) or equivalent. A service tolerance of $\frac{1}{8}$ inch on either side of the timing marks is allowable before adjustment is required.

IMPORTANT

The contact points of the pivotless breakers always must be adjusted to open at the proper position of the cam in relation to the timing marks at the breaker end of the magneto, and not for any fixed clearance between the contact points.

2. The ball bearings and all gears contain an adequate amount of grease and do not require lubrication between overhaul periods.

3. Examine the cam follower felt to see that it is properly lubricated. If oil appears on its surface when the felt is squeezed with the fingers, do not add oil; however, if it is dry, moisten it with aircraft engine lubricating oil, Specification No. AN-VV-O-446, grade 1120. Do not apply too much oil as the excess will be thrown off during operation and will go between the contact points, thereby causing pitting and burning. Always keep the breaker compartment clean and free from excess oil.

(2) SPARK PLUGS.—Remove spark plugs when engine is cold and replace with serviceable plugs of an approved type, using torque specified in Table of Limits.

(3) OIL SCREENS.—Remove and clean all removable oil screens at each inspection and at oil change. Whenever screens are removed for cleaning, the inside of the housing also will be cleaned thoroughly.

Note

Engine oil will be drained after each approximate 50 hours' flying, unless airplane in which engine is installed is equipped with hopper type tank. If hopper type tank is used, oil will be drained only at engine change, except when failure of an engine part makes it advisable to change before that time. Draining should be done while the oil is hot.

(4) COOLING SYSTEM.—Inspect cylinders for damaged or broken fins.

(5) MANIFOLD AND SUPERCHARGERS.—Inspect intake pipes for security of attachment, broken studs, and leaking gaskets. Inspect carburetor heater (if installed) and carburetor air horn security of mounting.

(6) POWER PLANT.—Inspect cylinders for general condition. Check the compression on each cylinder according to instructions in paragraph 3, section V. This will be done at the first 50-hour inspection following installation and at each second 50-hour inspection (100 hours) thereafter.

d. 100-HOUR.—Repeat 50-hour inspection.

e. 300-HOUR.

(1) VALVE MECHANISM.—The next complete inspection and adjustment will be made at approximately half the total time allowed between overhauls, in accordance with T.O. No. 02-1-6.

(2) In making the inspections set forth above, the following additional instructions will be observed:

(a) Remove rocker box covers.

(b) Check for broken springs, condition of valve spring washers, and security of retaining split-cone keys.

(c) Test side motion of rocker arm and ascertain condition of ball bearing support.

(d) Be sure all oil passages are open before reassembly.

(e) If any valve shows appreciable clearance (unless adjusting screw is loose), the roller making contact with end of valve may have worn flat; the roller pin may have worn its bearing hole eccentric; or, the push rod may be bent or otherwise damaged. If the push rods and rocker arm assemblies check as serviceable, proceed as follows:

1. Remove main oil pressure screen and inspect for excessive deposit of metal particles.

2. If none are present, or it is questionable as to whether the amount is "excessive," readjust valves and put engine back in service for not exceeding 3 hours. Then, reinspect all valves.

3. If reinspection shows excessive clearance again in the same valve and the oil screen shows metal deposits, remove engine from airplane and send to major overhaul depot for inspection of cam ring and cam follower assemblies.

(3) Refer to section VII for valve timing and adjustment of valve clearances.

f. ENGINE CHANGE.

(1) Clean oil screens on newly installed engines at the following periods:

(a) At completion of installation ground test.

(b) At completion of flight test.

(2) When an engine is changed, accomplish al special inspections and maintenance work prescribed by technical instructions to be done at engine change.

(3) Newly installed engines will be ground tested and flight tested in accordance with T.O. No. 02-1-4.

(4) Prepare newly installed engines for service in accordance with instructions in paragraph 5, section IV. Prepare replaced engines for storage in accordance with T.O. No. 02-1-1.

g. BLOCK TEST.—A complete detailed inspection and adjustment of valve mechanism will be made at the repair depots after the engine has completed the block test run.

SECTION VII

ADJUSTMENT, REPLACEMENT, AND MINOR REPAIR

1. GENERAL.

a. The work outlined in this section can be performed without the facilities usually available at major overhaul activities.

b. The necessary tools to accomplish this work are listed in section VIII.

2. CARBURETOR.

a. The carburetor is located at the extreme lower rear of the crankcase and is attached to a mounting pad cast integral with the main crankcase rear half.

b. The carburetor is installed on its mounting pad with a gasket between the parting flanges, and is retained by four castle nuts safetied with wire.

c. The grid and air horn mount on the base of the carburetor, and are retained by four 5/16-inch nuts.

d. Controls connecting to the carburetor are:

(1) Mixture control—on the right side of the body.

(2) Throttle—on the left side of the body.

(3) Gasoline supply line—on the rear side of the body.

e. All carburetor controls are to be safetied and the gasoline line hose connection must have a liner between the tubing and carburetor inlet nipple. Connect air horn drain line.

f. The carburetor may be removed from the engine by detaching the fuel line, throttle and mixture controls, removing the air horn and grid, and the four 5/16-inch castle nuts at the mounting pad.

g. Maintenance is to be accomplished in accordance with applicable carburetor publications.

