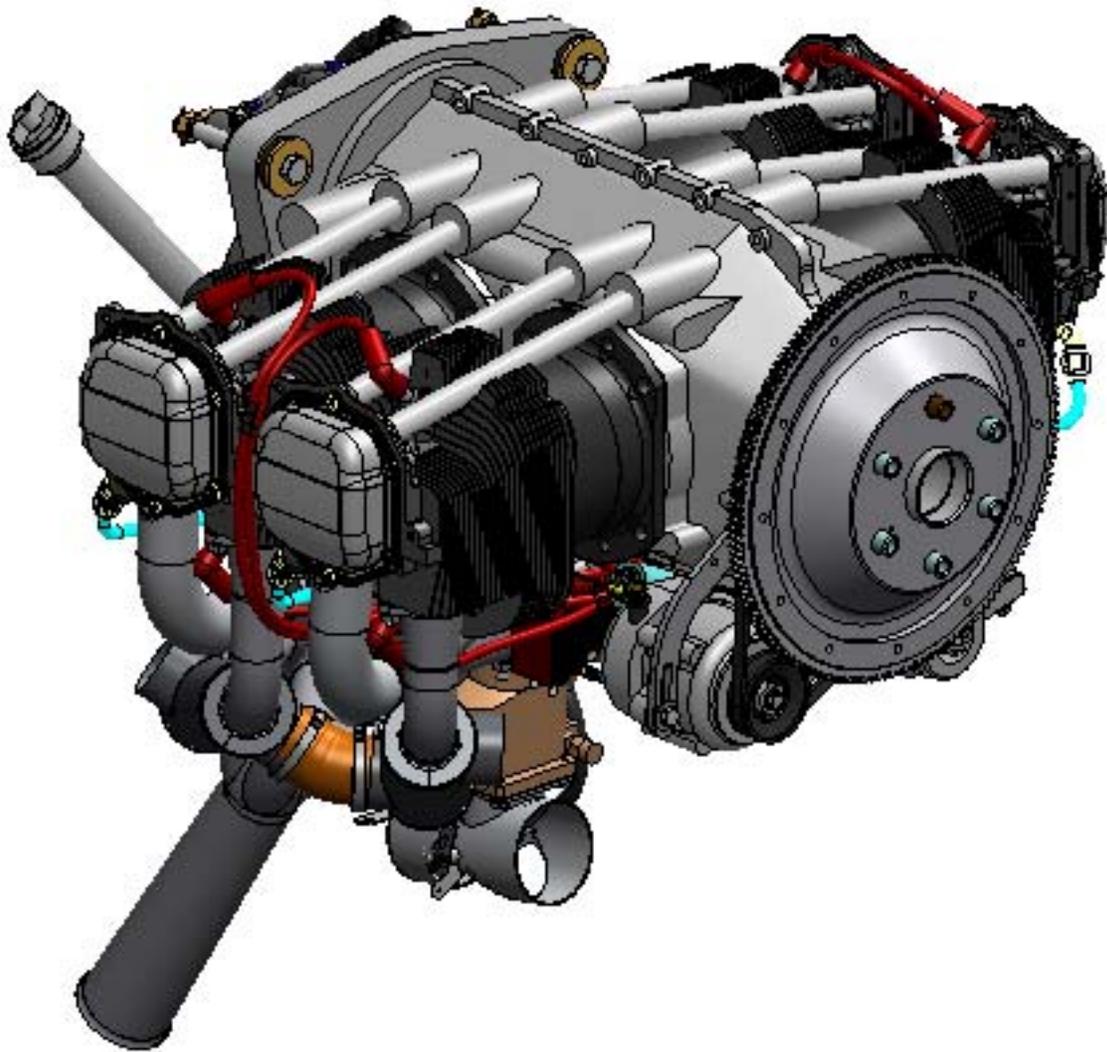


# CC340 ENGINE

## MANUAL







# **CC340 ENGINE MANUAL**

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**Revision History**

<b>Revision Letter</b>	<b>Effective Date</b>	<b>Description</b>	<b>Pages Revised</b>
NC	06/05/2009	INITIAL RELEASE	ALL PAGES
A	02/09/2010	1.5 - Added Consumables 2.2 - Revised TBO Statement 2.4 - Revised Table 2-1 2.4 - Revised Oil Capacity 2.5.6 - Revised Sump Oil Capacity 2.5.12 - Revised to manual priming system Figure 5-2a - Reversed bolt and nut direction Figure 5-3 - Added Connecting Rod Assembly Figure 5-6 - Updated to CCI Accessory Case 7-6 - Added description to part numbers Figure 7-6 - Reversed bolt and nut direction Figure 7-28 - Added CCI Lightweight Sump Figure 7-33 - Added Alternator Installation Section 8 - Removed References to Table 8-3 Section 9 - Revised Warning Statement Table 9-12 - Engine Baffles and Seals	1-4 2-1 2-2 2-3 2-4 2-6 5-21 5-22 5-26 7-9 7-17 7-55 7-63 All Pages 9-2 9-6
B	10/27/2010	2.4 - Revised Compression Ratio 2.4 - Revised Sparkplugs 2.5.8 - Revised Compression Ratio	2-3 2-3 2-5

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## **0. SAFETY ADVISORY**

To prevent personal injury and/or health hazards, users must know the manufacturer or supplier information and adhere to all procedures, recommendations, warnings and cautions set forth for the use, handling, storage, and disposal of materials. While the WARNINGS provided in this manual inform the user about dangerous materials or equipment that can cause injury; they do not replace the instructions of the manufacturer.

This Safety Advisory contains all the **WARNINGS** included in this manual.

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### **1. WARNING!**

**BEFORE MATERIALS CALLED OUT IN THIS PUBLICATION ARE USED, KNOW THE HANDLING, STORAGE AND DISPOSAL PRECAUTIONS RECOMMENDED BY THE MANUFACTURER OR SUPPLIER. FAILURE TO COMPLY WITH THE MANUFACTURERS' OR SUPPLIERS' RECOMMENDATIONS CAN RESULT IN PERSONAL INJURY.**

### **2. WARNING!**

**OPERATION OF A DEFECTIVE ENGINE WITHOUT DETERMINING THE CAUSE(S) OF THE DEFECT(S) MAY RESULT IN FURTHER DAMAGE TO ENGINE COMPONENT PARTS AND POSSIBLE INJURY TO PERSONNEL. ENSURE THAT ALL NECESSARY INSPECTION AND TROUBLESHOOTING PROCEDURES ARE ACCOMPLISHED. THESE PRECAUTIONS WILL HELP TO PREVENT INJURIES TO PERSONNEL AND/OR DAMAGE TO THE EQUIPMENT.**

### **3. WARNING!**

**FUEL IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. USE ONLY IN A WELL VENTILATED AREA FREE FROM SPARKS, FLAME, OR HOT SURFACES. AVOID EYE AND SKIN CONTACT. ALWAYS WEAR SPLASH GOGGLES, SOLVENT-RESISTANT GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

### **4. WARNING!**

**HOT OIL MAY CAUSE BURNS TO EYES AND SKIN. WEAR SPLASH GOGGLES AND INSULATED GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

### **5. WARNING!**

**ENGINE OIL IS HAZARDOUS AND MAY CAUSE INJURY TO SKIN AND EYES. WEAR PERSONAL PROTECTIVE GEAR.**

## **6. WARNING!**

USE NECESSARY PROTECTIVE GEAR. HEATED PARTS MAY CAUSE SEVERE BURNS.

## **7. WARNING!**

LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.

## **8. WARNING!**

LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

## **9. WARNING!**

USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.

## **10. WARNING!**

ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.

## **11. WARNING!**

USE THE CORRECT PERSONAL PROTECTION EQUIPMENT TO AVOID INJURY. ENSURE AREA IS FREE OF LOOSE OBJECTS THAT COULD BE MOVED BY PROPELLER AIR BLAST.

## **12. WARNING!**

ADHESIVE SEALANT IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. AVOID EYE AND SKIN CONTACT. USE PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

## **13. WARNING!**

SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH

**WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

**14. WARNING!**

**DO NOT INSTALL THE IGNITION HARNESS “B” NUTS ON THE SPARK PLUGS UNTIL THE PROPELLER INSTALLATION IS COMPLETED. FAILURE TO COMPLY COULD RESULT IN BODILY INJURY WHEN THE PROPELLER IS ROTATED DURING INSTALLATION.**

**15. WARNING!**

**IF ONE SURFACE IS REWORKED TO UNDERSIZE BY POLISHING OR GRINDING, ALL CORRESPONDING SURFACES MUST BE REWORKED TO THE SAME UNDERSIZE.**

**16. WARNING!**

**PLACE A SUITABLE STAND UNDER THE AIRCRAFT TAILCONE BEFORE REMOVING THE ENGINE. THE LOSS OF WEIGHT MAY CAUSE THE AIRCRAFT TAIL TO DROP.**

**17. WARNING!**

**DO NOT DAMAGE THE NITRIDED SURFACES OF THE CRANKSHAFT.**

**18. WARNING!**

**USE CORRECT PERSONAL PROTECTION. SOME CHEMICAL SOLUTIONS CAN CAUSE EYE, SKIN, AND LUNG DAMAGE. FOLLOW THE MANUFACTURER’S INSTRUCTIONS FOR EACH STRIPPING SOLUTION OR SURFACE TREATMENT SOLUTION.**

**19. WARNING!**

**WEAR SAFETY GOGGLES OR A FACE SHIELD. USE OF A HAMMER MAY PRODUCE LOOSE PARTICLES OR CHIPS THAT CAN CAUSE CUTS TO THE SKIN AND EYE DAMAGE.**

**20. WARNING!**

**DO NOT ROTATE ENGINE OR CRANKSHAFT BEFORE REMOVAL OF TIMING LOCATOR PINS.**

## **21. WARNING!**

**TO PREVENT THE POSSIBILITY OF SERIOUS BODILY INJURY OR DEATH, DO THE FOLLOWING BEFORE MOVING THE AIRCRAFT PROPELLER:**

- **VERIFY THAT ALL SPARK PLUG LEADS ARE DISCONNECTED.**
- **VERIFY THAT MAGNETO SWITCHES ARE CONNECTED TO MAGNETOS, THAT SWITCHES ARE IN THE “OFF” POSITION, AND THAT “P” LEADS ARE GROUNDED.**
- **VERIFY THAT THROTTLE POSITION IS “CLOSED.”**
- **VERIFY THAT MIXTURE CONTROL IS IN “IDLE-CUT OFF.”**
- **SET AIRCRAFT BRAKES AND BLOCK WHEELS. ENSURE THAT AIRCRAFT TIE DOWNS ARE INSTALLED, AND VERIFY THAT THE CABIN DOOR LATCH IS OPEN.**
- **DO NOT STAND WITHIN THE ARC OF THE PROPELLER BLADES WHILE TURNING THE PROPELLER.**

## **Section 1 INTRODUCTION**

### **1.1 About This Manual**

This Cub Crafters, Inc. (CCI) CC340 Engine Overhaul Manual provides owners, operators and mechanics with instructions and limits for the major overhaul, repair and inspection of CC 340 engines. Other essential information for CC340 engines is provided in the manuals listed below at paragraph 1-2, Related Engine Publications, and paragraph 1-3, Related Accessory Publications.

The information contained in this manual is based on current data available at the time of publication. However, this information may be revised through manual revisions as required. In addition, the information in this manual may be revised, updated, supplemented, and automatically amended by Service Instructions and Service Bulletins issued by Cub Crafters, Inc.

Separate sections of this manual describe the general and specific overhaul instructions required for the engine. These sections are organized in a logical sequence corresponding to the sequence of operations for engine disassembly, inspection and repair, and reassembly.

Manual sections are sequentially numbered. Within each section, pages, paragraphs, tables, and figures are numbered sequentially as a dash number following the page number. Page numbering is organized within each section. For example, the third page of manual Section 5 would be numbered as page 5-3. The tenth paragraph of manual Section 5 would be numbered 5.10. The second table of Section 5 would be numbered Table 5-2. The first figure appearing in Section 5 would be designated Figure 5-1.

The page number is displayed in the footer on each page. The paragraph number appears at the heading or beginning of each paragraph. The table number appears underneath of the table, and the figure number appears directly below each figure.

CCI makes every effort to provide clear and accurate information to those who own, maintain, operate and repair the CC340 engine. Likewise, CCI values field input that may indicate the need for revisions, additional information or improvement of our manuals. Please forward your comments and input to:

Cub Crafters, Inc.  
1918 South 16<sup>th</sup> Avenue  
Yakima, WA 98903

### **1.2 Related Accessory Publications**

- Volare (Marvel-Schebler/Precision) MA-4SPA Carburetor Service Manual
- MSAHBK-x
- Light Speed Engineering™ Plasma II and Plasma III CDI Systems Installation and Operation Manual
- Sky-Tec Aircraft Starting System Troubleshooting Guide

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### 1.3 Obtaining Service Information

All CC340 Engine manuals and service information may be purchased by contacting:

Cub Crafters Inc.  
1918 South 16<sup>th</sup> Avenue  
Yakima, WA 98903  
Phone: (509) 248-9491

Accessory Service Information may be obtained at:

- Lightweight alternators:  
[www.bandcspecialty.com](http://www.bandcspecialty.com); 316-283-3000; FAX 316-283-7400
- Electronic ignition systems:  
[www.lightspeedengineering.com](http://www.lightspeedengineering.com); 805-933-3299; FAX 805-525-0199
- Starters and alternators:  
[www.skytecair.com](http://www.skytecair.com); 800-476-7896, 817-573-2250; FAX 817-573-2252
- Float carburetors, dry vacuum pumps, oil filters:  
[www.tempestplus.com](http://www.tempestplus.com); 800-822-3200

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## 1.4 Abbreviations

A list of abbreviations used in this manual is shown in Table 1-1 below.

<b>Abbreviation</b>	<b>Definition</b>
AMS	Aerospace Material Specification
ASME	American Society of Mechanical Engineers
Assy	Assembly
ASTM	American Society for Testing Materials
BTC / BTDC	Before Top Center / Before Top Dead Center
CCW	Counterclockwise (rotation)
CHT	Cylinder Head Temperature
CW	Clockwise (rotation)
DIA	Diameter
EGT	Exhaust Gas Temperature
EX	Exhaust
F	Fahrenheit
Fig.	Figure
Ft-Lb	Foot-Pounds
g	gram
GPH	Gallons Per Hour
IAW	In Accordance With
ID	Inside Diameter
IN	Intake (or inlet)
In, or “	Inch
In-Lb	Inch-Pounds
Lb	Pounds
No.	Number
NPT	National Pipe Thread
OD	Outside Diameter
Oz.	Ounce
P/N	Part Number
PPH	Pounds per Hour
Prop	Propeller
PSI	Pounds Per Square Inch
RPM	Revolutions Per Minute
SAE	Society of Automotive Engineers
TEL	Tetraethyl Lead
TIR	Total Indicator Reading
UNC	Unified National Coarse
UNEF	Unified National Extra Fine
UNF	Unified National Fine
° or Deg.	Degree

**Table 1-1      Abbreviations**

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**1.5 Consumable Materials List**

Table 1-2 below provides a listing of consumable materials used during repair and overhaul of CCI CC340 engines.

Material	Source
Acetone or Methyl Ethyl Ketone (MEK)	Commercially Available
Assembly Grease – Lubriplate No. 105	Commercially Available
Assembly Grease – American Lubricants Molyshield	Commercially Available
Cleaning Solvent	Commercially Available
Copper Based Anti-seize compound, Henkel Loctite™ C5-A	Commercially Available
Food Grade Anti-seize compound, Henkel Loctite 1167237	Commercially Available
Fuelube™	Ohio Industrial Lubricants
Isopropyl alcohol	Commercially Available
Henkel Loctite™ 271, P/N 27183	Commercially Available
<b>Henkel Loctite™ 272</b>	<b>Commercially Available</b>
Henkel Loctite™ No. 2 Gasket Sealant P/N 30514	Commercially Available
Lubricating Oil, SAE 10	Commercially Available
Lubricating Oil, SAE 50	Commercially Available
Mineral Oil (MIL-L-6082), SAE 50 weight	Commercially Available
Permatex™, P/N 27100	Commercially Available
<b>Permatex Aviation Form-A-Gasket No. 3 Sealant</b>	<b>Commercially Available</b>
Pliobond™ #20	Commercially Available
Pre-Lube Mixture – approx. 15% pre-lubricant (STP™ brand or equivalent) plus 85% SAE 50 straight weight mineral oil	Locally Prepared Mixture
Preservative oil mix (MIL-C-6529, type 1, plus MIL-L-6082)	Locally Prepared Mixture
RTV™ 102 Silicone Sealant	General Electric
RTV™ 27C High Temp Orange Silicone	Commercially Available
Safety Wire (0.032) Type 304 Stainless Steel, P/N MS20995 C32	Commercially Available
Safety Wire (0.041) Type 304 Stainless Steel, P/N MS20995 C41	Commercially Available
Silastic™ 140 Sealant	Commercially Available
Silk thread, size 00 (100% Silk)	Commercially Available
STP™ High Viscosity Oil Treatment	Commercially Available
Titeseal™ No. 2 Gasket and Joint Compound P/N T2-01	Commercially Available
Phthalate resin-type enamel AMS3125C or equivalent MIL-E-7729 Randolph Black (#303)	Commercially Available
Toluene or equivalent AMS3180 (or equivalent Federal Spec TT-T-548)	Commercially Available
Zinc Chromate Primer	Commercially Available

**Table 1-2 Consumables**

**NOTE:**  
Equivalent substitutes may be used.

## **Section 2 DESCRIPTION AND OPERATION**

### **2.1 General Description**

The four-cylinder CC340 engine is a horizontally opposed, air-cooled, direct drive powerplant having a wet sump lubrication system. Cylinders are individually replaceable assemblies with bottom (“down”) exhaust ports. Induction systems are “hot” where the inlet riser and runners are an integral part of the interior of the oil sump. The intake runners are connected to the cylinder intake ports by means of individual pipes and heat shrunk seals. Fuel metering is accomplished by a float-type carburetor. A starter and alternator mount to the front of the engine. No provisions for accessories are made at the rear of the engine.

Components of the engine will be referenced in this manual as they are normally installed in the airframe with tractor type propeller thrust. Therefore, the “front” of the engine is the propeller end; and the “rear” of the engine is opposite. The oil sump is on the “bottom” of the engine and the cylinder pushrod tubes are on the “top”. The terms “left” and “right” are defined as being viewed from the rear of the engine looking toward the front.

Cylinder numbering is from the front to the rear with odd numbered cylinders on the right side of the engine. That is, the right-front cylinder is #1, and the left-rear cylinder is #4. Direction of crankshaft rotation is clockwise as viewed from the rear of the engine looking forward, unless otherwise specified.

### **2.2 Continued Airworthiness and Operational Safety**

All CC340 engines discussed in this manual must be installed, operated, and maintained in accordance with the limitations, conditions, and operating procedures described in the applicable manuals listed in paragraphs 1-2 and 1-3 above, as supplemented or amended by any applicable Cub Crafters Inc. Service Bulletins and Service Instructions and/or FAA Airworthiness Directives.

The CC340 engine’s “Time Between Overhauls” (TBO) has not yet been established. It is expected that the TBO will be set at 2400 hours. Until the official TBO is announced, ASTM 2339 paragraph 6.3.2 will govern TBO intervals. For the current accumulated time on the fleet leader, interested parties can call Cub Crafters Inc. to get information on the accumulated time on this aircraft.

In the future, we expect to establish TBO in accordance with ASTM 2339 paragraph 6.3.1.

### **2.3 Major Engine Components General Description**

All CC340 engines are air-cooled, four cylinder, horizontally opposed, direct drive engines.

The complete engine includes the following components and assemblies:

- Crankcase Assembly
- Rotating Assembly
  - Crankshaft Assembly and Gear
- Reciprocating Assembly
  - Connecting Rods and Pistons

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- Valve Train Assembly
  - Camshaft Assembly
  - Lifters
  - Hydraulic units
  - Pushrods
  - Rocker Arms
  - Valves
- Cylinder Assemblies
- Accessory Case and Drives
  - Accessory Case
  - Gears
  - Oil Pump
  - Starter
  - Starter Gear Support
- Oil Sump Assembly and Dipstick
- Induction System
- Fuel System
- Lubrication System (including oil filter)
- Ignition System (includes)
- Intercylinder Baffles
- \*Accessories

### NOTE:

Complete engine does not include outer cylinder baffles, baffle bulkheads and baffle seals, which are airframe items. Also not included are airframe-to-engine control cables, attaching hardware, hose clamps, exhaust system, or fittings. The Alternator is not included in the engine assembly as it is considered to be an airframe part.

## 2.4 Specifications

CC340 engines are rated at 180 Horsepower for take-off and climb limited to 5 minutes, and at 80 horsepower continuous from sea level to 12,000 feet. RPM must be adjusted at various altitudes to maintain the continuous power rating. Power charts are shown in Table 2-1 for power settings at various altitudes.

Pressure Altitude	RPM	Manifold Pressure	Fuel Flow LOP
Sea Level	2,100	15.5	4.6
2,000'	2,150	15.3	4.6
4,000'	2,200	15.1	4.7
6,000'	2,250	14.8	4.9
8,000'	2,300	14.0	4.8
10,000'	2,350	14.0	4.7
12,000'	2,400	13.5	4.7

**TABLE 2-1 POWER SETTINGS**

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<b>CC340 Engines Physical Specifications</b>	
Firing Order	1-3-2-4
Compression Ratio	9.0 to 1
Displacement	340.4 CI
Piston Stroke	4.125"
Cylinder Bore ID	5.125 "
Maximum RPM (5 minute limit)	2700 RPM
Height with Carburetor	24.6"
Length	32.8"
Dry Weight	241 Lbs.
Oil Capacity with Standard Sump	8 Quarts
Oil Capacity with Light Weight Sump	6 Quarts
Prop Drive Rotation	Clockwise
Carburetor	MA4SPA
Starter ring gear	149 tooth
Spark plugs (14MM)	Standard: Denso IK27 Alternate: Denso W27ESR-U

## **2.5 Features and Operating Mechanisms**

### **2.5.1 Crankshaft**

The CC340 crankshaft is machined from heat-treated forgings made of aerospace quality vacuum arc re-melt (VAR) Cr-Ni-Mo steel. Except for the propeller flange and rear gear mounting face, all surfaces of the crankshaft are case hardened by nitriding. Propeller flanges conform to AS 127, Type 1, and incorporate six flanged bushings internally threaded for .38-24 propeller attaching bolts.

The crank flange is machined to .375", and is drilled with 6 lightening holes evenly spaced in the flange. An expansion plug installed at the front end of the crankshaft oil cavity prevents oil from escaping out the front.

### **2.5.2 Connecting Rods**

CC340 connecting rods are made from heat treated aerospace quality Cr-Ni-Mo steel forgings. Connecting rods for 4.125" stroke engines are finished on external surfaces by machining and shot peening. All rods use replaceable bearing inserts in the big (crankshaft) ends and bronze bushings in the small (piston) ends. The bearing caps on the crankshaft ends are retained by two high-strength bolts and nuts. Rods are weighed with bolts and nuts and are closely matched for big end weight and total weight in opposed pairs.

### **2.5.3 Camshaft and Valve Train**

Camshafts are machined from carburized aerospace quality steel forgings. The camshaft is located above and parallel to the crankshaft and rotates in the same direction as the crankshaft since it is driven indirectly through an idler gear. The camshaft incorporates an integrally forged and machined drive gear, and has four exhaust cams (or lobes) and two intake cams (lobes) which are shared by lifters of opposing cylinders. The camshaft lobes actuate chilled iron hydraulic lifters that operate the valves through pushrods and valve rocker arms.

### **2.5.4 Crankcase**

The CC340 engine crankcase is machined from aerospace grade stabilized structural aluminum alloy castings. The assembly consists of two reinforced halves that separate along the vertical plane through the crankshaft axis. The two halves are machined as an assembly and are not separately interchangeable. The assembled halves are fastened together by means of high-strength studs, bolts, and nuts. The main bearing bores are machined for use with precision type main bearing inserts. As an option, some crankcases are machined for replaceable crankshaft thrust bearings. Camshaft bearings are machined directly into the case.

### **2.5.5 Accessory Case**

The CC340 engine accessory case is machined from heat-treated aluminum or magnesium alloy castings. The accessory case is fastened to the rear of the crankcase and the top rear of the sump with .25-20 cap screws and/or studs. Gaskets at both surfaces provide an oil seal. The interior of the accessory case provides a machined boss for attachment of the oil pump housing as well as an integrally machined tachometer shaft bore.

Externally, the accessory case would normally have provided drive pads for two magnetos or ignition devices, a propeller governor, either a diaphragm-type or gear driven AN type fuel pump, or a vacuum pump, but these accessories are not installed in the CC340 engine. Instead, the machined bosses for these accessories are covered with light-weight aluminum plates. A machined boss in the center of the casting provides a mounting for an oil screen housing. A crankcase breather fitting is located adjacent to the tachometer shaft boss. The accessory drive gears that would have driven magnetos and other accessories are not installed in the CC340 engine; hence these driven accessories cannot be installed.

### **2.5.6 Oil Sump and Induction System**

The CC340 engine has two sumps available. One is cast aluminum and the optional .080" sheet metal sump saves approximately 11 lbs in weight. The cast sump has a maximum capacity of 8 quarts of oil, while the sheet metal sump is 6 quarts of oil. Both sumps are bottom inlet, hot induction sumps for the MA4SPA carburetor attachment. Both sumps incorporate a drain plug for changing oil.

### **2.5.7 Cylinders**

Cylinders are individually replaceable and are manufactured from an aluminum head, which is screwed and shrunk onto a steel barrel. Heads are made from a special heat solution, heat treated and aged aluminum alloy casting. Cylinder barrels are machined from thru-hardened Airmotive Steel alloy forgings.

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The cylinder barrels are uniquely machined with tapered external cooling fins for lightness and uniform cooling. Cylinder bores are internally choked and honed to allow optimal ring seating and long life. Standard bore surface is thru-hardened steel. An optional Nickel+Carbide bore coating offers unsurpassed anti-wear and ring seating properties.

All cylinders incorporate a proprietary venturi intake valve seat for improved breathing and maximum engine power.

Dual spark plug bosses are machined for 14mm spark plugs.

### 2.5.8 Pistons

The pistons are made from heat-treated aluminum alloy castings. The piston pin is a full floating type with a plug located in each end of the pin. The compression ratio is 9.0 to 1. All pistons are of the three-ring type with two compression rings and one oil control ring located above the piston pin bore.

### 2.5.9 Cooling System

CC340 engines are air-cooled. Special inter-cylinder baffles are provided to direct the flow of cooling air through the fins of the cylinder barrels and cylinder heads. Cooling is of the downdraft type, and heated air is exhausted to the atmosphere through the rear of the aircraft engine cowling.

### 2.5.10 Carburetion System

Volare (formerly Marvel-Schebler/Facet/Precision) float type carburetors are of the updraft design and require bottom inlet hot induction sumps in order to properly vaporize metered fuel. All carburetors feature an adjustable mixture control with idle cutoff and throttle-actuated accelerator pump for even throttle response and improved starting. The Volare 10-3678-32 carburetor is used.

All float type carburetors require an airbox which have carburetor heat provisions to prevent carburetor icing under certain atmospheric conditions. Use of carb heat is addressed in the Aircraft POH.

### 2.5.11 Lubrication System

The engine has a full pressure, wet sump lubrication system supplied by a gear type pump which is driven directly by the gear installed in the rear of the crankshaft. The pump supplies oil under pressure to crankshaft main bearings, connecting rod bearings, camshaft bearings, lifter bores and hydraulic units, valve rocker arm bushings, and all accessory drive gear shafts and bearings. Oil to gear teeth, piston pins and cylinder bores is by splash and spray. Oil from each cylinder rocker box drains to the crankcase via #6 aluminum tubes.

A fine mesh oil screen provides filtered oil to the main oil galleries of the crankcase. A 1/8-NPT port on the accessory case provides a connection for an engine oil pressure gage. An oil-pressure relief valve is installed in a machined boss located above and to the rear of the #3 cylinder pad on the right crankcase half of the engine. A .687 diameter ball serves as the relief valve. Engine oil pressure is regulated by a coil spring, which is compressed by an adjustment screw in the oil pressure relief valve cap.

### **2.5.12 Priming System**

CC340 engines require a manual primer system.

### **2.5.13 Ignition System**

All CC340 engines are equipped with dual Light Speed Plasma III CDI Systems with 14mm spark plugs at all locations. Indicator lights illuminate on the instrument panel when a system is NOT functioning. The two independent systems are controlled with an ignition key switch.

## **Section 3 STANDARD PRACTICES**

### **3.1 General Practices**

To facilitate and ensure proper reinstallation or reassembly of Cub Crafters CC 340 engines, photograph, tag and/or mark all parts and hardware as to their location and orientation before they are removed or disassembled. Mark parts using tape, felt tip markers or tags with wire ties. Ensure that all tape and tags are removed before reassembly. Do not mark critical engine parts by punch marking, metal stamping or vibro-peening as these methods could cause failure.

Visually inspect all parts as they are removed for evidence of corrosion, wear, damage or deterioration. Tag unserviceable parts immediately so they are not re-used. Use extreme care during disassembly to prevent foreign matter (lock wire, nuts, washers, screws, gasket material, dirt, etc.) from entering the engine. It is always advisable to first wash or clean the area of the engine before disassembly or removal of any part. Prepare ahead of time by obtaining necessary protective caps, plugs and covers so no openings remain exposed.

#### **CAUTION**

**Dust caps used to protect open lines and fittings should always be installed OVER the ends of the lines or fittings and not IN the tube or fitting ends where they might be overlooked at reassembly.**

If anything is inadvertently dropped into the engine, cease work immediately in order to find and remove the item, even if that requires considerable time and disassembly.

Use only a plastic or rawhide mallet when installation of a part requires force except when a special tool or other procedure is specially called out in this manual.

Ensure that all parts are thoroughly clean and in serviceable condition before reassembly, especially during engine buildup. Nonmetallic parts must show no sign of deterioration.

All lock wire and cotter pins must fit snugly in holes drilled in specific hardware; must be tight, and must not come into contact with any moving part. Pigtail ends of lock wire must be tucked in as closely as possible to the part being secured. **TENSION OF THE LOCKWIRE MUST ALWAYS PULL THE THREADED FASTENER IN THE DIRECTION OF TIGHTENING.**

Replace any lock wire that is loose, nicked or over-twisted. See Figure 3-1 below.

#### **WARNING**

**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

On castellated nuts using cotter pins, the cotter pin head must fit into a recess of the nut with the other end bent such that one leg is bent back over the stud or bolt and the other leg is bent down flat against the side of the nut. **DO NOT LOOSEN OR OVERTIGHTEN CASTELLATED NUTS IN ORDER TO OBTAIN ALIGNMENT FOR INSTALLATION OF COTTER PINS OR LOCKWIRE!** If alignment cannot be obtained within the recommended tightening torque range, remove the castellated nut and install another of the same part number until alignment can be obtained at the proper torque.

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Lubricate all parts at assembly in accordance with the recommendations of this manual or the manufacturer of the part.

Tighten all parts to the recommended torque value using the proper lubricant, the specified tightening sequence and a high quality tool which has been calibrated and certified.

Observe all safety precautions and warnings in this manual.

### **3.2 Parts To Be Replaced**

Replace the following items with identical NEW parts ANY TIME they are removed, regardless of their appearance or condition:

- Paper or fiber gaskets
- Lock wire
- Cotter pins
- Lock Washers
- Elastic Stop Nuts
- Thread seal and Associated Sealing Paste
- O-ring Seals and Rubber Packings such as pushrod tube seals and cylinder base seals
- Circlips and Lock Rings
- Aluminum and Copper/Fiber Crush Washers
- Exhaust Gaskets
- Exhaust Nuts
- Connecting Rod Bolts and Nuts
- Insert Type Bearings
- Any Fastener with any type of thread damage
- Exhaust Valve Keys and Rotor Caps
- Loose Fitting Piston Pin Plugs
- Lip Type Oil Seals

### 3.3 Pre-Lubrication of Parts Prior to Assembly

In general, engine moving parts and threaded fasteners must be lubricated at the time of assembly. Follow the specific guidelines for major components in Section 7, Reassembly, of this manual. The general guidelines below should also be observed.

**WARNING**

**LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

- 3.3.1** Lubricate the following parts with Molyshield grease or equivalent:
- Intake and exhaust valve stems
  - Crankshaft thrust face and crankcase thrust surfaces (not bearings or journals)
  - Camshaft lobes and lifter faces
- 3.3.2** Lubricate spark plug threads sparingly with Champion Spark Plug Thread Lubricant, P/N 2612, or equivalent. Use care to keep lubricant from spark plug electrodes and barrel threads or ID.
- 3.3.3** Lubricate the following parts with Henkel Loctite Food Grade Anti-Seize Compound, no. 1167237, or equivalent:
- Threads of crankshaft gear bolts
  - Threads of connecting rod bolts
  - Faces of connecting rod nuts
- 3.3.4** Lubricate the following parts with Henkel Loctite Anti-Seize Compound, no. 76732, or equivalent:
- Tapered pipe threads of fuel injection nozzles (apply sparingly to male threads only and avoid first two threads)
- 3.3.5** Lubricate the following parts with Henkel Loctite Hydraulic Sealant, no. 569, or equivalent:
- Tapered pipe threads of fuel lines (not straight threads)
  - Tapered pipe threads of fuel injection system fittings (except fuel injection nozzles)
  - Tapered pipe threads of oil pressure and oil cooler lines
- 3.3.6** Lubricate the following parts with Titesal No.2 Gasket and Joint Compound, no. T2-01, or Henkel Loctite C5-A Anti-Seize compound, or equivalent:
- Male threads of tapered pipe plugs

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### NOTE

If desired, oil drain plugs or quick drain fittings may be sealed using PTFE tape. Do not allow tape to extend past end of plug. Use only a single wrap of tape. **DO NOT USE PTFE TAPE ON ANY OIL LINES, FUEL LINES, OR FUEL INJECTION LINES AND FITTINGS.**

- 3.3.7** All other parts, including engine bearings and crankcase thru-bolts, studs and nuts, cylinder base seals and O-rings must be lubricated using a mixture of 85% SAE 50 engine oil and 15% STP. Lightly oil crankcase main bearing bores and ID of connecting rods and caps with this mixture before installing bearing inserts. Lightly lubricate shanks of connecting rod bolts before installing in connecting rods.

### NOTE

Do not use grease of any kind on main bearings, connecting rod bearings or crankshaft journals. Grease may block drilled oil passages in crankcase, crankshaft and bearings and prevent flow of engine oil at startup, thereby causing damage to or failure of bearings and crankshaft.

## 3.4 Use of Sealants

Certain parts of CCI CC 340 engines require the careful and controlled use of recommended sealants or their equivalent. Prior to application of sealants, all surfaces must be clean, dry and free from oil or grease.

### WARNING

**ADHESIVE SEALANT IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. AVOID EYE AND SKIN CONTACT. USE PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

- 3.4.1** Paper or fiber gaskets may be assembled dry or using a light coating of the following products:
- Henkel Loctite No. 2 Gasket Sealant, P/N 30514
  - Titeseal No.2 Gasket and Joint Compound
  - K&W Copper Coat, P/N 1504-12

### NOTE

For best results, pushrod tube seals should be installed dry. **DO NOT** use oil or any type of gasket sealant on rubber valve rocker cover gaskets.

- 3.4.2** Apply a light coating of Pliobond #20 on the OD of the crankshaft seal and the ID of the crankcase seal bore immediately prior to assembly. Use caution to prevent sealant from contacting the crankshaft seal surface.
- 3.4.3** Use RTV™ 102 or Loctite 515 silicone sealant and size 00 silk thread to seal the upper and lower parting surfaces of the crankcase as shown in Figure 3-2 below. Sealant must be applied only to the left crankcase half in a thin, transparent film no more than 10 minutes prior to assembly of the case halves. Sealant must have a wet appearance at time of assembly. If it does not, remove and reapply. Do not apply sealant to main bearing saddles or thru-stud O-ring counterbores. Do not apply RTV™ 102 or Loctite 515 sealant within .20 inch of camshaft bearing bores.

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### NOTE

Do not use silicone sealant on O-rings, cylinder base seals, pushrod tube seals, cylinder flanges or on any parts of the engine exposed to fuel. Do not use silicone sealant on rubber valve rocker cover gaskets.

### 3.5 Precision Instruments and Tools

All CC340 engine component parts are manufactured to close tolerances using state-of-the art machine tools. In order to restore and maintain airworthiness and inspect for wear and proper fits and clearances, it is important that owners, operators and mechanics repair, maintain and overhaul CC340 engines use high quality precision instruments and tools under controlled conditions. These instruments and tools include outside micrometers and calipers, dial indicators, bore gages, plug gages, pressure and temperature gages and torque wrenches. These items should be calibrated at least annually by an accredited calibration laboratory able to provide certification of accuracy that has traceability to the National Institute of Standards and Technology (NIST), or to the equivalent agency of another country.

Certification of calibration is not a guarantee of future performance, however. All precision instruments and tools require careful handling, use and storage. Accuracy and proper operation should be questioned and verified any time they are subjected to mishandling and abuse or any time the results appear to be questionable.

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## **Section 4 ENGINE REMOVAL, DISASSEMBLY and CLEANING**

### **4.1 General**

Equipment and Materials to accomplish removal are listed in Table 4-1.

<b>NOTE</b> Standard aviation shop tools are required.
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<b>Item</b>	<b>Vendor</b>
Engine Stand	Commercially Available
Engine Hoist	Commercially Available
Protective Covers for Open Lines or Ports	Commercially Available
Tape, Tags and Felt Tip Markers	Commercially Available

**Table 4-1 Equipment and Materials List**

<b>WARNING</b> <b>FUEL IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. USE ONLY IN A WELL VENTILATED AREA FREE FROM SPARKS, FLAME, OR HOT SURFACES. AVOID EYE AND SKIN CONTACT. ALWAYS WEAR SPLASH GOGGLES, SOLVENT-RESISTANT GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.</b>
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<b>WARNING</b> <b>ENGINE OIL IS HAZARDOUS AND MAY CAUSE INJURY TO SKIN AND EYES. WEAR PERSONAL PROTECTIVE GEAR.</b>
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<b>WARNING</b> <b>ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.</b>
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### **4.2 Removal**

Before beginning engine removal, review paragraph 3-1, General Practices, in Section 3 of this manual.

Remove the engine from the airframe as follows:

<b>NOTE</b> Identify each item as the item is disconnected from the engine to aid in reinstallation.
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- Turn all cockpit switches and fuel selector valves to OFF.
- Remove aircraft cowling as required.
- Disconnect and remove ignition wires from the spark plugs.

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- Disconnect the battery ground cable.
- Disconnect the electrical cable to the starter.
- Drain the engine oil from the sump. Replace drain plug and tighten.
- Remove engine baffles as required.
- Remove air intake ducting and heat ducting as required.
- Remove engine exhaust system as required.
- Tag and disconnect the engine wiring bundles from all applicable components.
- Remove all clamps attaching engine wire bundles to engine components, and route bundles clear of the engine.
- Remove propeller in accordance with the airframe manufacturer's instructions.
- Remove throttle, carb heat, and mixture control cables or linkage as required. Consult the airframe manufacturer's maintenance manual for engine-to-airframe connections.
- Attach a hoist to the engine lifting eye, and relieve the weight from the engine mounts. Use ONLY the lifting eye(s) installed on the backbone of the crankcase to hoist the engine. Be certain that the hoist, chains, cables, straps or links are capable of supporting at least twice the weight of the engine.
- Remove the engine mounts and engine as follows:
  1. Loosen and remove the engine mounts bolts in accordance with manufacturer's instructions.
  2. Hoist the engine vertically out of the nacelle and clear of the aircraft.

### NOTE

Hoist the engine slowly, and ensure that all wires, lines, and hoses have been disconnected.

- Install the engine onto a disassembly stand, dolly, or an engine shipping container base.
- Install protective covers/plugs on any remaining open fuel, oil/hydraulic lines or fittings, electrical connections, air inlet and exhaust ports.

## 4.3 Preservation

If the engine is to be stored for longer than 30 days, refer to the Preservation and Storage section of the applicable CC340 Maintenance Manual for procedures and materials.

## 4.4 Disassembly

### 4.4.1 General

Disassembly materials and procedures are described in the paragraphs following. When necessary, disassembly illustrations are also provided. All item number references in the text are specific to this manual and the figures cited.

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#### 4.4.2 Disassembly Materials

Materials required for disassembly are listed in Table 4-2.

**NOTE**  
Equivalent substitutes may be used.

Description	Source
Penetrating Oil	Commercially Available

**Table 4-2 Disassembly Materials**

#### 4.4.3 Parts To Be Replaced: Major Engine Repair

For the purposes of this section, major engine repair is defined as complete engine disassembly for the purposes of inspection and/or limited component replacement that would not be considered a major overhaul. Time since major overhaul (SMOH) is carried forward. Examples would be:

- Engine disassembly and inspection following a prop strike or sudden stoppage
- Replacement a cracked crankcase
- Replacement of a spalled camshaft and lifters

At major engine repair, replace the parts shown in Table 4-3 with identical or superseding NEW parts ANY TIME they are removed, regardless of their appearance or condition:

All parts listed at paragraph 3-2 in this manual
Any parts found to be worn, damaged or otherwise unserviceable per the inspection criteria of Section 5 and/or the dimensional limits of Section 10 of this manual.
Camshafts and lifters may be reused provided that there is no evidence of corrosion, abnormal wear, pitting, chipping or spalling on camshaft lobes and lifter faces. Lifters must be re-installed in the same position from which they were removed. Hydraulic unit bodies and plungers are select fit items and must remain as a matched assembly after bleeding down. <b>DO NOT USE MAGNETS TO REMOVE HYDRAULIC UNITS OR PUSHROD SOCKETS.</b>
Oil, fuel and induction system lines and hoses (except for intake pipe and cylinder drain hoses) may be re-used provided that they are not damaged, contaminated or beyond material life limits.

**Table 4-3 Major Engine Repair Replacement Parts**

#### 4.4.4 Parts To Be Replaced: Major Engine Overhaul

For the purposes of this section, major engine repair is defined as complete engine disassembly for the purposes of inspection, repair and replacement, and reassembly with all part fits and clearances restored to new limits for standard sized parts or approved undersizes or oversizes. After reassembly, time since major overhaul (SMOH) is considered zero (0) hours in service.

At major engine overhaul, replace the parts shown in Table 4-4 with identical or superseding NEW parts ANY TIME they are removed, regardless of their appearance or condition:

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All parts listed at par. 3-2 in this manual
All engine oil, air and fuel hoses
Pistons, piston rings, piston pins and plugs
Camshaft, including tachometer shaft centering spacer
Lifter bodies
Connecting rod and rocker arm bushings
Rocker arm shafts
Exhaust valves, guides, keys, upper spring retainers and rotor caps
Vermatherm (thermostatic oil cooler bypass valve)
Oil pressure relief valve spring
Piston cooling nozzles
Ignition harnesses
Spark plugs (except fine wire electrodes)
Diaphragm-type fuel pump
Front expansion plug in crankshaft
Counterweight bushings in crankshaft and counterweights (if applicable)
Counterweight washers (if applicable)
Engine accessories such as magnetos, carburetors, starters, alternators, fuel injection systems and propeller governors must be overhauled per manufacturer recommendations. Aircraft oil coolers must be drained and flushed.

**Table 4-4 Major Engine Overhaul Replacement Parts**

#### 4.4.5 Special Tools and Equipment

Special tools and equipment required for disassembly are listed in Table 4-5.

**NOTE**

Standard reciprocating engine aviation shop tools and equipment are used unless otherwise specified.

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<b>Nomenclature</b>	<b>Source</b>
Compressor, Piston Ring	Commercially Available
Expander, Piston Ring	Commercially Available
Puller, Slide Hammer-Medium	Commercially Available
Compressor, Valve Spring	Commercially Available
Intercylinder Baffle Tool	Commercially Available
Puller, Valve Guide	Commercially Available
Puller Set, Oil Seal	Commercially Available
Stand, Vertical Nose Support	Commercially Available
Tool, Hydraulic Tappet Removal	Commercially Available
Wrenches, Cylinder Base Nut, 9/16" & 3/4"	Commercially Available

**Table 4-5 Special Tools and Equipment**

**4.4.6 General Disassembly Procedures**

- Place engine in horizontal position on a hoist or transfer cart.
- Remove the starter and ring gear support assembly.
- Remove the oil drain plug and drain the oil from the engine, if not previously drained.

**WARNING**  
**ENGINE OIL IS HAZARDOUS AND MAY CAUSE INJURY TO SKIN AND EYES. WEAR PERSONAL PROTECTIVE GEAR.**

- Prior to disassembly of other parts and components, place the engine on a secure vertical stand that supports the engine by the face of the crankshaft flange, not the prop flange bushings. Ensure that crankshaft flange is bolted securely.
- Photograph and/or tag all components and parts as they are removed. Bag and label loose assemblies or attaching hardware.
- Perform visual inspection during disassembly and immediately after disassembly. All individual parts should be laid out in an orderly manner as they are removed.
- All loose studs, cracked baffles, and loose or damaged fittings should be tagged to prevent being overlooked during regular inspection.

**WARNING**  
**FUEL IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. USE ONLY IN A WELL VENTILATED AREA FREE FROM SPARKS, FLAME, OR HOT SURFACES. AVOID EYE AND SKIN CONTACT. ALWAYS WEAR SPLASH GOGGLES, SOLVENT-RESISTANT GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

**WARNING**  
**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

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### 4.4.7 General Disassembly Procedures

#### 4.4.7.1 Carburetor Removal

1. Remove engine fuel lines and all attaching hardware.
2. Remove the carburetor as follows.
3. Remove nuts, lock washers and flat washers from studs, four places.
4. Remove carburetor from studs and discard gasket.

#### 4.4.7.2 Oil Level Gauge (dipstick) Housing Removal

1. Unscrew the oil gage and remove the oil gage housing. Discard seals.

#### 4.4.7.3 Accessory Case Assembly Removal

1. Remove the accessory case assembly by removing the bolts, lock washers, and flat washers. Remove bolt, washer, and nut, two places. Remove accessory case and gasket.
2. Remove nuts and washers to remove oil pump housing assembly. Remove oil pump drive shaft and impeller gears.

#### 4.4.7.4 Idle Gears and Shaft Removal

1. Remove idler gear. Remove idler shaft attaching screws and nut. Remove idler shaft from crankcase.

#### 4.4.7.5 Alternator and Bracket Removal

1. Remove alternator mount bolt and washer to loosen drive belt. Remove cotter pin, slotted nut, support bolt, and shims. Remove cotter pin, slotted nut, shims, and support bolt. Remove bolts and flat washers from strut bracket. Remove strut support and remove alternator.
2. Remove alternator bracket by removing bolts and lock plate. Remove bolt, flat washer, and adjusting link. Visually inspect hardware and bag for reuse if not damaged.

#### 4.4.7.6 Oil Sump and Induction System Disassembly

1. Remove screws, lock washers, and flat washers from intake pipe flange. Discard gaskets.
2. Cut heat shrink seals to free intake elbows from sump.
3. Remove oil screen plug, discard gasket, and remove oil suction screen. Inspect for debris.
4. Remove bolts, flat washers, lock washers, and nuts from sump assembly flange. Discard gasket.

#### 4.4.7.7 Cylinder Drain Tubes Removal

1. Loosen hose clamps on hose at drain nipple. Slide away from drain nipple. Loosen "B" nut at cylinder head fitting and remove tube assembly from cylinder.

#### 4.4.7.8 Intercylinder Cooling Baffle Removal

1. Remove the intercylinder cooling baffles by cutting safety wires attaching them to the front and rear composite baffles.

#### 4.4.7.9 Cylinder Removal

1. Remove the valve rocker cover screws and cover and discard gasket. Rotate the crankshaft to place the piston of the No. 1 cylinder at top center of the compression stroke.

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### NOTE

With the piston in this position both valves will be closed and the piston extended away from the crankcase to avoid damage when the cylinder is removed.

2. Remove the valve rocker shaft plugs, the valve rocker shaft, valve rocker arms, and the exhaust valve rotor cap from cylinder assembly. Remove the pushrod by grasping the rod end and pulling it through the rod tube. Remove nut, spring, and lock plate. Pull rod tube through cylinder head and discard tube seals and lock plate.
3. Remove cylinder assembly by removing nuts from cylinder base. Remove cylinder by pulling straight away from crankcase. As the cylinder is being pulled away, hold the piston to prevent damage. Discard cylinder base seal.
4. Remove the piston pin using a piston pin removal tool. Drive pin from piston to remove piston from the connecting rod.

### CAUTION

**The Connecting rod must be supported to prevent damage to the rod and crankcase. Support each connecting rod with cylinder hole plates designed to guide small end of connecting rod or by using heavy rubber bands or discarded cylinder base seals looped around the cylinder base studs.**

### NOTE

Removal of remaining cylinders and pistons may be done in any sequence, but less turning of the crankshaft is involved if the cylinders are removed in firing order 1-3-2-4.

#### 4.4.7.10 Cylinder and Valve Train Disassembly

1. Place cylinder over a suitable support post that contact the heads of the valves, and compress valve springs with spring compressor tool. Compress springs far enough to remove the valve spring retainer keys.

### NOTE

If the valve keys are stuck in the spring seat, a light blow with a plastic or leather mallet on top of the compressor tool will release keys. Be careful to compress the valve spring seats squarely with the valve stems in order to prevent nicks or gouges to the valve stems.

2. Remove upper valve spring seats, inner springs, outer springs, and lower valve spring seats from rocker box of cylinder. Keep parts for each valve (65, 70) separate. Hold valves by the stems to keep them from dropping out of the cylinder and remove cylinder from the support block. Reach inside the cylinder and remove valves. If valves cannot be readily removed, push valves back into the guides. Inspect valve stems for nicks, damage or raised metal in the groove for the keys; and repair as required with a small file. If necessary, clean carbon from valve stems.

### CAUTION

**Do not drive the valves through the guides.**

3. Using the piston ring expander tool, remove the rings from all pistons. Remove the top compression ring first and work down.

### CAUTION

**Be careful not to scratch or score pistons when removing the rings.**

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4. Remove the pushrod socket from the lifter body by first wiping oil from the socket with a clean cloth. Coat the ball end of a clean pushrod with heavy grease. Insert the ball end into the pushrod socket. Rotate the pushrod slight and gently withdraw it from the lifter. The socket will adhere to the grease and come out with the pushrod. **DO NOT USE A MAGNET**, and be careful not to drop the socket.
5. After removal of the pushrod socket, remove the hydraulic unit from each lifter body. Remove by inserting a piece of wire bent at a right angle into the lifter between the plunger and the lifter body. Turn wire 90 degrees to engage a coil of the spring on the plunger, and draw out the hydraulic unit as an assembly.

### CAUTION

**If they are to be re-used, maintain pushrod sockets and hydraulic units of each lifter assembly together during engine major repair or major overhaul operations. If camshaft and lifters will be re-used without benefit of re-grinding, the lifters must be reassembled in their original location in the crankcase. If the engine is having a major overhaul, camshaft and lifters must be reground or replaced.**

#### 4.4.7.11 Crankcase Disassembly

1. Remove nuts and spacers from ends of thru bolts forward of #2 cylinder pad. Draw or pull the thru-bolts from the crankcase using cylinder base nuts and washers and/or spacers or using a heavy slide hammer with a hardened steel adapter having .50-20 UNF female threads. All removal tools must have threads that are in good condition in order to prevent damage to the thru bolt threads.
2. Remove nuts, bolts, and washers. Be certain to remove .38-24 slotted nut behind camshaft gear.
3. Separate crankcase halves being careful not to allow camshaft to fall to floor. Be careful to keep the thru-studs in the right crankcase half from becoming misaligned when separating the crankcase halves.

### NOTE

Carefully pull crankshaft nose seal from crankcase forward on crankshaft to aid in crankcase half separation. If seal has been glued into crankcase, it may be necessary to cut this seal using an Exact-O knife, or equivalent. **USE EXTREME CARE TO NOT SCRATCH OR SCORE THE CRANKSHAFT WHEN CUTTING SEAL!**

4. Remove the bearing inserts, camshaft, and lifter bodies. Remove and discard o-ring seals.

### NOTE

Place each lifter body in its proper location in a cleaning basket and/or wire a small metal tag (1 EX, 1 IN, etc.) to each lifter body. The lifter bodies must be assembled in their original locations if re-used.

5. Remove all threaded plugs and piston cooling nozzles if installed. It may be necessary to heat the local area of the crankcase with a propane torch in order to remove threaded plugs. Discard threaded plugs and oil seals.

#### 4.4.7.12 Crankshaft Disassembly

1. With the crankshaft flange still firmly bolted to the engine stand (or firmly supported at the front and rear main bearing journals) remove connecting rod nuts. Remove the

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rods by tapping on the rod bolts with a soft hammer. Discard the connecting rod bearings, bolts, and nuts.

### NOTE

Maintain each cap and rod as an assembly. Rods and caps are not interchangeable.

2. To remove the crankshaft gear, flatten the lock plate and remove cap screw. Discard the bolt and lock plate. Examine gear for looseness (it should be snug in crankshaft). Remove gear by carefully laying the blade of a straight screwdriver on the aft edge of the rear main bearing journal tangent to the flange of the gear and located near the gear dowel. This screwdriver blade acts as a fulcrum and protects the crankshaft from damage. Lay the blade of a second straight screwdriver on the blade of the first screwdriver and insert it under the teeth of the crankshaft gear. The second screwdriver will be perpendicular to the first and pointing at the axis of the crankshaft. Gently pry the gear out of the crankshaft by pressing down on the handle of the second screwdriver. It may be necessary to work in several locations around the gear while moving it a little at each location.
3. Remove the crankshaft oil seal and discard.
4. Remove the crankshaft from the engine stand. The front expansion plug installed in the ID of the prop flange pilot will need to be removed for cleaning. Clamp the crankshaft in a large vise with soft (copper, brass, aluminum) jaws gripping only the sides of the #1 crankcheek. Using a large ball-peen hammer and a .75-inch diameter brass drift with a ball-shaped end placed in the center of the expansion plug, cave in the plug until it becomes loose and falls out of the crankshaft or can be easily lifted out with a small magnet.

#### 4.4.7.13 Camshaft Disassembly

1. Using a pair of internal retaining ring pliers, remove the retaining ring from the aft end of the camshaft and withdraw the tachometer shaft. Insert an aluminum rod .66-.70 in diameter and approximately 20 inches long into the front of the camshaft. Tap lightly on the rod with a soft hammer to remove the tachometer shaft spacer from the camshaft. Discard the spacer.

## 4.5 Cleaning

### 4.5.1 General

It is crucial that aircraft engine component parts be thoroughly clean when undergoing inspection, repair, testing and reassembly. This section provides information on materials, tools, and guidelines for cleaning.

It is very important to visually inspect engine component parts prior to cleaning. Residue from engine operation may provide information as to hidden defects or other dangerous conditions. Traces of wear metals, foreign contaminants and signs of overheating may be lost after thorough cleaning making it more difficult to completely diagnose the cause(s) of problems and related damage.

Parts that can be immediately rejected on the basis of visual inspection need not be subjected to cleaning, thus saving time, materials and cost.

### 4.5.2 Tools and Materials

Basic tools required during cleaning are listed below in Table 4-6.

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Consumable materials required during cleaning are listed in Table 4-7.

Item	Vendor
Parts cleaning brush (soft and stiff bristles)	Commercially Available
Immersing tank	Commercially Available
Scraper (wood or plastic)	Commercially Available
Media blaster (glass beads, walnut shells or plastic particles)	Commercially Available

**Table 4-6 Equipment Required for Cleaning**

### 4.5.3 Cleaning Processes

Two (2) processes are used 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.

**CAUTION**  
**Do not use sand or metallic abrasives with the grit blasting equipment.**

### 4.5.4 De-Greasing

Degreasing is accomplished by immersing or spraying the part using a petroleum solvent or by washing in an aqueous parts washer system.

Item	Vendor
Cleaning solvent or degreaser such as white furnace oil, Tarr, Inc. solvent 140, or Safety-Kleen solvent	Commercially Available
Aqueous parts cleaner such as Safety-Kleen Armakleen	Commercially Available
Decarbonizing solutions such as El Dorado CT-2600	Commercially Available
Degreasing solvents such as Chevron Phillips EcoSolv	Commercially Available
Isopropyl alcohol	Commercially Available
Aerosol electrical contact cleaner	Commercially Available
Lubricating oil (SAE 20)	Commercially Available
Anti-corrosion preservative oil such as WD-40 and CRC 3-36	Commercially Available
Abrasive cloth (crocus cloth)	Commercially Available
Abrasive pads, Scotchbrite™ 7447 or 6448	Commercially Available

**Table 4-7 Equipment Required for Cleaning**

**NOTE**  
Residue from the solvent washing must be captured and contained to prevent contamination of the surrounding environment.

**WARNING**  
**USE CORRECT PERSONAL PROTECTION. SOME CHEMICAL SOLUTIONS CAN CAUSE EYE, SKIN, AND LUNG DAMAGE. FOLLOW THE MANUFACTURER'S INSTRUCTIONS FOR EACH STRIPPING SOLUTION OR SURFACE TREATMENT SOLUTION.**

**CAUTION**

If any water-mixed degreasing solutions containing caustic compounds or soap are used, extreme care must be exercised. These 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 these water-mixed solutions, always thoroughly rinse the part in clean boiling water. **REGARDLESS OF METHOD OR SOLUTION USED, ALWAYS COAT AND SPRAY ALL PARTS WITH LUBRICATING OIL IMMEDIATELY AFTER CLEANING IN ORDER TO PREVENT CORROSION.**

**WARNING**

**USE NECESSARY PROTECTIVE GEAR. HEATED PARTS MAY CAUSE SEVERE BURNS.**

#### 4.5.5 De-Carbonizing

Decarbonizing is usually accomplished by immersion of the part in a decarbonizing solution (sometimes heated), such as El Dorado CT-2400, CT-2600, or suitable equivalent. Refer to the above caution for water-soluble decarbonizers. Remove hard carbon deposits after degreasing by brushing, scraping or grit blasting. After cleaning, rinse the parts in petroleum solvent, dry, and remove loose particles by blowing the particles out with compressed air. Use a shop air supply with a compressed air dryer system or an appropriate water trap.

Decarbonizing solutions will usually remove most of the enamel from machined surfaces. All remaining enamel should be removed by grit blasting, particularly in the narrow areas between cylinder cooling fins. Valve seats may be left unprotected during decarbonizing processes. This will facilitate the reconditioning of the valve seat in later procedures.

**CAUTION**

Extreme caution should be exercised when using a decarbonizing solution. 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. This practice often results in damage to the magnesium parts from electrolytic corrosion.

**CAUTION**

Use extreme care to prevent damage to machined surfaces. Mask all machined surfaces, as required. Plug all drilled oil passages to prevent damage or entry of foreign matter and ensure that all plugs and blasting media are completely removed from parts.

**WARNING**

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

**CAUTION**

**Do not use wire bristle brushes or metal scrapers on any bearing, machined or contact surfaces.**

**CAUTION**

**Media blasting of pistons must be limited to the piston top and the inside of the piston. DO NOT blast pistons with glass beads and do not blast piston ring grooves. Clean ring grooves only using A WOODEN or plastic SCRAPER. It is usually cheaper to replace pistons than to spend time cleaning them.**

#### 4.5.6 **Scratch and Corrosion Removal**

Remove superficial corrosion or pitted surfaces on the fillets at the edges of crankshaft main and crankpin journal surfaces, and thrust faces by polishing with crocus cloth or other mild abrasive material. Refer to the Table of Limits and Tightening Torques in Section 10 of this manual for limits.

**WARNING**

**DO NOT DAMAGE THE NITRIDED SURFACES OF THE CRANKSHAFT.**

Shallow or small scratches, minor abrasions, or pitting on gears or screwed fittings may be dressed out with a fine abrasive (crocus) cloth, small file, or polishing stone. Refer to the Table of Limits and Tightening Torques in Section 10 of this manual for limits.

#### 4.5.7 **Sump and Accessory Case Mounting Pads and Gasket Surfaces**

Clean mounting pads, gasket surfaces and studs by wiping with a clean cloth moistened with solvent. Use care to remove sludge and debris from around the bases of the studs. In some cases it may be necessary to remove bits of gasket material and sealer by using a razor blade scraper. Use extreme care to not scratch or gouge the machined gasket surfaces.

**NOTE**

Use care to not force debris into drilled oil passages, ports, or threaded holes.

**WARNING**

**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

#### 4.5.8 **Screens and Filters**

- A. Fuel system screens may be soaked and rinsed in clean solvent and dried with compressed air. Ultrasonic cleaning is preferred, but cleaning agent must be non-abrasive and non-corrosive to the screen material.
- B. Oil system filters. Oil screens may be soaked and rinsed in clean solvent and dried with compressed air. Ultrasonic cleaning is preferred, but cleaning agent must be

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non-abrasive and non-corrosive to the screen material. Disposable external oil filter elements are not cleaned.

- C. Air induction system filters. Foam air filters may be rinsed in clean solvent then washed with mild detergent and water and reinstalled. Follow manufacturer's instructions, and replace any filter showing signs of deterioration.

### NOTE

DO NOT clean paper air filter elements, and never use compressed air on air filter elements. Compressed air can easily open small holes in paper or foam filter elements and reduce their filtration capabilities considerably.

### WARNING

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

### WARNING

**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

#### 4.5.9 Preservation and Corrosion Prevention

Upon conclusion of visual inspection and all cleaning operations, rinse parts with clean petroleum solvent. Dry and remove any loose particles using clean, dry compressed air.

Parts that are to be subjected to non-destructive testing (NDT) such as penetrant testing or magnetic particle testing should undergo those processes as soon as possible. If parts will not undergo NDT within 24 hours, they should be protected by a liberal application of preservative oil to all surfaces.

For parts that will be repainted, do the following:

- Be sure that the part is thoroughly degreased, clean, and dry.
- Prime and paint in accordance with Section 6, Repair and Replacement, in this manual.

### WARNING

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

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**WARNING**

**LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

**WARNING**

**DO NOT INSTALL THE IGNITION HARNESS "B" NUTS ON THE SPARK PLUGS UNTIL THE PROPELLER INSTALLATION IS COMPLETED. FAILURE TO COMPLY COULD RESULT IN BODILY INJURY WHEN THE PROPELLER IS ROTATED DURING INSTALLATION.**

## **Section 5. INSPECTION, TESTS and CHECKS**

### **5.1 General**

Cub Crafters CC340 engine inspection consists of three (3) categories: visual, non-destructive, and dimensional.

- 1) Visual inspections deal primarily with cosmetic defects that may also be structural defects, such as corrosion pits, spalling, galling, discoloration due to overheating, scoring, chipping and visible cracks.
- 2) Non-destructive tests (NDT) are used to detect structural defects such as heat cracks, fatigue cracks and brittle fractures that may or may not be visible to the naked eye.
- 3) Dimensional checks are inspections concerned with the size, shape, and fit of a given part.

Upon successful completion of inspection, thoroughly clean all parts and coat with preservative oil.

Visual inspections should precede all other inspections. Residue from engine operation may provide information as to hidden defects or other dangerous conditions. Traces of wear metals, foreign contaminants and signs of overheating may be lost after thorough cleaning, making it more difficult to completely diagnose the cause(s) of problems and related damage. Refer to par. 4-5, Cleaning, in Section 4 of this manual.

Major structural component parts of the engine generally require only two types of NDT during overhaul. They are magnetic particle testing (MT) for ferromagnetic parts and liquid penetrant testing (PT) for non-magnetic parts. Other methods of NDT such as hardness testing, ultrasonic testing, eddy-current testing and pressure testing could be required to evaluate unusual defects or conditions addressed by Cub Crafters service bulletins or service instructions, should such conditions arise.

