TEXTRON Lycoming

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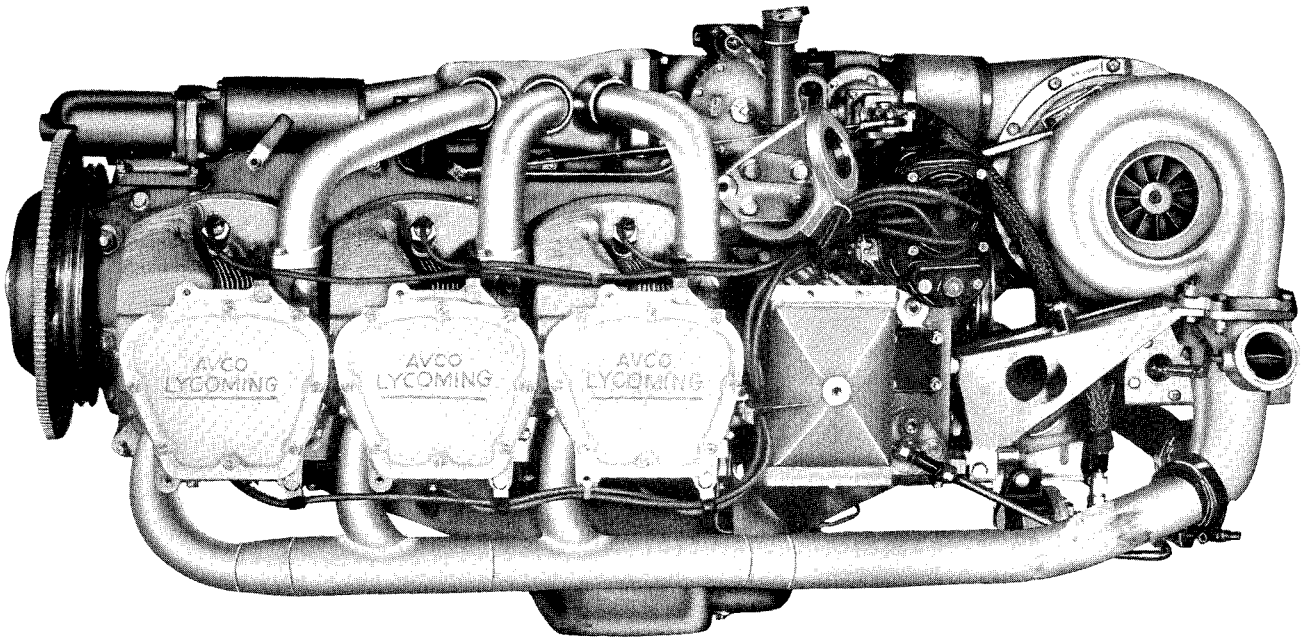
OVERHAUL MANUAL
AVCO LYCOMING

INTEGRAL ACCESSORY DRIVE AIRCRAFT ENGINES



APPROVED BY F.A.A.

AVCO LYCOMING WILLIAMSPORT DIVISION
AVCO CORPORATION
WILLIAMSPORT, PENNSYLVANIA 17701

2nd Edition
October, 1975

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TO THE OWNER OF THIS MANUAL

IN ADDITION TO THIS MANUAL AND SUBSEQUENT REVISIONS, ADDITIONAL OVERHAUL AND REPAIR INFORMATION IS PUBLISHED IN THE FORM OF SERVICE BULLETINS AND SERVICE INSTRUCTIONS. THE INFORMATION CONTAINED IN THESE SERVICE BULLETINS AND SERVICE INSTRUCTIONS IS AN INTEGRAL PART OF, AND IS TO BE USED IN CONJUNCTION WITH, THE INFORMATION CONTAINED IN THIS OVERHAUL MANUAL.

THIS OVERHAUL MANUAL, THE ENGINE OPERATOR'S MANUAL, AND ALL APPLICABLE SERVICE BULLETINS AND INSTRUCTIONS ARE ISSUED IN COMPLIANCE WITH F.A.R 21.50, AND SHALL BE USED BY MAINTENANCE PERSONNEL WHEN PERFORMING ACTIONS SPECIFIED IN F.A.R 43.13.

For a period of three (3) years new and revised pages for this manual will be furnished to owners, who fill out the registration card and return it to Textron Lycoming. Registered owners of this manual will be notified of any changes in revision policy or cost of revisions.

Service Bulletins, Service Instructions and Service Letters are available from all Textron Lycoming Distributors or from the factory by subscription. Consult the latest revisions to Textron Lycoming Service Letter No. L114. Textron Lycoming also publishes an Index of Service Bulletins, Instructions and Letters that lists all Bulletins, Instructions and Letters in alphabetical order by title and topic as well as a list of Bulletins, Instructions and Letters applicable to each engine series. Consult the Service Publication Section of the latest revision to Service Letter No. L114 for the current part number of the index.

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.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

SECTION 1.
INTRODUCTION

1-1. This manual contains the necessary information for the major overhaul of the Avco Lycoming integral accessory drive engines. Unless otherwise noted, all information and data in the manual will apply equally to all models; those portions of the text applying to any one particular model or series will be so identified.

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

1-3. The tools required for overhauling and inspection of the engines (excluding the ordinary mechanic's tools found in most overhaul shops) are listed in SSP-2172 Service Tools. Any special information required concerning these tools may be obtained by writing to the Service Department, Avco Lycoming Division, Williamsport, Pennsylvania, 17701. When requesting information concerning any of these tools, refer to the tool by name and part number and not merely by name.

1-4. Parts catalogs, for specific models, may be ordered from the department listed in paragraph 1-3. Because this manual covers the entire series of engines, it is almost impossible to call out attaching parts for specific models. Therefore, it is recommended that the parts catalogs be used in conjunction with the manual, when reassembling the engine.

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 procedure should be followed if, for any reason, parts are to be returned to the factory. You may obtain from, but preferably have your distributor complete, the applicable warranty or rework form. These forms must include the engine model and serial number, number of hours in service, the reason for the parts being returned and any other pertinent facts concerning the parts.

1-7. In this manual all references to locations of the 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 left side.

1-8. The direction of rotation of the crankshaft is clockwise as viewed from the rear. All references to direction of rotation of the various accessory drives are made as viewed facing the drive.

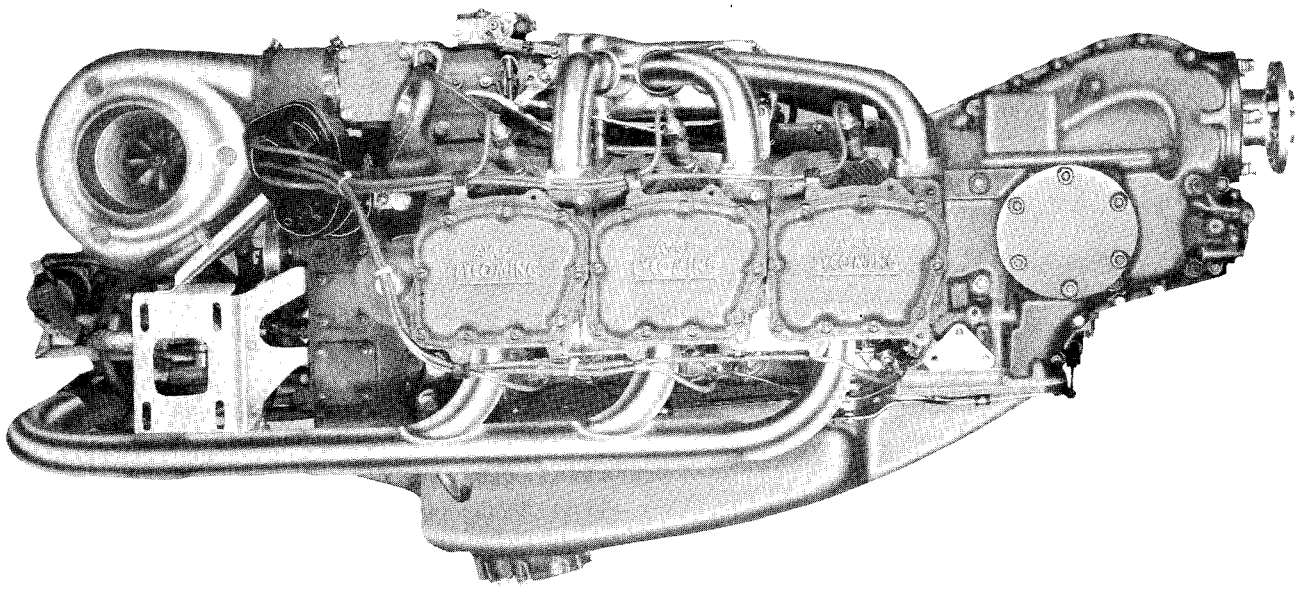


Figure 1-1. Typical TIGO-541 Series Engine

SECTION 2.
GENERAL DESCRIPTION

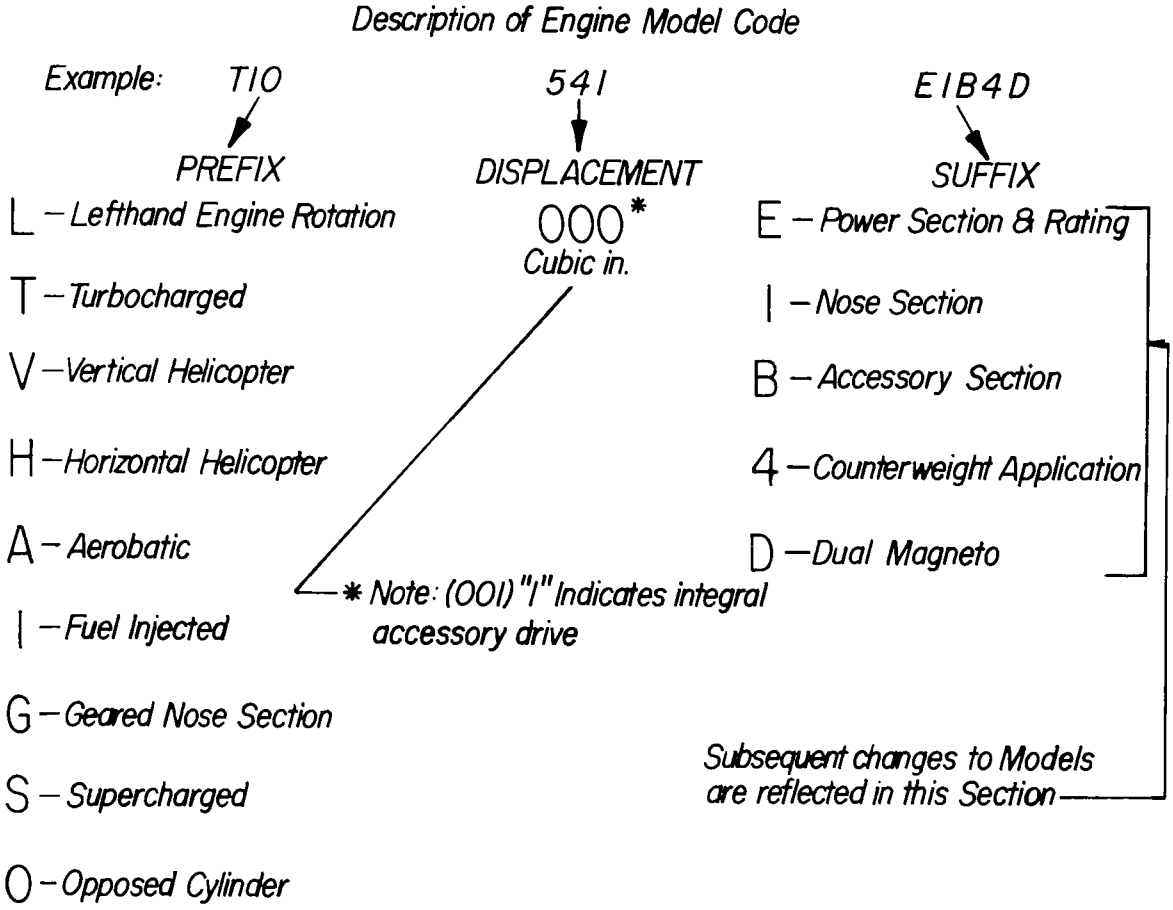


Figure 2-1. Description of Engine Model Code

2-1. This manual is designed to cover the overhaul of all Avco Lycoming integral accessory drive engines. The subject engines are horizontally opposed, wet sump, air cooled models.

2-2. CYLINDERS. The cylinders are of air-cooled construction with the major parts, head and barrel, screwed and shrunk together. The heads are 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. Rocker shaft bearing supports are cast integrally with the head along with housings to form the rocker boxes for both exhaust and intake valve rockers. Valve rockers are placed at an angle in the head. Intake ports are located in the upper side of the cylinder and the exhaust ports on the lower side.

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. Avco 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

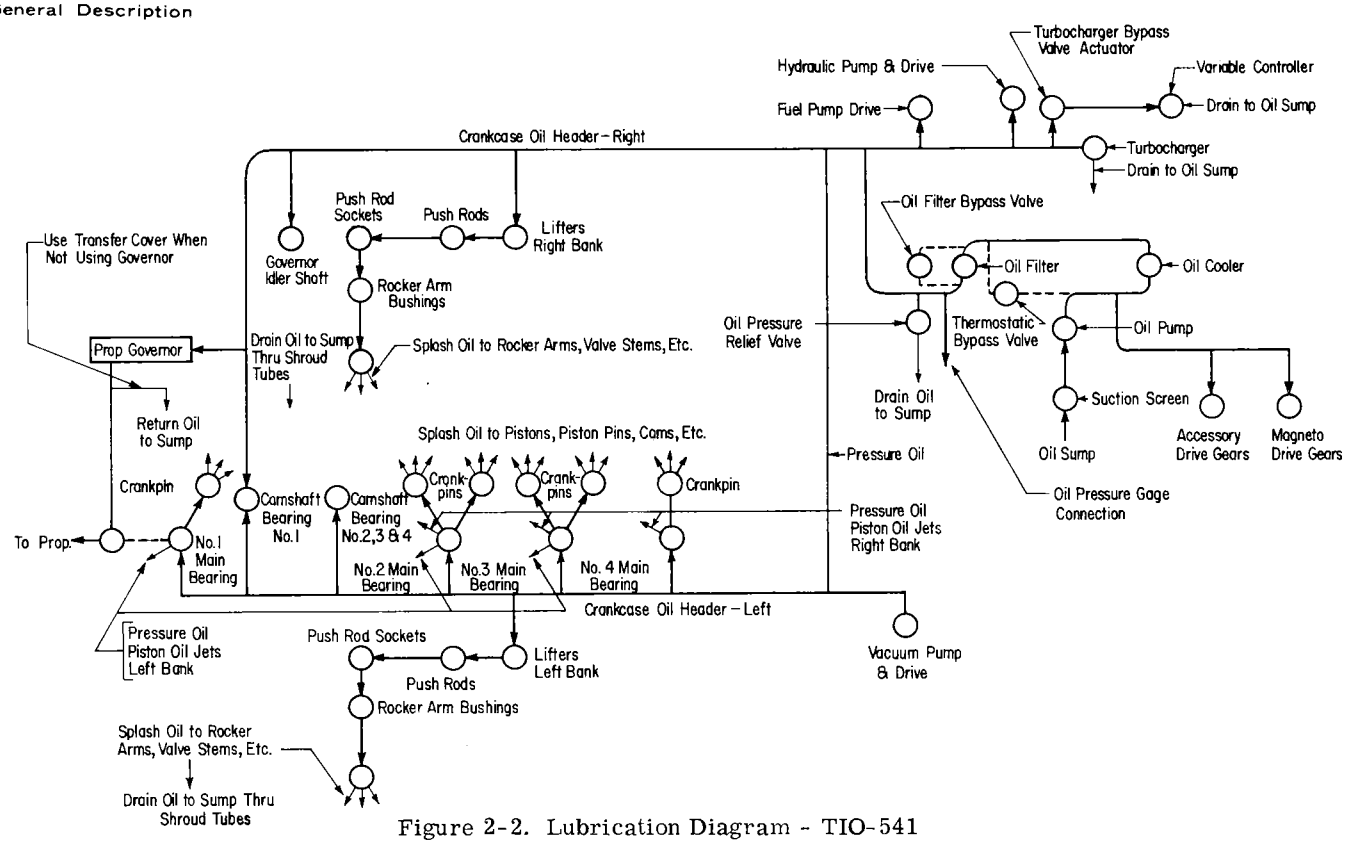


Figure 2-2. Lubrication Diagram - TIO-541

lists the approved spark plugs. Consult these publications for correct application to your particular installation.

2-6. VALVE OPERATING MECHANISM. The camshaft is located parallel to and below the crankshaft and operates in aluminum bearings. Ground and hardened cam lobes actuate automotive type hydraulic lifters which operate the valves through push rods and valve rockers. The hydraulic lifters automatically keep the valve clearance at zero eliminating the need of any valve clearance adjustment mechanism. The valve springs bear against hardened steel seats and are retained on the valve stems by means of tapered split keys. A rotator cap is used on the stem end of the sodium cooled exhaust valve.

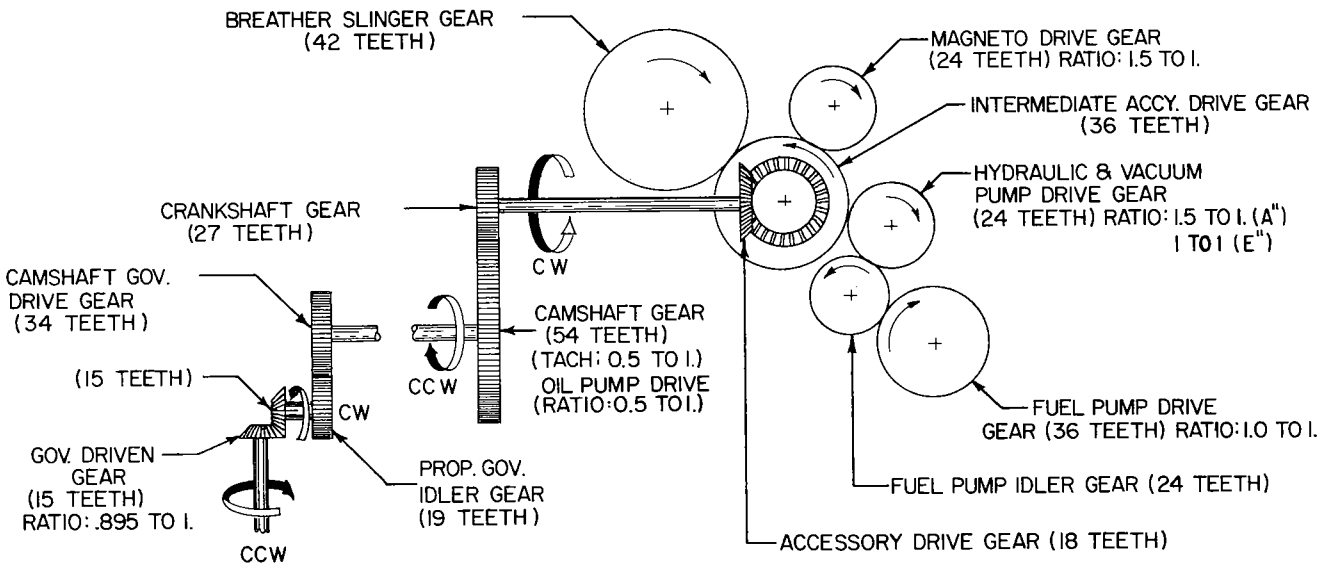


Figure 2-3. Gear Train Diagram - TIO-541

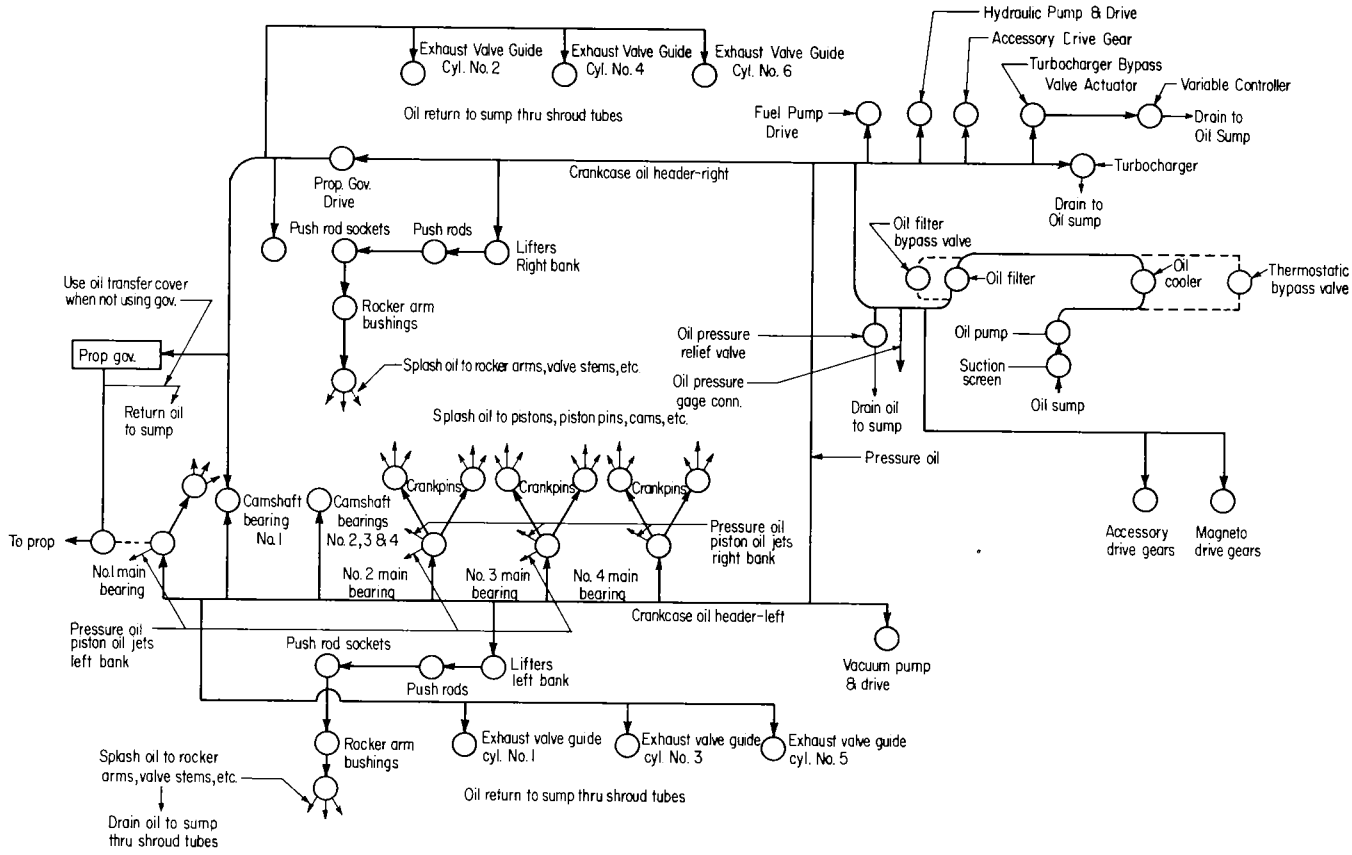


Figure 2-4. Lubrication Diagram TIO-541-E

2-7. CRANKSHAFT. The crankshaft is manufactured from a chrome nickel molybdenum steel forging. All journal surfaces are nitride hardened. Freedom from torsional vibration is assured by a system of dynamic counterweights.

2-8. CRANKCASE. The crankcase or integral housing consists of two reinforced aluminum alloy castings fastened together by means of thru bolts, studs and nuts. The mating surfaces are joined without the use of a gasket, and the main bearing bores are machined for use of precision type main bearing inserts. Bearing supports for the accessory drives are assembled in the crankcase. In addition bearing supports for a reduction gear drive are assembled in the TIGO series crankcase.

2-9. OIL SUMP. The engines covered in this manual are of the wet sump type. The oil sump is fastened to the bottom of the crankcase.

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 bronze bushings in the piston ends. The bearing caps on the crankshaft ends of the rod are retained by means of two bolts through each cap secured by nuts.

2-11. PISTONS. The pistons are machined, from an aluminum alloy forging, with grooves for two compression rings and an oil regulating ring. The piston pin is of the full floating type with a plug located in each end of the pin. Consult the latest edition of Service Instruction No. 1037 for proper piston and ring combinations for your particular installation.

2-12. COOLING SYSTEM. These engines are designed to be cooled by air pressure actuated by the forward movement of the aircraft. Close fitting baffles direct the airflow around the cylinder fins and the discharge air is then exhausted to the atmosphere.

2-13. LUBRICATION SYSTEM. Lubrication is of the full pressure wet sump type. Oil pressure is supplied by a gear driven pump housed in the accessory drive end of the crankcase. See figure 2-2, 2-4 and 2-6 for diagrams of the lubrication system.

2-14. IGNITION SYSTEM. Dual ignition is furnished by two -1200 series magnetos. The S6RN-1209 is a conventional magneto which is grounded out at the time the engine is started. The S6LN-1208 is a retard breaker magneto providing a fixed retard and a long duration spark for easier starting. A source of DC power and a starting vibrator are required to complete the installation. These magneto incorporate an integral feed-thru capacitor in the breaker circuit for suppression of breaker point arcing and conducted radio interference.

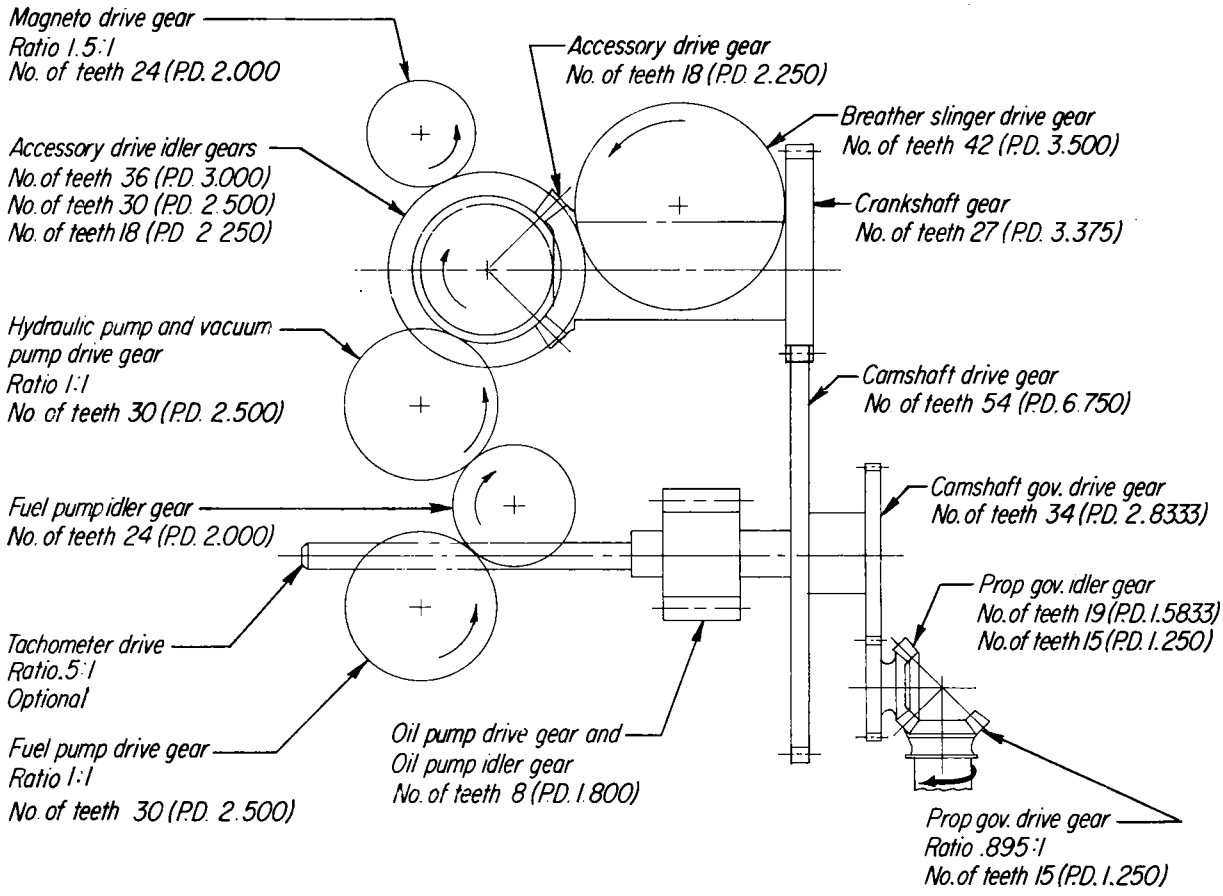


Figure 2-5. Gear Train Diagram TIO-541-E

2-15. INDUCTION SYSTEM. These engines are equipped with a Bendix RSA type fuel injection system. This fuel injector meters fuel, in proportion to mass air flow, to a nozzle cluster a central distribution zone. A manual mixture control and idle cut-off are provided.

2-16. A turbocharger is mounted as an integral part of the engine and provides constant air to the fuel injector inlet from sea level to critical altitudes.

2-17. TURBOCHARGER CONTROLS. The controller senses the outlet pressure (deck pressure) of the air from the compressor and in turn regulates the oil pressure which controls the position of the waste gate valve located in the engine exhaust. Engine oil utilized for this control system is supplied to the actuator through a restricted passage. The discharge pressure is determined by positioning the linkage of the variable pressure controller with the engine throttle mechanism.

2-18. The variable pressure controller is actuated by a pre-determined spring load which is set to operate through a range of 30 to 50 psi in the control system. The controller is set to close when the compressor discharge pressure is below a pre-determined manifold pressure to maintain the turbine speed and compressor discharge to provide the required cabin air pressure down to 25% of the normal rated power.

2-19. The action of the turbocharger control system is automatic and modulates continusouly as engine speed, power and altitude is varied. Bleed air on some models is controlled by a sonic nozzle that limits the flow of air to the cabin.

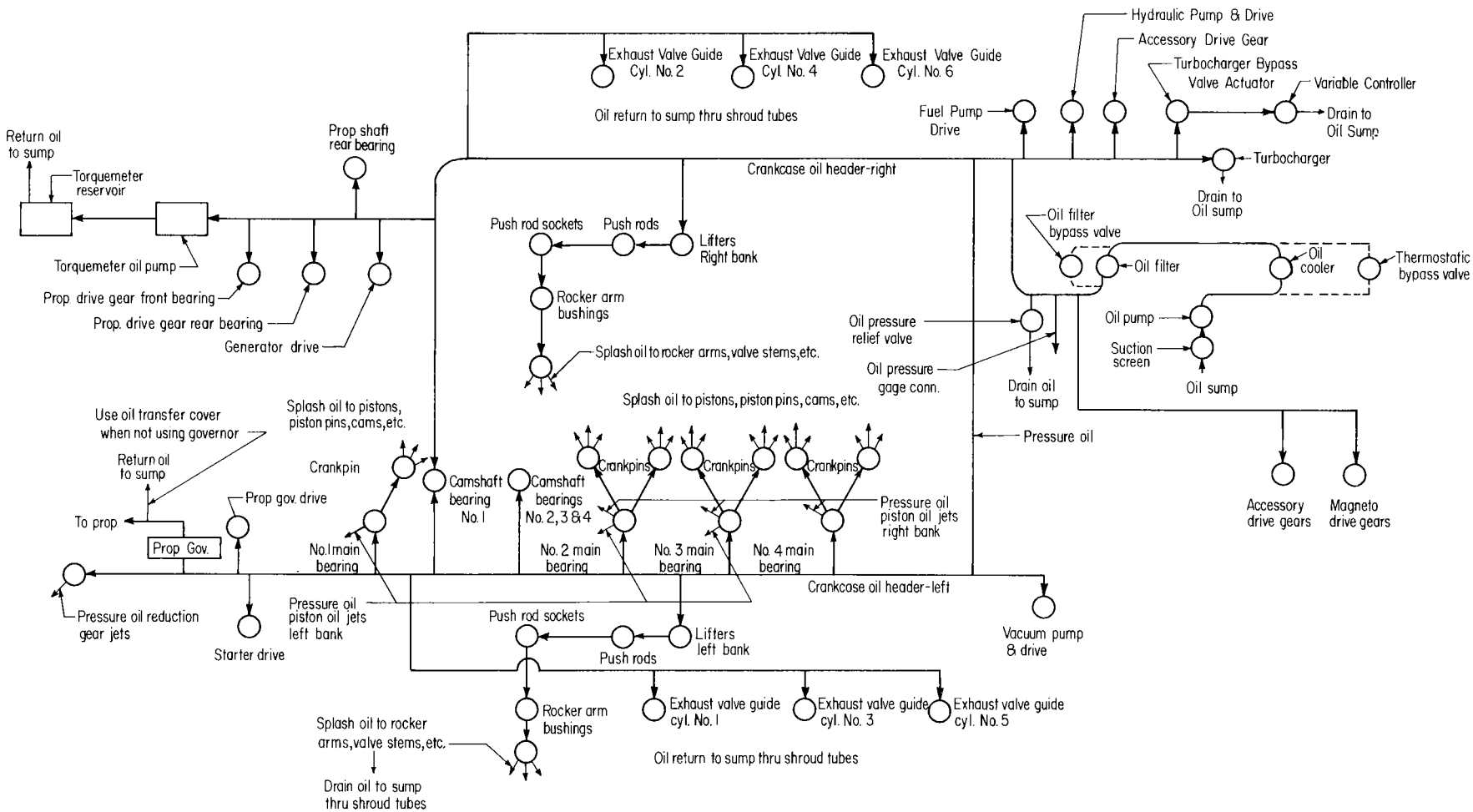


Figure 2-6. Lubrication Diagram TIGO-541

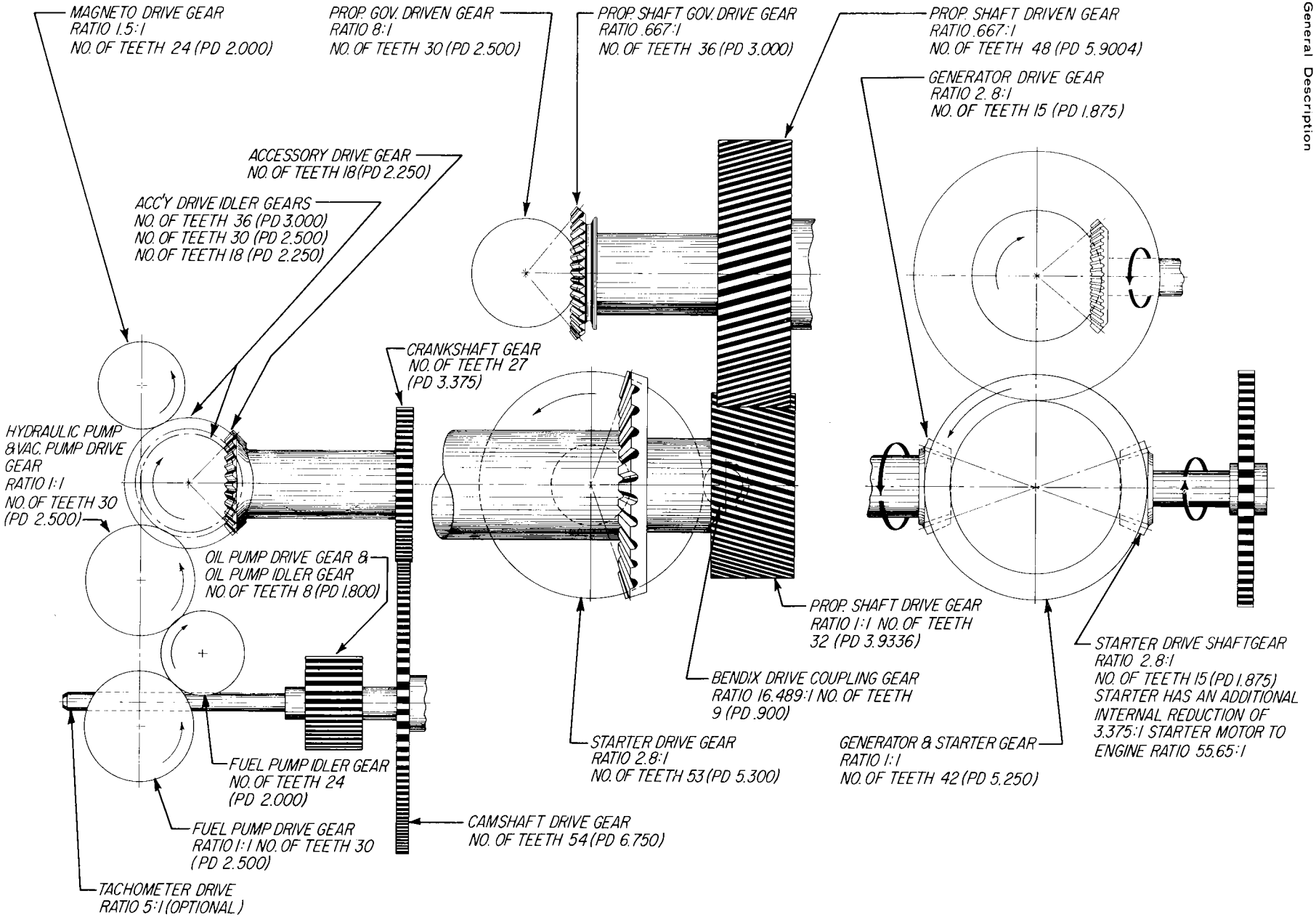


Figure 2-7. Gear Train Diagram TIGO-541-E Series

SECTION 3.
GENERAL OVERHAUL PROCEDURES

3-1. As mentioned in Section 1, this manual will describe in separate chapters the complete major overhaul procedures for each individual section of the engine, thus dividing the engine, for all practical purposes, into a series of individual handbooks dealing in turn with each component part. Since there are various prescribed 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 eliminating repetition.

3-2. No attempt shall be made to include overhaul procedures for the various trade accessories. These accessories are covered by overhaul manuals published by the 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 (ST-220) to the engine and remove from the airframe.

3-5. Place the skid (ST-278) in the overhaul stand (ST-162). Attach engine overhaul adapter (ST-165 or ST-240) and mount the assembly on the engine mounting ring (ST-161).

3-6. Place the overhaul stand and skid into position and lower the engine to the stand and remove cables. The engine is now in a position to be disassembled. Specific disassembly instructions are contained in the applicable section for each component.

3-7. Inasmuch as visual inspection immediately follows 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 and removal of dirt and sludge (soft carbon), and the removal of hard carbon deposits by decarbonizing, brushing or scraping and grit-blasting.

3-9. DEGREASING. Degreasing is accomplished by immersing or spraying the part in a 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 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 mixed solutions therefore, it is imperative that the parts be completely and thoroughly rinsed in clear 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 machined surfaces must, of course, be properly and 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 entrance of foreign matter.

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

3-14. At the conclusion of cleaning operations, rinse the part in petroleum solvent, dry and remove any loose particles of carbon or other foreign matter by air-blasting and 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 categories deal with structural defects in the parts while the third deals with the size and shape.

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

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

3-18. Dimensional inspections should be carried out in accordance with measurements and tolerances as listed in Table of Limits SSP-2070.

3-19. It is strongly recommended that an overhaul and inspection form, containing a list of all engine components, be utilized when overhauling an engine. This form should be prepared so that all overhaul and inspection procedures can be checked off as they are accomplished and any remarks noted. The use of this form will assure that no parts are inadvertently overlooked. Also, needless repetition can be avoided.

3-20. BEARING SURFACES. All bearing surfaces should be examined for scores, 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 comes within the specific clearance limits, however, it will not be satisfactory for reassembly into the engine unless inspection shows the part to be free from other serious defects. Ball bearings should be inspected visually and by feel for roughness, flat spots on balls, flaking or pitting of races, and for scoring on outside of races. All journals should be checked for galling, scores, misalignment and out-of-round condition. Shafts, pin, 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 a 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 overtightening, 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 show indications of some kind, and it is important that the operator exercise good judgment 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 judgment must also be used in determining the amount of current (amperage) applies; 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 correct 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 similar abrasive substance. Following any repair 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 excessive. 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 materials. 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 (AMS3125C or equivalent MIL-E-7729).

