TEXTRON Lycoming

652 Oliver Street
Williamsport, PA 17701 U.S.A.
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Overhaul Manual

TEXTRON Lycoming

76 Series Engines

Approved by F.A.A.

3rd Printing

Part No. 60294-9

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TO THE OWNER OF THIS MANUAL

THIS MANUAL HAS BEEN DESIGNED TO PERMIT ADDITION OF NEW AND REVISED PAGES, AS REQUIRED FOR COVERAGE OF NEW ENGINE MODELS, NEW SHOP PROCEDURES, AND PROCESSES. NEW AND REVISED PAGES WILL BE FURNISHED TO OWNERS OF THIS MANUAL WHO FILL OUT THE REGISTRATION CARD AND RETURN IT TO LYCOMING. THE PRICE OF THE MANUAL INCLUDES THE COST OF MAILING ALL REVISED AND NEW PAGES FOR THIS MANUAL TO THE ADDRESS SHOWN ON THE CARD FOR A PERIOD OF THREE (3) YEARS. REGISTERED OWNERS OF THE MANUAL WILL BE NOTIFIED OF ANY CHANGE IN REVISION POLICY OR COST OF REVISIONS.

SERVICE BULLETINS, LETTERS AND INSTRUCTIONS

Although the information contained in this manual is up-to-date at time of publication, users are urged to keep abreast of later information through Lycoming Service Bulletins, Instructions and Service Letters which are available from all Lycoming distributors or from the factory by subscription. Consult the latest edition of Service Letter No. L114 for subscription information.

SPECIAL NOTE

The illustrations, pictures and drawings shown in this publication are typical of the subject matter they portray; in no instance are they to be interpreted as examples of any specific engine, equipment or part thereof.

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SECTION 1

INTRODUCTION

1-1. This manual contains the necessary information for the major overhaul of the Lycoming 76 series engines. Unless otherwise noted the information and data will apply equally to all models. The portions of the text applying to any one particular model will be identified.

1-2. The main portion of the text is divided into sections corresponding to the basic engine components. Additional sections are provided for general description, preservation and storage information, and other items of a non-specific nature.

1-3. The tools required for overhauling the engine (excluding the ordinary mechanic's tools found in most overhaul shops) are listed in the Special Service Tool Catalog No. SSP2172. Inspection gages are also listed in the same catalog. Any special information required concerning the tools may be obtained by writing to Service Department, Lycoming Division, Williamsport, Pa. 17701. When requesting information concerning any of these tools refer to the tool name and part number.

1-4. Parts catalog for specific models of 76 series engines may be ordered from the department listed in paragraph 1-3. Because of product improvement it is almost impossible to call out attaching part numbers in the overhaul manual. Therefore, it is recommended that a parts catalog be used in conjunction with the overhaul manual, when reassembling the engines.

1-5. Service bulletins, service instructions and service letters are issued from time to time whenever the engine is modified or overhaul procedures revised. When received, these publications should be inserted in the rear of this manual or maintained in a separate file for ready reference.

1-6. The following procedures should be followed for any reason that parts are to be returned to Lycoming for warranty. The proper forms must be completed by your Lycoming Distributor, including the engine model, serial number, number of hours in service, the reason the parts are being returned, and any other pertinent information concerning the parts.

1-7. In this manual all references to locations of various components will be designated when viewing the engine from the rear. The power take off end is considered the front and the accessory drive end the rear. The oil sump is considered the bottom. Cylinders are numbered from front to rear with odd numbered cylinders on the right side and even numbered cylinders on the left side.

1-8. The direction of rotation of the crankshaft, as viewed from the rear, is clockwise on all models. All references to direction of rotation of the various accessory drives are as viewed facing the accessory drive mounting pad.

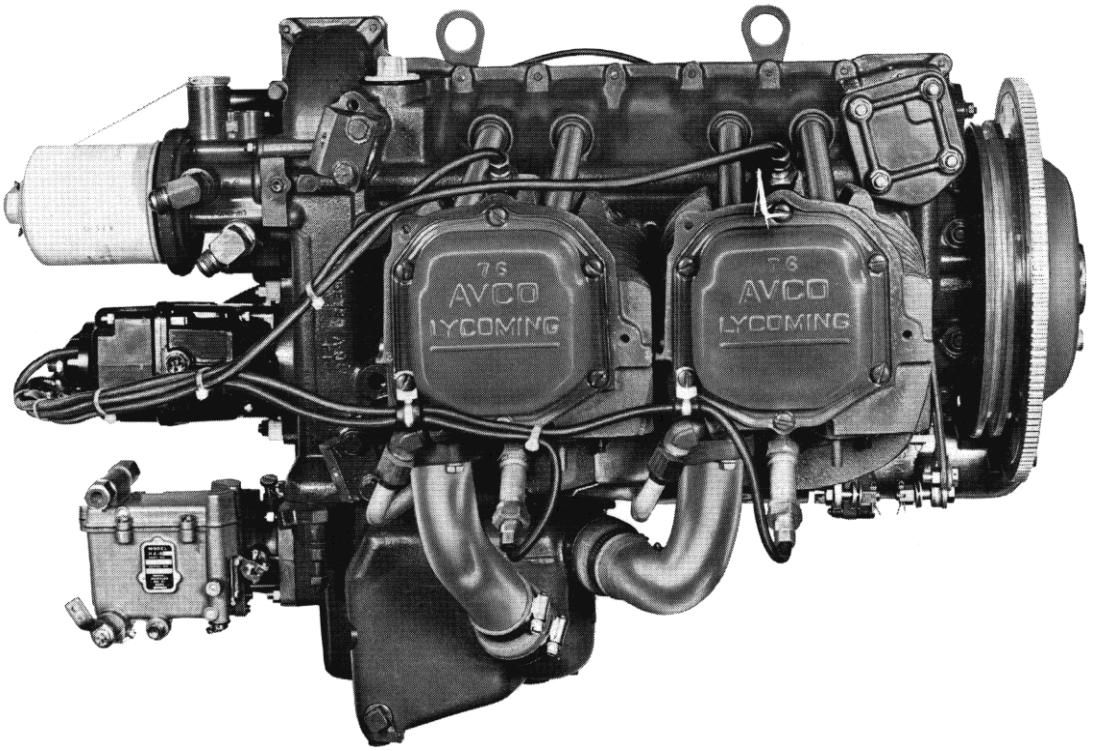


Figure 1-1. Typical 4 Cylinder Engine

SECTION 2

GENERAL DESCRIPTION

2-1. The engines covered in this manual are direct drive, four cylinder, horizontally opposed, air cooled models.

2-2. Cylinders. The cylinders are of air cooled construction with two major parts, head and barrel, screwed and shrunk together. The head is made from an aluminum alloy casting with a fully machined combustion chamber. Valve guides and valve seats are shrunk into machined recesses in the head. The rocker box is an integral part of the cylinder head which forms the housing for both the intake and exhaust valve rockers.

2-3. The cylinder barrels are machined from a chrome nickel molybdenum steel forging with deep integral cooling fins. The interior of the barrels are ground and honed to a specified finish.

2-4. Lycoming incorporates a color code painted on cylinder heads designating differences in the cylinder barrels and spark plug lengths. It is essential that personnel be familiar with this code as described in the latest edition of Service Instruction No. 1181.

2-5. Damage will result with the use of incorrect piston rings or spark plug lengths. The latest edition of Service Instruction No. 1037 lists the approved piston, piston ring and cylinder assemblies for all models while the latest edition of Service Instruction No. 1042 lists the approved spark plugs. Consult these publications for correct application to you particular installation.

2-6. Valve Operating Mechanism. A conventional type camshaft is located above and parallel to the crankshaft. The camshaft actuates the hydraulic lifter which operates the valve through the push rod and valve rocker. The valve rocker is held in place by the use of the rocker arm fulcrum. The valve spring bears against hardened steel seat and is retained on the valve stem by the use of split key. A rotator cap is used on the stem of the sodium cooled exhaust valve. The hydraulic lifter automatically keeps the valve clearance at zero thus eliminating the need for any valve clearance adjusting mechanism.

2-7. Crankcase. The crankcase consists of two reinforced aluminum alloy castings with the accessory housing as an integral part, fastened together by means of thru bolts, studs and nuts. The mating surfaces are joined without use of gaskets and the main bearing bores are machined for use of precision type bearing inserts.

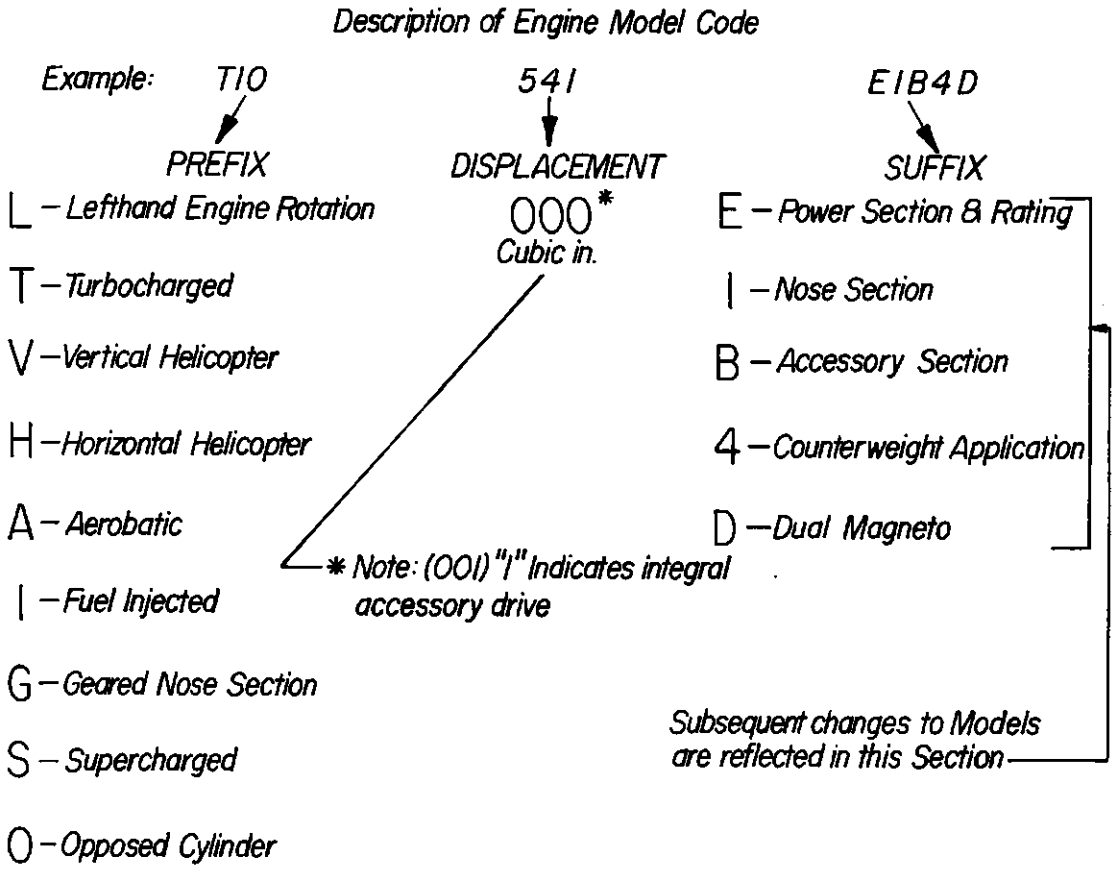


Figure 2-1. Description of Engine Code

2-8. Crankshaft. The crankshaft is made from a chrome nickel molybdenum steel forging and all journal surfaces are nitrided.

2-9. Crankshaft Counterweights. A system of dynamic counterweight, to eliminate torsional vibration, is employed on some four cylinder engines. Consult the latest edition of Service Instruction No. 1012 for the proper combination and location of the crankshaft.

2-10. Connecting Rods. The connecting rods are made in the form of "H" sections from alloy steel forgings. They have replaceable bearing inserts in the crankshaft ends and split type bronze bushings in the piston ends. The bearing caps on the crankshaft end of the rods are retained by two bolts through each cap secured by a nut.

2-11. Pistons. The pistons are machined from an aluminum alloy forging. The piston pin is the full floating type with a plug located in each end of the pin. Consult Service Instruction No. 1037 for proper piston and ring combinations.

2-12. Lubrication System. All subject engines employ a full pressure wet sump lubrication system. See figure 2-3 for schematic of the oil system for a typical 76 series engine.

2-13. Cooling System. These engines are designed to be cooled by air pressure built up on one side of the cylinder and discharged, with accompanying pressure drop, through the cylinder fins.

2-14. Induction System. The engine is equipped with a float type carburetor having a manual mixture control. Particularly good distribution of the fuel-air mixture to each cylinder is obtained through the center zone induction system, which is integral with the oil sump and is submerged in oil, insuring a more uniform vaporization of fuel and aiding in cooling the oil in the sump. From the riser the fuel-air mixture is distributed to each cylinser by individual intake pipes.

2-15. Ignition System. Dual ignition is furnished for the engine by two electrically independent ignition circuits in a single magneto housing. A single four pole rotor provides the magnetic energy for both circuits. Consult the latest edition of Service Instruction No. 1042 for a list of Lycoming approved spark plugs.

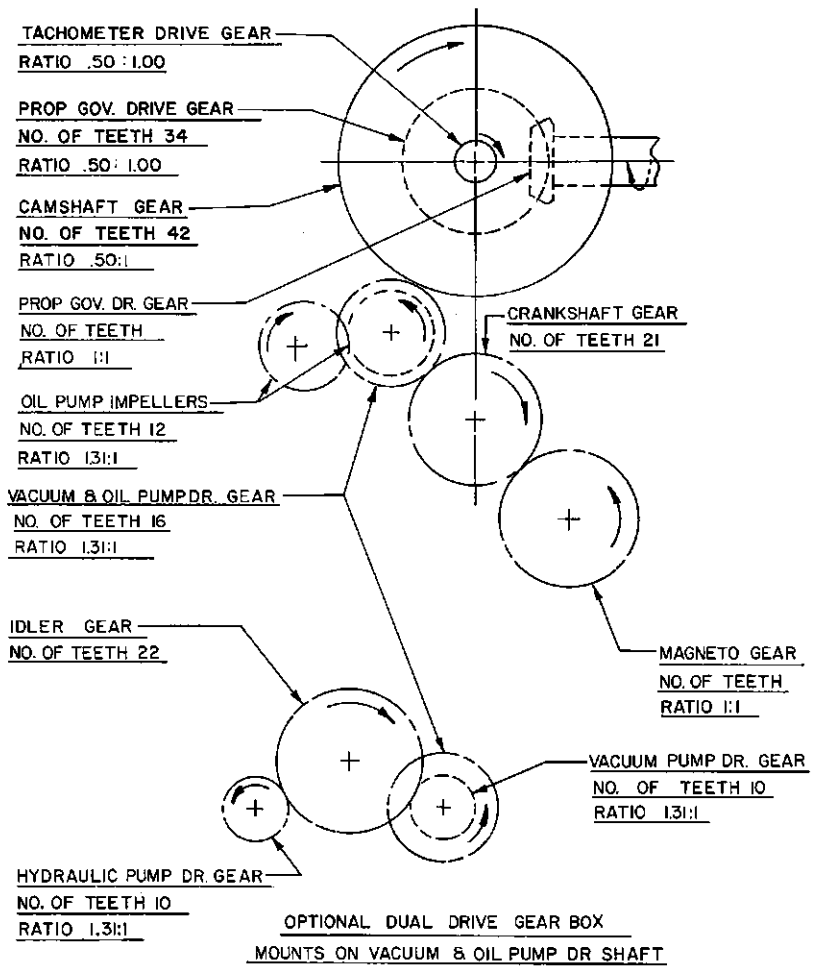


Figure 2-2. Gear Train Diagram - 4 Cylinder Engine

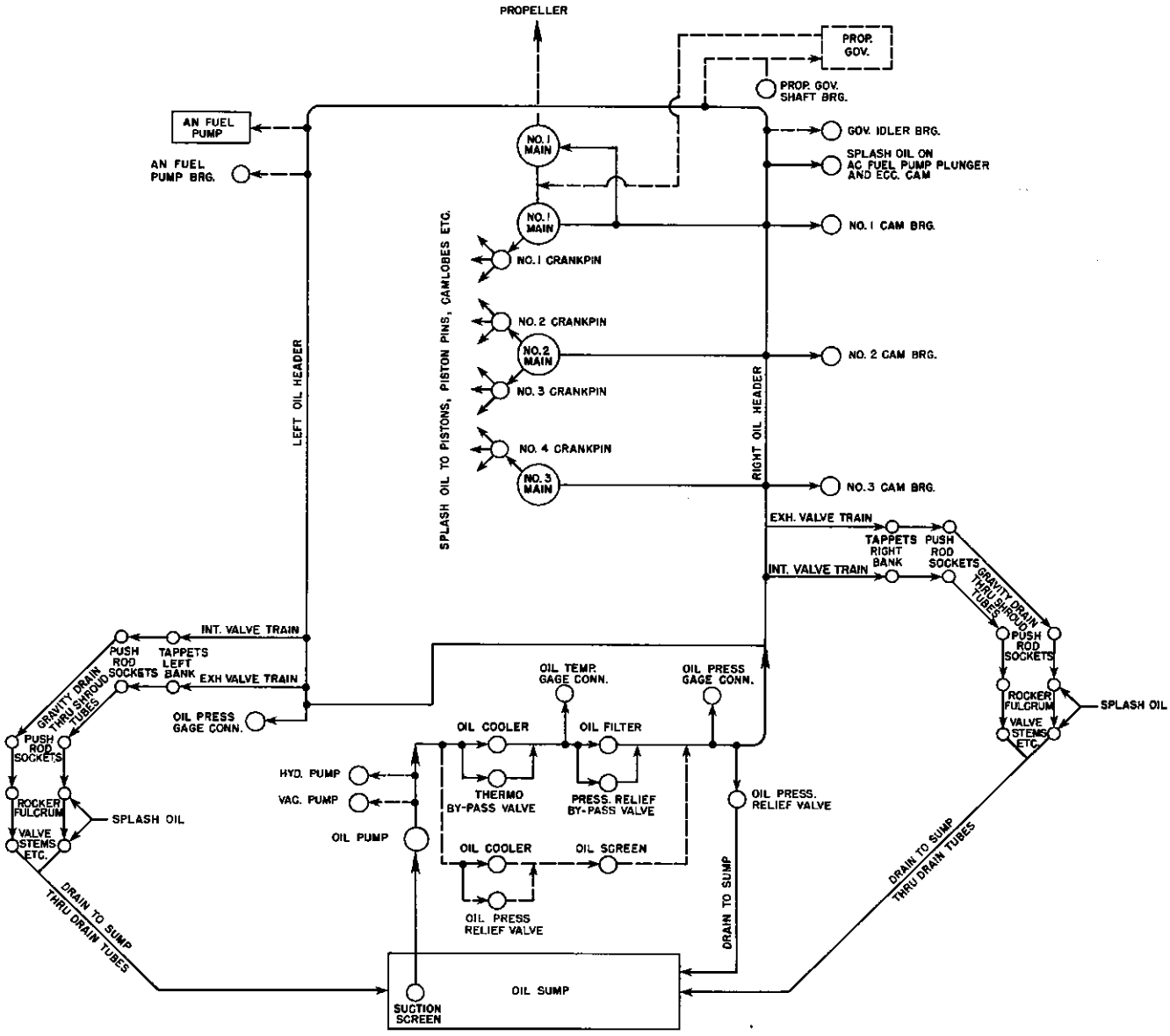


Figure 2-3. Oil Lubrication Schematic

SECTION 3

GENERAL OVERHAUL PROCEDURES

3-1. This manual will describe in separate sections the complete major overhaul procedures for each individual portion of the engine, thus dividing the manual for all practical purposes, into a series of individual handbooks dealing in turn with each component part. Since there are various overhaul practices and instructions of a non-specific nature, which apply equally to all basic engine components, these general instructions will be grouped together and described in this section, thus avoiding repetition.

3-2. No attempt shall be made to include overhaul procedures for the various trade accessories. These accessories are covered in overhaul manuals published by their respective manufacturer. Only such assembly and disassembly as required by engine installation will be covered.

3-3. Just prior to or immediately after removing the engine from the airframe, remove the oil drain plug and drain the oil from the engine.

3-4. Attach the engine lifting cable to the engine and remove from the airframe.

3-5. Attach the engine overhaul adapter (ST-165) on propeller flange. Mount the dynafocal mounting adapters (64898) on the engine mounts and place mounting ring (64759) on mounting adapters.

3-6. Place the skid (ST-278) on engine overhaul stand (ST-162) and lower engine into position on skid and stand. Remove the lifting cable. Specific disassembly instructions are contained in the applicable section for each component.

3-7. Inasmuch as visual inspection should be made while disassembling and immediately after disassembly, all individual parts should be laid out in an orderly manner as they are removed from the engine. No cleaning operation should be performed until this initial visual inspection has been completed. All loose studs, cracked cooling fins, loose or damaged fittings, and the like, should be carefully noted and tagged to prevent their being overlooked during regular inspection.

CLEANING

3-8. It is imperative to clean all engine parts thoroughly to facilitate inspection. Two processes are involved in cleaning engine parts; degreasing to remove dirt and sludge (soft carbon) and the removal of hard carbon by decarbonizing, brushing or scraping and grit-blasting.

3-9. Degreasing. Degreasing is accomplished by immersing or spraying the part in solution of white furnace oil (38-40 specific gravity) or a suitable commercial solvent such as Varsol or Perm-A-Chlor. Operators are warned against the use of solvents with which they are unfamiliar, since there are may products on the market which are injurious to aluminum and magnesium. Extreme care must be exercised if any water-mixed degreasing solutions containing caustic compounds or soap are used. Such compounds, in addition to being potentially dangerous to aluminum and magnesium, may become impregnated in the pores of the metal and cause oil foaming when the engine is returned to service. When using water-mixing solutions therefore, it is imperative that the parts be completely and thoroughly rinsed in clean boiling water after degreasing. Regardless of the method and type of solution used, coat and spray all parts with lubricating oil immediately after cleaning in order to prevent corrosion.

3-10. Removal of Hard Carbon. While the degreasing solution will remove dirt, grease and soft carbon, deposits of hard carbon will almost invariably remain on many interior surfaces. To facilitate removal, these deposits must first be loosened by immersion in a tank containing a decarbonizing solution (usually heated). A great variety of commercial decarbonizing agents are available, including such products as Gunk, Penetrol, Carbrax, Super-Chemaco, Gerlach No. 70, and many others. Decarbonizers, like the degreasing solutions previously mentioned, fall generally into two categories, water-soluble and hydrocarbons, and the same caution concerning the use of water-soluble degreasers is applicable to water-soluble decarbonizers.

CAUTION

Extreme caution should be exercised when using a decarbonizing solution on magnesium castings. It is recommended that the use of heated solutions be avoided unless the operator is thoroughly familiar with the particular solution being used. In addition, the operator is strongly advised against immersing steel and magnesium parts in the same decarbonizing tank, because this practice often results in damage to the magnesium parts from corrosion.

3-11. Decarbonizing will usually loosen most of the hard carbon deposits remaining after degreasing; the complete removal of all hard carbon, however, generally requires brushing, scraping or grit-blasting. All of these operations demand care on the part of the mechanic to avoid damage to machined surfaces. In particular, wire brushes and metal scrapers must never be used on any bearing or contact surface.

3-12. When grit-blasting parts do not use sand or any metallic abrasives. It is recommended instead that mildly abrasive organic substances such as rice baked wheat, plastic pellets, or crushed walnut shells be used. All machines surfaces must, of course, be adequately masked and all openings tightly plugged before blasting. The one exception to this is the valve seats, which may be left unprotected when blasting the cylinder head combustion chamber. It is often advantageous to grit blast the seats, since this will cut the glaze which tends to form (particularly on the exhaust valve seat) thus facilitating subsequent valve seat reconditioning. Under no circumstances

should the piston ring grooves be grit blasted. If necessary, soak the piston in petroleum solvent and scrape with a wooden scraper. When grit-blasting housings, plug all drilled oil passages with rubber plugs or other suitable material to prevent the entrances of foreign matter.

3-13. The decarbonizing solution will generally remove most of the enamel from exterior surfaces. All remaining enamel should be removed by grit-blasting particularly in the crevices between the cylinder cooling fins.

3-14. At the conclusion of cleaning operations, rinse the parts in petroleum solvent, dry and remove any loose particles by air-blasting. Apply a liberal coating of preservative oil to all surfaces.

INSPECTION

3-15. The inspection of engine parts during overhaul is divided into three categories, visual, structural and dimensional. The first two deal with the structural defects in parts while the third is concerned with the size, shape and fit.

3-16. Visual inspection should precede all other inspection procedures. Do not clean any parts prior to visual inspection, since indications of dangerous operating conditions can often be detected from the residual deposits found in some particular recess of the engine.

3-17. Structural failures can be determined by several different methods depending on the part involved. The following are a few of the methods employed: magnetic particle, dye penetrant, penetrant, x-ray and various electronic methods.

3-18. Dimensional inspections should be carried out in accordance with the measurements and tolerances as called out in the Table of Limits (SSP2070).

3-19. It is recommended that an inspection and overhaul form, containing a list of all engine components, be utilized when disassembling an engine. This form should be prepared so that all inspection and overhaul procedures can be checked off and remarks noted. This will also assure that no part is inadvertently overlooked.

3-20. Bearing Surfaces. All bearing surfaces should be examined for scoring, galling and wear. Considerable scratching and light scoring of aluminum bearing surfaces in the engine will do no harm and should not be considered cause for rejection of the part, provided it falls within the clearances set forth in the Table of Limits. Even though the part may come within specified limits it should not be reassembled into the engine unless inspection shows it to be free of other serious defects. Ball bearings should be examined visually and by feel for roughness, flat spots, flaking or pitting of races and for scoring on the outside of the races. All journal surfaces should be checked for galling, scores, misalignment and out-of-round condition. Shafts, pins etc. should be checked for straightness. This may be done in most cases by using vee blocks and a dial indicator.

3-21. Gears. All gears should be examined for evidence of pitting and excessive wear. These conditions are of particular importance when they occur on the involute of the teeth; deep pit marks in this area are sufficient cause to reject the gear. Bearing surfaces of all gears should be free from deep scratches. However, minor abrasions may be dressed out with fine abrasive cloth.

3-22. Corrosion on Stressed Areas. Pitted surfaces in highly stressed areas resulting from corrosion can cause ultimate failure of the part. The following areas should be carefully examined for evidence of such corrosion; interior surfaces of piston pins, the fillets at the edges of crankshaft main and crankpin journal surfaces, and thrust bearing races. If pitting exists on any of the surfaces mentioned to the extent that it cannot be removed by polishing with crocus cloth or other mild abrasive, the part must be rejected.

3-23. Screwed Fittings. Screwed fittings (any parts such as threaded fastenings or plugs) should be inspected for condition of threads. Badly worn or mutilated threads must not be tolerated; the parts should be rejected. However, small defects such as slight nicks or burrs may be dressed out with a small file, fine abrasive cloth, or stone. If the part appears to be distorted, badly galled, or mutilated by over-tightening, or from the use of improper tools, it must be replaced with a new one.

3-24. Magnetic Inspection. All ferro-magnetic steel parts should be inspected by the magnetic particle method. The successful detection of structural failure by magnetic inspection demands skill and experience on the part of operating personnel. It must be remembered that almost any fabricated steel part will shown indications of some kind, and it is important that the operator exercise good judgement in evaluating the indications. Too rigid an interpretation may result in the rejection of a sound part, while on the other hand, a part showing a dangerous indication may be returned to service as a result of a too casual diagnosis. In general, areas of stress concentration must be watched closely for fatigue cracks. These areas include such locations as keyways, gear teeth, splines, roots of threads, small holes and fillets.

3-25. Proper judgement must also be used in determining the amount of current (amperage) applied; too little current will not sufficiently magnetize the part, while too heavy an application will permanently damage the part by overheating and burning thin areas adjacent to the electrodes. Again, skill and experience on the part of the operator are of the utmost importance. Consult the latest edition of Service Instruction No. 1285 for proper amperage.

3-26. Corrosion-Prevention. Upon completion of inspection, coat all steel parts with preservative oil.

REPAIR AND REPLACEMENT

3-27. Damaged Parts. Abnormal damage such as burrs, nicks, scratches, scoring, or galling should be removed with a fine oil stone, crocus cloth, or any similiar abrasive substance. Following any repairs of this type, the part should be carefully cleaned in order to be certain that all abrasive has been removed and then checked with its mating part to assure that the clearances are not ex-

cessive. Flanged surfaces that are bent, warped, or nicked may be repaired by lapping to a true surface on a surface plate. Again the part should be cleaned to be certain that all abrasive has been removed. Defective threads can sometimes be repaired with a suitable die or tap. Small nicks can be removed satisfactorily with Swiss pattern files or small, edged stones, pipe tapped threads should not be tapped deeper in order to clean them up, because this practice will invariably result in an oversized tapped hole. If scratches or galling are removed from a bearing surface of a journal it should be buffed to a high finish. Generally it is impossible to repair cracks; however, welding operations may be performed in some parts of housings, providing the area is not a stressed section of the part. For example, almost any area of a rocker box may be welded, but no part of the cylinder head except the fins may be welded.

3-28. Painted Parts. Parts requiring use of paint for protection or appearance should be painted in accordance with the following recommendations using material from the following list of approved material. Thinner - Toluene or equivalent (AMS3180 or equivalent Federal Spec. TT-T-548). Primer - Zinc chromate (AMS3110 or equivalent MIL-P-8585). Enamel - Phthalate resin type (AMS315C or equivalent MIL-E-7729).

NOTE

All machines bosses should be masked before painting. Do not paint areas under hold down nuts where torque is required.

3-29. Aluminum and Steel Parts. Parts shall be cleaned and degreased prior to painting. Apply one coat zinc chromate primer, thinned with approximately two parts toluene, and air dry. Apply one coat of enamel and bake at 250°F., to 300°F., for one-half hour. Enamel may be allowed to air dry but an inferior finish will result. Parts from which paint has not been removed may be repainted omitting the primer coat.

3-30. Magnesium Parts. Magnesium parts should be cleaned thoroughly with a dichromate treatment prior to painting. This treatment consists of cleaning all traces of oil and grease from the part by using a neutral, non-corrosive degreasing medium followed by a rinse. After which the part is immersed for 45 minutes in a hot dichromate solution (3/4 lbs. of sodium dichromate to one gallon of water at 180°F. to 200°F., quantity as required). The part should then be washed thoroughly in cold running water, dipped in hot water and dried in an air blast. Immediately thereafter the part should be painted with a prime coat and engine enamel in the same manner as prescribed for aluminum parts.

3-31. Shroud Tubes. Shroud tube should be thoroughly cleaned and dipped in zinc chromate primer thinned to spraying consistency. After the primer is dried the shroud tube should be painted on the outside with engine enamel.

3-32. All paint applied in the foregoing operations should preferably be sprayed; however, if it is necessary to use a brush, care should be exercised to avoid an accumulation of pockets of paint.

3-33. Replacement of Studs. Any studs which are bent, broken, damaged or loose, must be replaced. The method of removing studs depends on the type of stud and manner in which it is broken. The procedure for removing and replacing studs is as follows:

a. If there is sufficient thread area available on stud, use a collet grip tool consisting of a tapered collet that threads onto stud and a housing that slips over the collet. Tighten bolt on top of the housing and draw collet into housing to lock puller on the stud with a tight grip.

b. If the collet type tool cannot be used, drill a small hole into the stud. Employ a pilot bushing to guide drill into center of stud when stud is broken beneath the surface of the crankcase. Redrill the hole to enlarge it to accommodate the proper size extractor. Using the extractor, remove the stud.

c. After studs have been removed, check for size and condition of threads in stud holes to determine whether oversize studs must be used for replacement. Coat threads of studs with thread lubricant. Specification JAN-A-669, and drive stud to correct depth by using a suitable stud driver.

3-34. Corrosion-Prevention. At the conclusion of all repair operations and subsequent inspection, coat all steel parts with preservative oil.

REASSEMBLY

3-35. Corrosion-Prevention. Prior to assembly of subassemblies, all parts should be cleaned to remove all traces of preservative oil and accumulated foreign matter. During assembly, cover all steel parts with a heavy coat of preservative oil. This mixture should be used on all machined surfaces, especially on bearing surfaces, cylinder bores and piston rings. The practive of using plain lubricating oil during assembly is not recommended.

3-36. Pre-Lubrication of Parts Prior to Assembly. Many premature failure of parts have been traced directly to improper pre-lubrication of engine assembly. If parts are not properly lubricated, or an inferior lubricant is used, many of the engine parts will become scored before the engine oil goes through its first cycle and has had a change to lubricate the engine. This, of course, will lead to premature parts failure prior to normal service life, and in some cases, lead to engine failure before normal service hours have been accumulated. It is of utmost importance, therefore, that the following recommendations be adhered to a engine assembly. Consult the latest edition of Service Instruction No. 1059.

3-37. Coat the camshaft lobes, face of tappet bodies and rocker tips with lubri-bond (A) or equivalent.

3-38. Coat the valve stems and the interior of the valve guides with Texaco Molytex "O" or equivalent.

3-39. All other parts should be coated with a mixture of 15% pre-lubricant (STP or equivalent) and 85% SAE No. 50 mineral base aviation grade lubricating oil.

3-40. Olite Bushings. During overhaul cleaning operations it is possible to wash the oil from these bushings; also, if a bushing has been replaced and either reamed or broached, its porosity may be affected. Therefore, before the

bushings are reassembled into the engine they must be impregnated by immersing then for at least fifteen minutes in engine oil that has been heated to 140°F.

3-41. It is strongly recommended that all overhaul facilities adapt a firm policy of checking pitch alignment of bevel gears at the same time backlash is adjusted during engine overhaul.

3-42. Table of Limits. The table of limits SSP1776 should be consulted whenever it is desired to determine the backlash and end clearance of gears, the clearance between mating machined parts, the clearance between mating parts which are in close contact with each other and the torque limits for various nuts, screws and fastenings.

3-43. Oil Seals and Gaskets. When building up an engine during major overhaul, replace all oil seals and gaskets throughout the engine. For complete replacement sets of seals and gaskets available for these engines, consult applicable parts catalog.

3-44. Arbitrary Replacement of Parts. It is recommended that certain parts throughout the engine be replaced at normal overhaul regardless of their apparent condition. Consult the latest edition of Service Bulletin No. 240 for information on the replacing of parts at overhaul. Included among these are the following:

All engine oil hose
All oil seals
All gaskets
All circlips, lockplates and retaining rings
Piston rings
All exhaust valves (except Inconel alloy valves)
All exhaust valve retaining keys
Crankshaft sludge tubes (where applicable)
Cylinder fin stabilizers
All bearing inserts (main and connecting rods)
Magneto drive cushions
Stressed bolts and fastenings
  Camshaft gear attaching bolts
  Connecting rod bolts and nuts
  Crankshaft flange bolts
Damaged ignition cable
All laminated shims
Crankshaft counterweight bushings
Piston pin plugs
A.C. diaphragm fuel pumps

SECTION 4

IGNITION SYSTEM

4-1. General. All four cylinder engines are equipped with high tension ignition systems which deliver high tension current directly to the spark plug outlets.

4-2. Dual Magnetos. The magneto features two electrically independent ignition circuits in one housing. A single four pole rotor provides the magnetic energy for both circuits. The magneto uses an impulse coupling to provide reliable ignition at engine cranking speed. At engine cranking speed the impulse coupling automatically retards the magneto until the engine is also at its retard firing position. The spring action of the impulse is then released to spin the rotating magnet and produce the spark to fire the engine. After the engine starts, the impulse coupling acts as a straight drive and magneto fires at the normal firing position of the engine.

4-3. Engine Firing Order. Four cylinder engine 1-3-2-4. Left hand rotation engine 1-4-2-3.

4-4. Ignition Harness. The harness is composed of the magneto terminal assembly, the ignition cable and the spark plug end assembly. The number of lead in the harness assembly is of course determined by the number of cylinders on the engine.

4-5. Spark Plugs. For information relative to approved spark plugs for the subject engine consult the latest edition of Service Instruction No. 1042.

REMOVAL AND DISASSEMBLY

4-6. Ignition Harness. Remove the terminals from the top and bottom spark plug. Detach all clips, clamps and grommet plates securing the leads to the engine. The ignition harness on the dual magneto cannot be removed from the magneto without removing the cover from the magneto.

NOTE

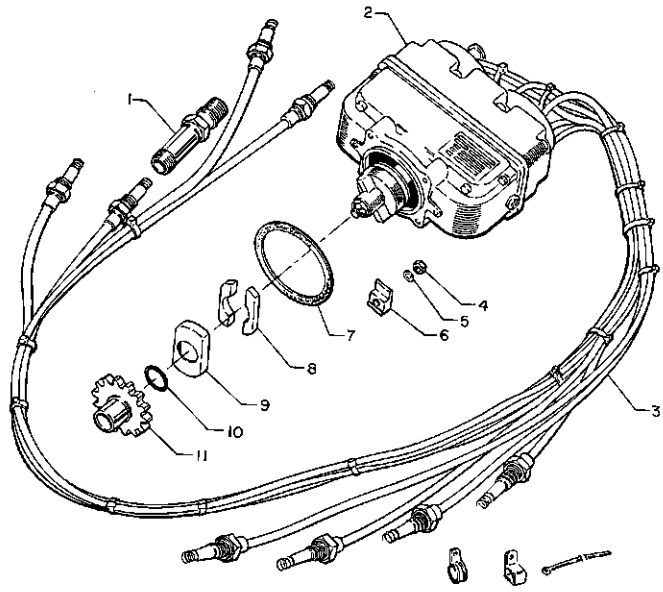
Before detaching clamps, clips, grommet plates etc., mark the location of each. Differences in various installations make it impossible for this manual to point out the correct attaching points.

4-7. Magneto. Loosen and remove the two 5/16-18 nuts, lockwasher and clamps which hold the magneto to engine. Remove magneto and harness from the engine.

INSPECTION

4-8. Ignition Harness. Unless the harness assembly is in obviously new condition and is known to have been recently installed, it is recommended that the harness be replaced at overhaul.

4-9. Magnetos. As previously mentioned, this manual will not endeavor to describe overhaul procedures for trade



1. Spark Plug
2. Magneto
3. Ignition Harness
4. Nut
5. Lockwasher
6. Clamp
7. Gasket
8. Cushion
9. Cushion Retainer
10. "O" Ring Seal
11. Gear

Figure 4-1. Magneto and Harness Assembly

accessories. Consult the manufacturer's applicable overhaul manual for inspection procedures.

REPAIR AND REPLACEMENT

4-10. Ignition Harness. Unless the harness assembly is in obviously new condition and is known to have been recently installed, it is recommended that the harness be replaced at overhaul. Lycoming does supply individual leads in two lengths, (48 or 72 inch) finished at the spark plug end and available from your local distributor. The following steps will describe the procedure for replacing a lead.

4-11. Removal of Condemned Lead. Remove clamps and brackets from applicable lead assembly. Cut cable ties from assembly and discard. Remove the cover from magneto.

4-12. Cut off condemned lead flush with the outer surface of the cover. Grip eyelet of lead with a pair of pliers and pull short length of conductor out of grommet and cover. Using a 3 inch long, 0.270 inch diameter drift, applied at outer surface of cover, drive out tapered ferrule and remaining pieces of insulation and shielding.

4-13. Replacement of Condemned Lead. To replace a condemned lead, proceed as follows:

a. Thread pre-stripped end of lead through magneto cover.

b. Scrape 1/2 inch of blue coating from braid being careful not to cut braid.

c. Push back braid and thread a new ferrule over wire and under braid until braid covers knurling. See figure 4-2.

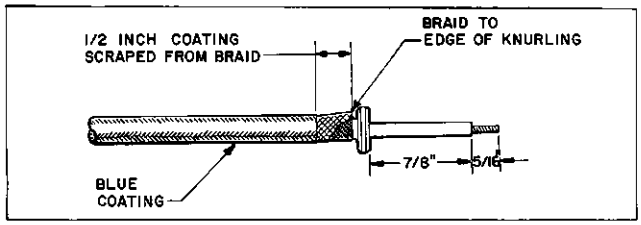


Figure 4-2. Ferrule Position Under Braid

d. Pull the lead back into the cover to wedge the braid between the taper of the cover and ferrule.

e. Place cover on proper support and seat ferrule using Bendix tool 11-7074 (ferrule seat tool) and mallet. Ferrule must be driven straight into cover and fully seated.

f. Place grommet over pre-stripped end of lead. Place new eyelet on conductor and cramp.

g. Pull lead to seat parts in proper place and remove slack from braid.