3. INSTALLING TIMING DISC AND POINTER.

Remove the propeller and install timing disc, tool No. A-3363. (See figures 33 and 34.) The disc mounts with its wide spline gap on the hub, located directly over the letter "O" stamped on the propeller shaft adjacent to the end of its spline. This position will align the crankshaft crank throw with the "0" degree position on the timing disc indicator. Install the timing disc pointer, tool No. 20453, under the two top 3/8-inch nuts retaining the thrust bearing cover and registering along the timing disc face. Tighten the thrust bearing cover nuts so the pointer will not wobble but may be moved sideways to the extremities of its mounting slots when tapped slightly with a fiber hammer.

4. FINDING TOP DEAD CENTER.

a. Remove front spark plugs from all cylinders and install top center indicator, tool No. A3247, in No. 1 cylinder spark plug hole. Turn crankshaft in direction of rotation to bring No. 1 piston up on top dead center at the termination of the compression stroke.

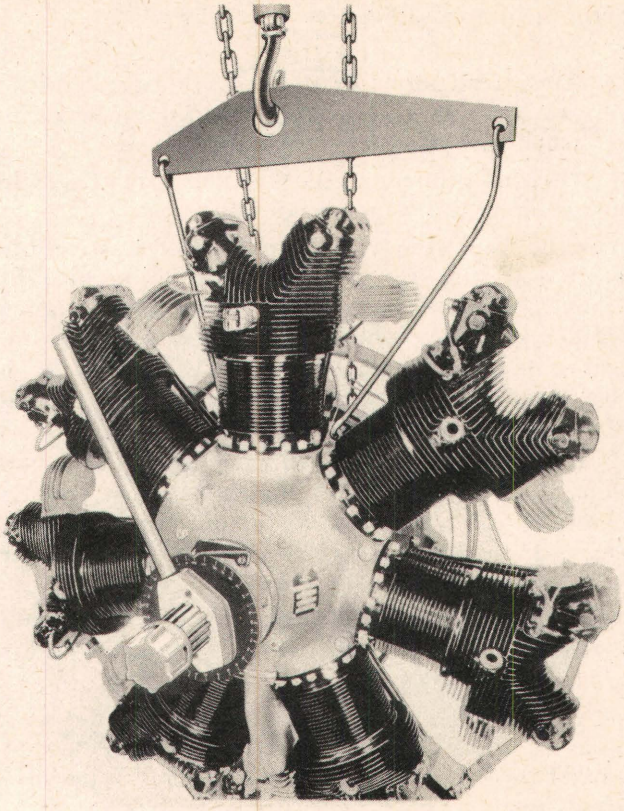


Figure 33—Lifting Beam and Timing Tools Attached

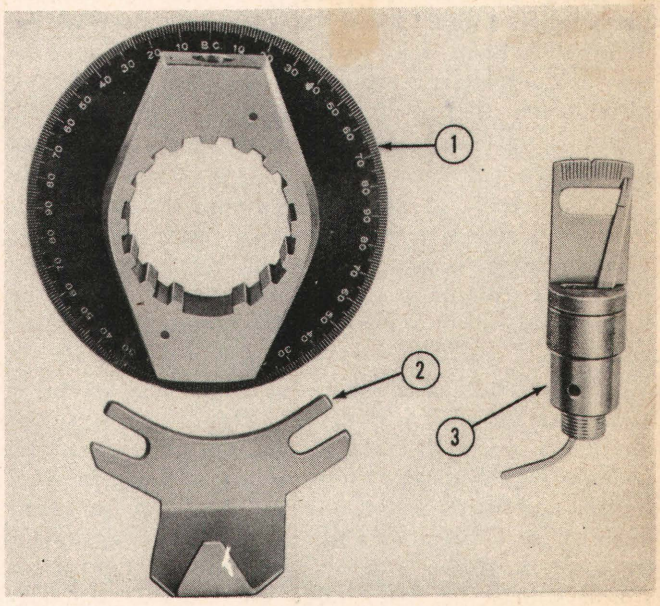


Figure 34—Engine Timing Tools

CAUTION

Do not stop with No. 1 piston on top dead center at termination of the *exhaust* stroke.

b. By moving crankshaft forward and backward slightly and watching the top center indicator pointer "X," it may be observed when the piston "goes over" the top arc of the crankshaft throw. Observation also will disclose that as the piston goes over center, while the crankshaft is moving in a continuous clockwise direction, the pointer "X" will travel from "A" towards "B" but will stop in an intermediate position on the indicator face, and then start back towards "A." When this approximate position is located, turn crankshaft counterclockwise enough to bring top center indicating pointer "X" back towards "A" with the crank throw 20 to 30 degrees before top center.

c. By tapping the timing disc handle lightly, turn the crankshaft in a clockwise direction until the top center indicating pointer "X" reaches a point in the approximate position "D." Stop turning crankshaft and record the number of degrees before top center shown by pointer.

d. Carefully continue to move crankshaft in a clockwise direction, observing the top center indicating arm as it travels up to its limit (somewhere near central position) and starts back again towards "A." Stop moving the crankshaft when the top center indicating pointer again reaches position "D," *i.e.*, the identical scribe mark from which the degrees before top center were previously recorded.

e. Record the number of degrees after top center indicated on the timing disc. The difference between the number of recorded degrees *before* and *after* top center divided by two will show the amount and direction that timing disc pointer should be moved on its studs. The object is to adjust the timing disc pointer to right or left so that the timing disc degrees will be equal on both sides of "zero" at both readings of top center indicating arm at position "D."

f. When the timing disc pointer has been correctly adjusted, tighten its retaining nuts, and position "0" as indicated by the pointer on the timing disc face will be top dead center.

