

# **OPERATOR'S MANUAL FOR IO-520 SERIES AIRCRAFT ENGINES**

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## **NOTICE**

**IN ORDER TO PROPERLY USE THIS ENGINE, THE USER MUST COMPLY WITH ALL INSTRUCTIONS CONTAINED HEREIN. FAILURE TO SO COMPLY WILL BE DEEMED MISUSE, RELIEVING THE ENGINE MANUFACTURER OF ANY RESPONSIBILITY.**

**THIS MANUAL CONTAINS NO WARRANTIES, EITHER EXPRESS OR IMPLIED. THE PURPOSE OF THE DATA PRESENTED IS INSTRUCTION, INFORMATION, AND SAFETY.**

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## FOREWORD

This booklet is intended to serve pilots and maintenance mechanics as a pocket size guide to operation and maintenance requirements. Subjects are limited to engine operation and inspection normally carried out on engines installed in aircraft of the personal and executive transport types. No effort is made herein to describe extensive repair work or overhaul. For such instructions refer to the Maintenance Manual for these engines. Careful observance of operating limits and compliance with recommended inspection procedures herein will enable the engines to serve faithfully.

World wide use of Continental engines in personal aircraft has led to the establishment of an extensive system of Factory Approved Service Stations and Dealers, and this service system has received the continuous attention of our Service Department with the aim of bringing spare parts, repair facilities and technical information to the aircraft operator so that now in most parts of the United States, at least, Continental Approved parts and service are as close as your nearest airport. In Canada, South America and other parts of the world Continental aircraft engine sales and service may be found in the larger centers of population. Continental Approved Service Stations and Dealers are regularly supplied with service bulletins, which are available for inspection by engine owners, and other interested persons at those offices. These bulletins may be obtained on an annual subscription basis for a nominal fee to cover cost of mailing. The extent of this service organization and the demands which it has placed on our Service Department personnel, in addition to the problems of production of the finest possible engines at fair and reasonable prices, have made it almost impossible to communicate directly with all individuals in regard to service matters. It is suggested that all technical questions, orders and reports can best and most quickly be handled by your nearest Continental Approved Dealer or Service Station and that you should become acquainted with that organization, where you will find a sincere interest in helping you to get the best service from your Continental engine.

No engine leaves our factory until it has passed a rigid operational test and inspection, therefore each new engine is believed to be free of defect. If any Continental engine or part is suspected of failure or does not function properly, advise your nearest Continental Approved Service Station, giving model and serial number, hours operated and complete details. Do not attempt repairs without factory authorization if adjustment is expected.

## CONTINENTAL MODEL IO-520 ENGINES

### INTRODUCTION

The Continental Series IO-520 are 6 cylinder, fuel-injected, engines with a continuous rating of 285 HP at 2700 RPM. The IO-520-D, E & F Engines also incorporate a 5 minute take-off rating of 300 HP at 2850 RPM. These air cooled engines have a wet sump oil system, dual magnetos and continuous-flow injection system. The fuel injection system supplies metered fuel to the individual cylinders through injector nozzles, to assure the proper fuel-air ratio for best performance at all altitudes.

### A. DESIGN FEATURES

#### 1. General

The engines have air-cooled, horizontally opposed, overhead valve cylinders with 5.25 inch bore, 4.00 inch stroke, 520 cubic inch displacement, and a compression ratio of 8.5:1. The cylinders have down-directed exhaust outlets. The crankshaft flange has six bolt holes, two dowel pins and a center pilot extension provided for attaching the propeller. Provisions are made in the pilot extension for the hydraulic propeller control oil which is supplied internally from the governor pad. The crankshaft is also equipped with pendulum type torsional damper weights. The engine has removable type hydraulic tappets. Positive rotation is provided for the exhaust valves by the use of rotators. Tappets, pushrod ends and rocker arm bearings are lubricated by the engine main oil pressure system.

The engines are furnished with a direct cranking starter and a generator or a direct driven alternator (IO-520-B, C & M Engines). The exhaust manifold systems are not supplied with the engines. The engine main fuel filter, engine controls, vacuum pump and propeller governor are furnished by the aircraft manufacturer.

The relatively high power delivered by these engines, per pound of weight, is achieved by utilization of carefully selected high strength materials, by improvements in design calculated to make the most of these high quality materials, and by very close control of critical dimensions, surface finishes, heat treatment and hardening processes. Careful work has produced more rugged engines than could be built by less exacting methods; however, no amount of ruggedness built into an engine will enable it to withstand serious mistreatment. Overheating, neglect, and inferior fuels and lubricants will seriously affect engine performance, particularly when the specific power rating is high and each part must be free to function properly in order to withstand the imposed loads with minimum wear. These considerations are mentioned here in order to emphasize the necessity of using only the manufacturer's recommended gasoline and oil and of keeping the fuel, oil and air filters clean. The octane rating of engine fuel should be as specified in Tabulated Data.

Bore (Inches) .....	5.25
Stroke (Inches) .....	4.00
Piston Displacement (cu. in.) .....	520
<b>Brake Horsepower</b>	
Rated Maximum Continuous Operation .....	285
Rated Maximum Take-Off .....	285 A-B-C-J-M 300 D-E-F-K-L (5 Min. Max.)
Recommended Maximum for Cruising .....	215 225-L
<b>Crankshaft Speed - RPM</b>	
Rated Maximum Continuous Operation .....	2700
Rated Maximum Take-Off .....	2700 A-B-C-J 2850 D-E-F-K-L
Recommended Max. for Cruising .....	2500 A-B-C-J 2550 D-E-F 2450 M 2600 L

## 2. Tabulated Data and Performance Curves

Manufacturer ..... Teledyne Continental Motors  
 Models ..... IO-520-A, B, C, D, E, F,  
 J, K, L, M

### Cylinders

Arrangement ..... Individual cylinders in a horizontally  
 opposed position.

Compression Ratio ..... 8.5:1

Firing Order ..... 1-6-3-2-5-4

Head Temperature

Maximum Allowable ..... 460° F.\*

Barrel Temperature

Maximum Allowable ..... 310° F.

Number ..... 6

Numbering (Accessory  
 toward propeller end):

Right Side ..... 1-3-5

Left Side ..... 2-4-6

\* Indicates temperature measured by plug-type thermocouple in tapped opening at bottom of cylinder head.

Intake Manifold Pressure (In. Hg.)

Maximum Take-off ..... Full Throttle

Maximum Continuous at Sea Level ..... 28.8

Maximum Continuous at Critical Altitude ..... 28.8

Recommended Continuous Max.  
 for Cruising ..... See Performance Chart

Fuel Control System ..... Continental Continuous Flow  
 Injector.

Minimum Fuel Octane Rating ..... 100/130 (Aviation Grade)

Oil Specification ..... Continental MHS-24

Above 40° F. .... SAE No. 50

Below 40° F. .... SAE No. 30 (or 10W30)

Oil Pressure

Minimum Idle (psi) ..... 10

Cruising Range (psi) ..... 30 to 60

Oil Sump Capacity (U. S. Qts.) ..... 12

Oil Level (Minimum for Operation) .....	**
Oil Consumption (lb./BHP/hr, Maximum at rated power and RPM) .....	0.015
Oil Temperature Limits	
Minimum for Take-Off .....	75° F.
Maximum Allowable with SAE No. 50 oil .....	240° F.
Recommended Cruising .....	170° F.
Ignition Timing (Compression stroke, breaker opens)	
Right Magneto, degrees BTC .....	22°
Left Magneto, degrees BTC .....	22° All

Accessories*	Qty	Manufacturer	Model
Magneto	2	Slick Electro	662
	1	Scintilla	S6RN-201
	1	Scintilla	S6RN-205
	1	Scintilla	S6RN-1201
	1	Scintilla	S6RN-1205
Spark Plugs	12	A.C. Spark Plug	273
	12	Champion	RHB-32N
Generator	1	)	12V, 50 amp.
	1	)	24V, 50 amp.
Alternator	1	)See Parts	12V, 70 amp.
	1	)Catalog	24V, 50 amp.
Starter	1	)	12V
	1	)	24V

\* See Parts Catalog for Engine Model Application.

#### Accessories Drive Ratios to Crankshaft (Viewing Drive)

Accessory Drive	Rotation	Ratio	Engine
Magneto (2)	CCW	1.5:1	ALL
Generator (belt dr.)	CCW	2.28:1	A-D-E-F-J-K-L
Alternator (direct dr.)	CCW	3:1	B-C-M

Starter	CCW	32:1	A-D-E-F-J-K-L
	CCW	48:1	B-C-M
# Prop. Governor	CW		
	facing pad	1:1	ALL
@ AND 20000 Dr. (2)	CW	1.5:1	ALL

\*\* Minimum oil level for satisfactory oil cooling is indicated by "LOW" mark on oil level gauge.

# Modified AND 20010 pad. This drive supplied with cover plate only.

@ These drives applied with cover plate only.

Dimensions	10-520-A&J	10-520-B	10-520-C	10-520-D	10-520-E	10-520-F	10-520-K	10-520-L	10-520-M
Length	40.91 in.	37.97 in.	42.81 in.	36.86 in.	47.16 in.	40.91 in.	40.91 in.	40.91 in.	48.74 in.
Width	33.56 in.	33.56 in.	33.56 in.	33.56 in.	33.56 in.	33.56 in.	33.56 in.	33.56 in.	33.56 in.
Height	19.75 in.	27.32 in.	19.78 in.	23.79 in.	19.75 in.	19.75 in.	19.75 in.	23.25 in.	20.58 in.
<b>Detail Weights</b>									
a. Basic Engine - Includes lubrication system, accessory drives, starter adapter, intake system, mounting brackets, cylinders, and four pendulum type dampers	412.43 Lbs.	406.65 Lbs.	398.72 Lbs.	411.43 Lbs.	411.43 Lbs.	411.43 Lbs.	411.43 Lbs.	412.80 Lbs.	397.1 Lbs.
Spark Plugs (12)	3.00 Lbs.	2.90 Lbs.	3.00 Lbs.	3.00 Lbs.	3.00 Lbs.	3.00 Lbs.	3.00 Lbs.	3.00 Lbs.	3.0 Lbs.
Magnetos (2)	12.88 Lbs.	10.50 Lbs.	11.50 Lbs.	12.88 Lbs.	10.50 Lbs.	12.88 Lbs.	11.50 Lbs.	12.88 Lbs.	10.5 Lbs.
Ignition Assembly (all weather)	2.75 lbs.	2.47 Lbs.	2.75 Lbs.	2.75 Lbs.	2.47 Lbs.	2.75 Lbs.	2.75 Lbs.	2.75 Lbs.	2.8 Lbs.
Basic Engine Weight (dry)	431.06 Lbs.	457.65 Lbs.	415.87 Lbs.	430.06 Lbs.	427.40 Lbs.	430.06 Lbs.	428.68 Lbs.	431.43 Lbs.	413.4 Lbs.
b. Basic Engine with Accessories									
Basic Engine	431.06 Lbs.	422.42 Lbs.	415.87 Lbs.	430.06 Lbs.	427.40 Lbs.	430.06 Lbs.	428.68 Lbs.	431.43 Lbs.	413.4 Lbs.
Starter	17.00 Lbs.	17.00 Lbs.	16.00 Lbs.	17.00 Lbs.	16.00 Lbs.	17.00 Lbs.	17.75 Lbs.	17.75 Lbs.	16.0 Lbs.
Generator	17.91 Lbs.	10.75 Lbs.	10.75 Lbs.	17.91 Lbs.	23.50 Lbs.	17.91 Lbs.			
Alternator		10.75 Lbs.	10.75 Lbs.				11.62 Lbs.	12.31 Lbs.	
Oil Cooler	7.50 Lbs.	7.38 Lbs.	7.38 Lbs.	7.50 Lbs.	7.50 Lbs.	7.50 Lbs.	7.50 Lbs.	5.25 Lbs.	7.4 Lbs.
Total Weight of Basic Engine and Accessories	473.47 Lbs.	457.65 Lbs.	450.00 Lbs.	472.47 Lbs.	474.40 Lbs.	472.47 Lbs.	465.55 Lbs.	466.74 Lbs.	436.8 Lbs.

