T. O. NO. 02-30AC-3

OVERHAUL INSTRUCTIONS

R-755-9
AIRCRAFT ENGINE

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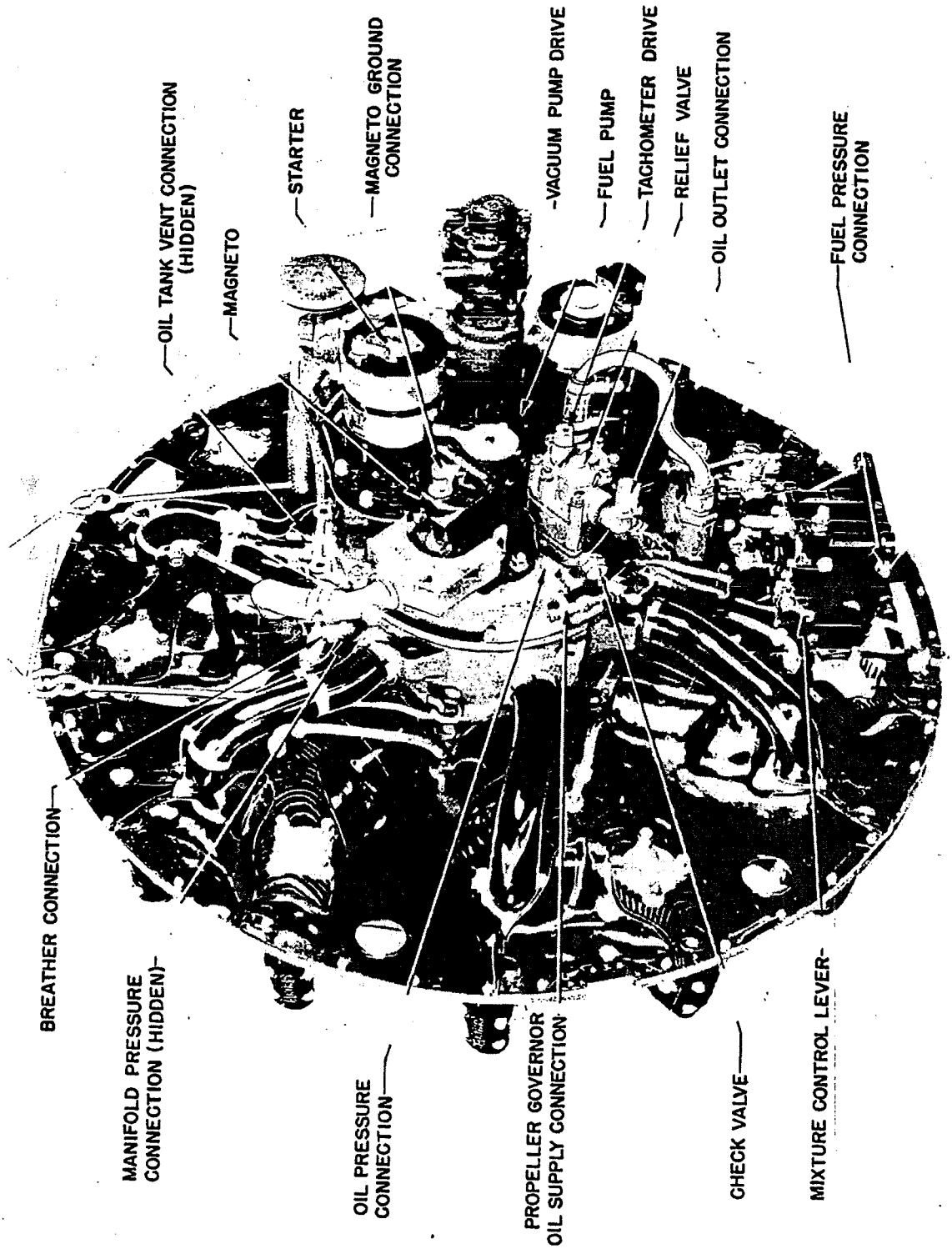


Figure 1 - 3/4 Left Rear View

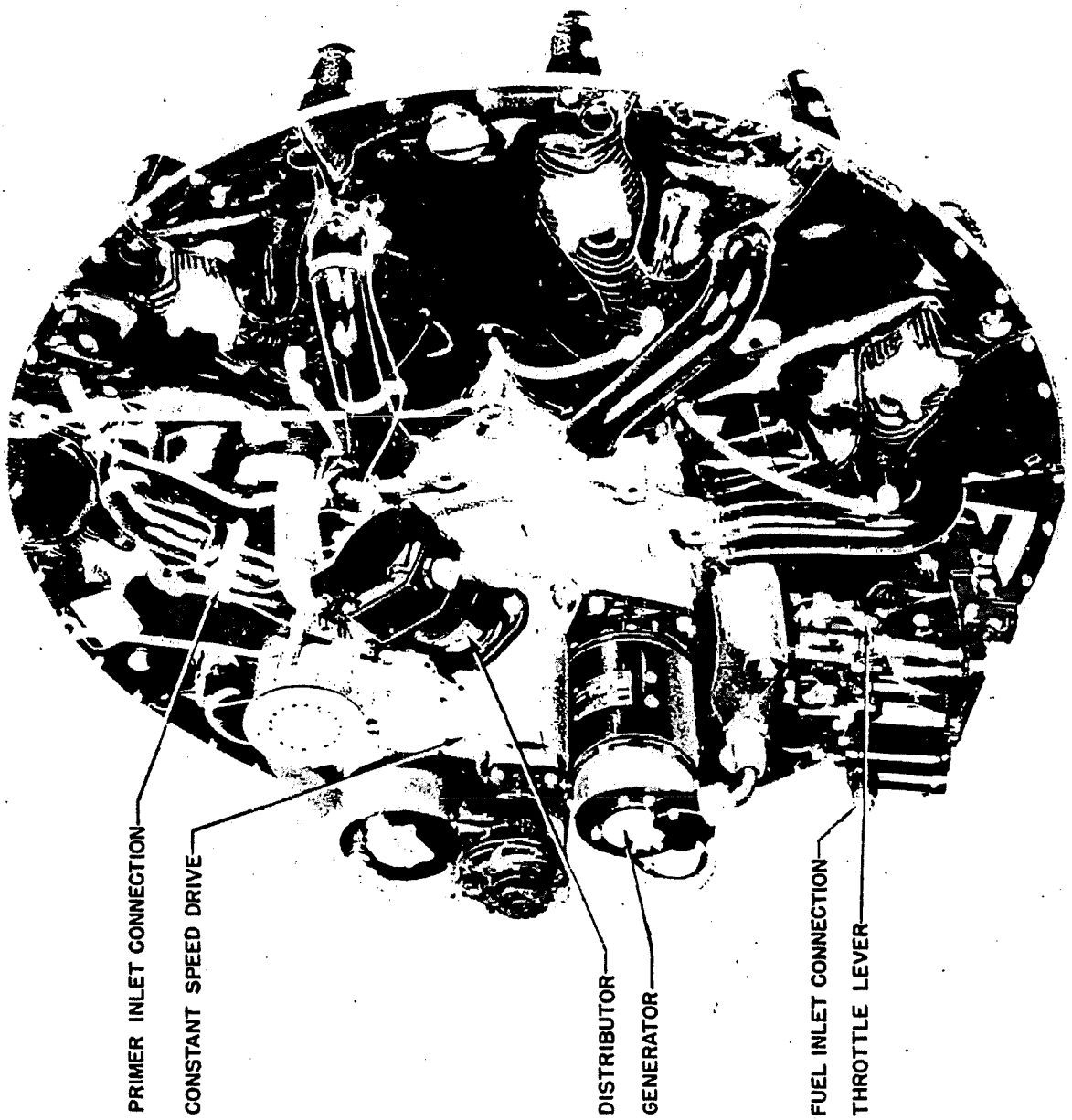


Figure 2 - 3/4 Right Rear View

SECTION I

INTRODUCTION

1. This publication comprises the Overhaul Instructions for the Model R-755-9 Engine, manufactured by Jacobs Aircraft Engine Company, Pottstown, Pa.

2. Throughout this Handbook 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" of the engine. The terms "Right" and "Left" are referred to as viewing the engine from the rear. Directions of rotation are determined by looking from the rear toward the front of the engine. The direction of rotation of the crankshaft is clockwise. The cylinders are numbered in a clockwise direction, the top cylinder being number one.

3. Limits (Clearance, fits, etc.) applicable to this engine will be found in the Table of Limits T. O. No. 02-30-1.

4. The special tools necessary for dismantling and reconditioning these engines are listed in the Overhaul Tools Catalog T. O. No. 02-30-3 and Service Tools Catalog T. O. No. 02-30-2.

5. Specification numbers as listed in this Handbook are basic numbers and will be interpreted to include all revisions and amendments thereto.

6. The following Service Publications contain related instructions and are listed only for convenient reference of Army personnel in the event further information is desired.

T. O. No.	
01-1-1	Cleaning of Aeronautical Equipment.
02-1-4	Handbook of Block, Ground, and Flight Test Instructions with Specific Block Test Sheets for Aircraft Engines.
02-1-6	Periodic Inspection and Adjustment of Valve Mechanisms.
02-1-28	Inspection and Tightening of Intake Pipe Packing Nuts.
02-1-55	Tightening of Cylinder Hold-Down Nuts and Cap Screws. Air-Cooled Radial Engines.
02-30AC-2	Service Instructions - R-755-9 Aircraft Engine.
02-30-1	Table of Limits - Jacobs Engines.
02-30-2	Service Tools Catalog - Jacobs Engines.
02-30-3	Overhaul Tools Catalog - Jacobs Engines.
03-5D-7	Aircraft Magnetos, Type VMN7-DF (Scintilla).
03-5E-1	Use and Servicing of Ceramic Aircraft Plugs - By Squadrons.
03-10B-1	Operation and Service Instructions, Aircraft Carburetors (Float Type) (Stromberg).
06-10-3	Prevention of Thread Seizures.
18-1-2	Magnetic Inspection Apparatus (Magnaflux).
29-1-3	Cleaning, Inspection, and Lubrication of Aircraft Antifriction Bearings.

SECTION II

DISMANTLING AND DISASSEMBLY

1. General.

a. The procedure outlined in this Section covers the complete dismantling and disassembly of the engine into its major component parts or sub-assemblies.

b. For complete disassembling and reconditioning of the engine a number of special tools are necessary, and it is very important that the disassembly of the engine be carried out with the proper tools as described in this Section. These special tools are listed and described principally in T. O. No. 02-30-3. Service tools referred to herein are described in T. O. No. 02-30-2.

c. The exterior of the engine will be sprayed with white furnace oil, gasoline or kerosene to remove all traces of dirt and grease. (Refer to T. O. No. 01-1-1).

d. As each part or sub-assembly is removed from the engine and placed on a suitable rack, its general condition should be observed, particularly with regard to the free movement of all gears and shafts. After preliminary inspection the sub-assemblies should be thoroughly cleaned, as described in Section III of this Handbook. Each sub-assembly should be inspected carefully before cleaning, noting any unusual conditions such as sludge deposits or the presence of metallic particles. If abnormal sludge deposits or metallic particles are found, samples of these should be retained for analysis in case the condition of the engine warrants such a procedure.

2. Preliminary Procedure Preparatory to Overhaul.

a. Turn the engine to the horizontal position and lock the stand.

b. Perform the following in the order outlined:

(1) Cylinder Baffles: Remove all cylinder baffles and baffle ring.

(2) Ignition Wires: Disconnect the ignition wires from the spark plugs.

(3) Spark Plugs: Remove the spark plugs and install a set of vented dummy plugs.

(4) Propeller Shaft Runout: Check propeller shaft runout with a Dial Indicator mounted from the cowling stud adjacent to the thrust bearing cover. Refer to Figure 3. The runout of the propeller shaft is measured at the front and rear propeller cone seats with a dial indicator while the propeller shaft is turned with the Wrench (Tool No. T-340). If the runout exceeds .005" at the rear propeller cone seat, or .010" at the front propeller cone seat, a note should be made to thoroughly check shaft when it is removed from the engine, to detect possible bending.

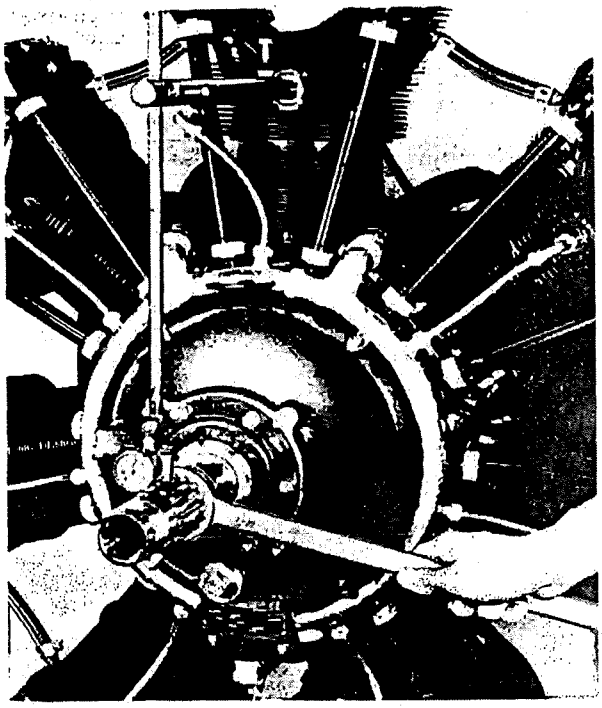


Figure 3 - Checking Propeller Shaft Runout with Dial Indicator

(5) Thrust Nut: Loosen the thrust nut one turn with the Wrench (Tool No. T-348-B). Refer to Figure 4. When loosening the thrust nut hold the crankshaft stationary with the Spline Wrench (Tool No. 340). If necessary to strike the Nut Wrench, use only a lead hammer or mallet.

(6) Distributor Blocks: Remove the distributor blocks from the magneto and distributor. When removing the distributor blocks from the magneto and distributor, care should be taken so that the molded block will not be broken by hitting the sides of the engine stand when removing the entire ignition manifold assembly.

(7) Accessories: Remove the magneto, starter, fuel pump, generator, and accessory drive unit.

(8) Ignition Manifold: Remove all nuts and clips securing the ignition manifold, assembly and remove the entire ignition manifold assembly.

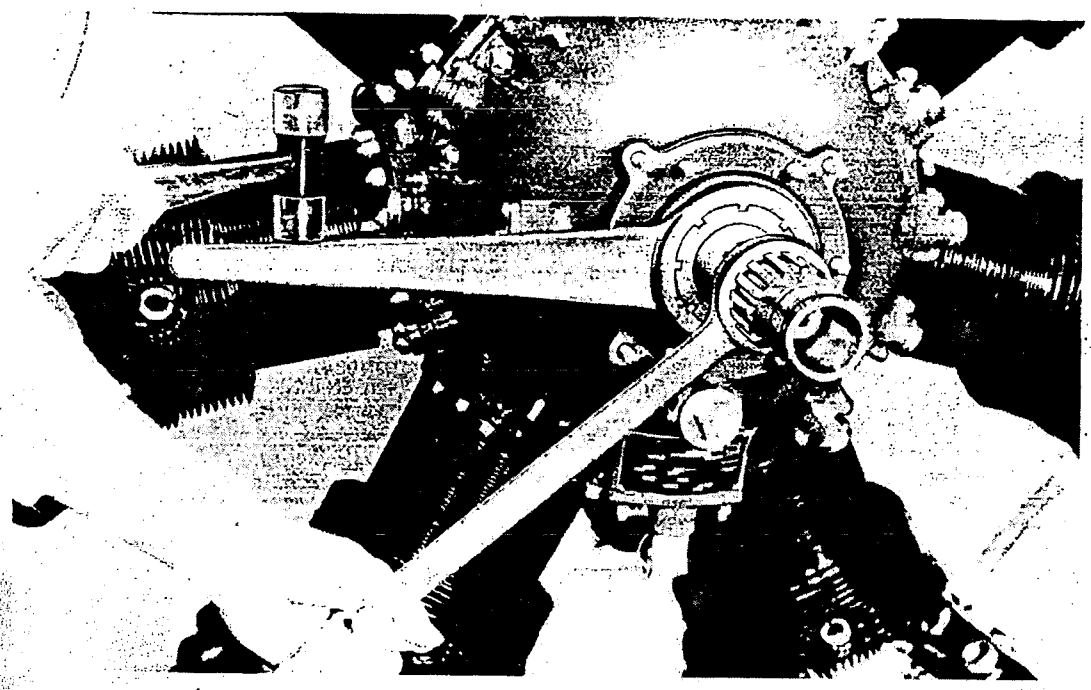


Figure 4 - Removing Thrust Nut

(9) Oil Sump: Remove oil drain hose line connecting the front case to the oil sump and allow the oil to drain.

(10) External Oil Lines: Loosen hose clamps and clips on all external oil lines and remove.

(11) Oil Pump and Oil Sump Tube Assembly: Loosen nut at crankcase and nut or hose clamp at oil pump end, and remove tube assembly.

(12) Priming System: Unscrew the priming tube union nuts from the fittings in the intake ports of Cylinders Nos. 1, 2 and 7. Remove the primer union nut from fitting in manifold. Unscrew the union nuts at the primer distributor. Remove nuts which hold the primer tube clips on the crankcase. Detach the intake pipe priming tube clips and remove the clips with the attached lengths of tubing. Tag each length of tubing to show the cylinder from which it was removed.

3. Disassembling Engine Into Sub-Assemblies.

a. Oil Sump Pad Flange.- Remove the nuts holding the flange to the front case and remove the flange and hose.

b. Carburetor.- Remove attaching nuts and washers from the carburetor flange studs and remove carburetor.

c. Oil Sump Strainer Assembly.- Remove Oil Sump fitting and Oil Sump plug. Remove Oil Sump Strainer.

d. Oil Pump Assembly.- (1) Remove the nuts and washers on the four studs holding pump to rear case.

(2) When all nuts are removed tap oil pump housing with a rubber mallet, at the same time pulling back in a straight line on the pump until the pump drive shaft is clear of the rear case.

e. Rear Case Assembly.- (1) Remove all

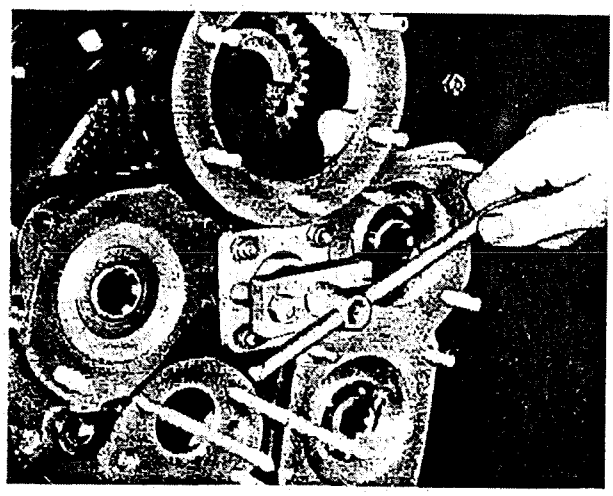


Figure 5 - Pulling Rear Case

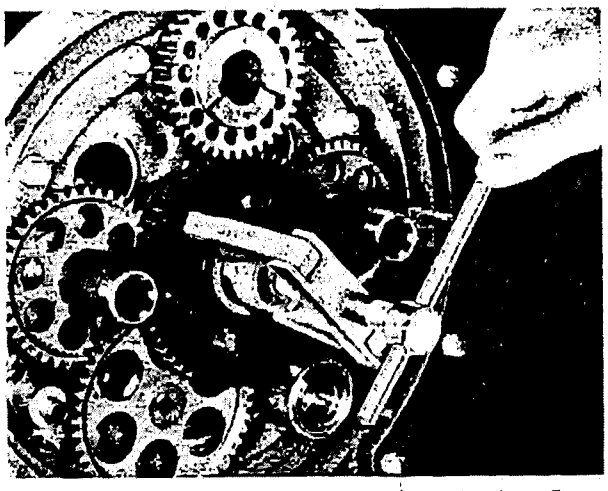


Figure 6 - Removing Crankshaft Cluster Gear

the nuts and washers which hold the rear case to the rear main crankcase.

(2) When all the nuts are removed, tap the rear case with a rubber mallet and remove case.

NOTE: The rear case can normally be removed by hand. If any difficulty is experienced, remove the case with Puller (Tool No. T-605-E). Refer to Figure 5.

f. Rear Intermediate Bearing Plate.-

(1) Bend tabs of crankshaft cluster gear lock washer back so that lock-nut can be removed.

(2) After tabs are bent back, remove lock-

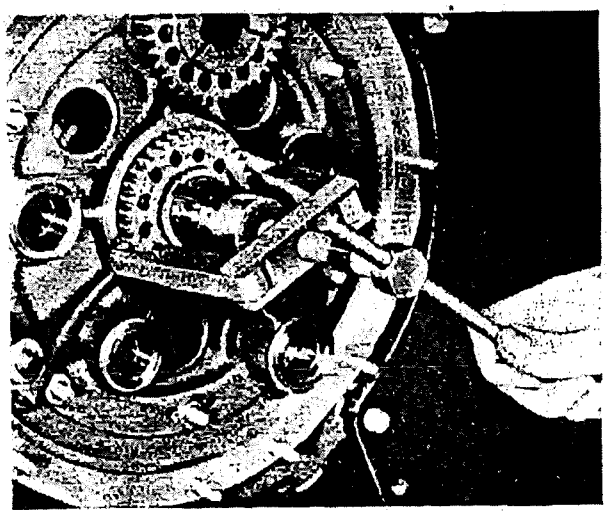


Figure 7 - Removing Magneto Drive Gear

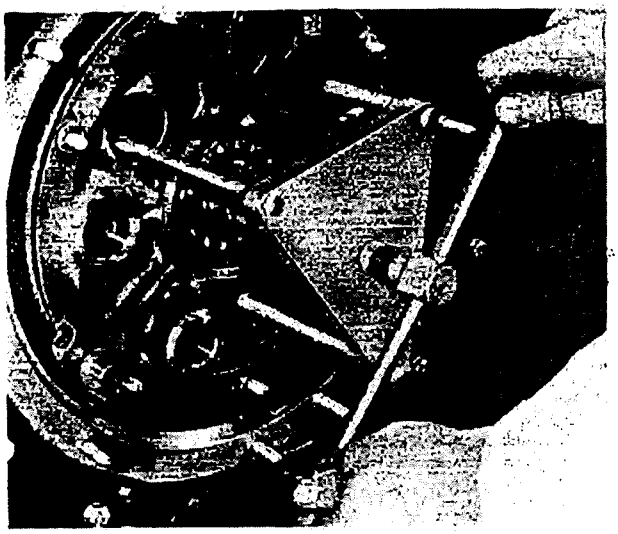


Figure 8 - Removing Intermediate Bearing Plate

nut with Wrench (Tool No. T-363).

(3) Remove the Crankshaft Cluster Gear with Puller (Tool No. T-11000). Refer to Figure 6.

(4) Remove the Magneto Drive Gear with Puller (Tool No. T-11000). Refer to Figure 7.

(5) After the gears have been removed, carefully remove the two crankshaft cluster gear keys.