5. MAGNETO INSTALLATION AND TIMING.

a. VMN7DF MAGNETOS.—Following completion of the operations in paragraph 4., this section, continue in the following manner:

(1) Turn the propeller shaft counterclockwise to about 40 to 45 degrees before top center and then turn clockwise, rotating the crankshaft carefully to bring the timing disc up to 32 degrees before top center. Allow the crankshaft to rest in this position.

(2) Take one magneto and, after removing the high tension distributor blocks and the breaker assembly cover, hold the magneto in both hands with the driving gear facing away and the breaker assembly directly under the eyes.

(3) Insert one finger of each hand through the high tension distributor holes on the right and left

sides and rotate the distributor gear slowly until the single and double scribe marks on the face of the gear are in line with corresponding scribe marks located on the magneto frame adjacent to the gear teeth. With the magneto held in this position, rotate the breaker assembly control arm to the right as far as possible and observe that the breaker points open and close with slight forward and reverse rotation of the distributor gear.

(4) Install a gasket over the studs on the accessory case at the magneto mounting pad. With the breaker points just opening, and the scribe marks registering on the distributor gear, mount the magneto on the right accessory mounting pad engaging the spline coupling.

(5) Recheck the position of the breaker assembly and make sure that it is in full advance position. Rotate the magneto to right and left within the extreme limits of its elongated mounting holes. If, within these limits, the breaker points open and close, the magneto drive spline is properly engaged. If the points remain open, the magneto is too fast and the magneto drive spline should be disengaged and rotated counterclockwise one spline. If the points remain closed, the magneto is too slow and the magneto drive spline should be disengaged and rotated one spline clockwise.

(6) Install the three large diameter washers and castle nuts on the mounting studs and tighten sufficiently to assure that the magneto is not so loose as to wobble on its mounting but, at the same time, loose enough to be rotated to right or left through the extremities of its elongated mounting holes when tapped lightly on the housing with a fiber hammer. Recheck the magneto breaker assembly to assure that it is in full advanced position, *i.e.,* full clockwise rotation of the breaker assembly control arm.

(7) Rotate the entire magneto counterclockwise to its full retard position and connect an Abbott A-100 timing light across the breaker points. Rotate the magneto clockwise by tapping with a fiber mallet, allowing it to turn within the limits of its elongated mounting holes until the timing light indicates that the points are opening. This point is in correct time at 32 degrees before top center and the magneto retaining nuts now should be tightened.

Note

A .0015-inch feeler gage may be used for timing *only* if a timing light is not available. Cellophane or cigarette paper never should be used in place of a feeler gage.

(8) The final timing check is made by backing the crankshaft off counterclockwise about 40 degrees before top center. With timing light connected across breaker points, rotate the crankshaft clockwise, carefully tapping the timing disc handle until the timing light indicates point opening. The timing disc should allow 32 degrees before top center. Continue rotating the crankshaft by carefully tapping the timing disc handle. (The left magneto timing light should indicate point opening at 29 degrees top center.)

CAUTION

Always be sure that the breaker assemblies are in full clockwise advanced position when the magneto is being timed.

(9) Safety the three retaining nuts with safety wire passed under the magneto housing.

(10) Replace covers on the breaker assemblies; install and safety the high tension ignition wire distributor blocks; install and safety the inter-magneto breaker assembly control rod where applicable, adjusting its length until the two clevis pins can be inserted with both breaker assembly arms in full advanced position.

(11) The right magneto fires the front spark plugs; the left fires the rear plugs. (See figure 35.) For additional information on the maintenance and overhaul of these magnetos, refer to the applicable accessory Technical Orders.

b. SF7RB-1 MAGNETOS.—Following the completion of the operations in paragraph 4., this section, continue as follows:

(1) Turn the propeller shaft counterclockwise to about 40 to 45 degrees before top center. Allow the crankshaft to rest in this position. Remove the main cover, breaker cover, and distributor block.

(2) Turn the magneto drive shaft until the timing mark on the distributor finger is approximately opposite the timing mark on the inside of the front end plate, when a straight edge placed on the step-out in the cam coincides with the timing marks on the rim of the breaker housing.

(3) When this is done, it may be found that the straight edge against the cam-step does not line up with the mark, but is at an angle to it. To correct this, turn the rotating magneto to another No. 1 position of the distributor finger until the straight edge lines up with the timing mark. It may be necessary to turn the distributor finger more than one turn before the straight edge lines up. At this position, the high tension electrode on the distributor finger will be opposite the distributor block electrode for firing the No. 1 cylinder.

(4) Install the magneto on the engine in the foregoing relation after installing the mounting screws or nuts to the extent that further adjustment cannot be made.

(5) Rotate the magneto to the right and left within the extreme limits of its elongated mounting holes. If, within these limits, the breaker points open and close, the magneto drive spline is engaged properly. If the points remain open or closed, remove and reinstall the drive spline as outlined in paragraph 5. *a.* (5), this section.

(6) Final timing and tightening of the hold down nuts will be accomplished as outlined in paragraph 5. *a.* (8) to (10) inclusive, this section.