For dimensional inspections, refer to the tables set forth in Section 10 of this manual.

Dimensional inspections also include measurement of ID, OD, run-out, flatness, out-of-roundness, backlash, squareness, perpendicularity, and clearances.

For repairs required prior to a final inspection or dimensional check of a part, refer to Section 6, Repair and Replacement, in this manual.

It is strongly recommended that a comprehensive form be used to document all inspection repair and assembly procedures. The form should be organized to record inspection results, repairs, and dimensional checks as they are completed. Information should be complete enough that someone who has not performed the work is able to determine what was accomplished and by whom. Use of a standard form will help to ensure that no key inspections, checks and tests are omitted and that important dimensional information can be reviewed at a later date.

### **5.2 Materials, Tools and Equipment**

Materials required for inspection are listed Table 5-1.

Special tools and equipment required for inspection are listed Table 5-2.

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Item	Source
Magnetic base oil such as Magnaflux Carrier II or Tarr, Inc. Solvent 140.	Commercially Available
Preservative oil such as WD-40 or CRC 3-36	Commercially Available
Liquid penetrant and developer	Commercially Available
Acetone	Commercially Available
Mineral spirits	Commercially Available
SAE #10 lubricating oil (check fuel nozzle flow)	Commercially Available

**Table 5-1 Inspection Materials**

**NOTE**  
Equivalent substitutes may be used.

Item	Source
Calipers, vernier, dial or digital, ID and OD; .001" graduations; calibrated	Commercially Available
Micrometers, OD; .0001" graduations; calibrated	Commercially Available
Telescoping gages	Commercially Available
Small hole gages	Commercially Available
Feeler gages, .001" - .025"	Commercially Available
Dial indicators; .001" graduations; calibrated	Commercially Available
Dial test indicators; .0005" graduations; calibrated	Commercially Available
Dial bore gages; .0005" or .0001" graduations; calibrated	Commercially Available
Vee blocks	Commercially Available
Granite surface plate, min. 18" x 24"; calibrated	Commercially Available
Spring force tester, calibrated	Commercially Available
Torque wrenches, 30-200 In-Lb, 150-1000 In-Lb; calibrated	Commercially Available
Machinist's rule	Commercially Available
Small flashlight	Commercially Available
10X Magnifier, illuminated	Commercially Available
Magnetic Particle Testing Equipment, AC; calibrated	Commercially Available
Liquid Penetrant Testing System	Commercially Available

**Table 5-2 Special Tools and Equipment**

**NOTE**  
Equivalent substitutes may be used.

### **5.3 General Inspection Procedures**

All journal surfaces must be checked for galling, scores, misalignment, and out-of-round condition. Pins and shafts must be inspected for straightness. Flanges must be checked for flatness and run-out.

Examine gears for evidence of pitting and excessive wear. This evidence is of special importance when found on the involute surface and the root of the gear teeth. Deep pit marks in this area are reason to reject the part. Wear that visibly alters the involute surface of gear teeth is cause for rejection.

Bearing surfaces of all gears, shafts and shaft gears may have minor abrasions dressed out with fine abrasive cloth but should be free from deep scratches.

Inspection of highly stressed areas for corrosion is necessary. These areas are susceptible to pitting and can cause failure of the part. Pitting in these areas that cannot be removed by polishing with crocus cloth or other fine abrasive is cause for rejection. For polishing procedures, see the Repairs section of this manual.

The following are components requiring particular attention with respect to this issue:

- fillets at the edges of crankshaft main and crankpin journal surfaces
- thrust bearing faces

Evidence of galling, micro-welding or overheating (steel parts turned blue or blue-black, cadmium plating melted and puddled) are cause for rejection.

Radial heat cracks on a thrust surface and heat cracks, ladder cracks and fatigue cracks on a journal are cause for rejection unless repairable by grinding to an undersize.

Inspect all threaded inserts, fasteners, studs, fittings, plugs, etc., for condition of threads. Excessively worn, deformed or galled threads should be rejected. Small defects (such as slight nicks or burrs) may be dressed out with a small file, fine abrasive cloth (crocus cloth), or oil stone. If distortion, galling, or mutilation resulting from over tightening is discovered, the part must be replaced.

### **5.4 General Requirements, Magnetic Particle Testing (MT)**

All parts must be thoroughly clean and dry prior to testing and again upon completion of the test procedures.

Refer to paragraph 4-5, Cleaning, in Section 4 of this manual. Test results must be carefully evaluated in order to permit accurate interpretation.

All ferro-magnetic steel parts should undergo fluorescent magnetic particle testing (MT) in accordance with specification ASTM E-1444, performed by appropriately trained and qualified personnel. AC magnetizing current is preferred, and the wet continuous method is mandatory. Complex parts such as crankshafts, camshafts, gears and connecting rods should be magnetized using both circular and longitudinal fields. Magnetizing current settings and procedures for magnetizing, inspection and demagnetizing should be developed and approved by a person holding ASNT Level III certification, or equivalent.

MT is especially effective when used on highly stressed parts such as crankshaft journals and fillets, keyways, gear teeth, splines, roots of threads, small holes, and fillets.

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**NOTE**

Perform the magnetic particle inspection strictly in accordance with industry standards and MT equipment manufacturer's guidelines. Failure to do so can result in erroneous readings and the re-use of critical components with hidden damage that may cause engine failure.

**CAUTION**

**Use extreme care to prevent arcing, overheating, or burning of the part when magnetizing current is conducted through the part. Such damage could result in subsequent failure of the part.**

### **5.5 General Requirements, Penetrant Testing (PT)**

Non-magnetic parts of the CC340 engine are not eligible for MT but must be inspected for defects using liquid penetrant testing (PT). PT is capable of identifying defects that are open to the part surface only such as pits, porosity and cracks. Parts undergoing PT must be thoroughly clean and dry before testing and must be thoroughly cleaned to remove all penetrant and developer residue upon completion of the test. Any oils or other fluids used for other non-destructive procedures must be thoroughly cleaned from the part upon completion of the test.

Procedures for PT should be developed in accordance with ASTM specification E-1220, ASME specification E-165, or equivalent and be approved by a person holding ASNT Level III certification for PT. Penetrant materials should conform to AMS 2644 and may be either Type 1 (fluorescent penetrant) or Type II (visible dye), and having penetrant sensitivity Levels 1 (low) or 2 (medium). Penetrant application and removal methods (water washable, solvent removable, etc.) and developer forms are optional depending on the equipment and system of the inspection facility; but all factors should be specified as a part of the ASNT Level III-approved procedures.

**NOTE**

Upon completion of any cleaning procedure, be sure to coat all steel parts with preservative oil. Do not handle cleaned parts any more than necessary prior to their reassembly into the engine as this handling reintroduces dirt and corrosive substances to the parts. For cleanliness, oil parts should be placed into protective plastic bags.

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**5.5.1 Cylinder Head Visual Inspections**      Refer to Figure 5-1

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Entire cylinder head	Obvious excessive damage to cylinder head; evidence of leakage between head and barrel	Reject and replace.
Exhaust port	Cracks inside port	Reject and replace.
Exhaust port	Damaged, corroded gasket surface	See Repair 6.7.1.
Valve seat	Loose, excessively worn or excessively reground seats	See Repair No. 6.7.2.4

**NOTE**

When replacing valve seats, seat bosses must be reworked to the next oversize of P05, P10, P20 or P30, as required to achieve full cleanup and correct ID.

Studs	Loose or damaged studs	Replace. See Repair No. 6-12.
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**NOTE**

Loose or damaged studs must be replaced with oversized studs P03, P07 or P12, as required.

Spark plug helical coil inserts	Loose or damaged inserts	Replace. See Repair No. 6.7.4.
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**NOTE**

Loose or damaged helical coil inserts must be replaced with oversized inserts.

Rocker box and intake port gasket surfaces	Nicked, scored or dented surfaces	See Repair No. 6.7.13 or resurface up to .010".
Cylinder head cooling fins	Cracked, damaged, bent, broken, missing	See Repair No. 6.7.5.
Drain line fitting	Damaged threads or flared surface	Reject and replace.

**5.5.2 Cylinder Head NDT**

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Penetrant inspect entire head	Cracks, especially in exhaust port, at spark plug bosses, seat bosses, rocker shaft bosses and between fins	Reject and replace. Repair by aircraft engine cylinder head repair station optional.

**5.5.3 Cylinder Head Dimensional Inspections**

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Rocker shaft boss bushings	Check ID of rocker boss bushings at a minimum of two (2) positions, 90 degrees apart, especially on exhaust side. Several check locations are preferred.	Refer to Table of Limits. See Repair No. 6.7.3.

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## 5.6 Cylinder

### 5.6.1 Cylinder Barrel Visual Inspections Refer to Figure 5-1

Area of Inspection	Condition or Parameter	Action
Entire cylinder barrel for general condition	Cracks, missing fins, excessive corrosion on OD, evidence of heat-to-barrel leaks	Reject and replace.
Cylinder barrel fins	Notches and nicks	Blend with hand grinder or file. See Repair No. 6.7.5
Cylinder barrel fins	Cracked or broken	Reject and replace cylinder.
Cylinder barrel skirt	Bent, cracked, or broken	Reject and replace.
Cylinder barrel mounting flange	Nicks	Blend with file or crocus cloth. See Repair No. 6.7.13
Visually inspect cylinder barrel interior.	Minor scoring or corrosion	Repair by honing. See Repair No. 6.7.9
Cylinder barrel ID	Deep scoring or pitting	Reject and replace.
Cylinder barrel ID	Minor pits, glazing or barrel wear	Repair by honing. See Repair No. 6.7.6.

**NOTE**

Steel cylinder bores may be reground .010" oversize if pistons and rings are available.  
Nickel+Carbide bores must be repaired by re-plating.

### 5.6.2 Cylinder Barrel NDT

Area of Inspection	Condition or Parameter	Action
Magnetic particle test (MT)	External cracks between fins or at fin roots; flange cracks; circular cracks in ID	Reject and replace.

### 5.6.3 Cylinder Barrel Dimensional Inspections

Area of Inspection	Condition or Parameter	Action
*Measure cylinder bore ID	Bore diameter Maximum taper of cylinder bore Maximum out-of-roundness	Refer to Table of Limits.
Measure part clearance	Fit between piston skirt and cylinder	Refer to Table of Limits.

**\*NOTE**

All cylinder barrel diameter measurements must be taken at a two (2) locations, 90 degrees apart at the plane specifically being measured.

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**5.7 Piston**

**5.7.1 Piston Visual Inspections**

Refer to Figures 5-2a and 5-2b

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Piston general condition	Top of piston for excessive pitting, cavities or surface distortion	Reject and replace.
Piston skirt	Scuffing, scoring, embedded metal, cracks	Reject and replace.
Piston structures	Inspect piston ring lands, piston pin holes, and bosses for excessive wear or damage.	Reject and replace.
Piston ring grooves	Cracks, damage, excessive wear	Refer to Table of Limits

**5.7.2 Piston NDT**

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Penetrant inspect (PT) entire piston	Cracks in ring lands, skirt or pin bosses	Reject and replace.

**5.7.3 Piston Dimensional Inspections**

Refer to Figure 5-2b

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Measure ring clearance	Side clearance between piston and ring	Refer to Table of Limits

**NOTE**

Pistons are ground with a slight taper from the skirt to the head. The exception is the lands between the top compression and oil control rings, which are ground parallel. Clearance on wedge type compression rings must be measured with ring flush to outside edge of piston as shown in Figure 5-3. Measurement by any other method will be erroneous.

Measure piston pin holes	Inside diameter of piston pin holes	Refer to Table of Limits.
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**NOTE**

No pitting or corrosion is permitted in this area.

Piston skirt in cylinder bore	Clearance between piston skirt and cylinder and piston diameter at top and bottom	Refer to Table of Limits.
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## 5.8 Crankcase

### 5.8.1 Crankcase Assembly Visual Inspections Refer to Figures 5-4 and 5-5

Area of Inspection	Condition or Parameter	Action
Obvious excessive damage or wear	Inspect all crankcase bearing bores and journals, saddle supports, support webs, tang slots, and flange surfaces.	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Fire damage	Oil, sludge and paint carbonized, deep washer imprints at thru bolt bosses, plating on studs melted	Reject and replace.
Thrust face	Surface galled, ferrous material embedded; rear thrust face or both; galling behind oil seal lip	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Main saddles and mating surfaces, cylinder pads, bearing dowels, idler shaft bosses	Fretting, heavy wear, flat spots, cracks; loose or broken bearing dowels; cracked or worn idler shaft boss pilot bores, cracked or worn bolt holes	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Flange mating surfaces, sump and accessory case gasket surfaces	Fretting, cracks, misalignment	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Lifter bores, camshaft bearing bores	Cracks, wear, embedded metal	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Main bearing bores	Cracks, fretting, tang slot wear; bore ID out-of-round and/or oversize or undersize; bearing bores misaligned	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Machined surfaces, cast or machined webs	Deep scratches, > .03" deep	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Machined surfaces, cast or machined webs	Minor scratches, < .03" deep	Blend/hand polish. See Repair No.6.7.13.
Tapered thread plug bosses	Cracks	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Tapered thread plug bosses	Stripped or damaged threads	Repair. See Repair No. 6.7.12.
Drilled and cast oil passages	Obstructed, incompletely drilled	Remove obstruction. Re-drill.
Studs or stud holes	Bent studs, galled or distorted threads, holes stripped	Replace. See Repair No. 6.7.12.
Cylinder deck studs	Studs broken, stud hole thread pulled	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Studs and thru bolts	Minor nicks on threads	Blend/hand polish. See Repair No. 6.7.13.

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**NOTE**

Surfaces may be checked visually and by feel for roughness, flaking, and pitting of races and for scoring on the outside of the bearing races. Shafts, pins, etc., may be checked using vee blocks and dial indicators.

**NOTE**

Fretting on main bearing saddle mating surfaces of the crankcase has a frosted appearance and tiny pit holes. Fretting **MUST** be repaired since it usually indicates a change in the size of the bearing saddle ID that can result in an excessively tight crankshaft bearing fit. This condition can cause bearing failure and crankshaft damage that may be non-repairable.

**5.8.2 Crankcase Assembly NDT**

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Penetrant inspect (PT) entire crankcase	Halves must be separated. Cracks in machined and/or structural areas	Reject and replace. Repair by aircraft engine crankcase repair station optional.

**5.8.3 Crankcase Assembly Dimensional Inspection** Refer to Figure 5-5

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Lifter bores, idler shaft bosses	Inside diameter. Use dial bore gage or fabricate go/no-go plug gage for lifter bores. Use telescoping gage for idler shaft bosses.	Refer to Table of Limits. If oversize, reject and replace. Repair by aircraft engine crankcase repair station optional.
Thickness	Measure between main saddle mating surfaces and cylinder pads	Refer to Table of Limits. Reject and replace if below limits.

**NOTE**

For the dimensional inspection below the crankcase halves must be assembled using the fasteners, thread lubricant and tightening torque values shown in Figure 5-5. If present, main bearing dowels must be removed prior to assembly.

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Camshaft bearing bores	Inside diameter. Use dial bore gage or fabricate go/no-go plug gage.	Refer to Table of Limits. If oversize, undersize, out-of-round or misaligned, reject and replace. Repair by aircraft engine crankcase repair station optional.
Main bearing bores	Inside diameter and out-of-roundness. Use dial bore gage or ring gage set to calibrated ring gage or setting fixture.	
Main bearing bores	Misalignment. Use alignment bar fabricated to dimensions shown in Section 11.	
Thrust face	Flatness and squareness with main bores.	

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## 5.9 Accessory Case

5.9.1 **Accessory Case and Oil Pump Housing Visual Inspections** Refer to Figure 5-6

Area of Inspection	Condition or Parameter	Action
Inspect entire accessory case and oil pump	Obvious excessive damage (remove all accessories and adapters for separate inspection)	Reject and replace.
Oil pump mounting pad in accessory case	Wear, scoring, embedded metal	See Repair No. 6.7.14.
Oil pump housing gear cavities	Wear, scoring, erosion, embedded metal	Reject and replace.
Machined surfaces, cast or machined webs	Deep scratches, > .03" deep	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Machined surfaces, cast or machined webs	Minor scratches, < .03" deep	Blend/hand polish. See Repair No.6.7.13.
Tapered thread plug bosses	Cracks	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Tapered thread plug bosses	Stripped or damaged threads	Repair. See Repair No. 6.7.12.
Drilled and cast oil passages	Obstructed, incompletely drilled	Remove obstruction. Re-drill.
Studs or stud holes	Bent studs, galled or distorted threads, holes stripped	Replace. See Repair No. 6.7.12.
Studs and thru bolts	Minor nicks on threads	Blend/hand polish. See Repair No. 6.7.13.
Installed fittings	Damaged threads or flared surface	Reject and replace.

5.9.2 **Accessory Case and Oil Pump Housing NDT**

Area of Inspection	Condition or Parameter	Action
Penetrant inspect (PT) entire castings	Cracks in machined and/or structural areas	Reject and replace. Repair by aircraft engine crankcase repair station optional.

5.9.3 **Accessory Case and Oil Pump Housing Dimensional Inspections** Ref. Figure 5-6

Area of Inspection	Condition or Parameter	Action
Oil pump mounting pad in accessory case	Depth from gasket surface	Refer to Table of Limits.
Oil pump gear bearing bores in accessory case and oil pump housing	Inside diameter	Refer to Table of Limits.
Accessory case gasket surface	Flatness	Refer to Table of Limits.

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## 5.10 Oil Sump and Induction

### 5.10.1 Oil Sump and Induction Housing Visual Inspections Refer to Fig. 5-7a thru 5-7d

Area of Inspection	Condition or Parameter	Action
Inspect entire oil sump and induction housing	Obvious excessive damage including fire damage and impact damage	Reject and replace.
Machined surfaces, cast or machined webs	Deep scratches, > .03" deep	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Machined surfaces, cast or machined webs	Minor scratches, < .03" deep	Blend/hand polish. See Repair No. 6.7.13.
Intake pipe connectors	Loose or leaking connectors	Re-swage or replace. See Repair No. 6.7.16.
Tapered thread plug bosses	Cracks	Reject and replace. Repair by aircraft engine crankcase repair station optional.
Tapered thread plug bosses	Stripped or damaged threads	Repair. See Repair No. 6.7.12.
Drilled and cast oil passages	Obstructed, incompletely drilled	Remove obstruction. Re-drill.
Studs or stud holes	Bent studs, galled or distorted threads, holes stripped	Replace studs. See Repair No. 6.7.12.
Studs and thru bolts	Minor nicks on threads	Blend/hand polish. See Repair No. 6.7.13.
Installed fittings	Damaged threads or flared surface	Reject and replace.

### 5.10.2 Oil Sump and Induction Housing NDT

Area of Inspection	Condition or Parameter	Action
Penetrant inspect (PT) entire castings or weldments	Cracks in machined and/or structural areas	Reject and replace. Repair by aircraft engine crankcase repair station optional.

### 5.10.3 Oil Sump and Induction Housing Dimensional Inspections

Area of Inspection	Condition or Parameter	Action
Machined gasket surfaces	Flatness	Refer to Table of Limits. Repair by aircraft engine crankcase repair station optional.

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## 5.11 Crankshaft

### 5.11.1 Crankshaft Visual Inspection

Refer to Figure 5-8 and 5-9

Area of Inspection	Condition or Parameter	Action
Entire crankshaft	Visible bending of prop flange and/or pilot journal, heavy corrosion in flange fillet or journal fillets, heat cracks, impact damage, fire damage	Reject and replace.
Bearing surfaces	Scoring, scratching, etching, galling, pitting, heat cracks, fatigue cracks, bearing failures	Reject and replace.
Bearing journals	Wear beyond serviceable limits	Reject and replace. Repair by aircraft engine crankshaft repair station optional.
Crankcheeks	Grinding on crankcheeks to re-balance crankshaft without benefit of re-nitriding	Reject and replace. Repair by aircraft engine crankshaft repair station optional.
Oil tubes	Damaged or missing	Reject and replace. Repair by aircraft engine crankshaft repair station optional.
Oil control plugs	Damaged or missing	Reject and replace. Repair by aircraft engine crankshaft repair station optional.
ID of front main journal	Pitting in first 4.0 inches	Repair. See Repair No. 6.7.18.
Prop flange bushings	Thread damage	Reject and replace.
Prop flange	Deterioration of the cadmium plating	Re-plate. See Repair No. 6.7.17.
Gear dowel	Damage other than fracture or looseness	Replace. See Repair No. 6.7.8.
Gear dowel, bolt threads, counterbore ID and face	Loose or fractured dowel, damaged threads, damaged counterbore ID and face	Reject and replace. Repair by aircraft engine crankshaft repair station optional.

### 5.11.2 Crankshaft NDT

<b>NOTE</b>
Perform a magnetic particle test (MT) whenever the crankshaft is removed from the engine.

Area of Inspection	Condition or Parameter	Action
MT entire crankshaft, especially oil holes and all fillets	Fatigue cracks, fractures, impact damage, cracked thrust collar	Reject and replace.
Prop flange aft fillet	Circular fatigue cracks in clock position of prop blades, especially on aerobatic engine cranks	Reject and replace.

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<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Thrust collar, front main oil tube holes, front main ID beneath thrust collar, prop flange bushing holes and lightening holes	Circular fatigue cracks/overload fractures, especially on cranks having had prop strikes, sudden stoppage and/or bent flanges	Reject and replace.
Front main and crankpin thrust faces	Radial heat cracks	Reject and replace. Repair by aircraft engine crankshaft repair station optional.
All bearing journal surfaces	Longitudinal heat cracks	Reject and replace. Repair by aircraft engine crankshaft repair station optional.

**CAUTION**

**Crankshafts must be re-nitrided using approved processes whenever the bearing journals are polished beyond .003” undersize (M03), reground to any undersize, whenever heat cracks are removed by grinding, or whenever material is removed for the purpose of re-balancing. All surfaces of the crankshaft are nitrided except for the gear counterbore and the area forward of the oil slinger.**

**Nitriding must be accomplished only by full cycle gas nitriding processes, other processes such as salt bath nitriding, ion nitriding, carbo-nitriding, or fluidized bed ferritic nitro-carburizing are not adequate and may result in crankshaft failure.**

**5.11.3 Crankshaft Dimensional Inspection**

Refer to Figure 5-8 and 5-9

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Main journals and crankpins	Diameter, taper and out-of-roundness	Refer to Table of Limits.
Crankpins	Side clearance with connecting rod	Refer to Table of Limits.
Front main journal thrust length	Measure and check clearance in crankcase. Crankshaft end clearance must not exceed maximum limit.	Refer to Table of Limits.
Oil slinger	Clearance with crankcase lip aft of seal bore. Slide crankshaft forward in case and check slinger clearance in both halves; min. .002”, maximum .007”. If beyond limits, rework crankcase, not crankshaft.	Refer to Table of Limits. Reject and replace if beyond limits. Repair by aircraft engine crankcase repair station optional.
Main journal runout	Support crankshaft at front and rear main journals using matched vee blocks on a surface plate. Measure runout of #2 and #3 (center) main bearing.	Refer to Table of Limits. Reject and replace if beyond limits. Repair by aircraft engine crankshaft repair station optional.

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Area of Inspection	Condition or Parameter	Action
Prop flange and pilot journal	Support crankshaft at front and rear main journals using vee blocks on a surface plate. Measure runout of the prop flange outside of flange bushings and pilot journal at fwd edge	Refer to Table of Limits. Reject and replace if beyond limits. Repair by aircraft engine crankshaft repair station optional.
Pilot journal	Outside diameter near forward edge; check at three (3) locations, minimum	Refer to Table of Limits. Reject and replace if beyond limits. Repair by aircraft engine crankshaft repair station optional.
*Gear counterbore	Inspect pilot diameter of the counterbore for size and damage and for fit of gear. Crank ID must not exceed 2.1262" at any point. Clearance with gear flange OD must not exceed .0005" at any point.	Refer to Table of Limits. Reject and replace if beyond limits. Repair by aircraft engine crankshaft repair station optional.
Gear dowel hole	Inside diameter, looseness with dowel	Refer to Table of Limits. Reject and replace if beyond limits. Repair by aircraft engine crankshaft repair station optional.

### \*NOTE

If the crankshaft counterbore face requires repairs other than those specified above, measure the dimension from the crankshaft counterbore face to the rear thrust face of the crankshaft front main journals. Refer to Table of Limits. If the dimension is greater than the minimum dimension shown, the counterbore face may be reworked as required but not to exceed minimum dimension. Runout of the reworked surface must not exceed .001 inch TIR with rear main journal. Flatness must not exceed .002 inch, and surface roughness must not exceed 90 micro-inches Ra. Do not plate counterbore face.

## 5.12 Connecting Rod

### 5.12.1 Connecting Rod Assembly Visual Inspections Refer to Figure 5-3

Area of Inspection	Condition or Parameter	Action
Rod / cap mating surfaces	Damage, nicks, fretting	Repair. See Repair No. 6.7.10.
Rod cap, I-beam, small end	Minor nicks or scratches, < .03" deep	Blend/hand polish. See Repair No.6.7.13.
Rod cap, I-beam, small end	Deep nicks or scratches, > .03" deep; Bent or twisted I-beam or cap	Reject and replace.
Bushing ID	Nicks, scratches, dents, cracks	Replace. See Repair No. 6.7.11.
Big end ID	Nicks, scratches, minor corrosion	Repair. See Repair No. 6.7.10.
Big end ID	Galling, metal transfer from bearings, cracks	Reject and replace.
Small end ID (bushing removed)	Galling, gouges, evidence that bushing was running loose, damage of any kind.	Reject and replace.

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<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Bolt bosses	Galling, gouges, damage in ID; Galling on nut seats	Reject and replace.
Big end thrust surfaces	Wear >.003", metal rolled over edges	Reject and replace. Inspect crankshaft thrust for wear and heat cracks.
Fire damage, bearing failure	Rod surfaces turned blue or blue-black, oil carbonized, deep corrosion pits	Reject and replace.

**5.12.2 Connecting Rod Assembly NDT**      Refer to Figure 5-3

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
*Inspect entire rod using MT	Galling or longitudinal cracks in big end or small end ID. Cracks in bolt bosses, gussets or fillets. Cracks and forging inclusions in I-beam. Heat cracks in thrust surfaces.	Reject and replace.

**\*NOTE**

Rod and cap must be separated. Big end cannot be properly magnetized or demagnetized if assembled. Inspect both rod and cap with at least two orientations of magnetic field. Use extreme care to avoid arcing if rods or caps are magnetized between contacts.

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Big end width	Measure big end width and side clearance on crankpin.	Refer to Table of Limits. Reject and replace rod if measurements are beyond limits.
*Big end ID	Inspect bore for size and out-of-roundness. Rod and cap must be assembled per Figure 5-3.	Refer to Table of Limits. If beyond limits, see Repair No. 6.7.10.
Thrust surfaces	Measure runout with big end ID after rework.	Refer to Table of Limits. Reject and replace rod if measurements are beyond limits.
**Small end	Inspect bore ID in small end of connecting rod.	Refer to Table of Limits. If beyond limits, reject and replace.
***Bushing ID	Measure bushing ID after installation and machining.	Refer to Table of Limits. See Repair No. 6.7.11.
****Bore alignment	Measure parallelism and convergence of bushing ID with big end ID after big end rework and/or bushing replacement.	Refer to Table of Limits. Replace bushing or reject and replace rod if alignments are beyond limits.

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**5.12.3 Connecting Rod Assembly Dimensional Inspections** Refer to Figure 5-3

**\*NOTE**  
Measure using dial bore gage set to calibrated ring gage or calibrated setting fixture. See Figure 5-3.

**\*\*NOTE**  
Measure using dial bore gage or air gage set to calibrated ring gage or calibrated setting fixture.

**\*\*\*NOTE**  
Measure using fabricated tool steel go/no-go plug gage that measures entire length of bore. Gage must be calibrated and periodically inspected for wear. Bushing may also be measured using dial bore gage or air gage set to calibrated ring gage or calibrated setting fixture.

**\*\*\*\*NOTE**  
Measure using calibrated tool steel mandrels with slight taper to become snug in bores similar to Lycoming tool 64530, or equivalent.

**5.13 Camshaft and Lifter**

**5.13.1 Camshaft and Lifter Visual Inspections** Refer to Figure 5-10

Area of Inspection	Condition or Parameter	Action
Entire camshaft, especially nose of cam lobes, gear teeth and main journals	Pitting, chipping, spalling, cracks, or other damage; visible change in profile at nose of lobes; flat spots and spalling of gear teeth.	Reject and replace. Repair by aircraft engine camshaft repair station optional.
Lifter bodies	Pitting, chipping, spalling, waviness on faces; corrosion pitting on OD of barrel; chipping of hydraulic unit seat in ID; socket wear in ID	Reject and replace. Repair by aircraft engine camshaft repair station optional.

**NOTE**  
Camshafts and lifter bodies must be replaced at major engine overhaul. Camshafts and lifters may continue in service in the course of major engine repair, provided that they are free of visible defects or signs of deterioration. Lifter must be reinstalled in the same position from which they were removed. See par. 4-4.2 and 4-4.3 above in this manual. Hydraulic lifter bodies **MUST BE REPLACED WITH NEW OR REGROUND LIFTER BODIES ANY TIME A NEW OR REGROUND CAMSHAFT IS INSTALLED.**

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**5.13.2 Camshaft and Lifter NDT**      Refer to Figure 5-10

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Inspect entire camshaft using MT	Pitting, chipping, spalling, cracks, especially at nose of lobes and root of gear teeth. Magnetize using center conductor with both circular and longitudinal fields.	If cracked, reject and replace. Repair by aircraft engine camshaft repair station optional.
Lifter bodies	Pitting, chipping, spalling or cracks on faces; cracks in barrel. Magnetize two directions in coil only. Do not pass current through lifter.	Reject and replace. Repair by aircraft engine camshaft repair station optional.

**5.13.3 Camshaft and Lifter Dimensional Inspections** Refer to Figure 5-10

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Camshaft main journals	Support camshaft front and rear main journals in matched vee blocks on surface plate. Measure runout at center bearing journal. in excess of 0.001 T.I.R.	Refer to Table of Limits. Reject and replace if beyond limits. Repair by aircraft engine camshaft repair station optional.
Camshaft main journals	Measure OD using outside micrometer.	Refer to Table of Limits.
Cam lobes and lifter faces	Measurable wear on these surfaces is cause for rejection any time they are removed from the engine.	Reject and replace. Repair by aircraft engine camshaft repair station optional.

**5.14 Rocker Arm, Pushrod, Valve and Spring**

**5.14.1 Rocker Arm, Pushrod, Valve and Spring Visual Inspections** Refer to Figure 5-11

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Rocker arm pushrod socket, thrust surfaces	Pitting, chipping, spalling, cracks, or other damage	Reject and replace.
Rocker arm bore	Gouging, scoring, evidence of bushing running loose	Reject and replace.
Rocker arm tip	Evidence of excessive wear or regrinding	Reject and replace.
Rocker arm oil holes	Obstructions or debris	Remove debris.
Pushrods	Obstructions or debris	Remove debris.
Pushrods	Loose or damaged ball ends; wear on tube OD	Reject and replace.
Pushrods, straightness	Roll on surface plate. Bend must be <.010"	Reject and replace.
Valves	Nicks, gouges, damage on stems; wear in key grooves; bent stems; burned faces	Reject and replace.
Valve stem and head	Pitting or erosion between stem and head	Reject and replace.
Valve springs	Pitting, wear on coils	Reject and replace.
Valve spring seats	Wear in key seat and coil seat areas	Reject and replace.

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Area of Inspection	Condition or Parameter	Action
Valve tip	Wear, chipping, pitting DO NOT REGRIND EXHAUST VALVE TIPS!	Reject and replace.

**5.14.2 Rocker Arm, Pushrod, Valve and Spring NDT** Refer to Figure 5-11

Area of Inspection	Condition or Parameter	Action
Inspect all surfaces using MT. <u>Exhaust valves cannot be inspected using MT.</u>	Fatigue cracks, forging inclusions. Use center conductor for rocker arms, valve springs and spring seats. Magnetize pushrods in coil only.	If cracked, reject and replace.
Lifter bodies	Pitting, chipping, spalling or cracks on faces; cracks in barrel. Magnetize two directions in coil only. Do not pass current through lifter.	Reject and replace. Repair by aircraft engine camshaft repair station optional.

**5.14.3 Rocker Arm, Pushrod, Valve and Spring Dimensional Inspections** Ref. Fig. 5-11

Area of Inspection	Condition or Parameter	Action
Rocker arm bores	Measure ID using dial bore gage or fabricated go/no-go plug gage.	Refer to Table of Limits. Reject and replace if beyond limits.
Rocker arm bushings	Check ID of rocker arm bushings at a minimum of two (2) positions, 90 degrees apart, especially on exhaust side. Several check locations are preferred.	Refer to Table of Limits. See Repair No. 6.7.9.
Valve stems	Measure OD using outside micrometer.	Refer to Table of Limits. Reject and replace if beyond limits.
Valve springs	Test spring force at specified compressed height using calibrated spring tester.	Refer to Table of Limits. Reject and replace if beyond limits.

**5.15 Accessory Gear and Shaft**

**5.15.1 Accessory Gear and Shaft Visual Inspections** Refer to Figure 5-12

Area of Inspection	Condition or Parameter	Action
Gear teeth	Pitting, chipping, spalling, cracks, visible flattening of tooth profile; wear in drive flat of oil pump impeller; thrust wear on impeller faces	Reject and replace.
Idler gear fuel pump eccentric	Wear, corrosion pits, galling	Reject and replace. Repair by aircraft engine repair station optional.
Oil pump shaft gear	Wear on flats in excess of .002"	Reject and replace.
Idler shafts	Wear, scoring, corrosion	Reject and replace.
Tachometer shaft	Chrome plated surface worn in seal area	Reject and replace.

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<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Shaft gear internal splines	Visible wear on spline teeth	Reject and replace.
Shaft gear thrust buttons	Visible wear	Replace thrust button.
Idler gear bushings	Wear, scoring, cracked or loose bushings	Reject and replace. Repair by aircraft engine repair station optional.
Fuel pump pushrod	Wear, pitting, flat spots on ends	Reject and replace.

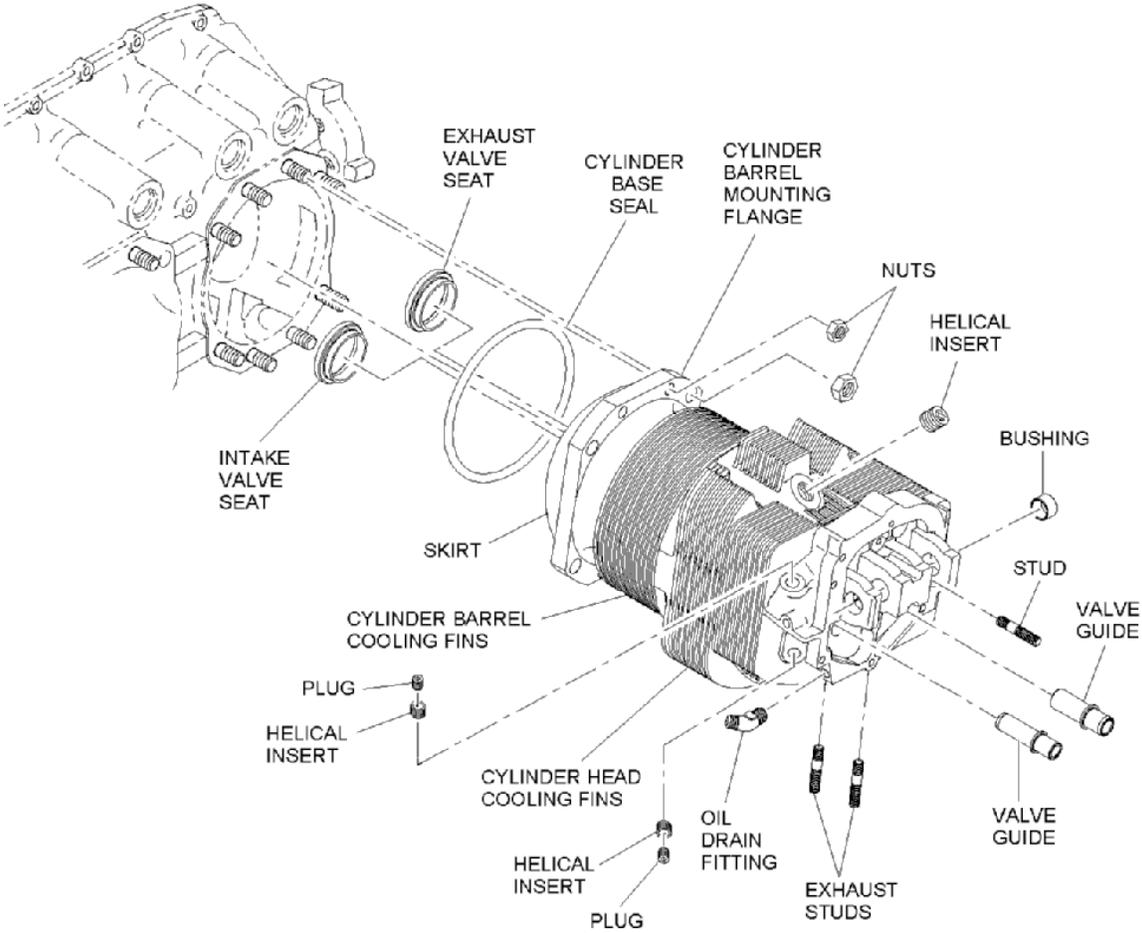
**5.15.2 Accessory Gear and Shaft NDT**      Refer to Figure 5-12

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Inspect all surfaces using MT.	Fatigue cracks, heat cracks, forging inclusions. Use center conductor for magneto gears, idler gears, crankshaft gears, oil pump gears.	If cracked, reject and replace.

**5.15.3 Accessory Gear and Shaft Dimensional Inspections**      Ref. Fig. 5-12

<b>Area of Inspection</b>	<b>Condition or Parameter</b>	<b>Action</b>
Shaft diameters	Measure OD using outside micrometer.	Refer to Table of Limits. Reject and replace if beyond limits.
Idler gear bushings	Check ID of idler bushings at a minimum of two (2) positions, 90 degrees apart, on both ends.	Refer to Table of Limits. See Repair No. 6.7.19.
Idler gear fuel pump eccentric	Measure OD using outside micrometer.	Refer to Table of Limits. Reject and replace if beyond limits.
Crankshaft gear	Measure flange OD using outside micrometer.	Refer to Table of Limits. Reject and replace if beyond limits.

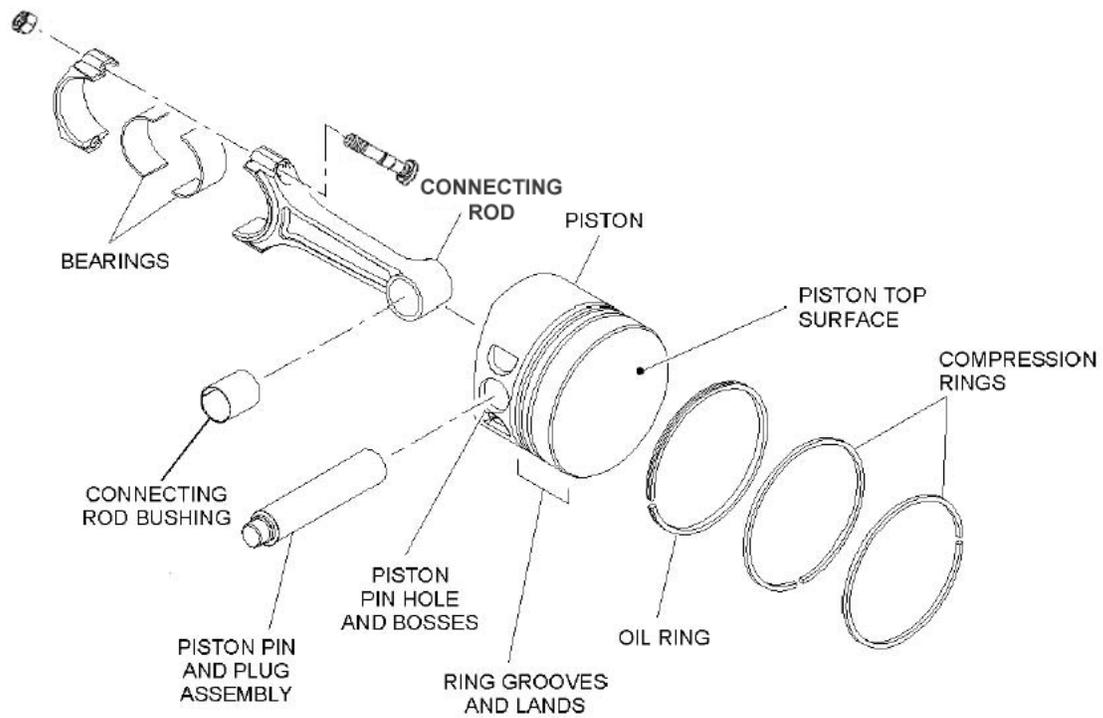
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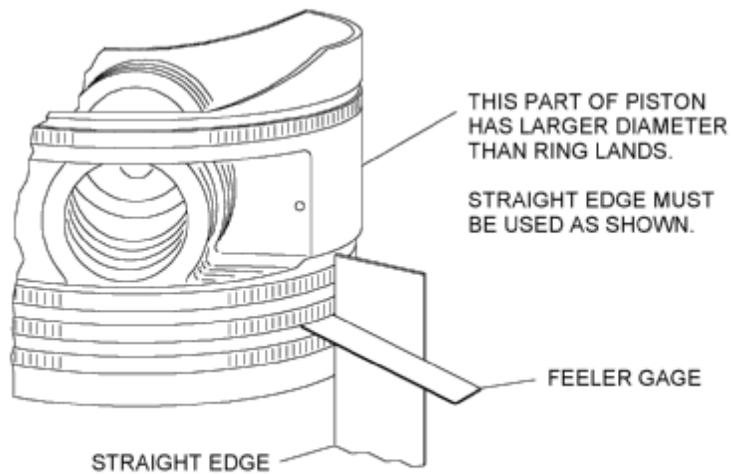
**Figure 5-1 Cylinder Assembly**

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**Figure 5-2a Piston and Connecting Rod Assembly**



**Figure 5-2b Piston Rings and Lands**

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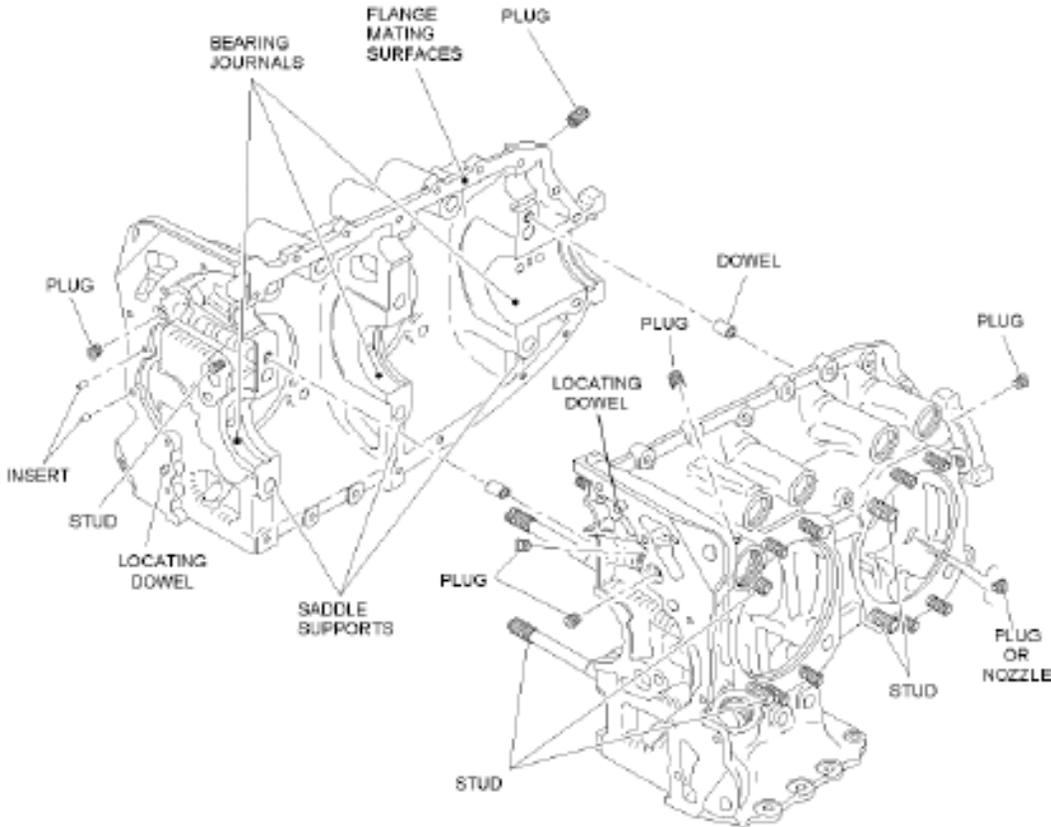
**Figure 5-3 Connecting Rod Assembly Inspections**

**CONNECTING ROD AND CAP ASSEMBLY INSTRUCTIONS:**

1. De-burr mating surfaces as required
2. Use new or slave hardware that has not exceeded 10 uses.
3. Assemble rod and cap around an arbor such as Lycoming ST-237, or equivalent.
4. Lightly oil shanks of bolts with SAE 50 oil before insertion into rod and cap.
5. Lubricate threads of bolts and nuts with Food Grade anti-seize compound.
6. Snug rod nuts with speed handle but do not torque.
7. Remove assembly arbor from big end.
8. Torque nuts to 240 In-Lb (20 Ft-Lb).
9. Torque nuts to 440-480 In-Lbs (38-40 Ft-Lb).
10. Measure bore ID at rod axis and +/- 30° of parting line.
11. Measured area must be within new limits.
12. Area within +/-20° of parting line may exceed new limits by no more than .0005 inch.
13. ID may not be less than new limits at any point.

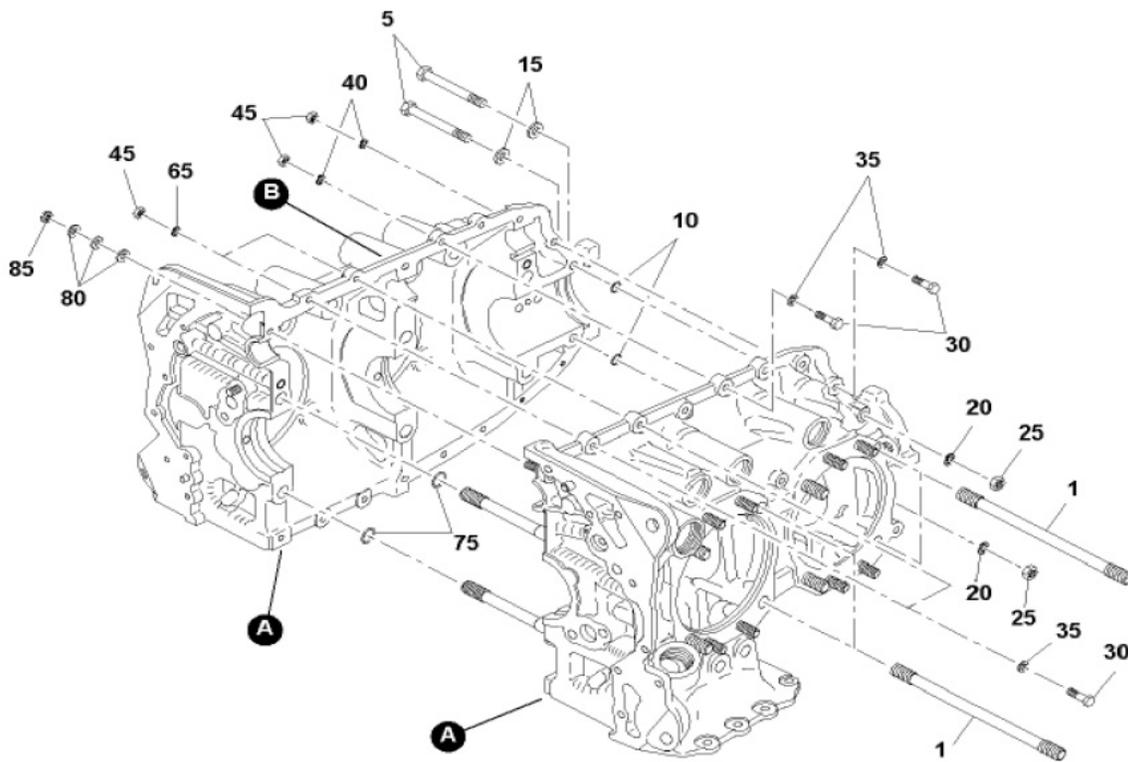
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**Figure 5-4 Crankcase Bearing and Flange Surfaces**

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- |                                  |                             |
|----------------------------------|-----------------------------|
| 1. THRU BOLT (1/2-20 X 10-11/16) | 55. BOLT (1/4-20 X 2")      |
| 5. BOLT (3/8-24 X 3-37/64)       | 60. FLAT WASHER (1/4 INCH)  |
| 10. OIL RING SEAL                | 65. LOCK WASHER (1/4 INCH)  |
| 15. LOCK WASHER (3/8 INCH)       | 70. PLAIN NUT (1/4-20)      |
| 20. PLAIN WASHER (3/8-24)        | 75. OIL SEAL                |
| 25. PLAIN NUT (3/8-24)           | 80. PLAIN WASHER (3/8 INCH) |
| 30. BOLT (1/4-20 X 1-1/2)        | 85. SLOTTED NUT (3/8-24)    |
| 35. FLAT WASHER (1/4 INCH)       | 90. BOLT (1/2-20 X 1-1/8)   |
| 40. LOCK WASHER (1/4 INCH)       | 95. BOLT (1/4 INCH)         |
| 45. PLAIN NUT (1/4-20)           | 100. SLOTTED NUT (1/4-20)   |
| 50. LIFTING STRAP                |                             |

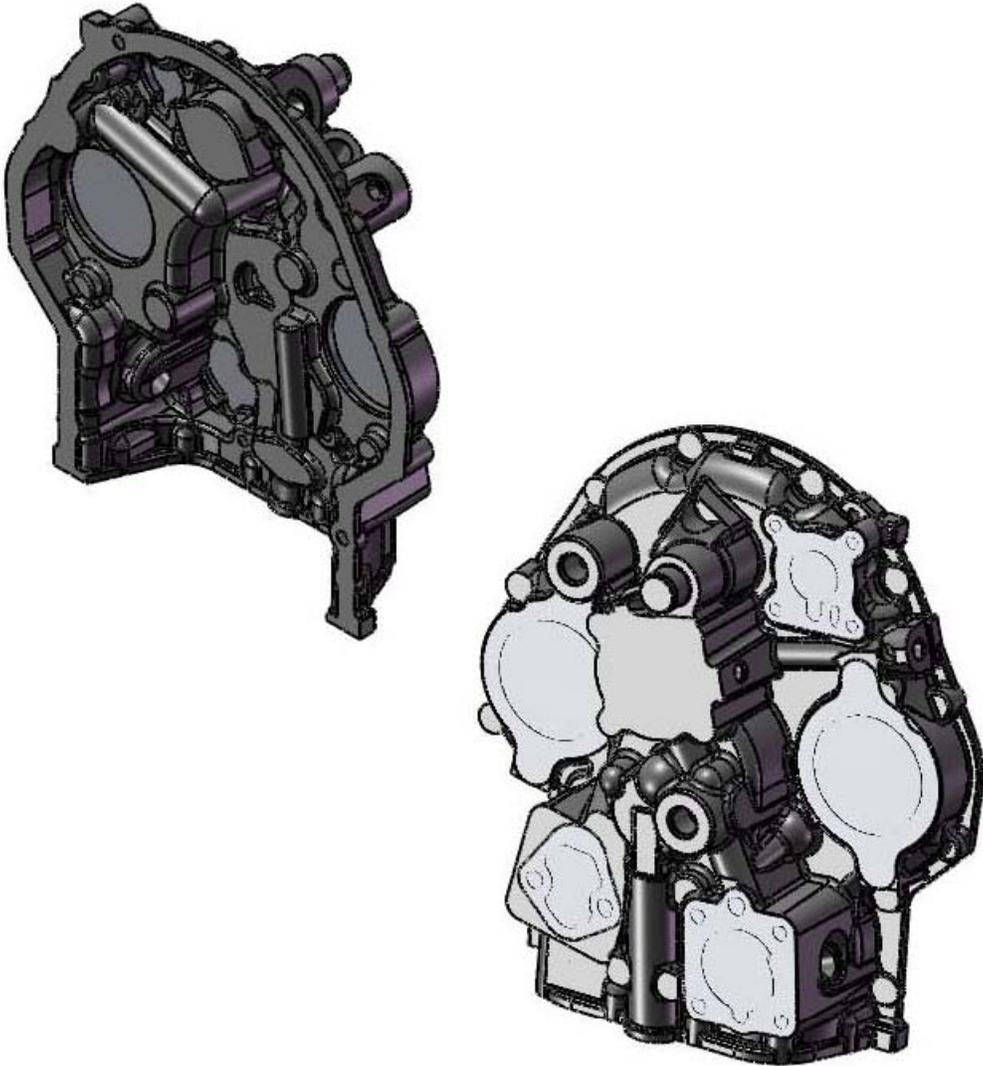
**Figure 5-5 Crankcase Dimensional Inspection Hardware**

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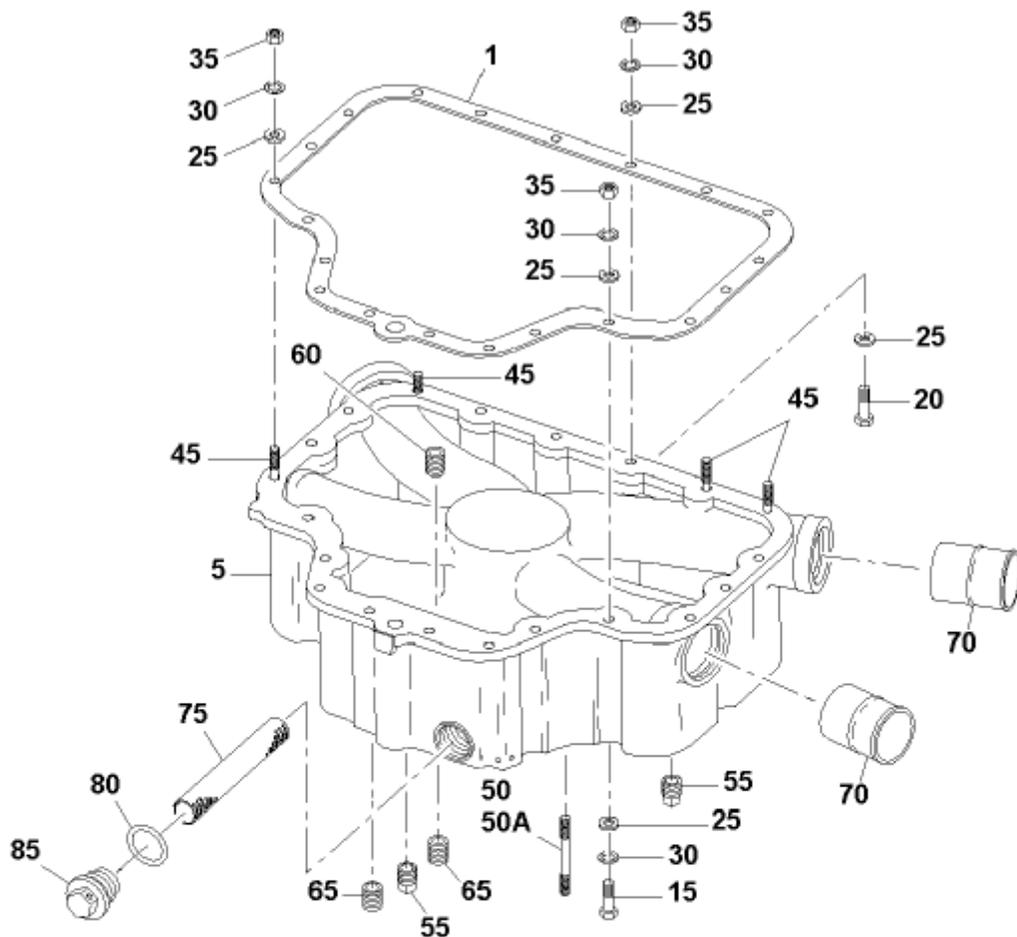
### CRANKCASE ASSEMBLY INSTRUCTIONS:

1. If main bearing bore alignment is to be checked using an alignment bar, remove all bearing dowels.
2. Inspect mating surfaces to remove nicks, burrs or foreign material
3. Inspect alignment dowels and replace if damaged. Lightly oil dowel OD.
4. Assemble case halves and tap together using plastic mallet. Lay crankcase on side on non-metal bench top.
5. Clean and inspect all assembly hardware. Threads must be in like-new condition, fewer than 20 uses for thru bolts and nuts. Replace hardware frequently.
6. Lightly oil center portion of thru bolts and drive into thru bolt holes until centered between halves. If necessary, use a threaded adapter to protect threads and drive into place using a brass hammer or ball-peen hammer and brass drift. Do not hammer directly on threaded ends of thru bolts.
7. Coat the threads of the thru bolts and two thru studs with C-5A anti-seize compound, or equivalent. Install a pair of case hardened washers at each location. Coat the face of each .50-20 nut with anti-seize compound and add a few drops of Grade 50 oil or oil/STP mixture (see Table 1-2) to the nut threads. Install nuts which should run freely onto the threads of the thru bolts or thru studs. If not, replace as required.
8. Snug nuts using speed handle.
9. Lubricate ¼-inch bolts and 3/8" bolts and 3/8" stud, washers and nuts similarly to Step 5. Snug nuts.
10. Torque nuts on center thru bolts and thru studs to 300 In-Lbs. Torque nuts on end thru bolts and thru studs to 300 In-Lbs.
11. Torque nuts on center thru bolts and thru studs to 550-600 In-Lbs Torque nuts on end thru bolts and thru studs to 550-600 In-Lbs Torque nuts on both ends of center and front thru bolts.
12. Torque nuts on 3/8" nose bolts to 150 In-Lb and then to 300 In-Lb. Tighten 3/8" nut above rear cam bearing to approximately 300 In-Lbs.
13. Torque nuts on 1/4-inch bolts above center and front camshaft bearings to 80-100 In-Lbs
14. Inspect main bores, cam bores and thrust face per par. 5-8.3 and Table of Limits.