(6) Remove the magneto driven gear, accessory drive gear, and the oil pump drive gear.

(7) Remove the nuts and lock washers which hold the intermediate bearing plate to the rear crankcase and remove the intermediate bearing plate with Puller (Tool No. T-604-C). Refer to Figure 8.

(8) The engine must then be turned so that the crankshaft is in a vertical position with the rear of the engine toward the floor.

g. Intake Pipes.- (1) In removing the intake pipes it is advisable to loosen the packing nut with the Wrench (Tool No. 569-7) and Handle (Tool No. 569-5) on each intake pipe at the crankcase end before removing the cap screws or nuts on the intake port flanges at the cylinder end. If this is not done the pipe will turn and jam the packing nut.

(2) Remove the intake pipes by removing intake port flange attaching cap screws or nuts and sliding flange over intake pipe.

(3) Grasp pipe at bend near intake port, twist pipe about a quarter turn to the right and pull.

(4) After intake pipes are removed, remove packing.

h. Push Rod Cover Tubes, Push Rods, Rocker Covers, Rockers.- (1) Loosen packing nut at cylinder end first and push nut over cover tube.

(2) Use water pump pliers lined with aluminum or soft brass strip in order not to damage knurled nut. Refer to Figure 9.

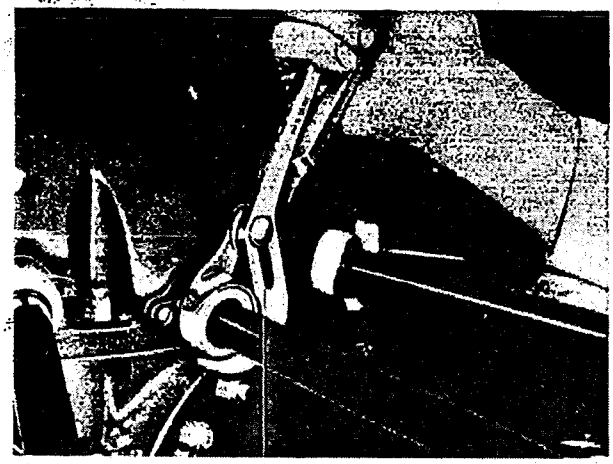


Figure 9 - Loosening Push Rod Cover Tube Packing Nut

(3) Break the rubber packing washer loose from cover tube.

(4) Remove all attaching nuts and washers from the rocker cover studs and remove covers.

(5) Loosen rocker arm adjusting screw lock-nuts with the Wrench (Tool No. T-786) and remove adjusting screw with the Service Kit Screw Driver (Tool No. T-422-B).

(6) Rotate the crankshaft at least two complete revolutions to bring the push rods to their outer position.

(7) Remove the push rods.

NOTE: The exhaust and intake push rods have different lengths and are marked "EX" or "IN". If found to be unmarked but of different lengths, they should be marked or kept separated so that they will be put back in the proper place after overhaul.

(8) Loosen push rod cover tube packing nut at the cylinder end with water pump pliers lined with aluminum or brass strip and break the rubber washers loose from the push rod cover tube.

(9) Remove push rod cover tubes by pushing each tube into the rocker box until tube end clears the tappet guide, then tilt tube away from tappet guides and pull out of rocker box.

i. Cylinders, Pistons, Piston Pins.-

(1) In removing the cylinders, the No. 1, or Master Rod Cylinder is the last one to be removed.

(2) To remove any cylinder bring the piston to the top of its stroke. (When the arrow or blanked spline on the front end of the crankshaft is in line with the cylinder, the piston will be at the top of its stroke.

(3) On engines equipped with automatic valve gear lubrication loosen hose clamps on hose connecting rocker boxes between each cylinder and remove hose.

(4) Turn the crankshaft until the No. 2 Piston is at the top of its stroke.

(5) Remove cylinder hold-down nuts with the cylinder hold-down Nut Wrench (See Tool List) and pull off the cylinder.

CAUTION: When pulling cylinders off, be careful the piston pin does not fall out, which may happen in the case of a worn pin, as piston pin and piston would then fall on floor and be damaged.

(6) Turn the crankshaft until No. 3 piston is at the top of its stroke, remove cylinder hold-down nuts as above and pull off the cylinder.

(7) Continue on around the engine, going through the same steps until No. 1, the master rod cylinder, is removed last.

(8) After removal, the cylinders should be set down on wood or some other soft surface in order not to distort or burr the ends of the barrels. Remove pistons by pushing out the piston pins.

NOTE: If difficulty is experienced in pushing out any piston pin, DO NOT DRIVE ON THE ALUMINUM PLUG in the pin. Carefully remove all the piston rings and slightly heat the top of the piston by means of a blow torch. The pin can then be easily removed.

j. Thrust Nut, Thrust Bearing Plate, Front Section.- (1) Remove the thrust nut using Wrench (Tool No. T-348-B).

(2) Remove all attaching nuts and stud spacers holding thrust plate to front case and remove thrust bearing plate by tapping the edge with a rubber mallet.

(3) Remove the crankshaft oil slinger, and thrust bearing plate spacer.

(4) Remove all the nuts and washers holding front case to crankcase and turn engine so that crankshaft is in a vertical position.

(5) Before removing front case rotate the crankshaft three or four revolutions to make sure all tappets are moved to their outer positions. This is necessary in order that the tappet rollers will be moved away from the cam. If not done, the tappet rollers may catch on the cam lobes, causing severe damage to the tappet rollers and pin, cam and tappet guides.

(6) After the above precautions are taken, remove front case with Puller (Tool No. T-7000), being careful the case is not cocked when pulling. Refer to Figure 10.

(7) Remove the timing gear with the Puller (Tool No. T-6000). Refer to Figure 11.

(8) Remove timing gear spacer, cam assembly and cam bearing.

(9) Screw a No. 10-32 Screw into the tapped hole in the timing gear key and remove key.

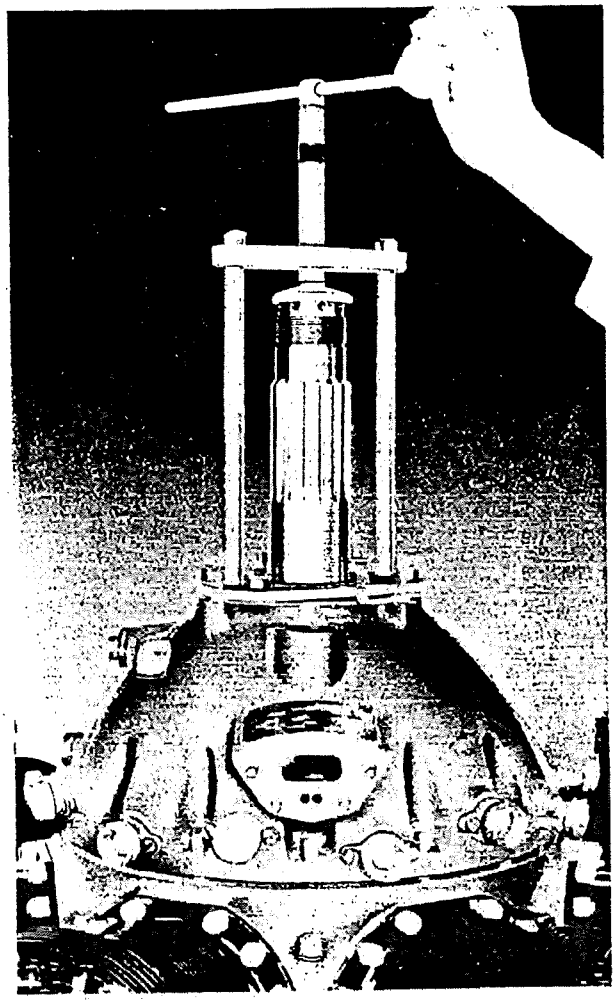


Figure 10 - Removing Front Case

k. Crankcase Main Section, Front.-

(1) Remove the six crankcase through bolts and the crankcase stud nut, but DO NOT remove the crankcase stud between No. 4 and No. 5 cylinders.

(2) Remove the front half of the main crankcase.

(3) When removing the front half of the main crankcase care should be taken to make sure that the case does not cock or bend on the stud or main bearing liner.

(4) The outer race and rollers of the front main bearings will usually remain in the

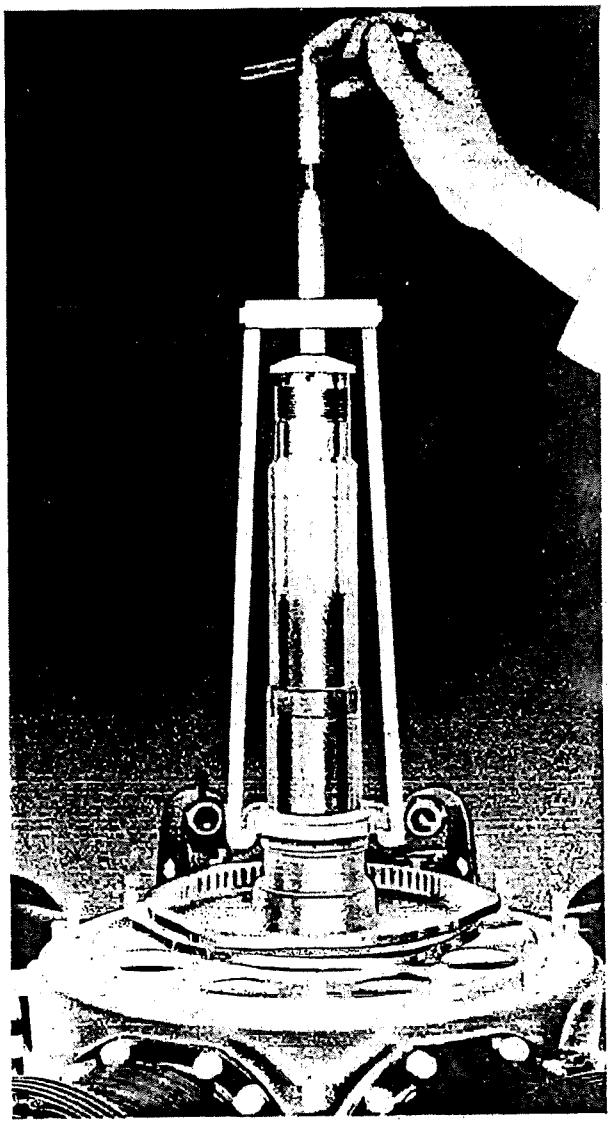


Figure 11 - Removing Timing Gear

front half of the crankcase as it is pulled off. They should be carefully removed to avoid dropping and should be segregated to prevent mixing with rollers from the rear main bearing.

l. Front Crankshaft, Master and Link Rods.-

(1) Remove the cotter pin in the crankshaft clamp bolt.

(2) Lock the crankshaft to prevent it from turning.

(3) Carefully unscrew the crankshaft clamp bolt nut with Wrench (Tool No. T-344). Refer to Figure 12.

(4) Tap out the crankshaft clamp bolt, using a fibre drift.

(5) After Clamp Bolt has been tapped out, drive the Wedge (Tool No. T-18000), carefully into the slot in the rear half of the crankshaft just enough to slightly spread the opening in the rear half of the crankshaft. Make sure wedge does not mar the crankpin.

(6) Carefully lift off the master rod assembly, together with the front half of the crankshaft. Make sure that the master rod assembly is held tightly against the crankcheek of the front half crankshaft at all times. Refer to Figure 13.

(7) BEFORE REMOVING MASTER ROD ASSEMBLY from crankshaft, carefully inspect end of crankpin for any burrs or rough spots. If any burrs or rough spots are found they should be carefully removed. Any roughness on the end of the crankpin will score the master rod bearing when the master rod is removed.

(8) Remove the master and link rod assembly.

m. Rear Crankshaft.- (1) Turn engine stand until crankshaft is in the horizontal position. Lock stand in this position.

(2) Remove rear half of the crankshaft, together with the rear main bearing.

(3) Place rear half of crankshaft in a vise having protected jaws. Bend tabs back on rear bearing lock washer so that lock-nut may be removed.

(4) Remove lock-nut with Wrench (Tool No. T-359). Refer to Figure 14.

(5) Remove outer race and rollers of rear main roller bearing, taking care to avoid dropping. Do not mix rear bearing parts with front bearing parts.

(6) Main bearing inner races can be removed if necessary with Puller (Tool No. T-6029). Refer to Figure 15. Puller must be placed on crankshaft as shown in illustration. Be certain to tag races to distinguish front from rear.

(7) All recently manufactured main roller bearings are serially numbered on inner and outer races to avoid mixing, but the rollers should be kept separate.

NOTE: After front and rear halves of

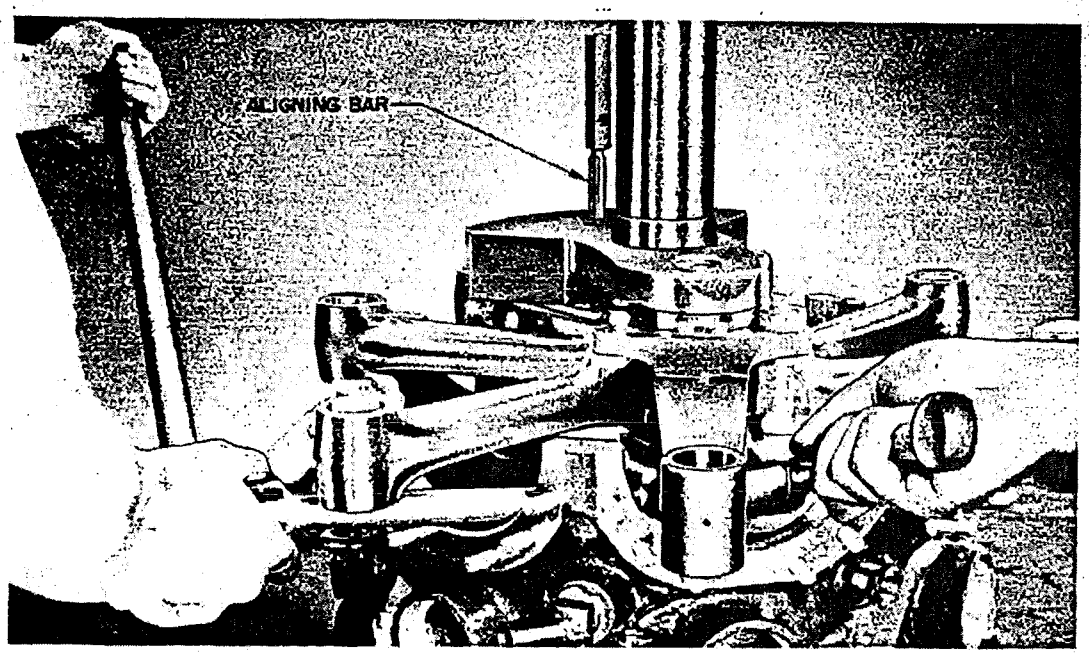


Figure 12 - Removing Crankshaft Clamp Bolt

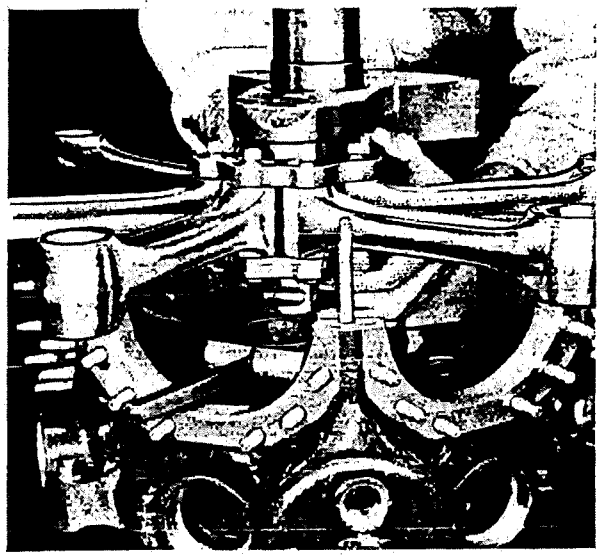


Figure 13 - Removing Front Crankshaft, Master and Link Rod Assembly

crankshaft are removed it is advisable to place propeller shaft cuff (Part No. 998 or 998-1) over crankpin for protection and to screw a thread protector (Part No. 974 or 10006) on end of front half in order to protect the threads.

4. Disassembly of Major Sub-Assemblies.

a. Ignition Manifold Assembly.- (1) At each engine overhaul the ignition manifold assembly should be disassembled and the ignition cable discarded.

(2) In order to disassemble the ignition manifold the distributor blocks and ignition cable markers should first be removed.

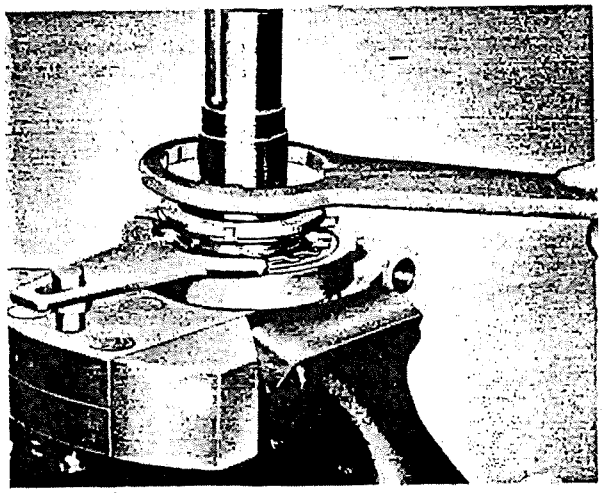


Figure 14 - Removing Rear Bearing Lock-Nut

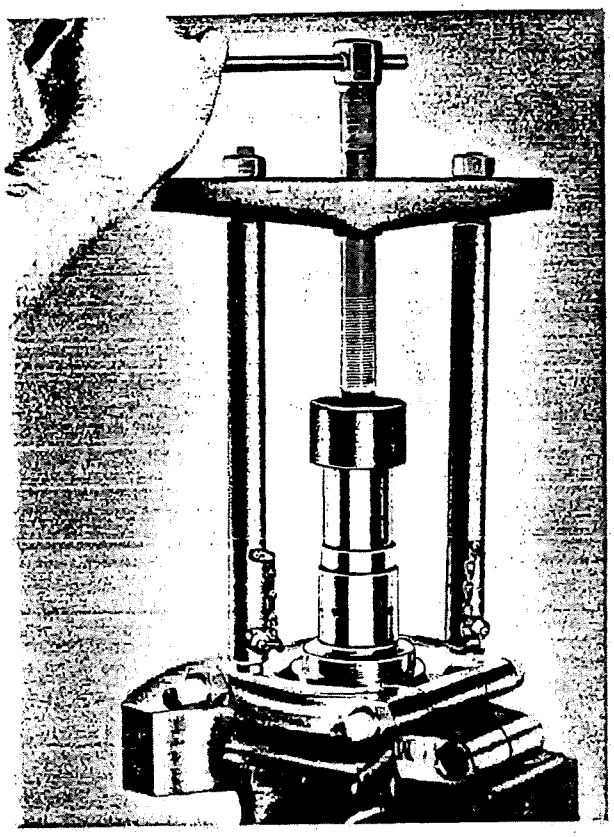


Figure 15 - Removing Rear Bearing Inner Race

(3) The distributor and magneto conduit assemblies are removed by unscrewing the union nuts at the manifold end.

(4) The coil conduit assembly is removed by unscrewing union nut at distributor elbow end.

(5) The spark plug terminals on ends of spark plug cables, and spark plug elbows, should also be removed along with the spark plug conduits which are removed by unscrewing union nuts at manifold end. The wires can then be pulled from the manifold.

b. Oil Pump Assembly.- (1) There are (3) three bolts that secure the various sections of the oil pump together. Remove the nuts and washers from the bolts in order to completely disassemble the pump.

(2) Remove oil pressure relief valve cap, spring, and ball.

(3) Tap end of oil pump shaft using mallet to loosen oil pump sections and lift off the scavenger section oil pump body.

(4) After body is removed, slide off the scavenger section gears from the oil pump drive

and idler shafts, and remove the keys from drive shaft.

(5) Remove the remaining sections and gears in the same manner until the disassembly is complete.

(6) After the pump has been disassembled remove the oil check valve cap, spring, ball, and body from the pressure section body.

(7) The relief valve body (and adapter, if any) may be left attached to the intermediate plate.

(8) On engines having automatic valve gear lubrication there will be an extra section called the Rocker Scavenger Section, which will have to be disassembled in the same manner as indicated above.

c. Rear Case Assembly.- Tap out the magneto and generator gear oil seals and drive out the generator gear ball bearing by tapping on the outer race of the bearing.

d. Rear Intermediate Bearing Plate Assembly.- Remove starter gear by removing starter gear bolt cotter pin, nut, washer and bolt. Drive out the rear crankshaft ball bearing by tapping gently around the inner race.

e. Cylinder Assembly and Piston Assembly.-

(1) Place each cylinder on a suitable block for support while disassembling. Remove rocker arm shaft and nut, tap out rocker arm shaft and remove rocker arm.

(2) Put the Valve Spring Compressor (Tool No. T-409-10) in place, pinning through the rocker shaft holes. Before attempting to compress the springs, rap the upper valve spring washer to loosen the washer from the locks and prevent straining the compressor. Refer to Figure 16.

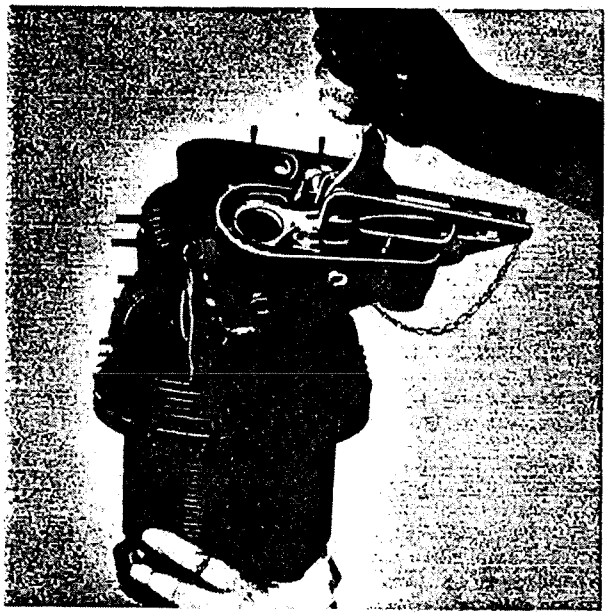


Figure 16 - Compressing Valve Spring

(3) After washer is loosened, compress the springs and remove the locks.

(4) Remove the compressor and lift off the cylinder from the block, holding the valves so that they do not fall out.

(5) Remove the valves and attach a marker to each showing the number of the cylinder from which it was taken.

(6) Remove the piston rings from the piston. Refer to Figure 17.

NOTE: When removing rings care should be taken not to scratch or raise any burrs on ring grooves or sides of piston. If rings are not to be discarded, care should be exercised to avoid twisting, and they should not be expanded more than is necessary for removal. They should be kept in exact order and identified to insure their proper replacement in the same grooves.

f. Front Case Assembly.- (1) To remove the cam drive pinion shaft and gear, turn the front case assembly over and rest on cowling studs.

(2) Remove lock wire from cam drive pinion bearing clamp nuts, and remove nuts.