NOTE

All machined 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 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 lb. of sodium dichromate to one gallon of water at 180°F. to 200°F., quantity as required). The part should be then 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 tubes should be thoroughly cleaned and dipped in a 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 accomodate 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.

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

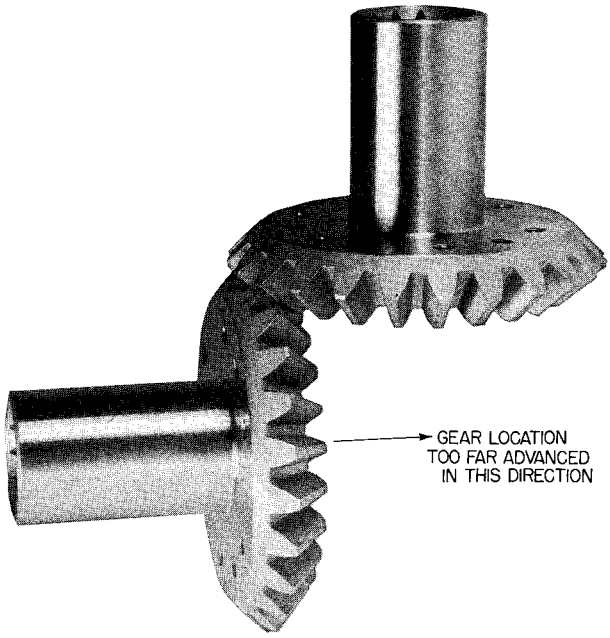


Figure 3-1. Bevel Gear Showing Extreme Pitch Alignment

on bearing surfaces, cylinder bores and piston rings. The practice 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 at 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 chance 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 fialure before normal service hours have been accumulated. It is of utmost importance, therefore, that the following recommendations be adhered to at engine assembly. Consult the latest edition of Service Instruction No. 1059.

3-37. Coat the camshaft lobes, face of tappet bodies and rocker arm tips with Texaco Molytex Type "O" 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 avaition grade lubricating oil.

3-40. OILITE BUSHINGS. During overhaul cleaning operations it is possible to wash the oil from these bushings; also, if a bushing has been replaced and either reamer or broached, its porosity may be affected. Therefore, before the bushings are reassembled into the engine they must be impregnated by immersing them for at least fifteen minutes in engine oil that has been heated to 140°F.

3-41. PITCH ALIGNMENT AND BACKLASH IN BEVEL GEAR ASSEMBLIES. During disassembly of engines returned to our factory, inspection personnel ocassionally find evidence of incorrectly assembled gears. This condition appears to be wholly confined to bevel gear assemblies wherein one of the gears had been replaced; that is, instances where a comparatively new bevel gear is meshed with an older worn gear. An exaggerated example of this sort is shown in figure 3-2. Note that the edges of the gear are not even; the one gear is too far forward on its longitudinal axis.

3-42. During manufacture of bevel gears, the relationship between the edges of the gear (or tooth length) is carefully controlled. Because of this relationship, the correct location of the interlocking teeth (pitch alignment) of the two bevel gears can be maintained if the mating edges of the gears are even.

3-43. In Avco Lycoming aircraft engines where bevel gears are employed, the gear mountings are similar to the arrangement shown in figure 3-3. That is, a laminated shim is usually provided between the mounting adapter and the housing, thus permitting each gear to be moved in either direction, along its longitudinal axis.

3-44. Designs such as this not only provide a means of obtaining correct backlash between the mating gears but also permit adjustment to correct pitch alignment, by correcting uneveness of the edges of the gears. The following procedure is suggested for obtaining both backlash and pitch alignment during assembly of the bevel gears.

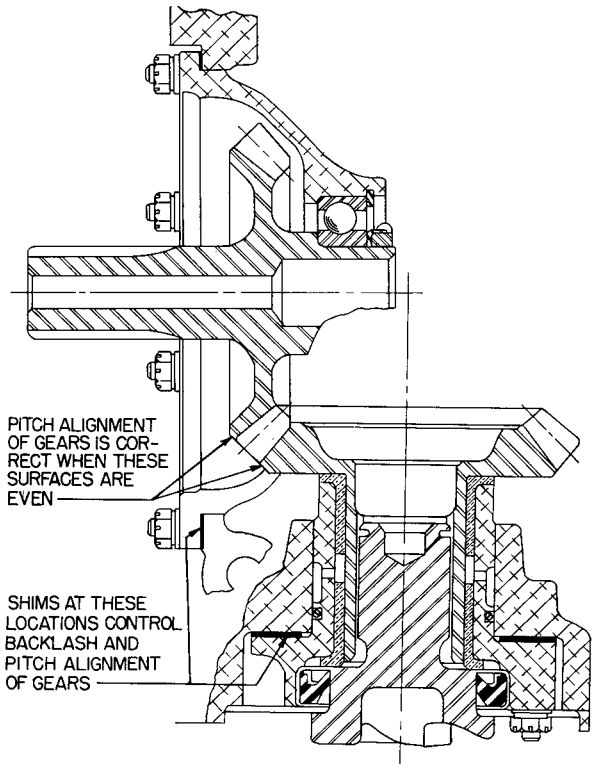


Figure 3-2. Typical Mounting for Support Bevel Gears

a. Assemble each gear and its associated parts in its housing using such gaskets and shims as are specified by the applicable parts catalog. Secure the gear mountings temporarily.

b. Remove or add shim laminations as required to obtain correct backlash.

c. Visually, and by feel, determine if the edges of the mating gears are even. If the edge of one gear protrudes beyond the edge of the other, remove shims from the protruding gear and add shims of equal thickness to the other gear to achieve pitch alignment of the gears.

NOTE

It is possible to perform step (c) prior to step (b); that is, pitch alignment can be corrected before adjustment for backlash is made provided these precepts are observed. The removal or addition of an equal amount of shim material from both gear mountings will change backlash but not pitch alignment. The removal or addition of shim material from one gear only will change backlash and pitch alignment and the removal of shim material from one gear with the addition of an equal amount of shim material to the other gear will change pitch alignment but not backlash.

3-45. 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.

3-46. TABLE OF LIMITS. The table of limits, SSP-2070, 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 moving parts which are in close contact with each other and the torque limits for various nuts, screws and fastenings.

3-47. 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.

3-48. ARBITRARY REPLACEMENT OF PARTS. It is recommended that certain parts throughout the engine be replaced at normal overhaul regardless of their apparent condition. 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
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 nut
  Crankshaft flange bolts
Ignition cables
All laminated shims
Crankshaft counterweight bushings
Propeller shaft thrust bearing (TIGO-541)

Consult the latest edition of Service Bulletin No. 240 for information on the replacing of parts at overhaul.

SECTION 4.
IGNITION SYSTEM

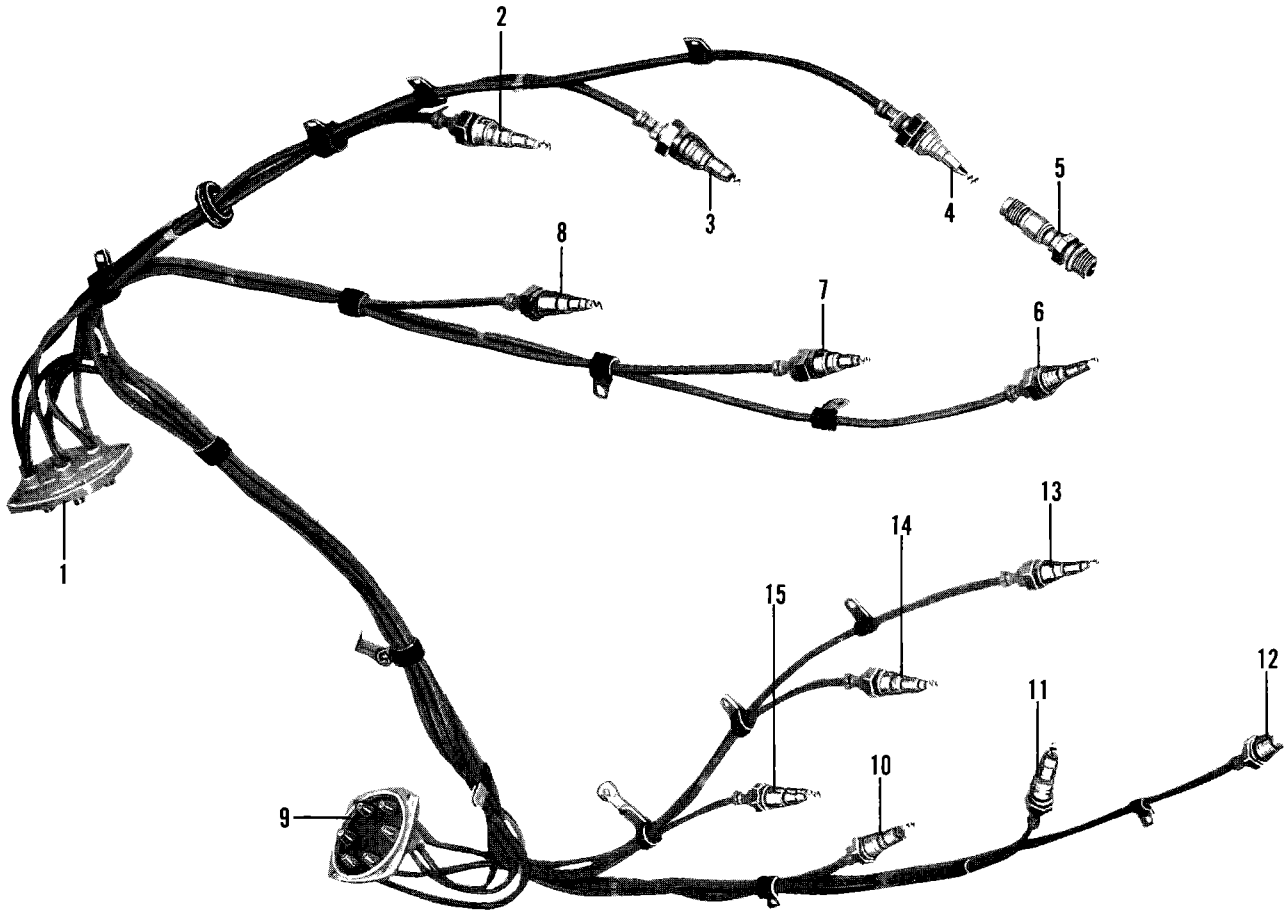
4-1. GENERAL. All subject engines are equipped with a high tension ignition system. A brief description of the system may be found in paragraph 2-14.

4-2. ENGINE FIRING ORDER. The engine firing order is 1-4-5-2-3-6.

4-3. MAGNETOS. Dual ignition is furnished by a S6LN-1208 magneto, a retard breaker magneto, mounted on the left side of the engine and a S6RN-1209 magneto mounted on the right side.

4-4. IGNITION HARNESS. Ignition harnesses will vary for each particular installation, however, for purposes of description, all harnesses are comprised of the same basic components. Basically, each lead is composed of a magneto terminal, cable and a spark plug assembly.

4-5. SPARK PLUGS. For information relative to approved spark plugs consult the latest edition of Service Instruction No. 1042.



1. Left Magneto Terminal
2. No. 5 Bottom Lead
3. No. 3 Bottom Lead
4. No. 1 Bottom Lead
5. Spark Plug
6. No. 1 Top Lead
7. No. 3 Top Lead
8. No. 5 Top Lead
9. Right Magneto Terminal
10. No. 6 Bottom Lead
11. No. 4 Bottom Lead
12. No. 2 Bottom Lead
13. No. 2 Top Lead
14. No. 4 Top Lead
15. No. 6 Top Lead

Figure 4-1. Typical Ignition Harness

REMOVAL FROM ENGINE

4-6. IGNITION HARNESS. Remove the spark plugs leads from the spark plugs. Detach, and mark locations, of the various clamps securing the harness to the engine. Complete the removal of the harness by removing the outlet plates from the magnetos. Remove the spark plugs from the cylinders.

4-7. MAGNETOS. See figure 4-2. Remove the four 5/16 nuts, washers and clamps securing the magnetos to the engine. Remove the magnetos and gaskets. Reach inside the left mounting pad and remove the cushions (12) and the magneto coupling (15). Reach through the mounting pad on the right and remove cushions (12) and pull the drive shaft (13) from its position.

NOTE

The gears mentioned in the above paragraph are associated with and form a part of the accessory drive train and should not be considered a part of the ignition system. They are removed at this time, however, to prevent their being dropped and damaged as the engine is rotated.

DISASSEMBLY

4-8. MAGNETOS. See figure 4-2. For the purposes of this manual the only disassembly required is the removal of the drive coupling (7). This is accomplished by removing the cotter pin (11), nut (10), washer (9), and removing the drive coupling (7) and Woodruff key (8) from the drive shaft. It is recommended that the nut be replaced on the shaft to protect the thread.

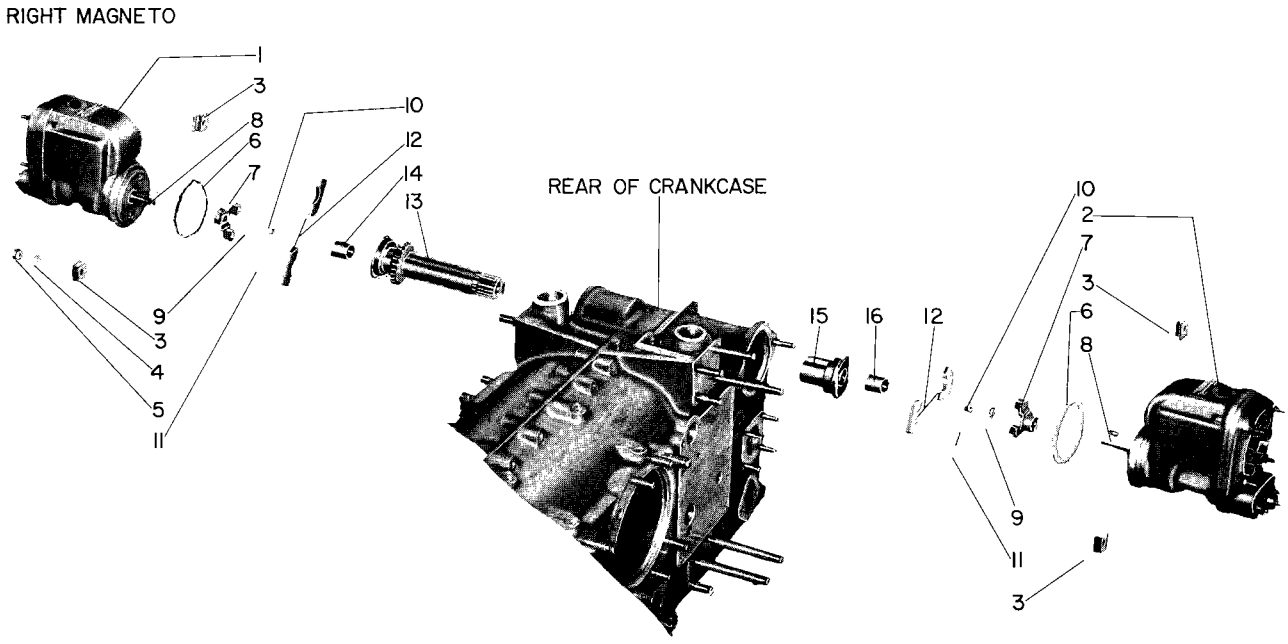
REPAIR AND REPLACEMENT

4-9. 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. Avco Lycoming does supply individual leads in two lengths, (48 or 78 inch) finished at the spark plug end and available from your local distributor. The following steps will describe the procedure for replacing a lead.

4-10. Removal of Condemned Lead. Remove clamps and brackets from applicable lead assembly. Cut cable ties from assembly and discard.

4-11. Cut off condemned lead flush with the outer surface of the cable outlet plate. Grip eyelet of lead with a pair of pliers and pull short length of conductor out of grommet and cable outlet plate. Using a 3 inch long, 0. 270 inch diameter drift, applied at outer surface of plate, drive out tapered ferrule and remaining pieces of insulation and shielding.

4-12. Replacement of Condemned Lead - To replace a condemned lead, proceed as follows:



1. Right magneto
2. Left magneto
3. Clamps
4. Washer
5. Nut
6. Gasket
7. Coupling
8. Woodruff key
9. Washer
10. Nut
11. Cotter pin
12. Drive cushions
13. Driveshaft
14. Driveshaft sleeve
15. Coupling
16. Driveshaft sleeve

Figure 4-2. Magnetos and Magneto Drive Assembly

a. Measure the length of the condemned lead assembly. Move coupling nut back on lead assembly and measure from outer end of the ferrule at the spark plug end. See figure 4-3. Add 1-3/4 inches to this measurement.

b. Cut the replacement lead assembly to the length determined in step a. Mark ferrule on spark plug end of lead with a metal stamp, scribe or rubber stamp to correspond with correct cylinder number. Starting at the spark plug location, thread new cable through grommets and clamps as necessary for correct routing of cut end of cable to magneto location.

c. Remove 1.250 inch of outer braid from end of lead. See figure 4-3. Use care not to nick or cut insulation when removing braid. Use Bendix tool no. 11-7803 to unbraid 3/8 inch of braided shielding. See figure 4-4. Wrap a single thickness of electrical tape around unbraided strands to facilitate insertion of lead end through hole in cable outlet plate.

d. Remove the cable outlet plate from the magneto. Support plate securely, and using suitable cutting pliers, split and remove eyelets from the leads adjacent to the lead being replaced. When splitting eyelet, make certain that wire strands are not cut. Removal of the eyelets on adjacent leads will allow grommet to be pulled away from outlet plate to facilitate insertion of the new lead.

e. Pass the taped end of the new lead through hole in outlet plate. Remove electrical tape from lead and install tapered end of ferrule under the unbraided strands of shielding (figure 4-4). Form strands of shielding evenly around tapered ferrule and pull lead back through cable outlet plate until the ferrule binds in the outlet well. Position the Bendix Tool No. 11-7074, seating tool over the wire and firmly seat the ferrule by tapping the seating tool with a hammer, or by using an arbor press.

f. Measure 1/2 inch from top of ferrule and strip remaining insulation from wire. Figure 4-5.

g. Insert Bendix Tool No. 11-7073 needle through the small hole in the grommet and over stripped end of wire, figure 4-6. Slide grommet down needle until it seats tightly against the tapered ferrule. See figure 4-7.

h. Cut the wire 3/8 inch from top of grommet outlet. Double wire over. Slide eyelet over doubled wire until it is firmly seated in recess of grommet outlet. See figure 4-8.

i. Using the "AB" groove of Bendix Tool No. 11-4152, crimping tool, crimp the eyelet to wire. Approximately 1/32 inch of wire should extend from end of eyelet after crimping.

NOTE

If the previously designated crimping tool is not available, a satisfactory connection can be made by soldering with Kester Flux 709 or equivalent and non-corrosive solder. After soldering, clean solder joints using denatured alcohol.

j. Before coupling the harness assembly to magneto, spray entire face of the grommet with a light coat of Plastic Mold Spray. This will prevent cable outlet grommet from sticking when it is necessary to remove the harness from magneto distributor block.

NOTE

Bendix Tools No. 11-7074, 11-7803 and 11-7073 are procurable from Avco Lycoming. Tool No. 11-4152 is available from Thomas Betts Co., Elizabeth, New Jersey under No. WT-111-M. Plastic Material Sales Co., Fanwood, New Jersey are manufacturers of Plastic Mold Spray.

4-13. MAGNETOS. As previously mentioned, this overhaul manual will not endeavor to describe the overhaul of trade accessories. Consult the magneto manufacturer's applicable manual for overhaul procedures.

REASSEMBLY AND INSTALLATION

4-14. MAGNETOS. See figure 4-2. Assemble a Woodruff key (8) in the slot in the driveshaft and install the drive coupling (7) and secure with washer (9) nut (10) and cotter pin (11).

4-15. MAGNETO INSTALLATION AND TIMING PROCEDURES. When engine build-up has progressed to a point where all major sub-assemblies have been installed, the magnetos may be installed and timed to the engine.

4-16. See figure 4-2. It is assumed that the magneto drive coupling (15), magneto drive shaft (13) and cushions (12) have been installed.

NOTE

The retard breaker magneto is installed on the left side of the engine.

4-17. Remove a spark plug from No. 1 cylinder and place a thumb over the spark plug hole. Rotate the crankshaft in direction of normal rotation until the compression stroke is reached, this is indicated by a positive pressure inside the cylinder tending to push the thumb off the spark plug hole.

a. (TIO-541 Series). Continue rotation the crankshaft in direction of normal rotation until the advance timing mark on the front face of the starter ring gear is in exact alignment with the small hole located at the 2 o'clock position on the front face of the starter housing. See figure 4-9. Starter ring gear may be marked at 20° and 25°. These engines use the 20° mark.

b. (TIGO-541 Series). Remove the timing hole cover, and sighting through the timing hole, continue to rotate the crankshaft until the 20° mark on the crankshaft front flange is in alignment with the crankcase parting surface. The crankshaft front flange may be marked 20-25-30.

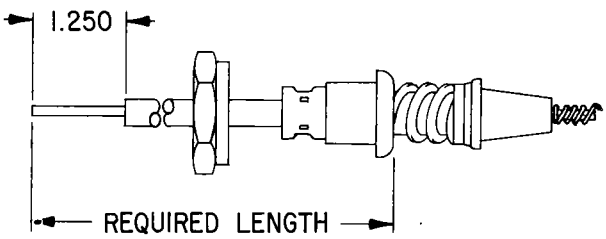


Figure 4-3. Measuring Lead Assembly Lengths

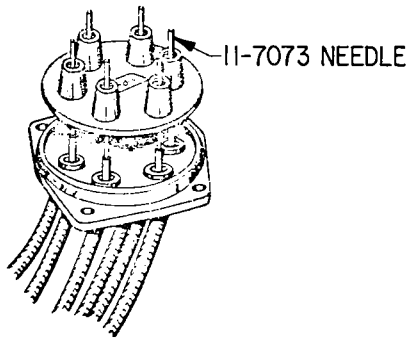


Figure 4-6. Installing Grommet Over Lead Assembly

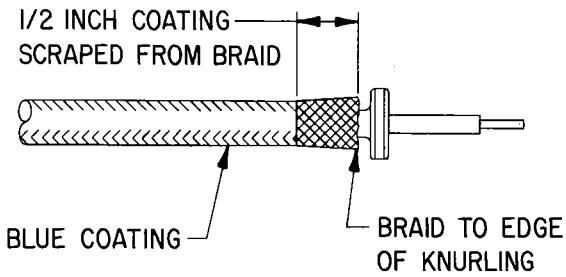


Figure 4-4. Ferrule Installed Under Shielding

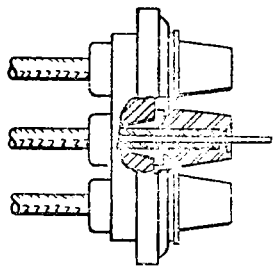


Figure 4-7. Lead Assembly Installed in Grommet

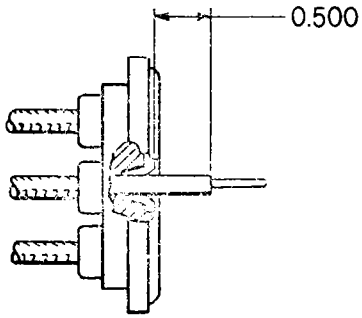


Figure 4-5. Measuring Wire from Top of Ferrule

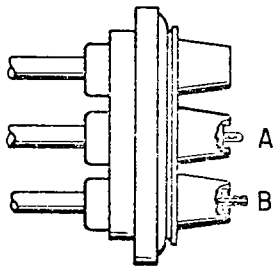


Figure 4-8. Wire Doubled Over for Installation of Eyelet

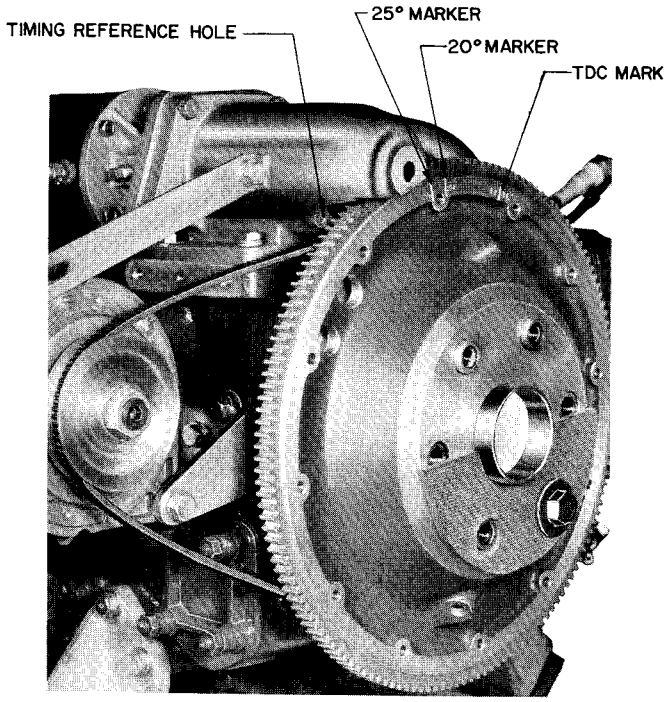


Figure 4-9. Reference Points - Timing Magnetos to Engine - TIO-541

NOTE

If the crankshaft is accidently turned in the direction opposite normal rotation, repeat the above procedure as accumulated backlash will make the final timing incorrect.

4-18. At this point, the engine is ready for assembly of the magnetos. Remove the inspection plugs from both magnetos and turn the drive shafts in direction of normal rotation until the first painted chamfered tooth on the distributor gear is aligned in the center of the inspection window. Being sure that the gear does not move from this position, install gaskets and magnetos on the engine. Secure clamps, with washers and nuts; tighten only finger tight.

4-19. Using timing light, attach the positive lead to a suitable adapter connected to the switch terminal of the magneto and the negative lead to any 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 light goes out. Bring the magneto back slowly until the light just comes on. Repeat this with the second magneto.

NOTE

Some timing lights operate in the reverse manner as described above, the light goes out when the breaker point open.

4-20. After both magnetos have been timed, check, as described below, to ascertain that both magnetos are are set to fire together.

4-21. Backoff the crankshaft a few degrees, the timing lights should go out. Bring the crankshaft slowly back in direction of normal rotation until the timing reference points are in alignment. At this point, both lights should go on simultaneously. Tighten nuts to specified torque.

4-22. IGNITION HARNESS INSTALLATION. Assemble spark plugs with gaskets and tighten to specified torque. Secure each harness to its respective magneto by screwing the outlet plate to the mounting surface. Arrange the leads, all leads should be marked with its spark plug location, and secure to the engine at locations marked at disassembly. Attach to spark plugs. See figure 4-10 wiring diagram.

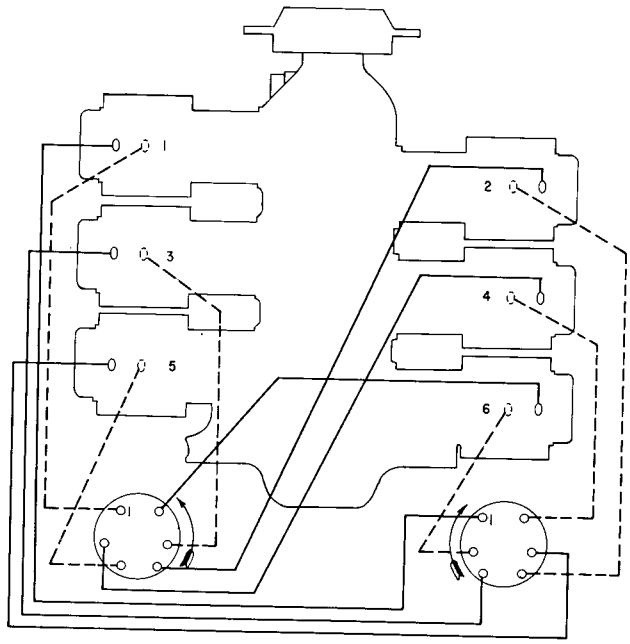


Figure 4-10. Ignition Wiring Diagram

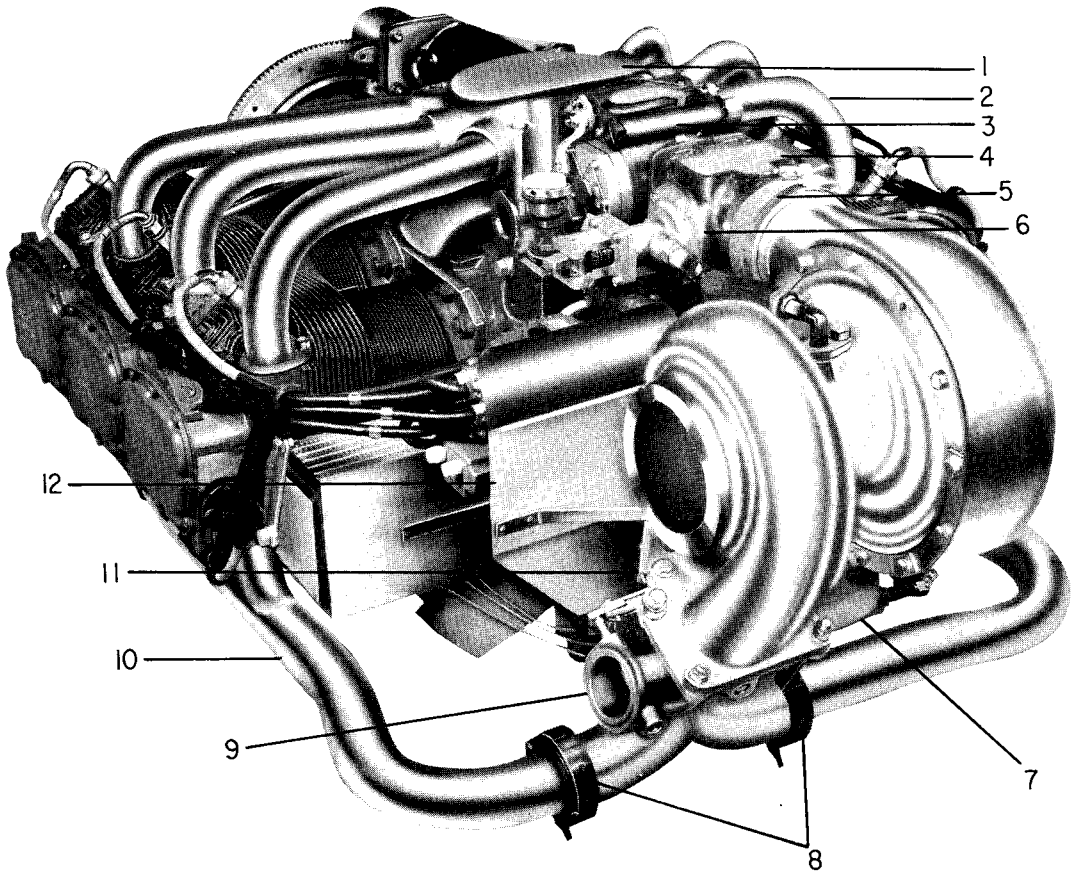
SECTION 5.
INDUCTION AND EXHAUST SYSTEMS

5-1. For purposes of this manual the induction system will be considered as consisting of the intake pipes, induction housing, pressurization valve, injector nozzles, fuel injector, fuel drain lines and fuel drain check valve. The exhaust system will be considered as consisting of the exhaust manifolds, turbocharger, exhaust bypass valve assembly and the variable pressure controller.

5-2. Fuel injectors, for the purposes of this manual, will be covered only to the extent of removing from and assembling to the engine. Overhaul of the fuel injectors is covered in the applicable Bendix publication.

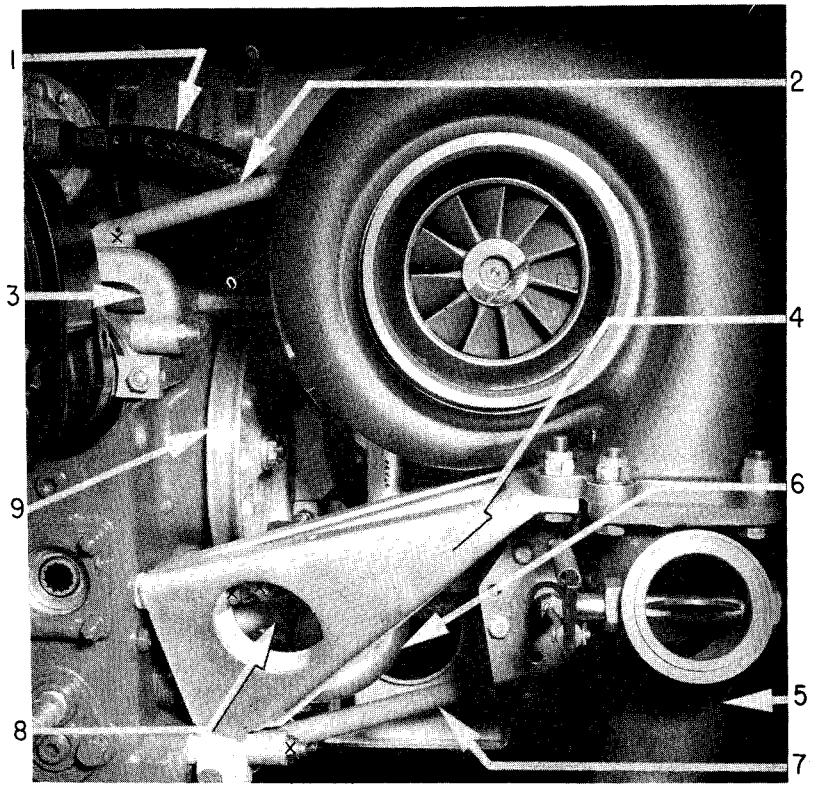
REMOVAL FROM ENGINE

5-3. TIO-541-A. See figure 5-1. Remove oil lines from turbocharger and controls. Loosen and remove the Marman clamps (8) securing the exhaust manifolds to the exhaust bypass assembly. Using wrench (ST-213), remove the 5/16 nuts and lockwashers from the exhaust flanges and remove the exhaust manifolds (10). Remove the four bolts and nuts securing the exhaust bypass valve assembly (9) to the compressor housing and remove the exhaust bypass valve assembly. The turbocharger, supports, brackets and struts may be re-



1. Induction housing
2. Intake pipe
3. Fuel injector
4. Adapter housing
5. Hose
6. Variable pressure controller
7. Waste gate acutator
8. Marman clamps
9. Exhaust bypass valve
10. Exhaust manifold
11. Turbocharger bracket
12. Magneto baffle

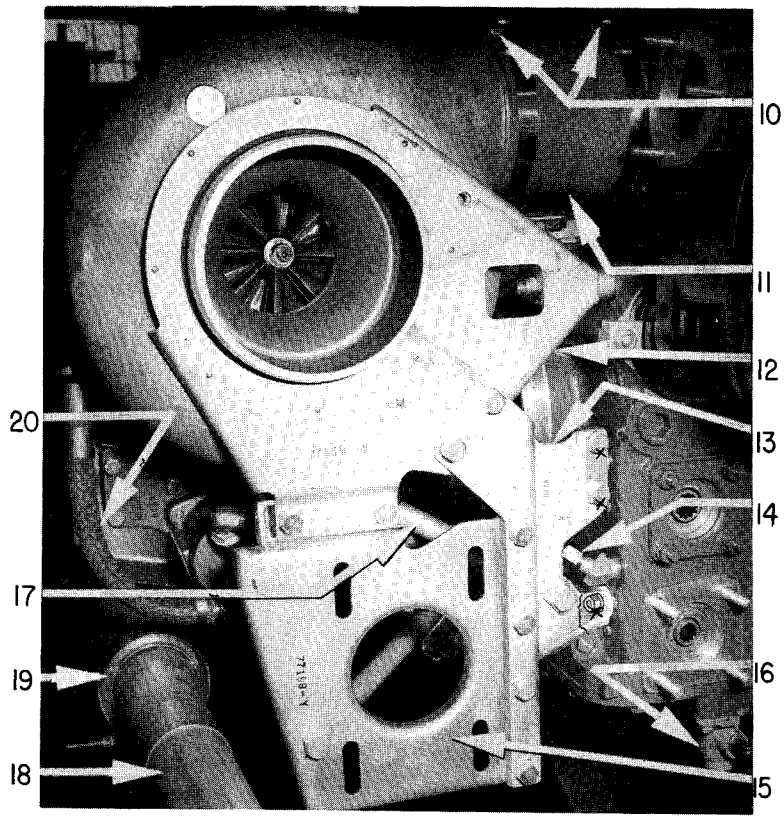
Figure 5-1. 3/4 Left Rear View - Typical TIO-541-A Series



1. Hose (actuator to controller)
2. Strut (turbocharger)
3. Support (turbocharger strut)
4. Bracket (turbocharger)
5. Exhaust by-pass valve assembly
6. Turbine oil drain tube
7. Strut (compressor mounting bracket)
8. Strut (compressor mounting bracket)
9. Compressor drive pulley
10. Hose clamps

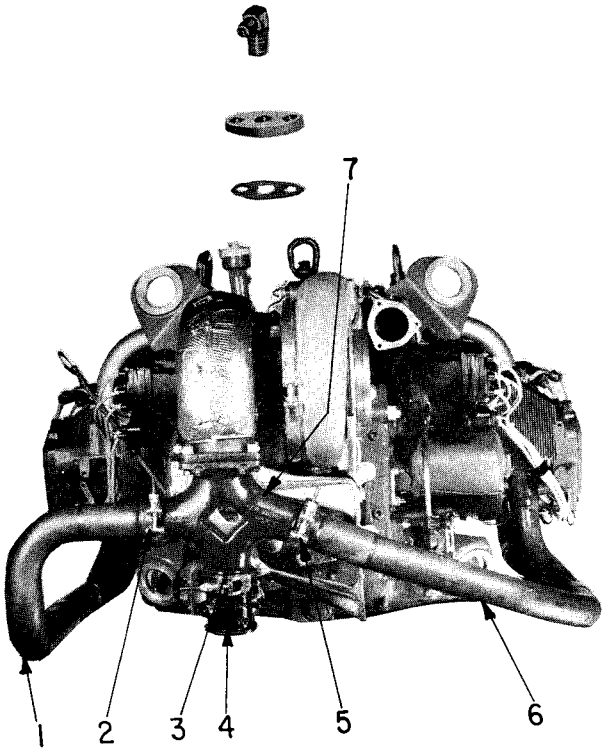
LEFT SIDE

11. Hose (turbocharger outlet to adapter)
12. Bracket (turbocharger and compressor)
13. Support (turbocharger and compressor)
14. Hose (crankcase to actuator)
15. Bracket (compressor mounting)
16. Fuel drain check valve
17. Strut (turbocharger)
18. Exhaust manifold
19. Marman clamps
20. Hose (actuator to turbine oil inlet)



RIGHT SIDE

Figure 5-2. Views of Typical Turbocharger Mounting ("E" Series) - TIO-541-E1A4, -E1B4



1. Exhaust manifold - left
2. V-band coupling
3. V-band coupling
4. Exhaust bypass valve
5. V-band coupling
6. Exhaust manifold - right
7. Transition assembly

Figure 5-3. Rear View of Typical TIGO-541

moved from the engine as an assembly and disassembled on the bench.

5-4. Loosen clamps on hose (5) connecting turbocharger to adapter assembly (4). Remove the capscrews securing the turbocharger mounting bracket (11) to the engine and remove the bracket and turbocharger assembly from the engine. Remove the magneto baffle plate (12).

5-5. Turbocharger and Exhaust Manifold (TIO-541-E1A4, -E1B4). See figure 5-2. Remove oil lines from turbocharger and controls. Loosen and remove the Marman clamps (19) securing the exhaust manifold to the exhaust bypass valve assembly (5). Using wrench (ST-163) remove the 1/2 inch self locking nuts from the exhaust flanges and remove the exhaust manifold.

5-6. Remove the four bolts and nuts securing the exhaust bypass valve assembly (5) to the compressor housing and remove the exhaust bypass valve assembly. The turbocharger, supports, brackets and struts may be removed from the engine as an assembly and disassembled on the bench. This is accomplished in the following manner:

a. Remove oil line from controller to actuator (1) and oil line from actuator to turbine oil inlet (20). Unfasten oil line from crankcase to actuator (14) at the actuator. This line will be easier to remove from the crankcase after the turbocharger assembly is removed. Loosen hose connecting turbine oil drain tube (6) to the crankcase.

b. By removing the nuts and bolts, identified by X on figure 5-2, the turbocharger, supports, brackets, and struts will remove as an assembly.

