

IO-520-B

BA

BB

C

CB

M

MB

CONTINENTAL[®] AIRCRAFT ENGINE

**PERMOLD SERIES ENGINE
MAINTENANCE
MANUAL**



TECHNICAL CONTENT ACCEPTED BY THE FAA

Publication M-11

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Supersedure Notice

This manual revision replaces the front cover and list of effective pages for Publication Part No. M-11, dated October 1998. Previous editions are obsolete upon release of this manual.

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Replacement Parts

WARNING

Use only parts that meet the engine type design.

Beware of replacement parts, materials and accessories that may be sold as aircraft quality but whose origin and quality are not known. These parts may be deceptively advertised as “unused,” “like new,” or “remanufactured,” and purchasers are often unaware that they are not eligible for use on certificated aircraft. The hazards involved in installing these types of parts on your aircraft are obvious.

Know Your Supplier

Many original parts and components are copied and the copies are sold at discounted prices for installation on U.S. certified aircraft. An original manufacturer's part is often used as a guide to make duplicates that appear to be as good as the original, but there are many unknowns about the quality of design, materials, and workmanship. Other factors that go into quality parts are the degree of heat treating and plating, and inspections, tests, and calibrations. Unfortunately, a cheaply produced part that looked “as good as the original” is usually found out too late.

Federal Aviation Regulations FAR 43.13 and FAR 145.57 specify performance rules for replacement of parts and materials used in the maintenance and alteration of United States certificated aircraft. FAR 91.403, FAR 121.363, FAR 123.45, and FAR 135.143(a) holds the owner/operator responsible for the continued airworthiness of the aircraft, and that includes the quality of replacement parts.

Identifying Approved Parts

Approved serviceable replacement parts are identified by:

1. Federal Aviation Administration (FAA) Form 8130-3 Airworthiness Approval Tag. An Airworthiness Approval Tag identifies a part or group of parts that have been approved by an authorized FAA representative.
2. FAA Technical Standard Order (TSO) number and identification mark indicating that the part or appliance was manufactured in accordance with the requirements of FAR 21 Subpart O.
3. FAA Parts Manufacturer Approval (PMA) symbol with the manufacturer's name, part number, make and model of the type certified product on which the part can legally be installed stamped on the part. An FAA/PMA is issued under FAR 21.305. Make and model information may be on a tag attached to the part.
4. Shipping ticket, invoice, or other document which verifies that the part was manufactured by a facility that was holding an FAA Approved Production Inspection System Certificate issued under FAR 21 Subpart F, or by a manufacturer holding an FAA Production Certificate issued under FAR 21 Subpart G.
5. Certificate of airworthiness for export issued by governments in countries other than the United States of America under the provisions of FAR 21 Subpart N.

Owner/Operator Responsibility

The owner/operator is responsible for the continued airworthiness of the aircraft. In accordance with FAR, certification of materials, parts and appliances for return to service for use on aircraft is the responsibility of the person/agency who signs the approval. To insure the continued safe operation of your aircraft, you must exercise great care when inspecting, testing, and determining the acceptability of all parts and materials. A very important part of this is verifying the origin of all materials, parts, and accessories that are used on your aircraft .

Notice to all users

This manual does not contain maintenance information for supplemental type certificated components or systems. This manual contains information on engines, components and systems designed, tested and certified by TCM in accordance with the pertinent type design data.

This manual contains maintenance information only. All personnel involved with these functions must thoroughly read and understand the information provided. These instructions provide the procedures necessary to maintain the engine and they must be carefully followed.

This manual contains no warranties, either expressed or implied.

WARNING

The Operator and Installation manual, Maintenance, manual, Overhaul manual, Service Documents and the Parts Catalog constitute the instructions for Continued Airworthiness prepared by TCM as approved by the FAA, pursuant to FAR Part 33. As required by FAR § 43.13, each person performing overhaul, maintenance, alteration or preventive maintenance on the engine or accessories must use the methods,

techniques and practices prescribed in the Instructions for Continued Airworthiness. Failure to comply with the Instructions for Continued Airworthiness may result in engine malfunction, engine failure, injury or death.

To The Mechanic

Prior to performing maintenance, alteration, overhaul or preventive maintenance, the mechanic must meet requirements of FAR 65 and must follow FAR Parts 43, 91 and 145 as applicable. Use this manual in conjunction with Teledyne Continental Motors (TCM) service documents, related publications, accessory manufacturer's instructions, FAR and FAA Advisory Circulars.

Notes, Cautions and WARNINGS

NOTE...

Special interest information which may facilitate performance of a procedure or operation of equipment.

CAUTION...

Used to emphasize certain information or instructions which if disregarded may result in damage to engine or accessories.

WARNING

Used to provide warning with respect to information and/or instructions which if disregarded will endanger personnel and/or severely damage the engine resulting in subsequent engine malfunction or failure.

Notes, cautions and warnings do not impose undue restrictions. They are provided to obtain maximum safety, efficiency and performance. Abuse, misuse or neglect of equipment can cause eventual engine malfunction or failure.

About This Manual

This maintenance manual and the publications listed in “Related Publications,” provide the information necessary to operate, maintain and install an aircraft engine. For a list of chapters contained in this manual refer to the “Table of Contents” earlier in this chapter. For chapter contents, refer to the chapter title page at the beginning of each chapter. The pages, figures and tables contained in this publication are numbered consecutively.

Scope

This publication contains the information necessary to perform scheduled maintenance, adjustment and testing of the IO-520-B, -BA, -BB, -C, -CB, -M and -MB engines.

Definition Of Terms

In this manual, front, rear, left and right refer to the engine as viewed from the accessory end. The accessory end is the rear and the propeller flange is the front of the engine. Cylinders are numbered starting from the rear, with odd numbers on the right and even numbers on the left.

Manual Revisions

Teledyne Continental Motors’ manuals are revised as necessary. Revisions to this manual will be furnished to purchasers who fill out and return the registration post card located in the front of this manual.

Page iii, “Current Status Of Pages,” is updated at each revision. Remove and discard the old page iii. Insert the new page iii as a record of which revisions have been incorporated into the manual.

If for any reason, you are uncertain whether all current revisions have been incorporated into the manual, contact Teledyne Continental Motors or a TCM Distributor to confirm the manual is the most current revision. Do not use the manual and do not perform any operation, maintenance or installation procedures or other operations upon the engine or accessories until the manual has been confirmed to be current.

This manual is current and correct to the best of Teledyne Continental Motors’ knowledge at the time of publication. Teledyne Continental Motors solicits and encourages users comments regarding suggested changes to this manual (a post card is provided at the front of the manual for this purpose.) Routine recommended changes or questions should be sent to:

**Teledyne Continental Motors
P.O. Box 90
Mobile, Alabama 36601
ATTN:
Technical Publications Department**

If the user observes incorrect information or mistakes in this publication that may affect safety in any manner, immediately contact the Technical Publications Department at (334) 438-3411 of Continental Motors at (334) 438-3411, or contact a Teledyne Continental Motors Distributor or the Federal Aviation Administration.

Related Publications

The following is a listing of related manuals:

1. Overhaul Manual for I0-520 Permold series engine models -B, -BA, -BB, -C, -CB, -M, and -MB Engines, Form OH-11.
2. Illustrated Parts Catalog for for I0-520 Permold series engine models -B, -BA, -BB, -C, -CB, -M and -MB Permold Series Aircraft Engine, Form X30624A.
3. Operator and Installation Manual, Form OI-11.
4. Teledyne Continental Motors Aircraft Engine Service Documents (including service bulletins).
5. Fuel Injection Manual, Form X30593A.
6. Starter Service Instructions, Form X30592.
7. TCM Ignition Systems Master Service Manual, Form X40000

The above publications can be ordered through your Teledyne Continental Motors Distributor or ordered directly, if prepaid, from:

Teledyne Continental Motors
P. O. Box 90
Mobile, Alabama 36601
ATTN: Publication Sales Department
Telephone: (334) 438-3411

For price information on the above publications request TCM Publications Pricing Index of Current Publications and Optional Publications.

ASTM

American Society for Testing and Materials (ASTM). Order through:

ASTM
1916 Race Street, Philadelphia, PA.
19103-1187 USA
Ph: (215) 299-5400

Slick Ignitions

Order Slick Ignition Systems Master Service Manual Index and Order Form through:

Slick Aircraft Products, Unison Industries
530 Blackhawk Park Avenue
Rockford, Illinois 61104
ATT: Subscription Department
Telephone: (815) 965-4700

Service Documents

Teledyne Continental Motors service documents are:

- (1) Mandatory Service Bulletin
 - (2) Critical Service Bulletin
 - (3) Service Bulletin
 - (4) Service Information Directive
 - (5) Service Information Letter
- Special Service Notice (SSN)

See “Related Publications,” for service document ordering information. Following are definitions of the above service document categories:

CATEGORY 1: “Mandatory Service Bulletin” (MSB)

Service documents relating to known or suspected hazards to safety that have been incorporated in whole or in part in an Airworthiness Directive (AD) issued by the FAA or have been issued, at the direction of FAA, by the manufacturer in order to require compliance with an already issued AD (or an equivalent issued by another country's airworthiness authority).

CATEGORY 2: “Critical Service Bulletin” (CSB)

Service documents (not included in Category 1) that have been determined by the product manufacturer to constitute a threat to continued safe operation of an aircraft or to persons or property on the ground unless some specific action (inspection, repair, replacement, etc.) is taken by the product owner or operator. Documents in this category may be incorporated in an Airworthiness Directive issued by the FAA.

CATEGORY 3: “Service Bulletin” (SB)

Service documents (not included in Categories 1 and 2) considered by the product manufacturer to constitute a substantial improvement to the inherent safety of an aircraft or component of an aircraft. This "Service Bulletin" category also

includes updates of instructions for continued airworthiness.

CATEGORY 4: “Service Information Directive” (SID)

Service documents (not included in Categories 1, 2 or 3) that have been determined by the manufacturer to be of value to an owner/operator in the use of a product by enhancing safety, maintenance or economy.

CATEGORY 5: “Service Information Letter” (SIL)

This category includes all information (not included in Categories 1 through 4) that may be of use to the owner/operator or maintainer of the aircraft.

Special Service Notice (SSN)

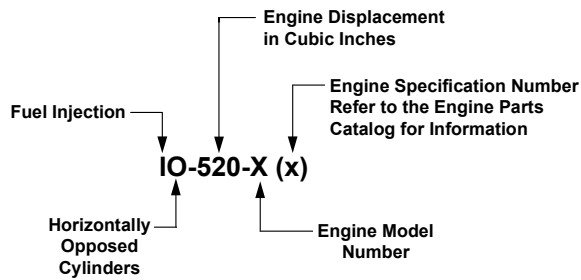
TCM may issue a Special Service Notice when a product condition can be rectified by direct contact with each customer to whom the product was delivered. Special service notices will be upgraded to Service Bulletins if confirmation of compliance with the Special Service Notice cannot be verified by TCM.

Service Reports And Inquiries

If for any reason you have an inquiry or require technical assistance, contact your local TCM distributor or TCM field representative. Requests for copies of Teledyne Continental Aircraft Engine service publications should be made through your distributor or Teledyne Continental Motors, P. O. Box 90, Mobile, AL 36601, ATTN: Publications Sales Department.

Engine Model Code

This is how a typical IO-520 engine model code is interpreted:



Engine Design Features

The IO-520 Permold series engines have six air cooled, horizontally opposed cylinders with overhead valves. The 5.25 inch bore and 4.00 inch stroke provides 520 cubic inches displacement.

The engines are fuel injected and feature up-draft induction systems. The crankshaft is equipped with pendulum type counterweight dampers that suppress torsional vibrations.

A gear-driven alternator is installed on the right-front side of the crankcase forward of the number 5 cylinder. The engine is equipped with two gear-driven magnetos and two accessory drive pads.

The exhaust system is supplied by the airframe manufacturer.

The IO-520 Permold Series engines have a doweled six bolt hole configuration propeller flange. A mounting pad is provided for a hydraulic controlled governor for a constant speed propeller.

A wet sump and positive displacement oil pump are installed on the lower rear of the crankcase. When properly adjusted under normal operating conditions, the desired oil pressure is maintained by a pressure relief valve located in the oil pump housing.

A geared, right-angle drive starter adapter with a direct current starter motor provides engine cranking.

Engine Specifications and Operating Limits

The operating limits and specifications listed in this section are applicable to the I0-520 Permold Series aircraft engines. Consult the I0-520 Operator And Installation Manual, Form OI-11 for additional operating procedures.

For time between overhaul (TBO) for I0-520 Permold Series engines see section 5-3 and the latest TBO Service Bulletin (Revised Overhaul Periods For All Teledyne Continental Aircraft Engines). Accessories supplied with the engine by TCM have the same TBO with criteria for service and longevity outlined in current TCM TBO Service Bulletins, unless otherwise specified.

Engine Specifications

Manufacturer: Teledyne Continental Motors
 Models: I0-520-B, -BA, -BB, -C, -CB, -M, -MB
 Cylinders

Arrangement.....	Individual cylinders horizontally opposed
Compression Ratio.....	8.5:1
Firing Order.....	1-6-3-2-5-4
Number of cylinders.....	6
Bore (Inches).....	5.25
Stroke (Inches).....	4.00
Piston Displacement (cu in).....	520

Brake Horsepower
 Rated Maximum Continuous Operation 285

Operating Limits

NOTE...

The following specifications apply to all I0-520 Permold Series engines unless otherwise specified.

Crankshaft Speed - RPM

Rated Maximum Continuous Operation.....	2700
Idle.....	600 min.

Intake Manifold Pressure At Idle (In. Hg.)

.....	18.5 max.
-------	-----------

Fuel Control System

..... Continental Continuous Flow Injection

Fuel..... See Chapter 7, "Servicing Fluids"

Oil..... See Chapter 7, "Servicing Fluids"

Oil Pressure

Idle, Minimum, psi..... 10

Normal Operation, psi @ 200° F..... 30 to 60

Oil Sump Capacity (U.S. Quarts) I0-520-B, -BA, -BB, -C, -CB, -M, -MB

.....	12
-------	----

Oil Consumption (LB /BHP/Hr. Max.)

.....	.006 X $\frac{\% \text{ Power}}{100}$
-------	---------------------------------------

Oil Temperature Limits

Minimum for Take-Off..... 24°C/75°F

Maximum Allowable..... 115.6°C/240°F

Ignition Timing (Compression stroke, breaker opens)

Right Magneto, degrees BTC..... 22° ± 1°

Left Magneto, degrees BTC..... 22° ± 1°

The following spark plugs are approved for use in engine models according to the following listing:

I0-520 Permold Series: TCM..... 634675
 Champion..... RHB32E

Spark Plug Gap:

..... Use spark plug manufacturer's specified gap

Accessory Drive Ratios to Crankshaft

Accessory	Direction of Rotation	Drive Ratio
Tachometer	CCW	.5:1
Magneto	CCW	1.5:1
Starter	CCW	48:1
Alternator (Gear Dr.)	CCW	3:1
**Propeller Governor	CW	1:1
Fuel Pump (Injection)	CW	1:1
Accessory Drives (2)	CW	1.5:1

“CW”- Clockwise and “CCW” - Counterclockwise (facing drive pad).

** This drive is a modified AND 20010 and is supplied with cover plate only.

<i>WARNING</i>

Oil pressure is applied to the face of accessory drive pads. If a gasket, accessory or cover is not properly installed or hardware is not properly torqued, oil leakage will occur.

DO NOT operate the engine without a propeller governor or internally grooved cover plate installed. Failure to do so will cause damage to the crankshaft and oil transfer collar.

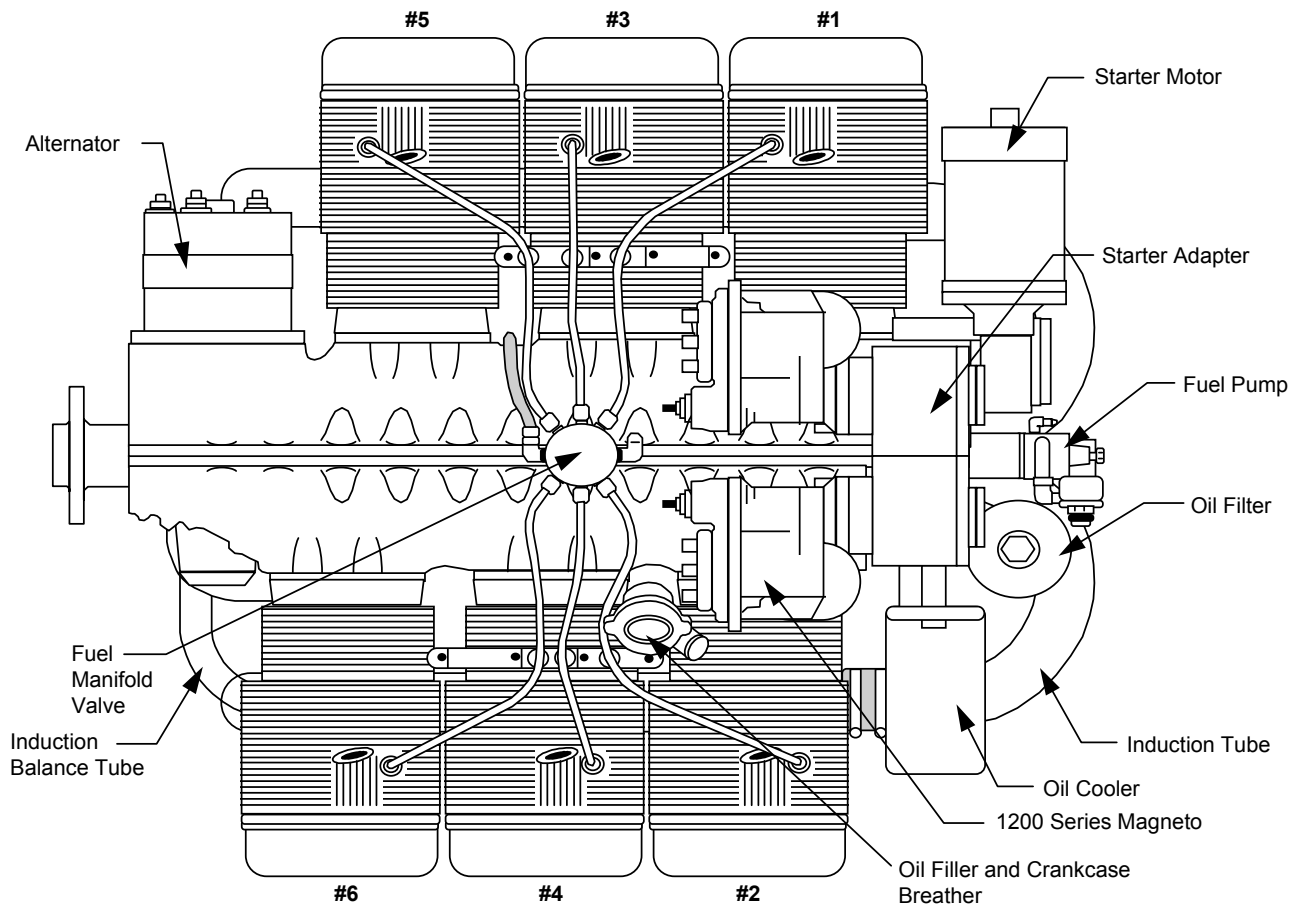


Figure 1-1
IO-520-B, -BA and -BB Engine Models - Top View

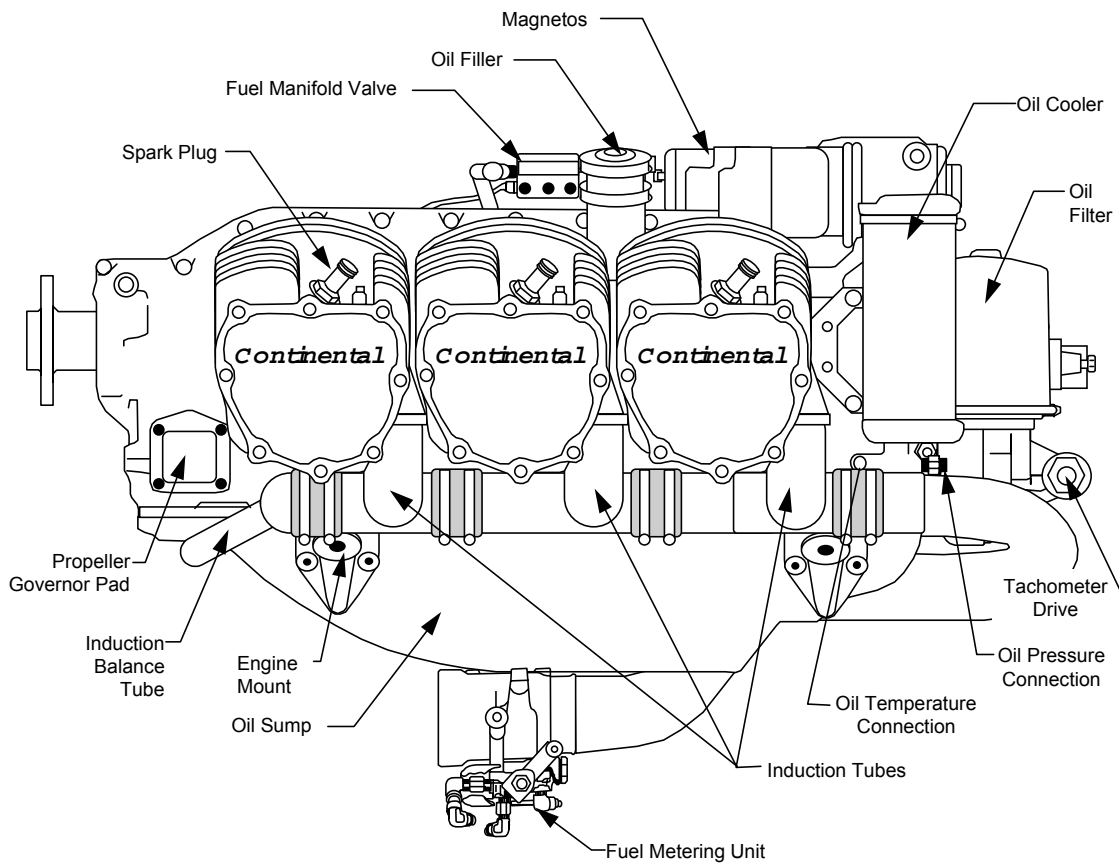


Figure 1-2
IO-520-B, -BA and -BB Engine Models - Side View

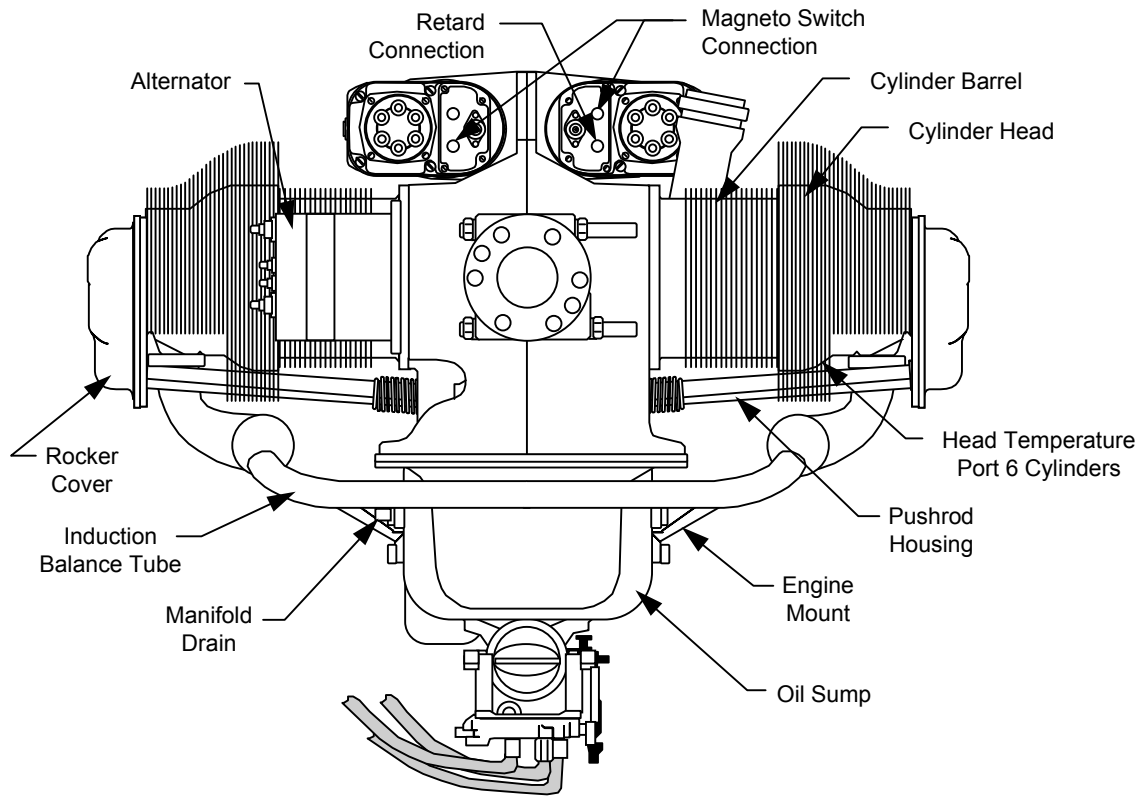


Figure 1-3
IO-520-B, -BA and -BB Engine Models - Front View

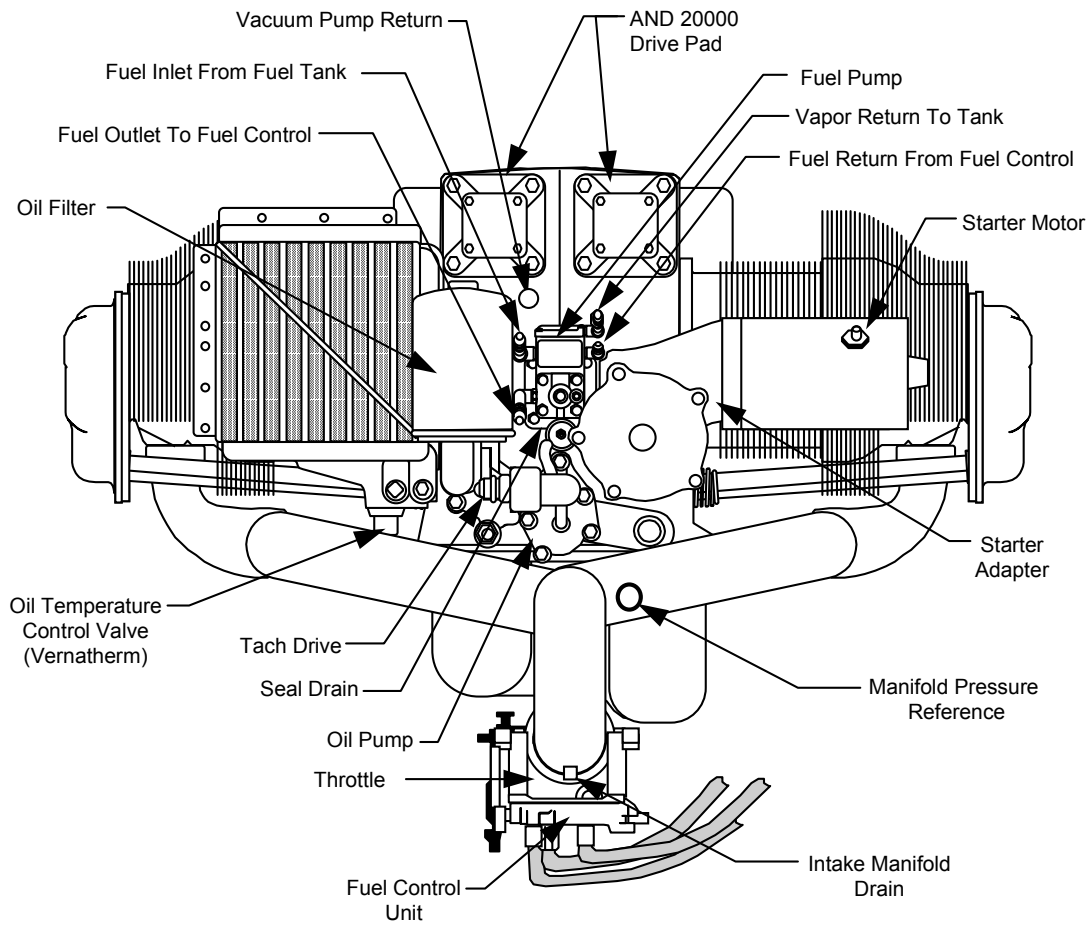


Figure 1-4
IO-520-B, -BA and -BB Engine Models - Rear View

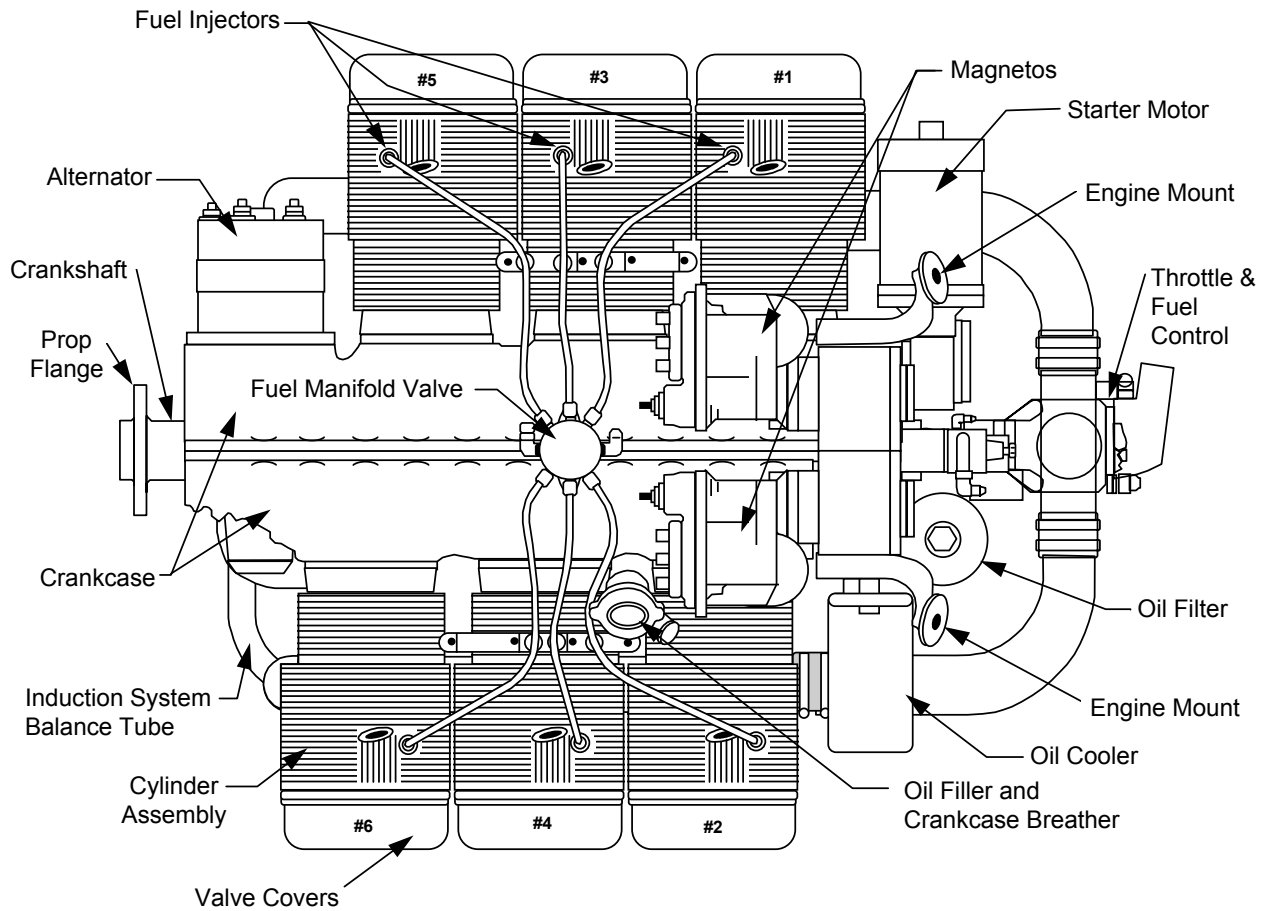


Figure 1-5
IO-520-C, -CB Engine Models - Top View

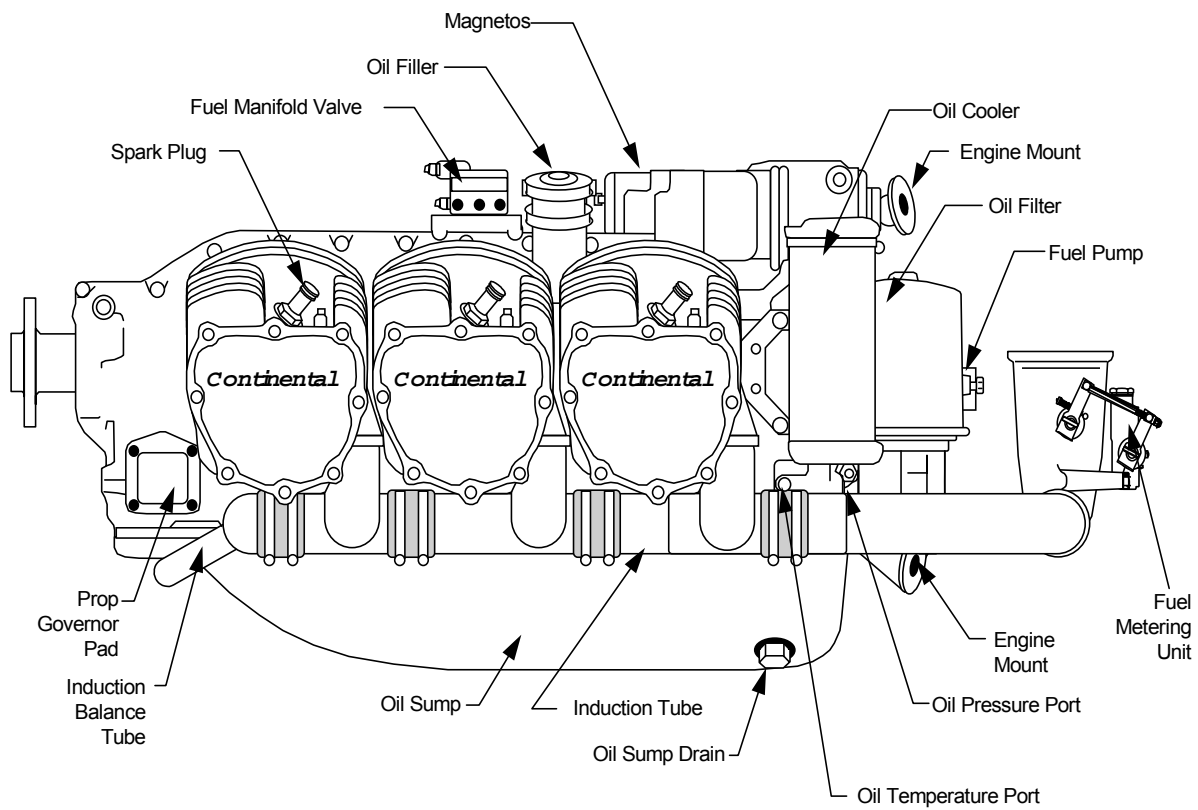


Figure 1-6
IO-520-C, -CB Engine Models - Side View

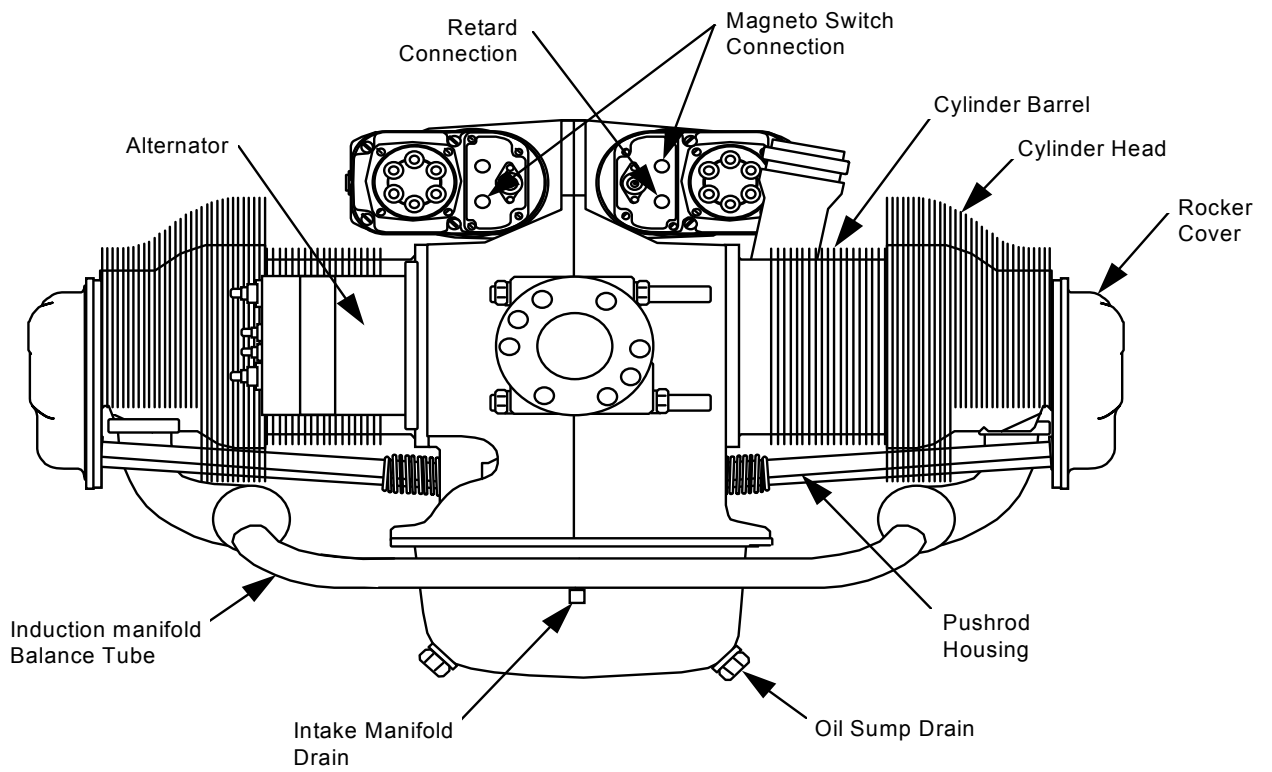


Figure 1-7
IO-520-C, -CB Engine Models - Front View

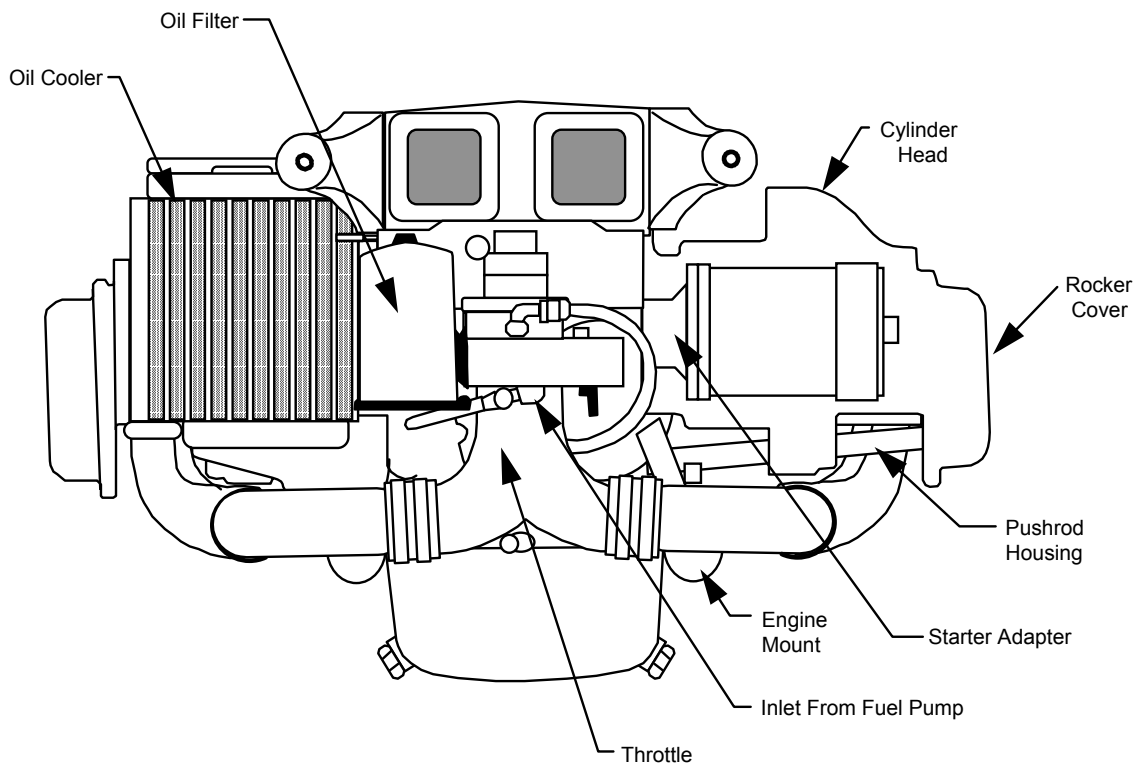


Figure 1-8
IO-520-C, -CB Engine Models - Rear View

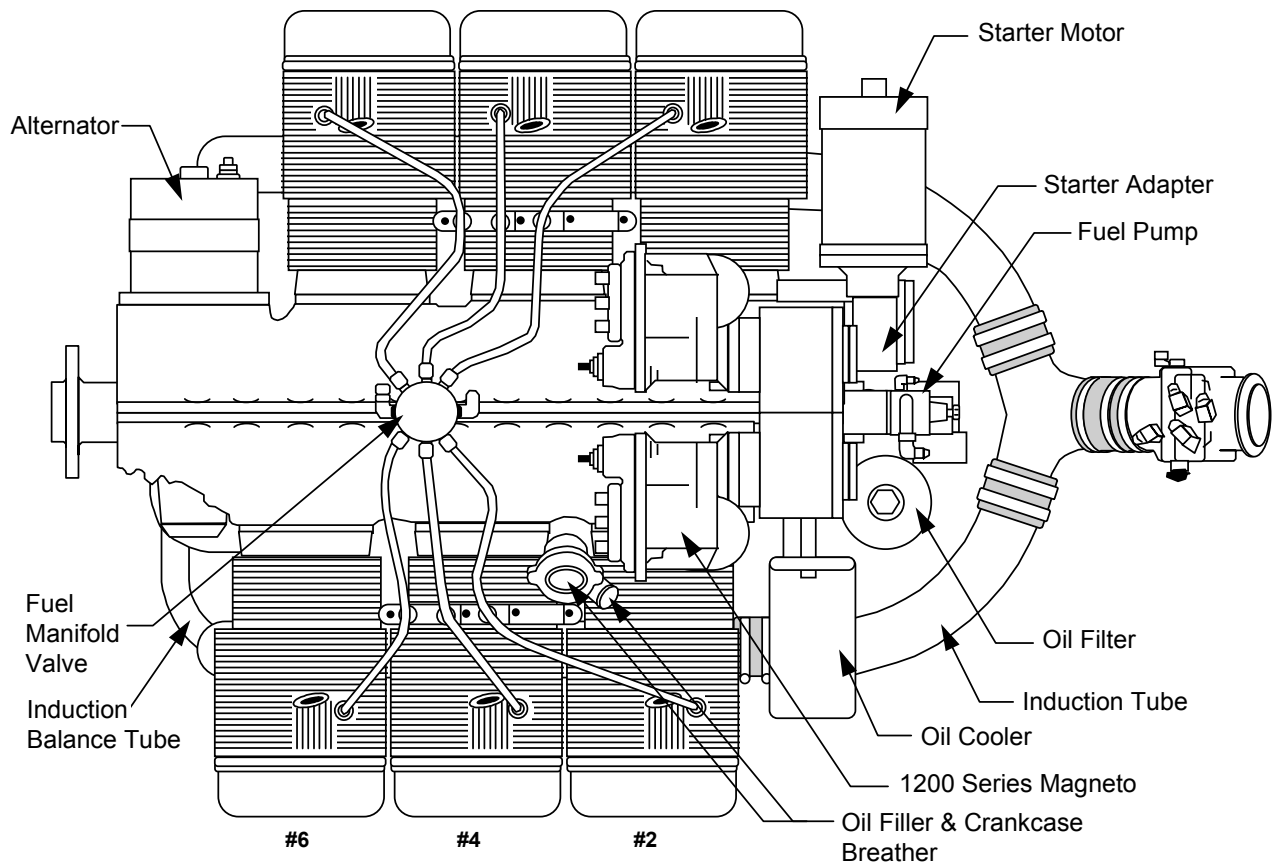


Figure 1-9
IO-520-M, -MB Engine Models - Top View

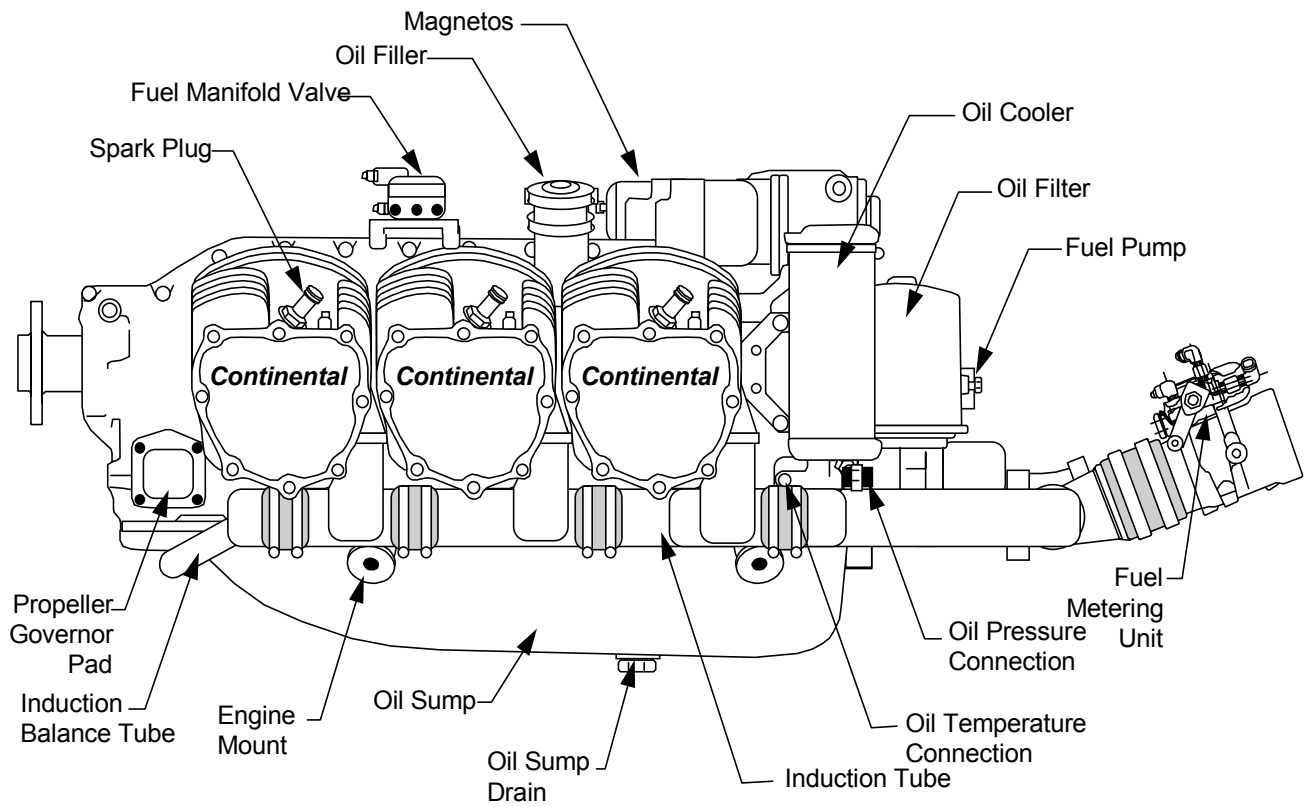


Figure 1-10
IO-520-M, -MB Engine Models - Side View

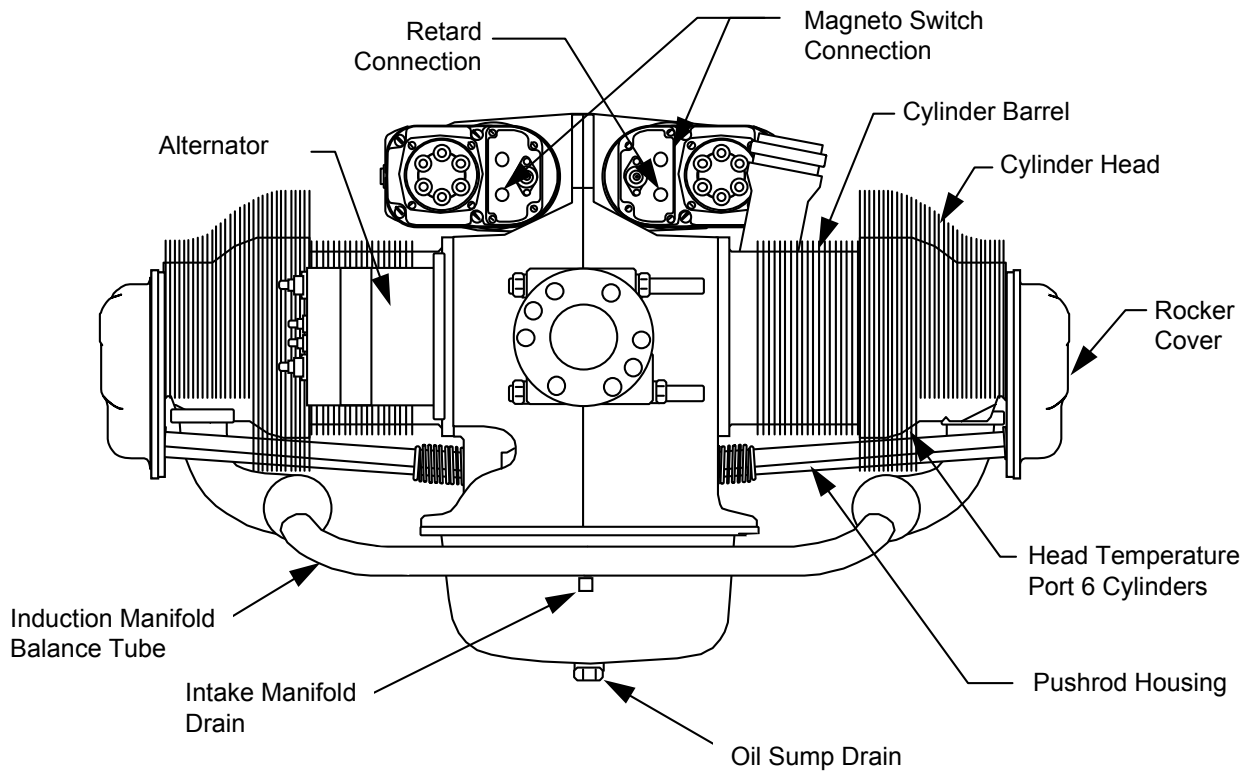


Figure 1-11
IO-520-M, -MB Engine Models - Front View

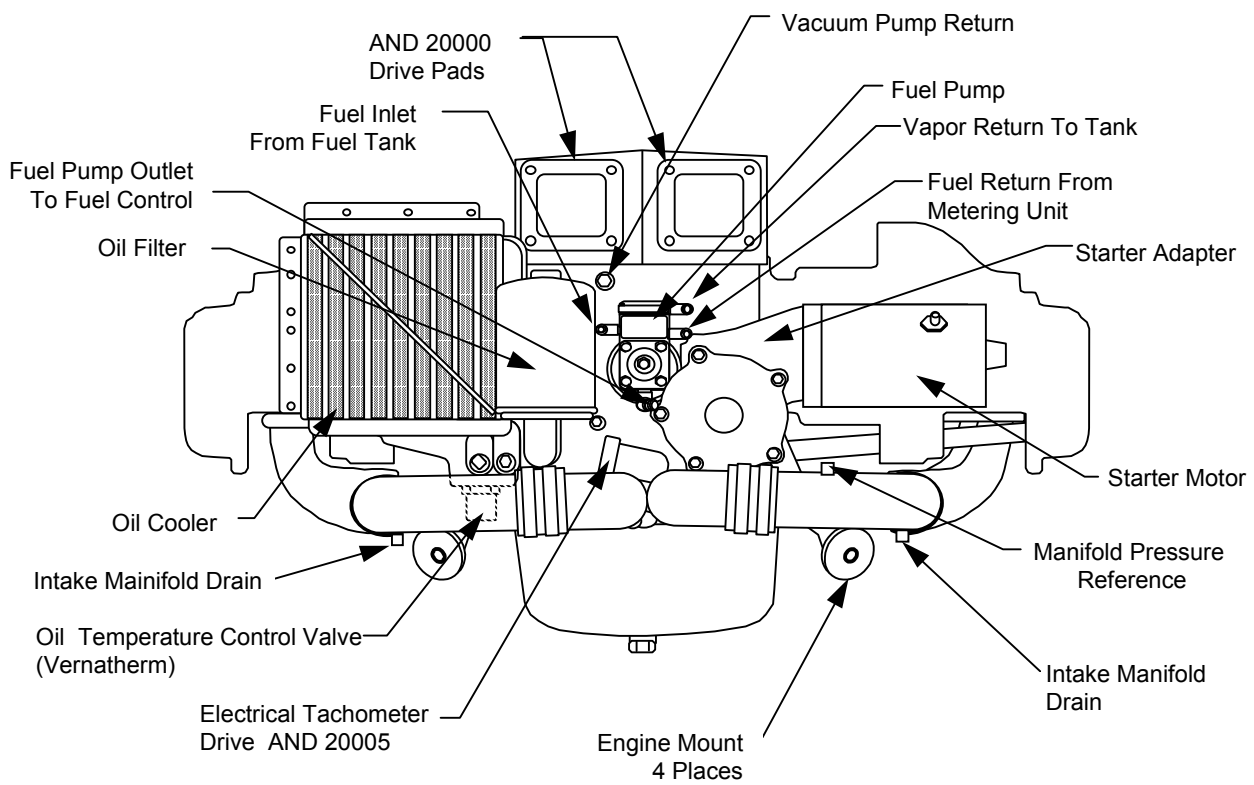


Figure 1-12
IO-520-M, -MB Engine Models - Rear View

Tools and Equipment

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Necessary Tools

The mechanic should be equipped with a complete set of tools that include the following:

1. Wrenches - 1/4" through 1 1/4"
2. Common and Philips Head Screwdrivers
3. Pliers - Common, Diagonal Cutters, Needle Nose, Duck Bill, Snap Ring, Safety Wire
4. Ratchets 1/4", 3/8", 1/2" Drive
5. Sockets - 1/4" Drive 5/32" through 1/2", - 3/8" Drive 3/8" through 1" - 1/2" Drive 7/16" through 1-1/4"
6. Sockets (Deepwell) -1/2" Drive, 7/6" through 1"
7. Feeler Gauges
8. Leather or Soft Plastic Mallet
9. Torque Wrenches* 0-500 In. Lbs. and 0-100 Ft. Lbs.
10. Micrometers*
11. Slide Hammer
12. Pullers
13. Thickness Gauges
14. Vernier Calipers*
15. Small Hole Gauges

* Must be currently calibrated, and the calibration must be traceable to the National Bureau of Standards.

