IO-470
OVERHAUL MANUAL

(MODELS)
IO-470-C
IO-470-D
IO-470-E
IO-470-F
IO-470-G
IO-470-H
IO-470-J
IO-470-K
IO-470-L
IO-470-M
IO-470-N
IO-470-P
IO-470-R
IO-470-S
IO-470-U
IO-470-V,VO

PART NO. X30588A

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MODELS: IO-470-C,D,E,F,G,H,J,K,L,M,N,P,R,S,U,V & VO

FORM X30588A

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WARNING

(Please note the following statements from FAA Advisory Circular 20-62C entitled "ELIGIBILITY, QUALITY, AND IDENTIFICATION OF APPROVED REPLACEMENT PARTS"):

"3. **BACKGROUND.** An increasing amount of replacement parts (including standard parts), materials, appliances, and instruments are offered for sale as being of aircraft quality when actually the quality and origin of these units are known. Users of such units are usually not aware of the potential hazards involved with replacement parts that are **not** eligible for use on certificated aircraft. Frequently such units are deceptively advertised or presented as **unused,"** "**like new,**" or "**remanufactured.**" This implies that the quality of such units is equal to an original or appropriately repaired or overhauled unit.

The performance rules for replacement of parts and materials used in the maintenance and alteration of U.S. certificated aircraft are specified in Federal Aviation Regulations (FAR) 43.13 and FAR 145.57. The responsibility for the continued airworthiness of the aircraft, which includes the replacement of parts, is the **responsibility** of the owner/operator as outlined in FAR 91.163, FAR 121.363, FAR 123.45, FAR 127.131 and FAR 135.143 (a).

4. **IDENTIFICATION OF THE APPROVED PARTS**. Approved serviceable replacement parts are identified as follows:

a. By an FAA Form 8130-3 (Formerly FAA Form 186), Airworthiness Approval Tag. An Airworthiness Approval Tag identifies a part or group of parts that have been approved by authorized FAA representatives.

b. By an FAA Technical Standard Order (TSO) number and identification mark that indicates the part or appliance has been manufactured under the requirements of FAR 37.

c. By an FAA/PMA symbol, together with the manufacture's name, trademark or symbol, part number, and the make and model of the type certificated product on which the part is eligible for installation, stamped on the part. An FAA Parts Manufacturer Approval (FAA/PMA) is issued under FAR 21.305. The make and model information may be on a tag attached to the part.

d. By shipping ticket, invoice, or other document which provides evidence that the part was produced by a manufacturer holding an FAA Approved Production Inspection System issued under FAA 21, Subpart F, or by a manufacturer holding an FAA Production Certificate issued under FAA 21, Subpart G.

e. By a certificate of airworthiness for export issued by a foreign government under the provisions of FAR 21, Subpart N.

11. **KNOW YOUR SUPPLIER**. It has come to our attention that many reproduced parts and components, particularly instruments which have been manufactured by persons other than the original manufacturer, are available for purchase and installation on U.S. certificated aircraft. Often, an original part is used as a sample to produce duplicates. The reproduced parts appear to be as good as the original part; however, there are many unknown factors to be considered that may not be readily apparent to the purchaser, i.e., heat treating, plating, inspections, tests and calibrations. All too often the faulty part is not discovered until a malfunction or an accident occurs.

12. **SUMMARY. In accordance with FAR's, certification of materials, parts, and appliances for return to service, for use on aircraft, is the responsibility of the person or agency who signs the approval**. The owner/operator as denoted in paragraph 3 of this advisory circular, is responsible, for the continued airworthiness of the aircraft. To assure continued safety in aircraft operation, it is essential that great care be used when inspecting, testing, and determining the acceptability of all parts and materials. Particular caution should be exercised when the identity of materials, parts, and appliances cannot be established or when their origin is in doubt."

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OVERHAUL MANUAL
FOR
IO-470 SERIES
AIRCRAFT ENGINE

- NOTICE -

The overhauler must comply with all the instructions contained in this manual in order to assure safe and reliable engine performance. Failure to comply will be deemed misuse, thereby relieving the engine manufacturer of responsibility under its warranty.

THIS MANUAL CONTAINS NO WARRANTIES, EITHER EXPRESSED OR IMPLIED. The information and procedures contained herein provide the overhauler with technical information and instructions applicable to proper overhaul procedures.

Prior to overhaul, the mechanic must meet requirements of Federal Aviation Regulation 65 and must follow FAR parts 43, 91, and 145, as applicable. This manual must be used in conjunction with the FAA Advisory Circular 43.13-1A, Acceptable Methods, Techniques and Practices -- Aircraft Inspection and Repair, as well as Teledyne Continental Motors' IO-470 Series Parts Catalog X30589A.

CHAPTER

INTRODUCTION

This Teledyne Continental Motors Overhaul Manual is prepared in accordance with the GAMA (General Aviation Manufacturers Association) format. The manual is divided into groups which enable a broad separation of contents, (Chapters) within each group.

The chapters are broken down into major systems, Engine - Reciprocating, Exhaust, Starting, etc. The System Chapters are arranged alphabetically. All System Chapters are assigned a number which becomes the first element of a standardized numbering system. The element "72" of the number series 72-00-00 refers to the System Chapter on "Engine Reciprocating." All information pertaining to the engine will be covered in this System Chapter.

The major System Chapters are then broken down into Sub-System Sections. These sections are identified by the second element of the standardized numbering system. The number "10" of the basic number series "72-10-00" is for the "disassembly" of the engine.

The Subsection is the third element of the standardized numbering system "72-10-12." This number is the final breakdown of the Chapter. Number "12" is for "Oil Pump Assembly," that is "Disassembled" from the "Engine."

EXAMPLE:

- Chapter -	- Section -	- Subsection -
"Engine Reciprocating"	"Disassembly"	"Oil Pump Assembly"
72	10	12

72 - 10 - 12

In producing this publication, considerable effort has been put forth to provide grammatically clear and accurate information. Teledyne Continental Motors solicits the users assistance in providing information for review on changes that the user may suggest.

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LIST OF ILLUSTRATIONS

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LIST OF CHARTS

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CHAPTER 1
INTRODUCTION

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1-00-00 SCOPE

Recommendations, cautions and warnings regarding overhaul of these engines are not intended to impose undue restrictions. They are inserted to obtain maximum performance from the engine in accordance with safety and efficiency. Abuse, misuse, or neglect of any piece of equipment can cause eventual failure. For an aircraft engine it is obvious that a failure may have disastrous consequences. Failure to observe the instructions, contained in this manual, constitutes unauthorized operation in areas unexplored during development of the engine, or in areas in which experience has proved to be undesirable or detrimental.

NOTES, *CAUTIONS* and **WARNINGS** are included throughout this manual. Application is as follows:

NOTE . . . Special interest information which may facilitate the operation of equipment.

CAUTION . . . Information issued to emphasize certain instructions or to prevent possible damage to engine or accessories.

WARNING . . . Information which, if disregarded, may result in severe damage to or destruction of the engine or endangerment to personnel.

1-00-01 RELATED PUBLICATIONS

A. Engine Manuals:

1. Maintenance and Overhaul Manual for IO-470 Series Aircraft Engine, Form X30588A.
2. Illustrated Parts Catalog for IO-470 Series Aircraft Engine, Form X30589A.
3. Teledyne Continental Motors Aircraft Engine Service Bulletins.
4. Fuel Injection Manual, Form X30593A

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

Teledyne Continental Motors
Aircraft Products Division
P. O. Box 90
Mobile, Alabama 36601
ATTN: Publications Department

B. Accessory Manuals:

1. Magnetos	Service Manual Form X40000 Teledyne Continental Motors Aircraft Products Divsion P.O. Box 90 Mobile, AL 36601 Attn: Publications Department
	Service Manual Slick Electro Inc. 530 Blackhawk Park Avenue Rockford, Illinois 61100
2. Alternator	Alternator Service Instructions Form X30531-2 Teledyne Continental Motors Aircraft Products Division P. O. Box 90 Mobile, Alabama 36601 Attn: Publications Department
3. Starter	Teledyne Continental Motors Form X30592 P. O. Box 90 Mobile, Alabama 36601 Attn: Publications Department

1-00-02 **BULLETINS.** Bulletins that are issued to Distributors and subscribers from Teledyne Continental Motors are divided into three separate groups: (1) Customer Information Bulletins; (2) Service Bulletins and (3) Mandatory Service Bulletins.

(1) Customer Information Bulletins are published to help provide the latest information on TCM marketing procedures, policies and product information.

(2) Service Bulletins provide current information related to service, maintenance and technical support of the product.

(3) Mandatory Service Bulletins are issued with required compliance information that may affect safety of flight.

These bulletins are also available to owners, operations or maintenance personnel on an annual subscription basis.

NOTE: Teledyne Continental Bulletins are easily distinguished by their title color:
(1) Customer Information Bulletins -- Blue;
(2) Service Bulletins -- Black;
(3) Mandatory Service Bulletins -- Red.

1-00-03 **SERVICE REPORTS AND INQUIRIES.** If for any reason you have an inquiry or require technical assistance beyond the scope of your service facility, 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 Department.

1-00-04 **100% REPLACEMENT PARTS.**
It is recommended that the following parts be replaced 100 percent during the major overhaul of any Teledyne Continental Motors' aircraft engine regardless of conditions.

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Hydraulic Lifters	All IO-346, IO-360, LTSIO/TSIO-360, O-470, IO-470, TSIO-470, GIO-470, IO-520, GTSIO-520, LTSIO/TSIO-520-285 Models.
Intake Guide Seals	All Models
Oil Seals	All Models
Gaskets, Packings & Hoses	All Models
Circlips, Lock Plates & Retaining Rings	All Models
Piston Rings	All Models
Valve Keepers	All Models
Bearings - Main, Rod Thrust	All Models
Rubber Drive Bushings	All Models
Exhaust Valves	All Models
Piston Pins	All Models
Roto-Coils	All Models
Needle Bearings	All Models
Woodruff Keys	All Models
Rocker Arm & Conn. Rod Bushings	All Models
Nuts - Self-locking	All Models
Cotter Pins	All Models
Pistons	All Models
Springs - Oil Pressure	All Models
Generator Belts	All Models
Springs - Starter Clutch	All Models
Harnesses	All Models
Oil Suction Screens w/Small Openings	All Models
Spark Plugs	All Models
Exhaust Clamps, Turbo to Tailpipe	All TSIO Models
Washers - Locking	All Models
Counterweight Bushings	All Models
Counterweight Pins	All Models
Primer Diverter Valve	All Models Where Applicable

CRANKCASES ALL MODELS

Re-assembly with configuration crankcase as per Service Bulletin M77-14 Rev. 1 and M83-10 Rev. 1 at the time major overhaul is recommended.

1-10-00 DEFINITIONS AND ABBREVIATIONS

1-10-01 ABBREVIATIONS/SYMBOLS

TERM	EXPLANATION
A.B.C.	After Bottom Center
ADMP	Absolute Dry Manifold Pressure
Approx.	Approximately
A.T.C.	After Top Center
Bar.	Barometric
B.B.C.	Before Bottom Center
B.H.P.	Brake Horsepower
BSFC	Brake Specific Fuel Consumption
B.T.C.	Before Top Center
F.A.A.	Federal Aviation Administration
C.A.R.	Civil Air Regulations
c.f.m.	Cubic Feet Per Minute
C.G.	Center of Gravity

C.H.T.	Cylinder Head Temperature
CCW	Counterclockwise Rotation
CW	Clockwise Rotation
°	Degrees of Angle
°F.	Degrees of Fahrenheit
EGT	Exhaust Gas Temperature
Fig.	Figure (Illustration)
Front	Propeller End
ft.	Foot or Feet
F.T.	Full Throttle
FT-LBS	Foot Pounds Torque
G.P.M.	Gallons Per Minute
gms	Grams
H_2O	Water
Hg.	Mercury
I.D.	Inside Diameter
in. (")	Inches
Hex.	Hexagon
hr.	Hour
IN-LBS	Inch Pounds Torque
Left Side	Side on which Nos. 2, 4 and 6 cylinders are located (Rear to Front)
Lbs.	Pounds
Lockwire	Stainless Steel Wire Used To Safety Connections, Etc.
100LL	100 Octane Low Lead Fuel
Man.	Manifold and or Manometer
Max.	Maximum
Min.	Minimum
30'	Thirty Minutes of Angle (60' equals one degree)
N.P.T.	National Pipe Thread (tapered)
N.C.	National Course (thread)
N.F.	National Fine (thread)
NRP	Normal Rated Power
OAT	Outside Air Temperature
O.D.	Outside Diameter
oz.	Ounce
Press.	Pressure
p.s.i.	Pounds Per Square Inch
PSIA	Pounds Per Square Inch Absolute
PSIG	Pounds Per Square Inch Gage
PPH	Pounds Per Hour
Rear	Accessory End of Engine
Rec.	Recommended
Right Side	Side on Which Nos. 1, 3 and 5 Cylinders are Located (rear to front)
R.P.M.	Revolution Per Minute
Std.	Standard
TBO	Time Between Overhaul
T.D.C.	Top Dead Center
T.I.T.	Turbine Inlet Temperature
Torque	Force x Lever Arm (125 ft.-lbs. torque = 125 lbs. force applied one ft. from bolt center or 62-1/2 lbs. applied 2 ft. from center, etc.)

1-10-02 DEFINITIONS.

ADMP	Absolute dry manifold pressure, is used in establishing a baseline standard of engine performance. Manifold pressure is the absolute pressure in the intake manifold; measured in inches of mercury.
Ambient	A term used to denote a condition of surrounding atmosphere at a particular time. For example: Ambient Temperature or Ambient Pressure.
BHP	Brake Horsepower. The power actually delivered to the engine propeller shaft. It is called Brake Horsepower because it was formerly measured by applying a brake to the power shaft of an engine. The required effort to brake the engine could be converted to horsepower - hence: "brake horsepower".
BSFC	Brake Specific Fuel Consumption. Fuel Consumption stated in pounds per hour per brake horsepower. For example, an engine developing 300 horsepower while burning 150 pounds of fuel per hour, has a BSFC of .5. $\frac{\text{Fuel Consumption in PPH}}{\text{Brake Horsepower}} = .5$
Cavitation	Formation of partial vacuums in a flowing liquid as a result of the separation of its parts.
Cold Soaking	Prolonged exposure of an object to cold temperatures so that its temperature throughout approaches that of ambient.
Corrosion	Deterioration of a metal surface usually caused by oxidation of the metal.
Critical Altitude	The maximum altitude at which a component can operate at 100% capacity. For example, an engine with a critical altitude of 16,000 feet cannot produce 100% of its rated manifold pressure above 16,000 feet.
Density Altitude	The effective altitude, based on prevailing temperature and pressure, equivalent to some standard pressure altitude.
Dynamic Condition	A term referring to properties of a body in motion.
Exhaust Back Pressure	Opposition to the flow of exhaust gas, primarily caused by the size and shape of the exhaust system. Atmospheric pressure also affects back pressure.
Four Cycle	Short for "Four Stroke Cycle". It refers to the four strokes of the piston in completing a cycle of engine operation (Intake, Compression, Power and Exhaust).
Fuel Injection	A process of metering fuel into engine by means other than a carburetor.
Gallery	A passageway in the engine or subcomponent. Generally one through which oil is directed.

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Galling or Scuffing	Excessive friction between two metal surfaces resulting in particles of the softer metal being torn away and welded to the harder metal.
Humidity	Moisture in the atmosphere. Relative humidity, expressed in percent, is the amount of moisture (water vapor) in the air compared with the maximum amount of moisture the air could contain at a given temperature.
Impulse Coupling	A mechanical device used in some magnetos to retard the ignition timing and provide higher voltage at cranking speeds for starting.
Lean Limit Mixture	The leanest mixture approved for any given power condition. It is not necessarily the leanest mixture at which the engine will continue to operate.
Manifold Pressure	Pressure measured in the intake manifold down-stream of the air throttle. Usually measured in inches of mercury.
Major Overhaul	Per FAA AC43-11 consists of the complete disassembly of an engine, inspected, repaired as necessary, reassembled, tested, and approved for return to service within the fits and limits specified by the manufacturer's overhaul data. This could be to new fits or limits or serviceable limits. The determination as to what fits and limits are used during an engine overhaul should be clearly understood by the engine owner at the time the engine is presented for overhaul. The owner should also be aware of any parts that are replaced, regardless of condition, as a result of manufacturer's overhaul data, service bulletin, or an airworthiness directive.
Mixture	Mixture ratio. The proportion of fuel to air used for combustion.
Naturally Aspirated (Engine)	A term used to describe an engine which obtains induction air by drawing it directly from the atmosphere into the cylinder. A non-supercharged engine.
Octane Number	A rating which describes relative anti-knock (detonation) characteristics of fuel. Fuels with greater detonation resistance than 100 octane are given performance ratings.
Oil Temperature Control Unit	A thermostatic unit used to divert oil through or around the oil cooler, as necessary, to maintain oil temperature within desired limits.
Overboost Valve	A safety device used on some turbocharged engines to relieve excessive manifold pressure in the event of malfunction.
Overhead Valves	An engine configuration in which the valves are located in the cylinder head itself.
Performance Rating	A rating system used to describe the ability of fuel to withstand heat and pressure of combustion as compared with 100 octane fuel. For example, an engine with high compression and high temperature needs a higher Performance Rated fuel than a low compression engine. A rating of 100/130 denotes performance characteristics of lean (100) and rich (130) mixtures respectively.

Permold	A term used to describe a process by which a crankcase is made. An engine with a permold crankcase has a front, right-hand mounted, gear driven alternator.
Pressure Altitude	Altitude, usually expressed in feet, (using absolute static pressure as a reference) equivalent to altitude above the standard sea level reference plane (29.92" Hg. Standard).
Propeller Load Curve	A plot of horsepower, versus RPM, depicting the power absorption characteristics of a fixed pitch propeller.
Propeller Pitch	The angle between the mean chord of the propeller and the plane of rotation.
PSIA	The absolute pressure measured by the number of pounds - force exerted on an area of one square inch.
Ram	Increased air pressure due to forward speed.
Rated Power	The maximum horsepower at which an engine is approved for operation.
Retard Breaker	A device used in magnetos to delay ignition during cranking. It is used to facilitate starting.
Rich Limit	The richest fuel/air ratio permitted for a given power condition. It is not necessarily the richest condition at which the engine will run.
Rocker Arm	A mechanical device used to transfer motion from the pushrod to the valve.
Run Out	Eccentricity or wobble of a rotating part.
Sandcast	A term used to describe a process by which a crankcase is made. An engine with a sandcast crankcase has a belt driven alternator mounted on the left rear accessory case and a front, right-hand mounted oil cooler.
Scavenge Pump	A pump (especially an oil pump) to prevent accumulation of liquid in some particular area.
Sonic Venturi	A device used in cabin pressurization systems, to limit the flow of air through a duct.
Standard Day	By general acceptance, a condition of the atmosphere wherein specific amounts of temperature, pressure, humidity, etc. exist.
Static Condition	A term referring to properties of a body at rest.
Sump	The lowest part of a system. The main oil sump on a wet sump engine contains the oil supply.

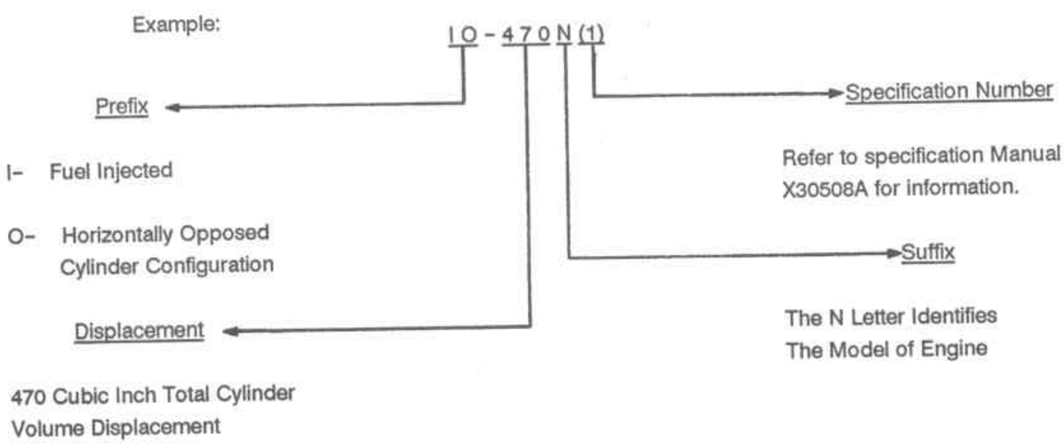
T.D.C.	Top Dead Center. The position in which the piston has reached the top of its travel. A line drawn between the crankshaft rotational axis, through the connecting rod end axis and the piston pin center would be a straight line. Ignition and valve timing are stated in terms of degrees before or after TDC.
Thermal Efficiency	Regarding engines, the percent of total heat generated which is converted into useful power.
T.I.T.	Turbine Inlet Temperature. The measurement of E.G.T. at the turbocharger turbine inlet.
Torque	Twisting moment, or leverage, stated in foot - pounds or inch-pounds.
Turbocharger	A device used to supply increased amounts of air to an engine induction system. In operation, a turbine is driven by engine exhaust gas. In turn, the turbine directly drives a compressor which pumps air into the engine intake.
Vapor Lock	A condition in which the proper flow of a liquid through a system is disturbed by the formation of vapor. Any liquid will turn to vapor if heated sufficiently. The amount of heat required for vaporization will depend on the pressure exerted on the liquid.
Turbo Supercharged (Engine)	A term used to describe an engine which obtains induction air by drawing it directly from the atmosphere into the Turbocharger Compression Inlet, compressing the air and routing it to the pressurized induction system.
Variable Pressure Controller	A device used to control the speed, and thus the output of the turbocharger. It does so by operating the wastegate which diverts, more or less, exhaust gas over the turbine.
Vernatherm Valve	A thermostatic valve used to divert oil through or around the oil cooler, as necessary, to maintain oil temperature within desired limits.
Viscosity	The characteristic of a liquid to resist flowing. Regarding oil, high viscosity refers to thicker or "heavier" oil while low viscosity oil is thinner. Relative viscosity is indicated by the specified "weight" of the oil such as 30 "weight" or 50 "weight". Some oils are specified as multiple-viscosity such as 10W30. In such cases, this oil is more stable and resists the tendency to thin when heated or thicken when it becomes cold.
Volatility	The tendency of a liquid to vaporize.
Volumetric Efficiency	The ability of an engine to fill its cylinders with air compared to their capacity for air under static conditions. A "naturally aspirated" engine will always have a volumetric efficiency of slightly less than 100%, whereas superchargers permit volumetric efficiencies in excess of 100%.

Wastegate Valve — A unit, used on turbocharged engines, to divert exhaust gas through or around the turbine, as necessary, to maintain turbine speed. As more air is demanded by the engine, due to throttle operation, the compressor must work harder. In order to maintain compressor and turbine speed, more exhaust must flow through the turbine. The wastegate valve closes and causes gas, which would go directly overboard, to pass through the turbine. The wastegate is usually operated by an actuator which gets necessary signals from the turbocharger controller.

DEFINITION OF TERMS

Front, rear, left and right, as used in this manual, refer to the engine as viewed by the mechanic facing the accessory end. Accessory end being the rear and propeller flange being the front of the engine. Cylinders are numbered starting from the rear, with odd numbers on the right and even numbers on the left.

1-10-03 DESCRIPTION OF ENGINE MODEL CODE



1-10-04 BASIC DESIGN FEATURES.

The IO-470 series engines are air cooled, having six horizontally opposed overhead inclined valve cylinders, except the IO-470-J & K which utilize the straight valve cylinder configuration. The cylinder displacement of 470 cubic inches is achieved with a 5.00 inch bore and a 4.00 inch stroke. The IO-470 series is fuel injected with an updraft runner induction system. The crankshaft is equipped with pendulum type counterweight dampers that suppress torsional vibrations.

The IO-470 engines have a doweled six bolt hole configuration propeller flange. A mounting pad is provided to utilize a hydraulic controlled governor for the constant speed propeller.

The IO-470 series engines are designed with a wet sump and a positive displacement oil pump installed on the lower rear portion of the crankcase. The desired oil pressure is maintained by a pressure relief valve located in the oil pump housing. Engine cranking is accomplished by a geared right angle drive starter adapter and a direct current starter motor.

The IO-470 series engines have provisions for a belt driven generator or alternator. The engine is equipped with two gear driven magnetos. The exhaust system may or may not be supplied with the engine by the engine manufacturer depending on the particular engine model.

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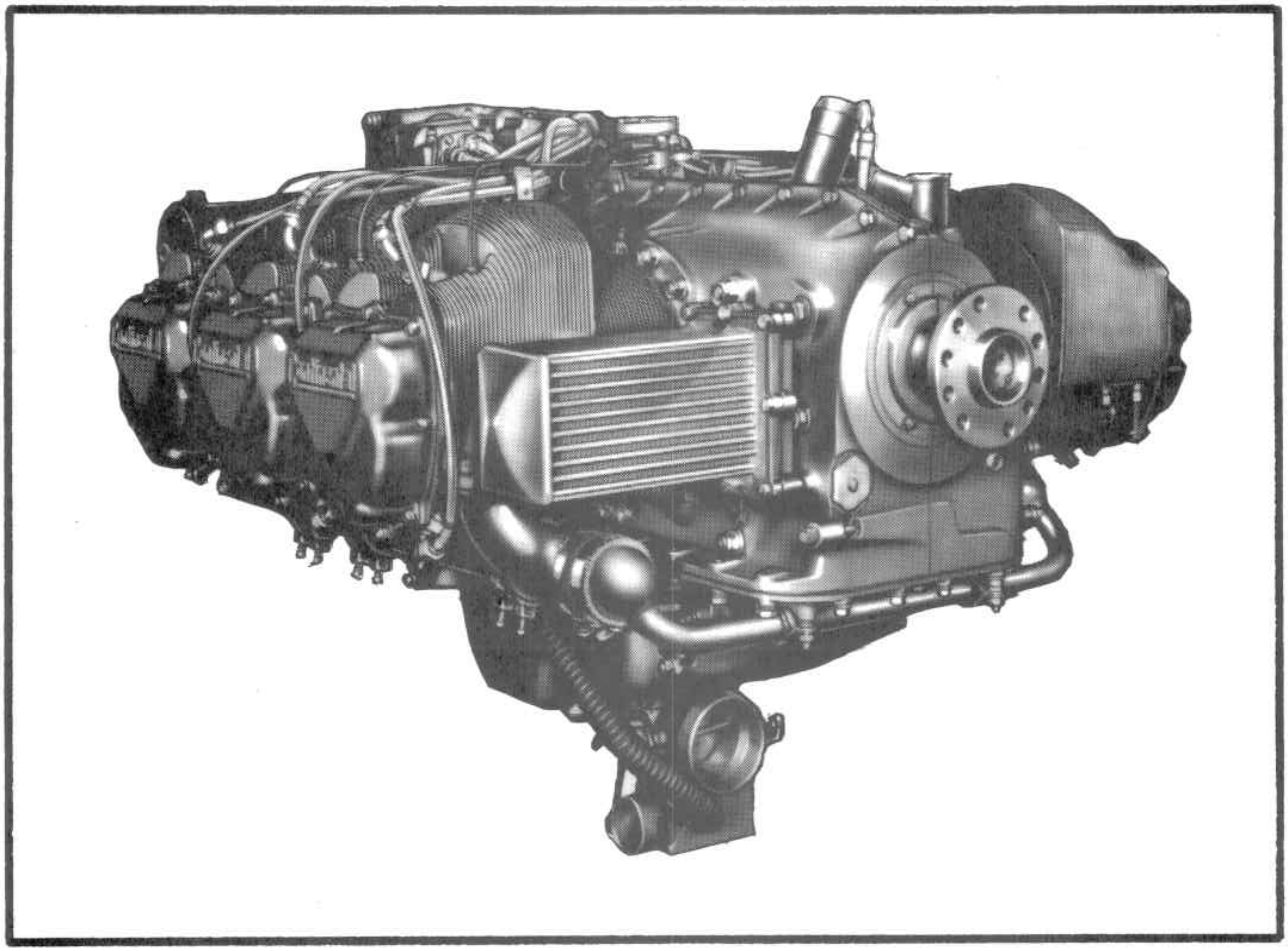

THREE–QUARTER RIGHT FRONT VIEW OF THE IO–470 SERIES.

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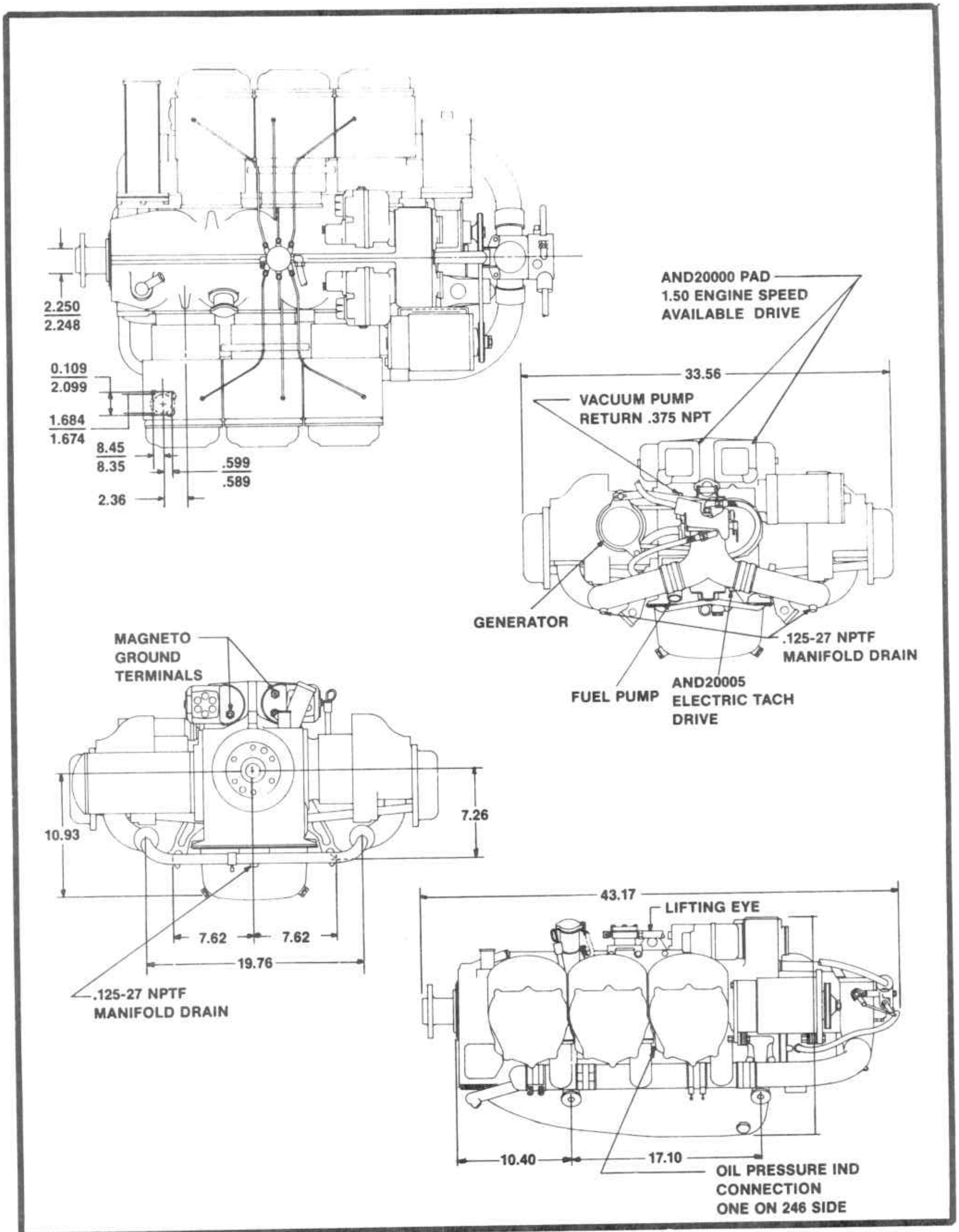

INSTALLATION DRAWING OF TYPICAL IO-470

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1-20-00 TOOLS

The mechanic should be equipped with a complete set of common tools to include the minimum of:

1. Wrenches - 1/4" thru 1"
2. Common and Philister Head Screwdrivers
3. Pliers - Common Dykes, Needle Nose, Duck Bill, Vise Grip, Snap Ring.
4. Ratchets 1/4", 3/8", 1/2" Drive
5. Sockets - 1/4" Drive 5/32" thru 1/2" - 3/8" Drive 3/8" thru 1" - 1/2" Drive 7/16" thru 1-1/4"
6. Sockets (Deepwell) - 1/2" Drive 7/16" thru 1"
7. Feeler Gages
8. Leather Mallet
9. Torque Wrenches (Calibrated) - 0-500 In. Lbs. - 0-100 Ft. Lbs.
10. Micrometers

1-20-01 SPECIAL TOOLS

Specific tools illustrated or similar tools marketed by other manufacturers are necessary for service and maintenance of the aircraft engine. Tool illustrations shown on the following pages are used with the permission of the respective manufacturers.

Illustrations in this section show only the general appearance of tools and do not correspond to the actual size or shape. Details of special tools, fixtures, equipment and consumable materials appropriate to overhaul procedures are listed in the various chapters and subsystems of this manual; the following information is primarily for procurement purposes.

The following special tools are for **All** the Teledyne Continental Engines for the purpose of convenience. To determine which tools are needed for your particular engine, refer to "Special Tool Index."

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SPECIAL TOOLS

PROCUREMENT SOURCES

COMPANY	GENERAL PRODUCT SUMMARY
ALCOR, INC. (ALR) Box 32516 10130 Jones Maltsberger Rd. San Antonio, TX 78284 512/349-3771	Instruments for Light Powered Aircraft Special Tools
BORROUGHS TOOL & EQUIP. CORP. **2429 N. Burdick St. (BTC)** Kalamazoo, MI 49007-1897 616/345-5163 or 345-2700	**Precision Instruments** Measuring Instruments Precision Tools Special Tools
CHAMPION SPARK PLUG, CO. (CSPC) Box 910, 900 Upton Ave. Toledo, OH 43661 419/535-2461	Spark Plugs, Ignitors Oil Filters Special Tools
EASTERN ELECTRONICS, INC. (EEI) 180 Roberts St. East Hartford, CT 06108 203/528-9821	Fuel Pressure Test Equipment Measuring Instruments Precision Tools Piston Position Indicators Printed and Standard Circuits
FEDERAL TOOL SUPPLY CO., INC. (FTSC) 10631 Capital Oak Park, Michigan 48237 800/521-1508 TOLL FREE or 313/543-9300	Precision Inspection Instruments Special Tools
OTC TOOLS & EQUIPMENT (OTC) Division of Owatonna Tool Company Owatonna, Minnesota 55060 507/451-5310	Precision Tools Special Tools Hydraulic Accessories
McMASTER-CARR SUPPLY CO. (MCSC) P.O. Box 4355 Chicago, Illinois 60680 312/833-0300	Precision Tools Special Tools
SNAP ON TOOLS (SOT) 2611 Commerce Blvd. Birmingham, Alabama 35210 205/956-1722	Precision Tools Special Tools

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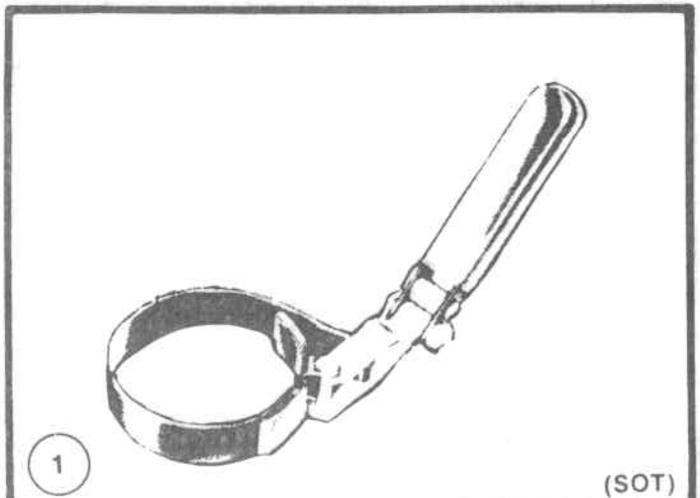
NOTICE

All tools reference under Sub-section 1-20-01 Special Tools, are for reference only, not for the purpose of promoting or suggesting tools to be purchased from the indicated sources.

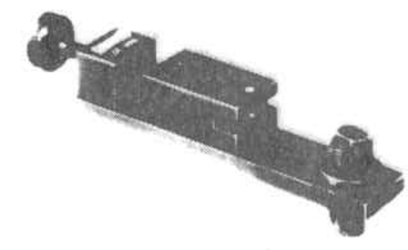
IDENTIFICATION CODE FOR TOOLS

EXAMPLE: The Supplier Identifier Code is shown in the lower right-hand corner of applicable tool photograph.

CODE		SUPPLIER
(ALR)	=	ALCOR, INC.
(BTC)	=	BORROUGHTS TOOL AND EQUIPMENT CORP.
(CSPC)	=	CHAMPION SPARK PLUG, CO.
(EEI)	=	EASTERN ELECTRONICS, INC.
(FTSC)	=	FEDERAL TOOL SUPPLY CO., INC.
(OTC)	=	OTC TOOLS & EQUIPMENT CO.
(MCSC)	=	McMASTER-CARR SUPPLY CO.
(SOT)	=	SNAP ON TOOLS



1 (SOT)



2 (CSPC)

Strap Wrench

For removal of oil filter, spring steel band surrounds and tightens as the handle is pulled. Vinyl gripped handle swivels to clear obstructions.
GA333 for 3" to 3-3/8" Dia. Filters
GA340 for 3-1/2" to 3-7/8" Dia. Filters
YA341 for 4-1/8" to 4-7/16" Dia. Filters

Oil Filter Sludge Inspection

Inspection of engine sludge trapped in spin-on oil filters has been recommended practice for many years. Licensed aircraft mechanics recognize the value of visual inspection to aid in determining if internal engine wear or malfunction has occurred, and to inspect for metal or other contaminates within the engine oil system.

Use of the Champion CT-470 Oil Filter Can Cutter eases the opening of spin-on filters without introducing foreign material into the filter.

Following is the recommended procedure for inspection of full flow oil filters:

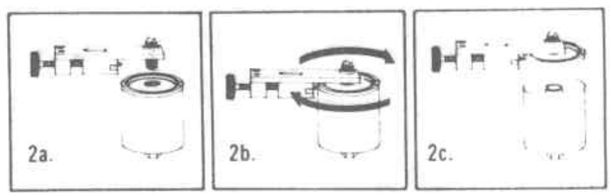
1) Remove filter from the engine and place on a drain tray. Allow oil to drain through a clean cloth to determine if foreign material drains from the filter.

2) Using the Champion CT-470 Can Cutter, open the filter as follows; (See photos):

   a. Insert threaded adapter in female threads of filter, or screw rotating bushing on male threads of filter.

   b. Slightly tighten cutter blade against filter and rotate 360°. Repeat operation until mounting plate section separates.

   c. Lift mounting plate to expose complete filter media for inspection.



2a. 2b. 2c.

3) Using clean plastic bucket containing approximately 1 pt. clean varsol, swish filter element around in the varsol to loosen entrapped metal or other contaminant.

4) Using a clean magnet, work it around in the varsol solution. Ferrous metal particles in the solution should adhere to the magnet for inspection.

5) After all ferrous metal particles have been retrieved by the magnet, pour remaining varsol through another clean shop rag, and in a bright light, any non-ferrous metals should be detectable.

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Cylinder Base Nut Wrenches
3882 Series

The 3882 Series wrenches feature 1/2" square drive and 12-point hex sockets. The wall thickness between the hex and wrench O.D. is closely controlled for maximum strength. Approx. 16" long overall.

3882 9/16" hex
3882-1 7/16" hex
3882-2 1/2" hex
3882-3 5/8" hex
3882-4 3/4" hex

3 (BTC)

Cylinder Base Nut Wrenches
For Bonanza Aircraft

These two wrenches are specially manufactured for the Bonanza, where space is limited. The overall wrench length is controlled to close tolerance to ensure easy access to nuts. 13" long.

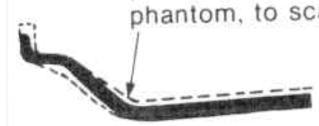
3882A 9/16" hex
3882-3A 5/8" hex

4 (BTC)

Cylinder Base Nut Wrench

Specially modified 3882-type wrench, this special wrench is perfect for those occasional situations when the 3882 wrench won't fit. It's a slightly different configuration, as shown above.

8079
9/16" hex



5 (BTC)

Spark Plug Wrench
8160

Wrench designed to remove and install spark plugs that are located behind the after cooler.

5A (BTC)

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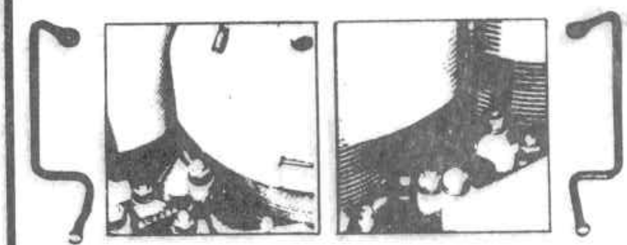
Cylinder Base Nut Wrenches For 470 and 520 Series

The special configuration of these wrenches permits access to the cylinder base nut areas as shown in photos. Approx. 17" long.



6 — 5203 5/8" hex — 5204 5/8" hex (BTC)

Cylinder Base Nut Wrenches For GTSIO-520F,K

The GTSIO-520F,K features certain nuts that are virtually unreachable without these wrenches.

7 — 8032 5/8" hex — 8031 9/16" hex (BTC)

Cylinder Base Nut Wrench For Continental 550 Engine

This 9/16" hex wrench is specifically designed for easy access to nuts on the 550 series engines. Standard 1/2" square drive. Rugged 4140 alloy steel, 13" long overall.

8 — 8158 (BTC)

Generator Base Nut Wrenches

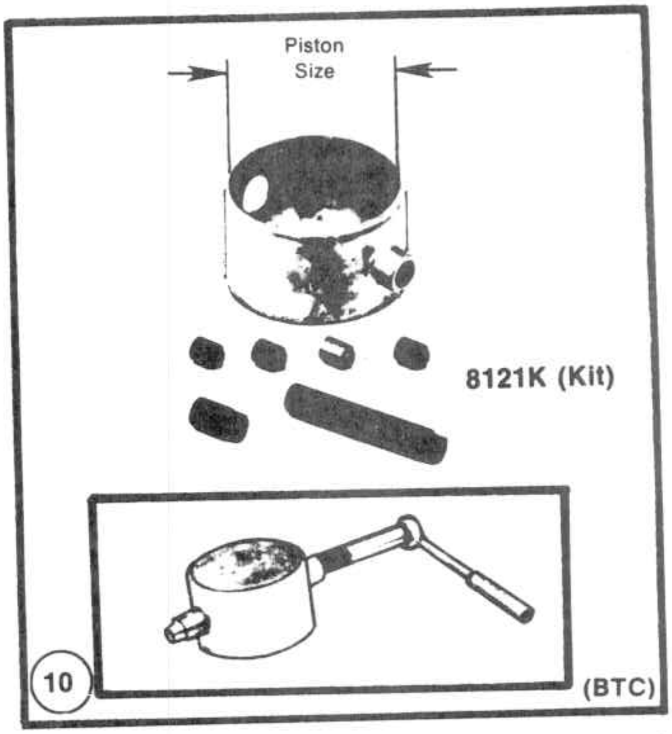
The 5205 is for Westinghouse 100-amp generators, and is 15" long overall, with 1/2"-square drive. The 5205-1 is 7-3/4" long with a right-angle handle for leverage.

9 — 5205 1/2" hex — 5205-1 1/2" hex (BTC)

Piston Pin Removers
8121 Series

Design allows piston pin removal without removing adjoining cylinder. Sizes to fit Continental engines.

Body Ass'y.	Piston Size
8121A	4-7/16"
8121B	5"
8121C	5-1/8"
8121D	5-1/4"

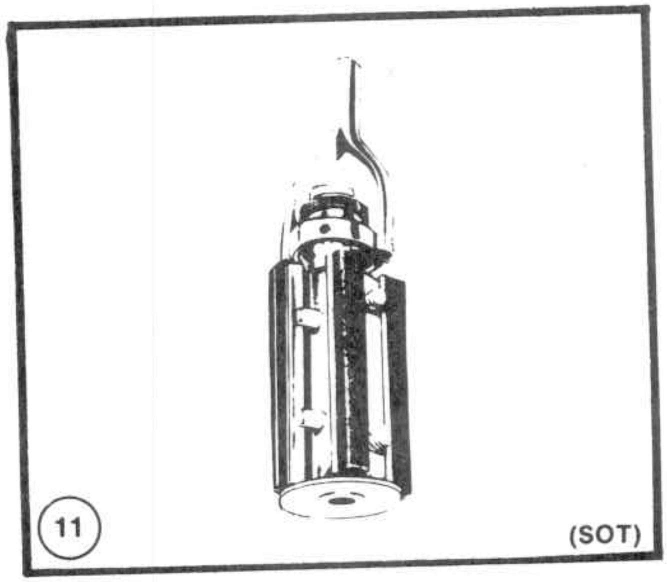


10 (BTC)

Cylinder Hone

Expandable racks adjust to cylinder size with universal joint action. Optional set for use on TCM cylinders.

CFL10 Standard/3" to 4-1/4"
CFL10-7 Optional/4" to 6-1/2"

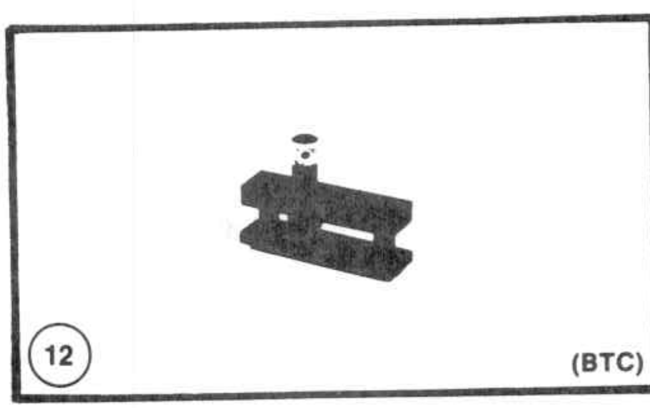


11 (SOT)

Crankshaft Blade and Damper Bushing Removers/Replacers

Back-up plates and forcing screws are rugged, heat-treated alloy steel. Be sure to keep forcing screws greased.

4965A – for 5/8" I.D. Bushings
3604 – for 3/4" I.D. Bushings
3607 – for 15/32" I.D. Bushings
3607-1 – for GTSIO-520
8068 – for .604 I.D. Bushings



12 (BTC)

Holding Fixture Adapters

With these adapters, you may bolt the cylinder onto the 5221B Fixture in order to do:

Cylinder Honing
Valve Seat Insert Work (insert removal, seat cutting, insert installation).

5221-12A Adapter for Continental A65-80, A90, C125, C145

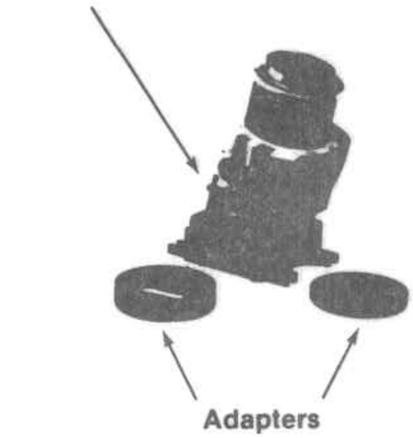
5221-13A Adapter for Continental O and IO-470 and 520 Series

5221-15A Adapter for Continental IO-360

5221-16A Adapter for Continental GTSIO-520

5221-17A Clamp Assembly (one req'd.)

Note: The original #5221 Fixtures require 4 additional tapped holes in rocker plate to accept the above adapters — a blueprint showing hole sizes and locations is included with adapters.



13 (BTC)

Universal Cylinder Holding Fixture 5221B

This is a heavy-duty, precision fixture manufactured to extremely close tolerances. Suitable for use on vertical mills or drill presses, it allows quick indexing of required angles for valve work.

Features:

- For all Continental Engines.
- Fixture indexes in all present positions required to machine valve guides.
- Locks in at these angles:
  0° 11°45′ 12°40′ 16°
  11°30′ 12° 15°
- Adapter rings are included to cover all Continental engines.

5221-10LA For wide deck

5221-11LA For narrow deck.

14 (BTC)

Valve Guide Cleaner 122

Expandable type fits all Continental engines.

15 (BTC)

Seal Seat Cutter 8066
Per Continental Bulletin M76-24

Modifies valve guide stems to accept oil control seals. Carbide-tipped cutter blades compensate for wear.

16 (BTC)

Spring Checker 7521A
Per Continental Bulletin M74-16

Check valve spring quickly and easily. Hydraulically actuated, extremely accurate readout (0-160 pounds). Includes step gauges for all required dimensions. 7521 Checker is less step gauges.

Max. spring dimensions: Ht.-2-1/2", O.D.-2".

(Heat-Shrink Type)

17 (BTC)

Valve Guide Removers
(Cold Force Removal Type)

Tough heat-treated steel.
3611 — .375" I.D. Guide
2874 — .436/.438" I.D. Guide

18 (BTC)

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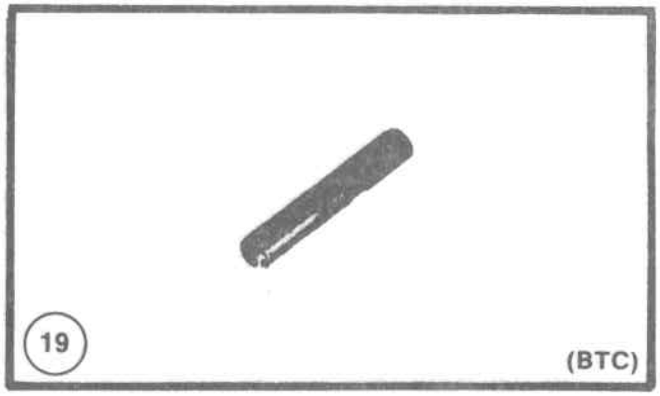
Valve Guide Replacers

Alloy steel, heat-treated for maximum toughness.

4912 — .344" I.D. Guide
3619 — .375" I.D. Guide
2842 — .436/.438" I.D. Guide



19 (BTC)

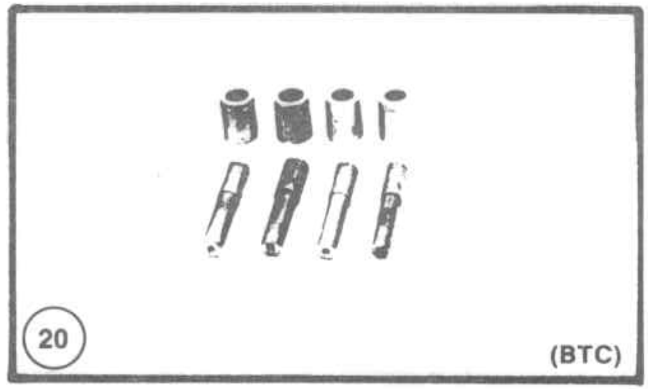
Rocker Arm Bushing Remover/Installer Set 8118

Driver and Adapter Ass'y.	Pilot Dia.	Ram Dia.	Replaces Tool
8118G	.731	.871	7233
8118H	.706	.808	5007/2881-1
8118J	.593	.699	4904
8118K	.573	.714	—

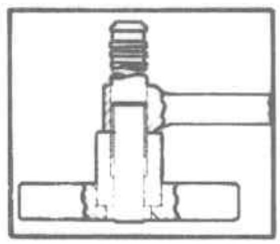
8118 Set includes one each 8118G, 8118H, 8118J, 8118K and 8098-10 Base.

Driver and Adapter Assemblies also available individually. The 8098-10 Base must be used with 8118G, 8118H, 8118J and 8118K Driver and Adapter Assemblies.

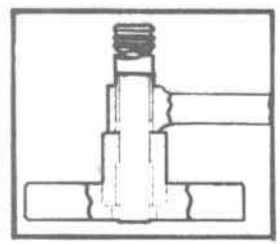
Makes rocker arm bushing removal/installation fast and easy. All components of 8118 set are also available individually.



20 (BTC)



REMOVING

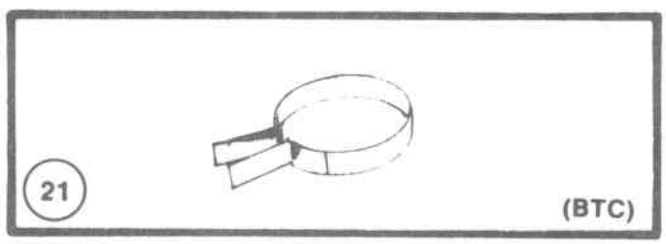


INSTALLING

Piston Ring Compressors

Flexible Band Type

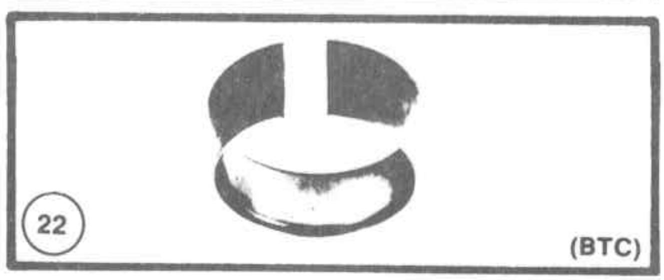
4901 — for 3-7/8" and 4-1/16" bore engines
2839 — for 5" and 5-1/4" bore engines
3618 — for 4-7/16" bore engines



21 (BTC)

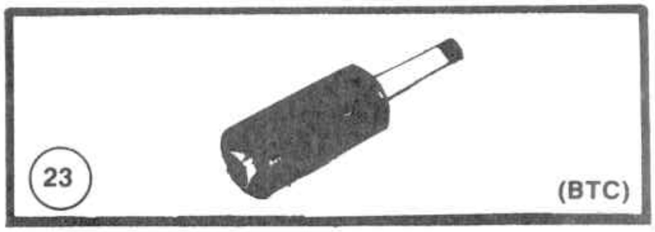
Solid, Tapered Type

4901B — for 3-7/8" bore engines
4901A — for 4-1/16" bore engines
3601 — for 4-7/16" bore engines
2839A — for 5" bore engines
5201 — for 5-1/4" bore engines



22 (BTC)

3170 — Floating holder, No. 3 Morse male, compensates for misalignment between reamer and work. Provides unrestricted float.

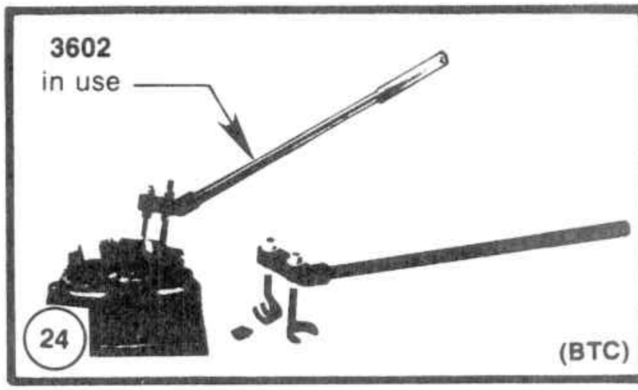


23 (BTC)

Valve Spring Compressor 3602

Adjustable type works on all Continental engines.

Hook installs on rocker shaft (or on special rocker nut furnished) and c-shaped collar compresses spring to allow keeper removal. All stressed parts are heat-treated steel. Handle is approx. 18" long for good leverage.

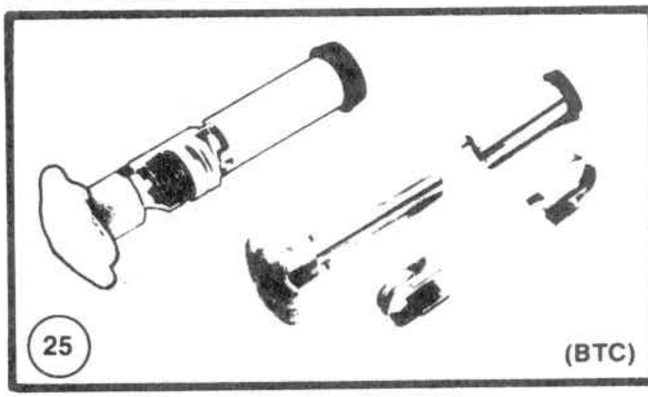


24 (BTC)

Push Rod Spring Compressor 68-3

For compressing and holding push rod springs on all engines with spring loaded tubes. The 68-3 compresses the spring, which can then be removed with furnished clips.

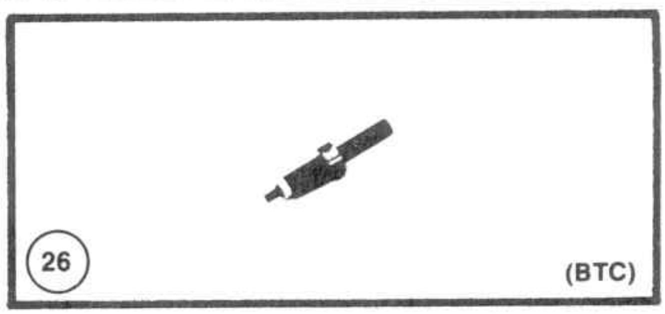
Eliminates wiring springs together — to install, simply insert spring then pull off clip! Includes instructions.



25 (BTC)

Flaring Tool for Push Rod Housing 4915A

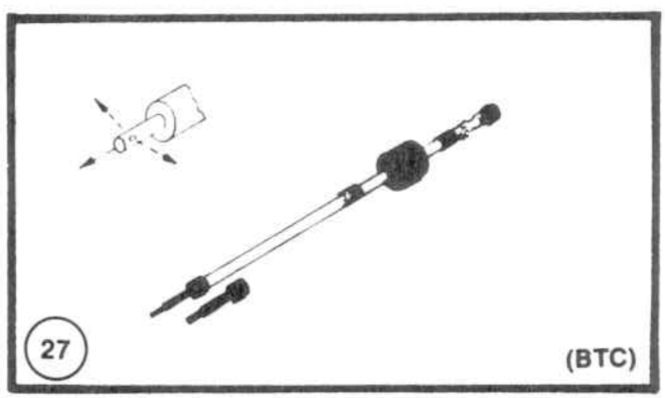
For A & C Series — expanding ball type tool. Balls rotate inside housing, expanding it into aluminum boss.



26 (BTC)

Valve Guide Remover 4981

Removes guides by heat-shrink method. Cylinder is heated to 550°F, then tool injects water into guide bore. A light tap with the slide hammer removes guide. A water reservoir (not included) supplies the low water pressure required to cool the guides for easy removal. Replacement guide is usually same size as the one removed.



27 (BTC)

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Valve Seat Insert Remover and Replacer 8086

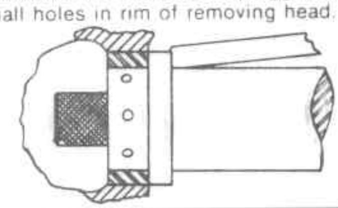
A complete tool set to remove and install valve seats by the heat-shrink method. Cylinders are heated to 600-650° F. Same handle and head is used to remove and drive down seats during installation. Mallet may be used on the handle as the seating force. Low water pressure on the order of 1 to 2 p.s.i. is all that is needed for pulling seats. This one tool set will do all Continental engines from 65 to 520 and IO-550.

Set includes:

- (1) Handle/lever assembly
- (12) Puller heads (sized to fit all Continental engines
- (10) Installer pilots
- (1) Remover plug
- 6 feet of super flexible hose to attach to water supply
- Instructions
- Storage case

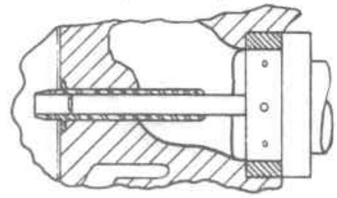
Tool is rigged for removal. Center is plugged to route water out thru small holes in rim of removing head.

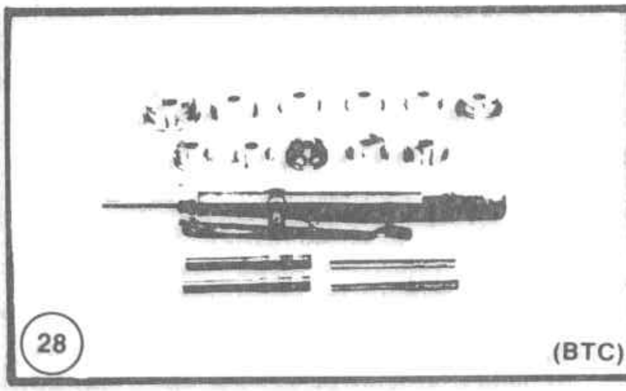
Fig. 1



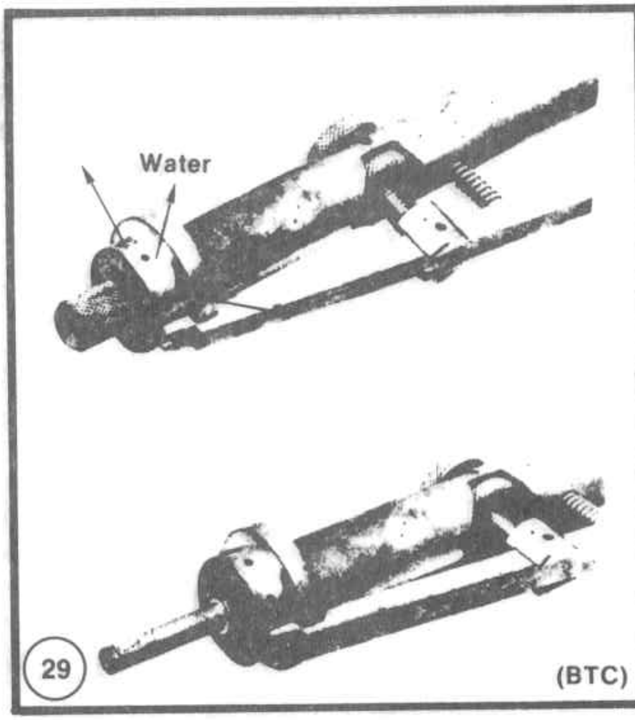
Tool is rigged for replacement. Guide on end of tool slips into valve stem hole for perfect alignment. No more cocked seats.

Fig. 2





28 (BTC)

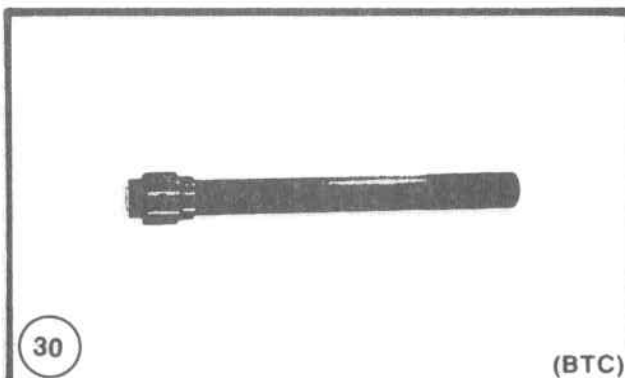


29 (BTC)

Installer Valve Seat Inserts

4910 — For 1-45/64" O.D. Exhaust and 1-53/64" O.D. Intake Inserts. (Includes head and handle.)

4956 — For 1-3/4" O.D. Exhaust and 1-57/64" O.D. Intake Inserts. (Includes head and handle.)



30 (BTC)

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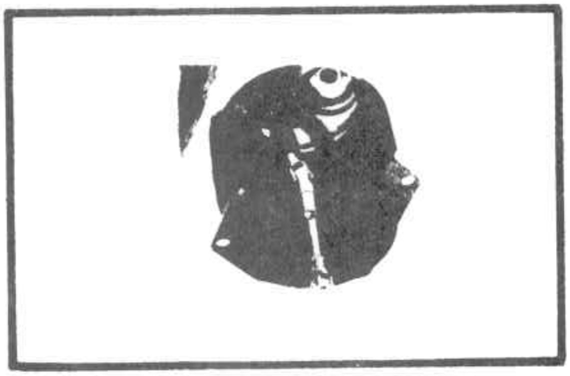
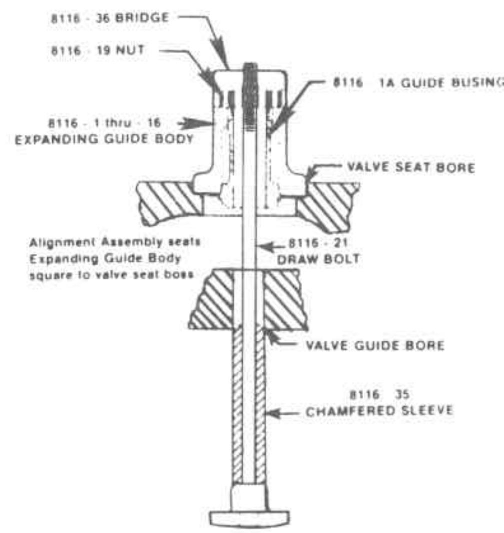
Valve Guide to Valve Seat Alignment System

Mis-aligned valve seats and guides can be re-aligned quickly.

Here's how it's done:

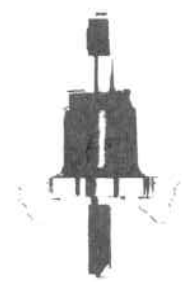
1. Remove old guides and seats.
2. Install Expanding Guide Body into valve seat boss.
3. Place Boring Bar into Guide. Bore valve guide boss concentric and perpendicular to valve seat. Follow up with Reamer.





31

Use your drill press for bore or ream operations as shown in this picture. The same guide set-up works for both.

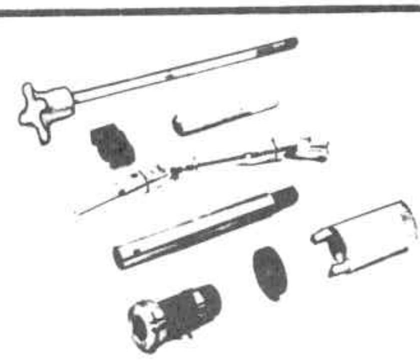


32 (BTC)

8116 Common Parts Kit

Does not include Expanding Guide Bodies or cutting tools. See below.

Select Size Parts are not part of 8116 kit. You buy only what you need (reamers, expanding guide bodies, boring bars, etc.).



33 (BTC)

Valve Stem Hole Reamers

(Takes place of 2847, 3606 & 4913 Series reamers).

Tool No.	Hole Dia.
8116-24	.344
8116-25	.375
8116-27	.436
8116-29	.438

34 (BTC)

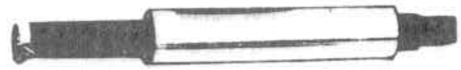
Boring Bars

Made of high-speed M2 tool steel, precision ground.

35 (BTC)

Reamers

Valve Guide Boss. (Takes place of 4914 and 4943 Series reamers.).



36 (BTC)

Reamers

Tool No.	Hole Dia.
8116-1R	.531
8116-2R	.536
8116-3R	.541
8116-4R	.546
8116-5R	.551
8116-6R	.561
8116-10R	.625
8116-11R	.630
8116-12R	.635
8116-13R	.640
8116-14R	.645
8116-15R	.655

*

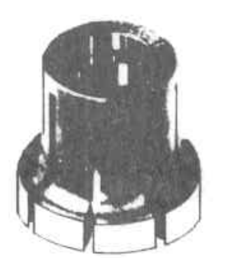
Boring Bars

Tool No.	Hole Dia.
8116-1B	.525
8116-2B	.530
8116-3B	.535
8116-4B	.540
8116-5B	.545
8116-6B	.555
8116-10B	.620
8116-11B	.625
8116-12B	.630
8116-13B	.635
8116-14B	.640
8116-15B	.650

(*Example: Use **8116-6B Boring Bar** to bore hole to .555, then finish with **8116-6R Reamer** to .561 dia.)

Expanding Guide Bodies

Expanding Body No.	Minimum Retracted Dia.	Maximum Expanded Dia.
8116-1	1.656	1.681
8116-2	1.685	1.710
8116-3	1.748	1.773
8116-4	1.785	1.810
8116-5	1.810	1.835
8116-6	1.839	1.864
8116-7	1.873	1.898
8116-8	2.068	2.093
8116-9	2.108	2.133
8116-10	2.113	2.138
8116-11	2.228	2.253
8116-12	2.388	2.413
8116-13	2.474	2.499
8116-14	2.515	2.540
8116-15	2.594	2.619
8116-16	2.629	2.654



37 (BTC)

Valve Seat Insert Cutters

Straight Side — Non-Step

WARNING! Measure New Insert O.D. and then select proper cutter.

(BTC) Straight Side Cutters

Part No.	Use	Finish Dim.	O.S.	Part No.	Use	Finish Dim.	O.S.
4909-8	Int	1.822	010"	4985-5	Int	2.140	030"
4909-9	Int	1.814	002"	4985-6	Exh	1.659	.005"
4909-12	Exh	1.689	002"	4985-7	Exh	1.664	.010"
4909-13	Exh	1.697	010"	4985-8	Exh	1.669	.015"
4954-5	Int	1.880	005"	4985-9	Exh	1.674	.020"
4954-8	Int	1.885	010"	4985-10	Exh	1.684	.030"
4954-9	Int	1.877	002"	5224-5	Int	2.522	.005"
4954-10	Int	1.895	020"	5224-10	Int	2.527	.010"
4954-11	Int	1.905	030"	5224-15	Int	2.532	.015"
4954-12	Exh	1.752	002"	5224-20	Int	2.537	.020"
4954-13	Exh	1.760	010"	5224-30	Int	2.547	.030"
4954-14	Exh	1.770	020	5225-5	Exh	1.793	.005"
4954-15	Exh	1.780	030	5225-10	Exh	1.798	.010"
4985-1	Int	2.115	005"	5225-15	Exh	1.803	.015"
4985-2	Int	2.120	010"	5225-20	Exh	1.808	.020"
4985-3	Int	2.125	015"	5225-30	Exh	1.818	.030"
4985-4	Int	2.130	020"				

(BTC)

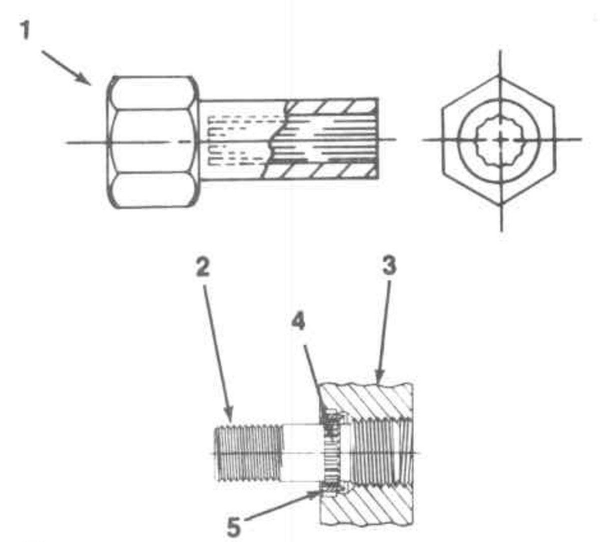
Step Side Cutters

Part No.	Small Diameter	Large Diameter	O.S.	Part No.	Small Diameter	Large Diameter	O.S.
8135	1.654	1.884	STD	8136-3	1.803	2.070	015"
8135-1	1.659	1.884	.005"	8136-4	1.808	2.070	020"
8135-2	1.664	1.884	.010"	8136-5	1.818	2.070	030"
8135-3	1.669	1.884	015"	8138	2.271	2.632	STD
8135-4	1.674	1.884	.020"	8138-1	2.276	2.632	005
8135-5	1.684	1.884	030"	8138-2	2.281	2.632	010
8136	1.788	2.070	STD	8138-3	2.286	2.632	015
8136-1	1.793	2.070	005"	8138-4	2.291	2.632	020
8136-2	1.798	2.070	010"	8138-5	2.301	2.632	030

Rosan Stud Remover

This stud remover is for use in extracting studs from cylinder assemblies using **Rosan type Studs.**

Using the hammer, drive the stud driver (1) over stud (2) as far as possible without making contact with the cylinder head (3). Using the ratchet or pull handle, apply a firm, constant pressure in the clockwise (tightening) direction, the serrations (4) on the stud will strip. When the stud gives, reverse the ratchet and back the stud out until there are three threads still engaged in the lock ring (5). Move the stud with the driver still attached, up, down and sideways. The lock ring will pop out of the cylinder without damaging it. The stud driver is Part No. 2769A13.



39

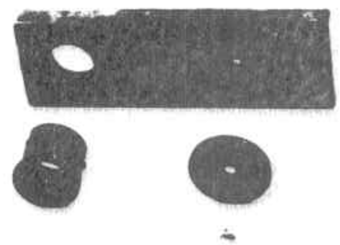
(MCSC)

Connecting Rod Reaming and Alignment Checking Fixture

With these precision tools, it's easy to check connecting rods (without bushings) for alignment and warpage.

The 8111A Base/Retainer Kit is required as well as one (or more) of the Adapter Kits described below. The 8111A Kit includes the high-carbon steel base (hardened and ground for long life); retaining collar, cap (for connecting rod) and wing nut.

The 8111A Base/Retainer Kit fits the following Adapter Kits as described below.



40 **Base/Retainer Kit 8111A** **(BTC)**

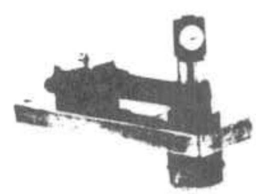
Adapter Kits

These kits contain the indicator gauge assembly, which has a dial indicator reading in ten-thousandths of an inch (.0001"). The gauge body is lapped into the mating bushing for accurate readings. Instructions are included.

Adapter Kits

8042C	for 520-470-E Series	1.125"
8072C	for O-200, O-300,360	1.00" & .922"

Complete tool combining 8111A Base with one of the 3 listed adapter kits shown checking rod for alignment.



41 **(BTC)**

Reamers, Connecting Rod Bushing

High-speed steel reamers with 3/4" diameter pilot. Use with 8111A Base/Retainer Kit and proper Adapter Kit as shown above.

874-40	.920" Roughing	use together
874-41	.923" Finishing	use together
5008	1.126" Finishing	
8071	1.000" Finishing	

Complete tool using same adapters shown above with piston pin reamer. See at left for proper reamer to use

42 **(BTC)**

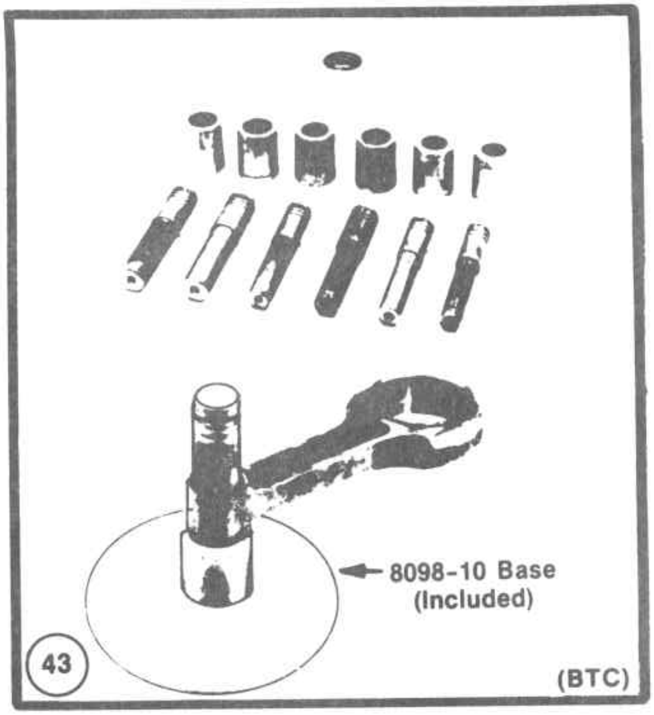
Universal Connecting Rod Bushing Remover and Installer Set 8098

Complete set for removing and installing connecting rod bushings for Continental Support bushing reverses for either installing or removing.

8098 Complete Set Includes:
8098-10 Base

Driver and Adapter Assembly	Pilot Dia.	Ram Dia.	Replaces Tool
8098A	.844	.966	4902
8098B	.907	1.058	4949
8098C	.967	1.058	—
8098D	.984	1.082	3613
8098E	1.109	1.182	L-149
8098F	1.109	1.230	2879

(Above Driver and Adapter Assemblies also available individually).



Common Drive Handle 8122A

This Drive Handle fits all pilots and cutters, and It features positive pin drive as shown. (combination of Morse taper and pin drive eliminates any slippage between handle and cutter.

By using the 8122A with the proper pilot from below, you may choose to pilot into valve stem hole or valve guide boss.

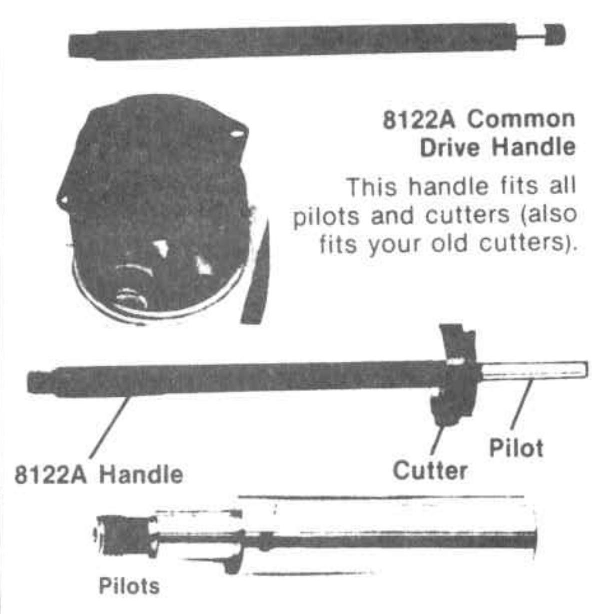
Pilots

All pilots are hardened and precision ground for accuracy. Two choices — pilot into valve stem hole or valve guide boss.

Pilot Choice No. 1 — Pilot Into Valve Stem Hole
(On new installations only)

Part No.	Pilot Dia.
8139	.343
8140	.374
8141	.435

CAUTION: Do not use on worn guides!



Pilot Choice No. 2 — Pilot Into Valve Guide Boss

Part No.	Pilot Dia.	Application	Part No.	Pilot Dia.	Application
8123	.530	Standard	8129	.624	Standard
8124	.535	Oversize .005	8130	.629	Oversize .005
8125	.540	Oversize .010	8131	.634	Oversize .010
8126	.545	Oversize .015	8132	.639	Oversize .015
8127	.550	Oversize .020	8133	.644	Oversize .020
8128	.560	Oversize .030	8134	.654	Oversize .030

44

(BTC)

Needle Bearing Installers

Precisely machined to make bearing installation fast.

23-1 .562" pilot
8053 .750" pilot

45 (BTC)

Hydraulic Crankshaft Dampner Bushing Remover/Replacer Sets 8077A and 8077B

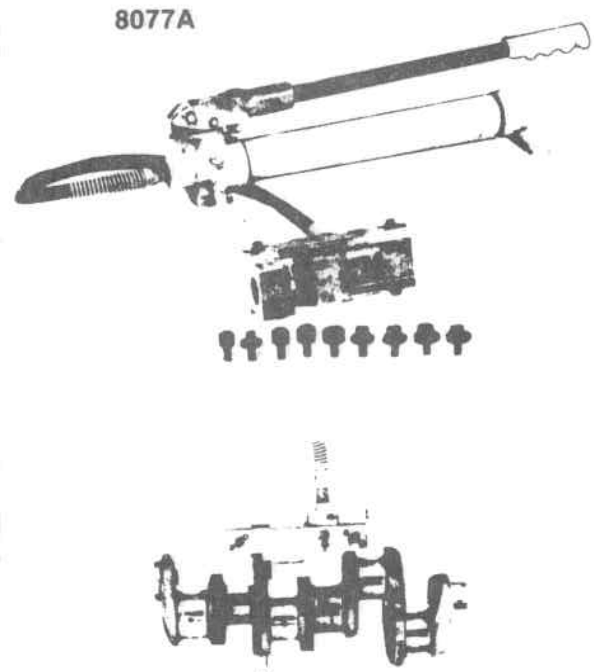
Remove and replace crankshaft bushings in a fraction of the time hydraulically! A few strokes of the pump handle removes or installs bushings with very little effort. Small actuating head fits in and around the crankshaft. Once the bushing is removed (or installed), a turn of the valve returns actuator for another cycle.

8077A includes:

10,000 psi pump and cylinder; 5-ton output cylinder; 3-ft. long flex hydraulic hose; all adapters to fit O-300 and 360, 470 and 520 Series.

8077B (less hydraulics) includes:

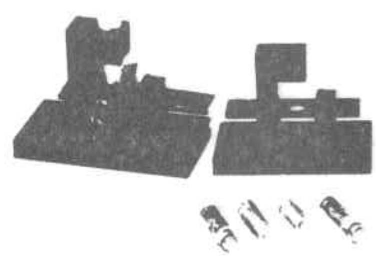
Items shown above in 8077A except no hydraulics are furnished. The actuator head has 1/4" NPT female port for connection to your hydraulic hose.



46 (BTC)

Counterweight Bushing Remover/Installer 8077C

Positive guide of all components assures perfect alignment. Includes adapters for O-300-360, 470 and 520 Series engines.



47 (BTC)

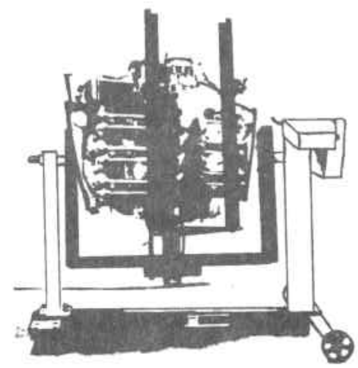
This manual provided free of charge by USA Vintage Bonanza 2007

All Position Engine Stand
Assembly-Disassembly
Transportation **8104**

Designed to save time on the overhaul floor. Minimum attaching hardware allows complete engine accessibility.

Positive frame rotation (360°) locks in infinite number of positions simply by releasing handle. Engine mounting plate also rotates 360° and locks in place with heat-treated lock pin.

Flange holder is pre-drilled to accept all Continental engines. Threaded adapters included to mount non-flanged crankshafts. Shipping weight 400 lbs.



48 (BTC)

Tork Band Tension Adjuster
7726

Adjust belt tension without damage to components. Use on alternators, compressors, etc. Allows grabbing difficult round components.

49 (BTC)

Generator Drive Holders

Hold drive gear for torquing or removing retaining nut.

4973 2.600" dia.
4973A 2.510" dia.

50 (BTC)

This manual provided free of charge by USA Vintage Bonanza 2007

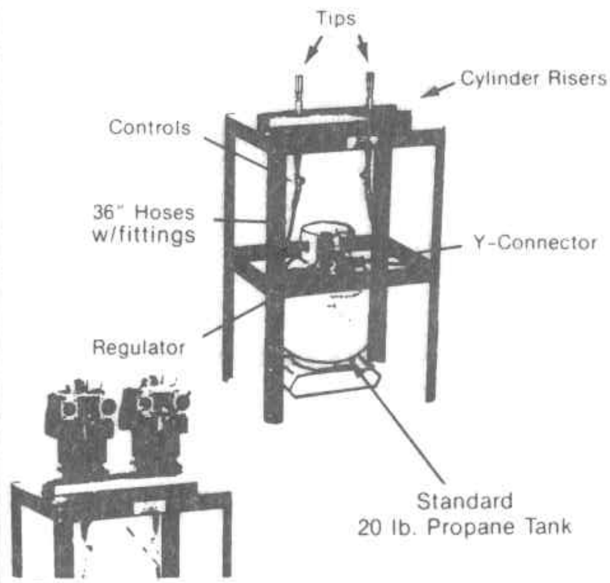
Cylinder Heating Stand 8156

In just 8-10 minutes, you can heat 2 cylinders simultaneously to 600°F. Or, you can heat one at a time (each tip is separately controlled).

Included with the 8156 Cylinder Heating Stand:

(2) Tips
(2) 36" Propane Hoses w/fittings
(1) Propane Regulator
(2) Controls
(1) Y-Connector
(1) Stand
(2) Cylinder Risers

All screws, nuts and washers needed; and instructions.



51 (BTC)

Blind Needle Bearing Puller 8093C

Use to remove 5/8" I.D. needle bearings in 470 and 520 Series engines. Use with 8054 Slide Hammer.

52 (BTC)

Starter Clutch Shaft Bearing Pullers

8093B for removing 1/2" I.D. bearings on O-200 Series

8093D for removing 3/4" I.D. bearings.

53 Use with 8054 Slide Hammer (BTC)

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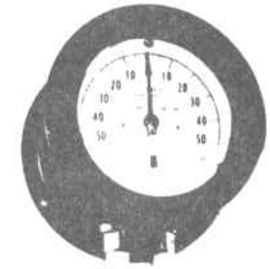
Differential Pressure Gauge 5210

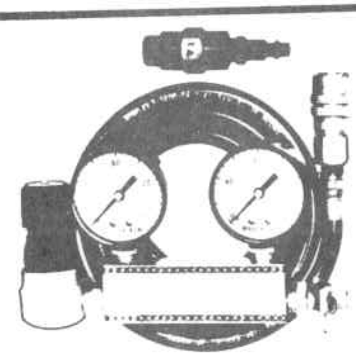
For turbo superchargers. A rugged, high precision gauge needed to set differential fuel measures. 50-0-50 psi, 4-1/2" dia. face, 1/4" pipe connection.



54 (BTC)

Differential Pressure Cylinder Checker 7251

Use standard shop air pressure to check condition of rings, cylinder walls and valves.



55 (BTC)

Belt Tension Gauge BT-33-73F
(TSIO-520-BE uses BT-33-89P)

Set belt tension quickly and accurately to ensure maximum belt and bearing life. The proper belt-tension eliminates slippage and increases efficiency of belt-driven components.

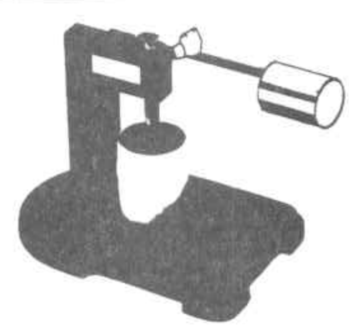
Compact — only 3¼" wide to fit in crowded areas. Easy to use — just apply gauge to belt, release ball handle and read tension on rotating dial.

Calibrated for A-section V-belts (⅜" to ½" top width) and K-section (4, 5 and 6 rib) poly-V belts. Range 30 to 180 lbs. and 130 to 800 newtons (dual scale).

56 (BTC)

Hydraulic Valve Lifter Tester BT-60C

For checking bleed down rate on hydraulic lifters. Hand input turns lifter as in actual use. Includes one gallon of BT-59 Test Oil (also available separately).



57 (BTC)

In-Aircraft Alternator/ Generator Tester 8091

Replaces test bench. Uses aircraft's own engine to check systems and tests without component removal. Long leads permit tester to remain in cockpit during testing.

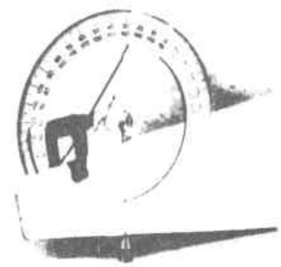
- Voltage output
- Rotor
- Brushes
- Stator
- Field Input
- Diodes
- Windings

Features 0-30v DC voltmeter; 10-0-10 amp DC ammeter; circuit breaker protected. Two point hook-up — field term. and cigarette lighter.

58 (BTC)

Engine Timing Disc 3608A

For all engines — universal application from J3 to DC3. Fastens to prop tip and accurate to ± 1/4 degree. Includes piston stop 3608A-15.



59 (BTC)

Pulley Holder 4974

For holding 2-1/2" to 3-1/2" dia. pulleys grip in pulley groove.

60 (BTC)

Pully Alignment Gage Bar 8082

The 8082 gage bar allows a quick and easy alignment check between driver sheave and compressor sheave.

Used when installing air conditioning on models IO-520 and TSIO-520. Includes adapter sleeve for 1/2" v-belts.

61 (BTC)

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Crankcase Drill Fixture For Starter Clutch Adapter — 8094A

Per Continental Bulletin 79-10

Modifies crankcase by drilling extra oil passage from rear main to starter bushing area.

62 (BTC)

Vacuum Pump — 8334

This new heavy-duty vacuum pump is designed for one-hand operation. Heavy steel wall; 0-30 in Hg; nozzle fits several sizes of tubing.

63 (BTC)

Generator Pulley Puller — 61-5

Quickly removes pulleys from 2-1/2" to 5" diameter. Applies even pressure on outside of pulley in pulley groove. All components are tough, heat-treated alloy steel.

64 (BTC)

Bearing and Bushing Drill Fixture — 8094B

Per Continental Bulletin 79-10

Use to rework your present stock of main journal bearings and starter shaft bushings. Use Bearing Puller 8093B (see at right).

65 (BTC)

Spark Plug Insert Replacer
4918

Features 1/2" square drive. Use on all engines.

66 (BTC)

Thru-Bolt Bore Step Cutters Per Continental Bulletin M77-9

Use to chamfer step in thru-bolt dowel boss prior to inserting improved thru-bolt with O-ring seal.

8064 Cutter, .480" dia.
8065 Cutter, .500" dia.

67 (BTC)

Spark Plug Insert Tap
504-1

For use on all engines. High-speed steel.

68 (BTC)

Spark Plug Insert Remover
4919

Use on all engines.

69 (BTC)

Slide Hammer
8054

Heavy duty slide hammer features 2-1/2-lb. slide and 5/8"-18 thread. 24" long overall. Use with 8114 Series removers.

70 (BTC)

Spark Plug Tap
445

18 millimeter threads. High-speed steel.

71 (BTC)

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Rosan® Lock Ring Installer
8074

Heat-treated, tough alloy steel. Knurled for sure grip. Approximately 4" long.

72 (BTC)

Stud Drivers

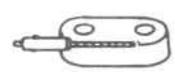
Six (6) different thread sizes:

505-1	1/4"-28	**505-5**	1/4"-20
505-2	5/16"-24	**505-6**	5/16"-18
505-3	3/8"-24	**505-4**	7/16"-20

73 (BTC)

Scavenge Pump Drill Fixture
4978

To modify 470 scavenge pump per Continental Bulletin M72-8. Includes fixture and drills with pre-set stops.



74 (BTC)

Crankcase Splitter Set
L423

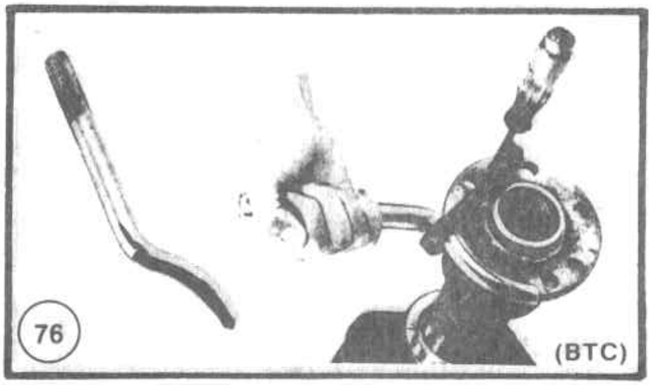
Makes splitting Continental crankcases easier and faster. Prevents crankcase damage. Puller assemblies bolt onto crankcase studs.

75 (BTC)

This manual provided free of charge by USA Vintage Bonanza 2007

Propeller Shaft Oil Seal Installer 5209

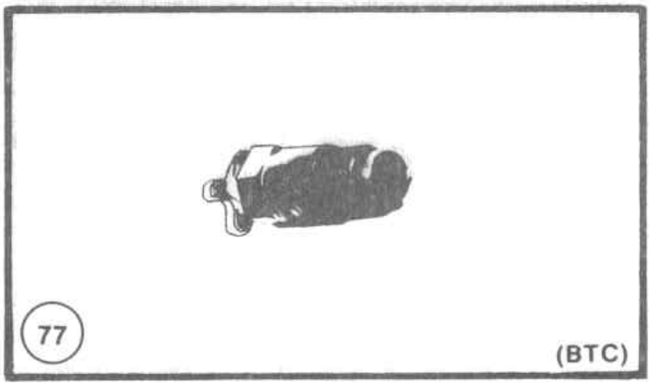
For all flanged shafts. For installing one piece stretch seals without damaging sealing surfaces. Be sure to oil the seal before installing.


76 (BTC)

Oil Pressure Relief Spot Facers

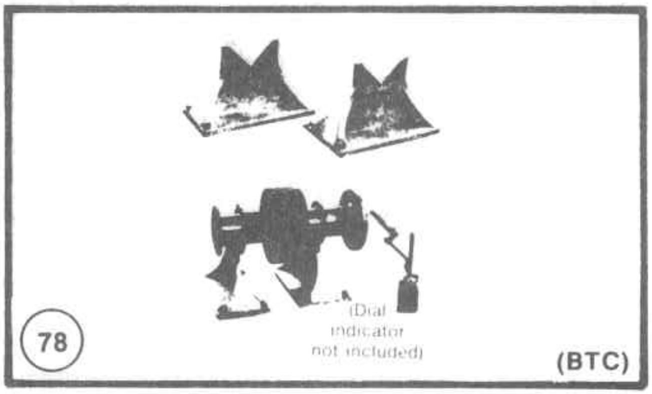
Positive stop to prevent excess material removal. Cutter blades are heat-treated high-speed steel.

8048 Spot Facer for 470 and 520
8155 Spot Facer for 360 Series


77 (BTC)

Runout Block Set 8117A

Use this set to check runout on crankshafts, etc. up to 4" diameter. Blocks are aluminum alloy with Teflon® bearing surfaces. Approx. size: 4" w x 8" l x 5" h each.

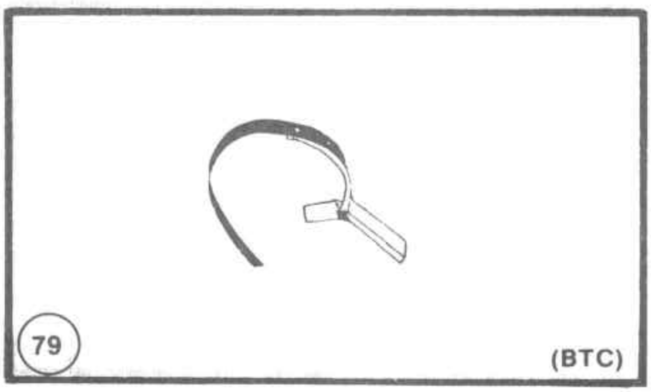


78 (BTC)

Polishing Tools for Crankshaft Bearings

Special aluminum frame and felt polishing surface.

8087A 1-7/8" to 2-1/4" dia.
8087B 2-1/4" to 2-5/8" dia.


79 (BTC)

Injector Nozzle Remover and Installer — 8165

This tool allows you to remove, install and tighten injector nozzles located close to intake parts on Piper Aircraft. Torque Wrench extension allows use of 3/8" square drive torque wrench to tighten nozzles to proper specifications.

Torque wrench extension is made of heat-treated steel for durability. Torque input and output is marked on extension.

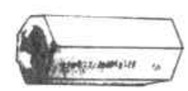
Installer is special, thin-walled 6-pt. ½" hex socket.

80 (BTC)

Crankcase Thru-Bolt Removers

Use with 8054 Slide Hammer (above) to remove stubborn bolts.

8114-8 Remover, 1/2"-20 threads
8114-7 Remover, 7/16"-20 threads
8114-6 Remover, 3/8"-24 threads



81 (BTC)

Hex Drive for Hex Tube Nuts — 7912A

Tubing nut wrench set for fuel systems, hydraulic systems and brakes.

82 (BTC)

Rotabroach Cutters — 7710

These cutters cut faster and cleaner than twist drills with only a fraction of the power and effort.

83 (BTC)

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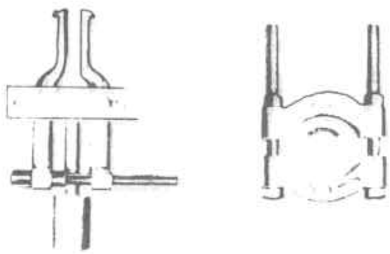
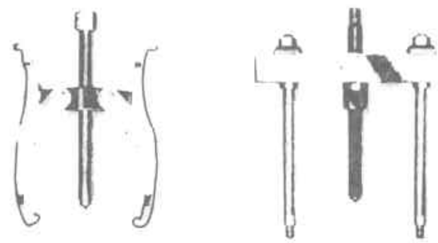
Pullers

These pullers provide a more controlled method to remove press-fit parts.



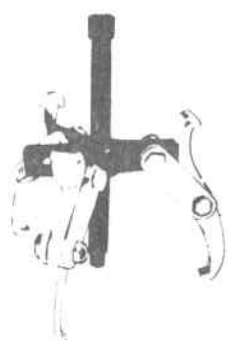
1153 679

84 (OTC)



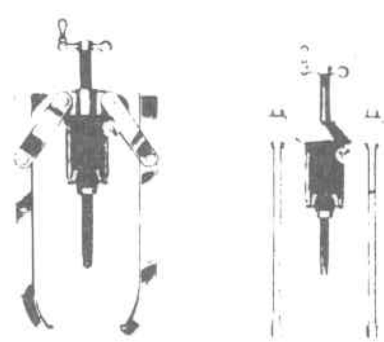
1035 927

85 (OTC)



1037

86 (OTC)



1079 1063

87 (OTC)

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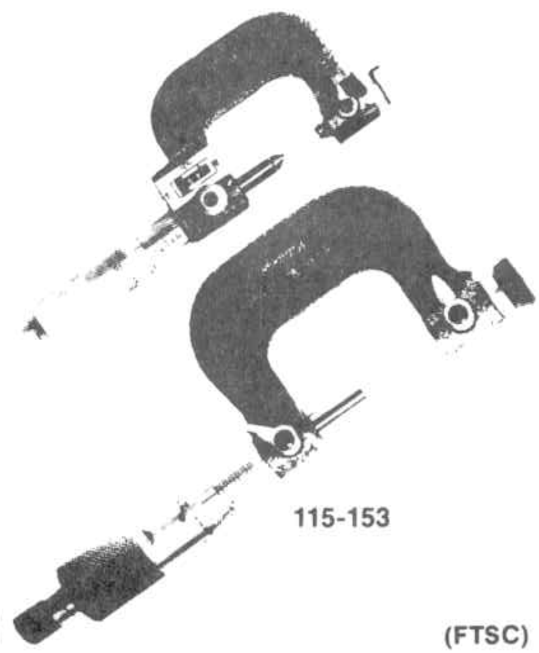
INSPECTION INSTRUMENTS

Outside Micrometers

Spherical Anvil Micrometers are specially useful in measuring the wall thicknesses of small parts such as sleeves, collars, tubings and various cylindrical workpieces. They are also used to measure dimensions from inside of holes to outside edges.



115-153

88

(FTSC)

Dial Bore Gages

Dial Bore Gages used for large volume "go, no-go" inspections or for determination of actual dimensions. Three-point contact (two guide pins and one interchangeable rod) assure alignment within bore. Zero point may be set with ring gage, micrometer, height master or gage blocks.

545-116

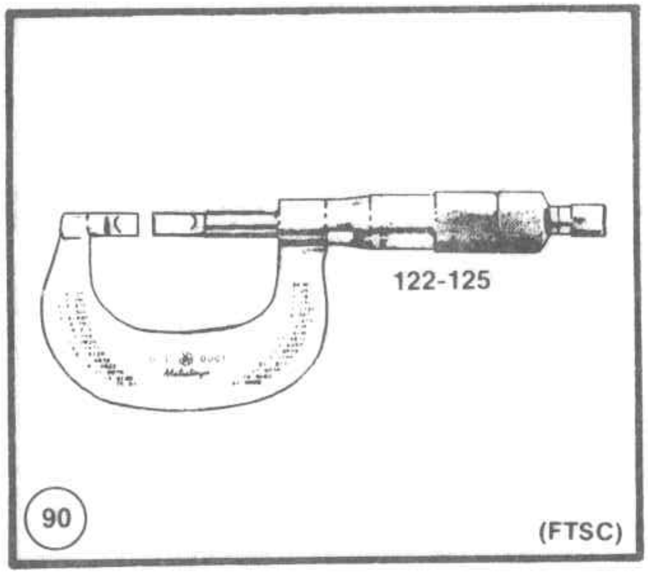
89

(FTSC)

Blade Micrometers

Non-Rotating Spindle TYPE 122, 222

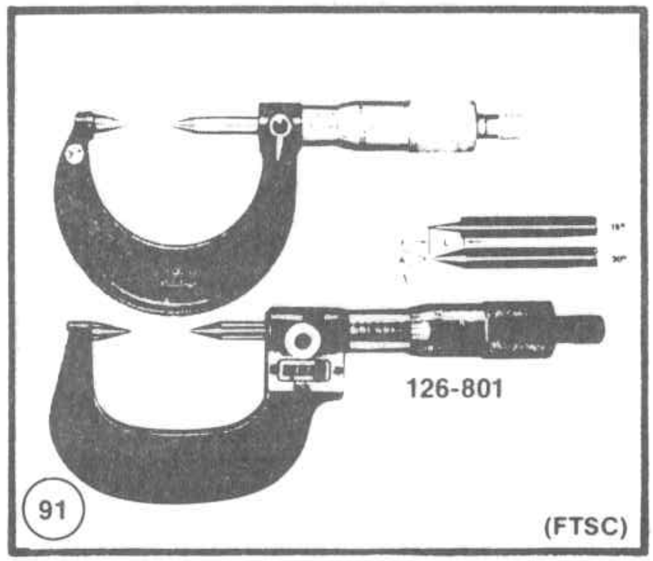
For measurements of narrow grooves, keyways and other hard to reach dimensions.