(3) After the nuts are removed lift off cam drive pinion bearing clamp washer.

(4) Remove cotter pin, nut and washer from front end of cam drive pinion shaft.

(5) When removing nut from cam drive pinion shaft, the cam drive gear should be locked to prevent gear from turning.

(6) The cam drive gear is removed from the cam drive pinion shaft with the Puller

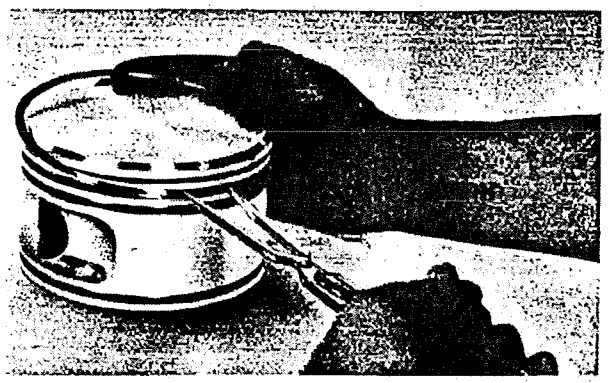


Figure 17 - Removing Piston Rings

(Tool No. T-6041-1), Brace (Tool No. T-6041-2), and two (2) Spacers (Tool No. T-6035).

(7) After the puller and brace are in place put two (2) Spacers (Tool No. T-6035) in recess of cam drive gear, one over the other, between the gear and boss in case. Refer to Figures 18 and 18A.

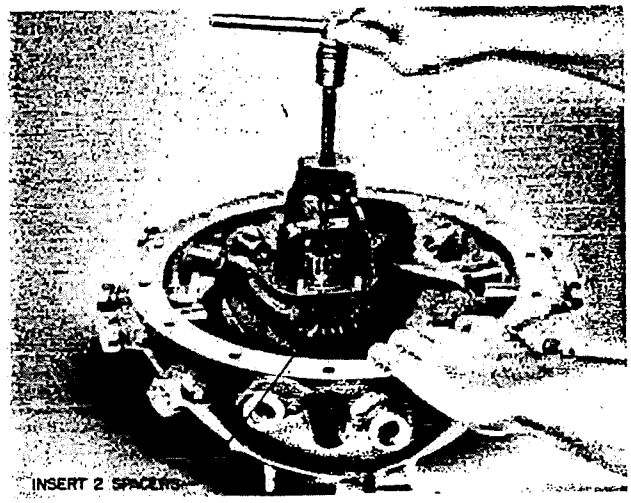


Figure 18 - Removing Cam Drive Pinion Shaft - Old Method

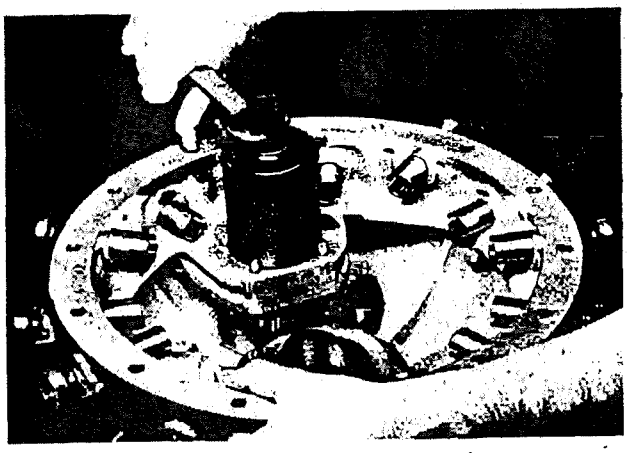


Figure 18A - Removing Cam Drive Pinion Shaft - New Method

(8) After spacers are in place, start pulling pinion shaft out.

(9) The bearings will come out attached to pinion shaft. To remove bearings from pinion shaft place shaft in a soft jawed vise and bend lock-nut tabs back.

(10) Remove lock-nut with Wrench (Tool No. T-378-2) and then remove front bearing, spacer and rear bearing.

(11) To remove thrust bearing and inner oil seal sleeve, place Driver (Tool No. T-591-D-A) in place against rear of inner oil seal sleeve and drive out. The thrust bearing will be removed from front case at the same time the inner oil seal sleeve is removed.

g. Front and Rear Crankshaft Assembly.

(1) Front Crankshaft Assembly.

(a) Remove crankpin bolt nut, crankpin bolt, and crankpin plug.

(b) To remove rear crankshaft oil plug, drill the plug at points where it is staked.

(c) Do not use a larger drill than is necessary to remove the punch mark and do not drill deeper than necessary. The plug can then be removed using Wrench (Tool No. T-345-B).

(2) Rear Crankshaft Assembly. - Remove front crankshaft oil plug as outlined above using Wrench (Tool No. T-345).

NOTE: The staking method of locking the crankshaft plugs has been obsoleted in favor of locking plugs with a lock and screw which are safety wired. To remove plugs locked by this method, it is necessary to remove safety wire, lock screw and lock. The plugs can then be removed with their respective Wrenches mentioned above.

h. Master and Link Rod Assembly.

(1) To remove knuckle pins and link rods, first remove cotter pin and knuckle pin bolt and then remove nut, bolt and knuckle pin washers.

(2) Before attempting to press out knuckle pins, place master rod on Base (Tool No. T-367) so that the small drilled oil holes inside the master rod bearing are down and the bearing lock plate is uppermost.

(3) The oil groove end of the knuckle pins will then be down and will be the part of the pin pressed out first.

CAUTION: If the pin is pressed out from the wrong side, the groove may pick up metal and score the hole in the master rod.

(4) Before pressing out each knuckle pin, place Wedge (Tool No. T-367-1) between master rod flanges near the knuckle pin to be removed. Use of the Wedge will prevent excess distortion of the master rod. Refer to Figure 19.

(5) Place Drift (Tool No. T-27000-B) in knuckle pin and press out, taking care to prevent its being damaged by falling.

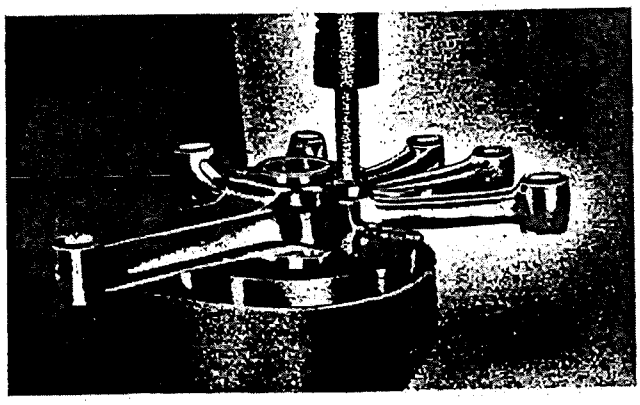


Figure 19 - Removing Knuckle Pin

SECTION III

CLEANING

1. General.

a. The cleaning of engine parts or subassemblies, should be done in accordance with T.O. No. 01-1-1, noting, however, the following recommendations.

(1) Use solvent, dry cleaning, Specification No. P-S-661, or kerosene, Specification No. VV-K-211, for degreasing, or as an after rinse for parts which have been in the carbon softening tank. Spraying and drying must be confined to the booth, and necessary ventilation provided.

(2) Most of the water mixed cleaning solutions listed in T.O. No. 01-1-1 contain either soap or caustic compounds. It has been found extremely difficult to remove all traces of these compounds from engine parts, and where compounds which contain soap are used, oil foaming may result immediately after starting the engine. In the case of the alkaline cleaners such as caustic soda, the alkaline compounds combine with the oil in the presence of acids which come from combustion gases and are normally present in the oil and form soap which produces oil foaming. In this case foaming may occur immediately or many hours after the engine is placed in service.

(3) As a result of the above experience the use of dry cleaning solvent, kerosene, or other hydrocarbons for cleaning purposes, is recommended. Under no circumstances should leaded gasoline be used for cleaning.

(4) If water mixed materials containing any form of soap or caustic compounds are used for cleaning it is of the utmost importance that all parts or assemblies be thoroughly rinsed with clear boiling water after using the compounds. It is imperative that all traces of the cleaning compound be removed before the parts are assembled. It is recommended where these compounds are used that the parts be scrubbed thoroughly in clear boiling water and then rinsed in a separate bath of boiling water.

2. Degreasing.

Approved formulas and procedures for degreasing are listed in T.O. No. 02-1-1. When spraying with volatile cleaning fluids every possible precaution against fire is necessary. Unless steel parts are to be inspected within 24 hours after cleaning, they should be sprayed with corrosion preventive mixture (refer to NOTE in section IV, paragraph 1.a.), and should then be recleaned before inspection.

3. Decarbonizing.

To remove hard carbon deposits it is recommended that such parts be placed in kerosene. Leave the parts immersed in the solution only long enough to loosen the bond between the carbon deposit and metal, then remove the parts from the solution and hand clean to remove the loosened deposits. The hand cleaning operation should be done immediately after removing the parts from the solution to prevent rehardening of the carbon deposits. In no case will gouges, hacksaw blades, abrasive cloth, or other such hard tools or materials be used to remove carbon from aluminum parts.

4. Cleaning Procedure.

a. After the external surfaces of the parts are cleaned, a special effort should be made to insure that all the internal passages of the engine are thoroughly cleaned and blown out with compressed air. Particular attention should be paid to the oil passages of the crankshaft, front case, rear crankcase and sump. After cleaning these oil passages they should be covered with scotch tape, or closed by other suitable method, to prevent dirt from entering while parts are on rack prior to final assembly.

b. Pistons. - Carbon will be removed from ring grooves by the procedure outlined in section III, T.O. No. 02-1-1. Wheat, clover seed, and plastic pellet blasting are the preferred methods of removing hard carbon. Sandblasting may be accomplished on the inside and tops of pistons and heads of valves only, utilizing grade 120 round sand, only if wheat mixture or other authorized materials are not available. Piston pinholes must be plugged, and proper masking employed to prevent damage to piston lands and skirt. The glazed surfaces present on the piston skirt will not be removed, except score marks will be removed by light stoning. Carbon lodged in oil holes may be removed by reaming with an under-sized drill. Final cleaning of the pistons may require polishing with crocus cloth and kerosene (Spec. VV-K-211) and final spray washing.

c. Cylinders. - Removal of the hard carbon from the combustion chamber and enamel from the outside of the cylinders before repainting may be done by sandblasting. Observe instructions for sandblasting as given for piston heads.

Prepare cylinders for sandblasting the carbon from the combustion chamber by installing a suitable cylinder wall protector sleeve in the cylinder. Install rubber plugs in the valve guide, from the inside. The threaded holes in the spark plug bushings should be protected with rubber plugs or with a set of dummy or discarded spark plugs. It is permissible to sandblast the valve seats. This is often desirable, as it cuts the carbon or glaze that is apt to form on the seats, particularly the exhaust, and facilitates reconditioning.

Judgment should be exercised in the matter of removing enamel from the outside of cylinders as it is not always necessary to remove all of the old enamel. Prepare cylinders for sandblasting outside surface by plugging the rocker bolt holes, spark plug bushings, and push rod cover tube glands. The rocker covers should be installed. Mask the exhaust and intake flanges and attaching studs.

The cylinder should be very carefully cleaned to remove all traces of sand used in sandblasting. Sand should be removed by the use of compressed air and gasoline. Care should be used in removing sand lodged in the joint between the head and the barrel.

d. Valves. - Any hard carbon remaining on the heads of the valve after removal from the cleaning solution may be removed with a fine wire brush.

e. Master Rods. - Cleaning of the master rods and its bronze bearing should be very carefully conducted. Cleaning solutions have a tendency to remove the lead particles in the surface of the bearing. To clean the master rod bearing wipe the bearing with a clean cloth saturated with dry cleaning solvent or equivalent. Do not attempt to clean used bearings by any other means such as polishing, burnishing or subjecting them to the action of any strong cleaning solution.

f. Bearings. - Ball and roller bearings should be cleaned with a neutral cleaning solution. In cases where hard carbon has been deposited in the bearing it may be immersed in any carbon solvent that will not attack the bearing or the retainer. Most bearing trouble is caused by the entry of dirt into the bearing. The cleaning of a bearing is a particular, painstaking job, and should be done with complete thoroughness and caution.

Anti-Friction Bearings are especially subject to magnetization, both in transit and storage and while running in the engine. Any magnetization of the bearings will cause minute magnetic particles to adhere to the balls and races and will cause scoring of these parts during operation. It is, therefore, recommended that all bearings be demagnetized by passing them through a demagnetizer, and thoroughly washed and oiled before installing them in an engine. New bearings should be demagnetized while still packed so that they will remain clean.

After removal from the cleaning solution the bearing should be washed and blown out with compressed air which is free of moisture and dirt. When blowing out the bearing with compressed air, hold both races to prevent turning of the bearing. DO NOT ALLOW THE BEARING TO SPIN. Spinning of the bearing in a dry condition will cause scoring of the races. The cleaning of the bearing should be continued until the bearing runs smoothly when well-oiled. A dry bearing will often appear loose and defective. When the bearing has been cleaned, it should be oiled, wrapped in waxed paper and put in a box to prevent the entry of dirt. A clean bearing should never be allowed to lie exposed on the work bench. For additional information on the cleaning of antifriction bearings refer to T. O. No. 29-1-3.

SECTION IV
INSPECTION

1. General.

a. All parts and sub-assemblies must be carefully inspected. The inspection procedure should include the measurement of all the working fits and clearances indicated by reference numbers and arrows on clearance wall charts. The desired fit or clearance will be found opposite the corresponding reference numbers in the Table of Limits (T. O. No. 02-30-1). The Table of Limits are self-explanatory as to method of use and contain reference numbers corresponding to those on the wall charts; minimum and maximum limits for the desired fit or clearance at each location, and replacement limit. A record of the wear and clearances, also pertinent information concerning the condition of the component parts of the engine, should be made by the inspector. Instructions for the re-conditioning or replacement of a part should be included when either of these two procedures is found necessary. From the information recorded by the inspector, it should be possible for workmen to determine readily what repair operations or replacements are necessary.

NOTE: After inspection, all steel engine parts will be covered with a light coat of corrosion preventive mixture consisting of one part engine corrosion preventive compound, Specification No. AN-VV-C-576, to three parts lubricating oil, grade 1065A, Specification No. AN-VV-O-446. The use of plain lubricating oil as a corrosion preventive measure will be discontinued.

b. It is understood that the following inspection procedure will apply generally to all detail parts and assemblies, and will be performed in conjunction with such inspection as may be specified for certain parts.

(1) Studs:- Examine all studs for tightness in their respective locations, and for possible mutilation of the external threads.

(2) Liners and Bushings: (a) Examine all liners and bushings for looseness with their respective parts.

(b) Examine condition of their bores for scoring, pitting, galling and other unusual wear.

(3) Paint: Examine condition of paint on all painted parts and repaint if necessary.

(4) Forgings and Castings: (a) Examine for nicks, cracks, and other possible mutilations.

(b) Examine all tapped holes for thread mutilations.

(c) Examine all flange faces for smoothness and remove remnants of old gaskets.

(5) Steel Parts: Steel parts which are subject to stress will be inspected by Magnetic Inspection as outlined in T. O. No. 18-1-2.

NOTE: AAF personnel only will not magnaflux valve springs and other coil springs.

(6) Gears and Shafts: (a) Gears will be examined for uneven tooth bearing, cracks and possible mutilation.

(b) Shafts will be examined for cracks, scores and straightness.

(7) Anti-Friction Bearings: Ball and roller bearings will be inspected and lubricated as prescribed in T. O. No. 29-1-3.

(8) Refer to T. O. No. 02-30AC-2 Section VII for further instructions on inspection.

2. Valve Inspection.

Due to the intense heat to which exhaust valves are subjected, their life is limited as compared with intake valves. Exhaust valves should be carefully inspected at overhaul for wear, stretch and erosion. To check the radius limit or stretch of the exhaust valve use Gage (Tool No. T-404). When using the gage, hold the valve at eye level with the edge of the gage against the valve stem and the curvature of the gage against the radius of the valve head, so that any passage of light between the valve and the gage may be readily seen. A clearance of .025" or more between the gage and the valve is cause for replacement of the valve. Figure 20 indicates the two points at which valves should be checked for stretch. Exhaust valves having creases or signs of swelling or straining where the head joins the stem, should be replaced regardless of what the radius or stretch gage shows. Check the condition of the grooves for galling or scoring by the locks, and for burrs which might have been caused during disassembly.

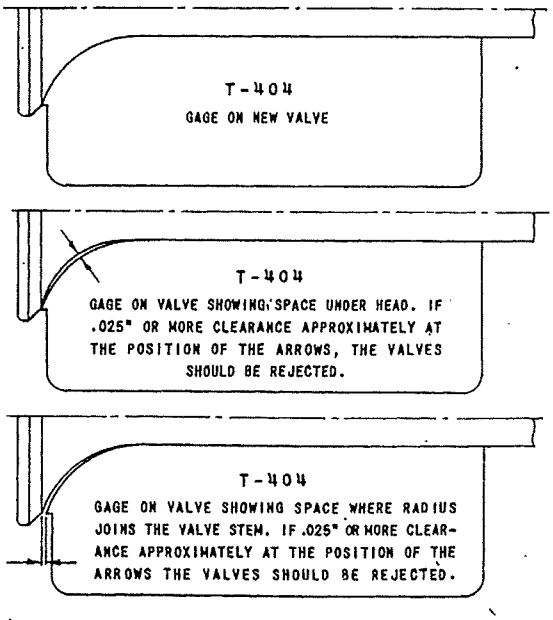


Figure 20 - Use of Valve Stretch Gage

SECTION V

REPAIR AND REPLACEMENT AND ASSEMBLY

1. General.

This Section describes in detail the necessary repair and replacement operations to be applied to parts which will restore the engine, as nearly as possible, to its condition when new. The instructions given herein, insofar as is possible, deal with each sub-assembly or parts thereof separately, completing the repair and assembly of each before proceeding to another assembly. This includes all operations up to final assembly with the engine.

2. Repair Precautions.

a. Whenever drilling or reaming holes, break all the sharp edges remaining around the holes and smooth away all burrs with a fine stone or crocus cloth.

b. Never use emery cloth for cleaning and polishing engine parts nor for any other purpose unless particularly specified in this Handbook. The use of emery cloth may leave abrasive particles in the engine as well as scratches which may develop into cracks and ultimate failure of the engine part.

c. The incorrect marking of parts or the marking of parts in certain areas may produce surface cracks which can progress into complete failure of the parts. This applies particularly to highly stressed parts which have been electrically etched. Marks placed on certain areas or parts by the factory are located at definite points where experience has indicated it will be safe to place them. Other parts are identified through the use of a special etching fluid. This fluid may be used to saturate an ordinary ink stamping pad and is used with a rubber stamp. After the part is etched, the surface should be cleaned and well-oiled with engine lubricating oil to prevent corrosion.

d. To obtain alignment of an oil hole in a bushing with the mating hole in the mating part, draw a pencil or crayon line lengthwise on the outside diameter of the bushing through the center of the oil hole and square with the face of the bushing. Mark the edge of the hole which is to receive the bushing. Install the bushing on its press-in plug. Align the two marks and press in the bushing.

e. The use of paraffin to plug oil holes to prevent entrance of chips is permissible provided paraffin is not run into the hole in a melted condition which would block off the holes and the oil passage and make removal difficult. If a small ball of paraffin is rolled between the fingers and then applied like putty, there will be no difficulty in removing all the paraffin in a flushing fixture.

3. Assembly Precautions.

a. The successful operation of the engine is entirely dependent upon the attention given to every detail in the inspection and assembly. It should be borne in mind by the inspector and mechanic that the slightest neglect on their part may result in the failure of the engine.

CAUTION: Cotter pins, safety wire, gaskets, leather oil seals, seal rings, and rubber hose should never be used a second time. Other safety features which have been bent or worn should be replaced with new parts.

b. Great care should be taken to prevent dirt, dust, cotter pins, nuts, washers and other small particles from falling into the engine during the assembly. Such foreign material can damage the gears and the bearings.

c. Prior to assembly of subassemblies all parts which have been treated with corrosion preventive mixture will be cleaned to remove all traces of the mixture and accumulated foreign matter. The use of compressed air after washing with cleaning fluid is recommended since rags or waste leave lint and other bits which may clog oil lines and strainers. These parts will then be covered with a heavy coat of corrosion preventive mixture consisting of one part engine corrosion preventive compound, Specification No. AN-VV-C-576, to three parts lubricating oil, grade 1120, Specification No. AN-VV-O-446.

d. Completely finish each step in the process of assembly as the work progresses. Do not leave a nut loose or uncottered with the intention of coming back to it later.

e. Do not slack off a nut to line up castellations with the cotter pin hole in the bolt or stud. If it cannot be tightened without exceeding the permissible torque value, use a new nut or washer.

f. Select cotter pins to fit tightly in their bolt or stud holes. Always install the head or loop end of the cotter pin to fit the castellation of the nut and not across or outside the castellation. Bend one leg of the cotter pin up and back over the bolt or stud tip and the other down flat against the nut.

g. When using safety wire, select a size which will fit the hole fairly tight. Twist the wire uniformly with the pliers and obtain tight loops at each end. The wire should be sufficiently tight to eliminate vibration which would cause breakage of the wire from wear.

h. In places where there is a possibility of oil seeping out from between machined surfaces as between the crankcase section parting flanges, the surfaces should be coated with a gasket paste, Specification No. AN-G-14, before assembly. Use new rubber oil seal rings under the cylinder hold-down flanges, and new oil seals at the ends of the push rod tubes.

i. Remember that the oil pump will not be-

gin to furnish the regular supply of oil until the engine has turned over several revolutions. For this reason, it is necessary to coat all surfaces normally lubricated by the oil from the pump, with a good supply of corrosion-preventive mixture consisting of one part corrosion-preventive compound, Specification No. AN-VV-C-576, mixed with three parts lubricating oil, Specification No. AN-VV-O-446, when the parts are assembled. All parts which are a drive or push fit should likewise be coated with oil to facilitate their assembly in the engine. In order to avoid chafing or scoring of crankshafts and propeller shafts when ball or roller bearings are pressed in place, micrographite should be used between the inner race of the bearing and the shaft. The shaft should be wiped clean with a dry cloth and a quantity of micrographite applied to the surface of the shaft and the shoulder against which the inner race rests before pressing on the bearing. After the bearing is in place, the excess powder should be removed. In the assembly procedure following, it will be assumed that the above recommendations and precautions have been applied. Instructions relative to the prevention of thread seizure are given in T. O. No. 06-10-3.

4. Ignition Manifold.

a. Repair.- Replace any grommets, clamps, flexible conduits, or terminal sleeves that are damaged.

b. Assembly.- Before reassembling the ignition manifold, new wires should be installed. Rewire the manifold, installing the wires in proper numerical order. Refer to the following table:

Table of Wire Lengths in Inches

Cyl. No.	Total Length Front Spark Plug	Total Length Rear Spark Plug
1	49	55
2	49	61
3	55	67
4	63	74
5	67	72
6	61	67
7	55	59

Cyl. No.	Wire Length from Manifold to Magneto	Wire Length from Manifold to Distributor
1	30-1/2	26-1/2
2	30-1/2	26-1/2
3	30-1/2	26-1/2
4	30-1/2	26-1/2
5	30-1/2	26-1/2
6	30-1/2	26-1/2
7	30-1/2	26-1/2

(2) Extreme care must be taken to avoid abrasion or other damage to ignition cables while wiring the manifold.