Possible Special Tool Procurement Sources

Note: All tools in the "Special Tool" list are for reference only, and not for the purpose of promoting or suggesting tools to be purchased from the indicated sources.

ALCOR Box 32516 10130 Jones Maltsberger Rd. San Antonio, TX 78284 Ph.512/349-3771	Instruments for Light Powered Aircraft Special Tools
KENT- MOORE 29784 Little Mack Roseville, MI 48066-2298 Ph. 800/253-0138	Precision Instruments Measuring Instruments Precision Tools, Special Tools
CHAMPION SPARK PLUG, CO. Box 910, 900 Upton Ave. Toledo, OH 43661 Ph. 419/535-2461	Spark Plugs, Ignitors, Oil Filters Special Tools
EASTERN ELECTRONICS, INC. 180 Roberts St. East Hartford, CT 06108 Ph. 203/528-9821	Fuel Pressure Test Equipment Measuring Instruments Precision Tools, Piston Position Indicators
FEDERAL TOOL SUPPLY CO., INC. 1144 Eddy St. Providence, Rhode Island 02940 Ph. 800/343-2050	Precision Inspection Instruments Special Tools
AIRCRAFT TOOL SUPPLY P.O. Box 4525, 2840 Breard St. Monroe, LA 71201 Ph. 507/451 -5310	Precision Tools Special Tools
McMASTER-CARR SUPPLY CO. P.O. Box 4355 Chicago, Illinois 60680 Ph. 312/833-0300	Precision Tools Special Tools
SNAP ON TOOLS 2611 Commerce Blvd. Birmingham, Alabama 35210 Ph. 205/956-1722	Precision Tools Special Tools
KELL-STROM TOOL COMPANY, INC. 214 Church St. Wethersfield, CT 06109	Ignition Test Equipment
FAX CORPORATION 210 South King St. Danbury, Connecticut 06813 Ph. 203/748-6117	Ultrasonic Test Equipment
MERRIT PRODUCTS 201 W. Manville, Compote, Cal. 90224 Ph. 310/639-4242	Special Tools
AERO TEST, INC. 29300 Goddard Rd, Romulus, Mi. 48174 Ph. 313/946-547	Model 20 ATM-C Porta-Test Unit
PARKER RESEARCH CORPORATION P.O. Box 1406 Dunedin Fl. 34697 Ph. 1-800-525-3935	Model DA-200 Contour Probe Fax. 813-797-3941

Special Tools

Specific tools listed below, or equivalent tools marketed by other manufacturers, are necessary for overhaul and maintenance.

General Engine Reciprocating

1. Master Orifice Tool for cylinder compression test available from Kent - Moore.
2. Differential Pressure Cylinder Checker available from Kent - Moore.

Ignition System

1. Borrough's 3608A Protractor/Timing Indicator Disc or equivalent for setting engine timing.
2. Model E25 Timing Indicator available from Eastern Electronics, Inc.
3. 11-9110-1 Magneto Timing Light available from KELL-STROM Tool Company Inc.

Fuel Injection

1. Borrough's 8165 Injector Nozzle Remover and Installer or equivalent.

Charging System

1. Borrough's 7726 Tork Band Tension Adjuster or equivalent for Gen./Alt. Belt Tensioning.
2. BT-33-73F Belt Tension Gauge available from Kent - Moore.
3. Borrough's 4973 Generator Drive Holders or equivalent.
4. Borrough's 61-5 Pulley Puller or equivalent for gen./alt. sheave removal
5. Borrough's 8091 GEN./ALT. Output Tester or equivalent.
6. 647 Alternator Analyzer Voltage Regulator Tester from Eastern Electronics, Inc.
7. E100 Alternator/Regulator/Battery Tester available from Eastern Electronics, Inc.
8. Model 29 Voltage & Circuit Tester available from Eastern Electronics, Inc.

Starting System

1. Borrough's 8093C Bearing Puller or equivalent for needle bearing removal.
2. Borroughs 23-1 Needle Bearing Installer or equivalent.

Lubrication System

1. Oil Pressure Relief Spot Facer available from Kent - Moore.

Cylinders

1. Push Rod Spring Compressor available from Kent - Moore.
2. 5204 & 8158A Cylinder Base Nut Wrenches available from Kent - Moore.
3. Borrough's 8079 Cylinder Base Nut Wrenches or equivalent.
4. 3882, 3882-2 Cylinder Base Nut Wrenches available from Kent - Moore.
5. Borrough's 5221A Holding Fixture Adapters or equivalent
6. Borrough's 5221 13A Cylinder Holding Fixture or equivalent.
7. Borrough's 8156 Cylinder Heating Stand or equivalent.

8. Borrough's 8086 Valve Seat Insert Remover & Replacer or equivalent.
9. Borrough's 4910 Installer Valve Seat Insert or equivalent.
10. Borrough's 4956 Installer Valve Seat Insert or equivalent.
11. Borrough's 8116 Common Parts Kit or equivalent.
12. Borrough's 8116-1 B through 15B Boring Bars or equivalent.
13. Borrough's 8116-1 R through 15R Reamers or equivalent.
14. Borrough's 8116-1 through 16 Expanding Guide Bodies or equivalent.
15. 4909 Valve Seat (Straight Side) Insert Cutters available from Kent - Moore.
16. 4954 Valve Seat (Straight Side) Insert Cutters available from Kent - Moore.
17. 4985 Valve Seat (Straight Side) Insert Cutters available from Kent - Moore.
18. 5224 Valve Seat (Straight Side) Insert Cutters available from Kent - Moore.
19. 5225 Valve Seat (Straight Side) Insert Cutters available from Kent - Moore.
20. 8135 Valve Seat (Step Side) Insert Cutters available from Kent - Moore.
21. 8136 Valve Seat (Step Side) Insert Cutters available from Kent - Moore.
22. 8138 Valve Seat (Step Side) Insert Cutters available from Kent - Moore.
23. Borrough's 8122A Common Drive Handle or equivalent.
24. 122 Valve Guide Cleaner available from Kent - Moore.
25. 4981 Valve Guide Remover available from Kent - Moore.
26. 2842 Valve Guide Replacer available from Kent - Moore.
27. Borrough's 3170 Floating Holder or equivalent.
28. 4981 Valve Guide Remover available from Kent - Moore.
29. Borrough's 8116-24 through 29 Valve Stem Hole Reamers or equivalent.
30. 2847-2CP Reamer (Carbide Tipped) available from Kent - Moore.
31. 2847-1CP Reamer (Carbide Tipped) available from Kent - Moore.
32. 2847-1HP Reamer (High Speed Steel) available from Kent - Moore
33. 2847-2HP Reamer (High Speed Steel) available from Kent - Moore
34. Plug Gauge for valve guide inspection available from Kent - Moore.
35. 4943-1 HS through 5HS Reamers, Valve Guide Boss available from Kent - Moore.
36. Borrough's 4918 Spark Plug Insert Replacer or equivalent.
37. Borrough's 4919 Spark Plug Insert Remover or equivalent.
38. Borrough's 445, 18mm Spark Plug Tap or equivalent for straightening out damaged
39. 2769A13 Rosan® Stud Remover available from McMASTER-CARR Supply Co.
Rosan® is a registered trademark of Fairchild Aerospace Fastener Division.
40. 8074 Rosan® Lock Ring Installer available from Kent - Moore.
41. Rocker Arm Bushing Remover/Installer available from Kent - Moore.
42. 7232 Reamer Rocker Arm Bushing available from Kent- Moore.
43. DA-200 Contour Probe available from Parker Research Corporation.

Crankcase

1. Borrough's 8114 Crankcase Through Bolt Removers or equivalent.
2. L423 Crankcase Splitter available from Kent - Moore.
3. Borrough's 505 Stud Drivers or equivalent.

Engine Drive Train

1. Borrough's 8117A Runout Block Set or equivalent for crankshaft inspection.
2. Wheel Fax Jr. Mark IV Model O for Crankshaft Ultrasonic Testing available from Fax Corporation.
Operator must be certified in accordance with TCM standards.
3. Borrough's 8087A Polishing Tools for Crankshaft Bearings or equivalent.
4. 4965A Crankshaft Blade and Damper Bushing Remover/Replacer available from Kent- Moore.
5. Borrough's 8077A Bushing Remover & Replacer, Counterweight or equivalent.
6. Borrough's 8111A Connecting Rod Fixture or equivalent.
7. Borrough's 8042C Adapter Kit or equivalent for connecting rod inspection.
8. 5008 Reamers for connecting rod bushing available from Kent - Moore.
9. D-4000 Federal Dimension Air Gauge for connecting rod bushing inspection available from Federal Tool Supply Co., Inc.
10. 1.1268 Setting Ring for checking 1.1267 to 1.1269 tolerance available from Federal Tool Supply Co., Inc.
11. 1.1268 Air Plug for checking 1.1267 to 1.1269 tolerance available from Federal Tool Supply Co., Inc.
12. Propeller Shaft Oil Seal Installer available from Kent - Moore

Operational Inspection

- 1 Alcor Portable Digital EGT Unit available from Alcor, Inc.
- 2 Alcor Portable Digital CHT available from Alcor, Inc.
- 3 Model 20 ATM-C Porta-Test Unit available from Aero Test, Inc.©

NOTE...

The rights to manufacture Borrough's Tools have been acquired by Kent-Moore.

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Sealants and Lubricants

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Sealants And Lubricants

Aviation Engine Oil Ashless Dispersant

Recommended Grade:

Above 40°F ambient air, sea level:	SAE 50 or 15W50
Below 40°F ambient air, sea level:	SAE 30 or 20W60

Manufacturer

BP Oil Corporation
Castrol
Castrol Limited (Australia)
Chevron U.S.A., Inc.
Continental Oil
Delta Petroleum Company
Exxon Company, U.S.A.
Gulf Oil Company
Mobil Oil Company
NYCO S.A.
Pennzoil Company
Phillips Petroleum Company
Phillips Petroleum Company

Quaker State Oil & Refining Company
Red Ram Limited (Canada)
Shell Australia
Shell Canada Limited

Shell Oil Company

Sinclair Oil Company
Texaco Inc.
Total France
Union Oil Company of California

Brand Name

BP Aero Oil
Castrol Aero AD Oil
Castrol Aero AD Oil
Chevron Aero Oil
Conco Aero S
Delta Avoil Oil
Exxon Aviation Oil EE
Gulfpride Aviation AD
Mobil Aero Oil
TURBONYCOIL 3570
Pennzoil Aircraft Engine Oil
Phillips 66 Aviation Oil, Type A
X/C Aviation Multiviscosity Oil
SAE 20W50, SAE 20W60
Quaker State AD Aviation Engine Oil
Red Ram X/C Aviation Oil 20W50
Aeroshell (R) W
Aeroshell Oil W, Aeroshell Oil W 15W50
Anti-Wear Formulation Aeroshell Oil W 15W50
Aeroshell Oil W, Aeroshell Oil W 15W50
Anti-Wear Formulation Aeroshell Oil W 15W15
Sinclair Avoil
Texaco Aircraft Engine Oil - Premium AD
Total Aero DM 15W50
Union Aircraft Engine Oil HD

Aviation Break-in Oil

MIL-C-6529 Type 11 Corrosion preventive mineral oil.

NOTE... Mineral oil conforming with MIL-C-6529 Type 11 contains a corrosion preventive additive and must not be used for more than 25 hours or six months, whichever occurs first. If oil consumption has not stabilized in this time, drain and replenish the oil and replace the oil filter.

Aviation Preservative Oil

Type	Suggested Sources	Application
MIL-C-6529 Type 11	(Aeroshell Fluid 2F or equivalent)	For Temporary storage (up to 90 days)
MIL-P-46002, Grade 1 oil	(NOX RUST VCI-105 or equivalent) May be purchased through: Rock Island Lubricant & Chemical Co. P.O. Box 5015 1320 1st Street Rock Island, Illinois 61204 Phone: 1 -800-522-1150	For Indefinite storage

Lubricants

Type	Suggested Sources	Application
Molyshield Grease	May be purchased through: American Lubricants 1227 Deeds Dayton, Ohio 45401 Phone: (513) 222 - 2851	Needle bearings and ball bearings Valve stems All ACC. drive splines and couplings Idler gear and pin Fuel injection controls, o-rings, springs, shafts and bushings Magneto rubber drive bushings Oil pump and scavenge pump gear shafts, ends and teeth. Oil pump and scavenge pump housing and cover gear contact areas. Starter worm gear drive teeth and bevel gear teeth
Dow Corning® G-N Paste. Dow Corning G-N Paste is a registered trademark of Dow Corning Corp.	For Distributor information call 1-800-248-2481, have state & city information available	Camshaft lobes and lifter faces
Type	Suggested Sources	Application

Continued

<p>Alvania (Shell #2) For Distributor information</p>	<p>Shell Product Information Center, Phone: 1-800-231-6950</p>	<p>Front crankshaft oil seal. Apply light coat at point of contact between nutseat and ferrule on ignition lead</p>
<p>MIL-S-3545C Grease (Shell #5)</p>	<p>Shell Product Information Center, Phone: 1-800-231-6950</p>	<p>Fuel injection linkage pivot points, throttle shaft bushings, lever bushings</p>
<p>Permatex Maintain® Lubricant</p>	<p>For Distributor information call: Permatex Customer Service @ Phone: 1-800-641-7376</p>	<p>Fuel injection linkage pivot points, throttle shaft bushings, lever bushings</p>
<p>646943 - Antiseize Lubricant or Loctite Anti-Seize Lubricant 767</p>	<p>May be purchased through your local TCM Distributor. For Distributor information, call Loctite Customer Service at 1-800-243-4874</p>	<p>All .3125 and larger studs unless otherwise specified. All mechanical tach drive housing threads not through to an oil source Air reference fittings on all throttle bodies</p>
<p>Approved, Clean, 50 Weight Ashless Dispersant Oil</p>	<p>See Aviation Engine Oil Ashless Dispersant Table</p>	<p>Cylinder stud and through bolt threads, crankcase stud threads, connecting rod bolt and nut threads and engine accessory stud threads</p>
<p>Approved Clean Break-In Oil</p>	<p>See Break-In Oil Table</p>	<p>Crankshaft bearings, connecting rod bearings, camshaft bearings, tachometer gears and adapters, accessory spur gear teeth, starter cone, bushing and nut, starter adapter clutch spring (ID and OD), sealing surface of valve guide seals, pistons, piston pins, piston rings, rocker arms, pivots, valves and tappets, thrust washers and o-rings, prop governor transfer collar and sleeve, oil filter adapter seals</p>
<p>CHAMPION® - Spark Plug Thread Lubricant No. 2612 [CHAMPION® is a registered trademark of Cooper Industries.]</p>	<p>For Champion Products Distributor information: Phone: 803-843-5400</p>	<p>Spark plugs</p>

Lubricants (Continued)

WD-40 or Chesterton No. 4	Chesterton Technical Product Information Phone: (508) 469-6783	Induction system hose connections
Dow Corning® No. 4	For Distributor information call 1-800-248-2481, have state & city information available	Spin-on oil filter rubber seals Magneto adapter gaskets (both sides) Gasket, governor pad (both sides)

Sealants

Type	Suggested Sources	Application
LUBRIPLATE® 930 AA (P/N L0096-035)	For Distributor information Call LUBRIPLATE® @ Phone: 1-800-733-4755	Apply to the outside diameter of valve guides at installation
TCM P/N 654514 CRC 336 Rust Preventative Compound	May be purchased through your local TCM Distributor	Spray exhaust end of turbocharger for engine preservation
Permatex Aviation Grade 3D and #641543 Silk Thread and #646942 Gasket Maker or Loctite Gasket Eliminator 515 Sealant	For Distributor information call: Permatex Customer Service @ Phone: 1-800-641-7376 May be purchased through your local TCM Distributor May be purchased through your local TCM Distributor For Distributor information call: Loctite Customer Service @ Phone: 1-800-243-4874	Crankcase parting face, oil pump covers, scavenge pump covers

Continued...

Sealants (Continued)

<p>653692 - Primer or Loctite LocQuic Primer 7649</p>	<p>May be purchased through your local TCM Distributor For Distributor information: Loctite Customer Service @ Phone: 1-800-243-4874</p>	<p>Crankcase crankshaft nose oil seal area</p>
<p>#646942- Gasket Maker or Loctite Gasket Eliminator 515 Sealant</p>	<p>May be purchased through your local TCM Distributor For Distributor information: Loctite Customer Service @ Phone: 1-800-243-4874</p>	<p>Engine nose seal, outside diameter of all uncoated oil seals except fuel pump adapter seal, between oil sump and oil sump gaskets</p>
<p>#642188 - Gasket Sealant (TCM) 1.5 oz. tube</p>	<p>May be purchased through your local TCM Distributor or K & W Copper Coat For Distributor information r-all: K & W Products Customer Phone: 1-800423-9446</p>	<p>Cam bore cover gasket (except beaded gaskets), idler pin gasket, oil filler neck gasket, pressed in plugs, 2 bolt suction tube gasket</p>
<p>Loctite Pipe Sealant with Teflon PS/T 592</p>	<p>For Distributor information: Loctite Customer Service @ Phone: 1-800-243-4874</p>	<p>Pipe threads (except fuel system fittings), pressure relief valve housing threads, stud holes that are exposed to oil.</p>
<p>#646940 - F/I Sealant or Loctite Hydraulic Sealant 569</p>	<p>May be purchased through your local TCM Distributor For Distributor information: Loctite Customer Service, Phone: 1-800-243-4874</p>	<p>All pipe thread fittings in fuel injection system (use sparingly on male threads only)</p>
<p>Miller Stephenson MS 122/CO2 Spray</p>	<p>For Distributor information: Miller-Stephenson Customer Service, Phone: 1-800-992-2424</p>	<p>Ignition harness terminals at magneto block end</p>

Adhesives

Type	Suggested Sources	Application
646941 High Strength Adhesive Sealant or Loctite 271 653696 Primer or Loctite LocQuic Primer 7471	May be purchased through your local TCM Distributor For Distributor information: Loctite Customer Service, Phone: 1-800-243-4874	Cylinder deck studs, squirt nozzles, fuel manifold valve diaphragm and plunger assembly, crankshaft nose seal retainer bolts, studs on coolant manifold
649306 Sealant (optional 646940) or Loctite Adhesive Sealant 222 (optional Loctite Hydraulic Sealant 569)	For Distributor information: Loctite Customer Service, Phone: 1-800-243-4874	Through stud holes on accessory end of crankcase, manifold valve to bracket screws
3M Brand EC1252 White Spot Putty	3M	Cylinder deck stud nuts, through bolt nuts, magneto flanges, throttle body and fuel metering unit

Miscellaneous

Type	Suggested Sources	Application
TCM P/N 626531-1 Enamel - Gold (1 qt) TCM P/N 626531-2 Enamel - Gold (1 gal)	May be purchased through your local TCM Distributor	High temp. paint for cosmetic and corrosion protection
TCM P/N 535001S Lockwire -.032 inch dia. Steel, Corrosion Resistant	May be purchased through your local TCM Distributor	Where applicable for lockwiring
"ACCELAGOLD" Turco® Products Tucker, GA 30084 [Accelagold is manufactured by Turco® Products, Inc.]	For sales and service: Elf Atochem N.A. Turco® Products Div. P.O. Box 195 State Route 95 West Marion, Ohio, 43302 215-419-5376	Corrosion protection interior and exterior aluminum parts
Engine Preservation Kit <ul style="list-style-type: none"> • Dehydrator plugs • Desiccant bags • Streamers, warning sign • Preservative oils 	May be purchased through: TANAIR P.O. BOX 117 Glenwood, MN 56334 (US & CAN) 1-800-4432136 (MN) 1-800-862-2443	Engine Preservation

Airworthiness Limitations

Airworthiness Limitations 4-3

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Airworthiness Limitations

This Airworthiness Limitations section has been FAA approved and specifies maintenance required under §§ 43.16 and 91.403 of the Federal Aviation Regulations unless an alternative program has been FAA approved. Federal Aviation Regulations §§ 43.16 and 91.403 require owner/operator compliance with all maintenance limitations in this section concerning mandatory replacement times, inspection intervals and other related procedures that are specific to this engine. Any such limitations listed below are part of the design limits of the engine and the engine was type certificated based upon required owner/operator compliance with the limitations.

Mandatory Replacement Times

Subject to additional information contained in FAA Airworthiness Directives (AD) issued after the date of certification, the engines covered in this manual do not contain any components having mandatory replacement times required by type certification.

Mandatory Inspection Intervals

Subject to additional information contained in FAA Airworthiness Directives (AD) issued after the date of certification, the engine does not require specific intervals of inspection pursuant to type certification.

Other Related Procedures

Subject to additional information contained in the Airworthiness Directives (AD) issued after the date of certification, there are no other related procedures required pursuant to the type certification for this engine.

Distribution of Changes to Airworthiness Limitations.

Changes to the Airworthiness Limitations section constitute changes to the type design of this engine and require FAA approval. Such changes will be published in FAA Airworthiness Directives (AD).

Note

The limitations in this section apply only to specific limitations which are part of the engine design. Under the Federal Aviation Regulations numerous other additional limitations are applicable to this engine and its accessories. For example Federal Aviation Regulation Parts 91 and 43, among other parts, define inspection criteria, maintenance requirements and procedures that are applicable to this engine. It is the responsibility of the owner / operator to maintain the engine in an airworthy condition by complying with all applicable Federal Aviation Regulations and by performing maintenance in accordance with TCM Instructions for Continued Airworthiness, which consist of TCM publications and service documents.

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Time Limits, Operational Inspection, Engine Troubleshooting

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General

The scheduled inspection and maintenance described in this section must be complied with in addition to all aircraft manufacturer and accessory manufacturer inspection and maintenance requirements. This manual does not contain inspection or maintenance requirements for supplemental type certificated engines, components or systems. Such information must be obtained from the supplemental type certificate holder.

Safety, efficiency and engine service life is predicated on compliance with the aircraft and engine manufacturer's required instructions, inspections and maintenance schedule. The owner/operator is primarily responsible for maintaining the engine in an airworthy condition, including compliance with applicable Airworthiness Directives as specified in Part 39 of the Federal Aviation Regulations (FAR); reference FAR 91.163. The owner/operator is responsible for assuring the engine meets the conformity requirements as specified by the original Type Certificate (TC) or any Supplemental Type Certificate (STC) that may apply to modifications or alterations accomplished after the issuance of the original TC.

NOTE

Engine operational inspection must be performed before and after any 50 or 100-hour inspections or maintenance in accordance with "Operational Inspection" requirements described in this Chapter.

During engine 50 and 100-hour inspections, if engine components must be replaced or repaired, refer to the applicable system maintenance chapter. Corrections and adjustments will be found in the individual system chapters.

WARNING

When performing any inspection or maintenance, always treat the engine as if the ignition switch was on. Do not stand or allow anyone else to stand within the arc of the propeller. A loose or broken wire or a component malfunction could cause the engine and propeller to rotate and/or start.

Engines operated in extremely humid locations or in exceptionally cold, damp climates or coastal areas may require more frequent inspections. If the engine is operated in excess of 100 hours per year, the engine should be inspected at each 100-hour interval in addition to an annual inspection.

Overhaul Period

Engine Models

I0-520-B, -BA, -BB, -C, -CB, -M, and

-MB Permold Series 1700 HOURS

NOTE

Overhaul periods for the engine include all engine accessories unless otherwise specified by the accessory manufacturer.

Operational Inspection

An operational inspection must be performed prior to and after 50/100-hour inspections.

Starting

Start engine using the starting procedure given in the airframe manufacturers Airplane Flight Manual (AFM).

Oil Pressure - Check, If no oil pressure within 30 seconds, shut engine down and investigate.

Operational Checklist

Check and record the following system data :

Starter _____

*Record RPM Drop for each magneto at 1700 (150 RPM MAXIMUM AND 50 RPM SPREAD MAXIMUM) _____

*Propeller Operation at 1700 _____

*Or as specified in aircraft manufacturer's instructions.

Increase engine to full power and record:

Manifold Pressure _____

RPM _____

Fuel Flow _____

Oil Pressure _____

Oil Temperature _____

Cylinder Head Temperature _____

Alternator Output _____

Reduce engine to idle and record:

Manifold Pressure _____

RPM _____

Oil Pressure _____

Oil Temperature _____

Cylinder Head Temperature _____

Magneto System Grounding Check _____

CAUTION...

The magneto system grounding check must be performed at idle RPM only. Damage to the engine may result at engine speeds above idle RPM.

With engine speed at idle rpm, quickly turn both magnetos off then back on. The engine should cease running momentarily indicating both magnetos are properly grounded. If engine continues to run, one or both magneto ground circuits is faulty and must be repaired prior to further operation.

Slowly move mixture control to IDLE CUT OFF and record:

Mixture RPM Rise (25 to 50 RPM) _____

Positive Fuel Cutoff _____

When propeller stops rotating, place ignition switch, master switch and fuel selector in off position.

Test Operating Limits

IO-520-M and -MB

Recommended Minimum for Idle _____ 600 RPM

Recommended Maximum for Cruising _____

_____ 225 @ 2500

Rated Maximum Continuous Operation

_____ 300 BHP @ 2700 RPM

IO-520-B, -BA, -BB

Recommended Minimum for Idle _____ 600 RPM

Recommended Maximum for Cruising _____

_____ 235 @ 2500

Rated Maximum Continuous Operation

_____ 300 BHP @ 2700 RPM

IO-520-C, -CB

Recommended Minimum for Idle _____ 600 RPM

Recommended Maximum for Cruising _____

_____ 235 HP @ 2500

Rated Maximum Continuous Operation

_____ 300 BHP @ 2700 RPM

NOTE:

① May not be obtainable with aircraft static.

Manifold Air Pressure at Idle (Inches Hg) Max.

_____ 18.5

Fuel - Aviation Gasoline - minimum grade
 100LL (Blue) or 100 (Green)

Fuel Flow at Full Throttle (Lbs./hr.)

Model	Pounds Per Hour	GPH
IO-520-B	146-156	24.9-26.6
IO-520-BA	146-156	24.9-26.6
IO-520-BB	146-156	24.9-26.6
IO-520-M	142-150	24.2-25.6
IO-520-MB	142-150	24.2-25.6
IO-520-C	152-160	25.9-27.3
IO-520-CB	152-160	25.9-27.3

Metered Fuel Pressure

Model	At Idle	At Full Throttle
IO-520-B	3.9-4.5	17.7-20.0
IO-520-BB	3.9-4.5	16.5-18.4
IO-520-C	3.9-4.5	17.6-19.6

Unmetered Fuel Pressure

Model	At Idle	At Full Throttle
IO-520-A	8.0-10.0	32.0-36.0
IO-520-B	8.0-10.0	29.2-36.2
IO-520-C	8.0-10.0	31.6-37.8

Mixture Rise At Idle Cutoff - RPM..... 25 - 50

Oil Temperature

Minimum for Takeoff..... 75° F.
 Limit..... 240° F.
 Recommended Flight Operation..... 170° F.

Oil Pressure

Idle, minimum psi..... 10
 Normal Operation psi..... 30 - 60
 Maximum (oil cold)..... 100

Oil Sump Capacity (Quarts)

IO-520-M, -MB, -B, -BA, -BB, -C, -CB
 12 Quarts

Magnetos

Magneto Drop (Max.)..... 150 RPM
 Magneto Spread (Max.)..... 50 RPM

Cylinder Head Temperatures

Cylinder Head Temperature with Bayonet
 Thermocouple (Limit)..... 460° F
 Recommended Operating Maximum..... 420° F
 Mixture Rise at Idle Cutoff-RPM..... 25-50

Time Interval Inspections

Engine mounted accessories not supplied by TCM may require servicing at specific intervals; some of these are alternators, pneumatic pumps, air/oil separators and stand-by generators. Refer to the instructions provided by the aircraft manufacturer, accessory manufacturer or STC holder for detailed information.

CAUTION...

New, rebuilt and overhauled engines or engines that have had overhauled or new cylinders and new piston rings installed must be given a 100-hour inspection after 25 hours of operation.

Oil Change Interval _____ 50 hours
_____ Or six months, whichever comes first.

CAUTION...

Use only TCM approved oils. See TCM approved oils in chapter 3, "Table of Sealants and Lubricants."

25-Hour Inspection

NOTE

Research and comply with all applicable Service Publications and Airworthiness Directives.

1. After the first 25 hours of operation on new, rebuilt or overhauled engines, perform a complete 100-hour inspection. Drain the oil used for engine break-in. If engine oil consumption has stabilized, service the engine with TCM approved oil. If oil consumption has not stabilized, service engine with a mineral oil conforming to MIL-C-6529 Type II.

NOTE...

Mineral oil conforming to MIL-C-6529 Type II is a straight mineral oil with a corrosion preventive additive. This oil must not be operated in excess of 25 hours or 6 months,

whichever occurs first. If oil consumption has not stabilized within the first 25 hours of engine operation, drain and replenish the oil and replace the filter.

Approved Oil Grade: All Temperatures

_____ TCM Approved Multiviscosity

Below 40° F. Ambient Air (Sea Level)

_____ TCM Approved SAE 30 or Multiviscosity

Above 40° F. Ambient Air (Sea Level)

_____ TCM Approved SAE 50 or Multiviscosity

2. Visually inspect the engine and nacelle for fuel, oil leaks and other discrepancies.
3. Correct any discrepancies noted during this inspection prior to returning the engine to service.

50-Hour Inspection

NOTE

Research and comply with any applicable Service Publications and Airworthiness Directives.

1. Thoroughly inspect the engine for any signs of leakage. Clean engine exterior by spraying or brushing with a flame resistant solvent used for general cleaning of engine parts.

NOTE

Any environmentally hazardous materials used in cleaning must be caught and disposed of in accordance with Environmental Protection Agency regulations.

CAUTION...

Do not use any alkaline cleaning solutions for external engine cleaning, these solutions will remove the "alodized" finish of aluminum parts.

CAUTION...

Do not use kerosene or gasoline for cleaning.

2. A preinspection operational run-up must be performed. See "Operational Inspection" of this chapter.
 - (a) Record the engine operating parameters.
 - (b) Verify the recorded parameters meet the published specifications for the engine as provided in the aircraft or engine manufacturer's Maintenance, Operator's and Overhaul Manuals.

After the operational inspection, inspect, isolate and repair any leaks found.

3. Reference the applicable Airplane Flight Manual for operational values.
4. Remove and inspect induction air filter. Clean or replace as instructed by the filter manufacturer. Inspect induction system ducts, seals and gaskets for condition, deterioration and obstructions in accordance with the aircraft manufacturer's instructions. With induction air filter installed:
 - (a) Verify the induction air filter retainer is properly installed and the attaching hardware is secure in accordance with the aircraft manufacturer's instructions.
 - (b) Replace any questionable components as required in accordance with the aircraft manufacturer's instructions.
 - (c) Inspect all engine controls for proper travel, freedom of movement, wear, correct rigging and correct attachment in accordance with the aircraft manufacturer's instructions.

CAUTION...

Failure to properly install the induction air filter will result in unfiltered air being ingested into the

engine which will accelerate engine wear and reduce engine service life.

5. Inspect induction air box for security and deterioration in accordance with the aircraft manufacturer's instructions.
6. Inspect the aftercooler core and associated air passages for obstructions.

WARNING

Insure that the fuel selector is in the off position prior to servicing fuel filters.

7. Drain the fuel filter and if sediment was noted, remove it. Service as required and reinstall in accordance with the aircraft manufacturer's instructions.
8. Visually inspect engine and nacelle for fuel, oil leaks and other discrepancies.
9. Drain engine oil. During engine oil change, oil must be drained into an appropriate container and disposed of properly. Reinstall oil drain plug with new gasket, torque and safety.
10. Remove oil filter. Inspect filter element. See "Oil Filter Element Inspection, Oil Analysis and Spectrographic Oil Analysis" in Chapter 7, "Servicing Fluids."
11. Place a thin film of Dow Corning® DC-4 compound on new oil filter gasket. Install new oil filter. Torque filter to values as directed by filter manufacturer and safety wire.
12. Inspect all induction system or cylinder drain(s) for clogging or restriction.
13. Inspect ignition leads for chafing, deterioration and proper routing.
14. Visually inspect magnetos for condition. Inspect, repair and adjust as required if magneto drop or spread was not within published limits.

15. Correct all discrepancies noted.

WARNING

Operation of a malfunctioning engine can result in additional engine damage, bodily injury or death.

16. At the completion of any maintenance event the engine must be given a complete and thorough operational run-up. A test flight will be required if any engine adjustments have been made which affect flight characteristics or operation; this test flight is required by FAR 91.167.

- (a) Record all engine parameters.
- (b) Verify recorded parameters are within the specifications published for the engine and aircraft.

WARNING

Failure to identify and correct fuel or oil leaks can result in engine/nacelle fire, loss of engine power, engine failure, bodily injury or death.

17. Correct any discrepancies noted during operational run-up prior to returning engine to service.

100-Hour Inspection

NOTE...

Research and comply with the Service Publications and Airworthiness Directives.

In addition to the items listed in 50 Hour the following inspections and maintenance must be performed.

1. Drain engine oil. Reinstall oil drain plug with new gasket, torque and safety.
2. Inspect the cylinder barrels and cylinder heads for cracks, leaks rust and pitting. Inspect cylinder head and barrel cooling fins for any restriction of cooling airflow.
3. Inspect all inner cylinder and peripheral baffling for correct installation, proper positioning, deterioration and missing or broken sections.
4. Perform a cylinder compression test in accordance with chapter 19
5. Inspect the entire engine, accessory section and nacelle for indications of fuel or oil leaks. Inspect all wiring, fluid lines, hoses and electrical connections for proper routing, support and evidence of deterioration.
6. Visually inspect all cylinder and accessory to engine attaching hardware for security. Visually inspect airframe to engine connections for security and corrosion.
7. Inspect the induction and exhaust system for leaks, cracks, deterioration, broken, missing or loose brackets, clamps and hardware.
8. Insure magneto to engine timing is within specifications in accordance with chapter 12 .

CAUTION...

Magnetos using riveted type impulse coupling require repetitive 100-hour inspection in accordance with the manufacturer's instructions.

9. Clean, inspect, gap, test and rotate all spark plugs. See chapter 12 for spark plug wear determination and spark plug rotation.

WARNING

Worn spark plugs that are continued in service may cause internal arcing in the magnetos.

10. Check all engine controls, control cables, control rod ends and levers for security, wear, proper assembly, routing and freedom of movement throughout the entire range of travel. See chapter 13 for fuel system component replacement and throttle/mixture control lever lubrication.

WARNING

Insure fuel selector is in the off position prior to removing the fuel metering unit inlet screen.

11. Inspect fuel nozzles, upper deck and fuel injection nozzle reference lines, hoses, manifolds and fittings for proper routing, support and signs of fuel stains. Inspect manifold valve for security of installation, proper venting and signs of fuel stains.

CAUTION...

Never clean nozzles with wire or other similar object. If nozzle jet is plugged and obstruction cannot be removed by solvent action, REPLACE THE NOZZLE.

12. At the first 100-hour inspection on new, rebuilt or overhauled engines, remove and clean all fuel injection nozzles. See 300 Hour Inspection.

NOTE...

Any environmentally hazardous materials used in cleaning must be collected and disposed of in accordance with Environmental Protection Agency regulations.

13. Inspect all accessories for condition, security of mounting and proper operation. Refer to aircraft or component manufacturer's Maintenance Manual for specifics.

14. Inspect engine mount legs for cracks. Check engine mount isolators for signs of deterioration, proper assembly and security.
15. Verify operation and accuracy of exhaust gas temperature (EGT) system. Note: The aircraft manufacturer may require the EGT system to be operational for all categories of flight. Check the limitations section of the Airplane Flight Manual for specific requirements.
16. Correct any discrepancies noted.
17. Perform post inspection operational run-up. Visually inspect engine and nacelle for fuel and oil leaks.
18. Correct any discrepancies noted during this inspection prior to returning engine to service.

300-Hour Inspection

Remove and clean all fuel nozzles by soaking in lacquer thinner, acetone or methyl ethyl ketone (MEK). Fuel nozzles must be cleaned every 300-hours and annual inspection.

500-Hour Inspection

In addition to the items listed for 100-hour inspections, perform the following inspections and maintenance every 500 hours of engine operation.

1. Magnetos require a thorough, detailed inspection. Refer to the applicable service and overhaul information published by the manufacturer of the magneto. Magnetos must be overhauled or replaced at the same intervals as the engine. TCM magnetos must be overhauled or replaced every four years regardless of total operating hours since last overhaul or replacement.
2. Engine mounted accessories not supplied by TCM such as alternators, stand-by generators, etc., may require servicing at specific intervals. Refer to the instructions provided by the aircraft manufacturer, accessory manufacturer or STC holder for detailed information.
3. TCM gear-driven alternators require inspection and testing at 500-hour intervals. Refer to the applicable alternator manufacturer's instructions. See "Related Publications" in the Introduction section of this manual.

Annual Inspection

Perform all requirements of 25, 50, 100, 200, 300 hour and any calendar inspections due. Comply with any 500 hour inspections that will come due before the next regularly scheduled maintenance event.

Unscheduled Maintenance

Unscheduled maintenance events include but are not limited to:

Propeller Strikes

A propeller strike is any incident, whether or not the engine is operating, that requires repair to the propeller or any incident while the engine is operating in which the propeller makes contact with any object that results in a loss of engine RPM. Propeller strikes against the ground or any object, can cause engine and component damage even though the propeller may continue to rotate. This damage can result in engine failure.

When the propeller is damaged by a small object during operation, such as a small stone, inspection and repair must be accomplished in accordance with the propeller manufacturer's published instructions. Any time damage from an object strike requires propeller removal for repairs the incident is considered a propeller strike.

Following any propeller strike a complete engine disassembly and inspection is mandatory and must be accomplished prior to further operation. Inspect all engine accessories in accordance with the manufacturer's instructions.

Hydraulic Lock

General Information

Hydraulic lock is defined as a condition in which a volume of liquid, equal to or greater than the clearance volume of the combustion chamber is present in the cylinder during starting. Incompressible liquid restricts piston travel during the compression stroke. Damage occurs after the preceding cylinder or cylinders in the firing order have fired providing the required force to drive the piston of the fluid filled cylinder through the compression stroke.

Hydraulic locks in horizontally opposed aircraft engines are due to excess fuel accumulation in the induction system and/or cylinder assembly or failure to properly drain preservation oil.

Damage from a hydraulic lock can be extensive. Engine components such as connecting rods, cylinder assemblies, pistons, piston pins, crankcase and crankshaft can be damaged due to overstress.

In the event the operator starts an over-primed or flooded engine, hydraulic lock may result. Indications of hydraulic lock are difficult to detect since the engine will not normally exhibit any unusual operation once the fuel-air mixture stabilizes. Therefore, the operator must be cognizant of the fact that a hydraulic lock can occur during an attempt to start an over-primed/flooded engine.

In the event of a hydraulic lock perform the following inspection:

1. Remove all cylinders and connecting rods in accordance with the current TCM Overhaul Manual. Inspect the connecting rods in accordance with the current TCM Overhaul Manual.

2. If all connecting rods meet the criteria specified by TCM, reassemble the engine in accordance with the current TCM Overhaul Manual.
3. If any connecting rod does not meet TCM specifications, remove and disassemble the engine to allow inspection of the crankcase and crankshaft in accordance with the current TCM Overhaul Manual. Replace any part that does not meet TCM specifications. Replace each non-conforming connecting rod and its associated piston, piston pin and cylinder assembly.

CAUTION...

Any parts that require replacement must be destroyed to prevent future installation.

4. Clean, inspect, repair, reassemble and test the engine in accordance with the current TCM Overhaul Manual.

Engine Overspeed Inspection

Engine operation at engine speeds in excess of rated RPM limitations can cause damage to the engine and can result in subsequent engine failure.

If an engine overspeed occurs determine the cause for overspeed and correct it. The airframe manufacturer's instructions on engine and propeller overspeed must also be referenced and followed.

If an engine overspeed occurs use the following procedures:

RPM To 3000

1. Less than one minute - No action required
2. More than one minute - Proceed as follows:
 - a. Drain oil through a fine mesh screen and inspect for debris.
 - b. Remove oil filter and inspect filter element for debris.

- c. Remove and inspect inside of rocker covers for debris. Inspect valve stem (keeper grooves) and valve keepers for condition, security and proper installation. Inspect valve springs, rocker arms, spring retainers, rotocoils, pushrods, etc.
- d. Perform a borescope inspection on all cylinders.
- e. If no discrepancies are noted, re-service engine, perform operational inspection and correct any discrepancies noted prior to returning the engine to service.
- f. If discrepancies are found a decision must be made, based on the evidence, as to the extent of the corrective action required.

RPM To 3300

In addition to action required for above, proceed as follows:

1. Remove all cylinder assemblies including rods and pistons.

Clean, inspect, repair or replace all components removed from the engine in accordance with the manufacturer's current overhaul manual. Using new connecting rod bolts and nuts, reassemble, service and test the engine in accordance with the current overhaul manual.

2. After five and ten hours of engine operation remove oil filter and inspect filter element for debris.

RPM Exceeding 3300

1. Remove engine and clearly identify "Removal For Overspeed".
2. Engine and accessories must be completely overhauled in accordance with the respective manufacturer's current overhaul instructions or replaced with certified airworthy components.

Lightning Strike

It is impossible to assess internal damage that may result from a lightning strike. A complete disassembly and inspection of the engine must be accomplished in accordance with the current overhaul manual.

Contaminated Fuel or Incorrect Fuel Grade

If the aircraft is inadvertently serviced with the wrong grade of fuel or jet fuel the fuel must be completely drained and the tank properly serviced.

Any engine operated on fuel of lower grade than approved for the engine or jet fuel must be completely disassembled, cleaned, inspected, repaired, reassembled and tested in accordance with the manufacturer's current overhaul manual.

General Troubleshooting Information

The troubleshooting chart which follows discusses symptoms which can be diagnosed and interprets the probable causes and the appropriate corrective actions to be taken.

Troubleshooting for individual systems follow the engine troubleshooting chart. Any attempt by unqualified personnel to adjust, repair or replace any parts, may result in engine malfunction or failure.

WARNING

Operation of a malfunctioning engine can cause further damage to a disabled component and possible injury to personnel.

Engine Troubleshooting		
TROUBLE	PROBABLE CAUSE	CORRECTION
Engine Will Not Start	No fuel to engine	Service aircraft fuel system in accordance with the airframe manufacturer's instructions
	Improper starting procedure	Refer to the airframe manufacturer's Airplane Flight Manual (AFM) for engine starting procedures. Check for performance of each item
	Cylinder overprimed. Engine flooded	Allow fuel to drain from intake system. WARNING...Starting an engine with a flooded intake system may result in hydrostatic lock and subsequent engine malfunction.
	Induction system leak	Torque or replace loose or damaged hose connection
	Excessive Starter slippage	Replace starter adapter
	Fuel system malfunction	Isolate cause and correct
	Ignition system malfunction	See "Ignition Troubleshooting"
Engine Will Not Run At Idling Speed	Fuel injection system improperly adjusted	See "Fuel Injection System Troubleshooting"
	Air leak in intake manifold	Torque loose connection or replace malfunctioning part
Rough Idling	Fuel injection system improperly adjusted	Adjust fuel system in accordance with chapter 22 "Fuel System Adjustment."
	Mixture levers set for improper mixture	Adjust the manual mixture control in accordance with the airframe manufacturer's Airplane Flight Manual .

Engine Troubleshooting (continued)		
TROUBLE	PROBABLE CAUSE	CORRECTION
	Fouled Spark Plugs	Remove, clean and adjust gaps in accordance with the spark plug manufacturer's instructions
Rough Idling (continued)	Hydraulic tappets fouled	Replace fouled tappets. Inspect and clean oil filter at more frequent intervals
	Burned or warped exhaust valves worn seat, scored valve guides	Inspect, repair or replace cylinder. Replace any burned, warped or worn exhaust valves
	Manifold valve vent obstruction	Repair or replace manifold valve
Engine Runs Too Lean At Cruising Power	Improper manual leaning procedure	Refer to the airframe manufacturer's Airplane Flight Manual (AFM) for engine operating instructions
	Fuel injection system maladjusted	Adjust fuel system in accordance with chapter 22, "Fuel System Adjustment"
Engine Runs Too Rich At Cruising Power	Restrictions in air intake passages	Check passages and remove restrictions
	Improper manual leaning of fuel/Air mixture	See the airframe manufacturer's Airplane Flight Manual (AFM) for correct leaning procedure
Engine Runs Too Lean Or Too Rich At Throttle Setting Other Than Cruise	Fuel injection system maladjusted	See "Fuel Injection System Troubleshooting"
Continuous Fouling Of Spark Plugs	Piston rings excessively worn or broken	Replace rings. Replace cylinder if damaged
	Piston rings are not seated	Hone cylinder walls, replace rings NOTE...Cylinder grinding and honing must be done by a qualified FAA approved rework facility
Engine Runs Rough At High Speed	Loose mounting bolts or damaged mount pads	Torque mounting bolts. Replace mount pads
	Plugged fuel nozzle jet	Clean. Replace nozzle if obstruction cannot be cleared by solvent action. Never use wire or any other object to clear nozzle jet
	Propeller out of balance	Remove and repair in accordance with airframe manufacturer's instructions
	Ignition system malfunction	See "Ignition Troubleshooting"

Engine Troubleshooting (continued)		
Continuous Missing At High Speed	Broken valve spring	Inspect, repair or replace cylinder. Replace valve springs
	Plugged fuel nozzle jet	Clean. Replace nozzle if obstruction cannot be cleared by solvent action. Never use wire or any other object to clear nozzle jet
	Burned or warped valve	Inspect, repair or replace cylinder. Replace any burned, warped or worn exhaust valves
	Hydraulic tappet dirty or worn	Remove and replace
Sluggish Operation And Low Power	Throttle not full open	Check and adjust linkage. See Rigging of Mixture and Throttle Controls in the applicable airframe manufacturer's instructions
	Restrictions in air intake passages	Inspect air intake and remove restrictions
	Ignition system malfunction	See "Ignition Troubleshooting"
	Fuel injection system maladjusted	See "Fuel Injection System Troubleshooting"
High Cylinder Head Temperature	Lean fuel/air mixture	See the airframe manufacturer's Airplane Flight Manual (AFM) for correct leaning procedure
	Debris between cylinder fins	Clean thoroughly
	Incorrect engine timing	Adjust engine timing in accordance with chapter 12
	Exhaust system gas leakage	Locate and correct in accordance with the airframe manufacturer's instructions
	Exhaust valve leaking	Repair cylinder. See chapter 19, "Cylinder assembly Maintenance."

Engine Troubleshooting (continued)		
TROUBLE	PROBABLE CAUSE	CORRECTION
Oil Leaks	At front of engine, damaged crankshaft oil seal	Replace crankshaft oil seal
	Around plugs, fittings and gaskets due to looseness or damage	Torque or replace
Low Compression	Piston rings excessively worn	Inspect, repair or replace cylinder. Replace piston rings
	Valve faces and seats worn	Inspect, repair or replace cylinder. Replace any worn parts
	Excessively worn cylinder walls	Replace cylinder & piston rings
Engine Will Not Stop At Idle Cutoff	Fuel manifold valve not seating properly	Repair or replace fuel manifold valve
Climbing to Altitude, Fuel Flow Fluctuates	Fuel Vaporization	Operate fuel boost pump in accordance with the airframe manufacturer's Airplane Flight Manual (AFM)
Low Fuel Pressure	Incorrect fuel pump adjustment	Check and adjust in accordance with chapter 22, "Fuel System Adjustment"
	Malfunctioning fuel pump relief valve	Replace fuel pump
High Fuel Pressure	Malfunctioning relief valve operation in fuel pump	Replace fuel pump
	Restricted recirculation passage in fuel pump	Replace fuel pump
	Incorrect fuel pump adjustment	Check and adjust per Chapter 22, "Fuel System Adjustment"
Fluctuating Fuel Pressure	Fuel gauge line leak or air in gauge line	Drain gauge line and torque connections in accordance with the airframe manufacturer's instructions
	Vapor in fuel system, excessive fuel temperature	Normally, operating the auxiliary pump will clear system. Operate boost pump in accordance with the airframe manufacturer's Airplane Flight Manual (AFM)
Engine Has Poor Acceleration	Idle mixture too lean	(Check RPM Rise, Idle Cutoff)., Adjust idle mixture in accordance with Chapter 22, "Fuel System Adjustment"

Engine Troubleshooting (continued)		
TROUBLE	PROBABLE CAUSE	CORRECTION
Engine Has Poor Acceleration (continued)	Incorrect fuel/air mixture, worn control linkage, or restricted air cleaner	Replace worn elements of linkage. Service air cleaner in accordance with airframe manufacturer's instructions
	Malfunctioning ignition system	Check ignition cables and connections in accordance with the ignition manufacturer's instructions Replace malfunctioning spark plugs
Engine Runs Rough At Speeds Above Idle	Improper fuel/air mixture	Check fuel manifold connections for leaks. Torque loose connections. Check fuel control/metering unit and linkage for setting and adjustment in accordance with chapter 22, "Fuel System Adjustment ." Check fuel filters and screens for debris. Check for proper fuel pump pressure.
	Restricted fuel nozzle jet	Clean. Replace nozzle if obstruction cannot be cleared by solvent action. Never use wire or any other object to clear nozzle jet
	Ignition system and spark plugs malfunctioning	Clean, regap and test spark plugs. Inspect, test and repair ignition system in accordance with the ignition system manufacturer's instructions. Replace components as required
Engine Lacks Power, Reduction in Maximum Manifold Pressure	Incorrectly adjusted throttle control linkage or dirty air filter	Check movement of linkage by moving control from idle to full throttle. Make proper adjustments in accordance with chapter 22, "Fuel System Adjustment." Replace worn components. Service air cleaner in accordance with the airframe manufacturer's instructions

Engine Troubleshooting (continued)		
TROUBLE	PROBABLE CAUSE	CORRECTION
Engine Lacks Power, Reduction in Maximum Manifold Pressure (continued)	Malfunctioning ignition system component	Inspect spark plugs for fouled electrodes, heavy carbon deposits, erosion of electrodes, improperly adjusted electrode gaps, and cracked porcelains. Test plugs for regular firing under pressure. Replace damaged or misfiring plugs. Gap spark plugs to spark plug manufacturer's specifications.
	Loose or damaged intake manifold	Inspect entire manifold system for possible leakage at connections. Replace damaged components, torque all connections and clamps to specifications
	Fuel nozzles restricted	Clean nozzles. Replace nozzle if obstruction cannot be cleared by solvent action. Never use wire or any other object to clear nozzle jet
Low Oil Pressure Indication On Engine Gauge	Insufficient oil in oil sump, oil dilution or using improper grade oil for prevailing ambient temperature	Add oil, or change oil to proper viscosity. Inspect for possible oil dilution, repair as required
	High oil temperature	Malfunctioning oil temperature control valve in oil cooler; oil cooler restriction. Replace valve and clean oil cooler
	Restricted oil filter. Leaking, damaged or loose oil line connections	Check for restricted lines, loose connections, and for partially plugged oil filter. Replace oil filter. Clean parts, torque connections, and replace malfunctioning parts
	Oil pressure gauge malfunction	Check oil pressure gauge calibration in accordance with the airframe manufacturer's instructions
	Engine oil pressure maladjusted	Adjust oil pressure in accordance with chapter 22, "Oil Pressure Adjustment"

Engine Troubleshooting (continued)		
TROUBLE	PROBABLE CAUSE	CORRECTION
Low Oil Pressure Indication On Engine Gauge (continued)	Low oil supply. Oil viscosity too low	Replenish. Drain and refill with correct viscosity
	Malfunctioning oil pump	Repair or replace oil pump
	Weak or broken oil pressure relief valve spring	Replace spring. Adjust oil pressure in accordance with chapter 22, "Oil Pressure Adjustment."
High Oil Temperature Indication	Prolonged ground operation	Limit ground operation to a minimum
	Malfunctioning gauge or bulb unit	Check wiring. Check bulb unit. Check gauge. Replace malfunctioning parts in accordance with the airframe manufacturer's instructions

Fuel Injection		
TROUBLE	PROBABLE CAUSE	CORRECTION
Fluctuating Fuel Flow Indications	Fuel vapor as a result of high ambient temperatures	If not cleared with auxiliary pump, check for clogged vent in fuel pump vapor separator cover. Clean only with solvent, no wires. Refer to airframe manufacturer's instruction
	Air in fuel flow gauge line. Leak at gauge connection	Repair leak and purge line. Refer to airframe manufacturer's instruction
Poor Idle Cutoff	Engine getting fuel	Check mixture control is in full idle cutoff. Check auxiliary pump is OFF. If neither, replace manifold valve.
Unmetered Fuel Pressure To High	Internal orifices plugged	Clean internal orifices injector pump. Refer to Fuel Injection Service Manual, Form X30593A
Unmetered Fuel Pressure Drop	Relief valve stuck open	Repair or replace fuel pump
Very High Idle And Full Throttle Fuel Pressure Present	Relief valve stuck closed	Repair or replace fuel pump
No Fuel Pressure	Check valve stuck open	Repair or replace fuel pump

Fuel Injection (continued)		
TROUBLE	PROBABLE CAUSE	CORRECTION
Engine Will Not Start And No Fuel Flow Gauge Indication	No fuel to engine	Check tank fuel level
	Mixture control improperly rigged	Check mixture control for proper rigging. Refer to airframe manufacturer's instruction
	Engine not primed	Check auxiliary pump switch position. Refer to airframe manufacturer's instruction
	Selector valve in wrong position	Position selector valve to MAIN TANK position. Refer to airframe manufacturer's instruction
Engine Will Not Start With Fuel Flow Gauge Indication	Engine flooded	Allow all fuel to drain from intake system. WARNING...Starting an engine with a flooded intake system may result in hydrostatic lock and subsequent engine malfunction
	No fuel to engine	Loosen one line at nozzle. If no fuel shows, with fuel flow on gauge, replace fuel manifold valve

Fuel Injection (continued)		
TROUBLE	PROBABLE CAUSE	CORRECTION
Rough Idle (continued)	Improper idle mixture	Adjust fuel mixture in accordance with chapter 22, "Fuel System Adjustment"
Poor Acceleration	Idle mixture incorrect	Adjust fuel mixture in accordance with chapter 22, "Fuel System Adjustment"
	Unmetered fuel pressure too high	Lower unmetered fuel pressure. Adjust in accordance with chapter 22, "Fuel System Adjustment."
	Worn linkage	Replace worn elements of linkage. in accordance with the airframe manufacturer's instruction
Engine Runs Rough	Restricted nozzle	Clean. Replace nozzle if obstruction cannot be cleared by solvent action. Never use wire or any other object to clear nozzle jet.
	Improper mixture	Adjust fuel mixture in accordance with chapter 22, "Fuel System Adjustment"
Low Fuel Flow Gauge Indication	Restricted flow to metering unit	Check for restriction between fuel pump and fuel metering unit
	Inadequate flow from fuel pump	Adjust engine-driven fuel pump in accordance with chapter 22, "Fuel System Adjustment"
High Fuel Flow Gauge Indication	Restricted flow beyond metering valve	Check for restricted nozzles or fuel manifold valve. Clean or replace as required
	Restricted recirculation passage in	Replace engine driven fuel pump

Induction		
TROUBLE	PROBABLE CAUSE	CORRECTION
Engine Will Not Start	Induction system intake obstructed	Locate and remove obstruction
Engine Will Not Run At Idling Speed	Induction system leakage	See chapter 14
Engine Runs Too Rich At Cruise Power	Restrictions in air intake passages	Check air passages remove restriction
Sluggish Operation And Low Power	Throttle not opening wide	Check and adjust control connections in accordance with the airframe manufacturer's instructions.