Screw Thread Micrometers

FOR MEASURING PITCH DIAMETERS
TYPE 126, TYPE 226
Interchangeable V-Anvil Type

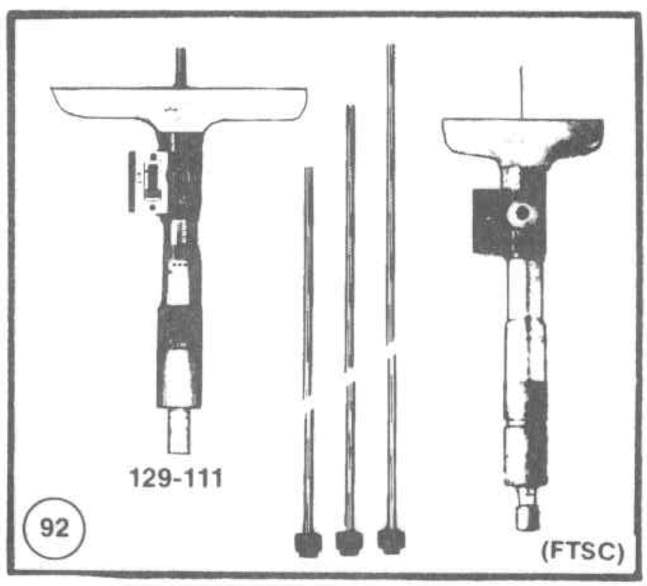
60 degree V-Anvil and Conical Spindle are made of high-grade special steel, hardened and precision ground.



Depth Micrometers

The Depth Micrometer is one of the basic measuring tools selected by machinists.

Ratchet stop for consistent and repetitive measurements.



93

(BTC)

Reamers, Rocker Shaft Support Boss

4903-1 — .645″ Roughing (.609″ Pilot)
4903-2 — .680″ Roughing (.643″ Pilot)
4903-3 — .703″ Finishing (Use with 4903-1 & 4903-2) (.678″ Pilot)
4903-4 — .708″ Finishing (Use with 4903-1, 4903-2 & 4903-3) (.701″ Pilot)
4903-5 — .723″ Finishing (Use with 4903-1, 4903-2, 4903-3 & 4903-4) (.706″ Pilot)

NOTE: 5129 SERIES ARE FOR STRAIGHT VALVE ENGINES ONLY.

5129-1 — .753″ Roughing (.718″ Pilot)
5129-2 — .788″ Roughing (.751″ Pilot)
5129-3 — .813″ Finishing (Use with 5129-1 & 5129-2) (.786″ Pilot)
5129-4 — .818″ Finishing (Use with 5129-1 & 5129-3) (.815″ Pilot)
5129-5 — .833″ Finishing (Use with 5129-1, 529-2, 5129-3 & 5129-4) (.815″ Pilot)

Reamer, Rocker Arm & Shaft Bushing

4905 — .609″ Std. (.594″ Pilot)

Reamer, Rocker Shaft Bushing

5130 — .719″ Std. (.707″ Pilot)

Reamer, Rocker Arm Bushing

7232 — .751″ Std. (.732″ Pilot)

94

(BTC)

Reamers, Valve Guide Boss

Use at 275 RPM maximum.

		USE MORSE ADAPTER
4914-1HS — .537″	.005″ O.S. (.531″ Pilot)	2689
4914-2HS — .542″	.010″ O.S. (.534″ Pilot)	2689
4914-3HS — .552″	.020″ O.S. (.539″ Pilot)	2689
4914-4HS — .547″	.015″ O.S. (.539″ Pilot)	2689
4914-5HS — .561″	.030″ O.S. (.549″ Pilot)	2689
4943-1HS — .631″	.005″ O.S. (.624″ Pilot)	2693
4943-2HS — .636″	.010″ O.S. (.628″ Pilot)	2693
4943-3HS — .646″	.020″ O.S. (.633″ Pilot)	2693
4943-4HS — .641″	.015″ O.S. (.631″ Pilot)	2693
4943-5HS — .656″	.030″ O.S. (.645″ Pilot)	2693

Engine Application Chart For Valve Guide Stem Hole Reamers

ENGINES	VALVE GUIDE PART NO.	REAMERS				USE MORSE ADAPTER NO.
		CARBIDE-TIPPED	HIGH-SPEED STEEL	CUTTING DIA.	PILOT DIA.	
0-200 EXH C75 THRU C145 0-300	24047 EXH	2847-2CP	2847-2HP	.438	.422	2686
	24024 INT	4913-1CP	4913-1HP	.344	.331	2684
A50 THRU A80 AND 0-200 INT	25276 EXH AND 21419 INT	4913-1CP	4913-1HP	.344	.331	2684
IO-360	630262 EXH AND 630262 INT	3606-CP	3606-HP	.375	.363	2684
E-165 THRU E-225 O-470 (ALL) 520 (ALL)	631496 EXH	2847-2CP	2847-2HP	.438	.422	2686
	631496 INT	2847-1CP	2847-1HP	.436	.422	2686

95

(BTC)

Adapt Square Shank Reamers to No. 2 or 3 Morse Taper Tapper

Part No.	Morse O.D.	Shank	Flats
2684	2	.323"	.242"
2686	3	.367"	.275"
2689	3	.480"	.360"
2693	3	.590"	.442"
4104			

Reducer Sleeve, No. 2 Morse I.D. to No. 3 Morse O.D. sleeve only — will not fit reamer shank.
NOTE . . . DO NOT use high-speed reamers on ni-resist guides.

96

(BTC)

Adapt Square Shank Reamers to No. 2 or 3 Morse Taper

Part No.	Morse O.D.	Shank	Flats
2684	2	.323"	.242"
2686	3	.367"	.275"
2689	3	.480"	.360"
2693	3	.590"	.442"
4104	**Reducer Sleeve,** No. 2 Morse I.D. to No. 3 Morse O.D. sleeve only — will not fit reamer shank.		

Suggestions For Reaming Valve Guide Stem Holes

1. Use high quality cutting oil.
2. Reamers are made to cut right hand only — **do not** turn backwards even a partial turn!
3. If using power, run high-speed reamers at 400 RPM maximum, and carbide-tipped at 700 RPM maximum. High-speed steel reamers for hand cutting.
4. The #5221B universal cylinder holding fixture is recommended for stem hole reaming, using a drill press or vertical mill.

97

(BTC)

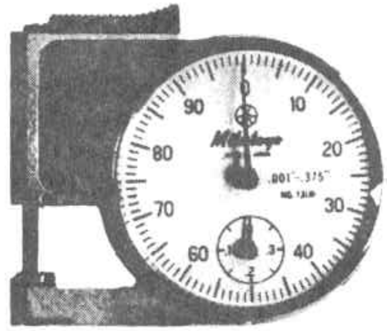
Plug Gauges, Valve Guide Stem Hole

Go and No-go Gauges are used to check for new limits (and service limits where applicable). Gauges are heat-treated alloy steel, precision ground.

2848-1 — .436" I.D. Guide
2848-2 — .438" I.D. Guide
3615 — .375" I.D. Guide

Dial Thickness Gage

For use in measuring wall thicknesses in hard to reach areas.



98 7308 (FTSC)

Precision Vernier Calipers

Precision Vernier instruments offer a wide range of precise tools for measuring accurately in thousandths of an inch. These include Vernier Calipers and Vernier Height gages in both the English and Metric Measure.

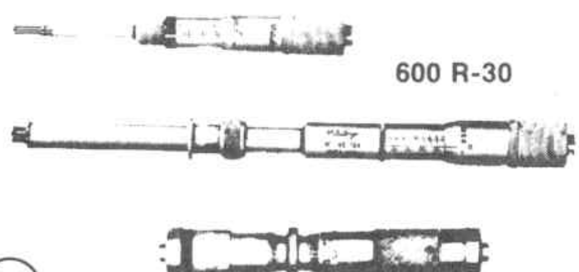
52.030-006

99 (FTSC)

Inside Measuring Instruments

Three measuring surfaces are lapped parallel to the longitudinal axis of the Micrometer, and stay aligned with the bore while measurements are taken.

Large ratchet stop provides constant measuring pressure to the wall surface, and insures repetitive reading to .0002" or .0001" (smaller ranges).

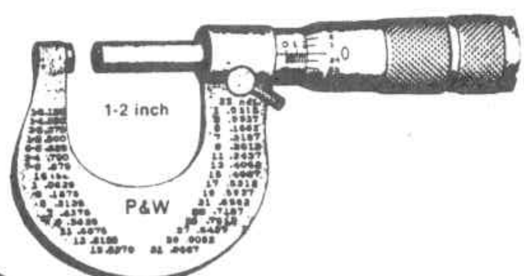


600 R-30

100 (FTSC)

Outside Micrometers

Spherical Anvil Micrometers are specially useful in measuring the wall thicknesses of small parts such as sleeves, collars, tubings and various cylindrical workpieces. They are also used to measure dimensions from inside of holes to outside edges.



101 (FTSC)

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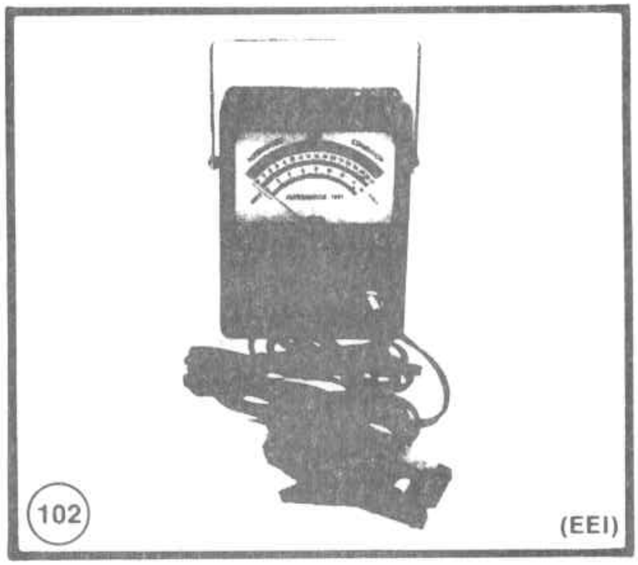
Alternator Analyzer Voltage Regulator Tester

For field or bench use

- Designed to pinpoint developing problems before a total system breakdown occurs.
- Oscilloscope type performance with easy to use "ok" or "Defective" presentation.
- Detects failing diodes before normal indications occur.

EASY TO USE

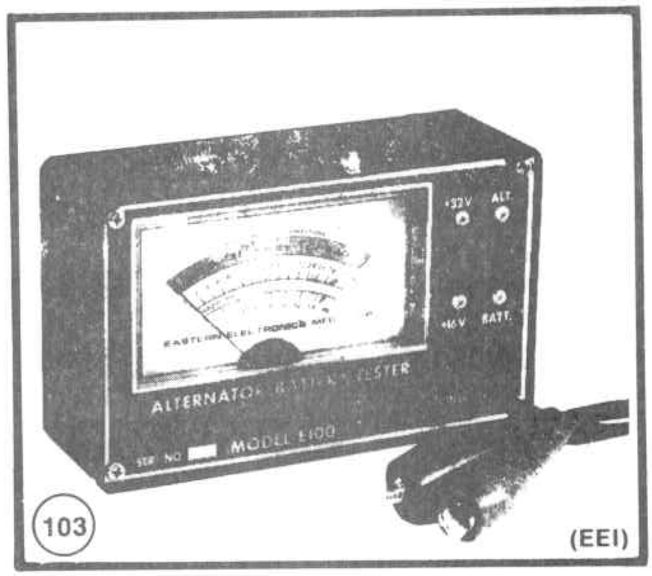
- Inductive probe clamps over wire for alternator ripple test.
- Voltage regulator test leads clip on alternator output terminal and engine ground.



102 (EEI)

Alternator/Regulator/ Battery Tester Model E100

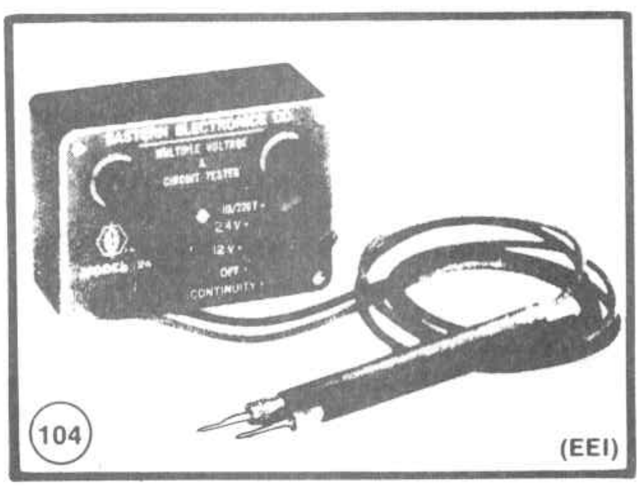
Designed to test alternators, regulators, batteries on 12 and 24 volt systems with currents up to 32 volts DC. Has a pointer zero adjustment screw on the face of the instrument. Circuitry is entirely solid state and no battery or power source is required. Power for the unit is derived from the systems under test.



103 (EEI)

Multiple Voltage & Circuit Tester For 12 & 24 Volts Model 29

Designed to test continuity of circuits, shorts, diodes, live circuits both low and high voltage in aircraft ignitions and electronic equipment. Reads both AC and DC in all positions. Has easy-to-see bright red signal lights, with bulbs replaceable by unscrewing lenses on face of tester.



104 (EEI)

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CHAPTER 4
AIRWORTHINESS LIMITATIONS

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AIRWORTHINESS LIMITATIONS

The Airworthiness Limitations Section is FAA-Approved and specifies maintenance required under SS43.16 and 91.163 of the Federal Aviation Regulations unless an alternative program has been FAA approved. This section is part of the type design of the IO-470 engine pursuant to S21.31 of the Federal Aviation Regulations.

1. Mandatory Replacement Times.

   Subject to additional information contained in FAA Approved Mandatory Service Bulletins issued after the date of certification, the IO-470 engine does not contain any components having mandatory replacement times required for type certification.

2. Mandatory Inspection Intervals.

   Subject to additional information contained in FAA Approved Mandatory Service Bulletins issued after the date of certification, 50 hour and 100 hour inspections as described in the IO-470 Series Overhaul Manual and inspections mandated by the FAA, under 43 and 91 of the Federal Aviation Regulations are required for type certification.

3. Other Related Procedures.

   Subject to additional information contained in FAA Approved Mandatory Service Bulletins issued after the date of certification, the IO-470 engines does not have any inspection-related or replacement time-related procedures required for type certification.

4. Distribution of Changes to Airworthiness Limitations.

   Changes to Airworthiness Limitations section constitute changes to the type design of the IO-470 engine and require FAA approval pursuant to Federal Aviation Regulations SS21.95, 21.97 or 21.99. Such changes will be published in FAA Approved Mandatory Service Bulletins, which are furnished to subscribers to TCM Service Bulletins and can be obtained by writing TCM, Publications Department, P.O. Box 90, Mobile, Alabama 36601.

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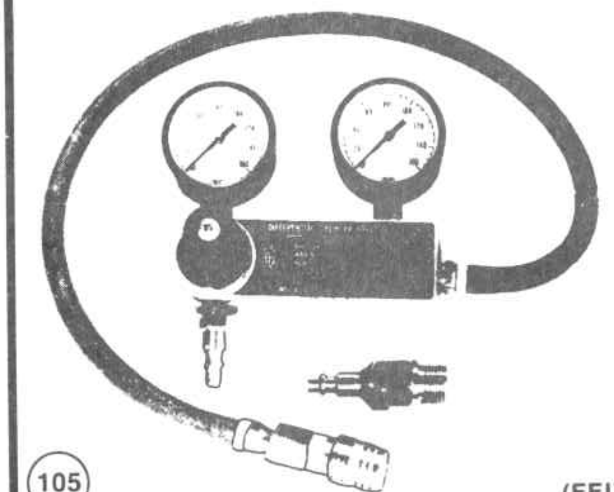
Differential Cylinder Pressure Tester Model E2

Pinpoint leaking valves, pistons, spark plug bushings, cracked cylinders, etc. Has heavy duty gauges and a precision regulator; long hoses with quick disconnects; 18mm plug connector fitting

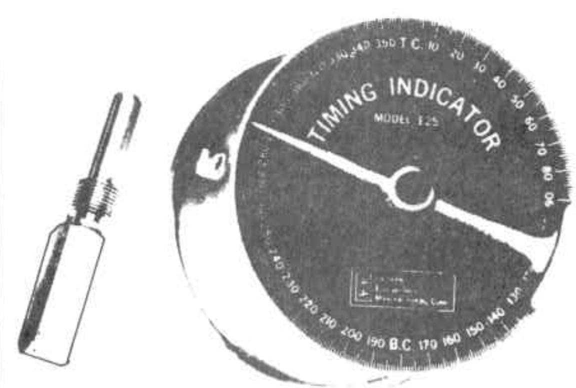
E-2-14 14mm Optional Plug Fitting
E-2-10 10mm Optional Plug Fitting



105 (EEI)

Aircraft Timing Indicator Model E25

Improves the accuracy and speeds up the process of timing an aircraft magneto to the engine. Easily attached to the propeller spinner with mounting bands. Has top dead center locator.



106 (EEI)

Aircraft Magneto Timing Light Model E50

Designed specifically for internal timing of aircraft magnetos and for synchronizing magnetos to aircraft engines. Attach three clips to the magnetos and adjust until both bright lights flash in synch; now magnetos are timed and synchronized.

• Compact 3 x 5 x 2⅝ • weight 1½ lbs. • Extra bright flashing lights • Comes complete with type AA Penlight batteries • Heavy duty unbreakable case with aluminum face plate.

107 (EEI)

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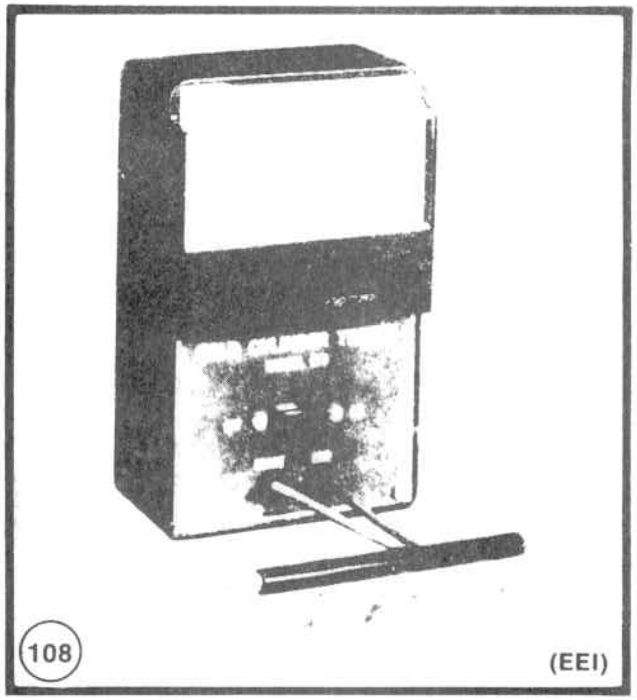
Cold Cylinder Tester
Model E10

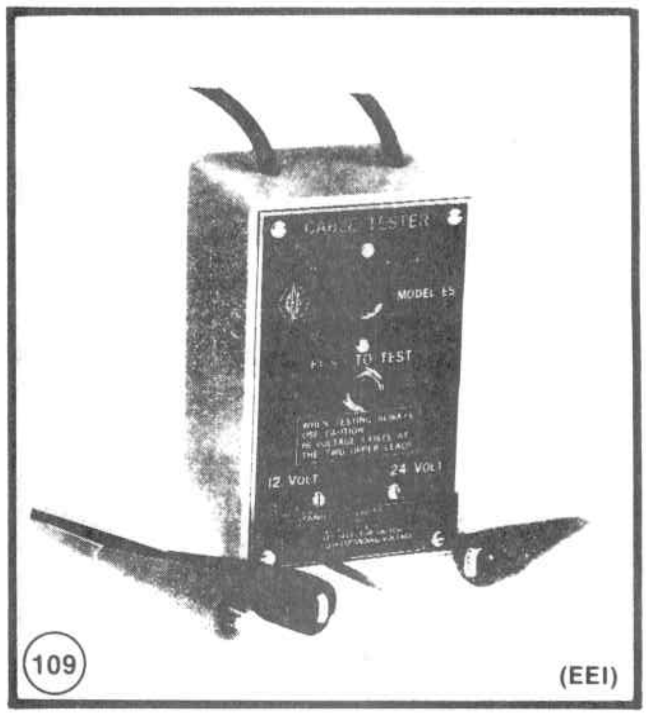
Attach one wire with an alligator clamp and use another cable with a hand-held probe to test comparative temperatures from cylinder to cylinder in a matter of seconds. Spot source of rough running, mag drop, loss of power in a matter of minutes.



108 (EEI)

Hi-Voltage Cable Tester
Model E5

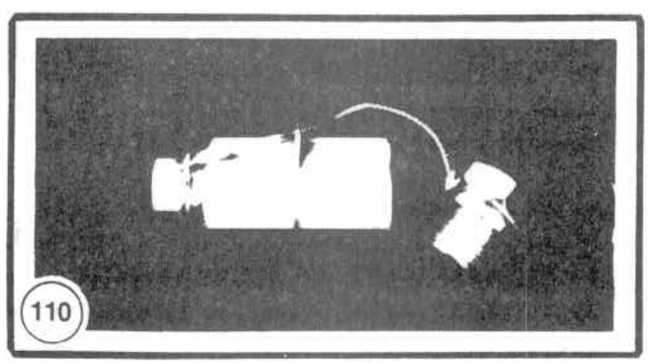
Designed to give a fast accurate test of the high tension ignition cables on aircraft engines. Simply connect three clip-on wires, press the test button, and a display light indicates instantly whether the cable is good or bad.



109 (EEI)

Master Orifice Tool
P/N 646953

Attach to differential cylinder pressure tester to check calibration and determine the low leakage limit. (Ref. Chapter 70-50-00).



110

CYLINDER HEAD TEMPERATURE/ EXHAUST GAS TEMPERATURE TEST UNITS

Alcor Portable Digital EGT Unit

For use with Type "K" Thermocouple. This device is a lightweight 9 volt LCD unit, with a disposable battery.

Temperature Range 1000° - 1800° F.

Part Number 85328

111

(ALR)

Alcor Portable Digital CHT Unit

This device is used with Type "J" Thermocouple. It is a lightweight 9 volt LCD unit, with disposable battery.

Temperature Range 200° - 600° F.

Indication from 32° - 600° F.

Part Number 85329

112

(ALR)

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SPECIAL TOOL INDEX

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SPECIAL TOOL INDEX
GENERAL TOOL INFORMATION

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
1	GA333 GA340. YA341	All	Filter - Strap Wrench	5-10-00
2	CT 470	All	Filter - Can Cutter	5-10-00
45	23-1	All	Installer - Needle Bearing	72-10-12
48	8104	All	Stand-Engine Mount All Position	72-10-01
49	7726	All	Adjuster-Belt Tension	N/A
50	4973	All	Holder-Generator Drive	72-60-07
55	7251	All	Checker-Cylinder Differential Pressure	70-50-00
56	BT-33-73F	All	Gauge-Belt Tension	N/A
	BT-33-89P	BE	Gauge-Belt Tension	N/A
59	3608A	All	Timing-Disk-Engine	72-60-14
60	4974	All	Holder - Pulley	N/A
63	8334	All	Pump Vacuum	72-60-00
76	5209	All	Propeller Shaft - Oil Seal Installer	72-50-07
77	8048	All	Spotfacer - Pressure Relief	72-60-04
78	8117A	All	Block - Runout	72-40-02
80	8165	All	Remover/Installer - Injector Nozzle	72-10-06
83	7710	All	Cutter-Rota Broach	72-20-13
106	Model E25	All	Indicator - Timing	72-60-14
107	Model E50	All	Light-Timing-Aircraft Magneto	5-20-02

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WRENCHES

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
3	3882	All	Wrench-Cylinder Base Nut	72-10-14B
4	3882A	TSIO-520 IO-520	Wrench-Cylinder Base Nut	N/A
5	8079	All	Wrench-Cylinder Base Nut	72-10-14
5A	8160	TSIO-520 BE	Wrench Spark Plug Remover/Installer	N/A
6	5203	520 & 470 Series	Wrench-Cylinder Base Nut	N/A
7	8031, 8032	GTSIO-520-F,K	Wrench-Cylinder Base Nut	N/A
8	8158	550 Series TSIO-520-CE	Wrench-Cylinder Base Nut (7th Stud)	N/A
9	5205	GTSIO-520-C,D	Wrench-Generator Base Nut	N/A
82	7912A	All	Wrench-Hex Drive - Tube Nuts	72-10-06

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PISTON/CYLINDER TOOLS

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
10	8121	All	Remover - Piston Pin	72-10-14B
11	CFL10/CFL10-7	All	Cylinder Hone	72-40-07
13	5221-17A	All	Adapter-Cylinder Holding Fixture	72-10-14
14	5221B	All	Fixture-Cylinder Holding	72-10-14
16	8066	All	Seat-Seal Cutter	72-20-16
21	4901	All	Compressor-Piston Ring Flex Band	72-60-03
22	4901B	All	Compressor-Piston Ring - Solid Taper	72-60-03
28	8086	All	Insert Valve Seat Replacer/Remover	72-40-08
29	8086	All	Insert Valve Seat Replacer/Remover	72-40-08
30	4910	All	Insert Valve Seat Replacer/Remover	72-40-08
38	4909-8	All	Cutters-Valve Seat Insert-Straight Side - Step Side	72-40-08
39	2769A13	All	Remover-Rosan Stud	72-20-12
46	8077	All	Remover - Installer	72-40-03
47	8077	All	Remover - Installer	72-40-03

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PISTON/CYLINDER TOOLS

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
51	8156	All	Stand-Cylinder Heating	72-40-08
66	4918	All	Replacer-Spark Plug Insert	72-20-14
67	8064	All	Step Cutter-Thru Bolt	72-40-01
68	504-1	All	Insert-Tap Spark Plug	72-20-14
69	4919	All	Remover-Spark Plug Insert	72-20-14
71	445	All	Tap-Spark Plug	72-20-14
72	8074	All	Installer-Rosan Stud Ring	72-20-12

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CRANKCASE/CRANKSHAFT

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
12	4965A	IO-470 IO-520	Remover/Replacer Crankshaft Blade Dampener	N/A
	3607-1	GTSIO -520	Remover/Replacer Crankshaft Blade Dampener	N/A
62	8094A	All	Fixture Crankcase - - Drilling Starter Clutch	72-20-08
65	8094B	All	Fixture-Bearing and Bushing Drill	72-20-08
70	8054	All	Hammer - Slip	72-20-12
73	505-1	All	Driver - Stud	72-20-12
74	4978	470	Fixture-Scan, Pump Drilling	N/A
75	L423	All	Splitter Set - Crankcase	72-10-17
79	8087A	All	Polisher-Crankshaft Bearing	72-20-21
81	8114-8	All	Remover Crankcase Thru-Bolt	72-20-12

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CONNECTING ROD FIXTURES

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
40	8111A	All	Fixture-Connecting Rod Reaming and Alignment	72-20-20
41	8042	All	Adapter - Kit	72-20-20
43	8098	All	Remover and Installer Connecting Rod Bushing	72-20-20

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VALVE TRAIN TOOLS

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
15	122	All	Cleaner-Valve Guide	72-20-16
16	8066	All	Seat-Seal Cutter	N/A
17	7521A	All	Checker - Spring	N/A
18	3611	All	Remover - Valve Guide	72-20-16
19	4912	All	Valve Guide Replacer	72-20-16
24	3602	All	Compressor-Valve Spring	72-10-14B
25	68-3	All	Compressor-Push Rod Spring	72-50-06
26	4915A	All	Tool-Flaring-Push Rod Housing	N/A
27	4981	All	Remover-Valve Guide Replacer/Remover - Valve Seat Insert	72-20-16
30	4910	All	Installer-Valve Seat Insert	72-20-16
31	8116	All	Installer-Valve Seat Insert	72-20-16
32	8116	All	Alignment System-Valve Guide to Valve Seat	72-20-16
33	8116	All	Alignment System-Valve Guide to Valve Seat	72-20-16
38	4909	All	Cutters-Insert Valve Seat	72-20-16
44	8122A	All	Handle Common Drive (Valve Stem)	72-20-16
57	BT60C	All	Tester Hydraulic Valve Lifter	72-40-09

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INSPECTION TOOLS

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
88	115-153	All	Micrometers - Outside	72-30-08
89	545-116	All	Gauge - Dial Bore	72-30-08
90	122-125	All	Micrometers - Blade	72-30-08
91	126-801	All	Micrometers - Screw Thread	72-30-08
92	129-111	All	Micrometers - Depth	72-30-08
98	7308	All	Gauge (Dial) Thickness	72-30-08
99	52-030-006	All	Calipers - Precision Vernier	72-30-08
100	606R-30	All	Instrument - Inside Measuring	72-30-08
101	193-101	All	Micrometers - Outside	72-30-08

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ALIGNMENT SYSTEM

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
31 32 33	8116	All	Alignment System - Valve Guide	72-60-16
40	8111	All	Alignment Fixture - Connecting Rod Reaming	72-20-20
61	8082	IO-520 TSIO-520 IO-550	Bar-Pulley - Alignment Gauge (Air Conditioning)	N/A

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TEST EQUIPMENT

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
54	5210	All	Gauge-Differential Fuel Pressure	5-20-03
57	BT-60C	All	Tester-Hydraulic Valve	72-40-09
58	8091	All	Tester-Alternator Generator	72-70-07
102	647	All	Tester Analyzer - Voltage Regulator	72-70-07
103	Model E100	All	Tester - Battery Alternator/Regulator	72-70-07
104	Model 29	All	Tester-Multi Voltage/ Circuit	72-70-07
105	E-2-14	All	Tester - Differential Pressure	70-50-00
108	Model E10	All	Tester-Cold Cylinder	72-70-08
109	Model E5	All	Tester-High Voltage Cable	72-20-27
110	646953	All	Master Orifice Tool	70-50-00
111	85328	All	Tester-Exhaust Gas Temperature	72-70-08
112	85329	All	Tester-Cylinder Head Temperature	72-70-08

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REAMERS

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
23	3170	All	Holder - Floating	72-40-08
34	8116-24	All	Reamer-Valve Stem Hole	72-20-16
35	8116-1B	All	Bar - Boring	72-20-16
36	8116-1R	All	Reamer	72-20-16
37	8116-1	All	Body - Expanding	72-40-08
40	8111A	All	Fixture-Connecting Rod Alignment Fixture	72-20-20
41	8042	All	Kit - Adapter	72-20-20
42	874-40	All	Reamer-Connecting Rod Bushing	72-20-20
93	4903-1	All	Reamer-Rocker Shaft Support Boss	72-20-17
94	4914-1HS	All	Reamer-Valve Guide Boss	72-20-16
95	2684	All	Reamer-Square Shank	72-20-16
96	2686	All	Reamer-Square Shank	72-20-16
97	2848-1	All	Gauge - Plug	72-20-16

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SPECIAL TOOL INDEX
PULLERS

FIG. NO.	TOOL PART NO:	ENGINE MODEL	NAME	CHAPTER AND SUBSYSTEMS
52	8093C	520 470	Puller - Blind Needle Bearing	72-10-12
53	8093B	All	Puller-Starter Clutch Shaft Bearing	72-10-12
64	61-5	All	Puller-Generator Pulley	72-10-00
84	679 1153	All	Puller	72-10-00
85	927 1035	All	Puller	72-10-00
86	1037	All	Puller	72-10- 00
87	1063 1079	All	Puller	72-10-00

1-30-00 PRODUCTS

The products in Section 1-30-01 are used as described in the manufacturing and assembly of the Teledyne Continental Engine. Through years of experience these products are best suited for their application and are highly recommended in field use.

The products list consisting of greases, sealants, threads, etc., are listed in three columns. The first being for the product manufacturer and Part Number. The second is the usage in the engine. The third and last is the applicable engines.

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APPLICATION CHART
SEALANTS/LUBRICANTS

ITEM NO.	TYPE/PART NUMBER	APPLICATION	MODELS	REMARKS
1	**Grease** - Molyshield (American Lubricants Co.)	. Starter Worm Gear Drive Teeth and Bevel Gear Teeth	All Models	———
		. Adapter - Tach Reduction	See Remarks	TSIO/LTSIO-360
		. Needle Bearings and Ball Bearings	All Models	———
		. Valve Stems	All Models	At Engine Assembly
		. All ACC. Drive Splines and Couplings	All Models	———
		. Idler Gear and Pin	See Remarks	GTSIO-520- IO-TSIO-520 IO-TSIO-O-470
		. Fuel Injection Controls, O-rings, Springs, Shafts and Bushings	See Remarks	All Models Except: TSIO-520-D, GTSIO-520-K & All 360 Which use Grade 50 MHS 27 Oil
		. Oil Pumps (pressure & scavenge)	All Models	Coat Gear Cavity at Ass'y of Pump
2	**Oil** - Grade 50, MHS 27 (CITGO, Inc.)	. Crankshaft Bearings . Connecting Rod Bearings . Prop Driver, Driven Gears and Bearings . Camshaft Bearings . Tachometer Gears and Adapters . Accessory Spur Gear Teeth . Quill Shaft Splines . Prop. Gov. Trans. Collar and Sleeve . Starter Cone, Bushing and Nut . Starter Clutch Spring (I.D. & O.D.)	All Models	———
		. Pistons, Piston Pins, Piston Rings	See Remarks	Use 600 W Mobil Cylinder Oil for Reman. Engines with Chrome Plated Cylinders
	(Cont'd.)	. Rocker Arms, Pivots, Valves and Tappets . Fuel Connections to Carb. (male threads only) . V.T.C Unit Pistons & Centrifugal Valves	See Remarks	6-285 & 6-320

ITEM NO.	TYPE/PART NUMBER	APPLICATION	MODELS	REMARKS
2 (Cont'd)	**Oil** - Grade 50, MHS 27 (CITGO, Inc.)	.Thrust Washers .Oil Filter Adapter Seals .O-rings .Connecting Rod Nuts - (Tiara engine only)	All Models	———
3	**#646943** - Anti-Seize Lubricant (TELEDYNE CONTINENTAL MOTORS Aircraft Products Division)	. Connecting Rod Nuts - (all models except Tiara) . All Fuel Injector Nozzles (at cyl. hd.) . Pressure Regulator Threads . Exhaust Studs (nut end before torquing) . All Class #4 Studs . Plug Vernatherm	All Models	Use sparingly on male threads only At Engine Assembly
4	**MIL-S-3545-C** - **Grease** (Shell #5)	. All Fuel Injection Linkage . O-rings on Fuel Pumps . Mixture Shaft Bushings	All Models	At Assembly
5	**Alvania** (Shell #2)	. Oil Seal Lips Only	All Models	———
6	Permatex Aviation Grade 3D (Permatex, Inc.)	(Permatex and Silk Thread) .Crankcase Parting Face - see Fig. 70-20 for Crankcase Threading Procedure . Crankcase Parting Face - see Fig. 70-20 for Crankcase Threading Procedure (Accessory End. From Idler Pin Bore to Top of Crankcase apply thin coat to unthreaded side of crankcase) . Pressure Oil Pump Covers	See Remarks	O-200, C90, O-300 470, 520, 550 GTSIO-520 6-285, 6-320 All Models
	(Use Together)			
7	**641543** - Silk Thread (TELEDYNE CONTINENTAL MOTORS Aircraft Products Division)	(Permatex, Silk Thread, and Gasket Maker) .Crankcase Parting Face - (see Fig. 70-20) Permatex and silk thread one half, Gasket Maker on opposite half .Scavenge Oil Pump Covers	See Remarks	All 360 Models All Models
	(Use Together)			
8	**#646942** - GASKET MAKER (TELEDYNE CONTINENTAL MOTORS Aircraft Products Division)	(Gasket Maker only) .Starter Adapter Assy. to Crankcase (Apply thin coat to adapter) .Sump to Crankcase (Apply thin coat to sump)	See Remarks	520 Permold Models only O-470G, IO-470C, J, H, N, K IO-520B, BA, BB, NB, N, TSIO-520D, DB, UB IO-550B
		(Gasket and Gasket Maker) .Sump to Crankcase (Apply thin coat between gasket and sump)	See Remarks	All Models with sump gaskets
9	**EC1252** - Putty - Seal - White Spot - 3M Brand	.Air Throttle & Fuel Metering Assembly .Magneto Flanges .Cylinder Deck Stud Nuts & All Thru Bolts	All Models	———

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ITEM NO	TYPE PART NUMBER	APPLICATION	MODELS	REMARKS
10	Gasket Sealant (TCM) **#642188** 1.5 oz. tube (TELEDYNE CONTINENTAL MOTORS Aircraft Products Division)	• All Gaskets - Both Sides. Except Magneto Gasket	See Remarks	Tiara 6-285. 6-320
		• Rocker Cover Gaskets (cover side)	See Remarks	For All Stamped Covers
		• Gasket Accessory Case to Crankcase (crankcase side only)	See Remarks	Models 3-90. O-200. O-300. 360 All
		• Gasket - Cam Bore Cover • Oil Gage Rod Housing to Crankcase	See Remarks	470 & 520 Models & GTSIO-520 Sandcast & 360 Models
		• Gasket - Idler Pin • Gasket - Intake Manifold • Oil Drain Back Tubes • Gasket & Oil Filler Neck Holes	See Remarks	Models 470. 520. & GTSIO-520 Models C90. O-200. O-300 Models 470. 520 (Sandcast) & GTSIO-520
		• Gasket - Oil Cooler - Both Sides • Oil Seal at Alt. Drive (O.D. only)	See Remarks	All 360 Models Tiara 6-285. 6-320
		• All Press Type Plugs (Hubbard. etc.) In Parting Line Area of 3-way Joints • Oil Seal Accessory Drive (O.D. only)	See Remarks	Sump to Crankcase. or Sump to Crankcase to Acc. Case Models TSIO360A.AB.C.CB. D.DB. IO360C.CB.G.GB
		• 2 Bolt Suction Tube Gasket - Both Sides	See Remarks	All 470 & 520 Models
11	**#646941** - High Strength Adhesive Sealant (TELEDYNE CONTINENTAL MOTORS Aircraft Products Division) Use With **#646944** - Primer (TELEDYNE CONTINENTAL MOTORS Aircraft Products Division)	• Rocker Cover Stud. Rocker Arm Pivot • Studs. Push Rod. Retainer Stud • Cylinder Deck Studs	See Remarks	Tiara Only All Models Break-A-Way Torque 100 In./Lbs After 2 Hrs
		• Crankcase Breather Tubes • Bolts for Nose Seal Retainer to Crankcase	See Remarks	Models 470-520 (Sandcast) & GTSIO520 Models
		• Squirt Nozzle (All)	All Models	—
		• Engine Mount Studs & Class 3 Studs in Accessory Cover	See Remarks	360 Models
		• Oil Pump Gear Mounting Pin in Accessory Cover	See Remarks	360 Models
		• Intake Manifold Mount Studs	See Remarks	C75. C85. C90. and O-200
		• All Press Fit Breather and Oil Filler Necks	See Remarks	360 Models
		• V.T.C. Unit Bushing Retaining Screw • V.T.C. Unit Housing to Crankshaft • Top Accessory Drive Gear (Breather Slinger) Bolts	See Remarks	Tiara
12	**#646940** - F/I Sealant (TELEDYNE CONTINENTAL MOTORS Aircraft Products Division)	• All Pipe Thread Fittings in Fuel Injection System	All Models	Use Sparingly on Male Threads Only

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ITEM NO.	TYPE/PART NUMBER	APPLICATION	MODELS	REMARKS
13	Plastic Mold Spray (Silicon Mold Release) **#VS 512** (Loctite)	. Ignition Harness Terminals at Magneto Block End	All Models	————
14	**(No Lubricant or Sealant)**	. Spark Plugs	All Models	Install Without Lubricant
15	**CRC 336** Rust Prevention Compound **CITGO, Inc.**	. Spray Exhaust End of Turbocharger	All Turbo Charged Engines	After Engine Test
16	Molybdenum Dag (70% **MO-52** and Petroleum Grease	. Camshaft Lobes	Tiara Only	At Engine Assembly
17	Pipe Sealant - Loctite (Teflon PS/T)	. Use on All Pipe Threads Except as Noted	All Models	————
18	Releaseagen SI - Mold Release **RELEASEAGEN, INC.**	. Intake Manifold Hoses and Flex Ducts	All Models	————
19	**Oil Grade 50, MHS 27**	. Cylinder Studs and Thru Bolts	All Models	Lube Threads Before Tightening Nuts
20	**MIL-L-46002** Oil - Preservative **Daubert Chemical, Inc. Or Pennsylvania Refining Co.**	. Engines for Temporary Storage Or Indefinite Storage	All Models	Use After Test
21	**TCM P/N 626531-1** Enamel-Gold (1 qt) **TCM P/N 626531-2** Enamel-Gold (1gal)	. High Temp. Paint for Cosmetic and Corrosion Protection	All Models	72-30-13 Application Available Thru **Teledyne Continental Motors**
22	**TCM P/N 535011S** Lockwire - .032 in. dia. Steel	. Where Applicable For Safety Wiring	All Models	————
23	"ACCELAGOLD" Turco Products Tucker, GA 30084	. Corrosion Protection Interior and Exterior Aluminum Parts	All Models	72-30-11 Application

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CHAPTER 5
TIME LIMITS/MAINTENANCE
CHECKS

INTENTIONALLY

LEFT

BLANK

5-00-00 GENERAL

WARNING . . . When performing any inspection or maintenance on the engine that requires turning on the master switch, always treat the engine as if the ignition switch was on. Do not stand, nor allow anyone else to stand, within the arc of the propeller, since a loose or broken wire, or a component malfunction, could cause the engine and propeller to rotate.

5-10-00 TIME LIMITS/INSPECTION PROGRAM

The owner or operator is primarily responsible for maintaining the engine in an airworthy condition, including compliance with all applicable Airworthiness Directives as specified in Part 39 of the Federal Aviation Regulations and "Airworthiness Limitation" of this manual per FAR A33.4. It is further the responsibility of the owner or operator to ensure that the engine is inspected in conformity with the requirements of Parts 43 and 91 of the Federal Aviation Regulations. Teledyne Continental Motors has prepared this inspection guide to assist the owner or operator in meeting the foregoing responsibilities. This inspection guide is not intended to be all-inclusive, for no such guide can replace the good judgement of a certified airframe and power plant mechanic in the performance of his duties. As the one primarily responsible for the airworthiness of the airplane, the owner or operator should select only qualified personnel to maintain the airplane.

Oil Change Interval: *

With integral screen filter	25 Hrs.
With small filter	50 Hrs.
With large filter	100 Hrs.

Oil Filter Interval:

With large or small filter	50 Hrs.

CAUTION . . . Use only oils conforming to Teledyne Continental Motors' Specification MHS24 or MHS25 after break-in period.

*NOTE . . . Hours stated or 6 months, whichever comes first. See TCM Service Bulletin M86-12 or current revision as applicable.

5-20-00 SCHEDULED MAINTENANCE

5-20-01 PREFLIGHT INSPECTION

Before each flight, the engine and propeller should be examined for damage, oil leaks, proper servicing and security. Refer to the airframe manual "Preflight Check List".

5-20-02 50 HOUR INSPECTION

Detailed information regarding adjustments, repair and replacement of components may be found in this Overhaul Manual. The following items should be checked during normal inspections.

1. Engine Conditions:	a. Magneto RPM drop:	Check
	b. Full Power RPM:	Check
	c. Full Power Manifold Pressure:	Check
	d. Full Power Fuel Flow:	Check
	e. Idle RPM:	Check

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Record any values not conforming to engine specifications so that necessary repair or adjustment can be accomplished.

2.	Oil Filter:	Replace filter, inspect cartridge.
3.	Oil:	Change oil, if integral screen or small filter is used.
4.	Air Filter:	Inspect and clean or replace as necessary.
5.	High Tension Leads:	Inspect for chafing and deterioration.
6.	Magnetos:	Check and adjust only if non-conformities were noted in Step 1.
7.	Magneto Filter:	Inspect for color, if white o.k., if red or contaminated replace.
8.	Visual:	Check hoses, lines, wiring, fittings, baffles, etc. for general condition, proper routing and positioning.
9.	Exhaust System:	Inspect for condition and leaks.
10.	Adjustments & Repairs:	Perform service as required on any items that are not within specifications.
11.	Engine Condition:	Run up and check as necessary for any items serviced in Step 10. Check engine for oil and fuel leaks before returning to service.

5-20-03 100 HOUR INSPECTION

Detailed information regarding adjustments, repair and replacement of components may be found in this Overhaul Manual. The following items should be checked during normal inspections:

1.	Engine Conditions:	a. Magneto RPM Drop:	Check
		b. Full Power RPM:	Check
		c. Full Power Manifold Pressure:	Check
		d. Full Power Fuel Flow:	Check
		e. Idle RPM:	Check

Record any values not conforming to engine specifications so that necessary repair or adjustment can be accomplished.

2.	Oil Filter:	Replace filter, inspect cartridge.
3.	Oil:	Drain while engine is warm. Refill sump.
4.	Valves/Cylinders:	Check compression (Refer to Chapter 70-50-00.)
5.	Cylinders, Fins, Baffles:	Inspect.

6.	Spark Plugs:	Inspect, clean, regap (if necessary), reinstall. Rotate plugs from upper to lower positions and vice versa to increase plug life.
7.	High Tension Leads:	Inspect for chafing and deterioration.
8.	Magnetos:	Check. Adjust points and timing if necessary.

NOTE . . . Minor changes in magneto timing can be expected during normal engine service. The time and effort required to check and adjust the magnetos to specifications is slight and the operator will be rewarded with longer contact point and spark plug life, smoother engine operation and less corrective maintenance between routine inspections.

NOTE . . . At each 500 hours, the magnetos should be disassembled and inspected according to Magneto Service Manual.

9.	Magneto Filter:	Inspect for color, if white o.k., if red or contaminated, replace.
10.	Air Filter:	Inspect and clean or replace as necessary.
11.	Alternate Air Door:	Check operation.
12.	Throttle Shaft and Linkage:	Inspect for wear and lubricate.
13.	Fuel Nozzles:	Inspect nozzles and vent manifold for leaks or damage, clean as required.
14.	Fuel & Oil Hoses & Lines:	Inspect for deterioration, leaks, chafing.
15.	Fuel System:	If pre-inspection run-up indicates a problem, clean fuel nozzles, metering unit screen, manifold valve screen and adjust as necessary (Refer to latest TCM Service Bulletin for procedure.)
16.	Engine Baffles and Seals:	Inspect for condition and correct positioning.
17.	Control Connections:	Inspect and lubricate.
18.	Exhaust:	Pressure check system. Check for condition and leaks, Pay particular attention to heater muffs.
19.	Adjustment & Repairs:	Perform service as required on any items that are not within specifications.
20.	Engine Condition:	Perform complete run-up. Check engine for fuel or oil leaks before returning to service.

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5-50-00 UNSCHEDULED MAINTENANCE

Detailed information required for component, part replacement, system adjustments, accessory replacement/repair, top overhaul, etc., can be found in "Related Publications" listed in Chapter 1.

No maintenance of the categories listed above should be attempted without consulting the applicable related publications.

NOTE . . . In case of engine overspeed, see TCM Service Bulletin M75-16 or current revision as applicable.

CHAPTER 70

STANDARD PRACTICES

70-00-00 GENERAL

To facilitate and ensure proper reinstallation, tag and/or mark all parts and hardware as to their location before they are removed or disassembled.

When removing any tubes or engine parts, look for indications of scoring, burning or other undesirable conditions. Tag any unserviceable parts or units for investigation and possible repair. Take extreme care to prevent foreign matter (lockwire, nuts, washers, dirt, etc.) from entering the engine whether it is on or off the aircraft. Make use of protective caps, plugs, and covers to ensure openings are unexposed.

CAUTION . . . Dust caps used to protect open lines should always be installed OVER the tube ends and NOT IN the tube ends. Flow through the lines may be blocked off if lines are inadvertently installed with the dust caps in the tube ends.

If anything is dropped into the engine, work should be stopped immediately and the item removed even if considerable time and labor is required.

Insure all parts are thoroughly clean before assembling, especially during engine build-up.

All lockwire and cotter pins must fit snugly in holes drilled in specific hardware. On castel-lated nuts, 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. Use only corrosion resistant steel for cotter pins or lockwire.

When replacing gaskets, packings, or rubber parts, use the same type or composition as that of the gasket that was removed.

Make sure replacement nonmetallic parts show no sign of storage deterioration.

Use only a mallet of plastic or rawhide when installation of a part requires such force.

Loose fitting spline drives external to the engine which have no means of lubrication should be lubricated with an anti-seize lubricant such as molylbdenum disulfide.

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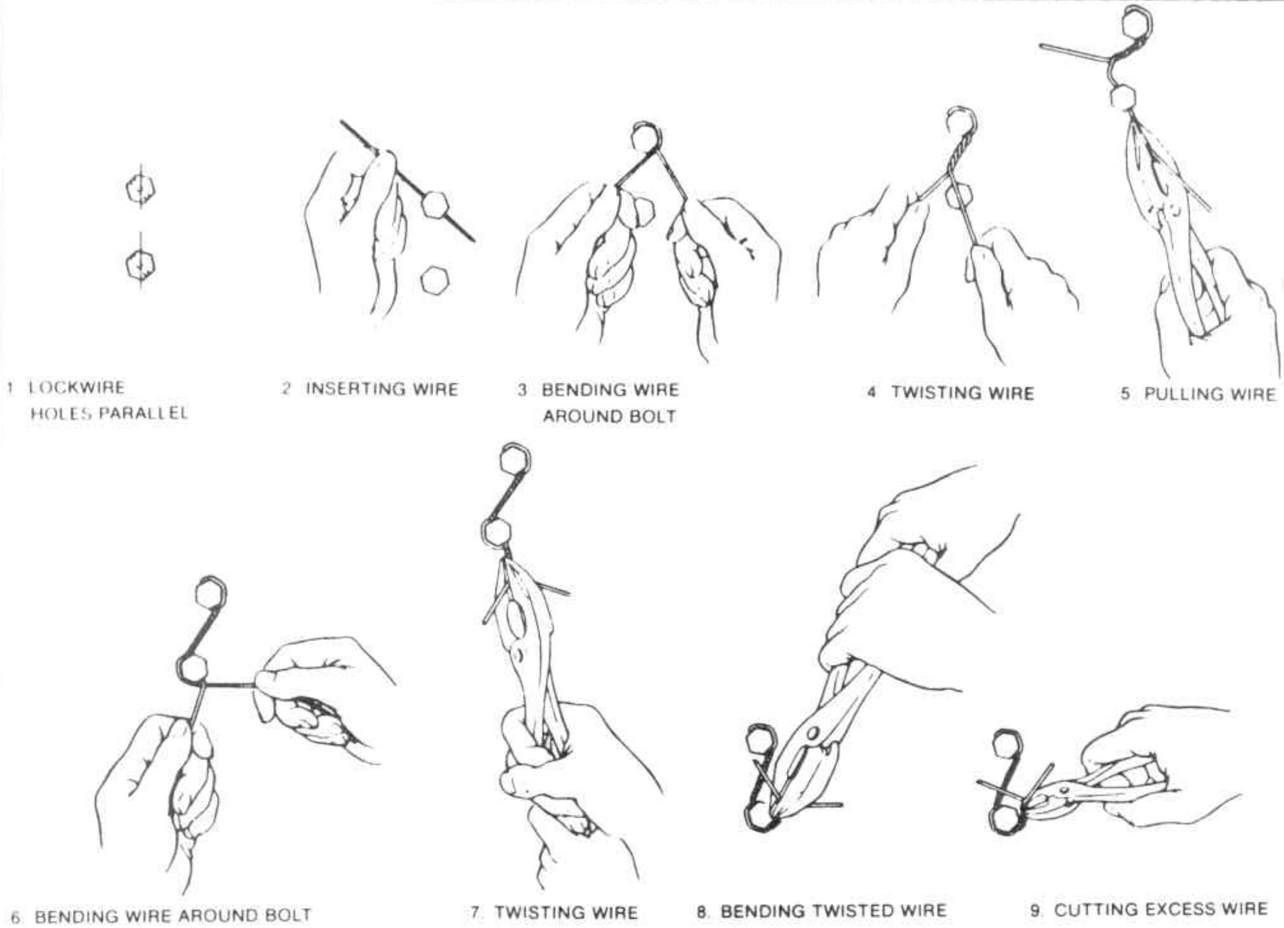
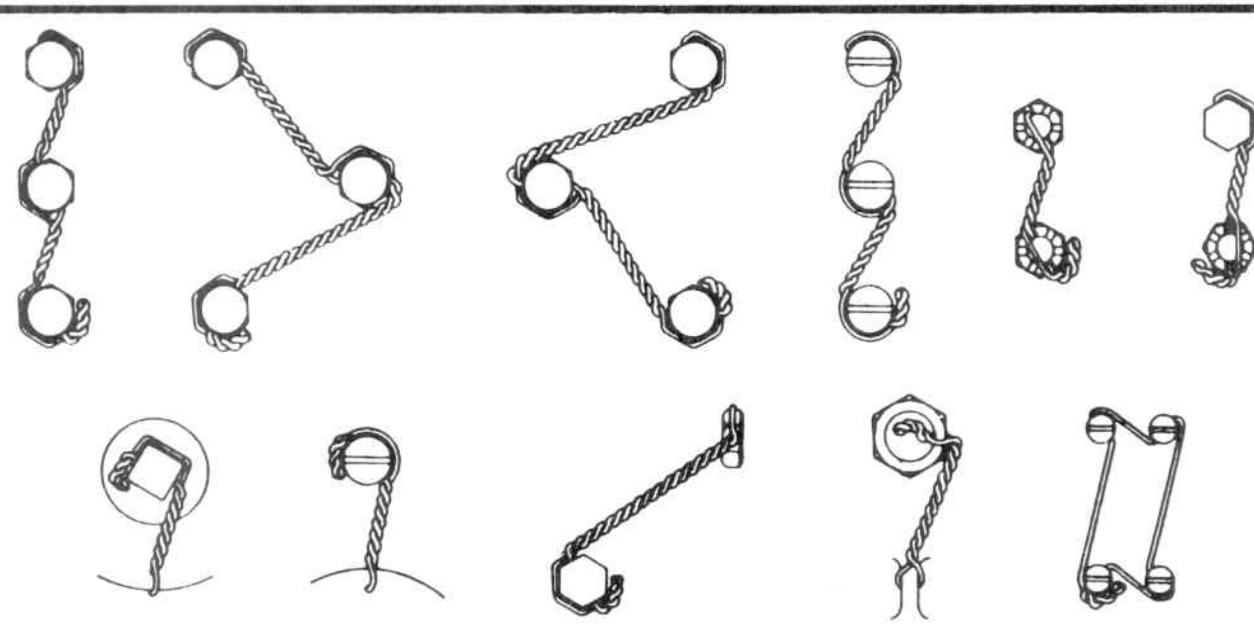
70–10–00 LOCKWIRE PROCEDURE



(a) Steps in applying safety wire.



(b) Typical safety wire patterns.

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70-20-00 CRANKCASE THREADING PROCEDURE.

1. Use full strength non-thinned Permatex aviation grade 3D. Shake or mix well before using.

2. Apply Permatex to the threaded case half first only in areas where thread is shown, using short light brush strokes until an even thin coat is obtained. The Permatex should be viscous enough that most of the brush marks disappear. If not, use a new can of aviation Permatex (Allow the Permatex to air dry to a tacky condition before threading).

3. Apply Permatex to all areas listed in step (2) above on the non-threaded crankcase half, using the same technique.

4. Apply grade D silk thread P/N 641543 as shown in illustration, being sure that free ends are covered by gaskets, except at oil seal. Note applying thead to L/H 2,4,6 side crankcase half may allow case halves to be assembled easier, due to gravity holding governor gear in place. Apply silk thread only in areas illustrated.

5. Assemble crankcase halves using bolts for alignment to prevent movement of the thread and torque all bolts in proper sequence according to Figure 72-60-02 Torquing sequence as soon as possible.

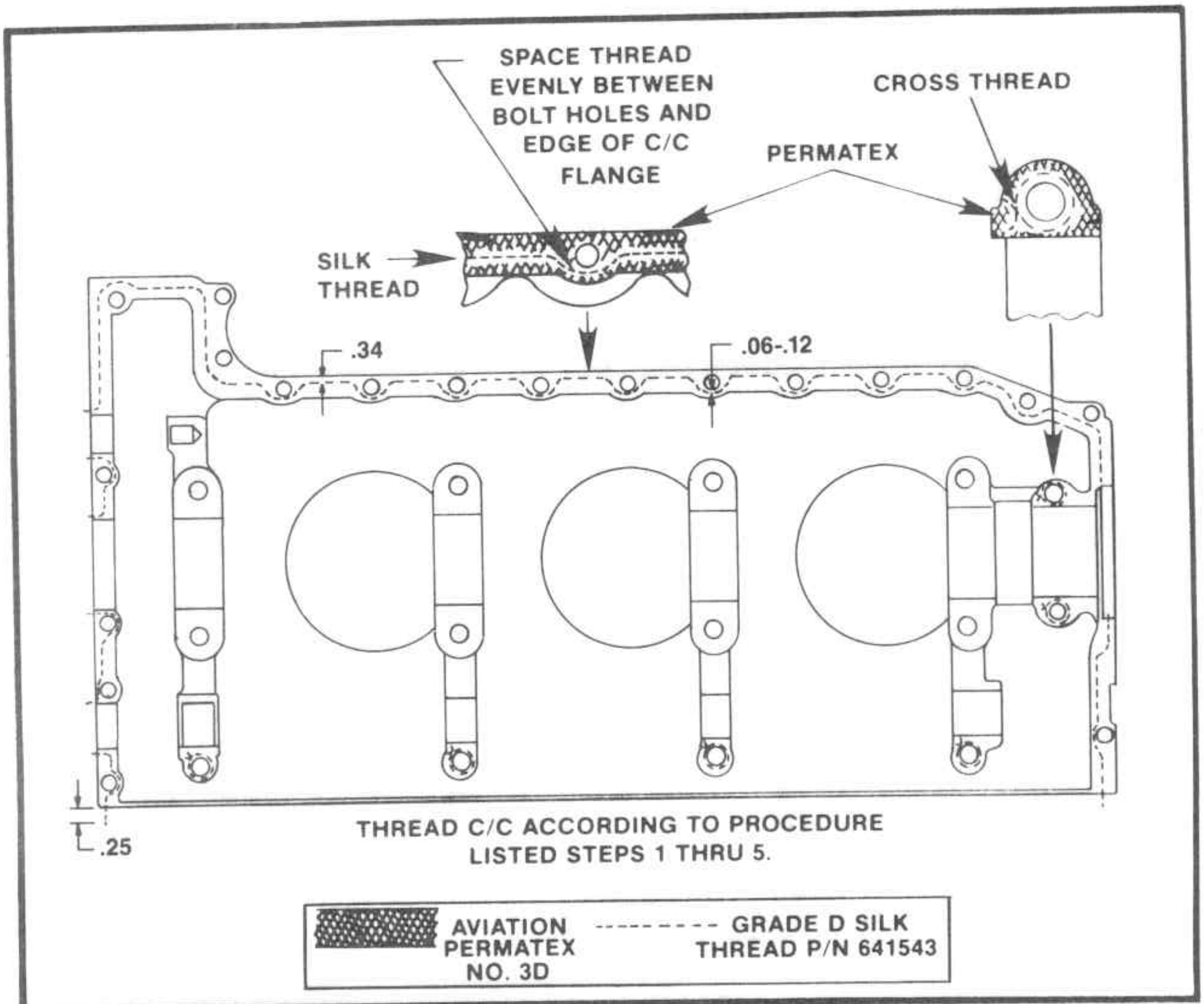

FIGURE 70-20-00. PERMATEX AND THREADING PROCEDURE.

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70-30-00 APPLICATION OF ADHESIVES.

Adhesives and sealants will be used only in specific applications, outlined in Chapter 1 "Sealants and Lubricants".

Gasket Maker P/N 646942 – Surfaces must be clean and free of oil and grit. Apply a thin even coat of Gasket Maker between .010 and .020 of an inch thick to the surface specified in Chapter 1 "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, or 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 (chlorinated solvent is helpful). Material on hands can be cleaned with waterless mechanic's hand soap followed by soap and water.

70-40-00 INSTALLATION OF GASKETS

All gaskets must be visually inspected prior to installation.

Following visual inspection; if the gasket shows any indication of gouges, nicks, cuts or bend and fatigue marks, immediately replace with new, pre-inspected gasket.

Gasket surfaces must be clean and free of oils and grit. Apply a thin coat of TCM Copper Coat #642188 to both sides of gasket unless otherwise specified. (Refer to Item No. 10 in Chapter 1 "Sealants and Lubricants" for application of Copper Coat). Once Copper Coat has been applied, position gasket with the Copper Coat to its respective side, according to Chapter 1 "Sealants and Lubricants". Evenly torque assembly into place without stressing gasket.

70-50-00 CYLINDER LEAKAGE CHECK (Compression)

GENERAL

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.

We have received reports of incorrect cylinder leakage check results caused by improper use of test equipment and/or by the use of faulty test equipment.

To help you accurately accomplish a leakage check, we submit the following information on leakage and use of the Master Orifice tool (Ref. Figure 70-50-01) to calibrate the leakage checking equipment used on Teledyne Continental engines.

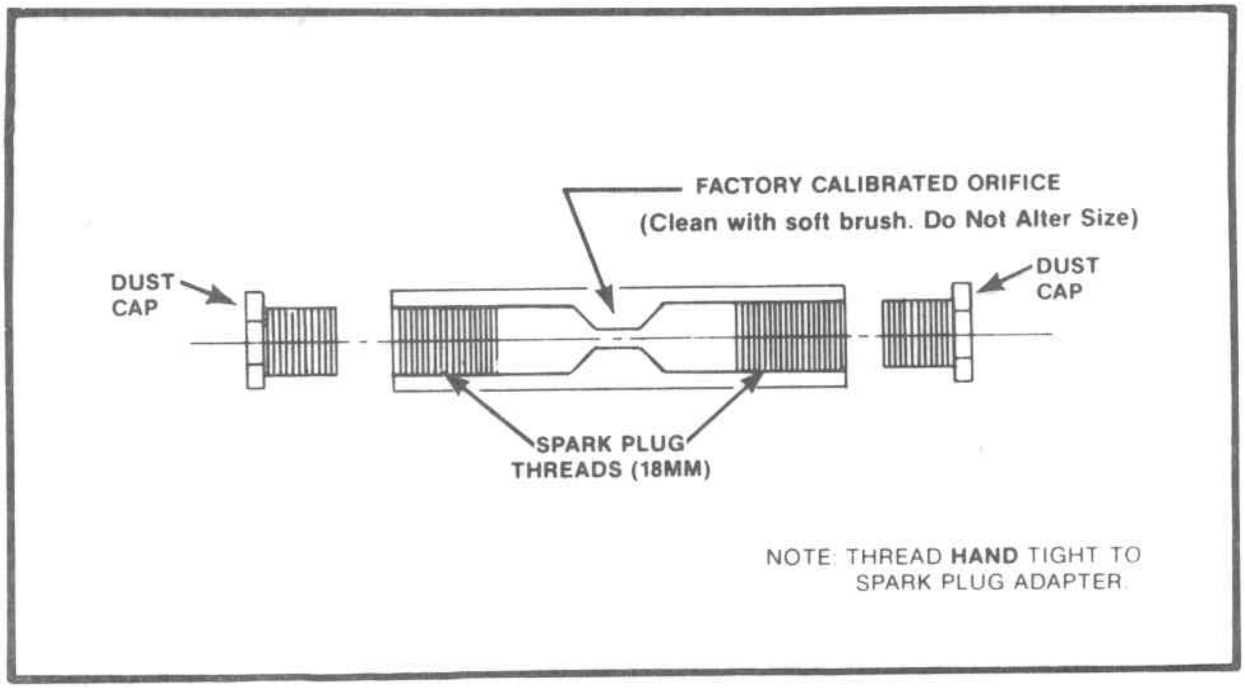
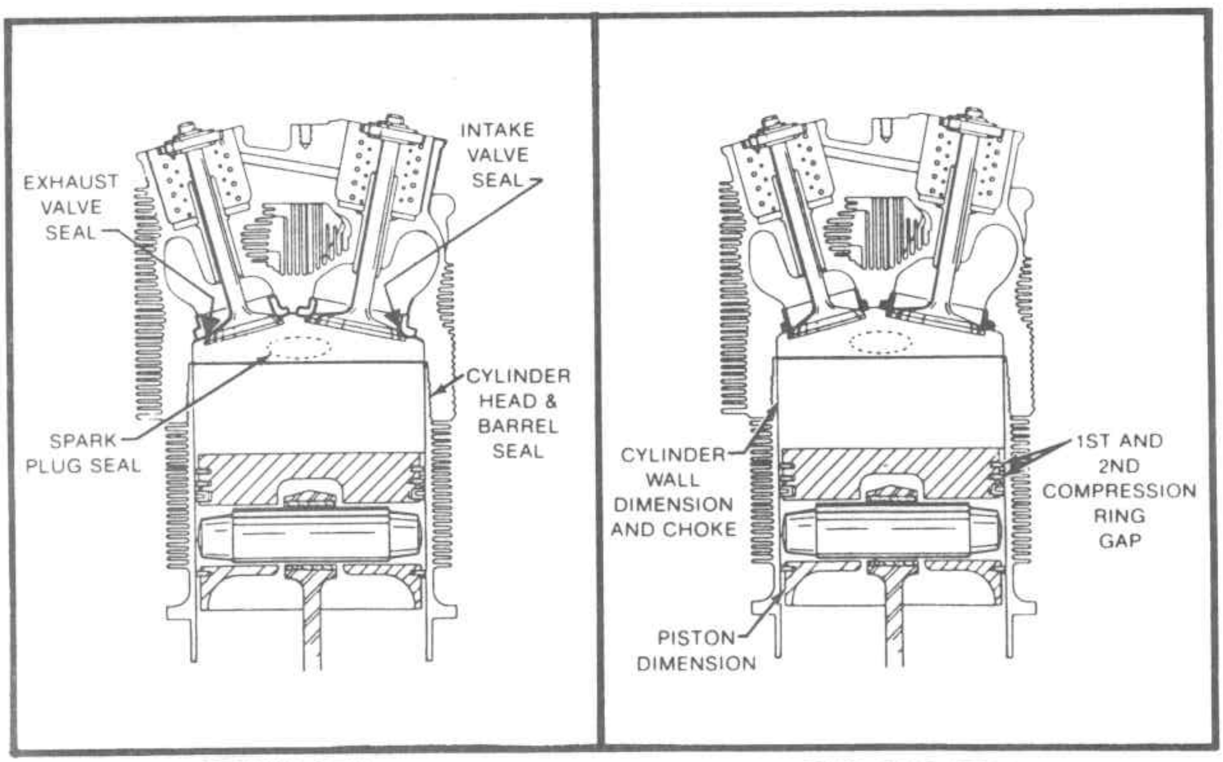


FIGURE 70-50-01. MASTER ORIFICE ASSEMBLY TOOL BORROUGHS P/N 646953.

Borroughs Tool & Equipment Corp.
2429 N. Burdick St.
Kalamazoo, MI 49007
Tel. 616/345-2700



STATIC SEAL **DYNAMIC SEAL**

FIGURE 70-50-02

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70–50–01 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 (Ref. Figure 70-50-02). No leakage of the static seal is permissible.

Dynamic Seal

The dynamic seal consists of the piston rings to the cylinder wall seal (Ref. Figure 70-50-02). This seal leakage can vary from engine to engine by the cylinder displacement, cylinder choke, ring end gap and piston design.

70–50–02 EQUIPMENT

Testing equipment must be kept clean and checked periodically for accuracy as follows: Using a line pressure of 100 to 120 p.s.i., close the cylinder pressure valve, then set the regulator pressure valve to 80 p.s.i. The pressure in both gages should stabilize with no leakage.

The restrictor orifice dimension in the differential pressure tester (Figure 70-50-03) 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 p.s.i. differential pressure.

Master Orifice Tool

For conformity in tester equipment, a Master Orifice Tool has been developed to calibrate equipment and determine the low indicated leakage limit prior to the engine leakage check. Connect compressed air at 100-120 p.s.i. to the tester with cylinder pressure valve closed. Turn the regulator pressure valve on, adjusting pressure to indicate 80 p.s.i. Remove the dust caps from both ends of the Master Orifice Tool and install onto your cylinder spark plug adapter. Turn the cylinder pressure valve on and readjust regulator pressure gage to read 80 p.s.i. At this time the cylinder pressure gage 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 your cylinder adapter.

A schematic diagram of a typical differential pressure tester is shown in Figure 70-50-03.

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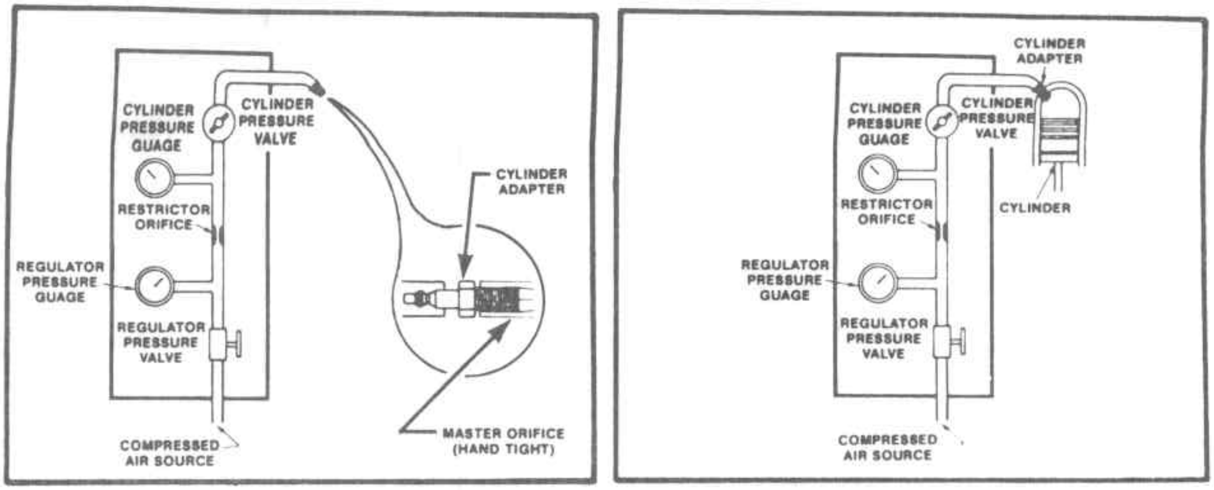

FIGURE 70-50-03. DIFFERENTIAL PRESSURE TESTER.

70-50-03 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 . . . Magnetos and fuel must be shut off prior to test to make certain that the engine cannot accidentally fire.

(a) Perform the test as soon as possible after the engine is shut down to ensure that the piston rings, cylinder walls, and other engine parts are well lubricated and at running tolerance.

(b) Remove the most accessible spark plug from each cylinder.

(c) 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.

(d) Install an adapter in the spark plug hole and connect the 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 p.s.i.

Continue rotating the engine against this pressure until the piston reaches top dead center (TDC). Reaching TDC 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 lease one-half revolation 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.

CAUTION . . . Care must be exercised in opening the cylinder pressure valve, since sufficient air pressure will be built up in the cylinder to cause it to rotate the crankshaft if the piston is not at TDC. It is recommended that the propeller be secured during check to prevent possible rotation.

(e) Open the cylinder pressure valve completely. Check the regulator pressure gage and adjust, if necessary, to 80 p.s.i.

(f) Observe the pressure indication on the cylinder pressure gage. The difference between this pressure and the pressure shown by the regulator pressure gage is the amount of leakage through the cylinder. If the cylinder pressure gage reading is **higher** than the previously determined master orifice calibrated pressure reading, proceed to the next cylinder leak check. If the cylinder pressure gage reading is **lower,** proceed with the following.

Static Seal Check (Figure 70–50–05)

(g) The source of air leakage should first be checked for the static seal. Positive identification of static seal leakage is possible by listening for air flow sound at the exhaust or induction system cylinder port. When checking for cylinder head to barrel leakage, use a soapy solution between the fins and watch for bubbles. Use a soapy solution also around both spark plug seals for leakage. NO LEAKAGE IS ALLOWED IN STATIC SEALS.

(h) If leakage is occurring in the intake or exhaust valve areas, it may be possible to correct a low reading by staking the valves. This is accomplished by placing a fiber drift on the rocker arm directly over the valve stem and tapping the drift several times with a hammer to dislodge any foreign material that may be between the valve face and seat.

CAUTION . . . When correcting a low reading in this manner, rotate the propeller so the piston will not be at TDC. 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.

NOTE . . . When the rocker cover is removed, inspect valve springs, valve retainers, and valve stem for wear. This may have contributed to the valve leakage.

(i) If leakage is noted between the cylinder head and barrel, REPLACE THE CYLINDER. If leakage cannot be corrected at the valves by "staking", the cylinder must be removed and repaired before a Dynamic Seal Check.

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.

(j) If the cylinder was removed for static leakage, replacement or repair, inspect piston ring gap and cylinder wall for tolerance (Ref. Dynamic Seal, Figure 70-50-02). Once the piston and the cylinder have been cleaned, inspected, and ring gap tolerances have been met, reassemble to the engine.

Dynamic Seal Check

(k) To check the dynamic seal of a cylinder, proceed with the leakage test and observe the pressure indication of the cylinder pressure gage. The difference between this pressure and the pressure shown by the regulator gage is the amount of leakage at the dynamic seal.

(l) If the leakage is below the previously determined low cylinder gage 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 (Figure 70-50-04).

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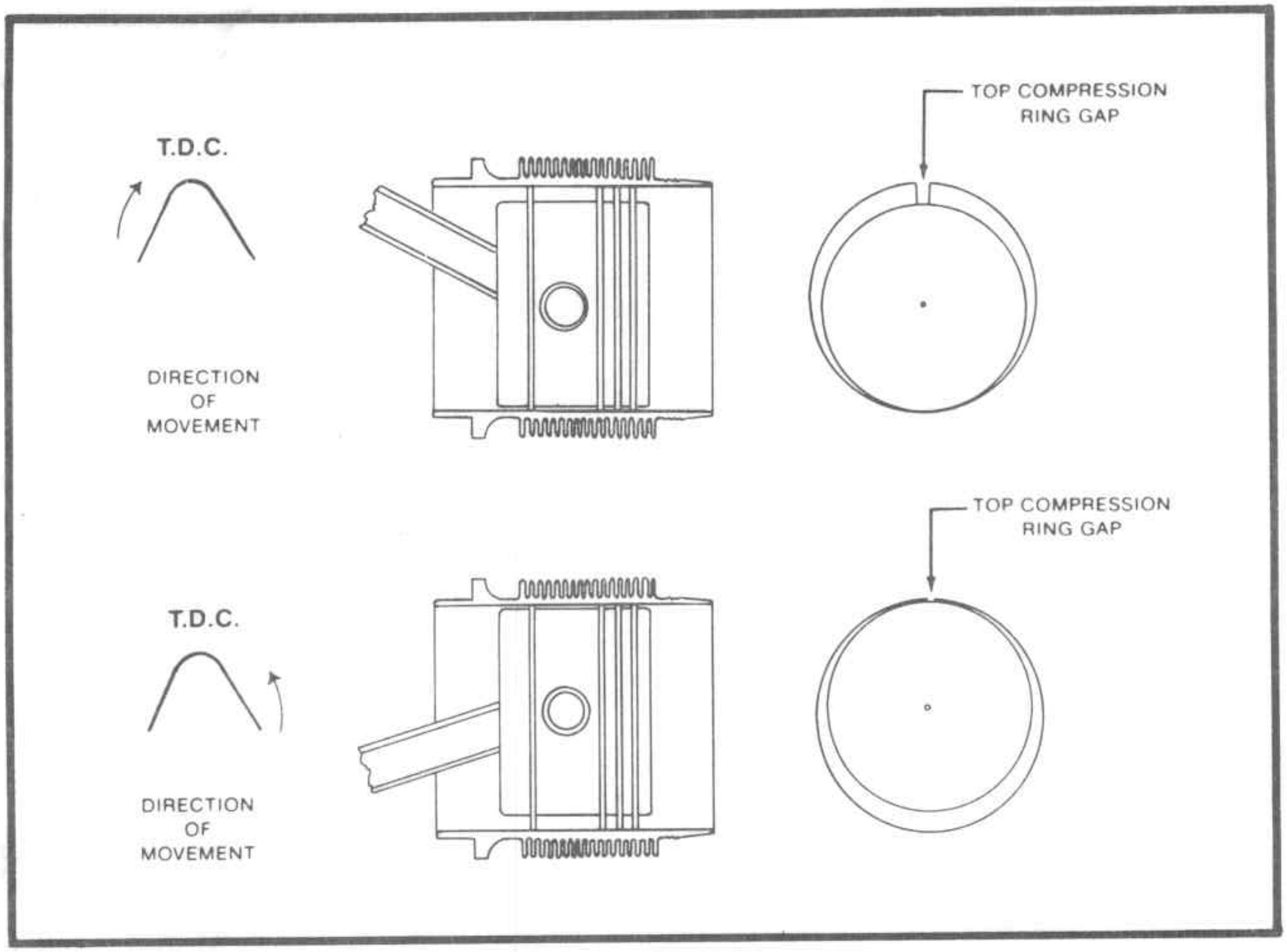

Figure 70-50-04.

First assure that the piston and piston rings are centered. This may be accomplished by reducing regulator pressure to 20 p.s.i. and working piston through TDC several times, bringing the piston to TDC in the normal direction of engine rotation. Adjust regulated pressure to 80 p.s.i. and determine amount of loss. If the gage 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 70-50-04, the compression ring location may have a direct bearing on the dynamic seal pressure check. Therefore, we suggest you complete the test in the opposite direction if readings are below prescribed limits.

(m) If recheck of cylinder pressure gage 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 should be accomplished as outlined in this engine overhaul manual and service bulletins.

FIRST CHECK	CHECK FOR	METHOD	1. DISCREPANCY	2. CORRECTIVE ACTION	2. CORRECTIVE ACTION
STATIC SEAL (NO LEAKAGE PERMISSIBLE)	Intake Valve to Seat Seal	Listen for Air Flow in Intake Port	Carbon	Stake Valve	
			(Cracked Cylinder)	Replace Cylinder	
			Seat Worn or Burned	Grind or Replace	Reinspect
			Valve Worn or Burned	Grind or Replace	
	Exhaust Valve to Seat Seal	Listen for Air Flow in Exhaust Port	Carbon	Stake Valve	
			(Cracked Cylinder)	Replace Cylinder	
			Seat Worn or Burned	Grind or Replace	Reinspect
			Valve Worn or Burned	Replace	
	Spark Plug (2) to Port Seal	Apply Soapy Solution Around Spark Plug	Loose Heli-coil	Replace Heli-coil	Reinspect
			Cracked Cylinder	Replace Cylinder	
	Cylinder Head to Barrel Seal	Apply Soapy Solution Between Head and Barrel	Bubbles	Replace Cylinder	
	Cylinder Head Cracks	Apply Soapy Solution Around Fins	Bubbles	Replace Cylinder	

SECOND CHECK	CHECK FOR	METHOD	1. DISCREPANCY	2. CORRECTIVE ACTION	2. CORRECTIVE ACTION
DYNAMIC SEAL	Leakage by Piston Rings	Test Gauge below Tolerance	Piston cracked or out of limits	Replace Piston	
			Worn Rings	Replace Rings	
			Cylinder wall dimentions out of limits	Replace Cylinder	
		Test Gauge above Tolerance	None	None	

FIGURE 70-50-05

INTENTIONALLY

LEFT

BLANK

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CHAPTER 72

ENGINE RECIPROCATING

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72–00–00 GENERAL

The operating limits and specifications listed in this section are applicable to the IO-470 aircraft engine. Consult Chapter 76, 77 and 80 for additional operating procedures.

For time between overhaul (TBO) for IO-470 series engines, see TCM Service Bulletin M85-13 or current revision as applicable (Revised Recommended Overhaul Periods For All Teledyne Continental Aircraft Engines). Accessories supplied with engines by TCM are considered to 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
Model IO-470

Cylinders
- Arrangement. . . . . . Individual cylinders in a horizontally opposed position
- Compression Ratio
- IO-470-C,G,P,R,T 8:1
- IO-470-D,E,F,H,L,M,N,S,U,V,VO 8.6:1
- IO-470-J & K 7:1
- Firing Order 1-6-3-2-5-4
- * Cylinder Head Temperature Maximum Allowable (all except IO-470-J & K) . . 460°F
- IO-470-J & K . . . . 450°F

*Indicates temperature measured by Bayonet Thermocouple, (Aeronautical Standard AS234 element or equivalent), installed in boss in bottom of cylinder head.

Number of Cylinders. 6

Numbering (Accessory toward propeller end):
- Right Side Cylinders 1-3-5
- Left Side Cylinders 2-4-6
- Bore (Inches) 5.00
- Stroke (Inches) 4.00
- Piston Displacement (cu. in.) 471

TOTAL ENGINE WEIGHT WITH ACCESSORIES – DRY (No oil in sump)

TOTAL WEIGHT:

IO-470-C	465.60 Lbs.
IO-470-D	466.50 Lbs.
IO-470-E	461.87 Lbs.
IO-470-F	464.66 Lbs.
IO-470-G	461.87 Lbs.
IO-470-H	465.60 Lbs.
IO-470-J	434.97 Lbs.
IO-470-K	394.90 Lbs.
IO-470-L	430.91 Lbs.
IO-470-M	428.06 Lbs.
IO-470-N	433.69 Lbs.
IO-470-P	511.75 Lbs.

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IO-470-R	462.87 Lbs.
IO-470-S	426.31 Lbs.
IO-470-T	474.50 Lbs.
IO-470-U	423.18 Lbs.
IO-470-V,VO	423.47 Lbs.

(Subject to product variation of ± 2.5%)

Engine Weight Includes:

Crankcase assembly, crankshaft assembly, camshaft assembly, valve drive train, cylinder assemblies, piston & connecting rod assemblies, oil sump assembly, oil cooler, generator/alternator, starter, starter adapter assembly, lubrication system , accessory drives, ignition system (includes spark plugs), fuel injection system, induction system, all engine attaching hardware, hoses, clamps and fittings.

DOES NOT INCLUDE:

Cylinder baffling, prop governor, airframe to engine control cables, attaching hardware, hose clamps and fittings.

OPERATING LIMITS

ENGINE MODEL	RATED MAX. CONT. BHP	REC. MAX. CRUISE BHP
IO-470-C	250	190
IO-470-D	260	188
IO-470-E	260	190
IO-470-F	260	195
IO-470-G	250	190
IO-470-H	260	194
IO-470-J	225	169
IO-470-K	225	169
IO-470-L	260	195
IO-470-M	260	190
IO-470-N	260	195
IO-470-P	250	190
IO-470-R	250	190
IO-470-S	260	190
IO-470-T	250	190
IO-470-U	260	190
IO-470-V & VO	260	195

Crankshaft Speed - RPM

Rated Maximum Continuous Operation
(IO-470-C,G,J,K,P,R & T) 2600
(IO-470-D,E,F,H,L,M,N,S,U,V & VO) 2625

Recommended Max. for Cruising
(All Models) 2450

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Intake Manifold Pressure (In. Hg.)

Maximum Take-Off . . . . See Performance Charts
Maximum Continuous . . . . See Performance Charts
Recommended Continuous Max. for Cruising . . . . See Performance Charts
Fuel Control System . . . . Continental Continuous Flow Injector
Unmetered Fuel Pressure (P.S.I.G.) . . . . (See Operating Limits 77-10-00)
Fuel (Min. Grade) all IO-470 except IO-470-J&K . . . . Aviation Grade 100 or 100LL
Fuel (Min. Grade) IO-470-J&K . . . . Aviation Grade 80 Octane.

WARNING . . . The use of a lower octane rated fuel can result in 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, the fuel tank must be completely drained, properly serviced, and the proper engine inspection completed.

Oil: (First 25 hours of operation . . . . Mineral (non-detergent) Oil or Corrosion Preventive Oil Corresponding to MIL-C-6529 Type II

Oil Specification . . . . MHS-24 or MHS-25

Normal Service
All Temperatures 15W-50
20W-50
Below 50°F. Ambient Air (Sea Level) . . . . SAE30 or 10W-30
Above 30°F. Ambient Air (Sea Level) SAE50

Oil Sump Capacity. See Operating Limits Section 77-00-01
Max. Oil Consumption (Lb./BHP/Hr. Max. at Rated Power at RPM)

ALL MODELS --

$$\frac{.006 \text{ LBS. X \% POWER}}{100}$$

Oil Pressure

Idle, Minimum, psi 10
Normal Operation, psi . . . . 30 to 60

Oil Temperature Limits

Minimum for Take-Off . . . . 24°C/75°F
Maximum Allowable . . . . 110°C/240°F

IGNITION TIMING ° BTC

IGNITION TIMING ° BTC	RIGHT	LEFT
IO-470-C	26°	26°
IO-470-D	20°	20°
IO-470-E	20°	20°
IO-470-F	20°	20°
IO-470-G	26°	26°
IO-470-H	20°	20°
IO-470-J	22°	22°

IGNITION TIMING ° BTC (Continued)

IGNITION TIMING ° BTC	RIGHT	LEFT
IO-470-K	22°	22°
IO-470-L	20°	20°
IO-470-M	20°	20°
IO-470-N	20°	20°
IO-470-P	26°	26°
IO-470-R	26°	26°
IO-470-S	20°	20°
IO-470-T	26°	26°
IO-470-U	20°	20°
IO-470-V & VO	20°	20°

ACCESSORIES

The following magnetos equipped with an appropriate harness are eligible on these engines at the indicated weight change.

	Wt. Change
One each TCM S6RN-201 and S6RN-205	None
One each TCM S6RN-1201 and S6RN-1205	+1 lb.
Two TCM S6RN-25	+1 lb.
Two Slick Electro Model 662 or 680	+2 lb.
Two TCM S6RN-1225	+1 lb.
Two Slick Electro Model 6210/6220	-3 lb.

The following spark plugs are approved for use in all engines covered in this manual.

MODELS

IO–470–C,G,R,P,T		
	TCM	630533, 632740, 635860, 632465, 632475, 646632, 646631, 646090, 641977, 646089
	AUBURN	273, 283, 293
	AUTOLITE	SL350
	CHAMPION	RHB32E, RHB32S, RHB36S
	SMITH	RSH35-BR/1, RSH35-8R, RSE35-8R/1
	AUTOLITE	SH26, SH260, PH26, PH260
	TCM	628325, 646629, 627643, 630049, 627978, 642097, 642098, 646091, 646092, 625350, 627449, 635862, 626364, 627450, 635861, 632462, 632463, 635146, 635147
IO–470–J,K		
	CHAMPION	EM41E, HM41E, REM38S, REM40E, RHM385, RHM40E
	SMITH	RSE23-3R, RSH23-3R, RSE-23-3R/1, RSH23-3R/1

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	AUTOLITE	*SH20A, SH15, SH200A, SH26, SH260*
	TCM	635863, 635150, 646629, 627643, 646630, 627978, 642097, 642098, 646091, 646092, 539432, 635350, 635862, 626363, 626362, 635861, 627892, 632460, 632461, 632462, 632463
IO-470-D,E,F,H,L,M,N,S,U,V	CHAMPION	RHB32E, RHB32S, RHB36S
	SMITH	RSH35-8R/1, RSH35-8R, RSE35-8R/1
	AUBURN	271, 273, 281, 283, 291, 293
	AUTOLITE	SL350
	TCM	634675, 646632, 646631, 646090, 641977, 646089, 630532, 630533, 632738, 632740, 635859, 635860, 632465

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72-00-01 INTRODUCTION

The arrangement and appearance of the engine components are indicated in Subsection 1-10-04. It will be observed that minimum length has been achieved by mounting the starter on right angle and by mounting the magnetos in the forward side of the accessory gear compartment formed by the crankcase castings at the rear. The magneto location also serves to shorten the high tension ignition cables as much as possible.

On the crankcase, an oil cooler is located in front of the No. 5 cylinder. A full flow oil filter is used in place of the integral type screen.

Configuration differences of the IO-470 engines are the oil sump, either cast aluminum or stamped aluminum sheet metal; cylinders - straight valve versus inclined valve, various induction systems, balance tubes and fuel injection assemblies.

Specific detail part differences in the IO-470 Series will be noted in the Parts Catalog (X30589A).

72-00-02 CRANKCASE

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 publication.

A. Bosses molded in the crankcase castings are line bored in the assembled castings to form bearings for the camshaft and seats for precision, steel-backed, lead alloy lined crankshaft main bearing inserts. Guides are bored through lateral bosses for tappets and for the governor drive shaft. A needle bearing is pressed into the right crankcase, to the right of the rear main bearing, to support the front end of the starter shaftgear.

B. 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. Each pad has six studs and two through bolts for attaching cylinder base flanges. The propeller governor mount pad is located at the left hand lower front corner. On the right sandcast crankcase an oil cooler mounting pad is located at the front.

C. The crankcase interior is ventilated by a pressed in type breather consisting of a tube and baffle assembly with a side extension for hose attachment. The breather assembly is located on the left upper crankcase.

NOTE . . . Engine crankcase halves are a machined set -- do not mix-match with any other set.

72-00-03 CRANKSHAFT

The method of numbering the crankshaft journals and cheeks is illustrated in Figure 72-00-03. Main journals, rod journals, and crankshaft cheeks are identified by letters and location numbers.

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

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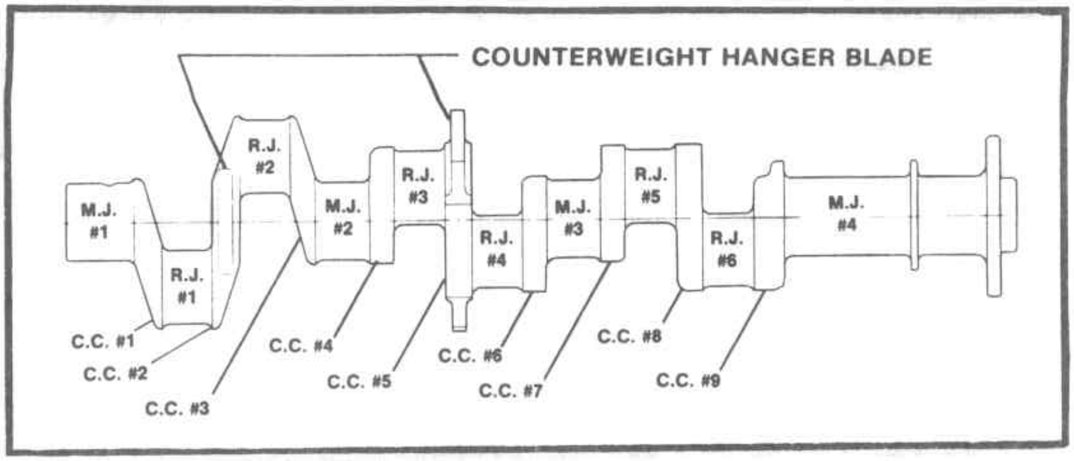

FIGURE 72-00-03. CRANKSHAFT NUMBERING.

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

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 designated a 6th order counterweight. Similarly, if a vibration occurs five times per revolution, the counteracting counterweight is designated a 5th order counterweight.

Crankshaft vibrations are caused by the firing of the cylinders. The sixth order of vibration is the strongest.

Counterweights are installed on hanger blades located on the crankshaft #2 cheek (2 counterweight configuration) and on the #2 and #5 cheeks (4 counterweight configuration). Where sixth order counterweights are used, they should always be installed on the #2 cheek. Where a crankshaft has 2 counterweights, one 4-1/2 order and one 6th order, they should be installed on the #2 cheek opposite each other. It makes no difference on which side they are installed.

The six throw 120° steel alloy forging is machined all over except some surfaces of the crankcheeks. The entire crankshaft is nitrided, then the mains and crankpins are polished. A special flange is formed at the front end for attachment of the propeller. A centerbored hole from the front end intersects a radial hole from the front main journal to conduct engine oil under pressure from the governor through an interior groove in the front main and thrust bearing (41, See Figure 72-00-10) to the center of the propeller hub. On IO-470 models an oil transfer collar encompassing the crankshaft between the front and rear halves of the main thrust bearing transfers the governor controlled oil from the crankcase passage to the crankshaft interior.

The crankshaft gear is heated prior to installation to obtain a shrink fit with the crankshaft. The gear is driven by a pilot dowel of uniform diameter, which is positively retained by the head of one of the six 5/16 inch gear retaining bolts.

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.

72-00-04 CONNECTING RODS

The "I" beam type connecting rods have split steel backed bronze piston pin bushings and two identical precision inserts (of the same type as the main bearings) at the crankpin end. Weight variation of rods in any one pair is limited to 1/2 ounce in opposing bays.

72–00–05 CAMSHAFT

A steel alloy forging is machined on four journals, nine cam lobes and the gear mount flange at the rear end. The lobes and journals are ground and hardened. A groove around the front journal passes engine oil from the right crankcase cross passage to the left case passage (See 33, 36 and 37 Figures 72-00-10). The camshaft gear is attached by four unequally spaced bolts to locate its timing mark in relation to the cam lobes.

72–00–06 PISTONS

The pistons used in the IO-470 series engines are either TCM recommended cast insert aluminum or aluminum forgings machined on all exterior surfaces. Some IO-470 models in the past have utilized a three ring piston. The ring grooves on the three ring piston are all above the pin hole. The two top grooves hold the top and second compression rings, the third groove holds a center grooved and slotted oil control ring and has six oil drain holes to the interior. Most IO-470 models utilize a four ring piston, the fourth groove being below the pin hole to hold a scraper ring. The skirt is solid and has cylinder relief cuts at the bottom to clear crankshaft counterweights. The piston pins are full floating ground steel tubes with aluminum plugs permanently forged in.

72–00–07 LIFTERS

The barrel type hydraulic lifters may be removed and replaced without complete disassembly of the engine. Construction and operation of the lifters are described in Section 72-00-11.

72–00–08 CYLINDERS

Externally finned aluminum alloy head castings are heated and valve seat inserts are installed before the head is screwed and shrunk onto an externally finned steel alloy barrel to make the permanent head and barrel assembly. Heat treated nitralloy exhaust and pre-finished aluminum bronze intake valve guides are pressed into the cylinder assembly. Special 18 mm helical coil thread inserts are installed in upper and lower spark plug holes. Smaller helical coils are installed in exhaust manifold attaching stud holes. Both intake and exhaust ports are on the bottom of the head when the cylinder is installed. Exhaust valve faces and tips are hardened using a special process. Valve stems are solid. Rotocoils on the two concentric springs surrounding each valve are locked to the stems by tapered, semicircular keys which engage grooves around the stems. Rotocoils are installed on exhaust & intake valves. The rotating action of this type retainer helps to prevent burning and eroding of the valve and valve seat. Inner spring retainers are pressed steel. Valve rocker covers are aluminum alloy castings. Rocker shafts are ground steel tubes, with a hole drilled in one end at a 90° angle to the longitudinal axis. The two inside rocker shaft bosses are drilled and tapped to accept the 5/16-inch rocker shaft retaining screws. Valve rockers are steel forgings with hardened sockets and rocker faces and pressed-in bronze bearings. They are drilled for lubrication. Pushrods are composed 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 a washer and seal ring. The bead at the crankcase end retains a washer, heavy spring, washer and seal ring.

72–00–09 GEAR TRAIN (See Figure 72–00–09).

The crankshaft gear (1) is turned clockwise by the crankshaft (2) and turns the camshaft gear (3), and through it the camshaft (4), and the idler gear (13) in the opposite direction, as indicated by arrows on the drawing. Camshaft lobes actuate the hydraulic lifters (5). The governor driven bevel gear (7) mates with and is driven by the governor drive bevelgear (6) on the camshaft. The spline shaft turns in a crankcase bore centered on the governor mount pad.

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The oil pump and tachometer drive shaftgear (8) is driven by the camshaft gear through mating splines. It projects forward and rearward from the oil pump and filter housing attached ot the rear end of the crankcase and drives the driven gear (9) which turns freely on a stub shaft pressed into the housing. On the reduced rear end of the shaftgear (8) the tachometer drive gear (10) is mounted, and a slot in the front end of its hub is driven by a pin in the shaft shoulder. The bevel gear drives a shaftgear mounted in the tachometer drive and pump cover casting.

The idler gear (13) is mounted on an eccentric pin (14) whose rear end flange is attached to two crankcase rear end studs. It is driven counterclockwise and drives the two magneto drive gears clockwise, as seen from the rear. Optional accessories mounted on the crankcase rear are driven by the internal splines of the magneto drive gears. The magneto gear and accessory adapters are attached to the upper corners of the crankcase rear surface and have AND20000 type accessory mount pads on their rear sides centered on the gear shafts. The front hub of each magneto drive gear has a side slot in which the magneto drive bushings and retainer are held and driven. A steel sleeve pressed into the gear center hole prevents excessive distortion of the rubber bushings, between which the driving lugs on the magneto impulse coupling fit.

The electric starter (17), is mounted on a right-angle drive adapter which is attached to the rear end of the crankcase. The tongue end of the starter shaft mates directly with the grooved end of the worm shaft. The worm shaft is supported between a needle bearing at its left end and a ball bearing which is retained in the adapter by a Truarc snap ring. The worm (21) is driven by the shaft through a Woodruff key. The worm wheel (22) is attached by four bolts to a flange on the clutch drum (23), which bears on the shaftgear (25). Two dowels center the wheel on the drum and transmit the driving torque. A heavy helical spring (24) covers both the externally-grooved drum and a similarly grooved drum machined on the shaftgear just ahead of the clutch drum. The spring is retained on the clutch drum by an in-turned offset at its rear end which rides in a groove around the drum, just ahead of the flange. The in-turned offset of the clutch spring is notched and the clutch drum is drilled and tapped for a spring retaining screw. The front end of the spring fits in a steel sleeve, pressed into the starter adapter. When the starter is energized, friction between the clutch spring and the adapter sleeve and between the spring and the clutch drum, which is turned by the worm wheel, tends to wind up the spring on the clutch and shaftgear drums, locking them together so that the shaftgear rotates and turns the crankshaft. As soon as the engine starts, the shaftgear is driven faster than the clutch spring and tends to unwind it, thus increasing the spring's I.D. so that the shaftgear spins free of the starter drive. The generator drive pulley (not illustrated) is mounted on the rear end of the shaftgear and driven through a Woodruff key so that it always turns at shaftgear speed.

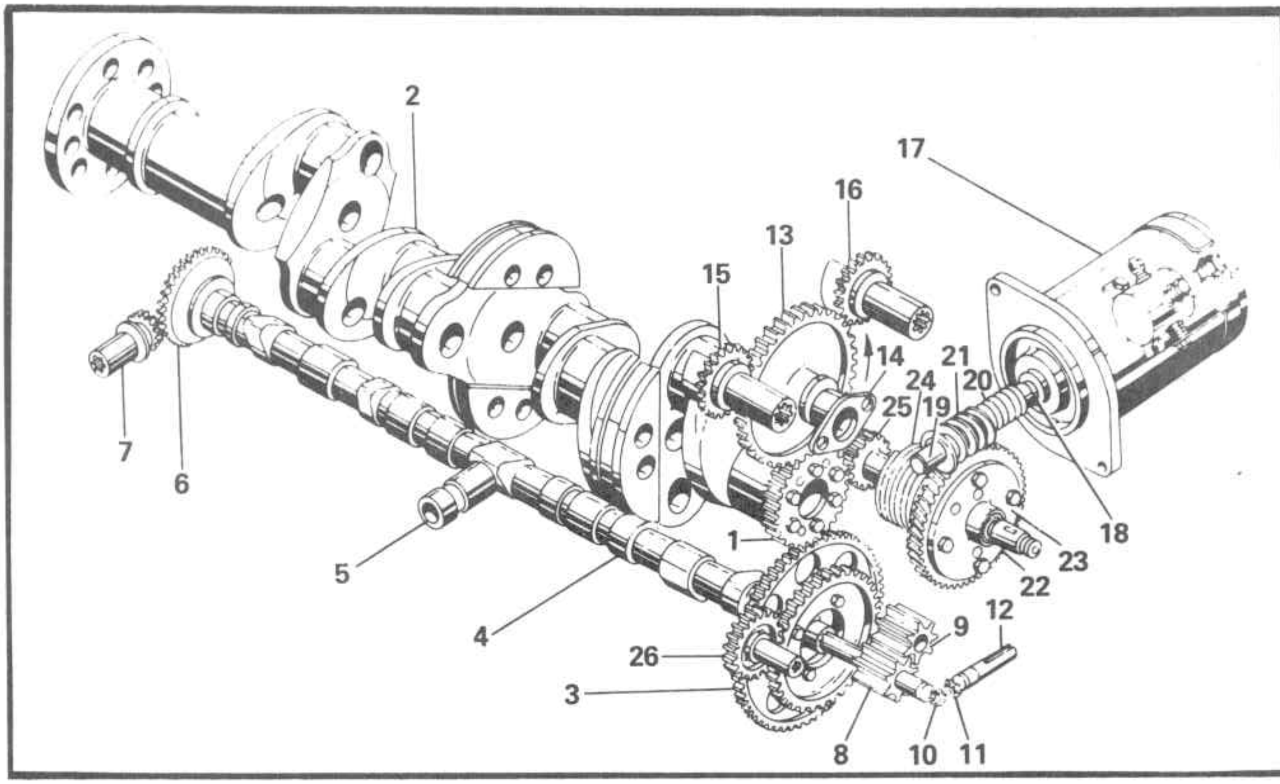

FIGURE 72-00-09. GEAR TRAIN DIAGRAM.

INDEX NO.	DESCRIPTION	SPEED RATIO
1.	Crankshaft gear	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 and tachometer drive shaftgear	1:0.5
9.	Oil pump driven gear	1:0.5
10.	Tachometer drive bevel gear	1:0.5
11.	Tachometer drive bevel gear shaft	1:0.5
12.	Tachometer drive shaft assembly	1:0.5
13.	Idler gear assembly	1:0.652
14.	Idler gear support pin	--
15.	Left magneto drive gear	1:1.5
16.	Right magneto drive gear	1:1.5
17.	Electric starter	48:1
18.	Starter coupling	--
19.	Worm drive shaft	48:1
20.	Worm shaft spring	--
21.	Starter worm gear	48:1
22.	Starter worm wheel	2:1
23.	Starter clutch drum	2:1
24.	Clutch spring	2:1
25.	Starter shaftgear	1:2
26.	Fuel pump gear	1:1

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72-00-10 LUBRICATION SYSTEM (See Figure 72-00-10).