5-7. Turbocharger and Exhaust Manifolds (TIO-541-E1C4, -E1D4, TIGO-541-E1A). See figure 5-3. Although the figure shows the rear of the TIGO-541, the arrangement at the rear is similar enough to call out removal procedure for subject engines. Remove the oil lines from turbocharger and controls. Loosen and remove the v-band couplings (2 and 5) securing the exhaust manifolds to the transition assembly (7). Using wrench (ST-163) remove the 1/2 inch self locking nuts from the exhaust flanges and remove the left and right exhaust manifolds (1 and 6).

5-8. Remove the four bolts and nuts securing the transition assembly (7) to the turbocharger and remove the transition assembly and the exhaust bypass valve assembly (4). By removing the nuts and bolts securing the turbocharger, supports etc. to the crankcase, it may be removed as an assembly and disassembled on the bench.

5-9. All Models. See figure 5-10. Remove the 1/4 inch bolts, lockwashers and washers at intake pipe flange and pull intake pipes (1) and seal rings (2) from the induction housing (8). Remove flanges (9) from pipes.

5-10. All Models. See figure 5-4. Remove cross shaft linkage shields (13 and 15), injector and controller connecting rods (1 and 9) and cross shaft assembly (14). Remove the tube assemblies (2 and 11). Remove flexible lines (6, 7 and 8)

5-11. Remove variable pressure controller (5) and sonic nozzle assembly (4) from those models employing this feature. Remove controller adapter (3) and fuel injector (10). Discard the gaskets. Remove the induction housing (12).

5-12. See figure 5-11. Loosen fuel drain lines from nipples in cylinder head and from the check valve (1) on the crankcase. Remove the various clamps and remove the fuel drain lines. Remove the check valve assembly (1).

DISASSEMBLY

5-13. Turbocharger. For overhaul of the turbocharger, the following special tools must be available:

a. A furnace, oven or hot oil bath which can be temperature controlled between 350°F. and 375°F.

b. An arbor press, and dial indicators.

5-14. Clean exterior of turbocharger with a pressure spray of cleaning solvent before disassembly. As each part is removed, place in a clean, protective container.

5-15. Prior to disassembling, mark the position of the compressor and turbine housings in relation to the center housing, so they may be reassembled in the same position.

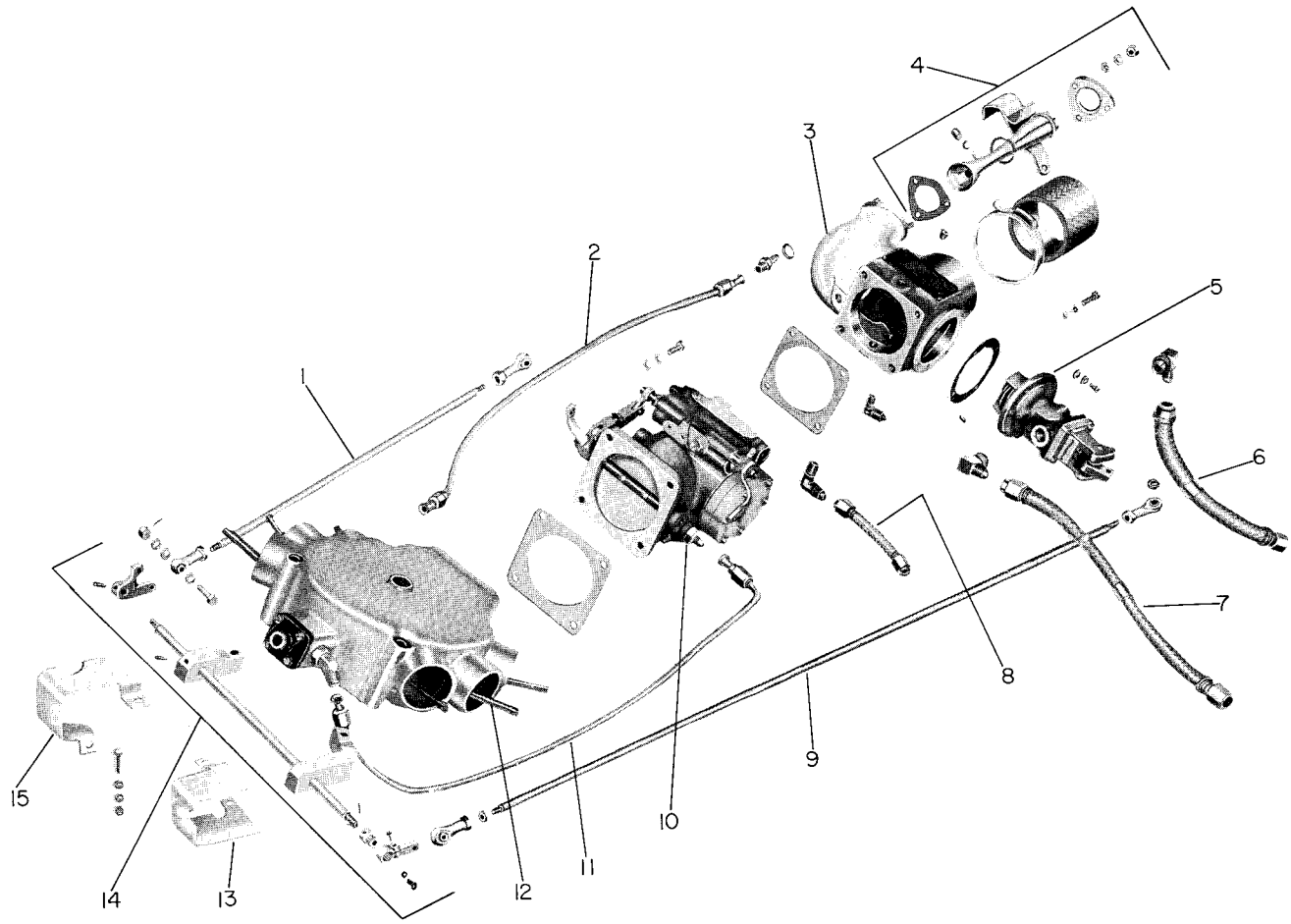
5-16. See figure 5-5. Remove the bolts and clamps securing the compressor and turbine housings to the center housing. Note that compressor housing on T-1879 and T18A21 are secured by a V-band coupling. Tap the housings with a soft hammer if necessary to break loose. Place the center housing assembly in the holding fixture (ST-133).

5-17. Before completing the disassembly the following procedure should be followed to determine whether it is necessary to replace or repair the thrust bearing, radial bearings, and rotating assembly of the center housing rotating assembly.

5-18. BEARING CLEARANCE. Fasten a dial indicator (plunger type with one inch travel) using a mounting plate, (see figure 5-6 for dimensions to fabricate a mounting plate) and one and one-quarter inch indicator extension rod, (see figure 5-7) to the turbocharger oil drain mounting pad (figure 5-8). The mounting plate and indicator can be secured with the bolts which were removed to gain access to the oil drain hole.

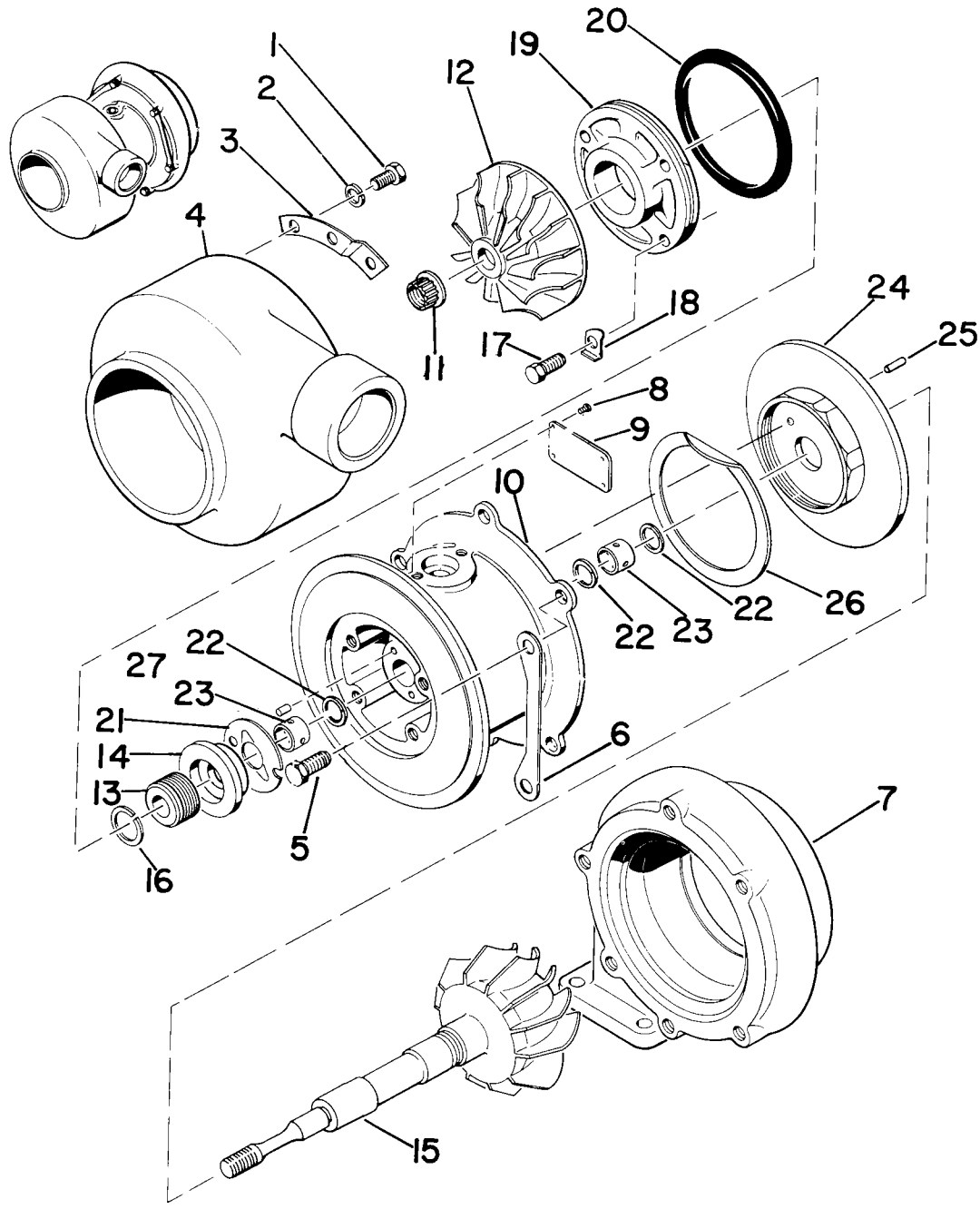
5-19. Radial Bearing Check. After securing the dial indicator properly, move the rotating shaft forward and away from the indicator. Use care to move the shaft in the same direction as the dial indicator travels. Equal pressures should be applied to the shaft at both ends simultaneously. The total dial indicator displacement should be less than 0.009 inch; if the measured movement is 0.009 inch or more, the cartridge rotating assembly must be repaired or replaced. The minimum should be no less than 0.004 inch.

5-20. Axial End Play Bearing Check. Fasten a dial indicator to the center housing so that the indicator tip rests on the end of the rotating shaft on the compressor side (figure 5-9). Move the shaft axially back and forth



1. Injector connecting rod
2. Tube assembly - Induction housing to controller
3. Controller adapter
4. Sonic nozzle assembly (not used on -E1B4)
5. Variable pressure controller
6. Hose - controller to crankcase
7. Hose - waste gate to controller
8. Hose - actuator to crankcase
9. Controller connecting rod
10. Fuel injector
11. Tube assembly - Injector to pressurizing valve
12. Induction housing
13. Linkage shield
14. Control shaft assembly
15. Linkage shield

Figure 5-4. Fuel Injector and Controller Linkage



1. Bolt
2. Washer
3. Clamp
4. Compressor housing
5. Bolt
6. Lockplate
7. Turbine housing
8. Drive screw
9. Nameplate
10. Center housing
11. Impeller locknut
12. Impeller
13. Thrust spacer
14. Thrust collar
15. Shaft wheel assembly
16. Piston snap ring
17. Machine screw
18. Lockplate
19. Thrust plate assembly
20. "O" ring
21. Washer
22. Retaining ring
23. Bearing
24. Backplate
25. Pin
26. Lockwasher
27. Pin

Figure 5-5. Turbocharger Assembly - T-1823 - Exploded View

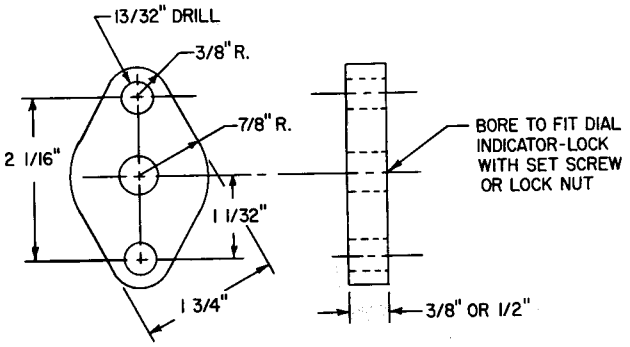


Figure 5-6. Mounting Plate for Attaching Dial Indicator

by hand; the total indicator reading should be between 0.004 and 0.009 inch. If the total indicator reading exceeds 0.009 inch, the cartridge rotating assembly must be repaired or replaced.

5-21. See figure 5-5. To remove the impeller (12) hold the shaft wheel assembly (15) in a suitable fixture. Place an Allen wrench in the Allen screw located in the end of the shaft wheel to hold the shaft from turning while removing the impeller nut (11) from the shaft wheel assembly. Heat the remainder of center housing group (13 through 28) in furnace, oven or oil bath to a temperature of 350° F. to 375° F. (maximum) for not longer than 10 minutes. If a hot oil bath is used, immerse the impeller only. No other form of heating these parts is acceptable.

CAUTION

Use reasonable care to avoid overheating or other damage to impeller vanes.

5-22. See figure 5-5 or 5-15. Disassemble rotating assembly (center housing group) in the sequence shown in the figures. See paragraph 5-23.

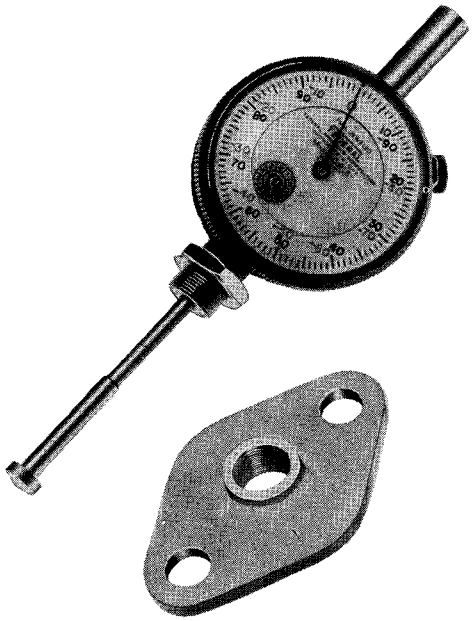


Figure 5-7. Dial Indicator With Extension

5-23. Back Plate Removal (Early models of T-1823). This back plate assembly (26 and 24, figure 5-5) is no longer employed. It has been replaced by a shroud wheel assembly which is clamped to housing. However, for those models still employing the backplate assembly the following procedures may be followed:

a. For overhaul facilities not equipped to machine off plate.

1. Remove center housing (10) from holding fixture ST-133 and secure to table of standard drill press.

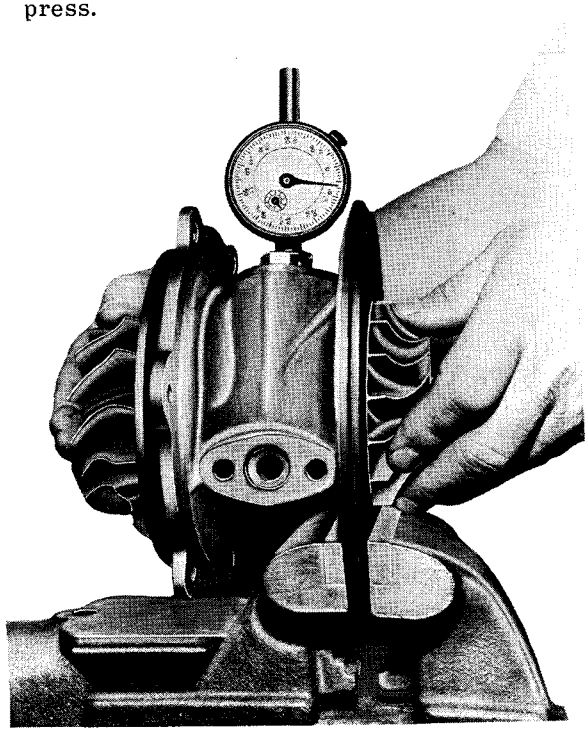


Figure 5-8. Dial Indicator Mounted on Oil Inlet Pad

2. Assemble drill plate, (ST-135) on top of backplate and locate so that drill bushings in the plate are directly over a flat on the hex surface on the bottom of the backplate.

3. Align a 3/8 inch end cutting, end mill (Standard) so that it just touches the threads on backplate. Set stop on drill press so that end mill will pass through hex surface and no more.

4. Position end mill with drill bushing in backplate fixture, and mill both holes to drill press stop.

5. Remove end mill and install standard 3/8 inch drill in drill press spindle. Moving toward the outside of the backplate from the previously drilled holes, drill three more holes in a straight line on both sides of backplate (24).

6. Employing a standard cold chisel, split the back plate by driving the chisel from outside edge of backplate (24) toward the center following line of

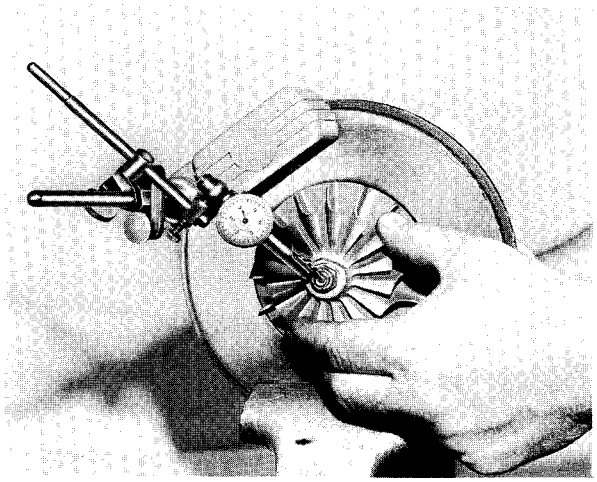


Figure 5-9. Dial Indicator Mounted on Housing

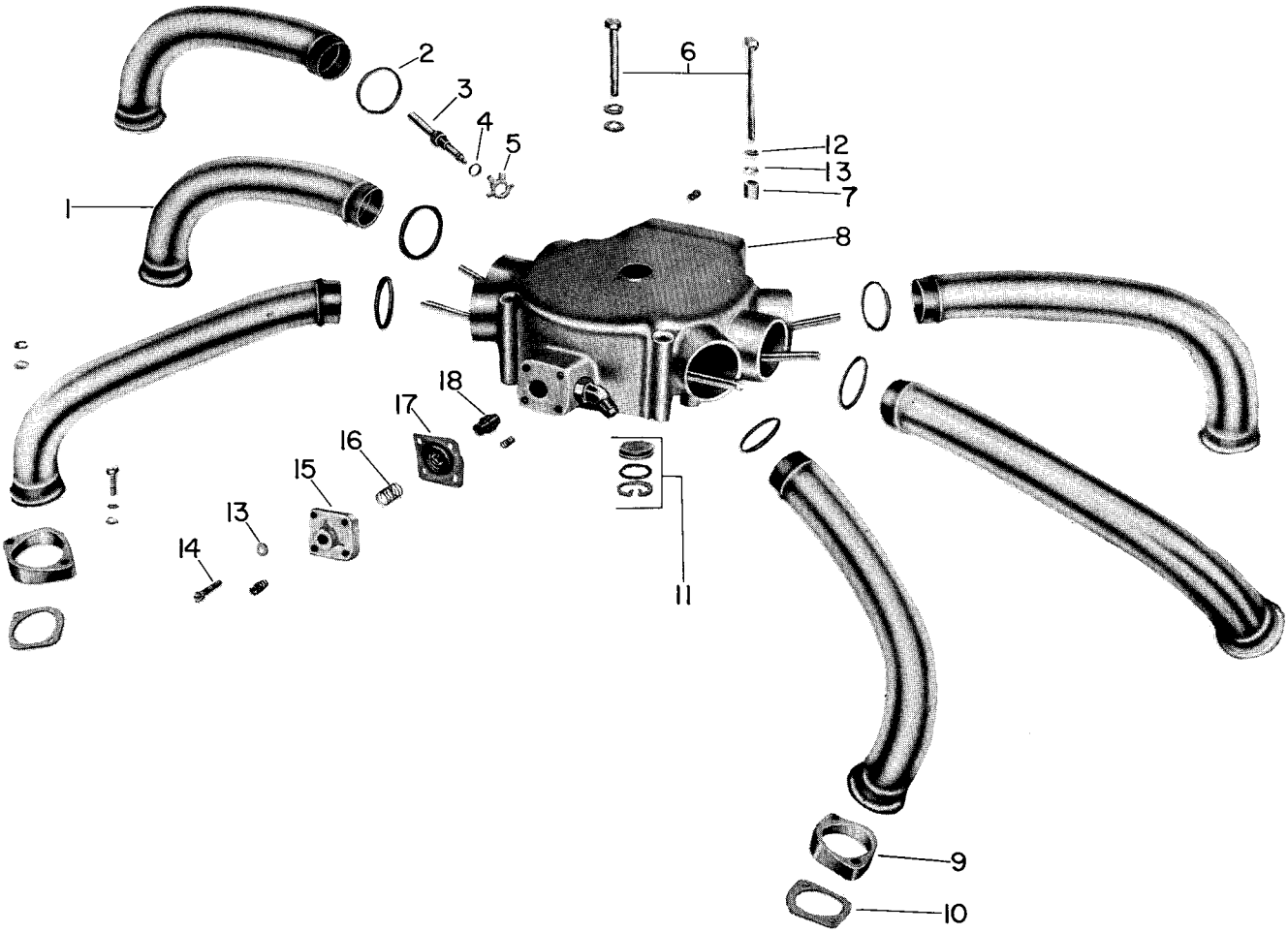
drilled holes. When backplate has been split on both sides, the hex surface on backplate may be turned by a special split type wrench, (ST-134).

7. Secure center housing securely in a suitable fixture, and insert wrench (ST-134) between center housing (10) and backplate (24). This is accomplished by spreading the wrench handles apart. Squeeze the handles together and assemble detail 7 of the wrench over the handles. Tighten adjusting screw securely. This will prevent the handles of wrench from spreading when pressure is applied, thus loosening grip on hex surface.

8. Using a No. 4 Nicholson rawhide hammer (or equivalent), strike wrench handles several sharp blows to loosen backplate (24). When plate is loose, unscrew from center housing and discard. Also, discard the lock plate located under hex surface.

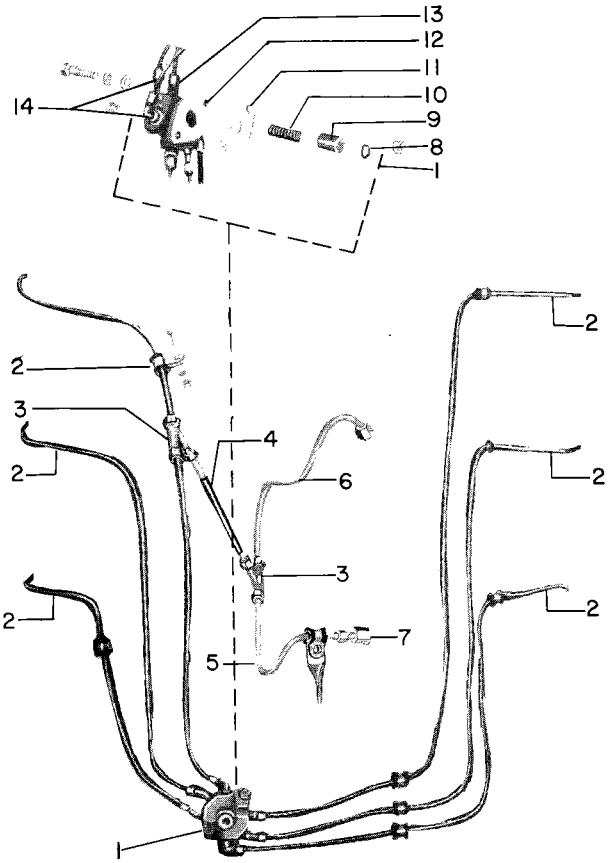
b. For overhaul facilities equipped to machine off backplate,

1. Mount center housing (10) in a three jaw, universal lathe chuck.



1. Intake pipes
2. Seal rings
3. Injector nozzle
4. Seal ring
5. Lockplate
6. Hex head bolts
7. Spacer
8. Induction housing
9. Intake pipe flange
10. Gasket
11. Seat assembly
12. Lockwasher
13. Washer
14. Screw
15. Pressurizing valve cover
16. Pressurizing valve spring
17. Valve and diaphragm
18. Pressurizing valve seat

Figure 5-10. Induction Housing Assembly and Pressurizing Valve



1. Fuel drain check valve assembly
2. Tube assemblies to cylinders
3. Tees
4. Fuel drain between tees
5. Tube (tee to induction housing)
6. Tube (tee to fuel pump)
7. Reducer
8. "O" ring
9. Plunger
10. Spring
11. Gasket
12. Valve housing
13. Nipple
14. Elbows

Figure 5-11. Typical Fuel Drain System

CAUTION

It is imperative that center housing is running true in the chuck, as all machining operations described hereinafter require true running of the housing.

2. Position lathe cutter at center hole in backplate (24), and machining from OD of center hole to OD of backplate remove all metal to face of hex on bottom side of backplate.

NOTE

The cutter must not touch any of the protruding surfaces of the center housing.

3. Reposition the cutter and making horizontal cuts, machine the hex down until merely a thread shell remains.

4. Break remaining thread shell with any suitable tool and remove. Remove and discard lockplate under hex.

CLEANING

5-24. Turbocharger. Before cleaning, visually inspect parts for signs of burning, rubbing or other damage which might not be evident after cleaning.

NOTE

If there is any evidence of failed bearings, the entire unit must be overhauled.

5-25. Soak all parts in clean carbon solvent for 20 to 25 minutes. After soaking use a stiff brush and remove all dirt particles. Dry parts thoroughly with filtered, moisture-free, compressed air at approximately 20 psig.

WARNING

Use cleaning solvent in a well-ventilated area. Avoid breathing fumes. Keep away from open flames.

5-26. Remove all carbon which has deposited in the drain annulus behind the rear bearing strut and back surface of center housing wall. A screwdriver or similar blunt instrument may be used. It is not necessary to completely clean the carbon from the threaded area in the turbine seal. Remove only enough to expose the thread surfaces. Interior surfaces of center housing may be sand blasted or shot peened with glass beads.

5-27. Buff the seal hub and shaft journals lightly with 600 grit paper to remove shellac or carbon deposits.

INSPECTION

5-28. Turbocharger. Parts must show no signs of damage, corrosion or deterioration. Threads must not be nicked, stripped or crossed.

5-29. SHAFT WHEEL ASSEMBLY. Turbine wheel must show no signs of rubbing, and vanes must not be torn or eroded to a feather edge. Shaft must show no signs of scoring, scratches or seizure with bearings.

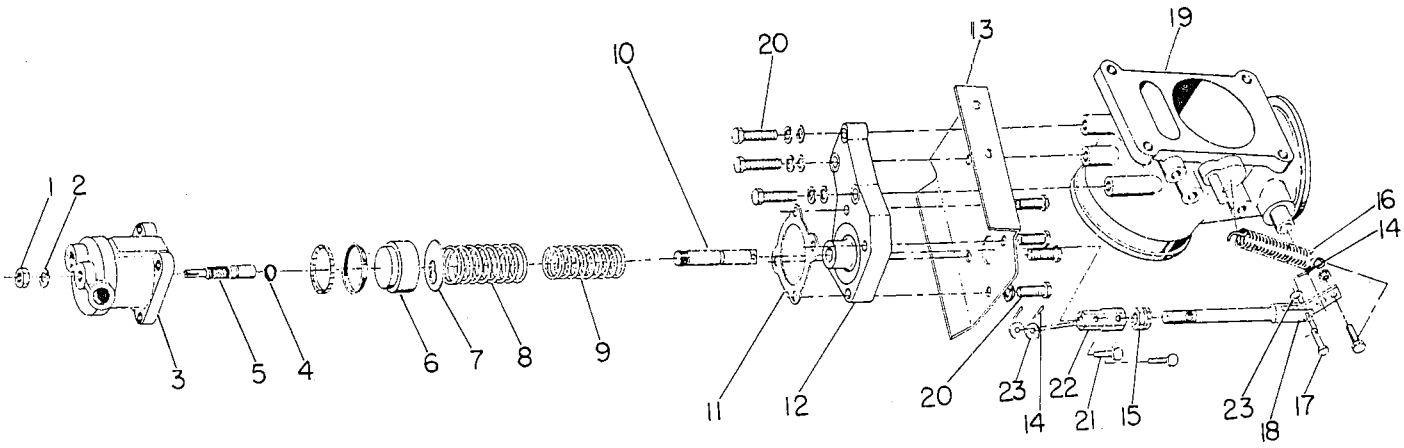
5-30. IMPELLER. Must show no nicks or signs of rubbing, and must be completely free of dirt or other foreign matter. Impeller bore must not be galled.

5-31. SEAL PARTS. Must show no signs of rubbing or scoring on running faces.

5-32. HOUSINGS. Must show no signs of contact with rotating parts. Oil and air passages must be clean and free of obstructions.

REPAIR AND REPLACEMENT

5-33. Turbocharger. Polish or burnish out minor surface damage. Use silicon carbide abrasive cloth for aluminum parts and crocus abrasive cloth for steel parts.



1. Nut
2. Lockwasher
3. Cylinder
4. "O" ring
5. Adjusting screw
6. Piston
7. Shaft retainer
8. Spring
9. Spring
10. Shaft
11. Gasket
12. Plate
13. Heat shield
14. Cotter pins
15. Locknut (TIO-541-A, -E1A4, -E1B4 only)
16. Spring
17. Flat head pin
18. Clevis
19. Bypass valve housing
20. Bolt
21. Flat head pins
22. Turnbuckle
23. Washer

Figure 5-12. Exhaust Bypass Valve - Exploded View

5-34. Replace the following parts: O-rings, lockplates, gaskets and retaining rings. Replace all damaged bolts.

NOTE

If bearings show signs of scores, nicks, shellac deposits, or foreign matter imbedment, replace.

5-35. Turbocharger. Check each part prior to installation to ensure cleanliness. As parts are assembled, cover all openings to prevent entry of dirt or foreign matter.

NOTE

If any foreign particle falls into turbocharger during reassembly, remove particle immediately, even though extensive disassembly is required.

5-36. Lubricate O-rings with a light coat of liquid soap of "Molykote, Type Z" before installation.

5-37. Assemble rotating assembly in reverse order of disassembly. See figure 5-5 or 5-15.

5-38. Lubricate OD of bearings before assembly.

5-39. Orient the center housing assembly to the turbine housing and secure with lockplates and bolts. Tighten to 100-110 inch pounds.

5-40. Orient the center housing to the compressor housing and secure. Note that T-1823 center housing is secured with lockplates and bolts. Apply a thin coat of Felpro (C5-A) or equivalent to bolt threads and tighten to 100-110 inch pounds. The housings of the T-1879 and T-18A21 turbochargers are secured with a v-band coupling.

5-41. TESTING. The turbocharger does not require special tests after overhaul. After unit is reinstalled on engine, follow instructions in following paragraph.

5-42. Immediately prior to mounting the unit, prime the lubrication system as follows: Invert turbocharger, fill center housing with new, clean oil through oil inlet strainer. Turn rotating assembly by hand to coat bearings and thrust washer with oil.

a. Coat threads of attaching bolts or studs with high temperature thread lubricant (Felpro C5A). Secure turbocharger to its mount. Connect ducts and make sure all connections are air tight.

b. Flush oil through oil inlet line and ensure that line is clean and unobstructed. Fill engine and oil inlet line with new, clean lubricating oil, and connect line. Connect oil return line.

5-43. INDUCTION HOUSING ASSEMBLY. See figure 5-10. Remove pressurizing valve assembly. Disassemble and inspect pressurization valve assembly (15-18). Inspect diaphragm for perforations etc. Remove induction housing seat assembly (11) and discard oil seal. Using wrench (ST-190) remove, clean and inspect injector nozzles (3). Discard oil seals (4) and lockplates (5).

5-44. FUEL DRAIN LINE ASSEMBLIES. Disassemble drain lines, clean and inspect. See figure 5-11. Disassemble, clean and inspect check valve assembly (1).

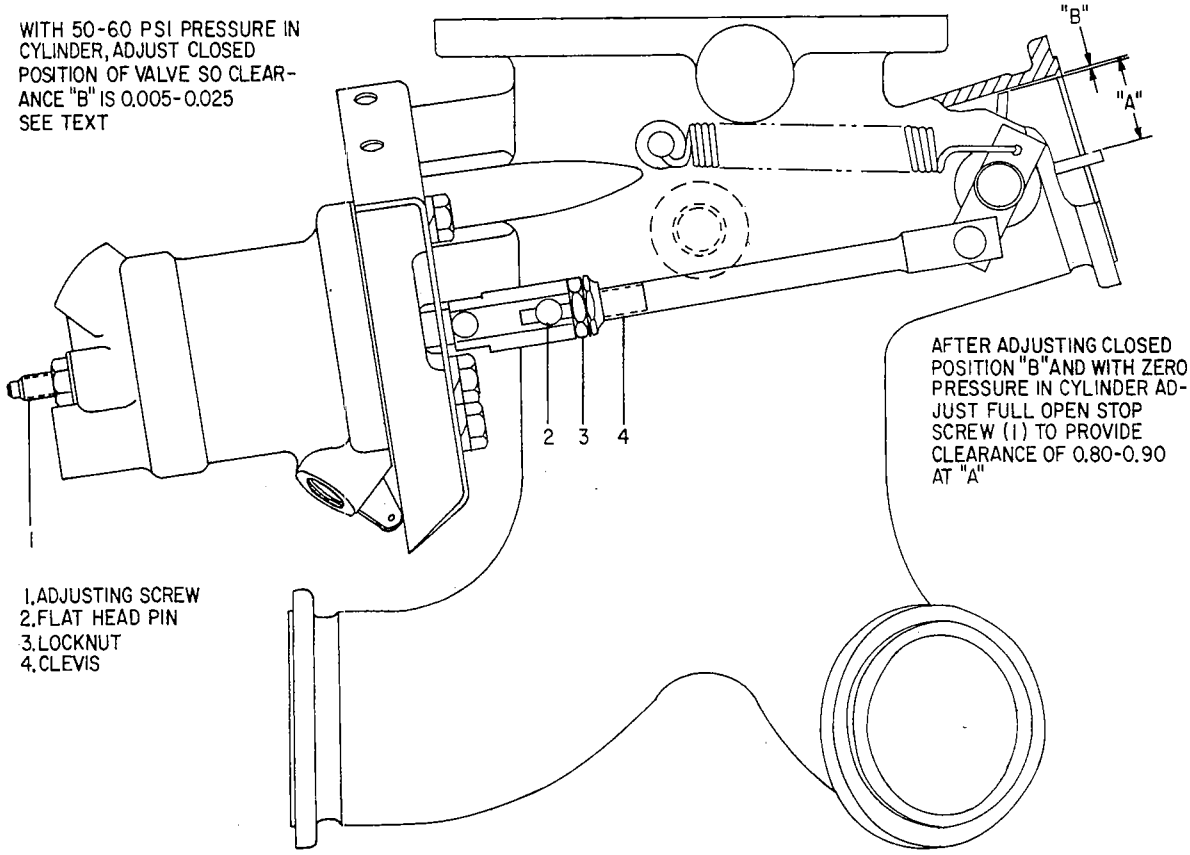


Figure 5-13. Exhaust Bypass Valve - Opened and Closed Positions - TIO-541-A, -E1A4, -E1B4

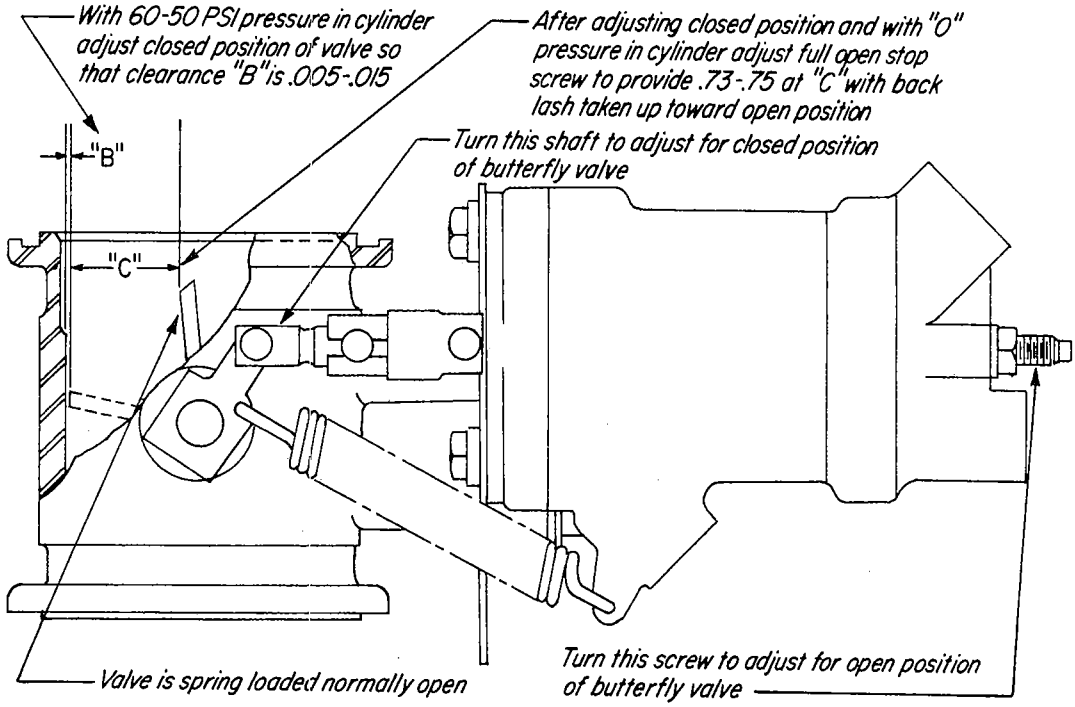
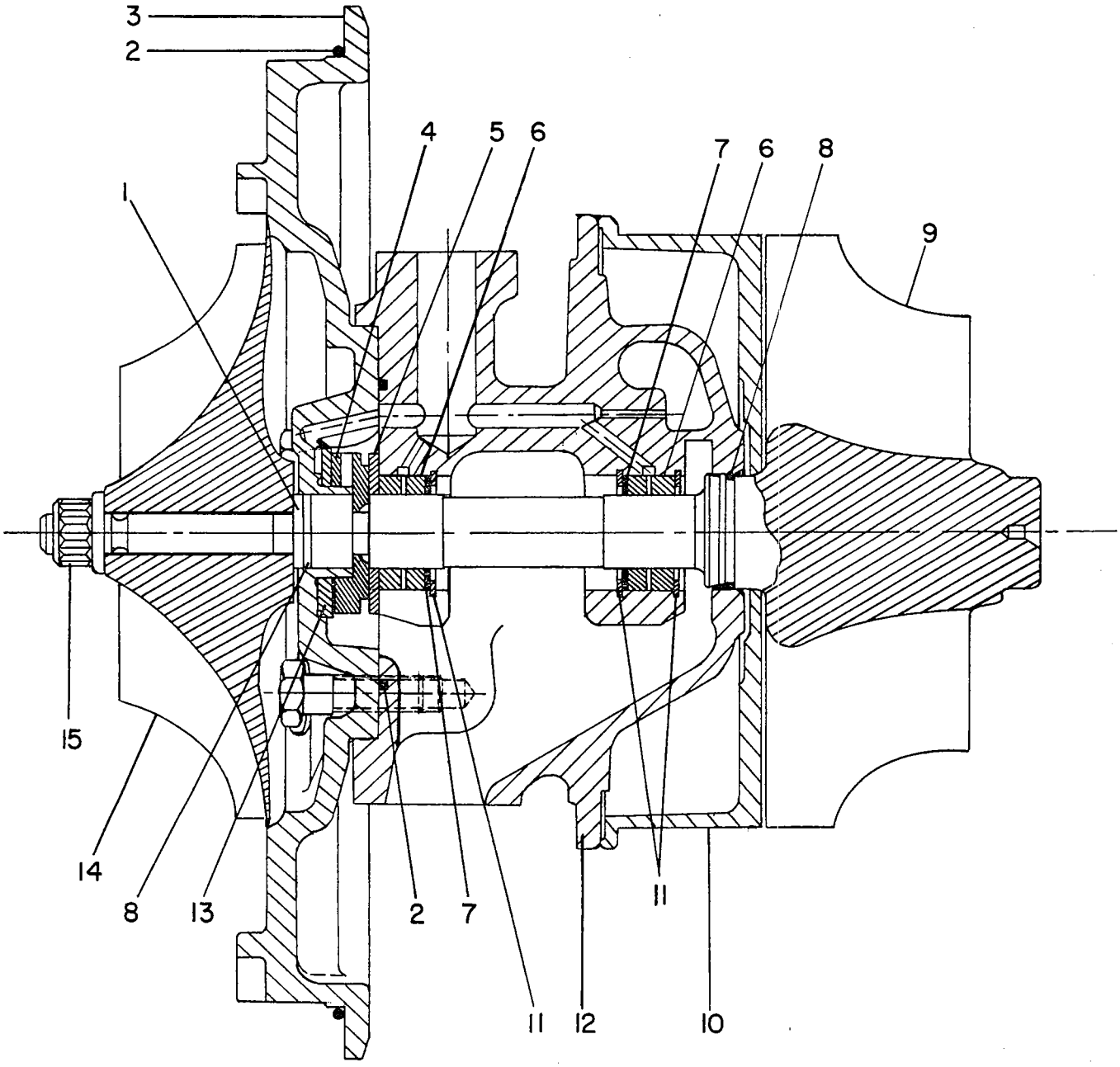


Figure 5-14. Exhaust Bypass Valve - Opened and Closed Positions - TIGO-541, TIO-541-E1C4, -E1D4

5-45. EXHAUST BYPASS VALVE. Although the physical appearance of parts may vary, the disassembly of all subject valves is similar and figure 5-12 will serve to demonstrate. Note that locknut (15) is used only on the type used on the TIO-541-A, -E1A4 and -E1B4. Also the spring (16) is attached on the TIO-541-E1C4, -E1D4 and TIGO-541 and shown in figure 5-14.