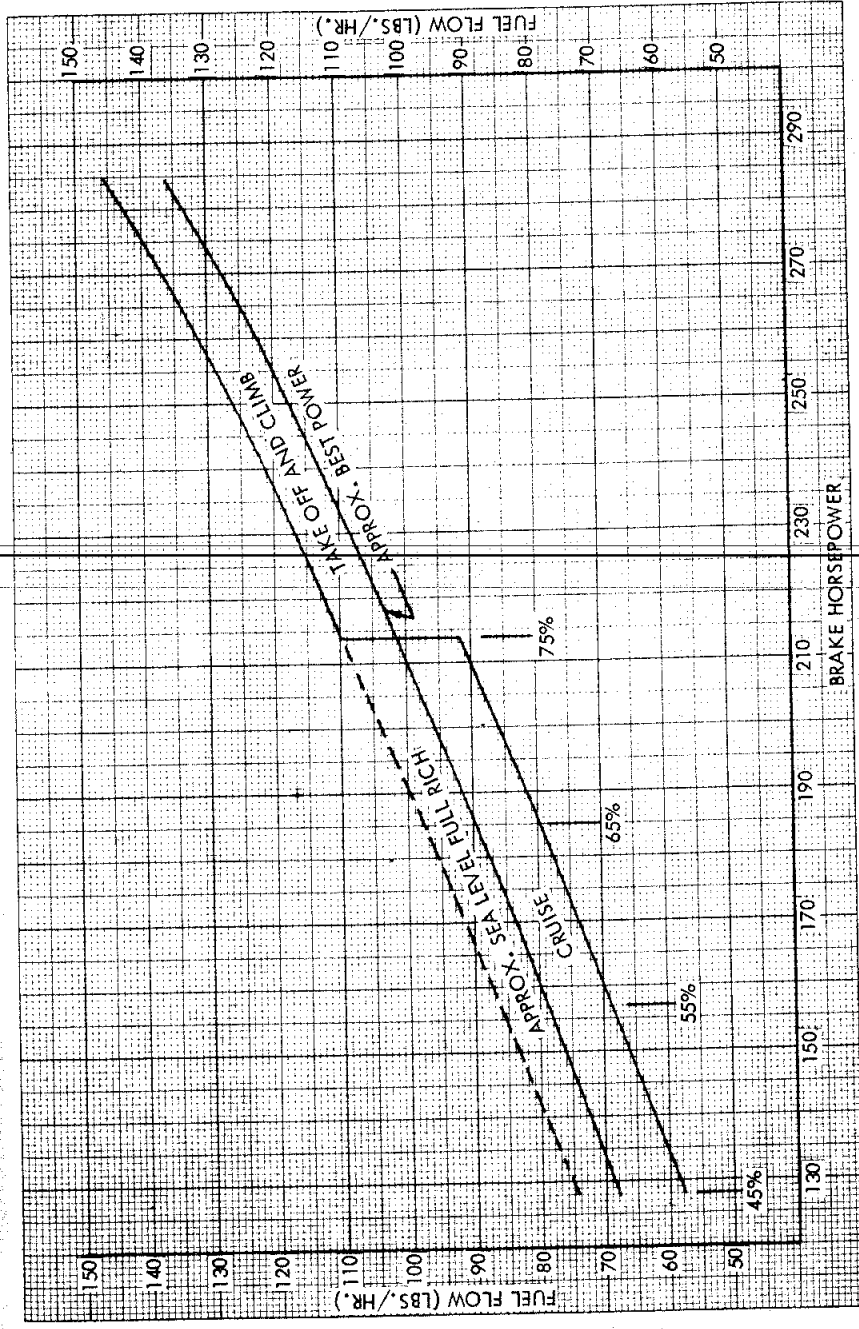


FIG. 1. FUEL FLOW VS. BHP FOR IO-520-A &amp; J.

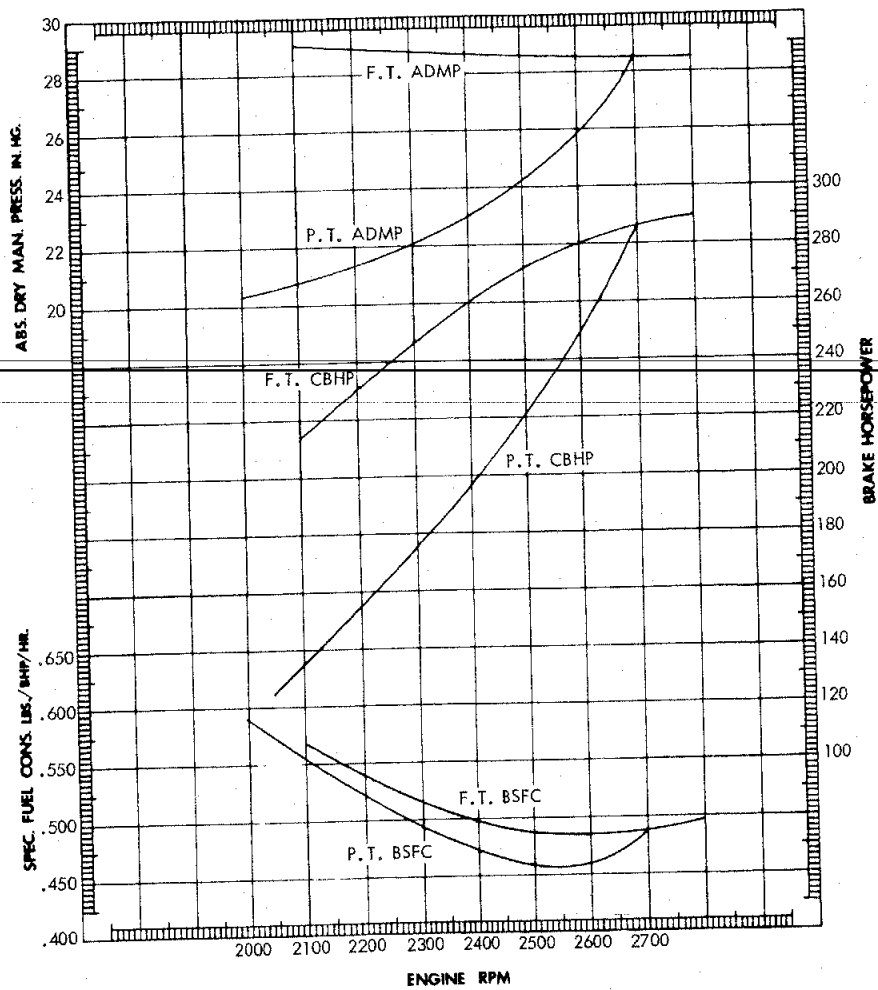


FIG. 2. SEA LEVEL PERFORMANCE CURVES FOR IO-520-A & J.

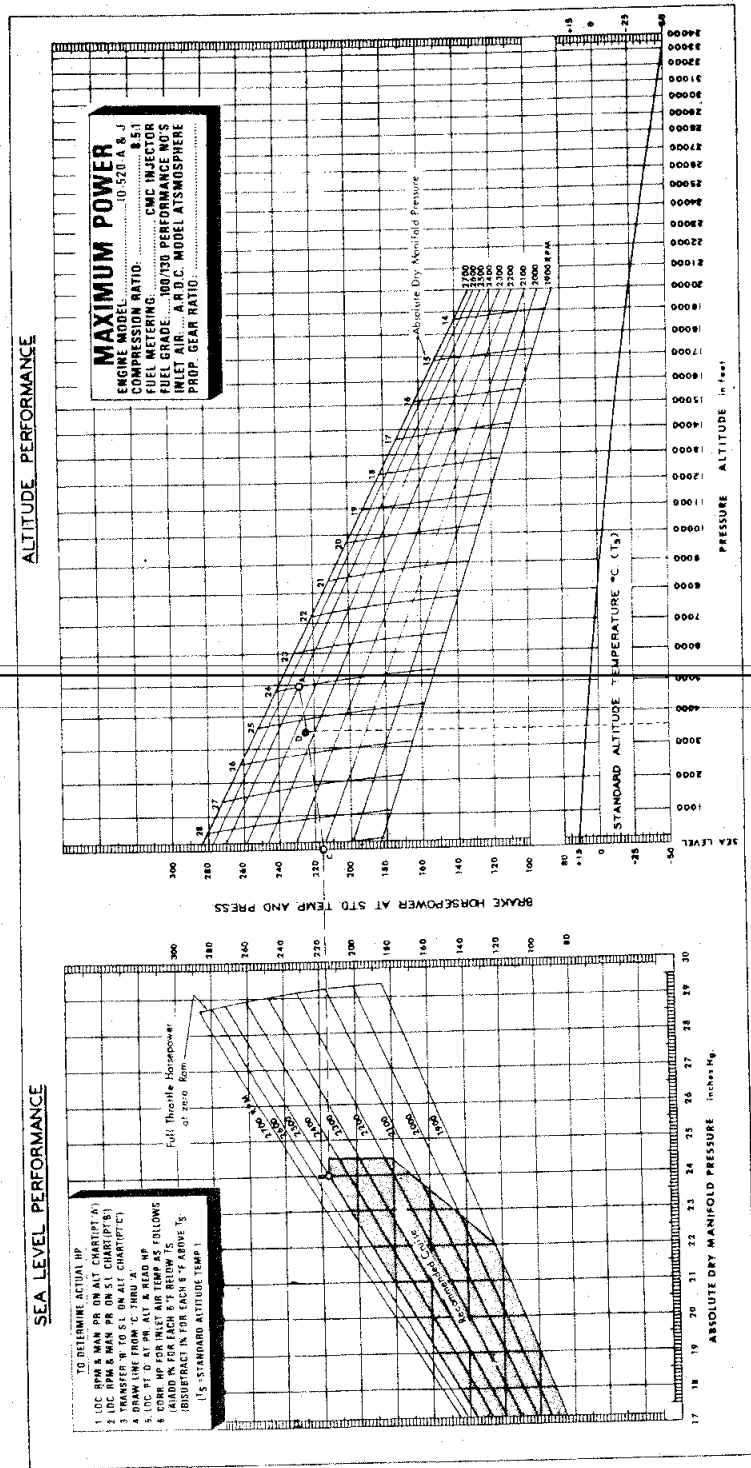


FIG. 3. ALTITUDE PERFORMANCE CURVES FOR IO-520-A & J.