Ignition		
TROUBLE	PROBABLE CAUSE	CORRECTION
Engine Fails To Start	Ignition switch OFF or grounded switch wires	Turn switch On. Check for grounded wires
	Spark plugs fouled, improperly gapped, or loose	Remove and clean. Adjust to proper gap in accordance with spark plug manufacturer's specifications. Torque spark plugs in accordance with chapter 12
	Magnetos improperly timed to engine	Refer to chapter 12, Ignition Timing for timing procedures
	Shorted condenser	Replace condenser in accordance with magneto manufacturer's instructions
	Magneto internal timing incorrect or timed for opposite rotation	Install correctly timed magneto
Rough Idling	Spark plugs fouled or improperly gapped	Clean spark plugs. Adjust to proper gap in accordance with spark plug manufacturer's specifications
	Weak condenser	Replace condenser in accordance with magneto manufacturer's instructions
Rough At Speeds Above Idle	Loose or improperly gapped spark plugs	Adjust to proper gap in accordance with spark plug manufacturer's specifications. Torque spark plugs in accordance with chapter 12

Ignition (continued)		
TROUBLE	PROBABLE CAUSE	CORRECTION
Rough At Speeds Above Idle (continued)	High tension leak in ignition harness	Inspect ignition harness in accordance with harness manufacturer's instructions
	Weak or burned out condenser as evidenced by burned or pitted breaker points	Replace points and condenser in accordance with magneto manufacturer's instructions
Sluggish Operation And/Or Excessive RPM Drop	Fouled or dead spark plugs	Clean spark plugs. Discard faulty plugs. Adjust to proper gap in accordance with spark plug manufacturer's specifications
	Improperly gapped spark plugs	Adjust to proper gap in accordance with spark plug manufacturer's specifications
Sluggish Operation And/Or Excessive RPM Drop (continued)	Magnetos out of time	Refer to Installation of Magnetos and Ignition Timing for proper timing procedure chapter 12. Refer to the magneto manufacturer's instructions for magneto internal timing
	Damaged magneto breaker points or condenser	Replace points and condenser in accordance with magneto manufacturer's instructions

Starting		
TROUBLE	PROBABLE CAUSE	CORRECTION
Starter Will Not Operate	Master switch circuit continuity	Refer to the airframe manufacturer's instructions
	Master circuit continuity	Refer to the airframe manufacturer's instructions
	Starter motor malfunctioning	See chapter 17, "Starter Maintenance"
Starter Motor Runs But Does Not Turn Crankshaft	Starter adapter drive train or clutch malfunctioning	See chapter 17, "Starter adapter Maintenance"
Starter Motor Dragging	Improperly charged battery	Refer to airframe manufacturer's instructions
	Starter switch contacts burned or dirty	Refer to airframe manufacturer's instructions
	Malfunctioning Starter	Chapter 17, "Starter Maintenance"

Lubrication		
TROUBLE	PROBABLE CAUSE	CORRECTION
Excessive Oil Consumption	Oil leakage	Replace leaking oil lines, torque loose connections
	Gasket or seal leakage	Replace gasket or oil seals
	Improper seasonal weight or grade oil	Service engine with proper oil, see chapter 7
	Worn piston rings or valve guides	Inspect, repair or replace cylinder. Replace piston rings
	Excessive crankcase pressure	See the most current revision of TCM service bulletin 89-9, "Excessive Crankcase Pressures."
High Oil Temperature Indication	Low oil supply	Replenish, see chapter 7
	Cooler air passages clogged	Clean thoroughly
	Cooler core plugged	Remove cooler and flush thoroughly
	Thermostat damaged or held open by solid matter	Remove clean valve and seat. If still inoperative, replace
	Oil Viscosity too high	Drain and refill with correct viscosity. See chapter 7
	Prolonged ground operation	Limit ground operation to a minimum. Refer to the airframe manufacturer's operating instructions
	Malfunctioning gauge or bulb unit	Check wiring. Check bulb unit. Check gauge. Refer to the Airframe Manufacturer's Instructions
	Exhaust leak	Replace malfunctioning component, insure exhaust system is installed properly, replace leaking gaskets
Low Oil Pressure Indication	Low oil supply. Oil viscosity too low	Replenish. Drain and refill with correct seasonal weight. See chapter 7
	Malfunctioning oil pump	Replace pump
	Malfunctioning pressure gauge	Check gauge. Clean plumbing. Replace if required in accordance with AFM Instructions
	Weak or broken oil pressure relief valve spring	Replace spring. Adjust pressure to 30-60 psi. in accordance with chapter 22
	Clogged oil filter	Replace oil filter

Cylinders		
TROUBLE	PROBABLE CAUSE	CORRECTION
Rough Idling	Hydraulic tappets fouled	See chapter 19, Cylinder Assembly Maintenance "Hydraulic Tappets"
	Burned or warped exhaust valves, worn valve seats. Scored valve guides	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
	Valve seats worn and leaking, piston rings worn or stuck in ring lands	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
High Cylinder Head Temperature	Exhaust valve leaking, cylinder baffles loose or bent. Cooling area between cylinder fins obstructed	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
	Exhaust gasket leaking	Replace gasket
	Valve seats worn and leaking, piston rings worn or stuck in ring lands	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
Low Compression	Piston rings excessively worn	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
	Valve faces and seats worn	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
	Excessively worn cylinder walls	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
	Valve seats worn and leaking, piston rings worn or stuck in ring lands	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
Continuous Fouling Of Spark Plugs	Piston rings excessively worn or broken	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
	Piston rings not seated	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
	Cylinder has been overheated	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
	Cylinder bore out of round	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
	Valve seats worn and leaking, piston rings worn or stuck in ring lands	See chapter 19, Cylinder Assembly Maintenance "Cylinders"
Sluggish operation and low power output	Valve seats worn and leaking, piston rings worn or stuck in ring lands	See chapter 19, Cylinder Assembly Maintenance "Cylinders"

Crankcase		
TROUBLE	PROBABLE CAUSE	CORRECTION
Oil Loss	Loose accessories or deteriorated gaskets	See chapter 20, "Crankcase Maintenance"
	Cracked crankcase	See chapter 20, "Crankcase Maintenance"
	Insufficient torque	Tighten hardware to proper torque in accordance with the applicable Overhaul Manual
Loose accessories	Loose or stripped studs	Replace studs in accordance with the applicable Overhaul Manual
	Insufficient torque	Tighten accessory hardware to proper torque in accordance with the applicable Overhaul Manual
Engine Runs Rough	Cracked engine mount	Replace engine mount in accordance with the applicable Overhaul Manual
Excessive Crankcase Pressure	Cylinder blow-by	Perform cylinder compression test

Crankshaft		
	PROBABLE CAUSE	CORRECTION
Prop Control "RPM"	Malfunctioning prop governor	See the airframe manufacturer's instructions
	Incorrect oil control collar to crankshaft clearance	Replace oil control collar and/or repair crankshaft in accordance with the applicable overhaul manual
Oil Loss	Worn crankshaft nose seal	Replace crankshaft nose oil seal in accordance with the applicable Overhaul Manual

***Unpacking, Deinhibiting,
Installation and Testing***

Engine Unpacking, Deinhibiting, Installation and Testing..... 6-3

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Engine Unpacking, Deinhibiting, Installation and Testing

Engine unpacking, deinhibiting, installation and testing must be performed in accordance with the instructions in the IO-520-B, BA, BB, C, CB, M & MB Permold Series Operation and Installation Manual, Form OI-11 and the airframe manufacturer's instructions.

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Servicing Fluids

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Servicing Oil

CAUTION...

Some funnel-type quart containers incorporate a styrofoam or aluminum seal. Remove this seal from the container and discard it before adding oil to the engine. If the seal becomes unattached and falls into the engine, engine damage and possible failure can result.

The oil system must be serviced to capacity with the oil grades specified in Chapter 3.

A certain amount of oil consumption is normal. If excessive consumption or any abrupt change in rate of consumption is detected, this condition must be corrected before further flight.

Maintain the engine compartment, nacelle and the fuselage adjacent to the nacelle in a clean condition in order that an oil leak can be detected and corrected before further flight.

WARNING

Engine operation with no oil or severely reduced oil levels will cause engine malfunction or failure.

Oil sump capacity in U.S. quarts:

IO-520-B, -BA, -BB, -C, -CB, -M, -MB.....12

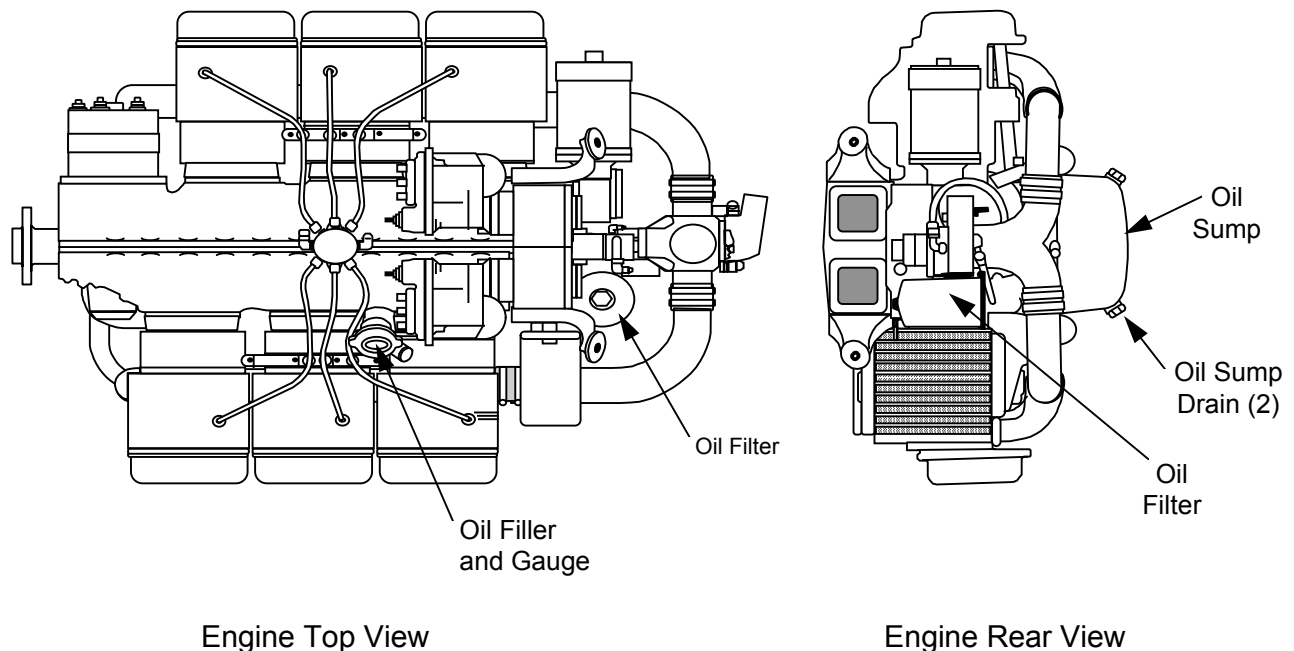


Figure 7-1
General Oil Servicing Points

NOTE...

Engines which have a complete set of new or overhauled cylinders and new piston rings must be serviced with clean, approved Engine Break-In and Preservation oil until oil consumption has stabilized (approximately 25 hours of operation). Thereafter, service the engine with clean ashless dispersant oil that is TCM approved.

CAUTION...

Petroleum base aviation engine oil is flammable and must be stored in a well ventilated area away from any heat source.

Oil Filter Element Inspection

Oil filter element inspection is recommended at each oil and filter change even if oil analysis is being used. Filter element inspection may identify Internal engine wear that will not be identified through oil analysis.

New, rebuilt, overhauled engines or engines that have had cylinders replaced will generally exhibit noticeable amounts of normal wear material at the first and second oil and filter change. The amount of material present should significantly decrease between the first and second oil and filter change if the engine and or cylinders have been properly operated during the break-in period.

As with oil analysis, oil filter element inspection provides maintenance personnel with additional information on the wear characteristics of a specific engine. Sudden, unexplained increases in concentration of wear material in a filter element should alert maintenance personnel to investigate the source and cause of the material.

Material Identification

- Ferrous attracts to magnet.
- Aluminum—will “sizz” or bubble when placed in a 50 % solution of muriatic acid.

- Bronze or Copper—will turn bright green when placed in nitric acid.
- Carbon—will disintegrate when rubbed between index finger and thumb.
- Sand—will not disintegrate when rubbed between two hard surfaces and will scratch glass when pressure is applied.
- Nickel—will not be magnetically attracted but looks similar to ferrous material.
- Tin—will not be attracted magnetically. It looks similar to nickel but is soft and malleable.

Oil Analysis

Spectrographic oil analysis has become popular with the owners and operators of general aviation piston powered aircraft. This process was developed more than 35 years ago by the railroads as a method of identifying wear characteristics in large diesel engines. Eventually oil analysis was adopted by the military and then by commercial and general aviation.

Engines are designed and manufactured using various materials and alloys. The engine lubrication system is designed to provide either pressure or splash oil to areas of the engine subjected to frictional loading. During normal operation these areas undergo minute, continuous wear; sub microscopic material is released from these contact surfaces and are suspended in the lubricating oil. Spectrographic oil analysis identifies these materials and their level of concentration in parts per million (PPM).

There are two accepted methods of performing oil analysis: atomic absorption and atomic emissions. Atomic absorption will identify suspended wear material that is five micron in size or smaller, while atomic emissions will identify suspended wear material that is ten micron in size or smaller. Since engine oil analysis is used as a tool to

establish engine wear trends and deviations from the established norm, either method is acceptable; however, it is important to realize the oil analysis program must utilize the same laboratory for all sample analysis. Comparing an oil analysis report from a separate laboratory will have little meaning if each laboratory uses a different analysis method.

Spectrographic Oil Analysis

A proper spectrographic oil analysis program should begin with the first engine oil change. Establishing a wear trend data base for an engine will require analysis of at least three oil samples. As the engine accumulates operating time and additional oil samples are analyzed, a definitive wear trend can be identified. Unexplained deviations from normal wear trend patterns should be investigated using accepted, conventional inspection methods.

Spectrographic oil analysis must be accomplished according to a set protocol to provide any useful information. Even if done properly, spectrographic oil analysis will rarely provide any prior indication of a fatigue type failure. A single spectrographic oil sample will usually not provide a high level of useful information since there is no established wear trend data on that specific engine for comparison.

Spectrographic oil analysis will assist in the identification of an internal engine problem. If samples are properly taken at regular intervals, it should provide the owner / operator and oil analysis technician with information relative to normal or abnormal wear that occurs during the course of engine operation. Deviations from an established wear trend pattern should alert the owner/operator and oil analysis technician to further investigate.

Limitations

Variations in operation, use and maintenance may be reflected in the parts per million content reported. Deviations from standard or previously used sampling procedures may result in variations to the parts per million content in the sample report.

General Procedures

To establish a data base for comparison and analysis, oil samples must be taken on a regular schedule using the same sampling techniques and laboratory. The engine must have been operated long enough to obtain normal operational temperatures and the oil sample taken within 30 minutes after engine shut down. The tube or funnels used to drain the oil from the sump must be clean and free of any debris or residue. If the oil sample is taken from the oil as it drains from the sump, allow approximately 1/3 of the oil drain prior to taking the sample. If the sample is taken via the oil filler or other location using a sampling tube, it is critical the sample be taken from two or three inches above the bottom of the oil sump, not from the bottom. Do not take an oil sample from the oil filter canister.

Servicing Fuel

Aviation Min. Grade

.....100LL (Blue) or 100(Green)

Refer to the airframe manufacturer's instructions for aircraft Fueling Procedure and Fueling Points.

WARNING

The use of lower octane rated fuel or jet fuel will result in damage or destruction of an engine the first time high power is applied. This would most likely occur on takeoff. If the aircraft is inadvertently serviced with the wrong grade of fuel or jet fuel the fuel must be completely drained and the tank properly serviced.

Any engine operated on fuel of lower grade than approved for the engine or jet fuel must be completely disassembled, cleaned, inspected, repaired, reassembled and tested in accordance with the current overhaul manual.

*Engine Preservation
and Storage*

Engine Preservation and Storage..... 8-3

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Engine Preservation and Storage

Engine engine preservation and storage must be performed in accordance with the instructions in the I0-520-B, -BA, -BB, -C, -CB, -M and -MB Operation and Installation Manual, Form OI-11.

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Standard Practices

General Practices..... 9-3
 Lockwire Procedure..... 9-4
 Tab Washer Installation..... 9-6
 Cotter Pin Installation..... 9-6
Adhesives..... 9-7
Gasket Installation..... 9-7

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General Practices

1. To facilitate and insure proper reinstallation, tag or mark all parts and hardware as they are removed or disassembled.
2. Tag any unserviceable parts or units for investigation and possible repair. Take extreme care to prevent lockwire, nuts, washers, dirt, etc., from entering the engine on or off the aircraft. Make use of protective caps, plugs and covers to insure openings are unexposed.

CAUTION...

Dust caps used to protect open lines must be installed OVER the tube ends and NOT IN the tube ends. Flow through the lines will be blocked if lines are inadvertently installed with the dust caps in the tube ends.

3. If anything is dropped into the engine work must be stopped immediately and the item removed.
4. Insure that all parts are thoroughly clean and lubricated as specified before assembling.
5. Insure all parts are thoroughly clean and lubricated as specified before assembling.
6. All lockwire and cotter pins must fit snugly in holes drilled in specific hardware. On castellated nuts, unless otherwise specified, the cotter pin head must fit into a recess of the nut with the other end bent such that one leg is back over the stud and the other is down flat against the nut in accordance with Figure 9-4. Use only manufacturer specified corrosion resistant steel cotter pins. All lockwire used on TCM engines must conform to MS20995 Condition A.
7. When replacing gaskets, packing, or rubber parts use the type or composition specified by the manufacturer.
8. Make sure replacement nonmetallic and metallic parts show no sign of storage deterioration. Parts exceeding specified shelf life limitations must not be used.
9. When a hammer is required to come in direct contact with an engine part during assembly or disassembly, use a mallet made of plastic or rawhide material only.
10. Parts removed from the engine must be cleaned and inspected in accordance with the specified instructions located in the applicable system chapter.

Lockwire Procedure

Lockwiring is the securing together of two or more parts with lockwire installed in such a manner that any tendency for a part to loosen will be counteracted by additional tightening of the lockwire.

All lockwire utilized on TCM engines must conform to MS20995 Condition A. Most bolts utilized in TCM engines that require lockwiring will use .032 lockwire and require twisting at a rate of 7

to 10 twists per inch. Smaller lockwire (when specified or required) will require twisting at a rate of 9 to 12 twists per inch. Lockwire must be new at each application.

Lockwire must be pulled taut while being twisted and caution must be exercised during the twisting operation to keep the lockwire tight without overstressing. See Figure 9-1, "General Lockwire Procedure," for steps in applying lockwire.

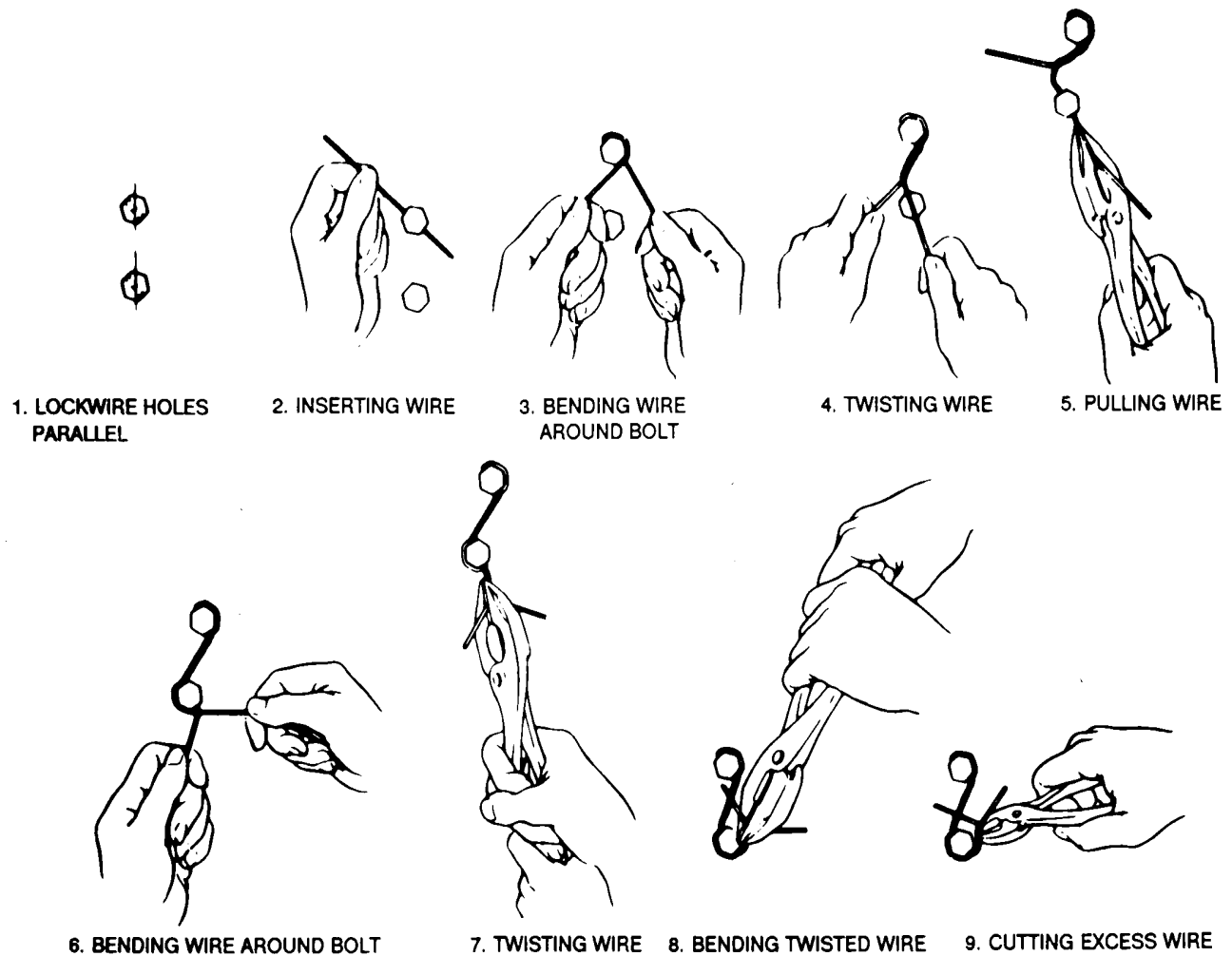


Figure 9-1
General Lockwire Procedure

Various examples of lockwiring are shown in Figure 9-2, "General Lockwire Patterns."

1. Check the units to be lockwired to insure they have been correctly torqued. Applying torque that is above or below specified limits to obtain alignment of the holes is not permitted.
2. It is desirable to have the holes parallel, but this is not a necessity. For right hand threads, the lockwire shall be installed in such a manner that
3. Insert half of the required length of lockwire through the first unit and bend around the head of the unit. The direction of wraps and twist of strands shall be such that the loop around the unit comes under the strand protruding from the hole so that the loop will stay down and will not tend to slip up and leave a slack loop.

Twist the strands while taut until the twisted part is just short of a hole in the next unit. The twisted portion should be within one-eighth (1/8) inch from the hole in either unit.

5. Insert the uppermost strand through the hole in the second unit and follow the rules in Paragraph three.
6. After lockwiring the last unit continue twisting the lockwire to form a pigtail, providing sufficient twists (four minimum) to assure that the pigtail will not unravel. Cut off the excess lockwire and bend the pigtail toward the part and against the bolt head flats. **Do not allow the pigtail to extend above the bolt head.**

4.

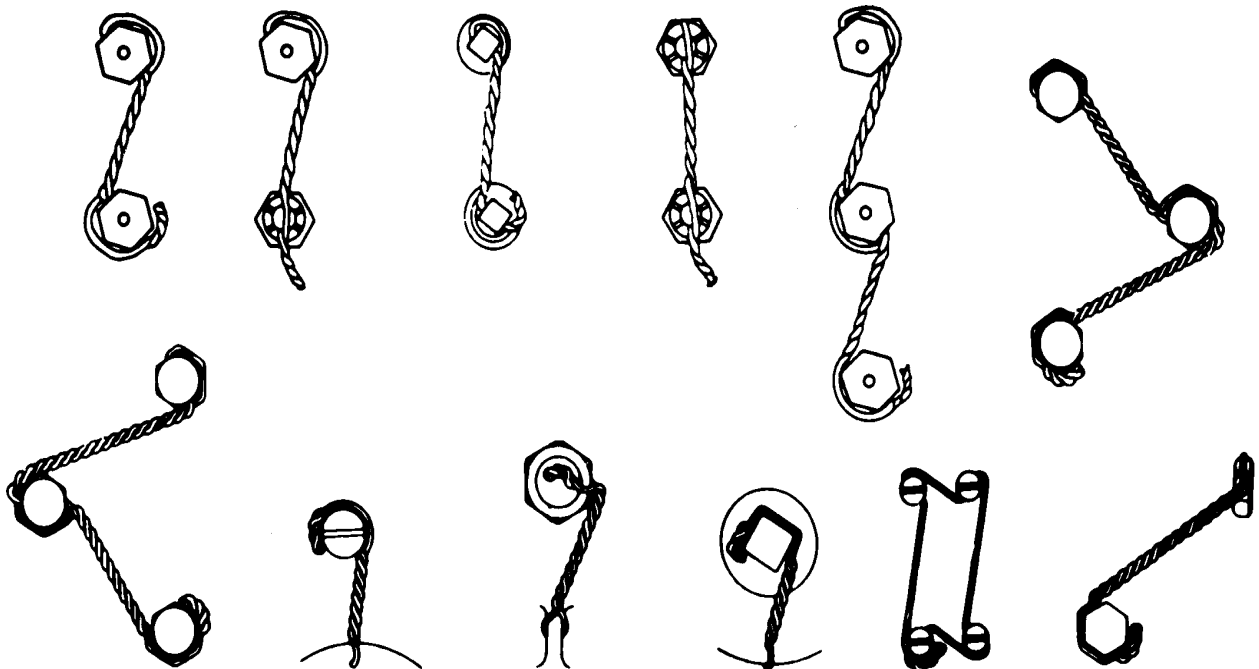


Figure 9-2
General Lockwire Patterns

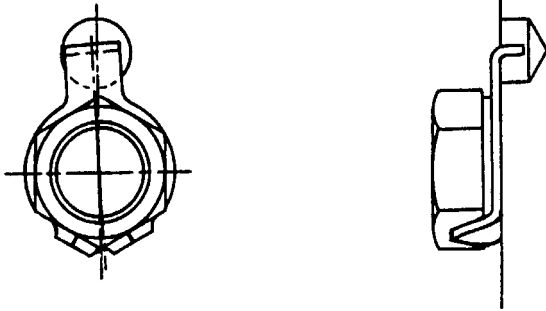


Figure 9-3
Tab Washer Installation Procedure

Tab Washer Installation

Tab washers are installed by fitting a tab in a tab slot and bending the remaining tabs firmly against the bolt or nut flat. Tab washers are used in various locations in TCM engines and must not be re-used after removal.

Tabs that are provided to be bent up against the head flats must be seated firmly with no scarring of the tabs. This provides proper locking of the unit and prevents tabs from breaking off.

1. Make certain the holding tab is located in the tab hole or slot.
2. Check the units to be secured and verify they are correctly torqued in accordance with the specified instructions of the applicable system section.
3. Bend tabs against the head flats firmly by tapping them into place with a soft drift. See Figure 9-3, “Tab Washer Installation Procedure.”

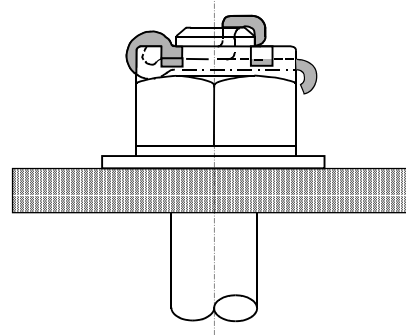


Figure 9-4
Cotter Pin Installation Procedure

Cotter Pin Installation

Cotter pins are installed by inserting the cotter pin through a hole in one part, slots in the other part and spreading the exposed ends.

Cotter pins are not reusable and must be replaced with a new cotter pin after removal.

1. Torque the nut to the lower limit of the torque specification. If the slots in the nut do not line up with one of the holes in the bolt continue torquing until one does. Do not exceed the upper limit of the torque specification. Change the nut if necessary.
2. Insert the cotter pin with the head seated firmly in the slot of the nut. Bend the ends over the flat on the nut and the end of the bolt. Trim the prong lengths as necessary.
3. Seat the prongs firmly against the bolt and nut. See Figure 9-4, “Cotter Pin Installation Procedure.”

CAUTION...

Do not use side-cutting type pliers to bend the ends over since the resulting nick could weaken the pin and allow a portion to become detached.

Adhesives

Adhesives and sealants will be used only in specific applications outlined in Chapter 3, "Table Of Sealants and Lubricants."

WARNING

The improper use of sealants and lubricants will cause engine malfunction or failure.

Gasket Maker P/N 646942 - Surfaces must be clean and free of nicks, burrs, oil and grit. Apply a thin even coat of Gasket Maker between .010 and .020 inch thick to the surface specified in Chapter 3, "Table Of Sealants and Lubricants."

Gasket Maker is an easily workable tacky gel which can be extruded onto one side of a flange surface from a tube and evenly spread. Small parts can be covered adequately by pressing them into a saturated polyester urethane sponge or by roll coating them with a short nap roller. Once Gasket Maker has been applied evenly torque assembly into place. Excess material can be cleaned by wiping with chlorinated solvent. Material on hands can be cleaned with waterless mechanics hand soap followed by soap and water.

NOTE...

TCM general purpose primer P/N 653160 must be used for surface preparation before applying Gasket Maker at the engine nose seal area.

Gasket Installation

All gaskets must be new, of the proper material and visually inspected prior to installation.

Following visual inspection, if the gasket shows any indication of gouges, nicks, cuts or bend and fatigue marks replace with a new manufacturer specified gasket.

Gasket surfaces must be clean and free of nicks, burrs, oil and grit. Apply a thin coat of TCM Gasket Sealant P/N #642188-1 to both sides of gasket unless otherwise specified. See Chapter 3, "Table Of Sealants and Lubricants," for application of gasket sealant. Once TCM Gasket Sealant has been applied install gasket. Install assembly and evenly torque hardware to specified value. This will prevent over stressing gasket.

WARNING

Gaskets and components must be properly positioned, hardware torqued and safetied as required during assembly to prevent oil loss.

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Engine Maintenance

General 10-3

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General

During engine 50 and 100 hour inspections, if engine components must be removed and replaced, refer to the applicable disassembly/-reassembly instructions found in the IO-520 Permold Series Overhaul Manual, Form X30568A as outlined in the Maintenance section of each system.

Note...

Engine operational inspection must be performed prior to any 50 or 100 hour static inspections. Refer to Chapter 5, "Operational Inspection."

Corrections and adjustments will be found in the individual system chapters of this manual under "Maintenance," and in Chapter 22, "Post Maintenance Adjustment and Test."

At the completion of all 50/100 hour inspection procedures, refer to Chapter 22 and perform the post maintenance operational test.

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Exhaust System

Exhaust System 11-3

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Exhaust System

This chapter is reserved for engines utilizing an exhaust system and components supplied on some engine models by Teledyne Continental Motors.

For IO-520-B, BA, BB, C, CB, M & MB exhaust system maintenance, refer to the airframe manufacturer's instructions.

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Ignition System

<i>TCM Ignition System</i>	<i>12-3</i>
<i>Ignition System Component Description</i>	<i>12-5</i>
<i>Magneto Accessory Drive Adapter</i>	<i>12-5</i>
<i>Spark Plugs</i>	<i>12-5</i>
<i>Magneto to Engine Timing</i>	<i>12-7</i>
<i>Operational Tests</i>	<i>12-7</i>
<i>Magneto Impulse Coupling Test</i>	<i>12-7</i>
<i>Timing Steps</i>	<i>12-8</i>
<i>Ignition System Maintenance</i>	<i>12-13</i>
<i>Magneto Drive Adapter Removal and Replacement</i>	<i>12-13</i>
<i>Service Limits</i>	<i>12-14</i>
<i>Magneto Removal and Replacement</i>	<i>12-15</i>
<i>Ignition Harness Removal and Replacement</i>	<i>12-15</i>

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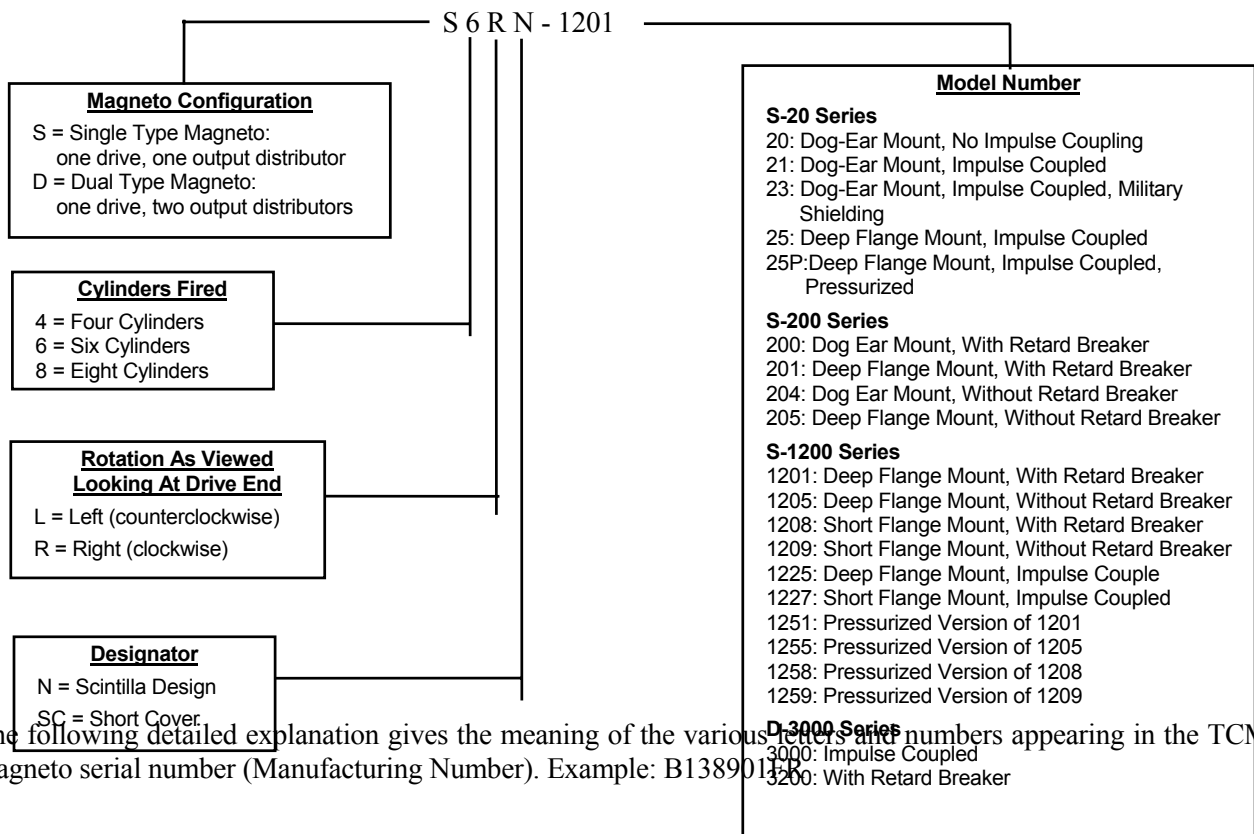
TCM Ignition System

Dual ignition is provided by two magnetos. The left magneto fires 1-3-5 lower and 2-4-6 upper spark plugs, while the right magneto fires the 1-3-5 upper and 2-4-6 lower spark plugs.

The TCM S6RN-201, -205, 1201, 1205 series magnetos are designed to provide ignition for six cylinder aircraft engines. The magnetos generate and distribute high tension current through high tension leads to the spark plugs. Because of the one piece housing design, these high tension magnetos are comparatively easy to maintain between overhauls. The magnetos must be overhauled at engine overhaul or four calendar year interval in accordance with the applicable Magneto Service Manual.

To obtain the retard spark necessary for starting, the S-20 series magnetos and some S-1200 series magnetos employ an impulse coupling. The purpose of the impulse coupling is to: (1) rotate the magneto between impulse trips faster than the engine cranking speed thus generating a better spark for starting the engine, (2) automatically retard the spark during engine cranking, and (3) act as a drive coupling for the magneto. S-200 series magnetos and some S-1200 series magnetos employ the "shower of sparks" ignition system, including a starter vibrator. The purpose of the "shower of sparks" is to: (1) boost ignition energy by feeding pulsating battery voltage to the magneto primary circuit during starting and (2) automatically retard the spark during engine cranking.

The following chart explains the various letters and numbers appearing in the type designations:



The following detailed explanation gives the meaning of the various letters and numbers appearing in the TCM magneto serial number (Manufacturing Number). Example: B138901201

B	13	89	01	F	R
Month ↓	Day of Month ↓	Year (1989) ↓	Sequential Number for unit begins with "01" each day ↓	Product Code: ↓	Factory Rebuilt (No letter for new) ↓
A. January B. February C. March D. April E. May F. June G. July H. August I. September J. October K. November L. December				D: S-20 E: S200 F: S1200 G: D3000	

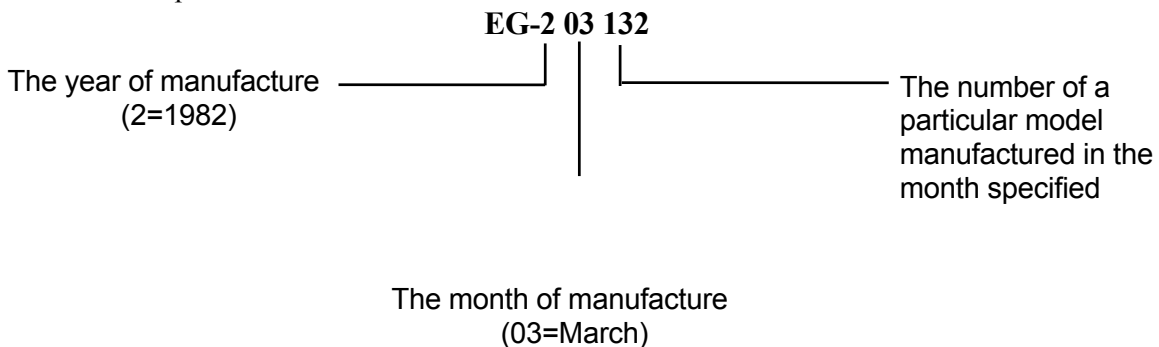
Ignition System Components

Conventional dual ignition is provided by two magnetos. The left magneto fires the 1-3-5- lower and the 2-4-6 upper spark plugs, while the right magneto fires the 1-3-5 upper and 2-4-6 lower spark plugs.

The Slick 6210 Series Magnetos, manufactured by Slick Electro Incorporated, 530 Blackhawk Park Avenue, Rockford, Illinois 61101, are designed to provide ignition for six cylinder light aircraft engines. The magnetos generate and distribute high tension current through high tension leads to the spark plugs.

To obtain the retard spark necessary for starting, the magnetos employ an impulse coupling. The purpose of the impulse coupling is to: (1) rotate the magneto between impulse trips faster than engine cranking speed, thus generating a better spark for starting the engine; (2) automatically retard the spark during engine cranking, and (3) act as a drive coupling for the magneto.

Slick serial number explanation:



Ignition System Component Description

For a detailed description of magnetos and harness, see TCM Ignition System Master Service Manual Form X40000 or Slick Ignition Systems Master Service Manual Form F-1100 as applicable. See “Related Publications” for ordering information.

Magneto Accessory Drive Adapter - Each magneto is driven by a magneto drive shaft, retainer and bushings housed inside a magneto and accessory drive adapter. The adapters are attached to the upper rear portion of the crankcase and secured by four studs, washers and nuts. The magneto drive shafts are installed in the front of the adapter and meshed in the proper position with the idler gear. Two rubber bushings (per magneto) are installed within a retainer on the drive shaft. The rubber bushings provide a shock absorbing engagement between magneto and engine drive train.

Spark Plugs

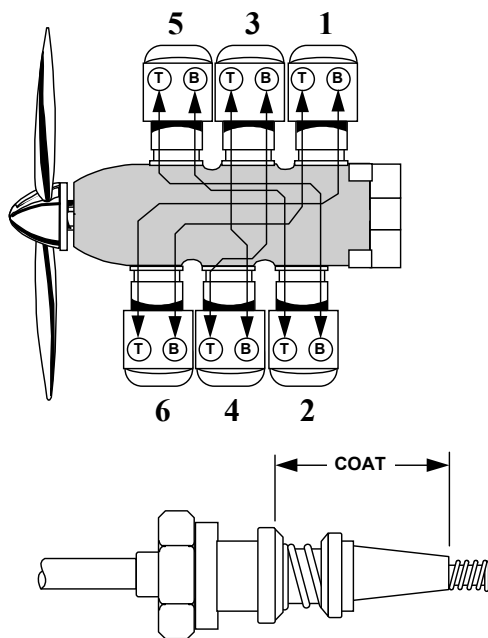
Remove spark plugs for cleaning or replacement in accordance with the applicable disassembly/reassembly instructions in the IO-520-B, BA, BB, C, CB M & MB Overhaul Manual, Form OH-11.

After spark plugs are removed:

1. Clean and gap or replace in accordance with the spark plug manufacturer’s specifications.
 2. Test spark firing under pressure using a Champion® cleaner/tester or equivalent.
 3. Replace any spark plug that does not fire properly. Insure that each spark plug is free of residue from the cleaning process.
1. Apply Champion® thread lubricant to all spark plugs in accordance with the manufacturer’s instructions and reinstall spark plugs in the reverse spark plug installation order. Do not torque spark plugs at this time.

CAUTION...

Never install a spark plug that has been dropped: discard it.



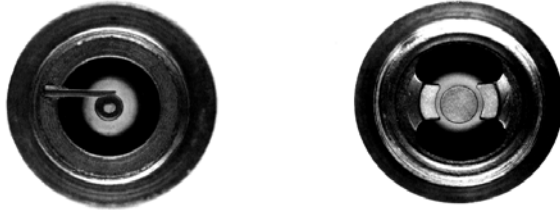
Spark Plug Rotation	
CYLINDER NUMBER	CYLINDER NUMBER
FROM	TO
1 TOP	6 BOTTOM
1 BOTTOM	6 TOP
2 TOP	5 BOTTOM
2 BOTTOM	5 TOP
3 TOP	4 BOTTOM
3 BOTTOM	4 TOP
4 TOP	3 BOTTOM
4 BOTTOM	3 TOP
5 TOP	2 BOTTOM
5 BOTTOM	2 TOP
6 TOP	1 BOTTOM
6 BOTTOM	1 TOP

Figure 12-1
Spark Plug Rotation

Use Figure 12-2 to help you make an informed decision whether to clean, regap, and reuse a spark plug or discard it.

NORMAL ELECTRODE CONDITION

Insulator tip gray, tan or light brown. Few combustion deposits. Electrodes not burned or eroded. Proper type heat range plug for engine and service. Spark plug should be cleaned regapped and tested before reinstallation.



NORMAL WORN-OUT CONDITION

Electrodes eroded by high-voltage sparking and by corrosive gases formed during combustion to less than 1/2 original thickness. More voltage needed to fire spark plugs - often more than ignition system can produce. Discard and replace with new spark plugs.



SEVERE WORN-OUT CONDITION

Excessively eroded center and ground electrodes plus extensive necking of fine wire ground electrodes indicate abnormal engine power or plugs long overdue for replacement. Check fuel metering and magneto timing. Discard spark plugs and check heat range before installing new ones.



ELECTRODE WEAR PATTERNS

Constant polarity occurs with even-numbered cylinder magnetos. One plug fires with positive polarity, causing excessive ground-electrode wear, while the next plug fires negatively, causing excessive center electrode wear. To equalize this, rotate as indicated in Figure 10-4.



*Figure 12-2
Spark Plug Wear*

Magneto to Engine Timing

WARNING

To prevent possibility of serious bodily injury or death, before moving the propeller accomplish the following:

- a. Disconnect all spark plug leads.
- b. Verify magneto switches are connected to magnetos, that they are in the "OFF" Position and "P" leads are grounded.
- c. Throttle position "CLOSED."
- d. Mixture control "IDLE-CUT-OFF."
- e. Set brakes and block aircraft wheels. Insure that aircraft tie-downs are installed and verify that the cabin door latch is open.
- f. Do not stand within the arc of the propeller blades while turning the propeller.

WARNING

Magneto-to-engine timing does not insure magneto, harness, and spark plug performance. Failure to properly maintain the magneto, harness, and spark plugs will lead to internal engine damage and failure. Magneto, ignition harness, and spark plugs must be maintained in accordance with the manufacturer's instructions.

CAUTION...

A single severe kickback while cranking the engine can cause failure of components in the cranking system. Kickback can be caused by intermittent operation of the impulse couplings.

Operational Tests

Perform the following operational tests at the specified intervals to insure that these systems are functioning properly:

Magneto Impulse Coupling Test

WARNING

Failure to properly ground magnetos will result in engine ignition and possible injury to personnel.

1. Insure that both magnetos are properly grounded and that all spark plugs are installed in all cylinders. Remove all spark plug harness lead ends from the spark plugs and ground them to the engine to prevent ignition.
2. Before cranking engine perform the following:
 - a. Magneto switch, if separate from starter switch Off
 - b. Mixture Idle Cut Off
 - c. Throttle Closed
 - d. Fuel selector Off
 - e. Master switch On
3. Crank engine several revolutions.

WARNING

Use extreme caution in the area of the propeller while performing this test. Do not stand or allow anyone else to stand in the propeller arc area.

- a. Impulse coupling operation is audible and can be felt through the magneto housings. The impulse couplings should consistently click together while the engine is being cranked.
- b. If no clicking or if only intermittent clicking is heard, remove the magnetos and service them in accordance with the magneto manufacturer's instructions.

c. When performing a magneto timing check, use the following tools:

- Top dead center locator
- Protractor and Pointer

The Eastern Electronics Model E25 Timing Indicator kit or equivalent is recommended.

Use the following timing procedure to insure correct engine timing.

NOTE...

Whenever setting or checking timing, always turn the crankshaft steadily in the direction of rotation to eliminate backlash error.

Timing Steps

1. Remove all top spark plugs.
2. Rotate the crankshaft in the direction of normal rotation until the number one piston is approximately at top dead center on the compression stroke.
3. Rotate the crankshaft in the opposite direction of normal rotation until the piston is far enough down the barrel to allow the TDC locator to be installed.
4. Install the Top Dead Center locator into number 1 cylinder top spark plug hole.
5. Slowly rotate the crankshaft in the direction of normal rotation until the piston lightly touches the TDC locator.
6. Install timing indicator disc on the crankshaft flange, propeller spinner or center hub of propeller blades.
7. Rotate disc of timing indicator until the 0 degree mark aligns with the pointer as shown in Figure 12-3.

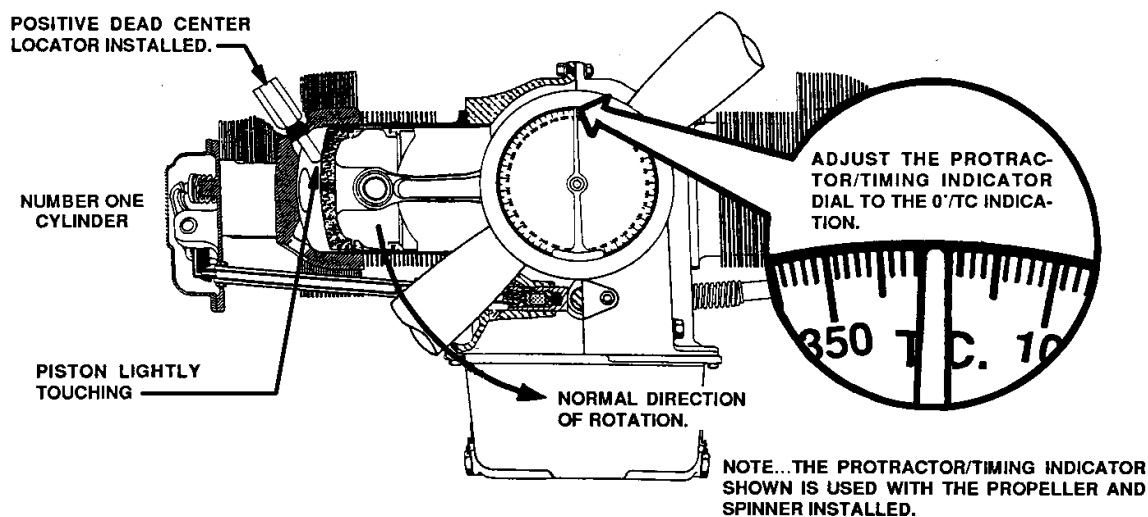


Figure 12-3
Timing Procedure Step 1

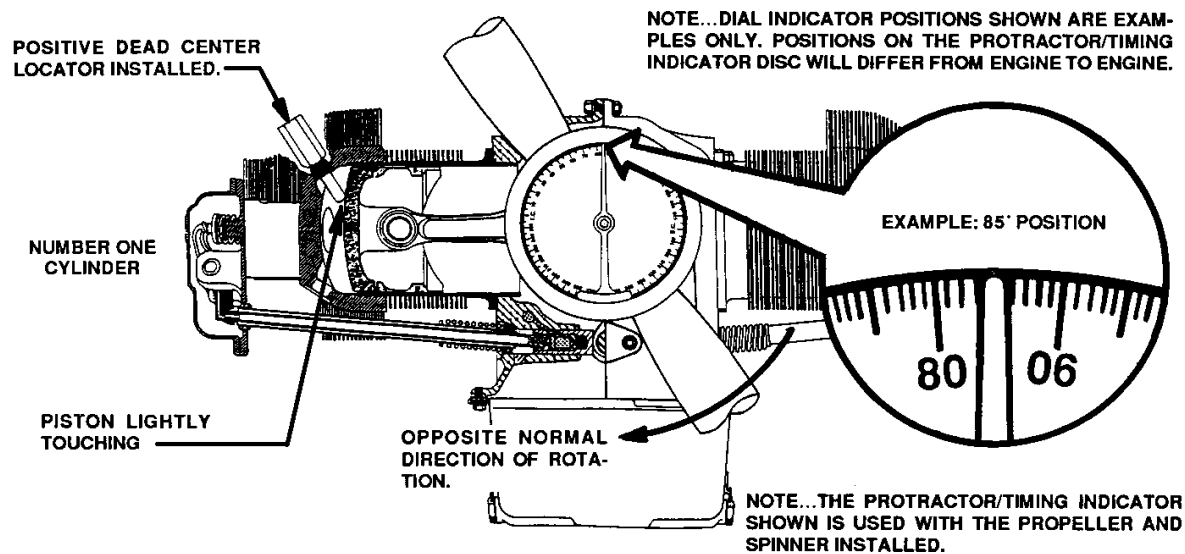


Figure 12-4
Timing Procedure Step 2

2. Slowly turn crankshaft in opposite direction of normal rotation until the piston lightly touches the TDC locator.
3. Observe the reading on the disc under the pointer and move the disc exactly one half of the number of degrees observed toward the top center mark. This will be one half the number of degrees remaining of 360 degrees of crankshaft rotation. You have now located top dead center.

NOTE...DIAL INDICATOR POSITIONS SHOWN ARE EXAMPLES ONLY. POSITIONS ON THE PROTRACTOR/TIMING INDICATOR DISC WILL DIFFER FROM ENGINE TO ENGINE.

POSITIVE DEAD CENTER LOCATOR INSTALLED.

NUMBER ONE CYLINDER

PISTON LIGHTLY TOUCHING

NORMAL DIRECTION OF ROTATION.

EXAMPLE: 42.5° POSITION

NOTE...THE PROTRACTOR/TIMING INDICATOR SHOWN IS USED WITH THE PROPELLER AND SPINNER INSTALLED.

Figure 12-5
Timing Procedure Step 3

10. Remove the TDC locator from the cylinder and find the compression stroke on the No. 1 cylinder by placing a finger over the spark plug hole (or by any other adequate method). As you come up on compression, stop the pointer at the TDC location determined in step 3. For engines equipped with impulse couplings, continue turning the propeller in the normal direction of rotation until each impulse coupling trips. Couplings may trip a few degrees on either side of TDC. If one or both couplings trip after TDC, turn the propeller back to a few degrees before TDC and approach the TDC position from the normal direction of rotation.