(3) Cut wire to the proper length as given in the above table and thread each spark plug wire into its proper position in the manifold. Dow Corning No. 4 compound, stock No. 7300-223100, may be used as a lubricant to aid in installation of wires.

(4) Draw flexible spark plug conduits over each wire, making sure that the rubber grommets are installed at each end of the conduit. Attach conduits to the manifold with union nuts.

(5) Install elbows and trim about 3/8" of insulation off the end of the wire, being careful not to cut any of the conductor strands. Install terminal assembly in place with the bare conductor inserted through the small opening in the sleeve. Separate the wire strands of the conductor and space evenly. Use a small piece of tubing inserted within the contact spring to bend the wires back snugly against the terminal sleeve.

(6) Install the conduit from the manifold to the magneto and conduit gaskets and tighten union nut at manifold end. Make sure a cap is tightly installed at the threaded fitting on magneto conduit outlet elbow.

(7) Install the manifold to distributor conduit and conduit gaskets, and tighten the union nut at the manifold end. Thread the distributor high tension lead through the threaded opening in the distributor conduit elbow.

(8) For the purpose of identification the cables at the magneto block end and distributor head end can be numbered by placing markers over the cables. A light test to determine wire location should be made before markers are placed over the cables. The cables should be numbered in accordance with firing sequence, not according to the cylinder numbers. The copper ferrules installed at end of wires (See Paragraph 9, below) can be used as markers. The engine firing order is 1, 3, 5, 7, 2, 4, 6. The magneto block is marked for insertion of wires. The lead from the No. 1 cylinder spark plug should be inserted in the No. 1 hole in the magneto block and leads from Cylinders Nos. 3, 5, 7, 2, 4 and 6 should be inserted in block holes 2, 3, 4, 5, 6 and 7 respectively. The distributor head is marked only for the location of Cylinder No. 1. Location of other wires numbered in order of firing sequence is shown on the Wiring Diagram. Refer to T.O. No. 02-30AC-2.

(9) Since the wire lengths quoted in the above table are liberal, it will be necessary to shorten the wires slightly so that the wire will fit neatly into the magneto block or distributor head. After cutting the ends of the wires trim off about 1/2" of insulation and bend the wire back over the insulation. Install a copper ferrule over the end of the cable and use a crimping tool to fasten. Back out the cable fastening screws from the magneto block or distributor head and insert each ca-

ble to the bottom of its hole. Screw down each cable holding screw so that it pierces the insulation, makes good contact with the wire core and secures the cable in place. It is very important that the piercing screw makes good contact with the wire in the cable. Install the distributor high tension lead in the center hole of the distributor head.

(10) Install flexible high tension coil lead conduit with grommets at each end and fasten union nut at distributor conduit end. Strip sufficient wire so that the terminal will fit flush against the conduit grommets. Cut bare wire to 3/8" extension past the coil terminal. Bend wire strands over and use a drop of solder on end of wire to secure coil terminal.

(11) Recheck wire locations, using the electrodes in the distributor head and magneto block and spark plug terminals.

5. Oil Pump Assembly.

a. Repair.- (1) Clean the finished surfaces of the oil pump sections with crocus cloth and gasoline. Replace tachometer drive bushing leather packing. Make whatever stud replacements are necessary.

(2) Stone the teeth of the gears to remove nicks and burrs. Remove all burrs, clean the bearing surfaces of the shafts and examine the key-ways and keys. Replacement keys usually require hand-fitting for which limits are given in the Table of Limits, AN 02-30-1.

(3) If replacement of an oil pump section is necessary, the mating surfaces of the adjacent sections should be checked using Prussian Blue. Spare part oil pump sections are already hand-lapped to a surface plate. If the two sections do not mate perfectly the section that has been in service should be lightly hand-lapped on a surface plate using a lapping compound. All lapping compounds must be very thoroughly washed off, paying particular attention to corners in gear pockets and shaft sockets.

(4) When assembling the oil pump, place a coat of Namco Oiline Plastiseal, sold by New Age Manufacturing Co., Nutley, New Jersey, or equivalent, on the mating surfaces of the oil pump sections to prevent seepage of oil. The Plastiseal should be thinned with alcohol until the proper consistency is obtained. Spread a thin layer about 1/8" to 1/4" wide around the outer edge of the mating surface. The entire surface need not be covered.

b. Assembly.- (1) Slip oil pump drive shaft through pump body. Put oil pump idler shaft in place and slip idler gear over shaft. Slip intermediate plate over mounting studs, drive shaft and idler shaft. Install the oil pressure relief valve body in place, using adapter if required by particular pump assembly. (Refer to Drawing).

(2) Insert keys in drive shaft and place the rocker scavenger section idler and drive gears over shafts. Put the rocker scavenger section body in place.

(3) Insert keys in drive shaft for scavenger section drive gear. Place scavenger section idler and drive gears over shafts.

(4) Place scavenger section body over mounting studs and attach with nuts and washers. Tighten all nuts evenly to prevent distorting the parts. Do not tighten the nuts excessively. Install oil pressure relief valve ball, spring, spring guide, gasket and cap in place. One or more spacers (Refer to Drawing for part number) should be included on the spring guide as experience proves necessary to provide the proper oil pressure.

(5) Install the oil pump check valve body, using the oil pump check valve Driver (Tool No. T-835), and the spring, gasket, and cap.

(6) Check assembled pump to see that it does not bind when drive shaft is rotated by hand.

6. Rear Intermediate Bearing Plate.

a. Repair.- (1) Make whatever stud replacements are necessary. Make certain all oil passages are clean. Bushings or liners that are slightly scratched or scored should be smoothed.

b. Rear Crankshaft Ball Bearing Liner.-

(1) If the rear crankshaft ball bearing liner requires replacement, drive out the two taper pins, turn the bearing liner down to a thin shell and collapse the remainder.

(2) Remove any burrs from the bore of the casting.

(3) Check the bore in the bearing plate to determine whether it has the proper fit with a standard liner as given in the Table of Limits.

(4) If the bearing plate is worn oversize, an oversize liner should be installed. Oversize liners are furnished, .025" oversize O.D. and should be mounted on an arbor and turned to the size to give the proper fit in the bearing plate.

(5) Heat the bearing plate to 93°C (200°F) and press in the new liner. Make sure the liner is bottomed properly.

(6) Drill two No. 21 holes through the liner and bearing plate in new locations.

(7) Ream with No. 2 taper pin reamer for No. 2 Taper Pin, Part No. 446-B, and install pins.

(8) Set up the bearing plate in a lathe,

centering carefully on the pilot diameter. The liner bore should be bored to a fine finish and to the proper dimension as determined from the Table of Limits. All burrs should be carefully removed.

c. Oil Transfer Bearing.- (1) If the oil transfer bearing requires replacement, the set screw should be removed and the bearing pressed out.

(2) Clean the bore of the bearing plate and remove any burrs.

(3) Check the new bearing for proper fit in the bearing plate. Press in a new bearing so that the hole in the bearing lines up with the main oil pressure line in the bearing plate.

(4) Insert a 3/16" drill through the tappet hole for the set screw and drill 3/32" deep into the bearing. Be careful not to drill through to the inside of the bearing.

(5) Install and safety wire the set screw. The bearing plate should then be set up in a lathe and centered to the crankshaft rear ball bearing liner.

(6) The oil transfer bearing should be bored to a fine finish and to the proper diameter as determined from the Table of Limits. All burrs should be carefully removed.

d. Starter Drive, Generator Drive, Oil Pump Drive and Magneto Drive Bushings.- The various drive bushings in the rear intermediate bearing plate must have their bearing surfaces located very accurately so that gear clearances are correctly maintained. Replacement of these bushings should not be attempted unless special facilities such as the proper fixtures and tools are available. It is recommended that complete assemblies of the rear intermediate bearing plate be kept in stock and that plates which require replacement of the above bushings be returned to the factory for installation of all new bushings, including the oil transfer bearing and ball bearing liner.

e. Gears.- (1) Gears should have all nicks, burrs and other mutilations smoothed with a fine stone. All nicks, burrs and score should be removed from the bearing surfaces of gears by using a fine stone and crocus cloth.

(2) If the aluminum plug in the generator, accessory, or magneto gear is loose, it should be replaced with a new cork plug. Installation of a new aluminum plug would distort the surface of the shaft. Gears already having cork plugs should have these replaced with new corks at each overhaul, utilizing the following procedure:

(a) Clean the inside diameter of the gear shaft to remove all foreign matter and particularly any oil.

(b) Lightly shellac the cork location inside the gear shaft and allow to dry. Use shellac, Specification No. TT-V-91, type 2.

(c) Immerse cork in alcohol and press in, using cork plug driver tool No. T-6060, and allow the shellac to dry again.

f. Assembly.- (1) Install the starter gear and secure it in place with the starter gear washer, bolt and nut.

(2) Tighten and cotter pin the nut.

7. Rear Case.

a. Repair.- (1) Make whatever stud replacements are necessary.

(2) Remove nicks and burrs from casting. Special care should be taken to remove all burrs and mutilations from the various drive pad surfaces.

b. Accessory Drive Unit.- (1) Ordinarily it is not necessary to disassemble the accessory drive unit. If disassembly of the unit is required the assembly should be heated to 93°C (200°F) in an oil bath.

(2) The propeller governor drive gear and double row bearing and the vacuum pump drive gear and double row bearing (optional) can be removed.

(3) Loosen the nuts securing the adapter and drive on the splined end of the accessory drive shaft and remove the shaft.

(4) Remove the drive adapter casting from the shaft.

(5) Use Wrench (Tool No. T-756) to remove the accessory drive shaft lock-nut. The spacers and gears can then be pressed off the shaft. The parts can be assembled in reverse order to the process described above.

(6) In assembling, heating of the housing is not required for installation of double row bearings.

8. Cylinder Assembly.

a. Repair.- (1) Painting Cylinders:

(a) When it is considered desirable to repaint cylinders remove traces of former enamel as outlined in Section III of this T. O. under Paragraph 4c.

(b) Apply black, heat resisting enamel, Specification No. AN-TT-E-501. Air dry for ten minutes, and then bake for ten minutes at 104°C (220°F).

(2) Stoning Cylinder Barrels.

(a) Light or moderate scores on cylinder barrels should be removed by stoning off the roughest portion and then smoothing the surface with wet or dry paper. Any area about 3 or 4 inches wide should be smoothed to prevent the formation of a narrow channel which would be susceptible to blow-by. If the area cannot be smoothed by removing less than .0015" material, the cylinder should be replaced or bored oversize. Honing of cylinders to remove scoring is not recommended as a general practice. It is difficult to hone barrels properly

due to the choked portion at the top of the barrel. If honing is employed the cylinders should always be removed after the run-in to check their condition. Do not attempt to remove scratches entirely. The surface adjacent to the scratch should be carefully stoned so that no sharp edges are in evidence.

(3) Cylinder Barrel Grinding:

(a) If after inspection it seems advisable to grind cylinder barrel oversize the barrel should be ground to .015" oversize on the diameter.

NOTE: The barrel diameter is choked where the head is shrunk onto barrel. When regrinding, the barrel should be ground straight.

(b) It is sometimes possible to rebarrel cylinder assemblies in which the heads are in good condition. For this operation it is necessary that cylinder assemblies be returned to the manufacturer.

(4) Valve Guides:

(a) Removing Valve Guides: If after inspection it is necessary to replace valve guides, mount cylinder on Fixture (Tool No. T-2000) and remove the valve guides as follows:

1. Remove the valve guide shoulders with a 3/4" spot facer using a 7/16" pilot for the intake and a 9/16" pilot for the exhaust.

2. After shoulder of guide is removed insert a 33/64" drill in intake guide making certain that it is centralized with bore in guide and drill to within 3/8" of valve guide end.

3. Follow same procedure for exhaust valve guide using a 43/64" drill.

4. After guides are drilled, press out with a suitable drift toward the valve seat.

5. After removal of the guide, the hole in the cylinder head must be checked for damage or an out-of-round condition.

(b) Installing Valve Guides:

1. Remove all burrs from valve guide holes in cylinder head.

2. Insert exhaust valve guide in place and press in with Drift (Tool No. T-29000). Two are required for use as drift and pilot respectively, when pressing guide into cylinder head. Refer to Figure 21.

3. Insert intake valve guide in place and press in with Drift (Tool No. T-28000). Two are required as for exhaust valve guide. Refer to Figure 21.

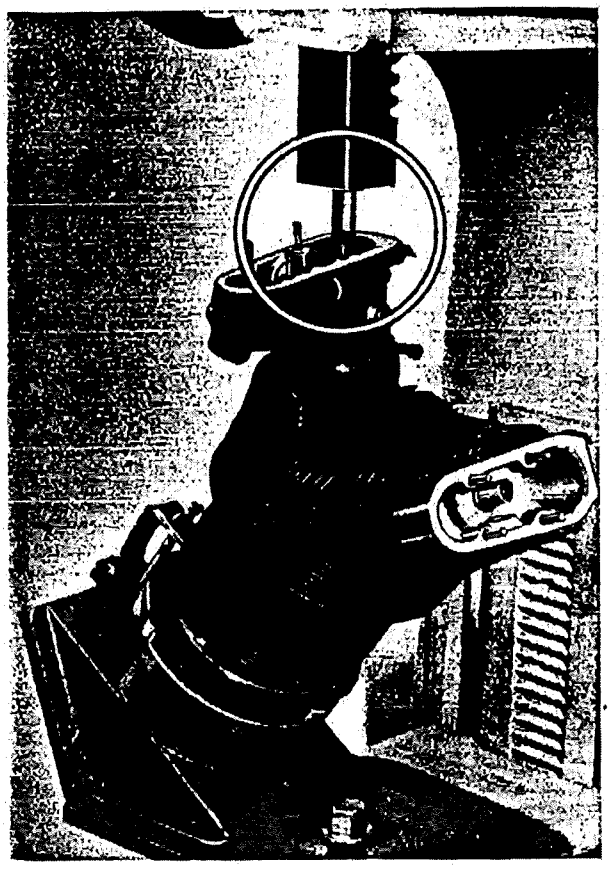


Figure 21 - Pressing in Valve Guides

4. After valve guides are pressed in place ream intake valve guide with Reamer (Tool No. T-6027), and exhaust valve guide with Reamer (Tool No. T-6028), to obtain the desired fit with the valve stem.

(c) Oversize Valve Guides:

1. If necessary to clean up the hole in the head, use a .010" oversize reamer.

2. Install .010" oversize guides, proceeding as outlined above.

(5) Replacing Spark Plug Bushings: In the event that it is necessary to replace a spark plug bushing, the following instructions will be complied with:

(a) Preliminary Instructions:

1. The cylinder assembly should be suitably mounted by clamping the cylinder barrel flange, on either a horizontal or vertical boring mill. The spark plug bushing to be re-

moved should be centered and aligned by indicating the counterbore in which the bushing is located, and the face of the bushing. It is not practical to remove the bushing by drilling but it is necessary to employ a boring tool which can be set for repeated light cuts.

(b) Removing Spark Plug Bushing:

1. Before removing spark plug bushing mark the location of the staking pin to make certain the pin will not be put back into the same hole. Bore out the spark plug bushing, with an adjustable boring head, taking several cuts until the tap drill diameter of approximately 1-1/64" is reached. This diameter must not be exceeded or the spark plug bushing thread in the head will be damaged. The spark plug bushing can then be easily removed.

(c) Inserting Spark Plug Bushing:

1. Before putting in the new spark plug bushing, clean the threads in the cylinder head by running the Spark Plug Bushing Tap (Tool No. T-6057) through by hand. Make certain there are no burrs, or rough spots in the thread, or on the face of the counterbore against which the bushing shoulder must seat. Put white lead on the threaded portion of spark plug bushing that enters the cylinder head to insure a good seal. Place two #8 pure rubber bands, Part No. 767, under the shoulder of the spark plug bushing.

2. Drive the bushing, part No. 400-A, into the head using Bushing Driver (Tool No. T-20000), MAKING CERTAIN THAT THE BUSHING IS FIRMLY SEATED AGAINST THE COUNTERBORE IN THE CYLINDER HEAD. Refer to Figure 22. It is usually unnecessary to heat the head or chill the bushing, although if the bushing is chilled, the additional clearance will facilitate proper seating of the bushing. Making certain to avoid the location of the original dowel pin hole, drill a No. 23 (.154) hole, 17/64" deep for pinning the bushing in place. To avoid cutting the rubber bands, the hole must be drilled at the extreme edge of the bushing and at an angle of 5° with the axis of the bushing. The hole will usually break through the edge of the bushing slightly. Drive pin, Part No. 450, into drilled hole making certain the pin is below the face of spark plug bushing. Peaning of the bushing to retain the pin is unnecessary and may distort the bushing shoulder. After the bushing is pinned in place re-tap spark plug threads, 18 MM., P.D. .6762/.6713 with Spark Plug Tap (Tool No. T-6059), and re-

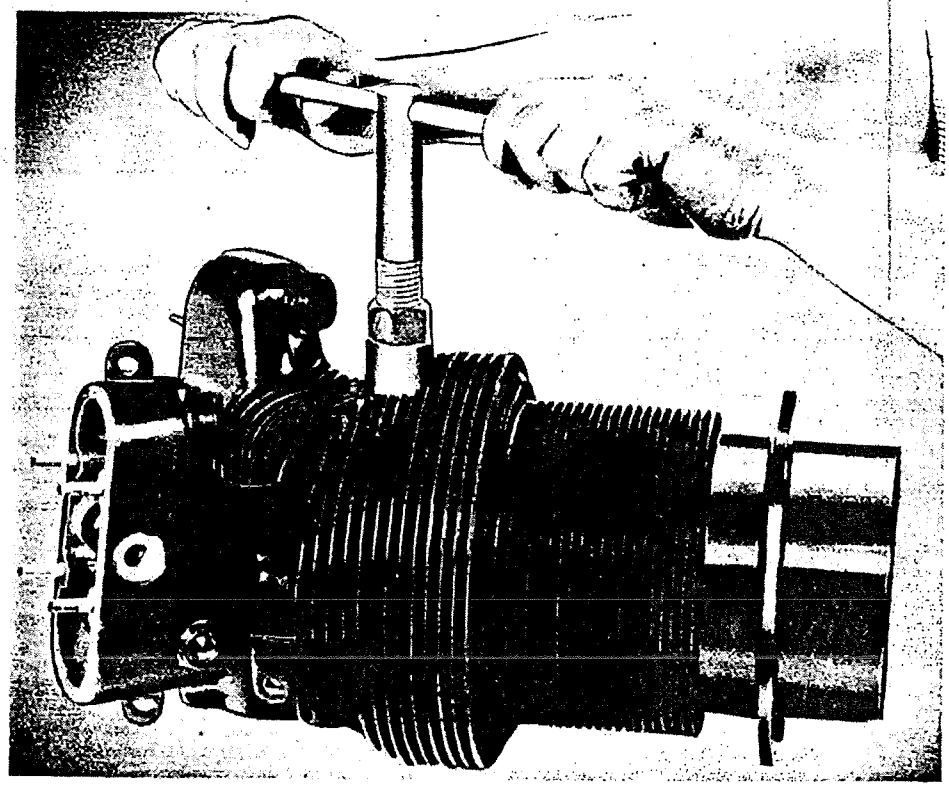


Figure 22 - Installing Spark Plug Bushing

face shoulder of spark plug bushing square with thread.

(d) Oversize Bushings:

1. In cases where the threads in the cylinder head cannot be satisfactorily cleaned up with the standard tap mentioned, the hole should be tapped to a .015" oversize pitch diameter (1.0875/1.0855), using Spark Plug Bushing Tap (+15), Tool No. T-6058. The cylinder assembly should then be heated slowly to 350 to 400° F. in an oven, and .015" oversize bushing, Part No. 400-A+15, installed. Other details of the procedure are as given above.

(6) Refacing Intake Valve Seats:

(a) Valve seats should be refaced at every normal overhaul.

(b) Remove carbon and glaze using Handle Set (Tool No. T-6052) and 45° Roughing Cutter (Tool No. T-6049).

(c) Clean up seat with 45° Finishing Cutter (Tool No. T-6050) and 30° Narrowing Reamer (Tool No. T-6051).

(7) Refacing Exhaust Valve Seats:

(a) Remove carbon and glaze using Handle Set (Tool No. T-6052) and 45° Roughing Cutter (Tool No. T-6046).

(b) Clean up seat with 45° Finishing Cutter (Tool No. T-6047) and 30° Narrowing Reamer (Tool No. T-6048).

(c) When valve seats require replacement, bore out the valve seats to a thin shell, using tool No. 6066 cutter-head for intake seat, and tool No. 6068, for exhaust seat. Collapse the shell to remove. Select replacement seat to obtain a .006" to .009" tight fit. If an oversize valve insert is required it will be necessary to take a light cut off the insert counterbore in order to obtain the specified fit. Heat the cylinder assembly to 246° to 260° C. (475° to 500° F.). Insert the valve seat firmly using tool No. 6062 and allow to cool.

(8) Refacing and Lapping Valves:

(a) At Overhaul, the faces of valves will be ground and lapped to a final seat with their mating valve seat inserts.

(b) Work will be performed as follows:

1. Remove any carbon deposit from around the valve face before attempting to reface the valve. Care must be taken not to scratch or mar the valve face during this operation.

2. Mount the valve in the chuck of a valve refacing machine set for an angle of 45°.

3. Remove only enough material to clean up the valve seat.

4. After grinding valve faces each valve will be lapped with its mating valve seat.

5. Apply a light coat of grinding compound on the seating face of the valve to be lapped, and insert the valve in its respective guide.

CAUTION: Do not allow any of the grinding compound to collect in the valve guide or on the cylinder walls.

6. Oscillate the valve back and forth with a twisting movement of the wrist, using Handle (Tool No. T-13000). This process should continue until there is a good bearing surface around the valve seat.

7. After the lapping operation, the lapped valves and their respective cylinders will be cleaned thoroughly to remove all traces of grinding compound.

(9) Replacement of Rocker Arm Bearings:

(a) If it is found necessary to replace the rocker arm bearing, proceed as follows:

1. Remove bearing by placing rocker arm on Support (Tool No. T-6037).

2. Insert Drift (Tool No. T-6037) in place and press bearing out using arbor press. Refer to Figure 23.

3. Press new bearing into place in similar manner with bearing entering chamfered side of bearing bore first.

b. Assembly.- (1) The following parts will be installed as specified.

(a) Valves: 1. Clean and oil valve guide and stems.