1. Thrust spacer
2. "O" ring
3. Backplate assembly
4. Thrust collar
5. Inboard thrust washer
6. Bearing
7. Washer
8. Piston ring
9. Wheel assembly
10. Shroud wheel
11. Retaining ring
12. Center housing assembly
13. *Outboard thrust washer
14. Impeller
15. Locknut

* - Detail part of backplate assembly.

Figure 5-15. Turbocharger Center Housing and Rotating Assembly (T-1879 and T-18A21)

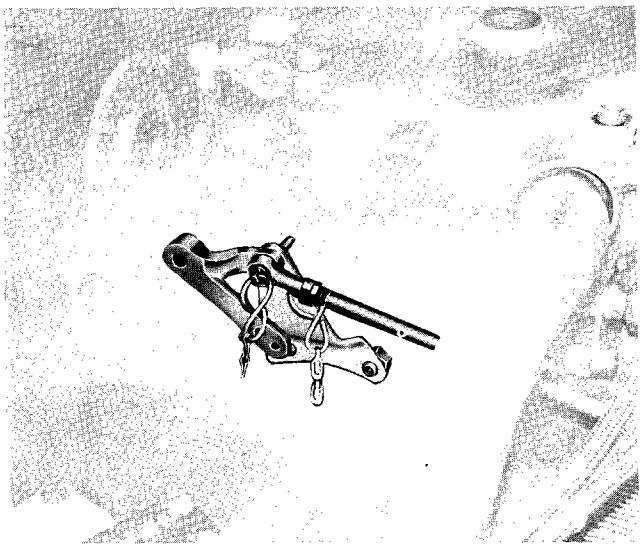


Figure 5-16. Fixture ST-319 Installed and Showing Cross Shaft Lever in Closed Throttle Position.

5-46. See figure 5-12. Remove cotter pins and flat head pins (17) from clevis (18). Leave turnbuckle (22) on shaft (10) to retain internal actuator springs (8 and 9).

5-47. Remove cylinder assembly (3), heat shield (13) with plate (12) from housing (19) and discard gasket (11).

5-48. Remove piston (6) with packing and expander. Discard packing and expander.

5-49. Remove retainer (7) and springs (8 and 9) by compressing retainer and sliding off shaft end slot.

5-50. Remove cotter pins and flat head pins from turnbuckle (22) and shaft (10).

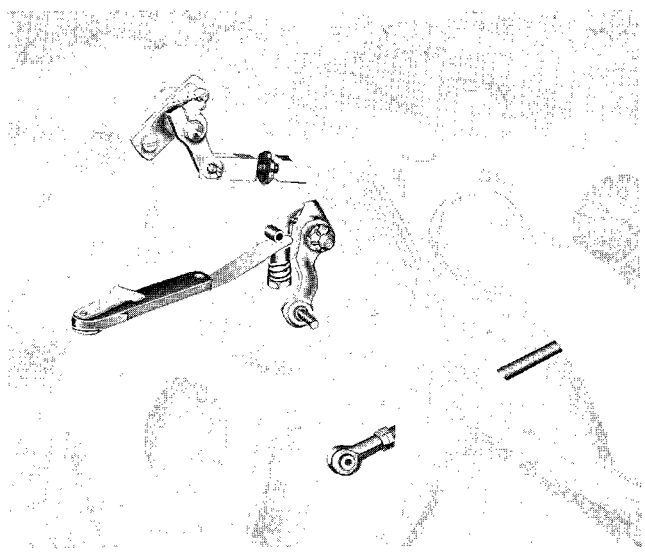


Figure 5-17. Setting Idle Adjusting Screw at Injector Stop Pin.

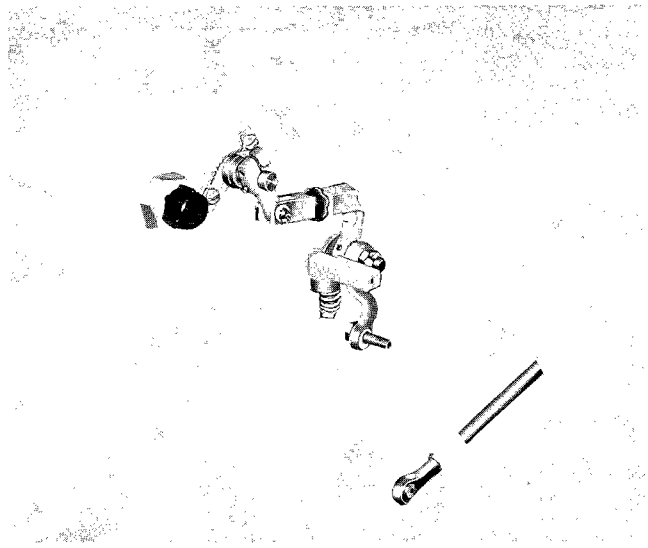


Figure 5-18. Obtaining Clearance of Throttle Lever in Closed Position.

5-51. Remove adjusting screw (5) and discard "O" ring (4).

REASSEMBLY

5-52. Use all new gaskets, "O" rings, packing, expander, cotter pins etc. and any parts that may have been damaged.

5-53. See figure 5-12. Install adjustment screw (5) and "O" ring (4) in cylinder (3).

5-54. Install new packing and expander in piston (6) and using (ST-129) install piston. Lubricate with engine oil. Be sure packing does not fold when inserted.

5-55. Install turnbuckle (22) on shaft (10) and install shaft through plate (12) and attach springs (8 and 9) with retainer (7). Install heat shield (13) to plate.

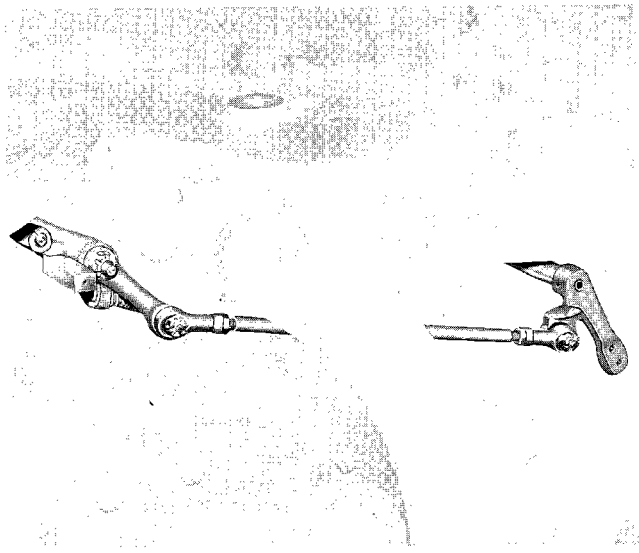


Figure 5-19. Obtaining Clearance of Throttle Lever in Full Open Position.

5-56. Install cylinder assembly to valve body (19) and torque to 60 - 80 inch pounds.

5-57. Assemble clevis (18) to lever arm with flat head pin (17) washer and cotter pin. Fully engage threads of clevis and turnbuckle. Temporarily install flat head pins (21) connecting clevis and turnbuckle.

5-58. (TIO-541-A, -E1A4, -E1B4). Install spring (16) to lever arm and stud. (TIGO-541, TIO-541-E1C4, -E1D4). Install spring (16) to lever arm and boss on actuator.

5-59. See figure 5-13. (TIO-541-A, TIO-541-E1A4, -E1B4). Apply 50 - 60 psi pressure to cylinder and adjust closed position ("B") of the valve by rotating turnbuckle counter-clockwise to fully close the butterfly. Back off turnbuckle clockwise until clearance "B" is 0.005 - 0.025 inch. Insert pins (2), and secure with cotter pins. Tighten lockbut (3) to 80 - 100 inch pounds.

5-60. With zero pressure in the cylinder adjust the full open stop position, with the adjusting screw (1) to provide clearance of 0.80 - 0.90 inch at "A". Tighten locknut to 60 - 80 inch pounds.

5-61. (TIO-541-E1C4, -E1D4, TIGO-541). See figure 5-14. With 50 - 60 psi pressure to cylinder adjust closed position of the valve by rotating turnbuckle counter-clockwise to fully close the butterfly. Back off the turnbuckle until clearance is 0.005 - 0.015 inch. Insert pins and secure with cotter pins.

5-62. With zero peessure in the cylinder adjust the open stop position by turning the adjusting screw to provide clearance of 0.73 - 0.75 inch.

5-63. For procedure to disassemble, overhaul, calibrate and reassemble the variable pressure controller consult AiResearch Industrial Division Publication No. TP-21.

FINAL ASSEMBLY

5-64. See figure 5-10. Reassemble injector nozzles (3) using new oil seal (4) and lockplate (5). Employ wrench (ST-190) for tightening nozzles. Reassemble pressurization valve assembly in housing. Secure housing (8) to the crankcase with four hex head bolts (6), washers and spacer. Assemble intake pipes (1).

5-65. See figure 5-4. Install gasket and fuel injector (10) to induction housing (12). Assemble gasket and adapter assembly (3) to the fuel injector. Install variable pressure controller (5) to housing. Place hose clamp on adapter housing.

5-66. Install tube assemblies (2 and 1) figure 5-4 and install control shaft assembly (14). Install the connecting rods in the following manner:

5-67. Remove injector connecting rod from both the cross shaft control lever and the throttle lever.

5-68. Position the cross shaft control lever using fixture ST-319 thus: Mount the fixture over no. 4 cylinder hold down 3/8 inch studs and nuts. Secure with two (P/N 383-B) nuts. If unable to secure with nuts because of insufficient thread, hold the fixture by hand. The fixture in position is shown in figure 5-16.

5-69. Back off idle stop adjusting screw until it just touches the injector stop pin when the throttle butterfly is fully closed. Check clearance with a piece of shim stock or an .0015 inch feeler gage. See figure 5-17.

5-70. Place gage (ST-318) over injector stop pin with side marked ".040" down and between pin and end of idle stop adjusting screw. Do not turn from full closed setting at this time. See figure 5-18.

5-71. Align hole in ball end of injector connecting rod, hole in cross shaft control lever and hole in fixture. Insert fixture pin through all three holes. See figure 5-16. With throttle lever held firmly against gage on injector, adjust the connecting rod length (maintaining approximately equal thread engagements on both ends) and attach to throttle lever. Remove fixture (ST-319) and attach injector connecting rod to the cross shaft control lever. Remove gage (ST-318).

5-72. Replace gage (ST-318) on injector stop pin with the side marked ".025" up. This is the desired clearance between the pad of the throttle arm and the injector stop pin with the throttle lever in full open position. Move cross shaft control lever forward to put injector throttle lever in full open position and maintain a constant pressure between the throttle arm pad and the gage while completing the following step. See figure 5-19.

5-73. Remove the controller connecting rod at the controller end. Push the controller arm against the full boost stop pin (forward). See figure 5-20. With the controller arm in this position and the throttle lever in the position obtained in the preceding step, adjust the controller connecting rod (maintaining approximately equal thread engagement on both ends) to match hole locations in both the controller arm and the connecting rod. Attach the connecting rod to the controller arm and remove the gage from the injector stop pin. See figure 5-21.

5-74. Install the sonic nozzle assembly (4, figure 5-4) on those models employing this feature.

5-75. TIO-541-A. See figure 5-1. Install magneto baffle (12) and turbocharger bracket (11). Install turbocharger. Assemble exhaust bypass assembly (9) to turbocharger intake. Assemble exhaust manifold assembly to exhaust ports. Note that the two gaskets are assembled with the flat sides toward the cylinder port and the raised interlocking face sides facing the manifold. Assemble gaskets and secure the manifold assembly to the exhaust bypass valve assembly with Marman clamps (8).

5-76. TIO-541-E1A4, -E1B4. See figure 5-2. Assemble the oil hose (14) to crankcase. This is easier to install before the brackets and supports are assembled.

5-77. Assemble turbocharger bracket (4) to crank-

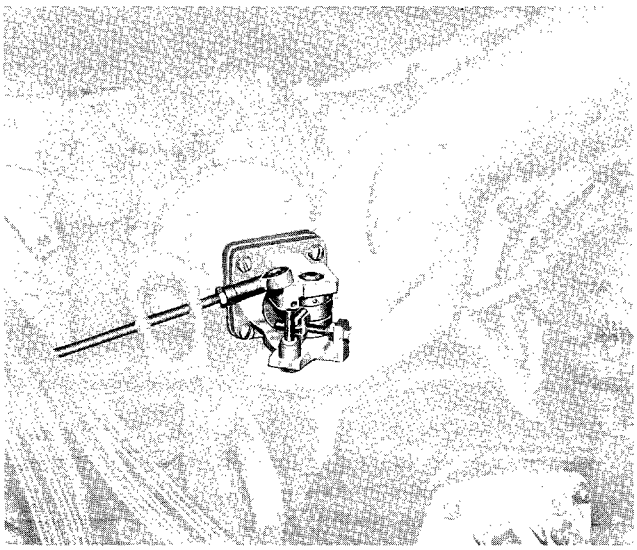


Figure 5-20. View Showing Controller Arm in Full Boost Position

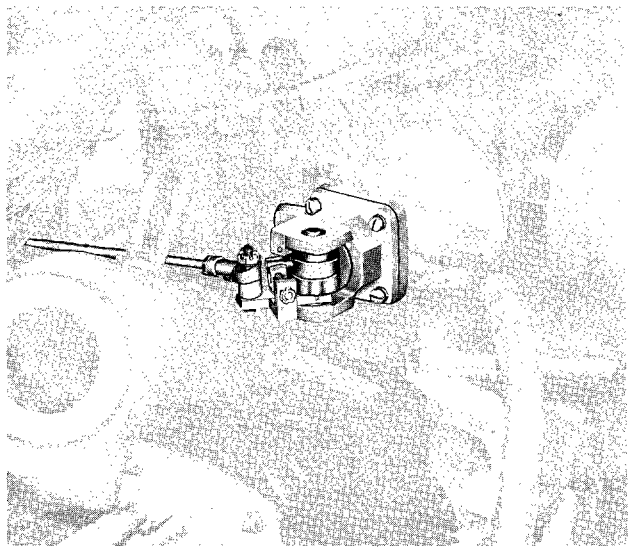


Figure 5-21. View Showing Connecting Rod Secured to Controller Arm in Full Boost Position

case. Assemble turbocharger and compressor support (13), compressor mounting bracket (15) and turbocharger and compressor (12) to the crankcase.

5-78. Reinstall struts in the reverse order as disassembled from the turbocharger assembly. Position the turbocharger assembly with the compressor outlet entering the hose (11) and the compressor wheel housing into the bracket (12). Fasten all struts and supports.

5-79. Assemble exhaust bypass valve assembly (5) to the turbine inlet. Assemble hose (14) to actuator. Assemble hose (20) from actuator to turbine oil inlet. Fasten hose connecting turbine oil drain (6) to crankcase.

5-80. Assemble exhaust manifolds in the same manner as described in paragraph 5-75.

5-81. TIGO-541, TIO-541-E1C4, -E1B4. See figure 5-3. Assemble the turbocharger, transition assembly, exhaust bypass valve and exhaust manifolds in reverse order of disassembly.

5-82. PRESSURIZATION VALVE SEAT. The pressurization valve seat is removed and replaced in the following manner.

a. Tap valve seat with a 3/8-24 tap.

b. Insert a 3/8-24 x 2-1/4 inch bolt through a socket and screw into the threaded hole in seat. Tighten bolt against socket until seat is removed.

c. Place a new pressurization valve seat in the driver, fabricated as shown in figure 5-22 and drive to a firm seat in the housing.

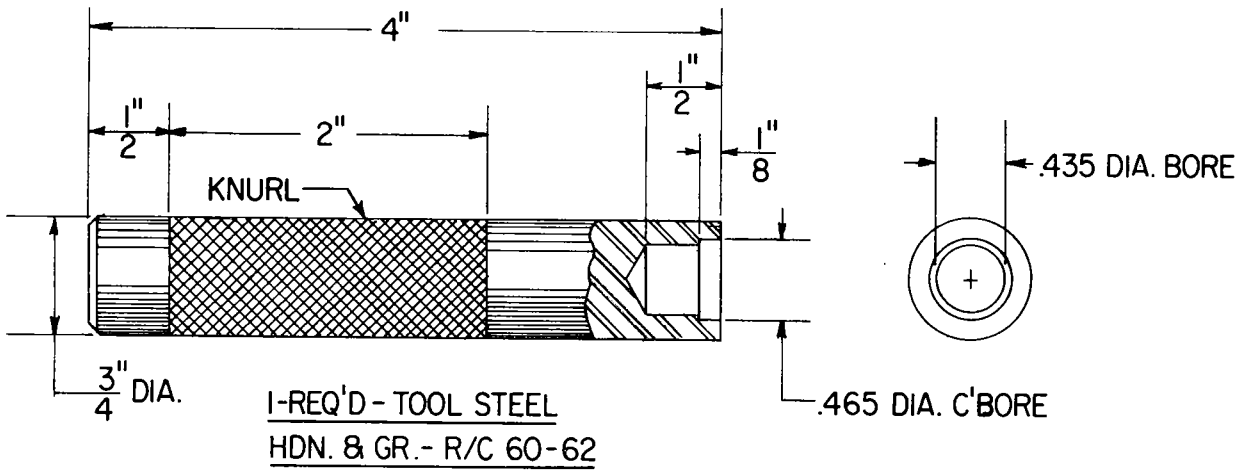


Figure 5-22. Driver - To Install Pressurization Valve Seat

SECTION 6.
LUBRICATION SYSTEM

6-1. For purposes of this manual the lubrication system will consist of the oil sump assembly, oil pump, oil filter and oil cooler.

REMOVAL FROM ENGINE

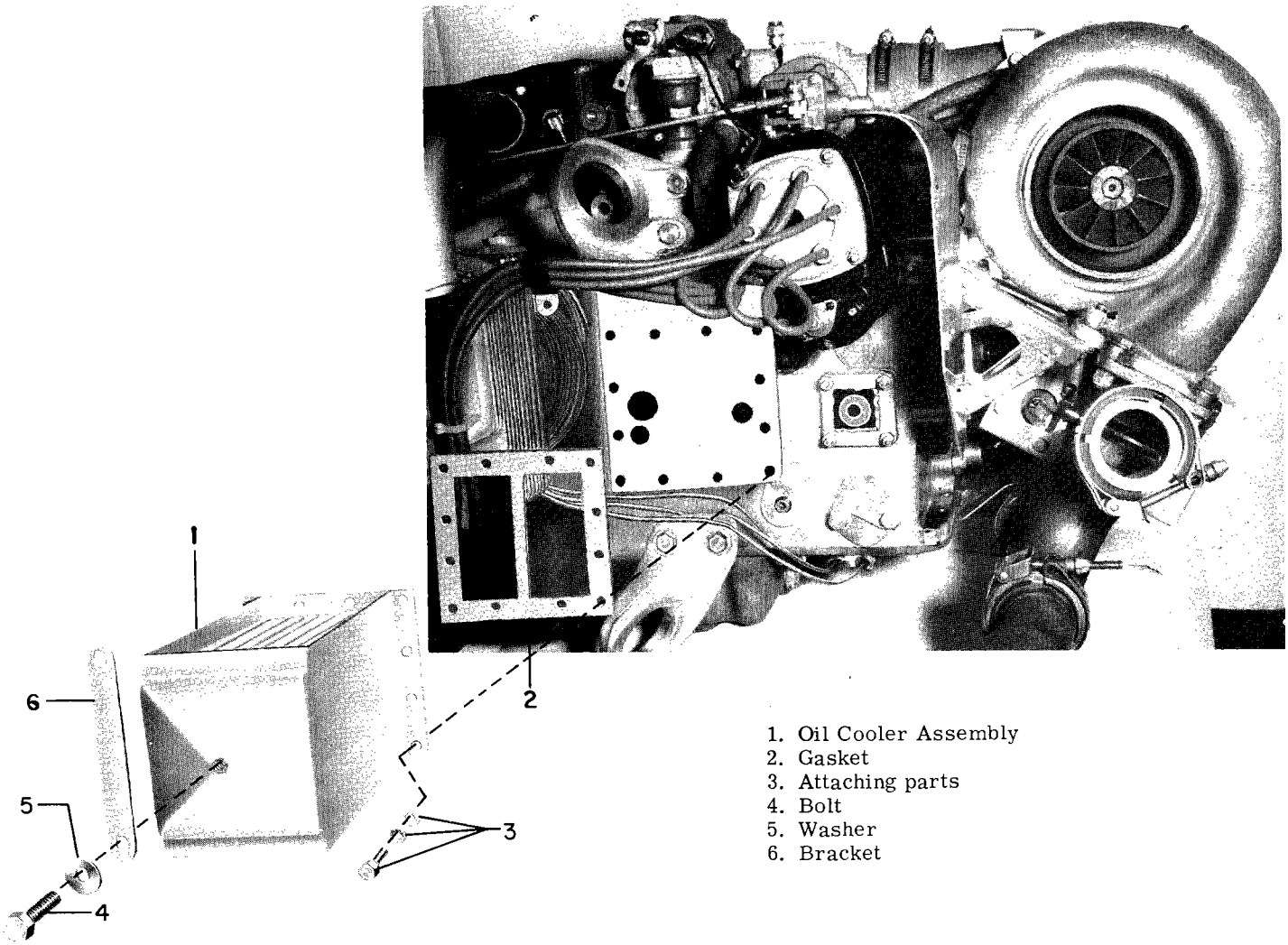
6-2. Oil Cooler (TIO-541-A Series). See figure 6-1. Remove the hex head bolt (4) washer (5) and bracket (6). Remove the attaching parts (3) and remove the oil cooler assembly (1) and gasket (2).

6-3. Oil Cooler (TIO-541-E). See figure 6-2. Remove the oil cooler damper assemblies (1 and 9) from the oil cooler and cylinder head. Remove the oil cooler heat shield (8) and remove the oil cooler (7), gasket (2), oil cooler spacer assembly (3) and gasket (4).

6-4. Oil Filter and Adapter Assembly (TIO-541-A). See figure 6-3. Remove the oil filter and adapter assembly (7) by removing the three hex head bolts and 1/4 inch nut securing it to the crankcase. Discard the gasket (10).

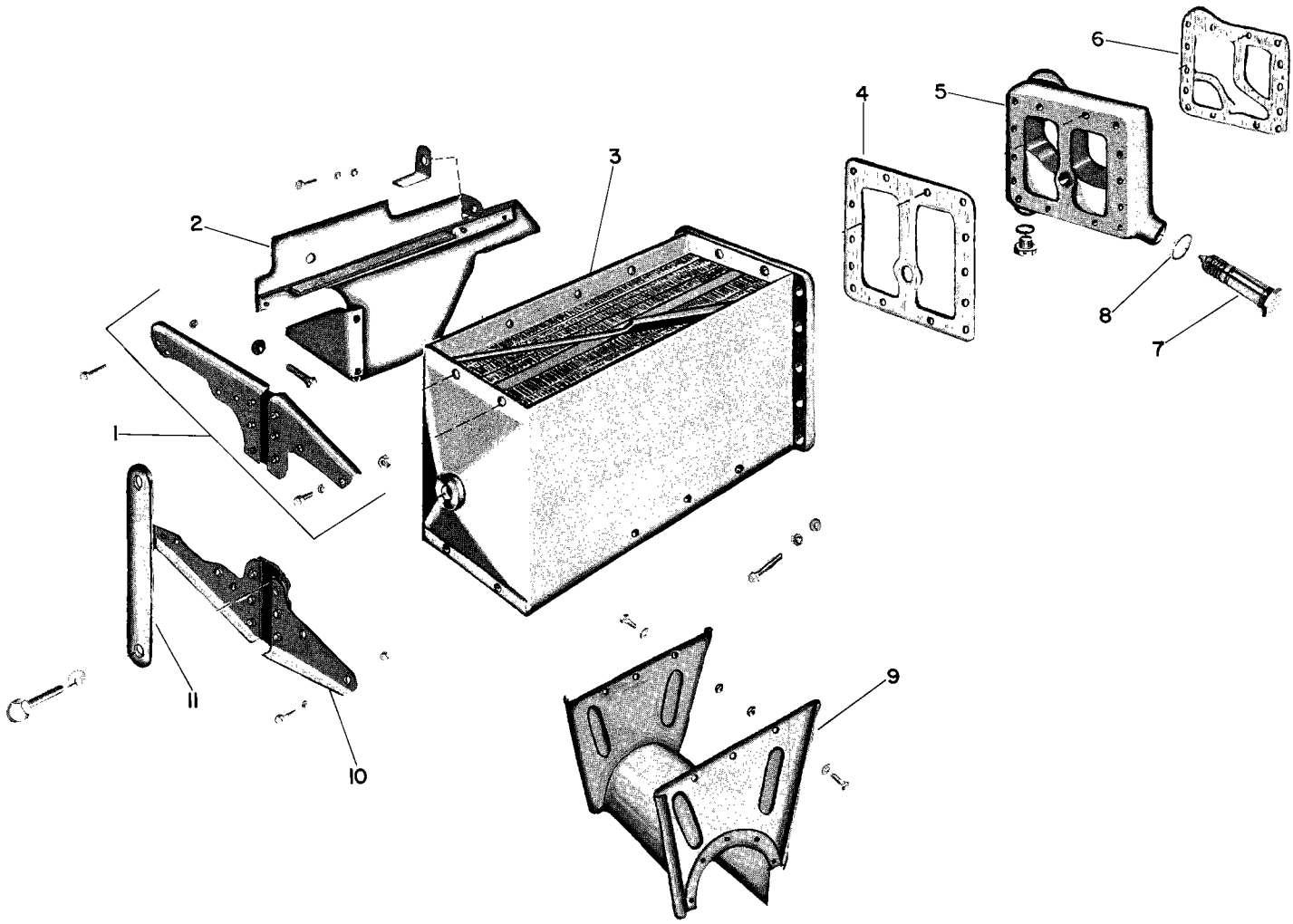
6-5. Oil Filter and Oil Filter Housing Adapter (TIO-541-E, TIGO-541-E). See figure 6-4. Remove the oil filter assembly (2) and housing (1) by removing the three hex head bolts and 1/4 inch nut securing it to the crankcase. Discard the gasket (11).

6-6. Oil Sump. See figure 6-5 (TIO-541-E). Remove the oil suction screen cover (21), gaskets (20-18) and screen (19).



1. Oil Cooler Assembly
2. Gasket
3. Attaching parts
4. Bolt
5. Washer
6. Bracket

Figure 6-1. Oil Cooler Assembly (TIO-541-A Series)



1. Damper assembly
2. Baffle
3. Oil cooler
4. Gasket
5. Spacer
6. Gasket
7. Temperature valve
8. Gasket
9. Heat shield
10. Damper assembly
11. Ignition lead support

Figure 6-2. Oil Cooler Assembly (TIO-541-E Series)

6-7. All Models. Remove the bolts securing the sump to the crankcase and lift away from the crankcase.

6-8. Oil Pump. See figure 6-5. It is assumed that the tachometer drive shaft (9) (where applicable) and the camshaft gear baffle (2) have been previously removed.

6-9. (TIO-541-E). Remove the oil suction tube assembly (17) and gasket (16) from the oil pump.

6-10. All Models. Turn the camshaft gear (1) so that the slot in the gear is in a horizontal position. Cut the lockwire and remove the 5/16 inch bolts (12) and disengage the oil pump driveshaft from the slot in the camshaft gear. The entire assembly can now be removed.

DISASSEMBLY

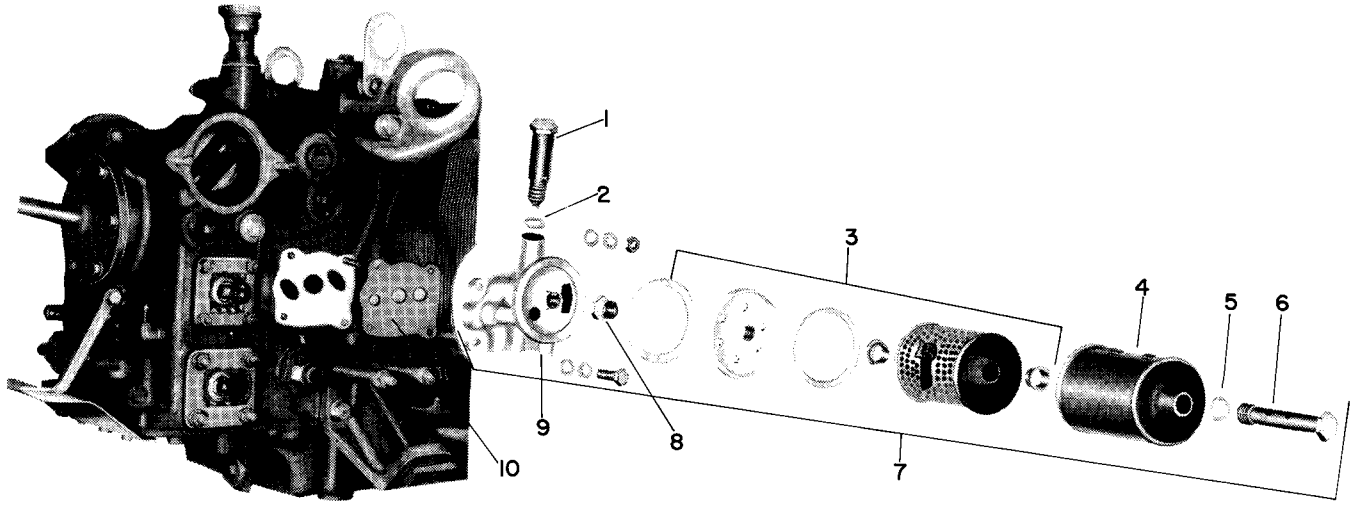
6-11. Oil Cooler. See figure 6-2. No disassembly of the oil cooler is required other than the removal of the oil cooler temperature control valve (6) and gasket (5) from the oil cooler spacer (3) employed on the E series.

6-12. Oil Filter (TIO-541-A). See figure 6-3. Remove the oil cooler temperature by-pass valve (1) and gasket (2). Loosen the center stud (6) attaching the filter assembly to the adapter (9). Discard the replacement assembly (7) and gasket (10).

6-13. Oil Filter (TIO-541-E, TIGO-541-E). See figure 6-4. Remove the oil pressure relief valve assembly (7, 8, 9 and 10). Loosen the bolt assembly (4) attaching the filter assembly to the housing (1) and discard the replacement assembly (6) and gasket (11).

6-14. Oil Sump (TIO-541-A, TIGO-541-E). See figure 6-5. Remove all plugs and the oil seal (28). Remove the oil suction screen assembly (25, 26 and 27). Discard oil seal and gaskets.

6-15. Oil Sump (TIO-541-E). See figure 6-5. Remove all plugs. Remove cover (21), gaskets (18 and 20) and screen (19).



1. Temperature control valve
2. Gasket
3. Replacement element assembly
4. Oil filter housing
5. Gasket
6. Center stud
7. Oil filter and adapter assembly
8. Plug
9. Adapter assembly
10. Gasket

Figure 6-3. Oil Filter and Oil Cooler Bypass Temperature Control Valve (TIO-541-A Series)

6-16. Oil Pump. See figure 6-5. Remove the hex head bolts securing the cover (8) to the body (5). Note that the impellers (7 and 13) will be loose in the body, remove the impellers. Remove the cotter pin (4) from the oil pump idler shaft (15) and remove the idler shaft from the body. Pull the drive shaft (3) from the body.

CLEANING

6-17. Clean all parts in accordance with the general instructions outlined in Section 3.

INSPECTION

6-18. Inspect all parts in accordance with the general instructions outlined in Section 3.

REASSEMBLY

6-19. Oil Cooler (TIO-541-A). See figure 6-1. Assemble the oil cooler assembly (1) and gasket (2) and secure to the crankcase with twelve bolts, lockwashers and washers (3). Attach the ignition lead support (6) lockwasher (5) and secure with bolt (4).

6-20. Oil Cooler (TIO-541-E). See figure 6-2. Assemble the oil cooler temperature control valve (6) into the oil cooler spacer (3) using a new gasket (5). Install the oil cooler spacer gasket (4) oil cooler spacer (3), oil cooler gasket (2) and oil cooler assembly (7) on the mounting pad. Install the heat shield (8) and the upper and lower damper assemblies (1 and 9).

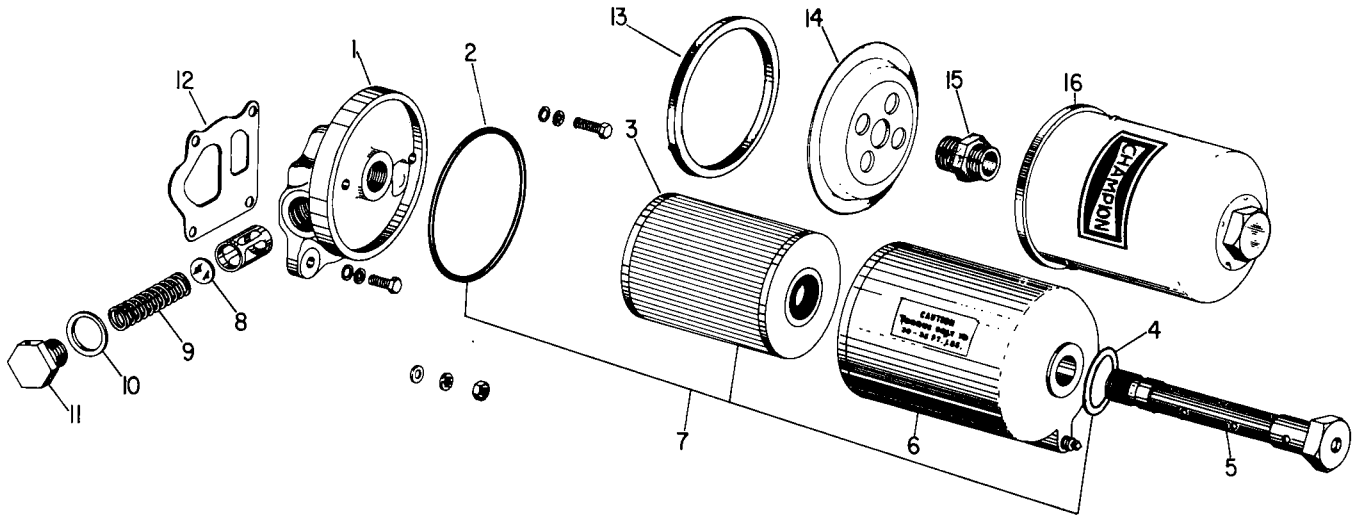
6-21. Oil Filter (TIO-541-A). See figure 6-3. Assemble oil cooler bypass temperature valve (1) into the adapter (9) using a new gasket (2). Assemble oil filter replacement element package (3) into housing (4) and secure the assembly to the adapter, using a new gasket (5), with the center stud (6). Tighten center stud to 20-25 foot lbs. torque. Place a new gasket (10) on the mounting pad and secure the oil filter and adapter assembly to the crankcase.

6-22. Oil Filter (TIO-541-E, TIGO-541-E). See figure 6-4. Assemble the oil pressure relief valve seat (8), valve spring (9), gasket (10), and plug (11) in the oil filter housing adapter (1). Place a new housing adapter gasket (12) on mounting pad and install the oil filter housing adapter (1) on crankcase. Install "O" ring seal (2) on the recess at the open end of the filter housing (6). Place the filter bolt assembly (5) using a new copper gasket (4) in the filter housing. Place filter element (3) over bolt and install on filter housing adapter. Tighten filter bolt to 30-35 foot pounds torque.

NOTE

On the TIO-541-E and TIGO-541-E some of the earlier model engines were manufactured without the recess machined at the open end of the oil filter housing. Therefore: the "O" ring seal and aluminum retaining ring must be used. For more information concerning the oil filter seal consult Service Bulletin No. 397.

The TIO-541-E and TIGO-541-E may be equipped with the spin-on filter as described in Service Instruction No. 1319. The converter plate gasket (13) must be replaced at time of overhaul. The gasket should be cemented onto the converter plate (14) with 3M Industrial Adhesive No. 847 or equivalent. Install the converter plate (14), converter plate stud (15) on the



1. Filter housing adapter
2. "O" ring seal
3. Filter element
4. Copper gasket
5. Bolt assembly
6. Filter housing
7. Replacement element kit
8. Relief valve seat
9. Relief valve spring
10. Gasket
11. Relief valve plug
12. Housing adapter gasket
13. Converter plate gasket
14. Converter plate
15. Converter stud
16. Spin-on filter

Figure 6-4. Oil Filter Assembly (TIO-541-E, TIGO-541-E)

oil filter housing adapter. Tighten stud to 50-60 foot pounds torque. Lubricate the spin-on oil filter (16) with clean engine oil and install on converter plate stud. Tighten filter to 18-20 foot pounds torque. Do not exceed the maximum torque of 20 foot pounds.