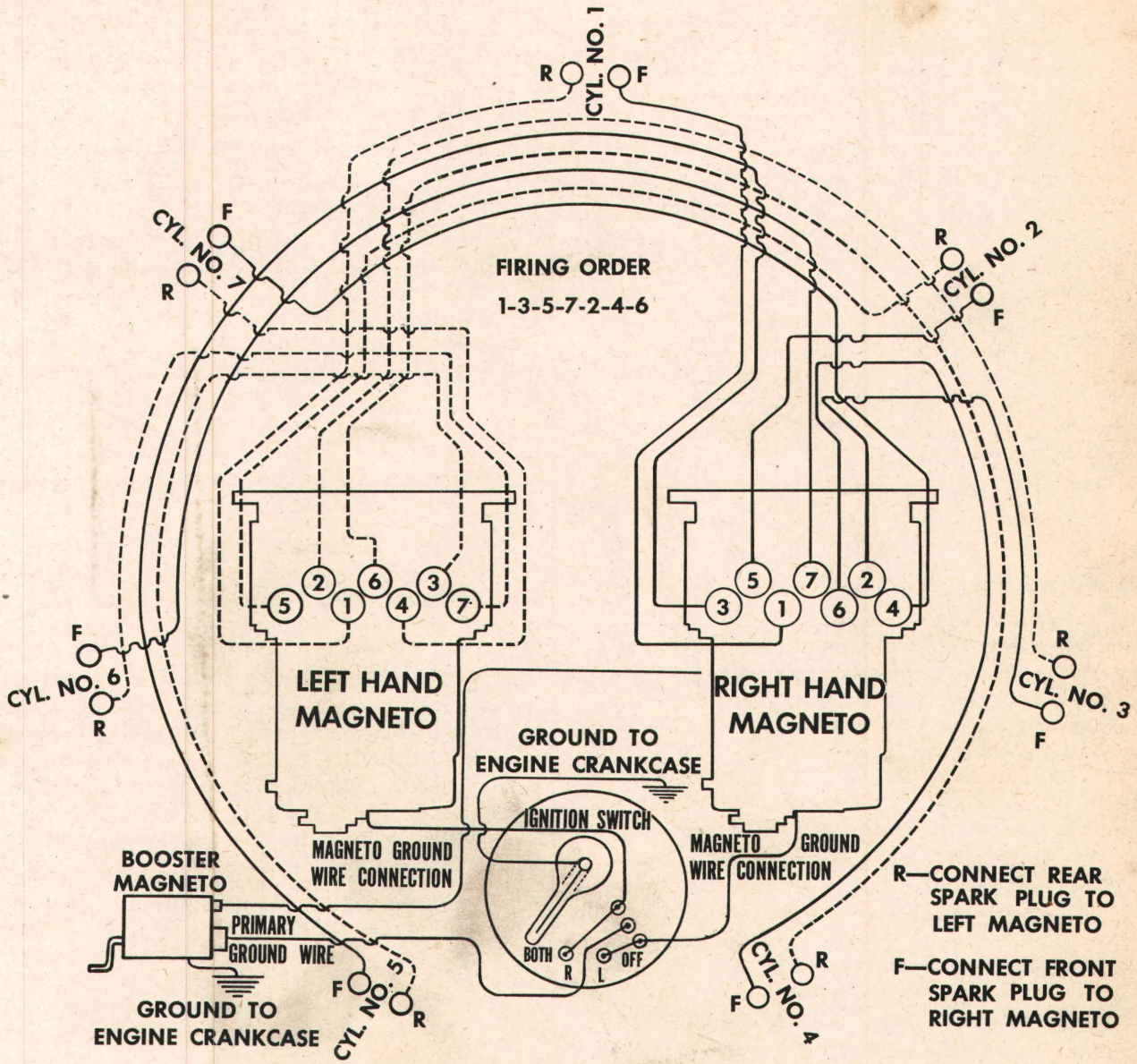


Figure 35—Ignition Wiring Diagram

Note

The only difference between the timing of the left magneto and that of the right is that on the left magneto the No. 1 piston must be set at 20 degrees before top center.

6. IGNITION WIRING AND SPARK PLUGS.

a. See figure 35 for the complete ignition wiring system and firing order.

b. High tension ignition wires are not repairable. If found unserviceable, they must be replaced with a new cable extending from the magneto distributor to the spark plug terminal. A new wire may be installed easily by soldering one of its ends to one end of the unserviceable wire, and pulling the new wire into position by withdrawing the old.

c. Damaged or lost ignition wire terminals must be replaced with new or serviceable one.

d. The following table shows individual ignition cable lengths in inches and the total inches required per engine:

R-670-5

Cylinder Number	*Left Magneto to Rear of Cylinder*	*Right Magneto to Front of Cylinder*
1	23 inches	42 inches
2	36 inches	29½ inches
3	52 inches	40 inches
4	61 inches	51 inches
5	40 inches	71 inches
6	30 inches	59 inches
7	19½ inches	48 inches

Total length required for one engine—50 ft. 2 in.

R-670-4, -11, -11A

Cylinder Number	*Left Magneto to Rear of Cylinder*	*Right Magneto to Front of Cylinder*
1	25½ inches	43 inches
2	36 inches	30½ inches
3	52 inches	42 inches
4	61 inches	55 inches
5	43 inches	71 inches
6	31 inches	59½ inches
7	17½ inches	47½ inches

Total length required for one engine—51 ft. 2.4 in.

e. Spark plugs are to be inspected and serviced in accordance with provisions of T.O. No. 03-5E-1.

7. VALVE TIMING.

The valve timing adjustment provisions on this engine, when once set, will remain intact indefinitely. If, during service operations, it becomes necessary to remove the accessory case or disengage the timing serrations, the engine should be removed from the airplane and sent to the overhaul depot.