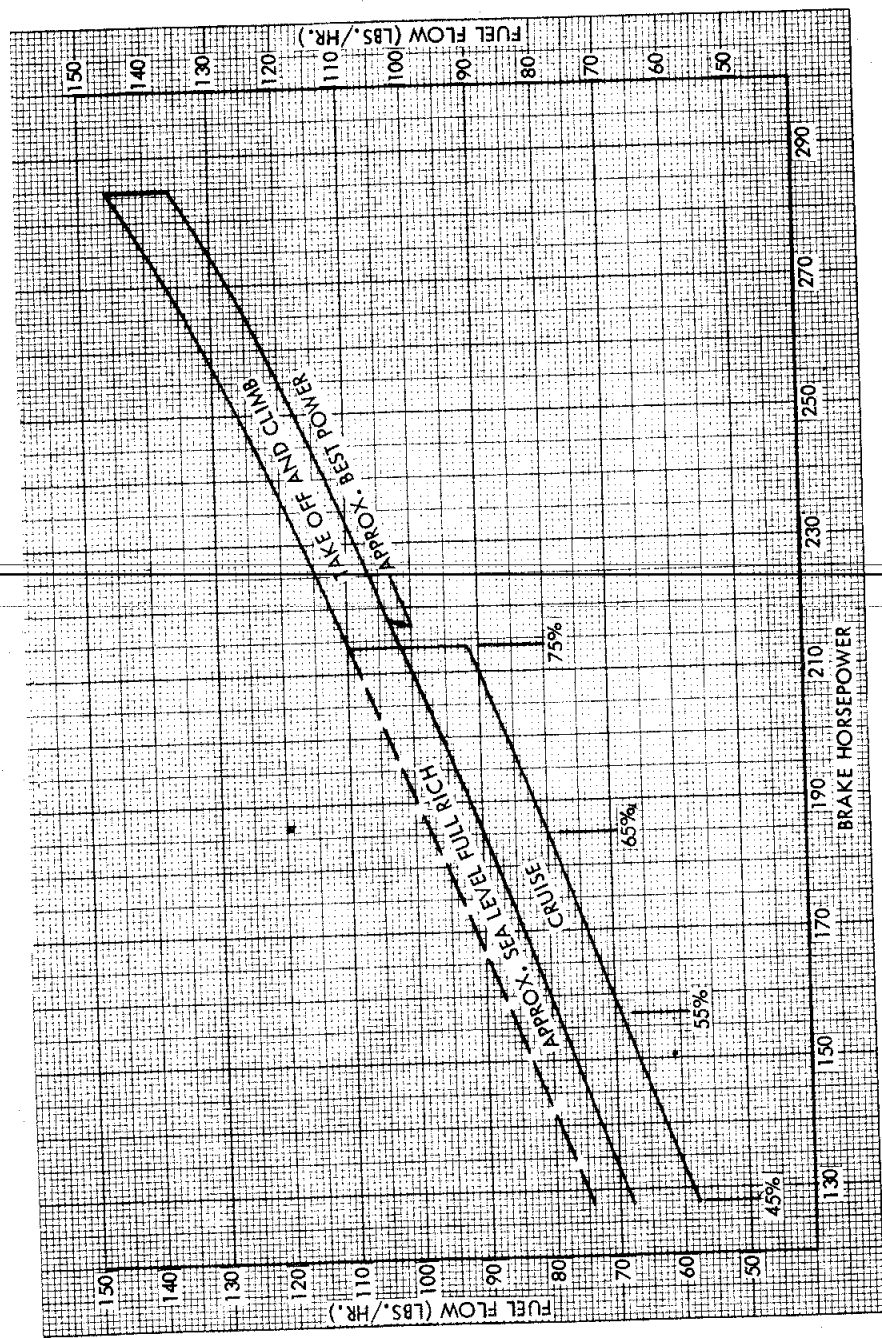


FIG. 4. FUEL FLOW VS. BHP FOR IO-520-B.

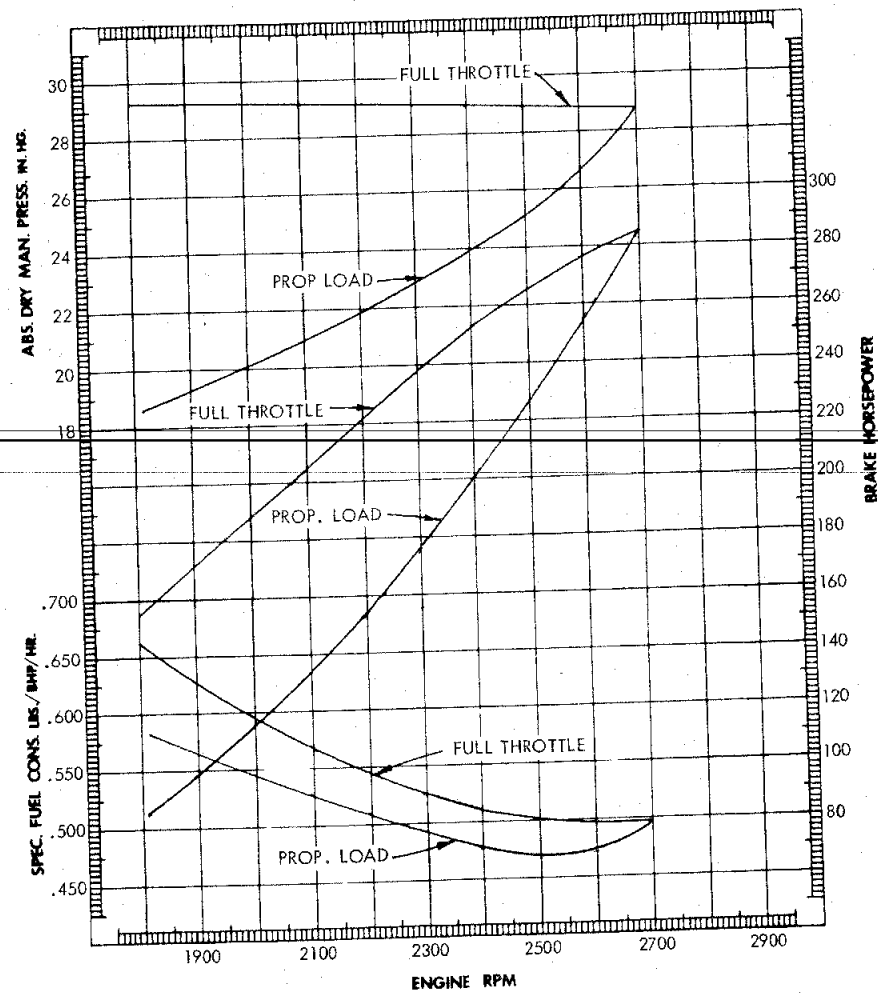


FIG. 5. SEA LEVEL PERFORMANCE CURVES FOR IO-520-B.

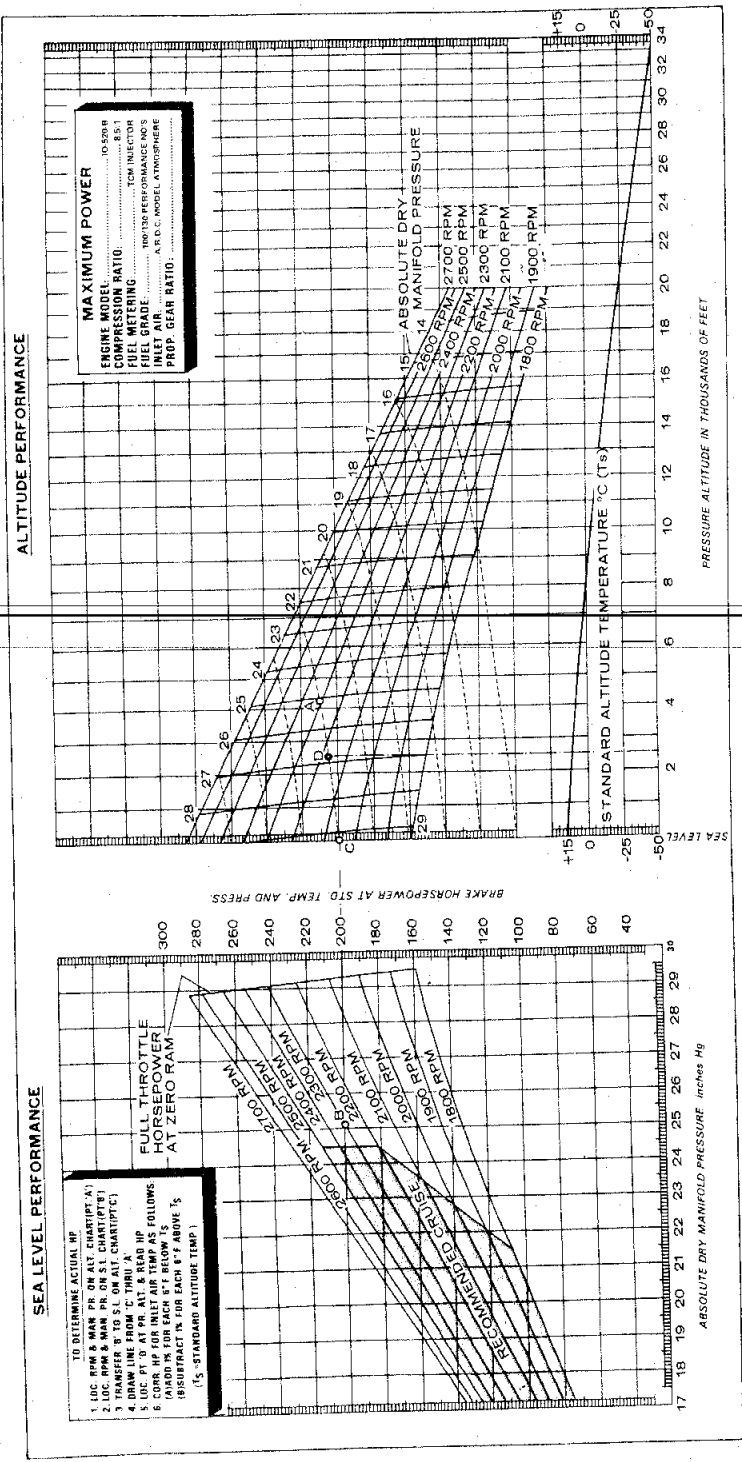


FIG. 6. ALTITUDE PERFORMANCE CURVES FOR IO-520-B.