A. The engine driven gear-type oil pump draws oil from the sump through the oil suction tube and crankcase oil passage. From the gear chamber, oil is directed to the oil filter chamber and tachometer drive gear. A filter by-pass valve is incorporated in the pump housing in the event that the filter becomes clogged.

B. After leaving the pump, oil is directed through passages to the right crankcase oil gallery. Right side valve lifters and guides are lubricated by passages leading off this gallery. An oil temperature control valve is located at the front end of the right oil gallery to regulate oil temperature within specific limits. When oil reaches a temperature high enough to require cooling, the control valve expands and blocks passage, directing oil to the cooler. From the control valve cavity, oil is directed to the camshaft passage. A groove around the front of the camshaft directs oil to the front camshaft bearing and left crankcase oil gallery.

C. Lubricating oil is directed to the governer drive bearing and propeller governer through passages off the left oil gallery. Oil is channeled through a discharge port to the crankshaft oil transfer collar, which directs it to the crankshaft interior.

D. Passageways from the left oil gallery direct oil to the main bearings and left side valve lifters.

E. Four drilled passages, radiating from the rear main bearing, conduct lubricating oil to the adapter ports of the fuel pump drive, right and left magneto and accessory drives and to starter shaftgear bearing. An intersecting passage directs oil to the idler gear support.

F. On engines utilizing piston oil cooling, each cylinder wall and piston is lubricated by individual oil squirt nozzles. These nozzles direct a continuous stream of oil at the piston inner dome.

G. Oil is returned to the sump through a system of oil transfer tubes and drain holes.

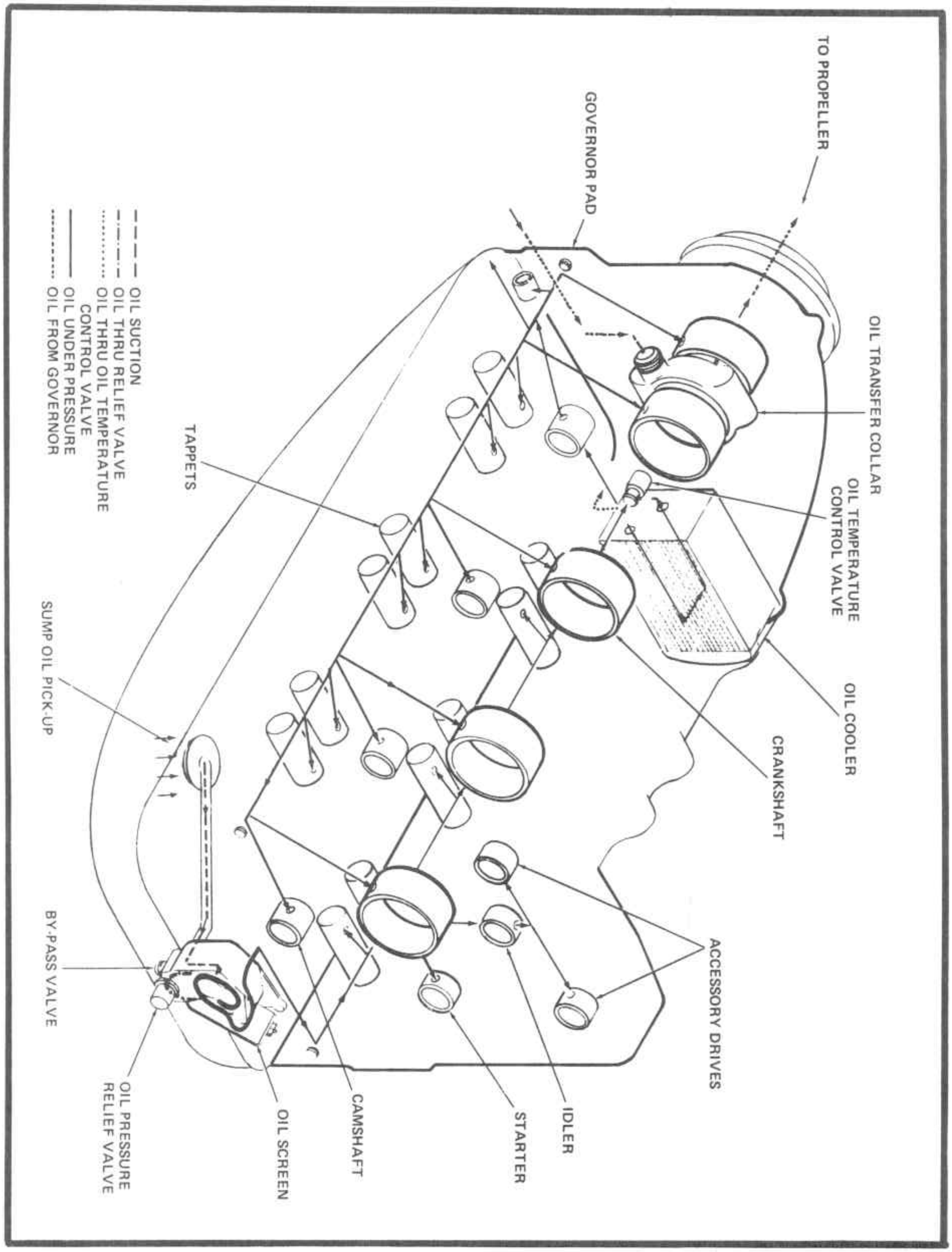

FIGURE 72–00–10 LUBRICATION SYSTEM DIAGRAM.

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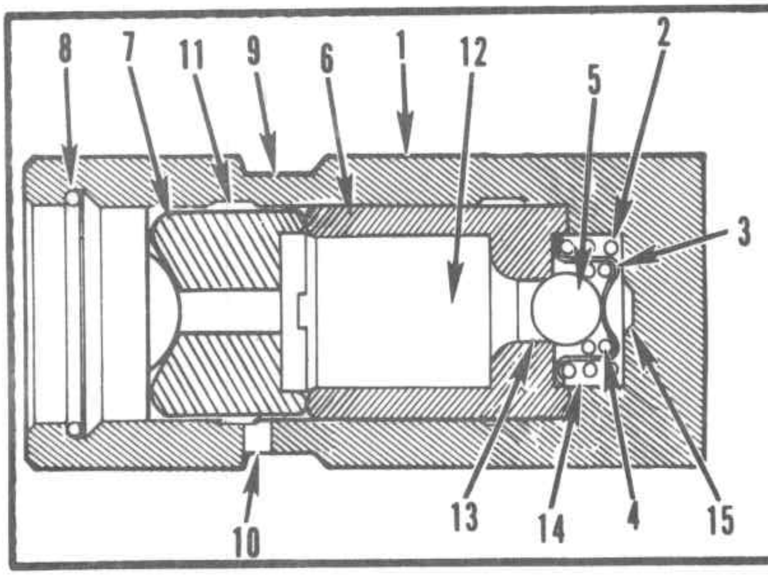
72-00-11 VALVE MECHANISM

Oil fed to hydraulic valve lifters, under pressure from the main oil galleries is divided between the overhead system, the lifter guide surfaces, and the oil reservoirs inside the lifters. Oil that reaches the pushrod ball ends is forced through the hollow pushrods to the drilled rockers and to grooves around their side drilled bearings. Each intake valve rocker also passes part of its oil supply to a squirt nozzle aimed toward the exhaust valve stem. Spray from these nozzles and from bearing ends lubricates the valve stems and springs. Intake valve guide seals are utilized to reduce oil seepage into the intake system. Oil is returned to the crankcase through the tubular pushrod housings which are sealed to the cylinder heads by Silastic rubber rings and to the crankcase by Silastic rubber flanged washers. Heavy springs hold the crankcase seal inward in the case recesses and the housing and cylinder seals outward in the cylinder head recesses. Drain holes in the lifter guides permit the returning oil to fall into the sump.

The barrel type hydraulic lifter (See Figure 72-00-11) consists of a steel body (1), an expanding spring (2), and 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 body picks up oil from crankcase supply hole. From the exterior groove oil is directed to interior body groove (11) through hole (1) and from the interior groove through the hole to the reservoir (12). Oil is withheld from reservoir (15) by check valve ball (5) which is supported by a spring (4) and retainer (3). 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 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 cylinder valve is closed to return "lash" in valve train to zero.

72-00-12 INDUCTION SYSTEM.

The air induction system used on the IO-470 Series Engines consist of intake tubes, a balance tube, connecting hoses, clamp assemblies, air throttle and fuel metering control. The air throttle assembly may be located either at the rear of the engine supported by brackets or below the oil sump supported by an inverted manifold assembly. The systems are provided with a drain valve at the lowest point in the manifold assembly to remove any fuel that may collect there.



1. Body
2. Spring, plunger
3. Check ball retainer
4. Spring, check ball
5. Check ball
6. Plunger
7. Socket
8. Ring, retaining
9. Oil groove, exterior
10. Oil inlet, body
11. Oil groove, interior
12. Oil reservoir, plunger
13. Hole, oil discharge
14. Oil reservoir, body
15. Hole, oil outlet

FIGURE 72-00-11

The throttle assembly is attached to the induction manifold which is connected to the elbows at the rear cylinder intake tubes by connector hoses and clamps. This assembly is then connected to the center intake tubes and the center to the front intake tubes in the same manner. Each intake tube is attached to the cylinder by a welded flange, four bolts, and is sealed by a gasket. The front cylinder intake tubes are connected by a balance tube assembly. The balance tube incorporates a boss and is supported by a bracket attached to the front of the oil sump.

The engine rear elbows are joined by a manifold riser connected by hoses and clamps. On these models the rear elbows are attached to the center intake tubes and in turn the center intake tubes are connected to the front intake tubes by means of connector hoses and clamps. The front cylinder intake tubes are connected by a balance tube assembly. A boss on the balance tube is provided for fuel drain provisions to prevent hydrostatic lock. The balance tube is supported by a bracket assembly attached to the front of the sump.

FUEL INJECTION

The fuel injection system consists of an engine driven fuel pump, fuel control, fuel manifold valve, nozzles and rigid fuel discharge tubes. For further information on the Continental continuous flow fuel injection system refer to the Continental Fuel Injection Overhaul Manual X30593A.

72–00–13 EXHAUST SYSTEM

Exhaust systems for the IO-470 series engines are supplied by the aircraft manufacturer.

72–00–14 IGNITION SYSTEM

A. High voltage current is generated and distributed to the upper spark plugs of the right side cylinders and lower spark plugs of the left side cylinders by a magneto mounted on the right side of the crankcase. An identical magneto mounted on the left side of the crankcase produces the current for the upper spark plugs of the left side cylinders and lower spark plugs of the right side cylinders. The high tension cables pass through braided flexible, shielded conduit assemblies which are connected to the magnetos by coupling nuts and to the spark plugs by elbows. The magnetos are driven through impulse couplings which incorporate springs and counterweighted latches. When cranking the engine, the latches engage magneto body stops to retard the rotors and ignition spark. Retarding the magneto rotors serves to retard ignition spark until the piston reaches top center at the beginning of the power stroke and to attain full secondary coil voltage as the rotor is spun rapidly through the breaker opening position at which the spark occurs. As engine speed increases, centrifugal force disengages the latches, and the magnetos are driven at full advance.

B. In engine models which employ the retard breaker system, the left magneto incorporates dual breakers which retard ignition spark during engine cranking. During the engine cranking period, the right magneto is grounded and inoperative. The retard breaker, in the left magneto, is actuated by the same cam as the main breaker, and is located so that its contacts will open at a predetermined number of degrees after the main breaker contacts open. A battery-operated starting vibrator furnishes electrical current to the magneto for retarded ignition starting, regardless of engine cranking speed. The retarded ignition is in the form of a "shower" of sparks instead of a single spark as obtained from the impulse coupling magneto. When the engine starts and the ignition start switch is released to return to its "BOTH" position, the vibrator circuit and the retard breaker circuit becomes inoperative. Simultaneously right magneto circuit becomes operative and both magnetos are firing at full advance position. (See note on next page).

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WARNING . . . Engine kickback while cranking may cause damage to the starter adapter clutch and is an indication of malfunctioning magneto retard system (impulse couplings or retard breaker not fuctioning properly).

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SECTION 72-10
DISASSEMBLY

72-10-00 DISASSEMBLY

INTENTIONALLY

LEFT

BLANK

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72-10-01 GENERAL

Instructions in this section are based on the assumption that all parts attached by the aircraft manufacturer, except optional pumps, have been removed.

Accessories supplied by the engine manufacturer may be serviced according to instructions supplied by the applicable accessory manufacturer.

ENGINE REMOVAL INSTRUCTIONS

Properly identify each part by marking or tagging as it is disconnected from the engine to aid in reinstallation.

NOTE . . . If the engine is being removed to be placed in storage, accomplish steps listed in Section 72-80-03 Titled "Indefinite Storage", prior to removal.

1. Turn all cockpit switches and fuel selector valves OFF.
2. Drain the engine oil from the sump. Replace drain plug and tighten.
3. Disconnect the battery ground cable.
4. Disconnect the starter cable.
5. Tag and disconnect the engine wiring bundle from the following components:
    a. Magnetos
    b. Alternator
    c. Tach Generator
    d. Oil Temperator Bulb
    e. Cylinder Head Temperature Bulb
    f. Remove all clamps attaching engine wire bundle to engine components and route clear of the engine.
6. Disconnect propeller, throttle, and mixture control cables.
7. Disconnect fuel, manifold pressure and oil hoses from engine.
8. Remove exhaust system.
9. Remove the propeller in accordance with airframe manufacturer's instructions.
10. Remove engine to airframe connections in accordance with airframe manufacturer's instructions.

Attach a hoist to the engine lifting eye and relieve the weight from the engine mounts.

CAUTION . . . Place a suitable stand under the aircraft tail section load bearing area (jack pad or A/C tiedown eye) before removing the engine. The loss of weight may cause the tail to drop.

11. Remove the engine mounts.

12. Hoist engine vertically out of the nacelle and clear of the aircraft.

NOTE . . . Hoist engine slowly, making sure that all wires, lines and hoses have been disconnected.

13. Install engine on a transportation stand, dolly, or on the engine shipping container base.

72-10-02 **EXTENT OF DISASSEMBLY.** Line drawings, reproduced in this section, are similar to those used in the parts catalog. The location of components and attaching parts in the illustrations will be sufficient to enable personnel to accomplish disassembly operations.

72-10-03 **PARTS TO BE DISCARDED.** Discard all shakeproof washers, lockwires, tab washers, rubber seal rings, oil seals, gaskets, cotter pins, flex hoses, hose connectors and magneto coupling (rubber) bushings in such a manner that they will not be used again inadvertently. Care should be taken in removing gaskets from aluminum parts by scraping. Such removal should be delayed until the part is to be cleaned. Refer to TCM Service Bulletin M85-12 "Overhaul 100% Replacement Parts," or current revision as applicable.

72-10-04 **PRELIMINARY CLEANING.** Spray, or brush with a solvent used for general cleaning of engine parts. Remove caked dirt on bolt heads and nuts especially. At the same time the oil sump drain plugs should be removed to drain any remaining oil.

CAUTION . . . Do not use caustic cleaning solutions for external precleaning, these solutions will remove the "alodized" finish of aluminum parts.

72-10-05 **IGNITION SYSTEM. (See Figure 72-10-05).**

A. Remove four sets of attaching parts (32, 31) and cable outlet plate (1) from each magneto (27).

B. Remove outlet plate grommet (2) and cable outlet plate (1) from ignition cables (1 thru 12). Remove ignition leads from spark plugs (21).

C. Remove clamps (18) by removing attaching parts (19). Remove attaching parts (24, 25) and remove clamp (23).

D. Remove ignition harness assembly from engine and discard.

E. Remove two sets of attaching parts (30, 29, 28), magnetos (27) and gaskets (26).

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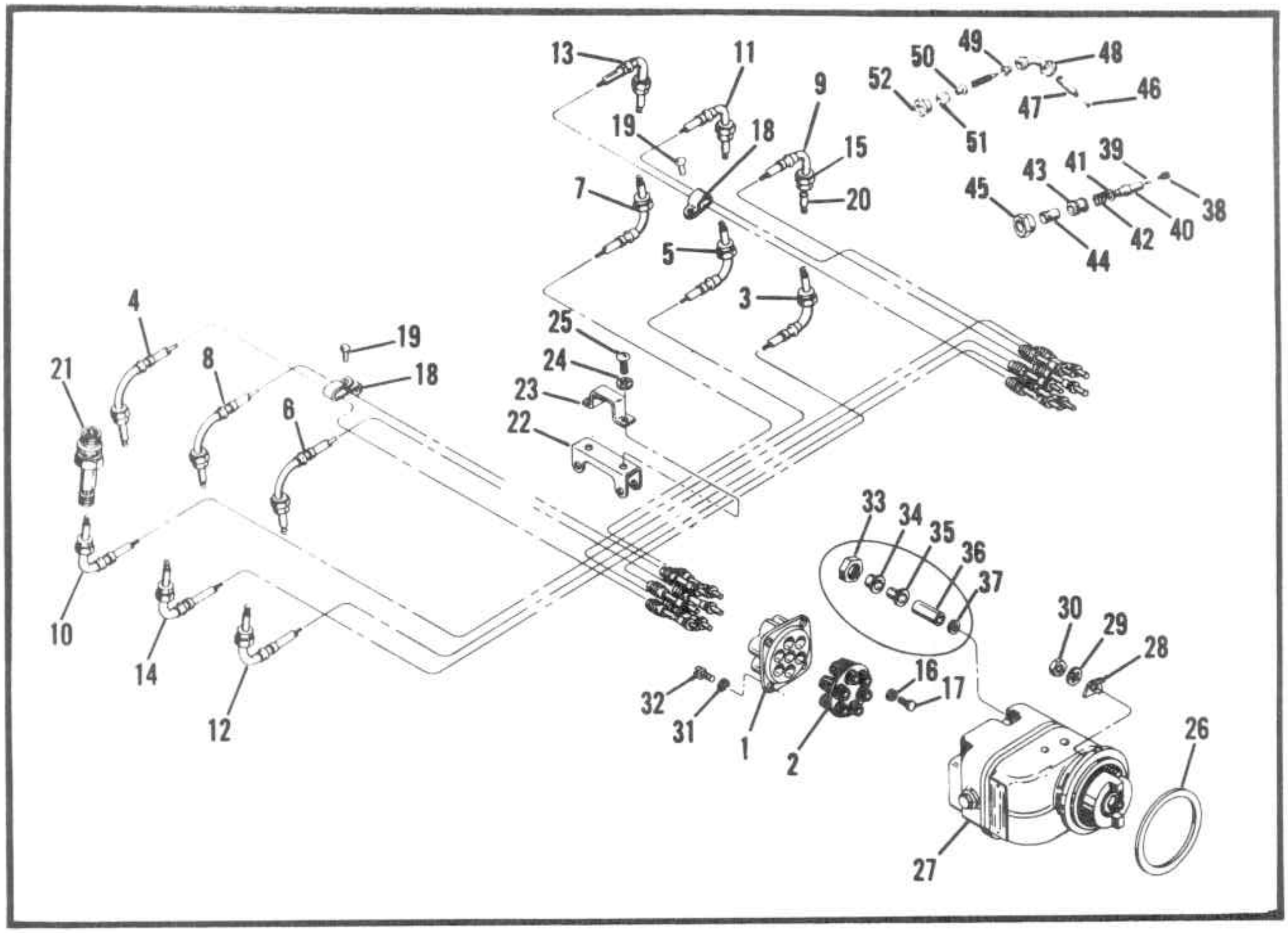

FIGURE 72-10-05. EXPLODED VIEW OF IGNITION SYSTEM.

1. High Tension Cable Outlet Plate
2. Outlet Plate Grommet
3. Cable Assy. to No. 1 Lower Spark Plug
4. Cable Assy. to No. 6 Upper Spark Plug
5. Cable Assy. to No. 3 Lower Spark Plug
6. Cable Assy. to No. 2 Upper Spark Plug
7. Cable Assy. to No. 5 Lower Spark Plug
8. Cable Assy. to No. 4 Upper Spark Plug
9. Cable Assy. to No. 1 Upper Spark Plug
10. Cable Assy. to No. 6 Lower Spark Plug
11. Cable Assy. to No. 3 Upper Spark Plug
12. Cable Assy. to No. 2 Lower Spark Plug
13. Cable Assy. to No. 5 Upper Spark Plug
14. Cable Assy. to No. 4 Lower Spark Plug
15. Coupling Nut
16. Brass Washer
17. Cable Piercing Screw
18. Two-Wire Cable Clamp
19. Round-Head Rivet
20. Spark Plug Terminal Sleeve
21. Approved Spark Plug
22. Brace (Assembled on Crankcase)
23. Clamp
24. Lockwasher
25. Round-Head Screw
26. Magneto Gasket
27. Magneto
28. Magneto Holding Washer
29. Lockwasher
30. Plain Hex Nut
31. Lockwasher
32. Fillister-Head Screw
33. Hex Coupling Nut
34. Outer Ferrule
35. Inner Ferrule
36. Insulating Sleeve
37. Brass Washer
38. Spring
39. Screw, Electrode
40. Sleeve, Ignition Cable
41. Washer
42. Spring
43. Drive Ferrule
44. Drive Ferrule, Plug End
45. Nut, Spark Plug End
46. Cable Piercing Pin
47. Sleeve
48. Elbow Assembly
49. Grommet
50. Ferrule, Cable, Inner
51. Ferrule, Cable, Outer
52. Nut, Spark Plug End

72-10-06 FUEL INJECTION SYSTEM
IO-470-C,H & J (See Figure 72-10-06A).

A. Disconnect six fuel discharge tubes (2) from manifold valve (74) and nozzles (3). Compress spring legs of each clamp (1), in turn, and remove tubes and clamps. Disconnect hose assembly (9) at manifold valve.

B. Loosen and remove nozzles (3) with a 1/2 inch deep socket. Store nozzles in clean container.

C. Invert engine; then loosen clamp (11), pull back duct (18) from fuel control cover shroud (4) and remove cover shroud.

D. Disconnect hose assembly (9) at fuel control assembly (46). Remove screw (5) to detach band (8) from bracket (6) and lift off assembled parts.

E. Disconnect hose assemblies (16, 17) at fuel control (46) and fuel pump (66). Remove screw (12) to detach band (15) from bracket (13) and lift off assembled parts.

F. Loosen parts indexed (37 through 44) to facilitate later disassembly, then remove air throttle assembly attaching parts (19 through 24) and withdraw air throttle and fuel control as a unit. To separate fuel control from air throttle body remove two sets of cotter pins (26) and washers (27, 28) to detach link rod assembly; then remove three sets of screws (33) and tab washers (34). Bottom shroud (36) will also come loose during this step.

G. Loosen and remove elbows (50, 51). Remove sheet metal screws (52) and take off fuel pump shroud (56).

H. Remove four sets of pump attaching parts (57, 58, 59), pump (66) and gasket (60).

I. Loosen nipple (70), elbows (71, 72) and plug (73) to facilitate later removal; then remove two sets of valve-to-crankcase bracket attaching parts and lift off valve and bracket as a unit. Remove attaching parts (67, 68) to separate bracket (69) and manifold valve (74).

NOTE . . . Further disassembly of the fuel injection system should not be attempted unless proper flow test equipment is available.

For overhaul instructions for the Fuel Injection System, see Form X30593A.

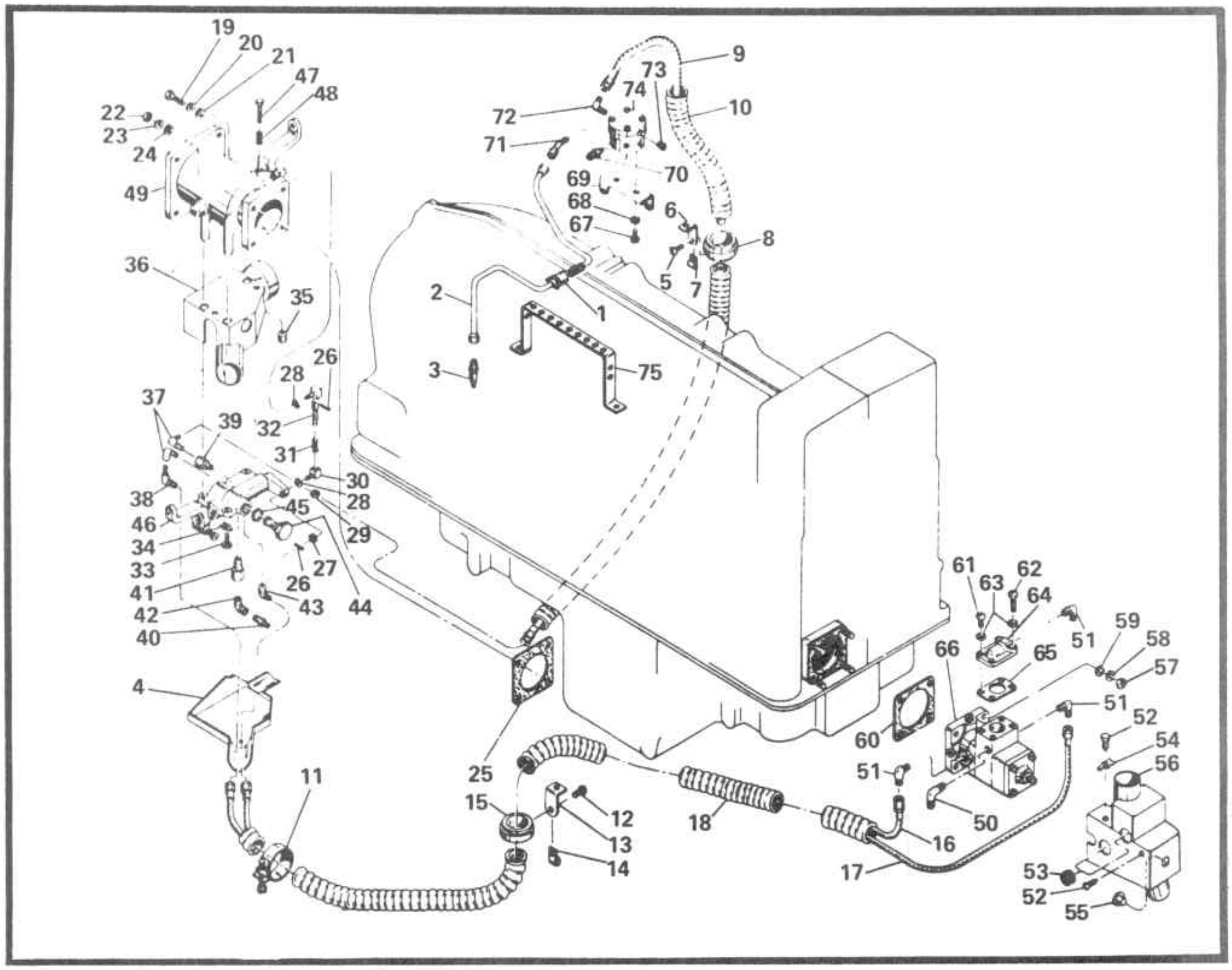

FIGURE 72-10-06A. FUEL INJECTION SYSTEM (IO-470-C,H,J).

1. Tube clamp
2. Fuel discharge tube
3. Fuel injection nozzle
4. Fuel control shroud
5. Sheet metal screw
6. Tube bracket
7. Speed nut
8. Wire harness band
9. Hose assembly
10. Flexible duct
11. Hose clamp
12. Sheet metal screw
13. Tube bracket
14. Speed nut
15. Wire harness band
16. Hose assembly
17. Hose assembly
18. Flexible duct
19. Bolt
20. Lockwasher
21. Washer
22. Nut
23. Lockwasher
24. Washer
25. Gasket
26. Cotter pin
27. Washer
28. Wave washer
29. Nut
30. Rod end
31. Spring
32. Rod and link
33. Screw
34. Tab washer
35. Bumper grommet
36. Fuel control valve bottom shroud
37. 90 degree elbow
38. 90 degree street elbow
39. Extension
40. Nipple
41. Extension
42. 90 degree street elbow
43. 90 degree elbow
44. Fuel screen
45. Gasket
46. Fuel control
47. Idle adjustment screw
48. Spring
49. Air throttle body
50. 90 degree elbow
51. 45 degree elbow
52. Sheet metal screw
53. Grommet
54. Speed nut
55. Caplug
56. Fuel pump shroud
57. Nut
58. Lockwasher
59. Washer
60. Gasket
61. Screw
62. Screw
63. Washer
64. Vapor separator cover
65. Gasket
66. Fuel pump
67. Screw
68. Lockwasher
69. Valve-to-crankcase bracket
70. Nipple
71. 45 degree elbow
72. 90 degree elbow
73. Plug
74. Fuel manifold valve
75. Fuel discharge tube bracket

72-10-06 FUEL INJECTION SYSTEM IO-470-D & U (See Figure 72-10-06B).

A. Disconnect six fuel discharge tubes (2) from manifold valve (69) and nozzles (3). Compress spring legs of each clamp (1), in turn and remove tube and clamp. Disconnect hose assembly (10) at manifold valve (69). Remove nozzles (3) and store in a clean container.

B. Disconnect hose assemblies (8, 9) at fuel pump (61); then loosen clamps (4) and remove ducts (5, 6) and clamps. Take out sheet metal screws (7) and work cover shroud (12) off control unit bottom shroud (25) onto hose assemblies (8, 9); then disconnect hose assemblies (8, 9, 10) from fuel injection control (36) and remove cover shroud.

C. Loosen nipples (26 and 29), plug (27), elbows (28, 31, 32, 33) extension (30) to facilitate later removal; then remove support brackets-to-air throttle and injection control as a unit. Disconnect spring (13) and remove two cotter pins (14), washers (15 and 16) to detach link rod assembly. Remove three screws (21) and tab washers (22) to detach bottom shroud (25) and fuel control unit (36) from air throttle body (41).

D. Remove elbows (42, 43, 44 and 46); then remove screws (45 and 47) and fuel pump shroud (51). Remove four sets of pump attaching parts (52, 53 and 54), fuel pump (61), gasket (55) and fuel pump drive coupling.

E. Loosen nipples (65), elbows (66 and 67) and plug (68) to facilitate later removal. Remove bracket-to-crankcase attaching parts and lift off valve and bracket as a unit. Remove screws (62) and washers (63) to separate bracket (64) from valve (69).

NOTE . . . Further disassembly of the fuel injection system should not be attempted unless proper flow test equipment is available.

For overhaul instructions for the Fuel Injection System, see Form X30593A.

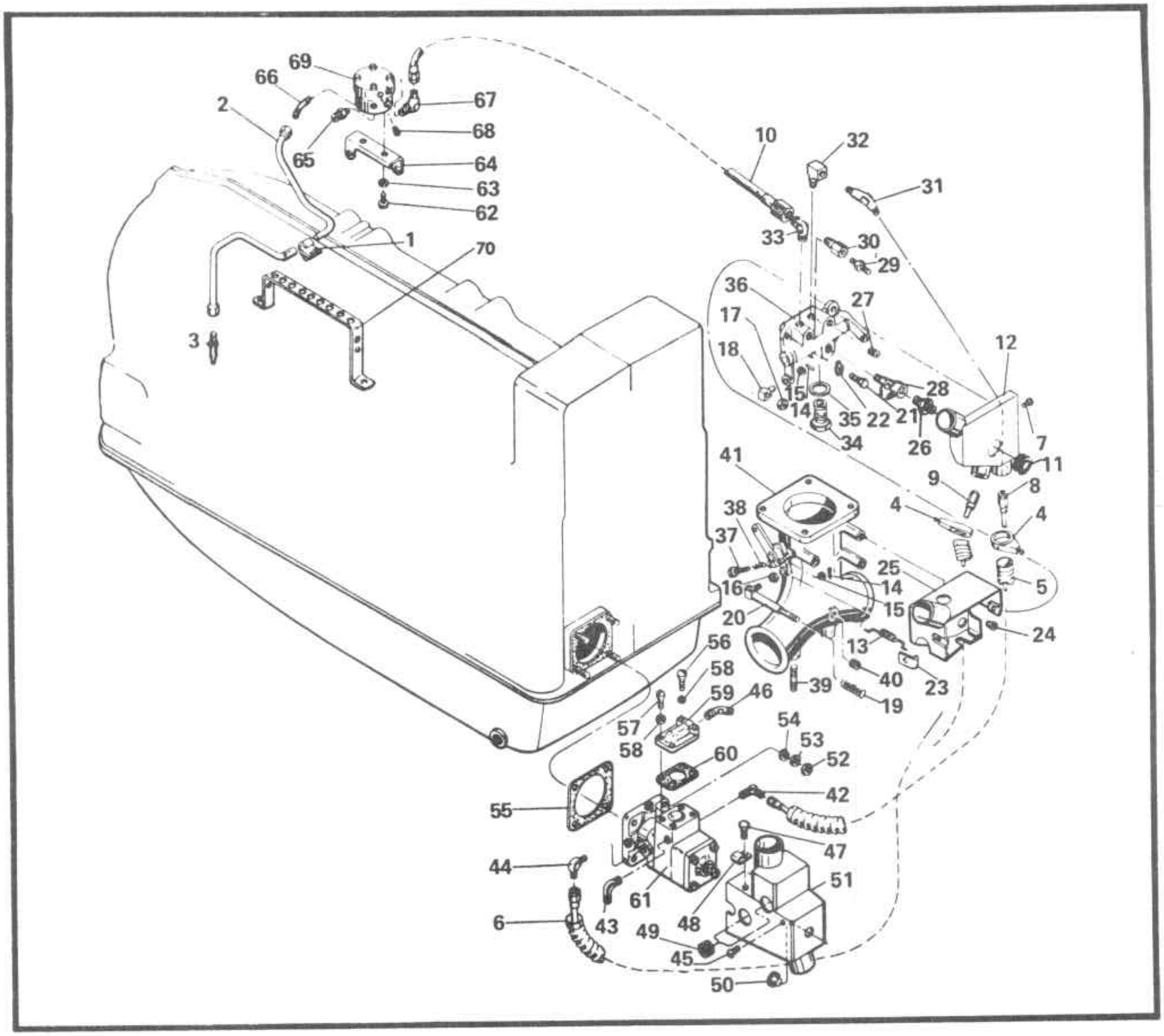

FIGURE 72-10-06B. FUEL INJECTION SYSTEM (IO-470-D & U).

1. Tube clamp
2. Fuel discharge tube
3. Fuel inj. nozzle
4. Hose clamp
5. Flexible duct
6. Flexible duct
7. Sheet metal screw
8. Hose assembly
9. Hose assembly
10. Hose assembly
11. Grommet
12. Cover shroud
13. Throttle spring
14. Cotter pin
15. Washer
16. Wave washer
17. Nut
18. Rod end
19. Spring
20. Rod and link
21. Screw
22. Tab washer
23. Speed nut
24. Grommet
25. Bottom shroud
26. Nipple
27. Plug
28. Tee
29. Nipple
30. Extension
31. 90 degree elbow
32. 90 deg. street elb.
33. 45 degree elbow
34. Fuel screen assy.
35. Gasket
36. Fuel control unit
37. Idle adj. screw
38. Idle adj. spring
39. Stud
40. Plug
41. Air throttle body
42. 90 degree elbow
43. 90 degree elbow
44. 90 degree elbow
45. Sheet metal screw
46. 45 degree elbow
47. Sheet metal screw
48. Speed nut
49. Grommet
50. Caplug
51. Fuel pump shroud
52. Nut
53. Lockwasher
54. Washer
55. Gasket
56. Screw
57. Screw
58. Washer
59. Vapor sep. cover
60. Gasket
61. Fuel pump
62. Screw
63. Lockwasher
64. Bracket
65. Nipple
66. 45 degree elbow
67. 90 degree elbow
68. Plug
69. Manifold valve
70. Fuel disch. tube bracket

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72–10–06 FUEL INJECTION SYSTEM IO–470–E,G,P & R (See Figure 72–10–06C).

A. Disconnect and remove six fuel discharge tubes (2) from manifold valve (67) and nozzles (3). Compress spring legs of each clamp (1), in turn, and remove tube and clamp. Disconnect hose assembly (9) at manifold valve. Remove nozzles (3) and store in a clean container.

B. Disconnect hose assemblies (10 and 11) at fuel pump (59). Loosen clamp (4 and 5) and remove ducts (6 and 7). Take out sheet metal screw (8) and work cover shroud (12) off control unit bottom shroud (26) onto hose assemblies (10 and 11). Disconnect hose assemblies (9, 10 and 11) from fuel control (35) and remove cover shroud.

C. Loosen nipple (27), extension (28), elbows (29, 30 and 31). Plug (32) and fuel screen (33) to facilitate later removal; then remove air throttle-to-support bracket attaching parts and remove air throttle and control as a unit.

D. Disconnect spring (13) from levers and remove two cotter pins (14), washers (15) and (16) to detach link rod assembly. Remove three screws (8) and tab washers (22) to detach bottom shroud (26) and fuel control body (35) from throttle body (40).

E. Remove elbows (41, 42 and 43); then remove screws (44 and 53) and fuel pump shroud (48). Take out four sets of pump attaching parts (49, 50 and 51), fuel pump (59), gasket (52) and fuel pump drive.

F. Loosen nipple (63), elbows (64 and 65) and pipe plug (66) to facilitate later removal. Remove bracket-to-crankcase attaching parts and lift off valve and bracket as a unit. Remove screws (60) and washers (61) to separate bracket (62) from manifold valve (67).

NOTE . . . .Further disassembly of the fuel injection system should not be attempted unless proper flow test equipment is available.

For overhaul instructions for the Fuel Injection System, see Form X30593A.

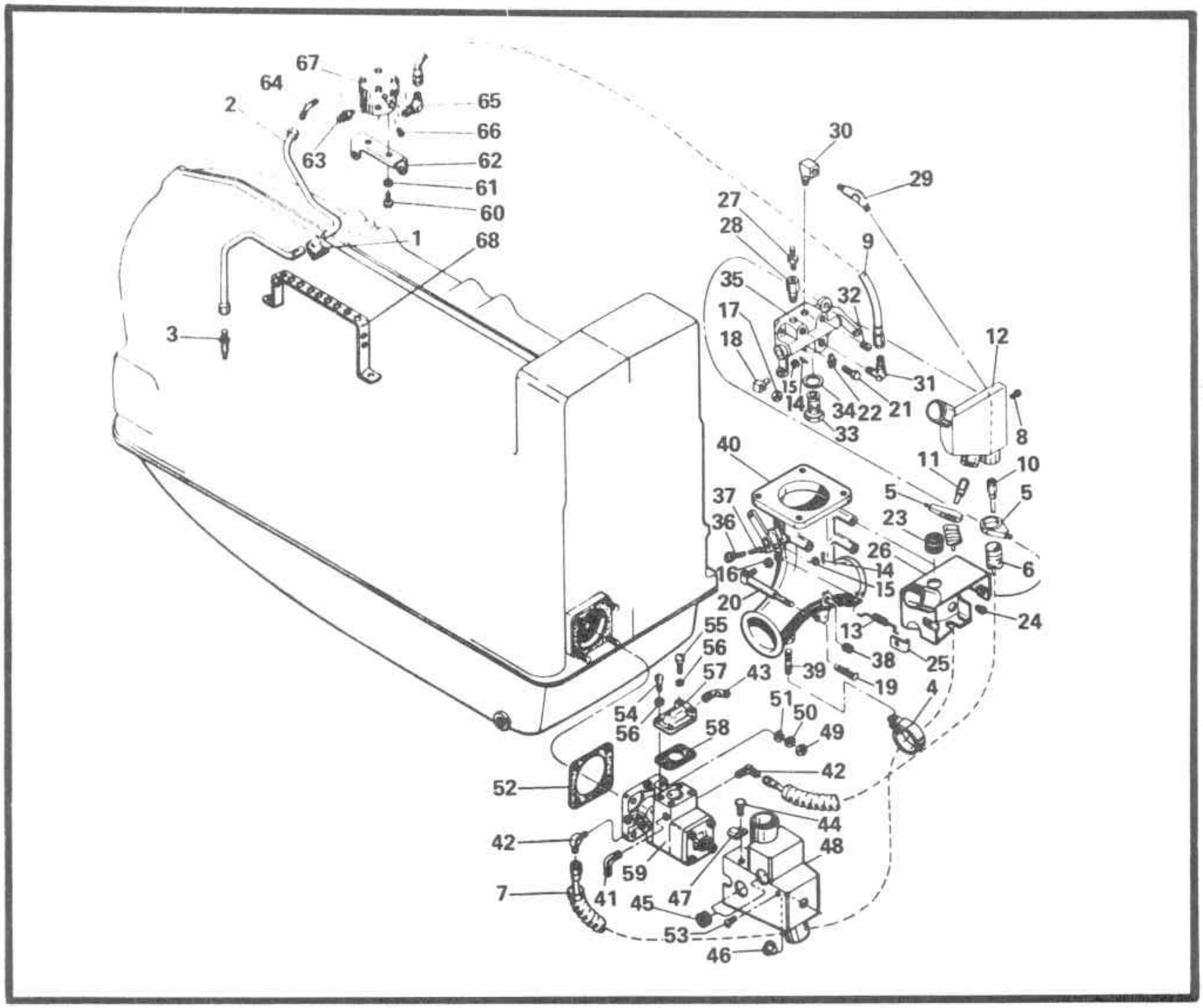

FIGURE 72-10-06C. FUEL INJECTION SYSTEM (IO-470-E,G,P & R).

1. Tube clamp
2. Fuel disch. tube
3. Fuel inj. nozzle
4. Clamp
5. Hose clamp
6. Flexible duct
7. Flexible duct
8. Sheet metal screw
9. Hose assembly
10. Hose assembly
11. Hose assembly
12. Cover shroud
13. Throttle spring
14. Cotter pin
15. Washer
16. Wave washer
17. Nut
18. Rod end
19. Spring
20. Rod and link
21. Screw
22. Tab washer
23. Grommet
24. Bumper grommet
25. Speed nut
26. Fuel control bottom shroud
27. Nipple
28. Extension
29. 90 degree elbow
30. 90 deg. street elb.
31. 90 degree elbow
32. Plug
33. Fuel screen assy.
34. Gasket
35. Fuel control
36. Idle adj. screw
37. Idle adj. spring
38. Plug
39. Stud
40. Air throttle body
41. 90 degree elbow
42. 90 degree elbow
43. 45 degree elbow
44. Sheet metal screw
45. Grommet
46. Caplug
47. Speed nut
48. Fuel pump shroud
49. Nut
50. Lockwasher
51. Washer
52. Gasket
53. Sheet metal screw
54. Screw
55. Screw
56. Washer
57. Vapor separator cover
58. Gasket
59. Fuel pump
60. Screw
61. Lockwasher
62. Bracket
63. Nipple
64. 45 degree elbow
65. 90 degree elbow
66. Plug
67. Manifold valve
68. Fuel disch. tube bracket

72-10-06 FUEL INJECTION SYSTEM
IO-470-F (See Figure 72-10-06D).

A. Disconnect six fuel discharge tubes (2) from manifold valve (57) and nozzles (3). Compress spring legs of each clamp (1), in turn, and remove tube and clamp. Remove nozzles (3) and store in a clean container.

B. Disconnect and remove hose assemblies (4 and 5); then remove elbow (6).

C. Remove nut (7), washers (8 and 9) and work shroud (10) off fuel control (26) onto hose assembly (11); then disconnect hose assembly (11) at fuel control and fuel manifold valve (57). Lift off both parts and slide hose out of shroud.

D. Remove air throttle body-to-oil sump flange attaching parts and lower air throttle and fuel control body from engine as an assembly. Loosen elbows (22), adapter (21), fuel screen (23) and plug (25) to facilitate later removal; then remove cotter pins (12) washers (13) and remove link rod assembly (15 through 18). Catch wave washers (14) as they drop out. Take out three screws (19) and tab washers (20) to detach fuel control body (26) from air throttle body (29).

E. Remove elbows (30, 31 and 32) and bushings (33) from fuel pump and vapor separator body (49); then take out screws (34 and 35) and withdraw fuel pump shroud (39). Take out four sets of pump attaching parts (40, 41 and 42) and withdraw fuel pump and vapor separator body (49) and gasket (43).

F. Loosen nipples (53), elbows (54 and 55) and plug (56) to facilitate later removal; then remove valve-to-crankcase bracket attaching parts and lift off valve and brackets as a unit. Take out screws (50) and lockwashers (51) to detach manifold valve (57) from bracket (52).

NOTE . . . Further disassembly of the fuel injection system should not be attempted unless proper flow test equipment is available.

For overhaul instructions for the Fuel Injection System, see Form X30593A.

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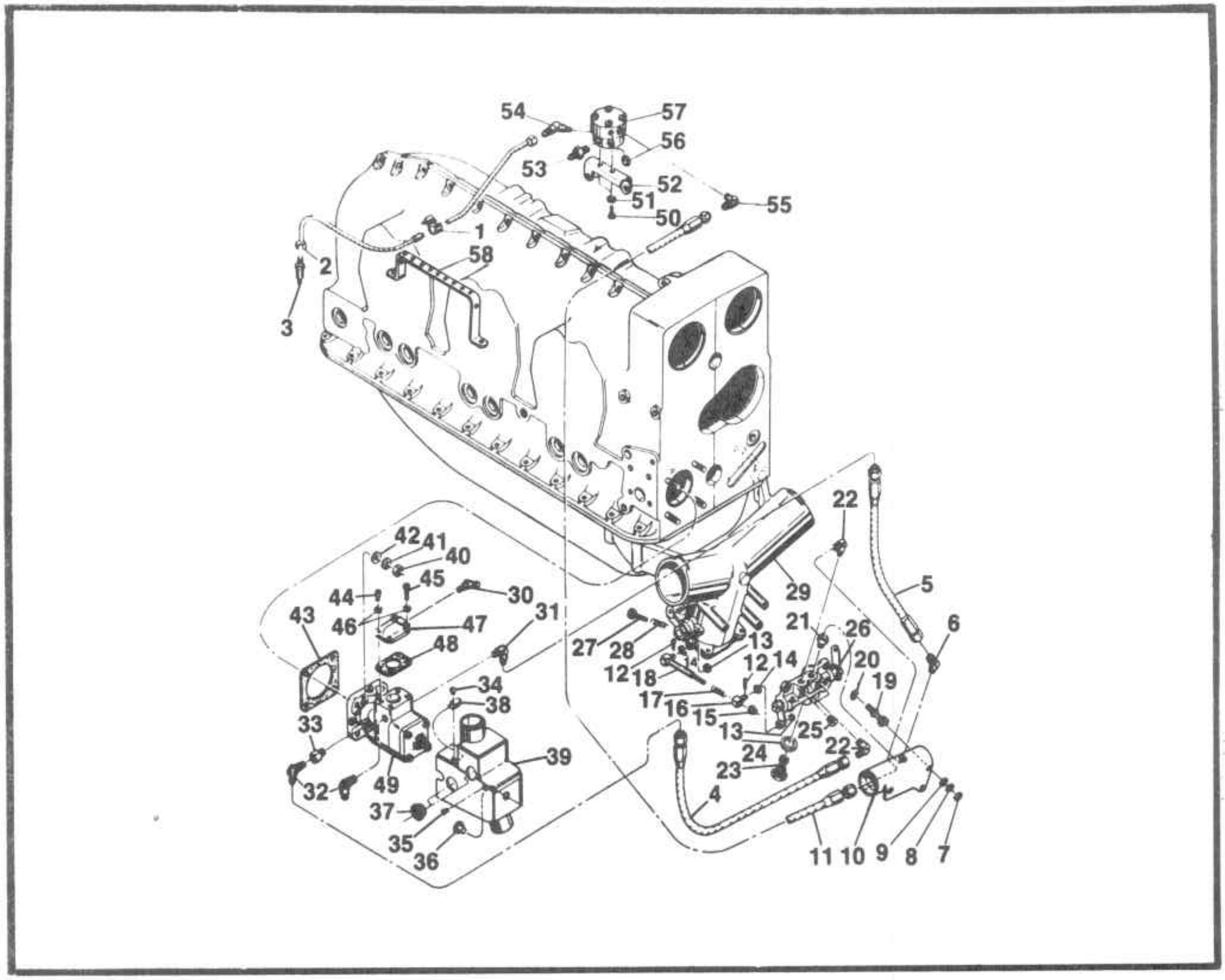

FIGURE 72-10-06D. FUEL INJECTION SYSTEM (IO-470-F).

1. Tube clamp
2. Fuel discharge tube
3. Fuel injection nozzle
4. Hose assembly
5. Hose assembly
6. 45 degree elbow
7. Nut
8. Lockwasher
9. Washer
10. Fuel control shroud
11. Hose assembly
12. Cotter pin
13. Washer
14. Wave washer
15. Nut
16. Rod end
17. Spring
18. Rod and link
19. Screw
20. Tab washer
21. Adapter
22. 90 degree elbow
23. Fuel screen
24. Gasket
25. Plug
26. Fuel control
27. Idle adjustment screw
28. Idle adjustment spring
29. Air throttle body
30. 45 degree elbow
31. 90 degree elbow
32. 90 degree elbow
33. Bushing
34. Sheet metal screw
35. Sheet metal screw
36. Caplug
37. Grommet
38. Nut
39. Fuel pump shroud
40. Nut
41. Lockwasher
42. Washer
43. Gasket
44. Screw
45. Screw
46. Washer
47. Vapor separator cover
48. Gasket
49. Fuel pump and vapor separator body
50. Screw
51. Lockwasher
52. Valve-to-crankcase bracket
53. Nipple
54. 45 degree elbow
55. 90 degree elbow
56. Plug
57. Fuel manifold valve
58. Fuel discharge tubes bracket

72-10-06 FUEL INJECTION SYSTEM IO-470-K & N (See Figure 72-10-06E).

A. Disconnect six fuel discharge tubes (2) from manifold valve (71) and nozzles (3). Compress spring legs of each clamp (1), in turn, and remove tubes and clamps. Disconnect hose assembly (9) at manifold valve.

B. Remove nozzles (3) and store in a clean container.

C. Invert engine; then loosen clamp (11), pull back duct (18) from fuel control cover shroud (4) and remove cover shroud.

D. Disconnect hose assembly (9) at fuel control assembly (44). Remove screw (5) to detach duct band (8) from bracket (6) and lift off assembled parts.

E. Disconnect hose assemblies (16 and 17) at fuel control (44) and fuel pump (63). Remove screw (12) to detach duct band (15) from bracket (13) and lift off assembled parts.

F. Loosen parts indexed (35 through 42) to facilitate later disassembly; then remove air throttle assembly attaching parts (19 through 20) and withdraw air throttle body (32) and fuel control (44) as a unit. To separate fuel control from air throttle body, remove two sets of cotter pins (21) and washers (22 and 23) to detach link rod assembly; then remove three sets of screws (30) and tab washers (31). Bottom shroud (33) will also come loose during this step.

G. Loosen and remove elbows (45 through 48). Remove sheet metal screws (49) and take off fuel pump shroud (53).

H. Remove four sets of pump attaching parts (54, 55 and 56), pump (63) and gasket (57).

I. Loosen nipple (67), elbows, (68 and 69) and plug (70) to facilitate later removal; then remove two sets of valve-to-crankcase bracket attaching parts and lift off valve and bracket (66) as a unit. Remove attaching parts (64 and 65) to separate bracket (66) as a unit. Remove attaching parts (64 and 65) to separate bracket (66) and manifold valve (71).

NOTE . . . Further disassembly of the fuel injection system should not be attempted unless proper flow test equipment is available.

For overhaul instructions for the Fuel Injection System, see Form X30593A.

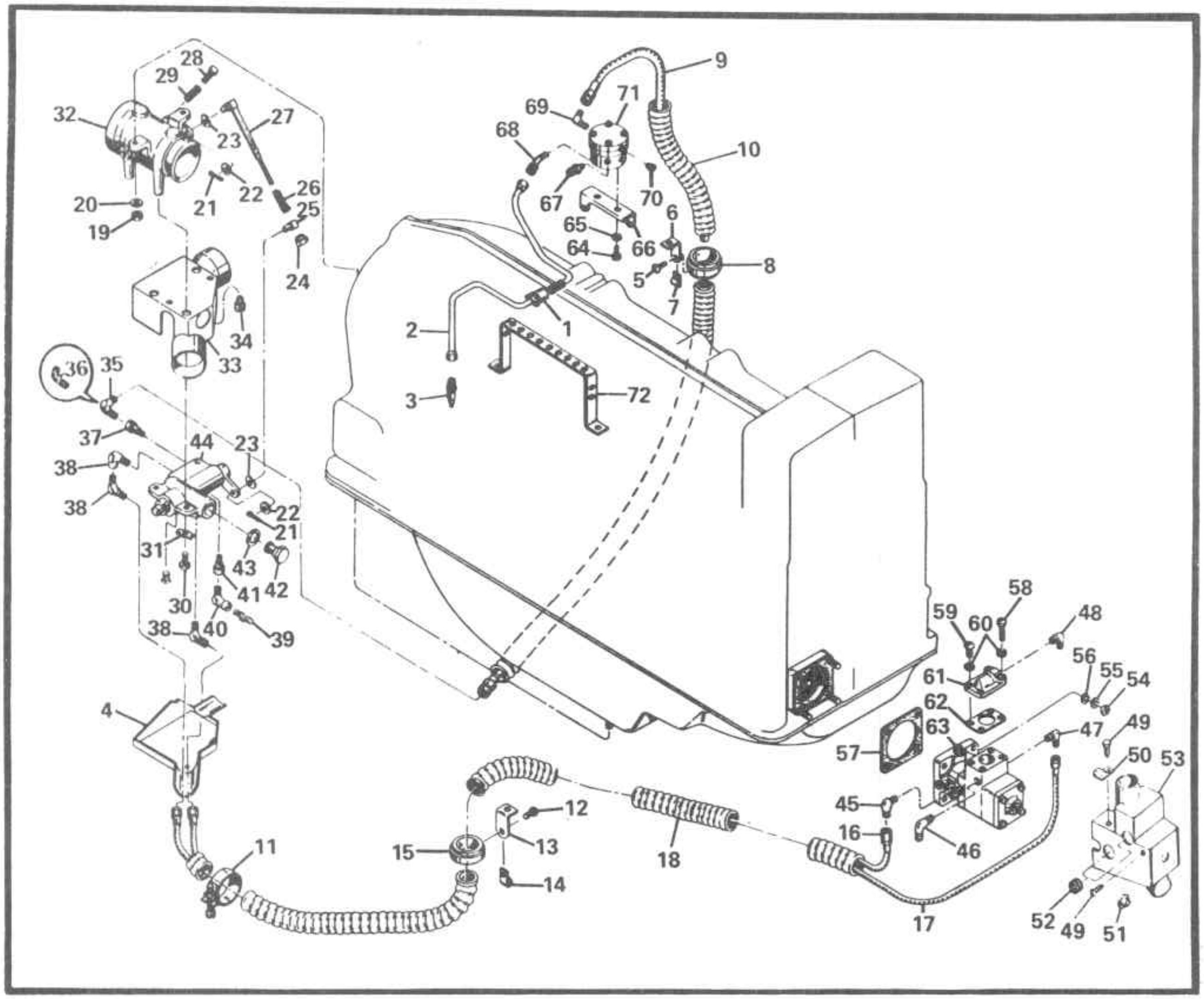

FIGURE 72-10-06E. FUEL INJECTION SYSTEM (IO-470-K & N).

1. Tube clamp
2. Fuel disch. tube
3. Fuel inj. nozzle
4. Fuel control shroud
5. Sheet metal screw
6. Tube bracket
7. Speed nut
8. Duct band
9. Hose assembly
10. Flexible duct
11. Hose clamp
12. Sheet metal screw
13. Tube bracket
14. Speed nut
15. Duct band
16. Hose assembly
17. Hose assembly
18. Flexible duct
19. Nut
20. Washer
21. Cotter pin
22. Washer
23. Wave washer
24. Nut
25. Rod end
26. Spring
27. Rod and link
28. Idle adj. screw
29. Spring
30. Screw
31. Tab washers
32. Air throttle body
33. Fuel control shroud
34. Grommet
35. 90 degree elbow
36. 45 degree elbow
37. Extension
38. 90 degree elbow
39. 90 degree elbow
40. 90 degree elbow
41. Extension
42. Fuel screen
43. Gasket
44. Fuel control
45. 90 degree elbow
46. 90 degree elbow
47. 90 degree elbow
48. 45 degree elbow
49. Sheet metal screw
50. Speed nut
51. Caplug
52. Grommet
53. Fuel pump shroud
54. Nut
55. Lockwashers
56. Washer
57. Gasket
58. Screw
59. Screw
60. Washer
61. Vapor sep. cover
62. Gasket
63. Fuel pump
64. Screw
65. Lockwasher
66. M/V Bracket
67. Nipple
68. 45 degree elbow
69. 90 degree elbow
70. Plug
71. Fuel manifold valve
72. Disch. tube bracket

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72-10-06 FUEL INJECTION SYSTEM
IO-470-L (See Figure 72-10-06F).

A. Disconnect six fueldischarge tubes (2) from manifold valve (59) and nozzles (3). Compress spring legs of each clamp (1), in turn, and remove tube and clamp. Disconnect hose assembly (6) at manifold valve (59). Remove nozzles (3) and store in a clean container.

B. Disconnect hose assemblies (4 and 5) at fuel pump (51). Disconnect hose assemblies at fuel control (27) and remove hose assemblies. Remove shroud attaching parts (7, 8 and 9) and remove shroud (10).

C. Loosen nipples (18), elbows (19 and 21), extension (20), fuel screen (24) and plug (26) to facilitate later removal; then remove support brackets-to-throttle assembly and remove air throttle and injection control as a unit. Remove two cotter pins (11), washers (12 and 13) to detach link rod assembly. Remove three bolts (22) and tab washers (23) to detach fuel control (27) from air throttle body (32).

D. Remove nipple (33), elbows (34, 35 and 36); then remove screws (37) and fuel pump shroud (41). Remove four sets of pump attaching parts (42, 43 and 44), fuel pump (51) and gasket (45).

E. Loosen nipple (55), elbows (56 and 57) and plug (58) to facilitate later removal. Remove bracket-to-crankcase attaching parts and lift off valve and bracket as a unit. Remove screw (52) and washers (53) to separate bracket (54) from valve (59).

NOTE . . . Further disassembly of the fuel injection system should not be attempted unless proper flow test equipment is available.

For overhaul instructions for the Fuel Injection System, see Form X30593A.

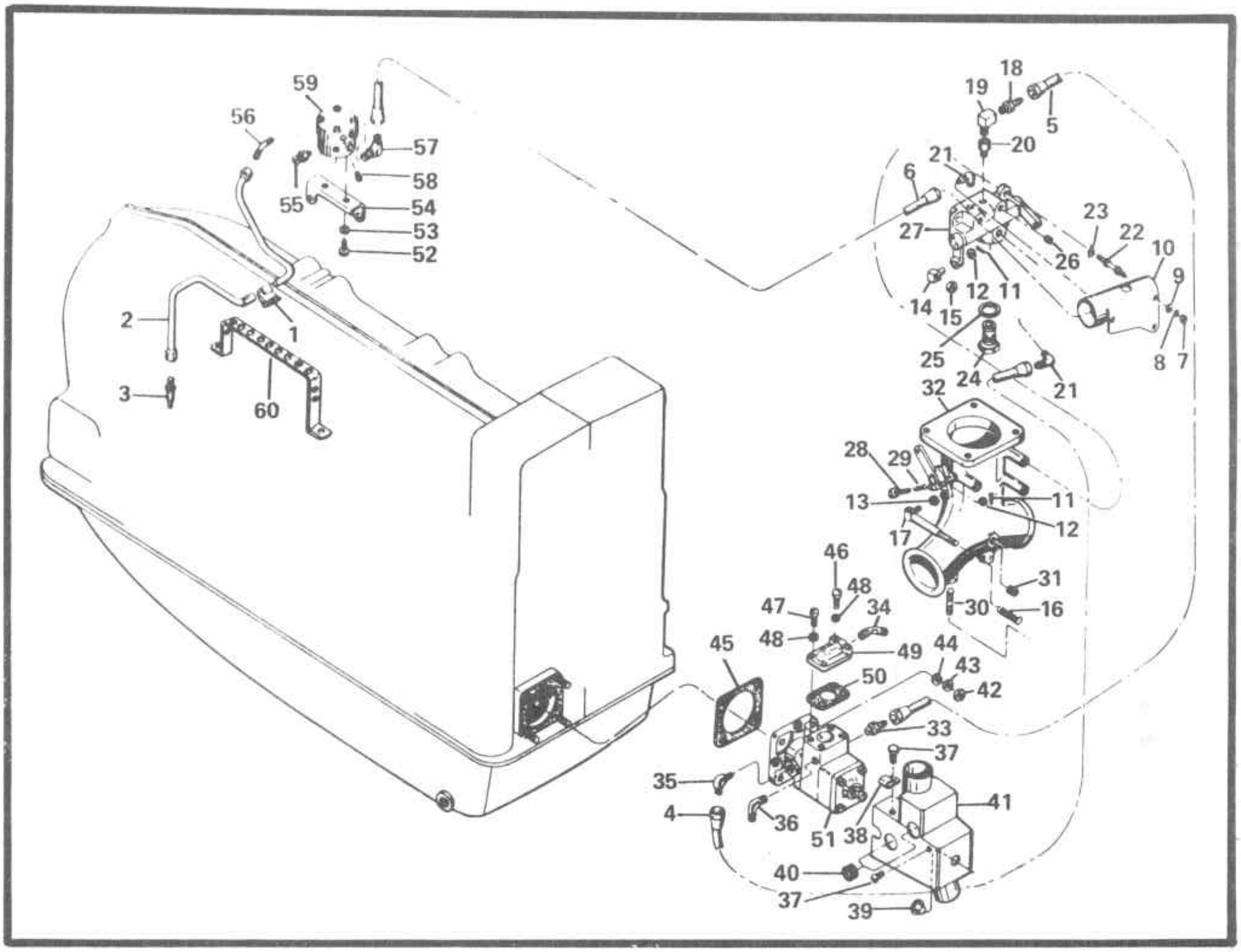

FIGURE 72-10-06F. FUEL INJECTION SYSTEM (IO-470-L).

1. Tube clamp
2. Fuel discharge tube
3. Fuel injection nozzle
4. Hose assembly
5. Hose assembly
6. Hose assembly
7. Hex nut
8. Lockwasher
9. Washer
10. Fuel control valve shroud
11. Cotter pin
12. Washer
13. Wave washer
14. Rod end
15. Self locking nut
16. Spring
17. Rod and link
18. Nipple
19. Street elbow
20. Extension
21. 90 degree elbow
22. Bolt
23. Tab washer
24. Fuel screen
25. Gasket
26. Pipe plug
27. Fuel control
28. Idle adjustment screw
29. Spring
30. Stud
31. Pipe plug
32. Air throttle
33. Nipple
34. 90 degree elbow
35. 90 degree elbow
36. 90 degree elbow
37. Sheet metal screw
38. Speed nut
39. Caplug
40. Grommet
41. Fuel pump shroud
42. Hex nut
43. Lockwasher
44. Washer
45. Gasket
46. Screw
47. Screw
48. Washer
49. Vapor separator cover
50. Gasket
51. Fuel pump
52. Screw
53. Lockwasher
54. Bracket
55. Nipple
56. 45 degree elbow
57. 90 degree elbow
58. Plug
59. Manifold valve
60. Fuel discharge tube bracket

72–10–06 FUEL INJECTION SYSTEM
IO–470–M (See Figure 72–10–06G).

A. Disconnect six fuel discharge tubes (2) from manifold valve (68) and nozzles (3). Compress spring legs of each clamp (1), in turn, and remove tubes and clamps. Disconnect hose assembly (12) at manifold (68).

B. Disconnect hose assemblies (4 and 5) at fuel pump (60) and at fuel control (31). Remove elbows (6 and 7) and shroud attaching parts (8, 9 and 10). Remove shroud (11) and disconnect hose assembly (12) at control (31).

C. Remove two sets of cotter pins (13) and washers (14 and 15), unhook spring (16) and remove rod and link (20).

D. Loosen nipple (23), tee (25), elbow (26), extension (27), plug (28) and screen (29) to facilitate later removal. Remove air throttle (37) and fuel control (31) as a unit from air throttle bracket.

E. Remove bolts (21) and washers (22) and separate fuel control from air throttle.

F. Remove fittings (38 through 45) from fuel pump (60). Remove sheet metal screws (46) and fuel pump shroud (50). Remove four sets of pump attaching parts (51, 52 and 53) and remove fuel pump (60) and gasket (54).

G. Loosen nipple (64), elbows (65 and 66) and plug (67) to facilitate later removal. Remove bracket-to-crankcase attaching parts and lift off valve and bracket as a unit. Remove screws (61) and washers (62) to separate bracket (63) from manifold valve (68).

NOTE . . . Further disassembly of the fuel injection system should not be attempted unless proper flow test equipment is available.

For overhaul instructions for the Fuel Injection System, see Form X30593A.

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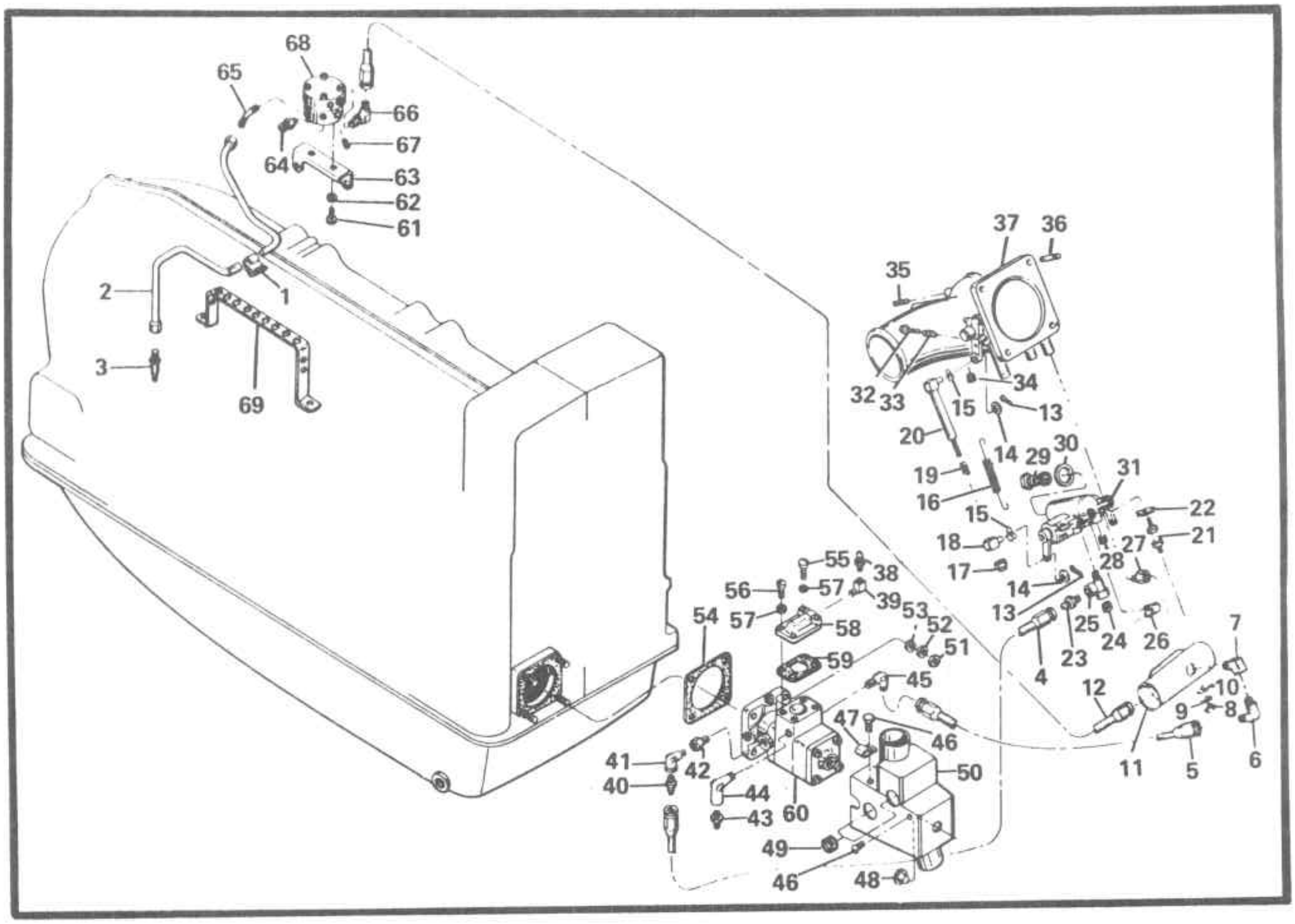

FIGURE 72-10-06G. FUEL INJECTION SYSTEM (IO-470-M).

1. Tube clamp
2. Fuel discharge tube
3. Fuel injection nozzle
4. Hose assembly
5. Hose assembly
6. 90 degree elbow
7. Street elbow
8. Hex nut
9. Lockwasher
10. Washer
11. Fuel control shroud
12. Hose assembly
13. Cotter pin
14. Washer
15. Wave washer
16. Spring
17. Self locking nut
18. Rod end
19. Spring
20. Rod and link
21. Bolt
22. Tab washer
23. Nipple
24. Pipe plug
25. Tee
26. 90 degree elbow
27. Extension
28. Pipe plug
29. Fuel screen
30. Gasket
31. Fuel control
32. Idle adjustment screw
33. Spring
34. Pipe plug
35. Stud
36. Stud
37. Air throttle
38. Nipple
39. Street elbow
40. Nipple
41. Street elbow
42. Bushing
43. Nipple
44. 90 degree elbow
45. 90 degree elbow
46. Sheet metal screw
47. Speed nut
48. Caplug
49. Grommet
50. Fuel pump shroud
51. Hex nut
52. Lockwasher
53. Washer
54. Gasket
55. Screw
56. Screw
57. Washer
58. Vapor separator cover
59. Gasket
60. Fuel pump
61. Screw
62. Lockwasher
63. Manifold valve bracket
64. Nipple
65. 45 degree elbow
66. 90 degree elbow
67. Plug
68. Fuel manifold valve
69. Fuel discharge tubes bracket

72-10-06 FUEL INJECTION SYSTEM
IO-470-S (See Figure 72-10-06H).

A. Disconnect six fuel discharge tubes (2) from manifold valve (60) and nozzles (3). Compress spring legs of each clamp (1), in turn, and remove tube clamp. Disconnect hose assembly (6) from manifold. Remove nozzles (3) and store in a clean container.

B. Disconnect hose assemblies (4 and 5) from fuel pump (52). Disconnect hose assemblies at fuel control (27) and remove hose assemblies. Remove shroud attaching parts (7, 8 and 9) and remove shroud (10).

C. Loosen elbows (19 and 20), nipple (21), plug (24) and fuel screen (25) to facilitate later removal. Remove spring (14), two sets of cotter pins (11) and washers (12 and 13) and remove rod and link assembly. Remove bolts (22) and tab washers (23) and separate fuel control (27) from throttle control (32).

D. Remove fittings (33 through 37) from fuel pump (52). Remove screws (38) and remove fuel pump shroud (42). Remove four sets of pump attaching parts (43, 44 and 45) and remove pump and gasket.

E. Loosen nipple (56), elbows (57 and 58) and plug (59) to facilitate later removal. Remove two sets of valve-to-crankcase attaching parts and remove valve and bracket as a unit. Remove attaching parts (53 and 54) to separate bracket (55) from manifold (60).

NOTE . . . Further disassembly of the fuel injection system should not be attempted unless proper flow test equipment is available.

For overhaul instructions for the Fuel Injection System, see Form X30593A.

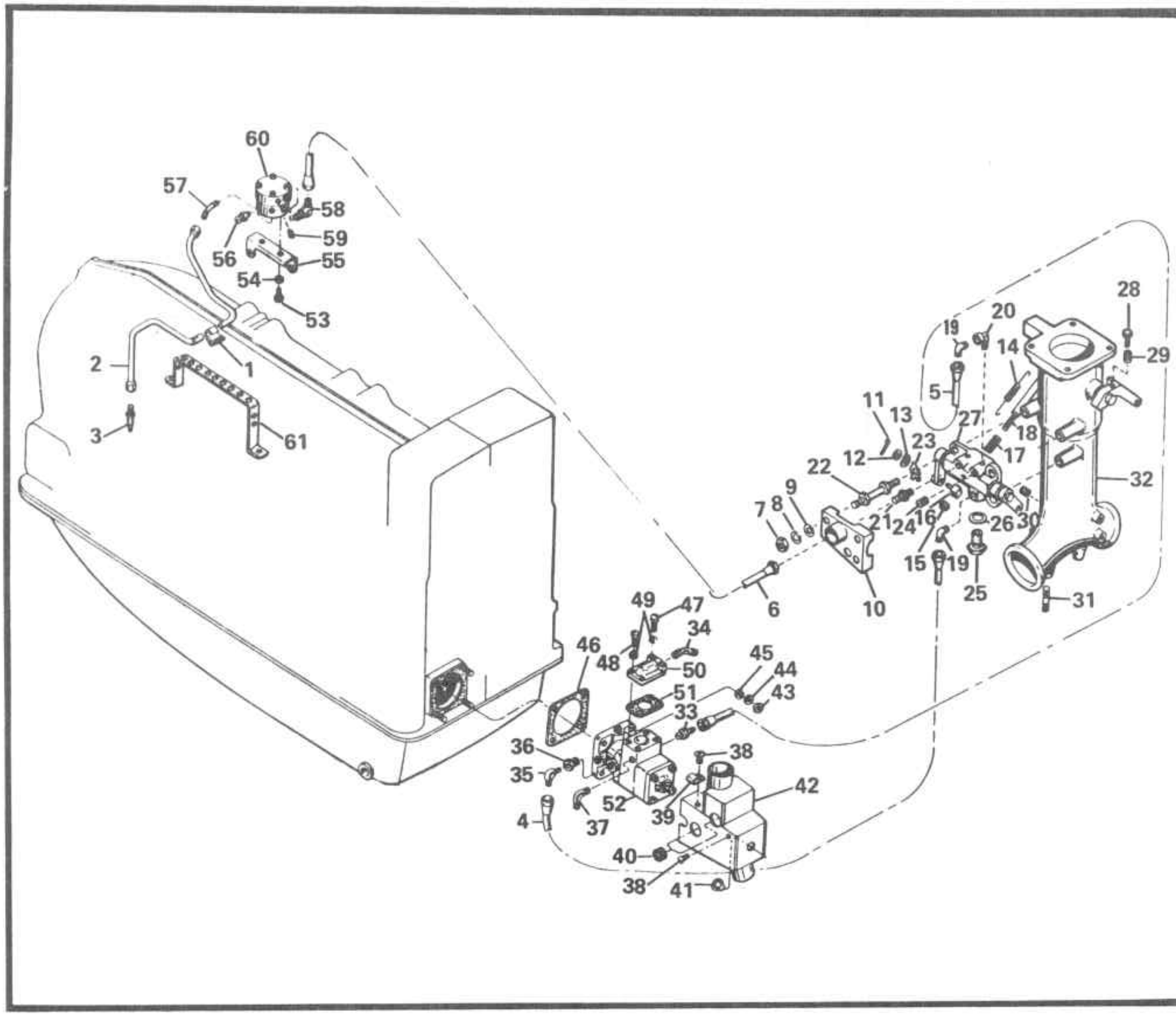

FIGURE 72-10-06H. FUEL INJECTION SYSTEM (IO-470-S).

1. Clamp
2. Fuel disch. tube
3. Fuel inj. nozzle
4. Hose assembly
5. Hose assembly
6. Hose assembly
7. Hex nut
8. Lockwasher
9. Washer
10. Fuel control valve shroud
11. Cotter pin
12. Washer
13. Wave washer
14. Spring
15. Hex nut
16. Rod end
17. Spring
18. Rod and link
19. 90 degree elbow
20. Street elbow
21. Nipple
22. Bolt
23. Tab washer
24. Pipe plug
25. Fuel screen
26. Gasket
27. Control valve
28. Idle adj. screw
29. Spring
30. Pipe plug
31. Stud
32. Air throttle
33. Nipple
34. 45 degree elbow
35. 90 degree elbow
36. Bushing
37. 90 degree elbow
38. Sheet metal screw
39. Speed nut
40. Grommet
41. Caplug
42. Fuel pump shroud
43. Hex nut
44. Lockwasher
45. Washer
46. Gasket
47. Screw
48. Screw
49. Washer
50. Vapor separator
51. Gasket
52. Fuel pump
53. Screw
54. Lockwasher
55. Bracket
56. Nipple
57. 45 degree elbow
58. 90 degree elbow
59. Plug
60. Manifold valve
61. Fuel discharge tube bracket

72-10-06 FUEL INJECTION SYSTEM
IO-470-V & VO (See Figure 72-10-06I).

A. Disconnect six fuel discharge tubes (2) from fuel manifold valve (58) and nozzles (3). Compress spring legs of each clamp (1) and remove tube and clamp. Disconnect fuel control to manifold valve hose assembly (10) at manifold valve. Remove nozzles (3) and store in a clean container.

B. Disconnect fuel pump to fuel control hose assemblies (8, 9) at fuel pump. Remove sheet metal screws (7) and work cover shroud off control unit bottom shroud onto hose assemblies (8, 9). Disconnect hose assemblies (8, 9, 10) from fuel injection control unit and remove cover shroud (12).

C. Loosen nipples, plugs, elbows and fuel screen to facilitate later removal. Remove throttle body support brackets and remove air throttle body and fuel control as a unit. Remove cotter pin and washers and detach link rod assembly. Remove three screws (20) and tab washers (21) to detach bottom shroud (24) and fuel control unit (33) from air throttle body (37).

D. Remove elbows from fuel pump assembly. Remove screws (43, 44) and fuel pump shroud (47). Take out two sets of attaching parts and remove fuel pump assembly (52), gasket (51) and fuel pump drive.

E. Loosen nipples (54) and elbows (55, 56, 57) in fuel manifold valve if necessary to facilitate later removal. Remove bracket-to-crankcase attaching parts and lift off valve and bracket as a unit.

NOTE . . . Further disassembly of the fuel injection system should not be attempted unless proper flow test equipment is available.

For overhaul instructions for the Fuel Injection System, see Form X30593A.

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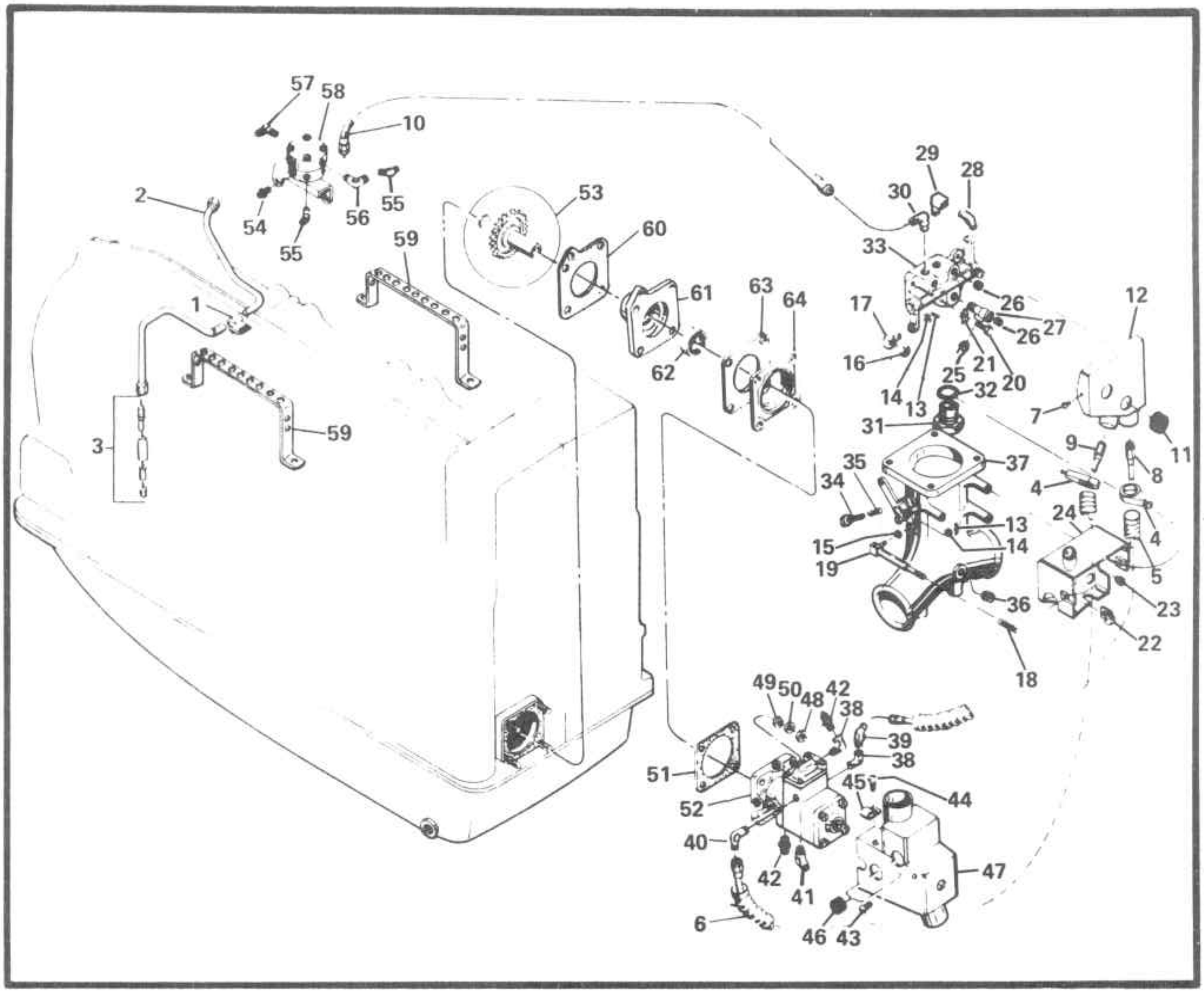

FIGURE 72-10-06I. FUEL INJECTION SYSTEM (IO-470-V, VO).

1. Tube clamp
2. Fuel disch. tube
3. Fuel inj. nozzle
4. Hose clamp
5. Flexible duct
6. Flexible duct
7. Sheet metal screw
8. Hose assembly
9. Hose assembly
10. Hose assembly
11. Grommet
12. Cover shroud
13. Cotter pin
14. Washer
15. Wave washer
16. Nut
17. Rod end
18. Spring
19. Rod and link
20. Screw
21. Tab washer
22. Speed nut
23. Grommet
24. Bottom shroud
25. Nipple
26. Plug
27. Tee
28. Elbow, 90°
29. Elbow, street, 90°
30. Elbow, 90°
31. Fuel screen assy.
32. Gasket
33. Fuel control unit
34. Idle adj. screw
35. Idle adj. spring
36. Plug
37. Air throttle body
38. Elbow, 90°
39. Elbow, 45°
40. Elbow, 90°
41. Elbow, 45°
42. Nipple
43. Sheet metal screw
44. Sheet metal screw
45. Speed nut
46. Grommet
47. Shroud
48. Nut
49. Lockwasher
50. Plain washer
51. Gasket
52. Fuel pump
53. Fuel pump dr. gear
54. Nipple
55. Elbow, 45°
56. Elbow, 90°
57. Elbow, 90°
58. Manifold valve
59. Fuel discharge tube bracket
60. Gasket
61. Adapter
62. Seal
63. Gasket
64. Insulator

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72-10-07 INDUCTION SYSTEM
IO-470-C & H (See Figure 72-10-07A).

A. Rotate engine stand bed so that engine is inverted.

B. Remove four sets of nuts (1), two clamps (2); then loosen two clamp assemblies (4) and pull off balance tube (3).

C. Loosen plug (8) to facilitate later removal; then loosen clamps (11), work hoses (12) clear of joints. Remove attaching parts (5, 6, 7) and pull rear manifold (9) from oil sump studs.

D. Remove four sets of intake tube attaching parts (13, 14, 15) from each cylinder and lift off tubes, hoses, and clamps as a unit from each bank of cylinders.

E. Remove clamps (11) and hoses (12) to separate intake tubes (16, 17, 18).

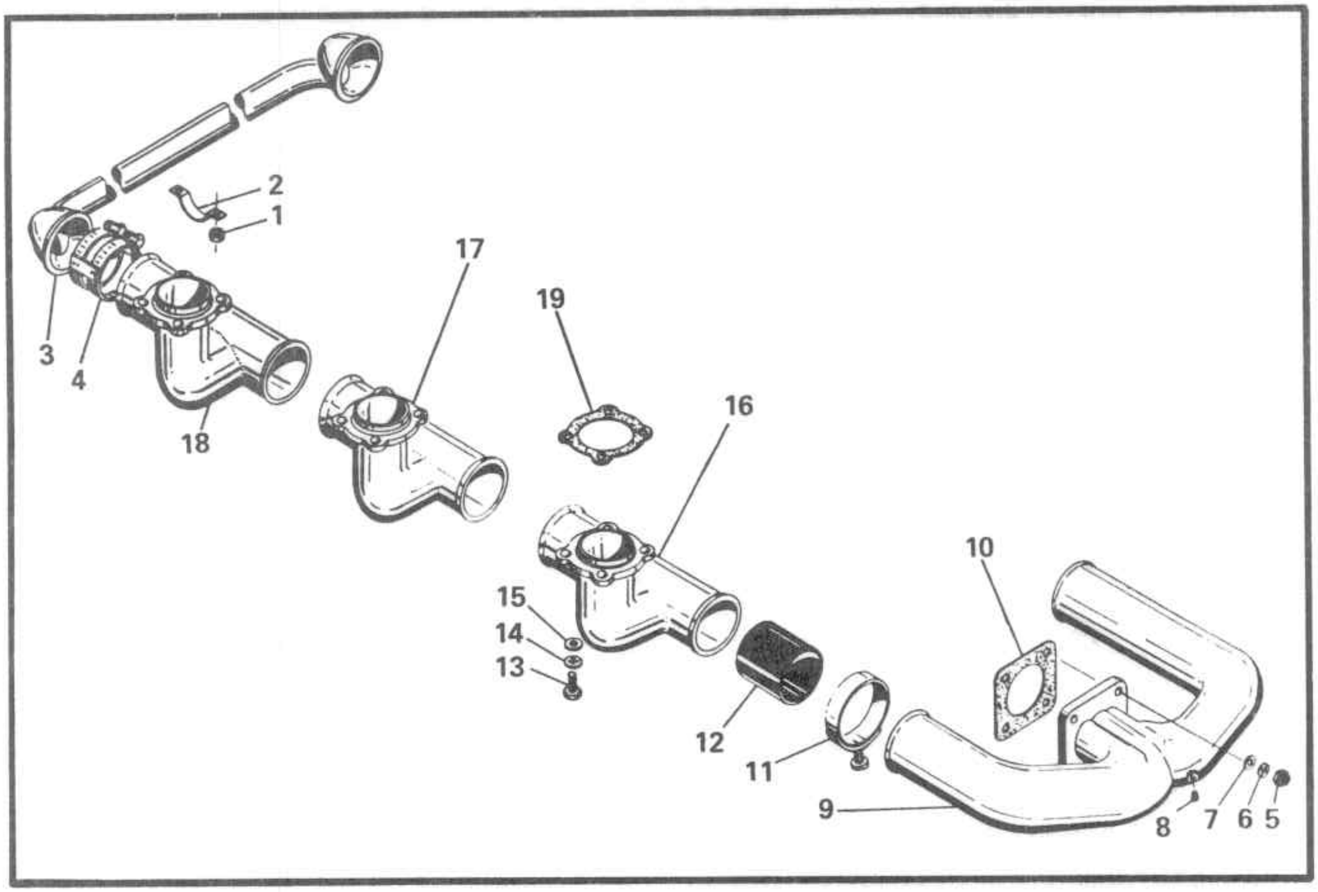

FIGURE 72-10-07A. INDUCTION SYSTEM (IO-470-C & H).

1. Nut
2. Clamp
3. Balance tube
4. Clamp assembly
5. Nut
6. Lockwasher
7. Washer
8. Plug
9. Rear manifold
10. Gasket
11. Clamp
12. Hose
13. Screw
14. Lockwasher
15. Washer
16. Intake tube assembly
17. Intake tube assembly
18. Intake tube assembly
19. Gasket

72-10-07 INDUCTION SYSTEM

IO-470-D,E,G,L,P,R,U,V & VO (See Figure 72-10-07B).

A. Rotate engine stand bed so that engine is inverted.

B. Loosen hose clamps (1 and 14) on elbow tube hoses (2 and 15) and remove elbow tubes (16 and 17).

C. Loosen clamp assemblies (36) and push hoses (37) onto front intake tubes (40) until clear of joints; then remove balance tube-to-bracket clamp attaching parts (18 thru 28 or 43 thru 46 as applicable) and balance tube (31).

D. Remove four sets of intake tube attaching parts (32, 33 and 34) from each cylinder and lift off tubes, hoses and clamps from each bank of cylinders as a unit. Loosen clamps and separate parts.

E. Detach and remove air throttle body bracket (47 through 53) from crankcase and two throttle body support brackets (57) from oil sump flange, by removing attaching hardware (3, 4, 7, 8, 54, 55 & 56).

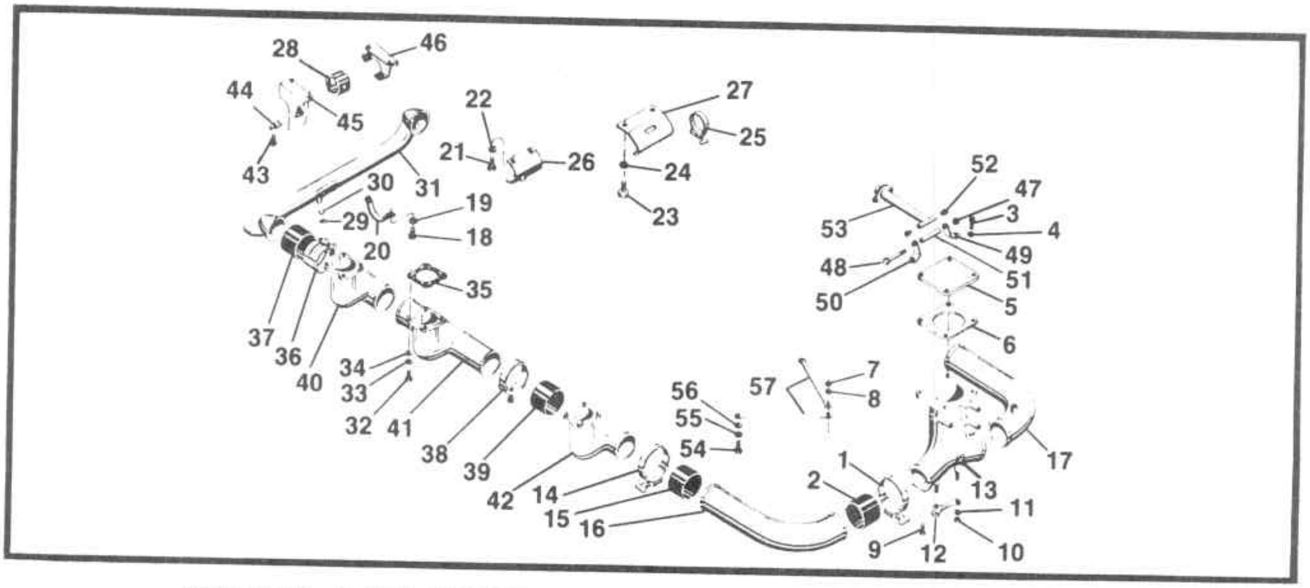

FIGURE 72-10-07B. INDUCTION SYSTEM (IO-470-D,E,G,L,P,R,U, V & VO).

1. Clamp
2. Hose
3. Screw
4. Lockwasher
5. Cover
6. Gasket
7. Nut
8. Lockwasher
9. Screw
10. Nut
11. Lockwasher
12. Throttle support brkt.
13. Air throttle assembly
14. Clamp
15. Hose
16. Left elbow tube assy.
17. Right elbow tube assy.
18. Screw
19. Lockwasher
20. Clamp
21. Screw
22. Lockwasher
23. Screw
24. Lockwasher
25. Clamp
26. Bracket balance tube
27. Bracket Balance tube
28. tube
29. Retaining ring
30. Drain valve
31. Balance tube
32. Bolt
33. Lockwasher
34. Washer
35. Gasket
36. Clamp
37. Hose
38. Clamp
39. Hose
40. Front intake tube
41. Center intake tube
42. Rear intake tube
43. Bolt
44. Tab washer
45. Left side bracket
46. Right side bracket
47. Nut
48. Bolt
49. Right support bracket
50. Left support bracket
51. Support bracket sleeve
52. Bushing
53. Support bracket
54. Screw
55. Lockwasher
56. Washer
57. Throttle body support brackets

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72-10-07 INDUCTION SYSTEM IO-470-F (See Figure 72-10-07C).

Disassembly procedures are as follows:

A. Rotate disassembly stand bed so that engine is inverted.

B. Loosen hose clamps (5) on elbow tube hoses (6). Remove hoses, clamps and elbows (14 and 16).

C. Loosen clamp assembly (4), remove two balance tube bracket-to-oil sump retaining screws (1), washers (2) and lift off balance tube (3).

D. Remove four sets of intake tube attaching parts (17, 18, and 19) from each cylinder. Lift off tubes, elbows, hoses and clamps as a unit from each bank of cylinders, then separate the parts.

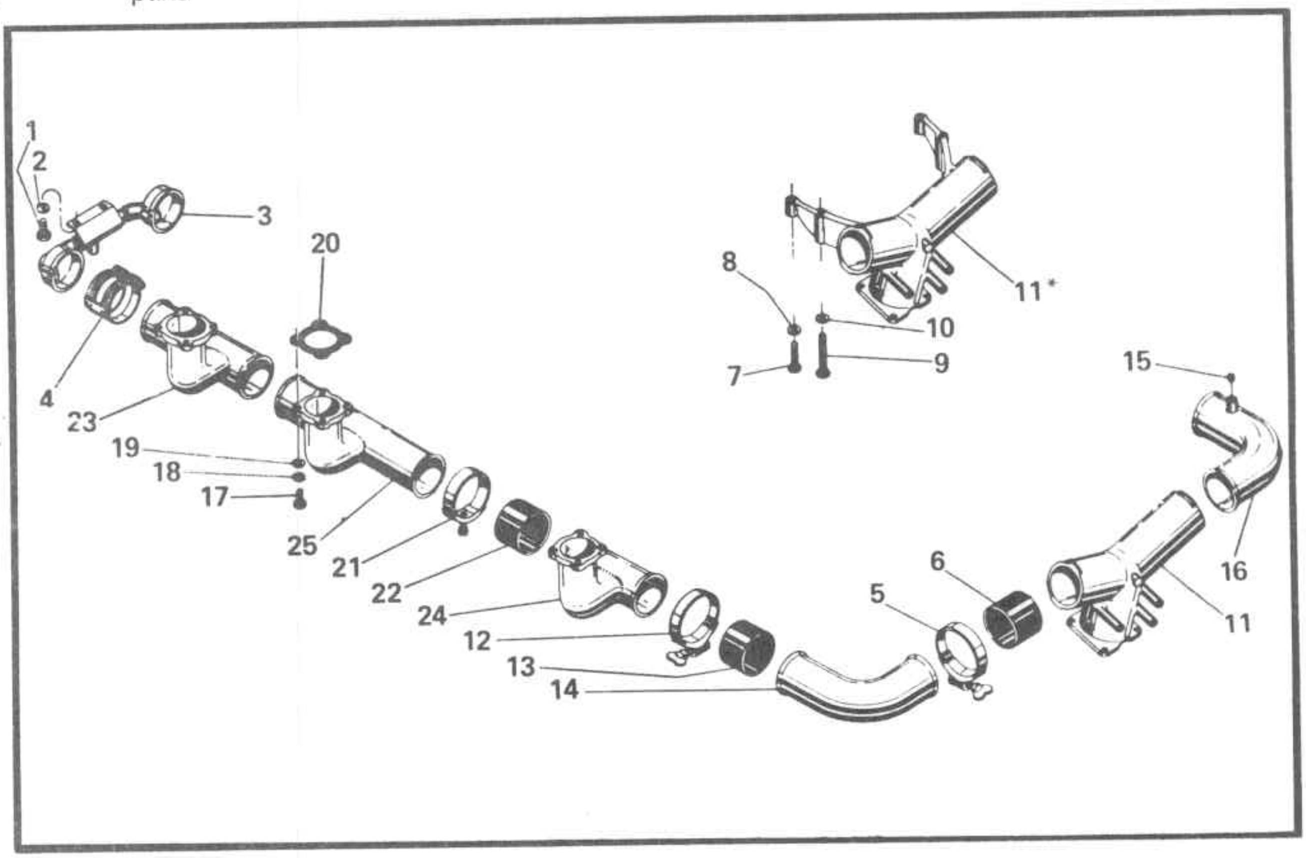

FIGURE 72-10-07C. INDUCTION SYSTEM (IO-470-F).

1. Screw
2. Lockwasher
3. Balance tube
4. Clamp
5. Clamp
6. Hose
7. Bolt
8. Washer
9. Bolt
10. Washer
11. Air throttle
12. Clamp
13. Hose
14. Left elbow tube
15. Plug
16. Right elbow tube
17. Bolt
18. Lockwasher
19. Washer
20. Gasket
21. Clamp
22. Hose
23. Front intake tube
24. Rear intake tube
25. Center intake tube

* Old style air throttle with cast mount legs.

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72-10-07 INDUCTION SYSTEM IO-470-J (See Figure 72-10-07D).

A. Rotate engine stand bed so that engine is inverted.

B. Loosen plug (6) to facilitate later removal; then loosen clamps (7), work hoses (9) clear of rear manifold (4). Remove attaching parts (1, 2, and 3) and pull rear manifold (4) from oil sump studs.

C. Remove four nuts (21), two clamps (20); then loosen two hose clamp assemblies (8) and pull off balance tube (18).

D. Remove four sets of intake tube attaching parts, (12, 13 and 14) from each cylinder and lift off tubes, hoses, and clamps as a unit from each bank of cylinders. Remove two bolts and washers from each tube flange.

E. Remove clamps (8) and hoses (9) to separate intake tubes (10 and 11).

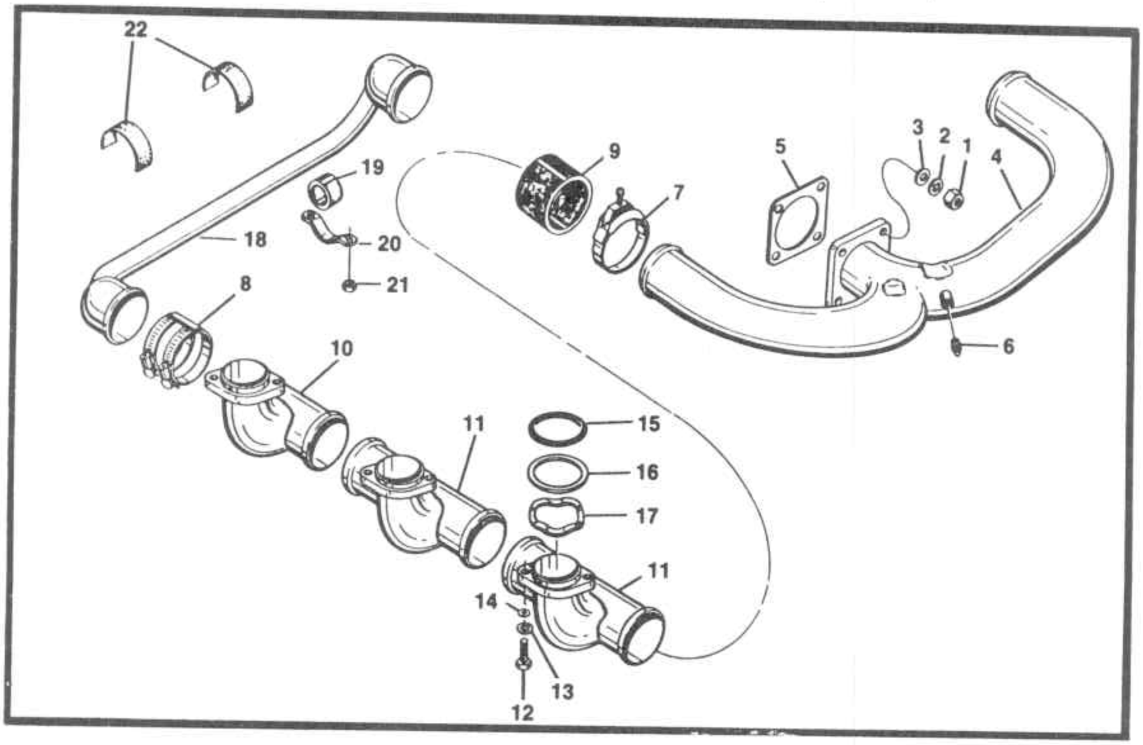

FIGURE 72-10-07D. INDUCTION SYSTEM (IO-470-J).

1. Nut, hex head
2. Washers, lock
3. Washer, plain
4. Tube, balance
5. Gasket
6. Plug, pipe
7. Clamp
8. Clamp
9. Hose
10. Tube, intake
11. Tube, intake
12. Bolt, hex head
13. Washer, lock
14. Washer, plain
15. Seal, intake manifold
16. Washer, intake manifold
17. Spring, intake manifold
18. Tube, balance
19. Bushing, balance tube
20. Clamp, balance tube
21. Nut, hex head
22. Felt, sump-to-balance tube

72-10-07 INDUCTION SYSTEM IO-470-K & N (See Figure 72-10-07E).

A. Rotate engine stand bed so that engine is inverted.

B. Loosen plug (8) to facilitate later removal; then loosen clamps (9, 5), work hoses (6, 10) clear of rear manifold (7). Remove hose clamp (3) and bracket (4) and remove rear manifold (7).

C. Remove attaching parts from four clamps (25), loosen hose clamp assembly and remove balance tube. Remove bushings (24) and felt (28).