8. STARTER.

a. The engine starter mounting pad is located in an upper central position on the accessory case.

b. The starter may be detached from the engine by first removing the one wire connected to its electrical terminal, then removing six ⅜-inch palnuts, plain nuts, and washers, and shifting the entire unit to the rear until it clears its mounting studs.

c. The R-670-4, -5, -6, -11, and -11A engines have an aluminum spacer located between two Vellumoid gaskets which separate the accessory case from the starter flange.

d. The starter is installed by placing the required gaskets on the mounting studs and then assembling the starter with its attaching washers, nuts, and palnuts. Connect the starter wire.

CAUTION

A special rubber "boot" always should be installed to cover any exposed portion of the electrical terminal connection.

9. PRIMER SYSTEM.

a. INSTALLATION. *(See figure 36.)*

(1) The external primer system consists of the following subassemblies and parts:

(a) One distributor.

(b) Four ⅛-inch stainless steel distributing lines:

1. To No. 6 cylinder, 37½ inches long.
2. To No. 7 cylinder, 25⅜ inches long.
3. To No. 1 cylinder, 17 inches long.
4. To No. 2 cylinder, 27⅜ inches long.

(c) Four elbow-type primer jets.

(d) Necessary clips and clamps to secure the installation. *(See figures 14 and 36.)*

(2) The distributor assembly is mounted to the intake pipe of No. 1 cylinder by a clamp. The primer distributor has seven primer line connections, three of which are closed with ⅛-inch pipe plugs, the other four having standard ⅛-inch primer lines connecting to the primer jets in cylinders No. 6, 7, 1, and 2. The elbow type primer jets are installed in the cylinders at drilled bosses on the front side adjacent to the rocker box. Their nozzles extend through the casting to the inside of the cylinder intake valve port just above the head of the intake valve. The primer lines, coming from the distributor, connect to these jets with standard ⅛-inch primer-line fittings.

b. PRIMER LINE REMOVAL.—The primer system can be removed from the engine in its separate individual assembly parts, or as a complete unit by releasing all clips and supports and disconnecting the individual distributing lines at their primer jets. The input connection to the distributor is a standard ⅛-inch pipe fitting and the airplane primer line is disconnected from the engine at this point. The primer elbows in cylinders No. 6, 7, 1, and 2 ordinarily remain installed in their cylinders during the cylinder life, unless they become clogged and require cleaning. Removal is accomplished by unscrewing the jet from its threaded boss.

10. CYLINDER REMOVAL, INSPECTION, AND REPLACEMENT.

a. REMOVAL.

(1) Remove propeller in accordance with T.O. No. 03-20A-1.

(2) Remove cowling if any.

(3) Remove all spark plugs and then remove the ignition housing assembly, together with the magneto distributing blocks. Wrap each magneto with a clean rag to keep dirt out.

(4) Remove primer system as outlined in paragraph 9. *b.*, this section.

(5) Rotate the crankshaft until the "0" stamped on the crankshaft near the end of the splines is in line with the No. 2 cylinder. Place a drip pan under engine.

(6) Remove the exhaust manifold or stacks at their attaching flange.

(7) Drain the engine oil sump located between the No. 4 and 5 cylinders. Inspect oil carefully for metal particles while draining. Remove, clean, and carefully inspect the main oil pressure screen and its housing, and the scavenge oil screen assembly.