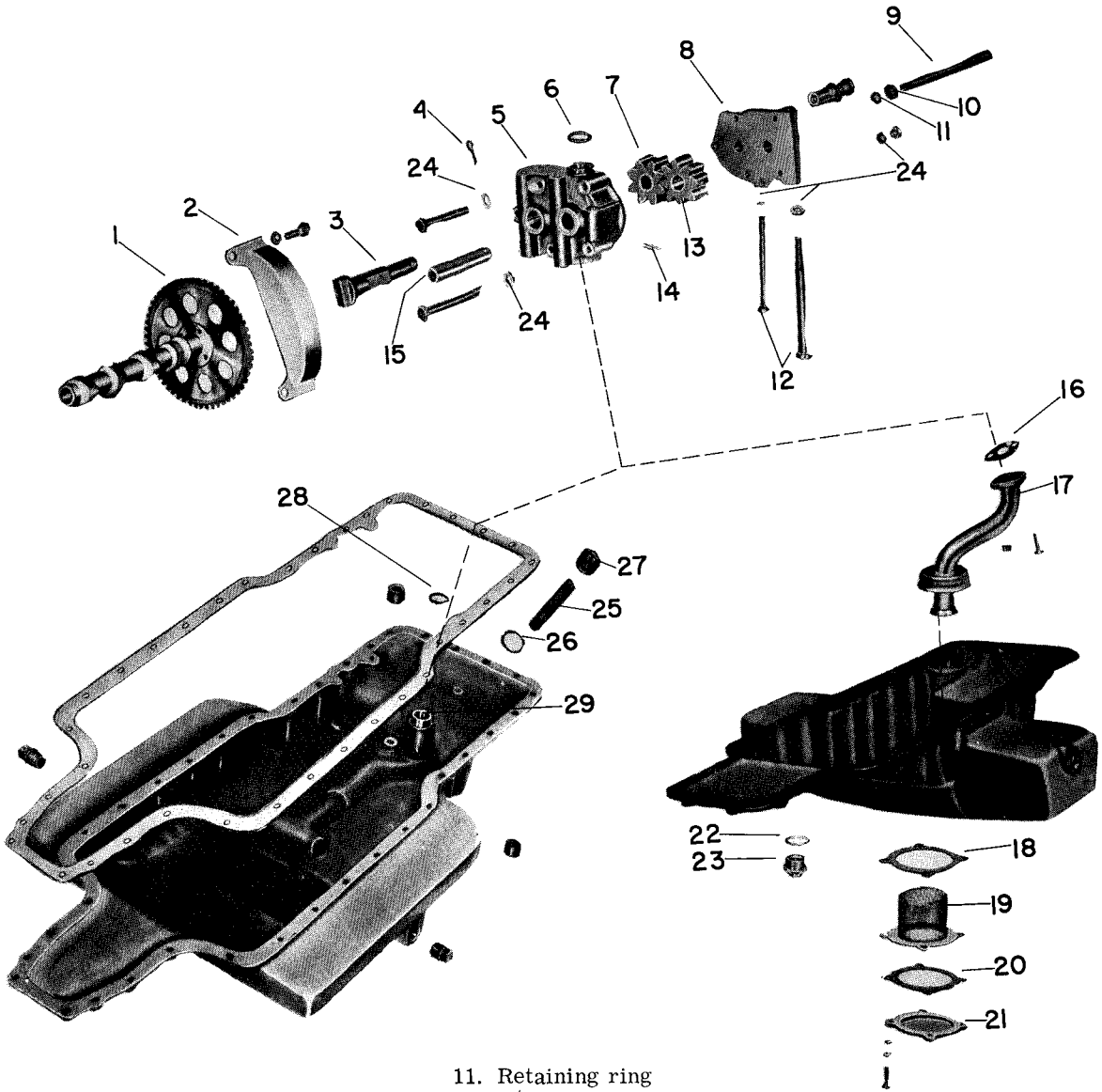
6-23. Oil Pump (All Models). See figure 6-5. Assemble a new oil seal (6) into the pump body (5). Install the idler shaft (15) into the body and assemble the cotter pin (4). Install the drive shaft (3) into the body and assemble the driving impeller (7) over the oil pump drive shaft (3) and the driven impeller (13) over the idler shaft (15) meshing the impellers. Place the cover (8) on the body assembly and secure with bolts and lockwire. Turn the camshaft gear (1) until the slot in the gear is in a horizontal position and engage the drive shaft (3) into the slot.

6-24. (TIO-541-A, TIGO-541-E). Secure the oil pump assembly to the case using the three 5/16 inch hex head bolts (12) and lockwire.

6-25. (TIO-541-E). Assemble a gasket (16) on the oil suction tube assembly (17). Assemble a sleeve (24) on the longest of the hex head bolts (12) and install this assembly through the larger hole in the oil tube assembly flange. Note that the bolt and sleeve assembly must be installed from an off center position. Attach the bolt to the oil pump assembly and complete securing the tube assembly with a 1/4-20 hex head bolt through the second hole in the flange. Install the other two 5/16 inch bolts (12) securing the oil pump assembly to the case and lockwire.

6-26. Oil Sump (TIO-541-A, TIGO-541-E). Assemble the oil suction screen assembly (25, 26 and 27) and all plugs. Install an oil seal (28) over the oil pump inlet dowel (29). Assemble the sump assembly to the crankcase.

6-27. (TIO-541-E). Install all plugs that were removed at disassembly and secure the sump assembly to the crankcase. Assemble a gasket (18) over the oil suction screen (19) and install the screen through the pad in the sump and into the oil suction tube assembly (17), be certain the screen is not distorted when entering the flange of the tube assembly. Assemble the gasket (20) and cover (21) on the pad.



1. Camshaft gear
2. Camshaft gear baffle
3. Oil pump drive shaft
4. Cotter pin
5. Oil pump body
6. Oil seal ring
7. Driving impeller
8. Oil pump cover
9. Tachometer drive shaft
10. Thrust washer
11. Retaining ring
12. 5/16-18 hex head shaft
13. Driven impeller
14. Dowel
15. Oil pump idler shaft
16. Gasket
17. Oil suction tube
18. Gasket
19. Oil suction screen
20. Gasket
21. Cover
22. Gasket
23. Plug
24. Washer
25. Oil suction screen
26. Gasket
27. Plug
28. Oil seal ring
29. Oil pump inlet dowel

Figure 6-5. Oil Pump and Oil Sump Assemblies

SECTION 7.
CYLINDERS, PISTONS AND VALVE TRAIN

7-1. The piston, being a reciprocating part, is normally grouped with the crankshaft in the theoretical breakdown of the engine into basic components. However, from a practical standpoint and for purposes of this manual, it is felt that the piston should be considered with the cylinder insofar as overhaul procedures are concerned. The basic configuration of the engine requires the removal and reassembly of the pistons at the same time the cylinders are removed or replaced.

7-2. Also, for the purposes of this manual, the valve train will be considered as all parts of the valve operating mechanism beyond the camshaft beginning with the hydraulic lifter assembly.

7-3. Although the cylinder assemblies on the various models differ, basic overhaul procedures are the same for all cylinder assemblies. The overhaul procedures described in this section will be applicable to all engines except as noted.

REMOVAL FROM ENGINE

7-4. At this point it is assumed that the intake pipes, exhaust manifolds, ignition harness, spark plugs, oil drain back tubes, fuel drain lines and exhaust valve guide oil lines (where applicable) have been removed.

7-5. Remove the fuel drain line nipples and exhaust valve guide oil line connectors, tees and elbows (where applicable). Using the intercylinder baffle tool (64885) turn the baffle retaining hook so that it disengages the retainer. Remove the intercylinder baffle and hook from between the cylinders.

7-6. CYLINDERS. See figure 7-1. Remove rocker box cover (19) and gasket (17). Also the rocker shaft covers (26) and gaskets.

7-7. Rotate the crankshaft to place the piston at top center of the compression stroke. With the piston in this position both valves are closed and the piston is extended away from the crankcase to avoid damage when the cylinder is removed.

7-8. Push the valve rocker shafts outward sufficiently to allow clearance for the removal of the valve rockers (15) and thrust washers (20). Remove the rotator cap (22) from the exhaust valve stem. Remove the push rods (23) by grapsing and pulling from the shroud tubes (27). Turn each shroud tube 90° in either direction, this will release the detent on the shroud tube from the spring. Remove the tubes by first removing them from the seal seats in the cylinder head and then withdrawing from the crankcase retainers. Remove the seals (25) and sleeves (24) from the cylinder head end and the seals from the crankcase. Place washers (30), spring (31) and sleeves (24) in a safe location and discard the seals.

7-9. Remove the cylinder base hold down nuts (4 and 5) and remove the cylinder by pulling directly away from the crankcase. Catch and hold the piston as it leaves the cylinder. Remove the rocker shafts (21) from the cylinder head and discard the oil seal ring (1). Set the cylinder aside for further disassembly.

7-10. PISTON. See figure 7-2. Remove the piston pin plugs (5) from the piston pin (4) and with the aid of the piston pin puller (64843) pull pin from piston and remove piston.

NOTE

The connecting rod must be supported to prevent damage to the rod and the crankcase. Figure 7-3 shows two methods of supporting the rods.

7-11. HYDRAULIC LIFTERS. See figure 7-1. Remove the shroud tube adapter (29) and gasket from the crankcase and remove the hydraulic lifter assembly (29) from the crankcase.

NOTE

The valve rockers, hydraulic lifters and push rods must be replaced in the same location from which they were removed.

DISASSEMBLY

7-12. CYLINDERS. See figure 7-1. Place cylinder over the holding block (64526-2), assemble valve spring compressor (ST-266) on cylinder, and compress valve springs (11 and 12) far enough to remove the retaining keys (14).

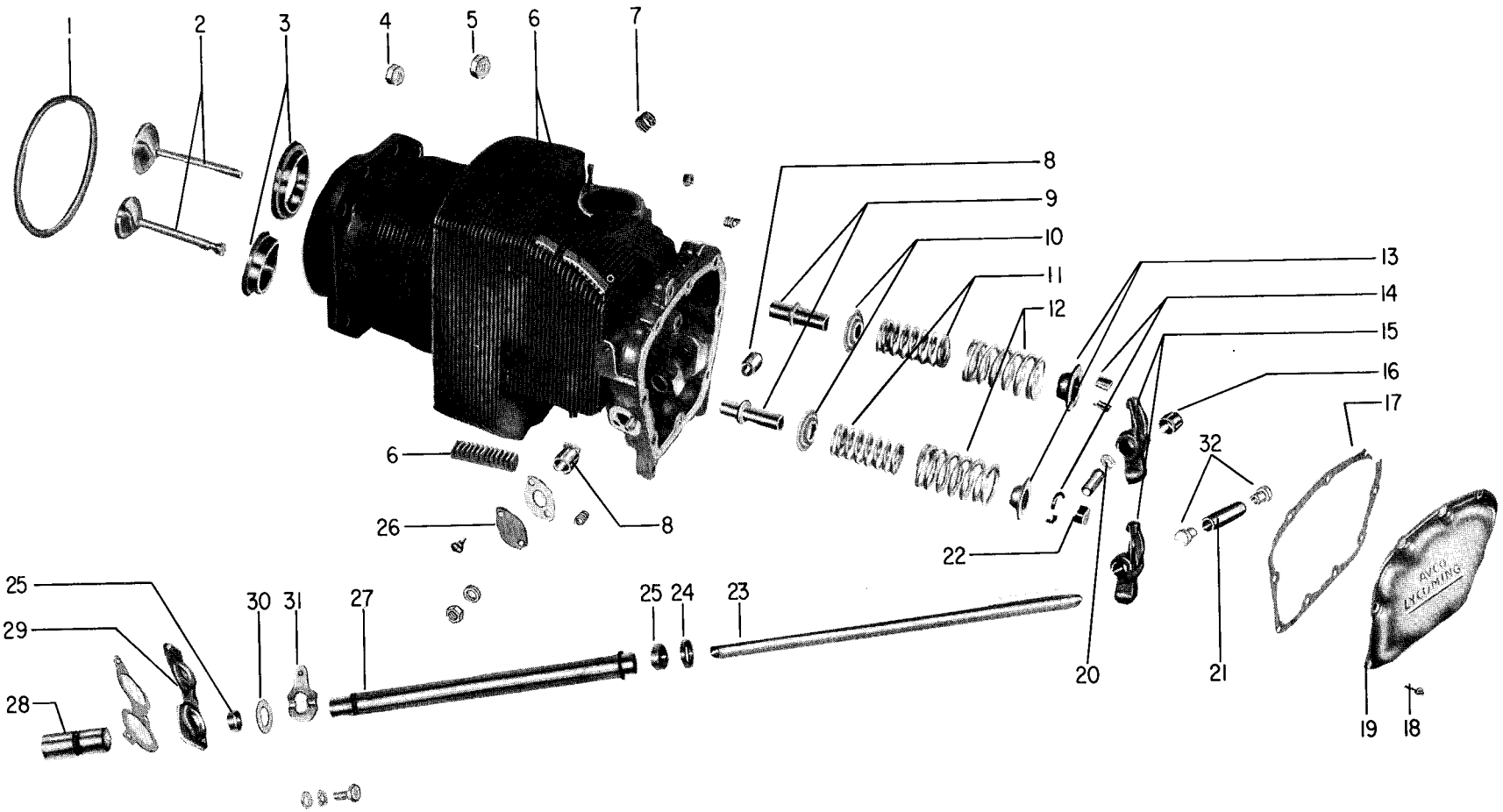
NOTE

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

7-13. Remove all valve spring seats (10 and 13) and valve springs (11 and 12) from the rocker box, keeping parts for each valve separate. Hold valves by stem and remove the cylinder from the holding block. Now reach inside and remove the valves from the barrel. If difficulty is experienced in pulling the tops of the valves through the guides (9), clean the carbon from the stem and then remove.

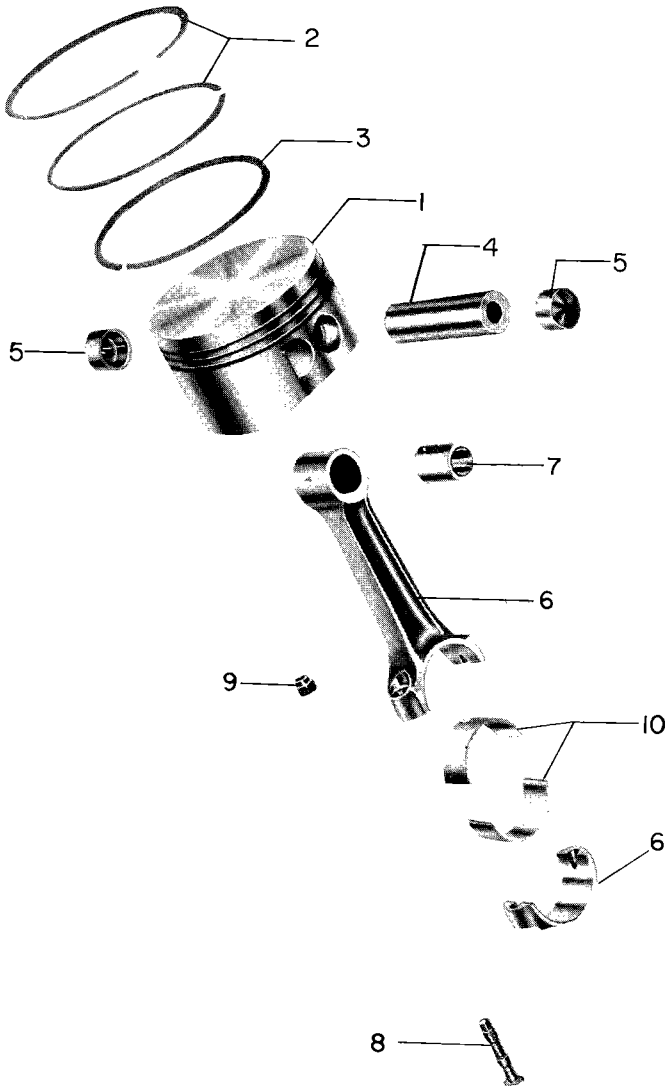
CAUTION

Do not drive the valves through the valve guides.



1. Oil seal ring
2. Valves
3. Valve seats
4. Plain nut, 3/8-24
5. Plain nut, 1/2-20
6. Cylinder fin stabilizers (A series)
7. Spark plug insert
8. Rocker shaft bushings
9. Valve guides
10. Valve spring seats (lower)
11. Valve springs (auxiliary)
12. Valve springs (outer)
13. Valve spring seats (upper)
14. Valve retaining key
15. Valve rockers
16. Valve rocker bushing
17. Rocker box gasket
18. Rocker box screws
19. Rocker box cover
20. Thrust washers
21. Valve rocker shafts
22. Valve stem cap
23. Push rod
24. Sleeve
25. Seal
26. Rocker shaft cover
27. Shroud tube
28. Hydraulic lifter
29. Shroud tube adapter
30. Washer
31. Shroud tube spring
32. Thrust buttons

Figure 7-1. Cylinder and Valve Train Assembly



1. Piston
2. Compression rings
3. Oil regulating ring
4. Piston pin
5. Piston pin plug
6. Connecting rod
7. Bushing
8. Connecting rod bolt
9. Nut
10. Bearing

Figure 7-2. Piston, Piston Rings and Connecting Rod

7-14. PISTONS. Using the piston ring expander (64713), remove the rings from the pistons. Remove the rings in order, starting at the top and working down. Be careful not to scratch or score piston while removing rings.

7-15. HYDRAULIC LIFTERS. Place the hydraulic lifter assembly in the fixture (ST-233) and remove the spring clip from the body. Remove the socket and plunger assembly. In the event that the fixture is not available, the assembly may be disassembled as follows. Insert a suitable tool into the socket and push in the plunger assembly until enough oil is forced out of the vent hole to release the pressure on the spring clip. Using a pair of pliers, remove the spring clip being careful as the spring clip will release with great force.

CLEANING

7-16. Clean all cylinder, piston and valve train parts in accordance with the general instructions described in Section 3.

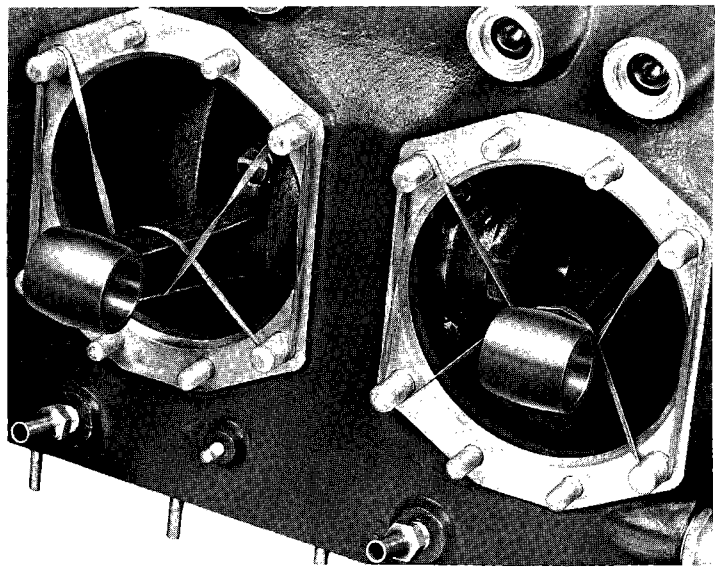
INSPECTION

7-17. 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.

7-18. 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).



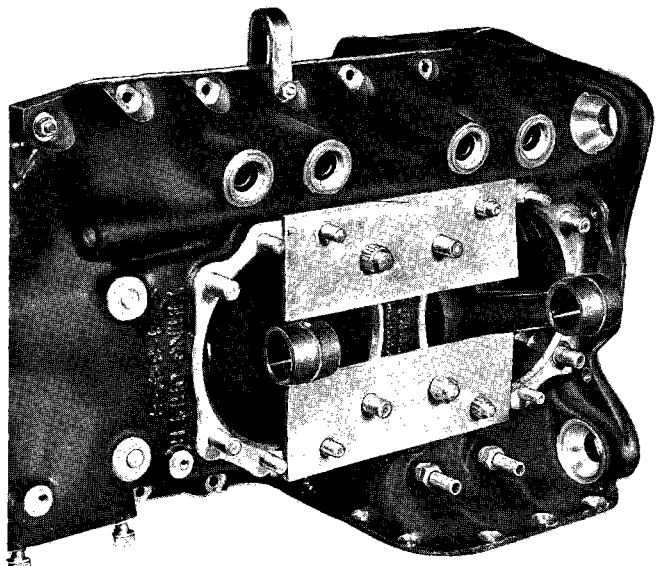


Figure 7-3. Method of Supporting Connecting Rods

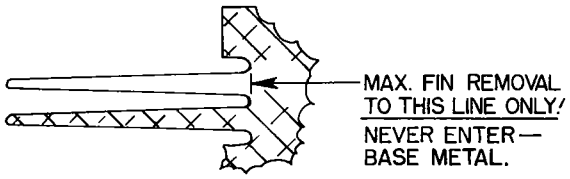


Figure 7-4. Maximum Fin Removal

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 is in accordance with figure 7-4.

cc. No burrs or sharp edges are permitted.

dd. Minimum fillet at the root of the removed portion of the fin is 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. Cracks in these areas can progress to a point where a cylinder might fail completely. Any cracks in these areas, regardless of length or depth, are cause for rejection of the cylinder.

(1) Between the 13th and 20th cylinder fin (counting from top) on exhaust port side of cylinder.

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

3. Cylinder Head Dome Area. See figure 7-5. Cracks in the spark plug fillet radius in direction of valve seat are not acceptable. Cracks in the spark plug fillet radius, in direction away from valve seat (see shaded area in figure 7-5) are acceptable up to 1.75 inch diameter.

7-19. 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 appropriate 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 positions 90° apart. If the gage enters the guide at any of the positions tested, mark the guide for replacement. Check the ID of the four rocker shaft bushings in the cylinder head, using the flat plug re-

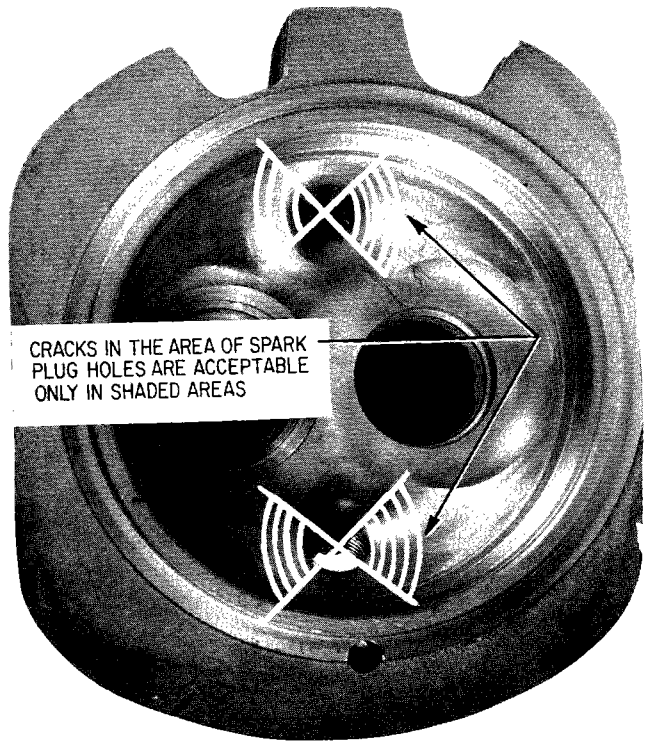


Figure 7-5. Inside View of Cylinder Head

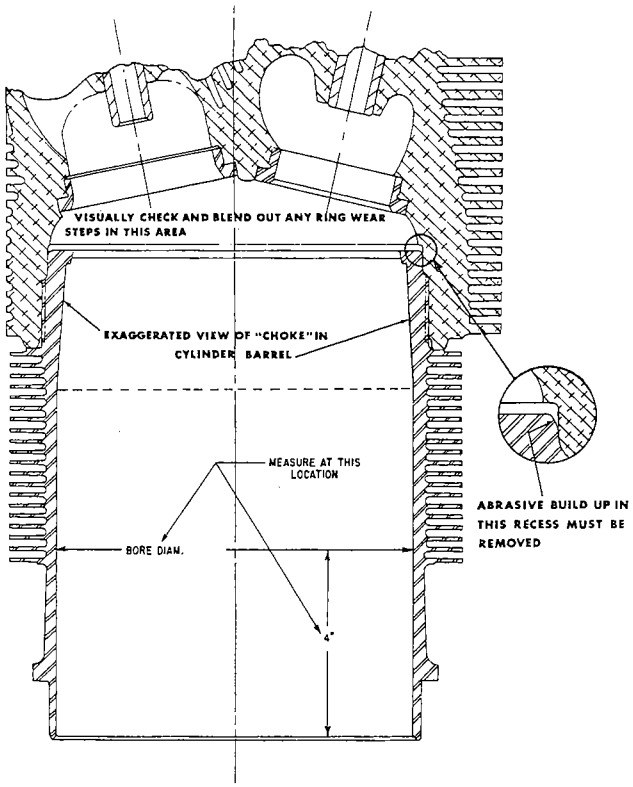


Figure 7-6. Inspection of Nitrided Barrels

jection gage (64613). Be sure to use the end of the gage marked "Cyl. Head". The opposite end, marked "Rocker Bushing" is 0.0015 inch larger in diameter by virtue of the greater wear limit allowed on the valve rocker bushing. As in the case of the valve guides, check for out-of-roundness by trying the gage at several different points on each diameter being checked.

7-20. CYLINDER BARREL (VISUAL INSPECTION). In addition to a thorough inspection of the cylinder barrel to ascertain its general condition, make the following specific checks:

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 or broken skirt.

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

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.

7-21. CYLINDER BARREL (DIMENSIONAL INSPECTION). See figure 7-6. 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 positions 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.

7-22. 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 hole bosses.

7-23. 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 Avco 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 7-7 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).

7-24. PISTON PIN AND PISTON PIN PLUGS. Check OD of piston pin against ID of hole in piston (reference

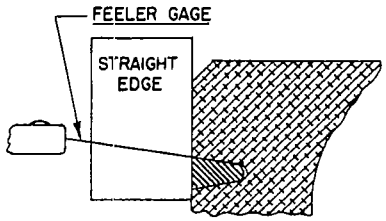


Figure 7-7. Method of Checking Piston Ring Side Clearance

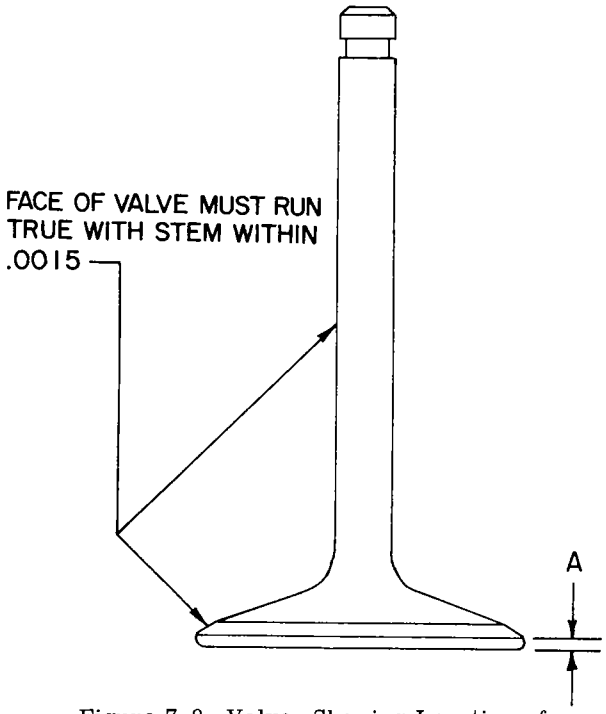


Figure 7-8. Valve, Showing Locations for Checking Run-Out and Measuring Edge Thickness

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.

7-25. VALVE ROCKERS. Damaged, badly worn, pitted or scored tips and push rod sockets warrant replacement of the rocker. Check the ID of the rocker bushing at several different positions with a flat plug rejection gage (64613). This is a double-end gage; be sure to use the end marked "Rocker Bushing". If the gage enters the bushing at any point, mark the bushing for replacement.

7-26. 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.

7-27. 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.

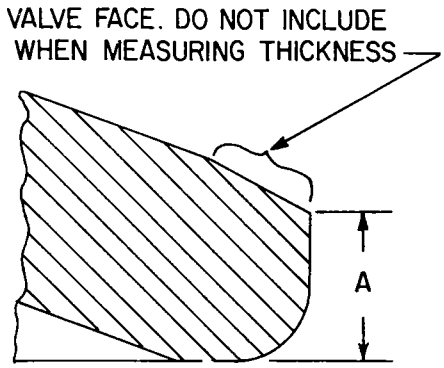


Figure 7-9. Section Thru Edge of Valve

NOTE

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

7-28. Check runout of valve face. See figure 7-8. Total runout must not exceed .0015 inch. Do not reuse any valves that exceed this limit.

7-29. Measure edge thickness of intake valve heads. See figure 7-8. If, after refacing, "A" is less than the limit shown in Table 7-1, the valve must not be reused.

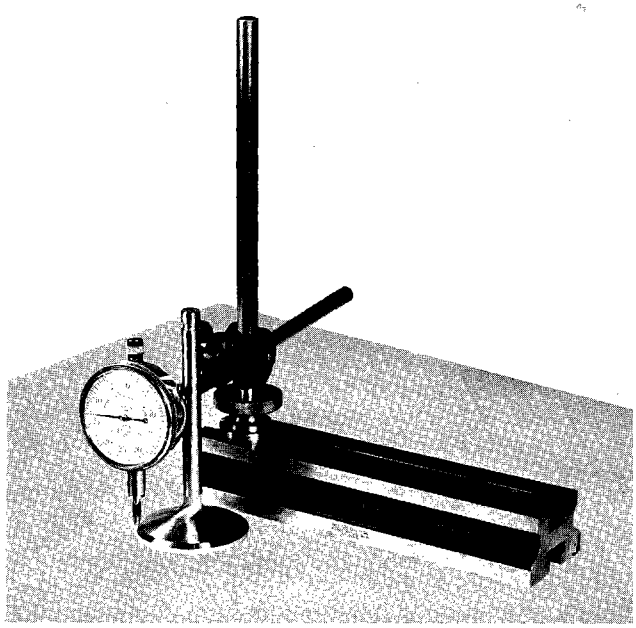
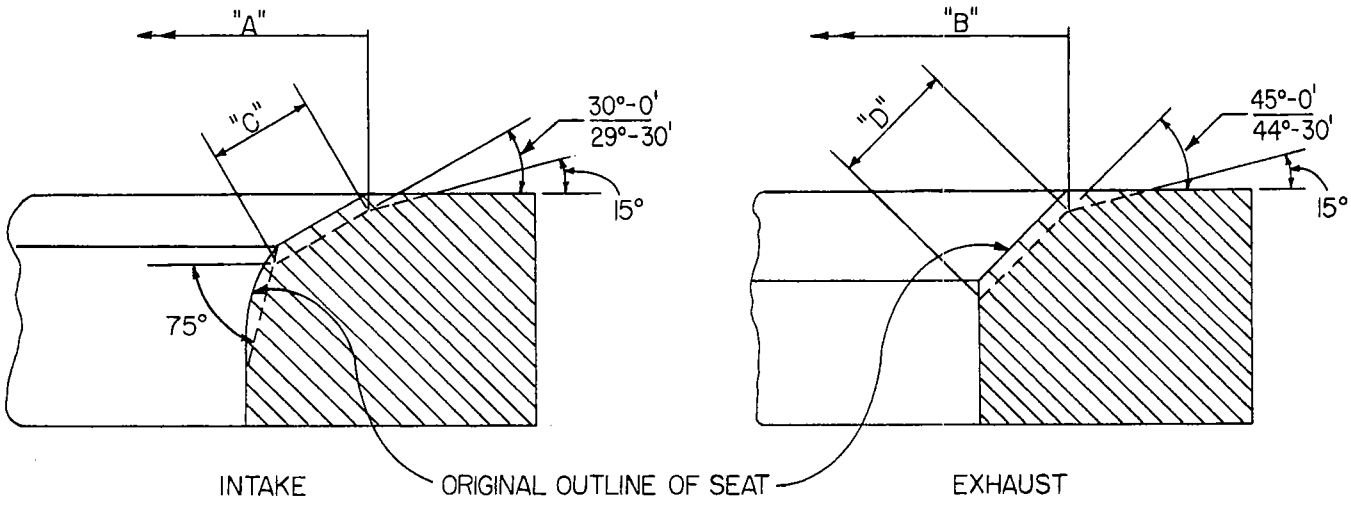


Figure 7-10. Method of Checking Edge Thickness With Dial Indicator

NOTE

The edge of intake valve heads are generally formed as shown in figure 7-9. 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 7-10.

7-30. 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.



MODEL	"A" (Intake)	"B" (Exhaust)	"C" (Intake)	"D" (Exhaust)
TIO-541-A	2.344/2.334	1.826/1.816	.093/.074	.106/.091
TIO-541-E	2.344/2.334	1.826/1.816	.093/.074	.106/.091
TIGO-541	2.344/2.334	1.826/1.816	.093/.074	.106/.091

Figure 7-11. Valve Seat Dimensions for Reconditioning

7-31. If superficial nicks and scratches on the valve indicate that the valve might be cracked, it should be inspected by the magnetic particle or dye penetrant method. Dye penetrant procedures should be carried out strictly within the recommendations of the manufacturer of the penetrant.

TABLE 7-1

Intake Valve Part No.	Min. Permissible Edge Thickness "A"	Engine Series
73117	.085 inch	TIO-541-A
76347	.085 inch	TIO-541-E
78671	.085 inch	TIGO-541
LW-13087	.085 inch	TIO-541-E TIGO-541

7-32. Critical areas include the face and top 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 lifter, regardless of the number of hours on the valve. Check the clearance between the valve stem and guide (reference 528, Table of Limits for exhaust valves, and reference 529 for intake valves).

7-33. HYDRAULIC LIFTERS. Inspect the hydraulic lifters for evidence of the following wear patterns.

7-34. 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 lifters but regardless of the degree, the lifter must be replaced.

7-35. Scoring - The lifter face is scored when small scratch-like lines are found on the surface. These marks are usually 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 lifter face. Any lifter face, with this condition in evidence, must be replaced.

7-36. Lifter Face Wear - The operation of this lifter provides that the lifter rotates during wiping action of the cam. This will form a groove, or path. This path will extend all the way across the face and deeper penetrations 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 required replacement of the lifter body.

7-37. If for any reason a new camshaft is to be installed in the engine, or the cam lobes are conditioned by regrinding, all of the hydraulic lifters must be discarded and replaced with new hydraulic lifters.

7-38. VALVE SPRINGS. Check the condition of all valve springs on a suitable spring tester, using the loads and deflections as given in references 800 and 801, Table of Limits.

REPAIR AND REPLACEMENT

7-39. General instructions for the repair of cylinder, piston and valve train parts will be found in Section 3. Specific instructions follow, possible revisions will be found later in the section.

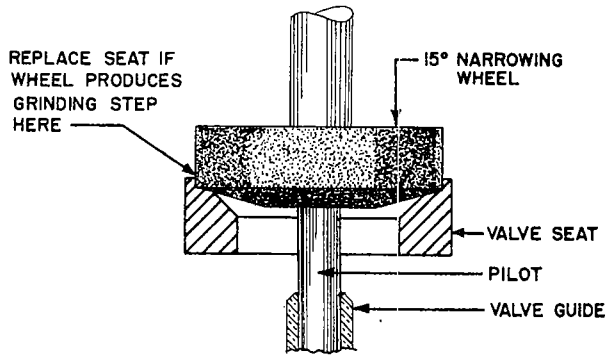


Figure 7-12. Rejection of Valve Seat

7-40. SPARK PLUG THREAD INSERT. Spark plug thread inserts which were rejected during inspection are removed and replaced as described in the following paragraphs.

7-41. 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. Then rotate the tool in a counter-clockwise direction, unscrewing the insert from the holes.

7-42. 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.

7-43. 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.

7-44. 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 counter-clockwise with the other hand, freeing the left half-turn of the insert. Be 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.

7-45. 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 expanwion can be kept within the thread gage limits by fixing the stop nut on the 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 chamgered edge around the periphery of the tapped hole. The staking sleeve may then be removed and adjusting screw released, and the expanding mandrel removed from the insert.

7-46. GRINDING VALVE SEATS. See figure 7-11. 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 7-11. Proceed in the following manner:

7-47. 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.

7-48. 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".

7-49. If seat wear has progressed to the extend 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 7-12).

7-50. VALVE SEAT REMOVAL AND REPLACEMENT. Valve seats that are loose, damaged or worn to the extent that they cannot be reground to the dimensions shown in figure 7-11 must be replaced.

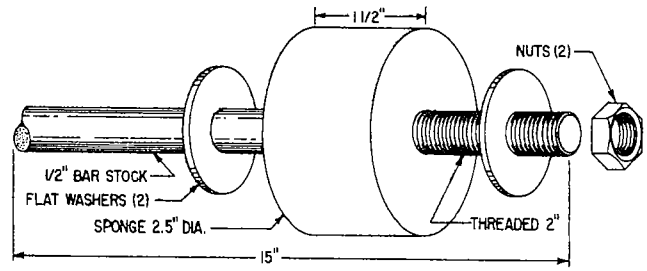


Figure 7-13. Valve Seat Removal Tool

TABLE 7-2

VALVE SEAT REPLACEMENT TOOLS

Engine Model	Intake Valve Seat			Exhaust Valve Seats		
	Recess Cutter	Pilot	Replacement Drift	Recess Cutter	Pilot	Replacement Drift
TIO-541-A Series	ST-51	ST-66	ST-64	ST-54	ST-67	ST-65
TIO-541-E Series	ST-51	ST-66	ST-64	ST-54	ST-257	ST-65
TIGO-541 Series	ST-51	ST-66	ST-64	ST-54	ST-257	ST-65

Special length, tapered shank driver ST-62 used with all recess cutters.

Hand drive adapter ST-63.

Replacement fixture ST-232.

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.

7-51. VALVE SEATS. Place the valve seat replacement fixture (ST-232) on a suitable surface and fasten securely. Fabricate a removal tool in accordance with the materials and dimensions shown in figure 7-13.

7-52. 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.

7-53. 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.

7-54. Refer to Table 7-2 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.

7-55. In the event the seats are to be cut by hand, install the hand drive adapter (ST-63) over the special drive and using a "T" handle proceed to cut the recesses as described in the preceding paragraph.

7-56. Heat cylinder to 400° F. to 425° F. and secure to replacement fixture. Chill seat and place on replacement drift (refer to Table 7-2) for correct drift and drive seat into the recess in the cylinder head by tapping end of drift with hammer.

7-57. Proceed to grind the faces of the newly installed valve seats as described in paragraphs 7-46 through 7-48.

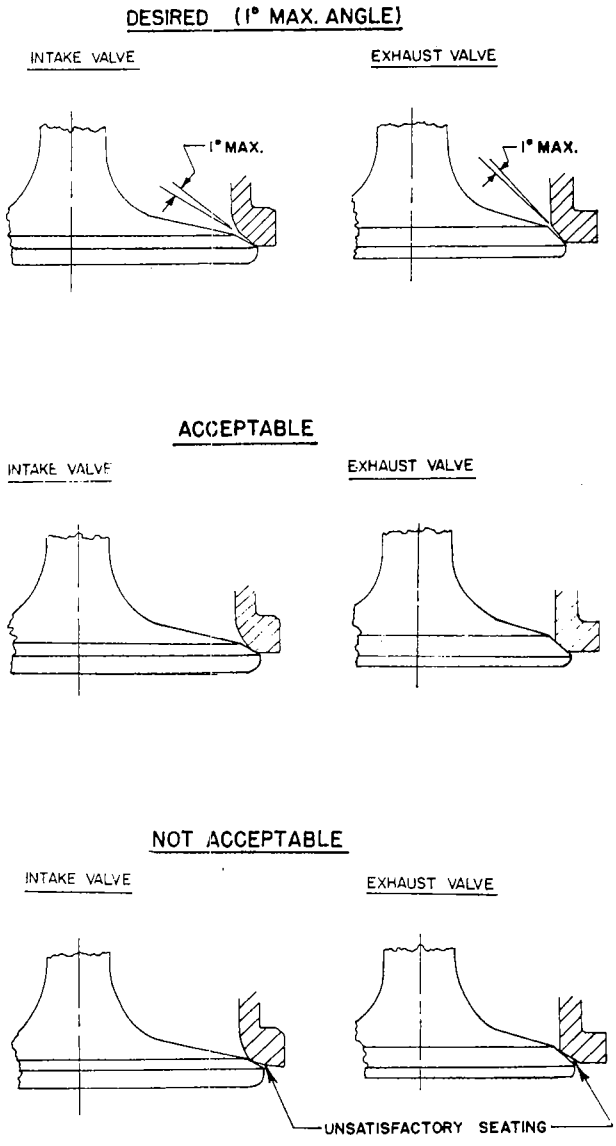


Figure 7-14. Acceptable, Desired and Not Acceptable Valve Contact with Seat Face

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.

