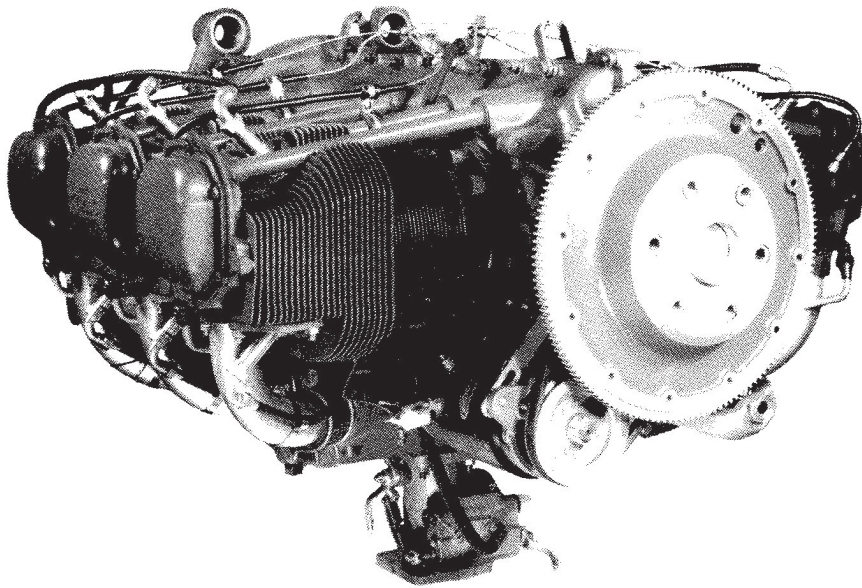


Overhaul Manual

Direct Drive Engine



Approved by F.A.A.

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SECTION 3.

GENERAL OVERHAUL PROCEDURES

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

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

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

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

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

3-6. Place the overhaul stand and skid into position and lower the engine to the stand and remove lifting cable. 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 should be made while disassembling and immediately after disassembly, all individual parts should be laid out in an orderly manner as they are removed from the engine. No cleaning operation should be performed until this initial visual inspection has been completed. All loose studs, cracked cooling fins, loose or damaged fittings, and the like, should be carefully noted and tagged to prevent their being overlooked during regular inspection.

CLEANING

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

3-9. **DEGREASING.** Degreasing is accomplished by immersing or spraying the part in solution of white

furnace oil (38-40 specific gravity) or a suitable commercial solvent such as Varsol or Perm-A-Chlor. Operators are warned against the use of solvents with which they are unfamiliar, since there are many 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 clean boiling water after degreasing. Regardless of the method and type of solution used, coat and spray all parts with lubricating oil immediately after cleaning in order to prevent corrosion.

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

CAUTION

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

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

3-12. When grit-blasting parts do not use sand or any metallic abrasives. It is recommended instead that mildly abrasive organic substances such as rice, baked wheat, plastic pellets, or crushed walnut shells be used. All machined surfaces must, of course, be adequately masked and all openings tightly plugged before blasting. The one exception to this is the valve seats, which may be left unprotected when blasting the cylinder head combustion chamber. It is often advantageous to grit blast the seats, since this will cut the glaze which tends to form (particularly on the exhaust valve seat) thus facilitating subsequent valve seat reconditioning. Under no circumstances should the piston ring grooves be grit blasted. If necessary, soak the piston in petroleum solvent and scrape with a wooden scraper. When grit-blasting housings, plug all drilled oil passages with rubber plugs or other suitable material to prevent the entrances of foreign matter.

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

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

INSPECTION

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

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

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

3-18. Dimensional inspections should be carried out in accordance with the measurements and tolerances as called out in the Table of Limits (Section 10).

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

3-20. BEARING SURFACES. All bearing surfaces should be examined for scoring, galling and wear. Considerable scratching and light scoring of aluminum

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

3-21. GEARS. All gears should be examined for evidence of pitting and excessive wear. These conditions are of particular importance when they occur on the involute of the teeth; deep pit marks in this area are sufficient cause to reject the gear. Bearing surfaces of all gears should be free from deep scratches. However, minor abrasions may be dressed out with 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 over-tightening, or from the use of improper tools, it must be replaced with a new one.