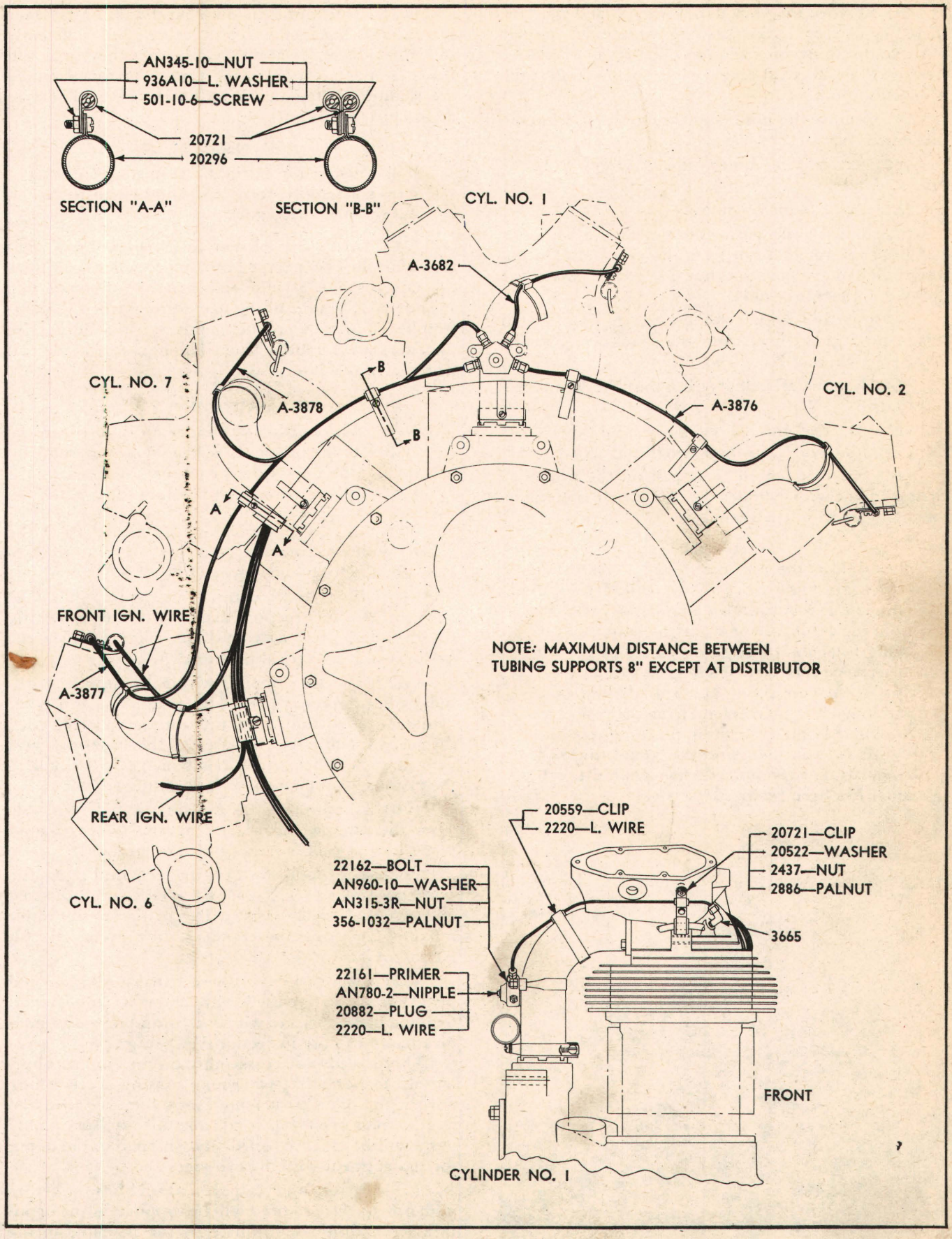


Figure 36—Primer Line Installation Diagram

(8) Remove the rocker box covers and gaskets, including external rocker scavenge drain lines, at their hose connections on cylinders No. 3, 4, 5, and 6. Remove the rocker oil drain line tee connection at the oil sump nipple.

(9) Remove the hose connecting nipple from the oil sump.

(10) Remove the finned exhaust elbow from the No. 5 cylinder.

(11) Remove the oil sump.

(12) Loosen all push rod housing gland nuts and back the retainer nut from the cam box. Do not loosen or remove push rod housing flange nuts at the crankcase attaching studs.

(13) Starting with cylinder No. 1, unscrew all intake pipe gland nuts from the crankcase threads, using wrench, tool No. 3193.

(14) Remove all palnuts from the cylinder mounting studs.

(15) Remove the 12 cylinder hold-down nuts from cylinder No. 2, using wrench, tool No. 20555.

(16) See that the "0" stamped on the propeller shaft is in line with cylinder No. 2 center line. Remove this cylinder from the crankcase.

CAUTION

Never allow the piston and rod assembly to slap against the sides of the cylinder pilot bore after the cylinder has been removed from the crankcase or while the crankshaft is being rotated. Secure seven pieces or rubber hose, large enough to encompass the "H" section of the connecting and articulating rods, and long enough to extend from the piston to the knuckle pin. Cut these pieces along one side and install them over the connecting and articulating rods immediately after the cylinder has been removed.

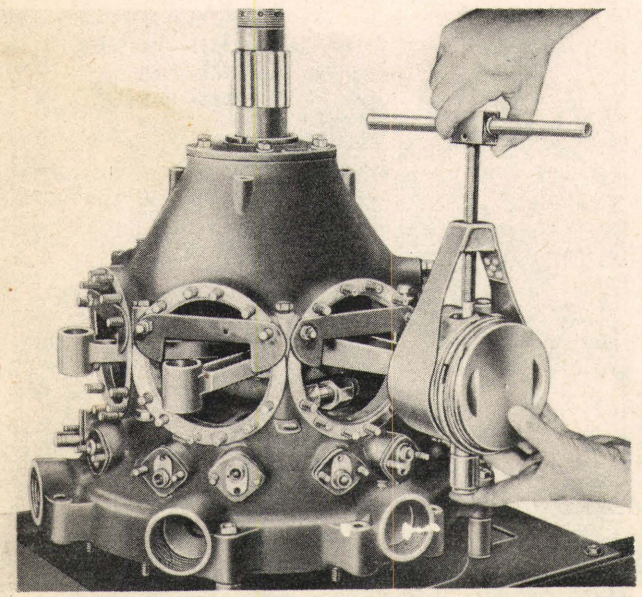


Figure 37—Removing Piston Pin With Tool No. A40093

(17) Remove the piston from the No. 2 cylinder by withdrawing its full floating piston pin sufficiently to release the articulating rod. Replace the piston pin in its former position in the piston. Piston numbers are stamped in the aluminum on the beveled surface at the piston pin boss.

Note

If the piston pin is tight, use piston pin remover assembly, tool No. A40093, to force out the pin. (See figure 37.)

(18) Turn the crankshaft in the direction of rotation until the "0" stamped on the propeller shaft lines up with the No. 3 cylinder center line. Remove this cylinder and piston in the manner described in paragraphs 10. *a.* (14) to (17), this section. Successive cylinders are removed from the engine in numerical order. Remove No. 1 last.

CAUTION

Never remove No. 1 cylinder until all other cylinders and pistons have been removed from the engine unless the procedure outlined in the following paragraph is followed.