2. Insert valve stems in guides.

3. Place a block in the cylinder to prevent the valves from falling.

(b) Rocker Arms and Valve Springs:

1. Insert valve spring lower washers over the valve stem guides.

2. Insert inner and outer valve springs over the lower washers. Make certain springs are properly seated on washer.

3. Place upper valve spring washers over valves and onto springs. Make certain washers are properly seated on springs.

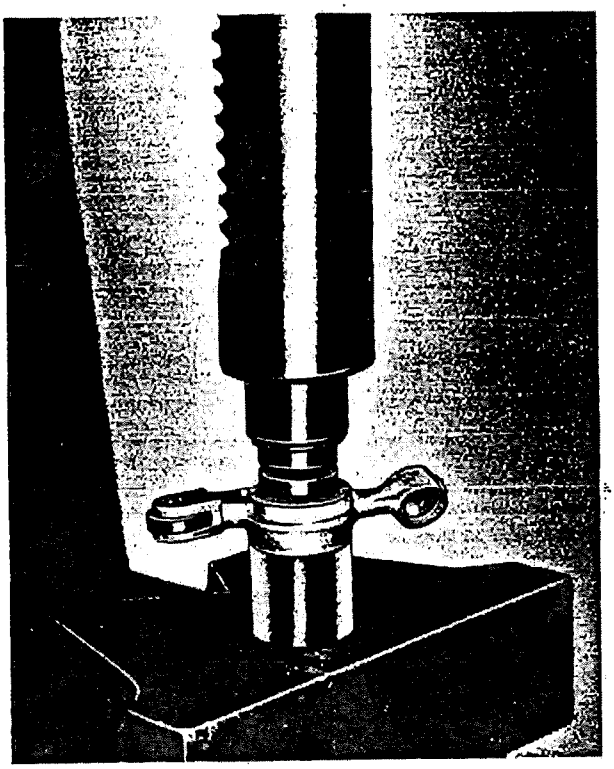


Figure 23 - Installing Rocker Arm Bearing

4. Place Valve Spring Compressor (Tool No. T-409-10) in place and compress valve springs.

9. Pistons, Piston Rings and Piston Pins.

a. Repair.- (1) Old piston rings should be removed from piston and replaced with new rings at each overhaul. Stone the piston skirt to smooth scores and scratches. Remove any carbon, nicks or burrs from the piston ring grooves.

(2) If it is found necessary to replace an old piston with a new one, it is important that the new piston be within .04 lbs. of the weight of the old one. The weight of the piston will be found stamped on the top of the piston.

(3) New piston pin plugs must be installed in each piston pin where looseness or excessive wear is apparent. Replacement Plug, Part No. 713-CS, must be fitted as follows:

(a) Measure the diameter of each piston pin hole to which a new plug must be fitted.

(b) Turn down each plug on the outside diameter to obtain .000" to .001" tight fit in the individual pin hole.

(c) Measure the depth of the ground hole in the pin. If the current type piston pin is not in use it may be necessary to cut off the end of the plug to a shorter length to prevent the plug from bottoming.

(d) Place plugs in dry ice (solid carbon dioxide CO_2) before installing or heat the pin in oil at a temperature of 350° to 375° F.

NOTE: If the oil method of heating is used, care must be exercised to remove all the oil within the pins before the installation of the new plug.

b. Assembly.- (1) When installing new rings at overhaul, it is important that the side and end clearances be within the Table of Limits.

(2) Check end clearance with Gage (Tool No. T-9000). Refer to Figure 24. Oversize rings should be checked for end clearance using an oversize cylinder barrel.

(3) Check side clearance. Refer to Figure 25.

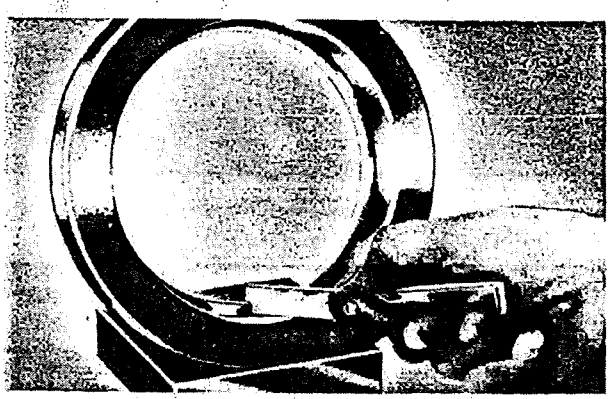


Figure 24 - Checking End Clearance of Piston Ring

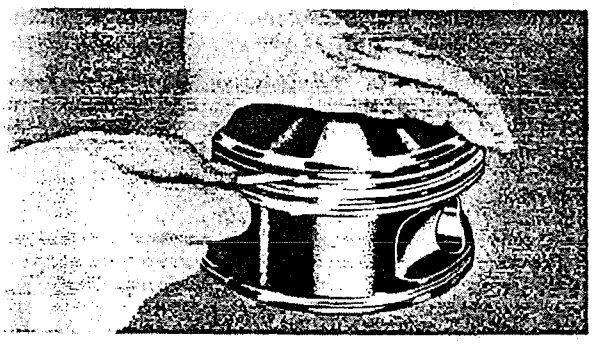


Figure 25 - Checking Side Clearance of Piston Ring

(4) Make certain that all piston rings are installed in their proper ring grooves in the piston, and are placed "TOP" up (toward the piston crown).

(5) Precaution must be taken not to expand the piston rings any more than necessary when assembling them in the grooves.

c. Oversize Pistons and Rings.- (1) Where it is necessary to grind the barrel .015" oversize, it is important that the same desired clearance be maintained between the piston and barrel as with standard size piston.

(2) Pistons and rings are available at .015" oversize on the diameter.

10. Crankcase Assembly - Main.

a. Repair.-

(1) Replacement of Main Bearing Liners:

If replacement of a main bearing liner is necessary, the following procedure should be followed:

(a) First drive out the two taper pins securing the liner. Make two hack saw cuts on opposite sides of the liner. The cuts should be made so that only a thin section of the liner remains. Use care not to cut into the crankcase. The liner can then be tapped out with a drift.

(b) The bore in the crankcase should then be checked for size and out-of-round. If a standard liner does not produce the desired fit with the crankcase as listed in the Table of Limits, an oversize liner should be used. Oversize liners are furnished .025" oversize and should be mounted on an arbor and turned to the size to give the proper fit in the case.

b. Assembly.

(1) Heat the case to 200° F. and install the liner. Drill and taper ream new holes through the liner and case, and drive two new taper pins. The front and rear halves of the main crankcases should be assembled before boring the liner.

(2) Set the assembled case up on a vertical lathe or boring mill and index the case so that the front and rear pilot diameters are in exact alignment. Bore out the liner to a fine finish and to the proper dimensions as determined from the Table of Limits.

11. Front Case.

a. Repair.-

(1) Removal of the tappet guides at overhaul is unnecessary unless unusual wear or looseness is noted, in which case proceed as follows:

(a) To remove the tappet guides break lock wire on fillister head screws attaching guides to the front case and remove screws.

(b) Stand the case on end and place the

Support (Tool No.T-6040) over the tappet guide to be removed.

(c) Place the Socket (Tool No. T-6039) in the slotted end of the tappet guide inside the case.

(d) Place the Drift (Tool No. T-6038) through the tappet guide opposite the one to be removed.

(e) Place case assembly on base of arbor press.

(f) The tappet guide to be removed should line up with the arbor of the press so that case will not tilt when applying pressure. Refer to Figure 26.

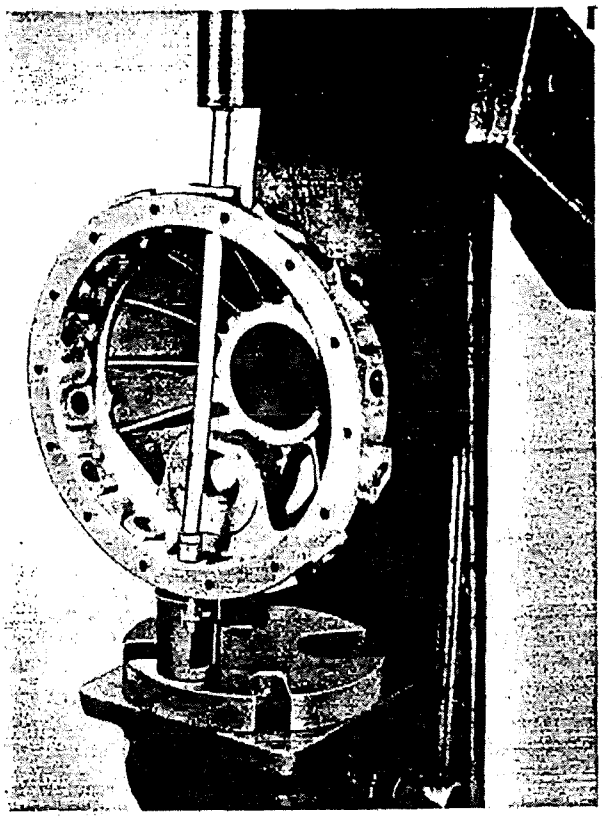


Figure 26 - Removing Tappet Guides

(2) The cast-in oil tube and the oil passages to the tappet guides should be thoroughly cleaned.

(3) Stone teeth of cam pinion and cam drive gear if necessary. If it is found necessary to remove cam drive pinion or cam drive gear, Refer to Section II. Remove any burrs, nicks or ring tracks from the propeller oil seal sleeve by stoning.

(4) If replacement of the thrust bearing liner is necessary, drive out the taper pins and bore the liner out to a thin shell and collapse the liner. If a standard liner does not produce the desired fit in the case, an oversize liner should be installed in the same manner as described under Paragraph 11, above, covering the main crankcase. The front section should be set up in a vertical lathe and carefully indexed so that the bearing liner is in exact alignment with the rear pilot diameter. The thrust bearing liner should then be bored, smooth to the required diameter.

(5) Outer Oil Seal Sleeve: Removal of the Outer Oil Seal Sleeve at overhaul is unnecessary, unless unusual wear of .010" maximum depth by the Oil Seal Rings is noted, in which case proceed as follows:

(a) Remove safety wire and attaching nuts. Heat case to 200° to 250° F. and tap out with a suitable drift.

b. Assembly.-

(1) Tappet Guides: When it is necessary to install a new tappet guide it should be done as outlined in the following paragraphs:

(a) Place front case on Fixture (Tool No. T-10000).

(b) Insert Tappet Guide Aligning Post (Tool No.T-31002) in proper location on front case.

(c) Insert Tappet Guide in position with aligning post.

(d) Attach Centering Clamp (Tool No. T-31001) to Drift (Tool No. T-6022) for inserting L-4 intake guides and to Drift (Tool No. T-6023) for exhaust guides. It is necessary to use the proper drift so that the shoulder angle of the Drift will properly fit the angle of tappet guide end.

NOTE: If many tappet guides are to be installed, it is suggested that the centering clamp be left installed on the Drift to avoid repeating the centering operation. To do this it will be necessary to provide a centering clamp for each Drift. Tighten centering clamp with hole of centering clamp above the aligning post.

(e) Press in tappet guides on an arbor press. Refer to Figure 27.

(f) When replacing tappet guides the roller slots must be lined up by means of Aligning Plate (Tool No. T-644-5). Refer to Figure 28. Install fillister head screws and lock wire.

(g) After tappet guides are pressed in, attach Collar (Tool No. T-644-E) to slotted end of tappet guide and ream to proper size with Reamer (Tool No. T-6043). Refer to Figure 29.

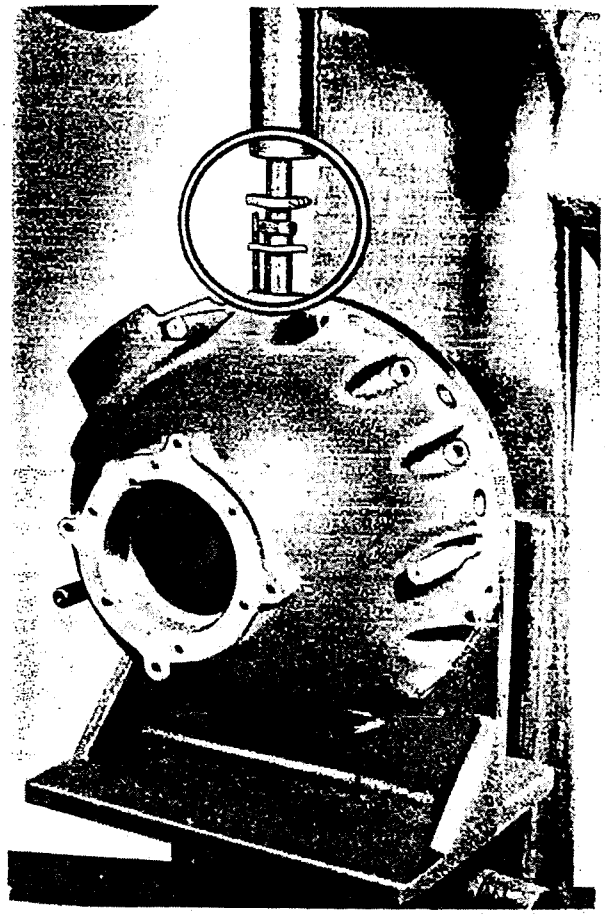


Figure 27 - Installing Tappet Guide

(h) Any studs on the cam drive pinion boss which interfere with the reaming operation can be removed before reaming and removed studs replaced by a .003" oversize stud if necessary.

(i) Use Gage, Tappet Guide "Go" (Tool No. T-6044), and Gage, Tappet Guide "No Go" (Tool No. T-6045) to check the size of the reamed hole.

(2) Cam Drive Pinion Assembly: If the cam drive pinion and cam drive gear have been removed, use the following procedure to reassemble them:

(a) If the propeller oil seal outer sleeve also requires replacement, the cam drive pinion and gear should, for convenience, be reinstalled first.

(b) Install the two bearings and the spacer on the cam pinion shaft. A press is usually required to install the two bearings.

(c) Place pinion gear in a soft-jawed vise.

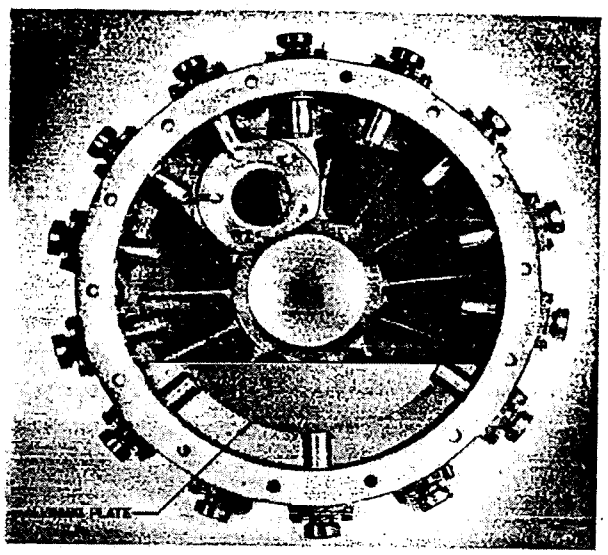


Figure 28 - Checking Alignment of Tappet Guides

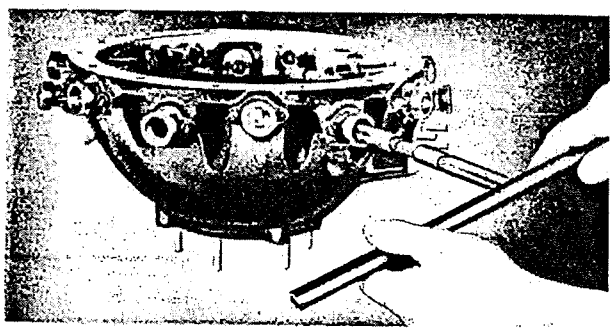


Figure 29 - Reaming Tappet Guides

(d) Install the lock washer and tighten lock-nut. Do not tighten the lock-nut excessively as this will cause the bearings to bind. Secure the nut with the tangs of the lock washer.

(e) Install the key. If a new key is required at this location, it should be very carefully fitted to the required limits.

(f) Check the cam drive gear and nut for proper fit with the key and shaft, before placing the shaft assembly in the case.

(g) Heat the case to 200° F. to 250° F.

(h) Put the gear in position under the cam drive pinion boss and drop the shaft in boss. The pinion assembly should enter the boss without driving.

(i) Install the clamp washer and tighten the nuts holding the clamp washer in place.

(j) Install the 8 - 1/2" special lockwire, part No. 979. Make

sure the gear is properly in place on the key and shaft.

(k) Block the gear with a copper block and tighten the castellated nut with an end wrench.

l. Cotter pin the nut, taking special care to bend the prongs of the cotter firmly back to prevent the cotter from shaking.

(3) Outer Oil Seal Sleeve:

(a) Check the propeller oil seal outer sleeve for the proper fit in the nose case.

(b) Heat the case to 200° to 250° F. and install the sleeve.

(c) Install the attaching nuts and safety wire.

12. Crankshaft.

a. Repair.-

(1) Light scratches and any gall marks on the crankpin and shaft should be removed with crocus cloth or wet and dry paper, first stoning lightly if necessary.

(2) The clamping area on the crankpin should not be stoned more than is absolutely necessary as reduction of the pin diameter or irregularities in its surface will produce a poorer clamping action.

(3) The inside of the crankshaft and oil passages must be thoroughly cleaned.

(4) Since removable threaded plugs are provided, it is usually unnecessary to remove any of the plugs permanently pressed in.

(5) In shafts fitted for use with the Hoover type propeller the oil passage between the two front plugs and outside the inserted tube, should be flushed without removing either plug.

(6) In the event the plugs pressed in either half of the crankshaft are found to have moved or are loose, they must be replaced. All the pressed in crankshaft plugs are available in +25 oversize on the diameter. When replacing a plug with an oversize plug it must be hand fitted to the clearances specified in the Table of Limits, T. O. No. 02-30-1.

(7) After plugs are fitted and pressed in carefully check the O. D. of the crankshaft at the plug location. If there is a slight bulge due to pressing in the plug the O. D. of the crankshaft must be stoned down to its true diameter.

(8) If the threaded plugs were staked in place, it usually is necessary to remove burrs left from drilling the stake hole or removing the plug.

(9) The threads in the crankshaft can be cleaned by using the Front Crankshaft Plug Tap (Tool No. T-6071) and the Rear Crankshaft Plug Tap (Tool No. T-6072). Take care to turn the tap only to the end of the original thread.

NOTE: It is recommended that the old method of locking plugs by staking be converted to locking the plugs with a lock, lockscrew and safety wire. This can be done at overhaul by drilling a 3/16" hole, 7/16" deep (Body Diameter), and tapping 1/4-28 thread, NF3, P. D. .2240/.2268, 5/16" deep, on center line of throw on the counterweight side, 1-5/32" from shaft axis on front half and 1-9/32" from shaft axis on rear half.

b. Assembly.-

(1) Insert plugs in front and rear shafts and tighten with Wrenches (Tool Nos. T-345 and T-345-B, respectively).

(2) After plugs are tightened place lock in slot of plug and attach to crankshaft with lockscrew.

(3) When lock is tightened safety wire screw to the lock.

(4) Assemble the crankpin plug, crankpin bolt, and castle nut. Check the crankpin plug to make sure it is properly seated.

(5) Install the gasketed plug in the front end of the crankshaft.

13. Master and Link Rod Assembly.

a. Repair.-

(1) General: (a) Check to make sure that all oil passages in the master rod are open.

(b) Carefully remove by stoning, any burrs or gall marks in the knuckle pin holes of the master rod.

(c) Knuckle pins should also have all scores and burrs removed by light stoning.

(d) Stoning of knuckle pins and holes should be kept to a minimum so as not to destroy the fit of the pin in the master rod.

(e) The surface of the master rod bearing should not be disturbed more than is absolutely necessary. A fine stone or crocus cloth may be used where required.

CAUTION: Under no circumstances should the bearing be scraped or burnished.

(2) If it is found necessary to replace master rod bearing, proceed as follows:

(a) General:

1. Replacement and reboring of the master rod bearing is normally a factory operation. If proper facilities are available the instructions below should be followed:

a. Removing Master Rod Bearing:

(1) Remove lock plate, screws and safety wire, and suitably mount the master rod on a boring mill or milling machine, in position to cut from the side where the lock plate was removed. The bearing to be removed should be centered and aligned by indicating the inside of the bearing. It is necessary to employ a boring tool which can be set for repeated light cuts.

(2) Bore out the bearing, taking care not to cut into the dowel pin, and bore to within 7/16" of the opposite end of bearing. Take several cuts until the dowel pin is reached. The pin can then be easily removed. Continue with several cuts until a 2-5/8" diameter is reached. This diameter must not be exceeded or the bore of the master rod is likely to be damaged. After the 2-5/8" diameter is reached press out the bearing with a suitable drift.

b. Installing Master Rod Bearing:

(1) Before putting in the new master rod bearing remove any burrs or sharp edges in the bore of the master rod. Place a clean new master rod bearing in dry ice and let stand for one-half hour. Mark the center line of the master rod on the end of the rod hub.

(2) Place the master rod in Base (Tool No.T-367) for insertion of the bearing. The chamfer in the end of the bearing must face toward the lock plate end of the master rod. Use a flat disc pusher piloted in the bearing and press the bearing completely into master rod with an arbor press. While pressing make certain the scribed line along the outside diameter of the bearing coincides with the master rod center line marked on the rod hub. If lines do not coincide when pressing bearing in master rod the oil passages in the bearing will not match with the oil passages in the master rod. If it is noticed that the lines do not coincide, immediately remove master rod and bearing from arbor press and clamp bearing between two pushers vise and tap master rod gently until the lines do coincide. Refer to Figure 30.

(3) After master rod bearing is pressed in place the dowel pin hole should be drilled 11/64" diameter and reamed to 3/16" diameter, 51/64" deep. Hole can be spotted from oil hole. The dowel should be a tap fit in the hole. After hole is drilled drive dowel pin in place. After pin is in place the inside diameter of the master rod bearing must be carefully bored to a smooth finish at the required diameter. The inside diameter of the bearing should be concentric with and parallel to the hub ends of the master rod. Check the master rod bearing and piston pin bushing for alignment. The parallelism between the piston pin hole and master rod in the plane of the axis of the two bushings should be within .002" full indicator reading measured at 4-1/4" spacing (2-1/8" each side of the rod axis). The twist about the rod axis should not exceed .010" full indicator reading measured at 5" spacing (2-1/2" each side of rod axis).

(4) Insert lock plate, lock screws and safety wire the screws.

b. Assembly.-

(1) Place master rod on Base (Tool No. T-367) with lock plate down against the plate.

(2) Coat outside diameter of knuckle pin with oil. Place knuckle pin on Pilot (Tool No. T-6061-1) with oil groove end uppermost.

(3) Align knuckle pin and pilot with Collar (Tool No. T-6061-2) and Screw Guide (Tool No. T-6061-3) into pilot finger tight.

(4) Insert link rod in place in master rod.

CAUTION: L-4 series link rods are unsymmetrical at the piston pin end and must be installed in master rod with trademark "LYNITE" or word "FRONT" (in channel of rod) toward the lock plate end of the master rod.

(5) Remove collar and insert guide into knuckle pin hole of master rod and link rod.