4-14. Magnetos. As previously mentioned, this overhaul manual will not endeavor to describe overhaul procedures for trade accessories. Consult the manufacturer's applicable manual for overhaul procedures.

REASSEMBLY

4-15. Magnetos. Before assembling the magneto gear or drive coupling (whichever is applicable) to the magneto drive shaft, apply a light coating of Go-Jo-No-Lox No. 72 compound or equivalent to the tapered section of the magneto drive shaft. This compound is manufactured by Gojer, Inc. Akron, Ohio, 44309. After assembling gear or coupling, wipe excess compound from the drive shaft.

4-16. See figure 4-1. Assemble "o" ring in groove on the inside of magneto gear. Install gear in bushing of crankcase. Install magneto drive cushion retainer in the magneto gear. Assemble magneto drive cushions in retainer. Install magneto gasket and magneto. Install clamps, lockwasher, and 5/16 plain nut. Tighten slightly until the final timing is completed.

4-17. Timing Magneto to Engine. Rotate the crankshaft in direction of normal rotation until no. 1 cylinder is on the compression stroke and approximately 35° BTC. Clamp the ignition timing pointer (64697) on the advance timing mark on the rear of the starter ring gear. The starter ring gear may be marked at 20° and 25°. Consult engine nameplate for correct advance timing mark to use. Continue rotating the crankshaft until the timing pointer and the parting flange of the crankcase align. Leave the crankshaft in this position until the magneto is installed.

4-18. In the event that an igntion timing pointer is not available an alternate method may be used. Rotate the crankshaft in direction of normal rotation until no. 1 cylinder is on the compression stroke and continue rotating the crankshaft until the correct advance timing mark on the front of the starter ring gear is in exact alignment with the small drilled hole located at the two o'clock position on the front face of the starter housing. Leave the crankshaft in this position until the magneto is installed.

NOTE

The advance timing mark is specified on the engine nameplate.

4-19. Remove the inspection plug from the magneto and rotate the drive shaft in direction of normal rotation until the painted chamfered tooth on the large distributor gear is aligned in the center of the inspection window. The shaft on the impulse coupling magnetos can be turned by depressing the pawl on the coupling. Be sure the magneto gear does not move from this position and secure each magneto finger tight. The magnetos are now ready for final timing.

4-20. Final Timing D-2000 Dual Magneto. Using a battery power timing light, attach the red lead of timing light to the left switch terminal, green lead of timing light to right switch, black lead to an unpainted portion of the engine. Rotate the magneto in its mounting flange to a point where the light comes on, then slowly turn it in the opposite direction until the red light goes out. Tighten the magneto clamps evenly.

4-21. Back off the crankshaft approximately 10° so the timing light goes on. Bring the crankshaft slowly back in the direction of normal rotation until red light goes out. Indicating the left main breaker opening at no. 1 firing

position. The right main breaker monitored by the green light must open within + 2 engine degrees of the no. 1 firing position. Completely tighten nuts to specified torque.

4-22. Ignition Harness. Prior to inserting spark plug lead in plug barrel use flurocarbon spray MS-S122 (available from Miller-Stephenson Chemical Co., 16 Sugar Hollow Rd., Danbury, Conn. 06813). Assemble the leads into proper spark plug. Consult wiring diagram figure 4-3. Torque nuts to 110 - 120 inch pounds.

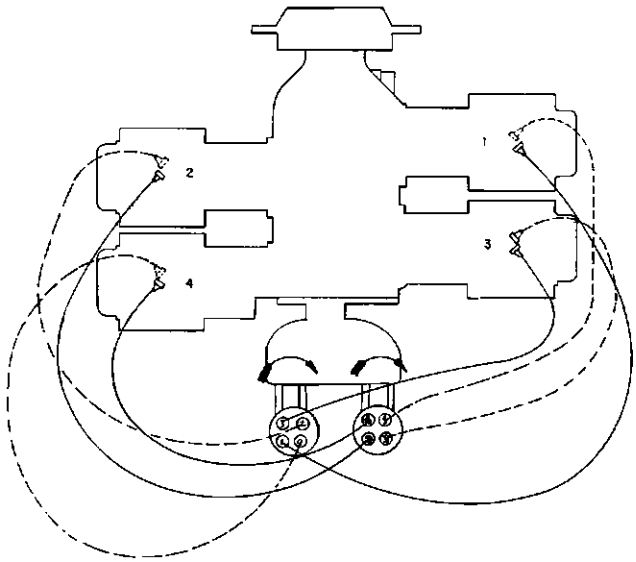


Figure 4-3. Ignition Wiring Diagram
(Four Cylinder Engine)

SECTION 5

CYLINDERS, PISTONS AND VALVE TRAIN

5-1. The piston, being a reciprocating part, is normally grouped with the crankshaft in a theoretical breakdown of the engine into basic components. However, from a practical standpoint, it is felt that the piston should be considered with the cylinder insofar as overhaul procedures are concerned. For example, the basic configuration of the engine requires the removal and reassembly of the pistons at the same time the cylinders are removed or replaced.

5-2. For the purposes of the manual, the valve train will be considered as all parts of the valve operating mechanism beyond the camshaft, beginning with the hydraulic lifter assembly.

5-3. Although subject engines employ parallel valve cylinders with down exhaust, basic overhaul procedures are the same for all cylinders. The overhaul procedures described in this section will be applicable to all cylinder assemblies except as noted.

5-4. Either plain steel, chrome plated, or nitride hardened steel cylinders may be employed on the engines discussed in this overhaul manual. The color code for these cylinders is as follows:

a. Plain steel	All grey
b. Chrome plated	Orange paint on cylinder fins below spark plug hole.
c. Nitride hardened steel	Blue paint on cylinder fins below spark plug hole.
d. .010 inch oversize plain cylinders	Green when applied to customer overhaul engines.
e. .020 inch oversize plain cylinders	Yellow when applied to customer overhaul engines.

NOTE

A yellow color, on fins ABOVE spark plug hole, indicates that long reach spark plugs are used.

REMOVAL FROM ENGINE

5-5. It is assumed that the ignition harness, intake pipes and primer lines have been previously removed.

5-6. Intercylinder Baffles. (where applicable) Using the intercylinder baffle tool (64885), release the baffle retaining hook so that it disengages the retainer. Remove the intercylinder baffle and hook from between the cylinders.

5-7. Oil Drain Tubes. Loosen hose clamps at lower end of tube and slide tube out of hose. Loosen gland nut at cylinder head fitting and remove drain tube.

5-8. Cylinder. See figure 5-1. Remove the rocker box cover (13) and gaskets (12). Rotate the crankshaft to place the piston of no. 1 cylinder at top center of the compression stroke. This will place the valves in closed position and the piston extended away from the crankcase to avoid damage when cylinder is removed.

5-9. Remove the 5/16-24 self-locking nut (11) from the valve rocker fulcrum (10). Remove the valve rocker arms and fulcrum from cylinder. Remove the square washers (9) from the stud. Remove the push rods (2) by grasping the end and pulling through the shroud tube. Remove the 1/4-20 plain nut (7), lockplate (6) and spring (5). Pull shroud tubes out through the cylinder head and discard the shroud tube seals (3).

5-10. Remove the cylinder base hold-down nuts; then remove the cylinder by pulling straight away from the crankcase. As the cylinder is pulled away, catch and hold the piston to prevent it from falling against the crankcase and being damaged. Discard the cylinder base oil seal rings.

5-11. Pistons. Remove piston pin plugs from the piston. Using a piston pin puller (64843), pull pin from piston and remove piston.

CAUTION

After the removal of a cylinder and piston the connecting rod must be supported to prevent damage to the rod and crankcase. This is done by supporting each connecting rod with torque hold down plate ST-222, rubber band (discarded cylinder base on seal rings) looped around the cylinder base studs as shown in figure 5-3.

5-12. Removal of the other cylinders and pistons may be done in any desired order, but less turning of the crankshaft is involved if the cylinders are removed successively in the engine's firing order 1-3-2-4. Left hand rotation firing order 1-4-2-3.

5-13. Hydraulic Lifters. Remove the hydraulic lifter from the crankcase. Place each lifter as removed from crankcase in its proper location in the cleaning basket. The hydraulic lifters must be replaced in the same location in crankcase from which they were removed.

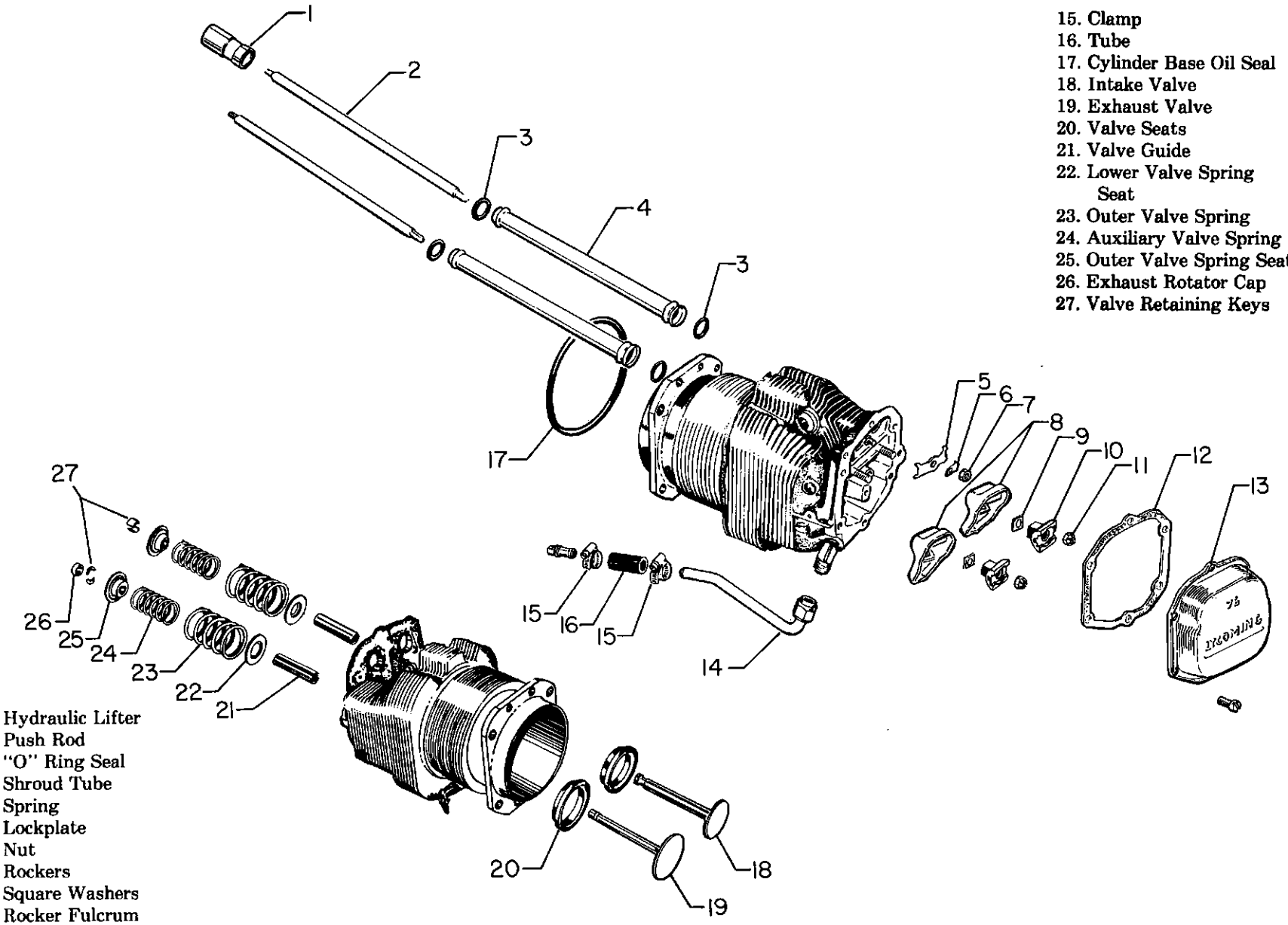
DISASSEMBLY

5-14. Cylinders. Place cylinder over the cylinder holding block (64526-2), assemble valve spring compressor (ST-419) on cylinder, and compress valve springs far enough to remove the valve retaining keys.

NOTE

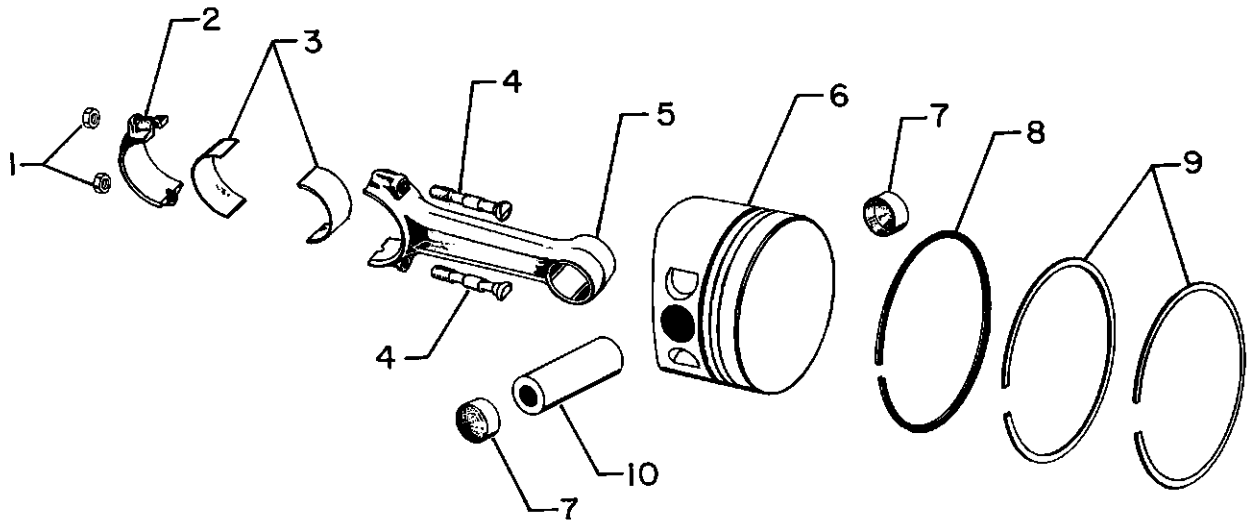
If keys are stuck tight in spring seat, a light blow with a leather mallet on top of compressor will release keys.

5-15. Remove all valve spring seats and springs from rocker box, keeping parts for each valve separate. Hold valves by the stem to keep them from dropping out of the cylinder, and remove cylinder from holding block. Now reach inside of cylinder and remove valves. If difficulty is experienced in pulling the tops of the valve stems through the valve guides, push the valves back in position and clean the carbon from the stems.



1. Hydraulic Lifter
2. Push Rod
3. "O" Ring Seal
4. Shroud Tube
5. Spring
6. Lockplate
7. Nut
8. Rockers
9. Square Washers
10. Rocker Fulcrum
11. Self-locking Nut
12. Gasket
13. Rocker Box Cover
14. Drain Back Tube
15. Clamp
16. Tube
17. Cylinder Base Oil Seal
18. Intake Valve
19. Exhaust Valve
20. Valve Seats
21. Valve Guide
22. Lower Valve Spring Seat
23. Outer Valve Spring
24. Auxiliary Valve Spring
25. Outer Valve Spring Seat
26. Exhaust Rotator Cap
27. Valve Retaining Keys

Figure 5-1. Cylinder Assembly



1. Nut
2. Connecting Rod Cap
3. Bearing Insert
4. Connecting Rod Bolt
5. Connecting Rod
6. Piston
7. Piston Pin Plug
8. Oil Regulating Ring
9. Compression Ring
10. Piston Pin

Figure 5-2. Piston and Connecting Rod Assembly

CAUTION

Do not drive the valves through the guides.

5-16. Place each valve, with its springs, seats and keys in its proper compartment of the cleaning and inspection basket (64553). No further disassembly of the cylinder is necessary unless inspection warrants the replacement of valve guides, valve seat, or primer nipple.

5-17. Pistons. Using the piston ring expander (64713), remove the rings from all pistons. Remove the rings in order, starting with the top ring and working down. Be careful not to scratch or score piston when removing rings.

5-18. Hydraulic Lifters. Place the hydraulic lifter assembly in the fixture (ST-233). Compress the plunger assembly until the spring clip is loose. Remove the spring clip from the lifter body. Remove the socket and plunger assembly from the body. In the event that the fixture is not available, the hydraulic lifter may be disassembled as follows: Insert a suitable tool into the socket and push the plunger assembly until oil is forced out of the vent hole and the pressure is released from the spring clip. Using a pair of needle nose pliers remove the spring clip from the lifter assembly. Remove the socket and plunger assembly from the lifter body.

NOTE

Some hydraulic lifters employ a circlip retaining ring in place of the spring clip as stated in paragraph 5-18.

CLEANING

5-19. Clean all cylinder, piston and valve train parts in accordance with the general instructions described in Section 3. Specific instructions follow:

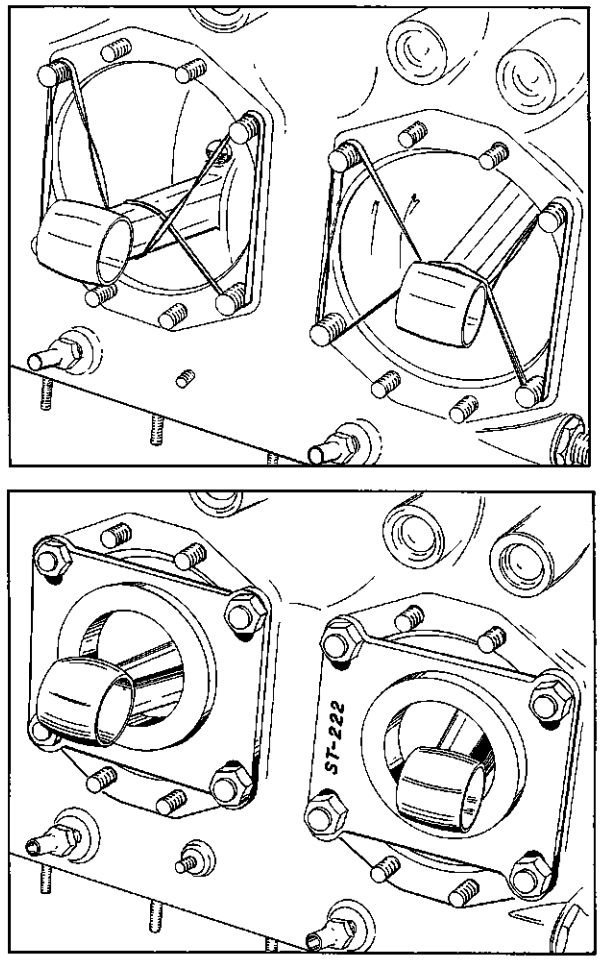


Figure 5-3. Two Methods of Supporting Connecting Rods

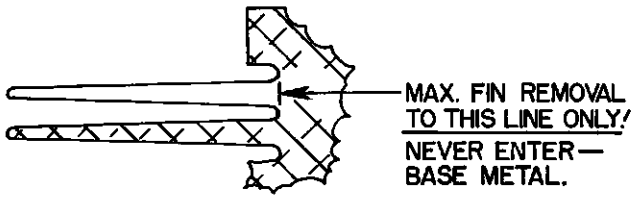


Figure 5-4. Maximum Fin Removal

5-20. Hydraulic Lifters. Use the cleaning basket in order to keep the valve operating mechanism parts separate. Dip the basket, with all parts contained in their proper compartment, in petroleum solvent.

CAUTION

It is imperative that various parts of each lifter assembly be kept together during the overhaul operations, in order that all component parts may be reassembled with their original mating parts and each completed assembly inserted in its original location in the crankcase. In the event parts are intermixed, discard, and install new assemblies.

INSPECTION

5-21. Inspect all cylinder, piston and valve train parts in accordance with the general instructions described in Section 3. Specific instructions will be found in the following paragraphs, possible revisions will be found later in the section.

5-22. Cylinder Head (Visual Inspection). Examine the cylinder head thoroughly, checking for the following possible defects.

a. Loose, scored, pitted or otherwise damaged valve seats. (Mark for replacement).

b. Loose or damaged studs. (Replace with 0.003, 0.007 or 0.012 oversize studs).

c. Loose or damaged spark plug heli-coil inserts. (Mark for replacement with oversize insert.

d. Loose, cracked or scored valve guides. (Mark for replacement).

e. Nicked, scored or dented mounting pads. (Intake and exhaust ports, rocker box covers.)

f. Cooling fins. The following standards shall prevail insofar as acceptance or rejection of cylinder heads are concerned.

1. Cracked fins.

(a) Fin adjacent to the exhaust port flange.

(1) Stop drilling, a 3/16 inch diameter hole through the end of the crack is permissible providing the end of the crack is at least 1/4 inch from the base of the metal.

(2) Fin removal to eliminate crack and reduce vibrating mass is permitted provided:

aa. Maximum removal is no more than one half the total fin width.

bb. Maximum removal in accordance with figure 5-4.

cc. No burrs or sharp edges are permitted.

dd. Minimum fillet at the root of the removed portion of the fin in one quarter inch radius. Minimum corner at top of fin adjacent to the removed portion is one half inch radius.

(b) Fins other than the above may be accepted provided not more than one crack per fin and its depth is no closer than 1/4 inch from the base of the metal and a fin stabilizer is used to reduce vibration and further deepening of the crack.

2. Physically damaged, broken or bent fins.

(a) The blended area for any one fin shall not exceed 3/8 square inches, nor 3/8 inch in depth.

(b) No more than two blended areas on any one fin.

(c) No more than four blended fins on the push rod side of the head. No more than six blended fins on the anti-push rod side of the head.

(d) In addition to the above, it is recommended that a fluorescent penetrant inspection of the cylinder be made. Pay particular attention to the following areas.

(1) Between the 15th and 20th cylinder fin (counting from the top) on exhaust port side of cylinder.

(2) The area around the lower spark plug counterbore.

5-23. Cylinder Head (Dimensional Inspection). Check the ID of each intake valve guide (it is recommended that exhaust valve guides be replaced at overhaul) with the flat plug rejection gage (ST-81). Check the diameter and out-of-roundness of the guide bore by checking with the gage at a minimum of two position 90° apart. If the gage enters the guide at any of the positions tested, mark the guide for replacement.

5-24. Cylinder Barrel (Visual Inspection). In addition to a thorough inspection of the cylinder barrel to ascertain its general condition, make the following specific checks.

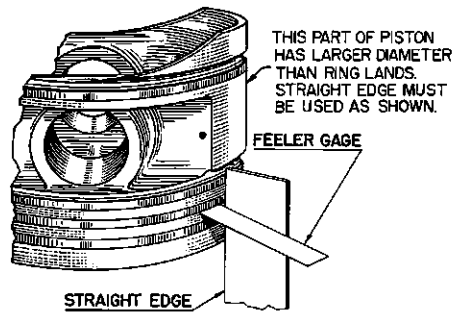


Figure 5-5. Method of Checking Piston Ring Side Clearance

a. Cooling Fins. It is recommended that notches or nicks be profiled with a hand grinder or file. A cracked cylinder barrel is cause for rejection of the cylinder.

b. Cylinder Skirt. Replace any cylinder having a bent, cracked, broken or corroded skirt.

c. Check mounting flange for cracks, nicks, warping, or corrosion.

d. Inspect interior of barrel for scoring or corrosion. Minor damage can be repaired by regrinding or honing; deep scoring or pitting, however, is cause for rejection of the cylinder.

e. Inspect interior of nitrided barrel for barrel glaze and a possible ring wear step at the point where the piston reverses travel at the top of the stroke. Repair of these items is fully described in Service Instruction No. 1047.

5-25. Cylinder Barrel (Dimensional Inspection). Dimensional inspection of the barrel consists of the following measurements (the numbers in parenthesis refer to the applicable reference numbers in the Table of Limits):

a. Fit between piston skirt and cylinder (519).

b. Maximum taper of cylinder walls (520).

c. Maximum out-of-roundness (521).

d. Bore diameter (522).

NOTE

All measurements involving cylinder barrel diameters must be taken at a minimum of two position 90° apart in the particular plane being measured. All measurements of nitrided barrels must be made in the straight portion below the starting point of the choke, or at least two inches below the top of the barrel.

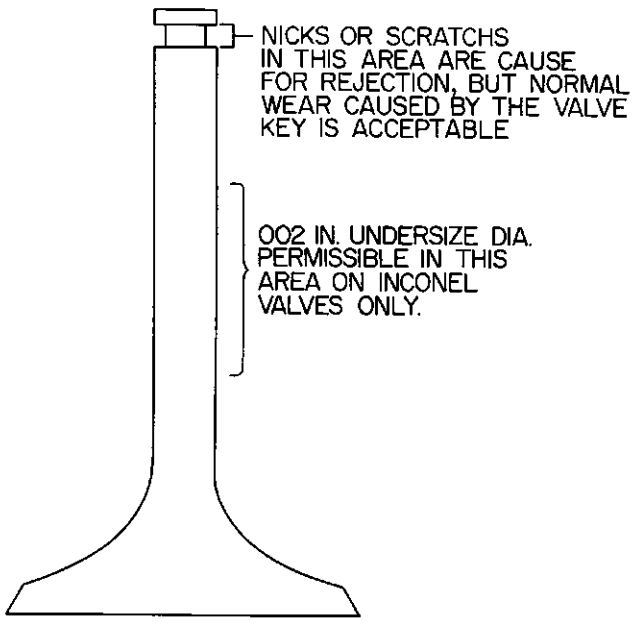


Figure 5-6. Area to Inspect Valve Stems

5-26. Piston (Visual Inspection). Examine the top of the piston for excessive pitting, cavaties or surface distortion. The latter may be evidence of detonation, particularly if the piston has been in service for a relatively short time. Other critical points which must receive thorough visual examination are the piston ring lands and grooves, piston pin holes, and piston pin holes bosses.

5-27. Piston (Dimensional Inspection). Make the following dimensional checks on each piston (the numbers in parenthesis refer to the applicable reference numbers in the Table of Limits).

a. Side clearance between piston ring and piston (514, 515 and 516). Pistons for Lycoming opposed engines are ground with a slight taper from the skirt to the head, with the exception of the lands between the top compression and oil control rings, which are ground parallel. The clearance on wedge type compression rings therefore must be measured as shown in figure 5-4 in order to obtain a true check of the side clearance.

b. Inside diameter of piston pin hole (512).

c. Clearance between piston skirt and cylinder and piston diameter at top and bottom (519).

5-28. Piston Pin and Piston Pin Plugs. Check OD of piston pin against ID of hole in piston (reference 512, Table of Limits). Measure fit between piston and plugs and check OD of plugs (reference 513, Table of Limits). Examine interior surfaces of piston pin for corrosion or pitting.

5-29. Valve Rockers. Damaged, badly worn, pitted or scored top and push rod sockets warrant replacement of the rocker. Rockers that are scored at the point of contact with the fulcrum must be replaced.

5-30. Push Rods. Inspect push rods for wear or looseness of ball ends. If ball ends are loose, replace the rod. Rod must be straight within .010 inch.

5-31. Valves. Remove the valves from the cylinder and clean to remove soft carbon and examine visually for physical damage, damage due to burning or corrosion. Valves that indicate damage of this nature must not be reused.

NOTE

Exhaust valves (except Inconel exhaust valves) should never be reused. Inconel exhaust valves may be reused if they comply with requirements of the following inspection.

5-32. Do not reuse valve in which stem diameter midway of valve measures less than that measured at the key end; excepting inconel valves which may be 0.002 inch undersize on stem diameter as shown in figure 5-6.

5-33. Check runout of valve face. See figure 5-7. Total runout must not exceed .0015 inch. Do not reuse any valves that exceed this limit.

5-34. Measure edge thickness of intake valve heads. See figure 5-7. If, after refacing, "A" is less than .060 the valve must not be reused.

NOTE

The edge of intake valve heads are generally formed as shown is figure 5-8. The thickness "A" can best be measured with an optical comparator; however, it can be measured with sufficient accuracy by means of a dial indicator and a surface plate, as shown in figure 5-9.

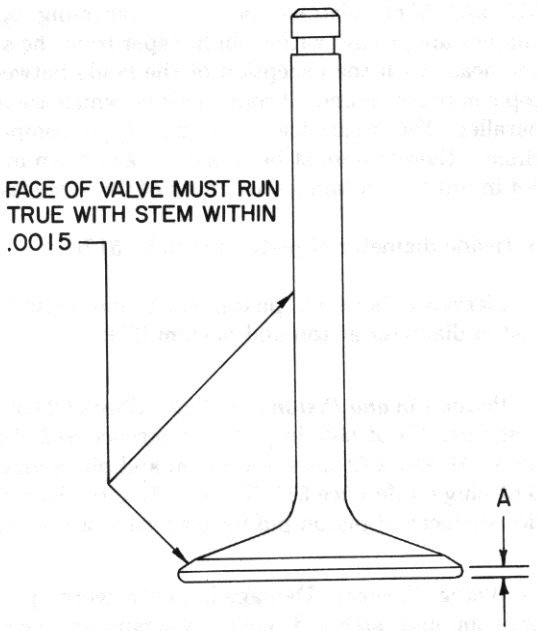


Figure 5-7. Valve Showing Locations for Checking Run-Out and Section for Measuring Edge Thickness

5-35. Using an optical magnifier, examine the valve in the stem area and the tip for evidence of cracks, nicks, tool marks, or other indications of damage. Damage of this nature seriously weakens the valve, making it liable to failure. Any valve having a nick, with ragged edges more than 1/16 inch in length should not be reused. A nick or tool mark of any sort in the keeper groove of an exhaust valve is sufficient reason for not reusing the valve. See figure 5-6.

5-36. If superficial nicks and scratches in the valve indicate that the valve might be cracked, it should be inspected by a magnetic particle or dye penetrant method. Dye penetrant procedures should be carried out strictly within the recommendation of the manufacturer of the penetrant.

5-37. Critical areas include the face and tip both of which should be examined for pitting and excessive wear. Minor pitting on valve faces can sometimes be removed by regrinding; otherwise the valve should be rejected. Replace any valve that has operated with a collapsed hydraulic tappet, regardless of the number of hours on the

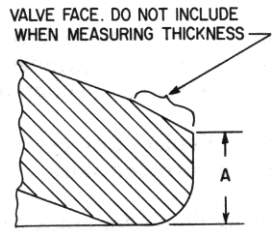


Figure 5-8. Section Through Edge of Valve

valve. (See inspection of hydraulic lifters.) Check the clearance between the valve stem and guide (reference 528, Table of Limits for exhaust valves, and reference 529 for intake valves).

5-38. Inspect the hydraulic lifter for evidence of the following wear patterns:

a. Spalling - If the face of the lifter shows small nicks or indentations near the center of the face it is considered pitted or spalled. The pitting will constitute small irregular holes, not to be confused with Rockwell hardness check marks, which are round and even. The area covered by spalling will vary with different lifter, but regardless of the degrees of spalling the lifter must be replaced.

b. Scoring - The lifter face is scored when small scratch-like lines are found near the outer edge of the face and will appear to radiate from the center. Other scoring marks may be present and extend to the center of the face. The lifter with this condition must be replaced.

c. Lifter Face Wear - The operation of the lifter provides that the lifter rotates during the wiping action of the camshaft lobe. This action will form a groove or path across the face of the lifter. Deeper penetration will be noted at the center of the face. If the wear is excessive it will be noticeable to the touch, if a fingernail is rubbed across the lifter face. This condition reguires replacement of the lifter.

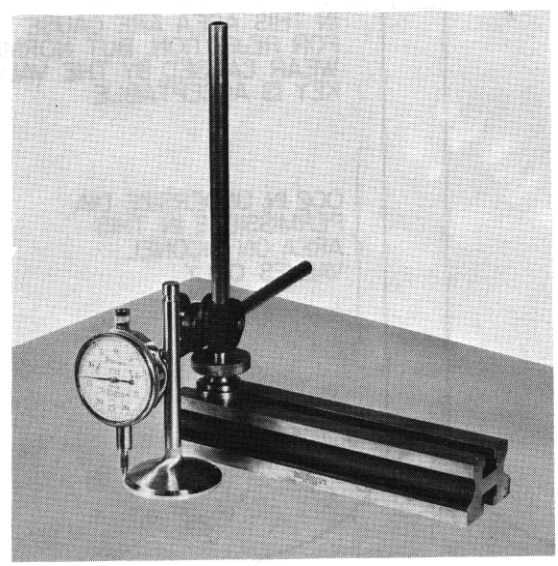


Figure 5-9. Method of Checking Valve Edge Thickness with Dial Indicator

NOTE

Indications of non rotation of the hydraulic lifters is not cause for rejection unless the lifter face is marked as described in Par. 5-38 a, b or c.

5-39. When the hydraulic lifter is rejected because of spalling or scoring, a visual inspection of the nose of the cam lobe with a magnifying glass (min. 10 power) must be made. Any indication of distress surface irregularity, or feathering of the edge of the cam lobe is cause for rejection of the camshaft.

NOTE

Whenever the camshaft is replaced, either with one that is reconditioned by grinding the cam lobes or a new camshaft, all hydraulic lifters must be replaced with new lifters.

5-40. Valve Springs. Check the condition of all valve springs on a suitable spring tester, using the loads and deflections as given in reference 800 and 801, Table of Limits.

REPAIR AND REPLACEMENT

5-41. General instructions for the repair of cylinder, piston and valve train parts will be found in Section 3. Specific instructions follow.

5-42. Spark Plug Thread Insert. Spark plug thread inserts which were rejected during inspection are removed and replaced as described in the following paragraphs.

5-43. Insert the extracting tool (64595) in the spark plug hole so that the edges of the tool cut into the top thread of the insert. Rotate the tool in a counter-clockwise direction, unscrewing the insert from the hole.

5-44. A new insert may be installed by use of the inserting tool (64594). Withdraw the mandrel part of the tool beyond the recessed section of its sleeve. The insert may then be assembled into the recess and the mandrel advanced to engage its slotted end with the tang of the insert. Rotate the mandrel clockwise and press forward slightly; this will engage the insert in threaded end of sleeve. Continue to rotate the mandrel while holding the sleeve thus securing the insert firmly on the inserting tool. The insert may then be wound through the threaded portion of the sleeve within one half turn from the end of the coil.

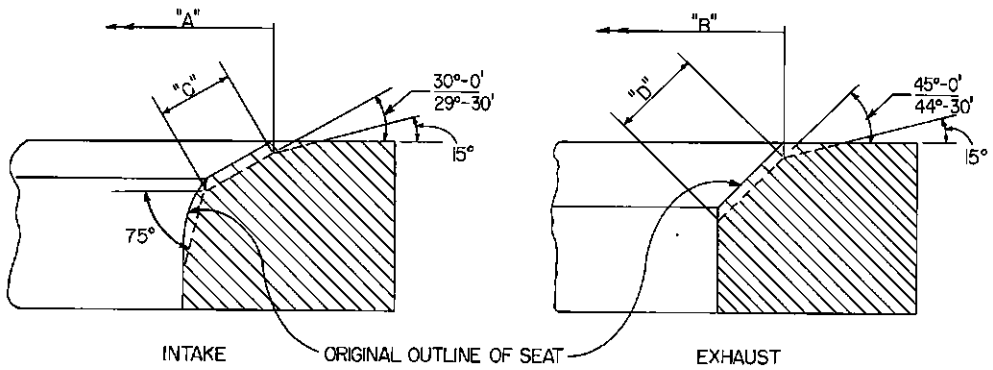
5-45. The adjustable brass screw on the sleeve tends to act as a brake, preventing the insert from unwinding. It is important that the insert be kept tight on the mandrel to facilitate its assembly in the threads of the cylinder head. The insert should be wound so that the adjacent turns of the insert are in contact with each other. This will eliminate the possibility of crossed threads.

NOTE

When inspection reveals the necessity of replacing a spark plug heli-coil insert, it must be replaced with a .010 inch oversize insert. A .010 inch bottoming tap (64596-1) is available.

5-46. When screwing the insert into the hole in the cylinder head, be sure that the first coil picks up the first thread. As the tool is turned,the insert will advance into the hole. When the face of the sleeve is approximately 1/16 inch from the face of the boss, the inserting tool should be held tightly by the handle and the sleeve rotated counterclockwise with the other hand, freeing the last half-turn of the insert. By sliding the sleeve toward the top of the mandrel, the end of the insert can be seen projecting above the boss. The mandrel should then be rotated in a clockwise direction until the insert disappears from sight. When this position is reached, the turning action should be stopped and the tool withdrawn. The top of the insert will be approximately one half turn from the face of the boss. However, if it is not, the tool should be reassembled and the insert turned until it is about one half turn from the face of the boss.

5-47. The tang of the insert can be broken off with needle-nose pliers at the location of the notch. Then using the expanding tool (64593), secure the insert firmly in the spark plug holes. The limit of expansion can be kept within the thread gage limits by fixing the stop nut on the



MODEL	"A" INTAKE	"B" EXHAUST	"C" INTAKE	"D" EXHAUST
0-320-H	2.154/2.155	1.740/1.750	.076/.117	.058/.077
O, LO-360-E	2.154/2.155	1.740/1.750	.076/.117	.058/.077

Figure 5-10. Valve Seat Dimensions for Reconditioning

expanding tool at the correct position. After expanding the insert, it may be staked by assembling the staking sleeve over the mandrel until the sleeve meets the boss. A slight blow on the top of the sleeve will impress a slight chamfered edge around the periphery of the tapped holes. The staking sleeve may then be removed and adjusting screw released, and the expanding mandrel removed from the insert.

5-48. Grinding Valve Seats. See figure 5-10. The ID of the valve guide is used as a piloting surface for all valve seat reconditioning operations. Grind valve seats, using suitable grinding equipment, to 30° angle on intake valve seats and 45° angle on exhaust valve seats. Grind to the dimensions called out in figure 5-10. Proceed in the following manner.

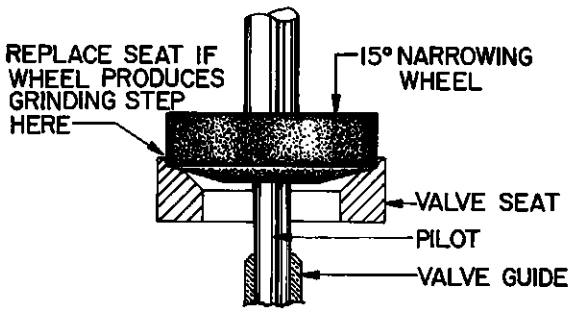


Figure 5-11. Rejection of Valve Seat

5-49. On intake valve seats, use a 15° grinding wheel to grind the top surfaces of the valve seat to produce the outer face diameter (dimension "A"). Bring the face of the intake valve seats to the specified width (dimension "C") by narrowing the throat with a 75° wheel.

5-50. On exhaust valve seats, use a 15° grinding wheel to grind the top surface of the valve seats to produce the outer face diameter (dimension "B"). The width of the exhaust valve seats should now conform to dimension "D".

5-51. If seat wear has progressed to the extent that the entire face of the 15° narrowing wheel must be brought into contact with the seat in order to achieve the specified diameter, the seat must be replaced. (See figure 5-11.)

5-52. Valve Seat Removal and Replacement. Valve seats that are loose, damaged or worn to the extent that they cannort be reground to the dimensions shown in figure 5-10 must be replaced.

NOTE

When it is necessary to replace intake or exhaust valve seats, the recess in the cylinder head must be cut .010, .020 or .030 oversize and the corresponding oversize seat installed.

5-53. Valve Seats. "Allison" type seat employed on all currect subject engines.

5-54. Place the applicable valve seat replacement fixture on a suitable surface and fasten securely. Fabricate a removal tool in accordance with the material and dimensions shown in figure 5-12.