(19) No. 1 cylinder may be removed from the engine without removing cylinders No. 2, 3, 4, 5, 6, and 7 by the following procedure:

(a) Proceed as outlined in paragraph 10. *a.* (14) to (16), this section, except that after removing the cylinder, great care must be taken to keep the master rod in a vertical position.

(b) Any side tipping within limits of the cylinder pilot bore may permit the piston rings in other cylinders to expand below the cylinder skit and lock themselves within the crankcase. If this happens, great care must be taken or serious damage will result to the pistons, piston rings, or articulating rods.

(20) All push rods and housings will disassemble from the engine after removing the two attaching ¼-28 nuts at each mounting flange location.

(21) Thoroughly clean the remaining engine assembly (refer to T.O. No. 01-1-1); coat all internal and external steel parts with corrosion-preventive mixture, and cover the crankcase to prevent any collection of dust or dirt.

(22) Remove intake pipes, exhaust elbows, and primer jets from the used cylinders; wash and coat all exposed metal surfaces with corrosion-preventive mixture (refer to note in section IV, paragraph 4. *b.* (2) *(a),)* until ready for reassembly on the engine. Thoroughly inspect all push rods, housing, rocker box covers, and other parts which were removed from the engine for serviceable condition. All non-serviceable parts will be cleaned, oiled, and shipped to the depot for replacement with the cylinders and pistons.

(23) Piston and cylinder assemblies, together with other parts required will be supplied by the depot in a serviceable condition ready for assembly to the engine, but they will not have been previously run-in.

b. INSPECTION.

(1) Inspect the carburetor in accordance with section VI, paragraph 2. *a.* (3).

(2) Completely service check the magnetos in accordance with section VI, paragraph 2. *c.*

(3) Replace all spark plugs with new or reconditioned plugs. Carefully inspect the entire ignition harness for serviceable condition. Refer to paragraph 6. *b.*, this section.

(4) Remove all cylinder hold-down studs that are loose, broken, or have damaged threads and send them to the overhaul depot, where the proper oversize replacements will be furnished. A complete listing of available oversize replacements will be found in the numerical section of parts catalog, AN 02-40AA-4.

(5) Check entire engine and see that all nuts are tight in accordance with the torque values set forth in Section XII of AN 02-40AA-3. See that all safetying is complete and tight.

(6) Inspect, tighten, and safety all engine mounting bolts.

(7) Make sure that both ends of all knuckle pins in the master rod are tight and that all safety Woodruff keys and circlips are in place.

(8) Visually inspect the master rod bearing for diameter and side clearance on its crank journal. A fore and aft pressure at the top of the rod will cause the bearing to rock on its journal, giving an indication of the amount of clearance present.

(9) Inspect the piston pin bushings in all rods for tightness and correct bore diameter.

(10) Inspect the crankshaft front and rear main bearings and their supporting bronze liners.

(11) Test crankshaft and clearance. The crankshaft is mounted in ball bearings, and no end play should be present at any time beyond what would be interpreted as "free running clearance."

(12) Carefully inspect all cam followers to make sure that a retaining circlip is installed on each, and that there is no evidence of the cam follower binding in its guide. The cam follower and guide assembly cannot be removed from the crankcase without removing the accessory case.

c. REPLACEMENT.

(1) In this operation it will be assumed at all times that all parts and assemblies are in a serviceable condition; thoroughly clean; and have been lubricated with corrosion-preventive mixture on their bearing surfaces.

(2) Install intake pipes on all cylinders received from the overhaul depot, but do not completely tighten the three mounting flange nuts until after the cylinder is assembled to the engine with the intake pipe gland nut threads well started. Install and safety wire all exhaust elbows except the No. 5 cylinder. Do not install push rods or housings until after cylinders are mounted on the crankcase. Remove valve adjusting screws and their lock nuts from all rocker arms.

(3) When assembling the engine, use new gaskets and packing throughout.

(4) Thoroughly clean and freely lubricate the interior of the crankcase and all internal parts with aircraft engine lubricating oil, Specification No. AN-VV-O-446, grade 1065, just prior to installing the cylinders.

(5) Turn crankshaft so that the "O" stamped at the end of the propeller shaft splines aligns with the No. 1 cylinder pilot bore. Inspect replacement piston assembly and see that all piston rings are free and in place and that the piston pin has its aluminum plug in each end. Lubricate piston rings, glands, the entire outside diameter of the piston, the pin and bore, and the inside diameter of the piston pin bushing on the master rod.

CAUTION

Install pistons with their numbers towards the front of the engine. Rotate piston rings until their gaps are located equidistant around the circumference of the piston.

(6) Cylinders are numbered on the outside diameter of their mounting flanges on the front side. Secure No. 1 cylinder, install the cylinder base oil seal, and the intake pipe gland nut and packing. Compress No. 1 piston rings and install cylinder on the crankcase.

CAUTION

Always start the intake pipe gland nut well into its thread before putting any cylinder base nuts on their studs. Do not attempt to force this gland nut into its thread but "jiggle" the cylinder top freely in all directions, allowing the intake pipe to rotate in its mounting flange. When these threads "line up" properly, the gland nut will "finger turn" into its threads.

(7) After the intake pipe gland nut is well started in its threads, install the cylinder retaining nuts and tighten as follows:

(a) Tighten all hold-down nuts to a snug position to insure that the cylinder is seated on the crankcase section. Loosen one nut at a time and retighten until contact is just made with the cylinder flange or washer. From this position, tighten the nut, using handle, socket wrench, torque indicating, ratchet, male ⅜-inch square drive, 0 to 600 inch-pounds (AAF stock No. 79-428450). The desired torque is 425 ± 25 inch-pounds; minimum, 400 inch-pounds; maximum, 450 inch-pounds.