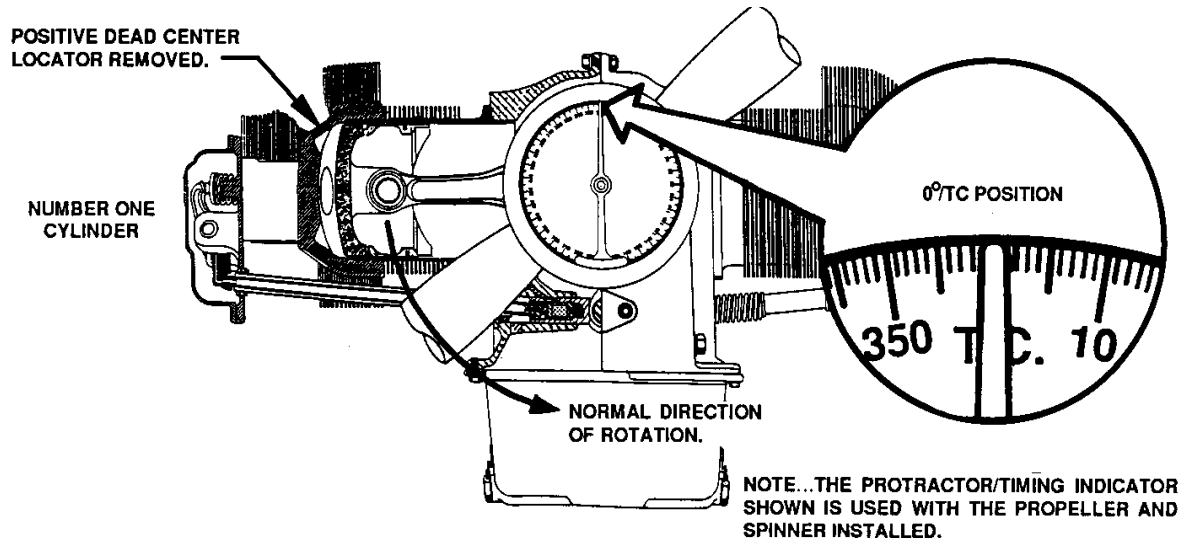


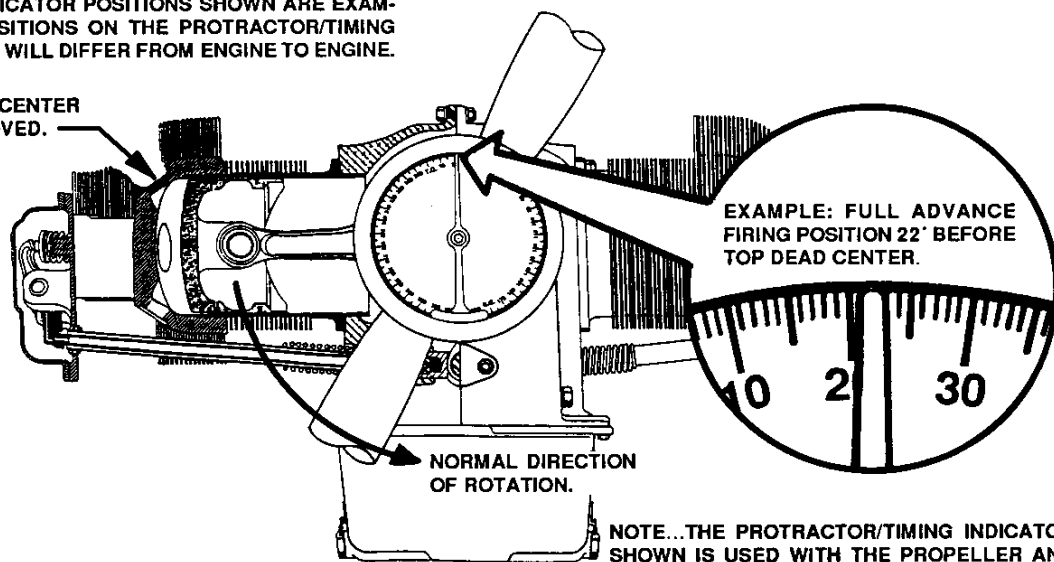
Figure 12-6
Timing Procedure Step 4

4. To check either the magneto timing or to time the magneto to the engine, move the propeller in the opposite direction of normal rotation past the specified magneto timing setting and then back in the direction of normal rotation until the desired setting before top dead center is under the pointer. (This removes gear backlash.)

NOTE...DIAL INDICATOR POSITIONS SHOWN ARE EXAMPLES ONLY. POSITIONS ON THE PROTRACTOR/TIMING INDICATOR DISC WILL DIFFER FROM ENGINE TO ENGINE.

POSITIVE DEAD CENTER LOCATOR REMOVED.

NUMBER ONE CYLINDER



NOTE...THE PROTRACTOR/TIMING INDICATOR SHOWN IS USED WITH THE PROPELLER AND SPINNER INSTALLED.

Figure 12-7
Timing Procedure Step 5

6. The breaker points should be just starting to open at this setting. Breaker point opening must be checked with a timing light.

Ignition System Maintenance

Magneto Drive Adapter Removal and Replacement

Remove magneto drive adapter assemblies for repair or replacement in accordance with the applicable portion of the “Magneto And Accessory Drive” disassembly instructions in the IO-520 Permold Series Overhaul Manual, Form OH-11. When performing magneto drive adapter repairs prior to engine TBO, the dimensional limits on page 12-12 may be used.

Caution...

When performing dimensional inspection, the following “Service Limits” may be used. However, they are intended only as a guide for reuse when performing engine maintenance prior to major overhaul. Parts with dimensions or fits that exceed service limits must not be reused. Parts with values up to and including service limits may be reused. However, consideration should be given to how close the engine is to its next recommended overhaul. Service limits must NOT be used when overhauling an engine.

Service Limits

Refer to Figure 12-8 for locations of the following magneto components:

Ref. No.	Description	Service Limits
1.	Bushing in magneto and accessory drive adapter Diameter:	0.0040T
2.	Magneto and accessory drive gear in adapter bushing Diameter:	0.0050L
3.	Oil seal in adapter Diameter:	0.0070T
4.	Sleeve in magneto and accessory drive gear Diameter:	0.0040T
5.	Magneto coupling retainer on magneto and accessory drive gear sleeve Diameter:	0.0550L
6.	Magneto and accessory drive gear End Clearance:	0.0770L
7.	Magneto coupling retainer in magneto drive gear slot Side Clearance:	0.040L
8.	Magneto coupling rubber bushings on magneto drive lugs Side Clearance:	0.0140L
9.	Magneto pilot in crankcase Diameter:	0.0050L

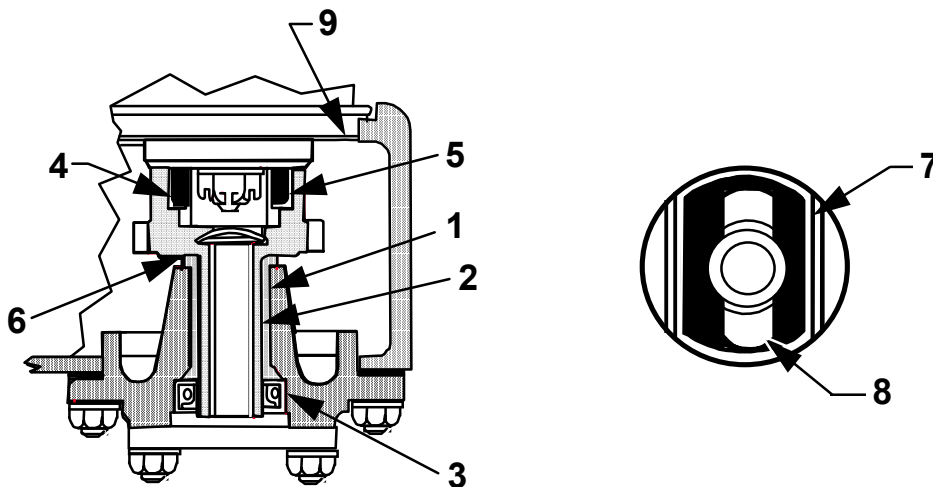


Figure 12-8
Service Limits

Magneto Removal and Replacement

Remove the magnetos for repair or replacement in accordance with "Ignition System Disassembly/Reassembly" in the IO-520 Permold Series Overhaul Manual, Form OH-11.

Magneto maintenance such as point replacement, condenser replacement, impulse coupling replacement or internal magneto timing must be performed in accordance with the magneto manufacturer's instructions.

Ignition Harness Removal and Replacement

Remove the harness assemblies for repair or replacement in accordance with the applicable "Ignition System Disassembly/Reassembly instructions" in the IO-520 Permold Series Overhaul Manual, Form OH-11.

Any harness assembly maintenance such as single lead replacement must be performed in accordance with the harness manufacturer's instructions.

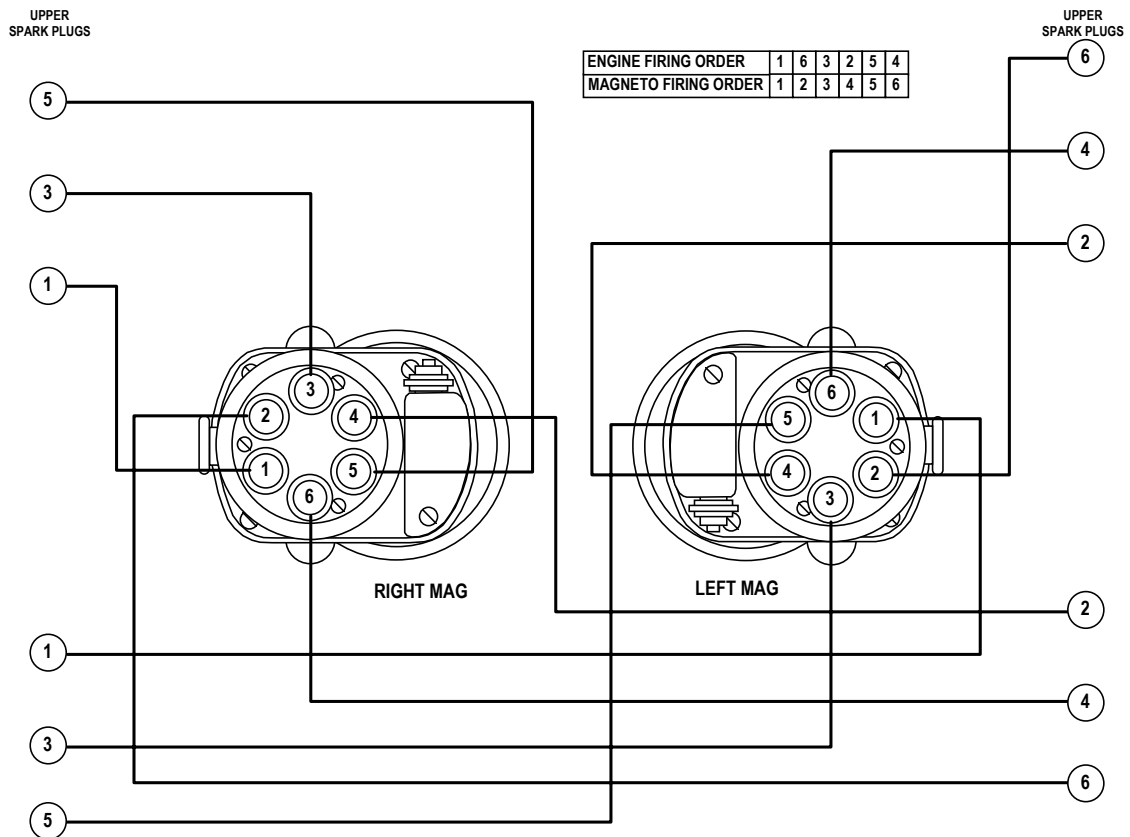


Figure 12-9
Ignition Wiring Diagram

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Fuel System

<i>Engine Fuel System Description</i>	<i>13-3</i>
<i>Fuel Pump</i>	<i>13-4</i>
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Engine Fuel System Description

IO-520-B, BA, BB, C, CB, M, MB fuel system.

The fuel injection system is a low pressure, multinozzle, continuous flow system that supplies fuel to the intake valve port in the cylinder head.

There are four basic elements in the fuel injection system: the fuel pump, fuel control unit, fuel manifold valve and fuel nozzles. Fuel flows from the fuel pump to the fuel control unit. The fuel then flows from the fuel control unit to the fuel manifold valve where it is distributed to the six fuel injector nozzles.

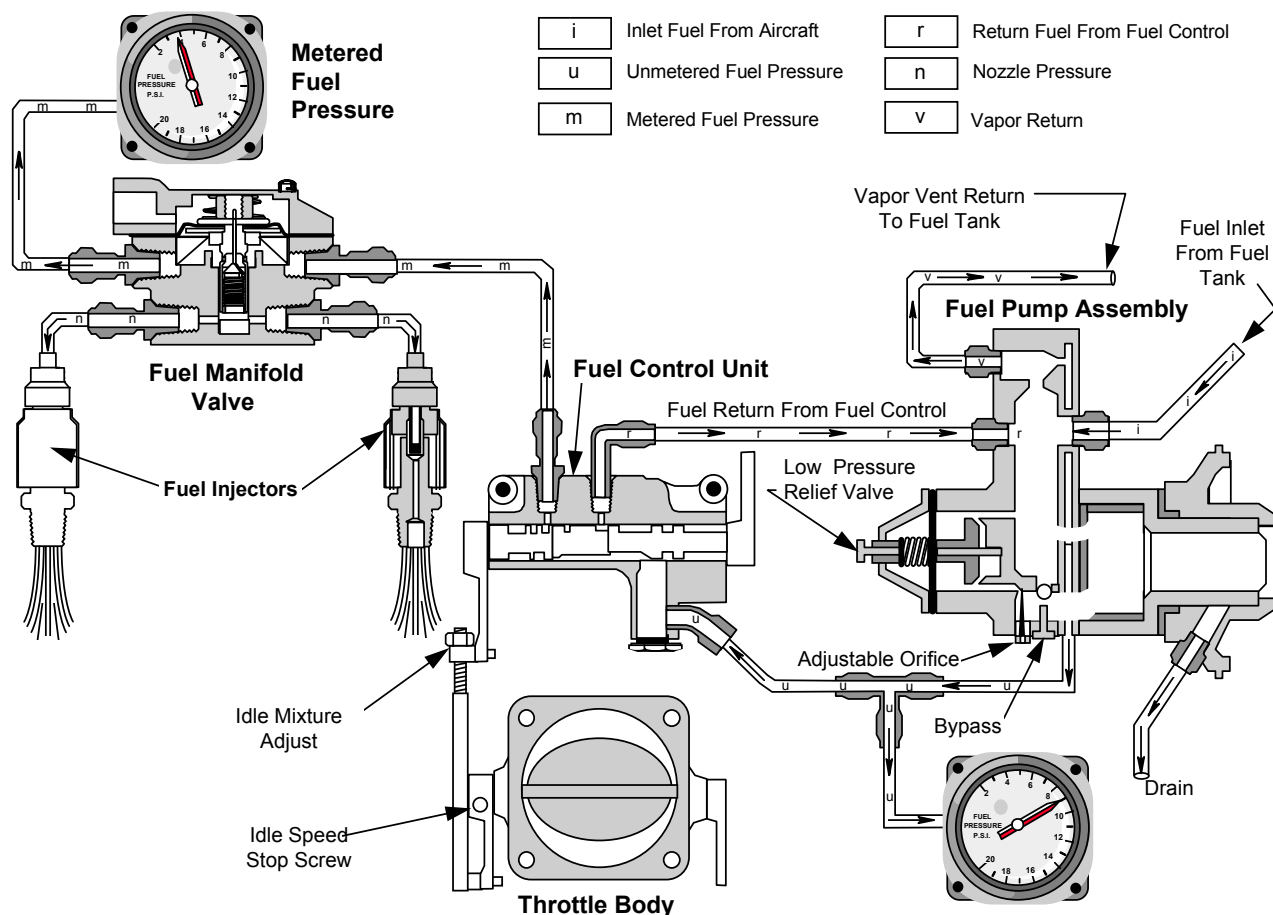


Figure 13-1 Fuel System

Fuel Pump

IO-520-B, BA, BB, C, CB, M, MB

Fuel enters the fuel pump at the swirl well of the vapor separator. Here, vapor is separated by a swirling motion so that only liquid fuel is fed to the pump. The vapor is drawn from the top center of the swirl well by a small pressure-jet of fuel and is fed into the vapor return line. This line carries the vapor back to the fuel tank. There are no moving parts in the vapor separator, and the only restrictive passage is used in connection with vapor removal. Thus, there is no restriction of main fuel flow.

Ignoring the effect of altitude or ambient air conditions for the moment, the use of a positive displacement, engine-driven pump means that changes in engine speed affect total pump flow proportionally. The fuel pump provides greater capacity than is required by the engine. Thus, a recirculation path is provided.

By arranging a variable orifice and relief valve in the recirculation path, the pump delivery pressure is maintained proportional to engine speed and ambient air pressure. This insures proper pump pressure and delivery at all engine operating speeds and altitudes.

The IO-520-B, BA, BB, C, CB, M and MB type fuel pumps utilize an aneroid and rod assembly that assist in controlling fuel flow. The aneroid housing is referenced to ambient air pressure. The aneroid bellows expands when the air pressure surrounding it decreases. As the aneroid expands it moves the rod increasing the size of the orifice opening. An increased amount of fuel flows through the orifice to a recirculation path. This decreases fuel flow from the fuel pump to the fuel control unit.

A check valve is provided so that boost pressure to the system can bypass the engine-driven fuel pump during starting. This feature also aids in the suppression of vapor formation during high ambient temperature conditions. The check valve permits use of the auxiliary airframe fuel boost pump in the unlikely event of an engine driven fuel pump malfunction.

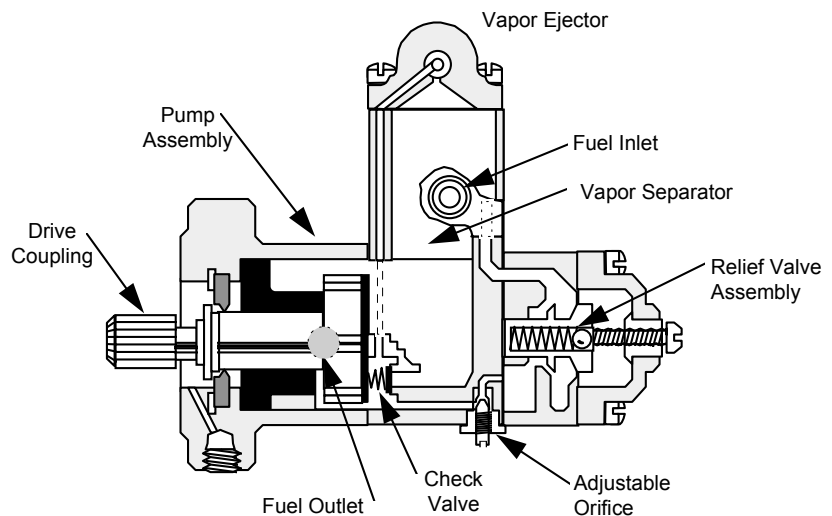


Figure 13-2
Fuel Pump
IO-520-B, BA, BB, C, CB, M, MB

Fuel Pump Replacement

The fuel pump can be replaced or it can be repaired and calibrated in accordance with the applicable instructions in the Fuel Injection System Parts And Overhaul Manual, Form X30593A, latest revision.

NOTE...Appropriate test calibration equipment must be used when overhauling TCM fuel injection system component.

Whenever the fuel pump is removed from the engine, both the fuel pump drive coupling to crankshaft gear clearance of 0.0095L to 0.0155L and the fuel pump drive coupling to fuel pump clearance 0.0030L to 0.0090L must be checked.

CAUTION...

When performing dimensional inspections, the following Fits and Limits may be used. However, they are intended only as a guide, when performing engine maintenance prior to major overhaul, in determining whether a part can be reused. Parts which have dimensions or fits that exceed service limits must not be reused. Parts which have dimensions or fits up to and including service limits may be reused. However, use sound judgment and take into consideration the engine's proximity to recommended overhaul.

1. Remove any airframe components required to gain access to the fuel pump in accordance with the airframe manufacturer's instructions. Remove the following hoses from their fittings on the fuel pump and install protective covers on the hose ends. Identify fuel line location for proper reinstallation:
 - a. Airframe to engine fuel connections in accordance with the airframe manufacturer's instructions.
 - b. Vapor return hose
 - c. Fuel outlet (unmetered pressure) hose.

2. Remove mixture control cable connection in accordance with the airframe manufacturer's instructions.
3. Remove the nuts and washers that hold the fuel pump on the crankcase:
 - a. 2 plain nuts
 - b. 2 lock washers
 - c. 2 hold down washers
 Discard lock washers.

CAUTION...

Do not allow the coupling to fall into the crankcase. If it does, you must retrieve it before proceeding.

4. Carefully remove the fuel pump, coupling, and gasket.
5. Discard gasket.
6. Inspect hoses for condition. Replace any hose that exhibits wear or deterioration.
7. Discard worn or damaged parts.
8. The fuel pump can be replaced or repaired and calibrated in accordance with the applicable instructions in the Fuel Injection System Parts And Overhaul Manual, Form X30593A, latest revision.
9. Fittings from the original fuel pump may be installed and oriented to the same position in the replacement pump.

CAUTION...

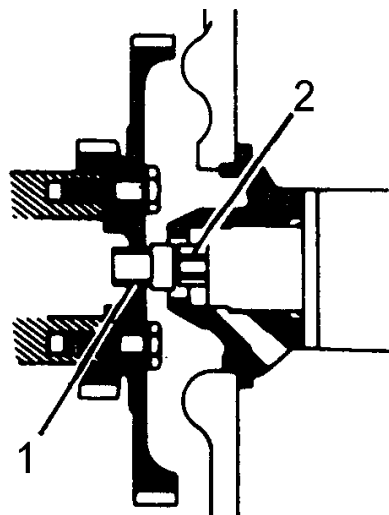
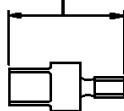
Never use Teflon tape on fuel injection system fittings.

10. The fittings must be clean and free of damage and debris prior to installation. Apply F/I sealant to tapered male threads in accordance with Figure 13-9. Install fittings in fuel pump and orient to the original positions.
11. Apply a small amount of Gasket Maker to the crankcase split lines above and below the fuel pump bore.

12. Apply Molyshield Grease to the coupling receptacle on the fuel pump.
13. Insert the fuel pump coupling into the coupling receptacle on the fuel pump. Insure that the coupling is fully seated .
14. Install the new gasket on the crankcase fuel pump bore studs.
15. Install the fuel pump on the crankcase by sliding the fuel pump on the fuel pump mounting studs while carefully guiding the fuel pump coupling into the square hole in the crankshaft gear.
1. Install hold-down washers, new lock-washers, and nuts on each stud.
2. Torque the fuel pump nuts to 180 - 220 inch pounds.
3. Install fuel hoses on fuel pump. Torque fuel pump hose connections in accordance with Table 2, "Torque Specifications for Hose Fittings."
4. Reinstall cowling and airframe accessories in accordance with the airframe manufacturer's instructions.
5. After all requirements of scheduled maintenance have been performed and prior to any engine operation, a complete fuel system leak check must be performed in accordance with the aircraft manufacturer or STC holder's information.

Service Limits

FUEL PUMP
COUPLING LENGTH
1.37 INCHES



Ref.	Description	Service Limit	
1.	Fuel pump drive coupling to crankshaft gear	Clearance:	0.0155L
2.	Fuel pump drive coupling to fuel pump	Clearance:	0.0090L

Throttle And Fuel Control Unit

IO-520-B, BA, BB, C, CB, M, MB

The throttle and fuel control unit controls engine air intake and sets the metered fuel pressure for proper fuel/air ratio. The air throttle is mounted at the air manifold inlet. The throttle valve controls the flow of air to the engine as positioned by the cockpit throttle control lever.

Fuel enters the fuel control unit through a strainer and passes to the metering valve. The rotary metering valve has a cam-shaped edge across the fuel delivery port. The position of the cam at the port controls fuel flow to the fuel manifold valve and fuel nozzles. The fuel mixture is controlled by the manual mixture control lever in the cockpit that is connected to the fuel control unit mixture control valve.

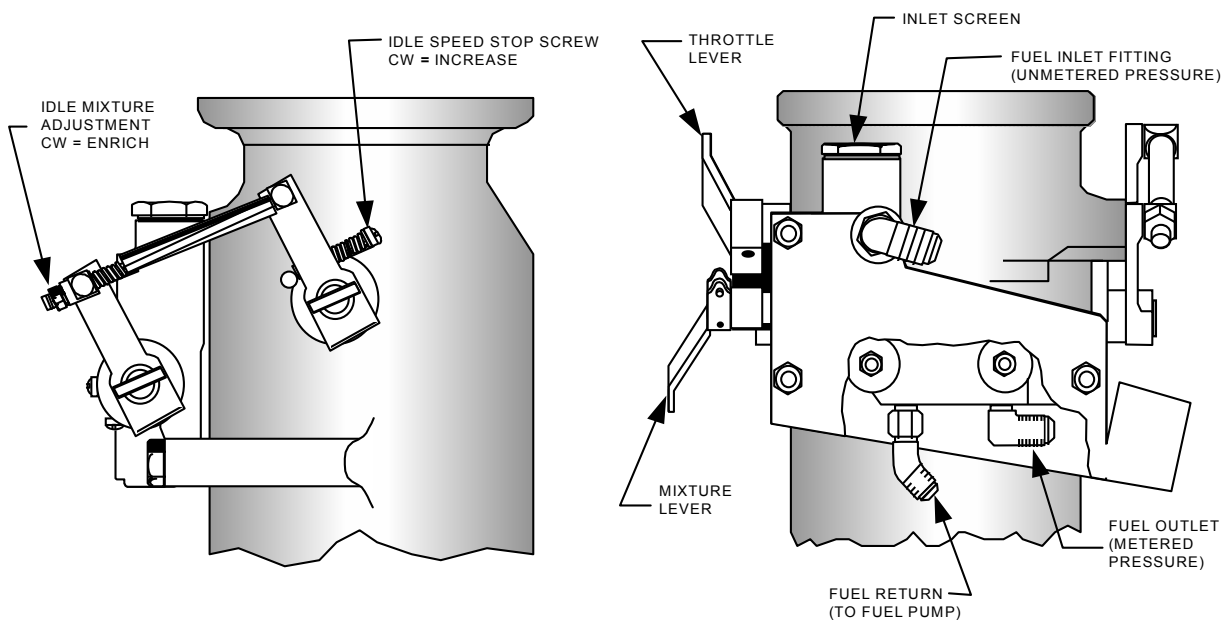


Figure 13-3
Air Throttle and Fuel Control Unit for IO-520-B, BA, BB, C, CB, M, and MB

Fuel Control Unit

IO-520-B, BA, BB, C, CB, M & MB

(Figure 13-4)

The fuel control body is made of bronze. The fuel metering shaft and mixture control shaft are made of stainless steel. The metering valve is located at one end and the mixture control valve is located at the other end of the control valve central bore. The valves ride in bushings and are sealed against leakage by o-rings. Loading springs force the valve ends against a fixed plug installed in the center of the central bore. This bronze plug has one passage that mates with the fuel return port and one passage that connects the mixture control valve chamber with the metering valve chamber. O-rings seal this plug in the central bore. Each valve includes a groove which forms a fuel chamber.

The contoured end face of the mixture control valve aligns with the passages in the metering plug to regulate the fuel flow from the fuel chamber. A control lever is installed on the mixture control valve shaft for connection to the cockpit mixture control. In the metering valve, a cam shaped cut is made on the outer part of the end face. A control lever on the metering valve shaft is connected to the air throttle valve shaft with linkage. The fuel return port in the control body connects to the return passage of the metering plug and alignment of the mixture control valve face with this passage determines the amount of fuel returned to the fuel pump. A removable plug at the fuel inlet port includes a filter screen to prevent admittance of debris.

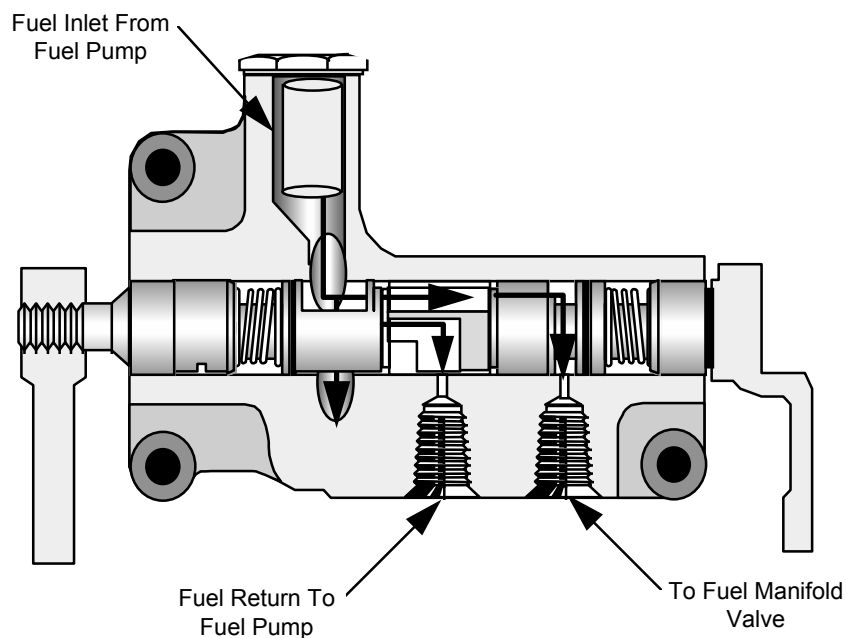


Figure 13-4
Fuel Control Unit for IO-520-B, BA, BB, C, CB, M, and MB

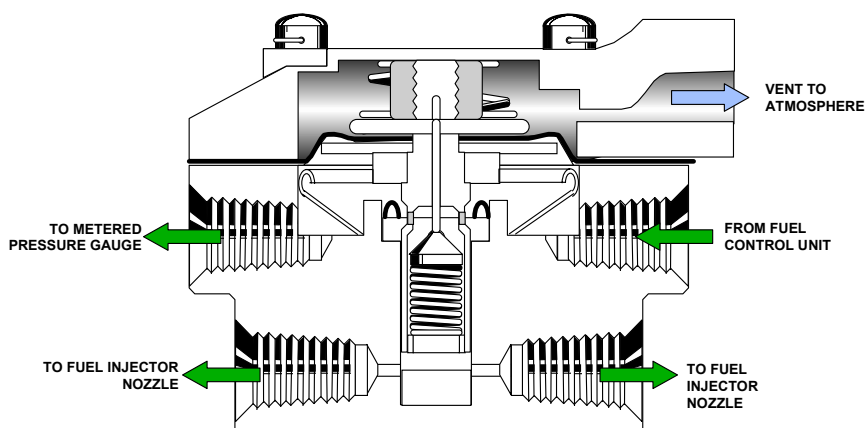


Figure 13-5
Fuel Manifold Valve

Fuel Manifold Valve

The fuel manifold valve body contains a fuel inlet, a diaphragm chamber and outlet ports for fuel lines to the individual nozzles. The spring loaded diaphragm carries a plunger in the central bore of the manifold body. The diaphragm is enclosed by a vented cover which retains the diaphragm loading spring. When the plunger is down in the body bore, fuel passages to the nozzles are closed off. The plunger is drilled for passage of fuel from the diaphragm chamber to its base and the valve within the plunger. As fuel flow increases pressure overcomes diaphragm spring tension causing the plunger to move to the open position and fuel flows from manifold valve outlets through fuel lines to the fuel nozzle assemblies.

Fuel Manifold Valve Replacement

The fuel manifold valve can be replaced with a new valve, or it can be repaired and calibrated in accordance with the applicable instructions in the

Fuel Injection System Parts And Overhaul Manual, Form X30593A, latest revision.

Use the following procedure to remove and replace the fuel manifold valve:

1. In accordance with manufacturer's instructions, remove cowling and any airframe accessories that may obstruct access to the manifold valve.
2. Disconnect the 6 fuel lines from the fuel manifold valve.
3. Disconnect the fuel hose from the elbow on the manifold valve.
4. Install protective covers on all open lines and hoses.
5. Remove crankcase backbone hardware at manifold bracket.
6. Remove the fuel manifold valve and mounting bracket from engine.

CAUTION...

Never use Teflon tape on fuel injection system fittings.

Fuel Nozzle

The fuel discharge nozzle is located in the cylinder head. The nozzle outlet is screwed into the tapped fuel nozzle hole in the cylinder head. The nozzle body has a drilled central passage with a counterbore at each end. The lower end is the fuel outlet. The upper bore contains a removable jet for calibrating the nozzles. Near the top, radial holes connect the upper counterbore with the outside of the nozzle body for air admission. These holes enter the counterbore above the orifice and draw outside

air through a cylindrical screen fitted over the nozzle body which keeps dirt and foreign material out of the interior of the nozzle. A press-fitted shield is mounted on the nozzle body and extends over the greater part of the filter screen, leaving an opening near the bottom. This provides both mechanical protection and an air path.

Nozzles are calibrated in several ranges and all nozzles furnished for one engine are of the same range identified by a letter stamped on the hex of the nozzle body.

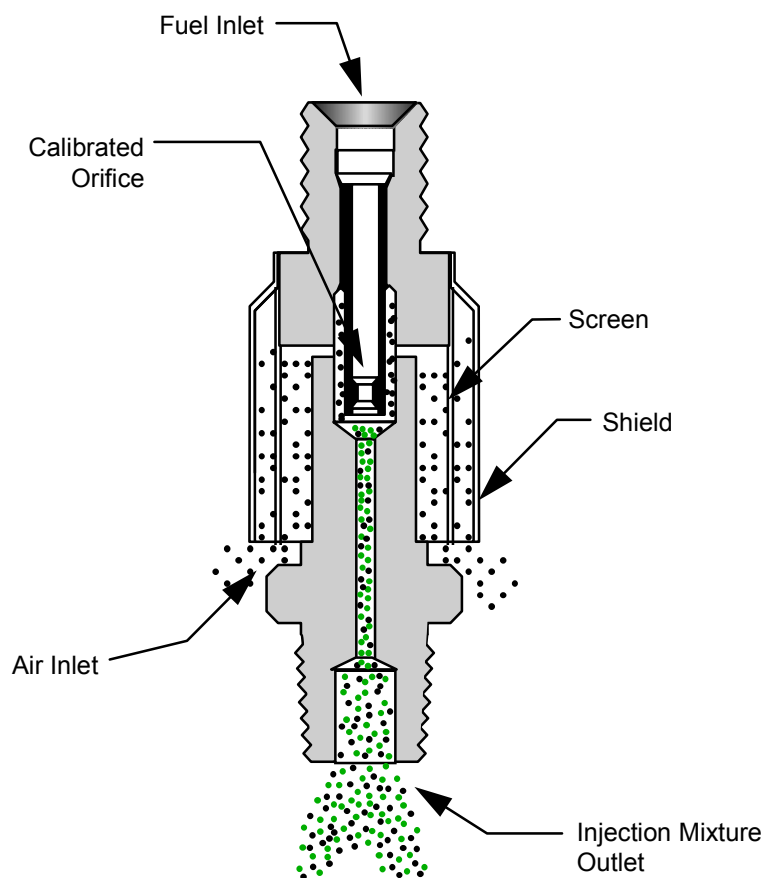


Figure 13-6
Fuel Nozzle

Fuel Nozzle Removal, Cleaning and Replacement

1. Remove cowling and any airframe accessories that may obstruct access to the fuel nozzles in accordance with the airframe manufacturer's instructions
2. Loosen and remove the fuel line from the fuel injector nozzle assembly.
3. Loosen and remove the fuel nozzle.
4. Clean nozzle by soaking in lacquer thinner, methyl ethyl keytone or acetone for several hours.
5. If a nozzle is obstructed and cannot be cleaned by solvent action, it must be replaced with a new nozzle.
6. Apply TCM 646943 antiseize lubricant to cylinder end of nozzle threads in accordance with Figure 13-14. Reinstall the nozzle and torque to 55 - 65 inch pounds.
7. Install fuel line on nozzle.
8. Torque the fuel line "B" nut to 40 - 45 inch pounds.
9. Reinstall all airframe supplied accessories and cowling in accordance with the airframe manufacturer's instructions.

After all requirements of scheduled maintenance have been performed and prior to any engine operation, a complete fuel system leak check must be performed in accordance with the aircraft manufacturer or STC holder's information.

CAUTION...

Do not attempt to clear nozzle obstruction with wire.

Fuel System Maintenance

Compare recorded findings of operational inspection with the following data:

ENGINE	RPM Propeller	Unmetered or Pump Pressure (PSI)	Metered Pressure (PSI)	Fuel Flow Lbs./Hr.	Fuel Flow Gal./Hr. (APPROX.)
①IO-520-M & MB	600 2700	8.0 - 10.0 32.0 - 36.0	3.9 - 4.5 18.0 - 19.8	142 - 150	24.2 - 25.6
①IO-520-B, BA, BB	600 2700	8.0 - 10.0 29.2 - 36.2	3.9 - 4.5 16.5 - 18.4	146 - 156	24.9 - 26.6
①IO-520-C, CB	600 2700	8.0 - 10.0 31.6 - 37.8	3.9 - 4.5 17.6 - 19.6	152 - 160	25.9 - 27.3

NOTE...Unmetered or pump pressure values and metered or nozzle pressure values are taken using a gauge vented to atmosphere. All readings are predicated on properly calibrated gauges.

① Flight test required to verify fuel flow vs. pressure altitude values are within the limits specified. See the Altitude Leaning Charts in chapter 22.

If the fuel injection system is found to be in good physical condition and operational inspection readings conform with the specified flows and pressures, the engine fuel system can be approved for return to service.

If the fuel system is not functioning properly, see troubleshooting in chapter 5 to determine the cause and procedure for correcting it.

Throttle, Fuel Control Unit and Mixture Levers Maintenance

To insure proper operation and to prevent accelerated wear of I0-520-B, BA, BB, C, CB, M, MB model engines, the fuel control to throttle linkage must be inspected for excessive play which can cause lost motion and breakage of parts due to vibration. Inspect the pivot points of levers and linkages on all I0-520 engine models for debris, old grease and oil. Clean pivot point areas thoroughly using clean Stoddard solvent. After cleaning, dry each area using compressed air.

WARNING

Whenever fuel control to throttle linkage, attaching hardware, levers or lever bushings have been replaced or reassembled, the fuel system must be checked and adjusted in accordance with the “Fuel System Adjustment” chapter and tested in accordance with chapter 22, “Post Maintenance Operational Test.” This test is MANDATORY.

NOTE...

Linkage connections between the throttle and fuel control unit are the same on the I0-520-B, BA, BB, C, CB, M, MB engine models; however, the throttle bodies, throttle levers and fuel control unit levers used on the different engine models are physically different.

Worn or corroded linkage, attaching hardware, levers or lever bushings must be replaced in accordance with the Permold Series Overhaul Manual, Form OH-11. After cleaning, inspection and repair has been accomplished as required, each pivot point must be lubricated using LPS 2, Permatex “Maintain®” Lubricant. If levers, link rods or bushings have been replaced or reassembled, initial

lubrication must be accomplished using Shell #5 Grease or Lubriplate #630AA or equivalent. Lubrication of levers, link rods, or bushings must be performed in accordance with Figure 13-7 on the following page.

Consult the airframe manufacturer and/or their most current published instructions concerning aircraft engine control cable attach point inspection, cleaning, repair, installation and lubrication.

After the above procedures have been accomplished, verify that each control has full limit of travel, that required safeties are in place, that no binding of levers or linkages is occurring and that control movement is not restricted by contact with other parts or components that are located in close proximity.

WARNING

Whenever the fuel pump, fuel control unit, fuel manifold valve or fuel injection nozzles are removed and replaced, the fuel system must be checked and adjusted in accordance with the “Fuel System Adjustment” chapter and tested in accordance with chapter 22, “Post Maintenance Operational Test” of this manual.

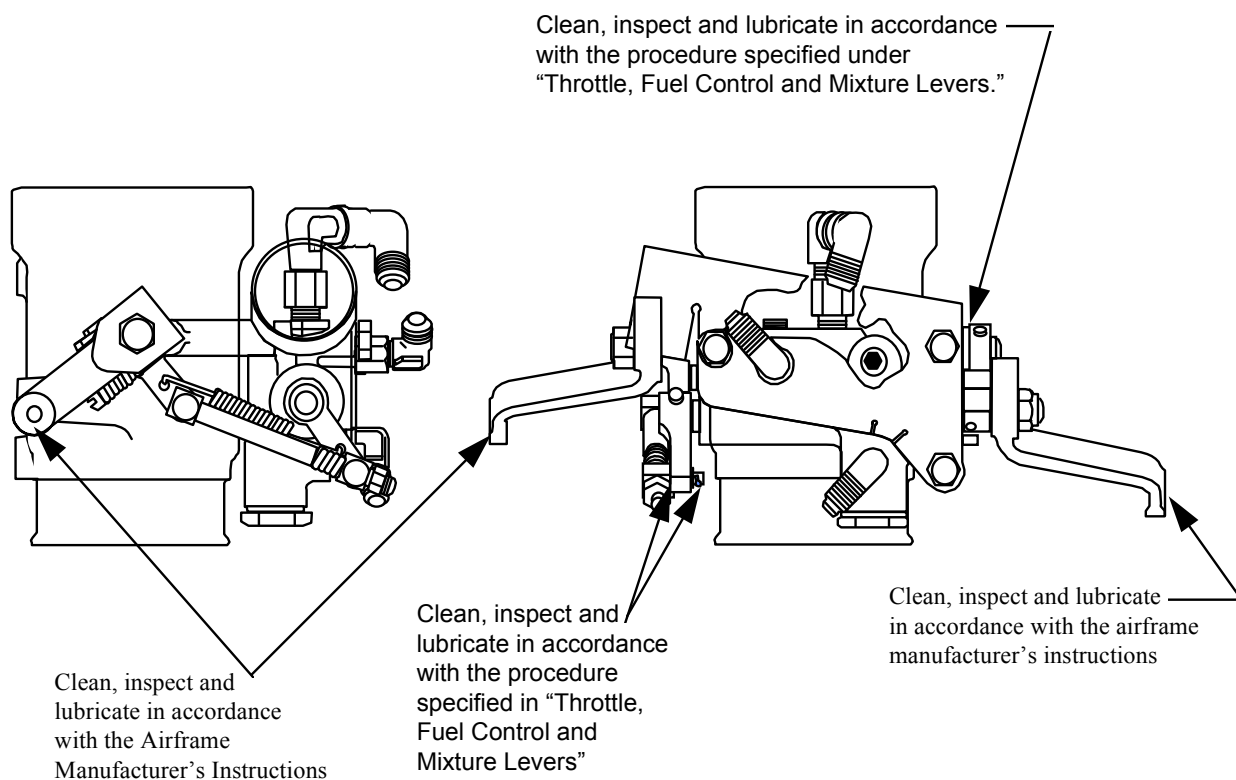


Figure 13-7
Throttle and Fuel Control Unit Lubrication for IO-520-B, -BA, -BB, -C, -CB, -M and -MB

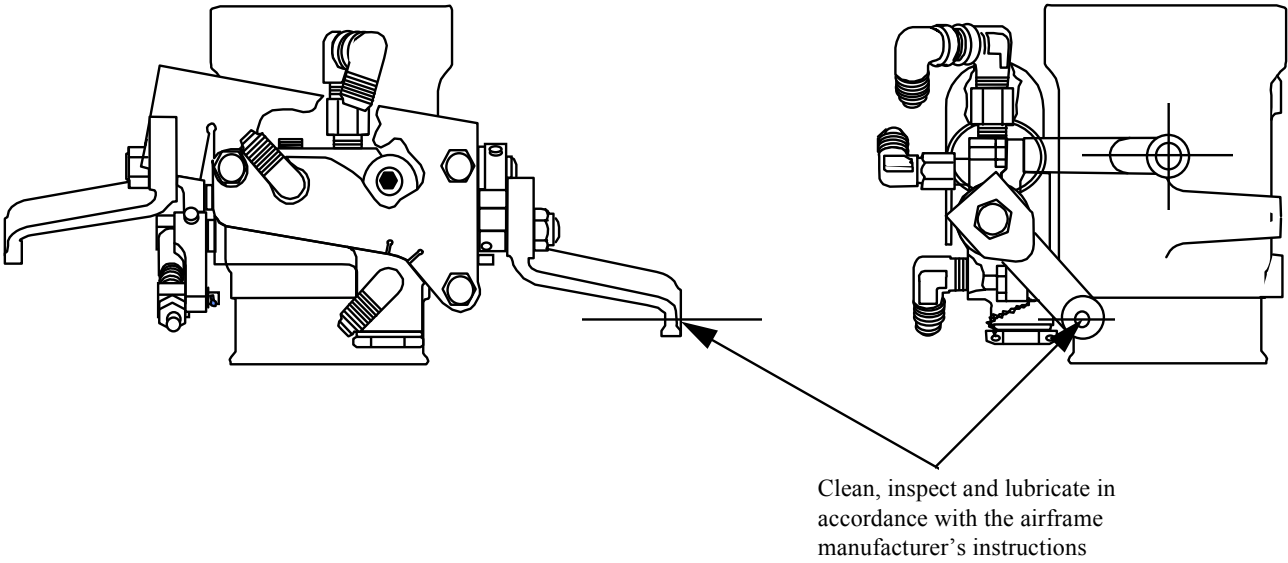


Figure 13-8
Throttle and Fuel Control Unit Lubrication for IO-520-B, -BA, -BB, -C, -CB, -M and -MB

1. Fittings from the original manifold valve may be installed and oriented to the same position in the replacement manifold valve. The fittings must be clean and free of damage and debris prior to installation. Apply F/I sealant to tapered male threads in accordance with Figure 13-9. Install fittings in fuel manifold valve and orient to the original positions. Torque fittings in accordance with Table 2, "Torque Specifications For Hose Fittings."
2. If the replacement manifold valve does not include a mounting bracket, remove the existing bracket from the old manifold valve as follows:
 - a. Cut, remove and discard lockwire.
 - b. Remove 4 screws and 4 lock washers. Discard lock washers.
 - c. Remove bracket and 4 plain washers from old manifold valve.
 - d. Clean manifold valve bracket and hardware with mineral spirits solvents and dry. Inspect all screw threads and insure that none are damaged.
 - e. Orient manifold valve bracket on new manifold valve using 4 plain washers and secure with 4 new lock washers and 4 screws.
 - f. Torque screws to 20 ± 1 inch pounds and lockwire in accordance with "Typical Lockwire Procedure" in Chapter 9.
 - g. Position manifold and bracket assembly over crankcase backbone mounting holes. Install manifold/bracket assembly to backbone with 2 screws, washers, and nuts. Torque to 180-220 inch pounds.
 - h. Remove all protective covers from fuel lines and hoses and reinstall fuel lines to the manifold valve. Insure that B-nut threads are clean and free of damage.

WARNING

While installing the bracket, do not displace or tear manifold valve diaphragm.

9. Torque fuel line to nozzle nuts to 40 - 45 inch pounds. Torque fuel line to manifold valve nuts to 55 - 60 inch pounds.
10. Torque fuel inlet hose to manifold valve elbow nut in accordance with Table 2, "Torque Specifications For Hose Fittings."
11. Reinstall removed airframe components in accordance with airframe manufacturer's instructions.
12. After all requirements of scheduled maintenance have been performed and prior to any engine operation, a complete fuel system leak check must be performed in accordance with the aircraft manufacturer or STC holder's information.

Throttle and Fuel Control Unit/ Throttle and Fuel Metering Unit Replacement

1. I0-520-M and MB throttle and fuel control units must be replaced in accordance with the airframe manufacturer's instructions.
2. On I0-520-B, BA, BB, C, CB, M & MB model engines, remove any airframe components required to gain access to the throttle and fuel control unit/throttle and fuel metering unit in accordance with the airframe manufacturer's instructions. Remove the following hoses from their fittings.
 - a. Fuel hose from fuel control unit/fuel metering unit to manifold valve.
 - b. Fuel hose(s) from fuel pump to fuel control unit/fuel metering unit.
3. Install protective covers on all loose hose ends.
4. On I0-520-B, BA & BB model engines, remove the throttle to induction manifold clamp and hose. Remove two bolts and washers and remove throttle and fuel control as a unit. On I0-520-C & CB model engines, remove the throttle to induction elbow clamps and hoses. Loosen and remove upper throttle support brackets and hardware in accordance with the airframe manufacturer's instructions. Remove nut from lower throttle body support bracket and remove throttle and fuel control as a unit.
5. Inspect hoses for condition. Replace any hose that exhibits wear, damage, or deterioration.
6. Remove and inspect all fittings for cleanliness and damaged threads. Replace fittings that are damaged.
7. TCM offers rebuilt fuel injection system components as an alternative to field repair of components.
8. The throttle and fuel metering unit can be repaired and calibrated in accordance with the applicable instructions in the Fuel Injection System Parts And Overhaul Manual, Form X30593, latest revision .
9. Fittings from the original fuel control unit/fuel metering unit may be installed and oriented to the same positions in the new or replacement fuel assembly. The fittings must be clean and free of damage and debris prior to installation. Apply F/I sealant to tapered male threads in accordance with Figure 13-9. Install fittings and orient to the original positions. Torque fittings in accordance with Table 2, "Torque Specifications For Hose Fittings."

CAUTION...

Never use Teflon tape on fuel injection system fittings.

1. Install I0-520-M & MB model engine throttle and control assemblies in accordance with the airframe manufacturer's instructions.
2. On I0-520-B, BA, BB, C, and CB model engines, using serviceable hoses and clamp assemblies, install the throttle and fuel control unit/throttle and metering unit on the intake manifold. Tighten hose clamps sufficiently to insure complete engagement and security of hose. Do not over tighten clamps to the point of cold flow.

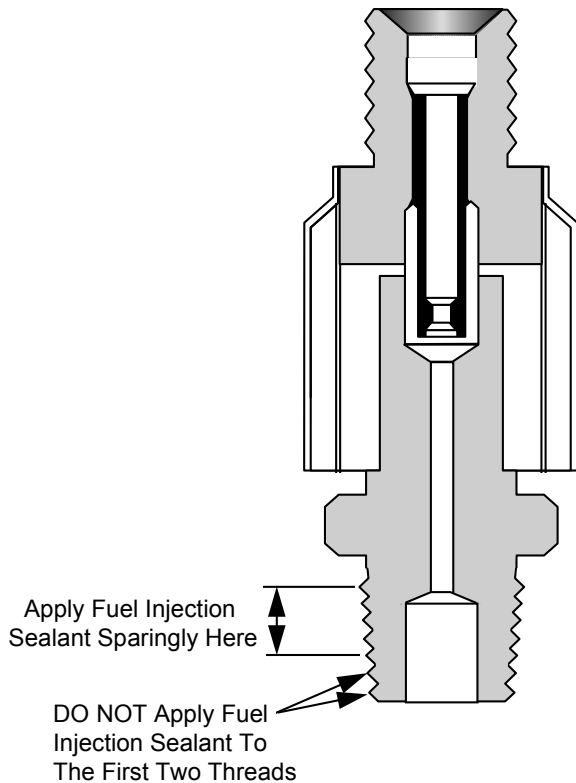


Figure 13-9
F/I Sealant Application

CAUTION...

Torque all hose connections and fittings in accordance with Table 2, "Torque Specifications For Hose Fittings" later in this chapter.

5. Install the following hoses:
 - a. Remove protective cover and install fuel hose from throttle and fuel control unit/throttle and fuel metering unit to manifold valve.
 - b. Remove protective cover and install fuel hose(s) from fuel pump to throttle and metering unit.
6. Reinstall cowling and airframe accessories in accordance with the airframe manufacturer's instructions.
7. After all requirements of scheduled maintenance have been performed and prior to any engine operation, a complete fuel system leak check must be performed in accordance with the aircraft manufacturer or STC holder's information.

3. On I0-520-B, BA and BB engines, install serviceable throttle and control unit on oil sump and secure with two washers and bolts. Torque bolts to 155-175 inch pounds. Install lock wire on bolts in accordance with Chapter 9.
10. On I0-520-C and CB model engines, align throttle stud with lower support bracket and install nut. Torque nut to 90-110 inch pounds. Install upper throttle support brackets and hardware in accordance with the airframe manufacturer's instructions.

Fuel Line Replacement

Use the following procedure to remove and replace an existing manifold valve to nozzle fuel line:

1. Separate fuel line from fuel line support bracket and clamp.
2. Disconnect the fuel line at the manifold valve.
3. Disconnect the fuel line at the fuel nozzle and remove fuel line.
4. Position a new or existing serviceable fuel line on the engine and connect it to the fuel manifold valve. Torque to 55 - 60 inch pounds.
5. Install the fuel line on the fuel nozzle. Torque B-nut to 40 - 45 inch pounds.
6. Install the fuel line into the fuel line support bracket and clamp.
7. If the rubber fuel line protector is damaged, replace it with a new protector.
8. After all requirements of scheduled maintenance have been performed and prior to any engine operation, a complete fuel system leak check must be performed in accordance with the aircraft manufacturer or STC holder's information .

Fuel Hose Replacement

1. Remove any airframe supplied support hardware from fuel hose in accordance with the airframe manufacturer's instructions. Remove fuel hose from its elbows. Drain fuel into a suitable container.
2. Inspect elbow threads for damage. Remove and replace elbow in accordance with the preceding component fitting installation instructions if damaged or worn.
3. Install new, clean fuel hose on elbows. The fuel hose must be routed in it's original position away from any heat source and any airframe support hardware that was removed must be reinstalled in accordance with the airframe manufacturer's instructions.
4. Torque hose fittings in accordance with Table 2, "Torque Specifications For Hose Fittings
5. After all requirements of scheduled maintenance have been performed and prior to any engine operation, a complete fuel system leak check must be performed in accordance with the aircraft manufacturer or STC holder's information.

TABLE 1 - TORQUE SPECIFICATIONS FOR FITTINGS			
SIZE	FITTING AND MATERIAL	TUBE O.D.	INCH POUNDS
5/16-24	#2 (Brass/Aluminum)	.125	15-30
5/16-24	#2 (Steel)	.125	15-50
3/8-24	#3 (Brass/Aluminum)	.188	40-65
3/8-24	#3 (Steel)	.188	50-90
7/16-20	#4 (Brass/Aluminum)	.250	60-80
7/16-20	(Steel)	.250	70-120
7/16-24	#4 (Steel)	.190	60-80
9/16-18	#6 (Brass/Aluminum)	.375	75-125
9/16-18	#6 (Steel)	.375	90-150
3/4-16	#8 (Brass/Aluminum)	.500	150-250
3/4-16	#8 (Steel)	.500	135-250
7/8-14	#10 (Brass/Aluminum)	.625	200-350
7/8-14	#10 (Steel)	.625	300-400

TABLE 2 - TORQUE SPECIFICATIONS FOR HOSE FITTINGS			
HOSE SIZE	THREAD SIZE	FITTING MATERIAL	INCH POUNDS
# 2	(5/16-24)	Hose End Fitting To Brass/Allum. Fitting Hose End Fitting To Steel Fitting	50-80 75-120
# 3	(3/8-24)	Hose End Fitting To Brass/Allum. Fitting Hose End Fitting To Steel Fitting	70-105 95-140
# 4	(7/16-20)	Hose End Fitting To Brass/Allum. Fitting Hose End Fitting To Steel Fitting	100-140 135-190
# 5	(1/2-20)	Hose End Fitting To Brass/Allum. Fitting Hose End Fitting To Steel Fitting	130-180 170-240
# 6	(9/16-18)	Hose End Fitting To Brass/Allum. Fitting Hose End Fitting To Steel Fitting	150-195 215-280
# 8	(3/4-16)	Hose End Fitting To Brass/Allum. Fitting Hose End Fitting To Steel Fitting	270-350 470-550
# 10	(7/8-14)	Hose End Fitting To Brass/Allum. Fitting Hose End Fitting To Steel Fitting	360-430 620-745
# 12	(1-1/16-12)	Hose End Fitting To Brass/Allum. Fitting Hose End Fitting To Steel Fitting	460-550 855-1055

Induction System

<i>Induction System Description</i>	<i>14-3</i>
<i>Air Throttle Assembly</i>	<i>14-4</i>
<i>Induction System Maintenance</i>	<i>14-5</i>

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Induction System Description

Engine components through which air flows following the aircraft air inlet filter/alternate air door are: throttle assembly, manifold, induction tubes and cylinder intake ports. Air flows through these components in the order they are listed.