D. Remove intake tube attaching parts, (12, 13 and 14) from each cylinder and lift off tubes, hoses, and clamps as a unit from each bank of cylinders. Remove bolts and washers from tube flange.

E. Remove clamps (9) and hoses (10) to separate intake tubes (15 and 16).

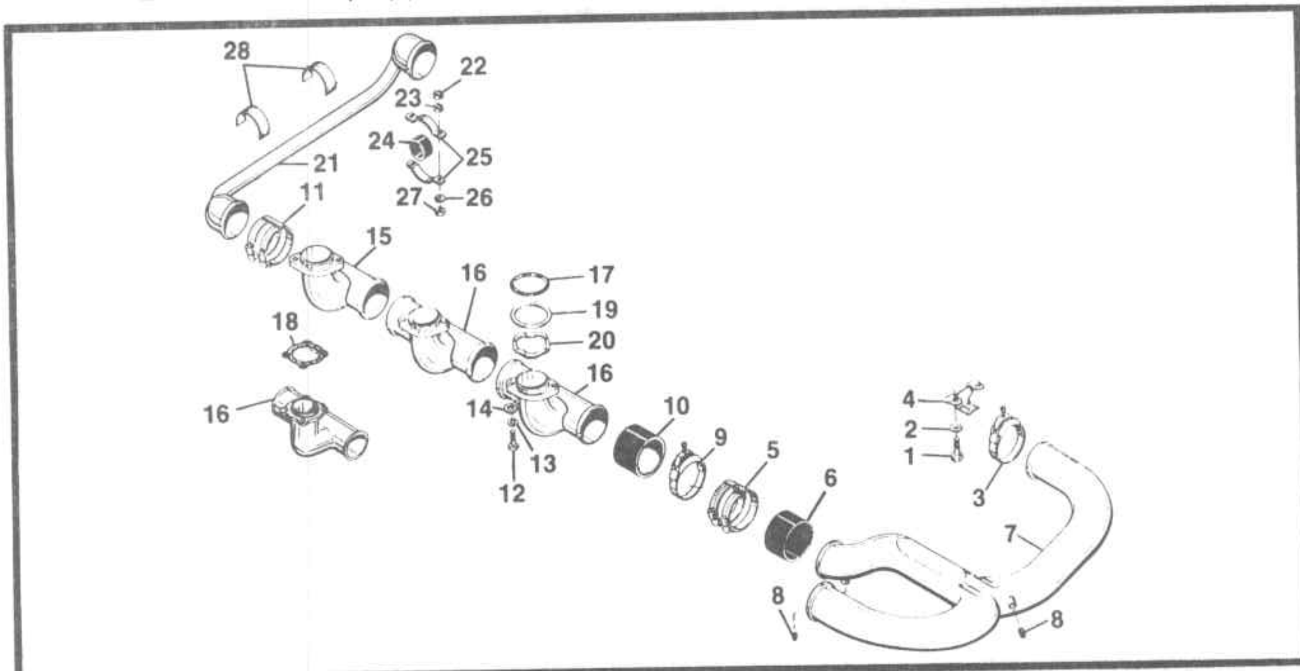

FIGURE 72-10-07E. INDUCTION SYSTEM (IO-470-K & N).

1. Bolt, hex head (IO-470-K)
2. Washer (IO-470-K)
3. Clamp
4. Bracket (IO-470-K)
5. Clamp
6. Hose
7. Manifold
8. Plug, pipe
9. Clamp
10. Hose
11. Clamp
12. Bolt, hex head
13. Washer, lock
14. Washer, plain (IO-470-K)
15. Tube, intake
16. Tube, intake (IO-470-N)
17. Seal, intake manifold
18. Gasket (IO-470-N)
19. Washer, intake manifold tube
20. Spring, intake manifold tube
21. Tube, balance
22. Spacer, balance tube
23. Spacer, balance tube
24. Bushing, balance tube
25. Clamp, balance tube
26. Washer, lock
27. Nut, hex
28. Felt, sump-to-balance tube

72-10-07 INDUCTION SYSTEM IO-470-M (See Figure 72-10-07F).

A. Rotate disassembly stand bed so that engine is inverted.

B. Loosen hose clamps (1) on elbow tube hoses (2). Remove hoses, clamps and elbows (3 and 4).

C. Loosen clamp assembly (28), remove two balance tube bracket-to-oil sump retaining screws (26), washers (27) and lift off balance tube (30).

D. Remove four sets of intake tube attaching parts (32, 33 and 34) from each cylinder. Lift off tubes, elbows, hoses and clamps as a unit from each bank of cylinders, then separate the parts.

E. Remove attaching parts (17 through 24) and two hex nuts, lockwashers and plain washers securing top of bracket to magneto and accessory drive studs. Remove bracket and disassemble bolt (11), hex nut (12), support brackets (13 and 14), sleeve (15) and bushings (16).

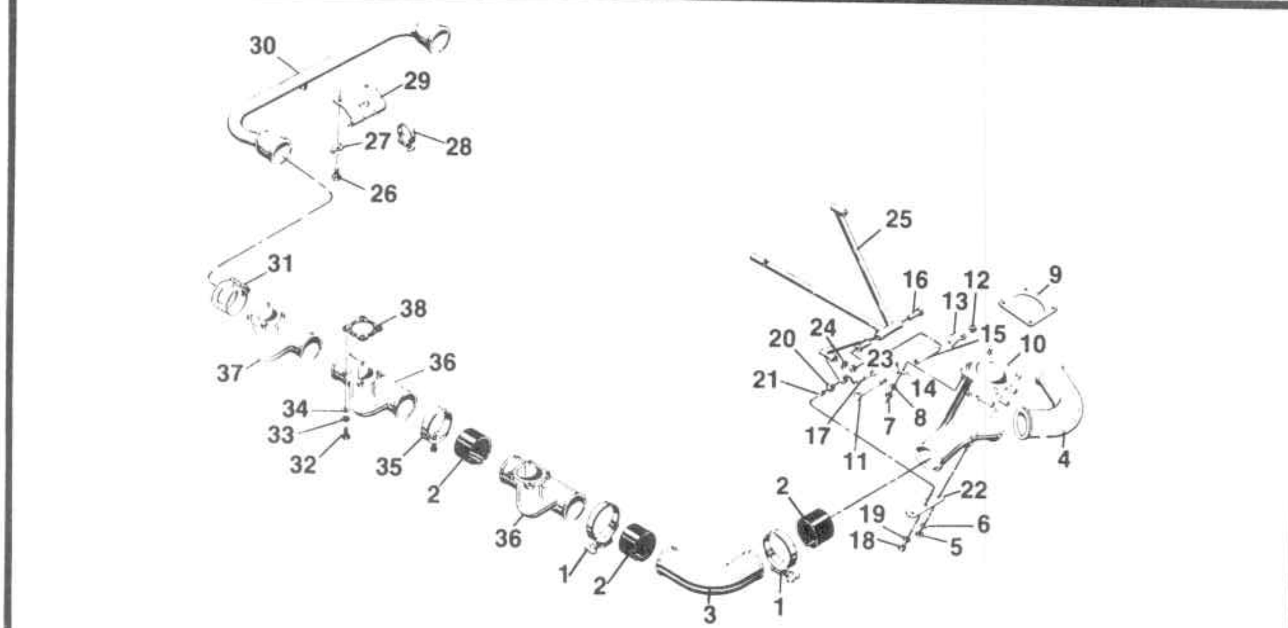

FIGURE 72-10-07F. INDUCTION SYSTEM (IO-470-M).

1. Hose clamp
2. Hose
3. Elbow tube
4. Elbow tube
5. Hex nut
6. Lockwasher
7. Hex nut
8. Lockwasher
9. Gasket
10. Air throttle assembly
11. Bolt
12. Hex nut
13. Support bracket
14. Support bracket
15. Sleeve
16. Bushing
17. Bolt
18. Self locking nut
19. Lockwasher
20. Grommet
21. Sleeve
22. Lower bracket
23. Hex nut
24. Lockwasher
25. Air throttle bracket
26. Screw
27. Tab washer
28. Balance tube clamp
29. Balance tube bracket
30. Balance tube
31. Hose clamp assembly
32. Bolt
33. Lockwasher
34. Washer
35. Hose clamp
36. Intake tube
37. Intake tube
38. Intake tube gasket

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72-10-07 INDUCTION SYSTEM IO-470-S (See Figure 72-10-07G).

A. Rotate engine stand bed so that engine is inverted.

B. Loosen hose clamps (2) on elbow tube hoses (1). Remove hoses, clamps and elbows (3 and 4).

C. Loosen clamp assembly (5), remove two balance tube bracket-to-oil sump retaining screws (6), washers (7) and lift off balance tube (8).

D. Remove four sets of intake tube attaching parts (9, 10 and 11) from each cylinder. Lift off tubes, elbows, hoses and clamps as a unit from each bank of cylinders, then separate the parts.

E. Remove attaching hardware (19 thru 23), (25 thru 28), air throttle brackets (24 and 29), air throttle assembly (30) and gasket (31).

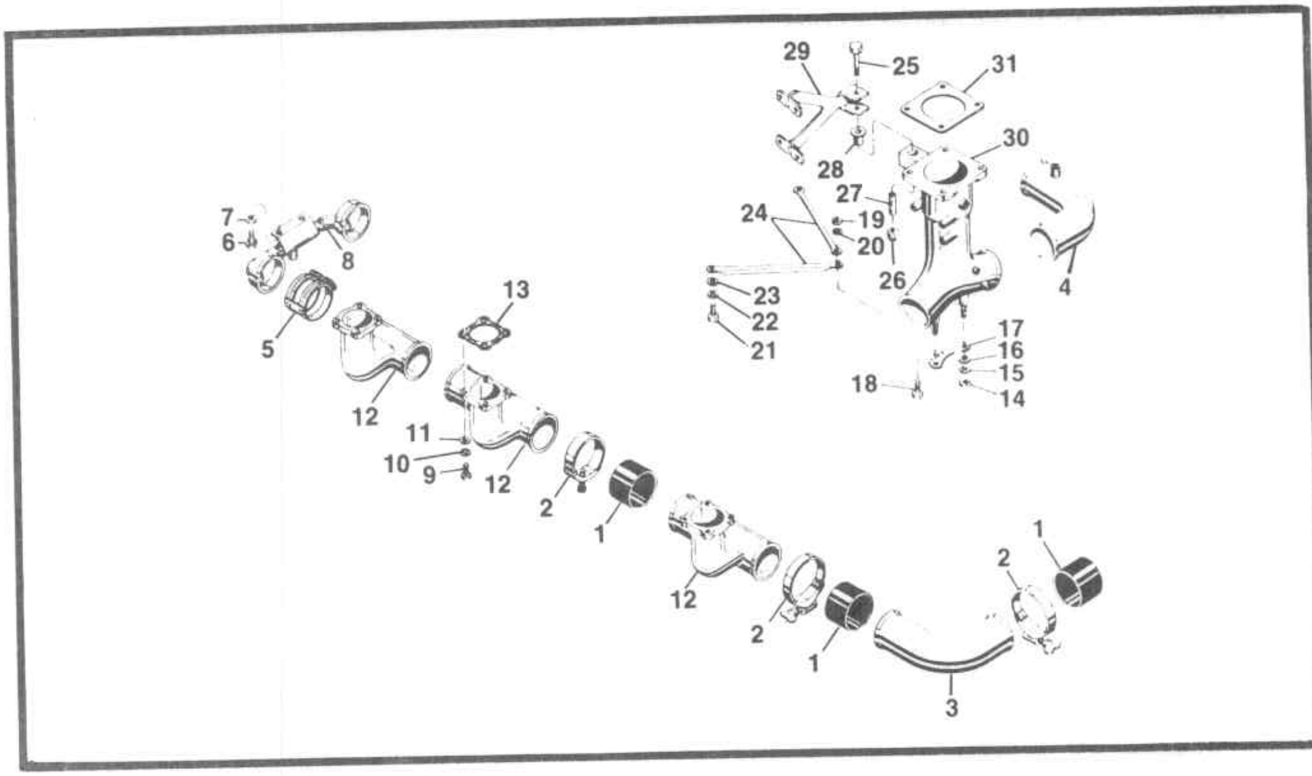

FIGURE 72-10-07G. INDUCTION SYSTEM (IO-470-S).

1. Hose
2. Hose clamp
3. Elbow tube
4. Elbow tube
5. Hose clamp assembly
6. Hex head screw
7. Washer
8. Balance tube
9. Bolt
10. Lockwasher
11. Plain washer
12. Intake tube
13. Intake tube gasket
14. Hex nut
15. Lockwasher
16. Plain washer
17. Lower bracket
18. Bolt
19. Hex nut
20. Lockwasher
21. Bolt
22. Lockwasher
23. Plain washer
24. Bracket
25. Bolt
26. Nut
27. Sleeve
28. Bushing
29. Bracket
30. Air throttle assembly
31. Air throttle gasket

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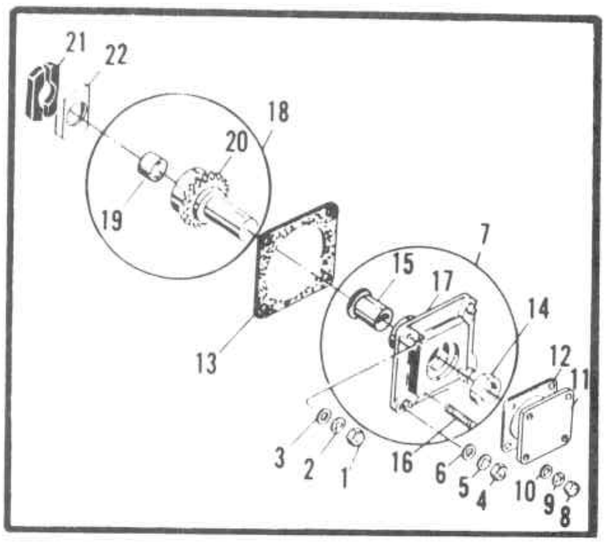
72-10-08 MAGNETO AND ACCESSORY DRIVES (See Figure 72-10-08).

A. Remove two sets of attaching parts (1, 2, 3) and six sets of attaching parts (4, 5, 6) and remove adapter assembly (7) and related parts as a unit.

B. Remove gear assembly (18), magneto drive coupling bushings (21) and retainer (22).

C. Remove attaching parts (8, 9, 10) and lift cover (11) and gasket (12). Remove oil seal (14) from adapter (17).



1. Nut, plain, hex
2. Washer, lock
3. Washer, plain
4. Nut, plain, hex
5. Washer, lock
6. Washer, plain
7. Adapter assembly
8. Nut, plain, hex
9. Washer, lock
10. Washer, plain
11. Cover, accessory drive
12. Gasket
13. Gasket
14. Seal, oil
15. Bushing, adapter
16. Stud
17. Adapter
18. Gear assembly
19. Sleeve
20. Gear, drive
21. Bushing
22. Retainer

FIGURE 72-10-08. MAGNETO & ACCESSORY DRIVES

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72-10-09 OIL SUMP IO-470-C,H,J & N (See Figure 72-10-09A).

Remove attaching hardware (21 through 23) and mounting brackets (20).

A. All hardware and induction system associated parts should have already been removed in Section 72-10-07.

B. Loosen plugs (13, 14, 15) to facilitate removal later.

C. Remove sump to crankcase attaching parts (17, 18, 19) and lift off sump.

D. Cut safety wires and remove suction tube attaching parts (3, 4, 5) and lift off tube assembly and gasket.

E. Do not disassemble oil sump any further unless necessary.

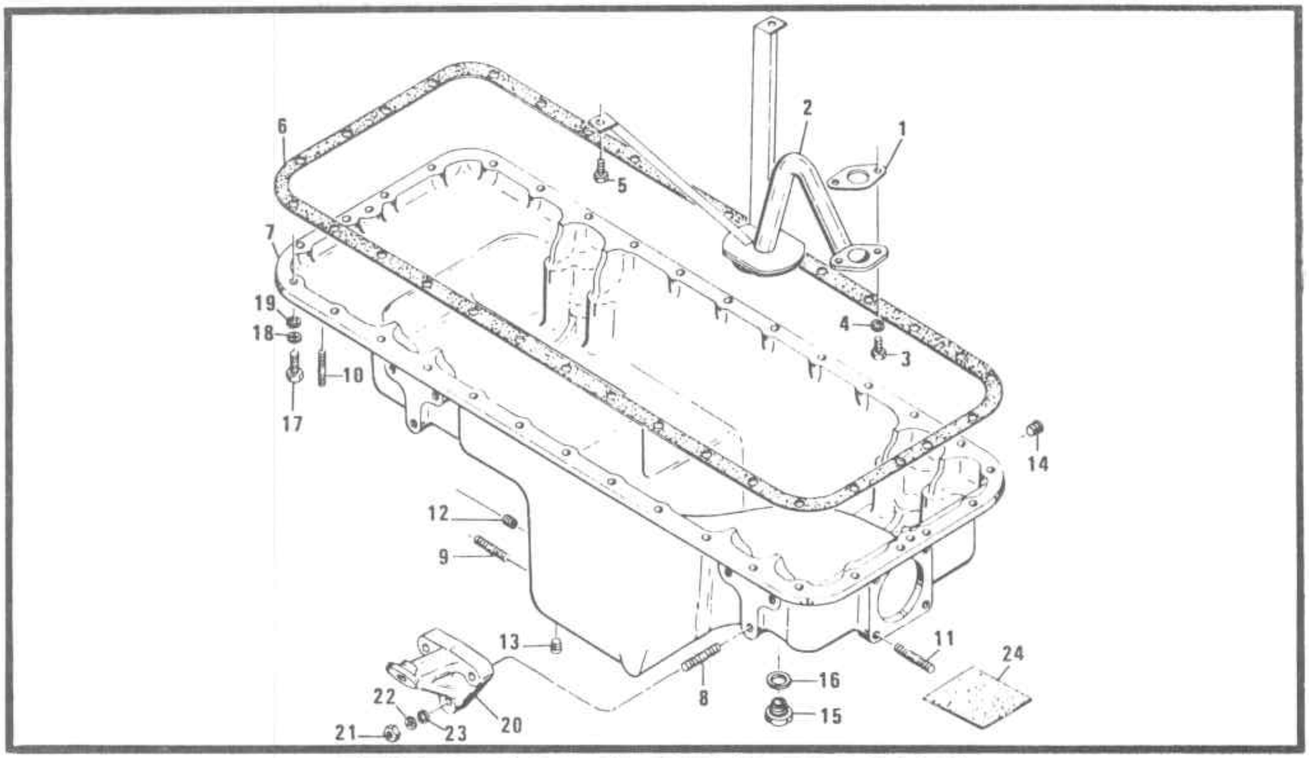

FIGURE 72-10-09A. OIL SUMP (IO-470-C,H,J & N).

1. Gasket
2. Tube assembly
3. Bolt
4. Washer, plain
5. Bolt
6. Gasket, oil sump
7. Sump, oil
8. Stud
9. Stud
10. Stud
11. Stud
12. Insert
13. Plug
14. Plug
15. Plug
16. Gasket
17. Bolt
18. Washer, lock
19. Washer, plain
20. Bracket, engine mount
21. Nut, hex
22. Washer, lock
23. Washer, plain
24. Felt

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72-10-09 OIL SUMP, IO-470-D,E,F,G,L,M,P,R,S,U,V (See Figure 72-10-09B).

A. Drain plug (1) and gasket (2) should have been removed when engine was mounted on stand. Remove attaching parts (3, 4, 5) and lift sump (6) from engine. If hard to remove, tap with a soft hammer. Do not pry. Remove and discard gasket (7).

B. Remove bolt (8), bolt (9), washer (10) to withdraw oil suction tube assembly (11) and remove gasket (12).

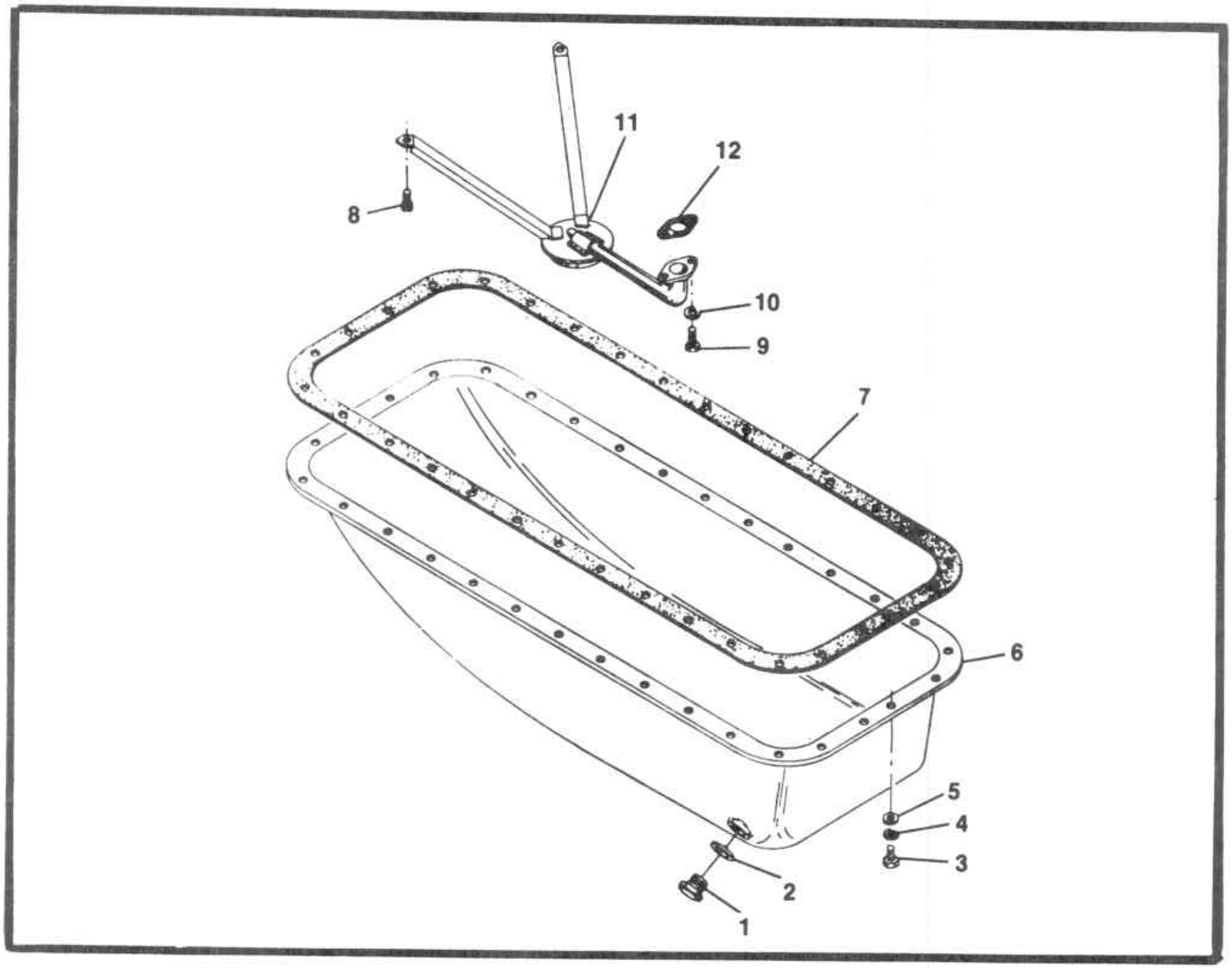

FIGURE 72-10-09B. OIL SUMP (IO-470-D,E,F,G,L,M,P,R,S,U,V).

1. Plug, Oil drain
2. Gasket, annular
3. Screw, hex head
4. Washer, lock
5. Washer, plain
6. Sump assembly, oil
7. Gasket, oil sump
8. Bolt
9. Bolt
10. Washer
11. Tube assembly, suction
12. Gasket

72-10-09 OIL COOLER IO-470-F (See Figure 72-10-10A).

A. Unscrew two long bolts to remove clamps from the front intercylinder baffles, and remove the left side clamp.

B. Remove one screw to remove the right clamp from the baffle between No. 5 cylinder and the cooler, and remove the clamp. Allow the baffle to drop free of the cooler mount flange.

C. Remove the five nuts and washers, then withdraw the oil cooler from the crankcase studs.

D. Take off the cooler-to-cylinder baffle and the cooler gasket.

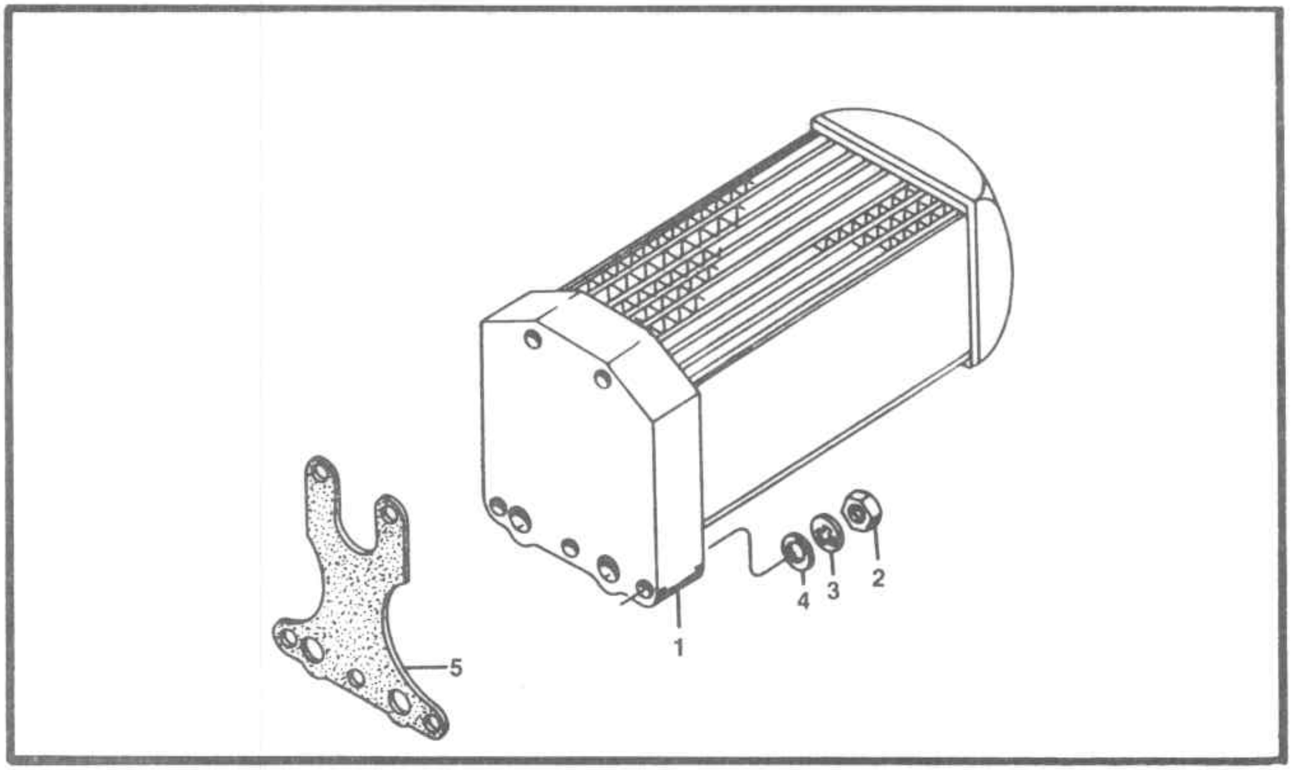

FIGURE 72-10-10A. OIL COOLER (IO-470-F).

1. Oil cooler
2. Nut, plain, hex
3. Lockwasher
4. Plain washer
5. Gasket

72-10-10 OIL COOLER IO-470-C,E,G,H,J,K,N,P,R,S. (See Figure 72-10-10B).

A. Remove five hex head bolts (2), three plain hex nuts (5), eight lockwashers (3) and plain washers (4)

B. Remove oil cooler (1).

C. Remove and discard gasket (6).

D. Remove nut (9), lockwasher (10), plain washer (11) and adapter (8), or remove two nuts (9), two lockwashers (10), two plain washers (11) and adapter (14) as applicable.

E. Remove and discard gaskets (12 or (13) as applicable.

NOTE . . . adapter (14) is used to provide connections for an externally mounted oil cooler.

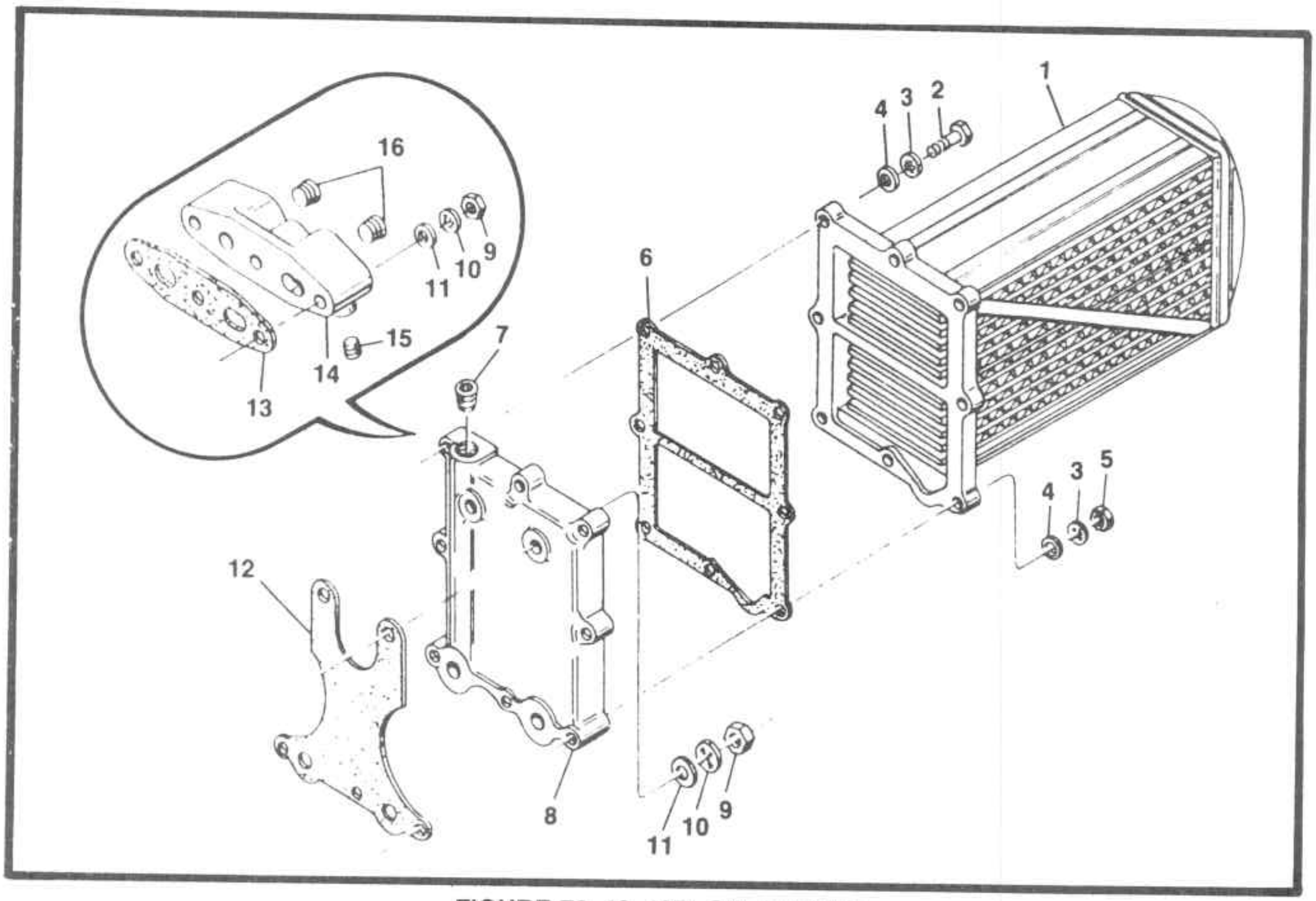

FIGURE 72-10-10B. OIL COOLER MODELS IO-470-C,E,G,H,J,K,N,R,S.

1. Oil cooler
2. Bolt
3. Lockwasher
4. Plain washer
5. Nut
6. Gasket, cooler-to-plate
7. Plug
8. Plate, oil cooler adapter
9. Nut
10. Lockwasher
11. Plain washer
12. Gasket, plate-to-crankcase
13. Gasket
14. Adapter
15. Plug
16. Plug

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72-10-10 OIL COOLER IO-470-D,L,M,N,U & V (See Figure 72-10-10C).

A. Remove twelve hex head bolts (2), twelve lockwashers (3), twelve plain washers (4), and oil cooler (1).

B. Remove and discard gasket (5) or (12) as applicable.

C. Remove five nuts (8), five lockwashers (9), five plain washers (10) and adapter (7) or (13) as applicable.

D. Remove and discard gasket (11) or (16) as applicable.

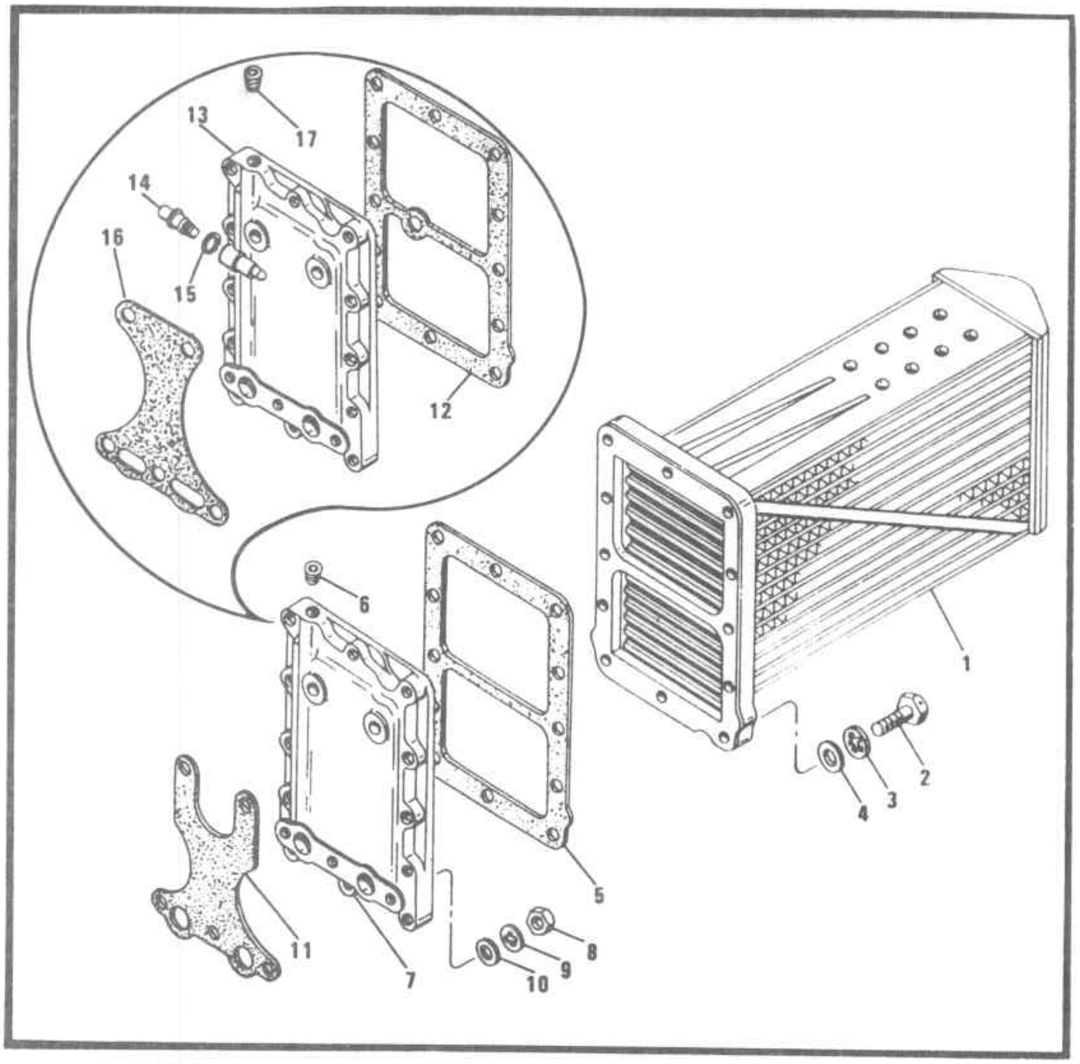

FIGURE 72-10-10C. OIL COOLER (IO-470-D,L,M,N,U & V).

1. Oil cooler
2. Bolt
3. Lockwasher
4. Plain washer
5. Gasket, cooler-to-plate
6. Plug
7. Plate, cooler-to-crankcase
8. Nut
9. Lockwasher
10. Plain washer
11. Gasket, plate-to-crankcase
12. Gasket, cooler-to-crankcase
13. Plate, oil cooler adapter
14. Oil temp. control valve
15. Gasket
16. Gasket, plate-to-crankcase
17. Plug

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72-10-11 GENERATOR IO-470-C,D,E,F,G,H,J,K,L,N,P,R & S (See Figure 72-10-11A).

A. Before loosening the vee belt (1), loosen the sheave retaining hex nut (4) on both generator (5) and starter adapter.

B. Cut the lockwire and loosen the three generator retaining bolts (6, 10, 15). Push the generator (5) inward. Remove the vee belt and upper retaining bolt (10).

C. Remove the two pivot bolts (6, 7), retaining hardware (8 thru 19), pull generator (5) free.

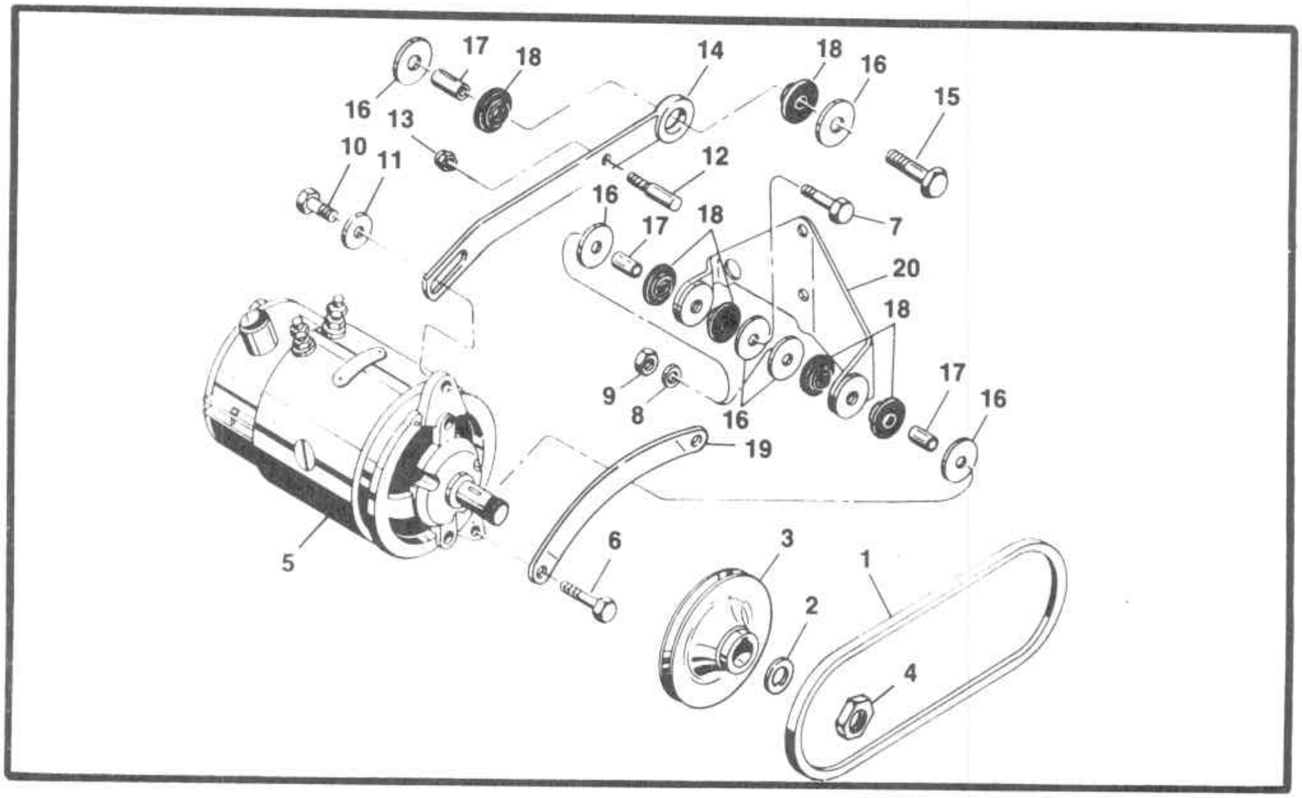

FIGURE 72-10-11A. GENERATOR (IO-470-C,D,E,F,G,H,J,K,L,N,P,R & S).

1. Belt, generator drive
2. Washer
3. Sheave
4. Nut, sheave
5. Generator
6. Bolt
7. Bolt
8. Washer, plain
9. Nut, plain hex
10. Bolt
11. Washer, special
12. Idler, kiss
13. Nut, elastic stop
14. Arm, generator adjusting
15. Bolt
16. Washer, special
17. Bushing
18. Bushing, rubber
19. Bushing, rubber
20. Bracket, generator mounting

72-10-11 GENERATOR IO-470-M (See Figure 72-10-11B).

A. Before loosening the vee belt (1), loosen the sheave retaining hex nut (4) on both generator (5) and starter adapter.

B. Cut the lockwire and loosen the three generator retaining bolts (6, 7, 11). Push the generator (5) inward. Remove the vee belt (1) and upper retaining bolt (11).

C. Remove the two pivot bolts (6, 7), retaining hardware (8 thru 21), and pull the generator (5) free.

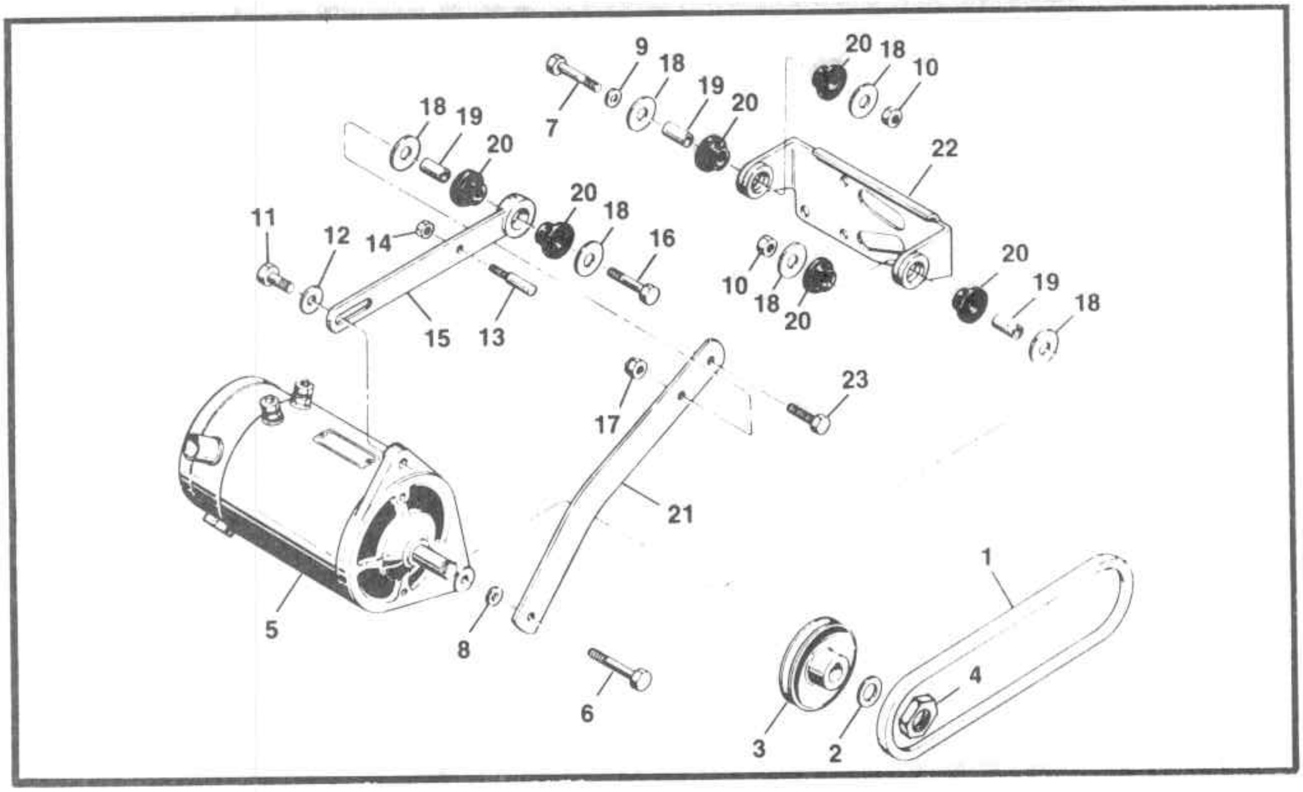

FIGURE 72-10-11B. GENERATOR (IO-470-M).

1. Belt, generator drive
2. Washer
3. Sheave, generator drive
4. Bolt
5. Generator
6. Bolt
7. Bolt
8. Washer, plain
9. Washer, plain
10. Nut, plain hex
11. Bolt
12. Washer, plain
13. Idler, kiss
14. Nut, elastic stop
15. Arm, generator adjusting
16. Bolt
17. Nut
18. Washer, special
19. Bushing
20. Bushing, rubber
21. Bracket, generator support
22. Bracket, generator mounting
23. Bolt

72-10-11 GENERATOR IO-470-U & V (See Figure 72-10-11C).

A. Before loosening the vee belt (1), loosen the sheave retaining hex nut (4) on both generator (5) and starter adapter.

B. Cut the lockwire and loosen the three generator retaining bolts (6, 7, 11). Push the generator (5) inward. Remove the vee belt and upper retaining bolt (11).

C. Remove the two pivot bolts (6, 7), retaining hardware (8 thru 21) and pull generator (5) free.

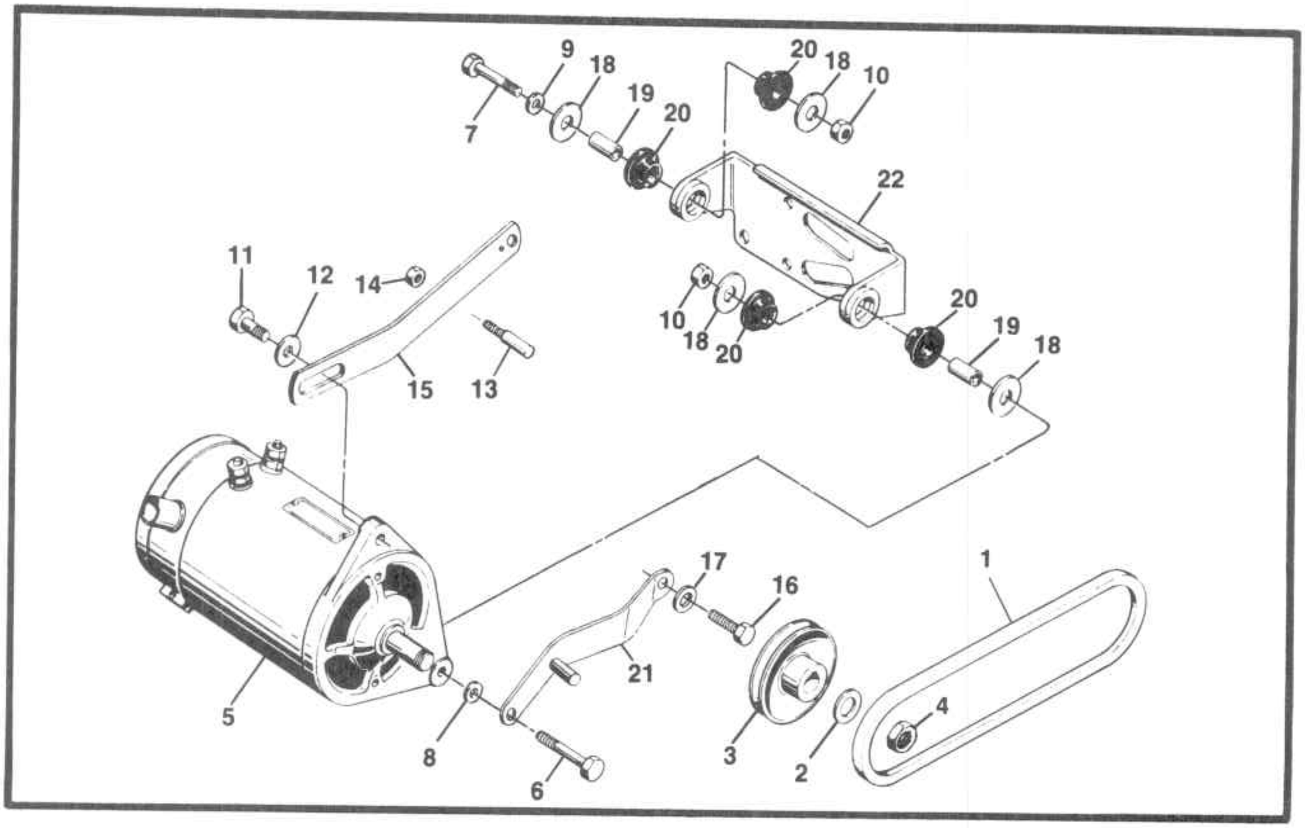

FIGURE 72-10-11C. GENERATOR (IO-470-U & V).

1. Belt, generator drive
2. Washer
3. Sheave, generator drive
4. Bolt
5. Generator
6. Bolt
7. Bolt
8. Washer, plain
9. Washer, plain
10. Nut, plain hex
11. Bolt
12. Washer, plain
13. Idler, kiss
14. Nut, elastic stop
15. Arm, generator adjusting
16. Bolt
17. Washer
18. Washer, special
19. Bushing
20. Bushing, rubber
21. Bracket, generator support
22. Bracket, generator mounting

72-10-11 ALTERNATOR (Optional) (See Figure 72-10-11).

A. Before loosening the vee belt (20), loosen the sheave retaining hex nut (21).

B. Remove lockwire and loosen two retaining nuts (13) and one bolt (9). Push alternator (1) inward and remove vee belt (20) and upper retaining bolt (9).

C. Remove two nuts (13), pivot bolt (5), washers (12), spacers (14) and alternator (1) from engine.

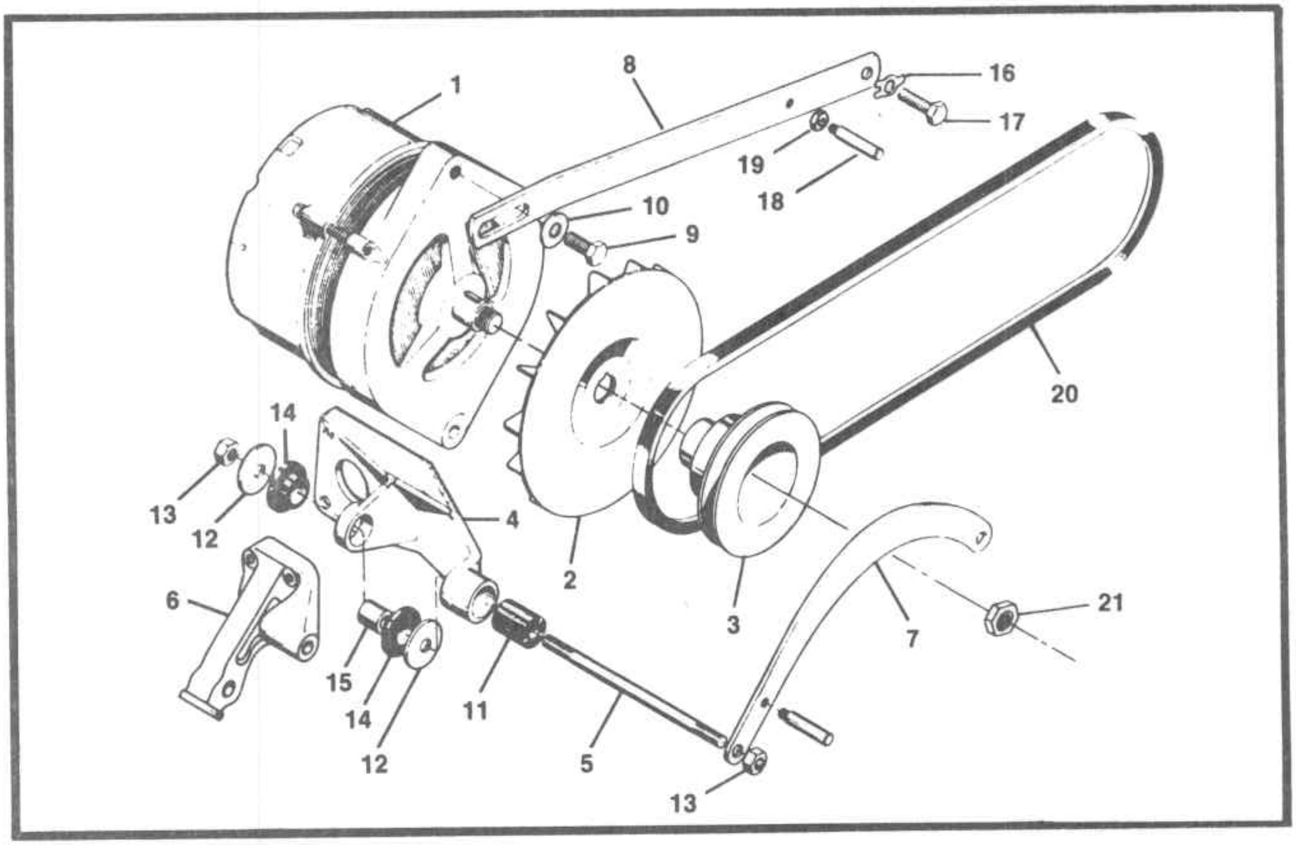

FIGURE 72-10-11. ALTERNATOR (OPTIONAL EQUIPMENT) ALL MODELS

1. Alternator
2. Fan, alternator
3. Sheave
4. Bracket
5. Pivot bolt
6. Engine Mount
7. Bracket
8. Bracket
9. Bolt
10. Washer
11. Bushing
12. Washer
13. Nut
14. Spacer
15. Bushing
16. Washer, tab
17. Screw
18. Idler, kiss
19. Nut, elastic stop
20. Belt
21. Nut, sheave retaining

INTENTIONALLY

LEFT

BLANK

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72-10-12 STARTER AND DRIVE ADAPTER ASSEMBLY (See Figure 72-10-12).

A. Remove the starter (3) and gasket (4).

B. Remove attaching bolts, nuts and washers, except the cover attaching bolts (5 & 19, Figure 72-10-12). Pull the adapter assembly off to the rear, and remove the gasket.

C. Start disassembly by removing nut (15).

D. Clamp the spur gear lightly in lead-shielded vise jaws while the nut is loosened.

E. Proceed in the order of index numbers, with the spur gear still clamped in the vise until the key (22) has been tapped out, the cover attaching parts (19 through 21) removed, and the cover assembly pulled from the gear shaft, carrying with it the sleeve (25).

F. Remove the retaining ring (27) with Truarc No. 3 or No. 23 pliers.

G. Use an arbor press and a round metal block of slightly smaller diameter than the hole to press out the oil seal (26).

H. To remove the shaftgear and clutch assembly from the adapter, support the rear side of the latter on blocks and tap the front end of the clutch spring (30) with a brass drift or (very carefully) with a pin punch all around.

I. Use a wheel puller or an arbor press to press the shaftgear (34) from the drum (33) and bearing (31) after removing the worm wheel.

J. To remove the clutch spring, clamp the drum flange between lead-shielded vise jaws. Remove the retaining screw (28) and washer (39). Rotate the spring until its depressed rear end lies across the upper 1/4 inch hole in the flange. Insert a 3/16 inch wide screwdriver blade, and pry the spring end outward clear of the drum groove. Hold it out while pulling the spring away.

K. To remove the worm and shaft assembly, clamp the adapter between shielded vise jaws. Use Truarc No. 5 or No. 25 pliers to remove the retaining ring (35). Using arbor press remove bearing (41) from adapter (43).

L. The worm gear may fit slightly tight on the sides of the key. Remove the Woodruff key (39) and the helical spring (37). If the ball bearing (38) is to be removed only to permit the Magnaflux inspection of the shaft, support its inner race on a sleeve with an inside diameter just large enough to clear the shaft flange, and press the shaft out. (Supporting on the outer race will damage the bearing).

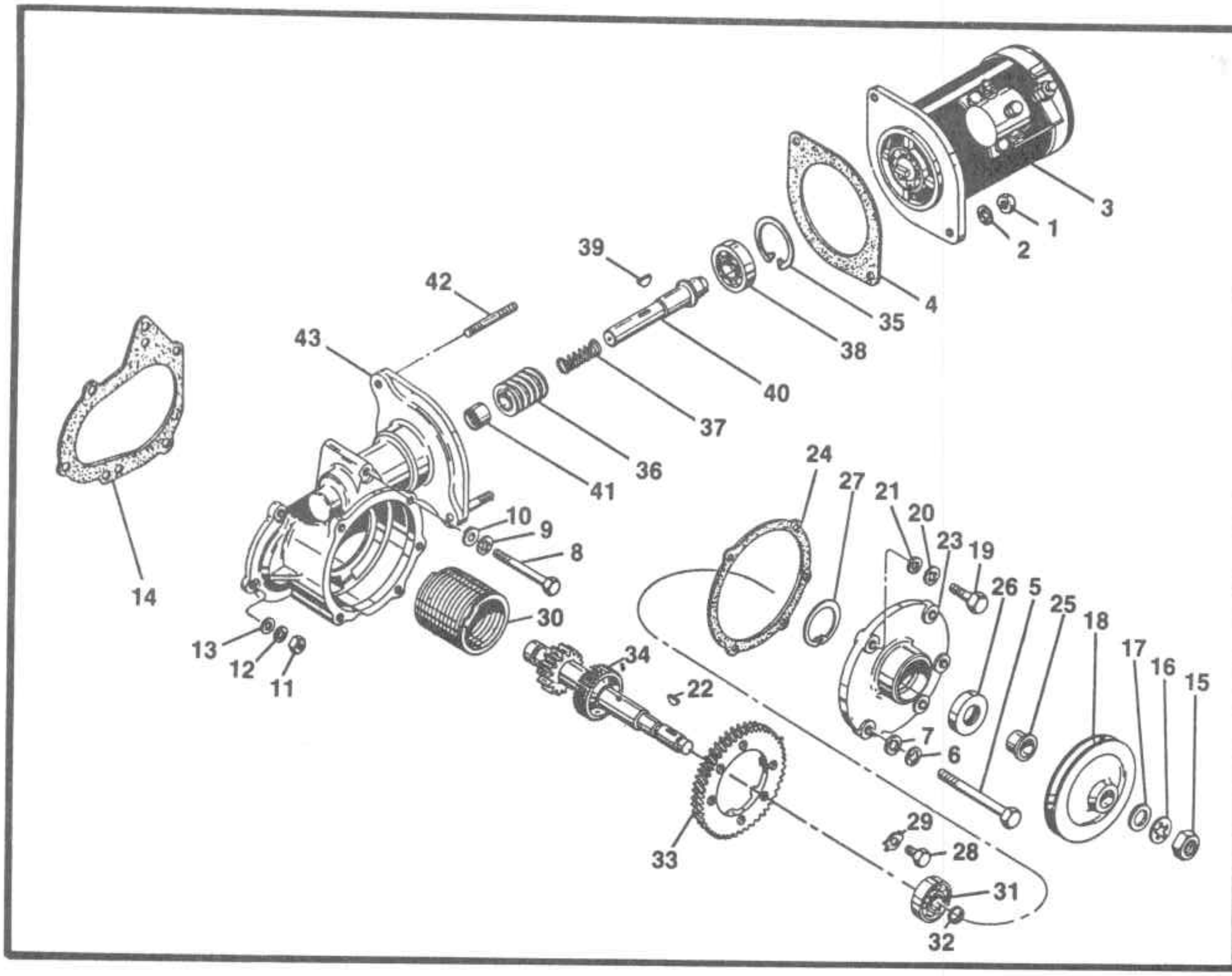

FIGURE 72-10-12. EXPLODED VIEW OF STARTER AND DRIVE ADAPTER.

1. Plain nut
2. Lockwasher
3. Starter
4. Gasket
5. Bolt, cover and adapter attaching
6. Lockwasher
7. Plain washer
8. Bolt, adapter attaching
9. Lockwasher
10. Plain washer
11. Plain nut
12. Lockwasher
13. Plain washer
14. Gasket
15. Plain nut
16. Lockwasher
17. Plain washer
18. Generator drive sheave
19. Bolt, cover
20. Lockwasher
21. Plain washer
22. Woodruff key
23. Cover
24. Gasket
25. Sleeve
26. Oil seal
27. Retaining ring
28. Bolt, spring retaining
29. Tab washer
30. Clutch spring
31. Bearing
32. O-ring
33. Starter worm wheel clutch drum
34. Starter shaft gear
35. Retaining ring
36. Starter worm gear
37. Spring
38. Bearing
39. Woodruff key
40. Worm drive shaft
41. Bearing
42. Stud
43. Adapter

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72–10–13 OIL PUMP ASSEMBLY (See Figure 72–10–13A & B).

A. Disconnect all lines, induction tubes, manifolds and accessories that may obstruct removal of the oil pump as a unit.

B. Loosen the oil filter cap (49 or 50) to facilitate later removal. Loosen the tachometer drive housing (10, Figure 72-10-13B) as applicable by turning its hex to the right.

C. Remove attaching hardware (2, 3, 4) from the crankcase-to-pump studs. Pulling pump assembly to the rear, remove pump (5) and gasket (1).

D. Remove oil filter (43 or 50) and gasket (51).

E. Remove attaching hardware (1, 2, 3, Figure 72-10-13B) and oil pump tach drive cover (41 or 42) as applicable.

F. Remove tach drive housing assembly, seal, gasket, thrust washer and tach drive shaft (items 4 thru 11, Figure 72-10-13B) from oil pump tach drive cover (41) or remove attaching hardware (20, 21, 22, 25, 26 27, Figure 72-10-13B, Tachometer Drive), covers, gaskets, oil seal and tach drive shaft (items 8, 19, 23, 24, 12 and 17, Figure 72-10-13B, Tachometer Drive) as applicable.

G. Remove gear assembly (37, 38, 39), oil pump driven gear assembly (35, 36), pressure relief valve (8 thru 16), (17 thru 22) or (23 thru 26) as applicable.

H. Remove filter bypass assembly (27 thru 30) or (31 thru 34) as applicable.

I. Remove plug (7) from oil pump housing.

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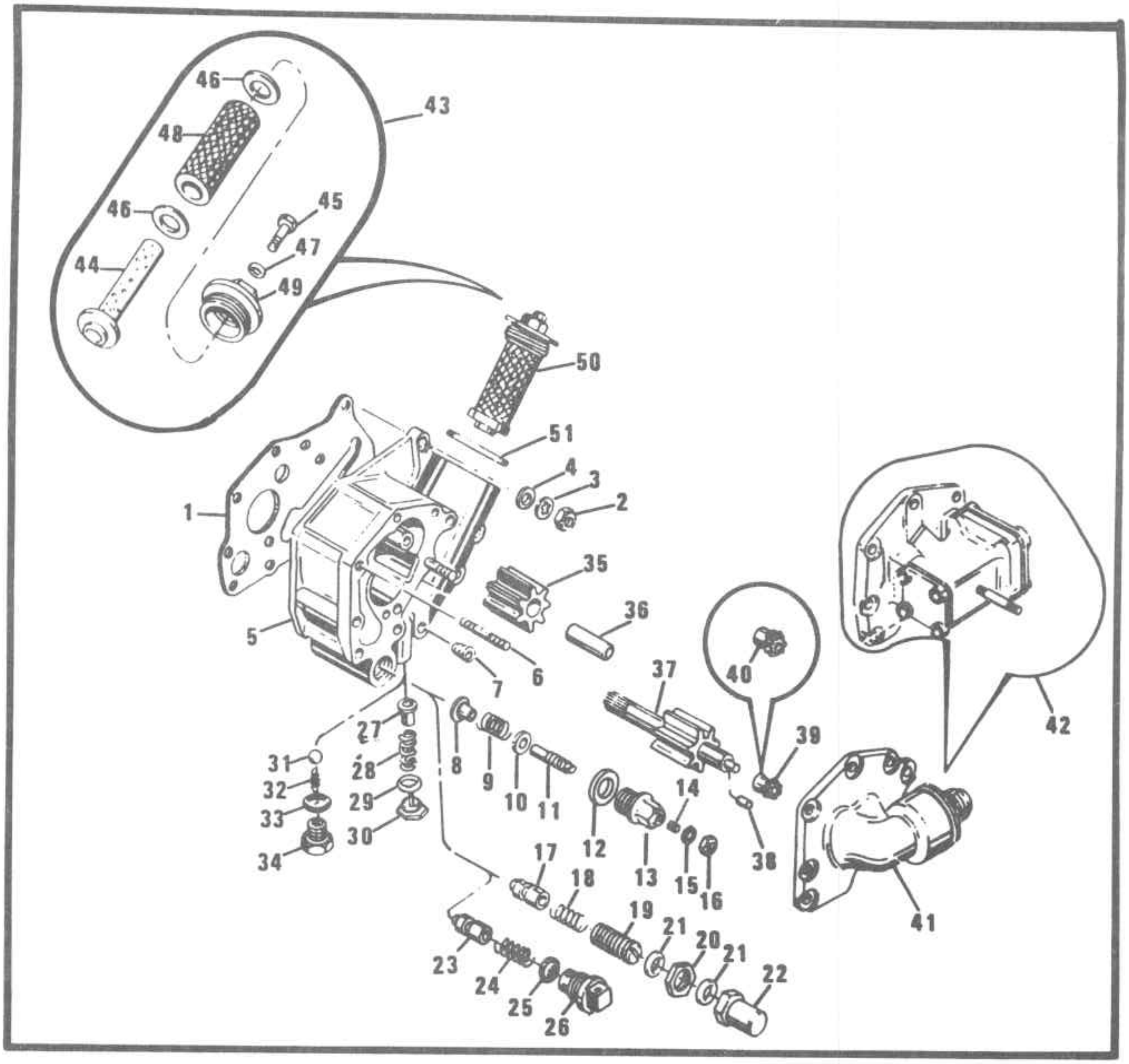

FIGURE 72-10-13A. OIL PUMP ASSEMBLY.

1. Gasket, oil pump housing
2. Nut, plain
3. Washer, lock
4. Washer, plain
5. Housing & shaft assembly
6. Stud
7. Plug
8. Plunger
9. Spring
10. Washer
11. Screw, adjusting
12. Gasket
13. Housing, relief valve
14. Insert
15. Gasket, copper
16. Nut, lock
17. Plunger
18. Spring, relief valve
19. Screw, adjusting
20. Nut, adjusting screw
21. Gasket
22. Cap, relief valve
23. Plunger, relief valve
24. Spring, relief valve
25. Gasket
26. Cap, relief valve
27. Valve, bypass
28. Spring, bypass
29. Gasket
30. Pin and plug assembly
31. Ball filter bypass
32. Spring, filter bypass
33. Gasket
34. Plug filter bypass
35. Gear
36. Bushing oil pump gear
37. Gear assy O/P and tach drive
38. Dowel
39. Gear bevel tach drive
40. Gear bevel tach drive
41. Cover, oil pump mech. tach
42. Cover, oil pump ele. tach
43. Filter, oil
44. Tube, perforated
45. Bolt, drilled hex head
46. Washer
47. Gasket, felt
48. Element filter
49. Body casting filter
50. Screen assembly, oil
51. Gasket, annular

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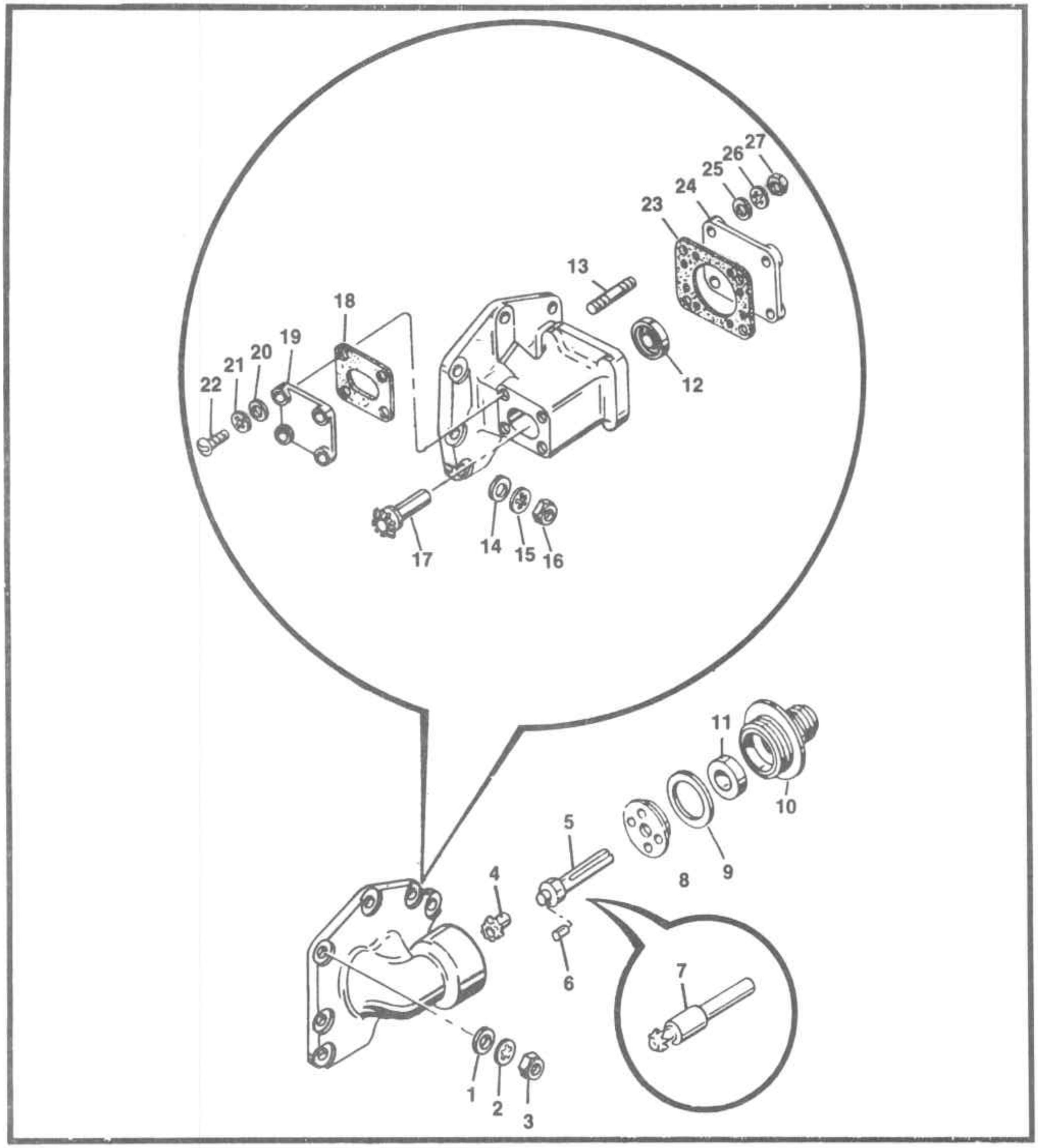

FIGURE 72-10-13B. OIL PUMP COVER AND TACHOMETER DRIVE.

1. Washer, plain
2. Washer, lock
3. Nut, plain
4. Gear, bevel
5. Shaft
6. Dowel
7. Shaft & Gear Assembly
8. Washer, thrust
9. Gasket, annular
10. Housing assembly, tach
11. Seal, oil
12. Seal, oil
13. Stud
14. Washer, plain
15. Washer, lock
16. Nut, plain
17. Gear, bevel tach drive
18. Gasket
19. Cover, tach gear box
20. Washer, plain
21. Washer, lock
22. Screw
23. Gasket
24. Cover, tach drive pad
25. Washer, plain
26. Washer, lock
27. Nut, plain

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72-10-14 CYLINDERS (See Figures 72-10-14 Inclined Valve or 72-10-14 Straight Valve).

BALANCE AND CYLINDER INTAKE TUBES (See Figure 72-10-06).

A. Prior to cylinder removal the intake and balance tubes should be removed.

B. Invert the engine, loosen and remove all hose clamps on the intake tube connecting hoses.

C. If not already accomplished, remove balance tube attaching hardware and brackets.

D. Remove balance tube.

E. On inclined valve cylinders remove 24 sets of intake tube- to- cylinder attaching parts. On straight valve cylinders remove 12 sets of intake tube- to- cylinder attaching parts.

F. Detach intake tubes from cylinders and discard gaskets. Cylinders may now be removed.

G. Remove the oil dipstick and six sets of rocker cover attaching hardware (31, 32, 33, Figure 72-10-14, Inclined Valve) or (29, 30, 31, Figure 72-10-14, Straight Valve). Using a rubber mallet, gently tap and remove the rocker covers (30, Figure 72-10-14A) or (28, Figure 72-10-14B).

H. Turn the crankshaft until the lifters of the cylinder being removed are on the heels of the cam lobes.

I. Remove the rocker shaft retaining bolt (28, Figure 72-10-14A) or bolts (19, Figure 72-10-14B) as applicable.

J. While holding the lower ends of both rockers inward (21, 24, Figure ;72-10-14A) or (22, 25, 72-10-14B), push the rocker shafts (20, Figure 72-10-14A) or shaft (18, Figure 72-10-14B) as applicable out to free the rockers and remove them. Withdraw both pushrods (39, Figure 72-10-14A) or (40, Figure 72-10-14B). Repeat the process on the other cylinders.

K. To remove each pushrod housing (38), push it toward the crankcase against its spring (37, Figure 72-10-14A) or (39, Figure 72-10-14B) until the outer end is clear of the cylinder hole, lift the outer end away from cylinder and remove housing, spring, steel washers and seal. A spring compressor that may assist pushrod housing removal can be purchased from Burroughs Tool Corporation (See Tool Section, Chapter 1 for details).

L. After all pushrod housings have been removed, lift out all intercylinder baffles; then push out and remove all hydraulic lifters. It is recommended that all hydraulic lifters be replaced at each major overhaul regardless of condition.

M. While the engine remains in the inverted position, remove the base nuts from the attaching studs and the through bolt on the sump side of the cylinder base flange.

N. Turn the engine to the upright position.

NOTE . . . As pistons and cylinders are being removed the piston to cylinder position should be checked and recorded to insure that piston is placed back in cylinder in same position at engine assembly. Pistons have a raised part no. on one side of the piston pin boss this number can be recorded as either forward or aft as applicable. Example: cylinder no. 4 piston P/N aft.

O. Turn the crankshaft until piston in cylinder being removed is at top dead center. Remove the base nuts from the three top attaching studs and through bolt. Cradle the cylinder in either arm, and withdraw it straight. Catch the piston with the other hand as the cylinder skirt comes off, and lower it carefully. Remove piston pin (47 or 48) and piston (43) with rings (44, 45, 46, 47) as an assembly. Remove rings (44, 45, 46 & 47) from piston (43). Be careful not to score piston with ring ends.

P. Remove the rubber seal rings (41 or 42) from all cylinder skirts.

Q. Use of a cylindrical wood block anchored to a workbench, with provisions for clamping the cylinder in place, is recommended to aid in the removal of the valve springs and to prevent dropping of the valves.

R. If the rocker shaft was removed, push it back into the cylinder head supports, and use it as a fulcrum for a lever-type spring compressor unless an arbor-type valve spring compressing stand is available.

S. Compress the valve springs with force applied at diametrically opposite points on the outer spring retainers, in turn, taking care not to allow the retainers to score the valve stems due to cocking. While each pair of springs is depressed, remove the two stem-locking keys from the retainer hole; then release pressure and lift out the outer retainer, springs, and inner retainer.

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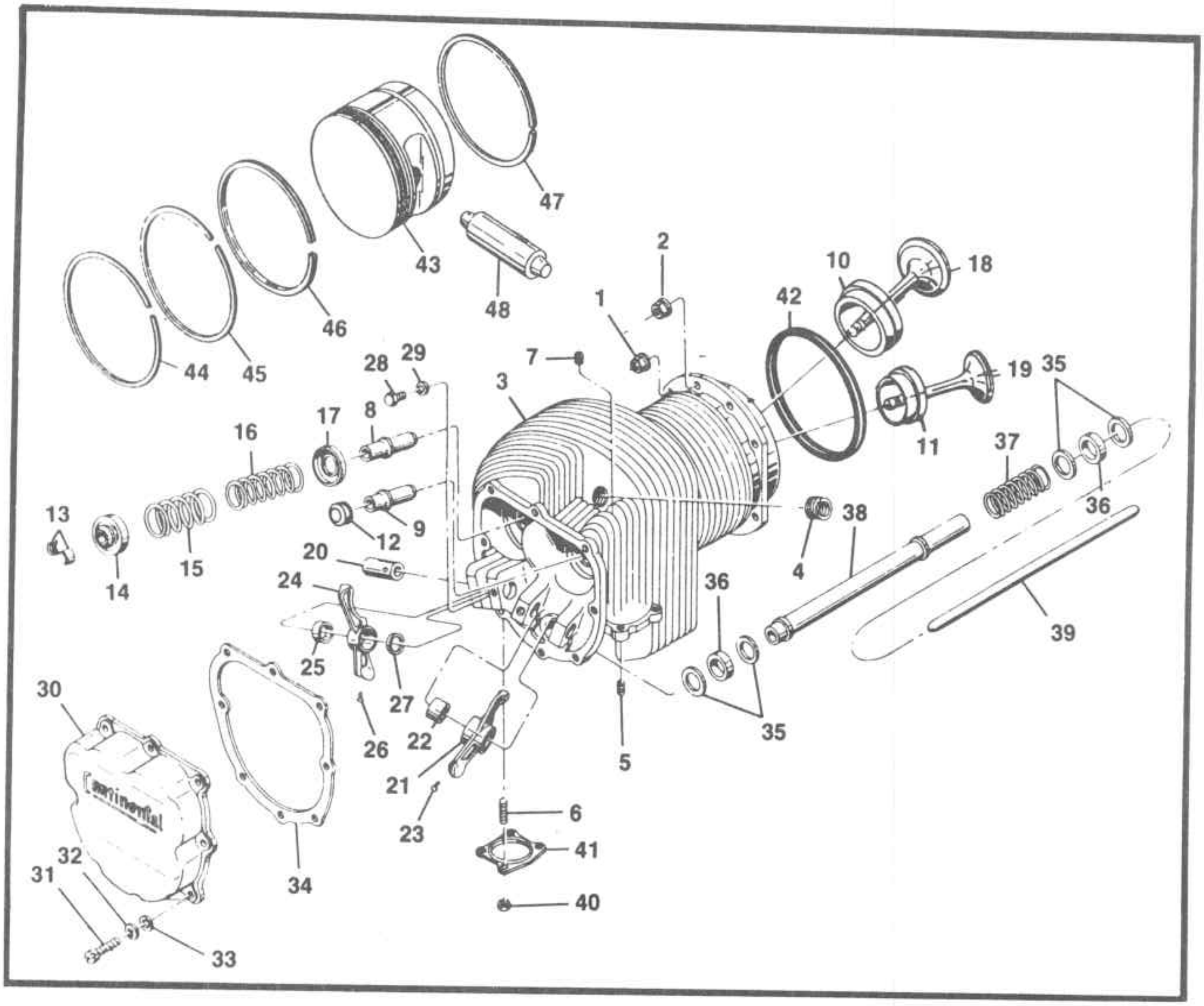

FIGURE 72-10-14A. CYLINDER ASSEMBLY (INCLINED VALVE)
ALL EXCEPT IO-470-J & K

1. Nut flanged
2. Nut flanged
3. Cylinder assembly
4. Insert spark plug
5. Insert
6. Stud
7. Plug
8. Guide, exhaust valve
9. Guide, intake valve
10. Seat, intake valve
11. Seat, exhaust valve
12. Seal assy., valve guide intake
13. Key, valve spring retainer
14. Rotocoil
15. Spring, outer
16. Spring, inner
17. Retainer, valve spring inner
18. Valve, intake
19. Valve, exhaust
20. Shaft valve rocker
21. Rocker assembly, intake
22. Bushing
23. Screw
24. Rocker assembly, exhaust
25. Bushing
26. Screw
27. Washer, thrust
28. Screw
29. Washer, plain
30. Cover, rocker
31. Screw
32. Washer, lock
33. Washer, plain
34. Gasket rocker cover
35. Washer pushrod housing
36. Packing pushrod housing
37. Spring pushrod housing
38. Housing pushrod
39. Pushrod
40. Nut
41. Gasket, exhaust flange
42. Packing, cylinder-to-crankcase
43. Piston
44. Ring, 1st groove
45. Ring, 2nd groove
46. Ring, 3rd groove
47. Ring, 4th groove
48. Pin, piston

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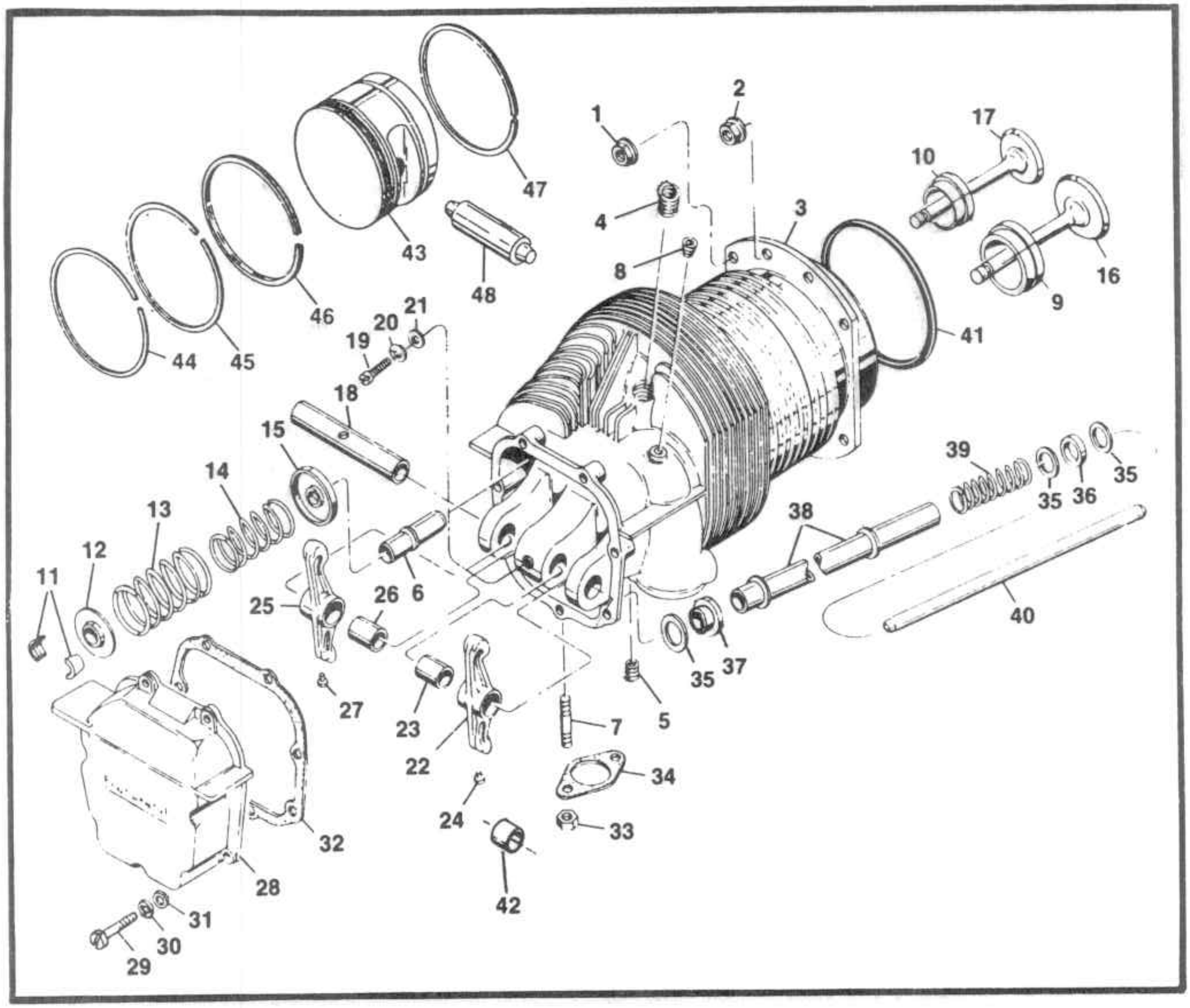

FIGURE 72-10-14B. CYLINDER ASSEMBLY (STRAIGHT VALVE) IO-470-J,K.

1. Nut, flanged
2. Nut, flanged
3. Cylinder assembly
4. Insert, spark plug
5. Insert, intake flange
6. Guide, intake, exhaust
7. Stud
8. Plug
9. Seat, exhaust valve
10. Seat, exhaust valve
11. Key, valve spring retainer
12. Rotocoil
13. Spring, valve, outer
14. Spring, valve, inner
15. Retainer, valve spring
16. Valve, intake
17. Valve, exhaust
18. Shaft, valve rocker
19. Screw
20. Washer, lock
21. Washer, plain
22. Rocker assembly, intake
23. Bushing
24. Screw
25. Rocker assembly, exhaust
26. Bushing, rocker
27. Screw
28. Cover, rocker
29. Screw
30. Washer, lock
31. Washer, plain
32. Gasket, rocker cover
33. Nut
34. Gasket, exhaust flange
35. Washer, pushrod housing
36. Packing, pushrod housing
37. Packing, pushrod housing
38. Housing, pushrod
39. Spring, pushrod housing
40. Pushrod
41. Packing, cylinder-to-crankcase
42. Bushing
43. Piston
44. Ring, 1st groove
45. Ring, 2nd groove
46. Ring, 3rd groove
47. Ring, 4th groove
48. Pin, piston

INTENTIONALLY

LEFT

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72-10-15 CRANKCASE. (See Figure 72-10-15A,B & C).

A. OIL FILLER NECK. Some early production model engines have a tubular filler neck pressed into a bored boss. On current models remove three screws, lockwashers and the oil filler neck located between No. 4 and No. 6 cylinders.

B. Turn the engine bed so that the left crankcase will be downward and support it with a 1/2 inch pipe, as illustrated in Figure 72-10-15B.

C. Detach the right engine mount brackets from the assembly stand.

D. Remove the attaching parts and attached parts (1 through 25) in the ascending order of index numbers.

E. With a nonmarring hammer, tap the upper ends of the right through bolts (34, 35, 36, 37) and pull them downward and out. Remove and discard gaskets (71).

F. Detach the idler gear support pin (29) and hold the idler gear (38) while the pin is withdrawn; then lower it to rest in the left crankcase. Remove and discard gasket (30).

G. Lift off the right crankcase subassembly.

H. Lift out the camshaft assembly, and remove the governor driver bevel gear. Lift out the governor driven gear, the idler gear assembly, then the assembly of crankshaft, connecting rods, gears and oil seal.

I. Detach the left engine mount brackets from the assembly stand, and lift off the left crankcase subassembly.

NOTE . . . Do not remove the upper flange attaching bolt and washer (69). These two parts are installed before the nearest magneto attaching stud and cannot be removed before removal of that stud without damaging the crankcase hole. Take care to avoid damage to the hole thread during subsequent overhaul operations.

J. Detach and remove from the left crankcase the parts numbered (46 through 56) with the exception of the three 3/8 in. pipe plugs.

K. Rotate and lift out of the right crankcase the main and thrust bearing inserts (39, 40) installed there. Discard all main and thrust bearing inserts and thrust washers from both crankcase subassemblies.

L. Unscrew the oil temperature control valve (65) and the straight thread plugs from the right crankcase. The four 3/8 inch socket-head pipe plugs need not be removed from the right crankcase.

M. Removal of engine mount brackets and attaching parts (45) from either crankcase casting is optional and dependent on the nature of repair operations to be performed.

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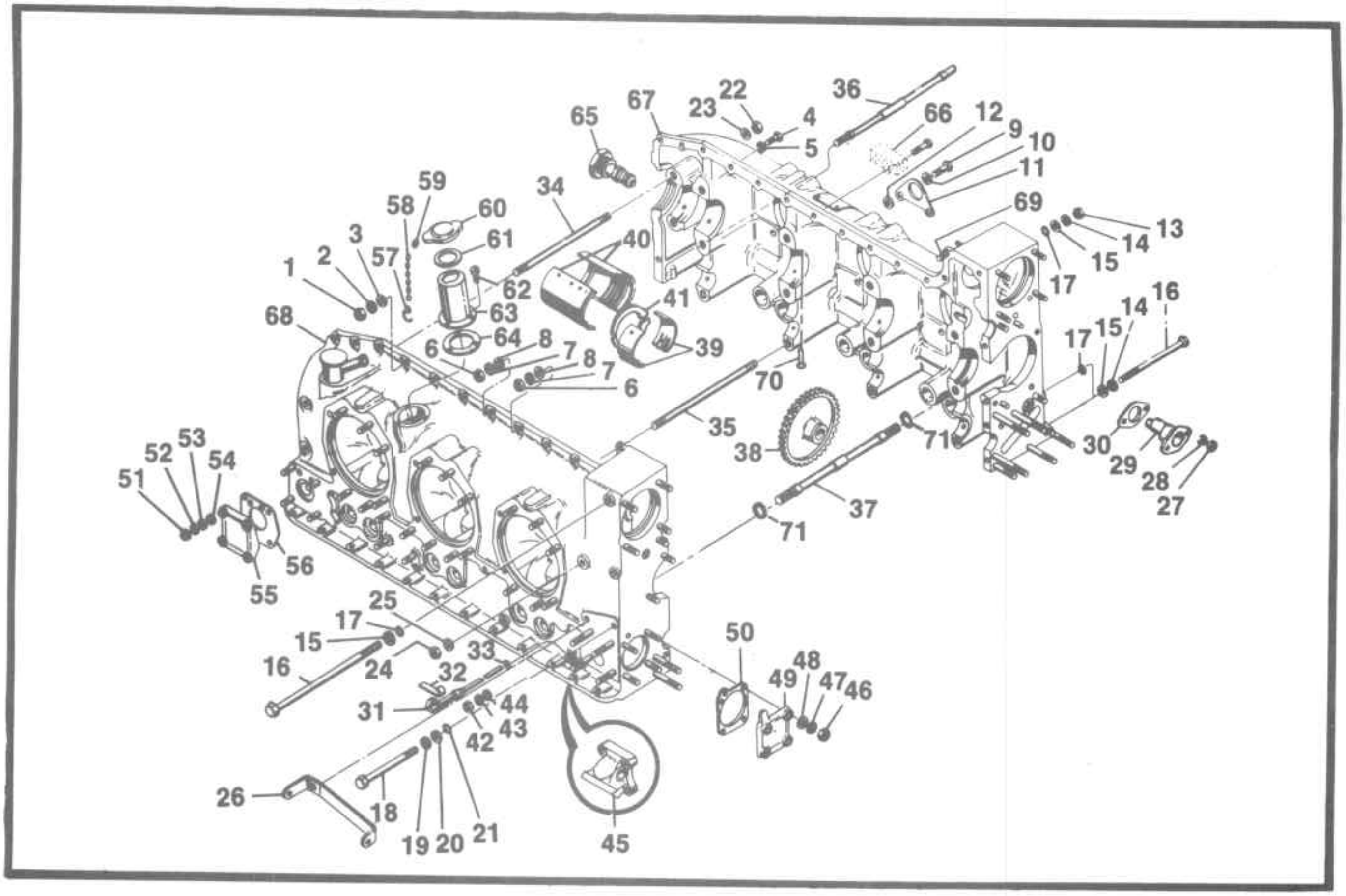

FIGURE 72-10-15A. CRANKCASE ASSEMBLY.

1. Plain hex nut
2. Lockwasher
3. Plain washer
4. Hex-head bolt
5. Plain washer
6. Plain hex nut
7. Lockwasher
8. Plain washer
9. Hex-head bolt
10. Lockwasher
11. Lifting eye
12. Spacer
13. Plain hex nut
14. Lockwasher
15. Plain washer
16. Hex-head bolt
17. O-ring packing
18. Hex-head bolt
19. Lockwasher
20. Plain washer
21. O-ring packing
22. Flanged nut
23. Plain washer
24. Flanged nut
25. Plain washer
26. Generator mount bracket
27. Plain hex nut
28. Lockwasher
29. Idler gear support pin
30. Gasket
31. Oil gage rod
32. Identification band
33. O-ring packing
34. Through bolt
35. Through bolt
36. Through bolt
37. Through bolt
38. Idler gear assembly
39. Crankshaft main bearing
40. Crankshaft thrust bearing
41. Thrust washer
42. Plain hex nut
43. Lockwasher
44. Plain washer
45. Mount bracket
46. Plain hex nut
47. Lockwasher
48. Plain washer
49. Fuel pump pad cover
50. Fuel pump pad gasket
51. Plain hex nut
52. Lockwasher
53. Plain washer
54. Spacer
55. Governor pad cover
56. Governor pad gasket
57. Oil cap retainer ring
58. Oil cap retainer chain
59. Retainer ring
60. Oil filler cap
61. Oil filler cap gasket
62. Screw
63. Oil filler neck
64. Oil filler neck gasket
65. Vernatherm valve
66. Primer distributor
67. Right crankcase
68. Left crankcase
69. Bolt
70. Nozzle, squirt
71. O-rings

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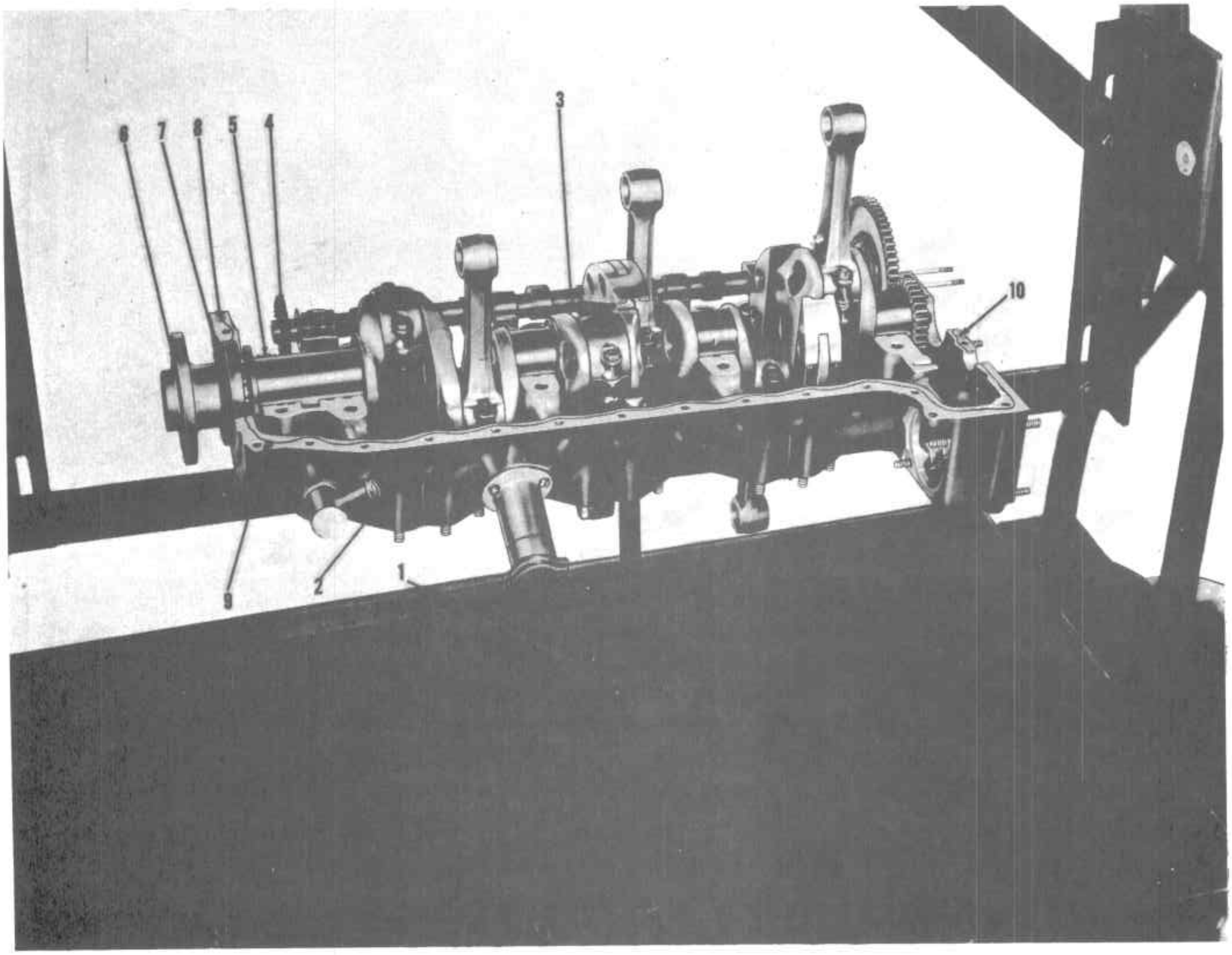

FIGURE 72-10-15B. LEFT CRANKCASE AND SHAFTS SUPPORTED FOR DISMANTLING OR FINAL ASSEMBLY.

1. 1/2 inch iron pipe of suitable length
2. Left crankcase with parting flange horizontal
3. Camshaft assembly
4. Governor driver bevel gear
5. Governor driven bevel gear and shaft assembly
6. Crankshaft, connecting rods and gear assembly
7. No. 50 silk thread on front parting flange below crankshaft
8. No. 50 silk thread on upper parting flange
9. No. 50 silk thread on rear parting flange between crankshaft and idler gear support pin holes

NOTE . . . Refer to Chapter 70 Standard Practices for crankcase threading procedure.

72-10-15 CRANKCASE AND CRANKSHAFT EXTENSION, IO-470-P (See Figure 72-10-15).

A. The IO-470-P crankcase assembly is similar to the basic O-470 crankcase assembly except the IO-470-P crankcase utilizes a crankshaft extension and housing assembly.

B. **REMOVAL.** Using a spanner wrench, remove bearing retainer nut (1). Remove attaching parts (2, 3 and 4) and bracket (5); then remove attaching parts (6 and 7) to pull extension housing (8) off of shaft (12). Store extension housing on wooden bench or rack so as not to damage parting flanges as this would effect the critical alignment procedures listed in reassembly and installation. Remove attaching parts (10 and 11) and pull crankshaft extension (12). To remove adapter (16), remove attaching parts (14 and 15) withdraw the adapter from crankcase. Use equally as much caution in storing and handling the adapter (16) as the housing (8).

C. **DISASSEMBLY.** To disassemble the housing (8) remove attaching parts (20, 21 and 22) pull cover (24). Use round block of slightly smaller diameter than the seal housing seat and press seal out of cover (24). Remove and discard O-ring (26) lift out bearing and spacer (27 and 28). Do not disassemble housing (8), adapter (16) or shaft (12) any further unless necessary.

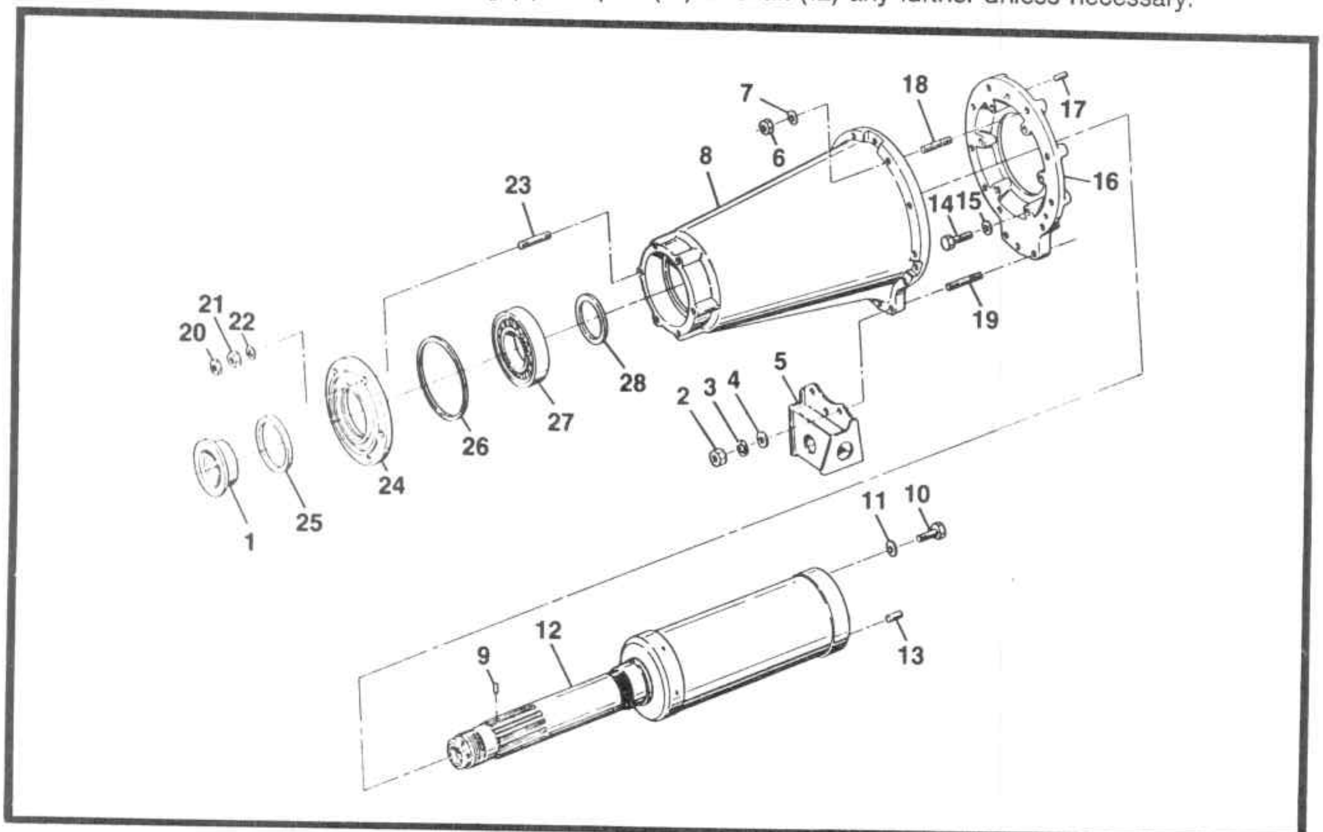

FIGURE 72-10-15C. CRANKCASE AND CRANKSHAFT EXTENSION (IO-470-P).