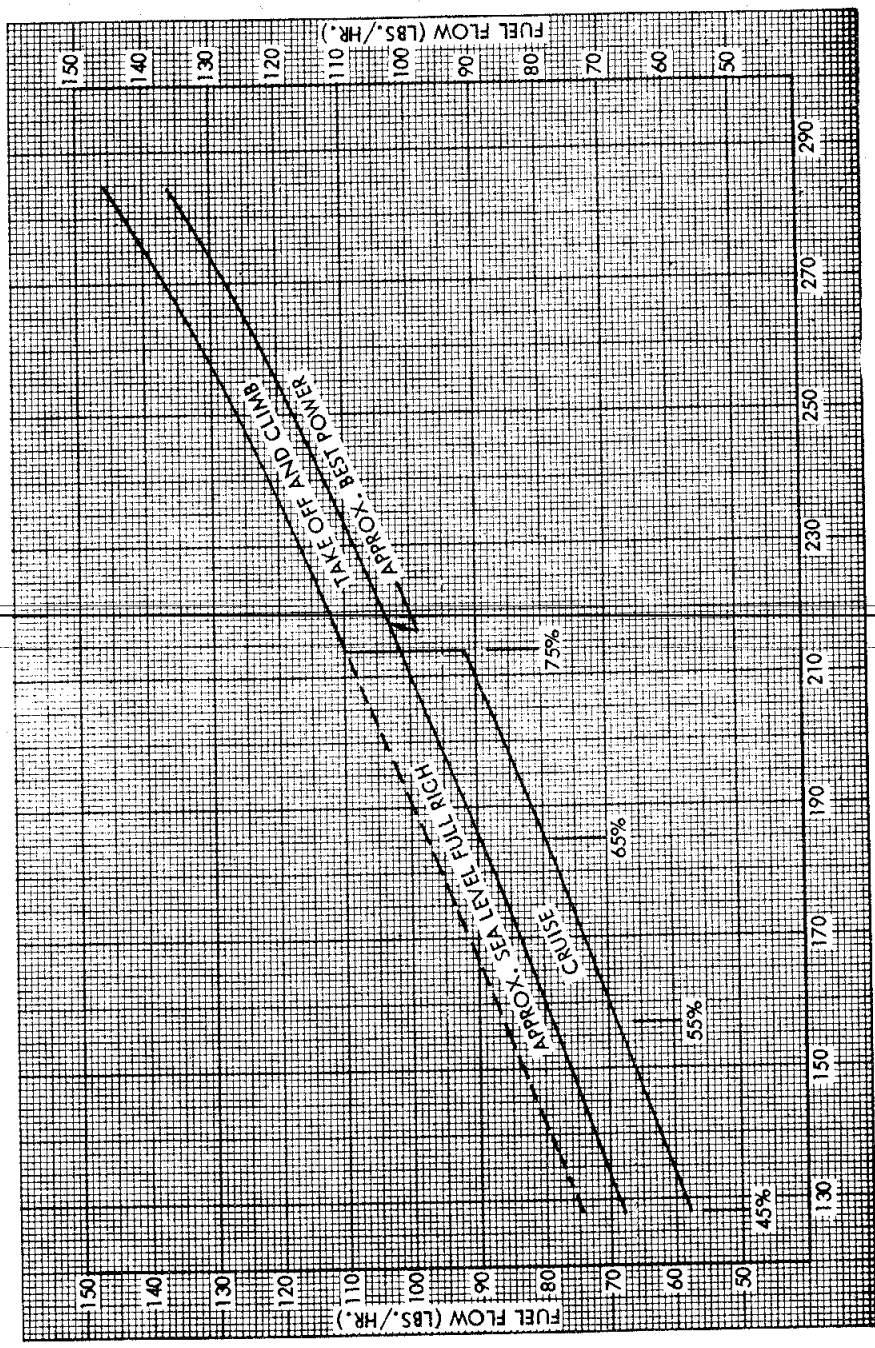


FIG. 7. FUEL FLOW VS. BHP FOR IO-520-C.

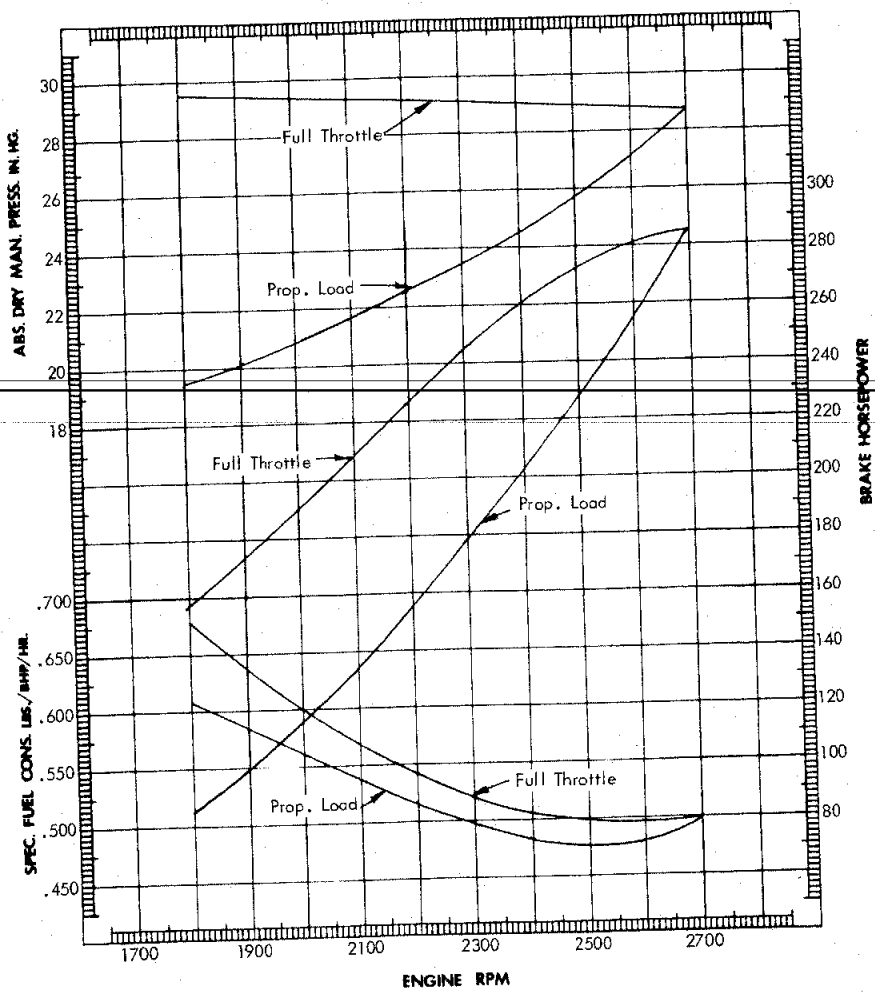


FIG. 8. SEA LEVEL PERFORMANCE CURVES FOR IO-520-C.

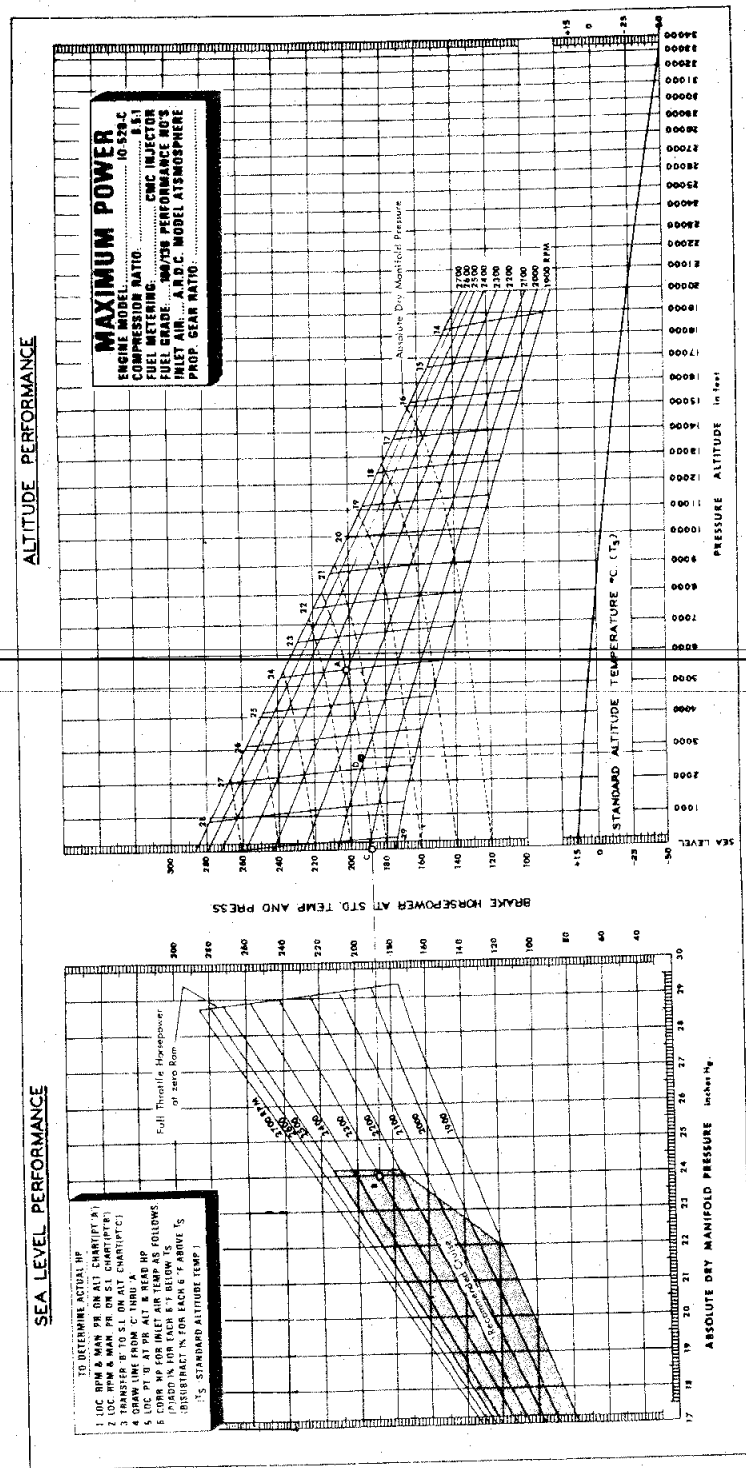


FIG. 9. ALTITUDE PERFORMANCE CURVES FOR IO-520-C.