Refer to the aircraft manufacturer's Airplane Flight Manual (AFM) for alternate air door operations.

The intake manifold is an air distribution system mounted below the engine cylinders. It serves to carry induction air to the individual cylinder intake ports.

The cylinder intake ports are cast into the cylinder head assembly. Air from the manifold is carried into the intake ports, mixed with fuel from the injector nozzles where it enters the cylinder as a combustible mixture when the intake valve opens.

Bottom View Of Engine
With Induction Manifold
Installed

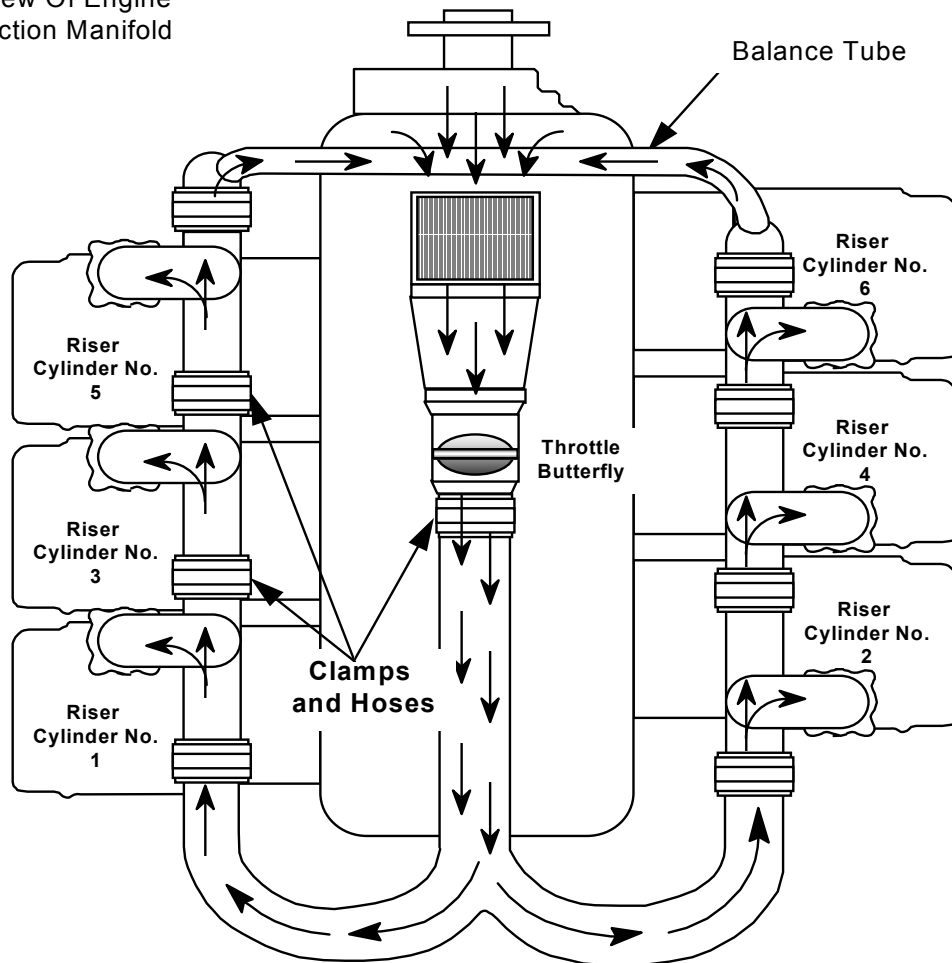


Figure 14-1
Induction System

Air Throttle Assembly

Air Throttle Assembly I0-520-B, BA, BB, C, CB, M & MB - The air throttle assembly is an aluminum casting that contains the shaft and throttle valve assembly. The throttle bore area is tailored to the engine size. No venturi or other restriction is used.

The shaft bosses contain bushings in which the shaft rides. Wave washers provide protection against vibration. An idle speed adjusting screw is provided in one of the throttle valve shaft levers and bears against a stop pin installed in the throttle body.

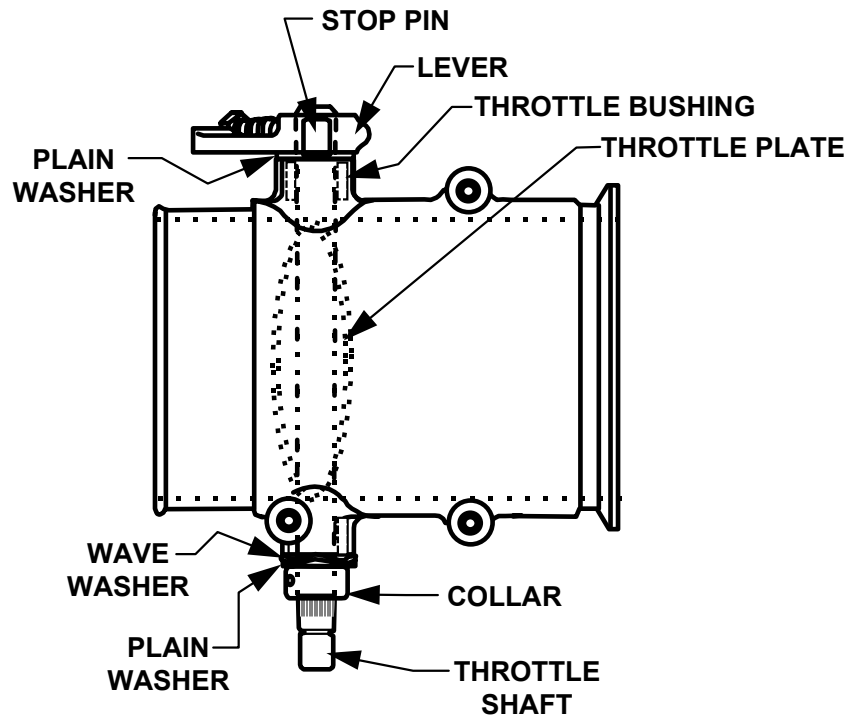


Figure 14-2
Air Throttle Assembly

Induction System Maintenance

Induction system maintenance is limited to removal and replacement of malfunctioning components and tightening loose connections in accordance with the applicable portions of the IO-520 Permold Overhaul Manual, Form OH-11 Induction System disassembly and reassembly procedures.

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Optional Air Conditioning Equipment

<i>Air Conditioning System Description</i>	<i>15-3</i>
<i>Air Conditioning System Components</i>	<i>15-3</i>
<i>Compressor Mounting Kit</i>	<i>15-3</i>
<i>Maintenance</i>	<i>15-4</i>

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Air Conditioning System Description

Teledyne Continental Motors supplies an optional compressor mounting bracket for the addition of a customer supplied belt driven compressor and air conditioning system. For a description of the complete air conditioning system refer to the airframe manufacturer's information.

Air Conditioning System Components

Compressor Mounting Kit

The compressor mounting bracket assembly is bolted to the 1-3-5 side rear crankcase half with one crankcase through bolt, two plain bolts and two lock washers. The bracket utilizes an adjustable block and idler sheave for tensioning the compressor belt.

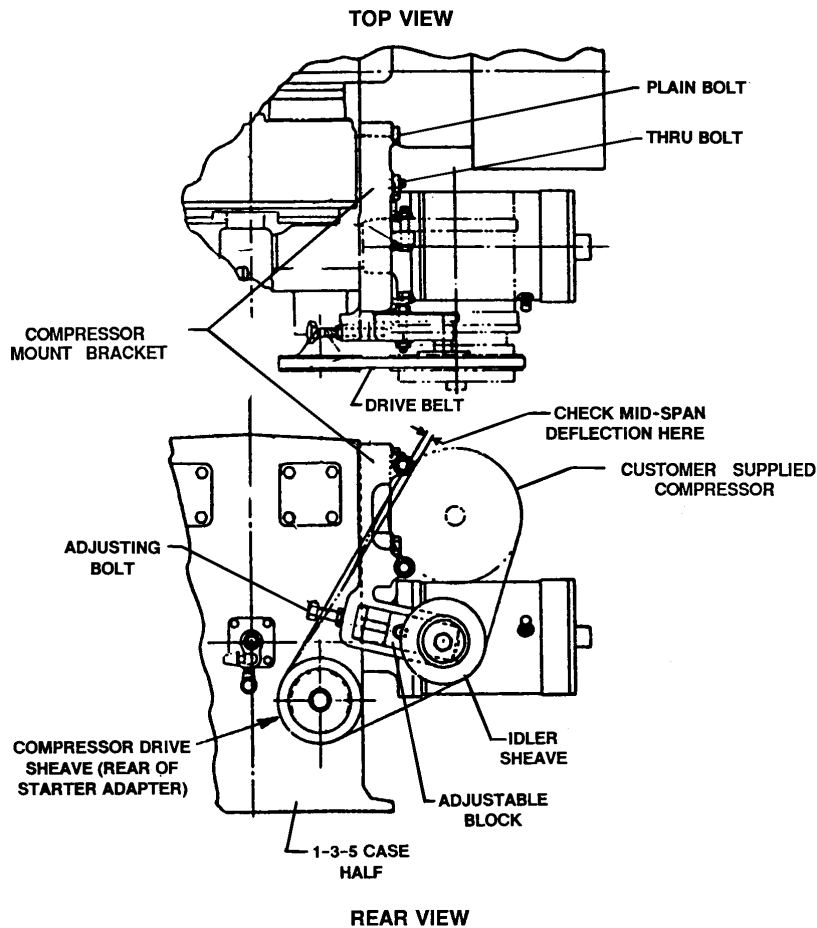


Figure 15-1
Optional Compressor Drive

Maintenance

Remove and replace worn or malfunctioning components in accordance with applicable portions of disassembly, reassembly in the IO-520 Permold Series Overhaul Manual, Form OH-11, Chapter 11 and the following:

Premature belt replacement can usually be attributed to improper alignment of the sheaves and/or improper belt tensioning. Use the following instructions to correct this problem.

The alignment of compressor, starter adapter and idler sheaves must be checked using Borroughs Tool Number 8082 alignment tool. Check tool flatness (calibration) by laying it on a surface table. Place the alignment tool around the drive sheave with the extended end overlaying the upper portion of the compressor sheave. When the alignment is

correct the alignment tool extended end (bar center) will fall within 0.020 inch of the center of the sheave. Use this same procedure to check the idler sheave, except the extended end of alignment tool will overlay the lower portion of the compressor sheave. See Figure 15-2, "Checking Sheave Alignment."

If drive sheave or idler are not in alignment, remove sheaves and install up to but do not exceed five 0.020 shims [P/N 643956-20] to achieve the correct alignment. See Figure 15-3, "Sheave Alignment." When idler sheave is properly adjusted torque sheave screw to 300-350 inch pounds torque. When drive sheave is properly adjusted, torque sheave 12-point, self-locking nut to 450-500 inch pounds. Nuts must be lubricated with clean aviation engine oil. All threads of sheave nut must be engaged.

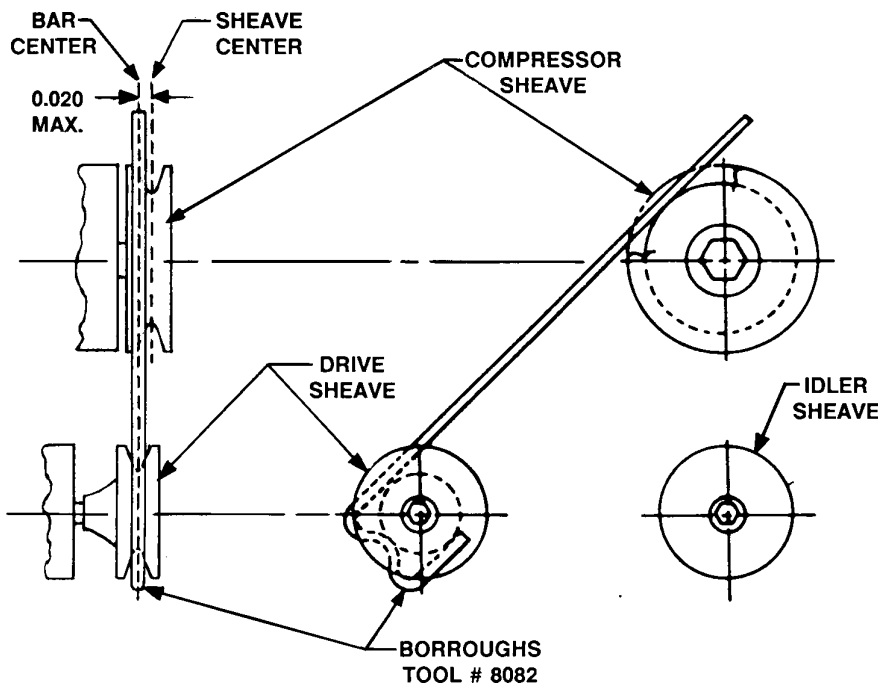


Figure 15-2
Checking Sheave Alignment

CAUTION...

Prevent engine from turning when torquing nut.

Refer to Figure 15-4, "Belt Tensioning," on the next page. Loosen the jam nut, adjusting bolt and slide nut. The slide nut should be loosened only enough to allow the slide to move freely and the adjusting bolt should be turned out far enough to allow installation of the belt.

Install the drive belt. Slide the idler pulley snugly against the belt and tighten the adjusting bolt finger tight into its socket. In this position the idler sheave should be rotatable by hand under the belt. Tighten the adjusting bolt two full turns. Torque the adjusting bolt jam nut to 275-375 inch pounds torque. Torque the idler sheave screw to 300-350 inch pounds.

Confirm belt tension is 50-70 pounds by one of the following methods:

1. Use a direct reading belt tension gage such as Borroughs Tool Number BT-33-73F.
2. Measure belt deflection under a five pound load at the center of the longest belt span. Correct deflection is 0.30- 0.40 inch.

If belt tension is not within the above tolerance, loosen jam nut and slide nut, readjust belt tension. One full turn of adjusting screw will give approximately ten pounds change in belt tension.

CAUTION...Do not over tighten drive belt.

After approximately five hours of operation, recheck belt tension and adjust as required to maintain 50-70 pounds belt tension.

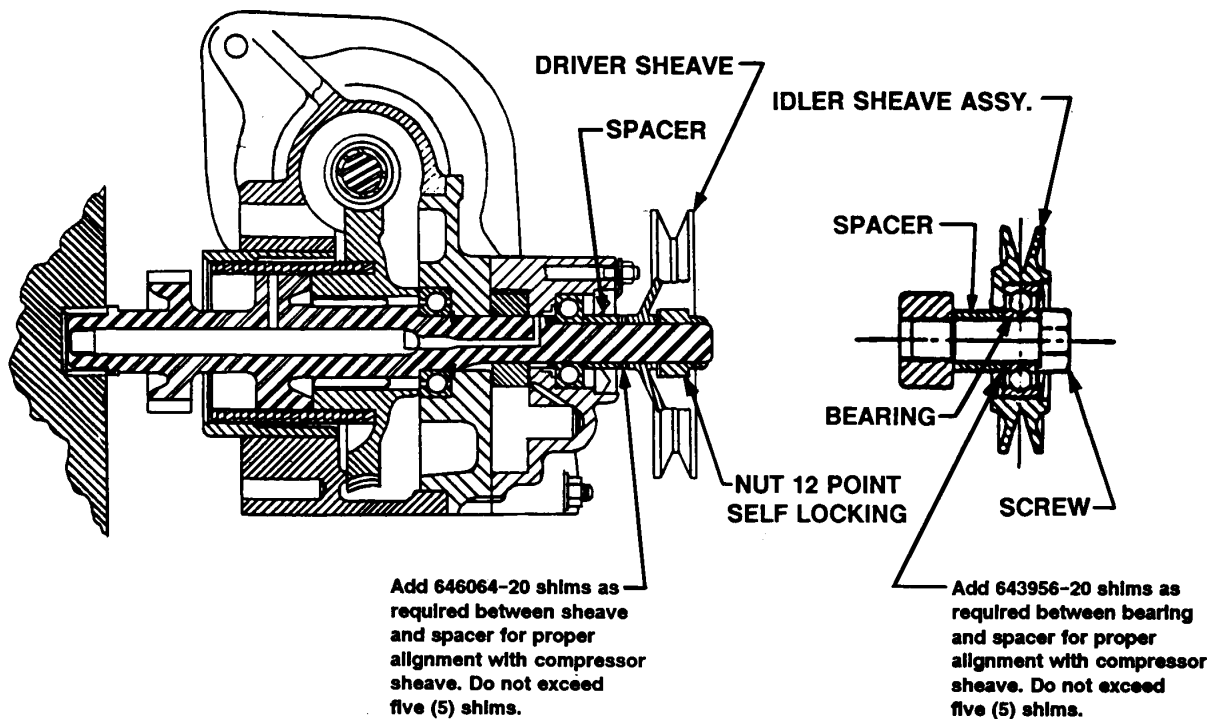


Figure 15-3
Sheave Alignment

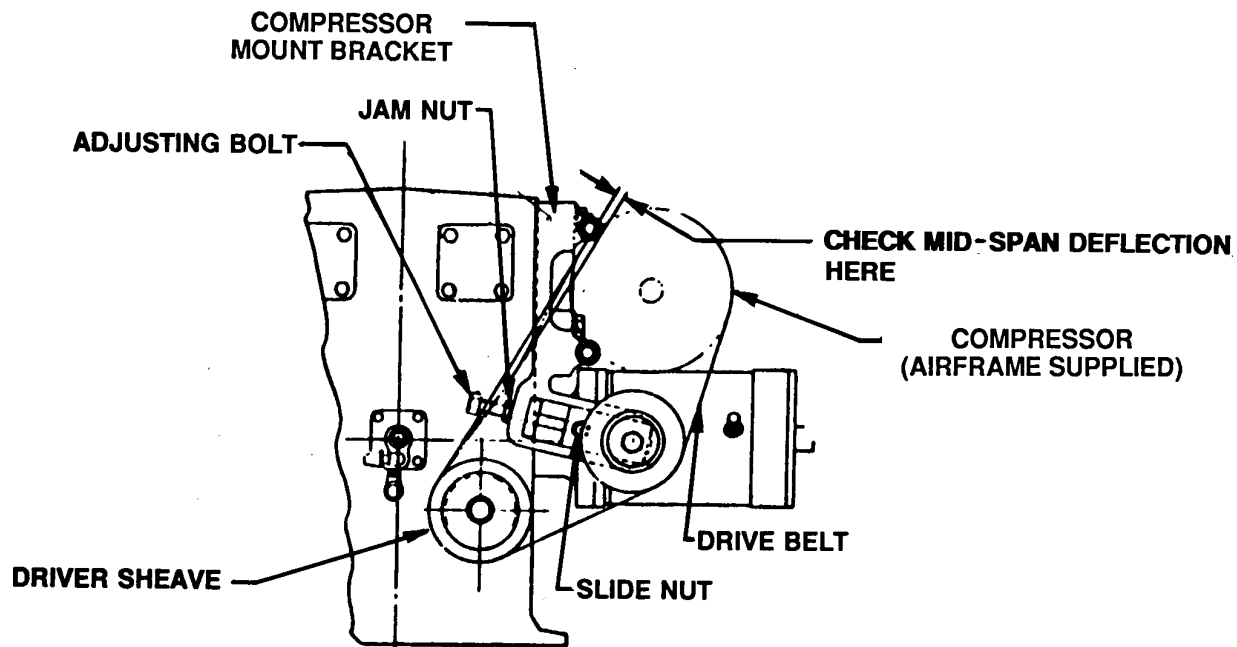


Figure 15-4
Belt Tensioning

Electrical Charging System

<i>Electrical Charging System</i>	16-3
<i>Electrical Charging System Components</i>	16-3
<i>Maintenance and Repair</i>	16-4
<i>Direct Drive Alternator Removal and Replacement</i>	16-4
<i>Alternator Drive Hub</i>	16-4
<i>Slippage Inspection</i>	16-4
<i>Repair/Replacement</i>	16-4
<i>Installation</i>	16-4

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Electrical Charging System

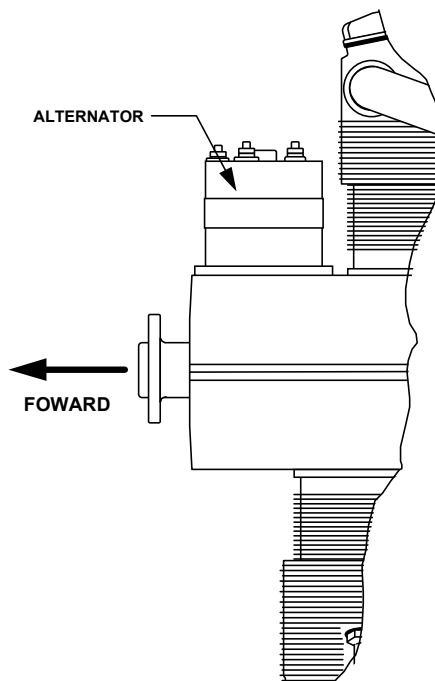
The IO-520-B, BA, BB, C, CB, M and MB model engines have a direct drive alternator mounted on the right front crankcase half. The alternator generates electrical current for powering the aircraft electrical system and for recharging aircraft batteries.

For a description of the aircraft electrical and charging system, refer to the airframe manufacturer's documentation.

For alternator location on the engine, refer to Figure 16-1, "Alternator Location."

Electrical Charging System Components

For detailed information about TCM alternators, refer to "Alternator Service Instructions," Form X30531-3.



*Figure 16-1
General Alternator Location*

Maintenance and Repair

For maintenance or repair of TCM alternators, refer to TCM Form X30531-3, "Alternator Service Instructions." The alternators may be removed for repair or replacement in accordance with the following removal and replacement instructions.

CAUTION...

When an alternator is removed that has a grounding strap, the strap must be reinstalled with the new or rebuilt alternator.

Direct Drive Alternator Removal and Replacement

Removal

1. Disconnect electrical connections from alternator in accordance with airframe manufacturer's instructions.
2. Remove plain washer, lock washer, and nut from the four mounting studs.
3. Discard lockwashers.
4. Remove the alternator from the mounting studs.
5. Remove gasket from mounting studs

Alternator Drive Hub

Slippage Inspection

Whenever the alternator is removed, perform the following drive gear hub slippage inspection:

1. The torque required to slip the elastomer coupling when new must be 180 inch pounds (15 foot pounds) torque minimum measured after 45° of revolution at a rate of 1 to 2 degrees per second.
2. Slippage must occur at the outside diameter of elastomer with no damage to the elastomer.
3. On couplings which have been in service for more than 25 hours, slippage torque must not be less than 140 inch pounds (11.7 foot pounds) torque.
4. Drive hubs that do not conform with the above specifications must be discarded.

Repair/Replacement

1. Alternator repair/replacement must be performed in accordance with TCM Alternator Maintenance and Parts Catalog, Form X30531A.

Installation

1. Install new gasket on new or rebuilt alternator.
2. Install alternator assembly on mounting studs with four plain washers, four new lock washers, and four plain nuts.
3. Torque nuts to 180 - 220 inch pounds.
4. Install all electrical connections in accordance with airframe manufacturer's instructions.

Starting System

<i>Starter and Starter Adapter</i>	<i>17-3</i>
<i>Starting System Components</i>	<i>17-4</i>
<i>Starter</i>	<i>17-4</i>
<i>Starter Adapter</i>	<i>17-4</i>
<i>Starting System Maintenance</i>	<i>17-5</i>
<i>Starter Motor Replacement</i>	<i>17-9</i>
<i>Starter Adapter Replacement</i>	<i>17-9</i>

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Starter and Starter Adapter

The I0-520 Permold Series engines utilize a starting system that employs an electric starter motor mounted on a right angle starter drive adapter. The right angle drive adapter serves to shorten engine overall length. As the starter motor is electrically energized, the adapter worm shaft

and gear engage the starter shaftgear by means of a spring and clutch assembly. As the shaftgear rotates, it in turn rotates the crankshaft gear and crankshaft. When the engine starts and accelerates, the gripping action of the clutch spring is relieved, disengaging the shaftgear from the worm shaft and electric starter motor.

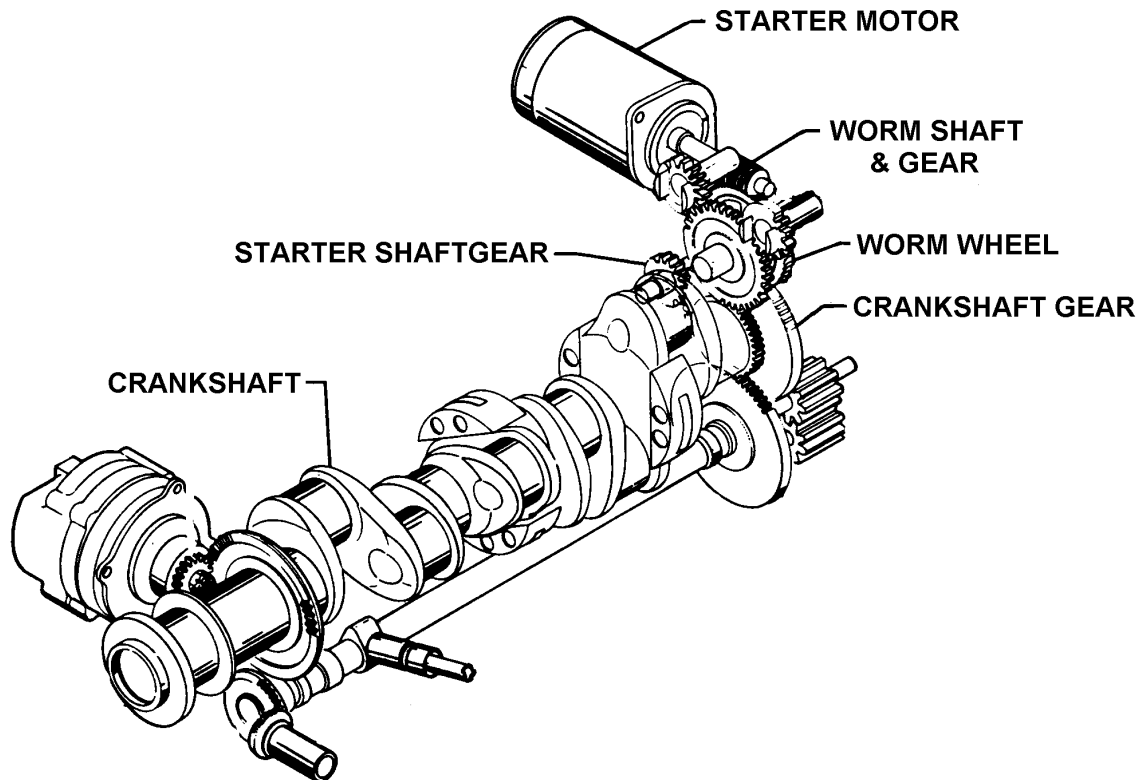


Figure 17-1
Starter and Starter Adapter

Starting System Components

Starter

For a detailed description of TCM electric starter motors See TCM Form X30592, Starter Service Instructions.

Starter Adapter

The starter adapter assembly uses a worm drive gear shaft and worm gear to transfer torque from the starter motor to the clutch assembly. The shaft is supported in the housing at the starter end by a

ball bearing and retaining ring, the opposite end is supported by a needle bearing pressed into the adapter housing. As the worm gear rotates the worm wheel and clutch spring, the clutch spring is tightened around the drum of the starter shaftgear. As the shaftgear turns, its torque is transmitted directly to the crankshaft gear. The starter shaftgear is supported at the adapter cover by a pressed in ball bearing, and is supported at the opposite end by a needle bearing pressed into the 1-3-5 crankcase half.

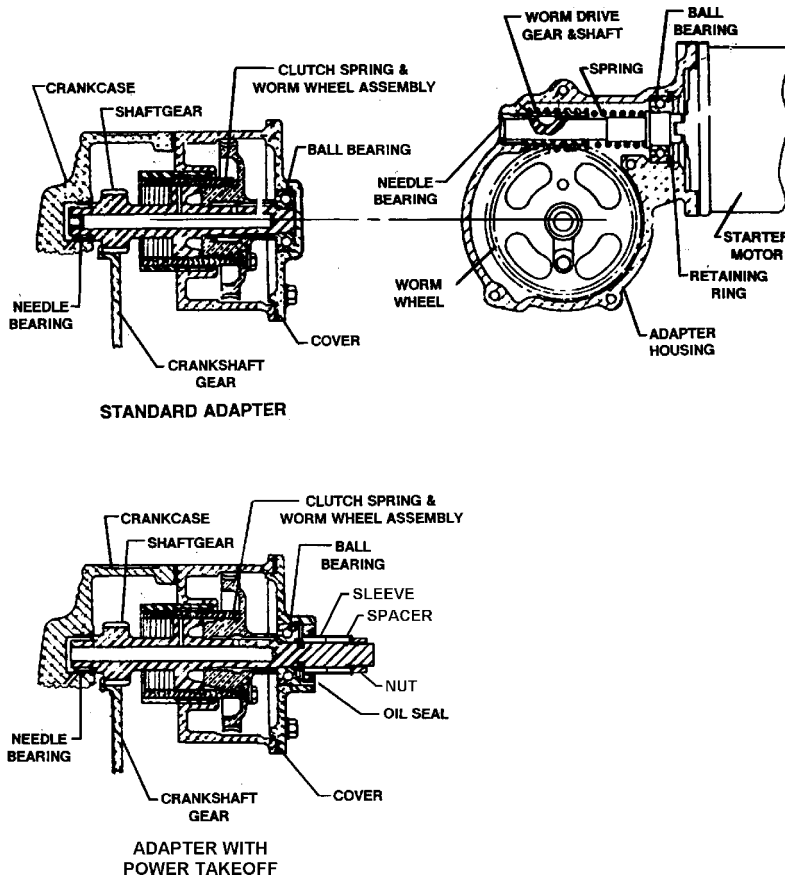


Figure 17-2
Starter Adapter

Starting System Maintenance

The starter motor may be removed for repair or maintenance in accordance with applicable portions of starter and starter adapter disassembly/reassembly instructions in the I0-520 Permold Series Overhaul Manual, Form OH-11.

Disassembly, maintenance and reassembly of the starter motor must be performed in accordance with the Starter Service Instructions, Form X30592.

When performing starter adapter repairs prior to engine TBO the following dimensional limits may be used.

CAUTION...

When performing dimensional inspection the following "Service Limits" may be used. However, they are only intended as a guide for reuse when performing maintenance of the engine prior to major overhaul. Parts with dimensions or fits that exceed service limits must not be reused. Parts with values up to and including service limits may be reused, however, judgment should be exercised considering the PROXIMITY of the engine to its recommended overhaul time.

SERVICE LIMITS			
REF.	DESCRIPTION		SERVICE LIMIT
1.	Starter shaftgear needle bearing hole crankcase	Diameter:	1.0005
2.	Starter shaft gear front (bearing) journal	Diameter:	0.7480
3.	Starter shaftgear in clutch drum bearing	Diameter:	1.0000L
4.	Clutch spring sleeve in starter adapter	Diameter:	0.0050T
5.	Starter shaft gear in ball bearing	Diameter:	0.0005L
6.	Bearing in starter adapter cover	Diameter:	0.0010L
7.	Worm wheel gear	End Clearance:	0.0250
8.	Worm wheel drum	Diameter:	Figure 17-6
9.	Starter Shaft gear drum	Diameter:	Figure 17-5
10.	① Clutch spring in clutch spring sleeve	Diameter:	0.0030T
11.	From center line of wormgear shaft to starter adapter thrust pads:		0.2520
12.	Needle bearing hole starter adapter	Diameter:	0.7495
13.	Ball bearing in starter adapter	Diameter:	0.0010L
14.	Worm gear shaft in needle bearing area	Diameter:	0.5600
15.	Worm gear shaft in ball bearing	Diameter:	0.0007L
16.	Starter worm gear on shaft	Diameter:	0.0040L
17.	Starter spring on worm drive shaft	Diameter:	0.0250L
18.	Starter pilot to starter drive adapter	Diameter:	0.0070L
19.	Starter drive tongue to worm shaft drive slot	Side Clearance:	0.0340L
20.	Starter worm wheel gear and worm gear	Backlash:	0.0200
1.	Starter adapter Cover Pilot In Adapter Housing	Diameter:	0.0040L

① When sand blasted diameter finish is smoother than 75 RMS, replace sleeve.

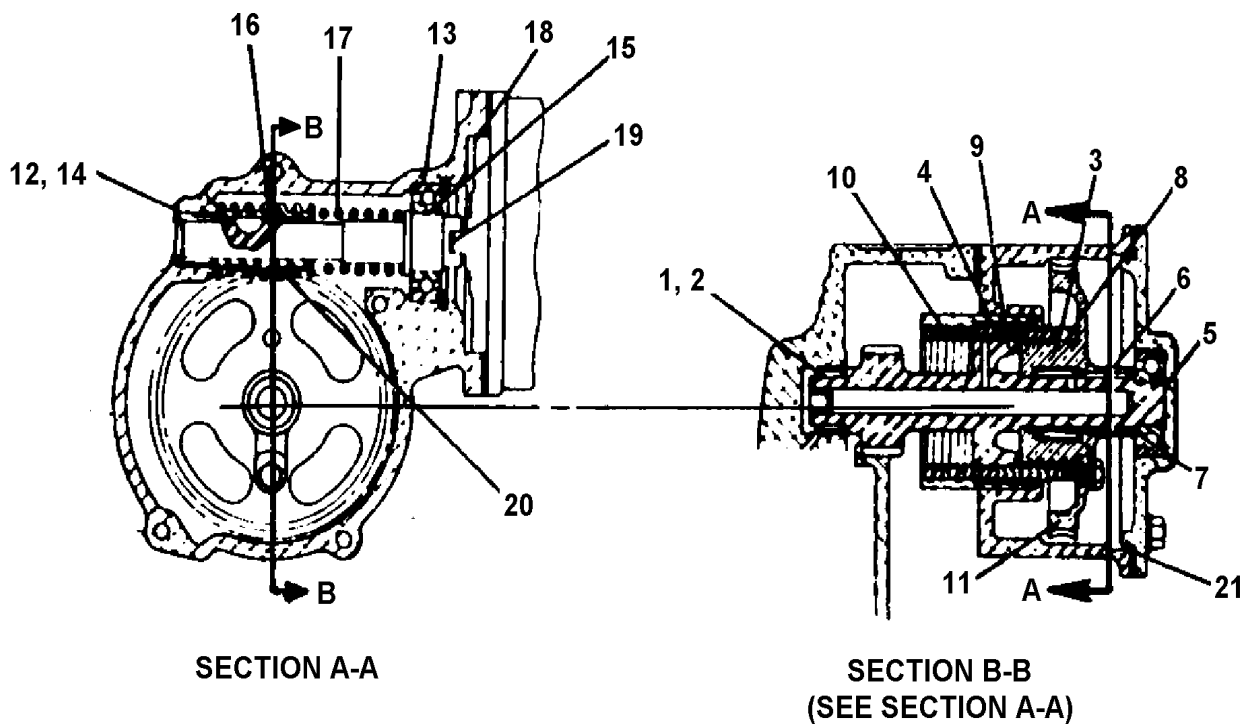


Figure 17-3
Starter Adapter Fits and Limits

SERVICE LIMITS			
REF.	DESCRIPTION		SERVICE LIMIT
1.	Starter shaftgear needle bearing hole crankcase	Diameter:	1.0005
2.	Starter shaftgear front (bearing) journal	Diameter:	0.7480
3.	Starter shaftgear in clutch drum bearing area	Diameter:	1.0000
4.	Clutch spring sleeve in starter adapter	Diameter:	0.0050T
5.	Starter shaftgear in ball bearing	Diameter:	0.0007L
6.	Bearing in starter adapter cover	Diameter:	0.0010L
7.	Worm wheel gear	End Clearance:	0.0250
8.	Worm wheel drum	Diameter:	See Figure 17-6
9.	Starter Shaftgear Drum	Diameter:	See Figure 17-5
10.	① Clutch spring in clutch spring sleeve	Diameter:	0.0030T
11.	From center line of worm gearshaft to starter adapter thrust pads:		0.2520
12.	Needle bearing hole starter adapter	Diameter:	0.7495
13.	Ball bearing in starter adapter	Diameter:	0.0010L
14.	Worm gearshaft in needle bearing area	Diameter:	0.5600
15.	Worm gearshaft in ball bearing	Diameter:	0.0007L
16.	Starter worm gear on shaft	Diameter:	0.0040L
17.	Starter spring on worm drive shaft	Diameter:	0.0250L
18.	Starter pilot to starter drive adapter	Diameter:	0.0070L
19.	Starter drive tongue to worm shaft drive slot	Side Clearance:	0.0340L
20.	Scavenge pump driver gear on starter gear shaft	Diameter:	0.0030L
21.	Scavenge pump driver gear in body	End Clearance:	0.0060L
22.	Scavenge pump driver gear in body	Diameter:	0.0160L
23.	Starter gearshaft in scavenge pump body	Diameter:	0.0040L
24.	Ball bearing in scavenge pump body	Diameter:	0.0011L
25.	Starter worm wheel gear and worm gear	Backlash:	0.0200

① When sand blasted diameter finish is smoother than 75 RMS, replace sleeve.

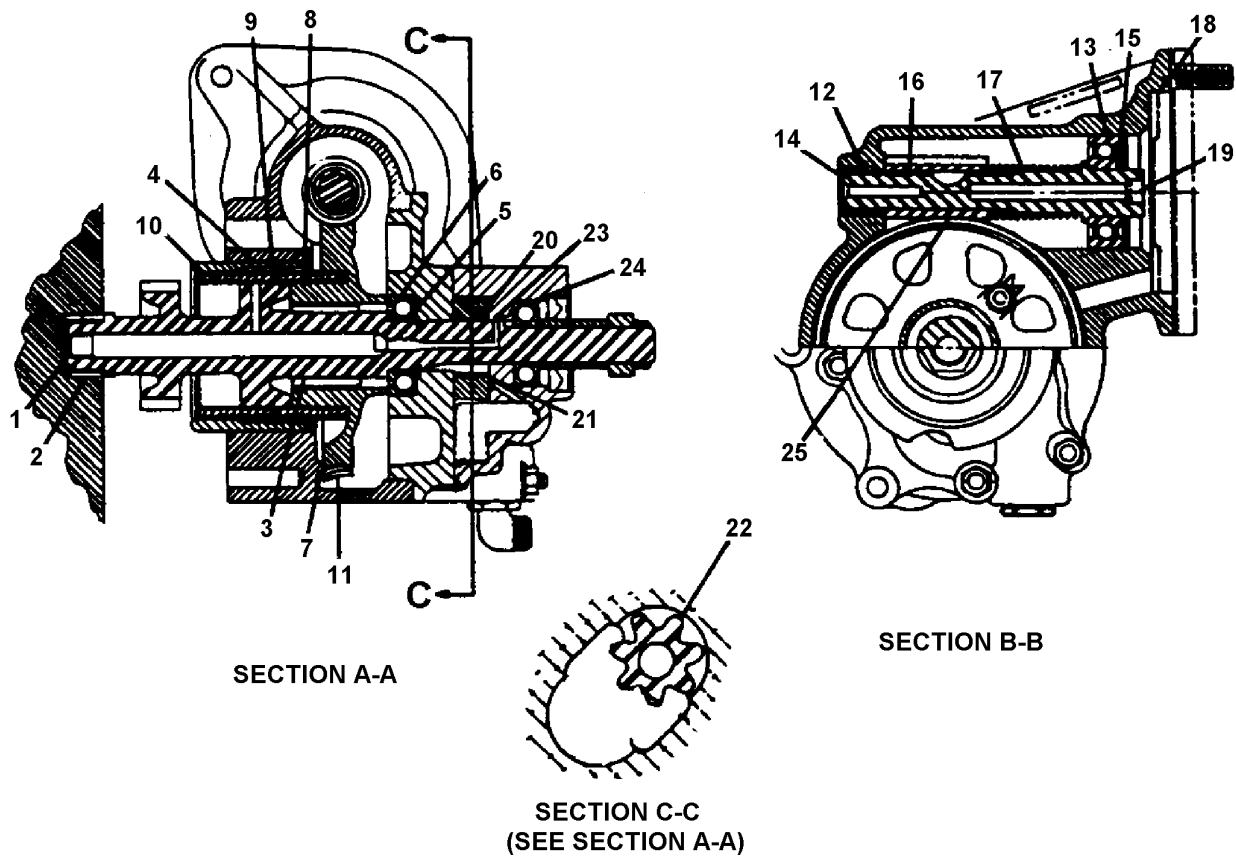


Figure 17-4
Customer Specification Starter Adapter Fits and Limits

Starter Motor Replacement

Removal

1. Disconnect electrical cable from starter motor in accordance with airframe manufacturer's instructions.
2. Remove the two nuts and plain washers from the starter motor mounting studs.
3. Carefully remove the starter motor assembly without damaging mounting stud threads.
4. Remove and discard O-ring.

Starter motor repair/replacement must be performed in accordance with TCM Starter Service Instructions, Form No. X30592.

Installation

1. Lubricate new o-ring with clean 50 wt. aviation engine oil and install on starter pilot.
2. Install starter motor on mounting studs and insure that drive lug aligns with slot. Secure starter motor with two plain washers and 2 nuts.
3. Torque nuts to 200 - 220 inch pounds.

Reconnect electrical cable in accordance with airframe manufacturer's instructions.

Starter Adapter Replacement

Removal

1. Remove starter motor in accordance with "Starter Motor Removal And Replacement."
2. Remove four sets of attaching parts (two on outside of crankcase between cylinder No. 1 and starter, and two on cover assembly.) remove starter adapter assembly from crankcase. Discard lock washers.

The starter adapter must be repaired in accordance with the IO-520-Permold Series Overhaul Manual, Form OH-11.

Replacement

1. Using the following, install new, rebuilt or serviceable starter adapter.
2. Apply a thin coat of TCM Gasket Maker 646942 to the starter adapter gasket crankcase mating surface only.
3. Apply TCM gasket maker to silk thread and split line of crankcase at oil pump bore. Place silk thread ends into split line of oil pump bore.
4. Install new gasket on crankcase.

CAUTION...

Sealant must be applied sparingly to prevent contamination of the engine oil system.

5. Lubricate teeth on starter shaftgear and mesh with crankshaft gear as starter adapter is placed in position. Seat adapter against gasket. Secure adapter assembly to crankcase with washers, new lock washers and nuts. Torque 5/16-24 nuts to 180-220 inch pounds. Torque 3/8 16 nuts to 200-220 inch pounds.
6. Replace starter motor in accordance with "Starter Motor Removal And Replacement."

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Lubrication System

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Lubrication System

The engine oil supply is contained in the oil sump. The oil is drawn from the sump through the oil suction tube to the intake side of the engine driven, gear type, oil pump. From the outlet side of the pump, oil is directed to the full flow, replaceable oil filter. A bypass valve is incorporated in the oil filter. An oil pressure relief valve is incorporated in the oil pump housing. The valve opens when the pump pressures exceed the adjusted limit and oil is directed back to the intake side of the oil pump gears.

From the oil filter discharge port, oil is directed through a crankcase passage to the oil cooler. In addition to facilities for oil cooling, the oil cooler incorporates an oil temperature control valve. Oil passing by the oil temperature control valve cavity directs oil either through the oil cooler core and or through the oil cooler bypass to the crankcase passage at the rear depending on the oil temperature. If engine oil temperature is above 180°F, all oil is directed through the oil cooler.

Oil entering the engine is directed to the hollow camshaft which serves as the engine main oil gallery. Grooves and drilled holes in the camshaft are located so as to afford proper lubrication through a system of orifices to the main bearings, hydraulic valve tappets, idler gear bushing, accessory drive gear bushings and the starter drive gear bearing.

Oil leaving the camshaft interior at the front of the crankcase is directed to the left main crankcase gallery, from there it is directed upward through crankcase oil passages to the main thrust bearing and to the governor drive gear.

WARNING

Oil pressure is applied to the face of the accessory drive pads. If gaskets, accessory or covers are not properly installed and hardware is not properly torqued oil leakage will occur.

From the governor drive gear lubricating oil is directed from the left main gallery through drilled crankcase passages and oil transfer collar to the crankshaft. Oil then travels through a transfer plug installed in the inside diameter of the crankshaft and is routed to the variable pitch propeller. Hydraulic valve tappets transfer oil from the main oil galleries to the cylinder overhead through the hollow pushrods to a drilled oil passage in the rocker arms. Oil exiting the rocker arms lubricates the valve stems, springs and rotocoils. The oil then falls to the lower rocker cavity and returns to the crankcase and sump through the pushrod housings.

Oil from the left main crankcase gallery is also directed upward through crankcase oil passages to the crankshaft main bearings and idler gear bushing. Oil is directed upward from the idler gear bushing to both accessory drive bushings. Oil lubricating the crankshaft mains is directed through the upper main bearing oil holes, through crankcase passages to oil squirt nozzles that spray oil onto the underside of the pistons for heat dissipation and lubrication. Oil falls from the pistons through the crankcase cavity back to the oil sump.

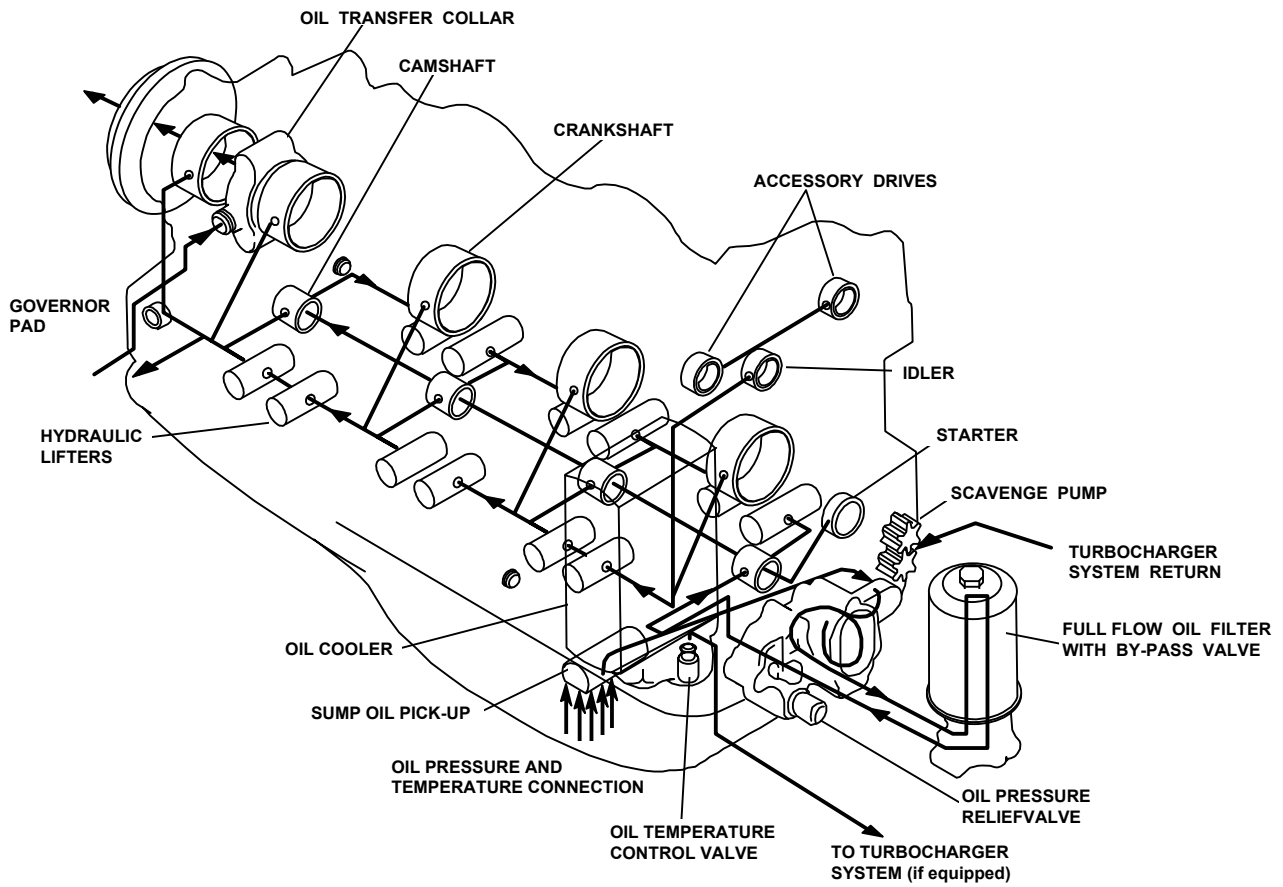


Figure 18-1
Lubrication System Schematic

Oil Pump

The positive displacement oil pump consists of two meshed gears that revolve inside the pump housing cavity. The clearance between the oil pump cavity and oil pump gear teeth is small.

The camshaft drives the oil pump drive gear, which drives the oil pump driven gear. The oil pump driven gear is supported by a shaft pressed into the oil pump housing.

The oil pump drive gear shaft is supported by the tach drive housing on one end and the oil pump housing at the opposite end. The oil pump drive gear has a tachometer drive gear attached to its end which drives a tachometer shaftgear inside the tach drive housing for either electrical or mechanical tachometers.

As the engine starts rotating, the oil pump drive gear turns (looking from the rear of the engine forward) counterclockwise, this drives the driven gear in a clockwise direction. The two gears turning creates a suction that draws oil from the sump, through the oil suction tube to the pump gears.

The oil is then forced around the outside of the gears and through a gallery to the oil filter adapter and pressure relief valve. Oil that flows past the pressure relief valve is directed through a passage back to the inlet side of the pump gears.

The adjustable oil pressure relief valve maintains oil pressure at a preset value to insure adequate lubrication to the engine and its accessories at high engine RPM. Oil pressure is adjusted by turning the oil pressure relief valve adjusting screw.

During normal operation, oil flows from the bypass to an area between the oil filter housing and filter element. The oil is then directed through the element, down to a gallery in the filter adapter, through a passage in the oil pump housing and out to the engine. The oil filter bypass allows the oil to continue to circulate through the engine if the filter element becomes clogged.

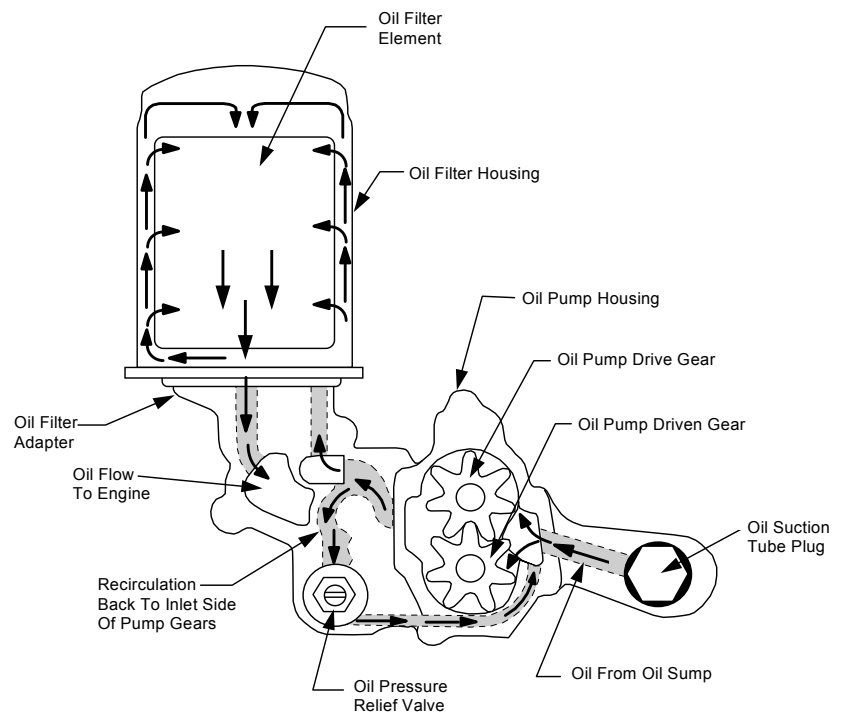


Figure 18-2
Oil Pump

Oil Cooler And Oil Temperature Control Valve

Oil flowing from the oil pump enters the oil cooler inlet where it is directed upward through the cooler core by the oil gallery. When the oil is below normal operating temperature, the oil temperature control valve (vernatherm) opens allowing oil to flow through the center bypass portion of the cooler. Oil flowing through the by-

pass flows past the oil temperature control valve and out to the crankcase main oil galleries and the camshaft.

When oil temperature reaches 180°F the oil temperature control valve closes, forcing the oil to flow through the oil cooler. As the oil flows through the cooler core, cooling air fins between the core oil passages dissipate excess heat from the oil, maintaining normal operating temperatures.

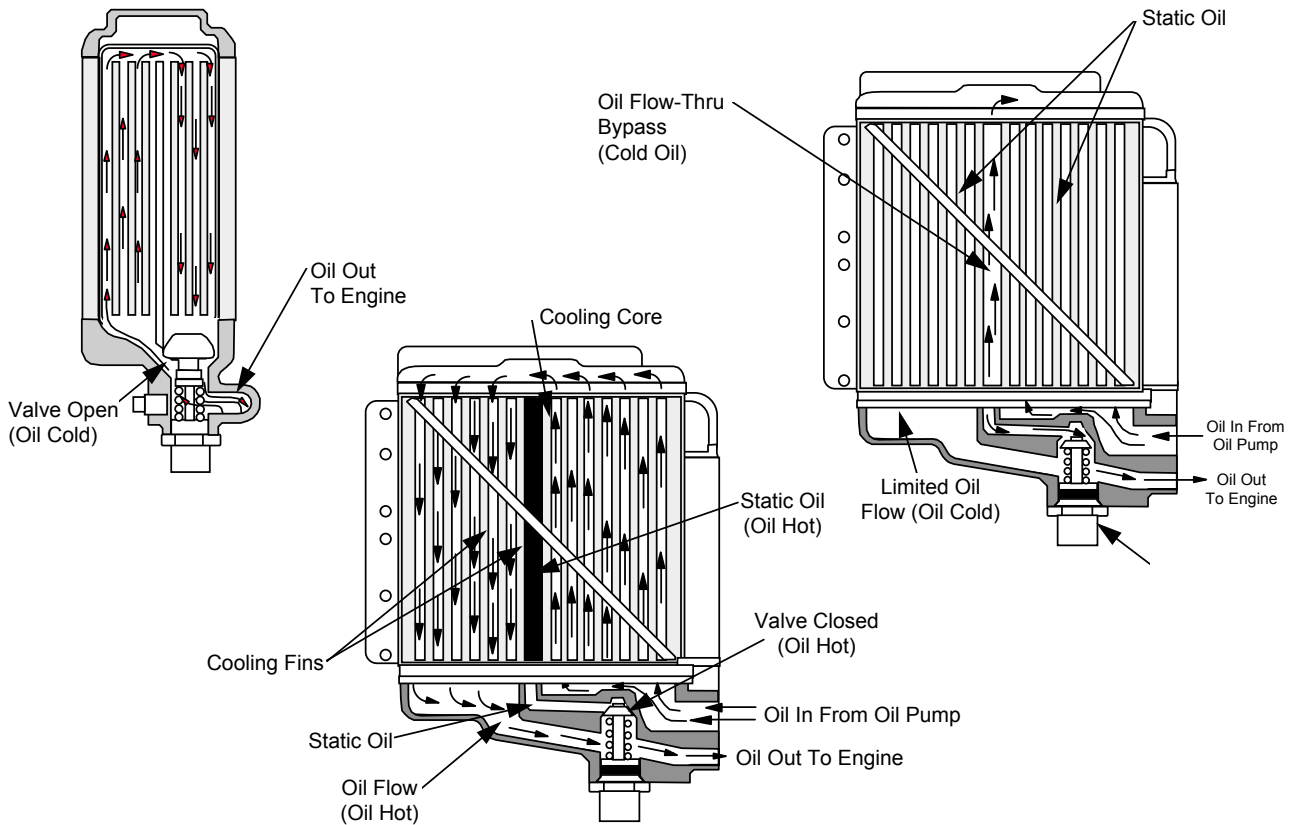


Figure 18-3
Oil Cooler

Oil Sump

The oil sump used on I0-520-A and C model engines is a stamp-pressed aluminum alloy assembly. The oil sump used on the I0-520-B model engines is cast aluminum with provisions for attaching engine mount legs. The sump is held to the crankcase sump mount flange with 32 bolts, washers and lock washers. The oil sump assembly incorporates a tapped drain plug boss, a plug, and a crush washer to facilitate draining engine oil. The drain plug boss has provisions for safety wiring of the oil drain plug.