1. Nut, bearing retainer
2. Nut, hex
3. Washer, lock
4. Washer, plain
5. Bracket assembly
6. Nut, hex
7. Washer, plain
8. Housing
9. Screw, special
10. Bolt, hex head
11. Washer, plain
12. Crankshaft, ext. assy.
13. Dowel
14. Bolt, hex
15. Washer, plain
16. Adapter
17. Dowel
18. Stud
19. Stud
20. Palnut
21. Nut, hex
22. Washer, plain
23. Stud
24. Cover
25. Seal
26. O-ring
27. Bearing, roller
28. Ring, spacer

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72-10-16 CAMSHAFT ASSEMBLY (See Figure 72-10-16).

A. Remove governor drive gear (2) and Woodruff key (3).

B. Remove four screws (4) and camshaft gear (5).

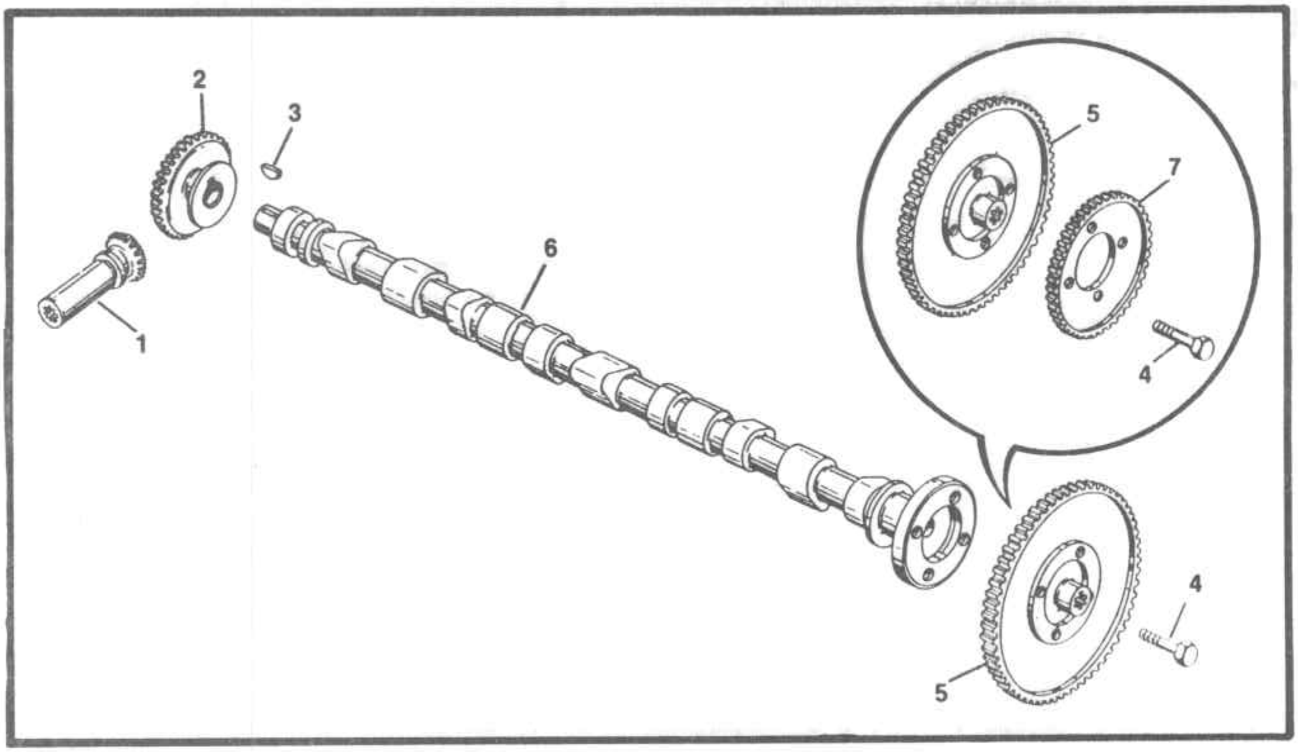

FIGURE 72-10-16. CAMSHAFT ASSEMBLY.

1. Gear, Governor Driven
2. Gear, Governor Drive
3. Key, Woodruff
4. Bolt
5. Gear, camshaft
6. Camshaft
7. Camshaft cluster gear

72-10-17 CRANKSHAFT (See Figure 72-10-17).

A. Crankshaft supports can be made by sawing a vee notch in the short side of each of two 2 x 4 x 10 in. wood blocks. Stand these edgewise on the bench, and lay the front and rear shaft journals in the notches.

B. Detach and remove the connecting rods. Rotate and remove their crankpin bearing inserts. Loosely reassemble the rods, cap bolts and nuts with position numbers matched.

C. With Truarc No. 1 or No. 21 pliers, compress the internal retaining rings; then remove the retaining plates and pins from the counterweights, and take the counterweights from the shaft.

D. Remove lock wires and six gear attaching screws and remove the crankshaft gear.

E. Lift the spring from the oil seal and unhook its ends. Twist and remove the rubber seal ring from the shaft.

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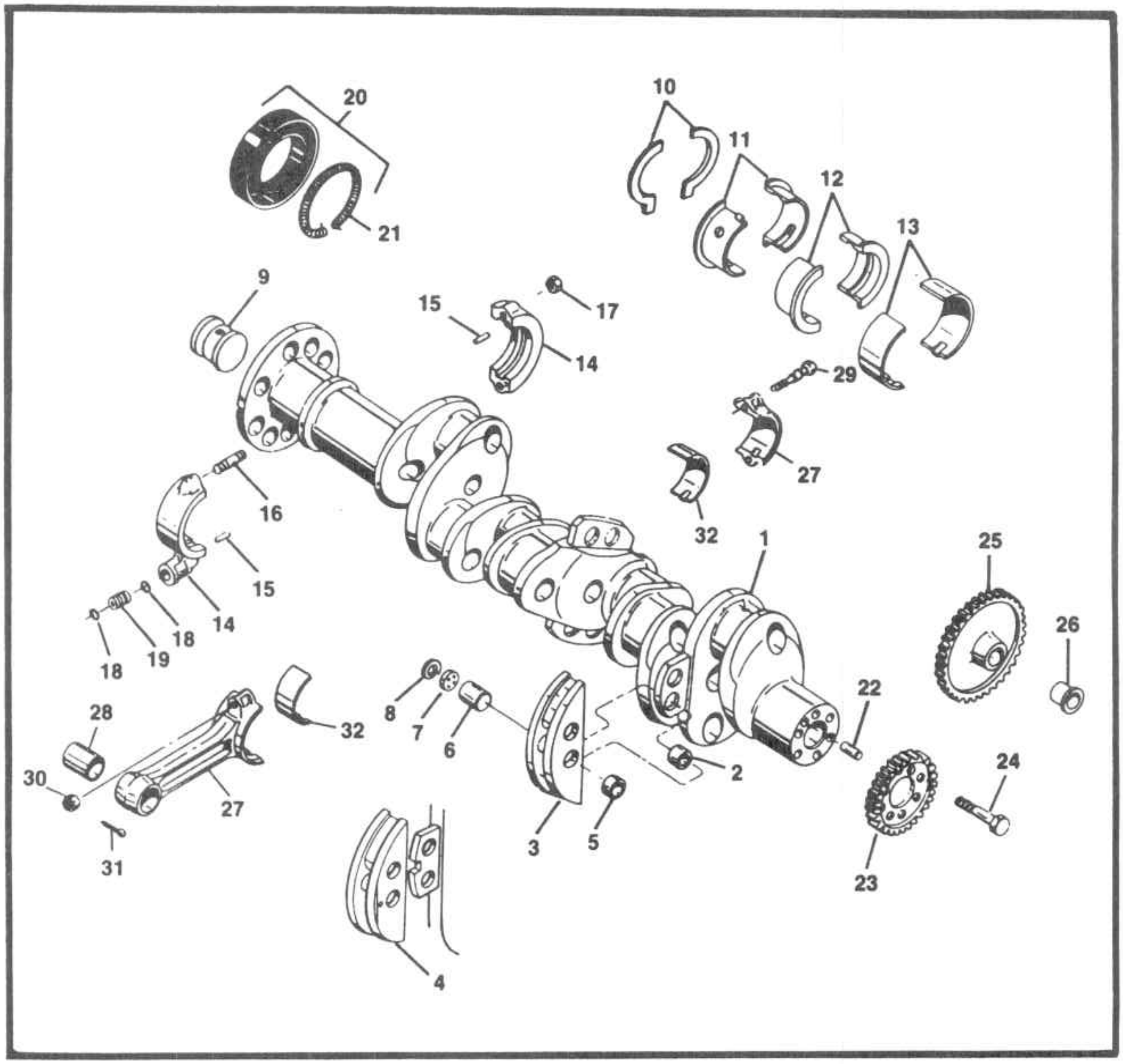

FIGURE 72-10-17. CRANKSHAFT ASSEMBLY.

1. Crankshaft and damper assy.
2. Bushing, damper
3. Counterweight assembly
4. Counterweight assembly
5. Bushing, counterweight
6. Pin
7. Plate
8. Snap ring
9. Plug, oil control
10. Washer, thrust
11. Bearing, main flanged
12. Bearing, main flanged
13. Bearing, main
14. Collar assembly
15. Dowel
16. Stud
17. Nut, Marsden, lock
18. O-ring
19. Sleeve
20. Seal assembly, oil
21. Spring, oil seal
22. Dowel
23. Gear, crankshaft
24. Screw, drilled hex
25. Gear assembly, idler
26. Bushing, idler gear
27. Connecting rod
28. Bushing
29. Bolt
30. Nut, slotted
31. Pin, cotter
32. Bearing, connecting rod

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72-10-18 EXHAUST SYSTEMS.

A. Exhaust systems for the IO-470 Sereis engines are supplied by the airframe manufacturer. For maintenance procedures refer to the applicable airframe manufacturer's instructions.

SECTION 72-20
CLEANING, REPAIR AND REPLACEMENT

INTENTIONALLY

LEFT

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72-20-00 CLEANING, REPAIR AND REPLACEMENT.

NOTE . . . It is recommended that all parts listed in Section 1-00-04, 100% Replacement Parts be replaced during major engine overhaul regardless of condition.

72-20-01 GENERAL.

Aluminum alloy parts can be degreased by spraying or brushing with any fortified mineral spirit solvent. Heavy grease or dirt deposits can be cleaned effectively by allowing parts to soak in this solvent for a short time. Carbon deposits and gum (oil varnish) may be removed easily by immersing these parts in a hot bath of an inhibited, **mild** alkaline cleaning compound. **Immersion time should be only as long as necessary to remove the deposits.** Carbon solvent should be employed only when carbon deposits are too hard or thick for removal by other solvents. Give speical attention to cleaning studs, tapped holes and drilled holes. Caution must be exercised in cleaning of all aluminum alloy engine parts. Immediately after removing soaked parts from inhibited, mild alkaline bath or hot soapy water, remove all traces of the alkaline by spraying the parts with a jet of steam or brush vigorously with a mineral spirit solvent. Cleaned parts may be dried by a jet of dry, compressed air to remove all solvent liquids.

CAUTION . . . All alkaline residues must be removed from crevices, recesses and holes to prevent the formation of a foaming emulsion in the engine lubricating oil after reassembly. If accelagold surface was removed by cleaning process, re-apply accelagold according to procedure listed in figure 72-30-12.

No polishing compound, abrasive paste, or powder is needed for cleaning engine parts. Scraping and abrasion with wire brushes, sandpaper, abrasive cloth, and buffing wheels are dangerous methods to use on soft metals like aluminum. Scratches resulting from such methods allow concetrated stress at the scratch and may cause fatigue failure.

Blasting techniques can be employed to remove hard carbon deposits if suitable equipment is available. Suitable types of grit for dry blasting are plastic pellets and processed natural materials, such as wheat grains and crushed fruit pits or shells. Air pressure should be the lowest that will produce the desired cleaning action. Small holes and finished surfaces which do not require cleaning should be protected from the blast by seals and covers, particularly if the grit is sharp. Sand, shot, metal grit and glass beads are too abrasive and too heavy for use on soft metals like aluminum, and must not be used.

CAUTION . . . After any blasting process, blow off all dust with dry compressed air and make sure that no grit has lodged in crevices, recesses and holes. Parts may also be cleaned with hot soapy water, then air dried with dry compressed air.

72-20-02 CYLINDERS. Precautions applicable to both aluminum and steel must be exercised in cleaning and storing these assemblies. Remove oil and loose material with a mild alkaline cleaner by spraying or brushing. If stubborn deposits of carbon remain on cylinder heads, the areas affected may be vapor blasted. All machined surfaces must be protected from abrasive action during the blasting operation.

72-20-03 PISTONS. Do not use wire brushes or scrapers of any kind. Soft or hard carbon deposits may yield to solvent action. If deposits remain, blast the piston heads with soft grit or by the vapor grit method, first having installed tight fitting skirt protectors, 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 groove scrapers, since the corner radii at the bottoms of the grooves and side clearances must not be altered.

It is unnecessary to remove discoloration and light scoring from piston skirts. The use of abrasive cloth on the skirts is not recommended because the diameters and cam-ground contour must not be altered. Heavily scored or burned pistons should be discarded, and it is recommended that pistons be replaced during major engine overhaul regardless of condition.

Honing of cylinder walls for any reason is justification for complete piston ring replacement.

72-20-04 **VALVES.** After degreasing intake valves, inspect them and discard any whose head is warped excessively, or insufficient stock to permit refacing within specified limits, or whose stem is burned, scored, eroded or nicked. Carbon deposits may be loosened by solvent action, or they may be scraped off while the valve is rotated in a polishing head or lathe collet. Apply crocus cloth moistened in mineral spirit, and polish the stems with dry crocus cloth. Replacement of exhaust valves is recommended at major overhaul regardless of condition.

72-20-05 **ROCKER SHAFTS.** Degrease these parts by brushing on mineral spirit solvent. Prior to magnetic inspection, polish the steel bearing surfaces with crocus cloth moistened with kerosene, then with dry crocus cloth.

72-20-06 **PUSHRODS, VALVE ROCKERS AND SMALL STEEL PARTS.** Degrease these parts with mineral spirit solvent. Give special attention to removal of sludge from all oil passages. Blow compressed air through pushrod.

72-20-07 **CAMSHAFT AND CRANKSHAFT.** All parts must be degreased by brushing or spraying with mineral spirit solvent. Give particular attention to threads, oil holes and recesses. Before magnetic inspection, the crankpins, main journals, oil seal race of the crankshaft and all journals, cam lobes and gear mount flange of the camshaft must be smoothed with crocus cloth moistened in mineral spirits. This is to be accomplished while shaft is rotated in a high speed lathe, (about 100 RPM). All gum (varnish) deposits must be removed to permit reliable magnetic indications. Ultrasonic inspect crankshaft per TCM Service Bulletin M81-2R1 or current revision as applicable.

72-20-08 **CRANKCASE.** The oil passages must be pressure-flushed with mineral spirit solvent and inspected with the aid of a flashlight. If the castings are immersed in an alkaline bath, it is strongly recommended that this treatment be followed by spraying with steam, followed by flushing the oil passages with solvent. After the castings dry, inspect them thoroughly for alkaline residues, and remove any traces of scum.

72-20-09 **GEARS.** Gears without bushings are freed of hard deposits by immersion in a caustic stripping bath when cold solvents are not effective. Bushings are discolored by this treatment; therefore, bushed gears must be cleaned by other methods. Spray or brush with a mineral spirit solvent using a brass wire brush.

CAUTION . . . Do not pressure blast gears; blasting will remove "Tufftride" hardener.

72-20-10 **SHEET METAL PARTS AND INTAKE MANIFOLD.** Clean these parts by spraying or brushing with mineral spirit solvent, or use a cold emulsion type cleaner and flush with water to rinse.

Immediately after cleaning bare steel parts spray or dip them in clean engine oil, or for longer storage in a corrosion-preventive oil mixture. Wrap ball bearings in waxed paper. Wrap or cover other clean parts to protect them from abrasive dust in the air.

72-20-11 **CASTINGS.** Remove the raised edges of nicks in machined surfaces with a hard Arkansas stone. Unobstructed flat surfaces, such as valve-rocker cover flanges, may be returned to true flatness by lapping with a true lap plate. Use fine grade lapping compound and move the casting in a figure 8 stroke without rocking it.

Gasket surfaces must be thoroughly cleaned with a suitable hydrocarbon solvent such as naptha, Methyl Ethyl Ketone (MEK) or Trichloroethylene (TCE), to remove dirt, oil and grease. Wipe surfaces dry before gasket is applied.

72-20-12 **STUD REPLACEMENT.** Remove damaged whole studs with a standard pattern stud remover or a small pipe wrench, turning slowly to avoid heating the castings. Remove broken studs, which cannot be gripped by drilling on center to the correct diameter for unscrewing them, with a splined stud extractor. Splined extractors and drills are usually sold in sets). Examine the course thread end of the damaged stud before discarding it to determine its size. Standard studs have no marking. For oversize stud identification, refer to Fig. 72-20-12. Clean the casting tapped hole with solvent and blow dry with compressed air; then examine the thread. If it is not torn, install the next larger oversize stud. If the old stud was of the maximum oversize, or if the thread is damaged, the hole may be tapped and a helical coil insert installed for a standard-size stud. Coat the new stud's course thread with High Strength Adhesive P/N 646941 if the hole is blind or if the hole goes through to a cavity subject to leakage. It is advisable to drive the new stud with a tee handle stud driver. Turn it slowly, and compare the estimated torque values listed in the Table of Limits. Drive the stud in until it projects a distance equal to the appropriate "Setting Height" (See Figure 72-20-12A,B & C).

FIGURE 72-20-12. CRANKCASE STUD SETTING HEIGHTS

INDEX NUMBER	LOCATION	THREAD SIZES	SETTING HEIGHT	MODEL IO-470
1	Cylinder mount pads	7/16-14 x 7/16-20	13/16	36
2	Engine mount pads	3/8-16 x 3/8-24	1-1/4	1
3		3/8-16 x 3/8-24	1-3/16	7
4		3/8-16 x 3/8-24	1-1/16	8
5	Oil cooler mount pad	1/4-20 x 1/4-28	1-5/8	
5		1/4-20 x 1/4-28	1-1/16	
5		1/4-20 x 1/4-28	57/64	5
6	Governor mount pad	5/16-18 x 5/16-24	1-3/8	4
7	Magneto mount pad	5/16-18 x 5/16-24	43/64	4
8	Magneto and accessory drive adapter pad	5/16-18 x 5/16-24	3/4	6
9		3/8-16 x 3/8-24	13/16	2
10	Idler pin pad	1/4-20 x 1/4-28	1/2	
10		1/4-20 x 1/4-28	5/8	2
11	Starter drive pad	5/16-18 x 5/16-24	13/16	2
12	Fuel pump pad	5/16-18 x 5/16-24	29/32	4
		5/16-18 x 5/16-24	1/5-16	4
13	Oil pump pad	1/4-20 x 1/4-28	2-9/32	2
14		1/4-20 x 1/4-28	7/8	1
15		1/4-20 x 1/4-28	2-13/16	2
16		1/4-20 x 1/4-28	3-1/8	5
	Cylinder	1/4-20 x 1/4-28	11/16	4
	Oil pump	1/4-20 x 1/4-28	5/8	2
	Oil pump cover	1/4-20 x 1/4-28	3/4	4
	Starter drive adapter	3/8-16 x 3/8-24	3/4	2
	Riser manifold	5/16-18 x 5/16-24	1-5/8	
	Riser manifold	5/16-18 x 5/16-24	1	4

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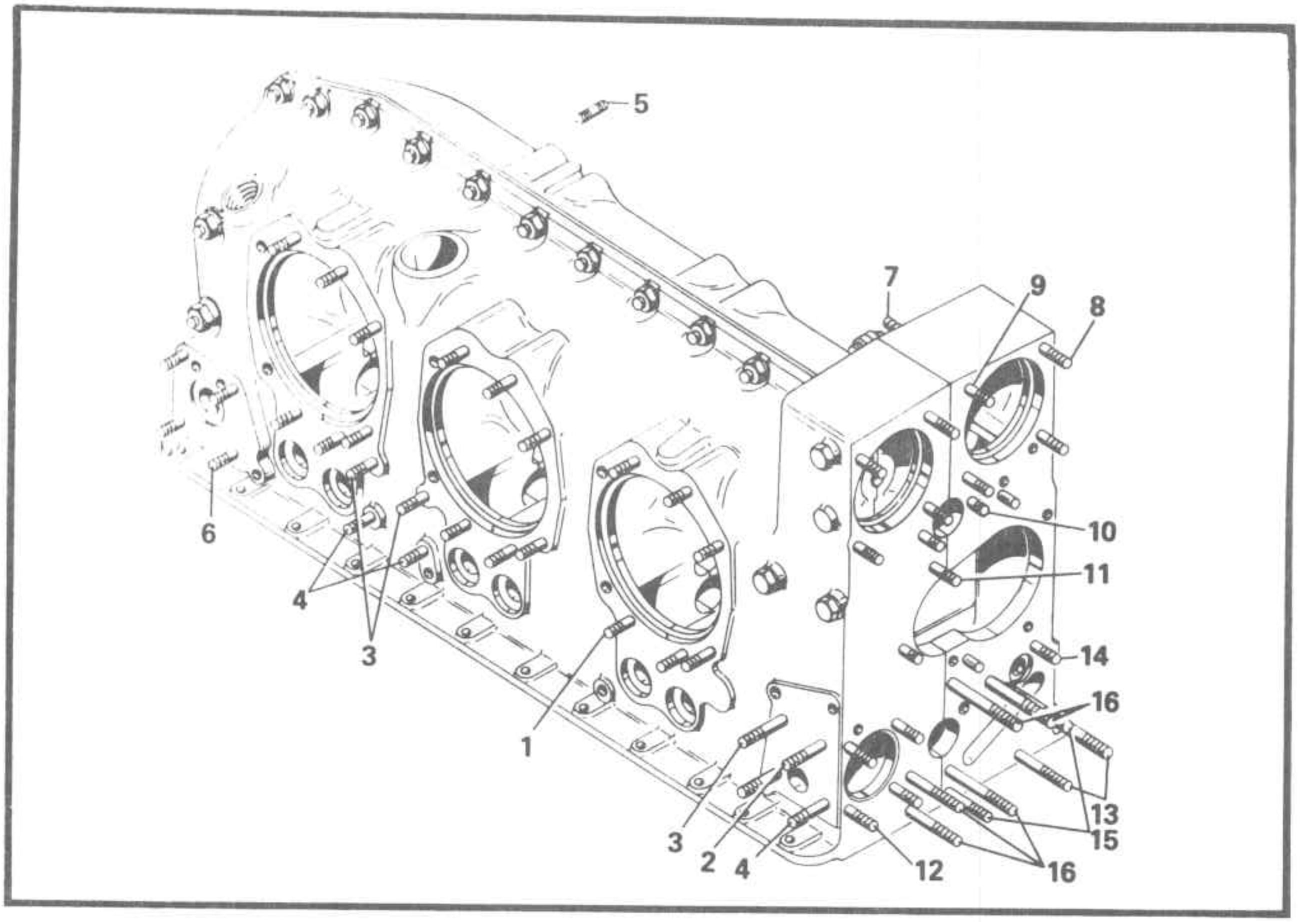

FIGURE 72-20-12A. CRANKCASE STUD SETTING HEIGHTS.

Typical Part No.	Oversize on Pitch Dia of Coarse Thread (inches)	Optional Identification Marks on Coarse Thread End		Identification Color Code
		Stamped	Machined	
XXXXXX	Standard	None		None
XXXXXXP003	.003			Red
XXXXXXP006	.006			Blue
XXXXXXP009	.009			Green
XXXXXXP007	.007			Blue
XXXXXXP012	.012			Green

FIGURE 72-20-12B. STANDARD AND OVERSIZE STUD IDENTIFICATION.

72-20-13 **HELICAL COIL INSERT INSTALLATION.** Helical coil inserts are installed at the factory in four tapped holes of each crankcase bottom flange, in three holes in the left crankcase parting flange, two in the right crankcase parting flange and in four bolt holes at each cylinder head intake port flange. Stainless steel helical coil inserts of special design are installed in all spark plug holes. Any of these inserts may be replaced if damaged. Tools are available through Authorized Distributors of The Heli-Coil Corp., Danbury, Connecticut 60810. The Manufacturer's Bulletin No. 650-R lists both manual and power-driven installing tools, tang break-off tools, special taps and plug gages. A tap drill bulletin is also available from the manufacturer. Helical coil inserts are available in both National Course and National Fine series in lengths equal to 1, 1-1/2 and 2 times nominal diameter and in pipe thread sizes. They are made of either carbon steel, phospher bronze or stainless steel, as specified by part number. They are supplied with or without a notch above the driving tang. The notch is provided to facilitate breaking off the tang in open holes.

Helical coil inserts are helical coils of wire with a diamond-shaped cross section forming both a male and female thread. The diameter of the insert, when compressed into a special tapped hole at the widest part of the wire (between male and female threads), is equal to the nominal screw size. The special finishing taps size the casting hole so that the pitch diameter of the female thread of the installed insert conforms to class 3 fit with standard bolt threads, or class 4 (tight) fit with standard-size studs. The difference in fit is due to a difference in pitch diameters of bolts and studs, so that only one set of helical coil special taps is required for installation of these inserts in both bolt holes and stud holes. Tap drilling depths and tapping depth for helical coil inserts to be installed in blind holes should conform to the recommendations relative to inserts of length equal to 2 times nominal diameter, as tabulated in the manufacturer's Bulletin No. 650-R. Helical coil tap drills and special taps must be run in perpendicular to the machined surface of the casting. Drilling must be done in a drill press after the casting is firmly supported, clamped and alignment checked. The tap will tend to follow the drilled hole. For drilling and tapping aluminum alloy castings, use a commercial grade cutting lubrication oil to prevent overheating of the metal and tearing of the thread.

To remove a damaged helical coil insert, use the proper size of extracting tool for the nominal thread size. Tap it into the insert so that the sharp edges get a good "bite"; then turn the tool to the left, and back out the helical coil until it is free. To install a new insert in a properly tapped hole, (after blowing out all liquid and chips), slide it over the slotted end of the driving mandrel of the proper size of installing tool and engage the driving tang (bend end) of the helical coil in the mandrel slot; then, wind the insert slowly into the tapped hole (See Figure 72-20-13B). The outer end of the insert should lie within the first full thread of the hole. Break off the driving tang of a notched helical coil by bending back and forth across the hole with long-nose pliers or with a special tang break-off tool.

FIGURE 72–20–13A. "HELICOIL" AND SPECIAL TOOL DATA

THREAD SIZE	BASIC TCM PART NO.	HELICAL COIL CORP. PART NO.	DRILLED HOLE DIAMETER	HELICAL COIL SPECIAL TAP. NO. * ROUGH	FIN.	HELICAL COIL THREAD PLUG GAUGE NO.	HELICAL COIL INSTALLING TOOLS STANDARD	PREWIND	TANG BREAK-OFF TOOL	HELI-COIL EXTRACTOR
1/4-20	24323-4	1185-4	.261-.266	186-4	187-4	188-4	724-4N	528-4N	1195-4	1227-6
5/16-18	24323-5	1185-5	.328-.333	186-5	187-5	188-5	724-5N	528-5N	1195-5	1227-6
3/8-16	24323-6	1185-6	.390-.395	186-6	187-6	188-6	724-6N	528-6N	1195-6	1227-6
7/16-14	24323-7	1185-7	.453-.448	186-7	187-7	188-7	724-7N	528-7N	1195-7	1227-16
18mm	520112	C2-52	.718-.723	2-22	2-21	2-1		543		1227-16

Notes: * For aluminum alloy castings. For numbers of taps designed for steel refer to the manufacturer's bulletin No. 650-R.

TCM Part Numbers: to basic part number add "B" for phosphor bronze, or "C" for stainless steel, add -1, -1.5 or -2 for length equal to nominal diameter times 1, 1-1/2 or 2, respectively. (All TCM furnished inserts are notched.)

Heli-Coil Part Numbers: To basic part number, as listed, add "B" for phosphor bronze, or "C" for stainless steel and "N" for a notched insert, if desired. Add "X" and length desired, expressed as a fraction of an inch. Example: 1185-5CN x 15/32 represents a 5/16-18 N.C. insert of stainless steel whose length is 15/32 inch, or 1-1/2 times its nominal diameter.

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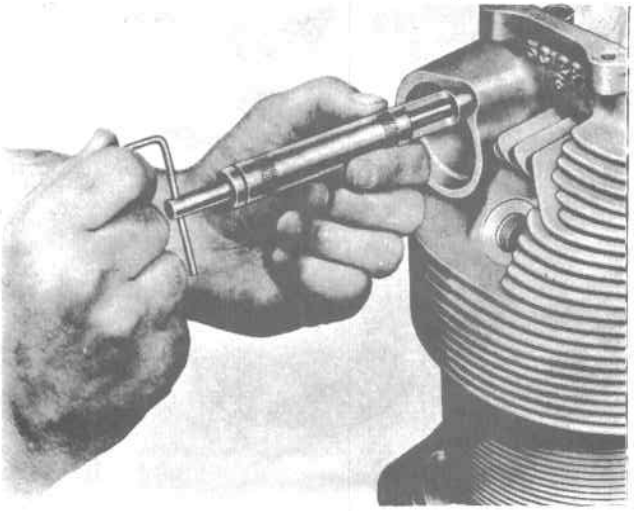


FIGURE 72-20-13B. INSTALLING TYPICAL HELICAL INSERT.

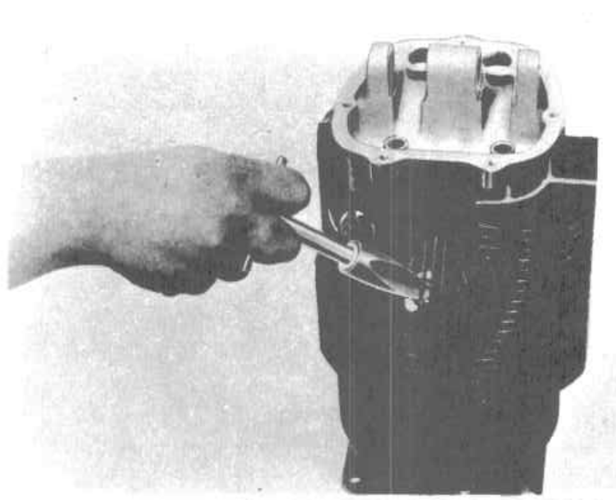


FIGURE 72-20-14C. REMOVING SPARK PLUG HOLE HELICAL INSERT.

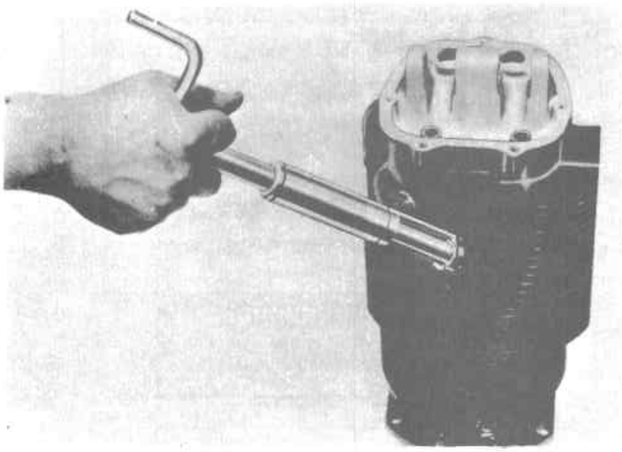


FIGURE 72-20-14A. INSTALLING SPARK PLUG HOLE HELICAL INSERT.

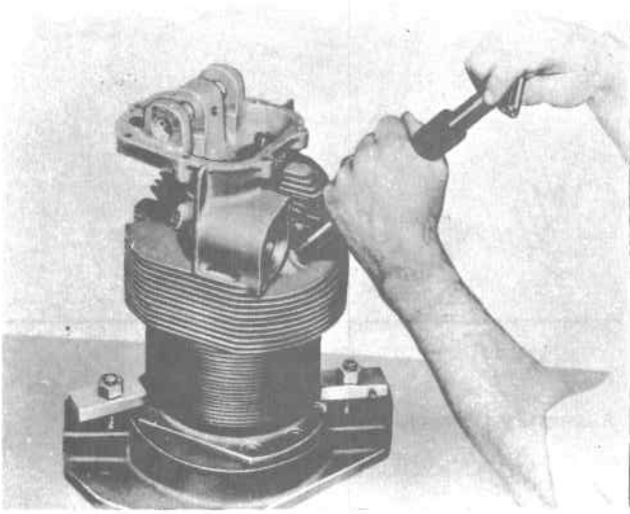


FIGURE 72-20-14B. EXPANDING SPARK PLUG HOLE HELICAL INSERT.

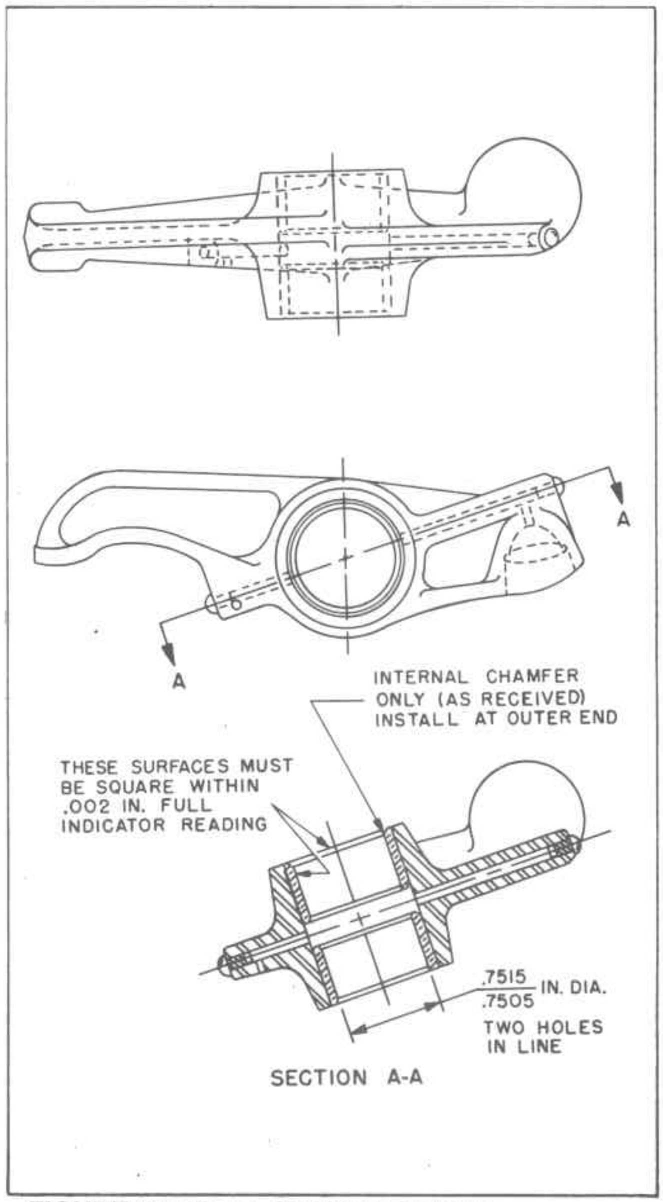
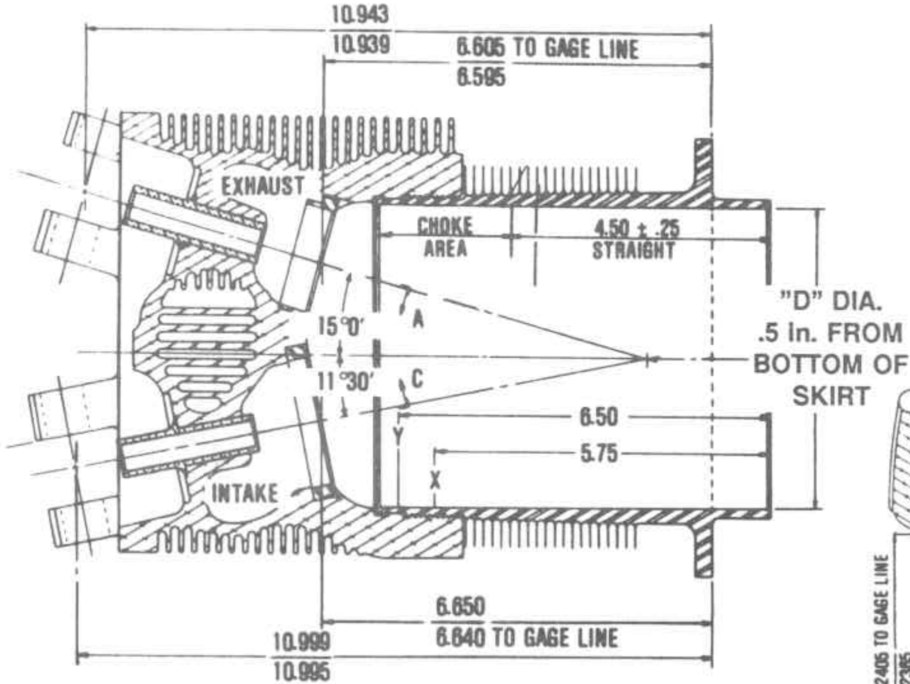
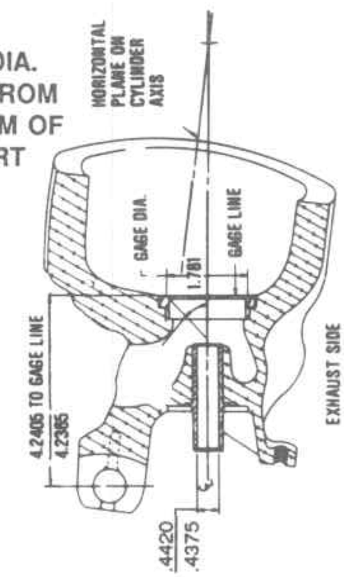
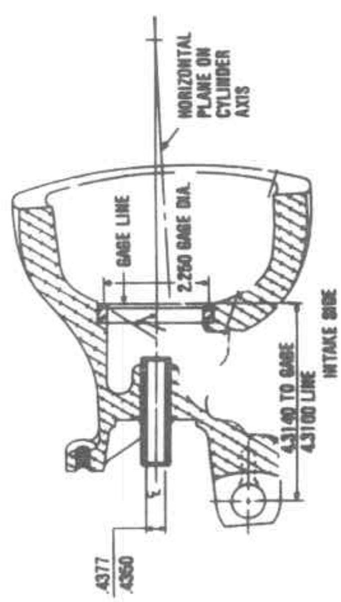


FIGURE 72-20-17. VALVE ROCKER BUSHING DIMENSIONS.







SIZE	"D" DIAMETER (INCHES)		
	NEW PARTS		SERVICE LIMITS
	MINIMUM	MAXIMUM	MAX
STANDARD	5.001	5.003	5.006
.005	5.006	5.008	5.011
.015	5.016	5.018	5.021

SIZE	"X" DIAMETER (INCHES)		
	NEW PARTS		SERVICE LIMITS FOR "X" DIAMETER IS ACTUAL MEASURED "D" DIAMETER PLUS .001 IN.
	MINIMUM	MAXIMUM	
STANDARD	4.998	5.000	
.005	5.003	5.005	
.015	5.013	5.015	

SIZE	"Y" DIAMETER (INCHES)	
	NEW PARTS	
	MINIMUM	MAXIMUM
STANDARD	4.995	4.997
.005	5.000	5.002
.015	5.010	5.012

NOTE:
Dimensions shown are finished after honing.

CAUTION: Cylinder assemblies exceeding new parts dimension shown are acceptable when performing maintenance before engine overhaul. However, piston ring gaps given in the table of limits MUST be maintained. When engine is being overhauled, TCM REQUIRES that all parts be brought back to new parts limits by rework or replacement. Installed parts should never exceed Service Limits. See Section 72-30-07 New Parts and Service Limits.

FIGURE 72-20-15A. CYLINDER ASSEMBLY DIMENSIONS (INCLINED VALVE)

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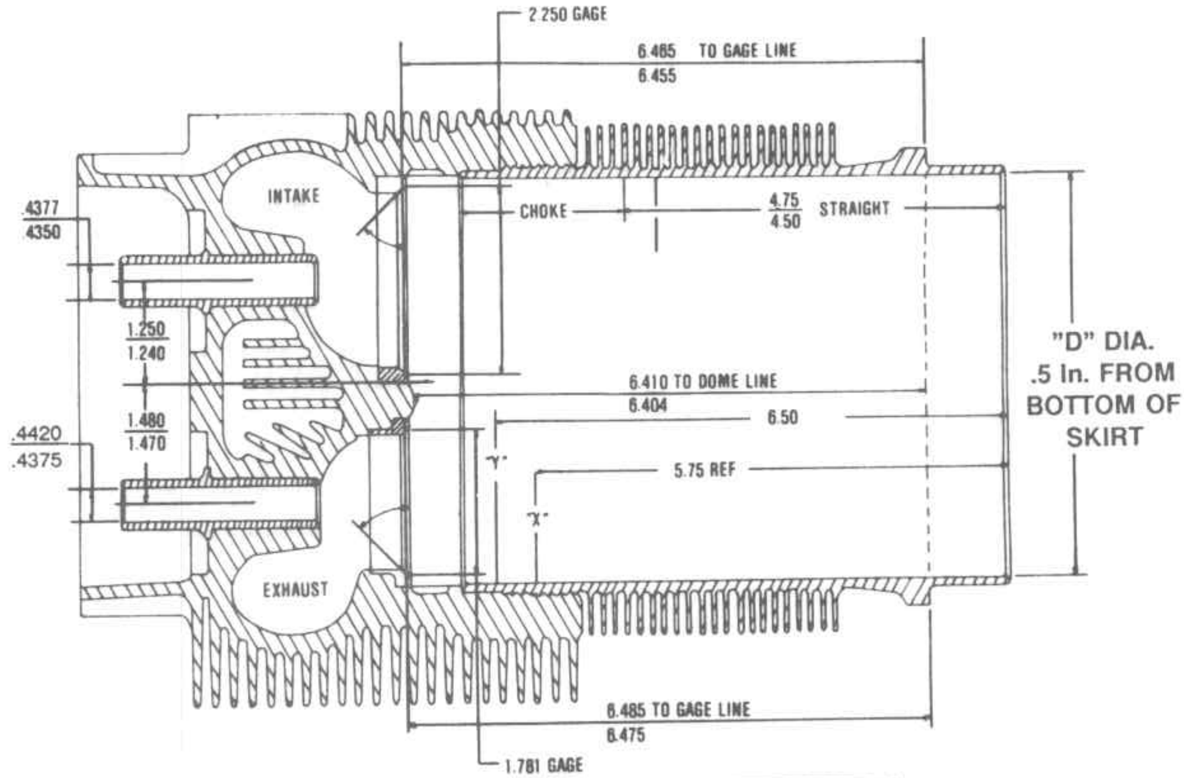

SIZE	"D" DIAMETER (INCHES)		
	NEW PARTS		SERVICE LIMITS
	MINIMUM	MAXIMUM	MAX
STANDARD	5.001	5.003	5.006
.005	5.006	5.008	5.011
.015	5.016	5.018	5.021

SIZE	"X" DIAMETER (INCHES)		SERVICE LIMITS FOR "X" DIAMETER IS ACTUAL MEASURED "D" DIAMETER PLUS .001 IN.
	NEW PARTS		
	MINIMUM	MAXIMUM	
STANDARD	4.998	5.000	
.005	5.003	5.005	
.015	5.013	5.015	

SIZE	"Y" DIAMETER (INCHES)	
	NEW PARTS	
	MINIMUM	MAXIMUM
STANDARD	4.995	4.997
.005	5.000	5.002
.015	5.010	5.012

NOTE: Dimensions shown are finish size after honing.

CAUTION: Cylinder assemblies exceeding new parts dimension shown are acceptable when performing maintenance before engine overhaul. However, piston ring gaps given in the table of limits MUST be maintained. When engine is being overhauled, TCM REQUIRES that all parts be brought back to new parts limits by rework or replacement. Installed parts should never exceed Service Limits. See Section 72-30-07 New Parts and Service Limits.

FIGURE 72-20-15B. CYLINDER ASSEMBLY DIMENSIONS (STRAIGHT VALVE).

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72-20-14 **SPARK PLUG HOLE HELICAL COIL INSERTS.** Before attempting to back out a damaged insert, use a sharp pointed tool to pry the teeth at outer end away from the cylinder head metal. Tap a helical coil extracting tool into the insert until it has a good bite (See Figure 72-20-14C). Place a new helical coil in the cut-out side of the installing tool sleeve with its driving tang toward the threaded end. Engage the tang with the slotted end of the driving mandrel and wind the insert into the sleeve thread, thus compressing it. Hold the sleeve so the helical coil can be seen through the slot in the threaded end, and turn the mandrel crank until the insert starts into the cylinder head hole. If the sleeve is not in contact with the head surface, grip sleeve and mandrel, and turn until the sleeve touches lightly (See Figure 72-20-14A). Wind the helical coil into the cylinder head until its toothed end lies within the first full thread. The teeth should be in position to enter the depressions made by the original insert. If driven too far, the insert will emerge in the combustion chamber and will have to be wound on through. When the helical coil is in correct position, use long-nose pliers to bend the driving tang back and forth across the hole until it breaks off at the notch. Coat a Heli-Coil Corporation No. 520-2 expanding tool, threaded end, with Alcoa thread lube or a mixture of white lead and oil, and screw it into the new insert until its final thread forces the teeth firmly into the cylinder head metal (See Figure 72-20-14B).

72-20-15 **FIN REPAIRS.** Straighten slightly-bent barrel fins with long-nose pliers. File to smooth the edges of broken head fins. If it becomes necessary to cut out a vee notch to stop a head fin crack, a slotted drill bushing to fit over the fin and a 3/16 inch twist drill may be used to cut the notch. Its apex must be rounded and the edges should also be rounded. If such repairs and previous breakage have removed as much as 10% of the total head fin area, the cylinder assembly has reached the limit of its repair and the cylinder must be replaced.

72-20-16 VALVE GUIDES REMOVAL AND INSTALLATION.

Use heavy duty drill press and Borroughs No. 5221 Holding fixture or equivalent to hold cylinder. DO NOT ATTEMPT PROCEDURE BY HAND.

VALVE GUIDE REMOVAL

1. Use a No. 4981 Remover. Select proper size head. Install on removing handle. Attach to cold water supply.

2. Heat cylinder to 550-600° F. Heat soak one hour.

3. Install pilot into guide. Hold down firmly into guide bore with hand on water release button. Use other hand to work sliding hammer. Release the water and hammer out guide while water is running. Both guides can be removed with one heating. Support cylinder with barrel up. Use wooden blocks to keep from damaging rocker cover surface.

4. Allow cylinder to cool to room temperature.

VALVE GUIDE INSTALLATION

1. Measure valve guide boss and select proper No.4914 or 4943 series reamer to ream valve guide boss to required oversize. Consult Table of Limits Figure 72-30-08 for proper interference fit. Guide boss must be clean and free from pits or grooves. Run standard reamer through first. If bore is not clean, go to next larger size reamer. Use No. 2849 Plug Gages to check fit.

2. Heat cylinder head to 450-500° F. and install guide cold with No. 4912, No. 2842, or No. 3619 Replacer. A small amount of lubricant oil on the guide will reduce the chance of binding during installation.

REAMING VALVE GUIDES

NOTE. . . For pre finished valve guides disregard the following steps 1 thru 4.

1. Install No. 5221B Holding fixture or equivalent into drill press to hold cylinder. DO NOT ATTEMPT PROCEDURE BY HAND.

2. Index fixture to proper angle and install cylinder into fixture. Zero in guide with dial indicator.

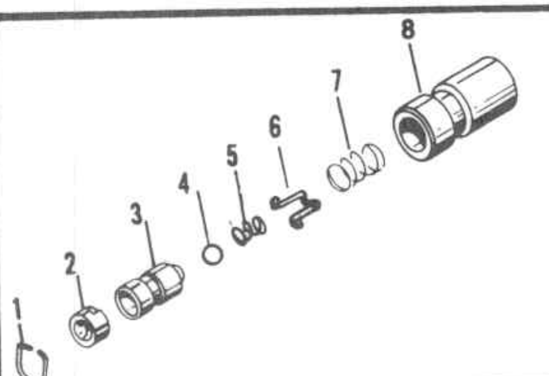
3. Select proper reamer from Borroughs Tool Catolog. Ream at 400 RPM for high speed steel reamers and 700 RPM for Carbide tip reamers (Do not use carbide tip reamers for hand cutting) with plenty of lubricants.

4. Check finished bore with No. 4933, No.2848 or No.3615 plug gages. Refer to Table of Limits Figure 72-30-08 for correct stem hole finished sizes.

72-20-17 **VALVE ROCKERS.** Worn bushings may be driven out with a suitable drift, and if properly designed, the same tool may be used to drive in new bushings. The rocker must be supported on a ring which will allow the old bushing to pass through. Press the new bushing in flush with the rocker hub after dipping it in clean lubricating oil. Ream the new bushing to the specified diameter. It is advisable to plug the oil holes with beeswax before reaming. Be sure to remove the wax after reaming. Lightly break the sharp edge at each end. (Refer to Figure 72-10-17). Using an oil squirt bottle, squirt oil through each rocker arm after beeswax removal to check for free oil flow.

72-20-18 **HYDRAULIC VALVE LIFTERS (See Figure 72-20-18).** Stand valve lifter on its flat end. Use a small screwdriver and carefully pry snap ring (1) from body groove, holding down socket (2) with a pushrod until ring has been removed. Invert lifter and catch socket as it drops out. Insert a finger into plunger (3) and withdraw plunger (3), spring (7) and check valve assembly (3, 4, 5, 6). If plunger is stuck in body (8), hold plunger down fully and scrape out carbon deposit. If this obstruction cannot be removed, or if plunger is seized by score marks, the entire assembly must be replaced. Remove spring (7) by turning as if to unwind it while pulling outward. Be careful not to stretch spring out of shape. Remove check ball (4) from plunger by removing retainer (6), lifting spring (5) and ball (4).

NOTE . . . If major engine overhaul, hydraulic valve lifters are recommended 100% replacement.



1. Ring, Retaining
2. Socket, Hydraulic Lifter
3. Plunger
4. Check Ball
5. Ball Check Spring
6. Ball Check Retainer
7. Spring Plunger
8. Body Valve Lifter

FIGURE 72-20-18. HYDRAULIC LIFTER.

72-20-19 CONNECTING RODS.

CAUTION . . . In order to assure good dynamic balance, connecting rod assemblies for new engines are selected in pairs with a maximum weight variation of 1/2 ounce in opposite bays. This limit cannot be maintained if material is removed from any of the original in a set. Therefore, rods are supplied in matched sets only.

72-20-20 PISTON PIN BUSHING REPLACEMENT. The connecting rod does not need to be heated for this operation. Press out the old bushing in an arbor press, using a drift only slightly smaller than the bushing O.D. Make sure that the rod bore is smooth. Dip the new bushing in engine lubricating oil before placing it in position, and locate the split as illustrated in Figure 72-20-20. (The position number is stamped on the rod and cap bosses on the far side). Ream or bore the new bushing to the specified diameter and check alignment as described in paragraph 72-40-05. The center-to-center distance given in Figure 72-20-20 will be held automatically if the bore is centered in the new bushing.

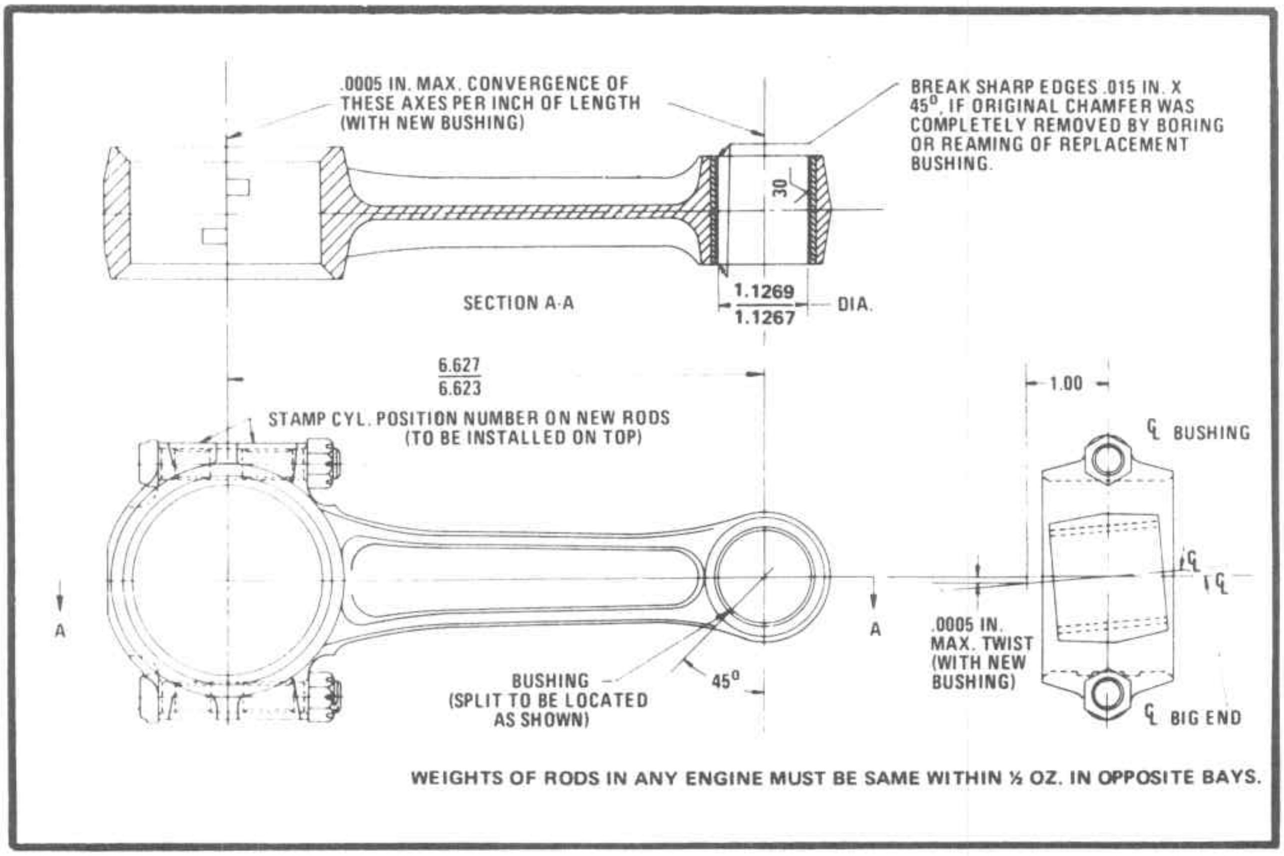


FIGURE 72-20-20. CONNECTION ROD AND BUSHING DIMENSIONS.

72-20-21 CRANKSHAFT ASSEMBLY. Raised edges from small nicks on hard surfaces such as crankpins and journals, can be removed with a hard Arkansas stone. Do not use a coarse abrasive. Do not attempt to remove deep scoring or indications of overheating which render the crankshaft unserviceable. Polish crankpins and main journals with long strips of crocus cloth while the shaft is rotated about 100 RPM in a lathe. Since gears are shrunk fit to the crankshaft, it may be necessary to dip the gear in oil heated to 300°F. before removal. These operations should precede magnetic particle inspection. Inspect crankshaft (ultrasonic) per TCM Service Bulletin M81-2R1 or current revision as applicable.

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Hardened steel bushings in the crankshaft blades must be removed and replaced if excessively worn. It is recommended that these bushings be replaced during major engine overhaul regardless of condition. It may be necessary to chill the old bushings to free them. New bushings must be chilled before installation, and the holes must be smooth. No finishing operation is required for the new bushings, since they are made to final dimensions. They must be pressed into the same positions as the original parts.

NOTE . . . Crankpins and crankshaft main journals may be reground to the allowable 0.010 inch undersize. Reground crankshafts must be re-nitrided.

CAUTION . . . Crankshaft counterweights are matched in pairs with a maximum weight variation of 2 grams, and the complete crankshaft and counterweights assembly is dynamically balanced. As a result, if either counterweight is damaged it will be necessary to discard both on that cheek and to procure a matched pair for replacement.

72-20-22 **IDLER GEAR.** Replacement of excessively worn idler gear bushings is not recommended, because a special fixture is required to hold the gear during the boring operation, in order to maintain the necessary concentricity of the bushing hole and the gear pitch circle.

72-20-23 **MAGNETO AND ACCESSORY DRIVE ADAPTER ASSEMBLY.** The magneto and accessory drive adapter bushing must be replaced at major overhaul. Turn down the bushing flange to the body diameter (0.942 inch) and bore out the bushing to a thin shell which can be collapsed. Take care not to cut into the end of the adapter boss or to mark the adapter bore. Press in a new bushing with an arbor press after dipping it in clean engine lubricating oil. The rear pad of the adapter, rather than the studs, must be supported on a parallel block and flat block must be used to exert pressure unless the arbor has a perfect end. Ream or bore the bushing to the specified diameter, then face the flange until it projects forward 1.454-1.458 inch from the adapter parting surface. Chamfer the bore at the flange end 1/16 inch deep on a 45° angle, and slightly break sharp edges at both ends. The bushing hole must be concentric with the adapter pilot shoulder within 0.002 inch and square with the parting surface within 0.002 inch per inch of length. Its flange thrust face must be parallel to the parting surface within 0.002 inch (full indicator reading).

CAUTION . . . Before boring a new bushing, plug its oil holes with beeswax to exclude chips from the adapter groove. Be sure to remove the wax completely after the operation.

The old seal may be driven out with a 1/8 inch diameter pin punch inserted through the four oblique oil holes in the bushing boss alternately. If the seal is too tight for that method, drill and tap two opposite machine screw holes in the exposed flange of the seal case to match two screw clearance holes in a pressure plate which can be laid on the adapter studs. Run nuts on two long machine screws; then insert the screws through the pressure plate holes, and screw them into the holes tapped in the seal. To avoid unnecessary stoning of the seal bore, tighten the nuts against the plate to pull the seal squarely from its recess. Smooth any scores in the vacant adapter counterbore. Coat the periphery of a new oil seal with lubricating grease, and press it into the adapter with an arbor press and a flat end block of 1-3/8 inch diameter by 1-1/4 inch length.

72-20-24 **TACHOMETER DRIVE HOUSING.** Remove the oil seal with a suitable oil seal puller. If the housing counterbore is scored, smooth it with crocus cloth. Spread a film of Grade 50 MHS 27 oil on the perimeter of a new seal. Then press the seal squarely into the housing with its lip pointed outward, facing the oil source.

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72-20-25 STARTER DRIVE ADAPTER. The clutch spring sleeve is pre-shrunk and doweled into the housing. If it is necessary to remove the needle bearing in the adapter, a removing driver may be purchased (See Section 1-20-00 Tools, Figure 45).

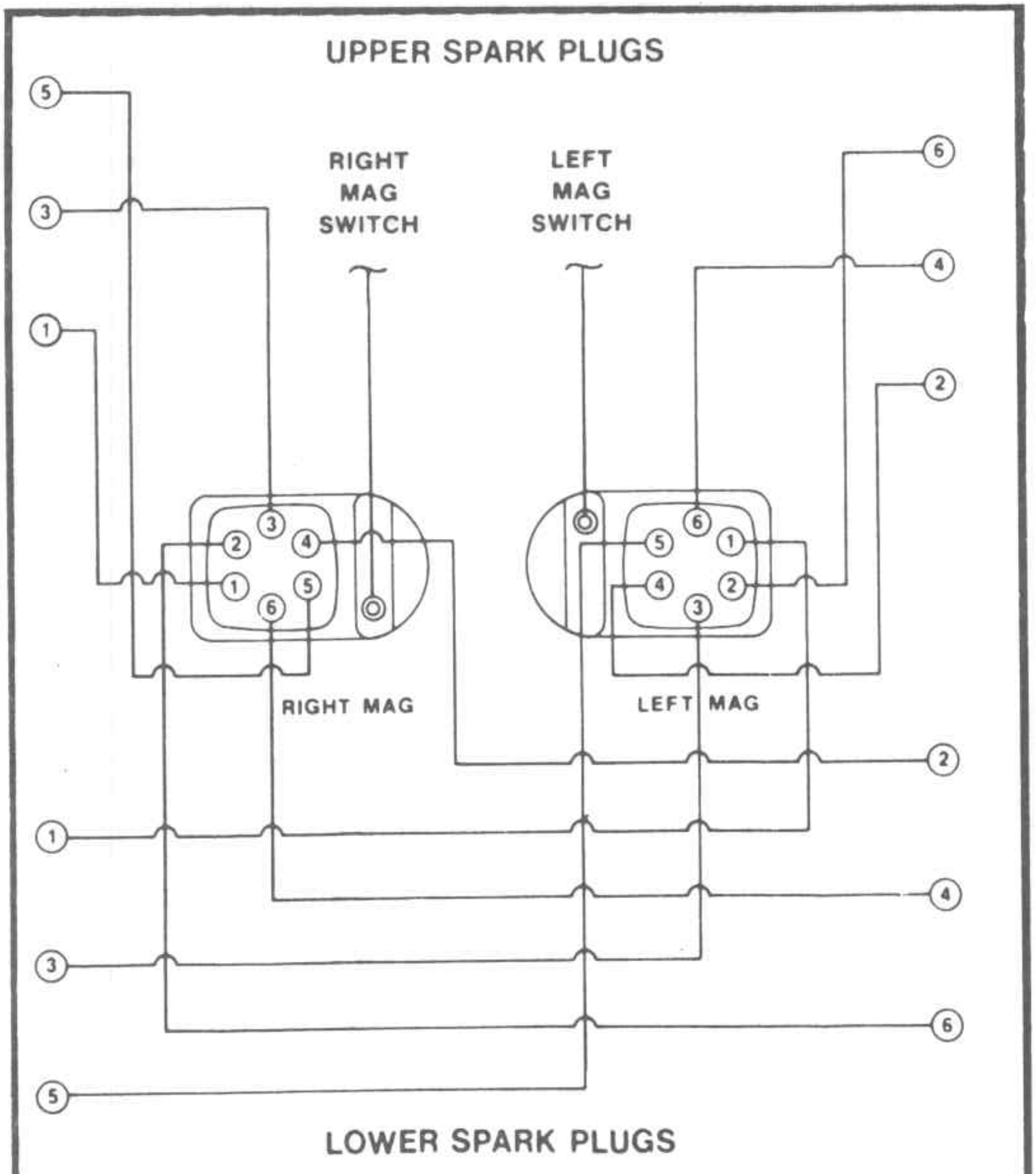
Check oil feed holes to the starter adapter shaftgear. Hole diameter must be .0918-.0968 to reduce possibility of clogging and causing lubrication loss to starter adapter clutch spring. The oil feed hole comes off the rear cam bearing of the 1-3-5 crankcase half and intersects a short hole in the center of the needle bearing counterbore. Hole can be enlarged to diameter shown above after removal of the starter adapter.

72-20-26 OIL PUMP ASSEMBLY. Except for stoning nicks on parting flanges and replacement of studs and worn parts, no repairs to the pump assembly are possible. The pump driven gear shaft is pressed into the pump housing and cannot be replaced successfully. The pump gear chamber must not be enlarged. If it is scored, the housing must be discarded. Heavy scoring on the gear contact area of the tachometer drive and pump cover renders this part unserviceable, unless the parting surface can be lapped smooth and perfectly flat.

72-20-27 IGNITION CABLES. All ignition cable assemblies or harness assemblies must be replaced at each overhaul. Unless the high tension outlet plates are in good condition, new cable assemblies and grommets may be installed on them and the cable ends secured to the grommet of each harness with a brass washer and a cable piercing screw, installed as in the original assembly. If only the cable assemblies and grommets are to be replaced, leave the cable clamping bracket on the original cables of each harness. Detach all cables from the high tension outlet plate by removing the cable piercing screws from their ends in the plate grommet. When the coupling nuts are unscrewed, the cables may be withdrawn and the grommet removed from the plate.

Observe the "1" mark on the exterior side of each outlet plate adjacent to the No. 1 cable outlet hole, (Refer to Figure 72-20-27), and observe that the numerals appearing at magneto ends of the high tension cables correspond to the consecutive order of outlet plate cable holes, while the relative positions of spark plug elbows indicate the installed position of the cables. Install cable assemblies (3 through 14, Figure 72-10-05) in the indicated positions in the two outlet plate and grommet assemblies (1 and 2), starting with the proper No. 1 cable assembly in the marked hole of each plate, and proceeding in consecutive order around the plates. As each cable end is inserted, screw in the cable coupling nut (33), and tighten it; then place one of the brass washers (16) and a cable piercing screw (17) at the grommet hole, and turn the screw in firmly, but not enough to cut the wire strands.

When all cables have been attached to the two outlet plates, locate a clamping bracket (18) on the proper cables of each harness in the same position as on the original cables, and install a rivet (19) to scure it. Parts indexed 21 through 32 will be installed at final assembly. This group should be collected and ready for installation. Parts indexed 33 through 37 are installed on the aircraft ignition switch wires. If replacement of spark plug ends is necessary, proceed with disassembly as indicated in Figure 72-10-05 (Items 38 through 45) for Slick Harness, and (Items 46 through 52) for Bendix Harness.



ENGINE FIRING ORDER	1	6	3	2	5	4
MAGNETO FIRING ORDER	1	2	3	4	5	6

FIGURE 72–20–27.
IGNITION WIRING DIAGRAM

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SECTION 72-30
INSPECTION

INTENTIONALLY

LEFT

BLANK

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72-30-00 INSPECTION

72-30-01 GENERAL

The following definitions apply to terms used to describe kinds of damage for parts to be inspected.

ABRASION: Scratching of a surface, either by motion while in contact with another part, by mechanical cleaning, or resurfacing with abrasive cloth or tapping compound.

BURNING: As applied to valve heads, this term indicates roughening or erosion due to high temperature gases escaping past valve faces. In other instances, it indicates drawing of the temper of steel parts to a soft (blue) condition as a result of overheating, in absence of lubrication on moving surfaces such as gear teeth, subject to high loading.

BURR: A sharp projection of metal from an edge, usually the result of drilling, boring, countersinking, etc., but may also be caused by excessive wear of one or both surfaces adjacent to the burred edge.

CORROSION: Deterioration of a surface, usually caused by oxidation of metal.

ELONGATION: Stretching or increase in length.

FRETTING: Scuffing or deterioration of a metal surface caused by vibration or chattering against another part. A fretted steel surface may appear dull, scuffed, or corroded, depending on length of time subjected to the action.

GALLING: Excessive friction between two metals resulting in particles of the softer metal being torn away and "welded" to the harder metal.

INDENTATION: Dents or depressions in a surface caused by severe blows.

OXIDATIONS: Chemical combining of a metal with atmospheric oxygen. Aluminum oxide forms a tough, hard film and protects the surface from further decomposition; however, iron oxides do not form a continuous cover or protect underlying metal. Therefore, the oxidation of steel parts is progressive and destructive.

PITTING (OR SPALLING): Small, deep cavities with sharp edges. May be caused in hardened steel surfaces by high impacts or in any smooth steel part by oxidation.

RUNOUT: Eccentricity or wobble of a rotating part. Eccentricity of two bored holes or two shaft diameters. A hole or bushing out of square with a flat surface. Usually measured with a dial indicator, and limits stated indicate full deflection of indicator needle in one revolution of part or indicator support.

SCORING: Deep grooves in a surface caused by abrasion, when fine hard particles are forced between moving surfaces, as in a bearing and journal, or by galling when a moving part is not supplied with lubricant.

PROTECTION FROM CORROSION: Coat all steel parts with corrosion preventive oil. At inspection, parts are wiped free of oil, to provide easy handling and true dimensional readings. Immediately after inspection, parts must be cleaned to eliminate fingerprints and contaminates, completely recoated with corrosion preventive oil and packaged properly to prevent damage.

72-30-02 VISUAL INSPECTION. Parts without critical dimensions, small parts, running parts and others of major importance, must be inspected visually, with at least a 10X magnifying glass, under good light for surface damage such as nicks, dents, deep scratches, visible cracks, distortion, burred areas, pitting, pick-up for foreign metal and removal of enamel coating. Visual inspection should also determine the need for further cleaning of obscure areas. Inspect all studs for possible bending, looseness or partial removal. Inspect all threaded parts for nicks and other damage to the screw threads. After visual inspection, the engine parts should be in three groups: Apparently serviceable parts, repairable parts and parts to be discarded.

72-30-03 MAGNETIC PARTICLE INSPECTION. Inspection by the Magneflux method must be conducted on all ferrous parts listed in Section 72-30-03, and in accordance with the methods and data in the table before dimensional inspection. The Magnaglow method is recommended whenever the necessary equipment is available. This method employs magnetic particles coated with a flourescent organic material which may be illuminated with a "black light", as in the Zyglo process, to amplify an indicaiton of weakness. If a crankshaft is doubtful after a circular magnetization and inspection, demagnetize and remagnetize it longitudinally for further inspection.

NOTE . . . Before magnetic particle inspection, valve rocker shafts must be polished with crocus cloth. TCM recommends 100% replacement of piston pins regardless of condition.

CAUTION . . . Before magnetic particle inspection of any part, plug small holes leading to obscure cavities with tight-fitting wood plugs or with a hard grease which is soluble in lubricating oil to prevent particles from lodging in places where they would be difficult to remove and places that are not subject to visual inspection. After magnetic particle inspection, remove all such plugs and clean the part thoroughly in solvent, and dry with compressed air. Check for complete demagnetization.

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72-30-03
MAGNETIC PARTICLE INSPECTION

FLOURESCENT METHOD PREFERRED,
WET CONTINUOUS PROCEDURE REQUIRED

Part	*Method of Magnetization	AC or DC Amperes	Critical Areas	Possible Defects
Crankshaft	Circular and Longitudinal	2000	Journals, fillets, oil holes, thrust flanges, prop flange.	Fatigue cracks, heat cracks, flange cracks, from prop strike.
Connecting Rod	Circular and Longitudinal	1500	All areas.	Fatigue cracks.
Camshaft	Circular and Longitudinal	1500	Lobes, Journals drilled hole edges.	Heat cracks. Fatigue cracks.
Piston Pin	Circular and Longitudinal	1000	Shear planes, ends, center.	Fatigue cracks.
Rocker Arms	On Conductor Bar and Single Between Heads	1000 800	Pad, socket under side arms and boss.	Fatigue cracks.
Gears to 6 Inch Diameter	Circular or on Center Conductor	1000 to 1500	Teeth, Splines, Keyways.	Fatigue cracks.
Gears over 6 Inch Diameter	Shaft Circular Teeth Between Heat Two Times 90°	1000 to 1500	Teeth, Splines.	Fatigue cracks.
Shafts	Circular and Longitudinal	1000 to 1500	Splines, Keyways, Change of Section.	Fatigue cracks, heat cracks.
Thru Bolts Rod Bolts	Circular and Longitudinal	500	Threads Under Head.	Fatigue cracks.

NOTE: (*)

LONGITUDINAL MAGNETISM: Current applied to solenoid coil surrounding the work.

CIRCULAR MAGNETISM: Current passed through work or through non-magnetic conductor bar inserted through work.

72-30-04 CRANKSHAFT ULTRASONIC INSPECTION PROCEDURE.

A. PURPOSE. To provide a procedure for ultrasonic inspection of crankshaft intermediate main bearing journal fillet areas.

B. METHOD. This procedure describes the use of a shear-wave, pulse-echo, angle-beam ultrasonic inspection technique.

The sound enters at one end of the main bearing journal and propagates through the steel at a 45° angle. The sound reaches the crankshaft center hole and is reflected back up into the region of the fillet at the other end of the same journal.

If an ultrasonic reflector in the form of a crack exists in the region, the sound is reflected back along the same path to the surface applied transducer, and displayed as a signal on the screen of the inspection instrument.

In the absence of a reflector in the region into which the sound is directed, no signal is displayed.

C. EQUIPMENT.

1. Instrument. Wheelfax Jr., Mark IV Model or Fax Corporation, Danbury, Connecticut.

2. Probe. Miniature Transducer Gamma Series 5MHz KrautKramer/Branson Cat. #MSWS 224-580 Miniature shear Wave Wedge 45° K/B Cat. #MSWS-X W-028 KrautKramer/Branson, Stratford, Connecticut.

3. Reference Block. TCM Part #643901.

4. Couplant. SAE 50 weight lubricating oil.

D. CALIBRATION.

1. Connect instrument to 120V AC source or note that self-contained rechargeable battery is at recommended level.

2. Lift instrument face cover and turn on by pulling the On/Off switch.

3. Turn gate off by pushing button switch on side of instrument.

4. Insert probe lead into connector on instrument side.

5. Clean surface of Reference Block, then apply oil to block surface near fillet opposite the test hole. Place probe on the oiled block with acute angle end backed up to the bearing journal fillet opposite the test hole. Manipulate the probe until the signal from the test hole reaches maximum height on the screen, always maintaining an oil film between the probe and journal surface. Holding the probe steady, adjust the Gain Control to bring the signal to approximately 80% of screen height. (5th horizontal line from bottom of screen). Observe that the test hole step and Reference Block back face reflections are visible on the screen, to the right of the test hole bottom signal.

6. Bring the bottom of the signal's left-hand flank to the vertical center line of the screen by adjusting the Delay Control.

7. Turn gate on by pressing gate switch. Adjust gate control to position the gate one division on both sides of the center line of the screen. The instrument is now calibrated and ready for use.

E. INSPECTION. Keeping in mind that the probe is positioned at one main bearing journal fillet while inspecting the opposite fillet area, proceed as follows:

1. Clean the surface, then apply couplant oil to one of the crankshaft intermediate bearing journals, and position probe as on the Reference Block, facing the opposite rod cheek in the approximate center of that rod journal. Carefully move the probe around the main journal about 45^{o} on both sides of the center, while watching the screen and alarm light.

2. Wipe all oil from the main journal, then reverse probe, applying oil only under the probe, scan opposite fillet. Repeat on the other intermediate main journal, inspecting a total of 4 fillet areas.

3. The presence of a reflector, which may be a crack in the fillet region will present a signal on the screen in the gate the same as that produced by the test hole in the Reference Block, and cause the alarm light to flash.

F. DISPOSITION ADVICE

1. If your crankcshaft meets the inspection criteria, the following additional steps should be accomplished:

a. Ascertain the heat code on the crankshaft. The code is alpha/numeric and consists of three digits, *i.e.* X45, N78. This code can be found on the number 1,3,4 or 9 cheek depending on crankshaft part number.

b. Ascertain if the crankshaft is made from air melt steel or vacuum arc remelt steel (VAR). Crankshafts made from air melt steel have no special identification. The crankshafts made from vacuum arc remelt steel are identified with the letters VAR forged into the crankshaft and located on the Number 3,7 or 9 cheek depending on the crankshaft part number.

c. Vibroetch the crankshaft flange, per Figure A, with the heat code, V (if VAR verified) no code if air melt steel, and the letter "U" (ultransonic inpsection) to the following format:

Example: 1. X45/V/U Heat Code/VAR Steel/Ultrasonic Inspected

2. X45/U Heat Code/ (No letter indicates air melt steel)/Ultrasonic Inspected.

With any subsequent ultrasonic inspection, you will include additional "U" codes, *i.e.*, X45/V/UU or /UU.

WARNING. . . Do not steel stamp the code as it can damage the crankshaft nitride. All stamping on the crankshaft by TCM was done prior to nitriding.

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NOTE. . . In some incidences the heat code and/or the VAR identification may have been ground off in the balancing process and, therefore, cannot be verified.

d. Make appropriate logbook entry as to compliance with this service bulletin.

2. If your crankshaft fails to meet the inspection criteria, contact TCM- Mobile Service Department 205/438-3411, for further instructions.

G. OPERATIONAL PRECAUTIONS

1. Couplant Oil. Proper transmission of sound requires a complete film of oil between the work surface and the probe. Apply oil generously to the crankshaft main journal, but only under the probe location. The surface of the fillet area under inspection must be free of oil to prevent spurious signals.

2. Probe Maintenance. At weekly intervals, or after equipment has been idle, loosen screws on probe and separate the transducer from the shoe sufficient to add oil between the mating surfaces.

The wear shoe is supplied radiused to fit the crankshaft journal. With usage, the shoe will wear sufficiently to change the sensitivity of the test. This condition will be noted when calibration becomes difficult or the patterns displayed on the screen differ from the original pattern. Replace the shoe for correction.

Replace probe lead when it becomes stiff or frayed to avoid electrical noise and spurious signals.

3. Signal Base. It is important to distinguish between valid signals displayed on the CRT screen, indicating a discreet reflector in the material, and a spurious signal caused by electrical noise or other extraneous source.

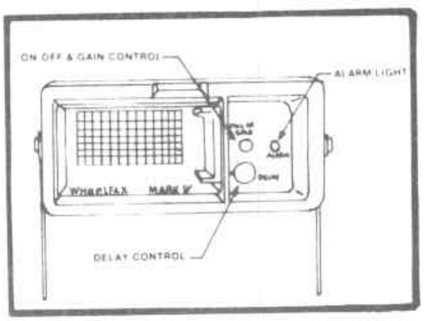

FIGURE 1.

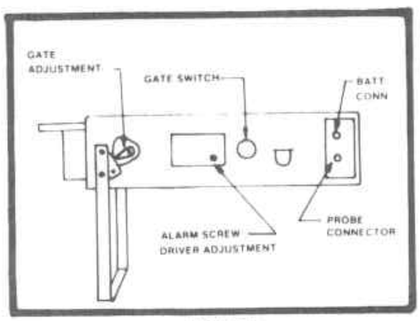

FIGURE 2

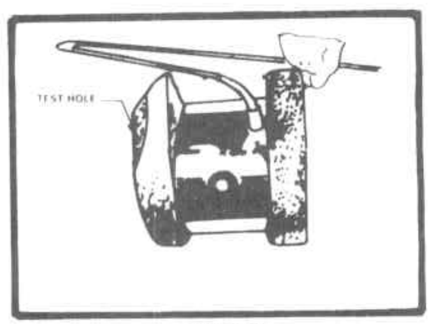

FIGURE 3

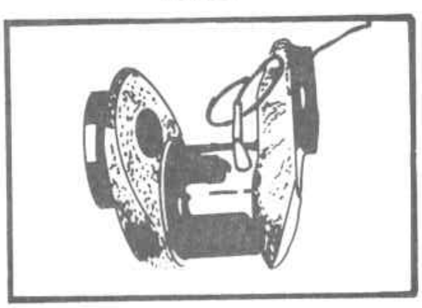

FIGURE 4.
SHOWING REGION OF FILLET TO BE INSPECTED

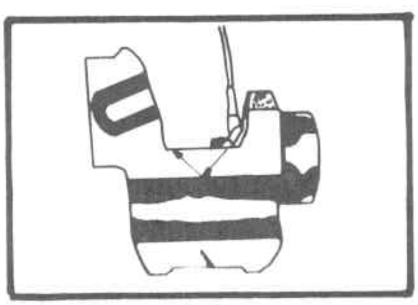

FIGURE 5.
SHOWING SOUND PATH FROM PROBE TO FILLET REGION

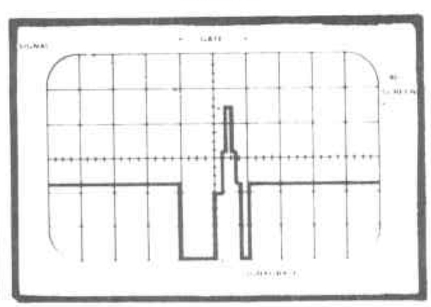

FIGURE 6
SHOWING VALID SIGNAL ON CRT SCREEN

FIGURE 72–30–04. CRANKSHAFT ULTRASONIC INSPECTION PROCEDURE.

Note on the Reference Block the signal produced by the .030" test hole bottom, has two distinct flanks, left and right, with a measurable space between. The space is a measure of the diameter of the reflector and is termed "Signal Base".

A valid signal has a discernible signal base, distinguishing it from a spurious signal which may appear as a signal flank display.

72-30-05 **FLOURESCENT PARTICLE INSPECTION.** This process commonly known under the trade name "Zyglo", is recommended for inspecting aluminum alloy parts for invisible cracks. The standard operating technique for the process is applicable.

72-30-06 **DIMENSIONAL INSPECTION.** Areas of running parts and bushings subject to wear should be inspected for serviceable fit with mating parts by comparative linear measurements and alignment measurements, using standard pattern precision measuring instruments such as micrometer calipers, telescoping gages, and dial indicators. The use of a dial-type cylinder bore gage is preferred, rather than tools not specifically designed for this purpose.

72-30-07 **DIMENSIONAL LIMITS.**

TCM provides a limited number of parts, dimensions, and assembly clearances in its publications which are considered essential to perform a quality overhaul of its' engines. These values are termed "New Parts Limits" taken from parts drawings in effect at the time of publication. In addition, a list of those items recommended for replacement at overhaul (100% Replacement Parts Section 1-00-04) is provided for which dimensional limits cannot be specified to determine their suitability for continued use.

TCM also provides "Service Limits" information for re-usable parts. They are intended as a guide line for reuse when performing maintenance of the engines prior to major overhaul.

Parts with dimensions or fits that exceed service limits should not be used. Parts with values up to and including service limits may be used, however, judgement should be exercised considering the proximity of the engine to its recommended overhaul time. Service limits should not be used when overhauling an engine.

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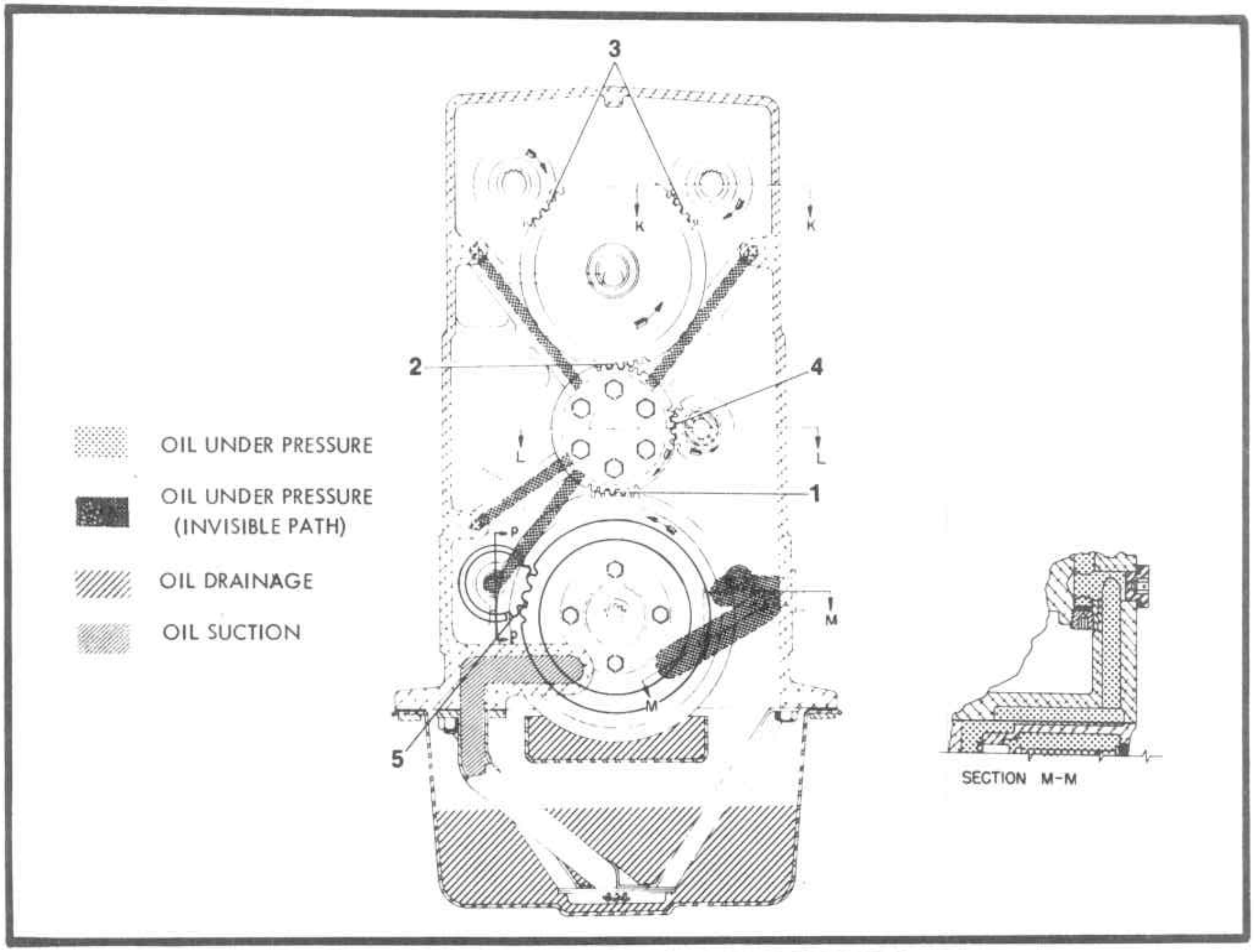

FIGURE 72-30-08. TABLE OF LIMITS CHART (1)

REF. NO.	DESCRIPTION	SERVICE LIMIT	NEW PARTS MIN.	NEW PARTS MAX.
	GEAR BACKLASH			
1	Crankshaft Gear and Camshaft Gear	0.016	0.008	0.012
2	Crankshaft Gear and Idler Gear.	0.016	0.008	0.012
3	Idler Gear and Magneto Drive Gear . . . . . . (Left and Right)	0.016	0.008	0.012
4	Starter Shaftgear and Crankshaft Gear. . . .	0.016	0.008	0.012
5	Cam Gear Cluster and Fuel Pump Drive Gear	0.016	0.008	0.012

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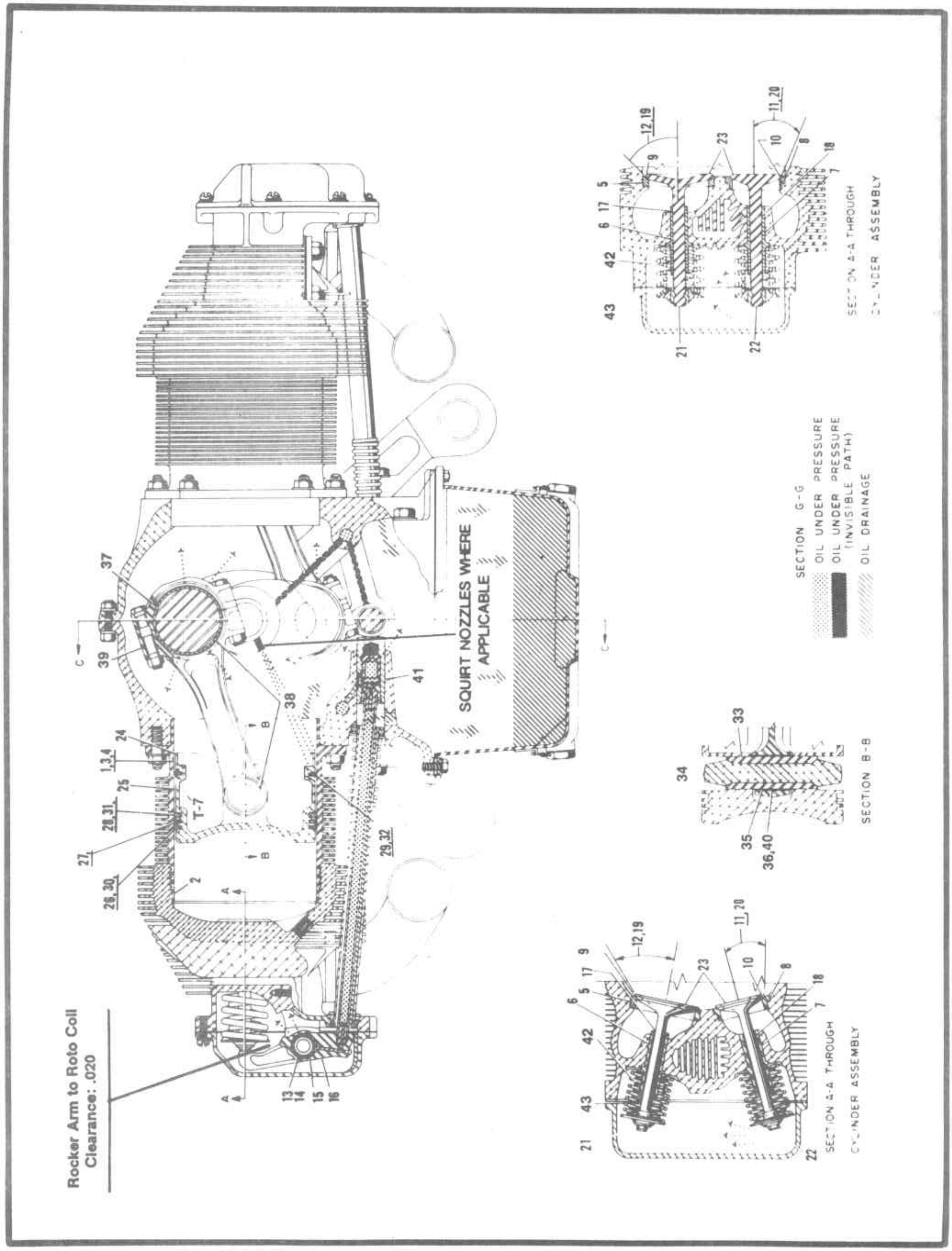

FIGURE 72-30-08 TABLE OF LIMITS CHART (2)

FIGURE 72-30-08
TABLE OF LIMITS
CHART (2)

REF. NO.	DESCRIPTION	SERVICE LIMIT	NEW PARTS MIN.	NEW PARTS MAX.
	CYLINDER & HEAD ASSY.			
1	Cylinder Bore (Lower 4-1/4" of barrel).		Ref. to Figure 72-20-15 A&B	
	Cylinder Bore choke		Ref. to Figure 72-20-15 A&B	
2	Cylinder bore, out-of-round			0.002
3	Cylinder bore, allowable oversize.		Ref. to Figure 72-20-15 A&B	
4	Cylinder bore, surface roughness (Nitride Barrels) using 180 grit stone, cross hatch (angle:)	-	22°-32°	-
	Microfinish (measured in direction of piston travel) (RMS:)	-	15	25
4	Cylinder bore surface roughness (Channeled Chrome) using 180 grit stone, cross hatch (angle:)	-	22°-32°	-
	Finish all area within ring travel. Must show evidence of contact with honing stone. Partially honed areas shall not exceed 10% of bore surface and no area shall exceed one inch in any direction.			
4	Cylinder bore surface rougness (Cermicrome)			
	Finish - pitting is undesierable if present, it is subject to the following limits:			
	Pits (No more than two pits in any 1/4 inch Dia. circle) (diameter:).	-	-	.031
	Not more than 25 pits of any size in entire cylinder bore is acceptable.			
5	Intake valve seat inserts in cylinder head, dia.		0.009 T	0.012 T
6	Intake valve guide in cylinder head, dia.. . . .		0.001 T	0.0025 T
7	Exhaust valve guide in cylinder head, dia. . . .		0.001 T	0.0025 T
8	Exhaust valve seat insert in cylinder head, dia.		0.007 T	0.010 T
9	Intake valve seat, width		0.128	0.132
10	Exhaust valve seat, width		0.109	0.113
11	Exhaust valve seat (To valve guide axis), angle		44° 30'	45°
12	Intake valve seat (To valve guide axis), angle		59° 30'	60°

FIGURE 72-30-08
TABLE OF LIMITS
CHART (2) Continued

REF. NO.		DESCRIPTION	SERVICE LIMIT	NEW PARTS MIN.	NEW PARTS MAX.
		ROCKER ARMS & SHAFTS			
13	①	Rocker shaft in cylinder head bosses, dia.. . . .	0.003 L	0.0015 L	0.003 L
13	②	Rocker shaft in cylinder head bosses, dia.. . . .	.004 L	0.000	0.004 L
14	①	Rocker shaft in rocker arm bearing, dia.. . . .	0.006 L	0.0025 L	0.004 L
14	②	Rocker shaft in rocker arm bearing, dia.. . . .	0.006 L	0.001 L	0.003 L
15	①	Rocker arm bearing in rocker arm, dia.		0.0015 T	0.0055 T
15	②	Rocker arm bearing in rocker arm, dia.		0.002 T	0.0065 T
16	①	Rocker arm, side clearance	0.015	0.004	0.011
16	②	Rocker arm, side clearance	0.035	0.004	0.016
17		Intake valve in guide, dia.	0.005 L	.001 L	.0042 L
18		Exhaust valve in guide, dia.	0.009 L	0.0035 L	0.009 L
19		Intake valve face (To stem axis), angle		59° 45'	60° 15'
20		Exhaust valve face (To stem axis), angle . . .		45°	45° 30'
21		Intake valve (Max. tip regrind .015), length	4.789	4.804	4.824
22		Exhaust valve (Max. tip regrind .015), length	4.791	4.806	4.826
23		Intake and exhaust valve (Full indicator reading), warpage	0.004		
		Valve rocker toe to valve stem (dry lifter) . . .		.060	0.200
		PISTONS, RINGS & PINS			
24		Piston (Bottom of skirt) in cylinder, dia.	0.013 L	0.008 L	0.012 L
25		Piston (Below third ring groove in cylinder) dia.	0.015 L	0.009 L	0.012 L
26		Top Piston ring (rectangular) side clearance	0.011 L	0.0065 L	0.0085 L
26		Top and second piston ring (Semi-Keystone), side clearance	0.012 L	0.008 L	0.010 L
27		Second piston ring (retangular) side clearance	0.010 L	0.005 L	0.008 L
28		Third piston ring (5/32 width), side clearance	0.0070 L	0.0035 L	0.0050 L
28		Third piston ring (3/16 width) side clearance	0.006 L	0.0015 L	0.0035 L
29		Fourth piston ring side clearnace.	0.010 L	0.006 L	0.008 L
30		Top and second rings (Rings in cylinder barrel 6.32 from bottom of barrel) gap . . .		0.010	0.030
31		Third ring (Ring in cylinder barrel 6.32 from bottom of barrel), gap		0.010	0.030
32		Fourth ring (Ring in cylinder barrel at 1.00 from end of barrel), gap		0.010	0.030

FOOTNOTES:

① Straight valve head.
② Incline valve head.

FIGURE 72-30-08
TABLE OF LIMITS
CHART (2) Continued

REF. NO.	DESCRIPTION	SERVICE LIMIT	NEW PARTS MIN.	NEW PARTS MAX.
33	Piston pin in piston, dia.	0.0013 L	0.0001 L	0.0007 L
34	Piston pin and plug in cylinder, end clearance.	0.090 L	0.036 L	0.048 L
35	Piston pin in connecting rod bushing, dia.	0.004 L	0.0022 L	0.0026 L
36	Piston pin bushing in connecting rod, dia.		0.0025 T	0.0050 T
37	Connecting rod bearing on crank pin (tri-metal bearing), dia.	0.006 L	0.0009 L	0.0034 L
38	Connecting rod piston bore with counterpin bore twist or convergence per inch of length	0.001	0.000	0.0005
39	Bolt in connecting rod, dia.		0.0000	0.0018 L
40	Connecting rod pin bore, dia.		1.1267	1.1269
41	Hydraulic tappet in crankcase, dia.	0.0035 L	0.001 L	0.0025 L
42	Inner valve spring No. 637837 (Compressed to 1.230 in. length), load	82 lbs.	87 lbs.	97 lbs.
42	Inner Valve spring No. 637837 (Compressed to 1.746 in. length), dia.	29 lbs.	32 lbs.	38 lbs.
43	Outer valve spring No. 631521 (Compressed to 1.275 in. length), load	118 lbs.	126 lbs.	140 lbs.
43	Outer valve spring No. 631521 (Compressed to 1.791 in. length), load	46 lbs.	49 lbs.	55 lbs.

FOOTNOTES:

(1) Straight valve head.
(2) Incline valve head.

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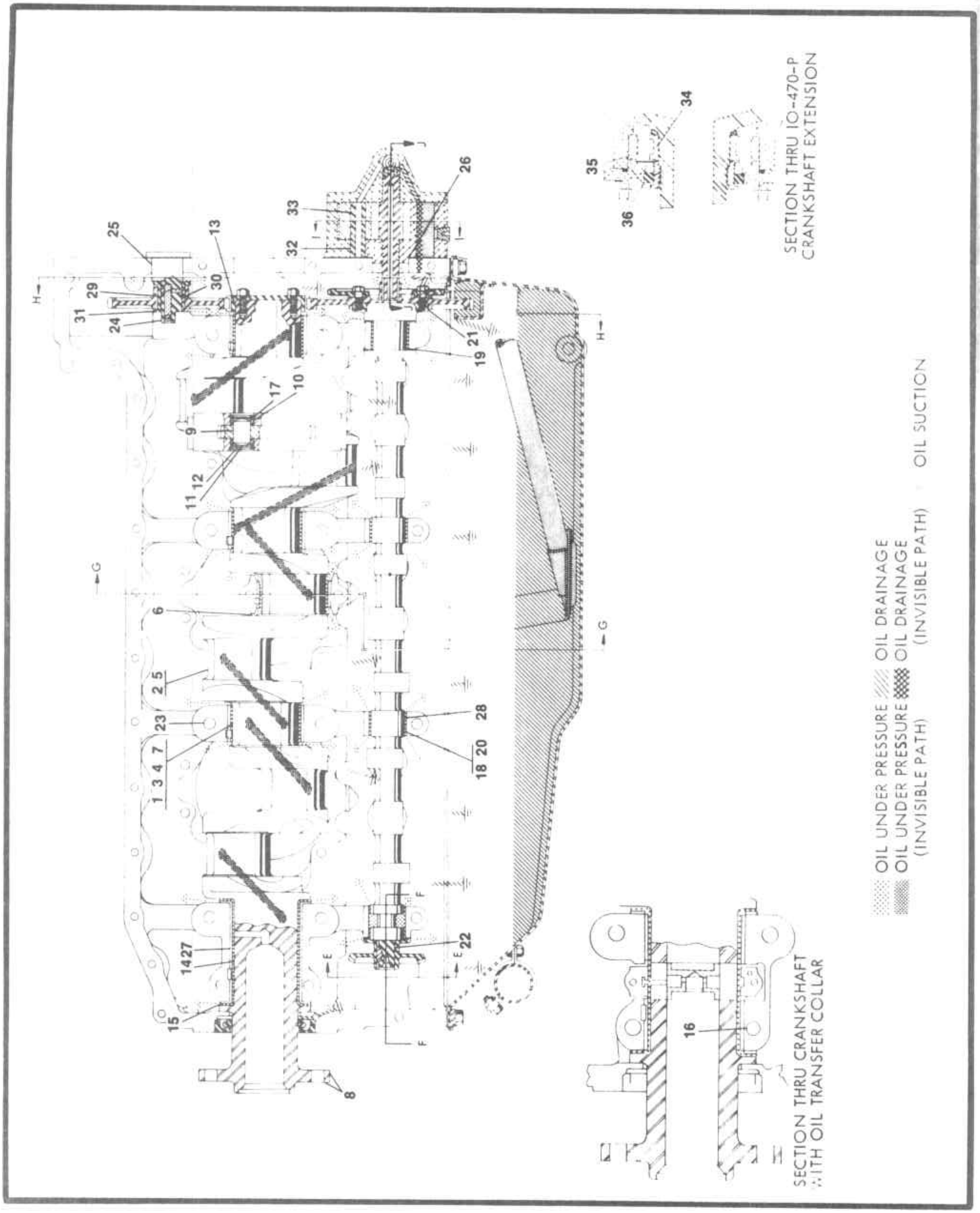

FIGURE 72-30-08 TABLE OF LIMITS CHART (3)

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FIGURE 72-30-08
TABLE OF LIMITS
CHART (3)

REF. NO.	DESCRIPTION	SERVICE LIMIT	NEW PARTS MIN.	NEW PARTS MAX.
	CRANKSHAFTS			
1	Crankshaft in main bearings (tri-metal) diameter	0.006 L	0.0018 L	0.0047 L
2	Crankpins, out-of-round	0.0015 ①	0.000	0.0005
3	Main journals, out-of-round	0.0015 ①	0.000	0.0005
4	Crankshaft main and thrust journals, dia.	2.372 ①	2.374	2.375
5	Crankpins, diameter	2.247 ①	2.249	2.250
6	Connecting rod on crankpin, end clearance	0.016	0.006	0.010
7	Taper over full crankshaft, bearing length	0.0015	0.000	0.0005
7	Crankshaft run-out at center main journals, (Shaft supported at thrust and rear, full indicator reading	0.015	0.000	0.015
8	Crankshaft wobble at propeller flange when supported at front and rear main journals, full indicator reading	0.005	0.000	0.005
9	Damper Pin Bushing in crank cheek extension, diameter		0.0015 T	0.003 T
10	Damper pin bushing in counterweight, dia.		0.0015 T	0.003 T
11	Damper pin in counterweight, end clearance	0.040	0.001	0.029
12	Pin retaining plate in counterweight, dia.	0.005 L	0.0005 T	0.0025 L
13	Crankshaft gear on crankshaft, dia.		0.000	0.002 T
14	Crankshaft in front bearing, diameter	0.005 L	0.0001 L	0.0021 L
14	Crankshaft in front bearing, diameter	0.006 L	0.0009 L	0.0039 L
15	Crankshaft in thrust bearing, end clearance	0.025	0.004	0.016
16	Oil transfer sleeve in crankcase, dia.		0.0005 L	0.002 L
16	Oil transfer collar on crankshaft, dia.	0.0018	0.0006 L	0.0013 L
16	Sleeve in oil transfer collar, dia.		0.0005 L	0.002 L
17	Damper pin bushing bore in counterweight and crankshaft extension, diameter	0.6265	0.622	0.626
	CAMSHAFT			
18	Camshaft journals in crankcase, diameter	0.005 L	0.001 L	0.003 L
19	Camshaft in crankcase, end clearance	0.014	0.005	0.009
20	Camshaft run-out at center journals (Shaft supported at end journals), full indicator reading	0.001	0.000	0.001
21	Camshaft gear on camshaft flange, diameter		0.0005 T	0.0015 L
22	Governor drive gear on camshaft, diameter	0.006 L	0.0002 L	0.002 L

FOOTNOTES:

① If crankshafts are worn beyond these limits they may be repaired by grinding journals to 0.010 under new shaft limits and renitriding journals.