**Figure 5-6 Accessory Casewith Cover Plates**

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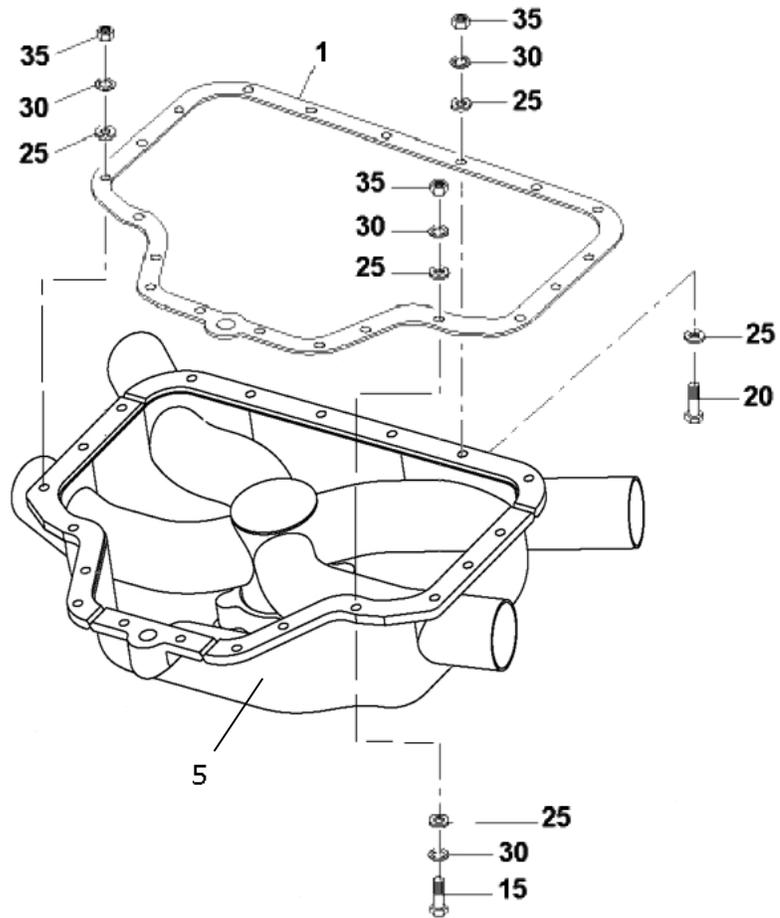


- |                      |                   |
|----------------------|-------------------|
| 1. GASKET            | 55. PLUG          |
| 5. OIL SUMP ASSEMBLY | 60. PLUG          |
| 15. BOLT             | 65. PLUG          |
| 20. BOLT             | 70. PIPE - INTAKE |
| 25. WASHER - PLAIN   | 75. SCREEN        |
| 30. WASHER - LOCK    | 80. GASKET        |
| 35. NUT - PLAIN      | 85. PLUG          |
| 45. STUD             |                   |
| 50. STUD             |                   |
| 50A. STUD            |                   |

**Figure 5-7 a Sump Assembly, Hot Induction**

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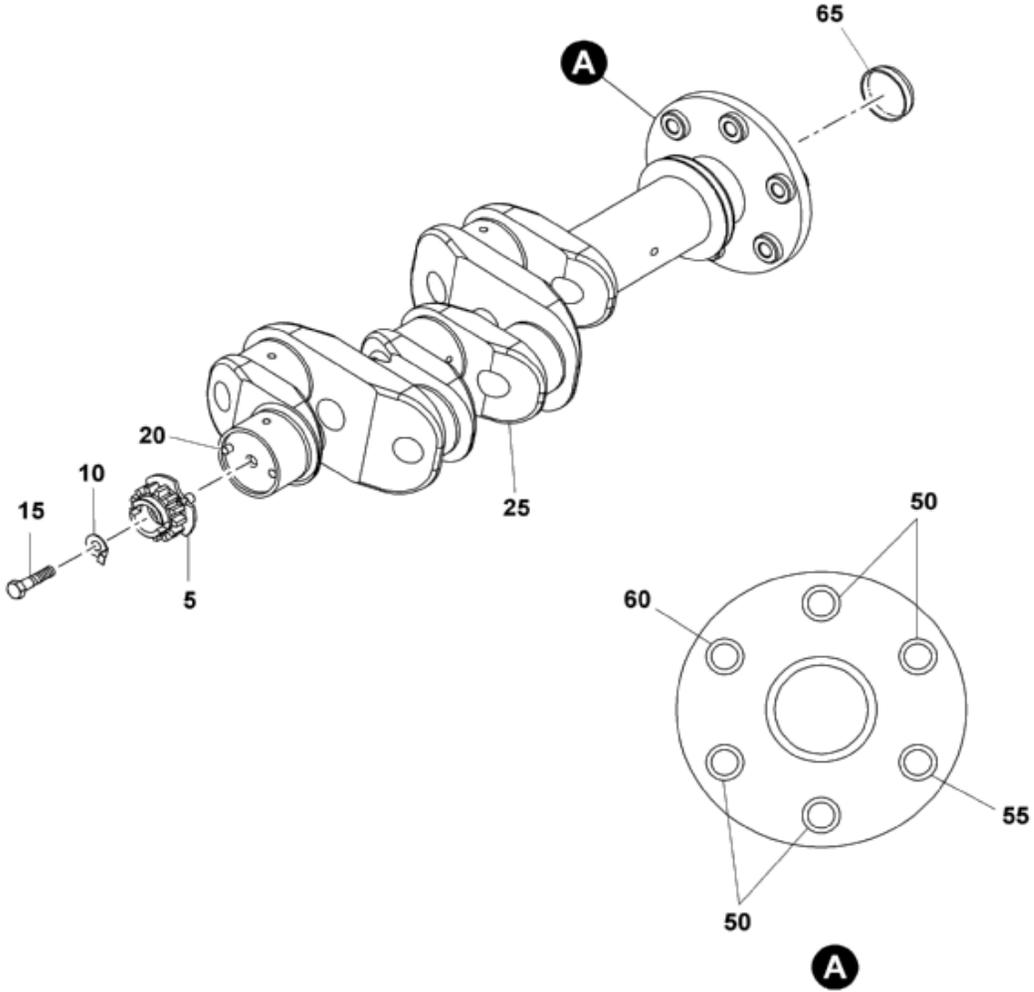


- |                      |                  |
|----------------------|------------------|
| 1. GASKET            | 25. PLAIN WASHER |
| 5. OIL SUMP ASSEMBLY | 30. LOCK WASHER  |
| 15. BOLT             | 35. PLAIN NUT    |
| 20. BOLT             |                  |

**Figure 5-7b Lightweight Cub Crafters Hot Induction Sump Assembly**

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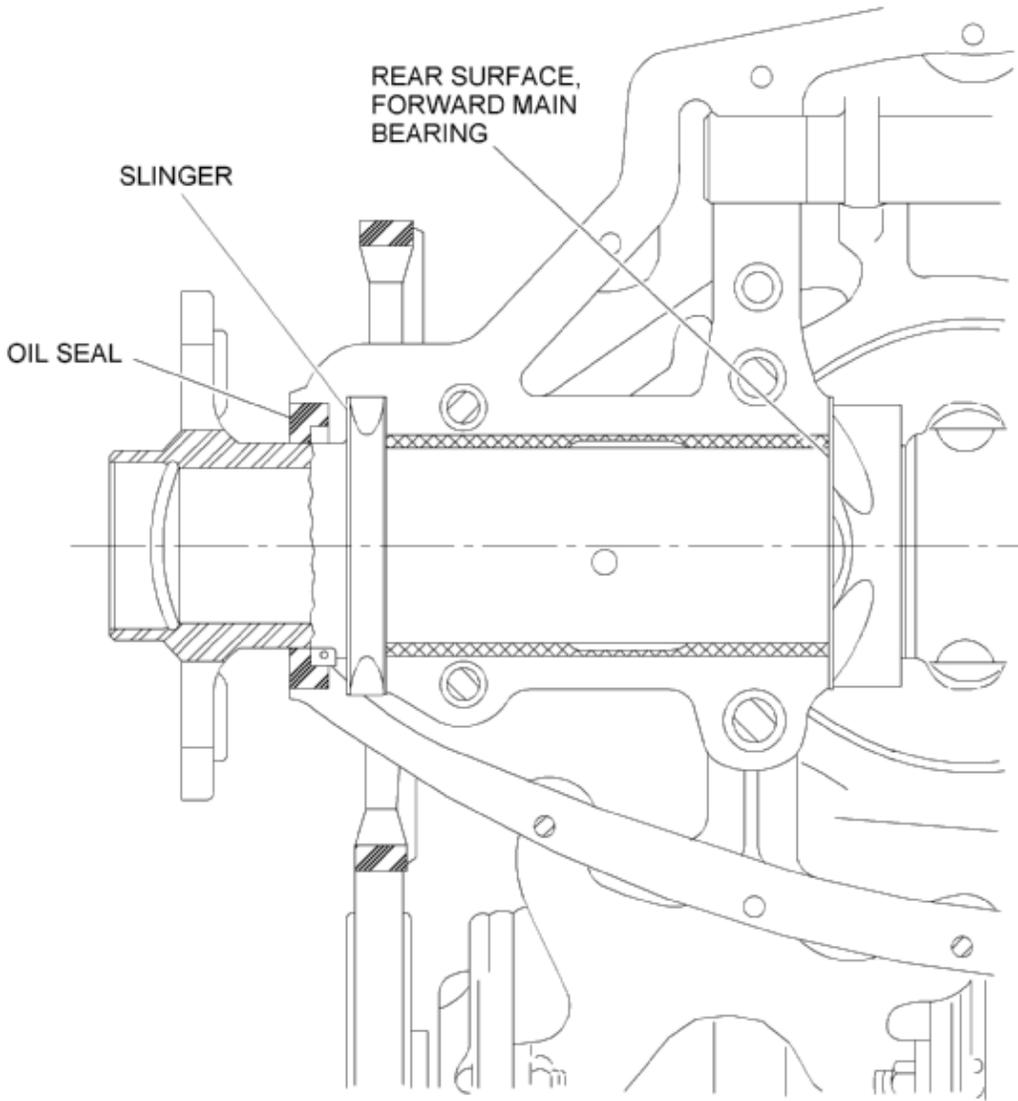


- 5. GEAR - CRANKSHAFT
- 10. LOCKPLATE
- 15. SCREW
- 20. DOWEL - STEPPED
- 25. CRANKSHAFT ASSY
- 50. BUSHING - LONG
- 55. BUSHING - INDEXED
- 60. BUSHING - SHORT
- 65. PLUG - EXPANSION

**Figure 5-8 Crankshaft Assembly**

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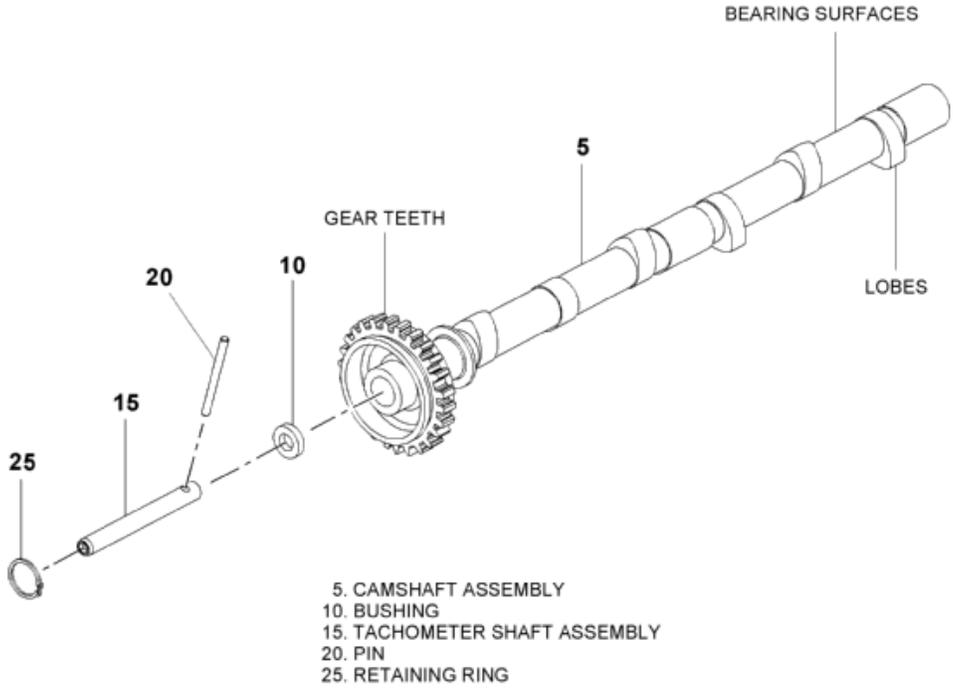
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**Figure 5-9 Crankshaft Front Main, Thrust Faces and Seal Journal**

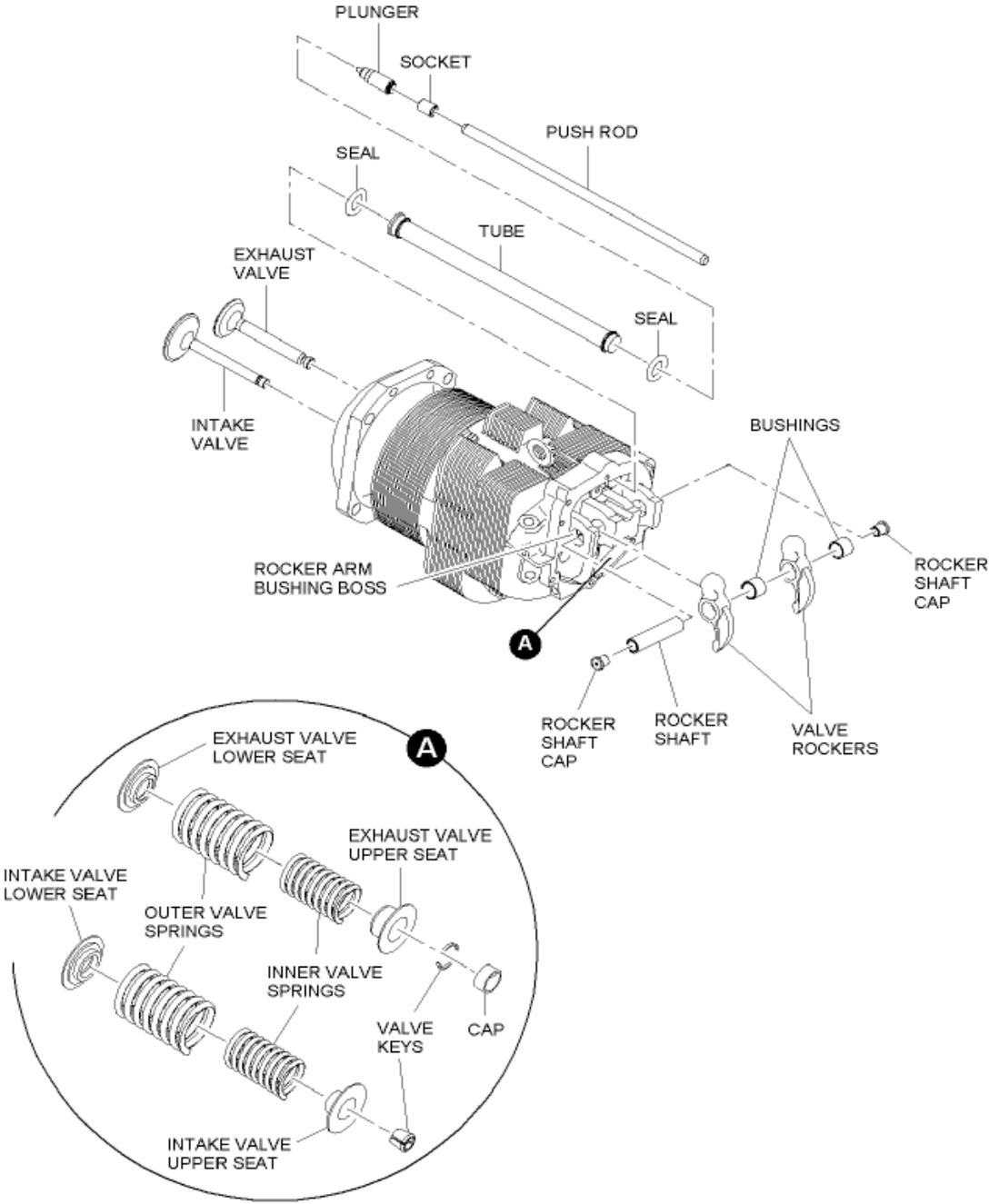
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**Figure 5-10 Camshaft Assembly and Lifter**

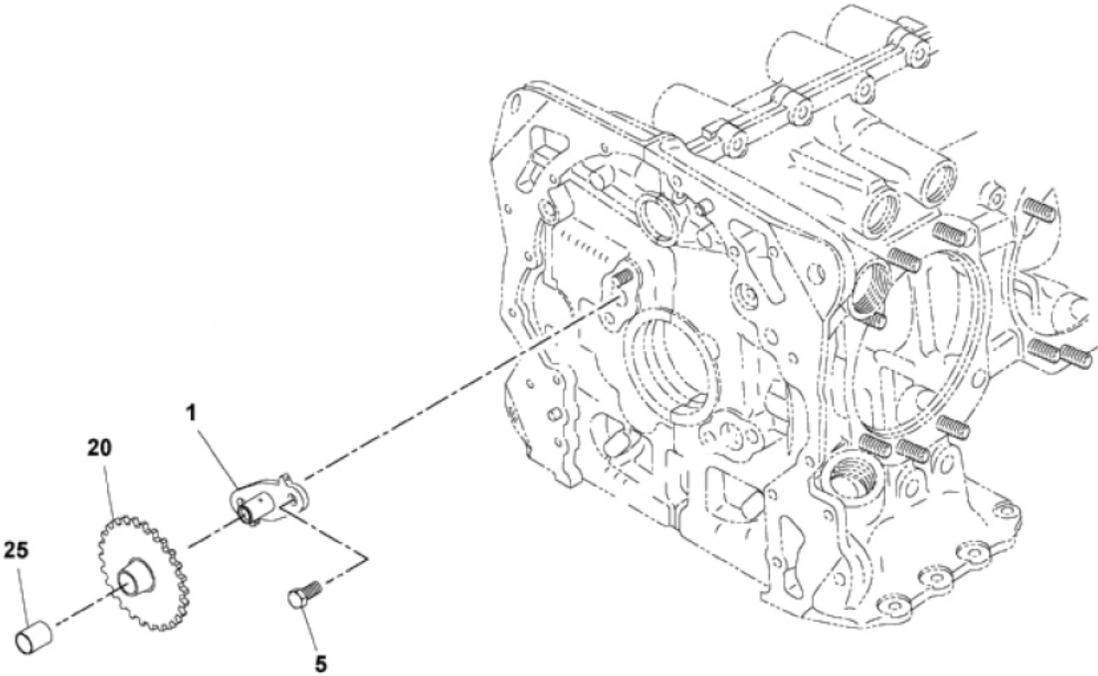
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**Figure 5-11 Valve Train**

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- |                |                |
|----------------|----------------|
| 1. IDLER SHAFT | 20. IDLER GEAR |
| 5. SCREW       | 25. BUSHING    |

**Figure 5-12 Accessory Drive Gears and Shaft Assemblies**

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## **Section 6 REPAIR AND REPLACEMENT**

### **6.1 General**

Cub Crafters' CC340 Engine component parts are eligible for a variety of repair procedures that, when performed according to the guidance of this Section and the dimensional limits of Section 10, are useful in restoring worn parts to a serviceable and airworthy condition.

It is the responsibility of the persons performing the repairs to ensure that the repairs are performed and inspected properly and to use the tools and methods described, or tools and methods of at least equal quality and reliability. Since CCI CC340 Engine component parts have many features in common with corresponding components of FAA-certificated aircraft engines, owners and operators are advised whenever possible to take advantage of the experience, training, specialized equipment and processes and the quality procedures general aviation engine repair stations.

All parts that do not meet the requirements of this manual after repair should be replaced with serviceable parts.

### **6.2 Repairs, Materials, Equipment and Codes**

Repairs and associated items are organized in a logical fashion as shown in the tables below. Specific repair procedures follow the tables.

- Repair procedures are listed in Table 6-1.
- Materials required for repair are listed in Table 6-2.
- Equipment used for repair is listed in Table 6-3.
- Codes used for undersize, oversize and repair are listed in Table 6-4.

Perform repair procedures as listed in Table 6-1 when components do not meet requirements specified in Section 5 (Inspection, Testing and Check) and/or Section 10, Table of Limits, in this manual.

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<b>Repair Procedure</b>	<b>Title</b>	<b>Description</b>
6.7.1	Cylinder Exhaust Port Repair	Procedures to reface exhaust port gasket surfaces
6.7.2	Valve, Valve Guide, and Valve Seat Repair	Procedures to repair valves and repair or replace valve guides and valve seats
6.7.3	Rocker Boss Bushing Replacement	Procedures to replace and finish rocker shaft bushings in cylinder head bosses
6.7.4	Spark Plug Threaded Insert Repair	Procedures to remove and replace spark plug helical coil inserts
6.7.5	Cylinder Cooling Fin Repair	Procedures to repair nicks, chips, cracks or other damage to cooling fins
6.7.6	Cylinder Bore Surface Repair	Procedures to restore ring finish to cylinder bores
6.7.7	Crankshaft Journal and Seal Surface Repair	Procedures to repair scratched or worn crankshaft journals
6.7.8	Crankshaft Dowel Repair	Procedures to remove and replace damaged dowel
6.7.9	Rocker Arm Bushing Repair	Procedures to replace bushings and reface tips
6.7.10	Connecting Rod Big End Repair	Procedures to repair out-of-tolerance big end of connecting rods
6.7.11	Connecting Rod Bushing Repair	Procedures to remove, replace and finish bushing and check alignment
6.7.12	Threaded Area and Stud Repair	Procedures to remove and replace studs and repair threaded holes
6.7.13	Nick and Scratch Repair	Procedures to repair minor nicks and scratches on machined surfaces
6.7.14	Paint and Surface Treatment Repair	Procedures to restore anti-corrosion surface treatments and/or paint
6.7.15	Accessory Case Oil Pump Boss Repair	Procedures to re-machine worn or scored oil pump pad
6.7.16	Sump Intake Pipe Connector Repair	Procedures to remove, replace damaged or loose intake pipe connectors
6.7.17	Crankshaft Flange Plating Repair	Procedures to repair crankshaft flange and oil seal journal plating
6.7.18	Crankshaft Front Main ID Repair	Procedures to remove corrosion pits in the ID of the crankshaft front main bearing journal.
6.7.19	Idler Gear Bushing Repair	Procedures to remove, replace and machine idler gear bushings
6.7.20	Crankshaft Expansion Plug Installation	Procedures to install and seat the front expansion plug

**Table 6-1 List of Repairs**

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<b>Material</b>	<b>Source</b>
Dressing wheel (polishing), die grinder burrs, small hand files	Commercially Available
Thread lubricant, SAE 50 oil and 15% STP or Food Grade Anti-Seize	Commercially Available
Loctite 271 or 290	Commercially Available
Abrasive (crocus) cloth; aluminum oxide paper	Commercially Available
Polishing belt, 320J aluminum oxide, or equivalent	Commercially Available
Zinc chromate primer (AMS 3110, or equivalent per MIL-P-8585)	Commercially Available
Enamel paint (AMS 3125C, or equivalent per MIL-E-7729)	Commercially Available
Toluene (AMS 3180 or equivalent per TT-T-548)	Commercially Available
Chromate conversion coating (MIL-C-5541, Class 1A or equivalent)	Commercially Available
Urethabond 104, zinc/polyurethane paint, or equivalent	Commercially Available
Nap paint roller, Worktools International 54011, or equivalent	Commercially Available

**Table 6-2 List of Materials**

<b>Material</b>	<b>Source</b>
Stud extractor	Commercially Available
Lathe	Commercially Available
Collet grip tool	Commercially Available
Spray gun (paint)	Commercially Available
Crankshaft grinder w/ grinding wheel (GA54-J5-V10 or equivalent)	Commercially Available
Hand file	Commercially Available
Reamer set	Commercially Available
Bushing puller kit	Commercially Available
Tap & die set	Commercially Available
Extraction tool for helical coil threaded inserts	Commercially Available
Insertion tool for helical coil threaded inserts	Commercially Available
Cylinder Rejuvenation Kit, AETKIT01	ECi, ECI distributors
Electric drill motor, 3/8" or 1/2"; 400-600 RPM	Commercially Available

**Table 6-3 List of Equipment**

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<b>Code or Marking</b>	<b>Definition</b>
M003	Part dimension is .003" undersize.
M006	Part dimension is .006" undersize.
M010	Part dimension is .010" undersize.
M015	Part dimension is .015" undersize.
M020	Part dimension is .020" undersize.
P003	Part dimension is .003" oversize.
P005	Part dimension is .005" oversize.
P010	Part dimension is .010" oversize.
P015	Part dimension is .015" oversize.
P020	Part dimension is .020" oversize.
P030	Part dimension is .030" oversize.
P040	Part dimension is .040" oversize.
M003M	Crankshaft main bearing journals .003" undersize.
M006M	Crankshaft main bearing journals .006" undersize.
M010M	Crankshaft main bearing journals .010" undersize.
M003P	Crankshaft crankpins (rod journals) are .003" undersize.
M006P	Crankshaft crankpins (rod journals) are .006" undersize.
M010P	Crankshaft crankpins (rod journals) are .010" undersize.
M003MP, etc.	Crankshaft main bearing journals and crankpins are .003" undersize. The same system applies for M006MP and M010MP. If main journals and crankpins are not the same undersize, the system below applies:
M003M M006P, etc.	Crankshaft main bearing journals are .003" undersize, crankpins are .006" undersize. Any combination of main bearing journal and crankpin undersizes is possible within the system of M003, M006 and M010 as long as all corresponding journals are reworked to the same undersize.
RN	Crankshaft has been re-nitrided.
PID	Crankshaft front main bearing ID has been painted with corrosion preventive paint.

**Table 6-4 List of Repair Codes**

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**6.3** *INTENTIONALLY LEFT BLANK*

**6.4** *INTENTIONALLY LEFT BLANK*

**6.5** *INTENTIONALLY LEFT BLANK*

**6.6** *INTENTIONALLY LEFT BLANK*

**6.7 Repair Procedures**

**6.7.1 Cylinder Exhaust Port Repair**

These procedures may be used to restore damaged or eroded exhaust port gasket surfaces of CCI CC340 Engine cylinders.

1. Remove spark plugs and fuel injector nozzle or primer nozzle from cylinder. Disassemble valve keys, spring seats, springs and valves per par. 4-4.6q.
2. Measure height of exhaust port studs and remove studs using a stud extractor. Discard studs.
3. Securely mount cylinder in fabricated fixtures on the table of a vertical milling machine so that the port gasket surfaces are horizontal and facing up toward the machine spindle.
4. Level cylinder in fixture by dial indicating clean surface of intake port gasket surface in both x and y axes to .001" per inch.
5. Using a suitable fly cutter or face milling cutter, machine the exhaust port for cleanup not to exceed .030" below the plane of the intake port. Blow out chips using compressed air.

**WARNING**

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

**WARNING**

**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

6. Install new exhaust port studs to the installed height of the old studs using a collet grip stud driver. Observe minimum stud driving torque of Table of Limits and Tightening Torques, Section 10, using oversize studs as required. If minimum,

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driving torque cannot be obtained with oversize stud, repair stud hole per 6.7.12 below.

7. Wash cylinder in clean petroleum solvent and air dry using compressed air. Ensure that all chips from machining have been removed.

**WARNING**  
**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

8. Reassemble cylinder, valves, springs and retainers using new exhaust valve keys per Sections 3 and 7 of this manual.

### 6.7.2 Valve, Valve Guide, and Valve Seat Repair

Exhaust valves and exhaust valve guides must be replaced at overhaul. Intake valve may be re-used, provided that they can be repaired within required dimensional limits per Table of Limits, Section 10. The surfaces of the valves and their seats can normally be resurfaced and reconditioned as a repair.

After removal from the cylinder head, the valves must be cleaned of all oil, sludge, varnish and carbon build-up prior to inspection. Refer to Sections 4 and 5 of this manual for appropriate cleaning and inspection procedures and limits on damage and wear.

#### 6.7.2.1 Valve Face Grinding

**CAUTION**  
**Do not attempt to bend or straighten the valve face or stem.**

**NOTE**  
Exhaust valves **MUST** be replaced at engine major overhaul.

1. Valve faces that have minor pitting or warping may be refaced by grinding.

**WARNING**  
**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

2. Set the valve grinding equipment to 30° for intake valves, 45° for exhaust valves. Use a soft #80 grit wheel to grind only enough of the valve face to remove wear and small pits. Dress grinding wheel frequently to produce a smooth, true surface on the valve face. Runout of ground valve face with stem should not exceed .0015" TIR.
3. Round off any burrs or sharp edges with a polishing stone while the valve is still turning in the valve grinding spindle.

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4. After grinding, inspect edge of valve face to verify that it exceeds minimum thickness per Figure 6-1.
5. After grinding and cleaning, the valve stem may be polished to remove superficial scratches.

### 6.7.2.2 Valve Guide Replacement

Thoroughly clean ID intake and exhaust valve guides, and inspect for scoring, wear and damage. Inspect ID of valve guides using plug gages or telescoping gages and a calibrated 0"-1" outside micrometer. Pay particular attention to the upper (rocker arm) end of intake valve guides and the lower (exhaust port) end of exhaust valve guides. Replace any guide that is not within serviceable limits. Replace all exhaust valve guides at engine major overhaul.

1. Remove valve guides as follows:
  - a. Manufacture valve guide pullers from 5-inch lengths of .75-16 UNF Gr 8 threaded rod. Drill and tap one end of the intake valve guide puller for .38-24 UNF thread, approximately 1.0" deep. Drill and tap one end of the exhaust valve guide puller for .50-20 UNF thread, approximately 1.0" deep. Manufacture the intake guide adapter from a .38-24 UNF x 3.0" long socket head capscrew by turning the head diameter to approximately .53" OD. Manufacture the exhaust guide adapter from a .50-20 x 3.0" long by turning the head diameter to approximately .63" OD. Manufacture a 3-inch thick steel block to rest on the rocker box gasket surface of the cylinder head with a .76"-.79" ID hole aligned with the centerline of the intake and exhaust valve guides.
  - b. Place the respective puller adapter (socket head capscrew) into the bottom end of the guide being removed. Thread the respective puller onto the adapter like a nut. Place the steel block over the puller so that it rests on the cylinder head. Place a case hardened thrust washer over the .75-16 puller. Thread a .75-16 UNF Gr 8 or L9 nut onto the puller. Use heavy oil or moly-graphite grease as a thread lubricant. Turn the nut clockwise until the guide is drawn out of the guide boss of the cylinder head.

#### NOTE

After the .75-16 nut is tightened against the thrust washer, it may help the guide to break loose by heating the guide boss of the cylinder head using a propane torch with the flame directed into the port. As an alternative to the above, the intake guide and puller may be tapped for .44-20 UNF thread for use of a .44-20 UNF threaded stud in lieu of a capscrew. The exhaust guide and puller may be tapped .56-20 UNF for use of a .56-20 UNF threaded stud in lieu of a capscrew.

2. Install valve guides as follows:
  - a. Prior to installation of a new valve guide, measure the ID of guide boss in the cylinder head a plug gage or dial bore gage set to a calibrated ring gage or calibrated fixture. Refer to Tables 6-5 and 6-6 and Figure 6-2 to determine if a standard or oversize guide must be used.

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- b. If an oversize guide must be installed, mount the cylinder in a guide reaming fixture set to the appropriate angle on a vertical milling machine or heavy duty drill press. Center the machine spindle with the guide boss. Ream the valve guide boss at a low RPM using copious amounts of cutting oil and a piloted reamer of the appropriate size.

**WARNING**

**LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

**WARNING**

**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

- c. Again measure the ID of the guide boss to confirm proper size.
- d. Heat the cylinder to between 350°F-425°F for a minimum of 1 hour. Position the new guide onto the end of a valve guide installation drift, and lubricate the guide OD with Lubriplate white grease or heavy oil. Chill the guide and installation drift to below 32°F.

**WARNING**

**USE NECESSARY PROTECTIVE GEAR. HEATED PARTS MAY CAUSE SEVERE BURNS.**

- e. When temperatures have stabilized, insert the guide in the hole in the cylinder head. Tap the installation tool with a hammer to ensure that guide is fully seated.

**WARNING**

**WEAR SAFETY GOGGLES OR A FACE SHIELD. USE OF A HAMMER MAY PRODUCE LOOSE PARTICLES OR CHIPS THAT CAN CAUSE CUTS TO THE SKIN AND EYE DAMAGE.**

- f. Allow the cylinder to cool. Ream the valve guide with an appropriate ID reamer. Check the finished ID with a hole plug gage.

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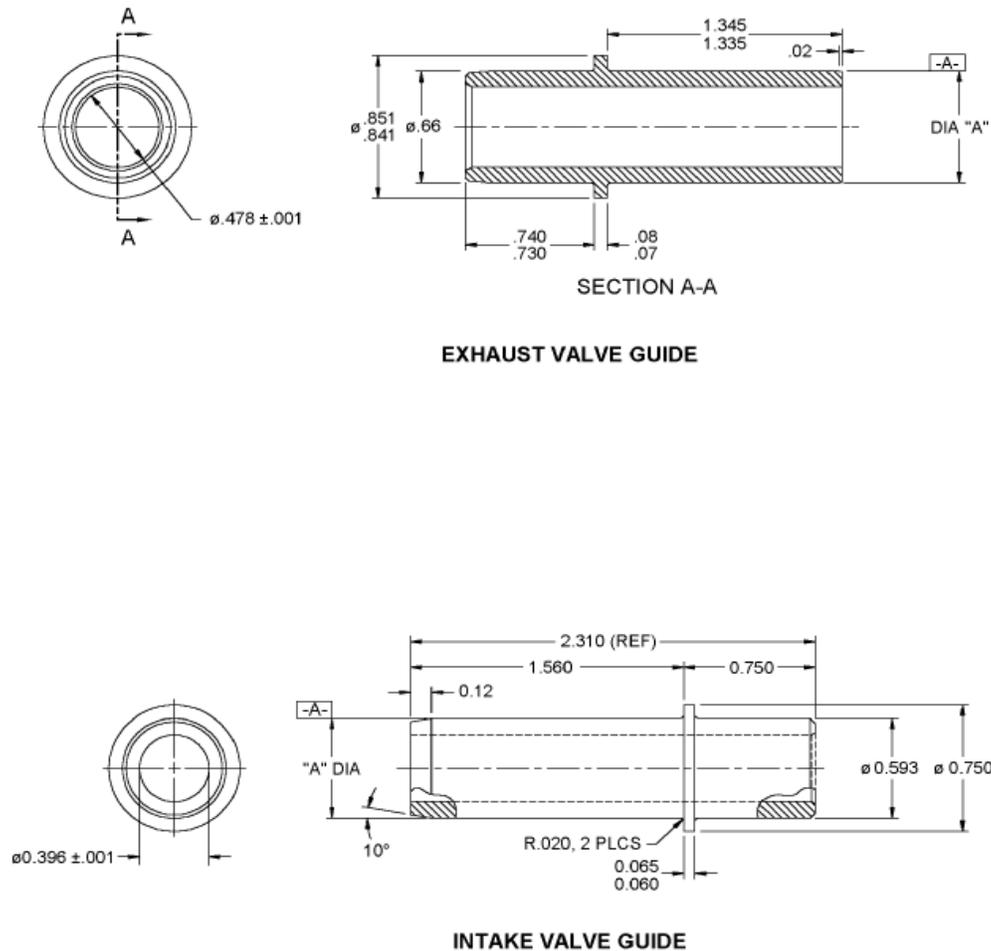
<b>Hi-Chrome Exhaust Valve Guide Part Number</b>	<b>Standard and Oversize (In)</b>	<b>“A” Diameter Guide OD (In)</b>	<b>“B” Diameter Guide Boss ID (In)</b>
AEL74230HC	STD	.6633 - .6638	.6613 - .6623
AEL74230HCP005	+ .005”	.6683 - .6688	.6663 - .6673
AEL74230HCP010	+ .010”	.6733 - .6738	.6713 - .6723
AEL74230HCP020	+ .020”	.6833 - .6838	.6813 - .6823
AEL74230HCP030	+ .030”	.6933 - .6938	.6913 - .6923
AEL74230HCP040	+ .040”	.7033 - .7038	.7013 - .7023

**Table 6-5 Exhaust Valve Guide Standard and Oversize Dimensions**

<b>Intake Valve Guide Part Number</b>	<b>Standard and Oversize (In)</b>	<b>“A” Diameter, Guide OD (In)</b>	<b>“B” Diameter Guide Boss ID (In)</b>
AEL61681	STD	.5933 - .5938	.5913 - .5923
AEL61681P005	+ .005”	.5983 - .5988	.5963 - .5973
AEL61681P010	+ .010”	.6033 - .6038	.6013 - .6023
AEL61681P020	+ .020”	.6133 - .6138	.6113 - .6123
AEL61681P030	+ .030”	.6233 - .6238	.6213 - .6223
AEL61681P040	+ .040”	.6333 - .6338	.6313 - .6323

**Table 6-6 Intake Valve Guide Standard and Oversize Dimensions**

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**Figure 6-2 Valve Guide Dimensions**

**6.7.2.3 Valve Seat Replacement**

Valve seats that are damaged, worn, or loose must be replaced according to the following or equivalent procedures:

**NOTE**

For best results, the valve guide should be replaced whenever a valve seat is replaced. To do so will ensure best seat-to-guide alignment and grinding of the valve seat with minimum material removal. . See paragraph 6.7.2.2 above for valve guide replacement procedures.

**NOTE**

Fabricate valve seat removal tools from threaded rod, appropriately sized fender washers and cellulose sponge material. Test washers and sponge material for size in a room temperature cylinder when sponge is wet. Tool should fully enter the seat with noticeable resistance without tearing the sponge. This resistance will be sufficient to extract the seat when the cylinder assembly is heated.

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1. Heat the cylinder to 475-500°F and secure to a fixture.

**WARNING**  
**USE NECESSARY PROTECTIVE GEAR. HEATED PARTS MAY CAUSE SEVERE BURNS.**

2. Soak the removal tool sponge in ice water, but do not freeze. Insert the tool into the valve seat and hold for a few seconds. The seat should shrink and be held by the sponge. Pull the tool back out with the seat. Use care to not tilt the seat during this process.

**NOTE**  
Perform this procedure as quickly as possible.

3. Allow the cylinder head to cool to room temperature. Clean seat boss as necessary by blasting lightly using plastic media.
4. Measure the ID of the valve seat recess to determine which oversize seat must be installed. Refer to Tables 6-7 and 6-8 below.
5. Mount the cylinder assembly firmly in a fixture at the appropriate angle on a vertical milling machine or heavy duty drill press. Center the seat boss under the spindle. Use an appropriately sized cutter and pilot installed in the proper drive shank. Ensure that the drive shank runs concentrically in the machine spindle and that the cutter pilot engages the ID of the valve guide or guide boss in the cylinder head.
6. Machine the seat boss in the cylinder head to proper oversize using a very low spindle RPM and liberal amounts of cutting oil. Remove no more metal than required to clean the minor diameter of the seat recess, and be careful to not deepen the recess.

**WARNING**  
**LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

7. Measure the ID of the machined seat boss to confirm proper diameter and a uniform surface free of tears or deep machining marks that could be a source of leakage between the valve seat and cylinder head.
8. Coat a valve seat replacement tool with Lubriplate white grease, and place a new valve seat of the appropriate size onto the tool. The tool must have the appropriately sized pilot to match the ID of the valve guide boss or guide in the cylinder head. Chill the tool and seat in a freezer or using CO<sub>2</sub> to 0°F or below.
9. Heat the cylinder to 450-500°F, and secure to a fixture. Center the pilot of the seat installer in the guide boss or guide ID and quickly install the seat into the bore of the seat boss. Allow the seat to warm up in the cylinder so that the grease used to hold it in place on the tool begins to melt. Tap the handle of the

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installer several times with a ball peen hammer to ensure that the seat is firmly in place. Wait five seconds and again tap the handle of the installer.

**WARNING**  
**USE NECESSARY PROTECTIVE GEAR. HEATED PARTS MAY CAUSE SEVERE BURNS.**

**NOTE**  
The seat must drop completely to the bottom of the recess as soon as it is installed in the cylinder head. If the seat is driven into place, it will destroy the necessary interference fit with the cylinder head and subsequently leak and/or loosen during engine operation!

**WARNING**  
**WEAR SAFETY GOGGLES OR A FACE SHIELD. USE OF A HAMMER MAY PRODUCE LOOSE PARTICLES OR CHIPS THAT CAN CAUSE CUTS TO THE SKIN AND EYE DAMAGE.**

10. Carefully withdraw the seat installer tool from the seat. The seat must not move or come out with the tool. If it does, it has insufficient interference fit and must be replaced.
11. Allow the cylinder to cool. Rework the valve guide boss and guide ID as required.
12. Grind the face of the new seat as described below at paragraph 6.7.2.4 in this section.

<b>Exhaust Valve Seat Part Number</b>	<b>Standard and Oversize (In)</b>	<b>“A” Diameter Seat OD (In)</b>	<b>“B” Diameter Seat Boss ID (In)</b>
AEL72058	STD	1.7395 - 1.7410	1.733 - 1.735
AEL72058P010	+ .010"	1.7495 - 1.7510	1.743 - 1.745
AEL72058P020	+ .020"	1.7595 - 1.7610	1.753 - 1.755
AEL72058P030	+ .030"	1.7695 - 1.7710	1.763 - 1.765

**Table 6-7 Exhaust Valve Seat Standard and Oversize Dimensions**

<b>Venturi Intake Valve Seat Part Number</b>	<b>Standard and Oversize (In)</b>	<b>“A” Diameter Seat OD (In)</b>	<b>“B” Diameter Seat Boss ID (In)</b>
AEL72052	STD	2.0815 - 2.0830	2.073 - 2.075
AEL72052P010	+ .010"	2.0915 - 2.0930	2.083 - 2.085
AEL72052P020	+ .020"	2.1015 - 2.1030	2.093 - 2.095
AEL72052P030	+ .030"	2.1115 - 2.1130	2.103 - 2.105

**Table 6-8 Intake Valve Seat Standard and Oversize Dimensions**

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### 6.7.2.4 Valve Seat Grinding

The ID of the valve guide is used as a pilot for all valve seat reconditioning operations.

**WARNING**  
**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

1. Grind valve seats wet with suitable equipment capable of supplying generous amounts of cutting oil or water soluble cutting oil to the work. Grind intake valve seats to a 30° angle and exhaust valve seats to a 45° angle. Grind valve seats to a surface roughness no greater than approximately 16 micro-inches Ra and concentric and square with the ID of the valve guide to within .002".

**WARNING**  
**LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

2. On intake valve seats, use a 15° grinding wheel to grind the top surface of the valve seats to produce the outer diameter (Dimension "A") of the 30° seating surface. Bring the seating surface of the intake valve seats to the specified width (Dimension "B") by narrowing from the ID using a 75° grinding wheel. Refer to Figure 6-3 and 6-4.
3. On exhaust valve seats, use a 15° grinding wheel to grind the top surface of the valve seats to produce the outer diameter (Dimension "C") of the 45° seating surface. Width of the seating surface on exhaust valve seats should conform to Dimension "D". Refer to Figure 6-3 and 6-4.
4. Replace the valve seat if wear has progressed to the extent that the 15° narrowing wheel contacts the face of the valve seat all the way to its outer diameter.
5. After grinding, check contact between valves and seats using either Prussian blue or by lapping using oil based fine grit lapping compound. After lapping, remove valve from cylinder and wipe all traces of lapping compound from valve face and valve seat. Apply a few drops of SAE 50 oil to the valve face and "dry lap" the valve to the seat using only oil. This will smooth the lapped surface and promote quick valve sealing at engine startup.

**NOTE**  
Use extreme care to keep all traces of valve lapping compound from valve stem and guide while lapping valves as it will severely scratch valve stems and guides.

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**CC340 ENGINE MANUAL**

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6. Thoroughly wash cylinder and valves in petroleum solvent and dry with compressed air after lapping to ensure that all traces of valve grinding grit and lapping compound are completely removed from cylinder.

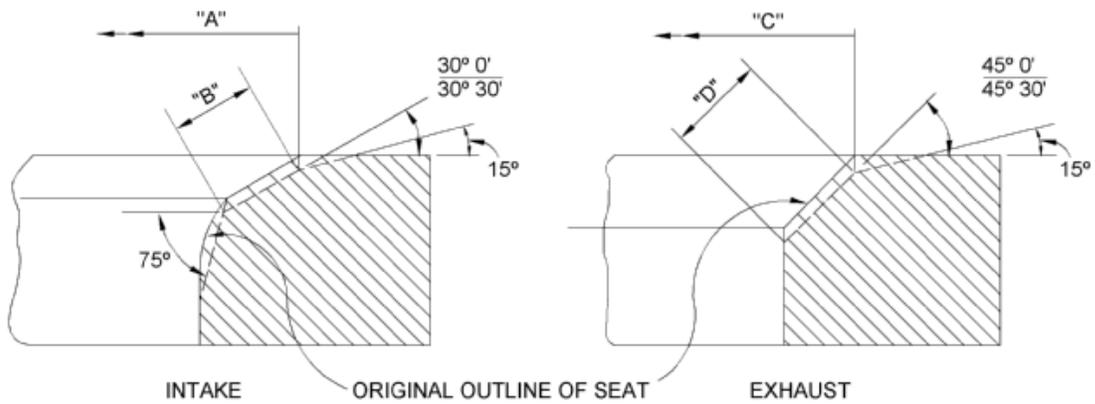
**WARNING**

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

**WARNING**

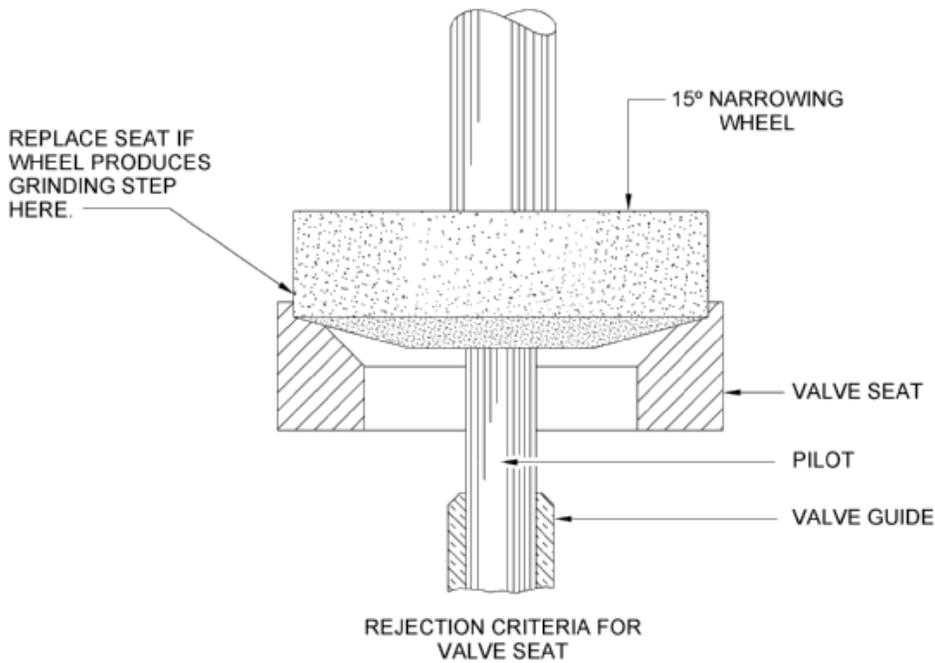
**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

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"A" (INTAKE)	"B" (INTAKE)	"C" (EXHAUST)	"D" (EXHAUST)
2.145 / 2.155	.076 / .117	1.740 / 1.750	.058 / .077

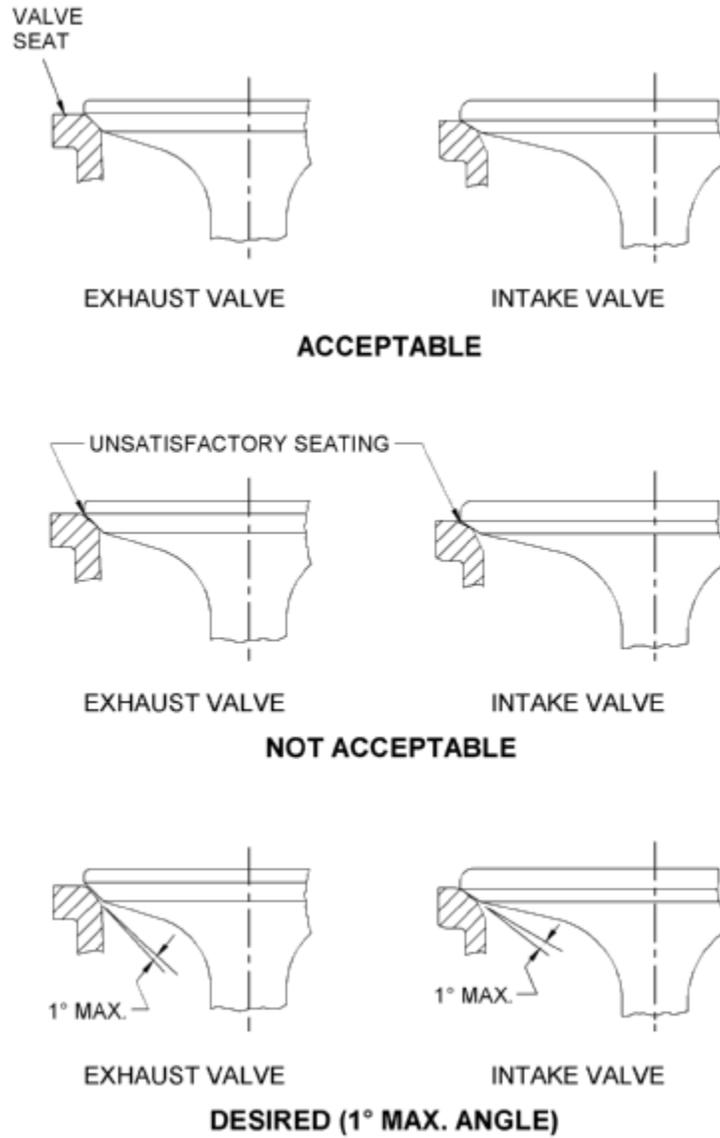
VALVE SEAT DIMENSIONS FOR RECONDITIONING



**Figure 6-3 Valve Seat Dimensions**

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**Figure 6-4 Valve to Seat Fit Acceptable Criteria**

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### 6.7.3 Rocker Boss Bushing Replacement

Worn or damaged bushings in the rocker shaft bosses of cylinders that were rejected during inspection must be removed and replaced as described in this repair procedure.

Fabricate a bushing removal drift of tool steel having a pilot approximately .620" diameter and a shouldered portion of the shank approximately .740" diameter. These portions of the tool should be of sufficient length to allow the .740" diameter portion of the shank to span the distance from the outer edge of one of the outer rocker bosses to the opposite edge of the inner rocker boss.

Also fabricate a rectangular steel block, or several blocks to snugly fit between the outer rocker bosses and the inner boss and just above the rocker shaft bushing holes. This block will support the outer bosses to prevent them from cracking when bushings are driven into or out of the outer bosses.

Replace bushings as follows:

1. Insert the bushing removal drift into one of the outer rocker bosses so that the shoulder of the tool rests against the edge face of the bushing. Be certain that the pilot diameter of the tool is free to move in the inner boss bushings.
2. Insert the steel block between the outer boss and inner boss but not so far that it would interfere with the bushing as it slides out of the boss.
3. Using a ball-peen hammer, tap on the end of the drift to remove the bushing by driving it inboard into the space between the bosses that is normally occupied by the rocker arm. Remove the drift and bushing.

**WARNING**  
**WEAR SAFETY GOGGLES OR A FACE SHIELD. USE OF A HAMMER MAY PRODUCE LOOSE PARTICLES OR CHIPS THAT CAN CAUSE CUTS TO THE SKIN AND EYE DAMAGE.**

4. Insert the drift into the opposite outer boss of the cylinder, and slide the steel block between the bosses. Drive out the bushing in the second outer boss by also driving it inboard into the space normally occupied by the rocker arm. Remove the steel block, the drift and the bushing.
5. Insert the drift into the outer boss until it contacts the edge of one of the inner bushings. Drive the inner bushing into the inner boss until it contacts the other bushing. Continue driving both bushings until one is forced out the opposite side of the inner boss.
6. Remove the drift far enough to remove the bushing just driven out, and re-insert the drift. Drive out the remaining bushing in the center rocker boss.
7. Clean the rocker bosses and visually inspect the bores for damage. Measure the ID of the bores to determine whether standard size bushings can be re-installed or whether the bosses must be reworked to an oversize. Refer to the Table of Limits in Section 10.

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8. Fabricate a bushing installation drift similar to the bushing removal drift but having a pilot diameter of .610”.
9. Oil the bores in the rocker bosses with SAE 50 oil.
10. Place a new bushing of the proper size between one of the outer rocker bosses and the inner rocker boss of the cylinder. Insert the pilot of the bushing installation tool through the outer boss, through the bushing and into the inner boss. Drive the bushing into the inner boss until it is just below the surface of the inner boss.
11. Remove the drift, and place a new bushing onto the pilot. Insert the drift into the outer boss. Place the steel block between the bosses, and drive the bushing into the outer boss until the inner edge is just below the inner machined surface of the boss. Remove the drift and the block, and turn the cylinder around.
12. Repeat step 10 to install the second bushing in the inner boss.
13. Repeat step 11 to install the bushing in the second outer boss.
14. Ream the new bushings to finished size using a line reamer having a .615” diameter pilot long enough to pass through at least one outer bushing and two inner bushings, and a smooth shank above the flutes that is .6244” - .6240” diameter and of sufficient length to allow the reaming flutes to pass through all four bushings from one side.
15. Thoroughly clean chips from the rocker bosses and inspect the ID using a plug gage or dial bore gage set to a calibrated ring gage or calibrated fixture. Refer to the Table of Limits in Section 10.
16. Penetrant inspect rocker shaft bosses to ensure that there are no cracks.
17. Apply several drops of SAE 10 oil to the bushings and allow to soak for 1-2 hours before assembling cylinder.

### WARNING

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

#### 6.7.4 Spark Plug Threaded Insert (Helical Coil) Repair

Remove and replace spark plug threaded inserts that were rejected during inspection as described in the procedures below. Use an extraction tool to remove the rejected insert as follows:

1. Insert the tool into the spark plug hole so that the edges of the tool cut into the top thread of the insert.
2. Rotate the tool counterclockwise to unscrew and remove the threaded insert from the hole.

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### NOTE

It may be necessary to grind the end of a .09"-.13" diameter pin punch at a 45°-60° angle to extract the serrated end of the threaded insert from its staked position in the cylinder head in order to unscrew the threaded insert from the hole.

3. Inspect the condition of the tapped hole after removal of the insert in accordance with the thread pitch limits of the manufacturer of the new threaded insert to be installed. If necessary, clean up the threads using an 18mm x 1.5 tap that is .010" oversize. Use isopropyl alcohol or aluminum tapping fluid as a lubricant.

### NOTE

Be extremely careful to start the tap squarely in the existing threads.

4. Withdraw the mandrel portion of the threaded insert installation tool beyond the recessed section of the sleeve. Place a new .010" oversize insert of the proper length into the recess area.
5. Allow the mandrel to advance to engage its slotted end with the tang of the insert.
6. Rotate the mandrel clockwise and press slightly to engage the insert in the threaded end of the sleeve.
7. Continue to rotate the mandrel while holding the sleeve to secure the insert firmly on the insertion tool.
8. Wind the insert through the threaded portion of the tool sleeve to within one-half turn of the end of the coil.
9. Keep the insert tight on the tool to prevent unwinding and to facilitate installation of the insert. Wind the insert so that the adjacent turns of the insert are in contact with each other. This eliminates the possibility of crossed threads.
10. Screw the insert into the hole.
11. Be sure that the first coil of the insert picks up the first thread of the hole. As the tool is turned, the insert will advance into the hole.
12. When the face of the sleeve is approximately 0.13 in. from the face of the spark plug boss gasket surface, boss, the inserting tool should be held tightly by the handle. The sleeve must be rotated counterclockwise which will free the last half-turn of the insert.
13. Slide the sleeve toward the top of the mandrel and check that the top of the insert projects above the boss.
14. Rotate the mandrel clockwise until the insert disappears from sight. Stop the turning action and remove the tool. The top of the insert should be one half turn from the face of the boss and the tang end should not protrude into the combustion chamber.
15. If the insert is positioned properly, break off the tang of the insert at the location of the notch.

### WARNING

**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING  
SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

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16. Use an expander tool to secure the insert in the plug hole. Set the limit of expansion by fixing the stop nut on the expanding tool at the correct position.
17. Assemble a staking sleeve over the mandrel until the sleeve meets the boss. Stake the insert by striking the top of the sleeve a light blow with a hammer. This will create a slight chamfered edge around the edge of the tapped hole.
18. Remove the staking sleeve, release the adjusting screw, and remove the expanding mandrel from the insert.

#### **6.7.5 Cylinder Cooling Fan Repair**

CC340 cylinders are manufactured from shell molded heads made of Titan Advanced AMS 4220 aluminum alloy and through-hardened AISI 4140 steel cylinder barrels having a Nickel+Carbide bore coating. Because the cylinder heads and barrels are made of different materials subjected to different stresses, repairs to cylinder head fins and cylinder barrel fins require different procedures and limitations.

##### **6.7.5.1 Cylinder Cooling Fins**

Repair cylinder head cooling fins as follows:

1. Cracks in the fins may be stop-drilled with a .190 in. diameter hole at the end of the crack, provided that the crack is at least .25 in. from the root of the fin. Break the edges of the drilled hole if possible.

**WARNING**  
**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS**  
**AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE**  
**LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

2. For fins cracked almost all the way across, it is permissible to remove a portion of the fin as follows (refer to Figure 6-5):
  - a. Material removed may not exceed one-half the total fin width.
  - b. No burrs or sharp edges may remain.
  - c. Fillet radius at the root of the removed portion of the fin must not be less than .25 inch. Corner at top of fin adjacent to the removed portion must not be less than .50 inch radius.
3. Repair damaged, cracked, or broken fins as follows:
  1. Blend the damaged area. Blended area for any one fin shall not exceed .38 sq.-in. area or .38 inch depth.
  2. No more than two blended areas on one fin.
  3. No more than four (4) blended areas on the pushrod side of the cylinder head and no more than six (6) blended fins on the port side of the cylinder head.
4. Perform a careful penetrant inspection (PT) upon completion of any cylinder head fin repairs, paying special attention to:
  - The area on exhaust port side of the cylinder head

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- The area between the fins located between the intake and exhaust ports of the head
- The area around the lower spark plug counter bore

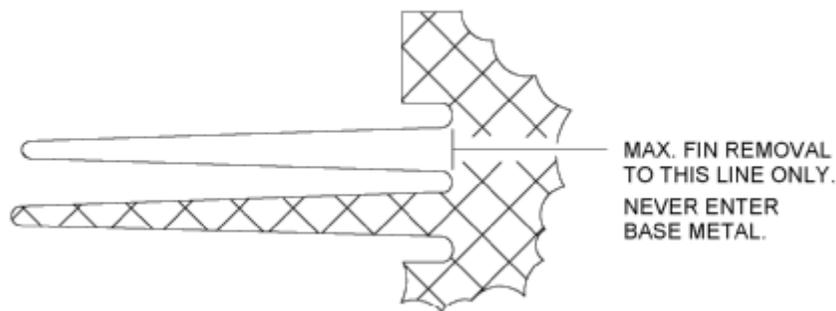
### 6.7.5.2 Cylinder Barrel Cooling Fins

Only very limited damage to cylinder barrel cooling fins may be repaired as follows:

1. Carefully straighten fins that are bent at an angle not exceeding 30 degrees.
2. Using small files and/or a hand-held hobby tool such as a Dremel Moto-Tool, completely blend and remove nicks or cracks on the outer circumference of the fins to a depth not to exceed .19 inch and with a blend radius of at least .50 inch.

**WARNING**  
**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

3. After repairs, perform magnetic particle test (MT) of the cylinder barrel using both circular and longitudinal fields. Reject any cylinder barrel with cracked fins, broken fins, missing fins or with fins bent at an angle exceeding 30 degrees and not repairable per step 2 above.



**Figure 6-5 Cylinder Head Cooling Fin Removal Maximum**

### 6.7.6 Cylinder Bore Surface Repair

CC340 engine cylinders are manufactured from shell molded heads made of Titan Advanced AMS 4220 aluminum alloy and through-hardened AISI 4140 steel cylinder barrels having a Nickel+Carbide bore coating. Nickel+Carbide process bores can be returned to service by using the AETKIT01 Rejuvenation Kit according to the procedures below.

**WARNING**



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- d. After micro-honing, the cylinder bore will be relatively smooth as compare to a steel bore, and the cross-hatch will be visible but faint. The surface roughness should measure 3 – 8 micro-inches Ra.
  - e. If the desired finish is not achieved after completion of the rejuvenation process, please call ECi Engineering Department (210-820-8101) for more information.
4. Cleaning
- a. Thoroughly clean all surfaces of the cylinder using petroleum solvent to remove honing oil followed by hot soapy water and a hot water rinse. Air dry immediately with compressed air or by placing cylinder in a warm oven.

**WARNING**  
**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

**WARNING**  
**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

- b. When cylinder is dry, wipe the ID of the cylinder bore with a clean white paper towel. If any honing residues are noted on the towel, clean the cylinder bore again.

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## CAUTION

Honing debris that is left in the cylinder will contaminate the engine oil system and may cause serious damage to pistons, rings and bearings.

4. Perform a dimensional inspection of the cylinder bore according to the appropriate figure for the engine model. Refer to Figure 6-7.

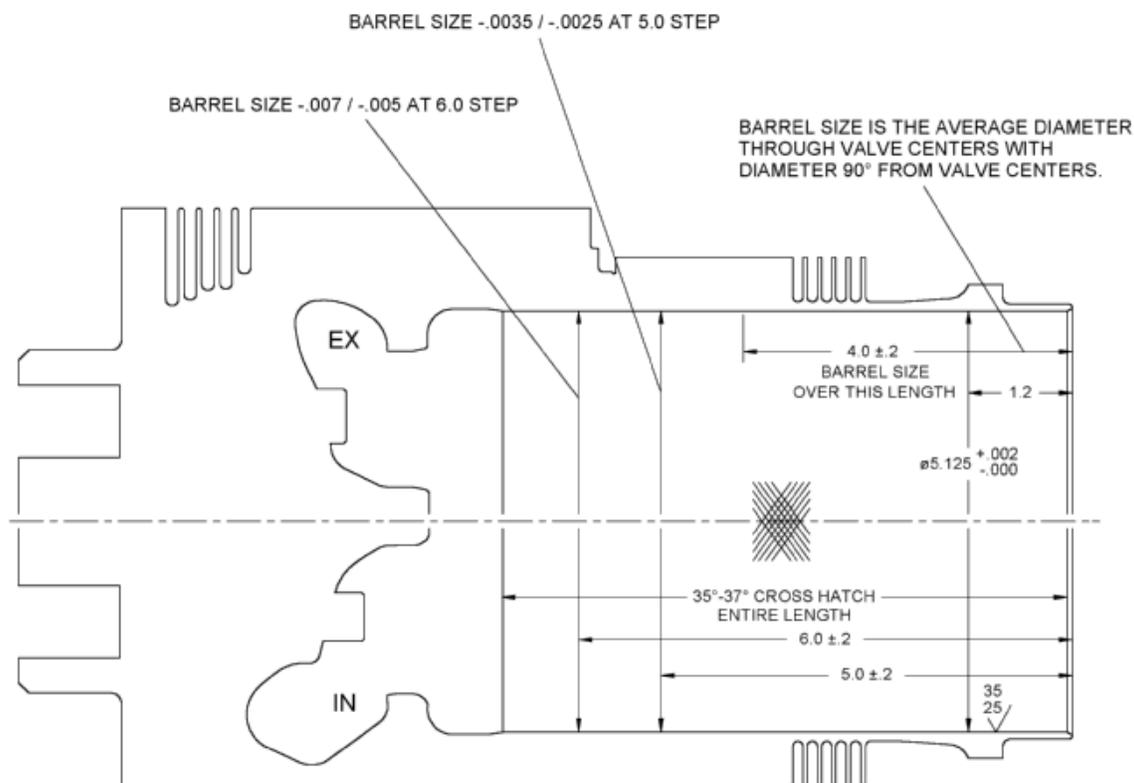


Figure 6-7 Cylinder Bore Dimensions

### 6.7.7 Crankshaft Journal and Seal Surface Repair

Determine if the crankshaft main bearing journals and crankpins are standard size or one of the approved undersizes before beginning any repair operation involving polishing or grinding. Also inspect the OD of the crankshaft propeller flange for any markings that might indicate previous rework to an undersize. Refer to Table 6-4, List of Repair Codes, in order to properly interpret flange markings that may indicate rework to an undersize.

Repair crankshaft journals according to the procedures below.

1. Measure crankshaft main bearing journals and crankpins using a calibrated 2-3 inch outside micrometer and compare to Table of Limits, Section 10, in this manual.
2. If journals are not excessively scratched or scored and are within new part limits or well within serviceable limits, the journals may be polished as follows:

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**WARNING**  
**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

- a. Mount the crankshaft securely in a crankshaft polishing machine or an engine lathe operating at approximately 50-75 RPM.
  - b. Using a motorized belt polisher and 1-inch wide 320J aluminum oxide polishing belts that have been broken in, lightly polish all crankpins and main journals to remove light wear marks and scratches.
  - c. Use care to avoid excessive polishing in journal fillets or to create flat spots around oil holes.
  - d. Test journal surfaces for roughness by rubbing the edge of a copper penny back and forth about five strokes. If a copper color appears on the journal surface, it is too rough and should be polished to a smoother finish or reground.
  - e. Measure journals after polishing being careful to note taper and out-of-roundness conditions that would require regrinding.
3. If measurements do not fall within specified limits or if the journals are excessively scratched or scored, the journals must be reworked to undersize.
- a. Worn standard size journals may be reworked to .003" undersize (M003) using "nutcracker" type polishing tools specifically designed for this purpose and the journals fitted with M003 bearings.
  - b. For this operation, lathe speed must not exceed 150 RPM. Polish per Step 2 above.
  - c. Measure journals after polishing being careful to note taper and out-of-roundness conditions that would require regrinding.

**NOTE**  
Do not attempt to polish crankshafts to M003 using belt polishers only.

**NOTE**

If one journal is polished to undersize, all corresponding journals must be polished to the same undersize. However, main bearing journals may be polished undersize without affecting crankpins. Likewise, the crankpins may be polished without affecting the main bearing journals.

**CAUTION**  
**Do not damage the nitrided surfaces of the crankshaft!**

4. If journals are excessively worn, scored or already .003" undersize, they may be repaired by grinding to .006" undersize (M006) or .010" undersize (M010), as required. Grinding requires high quality grinding equipment and careful operators familiar with the requirements of aircraft engine crankshafts. The following procedures must be observed:
- a. Use silicon carbide grinding wheels of 54 or 60 grit abrasive and generous amounts of grinding coolant.

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- b. Dress grinding wheel faces and radii frequently to provide a sharp surface that will not heat or crack the nitrided surface. See Table of Limits, Section 10 of this manual, for crankpin fillet radii dimensions.
- c. The grinding wheel must make a smooth blend with at least 50% of the existing journal fillet but must not leave a line or gap where the fillet becomes tangent to the face of the journal.
- d. It is preferable to not grind thrust surfaces on main journals or crankpins unless cracked or pitted.
- e. Grind journals to approximately .0003" smaller than the maximum new limit diameter of the undersize in order to allow for growth during nitriding.

### NOTE

If one journal is reground to undersize, all corresponding journals must be reground to the same undersize. However, main bearing journals may be ground undersize without affecting crankpins. Likewise, the crankpins may be reground without affecting the main bearing journals.

- f. After regrinding, perform complete magnetic particle testing (MT) of the crankshaft per par. 5-11.2 in this manual. No crack indications are allowed.
- g. Metal stamp or vibro-peen the correct size code(s) on the edge of the flange.
- h. Remove prop flange bushings noting their location, and remove dowel from the crankshaft gear counter bore.
- i. Clean crankshaft thoroughly and dry.
- j. Prepare the crankshaft for nitriding by lightly blasting all ground surfaces using fine grade virgin aluminum oxide blasting grit and the lowest compressed air pressure required to lightly but uniformly dull all ground surfaces. Blast nozzle must be kept in constant motion and be held at least 8 inches from the journal surface to prevent erosion or damage of the journal surfaces. Remove all grit using dry compressed air.