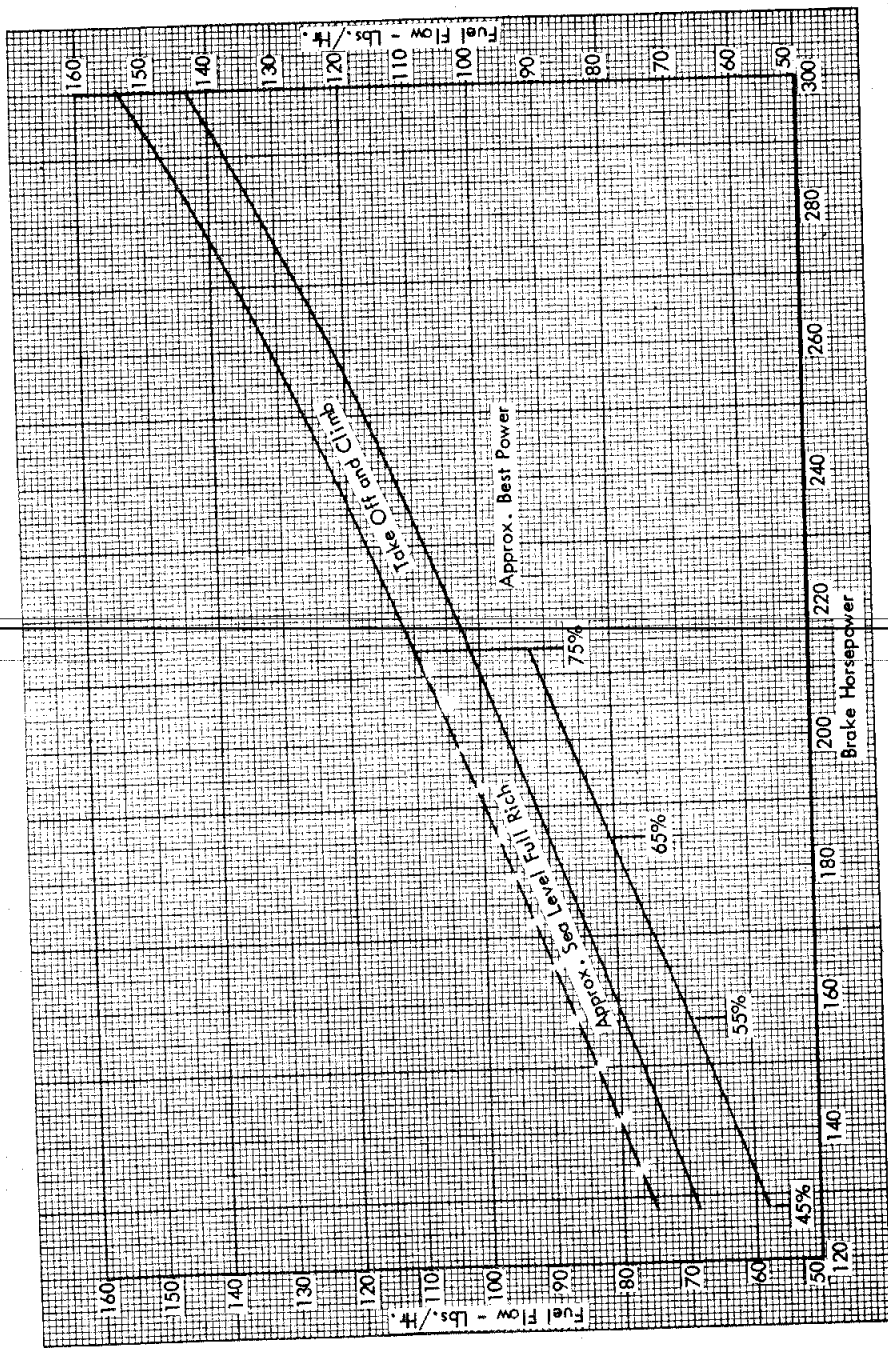


FIG. 10. FUEL FLOW VS. BHP FOR IO-520-D.

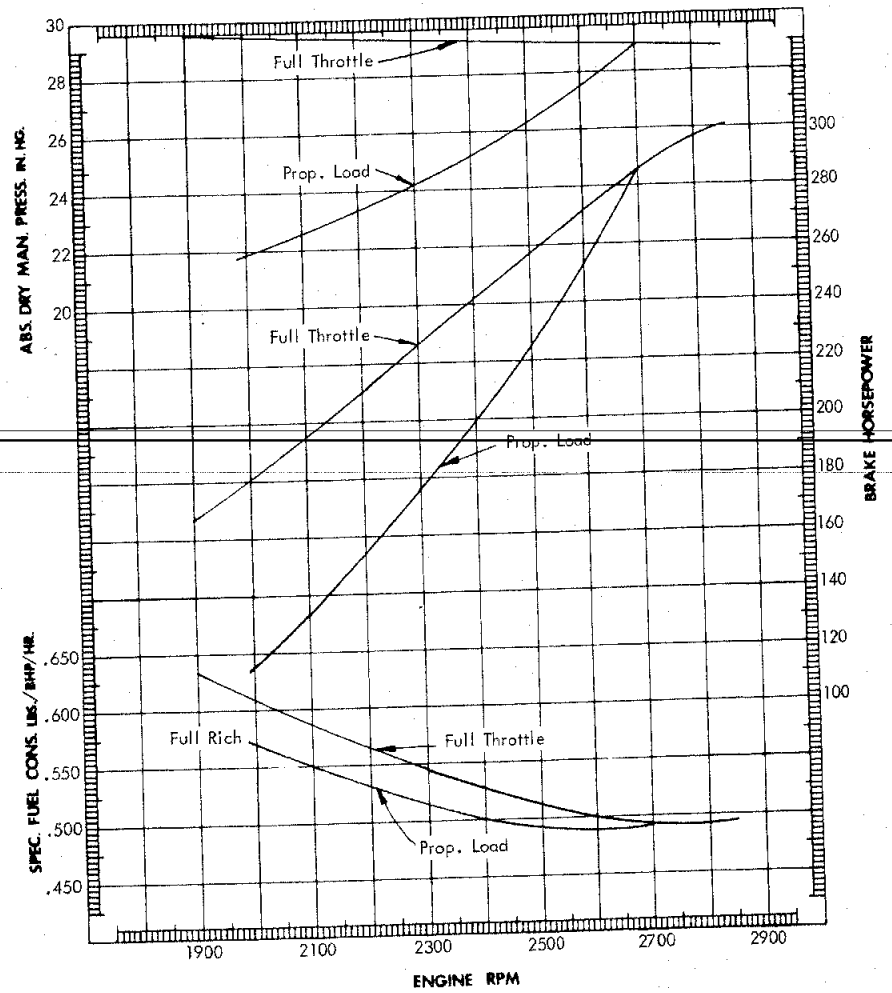


FIG. 11. SEA LEVEL PERFORMANCE CURVES FOR IO-520-D.

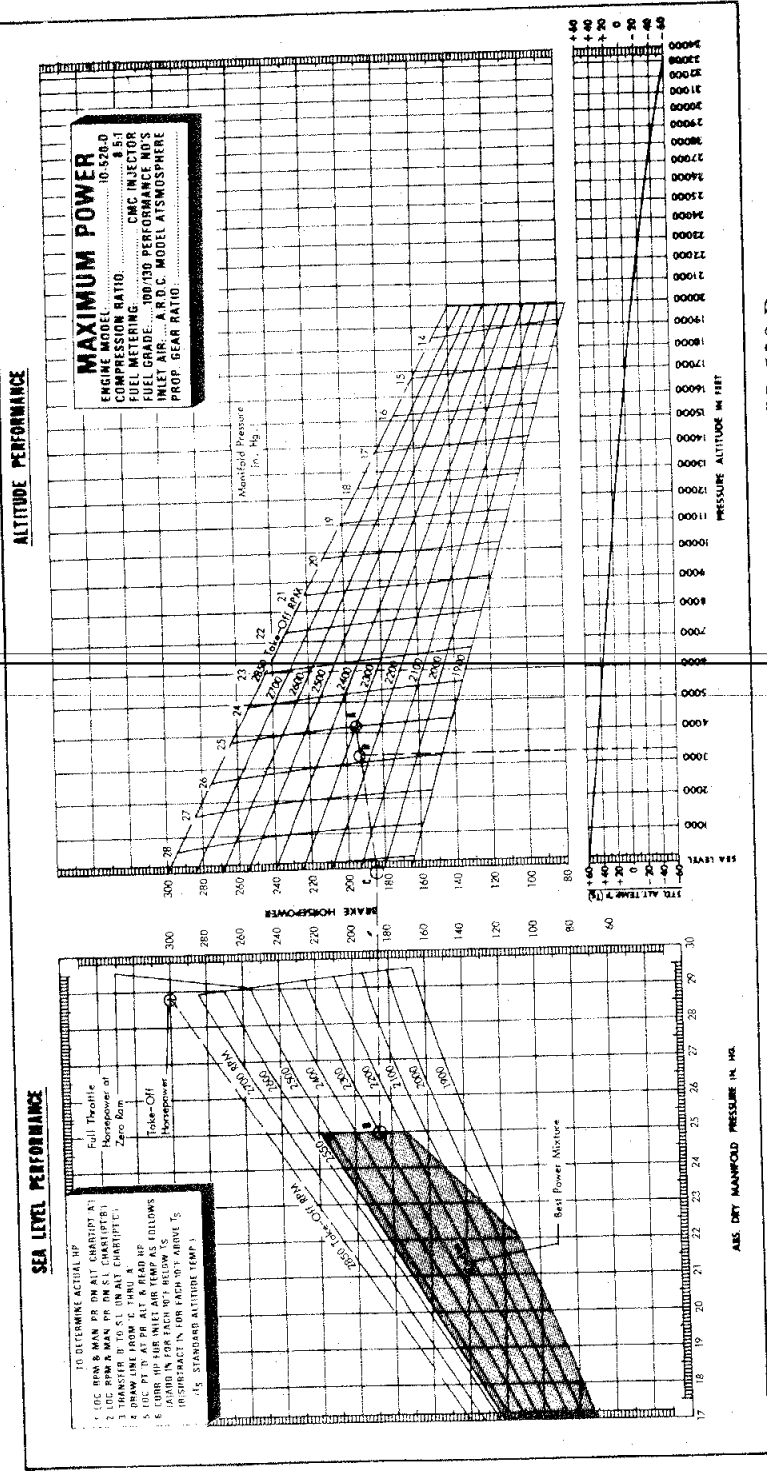


FIG. 12. ALTITUDE PERFORMANCE CURVES FOR IO-520-D.