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FIGURE 72-30-08
TABLE OF LIMITS
CHART (3) Continued

REF. NO.		DESCRIPTION	SERVICE LIMIT	NEW PARTS MIN.	NEW PARTS MAX.
		CRANKCASE AND RELATED PARTS			
23		Through bolt (10.75") in crankcase, diameter		0.0005 T	0.0013 L
24		Idler gear support pin in crankcase (Front), diameter.	0.0010 L	0.0015 T	0.0005 L
25		Idler gear support pin in Crankcase (Rear), diameter.		0.0005 L	0.0025 L
25		Idler pin front bore in crankcase, diameter. .		.500	.501
26		Oil pump housing pilot in crankcase, dia. . .		0.001 L	0.003 L
27		Crankcase main bearing journals, dia.. . . .		2.5625	2.5635
28		Camshaft bearing journals in crankcase, dia.		1.250	1.251
		ACCESSORY DRIVE IDLER ASSEMBLY			
29		Bushing in idler gear, diameter		0.001 T	0.003 T
30		Idler gear support in bushing, diameter . . .	0.005 L	0.0015 L	0.0035 L
31		Idler gear, end clearance.	0.043 L	0.004 L	0.037 L
		OIL PRESSURE PUMP ASSEMBLY			
32		Oil pump driven gear shaft in oil pump housing, diameter		0.001 T	0.003 T
33		Oil pump driven gear on shaft, diameter. . .	0.004 L	0.0005 L	0.0025 L
34	②	Roller bearing on shaft assembly, dia.. . . .		0.0011 T	0.0000
35	②	Roller bearing in housing, diameter		0.0000	0.0015 L
36	②	Oil seal in housing cover, diameter		0.0015 T	0.0085 T

FOOTNOTES:

① IO-470-C,D,E,F,G,H,J,K,L,M,N,R,S,U & V
② IO-470-P

FIGURE 72-30-08
TABLE OF LIMITS
CHART (4)

REF. NO.		DESCRIPTION	SERVICE LIMIT	NEW PARTS MIN.	NEW PARTS MAX.
		CRANKCASE AND RELATED PARTS			
1		Governor gear shaft in crankcase, dia. . . .	0.005 L	0.0014 L	0.0034 L
		OIL PRESSURE RELIEF VALVE ASSEMBLY			
2		Oil pressure relief valve plunger on adjusting screw, diameter.	0.004 L	0.0005 L	0.0020 L
		OIL PRESSURE PUMP ASSEMBLY			
3		Oil pump driver gear in pump housing, dia. .	0.006 L	0.0015 L	0.004 L
4		Oil pump driver gear shaft in pump housing, diameter.	0.0045 L	0.0015 L	0.003 L
5		Oil pump driven gear in pump housing, end clearance	0.005 L	0.0011 L	0.003 L
6		Oil pump driver gear in pump housing, end clearance	0.005 L	0.0011 L	0.0003 L
7		Oil pump driver gear shaft in oil pump cover, diameter.	0.0045 L	0.0015 L	0.003 L
8		Oil pump driver gear shaft in tachometer drive bevel gear, diameter	0.004 L	0.0005 L	0.0025 L
9		Oil pump driven gear in housing, diameter. .	0.006 L	0.0015 L	0.004 L
		TACHOMETER DRIVE ASSEMBLY			
10	①	Washer tachometer thrust, thickness	0.140	0.150	0.170
11	②	Tachometer drive shaft in oil pump cover, diameter.	0.0045 L	0.0015 L	0.003 L
12		Oil seal in tachometer drive housing, dia. . .		0.001 T	0.007 T
		GEAR BACKLASH			
13		Oil pump driver and driven gears, backlash .	0.027	0.014	0.0218
14		Tachometer drive gear and tachometer driven gear, backlash.	0.012	0.004	0.008
15		Governor drive gear and governor driven gear, backlash	0.009	0.002	0.006

FOOTNOTES:

① IO-470-E
② IO-470-C,E,F & G
③ IO-470-C,D,E,F,G,H,J,K,L,M,N,P, R & S
④ IO-470-U & V

FIGURE 72-30-08
TABLE OF LIMITS
CHART (4) Continued

REF. NO.		DESCRIPTION	SERVICE LIMIT	NEW PARTS MIN.	NEW PARTS MAX.
		SPRING TEST DATA			
16		Oil pressure relief valve spring No. 634150 compressed to 1.25 in. length, load	29 lbs.	32 lbs.	37 lbs.
17	③	Oil temperature control valve 0.16 inches, minimum travel at, temperature		135°F	173°F
18	④	Oil temperature control valve 0.090 inches, minimum travel at, temperature		120°F	170°F
18	③	Oil temperature control valve must close between, oil temperature		171°F	175°F
18	④	Oil temperature control valve must close between, oil temperature		168°F	172°F
19		Oil filter by-pass valve spring No. 631478 in pump comp. to 1.09 in. length, load . .	5.0 lbs.	5.3 lbs.	5.9 lbs.

FOOTNOTES:

① IO-470-E
② IO-470-C,E,F & G
③ IO-470-C,D,E,F,G,H,J,K,L,M,N,P,R & S
④ IO-470-U & V

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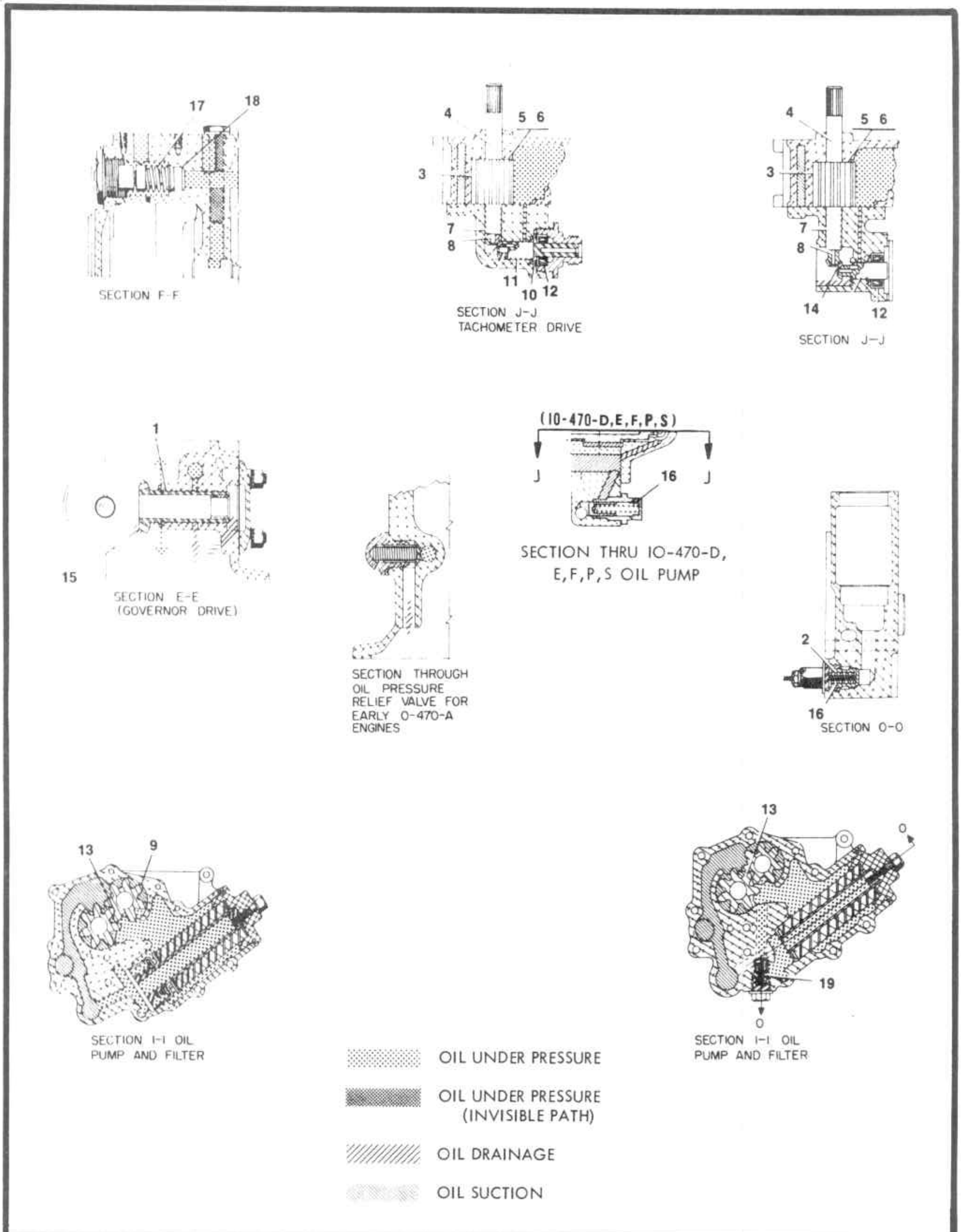

FIGURE 72-30-08 TABLE OF LIMITS CHART (4)

FIGURE 72-30-08
TABLE OF LIMITS
CHART (5)

REF. NO.	DESCRIPTION	SERVICE LIMIT	NEW PARTS MIN.	NEW PARTS MAX.
	CRANKCASE AND RELATED PARTS			
1	Magneto and accessory drive adapter pilot in crankcase, diameter.		0.00	0.004 L
	LEFT & RIGHT MAGNETO & ACCESSORY DRIVE ASSEMBLY			
2	Bushing in magneto and accessory drive adapter, diameter		0.001 T	0.004 T
3	Magneto and accessory drive gear in adapter bushing, diameter	0.005 L	0.0015	0.0035 L
4	Oil seal in adapter, diameter		0.001 T	0.007 T
5	Sleeve in magneto and accessory drive gear, diameter.		0.001 T	0.004 T
6	Magneto and accessory drive gear, end clearance		0.032 T	0.104 L
7	Magneto coupling retainer on magneto and accessory drive gear sleeve, diameter. . .	0.055 L	0.025 L	0.040 L
8	Magneto coupling retainer in magneto drive gear slot, side clearance	0.040 L	0.006 T	0.032 L
9	Magneto coupling rubber bushing on magneto drive lugs, side clearance		0.052 T	0.010 L
10	Magneto pilot in crankcase, diameter		0.000	0.004 L
	STARTER DRIVE			
11	Starter shaft gear in bearing, diameter. . . .	0.0031 L	0.0000	0.0025 L
12	Starter shaft gear front (Bearing) journal, diameter.	0.748	0.7495	0.750
13	Starter clutch drum on starter shaft gear, diameter.	0.0055 L	0.002 L	0.004 L
14	Clutch spring sleeve in starter adapter diameter.		0.003 T	0.005 T
15	Starter shaft gear in ball bearing diameter.		0.001 L	0.0005 T
16	Starter gear in oil seal sleeve diameter		0.000	0.0015 L
17	Bearing in starter adapter cover diameter.		0.001 L	0.0001 T
18	Oil seal in starter adapter cover diameter.		0.0017 T	0.0063 T
19	Starter adapter cover pilot in starter adapter diameter.		0.001 L	0.003 L
20	Worm wheel gear end clearance:.	0.085	0.043	0.074

FIGURE 72-30-08
TABLE OF LIMITS
CHART (5) (cont'd)

REF. NO.	DESCRIPTION	SERVICE LIMIT	NEW PARTS MIN.	NEW PARTS MAX.
21	From center line of worm gear shaft to starter adapter thrust pads	0.252	0.246	0.248
22	Needle bearing is starter adapter diameter.		0.001 L	0.001 T
23	Ball bearing in starter adapter diameter.		0.001 L	0.0001 T
24	Worm gear shaft in ball bearing diameter.		0.0001 L	0.0007 T
25	Starter worm gear on shaft diameter.	0.004 L	0.0005 L	0.0025 L
26	Starter piolot to starter drive adapter diameter.		0.001 L	0.0065 L
27	Starter drive tongue to worm shaft drive slot side clearance:	0.030 L	0.010 L	0.021 L
28	Needle bearing to shaft worm gear diameter.	0.0031 L	0.0005 L	0.0029 L
	FUEL PUMP ASSEMBLY			
29	Pilot fuel pump adapter in crankcase diameter.		0.001 L	0.006 L
30	Fuel pump gear in adapter diameter.	0.004 L	0.0005 L	0.0025 L
31	Fuel pump drive gear in crankcase end clearnace	0.054 L	0.002 L	0.038 L
32	Seal in fuel pump adapter diameter.		0.002 T	0.006 T
33	Insulator pilot in adapter, diameter.		0.0005 L	0.0045 L
34	Fuel pump pilot in insulator diameter.		0.005 L	0.0045 L
	GEAR BACKLASH			
35	Starter worm wheel gear and worm gear backlash	0.020	0.009	0.013

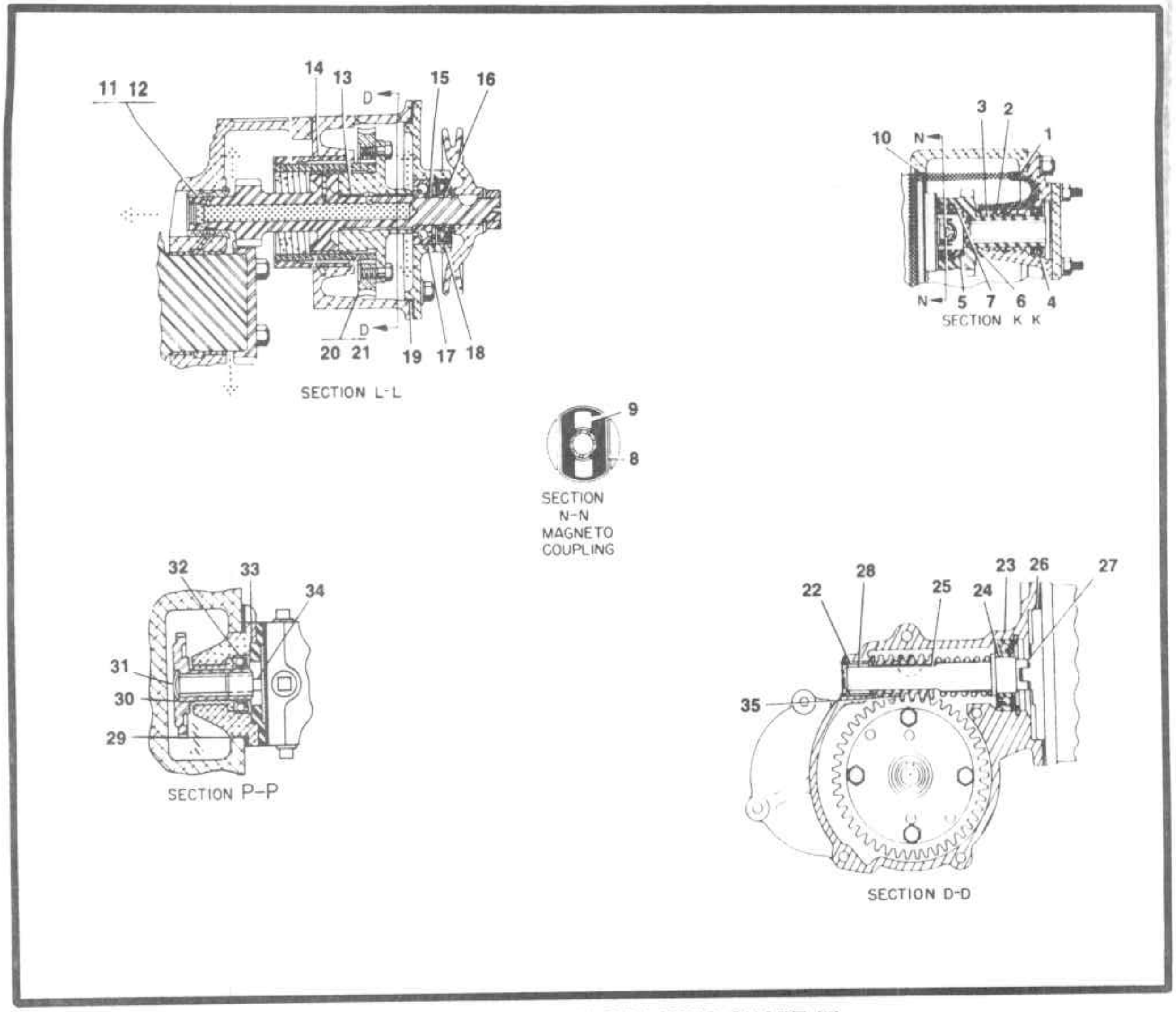

FIGURE 72-30-08. TABLE OF LIMITS CHART (5)

72-30-09 **ORIGINAL DIMENSIONS.** Although comparative measurements of mating parts will determine the serviceability of the fit, it is not always easy to determine which part has worn the most, and in some instances (e.g., main journals in new bearing inserts), accurate measurements of fit are not possible. While no limits of wear on critical dimensions have been assigned to specific parts, it is helpful in estimating wear to know the original dimensions. Therefore, the manufacturing limits "Critical New Parts Dimensions", in Section 72-30-09, should be consulted when the serviceability of a specific part is in doubt.

72-30-09

CRITICAL NEW PARTS DIMENSIONS

Part Name	Feature	New Dimension (Inches)
Cylinder Head	Rocker Shaft Boss Bore (Inclined Valve)	0.7495-0.7525
	(Straight Valve)	.7182-.7192
	Rocker Shaft O.D.	.7483-.7495
	Intake Valve Guide Bore (Pre-finished)	0.4377-0.4367
	Exhaust Valve Guide Bore (Nitralloy)	0.438-0.439
Valve Rocker	Outside Diameter	0.7490-0.7495
Valve Rocker Bushings	Inside diameter (Straigth Valve Cylinder Bushing)	.7192-.7202
	Inside diameter (Incline Valve Cylinder Bushing)	.7505-.7515
Intake Valve	Stem Diameter	0.4335-0.4340
Exhaust Valve	Stem Diameter	0.4345-0.4350
	Stem Diameter	0.4333-0.4340
Piston	① Diameter at bottom	4.991-4.993
	Piston Pin Bore Diameter	1-1246-1.1250
	Third Ring Groove Width	0.1890-0.1900
	Fourth Ring Groove Width	0.1000-0.1010

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CRITICAL NEW PARTS DIMENSIONS (cont'd)

Part Name	Feature	New Dimension (Inches)
Connecting Rod	Bushing Bore, Dia., Piston Pin End	1.1257-1.1261
	Bushing Bore Dia., Crank Pin End	2.3755-2.3760
	Piston Pin Bush Center to Crank Pin Center	6.623-6.627
	Conn. Rod to Crank Pin Bearing (Thickness)	.0618-.0623
Crankshaft Assembly	Crankpin Dia.	2.2480-2.2500
	Crankshaft Mains	2.3730-2.3750
	Counterweight & Crankshaft Pin Bushing I.D.(24)	0.622-0.626
Camshaft	Journal Dia.	1.247-1.249
Crankcase	Camshaft Bearings Dia.	1.250-1.251
	Lifter Guides Dia.	1.0005-1.0015
	Governor Driven Gear Bearing Dia.	0.8750-0.8760
	Starter Shaft Needle Bearing Hole Dia.	.09990-1.000

CRITICAL NEW PARTS DIMENSIONS (cont'd)

Part Name	Feature	New Dimension (Inches)
Hydraulic Valve Lifters	Outside Diameter Intake & Exhaust	0.9990-0.9996
Starter Worm Drive Shaft	Small End Dia.	0.5615-0.5625
	Needle Bearing Hole in Starter Adapter	0.7485-0.7495
Starter Shaftgear	Front Journal Dia.	0.7495-0.7500
	Knurled Drum Dia.	1.9310-1.9320
	Clutch Drum Support Dia.	0.7870-0.7880
Starter Shaftgear	Inside Diameter	0.7900-.0.7910
Starter Clutch Spring	Outside Diameter	2.3740-2.3760
	Inside Diameter	1.9380-1.9400
Starter Drive Adapter	Sleeve Front End I.D.	2.3380-2.3430
Oil Pump Driver Gear	Shaft Diameter	0.5597-0.5605
Oil Pump Driven Gear (539525)	Inside Diameter	0.5030-0.5040
Oil Pump Housing and Shaft Assembly	Driven Gearshaft Diameter	0.5015-0.5025
	Driver Gearshaft Hole Diameter	0.5620-0.5630
	Gear Chamber Depth	1.7485-1.7500
Magneto Drive Gears (629075)	Shaft Diameter	0.8115-0.8130
Magneto and Accessory Drive Adapter	Bushing Inside Diameter	0.7925-0.7975
Idler Gear Assembly	Bushing I.D.	0.7900-0.7950
Idler Gear Support Pin (534728)	Gear Support Diameter	0.8090-0.8105

(1) Measure piston diameters at right angles to pin bore.

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72-30-10 **PROTECTIVE COATING.** The manufacturer protects all aluminum alloy castings, sheet metal and tubing from corrosion by treating all surfaces, of the parts, with "Accelagold" (Turco Products, 3300 Montreal Industry Way, Tucker, Georgia 30084).

72-30-11 **APPLICATION OF "ANODIZING".** After any machining or repair operation, aluminum surfaces must be "Anodized". Surface color may vary from light gold, to dark brown. The "Accelagold" coating on mating or bearing surfaces is thin enough that it has no effect on dimensional tolerances.

Wrought or die cast, (smooth surface parts such as valve rocker covers and intake tubes), are "tumble blasted", prior to machining, to roughen surfaces before treatment. "Tumble blasting" must not be applied at overhaul on parts with machined surfaces.

CAUTION . . . Do not use enamel paint or primer for internal parts, as it may flake or break off during engine run and contaminate lubricating oil.

72-30-12 **REPAIR OF ANODIZED SURFACES.** If anodized parts have been remachined, rubbed with abrasives or scratched in handling so as to expose areas of bare aluminum, the surface may be repaired by local application of "Accelagold" solution in the following steps:

A. Clean bare area thoroughly with carbon tetrachloride. Do not under any circumstances use an oil base solvent or strong alkaline cleaner.

B. Mix a small quantity of hot water (180°F.) with 1-1/2 to 2 ounces of "Accelagold" powder to form a paste, then gradually dilute with hot water until a solution of one gallon is attained. This solution is to be adjusted by addition of nitric acid to a PH value of 1.5. to 1.7.

C. Apply solution with a rubber set paint brush in such a manner that solution flows over bare area. Allow solution to remain on the part from one to five minutes or until color of the new film is approximately same as original.

D. Flush part with clear water and dry with warm air current. Do not air blast or rub with cloth to dry new film area. If color is too light, repeat step "C" until desired color is obtained.

NOTE . . . If "Accelagold" does not adhere to metal, a more severe cleaning method must be used. 12 to 16 ounces of Oakite No. 61, or equivalent solution, per gallon of water is preferred. Apply and remove the solution with caution. An alkaline cleaner of this type will remove any "Accelagold" film previously applied. Remove cleaning solution thoroughly with plenty of hot water and vigorous brushing.

72-30-13 **ENAMEL COATINGS.** Ferrous parts when painted with gold enamel will be baked with infrared equipment for 15 minutes at 275-285°F. following application of each coat. Magnesium parts will be pickled and primed before painting; then baked with infrared equipment for 15 minutes at 275-285°F. following application of each coat of enamel.

NOTE . . . If a part which was originally anodized is to be refinished with enamel. it will not be necessary to apply zinc chromate primer except to the surface areas completely stripped of "Accelagold".

CAUTION . . . Before application of primer and enamel to a part, carefully mask all connection joints and mating surfaces. No primer or enamel is permissible on interior surfaces of any parts contacted by engine lubricating oil after assembly.

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SECTION 72-40
SPECIFIC INSPECTION

INTENTIONALLY

LEFT

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72-40-00 SPECIFIC INSPECTIONS.

72-40-01 **CRANKCASE.** If any cylinder base nut was loose at disassembly or if any of the cylinder attaching studs are bent, even slightly, or if there is definite evidence that a cylinder was loose at any time, then it is possible that reversal of stress has fatigued the studs and through bolts installed on that cylinder pad, in which case all of them must be replaced. Test for bent studs with a toolmaker's square. When inspecting for casting cracks pay particular attention to areas on and adjacent to the cylinder mount pads, tappet guides, bottom flange, and bearing bosses. Look for nicks on machined surfaces and scoring in shaft bearings and the shaftgear bushing. The castings must be clamped together at all attaching points before dimensional inspection of camshaft and crankshaft bearing bores.

NOTE . . . For cracked crankcase, (see TCM Service Bulletin M83-10 R1 or current revision as applicable).

72-40-02 **CRANKSHAFT.** In addition to magnetic particle, ultrasonic, visual and dimensional inspection, the shaft should be mounted on matched vee blocks on a surface plate (supporting the front and rear main journals) and rotated under a dial indicator placed on the center main journal in order to detect excessive bending. This is important if the aircraft has been involved in an accident resulting in a broken or bent propeller. (Refer to the Table of Limits 72-30-09 for limits of "run-out" at the center journal.)

NOTE . . . In case of prop strike (sudden stoppage), (see TCM Service Bulletin M84-16 or current revision as applicable).

72-40-03 CRANKSHAFT, COUNTERWEIGHT PINS, AND BUSHINGS.

A. Excessive localized galling of the crankshaft dampener pin bushings can affect propeller blade tip stresses. It is recommended that at each normal major overhaul, the pin bushings be replaced. Worn or out of round counterweight bore will require counterweight replacement.

B. Inspect in the following manner: Measure the inside diameter of bushing across points A, B and C. Take the average of A and B and deduct this from C. If the difference exceeds .001" then the bushing should be replaced. (Refer to Figure 72-40-03).

1. The C measurement should be the point of maximum diameter which is generally a point perpendicular to the lengthwise centerline of the crankshaft.

2. Measurements A and B should be taken at points approximately 60° either side of Point C.

3. After removing the bushings from the dampeners or the crankshaft blades, measure the inside diameter of the holes. Select a replacement bushing which will give an interference fit of .001" - .003" into each of the dampeners or the crankshaft blade holes.

C. Replacement bushings are available in standard, .0015", .003" and .005" oversize on the outside diameter.

D. Counterweight pins are identified by dash numbers stamped on one end. Because the dampener order is controlled by this pin diameter, it is imperative that only the correct pin, properly identified, be used.

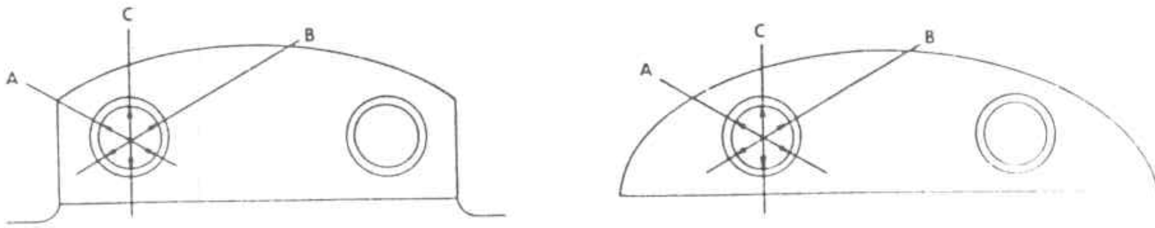

FIGURE 72-40-03. COUNTERWEIGHT BUSHING DIAMETER CHECK.

72-40-04 CAMSHAFT.

Inspect the journal for scoring, corrosion and overheating, Inspect lobes for pitting at the toes and for evidence of overheating or unusual wear.

72-40-05 CONNECTING RODS. **Because of the close tolerance required, TCM recommends using an airgage with correct size air plug and master setting ring to measure all worn bushings and locally replaced bushing.** If a bushing was replaced locally, it is also necessary to check its alignment with the big end bearing seat. The simplest method of making alignment measurements requires a push fit arbor, preferably at least eight inches long, for the bushing bore and another for the bearing seat, a surface plate, two matched vee blocks and two blocks of ground flat steel stock of equal height. To measure twist, insert the arbors into the rod bores; then lay the big end arbor in the vee blocks on the surface plate, and place the ground steel blocks under the ends of the bushing arbor at a measured distance apart. A feeler gage may be used to detect any clearance at either end under the bushing arbor. This, divided by the separation of the blocks in inches, will give the twist per inch of length. (Refer to Section 72-30-08, Table of Limits). To measure bushing and bearing convergence, mount a dial indicator on a surface gage, and swing the rod around the big end arbor to the vertical position against a firm stop. Pass the indicator over the bushing arbor at points an exact number of inches apart. The difference in readings at the two ends, divided by the distance between points of measurements, again gives the misalignment per inch, as specified in Section 72-30-08, Table of Limits.

72-40-06 GEARS. Inspect gear teeth for signs of overheating and excessive wear. Normal wear produces a fine polish on the tooth thrust faces. Alteration of the tooth profiles, score marks and pitting are sufficient cause for rejection.

72-40-07 PISTONS AND RINGS. Inspect the skirt for long, deep scores which indicate overheating and would be sufficient cause for rejection. If a telescoping gage is used to measure the pin bore, do not allow the spring pin to extend rapidly so as to strike the wall hard. Visually inspect for thorough cleaning, including the oil relief holes in the third ring groove. It is NOT necessary to remove light scores or discoloration from the exterior surfaces; do not use abrasives (including crocus cloth) on the skirt, since the cam-ground contour should not be altered. If the piston is dimensionally serviceable in other respects and apparently sound, measure side clearances of new rings, after measuring the ring gap as follows:

A. MEASURING RING GAP IN CYLINDER

Piston ring gap should be measured whenever a cylinder is removed for repair or overhaul. Insert ring into cylinder as illustrated in Figure 72-40-07B. Next, insert piston **without** rings installed into cylinder. Push piston down until piston ring is at a depth of 6.34" from bottom of cylinder skirt. Remove piston leaving ring squared at 6.34" depth. At this point measure the ring gap with a feeler gage. If gap is too tight according to Table of Limits, file ring to within limits and polish end with an Arkansas stone. If gap is too large go to a 0.005 inch oversize ring to reach Table of Limits.

B MEASURING RING SIDE CLEARANCE

After piston rings have been checked for ring gap, install rings on piston, do not allow their sharp ends to scratch the piston lands. Make certain part number is toward piston head. Now measure ring side clearance as follows:

1. Hold a straight edge against the side of the piston ring grooves adjacent to the piston pin relief, as shown in Figure 72-40-07A.

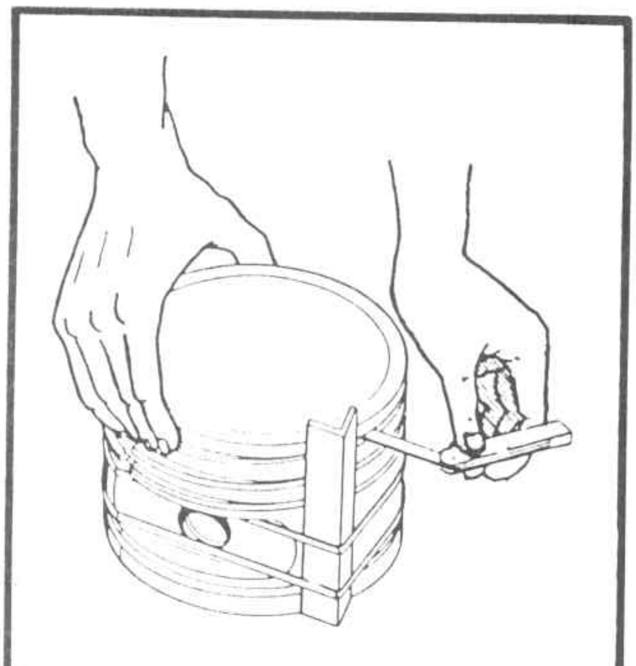

FIGURE 72–40–07A. INSPECTING RING SIDE CLEARANCE.

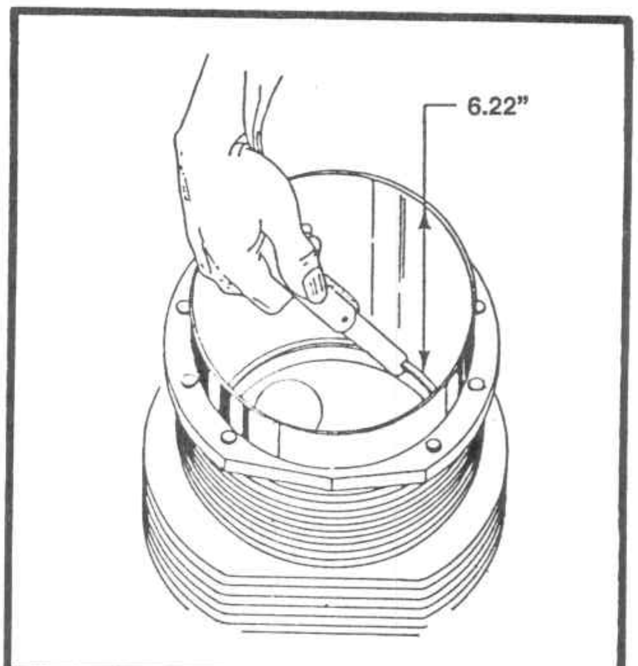

FIGURE 72–40–07B. MEASURING RING GAP IN CYLINDER.

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72-40-08 CYLINDERS. Measure barrel bore near the top of the ring travel limit and at the 4-1/4 inch station from the open end in the thrust direction and at right angles to that in order to detect out-of-roundness and wear-in taper. There should be little or no wear at the open end. Look for bent barrel fins and broken head fins. Barrel fins can be straightened if not badly bent or cracked. A reduction of not over 10% in area of head fins due to breakage is allowable. Look for cracked head fins, and specify repair of any radial crack by drilling a vee notch to remove it. If a radial crack extends to the root of a fin it may have penetrated the wall; hence the cylinder should be rejected. If the cylinder base nuts were loose at disassembly, or if the base studs were loose or bent, test the machined side of the cylinder flange for bending which is cause for rejection. Measure valve guides for wear, and look for scoring in their bores. Valve seats should be inspected after refacing to make sure that their outside diameters are still less than the valve head diameters. TCM recommends 100% replacement of all exhaust valves at engine overhaul regardless of condition, all intake valves should be measured in length if the stem tips were ground. Inspect the spark plug hole and intake flange screw hole helical coil inserts for looseness, deformation and position. The outer ends should lie in the first full thread of the tappet holes in which they are installed. The spark plug hole helical coil has teeth at the outer end which are forced into the head metal and should not be visible. If there was any evidence of over-heating of cylinder or piston, check as well as possible for turning of the head in relation to the barrel flange.

NOTE . . . Due to the choke specified for the cylinder barrel bore, a cam-controlled grinder is required to regrind worn barrels to the maximum allowable 0.015 inch oversize dimension.

PISTON TO CYLINDER DOME CLEARANCE. The **unobstructed** clearance above the steel cylinder barrel into the aluminum cylinder head must be a minumum of .120 in. If clearance is not adequate, material may be removed by grinding or honing the aluminum cylinder head to obtain this clearance with a corner radius of .62 in. **Measure clearance as illustrated.**

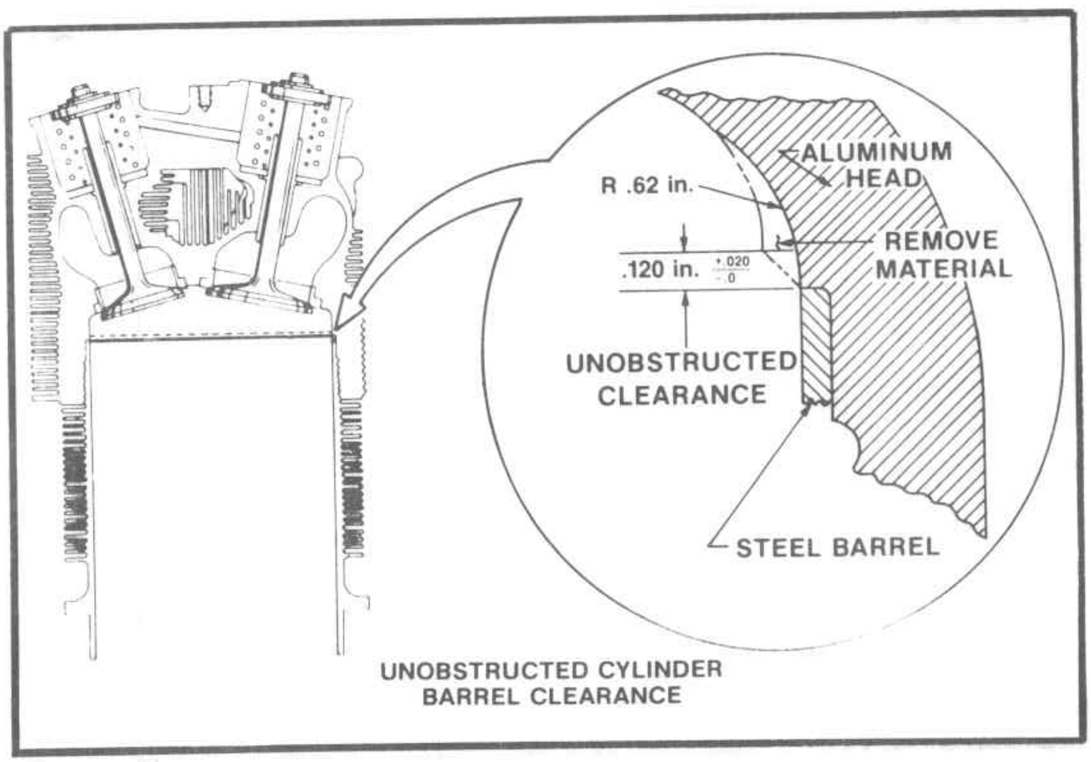

FIGURE 72-40-08 PISTON TO CYLINDER DOME CLEARANCE.

72-40-09 **HYDRAULIC VALVE LIFTERS.** During examination of each part, look for sludge and carbon residues. Also check for obstructed oil holes. Inspect face of cam follower on body for any type of damage and look for deep scoring and corrosion on exterior or tubular portion. Discard any lifter body which exhibits any of these faults, or at major overhaul. To test roughly for excessive diametrical clearance between hydraulic unit plunger and cylinder and to check valve wear in cylinder, start dry plunger into dry cylinder. While holding cylinder between thumb and middle finger, depress plunger with index finger and release it quickly. Compression of air in cylinder should make plunger kick back instantly. If plunger does not return fully, either it is excessively worn or check valve is leaking. To check for leaking valve, repeat compression test while plugging end of oil inlet tube with other hand. If plunger still does not kick back promptly, it and the cylinder are excessively worn. If it does kick back on the second test, either check valve seat is worn and leaking or it is dirty. Clean cylinder again and repeat first test (tube open). If plunger still does not kick back, valve is malfunctioning. Any unit failing to pass this rough check must be discarded. Discard both plunger and cylinder, since these parts are selectively-fitted and are not interchangeable. TCM recommends 100% replacement of valve lifters at engine overhaul regardless of condition.

72-40-10 **INTAKE TUBES.** Inspect intake tubes for distortion, cracks and out-of-roundness. All other types of damage will require replacement of the part as well.

72-40-11 **LUBRICATION SYSTEM.** Visually inspect all parts of the system in accordance with the instructions in Sections 72-30-03, 07 & 09.

72-40-12 **FUEL INJECTION SYSTEM.** Further disassembly of the fuel injection system is not recommended unless proper flow equipment is available. For complete overhaul instructions see Fuel Injection Overhaul Manual and Parts Catalog, Form X30593A.

72-40-13 **IGNITION SYSTEM.**

A. Teledyne Continental Motors recommends replacement of the complete ignition harness at every engine overhaul. If between major engine overhaul, repairs can be accomplished according to Chapter 74.

B. Magnetos should be disassembled and inspected at each 500 hr. interval according to Magneto Service Manual.

SPARK PLUGS (See Figure 72-40-13).

Teledyne Continental Motors aircraft engines utilize the two spark plug per cylinder configuration to provide a more efficient fuel/air mixture combustion and a safety feature in the event that one half of the combined dual ignition system fails to operate due to adverse conditions. Two basic type spark plugs are used -- fine wire and massive electrode. Check the current spark plug service bulletin for the correct plug to engine application. Spark plugs should be removed, cleaned, inspected, gapped or replaced if found to be defective at each 100 hour interval. (See Figure 72-40-13, Spark Plugs). As spark plugs are removed they should be marked to indicate cylinder position for relating a particular plug to any cylinder that may possibly have a serious cylinder, piston condition. When installing spark plugs, insure that there is only one gasket, and install in reverse. Screw spark plug into cylinder by hand to within one or two threads of gasket. If resistance is encountered, check threads for misalignment and cleanliness. Torque to 25-30 foot pounds, or 300-360 inch pounds.

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Normal

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

Worn Out Normal

Corrosive gases formed by combustion and the high voltage spark have eroded the electrodes. Spark plugs in this condition require more voltage to fire — often more than the ignition system can produce.

Worn Out Severe

Excessive eroded center and ground electrodes and extensive necking of fine wire ground electrodes indicate abnormal engine power operation. Check fuel metering and magneto timing. Discard the plugs and before installing new spark plugs a careful check should be made to determine if proper heat range plugs are being used.

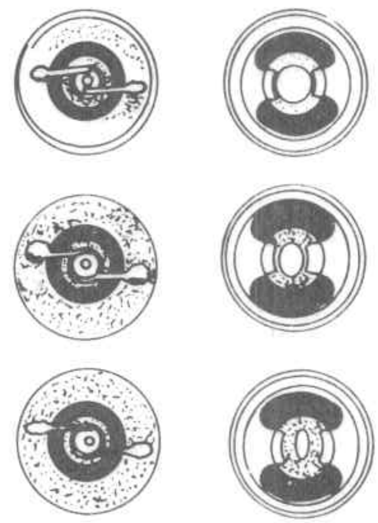
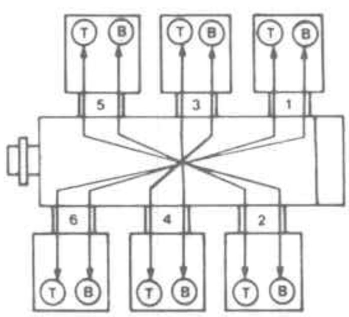


FIGURE 72-40-13A. SPARK PLUGS.



Reduce wear of spark plug electrodes, due to constant polarity, either negative or positive, by reversing bottom (B) spark plugs with top (T) spark plugs per chart.

CYL. No.				CYL. No.		
1	—	T	-TO-	6	—	B
2	—	B	-TO-	5	—	T
3	—	T	-TO-	4	—	B
4	—	B	-TO-	3	—	T
5	—	T	-TO-	2	—	B
6	—	B	-TO-	1	—	T

FIGURE 72-40-13B. REVERSE SPARK PLUG PROCEDURE.

72-40-14 EXHAUST SYSTEM.

For cleaning and inspection procedure pertaining to IO-470 series engine exhaust systems refer to the appropriate airframe manufacturer's instructions.

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INSPECTION CHART

Subassembly And Part	Inspect	Nature Of Inspection	Special Considerations
CYLINDER ASSY. Head & Barrel	Head/Barrel Junction	Discoloration, Seepage.	Clean, inspect if seepage continues, replace cylinder.
	Interior Walls	Corrosion, pitting, scoring.	Defects not permissible after removal of glaze.
	Bore Diameters	Wear in ring traversed area and step at top. Use dial-type gage set to zero near open end of bore.	Refer to Table of Limits for standard size bore or for over-size bore.
		After honing or roughening of glaze measure bore dia-meters, out-of-roundness and taper.	Dimensional honing should remove ring step of more than 0.002 inch diameter. Taper limit (Table of Limits) must not be exceeded by honing.
	Bore Walls	After roughening or honing, inspect scratch pattern and, if possible, measure surface roughness in micro inches RMS of 10% of cylinders as a quality check.	Refer to Table of Limits.
	Stem Holes in Valve Guides	Scoring, diameter, flare at ends.	Diameters of stem holes in new guides must be within limits for new parts and free of tool marks.
	Valve Seats	Roughness caused by honing.	If seats cannot be made serviceable by grinding with-in width limit, replace seat.
	Cooling Fins	Cracks and broken areas.	Cracked and/or broken cylinder head fins may be repaired, providing a total of not more than five square inches is, or has been removed.
	Base Flange	If attaching nuts were found loose at disassembly, test for flatness of mounting face.	Allow not over 0.001 inch out-of-flat on machined surface.
	Pilot	Out-of-roundness of pilot below face flange.	
	Spark Plug Thread Insert	Distortion or improper fit in cylinder head hole.	

72-40-15. INSPECTION CHART (Continued).

Subassembly And Part	Inspect	Nature Of Inspection	Special Considerations
	Pushrod Housing Stems	Looseness, leakage.	
	Valve Stems	Scoring, nicks in grooves, wear on tips.	Polishing must not reduce diameter below minimum for new parts.
	Valve Heads	Use dial indicator to determine warp. Make sure that grinding has not cut through Stellite face of exhaust valve or entered rounded edge on intake valve head.	
	Valve Length	Use height gage to detect stretch and check for reduction due to tip grinding.	Stretched valves may fail. Shortened valve may exceed ability of hydraulic lifters to take up lash.
Valve Rockers	Contact Foot	Scoring, diameter.	
	Oil Passages	Obstruction.	
	Hub	Side clearance between cylinder head supports.	Refer to Table of Limits.
Rocker Shaft	Outside Surface	Diameter, scoring, rough ends	
CONNECTING ROD ASSEMBLY Bushing	Inside Diameter	Measure using air gage with correct size air plug and master setting ring.	New bushings must be reamed within diameter limits for new parts. Sharp edges must be broken slightly. (Refer to Table of Limits, for new bushing limits.
CRANKSHAFT ASSEMBLY Crankshaft	Main Journals	Diameters, scoring, burning.	Must be polished before magnetic inspection. Ultrasonic Inspection.
	Crankpins	Diameters, scoring, burning.	Must be polished before magnetic inspection. Ultrasonic Inspection.
	Oil Seal Race	Scoring.	Must be polished.
	Screw Holes	Damaged or dirty threads.	
	Oil Holes	Obstructions.	

72-40-15. INSPECTION CHART (Continued).

Subassembly And Part	Inspect	Nature Of Inspection	Special Considerations
	Bending	Measure run-out at center journal and wobble on face of flange.	Required only if shaft has been subject to shock, prop strike, etc.
Gear Dowel	Tight Fit	Attempt to pull out by hand only.	
Oil Control Plug	Presence	Obstruction of oil hole, tight fit.	
Gear	Teeth, Screw, Threads	Burring, scoring, wear enough to alter profile. Damaged or dirty threads.	
CAMSHAFT ASSY.			
Camshaft	Journals	Diameter and fit in crankcase bearings. Scoring, pitting and corrosion.	Excessive bearing wear may be compensated by enlarging bearing and installing over-size shaft. Refer to "Crank-case."
	Lobes	Pitting along toe line, loss of slope along toe line, width across heel and toe at center of length.	Serious pitting not permis-sible. Toe line must taper in relation of axis to rotate valve lifters.
	Flange Screw Holes	Distortion of threads.	
	End and Rear Face of Flange	Nicks, peening, other irregularities.	Must be smooth to align gear.
Gear	Teeth	Scoring, burring, pitting, wear enough to alter profile.	
CRANKCASE ASSY.			
Crankcase Castings	Valve Lifter Guides	Diameter, scoring	
	Bearing Seats	Roughness, wear in tang notches.	Refer to Table of Limits
	Camshaft Bearings	Diameter, scoring, fit of rear bearing between camshaft flanges.	
	Oil Passages	Inspect visually, galleries, main and camshaft bearing supply holes, using inspector's flashlight to illuminate. Probe other oil holes with brass rod.	

72-40-15. INSPECTION CHART (Continued).

Subassembly And Part	Inspect	Nature Of Inspection	Special Considerations
	Tapped Holes	Deformed or dirty threads.	
Studs	Threads	Distortion.	
	Height	Check for backing outs.	Refer to Stud Height Table.
	Squareness	Use toolmaker's square to check studs suspected of bending.	Refer to Stud Height Table.
Idler Gear Support and Bushings	Bore	Inside diameter, scoring.	Refer to Table of Limits.
Needle Bearing	Rollers	Roughness or excessive play.	
Retainer	Mounting Surface Oil Seal	Warpage, cracks. Observe that old seal has been removed without damage to retainer.	
Oil Filler Neck	Tightness	Attempt to rock and pull out by hand only.	Must be tight in castings.
Oil Gage Rod	Distortion	Look for bent blade, obliterated "FULL" and "LOW" marks, loose collar, deformed cap.	
Plugs	Threads	Look for distortion.	
	Wrench Flats	Look for damaged corners.	
OIL COOLER ASSY.			
Oil Cooler	Headers, Fins, Core	Inspect visually for dents, deformed fins, punctures, stripped plug hole threads, cracks and scratches.	
	Machined Surfaces	Warpage and scratches.	
	All Areas	Cracks.	
Oil Temperature Control Valve	Seat	Roughness.	
OIL SUMP ASSY.			
Casting	Tapped Holes	Damaged threads, cracks around holes.	
	Mounting Surfaces	Scratches, warpage, cracks.	

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72-40-15. INSPECTION CHART (Continued).

Subassembly And Part	Inspect	Nature Of Inspection	Special Considerations
	All Areas	Cracks.	
Plugs	Threads	Look for distortion.	
	Wrench Flats	Look for damaged corners.	
Oil Suction Tube	Threads, Tube Filter	Damaged threads, dented tube, cracks in tube, distorted or plugged filter.	
Engine Mounting Brackets	Machined Surfaces	Scratches, cracks.	
OIL PUMP ASSY.			
Housing	All Areas	Cracks, scratches on machined, surfaces, restrictions in oil holes.	
	Gearshaft	Look for scoring, measure diameter.	Gears must turn freely. (Refer to Table of Limits.)
	Plugs	Distorted threads, damaged wrenching surfaces.	
Gears	Shafts	Measure diameters and compare with bushing diameters.	Refer to Table of Limits.
	Gear Teeth	Scoring, burring or wear enough to alter tooth profile.	
	Splines	Look for wear on side of splines and residual sludge.	
Gear Bushings	Bore Diameters	Use telescoping gage and micrometer caliper.	Refer to Table of Limits.
Oil Pressure Relief Valve Plunger	Outside Surface	Measure diameter. Look for scoring, nicks, etc.	
	Conical Face	Roughness.	Must seat perfectly in housing.
Oil Pressure Relief Valve Housing	Plunger Seat	Spread Prussian blue oil base pigment on face of plunger, and turn on seat, all around, plunger face must be lapped to seat. (Plunger held centered and aligned.)	
Oil Pump Cover	Shaft Holes	Measure diameters.	Refer to Table of Limits.
Tachometer Drive Housing	Threads, Flange Seal Bore	Thread distortion, warped mounting surface, scored seal counterbore.	See that old oil seal was removed.

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72-40-15. INSPECTION CHART (Continued).

Subassembly And Part	Inspect	Nature Of Inspection	Special Considerations
Oil Filter Adapter	Threads, Flange	Damaged threads, warped flange, cracks.	
Oil Filter	Threads, Screen Pilot Cup	Damaged threads, punctured screen, out-of-round pilot cup.	
STARTER ADAPTER ASSEMBLY			
Adapter	All Areas	Cracks, scratches on machined surfaces, damaged tapped holes.	
Needle Bearing	Rollers	Roughness or excessive play.	
Studs	Threads	Distortion or stripping.	
	Height	Check for backout	Refer to Stud Height Table.
	Alignment	Check studs suspected of bending with toolmaker's square.	
Gears	Shafts	Measure diameters and compare with bushing diameters.	Refer to Table of Limits.
	Gear Teeth	Scoring, burring or wear enough to alter tooth profile.	
Ball Bearing	Balls, Cage	Surface roughness, out-of-round, excessive depth and looseness.	
Adapter Cover	All Areas	Cracks, scratches on machined surfaces, damaged mounting holes.	
	Shaft Bearing	Look for scoring.	
	Bore	Measure diameter.	
	Oil Seal	See that oil seal was removed without damage to casting.	
ALTERNATOR Hub Assembly			
Hub	All Areas	Scored or under bearing surfaces.	Refer to Table of Limits.
	Spring	Damaged or broken.	

72-40-15. INSPECTION CHART (Continued).

Subassembly And Part	Inspect	Nature Of Inspection	Special Considerations
	Gear	Look for chipped, cracked and broken teeth, scoring, burring and wear enough to alter tooth profile.	
	Gear Bushing	Measure bore diameter.	Refer to Table of Limits.
	Thrust Washer	Thickness, excessive wear.	
INDUCTION SYSTEM Intake Manifold	Flanges	Check for warping by placing flanges on surface plate. Look for cracks.	
	Tubes	Look for dents, out-of-round ends, cracks.	
	Plug Bosses	Damaged threads, cracks around bosses.	
Clamps	Shape	Look for distortion such as out-of-roundness and lugs converging.	
Intake Riser	Stud	Check for straightness and thread damage.	
FUEL INJECTION SYSTEM Fuel Pump Adapter	All Areas	Cracks, damaged mounting holes, inspect tapped holes. Measure bore diameter.	
Fuel Pump Drive Gear	Teeth	Look for chipped, cracked and broken teeth, scoring, burring and wear enough to alter tooth profile.	
	Shaft	Measure outside diameter and compare with bore diameter.	Refer to Table of Limits.
	Gear Plug	Make sure that new plug was installed after magnetic particle inspection of gear and visual inspection for cleanliness of center bore.	
Drive Coupling	Fit	Check for looseness.	
Fuel Pump and Vapor Separator	Outside Area	Inspection is limited strictly to visual for evidence of damage or leakage.	Refer to Fuel Injection Manual X30593A.

72-40-15. INSPECTION CHART (Continued).

Subassembly And Part	Inspect	Nature Of Inspection	Special Considerations
Fuel Injection Control Assy.	Outside Area	Inspection is limited strictly to visual for evidence of damage or leakage.	Refer to Fuel Injection Manual X30593A.
Fuel Manifold	Outside Area	Inspection is limited strictly to visual for evidence of damage or leakage.	Refer to Fuel Injection Manual X30593A.
Valve Assy.			
Shroud Assy.	All Areas	Inspect visually for dents, cracks and broken joints.	
Air Throttle Assembly	Tapped Holes	Damaged threads, cracks around holes.	
	Studs	Bent or stripped stud threads.	
	All Areas	Cracks.	
	Shaft	Check alignment. Measure diameter.	No wear limits established.
	Plate	Check for warpage.	
Fuel Discharge Tubes	All Areas	Look for cracks, flat spots, out-of-round ends.	
Pipe Fittings	Threads	Distortion or stripping.	
	Wrench Flats	Look for damaged corners.	
MAGNETO AND ACCESSORY DRIVE ASSY. Adapter	Gear Bushing	Measure bore diameters.	Refer to Table of Limits.
	Oil Seal	Observe that old seal has been removed without damage to casting bore.	
	Studs	Look for stripped and deformed threads.	
Gear	Teeth	Scoring, burring or wear enough to alter tooth profile.	
	Shaft	Measure diameters and compare with bushing diameter.	Refer to Table of Limits.

SECTION 72-50
ASSEMBLY OF SUBASSEMBLIES

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72–50–00 ASSEMBLY OF SUBASSEMBLIES.

72–50–01 GENERAL.

NEW PARTS. Parts which require protection from atmospheric dust and moisture are wrapped or boxed individually or in sets. These must not be unpacked until they are ready to be installed, this includes precision bearing inserts and anti-friction bearings. Check other new parts on receipt for transit damage. Refer to the parts catalog, Form X30023A for part number of the complete gasket set, the main bearing set, the piston ring set, and sealants and lubricants per Chapter 1. All of which must be on hand when work is started. Use only new shakeproof or split lockwashers, tab washers, elastic stop nuts, cotter pins and annealed, corrosion-resistant lockwire.

TIGHTENING TORQUES. The accuracy of any torque indicating wrench depends on a smooth application of force. Do not back up a nut or bolt and leave it in that condition. If part is accidentally tightened too much, loosen it and retighten it to a value within the specified limits. If nut slot cannot be aligned with a cotter pin hole within the specified limits, substitute another serviceable nut. If the cotter pin hole in stud lies beyond the nut slots when the nut has been tightened properly, the stud has been improperly installed or has backed out, or the attached part has been reduced in thickness, or either nut or washer is incorrect part for that location. The situation must be corrected by whatever replacement is indicated by inspection.

GENERAL USE – TIGHTENING TORQUES.

BOLTS, NUTS & SCREWS			DRIVING STUDS	
SIZE	IN. LBS.	FT. LBS.	IN. LBS.	FT. LBS.
8-32	17.5-22.5	1.5-1.9		
10-32	36.0-50.0	3.0-4.2		
1/4-20	75.0-85.0	6.3-7.1	50.0-70.0	4.2-5.8
1/4-28	90.0-110	7.5-9.1		
5/16-18	155-175	13.0-14.6	100-150	8.3-12.5
5/16-24	180-220	15.0-18.4		
3/8-16	220-260	18.3-21.7	200-274	16.6-22.8
3/8-24	275-325	22.9-27.1		
7/16-14			300-424	25.0-35.4
7/16-20	400-450	33.3-37.5		
1/2-20	550-600	45.8-50.0		

TABLE OF TIGHTENING TORQUES FIGURE 72-50-01.

CRANKCASE	THREAD SIZE	TORQUE IN. LBS.	TORQUE FT. LBS.
Crankshaft gear screw	5/16-24	380-420	31.7-35
Oil Sump Flange Bolt	5/16-18	155-175	12.9-14.6
Crankcase Flange	5/16-24	180-220	15.0-18.3
Magneto to Crankcase Nut	5/16-24	100-120	8.3-10.0
Crankcase Tie Bolts Nut	3/8-24	370-390	30.8-32.5
Mounting Brackets to Crankcase Nut	3/8-24	275-325	22.9-27.1
Cylinder to Crankcase Studs Nut	7/16-20	490-510	40.8-42.5
Thru Bolts at Cad. Plated Washer Nut	7/16-20	440-460	36.6-38.3
Thru Bolt at Cylinder Flange Nut	7/16-20	490-510	40.8-42.5
Thru Bolts at Cylinder Flange Nut And Nose	1/2-20	690-710	57.5-59.1
Gear to Camshaft Bolt	5/16-24	240-260	20.0-21.7
Connecting Rod Nut ①	3/8-24	400-475	33.3-39.6
Connecting Rod Nut ①	7/16-28	475-525	39.6-43.8
Manifold Valve Cover Hold Down Screw (AN500A8-10)	8-32	17.5-22.5	1.5-1.9
Fuel Injector Nozzle (with Anti-Seize Compound)	5/16-24	55-65	4.6-5.4
Rocker Box Cover Screw	1/4-20	45-55	3.8-4.6
Intake Flange Screw	1/4-20	85-110	7.1-9.2
Oil Cooler to Adapter Bolt	1/4-20	100-110	8.3-9.2
Oil Pump Cover to Crankcase Bolt	1/4-20	75-85	6.3-7.1
Collar Assy.-Gov. Oil Transfer Nut	1/4-28	75-85	6.3-7.1
Spirotallic Exhaust Gasket Assy.-Attaching Manifold Flange Nuts	1/4-28	100-110	8.3-9.2
Rocker Shaft Hold Down Bolts	5/16-24	85-110	7.1-9.2
Throttle & Mixture Control Levers to Shaft Nut	5/16-24	100-120	8.3-10.0
Spirotallic Exhaust Gasket Assy.-Attaching Manifold Flange Nuts	5/16-24	200-210	16.7-17.5
Fuel Injection Line Nut	3/8-24	55-60	4.6-5.0
Starter to Adapter Nut	3/8-24	200-220	16.7-18.3
Alternator or Generator Pulley Nut	21/32-20	450-500	37.5-41.7
Oil Pressure Relief Valve-New Gasket Housing	1-1/8-18	240-260	20.0-21.7
Oil Temperature Control Valve	1-14	440-460	36.7-38.3
Spark Plug	18MM	300-360	25.0-30.0
Metering Unit Plug & Screen Assy.	5/8-18	120-130	10.0-10.8
Oil Bypass Plug	7/8-16	190-210	15.8-17.5

① Torque to low limit - if cotter pin will not enter, increase torque gradually up to high limit only. If cotter pin will not enter in this range, replace nut and repeat. In no case shall nuts be torqued below low limit or over high limit.

FIGURE 72-50-01. PIPE PLUGS

SIZE	IN. LBS.	FT. LBS.
1/8-27	60-80	5.0-6.7
1/4-18	130-150	10.8-12.5
3/8-18	185-215	15.4-18.0
1/2-14	225-285	21.3-23.8
3/4-14	310-350	25.8-29.2

NOTE . . . Torque loads listed are for use with 50 Wt. engine oil on threads. If cotter pin holes must be aligned, set torque wrench at low limit and tighten nut to first hole beyond this torque, except for connecting rods. Stud driving torques apply when studs are coated with lubricant or sealer.

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FINAL CLEANING. Immediately before assembling a group of parts they should be washed in, or sprayed with, a clean solvent and dried with dehydrated compressed air.

LUBRICATION. Immediately after final cleaning and before installation, coat all bare steel surfaces and journals with clean 50 Wt. engine lubricating oil, except where special lubricants are mentioned in the text. In some instances where gears and other running parts are accessible after assembly in a housing, additional oil whould be applied to assure full coverage. Before installing tapered pipe plugs or straight thread plugs, to prevent seizure and leakage of oil, coat the male threads with anti-seize compound. Coat both sides of gaskets with light-weight tight seal compound to assure a perfect seal and to counteract the permanent "set" caused by compression.

72-50-02 OIL PUMP ASSEMBLY. (See Figure 72-10-13).

A. If oil pressure relief valve setting has been lost in disassembly, turn adjusting screw (11 or 19) into relief valve housing (13) about halfway. Secure with copper washer (15) and nut (16). Install new gasket (12, 21 or 25), washer (10), spring (9, 18 or 24) and plunger (8, 17 or 23) onto adjusting screw and assemble into housing (5).

NOTE . . . Coat oil pump gear housing cavity with "Molyshield" grease.

B. Install driven gear assembly (35) on shaft. Install driver gear assembly (37, 33) in pump housing to mesh with driven gear. Install bevel gear (32) on drive gearshaft.

C. If electric tachometer is used, follow procedure described in paragraphs D, E, & F. If mechanical tachometer is used, skip to paragraph G and proceed as described. (See Figure 72-10-13, Oil Pump Cover and Tachometer Drive).

D. Install new oil seal (11) in tachometer drive housing (10). Install new gasket (9) on housing (10). Carefully work lip of oil seal over shaftgear (5 & 6 or 7) and push shaft through.

E. Hold gear end of tachometer drive shaftgear (5 & 6 or 7) up and insert shaftgear into oil pump cover. Screw housing (10), which is lefthand thread, into oil pump cover keeping bevel gear upward. Hand tighten only.

F. Place cover and tachometer drive assembly on pump housing. Turn drive gear to mesh bevel gears. Attach with two sets of attaching parts (1, 2, 3).

NOTE . . . Check for binding. If binding occurs, loosen cover and retighten.

G. Work shaftgear (17) carefully through lips of new oil seal (12). Install oil seal and shaftgear in oil pump cover. Install gaskets (18, 23), covers (19, 24) and secure with attaching parts (20, 21, 22 and 25, 26, 27). Install assembly on pump housing and secure with two sets of attaching parts (14, 15, 16).

72-50-03 STARTER DRIVE ADAPTER ASSEMBLY. (See Figure 72-10-12).

A. Install needle bearing (41) in adapter (43).

B. Press bearing (38) onto shaft (40). Install spring (37), Woodruff key (39) and worm gear (36). Insert assembly into adapter and install retaining ring (35).

C. Install clutch spring (30) on worm wheel (33). Turn spring so it tends to unwind until offset end drops into gear hub groove. Position spring on gear so screw notch is aligned with screw hole in gear web. Install tab washer (29) and screw (28).

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D. Lubricate spring, sleeve and shaftgear liberally with clean 50 Wt. engine oil. Install spring assembly onto shaftgear (34). Install bearing (31) and snap ring (32) on shaftgear. Insert shaftgear and worm wheel assembly into adapter. Make certain worm wheel and worm gear teeth are aligned.

E. Install gasket (24) on cover (23). Slide cover onto shaft and secure with two sets of attaching parts (19, 20, 21 and 5, 6, 7). Apply Permatex and silk thread to parting surface.

72-50-04 CYLINDER ASSEMBLY, ALL EXCEPT IO-470-J & K. (See Figure 72-10-14).

Each cylinder should have its position number (1 thru 6) stamped on the edge of its base flange. After disassembly cylinders should have been laid on a bench in order of position number. Piston pins and pistons should have been kept in order with their respective cylinder, as pistons and cylinders were removed and disassembled. The piston to cylinder position should have been checked and recorded to insure their proper placement at assembly.

A. Spread a film of "Molyshield" grease on valve stems (18, 19) and insert them in cylinders to which they have been lapped. Grasp valve stems and lift cylinder onto a post which will support valve heads. Clamp cylinder base flange to prevent it from rising. Again apply "Molyshield" to valve stems.

B. Place valve spring retainers (17) over valve guides (8 & 9), cupped side up. Install inner and outer valve springs (15, 16), per instructions in Figure 72-50-04, rotocoil (14). Compress springs and install keys (13). Make certain keys are properly seated before releasing pressure on springs. Remove cylinder from fixture and set it upright on a bench. Strike end of each valve stem sharply with a rawhide mallet to set stem keys. After valve mechanism has been assembled, check valve spring height according to dimensions given in table of limits figure 72-30-08.

C. Install new packing (42) on each cylinder skirt. Push against flange and make certain none are twisted. Coat cylinder bore walls thoroughly with castor oil or Grade 50 MHS 27 oil.

72-50-04 CYLINDER ASSEMBLY, IO-470-J & K.

A. Reassemble the straight valve cylinder components in the same manner as the inclined valve cylinder. Note that there is one common rocker shaft for both valve rockers which is secured by the washer (21), lockwasher (20) and screw (19).

B. Install washer (35), packing (37) on the cylinder end of the pushrod housing and the spring (39), washer (35), packing (36) and washer (35) upon installation of cylinder to engine. When the cylinder and pushrod housings are installed on the crankcase, secure the pushrod with clip (36) and washers and nuts (37, 38).

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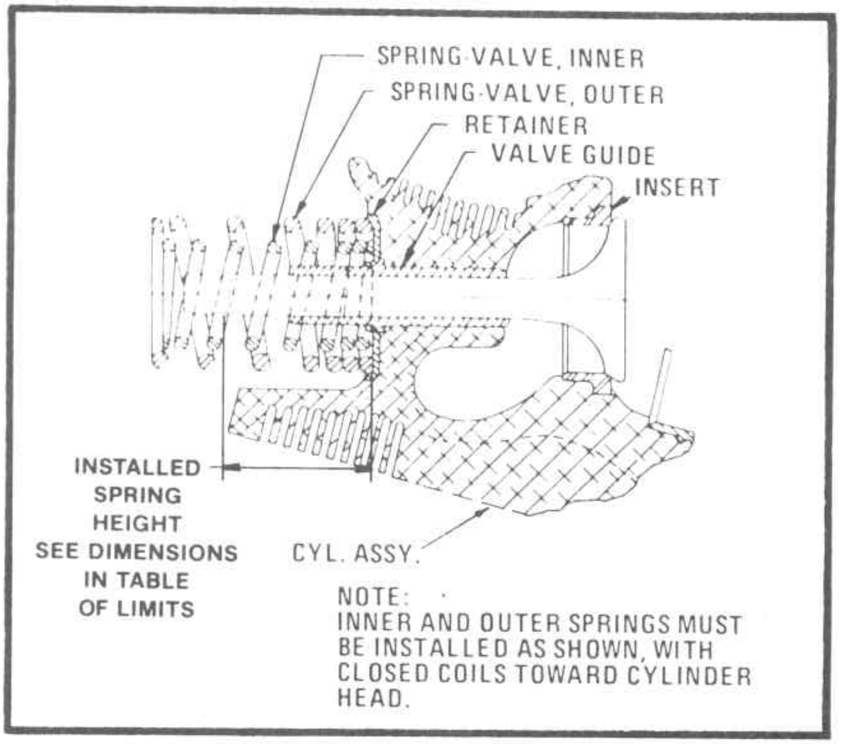

FIGURE 72-50-04. VALVE SPRING INSTALLATION.

72-50-05 PISTON AND RING ASSEMBLIES (See Figure 72-10-14 & 72-10-14 TSIO-520-BE).

A. Lubricate pistons (43) and rings (44, 45, 46, 47) liberally with Grade 50 MHS 27 oil.

B. Position first and third ring gaps on top of piston. Position second and fourth ring gaps 180° apart from the first and third ring gap.

72-50-06 PUSHROD HOUSINGS (See Figure 72-10-14).

A. Install a washer (35), packing (36) and second washer (35) on cylinder end of housings (38).

B. Install spring (37), washer (35), packing (36) and second washer (35) onto crankcase end of housing (38).

C. Lay two housings with each cylinder.

72-50-07 CRANKSHAFT AND CONNECTING RODS (See Figure 72-10-17).

NOTE . . . Torque values are specified in Table of Limits, Section 72-30-08.

A. Lay crankshaft on a bench with a notched wood block under front and rear journals.

B. Lay out connecting rod assembly parts (27 thru 32) opposite crankpins according to position number stamped on bolt bosses. Install new bearing inserts (32) in each rod and cap so their edges project the same distance.

C. Lubricate and install each rod and cap with their position numbers on top when odd number rods are extended to the right and even numbers to the left. Attach them with special bolts (29) and castellated nuts (30). Tighten nuts to specified torque and secure each with a cotter pin (31).

D. Attach counterweights (3) to crankcheeks with two pins (6) each and install plates and retaining rings and plates (7, 8). Install retaining plate and retaining ring with the flat or rough side of the retaining ring to the outside.

NOTE . . . Refer to Section 72-40-03 for diameter of pins.

E. Heat crankshaft small gear (23) to 300°F. Align gear dowel hole with crankshaft dowel (22) and tap gear onto crankshaft. Attach crankshaft large gear (25) to crankshaft small gear and to the crankshaft with six bolts (24). Tighten to specified torque and secure with locking wire.

F. Remove spring (21) from new oil seal (20). Unhook the spring ends using an unwinding motion. Wrap spring around shaft in seal area. Turn spring ends in unwinding direction; then join and allow one end to wind into the other.

G. Oil propeller flange and shaft liberally with clean engine oil and apply shell alvania #2 to I.D. of oil seal lips. Squeeze oil seal until egg-shaped and start seal over bottom of propeller flange, grooved side to the rear. Work seal carefully upward over the flange. Exercise care to prevent damage to seal lip. A special tool for stretching the seal over the prop flange is available from Borrough's Tool and Equipment Company, P/N 5209 (See Chapter 1).

H. After seal is in place, wipe oil from seal and shaft. Seal must be dry on inside and outside diamater before final crankcase installation.

CAUTION . . . No sealing cement or compound is to be used.

I. Install spring (21) into cavity in seal (20).

J. Install governor oil transfer collar (14 thru 17) and secure with nuts (17).

72–50–08 **CAMSHAFT (See Figure 72–10–16).**

A. Tap a Woodruff key (3) on front end of camshaft (6) and install governor drive gear (2).

B. Install gear (5) or gears (5 & 7) as applicable and secure with four screws (4), lockwire as required.

72–50–09 **CRANKCASE (See Figure 72–10–15).**

NOTE . . . Torque values are specified in Table of Limits, Section 72-30-08.

A. Replace any pipe plugs which were removed during previous operations. Install machine thread plugs.

B. Install gaskets (64) and oil filler tube (63). Secure with attaching parts (62).

C. Install gasket (56), governor pad cover (55) and secure with attaching parts (51 thru 54).

D. Install gasket (50), cover (49) and secure with attaching hardware (46, 47 & 48).

E. Install mounting legs (45). Secure with attaching hardware.

F. Lay crankcase halves open side up. Make sure squirt nozzles are in place. Lubricate cam bearings and main bearings. Insert main bearings (11, 12 & 13, Figure 72-10-17) so that edges project equally.

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72–50–10 FUEL INJECTION CONTROL AND AIR THROTTLE BODY ASSEMBLY.

CAUTION . . . Use only a fuel soluble thread sealant on any injector system connection fitting. TCM recommends (646946) F.I. sealant.

NOTE . . . Install plugs and connection fittings in proper ports of fuel injector components (See Figure 72-50-13), prior to subassembly.

NOTE . . . The fuel injection equipment is calibrated with plugs and fittings intact. Removal of any of these parts could allow small metal shavings to become lodged in the equipment. Prior to reassembly, any replacement fittings should first be screwed into proper size holes in a block of soft wood to reduce the likelihood of metal particles entering the system.

A. IO–470–G, H & J (See Figures 72–10–06 & 77–50–10A,B & C).

1. Place the control unit (46) and bottom shroud (36) under air throttle body (49); attach with tab washers (34) and bolts (33). Tighten bolts to torque specified in Tightening Torques, 72-50-01. Bend ear of tab washer to flat side of hex head on screw.

2. Place wave washer (28) on link rod (32) and insert into throttle lever; then install washer (27) and cotter pin (26).

3. Slide spring (31) and rod end (30) onto link rod (32); then attach elastic stop nut (29) to link rod. Place wave washer (28) on rod end (30) and insert rod end into control lever. Secure with washer (27) and cotter pin (26). Final adjustment of rod linkage will be established at final assembly.

4. Lubricate all fuel injection linkage using Shell #5 Mil-G-3545C.

B. IO–470–D & U (See Figures 72–10–06 & 72–50–10A,B & C).

1. Assemble control unit to air throttle body (41) with tab washers (22) and screws (21). Tighten screws and bend ear of tab washers to flat side of hex head on screw. Place wave washer (16) on link rod (20) and insert into throttle lever; then secure with washer (15) and cotter pin (14).

2. Slide spring (19) and rod end (18) onto link rod (20) and attach with elastic stop nut (17). Place wave washer (16) on rod end (18) and insert rod end into control unit lever. Secure with washer (15) and cotter pin (14). Final adjustment will be established at final assembly.

3. Attach shroud assembly (12) to control unit (36) using screws (7).

4. Lubricate all fuel injection linkage using Shell #5 Mil-G-3545C.

C. IO–470–E, G, P & R (See Figures 72–10–06 & 72–50–10A,B & C).

1. Position control unit (35) against throttle body (40) and attach with tab washers (22) and screws (21). Tighten screws and bend ear of tab washer to flat side of hex head on screw.

2. Place wave washer (16) on link rod (20) and insert into throttle lever; then secure with washer (15) and cotter pin (14).

3. Slide spring (19) and rod end (18) onto link rod (20); then attach elastic stop nut (17) to link rod. Place wave washer (16) on rod and insert rod end into control unit lever. Secure with washer (15) and cotter pin (14). Final adjustment will be established at final assembly.

4. Lubricate all fuel injection linkage using Shell #5 Mil-G-3545C.

D. IO–470–F (See Figures 72–10–05 & 77–50–10A,B & C).

1. Place the control unit (26) under air throttle body (29); attach with three tab washers (20) and stand-off bolts (19). Tighten bolts to torque specified in Tightening Torques, 72-50-01. Bend ear of tab washer to flat side of hex head on screw.

2. Place wave washer (14) on link rod (18) and insert into throttle lever; then install washer (13) and cotter pin (12).

3. Slide spring (17) and rod end (16) onto link rod (18); then attach elastic stop nut (15) to link rod. Place wave washer (14) on rod end (16) and insert rod end into control lever. Secure with washer (13) and cotter pin (12). Final adjustment of rod linkage will be established at final assembly.

4. Lubricate all fuel injection linkage using Shell #5 Mil-G-3545C.

E. IO–470–K & N (See Figures 72–10–06 & 72–50–10A,B & C).

1. Place control unit (44) and shroud (33) under air throttle body (33) and attach with tab washers (31) and screws (30). Tighten screws and bend ear of tab washers to flat side of hex head on screw. Place wave washer (23) on link rod (27) and insert into throttle lever; then secure with washer (22) and cotter pin (21).

2. Slide spring (26) and rod end (25) onto link rod (27) and attach elastic stop nut (24). Place wave washer (23) on rod end (25) and insert rod end into control unit lever. Secure with washer (22) and cotter pin (21). Final adjustment will be established at final assembly.

3. Lubricate all fuel injection linkage using Shell #5 Mil-G-3545C.

F. IO–470–L (See Figures 72–10–06 & 72–50–10A,B & C).

1. Position control unit (27) against throttle body (32) and attach with tab washers (23) and stand-off screws (22). Tighten screws and bend ear of tab washer to flat side of hex head on screw.

2. Place wave washer (13) on link rod (17) and insert into throttle lever; then secure with washer (12) and cotter pin (11).

3. Slide spring (16) and rod end (14) onto link rod (17); then attach elastic stop nut (15) to link rod. Place wave washer (13) on rod and insert rod end into control unit lever. Secure with washer (12) and cotter pin (11). Final adjustment will be established at final assembly.

4. Lubricate all fuel injection linkage using Shell #5 Mil-G-3545C.

G. IO–470–M (See Figures 72–10–06 & 77–50–10A,B & C).

1. Place the control unit (31) under air throttle body (37); attach with three tab washers (22) and stand-off bolts (21). Tighten bolts to torque specified in Tightening Torques, 72-50-01. Bend ear of tab washer to flat side of hex head on screw.

2. Place wave washer (15) on link rod (20) and insert into throttle lever; then install washer (14) and cotter pin (13).

3. Slide spring (19) and rod end (18) onto link rod (20); then attach elastic stop nut (17) to link rod. Place wave washer (15) on rod end (18) and insert rod end into control lever. Secure with washer (14) and cotter pin (13). Final adjustment of rod linkage will be established at final assembly.

4. Lubricate all fuel injection linkage using Shell #5 Mil-G-3545C.

H. IO–470–S (See Figures 72–10–06 & 72–50–10A,B & C).

1. Assemble control unit (27) to air throttle body (32) with tab washers (23) and stand-off screws (22). Tighten screws and bend ear of tab washers to flat side of hex head on screw.

2. Slide spring (17) and rod end (16) onto link rod (18) and attach elastic stop nut (15). Place wave washer (13) on rod end (16) and insert rod end into control unit lever. Secure with washer (12) and cotter pin (11). Final adjustment will be established at final assembly.

3. Lubricate all fuel injection linkage using Shell #5 Mil-G-3545C.

I. IO–470–V & VO (See Figures 72–10–06 & 72–50–10A,B & D).

1. Position control unit (33) against throttle body (37) and attach with tab washers (21) and screws (20). Tighten screws and bend ear of tab washer to flat side of hex head on screw.

2. Place wave washer (15) on link rod (19) and insert into throttle lever; then secure with washer (14) and cotter pin (13).

3. Slide spring (18) and rod end (17) onto link rod (19); then attach elastic stop nut (16) to link rod. Place wave washer (15) on rod and insert rod end into control unit lever. Secure with washer (14) and cotter pin (13). Final adjustment will be established at final assembly.

4. Lubricate all fuel injection linkage using Shell #5 Mil-G-3545C.

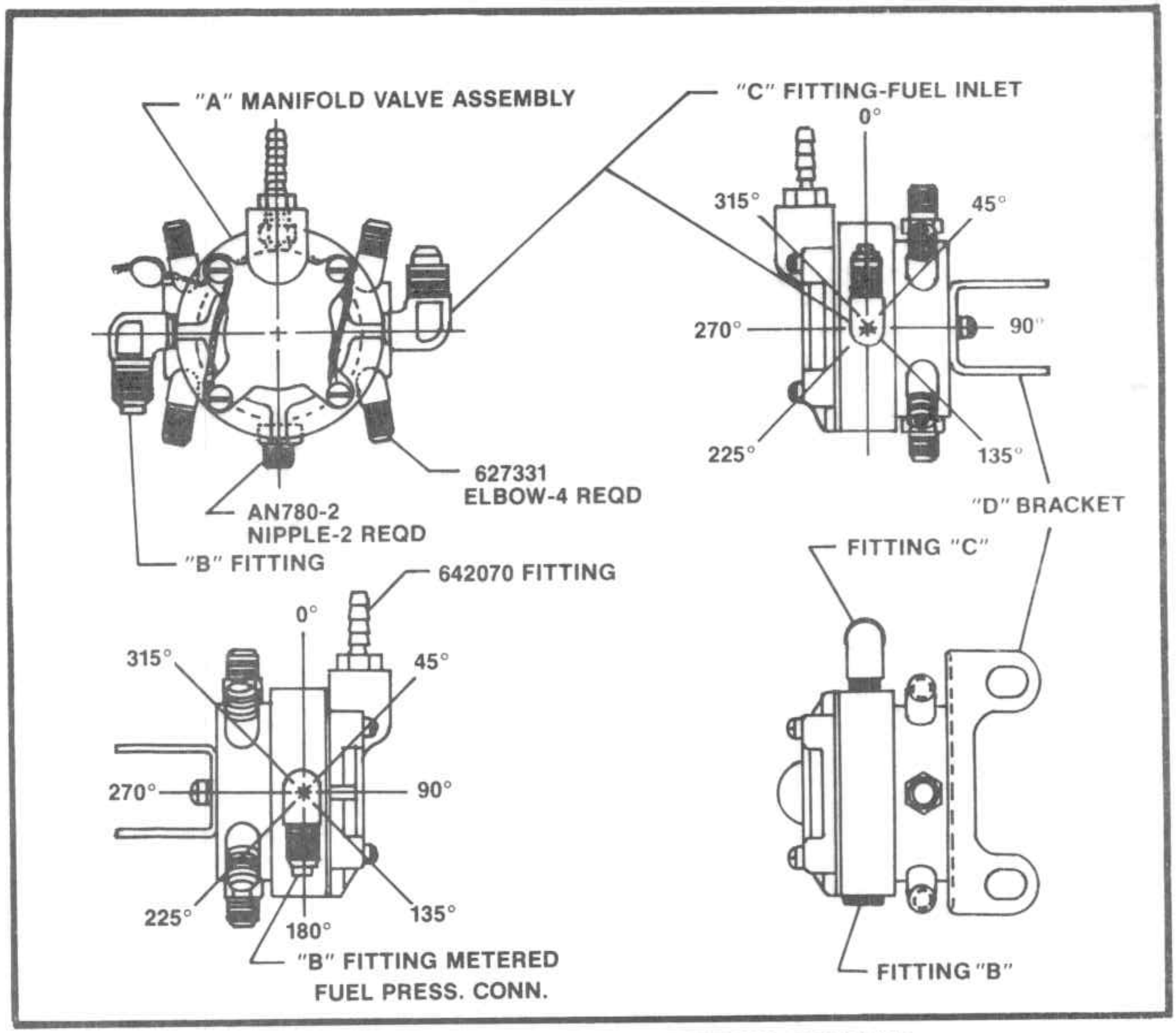

FIGURE 72-50-10A. MANIFOLD VALVE FITTING ORIENTED.

ENGINE MODEL	"A" MANIFOLD VALVE	"B" FITTING	"C" FITTING	"D" BRACKET
IO-470-C,D,E,H,J,L,N&U	631427	629518 - 1 PLUG	628437 - 180°	642064
IO-470-F&S	631427	643763 - 0°	628437 - 180°	642064
IO-470-K	631427	631658 - 0°	628437 - 180°	642064
IO-470-M	631427	628437 - 180°	628437 - 180°	642064
IO-470-V	631351	643763 - 0°	628437 - 180°	642064

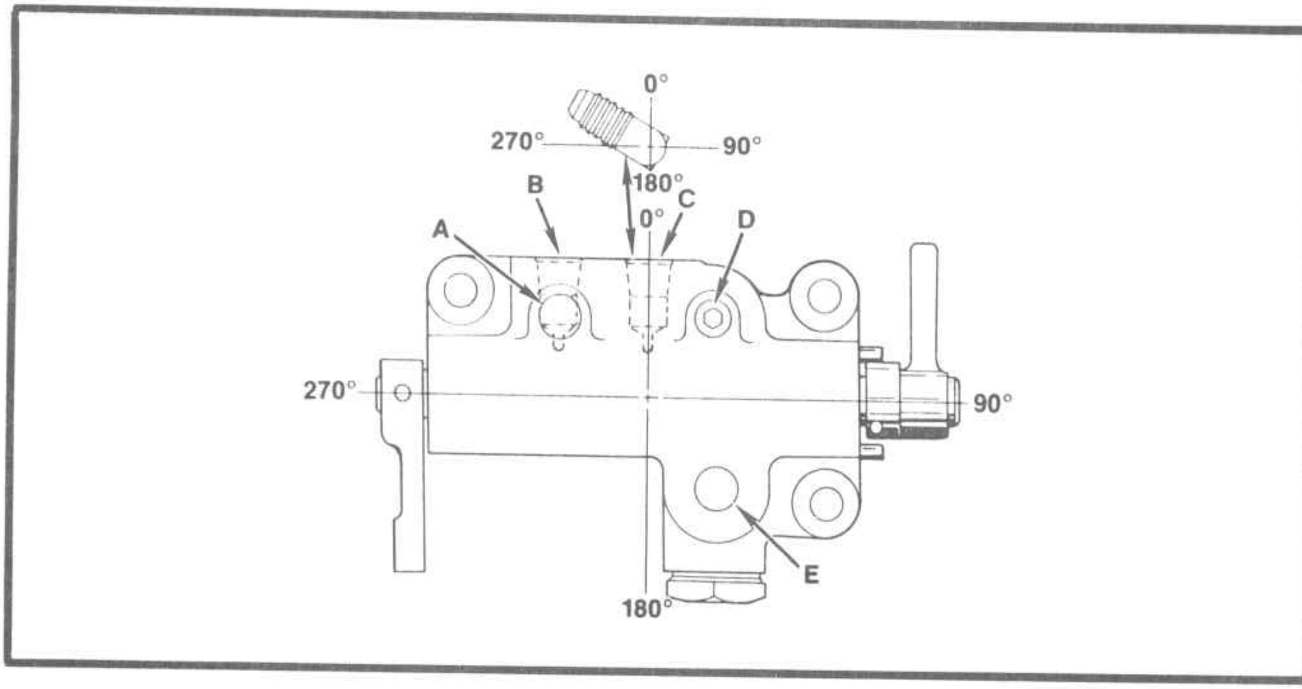

FIGURE 72-50-10B. CONTROL VALVE FITTING ORIENTATION.

ENGINE MODEL	FITTING "A"	FITTING "B"	FITTING "C"	FITTING "D"	FITTING "E"
IO-470-C&N	627119 - 180° 626900 628434 628062-1	628437 - 310°	627119 - 180° 628437 - 150°	AN932 - 2	628437 - 130°
IO-470-D	—	628476 - 255°	627119 - 180° 628437 - 150°	AN932 - 2	627642 - 215° 628438
IO-470-E	628437 - 319°	628434 626900 - 0°	627119 - 180° 628437 - 150°	AN932 - 2	628437 - 223°
IO-470-F	—	628437 - 270°	630119 628476 - 270°	AN932 - 2	628437 - 240°
IO-470-H	627119 - 180° 626900 628434	628437 - 310°	627119 - 180° 628437 - 150°	AN932 - 2	626437 - 130°
IO-470-J	627119 - 180° 626900 628434	628437 - 310°	627119 - 180° 628437 - 150°	AN932 - 2	626437 - 130°
IO-470-K	AN932 - 2	628437 - 310°	627119 - 180° 628437 - 150°	AN932 - 2	628437 - 130°
IO-470-L	—	628437 - 270°	630119 627119 - 90° 628428	AN932 - 2	628437 - 260°
IO-470-M	—	628437 - 270°	X12470 - 180° 672119 628478 - 150°	AN932 - 2	627642 - 215° 2024 628438
IO-470-S	628438	AN932 - C2	627119 - 135° 630119 628437 - 175°	AN932 - 2	628478 - 170°
IO-470-U	628434	628476 - 255°	627119 - 180° 628437 - 135°	AN932 - 2	627642 - 215° 2024 628438
IO-470-V&VO	—	628437 - 270°	633343 - 180° 628437 - 135°	AN932 - 2	628438 2024 634195 - 215°

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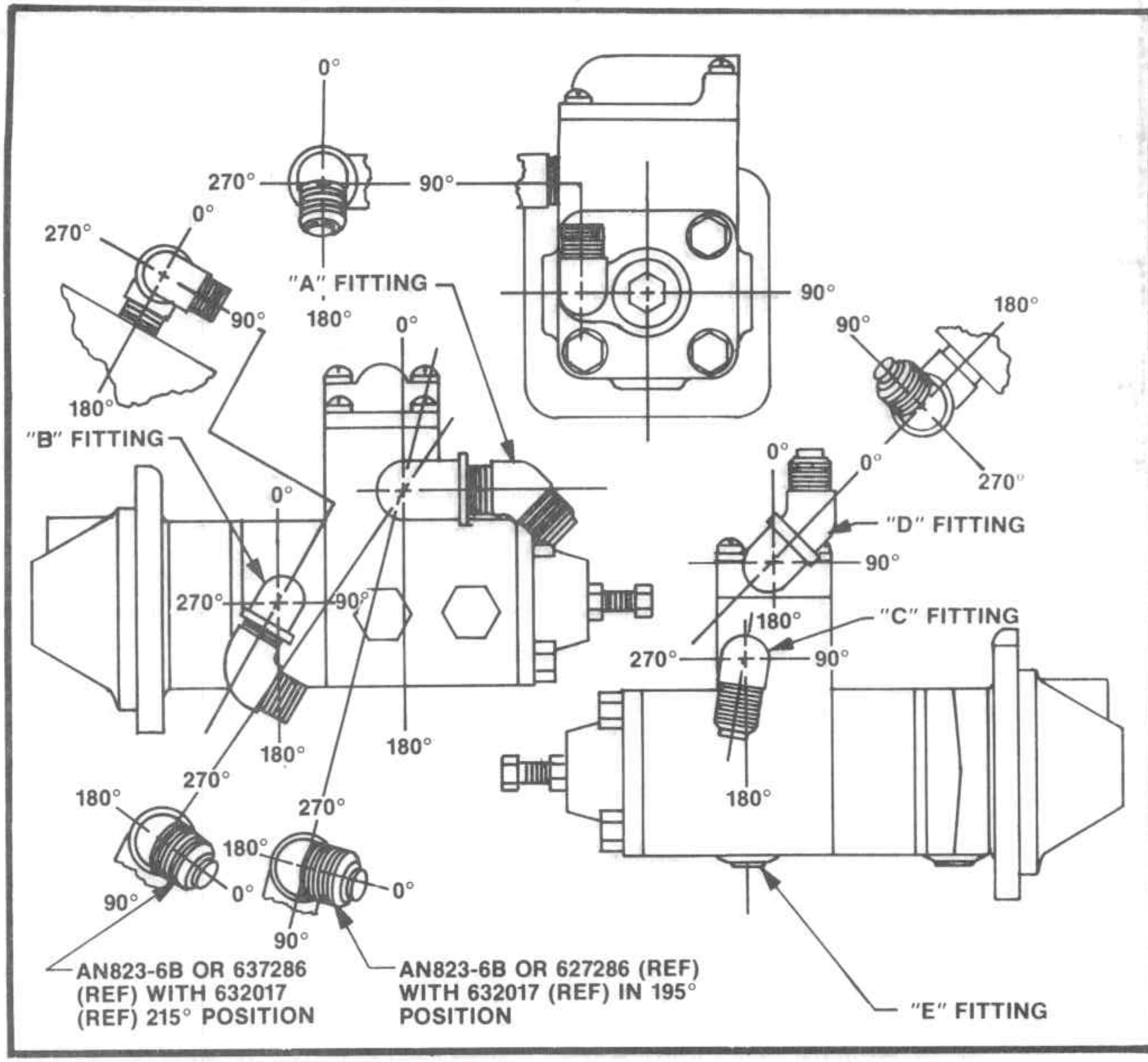

FIGURE 72-50-10C. FUEL PUMP FITTING LOCATIONS FOR ALL IO-470 (EXCEPT IO-470-V).

MODEL	INLET "A" FITTING	OUTLET "B" FITTING	MIXTURE RETURN "C" FITTING	VAPOR RETURN "D" FITTING	"E" FITTING
IO-470-D&E	632017 - 215° AN823-6B - 0°	628437 - 115°	628478 - 215°	628476 - 225°	
IO-470-F	632017 - 200° AN923-6B - 0°	628473 - 210°	628478 - 190°	628476 - 225°	AN932 - 2
IO-470-C,H,J&N	632017 - 200° AN823-6B - 0°	628437 - 240°	628478 - 190°	628476 - 215°	AN932 - 2
IO-470-U	632017 - 90° AN823-6B - 180°	630119 627119 - 150° 628438	628478 - 190°	628476 - 225°	AN932 - 2
IO-470-M	632017 - 200° 637286 - 340°	628436 - 175°	628478 - 210°	AN816-6 - 2 627119 - 15°	AN932 - 2
IO-470-S	628475 - 180°	628436 - 142°	628478 - 225°	628476 - 210°	AN932 - 2
IO-470-K	632017 - 200° AN823-6B - 0°	628437 - 240°	628478 - 190°	628476 - 215°	AN932 - 2
IO-470-L	632017 630065 - 105°	628437 - 135°	628478 - 205°	627119 - 45° 628476 - 90°	AN932 - 2

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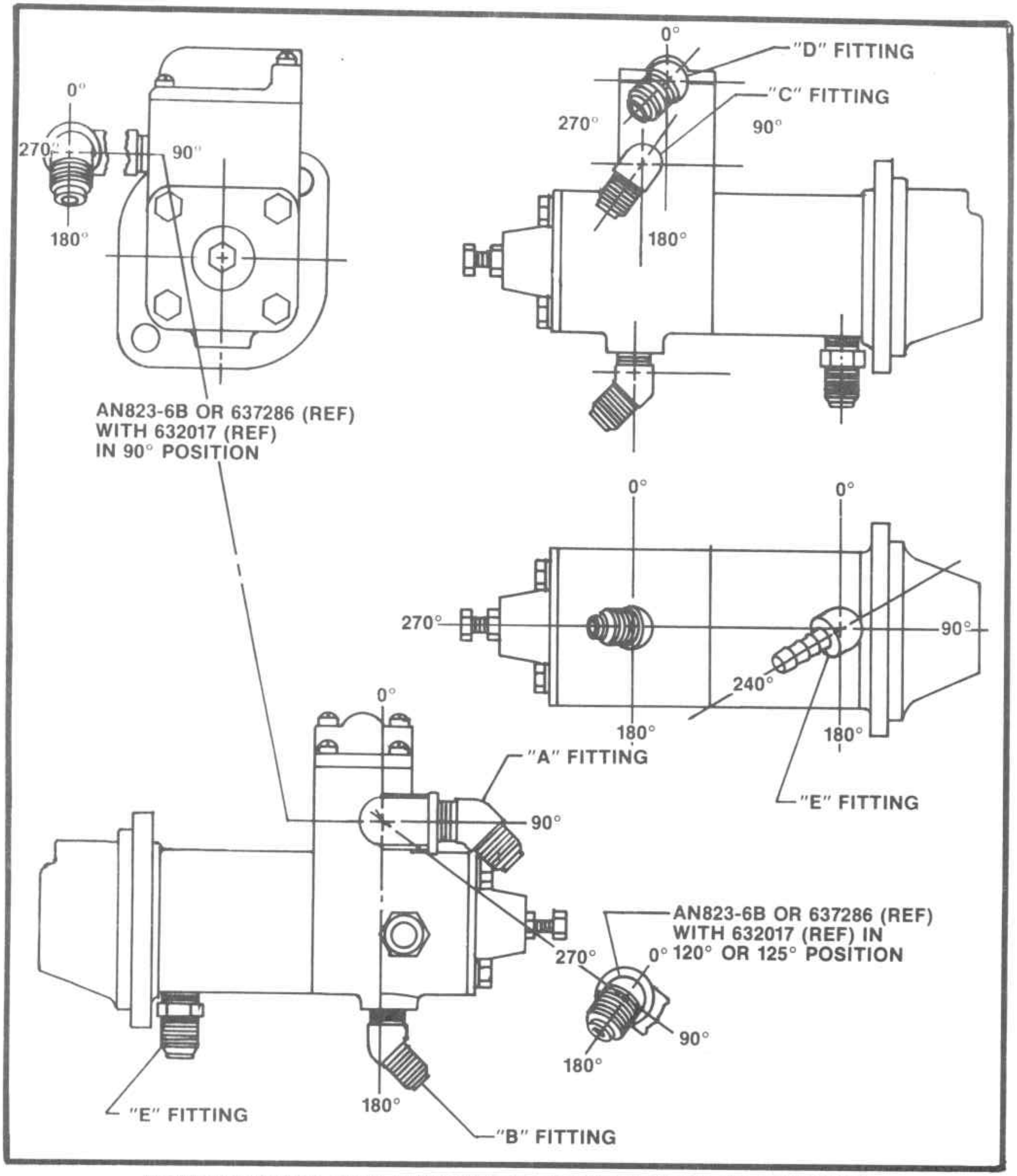

FIGURE 72-50-10D. FUEL PUMP FITTING LOCATIONS FOR (IO-470-V & VO).

MODEL	"A" FITTING	"B" FITTING	"C" FITTING	"D" FITTING	"E" FITTING
IO-470-V	632017 - 90° AN823-6B - 180°	628436 - 270°	628478 - 215°	628476 - 225°	628438

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INTENTIONALLY

LEFT

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SECTION 72-60
FINAL ASSEMBLY

INTENTIONALLY

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72-60-00 FINAL ASSEMBLY

72-60-01 GENERAL. Apply clean engine lubricating 50 Wt. engine oil liberally to all bare steel surfaces, journals, bearings and bushings, before and/or after installation, depending on accessibility, except where special lubricants are mentioned.

TIGHTENING TORQUES. See Table of Tightening Torques and Instructions, Section 72-50-01.

CLEARANCES. Wherever possible, measure clearances of running parts as they are installed. When end clearances and backlashes cannot be measured with normal thickness gages due to the inaccessible position of the parts, test for binding and excessive looseness by moving the running parts.

COVERS. Unless the atmosphere is unusually free of dust and airborne grit, it is advisable to cover openings as soon as possible and to cover assemblies and the partial engine assembly whenever they are not in the process of being assembled. Cover all openings into which small parts might be dropped.

72-60-02 CRANKCASE. (See Figures 72-10-15 & 72-60-02).

A. Install the oil filler neck and attach the mount brackets on the left crankcase to the assembly stand in the same way as during disassembly, and place the pipe support (1) under the casting.

B. The crankshaft oil seal inside & outside diameters should be clean and dry. Install oil transfer sleeve O-ring and sleeve.

C. Lubricate all main bearing inserts and crankshaft journals. Lift the shaft assembly by the number 1 connecting rod and the propeller mount flange. While a second person holds up the number 3 and 5 connecting rods, lower the assembly into position in the left crankcase bearings with the oil seal positioned so as to enter its case recess. The connecting rod position numbers should automatically be toward the upper case flange if properly installed. Lay the odd-numbered connecting rods on the upper flange.

D. Insert the governor-driven gear (5, Figure 72-10-15) into its bearing.

E. Slide the governor driver gear on the front end of the camshaft. Lay the camshaft assembly in its bearings in the left case, meshing the spur gear teeth with those of the crankshaft gear, so that the timing marks will align as illustrated in Figure 72-60-02, Idler Gear Support Pin and Timing Marks, and turning the governor driven gear to mesh it with the driver gear.

F. With a feeler gage, measure the crankshaft end clearance at either end of the thrust bearing with the shaft pushed toward that end. Similarly, measure the camshaft end clearance at either end of its rear bearing. Check for perceptible backlash between spur gears and bevel gears.

G. Install the idler gear assembly and support pin in the left crankcase as illustrated (bushing thrust flange to rear).

H. Use Aviation Permatex Grade 3D and spread in a thin but continuous film all around the left crankcase parting flange, taking care not to get it on other parts. Lay lengths of No. 50 silk thread on the parting flange. The thread should be inside the bolt holes but never on the edge. (See chapter 70 Standard Practices for crankcase threading procedure). Care should be taken to insure that only areas illustrated be threaded.

I. Stand up the odd-numbered connecting rods. Lubricate thrust washers with Molyshield grease and install in right crankcase subassembly.

J. Lay the right crankcase subassembly on the left case. Take care not to displace or damage the crankshaft oil seal. Make sure that thrust washers are in place.

K. For the following procedure refer to Figure 72-10-15, Crankcase Assembly. Lubricate O-rings (71) with clean engine oil and install on through bolts. Insert (from above) the two 8-7/8 in. through bolts (34) at the front of the crankcase, the 9-13/16 in. through bolt (36) in front of No. 5 cylinder mount pad, the seven 10-3/4 in. through bolts (35) through the cylinder mount pads and the four 10-1/2 in. through bolts (37) below the camshaft level. Tap all of these through to centered positions with a non-marring hammer. These bolts align the crankcase castings and thrust bearings.

L. Install a spacer and a flanged nut on each end of the two front through bolts, a spacer and a flanged nut on the top end of the two through bolts ahead of No. 5 cylinder and on the bottom end of the upper rear through bolt nearest to the magneto mount pad.