### WARNING

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

- k. Install a threaded brass bolt in the crankshaft gear bolt threads. Mask the crankshaft gear counter bore and dowel hole as well as the oil seal journal and flange areas from the front face of the oil slinger forward using a high quality nitriding stop-off paint to prevent nitriding of these surfaces. Also mask the prop flange bushing holes and lightening holes (if present) and the OD and ID of the prop flange pilot journal to a depth of approximately 1 inch, minimum.
- l. Re-nitride the crankshaft according to the notes at par. 5-11.2.
- m. After nitriding, inspect the journal surfaces for the presence of white layer which must be present in order for effective restoration of the nitrided case depth. If

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- white layer is present, copper sulfate droplets will not produce any copper plating on the crankshaft surface. Journals should have experienced approximately .0005" growth from the dimensions to which they were ground.
- n. Remove the brass plug and again blast the all traces of the crankshaft gear counter bore and prop flange using the same procedures as at step (j.) above.
  - o. Clean all blasting media from the crankshaft and chase the bolt hole threads.
  - p. Polish all bearing journals per Step 2 above. Polish the rear thrust surface of the crankshaft front main bearing journal (aft of #2 main) to remove white layer. Test with copper sulfate solution.
  - q. Polish the crankshaft oil seal journal and install prop flange bushings.
  - r. Measure and record all dimensions and run out of the main bearing journals and prop flange.
  - s. Perform complete MT of the crankshaft.
  - t. Re-plate the prop flange and seal journal area per Repair No. 6-7.17 below.
  - u. Install a new dowel per Repair No. 6-7.8 below.
  - v. Coat the clean surfaces of the crankshaft with preservative oil, and store until ready for reassembly
5. The crankshaft oil seal journal is not nitrided and may be repaired by polishing or grinding independently of the main journal or crankpins if the area is worn, scratched or rust pitted according to the following procedures:
- a. If the seal contact area only is lightly worn, it may be repaired by polishing up to .003" undersize (M003) per Step 2 or Step 3 above.

**WARNING**  
**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS**  
**AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE**  
**LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

- b. If wear, damage or minor rust pits cannot be cleaned up by polishing, remove the prop flange bushings; and grind the seal journal for cleanup but not to exceed .010" undersize (M010). Be especially careful to make a smooth blend with the .50-inch radius on the aft side of the prop flange.
- c. Polish the reground area, and check run out of the seal contact area which must not exceed .002" TIR with the #1 (front) main bearing journal. Surface roughness should not exceed 10 micro-inches, Ra.
- d. Perform MT of the reground area. No crack indications or heat checks are permitted.
- e. Re-install prop flange bushings, and re-plate the prop flange per Repair No. 6.7.17 below.

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### 6.7.8 Crankshaft Dowel Repair

Dowels in the crankshaft must be inspected for damage in accordance with par. 5.11.1 of this manual. Replace any dowel with visible physical damage to the .250" diameter portion, including evidence of arcing or overheating due resulting from magnetic particle testing (MT), or if the step on the dowel is set more than .020" below the surface of the crankshaft counter bore. Remove damaged dowels and install new dowel according to the following procedures:

1. Bolt the crankshaft securely on a vertical engine stand.
2. Cover the crankshaft completely with a plastic bag. Tear a hole in the bag to expose the crankshaft gear counter bore and tape the bag to the rear main journal of the crankshaft to keep chips from lodging anywhere in the crankshaft.
3. Carefully center punch the end of the dowel as close to the center as possible.

**WARNING**  
**WEAR SAFETY GOGGLES OR A FACE SHIELD. USE OF A HAMMER MAY PRODUCE LOOSE PARTICLES OR CHIPS THAT CAN CAUSE CUTS TO THE SKIN AND EYE DAMAGE.**

4. Using a 1/8-inch or #30 HSS drill bit and a drill motor, drill a pilot hole through the center of the dowel. As the bit begins to drill, examine the drilling to see that it is approximately centered in the dowel. Angle the drill motor as required to bring an off-center hole back to approximate center. Use WD-40 or cutting oil to lubricate the drill bit.

**WARNING**  
**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

5. Enlarge the pilot hole in the dowel 1-3 drill sizes at a time until #8 or #7 drill diameter is reached. Blow out chips from the pilot hole in the dowel.

**NOTE**

Use extreme care to keep the drill centered in the dowel. If the pilot hole is off-center, it may be necessary to break or grind off the .25" diameter portion of the dowel. DO NOT drill through the side of the .31" diameter portion of the dowel and into the crankshaft.

6. Using a high quality M6 x 1 HSS plug tap, tap threads in the pilot hole in the dowel. Start the tap straight, use WD-40 as a lubricant, and back up the tap frequently to clear chips. It is not necessary to tap completely through the dowel, but the tap should go deep enough to cut approximately 4-5 full threads in the .31" diameter portion of the dowel.
7. Remove the tap and clear all chips. Install a fully threaded M6 x 1 stud approximately 1.5 inches long in the threads tapped in the dowel. Place a bronze puller sleeve over the M6 x 1 stud. Make this sleeve approximately .53" OD x .34" ID x .75" long. File or machine a .15" wide relief at one end to clear the edge of the crankshaft counter bore.

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8. Place a heavy steel washer over the stud and install a M6 x 1 hex nut. Use a 10mm wrench to tighten the nut which will pull the dowel from the crankshaft.
9. Inspect the OD of the old dowel and the ID of the dowel hole in the crankshaft for galling or damage. Measure the ID of the crankshaft dowel hole, and compare to Table 6-9.
10. If required, bore or ream the dowel hole in the crankshaft to oversize as required for full cleanup.

### NOTE

Before boring or reaming the dowel hole, be certain that the correct oversize dowel is available. Mount the crankshaft securely in a milling machine fixture, and carefully center in the dowel hole before boring or reaming. Be careful to not deepen the dowel hole in the crankshaft.

11. To install a new dowel, carefully break the edge of the crankshaft dowel hole. Polish the edge of the dowel hole using a polishing rod made of .25" diameter brass with a 1-inch long slot cut in one end with a hacksaw. Slide a 1-inch square of worn Scotchbrite 6448 or 7447 pad into the slot in the rod. Mount the rod in a drill motor, and use the polishing rod and Scotchbrite as a miniature hone to polish the edge of the dowel hole.
12. Blow out all chips and debris from the crankshaft dowel hole and lightly oil the ID of the dowel hole using a cotton swab dipped in SAE 50 oil.

### WARNING

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

### CAUTION

**DO NOT fill the crankshaft dowel hole with oil! To do so will result in a hydraulic lock when attempting to fully seat the dowel.**

13. Lightly oil the OD of the new dowel and start it squarely into the dowel hole of the crankshaft using only a brass drift. When the dowel has started squarely, drive the dowel to the proper depth by tapping the brass drift with a ball peen hammer. The dowel is properly seated when the edge of the step is .010"-.020" below the surface of the crankshaft counter bore.
14. Remove the tape and plastic bag from the crankshaft, and thoroughly clean the crankshaft to ensure that no metal chips or foreign matter remain in any oil holes or lightening holes.
15. Test the fit and location of the dowel by installing and removing a sample crankshaft gear.

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### 6.7.9 Rocker Arm Bushing Repair

Rocker arm bushings that were rejected during inspection must be removed and replaced according to the repair procedures below. To remove bushings it will be necessary to fabricate three tools.

Fabricate the bushing driver from round tool steel bar approximately .88" diameter. Machine a pilot approximately .621" diameter x 1.00" long and a second diameter, approximately .740" diameter x 1.75" long concentric with the pilot. The shoulder between these two diameters must be a sharp 90° corner. Finally, knurl a length of the bar approximately 1.0" long and cut off. Chamfer all edges 45° x .03" except the shoulder described above. Heat treat to approximately HRc 60-64.

Second, fabricate a support block of 1.0" thick cold rolled steel with a hole through the center approximately .81" in diameter. This is the support block for bushing removal.

Third, fabricate a support block of 1.0" thick cold rolled steel with a hole through the center approximately .630" in diameter. This is the support block for bushing burnishing.

Use either an arbor press to remove and replace the bushings as follows:

1. Place the support block for bushing removal on the base of the press such that the center hole for bushing removal is directly under the ram of the press.
2. Insert the bushing driver into the rocker arm and place the rocker arm over the hole in the support block.

#### NOTE

Supporting the rocker arm only by the thrust surface on either side or the rocker. Do not allow bending loads to be applied to either arm of the rocker.

3. Press out the rocker arm bushing.
4. Clean the bushing bore in the rocker arm bore and the oil holes thoroughly to remove chips, sludge and other debris. Inspect the ID of the rocker arm bore, and repair any minor scores or scratches as required.
5. Lightly oil the ID of the rocker arm with SAE 50 oil.
6. Slide the rocker arm support block slightly to the side so that the center hole is not directly under the ram of the press, or lay a smooth solid steel plate on the table of the press.
7. Lay the rocker arm on the support block or plate and centered under the ram of the press.

#### NOTE

Avoid supporting the rocker arm in such a way that bending loads are placed on the rocker arms in order to prevent damage to the rocker arm.

8. Lightly oil the OD of a new bushing, and place the bushing atop the rocker arm bushing hole so that the lubrication hole in the bushing is aligned with the oil hole on the pushrod side of the rocker arm bore.

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9. Gently lower the ram of the press onto the bushing to square it up with the bushing hole in the rocker arm. Press the bushing in flush with the thrust surface of the rocker arm.
10. Place the support block for bushing burnishing on the table of the press with the center hole aligned below the ram of the press.
11. Thoroughly oil the OD of a bushing burnishing tool such as Lycoming tool P/N 64541 and insert the smaller diameter end of the tool into the new bushing in the rocker. Place the rocker and burnisher onto the support block with the pilot of the burnisher in the center hole of the support block. Press the burnisher through the bushing.

### CAUTION

**Finish bushings ONLY by burnishing or reaming. DO NOT hone rocker arm bushings! Rocker arm bushings are made of porous bronze material that can entrap abrasive particles from the honing process and may result in premature bushing and valve rocker shaft wear.**

12. If necessary, lightly sand both thrust surfaces of the rocker arm to remove minor nicks or any slightly protruding edge of the bronze bushing. Use 320 or 400 grit aluminum oxide paper placed on a flat surface plate.
13. Regrind the curved tip or "foot" of the rocker arm on a valve grinder with rocker arm re-facing attachment in good condition. Retain original curvature of tip, and grind the minimum amount of material for cleanup. Ground surface must be parallel to bushing ID within .003". Surface roughness must not exceed 60 micro-inches, Ra.
14. Wash the rocker arm in solvent and dry with compressed air making certain that all chips are removed and that the oil holes are clear.

### WARNING

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

### WARNING

**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

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15. Inspect ID of bushing using a go/no-go plug gage, or dial bore gage or air gage set to a calibrated ring gage or setting fixture. Refer to Section 10, Table of Limits, for new parts ID of bushing.
16. Soak rocker arms in SAE 40 engine oil overnight to thoroughly impregnate bushings with oil before assembly.

### 6.7.10 Rocker Arm Bushing Repair

Big ends of the connecting rods that do not conform to dimensional limits may be repaired according to the procedures below.

#### **CAUTION**

**Do NOT attempt to repair the big ends of connecting rods that exhibit galling in the areas of the big end bore indicated below in Figure 6-10. Galling in the form of raised areas of micro-welded metal from the back of the rod bearing creates micro structural damage that can lead to fatigue cracks and rod failure.**

1. Inspect connecting rod big end ID for galling per Figure 6-10. Reject any rods where galling is present.
2. Grind mating surfaces of rod and cap in grinding machine designed specifically for this purpose. Reground mating surfaces must be flat and parallel with each other within .001" and perpendicular with the rod and cap thrust surfaces within .0005 inch per inch. Remove the minimum amount of material required for complete cleanup and not more than .003" of material at any point.
3. Lightly break edges of mating surfaces and bolt holes. Wash connecting rods and caps in clean solvent and dry with compressed air.

#### **WARNING**

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

#### **WARNING**

**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

4. Assemble rods and caps according to the assembly instructions of Figure 5-3 in this manual. Due to the reduction in big end ID, an assembly arbor such as Lycoming ST-237 cannot be used.
5. Measure big end ID diagonally across parting line using a dial bore gage set to a calibrated ring gage or setting fixture to determine whether full cleanup of the ID can be achieved. If rod and cap are offset more than .0015" across the parting line, or if the ID dimension across the parting line is still beyond the maximum serviceable diameter (refer to Table of Limits, Section 10), reject connecting rod.

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6. Lightly sand the connecting rod thrust faces on 320 or 400 grit aluminum oxide paper on a flat surface plate to remove minor burrs. Mount connecting rod in a grinding fixture that clamps the connecting rod squarely by the thrust surfaces. Center the rod by dial indicating the ID, and grind the big end ID to new limits. Use generous amounts of grinding coolant to prevent any localized heating of the rod.
7. As an alternative to grinding, the big end ID may be resized on a honing machine that clamps the connecting rod by the thrust surfaces to guide the rod over the honing mandrel. Hone big end ID to new limits. After honing, mount connecting rod on a rotating fixture that can indicate squareness of the bore with the thrust surfaces which must not exceed .0025" TIR.
8. Replace connecting rod bushing, bore to size and check alignment as described below in Repair No. 6-7.11.
9. Separate rod and cap and clean with solvent and compressed air. Perform magnetic particle test (MT) of separated rod and cap as described at par. 5-12.2 above. Inspect rod and cap big end ID surfaces using coil shots in several orientations. Reject rod if ANY crack indications are noted.
10. If MT results are acceptable, demagnetize and clean rod and cap. Apply preservative oil to prevent rust and place inside a clean, dry plastic bag until ready for engine assembly.

### 6.7.11 Connecting Rod Bushing Repair

Small end bushings in the connecting rods that are worn beyond limits or that were rejected during inspection due to damage must be removed and replaced as described according to the procedures below. Also, connecting rod bushings should be replaced whenever the big end ID of the connecting rod is repair according to Repair No. 6-7.10 above.

Connecting rod bushings are a thin-wall hard copper alloy requiring the use of precision made tools and fixtures for safe removal and replacement. Bushing removal and installation drifts should be manufactured to tool steel heat treated to a hardness of approximately HRc 60-64 with critical diameters and shoulders finish ground for concentricity and squareness and having a surface roughness of 20 micro inches, Ra, or less.

The bushing removal drift should have a pilot diameter of 1.117" x 1.30" long and a concentric shoulder diameter of 1.170" x 2.0" long and a knurled handle of approximately diameter 1.25" x 1.5" long.

The bushing installation drift should have a pilot diameter of 1.105" x 1.30" long and a concentric head diameter of approximately 1.50" x .75" long.

Two bushing installation removal/replacement fixtures should be made from 1-inch thick steel plate 6 inches wide x 12 inches in length. Fixture 1 will be used for connecting rods of 340 cubic inches using connecting rods with a center-to-center dimension of 6.500" and a big end width of 1.433"-1.431". Make Fixture 1 with the following detail dimensions:

**Fixture 1:** Mount a steel disc 2.283"-2.285" OD x .50" thick and with a 45° x .06" chamfer on the plate so that the center of the disc 3.0" from the end and from either side edge. On the exact radius of 6.500" from the center of the disc, machine two holes 2.50" apart. Bore

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one hole to approximately 1.21" diameter, and break edges. This hole will be used for removal of bushings. Bore the second hole for installation of a hardened steel drill bushing 1.130" ID and with a minimum flange OD on the bushing of 1.50". The head of the flanged bushing must be recessed into the steel plate and be ground flush with the surface of the plate so that there is no more than a .005"-.010" edge break at the entrance to the drill bushing ID. This hole will be used for installation and burnishing of bushings. If desired, adjustable v-shaped guides may be added to approximately center the rod bushing hole over the appropriate hole in the fixture.

Equivalent Lycoming tools may be used.

Use a heavy duty arbor press or a hydraulic press specifically designed for connecting rod bushing removal and installation. Remove and re-install bushings as follows:

1. Place Fixture 1 described above on the base of the press with the bushing removal hole directly centered under the ram of the press. Place a connecting rod on the fixture with the bushing hole centered over the Fixture hole intended for bushing removal. Connecting rod and cap may be assembled or removed.

### NOTE

Do NOT support the connecting rod in any way that will transmit loads to the I-beam section of the rod. All loads applied by the press must be directly supported beneath the opposite side of the small end. Bushing being removed must drop freely from the connecting rod when completely pressed out.

2. Insert the bushing removal drift into the rod bushing. Insert the tool in the connecting rod small end bushing so that the shoulder of the tool rests on the edge face of the bushing and is clear of the ID of the connecting rod bore
3. Press out connecting rod bushing.
4. Clean connecting rod small end bore thoroughly as described in Section 4 of this manual. Inspect small end ID gouges, scrapes or galling that may have resulted from bushing installation and removal. Reject any rod with such damage. Repair any minor nicks and scratches per Repair No. 6.7.13 below.
5. Measure small end bore ID using an air gage or dial bore gage set to a calibrated ring gage or setting fixture. Compare measurement to new limits found in Section 10, Table of Limits.
6. Perform magnetic particle test (MT) on connecting rod small end with bushing removed. Reject rod for any crack indications or indications of forging inclusions. Demagnetize rod.
7. Lubricate connecting rod small end bore with SAE 50 oil.
8. Place Fixture 1 or Fixture 2 on the base of the press with the bushing installation hole (hole with flanged, hardened steel bushing installed) centered directly under the ram of the press.
9. Lubricate the OD of a new bushing with SAE 50 oil and place on bushing installation drift. Place the drift and bushing over the small end bore of the rod with the split in the bushing located at either the 10:30 or 1:30 position with respect to the axis of the rod. If the bushing has two small cutouts on one end, this end should enter the rod

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first. Locate cutouts at approximately the 8:00 and 4:00 positions. Pinch the bushing to close the gap at the split and hold in that position over the hole in the rod.

10. Slowly and carefully lower the ram of the press against the bushing installation drift so that it is squared up with the ram of the press and centered in the edge of the hole in the connecting rod.
11. Slowly begin pressing the bushing into the rod observing that installation has begun uniformly and squarely around the entire 360-degree circumference of the bushing.
12. When it is certain that proper installation has begun, **KEEP HANDS AND FINGERS COMPLETELY CLEAR OF THE RAM OF THE PRESS, THE BUSHING INSTALLATION DRIFT AND THE CONNECTING ROD.** Press the bushing in fully until the head of the bushing installation tool is seated firmly against the side of the rod.
13. Remove the bushing installation drift. Oil thoroughly the OD of the bushing burnisher (Lycoming tool 64580 or equivalent) and insert the pilot (smaller diameter end) into the bushing. Ensure that the pilot of the burnisher has entered the hardened steel bushing of Fixture 1 or Fixture 2.
14. Gently lower the ram of the press onto the end of the burnisher. **KEEP HANDS AND FINGERS COMPLETELY CLEAR OF THE RAM OF THE PRESS, THE BURNISHER AND THE CONNECTING ROD.** Press the burnisher all the way through the bushing until it drops freely out the bottom.
15. Remove the rod from the fixture and inspect the bushing. If installation has shaved copper material from the bushing, remove the bushing and correct the cause of the problem. Repeat installation of another new bushing.
16. If not previously assembled, lubricate serviceable slave bolts and nuts and assemble cap, bolts and nuts and torque per par. 5-12.3 and Figure 5-3 in this manual.
17. Mount rod and cap assembly on a connecting rod bushing line boring machine that has been set to the proper center-to-center dimension for the connecting rod part number. Refer to Section 10, Table of Limits.
18. Bore bushing to new limits. Refer to Section 10, Table of Limits. Remove rod from boring machine.

### WARNING

**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

19. Break edges of bored bushing .005"-.015" and remove chips.
20. Measure bushing ID using a calibrated Go/No-Go plug gage or a dial bore gage or air gage set to a calibrated ring gage or setting fixture. Refer to Section 10, Table of Limits.

### NOTE

Bushings that are slightly undersized may be brought up to size by honing, but surface roughness of finished bushing must not exceed 32 micro-inches, Ra. DO NOT ATTEMPT TO

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ENLARGE BUSHINGS USING SCOTCHBRITE AND POLISHING RODS! Bushings that are oversized must be replaced.

21. Inspect alignment of bushing ID with big end bore using arbors and fixtures that locate securely in both the big end and bushing ID. Refer to Section 10, Table of Limits.

### NOTE

Use tools similar to Lycoming P/N 64530 for alignment inspection. Alignment fixtures that make use of loose fitting arbors (or piston pins) are suitable only for identifying badly bent or twisted rods and are not sufficient for this inspection.

22. Separate rods and caps, wash in solvent and air dry using dry compressed air. Coat all surface of the rod with preservative oil and place inside a clean plastic bag until ready for assembly.

### 6.7.12 Threaded Area and Stud Repair

Threaded bosses and studs on component parts may undergo limited repairs according to the procedures below. When there is damage of any kind to threaded bosses and/or studs, be certain that the bosses are not cracked. Inspect the associated area(s) closely using a 10X illuminated magnifier, and perform a liquid penetrant test (PT) or magnetic particle test (MT) in accordance with Section 5 of this manual.

#### 6.7.12.1 Light Damage

1. Lightly damaged threaded bosses on castings, including bosses having tapered pipe threads, may be repaired by lightly cleaning the threads using standard thread taps of the correct pitch and diameter. Be certain that the bosses are not cracked, and do not tap tapered pipe threads more than 1.5 threads deeper than as manufactured.
2. After cleaning threads, remove all chips and install stud or cap screw of the correct length and thread engagement length. Install appropriate heavy washers and/or spacers and nut, as required. Torque test the fastener three (3) times at 120% of the recommended assembly torque value.
3. If the repaired threads show no sign of yielding, the repair may be considered successful. Remove and discard the test fastener, and proceed with other inspections and repairs as required.
4. If the threads yield or pull, remove the test fastener and repair the pulled threads as described below.

#### 6.7.12.2 Heavy Damage

1. Remove any installed studs or cap screws.
2. Disassemble any installed parts from the component as required in order to prevent entry of machining chips that may be difficult to detect or clean out after repair.
3. Mount the component securely on the table of a heavy duty drill press or milling machine.

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4. Center the machine spindle in the damaged hole.
5. Carefully inspect the component for oil passages or machined areas where chips may become trapped, and cover or plug the areas as required using tape, brightly colored plastic plugs and/or plastic bags.
6. Determine the correct diameter, pitch and length for a helical coil threaded insert that will be used for repair. Determine from the insert manufacturer's data the appropriate drill size to be used.

**NOTE**

It is usually better to drill holes for tapping or installation of helical coil inserts by starting with a smaller size and gradually increasing drill diameter to finished size. **IN ALL CASES, BE CERTAIN THAT THE DRILL RUNS TRUE IN THE DRILL CHUCK OR COLLET OF THE MACHINE. DRILLS THAT ARE BENT OR DO NOT RUN TRUE WILL RESULT IN AN OVERSIZE HOLE.**

7. Drill the hole to the required size and blow out chips. Use a light cutting oil for drilling and tapping steel, bronze or magnesium. Use aluminum tapping fluid or undiluted isopropyl alcohol for drilling and tapping aluminum.

**WARNING**

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

**WARNING**

**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

**WARNING**

**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

8. Inspect diameter of drilled hole and compare to threaded insert manufacturer's data for steel or aluminum.
9. Install correct special thread tap for helical coil insert in the chuck or collet of the machine. Lower the spindle, and turn the spindle by hand so that the tap begins to tap threads squarely with the adjacent machined surface. Turn tap at least 3-4 turns in this manner.
10. Loosen chuck or collet and install a manual tap handle on the tap. Continue tapping to the proper depth, backing up the tap as required to clear chips and to remove chips from the bottom of the drilled hole so that the tap can reach the full

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depth. If necessary after tapping with a plug tap, finish tapping with a special bottoming tap. Remove the tap and clear all chips from the hole.

11. Install the correct helical coil insert into the installation tool and begin threading it into the tapped hole. Be certain that the lead thread of the insert starts squarely and does not cross-thread or skip a thread as it is being installed. Continue threading the insert into the hole until it becomes free of the installation tool sleeve. Thread in the insert until the last coil is approximately 1/2-turn below the part surface.
12. Carefully remove the installation tang (unless using tangless inserts) from the helical coil insert and ensure that it is completely removed and also that it has not lodged anywhere in the component itself.

**WARNING**  
**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

13. After cleaning threads, remove all chips and install stud or cap screw of the correct length and thread engagement length. Install appropriate heavy washers and/or spacers and nut, as required. Torque test the fastener three (3) times at 120% of the recommended assembly torque value.
14. If the repaired threads show no sign of yielding, the repair may be considered successful. Remove and discard the test fastener, and proceed with other inspections and repairs as required.
15. If the threads yield or pull, reject the component.

**NOTE**  
Other thread repair methods such as steel sleeve inserts staked with pins or tapered plugs are NOT approved. Use ONLY helical coil type inserts.

### 6.7.12.3 Stud Thread Repairs

Stud thread repairs are limited to minor nicks or damage on end threads. Repair only with localized use of a thread file of the correct thread type and pitch. Do not repair stud threads using a die or thread chaser as these will alter thread form and reduce the load carrying ability of the stud.

**NOTE**  
Whenever damage is noted on the threads of studs, inspect the associated nuts for damage as well. Discard all fasteners exhibiting deformed, rusted or galled threads.

**CAUTION**  
**DO NOT use thread files, dies or thread chasers to repair damaged threads on connecting rod bolts, crankshaft gear bolts or crankcase thru bolts or thru studs or cylinder deck studs. If damaged in any way, replace these components and associated nuts with new parts only!**

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### 6.7.12.4 Stud Replacement

1. Bent studs (with the exception of crankcase thru studs and thru bolts) may be straightened, provided that the bend is in the un-threaded portion of the stud, does not exceed 10 degrees of bend, and there are no nicks or scratches associated with the bend. Replace any stud that is bent in the threads of either end.
2. Use a collet type tool to remove studs. If necessary, the associated area of the casting may be heated with a small propane torch or natural gas torch with a flame spreader to heat the area of the casting to aid in loosening of the stud. Do not use an acetylene torch for heating as the high temperature may cause cracking or structural damage to the material.
3. Install new studs using a collet type tool in good condition. Note stud driving torque as stud is being installed, and refer to the stud driving torque limits in Section 10, Table of Limits and Tightening Torques.
4. If stud driving torque is below limits, remove stud and replace with an oversize and/or use Loctite 271. If oversize stud is not available or minimum stud driving torque cannot be achieved, repair the threaded boss using a helical coil insert per par. 6-7.12b above.

### 6.7.13 Threaded Area and Stud Repair

#### 6.7.13.1 Non-stressed Areas

Minor nicks and scratches < .03" deep on machined gasket surfaces may generally be repaired by blending with a small hand file and/or a flat steel block and 240 or 320 grit aluminum oxide paper.

1. Sand or file only enough to remove raised metal, but do not file or sand excessively if the scratch or nick will be filled with gasket sealer at assembly.
2. If necessary, lap mating surfaces on a surface plate to remove abnormal damage.
3. Clean to remove all abrasive dust and other debris. When parts are lapped, check with mating parts to verify that fits and clearances are still within tolerances. Refer to Section 10, Table of limits.

#### **CAUTION**

**DO NOT use the above procedures to repair fretting on critical surfaces such as main bearing saddle mating surfaces affected by fretting. Lapping or sanding these surfaces will result in improper bearing clearances and possible bearing and crankshaft damage.**

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### 6.7.13.2 Stressed Areas

1. For stressed areas such as crankshaft main bearing journals and crankpins, small nicks and scratches on the bearing surfaces may be dressed out by using a .19"-.25" diameter rod wrapped with a length of dull 320 grit crankshaft polishing belt. Carefully guide the rod to dress out the small nick or scratch in a localized area, but do not leave a depression greater than .0015" deep unless the crankshaft will be re-nitrided.
2. Crankshafts deeper damage may be repaired only by grinding and re-nitriding. No welding of any kind is permitted on crankshafts, connecting rods, gears or shafts.
3. For areas such as webs and reinforcement ribs between cylinder decks and main bearing saddles of crankcases, dress out nicks, scratches and minor damage up to .03" deep using a small round file and a .25" diameter rod wrapped with 240-grit aluminum oxide abrasive cloth. Length and width of the blended area must be at least 10X the depth and be free of tool marks and sharp corners or edges.
4. Aluminum and magnesium parts with deeper damage may qualify for repair by welding and machining by aircraft engine repair stations having approved process specifications and procedures.

### 6.7.14 Paint and Surface Treatment Repair

External components are designed for both high functionality and an attractive appearance which includes the use of surface treatments to resist corrosion and enhance heat dissipation. These treatments may require restoration and repair from time to time according to the procedures below.

Paint that has been lost during operation or as a result of cleaning and inspection procedures should be restored before the parts are returned to service.

Parts such as the crankcase, sump or accessory case that have been completely stripped of paint may be given a chromate conversion coating conforming to MIL-C-5541, Class 1A, prior to painting. This coating also enhances the adhesion of primer and paint.

Use paint and primer conforming to the list of materials shown in Table 6-10 below. Whenever possible, paint and primer should be applied by spraying. Primer thickness should never exceed .001", and paint should be applied in a uniform thin coat that provides complete coverage but avoids heavy coatings that may crack or sag and inhibit heat transfer.

#### NOTE

Mask all machined bosses, nut spotfaces and installed studs before painting. DO NOT apply paint to the seat areas for the base nuts on cylinder flanges. First, apply a light coating of zinc chromate primer to the flange, not to exceed .0005" thick, and allow to dry. Mask the seat areas for base nuts on the cylinder flange using tape, adhesive discs or machined metal plugs before painting the cylinder flange and barrel.

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Material	Source
Chromate conversion coatings conforming to MIL-C-5541	Commercially Available
Resin-type enamel, AMS 3125C or equivalent MIL-E-7729 (such as Randolph Black # 303)	Commercially Available
Toluene or equivalent AMS 3180 (or equivalent Federal Spec TT-T-548)	Commercially Available
Zinc chromate primer, aerosol spray preferred	Commercially Available

**Table 6-10 Paint and Surface Treatment Materials**

Clean and degrease all parts prior to surface treatment and paint procedures. Refer to Section 4 of this manual.

**WARNING**  
**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

**WARNING**  
**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

#### 6.7.14.1 Surface Treatment Repair Paint and Surface Treatment Repair

1. Aluminum parts must be clean and entirely free of oil film prior to processing. If necessary, plastic media blasting may be used to clean surfaces before processing. Refer to Section 4 of this manual. Inspect the part carefully to verify that no blasting media remain in thread bosses, passages or behind installed parts.
2. Ensure that all chromate conversion coating chemicals are within the required parameters in accordance with MIL-C-5541 and/or product manufacturer specifications.
3. Immerse the part in the processing tank and rotate or agitate slowly in order to allow air bubbles and air pockets to escape to the surface. AVOID SPLASHING.

**WARNING**  
**BEFORE MATERIALS CALLED OUT IN THIS PUBLICATION ARE USED, KNOW THE HANDLING, STORAGE AND DISPOSAL PRECAUTIONS RECOMMENDED BY THE MANUFACTURER OR SUPPLIER. FAILURE TO COMPLY WITH THE MANUFACTURERS' OR SUPPLIERS' RECOMMENDATIONS CAN RESULT IN PERSONAL INJURY.**

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**WARNING**

**USE CORRECT PERSONAL PROTECTION. SOME CHEMICAL SOLUTIONS CAN CAUSE EYE, SKIN, AND LUNG DAMAGE. FOLLOW THE MANUFACTURER'S INSTRUCTIONS FOR EACH STRIPPING SOLUTION OR SURFACE TREATMENT SOLUTION.**

4. When desired color is obtained, raise the part above the processing tank and allow chromate solution to drain from the part for approximately 15 seconds.

**NOTE**

Color may continue to darken as part drains if processing solution is near maximum concentration. Allow for this when establishing the processing time. When possible, establish processing time using a test part. Baking will also darken color considerably.

5. Rinse the part thoroughly using warm water, and air dry using fans and/or compressed air.

#### 6.7.14.2 Paint Repair

Apply paint according to the following procedures:

1. Apply one coat of zinc chromate primer. If bulk paint is used, thin with toluene; approximately two (2) parts toluene to one (1) part paint. Allow to air dry.

**NOTE**

If paint is still intact and part is simply being repainted, omit primer coat. .

2. Apply one coat of enamel. Thin enamel with toluene as required in order to produce a smooth, glossy finish. Allow part to air dry. Then bake at 200-250°F for 30-45 minutes. Remove from oven and allow to cool.

**WARNING**

**USE NECESSARY PROTECTIVE GEAR. HEATED PARTS MAY CAUSE SEVERE BURNS.**

3. Special Procedures for Painting Cylinders
  - a. Remove as much old paint as possible from cylinder heads and barrels using decarbonizing solutions and plastic media blasting as required in accordance with Section 4.
  - b. If desired, cylinder heads may be treated with chromate conversion coatings only and left unpainted.
  - c. Mask the port flanges, spark plug bosses, rocker cover gasket surface and barrel skirt. Use tape, plugs, foil, metal covers, etc. as required. See precautionary notes at Table 6-10 above.
  - d. Apply a light coating of zinc chromate primer to the cylinder flange.

**CAUTION**

**Thickness of primer on the cylinder flange must never exceed .0005". Use either a Tinsley thickness gage or a micrometer to measure the thickness of the flange before and after painting. If the primer is too thick, it must be removed and the barrel repainted.**

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- e. Mask the seat areas for the cylinder base nuts using tape, adhesive discs or machined metal plugs before painting the cylinder flange and barrel.
- f. Paint the cylinder with an enamel resin that has been properly thinned with toluene to provide a uniform spray leaving a glossy appearance. Direct the spray to coat the surfaces between the fins as uniformly as possible while avoiding a heavy buildup of paint.
- g. After painting, remove all plugs, covers and masking. Wet a cloth with toluene and clean all paint residue or overspray from the underside of the cylinder flange, the barrel skirt and the cylinder bore ID.
- h. Allow the cylinder to air dry for 15 minutes, and bake at 200-250°F for 30-45 minutes.

### 6.7.15 Accessory Case Oil Pump Boss Repair

The oil pump boss in the accessory case of may be repaired by re-machining if the surface becomes worn or scored in the gear thrust areas during engine operation. Repair according to the procedures below:

#### **CAUTION**

**Do not attempt to repair the oil pump boss surface by localized sanding, polishing, or buffing using die grinders and abrasive pads or discs. Such localized repairs will reduce the contact area necessary to support thrust loads of the gears and may increase gear side clearance and internal leakage of the oil pump. In addition, loss of flatness may allow the joint between the oil pump housing to draw air and/or leak oil and reduce engine oil pressure.**

1. Measure the depth of the oil pump boss below the gasket surface of the accessory case to determine if the area is repairable by machining. Refer to Section 10, Table of limits.
2. If the accessory case is repairable, measure the setting height of the three oil pump housing mounting studs. Remove the studs using a collet type stud driver. If the stud driver interferes with the accessory case casting at one location, triple nut this stud. Use a propane torch, as required, to warm the casting and assist with stud removal.
3. Mount the accessory case securely on the table of a vertical milling machine. Before doing so, dial indicate the head of the milling machine to ensure that it is perpendicular with the table within .0002 inch per inch.
4. Dial indicate the oil pump boss across its width and length. Using shims or by adjusting the mounting fixture, level the boss to within .001" TIR.
5. Mount a face mill or fly cutter approximately 2.0 inches in diameter and having a .03" corner radius in the spindle of the milling machine. Lower the mill or cutter onto the surface and start the machine.
6. Using aluminum tapping fluid or isopropyl alcohol as a cutting fluid, proceed to machine the oil pump boss for cleanup, removing only as much material as necessary to remove all scores and wear marks. Pay close attention to the areas

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around the mounting stud holes to ensure that machining extends past the area of contact with the oil pump housing.

### WARNING

**LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

### WARNING

**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

7. Stop the milling machine and remove the cutter. Measure the depth of the machined surface below the accessory case gasket surface to determine that maximum dimension has not been exceeded. Refer to Section 10, Table of Limits.
8. Dial indicate the machined surface in both directions to determine flatness which must not exceed .001". Roughness of machined surface must not exceed 32 micro-inches, Ra.
9. Remove the accessory case from the milling machine and blow out all chips and debris using compressed air.

### WARNING

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

10. Mark the accessory case in an area adjacent to the oil pump boss to indicate the amount of material removed. For example, if .004" of material was removed during machining, mark the accessory case M004. Mark by vibro-peening using characters .13"-.19" high.
11. Re-install studs to original setting height according to procedures of par. 6-7.12d above.
12. Place a serviceable oil pump housing, shaft and gears on the oil pump boss and install flat washers and .31-18 UNC hex nuts. Align housing for free rotation of gears. Snug nuts and again check for free rotation of gears. If there is any binding of the gears, identify and correct the problem.

### NOTE

Inspect gears before trial assembly to ensure that gear teeth are free of nicks and burrs that could score the newly machined surface of the oil pump boss.

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13. If gears rotate freely, remove the oil pump housing and gears; and proceed with other inspections and repairs of the accessory case as required.

#### **6.7.16 Sump Intake Pipe Connector Repair (Cast Style Sump)**

This repair applies only to engines equipped with a cast hot induction oil sump and induction assembly having a vertical inlet with bottom mount for the carburetor. Repair intake pipe connectors as described below:

##### **6.7.16.1 Loose or Leaking Pipe Connectors**

1. Thoroughly clean sump per Section 4 and inspect per Section 5 of this manual.
2. If intake pipe connectors are slightly loose or leaking, they may be repaired by re-swaging.
3. Warm sump in an oven to approximately 125° F. Remove the sump from the oven and stand the sump vertically with the loose intake pipe connector pointing up. Apply Loctite no. 271 or 290 around the connector and allow it to wick into the joint.
4. Re-swage the connector using a special swaging tool such as Lycoming tool P/N 64781, or equivalent.
5. Allow Loctite to cure for at least one hour.
6. Plug intake pipe connectors with hard rubber stoppers or expansion plugs. Fabricate a cover plate to fit the inlet flange. Drill and tap the cover plate for suitable threads in order to connect a small hand operated air pump such as a bicycle tire pump with accurate pressure gage to the plate. Secure the plate onto the sump using a new gasket, flat washers and hex nuts.
7. Operate the pump to pressurize the induction passages to 1-2 PSI. Check for leaks at the intake pipe connectors, and re-swage or replace connectors as required.

##### **6.7.16.2 Damaged Intake Pipe Connectors**

1. If connectors are damaged, or if they cannot be properly tightened by re-swaging, remove the connector(s) by caving in one side so that the connector can be collapsed sufficiently to be removed from the sump bore.
2. Inspect the sump bore for damage, and measure inside diameter at several points using a telescoping gage and calibrated 1-2" outside micrometer. Refer to Section 10, Table of Limits for bore diameter.
3. If bore is within limits, fabricate a tool to install a new intake pipe connector. Make the tool from 1.80" diameter cold rolled steel bar approximately 3.5 inches long. Machine a pilot 1.665" diameter x 2.0" long.
4. Coat the ID of the sump bore and the OD of a new connector with Loctite 271. Holding the sump securely, place the connector on the installation tool and drive squarely into the sump bore until fully seated.

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**WARNING**  
**WEAR SAFETY GOGGLES OR A FACE SHIELD. USE OF A HAMMER MAY PRODUCE LOOSE PARTICLES OR CHIPS THAT CAN CAUSE CUTS TO THE SKIN AND EYE DAMAGE.**

5. Swage the connector and test for leaks following Steps 4-7 above.

**6.7.17 Crankshaft Flange Plating Repair**

Crankshaft flanges are tin plated in order to prevent corrosion. If the tin plating is worn through, or if the oil seal journal has been repaired by polishing or grinding, the flange area may be re-plated according to the procedures below.

1. Perform any necessary repairs to the oil seal journal per Repair No. 6-7.7 above.
2. Thoroughly clean the crankshaft to remove all traces of sludge, grease, oil and paint.

**WARNING**  
**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

**WARNING**  
**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

3. If removed, re-installed the propeller flange bushings in the correct locations.
4. Cover all oil holes in the crankshaft with plastic electrical tape. If crankshaft has a rear plug installed inside the front main journal, tape or plug the 1.06" diameter lightening hole on the #1 crank cheek aft of the plug. Install a plug in the 1.88 or 1.31 front main ID of the crankshaft aft of the 2.00" ID of the flange pilot. Cover both of the cross-tube holes in the front main of the crankshaft.
5. Remove all old plating from the crankshaft by blasting with glass beads using a maximum 60 PSI air pressure in a glass bead cabinet.
6. Remove all glass beads and blasting residue from the crankshaft with compressed air.
7. Remove all plugs and tape and thoroughly wash the crankshaft in clean solvent to remove all traces of glass beads and blasting residue. Take special precautions to clean the area on the aft side of the rear plug inside the front main ID of the crankshaft, if installed.

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8. Dry the crankshaft with compressed air, and place the crankshaft in an oven and bake at 200°F for approximately one (1) hour to remove all traces of solvent and oil. Remove crankshaft from oven and allow to cool. Chemically clean the crankshaft as required according to approved electroplating procedures, and plate the oil seal journal and flange area from the front side of the oil slinger forward.

**WARNING**  
**USE NECESSARY PROTECTIVE GEAR. HEATED PARTS MAY CAUSE SEVERE BURNS.**

9. Polish the seal journal area with a dull 320-grit crankshaft polishing belt or crocus cloth to smooth the surface after blasting.

**WARNING**  
**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

10. Chemically clean the crankshaft as required according to approved electroplating procedures, and plate the oil seal journal and flange area from the front side of the oil slinger forward.
11. Plate crankshaft with tin per AMS 2409 or with cadmium per AMS 2400, .0002"-.0005" depth. After plating, bake at 275-300° F, 5-8 hours at temperature.
12. After plating, inspect crankshaft to verify that no plating has been deposited on any bearing journal or thrust surface. If any plating is found, hand polish with no. 7447 Scotchbrite abrasive pad until all traces of plating are removed.
13. Apply preservative oil to all surfaces of the crankshaft and place inside a clean plastic bag until ready for reassembly.

### 6.7.18 Crankshaft Front Main ID Repair

Crankshafts have been designed to resist corrosion pitting inside the front main ID just aft of the prop flange pilot journal. From the factory, these crankshafts are coated with a zinc-rich anti-corrosion coating, Urethabond no. 104. During cleaning, overhaul and inspection of the crankshaft it is necessary to remove this paint so that the crankshaft may be inspected and repaired as required according to the procedures below:

1. If the Urethabond 104 paint has not been removed by cleaning and decarbonizing process, set the crankshaft up in a large engine lathe and steady rest. Use hard copper inserts (such as sections cut from scrap connecting rod bushings) to cover the lathe jaws to prevent damage to the rear main bearing journal of the crankshaft.
2. Rest the front main bearing journal of the crankshaft in a steady rest, but do not run the supports of the steady rest directly on the bearing surface of the crankshaft. Instead, place two heavy wall main bearing inserts on the crankshaft main bearing so that the tangs are nearer the flange end of the crankshaft. Install a worm drive hose clamp around the bearings on the side opposite the flange of the crankshaft flange. Oil the bearing through the holes and slide it into place so that it is clear of the fillet adjacent to the thrust collar on the front main bearing of the crankshaft. Position the

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bearing with the split line horizontal, and position the steady rest so that the support fingers contact the bearing but not the hose clamp.

3. With the tailstock center snugly resting in the machine center of the flange pilot to center the crankshaft, tighten the two lower support fingers of the steady rest uniformly and evenly to gently support the bearing inserts against the crankshaft with no clearance. Gently tighten the top steady rest finger against the bearings until slight resistance to rotation of the crankshaft can be felt. Back off the top steady rest finger very slightly until resistance is not longer felt. This will allow the crankshaft to run in the bearings smoothly with no clearance or vibration and no heat buildup.
4. Tighten the lathe chuck securely, and slide the tailstock away from the crankshaft flange. Place a dial test indicator against the flange face and run the crankshaft at approximately 125 RPM for about 30 seconds. Note the reading on the indicator. If it remains steady and does not climb, the crankshaft is centered in the steady rest; and work may proceed. If the reading of the dial indicator begins to climb, the crankshaft is not centered in the steady rest and is "walking" out of the chuck. Repeat setup of the steady rest until crankshaft is stable.
5. As repairs proceed, periodically lubricate the bearing by adding a few drops of SAE 50 oil or oil/STP mixture to the oil holes in the bearings. If bearings begin to heat up, the top finger of the steady rest must be loosened very slightly to add a slight amount of clearance.
6. Using a heavy duty boring bar with a cutting tool having a .06"-.09" radius, proceed to machine out the Urethabond paint from the ID of the crankshaft without removing more than the minimum amount of steel required to remove the paint. Machine to a depth of 3.5-4.0 inches aft of the forward edge of the flange pilot journal.

### WARNING

**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

7. Stop lathe and measure ID of front main journal. Compare to Section 10, Table of Limits, and Figure 6-11. If beyond limits, reject crankshaft.
8. Inspect the crankshaft ID for the presence of corrosion pits using a small bright flashlight and a small mirror such as a dental mirror. If pits are noted, proceed to machine the crankshaft ID to remove the pits. If pits cannot be removed without exceeding maximum ID of the crankshaft (see Table of Limits), the crankshaft must be rejected.
9. When machining is complete, remove the crankshaft from the lathe, blow out all chips and wash thoroughly to remove all oil and grease.

### WARNING

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

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**WARNING**

**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

10. Perform a magnetic particle test on the front main ID in accordance with par. 5-11.2 of this manual. Magnetize and inspect with both longitudinal and circular fields. Reject crankshaft if any indications of cracks or forging inclusions are noted on the crankshaft ID.
11. If no cracks are noted, demagnetize and clean crankshaft. Proceed with other repairs and inspections as required.
12. If crankshaft flange is to be re-plated, this should be accomplished prior to Step 13.
13. Clean crankshaft to remove all traces of oil from the front main ID. Use a 4" long nap paint roller such as Worktools International #54011 mounted on a ¼" rod to apply one coat of Urethabond 104 paint to the ID of the crankshaft to a minimum depth of 3.50" from the step inside the flange pilot. Coverage must be thin but 100%.
14. Allow to air dry 45 minutes, and apply a second coat of Urethabond 104 over the first coat. Again, coverage must be 100%.
15. If not already present or visible, metal stamp or vibro-peen the letters "PID" (i.e., "Painted ID") on the edge of the propeller flange.
16. Allow paint to air dry for at least four (4) hours at 75° F before exposing to moisture, solvents or oils. If humidity is high and or ambient temperature is below 75° F, allow to dry overnight.

#### **6.7.19 Idler Gear Bushing Repair**

Idler gears, P/N AEL72231, AEL74996 and AEL75072 are an assembly made of a forged steel gear with carburized teeth and a hard copper bushing, AEL77309, this is finished after assembly. If the bushing becomes worn, scored or damaged, it may be replaced according to the repair procedures below:

1. Fabricate a bushing driver of cold rolled steel bar approximately .680" OD x 3.5" long. Machine a pilot .623" diameter x .50" long. Chamfer the end 45° x .03". The step between the pilot diameter and the full diameter of the too must be a sharp 90° corner.
2. Place the support block for rocker arm bushing removal (see Repair No. 6-7.9 above) on the table of an arbor press and centered under the ram of the press. Place the gear on the support block and centered with the hole in the block. Place the bushing driver in the bushing of the gear.
3. Press the bushing out of the gear. Polish and inspect the ID of the gear. Remove any nicks or burrs on the ID of the gear. Measure the ID of the gear, and compare to the new parts diameter per Section 10, Table of Limits.
4. Lightly oil the ID of the gear and the OD of a new bushing. Place the gear on a solid portion of the support block and place the bushing into the chamfer of the center hole

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in the gear. Gently lower the ram of the press onto the bushing to square it up against the ram. Press the bushing into the gear until the ram contacts the gear.

5. Fabricate a bushing seating tool from .680" diameter cold rolled steel bar x approximately 1.0" long. Machine the ends flat with a minimum edge break. Place the bushing seating tool on the end of the bushing, and press the bushing slightly deeper into the gear until it is centered between the thrust faces of the gear bore.
6. Fabricate a machining fixture for either a milling machine or a lathe that will locate the gear so that the tops of the gear teeth and the faces of the gear teeth will have .001" TIR, maximum.
7. Bore the bushing ID to finished diameter and a surface roughness of 32 micro-inches, Ra maximum. Refer to Section 10, Table of Limits for new parts diameter for finished bushing.

**WARNING**  
**USE THE CORRECT PERSONAL PROTECTION PARTICLE MASKS OR RESPIRATORS AND SAFETY GOGGLES. MACHINING, POLISHING OR GRINDING MAY PRODUCE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.**

8. Remove gear from machining fixture, break edges of bushing and inspect pitch diameter runout of gear teeth to verify concentricity of bushing. Refer to Section 10, Table of Limits for new parts diameter for finished bushing.
9. Apply preservative oil to gear and place in clean plastic bag until ready for assembly.

### 6.7.20 Crankshaft Expansion Plug Installation

CC340 engines that will operate with fixed pitch propellers require installation of a new front expansion plug after cleaning, inspection and repair of the crankshaft. Install and seat this plug according to the repair procedures below.

1. Fabricate a plug seating tool of tool steel. Machine the head of the tool to approximately 1.90" diameter x .75" long with an integral knurled handle approximately .88" diameter x 6.0" long. Chamfer ends 45° x .06". Heat treat tool to approximately HRc 50-56.
2. If the crankshaft previously operated in an engine having a constant speed propeller, drill a .19" diameter hole in the center of the rear plug. Ensure that all chips are removed from the crankshaft, especially on the aft side of the plug.

**WARNING**  
**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

3. Clamp the crankshaft in a large bench vise with soft (copper, brass, aluminum) jaws gripping only the sides of the #1 crankcheek. Refer to the Figure for plug removal at paragraph 4.4.6.19.

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4. Apply a smooth, continuous bead of Tite Seal No. 2 gasket sealer at the step between the 2.00" ID of the prop flange pilot journal and the 1.88" ID of the crankshaft front main journal.
5. Place a new expansion plug into the crankshaft pilot journal ID, and ensure that the plug is resting squarely against the step in the crankshaft. If necessary, use a magnet to help position the plug in the bore. The plug must be installed with the convex side out.
6. Place the head of the plug seating tool against the plug. Using a large ball-peen hammer against the plug seating tool, proceed to seat the plug by flattening the convex shape which causes the plug to expand.

**WARNING**  
**WEAR SAFETY GOGGLES OR A FACE SHIELD. USE OF A HAMMER MAY PRODUCE LOOSE PARTICLES OR CHIPS THAT CAN CAUSE CUTS TO THE SKIN AND EYE DAMAGE.**

7. Using a depth gage or dial caliper and straightedge placed across the front of the crankshaft pilot, measure the depth of the plug at its edges and across the formerly convex portions. Plug is properly seated when the convex portion rises no more than approximately .030" above the edges of the plug. **DO NOT FORCE THE PLUG INTO A CONCAVE SHAPE, OR IT WILL BECOME LOOSE.**
8. Remove excess sealer using a shop towel and isopropyl alcohol.

**WARNING**  
**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

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## Section 7 ENGINE ASSEMBLY

### 7.1 General Information

This section provides standard procedures, materials and tools for the assembly of the Cub Crafters CC340 engine. Prior to beginning engine assembly, the engine assembler should review Section 3, Standard Practices, in this manual. Refer to Section 10, Table of Limits and Torque Values, for specific information on part dimensions, clearances and recommended torque values for general use as well as specific fasteners.

**NOTE**

Limits followed by a letter "T" indicate "tight", or interference, fit such as a valve seat or valve guide in a cylinder head. Where no "T" exists, the fit is a clearance dimension such as the clearance between a piston skirt and a cylinder bore.

Verify that all necessary parts, tools and materials are available and suitable for use before beginning engine assembly. To ensure that only correct parts are installed during assembly, refer to CCI's master drawing list for the CC340 engine.

To assist the assembler in determining that nothing has been omitted during the assembly process, Appendix 7-1 provides In-Process Inspection Checklists for use at various stages of assembly.

### 7.2 Required Assembly Materials

Materials required for assembly are listed in Table 7-1 below.

Material	Source
Acetone or Methyl Ethyl Ketone (MEK)	Commercially Available
Assembly Grease – Lubriplate™ No. 105	Commercially Available
Isopropyl Alcohol, undiluted	Commercially Available
Cleaning Solvent	Commercially Available
Copper Based Anti-seize, Fel-Pro™ C5-A	Commercially Available
Henkel Loctite™ Food Grade Anti-Seize Compound	Commercially Available
<b>Loctite™ no. 241</b>	Commercially Available
<b>Loctite™ no. 272</b>	Commercially Available
Loctite™ No. 2 Gasket Sealant	Commercially Available
Oil, Aviation Grade (Mineral, Non-detergent)	Commercially Available
Permatex™ P/N 27100	Commercially Available
<b>Permatex Aviation Form-A-Gasket No. 3 Sealant</b>	<b>Commercially Available</b>
Pre-Lube Oil Mixture – approx. 15% STP™ and 85% SAE 50 Aviation Oil	Mixed Locally
RTV™ 102 Silicone Sealant	Commercially Available
RTV™ High Temp Orange Sealant	Commercially Available
Safety Wire (0.032 in.) Type 304 Stainless, P/N MS20995 C32	Commercially Available
Safety Wire (0.041 in.) Type 304 Stainless, P/N MS20995 C41	Commercially Available
Silk Thread, 00 or #50 (100% Silk)	Commercially Available
STP™ High Viscosity Oil Treatment	Commercially Available
Titeseal™ No. 2 Gasket and Joint Compound P/N T2-01	Commercially Available

**Table 7-1 Assembly Materials**

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**NOTE**

Equivalent substitutes may be used for listed items.

### 7.3 Special Tools and Equipment

Special tools and equipment required for assembly are listed in Table 7-2 below.

**NOTE**

Equivalent substitutes may be used for listed items. Unless otherwise specified, standard reciprocating engine aviation shop tools and equipment are used.

DESCRIPTION	SOURCE
Compressor, Valve Spring & Bar	Commercially Available
Piston Ring Expander	Commercially Available
Driver Set, Oil Seal	Commercially Available
Puller, Slide Hammer – Medium	Commercially Available
Socket, Connecting Rod Nut, 9/16" hex	Commercially Available
Stand, Engine	Commercially Available
Tool, Crankcase Separating	Commercially Available
Tool, Intercylinder Baffle	Commercially Available
Cylinder Base Nut Wrenches, 3/4" and 9/16"	Commercially Available
Piston Ring Grinder	Commercially Available
Piston Ring Compressor	Commercially Available
Crankshaft Oil Seal Installation Tool	Commercially Available
Internal Retaining Ring Pliers	Commercially Available

**Table 7-2 • Special Tools and Equipment**

### 7.4 Engine Assembly Precautions

Engine assembly involves the use of a number of tools, materials and operations that could pose a risk to health and safety unless proper precautions are observed. The assembler is advised to review general warnings in Section 1 of this manual, to observe specific warnings in this section, and to ensure that all necessary safety equipment is readily available and in use.

**WARNING**

**BEFORE MATERIALS CALLED OUT IN THIS PUBLICATION ARE USED, KNOW THE HANDLING, STORAGE AND DISPOSAL PRECAUTIONS RECOMMENDED BY THE MANUFACTURER OR SUPPLIER. FAILURE TO COMPLY WITH THE MANUFACTURERS' OR SUPPLIERS' RECOMMENDATIONS CAN RESULT IN PERSONAL INJURY.**

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**WARNING**

**LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

**WARNING**

**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

**NOTE**

Unless otherwise specified, all torque values listed for nuts, bolts, and screws are based upon the use of the proper thread lubricant or anti-seize compound.

**NOTE**

Unless otherwise specified, all gaskets are installed dry.

### **7.5 Preparation of Crankcase for Assembly**

- 1) Place crankcase halves on a clean workbench. Blow off all surfaces of the case halves using clean, dry compressed air.

**WARNING**

**COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES. WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

- 2) Inspect for handling damage or any physical damage such as slight nicks, burrs and scratches on mating surfaces, bearing bores, thrust faces, cam bores and lifter bores. Inspect crankshaft seal bore for evidence of wear. Verify that alignment dowels are both in place.
- 3) Inspect threads of studs for damage, corrosion or foreign matter.
- 4) Inspect main bearing bores and cam bores (particularly if the crankcase has been overhauled and/or welded) to see that all necessary oil passages are present and open.
- 5) Inspect tang slots in main bearing saddles for deformation and wear.
- 6) Inspect installed height of bearing dowels in all main bearing saddles. Verify that dowels are secure and at the correct height of .070"-.090" above the bearing bore surface. Refer to Figure 7-1.
- 7) Inspect oil galleries in each crankcase half to ensure they are clean and that all oil holes to bearing saddles and lifter bores are open and intersect properly. Compressed air may be used.

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- 8) Lightly oil both sides of center and rear main bearing inserts, and install center and aft main bearings in case halves.

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- 9) Apply a light coat of pre-lube oil to ID of front main bearings (Refer to Figure 7-2a) and install on crankshaft. Carefully lower crankshaft and front main bearings into right crankcase half. If so equipped, install a thrust washer half in the machined recess of the rear crankcase thrust face.
- 10) Insert P/N SC50203-001 or VP7004-002 into oil galley passage until plug bottom outs against far side. Carefully peen edge of oil galley passage hole to secure plug; thus preventing it from backing out of oil galley passage. See Figure 7-2b.
- 11) Push crankshaft forward against the thrust face or thrust washer. Using a feeler gage, check clearance between the front thrust face and the crankshaft and between the oil slinger and the seal retaining lip of the crankcase. Refer to Section 10, Table of Limits for required clearances. Record actual clearances.
- 12) Rotate crankshaft 360 degrees when in the full-forward and full-aft position to ensure that there is adequate clearance between the crank cheeks and crankcase.
- 13) Repeat steps 9-11 in the left crankcase half and record clearances.

**NOTE**

The front main bearing splits on the horizontal centerline of the engine (at 90° to the split line of the crankcase).

**CAUTION**

**Be sure that front main bearings properly engage dowels in crankcase half and that bearings seat completely in the main bore.**

- 14) Carefully lift crankshaft and front main bearings from left crankcase half. Ensure that bearings do not fall or become damaged during removal.
- 15) Remove front main bearings from crankshaft and install in left crankcase half making sure that bearings properly engage the two dowels and seat completely in the main bore.
- 16) Apply reference marks to the bearings and crankcase as shown in Figure 7-9. Remove bearings and place in bag to keep clean until final assembly.
- 17) Lightly lubricate camshaft bearings in crankcase, and temporarily install the camshaft and rotate in each crankcase half. Using a feeler gage, measure and record the end clearance in each half. Refer to Section 10, Table of Limits in this manual.

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- 18) Check 1/16-NPT and 1/8-NPT threaded areas of crankcase oil galleries. Install 4 each 1/16-NPT socket head pipe plugs and 5 each 1/8-NPT socket head pipe plugs, (Figure 7-5), using Tite Seal™ thread sealant. Torque plugs to 40 in-lbs.
- 19) Install a 1/4-NPT pipe plug in the boss leading to the front main bearing saddle just forward of the #1 cylinder pad. Use Tite Seal™ thread sealant and torque plug to 85 in-lbs.
- 20) Install piston cooling nozzles using Loctite™ 271 (Refer to Figure 7-5). Torque nozzles to 100 in-lbs.

If piston cooling nozzles will not be used, install 1/16-NPT plugs, MS27769-1, in place of nozzles. Oil threads and torque plugs to 40 in-lbs.

### 7.6 Preparation of Crankshaft for Assembly

- 1) Visually inspect crankshaft for handling damage, scratching or scoring on bearing surfaces, oil slinger, seal journal and thrust faces.
- 2) Measure and record main journal and crankpin dimensions with 2-3" calibrated micrometer. Dimensions must be within limits per Section 10, Table of Limits, in this manual.
- 3) Inspect gear bolt threads, dowel and condition of threads in prop flange bushings.
- 4) Verify that rear plug inside front main bearing ID is not installed. (this is only used for C/S props) Install a new expansion plug in the front of the crankshaft in accordance with Repair No. 6.7.20.
- 5) Remove spring from new crankshaft oil seal (Refer to Figure 7-2). Apply pre-lube oil mixture to the crankshaft propeller flange and I.D. of oil seal. Install oil seal with flat side out to prop flange. Use tool to carefully stretch seal over flange.
- 6) Install spring around crankshaft oil seal journal and ensure that ends are fully engaged. Re-install the spring in the seal groove.
- 7) Clean oil from the prop flange.
- 8) Apply a few drops of oil to the crankshaft oil seal journal, and slide the seal forward toward the crankshaft flange.

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- 9) Install and secure the crankshaft to a vertical support stand.
- 10) Inspect the crank gear (1, Figure 7-3), for defects. Measure the mounting flange diameter of the gear using a 2-3" calibrated micrometer and compare to Section 10, Table of Limits. Inspect screw (15) and lock plate (10) for defects. These parts must be new at each assembly.

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- 11) Lightly lubricate the OD of the gear and place it into the crankshaft counter bore. Using a ball-peen hammer a brass drift approximately .63" diameter, carefully tap the gear flange so that it begins to enter the crankshaft counter bore. Be certain that the gear is aligned with the dowel and that it enters the counter bore squarely. Progressively tap the gear around its circumference until it is fully seated in the crankshaft counter bore.

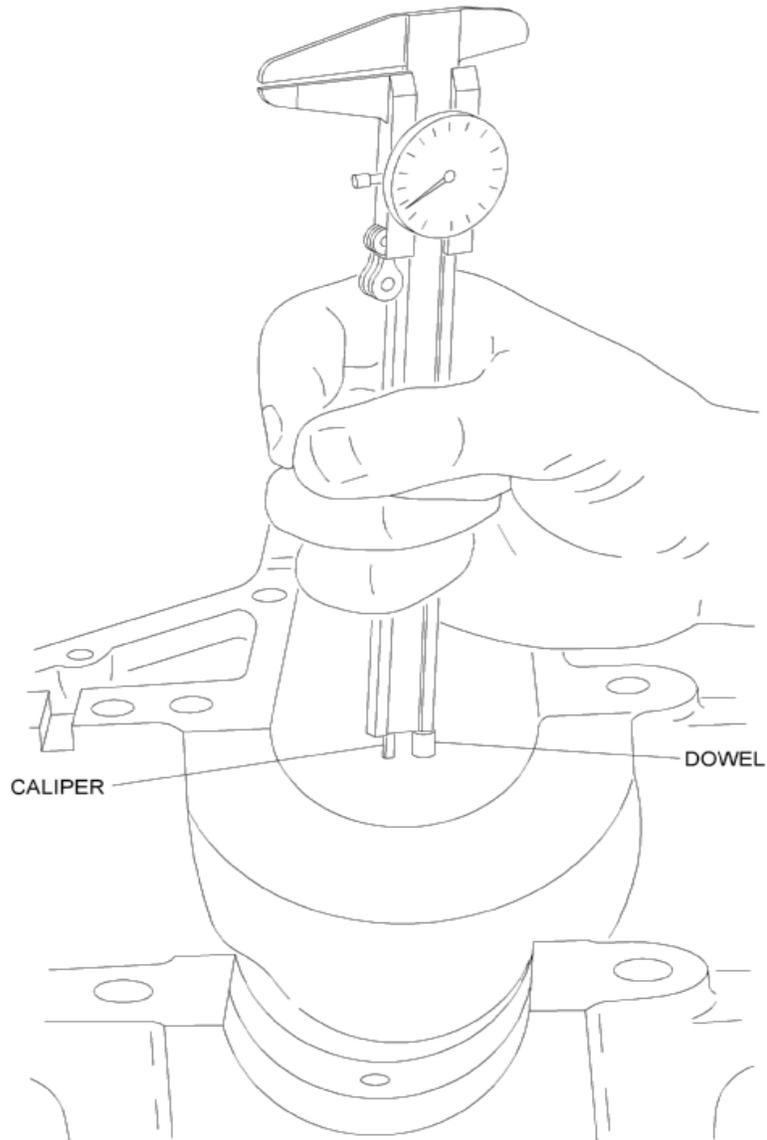
### WARNING

**WEAR SAFETY GOGGLES OR A FACE SHIELD. USE OF A HAMMER MAY PRODUCE LOOSE PARTICLES OR CHIPS THAT CAN CAUSE CUTS TO THE SKIN AND EYE DAMAGE.**

- 12) Lubricate the threads of the bolt with Food Grade Anti-Seize compound, and turn the bolt into the crankshaft using a speed handle to spread the anti-seize lubricant. Remove the bolt and apply a fresh light coating of anti-seize to the threads. Place a new lock plate on the bolt and install the bolt and lock plate in the crankshaft gear. Torque bolt to 125 in-lb, and inspect for clearance between the gear flange OD and the crankshaft ID using a .001" feeler gage. The clearance must not exceed .0005" at any point. Tap the gear lightly with the hammer and brass drift to ensure that the gear fits evenly in crank recess, aligns with dowel, and sits flat when the bolt is torqued. Check for clearance between the gear mounting face and the mounting face of the crankshaft at each of the three scallops in the gear using a .001" feeler gage. **NO CLEARANCE IS PERMITTED.** The gear should have a solid sound when tapped with the brass drift. If these inspections are satisfactory, proceed with final assembly.
- 13) Torque crankshaft gear bolt (15) to 204 in-lb. Tap the head of the bolt several times with the hammer and brass drift and again torque to 204 in-lb. Check torque 2-3 times to ensure that lock plate has fully yielded to the clamping force of the bolt. When the bolt no longer rotates at 204 in-lb, bend the tab of the lock plate securely against the flat on the side of the bolt head that is best aligned with the tab.