5-55. Heat cylinder to a temperature of 600°F. and secure to fixture. Soak the sponge of the removal tool in cold water. Insert the tool down through the valve seat, the seat will shrink and cling to the sponge. Withdraw the tool being careful not to cock the seat. This entire procedure should be performed as swiftly as possible after removing the cylinder from the heat.

5-56. Measure the ID of the valve seat recess in the cylinder head. Compare the measurement with the original manufactured diameter of the recess (see Table of Limits) and determine which oversize seat is to be installed.

5-57. Refer to Table 5-1 and select the proper cutter and pilot. Install the pilot in the cutter, tighten and install cutter in special drive. Install on drill press and proceed to cut the recess in the cylinder head to proper size. Note that the pilot engages the ID of the valve guide hole in the cylinder head. Remove no more metal from the bottom of the recess than is necessary to clean up the major diameter.

5-58. In the event the seats are to be cut by hand, install the hand drive adapter over the special drive and using a "T" handle proceed to cut the recesses as described in the preceding paragraph.

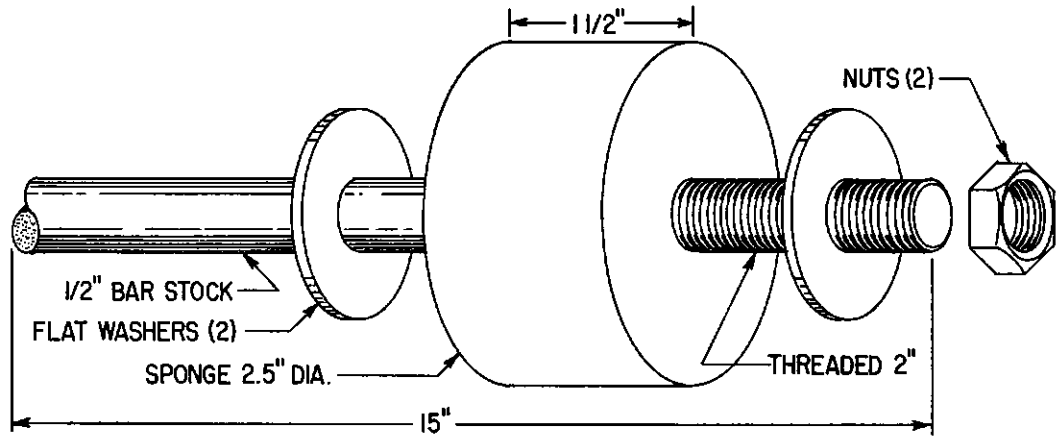


Figure 5-12. Valve Seat Removal Tool

TABLE 5-1

VALVE SEAT REPLACEMENT TOOLS

VALVE SEAT RECESS CUTTER

ID Valve Seat Hole in Cylinder Head	Part No.
1.733-1.735	ST-52,-1,-2,-3
2.087-2.089	ST-57-1,-2,-3

-1 Indicates .010 inch oversize
-2 Indicates .020 inch oversize
-3 Indicates .030 inch oversize

VALVE SEAT RECESS CUTTER PILOT

ID Valve Guide Hole in Cylinder Head	Part No.
.5913-.5923	ST-66-1,-2,-3,-5
.6613-.6623	ST-67-1,-2,-3,-5

ST-66 is standard
-1 Indicates .010 inch oversize
-2 Indicates .020 inch oversize
ST-66 is standard
-3 Indicates .030 inch oversize
-5 Indicates .005 inch oversize

VALVE SEAT REPLACEMENT DRIFT

ID of Valve Seat	Part No.
1.870-2.060	ST-64
1.474-1.730	ST-65

VALVE SEAT REPLACEMENT FIXTURE

	Part No.
Parallel Valve Cylinder Heads	ST-250

VALVE SEAT RECESS CUTTER DRIVER

	Part No.
Used with all ST series cutters	ST-62
Hand Drive adapter	ST-63

5-59. Heat the cylinder to 400° to 425°F. and secure to applicable replacement fixture. Chill new seat and place on replacement drift (see Table of 5-1 for correct drift) and drive seat into the recess in the cylinder head by tapping end of drift with hammer.

5-60. Proceed to grind the faces of the newly installed valve seats as described in paragraphs 5-48 thru 5-50.

NOTE

Whenever a new valve seat is installed, it is required that its matching valve guide be replaced. This will assure concentric grinding of the new seat.

5-61. Valve Refacing. Place valve in a suitable valve refacing machine (Snap-On VR-300) or equivalent. Set refacer to 30° for intake valves and 45° for exhaust valves. Using a soft no. 80 grit wheel, remove no more metal than is necessary to clean up pits in the valve face or to correct any apprarent warping condition. Round off with a hand stone any sharp or burred edges left around the valve face after refacing; this is best accomplished while valve is turning in the refacing machine.

5-62. Valve Guide Replacement. Damaged or worn valve guides are removed and new guides installed in accordance with the procedures described in the following paragraphs.

NOTE

Unless valve guide is in obviously new condition it is better to replace it. Should the guide be bell mouthed it will be impossible to get concentric grind of the valve seat.

5-63. Valve Guide Removal. Screw the nut of valve guide puller (ST-49) to the head of bolt (3/4-16). Place the retainer over valve guide inside of rocker box. Insert the bolt (3/4-16) into the retainer and valve guide. From cylinder barrel end insert the bolt (3/8-24) into the end of 3/4 inch bolt. Tighten the 3/8 bolt until snug against the valve guide. Turn the nut in rocker box in a clockwise direction until valve guide is out of cylinder head.

5-64. Valve Guide Selection. Check each valve guide hole in the cylinder head with the applicable valve guide hole plug gage. (See Table 5-2.) Determine if the same size guide may be used or whether the next oversize guide is required.

6-65. Valve Guide Installation. Mount the applicable valve guide replacement fixture on a drill press table. Fasten cylinder securely in place on the fixture (64714).

TABLE 5-2

VALVE GUIDE REPLACEMENT TOOLS

GAGE	SIZE	REAMER
	Valve Guide Hole in Cylinder (.5913/.5923 Hole)	
64571	Standard	--------
64507	.005 oversize	64678-2
64509	.010 oversize	64678-3
64511	.020 oversize	64678-4
64639	.030 oversize	64678-5
	(.6613/.6623 Hole)	
64940	Standard	64924
64928	.005 oversize	64924-1
64929	.010 oversize	64924-2
64930	.020 oversize	64924-3
64931	.030 oversize	64924-4
	Valve Guide ID	
64514	All Intake Valve	64684
64927	.4985/.4995 (Ni-Resist) Exhaust	
	Pilot Diameter	
	.4778/.4783	ST-113-2
Replacement fixture		64714
Installation drift (intake)		ST-304
Installation drift (exhaust)		ST-303
Valve guide puller		ST-49

5-66. If it has been determined that the next oversize guide is required, select the appropriate reamer (See Table 5-2) and proceed as follows. Mount the reamer in the drill press spindle and ream the valve guide hole in the cylinder head. Check the reamed hole with the corresponding gage (See Table 5-2).

5-67. Heat the cylinder to 400° to 425°F. for a minimum of one hour. Place the new valve guide, that has been chilled, on the appropriate valve guide installation drift (See Table 5-2) and insert the guide in the hole in the cylinder head. Drive the valve guide until the drive bottoms on the lower valve spring pocket. Use driver (ST-303) for exhaust valve guide and (ST-304) for intake valve guide. Check the valve guide drive height which is measured from the lower valve spring pocket to the top of the valve guide. The dimension is .775 for exhaust valve guide and .715 for intake valve guide. The dimension must be held within ±.010 of the above. Do not measure from the counterbore flange seat.

5-68. Any nitrided cylinder barrel that exceeds the allowable service limits in diameter, taper, or out-of-roundness must either be rebarreled or reconditioned by chrome-plating. Consult Service Instruction No. 1047 for information relative to reconditioning nitrided cylinder barrels.

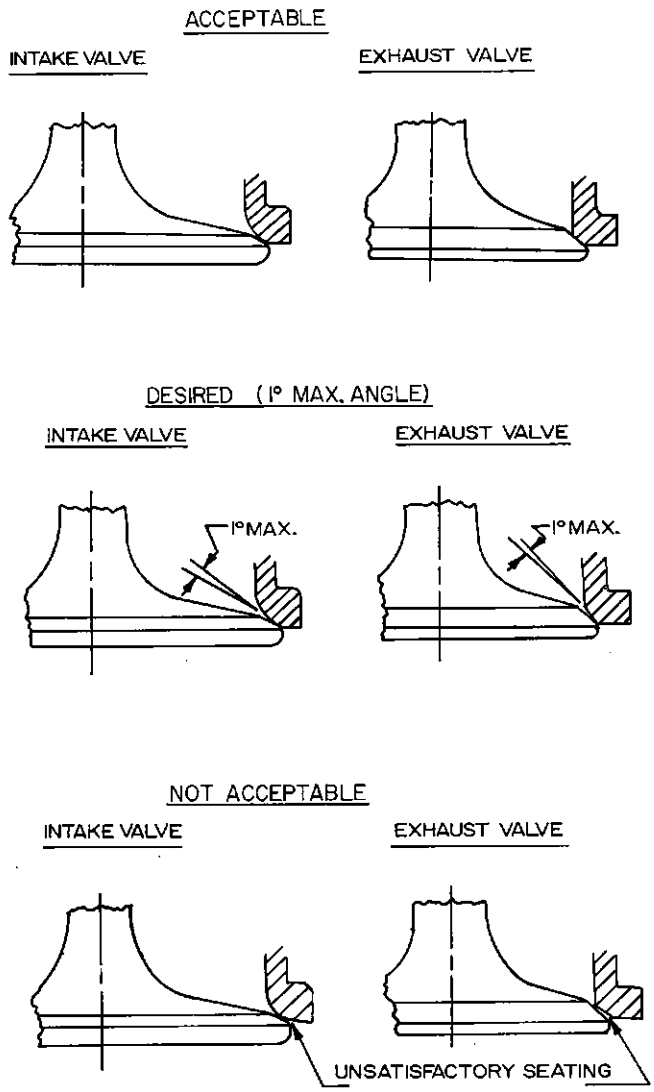


Figure 5-13. Acceptable, Desired and Non-Acceptable Valve Contact with Seat Face

5-69. Reconditioning Chrome Plated Barrels. Although it is not practical to remove wear steps by regrinding, such barrels can be restored by a stripping and replating process. Consult Service Letter No. 159 for facilities approved by Lycoming to perform this chrome plating process.

5-70. Valve Repair. Repairs to valves are limited to removal of carbon, regrinding of face, and polishing superficial scratches. Bending processes, to straighten and puddling to restore the face must not be attempted.

5-71. Warped Exhaust Flanges. If a warped exhaust flange is note, the flange should be straightened by grinding.

REASSEMBLY

5-72. Assembly of Pistons. Figure 5-2. Using the piston ring expander, assemble the new rings on pistons in the order described in the following paragraphs.

5-73. With the piston lying top up on the workbench, install the oil regulating ring equalizer in the first groove above the piston pin hole. Assemble the regulating ring (8) over the equalizer with its gap 180° opposite the equalizer gap. Compress the assembly several times with the fingers to make sure the ring lies free and loose in the groove. Both the equalizer and the regulating ring are symmetrical and may be installed with either side upward.

5-74. Install the compression rings (9) in the remaining top grooves. The compression rings are etched on one side with the word "top", this side must be installed toward the top of piston.

5-75. Pistons. Upon completion of assembly of the piston ring, check the side clearance of the rings in the grooves. Use feeler gage and straight edge as shown in figure 5-5.

NOTE

Under no circumstances should oversize piston rings be used in chrome plated barrels.

5-76. Assembly of Cylinder. See figure 5-1. Coat the valve guides and valves with a pre-lubricant as described in paragraph 3-39. Insert the intake (18) and exhaust valve (19) in their respective guides. The intake valve can be identified by the fact that it is slightly larger than the exhaust valve. Hold the end of the valve stems and place the cylinder on the applicable cylinder holding block. Install on each valve a lower spring seat (22). outer (23) and auxiliary valve spring (24), and upper valve spring seat (25).

NOTE

Assemble the dampener ends of springs (close wound coils marked with dye or lacquer) downward or next to lower spring seats.

5-77. Compress the valve springs with the valve spring compressor (ST-419) and assemble the valve retaining keys (27). If the valve is not seated properly the valve may be seated by using a wooden hammer handle against the tip of valve stem and hitting hammer with palm of hand. No other means should be used.

NOTE

Sodium-cooled exhaust valves are assembled with special keys and caps. Do not install caps until just before valve rockers are installed.

WARNING

Do not under any circumstances assemble chrome plated piston rings in a chrome plated cylinder barrel. If in doubt as to the proper combination of rings to be used, refer to the latest edition of Service Instruction No. 1037 or contact the Service Department, Lycoming Division.

5-78. Installation of Pistons and Cylinders. See that all preservative oil accumulation on cylinders and piston assemblies is washed off with solvent and thoroughly dried with compressed air. Immediately prior to assembly of piston and cylinder to the engine, space the ring gap and apply a generous coating of oil mixture as described in paragraph 3-39. Apply to inside of cylinder barrel and to piston and rings working the oil mixture around the rings and into groove. Starting with no. 1 cylinder proceed to install as follows:

5-79. Rotate crankshaft so that no. 1 piston, when installed, will be approximately at top dead center on the firing stroke; this is determined by both tappets of no. 1 cylinder being on the base circle of the cam lobes. Before any attempt is made to rotate the crankshaft support the connecting rods as shown in figure 5-3.

5-80. Figure 5-2. Assemble piston on connecting rod with piston number, which is stamped on bottom of piston head, toward the front of the engine. The piston pin (10) should be palm or hand push fit. If the original piston pin is tighter than a palm push fit, it is probably caused by nicks or slight carbon in the piston pin bore of the piston. If a new piston pin or piston is to be installed, select the pin to give a palm push fit at room temperature of 15° to 20°C. (60° to 70°F.). After piston pin is in place and centrally located, insert a piston pin plug (7) at each end of the piston pin.

5-81. Place a rubber cylinder base oil seal ring (figure 5-1) around the cylinder base assemble the application piston ring compressor over the top piston rings and install the cylinder over the piston, pushing the piston ring compressor ahead with the cylinder barrel. As the cylinder barrel approaches the crankcase, catch the piston ring compressor as it drops off the piston skirt. When the base of cylinder is seated on crankcase pad, secure the cylinder with 3/8 inch and 1/2 inch cylinder base nuts, tightening the nuts finger tight only.

5-82. To assure proper assembly of the crankcase halves and to eliminate the possibility of subsequent loosening of cylinder base nuts, a definite and specific sequence of tightening all crankcase and cylinder base nuts must be followed. Be certain that crankcase halves have been brought together, and fastenings secured as directed in Section 7 before installing cylinders. The cylinder base hold-down nuts are installed as described in the following paragraphs.

5-83. When all cylinders have been initially installed on the crankcase as described in paragraph 5-81, begin tightening all cylinder base nuts as described below, using the proper cylinder base nut wrenches and handle in conjunction with a suitable torque indicator. Torque wrenches should employ the flexible beam design hydraulic principle or a dial indicator with rack and pinion.

NOTE

Before installing cylinder hold-down nuts, lubricate crankcase through stud threads with any one of the following lubricants, or combination of lubricants.
1. 90% SAE 50W engine oil and 10% STP.
2. SAE 30 oil.
3. Fel-Pro Food Grade AA Anti-Seize Lube.

a. Tighten 1/2 inch hold down nuts to 300 inch pounds (25 foot pounds) torque.

b. Using the same sequence, tighten the 1/2 inch nuts to 600 inch pounds (50 foot pounds).

c. Tighten the 3/8 inch hold down nuts to 300 inch pounds (25 foot pounds) torque. Sequence is optional.

d. As a final check hold the wrench at the correct torque, on each nut for about five seconds. If the nut does not turn, it may be presumed to be tightened to correct torque.

5-84. After all cylinder base nuts have been tightened, remove any nicks in the cylinder fins by filing or burring.

5-85. Install some type of vented plug in each spark plug hole after assembly of cylinder to prevent entrance of foreign matter and at the same time to permit the engine to be turned easily by hand.

5-86. Install hydraulic lifter (1) in crankcase. (Figure 5-1).

5-87. Assemble new shroud tube seal (3) on both ends of shroud tubes. (Figure 5-1.)

5-88. Parallel Cylinder. (Figure 5-1.) Install each shroud tube through its hole in the rocker box and press to firmly seat the seals in their respective position in the cylinder head and crankcase. Install shroud tube spring (5), lockplate (6), and 1/4-20 plain nut (7) over stud provided in the rocker box. Tighten nut to proper torque and secure by bending the lockplate up around the nut.

5-89. Dip the push rod in the oil mixture as described in paragraph 3-39 and insert the full length into the shroud tube. Press tightly against the outer end of push rod to check spring tension and free travel of the dry hydraulic lifter assembly.

NOTE

Before installing the exhaust rocker arm be certain that the exhaust valve rotator cap is on the valve stem.

5-90. Install two square washers (9), rocker arm (8) and rocker arm fulcrum (10) seat on stud. Install 5/16-24 self-locking nut (11) and tighten to the proper torque, see Table of Limits figure reference (877). Check the dry tappet clearance by pressing the thumb on the push rod end of the rocker arm. Record the clearance between the rocker arm and the top of valve stem. Use valve clearance gage ST-23. Valve clearance is .028-.080 inch. The adjustment of the dry tappet clearance is obtained by increasing or decreasing the number of square washers (9) placed under the rocker arm fulcrum. Increased number of washers will increase the clearance.

NOTE

When adjusting the dry tappet clearance it is best to use a plain 5/16-24 nut. Then after the proper clearance is obtained install the 5/16-24 self-locking nut.

5-91. At completion of valve clearance check on each cylinder, recheck clearance on all cylinders and make necessary corrections. Coat all mechanism parts within rocker boxes as described in paragraph 3-37 and 3-39. Assemble rocker box cover gaskets and covers on each rocker box and tighten to specified torque.

5-92. Intercylinder Baffles. All intercylinder baffles must be attached with an "S" type retaining hook and a slotted retainer. Hook the baffle retaining hook through the hole in the baffle. Place the baffle in position beneath and between the cylinders, running the hook up between the cylinder barrels. Place a baffle retainer in place between the cylinders and using a baffle installation tool (64885), bring the retainer hook through the slot in the retainer. During the operation the retainer is forced down until the hook comes above the surface of the retainer far enough to be hooked over the bridge between the slots in the retainer.

SECTION 6

OIL SUMP AND FUEL INDUCTION

6-1. No attempt will be made to describe the overhaul of the carburetors used on the engine models covered in the overhaul manual. Overhaul information for the carburetors can be obtained from Marvel-Schebler Products Division publication no. MS609/631.

DISASSEMBLY

6-2. Intake Pipes. Loosen and remove the capscrews that attach the intake pipe flange to the cylinder head intake port. Loosen the hose clamps and slide the pipe off the sump connector. Mark the intake pipes as they are removed from the engine so that they may be reassembled in the same location.

6-3. Carburetor. Remove the carburetor from the mounting pad of the sump.

6-4. Oil Suction Screen. See figure 6-1 or 6-2. Unscrew the hex head plug and remove gasket and suction screen.

6-5. Oil Sump. Remove the fastenings from the periphery of the sump and remove the sump.

CLEANING

6-6. Oil Sump. Clean the sump according to the general instructions contained in Section 3. Clean the oil passages with solvent and a suitable brush and blow out with compressed air. Do not clean the oil suction screens until they have been inspected for metal particles.

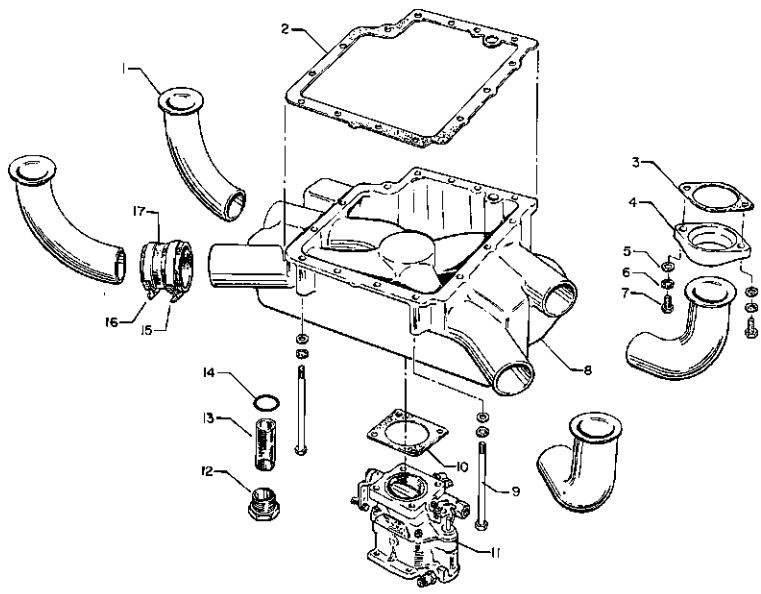
6-7. Carburetors. Clean the carburetors in accordance with the manufacturer's instructions.

INSPECTION

6-8. Inspect the sump according to the general instructions contained in Section 3.

6-9. Oil Suction Screen. Before cleaning the screen, inspect for evidence of metal particles, which could serve as an aid to locate deterioration in some section of the engine. Inspect the screen for distortion or openings of the mesh.

6-10. Carburetors. Inspection of carburetors must determine parts serviceability and repair and replacement requirements. Check applicable manufacturer's publications for limits to be used when conducting inspection.



1. Intake Pipe
2. Sump Gasket
3. Intake Pipe Gasket
4. Flange
5. Washer
6. Lockwasher
7. Bolt
8. Sump
9. Bolt
10. Gasket
11. Carburetor
12. Cap
13. Screen
14. Gasket
15. Clamp
16. Clamp
17. Hose

Figure 6-1. Oil Sump and Related Parts

REPAIR AND REPLACEMENT

6-11. Carburetor. All repair and replacement procedures must be carried out in conjunction with the manufacturer's publication. Consult Marvel-Schebler Products Division publication no. MS609/631.

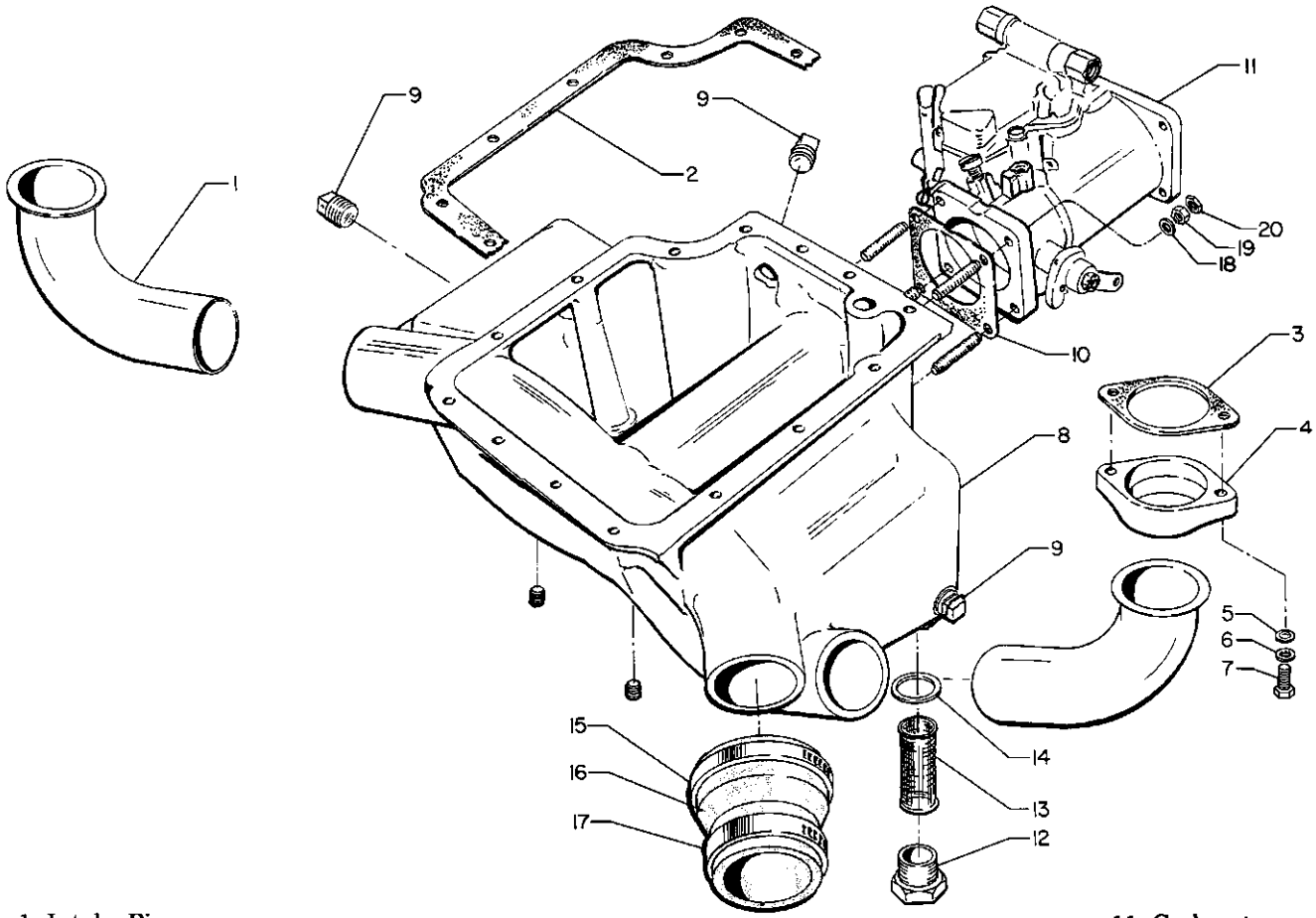
REASSEMBLY

6-12. When the engine assembly has progressed to the point where the crankcase has been assembled, the sump may be installed on the engine. Using a new gasket assemble the oil sump to the crankcase. Consult the applicable parts catalog for the correct fastening. Tighten all fastening to the proper torque as stated in the Table of Limits.

6-13. Intake Pipes. See figure 6-1 or 6-2. Slide an intake pipe flange (4) over each intake pipe (1). Assemble hose (17) and two clamps (15 and 16) over end of intake pipe and install on sump. Place a new gasket (3) over the intake port and secure the flange to the cylinder. Tighten hose clamps on hose.

6-14. Install oil suction screen (13), cap (12) and gasket (14).

6-15. Install gasket (10) and carburetor (11).



1. Intake Pipe
2. Sump Gasket
3. Intake Pipe Gasket
4. Intake Pipe Flange
5. Plain Washer
6. Lockwasher
7. Bolt
8. Sump
9. Plug
10. Gasket
11. Carburetor
12. Plug
13. Screen
14. Gasket
15. Large Clamp
16. Hose
17. Small Clamp
18. Plain Washer
19. Nut
20. Locknut

Figure 6-2. Oil Sump and Related Parts
0-360

SECTION 7

CRANKCASE, CRANKSHAFT AND RECIPROCATING PARTS

7-1. At this time it is assumed that the magneto, cylinders and sump have been removed from the engine.

DISASSEMBLY

7-2. Remove the oil pump and vacuum pump body assembly by removing the four plain nuts, lockwashers and plain washers. Discard the "o" rings seal and oil seal in pump body. Remove the driven impeller from the crankcase and the driving impeller from the pump shaft. The oil pump shaft cannot be removed until the crankcase is parted. See figure 7-1.

7-3. Remove the oil pressure screen housing and the oil cooler adapter or the oil filter adapter assembly (where applicable) from crankcase. Remove the oil cooler adapter from the oil filter adapter. Remove the oil filter and adapter plate. Also remove thermostatic oil by-pass valve. Discard all gaskets.

7-4. Remove the oil relief valve plug, gasket, spring and ball from the crankcase.

7-5. Remove the oil filler tube.

7-6. Remove the nuts and bolts from the parting surface of the crankcase, which hold the crankcase halves together. Remove the crankcase from the overhauls stand and place on the work bench.

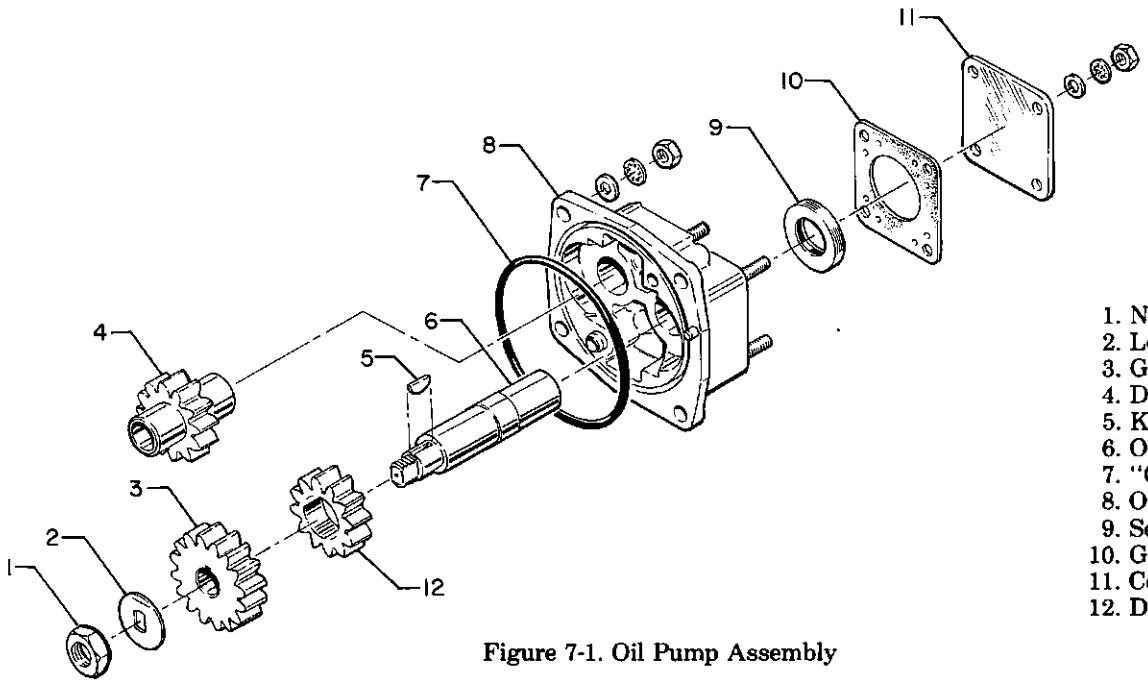
7-7. Remove the starter ring gear support assembly (16, figure 7-3) from the crankshaft propeller flange by tapping lightly on the rear of the assembly. The alternator drive belt will be removed with this unit.

7-8. Remove the external retaining ring (12), seal retainer (11) and "o" ring seal (10) from the tachometer drive adapter (figure 7-3). The tachometer drive adapter can not be removed until the crankcase is separated.

7-9. On engines equipped with a governor drive, remove the governor drive cover (25), "o" ring (26), and governor drive thrust washer (27), (Figure 7-3) from the nose of the crankcase.

7-10. The crankcase may be separated by first resting on the bottom of crankcase and gently tapping with a soft hammer the thru-studs on the loose ends until the crankcase begins to separate. Place the crankcase on the left side and continue to remove the right half of crankcase. Reach down through the cylinder pads and push the crankshaft bearing insert down on the crankshaft, so they will not fall when crankcase half is removed. Separate the crankcase by hand and remove the bearing inserts and crankshaft assembly.

7-11. Remove the camshaft, tachometer drive adapter and the crankcase breather baffle. Engines equipped with a propeller governor it is necessary to remove the governor drive gear at the time the camshaft is removed. Also remove the governor drive shaftgear from the right half of the crankcase.



1. Nut
2. Lockplate
3. Gear
4. Driven Impeller
5. Key
6. Oil Pump Shaft
7. "O" Ring Seal
8. Oil Pump Body
9. Seal
10. Gasket
11. Cover
12. Driving Impeller

Figure 7-1. Oil Pump Assembly

1. Gasket
2. Oil Level Gage
3. Filler Tube
4. "O" Ring Seal
5. Bearing Inserts
6. Oil Relief Valve Plug
7. Gasket
8. Spring
9. Ball
10. Crankshaft Seal

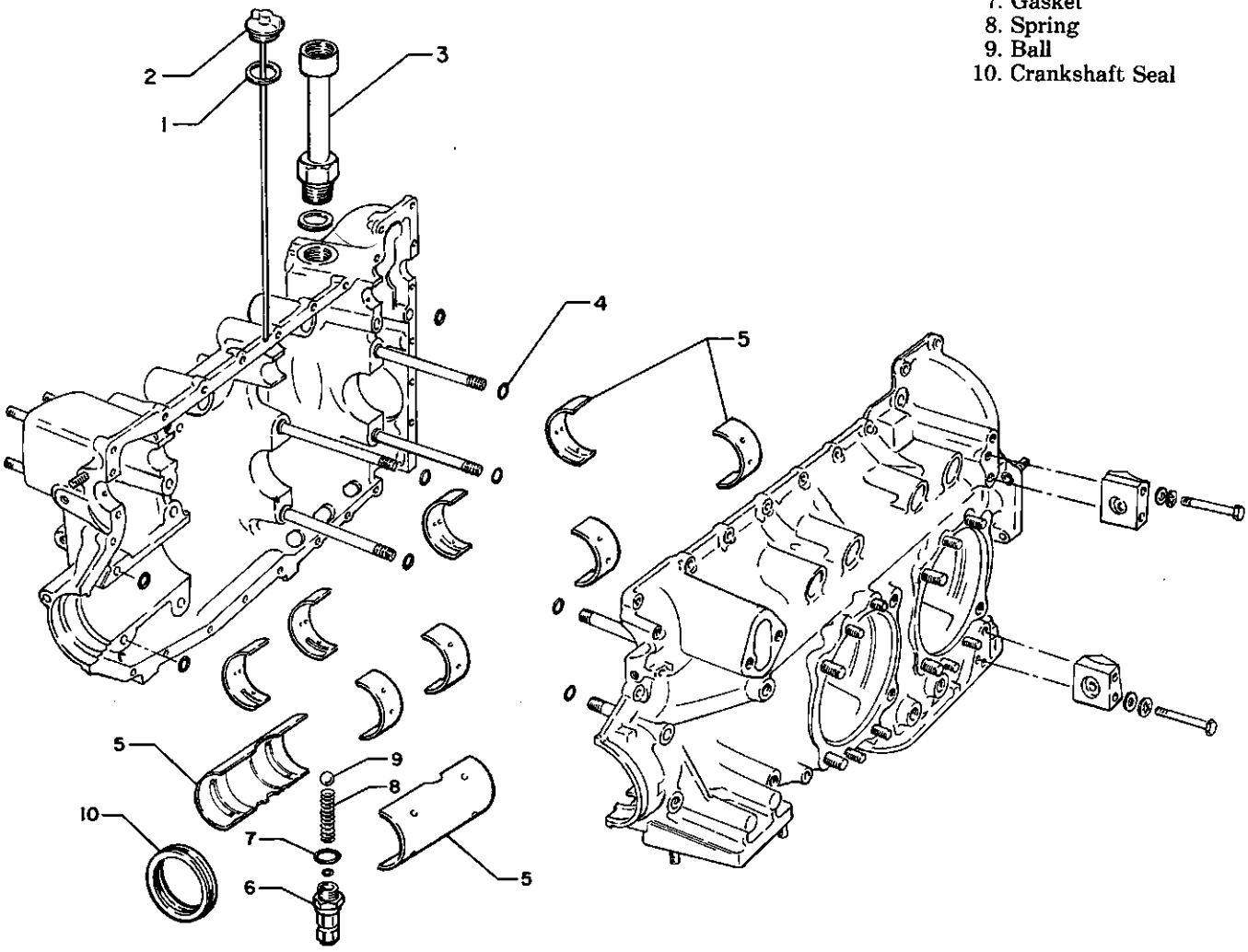


Figure 7-2. Crankcase Assembly

7-13. Camshaft. Remove the camshaft gear and the tachometer shaft.

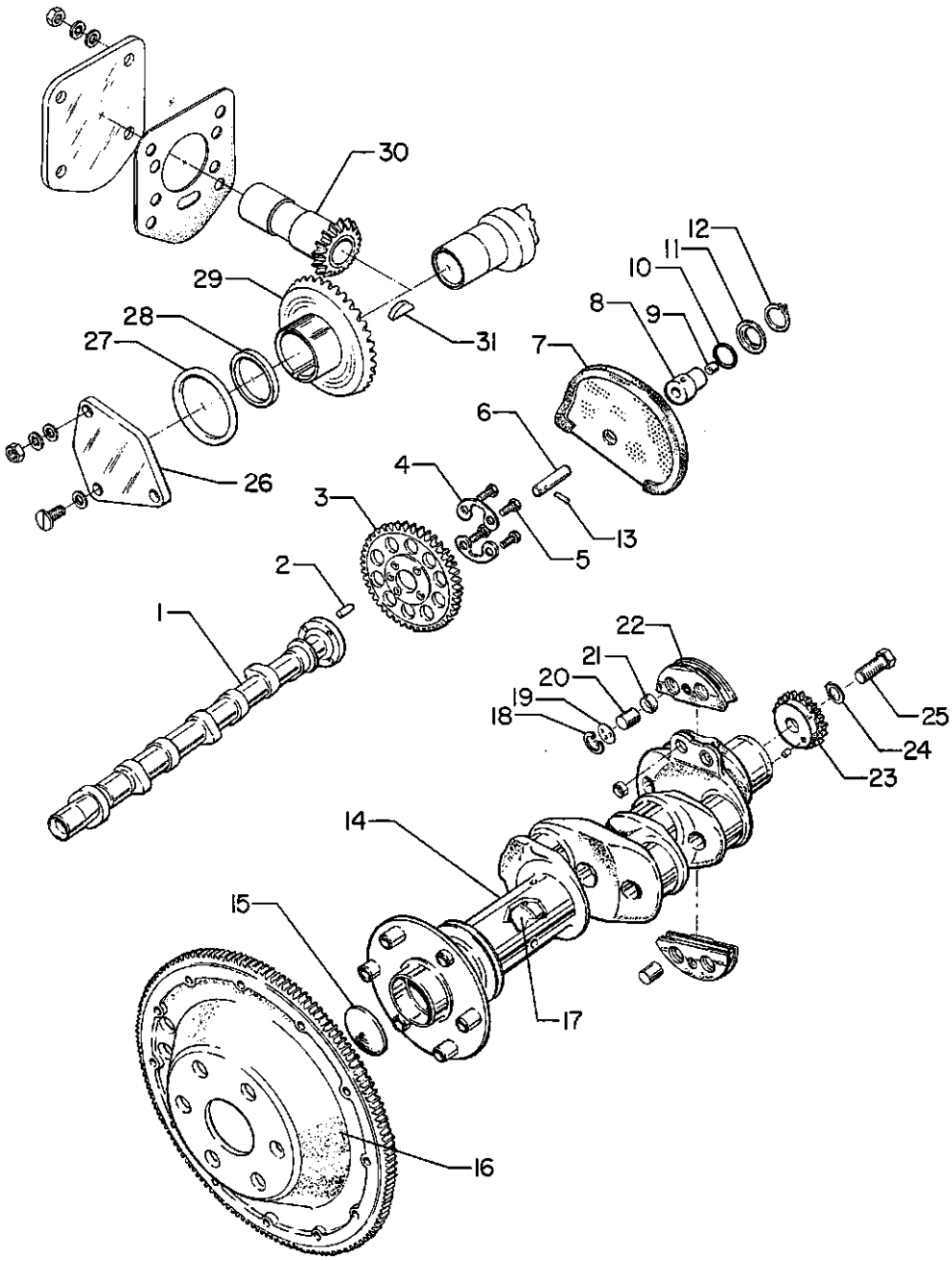
7-14. Remove the oil and vacuum pump drive shaft by removing the nut and lockplate. Use service tool ST-416 to turn pump shaft while holding nut with open end wrench. Remove oil pump drive gear. Remove drive shaft from crankcase.

7-15. Crankshaft. With the crankshaft properly supported at front and rear main bearings, remove the nuts securing the rod caps to the connecting rod. Remove the rods by tapping on the rod bolts with a soft hammer. Discard the bearing inserts, bolts and nuts. Reassemble each cap with its corresponding rod. Rods and caps are not interchangeable.