3-24. MAGNETIC INSPECTION. All ferro-magnetic steel parts should be inspected by the magnetic particle method. The successful detection of structural failure by magnetic inspection demands skill and experience on the part of operating personnel. It must be remembered that almost any fabricated steel part will 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) applied; too little current will not sufficiently magnetize the part, while too heavy an application will permanently dam-

CAUTION

All crankpin journal sludge tubes must be removed from the crankshaft; otherwise accumulated sludge loosened during cleaning will clog the crankshaft oil passages and cause subsequent bearing failures. The oil transfer tubes, however, which conduct oil from the main bearings to the crankpin journals must not be removed under any circumstances. Sludge tubes are not employed in later model crankshafts. However, this is not to imply that sludge tubes can be removed and not replaced in those crankshafts originally using sludge tubes.

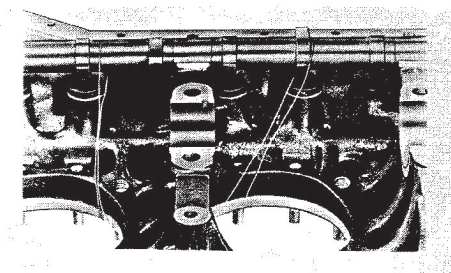


Figure 7-2. Camshaft Wired to Crankcase Half

7-16. Remove the crankshaft oil seal (18, figure 7-1) from the crankshaft. Do not remove the propeller flange bushings from the flange of the crankshaft unless they are damaged and/or loose.

7-17. Counterweights - See figure 7-5. Counterweights (8) are disassembled from the crankcase merely by removing the retaining rings (11), after which the washers (10), rollers (9) and counterweights (8) may be detached from the crankshaft lug.

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 used with the counterweights are selectively fitted to the washer seats in the counterweights during manufacture. It is advisable, therefore, to mark all counterweight parts during disassembly to insure proper identification. These markings must be impermanent. No scoring, scratching, etching or other permanent marking of any kind is permissible on these parts.

7-18. Sludge Tubes (4 cylinder engines - where applicable). Remove the four crankshaft sludge tubes (30, figure 7-5) with the sludge tube removal drift (P/N 64548) by placing drift end of the tool in the tube and driving out the tube with the bar portion of the tool. Do not clean the tubes but lay them aside to ascertain the presence or absence of metal particles in the sludge deposits. Do not re-use sludge tubes.

7-19. Sludge Tubes (6 and 8 cylinder engines - where applicable). When removing either six or eight cylinder engine sludge tubes use slide hammer puller (P/N 64782) and an adapter. Adapter P/N 64547 for six cylinder engines and adapter P/N 64784 for eight cylinder engines. Remove the jaws from the slide hammer puller and assemble the puller adapter on the slide hammer puller. Remove collar from the adapter, insert the adapter through the sludge tube, and reassemble the collar. Pull the tube out of the crankshaft with a series of quick hard strokes of the slide hammer. Do not clean tubes but lay them aside for examination to ascertain the presence or absence of metal particles in the sludge deposits. Do not re-use sludge tubes.

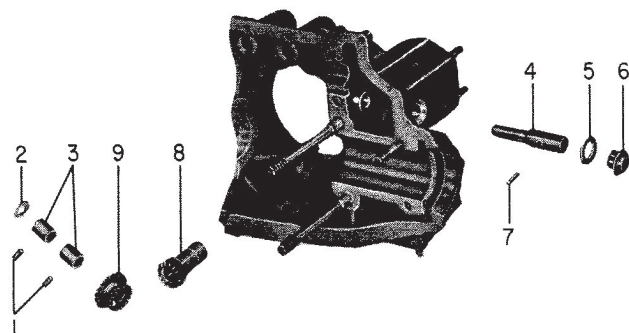
CLEANING

7-20. All crankcase, crankshaft and reciprocating parts are cleaned in accordance with the general instructions outlined in Section 3. When cleaning the crankshaft, clean the inside of all crankpin and main bearing journals and all oil passages with suitable brushes, after which flush thoroughly with clean solvent and compressed air.

CAUTION

Do not attempt under any circumstances to clean the crankshaft without first removing the crankshaft sludge tubes (where applicable). The solvent will loosen but not remove accumulated sludge. This loose sludge is certain either to form a stoppage in the nearest oil passage, or to wash through and cause a bearing failure.

7-21. Piston Cooling Oil Jets. (Where applicable) 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.



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|------------------------|-------------------------------|
| 1. Dowel | 6. Hex Head Plug |
| 2. Thrust Washer | 7. Spring Pin |
| 3. Idler Gear Bushings | 8. Prop. Governor Driven Gear |
| 4. Idler Gear Shaft | 9. Prop. Governor Idler Gear |
| 5. Gasket | |

Figure 7-3. Propeller Governor Drive
(4 cylinder engines with housing on crankcase)