Oil Suction Tube

The oil suction tube extends from the oil sump to the oil pump inlet providing oil pickup and flow path. The pickup tube entrance is screened. The oil screen on I0-520-B engines has .06" diameter holes. The oil screens on I0-520-A and C engines have .085" diameter holes. On I0-520-A and -C engines, the pickup end is supported by welded brackets bolted to the crankcase spine below the camshaft. On I0-520-B engines, the pickup end is supported by welded brackets bolted to two crankcase bolt bosses. The opposite end with a crush washer installed protrudes through the crankcase into the oil pump inlet. The threaded tube end is held and sealed to the oil pump housing by a crush washer and a plug.

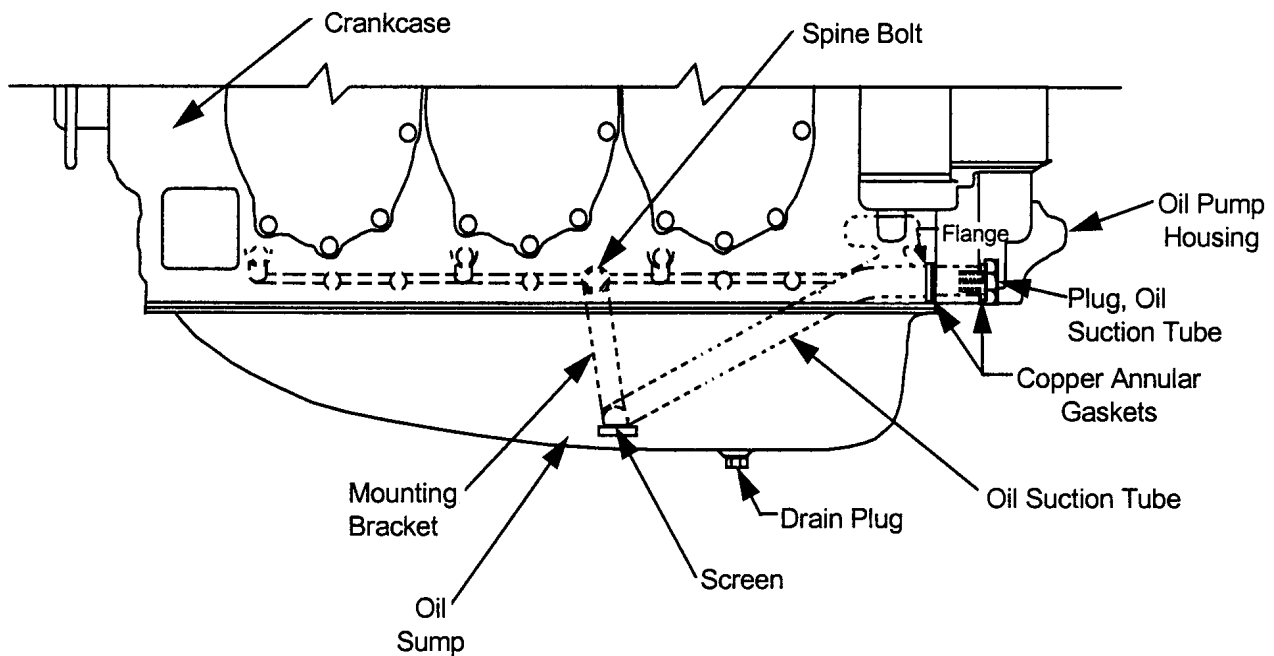


Figure 18-4
Oil Sump and Suction Tube

Lubrication System Maintenance

Oil filter Adapter Stud Replacement

A new stud P/N 653490 must be installed if :

1. The old stud is a plain steel color with a length of 1.440" inch.
2. If the old stud is found to be loose or installed beyond the stud setting height specified in Figure 18-6, "Oil Filter Adapter Stud Inspection." Install new stud in accordance with the following procedure:
 - a. Remove old stud P/N 632373 and inspect the threads in the adapter housing for damage. Replace the adapter housing if any thread damage is evident.

NOTE...

Oil filter adapters that incorporate this modification from the factory can be determined by the letter "S" stamped into the adapter housing, See Figure 18-5 "Stud Identification."

- b. Clean the adapter housing threads thoroughly to remove any remaining thread adhesive and oil.
- c. Install the applicable new stud (P/N 653490) and confirm that the incomplete thread on the stud stops at the first thread in the adapter housing and does not continue into the housing below the minimum .500" extension. See Figure 18-5, "Oil Filter Adapter Stud Inspection." Replace the adapter housing if the extension is less than the specified .500" minimum.
- d. After extension height inspection, remove the stud from the adapter. Clean the threads of the adapter housing and stud with Loctite "Primer T" (TCM P/N 646944) and allow to dry.
- e. Apply a line of Loctite 271 (TCM P/N 646941) along the large threads (.8125-16 end) of the stud and install into the adapter finger tight to 30 inch pounds torque. Check for proper stud extension height in accordance with Figure 18-6," Oil Filter

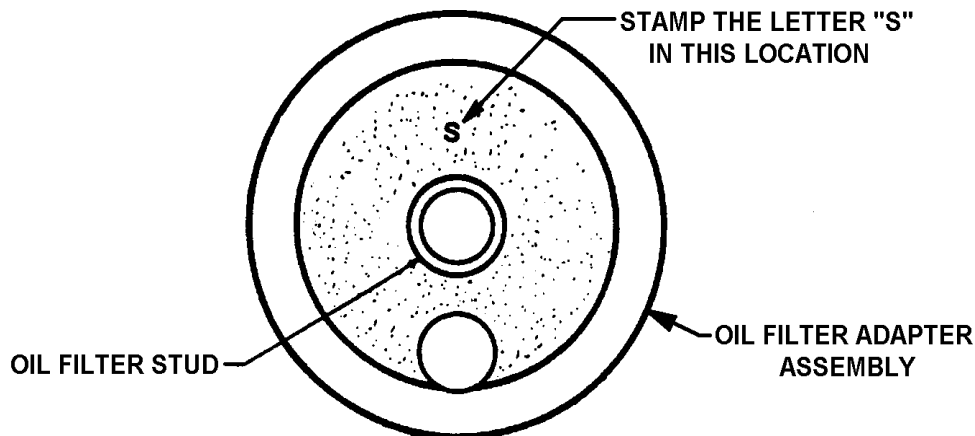


Figure 18-5
Stud Identification

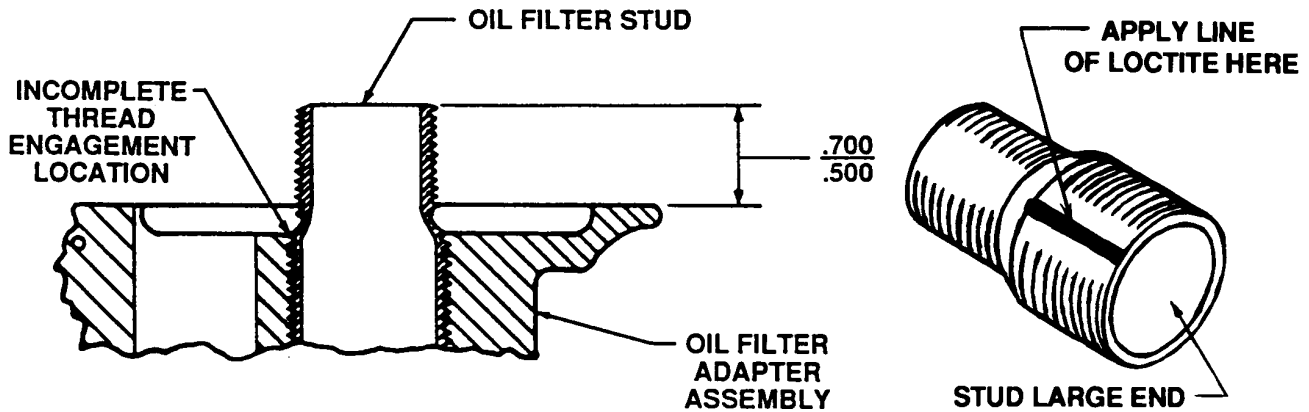


Figure 18-6
Oil Filter Adapter Stud Inspection

Adapter Stud Inspection."

- f. Allow the parts to cure for a minimum of thirty minutes prior to installation of the oil filter.

CAUTION...

Curing times may vary depending on ambient temperature. Consult Loctite instructions.

- g. After installation of a new oil filter adapter stud, stamp a .125" high letter "s" in the location shown in Figure 18-5 Stud Identification

Oil Pump

Malfunctioning oil pumps or oil pump components must be removed and discarded.

The oil pump may be removed in accordance with oil pump disassembly/reassembly instructions in the IO-520 Permold Series Overhaul Manual, Form No. OH-11.

Repairs other than smoothing nicks on parting surfaces, replacing studs and worn parts, and refacing the oil pressure relief valve seat on the oil pump housing are not possible.

The pump driven gear shaft is pressed into the pump housing and is not field replaceable. The pump gear chamber must not be enlarged. If it becomes scored, the pump housing must be discarded. Scoring on the gear contact area of the oil pump cover renders it unserviceable unless the parting surfaces can be lapped smooth and perfectly flat.

If required, replace oil pump housing studs in accordance with the IO-520 Permold Series Overhaul Manual, Form OH-11.

Oil Filter Adapter

Discard oil filter adapters that are cracked or that are worn beyond specified limits. Smooth small nicks on parting surface. No other repairs are possible.

Oil Sump

If the oil sump must be removed for repair or replacement, see the I0-520 Permold Series Overhaul Manual, Form OH-11. Any airframe components that obstruct removal must be removed in accordance with the airframe manufacturer's instructions.

Whenever the oil sump is removed, the oil suction tube screen must be cleaned and all lower internal hardware must be inspected for secure installation and safetying.

Discard any oil sump that is warped or cracked.

Oil Suction Tube

The outer suction tube to oil pump housing plug gasket can be removed and replaced.

To gain access to the oil suction tube assembly, the oil sump assembly must be removed.

Oil Cooler

The oil cooler or its components may be removed for replacement and repair in accordance with applicable portions of oil cooler disassembly/-reassembly instructions in the I0520 Permold Series Overhaul Manual, OH-11.

Oil Pressure Relief Valve

Cut safety wire, remove oil pressure relief valve, and inspect the plunger for scoring, nicks, and the conical face for roughening. Oil pressure relief valves with scoring, nicks, roughening of the conical face or that exceed the specified limits must be discarded and replaced with new. Inspect the oil pressure relief valve seat for scoring, nicks

or roughening. Seats with these indications must be refaced. Using the specified oil pressure relief spot facer, reface the pressure relief valve seat in the oil pump housing.

CAUTION...

Reface pressure relief valve seat using light finger pressure when turning refacing tool.

After the refacing procedure, the depth from the top of the oil pump housing to the seat face must not exceed the specified limit item (2) in Figure 18-7," Lubrication System Service Limits. "Oil pump housings exceeding specified limits must be discarded.

CAUTION...

Thoroughly clean oil pressure relief valve cavity after refacing procedure. All debris from the refacing procedure must be removed.

1. Reassemble serviceable or new relief valve housing and adjusting screw. Turn adjusting screw into housing about halfway.
2. Install new copper washer and nut.
3. Assemble plunger, spring, washer and slide into housing. Coat housing threads with TCM anti-seize lubricant.
4. Insure relief valve components are aligned and install in oil pump housing.
5. Torque housing to 240-260 inch pounds.
6. Safety wire oil pressure relief valve housing in accordance with chapter 9," Lockwire Procedure."
7. The engine oil pressure must be adjusted prior to release for return to service in accordance with Chapter 22, "Oil Pressure Adjustment."

Oil Temperature Control Valve

Remove the oil temperature control valve and inspect the valve seat for scoring, nicks, roughness or deterioration. Oil temperature control valves exhibiting any of these indications or that exceed specified limits must be discarded and replaced with new.

1. Reinstall serviceable or new oil temperature control valve using new gasket and torque to 440-460 inch pounds.
2. Safety wire oil temperature control valve housing in accordance with Chapter 9, "Lockwire Procedure."

Tach Drive Assembly

Repairs other than stud replacement, worn parts replacement, and stoning nicks on parting flanges are not possible. Discard tach drive assemblies that are cracked or worn beyond the specified limits. Replace studs in accordance with the I0520 Permold Series Overhaul Manual, Form OH-11.

When performing lubrication system component repairs prior to engine TBO, the following dimensional limits may be used.

CAUTION...

When performing dimensional inspection, the following "Service Limits" may be used. However, they are intended only as a guide for reuse during engine maintenance prior to major overhaul. Parts with dimensions or fits that exceed service limits must not be reused. Parts with values up to and including service limits may be reused. However, the PROXIMITY of the engine to its recommended overhaul time should be considered.

SERVICE LIMITS			
REF.	DESCRIPTION		SERVICE LIMIT
OIL PRESSURE RELIEF VALVE ASSEMBLY			
1.	Oil Pressure Relief Valve Adjusting Screw In Plunger	Diameter:	0.0070L
2.	Oil Pressure Relief Valve Seat In Housing	Depth:	1.060
OIL PRESSURE PUMP ASSEMBLY			
3.	Oil Pump Drive Gear In Pump Housing	Diameter:	0.0070L
4.	Oil Pump Drive Gear Shaft In Pump Housing	Diameter:	0.0045L
5.	Oil Pump Driven Gear To Driven Gearshaft	Diameter:	0.0040L
6.	Oil Pump Drive Gear In Pump Housing	End Clearance:	0.0050
7.	Oil Pump Driven Gear In Pump Housing	End Clearance:	0.0050
8.	① Oil Pump Drive Gear Shaft In Tach Drive Housing	Diameter:	0.0045L
9.	② Oil Pump Drive Gear Shaft In Tach Drive Housing	Diameter:	0.0045L
10.	① Oil Pump Drive Gear Shaft Pin In Bevel Gear	Diameter:	0.0040L
11.	② Oil Pump Drive Gear Shaft Pin In Bevel Gear	Diameter:	0.0040L
12.	Oil Pump Driven Gear In Pump Housing	Diameter:	0.0080L
13.	① Tach Drive Shaft In Tach Drive Housing	Diameter:	0.0045L
14.	② Tach Drive Shaft In Tach Drive Housing	Diameter:	0.0045L
15.	① Oil Seal In Tach Drive Housing	Diameter:	0.003L
16.	② Oil Seal In Tach Drive Housing	Diameter:	0.0065T
GEAR BACKLASH			
17.	Oil Pump Drive and Driven Gears	Backlash:	0.0160
18.	① Tach Drive and Driven Bevel Gears	Backlash:	0.0120
19.	② Tach Drive and Driven Bevel Gears	Backlash:	0.0120
SPRING TEST DATA			
20.	Oil Pressure Relief Valve Spring Compressed To 1.25 Inch Length	Load:	30 Lbs.
21.	Oil temperature control valve 0.090 inches min. travel at	Oil Temperature:	120°-170°
	Oil temperature control valve must close between	Oil Temperature:	168°-172°

① I0-520-B ② I0-520-A and C

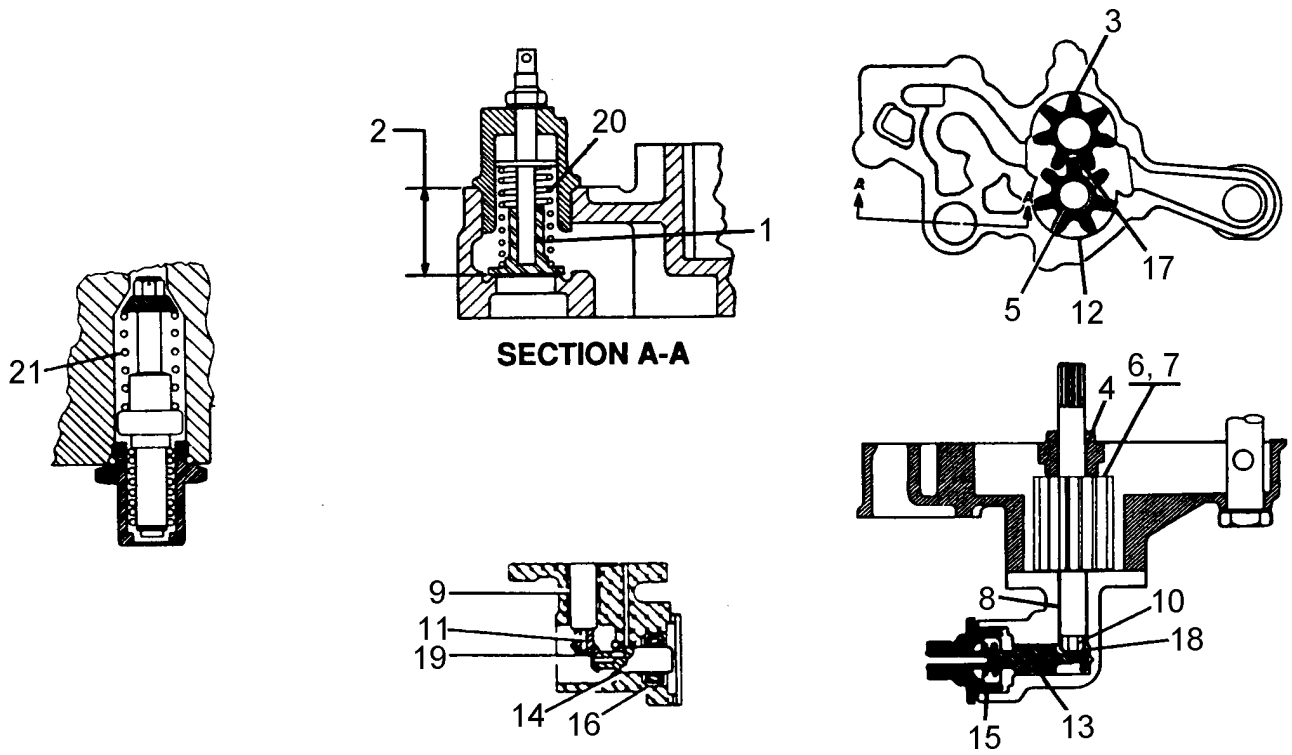


Figure 18-7
Lubrication System Service Limits

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Cylinder Assembly

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<i>Cylinders, Pistons and Overhead Drive Train</i>	19-4
<i>Cylinder Assembly Description IO-520-B, -BA, -BB, -C, -CB, -M, -MB</i>	19-5
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Cylinder Cooling

Cylinder cooling is accomplished by transferring heat from the cylinder barrel and head cooling fins to the surrounding airflow. Airframe engine cowlings and engine/airframe supplied baffles and baffle seals direct cooling airflow close and evenly around the cylinders. Controlling airflow in this manner contributes to uniform cylinder tempera-

tures. Cooling airflow is generated by air from the propeller and ram air induced by the aircraft's forward movement. This airflow is regulated by the size of the cooling air inlets and outlets. Increasing or decreasing outlet size with the use of airframe cowl flaps changes airflow and is used as an aid in controlling engine operating temperatures. Below is a general illustration showing engine cooling airflow.

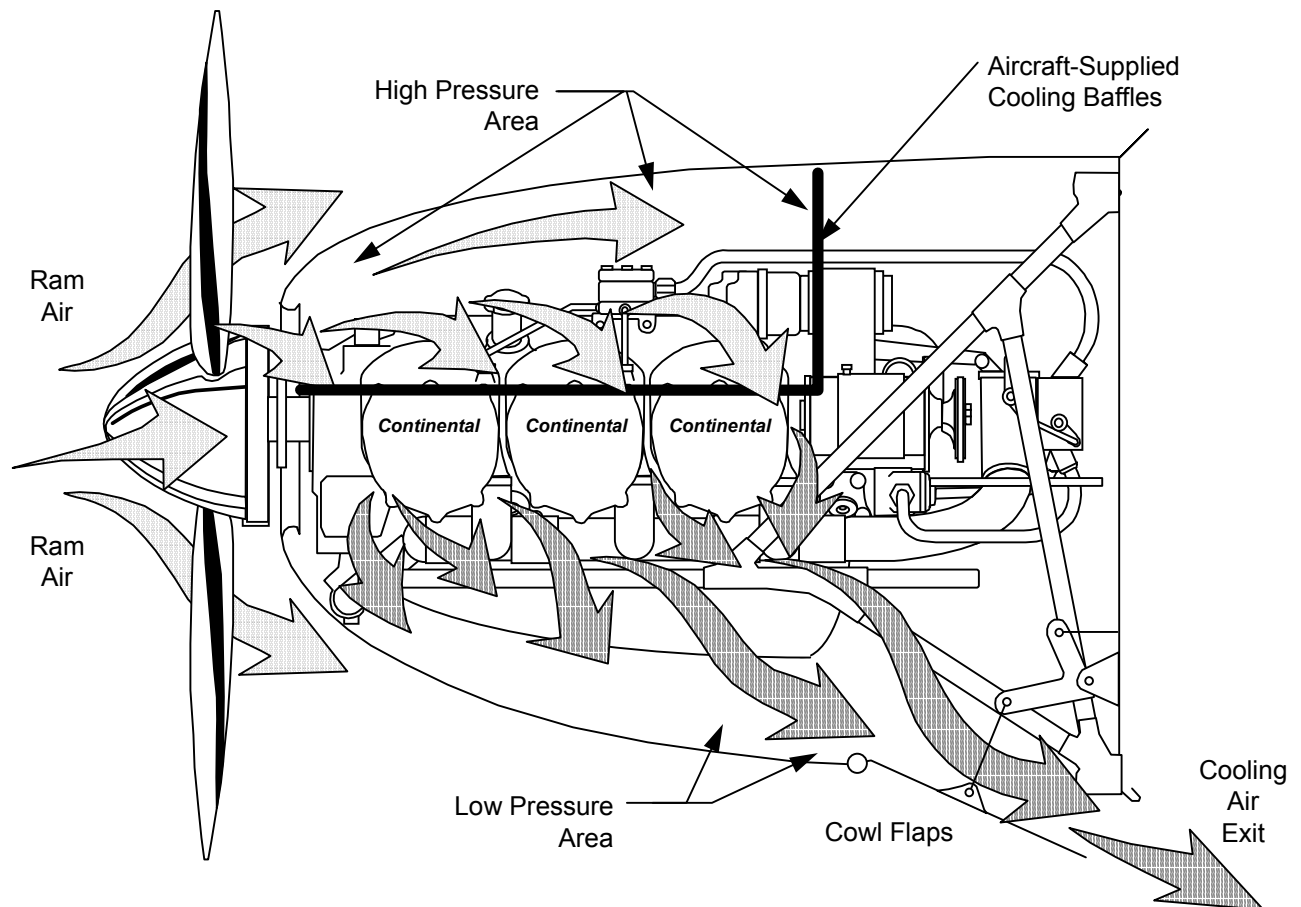


Figure 19-1
Engine Cooling Airflow

Cylinders, Pistons and Overhead Drive Train

The cylinders, pistons and overhead drive train are the portion of the engine that develop power. The cylinder combustion chamber provides a controlled area for burning fuel/air mixture and converting that heat energy into mechanical energy. Aviation fuel and air is drawn into a cylinder during the intake stroke, compressed by the piston during the compression stroke and then ignited by a high intensity spark produced across the spark plug electrode air gap during the power stroke. As the mixture is ignited, the expanding gases force the piston to move inward toward the crankshaft.

This inward motion acting on the connecting rod and crankshaft throw is converted into circular or

rotary motion by the crankshaft. As the crankshaft throw rotates past half of one revolution, the connecting rod and piston start moving outward on the exhaust stroke toward the cylinder head. During this movement, the exhaust valve begins to open allowing the burned mixture (exhaust) to escape. Momentum from the crankshaft forces the piston toward the cylinder head in preparation of the next intake stroke event.

Proper mechanical timing between the crankshaft and camshaft allows the intake and exhaust valves to open and close in synchronization with piston position in all six cylinders.

Proper magneto internal timing and magneto to engine mechanical timing allow precise spark plug ignition, $22^{\circ}\pm 1^{\circ}$ before top dead center, during the piston's compression stroke.

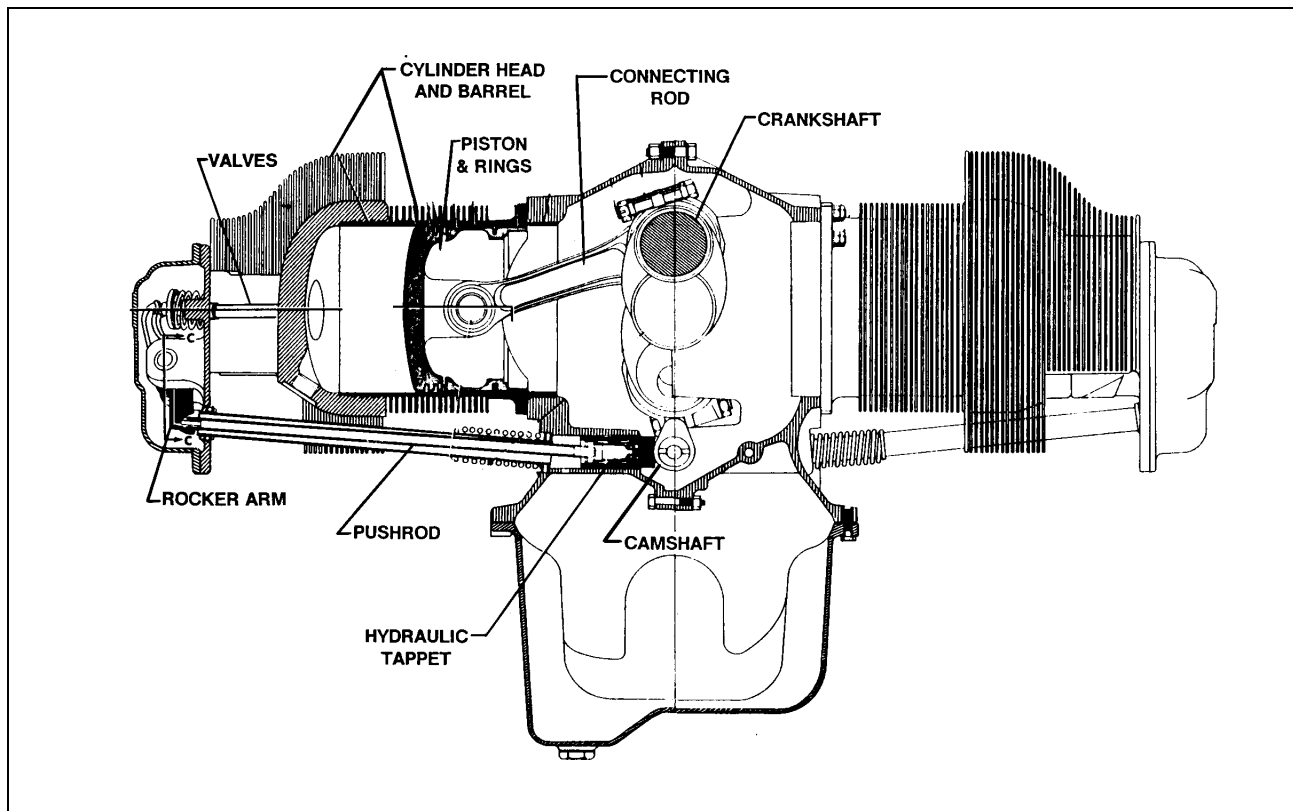


Figure 19-2
Cylinder, Piston, and Overhead Drive Train IO-520-B, -BA, -BB, -C, -CB, -M, -MB

Cylinder Assembly Description

Cylinder, Valve Guides, Valves, Rotocoil And Retainer - The externally finned aluminum alloy head castings are heated and valve seat inserts installed before the head is screwed and shrunk onto an externally finned steel alloy barrel to make the permanent head and barrel assembly. The cylinder barrel is nitrided for wear resistance. Intake and exhaust valve guides are pressed into the heated cylinder assembly. Special helical coil thread inserts are installed in upper and lower spark plug holes. The cylinder intake and exhaust ports are located

below the cylinder as installed. Exhaust valve faces are Stellite and stem tips are hardened. Valve stems are solid. A rotocoil assembly retains the two concentric springs surrounding the exhaust valve and is locked to the exhaust valve stem by tapered, semicircular keys which engage grooves around the stem. The controlled rotating action of this type retainer helps to prevent burning and eroding the valve and valve seat. A retainer retains the two concentric springs surrounding the intake valve and is locked to the intake valve stem by tapered, semicircular keys which engage grooves around the stem. Valve rocker covers are painted diecast aluminum.

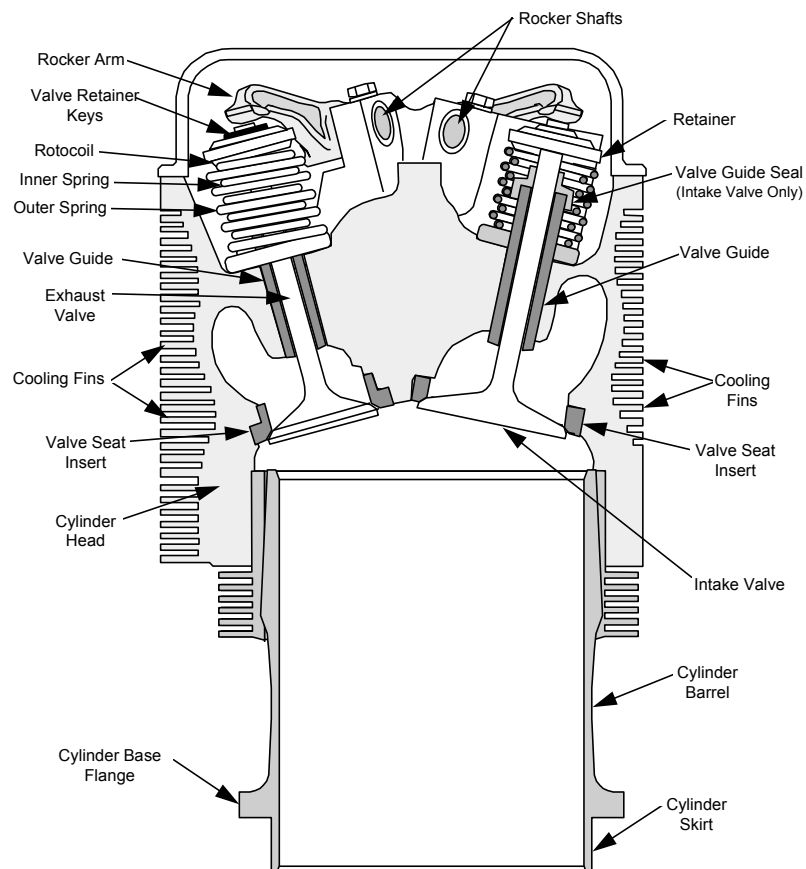


Figure 19-3
Cylinder Assembly Description IO-520-B, -BA, -BB, -C, -CB, -M, -MB

Piston

Pistons are aluminum alloy castings with a steel insert cast into the top ring groove. The skirts are solid and have cylindrical relief cuts at the bottom.

Pistons have three ring grooves above the pin hole and one ring groove below. Compression rings are installed in the top, and second grooves. The groove

below the pin hole contains an oil scraper. A center grooved and slotted oil control ring is installed in the third groove which has six oil drain holes to the interior. Weight differences are limited to 1/2 ounce or 14.175 grams in opposing bays. Piston pins are full floating with permanently pressed-in aluminum end plugs.

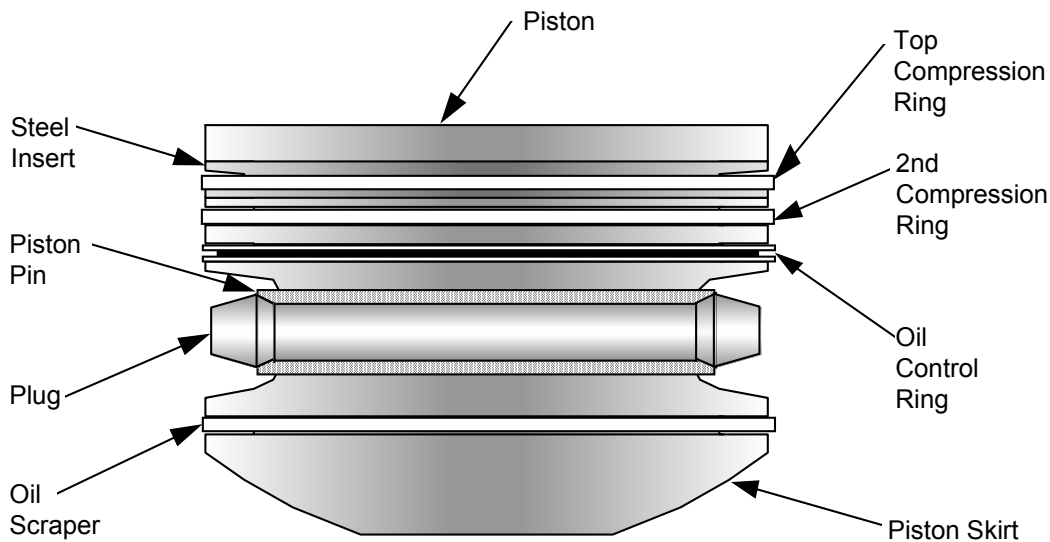


Figure 19-4
Piston Assembly

Valve Rockers, Shafts, Pushrods And Housings (Overhead Drive Train)

Valve rockers are steel forgings with hardened sockets, rocker faces and pressed in bronze bushings. They have a drilled oil passage for lubrication. The rocker shafts are held in place in

the rocker bosses by bolts and washers. Pushrods are constructed of steel tubes and pressed-in, hardened, forged steel ball ends, which are center drilled for oil passages. The pushrod housings are beaded steel tubes. The bead at the cylinder end retains washer, gasket and a second washer. The bead at the crankcase end retains a heavy spring, washer, packing ring and second washer.

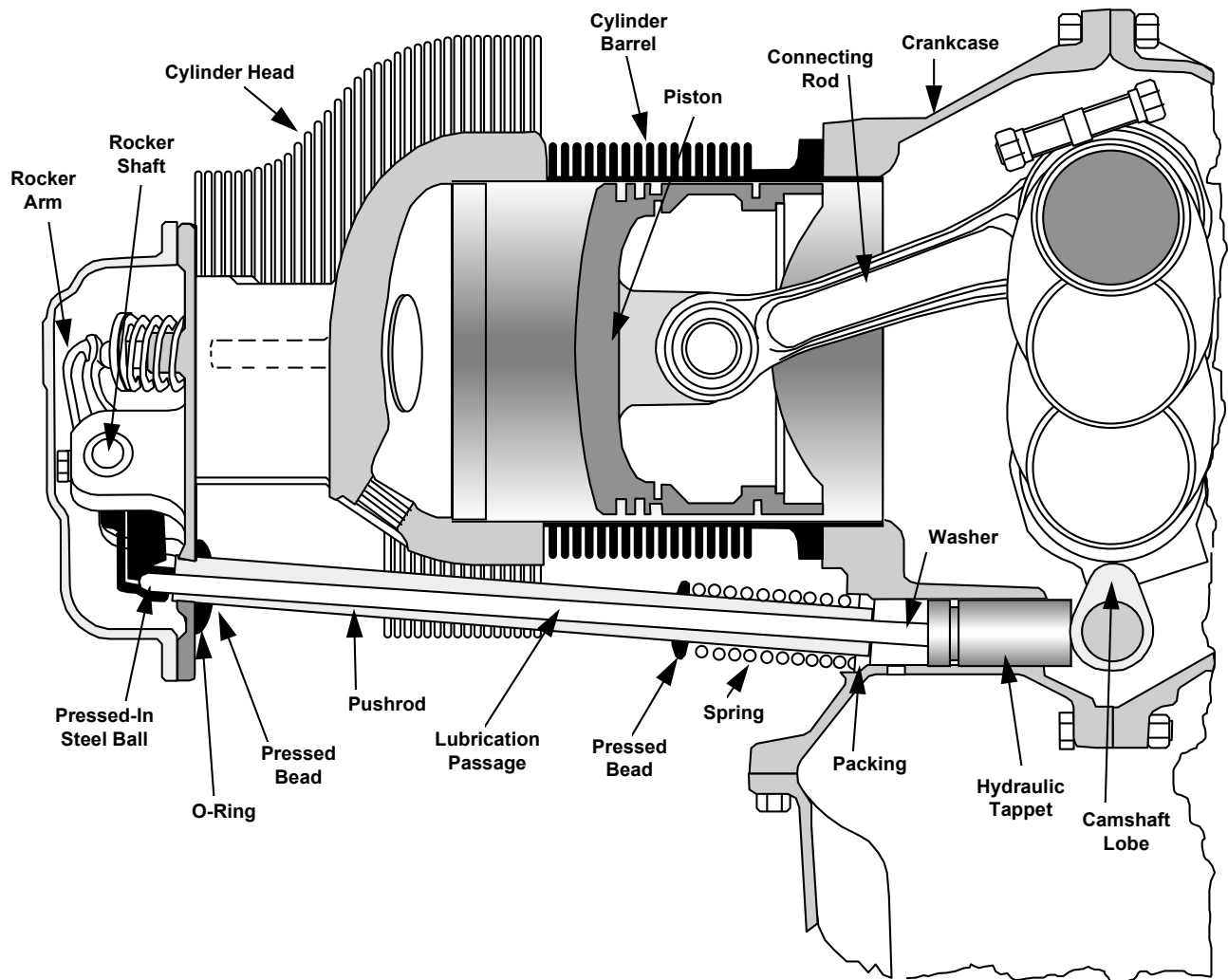


Figure 19-5
Overhead Drive Train IO-520-B, -BA, -BB, -C, -CB, -M, -MB

Hydraulic Tappet

See Figure 19-8. The barrel type hydraulic valve tappet consists of a steel body (1), an expanding spring (2), a check valve assembly (3, 4 and 5), a plunger (6), a socket (7) for pushrod end, and a retaining ring (8). A groove (9), around outside of the body picks up oil from the crankcase supply hole. From the exterior groove oil is directed to the interior body groove (11) through hole (10) and from the interior groove through the hole to the reservoir (12). Oil is withheld from reservoir (14) by check valve ball (5) which is supported by a

spring (4) in the housing (1). The check valve is opened by outward motion of the plunger under pressure of the expanding spring whenever a clearance occurs in the valve train. Thus the body reservoir is kept full of oil which transmits lifting force from the body of the plunger. The plunger and socket are selectively fitted to the body to permit a calibrated leakage so the lifter will readjust its effective length after each cycle while the cylinder valve is closed to return "lash" in valve train to zero. The barrel type hydraulic tappets may be removed and replaced without complete disassembly of the engine.

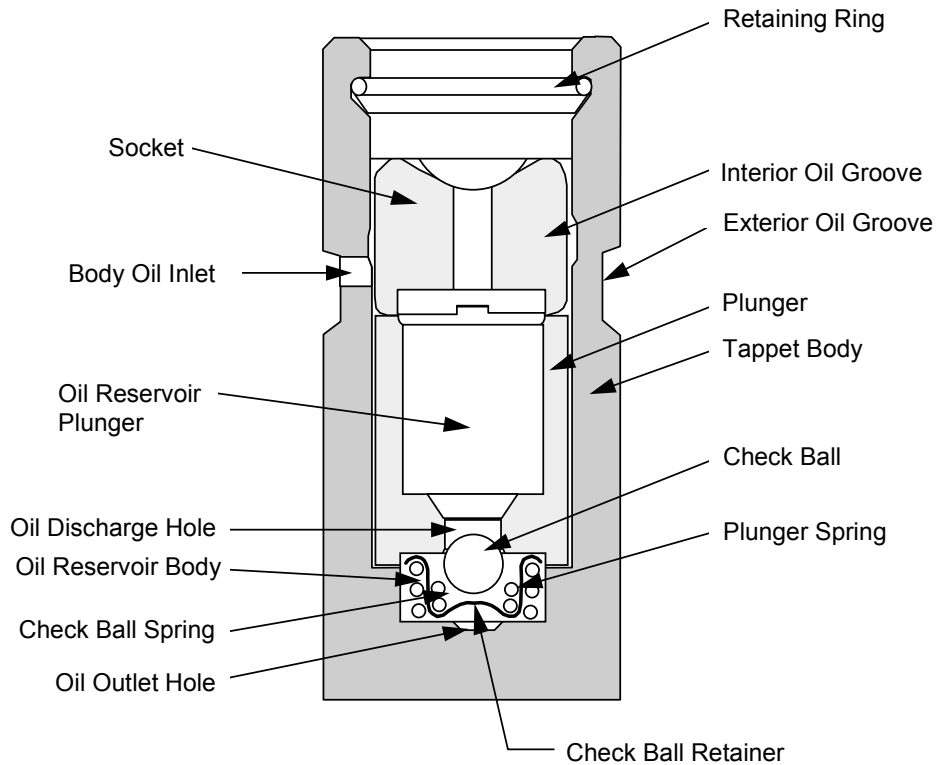


Figure 19-6
Hydraulic Tappet

Cylinder Assembly Maintenance

Cylinder Compression Test

The differential pressure test is an accepted method of determining cylinder condition by measuring air pressure loss past the pistons, rings and valves. The operation of the equipment is based on the principle that, for any given airflow through a fixed orifice, a constant pressure drop across that orifice will result.

The compression testing equipment must be calibrated and used in the proper manner to insure accurate results.

To accurately accomplish a leakage check, use the following information on leakage and use the Master Orifice tool to calibrate the leakage checking equipment used on Teledyne Continental engines.

Leakage Checks

Cylinder leakage is broken down into two areas of concern the "Static Seal" and the "Dynamic Seal."

Static Seal

The static seal consists of the valve to valve seat seals, spark plug to spark plug port seals and cylinder head to barrel seal. No leakage of the static seal is permissible.

Dynamic Seal

The dynamic seal consists of the piston rings to the cylinder wall seal. This seal leakage can vary from cylinder to cylinder, ring gap position, wear or the amount of engine oil on the cylinder wall.

Equipment

Testing equipment must be kept clean and checked periodically for accuracy as follows: using a line pressure of 100 to 120 pounds per square inch, close the cylinder pressure valve, then set the regulator pressure valve to 80 pounds per square inch. The pressure in both gauges should stabilize with no leakage.

The restrictor orifice dimension in the Master Orifice Tool for Teledyne Continental aircraft engines must be 0.040 inch orifice diameter, 0.250 inch long with 60° approach angle, and must flow 120 ± 5 cubic feet per hour at 30 pounds per square inch differential pressure.

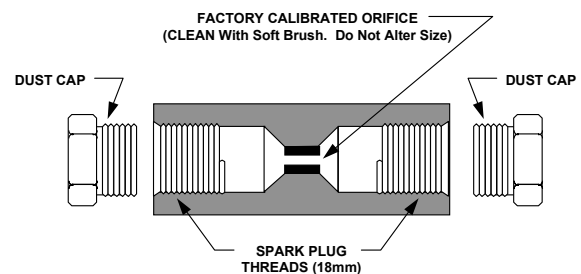


Figure 19-7
Master Orifice Tool

Master Orifice Tool

For conformity in testing equipment a Master Orifice Tool, Part Number 646953, is available to calibrate equipment and determine the low indicated leakage limit prior to the engine leakage check. Connect compressed air at 100 - 120 pounds per square inch to the tester with cylinder pressure valve closed. Turn the regulator pressure valve on, adjusting pressure to indicate 80 pounds per square inch. Remove the dust caps from both ends of the Master Orifice Tool and install onto a cylinder spark plug adapter. Turn the cylinder pressure valve on and readjust regulator pressure gauge to read 80 pounds per square inch. At this time the cylinder pressure gauge indication will be the low allowable limit for cylinder leak checks. The low allowable limit is referred to as the master orifice calibrated pressure reading. After the master orifice calibrated pressure reading has been recorded, close regulator pressure valve and remove Master Orifice Tool from the cylinder adapter. See the schematic diagram of a typical differential pressure tester shown below.

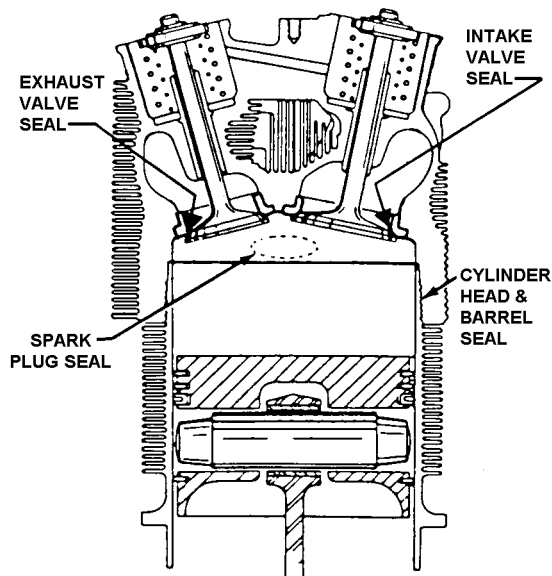


Figure 19-8
Static Seal

Performing The Check

The following procedures are listed to outline the principles involved, and are intended to supplement the manufacturer's instructions for the particular tester being utilized.

WARNING

To prevent possibility of serious bodily injury or death, before moving the propeller accomplish the following:

- a. **Disconnect all spark plug leads.**
- b. **Verify magneto switches are connected to magnetos, that they are in the "OFF" Position and "P" leads are grounded.**
- c. **Throttle position "CLOSED."**
- d. **Mixture control "IDLE-CUT-OFF."**
- e. **Set brakes and block aircraft wheels.**

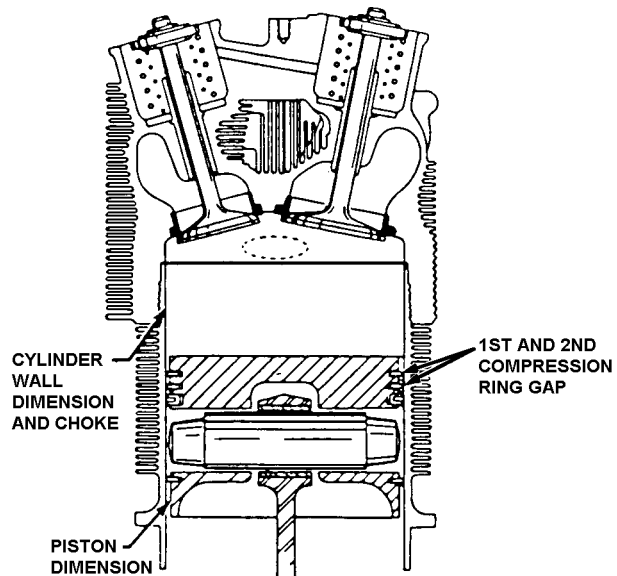


Figure 19-9
Dynamic Seal

- f. Insure that aircraft tie-downs are installed and verify that the cabin door latch is open.
- g. Do not stand within the arc of the propeller blades while turning the propeller.
 1. Perform the test as soon as possible after the engine is shut down to insure that the piston rings, cylinder walls, and other engine parts are well lubricated and at operating conditions.
 2. Turn the crankshaft by hand in the direction of rotation until the piston, in the cylinder being checked, is coming up on its compression stroke.
11. Install an adapter in the spark plug hole and connect the calibrated differential pressure tester to the adapter. (NOTE: Cylinder pressure valve is in the closed position.) Slowly open the cylinder pressure valve and pressurize the cylinder, not to exceed 20 psi. Continue rotating the engine against this pressure until the piston reaches top dead center. Reaching top dead center is indicated by a flat spot or sudden decrease in force required to turn the crankshaft. If the crankshaft is rotated too far, back up at least one-half revolution and start over again to eliminate the effect of backlash in the valve operating mechanism and to keep the piston rings seated on the lower ring lands. This is critical because the slightest movement breaks this piston ring sealing and allows the pressure to drop.

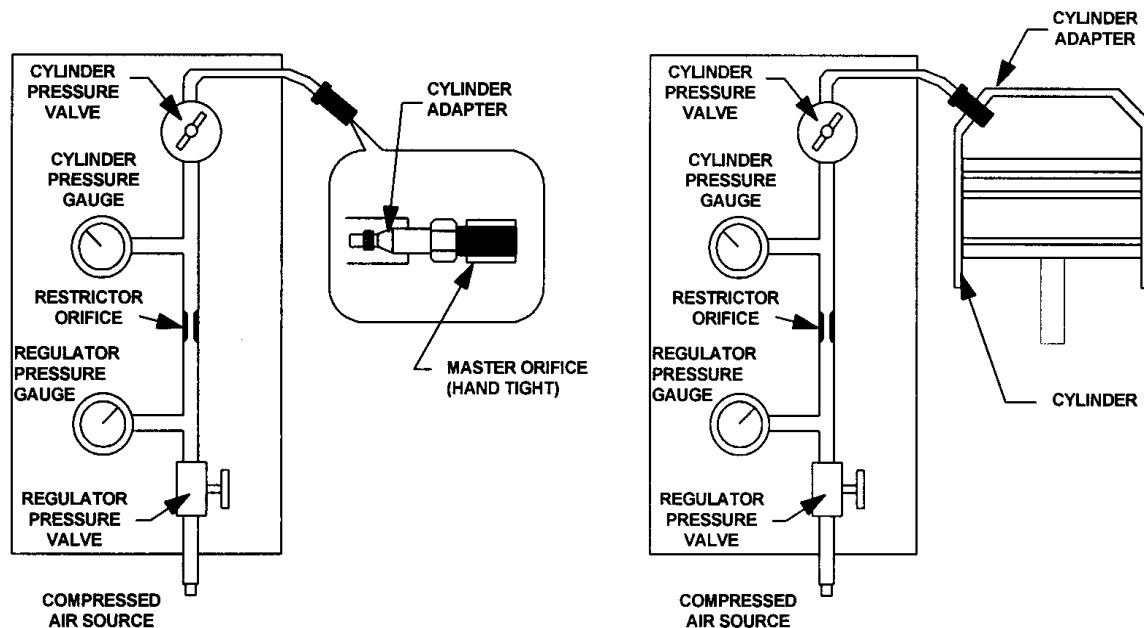


Figure 19-10
Differential Pressure Tester Calibration

WARNING

Care must be exercised in opening the cylinder pressure valve, since sufficient air pressure will be built up in the cylinder causing it to rotate the crankshaft if the piston is not at top dead center. The propeller must be secured during check to prevent rotation.

4. Open the cylinder pressure valve completely. Check the regulator pressure gauge and adjust, if necessary to 80 pounds per square inch.
5. Observe the pressure indication on the cylinder pressure gauge. The difference between this pressure and the pressure shown by the regulator pressure gauge is the amount of leakage through the cylinder. If the cylinder pressure gauge reading is higher than the previously determined master orifice calibrated pressure reading, proceed to the next cylinder and perform leak check. If the cylinder pressure gauge reading is lower, proceed with the following:

NOTE...

Document cylinder compression pressure.

6. Check the static seal for leakage (See Figure 19-8, "Static Seal"). Positive identification of static seal leakage is possible by listening for air flow sound at the exhaust or induction system port. When checking for cylinder head to barrel leakage, use a soapy solution at the cooling jacket to barrel junction and watch for bubbles. Use a soapy solution around both spark plug seals for leakage. **NO LEAKAGE IS ALLOWED IN STATIC SEALS.**
7. If leakage is occurring in the intake or exhaust valve areas, try staking the valves. Remove rocker covers from applicable cylinder. Place a fiber drift on the rocker arm directly over the valve stem and tap the drift several times with a hammer to dislodge any debris that may be

between the valve face and seat. If leakage by the valves cannot be corrected by, "staking," the cylinder must be removed for repair or replacement.

CAUTION...

When correcting a low reading in this manner, rotate the propeller so the piston will not be at top dead center. This is necessary to prevent the valve from striking the top of the piston in some engines. Rotate the propeller again before rechecking leakage to reset the valves in the normal manner. Do not allow the fiber drift to contact the valve spring retainer or rotocoil.

8. If leakage is noted between the cylinder head and barrel, **REPLACE THE CYLINDER**, (See Figure 19-9, "Dynamic Seal.")
9. To check the dynamic seal of a cylinder, proceed with the leakage test and observe the pressure indication of the cylinder pressure gauge. The difference between this pressure and the pressure shown by the regulator gauge is the amount of leakage at the dynamic seal.

WARNING

To prevent possibility of serious bodily injury or death, before moving the propeller accomplish the following:

- a. **Disconnect all spark plug leads.**
- b. **Verify magneto switches are connected to magnetos, that they are in the "OFF" Position and "P" leads are grounded .**
- c. **Throttle position "CLOSED."**
- d. **Mixture control "IDLE-CUT-OFF."**
- e. **Set brakes and block aircraft wheels. Insure that aircraft tie-**

Continued...

downs are installed and verify that the cabin door latch is open.

f. Do not stand within the arc of the propeller blades while turning the propeller.