7-16. Remove the crankshaft oil seal and the expansion plug from the crankshaft. Do not remove the propeller flange bushings from the flange of the crankshaft unless they are damaged and/or loose.

NOTE

Engines that are equipped with a propeller governor drive do not employ an expansion plug in the crankshaft.



1. Camshaft
2. Dowel
3. Camshaft Gear
4. Lockplates
5. Bolts
6. Tachometer Shaft
7. Breather Baffle
8. Tachometer Adapter
9. Seal
10. "O" Seal Ring
11. Seal Retainer
12. Retainer Ring
13. Pin
14. Crankshaft
15. Expansion Plug
16. Starter Plug Gear Support
17. Plug
18. Retaining Ring
19. Washer
20. Roller
21. Counterweight Bushing
22. Counterweight
23. Crankshaft Gear
24. Lockplate
25. Bolt
26. Cover Plate
27. "O" Ring Seat
28. Thrust Washer
29. Gov. Drive Gear
30. Gov. Drive Shaft Gear
31. Key

Figure 7-3. Camshaft, Gov. Drive and Crankshaft Assembly

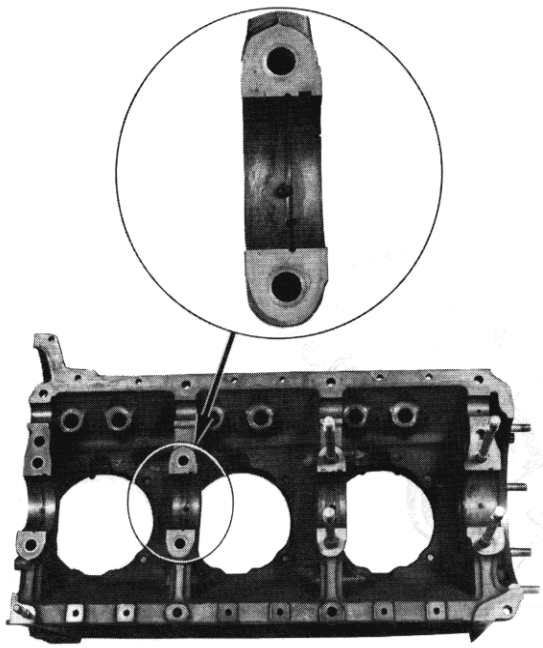


Figure 7-4. Crankcase Interior Showing Moderate Fretting at Stud Locations on Saddle Supports

7-17. Counterweights. See figure 7-3. Counterweights are disassembled from the crankshaft merely by removing the retaining rings (18), after which the washers (19), rollers (20) and counterweights (22) may be removed from the crankshaft ear.

NOTE

All counterweights and their related parts must be reassembled in the same location that they occupied on the crankshaft before disassembly. For example: The retaining washers used with the counterweights are selectively fitted to the washer seats in the counterweights at the time of manufacture. It is advisable therefore, to mark all counterweight parts during disassembly to insure positive identification. These marks must be impermanent. No scoring, scratching, etching, or other permanent marking of any kind is permissible on the counterweight parts.

7-18. To remove the crankshaft gear (23) flatten out the lockplate (24) and remove the hex head screw or screws (figure 7-3). Tap the crankshaft gear gently with a fibre drift to remove gear from crankshaft. Do not remove the dowel from rear of crankshaft unless it has been obviously damaged.

NOTE

On some of the earilier model of the 76 series engine, it was not recommended to remove the crankshaft gear. These can be identified by the presentence of 1 or 2 dowels at the mating surface between the crankshaft and gear. Some models are equipped with the gear fasten to the crankshaft by means of one bolt, lockplate and a locating dowel. Other gears are secured by means of two bolts, lockplate and a locating dowel. When bolts are present the gear can be removed.

CLEANING

7-19. All crankcase, crankshaft and reciprocating parts are cleaned in accordance with the general instructions outlined in Section 3. When cleaning the crankshaft, clean the inside of all crankpin and main bearing journals and all oil passages with suitable brushes, after which flush thoroughly with clean solvent and compressed air.

INSPECTION

7-20. Inspect all crankcase, crankshaft and reciprocating parts in accordance with the general instructions contained in Section 3. Specific instructions follow.

7-21. Bearings (Precision Type). All precision type bearing inserts used for main crankshaft bearings and connecting rod bearings should be replaced with new bearing inserts at overhaul.

7-22. Crankcase (Visual Inspection). Check carefully for burrs, nicks and cracks around the bearing support webs. Check bearing bores and inspect tang slots for any roughness that might cause improper seating of bearing inserts. Check all drilled holes.

7-23. Fretting on the contacting surfaces of the bearing saddle supports in the crankcase occurs on some engines. This condition is caused by slight motion between the contacting surfaces and results in erosion of the metal surface. The affected areas have tiny pit holes and a frosted appearance, as contrasted to adjacent shiny unaffected surfaces. See figure 7-4. This condition can be misleading because of its trivial appearance; nevertheless it can be the cause of severe engine damage.

7-24. Fretting, by inself in this area, does not appreciably damage the structure of the metal, but the metal removed by the fretting action does change the size of the bearing saddles sufficiently to cause loose thru-studs and undersize main bearing bores. If not detected during overhaul, excessively tight crankshaft bearing fits will result with eventual engine failure.

7-25. Crankcase (Dimensional Inspection). The following paragraphs on crankshaft and camshaft dimensions will also describe dimensional requirements of the crankcase.

7-26. Crankshaft (Visual Inspection). Carefully inspect all surfaces of the shaft for cracks, checking the bearing surfaces with particular care for scoring, galling, corrosion, pitting or other damage.

7-27. Crankshaft (Dimensional Inspection). Place the crankshaft in Vee blocks supported at the locations called out in Table of Limits (reference 556) and using a surface plate and dial indicator measure the run-out at center main bearings. If this total indicator reading exceeds the dimensions given in reference 556 the shaft must not be reused.The crankshaft flange run-out may be checked at this time and if the total indicator reading exceeds the run-out given in Table of Limits (reference 607) the shaft must be rejected.

CAUTION

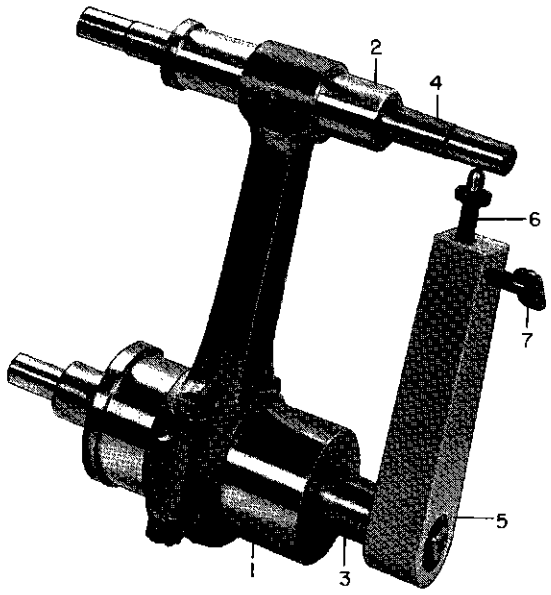
Any attempt to straighten a bent crankshaft will result in rupture of the nitrided surface of the bearing journals, a condition that will cause eventual failure of the crankshaft.

7-28. Using new inserts at all main bearing locations, assemble crankcase halves together, temporarily torque all thru-bolts to 300 inch pounds and measure the ID of the bearings. Measure the OD of the crankshaft main bearing journals and compare the resulting clearances with the Table of Limits (reference 501). Assemble the connecting rods temporarily (using new bearing inserts) and check the crankpin journal clearances in the same manner, see Table of Limits (reference 502). If clearances do not fall within prescribed limits, the shaft must be brought undersize. See Repair and Replacement section for instructions for regrinding.

7-29. Camshaft (Visual Inspection). Carefully inspect all surfaces of the camshaft for cracks, scoring, galling, corrosion, pitting or other damage; be particularly careful when inspecting bearing surfaces. If a hydraulic lifter has been rejected for spalling, inspect the corresponding cam lobe. Any indication of distress, surface irregularity or feathering at the edge of the cam lobe is cause for rejection of the camshaft.

7-30. Camshaft (Dimensional Inspection). Support the camshaft in Vee blocks at its front and rear bearing journals and check the run-out at the center bearing location. See Table of Limits (reference 539). Slight bending operations are permissible on the camshaft providing careful magnetic inspection follows such procedures. Measure the diameter of the camshaft bearing journals and check them against the bearings formed by the crankcase. Reference 537, Table of Limits.

7-31. Connecting Rods (Dimensional Inspection). Discard all connecting rod bolts and nuts; new bolts and nuts are to be used on assembly. Check condition of bore in large end for seating of the bearing inserts. Check bore in small end of bushing with connecting rod bushing plug gage (P/N 64537). If the gage enters the bushing, bushing must be replaced.



1. Tapered Sleeve (Crankpin End)
2. Tapered Sleeve (Piston Pin End)
3. Arbor (Crankpin Sleeve)
4. Arbor (Piston Pin Sleeve)
5. Gage Arm
6. Adjusting Screw
7. Wing Nut

Figure 7-5. Checking Parallelism of Connecting Rods

7-32. Connecting Rod Parallelism Check. See figure 7-5. Using connecting rod parallelism and squareness gage (P/N 64530), insert tapered sleeves (1 and 2) in bearing holes in connecting rod. Be sure that bearing cap is assembled properly and securely tightened. Place arbors (3 and 4) through sleeves (1 and 2 respectively) and place gage arm to exact distance between arbors and lock the adjusting screw with nut (7). Then remove gage arm, place it on other end of arbor (3), and check distance between arbors. For exact parallelism or alignment, the distances checked on both sides will be the same. See reference 566, Table of Limits.

7-33. Connecting Rod Squareness Check. See figure 7-6. Using the same gage that was used in the parallelism check described above, place parallel blocks (1) on surface plate and, with sleeves and arbors still in place in connecting rod, place ends of arbor on parallel blocks. Check clearance at points (2) where arbors rest on parallel blocks, using a feeler gage. For exact squareness or zero twist, no clearance will exist at the designated points. See reference 567, Table of Limits.

7-34. Counterweight Bushing. Wear in the counterweight bushing is usually evident as out-of-round on the inside diameter. Check each bushing with the bore gage P/N ST-73. The diameter should be between .7485 and .7505 inch. Out-of-round should not exceed .0005 inch. The ST-73 gage is specially made so that it can be set with a micrometer. If the diameter of any bushing is oversize, or excessively out-of-round all the bushing in the counterweight must be replaced.

7-35. Crankshaft Counterweight Bushing. Wear or damage to the crankshaft counterweight bushing (21), figure 7-3 located in the crankshaft counterweight lobes is almost impossible to detect by normal inspection procedures. Because of this situation and as damage to the counterweight bushing could cause failure to the counterweight and/or the crankshaft, it is mandatory that these bushings be replaced at overhaul. The procedure for the removal and replacement of the crankshaft counterweight bushing is contained in paragraph 7-43.

REPAIR AND REPLACEMENT

7-36. Repair all crankcase, crankshaft and reciprocating parts in accordance with the general instructions contained in Section 3. Specific instructions follow.

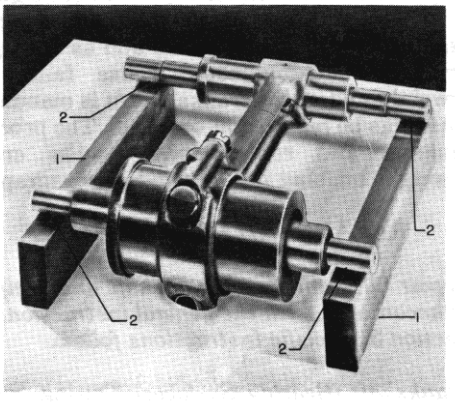
7-37. Crankshaft (Bearing Surfaces). During overhaul of the crankshaft, the operator must determine if it has standard or undersize bearing journals, then proceed with its overhaul accordingly. Undersize crankshafts are identified by a code symbol stamped on the front of the flange as a suffix to the part number. In addition to the code symbols the letters RN are stamped as a suffix to the serial number indicating the shaft has been renitrided. The code symbols are, M03MP (main and crankpin journals 0.003 inch undersize), M03M (main bearing journals 0.003 inch undersize), M03P (crankpin bearing journals 0.003 inch undersize). If the maximum service limits are exceeded (reference 501 or 502, Table of Limits) standard

shafts may be polished to 0.003 inch undersize and fitted with 0.003 inch undersize bearing inserts. Renitrided 0.003 inch undersize shafts may be polished to 0.006 inch undersize and fitted with 0.006 inch undersize bearing inserts. Do not allow lathe speed to exceed 150 RPM at any time during polishing operation.

NOTE

Note that if one surface is polished to .003 or .006 undersize all corresponding surfaces must be polished to same size. Polishing to undersize is preferred to grinding because shafts that are polished do not require renitriding whereas any grinding operation requires that the shaft be renitrided. This is necessary because of the nonuniformity of grinding tools. The possibility exists wherein the grinding wheel will cut through the nitrided surfaces on one or more of the journal radii causing area of stress concentration that can develop into fatigue cracks and ultimately result in a broken crankshaft.

7-38. If it is necessary to make a standard shaft journal surface more than 0.003 inch undersize or a renitrided 0.003 inch undersize more than 0.006 inch undersize, the crankshaft must be ground to undersize and renitrided. Standard shafts may be ground to 0.006 inch or 0.010 inch undersize, renitrided 0.003 inch undersize shafts must be ground to 0.010 inch undersize. Shafts must be fitted with the corresponding undersize bearing inserts. Grinding the crankshaft is a delicate operation requiring adequate grinding facilities and a great deal of skill. A properly dressed wheel (Carborundum (GA54-J5-V10 or equivalent) must be used with generous amounts of coolant. The wheel must be fed to the journal or pin very slowly and the final ground finish maintained during the complete operation. This procedure must be followed to eliminate possibility of grinding cracks. After grinding, the crankshaft must be carefully inspected by the magnetic particle method. If any cracks or checks are found, the shaft must be rejected.



1. Parallel Blocks 2. Check Points

Figure 7-6. Checking Squareness of Connecting Rods

NOTE

If one crankpin bearing surface is ground undersize all crankpin bearing surfaces must be ground to same undersize. If one main bearing surface is ground undersize all main bearing surfaces must be ground to same undersize. Main bearing surfaces may be ground without affecting crankpin surfaces and similarly crankpin bearing surfaces may be ground without affecting the main bearing surfaces. After any grinding operation the crankshaft must be renitrided. It is recommended that the shaft be returned to Lycoming for renitriding.

7-39. *Crankshaft - Straightening Flange.* Maximum permissible flange run-out is 0.018 inch TIR. If the flange run-out exceeds 0.018 inch the crankshaft must be rejected. If the flange run-out is less than 0.018 inch the flange may be straightened as described in the following paragraphs.

Before attempting any straightening operations, the flange bushings must be removed. When the surface distortion of the flange has been reduced as much as possible, the front face of the flange must be trued up by grinding. However, if the minimum width of the flange after grinding (Dimension "A", figure 7-7 is less than the dimensions as called out in Table 7-1, the shaft must be rejected.

TABLE 7-1

ENGINE MODEL	MIN. WIDTH OF FLANGE
0-320-H	.260 inch
0-360-E	.370 inch

CAUTION

Extreme care must be exercised during any straightening operation to avoid damage to the nitrided surfaces of the crankshaft. The nitrided surfaces extend from the front face of the slinger to the crankshaft gear mounting surface. These nitrided surfaces are glass hard and will crack if shaft is bent, dropped or handled carelessly.

At the conclusion of any straightening operations, the entire crankshaft must be inspected by the magnetic particle method paying particular attention to the bearing surfaces and the fillet areas at the base of the flange. See Section 3.

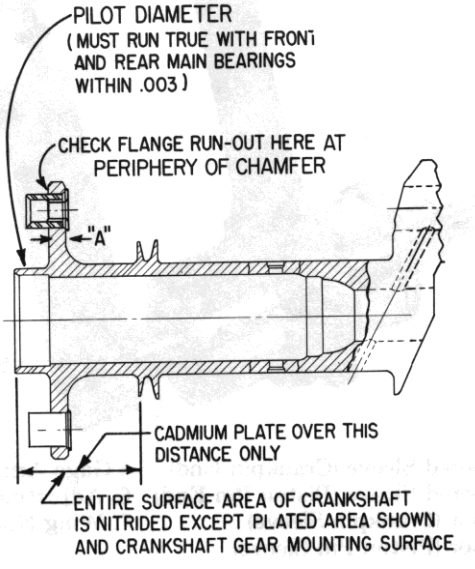


Figure 7-7. Limits for Straightening Bent Propeller Flange

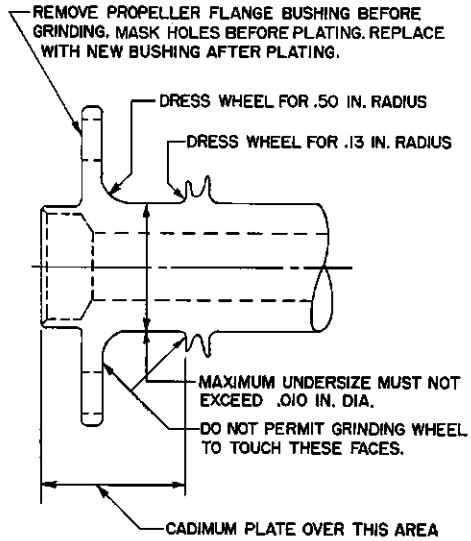


Figure 7-8. Reconditioning Crankshaft Oil Seal Surface

7-40. After inspection, install the flange bushings and then cadminum plate the ground surfaces of the crankshaft flange. The plating, which should be 0.0005 inch maximum thickness, should be permitted to extend along the crankshaft proper only in the area shown in figure 7-7.

7-41. Reconditioning Worn Crankshaft Oil Seal Surface. If inspection personnel have found that the crankshaft oil seal surface on the shaft itself is damaged to the extent that the oil seal might leak, the following procedures are submitted to recondition this area of the crankshaft.

1. Remove propeller flange bushings from crankshaft flange and note the locations of long and short bushings replacement. Do not scribe on shaft. Use Lycoming Special Tool ST-115 to remove flange bushings.

2. Strip cadmium plate from propeller flange and the area of the oil seal by immersing the shaft in a solution of ammonium nitrate (one pound of ammonium nitrate for each gallon of water).

3. Set up crankshaft in an external grinder and center carefully.

4. Use a No. 54 grit wheel and grind the area between the propeller flange and the oil seal face to remove nicks and scratches. Depth of grind must not exceed 0.005 inch (0.010 inch u/s diameter).

NOTE

The grinding wheel, on the corner toward the propeller flange must be dressed to 0.05 inch radius while the opposite side, toward oil slinger, must be dressed 0.13 inch radius. Both radii must blend perfectly. Do not permit the side of the wheel to touch the propeller flange or face of oil slinger. See figure 7-8.

5. A No. 54 or 60 grinding wheel will produce a finish of approximately 8 to 10 microns. The surface roughness of the oil seal area should not exceed 10 microns before polishing with crocus cloth.

6. Polish the oil seal area of the shaft with crocus cloth while the shaft is rotated counter-clockwise when viewed from the flange (front) end of shaft. Do not move the cloth while polishing because the area must be free of spiral marks.

7. Clean the shaft to remove all traces of grinding dust and mask the bushing holes in the flange.

8. Cadmium plate (in accordance with AMS2400) the flange and oil seal area of the crankshaft as indicated in figure 7-8. Do not plate beyond the 0.13 inch radius.

9. After plating, bake the crankshaft at 275°F. + 10°F. for 5 hours to eliminate possibility of surface embrittlement.

10. See the applicable Lycoming Parts Catalog for the particular engine model for correct propeller flange bushings and install new plated service bushings in the flange. Chill the bushings by refrigeration and install with Lycoming Service Tool No. ST-115.

11. Support crankshaft in vee-blocks at the end journals and measure run-out at refinished area. Total indicated run-out must not exceed 0.002 inch.

12. Examine crankshaft by magnetic particle method.

7-43. Crankshaft Counterweight Bushing Replacement (Where Applicable). Wear or damage to the crankshaft counterweight bushing located in the counterweight lobes is almost impossible to detect by normal inspection procedures. Because of the possible damage to the counterweight and/or the crankshaft from wear or damage counterweight bushing, it is mandatory that the bushing be replaced at overhaul. The procedure for removal and replacement of the crankshaft counterweight bushings is as follows:

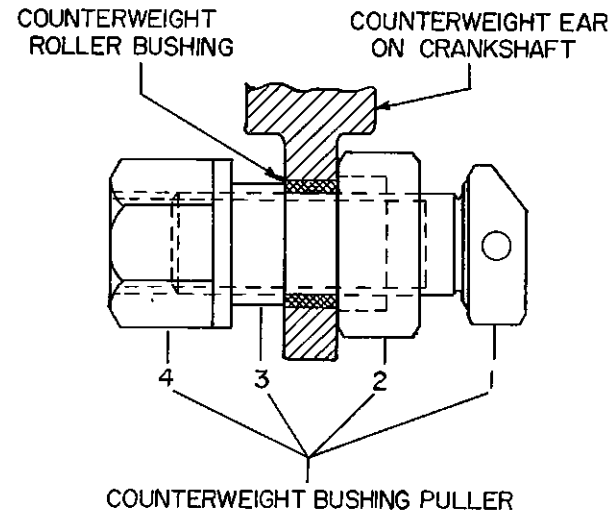


Figure 7-9. Removal of Crankshaft Counterweight Bushing

1. (See figure 7-9). Thread the bolt of the counterweight bushing puller P/N 64872 through the puller plate (2) so that the recess of the plate will be next to the crankshaft lobe when bolt is inserted through the crankshaft counterweight bushing. Install the small puller bushing (3) over end of bolt and install nut (4) on bolt. As the nut is tightened on the bolt, the counterweight bushing will be pushed out of its recess in the crankshaft counterweight mounting lobe and into the recess of the puller plate.

2. Measure the inside diameter of the hole in the crankshaft lobe that the bushing was removed from. If the hole in the lobe measures .9369 to .9377 inch no reaming of the hole is necessary and a standard size bushing can be installed. If the hole measures more than .9377 inch, the next oversize bushing must be installed and the hole must be reamed accordingly. See Table 7-2 for the proper reamer.

TABLE 7-2

Hole Size	Reamer No.
.9369/.9377	None
.9420/.9425	64874
.9445/.9450	ST-210
.9470/.9475	64875
.9495/.9500	ST-211
.9520/.9525	64876

3. Determine the oversize reamer needed and assemble the reaming fixture (ST-280) over the crankshaft ear. Select the two opening in the fixture to line up with the bushing holes and install the plugs provided to line up the holes in the fixture with the holes in the crankshaft ears. Secure the fixture by tightening the set screw. Assemble the reamer in a suitable handle and proceed to hand ream the hole in the crankshaft ear to the proper size.

4. Assemble the puller (P/N 64872) to the crankshaft ear in the same manner as described in Step 1, except that the large puller bushing is used instead of the small puller bushing. Place the correct size counterweight bushing on the puller bolt between the crankshaft ear and large puller bushing. As the puller nut is tightened, the bushing will be forced into place in the crankshaft ear.

NOTE

The inside diameter of the crankshaft counterweight bushing is finished at time of manufacture and no further machining of the bushing is necessary. Care must be exercised when installing the bushing so that the finished inside diameter is not damaged. Under no circumstances should the bushing be removed or installed by the use of a hammer and drift.

5. After the crankshaft counterweight bushing is installed, check its alignment with the main bearing by placing the crankshaft in vee blocks on a surface plate. Install the wedge blocks P/N ST-212 in the bushing and compare parallelism of the wedge blocks with the main bearing journals. Bushing must be parallel with in .002 inch. Support the crankshaft in vee blocks at the journals adjacent to the bushing location.

7-44. Counterweight Bushing Replacement. Consult the latest edition of Service Instruction No. 1143 for detail information relative to rebushing counterweights an subsequent inspection.

7-45. Connecting Rod Bushings. If the bushing in the small end of the connecting rod is worn beyond service limits, it can be removed and replaced by accomplishing the following procedure;

1. Clamp the connecting rod on the connecting rod replacement block (P/N 64597) in such a manner that the small bushing in the rod is in alignment with the hole stamped "Remove Bushing". Use the connecting rod bushing removal drift (P/N 64535) and drive the bushing out of the rod. Move the connecting rod to the "Install and Burnish" position and clamp it securely in place. Using the replacement drift (P/N 64536) drive a new bushing in place in the rod. Be sure the split in the bushing is located so that it is toward the piston end of rod and 45° off the centerline.

2. Use a suitable arbor press and the connecting rod bushing burnisher (P/N 64580) to burnish bushing in place. Pass the burnisher completely through the bushing. Remove the rod from the holding block and finish bore the bushing to diameter shown in Table of Limits, reference 510. Check the bushing ID with finish ID gage (P/N 64767). Check alignment of the hole in the bushing with connecting rod parallelism and squareness gage (P/N 64530) as described in paragraphs 7-29 and 7-30. If the assembly does not meet the requirements shown in references 566 and 567, Table of Limits, the entire assembly must be replaced.

7-46. Starter Ring Gear. The latest edition of Service Instruction No. 1141 contains all information necessary to accomplish the replacement of the starter ring gear.

7-47. Crankcase - Fretting. Consult the latest edition of Service Instruction No. 1112 for information relative to inspection and repair of crankcases damaged by fretting.

7-48. Crankcase - Fretting. The latest edition of Service Instruction No. 1123 contains all requirements necessary to modifty the crankcase to prevent fretting.

REASSEMBLY

7-49. Expansion Plug. (Figure 7-3). On engines equipped for fixed pitch propeller use the expansion plug (15) installation drift (P/N 64681) to install a new expansion plug in place in the front of the crankshaft with the convex side toward the front. Be sure the plug fits firmly against the shoulder provided for it on the inside diameter of the crankshaft.

7-50. Plug. On engines equipped for a controllable pitch propeller, a plug is installed at the rear of the bore in the front of the crankshaft. If this plug has been removed during overhaul, install a new plug by sliding it sideways past the crankshaft propeller oil tube (see figure 7-3). When the plug is properly positioned in the rear of the bore (flange forward) insert the oil plug drift (P/N 64770 for 1-3/4 inch plug) and seat the plug with several sharp hammer blows on the drift.

7-51. Propeller Flange Bushings. If the propeller flange bushings have been removed from the crankshaft, new bushings must be installed. Use the crankshaft flange bushing replacement tool (ST-115) to install new bushings. Consult the applicable Parts Catalog for proper location of the bushings.

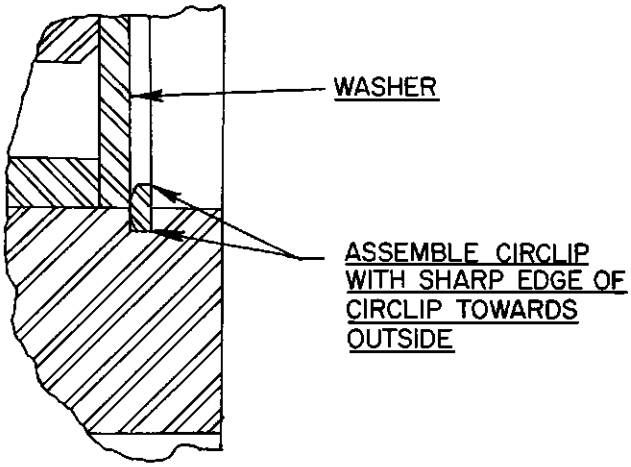


Figure 7-10. Assembly of Washer and Retaining Ring in Counterweight

7-52. Counterweight Assembly. (Figure 7-3). When assembling the counterweights which have previously been installed on the engine, use the identifying marks made on the various parts during the disassembly. To enable matching each washer to the proper seat on the counterweight from which it was removed. Install washer (19) with chamfered side toward the roller and retainer ring (18) with the sharp edges toward the outside on one side of the counterweight. (See figure 7-11). Place the counterweight on the proper crankshaft lobe, insert the proper roller and secure the assembly by installing the washer (19) and retaining ring (18) as stated above. After the installation of the retaining ring the gap must be in the position as shown in figure 7-11. Insert one end of the counterweight retaining ring gap gage P/N 64892-2, between the ends of the ring, making sure the gage is resting in the bottom of the groove. The gage must pass betwen the ends of the retaining ring and must clear the inside edge at the top of the retaining ring. If the gage does not enter the gap of the retaining ring and clear the top of the ring, the ring is not completely seated in the groove properly. Make sure that all rings are seated in the proper position. Consult the latest edition of Service Instruction No. 1012 for the correct location of each counterweight on the crankshaft.

7-53. Connecting Rods. (Figure 5-2). Assemble two new connecting rod bolts (4) in each connecting rod (5). Install new bearing inserts (3) in the connecting rod and cap (2), making sure the tang of each bearing insert enters the locating slot. Assemble each connecting rod and cap, tighten the nuts (1) moderately. Measure the inside diameter of each bearing and check for clearance against the measurements taken previously on the diameter of the crankpin journals.

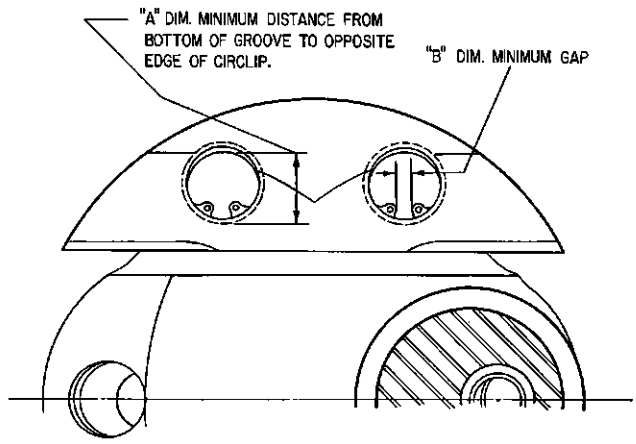


Figure 7-11. Location of Gap When Installing Retaining Rings

NOTE

Do not take measurements of connecting rod bearing across the parting of the rod and cap. Take all measurements at 60° from the parting of connecting rod and cap.

7-54. Place the crankshaft on a suitable support on the bench so that all crankpins are free for installation of connecting rods. Disassemble connecting rods after checking bearing ID, thoroughly coat both inserts and the crankpin journals with preservative oil and assemble rods on their respective crankpins. The order of assembly should be such that the numbers stamped on the caps and rods will be down (toward the sump).

NOTE

Connecting rods are marked at manufacture with the part number followed by a letter (A through E) designating weight groups. It is recommended that replacement sets of rods be of the same weight classification. Individual rods may be replaced by a service rod bearing the letter "S".

7-55. The connecting rod bolts are tightened to a specified torque of 480 inch pounds (40 foot pounds).

7-56. Camshaft. See figure 7-3. Secure the tachometer shaft (6) to the end of the camshaft with pin (13). Assemble the camshaft gear (3) over stepped dowel (2) and secure gear to camshaft with lockplate (4) and hex head screws (5). On engine employing the propeller governor, install woodruff key (31) and governor drive gear (27) figure 7-3.

7-57. Crankcase. Place both crankcase halves on a suitable support with the interior of each half facing upward. Place new bearing inserts in the crankcase making certain that the tang of each insert is fitted into the recess provided in the crankcase.

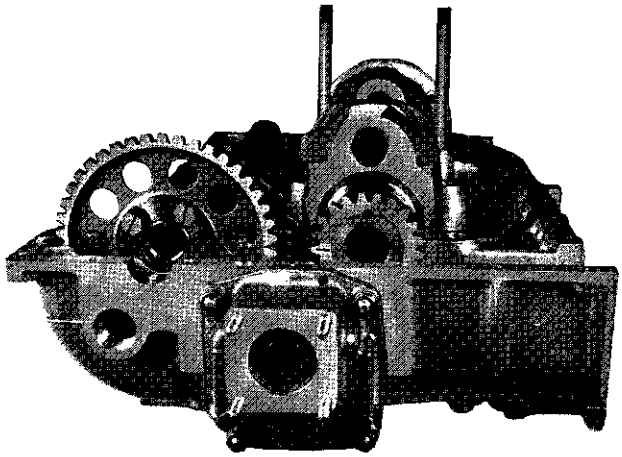


Figure 7-12. Showing Timing Marks Position on Camshaft Gear and Crankshaft Gear

7-58. Place the left crankcase half on a suitable support on the bench with the cylinder pads down. This support should be so constructed as to give approximately six inches clearance between the crankcase and bench.

7-59. Lay the right crankcase half on the bench with the cylinder pads down. Install the governor drive shaft gear where applicable.

7-60. A counterbored recess is provided for an oil seal ring at each bolt and stud location. Install a new oil seal ring (4, figure 7-2) at the base of each stud.

7-61. Oil and Vacuum Pump Drive. See figure 7-1. Install key (5) in keyway on the oil and vacuum pump shaft (6). Install shaft in left half of crankcase. Place oil pump drive gear (3) on shaft and secure with lockplate (2) and nut (1). Use service tool ST-416 to tighten pump nut. Torque to 55 foot pounds. Secure nut with lockplate.

7-62. Prelubricate the camshaft lobes and bearings with Lubi-Bond or equivalent. Place the camshaft assembly in the left half of crankcase. As the camshaft assembly is place in the crankcase, the breather baffle must be installed at the same time. The baffel is marked on one side "toward rear of engine" and must be installed with the flat edge toward the sump. The timing mark on the camshaft gear must be in a plane with the parting surface of the crankcase. The mark must be located between the camshaft and the crankshaft gear as shown in figure 7-12.

NOTE

The timing mark on the camshaft gear and crankshaft gear may be a etched straight line, circle or a dot.

7-63. Install new oil seal in tachometer drive adapter. Slide adapter over tachometer shaft so the adapter will be at the proper location on the dowel of crankcase.

7-64. Prelubricate the main bearing inserts of the left half of the crankcase. Pick up the crankshaft assembly by the odd number connecting rods and lower into the left half of crankcase, being careful not to move the timing mark on the camshaft gear. The timing mark on the crankshaft gear and camshaft gear must be in a plane with the parting surface of the crankcase as shown in figure 7-12.

NOTE

If the timing marks are not in the proper plane after the crankshaft is in place, rotate the crankshaft until the timing mark is in the correct position. Raise the camshaft until the camshaft gear is disengaged from the oil pump drive gear and rotate the camshaft until timing mark is the correct plan with the crankcase parting surface. See figure 7-12.

7-65. See figure 7-13. If either the crankcase or crankshaft has been replaced, the crankshaft end clearance must be checked. When crankshaft is located in the left crankcase half push the crankshaft forward as far as possible. Check the clearance, at the rear of the front main bearing surface, between the crankcase and crankshaft shoulder. (Point "A"). If clearance exists between crankcase and crankshaft thrust surface (Point A) regrind the front face of the crankshaft slinger (Point "B") to remove the clearance. Grind only that amount, from the face of the slinger, necessary to remove clearance. Push the crankshaft as far as possible to the rear of crankcase. Check the clearance between the thrust surface of crankshaft and crankcase.

7-66. Prelubricate the main bearing inserts of the right crankcase half.

7-67. Apply a film of non-hardening gasket compound to the outside mating surfaces of each crankcase half. The compound must not be applied to any of the interior mating surfaces such as the bearing support webs. Next imbed a length of "oo" silk thread in the gasket compound along outside edge of left crankcase half. Run the length of thread so that it is both sides of bolt hole without touching each other. An alternate method of sealing is discussed in Service Instruction No. 1125.

NOTE

On engine with governor, hold the governor drive gear shaft is right half of crankcase with safety wire that can be removed when crankcase to fasten together.

7-68. Lower the right half of the crankcase so that the studs align properly with the left half. If necessary, tap the right half gently with a soft hammer to facilitate assembly. However, no difficulty will be encountered if the two halves are kept parallel while the right is being lowered onto the left. After the cases are together, tap the right half with a soft hammer to seat it securely all around.

NOTE

When tapping crankcase with soft hammer as stated in paragraph 7-68 be careful that the camshaft gear is not jared out of time.

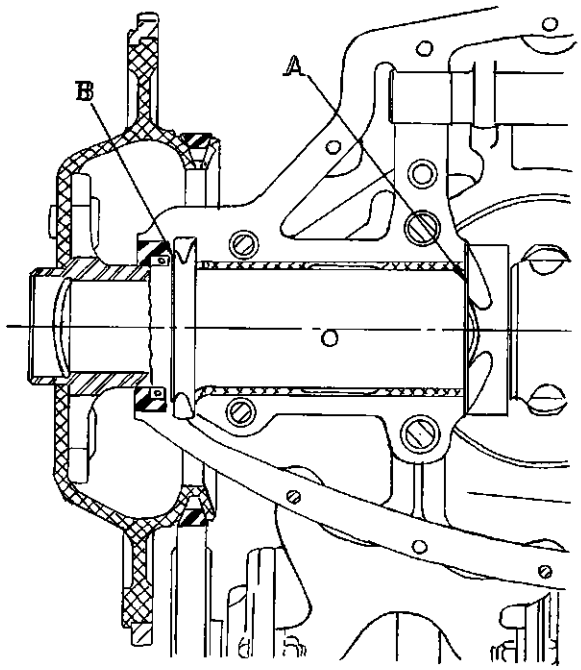


Figure 7-13. Checking Crankshaft End Clearance

7-69. Install all crankcase fastenings. Consult the applicable Parts Catalog for correct attaching parts.

7-70. In order to insure uniform loading on the main bearings, it is necessary to tighten the studs and bolts in the following sequence.

7-71. Install torque hold down plate (ST-222 or equivalent) at cylinder pads.

7-72. Install nuts on free ends of 1/2 inch thru-studs and using the sequence specified in figure 7-14, tighten to 300 inch pounds (25 foot pounds).

7-73. Using the same sequence as specified in paragraph 7-72, tighten the nuts on the thru-studs to 600 inch punds (50 foot pounds) torque.

7-74. Torque 3/8 inch nuts at front main bearing (4, figure 7-13) to 300 inch pounds (25 foot pounds).

7-75. Using the sequence specified (5 thru 10, figure 7-14), tighten 1/4 inch nuts at crankcase parting face to 98 - 108 inch pounds (8 to 9 foot pounds).

7-76. Using any sequence tighten the remaining 1/4 inch nut at crankcase parting face 96 to 108 inch pounds (8 to 9 foot pounds).

7-77. Tachometer Drive. See figure 7-3. Place "o" ring seal (10) over the tachometer adapter (8). Install tachometer drive seal retainer (11) and external retaining ring (12) on the adapter.

7-78. Oil and Vacuum Pump. See figure 7-1. Install the oil pump driving impeller (12) on the previously installed oil pump shaft (6). Place the driven impeller (4) in the crankcase. Install new oil seal (9) in the oil pump body. Place "o" ring seal (7) in groove of pump body. Install oil pump body over pump shaft and impellers. Secure with plain washers, lockwashers, and attaching nuts. Tighten the attaching nuts in a random pattern and increasing steps until the final torque of 150 inch pounds is reached. After each step rotate the crankshaft to insure that the impellers are free and not binding. If any binding occurs, loosen the attaching nuts to free the impellers and retorque using a different tightening sequence until crankshaft can be rotated and oil pump is free.

NOTE

When installing oil and vacuum pump body be careful not to damage the oil seal.

7-79. Oil Cooler Adapter and Oil Pressure Housing. See figure 7-15. Assemble the oil cooler bypass plunger (3), spring (4), gasket (5) and plug (6) in the oil cooler adapter (2). Install adapter (2), oil cooler adapter gasket (1) along with oil pressure screen housing (9), screen (8), and gasket (7) on the crankcase assembly.

7-80. Oil Filter Adapter Assembly. See figure 7-16. Assemble the oil filter adapter (4) with gasket (7) on crankcase. Install temperature control valve (5) in adapter. Install converter plate (3) and converter plate stud (2) to oil filter adapter assembly. Torque converter plate stud to 50 - 60 foot pounds.

7-81. Assemble the crankshaft oil seal.

1. Remove spring from the new seal.

2. Apply a thin film of Lubriko M-6 grease on sealing surface of seal, on crankshaft sealing surface and on edge of crankshaft propeller flange. Consult Service Instruction No. 1324 for information on crankshaft oil seal.