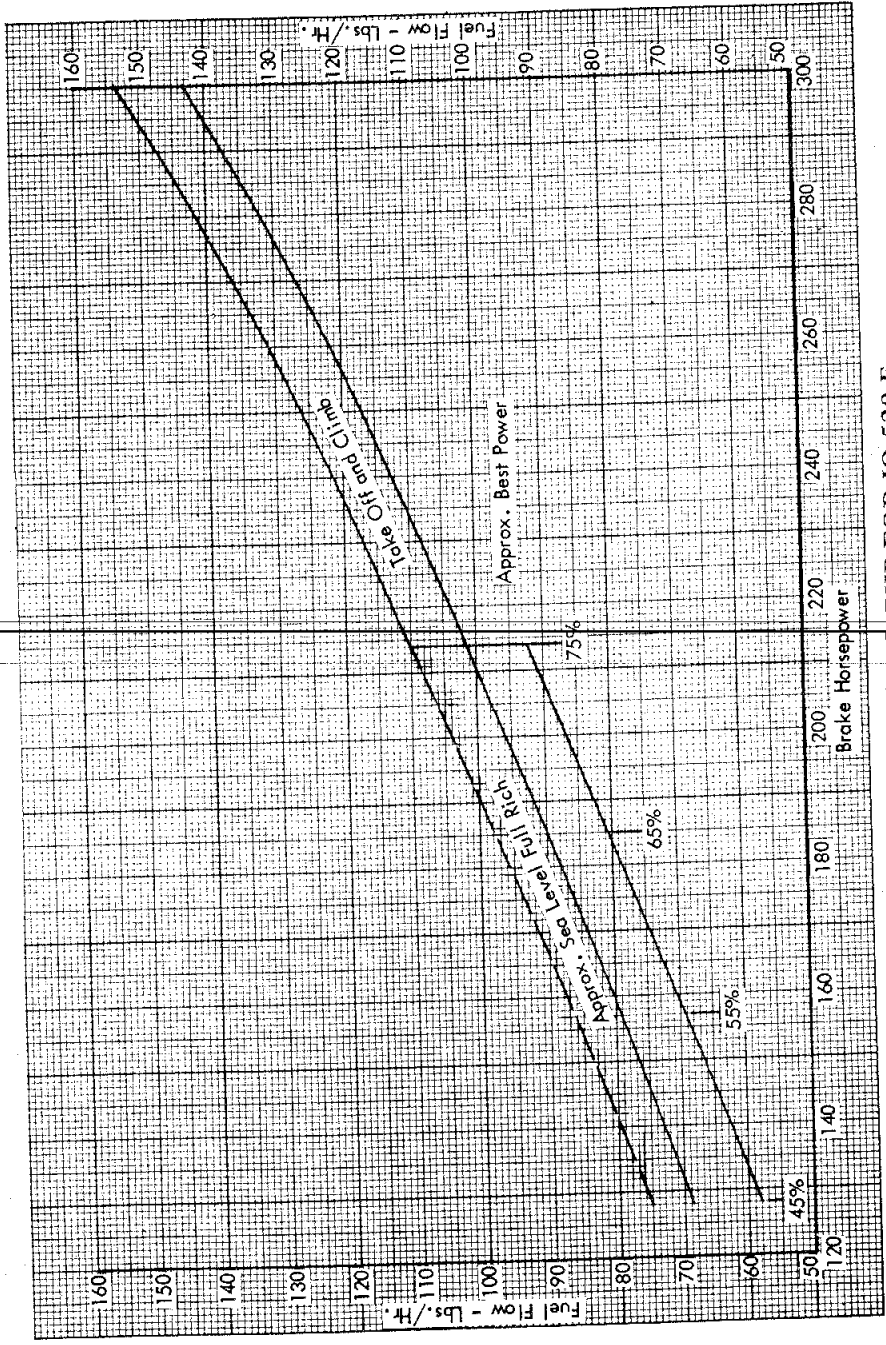


FIG. 13. FUEL FLOW VS. BHP FOR IO-520-E.

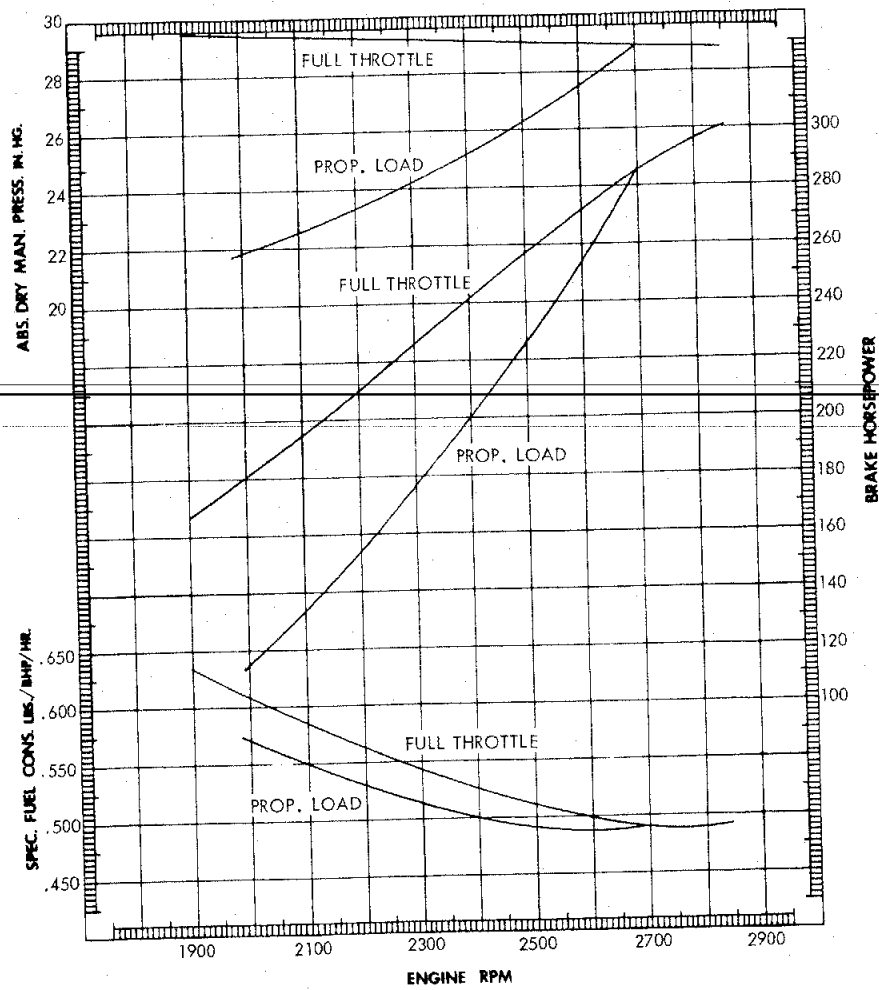


FIG. 14. SEA LEVEL PERFORMANCE FOR IO-520-E.

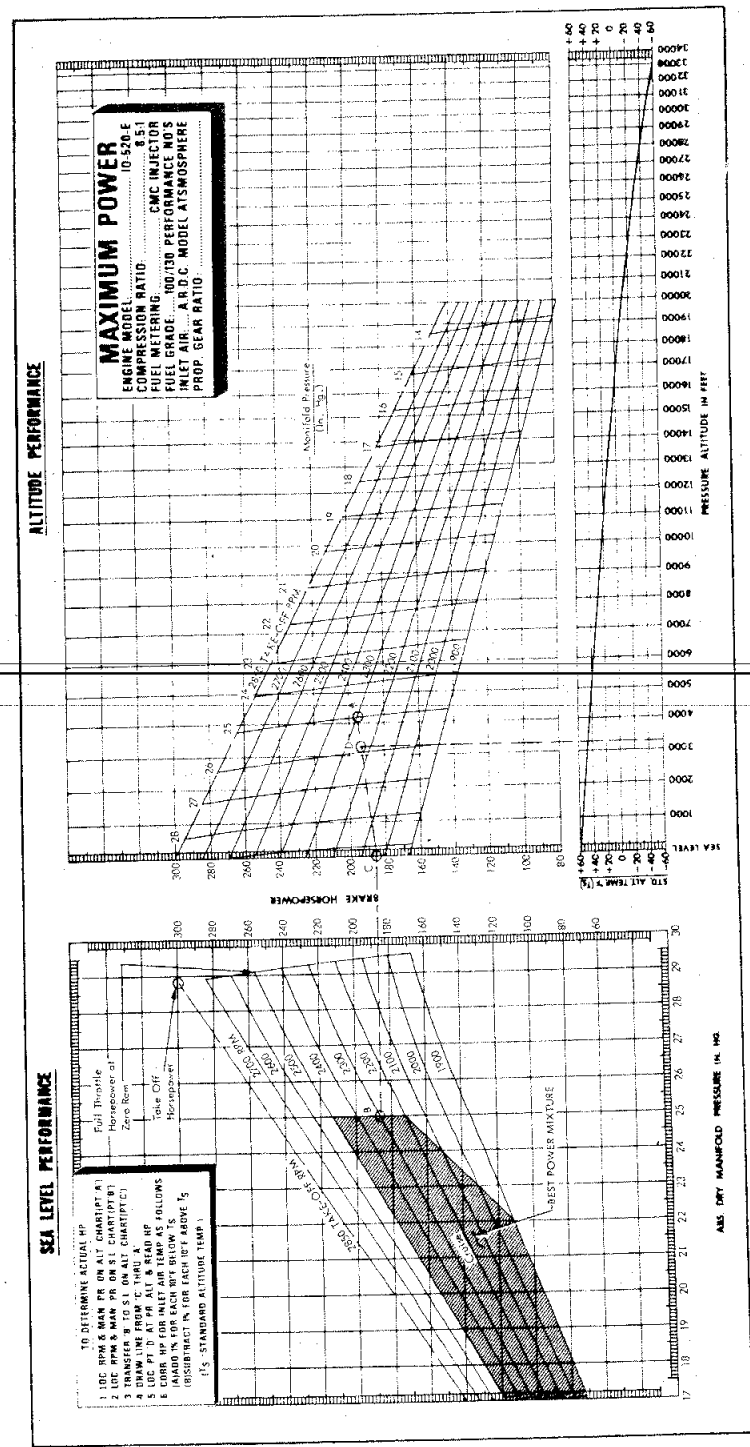


FIG. 15. ALTITUDE PERFORMANCE FOR IO-520-E.