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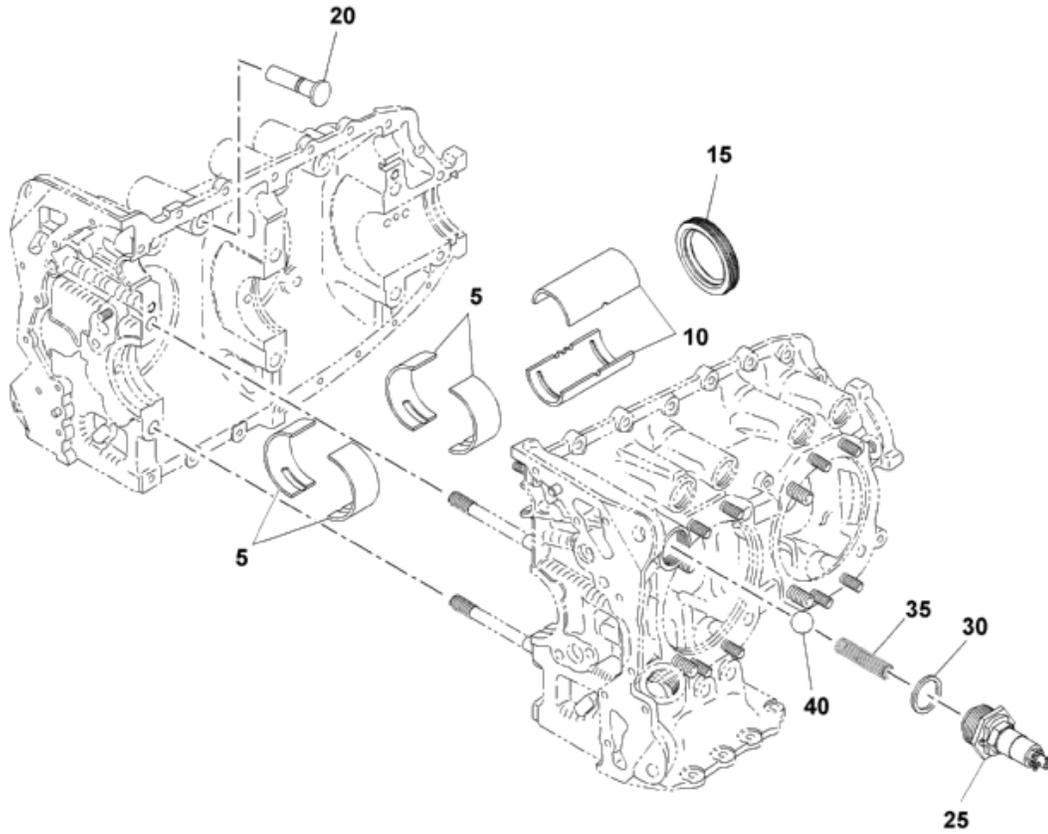
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**Figure 7-1 Main Bearing Dowel Height (typical)**

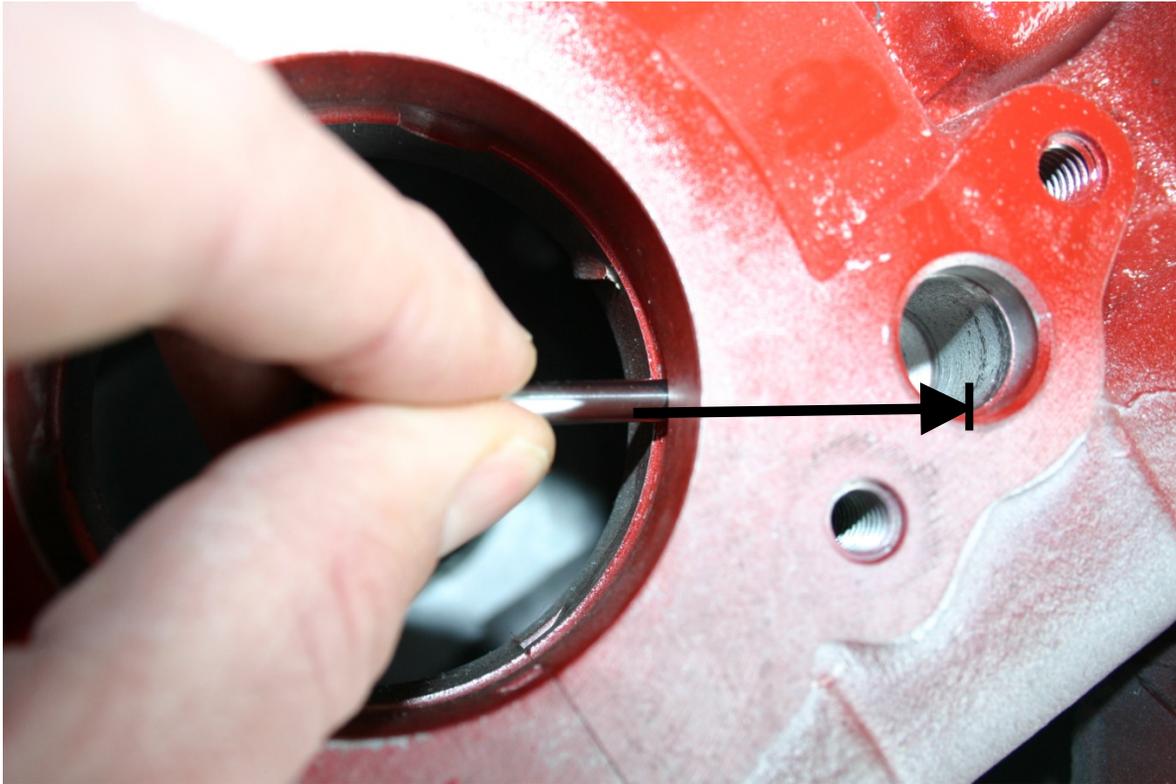
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ITEM NO.	DESCRIPTION
5	MAIN BEARINGS
10	FRONT MAIN BERRINGS
15	SEAL, CRANKSHAFT OIL
20	LIFTER BODY
25	VALVE ASSEMBLY - OIL RELIEF
30	COPPER GASKET
35	SPRING
40	BALL

**Figure 7-2a Main Bearings, Crankshaft Oil Seal and Oil Pressure Relief Valve**



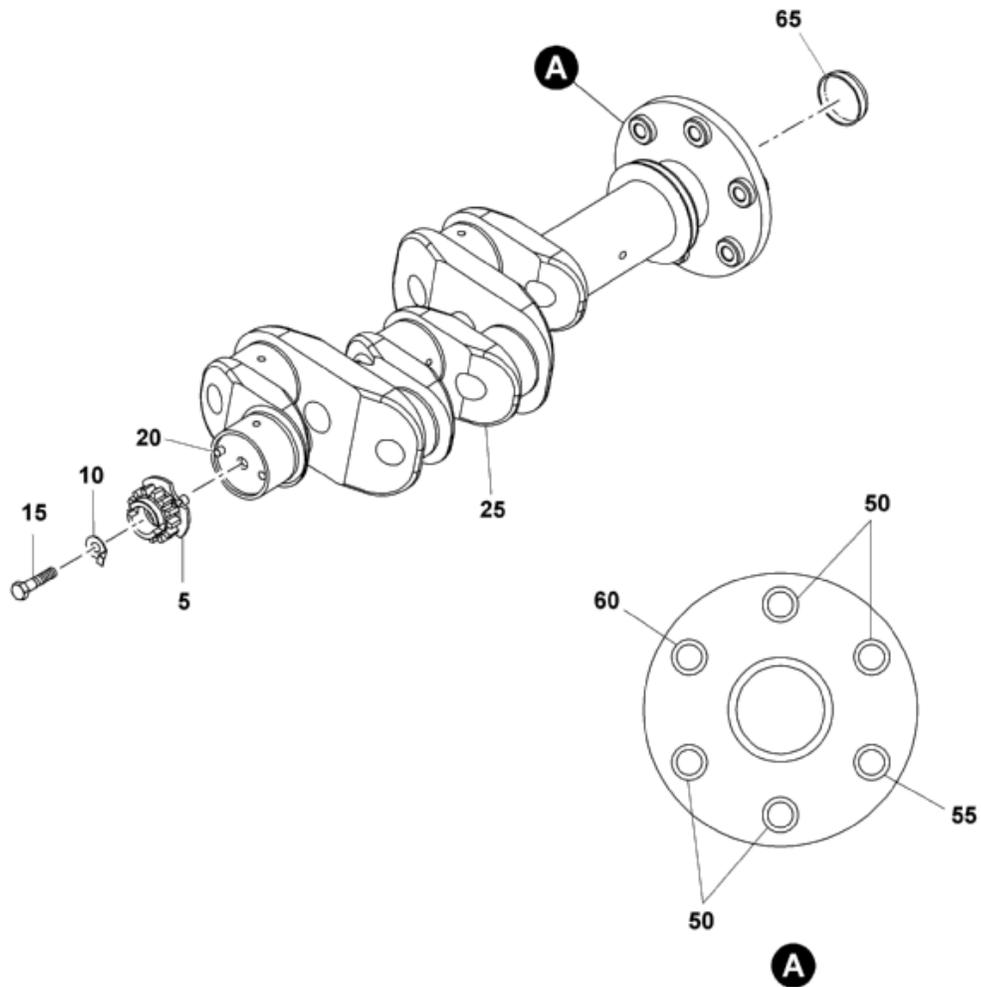
**Figure 7-2b Crankcase Plug Installation for Right Idler Gear**

Insert P/N SC50203-001 (Pin) into oil galley passage until plug bottoms out against far side (see arrow) or screw VP7004-002 (Plug) until secure.

Carefully peen edge of oil galley passage hole to secure pin (SC50203-001); thus preventing it from backing out of oil galley passage. Peening is not required when VP7004-002 (Plug) is used.

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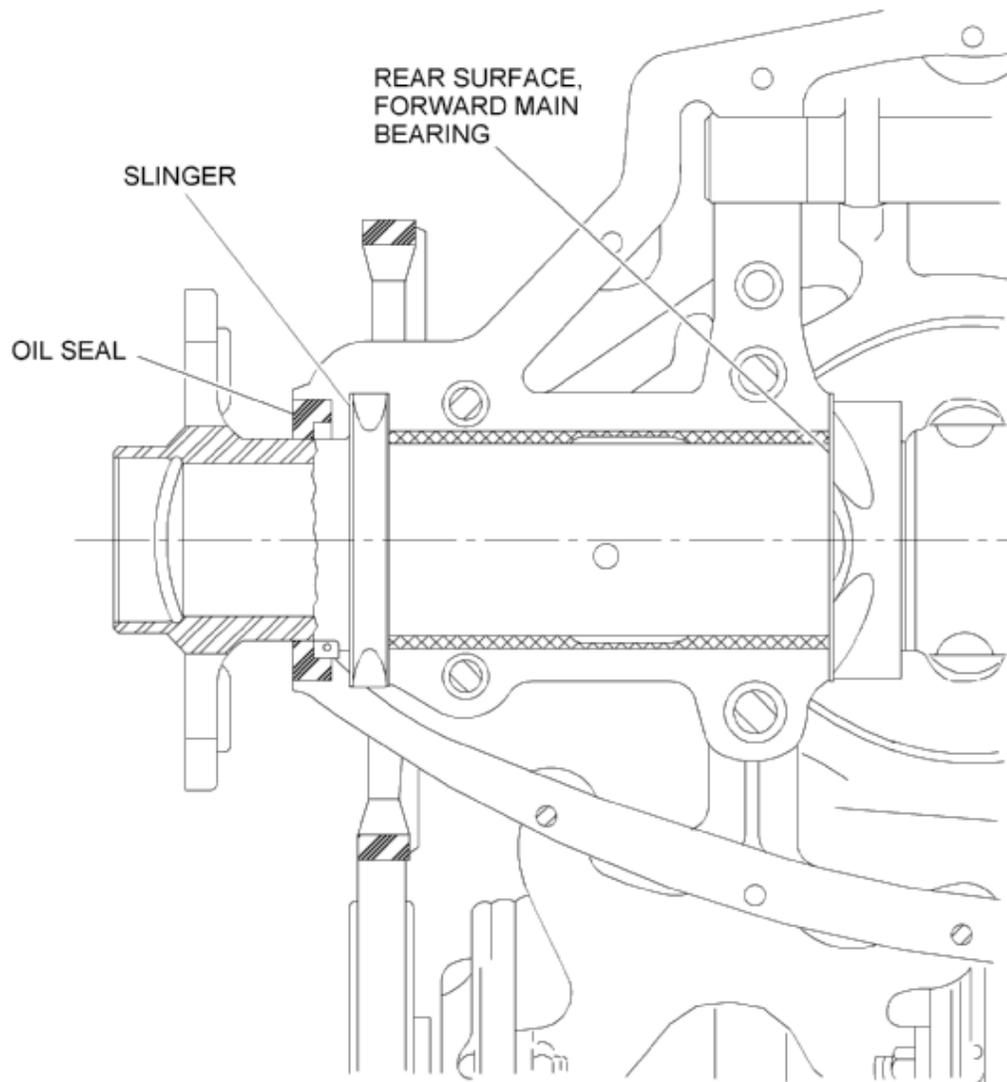


- 5. GEAR - CRANKSHAFT
- 10. LOCKPLATE
- 15. SCREW
- 20. DOWEL - STEPPED
- 25. CRANKSHAFT ASSY
- 50. BUSHING - LONG
- 55. BUSHING - INDEXED
- 60. BUSHING - SHORT
- 65. PLUG - EXPANSION

**Figure 7-3 Crankshaft Assembly and Gear**

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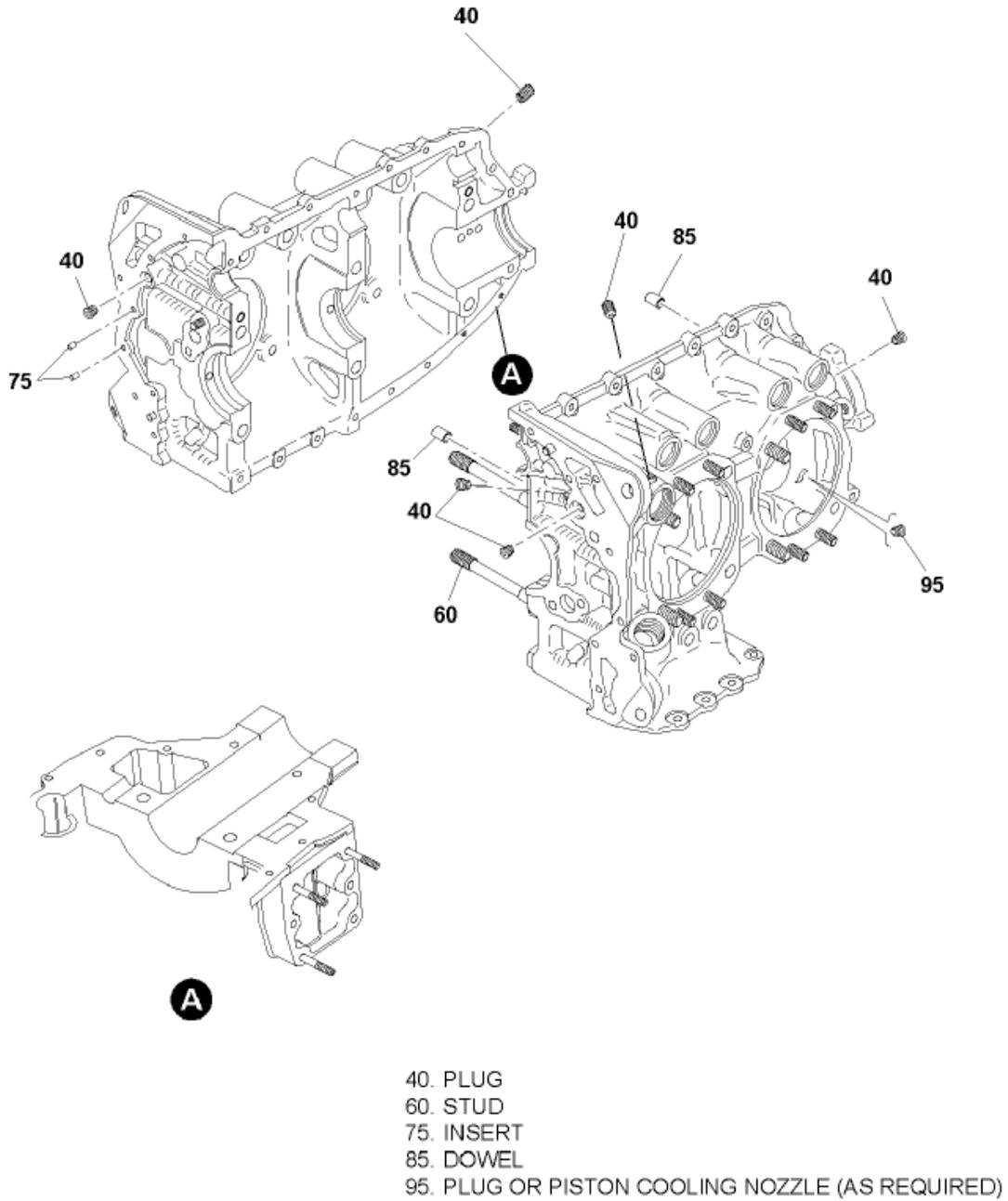
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**Figure 7-4 Crankshaft Thrust and Oil Slinger Clearance**

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**Figure 7-5 Crankcase Assembly Detail Parts**

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## 7.7 Preparation of Connecting Rods for Assembly

- 1) Visually inspect the rod assembly (5, Figure 7-6) for handling damage, defects, and corrosion.
- 2) Inspect the big end ID and rod/cap mating surface. These must be smooth and free of burrs.
- 3) Verify correct rod part number and serial/match number for each rod and cap.
- 4) Check each piston pin (35) in each rod bushing. Pins must slide freely through the bushing.
- 5) Weigh each rod and cap assembly with bolts and nuts, and record weight.

**NOTE**

Rod weight differences must not exceed 2 grams in opposing pairs.

## 7.15 Assembly of Connecting Rods on Crankshaft

- 1) Verify that rod bolts and nuts (10 and 15, Figure 7-6) and bearings (1) are the correct part number and size (for bearings). Visually inspect threads of bolts and nuts to verify that they are clean and free of defects. These parts must be new at each assembly.
- 2) Lightly lubricate bolt shanks with pre-lube oil. Lubricate threads with Food Grade Anti-Seize compound.

**WARNING**

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- 3) Lightly lubricate the ID of each rod and cap, and install a new rod bearing shell (1) in each rod and cap.
- 4) Apply pre-lube oil to the bearing surface.
- 5) Apply pre-lube oil to the crankpins and thrust areas of the crankshaft.
- 6) Insert two rod bolts through the bolt boss of each connecting rod.
- 7) Carefully assemble a rod and cap on each crankpin. **DO NOT ALLOW BOLT THREADS TO CONTACT THE CRANKPIN AS RODS ARE ASSEMBLED.**
- 8) Install connecting rods in opposed pairs having the closest weight match; that is #1 and #2 as an opposed pair and #3 and #4 as an opposed pair. Visualize the crankshaft as if #1 and #2 crankpins were at TDC position. Install rods on #1 and #2 crankpins so that the rod/cap match numbers or cylinder location numbers would face the bottom of the engine (away from the camshaft). Install rods on #3 and #4 crankpins as if these were at BDC, again so that the rod/cap match numbers or cylinder location numbers would face the bottom of the engine (away from the camshaft). Refer to Figure 7-7. Install with serial numbers in same plane and down towards oil sump.

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- 9) Install the nuts with flat side to the connecting rod or cap, as applicable. Refer to Figure 7-7. Snug both nuts using a speed handle, and rotate rod to check for proper fit. There should be no binding.
- 10) Tighten each rod nut to 240 in-lb torque. Tighten each rod nut to 480 in-lb. torque. Again check for free rotation. Double-check each nut several times.
- 11) Using clean feeler gages, measure and record connecting rod-to-crankshaft side clearance. Clearance must be within limits per Section 10, Table of Limits, in this manual.

### 7.16 Assembly of Crankcase and Crankshaft

- 1) With crankcase halves lying on bench with interior sides up, ensure that center and rear main bearings (5, Figure 7-2a) are installed and lubricated with pre-lube.
- 2) Lubricate lifter bores in crankcase halves and shanks of lifter bodies (20), and install bodies in case halves.
- 3) Verify that tachometer shaft centering spacer (15, Figure 7-8) is installed in camshaft. Install tachometer shaft and pin assembly (15 and 20) in camshaft (5), and secure with circlip (25). Ensure that the circlip has its sharp edge facing out and that it is fully seated in the camshaft groove.
- 4) Apply a liberal coating of Molyshield grease to faces of all lifter bodies and the camshaft lobes. Apply cam pre-lube liberally to tappet (20) faces and camshaft lobes.
- 5) Place camshaft assembly (5) on bench beside case halves.
- 6) Clean mating surfaces of both case halves, including nose seal area, with acetone or MEK.
- 7) Clean nose seal OD with acetone or MEK.

**WARNING**  
**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

- 8) Lubricate surfaces of front main bearings liberally with pre-lube oil, and place on front main bearing journals of crankshaft. Align parallel marks. Refer to Figure 7-10.
- 9) Install two 3/8 in. bolts with their corresponding flat washers through the right crankcase half and, install an O-ring on each (75, Figure 7-11a).
- 10) Install an O-ring (75) on each rear through stud of the right crankcase half.
- 11) Lightly coat the four (4) special O-rings with straight STP to make them sticky and install them in the concentric grooves around the thru bolt holes of the center and front main bearing saddles.
- 12) Apply pre-lube oil to crankshaft main bearing journals and camshaft bores in crankcase.
- 13) Coat the thrust faces of the crankcase and crankshaft with Molyshield grease.

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- 14) Lay out crankcase assembly hardware per Figure 7-11a and 7-11b together with appropriate hand tools.

**STOP!**

**PERFORM IN-PROCESS ASSEMBLY INSPECTION CHECKLIST #1.  
REFERENCE APPENDIX 7-1.**

- 15) Verify that crankcase case mating surfaces are clean and dry.

**WARNING**

**ADHESIVE SEALANT IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. AVOID EYE AND SKIN CONTACT. USE PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

- 16) Apply a thin, even coat of RTV-102 or Loctite™ 515 sealant to the upper and lower mating flanges (“backbone” and “breastbone” surfaces) of the LEFT CRANKCASE HALF ONLY. Apply an even coat of Pliobond #20 to the crankshaft nose seal bore (nose seal) of both case halves and to the OD of the crankshaft oil seal.

**NOTE**

When using RTV 102, the coating must not be too thick. A thin translucent coating is sufficient. Do not apply within approximately .19” of cam bores. Wipe off any excess on the inside and outside edges. Refer to Figure 7-12. This sealant will dry quickly when applied this thinly. Therefore, it is important to proceed quickly until case halves are together and snug. A helper is required during this assembly process.

- 17) Lay a single line of silk thread on the RTV sealant at the centerline of the sealing surface and loop around the inside of each bolt hole. Extend the thread beyond the crankcase mating surface approximately .38” to the accessory gasket surface at the rear, to the nose seal surface at the front and to the sump gasket surface at the bottom. Refer to Figure 7-12.
- 18) As a helper places the left case half up to the crank assembly with the connecting rods protruding through their appropriate cylinder holes, the assembler aligns the front main bearing inserts with the dowels in the crankcase so that the reference marks align properly. The helper must exert light pressure against case half while the assembler adjusts the front main bearing until it snaps into place.

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### NOTE

Using a tool to gently lift up on bearing while holding case half-tight to crankshaft will aid in determining if bearing is properly seated. When properly seated, the bearing and case will move slightly up and down together as the front of the bearing is pried up and down.

- 19) When the left crankcase half and bearing are seated properly, the helper inserts a tool through the #2 connecting rod piston pin hole. A 1.06" diameter x approx. 8.0" wood dowel or Garolite rod is best suited for this purpose. The case must be rotated to wedge the tool against the crankcase #2 cylinder pad. Firm pressure must then be maintained on the crankcase. Refer to Figure 7-13.

### NOTE

The helper **MUST** maintain constant pressure on the left case half throughout the assembly process until case halves are snugged together. Sufficient assembly hardware must be installed to keep the front main bearing fully seated on the locating dowels.

- 21) Check thread and slide crankshaft seal (15, Figure 7-2a) into proper location in left case half.
- 22) Install camshaft in left case half and have helper hold in place.
- 23) Mate the right case half to the left case half by carefully aligning rear thru studs and front 3/8-in. nose bolts. Before case halves are completely drawn together, verify that O-rings on center and front main saddle mating surfaces are still in place.

### NOTE

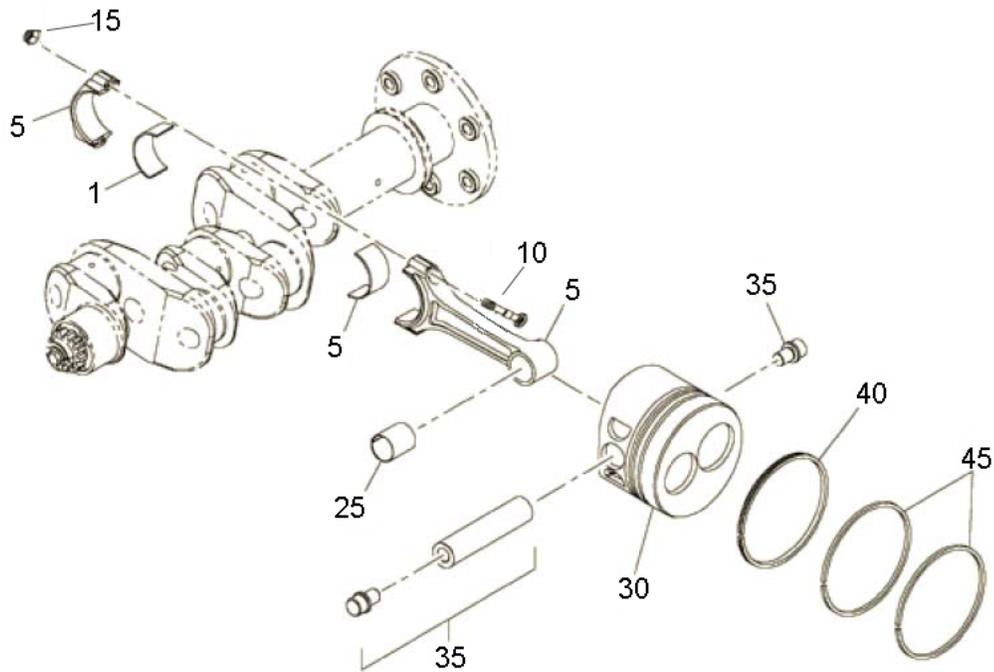
Use care to not push out the 3/8 in. nose bolts (Figure 7-11a) so that the O-rings do not fall out.

- 24) Draw the crankcase halves completely together, and verify that crankshaft seal is properly in place.
- 25) Install backbone bolts (Figure 7-11a), breastbone bolts, and nose bolts with appropriate hardware. Snug all uniformly. Check for free case to crank rotation.
- 26) Lightly lubricate shank and threads of the four 1/2 in. dia. thru bolts (1, Figure 7-11a), with pre-lube oil. Install using a soft faced (dead blow) hammer as far as possible. Finish installation with sufficiently sized ball-peen hammer or equivalent. Use a nut or threaded cap to protect the threads and thru-bolt end. Thru bolts are properly installed when an equal number of threads protrude from each case half.

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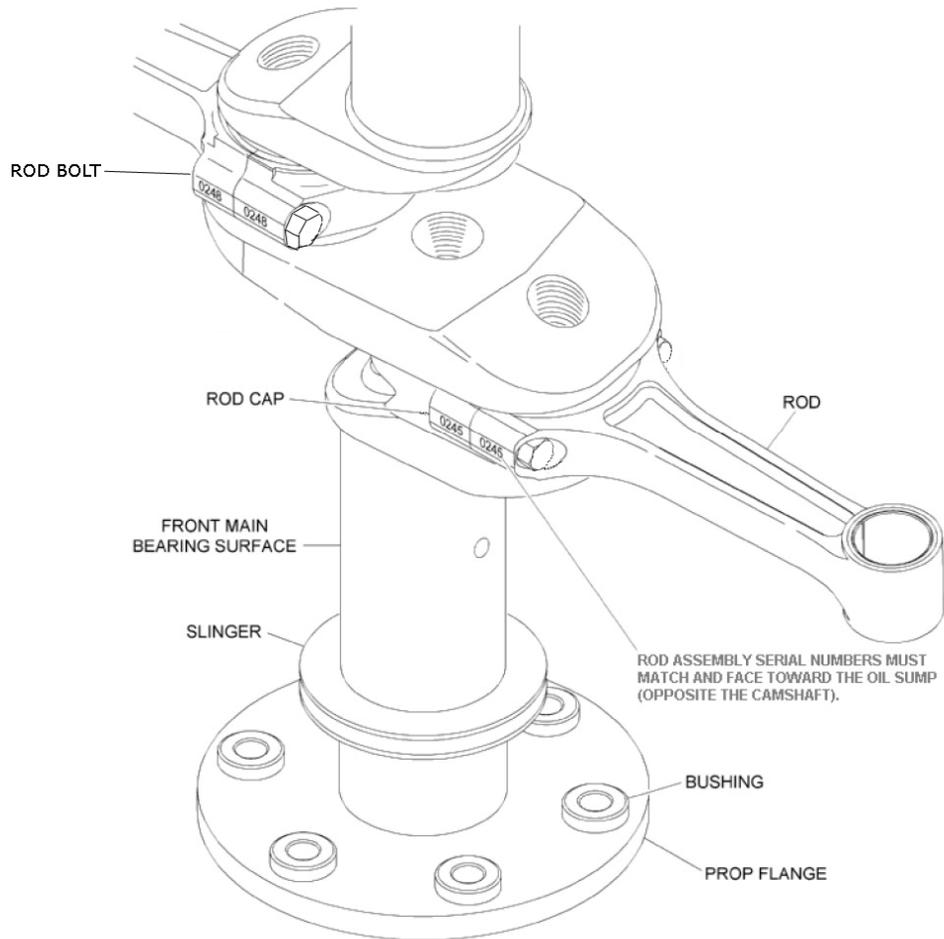


- |                 |                           |
|-----------------|---------------------------|
| 1. Bearing      | 30. Piston                |
| 5. Rod Assembly | 35. Pin and Plug Assembly |
| 10. Bolt - Rod  | 40. Ring - Oil Control    |
| 15. Nut - Rod   | 45. Ring - Compression    |
| 25. Bushing     |                           |

**Figure 7-6 Connecting Rod, Bearing and Piston Assembly**

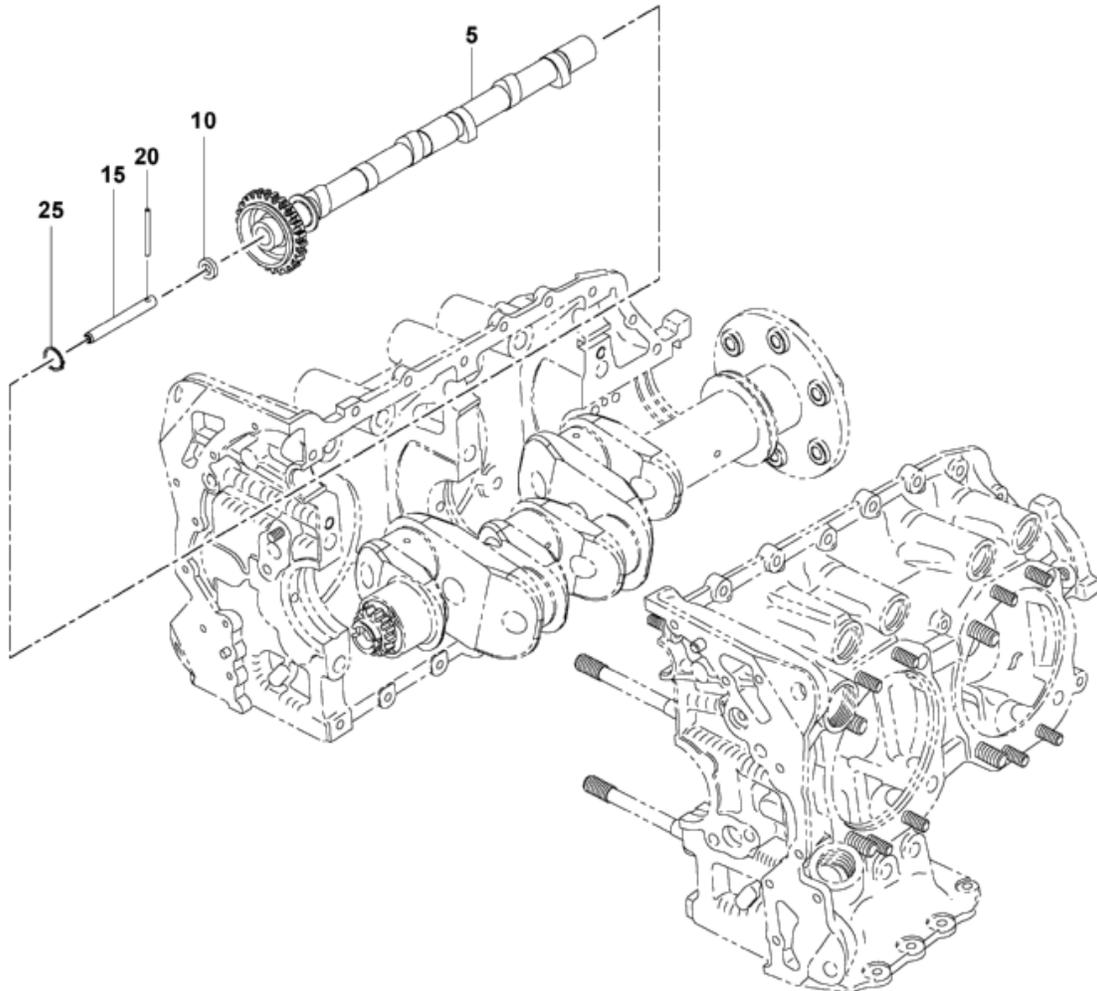
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**Figure 7-7 Connecting Rod Installation**

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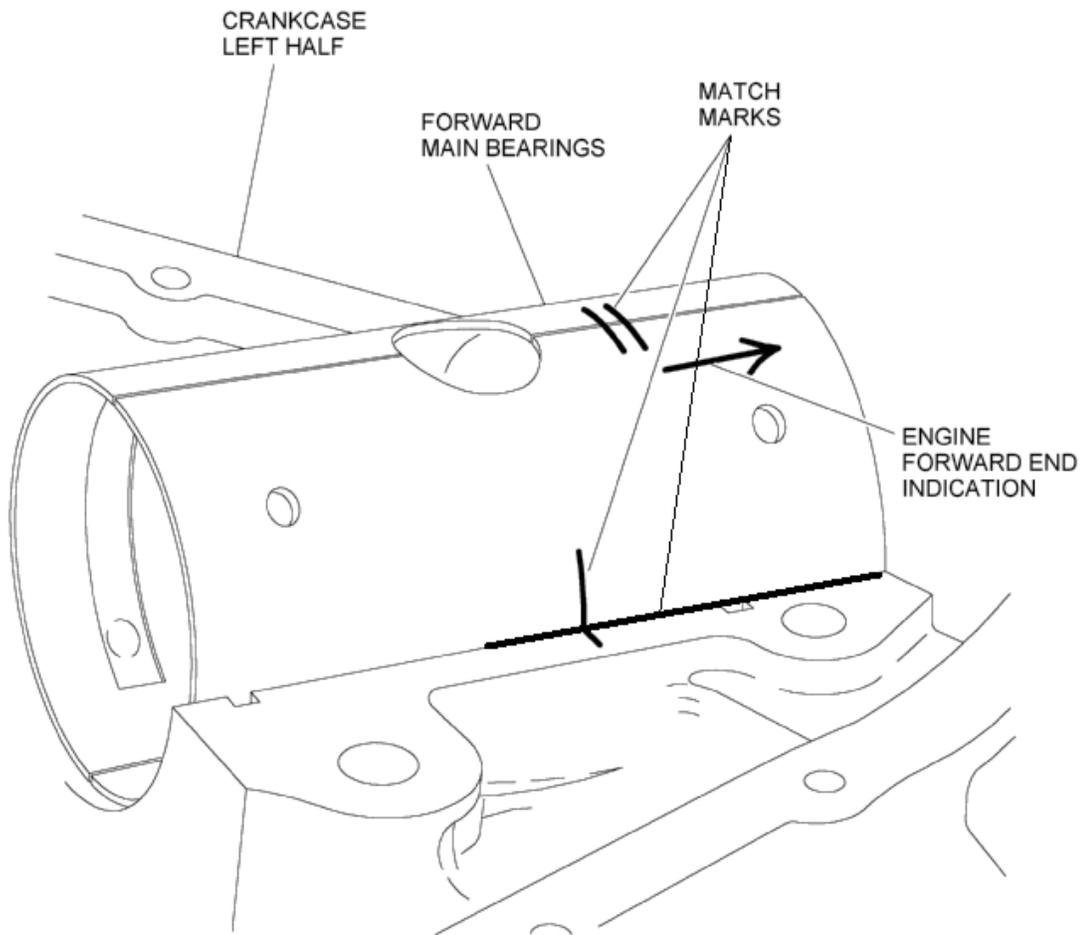


- 5. CAMSHAFT ASSEMBLY
- 10. BUSHING
- 15. TACHOMETER SHAFT ASSEMBLY
- 20. PIN
- 25. RETAINING RING

**Figure 7-8 Camshaft and Tachometer Shaft Assembly**

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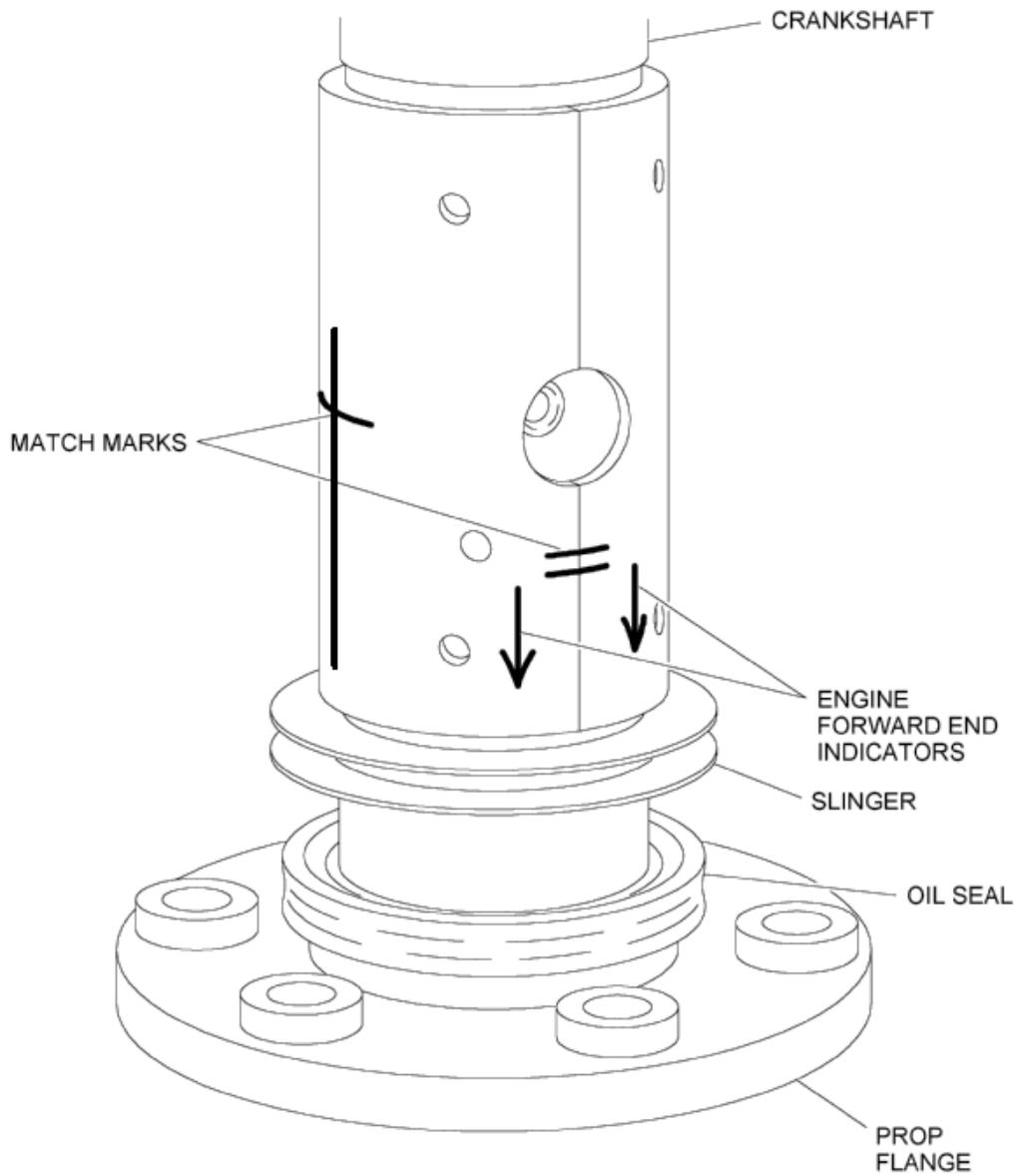
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**Figure 7-9 Front Main Bearing Reference Marks**

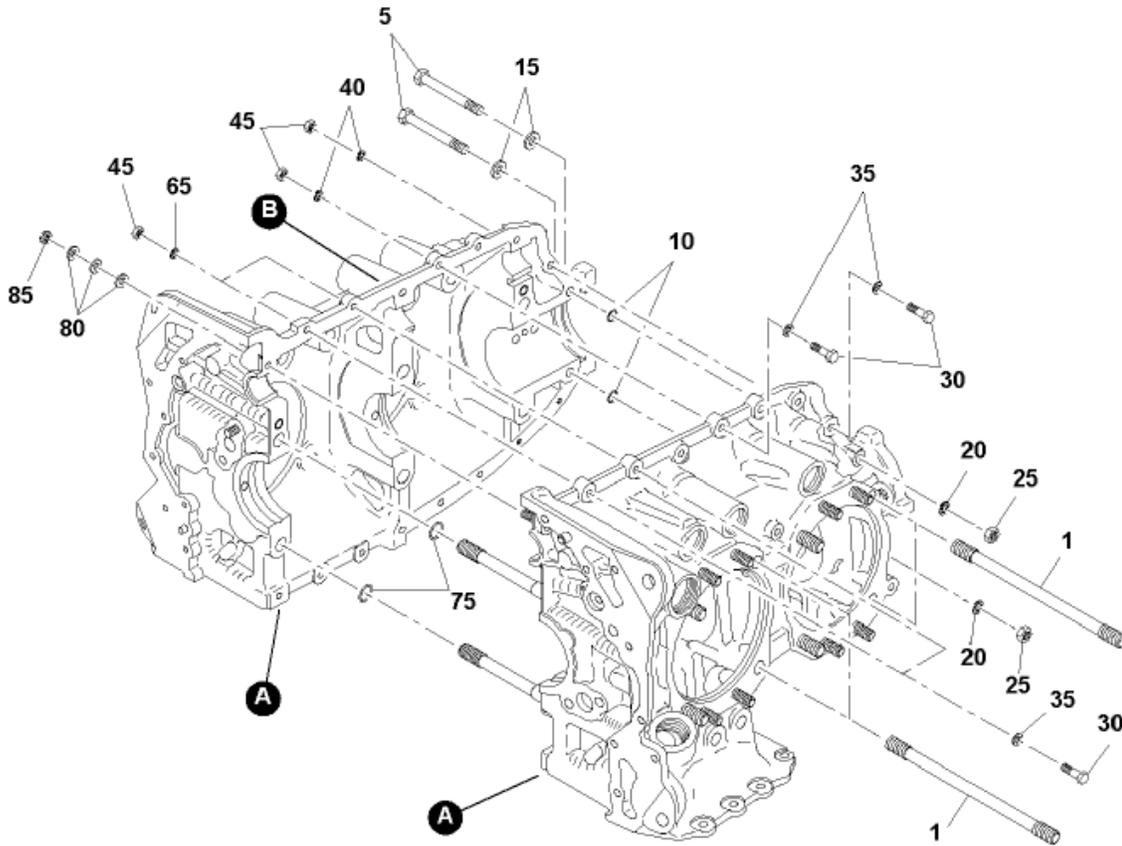
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**Figure 7-10 Front Main Bearing Installation on Crankshaft**

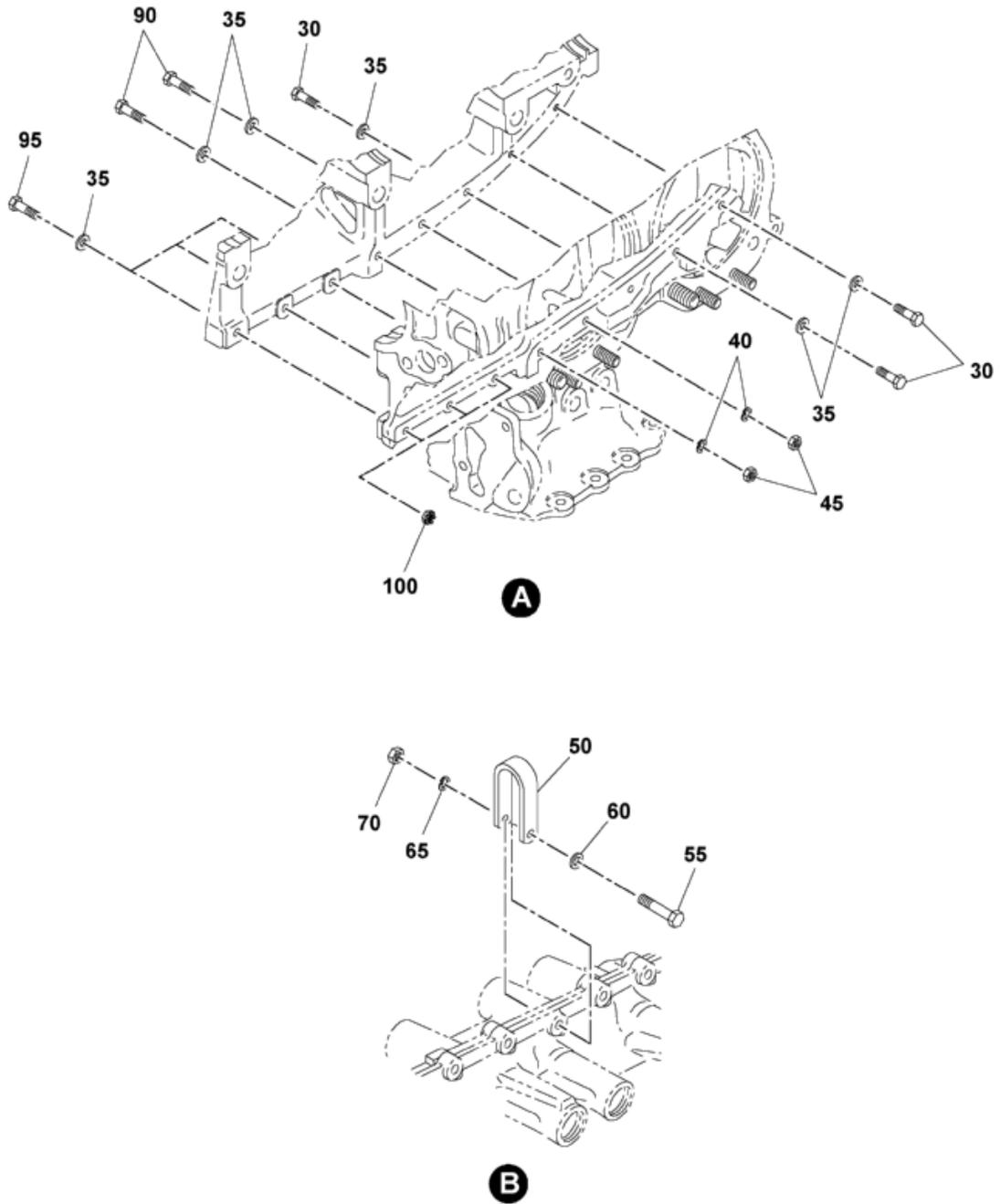
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- |                              |                               |
|------------------------------|-------------------------------|
| 1. STUD (1/2-20 X 10-11/16)  | 55. BOLT (1/4-20 X 2")        |
| 5. BOLT (3/8-24 X 3-37/64)   | 60. WASHER - FLAT (1/4 INCH)  |
| 10. SEAL - OIL RING          | 65. WASHER - LOCK (1/4 INCH)  |
| 15. WASHER - FLAT (3/8 INCH) | 70. NUT - PLAIN (1/4-20)      |
| 20. WASHER - LOCK (3/8 INCH) | 75. SEAL - OIL                |
| 25. NUT - PLAIN (3/8-24)     | 80. WASHER - PLAIN (3/8 INCH) |
| 30. BOLT (1/4-20 X 1-1/2)    | 85. NUT - SLOTTED (3/8-24)    |
| 35. WASHER - FLAT (1/4 INCH) | 90. BOLT (1/2-20 X 1-1/8)     |
| 40. WASHER - LOCK (1/4 INCH) | 95. BOLT (1/4 INCH)           |
| 45. NUT - PLAIN (1/4-20)     | 100. NUT - SLOTTED (1/4-20)   |
| 50. STRAP - LIFTING          |                               |

**Figure 7-11a Crankcase Attaching Hardware**

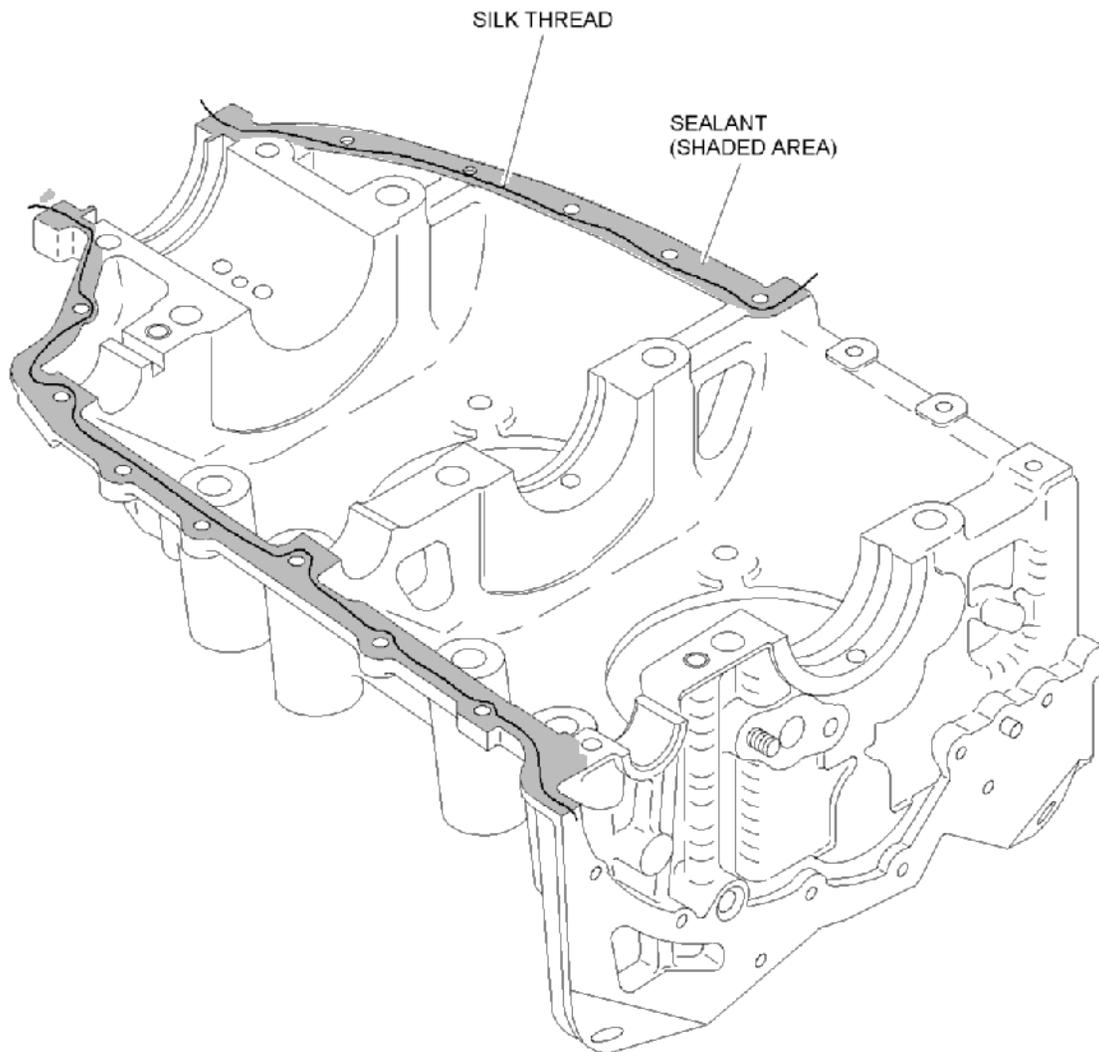
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**Figure 7-11b Crankcase Attaching Hardware (cont'd.)**

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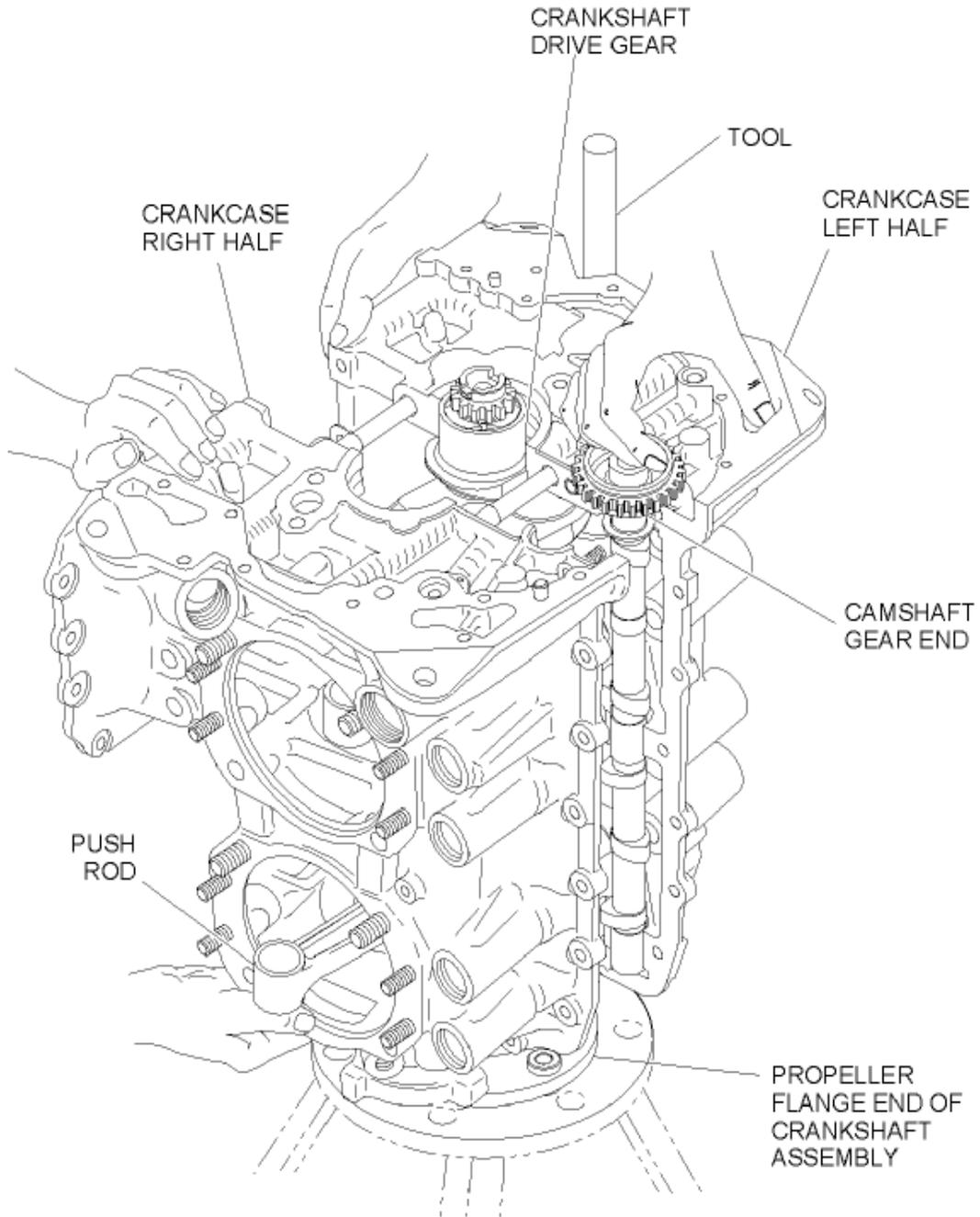
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**Figure 7-12 Crankcase Sealant and Silk Thread Application**

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**Figure 7-13 Assembly of Crankcase Halves**

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### 7.17 Preparation of Cylinders for Assembly

- 1) Verify cylinder part number and type. Visually inspect cylinder for general condition and possible handling or shipping damage.
- 2) Visually inspect threaded holes helical coil thread inserts for integrity and absence of foreign matter.
- 3) Verify the valve, spring, and key part numbers (Figure 7-14).
- 4) Coat valve stems with Molyshield grease, and install valves in guides. While holding valve to prevent them from falling out, place cylinder on a clean assembly post or stand. Place lower valve spring seats over guides, and place a pair of valve springs on each. Place the upper spring seat on each valve. Using a valve spring compressor, compress the upper spring seats squarely in order to prevent nicks or damage to valve stems. Install a pair of new keys in each upper spring seat, and release spring compressor.

**WARNING**  
**LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

- 5) Remove cylinder from assembly post and tap on the upper spring seats with a plastic mallet to seat the keys.
- 6) If available, use a pressure test fixture to check for leaks at the valves or between the valve seats and cylinder head.
- 7) Place a dab of Lubriplate or Molyshield grease inside the recess of the exhaust valve rotator cap. Press the rotator cap firmly onto the stem of the exhaust valve. The grease will hold the rotator cap in place during cylinder installation.
- 8) Clean cylinder bores using a clean, lint-free shop towel moistened with acetone or MEK.

**WARNING**  
**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

- 9) Inspect pistons (Figure 7-6) for correct part number and weight.

**NOTE**  
Piston weight differences should not exceed 2 grams in opposing pairs.

- 10) Clean piston pins with acetone or MEK, and check for fit in each piston. Pins are a push fit with light lubrication on the OD.

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- 11) Using clean feeler gages, measure clearance between piston skirt and cylinder bore ID with the bottom edge of the piston skirt approximately 1.0" from the bottom of the bore. Clearance must be within limits per Section 10 of this manual.
- 12) Verify piston ring type and part numbers. Top compression ring should be a plasma-filled (dull, silver-gray metal sprayed surface; NOT a shiny chrome surface). Second compression ring and oil control ring should be plain with a black phosphate coating finish.
- 13) Check end gaps of compression rings (Figure 7-6) and oil control ring with feeler gauge. End gap in straight portion of cylinder bore (1"-3" from cylinder flange) at top of piston stroke (choked portion of cylinder bore) must be within limits per Section 10, Table of Limits, in this manual.
- 14) Use a ring expander to install rings the rings in their respective grooves. Install the oil control ring first and the top compression ring last

**NOTE**

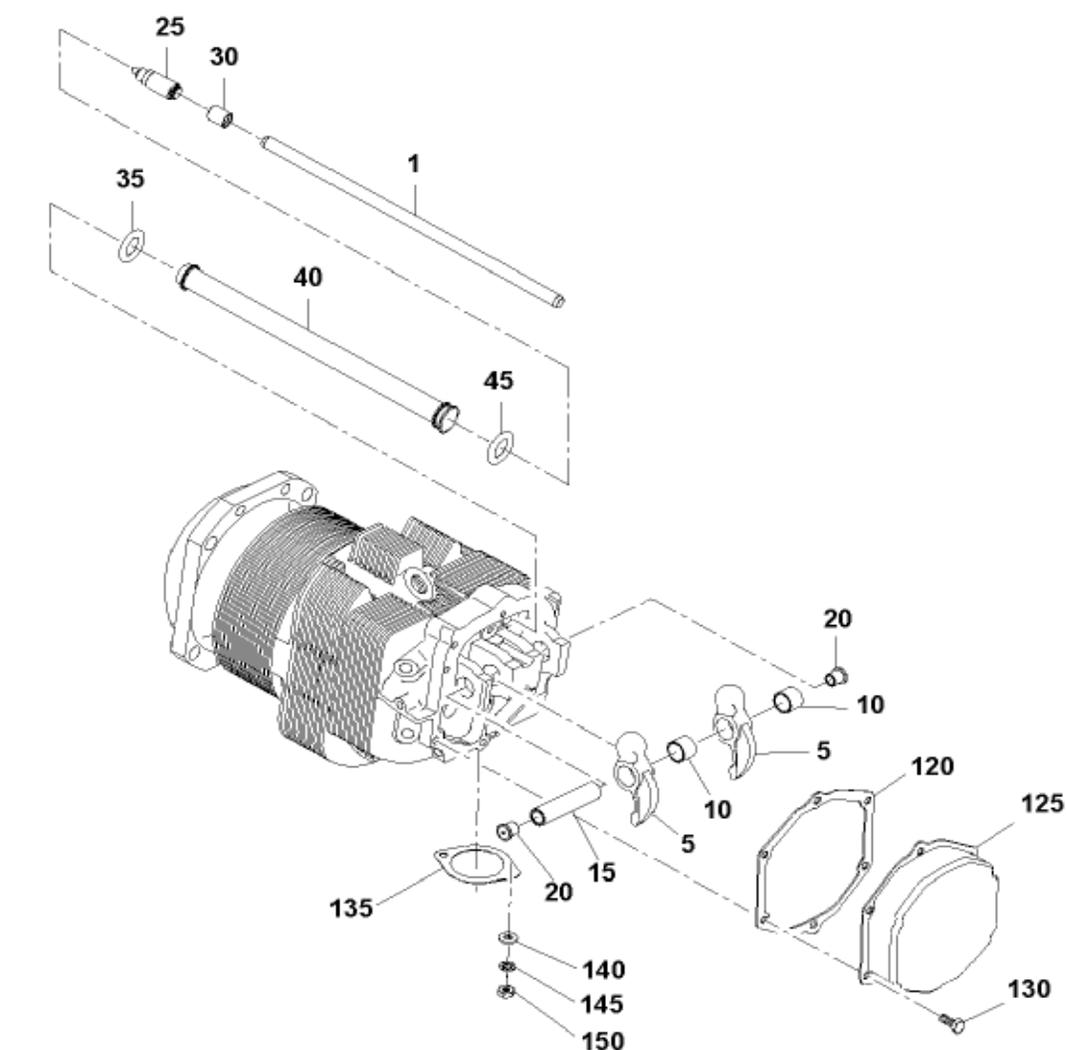
Piston ring part numbers must face "up"; that is, toward the top of the piston.