3. Place seal over edge of propeller flange with open portion of seal toward the flange.

4. Insert pin in crankshaft propeller bushing to hold both sides of seal.

5. Use tool ST-383 over propeller flange and under seal. Rotate tool around propeller flange until seal is on crankshaft.

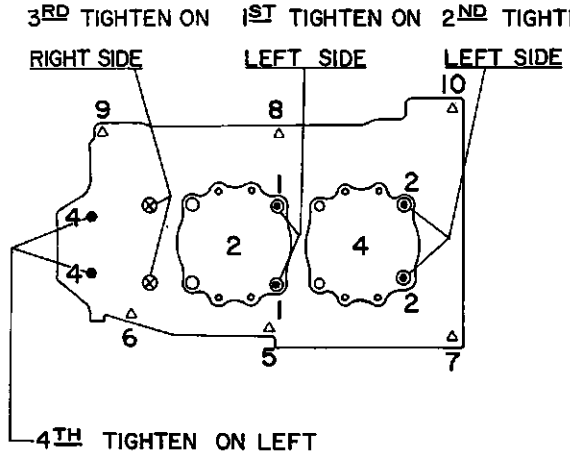


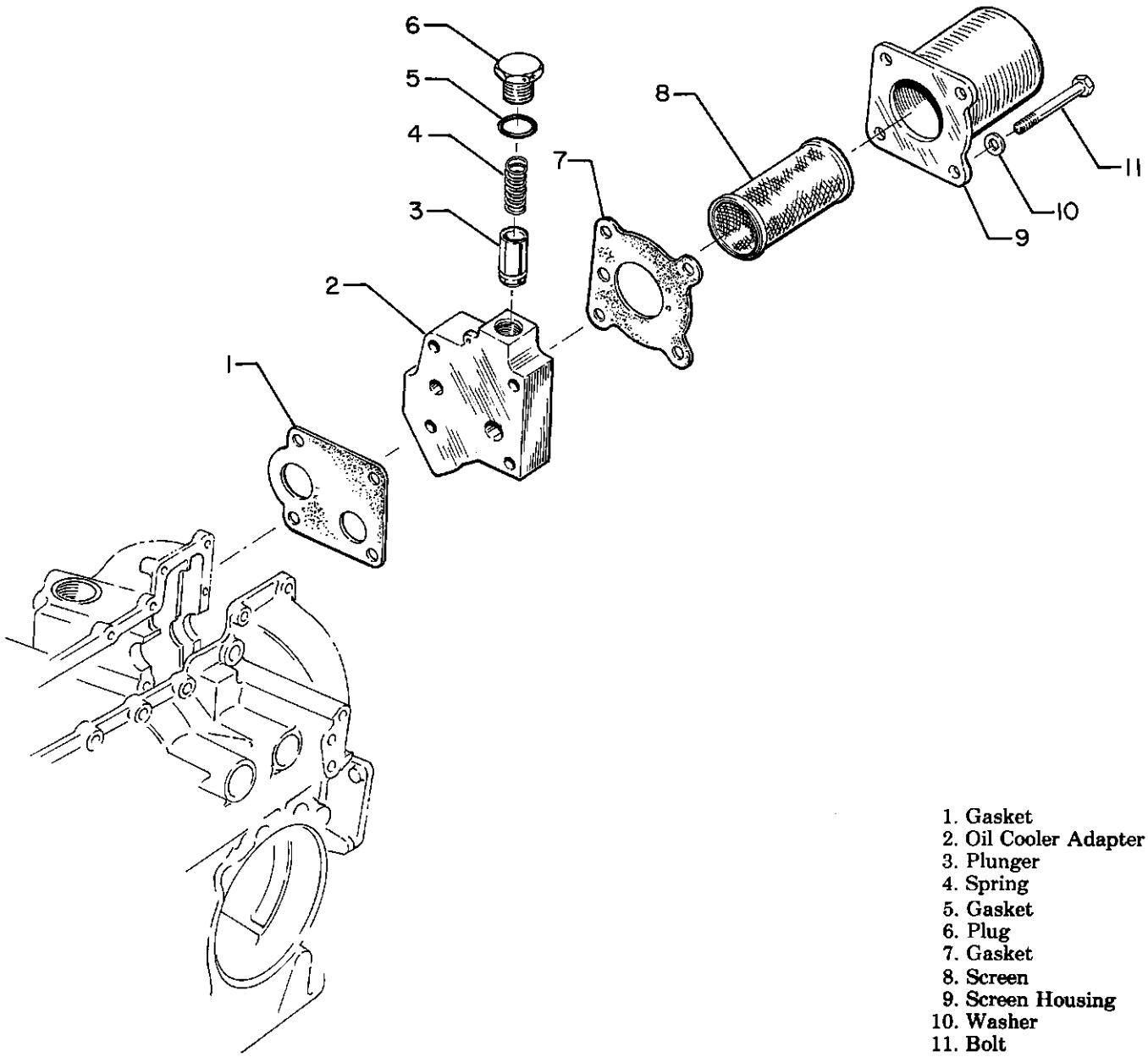
Figure 7-14. Crankcase Tightening Sequence (Four Cylinder)

6. Install spring over crankshaft and fasten so that there is no twists and kinks. Force spring into the rear of the oil seal.

7. Clean all grease from the outside diameter of seal, propeller flange and the crankcase seal bore.

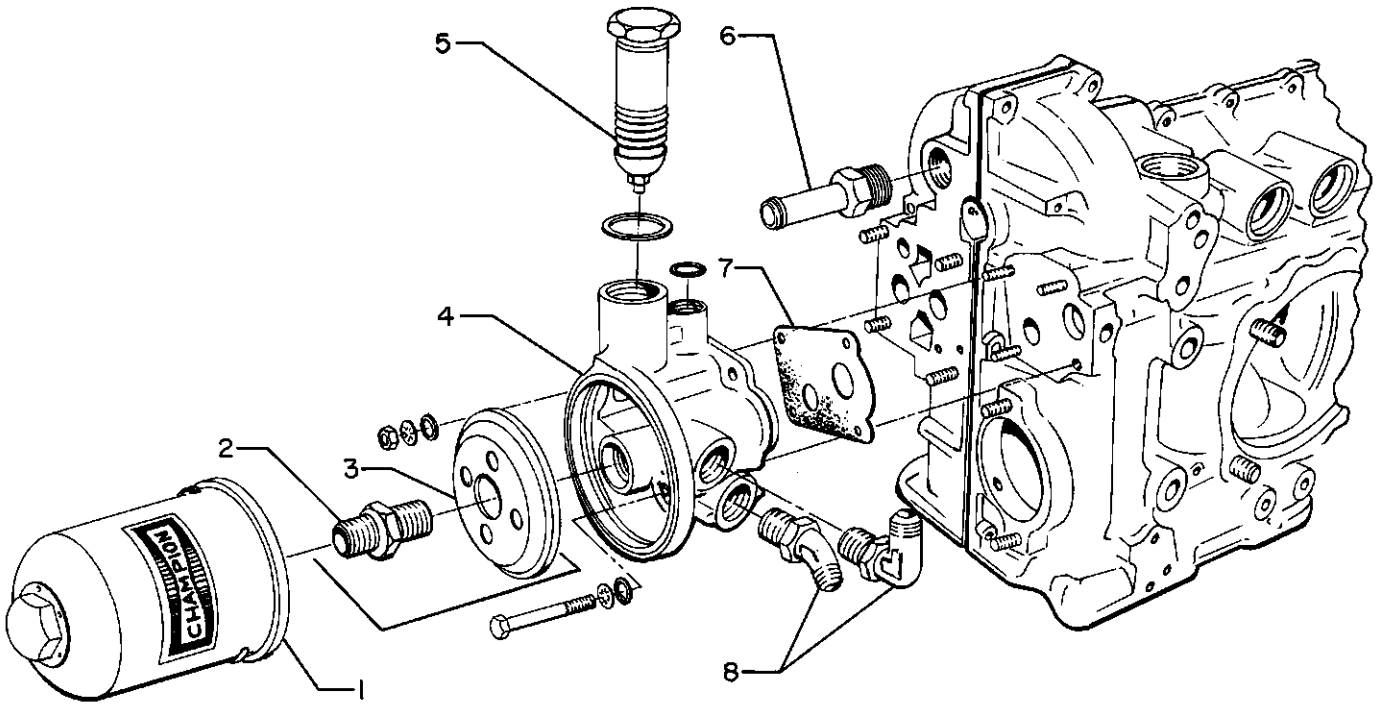
8. Apply a coat of adhesive Goodyear Pliobond No. 20 or Dow Corning Silastic No. 140 to outside diameter of the seal. Insert seal into crankcase with firm pressure until it is sealed in the crankcase bore.

7-82. Generator or Alternator Drive Belt (Where Applicable) and Ring Gear Support Assembly. Place the drive belt in the pulley of the ring gear support and assemble the ring gear support over the propeller flange bushings. Be sure the bushing hole in the ring gear support bearing the identification "O" is assembled over the flange bushing also identified with "O" etched on crankshaft flange next to bushing. The starter ring gear must be located correctly to assure proper alignment of the timing marks on the ring gear.



1. Gasket
2. Oil Cooler Adapter
3. Plunger
4. Spring
5. Gasket
6. Plug
7. Gasket
8. Screen
9. Screen Housing
10. Washer
11. Bolt

Figure 7-15. Oil Cooling Adapter and Oil Pressure Screen Assembly



1. Oil Filter
2. Converter Plate Stud
3. Converter Plate
4. Oil Filter Adapter
5. Temp. Control Valve
6. Breather Fitting
7. Adapter Gasket
8. Oil Cooler Fittings

Figure 7-16. Oil Filter Adapter Assembly

SECTION 8

TEST PROCEDURE

8-1. At the completion of the engine after overhaul, it is recommended that the engine be mounted upon a test stand for its initial or run-in operation. The run-in serves a two-fold purpose; first, to seat piston rings and burnish any new parts that may have been installed and second, to give the operator control over the first critical hours of operation, during which time he can observe the functioning of the engine by means of the test cell instruments. Also, at this time any malfunction can be corrected and oil leaks repaired.

8-2. The test stand should be installed in a test cell that is clean and free of any articles that could be moved by the test club air blast.

8-3. The following instruments should be used, plus any additional instruments that may be deemed necessary by the operator. 0° to 600°F. temperature gage, counter tachometer, fuel flow meter, fuel pressure gage, manifold pressure gage, oil temperature gage, oil pressure gage and an oil flow measuring device.

NOTE

Lycoming recommends that a test cell be used for run-in of engines after overhaul. Consult engine test equipment, SSP1169, for more detail list of cell equipment and schematic of oil supply system and fuel. In the event a test cell is not available, it is permissible to mount the engine in the airframe for the run-in providing the following requirements are observed.

1. Consult Table 8-4 for the correct configuration of test club adapter and bolts to be used during test. Do not use a flight propeller during test.

2. A cooling shroud equivalent to a test cell cooling shroud is installed.

3. The airframe gages may not be used. All necessary calibrated gages shall be installed independent of the airframe.

8-4. Test stand oil supply pressure to engines which can be run simulated wet sump shall be held to 1.5 - 2.0 psi throughout the run. Test stand oil supply pressure to engines run simulated dry sump shall be held to 0.5 - 3.0 psi at rated conditions. Personnel should consult Service Bulletin No. 113 when desiring to use dry sump test stand installation for wet sump engines.

8-5. Engines equipped with an integral full flow oil filter, should be run-in with a slave filter and the regular filter installed at the end of the run.

8-6. Any engine accessory drive which transmits oil pressure through oil passages in the engine and which is not pressurized by normal operation on the test stand must be checked for leakage at normal oil pressure by means of a special drive cover with oil transfer holes as required. The oil passages involved shall be inspected for external leaks at the completion of the test run.

8-7. It is desirable to have some method of maintaining the oil temperatures within the specified limits during the run-in. See Table 8-1. Engine should be idled until the oil temperature is approximately 140°F. (60°C.) before starting the run-in schedule. See Table 8-2.

8-8. Operate during the run-in with (MIL-L-6082 Grade 1100) lubricating oil or if the engine is to be stored operate with a mixture of 35' MIL-C-6529, type 1 and 65' MIL-L-6082.

8-9. Fuel should conform to specifications. See Table 8-1.

8-10. Engines equipped with a fuel pump shall be tested with a test stand fuel system terminating in a float chamber vented to the atmosphere. The fuel level in this chamber shall be below the entrance to the fuel pump by at least one foot. The fuel pressure to the chamber shall be maintained at 2 to 5 psi.

8-11. Engines not equipped with a fuel pump shall be tested with a remote fuel pump.

8-12. Attach the instrument connections and connect oil and fuel lines. Connect throttle and mixture control levers to the stand controls. Be sure the cables are free and not binding and that the travel is sufficiently long enough to completely open and close throttle and move the mixture control from full rich to idle cut-off. Install the applicable cooling shroud, test club (64802), adapter (64980) and bolts (64983). See Special Service Tool Catalog No. SSP2172. Be certain that the test club will turn up the rated RPM ± 50. See Table 8-1.

8-13. It is desirable to keep a log sheet and record the instrument reading during each speed of the run-in schedule.

8-14. Before starting be certain that the magneto switch is in the "off" position. Turn the engine over a few revolutions to ascertain that no interference exists within the arc of the test club or within the engine itself. If it does not turn freely, do not try to force it or attempt to start until the cause has been determined and the fault corrected.

TABLE 8-1

ENGINE RUN-IN TEST LIMITS

Models	Fuel Press. psi-at inlet to carb. or injector	Fuel-Minimum Octane Rating Aviation Grade	Maximum Oil Consumption		Oil Press. Operating-psi		Oil Inlet Temp. °F.	Oil Outlet Temp °F.	Max. Cyl. Head Temp. Bayonet Location °F.	Full Throttle Engine Speed RPM
			Lbs./Hr.	Qt./Hr.	Normal	Idle				
0-320-H	1-6	100/130	1.2	.67	75-85	35	165-230	190-210	500	2700
0-360-E	1-6	100/130	1.4	.78	75-85	35	165-230	190-210	500	2700

TABLE 8-2

RECOMMENDED RUN-IN SCHEDULE			
RPM	LOAD	TIME	REMARKS
1200	Prop. load	10	
1500	Prop. load	10	
1800	Prop. load	10	
2000	Prop. load	10	
2200	Prop. load	10	Check magneto drop-off*.
2400	Prop. load	10	
Normal Rated**	Prop. load	15	
Normal Rated**	Prop. load	60	Oil consumption run.

* - Do not exceed 150 RPM drop on either magneto or 35 RPM difference between magneto.

8-15. Run-In. Start the engine in accordance with the following procedure.

a. Place mixture control in full-rich position.

b. Turn fuel valve to on position.

c. Set throttle at 1/10 open position.

d. Turn magneto switch to "left" and engage starter.

(1) Turn combination magneto starter switch to start.

e. When engine fires move magneto switch to "Both".

(1) Combination spring loaded switches will return to "Both".

CAUTION

If oil pressure is not observed with ten (10) seconds, stop engine and determine cause.

8-16. Operate engine at approximately 1000 RPM until a minimum oil in temperature of 140°F. is obtained. Check magneto drop-off and general operation of the engine. Check the engine for oil leaks. Any malfunction or oil leak should be remedied before continuing the run.

8-17. Complete the run in accordance with the schedule listed in Table 8-2.

8-18. Oil Consumption Run. An oil consumption run should be made at the end of the run-in schedule. Oil consumption can be determined by the use of a scale tank through which the oil line pass and the scale reading taken at the beginning and end of the oil consumption run. Or it can be determined by draining and weighing the oil supply before and after the oil consumption run. Oil temperature should be held as closely as possible to the limits shown in Table 8-1. Oil consumption should not exceed the maximum as listed in Table 8-1.

8-19. Oil Pressure Relief Valve. Subject engines are equipped with a non-adjustable relief valve. A brief description follows.

8-20. Non-Adjustable Oil Pressure Relief Valve. Although the valve is not adjustable, the oil pressure can be controlled by the addition of STD-425 washers under the cap as required (maximum of nine), to increase the pressure. Particles of metal or other foreign matter between the ball and the seat can cause the oil pressure to drop or fluctuate. Therefore, if a drop or excessive fluctuation is noted it is advisable to disassemble, inspect and clean the valve.

8-21. Idle Speed Adjustment. With the engine thoroughly warmed up, check magneto drop-off. If the magneto drop-off is normal, proceed with the idle adjustment. Close the throttle. Adjust the idle speed adjusting screw so as the engine RPM is approximately 600 RPM. After the mixture is adjusted it may be necessary to readjust the idle RPM to the desired speed.

8-22. Mixture Adjustment. With the engine operating at the idle speed as previously set, move the mixture control lever with a smooth steady pull into the idle cut-off position and observe the tachometer for any change in RPM during the leaning process. Caution must be exercised to return the mixture control level to "Full Rich" before the RPM can drop to a point where the engine cuts out. An increase of more than 50 RPM while "leaning out" indicates an excessively rich mixture. A decrease in RPM (if not preceded by a momentary increase) indicates that the mixture is too lean.

8-23. If it is indicated that the mixture is either too lean or too rich, turn the idle mixture adjustment in the direction required for correction. Check this setting by repeating the procedure in paragraph 8-21. Each time the adjustment is changed, it is necessary to run the engine for a short time at 2000 RPM to clear the engine out before proceeding with the idle speed check. The final adjustment of the idle speed should be made with the throttle closed against the idle stop.

8-24. Preservation and Storage. In the event the engine is to be stored at the completion of the run-in the engine should be preserved in the following manner.

8-25. Upon completion of the run-in, drain the oil. Refill the engine with a 1 to 1 mixture of MIL-C-6529, Type 1, and Bayol "D" or equivalent.

8-26. Remove top spark plugs, and with the crankcase full of oil, slowly turn the propeller through two (2) revolutions.

Let engine stand for ten (10) minutes after which the propeller should be turned back and forth through 90° for twelve (12) cycles. Drain the preservative oil.

8-27. Spray the exhaust port and valve of each cylinder with the piston approximately 1/4 turn before top center of the exhaust stroke using MIL-C-6529 oil, Type 1.

8-28. Spray each cylinder with an airless spray gun (Spraying System Company "Gunjet" model 24A-8395 or equivalent) through the spark plug holes with MIL-C-6529 oil, Type 1. Spray approximately two (2) ounces of oil into each cylinder.

8-29. For all spraying the spray nozzle temperature shall be maintained between 200°F. and 220°F.

NOTE

In the event an airless spray gun is not available, it is recommended that a moisture trap be installed in the air line of the conventional spray gun and the oil shall be 200°F. to 220°F. at the nozzle.

8-30. Seal the breather openings with oil and moisture resistant caps or dehydrator plug, P/N 40238 or AN4062-11.

8-31. All accessory drives for which oil seals are provided shall be liberally coated with MIL-C-6529 oil, Type 1, before applying the drive covers.

8-32. Engines shall have spark plugs installed in the bottom cylinder location and dehydrator plugs, P/N 40238 installed in the upper cylinder location. The ignition harness shall be attached to the spark plugs in the bottom locations and have ignition cable protectors (AN-4060) on the top locations.

8-33. Exhaust ports and other openings should be closed with suitable covers.

8-34. All exposed cadmium plated and machined surfaces should be liberally coated with soft-film, corrosion preventitive compound, MIL-C-16173, Grade 2.

8-35. Although the above procedure should prevent corrosion under favorable conditions it is recommended that the engine be periodically inspected for evidence of corrosion. If corrosion should be present, the affected part should be cleaned and the engine represerved. Also, engines preserved by the above procedures are not adequately protected for extended periods of storage. If at the end of 60 days it is found that the engine must remain in storage it must be represerved.

8-36. Represervation Run. The represervation run should be accomplished under the same conditions as the run-in after overhaul except that only the followin time schedule must be followed.

TABLE 8-3

RECOMMENDED REPRESERVATION SCHEDULE		
RPM	LOAD	TIME (MINUTES)
1200	Prop. Load	5
1800	Prop. Load	5
2400	Prop. Load	5
Normal Rated	See Table 8-1	15

8-37. Preservation and Storage. Float Type Carburetors. Carburetor shall be emptied of all residual gasoline and the throttle locked in the closed position.

TABLE 8-4

TEST PROPELLER CONFIGURATION

ENGINE MODELS	TEST PROPELLER P/N	TEST PROPELLER ADAPTER P/N	TEST PROPELLER BOLTS P/N
0-320-H	64802	64980	64983
0-360-E	64803	64981	64984
LO-360-E	ST-298	64981	64984

SECTION 9
TABLE OF LIMITS

This section of the manual has been reserved for the Special Service Publication No. SSP-1776 Part I, Table of Limits and Tightening Torque Recommendations.

Upon receipt of the owner's registration card, attached in the front of this manual, at Lycoming, a copy of the Special Service Publication SSP-1776 Part I will be forwarded to the registered owner.

The SSP-1776 Part I should then be inserted in the manual at this location.

Also, the return of the registration card will assure the owner that for a period of three (3) years all future revisions to this publication and the Table of Limits will automatically be forwarded.

TEXTRON Lycoming

DIRECT DRIVE

SERVICE TABLE OF LIMITS AND TORQUE VALUE RECOMMENDATIONS

NOTICE

The basic Table of Limits, SSP2070 (including SSP2070-1, SSP2070-2, SSP2070-3 and SSP2070-3A) has been completely revised and reissued herewith as SSP1776. It is now made up of the following four parts, each part contains five sections.

PART I	DIRECT DRIVE ENGINES (Including VO and IVO-360)
PART II	INTEGRAL ACCESSORY DRIVE ENGINES
PART III	GEARED ENGINES
PART IV	VERTICAL ENGINES (Excluding VO and IVO-360)

SECTION I	500 SERIES	CRANKCASE, CRANKSHAFT & CAMSHAFT
SECTION II	600 SERIES	CYLINDERS
SECTION III	700 SERIES	GEAR TRAIN
SECTION IV	800 SERIES	BACKLASH (GEAR TRAIN)
SECTION V	900 SERIES	TORQUE AND SPRINGS

This publication supersedes and replaces the previous publications SSP2070, SSP2070-1, SSP2070-2, SSP2070-3 and SSP2070-3A; it is not to be used in conjunction with them. To make sure that SSP1776 will receive the attention of maintenance personnel, a complete set of pages for the book is sent to all registered owners of Overhaul Manuals. These recipients should remove all previous Table of Limits material from the Overhaul Manual and discard.

Additional copies of this revised Table of Limits, bound in a plastic cover, are available as indicated in the latest edition of Service Letter No. L114.

Reference numbers in the Table of Limits vary from previous Table of Limits therefore, the current as well as the old numbers are listed. The shaded columns contain the old reference numbers.

* - Indicates cut-off date for data retrieved prior to publication.

INTRODUCTION
SERVICE TABLE OF LIMITS

This Table of Limits is provided to serve as a guide to all service and maintenance personnel engaged in the repair and overhaul of Textron Lycoming Aircraft Engines. Much of the material herein contained is subject to revision; therefore, if any doubt exists regarding a specific limit or the incorporation of limits shown, an inquiry should be addressed to the Textron Lycoming factory for clarification.

DEFINITIONS:

Ref. (1st column)	The numbers in the first column headed "Ref." are shown as a reference number to locate the area described in the "Nomenclature" column. This number will be found in a diagram at the end of each section indicating a typical section where the limit is applicable.
Ref. (2nd column)	Indicates the old reference number. There are no diagrams in this manual for these numbers. These numbers are only to be found in previous publications.
Chart (3rd column)	The letter or letter and number in this column are used as symbols to designate engine models to which the specific limits is applicable. A list of the letter or letter and number and the engine to which they refer is shown below.
Nomenclature (4th column)	This is a brief description of the parts or fits specified in the adjacent columns and indicated in the diagram at end of each section.
Dimensions (5th & 6th columns)	The dimensions shown in column 5 are the minimum and maximum dimensions for the part as manufactured. The dimensions shown in column 6 indicate the limit that must not be exceeded. Unless it can be restored to serviceable size, any part that exceeds this dimension must not be rebuilt into an engine.
Clearance (7th & 8th columns)	Like the dimensions shown in the 5th and 6th columns, the clearance represents the fit between the two mating surfaces as controlled during manufacture and as a limit for permissible wear. Clearances may sometimes be found to disagree with limits for mating parts; for example, maximum diameter of cylinder minus minimum diameter of piston exceeds limit for piston and barrel clearance. In such instances, the specified maximum clearance must not be exceeded.

In some instances, where a parts revision has caused a dimensional or tolerance change, the superseded dimenional data has been deleted from the list; provided compliance with the change is not mandatory.

Letters of the alphabet and numbers are used as symbols throughout the Table of Limits to represent specific interpretations and to designate engine models. Letters in parenthesis refer to dimensional characteristics; letters (or combinations of letters and numbers) without parenthesis indicate engine models. They are listed below with their separate definitions.

(A)	These fits are either shrink fits controlled by machining, fits that may readily be adjusted, or fits where wear does not normally occur. In each case, the fit must be held to manufacturing tolerance.
(B)	Side clearance on piston rings must be measured with face of ring flush with piston .
(D)	The dimensions shown are measured at the bottom of the piston skirt at right angles to the piston pin.
(E)	Permissible wear of the crankshaft (rod and main bearing journals) to be minus 0.0015 on the diameter.
(L)	Loose fit; wherein a definite clearance is mentioned between the mating surfaces.
(T)	Tight fit; shrink or interference fit.
(WD)	Wide Deck Crankcase.

Introduction

The illustrations shown are typical of the referenced limit or fit described in the Table and in no instance are these illustrations intended to represent a specific part or engine model unless specified. Also, the terms used to designate cylinder, piston and ring materials such as "nitride, chrome, half-wedge" are more fully explained in the latest edition of Service Instruction No. 1037.

PART I DIRECT DRIVE ENGINES (Including VO and IVO-360)

CHART	MODELS
A	0-235
A1	0-235-F, -G, -K, -L
B	0-290
B1	0-290-D2
D	0-435-A
BD	0-320-H (76 Series)
G	O, IO, LIO, AEIO-320
G1	O, IO-320 With Gov. at Front (0-320-E1F, -E1J, -D1F & IO-320-D1B)
G2	AIO-320
J	0-340
Y	VO, IVO-360
S	O, IO, LIO, HIO, LHIO, TO, TIO, AEIO-360
S1	TO-360
S2	AIO-360
S3	TIO-360
S4	0-360-A With Gov. at Front (0-360-A1H, -A1LD)
S5	IO, LIO-360-A, -C (Angle Valve)
S6	IO, LIO-360-A, -C With Gov. at Front (IO, LIO-360-C1E6 & IO-360-A1D6)
S7	HIO-360-D
S8	HIO-360-B
S9	HIO-360-C, -E
S10	HIO-360-A
T	O, IO, LIO, AEIO, TIO, LTIO-540
T1	0-540-G, -H & IO-540-N, -R (Large Mains - Parallel Valve)
T2	IO-540-A, -B, -E, -G, -P (Angle Valve)
T3	IO-540-K, -M, -S; TIO, LTIO-540-A, -F, -J, -N, -R (Large Mains - Angle Valve)
T4	TIO-540-C, -E, -G, -H
AF	IO-720
BE	O, LO-360-E (76 Series)

NOTE: In "Chart" column, a number appearing after a letter shows exception to the basic model.

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION I CRANKCASE, CRANKSHAFT, CAMSHAFT

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
500	501	A	All Main Bearings and Crankshaft			.0025L / .0055L	.0060L
		B-D-G-J-S-T-Y-BD-BE-AF	Main Bearings and Crankshaft (Thin Wall Bearing - .09 Wall Approx.)			.0015L / .0045L	.0060L
		B-G-J-S-T-Y-AF	Main Bearings and Crankshaft (Thick Wall Bearing - .16 Wall Approx.)			.0011L / .0041L	.0050L
		A	Diameter of Main Bearing Journal on Crankshaft	2.3735 / 2.375	(E)		
		B-D-G-J-S-T-Y-BD-BE	Diameter of Main Bearing Journal on Crankshaft (2-3/8 in. Main)	2.3745 / 2.376	(E)		
		T1-T3-AF	Diameter of Main Bearing Journal on Crankshaft (2-5/8 in. Main)	2.6245 / 2.626	(E)		
		S8-S10	Diameter of Front Main Bearing on Journal on Crankshaft (2-3/8 in. Main)	2.3750 / 2.3760	(E)		
		T1-T3-AF	Diameter of Front Main Bearing Journal on Crankshaft (2-5/8 in. Main)	2.6245 / 2.6255	(E)		
500	955	A-B-B1-D-G*-BD-BE	Crankcase Bearing Bore Diameter (All) (Thin Wall Bearing) (2-3/8 in. Main)	2.566 / 2.567	2.5685		
		G**-J-S-T-Y	Crankcase Bearing Bore Diameter (All Except Front) (Thick Wall Bearing) (2-3/8 in. Main)	2.6865 / 2.6875	2.6890		
		T1-T3-AF	Crankcase Bearing Bore Diameter (Front Only) (Thin Wall Bearing) (2-5/8 in. Main)	2.816 / 2.817	2.8185		
		T1-T3-AF	Crankcase Bearing Bore Diameters (All Except Front) (Thick Wall Bearing) (2-5/8 in. Main)	2.9365 / 2.9375	2.9390		
		S1-T-AF	Crankcase Bearing Bore Diameter (All) (Thin Wall Bearing) (2-5/8 in. Main)	2.816 / 2.817	2.8185		
		G**-J-S-T-Y * 0-320-A, -E Narrow Deck. ** 0-320-A, -E Wide Deck.	Crankcase Bearing Bore Diameter (Front Only) (Thin Wall Bearing) (2-3/8 in. Main)	2.566 / 2.567	2.5685		
501	502	ALL	Connecting Rod Bearing and Crankshaft			.0008L / .0038L	.0050L
		A-B-D-G-J-S-T-Y-BD	Diameter of Connecting Rod Journal on Crankshaft (2-1/8 in.)	2.1235 / 2.125	(E)		

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION I CRANKCASE, CRANKSHAFT, CAMSHAFT

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
501	502	S-T-AF	Diameter of Connecting Rod Journal on Crankshaft (2-1/4 in.)	2.2485 / 2.250	(E)		
	954	A-B-D-G-J-S-T-Y-BD-BE	Connecting Rod Bearing Bore Diameter (2-1/8 in.) (Measured At Axis 30° on Each Side)	2.2870 / 2.2875			
		S-T-AF	Connecting Rod Bearing Bore Diameter (2-1/4 in.) (Measured At Axis 30° on Each Side)	2.4205 / 2.4210			
502	564	ALL	Connecting Rod - Side Clearance			.004L / .010L	.016L
503	566	ALL	Connecting Rod - Alignment			.010 in 10 Inches	
504	567	ALL	Connecting Rod - Twist			.012 in 10 Inches	
505	556		Crankshaft Run-Out at Center Main Bearing				
		4 CYLINDER	Mounted on No. 1 and 4 Journals Max. Run-Out No. 2 Journal			.002	.002
			Mounted on No. 1 and 4 Journals Max. Run-Out No. 3 Journal			.005	.0075
			Mounted on No. 2 and 4 Journals Max. Run-Out No. 3 Journal			.003	.0045
		6 CYLINDER	Mounted on No. 2 and 5 Journals Max. Run-Out No. 1 Journal			.002	.002
			Mounted on No. 2 and 5 Journals Max. Run-Out No. 3 Journal			.005	.0075
			Mounted on No. 2 and 4 Journals Max. Run-Out No. 3 Journal			.003	.0045
			Mounted on No. 3 and 5 Journals Max. Run-Out No. 4 Journal			.003	.0045
		8 CYLINDER	Mounted on No. 2 and 6 Journals Max. Run-Out No. 1 Journal			.002	.002
			Mounted on No. 2 and 4 Journals Max. Run-Out No. 3 Journal			.003	.0045
			Mounted on No. 3 and 5 Journals Max. Run-Out No. 4 Journal			.003	.0045
			Mounted on No. 4 and 6 Journals Max. Run-Out No. 5 Journal			.003	.0045
			Mounted on No. 2 and 6 Journals Max. Run-Out No. 3,4 and 5 Journals			.005	.0075
506	568	ALL	Crankshaft and Crankcase Front End Clearance			.009L / .016L	.026L
507	938	ALL	Clearance - Front Face of Crankshaft Oil Slinger to Front Face of Recess in Crankcase (Crankshaft Against Thrust Face)			.002 / .007L	(A)

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION I CRANKCASE, CRANKSHAFT, CAMSHAFT

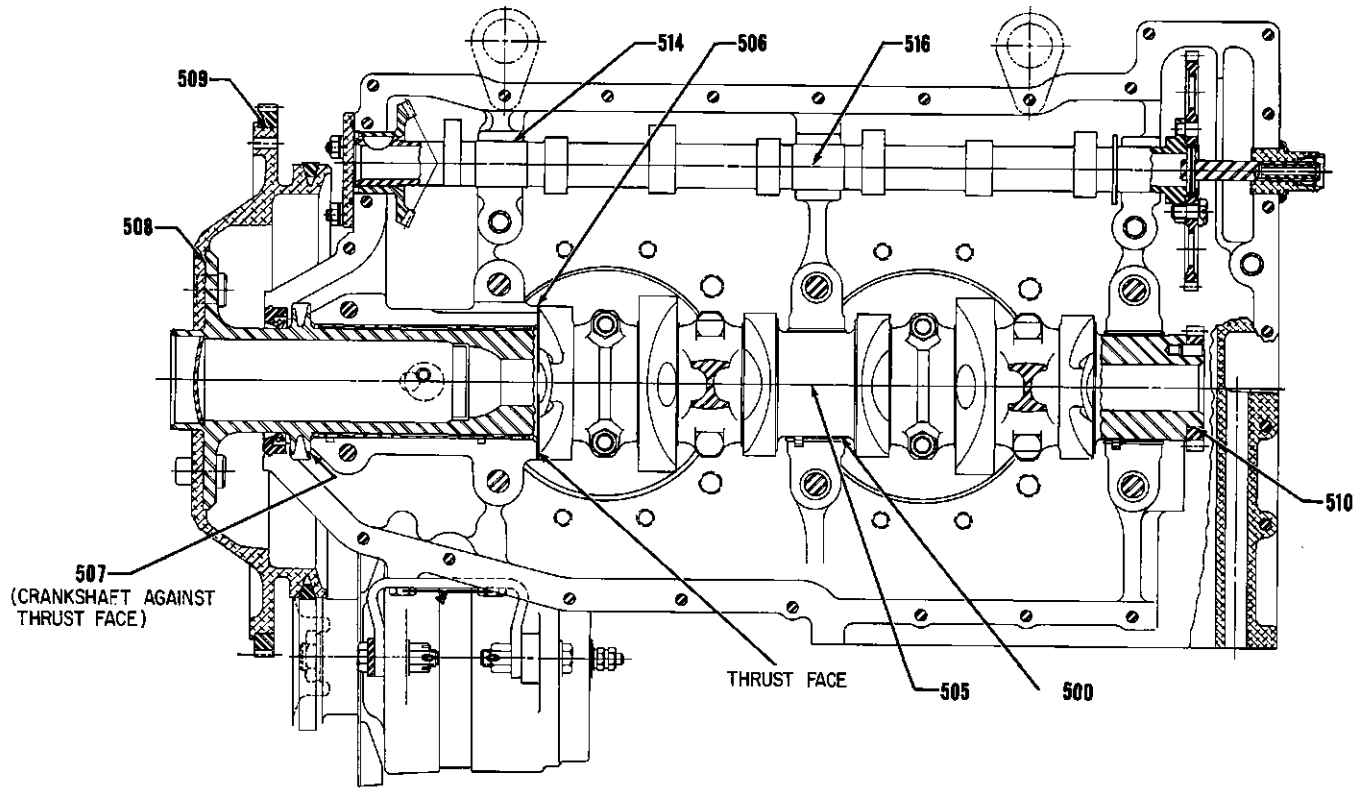
Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
508	607	ALL	Crankshaft Prop. Flange Run-Out			.002	.005
509	941	ALL	Starter Ring Gear and Support			.014T / .022T	(A)
510	504	A-B-D-G-J-S-T-Y-AF BD-BE	Crankshaft Timing Gear and Crankshaft			.0005T / .0010L	(A)
511	536	A-B-D-G-J-S-T-Y-AF	Tappet Body and Crankcase			.0010L / .0033L	.004L
		BD-BE	Tappet Body and Crankcase			.0010L / .0030L	.004L
		A-B	O.D. of Tappet	.6232 / .6240	.6229		
		B1-D-G-J-S-T-Y-AF	O.D. of Tappet	.7169 / .7177	.7166		
		BD-BE	O.D. of Tappet	.8740 / .8745	.8737		
		A-B	I.D. Tappet Bore in Crankcase	.6250 / .6263	.6266		
		B1-D-G-J-S-T-Y-AF	I.D. Tappet Bore in Crankcase	.7187 / .7200	.7203		
		BD-BE	I.D. Tappet Bore in Crankcase	.8755 / .8773	.8776		
512	559	B1-D-G-J-S-T-Y	Tappet Plunger Assembly and Body - Chilled			.0010L / .0047L	.0067L
		S7-S1-AF	Tappet Plunger Assembly and Body - Hyperbolic			.0010L / .0067L	.0087L
513	560	B1-D-G-J-S-T-Y	Tappet Socket and Body			.002L / .005L	.007L
		S7-S1-AF	Tappet Socket and Body (Hyperbolic)			.002L / .007L	.009L
514	537	ALL	Camshaft and Crankcase			.002L / .004L	.006L
515	538	ALL	Camshaft - End Clearance			.002L / .009L	.015L
516	539	ALL	Camshaft Run-Out at Center Bearing Journal			.000 / .001	.006
517	578	All Models Using Counterweights	Counterweight Bushing and Crankshaft			.0013T / .0026T	(A)
518	579	All Models Using Counterweights	Counterweight Roller - End Clearance			.007L / .025L	.038L
519	580	All Models Using Counterweights	Counterweight and Crankshaft - Side Clearance*			.003L / .013L	.017L
520	696	All Models Using Counterweights	Counterweight Bore and Washer O.D.			.0002L / .0030L	(A)
521	775	All Models Using Counterweights	I.D. of Counterweight Bushing	.7485 / .7505	.7512		
		* Measure below roller next to flat.					