7-58. 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 #80 grit wheel, remove no more metal than is necessary to clean up pits in the valve face or to correct any apparent 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.

7-59. VALVE GUIDE REPLACEMENT. Damaged or worn valve guides are removed and new guides installed in accordance with the procedures described in the following paragraphs. Refer to Table 7-3 for valve guide replacement tools.

7-60. Screw the nut of the 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 the cylinder barrel end insert the bolt (3/8-24) into the end of the 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 free of cylinder head.

7-61. Check each valve guide hole in the cylinder head with the applicable valve guide hole plug gage. If the gage enters the hole more than 1/8 inch it will be necessary to ream the hole and install an oversize guide. If the gage enters the hole easily or seems loose in the hole, it is evident that an oversize guide has already been installed and the next larger guide must be used.

7-62. Mount valve guide replacement fixture (P/N 64644) on drill press table. Fasten cylinder securely in place on the fixture and set fixture to proper angle for the valve guide being installed (11° 45 minutes for intake valve, 12° 40 minutes for exhaust valve).

7-63. Determine the proper size reamer, mount the reamer in the drill press spindle and ream the valve guide hole in the cylinder head. Check the reamed hole with the appropriate plug gage (see Table 7-2).

7-64. Heat cylinder to 400° F. to 425° F., chill valve guide. Place guide on proper valve guide installation drift, insert the guide in the hole of the cylinder head. Drive the guide to a firm seat with sharp hammer blows on the end of drift. After the cylinder has cooled, ream the valve guide with the appropriate valve guide ID reamer. Check the finished ID of the guide with the appropriate valve guide ID plug gage.

7-65. On all newly installed valve guides, break the inner edge of the upper (rocker box) end of the guide as shown in figure 7-15.

TABLE 7-3

VALVE GUIDE REPLACEMENT TOOLS

GAGE	SIZE	REAMER
	Valve Guide Hole in Cylinder Head	
	(.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
	(.6933/.6943 hole)	
ST-259	Standard	--------
ST-259-5	.005 oversize	ST-258-5
ST-259-1	.010 oversize	ST-258-1
ST-259-2	.020 oversize	ST-258-2
ST-259-3	.030 oversize	ST-258-3
	Valve Guide ID	
64514	All intake valves	64684
ST-155	.4995/.5005 exhaust valve	
	Pilot diameter .4828/.4833	ST-143-1
	Pilot diameter .4778/.4783	ST-143-2
Replacement Fixture		64644
Installation Drift (Intake)		64505
Installation Drift (Exhaust)		64923
Valve Guide Puller		ST-49

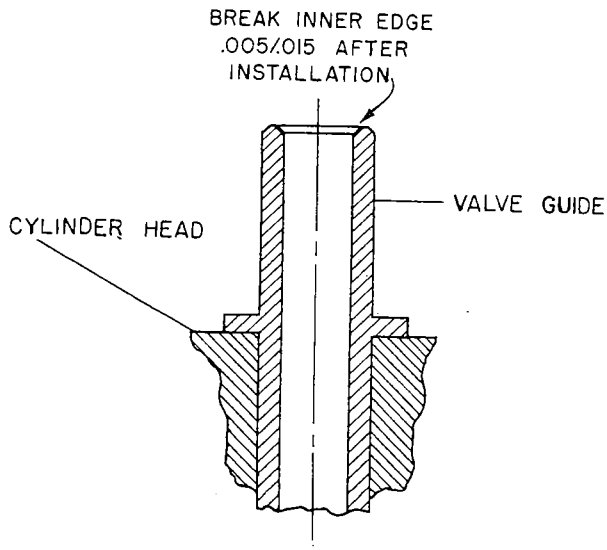


Figure 7-15. Breaking Inner Edge of Exhaust Valve Guide

7-66. VALVE ROCKER THRUST WASHERS. Excessive side clearance between the valve rocker and cylinder head (reference 533, Table of Limits) caused by excessive wear on the inner rocker shaft support boss may be brought within limits in the following manner:

a. Use the inner rocker shaft spotfacer (64862) to clean up the surface of the inner rocker shaft support boss, removing no more metal than is necessary.

b. Select and fit any two of the three undersize washers that will bring the side clearance within the service limits.

7-67. REPLACEMENT OF VALVE ROCKER SHAFT BUSHING. Remove the outer and inner bushing using the rocker shaft bushing removal drift (64814).

7-68. Check each rocker shaft bushing hole in cylinder head with a standard plug gage (64810). If plug gage enters hole more than 1/8 inch an oversize rocker shaft bushing will be required. If the fit of plug gage in the hole is quite loose, it is evident that the bushing that was removed was an oversize bushing. Use the 0.005 oversize plug gage to determine what oversize bushing should be used for replacement. When the proper size replacement bushing has been determined, proceed to ream bushing hole in the cylinder head.

7-69. Place the pilot of the outer rocker shaft bushing hole in cylinder head reamer (64812 or 64813) through the outer hole into the inner hole and proceed to ream the outer hole. Place the inner rocker shaft bushing hole in cylinder head reamer (64832 or 64833) through the outer hole and ream the inner hole. Clean cylinder and reamed holes thoroughly.

7-70. Install new rocker shaft bushings in the following manner: Place the stop of the outer rocker shaft bushing installation drift (64815) between the inner rocker shaft bushing boss and the outer rocker shaft bushing boss. Assemble new bushing on drift, insert drift pilot through boss into stop and tap bushing into place. Assemble the new bushing on the pilot of the inner rocker shaft bushing installation drift (64816) and position bushing and pilot. Insert drift through outer bushing into pilot and tap inner bushing into place.

7-71. After installing new rocker shaft bushing in cylinder head, ream the bushing inside diameter. To do this, place the pilot of the outer rocker shaft bushing ID semi-finish reamer (64819) through the outer bushing and ream outer bushing. Place the inner rocker shaft bushing ID semi-finish reamer (64820) through the outer bushing and ream the inner bushing. Repeat the same procedure, this time using the outer and inner finish reamer (64821 and 64822). Check the finish ID hole in the rocker shaft bushings with the rocker shaft bushing ID plug gage (64823). Clean the cylinder and reamed hole thoroughly.

NOTE

After bushings have been reamed they must be impregnated with oil by immersing them for at least 15 minutes in engine oil that has been heated to 60°C. (140°F.).

7-72. REPLACEMENT OF VALVE ROCKER BUSHINGS. If valve rocker bushings are damaged or worn, they can be replaced in the following manner:

7-73. Place the valve rocker in position in the valve rocker holding fixture (64540) and, using a suitable drift, remove the bushing from the valve rocker.

7-74. Using a suitable arbor press, install a new bushing in the valve rocker. Make sure the oil hole in the bushing is aligned with the oil hole in the valve rocker.

7-75. Burnish the housing by using an arbor press to pass the valve rocker bushing burnisher (64541) completely through the bushing. Remove the rocker from the fixture and check the finished ID with the valve rocker bushing finish ID gage (64542).

7-76. RECONDITIONING NITRIDED CYLINDER BARRELS. When a nitrided barrel is worn beyond service limits, it can be reconditioned by chrome plating or in certain cases by re-barreling. Consult Service Instruction No. 1047 for information relative to reconditioning nitrided barrels.

7-77. VALVE REPAIR. Repair to valves are limited to removal of carbon, regrinding the face, and polishing superficial scratches. Bending processes to straighten and puddling to restore the face must not be attempted.

REASSEMBLY

7-78. ASSEMBLY OF PISTONS. Using the piston ring expander, assemble the new rings on pistons in the order described in the following paragraphs.

7-79. 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 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.

7-80. Install compression rings in the remaining top grooves The compression rings are etched on one side with the word "TOP" and this side must face toward the top of the piston.

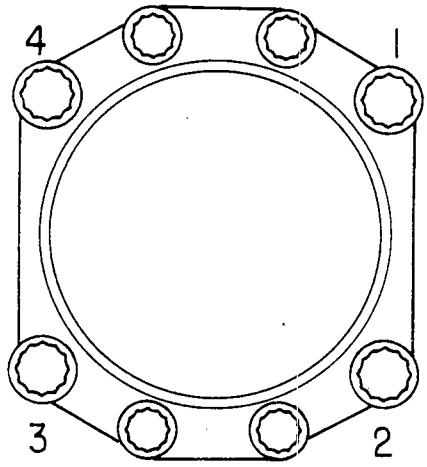
CAUTION

If in doubt as to the proper combination of rings to be used, refer to the latest revision of Service Instruction No. 1037 or contact the Service Department, Avco Lycoming Division.

7-81. Upon completion of assembly of the piston rings, check the side clearance of the rings in the piston grooves. Use feeler gage and straight edge as shown in figure 7-7.

NOTE

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



FIRST - TIGHTEN NUTS 1,2,3 AND 4 IN CLOCKWISE SEQUENCE, STARTING WITH NO. 1. TIGHTEN NUTS TO 300 IN. LBS. TORQUE.

SECOND - IN SAME SEQUENCE, TIGHTEN NUTS 1,2,3 AND 4 TO 600 IN. LBS. TORQUE.

Figure 7-16. Sequence for Tightening Cylinder Base Nuts

7-82. ASSEMBLY OF CYLINDER. See figure 7-1. Apply locktite instant pipe sealant #70 to exhaust valve guide oil line connectors, tees and elbows (where applicable), assemble in cylinder head and tighten to 100 inch lbs. torque. Install fuel drain line nipples in cylinder head. Coat the valve guides and valves with a prelubricant as described in paragraph 3-38. Insert the intake and exhaust valve in their respective guides. The intake valve can be identified by the fact that it is slightly larger than the exhaust valve. Hold the ends of the valve stems and place the cylinder on the applicable cylinder holding block. Install on each valve a lower spring seat (10), outer and auxiliary valve spring (11 and 12) and outer valve spring seat (13).

NOTE

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

7-83. Compress the springs with the valve spring compressor and assemble the valve retaining keys (14).

NOTE

Exhaust valves are assembled with special keys (14) and caps (22). Do not install caps until just before valve rockers are installed.

7-84. INSTALLATION OF PISTONS AND CYLINDERS. See that all preservative oil accumulation on cylinder and piston assemblies is washed off with solvent and thoroughly dried with compressed air. Insert valve rocker shafts in their bores in the rocker box. Immediately prior to assembly of piston and cylinder to the engine, space the rings correctly and apply a generous coating of the oil mixture described in paragraph 3-39. Apply to the inside of the cylinder barrel and to piston and rings working and mixture well around the rings and into the grooves. Starting with No. 1 cylinder, proceed to install as follows:

7-85. 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 7-3.

7-86. 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 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 at each end of the piston pin.

7-87. When the crankcase fastenings have been tightened as described in Section 8, the cylinder may be installed. Install in pairs beginning at the rear and proceeding toward the front. Proceed as follows.

NOTE

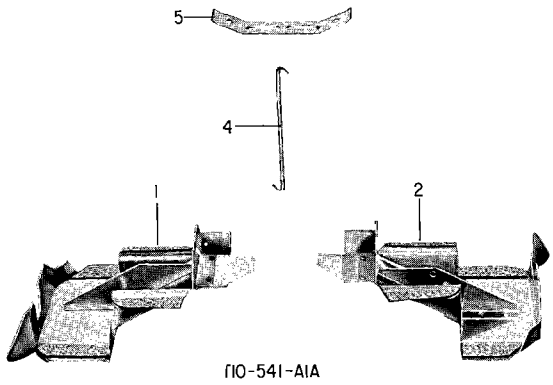
The two front half inch through studs of each cylinder are not secured by screw threads; instead the center of each stud serves as a dowel to insure crankcase alignment at the bearing webs while the threaded ends protrude through the cylinder mounting pads. Therefore, when tightening the 1/2 inch cylinder base hold down nuts, the opposite side must be held so that the stud does not turn while torque is being applied.

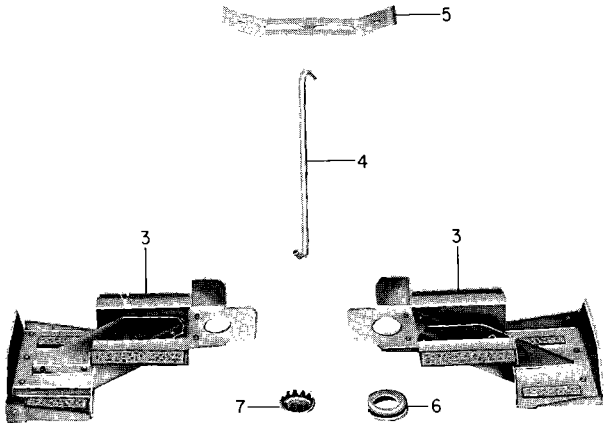
7-88. Place a new cylinder base seal ring (1) around the cylinder base, assemble the piston ring compressor (64712) over the piston rings and install the cylinder over the piston, pushing the piston ring compressor ahead with the cylinder barrel. As the cylinder barrel approaches the crankcase, catch the ring compressor as it drops off the piston. When the base of the cylinder is seated on the crankcase pad, secure with 3/8 inch and 1/2 inch nuts, tightening the nuts finger tight only. Before tightening any of the nuts to final torque, complete the assembly of all cylinders as described above.

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. Parker Thread Lube.
3. 60% SAE 30 engine oil and 40% parker Thread Lube.





1. Baffle assembly
2. Baffle assembly
3. Baffle assembly
4. Retainer hook
5. Baffle retainer
6. Grommet
7. Button plug

Figure 7-17. Intercylinder Baffles

7-89. When all cylinders have been initially installed on the crankcase as described in paragraph 7-88, 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 employing the flexible beam design are recommended in preference to those using the hydraulic principle or a dial indicator with rack and pinion.

7-90. Tighten the 1/2 inch cylinder base hold down nuts in the sequence and to the torque shown in figure 7-16.

NOTE

Because the front two through studs at each cylinder pad are not secured by screw threads, the opposite hold down nuts on these studs must be tightened simultaneously.

7-91. Tighten the 3/8 inch cylinder base hold down nuts to 300 inch pounds torque. Sequence is optional.

7-92. As a final check hold the torque wrench on each nut for about five seconds. If the nut does not turn, it may be presumed to be tightened to correct torque.

7-93. Install some type of vented plug in spark plug holes to prevent entrance of foreign matter and to allow the engine to be easily turned.

7-94. See figure 7-1. Install hydraulic lifters (28) in the crankcase and assemble the shroud tube adapter gasket and shroud tube adapter (29) on the crankcase.

7-95. Assemble new shroud tube oil seals (25) in their retainers in the crankcase and assemble another shroud tube seal (25) over the cylinder head end and center a sleeve (24) over the seal.

7-96. Assemble shroud tube spring (31) over the inner ends of the two shroud tubes (27) so that the detent nothces in the spring are approximately 90° removed from the detents on the tubes. Place shroud tube wash-

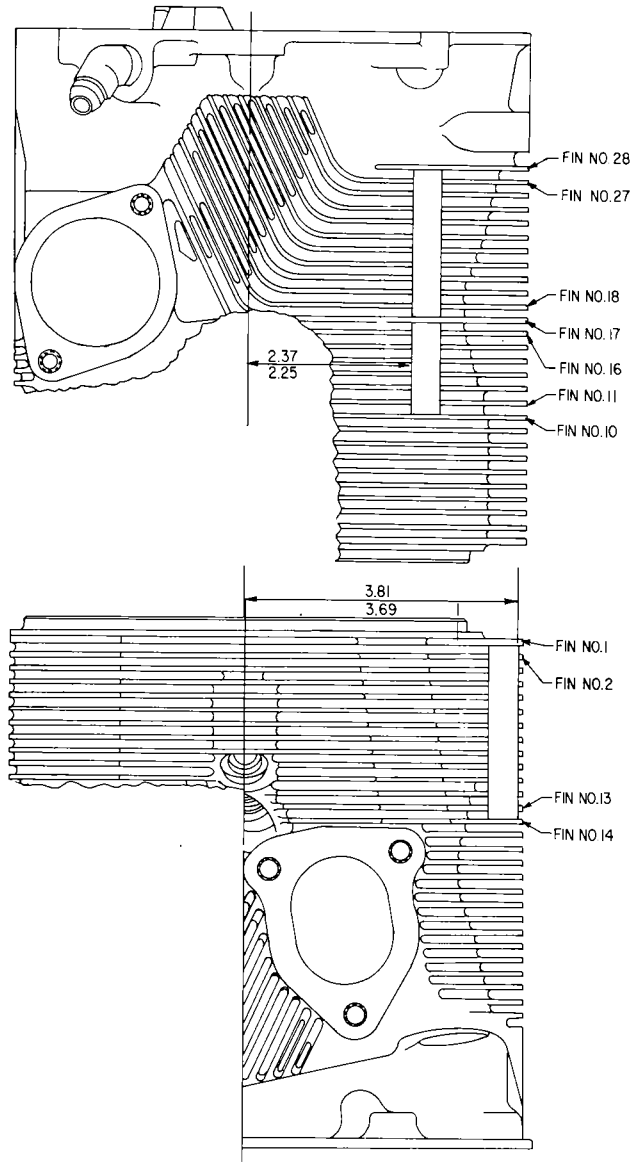


Figure 7-18. Cylinder Head Fin Stabilizers

ers (30) (maximum of two), to bring minimum overlap between the spring and detent lugs to 1/8 inch, over end of each tube. Insert tube ends into the seals in the crankcase. Hold both shroud tubes with detent at inner end at unlocked position and insert the outer ends of the tubes in the cylinder head. See that the seals are seating squarely and turn each shroud tube 90°, thus locking the tubes by engaging the detents with the notches in the spring.

7-97. Select the proper push rods (23), dip in oil mixture described in paragraph 3-39 and insert full length through the shroud tubes. Press tightly against outer end to check spring tension and free travel of the hydraulic lifter assembly.

7-98. Slide rocker shafts (21) back and install valve rockers (15) and thrust washers (20). TIGO series install a thrust button (32) in each end of rocker shaft. Before installing exhaust valve rocker place rotator cap (22) over the exhaust valve stem. Slide rocker shaft back into position. If the clearance between the valve rocker and cylinder head cannot be brought within limits (see Table of Limits) by the use of standard washers, clean up the worn valve rocker support boss as described in paragraph 7-66 and use any of the selective fit undersize washers to bring the clearance within limits.

NOTE

The valve rockers, intake and exhaust, differ on the TIO-541-A. The valve rockers on the TIO-541-E and the TIGO-541 series are the same for intake and exhaust.

7-99. Check dry or unloaded tappet clearance by pushing in on push rod end of valve rocker and measuring the clearance between end of valve rocker and valve stem tip. Clearance should measure .040/.105. If clearance is out of limits adjust by using a longer or shorter push rod. Refer to Table 7-4 for part number and length of push rods.

7-100. When all dry tappet clearances have been determined, coat all parts in the rocker box as described in paragraphs 3-37 through 3-39 and install the rocker box cover gaskets (17) and covers (19) and secure with self locking screw (18).

7-101. (TIO-541-E and TIGO) Coat valve rocker shaft cover studs with non-hardening Permatex #2 or equivalent and coat both sides of gasket with POB sealer or equivalent. Install gasket and cover (26) and secure with one self sealing, slotted head screw, one washer and one nut.

7-102. (TIO-541-A) Assemble gasket and valve rocker cover and secure with self sealing, slotted head capscrews.

7-103. INTERCYLINDER BAFFLES. See figure 7-17. Note that the intercylinder baffles differ according to engine model. To install baffles, proceed as follows: Place the baffles in place beneath and between the cylinders, running the hook up between the cylinder barrels. Place a retainer in place between the cylinders, and with the aid of a baffle installation tool (64885), bring the retainer hook through the slot in the retainer. When hook is far enough above the retainer, turn and hook over the bridge between the retainer slots.

7-104. CYLINDER HEAD FIN STABILIZERS (TIO-541-A1A only). Clean the stabilizers and affected fin area thoroughly to remove all traces of grease, dirt of other foreign matter.

7-105. Apply Dow Corning Silastic 140 adhesive to the fin stabilizers and press surfaces together in the locations described in figure 7-18.

TABLE 7-4

PUSH ROD ASSEMBLIES

Engine Model	Push Rod P/N	Length
TIO-541-A	73580 (Intake)	13.790-13.803
TIO-541-A	73581 (Intake)	13.817-13.830
TIO-541-A	73582 (Intake)	13.844-13.857
TIO-541-A	73568 (Exhaust)	13.505-13.518
TIO-541-A	73569 (Exhaust)	13.532-13.545
TIO-541-A	73570 (Exhaust)	13.559-13.572
TIO-541-E, TIGO-541-E	76180 (Intake or Exhaust)	13.955-13.972
TIO-541-E, TIGO-541-E	76181 (Intake or Exhaust)	13.992-14.009
TIO-541-E, TIGO-541-E	76182 (Intake or Exhaust)	14.029-14.046
TIO-541-E, TIGO-541-E	76183 (Intake or Exhaust)	14.066-14.083

SECTION 8.
CRANKCASE, CRANKSHAFT AND ACCESSORY DRIVES

DISASSEMBLY

8-1. (TIO-541). Remove the starter ring gear and support assembly (1, figure 8-3) from the crankshaft propeller flange by tapping lightly on the rear face of the support. The alternator drive belt should also be removed from the engine at this time.

8-2. (TIO-541). See figure 8-1. Remove the oil pressure relief valve assembly (1 or 26), the dip stick (5 or 6) and the oil filler extension (7 or 8). Remove all threaded plugs so cleaning will be facilitated. Remove oil seals and engine mounts. Remove crankshaft oil seal retainer (17) and oil seal (22). Remove the peripheral fastenings, the lifting eyes (9 or 11) and the lifting strap (19). Remove the nuts from the through bolts.

NOTE

The crankshaft oil seal retainer (17) mentioned in the preceding paragraph is not employed on all models.

8-3. (TIGO-541). See figure 8-2. Remove the oil pressure relief valve assembly (11) and oil bypass valve housing (10). Remove the dip stick (8) and oil filler tube (5). Remove all threaded plugs so cleaning will be facilitated. Remove engine mounts. Remove the peripheral fastenings and remove the lifting eyes (1) and lifting strap (4).

8-4. (All Models). Place the crankcase assembly on its right side and remove the lockwire and fastenings securing the bottom of the case.

8-5. Remove the through studs using service tool ST-271. Pull the left half of crankcase away from the right half. When the halves of crankcase are about 1 inch apart, reach through the cylinder mounting pads and push left halves of the main bearing down on the shaft to prevent them from falling from left half of crankcase. Proceed to remove the left half, holding the governor driven gear on the TIO-541 series, remove the gear from the crankcase half. Remove the piston cooling nozzles from the crankcase.

8-6. (TIO-541-E and TIGO-541). See figure 8-12. Remove the cotter pin (14) and nut (13) from shaft. Remove the washer (12), pulley (11), oil seal (6), drive adapter (3) and gasket (2). Remove drive shaft (1) from the accessory drive gear.

8-7. (TIGO-541). See figure 8-9. Remove the propeller drive shaft gear assembly (17) generator and starter gear (16) along with the spring adapter (15) and spring (14). Remove the propeller shaft (2) and component parts.

8-8. (TIO-541). See figure 8-5. Remove the external hex head plug (6) and gasket (5). Remove the propeller idler gear shaft (4), idler gear (2), thrust washer (1) and propeller driven gear (3).

8-9. (All Models). Remove the camshaft assembly and on the TIO-541 series remove the circlips (27, figure 8-3) and remove the governor drive gear (23, figure 8-3).

8-10. Remove the crankshaft assembly. See figure 7-2. With the crankshaft properly supported at the main bearings, remove the nuts (9) from the connecting rod bolts (8) and disassemble the connecting rod by lightly tapping the bolts. After removing the rods, discard the inserts and reassemble the cap and rod. This is essential as the rods and caps are not interchangeable. The number of the cylinder is stamped on the side of both the rod and cap and it should be reinstalled on the correct throw.

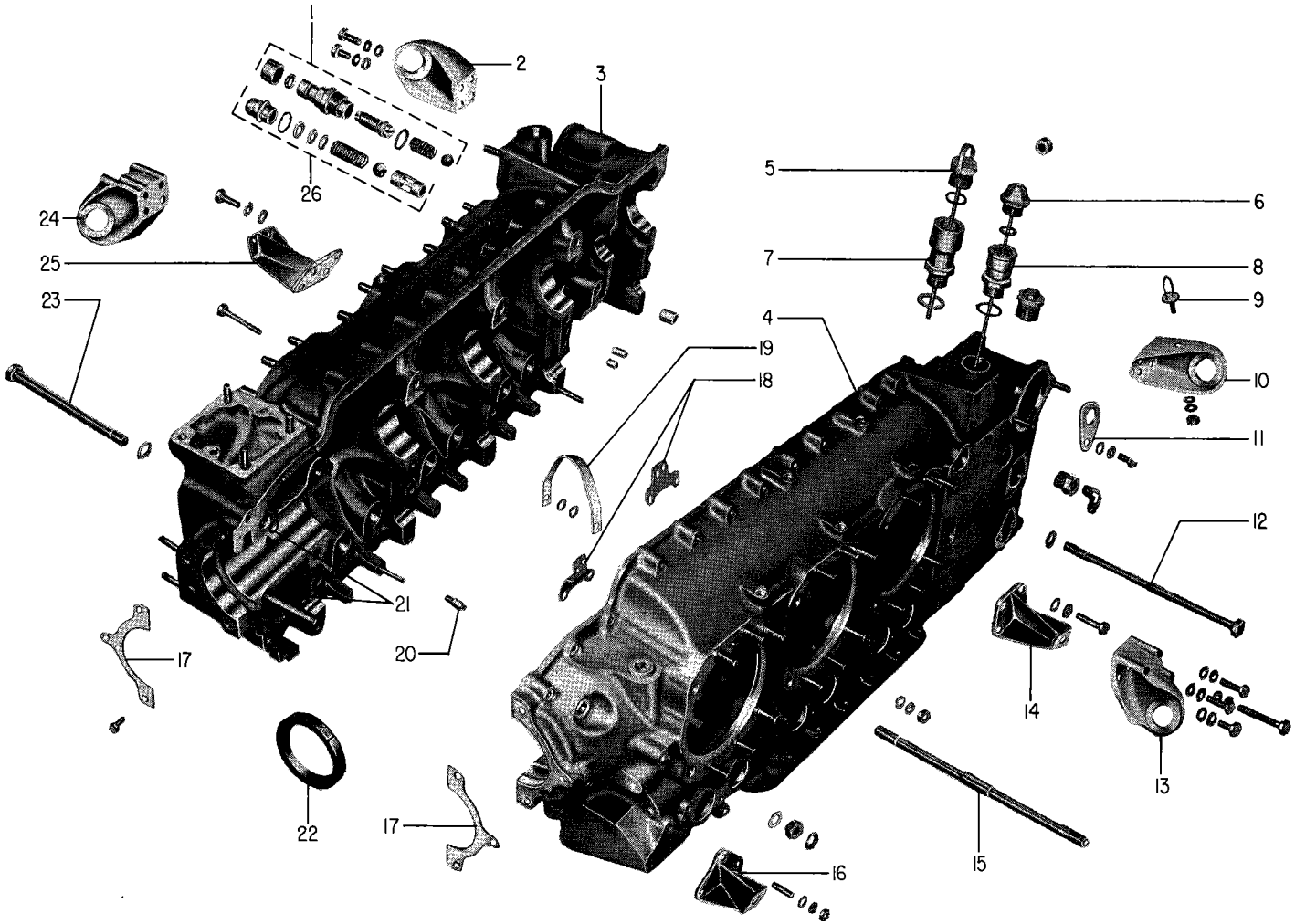
8-11. (TIO-541). See figure 8-3. Remove the accessory drive gear (16) from the crankshaft gear (12). Unscrew the hex head bolts (15) remove the lockplate (14) and tap the crankshaft gear (12) off the crankshaft. Do not remove the dowel (13) unless it is loose or damaged. It will not be necessary to remove the expansion plug (2) unless it is damaged or leaking. It is also not necessary to remove the propeller flange bushings (24, 25 and 26) unless they are loose or damaged.

8-12. (All Models). See figure 8-3 or 8-4. To remove the counterweight assemblies (10), remove the circlip (6), washer (7) and remove the counterweight (10) and rollers (8) from the crankshaft.

NOTE

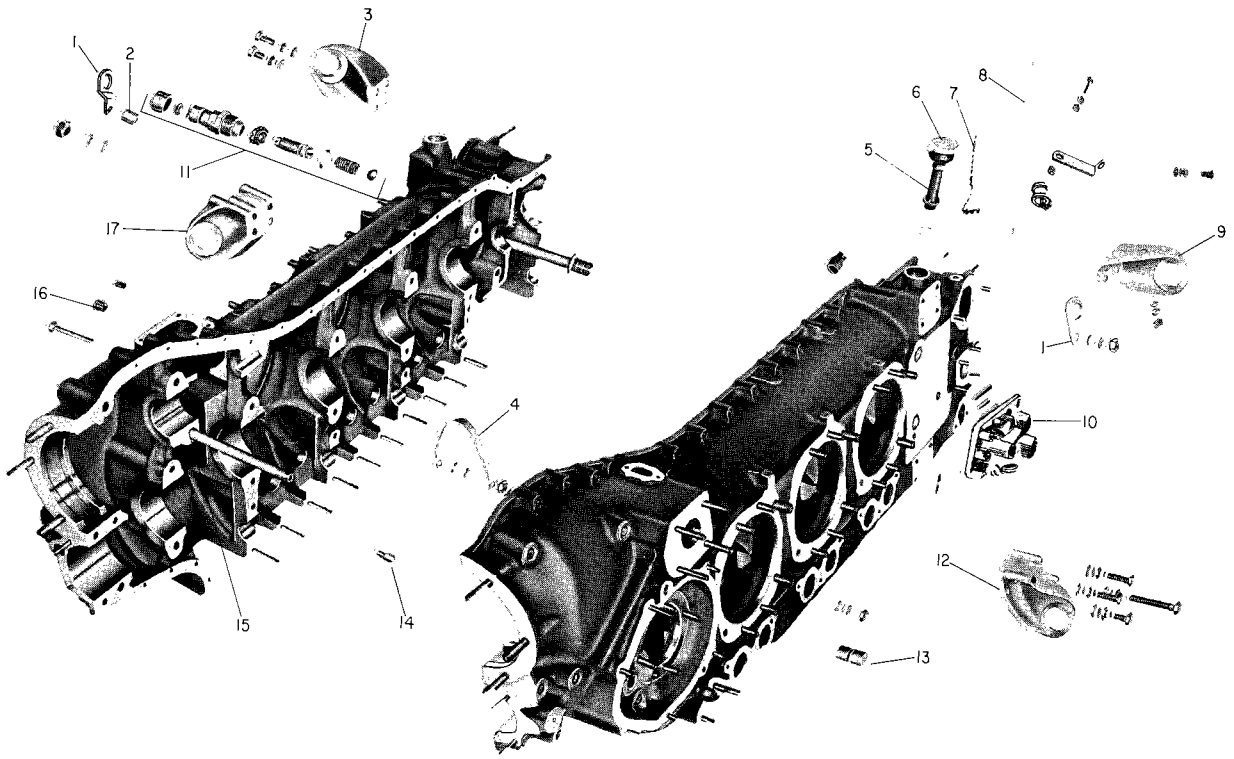
All counterweights and their related parts should be reassembled in the same location they occupied on the crankshaft before disassembly. For example the retaining washers are selectively fitted to the washer seats. It is advisable, therefore, to mark all counterweight parts to insure proper identification. The markings must be impermanent. No scoring, etching, scratching or other permanent marking of any kind is permissible on these parts.

8-13. (TIGO-541). See figure 8-7. Remove the accessory drive gear (5) from the crankshaft gear (1). Unscrew the hex head bolts (4), remove the lockplate (3) and tap the crankshaft gear (1) off the crankshaft. Do not remove the dowel (2) unless it is loose or damaged.



1. Oil relief valve (adjustable)
2. Mount, upper right ("E")
3. Right crankcase half
4. Left crankcase half
5. Dip stick, cam action
6. Dip stick, screw type
7. Oil filler extension, long
8. Oil filler extension, short
9. Lifting eyes ("E")
10. Mount, upper left ("E")
11. Lifting eyes ("A")
12. Through bolt
13. Mount, lower left ("E")
14. Mount, left rear ("A")
15. Through stud
16. Mounts, front ("A")
17. Oil seal retainer
18. Support brackets ("A")
19. Lifting strap
20. Piston cooling nozzle
21. Oil seal rings
22. Crankshaft oil seal
23. Through bolt
24. Mount, lower right ("E")
25. Mount, right rear ("A")
26. Oil relief valve (non-adjustable)

Figure 8-1. Typical Crankcase Assembly - TIO-541



1. Lifting eyes
2. Lifting eye spacer
3. Mount - upper right
4. Lifting strap
5. Oil filler tube
6. Oil filler tube cap
7. Oil filler tube chain
8. Oil level gage assembly
9. Mount - upper left
10. Oil bypass valve housing
11. Oil pressure relief valve assembly
12. Mount - lower left
13. Hydraulic lifter
14. Piston cooling nozzle
15. "O" ring
16. Starter housing bushing
17. Mount - lower left

Figure 8-2. Typical Crankcase Assembly (TIGO-541)

8-14. (All Models). Unscrew the hex head bolts, remove the lockplates and camshaft gear from the camshaft.

8-15. (TIO-541). See figure 8-6. Lift out the hydraulic and vacuum pump driveshaft (8), the intermediate accessory drive gear (7) and the accessory idler gear (16). Remove the circlip (9) from the fuel pump idler gear shaft (14) and remove the idler gear (10) and thrust washer (12) from the shaft. Remove the capscrews (15) and lockplate (3) from the shaft. Remove the circlip (9) from the outside of the case and remove the fuel pump drive gear (11) and thrust washer (12). Remove the cotter pin (17) and slotted nut (18) from outside of case and remove the breather slinger gearshaft (6). The slinger gear (21), pinion rollers (20), thrust washer (12) and shield (19) can be removed.

8-16. (TIGO-541). See figure 8-7. Remove the hydraulic and vacuum pump driveshaft (7), the intermediate accessory drive gear (6) and the accessory idler gear (19). Remove the circlip (8) from the fuel pump idler gear shaft (14) and lift the idler gear (9) and thrust washer (17) from the shaft. Unscrew the hex head bolts (16) and remove the lockplate (15) and idler gearshaft (14). Remove the circlip (13) from the outside of the case and lift out the thrust washer (12) and fuel pump drive gear (11).

8-17. Propeller Shaft Assembly. See figure 8-9. Remove the circlip (18), "O" ring (19) and pull oil transfer tube (20) from oil supply tube (1). Remove governor drive gear (13) and locknut (12). Remove cones (9 and 11), prop shaft driven gear (10), thrust bearing (8), oil slinger (7), shim (6), thrust bearing cap (5), oil seal (4) and Woodruff key (3).

8-18. Starter Drive Assembly. See figure 8-10. Remove nut (9) from a shaftgear (7) and disassemble as shown.

NOTE

Torquemeter oil pump assembly is no longer applicable to TIGO-541 series engines. See Service Bulletin No. 350 for detailed information.

8-19. Thrust Bearing Propeller Shaft Drive. See figure 8-11. Disassemble as shown.

8-20. Starter Drive Adapter Assembly. See figure 8-13. Disassemble as shown in figure 8-13.

8-21. Alternator Drive Assembly. See figure 8-14. Disassemble as shown in figure 8-14.

CLEANING

8-22. All crankcases, crankshafts and accessory drives etc. should be 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 oil passages with suitable brushes, after which thoroughly flush with clean solvent and compressed air.

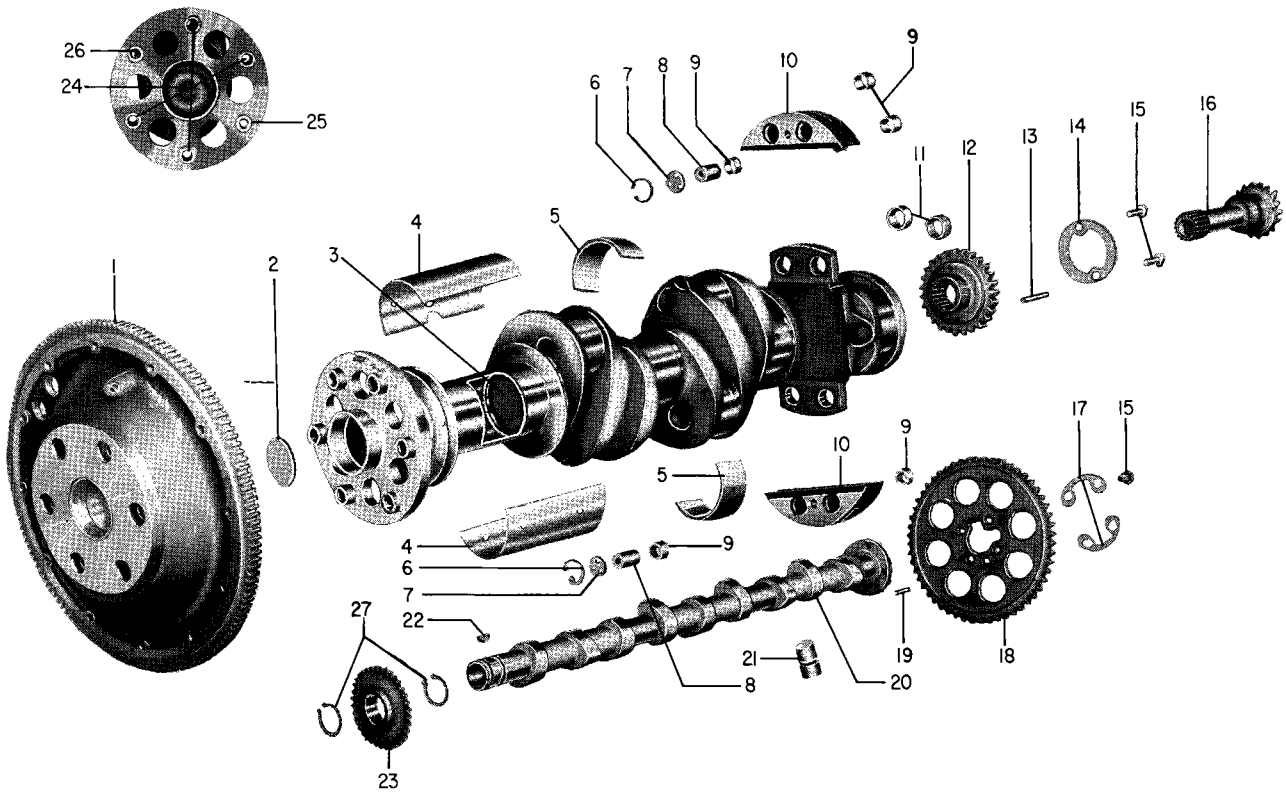
8-23. PISTON COOLING OIL JETS. Immerse the piston cooling nozzle in petroleum solvent. Hold the ball check valve off its seat in the nozzle by inserting a light copper wire or other relatively soft material through the threaded end of the nozzle and wash thoroughly so that any dirt particles that may be under the ball seat will be washed out.

8-24. 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.

8-25. 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.