- 15) Using clean feeler gages, check side clearance of each ring in accordance with Figure 5-2b in Section 5 of this manual. Side clearance must be within limits per Section 10, Table of Limits.

**NOTE**

Side clearance must be checked with each ring in its respective groove and flush with outside diameter of the piston ring lands.

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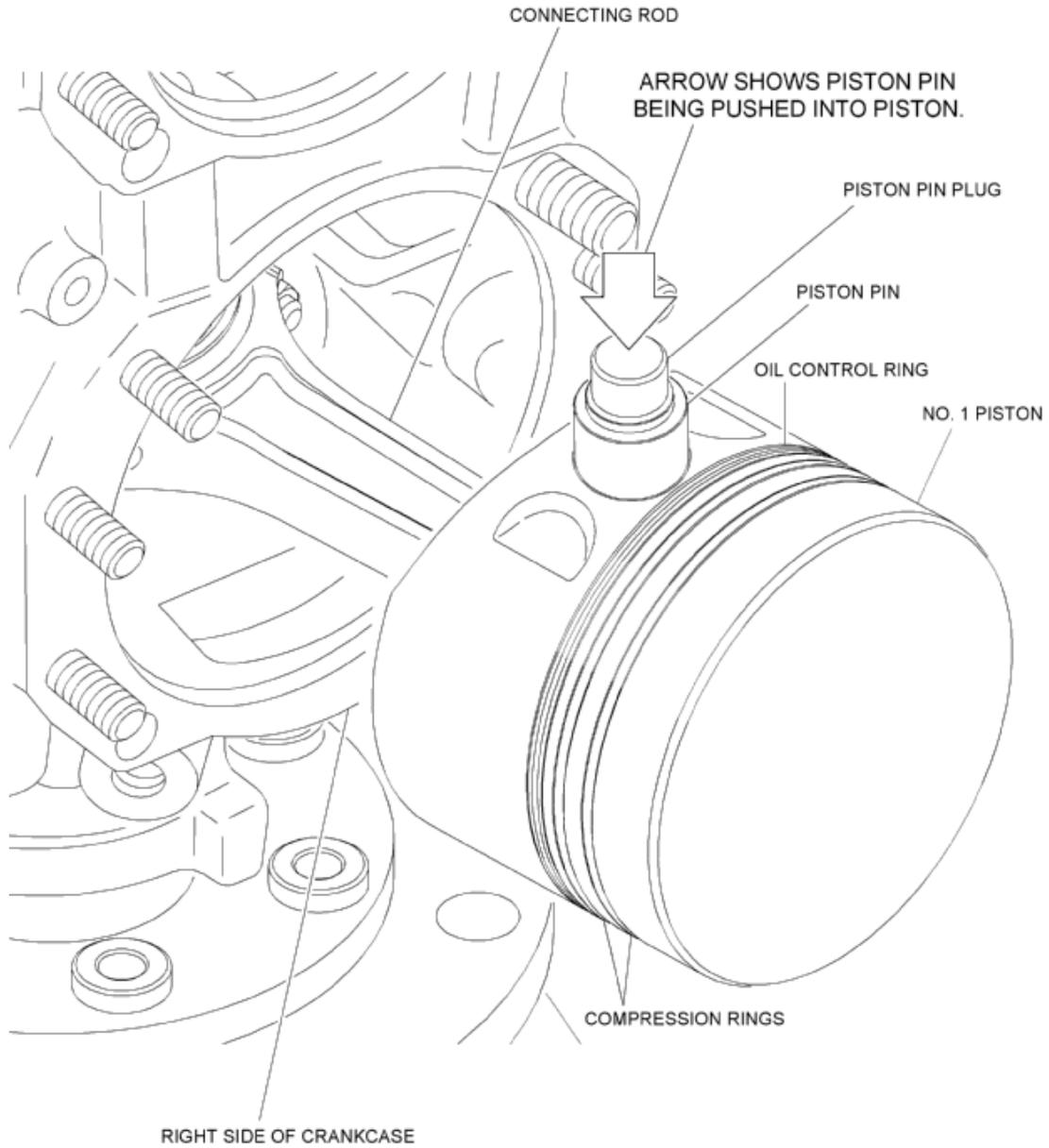
- 1. PUSH ROD
- 5. ROCKER ARMS
- 10. BUSHING
- 15. ROCKER ARM SHAFT
- 20. CAP - ROCKER SHAFT
- 25. PLUNGER ASSY
- 30. PUSH ROD SOCKET
- 35. SEAL - TUBE BOTTOM
- 40. SHROUD TUBE
- 45. SEAL - TUBE TOP

- 120. GASKET - VALVE COVER
- 125. VALVE COVER
- 130. SCREW
- 135. GASKET - EXHAUST
- 140. WASHER - FLAT
- 145. WASHER - LOCK
- 150. NUT - PLAIN

**Figure 7-14 Valve Train and Related Parts**

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**Figure 7-15 Assembly of Piston on Connecting Rod**

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### 7.11 Assembly of Cylinders to Crankcase

- 1) Prepare all cylinder base nuts by applying a few drops of pre-lube oil to the threads and nut faces.
- 2) Lubricate the rings and ring grooves on the piston with pre-lube oil.

**WARNING**

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- 3) Stagger the ring gaps on the piston as follows: top compression ring gap at approximately 10:00 o'clock position; second compression ring gap at approximately 2:00 o'clock; and the oil control ring gap at approximately 11:00 o'clock.

**NOTE**

The gap of the expander in the oil control ring should be approximately 180° from the ring gap. Be certain that the ends of the expander meet but do not overlap.

- 4) Lubricate the cylinder bores, piston pins and piston pin bushing in connecting rod with pre-lube oil.
- 5) Lubricate the cylinder base o-ring (Figure 7-16) with SAE 50 oil and install over the cylinder base.
- 6) Lubricate cylinder deck studs and through bolts with pre-lube oil.
- 7) Slowly rotate the crankcase until the #1 connecting rod is at the top of the stroke. Use care to prevent rods and rod bolts from contacting the crankcase as it is rotated.
- 8) Install the #1 piston on the #1 connecting rod with the piston pin per Figure 7-15 so that piston ring end gaps are toward the top of the engine.
- 9) Be sure that the piston ring compressor is clean, and slide it over the piston and rings far enough to allow the top of the piston to enter the cylinder bore.
- 10) Verify that a base seal is installed on the barrel skirt, and install cylinder #1 making certain that the intake and exhaust ports are oriented to the bottom of the engine. Push the cylinder onto the piston while keeping it centered with the cylinder hole in the crankcase and until the oil control ring is well inside the cylinder bore. Remove the ring compressor, and continue to slide the cylinder onto the piston. Carefully guide the skirt of the cylinder barrel into the cylinder hole of the crankcase and over the cylinder deck studs of the crankcase. Refer to Figure 7-17.
- 11) Install the cylinder base nuts (Figure 7-16), and tighten to snug.

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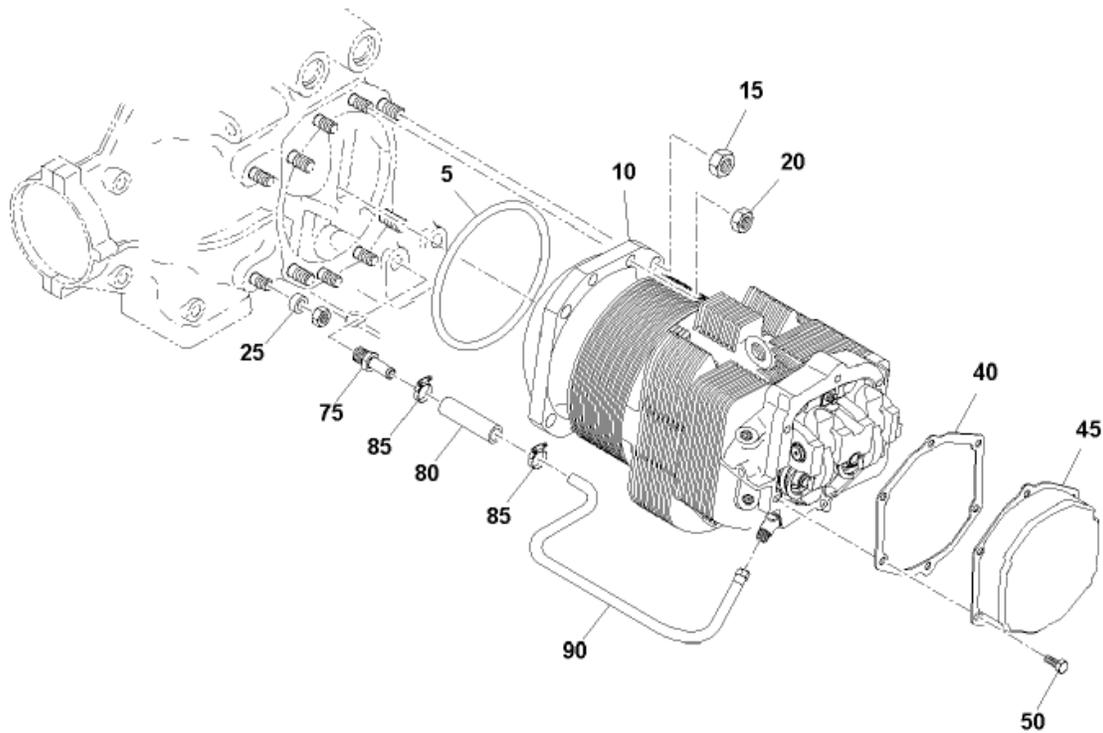
- 12) Repeat the above process with cylinder #2. Rotate the crankcase 180 degrees around the crankshaft and repeat the cylinder installation process with cylinders #3 and #4 in that order. The connecting rod of the cylinder being installed should always be at top dead center (TDC).
- 13) Install two spacers and cylinder base nuts on free ends of thru bolts ahead of #2 cylinder. Tighten the large cylinder base nuts (Figure 7-16) to 300 in-lbs torque. Tighten the small base nuts to 150 in-lbs torque. Follow torque sequence shown in Figure 7-18.
- 14) Tighten all crankcase assembly fasteners to the recommended torque values per Section 10, Table of Limits and Tightening Torques, according to the sequence shown in Figure 7-18. Note that three .25-20 UNC slotted nuts (Figure 7-11b) on drilled-shank bolts on bottom of crankcase are to be torqued to 55-60 in-lbs which is lower than the torque for other .25-20 UNC fasteners.
- 15) Tighten large cylinder base nuts to 600 in-lbs torque. Nuts on opposite ends of thru bolts should be cross-torqued simultaneously by the assembler and a helper. Tighten small cylinder base nuts to 300 in-lbs torque. Again, torque in the sequence shown in Figure 7-18. Double check torque of these nuts several times.
- 16) Double check torque of remaining crankcase assembly fasteners.
- 17) Torque slotted .38-24 UNF nut (Figure 7-11a) above camshaft gear to 300 in-lbs. Install safety wire (.041") through drilled stud and slotted nut and secure to adjacent hole in left case half.

**WARNING**  
**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

- 18) Safety wire three slotted nuts and drilled head bolts on bottom of crankcase as a set using .032" safety wire as shown in Figure 7-23.

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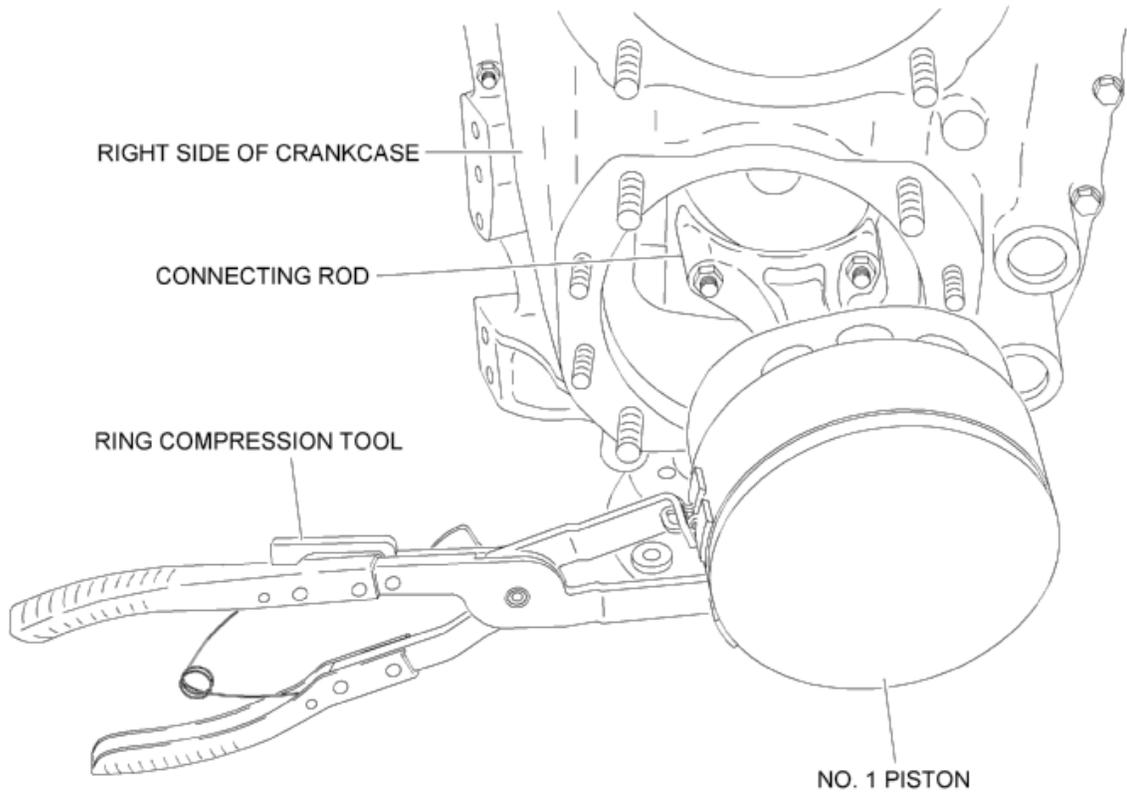


- |                            |                    |
|----------------------------|--------------------|
| 5. SEAL - CYLINDER BASE    | 75. NIPPLE - DRAIN |
| 10. CYLINDER ASSEMBLY      | 80. HOSE           |
| 15. NUT - PLAIN (1/2 X 20) | 85. CLAMPS         |
| 20. NUT - PLAIN (3/8 X 24) | 90. TUBE ASSEMBLY  |
| 25. SPACER                 |                    |
| 40. GASKET                 |                    |
| 45. COVER                  |                    |
| 50. SCREW                  |                    |

**Figure 7-16 Cylinder Assembly Hardware and Oil Drain Tube**

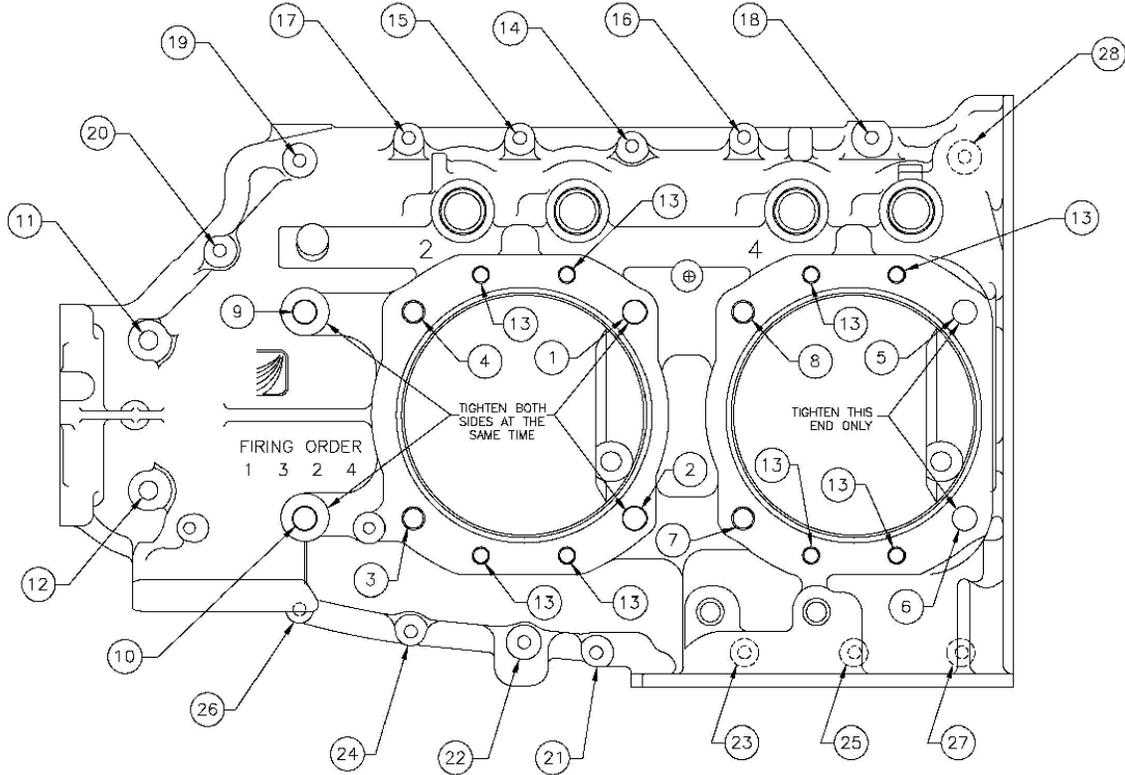
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**Figure 7-17 Use of Piston Ring Compressor**

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**Figure 7-18 Crankcase Assembly Hardware Tightening Sequence (Left Side)**

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**7.12 Installation of Idler Shafts and Gears and Internal Gear Timing**

- 1) Verify a setting height of .49”-.53” for the drilled stud at idler shaft boss of the left crankcase half.
- 2) Install the idler shaft on the left crankcase half (Figure 7-19a) with one drilled-head cap screw and one slotted nut. Torque the cap screw and nut in accordance with the torque specifications of Section 10 of this manual. Safety the cap screw and nut to holes provided in the flange of the idler shaft using .032” safety wire. Refer to Figure 7-19b.

**WARNING**  
**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

- 3) Inspect idler gear and for handling damage, burrs, and general condition

**WARNING**  
**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

- 4) Apply pre-lube oil to idler shaft and gear bushings.
- 5) Using a bright blue or black felt tip marker, highlight the timing marks on the crankshaft gear, camshaft and idler gear.
- 6) Place the left-hand idler gear over the left idler shaft aligning its timing marks with the corresponding timing marks on the crankshaft gear and camshaft gear. The double timing marks on the idler gear must straddle the single timing mark on the crankshaft gear. The double timing marks on the camshaft gear must straddle the single timing mark on the idler gear. Rotate crankcase and camshaft as required to obtain gear tooth alignment. See Figure 7-20.
- 7) Check gear backlash of the idler gear with a feeler gauge or dial indicator. Backlash limits must be within limits specified in Section 10 of this manual.

**STOP!**  
**PERFORM IN-PROCESS ASSEMBLY INSPECTION CHECKLIST #2.**  
**REFERENCE APPENDIX 7-2.**

### 7.13 Hydraulic Unit Cleaning, Inspection and Installation

**NOTE**

Hydraulic units (Figure 7-14) are an assembly of two major components: 1) a body with a ball-type check valve in the base, and 2) a plunger with an integral return spring that snaps into the body. These parts are machined to close tolerances and are select-fitted in manufacture to provide a specified leak-down rate at a constant load. Bodies and plungers must not be intermixed. Separate them for cleaning and inspection one at a time, OR use a special tray or basket with compartments that will prevent mixing of bodies and plungers.

**CAUTION**

**Do Not handle hydraulic units or pushrod sockets using magnets. Magnetization of the hydraulic unit may prevent the check ball from operating properly and may result in engine operation with a “Flat” lifter that can lead to valve damage or failure.**

- 1) Visually inspect the head of the plunger. If visibly worn or grooved, replace entire unit.
- 2) Remove the plunger from the body by pulling on the head of the plunger while twisting the plunger in a clockwise direction. If plunger cannot be removed without tools, replace entire unit.
- 3) Inspect plunger OD and body ID for wear and scoring. If visibly worn or damaged, replace entire unit.
- 4) Clean body and plunger by soaking first in clean petroleum solvent for several hours and then in acetone or MEK for one hour. Remove from solvent and allow excess to drain off. Clean and air dry with dry, compressed air.

**WARNING**

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

**WARNING**

**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

- 5) Apply one drop of SAE 10 oil to the OD of the plunger and spread evenly. Hold the hydraulic unit vertical, and insert the plunger into the body. Quickly release the plunger. There should be enough compressed air in the body to cause the plunger to spring back at least partially. Test twice more. If plunger does not spring back, check ball is leaking. Replace entire unit.
- 6) If plunger springs back satisfactorily, press the plunger into the body while rotating the plunger CW or the body CCW so that the spring again snaps into the groove in the body.

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- 7) Quickly depress the plunger and release. The spring should quickly return the plunger to its resting position.
- 8) Again depress the plunger fully and hold. Use a short length of .06" diameter to unseat the check ball. A slight release of compressed air should be noted. Repeat if necessary.
- 9) If hydraulic unit passes the above inspections it is serviceable.
- 10) Apply a light coat of pre-lube oil to the OD of each plunger.

**WARNING**  
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- 11) Insert hydraulic unit, small tube end first, into lifter body in crankcase. Refer to Figure 7-14.
- 12) Insert pushrod socket (Figure 7-14) into lifter body on top of hydraulic unit. The hemispherical side of the socket must be facing out (flat bottomed counter bore rests on top of hydraulic unit).

#### **7.14 Installation of Pushrod Tubes, Pushrods, and Rocker Arms**

- 1) Visually inspect the pushrod tubes (Figure 7-14) for straightness, dents, or burrs. Verify that ID of each tube is clean and free of debris.
- 2) Gather the eight top seals (Figure 7-14) and eight bottom seals for the pushrods from the engine gasket set. Install the eight top seals on the pushrod.
- 3) Insert a pushrod through the one of the pushrod holes in #1 cylinder. Install the bottom seal and slide the pushrod toward the crankcase. Using a laboratory washing bottle squirt several drops of isopropyl alcohol onto each seal. Quickly push and twist the pushrod into position while the seals are wet. Inspect both seals to ensure that they are properly seated. Repeat the process with the remaining pushrod tubes.

**NOTE**

Pushrod tube seals function best when installed dry. The purpose of the isopropyl alcohol is to provide a temporary lubricant to aid assembly. The alcohol will evaporate relatively quickly and leave no residue. Use care to avoid contact with enamel that is not fully cured.

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**WARNING**

**SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT SKIN AND EYE CONTACT, AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

- 4) Install spring clip on the stud between the pushrod tubes in the cylinder head so that it engages the end of both pushrod tubes.
- 5) Install lock plate and .25-20 UNC hex nut.
- 6) Torque nut to 50-70 in-lbs. Secure nut by bending lock tab with screwdriver or pliers.
- 7) Inspect pushrods for bends or damage. Blow clean, dry compressed air through each pushrod. Also visually inspect ID of each pushrod to verify that each is clear, clean, and open.

**WARNING**

**LIMIT COMPRESSED AIR PRESSURE TO NOT MORE THAN 30 PSI AND USE OSHA-APPROVED NOZZLES WHEN USING COMPRESSED AIR TO CLEAN OR DRY PARTS. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. WEAR EAR PLUGS OR SAFETY HEADPHONES AND GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF CASE OF EYE INJURY, GET MEDICAL ATTENTION PROMPTLY.**

- 8) Install pushrods in pushrod tubes of #1 cylinder. Rotate crankcase while holding pushrods until #1 piston is at TDC of compression stroke which is indicated by no movement of either lifter or pushrod. If movement of either pushrod is noted, rotate crankcase 360 degrees.

**NOTE**

Pushrods are manufactured in several lengths as the only available means of adjusting the dry lifter clearance measured between the rocker arm and the tip of the valve. Use the appropriate pushrod length to achieve proper clearance of .028"-.080" when the dry hydraulic unit is completely compressed.

- 9) Verify that a rotator cap is present on the stem of each exhaust valve. If not present, apply a dab of grease to the rotator cap and press into place on the exhaust valve stem.
- 10) Inspect rocker arms for general condition. Verify that bushings are properly installed and that the rocker shaft fits correctly. Lubricate pushrod socket and oil feed hole in the rocker arm to verify clear passage.
- 11) Lightly oil rocker shafts, and install rocker arms and shaft in the #1 cylinder.

**NOTE**

It is necessary to compress the hydraulic units by pushing down on the pushrod end of the rocker arms in order to install the rocker shaft.

- 12) After the rocker shaft is installed, check dry lifter clearance by pressing down firmly on the pushrod end of the rocker arm and measuring the clearance between the tip of the rocker

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arm and the valve stem with clean feeler gages. Clearance must be within limits per Section 10 of this manual. Change pushrod length as required to achieve proper dry lifter clearance.

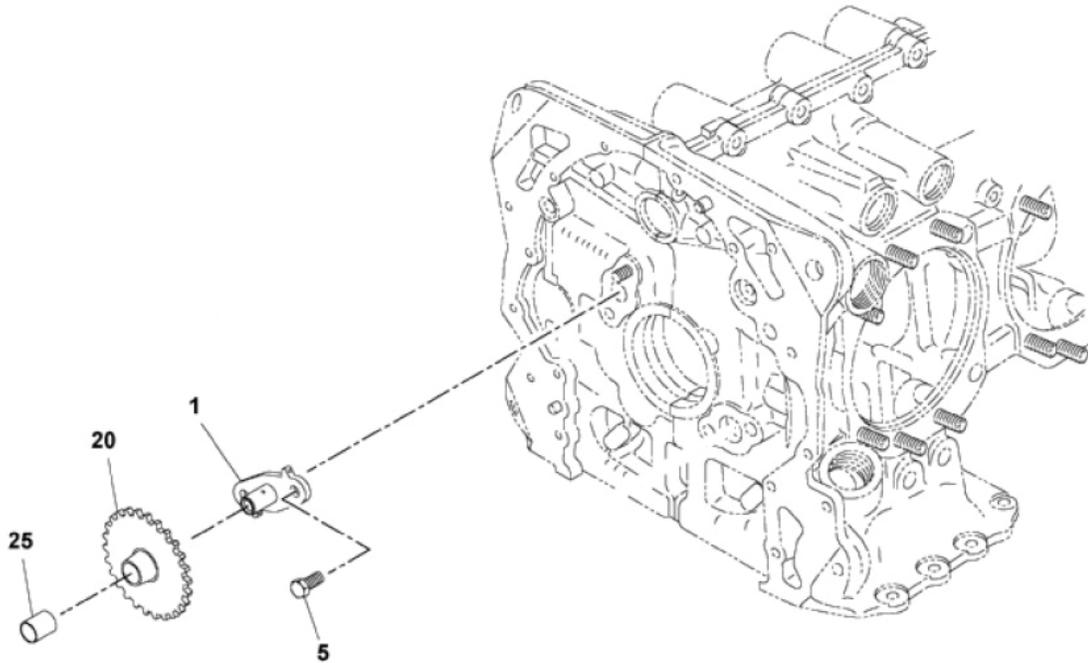
- 13) Repeat for all remaining cylinders.
- 14) Apply a dab of grease to the rocker shaft thrust buttons and install one in each end of the rocker shaft.
- 15) Prepare the rocker cover (Figure 7-14), gasket, and attaching screws. Apply Loctite™ 241 to attaching screws.
- 16) Verify that both thrust buttons are in place, and apply several drops of oil to the interface between the rocker arm thrust surfaces and the cylinder rocker bosses as well as at the tip of the rocker arm and valve stem.
- 17) Immediately install the rocker cover and gasket, and evenly tighten the screws using the recommended torque value and sequence in accordance with Section 10 of this manual.

### NOTE

Rocker cover gaskets are available in several materials. Rubber gaskets **MUST BE INSTALLED DRY AND REQUIRE A LOWER TORQUE VALUE FOR THE COVER ATTACHING SCREWS** than when using cork or fiber gaskets. Refer to Section 10 of this manual.

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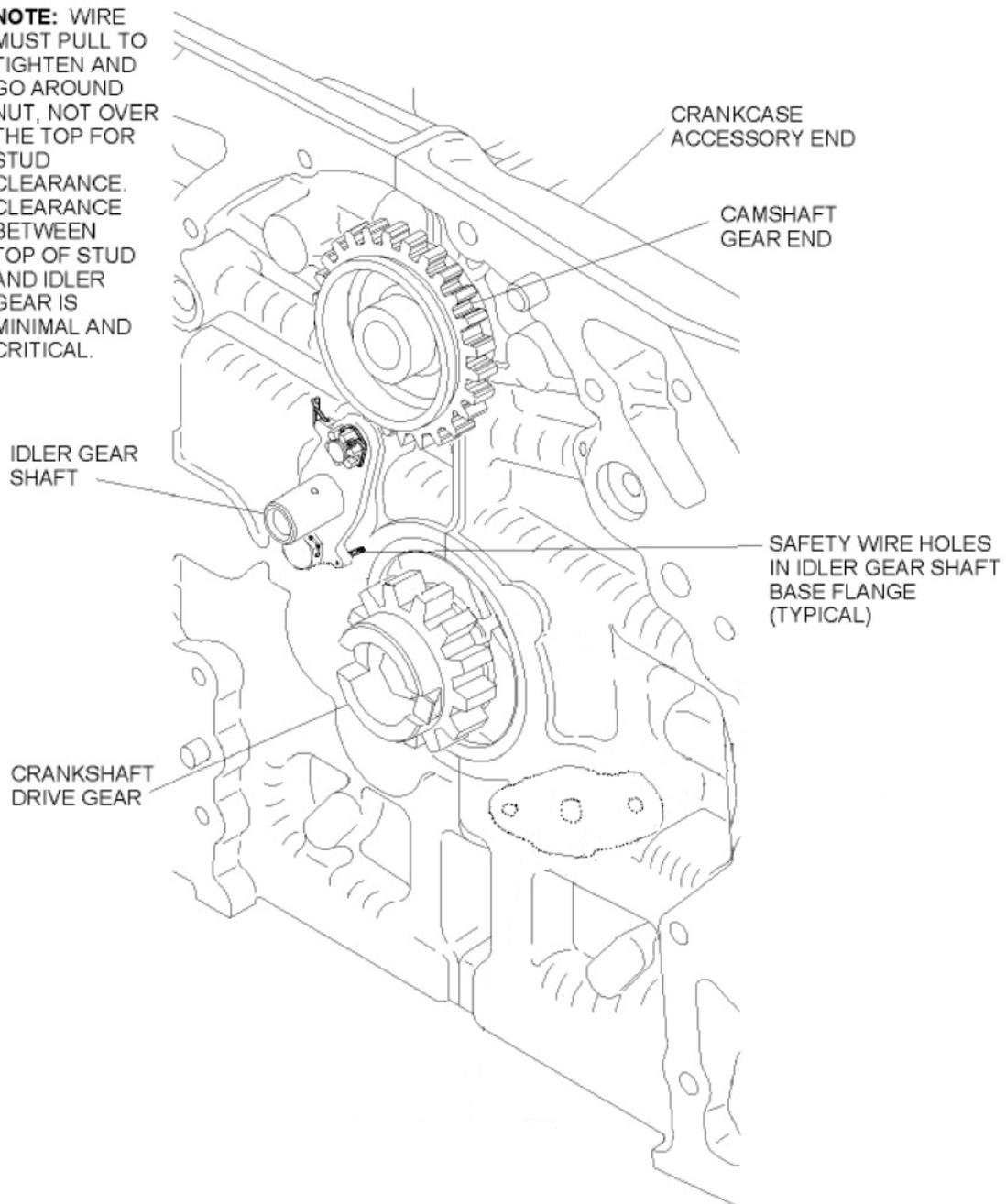


**Figure 7-19a Idler Shaft and Gear Assembly**

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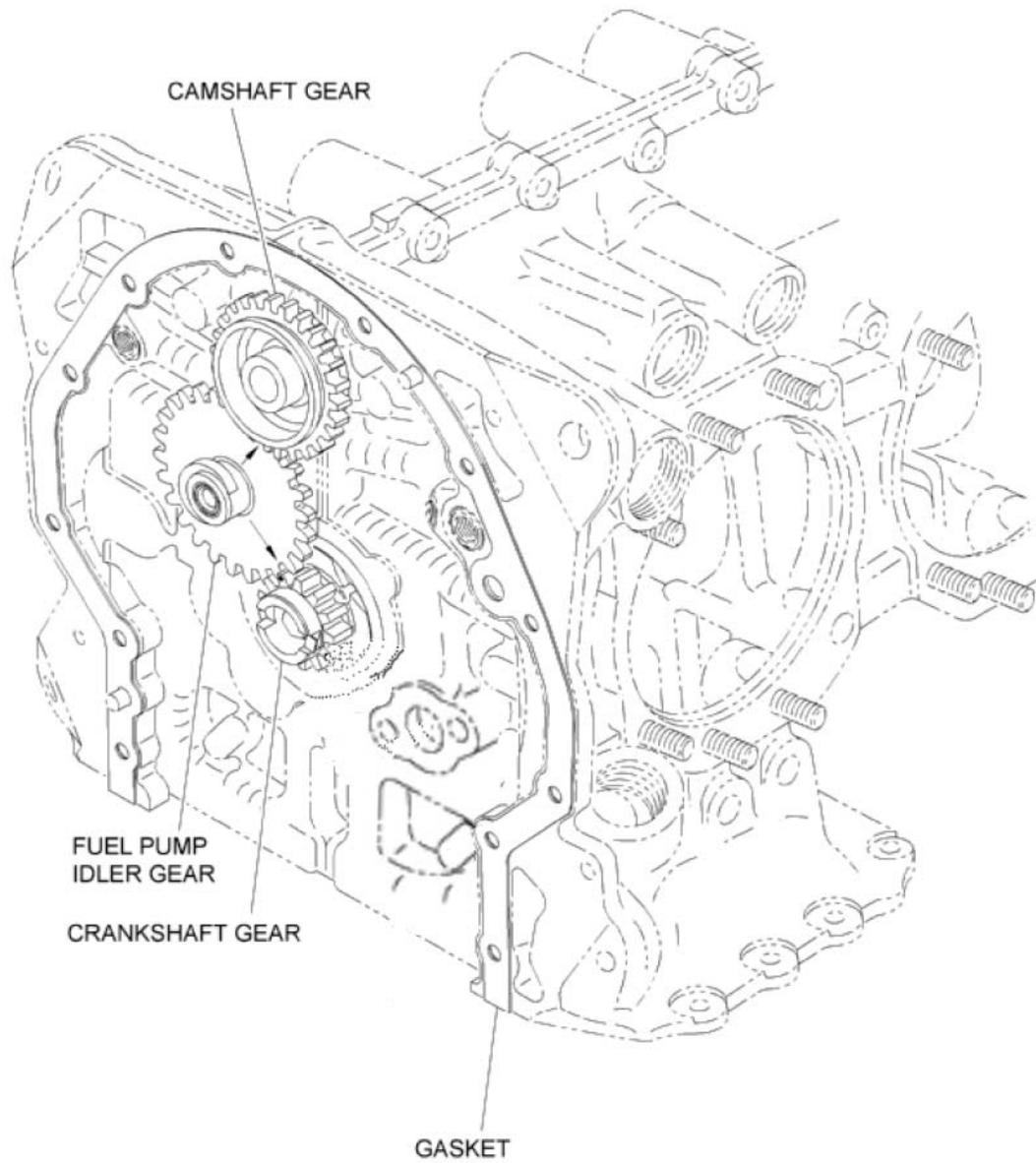
**NOTE:** WIRE MUST PULL TO TIGHTEN AND GO AROUND NUT, NOT OVER THE TOP FOR STUD CLEARANCE. CLEARANCE BETWEEN TOP OF STUD AND IDLER GEAR IS MINIMAL AND CRITICAL.



**Figure 7-19b Idler Shaft Safety Lock Wire Installation**

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**Figure 7-20 Idler Gear Installation and Timing Marks**

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### **7.15 Accessory Case Inspection and Subassembly**

- 1) Inspect the accessory case (Figure 7-21) for damage paying special attention to studs, threaded holes, and mating surfaces, especially the oil pump pad.
- 2) Carefully install a new tachometer shaft seal. Break leading edge of metal shell on seal using a small file, and apply a light coating of Molyshield grease to the seal OD before installation. Install seal with lip side facing inward. A convenient installation tool may be made from an old tachometer shaft (with the pin removed) and valve rocker arm shaft. Place the seal over the tachometer shaft, and install the shaft and seal into the tachometer adapter of the accessory case. Place the rocker shaft over the tachometer shaft, and lightly tap the seal into the bore using a small hammer only until the seal is seated. Remove tools.
- 3) Install the plug and oil pressure fitting if removed for cleaning. Tighten per torque specifications of Section 10 of this manual.
- 4) Install plug and crush gasket and tighten per torque specifications of Section 10 of this manual.
- 5) Install the oil cooler bypass valve, plunger, and spring before installing plug.
- 6) Inspect the oil pump housing for damage, and verify installation and security of 1/16-NPT plug, if so equipped.
- 7) Inspect the oil pump gears and oil pump drive shaft for damage. Note especially any nicks or raised edges on the sides or tops of gear teeth. Inspect oil pump shaft bores in accessory case.
- 8) Install the oil pump gears and drive shaft into the oil pump housing. Inspect gear backlash and gear clearance in pump housing per Section 10 of this manual.
- 9) Apply pre-lube oil liberally to gears, shafts, gear cavities in pump housing, and shaft bores in accessory case.

**WARNING**

**LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

- 10) Install the oil pump assembly over studs in accessory case. Install the flat washers and slotted nuts on the studs. Tighten the nuts to snug.
- 11) Check for free rotation of the oil pump drive shaft. Shaft and gears **MUST** rotate freely and smoothly.

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### NOTE

If necessary, loosen the nuts and slightly twist or adjust the position of the pump housing to achieve free and smooth rotation of the oil pump gears. If free rotation cannot be readily achieved, disassemble to determine and correct the cause of the problem.

- 12) Evenly tighten the slotted nuts to 150 in-lbs. torque per Section 10 of this manual. Check for alignment of safety wire holes with slots in nuts. If holes and slots do not align, nuts may be tightened to a maximum of 204 in-lbs. If alignment cannot be achieved within this range, replace the nut and again torque to 150 in-lbs and repeat the process until alignment is achieved.

### CAUTION

**Do Not loosen nuts to less than 150 IN-LBS. Torque to achieve alignment of holes and slots.**

- 13) Safety wire three slotted nuts as a set using .032" safety lock wire as shown in Figure 7-22.

### WARNING

**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE or helical coil threaded inserts.**

## STOP!

**PERFORM IN-PROCESS ASSEMBLY INSPECTION CHECKLIST #3.  
REFERENCE APPENDIX 7-3.**

### 7.16 Assembly of Accessory Case to Engine

- 1) Apply pre-lube oil to the tachometer shaft (Figure 7-8) as well as to the gear teeth of cam, crank and idler gear.

### WARNING

**LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

- 2) Verify that the mating surfaces of the crankcase and accessory case are clean, flat, and free from burrs or scoring.
- 3) Verify that the two alignment dowels are installed in the crankcase and at the proper setting height.
- 4) Install the accessory case gasket (Figure 7-21) to the crankcase over the dowels. If desired, a light coating of Titeseal No. 2 or K&W Coppercoat gasket sealer may be applied to both sides of the gasket around the area of the main oil passage above the right magneto bore.

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- 5) Verify alignment of timing marks on gears, and install the accessory case assembly over the tachometer shaft being careful to align the tangs of the oil pump drive shaft with the slots in the crankshaft gear.
- 6) Lightly tap the accessory case into place over the dowels using a soft hammer as required.
- 7) Secure the accessory case with washer (Figure 7-21), lock washer, and bolt at ten places. Secure with the bolt, washer and lock washer at two places.
- 8) Evenly tighten the bolts beginning with the two immediately outboard of the magneto bores and cross-torquing around the housing. Apply final torque to the bolts per Section 10 of this manual. After gasket has fully seated, double check all bolts for torque.
- 9) Trim the excess material of the accessory case gasket flush with the sump mating surfaces of the accessory housing and crankcase. See Figure 7-23.

### 7.17 Installation of Intercylinder Baffles

- 1) Install the intercylinder baffles with a small dab of high temp RTV. Use an old spring and hook to hold in place until the RTV sets up.

### 7.18 Inspection and Assembly of the Sump and Induction Housing

- 1) Inspect the sump (Figure 7-25) for security of the swaged intake pipe connectors (Figure 7-25), for general condition and damage to studs, threaded bosses and machined gasket surfaces.

**WARNING**  
**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

- 2) Place the sump gasket on the sump making certain that it slides over the sump studs without tearing.
- 3) Install the sump with bolts, lock washers, flat washers, and nuts at 16 places. Install the flat washers, lock washers, and nuts on the sump studs at 4. Snug the bolts and nuts, and evenly tighten in a cross-cross pattern around the entire sump. Torque the bolts and nuts to 96 in-lbs. per Section 10 of this manual.
- 4) Apply Food Grade Anti-Seize compound to the threads of the oil drain plug(s). Install the plug(s) in the sump, and torque to 160 in-lbs. Safety wire the plug(s) to the adjacent drilled holes on the sump using .032" safety lock wire.

**WARNING**  
**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

### 7.19 Installation of the Oil Pressure Relief Valve Assembly

- 1) Apply pre-lube oil to the threads in the crankcase at the oil pressure relief valve boss.
- 2) Insert the ball (Figure 7-2) into the hole in the crankcase.

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- 3) Install the pressure relief valve spring into the oil pressure relief valve housing.
- 4) Install the copper crush gasket on the relief valve housing so that the gasket seam will contact the crankcase.
- 5) Apply pre-lube oil to the threads of the oil pressure relief valve housing, and install the housing in the crankcase.
- 6) Tighten the relief valve assembly until the valve body contacts the gasket. Then tighten an additional 90° (1/4 turn). Safety wire the relief valve housing to the adjacent drilled hole in the crankcase using .032" safety lock wire.

**WARNING**  
**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

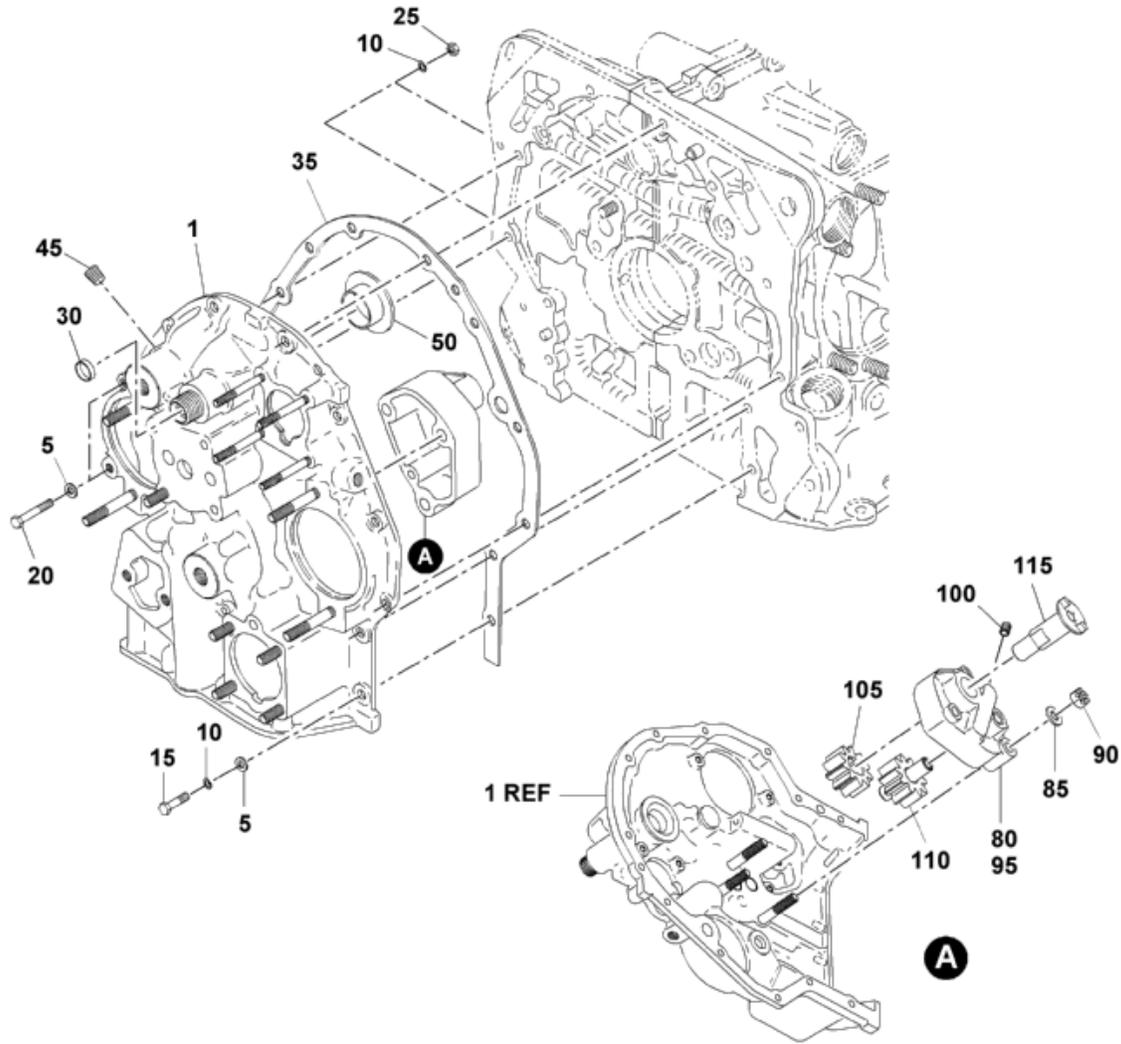
**7.20 Dipstick Housing and Dipstick (oil gauge)**

- 7) Install the dipstick housing (Figure 7-26) with the gasket into the crankcase. Tighten the assembly to 300 in-lbs.
- 8) Safety wire the dipstick tube to the adjacent drilled hole in the crankcase using .032" safety lock wire.

**WARNING**  
**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

- 9) Place an O-ring seal on the dipstick and install the dipstick into the tube.

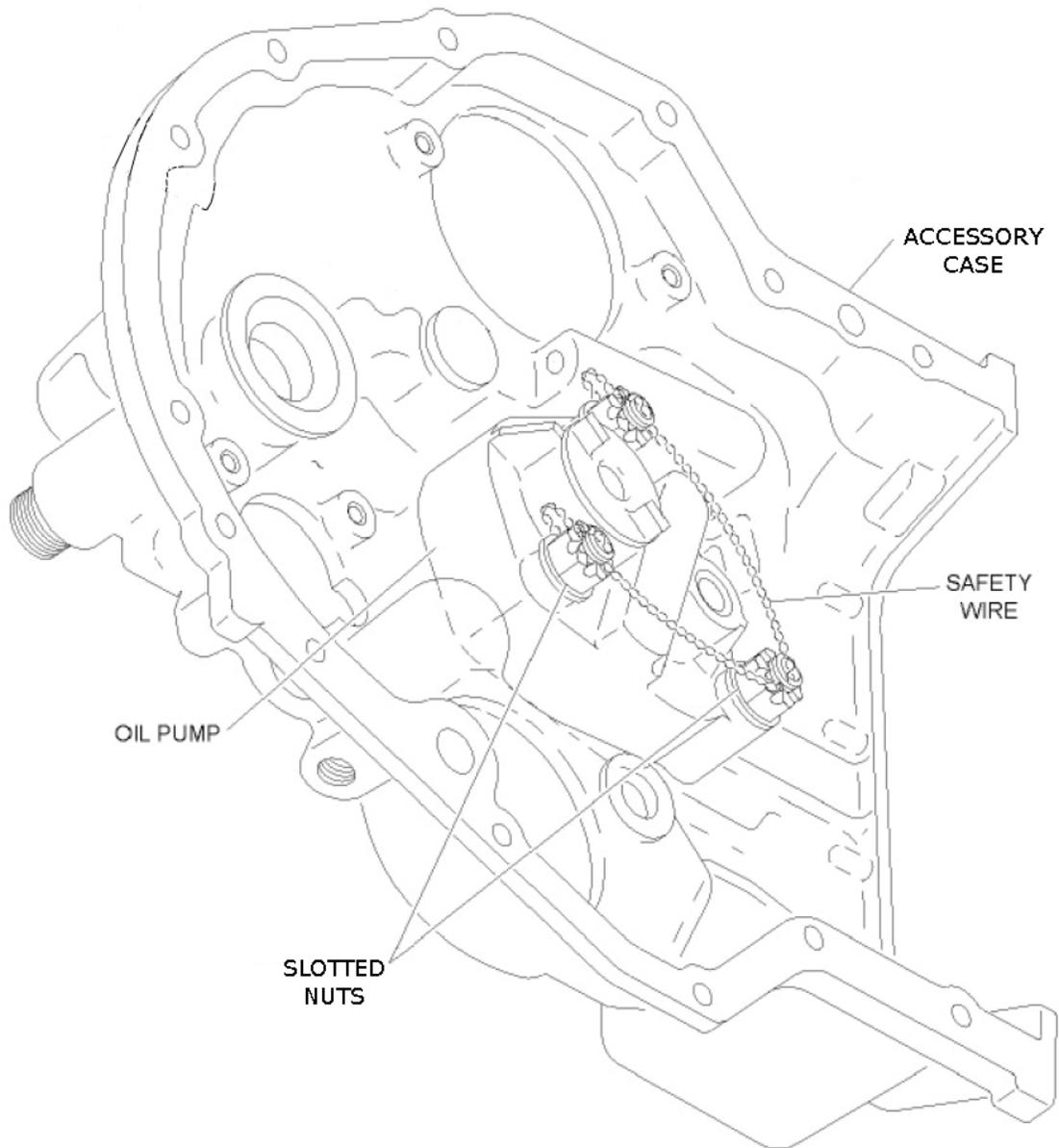
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**Figure 7-21  
Accessory Case and Oil Pump**

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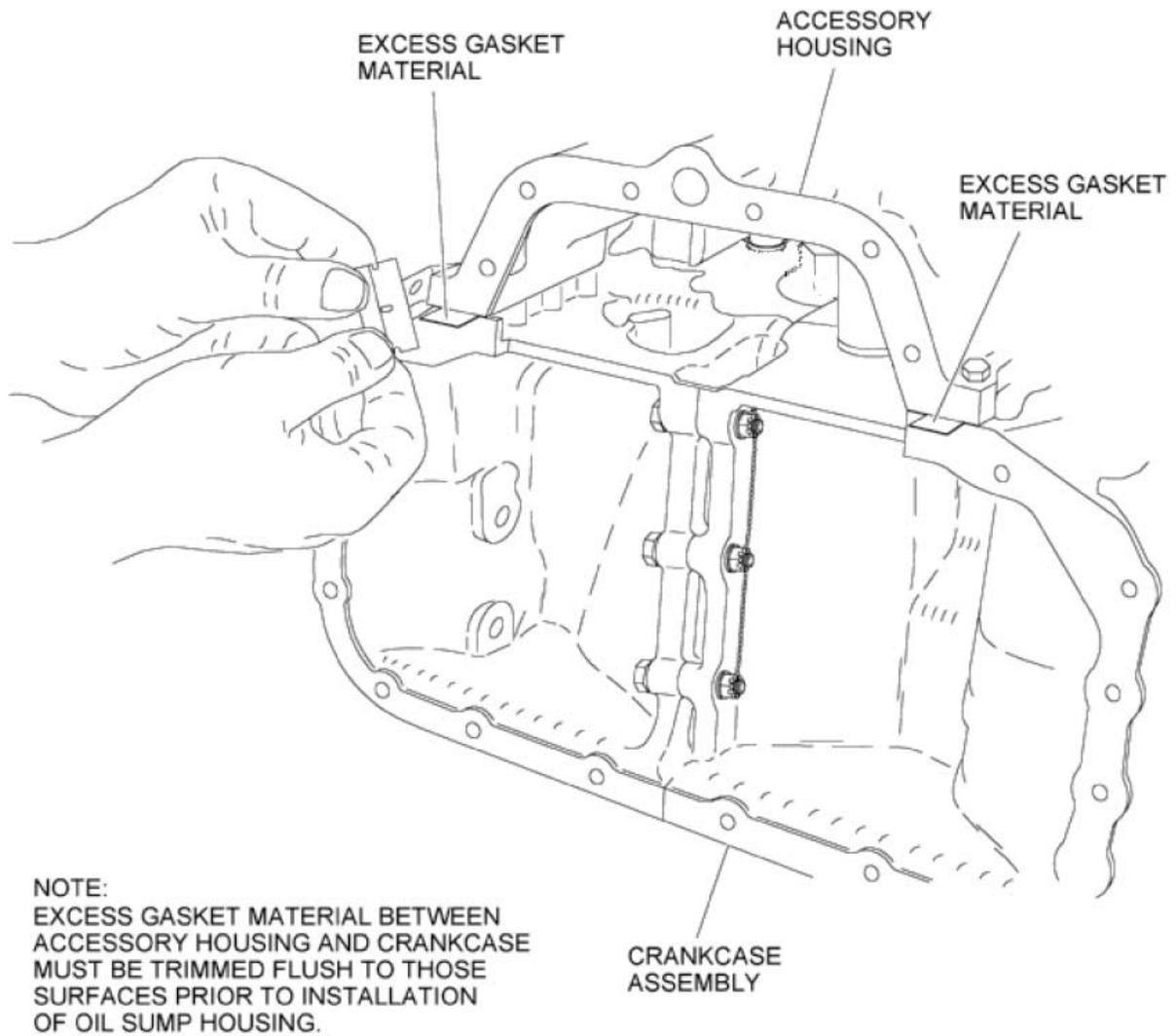
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**Figure 7-22 Oil Pump Assembly**

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**Figure 7-23 Trimming Accessory Case Gasket Material**

### **7.21 Installation of Cylinder Drain Tubes**

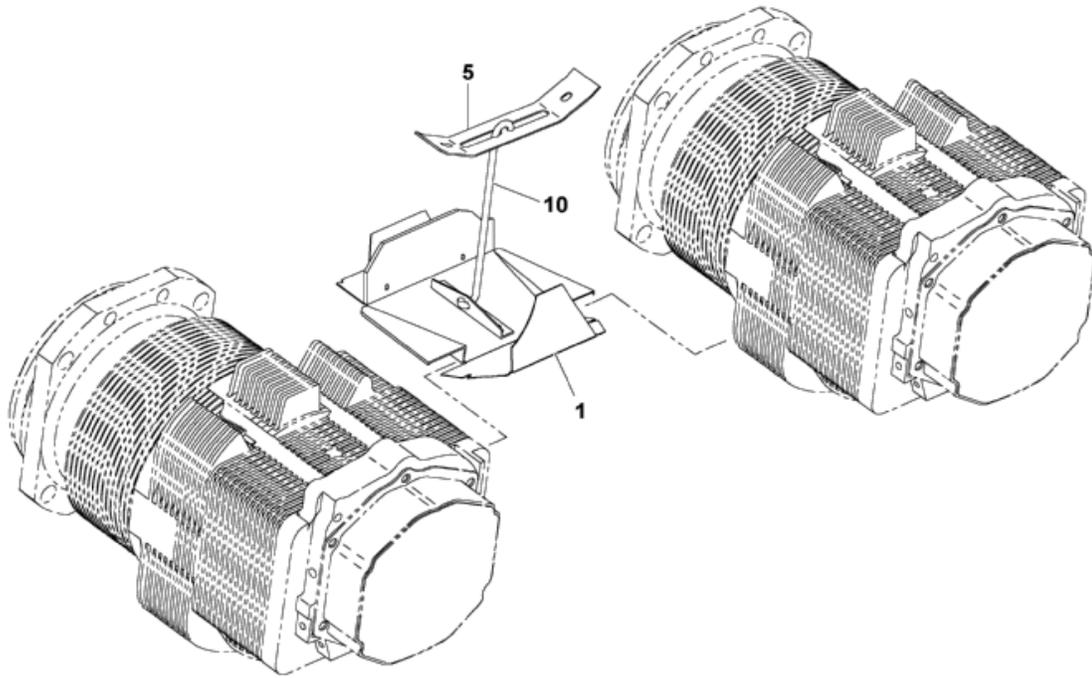
- 1) Install the cylinder drain tube hoses (Figure 7-16) on the nipples installed in the crankcase. Install two clamps on each hose, and position in inner clamp to secure the hose to each nipple. Torque the inner clamp to 10 in-lbs.
- 2) Apply pre-lube oil to the threads on the cylinder head drain fitting. Ensure that the fitting is tight and pointed in the correct direction.
- 3) Insert each drain tube into its respective drain hose and thread the B-nut onto the cylinder head fitting.
- 4) Position the outer clamp on each drain hose to secure the hose to the drain tube. Torque the clamp to 10 in-lbs. Hold the drain tube to prevent it from rotating or misaligning the drain hose, and torque each B-nut to 75-125 in-lbs.

### **7.22 Installation of Intake Pipes**

- 1) Slide an intake flange (Figure 7-27 or 7-28) onto the intake pipe so that the flanged end of the pipe rests in the recessed flat side of the intake flange.
- 2) Slide a 2" section of heat shrink seal over intake tube.
- 3) Lightly oil the threads of the bolts and place a lock washer and flat washer on each. Insert bolts into the holes in the intake flange, and install the gasket over the bolts. Refer to Figure 7-29.
- 4) Slide the heat shrink seal in place as the intake pipe is aligned with the sump intake stubs. Start the two flange bolts into the threaded holes in the cylinder intake port, and snug the bolts lightly.
- 5) Center the intake heat shrink seal over the joint between the intake pipe and the sump or plenum. Apply heat to the shrink tube to completely shrink it and seal the tubes from any air leaks.
- 6) Ensure that the flange end of the intake elbow fits completely in the recess in the aluminum flange and that the flange mates squarely with the intake port. Torque the bolts to 96 in-lbs. per Section 10.
- 7) Inspect installation of intake pipes and cylinder drain tubes to ensure that there is no interference of either with another part.
- 8) The rubber hose on the cylinder drain tubes should be positioned so that they apply light pressure on the intercylinder baffles.