SERVICE TABLE OF LIMITS

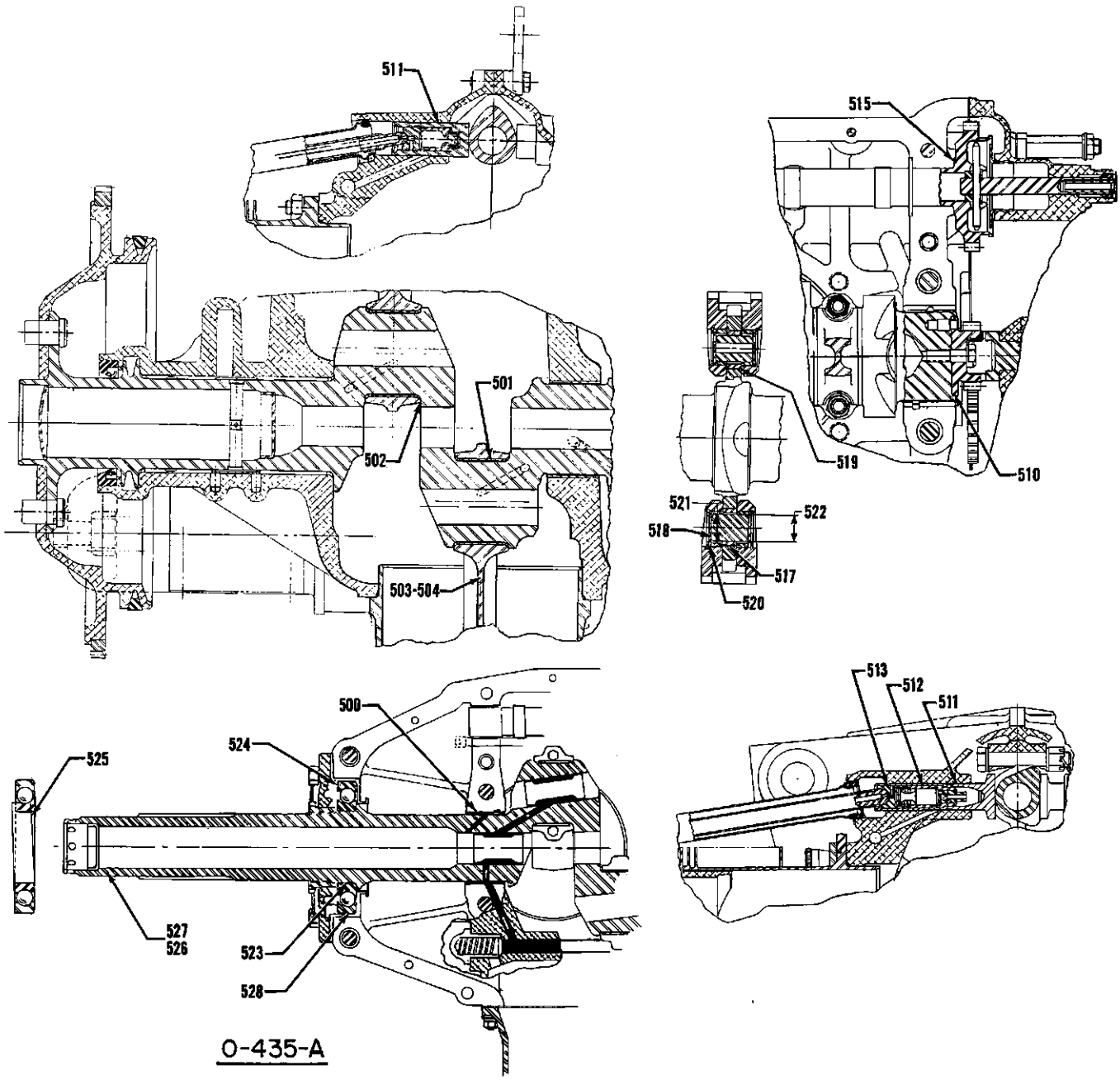
PART 1 DIRECT DRIVE ENGINES

SECTION I CRANKCASE, CRANKSHAFT, CAMSHAFT

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
522	774	ALL (AS APPLICABLE)	O.D. of Counterweight Roller (See latest edition of Service Instruction No. 1012)				
523	503	D	Thrust Bearing and Propeller Shaft			.0000 / .0012L	.002L
524	509	D	Thrust Bearing and Thrust Bearing Cap Clamp Fit (Shim to this Fit)			.003T / .005T	(A)
525	555	D	Thrust Bearing Tilt		.027 Tilt		
526	505	D	Crankshaft Run-Out - Rear Cone Location				.003
527	506	D	Crankshaft Run-Out - Front Cone Location				.007
528	508	D	Thrust Bearing and Thrust Bearing Cage			.0016L / .0034L	.0045L



Longitudinal Section Thru Engine



Crankcase, Crankshaft, Camshaft and Related Parts

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION II CYLINDERS

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions Mfr. Min. & Max.	Dimensions Serv. Max.	Clearances Mfr. Min. & Max.	Clearances Serv. Max.
600	510	ALL	Connecting Rod and Connecting Rod Bushing	Bushing To Be Burnished in Place			
		ALL	Finished I.D. of Connecting Rod Bushing	1.1254 / 1.1262			
601	510	A-B-D-G-J-BD	Length Between Connecting Rod Bearing Centers	6.4985 / 6.5015			
		S-T-Y-AF-BE	Length Between Connecting Rod Bearing Centers	6.7485 / 6.7515			
602	511	ALL	Connecting Rod Bushing and Piston Pin			.0008L / .0021L	.0025L
603	512	ALL	Piston Pin and Piston			.0003L / .0014L	.0018L
		ALL	Diameter of Piston Pin Hole in Piston	1.1249 / 1.1254			
		ALL	Diameter of Piston Pin	1.1241 / 1.1246			
604	513	A-G-J-S-T-AF-BD-BE	Piston and Piston Pin Plug			.0002L / .0010L	.002L
		A-G-J-S-T-AF-BD-BE	*Diameter of Piston Pin Plug	1.1242 / 1.1247			
605	513	B-D-G-J-S-T-Y-AF	Piston Pin and Piston Pin Plug (Optional)			.0005L / .0025L	.005L
		G-J-S-T-Y-AF	*Diameter of Piston Pin Plug	.5655 / .5665			
		B-D	Diameter of Piston Pin Plug (Thin Wall Pin)	.8405 / .8415			
		*See latest edition of Service Instruction No. 1267.					
606	514	A-B	Piston Ring and Piston - Side Clearance (Top Ring Comp.) (Plain) Full Wedge			.000 / .004L	.006L(B)
		B-D	Piston Ring and Piston - Side Clearance (Top Ring Comp.) (Chrome) Full Wedge			.0025L / .0065L	.008L(B)
		G-J-S-T-Y-AF-BD-BE	Piston Ring and Piston - Side Clearance (Top Ring Comp.) Half Wedge			.0025L / .0055L	.008L(B)
606	515	B	Piston Ring and Piston - Side Clearance (2nd Ring Comp.) (Chrome) Full Wedge			.0025L / .0065L	.008L(B)
		A-B-D-G-J-S-T-Y-AF-BD-BE	Piston Ring and Piston - Side Clearance (2nd Ring Comp.) Full or Half Wedge			.000 / .004L	.006L(B)
		J	Piston Ring and Piston - Side Clearance (3rd Ring Comp.) Half Wedge			.000 / .004L	.006L(B)
606	516	ALL	Piston Ring and Piston - Side Clearance (Oil Regulating)			.002L / .004L	.006L(B)

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION II CYLINDERS

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions Mfr. Min. & Max.	Dimensions Serv. Max.	Clearances Mfr. Min. & Max.	Clearances Serv. Max.
606	517	A	Piston Ring and Piston - Side Clearance (Bottom)			.003L .0055L	.007L(B)
607	615	ALL	Piston Ring Gap (Compression) Plain and Chrome Cylinders (Straight Barrels)			.020 .030	.047
		ALL	Piston Ring Gap (Compression) Nitrided and Chrome Cylinders (Choke Barrels)			.045 .055	.067
		ALL	Piston Ring Gap (Oil Regulating) (All Barrels)			.015 .030	.047
		A-T2	Piston Ring Gap (Oil Scraper) (All Barrels)			.015 .030	.047

For Choke Barrels - Ring gap is measured within 4 inches from bottom. Ring gap at top of travel must not be less than .0075.

For all Other Barrels - Ring gap is measured at top limit of ring travel.

		Engine and Piston Application		Min. Piston Diameter			Cylinder Barrel		
		Engine Chart Code Letter	Piston Number	Top	Bottom	Type of Piston	Type of Surface	Maximum Diameter	Max. Clearance Piston Skirt & Cyl.
608	519	A	61147, 73851	4.3470	4.3555	Cast-Round	P	4.3795	.021L
608	522		61333	4.3470	4.3555	Forged-Round	P	4.3795	.021L
609	520		LW-11621*, LW-13623*	4.3290	4.3605	Cast-Cam	N	4.3805	.018L
610	521	B	69841*, 69958, 70396	4.8290	4.8620	Cast-Cam	P - C	4.8805	.018L
		D	69958	4.8290	4.8620	Cast-Cam	P	4.8805	.018L
		G,S,T	73196, 74059, 75413	5.0790	5.1090	Cast-Cam	P-C-N	5.1305	.018L
		G	69337	5.0790	5.1090	Forged-Cam	P - C	5.1305	.018L
		J,S,Y,T	71594*, 72967*, 74530*, 75089*	5.0790	5.1090	Cast-Cam	P-C-N	5.1305	.018L
		B D	LW-15357*	5.0790	5.1090	Cast-Cam	N	5.1305	.018L
		S,T,AF	73264*, 75617*, 76966, 78203*, LW-10207*, LW-13358*, LW-14610*, LW-11487*, LW-10545	5.0790	5.1090	Forged-Cam	N - C	5.1305	.018L
		T	LW-13396*	5.0790	5.1090	Cast-Cam	N	5.1305	.018L

NOTES:

To find the average diameter of cylinder in an area 4" above bottom of barrel: First, measure diameter at right angles from plane in which valves are located. Second, measure diameter through the plane in which valves are located. Add both diameters; this sum, divided by 2, represents the average diameter of the cylinder.

*=High Compression.

Cylinder Barrel: P=plain steel, N=nitride hardened, C=chrome plated.

To find the average out-of-round, measure diameter of cylinder in an area 4" above bottom of barrel: First, measure diameter at right angles from plane in which valves are located. Second, measure diameter through the plane in which valves are located. Difference between diameters must not exceed .0045 inch.

Maximum taper and out-of-round permitted for cylinder in service is .0045 inch.

See Service Instruction No. 1243 for identification of cast and forged pistons. The suffix "S" that will be found with the part number on 76966, 78203, LW-10207, LW-10545, LW-11487, LW-13358, LW-14610 pistons indicates the piston weight is within the limits specified for any group of pistons and may be substituted for any like piston on a particular engine. Other pistons are manufactured within weight limits that do not require any weight controlled piston for replacement.

Piston diameter at top is measured at top ring land (between top and second compression ring grooves) at right angle to piston pin hole; diameter at bottom of piston is measured at the bottom of the piston skirt at right angles to the piston pin. See Service Instruction No. 1243 for illustration.

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION II CYLINDERS

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
611	523	A	Exhaust Valve Seat and Cylinder Head			.0065T / .010T	(A)
		B-D-G-J-S-T-Y-BD-BE	Exhaust Valve Seat and Cylinder Head			.0045T / .008T	(A)
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Exhaust Valve Seat and Cylinder Head			.0075T / .011T	(A)
		A	O.D. Exhaust Seat	2.0025 / 2.004			
		B-D-G-J-S-T-Y-BD-BE	O.D. Exhaust Seat	1.7395 / 1.741			
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	O.D. Exhaust Seat	1.9355 / 1.937			
		A	I.D. Exhaust Seat Hole in Cylinder Head	1.994 / 1.996			
		B-D-G-J-S-T-Y-BD-BE	I.D. Exhaust Seat Hole in Cylinder Head	1.733 / 1.735			
611	523	S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Exhaust Seat Hole in Cylinder Head	1.926 / 1.928			
612	524	A	Intake Valve Seat and Cylinder Head			.0070T / .0105T	(A)
		B-D-G-J-S-T-Y-AF-BD-BE	Intake Valve Seat and Cylinder Head			.0065T / .010T	(A)
		A	O.D. Intake Seat	2.0965 / 2.0975			
		A1-B-D	O.D. Intake Seat	1.9265 / 1.928			
		B1-C-J-S-T-Y-BD-BE	O.D. Intake Seat	2.0815 / 2.083			
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	O.D. Intake Seat	2.2885 / 2.290			
		A	I.D. Intake Seat Hole in Cylinder Head	2.087 / 2.089			
		A1-B-D	I.D. Intake Seat Hole in Cylinder Head	1.918 / 1.920			
		B1-G-J-S-T-Y-BD-BE	I.D. Intake Seat Hole in Cylinder Head	2.073 / 2.075			
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	I.D. Intake Seat Hole in Cylinder Head	2.280 / 2.282			
613	526	ALL	Exhaust Valve Guide and Cylinder Head			.001T / .0025T	(A)
613	527	A-B-D-G-J	O.D. Exhaust Valve Guide	.5933 / .5938			

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION II CYLINDERS

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
613	527	Y	O.D. Exhaust Valve Guide	.6267 / .6272			
		G-J-S-T-AF-BD-BE	O.D. Exhaust Valve Guide	.6633 / .6638			
		S1	O.D. Exhaust Valve Guide	.6953 / .6958			
		A-B-D-J	I.D. Exhaust Valve Guide Hole in Cylinder Head	.5913 / .5923			
613	527	Y	I.D. Exhaust Valve Guide Hole in Cylinder Head	.6247 / .6257			
		G-J-S-T-AF-BD	I.D. Exhaust Valve Guide Hole in Cylinder Head	.6613 / .6623			
		S1	I.D. Exhaust Valve Guide Hole in Cylinder Head	.6933 / .6943			
614	527	ALL	Intake Valve Guide and Cylinder Head			.0010T / .0025T	
		ALL	O.D. Intake Valve Guide	.5933 / .5938			
		ALL	I.D. Intake Valve Guide Hole in Cylinder Head	.5913 / .5923			
615	528	A-B-D	Exhaust Valve Stem and Valve Guide			.0020L / .0038L	(A)
		A1-G-J-S-T-BD-BE	Exhaust Valve Stem and Valve Guide (Parallel Valve Heads)			.0040L / .0060L	(A)
		Y	Exhaust Valve Stem and Valve Guide			.0035L / .0053L	(A)
		S1-S2-S3-S5-S6-T2-T3-AF	Exhaust Valve Stem and Valve Guide (Angle Valve Heads)			.0037L / .0050L	(A)
		S7-S9-S10	Exhaust Valve Stem and Valve Guide (Angle Valve Heads - Helicopter)			.0035L / .0055L	(A)
		A-B-D	O.D. Exhaust Valve Stem	.4012 / .4020			
		A1	O.D. Exhaust Valve Stem	.4320 / .4333			
		G-J-Y	O.D. Exhaust Valve Stem	.4332 / .4340			
		G-J-S-T-BD-BE	O.D. Exhaust Valve Stem (Parallel Valve Heads)	.4935 / .4945	.4915		
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	O.D. Exhaust Valve Stem (Angle Valve Heads)	.4955 / .4965	.4937		

Service allowable limits of .4937 or .4915 is applicable only to inconel or nimonic valves.

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION II CYLINDERS

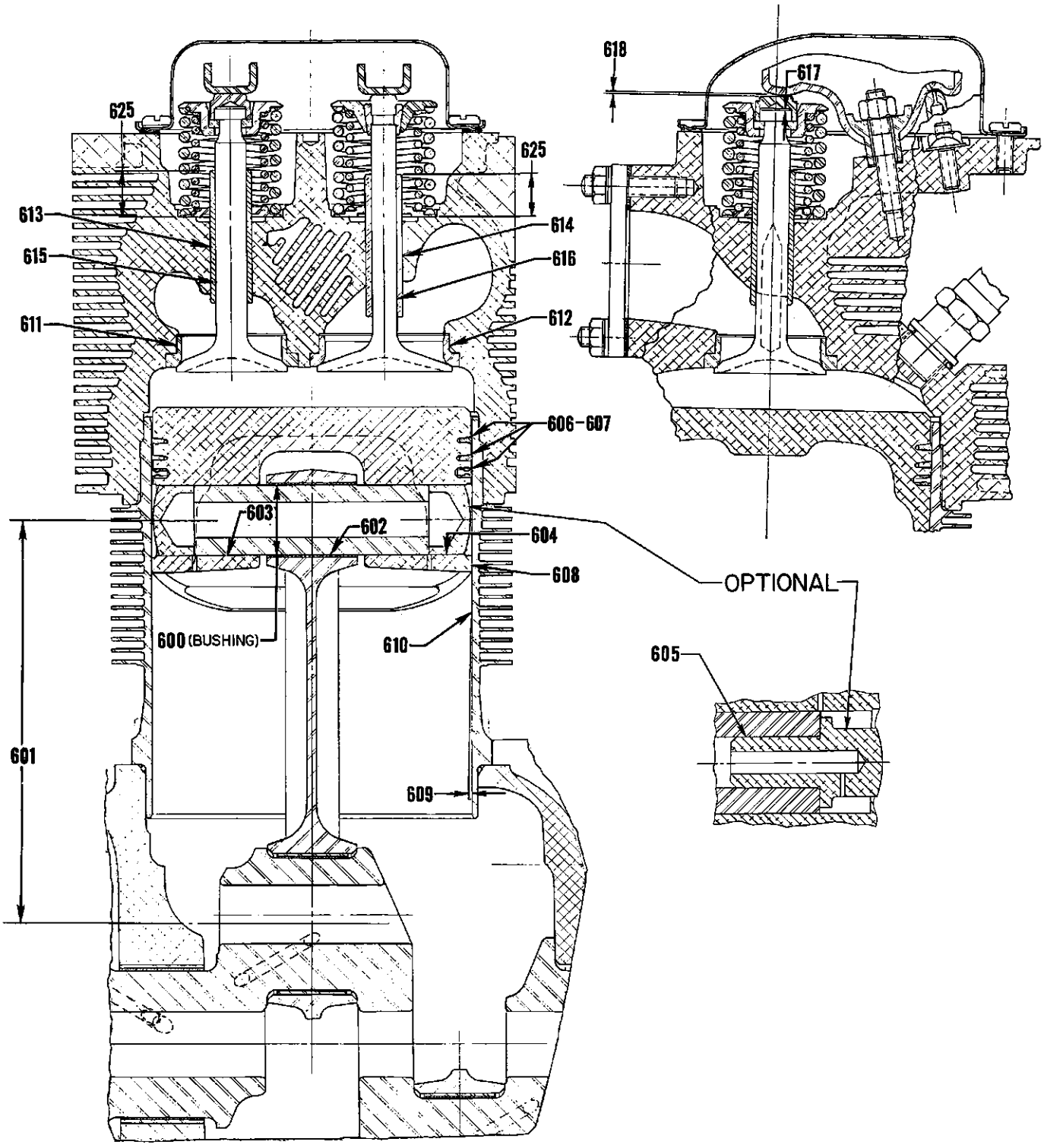
Ref. New	Ref. Old	Chart	Nomenclature	Dimensions Mfr. Min. & Max.	Dimensions Serv. Max.	Clearances Mfr. Min. & Max.	Clearances Serv. Max.
615	527	A-B-D	Finished I.D. Exhaust Valve Guide	.4040 / .4050			
		A1-G-J	Finished I.D. Exhaust Valve Guide	.4370 / .4380			
		Y	Finished I.D. Exhaust Valve Guide	.4375 / .4385			
		G-J-S-T-BD-BE	Finished I.D. Exhaust Valve Guide (Parallel Valve Heads)	.4985 / .4995			
		S1-S2-S3-S5-S6-T2-T3-AF	Finished I.D. Exhaust Valve Guide (Angle Valve Heads)	.4995 / .5005			
		S7-S9-S10	Finished I.D. Exhaust Valve Guide (Angle Valve Heads - Helicopter)	.5000 / .5010			
		1/2 inch diameter exhaust valves may have exhaust valve guides that are .003 in. over the maximum inside diameter limit, anytime up to 300 hours of service. After 300 hours of service, inside diameter of exhaust valve guide may increase .001 in. during each 100 hours of operation up to the recommended overhaul time for the engine, or not to exceed .015 inch over the basic I.D. See latest edition of Service Instruction No. 1009 for recommended overhaul time.					
616	529	ALL	Intake Valve Stem and Valve Guide			.0010L / .0028L	.006L
		ALL	O.D. Intake Valve Stem	.4022 / .4030	.4010		
616	527	ALL	Finished I.D. Intake Valve Guide	.4040 / .4050			
617	951	ALL	Intake and Exhaust Valve and Valve Cap Clearance (Rotator Type Small Dia. Head)			.000 / .004L	.005L
618	952	A-B	Solid Tappet Clearance (After Engine in Run)			.006 / .012	
		G-D-J-S-T-Y-AF-BD-BE	Dry Tappet Clearance			.028 / .080	
619	530	A	Valve Rocker Shaft and Cylinder Head (No Bushing)			.0001L / .0013L	.0025L
619	611	B-D-J-S-T-Y	Valve Rocker Shaft and Valve Rocker Bushing (Parallel Valve Heads)			.0001L / .0013L	.0025L
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Valve Rocker Shaft and Valve Rocker Bushing (Angle Valve Heads)			.0001L / .0013L	.0025L
619	530	A	Finished I.D. of Valve Rocker Shaft Bores in Cylinder Head (No Bushings)	.6246 / .6261	.6270		
619	611	B-D-G-J-S-T-Y	Finished I.D. of Valve Rocker Shaft (Bushing) in Cylinder Head (Parallel Valve Heads)	.6246 / .6261	.6270		

SERVICE TABLE OF LIMITS

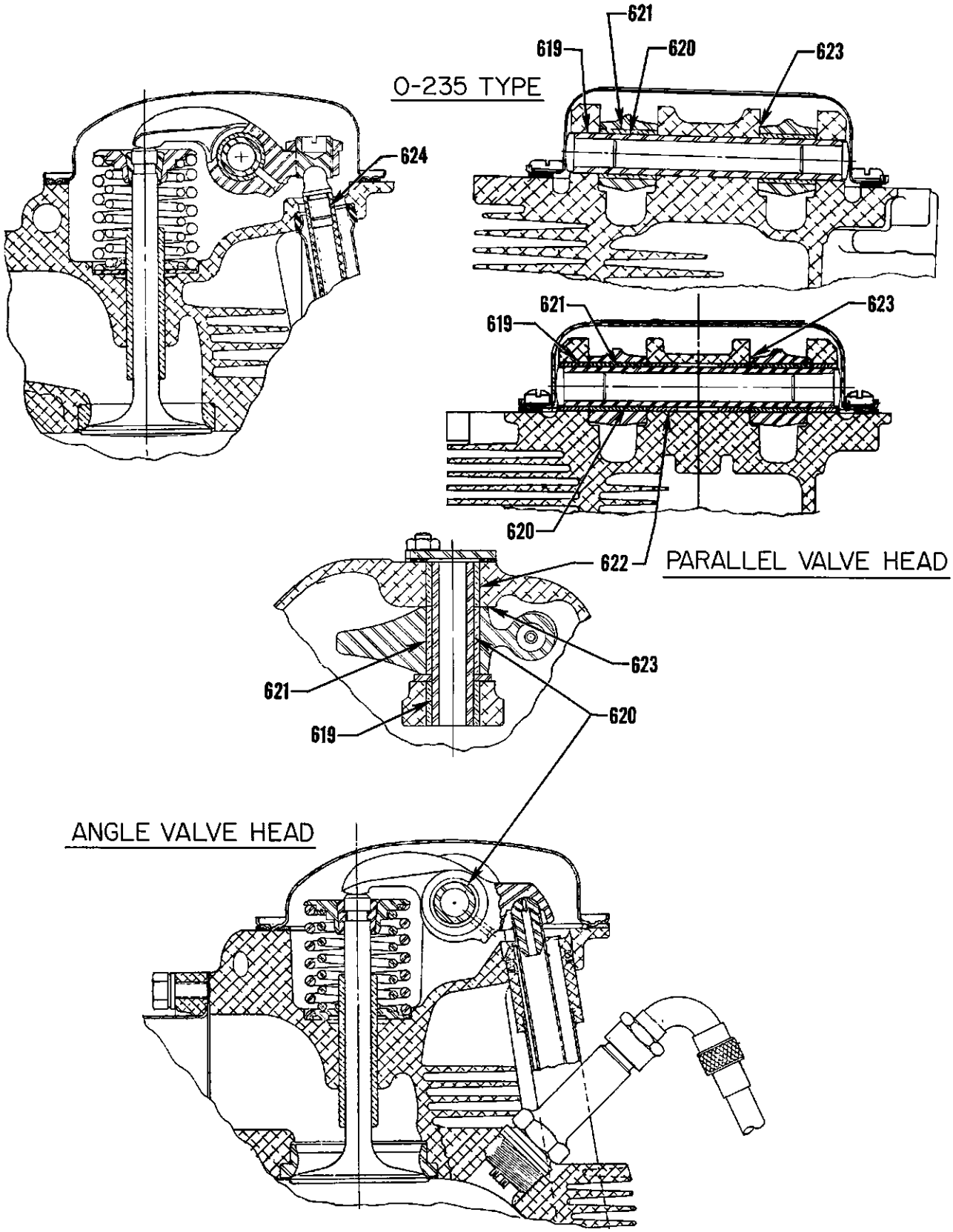
PART 1 DIRECT DRIVE ENGINES

SECTION II CYLINDERS

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
619	611	S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Finished I.D. of Valve Rocker Shaft (Bushing) in Cylinder Head (Angle Valve Heads)	.6246 .6261	.6270		
620	531	ALL	Valve Rocker Shaft and Valve Rocker Bushing			.0007L .0017L	.004L
		ALL	Finished I.D. of Rocker Arm Bushing	.6252 .6263	.6270		
		ALL	O.D. Valve Rocker Shaft	.6241 .6245	.6231		
621	532	ALL	Valve Rocker Bushing and Valve Rocker	Bushing Must Be Burnished In Place			
622	612	ALL	Valve Rocker Shaft Bushing and Cylinder Head			.0022T .0038T	(A)
		ALL	Valve Rocker Shaft Bushing Hole in Cylinder Head	.7380 .7388			
623	533	A-B-D-G-J-Y-S-T	Valve Rocker and Cylinder Head - Side Clearance (Parallel Valve Heads)			.005L .013L	.016L
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Valve Rocker and Cylinder Head - Side Clearance (Angle Valve Heads)			.002L .020L	.024L
624	535	A-B-J	Push Rod and Ball End			.0005T .0025T	(A)
625	971	A	Intake and Exhaust Valve Guide Height	.705 .725			
		ALL	Intake Valve Guide Height (Parallel Valve Heads)	.705 .725			
		ALL EXCEPT 0-235	Exhaust Valve Guide Height (Parallel Valve Heads)	.765 .785			
		ALL	Intake and Exhaust Valve Guide Height (Angle Valve Heads)	.914 .954			
			MEASURE VALVE GUIDE HEIGHT FROM THE VALVE SPRING SEAT COUNTERBORE IN THE CYLINDER HEAD TO THE TOP OF VALVE GUIDE.				



Cylinder, Piston and Valve Components



Cylinder, Piston and Valve Components

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION III GEAR TRAIN SECTION - OIL PUMP

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
700	545	ALL	Oil Pump Drive Shaft and Oil Pump Body or Cover			.0010L / .0025L	.004L
701	601	A-B-D-G-J-S-T-AF	Oil Pump Drive Shaft and and Accessory Housing			.0015L / .0030L	.006L
		Y	Oil Pump Drive Shaft and Accessory Case			.0015L / .0030L	.006L
		BD-BE	Oil Pump Drive Shaft and Crankcase			.0010L / .0025L	.004L
702	980	S-T-AF (DUAL MAGNETO)	Oil Pump Drive Shaft - End Clearance			.015L / .050L	.065L
		BD-BE	Oil Pump Drive Shaft - End Clearance			.017L / .037L	.047L
703	542	A-B-D-G-J-S-T-Y-AF	Oil Pump Impellers - Diameter Clearance			.002L / .006L	.008L
		BD-BE	Oil Pump Impellers - Diameter Clearance			.0035L / .0075L	.009L
704	543	ALL (Except BD-BE)	Oil Pump Impeller - Side Clearance			.002L / .0045L	.005L
		BD-BE	Oil Pump Impeller - Side Clearance			.003L / .005L	.006L
		AS APPLICABLE	Width of Oil Pump Impellers	.622 / .624	.621		
		AS APPLICABLE	Width of Oil Pump Impellers	.747 / .749	.746		
		AS APPLICABLE	Width of Oil Pump Impellers	.995 / .997	.994		
		BD-BE	Width of Oil Pump Impellers	.622 / .623	.620		
705	544	S-T-AF (DUAL MAGNETO)	Oil Pump Impeller and Idler Shaft			.0010L / .0025L	.004L
		A-B-D-G-J-S-T-Y-AF	Oil Pump Impeller and Idler Shaft			.001T / .003T	(A)
		BD-BE	Oil Pump Impeller and Idler Shaft			.002T / .004T	(A)
706	558	A-B-D-G-J-S-T-Y-AF	Oil Pump Idler Shaft and Oil Pump Body			.0005L / .0020L	.003L
		BD-BE	Oil Pump Idler Shaft and Oil Pump Body			.0010L / .0025L	.003L
		S-T-AF (DUAL MAGNETO)	Oil Pump Idler Shaft and Oil Pump Body			.0000 / .0015T	(A)
707	602	A-B-D-G-J-S-T-Y-AF	Oil Pump Idler Shaft and Accessory Housing			.0010L / .0025L	.0035L
		BD-BE	Oil Pump Idler Shaft and Crankcase			.0010L / .0025L	.0035L

SECTION III GEAR TRAIN SECTION - SCAVENGE PUMP

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
708	545	G2-S2	Scavenge Pump Drive Shaft and Adapter			.0010L / .0025L	.004L
709	546	G2-S2	Scavenge Pump - End Clearance			.000 / .045L	.060L
710	542	G2-S2	Scavenge Pump Impellers - Diameter Clearance			.007L / .011L	.014L
711	543	G2-S2	Scavenge Pump Impellers - Side Clearance			.003L / .005L	.006L
		G2-S2	Width of Impellers	1.496 / 1.498	1.495		
712	544	G2-S2	Scavenge Pump Impellers and Idler Shaft			.0010L / .0025L	.004L
713	544	G2-S2	Scavenge Pump Body and Idler Shaft			.0000 / .0015T	(A)
714	772	S3-T4-AF (WIDE DECK)	Turbocharger Scavenge Pump Drive and Adapter			.0010L / .0025L	.004L
715	986	S3-T4-AF (WIDE DECK)	Turbocharger Scavenge Pump Shaft and Adapter			.0010L / .0020L	.0035L
716	949	S3-T4-AF (WIDE DECK)	Gerotor Pump - Rotor - Side Clearance			.0015L / .003L	.004L
717	950	S3-T4-AF (WIDE DECK)	Gerotor Pump Housing and Adapter			.0005L / .0020L	(A)
718	985	S3-T4-AF (WIDE DECK)	Turbocharger Scavenge Pump - End Clearance			.0055L / .0365L	.0415L
		T4 (DUAL MAGNETO)	Turbocharger Scavenge Pump - End Clearance			.0105L / .0395L	.0445L
		SECTION III GEAR TRAIN SECTION - FUEL PUMP					
719	629	A-B-D-G-J-S-T	AC Fuel Pump Plunger and Accessory Housing			.0015L / .003L	.005L
720	619	J-S-T-AF	Crankshaft Idler Gear and Crankshaft Idler Gear Shaft			.001L / .003L	.005L
721	983	S-T-AF (DUAL MAGNETO)	Crankshaft Idler Gear Shaft and Accessory Housing			.0020L / .0035L	.0065L
		S-T-AF (DUAL MAGNETO)	Crankshaft Idler Gear Shaft and Crankcase			.0020L / .0035L	.0065L
722	767	S-T-AF	AN Fuel Pump Idler Gear and Shaft			.001L / .003L	.005L
723	984	S-T-AF (DUAL MAGNETO)	AN Fuel Pump Idler Gear Shaft and Accessory Housing and Crankcase			.0020L / .0035L	.0065L
		S-T-AF (DUAL MAGNETO)	AN Fuel Pump Idler Shaft and Crankcase			.0020L / .0035L	.0065L

SECTION III GEAR TRAIN SECTION - FUEL PUMP (CONT.)

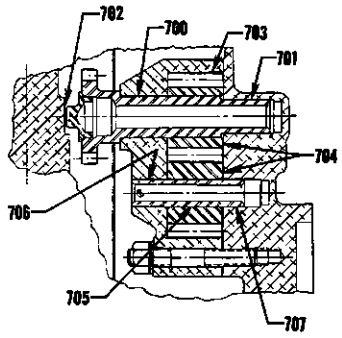
Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
724	620	A-B	Crankshaft Idler Gear - End Clearance			.003L / .043L	.058L
		G-J-S-Y	Crankshaft Idler Gear - End Clearance			.005L / .040L	.055L
		T-AF	Crankshaft Idler Gear - End Clearance			.007L / .037L	.052L
		S (DUAL MAGNETO)	Crankshaft Idler Gear - End Clearance			.020L / .030L	.040L
		T (DUAL MAGNETO)	Crankshaft Idler Gear - End Clearance			.015L / .038L	.046L
725	768	S	AN Fuel Pump Idler Gear - End Clearance			.010L / .045L	.055L
		T-AF	AN Fuel Pump Idler Gear - End Clearance			.002L / .018L	.024L
		S-T-AF (DUAL MAGNETO)	AN Fuel Pump Idler Gear - End Clearance			.015L / .038L	.045L
726	769	S-T-AF-Y	AN Fuel Pump Drive Shaft Gear and Adapter			.0010L / .0025L	.004L
727	770	S	AN Fuel Pump Drive Shaft Gear - End Clearance			.035L / .069L	.079L
		T-AF	AN Fuel Pump Drive Shaft Gear - End Clearance			.044L / .081L	.091L
		T-AF (DUAL MAGNETO)	AN Fuel Pump Drive Shaft Gear - End Clearance			.035L / .073L	.083L
		Y	AN Fuel Pump Drive Shaft Gear - End Clearance			.000L / .067L	.075L
		SECTION III GEAR TRAIN SECTION - GOVERNOR & HYDRAULIC PUMP					
728	668	T-AF (NARROW DECK)	Front Governor Drive Idler Shaft (Both Ends) and Crankcase			.0010L / .0025L	.004L
729	668	G1-G2-S2-S4-S6-T-AF (WIDE DECK)	Front Governor Idler Gear and Shaft			.0010L / .0025L	.004L
730	668	BD-BE	Front Governor Drive Gear and Crankcase			.0010L / .0025L	.004L
		BD-BE	Front Governor Drive Gear and and Camshaft			.0005L / .0025L	.004L
731	670	G1-G2-S-T-AF	Front Governor Gear and Crankcase			.0010L / .0025L	.004L
		BD	Front Governor Gear and Crankcase			.0010L / .0030L	.004L
732	674	G1-G2-S-T-AF	Front Governor Gear - End Clearance			.008L / .016L	.021L
		BD-BE	Front Governor Gear - End Clearance			.0045L / .0165L	.021L

SECTION III GEAR TRAIN SECTION - GOVERNOR & HYDRAULIC PUMP (CONT.)

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
733	675	G-J-S	Rear Governor Gear and Adapter			.0010L / .0025L	.005L
		G-S (DUAL MAGNETO)	Rear Governor Gear and Accessory Housing			.0010L / .0025L	.005L
734	674	G-J-S	Rear Governor Gear - End Clearance			.002L / .024L	.034L
		G-S (DUAL MAGNETO)	Rear Governor Gear - End Clearance			.002L / .037L	.044L
735	772	T-AF	Hydraulic Pump Gear and Adapter			.0010L / .0025L	.004L
		T-AF (DUAL MAGNETO)	Hydraulic Pump Gear and Accessory Housing			.0010L / .0025L	.004L
736	773	T-AF	Hydraulic Pump Gear - End Clearance			.010L / .066L	.076L
		T-AF (DUAL MAGNETO)	Hydraulic Pump Gear - End Clearance			.007L / .032L	.039L
		SECTION III GEAR TRAIN SECTION - VACUUM & TACHOMETER					
737	622	A-B-G-J-S-T-Y-AF	Vacuum Pump Gear and Adapter			.0010L / .0030L	.0045L
737	989	S-T-AF (DUAL MAGNETO)	Vacuum Pump Gear and Accessory Housing			.0010L / .0025L	.004L
737	589	D	Vacuum Pump Gear and Accessory Housing			.0010L / .0025L	.006L
738	590	A-B-G-J-S-T-AF	Vacuum Pump Gear - End Clearance			.010L / .057L	.075L
		D	Vacuum Pump Gear - End Clearance			.003L / .020L	.030L
		Y	Vacuum Pump Gear - End Clearance			.000 / .067L	.075L
		S (DUAL MAGNETO)	Vacuum Pump Gear - End Clearance			.012L / .044L	.055L
		T-AF (DUAL MAGNETO)	Vacuum Pump Gear - End Clearance			.017L / .039L	.050L
739	625	A-B-Y	Tachometer Drive Shaft and Adapter			.0015L / .0035L	.006L
		BD-BE	Tachometer Drive Shaft and Adapter			.0010L / .0050L	.0065L
739	540	D-G-J-S-T-AF	Tachometer Drive Shaft and Accessory Housing			.0015L / .0035L	.006L
740		G-J-S (DUAL DRIVE)	Vacuum Pump Gear and Adapter			.0010L / .0025L	.004L
741	789	G-J-S (DUAL DRIVE)	Vacuum Pump Gear - End Clearance			.000 / .017L	.027L

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
742	791	G-J-S (DUAL DRIVE)	Idler Gear and Shaft			.0010L / .0030L	.005L
743		G-J-S (DUAL DRIVE)	Idler Gear - End Clearance			.021L / .041L	.060L
744	764	G-J-S (DUAL DRIVE)	Propeller Governor Gear and Adapter			.0013L / .0028L	.005L
		G-J-S (DUAL DRIVE)	Hydraulic Pump Gear and Adapter			.0013L / .0028L	.005L
745	794	G-J-S (DUAL DRIVE)	Propeller Governor or Hydraulic Pump - End Clearance			.000 / .054L	.074L
		SECTION III GEAR TRAIN SECTION - MAGNETO, GENERATOR, STARTER					
746	677	T	Magneto Bearing and Gear			.0005T / .0001L	.0005L
746	549	D	Magneto Bearing and Gear			.0008T / .0001L	.0005L
747	677	T	Magneto Bearing and Crankcase			.0002T / .0007L	(A)
747	561	D	Magneto Drive Bearing and Adapter			.0006T / .0008T	(A)
748		S7	Magneto Bearing and Gear			.0001T / .0010T	(A)
749		S7	Magneto Bearing and Adapter			.000 / .0012L	.0015L
750	987	S-T-AF (DUAL MAGNETO)	Magneto Drive Gear and Crankcase			.0010L / .0025L	.003L
751	988	S-T-AF (DUAL MAGNETO)	Magneto Drive Gear - End Clearance			.005L / .073L	.083L
752		AF	Magneto Drive Gear and Shaft			.001L / .003L	.005L
753		BD-BE	Magneto Drive Gear and Crankcase			.001L / .003L	.005L
754	784	Y	Magneto Shaft Gear and Magneto Case			.001L / .003L	.005L
755	786	Y	Magneto Shaft Gear and Support Assembly			.001L / .003L	.005L
756		Y	Magneto Shaft Gear and Accessory Drive Shaft Gear - End Play			.0075 / .0125	.015
757	787	Y	Accessory Drive Shaft Gear and Support Assembly			.001L / .003L	.005L
758		S	Magneto Gear and Bushing (S4LN-21 and S4LN-1227)			.0005L / .0020L	.0035L
		T	Magneto Gear and Bushing (S6LN-21 and S6LN-1227)			.0015L / .0035L	.0055L

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
758		T-AF (DUAL MAGNETO)	Magneto Gear and Bushing			.0015L / .0035L	.0055L
7095		BD, BE	Bushing - Magneto Drive and Crankcase			.0025T / .0045T	(A)
759	627	D	Generator Gear Bushing and Generator Gear			.0020T / .0035T	(A)
760	628	D	Generator Gear Bushing and Generator Drive Coupling Adapter			.001L / .0028L	.005L
761	632	D	Bendix Drive Gear Bushing and Crankcase			.0005T / .0025T	(A)
762	633	D	Bendix Drive Gear and Bendix Drive Gear Bushing			.0010L / .0025L	.005L
763	634	D	Bendix Drive Shaft and Bendix Drive Housing			.003L / .005L	.010L
764	637	D	Bendix Drive Shaft - End Clearance			.000 / .0059L	.080L



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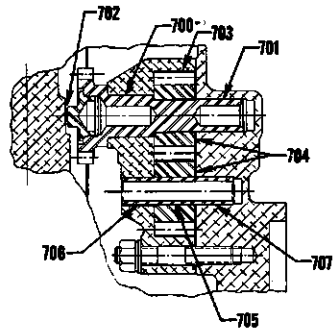

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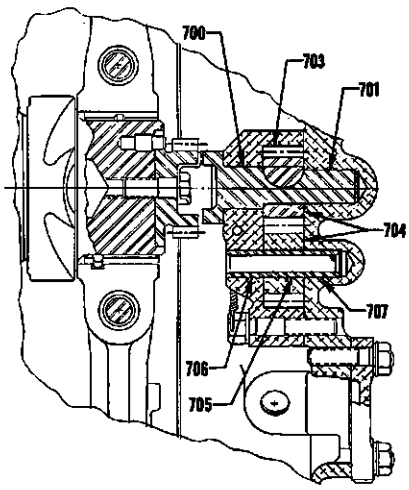