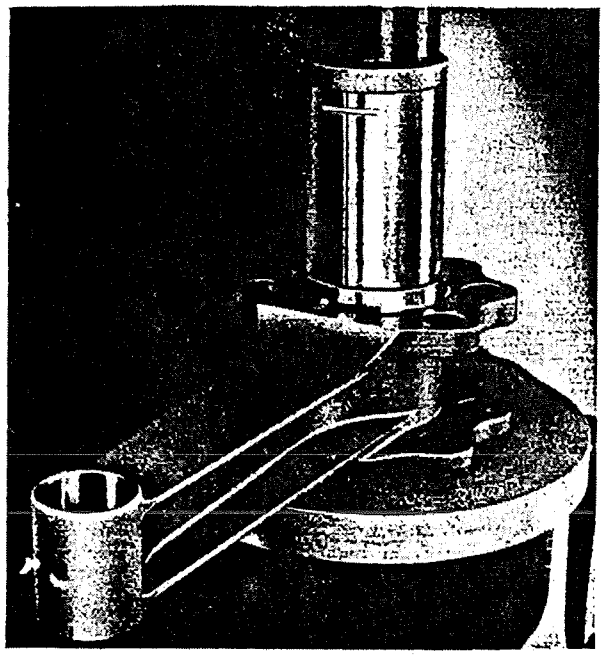


Figure 30 - Replacing Master Rod Bearing

(6) Place Wedge (Tool No.T-367-1) between master rod flanges near the knuckle pin being pressed in. This is to prevent distortion of the master rod.

(7) Turn knuckle pin with central oil holes radially outward toward the link rod and press in with the arbor press. Refer to Figure 31.

(8) Continue above procedure until all knuckle pins are pressed in.

(9) Assemble knuckle pin bolt washers, bolts and nuts. Do not tighten the knuckle pin nuts excessively.

(10) After the nut is tightened, insert with the heads radially outward toward the link rod and carefully secure the cotter pins in a manner which will not permit them to shake in their holes.

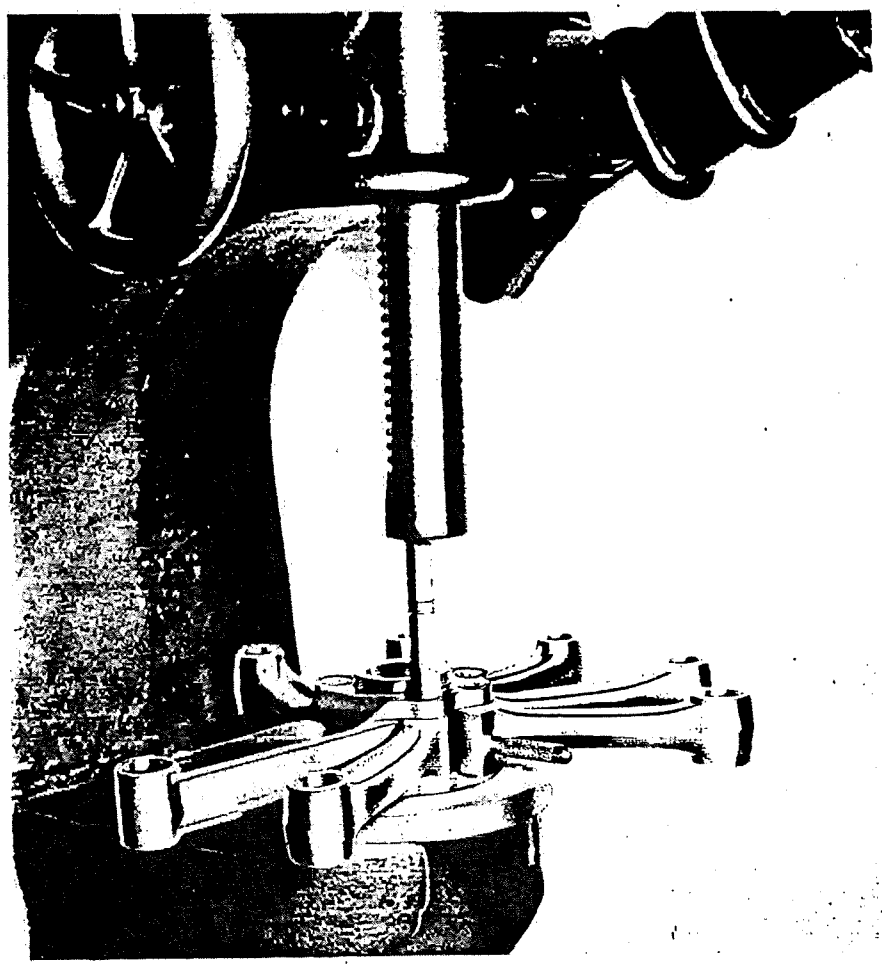


Figure 31 - Installing Knuckle Pins.

SECTION VI
FINAL ASSEMBLY AND TESTING

General.

a. After the sub-assemblies and accessories have been cleaned, inspected, repaired and reassembled as described in the previous Sections, final assembly of the engine can be started.

NOTE: Any steel component parts or assemblies included in final assembly of the engine, which have not yet been treated with a heavy coating of corrosion preventive mixture as directed in section V, paragraph 3.c., will be so treated before final assembly. This mixture consists of one part engine corrosion preventive compound, Specification No. AN-VV-C-576, to three parts lubricating oil, grade 1120, Specification No. AN-VV-O-446. The practice of using plain lubricating oil during assembly will be discontinued.

b. The instructions in this section are written with the assumption that new gaskets, packing, hose and leather or rubber seals should be installed where they are required, replacing those which were removed at disassembly. All mating gears, shafts and bearings will be adequately oiled prior to installation. All safety wiring, hose clamps and cotter pins will be installed where necessary, following the final assembly of each part.

2. Crankcase - Main-Rear.

With the overhaul stand mounting plate in the horizontal position, mount the crankcase-main-rear on the overhaul stand. Secure to the overhaul stand using washers under the nuts to prevent damaging the mounting lugs.

3. Crankshaft-Rear.

a. Place rear half crankshaft vertically in a smooth jawed vise and tighten vise until the crankshaft is firmly held. Care should be taken that crankshaft is not marred by the vise jaws.

b. Place inner race of rear main bearing over crankshaft and drive onto bearing seat using Driver (Tool No. T-24000) and Adapter for the particular make of bearing being installed. (Refer to T. O. No. 02-30-3) for Tool No. T-23000-2, -3, or -4). Refer to Figure 32. Make certain that bearing race is firmly seated. Assemble rollers, cage, outer race and retainer in place, and then place lock washer against inner race of bearing. Make certain that the retainer is properly centered on the bearing.

c. Put lock-nut in place and tighten with Wrench (Tool No. T-359), and at the same time hold lock washer in place with Clamp (Tool No. T-358-B) until nut is tightened.

d. After lock-nut is tightened remove clamp and bend tabs of lock washer into slots of lock-nut. All tabs of the lock washer should be bent tight against the lock-nut.

e. With the overhaul stand rotated to put mounting plate in vertical position, place crankshaft rear into rear main crankcase.

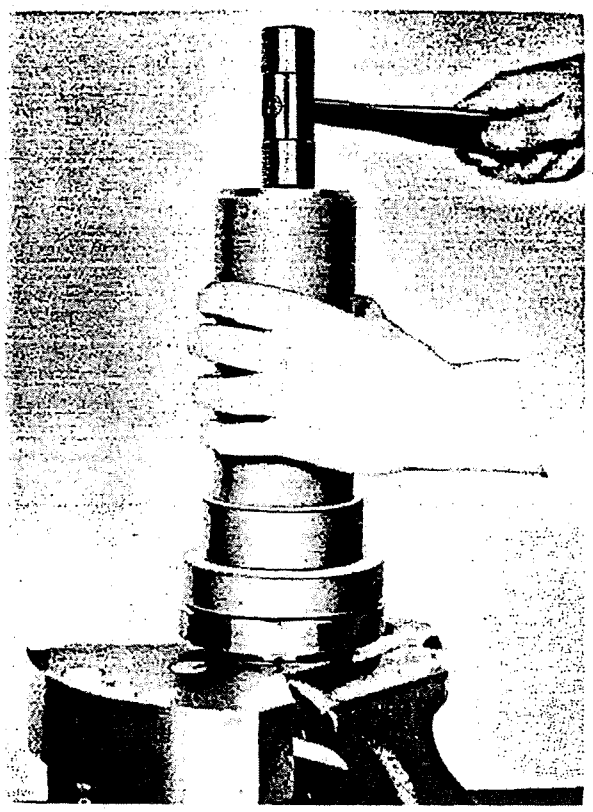


Figure 32 - Installing Rear Main Roller Bearing

4. Intermediate Bearing Plate, Cluster Gear

a. Place intermediate bearing plate in position and tap lightly using a mallet to insure proper seating in crankcase.

b. Place bearing plate attaching nuts and lock washers onto studs and tighten.

c. Drive crankshaft rear bearing on crankshaft with Driver (Tool No. T-6076) and adapter (Tool No. T-6076-4). While driving bearing onto crankshaft support crankshaft, if necessary.

d. Insert crankshaft cluster gear keys in key-ways on crankshaft (Refer to Table of Limits if a new key is to be fitted) and drive magneto drive gear onto crankshaft with Driver (Tool No. T-6076).

e. Insert oil pump drive gear and magneto drive gear into intermediate bearing plate.

f. Install crankshaft cluster gear on crankshaft with Driver (Tool No. T-6076), making certain the gear is firmly seated.

g. Place crankshaft cluster gear lock-nut washer over shaft against face of cluster gear. Screw cluster gear lock-nut on shaft and tighten with Wrench (Tool No. T-363). After lock-nut is properly tightened bend tabs of lock washer onto slots of lock-nut.

5. Generator Drive Gear, Rear Case.

a. Place generator gear with ball bearing assembled, in rear case and tap generator gear until bearing is properly seated in position.

b. Place rear case assembly into position and make certain gears are properly meshed before tightening case. This can be done by rocking the crankshaft back and forth while moving the rear case assembly into place.

c. Install the generator gear and magneto drive gear oil seals using Guide (Tool No. T-607-1) and Driver (Tool No. T-607-2), for each. Refer to Figure 33.

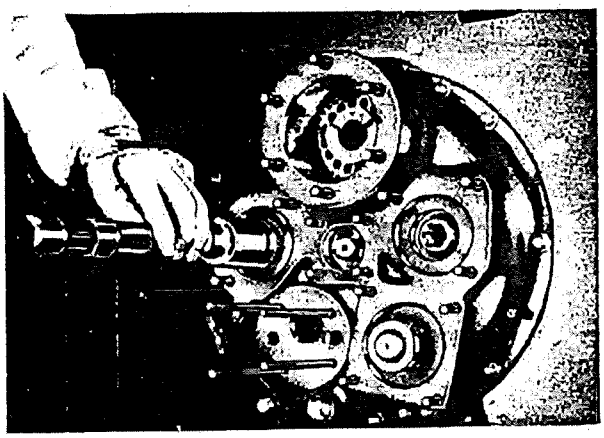


Figure 33 - Installing Generator and Magneto Drive Gear Oil Seals

6. Crankshaft-Front, Master and Link Rod Assembly.

a. Turn engine stand with crankshaft in a vertical position.

b. Wipe crankpin and crankpin hole in rear half crankshaft with carbon tetrachloride to remove any oil or grease that may be on the shaft. THESE SURFACES MUST BE KEPT CLEAN UNTIL ASSEMBLED AND CLAMPED TIGHT.

c. Spread slot in rear crankshaft with Wedge (Tool No. T-18000) just enough to permit crankpin to enter rear half of crankshaft freely. Refer to Figure 34.

d. Wipe master rod bearing clean of oil. Place master and link rod assembly over hole in rear half of crankshaft, WITH LOCK PLATE ON MASTER ROD UPPERMOST. Very carefully put front half of crankshaft in place, through

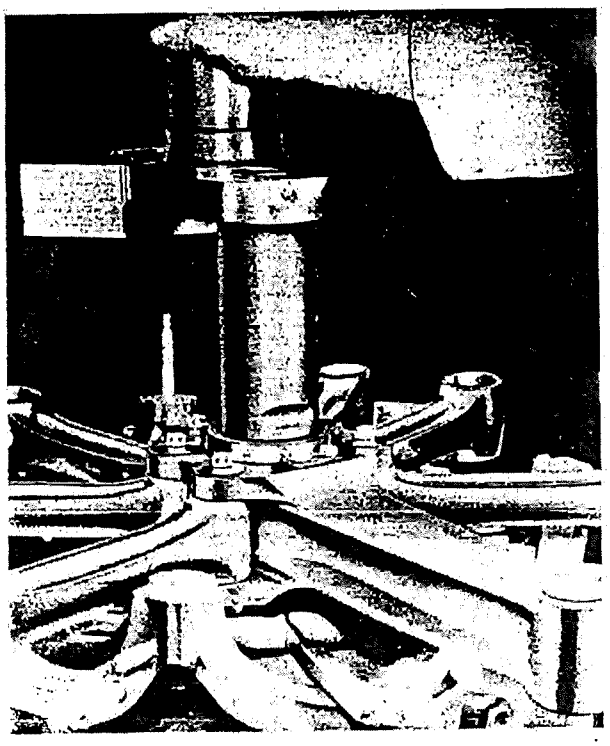


Figure 34 - Installing Front Half Crankshaft

master rod and crankpin hole.

e. Place the proper feeler gage between master rod and front cheek of crankshaft to insure the required end clearance between master rod and crankpin specified in Table of Limits.

f. Insert Aligning Bar (Tool No. T-6056) through aligning holes in both counterweights. Then remove wedge holding clamp hole open.

g. Measure length of crankshaft clamp bolt with a micrometer, and then push clamp bolt in with a suitable drift.

CAUTION: To maintain the best crankshaft balance the bolt should be inserted from right to left as the mechanic faces the vertical shaft with crankpin nearest him, counterweights opposite. The cotter hole should be parallel to the crankshaft axis.

h. After clamp bolt is in place, lubricate threads and face of clamp bolt nut lightly with "Bestolife" Lead Seal No. 270 (I. H. Grancell Co., Los Angeles, California), or equivalent, then place clamp bolt nut on clamp bolt.

CAUTION: Before tightening clamp bolt the alignment of crankshaft must be rechecked by making sure that the aligning bar will enter both counterweights without binding. To avoid binding, THE ALIGNING BAR MUST BE WITHDRAWN

FROM THE LOWER COUNTERWEIGHT BEFORE ACTUALLY TIGHTENING THE BOLT.

i. Tighten the clamp bolt, using Wrench (Tool No. T-344) to turn the nut while the bolt is held by a box-socket end wrench. Refer to Figure 35. The Part No. 30100, or No. 30099 bolt must be tightened until it is stretched to .012" minimum (or next cotter pin slot) as determined by again measuring with a micrometer. (Note that the Part No. 342-C bolts in L-4 series engines must be stretched to only .008" or the next cotter slot). CARE SHOULD BE EXERCISED TO MEASURE THIS STRETCH ACCURATELY.

j. After bolt has been measured and proper stretch has been obtained, centerpunch bolt and nut to indicate relative position of nut on bolt so that bolt can be brought back to the proper stretch by lining up the punch marks in the event that nut has to be loosened.

k. Check the alignment of shaft again and if aligning bar cannot be easily entered into aligning holes of the crankshaft this indicates the crankshaft is not in proper alignment. If it is found that the crankshaft is not in proper alignment the clamp bolt must be loosened and the alignment procedure repeated. THE FEELER GAGE DETERMINING THE BEARING END CLEARANCE MUST REMAIN IN PLACE UNTIL THE CLAMP BOLT IS FINALLY TIGHTENED.

l. After the crankshaft is properly aligned and the clamp bolt is properly stretched, place cotter pin through clamp bolt and bend ends firmly back making sure that the cotter pin is not free to shake in its hole.

m. Remove oil hole protecting masks from crankshaft and wipe crankshaft clean.

7. Crankcase-Front.

a. Place front half main crankcase over the shaft without tightening in place.

b. Place inner race of front main roller bearing on crankshaft and drive onto its seat with Driver (Tool No.T-23000) and Adapter for the particular make of bearing being installed. (Refer to T.O.No.02-30-3 for Tool No.T-23000-2, -3, or -4). Refer to Figure 36.

c. Place the outer race, rollers, etc., of main roller bearing into the crankcase and make certain the bearing rollers clear the inner race. After bearing rollers are lined up, tap outer race of bearing lightly with mallet until bearing is properly seated.

d. Tap crankcase through bolts into place and tighten. In tightening crankcase bolts first draw up bolts snugly all around so that case is evenly drawn together, and then tighten with the proper torque specified in Table of Limits.

8. Check Runout of Crankshaft.

a. Wipe crankshaft off with dry cloth to remove any grease or dirt.

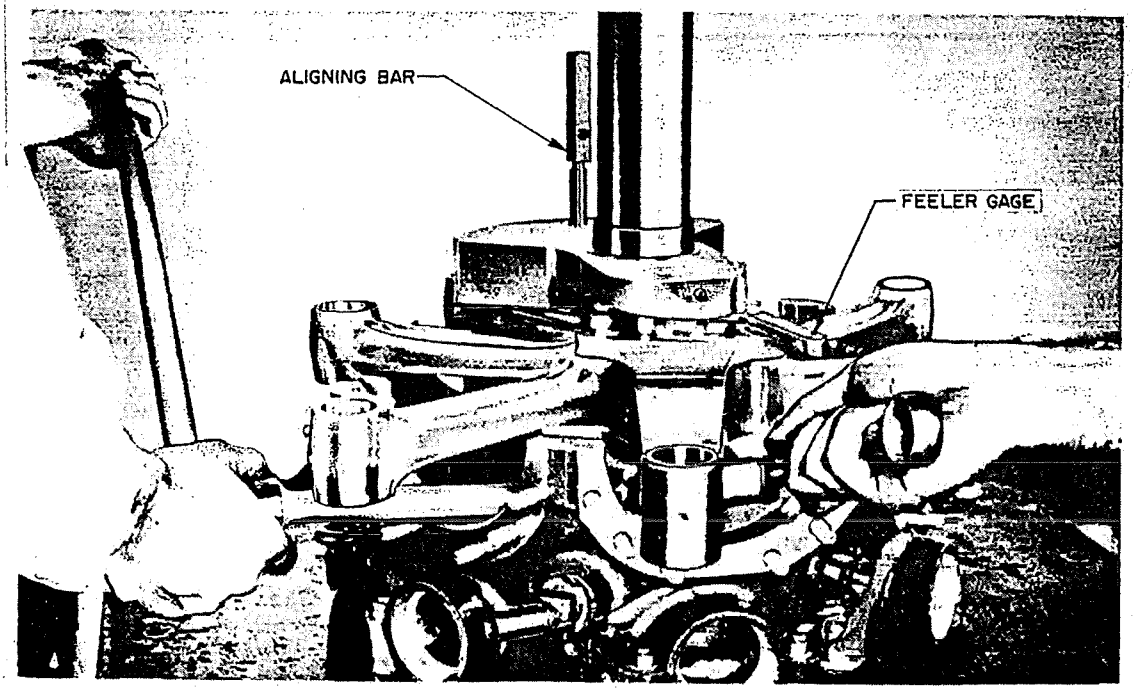


Figure 35 - Tightening Crankshaft Clamp Bolt.

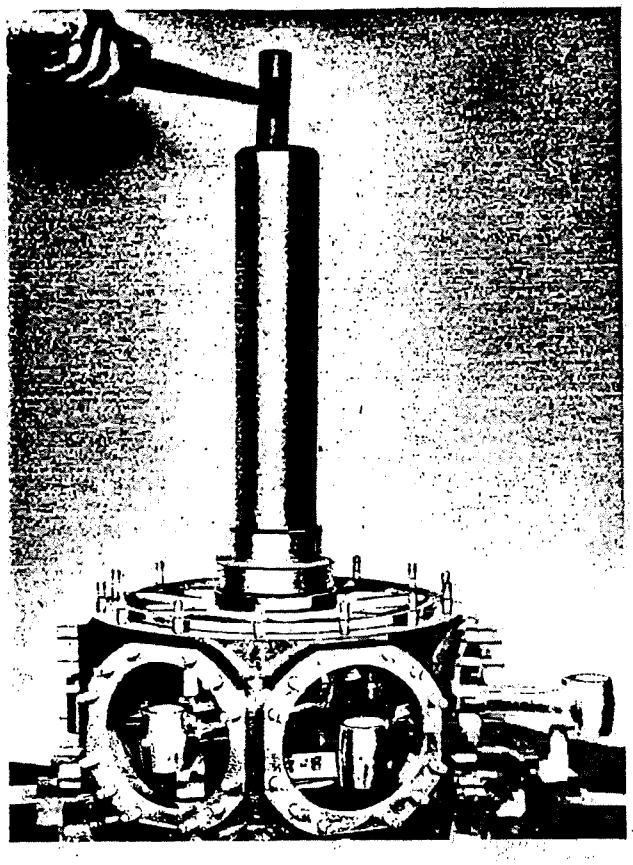


Figure 36 - Installing Front Main Roller Bearing

b. Mount crankshaft Aligning Indicator (Tool No. T-6011) onto a stud in the front crankcase and check the runout of the crankshaft with dial indicator. The total runout must not exceed .0025", measured approximately 2" behind the thrust nut thread. Refer to Figure 37.

NOTE: If the total dial indicator reading is more than .0025" place the aligning bar through the aligning holes of the crankshaft to make certain that the shafts did not twist in tightening the clamp bolt. If the aligning bar enters the aligning holes easily and without binding, the shafts are in alignment. If this check shows the shaft to be not properly aligned, it should be removed from the engine and checked for straightness.

9. Cam Assembly, Timing Gear Spacer, Timing Gear.

a. Coat the crankshaft with white lead in oil, or equivalent, to prevent scratches which might occur due to assembling two dry surfaces together.

b. Place cam bearing and cam assembly on crankshaft.

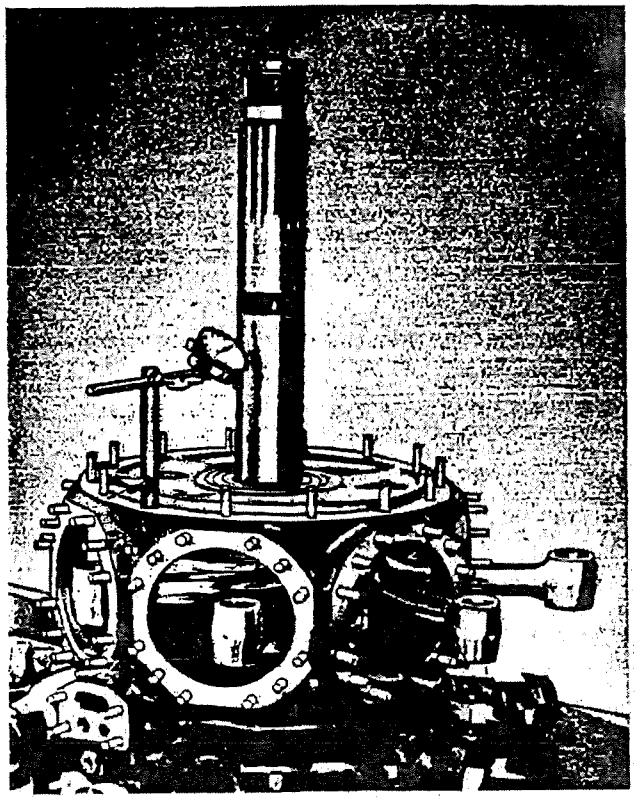


Figure 37 - Checking Crankshaft Runout

CAUTION: Before placing cam bearing on crankshaft make certain that the retainer plate of the front main roller bearing is properly seated and flush against bearing. The plate may be greased lightly to hold it in place. If this is not done the plate may break when driving on timing gear.

c. Insert timing gear key in crankshaft (Refer to Table of Limits if a new key is to be fitted) and then place timing gear on crankshaft, tapping gear lightly to insure proper seating on key.

d. Turn engine stand to crankshaft horizontal position.