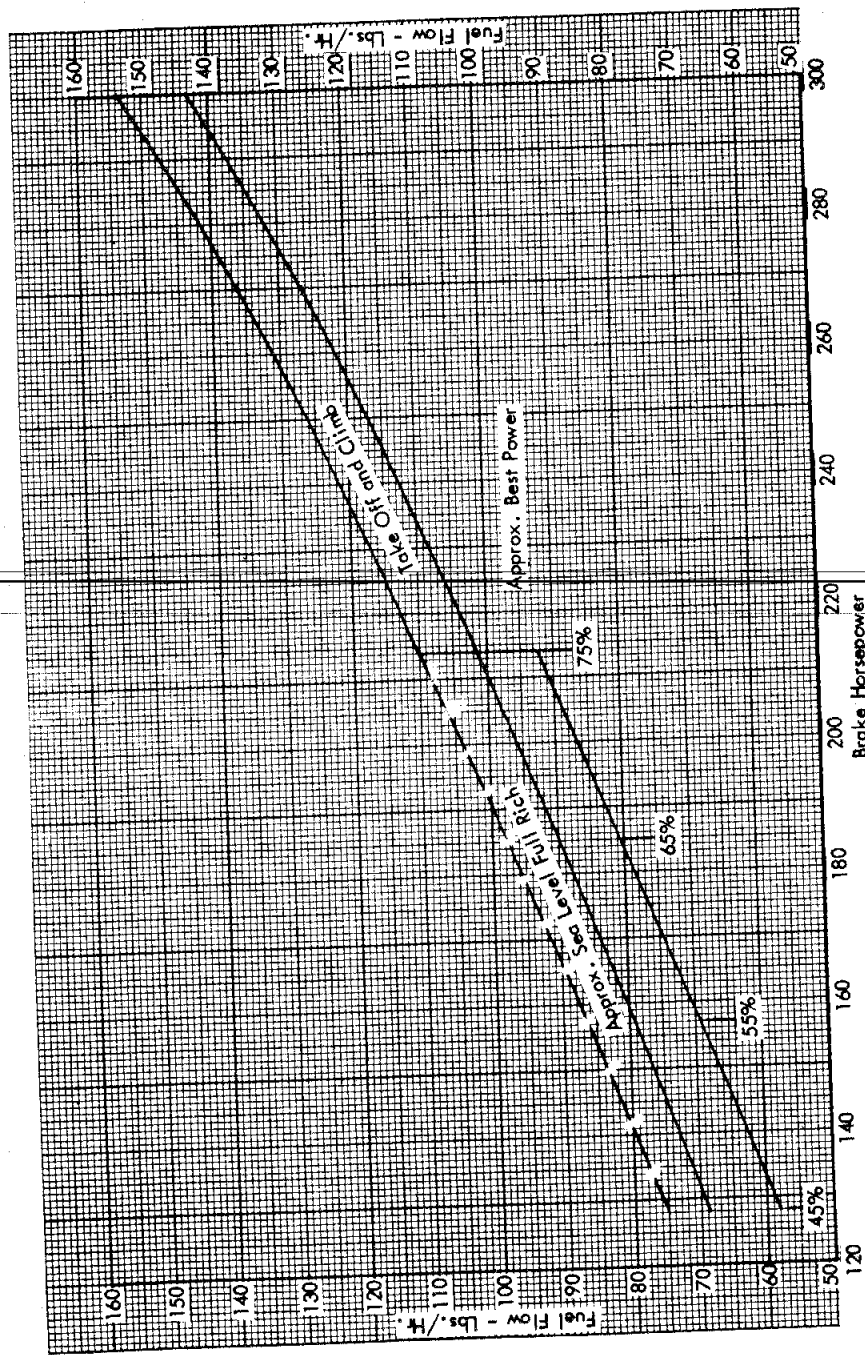


FIG. 16. FUEL FLOW VS. BHP FOR IO-520-F, K & L.

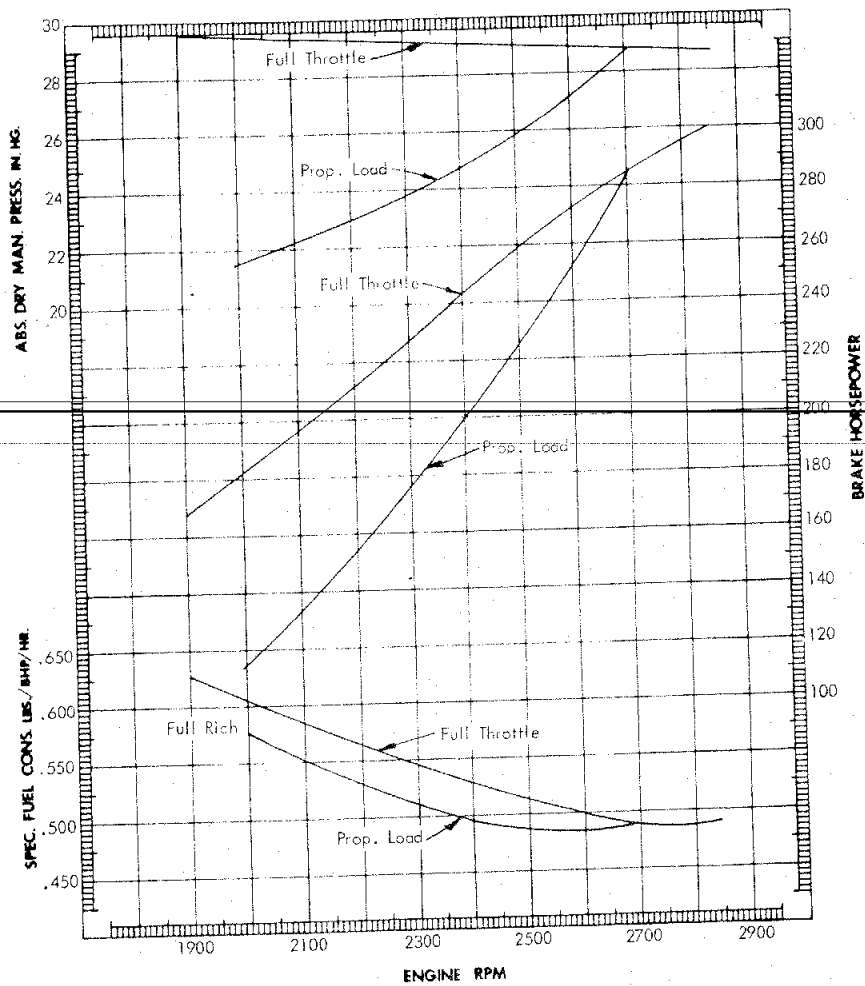


FIG. 17. SEA LEVEL PERFORMANCE FOR IO-520-F, K & L

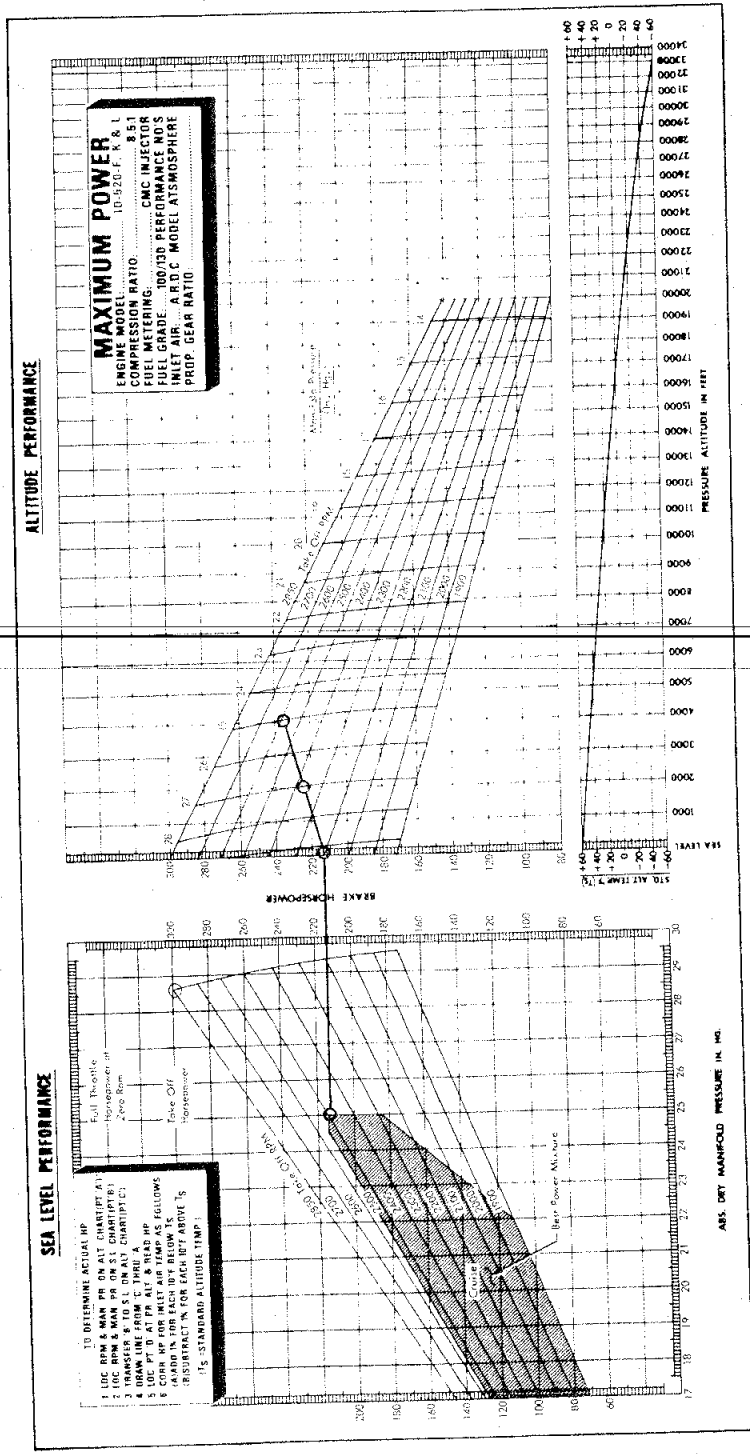


FIG. 18. ALTITUDE PERFORMANCE FOR IO-520-F, K & L.