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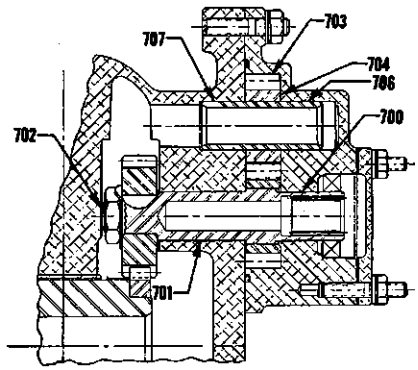
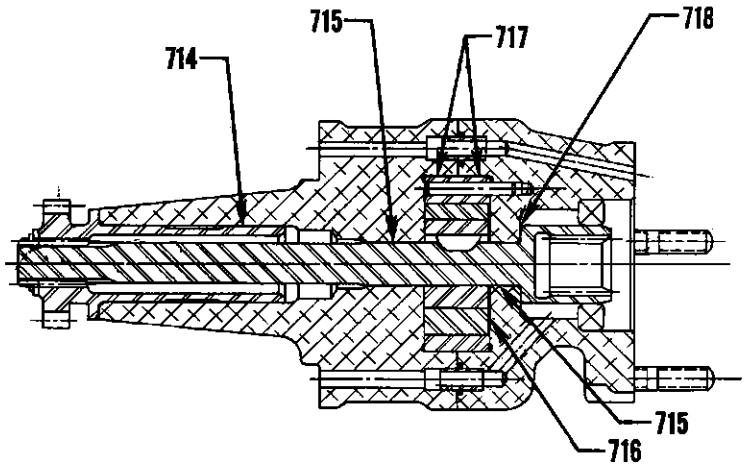


O-320-H,O,LO-360-E

Oil Pumps



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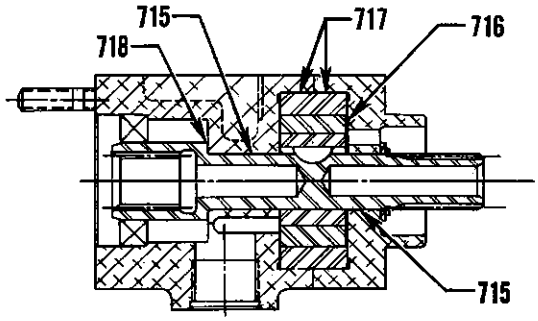
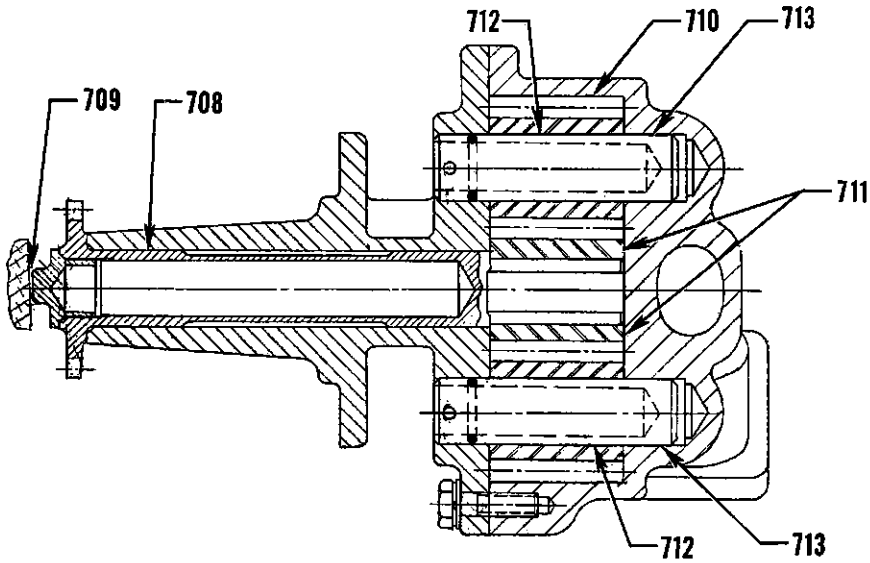
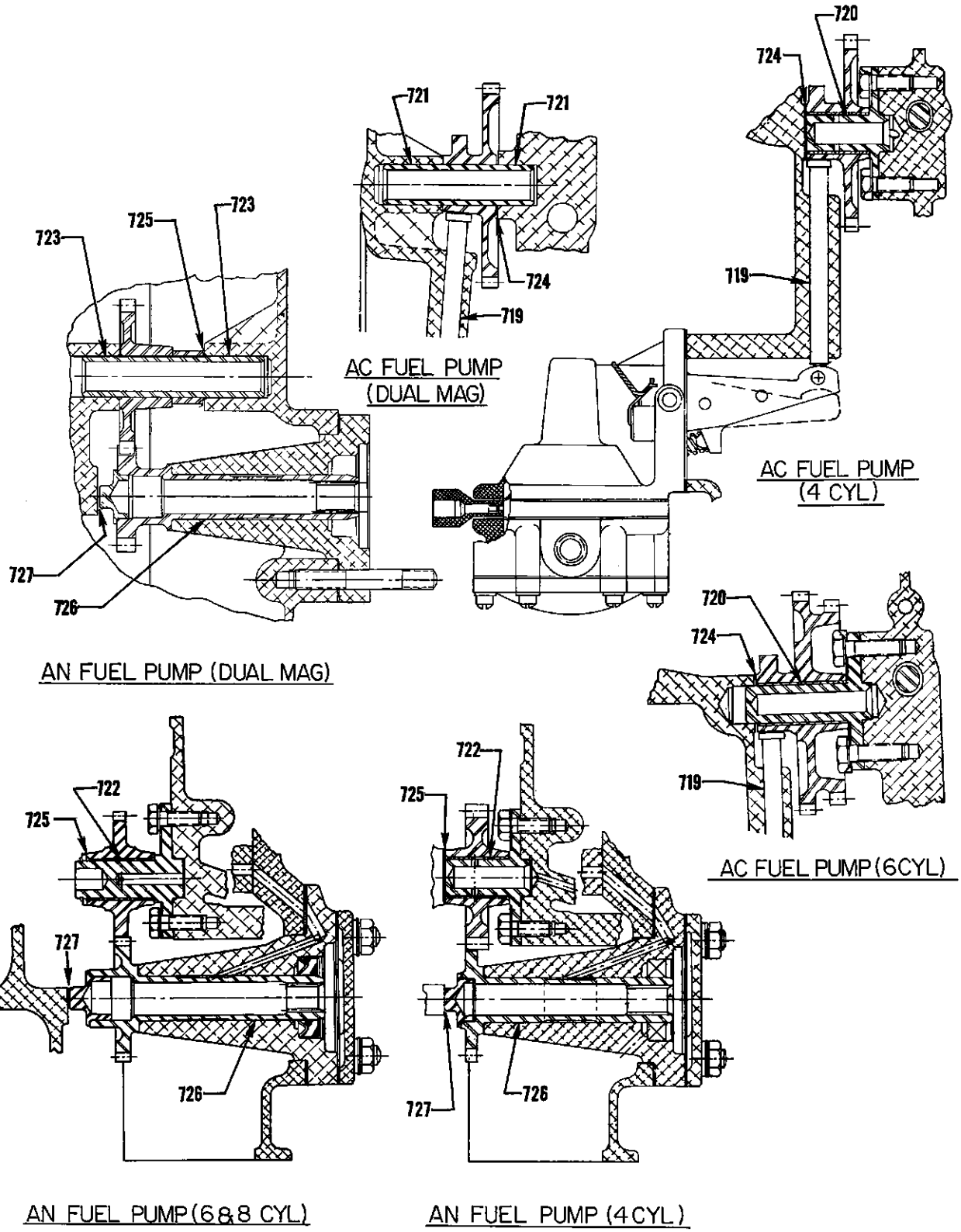
TURBO SCAVENGE PUMP & GOV. (TIO-360)



DUAL MAG: TURBO SCAVENGE PUMP & HYD. PUMP



SCAVENGE PUMP AIO 320 & AIO-360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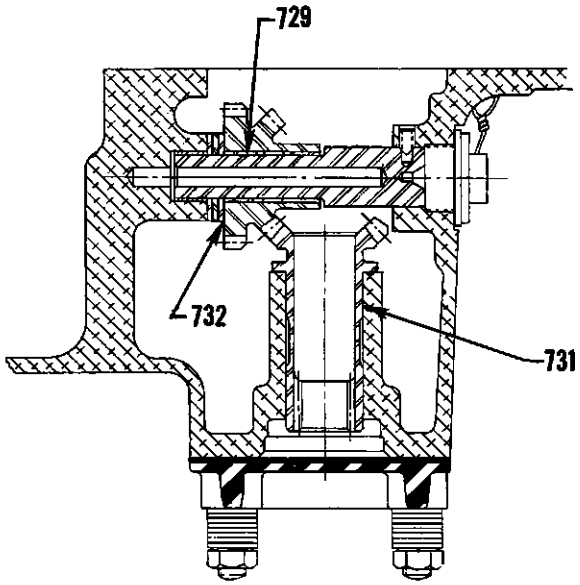
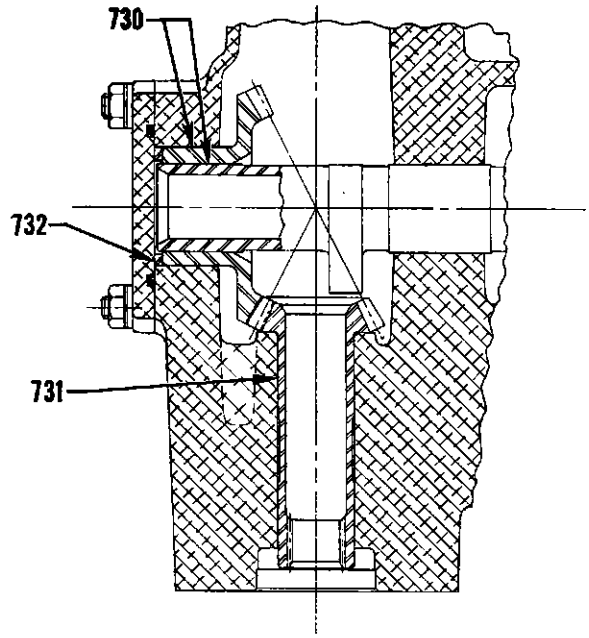
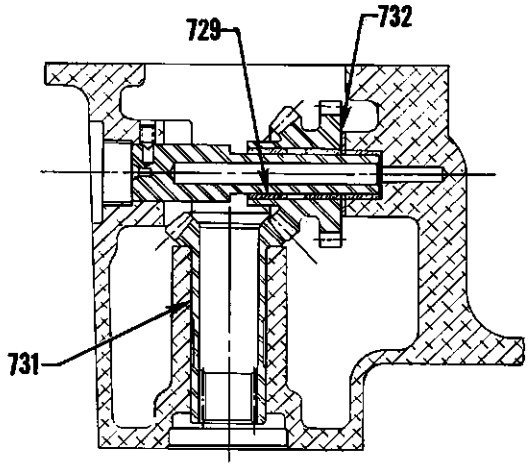
721
723
725
723
719
724
719
AC FUEL PUMP
(DUAL MAG)
AC FUEL PUMP
(4 CYL)
727
726
AN FUEL PUMP (DUAL MAG)
720
724
719
AC FUEL PUMP (6CYL)
722
725
722
725
727
726
727
726
AN FUEL PUMP (6&8 CYL)
AN FUEL PUMP (4CYL)



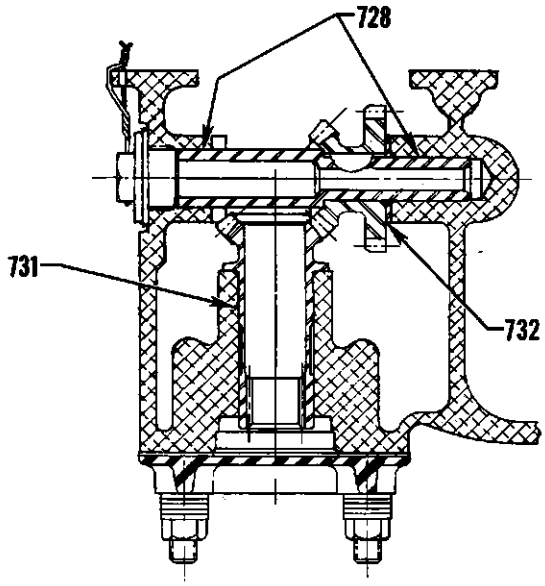
4 & 8 (WIDE DECK)



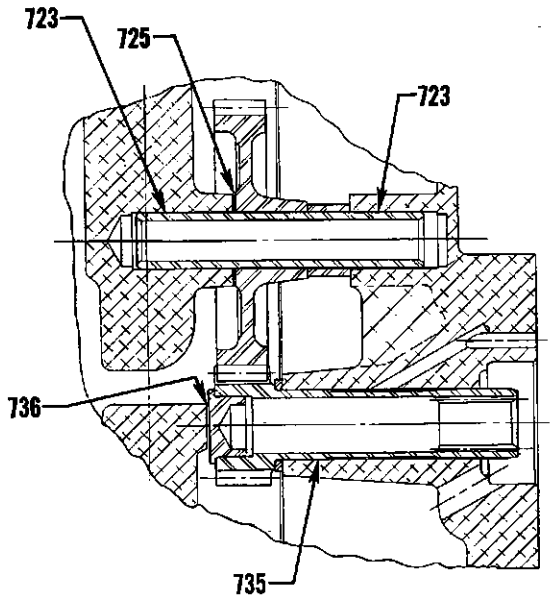
O-320-H O,LO-360-E



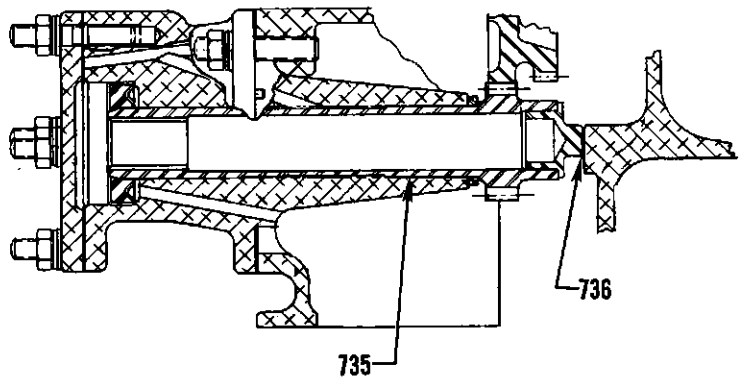
6 CYL. (WIDE DECK) (2200 LB)



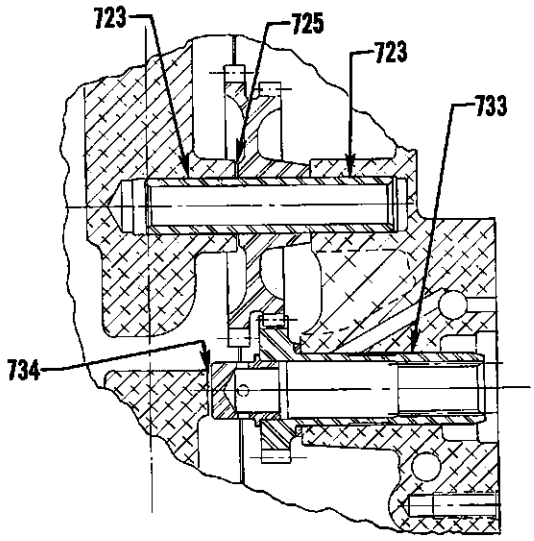
NARROW DECK (6 & 8 CYL.



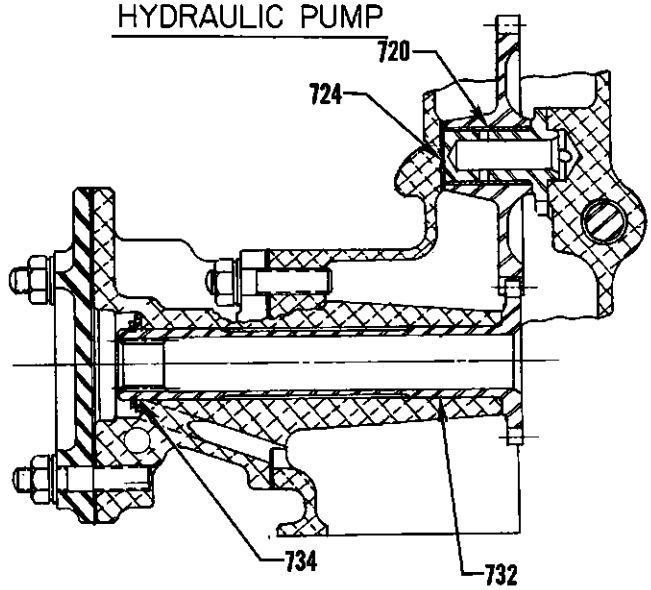
HYDRAULIC PUMP-DUAL MAG



HYDRAULIC PUMP

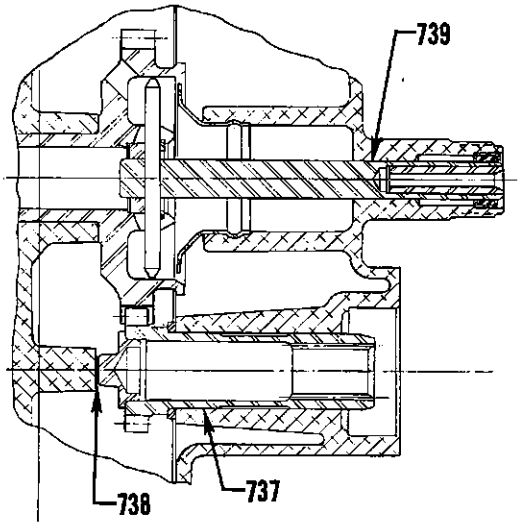


REAR PROP. GOV. (4 CYL.)
(DUAL MAG.)

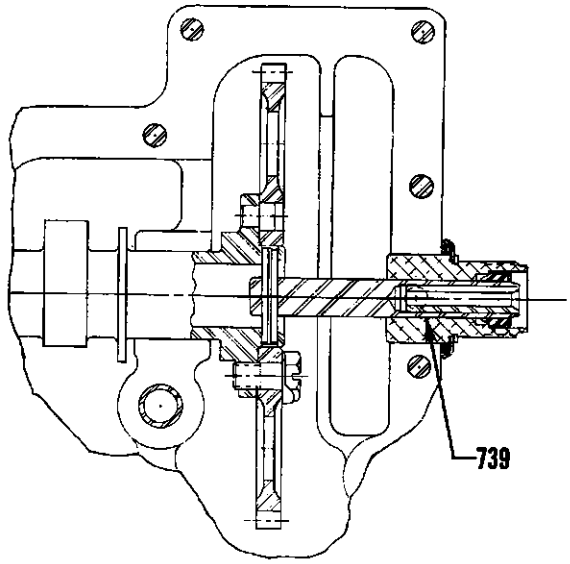


REAR PROP. GOV. (4 CYL.)
(STANDARD)

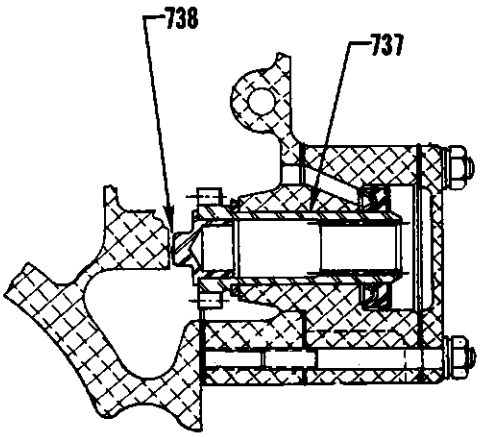
Rear Governor and Hydraulic Pumps



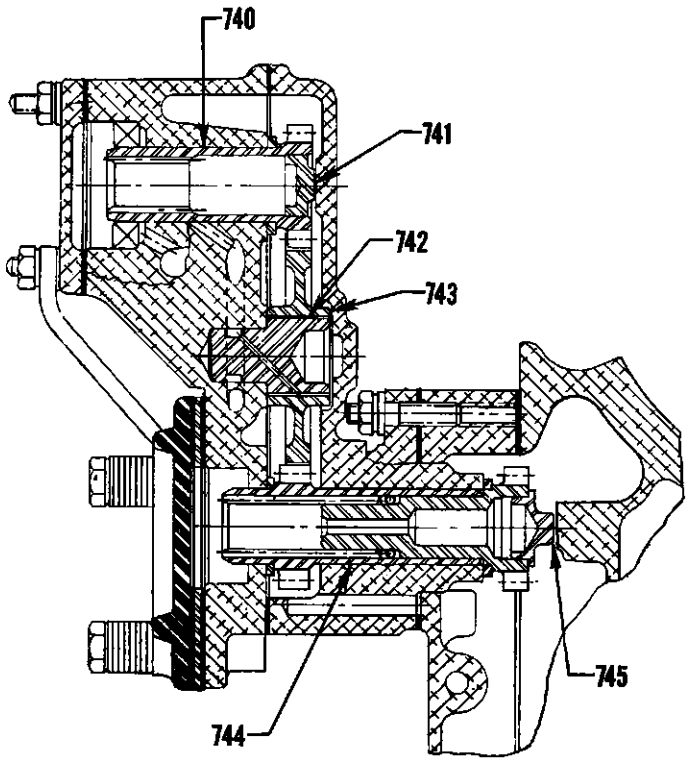
VACUUM PUMP & TACHOMETER



TACHOMETER DRIVE

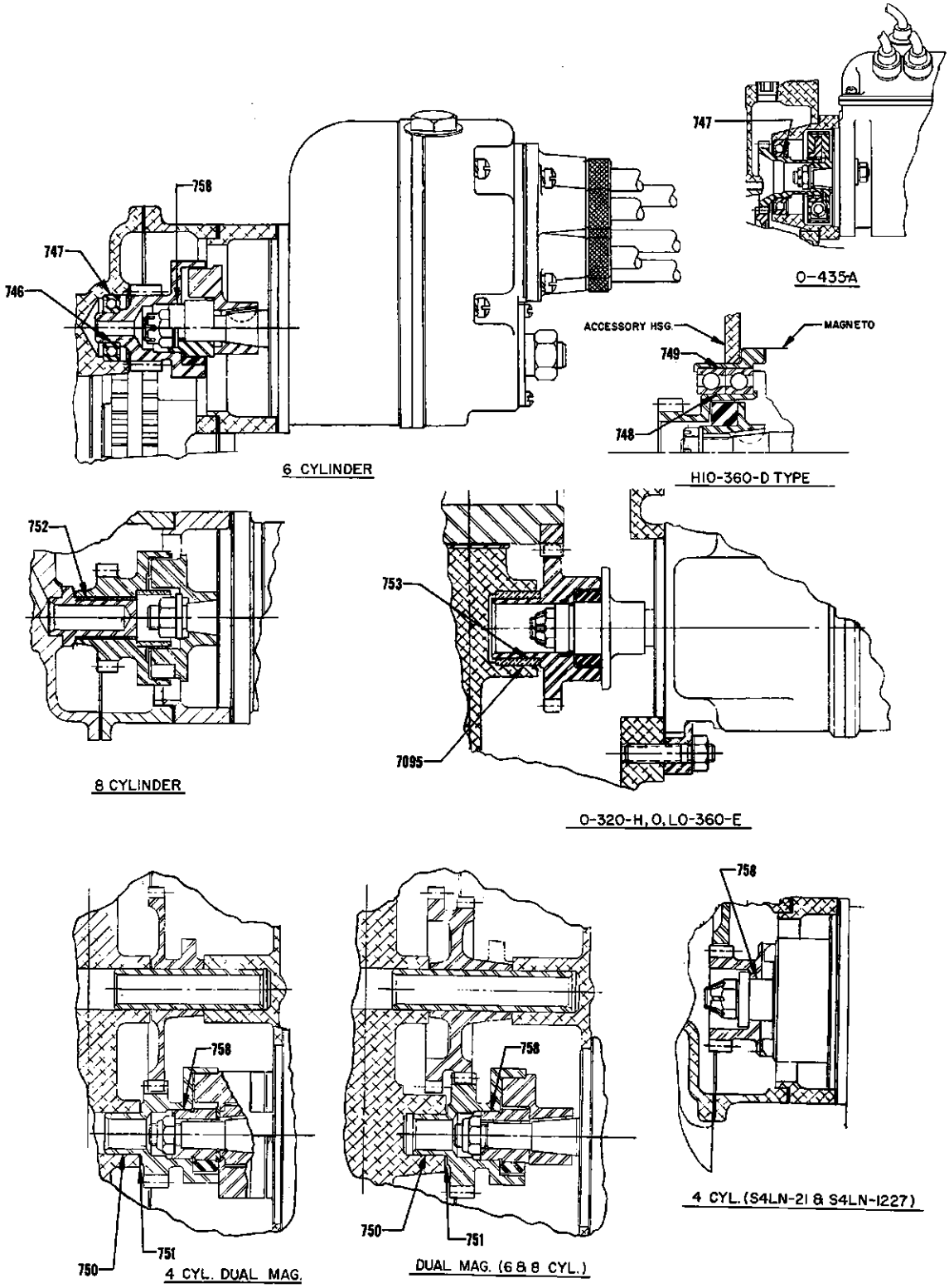


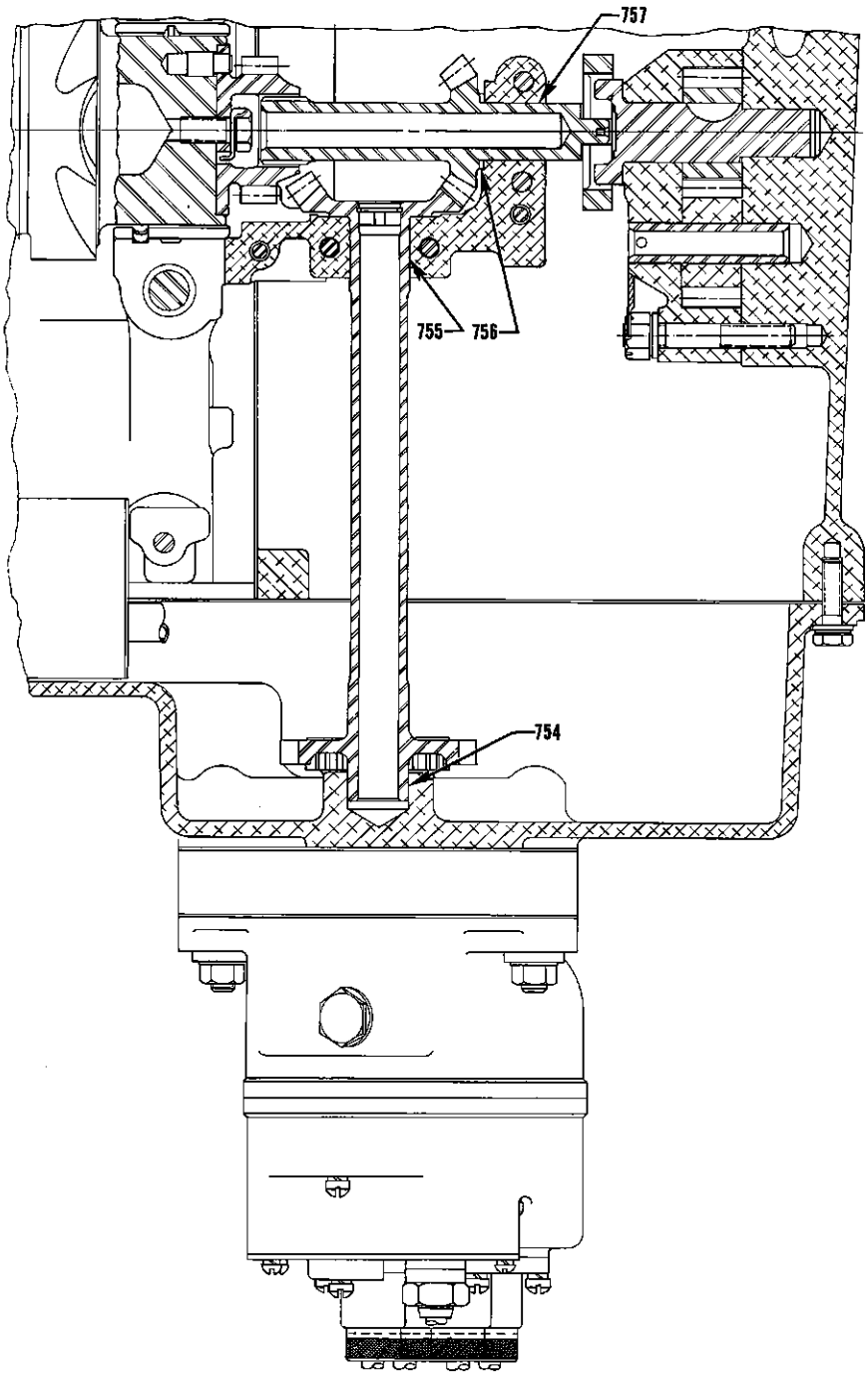
VACUUM PUMP



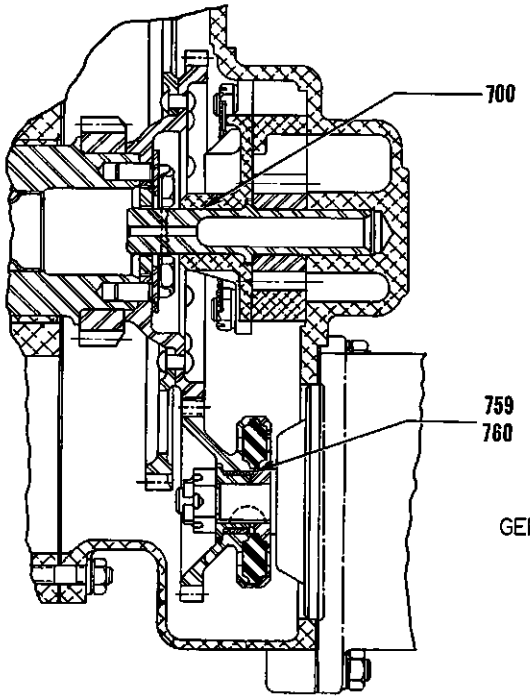
DUAL DRIVE (VACUUM PUMP & PROP. GOV.)
OR (VACUUM PUMP & HYD. PUMP)

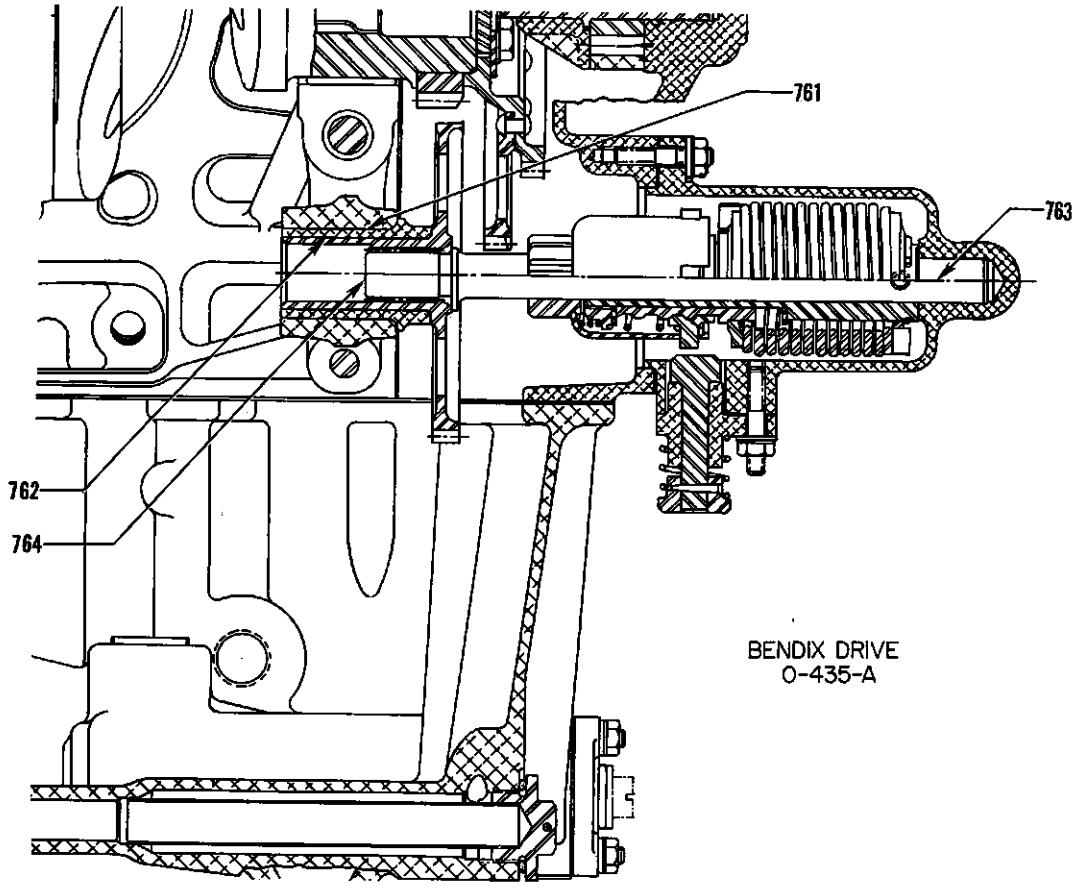
Tachometer Drives, Vacuum and Hydraulic Pumps


747
O-435-A
758
747
746
6 CYLINDER
ACCESSORY HSG.
MAGNETO
749
748
HIO-360-D TYPE
752
8 CYLINDER
753
7095
O-320-H, O, LO-360-E
758
758
758
750
751
4 CYL. DUAL MAG.
750
751
DUAL MAG. (6 & 8 CYL.)
4 CYL. (S4LN-21 & S4LN-1227)



VO, IVO-360

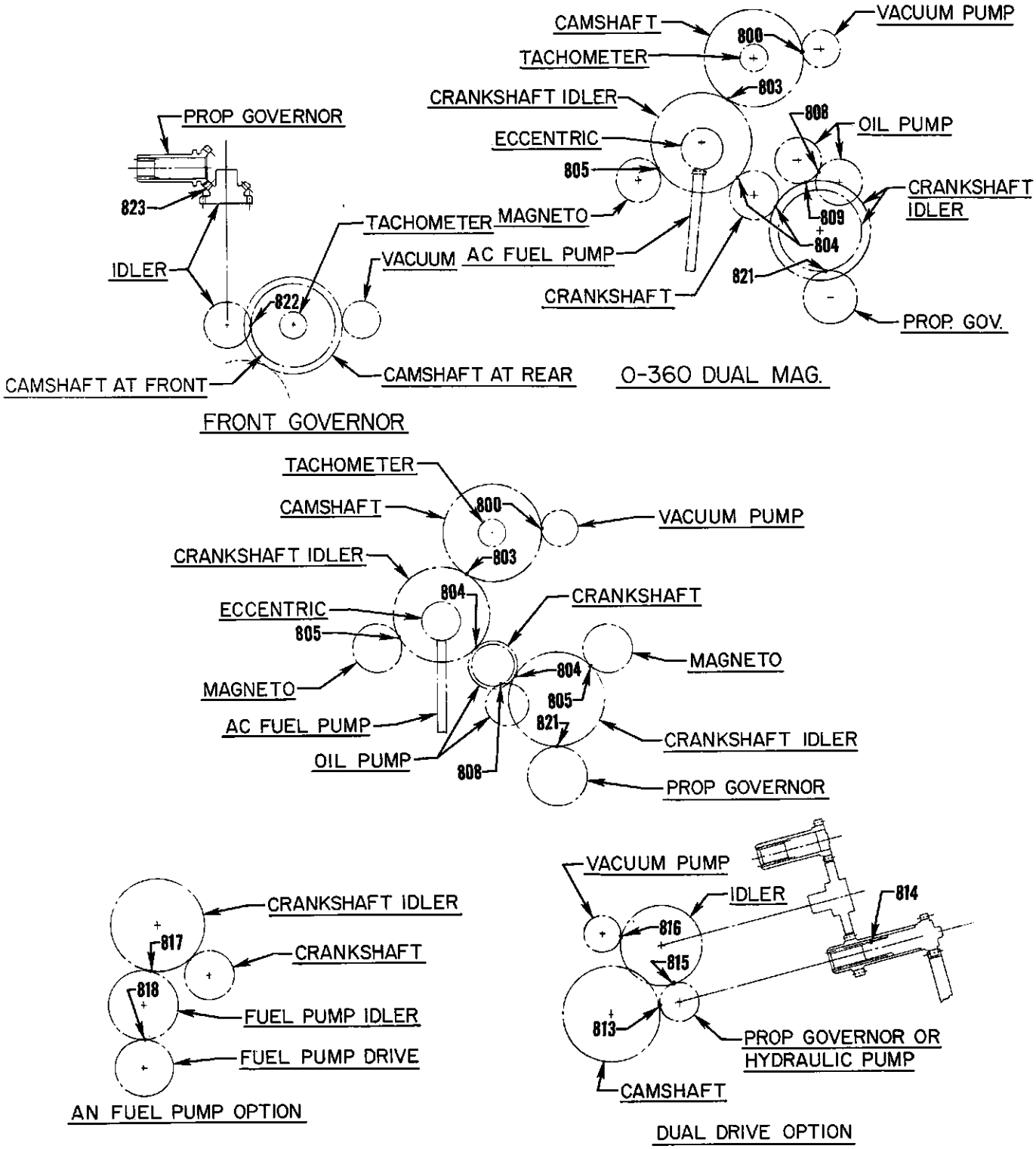




Generator and Bendix Drive

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
800	623 979	A-B-G-J-S-T-Y-AF	Camshaft and Vacuum Pump - Backlash			.004 .015	.020
801	1002	BD-BE	Camshaft and Vacuum and Oil Pump Drive - Backlash			.006 .014	.020
802	623	Y	Camshaft and Fuel Pump - Backlash			.004 .015	.020
803	616 978	A-B-G-J-S-T-Y-AF	Camshaft and Crankshaft Idler - Backlash			.004 .015	.020
804	617 972	A-B-G-J-S-T-Y-AF	Crankshaft and Crankshaft Idler - Backlash			.004 .015	.020
805	618 977	A-B-G-J-S-T-AF	Magneto Drive and Crankshaft Idler - Backlash			.004 .015	.020
806	1004	BD-BE	Magneto Drive and Crankshaft Gear - Backlash			.006 .014	.020
807	1003	BD-BE	Crankshaft Gear and Vacuum and Oil Pump Drive - Backlash			.006 .014	.020
808	553	A-B-D-G-J-S-T-Y-AF	Oil Pump Impellers - Backlash			.008 .015	.020
		BD-BE	Oil Pump Impellers - Backlash			.008 .012	.020
809	975	S-T-AF (DUAL MAGNETO)	Oil Pump Drive and Crankshaft Idler - Backlash			.004 .015	.020
810	783	Y	Magneto and Magneto Shaft Gear - Backlash			.004 .015	.020
811	785	Y	Accessory Drive Shaft Gear and Magneto Driven Shaft Gear - Backlash			.003 .005	.012
812	788	Y	Crankshaft Gear and Accessory Drive Shaft Gear - Spline Backlash			.002 .005	.015
813		G-J-S (DUAL DRIVE)	Camshaft and Propeller Governor or Hydraulic Pump - Backlash			.004 .015	.020
814	793	G-J-S (DUAL DRIVE)	Governor or Hydraulic Pump Drive and Drive Gear - Spline Backlash			.0013 .0073	.010
815	792	G-J-S (DUAL DRIVE)	Governor or Hydraulic Pump and Idler - Backlash			.004 .015	.020
816	790	G-J-S (DUAL DRIVE)	Vacuum Pump and Idler - Backlash			.004 .015	.020
817	765	S-T-AF	AN Fuel Pump Idler and Crankshaft Idler - Backlash			.004 .015	.020
818	766 976	S-T-AF	AN Fuel Pump Idler and Fuel Pump Drive - Backlash			.004 .015	.020