10. Oil Pump Assembly.

a. Place oil pump assembly on mounting studs and turn crankshaft until pump shaft can be properly entered in oil pump drive gear.

b. Place washers and nuts on mounting studs and tighten oil pump assembly rear case.

11. Carburetor.

a. Place carburetor on mounting studs and attach, using one special washer with a lockwire hole on a stud nearest fuel-air mixture thermometer plug, and lockwire washer and plug.

12. Priming Crankshaft With Oil.

a. Turn engine stand so that the crankshaft is in the vertical position with the rear case facing up.

b. Since the crankshaft is assembled dry it is necessary to prime the crankshaft with oil to prevent wear on parts while timing the engine.

c. Approximately 1-1/2 pints of SAE No. 30 Lubricating Oil is forced through the oil pressure connection by means of a Zerk Gun adapted to a 1/4" pipe fitting. Oil is added until the oil flows out of the master rod bearing at both ends.

d. The crankshaft shall be turned so that film of oil is spread evenly between the crankpin and master rod bearing.

e. Remove the Zerk Gun and turn the engine so that the crankshaft is up, vertical.

f. Fill oil gun barrel with engine oil and force into the system. Repeat this until oil flows freely from ends of master rod bearing.

g. Rotate crankshaft to distribute oil in master rod bearing assembly. Refer to Figure 38.

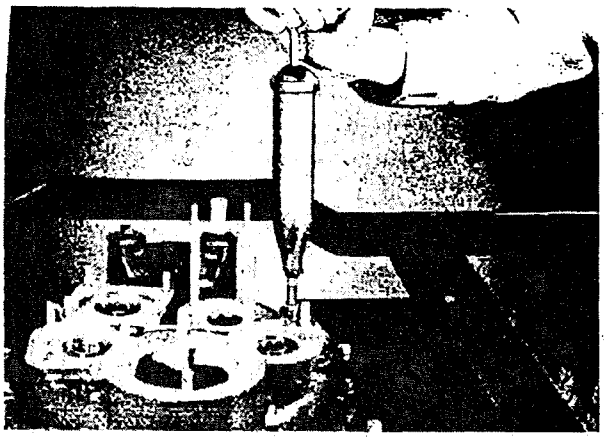


Figure 38 - Priming Crankshaft with Oil

CAUTION: Cuffs should be placed on the link rods and care taken not to nick link rods, master rod or cylinder bores in the crankcase while turning the crankshaft for further checking. Turn crankshaft slowly.

13. Oil Sump Strainer.

a. Insert oil strainer in crankcase and tighten with a suitable wrench. After oil strainer is properly tightened safety wire to square head oil sump plug.

b. Turn engine stand so that crankshaft is in a vertical position with rear of engine nearest the floor.

14. Piston Pins, Pistons, Cylinders.

a. Lubricate piston pins and pin holes in piston with engine oil and then place pistons over link rods and insert piston pins.

b. Make certain that the pistons are assembled in their proper locations, and that cylinder number stamped on the top of the piston crown over the FRONT pin boss is placed toward the FRONT of the engine.

c. Before putting cylinders in place coat cylinder barrel wall THOROUGHLY with engine oil and make certain a new rubber oil seal ring has been placed on the cylinder skirt.

d. Use engine oil freely in each ring groove on each piston.

e. Turn crankshaft to bring master rod to top center and slide cylinder carefully and squarely into place using Ring Compressor (Tool No. T-14000). Refer to Figure 39.

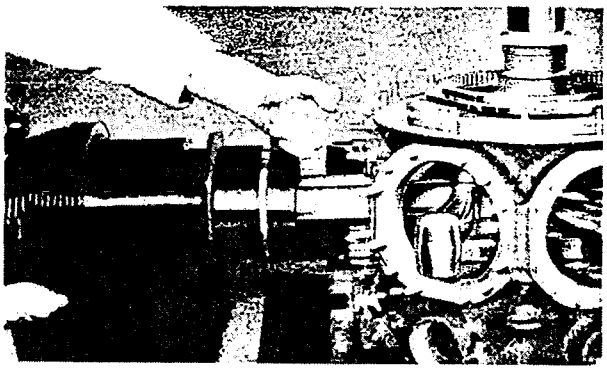


Figure 39 - Installing Cylinder

f. Follow this procedure in order until all the cylinders are in place, attaching each cylinder to crankcase in turn. Using first an open-end wrench and then the cylinder hold-down Nut Wrench (Tool No.569-16) tighten nuts with the proper torque specified in Table of Limits.

15. Intake Pipes.

a. Assemble the intake pipes by sliding intake pipe packing nut and new packing onto intake pipe.

b. Then insert pipe into crankcase, and slide flange onto intake port using a new port gasket.

c. Attach intake port flange with the cap screws or nuts and tighten finger-tight.

d. Tighten the packing nut with Wrench (Tool

No.T-641) making sure that it is not too tight, otherwise the packing will grip so tightly that the pipe cannot slide in and out of the rubber packing gland during the expansion and contraction of the cylinder, with resultant cracking of the pipe flange at the cylinder head.

e. On the L-4MB engine the intake pipe flange is attached to the cylinder head with cap screws which must be safety wired.

16. Front Case.

a. Turn engine stand so that crankshaft is in the horizontal position.

b. Place Timing Disc (Tool No. T-33000) on crankshaft and rotate shaft to approximately 1° or 1-1/2° before top center for No. 1 cylinder. This can be readily done if the Timing Disc is placed with its 0° reading in line with the blanked spline on the crankshaft of the L-4MB engines, since the blanked spline is aligned with the crank throw.

c. To keep the cam stationary until the front case is put on it is necessary to use a "timing wire" which is best made from 1/16" diameter welding wire, straight and 12" long. It is advisable to slightly flatten one end of the wire. This end must then be inserted through the timing hole in the cam hub and front main crankcase.

d. Rest a 12" steel straight edge over the two top cam lobes and turn cam until there is an equal distance between straight edge and the studs directly above. Refer to Figure 40.

e. Using a pair of pliers, press the timing wire toward the crankcase and turn the wire slightly to lock the cam in position.

NOTE: Gently try to rock the cam to make certain cam will not get out of position. Cam must not be free to rotate. If it does the cam must again be lined up with the crankshaft.

f. Before putting front case in place, check to make certain that the pins are in the tappet rollers.

g. Draw out all the top tappets and hold by placing the ends of a 1/16" diameter, 9" long, piece of music wire into the oil holes of adjacent tappets. This must be done so that the tappet rollers will clear the cam lobes when putting front case in place.

h. Place front case in position and turn cam pinion gear with fingers through timing hole until the tooth with the punch mark is between the teeth that are punch marked on the timing gear. Refer to Figure 41.

NOTE: In the event that a new timing gear and/or a new cam drive pinion gear is being installed at overhaul, it will be necessary to select the tooth of the cam drive pinion gear that meshes accurately between the fourth and fifth timing gear teeth to the left (facing the engine from in front) counting the tooth of the timing gear directly under the key as number one tooth. When engine is timed, gear teeth should be punched as indicated above for future identification.

i. Place a light film of Medium "Tite-Seal" or equivalent over the front case flange (mating the crankcase), and slide the front case onto crankcase studs taking care not to disturb the cam setting.

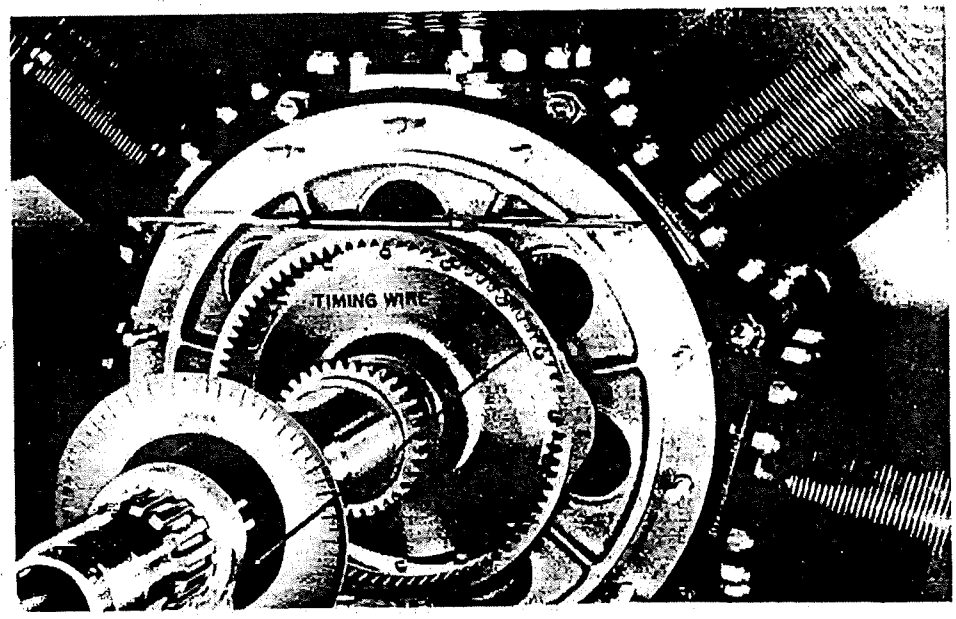


Figure 40 - Leveling Cam Lobes

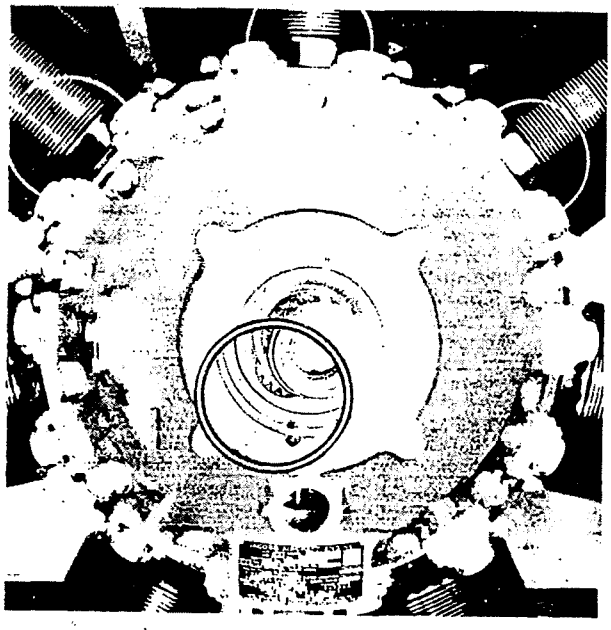


Figure 41 - Timing Marks on Timing Gear and Cam Drive Gear

NOTE: If front case does not go on easily check tappets to make sure rollers are not in-interfering with cam lobes.

j. Place a few nuts and washers around the front case to hold it evenly in position and then check the valve timing.

17. Checking Valve Timing.

a. The valve timing will be checked as follows on the No. 1 cylinder:

(1) Remove wire holding the intake and exhaust tappets for No. 1 cylinder. Turn the engine stand so that the crankshaft is horizontal, and turn the crankshaft one revolution in either direction to get the piston in the No. 1 cylinder on top center at the end of the compression stroke. (Both valves closed). Insert intake and exhaust push rods for the No. 1 cylinder.

NOTE: Some push rods are not marked, but on engines having rods of two different lengths, the exhaust push rod is slightly shorter than the intake push rod.

(2) Insert the intake and exhaust valve adjusting screws into the rocker arms and adjust and lock to the hot clearances of .040" for the exhaust valve and .035" for the intake valve.

(3) Valve clearances are checked at the tips of the valve stems. Refer to Figure 42.

(4) Place Spline Wrench (Tool No. T-340)

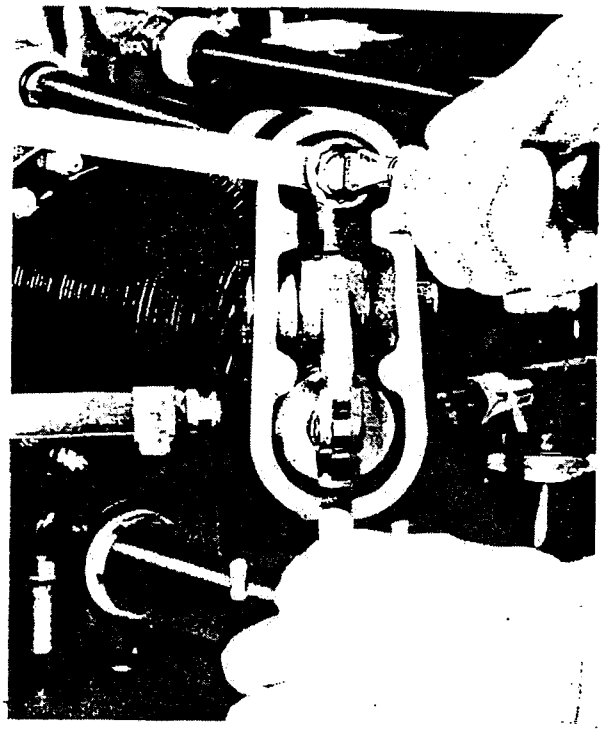


Figure 42 - Adjusting Valve Clearances

on crankshaft and attach the Timing Disc and Pointer (Tool No. T-33000). Attach the Disc to the crankshaft and the Pointer to the thrust bearing plate studs. Refer to Figure 43.

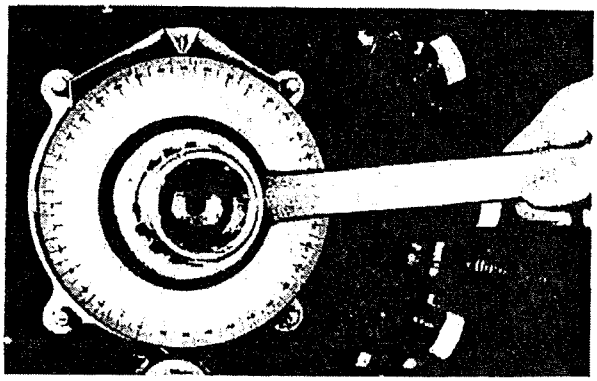


Figure 43 - Use of Timing Disc and Pointer

(5) Rotate the crankshaft clockwise approximately 110° until rocker roller of intake valve just begins to tighten. This can be observed by placing fingers of one hand on roller and rotating the crankshaft with the other hand. This is the position in which the intake valve closes in normal operation. Note the angle on the timing disc. The intake valve should close

at 62° ± 5° after bottom center.

(6) Turn crankshaft counter-clockwise (normal direction of rotation) approximately 220°. Check roller of exhaust valve until it just begins to tighten. This is the position in which the exhaust valve opens. Note the angle on the timing disc. The exhaust valve should open at 62° ± 5° before bottom center.

(7) Again turn crankshaft counter-clockwise approximately 220° until intake valve roller just begins to tighten. This is the position in which the intake valve opens. The intake valve should open approximately 19° before top center.

(8) Turn shaft counter-clockwise approximately 40° until roller of exhaust valve just begins to be free. This is the position in which the exhaust valve closes. The exhaust valve should close approximately 13° after top center.

18. Installing and Timing Magneto.

a. Rotate crankshaft until piston in No. 1 cylinder is on top center at the end of the compression stroke. (Both valves closed.)

b. Turn crankshaft approximately one-half revolution opposite direction of engine rotation. Then return in normal direction of crankshaft rotation to 30° before top center.

c. Set the breaker points clearance between .010" to .014", preferably at .012", for the full open position of the breaker.

d. Turn the magneto shaft until the timing marks on the large magneto distributor gear come opposite the timing marks on the inside of the magneto front end plate. Refer to Figure 44.

e. Install the magneto as nearly as possible in this position. The mounting flange nuts should not be completely tightened. Check the magneto timing, using timing light, Abbott Type A-100, stock No. 8042-273875, or equivalent. (See figure 45.) Turn the magneto in the slots in the mounting flange until the correct setting is obtained. Both magneto breaker points should open at the same position of the crankshaft.

f. Tighten the magneto mounting flange nuts and recheck to make sure the .0015" shim stock between the points is released by a slight pull.

NOTE: If a correct setting cannot be obtained, the magneto should be removed. Turn the magneto coupling in one direction approximately 1-3/4 revolutions until the timing marks on the gear and the front end of the magneto again index. Reinstall magneto using a different tooth to mesh and repeat the above instructions. Repeat if necessary until a correct timing check is secured.

19. Installing and Timing Distributor.

a. Turn the crankshaft in the normal direction of rotation until the No. 1 piston is at top dead center on the compression stroke.

b. The distributor is installed in the retarded position. Remove the distributor cap and make sure that the distributor finger is seated properly. Set the breaker point clearance between .014" and .018" preferably at .016" for the full open position of the breaker. Turn the bevel gear on the distributor shaft until the points just begin to open. Install the distributor on the distributor pad of the accessory drive unit so that the slots in the mounting flange are inserted about the center of the mounting studs and the bevel gear meshes with the neighboring gear in the accessory drive unit.

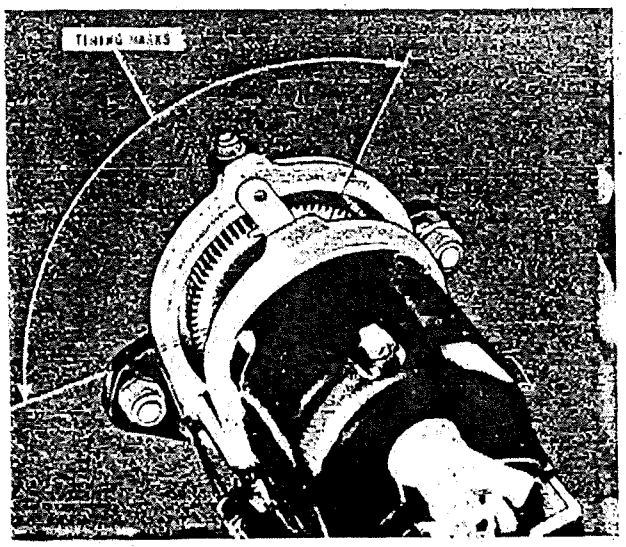


Figure 44 - Magneto Timing Marks.

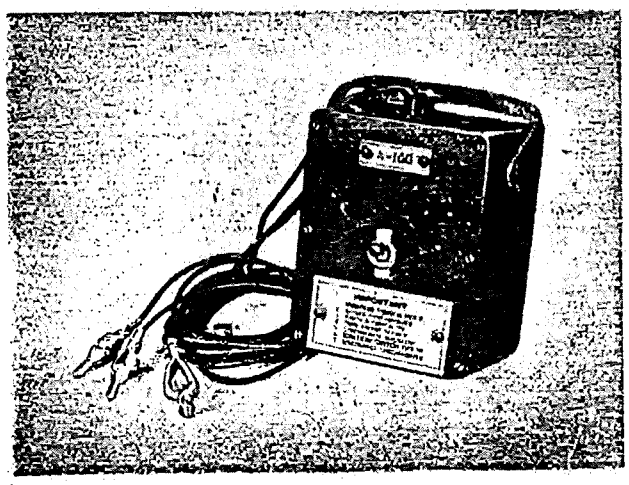


Figure 45 - Timing Light

c. Install the washers and nuts on the mounting studs and draw down to the proper torque.

d. Check the distributor timing with a timing light, turning the distributor finger in the clockwise direction (retard position). Correct setting should be obtained by rotating the distributor in the slots in the mounting flange. During this operation airplane battery voltage should not be applied to the breaker points.

e. Retighten the mounting nuts and check again as indicated above.

20. Inner Oil Seal Ring, Thrust Bearing, Thrust Plate, Thrust Nut.

a. Assemble the seal rings to the inner oil seal sleeve, with cast iron rings nearest the center and bronze and cast iron rings placed alternately. Refer to Figure 46A.

b. Place Oil Seal Assembly Sleeve (Tool No. T-591-C) over crankshaft and against front case.

c. Slide the inner oil seal sleeve with rings assembled, over the crankshaft and into the Tool which acts by means of its tapered inlet to compress the rings and permit their entering the outer sleeve. Refer to Figure 46.

d. Tap oil seal sleeve with a fibre drift until it is properly seated in outer oil seal sleeve.

e. Drive thrust bearing into place using Drift (Tool No. T-25000 with Adapter T-25000-2). Make certain that thrust bearing is properly seated. Refer to Figure 47.

f. Accurately measure with a micrometer depth gage the depth from the thrust plate mounting surface to the outer race of the thrust bearing.

g. Then measure depth of thrust plate shoulder and thickness of thrust bearing plate spacer.

h. Measure the thickness of the thrust plate shim.

i. Add the length of the thrust plate shoulder and the width of the thrust bearing plate spacer together and subtract the depth measured from the top of the thrust plate mounting pad to the outer race of the bearing, plus the thickness of the shim. The difference should be .004" to .005".