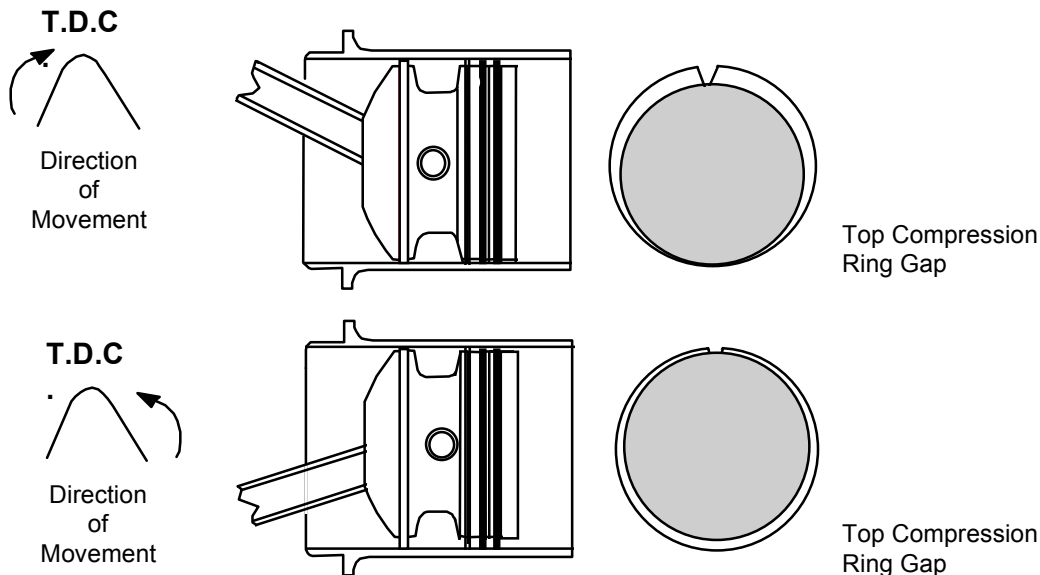
10. If the leakage is below the previously determined low cylinder gauge reading, loss past the dynamic seal may be due to piston ring end gap alignment or by the piston and piston rings angular direction in the cylinder bore. See Figure 19-13, "Ring Positioning." First insure that the piston and piston rings are centered. This can be accomplished by reducing regulator pressure to 20 pounds per square inch and working piston through top dead center several times bringing the piston to top dead center in the normal direction of engine rotation. Adjust regulated pressure to 80 pounds per square inch and determine amount of loss. If the gauge reading is higher than the previously determined master orifice calibrated reading, proceed to next cylinder to be tested.

NOTE:

Piston ring rotation within the ring land is a normal design characteristic. As illustrated in Figure 19-13, "Ring Positioning," the compression ring location may have a direct bearing on the dynamic seal pressure check. Therefore, complete the test in the opposite direction if readings are below prescribed limits.

11. If recheck of cylinder pressure gauge reading indication remains below allowable loss, engine may be run up to operating temperature and rechecked prior to cylinder being removed and repaired. Rework of cylinders must be accomplished in accordance with "Cylinder Assembly Repair And Replacement" in the I0-520 Permold Series Overhaul Manual, Form OH-11.

After cylinder compression test, if all cylinders are within specifications reinstall spark plugs and torque to 300-360 inch pounds.



*Figure 19-11
Ring Positioning*

Compression Test Troubleshooting

Use the following troubleshooting chart as a guide. Review the probable causes and other listings of problems that have similar symptoms. The probable causes are listed in order of “easiest to find” which is not necessarily in order of probability of occurrence.

First Check	Check For	Method	Discrepancy	① Corrective Action
Static seal (No leakage Permissible)	Intake valve to seat seal	Listen to air flow in intake port	Carbon Cracked cylinder Seat worn or burned Valve worn or burned	Stake valve Replace cylinder Reface or replace Reface or replace
	Exhaust valve to seat seal	Listen for air flow in exhaust port	Carbon Cracked cylinder Seat worn or burned Valve worn or burned	Stake valve Replace cylinder Reface or replace Replace
	Spark plug (2) to port seal	Apply soapy solution around spark plug	Loose helical coil Cracked cylinder	Replace helical coil Replace cylinder
	Cylinder head to barrel seal	Apply soapy solution between head and barrel	Bubbles	Replace cylinder
	Cylinder head cracks	Apply soapy solution around cylinder head area	Bubbles	Replace cylinder
Second Check	Check For	Method	Discrepancy	Corrective Action
Dynamic seal	Leakage by piston rings remove oil filler cap,	Test gauge below tolerance	Piston cracked or out of limits	Replace piston
	listen		Worn rings	Replace rings
			Cylinder wall dimensions out of limits	Replace cylinder
		Test gauge above tolerance	None	None

① Perform all corrective actions in accordance with “Cylinder Assembly Maintenance” in this chapter.

WARNING

Fuel injection lines must not be bent or deformed. The fuel injection lines must be securely clamped to the fuel line support brackets. Do not assemble in a binding configuration.

Single Cylinder Removal

Disconnect battery in accordance with the airframe manufacturer's instructions. Tag the propeller with the warning "DO NOT TURN PROPELLER." Remove cowling and any airframe supplied accessories in accordance with the airframe manufacturer's instructions. Remove cylinder using cylinder and piston removal instructions in the IO-520 Permold Series Overhaul Manual, Form OH-11.

NOTE...

When the cylinder is removed with the spark plugs installed, inspection can be accomplished by filling the inverted cylinder bore with nonflammable solvent and then inspected for leaks at the static seal areas.

When a cylinder is removed, use the following information below under "Pistons" to clean pistons prior to dimensional inspection.

Pistons

Do not use wire brushes or scrapers of any kind. Soft or hard carbon deposits may yield to solvent action. If deposits remain, install tight fitting skirt protector and blast the piston head with soft grit or by the vapor grit method. Do not use sand shot, metal grit or glass beads. Ring grooves must be cleaned by pulling lengths of binder twine or very narrow strips of crocus cloth through them. Do not use automotive ring grooves scrapers, since the corner radii at the bottoms of the grooves and side clearances must not be altered. Abrasive cloth must not be used on the piston skirts because the diameters and cam-ground contour must not be

altered. Scored or burned pistons must be discarded. After cleaning, thoroughly rinse pistons using a Stoddard solvent to remove all debris.

Rings

Piston rings must be replaced 100%.

Before any repair procedures are performed after cleaning, the cylinder and related components must be visually, fluorescent penetrant, and magnetic particle inspected as applicable in accordance with the IO-520 Overhaul Manual, Form OH-11.

Connecting Rods

Cylinders removed which have indications of:

- Burnt paint
 - Pistons with four point scoring
 - Erosion of the piston crown
1. Remove piston, piston pin and connecting rod in accordance with the IO-520 Permold Series Overhaul Manual, Form OH-11
 2. Remove piston pin bushing and inspect connecting rod in accordance with the IO-520 Permold Series Overhaul Manual, Form OH-11.
 3. Magnaflux all components in accordance with the IO-520 Permold Series Overhaul Manual, Form OH-11. Replace any part that does not conform with the inspection requirements of the overhaul manual.
 4. Replace piston pin bushing in accordance with the IO-520 Permold Series Overhaul Manual, Form OH-11.
 5. Install connecting rod in accordance with the IO-520 Permold Series Overhaul Manual, Form OH-11.
 6. Install **new** piston rings and piston pin in accordance with the IO-520 Permold Series Overhaul Manual, Form OH-11.

Single Cylinder Reassembly

After all cylinder components have been cleaned, inspected and repaired in accordance with TCM specifications, reassemble cylinder in accordance with "Cylinder and Piston Subassembly" of the IO-520 Permold Series Overhaul Manual, Form OH-11.

Single Cylinder Reinstallation

Reinstall repaired or new cylinder in accordance with the IO-520 Permold Series Overhaul Manual, Form OH-11. Loosely install spark plugs and gaskets in cylinder. Have an assistant hold nuts on opposite end of cylinder through bolts when torquing cylinder attaching hardware.

WARNING

Lubricate all cylinder deck stud and through bolt threads with clean 50-weight aviation oil. Failure to lubricate threads will result in incorrect fastener preloading and loss of main bearing crush, engine damage and possible failure.

Cylinder Torque Procedures

Cylinder torquing must be accomplished by two people to install and tighten cylinder attaching hardware.

The proper torque sequence for all cylinder applications requires a three-step torque process:

1. Torque cylinder base nuts to 50% of the rated value using the sequence shown in the applicable engine overhaul manual. Do not torque the cylinder through bolt nuts during this initial torque sequence.
2. Torque the cylinder through bolt nuts and cylinder base nuts in the sequence shown in the IO-520 Permold Series Overhaul Manual,

Form OH-11. Torque to the maximum value rated for the cylinder base nuts.

1. Torque the through bolt nuts to their maximum rated values in the applicable engine overhaul manual. Torque the 7th stud nut last as applicable.

Position numbers 1, 4

..... 790-810 (12 Point Nut)

..... 690-710 (6 Point Nut)

Position numbers

2,3,5,6,7,8,9,10 490-510

1/2 inch through bolts at

cadmium plated washers 615-635

NOTE...

When replacing less than a full set of six point nuts prior to overhaul the twelve point nut may be used and torqued to 690-710 inch pounds torque.

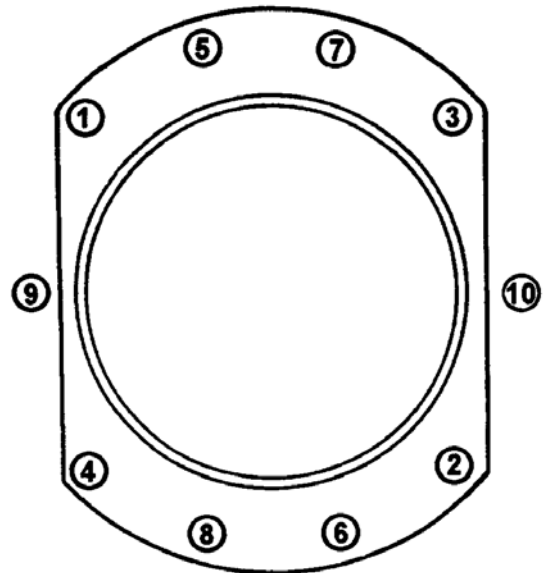


Figure 19-14
Single Cylinder Torque Sequence

Hydraulic Valve Tappets

Malfunctioning hydraulic valve tappets must be removed, discarded and replaced with new. Remove and replace tappets in accordance with the applicable instructions in the I0-520 Permold Series Overhaul Manual, Form OH-11.

Reinstall all valve train components that were removed using new o-rings, seals and gaskets in accordance with in the I0-520 Permold Series Overhaul Manual, Form OH-11. Rocker cover screws must be torqued to 45-55 inch pounds and safetied as required.

CAUTION...

When performing dimensional inspection the following "Service Limits" may be used. However, they are only intended as a guide for reuse when performing engine maintenance prior to major overhaul. Parts with dimensions or fits that exceed service limits must not be reused. Parts with values up to and including service limits may be re-used, however, judgment should be exercised considering the PROXIMI-TY of the engine to its recommended overhaul time.

When performing cylinder assembly repairs prior to engine TBO the following dimensional limits may be used.

CYLINDER ASSEMBLY SERVICE LIMITS IO-520-B, -BA, -BB, -C, -CB, -M, -MB		
REF.	DESCRIPTION	SERVICE LIMIT
CYLINDER ASSEMBLY		
1.	Cylinder bore (lower 4-1/4" of barrel) Diameter:	See Figure 19-16
2.	Cylinder bore choke (at 5.75" from open end of barrel) Taper:	See Figure 19-16
3.	Cylinder bore out-of-round :	0.0020
4.	① Cylinder bore Allowable Oversize:	See Figure 19-16
5.	Cylinder bore surface roughness (Nitride Barrels) using 180 grit stone, cross hatch Angle: Finish (in micro inches) R _a :	22° - 32° 30-50
6.	Cylinder barrel in crankcase Diameter:	0.0100L
7.	Intake valve seat insert in cylinder head Diameter:	0.012T
8.	Intake valve guide in cylinder head Diameter:	0.0025T
9.	Exhaust valve guide in cylinder head Diameter:	0.0030T
10.	Exhaust valve seat insert in cylinder head Diameter:	0.0100T
11.	Intake valve seat Width:	See Figure
12.	Exhaust valve seat Width:	See Figure
	Exhaust valve seat-to-valve guide axis Angle:	45°-00'
	Intake valve seat-to-valve guide axis Angle:	60°-15'
ROCKER ARMS AND SHAFTS		
13.	Rocker shaft in cylinder head bosses Diameter:	0.003L
14.	Rocker shaft in rocker arm bearing Diameter:	0.0040L
15.	Rocker arm bushing (inside) Finish Bore Diameter:	0.7515
16.	Rocker Arm Side Clearance:	0.0350L
17.	Intake valve in guide Diameter:	0.0050L
18.	Exhaust valve in guide Diameter:	0.0062L
19.	Intake valve face (to stem axis) Angle:	60°-15'
20.	Exhaust valve face (to stem axis) Angle:	45°-30'
21.	Intake valve face (gauge line) to stem Length:	4.714
22.	Exhaust valve Length:	Replace 100%
23.	Intake and exhaust valve seat-to-stem (full indicator reading) Run-out:	0.0040
24.	Rocker arm foot-to-valve stem (dry valve gear lash) :	0.2000

REF.	DESCRIPTION	SERVICE LIMIT
PISTONS, RINGS AND PINS		
25.	Piston (bottom of skirt) in cylinder	Diameter: 0.0110L
26.	Top piston ring in groove	Side Clearance: 0.006L
27.	Second piston ring in groove	Side Clearance: 0.006L
28.	Third piston ring in groove	Side Clearance: 0.0075L
29.	Fourth piston ring in groove	Side Clearance: 0.0100L
30.	Top ring gap at 1.00 ± .50 depth (in cylinder barrel)	Gap: 0.044
31.	② Second ring gap at 1.00 ± .50 depth (in cylinder barrel)	Gap: 0.050
32.	Third ring gap at 1.00 ± .50 depth (in cylinder barrel)	Gap: 0.036
33.	Fourth ring gap at 1.00 ± .50 depth (in cylinder barrel)	Gap: 0.031
34.	Piston pin in piston (standard or 0.005' oversize)	Diameter: 0.0015L
35.	Piston pin	Diameter: 1.1245
	Piston pin (0.005 oversize)	Diameter: 1.1295
36.	Piston pin in cylinder	End Clearance: 0.090L
37.	Piston pin in connecting rod bushing	Diameter: 0.0040L
38.	Bushing in connecting rod	Diameter: 0.0050T
39.	Bolt in connecting rod	Diameter: 0.0018L
40.	Connecting rod bearing on crankpin	Diameter: 0.0060L
41.	Connecting rod on crankpin	End Clearance: 0.0160
42.	Connecting bearing and bushing twist or convergence per inch of length:	0.0010
43.	Hydraulic tappet in crankcase	Diameter: 0.0035L
SPRING TEST DATA		
44.	Inner valve spring 631521 compressed to 1.230 in. length	Load: 82 Lbs.
	Inner valve spring 631521 compressed to 1.746 in. length	Load: 29 Lbs.
45.	Outer valve spring 637837 compressed to 1.275 in. length	Load: 118 Lbs.
	Outer valve spring 637837 compressed to 1.791 in. length	Load: 46 Lbs.
46.	Installed outer valve spring	Height: 1.791

NOTES: T=Tight L=Loose

① Use .005" oversize rings.

② Gap for second ring must be at least .006 larger than gap for top ring.
(See illustration on next page)

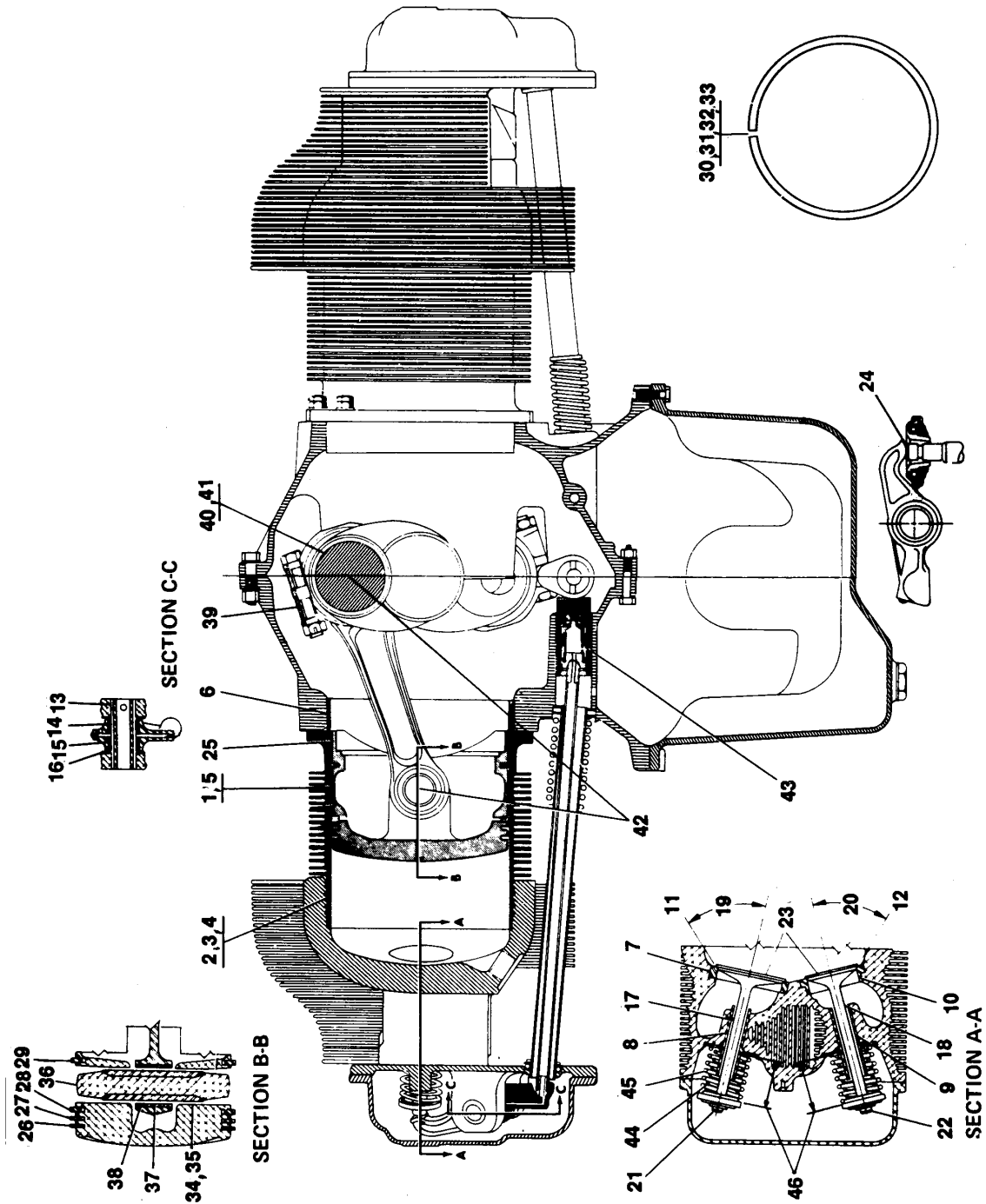
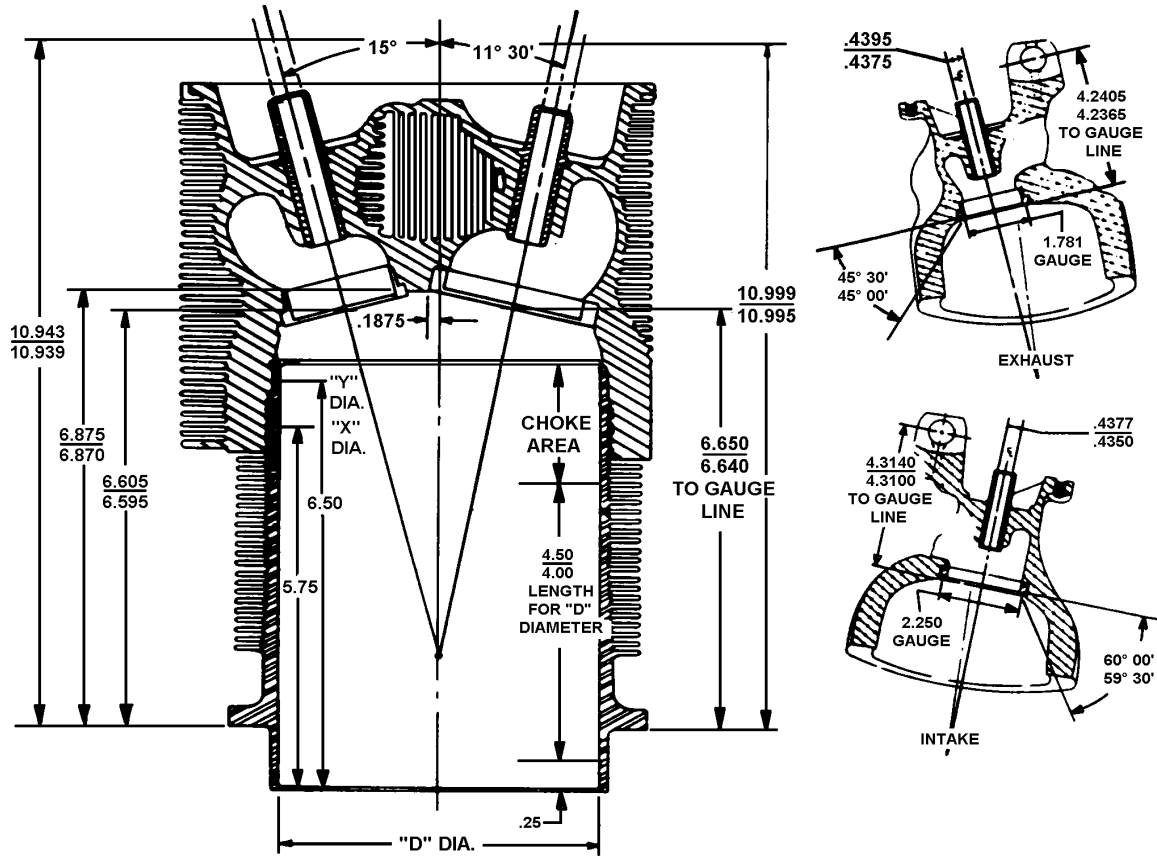


Figure 19-15
Cylinder Assembly Service Limits for IO-520-B, -BA, -C, -CB, -M, -MB



SIZE	"D" DIAMETER SERVICE LIMITS		"X" DIAMETER SERVICE LIMITS	
	MIN.	MAX.	MIN.	MAX.
STD.	5.254	5.256	5.255	5.257
.005	5.259	5.261	5.260	5.262
.010	5.264	5.266	5.265	5.267
.015	5.269	5.271	5.270	5.272

Note:

Dimensions shown are finish size after honing.

Cylinder bore out of round not to exceed (new) 0.002 (service) 0.003

Figure 19-16
Cylinder Assembly Service Limits for IO-520-B, -BA, -BB, -C, -CB, -M, -MB

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Crankcase

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Crankcase Description

The crankcase is the foundation of the engine. It supports the crankshaft, camshaft, various gears accessories, cylinders and various brackets. The crankcase provides a tight enclosure and oil galleries for lubrication. The crankcase is sufficiently rigid and strong to prevent misalignment of the crankshaft, camshaft and bearings. The crankcase is made of aluminum alloy.

Two aluminum alloy castings are joined along the vertical center plane to form the complete crankcase. The individual castings (with studs and inserts) will be referred to as the “left crankcase” and “right crankcase” throughout this chapter.

Bosses molded in the crankcase castings are line bored in the assembled castings to form bearings

for the camshaft and saddles for precision crankshaft main bearing inserts. Guides are bored through lateral bosses for hydraulic tappets and on the left crankcase half for the governor drive gear shaft. A needle bearing bore is located on the right crankcase half at the rear main bearing saddle for the starter adapter needle bearing.

Cylinder mounting pads on the left crankcase are farther forward than the corresponding pads on the right crankcase to permit each connecting rod to work on a separate crankpin. There are seven studs and two through bolts for attaching cylinder base flanges. The propeller governor mount pad is located on the left hand lower front corner of the left case half. On the right Permold crankcase an alternator pad is located at the front ahead of the #5 cylinder mount pad.

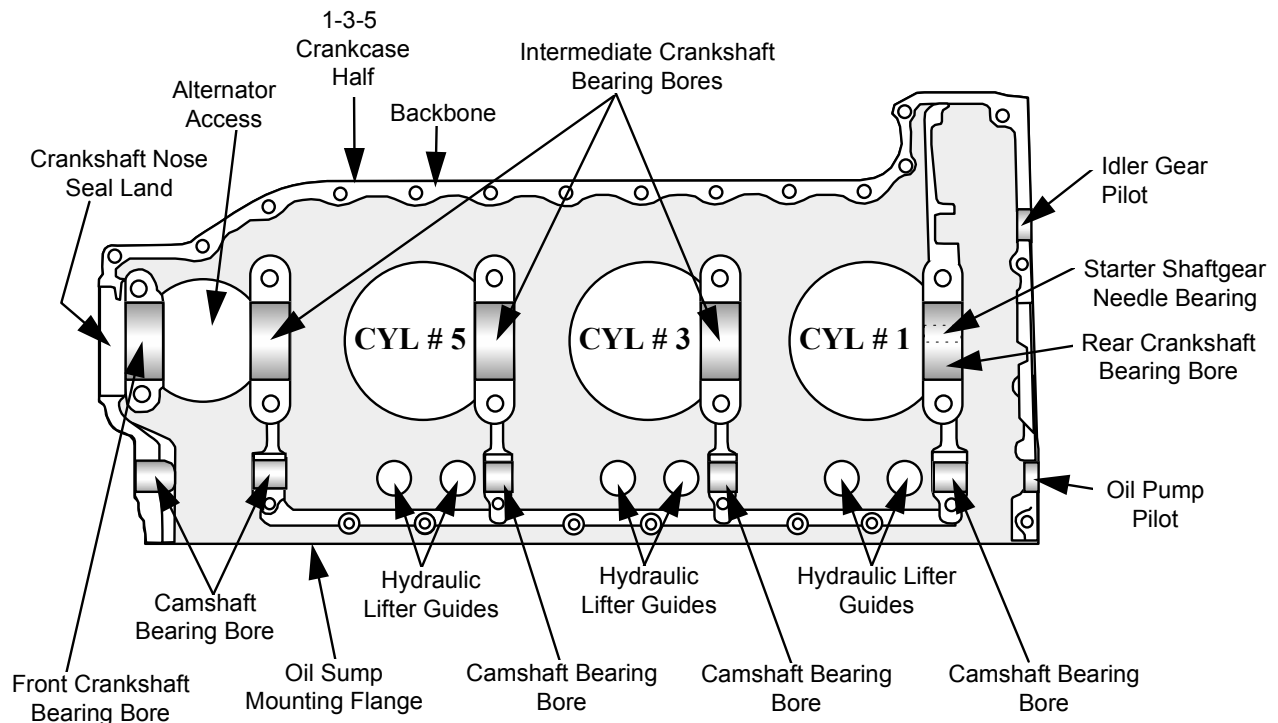


Figure 20-1
Crankcase

Crankcase Maintenance

Crankcase Cracks

Critical (white) and noncritical (shaded) areas are illustrated in Figure 20-3. If a crack is observed in any of the noncritical (shaded) areas that is less than two (2) inches in length, the crack should be scribe-marked at its extremities and reinspected for crack progression at the next 50 hours of operation. If no progression is observed and no additional cracks are found, continue to inspect at regular intervals not to exceed 100 hours of operation.

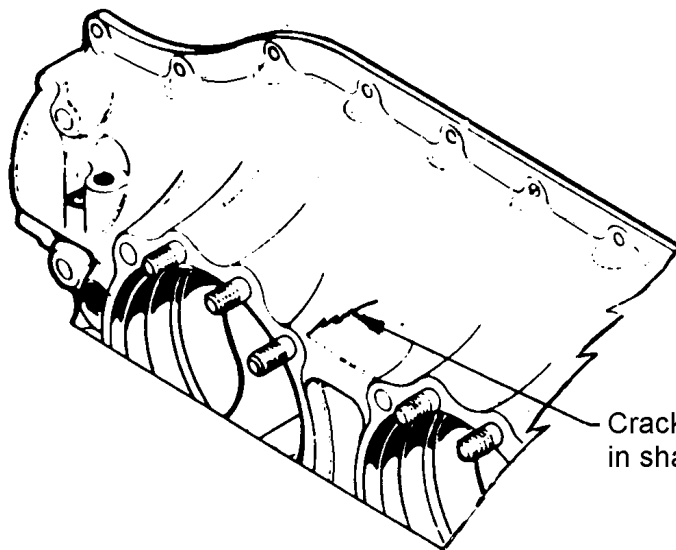
Critical Areas

If a crack is observed in any non-critical (shaded) area that is more than two (2) inches in length, or if a previously observed crack has progressed to two (2) or more inches in length, repair or replace the crankcase prior to further flight.

If any crack is observed in a critical (white) area, repair or replace the crankcase or engine prior to further flight.

Reasons for Crankcase Replacement

1. Any crack in the critical (white) areas.
2. Any crack two (2) inches or more in length in the noncritical (shaded) area.
3. Any crack that is leaking oil (not seeping) .



Cracks less than 2 inches in length and located in shaded areas as illustrated in Figure 17-2.

*Figure 20-2
Inspection of Crankcase Noncritical Area*

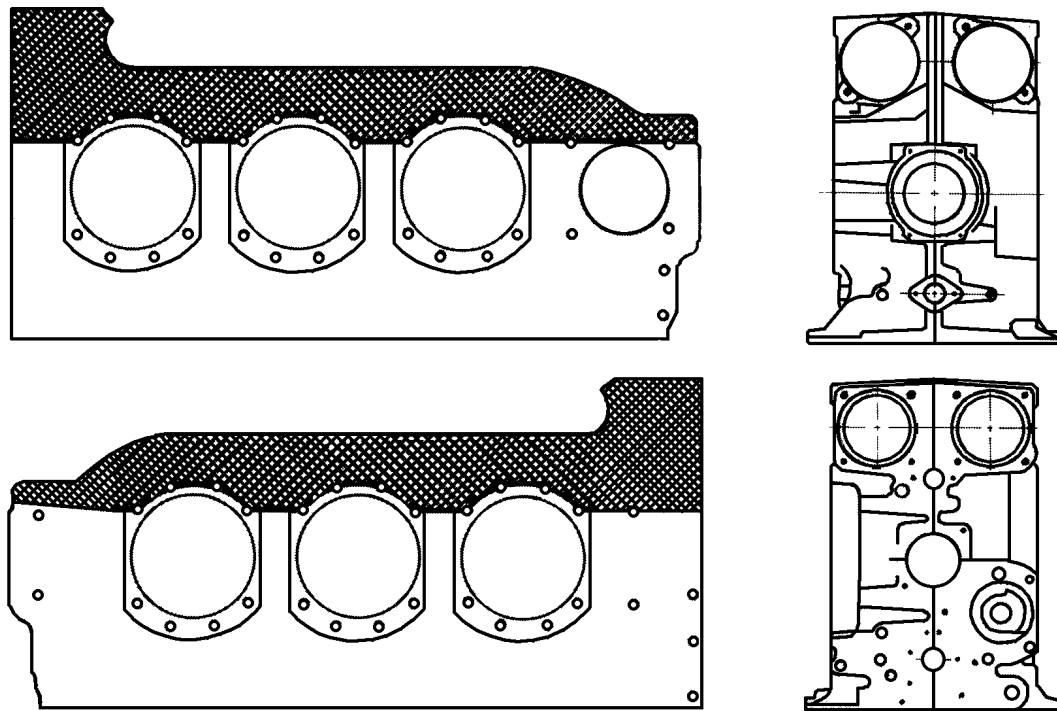


Figure 20-3
Critical (Clear) Areas and Noncritical (Shaded) Areas of the Crankcase

CAUTION...

Repair of the crankcase must be performed by repair facilities certified to perform specialized crankcase repairs.

WARNING

Weld repairs must not be performed in the critical (clear) areas of the crankcase as shown in Figure 20-3.

TCM has established that welding of the crankcase is an acceptable repair process. The weld procedure must conform with approved TCM repair standards and the dimensional integrity of the crankcase must be maintained.

Crankcase Gaskets

Leaking gaskets must be replaced. Remove component, install new gasket and reinstall component in accordance with applicable system or component section in the I0-520 Permold Series Overhaul Manual, Form OH-11. Exercise judgment as to the extent of disassembly required. During reassembly, insure that all reinstalled components are properly torqued and safetied.

Crankcase Studs

The replacement of crankcase studs or helical coils require component removal and replacement in accordance with the applicable component system section in the I0-520 Permold Series Overhaul Manual, Form OH-11. During reassembly, insure

that all reinstalled components are properly torqued and safetied .

Engine Mounts

Replace engine shock mounts in accordance with the airframe manufacturer's instructions. Replace any cracked or broken engine mounts in accordance with in the I0-520 Permold Series Overhaul Manual, Form OH-11.

CAUTION...

When relieving engine weight from the airframe, the engine hoist must be attached to the engine lifting eyes only.

NOTE...

Place a support at the load bearing area of aircraft tail to prevent damage to the airframe.

Crankcase Separation

If the crankcase halves must be separated, remove the engine from airframe in accordance with the I0-520 Permold Series Overhaul Manual, Form OH-11 and the airframe manufacturer's instructions. Engine disassembly, cleaning, inspection, repair, replacement and assembly must be accomplished in accordance with the I0-520 Permold Series Overhaul Manual, Form OH-11.

NOTE...

Exercise judgment in determining how far systems and components should be disassembled.

Any maintenance of engine systems and components removed from engine must be performed in accordance with that particular system or component chapter of this manual.

CAUTION...

Dimensional inspection of the crankcase and crankcase internal components must be performed in accordance with the I0-520 Permold Series Overhaul Manual, Form OH-11. Prior to dimensional inspection, insure that the part conforms with all visual,

fluorescent penetrant, magnetic particle or ultrasonic inspection requirements.

All crankcase repairs must be performed in accordance with the I0-520 Permold Series Overhaul Manual, Form OH-11. Any accessory not supplied by TCM that was disassembled for maintenance must be reassembled in accordance with the applicable accessory manufacturer's instructions. Any maintenance involving crankcase separation will require an acceptance test, oil consumption determination, reinstallation in airframe and test flight in accordance with the I0-520 Permold Series Overhaul Manual, Form OH-11.

Crankcase/Starter Needle Bearing Installation

If a new crankcase needle bearing has to be installed in the engine prior to overhaul, use a modified needle bearing tool and fixture shown in Figures 20-4 and 20-5 on the following page. Replace the needle bearing in accordance with the I0-520 Permold Series Overhaul Manual, Form OH-11.

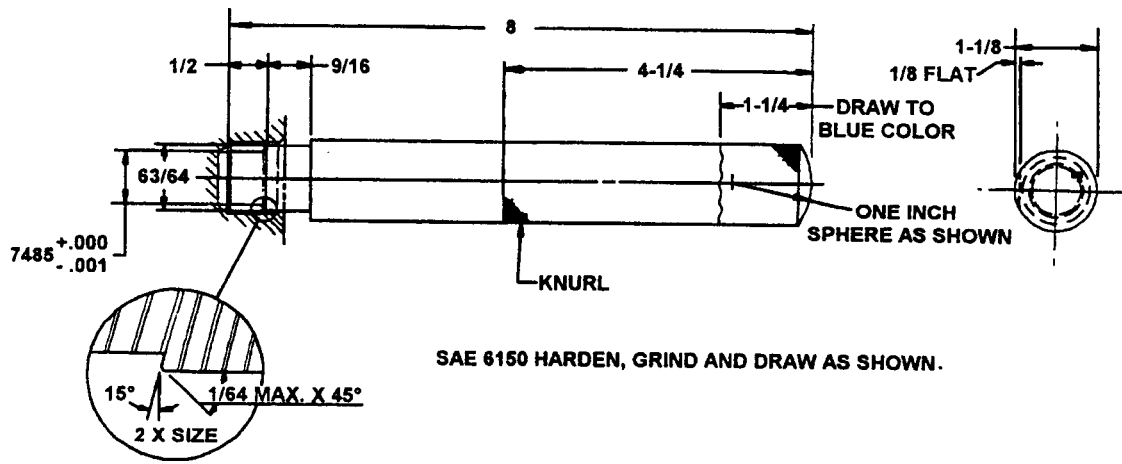


Figure 20-4
Crankcase Needle Bearing Installer

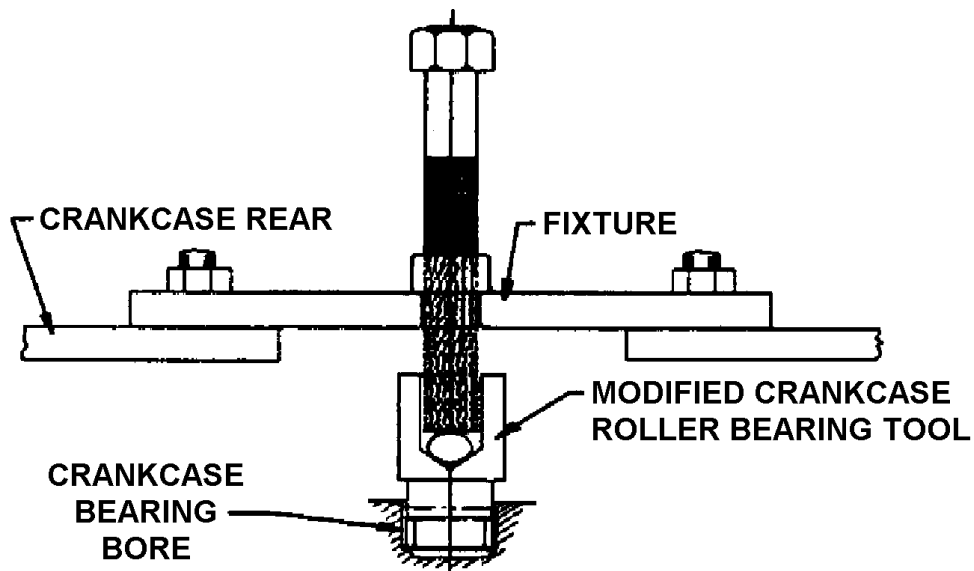


Figure 20-5
Modified Crankcase Needle Bearing Tool

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Engine Drive Train

<i>Engine Drive Train</i>	21-3
<i>Crankshaft</i>	21-5
<i>Connecting Rod</i>	21-6
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<i>Oil Seal Installation</i>	21-10
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Engine Drive Train

When starting engine, torque is transmitted from the starter (13) through starter adapter components (14 through 19) to crankshaft gear (1). As worm-wheel (17) is turned, the spring mounted on its hub, is tightened to grip the shaftgear (18) drum. After engine is started the spring returns to its normal position releasing the shaftgear and disengaging the starter. Torque is transmitted to the alternator by a face gear (21) mounted on the crankshaft. Torque from the crankshaft (2) is transmitted by the crankshaft gear (1) directly to the idler gear (10) and the camshaft gear (3).

The idler gear, rotating in a counterclockwise direction, drives the magneto drive gears (11, 12). Optional accessories mounted on the crankcase upper rear are driven by internal splines of magneto drive gears.

The fuel pump coupling is driven directly from the crankshaft gear (1). The splined end of the oil pump drive gear (8) mates with the internal splines of the camshaft gear and transmits torque to the oil pump driven gear (9). The governor drive bevel gear (6) is keyed to the camshaft (4) and meshes with and drives the governor drive bevel gear (7).

Shown below are the accessory gear to crankshaft gear drive ratios. The item numbers correspond with those shown in Figure 21-1, "Engine Drive Train"

ITEM	DESCRIPTION	GEAR RATIO
1.	Crankshafts Gears.....	1:1
2.	Crankshaft.....	1
3.	Camshaft Gear.....	1:0.5
4.	Camshaft.....	1:0.5
5.	Hydraulic Tappet.....	—
6.	Governor Drive Bevel Gear.....	1:0.5
7.	Governor Driven Bevel Gear.....	1:1
8.	Oil Pump Drive Shaftgear.....	1:0.5
9.	Oil Pump Driven Gear.....	1:0.5
10.	Idler Gear Assembly.....	1:0.652
11.	Right Magneto Drive Gear.....	1:1.5
12.	Left Magneto Drive Gear.....	1:1.5
13.	Starter.....	48:1
14.	Starter Coupling.....	—
15.	Worm Drive Shaft.....	48:1
16.	Starter Worm Gear.....	48:1
17.	Starter Worm Wheel.....	3:1
18.	Starter Shaftgear.....	3:1
19.	Alternator.....	3:1
20.	Alternator Driven Gear.....	3:1
21.	Alternator Drive Gear.....	1:1

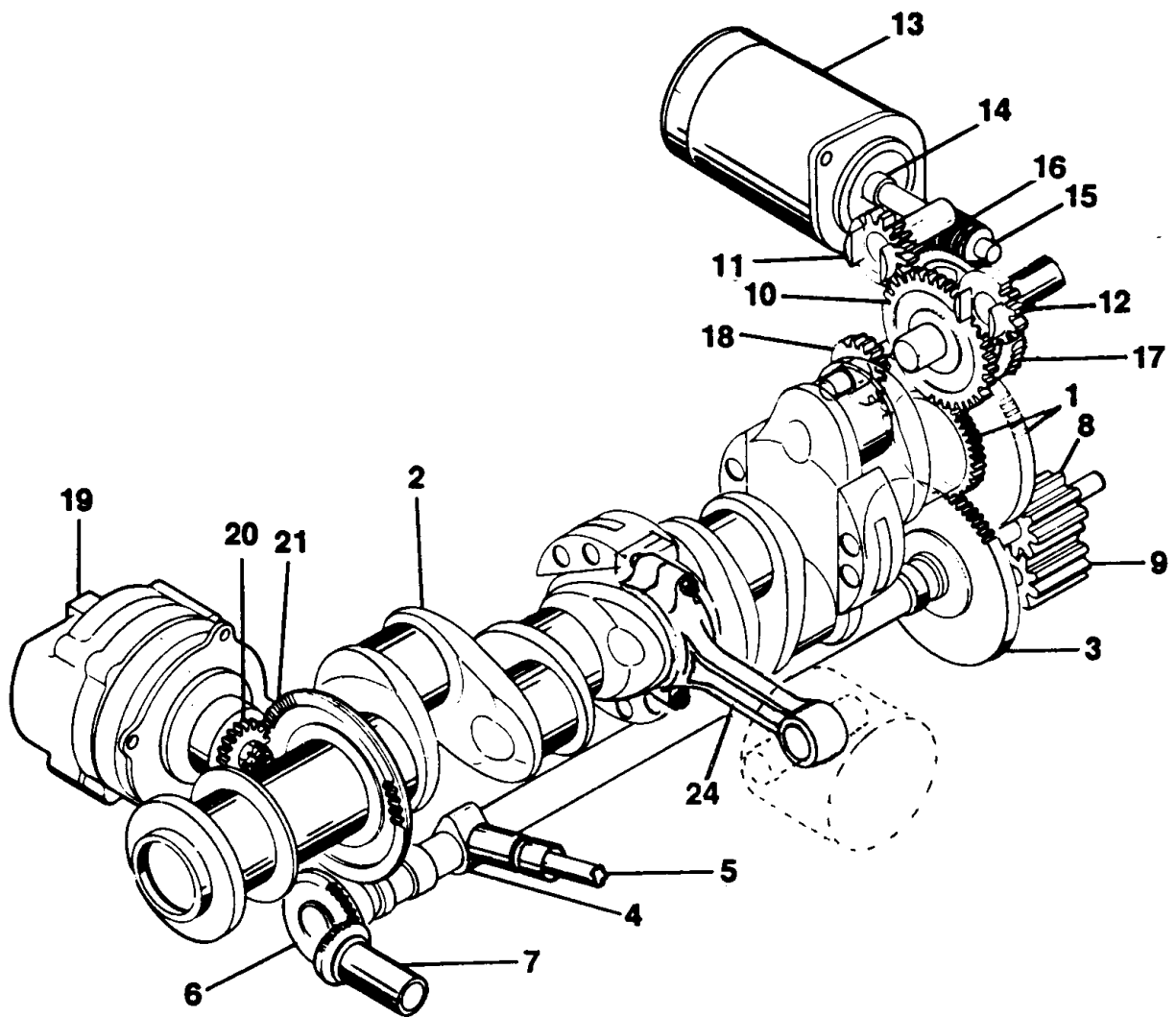


Figure 21-1
Engine Drive Train

Crankshaft

The crankshaft is made of aircraft quality steel. The crankshaft has five, machined, main journals which rotate on the bearings in the crankcase. Six, machined, rod journals provide for attachment of the connecting rod assemblies.

The following shows the method of numbering the crankshaft main journals, connecting rod journals and crankshaft cheeks which are identified by letters and location numbers.

The method of numbering the crankshaft journals and cheeks is illustrated in Figure 21-2. Main journals, rod journals, and crankshaft cheeks are identified by letters and location numbers.

- (a) Main Journal - M.J.
- (b) Rod Journal - R.J.
- (c) Crankshaft Cheek - C.C.

Counterweights are supplied in matched pairs with the bushings installed. This is necessary to insure that their weight difference does not exceed 2 grams.

The counterweight order number designates the vibration order the counterweight is absorbing. If a vibration occurs six times per revolution, the counterweight which has been tuned to counteract this frequency of vibration is a 6th order counterweight. Similarly, if a vibration occurs five times per revolution, the counteracting counterweight is a 5th order counterweight.

On IO-520 Permold engine crankshafts (except IO-520-BA) two sixth order counterweights are installed on the #2 cheek hangers. The #5 cheek hangers support one fifth and one fourth order counterweight. On the IO-520-BA engine crankshaft, two sixth order counterweights are installed on the #2 cheek hangers. The #5 cheek hangers support one sixth and one 4th order counterweight. It does not matter on which side of a cheek a particular counterweight is installed.

The crankshaft gear is heated prior to installation to obtain a shrink fit. The gear is positioned on the crankshaft by a dowel pin. The crankshaft gear incorporates a square drive hole that accepts the

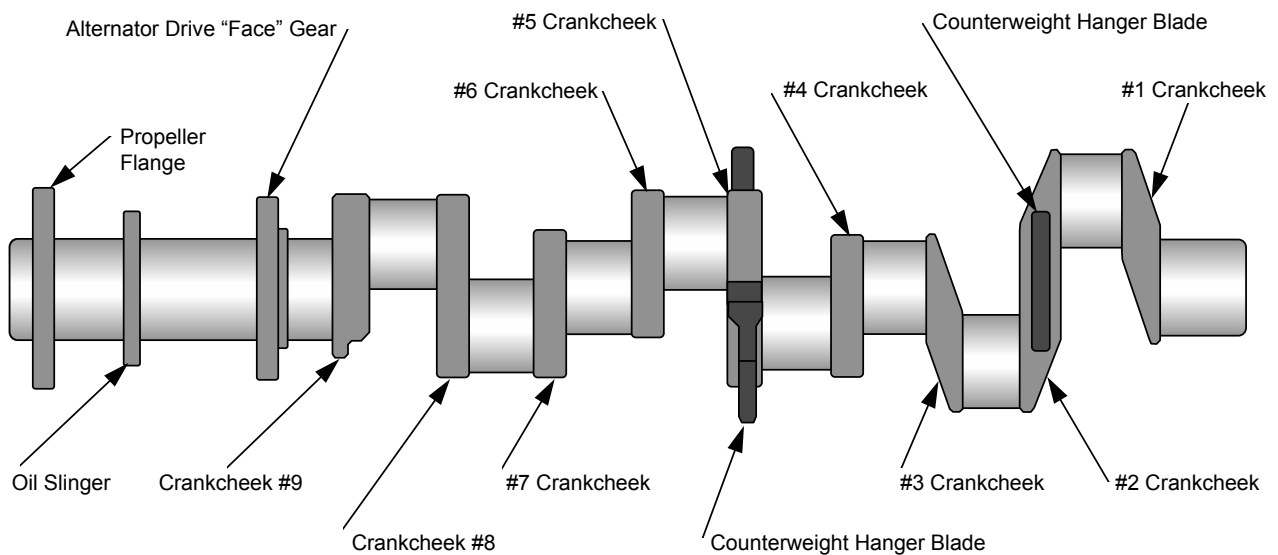


Figure 21-2
Crankshaft

square drive fuel pump coupling providing a direct drive for the fuel pump. The gear also has a timing mark to provide a means of insuring correct crankshaft to camshaft timing.

The alternator drive gear, is attached to the flange just behind the #5 main journal location at the front of the crankshaft and is secured by four bolts and lockplates.

A neoprene oil seal, which is stretched over the crankshaft flange, and a split retainer ring are seated between the crankcase castings in the front shaft exit area and is sealed to the crankshaft by a helical spring inside the seal's cavity.

Connecting Rod

Connecting rods are made of aircraft quality steel. The plain type connecting rod large diameter end, which attaches to the crankshaft crankpin or rod journal, is fitted with a cap and two-piece bearing. The bearing cap is held to the main rod by two bolts and either spiral lock nuts or pinned castellated nuts.

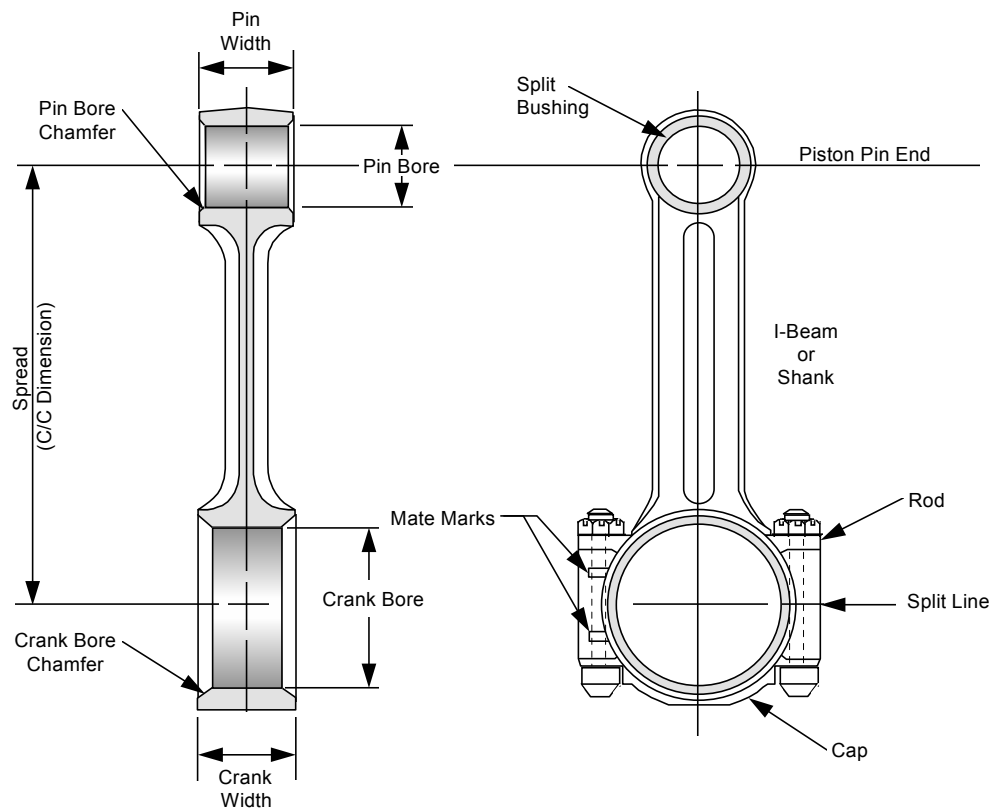


Figure 21-3
Connecting Rod Description

The portion of the rod between the crankpin and piston pin ends is called the “I beam.” A split steel backed bronze bushing is pressed into the piston pin end and machined for a precision pin to bushing fit. Weight variation of connecting rods between opposing bays. Example: #5 and #6 connecting rods, is limited to 1/2 ounce or 14.175 grams.

Camshaft

The camshaft is made of aircraft quality steel. The forging is machined on four (4) main journals, nine cam lobes and the gear mount flange at the rear of the camshaft. The main journals ride within the crankcase camshaft bores. The hydraulic

tappet movement inward and outward in their bores is caused by the eccentric shape of the cam lobes. The lobes and journals are ground and hardened. Movement of the tappets open and close the intake and exhaust valves within the cylinder head by mechanical linkage of the pushrods and rocker arms. The valves opening and closing is synchronized with piston position due to timing of the camshaft and crankshaft gears. Four unequally spaced bolts retaining the gear to the camshaft insure proper positioning, locating the gear’s timing mark in relation to the cam lobes. The camshaft gear incorporates a splined drive for driving the engine oil pump. A front mounted bevel gear drives the prop governor bevel gear.

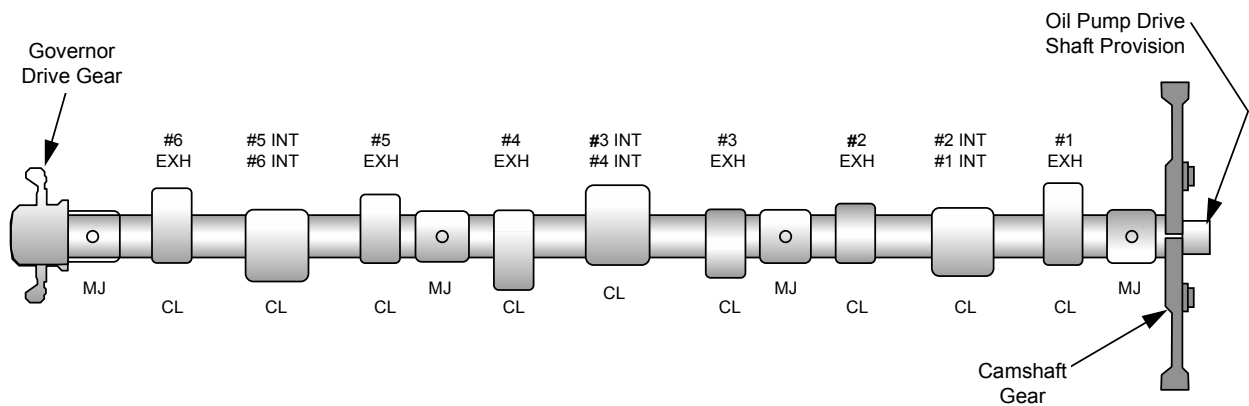


Figure 21-4
Camshaft

Idler Gear

The idler gear support pin supports the idler gear. The bushing in the crankcase supports the forward part of the idler gear support pin shaft. The idler gear is driven directly by the crankshaft. The idler gear drives the left and right magneto accessory drive gears.

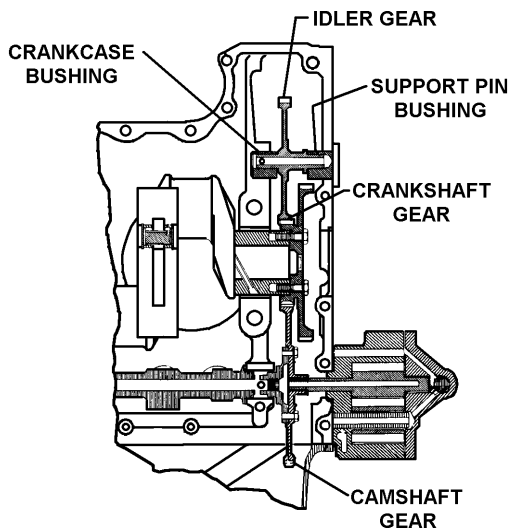


Figure 21-5
Idler Gear

Engine Drive Train Maintenance

Crankshaft Nose Oil Seal

The crankshaft nose oil seal may be replaced according to the following instructions:

WARNING

To prevent starting of engine before moving the crankshaft, accomplish the following:

- a. Disconnect all spark plug leads.
- b. Verify magneto switches are connected to magnetos, that they are in the "OFF" Position and "P" leads are grounded.
- c. Throttle position "CLOSED."
- d. Mixture control "IDLE-CUT-OFF."
- e. Set brakes and block aircraft wheels.
- f. Insure that aircraft tie-downs are installed and verify that the cabin door latch is open.
- g. Do not stand within the arc of the propeller blades while turning the propeller.