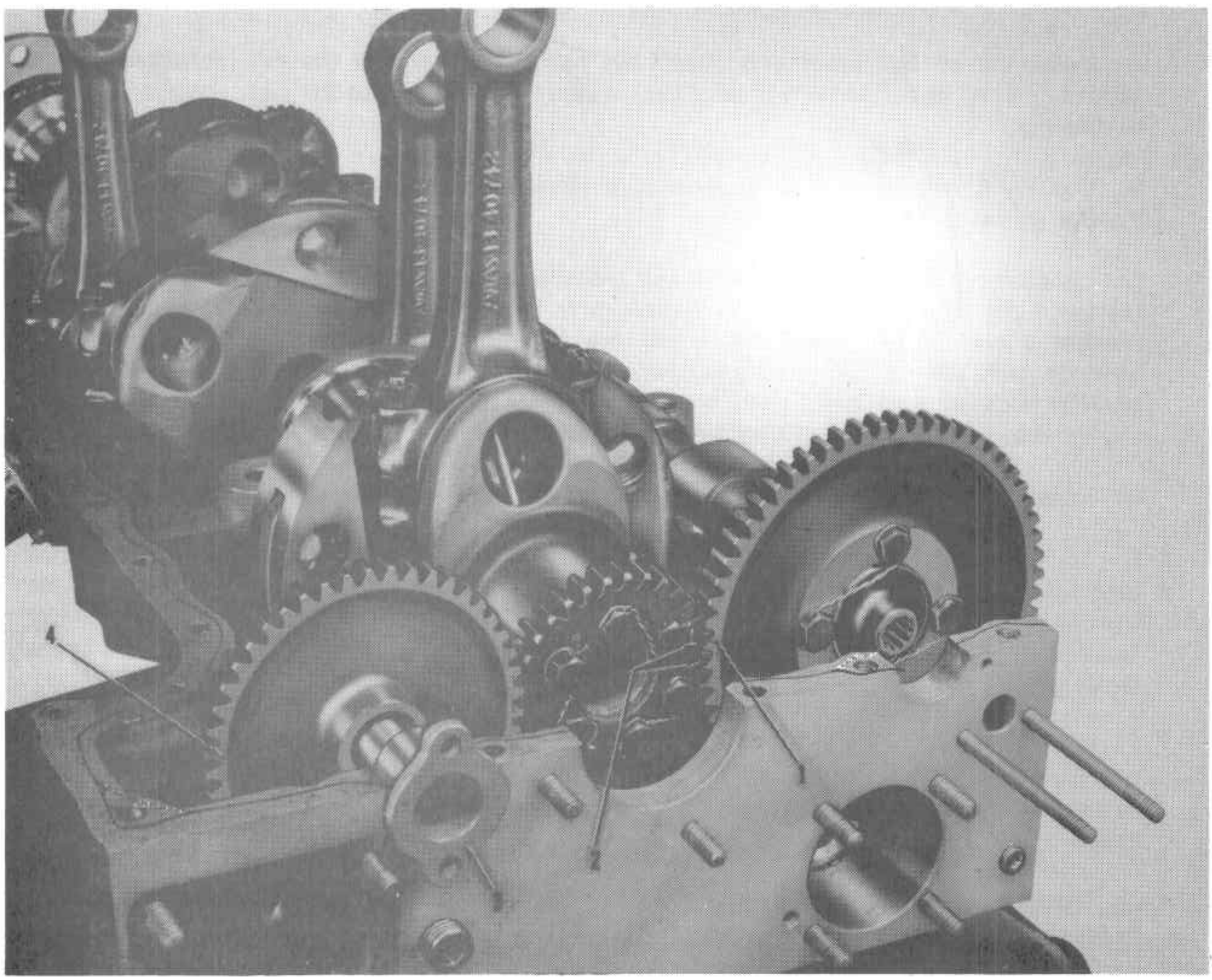

FIGURE 72-60-02. IDLER GEAR, SUPPORT PIN AND TIMING MARKS.

1. Camshaft timing mark
2. Crankshaft timing mark
3. Idler gear support pin
4. Idler gear

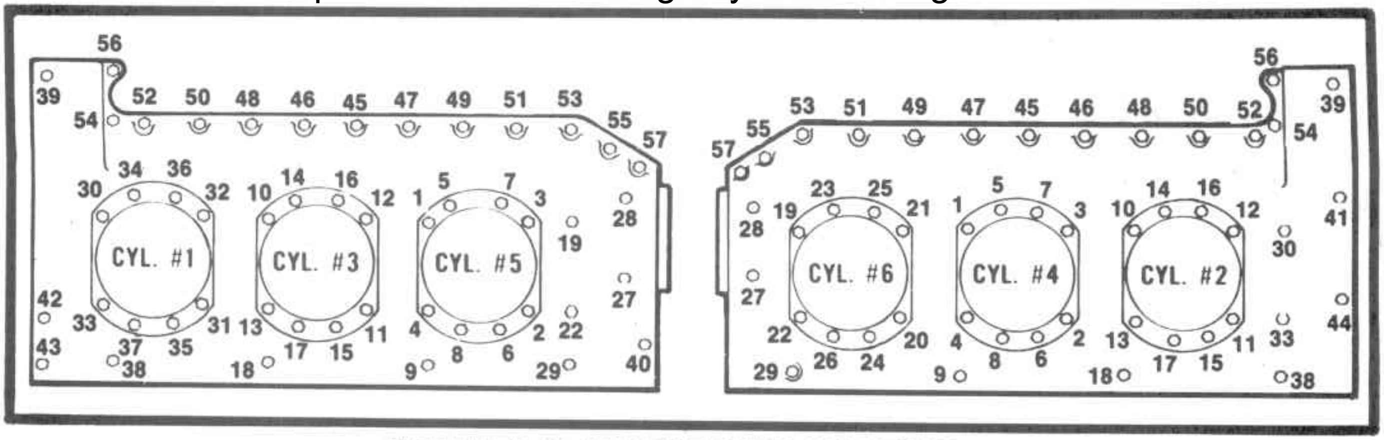

FIGURE 72-60-02C. TORQUING SEQUENCE.

a. Nuts on both ends of thru bolts must be torqued.
b. All studs and thru bolt threads to be lubricated per Sealants and Lubricants Application Chart, Chapter 1-30-00.

ASSEMBLY PROCEDURE

1. Insert thru bolts.

2. Snug bolts 27, 28, 39 & 43.

3. Install cylinders 4 and 5. Tighten stud nuts (2,3,5,6,7&8) and thru bolts (1,4&9) to 300-400 inch lbs. in sequence shown.

4. Install cylinders 2 and 3. Tighten stud nuts (11,12,14,15,16,&17) and thru bolts (10,13,&18) to 300-400 inch lbs. in sequence shown.

5. Install cylinder No. 6. Tighten stud nuts (20,21,23,24,25&26) and thru bolts (19,22,27,28&29) to 300-400 inch lbs. in sequence shown.

6. Install cylinder No. 1. Tighten stud nuts (31,32,34,35,36&37) and thru bolts (30,33,&38) to 300-400 inch lbs. in sequence shown.

7. Torque thru bolts and stud nuts 1 thru 38 to the correct torque values in sequence shown.

8. Tighten bolts No. 39 thru 57 in sequence shown to torque specified on the chart listed below.

   NOTE . . . Repeat torquing sequence (1-57) to insure that all thru bolts and stud nuts have been torqued to the correct value.

CRANKCASE TORQUE VALUES

Torque-inch lbs.	Sequence Number
690-710	1,4,10,13,19,22,30,33
490-510	2-3,5-9,11-12,14-18,20-21,23-29,31-32,34-38
275-325	39
180-220	40-57

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M. Install two spacers (12), lifting eye (11) and its attaching parts (6, 7, 8, 9, 10).

N. Immediately behind the lifting eye install the brace, Figure 72-60-02, Left Side of Complete Crankcase Assembly, then install the upper flange attaching parts (1, 2, 3, 4, 5), and install washers and a nut (1, 2, 3) on the bolt (71) already in place. Do not tighten any of these attaching parts yet.

O. Install one bolt and washers (18, 19, 20) at the left rear, one O-ring and two bolts and washers (18 through 21) at the right rear and one bolt and washers (18, 19, 20) at right front. Do not tighten any of the attaching parts in this group yet.

P. Seat the idler gear support pin. The eccentric shoulder must be away from the crankshaft. Do not install the attaching parts yet.

Q. Tighten moderately all attaching parts installed in steps "D" and "E".

R. Install two O-rings, one bolt and attaching parts (13 through 17) in the upper rear case hole, and tighten the nut.

S. Again check the crankshaft and camshaft end play, this time with a dial indicator.

T. Install the generator mount bracket on the lower rear through bolt, and attach it with a nut and spacer.

U. Install and tighten the support pin attaching parts (27 through 30).

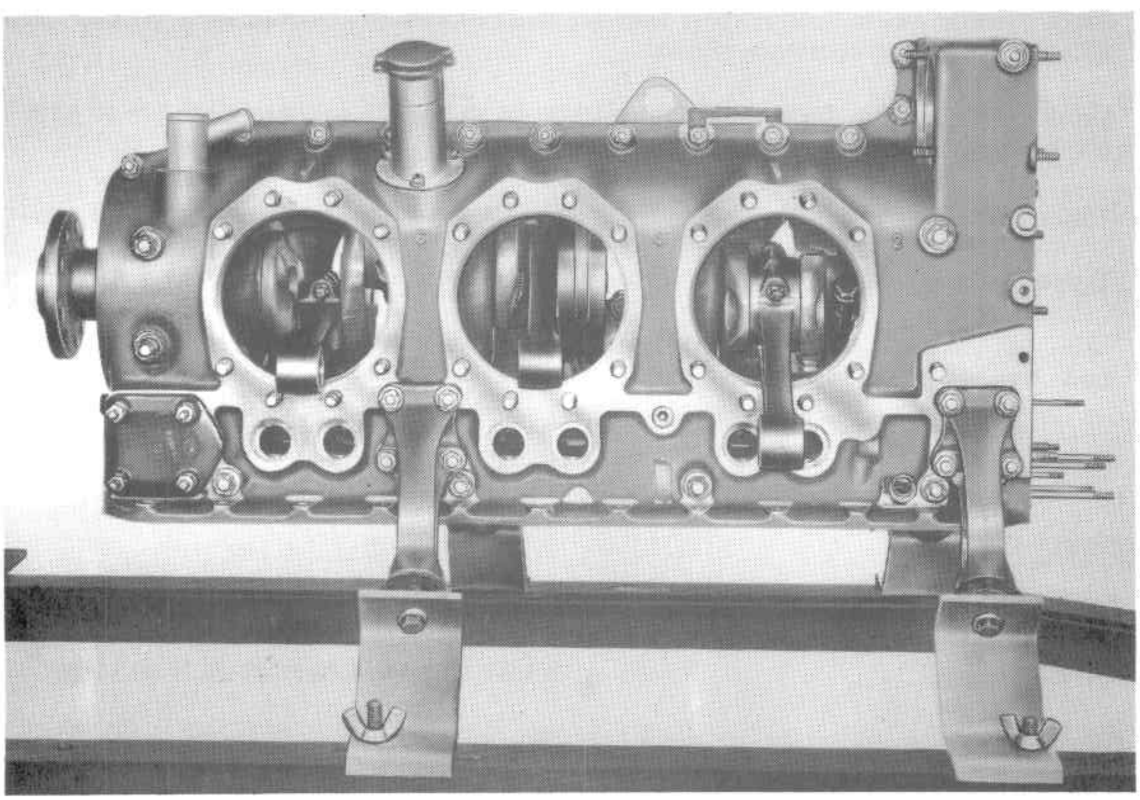

FIGURE 72–60–02. LEFT SIDE OF COMPLETED CRANKCASE ASSEMBLY.

72-60-03 CYLINDERS AND PISTONS (See Figure 72-10-14).

A. Before installing each cylinder and piston, rotate crankshaft to place connecting rod in its outermost position.

B. Dip piston pin in lubricating oil before installing in piston and connecting rod. Lubricate all cylinder flange mounting studs before installation of cylinder assemblies to crankcase. Lubricate piston and rings liberally with engine lubricating oil.

C. Piston ring gaps should be positioned 180° apart with the first or top ring gap toward top of piston.

NOTE . . . Install pistons and cylinders in desired order. It is suggested that Nos. 4 and 5 be installed first to minimize turning of the crankshaft and to prevent excessive unbalance. Turn the crankshaft for Nos. 2 and 3 and install the assemblies. Then turn the shaft for Nos. 1 and 6, and install the last two assemblies.

D. Place the piston over the connecting rod with the position number on its head forward. Push the pin through until it is centered.

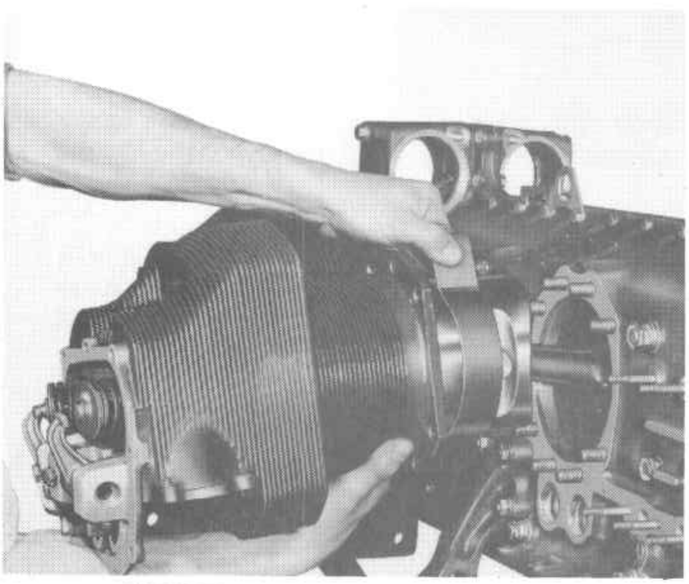

FIGURE 72-60-03. INSTALLING NO. 5 CYLINDER.

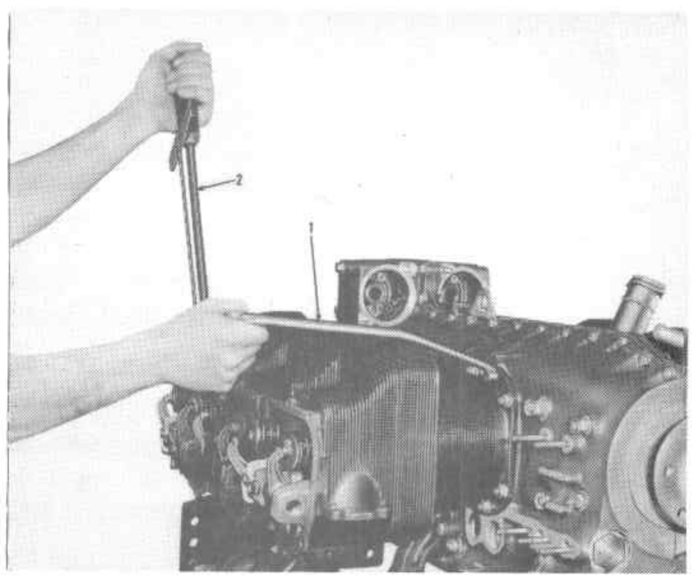

FIGURE 72-60-03. TIGHTENING CYLINDER BASE NUT.

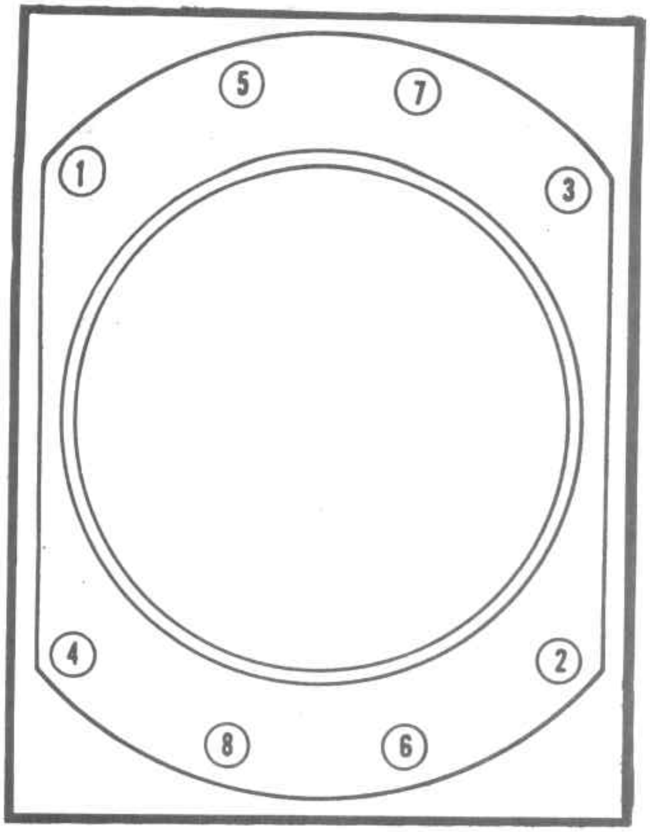

FIGURE 72–60–03. CYLINDER FLANGE TORQUE SEQUENCE FOR SINGLE CYLINDER INSTALLATION.

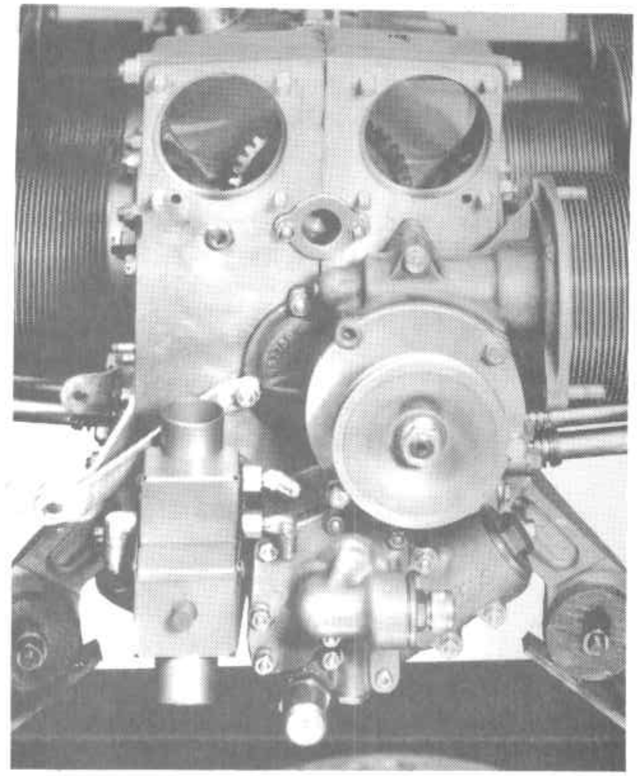

FIGURE 72–60–04. OIL PUMP, FUEL PUMP AND STARTER ADAPTER INSTALLED.

E. Hang a piston ring compressor on the piston skirt. Holding the cylinder in left arm, center the compressor over the piston rings and compress them fully. Push the cylinder onto the piston, forcing the compressor off the piston.

F. Remove the ring compressor and start the cylinder base flange onto the hold-down studs. Make sure the base flange packing ring is in place and not twisted. Seat cylinder barrel flange on crankcase cylinder pad. Install, but do not tighten, attaching parts (1, 2). Top four nuts should be installed first.

G. After installing all pistons and cylinders, tighten and torque nuts according to sequence shown in Figure 72-60-02, Torquing Sequence.

H. Install spark plugs and gaskets in upper cylinder holes.

72–60–04 OIL PUMP (See Figures 72–10–13).

A. Remove attaching parts (1, 2, 3 or 14, 15, 16) Figure 72-10-13, Oil Pump Cover and Tachometer Drive) and detach cover from pump.

B. Coat gear cavity using molyshield grease.

C. Spread a film of No. 3 Aviation Permatex on rear cover flange of the oil pump. Lay No. 50 silk thread inside the bolt holes and studs but clear of the edge and cross threads on low pressure side of pump.

C. Replace cover assembly and secure with same attaching parts.

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D. Install gasket (1, Figure 72-10-13, Oil Pump Assembly) on crankcase.

E. Install gasket (51) and oil filter screen (50), install oil pump assembly on crankcase studs and secure with attaching parts (2, 3, 4 and 14, 15, 16 or 1, 2, 3,, Figure 72-10-13, Oil Pump Cover and Tachometer Drive) in Section 72-50-01.

F. Tighten lefthand threaded tachometer drive housing.

72-60-05 FUEL PUMP (See Figure 72-10-06).

A. Lubricate fuel pump drive coupling with "Molyshield" grease.

B. Install coupling in pump. Install new gasket and mount fuel pump and vapor separator on crankcase studs. Secure with two sets of attaching parts.

72-60-06 STARTER DRIVE ADAPTER (See Figure 72-10-12).

A. Apply a thin coat of TCM Gasket Maker 646942 to the crankcase mating surface only.

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

B. Lubricate spur gear and mesh it with crankshaft gear as adapter is placed in position. Seat adapter against gasket. Secure adapter assembly to crankcase with attaching parts (6, 7, 11, 12, 13, 19, 20 & 21, Figure 72-10-12).

C. Install gasket (4) on starter pilot. Turn starter shaft until tongue aligns with worm drive shaft slot. Mount starter (3) and secure with attaching parts (1, 2).

72-60-07 GENERATOR ASSEMBLY (See Figure 72-10-11).

A. Install sheave (3) on generator. Secure with retaining nut.

B. Install generator on generator mounting bracket (19 or 21 or 22), install bracket to generator lower attaching hardware. Attach generator drive belt and adjusting arm to generator attaching hardware, tension drive belt and tighten generator bolts.

72-60-07 OPTIONAL ALTERNATOR (See Figure 72-10-11).

A. Install alternator to bracket, secure with lower attaching hardware. Install alternator to adjusting arm hardware and alternator drive belt, tension drive belt and tighten alternator bolts.

72-60-08 MAGNETO AND ACCESSORY DRIVE ADAPTERS (See Figure 72-10-07).

A. Place two new gaskets onto the two upper four stud mount pads at the rear of the crankcase so that oil holes in gaskets are aligned with crankcase oil outlet holes.

B. Install two adapter assemblies with oil holes aligned with crankcase oil outlet holes. Attach both with plain washers, lockwashers and nuts.

72-60-09 OIL COOLER (IO-470-F) (See Figure 72-10-10).

A. Install gasket (5). Mount oil cooler on crankcase and secure with attaching parts (2 thru 4).

OIL COOLER FOR IO-470-C, E, G, H, J, K, N, R & S (See Figure 72-10-10).

A. Install gasket (12), adapter (8 or 14), gasket (6), oil cooler (1) and attaching hardware (2, 3, 4 & 5).

OIL COOLER FOR IO-470-D, L, M, N, U & V.

A. Install gasket (11 or 16), adapter (7 or 13), gasket (5 or 12), oil cooler (1) and attaching hardware (2 thru 4).

72-60-10 VALVE MECHANISM (See Figure 72-10-14).

A. Turn engine upside down.

B. Lubricate exterior surface of each hydraulic valve lifter just prior to installation. Apply oil to socket, but not into body oil holes. Install all valve lifters.

C. Install six pushrod housings nearest to engine mount brackets first, since spring compressor tool (Chapter 1) must lie close to horizontal in order to clear crankcase flange.

D. To install each pushrod housing (38), compress spring (37, 39) and place packing (36) between two steel washer (35) on that end of housing. Insert this end of housing into crankcase guide until other end and its seal ring can be aligned with cylinder head opening. Move assembly outward until packing (36 or 37), sandwiched between two or one steel washers (35) as applicable has entered cylinder hole. Release spring slowly until it is free and remove spring compressor (See Figure 72-60-13).

E. Before installing valve-actuating parts on each cylinder, turn crankshaft until cam lobes for that pair of valve lifters are on the base circle and not on the ramp, (T.D.C. compression stroke).

F. Install lubricated pushrods (39 or 40) and seat them in valve lifter sockets. Install proper rocker assembly (21 thru 26 or 22 thru 27), thrust washers (27) as applicable and insert rocker shaft (20 or 18). Line up hole in shaft with hole in rocker shaft boss. Install rocker shaft retaining screw (19 or 28) and washers (29 or 20, 21), and secure with safety wire.

NOTE . . . Be sure to lubricate all moving parts liberally with engine oil.

NOTE . . . Check valve to rocker clearance (Ref. 72-30-08).

G. Install all pushrods and rockers in other cylinders in same manner. Install valve rocker covers (28 or 30), gaskets (32 or 34) and secure with attaching parts (31, 32, 33 or 29, 30, 31).

72-60-11 OIL SUMP, IO-470-D, E, F, G, L, M, P, R, S, U & V (See Figure 72-10-09).

A. Install gasket (12) on suction tube (11). Attach suction tube to crankcase using attaching hardware (9 & 10). Attach suction tube brackets to crankcase with bolts (8). Secure bolt to brace with lockwire. Tighten to torque specified in Table of Limits, Section 72-30-08.

B. Spread a film of TCM Gasket Maker, P/N 646942, compound on sump side ONLY of the sump gasket (7) and position it on the sump.

C. Lay sump on crankcase and install attaching parts (5, 4, 3). Make sure plug and gasket (1, 2) are installed and tight.

OIL SUMP, IO–470–C, H, J & N (See Figure 72–10–09).

A. Install gasket (1) on suction tube assembly (2). Attach oil suction tube to crankcase using attaching hardware (3 & 4). Secure suction tube brackets to crankcase with screw (5) and secure with lockwire. Torque to value specified in Table of Limits, Section 72-30-08.

B. Spread a film of TCM GAsket Maker, P/N 646942, compound on sump side ONLY of gasket (6) and position it on sump.

C. Lay sump (7) on crankcase, and install attaching parts (17, 18, 19). Make sure plug and gasket (15, 16) are installed and tight.

D. Install mounting legs (20) and secure with attaching parts (21, 22, 23).

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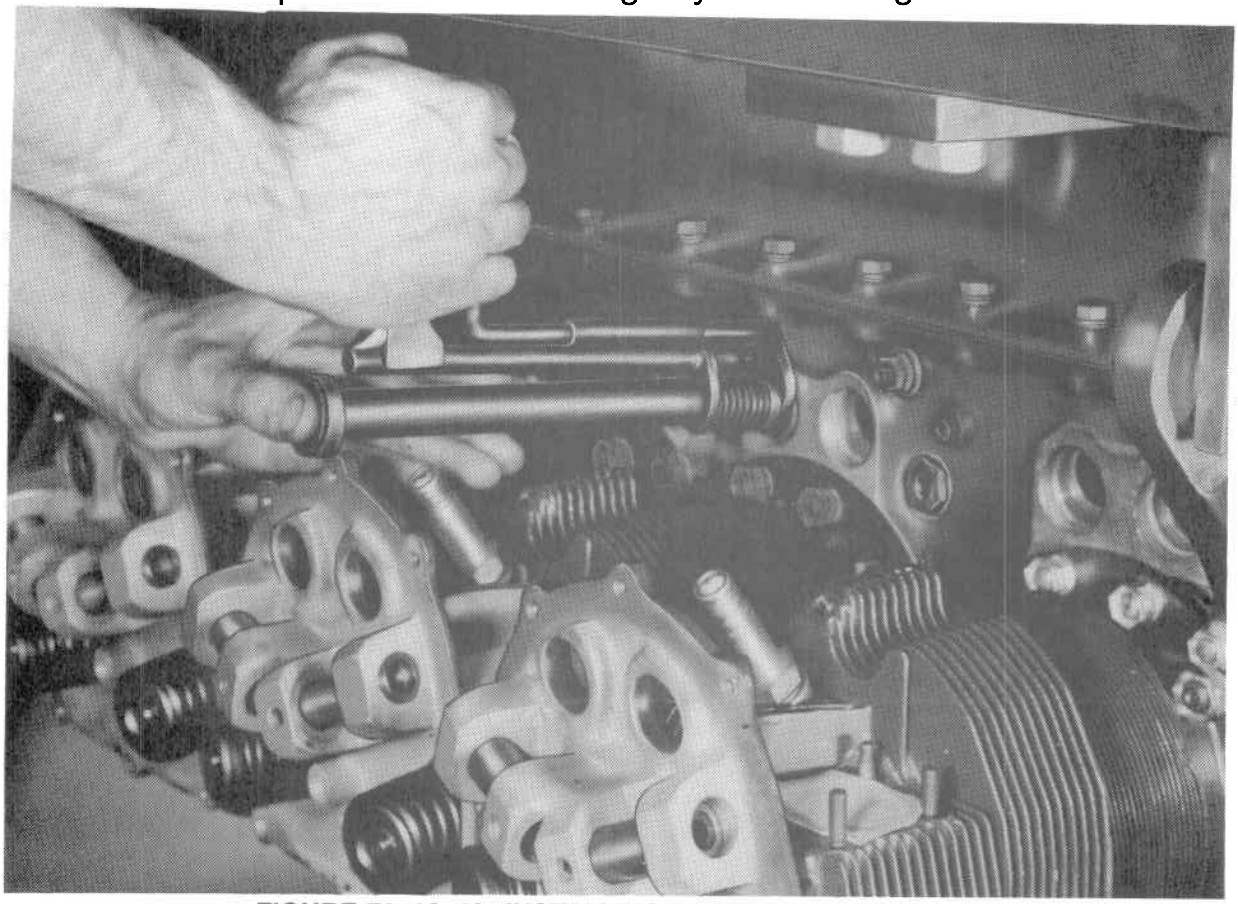


FIGURE 72-60-10. INSTALLING PUSHROD HOUSING.

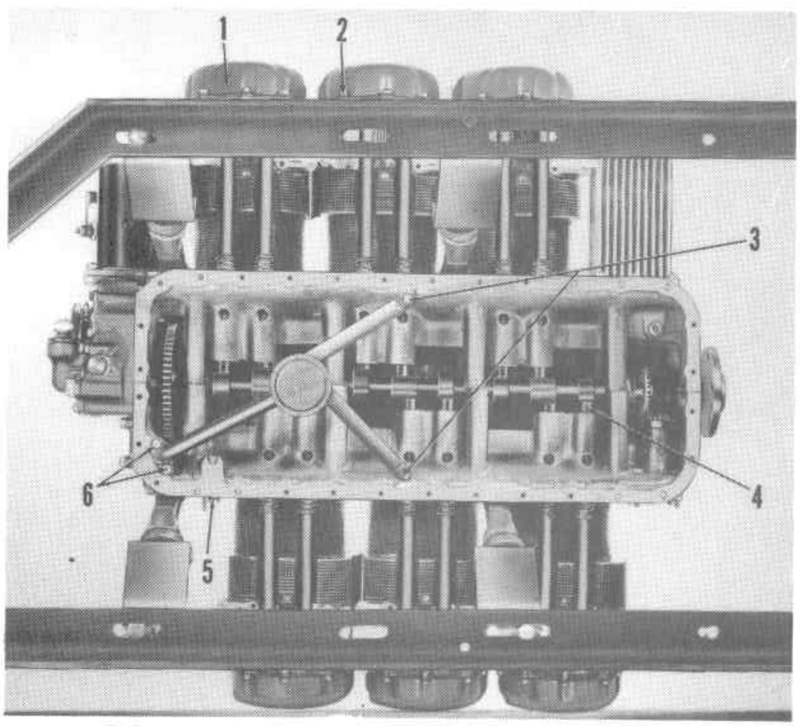


FIGURE 72-60-11. BOTTOM VIEW WITH VALVE MECHANISM AND OIL SUCTION TUBE.

1. Cover, rocker
2. Screw
3. Bolt
4. Lifter, hydraulic
5. Guide, oil gage rod
6. Bolt

72-60-12 **INDUCTION SYSTEM (See Figure 72-10-08).**

A. Push a new applicable hose on either end of intake manifold elbows. Slide one hose clamp to a midway position on overlapping portion. Turn each clamp so that a screwdriver can be aligned with its screw, clear of obstruction, when tube is installed. Tighten screw only enough to hold hose in position.

B. Place a hose clamp on each end cylinder intake tube so it faces center tube. Push end tubes into hose previously installed on center intake tubes. Work hose clamps over ends of hoses, but not past bead. Do not tighten at this time.

C. Push hose on each front and rear intake tube and install a clamp on overlapping portion behind tube bead. Tighten clamps.

D. Lay new gasket on intake flange of each cylinder. Position each assembly of tubes and hoses on proper bank of cylinders and adjust each tube so it seats squarely on cylinder port.

E. Attach each intake flange to its cylinder with four sets of attaching parts. Torque to value specified in Table of Limits, Section 72-30-09. Position clamp on two center hoses on each side inside tube beads and tighten.

F. Install clamps and bracket on balance tube. Push tube ends into connecting hoses installed on front intake tubes. Position clamp and secure bracket to sump with two sets of attaching parts. Position clamp assemblies, between tube and elbow, over beads and tighten. Turn engine upright.

INDUCTION SYSTEM FOR IO-470-C & H (See Figures 72-10-07 & 72-10-08).

A. Push hoses and clamps on No. 1 and No. 2 intake tubes (16) until clear of ends. Position intake manifold (9) between tubes (16) and install hoses (12) and clamps (11).

B. Secure intake manifold (9) to oil sump using new gasket (10) and attaching hardware (5, 6 & 7).

C. Attach air throttle and control assembly (49, Figure 72-10-06) to oil sump using new gasket (25) and attaching hardware (22, 23 & 24).

INDUCTION SYSTEM FOR IO-470-D, E, G, L, P, R, U, V & VO (See Figure 72-10-07).

A. Push hoses and clamps on No. 1 and No. 2 intake tubes (41) until clear of ends. Position riser tubes (16 & 17) on No. 1 and No. 2 intake tubes (41) and attach using hoses and clamps (14 & 15).

B. Attach throttle assembly (13) to engine, using bracket (52) and attaching hardware (46 thru 51).

C. Secure riser tube assemblies to air throttle assembly using hoses (2) and clamps (1).

INDUCTION SYSTEM FOR IO-470-F (See Figure 72-10-07).

A. Push hoses and clamp on No. 1 and No. 2 intake tubes (24) until clear of ends. Position tube assemblies (14 & 16) on No. 1 and No. 2 intake tubes (24) and attach using hoses and clamps (12 & 13).

B. Position air throttle assembly (11) between tube assemblies (14 & 16) and attach using hoses (6) and clamps (5).

INDUCTION SYSTEM FOR IO-470-J (See Figure 72-10-07).

A. Push hoses and clamps on No. 1 and No. 2 intake tubes (11) until clear of ends. Position air manifold assembly (4) between No. 1 and No. 2 intake tubes (11) and attach using hoses (9) and clamps (7).

B. Secure air manifold assembly (4) to engine oil sump using attaching hardware (1, 2, 3).

INDUCTION SYSTEM FOR IO-470-K & N (See Figure 72-10-07).

A. Push hoses and clamps on No. 1 and No. 2 intake tubes (16) until clear of ends. Position air manifold assembly (7) between intake tubes No. 1 and No. 2 (16), attach using hoses (10) and clamps (9).

B. Secure air manifold to air throttle assembly using hose (6) and clamp assembly (5).

INDUCTION SYSTEM FOR IO-470-M (See Figure 72-10-07).

A. Push hoses and clamps on No. 1 and No. 2 intake tubes (36) until clear of ends. Position intake tubes (3 & 4) on intake tubes No. 1 and No. 2 (36) and attach using hoses (2) and clamps (1).

B. Position air throttle assembly (10) between intake tubes (3 & 4) using bracket (25) and attaching hardware (7, 8, 11 thru 24), secure air throttle assembly to engine.

C. Attach intake tubes (3 & 4) to air throttle assembly (10) using hoses (2) and clamps (1).

INDUCTION SYSTEM FOR IO-470-S (See Figure 72-10-07).

A. Push hoses and clamps on No. 1 and No. 2 intake tubes (12) until clear of ends. Position intake tubes (3 & 4) on intake tubes No. 1 and No. 2 (12) and attach using hoses (1) and clamps (2).

B. Position air throttle assembly (30) between intake tubes (3 & 4). Secure air throttle assembly to engine using brackets (29 & 24) and attaching hardware (14 thru 28).

C. Attach intake tubes (3 & 4) to air throttle assembly (30) using hoses (1) and clamps (2).

72-60-13 **FUEL INJECTION (See Figures 72-10-06 & 72-50-10).**

A. Place square drive fuel pump coupling in crankcase cavity after it has been thoroughly lubricated.

B. Coat both sides of gasket with a film of TCM Gasket Sealant, P/N 642188. Install gasket on crankcase studs, then slide fuel pump onto studs and secure with two sets of attaching parts. Install shroud on fuel pump.

NOTE . . . For all Fuel Injection Systems prepare the engine for test after overhaul according to instructions contained in Chapter 73, "Engine Fuel System" and run-in schedule.

FUEL INJECTION FOR IO-470-C, H & J (See Figure 72-10-06).

A. Install fuel nozzles (3) into cylinders using TCM Anti-Seize 646943 on male threads only. Install sleeves over nozzles and attach fuel discharge tubes (2). Secure tubes to bracket (75) with clamps (1). Attach discharge tubes to fuel manifold valve (74).

B. Install fuel hose (9) from manifold valve to fuel control (46). Install fuel hoses from fuel control to fuel pump and secure using applicable attaching hardware.

FUEL INJECTION FOR IO–470–D & U (See Figure 72–10–06).

A. Install fuel nozzles (3) into cylinders using TCM Anti-Seize 646943 on male threads only. Install sleeves over nozzles and attach fuel discharge tubes (2). Secure tubes to bracket (70) with clamps (1). Attach discharge tubes to fuel manifold valve (69).

B. Install fuel hose (10) from manifold valve to fuel control (36). Install fuel hoses from fuel control to fuel pump and secure using applicable attaching hardware.

FUEL INJECTION FOR IO–470–E, G, P & R (See Figure 72–10–06).

A. Install fuel nozzles (3) into cylinders using TCM Anti-Seize 646943 on male threads only. Install sleeves over nozzles and attach fuel discharge tubes (2). Secure tubes to bracket (68) with clamps (1). Attach discharge tubes to fuel manifold valve (67).

B. Install fuel hose (9) from manifold valve to fuel control (35). Install fuel hoses from fuel control to fuel pump and secure using applicable attaching hardware.

FUEL INJECTION FOR IO–470–F (See Figure 72–10–06).

A. Install fuel nozzles (3) into cylinders using TCM Anti-Seize 646943 on male threads only. Install sleeves over nozzles and attach fuel discharge tubes (2). Secure tubes to bracket (58) with clamps (1). Attach discharge tubes to fuel manifold valve (57).

B. Install fuel hose (11) from manifold valve to fuel control (26). Install fuel hoses from fuel control to fuel pump and secure using applicable attaching hardware.

FUEL INJECTION FOR IO–470–K & N (See Figure 72–10–06).

A. Install fuel nozzles (3) into cylinders using TCM Anti-Seize 646943 on male threads only. Install sleeves over nozzles and attach fuel discharge tubes (2). Secure tubes to bracket (72) with clamps (1). Attach discharge tubes to fuel manifold valve (71).

B. Install fuel hose (9) from manifold valve to fuel control (44). Install fuel hoses from fuel control to fuel pump and secure using applicable attaching hardware.

FUEL INJECTION FOR IO–470–L (See Figure 72–10–06).

A. Install fuel nozzles (3) into cylinders using TCM Anti-Seize 646943 on male threads only. Install sleeves over nozzles and attach fuel discharge tubes (2). Secure tubes to bracket (60) with clamps (1). Attach discharge tubes to fuel manifold valve (59).

B. Install fuel hose (6) from manifold valve to fuel control (27). Install fuel hoses from fuel control to fuel pump and secure using applicable attaching hardware.

FUEL INJECTION FOR IO–470–M (See Figure 72–10–06).

A. Install fuel nozzles (3) into cylinders using TCM Anti-Seize 646943 on male threads only. Install sleeves over nozzles and attach fuel discharge tubes (2). Secure tubes to bracket (69) with clamps (1). Attach discharge tubes to fuel manifold valve (68).

B. Install fuel hose (12) from manifold valve to fuel control (31). Install fuel hoses from fuel control to fuel pump and secure using applicable attaching hardware.

FUEL INJECTION FOR IO-470-S (See Figure 72-10-06).

A. Install fuel nozzles (3) into cylinders using TCM Anti-Seize 646943 on male threads only. Install sleeves over nozzles and attach fuel discharge tubes (2). Secure tubes to bracket (61) with clamps (1). Attach discharge tubes to fuel manifold valve (60).

B. Install fuel hose (6) from manifold valve to fuel control (27). Install fuel hoses from fuel control to fuel pump and secure using applicable attaching hardware.

FUEL INJECTION FOR IO-470-V & VO (See Figure 72-10-06).

A. Install fuel nozzles (3) into cylinders using TCM Anti-Seize 646943 on male threads only. Install sleeves over nozzles and attach fuel discharge tubes (2). Secure tubes to bracket (59) with clamps (1). Attach discharge tubes to fuel manifold valve (58).

B. Install fuel hose (10) from manifold valve to fuel control (33). Install fuel hoses from fuel control to fuel pump and secure using applicable attaching hardware.

72-60-14 MAGNETO DRIVE GEARS (See Figures 72-10-07 & 72-60-14).

A. With engine in upright position, insert one pressed steel retainer (18) into each gear hub slot.

B. Cover each of four new rubber coupling bushings with a film of Molyshield grease and insert two bushings (21) into each retainer, rounded long edges first.

C. Turn the crankshaft to the No. 1 cylinder advance firing angle as described in Figure 72-60-17. Install sleeve (19) into magneto drive gear (20). Lubricate each gear (20) and insert into bushings (15). Observe the shaft ends from the rear as they are carefully pushed through the adapter oil seals to make sure the oil seal lips are not reversed or damaged. Mesh the magneto drive gears to the idler gear to the approximate position shown in Figure 72-60-14. These positions will vary slightly due to the difference in magnetos and gears.

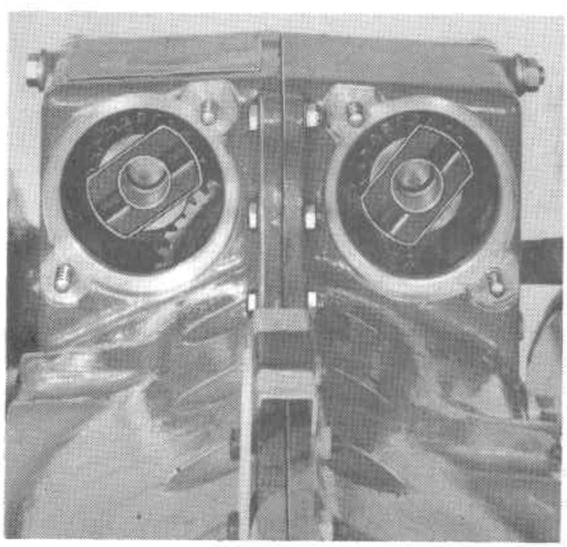


FIGURE 72-60-14. POSITION OF MAGNETO COUPLINGS.

72-60-15 PLACING CRANKSHAFT IN TIMING POSITION.

In conducting magneto timing, the use of a positive dead center locator, protractor and pointer are the most accurate tools to use. Tools which call for a specific arm on the piston dome are more susceptible to error.

NOTE . . . If the engine is equipped with a right angle drive starter adapter and does not freely turn in the opposite direction of normal rotation, the starter motor should be disengaged or removed from the starter adapter. Some right angle starter drive adapters incorporate an over-riding spring clutch design that restricts engine rotation in the opposite direction of normal rotation.

CAUTION . . . The importance of establishing and maintaining correct magneto to engine timing cannot be overemphasized. Incorrect timing, in addition to producing a rough running engine, can lead to detonation, pre-ignition, possible internal engine damage or failure.

A. Direct Drive Engines, Timing Procedure.

1. Remove all top spark plugs. Rotate piston to the start of the compression stroke. Install the top dead center locator into No. 1 cylinder top spark plug hole.

2. Install timing disc of indicator being used on crankshaft.

3. Turn crankshaft slowly in direction of rotation until piston lightly touches TDC locator.

4. Rotate disc of timing indicator until top center mark is under the pointer.

5. Slowly turn crankshaft in opposite direction until piston lightly touches TDC locator. Observe the reading on the disc under the pointer and move the disc to exactly one-half of the number of degrees observed toward the top center mark. You have now located top dead center.

6. Remove TDC locator from the cylinder and find the compression stroke on No. 1 cylinder by placing a finger over the spark plug hole, or any other adequate method. As you come up on compression stop the pointer at the TDC location as determined in step 5.

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

MODEL	RIGHT MAG ①	LEFT MAG ①
IO-470-D,E,F,H,L,M,N,S,U,V & VO	20° BTC	20° BTC
IO-470-J & K	22° BTC	22° BTC
IO-470-C,G,P,R & T	26° BTC	26° BTC

① Magneto setting tolerance to be plus or minus one (1) degree unless otherwise noted.

72-60-16 MAGNETOS.

A. Remove inspection hole plugs from magnetos.

B. Turn impulse coupling backward, so latches will not engage, until timing pointer inside inspection hole is aligned with marked distributor gear tooth.

NOTE . . . See TCM Service Bulletins M82-12, M84-8 or current revisions as applicable.

C. Without turning the magneto coupling, hold the magneto in the horizontal position it will occupy when installed, and check alignment of gear coupling slot and impulse coupling lugs. If not aligned, pull gear out of mesh (but not out of oil seal) and turn to correct alignment. Push gear back into mesh.

D. Place new gasket on magneto flange and install magneto carefully so drive coupling lugs mate with slots of drive bushings. Install holding washers, lockwashers and nuts, but tighten only enough to permit turning the magneto for final timing, without looseness. Install right magneto with outer end slightly below horizontal and left magneto with outer end slightly above horizontal.

E. Connect timing light lead to ground terminal of each magneto. Both timing lights should be on. Tap the right magneto up with a non-marring hammer until the light goes out. Tap the left magneto down until the light goes out. Secure magnetos.

F. Turn the crankshaft a few degrees counterclockwise, then clockwise until the timing indicators pointer is pointing to the correct degree for model engine. Both timing lights should go out at the same time. The timing mark on the crankshaft flange should also align with crankcase parting flange, or the timing mark on the alternator drive gear appears in the center of the crankcase inspection hole.

G. Install gaskets and covers on mount pads behind magneto drive gears and attach with four sets of plain washers, lockwashers and nuts.

72-60-17 IGNITION HARNESS (See Figures 72-20-27 & 72-60-17).

A. The high tension cable outlet plates can be attached to either magneto in only one position. The very shortest ignition cable is for No. 1 upper spark plug, and identifies proper assembly for the right magneto. Notice the "1" on the outlet plates next to the No. 1 cylinder cable outlet holes.

B. Attach cable outlet plate to magneto.

C. Lay lower spark plug cables from each magneto across the brace on crankcase top flange in two layers of three cables each. Install clamp and its attaching parts.

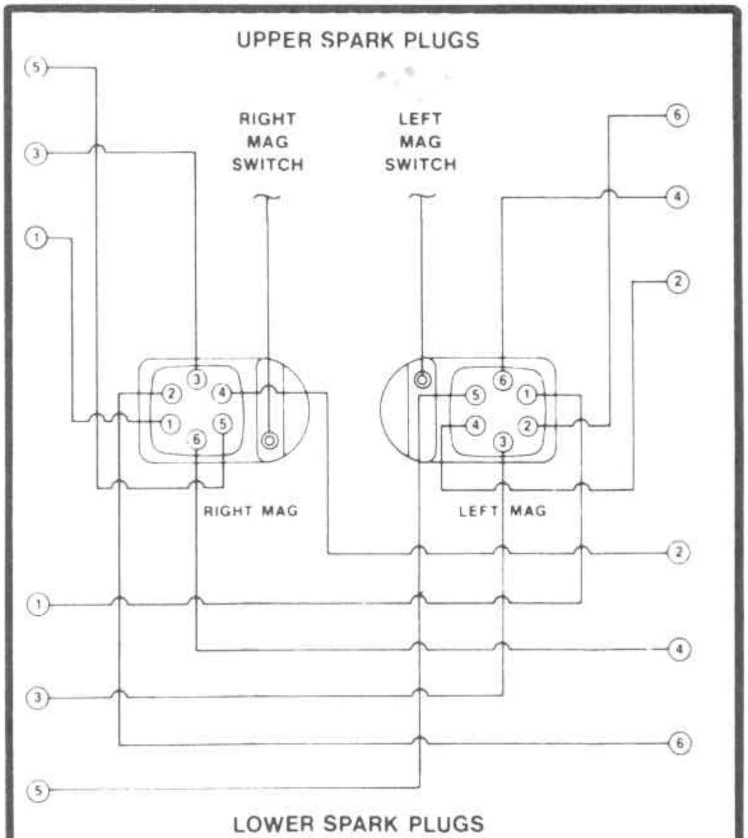
D. Install a clamp on each ignition cable and position fuel discharge tube bracket over cables on right cylinder bank.

E. Snap retaining clamp of cable 1R into top hole in rear leg of bracket. Following this, starting from the rear, snap 1L into first hole, 3R into 3rd hole, 3L into 4th hole, 5R into 6th hole and 5L into front leg of bracket. Position bracket so that its centerline is 6-3/4 inches from edge of No. 1R ferrule and 20-3/4 inches from edge of No. 5L ferrule. Position second bracket over cables on left cylinder bank. Snap retaining clamp of No. 2L cable into bottom and 2R into top hole in rear leg of bracket. Starting from the rear, snap cable 4R into second hole and 6L into hole in front leg of bracket. Position bracket so that its centerline is 21-1/4 inches from edge of No. 2R ferrule and 7-1/2 inches from edge of No. 6 ferrule.

F. Install all spark plugs not already in place with smooth copper gaskets. Tighten all plugs to torque specified in Tightening Torques, Section 72-50-02.

G. Insert cable terminal sleeves into the proper plugs and screw on the elbow coupling nuts only enough to keep the elbows from turning. Keep the lower spark plug cables above the intake manifold and inside the intake elbows.

H. Check service bulletins occasionally issued by ignition harness manufacturers regarding tips for increased service life.



ENGINE FIRING ORDER	1	6	3	2	5	4
MAGNETO FIRING ORDER	1	2	3	4	5	6

FIGURE 72-60-17.
IGNITION WIRING DIAGRAM

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72-60-18 **FUEL LINES & HOSES (See Figure 72-10-08).**

A. Make sure that all nozzles have been installed using Anti-Seize No. 646943 and properly tightened. Install air manifold tubes to nozzle sleeves. Make sure attaching parts are assembled as shown in Figures 72-10-08.

B. Snap the discharge tube retaining clamps into brackets and secure tubes in clamps.

C. Connect tubes to respective nozzles and manifold valve fittings.

D. Install fuel hoses and secure as required.

72-60-19 **EXHAUST SYSTEM.**

A. Exhaust systems for IO-470 series engines are supplied by the airframe manufacturer. For assembly procedures refer to the appropriate airframe manufacturer's instructions.

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SECTION 72-70
TESTING AFTER OVERHAUL

72-70-00 TESTING AFTER OVERHAUL

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72-70-00 TESTING AFTER OVERHAUL

72-70-01 **TEST STAND.** After each major overhaul, engine performance should be tested and new parts run-in while the engine is mounted on a rigid test stand, enclosed in cell of such design that recirculating air is held to a minimum. The engine stand should be constructed in a way to permit accessibility to all engine line and instrument connections and to permit frequent inspection of all points of possible leakage. All tubes, wires, rods and cables used to connect instruments and controls should be well supported, and of sufficient flexibility to permit them to be moved out of the way during installation and removal of the engine.

NOTE . . . When necessary, the airframe can be considered a suitable test stand for running in overhauled engines with the use of a test propeller and equipped with a suitable shroud or scoop to gather and direct cooling air over the cylinders. Engine must be equipped with all the calibrated instruments listed on 72-70-08 "Instruments" of this manual.

72-70-02 **TEST CLUB.** Unless a dynamometer is used to apply controlled loads to the crankshaft, it will be necessary to install a wood test club such as those supplied by the Hartzell Propeller Fan Co., Piqua, Ohio. Test clubs are supplied in standard diameters and must be customized as required. After customizing they should be calibrated with a torque meter.

72-70-03 **COOLING AIR SCOOP.** The scoop must be designed to fit over the tops of all cylinders, with padded seals for rear cylinders and valve rocker covers, to direct an adequate flow of air downward through the cylinder fins. Vanes are necessary to direct cooling air to the center cylinder and the oil cooler. CHT should not vary more than 50°F. between coolest and hottest cylinders. Provide an air duct to the alternator vent tube.

72-70-04 **INDUCTION AIR INTAKE.** An air filter and housing should be attached to the turbocharger inlet flange. The filter area must be sufficient to avoid restriction of air flow. Always clean filter before each test. Calculations of filter area should be based on approximately 389 c.f.m. of air required by the engine at full throttle and on the filter capacity per unit of area. The calculated area of a clean filter should be increased by at least 50% to allow for dirt accumulation.

72-70-05 **EXHAUST SYSTEM.** For testing purposes the exhaust system supplied by the airframe manufacturer should be installed.

72-70-06 **CONTROLS.** The only controls required are a mixture control and throttle control capable of operating the fuel control and metering shafts through their complete ranges, and a standard twin magneto switch connected to the magneto ground terminals.

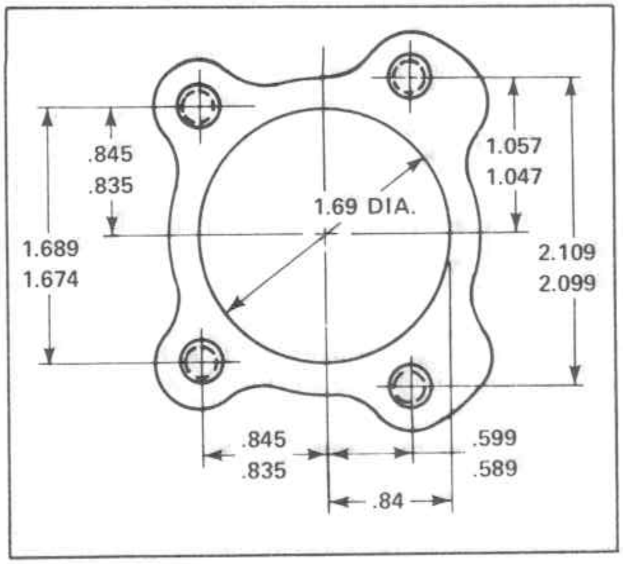

FIGURE 72-70-05. EXHAUST FLANGE DIMENSIONS.

72-70-07 **ELECTRICAL WIRING.** A storage battery must be connected by a No. 0 stranded copper cable from its positive terminal to the power terminal of the starter or starter solenoid. The battery negative terminal must be connected to the engine or both battery terminal and engine may be grounded. A small insulated wire should connect the starter solenoid coil terminal to a 5 ampere pushbutton switch. The other switch terminal must be connected to the engine or both to common ground.

72-70-08 **INSTRUMENTS.** The control panel should be equipped with the following calibrated engine instruments.

A. A mechanically driven (counterclockwise, 1/2 engine RPM) tachometer and flexible shaft assembly is required.

B. An oil pressure gage and tube connection.

C. An oil temperature gage and capillary assembly.

D. A cylinder head temperature gage and wiring to each cylinder. (See test operating limitations for different maximum temperatures).

E. A water manometer with rubber hose connection to the vacuum pump oil return hole at the rear of the crankcase.

F. An ammeter connected in the generator or alternator circuit.

G. Fuel flow gage or fuel pressure gage.

H. An exhaust gas temperature gage.

I. Manifold pressure gage.

72-70-09 **BREATHER.** A substantial hose of 3/4 inch ID should be securely clamped over crankcase breather elbow and support so as to lead to a point above and to the rear of engine.

72-70-10 **FUEL SYSTEM.** The test stand fuel system is to incorporate an auxiliary pump capable of delivering fuel to and through engine system at a pressure of 2.5 to 4.0 p.s.i. indication on fuel pressure gage. Means of determining, by weight, fuel consumption for given periods of time and at specified percentage of power should also be included. Connect stand fuel supply line to upper elbow projecting from left side of fuel pump shroud. Connect fuel pump-to-supply tank return line to upper elbow projecting from right side of fuel pump. Connect fuel pressure gage line to the fitting projecting from the center rear of fuel manifold valve.

72-70-11 **GOVERNOR PAD COVER.** A removable oil transfer tube conducts oil under pressure from the front main bearing through the crankshaft to the propeller hub. Crankshafts are equipped with an oil transfer collar to supply the governor controlled oil to the crankshaft for use with an oil controlled propeller. When a test club or fixed pitch propeller is used for testing purposes, the governor pad cover must have an internal grooved surface to allow the circulating oil to lubricate the oil transfer collar. The governor pad cover is not needed if a propeller governor is installed.

72-70-12 **ENGINE TEST.**

A. Make one check on performance of each magneto alone at 2100 RPM. Clear spark plugs by operating with both magnetos on for a few seconds between checks.

B. Take instrument readings at the beginning, in the middle, and at the end of the full throttle period. Take one reading during each of the other periods as soon as conditions have stabilized.

NOTE . . . The maximum allowable cylinder head temperature and the maximum allowable oil temperature must not be exceeded at any time during the test.

C. Extend the second period of each test schedule, if necessary, to raise the oil temperature to 100°F.

D. Run the engine according to the schedule in this section after a major overhaul. (Standard Acceptance Test).

NOTE . . . If tests must be conducted in extremely cold weather, it may be necessary to shield the crankcase from the cooling air stream, since it takes some heat from the oil.

72-70-13 **STARTING PROCEDURE.**

A. Open throttle to approximately 900 to 1200 RPM position.

B. Turn magneto switch to "BOTH" position.

C. Press boost pump button and hold it until 2.5-3.0 or 4.0 p.s.i. nozzle pressure depending on type pump used is obtained; then release boost pump button and press starter button.

NOTE . . . During operation of the starter, the boost pump may be used intermittently to maintain 2.5 to 3.0 or 4.0 p.s.i. nozzle pressure depending on type pump used. DO NOT use boost pump after engine is running smoothly.

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72-70-14
OVERHAUL TEST RUN
STANDARD ACCEPTANCE TEST

Period	Time-Minutes		RPM
1	5		1200
2	5		1600
3	10		2450
4	15	① ⑥	Rated RPM
5	10	② ③ ⑥	Engine Parameter Checks
6	10		2450
7	5	④	Idle RPM 600 $\pm$ 25
8	15	⑤ ⑥	75% power
9	15	⑤ ⑥	75% power
10	15	⑥ ⑦	75% power
11	15	⑥ ⑦	75% power
	120		TOTAL MINUTES

① Adjust Engine - Fuel Flow and Pressure (Reduce RPM For Adjustments)

② Check Fuel System, Oil Pressure, Oil Temperature, M.A.P., C.H.T. and Alternator.

③ Magneto Drop and Spread To Be Taken. Engine Must Be Throttled To Specified RPM and Temperature Allowed To Settle Out Before Taking Magneto Drop And Spread.

④ Cooling Period - 300° Max. C.H.T. Before Shut-Down, Recheck Idle Adjustments.

⑤ Runs 8 And 9 Must Be Made With Stops For Leak Checks At The End Of Each Run.

⑥ See Operating Limits Section 77-10-00.

⑦ Fuel And Oil Leaks Are Not Acceptable.

72-70-14
OIL CONSUMPTION DETERMINATION

Period	Time-Minutes	RPM
1	5	1200
2	5	1600
3	5	2450
4	10	① ② Rated RPM
5	10	① ③ ④ Engine Parameter Checks
6	5	⑦ Idle RPM 600 ± 25
Stop engine, drain oil, weigh oil in for oil consumption determination.		
7	5	① ⑤ Warm Up to Rated RPM (Minimum 1200 RPM)
8	30	① ⑥ 75% power
9	5	⑦ Idle RPM 600 ± 25

⑧ After test schedule is completed, stop engine, drain, weigh oil and record.

① See Operating Limits Section 77-10-00.

② Adjust engine - fuel flow and pressure (Reduce RPM for adjustments).

③ Check fuel injection, oil pressure, oil temperature, M.A.P., C.H.T. and alternator.

④ Magneto drop and spread to be taken. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.

⑤ Refill sump with clean oil.

⑥ Readings must be recorded after completion of each 10 minute interval during run.

⑦ Cooling period -300° Max. C.H.T. Before shut-down, recheck idle adjustments.

⑧ For maximum oil consumption, refer to Section 72-00-00 Engine Specifications.

72-70-14 OVERHAUL TEST RUN
TEST OPERATING LIMITS

FEATURE	
Maximum Takeoff Power	
IO-470-C,G,P,R & T	250 @ 2600
IO-470-D,E,F,H,L,M,N,S,U,V & VO	260 @ 2625
IO-470-J & K	225 @ 2600
Fuel Grade	100LL/100
Fuel Pump Pressure (PSI) (See Performance Charts)	Section 76-30-00
Engine Intake Air Temperature	Ambient
Manifold Pressure (See Performance Charts)	Section 76-30-00
Oil Grade ①	
Normal Service Above 30°F.	SAE 50
Below 50°F.	SAE 30 or 10W30
All Temperatures	15W50 20W50
Oil Consumption at Max. Continuous Power (Lbs/BHP/Hr. Max. at Rated Power at RPM)	
All Models	$\frac{.006 \text{ lbs.} \times \% \text{ Power}}{100}$
Oil Temperature (Min. for Takeoff)	75°F.
Oil Temperature (Max.) All except IO470-LO,VO	225°F.
IO470-LO,VO	240°F.
Oil Pressure at Cruise (PSI Max.) (oil temperature 175°F.-185°F.)	30-60
Oil Pressure at Idle (PSI Min.)	10
Ignition Timing	
IO-470-D,E,F,H,L,M,N,S,U,V & VO	
Left Magneto ° BTC	20°
Right Magneto ° BTC	20°
IO-470-J & K	
Left Magneto ° BTC	22°
Right Magneto ° BTC	22°
IO-470-C,G,P,R & T	
Left Magneto ° BTC	26°
Right Magneto ° BTC	26°
Cylinder Head Temperature (Max.) with Bayonet Thermocouple	
(All Models except IO-470-J & K)	460°F.
IO-470-J & K	450°F.

① For first 25 hours of operation. See Operating Limits Figure 72-00-00.

72-70-15 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 aircraft flight manual. Conduct a normal takeoff with full power and monitor the fuel flow, RPM, oil pressure, cylinder head temperatures and oil temperatures. Reduce to climb power in accordance with the flight manual and maintain a shallow climb attitude to gain optimum airspeed and cooling. Rich mixture for all operations except lean for field elevation where applicable and lean to maintain smoothness during climb in accordance with airframe manufacturer's operating instructions.

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. Engine controls or aircraft attitude should be adjusted as required to maintain engine instrumentation within specifications.

Descent from high altitude should be accomplished at cruise power settings, with the mixture control positioned accordingly.

CAUTION . . . Rapid descents at high RPM and idle manifold pressure are to be avoided.

During descent, monitor cylinder head and oil temperatures, maintaining above the minimum specified limits.

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. If power must be reduced for long periods, adjust propeller to minimum governing RPM and set manifold pressure no lower than necessary to obtain desired performance. If the outside air is extremely cold, it may be desirable to add drag (gear, flaps) to the aircraft in order to maintain engine power without gaining excess airspeed. Do not permit cylinder temperature to drop below 300°F. for periods exceeding five (5) minutes.

Any discrepancies detected during test flight or any final adjustments necessary should now be made. The engine can be operated in normal service in accordance with the aircraft flight manual.

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SECTION 72-80
ENGINE PRESERVATION

72-80-00 ENGINE PRESERVATION

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72-80-01 GENERAL.

Engines in aircraft that are flown only occasionally tend to exhibit cylinder wall corrosion more than engines in aircraft that are flown frequently.

Of particular concern are new engines or engines with new or freshly honed cylinders after a top or major overhaul. In areas of high humidity, there have been instances where corrosion has been found in such cylinders after an inactive period of only a few days. When cylinders have been operated for approximately 50 hours, the varnish deposited on the cylinder wall offers some protection against corrosion. Hence a two step program for flyable storage category is recommended.

Obviously, even then proper steps must be taken on engines used infrequently to lessen the possibility of corrosion. This is especially true if the aircraft is based near the sea coast or in areas of high humidity and flown less than once a week.

In all geographical areas the best method of preventing corrosion of the cylinders and other internal parts of the engine, is to fly the aircraft at least once a week, long enough to reach normal operating temperatures, which will vaporize moisture and other by-products of combustion. In consideration of the circumstances mentioned, TCM has listed three reasonable minimum preservation procedures, that if implemented, will minimize the detriments of rust and corrosion. It is the owner's responsibility to choose a program that is viable to the particular aircraft's mission.

Aircraft engine storage recommendations are broken down into the following categories:

A. Flyable Storage (Program I or II)

B. Temporary Storage (up to 90 days)

C. Indefinite Storage

72-80-02 FLYABLE STORAGE (Program I or II)

Program I - Engines or cylinders with less than 50 operating hours:
a. Propeller pull thru every 5 days as per paragraph 2; and
b. Fly every 15 days as per paragraph 3.

Program II - Engines or cylinders with more than 50 operating hours to TBO if not flown weekly:
a. Propeller pull thru every 7 days as per paragraph 2; and
b. Fly every 30 days as per paragraph 3.

1. Service aircraft per normal airframe manufacturer's instructions.

2. The propeller should be rotated by hand without running the engine. For 4 and 6 cylinder straight drive engines, rotate the engine six revolutions. Stop the propeller 45° to 90° from the original position. For 6 cylinder geared engines, rotate the propeller 4 revolutions and stop the propeller 30° to 60° from the original position.

CAUTION . . . FOR MAXIMUM SAFETY, ACCOMPLISH ENGINE ROTATION AS FOLLOWS:

a. Verify magneto switches are "OFF"
b. Throttle position "CLOSED"
c. Mixture control "IDLE CUT-OFF"
d. Set brakes and block aircraft wheels
e. Leave aircraft tie-downs 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.

3. The aircraft should be flown for thirty (30) minutes, reaching, but not exceeding, normal oil and cylinder temperatures. If the aircraft cannot be flown it should be represerved in accordance with "B" (Temporary Storage) or "C" (Indefinite Storage). Ground running is not an acceptable substitute for flying.

NOTE . . . If "b." in each program cannot be accomplished on schedule due to weather, maintenance, etc., pull the propeller thru daily as soon as possible.

It is necessary that for future reference, if required, the propeller pull thru and flight time be recorded and verified in the engine maintenance record/log with the date, time and signature.

72-80-03 TEMPORARY STORAGE (Up to 90 Days).

1. Preparation for Storage

a. Remove the top spark plug and spray preservative oil (Lubrication Oil - Contact and Volatile Corrosion - Inhibited, MIL-L-46002, Grade 1) at room temperature, through upper spark plug hole of each cylinder with the piston in approximately the bottom dead center position. Rotate crankshaft as each pair of opposite cylinders is sprayed. Stop crankshaft with no piston at top dead center. A pressure pot or pump-up type garden pressure sprayer may be used. The spray head should have ports around the circumference to allow complete coverage of the cylinder walls.

NOTE . . . Shown below are some approved preservative oils recommended for use in Teledyne Continental engines for temporary and indefinite storage.

MIL-L-46002, Grade 1 Oils:

NOX RUST VCI-105	Daubert Chemical Company 4700 S. Central Avenue Chicago, Illinois (312) 496-2327

b. Re-spray each cylinder without rotating crankshaft. To thoroughly cover all surfaces of the cylinder interior, move the nozzle or spray gun from the top to the bottom of the cylinder.

c. Re-install spark plugs.

d. Apply preservative to engine interior by spraying the above specified oil (approximately two ounces) through the oil filler tube.

e. Seal all engine openings exposed to the atmosphere using suitable plugs, or moisture resistant tape, and attach red streamers at each point.

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f. Engines, with propellers installed, that are preserved for storage in accordance with this section should have a tag affixed to the propeller in a conspicuous place with the following notation on the tag: "DO NOT TURN PROPELLER - ENGINE PRESERVED". PRESERVATION DATE ______________________________.

NOTE . . . If engine is not returned to flyable status at the expiration of the temporary (90 day) storage, it must be preserved in accordance with the indefinite storage procedures.

2. Preparation for Service

a. Remove seals, tape, paper and streamers from all openings.

b. With bottom spark plugs removed from the cylinder, hand turn propeller several revolutions to clear excess preservative oil, then re-install spark plugs.

c. Conduct normal start-up procedure.

d. Give the aircraft a thorough cleaning and visual inspection. A test flight is recommended.

72–80–04 INDEFINITE STORAGE.

1. Preparation for Storage

a. Drain the engine oil and refill with MIL-C-6529 Type II. The aircraft should be flown for thirty (30) minutes, reaching, but not exceeding normal oil and cylinder temperatures. Allow engine to cool to ambient temperature. Accomplish steps "1.a." and "1.b." of Temporary Storage.

NOTE . . . MIL-C-6529 Type II may be formulated by thoroughly mixing one part compound MIL-C-6529 Type I (Esso Rust-Ban 628, Cosmoline No. 1223 or equivalent) with three parts new lubricating oil of the grade recommended for service (all at room temperature). Single grade oil is recommended.

b. Apply preservative to engine interior by spraying MIL-L-46002, Grade 1 oil (approximately two ounces) through the oil filler tube.

2. Install dehydrator plugs MS27215-1 or -2, in each of the top spark plug holes, making sure that each plug is blue in color when installed. Protect and support the spark plug leads with AN-4060 protectors.

3. If the engine is equipped with a pressure-type carburetor, preserve this component by the following method. Drain the carburetor by removing the drain and vapor vent plugs from the regulator and fuel control unit. With the mixture control in "Rich" position, inject lubricating oil, grade 1010, into the fuel inlet at a pressure not to exceed 10 p.s.i. until oil flows from the vapor vent opening. Allow excess oil to drain, plug the inlet, tighten and safety the drain and vapor vent plugs. Wire the throttle in the open position, place bags of desiccant in the intake and seal the opening with moisture-resistant paper and tape, or a cover plate.

4. If the carburetor is removed from the engine, place a bag of desiccant in the throat of the carburetor air adapter. Seal the adapter with moisture-resistant paper and tape on a cover plate.

5. The TCM fuel injection system does not require any special preservation preparation. For preservation of the Bendix RSA-7DA1 fuel injection system, refer to the Bendix Operation and Service Manual.

6. Place a bag of desiccant in the exhaust pipes and seal the openings with moisture-resistant tape.

7. Seal the cold air inlet to the heater muff with moisture-resistant tape to exclude moisture and foreign objects.

8. Seal the engine breather by inserting a dehydrator MS27215-2 plug in the breather hose and clamping in place.

9. Attach a red streamer to each place on the engine where bags of desiccant are placed. Either attach red streamers outside of the sealed area with tape or to the inside of the sealed area with safety wire to prevent wicking of moisture into the sealed area.

10. Engines, with propellers installed, that are preserved for storage in accordance with this section should have each propeller tagged in a conspicuous place with the following notation on the tag: "DO NOT TURN PROPELLER - ENGINE PRESERVED." PRESERVATION DATE ______________________________.

PROCEDURES NECESSARY FOR RETURNING AN AIRCRAFT TO SERVICE ARE AS FOLLOWS:

1. Remove the cylinder dehydrator plugs and all paper, tape, desiccant bags, and streamers used to preserve the engine.

2. Drain the corrosion preventive mixture and re-service with recommended lubricating oil.

   WARNING . . . When returning the aircraft to service do not use the corrosion preventive oil referenced in paragraph C.1.a. for more than 25 hours.

3. If the carburetor has been preserved with oil, drain it by removing the drain and vapor vent plugs from the regulator and fuel control unit. With the mixture control in "Rich" position, inject service type gasoline into the fuel inlet at a pressure not to exceed 10 p.s.i. until all of the oil is flushed from the carburetor. Re-install the carburetor plugs and attach the fuel line.

4. With bottom plugs removed, rotate propeller to clear excess preservative oil from cylinders.

5. Re-install the spark plugs and rotate the propeller by hand through the compression strokes of all the cylinders to check for possible liquid lock. Start the engine in the normal manner.

6. Give the aircraft a thorough cleaning, visual inspection and test flight per airframe manufacturer's instructions.

AIRCRAFT STORED IN ACCORDANCE WITH THE INDEFINITE STORAGE PROCEDURES SHOULD BE INSPECTED PER THE FOLLOWING INSTRUCTIONS:

1. Aircraft prepared for indefinite storage should have the cylinder dehydrator plugs visually inspected every 15 days. The plugs should be changed as soon as their color indicates unsafe conditions of storage. If the dehydrator plugs have changed color in one-half or more of the cylinders, all desiccant material on the engine should be replaced.

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2. The cylinder bores of all engines prepared for indefinite storage should be re-sprayed with corrosion preventive mixture every six months, or more frequently if bore inspection indicates corrosion has started earlier than six months. Replace all desiccant and dehydrator plugs. Before spraying, the engine should be inspected for corrosion as follows: Inspect the interior of at least one cylinder on each engine through the spark plug hole. If cylinder shows start of rust, spray cylinder corrosion preventive oil and turn prop over six times, then re-spray all cylinders. Remove at least one rocker box cover from each engine and inspect the valve mechanism.

The above procedures are a general recommendation for our customers. Since local conditions are different and Teledyne Continental Motors has no control over the application, more stringent procedures may be required. Rust and corrosion prevention are the owner's responsibility.

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CHAPTER 73
ENGINE FUEL SYSTEM

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73–00–00 ENGINE FUEL SYSTEM.

The fuel injection system utilized is the multi-nozzle continuous flow type which controls fuel flow to match engine air flow. Any change in air throttle position, engine speed, or a combination of both, causes changes in fuel flow in the correct relations to engine air flow. A manual mixture control and a pressure gauge indicating metered fuel flow are provided for precise leaning at any combination of altitude and power setting. As fuel flow is directly proportioned to metered fuel pressure, settings can be predetermined and fuel consumption can be accurately predicted.

The continuous flow system permits the use of a typical rotary vane pump with integral relief valve in place of a much more complex and more expensive plunger type pump. The relief valve maintains maximum fuel flow under full power conditions. With this system there is no need for an intricate mechanism for timing injection to the engine.

The fuel injector pump is equipped with a vapor separator where the vapor is separated from liquid fuel by swirling action. Vapor is returned to the fuel tank. The fuel injector pump forces liquid fuel into the fuel-air mixture control assembly.

The fuel-air mixture control assembly controls the amount of intake air admitted into the intake manifold, and meters the proportionate amount of fuel to the manifold valve. The assembly has three control units; one for air in the air throttle assembly, and two for the fuel-air control unit.

a. The air throttle assembly includes a butterfly valve which controls the amount of air entering the intake manifold. This valve is controlled by a lever which is connected to the aircraft throttle control.

b. The fuel control assembly contains a metering valve and a mixture control valve. The metering valve is linked to the cockpit mixture control. The fuel control also by-passes excess fuel back to the fuel injector pump inlet port.

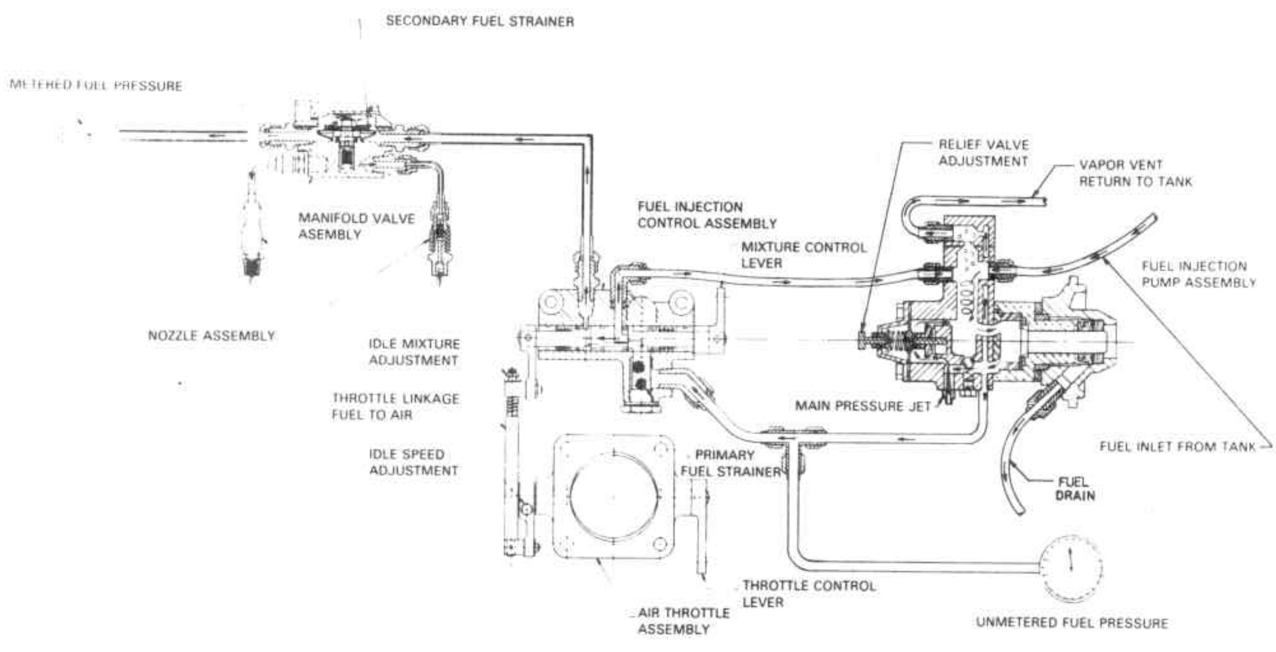

FIGURE 73–00–00. FUEL SYSTEM SCHEMATIC.

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73-10-00 SET-UP PROCEDURE.

The full rich performance of the fuel injection system on all injected engines is controlled by manual adjustment of air throttle and fuel mixture at idle and pump pressure at idle and full throttle. Fuel pressures of fixed orifice pumps can only be adjusted with the relief valve screw located on the centerline at the rear of the pump. Adjustable orifice pumps have an additional facility for adjusting pump pressure at both idle and full throttle RPM.

73-10-01 NATURALLY ASPIRATED ENGINES.

To make full rich adjustments on engines equipped with adjustable orifice pumps, run-up engine to obtain **normal operating temperature** and proceed as follows:

A. Tee into either the fuel pump outlet fitting or metering unit inlet fitting (whichever is more accessible) with an appropriate pressure gage and extended fuel line to observe fuel pump pressures. (This gage should be properly calibrated and vented to atmosphere on all engines).

NOTE . . . Tees are already incorporated on some engine models.

B. On all engines, back the throttle plate idle screw out of contact with the stop. Use the throttle to hold to the specified idle RPM.

C. Turn the fuel pump relief valve adjustment on the centerline of the pump to obtain pressure limits specified for idle RPM, CW to increase pressure; CCW to decrease pressure. Verify that mixture control is in full rich position.

D. Maintaining idle pump pressure and idle RPM, obtain correct idle mixture with adjustment provided at metering unit on throttle body. Optimum idle mixture exists if, upon leaning with the mixture control, an increase of 25 to 50 RPM is obtained, depending on airport elevation.

The preceding steps have provided:

(1) Correct pump pressure

(2) Correct fuel flow

(3) Correct fuel metering cam to throttle plate orientation.

NOTE . . . Do not adjust idle mixture without first determining that idle pump pressure is correct.

E. Advance full throttle and maximum rated engine RPM to check pump pressure and nozzle (metered) pressure or flow. (Nozzle pressure or flow values may be monitored by either the gage provided in the aircraft or an auxiliary pressure gage teed into the fuel manifold valve pressure port). Criteria for full throttle full rich adjustment of the fuel system should be specified nozzle pressure or flow values. Unmetered pump pressures at full throttle are included for reference only and may be used for troubleshooting the metering unit portion of the fuel system.

F. To obtain specified values of nozzle pressure or fuel flow at full throttle and rated RPM, turn the adjustable orifice adjusting screw (located on the side of the pump) CW to increase pressure and CCW to decrease pressure.

NOTE . . . If at static run-up rated RPM cannot be achieved at full throttle, adjust nozzle pressure or fuel flow to obtain specified values when rated RPM is achieved during takeoff roll.

G. Reset idle stop screw to appropriate engine specification.

CAUTION . . . On some aircraft, all pump pressure checks, mixture, and idle speed adjustments must be performed with the aircraft auxiliary pump on "low position". Refer to aircraft maintenance manual for details.

NOTE . . . For fuel system pressures and flow values refer to TCM Service Bulletion M84-6R1 or current revision as applicable.

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73-10-06 FUEL SYSTEM TROUBLESHOOTING CHART

This troubleshooting chart is provided as a guide. Review all probable causes given, check other listings of troubles with similar symptoms. Items are presented in sequence of the approximate ease of checking, not necessarily in order of probability.

TROUBLE	PROBABLE CAUSE	CORRECTION
Engine Will Not Start And No Fuel Flow Gage Indication	No fuel to engine.	Check tank fuel level.
	Mixture control improperly rigged.	Check mixture control for proper rigging.
	Engine not primed.	Auxiliary pump switch in PRIME position.
	Selector valve in wrong position.	Position selector valve to MAIN TANK position.
Engine Will Not Start With Fuel Flow Gage Indication	Engine flooded.	Reset throttle, clear engine of excess fuel, try another start.
	No fuel to engine.	Loosen one line at nozzle. If no fuel shows, with fuel flow on gage, check manifold valve calabration or replace fuel manifold valve.
Rough Idle	Nozzle restricted.	Remove nozzles and clean.
	Improper idle mixture.	Adjust fuel-air control unit in accordance with adjustment procedures.
Poor Acceleration	Idle mixture incorrect.	Adjust fuel-air control unit in accordance with adjustment procedures.
	Unmetered fuel pressure too high.	Lower unmetered fuel pressure.
	Worn linkage.	Replace worn elements of linkage.
Engine Runs Rough	Restricted nozzle.	Remove and clean all nozzles.
	Improper mixture.	Improper pump pressure, check fuel pump calibration or replace pump.
Low Fuel Flow Gage Indication	Restricted flow to metering valve.	Check mixture control for full travel. Check for clogged fuel filters.
	Inadequate flow from fuel pump.	Adjust engine-driven fuel pump.

73-10-06 FUEL INJECTION SYSTEM TROUBLESHOOTING CHART

TROUBLE	PROBABLE CAUSE	CORRECTION
High Fuel Flow Gage Indication	Restricted flow beyond metering valve.	Check for restricted nozzles or fuel manifold valve. Clean or replace as required.
	Restricted recirculation passage in fuel pump.	Check pump calbiration or replace engine-driven fuel pump.
Fluctuating or Erroneous Fuel Flow Indications	Vapor in system, excess fuel temperature.	If not cleared with auxiliary pump, check for clogged ejector jet in vapor separator cover.
	Air in fuel flow gage line. Leak at gage connection.	Repair leak and purge line.
Poor Idle Cut-Off	Engine getting fuel.	Check mixture control is in full idle cut-off. Check auxiliary pump is OFF. If neither, check manifold valve calibration or replace manifold valve.
No Unmetered Fuel Pressure	Internal orifices plugged.	Clean internal orifices in injector pump. Check for suction air leaks.
Unmetered Fuel Pressure Drop	Relief valve stuck open.	Repair or replace injector pump.
Very High Idle And Full Throttle Fuel Pressure Present	Relief valve stuck closed.	Repair or replace injector pump.
No Fuel Pressure	Check valve stuck open.	Repair or replace injector pump.

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CHAPTER 74
IGNITION

TCM IGNITION SYSTEM

74-00-00 GENERAL

Conventional 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 S-20,S-200 and S-1200, Series Magnetos are designed to provide ignition for six cylinder aircraft engines. The magnetos generate and distribute high tension pulses through high tension leads to the spark plugs. Overhaul is recommended at engine overhaul or at the expiration of four years without regard to engine operating hours, whichever comes first.

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 magnet 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. S-200 series magnetos and some S-1200 series magnetos employ the "shower of sparks" ingition 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 detailed explanation gives the meaning of the various letters and numbers appearing in the type designations:

A. "S" indicates single type ignition unit.

B. "6" indicates number of cylinders fired.

C. "R" or "L" indicates direction of rotation of rotating magnet viewed from drive end; R for righthand, L for left-hand.

D. "N" indicates manufactured by TCM.

E. The dash number (such as -25) indicates a certain execution of the basic type magneto.

74-00-01 MAGNETO INSTALLATION

Insure that magneto is proper part number for engine installation. Insure that internal timing of magneto is correct as per TCM form no. L-250-10 (or latest revision) for S-20 series magneto or as per TCM form no. L-527-4 (or latest revision) for S-200 series magnetos, or as per TCM Form No. X42001 (or latest revision) for S-1200 series magnetos. These publications are included in TCM Ignition Systems Master Service Manual Form No. X40000 (Printed Edition) or Form No. X40000F (Microfiche Edition).

Remove timing inspection window plug from top of magneto.

Turn engine crankshaft until piston in the No. 1 cylinder is at its full advance firing position. Rotate the magneto shaft in its normal direction of rotation until the painted chamfered tooth of the distributor gear is centered in the inspection window. Install magneto on engine. Do not tighten magneto hold-down bolts.

Fabricate P-lead adapter using appropriate terminal kit and a length of wire. Install adapter lead on switch terminal of magneto. Connect positive lead of TCM 11-9110-1 timing light, or equivalent, to bare end of adapter. Connect common lead of timing light to a good ground.

If timing light is out, rotate magneto housing in the same direction as its magnet's rotation a few degrees beyond point where light comes on. Then slowly turn magneto housing in opposite direction until light just goes out. Secure magneto housing in this position and recheck adjustment. Replace timing window plugs.

Repeat the above steps for second magneto. Check magneto synchronization with 11-9110-1 timing light or equivalent. If necessary, loosen magneto hold-down bolts of one magneto and "bump" with soft mallet to synchronize magnetos. Tighten all magneto hold-down bolts. Refer to figure 72-50-01 (6) for proper torque

Disconnect timing light from magneto. Make connections between magneto and ignition switch using 18 gage wire following airframe manufacture's wiring instrucitons.

WARNING . . . The magneto is in a SWTICH ON condition when the switch wire is disconnected. Therefore, the usual precaution must be observed.

74-00-02 HARNESS ASSEMBLY INSTALLATION

Before installing harness on magneto check mating surfaces for cleanliness. Spray entire face of grommet with a light coat of silicone spray parting agent* to prevent harness grommet from sticking to magneto distributor block. For S-20 and S-200 series magnetos, install and tighten screws around plate alternately to seat cover squarely on magneto. Apply 25 to 35 in.-lbs. torque to screws. For S-1200 series magnetos, install and tighten nuts around plate alternately to seat cover squarely on magneto. Apply 18 to 22 in.-lbs. torque to nuts.

*Silicone spray parting agent S512, IMS Company 10373 Stafford Road, Auburn, OH 44022.

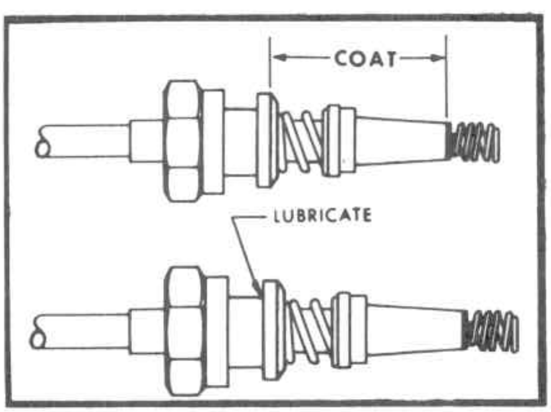

FIGURE 74-00-04. COATING INSULATING SLEEVE.

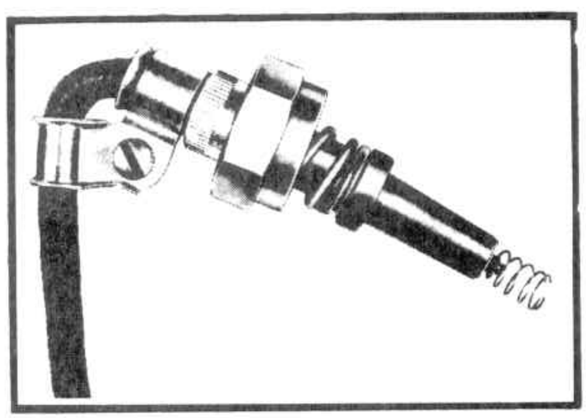

FIGURE 74-00-04. INSTALLATION OF ELBOW CLAMP.

The harness assemblies are constructed of a lightweight, flexible, silicone coated cable having a 400°F temperature rating. Because the harness assemblies are lightweight and flexible, the following suggestions should be observed when installing the harness on an engine:

A. Support leads with as many clamps and cable ties as are necessary to prevent any whipping or chafing action.

B. Route leads as far away from exhaust manifold as possible to insure they are not exposed to temperatures in excess of 400°F.

C. To prevent sticking of sleeves and to minimize twisting of ferrule, coat insulating sleeves* and lubricate ferrule shoulders** (see Figure 74-00-04). Fasten coupling nuts to the proper spark plugs and torque as specified in Table 74-00-04. Tighten elbow assembly nuts to outer ferrule.

*Flourocarbon Spray MS #S-122, Miller-Stephenson Chemical Co., Inc.,
16 Sugar Hollow Road, Danbury, Connecticut 06810.

**Go-Jo No-Lok No. 72 Compound, Gojer, Inc., Akron, Ohio 44309 or Molykote Type G,
The Alpha Molykote Corp., Stamford, Connecticut 06904.

NOTE . . . Hold ferrules while tightening or loosening spark plug coupling nuts to protect against twisting conduit or cable.

D. If elbow assemblies are not used and installation results in a severe angle where conduit connects to the spark plug, use clamp P/N 10-320283 as shown in Figure 74-00-04, "Installation of Elbow Clamp". Secure clamp with screw and lockwasher P/N 10-35936-6 and nut P/N 10-90404-4. The clamp will maintain a 70° elbow eliminating overstressing the lead.

FIGURE 74-00-04. COUPLING NUT TORQUE VALUES.

Spark Plug Coupling Thread	Torque (In. - lb.)
5/8-24	90-95
3/4-20	110-120

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74-20-00 IGNITION TROUBLESHOOTING.

This troubleshooting chart is provided as a guide. Review all probable causes given, check other listings of troubles with similar symptoms. Items are presented in sequence of the approximate ease of checking, not necessarily in order of probability.

TROUBLE	PROBABLE CAUSE	CORRECTION
Engine Fails To Start Due to Ignition Trouble	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. Tighten to specified torque.
	Magnetos improperly timed to engine.	Refer to Installation of Magnetos and Ignition Timing for timing procedures.
	Shorted capacitor.	Replace capacitor.
	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 spark plug gap.
	Weak capacitor.	Replace capacitor.
Rough At Speeds Above Idle	Loose or improperly gapped spark plugs.	Tighten to specified torque. Adjust to proper gap.
	High tension leak in ignition harness.	Check for faulty insulation.
	Weak or burned out capacitor as evidenced by burned or pitted breaker points.	Replace points and capacitor.
Sluggish Operation And/Or Excessive RPM Drop	Fouled or dead spark plugs.	Clean spark plugs. Replace dead spark plugs.
	Improperly gapped spark plugs.	Adjust to proper gap.
	Magnetos improperly timed to engine.	Refer to Installation of Magnetos and Ignition Timing for proper timing procedure.
	Damaged magneto breaker points or capacitor.	Replace points and capacitor.

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(SLICK IGNITION SYSTEM)

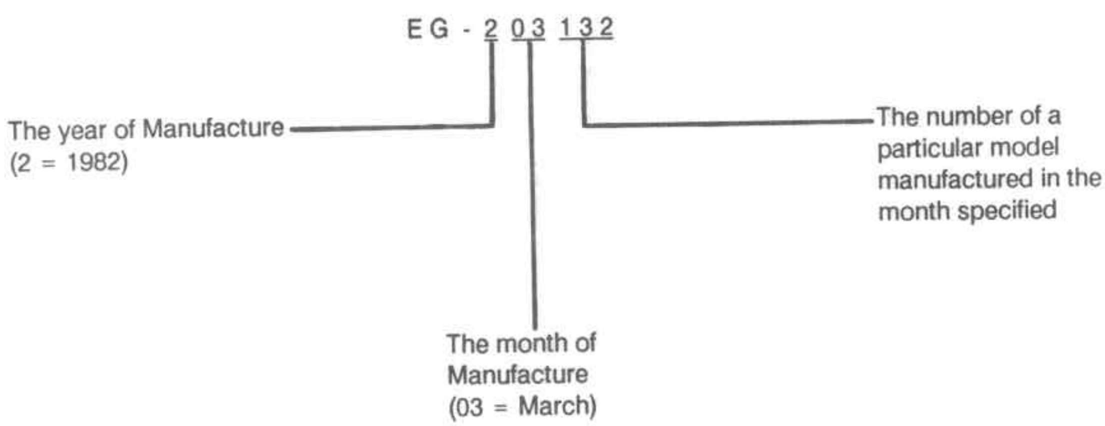
74-30-00 GENERAL

Conventional dual ignition is provided by two magnetos. The left magneto fires the six (6) upper spark plugs, while the right magneto fires the six (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 magnet 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.

The following detailed explanation gives the meaning of the various numbers appearing in the serial number.



74-30-01 MAGNETO INSTALLATION AND TIMING TO ENGINE

Before magnetos are installed on the engine, the rotation and internal magneto timing must be correct. For rotation and internal timing procedure refer to the appropriate magneto manufacturers instructions.

The magneto to engine timing check to be performed at every 100 hour and annual inspection.

CAUTION . . . Be sure magneto switch is OFF and "P" leads are grounded.

1. Remove top spark plug from number one cylinder. Place thumb over spark plug hole and rotate crankshaft in normal direction of rotation to ensure piston is on compression stroke. Turn engine crankshaft until No. 1 piston is at its full advance firing position. See chapter 72-00-00 Ignition timing for applicable full advance firing position.

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2. Insert the T-118 timing pin in "L" or "R" hole (depending on magneto rotation) in the distributor block. Turn rotor in the opposite rotation of magneto until pin engages the gear, install magneto and gasket on mounting pad of accessory housing and remove timing pin. Secure tightening bolts finger tight.

3. Connect a standard timing light between engine ground and left magneto condenser terminal. Switch must be "ON".

4. Turn the complete magneto opposite normal rotation of the magneto on engine mount until the timing light indicates the contact breaker points are just opening. Secure magneto. Turn switch "OFF".

5. Turn on the switch of the timing light. Rotate the crankshaft slowly in direction of normal rotation until engine is in full advance firing position. See Section 72-00-00 for correct firing position. Ensure timing light indicates contact opening at this point. Adjust magneto-to-timing as necessary.

6. Connect other positive wire of timing light to right magneto condenser terminal and time the magneto in the same manner as left magneto.

7. Following timing of both magnetos, with timing light wires still connected, recheck magneto timing as previously described to insure that both magnetos are timed to fire together. If timing is correct, timing light will indicate both magneto contacts are opening simultaneously at engine full advance firing position. See Section 72-00-00 for correct firing position. If contacts do not open within limits, adjust magneto to engine timing as necessary.

CAUTION . . . When installing the magneto on the engine using the available nuts and clamps, please take the following precautions. Tighten both nuts by hand to finger tightness. Tighten each nut to 8 ft.-lbs., and then tighten them alternately in several steps to 17 ft.-lbs. Exceeding 17 ft.-lbs. may cause the mounting flange to crack.

For further information on the magnetos and ignition system refer to the applicable manufactures instructions.

74-30-02 HARNESS ASSEMBLY INSTALLATION

Before installing harness on magneto check mating surfaces for cleanliness. Install and tighten nuts around plate alternately to seat cover squarely on magneto. Torque nuts to 18-22 in.-lbs.

The harness assemblies are constructed of a lightweight, flexible, silicone coated cable having a 400°F. temperature rating. Because the harness assemblies are lightweight and flexible, the following suggestions should be observed when installing the harness on an engine:

A. Support leads with as many clamps and cable ties as are necessary to prevent any whipping or chafing action.

B. Route leads as far away as possible from exhaust manifold to insure they are not exposed to temperatures in excess of 400°F.

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C. To prevent sticking of sleeves and to minimize twisting of ferrule, coat insulating sleeves* and lubricate ferrule shoulders**. Fasten coupling nuts to the proper spark plugs and torque as specified in Table II. Tighten elbow assembly nuts to outer ferrule.

*Flourocarbon Spray MS #S-122, Miller-Stephenson Chemical Co., Inc., 16 Sugar Hollow Road, Danbury, Connecticut 06810.

**Go-Jo No-Lok, Gojer, Inc., Akron, Ohio 44309 or Molykote Type G, The Alpha Molykote Corp., Stamford, Connecticut 06904.

NOTE . . . Hold ferrules while tightening or loosening spark plug coupling nuts to protect against twisting conduit or cable.

D. Clamp harness leads as required.

FIGURE 74–30–04. COUPLING NUT TORQUE VALUES.

Spark Plug Coupling Thread	Torque (In.–lb.)
5/8-24	90-95
3/4-20	110-120

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74-50-00 IGNITION TROUBLESHOOTING.

This troubleshooting chart is provided as a guide. Review all probable causes given, check other listings of troubles with similar symptoms. Items are presented in sequence of the approximate ease of checking, not necessarily in order of probability.

TROUBLE	PROBABLE CAUSE	CORRECTION
Engine Fails To Start Due to Ignition Trouble	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. Tighten to specified torque.
	Magnetos improperly timed to engine.	Refer to Installation of Magnetos and Ignition Timing for timing procedures.
	Shorted condenser.	Replace condenser.
	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 spark plug gap.
	Weak condenser.	Replace condenser.
Rough At Speeds Above Idle	Loose or improperly gapped spark plugs.	Tighten to specified torque. Adjust to proper gap.
	High tension leak in ignition harness.	Check for faulty inspection.
	Weak or burned out condenser as evidenced by burned or pitted breaker points.	Replace points and condenser.
Sluggish Operation And/Or Excessive RPM Drop	Fouled or dead spark plugs.	Clean spark plugs. Replace dead spark plugs.
	Improperly gapped spark plugs.	Adjust to proper gap.
	Magnetos out of time with plugs.	Refer to Installation of Magnetos and Ignition Timing for proper timing procedure.
	Damaged magneto breaker points or condenser.	Replace points and condenser.

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CHAPTER 75
AIR

75-00-00 GENERAL

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75-00-00 GENERAL

The induction system components include the aircraft filter/alternate air door, throttle, intake manifold, intake tubes and cylinder intake ports. Air flows through these components in the order they are listed.

Refer to Pilots Operating Handbook for alternate air door operations.

The air throttle assembly controls the amount of intake air going to the cylinders which is combined with fuel that is metered by the fuel control that is mounted on the air throttle body and connected to the throttle shaft by levers and control linkage.

The induction manifold is an air distribution system mounted in several different configurations according to engine model. 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, and enters the cylinder as a combustible mixture when the intake valve opens.

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CHAPTER 76
ENGINE CONTROLS

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76-00-00 GENERAL

The curves in this chapter represent uninstalled performance and are provided as a reference in establishing power conditions for takeoff, climb and cruise operation. Refer to aircraft manufacturer's flight manual for tabular climb and cruise data.

76-10-00 CRUISE CONTROL BY PERFORMANCE CURVE.

1. Set manifold pressure and RPM at cruise power selected.

2. To determine actual horsepower, employ the following procedure:

A. Correct horsepower for inlet air temperature as follows:

(TS = Standard Altitude Temperature 59°F)

(1) Add 1% for each 6°F below TS.

(2) Subtract 1% for each 6°F above TS.

3. Adjust mixture to lean out fuel flow for cruise settings according to applicable fuel flow vs. brake horsepower curve.

CAUTION . . . When increasing power, enrich mixture, advance RPM and adjust throttle in that order. When reducing power, retard throttle, then adjust RPM and mixture.

NOTE . . . It may be necessary to make minor readjustments to fuel flow (mixture) after changing RPM.

76-20-00 CRUISE CONTROL BY E.G.T.

If exhaust gas temperature indicator is used as an aid to leaning proceed as follows:

1. Adjust RPM for desired cruise setting.

2. Slowly move mixture control toward "lean" while observing E.G.T. gage. Note position on the instrument where the needle "peaks" or starts to drop as mixture is leaned further.

3. For the maximum recommended cruise setting see Operating Test Limits (72-70).

CAUTION . . . Do not attempt to adjust mixture by use of E.G.T. at setting above 78% of maximum power. Also, remember that engine power will change with ambient conditions. Changes in altitude or outside air temperature will require adjustments in manifold pressure and fuel flow. (Refer to Charts Fuel Flow Vs. BHP).

Gage fuel flow should fall between the maximum and minimum values on the curve. If not, the fuel injection system or instrumentation (including tachometer, manifold pressure, fuel flow gage or E.G.T. system) should be checked for maladjustments or calibration error.

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76-30-00 PERFORMANCE CHARTS

The following performance charts are classified under Figure 76-30-00.