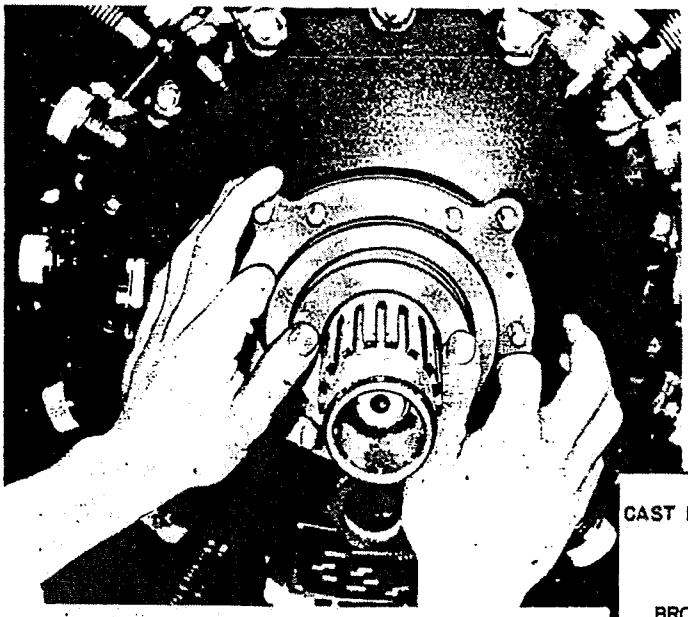


Figure 46
Installing Inner Oil
Seal and Rings

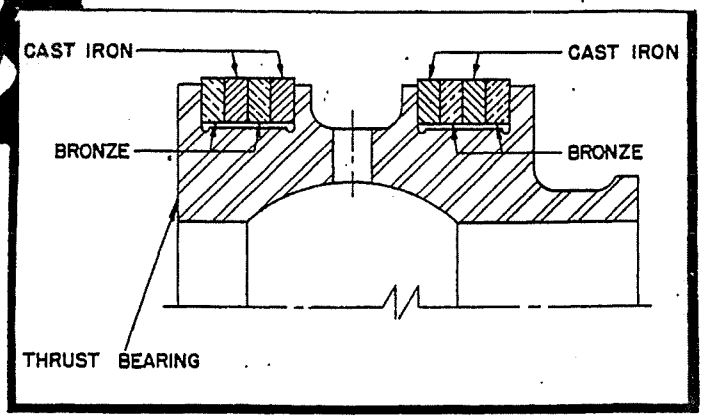


Figure 46A
Arrangement of Oil
Seal Rings

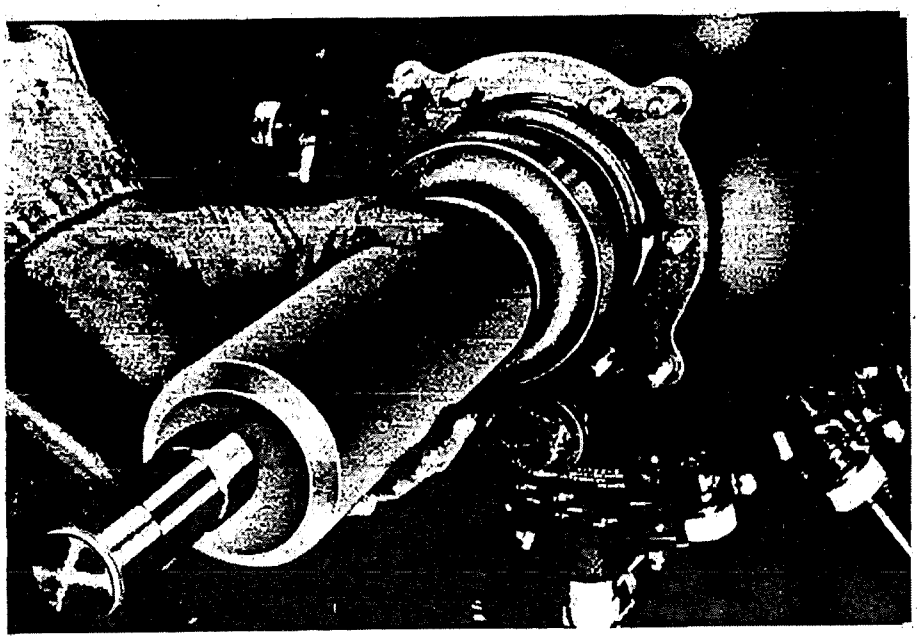


Figure 47 - Installing Thrust Bearing Onto Crankshaft

j. If this difference is not found, it is necessary to peel off enough laminations of the shim to give the required .004" or .005" tight pinch of the thrust plate against the thrust bearing.

k. Insert thrust bearing plate spacer, shim, and thrust plate.

l. Attach thrust plate spacers and attaching nuts and tighten nuts to secure thrust plate.

m. Screw thrust nut onto crankshaft and tighten with Wrench (Tool No. T-348-B) until thrust nut is properly seated.

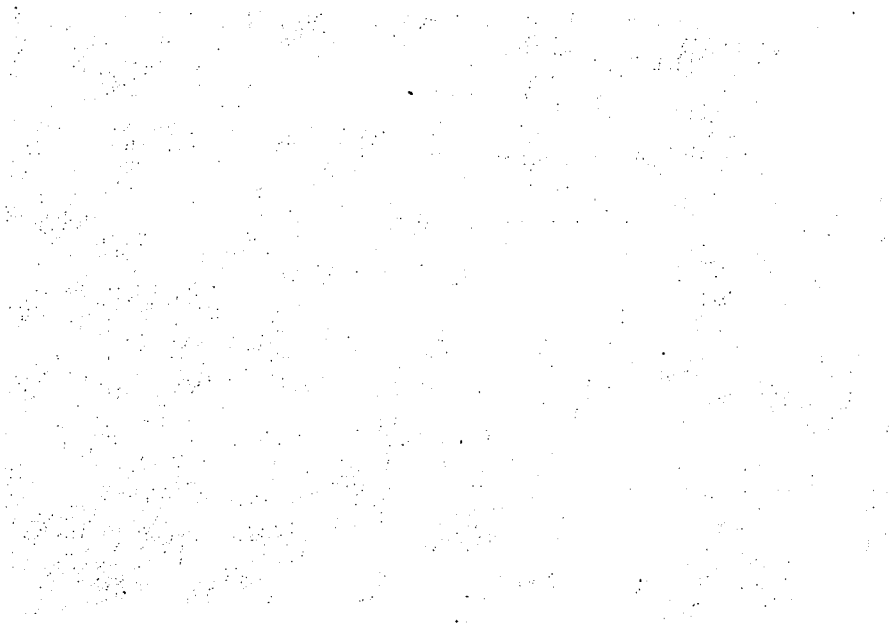
n. Insert timing hole plug and washer. Tighten plug and safety wire.

21. Oil Sump Drain Hose.

a. Attach a new oil sump drain hose in place over hose elbows in front case and crankcase. After oil sump drain hose is in place, tighten hose clamps.

22. Priming System.

a. Attach primer distributor to No. 1 intake pipe. Attach primer lines for Nos. 1,2,



and 7 cylinders and the intake manifold, to the primer distributor. Fasten primer lines to intake pipes of primed cylinders with provided clamps, and also fasten to crankcase. It is usually unnecessary to replace at each overhaul the rubber sleeves protecting the priming lines in their clips, but if replaced, the new sleeves must be split on one side to slip onto the tubes.

23. Push Rod Cover Tubes, Push Rods, Rocker Covers.

a. Insert push rod cover tubes in place. Push tube carrying nuts and new packings into cylinder head and then pull down onto tappet guide.

b. Tighten push rod packing nuts as tightly as possible by hand. Install push rods and bring piston in No. 1 cylinder to top center at the end of the compression stroke. (Both valves closed).

c. Tighten adjusting screws in rocker arms until cold running valve clearance of .008" is obtained at both the exhaust and intake valves.

d. After checking No. 1 cylinder, turn the engine to the other cylinders in firing order, as follows: Nos. 3, 5, 7, 2, 4 and 6. Proceed with each individual cylinder as outlined above.

e. After the proper clearances are obtained the rocker arm adjusting screws should be locked by tightening the lock-nuts.

f. Valve clearance adjusting screws lock-nuts should be checked to determine that all have sufficient thread engagement with the valve adjusting screw.

g. Install all rocker covers and tighten the cover stud nuts with the proper torque specified in Table of Limits, T. O. No. 02-30-1.

h. Grease the rocker box fittings thoroughly with a pressure gun on engines having manual valve lubrication.

NOTE: Replace all No. 424-D rocker covers with improved covers No. 30081, if practical. Cork and vellumoid gaskets, No. 449-C, should not be used as they compress excessively causing cover breakage. The proper gasket is No. 30105 (of synthetic rubber and asbestos, 1/32" thick) of which one only is required under No. 30081 covers, whereas two must be used under each No. 424-D, cover.

i. Install new rubber hose between the No. 4 and No. 5 cylinder rocker covers and tighten hose clamps.

24. Rocker Vent Tube, Rocker Scavenger Tube, External Oil Lines.

a. Place new rubber hose on both ends of 3/8" rocker vent tube.

b. Attach vent tube, one end to No. 1 cylinder intake rocker cover elbow and the other to hose nipple or elbow on crankcase, and tighten hose clamps.

c. Attach the 3/8" rocker scavenger tube, one end to the oil pump elbow and one end to the No. 5 cylinder exhaust rocker cover elbow, and tighten hose clamp.

d. Install all external oil lines and tighten provided hose clamps.

e. The rocker scavenger tube and the oil pressure tube from the rear case to front case sump cover should be anchored to one carburetor mounting sump by means of the clip and two new rubber sleeves.

25. Ignition Manifold Assembly.

a. Place the ignition manifold assembly in position on the front case, passing the large flexible conduit for the Magneto between No. 7 and No. 1 cylinders, and the conduit for the Distributor between No. 1 and No. 2 cylinders.

b. Place the four mounting clips over the mounting studs on front case and install the nuts.

c. Attach the front spark plug terminals to the plugs.

d. Attach terminals to rear spark plugs.

e. Insert the magneto and distributor ends of the cables into their respective distributor blocks. Make certain all piercing screws are backed out to insure proper seating cables.

f. The cables are marked and should be inserted in the same numbered hole in the distributor blocks.

g. After cables are properly seated in distributor block holes, secure them with the piercing screws.

26. Testing Engine After Overhaul.

Complete information concerning block, installation and flight tests is given in T. O. No. 02-1-4.

27. Storage.

Unless engine is to be installed in an airplane within 48 hours, engine shall be prepared for storage. Complete information concerning the preparation of these engines for storage is given in T. O. No. 02-1-1, supplemented by the information contained in Section IV of T. O. No. 02-30AC-2.

SECTION VII

ACCESSORIES

1. General.

The disassembly, inspection, repair, assembly and final test of engine accessories such as carburetors and magnetos are covered in this Section. Where descriptive literature is available to the Air Force from the accessory manufacturer, the Technical Order applying thereto is given.

2. Carburetor.

For complete instructions, refer to Handbook of Instructions for Stromberg Aircraft Carburetor, T. O. No. 03-10B-1.

3. Magnetos.

For complete instructions refer to T. O. No. 03-5D-7.

4. Radio Shielding.

For complete information concerning the ignition cable shielding with which these engines are equipped, refer to T. O. No. 08-5-1 and Section IX, T. O. No. 02-30AC-2.

5. Spark Plugs.

For complete instructions refer to T. O. No. 03-5E-1.

6. Distributor.

For complete instructions refer to Handbook of Instructions for Bendix-Scintilla Distributor Type WL-7A for Jacobs Aircraft Engines.

7. Coil.

For complete instructions refer to Handbook of Instructions for Bendix-Scintilla Coil.

SECTION VIII

ADDITIONAL OVERHAUL AND MAJOR REPAIR INSTRUCTIONS ISSUED BY THE AIR FORCE.

SECTION II
TABLE OF LIMITS

1. R-755-9 ENGINE.

Ref. No.	Chart No.	DESCRIPTION OF LIMITS	Mfg. Min	Mfg. Max	Replacement Max
1	3	Piston in Cylinder			
		—Top Land	.052	.057	
		—Second and Third Lands	.042	.047	
		—Skirt	.027	.031	.038
2	3	Rings—Piston—in Grooves—			
		All Cylinders—Side Clearances			
		Top Groove	.0045	.0055	
		Second Groove	.0050	.0065	
		Third Groove	.0050	.0065	
		Fourth Groove	.0050	.0065	
		Gap—All Grooves—All Cylinders	.070	.075	
3	3	Pin—Piston			
		Piston—Hand Push Fit (Select)	.0000	.0005L	.004L
		Master Rod	.0015L	.0022L	.005L
		Link Rod	.0003L	.0010L	.004L
4	3	Pin—Knuckle—Link Rod	.00025L	.0010L	.003L
		—Master Rod	.00035T	.0010T	*
5	3	Rod—Link, in Master Rod (End Clearance)	.0170L	.0230L	.035L
6	3	Rod—Master, to Crankpin (Diameter)	.0040L	.0055L	.008L
7	3	Rod—Master, to Crankpin (End Clearance)	.0180L	.0240L	.040L
8	3	Liner—Main Bearing, in Crankcase	.0040T	.0070T	*
9	3	Bearing—Main Roller, in Liner	.0001T	.0018T	.002L
10	3	Crankshaft to Main Bearing	.0003L	.0008T	.001L
11	3	Liner—Thrust Bearing, in Front Case	.0040T	.0070T	*
12	3	Bearing—Thrust, in Liner	.0001L	.0015T	.003L
13	3	Crankshaft to Thrust Bearing	.0005L	.0006T	.001L
14	3	Plate—Thrust, to Front Case (Diameter)	.0000	.0020L	.008L
15	3	Guide—Valve, in Cylinder Head (Intake)	.0005T	.0015T	*
16	3	Guide—Valve, in Cylinder Head (Exhaust)	.0005T	.0015T	*
17	3	Valve—Intake, in Guide	.0015L	.0030L	.008L
18	3	Valve—Exhaust, in Guide	.0020L	.0045L	.010L
19	3	Seat—Valve, in Cylinder Head (Intake)	.0060T	.0090T	*
20	3	Seat—Valve, in Cylinder Head (Exhaust)	.0060T	.0090T	*
21	3	Bearing in Rocker Arm	.0007T	.0017T	*
22	3	Shaft—Rocker Arm, in Bearing	.0002L	.0010L	.002L
23	3	Shaft—Rocker Arm, in Cylinder Head	.0002L	.0010L	.002L
24	3	Ball End—in Push Rod (Intake and Exhaust)	.0015T	.0035T	*
25	3	Barrel—Cylinder, in Crankcase	.0040L	.0070L	
26	3	Barrel—Cylinder—Maximum Out-of-round and Taper (Excludes cold taper at head joint)			.006
27	3	Cam Hub—to Cam Bearing (Diameter)	.0024L	.0035L	.0065L
28	3	Cam Hub—to Cam Bearing (End Clearance)	.0100L	.0140L	.025L
29	3	Bearing—Pinion Shaft to Front Case	.0006L	.0010T	.003L
30	3	Bearing—Pinion Shaft to Front Case (Large)	.0006L	.0010T	.003L
31	3	Shaft—Cam Pinion, to Bearing	.0001L	.0007T	.001L
32	3	Gears—Timing and Cam Drive (Backlash)	.0040	.0080	.020
33	3	Gears—Cam Pinion and Ring (Backlash)	.0040	.0080	.020
34	3	Guide—Tappet, in Front Case (Intake and Exhaust)	.0000	.0010T	.001L
35	3	Tappet in Guide	.0003L	.0012L	.003L
36	3	Pin—Tappet Roller, in Roller	.0013L	.0023L	.005L
37	3	Pin—Tappet Roller, in Tappet	.0013L	.0028L	.005L

R-755-9 ENGINE (cont)

Ref. No.	Chart No.	DESCRIPTION OF LIMITS	Mfr. Min	Mfr. Max	Replacement Max
38	3	Gears—Oil Pump (End Clearance)	0025L	.0040L	.008L
39	3	Gears—Oil Pump (Backlash)	.0040	.0100	.020
40	3	Gears—Oil Pump, on Idler Shaft	.0005L	.0015L	.003L
41	3	Oil Pump—Pressure Section, to Rear Case	.0020L	.0040L	
42	3	Bushing—to Oil Pump Pressure Section	.0010T	.0030T	*
43	3	Shaft—Oil Pump Drive to Bushing and Pump (Pressure Section)	.0015L	.0030L	.005L
44	3	Shaft—Oil Pump Drive to Bushing and Pump (Scavenger Section)	.0015L	.0030L	.008L
45	3	Bushing—to Oil Pump Scavenger Section	.0003L	.0012L	.003L
46	3	Shaft—Idler, to Oil Pump (End Section)	.0005L	.0010T	.002L
47	3	Shaft—Idler, to Oil Pump (Center Section)	.0000	.0015L	.0025L
		Shaft—Drive, to Oil Pump (Center Section)	.0010L	.0025L	.004L
48	3	Front Case to Crankcase	.0000	.0040T	.008L
49	3	Crankcase—Front Half to Crankcase—Rear Half	.0000	.0040T	.002L
50	3	Rear Case to Crankcase	.0010L	.0040L	
51	3	Plug (Small) in Crankshaft (Front and Rear)	.0010T	.0035T	*
52	3	Plug (Large) in Crankshaft (Front)	.0010T	.0040T	*
		For Replacement, Fit Plug to	.0010T	.0025T	*
55	3	Gear—Starter, to Bushing (End Clearance)	.0060L	.0260L	
56	4	Gear—Generator—Drive to Bushing (End Clearance)	.0060L	.0300L	
57	4	Gear—Magneto Driven to Bushing (End Clearance)	.0370L	.0750L	
58	3	Gear—Oil Pump Drive to Bushings (End Clearance)	.0350L	.0690L	
63	3	Gears—Crankshaft Cluster and Oil Pump Drive (Backlash)	.0040	.0080	.018
69	3	Crankshaft to Oil Feed Bearing	.0015L	.0030L	.0045L
70	3	Bearing—Oil Feed to Rear Intermediate Bearing Plate	.0010T	.0030T	*
74	3	Bushing—Oil Pump Drive Gear to Rear Intermediate Bearing Plate	.0010T	.0030T	*
75	3	Gear—Oil Pump Drive, in Bushing	.0010L	.0020L	.004L
77	4	Gear—Generator Drive, in Bushing	.0020L	.0030L	.005L
79	3	Gear—Starter, in Bushing	.0010L	.0020L	.004L
83	3	Bushing to Master Rod (Piston Pin End)	.0010T	.0020T	*
84	3	Plug to Piston Pin	.0010T	.0020T	*
		Plug to Piston Pin (Service Replacement), Fit to	.0000	.0010T	*
85	3	Bearing to Master Rod	.0010T	.0020T	*
86	3	Plate—Thrust to Front Case (Peel shim to obtain clamp fit of)	.0020T	.0040T	*
91	4	Bushing—Generator Drive and Magneto Driven Gear to Rear Intermediate Bearing Plate	.0010T	.0030T	*
92	4	Gear—Magneto Driven in Bushing	.0020L	.0030L	.005L
93	4	Seal—Oil, to Rear Case (Magneto and Generator Drive)	.0010T	.0070T	*
103	3	Gear—Timing, to Crankshaft	.0004L	.0014L	.002L
104	3	Bearing—Cam, to Crankshaft	.0004L	.0019L	.0025L
105	3	Gear—Crankshaft Cluster, to Crankshaft	.0000	.0010L	.0016L
		Gear—Magneto Drive, to Crankshaft	.0000	.0010L	.0016L
107	4	Gears—Crankshaft Cluster and Generator (Backlash)	.0040	.0080	.018
113	3	Liner—Rear Intermediate Bearing Plate	.0030T	.0060T	*
114	3	Bearing—Ball, in Liner—Rear Intermediate Bearing Plate	.0010L	.0008T	.004L
115	3	Plate—Rear Intermediate Bearing, to Crankcase	.0000	.003T	.002L
116	4	Gears—Magneto Drive and Magneto Driven (Backlash)	.0040	.0080	.018
117	3	Gear—Crankshaft Cluster and Starter (Backlash)	.0040	.0080	.018L
118	3	Bushing—Starter Gear, to Rear Intermediate Bearing Plate	.0010T	.0040T	*
119	3	Bearing—Rear Ball, to Crankshaft	.0005L	.0005T	.001L
120	3	Gears—Oil Pump, to Pump Bodies (Diametral Clearance)	.003L	.005L	.010L
124	3	Fitting—Propeller Oil, to Front Case	.0005L	.0015L	.002L
125	3	Sleeve—Inner, to Crankshaft	.0004L	.0019L	.0025L
126	3	Sleeve—Outer, to Front Case (Shrink Fit)	.0000T	.0015T	*
127	3	Rings—Oil Seal (Side Clearance, Total Four Rings in Groove)	.0055L	.0115L	
128	3	Rings—Oil Seal (Step Joint)—Gap	.012	.018	
		Rings—Oil Seal (Butt Joint)—Gap	.010	.015	

Ref. No.	Chart No.	DESCRIPTION OF LIMITS	Mfg. Min	Mfg. Max	Replacement Max
130	4	Bearing—Generator Drive Gear, in Rear Case	.0001L	.001L	.003L
131	4	Gear—Generator Drive, to Bearing	.0001L	.0007T	.001L
132	3	Key—Oil Pump Drive Shaft			
		Side Clearance in Shaft Fit to	.0005T	.0015T	.003L
		Side Clearance in Gears Fit to	.0015L	.0040L	.006L
		Radial Clearance in Gears	.0005L	.0143L	
133	3	Key—Cluster Gear			
		Side Clearance in Crankshaft Fit to	.0000	.0010L	.002L
		Side Clearance in Magneto Drive and Cluster Gears Fit to	.0000	.0020L	.003L
		Radial Clearance in Gears	.004L	.0140L	
134	3	Key—Timing Gear			
		Side Clearance in Crankshaft Fit to	.0000	.0010L	.002L
		Side Clearance in Gear Fit to	.0000	.0020L	.003L
		Radial Clearance in Gear	.0035L	.0160L	
135	3	Key—Cam Drive Gear			
		Side Clearance in Pinion Shaft Fit to	.0000	.0010L	.003L
		Side Clearance in Cam Drive Gear Fit to	.0000	.0030L	.004L
		Radial Clearance in Gear	.0030L	.0170L	
136	4	Tube—Oil, in Rear Intermediate Bearing Plate	.0010T	.0025T	*
137	4	Tube—Oil, in Rear Case	.002L	.003L	
138	3	Maximum Run-out Rear Cone Seat (Safe Limit for Service Operation)		.005	
		Maximum Run-out Front Cone Seat (Safe Limit for Service Operation)		.010	
**148	3	At Assembly, Maximum Crankshaft Run-out at or Near Thrust Bearing Seat		.0025	

SECTION III
MISCELLANEOUS

1. SPRING PRESSURES.

All models.

Part No.	*Description*	*Wire Dia*	*Minimum Load When New*
327	Spring—Relief Valve	.0625	8–1/2 to 9 lb at 2–1/8 in.
838	Spring—Check Valve	.034	1/2 lb at 1–13/16 in.
838-B	Spring—Check Valve	.031	.19 lb at 1–7/8 in.

Part No.	*Description*	*Wire Dia.*	*Minimum Load When New*		*Minimum Load Before Replacement*
			Valve Closed	*Valve Open*	*Valve Open*
409-L	Spring—Valve Outer	.170	58 lb at 1–7/8 in.	88 lb at 1–13/32 in.	85 lb at 1–13/32 in.
410-L	Spring—Valve Inner	.125	33 lb at 1–7/8 in.	48 lb at 1–13/32 in.	46 lb at 1–13/32 in.

2. TORQUE LIMITS, ETC.

All models. Refer to Charts No. 3 and 7.

T-200	Crankshaft Clamp Bolt,	
	Part No. 342-C (obsolete) stretch to	.006 in. to .008 in.
	Part No. 30099, 30100, stretch to	.012 in. min or next cotter hole
T-201	Crankcase Bolt Nuts	325 to 350 in.-lb
T-202	Cylinder Hold-down Nuts	250 to 300 in.-lb
T-203	Rocker Shaft Nuts	125 in.-lb.
T-204	Rocker Cover Stud Nuts	40 to 50 in.-lb
T-205	Spark Plugs	300 to 360 in.-lb.
T-206	Thrust Nut	7200 in.-lb
**T-207	Nut—5/8 in. Special (Cam Drive Pinion Shaft)	400 to 600 in.-lb
**T-208	Valve Clearance Adjusting Screw Lock Nut	300 to 325 in.-lb
**T-209	Fuel Pump Nuts (On Rear Case)	100 in.-lb
**T-210	Exhaust Port Stud Nuts	100 to 120 in.-lb.
	Torque for Installing Studs (Except Step-studs):	
	1/4 in. Studs	70 in.-lb
	5/16 in. Studs	150 in.-lb
	3/8 in. Studs	275 in.-lb

3. CRANKSHAFT RUN-OUT.

	Maximum Allowable
All Models—At Rear Cone (Safe Limit for Service Operation)	.005 in.
At Front Cone (Safe Limit for Service Operation)	.010 in.
All Models—At Assembly, Maximum Crankshaft Run-out Measured 2 inches Behind the Thrust Nut Threads	.0025 in.