CAUTION

The position of the wrench must be maintained so that its turning axis always coincides with the vertical center line of the hold-down nut being tightened. All nuts should be tightened slowly and smoothly until the proper torque limit is reached. Once a nut has started turning, there must be no stopping until the proper torque has been applied. Jerking of

the torque wrench *must* be avoided. Care should be exercised to insure that the socket of the wrench does not contact the cylinder wall during the tightening procedure as such contact will cause an erroneous torque reading.

(b) Recheck each nut by installing the torque wrench and gradually turning to the desired torque limit. If any movement of the nut is noted during this inspection, loosen and retighten the nut in accordance with instructions in paragraph 10. *c.* (7) *(a)*, this section.

(c) After completing the check described in the preceding paragraph, the hold-down nuts should be safetied appropriately.

(d) No further inspection of cylinder hold-down nuts will be necessary between engine overhauls.

(8) Rotate the propeller shaft mark "0" until it aligns with the No. 2 cylinder pilot bore. Install the No. 2 piston and cylinder as outlined under paragraphs 10. *c.* (5), (6), and (7), this section.

(9) Install the remaining cylinders in their numerical order following the above procedure. Make sure when a cylinder is being installed that the propeller shaft mark "0" is in alignment with the corresponding cylinder pilot bore and that the piston and cylinder numbers correspond.

(10) Starting with the No. 1 cylinder and working in numerical order, tighten all intake pipe gland nuts, using the torque specified in AN 02-40AA-3.

(11) Starting with the No. 1 cylinder and working in numerical order, tighten and install palnuts on all intake pipe flange nuts. Use torque specified in Table of Limits.

(12) Remove old packing from the push rod housing gland nuts and install new packing. Start each gland nut on a push rod housing retainer nut, and push the two-nut assembly down on its housing sufficiently to clear the end.

(13) Install a new push rod housing gasket at each of the cam follower guide mounting pads. Starting with cylinder No. 1 and working in numerical order, install all push rod housings, being sure that there is a new lead gasket between the retaining nut and rocker box, and that the nut is started into the rocker box threads before putting the flange nuts on the crankcase studs. Tighten all nuts and safety with palnuts, using torque specified in AN 02-40AA-3.

(14) Tighten all push rod housing retainer nuts in their rocker box threads, and tighten all push rod housing gland nuts on their retaining nuts. Use torque specified in Section XII of AN 02-40AA-3.

(15) Starting with the No. 1 cylinder and aligning the propeller shaft "0" mark with each cylinder as assembly in firing order progresses, install the push rods and valve adjusting screws. When installing, adjust these screws to approximately .010-inch clearance.

(16) Install the oil sump and the No. 5 cylinder exhaust elbow. Install the nipple in oil sump.

(17) Rotate the crankshaft six to eight complete revolutions in the direction of rotation, stopping on the No. 1 cylinder at the end of its compression stroke.

(18) Adjust all valves to .010-inch clearance, starting with the No. 1 cylinder and continuing in firing order. Always have the propeller shaft "0" mark aligned with the cylinder being adjusted. Tighten the adjusting screw lock nuts to the torque limits specified in AN 02-40AA-3. After all valves have been adjusted, recheck the clearances proceeding in continued firing order, being sure that no valve has less than .010-inch clearance. In this second valve clearance check, the valves will be actuated from the second lobe on the three-lobe cam ring, and the clearance may vary slightly. It is essential that no valve is tighter than the specified value.

(19) Lubricate all mechanism inside the rocker box with corrosion-preventive mixture and install the rocker box covers with new gaskets. Tighten the rocker box cover nuts from the center out. Safety with palnuts. Use the torque specified in AN 02-40AA-3.

(20) Install all external rocker scavenge oil pipes and required connections from the rocker box covers to the oil sump.

(21) Install the complete primer system in accordance with information contained in paragraph 9., this section. (See figure 36.)

(22) Install the complete ignition wire harness assembly. Install spark plugs, using the torque specified in AN 02-40AA-3. Attach all ignition wire terminals and safety.

(23) Install exhaust stacks or exhaust collector ring.

(24) Install all engine cowling and baffling required by the installation.

(25) Install the propeller in accordance with the applicable publication.

(26) The engine will be started, "run-in" and test flown in accordance with applicable instructions contained in the airplane handbook and T.O. No. 02-1-4.

SECTION VIII
SERVICE TOOLS

Tool No.	*Nomenclature*	*Application*
2330	Bar—Cross	For use with spark plug socket wrench and valve adjusting screw wrench
2889	Gage—Feeler	To obtain proper valve clearance
3096	Compressor—Valve spring	Removal and installation of valve spring locks
3193	Wrench—Intake gland nut	Removal and installation of intake gland nut from crankcase section
20445	Wrench—Valve adjusting screw	Loosening and tightening valve adjusting screw
20446	Wrench—Valve adjusting screw nut	Loosening and tightening valve adjusting screw nut
20483	Wrench—Push rod housing gland nut	Loosening and tightening push rod housing gland nut
20520	Wrench—Push rod housing retainer nut	Loosening and tightening push rod housing retainer nut
20555	Wrench—Box socket, ½-inch hex.	Cylinder hold-down nuts and palnuts
20879	Wrench—Socket	Spark plug installation and removal

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