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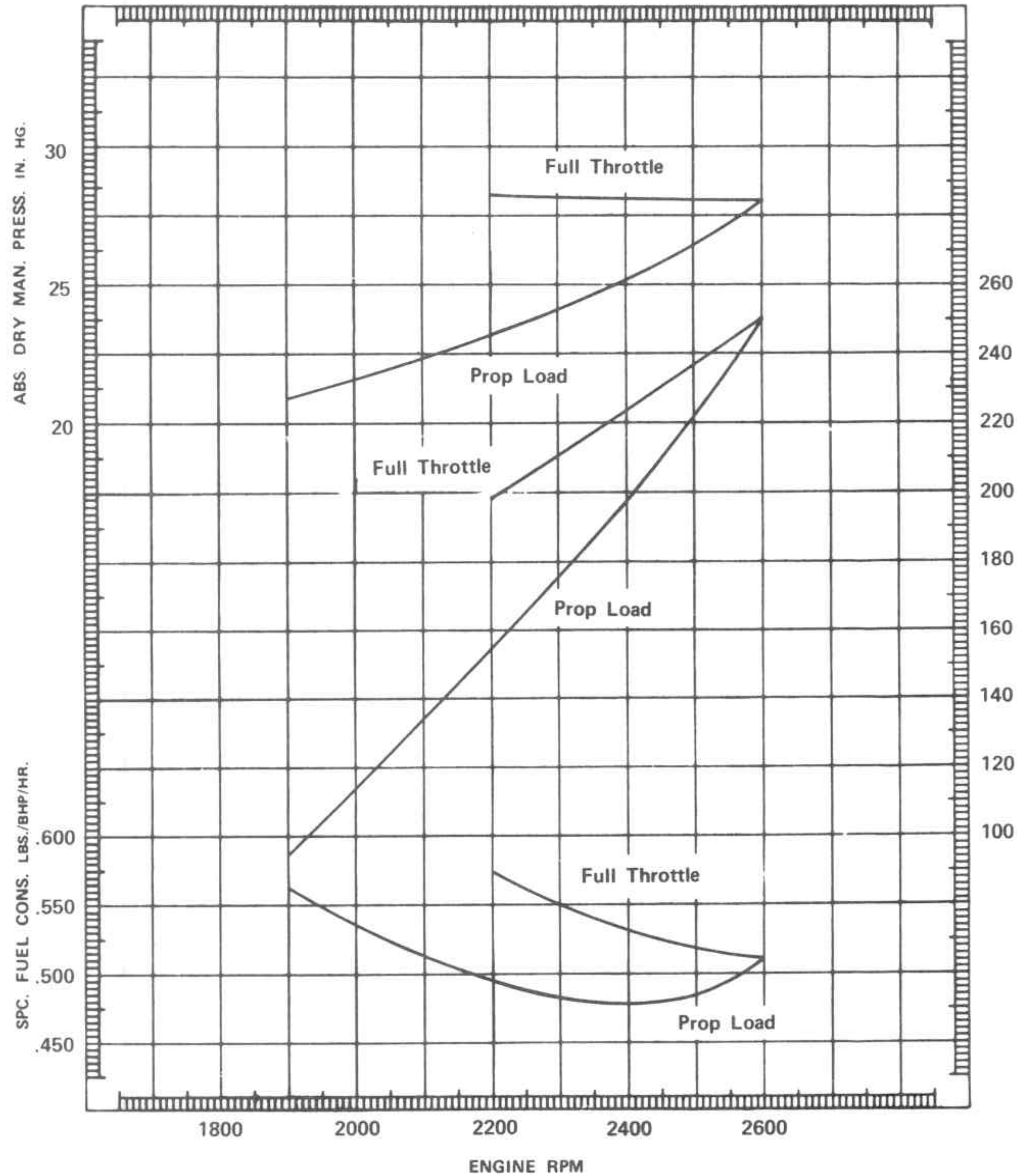
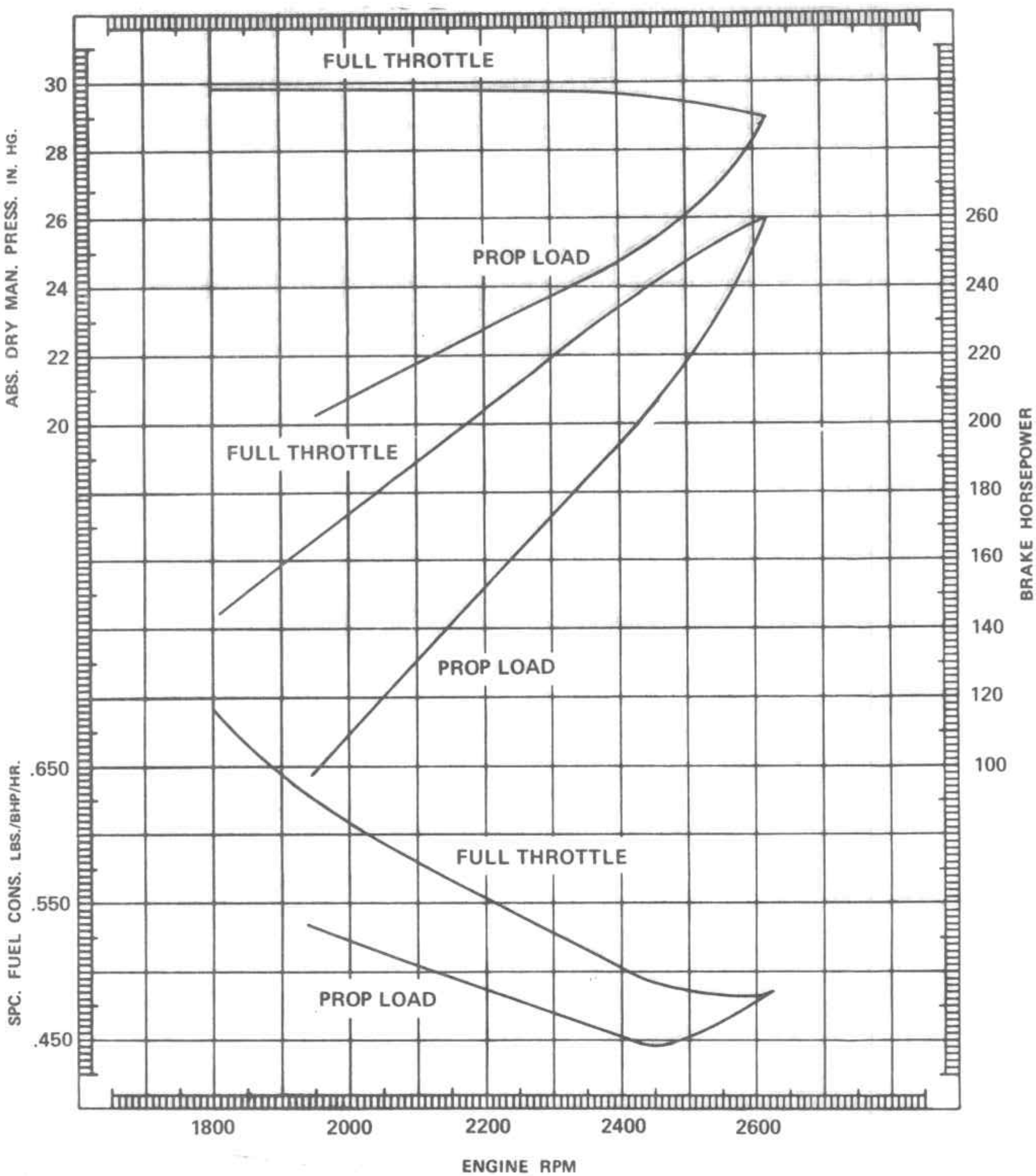


SEA LEVEL PERFORMANCE CURVE
IO-470-C, G, P, R, T

76-05



SEA LEVEL PERFORMANCE CURVE
IO-470-D, E, F, L, M, S

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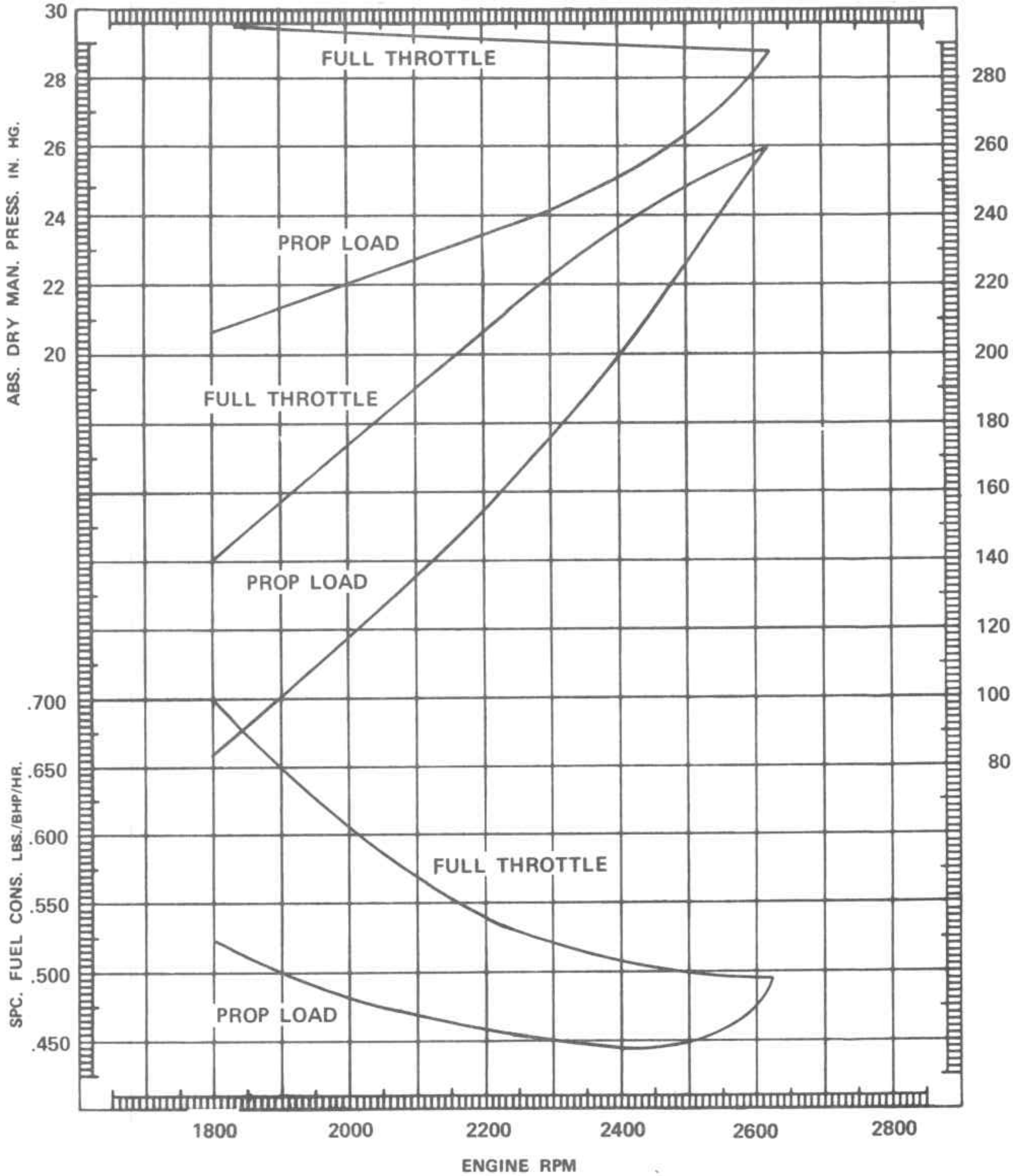
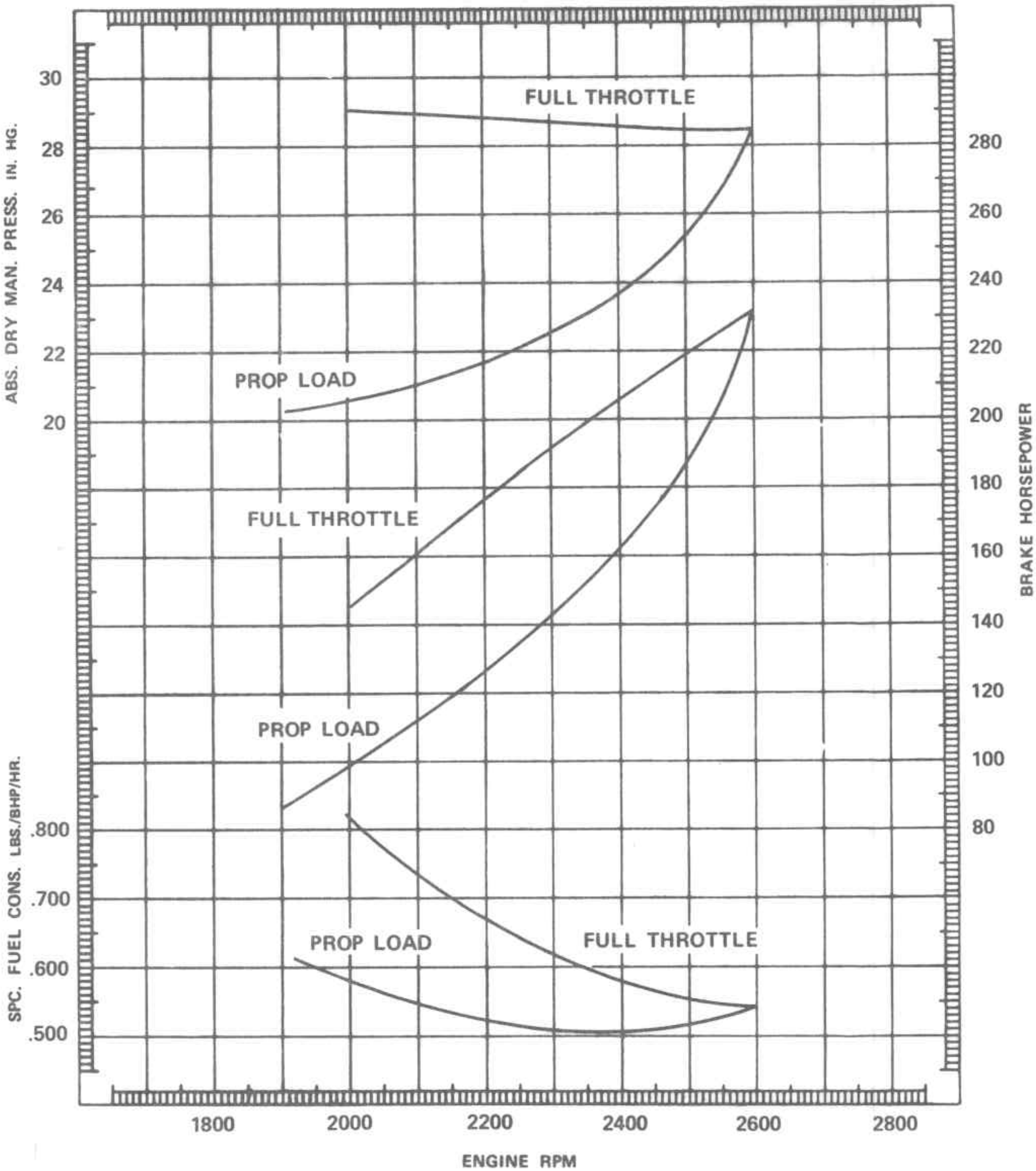
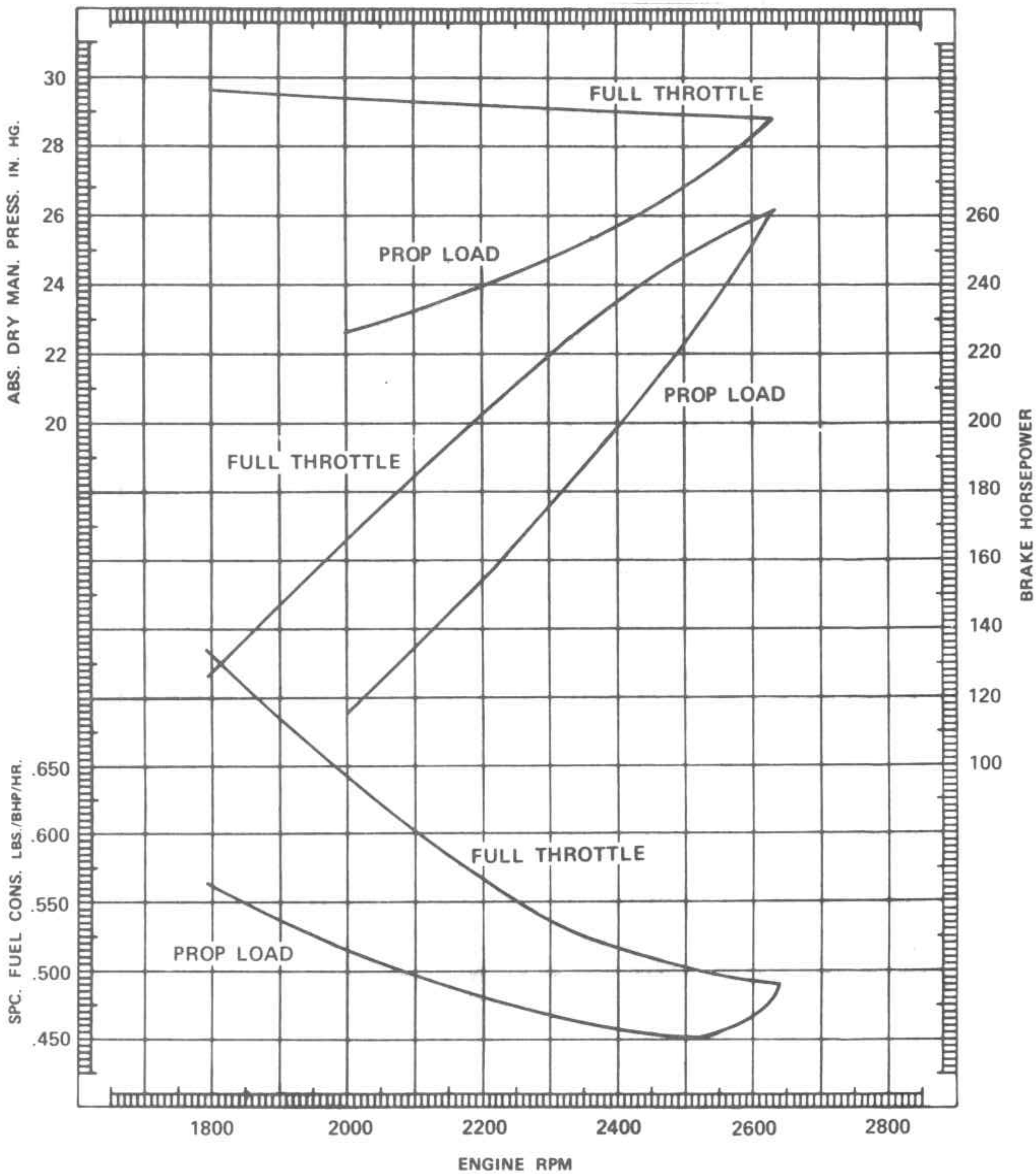


SEA LEVEL PERFORMANCE CURVE
IO-470-H, N

76-07



SEA LEVEL PERFORMANCE CURVE
IO-470-J, K



SEA LEVEL PERFORMANCE CURVE
IO-470-U

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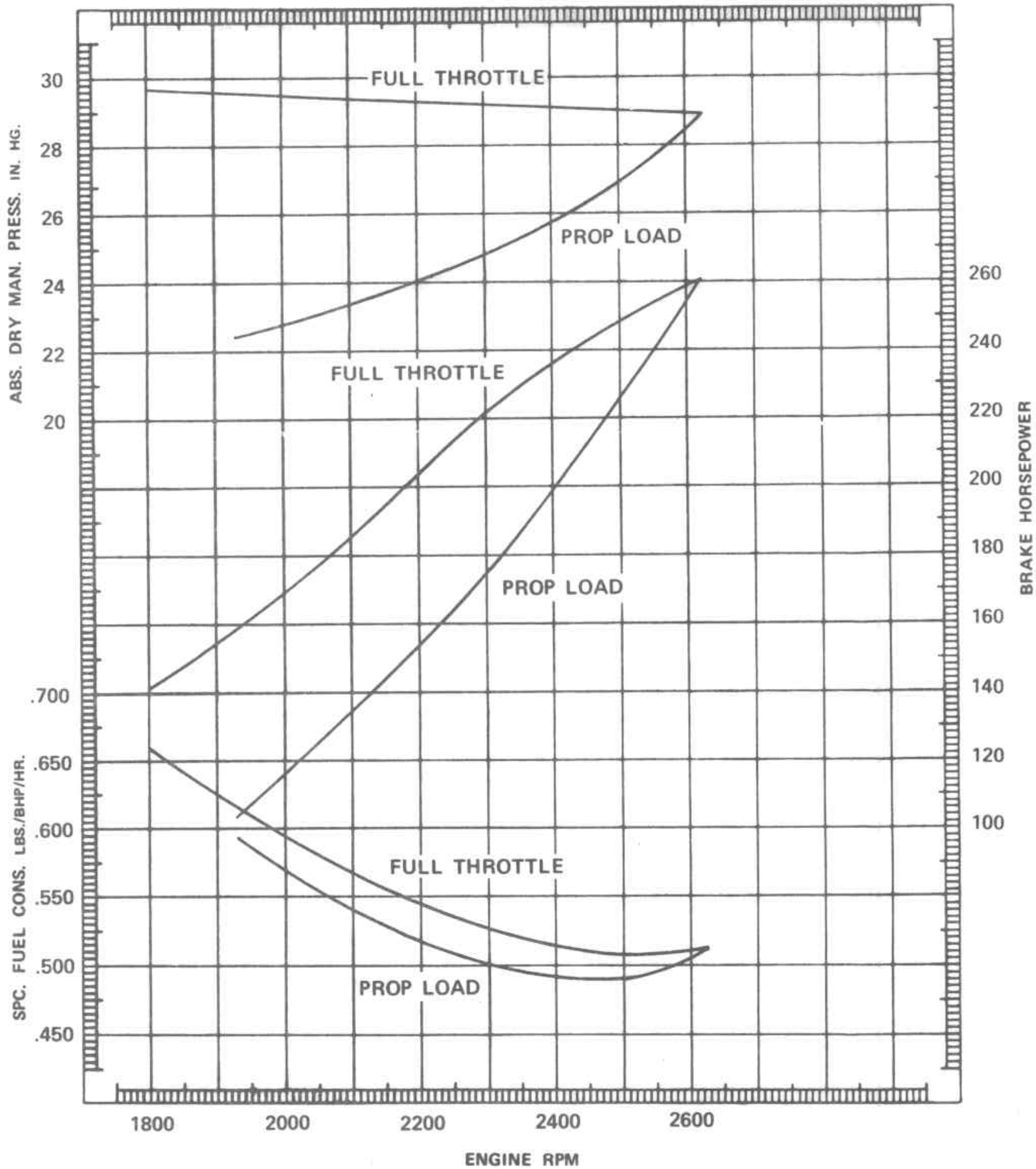
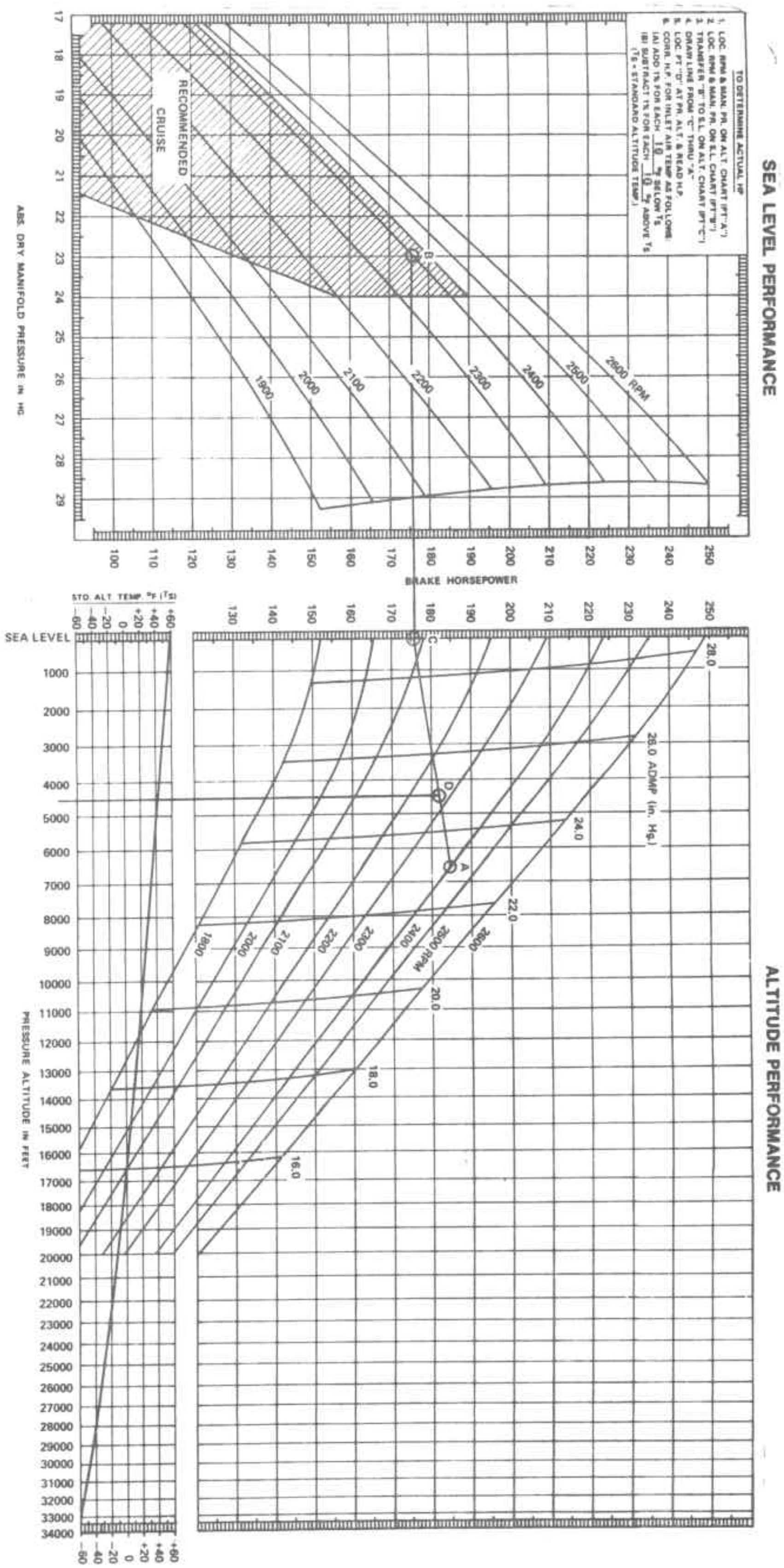


SEA LEVEL PERFORMANCE CURVE
IO-470-V, VO



SEA LEVEL VS ALTITUDE PERFORMANCE CURVE
IO–470–C, G, P, R, T

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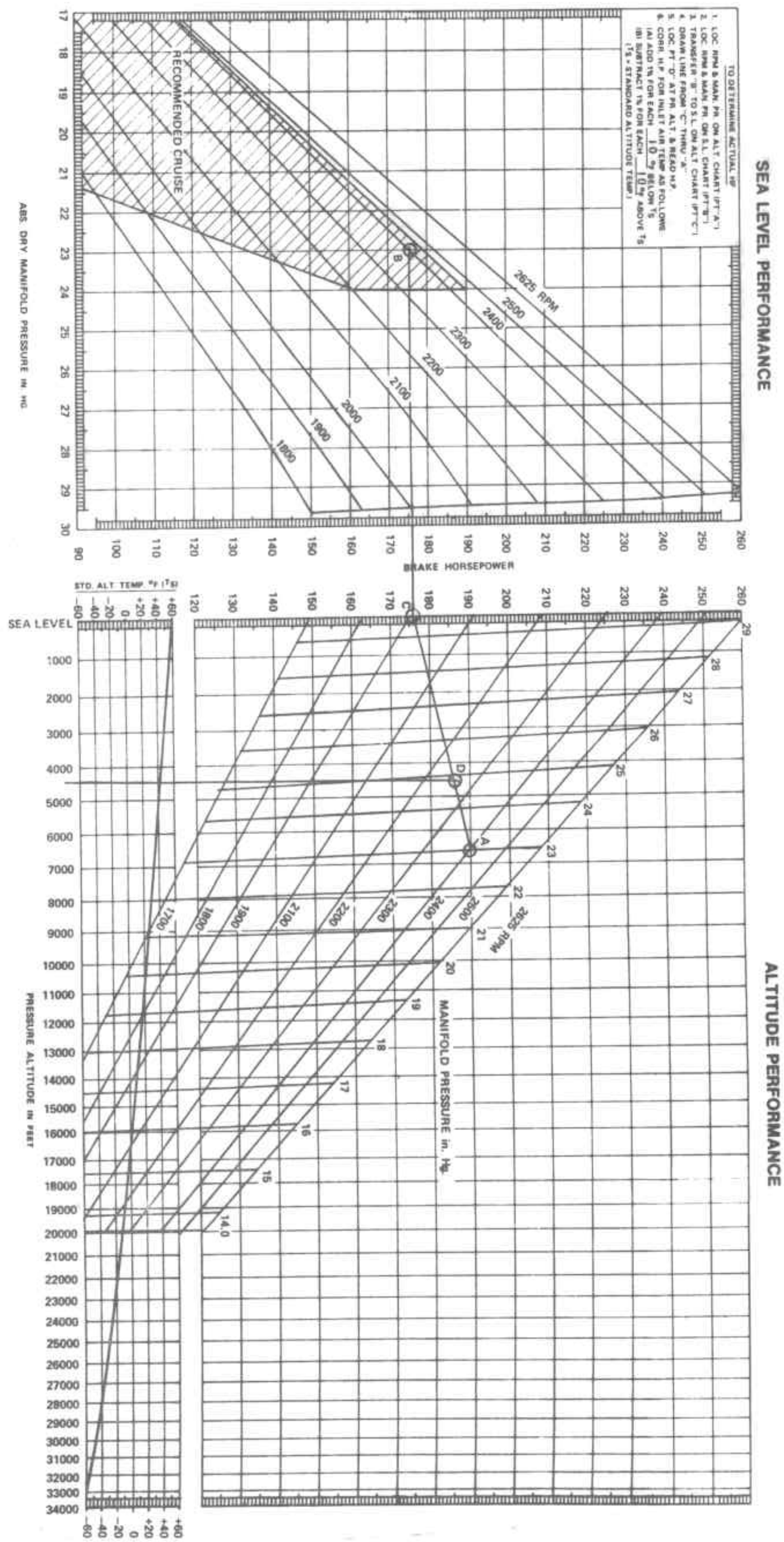
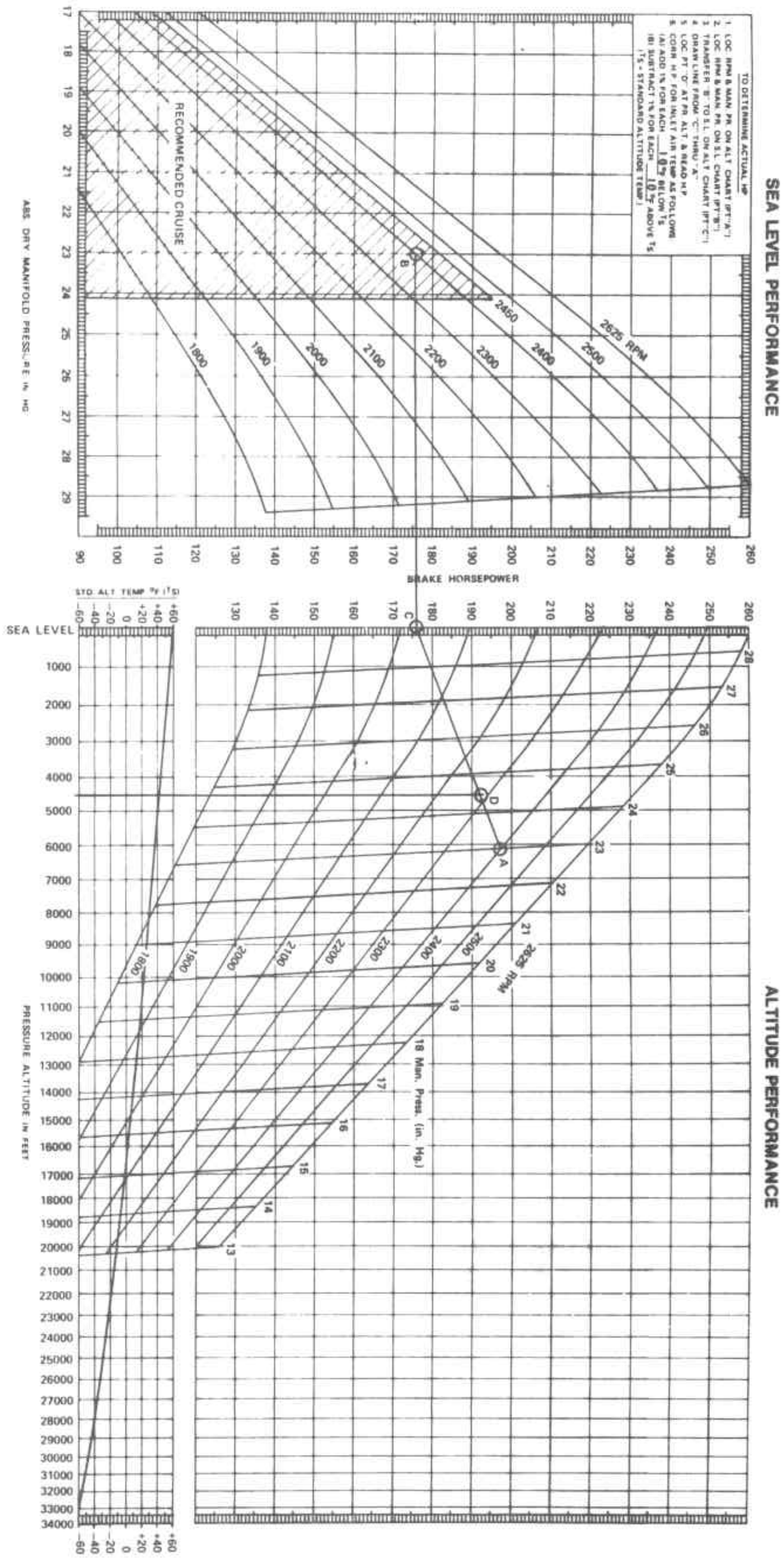
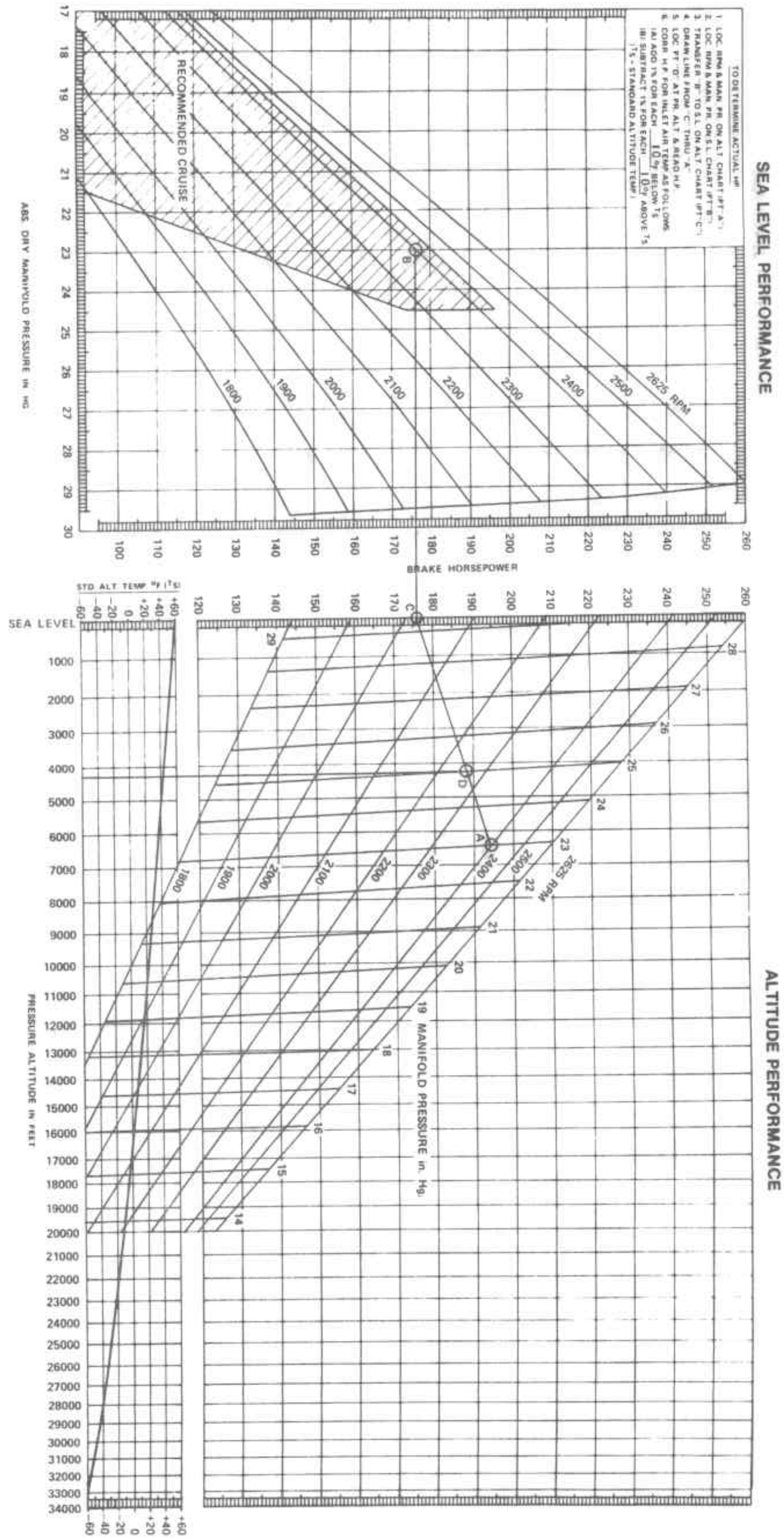


SEA LEVEL VS ALTITUDE PERFORMANCE CURVE
IO–470–D, E, M, S



SEA LEVEL VS ALTITUDE PERFORMANCE CURVE
IO-470-H



SEA LEVEL VS ALTITUDE PERFORMANCE CURVE
IO–470–L

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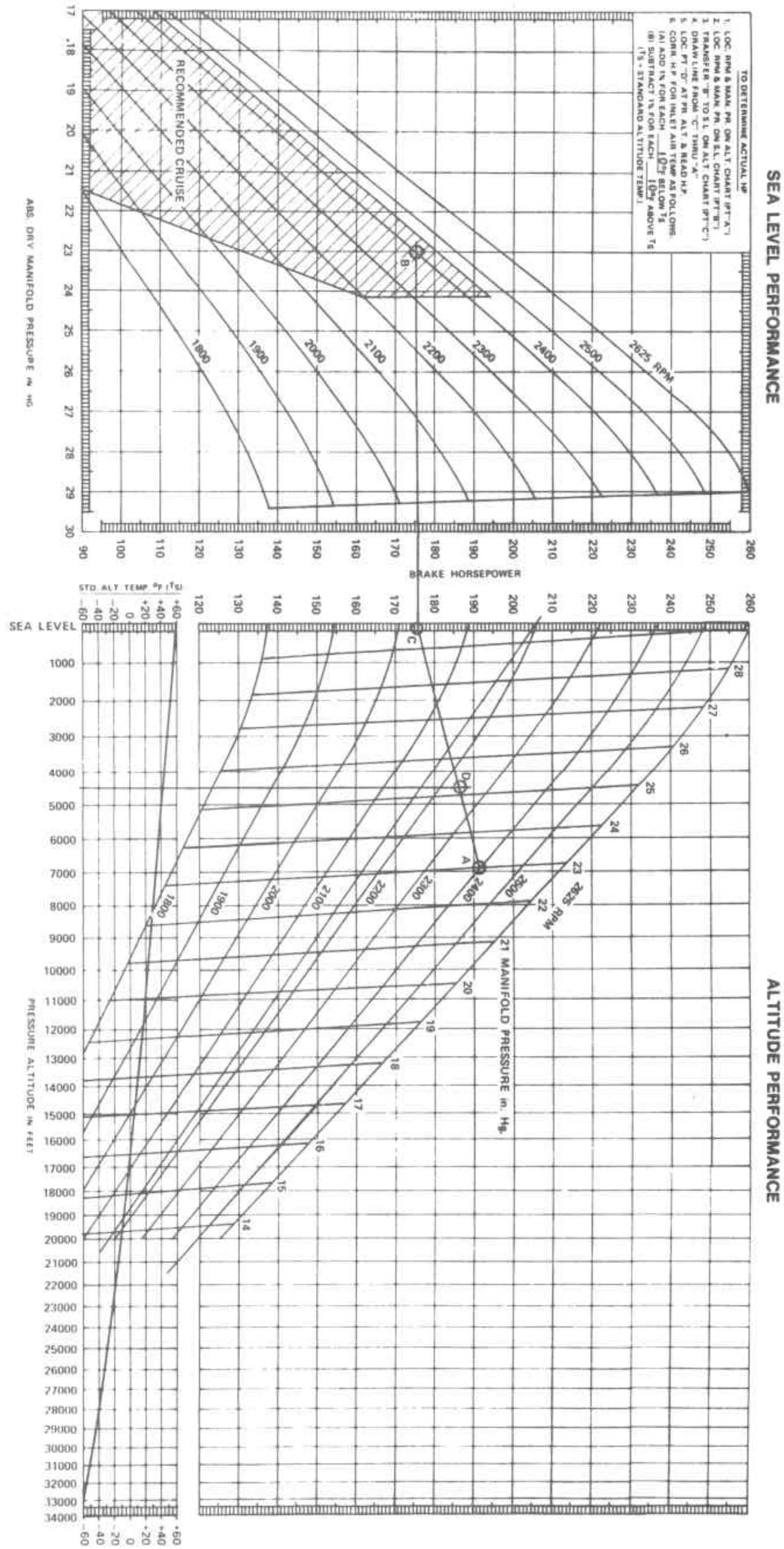

SEA LEVEL VS ALTITUDE PERFORMANCE CURVE
IO–470–N

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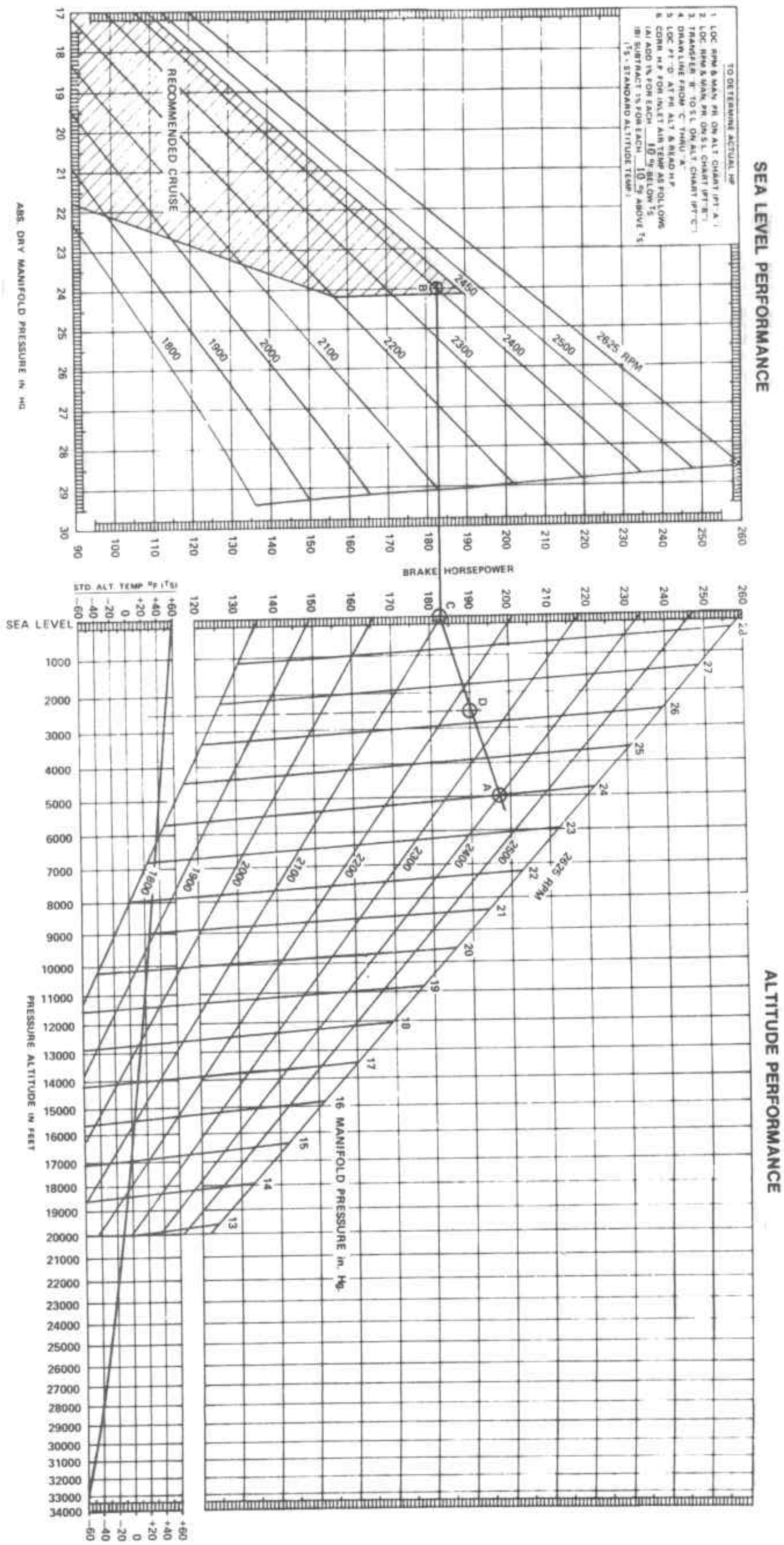

SEA LEVEL VS ALTITUDE PERFORMANCE CURVE
IO-470-U

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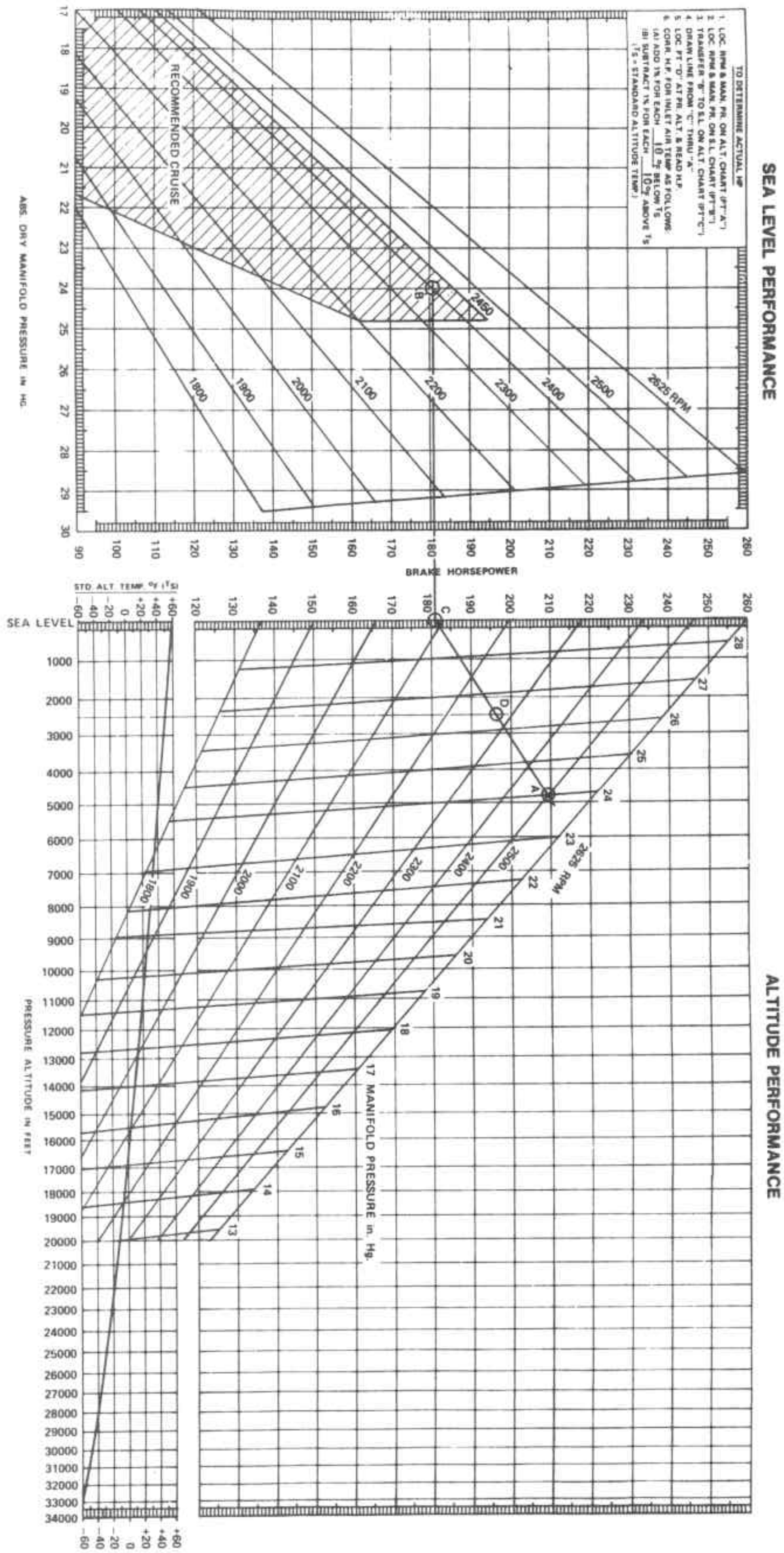

SEA LEVEL VS ALTITUDE PERFORMANCE CURVE
IO-470-V, VO

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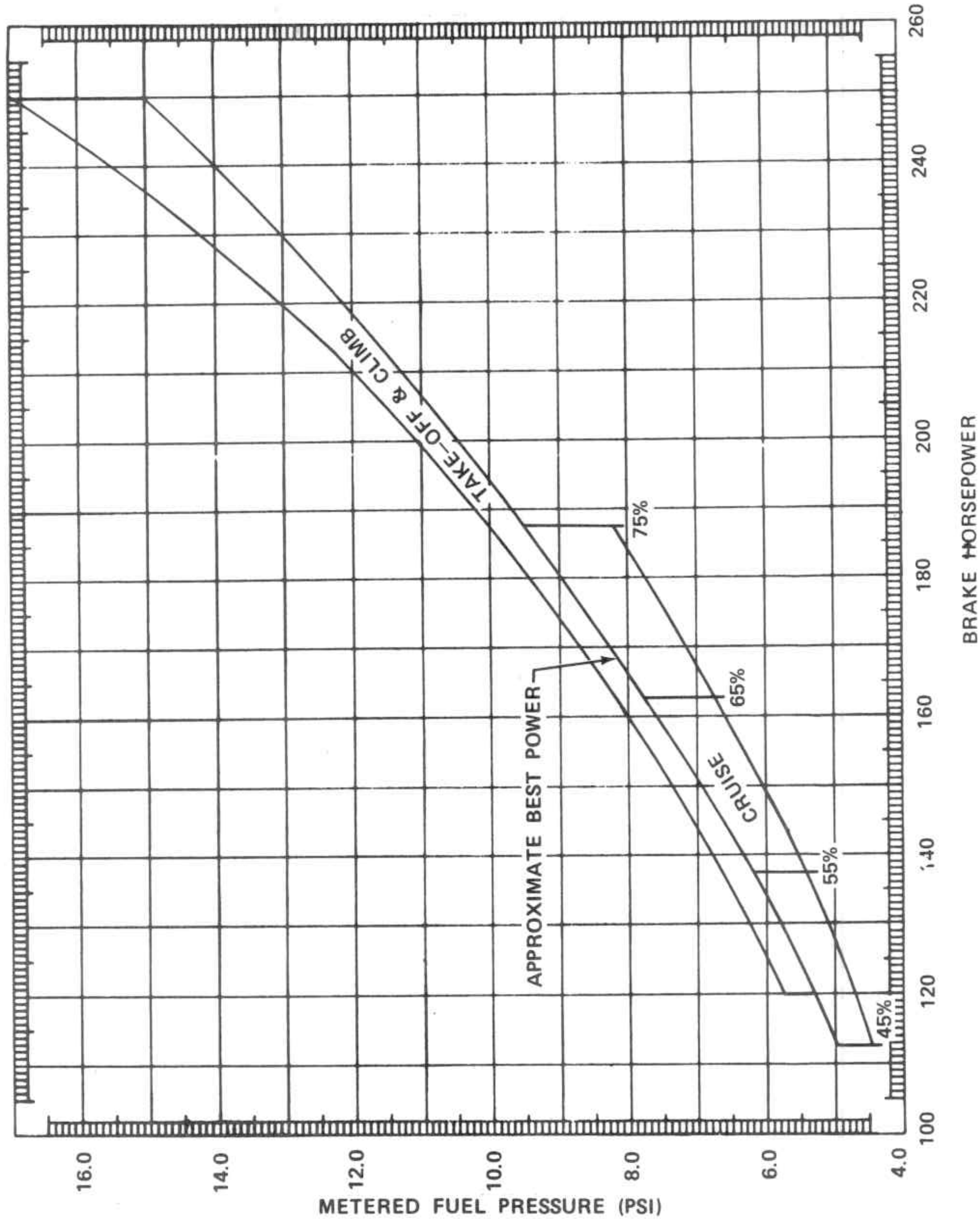
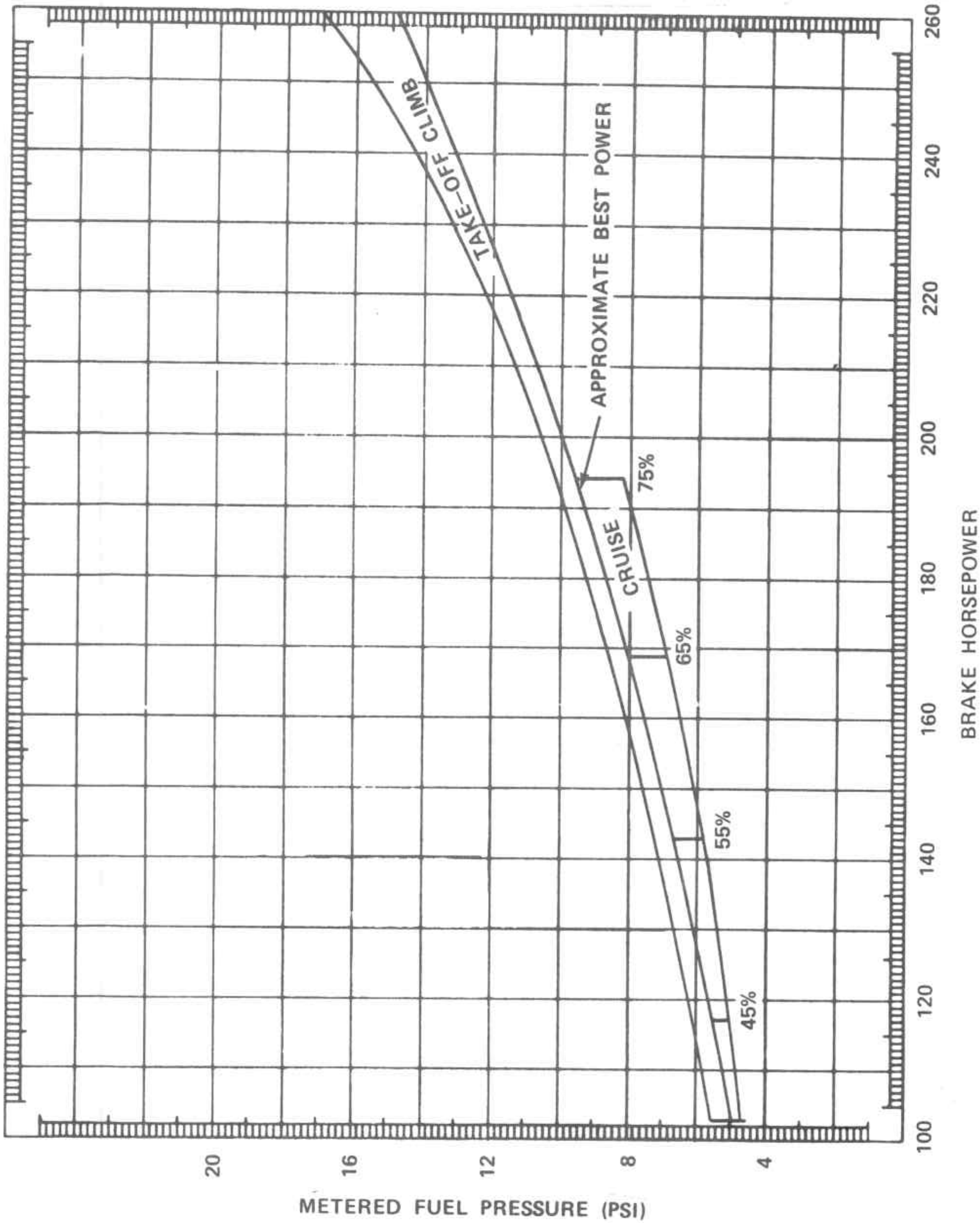
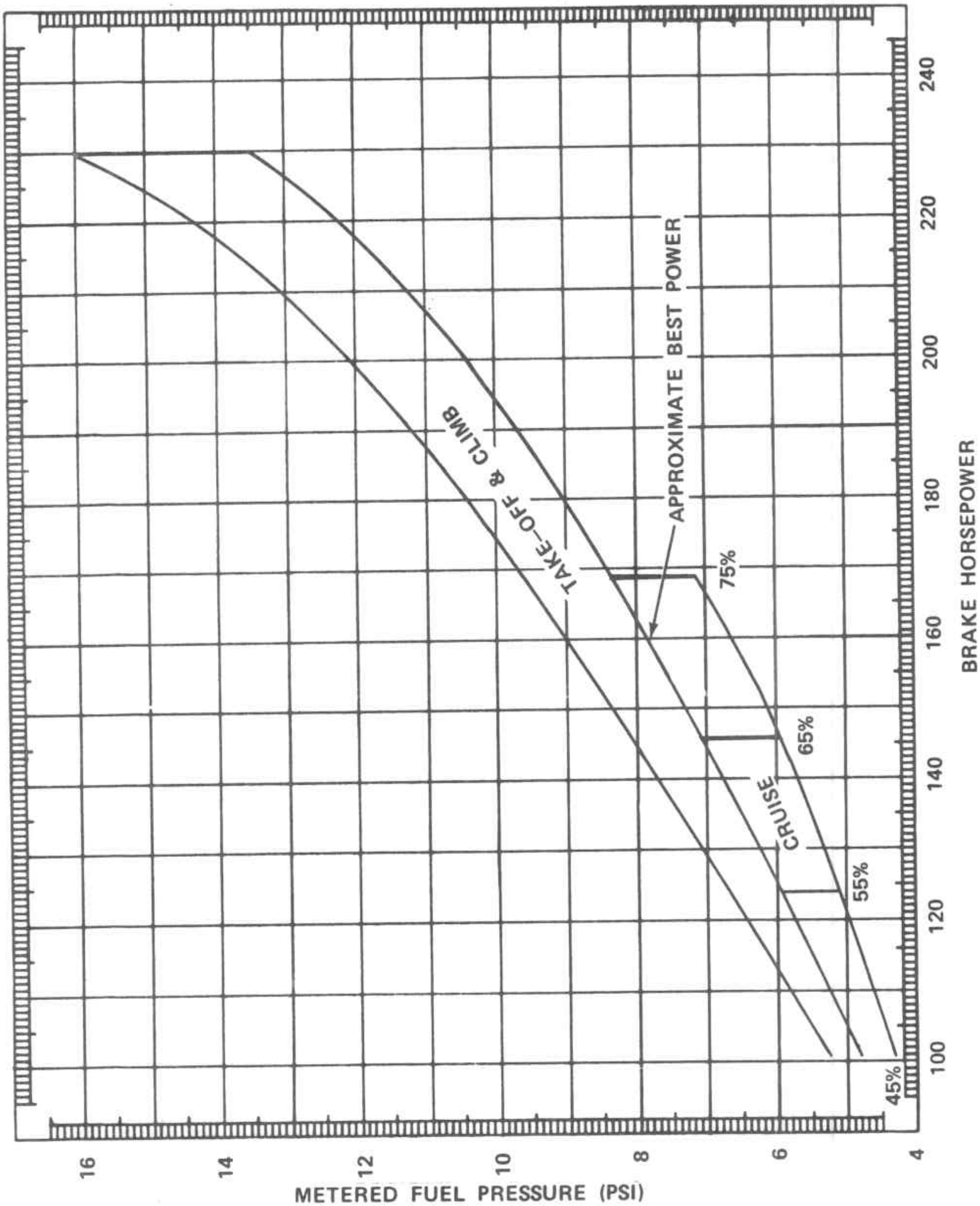


METERED FUEL PRESSURE (PSI) VS BHP
IO-470-C, G, P, R, T



METERED FUEL PRESSURE (PSI) VS BHP
IO-470-D, E, F, H, L, M, N, S



METERED FUEL PRESSURE (PSI) VS BHP
IO-470-J, K

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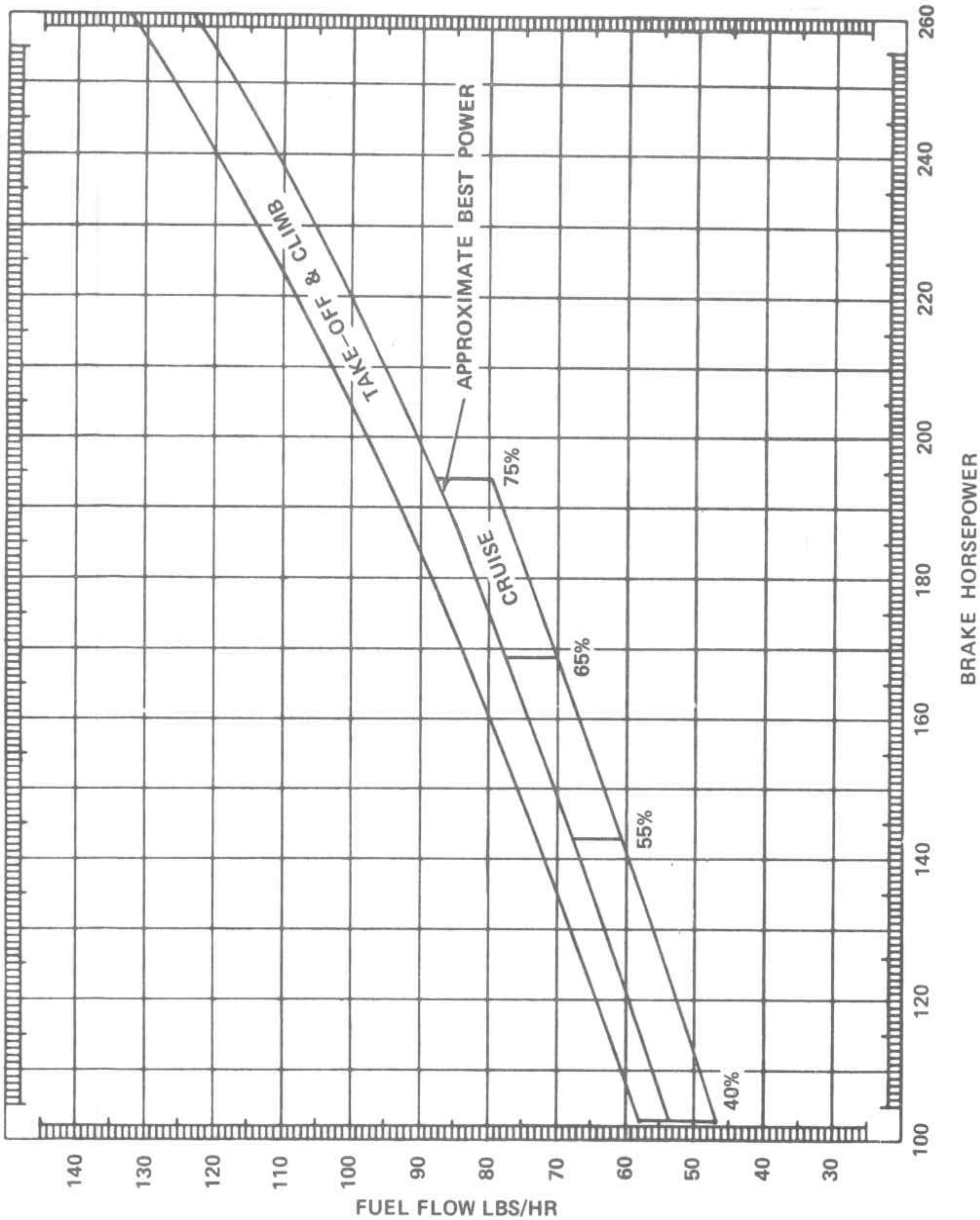

FUEL FLOW (LB/HR) VS BHP
IO-470-U

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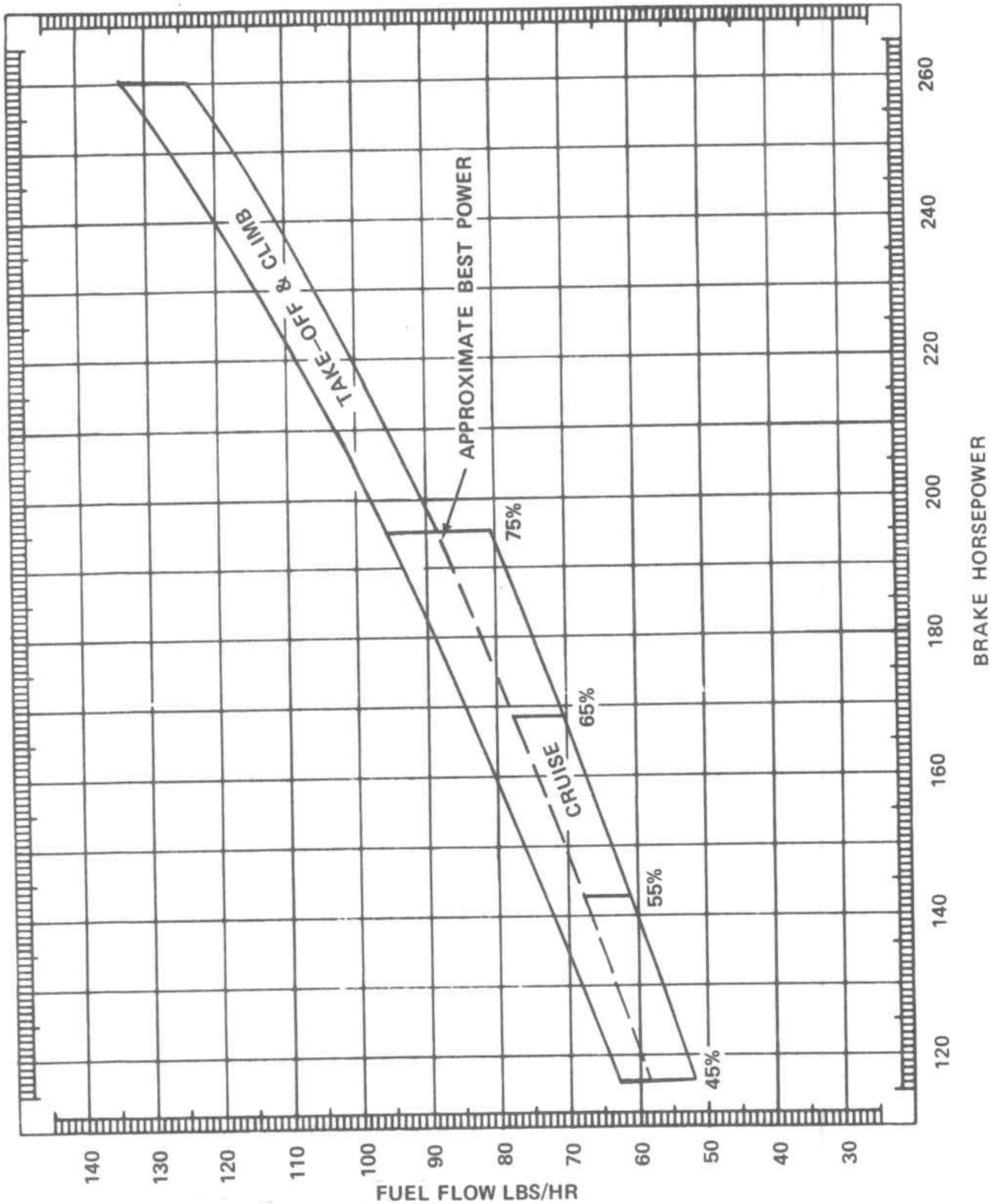

FUEL FLOW (LB/HR) VS BHP
IO–470–V, VO

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CHAPTER 77
ENGINE INDICATING

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77-00-00 GENERAL

1. The following magnetos equipped with an appropriate harness are eligible on these engines at the indicated weight.

	WEIGHT
One each Bendix S6RN-201 and S6RN-205	10.41 Lbs.
Two Bendix S6RN-25.	11.00 Lbs.
Two Slick Electro Model 662	13.50 Lbs.
Two Slick Electro Model 6210	13.50 Lbs.

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

MODELS:

IO-470-C,G,R,P,T

CHAMPION	REM38E, REM38S, REM40E, RHM38E, RHM40E
SMITH	RSE23-3R, RSH23-3R, RSE23-3R/1, RSH23-3R/1
AUBURN	SR83P, SR87, SR93, HSR86, HSR87, HSR93
AUTOLITE	SH26, SH260, PH26, PH260
TCM	628325, 646629, 627643, 630049, 627978, 642097, 642098, 646091, 646092, 625350, 627449, 635862, 626364, 627450, 635861, 632462, 632463, 635146, 635147

IO-470-J,K

CHAMPION	EM41E, HM41E, REM38S, REM40E, RHM38S, RHM40E
SMITH	RSE23-3R, RSH23-3R, RSE23-3R/1, RSH23-3R/1
AUBURN	A88, SR83P, SR93, HSR83P, HSR88, HSR93
AUTOLITE	SH20A, SH15, SH200A, SH26, SH260
TCM	635863, 635150, 646629, 627643, 646630, 627978, 642097, 642098, 646091, 646092, 539432, 635350, 635862, 626363, 626362, 635861, 627892, 632460, 632461, 632462, 632463

IO-470-D,E,F,H,L,M,N,S,U,V

CHAMPION	RHB32E, RHB32S, RHB36S
SMITH	RSH35-8R/1, RSH35-8R, RSE35-8R/1
AUBURN	271, 273, 281, 283, 291, 293
AUTOLITE	SL350
TCM	634675, 646632, 646631, 646090, 641977, 646089, 630532, 630533, 632738, 632740, 635859, 635860, 632465

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ACCESSORIES DRIVE RATIOS TO CRANKSHAFT (Viewing Drive)

Accessory	Direction of Rotation*	Drive Ratio to Crankshaft
Tachometer	CCW	.5:1
Magneto	CCW	1.5:1
Starter	CCW	32:1
Alternator (Gear Drive)	CCW	2.28:1
**Propeller Governor	CW	1:1
Fuel Pump (Injection)	CW	1:1
Accessory Drives (2)	CW	1.5:1

*"CW" - Clockwise and "CCW" - Counterclockwise

**This drive is a modified AND20010 and is supplied with cover plate only.

77-10-00 OPERATING LIMITS

Crankshaft Speed - RPM

Idle RPM . . . . 600 ± 25

Rated Maximum Continuous Operation (O-470-C,G,J,K,P,R & T). 2600

Rated Maximum Continuous Operation (O-470-D,J,K,L,M,N,S,T,U,V & VO). . 2625

Recommended Continuous Maximum for Cruising

IO-470-C,E,F,G,H,P & R . . . . --

IO-470-D,J,K.L,M,N,S,T,U,V & VO 2450

Maximum Continuous Manifold Pressure (See Performance Charts Section 76-30-00)

Recommended Continuous Maximum for Cruising . (See Performance Charts Section 76-30-00)

Fuel Control System . . . . Continental Continuous Flow Injector

Metered Fuel Pressure at Full Throttle (PSI)

IO-470-C,D,E,F,G,H,P,R & T 15.0-17.0

IO-470-J 12.8-16.0

IO-470-K 13.5-16.0

IO-470-L 15.5-17.5

IO-470-M,N, & S 14.8-16.9

Fuel-Aviation Gasoline-Min. Grade . . . . 100LL (Blue) or 100 (Green)

IO-470-C,G,P,R & T . . . . 91-96 (Blue)

IO-470-D,E,F,H,L,M,N,S,U,V & VO . . . . 80-87 (Red)

Oil Specification . . . .(Refer to Chapter 9 for Spec. MHS-24 or MHS-25

All Temperatures 15W-50

Below 50°F Ambient Air (Sea Level) . . . . SAE 30, 10W-30, 15W-50 or 20W-50

Above 30°F Ambient Air (Sea Level) . . . . SAE 50

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Oil Pressure	
Idle, Minimum psi	10
Normal Operation, psi	30 to 60
Oil Sump Capacity	Quarts
All	12.0
Usable Oil Nose Up	
15°	6.0
Usable Oil Nose Down	
15°	6.0

Max. Oil Consumption (Lb./BHP/Hr. Max. at Rated Power at RPM)

All Models:

$$\frac{.006 \text{ lbs} \times \% \text{ Power}}{100}$$

Oil Temperature Limits	
Minimum for Take-Off	75°F
Maximum Allowable (All models except IO470-LO,VO)	225°F
IO470-LO,VO	240°F
Magneto Spread 2100 RPM	50 RPM Max. Drop

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77-20-00 ENGINE TROUBLESHOOTING CHART

This troubleshooting chart is provided as a guide. Review all probable causes given, check other listings of troubles with similar symptoms. Items are presented in sequence of the approximate ease of checking, not necessarily in order of probability.

TROUBLE	PROBABLE CAUSE	CORRECTION
Engine Will Not Start	Fuel tank empty.	Fill with correct grade of fuel.
	Improper starting procedure.	Refer to Pilot's Checklist for starting procedures and check for performance of each item.
	Cylinder overprimed. Engine flooded.	Place mixture levers in IDLE CUT-OFF position. Open throttle wide. Turn engine over several revolutions to clear cylinders.
	Induction system leak.	Tighten or replace loose or damaged hose connection.
	Excessive starter slippage.	Replace starter adapter.
	Fuel system malfunction.	Isolate cause and correct. (See Troubleshooting the Fuel Injection System).
	Ignition system malfunction.	Isolate cuase and correct. (See Troubleshooting the Ignition System).
	Manifold valve vent obstruction.	Repair or replace manifold valve.
Engine Will Not Run At Idling Speed	Propeller levers set in high pitch (DECREASE RPM).	Use low pitch (INCREASE RPM) position for all ground operations.
	Fuel injection system improperly adjusted.	See Troubleshooting the Fuel Injection System.
	Air leak in intake manifold.	Tighten loose connection or replace damaged part.
Rough Idling	Fuel injection system improperly adjusted.	See Troubleshooting the Fuel Injection System.
	Mixture levers set for improper mixture.	Use FULL RICH position for all ground operation, except high altitude airports.
	Fouled spark plugs.	Remove and clean. Adjust gaps.
	Hydraulic lifters fouled.	Remove and clean lifters. Inspect and clean oil filter at more frequent intervals.

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TROUBLE	PROBABLE CAUSE	CORRECTION
Rough Idling (Cont'd)	Burned or warped exhaust valves, worn seat, scored valve guides.	Repair cylinder. Valve guides.
Engine Runs Too Lean At Cruising Power	Improper manual leaning procedure.	Refer to Chapter 76 for proper fuel flow settings.
	Fuel flow reading too low.	Check fuel strainer for clogging. Clean screen.
	Fuel injection malfunction.	See Troubleshooting the Fuel Injection System.
Engine Runs Too Rich At Cruising Power	Restrictions in air intake passages.	Check passages and remove restrictions.
Engine Runs Too Lean Or Too Rich At Throttle Setting Other Than Cruise	Fuel injection malfunction.	See Troubleshooting the Fuel Injection System.
Continuous Fouling Of Spark Plugs	Piston rings excessively worn broken.	Replace rings. Replace cylinder if damaged.
	Piston rings are not seated.	Hone cylinder walls, replace rings.
Engine Runs Rough At High Speed	Loose mounting bolts or damaged mount pads.	Tighten mounting bolts. Replace mount pads.
	Plugged fuel nozzle.	Clean.
	Propeller out of balance.	Remove and repair.
	Ignition system malfunction.	See Troubleshooting the Ignition System.
Continuous Missing At High Speed	Broken valve spring.	Replace.
	Plugged fuel nozzle.	Clean.
	Hydraulic tappet dirty or worn.	Remove and clean or replace.
	Burned or warped valve.	Remove and clean or replace.
Sluggish Operation And Low Power	Throttle not opening wide.	Check and adjust linkage. (See Rigging of Mixture and Throttle Controls).
	Restrictions in air intake passages.	Check.

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TROUBLE	PROBABLE CAUSE	CORRECTION
Sluggish Operation And Low Power (Cont'd)	Ignition system malfunction.	See Troubleshooting the Ignition System.
	Fuel injection malfunction.	See Troubleshooting the Fuel Injection System.
	Valve seats worn and leaking. Piston rings worn or stuck in grooves.	Borescope cylinders and check compression.
High Cylinder Head Temperature	Low octane fuel.	Drain tanks and replace with correct grade of fuel.
	Lean fuel/air mixture due to improper manual leaning procedure.	See "CORRECTION" under "Engine run too lean at cruising power."
	Cylinder baffles loose or bent.	Check and correct.
	Dirt between cylinder fins.	Clean thoroughly.
	Excessive carbon deposits in cylinder head and on pistons.	Check ignition and fuel injection system.
	Magnetos out of time. No appreciable drop detected during pre-flight check.	Re-time, internally and externally
	Magneto distributor block contamination.	Disassemble and repair as required or replace magneto.
	Exhaust system gas leakage.	Locate and correct.
	Exhaust valve leaking.	Repair cylinder.
Oil Leaks	At front of engine; damaged crankshaft oil seal.	Replace.
	Around propeller mounting flange: damaged hub O-ring seal.	Replace.
	Around plugs, fittings and gaskets due to looseness or damage.	Tighten or replace.
Low Compression	Piston rings excessively worn.	Repair cylinder.
	Valve faces and seats worn.	Repair cylinder.
	Excessively worn cylinder walls.	Replace cylinder & piston rings.

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TROUBLE	PROBABLE CAUSE	CORRECTION
Slow Engine Acceleration On A Hot Day	Mixture too rich.	Momentarily pull mixture control back until engine acceleration picks up, then set proper mixture.
Rough Idle At Airfields With Ground Elevation Of 3500 Feet Or Higher	Mixture too rich.	Pull mixture control back to where the engine operates the smoothest at IDLE RPM.
Slow Engine Acceleration At Airfields With A Ground Elevation Of 3500 Feet Or Higher	Mixture too rich.	Adjust mixture per Chapter 76.
Engine Will Not Stop At Idle Cut-Off	Fuel manifold valve not seating tightly.	Repair or replace manifold valve.
High Engine Idle Pressure Impossible To Obtain	Fuel manifold valve sticking closed.	Repair or replace manifold valve.
	Fuel manifold valve vent obstruction.	Repair or replace manifold valve.
Erratic Engine Operation	Fuel manifold valve sticking, or not free.	Repair or replace manifold valve.
Climbing to Altitudes Above 12,000 Feet, Engine Quits When Power Reduced.	Fuel vaporization.	Operate fuel boost pump according to aircraft manufacturer's instructions. See fuel flow per Chapter 76.
Low Fuel Pressure	Restricted flow to fuel metering valve.	Check mixture control for full travel. Check for restrictions in fuel filters and lines, adjust control and clean filter. Replace damaged parts.
	Fuel control lever interference.	Check operation of throttle control and for possible contact with cooling shroud. Adjust as required to obtain correct operation.
	Incorrect fuel injector pump adjustment and operation.	Check and adjust using appropriate equipment. Replace malfunctioning pumps.
	Malfunctioning fuel injector pump relief valve.	Replace pump.

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TROUBLE	PROBABLE CAUSE	CORRECTION
High Fuel Pressure	Restricted flow beyond fuel control assembly.	Check for restricted fuel nozzles or fuel manifold valve. Clean or replace nozzles. Replace malfunctioning fuel manifold valve.
	Malfunctioning relief valve operation in fuel injector.	Replace fuel injector pump.
	Restricted re-circulation passage in fuel injector pump.	Replace pump.
Fluctuating Fuel Pressure	Vapor in fuel system, excessive fuel temperature.	Normally, operating the auxiliary pump will clear system. Operate auxiliary pump and purge system.
	Fuel gage line leak or air in gage line.	Drain gage line and tighten connections.
	Restrictions in vapor separator vent.	Check for restriction in ejector jet of vapor separator cover. Clean jet with solvent (only). Do Not Use Wire as Probe. Replace defective parts.
Low Oil Pressure On Engine Gage	Insufficient oil in oil sump oil dilution or using improper grade oil for prevailing ambient temperature.	Add oil, or change oil to proper viscosity.
	High oil temperature.	Malfunctioning vernatherm valve in oil cooler; oil cooler restriction. Replace valve or clean oil cooler.
	Leaking, damaged or loose oil line connections - Restricted screen or filter.	Check for restricted lines and loose connections, and for partially plugged oil filter or screens. Clean parts, tighten connections, and replace malfunctioning parts.
Engine Runs Rough At Speeds Above Idle	Improper fuel-air mixture.	Check manifold connections for leaks. Tighten loose connections. Check fuel control and linkage for setting and adjustment. Check fuel filters and screens for dirt. Check for proper pump pressure, and replace pump if malfunctioning.
	Restricted fuel nozzle.	Remove and clean all nozzles.

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TROUBLE	PROBABLE CAUSE	CORRECTION
Engine Runs Rough At Speeds Above Idle (Cont'd)	Ignition system and spark plugs malfunctioning.	Clean and regap spark plugs. Check ignition cables for malfunctions. Replace malfunctioning components.
Engine Lacks Power Reduction In Maximum Manifold Pressure	Incorrectly adjusted throttle control, "sticky" linkage or dirty air cleaner.	Check movement of linkage by moving control from idle to full throttle. Make proper adjustments and replace worn components. Service air cleaner.
	Malfunctioning ignition system.	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. Spark plug gap to be 0.015 to 0.019 inch.
	Loose or damaged intake manifolds.	Inspect entire manifold system for possible leakage at connections. Replace damaged components, tighten all connections and clamps.
	Fuel nozzles malfunctioning.	Check for restricted nozzles and lines and clean or replace as necessary.
Engine Has Poor Acceleration.	Idle mixture too lean.	Readjust idle mixture.
	Incorrect fuel-air mixture, worn control linkage, or restricted air cleaner.	Tighten loose connections, replace worn elements of linkage, service air cleaner.
	Malfunctioning ignition system.	Check accessible cables and connections. Replace malfunctioning spark plugs.

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CHAPTER 78
EXHAUST

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78-00-00 GENERAL

Exhaust systems for all IO-470 model engines are supplied by the airframe manufacturer, for Overhaul, Maintenance and Troubleshooting Procedures refer to the airframe manufacturer's instructions.

CHAPTER 79
OIL

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79-00-00 GENERAL

The marketers of the aviation lubricating oils listed below have supplied data to Teledyne Continental Motors indicating their products conform to all requirements of TCM Specification MHS-24D or MHS-25, Lubricating Oil, Ashless Dispersant.

In listing the product names, TCM makes no claim or verification of marketer's statements or claims. Listing is made in alphabetical order and is provided only for the convenience of the users.

79-10-00 APPROVED PRODUCTS

Supplier	Brand
MHS-25	
Mobil Oil Company	Mobil AV 1
MHS-24-D	
BP Oil Corporation	BP Aero Oil
Castrol Limited (Australia)	Castrolaero AD Oil
Chevron U.S.A., Inc.	Chevron Aero Oil
Continental Oil	Conco Aero S
Delta Petroleum Company	Delta Avoil Oil
Exxon Company, U.S.A.	Exxon Aviation Oil EE
Gulf Oil Company	Gulfpride Aviation AD
Mobil Oil Company	Mobil Aero Oil
Pennzoil Company	Pennzoil Aircraft Engine Oil
Phillips Petroleum Company	Phillips 66 Aviation Oil, Type A
Phillips Petroleum Company	* X/C Aviation Multiviscosity Oil SAE 20W-50, SAE 20W-60
Quaker State Oil & Refining Co.	Quaker State AD Aviation Engine Oil
Red Ram Limited (Canada)	Red Ram 20W-50 Aviation Motor Oil
Shell Canada Limited	Aeroshell Oil W, Aeroshell Oil W 15W-50
Shell Oil Company	Aeroshell Oil W, Aeroshell Oil W 15W-50
Sinclair Oil Company	Sinclair Avoil
Texaco, Inc.	Texaco Aircraft Engine Oil - Premium AD
Union Oil Company of California	Union Aircraft Engine Oil HD

*NOTE . . . This does not include X/C II Aviation Oil.

NOTE . . . The operator using an oil analysis service is reminded that an oil analysis does not reveal all abnormal engine conditions. It should not be used as a replacement or substitute for routine maintenance and inspection procedures recommended in the Operator's Manual, Service Bulletins, or other directives. For further information, see TCM Service Bulletin M87-12 or current revision as applicable.

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79-20-00 OIL SYSTEM TROUBLESHOOTING CHART

This troubleshooting chart is provided as a guide. Review all probable causes given, check other listings of troubles with similar symptoms. Items are presented in sequence of the approximate ease of checking, not necessarily in order of probability.

TROUBLE	PROBABLE CAUSE	CORRECTION
High Oil Temperature Indication	Low oil supply.	Replenish.
	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 seasonal weight. (See Chapt. 2)
	Prolonged ground operation.	Limit ground operation to a minimum.
	Malfunctioning gage or bulb unit.	Check wiring. Check bulb unit. Check gage. Replace malfunctioning parts.
Low Oil Pressure Indication	Low oil supply.	Replenish.
	Oil viscosity too low.	Drain and refill with correct seasonal weight. (See Sec. 2)
	Foam in oil due to presence of alkaline solids in system.	Drain and refill with fresh oil. (It may be necessary to flush cooler core if presence of alkaline solids is due to a previous cleaning with alkaline materials).
	Malfunctioning pressure pump.	Replace pump.
	Malfunctioning pressure gage.	Check gage. Clean plumbing. Replace if required.
	Weak or broken oil pressure relief valve spring.	Replace spring. Adjust pressure to 30-60 psi by adjusting screw.

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CHAPTER 80
STARTING

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80–00–00 GENERAL

The life of your engine is determined by the care it receives. Follow the instructions contained in this manual carefully.

The engine received a run-in operation before leaving the factory. Therefore, no break-in schedule is required. Straight mineral oil (MIL-C-6529 Type II) should be used for the first oil change period (25 hours).

The minimum grade aviation fuel is 80 octane for IO-470 models J & K; and 100/100LL for all IO-470 models except IO-470-J & K. If the minimum grade fuel required is not available use a higher rating. Never use a lower rated fuel.

WARNING . . . The use of a lower octane rated fuel can cause pre–ignition and/or detonation which can damage an engine the first time high power is applied, possibly causing engine failure. This would most likely occur on takeoff. If the aircraft is inadvertently serviced with the wrong grade of fuel, then the fuel must be completely drained and the tank properly serviced, prior to engine operation.

CAUTION . . . This section pertains to operation under standard environmental conditions. The pilot should thoroughly familiarize himself with abnormal environmental conditions. Whenever such abnormal conditions are encountered or anticipated, the procedures and techniques for normal operation should be tailored accordingly. For example, if the aircraft is to be temporarily operated in extreme cold or hot weather, consideration should be given to an early oil change and/or routine inspection servicing.

NOTE . . . The following checklists are general in nature, since the various airframe/powerplant combinations are not necessarily the same in setup and layout. Consult your own pilot's operating handbook for the specific challenge and response checklists required for your aircraft.

80–00–01 PRESTARTING

Before each flight the engine and propeller MUST be examined for damage, oil leaks, security and proper servicing.

1. Place the ignition switch to the "OFF" position.
2. Operate all controls and check for binding and full range of travel.
3. Assure that fuel tanks contain proper type and quantity of fuel. (see paragraph 3 above).
4. Drain a quantity of fuel from all sumps and strainers into a clean container. If water or foreign matter is noted, continue draining until only clean fuel appears.
5. Check oil level in sump.
6. Check cowling for security.

80–00–02 STARTING

1. Fuel Selector - ON, appropriate tank.
2. Propeller Control - HIGH RPM.
3. Mixture Control - FULL RICH.
4. Battery Switch - ON.

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5. Throttle - FULL OPEN.

6. Boost Pumps or Primer - ON, 2 to 3 seconds.

7. Throttle - 1/2 INCH OPEN.

8. Magneto/Start Switch - START position.

Release the Magneto/Start Switch to BOTH position as soon as the engine starts.

CAUTION . . . Do not engage the starter when the engine is running, as this will damage the starter. Do not crank for longer than thirty seconds at a time, as this may cause the starter motor to overheat. If the engine does not start after thirty seconds of cranking, allow a 3 to 5 minute cooling period before attempting to restart.

CAUTION . . . If engine kicks back when starting, DO NOT attempt to start. The ignition starting system is inoperative and must be repaired before damaging starter adapter assembly.

9. Throttle 1000 to 1500 RPM.

10. Oil Pressure - ABOVE 30 POUNDS WITHIN 30 SECONDS.

11. Alternator Switch - ON.

12. Use the same procedure to start other engine, if operating a twin engine installation.

80-00-03 GROUND WARM-UP

Teledyne Continental aircraft engines are aircooled and are dependent on the forward speed of the aircraft for cooling. To prevent overheating, it is important that the following rules be observed.

1. Head the aircraft into the wind.

2. Operate the engine on the ground with the propeller in ""Full Increase" RPM position.

3. Avoid prolonged idling at low RPM. Fouled spark plugs can result from this practice.

4. Leave mixture in "Full Rich". (See "Ground Operation at High Altitude Airports", Section 80-00-09 for exceptions).

5. Warm-up 900-1000 RPM.

80-00-04 PRE-TAKEOFF CHECK

1. Maintain engine speed at approximately 900 to 1000 RPM for at least one minute in warm weather, and as required during cold weather, to prevent cavitation in the oil pump and to assure adequate lubrication.

2. Advance throttle slowly until tachometer indicates an engine speed of approximately 1200 RPM. Allow additional warm-up time at this speed depending on ambient temperature. This time may be used for taxiing to takeoff position. The minimum allowable oil temperature for run-up is 75°F.
CAUTION . . . Do not operate the engine at run-up speed unless oil temperature is 75°F. minimum and oil pressure is within specified limits of 30-60 PSI.

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3. Perform all ground operations with cowling flaps, (if installed), full open, with mixture control in "FULL RICH" position, dependent on field elevation, and propeller control set for maximum RPM (except for brief testing of propeller governor).

4. Restrict ground operations to the time necessary for warm-up and testing.

5. Increase engine speed to 1700 RPM only long enough to perform the following checks:

a. Magnetos: With both magnetos "ON", position the right magneto switch "OFF" and note engine RPM; now back to both magnetos "ON" to clear the spark plugs. Then position the left magneto switch "OFF" and note engine RPM. Now return switch to both magnetos "ON". The difference between the two magnetos operated individually should not differ more than 50 RPM with a maximum drop for either magneto of 150 RPM. Observe engine for excessive roughness during this check.

If no drop in RPM is observed when operating on either magneto alone, the switch circuit should be inspected.

WARNING . . . Absence of RPM drop when checking magnetos may indicate a malfunction in the ignition circuit. This type of malfunction should be corrected prior to continued operation of the engine. Should the propeller be moved by hand (as during preflight) the engine may start and cause injury to personnel.

CAUTION . . . Do not underestimate the importance of a pre-takeoff magneto check. When operating on single ignition, some RPM drop should be noted. Normal indications should be a 25-75 RPM drop and slight engine roughness as each magneto is switched off. Absence of a magneto drop may be indicative of an open switch circuit or an improperly timed magneto. A drop in RPM that exceeds 150 may indicate a faulty magneto or fouled spark plugs.

Minor spark plug fouling can usually be cleared as follows:

(1) Magnetos - Both On.

(2) Throttle - 2200 RPM.

(3) Mixture - Move toward idle cutoff until RPM peaks and hold for ten seconds. Return mixture to full rich.

(4) Magnetos - Recheck.

If the engine is not operating within specified limits, it should be inspected and repaired prior to continued operational service.

Avoid prolonged single magneto operation to preclude fouling of the spark plugs.

B. Check throttle and propeller operation.

Move propeller governor control toward low RPM position and observe tachometer. Engine speed should decrease to minimum governing speed (200-300 RPM drop). Return governor control to high speed position. Repeat this procedure two or three times to circulate warm oil into the propeller hub.

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Where applicable move propeller control to "Feather" position. Observe for 300 RPM drop below minimum governing RPM, then return control to "Full Increase" RPM position.

CAUTION . . . Do not operate the engine at a speed in excess of 2000 RPM longer than necessary to test operation and observe engine instruments. Proper engine cooling depends upon forward speed of the aircraft. Discontinue testing if temperature or pressure limits are approached.

1. Instrument indications.

A. Oil Pressure: The oil pressure relief valve will maintain pressure within the specified limits if the oil temperature is within the specified limits and if the engine is not excessively worn or dirty. Fluctuating or low pressure may be due to dirt in the oil pressure relief valve or congealed oil in the system. This should be corrected prior to continued operation of the engine.

B. Oil Temperatures: The oil cooler and oil temperature control valve will maintain oil temperature within the specified range unless the cooler oil passages or air channels are blocked, leading to rapid wear of moving parts in the engine.

C. Cylinder Head Temperature: Any temperature in excess of the specified limit may cause cylinder or piston damage. Proper cooling of cylinders depends on cylinder baffles being properly positioned on the cylinder heads and barrels, and other joints in the pressure compartment being tight to force air between the cylinder fins. Proper cooling also depends on operating practices. Fuel and air mixture ratio will affect cylinder temperature. Excessively lean mixture causes overheating even when the cooling system is in good condition. High power and low air speed, or any slow speed flight operation, may cause overheating by reducing the cooling air flow. The engine depends on the ram air flow developed by the forward motion of the aircraft for proper cooling.

D. Battery Charging: The ammeter should indicate a negative charging rate while the engine is being started. The ammeter reading should return to the positive side as soon as the engine starts and RPM increases. A low charging rate is normal after the initial recharging of the battery. A zero reading or negative reading with electrical load may indicate a malfunction in the alternator regulator system.

80-00-05 FLOODED ENGINE

1. Mixture Control - IDLE CUT-OFF.

2. Throttle - FULL OPEN.

3. Magneto/Start Switch - START.

4. As the engine starts, return the Magneto/Start switch to BOTH. Retard the throttle and slowly advance the mixture control to FULL RICH position.

80-00-06 COLD WEATHER OPERATION. (Ambient Temperature Below Freezing).

NOTE . . . Prior to operation and/or storage in cold weather assure engine oil viscosity is SAE 30, 10W30, 15W50 or 20W50. In the event of temporary cold weather operation not justifying an oil change to SAE 30, consideration should be given to hangaring the aircraft between flights.

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Engine starting during extreme cold weather is generally more difficult than during higher temperature conditions. Cold soaking causes the oil to become thicker (more viscous), making it more difficult for the starter to crank the engine. This results in a slow cranking speed and an abnormal drain on the battery capacity. At low temperatures, gasoline does not vaporize readily, further complicating the starting problem.

CAUTION . . . During cold weather operation fuel vaporization characteristics are poor. Mismanagement of the auxiliary fuel pump or overpriming of the engine could lead to cylinder hydrostatic lock.

False starting (failure to continue running after starting) often results in the formation of moisture on the spark plugs due to condensation. This moisture can freeze and must be eliminated either by applying heat to the engine or removing and cleaning the spark plugs.

80–00–07 PREHEATING

The use of preheat and auxiliary power unit (APU) will facilitate starting during cold weather and is recommended when the engine has been cold soaked at temperatures of 20°F. and below in excess of 2 hours. Successful starts without these aids can be expected at temperatures below normal, provided the engine is in good condition and the ignition and fuel systems are properly maintained.

The following procedures are recommended for preheating, starting, warm-up, run-up and takeoff.

1. Select a high volume hot air heater. Small electric heaters which are inserted into the cowling opening do not appreciably warm the oil and may result in superficial preheating.

WARNING . . . Superficial application of preheat to a cold–soaked engine can cause damage to the engine.

A minimum of preheat application may warm the engine enough to permit starting but will not de-congeal oil in the sump, lines, cooler, filter, etc. Congealed oil in such lines may require considerable preheat. The engine may start and apparently run satisfactorily, but can be damaged from lack of lubrication due to congealed oil in various parts of the system. The amount of damage will vary and may not become evident for many hours. On the other hand, the engine may be severely damaged and could fail shortly following application of high power.

Proper procedures require thorough application of preheat to all parts of the engine. Hot air should be applied directly to the oil sump and external oil lines as well as the cylinders, air intake and oil cooler. Excessive hot air can damage nonmetallic components such as seals, hoses and drive belts, so do not attempt to hasten the preheat process.

Before starting is attempted, turn the engine by hand or starter until it rotates freely. After starting, observe carefully for high or low oil pressure and continue the warm-up until the engine operates smoothly and all controls can be moved freely. Do not close the cowl flaps to facilitate warm-up as hot spots may develop and damage ignition wiring and other components.

2. Hot air should be applied primarily to the oil sump and filter area. The oil drain plug door or panel may provide access to these areas. Continue to apply heat for 15 to 30 minutes and turn the propeller, by hand, through 6 or 8 revolutions at 5 to 10 minute intervals.

3. Periodically feel the top of the engine, and when some warmth is noted, apply heat directly to the upper portion of the engine for approximately five minutes. This will provide sufficient heating of the cylinders and fuel lines to promote better vaporization for starting. If enough heater hoses are available, continue heating the sump area. Otherwise, it will suffice to transfer the source of heat from the sump to the upper part of the engine.

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4. Start the engine immediately after completion of the preheating process. Since the engine will be warm, use normal starting procedure.

NOTE . . . Since the oil in the pressure gage line may be congealed, as much as 60 seconds may elapse before oil pressure is indicated. If oil pressure is not indicated within one minute, shut the engine down and determine the cause.

5. Operate the engine at 1000 RPM until some oil temperature is indicated. Monitor oil pressure closely during this time and be alert for a sudden increase or decrease. Retard throttle, if necessary to maintain oil pressure below 100 psi. If oil pressure drops suddenly to less than 30 psi, shut down the engine and inspect the lubrication system. If no damage or leaks are noted, preheat the engine for an additional 10 to 15 minutes before restarting.

6. Before takeoff, run up the engine to 1700 RPM. If necessary approach this RPM in increments to prevent oil pressure from exceeding 100 psi.

At 1700 RPM, adjust the propeller control to Full Decrease RPM until minimum governing RPM is observed, then return the control to Full Increase RPM. Repeat this procedure three or four times to circulate warm oil into the propeller dome. If the aircraft manufacturer recommends checking the propeller feathering system, move the control to the Feather position but do not allow the RPM to drop more than 300 RPM below minimum governing speed.

NOTE . . . Continually monitor oil pressure during run-up.

7. Check magnetos in the normal manner.

8. When the oil temperature has reached 100°F. and oil pressure does not exceed 80 psi at 1700 RPM, the engine has been warmed sufficiently to accept full rated power.

CAUTION . . . Do not close the cowl flaps in an attempt to hasten engine warm-up.

NOTE . . . Fuel flow will probably be on the high limit; however, this is normal and desirable since the engine will be developing more horsepower at substandard ambient temperatures.

NOTE . . . Starting a cold soaked engine at temperatures below 20°F without the application of preheat is not recommended by TCM

80–00–08 HOT WEATHER OPERATION (Ambient Temperature In Excess of 90°F.)

CAUTION . . . When operating in hot weather areas, be alert for higher than normal levels of dust, dirt or sand in the air. Inspect air filters frequently and be prepared to clean or replace them if necessary. Weather conditions can lift damaging levels of dust and sand high above the ground. If the aircraft is flown through such conditions, an oil change is recommended as soon as possible. Do not intentionally operate the engine in dust and/or sand storms. The use of dust covers on the cowling will afford additional protection for a parked aircraft.

Flight operation during hot weather usually presents no problem since ambient temperatures at flight altitudes are seldom high enough to overcome the cooling system used in modern aircraft design. There are, however, three areas of hot weather operation which will require special attention on the part of the operator. These are: (1) Starting a hot engine; (2) Ground operation under high ambient temperature conditions; and (3) Takeoff and initial climbout.

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1. Starting a Hot Engine. After an engine is shutdown, the temperature of its various components will begin to stabilize; that is, the hotter parts such as cylinders and oil will cool, while other parts will begin to heat up due to lack of air flow, heat conduction, and heat radiation from those parts of the engine which are cooling. At some time period following engine shutdown the entire unit will stabilize near the ambient temperature. This time period will be determined by temperature and wind conditions and may be as much as several hours. This heat soaking is generally at the extreme from 30 minutes to one hour following shutdown. During this time, the fuel system will heat up causing the fuel in the pump and lines to "boil" or vaporize. During subsequent starting attempts, the fuel pump will initially be pumping some combination of fuel and fuel vapor. At the same time, the injection nozzle lines will be filled with varying amounts of fuel and vapor. Until the entire fuel system becomes filled with liquid fuel, difficult starting and unstable engine operation can normally be expected.

The state of the fuel itself can affect these fuel vapor conditions. Fresh fuel contains a concentration of volatile ingredients. The higher the concentration, the more readily the fuel will vaporize and the problems with vapor in the fuel will be more severe. Time, heat or exposure to altitude will "age" aviation gasoline causing the volatile ingredients to dissipate. This reduces the tendency of fuel to vaporize and, may induce problems with starting. If the volatile condition reaches a low enough level, starting may become difficult due to poor vaporization at the fuel nozzles since the fuel must vaporize in order to combine with oxygen in the combustion process.

The operator, by being aware of these conditions, can take certain steps to cope with problems associated with hot weather/hot engine starting. The primary objective should be that of permitting the system to cool. Lower power settings during the landing approach when practical will allow some cooling prior to the next start attempt. Reducing ground operating to a minimum is desired to keep engine temperatures down. Cowl flaps should be opened fully while taxiing. The aircraft should be parked so as to face into the wind to take advantage of the cooling affect. Restarting attempts will be most difficult from 30 minutes to one hour after shutdown. Following that interval the fuel vapor will be less pronounced and normally will present less of a restart problem.

2. Ground Operation in High Ambient Temperature Conditions. Oil and cylinder temperatures should be monitored closely during taxiing and engine run-up. Operate with cowl flaps full open. Do not operate the engine at high RPM except for necessary operational checks. If takeoff is not to be made immediately following engine run-up, the aircraft should be faced into the wind with the engine idling at 900-1000 RPM. It may be desirable to operate the fuel boost pumps to assist in suppressing fuel vaporization and provide more stable fuel pressure during taxiing and engine run-up.

3. Takeoff and Initial Climbout. Temperatures should be closely monitored and sufficient airspeed must be maintained to provide proper cooling of the engine.

CAUTION . . . Reduced engine power will result from higher density altitude associated with high temperature.

80-00-09 GROUND OPERATION AT HIGH ALTITUDE AIRPORTS

Because of insufficient air density at altitudes, oil pressure, oil temperature and cylinder head temperature gages should be carefully observed to prevent engine overheating.

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CHAPTER 81
TURBINES

81–00–00 GENERAL (NOT APPLICABLE)

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81-00-00 GENERAL

The IO-470 model engines are naturally aspirated engines not utilizing a turbocharger.

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