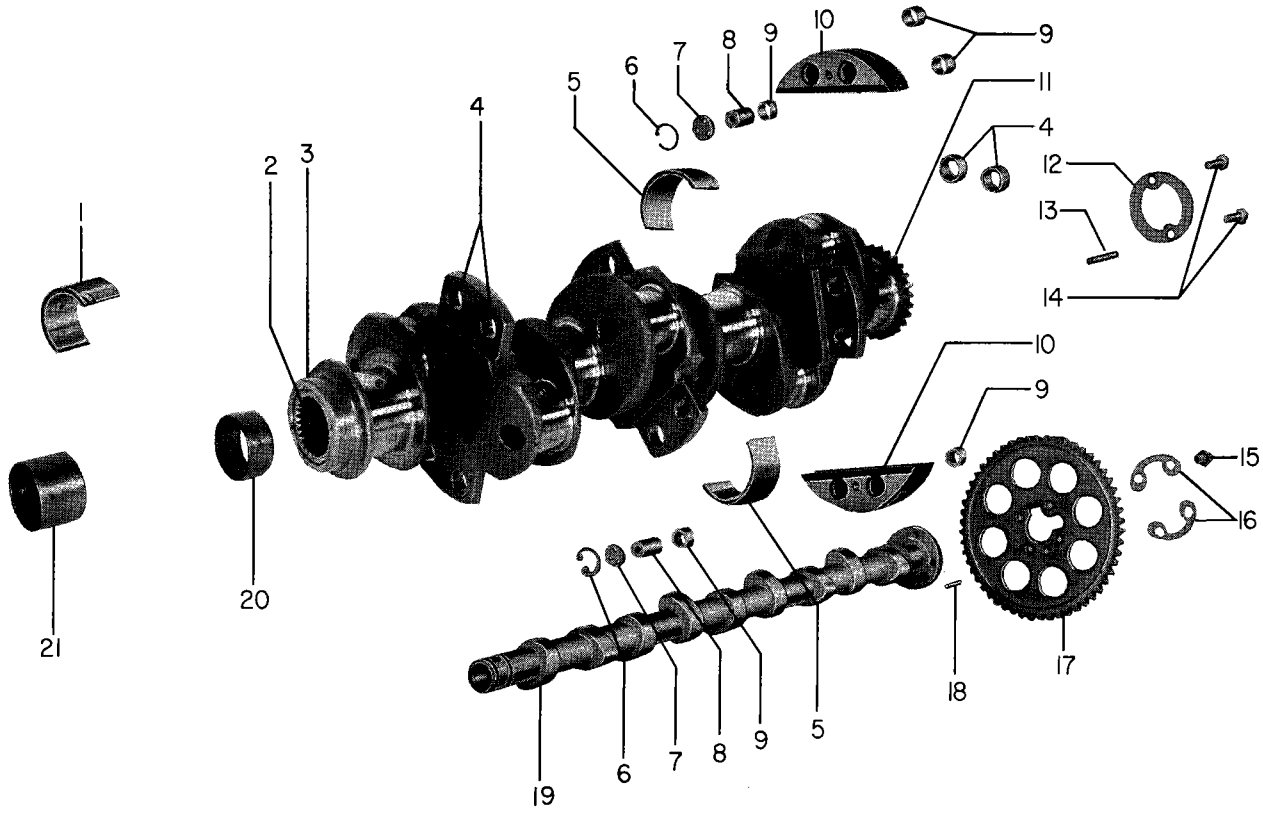
8-26. CRANKCASE (DIMENSIONAL INSPECTION). The following paragraphs on crankshaft and camshaft dimensions will also describe dimensional requirements of the crankcase.

8-27. CRANKSHAFT (VISUAL INSPECTION). Carefully inspect all surfaces of the shaft for cracks. Check the bearing surfaces with particular care for galling, scoring or other damage. Inspect oil transfer tubes for tightness. Check propeller flange bushings for tightness; mark for replacement any that are loose.



1. Ring gear and support assembly
2. Expansion plug
3. Plug
4. Front main bearing
5. Main bearing
6. Circlip
7. Washer
8. Roller
9. Counterweight bushing
10. Counterweight - "E" series employs 4 ct'wts.
11. Crankshaft ct'wt. bushings
12. Crankshaft gear
13. Dowel
14. Lockplate
15. Hex head bolts
16. Accessory drive gear
17. Lockplate
18. Camshaft gear
19. Dowel
20. Camshaft
21. Hydraulic lifter
22. Woodruff key
23. Governor drive gear
24. Propeller flange bushing, long
25. Propeller flange bushing, short
26. Propeller flange bushing, indexing
27. Circlips

Figure 8-3. Crankshaft and Related Parts (TIO-541)



1. Prop. shaft bearing
2. Spline bushing
3. Dowel
4. Crankshaft counterweight bushing
5. Crankshaft bearing
6. Retaining ring
7. Counterweight washers
8. Counterweight rollers
9. Counterweight bushings
10. Counterweight
11. Crankshaft gear
12. Lockplate
13. Dowel
14. Hex head bolts
15. Hex head bolts
16. Lockplate
17. Camshaft gear
18. Stepped dowel
19. Camshaft
20. Prop. drive gear rear bearing
21. Prop. drive gear front bearing

Figure 8-4. Crankshaft and Related Parts (TIGO-541)

8-28. 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 re-used. 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.

8-29. Using new inserts at all main bearing locations, assemble crankcase halves together temporarily 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 reground undersize. See Repair and Replacement section for instructions for regrinding.

8-30. 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 hydraulic lifter has been rejected for spalling or excessive wear, 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.

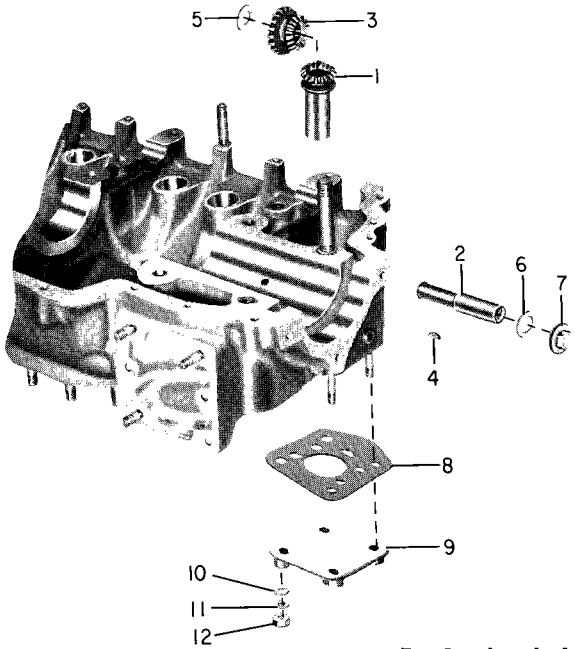
8-31. CAMSHAFT (DIMENSIONAL INSPECTION). Support the camshaft in Vee blocks at its front and rear bearing journals and check the run-out at the center bearing location. See reference 539, Table of Limits. Slight bending operations are permissible on

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.

8-32. CONNECTING RODS (VISUAL INSPECTION). It is necessary to make a thorough visual check for galling. Galling is generally indicative of excessive speed or overboosting; and if permitted to exist can result in failure of the rod.

8-33. Galling, as shown in figure 8-15, is caused by an infinitesimal movement between the surfaces of the bearing insert and the connecting rod during periods of high loading such as is produced during overspeed or excessive manifold pressure operation. The visual evidence produced by galling appears as if particles of metal from one contacting surface had welded to the other. The bearing insert shown in figure 8-15 represents a typical case of galling; while the connecting rod bearing bore shown is an example of severe galling and indicative of imminent failure of the connecting rod. Regardless of extent, evidence of any galling is sufficient reason for rejection of the complete rod assembly.

8-34. The rods and bearing inserts must be thoroughly clean and the examination carried out with the aid of a 6 power magnifying glass (minimum) or bench microscope. Do not mistake stains or discoloration for galling; surface blemishes are easily removed with a fine abrasive cloth, chemical cleaner or steel wool while galling cannot be removed. Galling is a distortion in the metal and is comparable to corrosion in the manner in which it weakens the metallic structure of the connecting rod.



1. Governor driven gear
2. Governor idler gear shaft
3. Governor idler gear
4. Key
5. Thrust washer
6. Gasket
7. Hex head plug
8. Gasket
9. Cover
10. Washer
11. Lockwasher
12. Nut

Figure 8-5. Propeller Governor Drive (TIO-541)

8-35. CRANKSHAFT COUNTERWEIGHT BUSHINGS. Wear or damage to the crankshaft counterweight bushings located in the crankshaft counterweight lugs, is almost impossible to detect by normal inspection procedures. Because of this situation and as damage to the crankshaft counterweight bushings could cause failure of the counterweight and/or the crankshaft, it is mandatory that these bushings be replaced at overhaul. The procedure for removal and replacement of the crankshaft counterweight bushings is contained in paragraphs 8-50 through 8-55.

8-36. Measure the out-of-roundness of all crankpin and main bearing journals on the crankshaft and all camshaft bearing journals.

NOTE

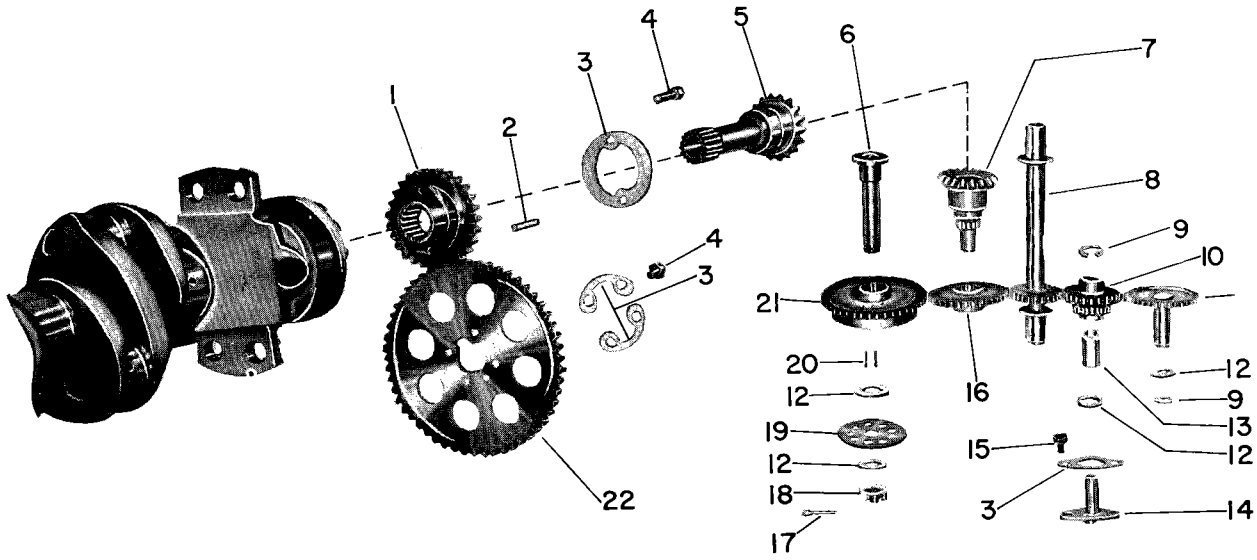
If a new or reconditioned camshaft is to be used on the engine, new tappet bodies must also be used.

8-37. CONNECTING RODS. Discard connecting rod bolts and nuts; new bolts and nuts are to be used on reassembly. Check condition of bore in large end for seating of the bearing inserts. Check bore in small end bushing with connecting rod bushing plug gage (64537). If this gage enters the bushing, the bushing must be replaced.

8-38. CONNECTING ROD PARALLELISM CHECK. See figure 8-16. Using connecting rod parallelism and squareness gage (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 and place gage arm (5) on arbor (4). Set adjusting screw (6) on gage arm to exact distance between arbors and lock the adjusting screw with the wing nut (7). Then remove gage arm and place it on the other end of arbor (4), 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

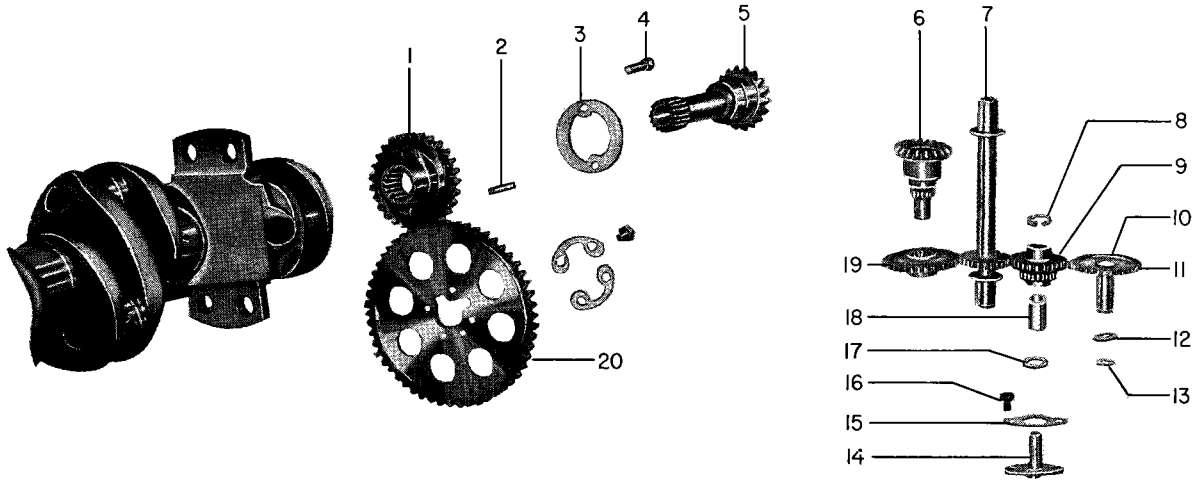
8-39. CONNECTING ROD SQUARENESS CHECK. See figure 8-17. Using the connecting rod parallelism and squareness gage (64530) with the gage arm removed, place parallel blocks (1) on surface plate and, with sleeves and arbors still in place in connecting rod place ends of arbors on parallel blocks. Check clearance at points (2) where arbor rests 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.

8-40. PISTON COOLING OIL JETS. Test the nozzle assemblies for correct pressure in the following manner. Using SAE #10 motor oil at a temperature of 65° to 90° F. direct a flow of oil through the nozzle. The oil stream must pass from the nozzle through a one inch diameter hole located on a center line through the nozzle and 4.5 inches from the face of the nozzle at 50 psi. The valve must not open below 37 psi; the valve opening shall be defined as the point where leakage changes from droplets to a stream.



1. Crankshaft gear
2. Dowel
3. Lockplate
4. Hex head bolt
5. Accessory drive gear
6. Breather gear shaft
7. Accessory drive gear (inter.)
8. Hydraulic and vacuum pump drive gear shaft
9. Retaining ring
10. Fuel pump idler gear
11. Fuel pump drive gear
12. Thrust washer
13. Bushing
14. Fuel pump idler gear shaft
15. Hex head bolt
16. Accessory idler gear
17. Cotter pin
18. Shear nut
19. Breather shield
20. Pinion rollers
21. Breather slinger gear
22. Camshaft gear

Figure 8-6. Accessory Drive Gear Train - TIO-541



1. Crankshaft gear
2. Dowel
3. Lockplate
4. Hex head bolt
5. Accessory drive gear
6. Intermediate accessory drive gear
7. Hydraulic and vacuum pump drive shaftgear
8. Retaining ring
9. Fuel pump idler gear
10. Plug
11. Fuel pump drive gear
12. Thrust washer
13. Retaining ring
14. Fuel pump idler gear shaft
15. Lockplate
16. Hex head bolt
17. Thrust washer
18. Bushing
19. Accessory idler gear
20. Camshaft gear

Figure 8-7. Accessory Drive Gear Train - TIGO-541

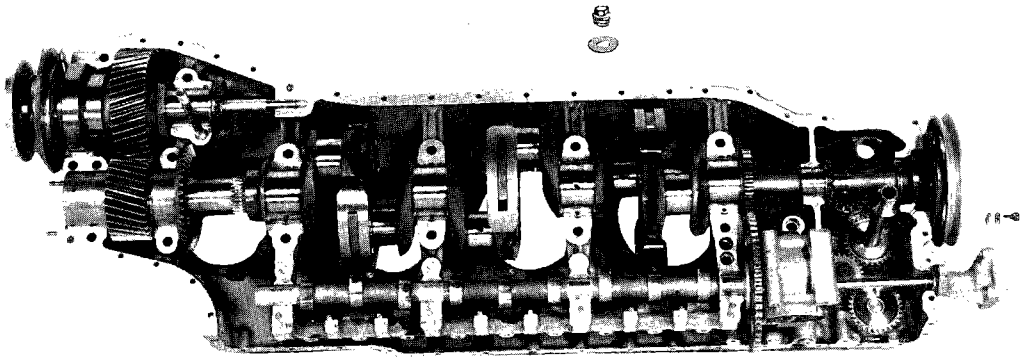


Figure 8-8. Crankshaft, Camshaft and Gears Assembled in Right Crankcase Half (TIGO-541)

REPAIR AND REPLACEMENT

8-41. Repair all crankcase, crankshaft and reciprocating parts in accordance with the general instructions contained in Section 3. Specific instructions follow.

8-42. 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 areas of stress concentration that can develop into fatigue cracks and ultimately result in a broken crankshaft.

8-43. 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 degree of skill. A properly dressed wheel (Carborundum (GA-54-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.

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 Avco Lycoming for renitriding.

8-44. STRAIGHTENING CRANKSHAFT FLANGE. (TIO-541). If the crankshaft run-out exceeds the maximum service limit of .005 inch but does not exceed 0.018 inch TIR and the rest of the shaft is within the limits given in the Table of Limits, the crankshaft flange may be straightened.

8-45. When surface distortion of the flange has been reduced as much as possible the front face of the flange should then be trued by grinding. This operation is permissible, however, only if the minimum width of the flange after grinding is not less than 0.430 inch.

CAUTION

Exercise extreme care during straightening operations in order to avoid damage to the nitrided surfaces of the crankshaft. These surfaces, which extend without interruption from the front oil seal seat to the crankshaft gear position are glass-hard and will crack if the shaft is bent, dropped or carelessly handled in any way.

8-46. At the conclusion of straightening operations, the entire crankshaft must be inspected by the magnetic particle method, paying particular attention to bearing surfaces and the fillet areas at the base of the flange.

8-47. Cadmium plate the ground surfaces of the crankshaft flange. The plating, which should be 0.005 inch maximum thickness, should extend along the crankshaft only to front face of slinger.

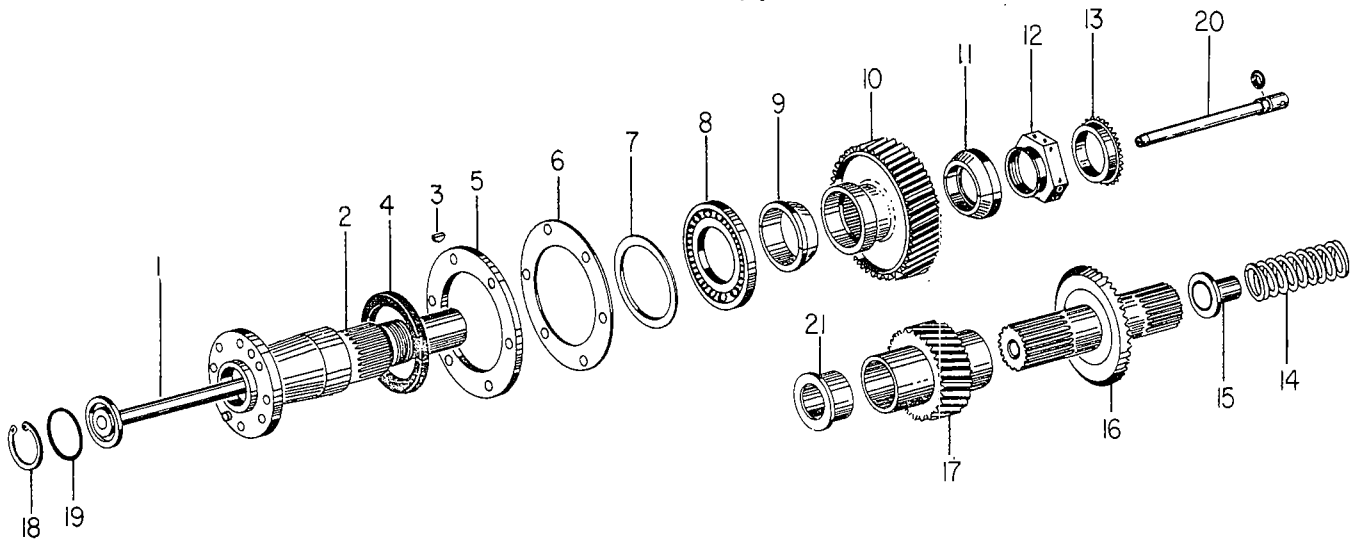
8-48. CRANKSHAFT OIL SEAL SURFACE. Oil leaks that develop at the front crankshaft oil seal can usually be eliminated by removing nicks, scratches, or similar physical damage from the oil seal area of the crankshaft and by restoring its surface finish to like-new condition. Consult Service Instruction No. 1111 for procedures and tooling required to accomplish this reconditioning.

8-49. CYLINDER BASE STUD REMOVAL AND REPLACEMENT. In the event of a cylinder base stud failure, the adjacent studs are immediately placed under a greater operating pressure and likely to be stressed beyond their elastic limit. Therefore, in the event of a stud failure, all of the hold down studs adjacent to the failed stud must be replaced. Consult Service Bulletin No. 211 for procedures and tooling required to remove and replace studs.

8-50. Crankshaft, Counterweight Bushing Replacement (Where applicable). Wear or damage to the crankshaft counterweight bushings located in the crankshaft counterweight lugs, is almost impossible to detect by normal inspection procedures. Because of this situation and as damage to the crankshaft counterweight bushings could cause failure of the counterweight and/or the crankshaft, it is mandatory that these bushings be replaced at overhaul. The procedure for removal and replacement of the crankshaft counterweight bushings follows.

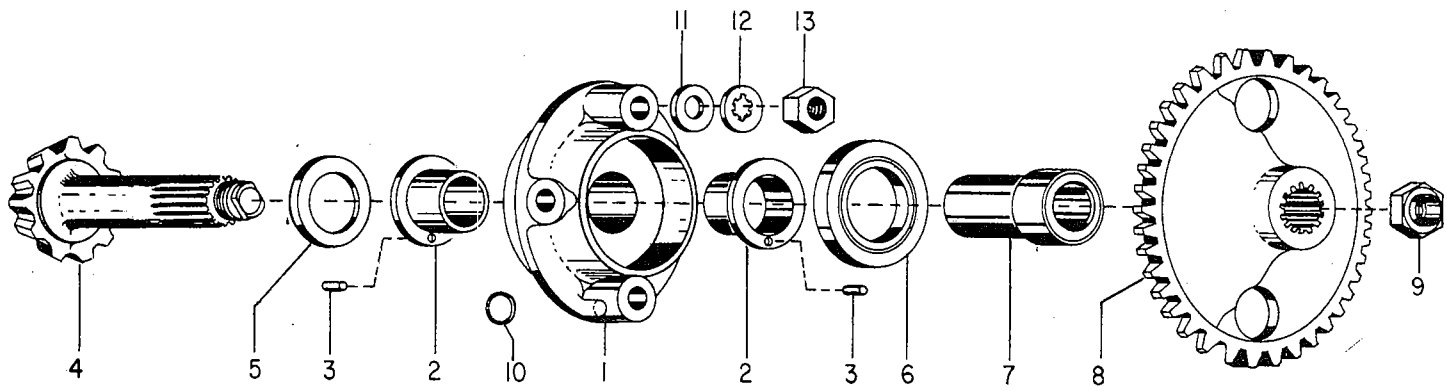
8-51. Thread the bolt of the counterweight bushing puller through the puller plate, positioning the plate so that the recess in it will be next to the crankshaft when the puller bolt is inserted through the bushing in the crankshaft. Install the small puller bushing over the end of the bolt and then place the puller nut over the end of the bolt and tighten. As the nut is tightened on the bolt the counterweight bushing will be pushed out of its recess in the crankshaft counterweight mounting ear and into the recess in the puller plate. See figure 8-18.

8-52. Measure the ID of the roller bushing hole in the crankshaft. If the hole measures 0.9369 - 0.9377 inch, no reaming of the hole is necessary and a standard bushing may be installed. If the roller bushing hole measures more than 0.9377 inch, the next oversize bushing must be installed and the hole reamed accordingly. See Table 8-1.



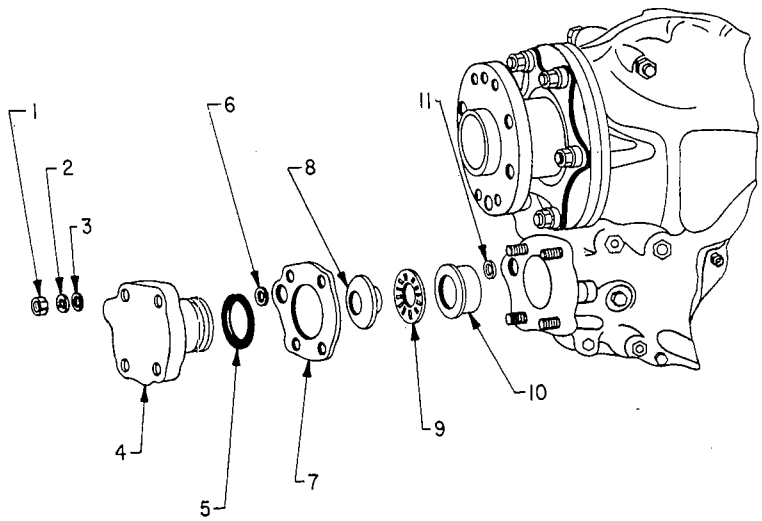
1. Prop. oil transfer tube
2. Prop. shaft
3. Woodruff key
4. Prop. shaft oil seal
5. Thrust bearing cap
6. Shim
7. Oil slinger
8. Thrust bearing
9. Prop. hub split cone
10. Prop. shaft driven gear
11. Prop. hub split cone
12. Prop. shaft nut
13. Governor drive gear
14. Spring
15. Spring adapter
16. Generator and starter gear
17. Prop. drive shaftgear
18. Retaining ring
19. "O" ring seal
20. Prop. oil supply tube
21. Rear thrust bearing race

Figure 8-9. Propeller Shaft, Generator and Starter Drives (TIGO-541)



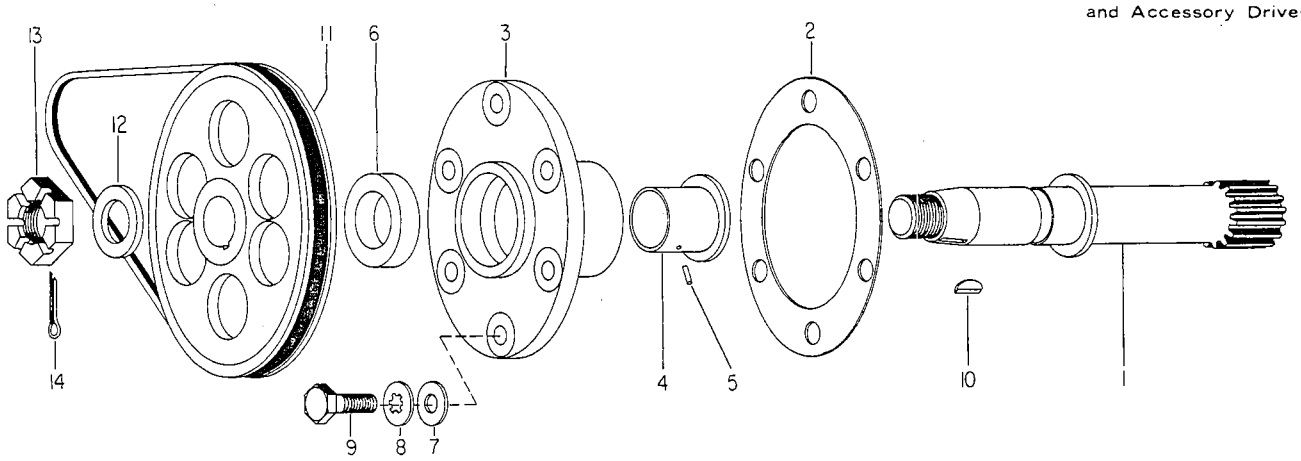
1. Starter drive adapter
2. Bushing
3. Dowel
4. Starter drive shaftgear
5. Thrust washer
6. Seal
7. Starter drive gear spacer
8. Starter drive gear
9. Nut
10. "O" ring
11. Washer
12. Lockwasher
13. Nuts

Figure 8-10. Starter Drive Assembly (TIGO-541)



1. Nut
2. Lockwasher
3. Washer
4. Cover
5. Seal ring
6. "O" ring seal
7. Shim
8. Seat
9. Thrust bearing
10. Rear bearing race
11. "O" ring seal

Figure 8-11. Thrust Bearing Propeller Shaft Drive Components



1. Compressor drive shaft
2. Gasket
3. Compressor drive adapter
4. Bushing
5. Dowel
6. Oil seal
7. Washer
8. Lockwasher
9. Hex head bolt
10. Woodruff key
11. Compressor drive pulley
12. Washer
13. Slotted shear nut
14. Cotter pin

Figure 8-12. Compressor Drive Assembly (TIGO-541, TIO-541-E)

TABLE 8-1

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

8-53. Determine the oversize reamer needed and assemble the reaming fixture ST-280 over the crankshaft lug. Select the two openings in the fixture to line up with bushing holes and install the plugs provided to line up the holes in the fixture with the holes in the crankshaft lugs. Secure the fixture by tightening the set screws. See figure 8-19. Assemble the reamer to a suitable brace and proceed to hand ream the hole in the crankshaft lug to proper size.

8-54. Assemble the puller to the crankshaft in the same manner as described in paragraph 8-51, except that the large puller bushing is used instead of small puller bushing. Place the correct size crankshaft lug and the large puller bushing. When the puller nut is tightened, the bushing will be forced into place in the crankshaft.

CAUTION

The inside diameter of these bushings is finished at the factory and no further machining of the bushing is necessary. Caution must be exercised when installing the bushings so that this finished ID is not damaged. Because of possible damage to the crankshaft, never, under any circumstances, remove or install the roller bushings by use of a drift.

8-55. After the bushing is installed, check its alignment with the main bearings by placing the crankshaft in vee blocks on a surface plate. Install the wedge blocks, Tool No. ST-212, in the bushing and compare parallelism of the wedge blocks with that of the main journals. Bushing must be parallel with .002 per inch. Support the crankshaft in the vee blocks at journals adjacent to the bushing location.

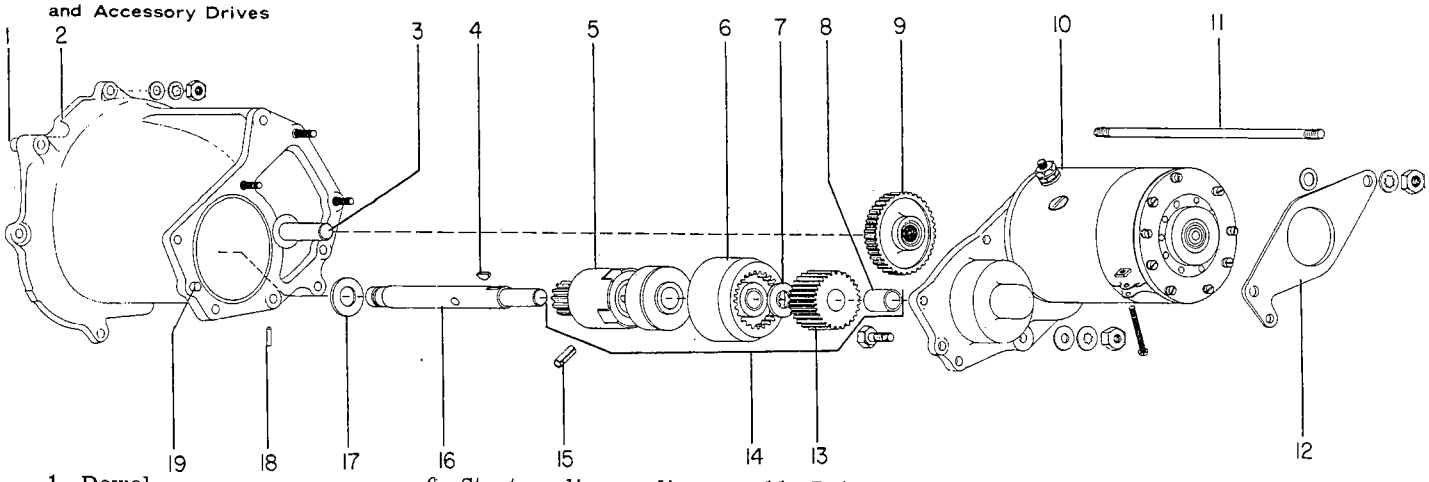
8-56. CONNECTING ROD BUSHINGS. If the bushing in the small end of the connecting rod is worn beyond service limits, it can be replaced in the following manner.

8-57. Clamp the connecting rod on the connecting rod bushing replacement block (64597) in such a manner that the small bushing in the rod is in alignment with the hole stamped "Remove Bushing". Using the connecting rod bushing removal drift (64535), 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 (64536), drive the new bushing into place in the rod. Locate bushing so that split is toward the piston end of the rod and 45° off the center line.

8-58. Use a suitable arbor press and the connecting rod bushing burnisher (64580) to burnish the bushing in place. Pass the burnisher completely through the bushing. Remove the rod from the holding block and finish bore the bushing to the diameter shown in reference 510, Table of Limits. Check the bushing ID with finish ID gage (64767). Check alignment of the hole in bushing with the connecting rod parallelism and squareness gage as described in paragraphs 8-38 and 8-39. If the assembly does not meet the requirements shown in reference 556 and 567, Table of Limits, the entire assembly must be replaced.

REASSEMBLY

8-59. CRANKSHAFT. (TIO-541). (2, figure 8-3). If the expansion plug was removed install a new plug in the following manner: Use the crankshaft welch plug driver (64681) to drive the plug in place with the convex side toward the front. Be sure the plug seats firmly against the shoulder provided on the ID of the crankshaft.



1. Dowel
2. Starter drive housing
3. Starter idler gear shaft
4. Woodruff key
5. Starter slip coupling
6. Starter slip coupling
7. Thrust washer
8. Bushing
9. Starter idler gear
10. Starter
11. Retaining plate studs
12. Retaining plate
13. Slip coupling gear
14. Slip coupling assy.
15. Pin
16. Bendix drive shaft
17. Thrust washer
18. Dowel
19. Dowels

Figure 8-13. Starter Drive Adapter Assembly (TIGO-541)

8-60. 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 the new bushings. See figure 8-3 for proper location of the bushings.

8-61. See figure 8-3. Install the crankshaft gear (12) over the dowel on the shaft and secure with lockplate (14) and hex head bolts (15).

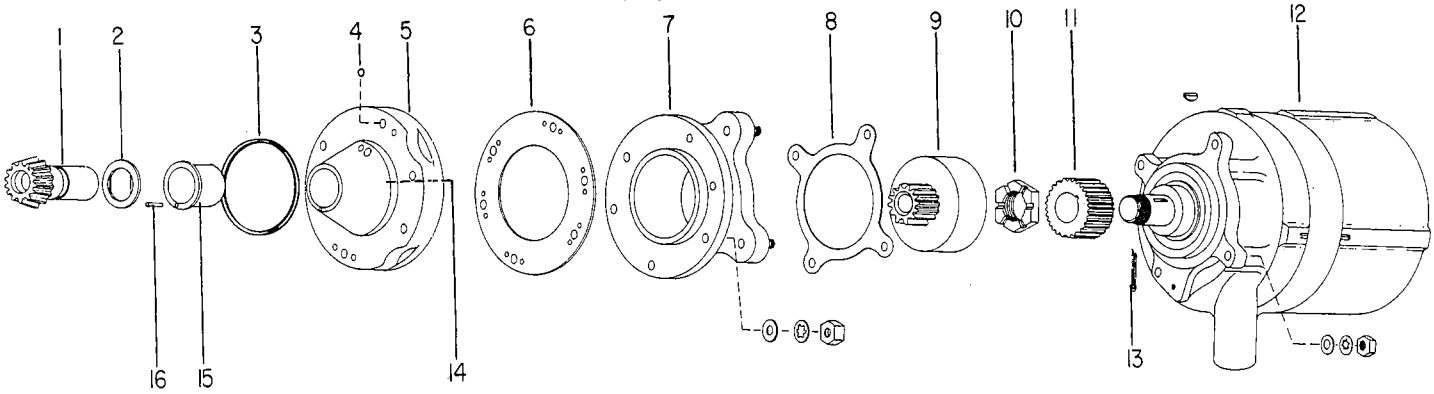
8-62. (TIGO-541). See figure 8-4. Assemble the crankshaft gear (11) over the dowel on the shaft and secure with lockplate (12) and hex head bolts (14).

8-63. (All Models). Using identifying marks made on the various counterweight parts during disassembly, match each washer with the proper seat on the counterweight from which it was removed. Install washers and new retaining rings on one side of the counterweight, place the counterweight on its proper ear of the crankshaft, insert the rollers, and secure the assembly by installing the washers and retaining rings on the other side of the counterweight.

NOTE

Washers are installed with the chamfered side in toward the roller and the retaining rings are inserted with the sharp edge outward (see figure 8-20) and the gap in position shown in figure 8-21.

8-64. Insert one end of the counterweight retaining ring gap gage (64892) between the ends of the counterweight retaining ring. Make sure the gage is resting on the bottom of the groove. The gage must pass between the ends of the retaining ring and when rocked back and forth must clear the inside edge of the top of the retaining ring. If the gage does NOT pass freely between the ends and under the top of the ring, the ring is NOT seated properly. Be certain all rings are properly seated.



1. Alternator drive gear
2. Thrust washer
3. "O" ring
4. "O" ring
5. Alternator drive adapter
6. Gasket
7. Alternator adapter
8. Gasket
9. Alternator drive coupling
10. Slotted shear nut
11. Drive coupling adapter
12. Alternator
13. Cotter pins
14. "O" ring
15. Bushing
16. Dowel

Figure 8-14. Alternator Drive Assembly (TIGO-541)

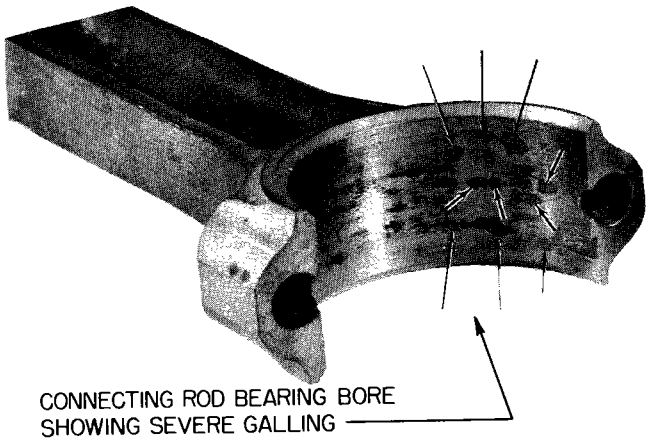
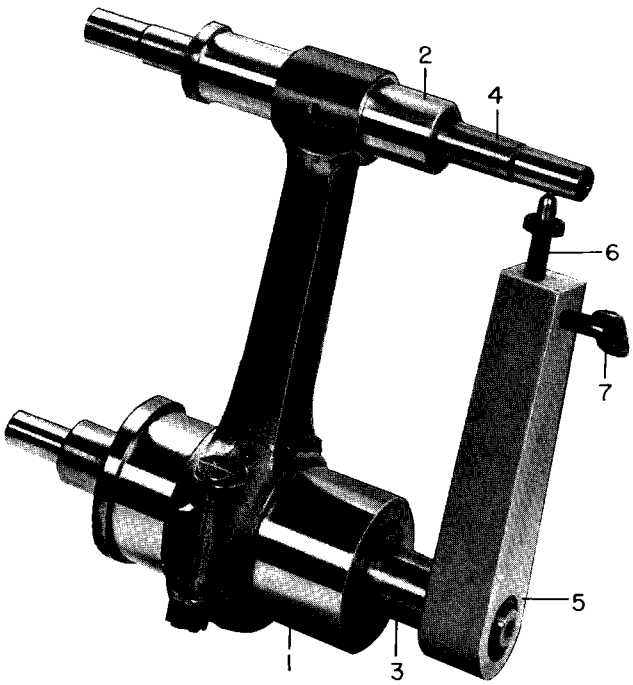


Figure 8-15. Connecting Rod Showing Damage by Galling

8-65. Assemble two new connecting rod bolts in each connecting rod cap and install new bearing inserts in the connecting rods and connecting rod caps, making sure the tang on each bearing insert enters locating slot in cap and connecting rod. Assemble each connecting rod assembly after installing inserts; tighten bolt nuts moderately tight. Measure the ID of each bearing and check for clearance against measurements taken previously on diameter of crankpin journals.