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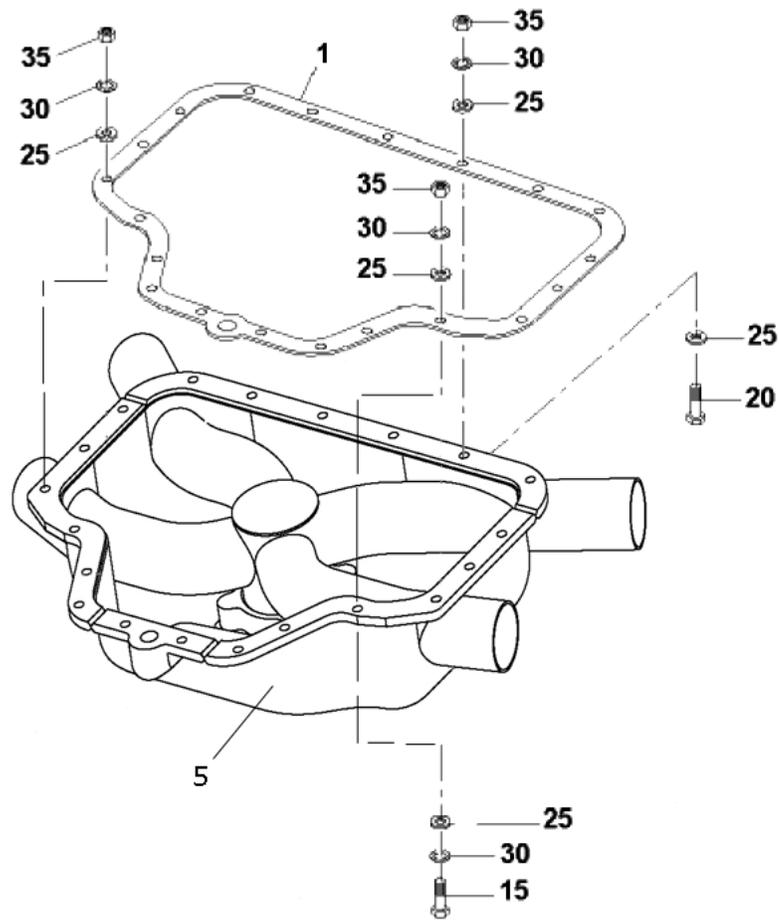
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- 1. BAFFLE ASSEMBLY
- 5. RETAINER
- 10. HOOK - RETAINER

**Figure 7-24 Intercylinder Baffle**

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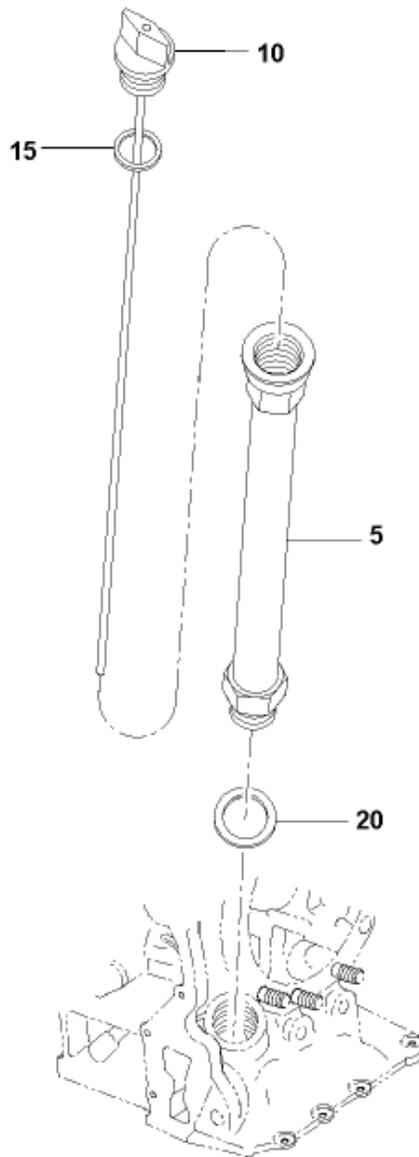


- |    |                  |    |               |
|----|------------------|----|---------------|
| 5  | Lightweight Sump | 30 | Washer – Flat |
| 15 | Bolt             | 35 | Hex Nut       |
| 25 | Washer – Lock    |    |               |

**Figure 7-25 • CubCrafters Special Lightweight Sump and Induction Housing**

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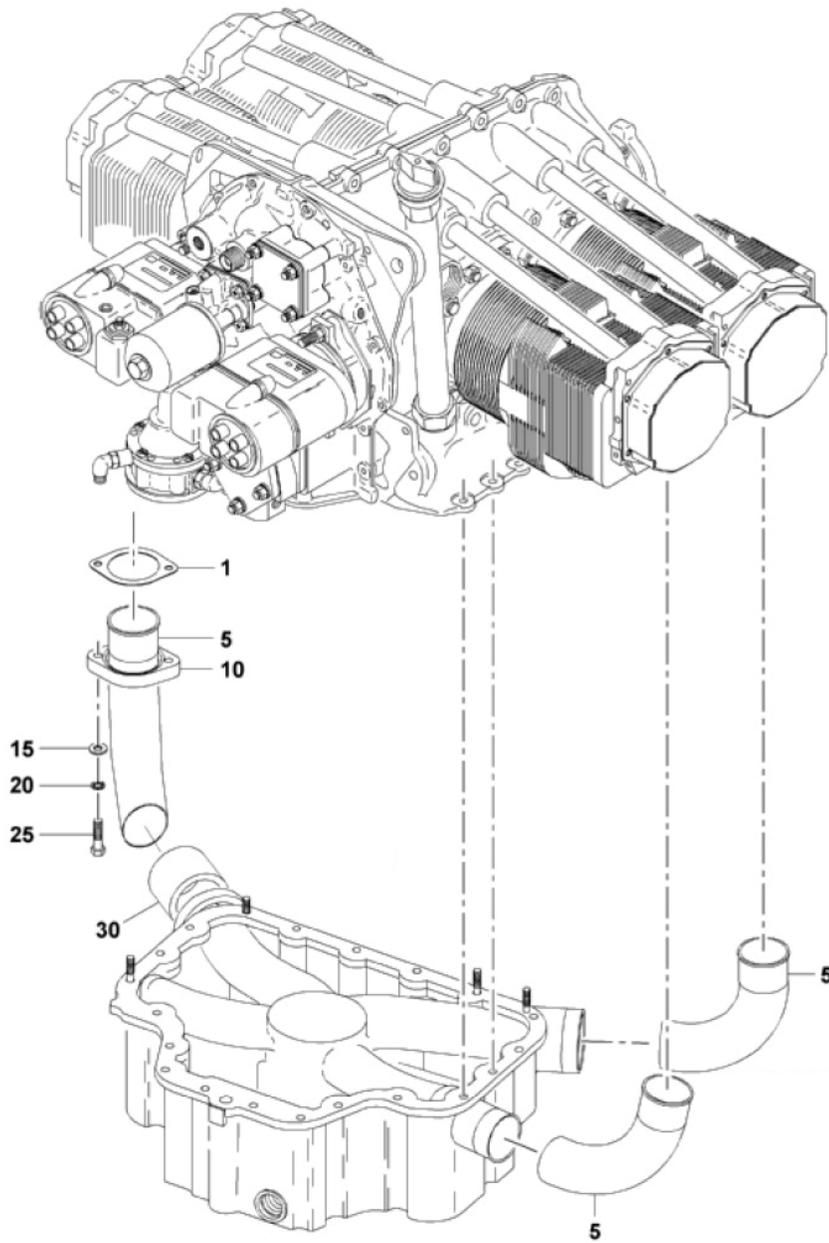


5.	DIPSTICK TUBE	15.	GAUGE SEAL
10.	DIPSTICK	20.	DIPSTICK TUBE SEAL

**Figure 7-26 Dipstick and Dipstick Tube**

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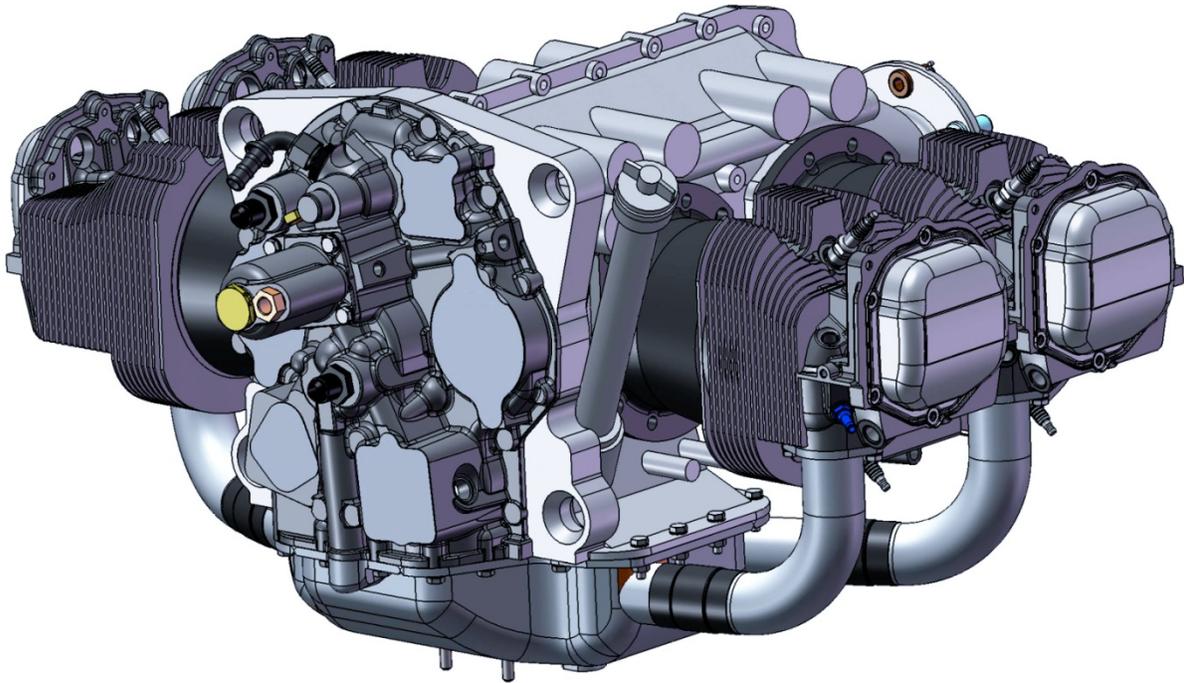


- |    |                      |    |                  |
|----|----------------------|----|------------------|
| 1  | Gasket - Flange      | 20 | Washer - Lock    |
| 5  | Pipe - Intake        | 25 | Screw Cap        |
| 10 | Flange - Intake Tube | 30 | Heat Shrink Seal |
| 15 | Washer - Plain       |    |                  |

**Figure 7-27 Intake Pipes and Hoses (“hot sump”)**

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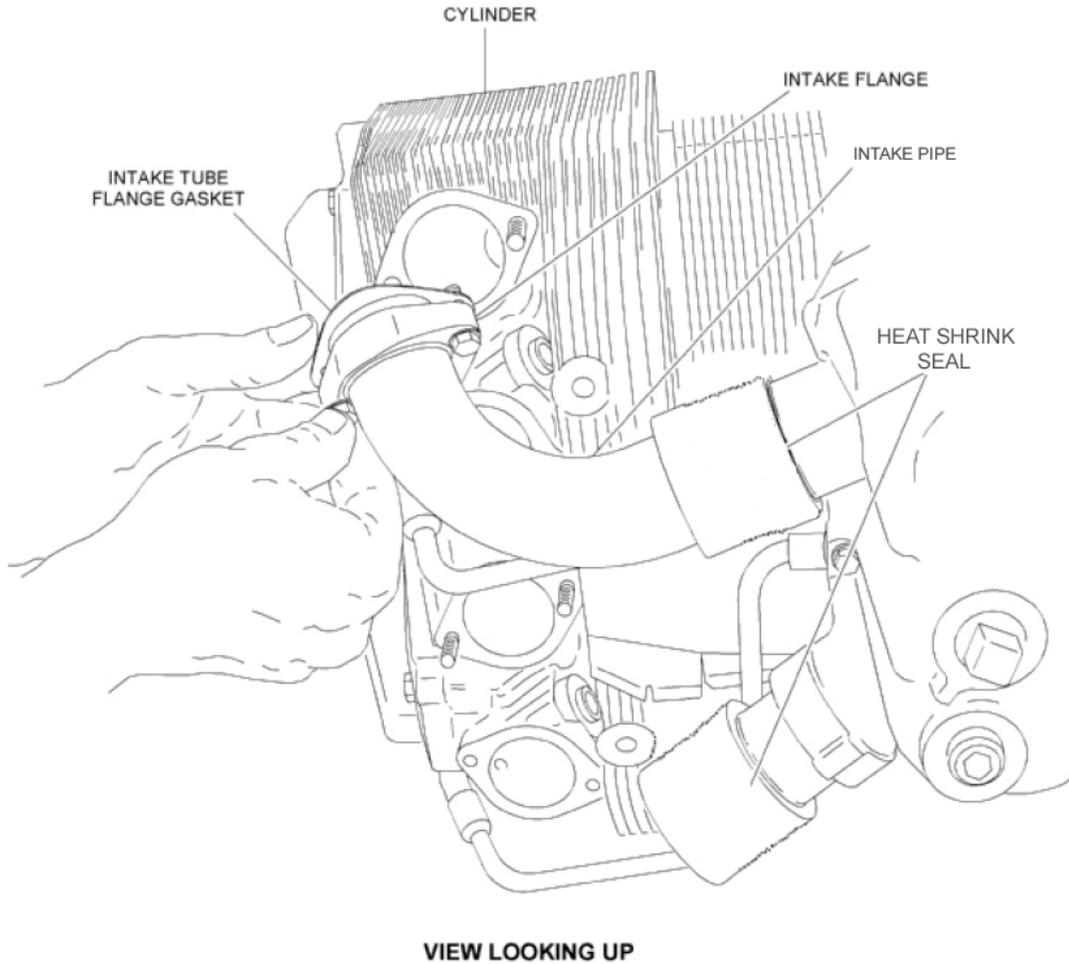
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**Figure 7-28 CubCrafters Special Lightweight Sump and Intake Pipes**

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**Figure 7-29 Intake Pipe Assembly (typical)**

**STOP!**

**PERFORM IN-PROCESS ASSEMBLY INSPECTION CHECKLIST #4.  
REFERENCE APPENDIX 7-4.**

### **7.23 Installation of Oil Pressure Screen and Housing**

- 1) Verify that an oil cooler bypass valve plunger and spring have been installed under the plug. Refer to note at paragraph 7-19 above. If plunger and spring are not present, install them at this time.
- 2) Examine the pressure screen and housing to ensure that they are clean and free of metal particles or damage.
- 3) Place the screen inside the housing, and install on the accessory case with the gasket, flat washers, lock washers, one .25-20 hex nut, and three screws. Torque to 96 in-lbs. per Section 10.

**WARNING**

**LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. OBTAIN AND READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER BEFORE USE. ALWAYS USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

**WARNING**

**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

### **7.24 Installation of Carburetor**

- 1) Verify the correct part number and model of the carburetor.
- 2) Install the carburetor (Figure 7-31) with the mixture control lever toward the rear of the engine. Install the carburetor using gasket, flat washers, lock washers, and .31-18 UNC hex nuts. Tighten and torque the nuts according to the following sequence:
  - Run the nuts onto the studs finger tight until the carburetor and gasket squarely contact the gasket surface of the sump/induction housing assembly.
  - Cross-torque the nuts to 90 in-lbs.
  - Cross-torque the nuts to 204 in-lbs.
  - Double-check the nuts after gasket has set to 204 in-lbs.

### **7.25 Installation of Primer System (If Furnished)**

A primer system is not ordinarily furnished with a CC340 engine. It is optional. If furnished, assemble according to the procedures below.

- 1) Apply Henkel Loctite™ no. 76732 anti-seize compound to the threads of the primer nozzles (Figure 7-30).

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- 2) Remove 1/8-27 NPT plugs from the intake ports in cylinder numbers 1, 2, and 4. Install the primer nozzles, and torque to 60 in-lbs.
- 3) Install the primer lines to the nozzles and "T" fittings. Clamp the primer lines to the intake pipes and sump flange per Figure 7-30.

#### **7.26 Light Speed Engineering CDI System Installation**

CC340's are equipped with Light Speed Engineering CDI (capacitor discharge ignition) systems. These are fully electronic ignition systems that rely on direct crankshaft sensors consisting of magnets installed in the starter gear support assembly ("flywheel") and transducer pickups mounted on the front of the crankcase.

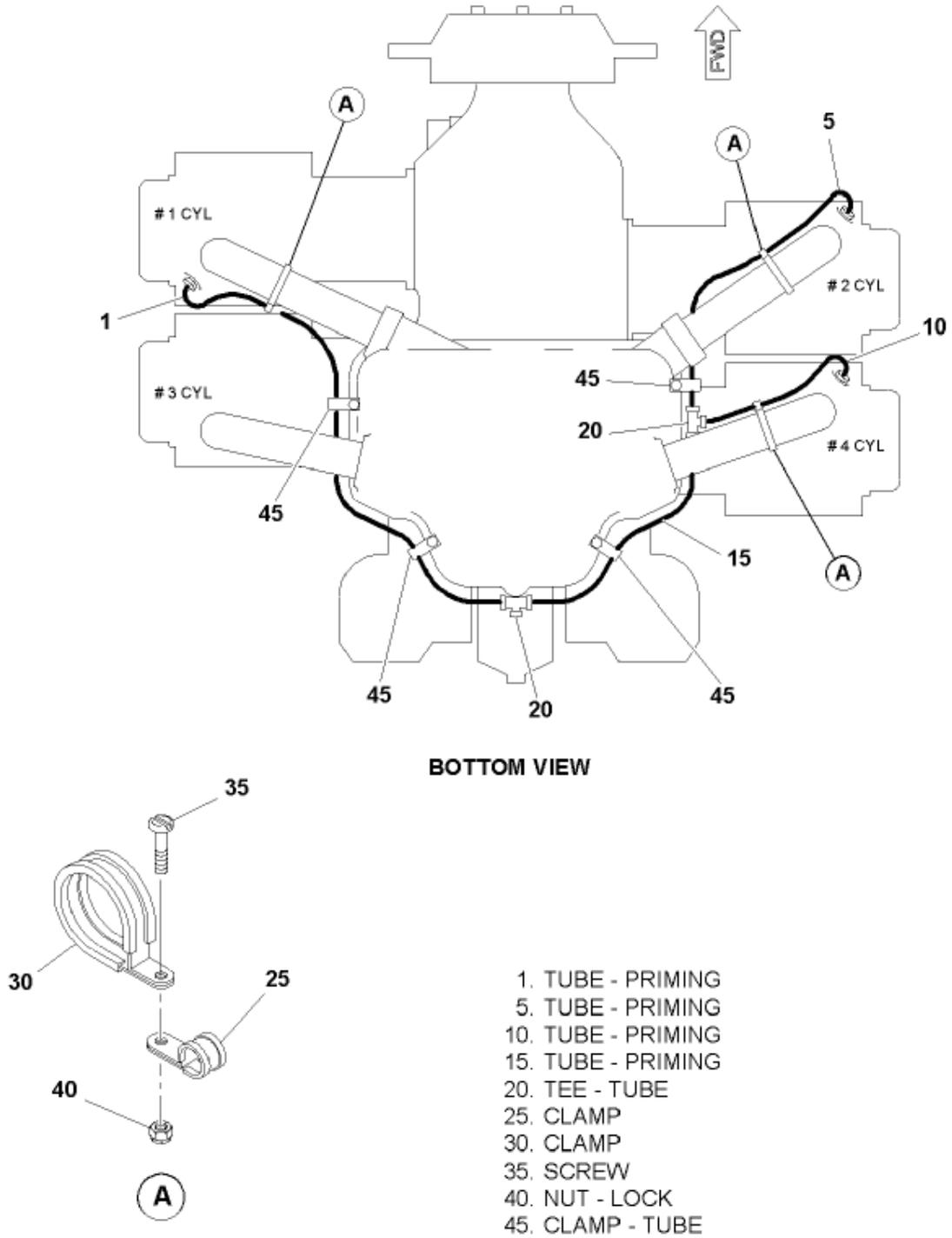
For installation of Light Speed CDI Systems, follow the installation instructions of the current Light Speed Engineering Plasma III CDI Systems Installation and Operation Manual. Light Speed CDI Systems will require modification of the starter ring gear support assembly prior to assembly.

See paragraph 1-3 and 1-4 in this manual for contact information for Light Speed Engineering and all other accessory manufacturers.

#### **7.27 Starter Installation**

- 1) Verify the starter part number and that the starter drive gear is compatible with the teeth of the gear on the starter gear support assembly. CC340 Engines are supplied with starter ring gears of 12/14 pitch with 149 gear teeth.
- 2) Verify that the starter mount boss has both .31" diameter dowels present. Mount the starter on the crankcase pad per starter manufacturer's installation instructions. Install flat washers (Figure 7-31), lock washers, one .31-18 UNC bolt and three .31-18 UNC hex nuts. Tighten and torque the bolt and nuts to 204 in-lbs.

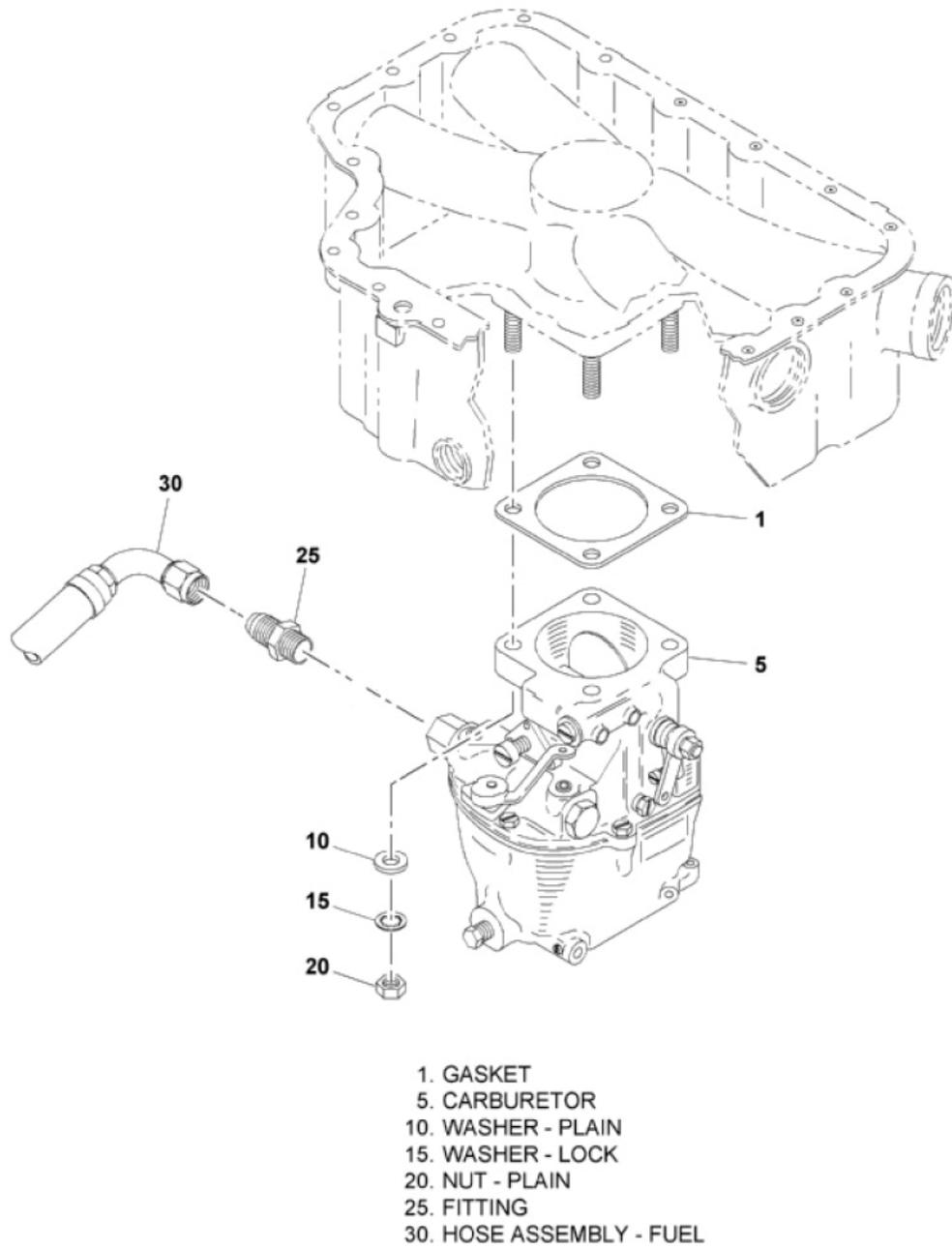
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**Figure 7-30 Fuel Priming System (optional)**

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**Figure 7-31 Carburetor Installation**

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## 7.28 Engine Removal

Remove the engine from the vertical support stand and place horizontally on suitable transfer cart or support stand.

**NOTE**

Support engine by the lifting eye using a hoist and/or by attaching the engine mount bosses to a suitable support stand. Do not rest the engine on the oil sump, valve rocker covers or intake pipes; and do not support it horizontally by the crankshaft flange.

## 7.29 Starter Gear Support Installation and Alternator Final Assembly

**NOTE**

If engine will use a Light Speed Engineering CDI System with direct crank sensors, ensure that the starter gear support assembly is correctly modified. Install the crank sensor brackets and adjust the sensors per Light Speed Engineering CDI System instructions.

- 1) Install the starter gear support assembly on the crankshaft flange. Note that one bushing in the crankshaft flange has a larger OD extending .24" forward of the flange face. This is the indexing bushing that MUST engage the one hole in the starter gear support assembly that has a larger ID than the other five.
- 2) The starter gear support assembly is correctly installed when the "TC #1" timing mark on the FRONT side of the starter gear support assembly aligns with the .07" diameter hole in the starter housing when the piston is at TDC in the #1 (right front) cylinder of the engine. At the same time, the "TC #1" mark on the AFT side of the starter gear support will be at 12:00 above the parting line of the crankcase.
- 3) Verify that the starter gear support assembly rests squarely against the crankshaft flange, and install two bolts with flat washer and suitable spacers over the protruding flange bushings in order to secure the starter gear support to the crankshaft flange.
- 4) Install alternator belt (not shown) on starter ring gear support assembly and alternator sheave. Adjust alternator and/or brackets to achieve proper alignment. Use a straightedge to verify.
- 5) Adjust belt tension to allow a mid-span deflection of 0.31" with a 14-lb load.

**NOTE**

An alternate method of checking belt tension is to measure the torque required to slip the belt at the small alternator pulley. A new belt is properly tensioned when 12 ft-lb  $\pm$ 1 is required to cause it to slip. Note that belt tension may require adjustment soon after engine operation begins.

- 6) Torque and safety the 3/8-24 slotted nuts to 360 in-lb.

**WARNING**

**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

- 7) Torque and safety all other attaching hardware in accordance with recommended torque values of Section 10 of this manual.

**STOP!**

**PERFORM IN-PROCESS ASSEMBLY INSPECTION CHECKLIST #5.  
REFERENCE APPENDIX 7-5.**

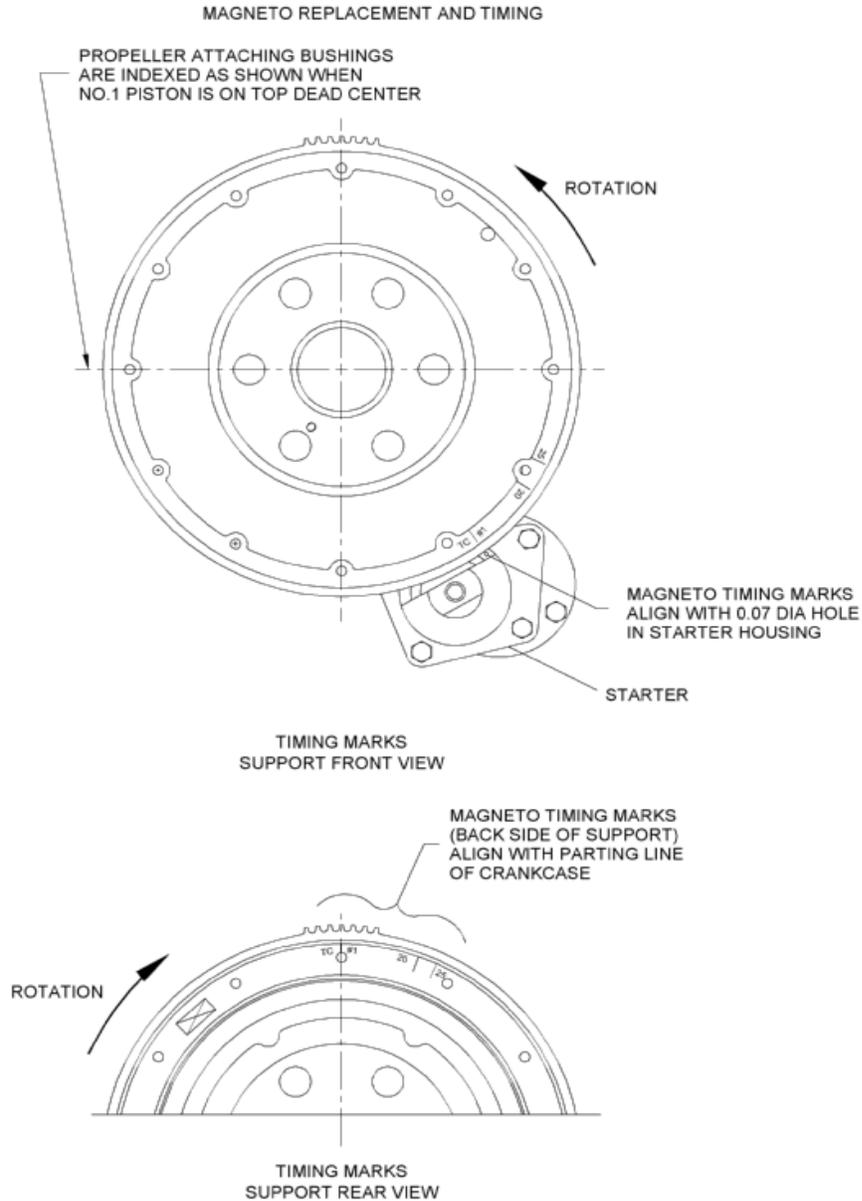


Figure 7-32 Starter Ring Gear Support and Timing Marks

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**Figure 7-33 Alternator Installation**

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**Appendix 7-1 • In-Process Assembly Inspection Checklist #1**

**NOTE**

This checklist may be photocopied and identified with engine model number and serial number and kept as part of the permanent engine maintenance records.

- Verify correctness of all parts and procedures prior to further assembly of crankcase halves to the crankshaft assembly.
- In-process assembly inspection shall include visual inspection of parts and written records in accordance with the assembly guidelines in this Overhaul Manual.
- This inspection shall be accomplished during the engine assembly process as noted in the Section 7 of this manual. Perform the following inspections, and initial each item:

- \_\_\_\_\_ 1 Crankcase serial numbers match, each case half
- \_\_\_\_\_ 2 Crankshaft part number correct
- \_\_\_\_\_ 3 Camshaft part number correct
- \_\_\_\_\_ 4 Main bearing part numbers correct and fit properly; oil holes present and clear; bearing dowels present and correct height
- \_\_\_\_\_ 5 All pipe plugs, nozzles, oil passage plugs and fittings are properly installed in the case halves
- \_\_\_\_\_ 6 Lifter bodies fit properly in lifter bore and all bodies are installed
- \_\_\_\_\_ 7 Camshaft rotates freely in each case half, end clearance correct
- \_\_\_\_\_ 8 All crankcase mating surfaces clean, free of burrs and/or scoring;
- \_\_\_\_\_ 9 Crankshaft thrust bearing and slinger clearance correct
- \_\_\_\_\_ 10 Connecting rod side clearance correct
- \_\_\_\_\_ 11 Connecting rod installation and rod/cap match number orientation correct
- \_\_\_\_\_ 12 Connecting rod nut assembly correct with the raised face visible; torque correct
- \_\_\_\_\_ 13 Connecting rods spin freely on crankpin with no binding
- \_\_\_\_\_ 14 Nose bolts are installed with o-rings in the right case half
- \_\_\_\_\_ 15 O-rings present on rear thru studs in right case half and at 4 main saddles, left case half
- \_\_\_\_\_ 16 Crankshaft gear fully seated, clearance checks OK; bolt torque, lock tab secure
- \_\_\_\_\_ 17 Crankshaft seal installed with the flat side toward crankshaft prop flange; spring correctly installed in the seal groove or lip.
- \_\_\_\_\_ 18 Front main bearing on the crankshaft has correct part number, alignment marks match and are correctly oriented
- \_\_\_\_\_ 19 Tachometer shaft centering spacer, shaft assy. and circlip correctly installed in camshaft

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**Appendix 7-2 • In-Process Assembly Inspection Checklist #2**

**NOTE**

This checklist may be photocopied and identified with engine model number and serial number and kept as part of the permanent engine maintenance records.

- Inspect and verify the correct assembly of cylinders and assembly hardware, including proper torque and safety techniques. Verify the internal timing of the crankshaft gear, camshaft gear, and idler gear as well as proper clearances and gear lash.
- This quality inspection shall include visual and physical inspection of parts and assemblies in accordance with the assembly guidelines in this Overhaul Manual.
- This inspection shall be accomplished during the engine assembly process as noted in Section 7 of this manual. Perform the inspections, and initial each item:

- \_\_\_\_\_ 1 Sealer and silk thread properly applied
- \_\_\_\_\_ 2 Crankcase halves properly assembled keeping front main bearings in place
- \_\_\_\_\_ 3 O-rings were in place as case halves were drawn together
- \_\_\_\_\_ 4 Crankshaft seal properly seated in both halves
- \_\_\_\_\_ 5 Peripheral hardware in place to hold case halves together
- \_\_\_\_\_ 6 Center and front thru bolts properly installed and centered
- \_\_\_\_\_ 7 Valves, springs and keys properly assembled; two springs on each valve
- \_\_\_\_\_ 8 Pistons correct part number; weights match OK; skirt clearance in cylinder within limits
- \_\_\_\_\_ 9 Piston rings correct type; end gap and side clearance within limits
- \_\_\_\_\_ 10 Base seal on each cylinder barrel skirt before installation on crankcase
- \_\_\_\_\_ 11 Torque of cylinder base nuts correct and checked per Section 10
- \_\_\_\_\_ 12 Torque on all crankcase assembly hardware in accordance with Section 10
- \_\_\_\_\_ 13 Slotted nut on drilled stud under the camshaft gear torqued; safety wire installed
- \_\_\_\_\_ 14 Safety wire on drilled belly bolts/slotted nuts at sump location
- \_\_\_\_\_ 15 Idler shaft hardware properly safety wired; pigtails clear idler gears
- \_\_\_\_\_ 16 Clearance between the idler shaft stud and left idler gear OK
- \_\_\_\_\_ 17 Timing marks align correctly between the crankshaft gear, idler gear, and camshaft gear with #1 cylinder on TDC (top dead center).
- \_\_\_\_\_ 18 Backlash of the idler gears with the crankshaft gear and camshaft gear within limits

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**Appendix 7-3 • In-Process Assembly Inspection Checklist #3**

**NOTE**

This checklist may be photocopied and identified with engine model number and serial number and kept as part of the permanent engine maintenance records.

- Inspect and verify proper installation, safety, and clearances of the cylinder valve train and accessory housing subassembly prior to rocker cover and accessory housing installation.
- This quality inspection shall include visual inspection of assembly and safety techniques. A physical check of clearances shall be performed as described in this list.
- This inspection shall be accomplished during the engine assembly process as noted in the Section 7 of this manual. Perform the inspections, and initial each item:

- \_\_\_\_\_ 1 Hydraulic units proper part number and checked for free operation
- \_\_\_\_\_ 2 Hydraulic units and pushrod sockets correctly installed
- \_\_\_\_\_ 3 Pushrod tube seals installed correctly and in proper position
- \_\_\_\_\_ 4 Pushrod tube retainer spring correctly installed over each pushrod; lock tab secure
- \_\_\_\_\_ 5 Exhaust valve rotator cap present on the stem of each exhaust valve
- \_\_\_\_\_ 6 Dry tappet clearance for each rocker arm checked and within limits per Section 10
- \_\_\_\_\_ 7 Rocker shaft thrust buttons present in each rocker shaft
- \_\_\_\_\_ 8 Valve rocker covers properly installed; torque of attaching screws correct for gasket
- \_\_\_\_\_ 9 Accessory case inspected for freedom from damage, general condition OK
- \_\_\_\_\_ 10 Tachometer shaft seal installed correctly
- \_\_\_\_\_ 11 Plugs and fittings installed correctly
- \_\_\_\_\_ 12 Oil pump pad in serviceable condition
- \_\_\_\_\_ 13 Oil pump housing attaching nuts correctly safety wired
- \_\_\_\_\_ 14 Oil pump drive shaft rotates smoothly
- \_\_\_\_\_ 15 Fuel pump plunger installed correctly (head contacts idler gear)

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**Appendix 7-4 • In-Process Assembly Inspection Checklist #4**

**NOTE**

This checklist may be photocopied and identified with engine model number and serial number and kept as part of the permanent engine maintenance records.

- Inspect and verify proper installation of the accessory case, rocker covers, intercylinder baffles, sump, cylinder drain tubes, induction/intake system, vacuum pump adapter
- This quality inspection shall include visual and physical inspections of the complete engine assembly.
- This inspection shall be accomplished after the engine assembly has been completed as noted in Section 7 of this manual. Perform the inspections, and initial each item:

- \_\_\_\_\_ 1    Accessory case properly installed, gasket trimmed
- \_\_\_\_\_ 2    Intercylinder baffles correct for cylinder type; installation correct
- \_\_\_\_\_ 3    Valve rocker covers secure
- \_\_\_\_\_ 4    Oil sump securely installed; suction screen and drain plugs installed and safety wired
- \_\_\_\_\_ 5    Oil pressure relief valve secure; safety wire in place
- \_\_\_\_\_ 6    Oil dipstick and dipstick tube properly installed; safety wire in place
- \_\_\_\_\_ 7    Cylinder drain tubes installed correctly; B-nuts tight; hose clamps secure
- \_\_\_\_\_ 8    Intake pipe flanges and gaskets installed correctly; flange mates parallel to port surface
- \_\_\_\_\_ 9    Vacuum pump adapter installed correctly; gear end clearance and backlash within limits

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**Appendix 7-5 • In-Process Assembly Inspection Checklist #5**

**NOTE**

This checklist may be photocopied and identified with engine model number and serial number and kept as part of the permanent engine maintenance records.

- Inspect and verify proper installation of the fuel pump, prop governor and adapter, governor oil line, oil filter adapter or pressure screen, carburetor or fuel injection system, ignition system, starter, alternator, starter gear support assembly and ignition timing
- This quality inspection shall include visual and physical inspections of the complete engine assembly.
- This inspection shall be accomplished after the engine assembly has been completed and prior to engine test. Perform the inspections, and initial each item:

\_\_\_\_\_ 1 Oil pressure screen and housing secure; bypass plunger and spring installed

\_\_\_\_\_ 2 Carburetor installation correct and secure

\_\_\_\_\_ 3 Primer lines or fuel injection lines and hoses properly routed and secure, as applicable

\_\_\_\_\_ 4 CDI ignition system components properly installed and secure

\_\_\_\_\_ 5 Starter correct model for ring gear type; starter installation secure

\_\_\_\_\_ 6 Starter gear support properly indexed; gear teeth match starter drive

\_\_\_\_\_ 7 CDI system timing correct for model and compression ratio

\_\_\_\_\_ 8 Spark plugs correct heat range; installed and torqued; ignition leads properly routed and clamped

\_\_\_\_\_ 9 All hardware secure; air inlet, ex ports and breather fitting fitted with plugs or covers

\_\_\_\_\_ 10 Engine preserved awaiting test run: \_\_\_\_\_ *Signature* \_\_\_\_\_ *Date*

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## **Section 8. ENGINE INSTALLATION, RUN-IN and BREAK-IN**

### **8.1 General Information**

Equipment, materials and procedures to accomplish installation, run-in and break-in are listed in Table 8-1 below.

CC340 engines are supplied with Nickel+Carbide™ cylinder bores. However, the information in this section applies to all types of cylinder bores that may be fitted to the engines such as:

- STEEL - Plain, nitrided, through hardened
- CHROME - Porous, silicon carbide impregnated
- NICKEL COMPOSITE - Cerminil® process or Nickel+Carbide™

<b>Item</b>	<b>Vendor</b>
Engine Hoist	Commercially Available
Aircraft engine oil, 20W50 mineral, no anti-scuff additive	Commercially Available
Aviation shop tools, including calibrated torque wrenches	Commercially Available
Engine pre-oiler	Commercially Available or Fabricated Locally
Engine test stand or test cell, if available	Commercially Available
Test club, if available	Commercially Available
Engine cooling duct	Fabricated Locally

**Table 8-1 Equipment and Materials List**

### **8.2 Run-In and Break-In**

CC340 engines are assembled and tested for a period of one to two hours prior to release for installation. This test run typically does not accomplish complete engine break-in but serves an important function which is to:

- Prove that the engine will produce rated power and/or static RPM
- Correct any oil, fuel, or induction leaks
- Check general operation of the fuel system
- Allow engine oil pressure to be set
- Provide initial stage of break-in

After run-in, the engine is released to the installer who deals with installation, baffling, fuel settings, additional break-in and other unique considerations which can only be dealt with on the actual airframe in which the engine will operate.

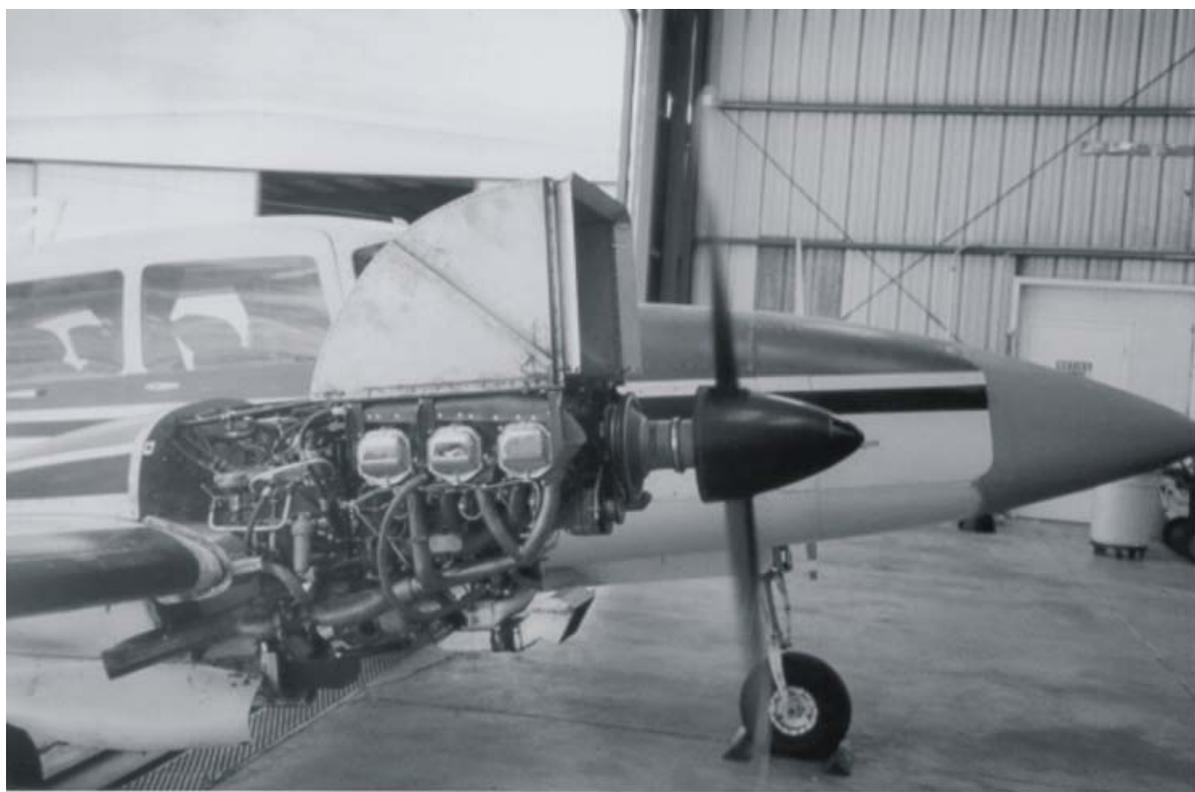
Break-in is understood to occur upon installation of the engine in the aircraft when, after initial adjustments and functional tests, the engine is test flown for a period of several hours during which piston ring seating occurs so that oil consumption and cylinder/oil temperatures stabilize. During this process any final adjustments are made to fuel systems and propeller governor RPM settings, etc.

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The preferred location to accomplish run-in is in a dedicated aircraft engine test cell or test stand. However, run-in may also be accomplished successfully on the aircraft when proper precautions are observed and the necessary equipment is used. Regardless of whether accomplished in a test cell or on-wing, engine run-in requires the use of a properly designed engine cooling duct (or “shroud”) such as the one in Figure 8-1 below.

The major consideration during run-in is adequate cooling of the cylinders and oil. Inter-cylinder baffles must be in place so that cooling air is forced between the cooling fins of the cylinder barrels on the downwind side as well as the side facing the cooling air. The duct and baffles must be appropriate to the type engine and propeller to be used. Test club type propellers are generally much smaller diameter than flight propellers, thus forcing the air close to the engine. Since flight propellers move most of the air near the blade tips, the duct used must be much taller to capture the necessary cooling air.



**Figure 8-1 Engine Run-In Using Flight Propeller and Cooling Duct**

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## 8.3 Preparing Engine for Run-In (in test cell or on-wing)

If the engine has been preserved, accomplish the following:

1. Remove all protective wrapping, tape or desiccant bags.
2. Inspect the engine for rust, corrosion or shipping damage; and repair as required.
3. Remove desiccant plugs or shipping plugs installed in the upper spark plug holes of the cylinders, and inspect the cylinder bores for contamination.
4. Remove the shipping plugs installed in the lower spark plug holes, and turn the crankshaft through at least twice to remove any excess preservative oil from the cylinders.
5. Drain preservative oil from the engine.

**WARNING**  
**ENGINE OIL IS HAZARDOUS AND MAY CAUSE INJURY TO SKIN AND EYES. WEAR PERSONAL PROTECTIVE GEAR.**

**NOTE**

Engines exposed to cold temperatures for more than four hours should be brought into an atmosphere of at least 70°F for 24 hours or more before attempting to drain the preservative oil. If this is not possible, warm the engine using heat lamps before attempting to drain the oil.

6. Remove oil suction screen to ensure that preservative oil flows out freely and has not congealed in the screen. Replace screen with a new gasket and safety wire. Tighten plug per Section 10.

**WARNING**  
**ALWAYS WEAR SAFETY GOGGLES WHEN CUTTING, INSTALLING, OR REMOVING SAFETY LOCKWIRE OR HELICAL COIL THREADED INSERTS.**

7. Remove protective plugs or covers from exhaust ports, crankcase breather fitting and air inlet. Ensure that any desiccant bags or capsules installed in these locations are removed.
8. Replace the oil drain plug(s) in the sump, and torque per Section 10. Install safety wire.

## 8.4 Engine Run-In Using Test Cell

**NOTE**

If test cell or test stand is not available for run-in, proceed to par. 8-5 below. Engine **MUST** be run-in using 100LL aviation gasoline.

1. Assess engine accessory drive pads such as the vacuum pump pad and prop governor drive pad.
2. If no vacuum pump is installed, verify that the drive adapter has a metal cover and gasket securely installed to prevent an oil leak. If vacuum pump is installed, either remove the pump and install a cover on the drive pad or install fittings in the pump and connect the inlet and outlet with a hose. Use no oil on the fittings.

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3. If a prop governor drive pad is installed but the engine will be run-in using a fixed pitch propeller or test club, ensure that a metal and gasket are securely installed on the governor adapter. If a constant-speed test propeller will be used for run-in, remove the cover from the adapter and install the prop governor with a new gasket, flat washers, lock washers and .31-18 UNC hex nuts. Cross-torque the nuts to 204 in-lbs.
4. Mount the engine securely on the test stand, and connect necessary fuel supply and return, fuel pressure, oil pressure, oil cooler, and manifold pressure hoses. Install an oil temperature probe and connect the lead(s) to the instrument. Connect a breather tube to the breather fitting on the accessory case. Connect throttle, mixture and governor (if applicable) control cables, and check rigging for free movement and full travel. Connect P-leads to magnetos or CDI system. Install an air box with filter on the carburetor, fuel injector servo or throttle assembly.
5. Connect the tachometer cable if a mechanical tachometer is to be used, or connect the electronic tachometer as required.
6. Install all necessary baffles, baffle seals and engine cooling duct.

### NOTE

If engine will be run-in using a dynamometer rather than a propeller or test club, a forced air cooling system must be provided. Forced air cooling systems must provide all the cooling air required during the run-in test and should be able to maintain cylinder temperatures below 400°F (204°C) at any point in the process. Intercylinder baffles are normally required, and the cooling system should be capable of maintaining at least 6 inches of water static pressure differential between the cooling air intake and outlet.

7. If engine is intended for constant speed propeller operation in the aircraft but will be run-in using a fixed pitch propeller, install an expansion plug in the front of the crankshaft per par. 6-7.20. If engine is intended for constant speed propeller operation in the aircraft and will be run-in using a constant speed propeller but an expansion plug is installed in the front of the crankshaft, the plug must be removed per par. 4-4.6s. Verify that an undrilled plug is installed at the rear of the front main ID aft of the cross tube in the crankshaft ID.
8. Ensure that the propeller hub is completely clean, and Install the propeller using a new O-ring seal, and torque hub bolts per propeller manufacturer's data.

### WARNING

**DO NOT INSTALL THE IGNITION HARNESS "B" NUTS ON THE SPARK PLUGS UNTIL THE PROPELLER INSTALLATION IS COMPLETED. FAILURE TO COMPLY COULD RESULT IN BODILY INJURY WHEN THE PROPELLER IS ROTATED DURING INSTALLATION.**

9. Install a test exhaust system or individual exhaust pipes approximately 10 inches long on each exhaust port.
10. Fill an oil can with a long, slightly curved extension tube with Phillips XC 20W50 aviation oil. Rotate the propeller so pistons are at the mid point of their travel. Insert the oil can tube into each cylinder until it contacts the upper side of the cylinder wall. Apply several shots of oil while moving to tube to various positions. This will oil both cylinder walls somewhat before start-up.

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**WARNING**  
**ENGINE OIL IS HAZARDOUS AND MAY CAUSE INJURY TO SKIN AND EYES. WEAR PERSONAL PROTECTIVE GEAR.**

11. Remove both 1/8-NPT plugs from the front of the main oil galleries in the crankcase. Connect an engine pre-oiler containing Phillips XC 20W50 aviation oil to one oil gallery. Pressurize the oil gallery system until oil begins to flow out the other oil gallery. Install the plug in the open oil gallery, and continue pressurizing the engine oil system at approximately 35 PSI until approximately one quart of oil has been pumped into the system. Slowly rotate the propeller through two or three revolutions as the engine is being pre-oiled. Some pressure should show on the test cell gage. Remove the pre-oiler and reinstall the oil gallery plug.
12. Fill the engine with the required quantity of Phillips XC 20W50 aviation oil.
13. Install the spark plugs in all cylinder holes and torque per Section 10. If using spark plug thermocouples to provide cylinder head temperature (CHT), install these in place of spark plug gasket(s). If not using spark plug thermocouples, install bayonet-type adapters and CHT thermocouples.
14. Connect a suitable ground strap to the engine, and connect the starter cable to the starter.
15. Double-check the security of all installations and connections. Leaving fuel and magneto switches "off", crank the engine through several revolutions to ensure adequate clearance. If the propeller does not turn freely, find and correct the cause of the problem before attempting to start the engine.

**WARNING**  
**USE THE CORRECT PERSONAL PROTECTION EQUIPMENT TO AVOID INJURY. ENSURE AREA IS FREE OF LOOSE OBJECTS THAT COULD BE MOVED BY PROPELLER AIR BLAST.**

16. When engine starts, hold RPM to 1200 and observe oil pressure. If oil pressure is not achieved within 10-30 seconds, STOP ENGINE IMMEDIATELY TO DETERMINE THE CAUSE.
17. After oil pressure is obtained, increase engine RPM to 1800; and run for three minutes. Shut engine down to check for fuel and oil leaks and correct as required.

**WARNING**  
**USE NECESSARY PROTECTIVE GEAR. HEATED PARTS MAY CAUSE SEVERE BURNS.**

18. Re-start engine and operate at approximately 1200 RPM until oil temperature reaches 140° F. Adjust fuel and oil pressure as required and check magneto drop. Note CHT and general engine operation.
19. When oil temperature reaches 140° F, run-in the engine according to Stages 1-6 of Table 8-2 below. However, CHT should not exceed 400° F.
20. At the end of Stage 6 of the run-in schedule, bring the engine to idle, and adjust idle mixture and idle speed as required. Shut down the engine, and drain the oil into a clean

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container of known weight for exactly ten (10) minutes. Return the oil to the engine adding approximately ¼ cup to account for residual oil in container.

**WARNING**  
**HOT OIL MAY CAUSE BURNS TO EYES AND SKIN. WEAR SPLASH GOGGLES AND INSULATED GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

21. Re-start the engine, and when oil temperature reaches 140° F begin Stage 7 of the run-in schedule, the oil consumption run. CHT should not exceed 400° F.
22. After 60 minutes, shut down the engine and drain the oil for exactly ten (10) minutes into the same container of known weight (washed to remove all residual oil). Weight the oil to determine the amount consumed.

**WARNING**  
**HOT OIL MAY CAUSE BURNS TO EYES AND SKIN. WEAR SPLASH GOGGLES AND INSULATED GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

23. If engine operation and oil consumption are satisfactory, remove the propeller and remove the engine from the test cell or test stand. Use care to install protective covers or caps to all open holes and fittings.
24. Preserve engine if it will be stored, or proceed to par. 8-5, "Preparing The Engine For Service".

Stage	RPM	Engine Load	Time (Minutes)	Remarks
Stage 1	1500	Propeller load	20	Check magneto drop. Do not exceed 125 RPM on either magneto. Difference between magnetos should not exceed 35 PRM.
Stage 2	1800	Propeller load	10	
Stage 3	2000	Propeller load	10	
Stage 4	2200	Propeller load	10	
Stage 5	2400	Propeller load	10	
Stage 6	Normal rated*	Propeller load	15	
Stage 7	Normal rated*	Propeller load	60	Oil consumption run.

**Table 8-2 Recommended Run-In Schedule**

### 8.5 Preparing the Engine for Service

Procedures in this paragraph assume that the engine has been prepared for run-in per paragraph 8.3 above and that it has been run-in in a test cell per paragraph 8.4 or will be run-in on the aircraft per paragraph 8.8 below. If engine has been preserved after run-in in a test cell, repeat the steps of paragraph 8.3 above, then proceed as follows:

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1. Assess engine accessory drive pads such as the vacuum pump pad and prop governor drive pad. If no accessory is to be installed, verify that a metal cover is securely installed on the drive along with the proper gasket.
2. If necessary to install a vacuum pump or lightweight gear-driven alternator, remove the cover from the drive adapter, and install the vacuum pump or alternator in accordance with paragraph 7.28 in this manual.
3. If a propeller governor is to be installed, verify that the drive adapter and oil line are installed in accordance with paragraph 7.32 in this manual. Remove the cover plate from the drive adapter. Lubricate the governor shaft splines with engine oil, install a new gasket, and then install the propeller governor making sure that the splines properly engage the shaft gear. Install flat washers and new lock washers. Install .31-18 UNC hex nuts and cross-torque to 204 in-lbs. per Section 10.
4. If not already installed, install the alternator mounting brackets, alternator and drive belt; and adjust belt tension in accordance with paragraphs 7.43 and 7.45 in this manual.
5. Install any airframe manufacturers' required cooling baffles, hoses, fittings, brackets and ground straps in accordance with airframe manufacturer's instructions.
6. If the engine will operate with a fixed pitch propeller, verify that it has an expansion plug installed in the front of the crankshaft flange pilot journal. Verify that rear plug in front main ID is not present or has a hole. If rear plug has no hole and crank ID is 1.87", pierce the rear plug with approximately .19" diameter hole. If crank ID is 1.31", remove the 1/8-NPT pipe plug from the center of the rear plug. Be careful to not damage the oil cross tube ahead of the rear plug. Then install a new front expansion plug per Repair No. 6.7.20 in this manual.
7. If engine will operate with a constant speed propeller but has an expansion plug installed in the front of the crankshaft, remove the expansion plug per paragraph 4.4.6.19 in this manual. Inspect the crankshaft ID to determine whether a rear plug is installed. If the crankshaft ID is 1.87" and no rear plug is installed, a new rear plug must be installed with special tooling. If the crankshaft ID is 1.31" and a rear plug is installed but the 1/8-NPT pipe plug is removed, install a new 1/8-NPT plug and torque to 35 in-lbs.
8. If the crankshaft ID is 1.87" and a rear plug is installed but this plug is drilled or pierced, engine disassembly is required. If the crankshaft ID is 1.31" and no rear plug is installed, engine disassembly is required.

### 8.6 Installation of Engine

1. Install engine per airframe manufacturer's instructions. Use only the lifting eye bracket installed on the backbone of the crankcase to hoist the engine.
2. Consult the above instructions and manual for instructions for engine-to-airframe connections and rigging of controls. Remove all protective covers, plugs, caps and identification tags as each item is connected or installed.
3. Follow all requirements of Section 3, Standard Practices, in this manual. Follow torque recommendations of Section 10 of this manual or those of the airframe or propeller manufacturer. Use only calibrated torque wrenches and do not substitute similar hardware for a specific manufacturer part number.
4. The aircraft fuel tanks and lines must be purged to remove all contamination prior to installation in the main fuel inlet line to the fuel pump or engine.

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### WARNING

**FUEL IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. USE ONLY IN A WELL VENTILATED AREA FREE FROM SPARKS, FLAME, OR HOT SURFACES. AVOID EYE AND SKIN CONTACT. ALWAYS WEAR SPLASH GOGGLES, SOLVENT-RESISTANT GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

### CAUTION

**Failure to purge the aircraft fuel tanks and lines can cause erratic fuel system operation and damage to fuel system components.**

5. Install the approved propeller in accordance with the manufacturer's instructions.

### WARNING

**DO NOT INSTALL THE IGNITION HARNESS "B" NUTS ON THE SPARK PLUGS UNTIL THE PROPELLER INSTALLATION IS COMPLETED. FAILURE TO COMPLY COULD RESULT IN BODILY INJURY WHEN THE PROPELLER IS ROTATED DURING INSTALLATION.**

6. Inspect the induction system and exhaust system to verify that all items are secure and do not interfere with other components.
7. Inspect all electrical wiring, instrument wiring tachometer cable (if applicable), engine control cables, oil lines, fuel lines and air lines for security. Ensure that all connections allow normal movement of the engine on its rubber mounts so that engine movements do not apply improper loads to the controls or lines. Ensure that no lines or wiring are routed close to the exhaust system.
8. Calibrate the engine oil dipstick as follows:
  - Ensure that air pressure in tires and oleo struts is within airframe manufacturer's limits.
  - Move aircraft to a level location so that it is parked in its normal ground attitude.
  - Add four (4) quarts of Phillips XC20W50 oil, or equivalent, to the engine. Allow five minutes for each bottle to drain.
  - Install the dipstick and remove. Note the oil level and scribe or lightly vibro-peen a line on the dipstick at the level of the oil. Vibro-peen the digit "4" just above this line.
  - For six (6) quart sumps, add a fifth quart of oil. Wipe off the dipstick, reinstall and remove. Note the oil level, scribe a line and vibro-peen "5" Just above it. Add a sixth quart of oil. Wipe off the dipstick, reinstall and follow the same procedure to mark the 6-quart level.
  - For eight (8) quart sumps, add two (2) quarts of oil and mark the 6-qt. level on the dipstick. Add two additional quarts of oil and mark the 8-qt. level on the dipstick. The dipstick is now calibrated for this particular engine and aircraft.

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### **8.7 Precautions Prior to Engine Start-up**

- Refer to the engine warranty. Violation of these procedures will void the engine's warranty.
- Thoroughly review the aircraft manufacturer's flight manual for aircraft systems and engine operating instructions and precautions.
- Review Engine Operating Instructions Manual for 4-cylinder engines.
- Start the engine only if an assistant is available who can observe the aircraft for any concerns that cannot be observed from the aircraft cockpit.
- Ensure that adequate fire extinguishing equipment is available and that its correct use is understood.
- Use only 100LL aviation gasoline for all run-in and break-in operation of the engine.
- Do NOT use Lycoming engine oil additive, P/N LW-16702, oils containing the additive, or synthetic oils.
- Verify accuracy of instruments required for engine operation.
- Engine baffles and seals must be in good condition and properly installed.
- Correct any defects before starting the engine.

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**WARNING**

**OPERATION OF A DEFECTIVE ENGINE WITHOUT DETERMINING THE CAUSE(S) OF THE DEFECT(S) MAY RESULT IN FURTHER DAMAGE TO ENGINE COMPONENT PARTS AND POSSIBLE INJURY TO PERSONNEL. ENSURE THAT ALL NECESSARY INSPECTION AND TROUBLESHOOTING PROCEDURES ARE ACCOMPLISHED. THESE PRECAUTIONS WILL HELP TO PREVENT INJURIES TO PERSONNEL AND/OR DAMAGE TO THE EQUIPMENT.**

**WARNING**

**USE THE CORRECT PERSONAL PROTECTION EQUIPMENT TO AVOID INJURY. ENSURE AREA IS FREE OF LOOSE OBJECTS THAT COULD BE MOVED BY PROPELLER AIR BLAST.**

### **8.8 Engine Run-in on the Aircraft**

Engine run-in on the aircraft should not be attempted if ambient air temperature is below 50° F or above 90° F. Run-in on the aircraft also assumes the use of a cooling duct as shown above in Figure 8-1. Accomplish run-in on the aircraft according to the procedures in this paragraph. Before starting, the engine must be pre-oiled as described below:

1. Remove the ignition leads from the spark plugs, and remove the spark plugs.
2. Fill an oil can with a long, slightly curved extension tube with Phillips XC 20W50 aviation oil. Rotate the propeller so that pistons are at the mid point of their travel. Insert the oil can tube into each cylinder until it contacts the upper side of the cylinder wall. Apply several shots of oil while moving the tube to various positions. This will oil both cylinder walls somewhat before start-up.

**WARNING**

**ENGINE OIL IS HAZARDOUS AND MAY CAUSE INJURY TO SKIN AND EYES. WEAR PERSONAL PROTECTIVE GEAR.**

3. Remove both 1/8-NPT plugs from the front of the main oil galleries in the crankcase. Connect an engine pre-oiler containing Phillips XC 20W50 aviation oil to one oil gallery. Pressurize the oil gallery until system until oil begins to flow out the other oil gallery. Install the plug in the open oil gallery, and continue pressurizing the engine oil system at approximately 35 PSI until approximately one quart of oil has been pumped into the system. Slowly rotate the propeller through two or three revolutions as the engine is being pre-oiled. Some pressure should show on the test cell gage. Remove the pre-oiler and reinstall the oil gallery plug.
4. If the engine was filled to maximum sump capacity calibration of the dipstick prior to pre-oiling, the sump may be over-filled. Check oil level and drain oil from the sump as required to return oil level to no more than the 6- or 8-quart level.
5. Install the spark plugs in all cylinder holes and torque per Section 10. If using spark plug thermocouples to provide cylinder head temperature (CHT), install these in place of spark plug gasket(s). If not using spark plug thermocouples, install bayonet-type adapters and CHT thermocouples. It is preferable to have each cylinder instrumented for CHT.
6. Head aircraft into the wind for ground runs.

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7. Limit initial run to three minutes. Hold initial engine RPM to 1200 to obtain oil pressure, and then increase to 1800 RPM to minimize cam lobe stress. If oil pressure is not obtained within 30 seconds, shut down and investigate cause.
8. Allow engine to cool (below 100°F CHT), and repeat short runs up to 2000 RPM to ensure discrepancies are corrected. Note that low RPM increases stress on cam lobes. Under no circumstances should high power be used to adjust fuel flow (flight without proper fuel flow is damaging to the engine). Engine runs should be limited to three minutes when using porous chrome plated cylinders.\* Runs on all other cylinder types should be limited to four minutes to prevent overheating. While performing ground runs, do not permit cylinder head temperatures to exceed 400°F or oil temperature to exceed 200° F. During the last run before flight, a short full power application of 10-20 seconds is advisable to ensure take-off power is available. An idle mixture check is also advisable (reference the appropriate fuel system service data).

### NOTE

The operator should be aware that, if installed, older porous type chrome plated cylinder bores have more critical cooling requirements than other cylinder bore surfaces.

9. The engine installation should be thoroughly inspected prior to the first flight. Fuel and oil leaks should be corrected and all baffles and cowling should be re-inspected. The oil should be checked to ensure that blow-by has not darkened it excessively, and to verify the quantity.
10. Cycling the propeller can place unnecessary stresses on the cylinders, and should be minimized prior to first flight. We recommend that the propeller be cycled sparingly, and only to verify that oil has filled the propeller dome and propeller control has been achieved.
11. Initial flight when OAT is above 90°F is not recommended.
12. Keep aircraft weight to a minimum. Only required crew should be aboard the airplane for the test flight.
13. On take-off, use minimum power to reach 40 MPH (IAS) before applying required take-off power. CAUTION: Determine that there is sufficient runway remaining in order to reach take-off airspeed.
14. Use take-off power only as long as necessary to get to BEST CLIMB AIRSPEED. Reduce manifold pressure to minimum required for clean in-flight attitude. Leave propeller in flat pitch for at least 5 minutes after take-off. For aircraft not equipped with a variable pitch propeller or manifold pressure gauge, reduce power to 75%. Use minimum rate of climb with maximum air speed consistent with terrain.
15. When desired altitude is reached and cylinder head and oil temperatures are satisfactory, aircraft should be operated at 75% power until 20-30 minutes of flight time have elapsed. The engine should then be operated at various power settings and engine operating parameters observed until at least 45 minutes of flight time have elapsed. All power changes should be made very gradually, especially power reductions.
16. During the test flight, any time that a persistent high oil or cylinder head temperature is noted, a precautionary landing and inspection should be made to determine the cause. Maximum permissible cylinder head temperatures are published in each specific engine's type certificate data sheet. These maximum permissible temperatures range from 450°F to 525°F, depending on the engine type. Consult your specific engine's type certificate data sheet for maximum operating temperature.

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17. On initial flight, after at least 30 minutes of satisfactory flight time have been accumulated, the aircraft should be landed and the engine be re-inspected. Oil consumption should be noted; and, if excessive, should be investigated before further flight.
18. Test flight and results should be entered in the engine log books before the airplane is released to service. Operators should be cautioned against long ground runs and prolonged climbs at low air speeds.
19. Ground operations and continuous climb at low airspeed should be minimized until the engine has accumulated at least 25 hours operating time. Cylinder overheating can cause cylinder bore glazing and/or piston scuffing at any time during engine operation but cylinder assemblies are most susceptible to these problems during the first 25-50 hours of operation. Whenever glazing and/or scuffing become severe, the only remedy is to remove the offending cylinder(s), mechanically remove the glaze, replace the piston if necessary and install a new set of rings.

### **8.9 Engine Break-In Procedures (first 100 hours)**

Cub Crafters, Inc. recommends the break-in procedures below for the first 100 hours of operation for any new or overhauled engine, regardless of the type of cylinder bore surface on the engine.

For convenience, Appendix 8-1 provides a sample engine break-in record that may be photocopied and completed and added to the engine or aircraft permanent maintenance records.

1. Verify that the engine has been run-in. See par. 8-2 above. If run-in has not been performed, follow the procedures of par. 8-3 through 8-8 above.
2. For the initial flight after run-in, fast idle (850-1,000 RPM) engine for three to four minutes. Shut down and inspect for oil leaks. During ground runs, do not permit cylinder head temperatures to exceed 400°F or oil temperature to exceed 200°F.
3. Thereafter, perform all necessary pre-flight inspections, start engine, run up normally, taxi and take off immediately to minimize ground running. Reduce manifold pressure as soon as practical. Slowly reduce engine speed to maximum continuous RPM (top of green) for fixed pitch propellers, reduce power to 75%.
4. Maintain a shallow climb to keep cylinder head temperatures as low as possible. Maximum permissible cylinder head temperature.
5. Level off at altitude and maintain 75% power for at least 30 minutes. During the first 50 hours of the break-in period, piston rings will seat best if cruise is maintained at 65% to 75% power. Oil consumption will also be optimized under these operating conditions. Normal ground idle may be used after the engine temperatures and oil consumption have satisfactorily stabilized.
6. Keep flying weight to a minimum to reduce power requirements during take off.
7. Follow break-in lubrication procedures recommendations below in par. 8-10, Lubrication for Run-In and Break-In.