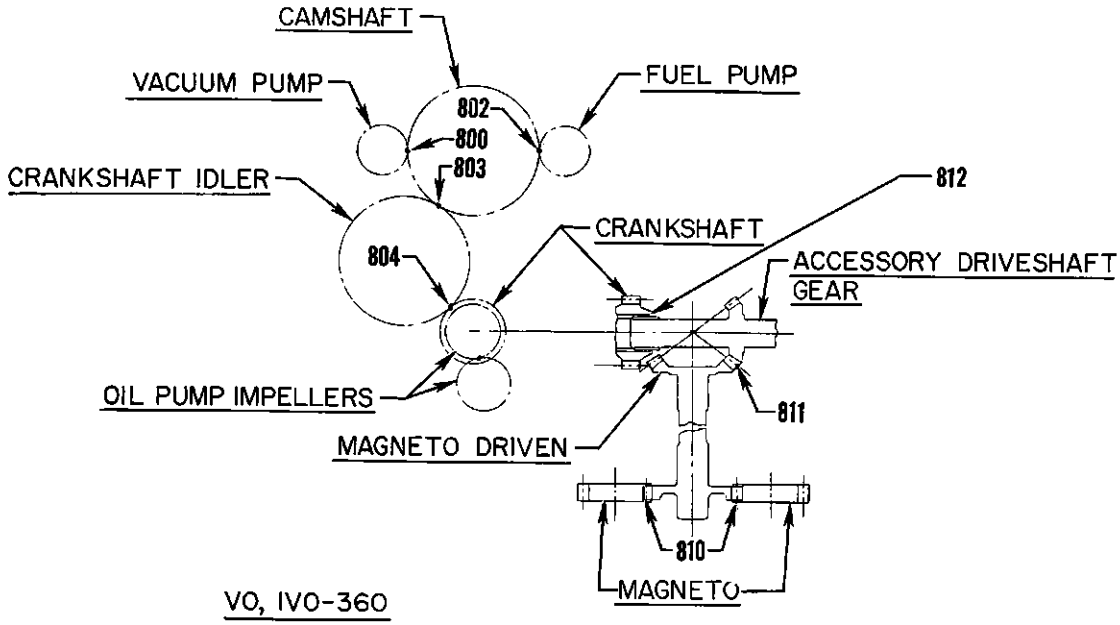
Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
819	973	S-T-AF (DUAL MAGNETO)	Crankshaft Gear and AN Fuel Pump Idler - Backlash			.004 / .015	.020
820	974	T-AF	Hydraulic Pump and Crankshaft Idler - Backlash			.004 / .015	.020
821	676	G-J-S	Propeller Governor Drive and Crankshaft Idler - Backlash (Rear Governor)			.004 / .015	.020
822		G1-G2-S2-S4-S6-T-AF	Propeller Governor Idler and Camshaft - Backlash (Front Governor)			.004 / .015	.020
823	669	G1-G2-S2-S4-S6-T-AF	Propeller Governor Drive and Idler - Backlash (Bevel Gears) (Front Governor)			.004 / .008	.015
824	669	BD-BE	Propeller Governor Drive and Camshaft - Backlash (Bevel Gears) (Front Governor)			.003 / .011	.015
825	550	D	Crankshaft Timing Gear and Camshaft Gear - Backlash			.004 / .015	.020
826	551	D	Camshaft Gear and Generator Gear - Backlash			.004 / .015	.020
827	552	D	Crankshaft Gear and Generator Gear - Backlash			.004 / .015	.020
828	562	D	Magneto Coupling Spline - Backlash			.001 / .005	.0075
829	621	D	Vacuum Pump Gear and Vacuum Pump Drive Gear - Backlash			.004 / .015	.020
830	635	D	Starter Drive and Bendix Drive Gear - Backlash			.004 / .015	.020
831	636	D	Bendix Drive Shaft Spline and Bendix Drive Gear Spline - Backlash			.001 / .006	.015
832	766	S	Injector Pump Idler Gear and Injector Pump Drive Shaft Gear - Backlash			.004 / .015	.020



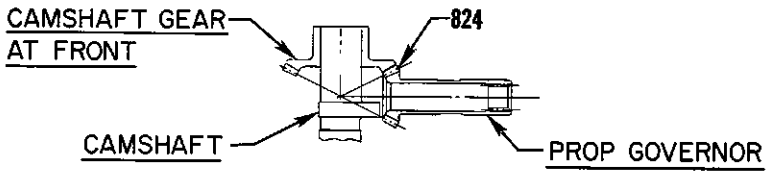
0-235, 0-320, 0-340 & 0-360

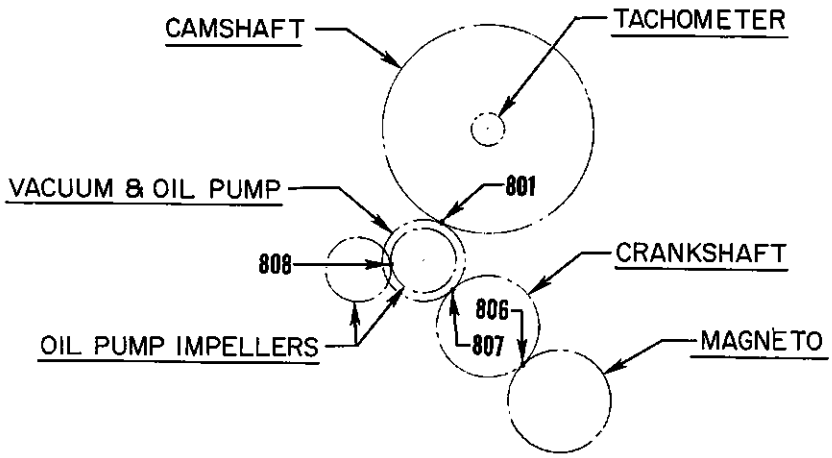
ALL VIEWS SHOWN FROM REAR OF ENGINE

Backlash (Accessory Drives)



VO, IVO-360

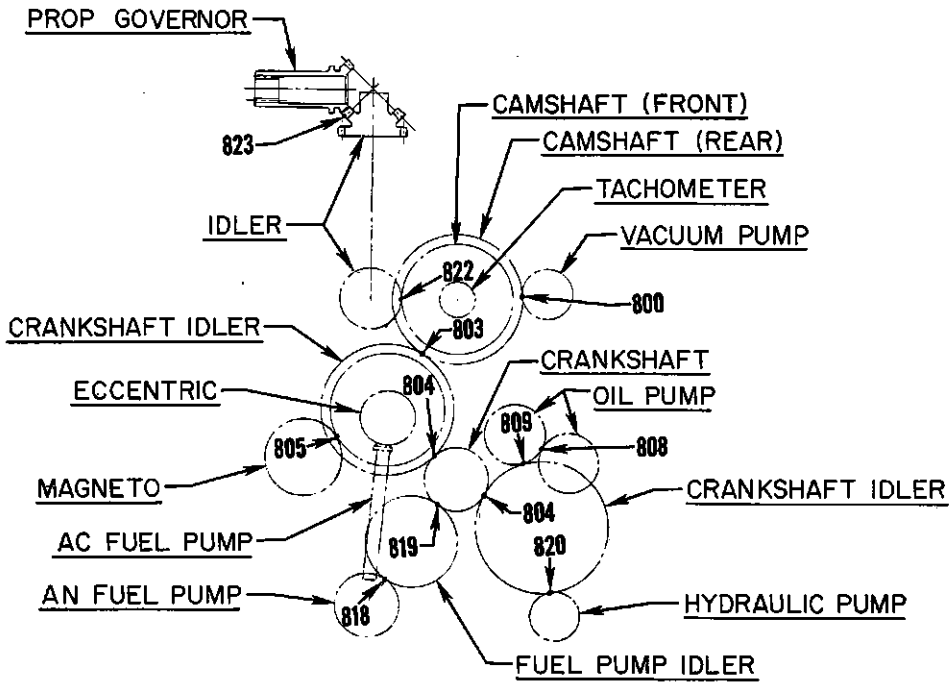




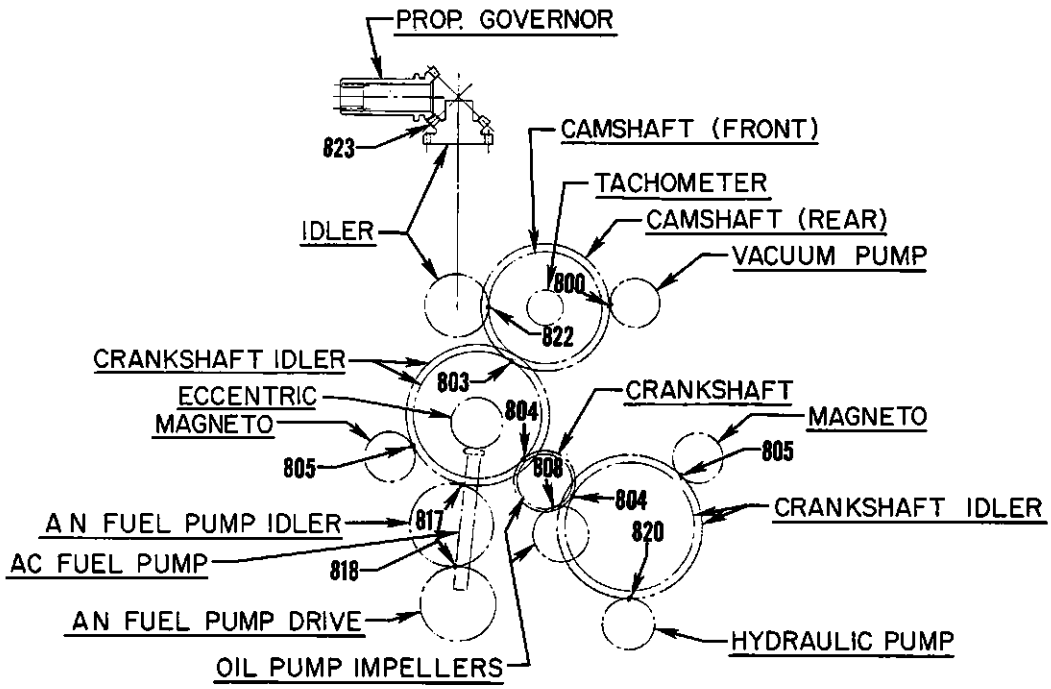
O-320-H, O, LO-360-E

ALL VIEWS SHOWN FROM REAR OF ENGINE

Backlash (Accessory Drives)



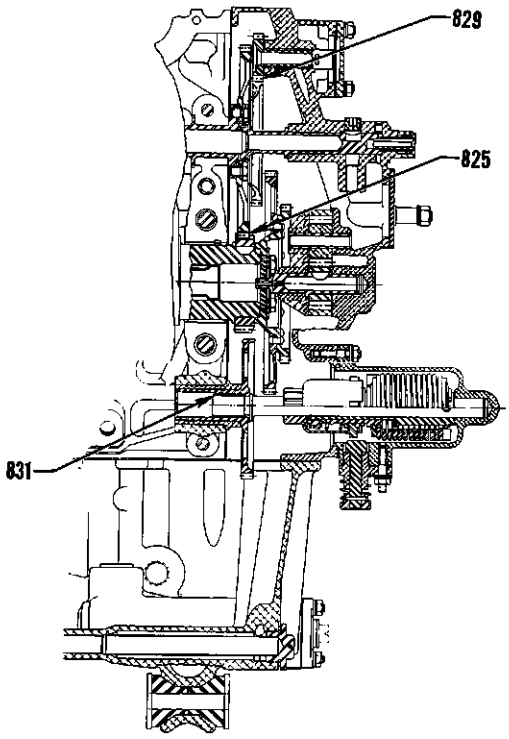
O-540 & IO-720 DUAL MAG.



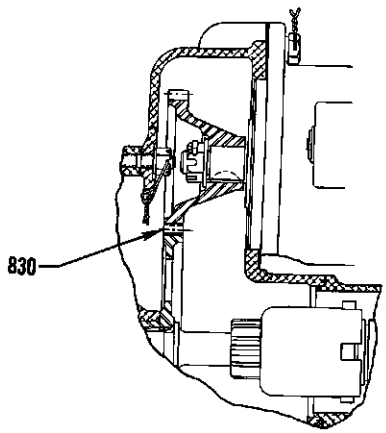
O-540 & IO-720

ALL VIEWS FROM REAR OF ENGINE

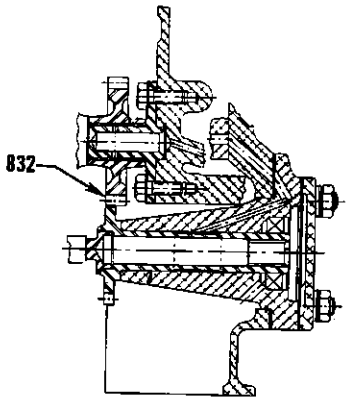
Backlash (Accessory Drives)

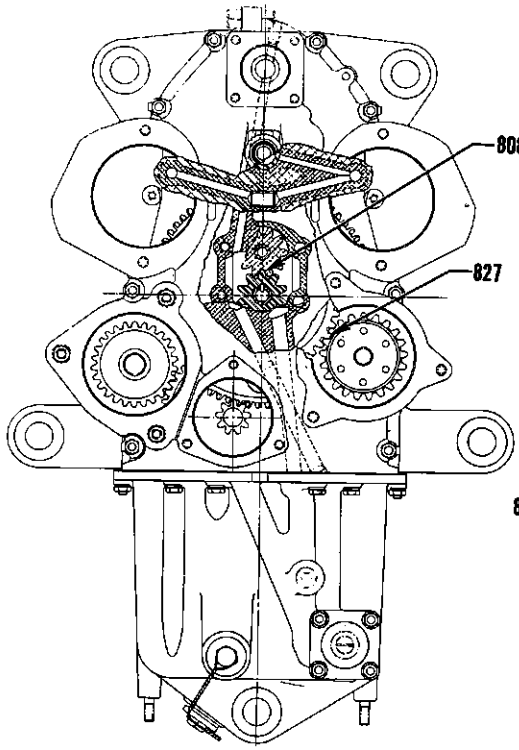


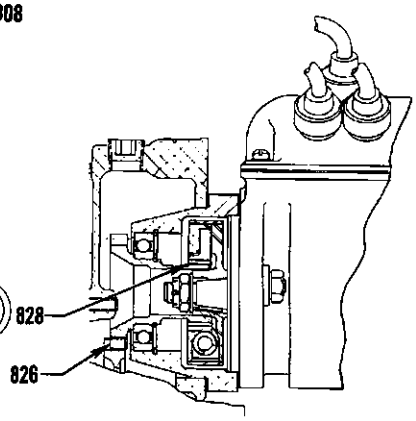
ACCESSORY HOUSING
O-435-A



STARTER DRIVE
O-435-A







MAGNETO DRIVE
O-435-A

SECTION THRU REAR
OF ENGINE

Backlash (Accessory Drives)

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION V SPECIAL TORQUE REQUIREMENTS

Ref. New	Ref. Old	Chart	Thread Size	Nomenclature	Torque Limits
900	829	A-B-D-G-Y-S-T-BD-BE	3/8-24	Connecting Rod Nuts	480 in. lbs.
		J	3/8-24	Connecting Rod Nuts	360 in. lbs.
		S1-S3-S5-S6-S7-S9-T3-AF	3/8-24	Connecting Rod Bolts - Tighten to Length	2.255 - 2.256
901	878	BD-BE	9/16-18	Oil Pump Shaft Nut	660 in. lbs.
902	877	BD-BE	5/16-24	Rocker Stud Nut	150 in. lbs.
903	840	ALL (AS APPLICABLE) (EXCEPT S7)	3/8-24	Magneto Nut (To attach drive member to magneto) - Bendix - Sintered Bushing - Gray	120 - 150 in. lbs.
				Magneto Nut (To attach drive member to magneto) - Bendix - Steel Bushing	170 - 300 in. lbs.
				Magneto Nut (To attach drive member to magneto) - Slick	120 - 300 in. lbs.
		S7	1/2-20	Magneto Nut (To attach drive member to magneto)	170 - 300 in. lbs.
904	839	ALL	10-32	Magneto Plate Screws (To attach ignition cable outlet plate to magneto)	15 in. lbs.
905	853	ALL	1/4-20	Rocker Box Screws	50 in. lbs.
906	852	ALL	5/16-18	Exhaust Port Studs	40 in. lbs. min.
907	830	ALL	18MM	Spark Plugs	420 in. lbs.
908	860	ALL	1/8-27 NPT	Fuel Pump Vent Fitting (Approximately two turns beyond finger tight)	96 in. lbs.
909	862	ALL	5/8-32	Alternator Pulley Nut	450 in. lbs.
910	864	ALL	1/4-28	Alternator Output Terminal Nut	85 in. lbs.
911	865	ALL	10-32	Alternator Auxiliary Terminal Nut	30 in. lbs.
912		ALL	5/16-24	Starter Terminal Nut	24 in. lbs.
913	857	ALL (AS APPLICABLE)	1/16-27 NPT	Piston Cooling Nozzle in Crankcase	100 in. lbs.
914	854	Y-S-T-AF	1/8-27 NPT	Injector Nozzle in Cylinder Head	60 in. lbs.
915	869	ALL (AS APPLICABLE)	3/4-16	Oil Filter Bolt (AC Can and Element Type)	300 in. lbs.
		ALL (AS APPLICABLE)	13/16-16	Oil Filter (Throw Away Type)	240 in. lbs.
	874	ALL (AS APPLICABLE)	3/4-16	Converter Stud	720 in. lbs.
916		ALL (AS APPLICABLE)	3/4-18 NPT	Carburetor Drain Plug	144 in. lbs.
917		ALL (AS APPLICABLE)	1.00-14	Oil Cooler Bypass Valve	300 in. lbs.
918		ALL (AS APPLICABLE)	1 1/4-12	Oil Pressure Relief Valve	300 in. lbs.

Ref. New	Ref. Old	Chart	Thread Size	Nomenclature	Torque Limits
919	871	ALL	1/4 Hex Head and Below	Hose Clamps (Worm Type)	20 in. lbs.
			5/16 Hex Head and Above	Hose Clamps (Worm Type)	45 in. lbs.
920	875	ALL		Cylinder Head Drain Back Hose Clamps	10 in. lbs.

921 — S-T — Exhaust V-Band Coupling Torque Data

Coupling Size Tube OD	Avco Lycoming Part No.	Vendor Part No.	T-Bolt Split Type Locknut Torque In. Lbs.	1/4 In. Drilled Hex Nut With Safety Wire Torque In. Lbs.
1.75 in.	LW-12093-4	MVT69183-175	65	75
2.00 in.	LW-12093-5	MVT69183-200	85	75
2.25 in.	LW-12093-6	MVT69183-225	85	75
2.25 in.	LW-12125-3	MVT69197-225	85	
3.69 in.	LW-13464	U4204-55-369M	70	
3.69 in.	LW-14985	ANH1000902-10	70	

922 — ALL — Turbocharger V-Band Torque Data

Turbocharger Model No.	V-Clamp Part No.	V-Clamp Diameter	Torque In. Lbs.
TO-473*	400500-600	6.00 in.	40-80
TEO659*	400500-685	6.85 in.	40-50
THO8A60*	400500-775	7.75 in.	40-60
THO8A69*	400500-775	7.75 in.	40-60
301E10-2**	TC-6-15	6.50 in.	15-20

* - AiResearch turbocharger.
** - Rajay turbocharger.

See latest edition of Service Instruction No. 1238 for assembly procedure.

Ref. New	Ref. Old	Chart	Thread Size	Nomenclature	Torque Limits
927	863	ALL DUAL MAGNETO MODELS	1/2-20	Crankshaft Gear Bolt	660 in. lbs.
		BD	1/4	Crankshaft Gear Bolts	96 - 120 in. lbs.
928		ALL	3/8-16	Cylinder Hold Down Studs (Crankcase Driving Torque)	100 in. lbs.
			7/16-14	Cylinder Hold Down Studs (Crankcase Driving Torque)	200 in. lbs.
			1/2-13	Cylinder Hold Down Studs (Crankcase Driving Torque)	250 in. lbs.
929	858	A-B-D-BD-BE-J-G-Y-S-T-AF	3/8	Cylinder Hold Down Nuts	300 in. lbs.
		A1	7/16	Cylinder Hold Down Nuts	420 in. lbs.
		B-D-BD-BE-J-G-Y-S-T-AF	1/2	Cylinder Hold Down Nuts	600 in. lbs.
		Cylinder Hold Down and Crankcase Parting Flange Nuts' Tightening Procedures - See latest edition of Service Instruction No. 1029.			

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION V SPECIAL TORQUE REQUIREMENTS (CONT.)

Ref. New	Ref. Old	Chart	Thread Size	Nomenclature	Torque Limits
930	849	ALL	3/8	Allen Head Screw (Diaphragm Fuel Pump)	225 - 250 in. lbs.
931		A	9/16	Locking Nut (Valve Adjusting Screw)	450 in. lbs.
932	858	ALL	5/16-18	Exhaust Transitions - Studs (Driving Torque)	100 in. lbs.
		ALL	3/8-16	Exhaust Transitions - Studs (Driving Torque)	200 in. lbs.

SECTION V SPRINGS

		Chart	Nomenclature	Avco Lyc. Part No.	Wire Dia.	Length At Comp. Length	COMP. LOAD Mfr. Min.	Mfr. Max.	Serv. Max.
950	800	A-B-D-G-J-S-T-Y-BD-BE	Outer Valve Springs (Parallel)	76994 LW-11800	.177	1.30 in.	112 lb.	122 lb.	109 lb. min.
		A-B-D-G-J-S-T-Y-BD-BE	Outer Valve Springs (Parallel)	65427	.162	1.30 in.	82 lb.	89 lb.	79 lb. min.
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3	Outer Valve Springs (Angle)	68326	.177	1.46 in.	103 lb.	111 lb.	100 lb. min.
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3	Outer Valve Springs (Angle)	LW-11796	.182	1.43 in.	116 lb.	124 lb.	113 lb. min.
951	801	A-B-D-G-J-S-T-Y-BD-BE	Auxilliary Valve Spring (Parallel)	65567 LW-11795	.135	1.17 in.	61 lb.	67 lb.	58 lb. min.
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Auxilliary Valve Spring (Angle)	68328 LW-11797	.142	1.33 in.	75 lb.	83 lb.	72 lb. min.
952	802 803	ALL (AS APPLICABLE)	Oil Pressure Relief Valve Spring						
		Avco Lycoming Part Numbers	Identification: Dye	Free Length					
		61084	None	2.18	.054	1.30 in.	8.5 lb.	9.5 lb.	8.3 lb. min.
		65703	None	2.16	.063	1.47 in.	17.8 lb.	19.4 lb.	18.0 lb. min.
		68668	Purple	2.04	.054	1.30 in.	7.1 lb.	7.8 lb.	6.9 lb. min.
		77467	Yellow	1.90	.054	1.30 in.	6.4 lb.	7.1 lb.	6.2 lb. min.
		LW-11713	White	2.12	.059	1.44 in.	10.79 lb.	11.92 lb.	10.5 lb. min.
953	811	A-B-G-J-S-T-Y-AF	Oil Cooler Bypass Spring		.0465	1.94 in.	6.50 lb.	7.25 lb.	6.41 lb. min.
954		BD-BE	Oil Filter Bypass Spring		.047	1.00 in.	3.05 lb.	3.55 lb.	3.0 lb. min.
955	806	D	Magneto Coupling Spring		.091	.603 in.	20 lb.	22 lb.	19 lb. min.

SERVICE TABLE OF LIMITS

STANDARD TORQUE
UNLESS OTHERWISE LISTED

Torque limits for propeller attaching bolts to be supplied by propeller or airframe manufacturer.

TABLE I

BOLTS, SCREWS AND NUTS

Thread	Torque In. Lb.	Torque Ft. Lb.	Thread	Torque In. Lb.	Torque Ft. Lb.
10	49	------	1/2	900	75
1/4	96	------	9/16	1320	110
5/16	204	17	5/8	1800	150
3/8	360	30	3/4	3240	270
7/16	600	50			

THIN NUTS (1/2 DIA OF BOLT) - 1/2 LISTED TORQUE

TABLE II

PIPE PLUGS

Thread	Torque In. Lbs.
1/16-27 NPT	40
1/8-27 NPT	40
1/4-18 NPT	85
3/8-18 NPT	110
1/2-14 NPT	160
3/4-14 NPT	230
1-11 1/2 NPT	315

TABLE III

CRUSH TYPE ASBESTOS GASKETS

Thd. Pitch On Part To Be Tightened Threads Per Inch	ANGLE OF TURN Aluminum Asbestos	Copper Asbestos
8	135°	67°
10	135°	67°
12	180°	90°
14	180°	90°
16	270°	135°
18	270°	135°
20	270°	135°
24	360°	180°
28	360°	180°

NOTE

Install all crush type gaskets except the self centering type, with the unbroken surface against the flange of the plug or part being tightened against the seal. Turn the part until the sealing surfaces are in contact and then tighten to the angle of turn listed for the appropriate thread size.

NOTE: Lubricate Threads Unless Otherwise Specified.

TABLE IV

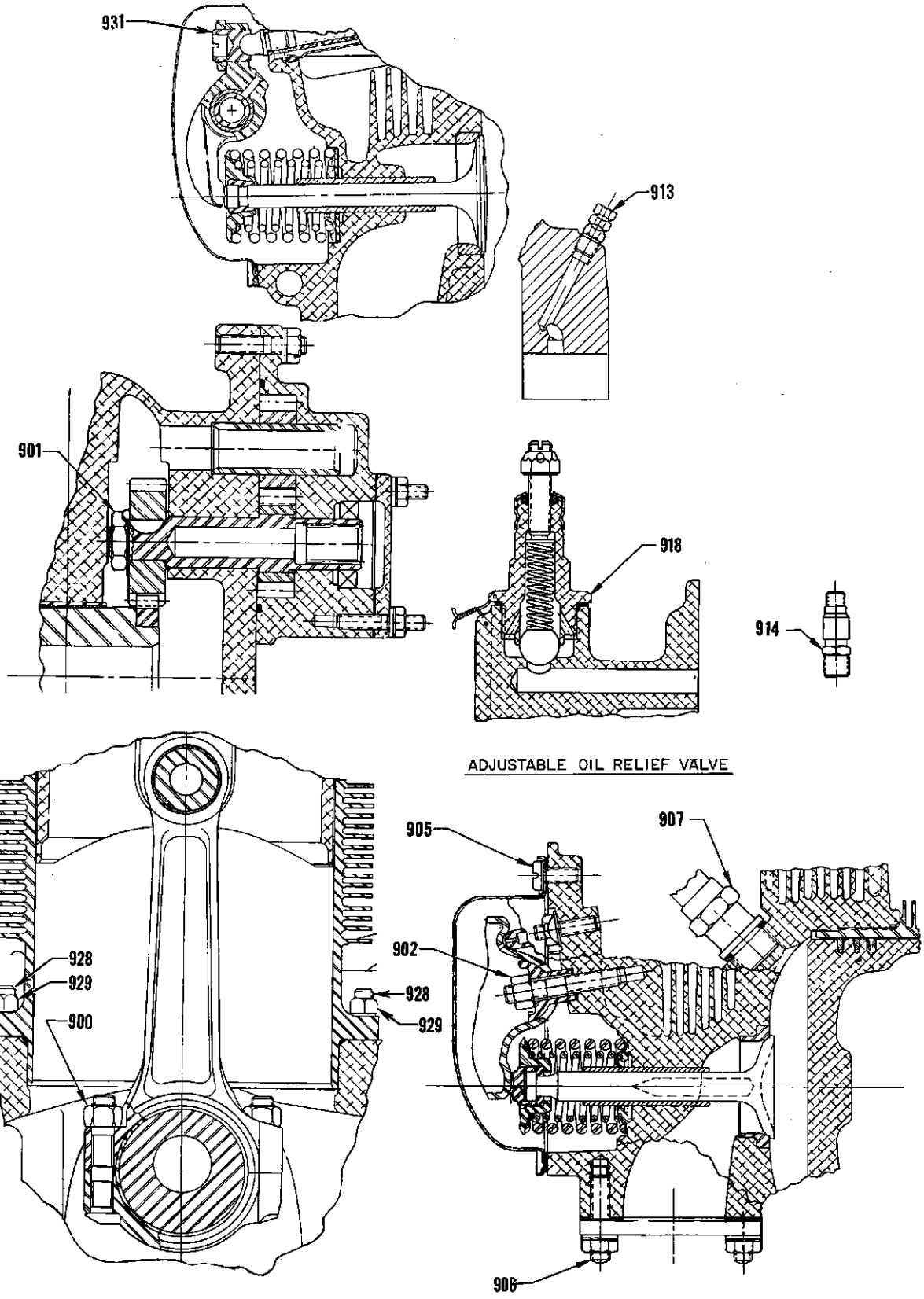
FLEXIBLE HOSE OR TUBE FITTINGS

Tube Size	Thread	Torque In. Lbs.
(-3) 3/16	3/8-24	30
(-4) 1/4	7/16-20	30
(-5) 5/16	1/2-20	35
(-6) 3/8	9/16-18	35
(-8) 1/2	3/4-16	60
(-10) 5/8	7/8-14	70

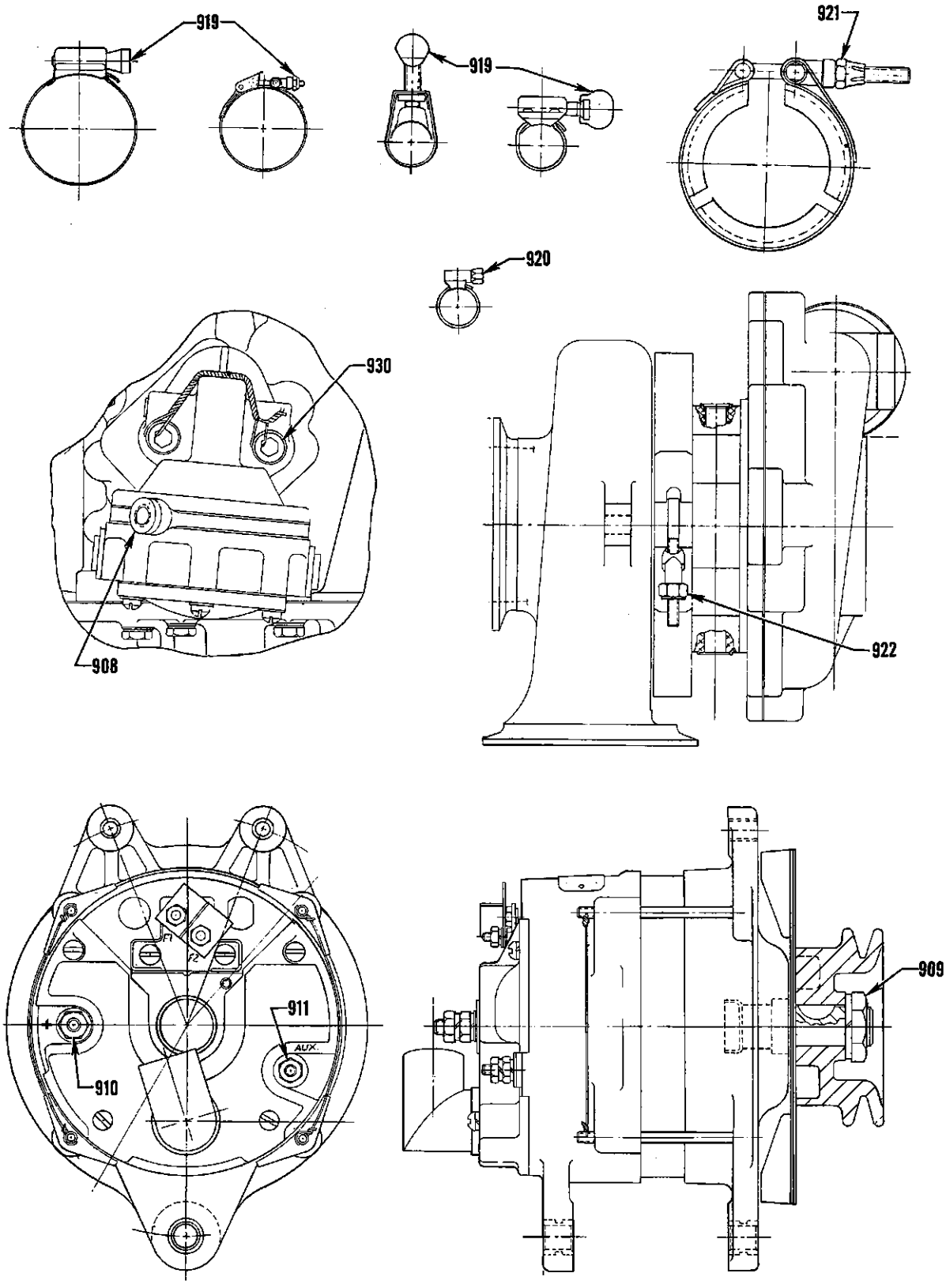
TABLE V

STUDS MIN. DRIVING TORQUE

Threads	Torque In. Lb s.
1/4-20	15
5/16-18	25
3/8-16	50



Engine Accessories and Hardware



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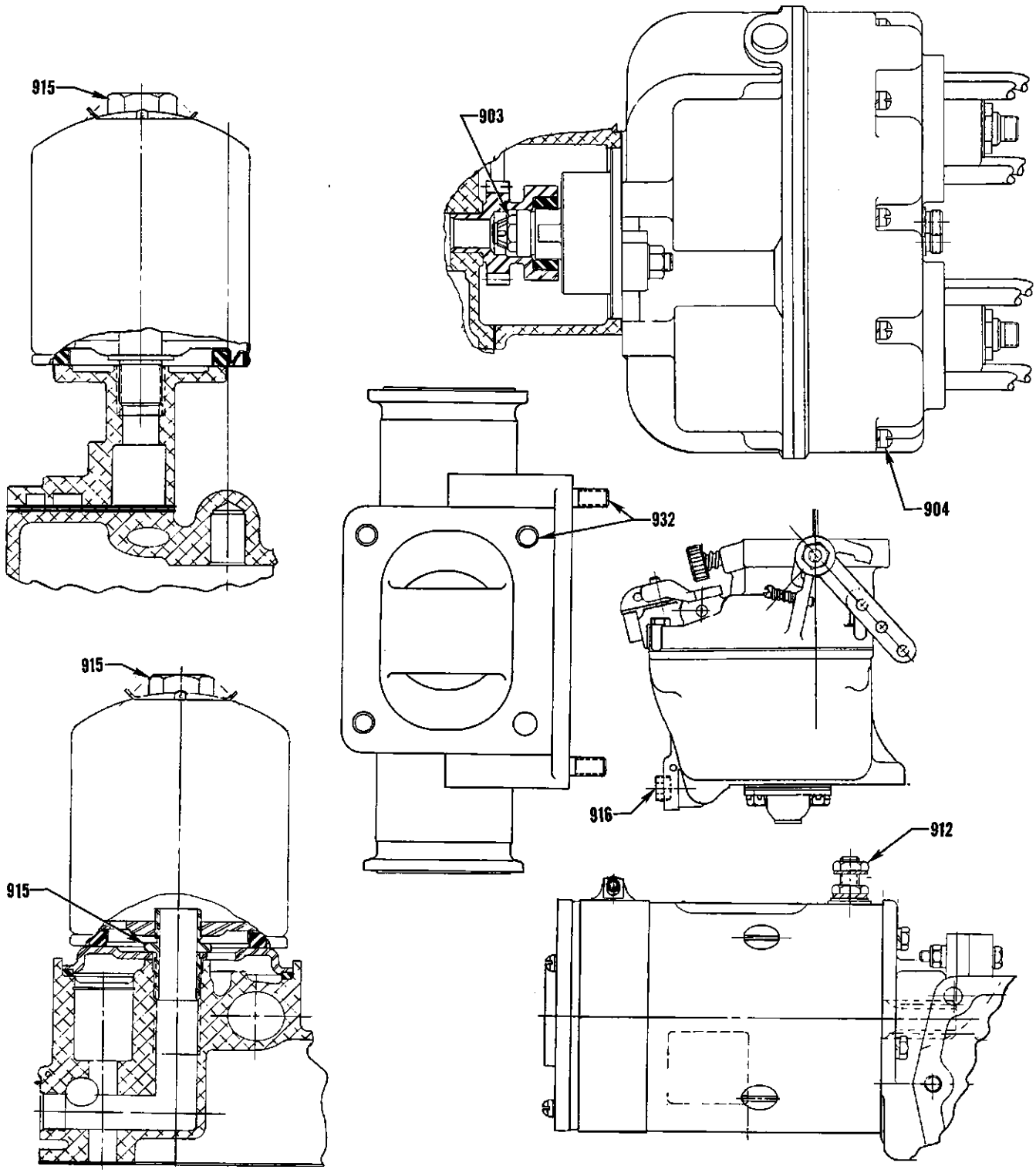

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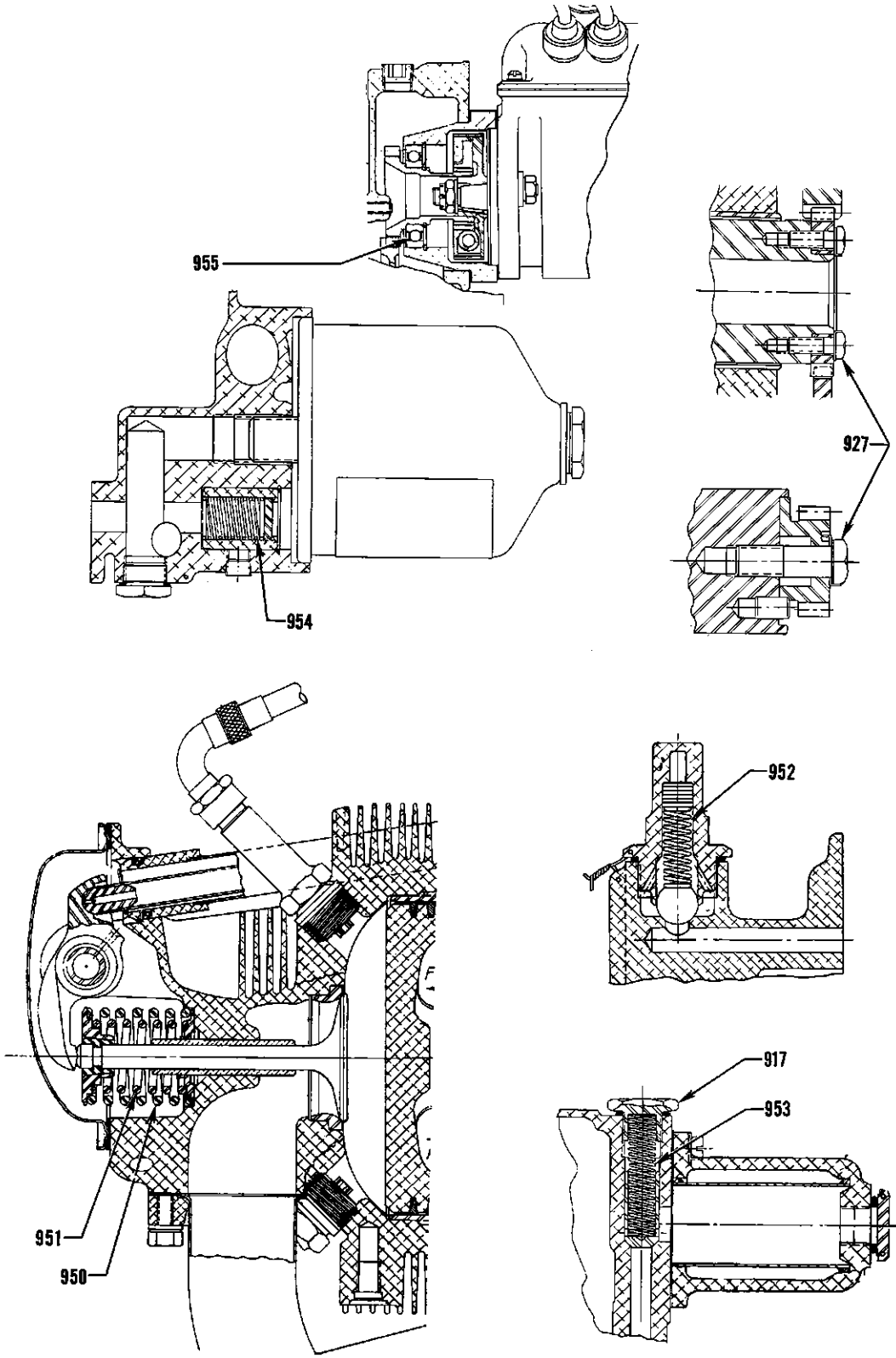

Engine Springs and Hardware