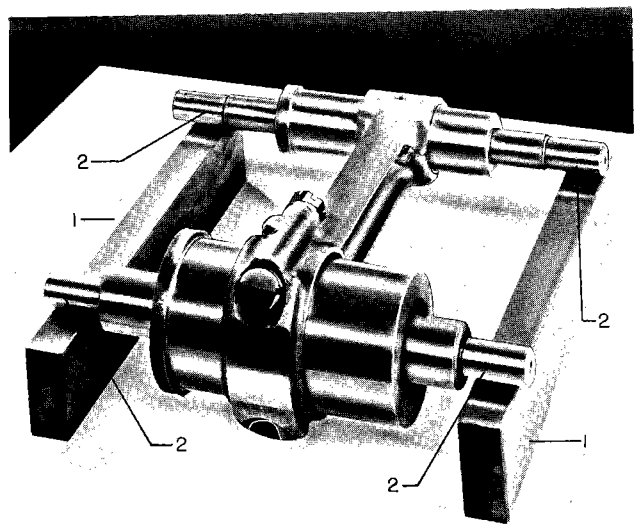
1. Tapered sleeve
2. Tapered sleeve
3. Arbor
4. Arbor
5. Gage arm
6. Adjusting screw
7. Wing nut

Figure 8-16. Checking Parallelism of Conn. Rod

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".

8-66. Place the crankshaft on a suitable support on bench so that all crankpins are free for installation of



1. Parallel blocks
2. Check points

Figure 8-17. Checking Squareness of Connecting Rod

connecting rods. Disassemble connecting rods after checking bearing ID, thoroughly coat both the 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 on the rods will be down (toward sump).

8-67. Using a socket wrench, alternately tighten the connecting rod nuts and check rod bolt stretch with the stretch bolt gage (64945). Continue to tighten until bolts are stretched to 2.255/2.256 inches. If the stretch limit of 2.256 inch is exceeded, the connecting rod bolt must be replaced. Check the connecting rod side clearance according to Table of Limits.

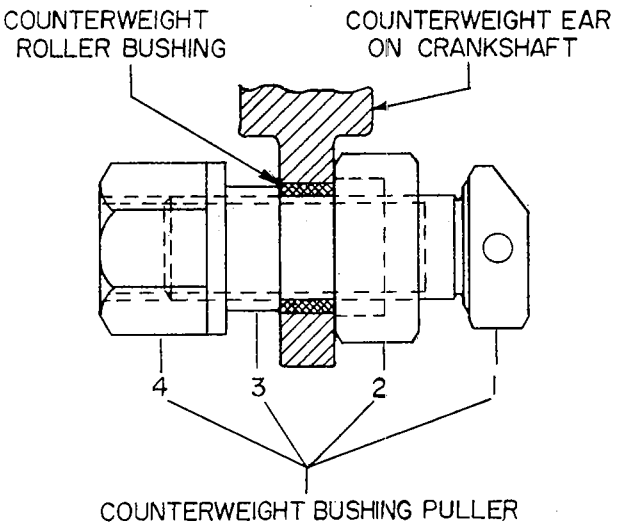
8-68. CAMSHAFT. (TIO-541). See figure 8-3. Assemble propeller governor drive gear (23) and secure with circlips (27). Assemble camshaft gear (18) and secure with lockplate (17) and hex head bolts (15).

8-69. (TIGO-541). See figure 8-4. Assemble camshaft gear (17) and secure with lockplate (16) and hex head bolts (15).

8-70. CRANKCASE. (All Models). Apply thread lubricant and install those plugs which were removed to facilitate cleaning the oil passages. Install piston cooling jets and tighten to specified torque. Reference 857, Table of Limits.

8-71. Install new main bearing inserts for all main bearings in both crankcase halves, being sure that the tang on each bearing insert fits into the slot in the crankcase. Bolt crankcase halves together temporarily and measure the ID of each main bearing formed by the inserts. Check the clearances with the measurements previously taken on the journals. Also measure the ID of camshaft bearings formed by camshaft bearing bore and check the clearances with the measurements previously taken on the journals. Separate the crankcase halves.

8-72. (TIO-541). Place both crankcase halves on a suitable support with interior of each facing upward. Place new main bearing inserts in the center and rear



1. Puller bolt
2. Puller plate
3. Puller removal bushing
4. Puller nut

Figure 8-18. Removal of Counterweight Bushing from Crankshaft

main bearings of both crankcase halves, making certain that the tang of each insert is fitted into the recess provided in the crankcase. Place the front main bearing temporarily in position in the right crankcase half. Be sure that insert is properly located. Using a sharp pencil, trace on the bearing both lines of intersection between the crankcase parting flanges and the bearing. Also make a vertical reference mark on both the bearing and the crankcase at any convenient point along the line of intersection, thus locating the bearing both radially and axially. These marks are necessary to ensure proper seating of the bearing halves when positioning crankshaft in the crankcase.

8-73. Crankshaft Oil Seal (TIO-541) - Clean thoroughly oil seal recess in crankcase and crankshaft sealing

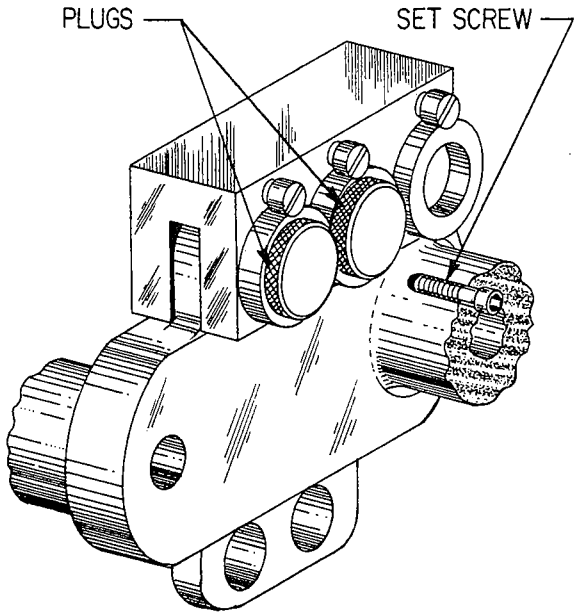


Figure 8-19. Reaming Fixture Assembled to Crankshaft

surface of all foreign matter with Methyl-Ethyl Ketone, Acetone, Napasco SC-200, M17 or M114 solvent.

8-74. Apply a thin film of Lubriko M-6 grease (or equivalent) on the sealing surface of the seal and around the crankshaft at the sealing surface.

8-75. Slip the seal around the crankshaft with the sealing lip toward the crankcase recess.

8-76. Clean the outside diameter of the crankshaft seal with solvent to remove any grease film. Apply Goodyear Pliobond No. 20 or Dow Corning Silastic No. 140 to the outside diameter and the split.

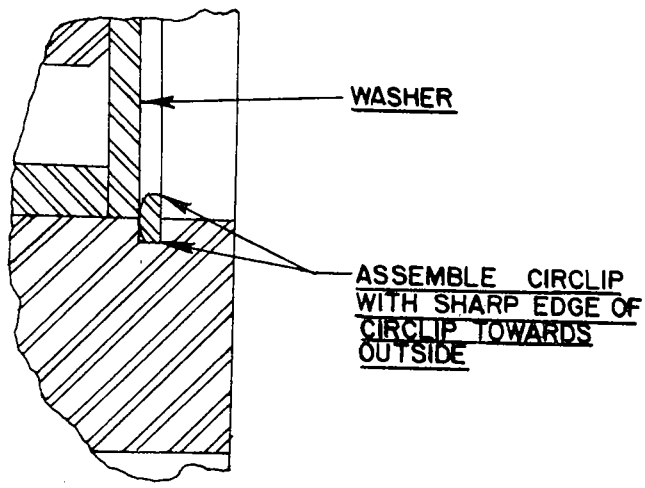


Figure 8-20. Assembly of Circlip Counterweight

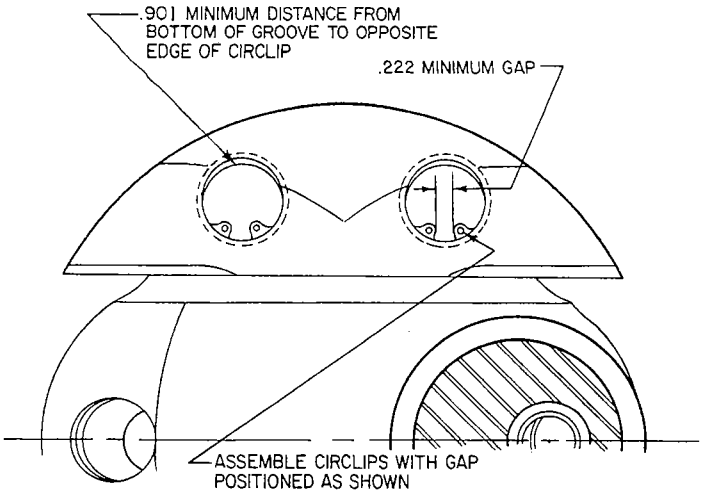


Figure 8-21. Location of Gap When Installing Retaining Rings

8-77. Place the right crankcase half on a suitable support on the bench with the cylinder mounting pads down.

8-78. See figure 8-5. (TIO-541). Place the governor driven gear (3) in its recess in the housing. Insert the idler gear shaft (4) through the opening in the case and assemble the idler gear (2) and thrust washer (1). Note that the thrust washer is a selective fit. Assemble the gasket (5), plug (6) and secure with lockwire.'

8-79. Place the crankshaft in the right crankcase half with the seal in its recess so the split will be in the 1 o'clock position. Now install the left crankcase half in place. Work the seal for final seating by using both hands, starting opposite the gap and working toward the gap.

8-80. See figure 8-6. Assemble the fuel pump idler gear shaft (14), lockplate (3) and secure with hex head bolts (15). Assemble the thrust washer (12) and idler

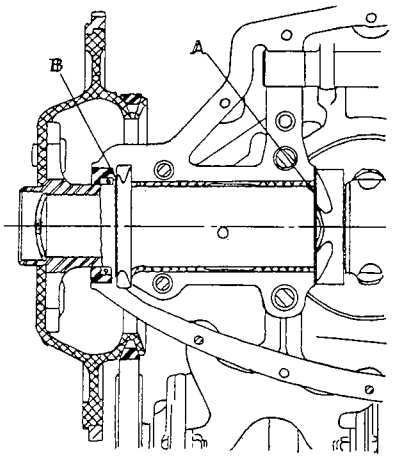


Figure 8-22. Crankshaft End Clearance Check

gear (10) over the shaft, secure with circlip (9). Assemble the fuel pump drive gear (11), thrust washer (12) into the opening in the case and secure on the outside of the case with the circlip (9). Assemble the breather slinger gear (21), thrust washer (12) breather shield (19), second thrust washer on the breather gear shaft (6). Install the assembly through the opening in the case, assemble slotted shear nut (18) tighten and secure with cotter pin (17). Install the hydraulic and vacuum pump drive shaft (8), accessory idler gear (16 and intermediate accessory drive gear (7).

8-81. Coat the main bearing journals of the crankshaft and the main bearing inserts with the mixture described in paragraph 3-39 and assemble the inserts. Pick up the crankshaft by numbers one and five connecting rods

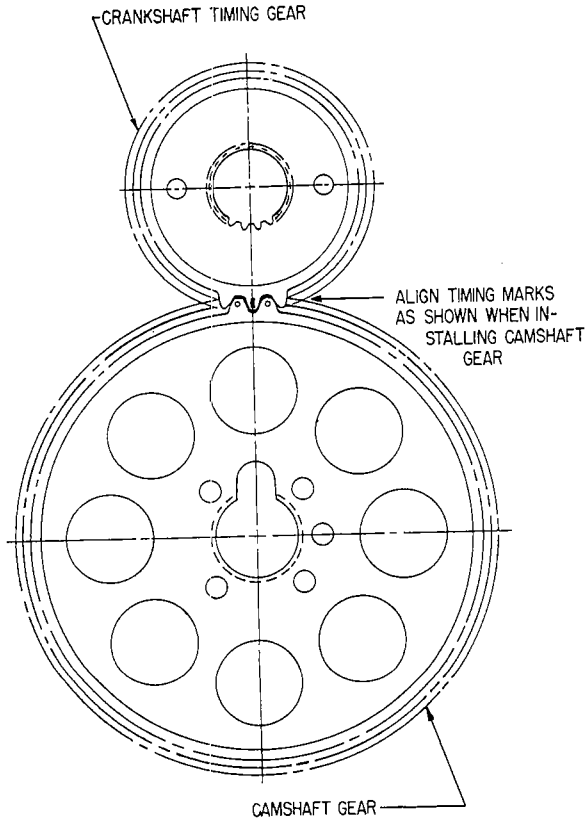


Figure 8-23. Alignment of Timing Marks

and lower the shaft into the right crankcase half, permitting rods 2, 4 and 6 to pass through their respective cylinder mounting pads. Using the reference marks previously made, adjust the main bearings.

8-82. See figure 8-22. If either the crankcase or crankshaft has been replaced, the end clearance of the crankshaft in the crankcase must be checked. Push the crankshaft as far front as possible and check the clearance at the rear of the front main bearing surface between the crankcase and crankshaft shoulder. If clearance is evident between the crankcase and crankshaft shoulder (see point "A"), regrind the front face of the crankshaft slinger (point "B") to remove the clear-

ance. Grind only that amount from the face of the slinger to remove clearance.

8-83. (TIGO-541). See figure 8-8. Reassemble the accessory drive gears in the reverse order of disassembly. Consult figure 8-7.

8-84. Assemble the two halves of the crankcase together with three, 1/2-20 thru studs. One at top and two at bottom of bearing bore. Tighten 300 inch pounds torque. Also, secure the rear of the crankcase with several 1/4-20 bolts; tighten these to 40 inch pounds torque.

a. Place thrust bearing (8) in thrust bearing bore with the filling slot toward the rear of the crankcase; be sure it is tight against the seat.

b. Place the thrust bearing cap (5) on the mounting studs and hold in place with two or three 3/8-16 nuts, finger tight so cap is against the bearing.

c. The amount of pinch, or pressure erected on the bearing is controlled by the thickness of the shim. This is accomplished as follows: Measure the clearance between the crankcase and the thrust bearing cap with a thickness gage. The clearance minus .003/.005 is the thickness for the new shim (6) when installed. The thickness of the shim is reduced by peeling off laminations; each lamination is .002 inch thick.

d. Apply a liberal amount of engine oil to the outside diameter of the double lip front oil seal (4) and with a suitable press, press the seal into the thrust bearing cap (5). The seal should be located with the twin lip side down.

e. Apply Anolith No. 2, Shell Alvania No. 2, or equivalent to the inside surface of the propeller shaft seal (4) and the outside surface of propeller shaft (2). Stand the shaft on the flange, and place the thrust bearing cap and seal on shaft and slide toward the propeller flange. In this position the two lips of the seal are facing up.

f. Install the previously prepared shim (6), on the propeller shaft.

g. Install slinger (7) with chamfered side of hole toward propeller shaft flange.

h. Liberally pre-oil the bearing (8) with 600W or SAE No. 50 engine oil around the inside surface of the races and then install on propeller shaft with the filling slot facing upward.

i. Install brass cone (9) with slot in line with keyway of the propeller shaft.

j. Install gear (10) with lockwire hole pointing upward and in line with keyway of the propeller shaft.

k. Lubricate propeller shaft threads with Parker Threadlube or equivalent.

l. Lubricate the split cone (11) on outside surface and install on propeller shaft.

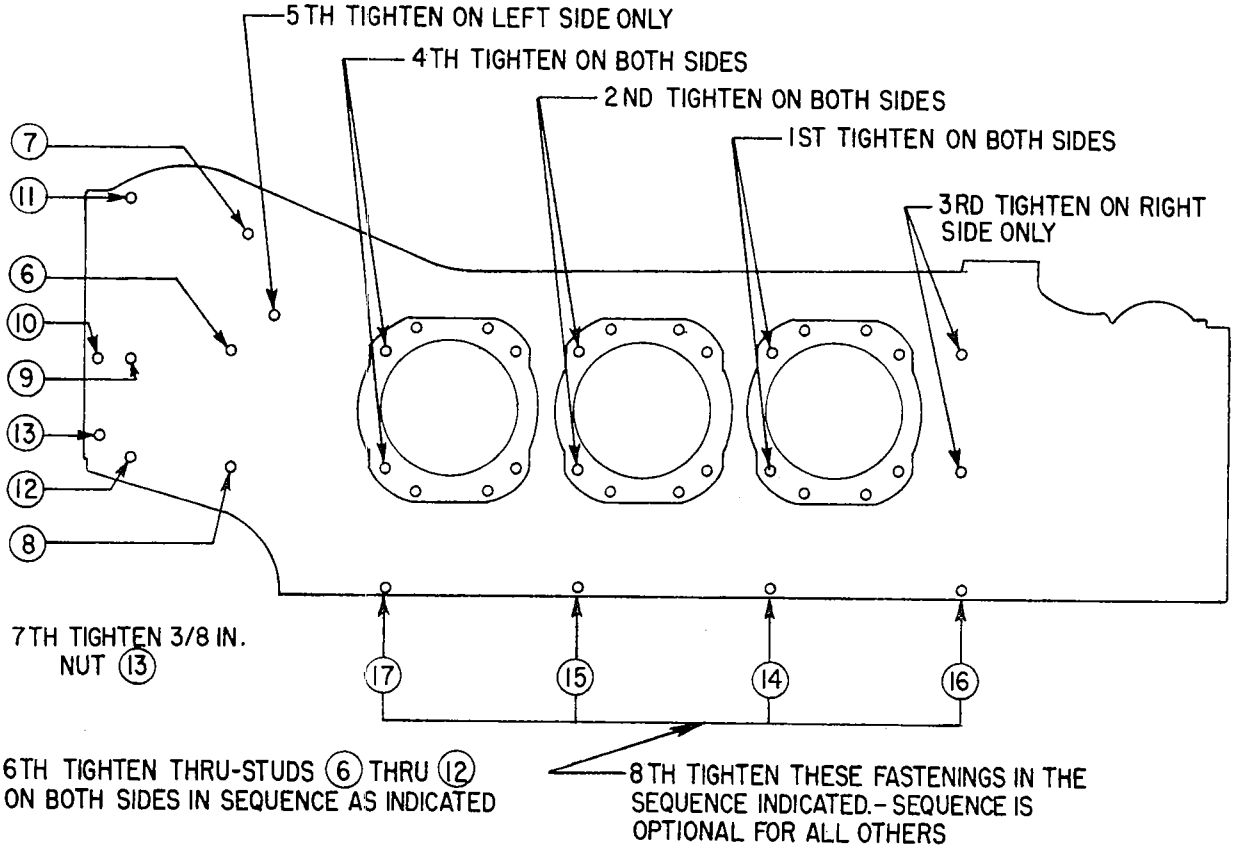


Figure 8-24. Crankcase Tightening Sequence (TIGO-541)

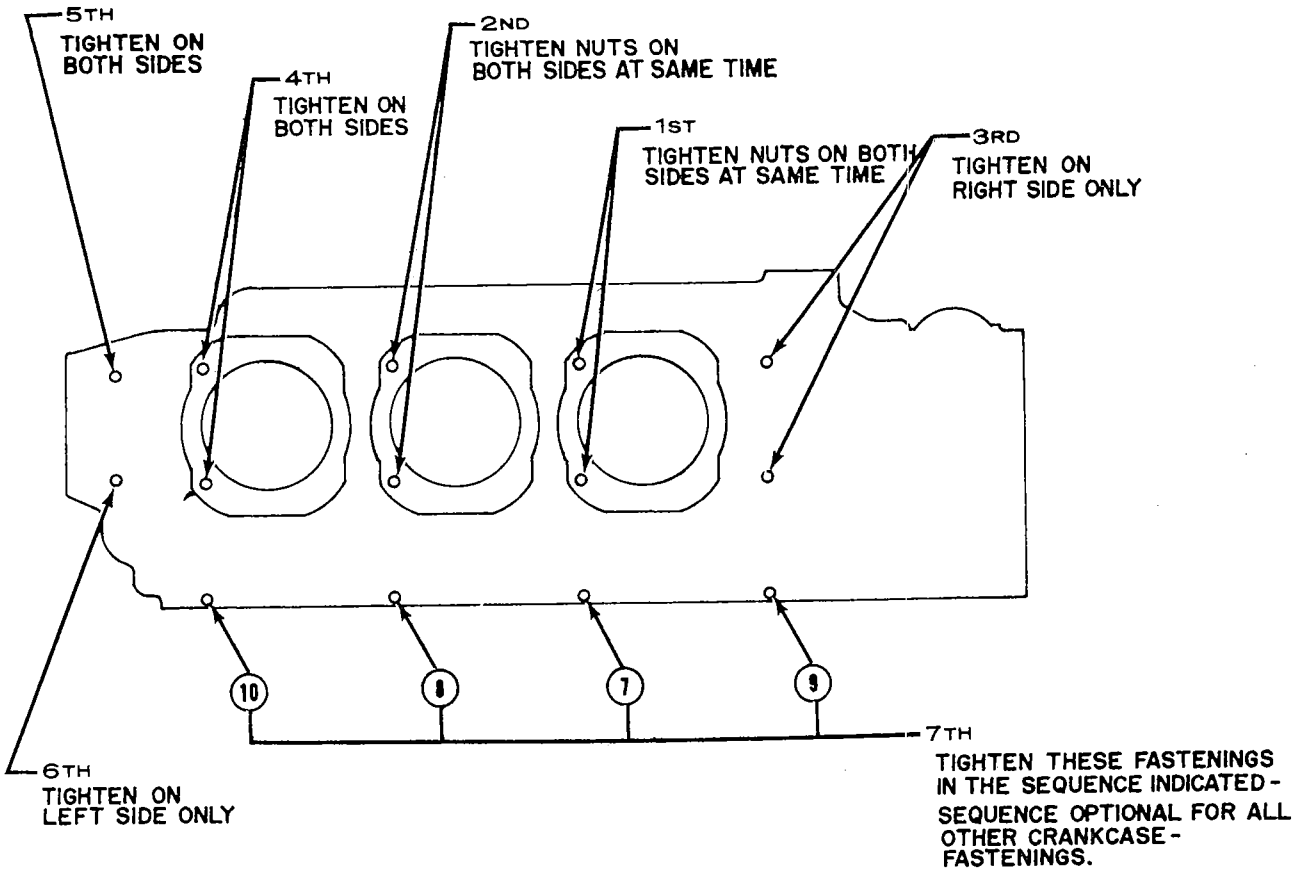


Figure 8-25. Crankcase Tightening Sequence (TIO-541)

m. Install propeller shaft nut (12) on shaft, tighten with finger keeping the spacing of cone equal on both sides of shaft.

n. Install propeller shaft on ST-329 fixture (propeller shaft locknut assembly) and tighten propeller shaft nut to 1000 foot pounds torque.

o. Set propeller shaft assembly in v-blocks located at the thrust bearing and at other end of propeller shaft. Place 1/4 inch diameter length of drill rod between the gear teeth; check run-out of the gear at about 6 places. Allowable run-out of the gear is ± .001 inch (.002 total indicated reading). If the run-out of the gear is not within the limits of ± .001, loosen propeller shaft nut and rotate split cone AN-5007-20, 90°. Retorque propeller shaft nut and recheck run-out. Repeat until the run-out is within the limits.

p. Safety wire propeller shaft nut (12) to gear (10).

NOTE

Lubricate propeller shaft thrust bearing with a liberal amount of 600W type lubricant or engine oil before installing in the crankcase.

8-85. (All Models). Coat camshaft as directed in paragraph 3-37 through 3-39. Install the camshaft in the right crankcase half positioning the crankshaft gear timing mark between the two marked teeth on the camshaft gear. See figure 8-23. Check the end clearance of the camshaft. (See Table of Limits).

8-86. Coat the outer mating surface of each crankcase half with a thin film of non-hardening gasket compound. The compound, which is used only to prevent leakage of oil to the outside of the engine, must not be applied to any of the interior mating surfaces such as the bearing support webs. Next, imbed a length of "00" silk thread in the gasket compound along the outside edge of crankcase half. Run thread so that it is on both sides of bolt hole without touching each other.

8-87. Install the "O" rings (21, figure 8-1 or 15, figure 8-2). Lower the left half of the crankcase carefully so that the studs align properly with the right half. If necessary, tap the left half gently with a soft hammer to facilitate assembly. However, no difficulty will be encountered if the two halves are kept parallel while the left is being lowered onto the right. After the cases are together, tap the right half with a soft hammer to seat it securely all around.

8-88. Assemble the crankshaft oil seal retaining plates (where applicable) (17, figure 8-1) and secure with capscrews.

8-89. There is a definite sequence that must be followed when tightening the fastenings of the crankcase halves.

8-90. In the integral accessory drive models, one pair of half-inch thru-studs on each cylinder pad (as well as additional thru-studs at both front and rear of the crankcase) are not secured by screw-threads; instead, the center of each stud serves as a dowel to insure crankcase alignment at the bearing webs, while the threaded ends of the studs protrude through the cylinder mounting pads of the crankcase for attaching the cylinders. Consequently, each of these studs as indicated in figures 8-24 and 8-25 must be tightened at both ends, simultaneously.

NOTE

Before the tightening procedure is started, make sure all half-inch thru-studs are assembled with equal lengths extending from both sides of the crankcase. Also be sure the threaded end of the half-inch thru-bolts extend through the side of the crankcase as indicated in figure 8-24 and 8-25.

8-91. Proceed to tighten fastenings in the following sequence.

8-92. (TIGO-541). See figure 8-24. Install spacers or flat washers and nuts over the 1/2 inch thru-studs and tighten to 300 inch pounds torque in the sequence indicated in figure 8-24.

8-93. In the same sequence tighten all 1/2 inch thru-studs to 600 inch pounds torque.

8-94. Tighten the balance of the crankcase fastenings as directed in figure 8-24.

8-95. (TIO-541). See figure 8-25. Install spacers or flat washers and nuts over the 1/2 inch thru-studs and tighten to 300 inch pounds torque in the sequence indicated in figure 8-25.

8-96. In the same sequence tighten all 1/2 inch thru-studs to 600 inch pounds torque.

8-97. Tighten the balance of the crankcase fastenings as directed in figure 8-25.

8-98. Note that the bolts securing the inside of the halves are lockwired.

8-99. (TIGO-541). The thrust bearing cap, both sides of the bearing cap shim, and the mating surface of the crankcase should be coated with P0B (or equivalent) before assembly.

8-100. Assemble the ring gear and support assembly (1, figure 8-3) on the crankshaft flange.

8-101. See figure 8-1. Assemble the oil relief valve assembly (1 or 26), the oil filler extension (7 or 8) and the dip stick (5 or 6). Assemble engine mounts, lifting eyes (9 or 10) and lifting strap (19).

8-102. (TIGO-541). See figure 8-2. Assemble the oil bypass valve housing assembly (10), oil pressure relief valve assembly (11) and install. Install the oil filler tube (5) and the dip stick (8). Assemble the lifting strap (4) and engine mounts.

8-103. See figure 8-10. Reassemble the starter drive assembly in the reverse order of disassembly as directed in paragraph 8-18. Consult Service Instruction No. 1242.

8-104. See figure 8-13. Reassembly of the starter drive adapter assembly. Fill 75% of starter motor housing assembly with Molytex "O" Grease. Assemble in the reverse of the disassembly.

8-105. Reassemble the thrust bearing propeller shaft. Figure 8-11. Fill 50% of cavity near end of gear with Loctite Grade A sealing compound. Position the thrust bearing rear race (7) squarely in gear cavity and drive it in place until seated. Lubricate the thrust bearing (6) with Molytex O Grease or 600W oil and place on bearing seat (5). Install both thrust bearing and seat into recess of crankcase. Temporarily install cover (1) gently pressing against the cover to move the entire assembly to the rear. Secure the cover with four nuts. Determine the shim thickness by measuring clearance between cover and mounting pad with feeler gage. Distance measured plug .007 inch will equal the shim thickness required to maintain .005/.010 inch end clearance for gear and housing.

Install oil ring seal (2) in groove of cover. Coat both sides of shim and mating surfaces of cover and crankcase with General Electric Corp. RTV-106 sealant. Install oil seal ring (3) in recess around dowel on cover. Place shim over dowel and second oil seal ring (3) on dowel. Install cover and shim on crankcase.

8-106. See figure 8-14. Reassemble the alternator drive assembly in the reverse order of disassembly as shown in figure 8-14.

NOTE

Apply Molytex Type "O" Grease to alternator drive coupling and the alternator drive coupling adapter assembly before assembly. Figure 8-14.

SECTION 9.
TEST PROCEDURE

9-1. At the completion of assembly 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 twofold 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 and observe and repair any oil leaks that may occur.

NOTE

Avco Lycoming recommends that a test cell be used for run-in of engines after overhaul. In the event that 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. The proper test club, not a flight propeller, is used.

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.

9-2. The following instruments should be used, plus any additional instruments that may be deemed necessary by the operator. Cylinder head thermocouples, counter tachometer, fuel flow meter, fuel pressure gage, manifold pressure gage, oil temperature gage, oil pressure gage and an oil flow measuring device.

9-3. 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.

9-4. 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 test. Test stand oil supply pressure to engines tested simulated dry sump shall be held between 0.5-3.0 psi at rated conditions.

9-5. Engines equipped with an integral, full flow, oil filter, should be tested with a slave filter assembly and the regular filter installed at the end of the run.

9-6. Also, a slave filter should be installed between the oil supply hose and the turbocharger oil inlet. This slave filter shall have a particle filtering capability of 100 microns or less and have a pressure relief valve set to 15-18 psi differential. This will insure that no metal particles are carried from the engine to the turbocharger lubrication system.

9-7. 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 entrances to the fuel pump by at least one foot. The fuel pressure to the chamber shall be maintained at 2 to 5 psi.

9-8. Engines not equipped with a fuel pump shall be tested with either a remote or installed representative fuel pump. The test stand fuel system for this type of engine shall terminate in a float chamber vented to the atmosphere. Fuel pressure to the chamber shall be maintained at 2 to 5 psi.

9-9. Any engine accessory drive, such as propeller governor drive, which transmits oil pressure through oil passages in the engine and which is not pressurized by normal operation of the engine on the test stand shall be checked for leakage at normal oil pressure by means of a special drive cover with oil transfer passages as required. The oil passages involved shall be inspected for external leaks at the completion of the run.

9-10. It is desirable to have some method of maintaining the oil temperature within the specified limits during the run-in.

9-11. The engine should be operated during the run-in with ashless dispersant lubricating oil conforming to specification MIL-L-22851. The oil should be heated to 140° F. minimum before starting the run-in schedule.

9-12. If the engine is not to be installed in the airframe immediately, the engine should be preserved as directed in Section 10.

9-13. Fuel shall conform to specifications. The specified fuel for this series engine is 100/130 minimum octane aviation grade gasoline.

9-14. Attach the instrument connections and install 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 the throttle and to move the mixture control from full rich to idle cut-off.

9-15. Install cooling shroud (ST-164), test club (64803) and adapter (64981) on TIO-541 series. Install cooling shroud (ST-164), test club (ST-241) and adapter (ST-242) on TIGO-541 series. Be certain the test club will turn up rated RPM ± 50 at limiting manifold pressure. See Table 9-1.

TABLE 9-1

ENGINE RUN-IN TEST SPECIFICATIONS

	Fuel Pressure psi - at inlet to injector	Fuel - Minimum Octane Rating Aviation Grade	Max. Cyl. Head Temp. Bayonet Location °F.	Rated Engine Speed RPM	Limiting Manifold Pressure
TIO-541-A	33-37	100/130	475	2575	37 in. hg.
TIO-541-E	33-37	100/130	475	2900	41 in. hg.
TIGO-541-C	33-37	100/130	475	3200	42. 5 in. hg.
TIGO-541-D	33-37	100/130	475	3200	46. 5 in. hg.
TIGO-541-E	33-37	100/130	475	3200	45 in. hg.

ENGINE RUN-IN SPECIFICATIONS (CONT.)

	Maximum Oil Consumption		Oil Pressure Operating - psi		Oil Inlet Temp. °F.	Oil Outlet* Temp. °F.
	Lbs./Hr.	Qt./Hr.	Normal	Idle		
TIO-541-A	2.0	1.1	70-79	25	190-245	210-230
TIO-541-E	2.0	1.1	70-79	25	190-245	210-230
TIGO-541-C	2.0	1.1	70-79	25	190-245	210-230
TIGO-541-D	2.0	1.1	70-79	25	190-245	210-230
TIGO-541-E	2.0	1.1	70-79	25	190-245	210-230

* - Desired during oil consumption run.

9-16. It is desirable to keep a log sheet and record the instrument readings during each speed of the run-in schedule. See Table 9-2.

9-17. 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.

9-18. TEST RUN. Start the engine in accordance with the following procedures.

a. Place mixture control in idle cut-off.

b. Turn fuel valve to "on" position.

c. Set throttle at 1/10 open position.

d. Turn magneto switch to "left" and engage starter. Turn combination magneto-starter switches to "start".

e. When engine fires, move mixture to full rich.

f. Move magneto switch to "both", combination spring loaded switches will return to "both".

CAUTION

If oil pressure is not indicated within ten seconds, stop engine and determine cause.

9-19. Operate engine at approximately 1000 RPM until oil temperature of 145° F. is obtained. Check magneto drop-off and general operation of the engine. Check the engine for obvious oil leaks. Any malfunction or oil leak should be remedied before continuing the run.

9-20. Complete the run in accordance with the schedule listed in Table 9-2.

TABLE 9-2

RECOMMENDED RUN-IN SCHEDULE

RPM	LOAD	TIME	
1000	Prop. Load	10	Check for oil leaks.
1600	Prop. Load	10	
1800	Prop. Load	10	
2000	Prop. Load	10	Check magneto drop-off. Do not
2200	Prop. Load	10	exceed 125 RPM on either mag
2400	Prop. Load	10	or 35 RPM between mags.
Normal Rated ±50	Limiting Manifold	15	
See Remarks	Prop. Load	15	Stabilization run.
See Remarks	Prop. Load	30-60	Oil consumption run. Rated 2575 - Operate 2575 Rated 2900 - Operate 2700 Rated 3200 - Operate 2850

9-21. OIL CONSUMPTION RUN. An oil consumption run should be made at the end of the run-in schedule. This can be accomplished by the use of a scale tank through which the oil lines pass and the scale reading taken at the beginning and end of the oil consumption run. Or it can be accomplished by draining and weighing the oil in the supply tank before the oil consumption run and draining and weighing the oil in the supply tank at the end of the oil consumption run. Oil temperatures should be the same at the beginning and end of the oil consumption run. Oil consumption should not exceed the maximum as listed in Table 9-1.

9-22. OIL PRESSURE RELIEF VALVE. The oil pressure relief valve, located in the crankcase just forward of the fuel pump drive, is adjustable. This allows the operator to maintain oil pressure within the specified limits. Table 9-1. If the pressure is less or greater than specified, adjust the valve as follows. Stop the engine, remove the oil pressure relief cap and adjust the adjusting screw. Tighten to increase, loosen to decrease pressure. Select spring to give a minimum of three threads exposed on adjusting screw to allow field adjustment.

9-23. IDLE SPEED AND MIXTURE ADJUSTMENT. With engine thoroughly warmed up, check magnetos in the usual manner. If the drop-off is excessive, check for fouled spark plugs. If drop-off is normal, proceed with idle adjustment. Close the throttle to idle at approximately 600 RPM. If the RPM increases appreciably after a change in the idle mixture adjustment during the succeeding steps, readjust the idle speed adjustment to restore the desired RPM.

9-24. When the idle speed has been stabilized, move the mixture control lever with a smooth, steady pull into the "Idle Cut-Off" position and observe the tachometer for any change during the leaning process. Caution must be exercised to return the mixture control to the "FULL RICH" position 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 idle mixture. An immediate decrease in RPM (if not preceded by a momentary increase) indicates the idle mixture is too lean.

9-25. If it is indicated that the mixture is either too rich or too lean, turn the idle mixture adjustment one or two notches in the direction required for correction. Check this setting by repeating the above procedure. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling.

9-26. In the event that the engine is not to be installed in the airframe at the end of the run-in, it should be prepared for storage or shipment as described in Section 10.

SECTION 10.
PRESERVATION AND STORAGE

10-1. Overhauled engines, not destined to be immediately installed in an airframe, should undergo the run-in period using the recommended oil as directed in Section 9.

10-2. Before removal from the stand, the engine should be further protected against corrosion in the following manner.

10-3. Upon completion of the test run, drain the oil from the engine. Remove bottom spark plug from each cylinder. Fill engine completely with a 1 to 1 mixture of MIL-C-6529 Type 1 and ISOPAR "M" or equivalent until oil flows from breather fitting. With engine full of oil, slowly turn propeller through two complete revolutions. Let engine stand with oil ten minutes, after which the propeller shall be rocked back and forth through 90° for 12 cycles. Drain preservation oil from the engine.

NOTE

Preservative oil drained from the engine may be saved and returned to the tank for reuse.

10-4. Without turning the engine, 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.

NOTE

Do not turn engine crankshaft after treatment as stated in paragraph 10-3.

10-5. For all spraying the spray nozzle temperature shall be maintained between 200° F. and 220° F.

10-6. Spray each cylinder through the spark plug holes with MIL-C-6529 Type 1 oil. Seal all openings with suitable covers.

10-7. All accessory drives for which oil seals are provided shall be liberally coated with MIL-C-6529 Type 1 oil before installing the drive covers.

10-8. The fuel injectors should be emptied of fuel and flushed with oil, MIL-O-6081, grade 1010. During flushing, the oil pressure applied to the fuel passage shall not exceed eight pounds per square inch. Under no circumstances shall the regulator air chambers, air passages or automatic mixture control be flushed with oil; these must be kept dry at all times. Drain excess oil and replace the plugs. Lock the throttle in the closed position.

10-9. Reinstall the spark plugs in the lower spark plug holes and dehydrator plugs (Avco Lycoming P/N 40238 or equivalent) in the upper spark plug holes. Attach the ignition harness at the bottom locations and have ignition cable protectors, AN-4060, on the top location.

NOTE

Dehydrator plugs do not remove moisture from the engine. The changing color of the dehydrator plug indicates only that moisture is present and remedial steps must be taken.

10-10. EXTERIOR SURFACES AND ACCESSORIES. All exposed cadmium plated and machined surfaces should be coated with soft film corrosion-preventive compound MIL-C-16173 Grade 2. Any other accessories or parts not attached to the engine must be protected by dipping the part in preservative oil. It must then be drained and wrapped in grease-proof paper. This procedure applies to spark plugs and electrical components, except they are not to be dipped in the preservative oil.

10-11. The above procedures do not preserve the engine for extended periods. The engine should be examined periodically for evidence of corrosion. The time between examinations will vary depending on weather, locality and storage conditions. If corrosion is in evidence, the engine should be cleaned free of corrosion and represerved.

10-12. Also, if the internal parts of the engine should be accidentally turned, represervation is required at once.

10-13. FUEL INJECTORS. (Removed from engine). Any unit taken out of service, or those units being returned for overhaul, must be flushed with a preservative grade oil (Mil-O-6081 Grade 1010). This is accomplished by the following procedure:

a. Remove all plugs and drain all fuel from the injector.

b. Replace all plugs and pour approximately one ounce of flushing oil into the fuel inlet fitting and rock to cover all the interior surfaces.

c. Install suitable shipping plug on all fittings. Lock the throttle in the closed position.

d. The injector should be protected from dust and dirt and given such protection against moisture as the climate conditions require.

10-14. SALT WATER PRESERVATION OF FUEL INJECTORS. If any of the units are to be shipped over or stored near salt water, the following precautions should be observed.

a. Spray the exterior of the injector with an approved preservative oil, Socony Mobil Oil, Avrex 901 or equivalent.

b. Pack in a sealed, dust-proof container, and wrap container with moisture and vapor-proof material and seal. Pack a one-half pound bag of silica-gel crystals in the dust-proof container along with the injector. The bag must NOT touch the injector. Pack the wrapped unit in a suitable shipping case.

SECTION 11
TABLE OF LIMITS

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

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

The SSP-1776 Part II 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.

Revised May, 1980