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**8.10 Lubrication For Run-In and Break-In**

Cub Crafters, Inc. recommends the use of Phillips X/C 20W50 aviation engine oil for run-in and break-in as well as continued operation. This oil is ashless dispersant to keep contaminants and sludge from accumulating in the engine so that they may be flushed out with each oil change. Its multi-viscosity flow characteristics provide optimum lubrication at all normal operating temperatures. Since the oil is 100% mineral-based, no oil change is required to facilitate the break-in process for any newly installed cylinders unless optional LW-16702 oil additive has been added.

For best results and long engine life, perform engine oil and filter changes according to the schedule in Table 8-3.

<b>Hours Since New or Since Overhaul</b>	<b>Maintenance Actions</b>	<b>Lubrication Package</b>
0	Initial fill-up	Phillips X/C 20W50
10	Change oil and filter	Phillips X/C 20W50
35	Change oil and filter	Phillips X/C 20W50 (LW-16702 additive optional)
60	Change oil and filter	Phillips X/C 20W50 (LW-16702 additive optional)
*Every 50 hrs. or 3 months, whichever comes first	Change oil and filter	Phillips X/C 20W50 (LW-16702 additive optional)
<b>Table 8-3 Oil and Filter Change Schedule</b>		

\*If engine has oil pressure screen but does not have spin-on filter, reduce oil change intervals to 25 hours or 3 months, whichever comes first.

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**Appendix 8A Break-In Record**

**NOTE**

This checklist may be photocopied and identified with engine model number and serial number and kept as part of the permanent engine maintenance records.

**NAME:** \_\_\_\_\_

**STREET:** \_\_\_\_\_

**CITY:** \_\_\_\_\_ **STATE:** \_\_\_\_\_ **ZIP CODE:** \_\_\_\_\_

**COUNTRY:** \_\_\_\_\_ **PHONE:** \_\_\_\_\_

**A/C MODEL:** \_\_\_\_\_ **ENGINE MODEL:** \_\_\_\_\_

**AIRPORT:** \_\_\_\_\_

**POWER SETTINGS:** \_\_\_\_\_

**TACH:** \_\_\_\_\_ **M.P.:** \_\_\_\_\_

**GROUND TIME:** \_\_\_\_\_

**FLIGHT TIME:** \_\_\_\_\_ **AVG HRS/MONTH:** \_\_\_\_\_

**Break-In Checklist for First Flight:**

- \_\_\_\_\_ Read entire contents of Section 8 of Overhaul Manual
- \_\_\_\_\_ Ensure engine was successfully run-in (if not, refer to Section 8.4 through 8.8)
- \_\_\_\_\_ Did not use synthetic oil
- \_\_\_\_\_ 100LL aviation gasoline Used
- \_\_\_\_\_ Checked oil/fuel levels
- \_\_\_\_\_ Pre-lubed engine prior to starting
- \_\_\_\_\_ Started engine, ran up normally, taxied and took off
- \_\_\_\_\_ Did not cycle (feather) propeller during flight
- \_\_\_\_\_ Climbed out at a low angle of attack for BEST CLIMB AIRPSEED
- \_\_\_\_\_ Leveled off at 2000-3000 feet AGL if traffic and conditions permitted
- \_\_\_\_\_ Kept power at top of the green arc on the tachometer and MAP gauge or 74% power (whichever is higher) for ½ hour

**Remarks:** \_\_\_\_\_

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## Section 9: Troubleshooting

### 9.1 General Information

This section provides troubleshooting procedures and possible causes for the most common symptoms of improper engine operation. When troubleshooting, review all possible causes. Begin by ruling out possible causes that are most easily investigated.

For additional information refer to the Light Speed Engineering troubleshooting in Paragraph 9.3 of this manual.

When investigating possible causes of lubrication system problems, refer to Figure 2-18.

- Special tools and equipment are listed in Table 9-1.
- An index of Troubleshooting Procedures is found in Table 9-2.

<b>Table 9-1 • Special Tools and Equipment</b>	
<b>Item</b>	<b>Vendor</b>
Electrical Multi-Tester	Commercially Available
Ignition System Hi-Tension Lead Tester	Commercially Available

<b>Table 9-2 • Troubleshooting Procedures Index</b>	
<b>Symptom Set</b>	<b>Table</b>
Engine Will Not Start	9-3
Engine Kickback During Starting	9-4
Engine Roughness at Idle	9-5
Engine Does Not Develop Full Power	9-7
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High Cylinder Head Temperature (CHT)	9-10
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Excessive Oil Consumption	9-13
Crankshaft Seal Leaks	9-14

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## **9.2 Troubleshooting Procedures**

The utmost care must be taken when performing troubleshooting engine problems and maintenance of any kind. Remove and re-install items such as the aircraft cowling and engine cooling baffles in accordance with the airframe maintenance manual. Always observe the precautions listed below.

**WARNING**

**OPERATION OF A DEFECTIVE ENGINE WITHOUT DETERMINING THE CAUSE(S) OF THE DEFECT(S) MIGHT RESULT IN FURTHER DAMAGE TO ENGINE COMPONENT PARTS AND POSSIBLE INJURY TO PERSONNEL. ENSURE THAT ALL NECESSARY INSPECTION AND TROUBLESHOOTING PROCEDURES ARE ACCOMPLISHED. THESE PRECAUTIONS WILL HELP TO PREVENT INJURIES TO PERSONNEL AND/OR DAMAGE TO THE EQUIPMENT.**

**WARNING**

**FUEL IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. USE ONLY IN A WELL VENTILATED AREA FREE FROM SPARKS, FLAME, OR HOT SURFACES. AVOID EYE AND SKIN CONTACT. ALWAYS WEAR SPLASH GOGGLES, SOLVENT-RESISTANT GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

**WARNING**

**HOT OIL MAY CAUSE BURNS TO EYES AND SKIN. WEAR SPLASH GOGGLES AND INSULATED GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

**WARNING**

**ENGINE OIL IS HAZARDOUS AND MAY CAUSE INJURY TO SKIN AND EYES. WEAR PERSONAL PROTECTIVE GEAR.**

**WARNING**

**TO PREVENT THE POSSIBILITY OF SERIOUS BODILY INJURY OR DEATH, DO THE FOLLOWING BEFORE MOVING THE AIRCRAFT PROPELLER:**

- **VERIFY THAT ALL SPARK PLUG LEADS ARE DISCONNECTED.**
- **VERIFY THAT IGNITION SWITCHES ARE CONNECTED TO IGNITION SYSTEM AND THAT SWITCHES ARE IN THE "OFF" POSITION.**
- **VERIFY THAT THROTTLE POSITION IS "CLOSED."**
- **VERIFY THAT MIXTURE CONTROL IS IN "IDLE-CUT OFF."**
- **SET AIRCRAFT BRAKES AND BLOCK WHEELS. ENSURE THAT AIRCRAFT TIE DOWNS ARE INSTALLED, AND VERIFY THAT THE CABIN DOOR LATCH IS OPEN.**
- **DO NOT STAND WITHIN THE ARC OF THE PROPELLER BLADES WHILE TURNING THE PROPELLER.**

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<b>Table 9-3 • Engine Will Not Start</b>	
<b>Possible Cause</b>	<b>Corrective Action</b>
No fuel	Turn fuel selector "On" and/or fill tanks with fuel
Excessive priming	Pull circuit breakers for each ignition system, place mixture control in "Idle Cut-Off", open throttle and clear cylinders by cranking a few seconds. Repeat several times. Reset ignition breakers and resume normal starting procedures.
Insufficient priming	Repeat priming procedures and resume normal starting procedures. Stroke throttle while engine is turning.
Ignition system shorted	Check with electric tester, and replace any defective wires.
Low or dead battery	Recharge or replace battery.
Insufficient fuel flow	Main fuel strainer clogged. Disconnect fuel line and check fuel flow. Clean or replace fuel filter.
Water in carburetor	Drain fuel tank sumps and main fuel strainer. Drain carburetor and fuel lines.
Internal failure	Perform cylinder pressure test to check for piston or valve problems. Check oil screens for metal particles. If found, complete overhaul of the engine may be required.
CDI system provides no spark	Check for proper sensor adjustment and electrical power. Refer to Paragraph 9.3 for CDI system troubleshooting guide.

<b>Table 9-4 • Engine Kickback During Starting</b>	
<b>Possible Cause</b>	<b>Corrective Action</b>
Starter unable to pull completely through compression stroke	Troubleshoot starter or charge battery
Incorrect ignition timing	Check and adjust CDI system ignition timing.
Spark plug leads crossed	Check engine electrical system diagram and make correction of connections.

<b>Table 9-5 • Engine Roughness at Idle</b>	
<b>Possible Cause</b>	<b>Corrective Action</b>
Incorrect idle mixture	Adjust mixture.
Water in fuel	Drain fuel sumps and main fuel strainer. Drain carburetor float bowl.
Induction system air leak	Tighten all connections in the induction system. Replace any damaged parts.
Incorrect idle speed adjustment	Adjust throttle stop to obtain correct idle.
Carburetor idle jet plugged	Clean and repair carburetor.
Dirty or fouled spark plugs	Clean or replace spark plugs.
Uneven cylinder compression	Check condition of piston rings and valve seats.
Spark plug wires damaged	Replace ignition harness

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**Table 9-7 • Engine Does Not Develop Full Power**

Possible Cause	Corrective Action
Induction system air leak	Tighten all connections and replace damaged parts.
Crankshaft/camshaft internal timing incorrect	Check internal timing with #1 cylinder at TDC. Remove #2 rocker cover and rotate crankshaft +/- 20°. Rocker should have equal movement.
Throttle valve does not fully open	Adjust throttle lever or cable for proper rigging.
Improper fuel flow	Check main fuel strainer and fuel lines for restrictions. Check fuel pump(s) for proper operation. Check fuel system settings.
Mixture too lean or too rich	Check fuel system settings and operation of fuel pumps.
Restriction in air filter or inlet	Replace filter and examine air inlet to remove restrictions.
Improper fuel	Drain and refill tank with proper fuel. <b>If fuel has been contaminated with jet fuel, engine must be overhauled.</b>
Incorrect ignition timing	Check magneto or CDI system timing and correct as required. Check for correct installation of spark plug leads.
Fouled or failed spark plugs	Clean, test and replace spark plugs as required.
Weak or broken valve springs	Replace valve springs and repair valves and seats as required.
Badly worn camshaft lobes & lifters	Replace camshaft and lifters. Overhaul governor, propeller and oil cooler.
Bent pushrods	Check for sticking exhaust valves and damage to lifter bodies, camshaft lobes and valve spring retainers. Check operation of hydraulic units. Replace pushrods as required.

**Table 9-8 • Excessive Engine Vibration**

Possible Cause	Corrective Action
Broken engine mount	Replace or repair mount.
Mounting bushings worn	Install new mounting bushings.
Propeller out of balance	Re-balance propeller.
Propeller blades out-of-track	Overhaul propeller. Check for crankshaft flange damage.
Bent crankshaft propeller flange	Disassemble engine and repair or replace crankshaft and crankcase. Inspect propeller for damage.
Loose propeller	Ground engine. Overhaul engine, propeller and magnetos.
Loose or bent prop spinner.	Inspect spinner and bulkhead for damage. Replace as required.
Carburetor icing	Inspect carburetor air box and operation of carb heat valve.

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**Table 9-9 • Engine Runs Rough at High Power Settings**

Possible Cause	Corrective Action
Mixture too rich; indicated by sluggish engine operation, red exhaust flame at night. Extreme cases indicated by black smoke from exhaust	Readjustment of fuel injector or carburetor may be required by authorized personnel.
Mixture too lean; indicated by overheating or backfiring	Check fuel lines for dirt or other restrictions. Readjustment of fuel injector or carburetor may be required by authorized personnel.
Leaks in induction system	Tighten all connections. Replace damaged parts.
Defective or fouled spark plugs	Clean and gap or replace spark plugs.
Improper fuel	Drain and refill tank with proper grade. <b>If fuel has been contaminated with jet fuel, engine must be overhauled.</b>
Defective or damaged ignition leads	Check leads with high-tension lead tester. Replace defective leads or ignition harness.
Defective CDI system coils, sensors or control units	Troubleshoot, test and replace system components as required per manufactures manuals.

**Table 9.10 • High Cylinder Head Temperature (CHT)**

Possible Cause	Corrective Action
Mixture setting too lean	Use a richer mixture setting and leaning procedures
Induction system air leaks	Tighten all connections in the induction system. Replace any damaged parts.
Incorrect ignition timing	Check timing and adjust as required.
Improper fuel	Drain and refill tank with proper grade. <b>If fuel has been contaminated with jet fuel, engine must be overhauled.</b>
Restrictions in exhaust system	Inspect and repair or replace exhaust system components as required.
Thermocouple wires too close to exhaust pipe	Reroute wires.
Damaged or missing intercylinder baffles, baffle seals and bulkheads.	Install and repair or replace baffles and seals as required.
Pre-ignition due to carbon or wrong heat range spark plugs	Clean and/or replace spark plugs. Clean carbon through proper leaning procedures.
Defective CHT gauge or thermocouples	Have gauge calibrated and replace defective thermocouples as required.
Loose valve seats and guides	Repair and replace valve seats and guide and regrind or replace valves.

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**Table 9.11 • Low Indicated Oil Pressure**

<b>Possible Cause</b>	<b>Corrective Action</b>
Low oil level in engine	Add oil to proper level and inspect oil screens and filters for evidence of metal particles and engine damage.
Oil pressure line plugged	Clean or replace line.
Leak in line to oil cooler	Tighten loose components or replace as required.
High oil temperature	See Table 9-12, "High Indicated Oil Temperature", below.
Defective pressure gauge or sending unit	Replace defective gauge and/or sending unit.
Oil suction screen or pressure screen obstructed	Check for source of obstruction and clean as required. Check engine for metal contamination and internal damage.

**Table 9-12 • High Indicated Oil Temperature**

<b>Possible Cause</b>	<b>Corrective Action</b>
Engine cooling baffles and seals allow cooling air to bypass	Check baffles and seals for proper installation and missing or damaged seals.
Improperly routed oil cooler lines	Check all connections and locations for oil to cooler and return from cooler to be sure oil circulates properly. Reconnect as required.
Insufficient air flow to cooler	Inspect for restrictions and/or reroute airflow to cooler
Clogged, obstructed oil lines	Remove obstructions. Inspect oil lines for internal flap(s).
Excessive blow-by	Perform cylinder differential pressure test to check condition of piston rings. Inspect cylinder bores using borescope, and repair or replace as required.
Failing or failed bearing	Examine sump and oil screens or filter for metal particles. Check crankshaft end clearance in crankcase. Engine overhaul may be required.
Defective temperature gauge or sending unit	Have gauge and/or sending unit calibrated and replace as required.
High cylinder head temperatures	Check for excessively lean fuel mixture and/or incorrect ignition timing.

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<b>Table 9-13 • Excessive Oil Consumption</b>	
<b>Possible Cause</b>	<b>Corrective Action</b>
Wrong grade of oil	Drain and refill sump with proper weight and grade of oil for ambient temperature.
High oil temperatures	See Table 9-12, "High Indicated Oil Temperature", above.
Failing or failed bearings	Examine sump and oil screens or filter for metal particles. Check crankshaft end clearance in crankcase. Engine overhaul may be required.
Worn piston rings or cylinder bores	Overhaul cylinders, and install new pistons and rings.
Incorrect installation of piston rings	Overhaul cylinders, and install new rings.
Worn valves and guides	Replace valves, valve guides and regrind valve seats.
Failure of rings to seat on new cylinders	Use mineral base oil. Climb to cruise altitude at full power and operate at 75% cruise power setting until oil consumption stabilizes. See Run-In and Break-In Procedures in Section 8 of this manual. If cylinder bores are glazed, cylinders must be removed, re-honed and assembled with new piston rings.
Engine overfilled with oil	Drain oil and re-fill with proper quantity. See procedures for dipstick calibration in par. 8-6(8) of this manual. Recalibrate or replace as required.
Oil siphoned from engine in flight	Ensure that dipstick is tight and that o-ring is in good condition. Inspect location of breather line exit from cowl which may put the breather line in a high vacuum area during flight. Cut or relocate breather line as required and/or add a vacuum break to the line. Repair oil leaks as required.
Crankcase breather line blocked	Inspect breather line for obstruction and/or formation of ice in extremely cold weather.

<b>Table 9-14 • Crankshaft Seal Leaks</b>	
<b>Possible Cause</b>	<b>Corrective Action</b>
Seal worn, cracked	Replace seal.
Seal loose in case	Replace seal. Inspect crankcase for worn or P050 seal bore.
Crankshaft oil seal surface damaged	Disassemble engine and repair crankshaft oil seal surface in accordance with Repair No. 6-7.7 in this manual.
Crankcase pressurized	Perform cylinder differential pressure test to check for excessive blow-by. Inspect crankcase breather line for obstruction. Repair as required.
Damage to crankshaft and crankcase thrust bearing surfaces	Check crankshaft for end clearance and oil slinger clearance with crankcase. Check oil screens and/or filter for metal contamination. Engine overhaul may be required.

### **9.3 Lightspeed Ignition Troubleshooting Procedures**

One of the first priorities in designing the LSE **PLASMA CDI** System was its reliability. State-of-the-art circuitry is used throughout combined with professional design. It is unlikely that failures will occur during normal operation.

This is unlike the conventional magneto systems where failure is predictable. Also, contrary to magneto or other distributor systems, there is no wear or other loss in performance over time. In short, it either works or does not.

#### **IF SYSTEM FAILURE DOES OCCUR:**

All components supplied with the PLASMA CD system have been carefully tested. If any of these components are substituted, optimum performance cannot be guaranteed and such changes might affect the warranty. If deviations from the instructions or supplied materials have been made, please correct those changes before contacting LSE with any problems.

Consult the wiring diagram and ensure proper connection of signal wires and power supply.

LSE recommends high-tension lead replacement every 500 hours or every three years whichever comes first, independent of the ignition source.

On Hall Sensor modules, remove the cover with its circuit board attached and inspect for bearing wear and oil contamination. If problems are visible, return the housing to LSE for inspection and overhaul. With the spark plug leads removed from all coils and the 9 pin connector in place (accessory case driven Hall Effect Modules) and power on, rapidly move the south pole of a magnet past each Hall sensor.

On Direct Crank sensor systems, this can be achieved by rocking the prop so that the magnets in the flywheel move past the Hall sensors on the circuit board. You should be able to generate a spark at the coils from each of the four sensors. Also, verify the gap between the sensors and the magnet to be 0.030" – 0.060".

Using an Ohmmeter, the BNC cable should be open between the shield and the center conductor and about 1 ohm when it is connected to the coil. Measuring from each spade terminal to each output terminal of the coil should show an open circuit. Any conductivity here indicates a failed coil.

Verify the input wire harness (running from the triggering mechanism to the Plasma CD box) is routed with at least a 1/2" separation from the output wires (RG400 primary ignition wires running from the Plasma CD module to the ignition coils). These wires must be routed through different holes in the firewall in order to maintain a 1/2" or greater separation.

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### 9.3.1 LSE STARTING PROBLEMS

If your battery can no longer crank your engine over, you can hand start your engine using proper safe procedures. The LSE **PLASMA CDI** System will provide an accurate spark every compression stroke on 4 or 6 cylinder engines as long as the battery has more than 8 Volts.

**Do not attempt to hand prop your engine with your non-impulse magneto hot.**

If the engine backfires it is also possible that the impulse coupling of the remaining mag is not engaging properly. Any backfiring into the intake side contaminates the intake manifold and starting will be more difficult until fresh fuel is available. Turn the mag off during engine start if it causes a problem.

\*If you are using an aircraft key switch to turn the Plasma CDI (only Plasma II+, III, and some of the Plasma I systems) on and if the Plasma CDI is not labeled version: "PMS" or "A", be sure to pause in the "Both" position of the switch for a least 2 seconds before engaging the starter. This ensures accurate firing during start.

### 9.3.2 Radio Noise

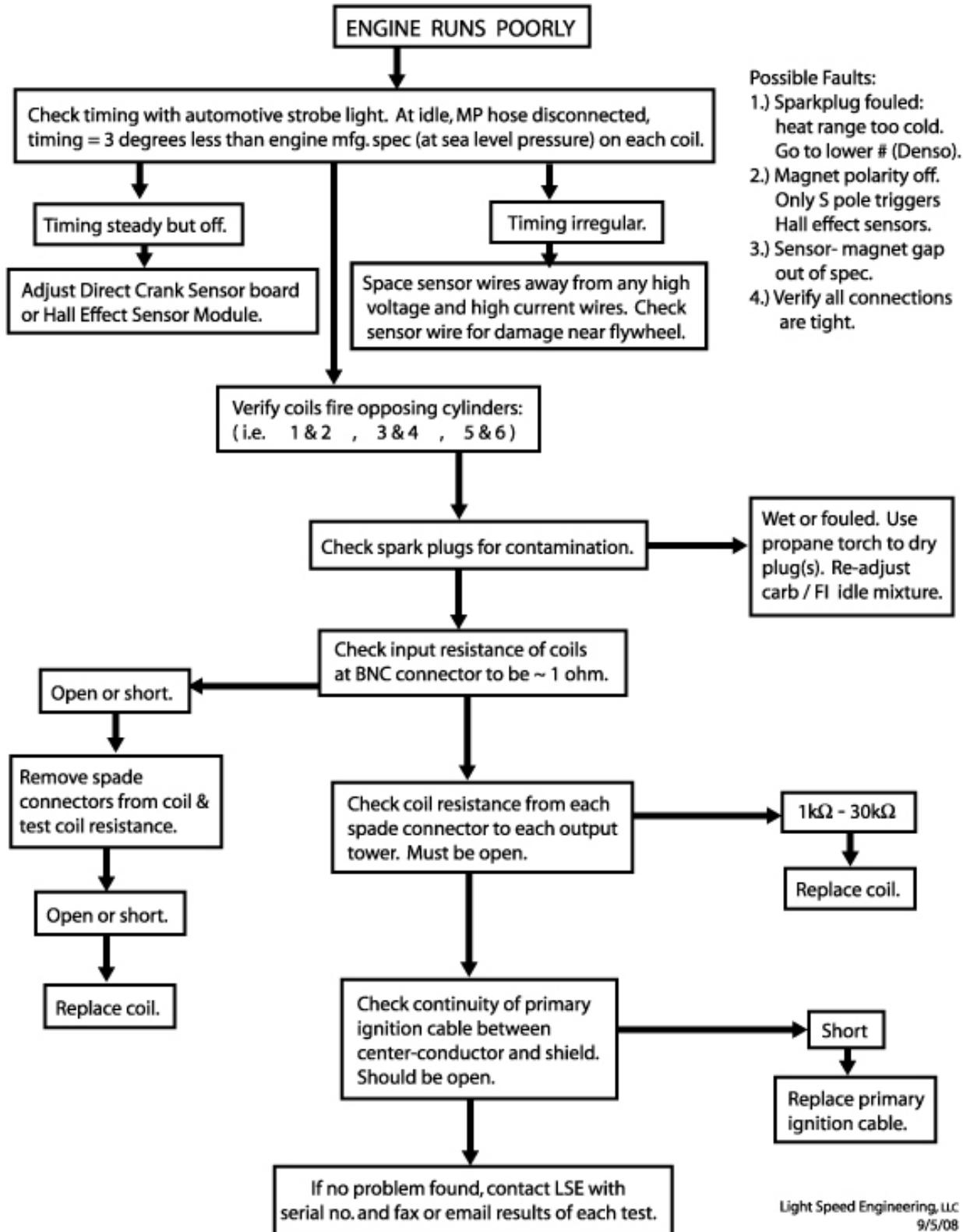
The Plasma CDI systems are designed to not interfere with any aircraft radios if installed per manual. If noise is noticed on the radio, it is an indication of arcing on the high voltage lines. This can be anywhere between the BNC connectors and the spark plugs.

Powering the system from your avionics buss will also cause noise. Both power and ground should come directly from the battery terminals.

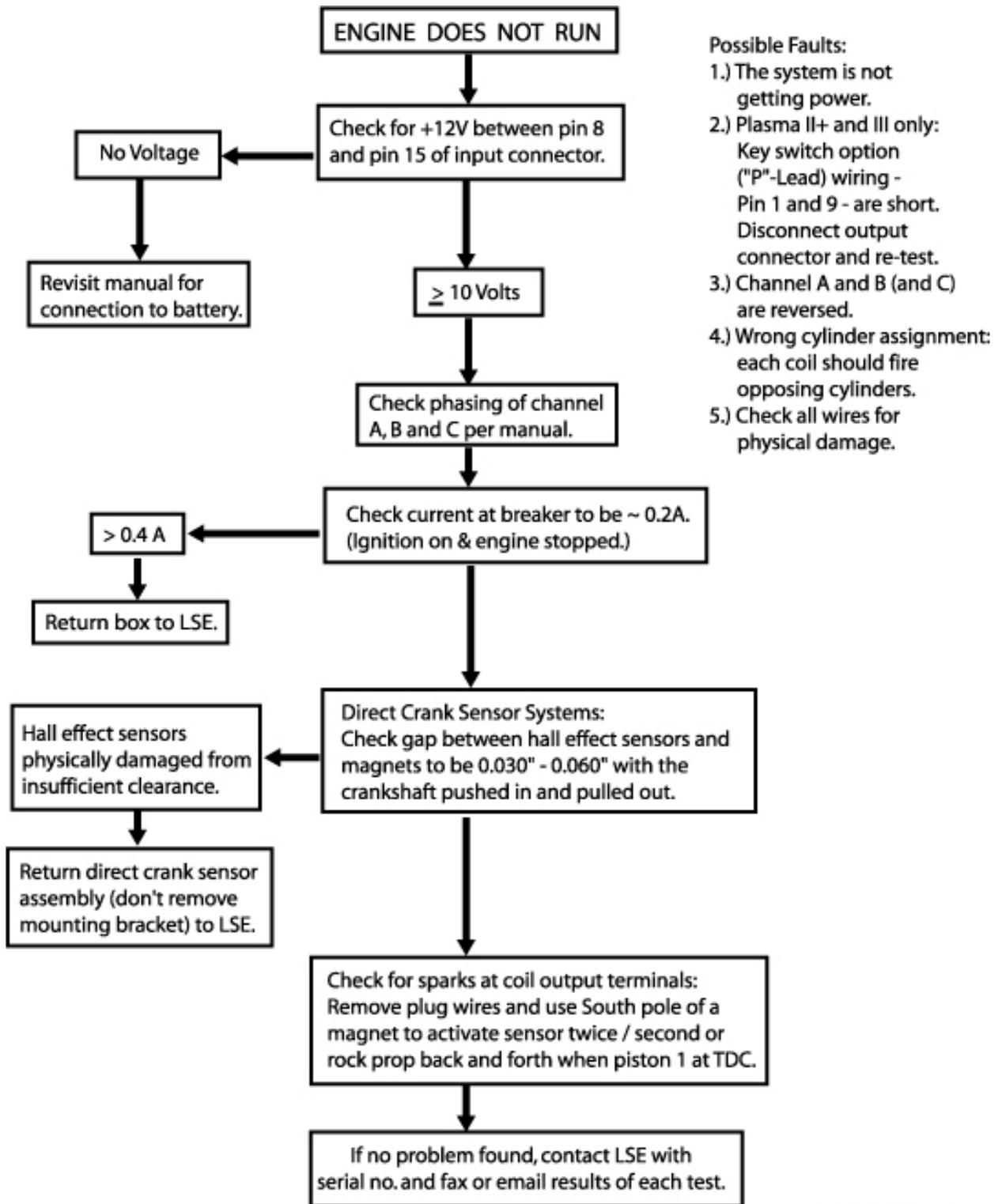
If you experience radio static that disappears when you turn the Plasma CD electronic ignition system off, check the following possible sources and make any necessary corrections.

1. If you are operating an aircraft key switch, confirm there is not a ground wire installed from the ignition switch to aircraft ground. Remove the ground wire if one is installed. Only the shield of the two "P"-leads should be connected to the switch terminal labeled ground.
2. If you are using Denso ESR-U or ESR-V sparkplugs, check the security of the ferules on the spark plug electrical connection. These plugs have threaded ferules that must be tightened securely. Sparkplugs, included with systems sold after June 2002, have solid terminals.
3. Examine the high-tension lead connection to both the coils and the spark plugs and confirm they are secured tightly to the metal connector clip inside the boot.

**FLOWCHART 1: TROUBLESHOOTING- ENGINE RUNS POORLY**



**FLOWCHART 2: TROUBLESHOOTING- ENGINE DOES NOT RUN**



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## **Section 10: TABLE OF LIMITS and TIGHTENING TORQUES**

### **10.1 General**

This section provides dimensions, fits, clearances and tightening torque values for repair and overhaul of the CC340 engine and component parts. Where practical, service limits for used parts are provided. When major engine repairs are performed (see par. 4-4.2), engines should be reassembled with all part fits and clearances within new or service limits. When major engine overhauls are performed (see par. 4-4.3), engines should be reassembled with all parts, fits and clearances within new limits. If no service limits are provided, new limits must be maintained at all times.

### **10.2 Limit Categories**

- CC340 model application codes are listed in Table 10-1.
- Critical new part dimensions are provided in Table 10-2.
- Part fits and clearances with new and service limits are provided in Table 10-3.
- Gear backlash limits are provided in Table 10-4.
- Spring dimensions and test data are provided in Table 10-5.
- Stud setting heights and driving torques are provided in Table 10-6.
- Special torque limits are provided in Table 10-7.
- General torque limits are provided in Table 10-8.

<b>Engine Models</b>	<b>Code</b>
CC340 parallel valve series	B

**Table 10-1 Engine Model Application Codes**

**NOTE**

All dimensions are in inches.

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Ref.	Code	Component and Feature	New Minimum	New Maximum
1	B	Camshaft, main bearing journal diameter	1.027	1.028
2	B	Connecting rod, small end bore diameter	1.1835	1.1845
3	B	“ “ center-to-center length	6.4985	6.5015
4	B	“ “ big end ID	2.2870	2.2875
5	B	“ “ big end width	1.431	1.433
6	B	Crankcase, front main bearing bore diameter	2.566	2.567
7	B	“ intermediate & rear main bearing bore dia.	2.6865	2.6875
8	B	“ camshaft bearing bore diameter	1.030	1.031
9	B	“ lifter bore diameter	.7187	.7197
10	B	“ oil seal bore diameter	3.307	3.312
11	B	“ Recess depth, AELSTD2013 O-ring	.048	.055
12	B	“ Recess depth, .693 dia., AEL72075 O-ring	.063	.070
13	B	“ Recess depth, .593 dia., AEL72091 O-ring	.078	.093
14	B	“ thrust bearing length, no thrust washers	5.096	5.100
15	B	“ thrust bearing length, w/ thrust washer mod	5.0005	5.004
16	B	“ thickness, cylinder deck to cylinder deck		
17	B	Crankshaft, thrust bearing length	5.109	5.112
18	B	“ crankpin width	1.437	1.441
19	B	“ stroke	4.120	4.130
20	B	“ radius of crankpin fillets	.140	.156
21	B	“ radius of main bearing journal fillets	.140	.156
22	B	“ diameter of propeller flange pilot journal	2.248	2.250
23	B	“ propeller flange thickness	.370	.390
24	B	“ propeller flange thickness	.430	.450
25	B	“ propeller flange thickness (CubCrafters spec.)	.310	.330
26	B	Crankshaft gear, diameter of mounting flange, STD size	2.1250	2.1255
27	B	Cylinder, bore ID, straight portion of cylinder bore	5.1245	5.1275
28	B	“ length, cylinder flange to CL of rocker boss	11.721 +.040/-.010	
29	B	Piston pin, diameter	1.1241	1.1256
30	B	“ “ overall length with plugs	5.08	5.10
31	B	Rocker arm, ID of bore diameter (w/o bushing)	.749	.751
32	B	“ “ width of thrust surfaces	.874	.877
33	B	Rocker shaft, diameter	.6241	.6245
34	B	Shaft, idler gears, diameter	.622	.623
34	B	Shaftgear, fuel pump drive, diameter	.7468	.7473
36	B	“ vacuum pump drive, diameter	.872	.873
37	B	“ prop governor drive, diameter	.8735	.8740
38	B	Valve, exhaust, stem diameter	.4940	.4945
39	B	“ intake, stem diameter	.4022	.4030

**TABLE 10-2 Critical New Part Dimensions**

Part fit and clearance dimensions shown below in Table 10-3 with a “T” suffix are a tight (interference) fit. Where clearance ranges between a tight and loose fit, tolerances are give a

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“T” or “L” suffix, respectively. All undesignated clearances are a loose fit. All dimensions are in inches.

**NOTE**

Some dimensions and clearances are designated by additional notes as follows:

- A. These are dimensions or fits that are controlled by machining, grinding and/or honing. In some cases, the original or property or fit is restored by machining to an oversize or undersize and/or use of oversize or undersize parts in the assembly. In each case, the dimension or fit must be held to manufacturing tolerances.
- B. Clearance between exhaust valves and valve guides may exceed the maximum new limit by .003 at any time during the initial 300 hours of operation. Thereafter, clearance may increase by up to .001 per 100 hours of engine operation but should not exceed the maximum new limit by more than .015.

Ref.	Code	Component and Feature	Dimensions		Clearances	
			New Min. And Max.	Service Limit	New Min. And Max.	Service Limit
<b>10.3.1 Accessory Case and Oil Pump</b>						
211	B	Accessory case gasket surface to oil pump pad	2.215 2.225	2.235		
212	B	Flatness, oil pump pad <i>(Surface roughness must not exceed 32 Ra)</i>	.001	(A)		
213	B	Parallelism, oil pump pad to gasket surface	.001	(A)		
214	B	Oil pump drive shaft in accessory case bore			.0015 .0030	.006
215	B	Oil pump drive shaft in oil pump housing bore			.0010 .0025	.004
216	B	Oil pump idler gear shaft in accessory case bore			.0010 .0025	.0035
217	B	Oil pump idler gear shaft in oil pump housing bore			.0005 .0020	.003
218	B	Oil pump gears, diameter clearance in housing			.002 .006	.008
219	B	Oil pump gears, side clearance			.0020 .0045	.005
220	B	Oil pump drive impeller on drive shaft				
221	B	Tachometer shaft in accessory case bore			.0015 .0035	.006
222	B	Fuel pump pushrod in accessory case bore			.0015 .0030	.005
223	B	Tachometer shaft seal in tachometer adapter			.001 T .003 T	
<b>224-240</b>		<b>RESERVED</b>				

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Ref.	Code	Component and Feature	Dimensions		Clearances	
			New Min. And Max.	Service Limit	New Min. And Max.	Service Limit
<b>10.3.2 Camshaft</b>						
241	B	Runout of center main bearing journal			.000 .001	.006
242	B	Diameter, main bearing journals	1.027 1.028	1.026		
243	B	Main bearings in crankcase bores			.002 .004	.006
244	B	End clearance, rear main bearing in crankcase			.002 .009	.015
245	B	Spacer, tach shaft centering, in camshaft bore			.0050 T .0030 T	
<b>246-250</b>		<b>RESERVED</b>				
<b>10.3.3 Connecting Rod and Bearings</b>						
251	B	Big end bore dia. Measure at axis and +/- 30° ( <i>Service limit applies only within .50" of parting line.</i> )	2.2870 2.2875	2.2880		
252	B	Big end bore, surface roughness, maximum	32 Ra	(A)		
253	B	Width, big end. ( <i>*Conn. rod side clearance on crankshaft must not exceed limits of Ref. 264.</i> )	1.431 1.433	1.427*		
254	B	Runout, thrust surfaces with big end ID, TIR			.000 .002	.0025
255	B	Bushing, fit in connecting rod ( <i>Bushing must be burnished in place before boring.</i> )			.0025 T .0050 T	
256	B	Bushing, finished ID	1.1254 1.1262	1.1266		
257	B	Bushing, surface roughness after machining, max.	32 Ra	(A)		
258	B	Convergence, bushing ID and big end bore ID ( <i>Tolerance is per inch of length of arbor.</i> )			.001/in.	
259	B	Twist, bushing ID and big end bore ID ( <i>Tolerance is per inch of length of arbor.</i> )			.0012/in	
260	B	Center-to-center, bushing ID and big end ID	6.4985 6.5015	6.4955		
261	B	Maximum rod and cap parting surface rework		.003		
262	B	Side clearance with crankpin thrust surfaces			.004 .010	.016
263	B	Bearings, diameter clearance on crankpin			.0008 .0038	.005
264	B	Weight difference between opposed pairs		2 g.		
265	B	Weight difference between pairs in engine set	2 grams x no. of cylinders			

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266-270		RESERVED				
Ref.	Code	Component and Feature	Dimensions		Clearances	
			New Min. And Max.	Service Limit	New Min. And Max.	Service Limit
<b>10.3.4 Crankcase</b>						
271	B	Diameter, front main bearing bore	2.566 2.567	2.5685		
272	B	Diameter, intermediate and rear main bearing bores ( <i>Crankcases with thin-wall bearings</i> )	2.566 2.567	2.5685		
273		Diameter, intermediate and rear main bearing bores ( <i>Crankcase with heavy-wall bearings</i> )	2.6865 2.6875	2.6890		
274	B	Diameter, camshaft bearing bores	1.030 1.031	1.032		
275	B	Diameter, lifter bores	.7188 .7197	.7209		
276	B	Lifter bodies in lifter bores			.001 .003	.004
277	B	Flatness, parting surfaces	.000 .004	(A)		
278	B	Surface roughness, parting surfaces	32 Ra	(A)		
279	B	Flatness, cylinder pads	.000 .002	(A)		
280	B	Parallelism, cylinder decks and main bearing bores	.000 .002	(A)		
281	B	Thickness, cylinder deck to cylinder deck	8.995 9.005	8.970		
282	B	Flatness, thrust faces at front main bearing	.0005	(A)		
283	B	Squareness, thrust faces with main bearing bores	.0005	(A)		
284	B	Thru bolts in holes, thrust and intermediate mains			.0000 T .0035 T	(A)
285	B	Thrust washer counterbore in crankcase, diameter ( <i>W/ optional thrust washer mod only</i> )	3.405 3.415	(A)		
286	B	Thrust washer tang stops, depth below parting line ( <i>W/ optional thrust washer mod only</i> )	.385 .395	(A)		
287	B	Bearing dowel in crankcase dowel hole			.0000 T .0010 T	
288	B	Alignment dowel (AELSTD557)			.0005 T .0015 T	
289-300		RESERVED				

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Ref.	Code	Component and Feature	Dimensions		Clearances	
			New Min. And Max.	Service Limit	New Min. And Max.	Service Limit
<b>10.3.5 Crankshaft</b>						
301	B	Main bearing journal diameter ( <i>Worn journals may be reground to M003, M006 or M010 and renitrided</i> )	2.124 2.125	2.3735		
302	B	Crankpin diameter ( <i>Worn journals may be reground to M003, M006 or M010 and renitrided</i> )	20 Ra	2.1225		
303	B	Bearing journals, surface roughness, maximum		(A)		
304	B	Oil seal journal diameter ( <i>Rework w/o renitriding but fillets must blend with no discontinuities.</i> )	2.374 2.376	2.363		
305	B	Oil seal journal, surface roughness, maximum	10 Ra	(A)		
306	B	Width, between crankpin thrusts ( <i>*Side clearance with rod must not exceed limits of Ref. 264.</i> )	1.437 1.441	1.445		
307	B	Thrust clearance in crankcase			.009 .016	.026
308	B	Oil slinger clearance in crankcase			.002 .007	(A)
309	B	Front main bearing journals in crankcase bearings			.0015 .0045	.006
310	B	Intermediate and rear bearing journals in bearings			.0011 .0045	.005
311	B	Runout, #2 main journal; crankshaft mounted #1, #4			.000 .002	
312	B	Runout, #3 main journal; crankshaft mounted #2, #4			.000 .003	.0045
313	B	Runout, #3 main journal; crankshaft mounted #1, #4			.0000 .005	.0075
314	B	Runout, oil seal journal; crankshaft mounted #1, #4			.000 .002	(A)
315	B	Runout, flange edge; crankshaft mounted #1, #4			.000 .002	.005
316	B	Runout, flange pilot; crankshaft mounted #1, #4			.000 .003	(A)
317	B	Runout, thrust face; crankshaft mounted #1, #4			.0000 .0015	(A)
318	B	Perpendicularity, thrust face with #2 main journal			.000 .002	(A)
319	B	Thrust length, between thrust faces ( <i>Restore oil slinger clearance per Ref. XXX by grinding slinger</i> )	5.109 5.112	5.122		

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Ref.	Code	Component and Feature	Dimensions		Clearances	
			New Min. And Max.	Service Limit	New Min. And Max.	Service Limit
320	B	Flatness, thrust face	.0000 .0005	(A)		
321	B	Thickness, propeller flange	.370 .390	.355		
322	B	Thickness, propeller flange	.430 .450	.420		
323	B	Thickness, propeller flange (CubCrafters spec.)	.300 .320	.290		
324	B	Flatness, propeller flange	.003	(A)		
325	B	Diameter, gear counterbore in rear main journal <i>(May be reworked up to P020 for oversize gear)</i>	2.125 2.126	2.1262		
326	B	Runout, counterbore ID with rear main journal			.000 .001	(A)
327	B	Runout, gear counterbore face with rear main journal			.000 .004	(A)
328	B	Crankshaft gear flange in counterbore ID <i>(Clearance may not exceed .0005 at any point.)</i>			.0005 T .0005 L	(A)
329	B	Crankshaft gear dowel in crankshaft dowel hole			.0000 T .0015 T	(A)
330	B	Propeller flange bushing in flange bushing hole			.0005 T .0020 T	(A)
331	B	Starter gear support on crankshaft flange pilot			.000 .002	.003
332	B	Starter ring gear on support			.014 T .022 T	
<b>333-350</b>		<b>RESERVED</b>				
<b>10.3.6 Cylinder, Valves and Rocker Arms</b>						
351	B	Cylinder bore ID, first 1.02 of barrel	5.1245 5.1280	(A)		
352	B	Cylinder bore ID, above 1.02 to start of choke	5.1245 5.1275	.000 -.001		
353	B	Choke, from 4.375 to 5.625 above end of barrel	-.001 -.003			
354	B	Choke, from 5.625 to 6.375 above end of barrel	-.003 -.006			
355	B	Cylinder bore, surface roughness, Nickel+Carbide	3-8 Ra	6-8 Ra		
356	B	Cylinder bore, surface roughness, steel	25Ra 35 Ra	(A)		

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Ref.	Code	Component and Feature	Dimensions		Clearances	
			New Min. And Max.	Service Limit	New Min. And Max.	Service Limit
357	B	Guide, exhaust valve, in cylinder head boss			.0010 T .0025 T	(A)
358	B	Guide, exhaust valve, finished ID	.4985 .4995	(B)		
359	B	Exhaust valve in valve guide			.004 .006	(B)
360	B	Guide, intake valve, in cylinder head boss			.0010 T .0025 T	(A)
361	B	Guide, intake valve, finished ID	.404 .405	.4065		
362	B	Intake valve in valve guide			.0010 .0028	.006
363	B	Surface roughness, finished ID of all valve guides <i>(Finish with sizing ball and/or hone as required.)</i>	40 Ra	(A)		
364	B	Seat, exhaust, in cylinder head boss			.0045 T .0080 T	(A)
365	B	Seat, intake, in cylinder head boss			.0065 T .0100 T	(A)
366	B	Rocker shaft boss, bushing hole ID	.7378 .7388	(A)		
367	B	Rocker boss bushing in rocker boss			.0024 T .0044 T	(A)
368	B	Rocker boss bushing, finished ID <i>(Bushing must be burnished or reamed in place.)</i>	.6246 .6261	.6270		
369	B	Rocker arm bushing in rocker arm			.001 T .004 T	
370	B	Rocker arm bushing, finished ID <i>(Bushing must be burnished in place.)</i>	.6252 .6263	.6270		
371	B	Rocker shaft in rocker boss bushing			.0001 .0020	.0025
372	B	Rocker shaft in rocker arm bushing			.0007 .0022	.004
373	B	Rocker shaft OD	.6241 .6245	.6231		
374	B	Rocker arm side clearance in cylinder head bosses			.005 .013	.016
375	B	Rocker arm, maximum tip regrind		.015		
376	B	Rocker arm, parallelism of tip to bushing ID	.000 .003	(A)		
377	B	Rocker arm, surface roughness of tip, max <i>(Hardness must not be less than HRc 55.)</i>	60 Ra	(A)		

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Ref.	Code	Component and Feature	Dimensions		Clearances	
			New Min. And Max.	Service Limit	New Min. And Max.	Service Limit
378	B	Rocker arm tip to valve stem clearance, dry lifter <i>(Use different pushrod lengths to obtain clearance.)</i>			.028 .080	(A)
<b>379-400</b>		<b>RESERVED</b>				
<b>10.3.7 Drive Adapters and Accessory Drive Shaftgears</b>						
401	B	AN fuel pump drive shaftgear in adapter, diameter			.0010 .0025	.004
402	B	AN fuel pump drive shaftgear in adapter, end clear.			.035 .069	.079
403	B	Prop governor drive shaftgear in adapter, diameter			.0010 .0025	.005
404	B	Prop governor drive shaftgear in adapter, end clear.			.008 .016	.021
405	B	Vacuum pump drive shaftgear in adapter, diameter			.001 .003	.0045
406	B	Vacuum pump drive shaftgear in adapter, end clear.			.010 .057	.075
407	B	Thrust button in fuel and vacuum pump shaftgears			.0000T .0015T	
408	B	Fuel pump drive coupling, backlash in shaftgear			.0035 .0095	.011
409	B	Fuel pump drive coupling, clearance in square drive			.0035 .0095	.011
<b>410-420</b>		<b>RESERVED</b>				
<b>10.3.8 Idler Gears and Shafts</b>						
421	B	Idler gear bushing and idler gear, all			.0005 T .0025 T	
422	B	Idler gear bushing, finished ID, all	.625 .626	.627		
423	B	Idler gear bushing and idler shaft, all			.001 .003	.005
424	B	Idler shaft diameter, all	.623 .624	.622		
425	B	End clearance, camshaft and accessory idler gears			.005 .040	.055
426	B	End clearance, AN fuel pump idler gear			.010 .045	.055
<b>427-440</b>		<b>RESERVED</b>				

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Ref.	Code	Component and Feature	Dimensions		Clearances	
			New Min. And Max.	Service Limit	New Min. And Max.	Service Limit
<b>10.3. 9 Piston Pin, Piston and Rings</b>						
441	B	Piston diameter, top <i>(Measure between top and second ring grooves, 90° to piston pin bore.)</i>	5.0826 5.0856	5.079		
442	B	Piston diameter, bottom <i>(Measure at bottom of skirt at 90° to piston pin bore.)</i>	5.1181 5.1196	5.109		
443	B	Piston, skirt clearance in cylinder bore			.0049 .0094	.018
444	B	Piston, weight difference between opposed pairs	0 g. 2 g.	10 g.		
445	B	Piston, pin bore diameter	1.1249 1.1252	1.1254		
446	B	Piston pin in piston			.0003 .0011	.0014
447	B	Piston pin in connecting rod bushing			.0008 .0021	.0025
448	B	Piston pin, diameter	1.1241 1.1246	1.1239		
449	B	Piston pin and plug assembly in cylinder, end clear.			.0245 .0475	.063
450	B	Top compression ring, side clearance			.0015 .0050	
451	B	Second compression ring, side clearance			.0015 .0050	
452	B	Oil control ring, side clearance			.002 .004	
453	B	Top compression ring, end gap at bottom of bore			.030 .050	
454	B	Second compression ring, end gap at bottom of bore			.030 .050	
455	B	Oil control ring, end gap at bottom of bore			.015 .035	
456	B	Min. end gap at top of travel, all piston rings			.0075	
<b>457-460</b>		<b>RESERVED</b>				
<b>10.3. 10 Sump and Induction Housing Assembly</b>						
461	B	Connection, intake pipe, in sump bores <i>(Must be securely swaged in place after installation.)</i>			.004 T .006 L	
<b>462-800</b>		<b>RESERVED</b>				
<b>Table 10-3 • Part Fits and Clearances, New and Service Limits</b>						

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**NOTE:**  
All dimensions are in inches.

Ref.	Code	Drive Gear-to-Gear	New Min. and Max.	Service Limit
801	B	Crankshaft gear to camshaft/accessory idler gears	.004 .015	.020
802	B	Camshaft idler gear to camshaft gear	.004 .015	.020
803	B	Vacuum pump shaftgear to camshaft gear	.004 .015	.020
804	B	Magneto drive gears to idler gears	.004 .015	.020
805	B	Oil pump gears	.008 .015	.020
806	B	Camshaft idler gear to AN fuel pump idler gear	.004 .015	.020
807	B	Fuel pump idler gear to fuel pump drive shaftgear	.004 .015	.020
808	B	Accessory idler gear to prop governor shaftgear	.004 .015	.020
<b>809-820</b>		<b>RESERVED</b>		

**Table 10-4 • Gear Backlash Limits**

Ref.	Description and Part Number	Wire Dia.	Free Length	Compressed: @ In. = Lbs.		Compressed: @ In. = Lbs.	
				Height	Min. / Max.	Height	Min. /Max.
821	Oil pressure relief AEL61084	.054	2.18	1.30	8.5 9.5		
822	Oil pressure relief AEL68668	.054	2.04	1.30	7.1 7.8		
823	Oil pressure relief AEL77467	.054	1.90	1.30	6.4 7.1		
824	Inner valve spring AEL11795	.134 .136	1.94	1.64	29 33	1.17	61 75
825	Outer valve spring AEL11800	.176 .178	2.50	1.77	60 66	1.30	112 120
<b>826-830</b>	<b>RESERVED</b>						

**Table 10-5 • Spring Dimensions and Test Data**

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**NOTES**

All dimensions in Table 10-6 are in inches. Stud thread diameter and pitch data refer to only the end of the stud installed in the component. Driving torque values are In.-Lbs. and are considered minimum allowable values. Where necessary, Loctite 271 or 567, or equivalent, may be used to secure studs.

Ref.	Part No.	Size	Location and Application	Setting Height	Driving Torque
<b>10.6.1 Accessory Case</b>					
831	AEL61400	.25-20 x 1.19	Oil screen housing/filter adapter boss	.69	15
832	AEL61400	.25-20 x 1.19	Vacuum pump pad w/ cover plate only	.69	15
833	AEL25C10	.25-20 x 1.25	Vacuum pump pad, w/ optional accessory	.75	15
834	AEL25C10	.25-20 x 1.25	Sump gasket surface	.75	15
835	AEL25C11	.25-20 x 1.38	Vacuum pump pad, w/ dual drive adapter only	.88-.94	15
836	AEL25C11	.25-20 x 1.38	Sump gasket surface	.88-.94	15
837	AEL25C12	.25-20 x 1.50	Vacuum pump pad, w/ optional accessory	1.00	15
838	AEL25C20	.25-20 x 2.50	Vacuum pump pad, w/	2.00	15
839	AEL25C22	.25-20 x 2.75	Vacuum pump pad, w/	2.25-2.31	15
840	AEL25C31	.25-20 x 3.88	Vacuum pump pad, w/ dual drive adapter only	3.44	15
841	AEL31C12	.31-18 x 1.50	Prop governor pad	.75	25-100
842	AEL31C12	.31-18 x 1.50	AN fuel pump pad	.88	25-100
843	AEL31C12	.31-18 x 1.50	L & R magneto pad, non-impulse magnetos	.88-.94	25-100
844	AEL31C13	.31-18 x 1.63	Prop governor pad	.88	25-100
845	AEL31C13	.31-18 x 1.63	L magneto pad, optional ignition system	1.06	25-100
846	AEL31C16	.31-18 x 2.00	L & R magneto pad, optional ignition system	1.44	25-100
847	AEL31CD17	.31-18 x 2.13	Oil pump pad	1.47	25-100
848	AEL31C19	.31-18 x 2.38	AN fuel pump pad	1.72	25-100
849	AEL31C19	.31-18 x 2.38	L & R magneto pad, w/ impulse coupling mags	1.81	25-100
850	AEL31C38	.31-18 x 4.75	AN fuel pump pad, w/ optional accessory	4.09	25-100
851	AEL31C40	.31-18 x 5.00	AN fuel pump pad, w/ optional accessory	4.34	25-100
<b>852-860</b>	<b>RESERVED</b>				
<b>10.6.2 Crankcase</b>					
861	AEL13793	.31-18 x .94	Left idler shaft boss	.49-.53	25
862	AEL31C12	.31-18 x 1.50	Starter mount pad, rear	.70-.74	25
863	AEL31C13	.31-18 x 1.63	Starter mount pad, front	.90-.94	25
864	AEL38-13	.38-16 x 1.63	Cylinder pads	.78-.82	100
865	AEL38D17	.38-16 x 2.13	Above rear camshaft bearing boss	1.27-1.36	100
866	AEL50-15	.50-13 x 1.88	Cylinder pads	.84-.88	250
867	AEL75154	.59-13 x 10.03	Thru studs at rear main bearing saddle	5.47-5.54	250
<b>868-870</b>	<b>RESERVED</b>				

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Ref.	Part No.	Size	Location and Application	Setting Height	Driving Torque
<b>10.6.3 Cylinder</b>					
871	AEL25C9	.25-20 x 1.13	Rocker box, pushrod tube retainer spring stud	.48	15
872	AEL25C10	.25-20 x 1.25	Rocker box, pushrod tube retainer spring stud	.48	15
873	AEL31C12	.31-18 x 1.50	Exhaust port flange	.81	40
<b>874-880</b>	<b>RESERVED</b>				
<b>10.6.4 Sump Assembly</b>					
881	AEL61400	.25-20 x 1.19	Sump-to-crankcase gasket surface	.63	15
882	AEL31C15	.31-18 x 1.88	Carburetor mount, bottom inlet only	1.13	25
<b>883-899</b>	<b>RESERVED</b>				
<b>Table 10-6 • Stud Setting Height and Driving Torque Limits</b>					

Ref.	Thread Diameter and Pitch	Description and Location	Torque
<b>10.7.1 Major Engine Components and Assemblies</b>			
900	1/16-27 NPT	Pipe plugs in internal crankcase oil galleries	60
901	1/16-27 NPT	Piston cooling nozzles and camshaft spray nozzles in crankcase	100
902	1/8-27 NPT	Pipe plugs in crankcase and accessory case oil galleries	60
903	1/8-27 NPT	Pipe plugs in cylinder head intake port boss	60
904	1/8-27 NPT	Drain valve, ECI Cold Induction plenum	40
905	1/4-18 NPT	Pipe plug or governor oil pressure elbow in crankcase	130
906	3/8-18 NPT	Pipe plug in accessory case drain boss	110
907	1/2-14 NPT	Pipe plug in oil sump drain bosses	160
908	#10-24	Capscrews, attach flow divider and manifold valve to bracket	20
909	#10-32	Capscrews and nuts, fuel injection line support clamps to brackets	25
910	.25-20	Capscrew, manifold valve bracket to side of crankcase (not backbone)	50
911	.25-20	Nuts and bolts, manifold valve bracket to crankcase backbone	96
912	.25-20	Nut, pushrod tube retainer spring	50-70
913	.25-20	Capscrew, valve rocker cover to cylinder head, <i>fiber gasket only</i>	50
914	.25-20	Capscrew, rocker cover to cylinder, <i>dry rubber gasket only, warm</i>	20
915	.25-20	Capscrew, rocker cover to cylinder, <i>dry rubber gasket only, cold</i>	25
916	.25-20	Slotted nut, drilled bolts at crankcase lower backbone	55-60
917	.25-20	Nut, vacuum pump pad cover plate (no installed accessory)	70-90
918	.25-20	Nuts and capscrews, crankcase backbone, sump and accessory case	96
919	.25-20	Nuts and capscrews, vacuum pump and oil screen housing/filter adapter	96
920	.25-20	Capscrews, intake pipe flanges to cylinder intake ports	96

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Ref.	Thread Diameter and Pitch	Description and Location	Torque
921	.31-18	Slotted nuts, oil pump housing to accessory case studs	150-204
922	.31-18	Nuts, cover plates to accessory case pads (no accessory installed)	150-180
923	.31-18	Slotted nut, idler shaft stud	150
924	.31-18	Drilled capscrews, idler shafts to crankcase	200
925	.31-18	Nuts, attach carburetor to oil sump w/ bottom inlet	204
926	.31-18	Nuts and capscrew, attach starter to crankcase pad	204
927	.31-18	Capscrews, alternator mount brackets to crankcase	204
928	.31-18	Nuts, governor adapter to accessory case studs; governor to adapter	204
929	.31-18	Nuts, magneto or CDI unit to accessory case studs, after timing	200
930	.31-24	Capscrew, attach gear to crankshaft <i>see special procedures, par. 7-6</i>	204
931	.31-24	Starter terminal nut	24
932	.38-16	Hex head capscrews, cover plate on fuel pump pad (no AC fuel pump)	160
933	.38-16	Socket head capscrews, diaphragm-type (AC) fuel pump to accy. case	225-250
934	.38-24	Slotted nut, attach drive gear or coupling to Unison/Slick magneto	120-300
935	.38-24	Slotted nut, attach drive gear or coupling to TCM/Bendix magneto	170-300
936	.38-24	Slotted nut, at drilled stud above rear camshaft bearing in crankcase	300
937	.38-24	Nut, bolts at crankcase nose	300
938	.38-24	Nut, cylinder base	300
939	.38-24	Slotted nut, alternator mount bosses	360
940	.38-24	Nut, connecting rod bolt <i>see special procedures, par. 7.8</i>	480
941	.50-20	Nut, cylinder base	600
942	.56-18	Nut, adjustable fitting on governor adapter	110
943	.56-18	B-nuts, prop governor oil line, steel fittings	215-280
944	.56-18	B-nut, cylinder drain line, aluminum fittings	75-125
945	.81-16	Oil filter, spin-on type	192-216
946	1.00-14	Vernatherm (thermostatic oil cooler bypass) valve	300
947	1.13-12	Dipstick tube	300
948	1.25-12	Oil pressure relief valve housing (tighten 90° after gasket contact)	300
949	--	Clamp, cylinder drain hose, worm type (10 in-lb. if old thumbscrew type)	20
950	--	Clamp, intake pipe hose, worm type	45
951	.63-24	B-nut, spark plug lead	90-95
952	.75-20	B-nut, spark plug lead	110-120
953	14mm x 1.25	Spark plug	160
954	18mm x 1.50	Spark plug	420
<b>955-969</b>	<b>RESERVED</b>		

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Ref.	Thread Diameter and Pitch	Description and Location	Torque
<b>10.7.2 Fuel System Lines and Fittings</b>			
<b>A. Primer System and Carburetor</b>			
970	1/8-27 NPT	Primer nozzles in cylinder head boss	60
971	.31-32	B-nut, primer line	25-40
972	.44-20	B-nut, #4 fuel line hose at carburetor, aluminum fitting	100-140
973	.44-20	B-nut, #4 fuel line hose at carburetor, steel fitting	135-190
974	.56-18	Nut, adjustable fuel line fitting in diaphragm-type fuel pump	110
975	.56-18	B-nut, #6 fuel line hose at fuel pump or carburetor, steel fitting	215-280
976	.56-18	B-nut, #6 fuel line hose at carburetor, aluminum fitting	75-125
<b>977-999</b>	<b>RESERVED</b>		
<b>Table 10-7 • Special Tightening Torque Limits</b>			

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## **Section 11. ACCESSORY OVERHAUL**

### **11.1 General**

CC340 engines have been designed and manufactured expressly as reliable, high performance powerplants for modern aircraft. Since engine operation is entirely dependent on the proper operation of all internal and external systems, it is vital that engine accessories be given the same level of maintenance, repair and overhaul as the engine itself. Due to the unique application and design of aircraft engines, most engine accessories are unique and have no equivalent counterpart in the commercial market.

Cub Crafters, therefore, recommends that all engine accessories be replaced or overhauled by the manufacturer or a qualified aviation accessory repair station whenever the engine undergoes major overhaul as defined by paragraph 4.4.3 of this manual. In addition, accessories should also be repaired or overhauled whenever any type of malfunction, improper operation or failure occurs. The guidelines for repair and overhaul of specific accessories provided below are intended to supplement those of the particular manufacturer.

### **11.2 Alternators**

Modern alternators are more compact and have achieved a higher level of reliability than alternators in use several decades ago. Nevertheless, aircraft applications are quite demanding in that the alternator is frequently subjected to higher levels of vibration, higher operating temperatures and somewhat restricted airflow, particularly during ground operation. Aircraft alternators should be repaired and overhauled thoroughly bench tested by experienced repair stations using only the highest quality electrical components and bearings, balanced rotors and brushes suitable for high altitude operation. Particular attention should be paid to the safety methods and integrity of all fasteners.

### **11.3 Float Type Carburetors**

Carburetor overhaul consists of replacement of all gaskets, seals, float valves, throttle shafts and bushings and any other worn or deteriorated parts or parts requiring replacement due to fuel blend changes. Testing typically consists of checking float valve operation, mixture control operation and economizer settings. Some carburetor repair stations also have the capability of measuring the actual metering capability of the carburetor on a mass airflow bench. Since aircraft carburetors have no commercial application, they should not be serviced by any non-aviation repair station.

### **11.4 Ignition System - Light Speed Engineering CDI System**

Except for the Hall-effect gear driven transducer systems installed on the accessory case in place of magnetos, the Light Speed CDI system has no moving parts. The Hall-effect transducers may be returned to the manufacturer for replacement of bearings and seals and testing. Other overhaul tests and inspections consist of electrical checks and transducer position adjustments provided in the Light Speed Engineering CDI Systems Installation and Operation Manual.

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### 11.5 Starters

CC340 Engines are furnished with latest generation lightweight starters having powerful permanent magnet motors of either 12- or 24-volt design. Since these starters have a unique mounting pad they are manufactured specifically for aircraft engine use. They may be repaired, overhauled and tested only by the manufacturer or by aircraft accessory repair station having the necessary test equipment.

While aircraft engine starters may seem to provide a relatively low number of engine starts in relation to the hours of engine operation, as compared to automotive and commercial engines, starter maintenance and operation must not be neglected or assumed. In case an in-flight engine restart is required due to heavy water ingestion, carburetor icing or inadvertent fuel mismanagement, the starter must operate with 100% reliability at all times.

### 11.6 Spark Plugs

While not an accessory, spark plugs are a vital link in the engine ignition system. Spark plugs should be replaced at engine major overhaul and whenever worn or damaged. They should only be cleaned following the recommendations of the manufacturer. Spark plugs should be handled very carefully and placed in secure, numbered racks or trays whenever removed from the engine. The old aviation rule "Drop it once, drop it twice" (that is, drop it in the scrap bin) still applies. A spark plug that has been dropped or over-torqued may have a cracked insulator or broken internal gas seal that could cause malfunction or failure in operation. This is particularly true of shielded 18mm spark plugs in which most of the ceramic insulator is not readily visible.

## **Section 12. SERVICE TOOLS**

Sections 6 and 7 of this manual provide descriptions and essential material and dimensional information for a variety of service and inspection tools such as bushing drivers and Go/No-Go plug gages that can be very helpful in the course of accomplishing the various repair processes and removal or replacement of parts. As determined by customer demand, these service tools may be made available from time to time by Cub Crafters or by aftermarket aircraft tool suppliers. As these service tools become available, they will be listed along with pertinent information in this section.

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