Preparation

1. Remove oil seal.
2. Clean surfaces thoroughly making certain that no debris remains on the shaft or in the seal counterbore. Wash seal area with solvent.
3. Remove any plating in the one inch area shown in Figure 21-6, "Helix Pattern Application." Remove plating by working a piece of very fine emery cloth back and forth around the shaft. This should blend the finish uniformly without leaving any lines (scratches).

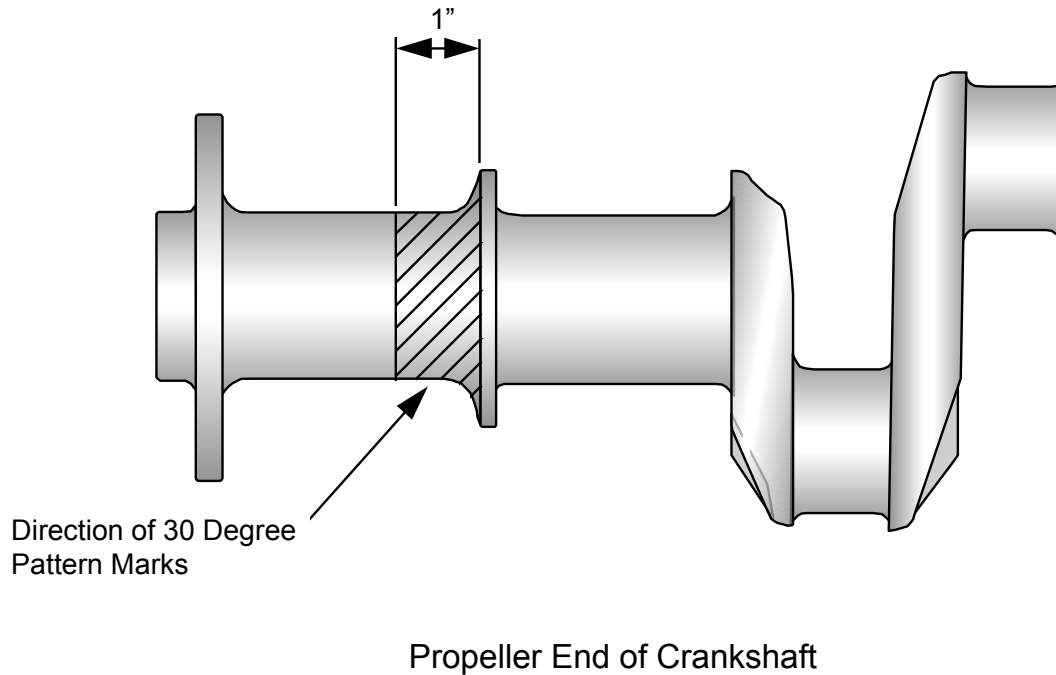


Figure 21-6
Helix Pattern Location

1. See Figure 21-6, “Helix Pattern Application.” Apply helix using a strip of 180 grit emery cloth approximately one half inch wide. Do approximately one quarter of the surface indicated at a time, stroking the cloth outward toward the propeller flange in the direction of rotation (CCW) towards you using maximum hand pressure. Reverse direction for left hand rotating engines. This should result in a 30° pattern similar to that illustrated in Figure 21-6, “Helix Pattern Application.” After doing the first portion rotate crankshaft by hand to make next portion available. Apply the same pattern again and continue completely around the crankshaft in this manner.
2. Repeat cleaning operation.

Oil Seal Installation

1. Use the specified oil seal assembly only. Check the spring length. It should be $7 - 53/64^{+0} - 1/32$ in length. See Figure 21-7, "Crankshaft Oil Seal."
2. Remove spring and reinforcing ring from oil seal. Unhook spring ends using an unwinding motion. Place spring around crankshaft in oil seal area and turn spring ends in an unwinding direction the join and allow one end to wind into the other end.
1. Apply Alvania™ (Shell #2) to lip of oil seal and prop flange only. Squeeze oil seal until egg shaped and start over flange. A special tool P/N5209 is available from Kent Moore to assist in oil seal installation. After oil seal is on shaft wipe all grease from oil seal and shaft. The oil seal outside diameter must be clean and dry before installation in the crankcase. Press the

reinforcing spring into the oil seal recess by moving fingers in both directions from split. Insure spring is in deepest part of recess all the way around.

2. Apply a thin coat of Permatex to outside diameter of seal.
3. Using thumb pressure, work seal into crankcase counterbore.
4. After seal is in place, wipe oil from seal and shaft.
5. Spray exposed portion, from which plating has been removed, with aluminum primer.
6. Apply Loctite 271 to oil seal retainer screws. Apply Loctite Primer 7471 to crankcase oil seal retainer screw holes. Install crankshaft oil seal retainer plates and secure with screws. Torque screws to 21-25 inch pounds.

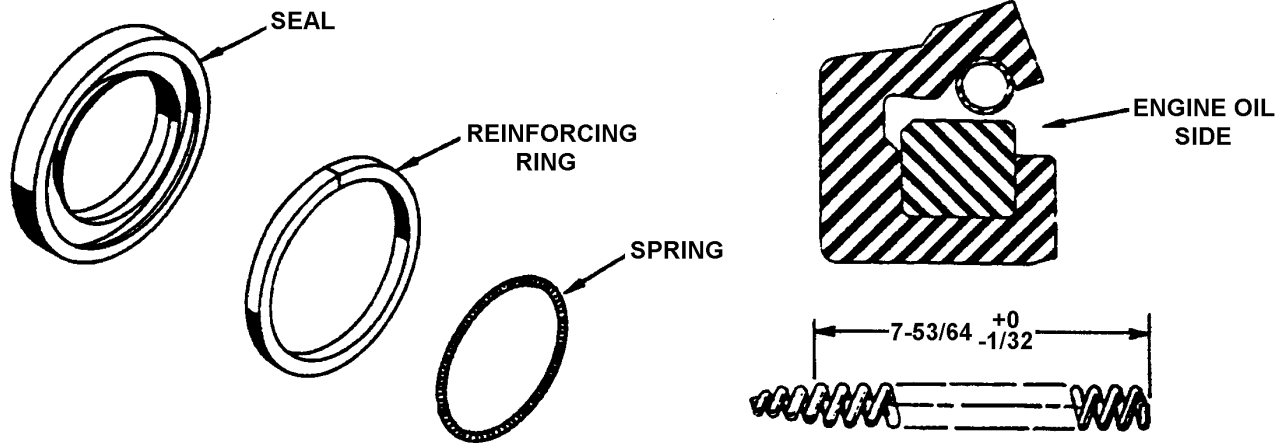


Figure 21-7
Crankshaft Oil Seal

Engine Drive Train Component Removal

If all other probabilities have been evaluated and it is determined that a malfunction is occurring with internal engine components, remove the engine from the airframe and disassemble it in accordance with the I0-520 Permold Series Overhaul Manual, Form OH-11 and the airframe manufacturer's instructions.

CAUTION...

When relieving engine weight from the airframe, attach the engine hoist only to the engine lifting eyes.

NOTE...

Place a support at the load bearing area of airframe tail to prevent damage to the airframe.

NOTE...

Exercise judgment in determining the extent of disassembly.

Maintenance of removed engine systems and components must be performed in accordance with that particular system or component section of this manual.

CAUTION...

Dimensional inspection of the crankcase and crankcase internal components must be performed in accordance with the I0-520 Permold Series Overhaul Manual, Form OH-11. Prior to dimensional inspection, insure that the part conforms with all visual, fluorescent penetrant, magnetic particle or ultrasonic inspection requirements.

NOTE...

When the engine has been disassembled a complete visual, dimensional and non destructive test inspection must be performed on all components prior to reassembly.

Engine disassembly, cleaning, inspection, repair, replacement, assembly and test must be

accomplished in accordance with the I0-520 Permold Series Overhaul Manual, Form OH-11.

Postmaintenance Adjustment and Test

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<i>Servicing With Fluids</i>	22-3
<i>Operational Test</i>	22-3
<i>Oil Pressure Adjustment</i>	22-3
<i>Fuel System Adjustment</i>	22-4
<i>Adjustment Tools and Equipment Required</i>	22-4
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Post Maintenance Operational Test

An operational test must be performed after each:

- 50-hour inspection
- 100-hour inspection
- Annual inspection.

Servicing With Fluids

Refer to Chapter 7 and insure that:

1. The engine has been properly serviced with the specified oil.
2. The aircraft has been serviced with the specified fuel in accordance with the airframe manufacturer's instructions. See chapter 7 for fuel specifications.

Operational Test

After engine maintenance is completed, an engine operational inspection must be performed in accordance with Chapter 5.

NOTE...

If a new cylinder or cylinders and piston rings have been installed:

1. Start the engine in accordance with the airframe manufacturer's Airplane Flight Manual (AFM)
 2. Operate the engine at 750 RPM for one minute, gradually increasing RPM to 1000 RPM in three minutes.
 3. Check the magneto circuit for proper grounding prior to a normal shutdown.
 4. Allow the engine to cool adequately and visually inspect for any irregularities.
1. If the engine exhibits any irregularities, refer to the applicable chapter and correct all discrepancies. **All discrepancies must be corrected prior to operational test and engine adjustment.**

2. After the operational inspection is completed, make any required engine system adjustments as follows:

Oil Pressure Adjustment

1. Prepare the aircraft for ground run up and start the engine in accordance with the aircraft manufacturer's instructions.
2. Turn the oil pressure adjusting screw clockwise to increase oil pressure and counter-clockwise to decrease oil pressure. With engine oil at normal operating temperature, adjust the oil pressure to 10 psi idle minimum and 30-60 psi normal operation. Torque locknut and safety as required.

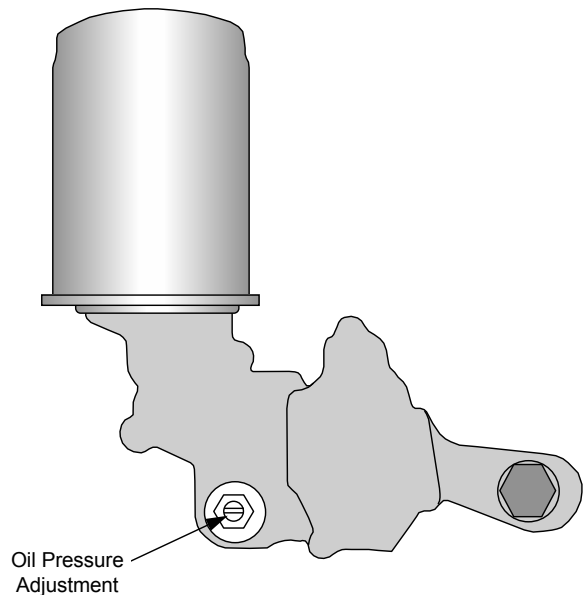


Figure 22-1
Oil Pressure Adjustment on Oil Pump

Fuel System Adjustment

The procedures and values provided apply to TCM fuel injected engines that have not been modified from their type design. Refer to supplemental type certificate (STC) holder information and instructions for aircraft and engines that have been modified from their type design.

Aircraft and engines that have been modified from their type design must have the fuel injection system maintained in accordance with the Supplemental Type Certificate Holders FAA approved instructions.

CAUTION...

Engine performance, service life and reliability will be compromised if the engine fuel injection system is neglected.

The following adjustment procedures are presented in a sequential format that must be followed to insure proper fuel system adjustment. Reference the applicable Aircraft Maintenance Manual for detailed fuel system adjustment and maintenance procedures.

Any fuel system that cannot be adjusted to meet the specified values will require repair or replacement of the affected components prior to further engine operation.

CAUTION...

Refer to Chapter 13, Tables 1 and 2, for specified values when torquing all hose connections and fittings.

Adjustment Tools And Equipment Required

A complete set of tools and test equipment is essential for correct setup of TCM fuel injection systems. Various combinations of these tools and equipment will be used, depending on the engine model. A proper inventory of tools and equipment for fuel system adjustment will include the following:

1. TCM recommends the Model 20 ATM - C Porta Test Unit P/N 630045-20 ATM-C or equivalent to insure the fuel injection system meets all pressure and flow specifications. An alternative procedure would be to use calibrated gauges. You may acquire a Model 20 ATM-C Porta Test Unit by contacting the following company:
AERO TEST, Inc.
29300 Goddard Road
Romulus, Michigan 48174
(313) 946-9000
 - a. One (1) calibrated 0-60 PSI gauge, graduated in 1 PSI increments. This gauge will be used for unmetereed pressure measurement.
 - b. One (1) calibrated 0-30 PSI gauge, graduated in 1 PSI (maximum) increments. This gauge will be used for metered pressure measurements and verification of aircraft fuel flow gauge indications.
2. Two (2) P/N MS51523-B4 swivel tees. These fittings will be used to tee into fuel lines for unmetereed and metered pressure reference.
3. Hoses of appropriate diameters and sufficient lengths to keep personnel and equipment away from propeller arc area.
4. Common hand tools including: 7/8", 11/16", 9/16", 1/2", 3/8", 7/16", 11/32", and 5/16" wrenches. A 1/4" drive: ratchet and sockets, universal swivel, extension and a 5/32" allen wrench, common screw driver, a calibrated

torque wrench, an oil can, mirror and flashlight. Safety equipment including hearing and eye protection.

5. Tachometer verification instrument - various types are available. Verify aircraft tachometer accuracy prior to fuel system adjustment.

Presetup Procedures

1. Prior to fuel system adjustments, flush the aircraft fuel system by first removing the engine-driven fuel pump inlet hose and terminating the end into a large, clean container. Operate the aircraft boost pump and allow a minimum of one gallon of fuel to flow through the system. Take necessary precautions to prevent a fire hazard. If contamination is present, locate and correct the source, and repeat this step prior to proceeding.
2. Prior to any checks or adjustments, verify the accuracy of the tachometer, manifold pressure gauge and fuel flow gauge. Any gauge found to be inaccurate must be repaired or replaced prior to adjusting the fuel system.

WARNING

Use of inaccurate gauge(s) will result in incorrect adjustment of the engine fuel system, possible cylinder wear due to lean operation, preignition, detonation, loss of power and severe engine damage.

3. Insure that all fuel system components are of the correct part number and installed properly. Correct any discrepancies noted.
4. Remove, inspect, clean, and reinstall the aircraft and engine fuel screens in accordance with the manufacturer's instructions.
5. Inspect the aircraft induction air filter and alternate air system for condition, operation and cleanliness. Repair or replace any

component that is not operating properly in accordance with the airframe manufacturer's instructions.

6. Inspect the aircraft vapor return system for proper operation in accordance with the manufacturers' instructions. Correct any discrepancies noted.
7. Insure the fuel manifold valve vent and fuel pump drain lines are properly installed, open and free of obstruction. Correct any discrepancies noted.
8. Inspect all engine control rod ends for wear, freedom of movement, proper installation and security in accordance with the test stand or aircraft manufacturer's instructions. Correct any discrepancies noted.
9. Insure all engine controls operate freely throughout their full range of travel and are properly adjusted in accordance with the aircraft manufacturer's instructions.
10. Lubricate all control rod ends and fuel system components in accordance with Chapter 13 of this manual and the aircraft manufacturer's instructions.

WARNING

Failure to correctly install and maintain engine controls can result in loss of system control and subsequent engine power.

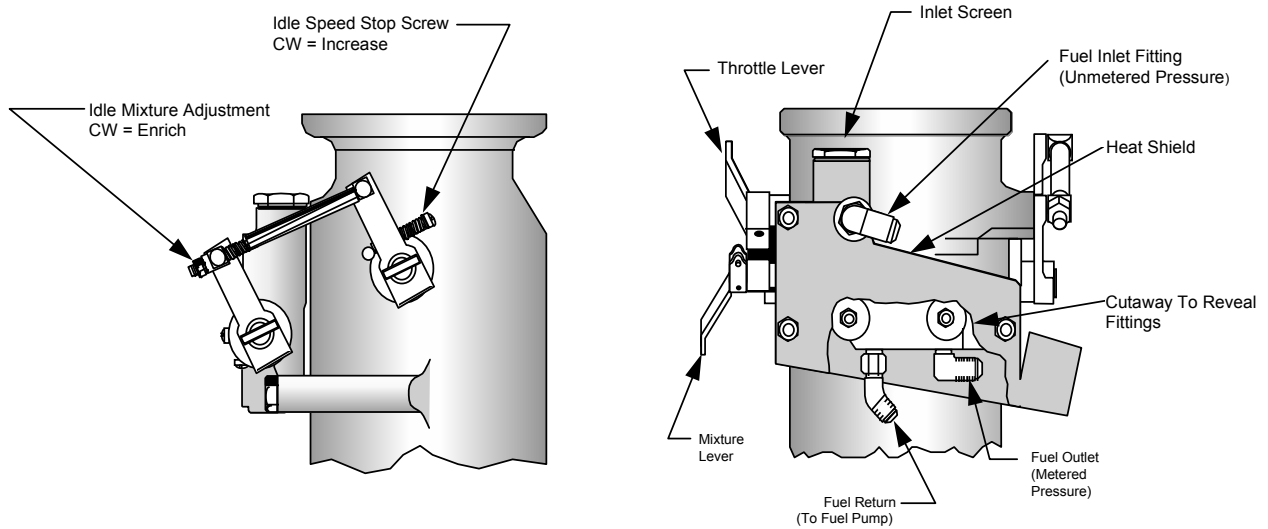


Figure 22-2
Throttle, Fuel Control and Metering Unit Adjustments

Setup Procedures

1. Locate the IDLE speed stop screw on the throttle body and turn it counter-clockwise two complete turns. See Figure 22-2. During fuel system adjustment, IDLE RPM will be controlled manually using the cockpit throttle control.

WARNING

During removal and installation of fuel lines and hoses, failure to properly support component fittings can result in fitting and/or component damage and loss of system pressure. Refer to Chapter 9, "Standard Practices."

2. Loosen and remove the unmetered fuel supply hose from either the fuel pump outlet fitting or the fuel metering unit inlet fitting, whichever is most accessible

3. Install and torque the MS51523-B4 swivel tee directly to the fuel pump outlet fitting or to the fuel metering unit inlet fitting as applicable.

NOTE...

Installation may require combinations of different fittings and hoses to facilitate installation of unmetered and metered test equipment connections.

4. Attach the unmetered fuel supply hose to the straight end of the tee connector and torque.
5. Connect the unmetered test hose from the Porta Test Unit to the tee fitting and torque. If using the alternative procedure, connect the 0-60 PSI gauge to the swivel tee using a length of hose which will provide proper clearance from the engine cowling and propeller arc. Torque all connections.
6. Loosen and remove the metered fuel supply hose from the manifold valve inlet fitting.

7. Install and torque the second MS51523-B4 swivel tee directly to the fuel manifold valve inlet fitting.
8. Attach the metered fuel supply hose to the straight end of the tee connector and torque.
9. Connect the metered pressure test hose from the Porta Test Unit to this second tee connector and torque. If using the alternative procedure, connect the 0-30 PSI gauge to the swivel tee using a hose long enough to provide proper clearance from the engine cowling and propeller arc. Torque all connections.
10. Position the throttle control in the FULL OPEN position and the mixture control to FULL RICH. Operate the aircraft boost pump in accordance with the aircraft manufacturer's instructions. Following the instructions provided with the Porta Test Unit, bleed all air from the test unit and hoses. If using the alternative calibrated test gauges, loosen the test connections at each gauge to bleed the lines of any air. Operate the boost pump only long enough to allow purging of air from the installed test equipment. Verify that all fuel lines, hoses and fittings are secured and torqued and that no fuel leaks exist before proceeding. Insure test hoses have been routed clear of the exhaust system and are supported their entire length to preclude inaccurate gauge readings.

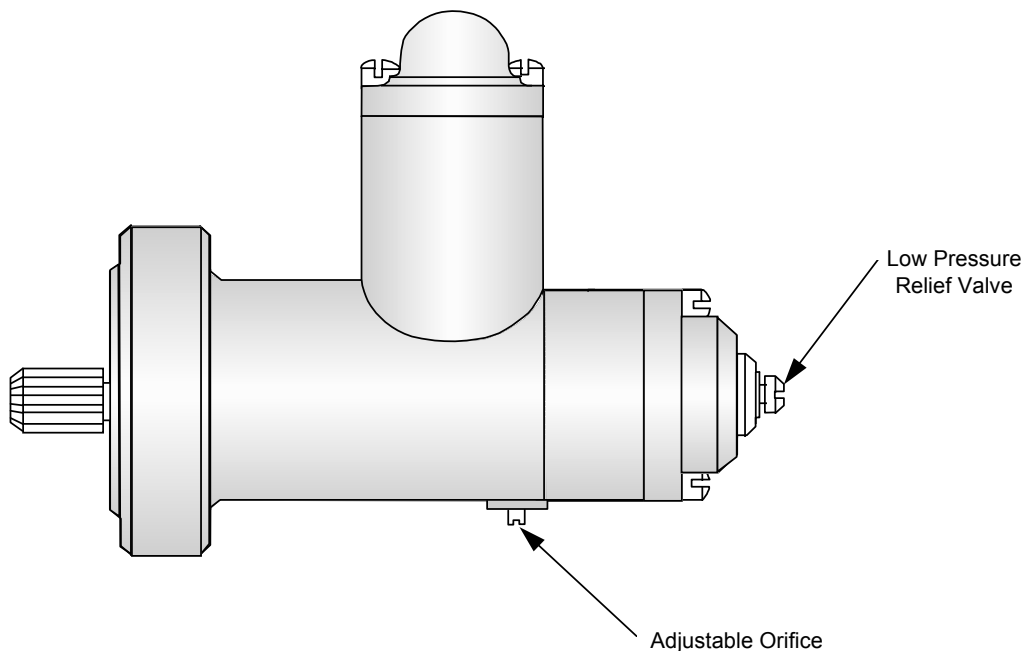


Figure 22-3
Fuel Pump Adjustments

11. Inspect the exhaust and induction systems for proper installation, security and leaks. Correct any discrepancies noted.
12. Inspect all lines, hoses and wire bundles for chafing, loose connections, leaks and stains. Correct any discrepancies noted.
13. Loosen and remove the metered fuel supply hose from the manifold valve inlet fitting.
14. Install and torque the second MS51523-B4 swivel tee directly to the fuel manifold valve inlet fitting.
15. Attach the metered fuel supply hose to the straight end of the tee connector and torque.
Connect the metered pressure test hose from the Porta Test Unit to this second tee connector and torque. If using the alternative procedure, connect the 0-30 PSI gauge to the swivel tee using a hose long enough to provide proper clearance from the engine cowling and propeller arc. Torque all connections.
16. Position the throttle control in the FULL OPEN position and the mixture control to FULL RICH. Operate the aircraft boost pump in accordance with the aircraft manufacturer's instructions. Following the instructions provided with the Porta Test Unit, bleed all air from the test unit and hoses. If using the alternative calibrated test gauges, loosen the test connections at each gauge to bleed the lines of any air. Operate the boost pump only long enough to allow purging of air from the installed test equipment. Verify that all fuel lines, hoses and fittings are secured and torqued and that no fuel leaks exist before proceeding. Insure test hoses have been routed clear of the exhaust system and are supported their entire length to preclude inaccurate gauge readings.
17. Install the engine cowling or cooling shroud during ground operation.

WARNING

Make certain all fuel has drained from the induction system prior to attempting engine start. Failure to do so could cause hydraulic lock and subsequent engine failure .

18. The Operational Test Form on page at the end of this chapter may be reproduced for use in recording adjustments and test indications. Record the applicable IDLE and FULL POWER adjustment points: RPM, fuel pressure, fuel flows, manifold pressure and fuel/air mixture rise from "Test Operating Limits" in Chapter 5 and Aircraft Maintenance Manual on the operational test form. See the end of this chapter for:

- **Constant Speed Sea Level Performance Curve**
- **Fuel Flow Vs. Brake Horsepower Performance Curve**
- **Fuel Flow Vs. Metered Pressure Performance Curve**

NOTE...

To insure optimum cooling during FULL POWER operations, the FULL POWER fuel flow should be set to the maximum specification limit.

WARNING

Before starting the engine, insure that the aircraft wheels are chocked and brakes are set.

19. Prepare the aircraft for ground run and start the engine in accordance with the aircraft manufacturer's instructions.
20. Advance the throttle to 1500 to 1800 RPM. While monitoring all engine gauges, operate the engine at this speed until the engine

temperatures and pressures have stabilized in the operational range. Use the operational test form to record the gauge indications.

21. With the mixture control in the FULL RICH position, reduce the throttle to the specified IDLE RPM. Record the unmetered pressure indicated on the gauge. Slowly move the mixture control toward the IDLE CUT-OFF position and record the maximum RPM rise. Return the mixture control to FULL RICH.
22. Monitoring all engine gauges, slowly advance the throttle control to full rated power for the engine and allow the engine to stabilize for 15 seconds. Record all engine and test gauge indications. **DO NOT ALLOW ENGINE TEMPERATURES TO EXCEED 420°F CYLINDER HEAD TEMPERATURE AND 210°F OIL TEMP.** Retard throttle control to 800 to 1000 RPM.

NOTE...

Engine driven fuel pump output pressures vary with engine RPM. If the engine will not achieve full power rpm during static ground operational test run use Table 22-1 to correct the metered fuel pressure specification for the actual rpm achieved.

NOTE...

Insure that all engine and engine-related aircraft systems are adjusted and functioning properly before making any adjustment to the fuel system.

23. Compare the recorded IDLE fuel pressure, IDLE RPM fuel/air mixture rise and full power RPM, manifold pressure (as applicable), unmetered fuel pressure, metered fuel pressure and fuel flow indications with the specified values recorded on the operational test form. If all recorded values are within specifications, proceed to paragraph 22.

24. If any of the recorded readings are not within specifications, the fuel system will require complete adjustment.

Caution...

All readings must be taken with mixture control in the full rich position.

25. Install the engine cowling or cooling shroud during all ground operation.

NOTE...

Insure that the manifold pressure is adjusted in accordance with the aircraft manufacturer's instructions.

WARNING

Make all adjustments with the engine stopped and the ignition and master switches in the off position.

26. To adjust the IDLE RPM unmetered pump pressure, loosen the lock nut on the low pressure relief valve. See Figure 22-3. Turning the adjustment clockwise (CW) will increase pressure and counterclockwise (CCW) will decrease pressure. Operate the engine at 1500 - 1800 RPM for 15 seconds after each adjustment, then retard the throttle to the specified IDLE RPM. Repeat this step until pressure is within specified limits.

NOTE...

It is desirable to set IDLE RPM unmetered pump pressure to the minimum limit. With properly adjusted fuel/air mixture, this will provide a slight fuel enrichment during part throttle operations.

27. With engine operating at the specified IDLE RPM and unmetered fuel pressure, slowly move the mixture control from the FULL RICH position toward IDLE CUT-OFF to

check fuel/air mixture. A rise of 25 to 50 RPM should be obtained. An RPM change greater than 50 indicates the mixture is too rich and a change that is less than 25 indicates the mixture is too lean. Any mixture conditions that are too rich or too lean will be adjusted as follows:

- a. Adjust idle mixture in accordance with Figure 22-2, "Throttle and Fuel Metering Adjustments."
 - b. Perform an IDLE fuel/air mixture check and observe RPM rise. If the RPM rise is not within specifications, advance the throttle control to 1500 - 1800 RPM for 15 seconds after each adjustment to clear the engine. Retard the throttle control to IDLE RPM and repeat mixture check. Make the necessary adjustment. Repeat this procedure until the specified RPM rise is achieved.
 - c. Recheck IDLE RPM unmetered pump pressure. If pressure is not within limits, repeat Steps 18, 19, 19-a and 19-b before continuing.
28. See chapter 5 "Test Operating Limits." Adjust the full power fuel flow to the specified value by turning the adjustable orifice screw clockwise to increase fuel flow and counterclockwise to decrease fuel flow. See Figure 22-3 for fuel pump adjustments.
29. When full power fuel flow has been adjusted to the specified values, recheck the IDLE RPM unmetered fuel pressure and fuel/air mixture. If any values are not within specified limits, repeat the adjustment procedures.
30. With the fuel system set to the specified pressure and flow values, set the IDLE RPM to the specified value by turning the Idle Speed Stop screw clockwise to increase RPM and counterclockwise to decrease RPM. See

Figure 22-2 and chapter 5, "Test Operating Limits."

Postsetup Procedures

1. Insure that the master switch, ignition switch and fuel selector are in the off position.
2. Remove the engine cowling or cooling shroud in accordance with the aircraft manufacturer's instructions. Remove all test gauges, fittings and hoses that were installed for fuel system setup. Reconnect all fuel hoses to their original locations, support and torque all fittings to the specified value.
3. Perform a complete fuel system leak check in accordance with the aircraft manufacturer's instructions. Correct any discrepancies noted.
4. Install engine cowling or cooling shroud in accordance with the aircraft manufacturer's instructions.
5. Perform a complete operational ground run-up and verify that all fuel system performance specifications are achieved .
6. Repeat the setup and adjustments as required until the fuel injection system is performing within the published specification for the aircraft and engine.

Metered Pressure Vs. RPM @ 70°F Fuel Temperature		
Static Engine RPM	Correction Factor	Corrected Metered Pressure (Metered Pressure x Correction Factor)
Rated RPM	1	
-20	.991	
-40	.982	
-60	.973	
-80	.964	
-100	.955	
-120	.946	

NOTE: All values are approximate. Variations may be noticed due to engine and installation specific influences.

Example: I0-520-B, -BA, -BB: Maximum Rated RPM = 2700
Metered Fuel Pressure Limits = 16.5 - 18.4

If maximum static engine RPM = 2640, (-60 RPM) use Correction Factor .973

Metered Fuel Pressure Limits x Correction Factor = Corrected Metered Pressure Limits

16.5 x .973 = 16.0545 (Minimum Metered Pressure Limit) @ 2640 RPM

18.4 x .973 = 17.9032 (Maximum Metered Pressure Limit) @ 2640 RPM

Table 22-1
Compensation Table for Static Ground Setup

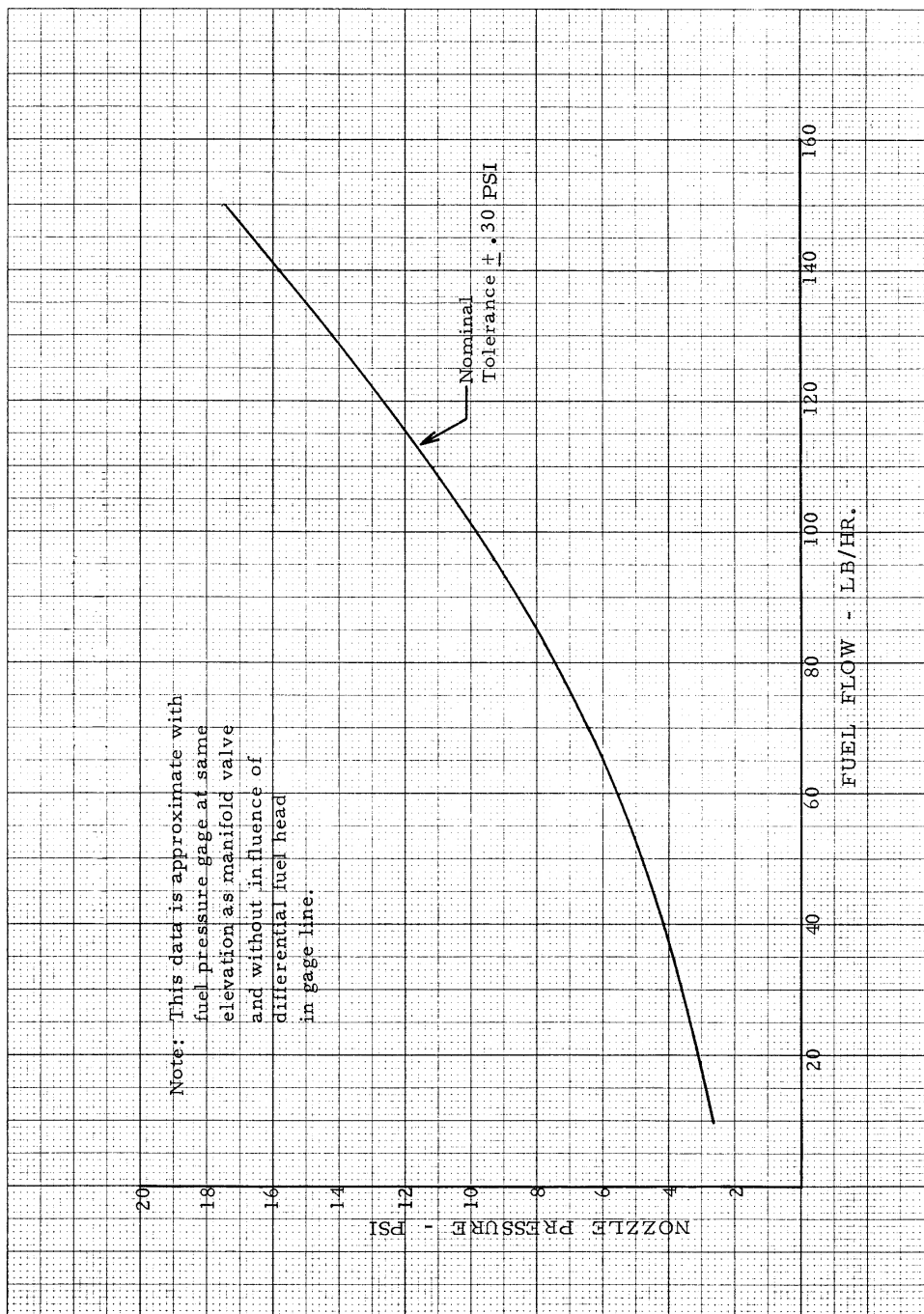


Chart 22-1
IO-520-B, -BA, -BB Metered Fuel Pressure vs. Fuel Flow

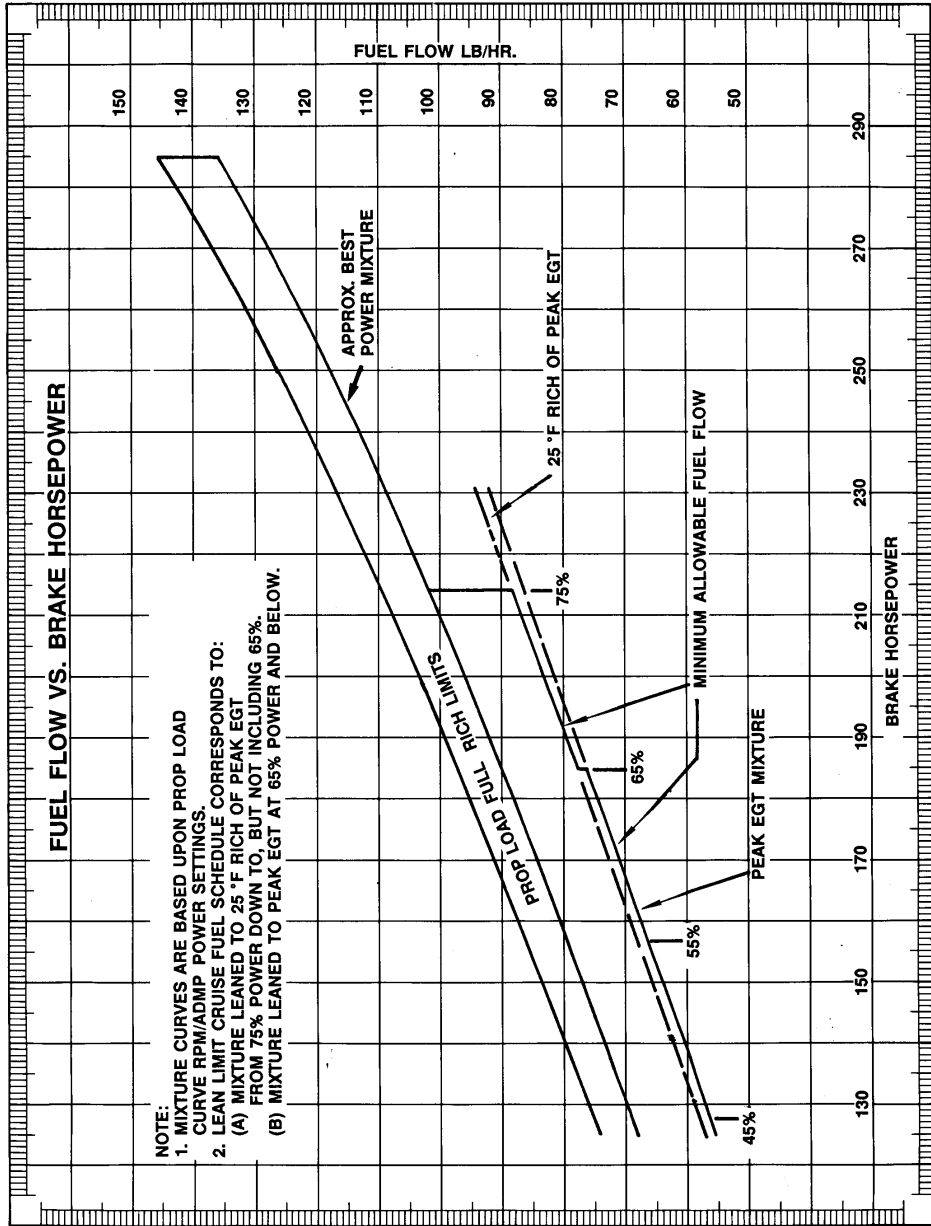


Figure 22-2
IO-520-B, -BA, -BB Brake Horsepower vs. Fuel Flow

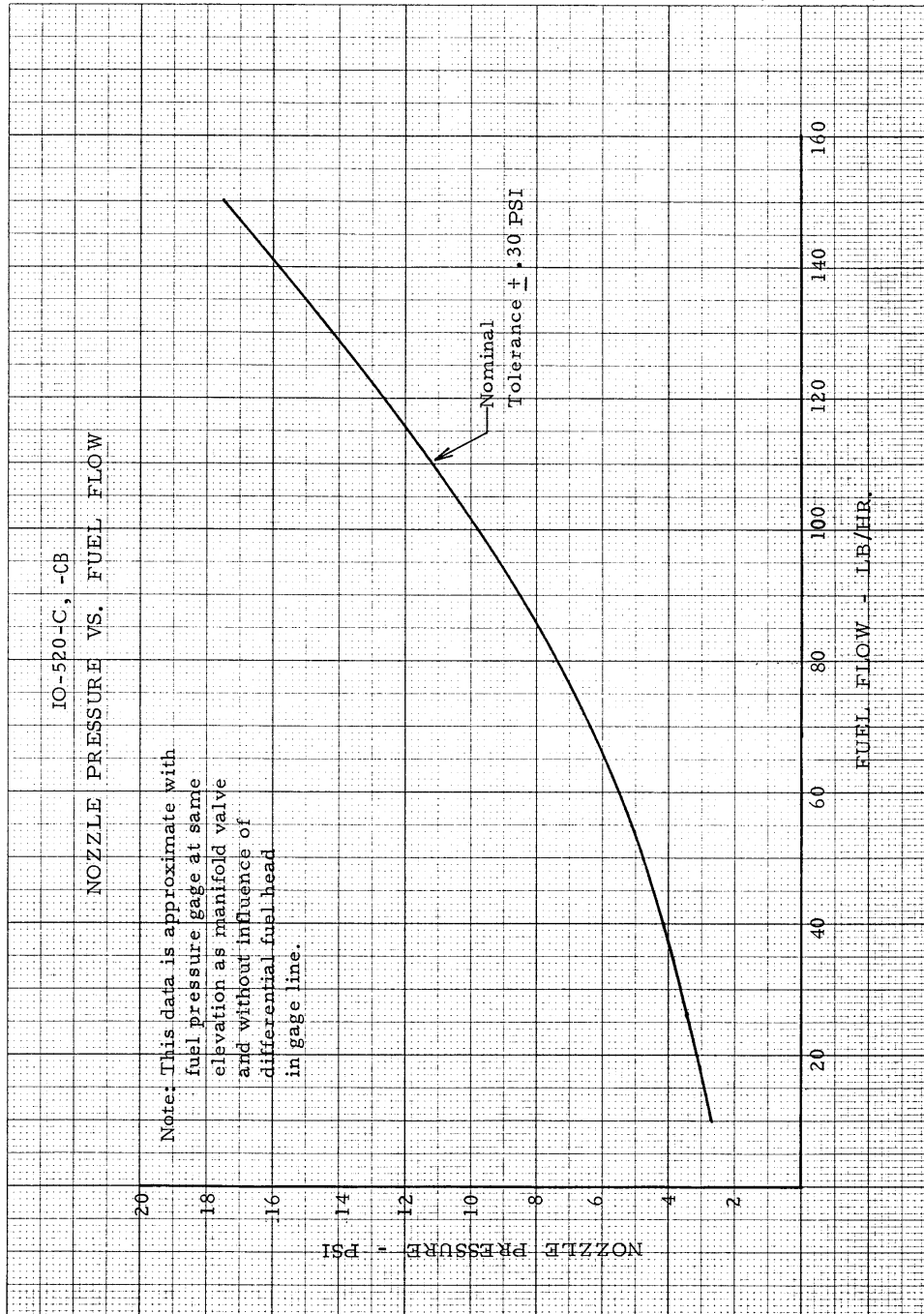


Figure 22-3
IO-520-C, -CB Metered Fuel Pressure vs. Fuel Flow

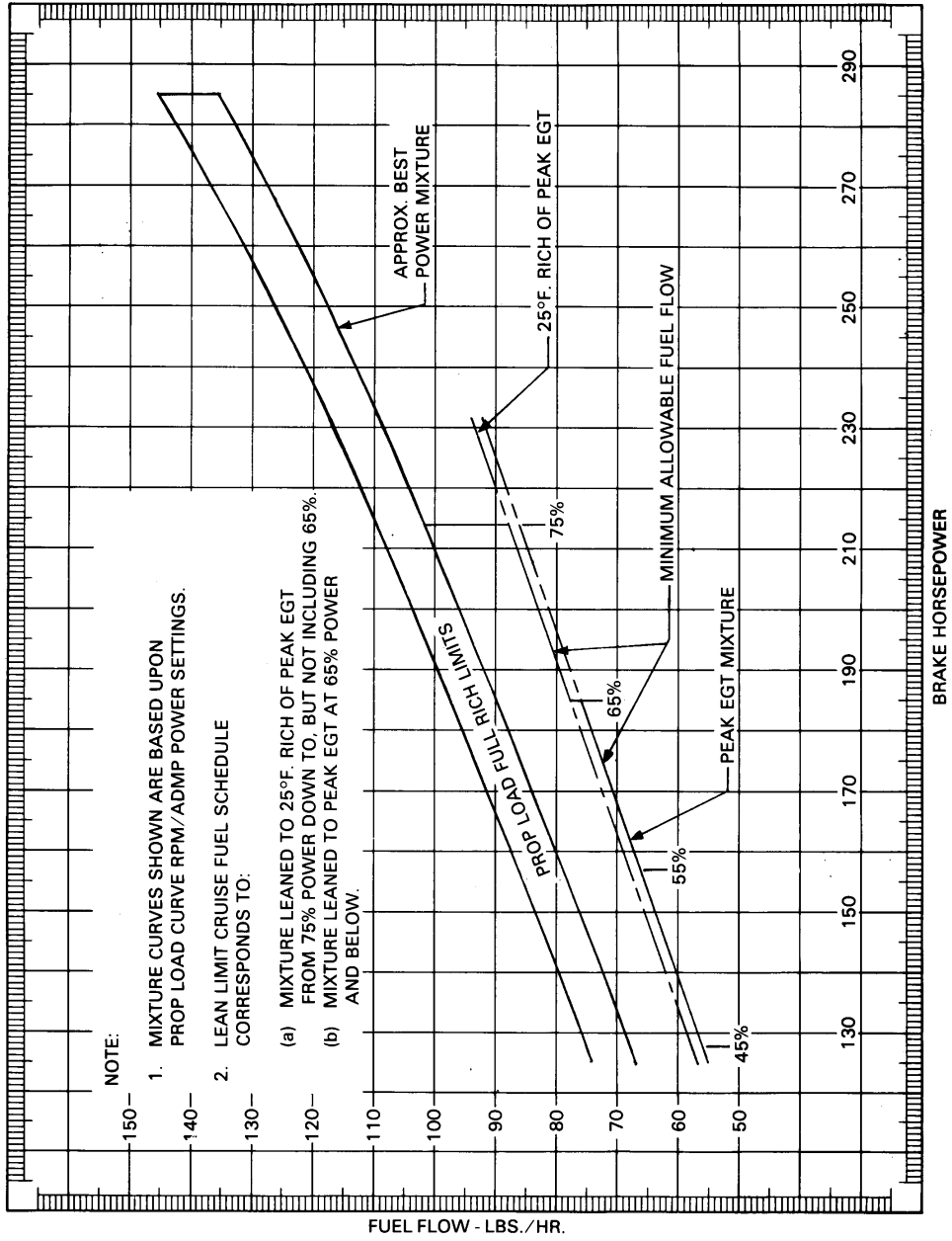


Figure 22-4
IO-520-C, -CB Fuel Flow vs. Brake Horsepower

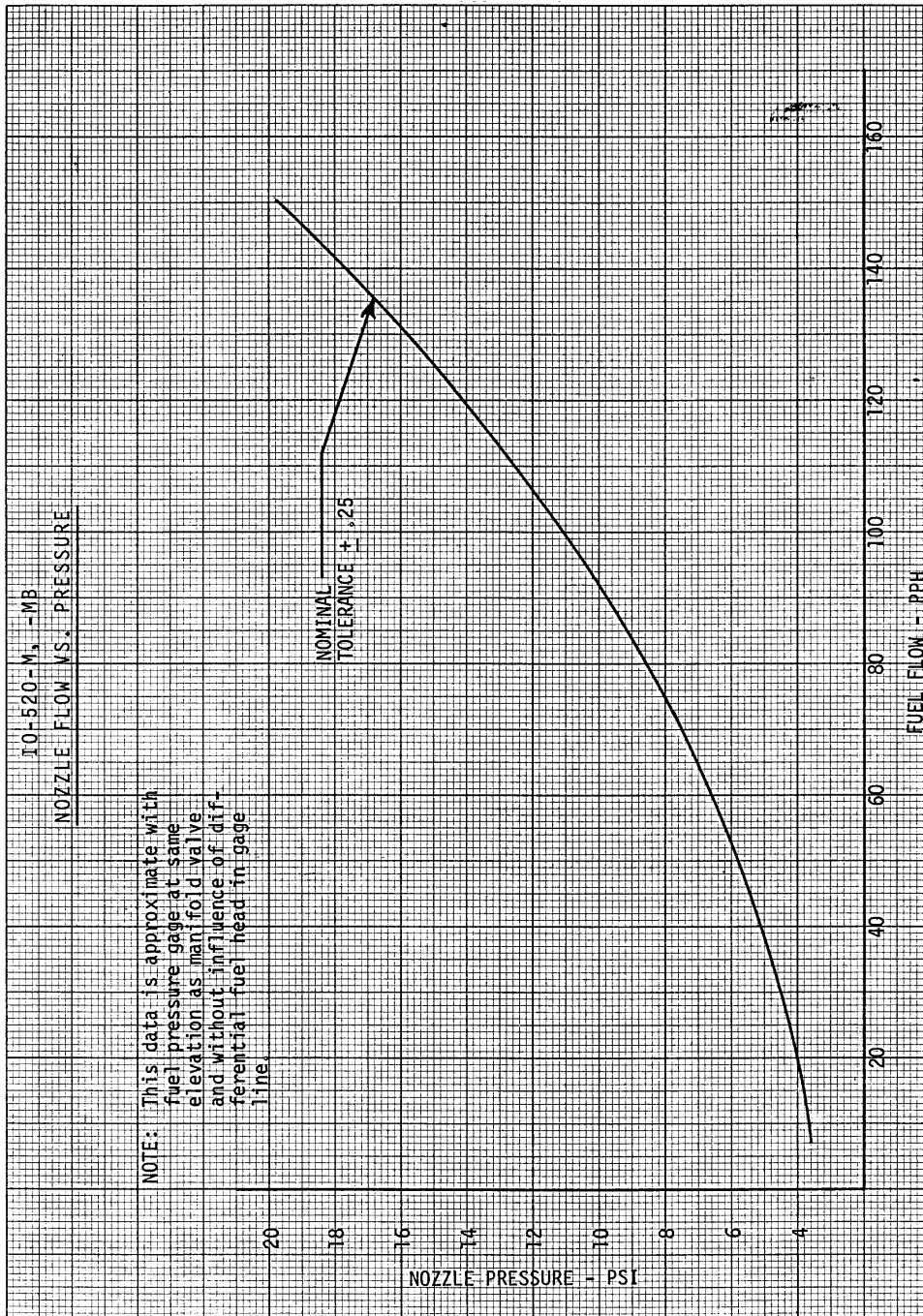


Figure 22-5
IO-520-M, -MB Metered Fuel Pressure vs. Fuel Flow

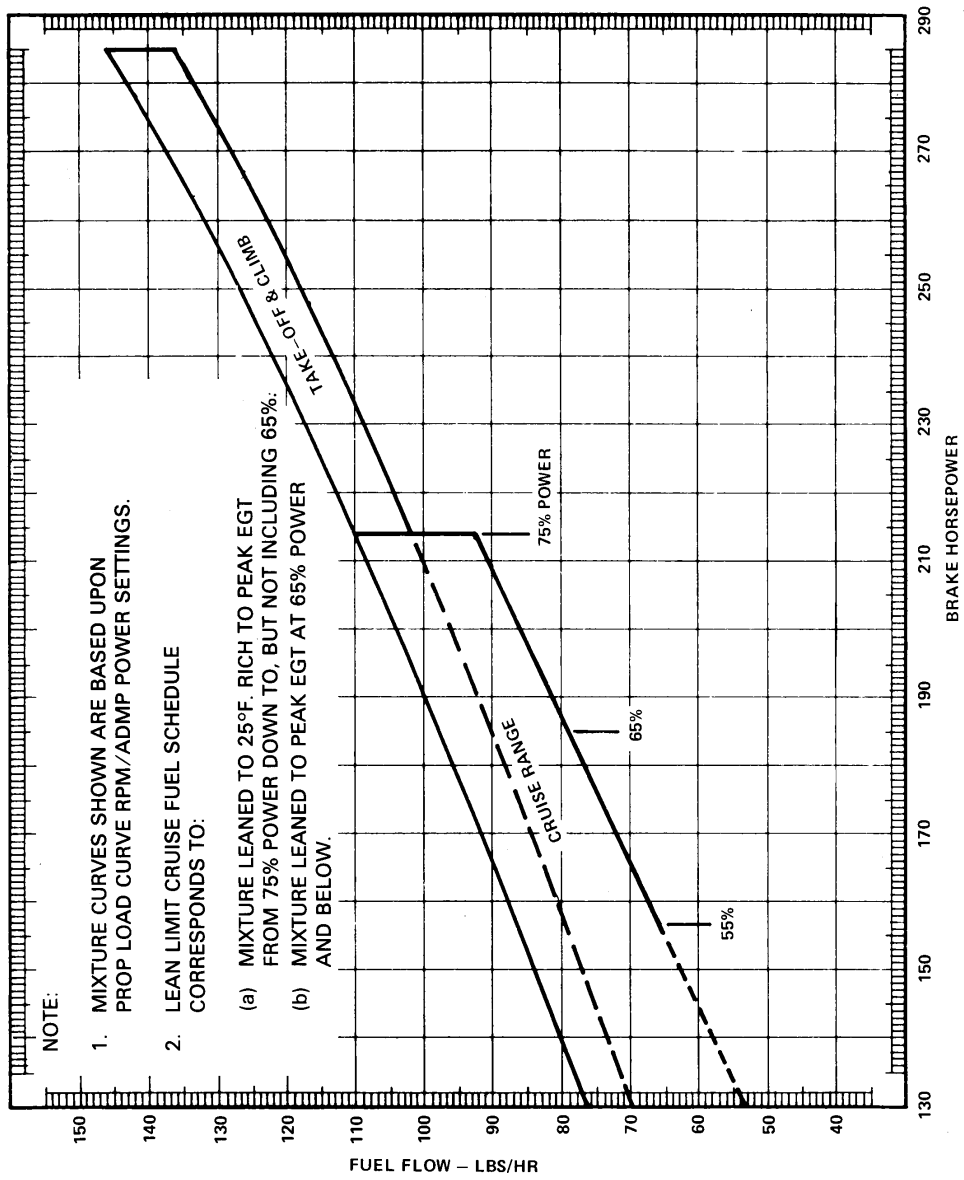


Figure 22-6
IO-520-M, -MB Fuel Flow vs. Brake Horsepower

Test Flight

Refer to the aircraft manufacturer's or Supplemental Type Certificate (STC) holders POH/AFM for specific operational information.

NOTE...

I0-520-M, -MB, -B, -BA, -BB, -C, -CB engines require the auto lean operation inspection below during test flight.

Ambient air and engine operating temperatures are of major concern during this test flight. Do a normal preflight run-up in accordance with the Airplane Flight Manual. Conduct a normal take-off with full power and monitor the fuel flow, RPM, oil pressure, coolant temperatures and oil temperatures. Reduce to climb power in accordance with the Airplane Flight Manual. The manual mixture control should be set in the full rich position for all operations except leaning for field elevation and leaning to maintain smoothness during climb and leaning for cruise economy. Leaning operations must be performed in accordance with the Airplane Flight Manual.

NOTE...

New, rebuilt and overhauled engines or engines that have had new or repaired cylinders installed must be flown in accordance with the following procedure for the first two hours of operation.

Level flight cruise should be at 75% power with best power or richer mixture for the first hour of operation. The second hour power settings should

alternate between 65% and 75% power with the appropriate best power mixture settings. The best power mixture setting is 100° to 125° rich of peak turbine inlet temperature. Engine controls or aircraft attitude should be adjusted as required to maintain engine temperatures and pressures within specifications.

Descent from high altitude should be accomplished at low cruise power settings. During descent, engine pressures and temperatures must be carefully monitored. Avoid long descents with cruise RPM and manifold pressure below 18" Hg.

CAUTION...

Avoid rapid descents at high RPM and low manifold pressure.

During descent monitor coolant and oil temperatures maintaining above the minimum recommended operating range .

NOTE...

Avoid long descents at low manifold pressure, which can result in excessive engine cooling. Satisfactory engine acceleration may not occur when power is applied.

Any discrepancies detected during test flight must be corrected and the aircraft again test flown prior to approval of engine for return to service. The appropriate logbook entries must be made in accordance with Part 43 of the Federal Aviation Regulations (FAR) before the engine can be returned to service.

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