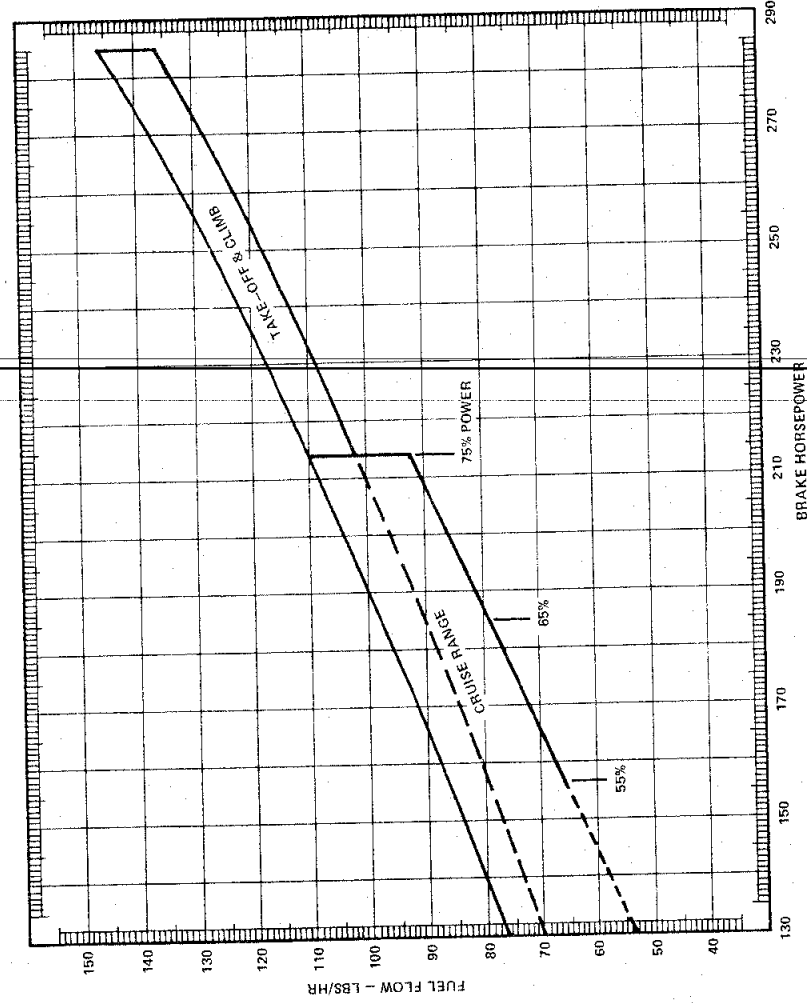


FIG. 19. FUEL FLOW VS. BHP FOR IO-520-M.



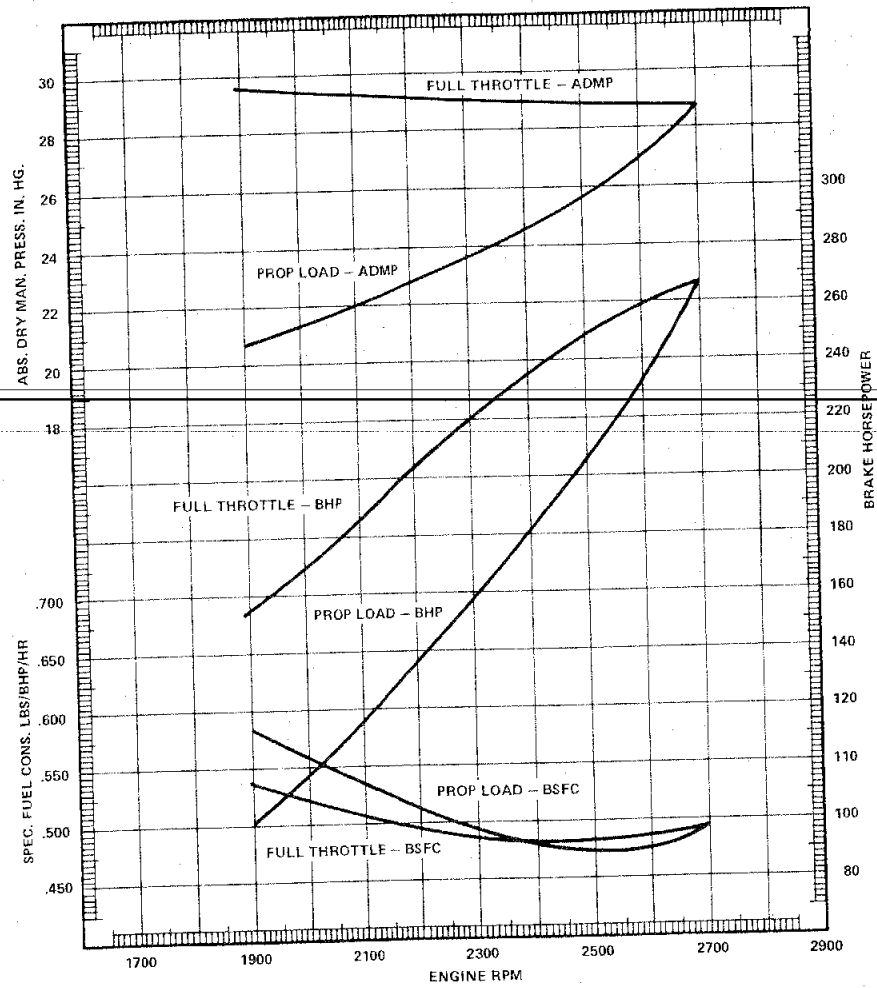
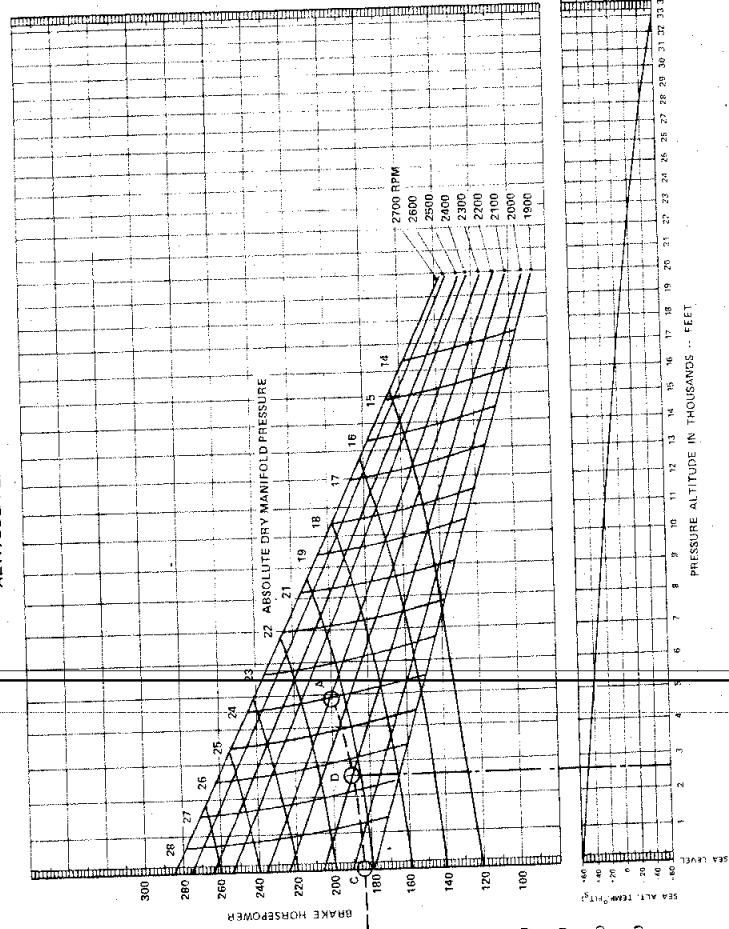


FIG. 20. SEA LEVEL PERFORMANCE FOR IO-520-M.

ALTITUDE PERFORMANCE



SEA LEVEL PERFORMANCE

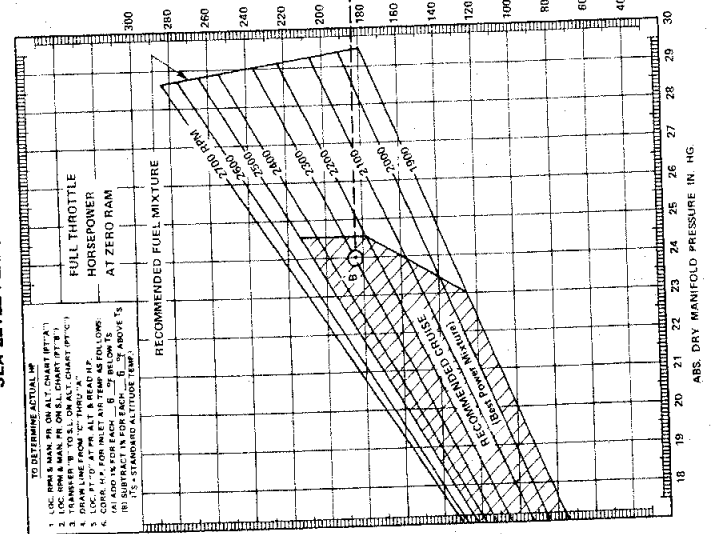


FIG. 21. ALTITUDE PERFORMANCE FOR IO-520-M.

### 3. Oil System

The engine is lubricated by a force feed system. A thermostatically controlled oil cooler maintains oil temperatures normally at 170 - 180°F. Warm oil circulates continuously through warm-up passages in the coolers, to prevent oil congealing when operating in low temperatures. The capacity of the oil sump is designed so the quantity of oil available is sufficient to lubricate the engine at any nose up or nose down attitude at positive "G" loads. It is difficult to uncover the pick up line, which would result in low oil pressure if the level in the sump is maintained at the recommended level shown on the engine oil gauge rod. Accessible oil sump drain plugs are provided for use in changing oil at the recommended intervals.

The main oil pressure pump picks up oil from the sump and discharges it through a passage to the oil filter and oil cooler, and to the engine oil galleries and bearings.

Each cylinder wall and piston is additionally lubricated by individual oil squirt nozzles which direct a continuous oil stream at the piston inner dome. Oil is returned to the sump through drain holes. A filter by-pass valve is incorporated (in the filter adapter on permold engines with full flow type filters, and directly on the oil pump on the sandcase engines with the integral type oil screen) in the event the filter becomes clogged. Another passage in the filter housing is machined to accommodate a pressure relief valve which regulates the pressure in the engine main galleries.

Excess incoming oil is returned to the sump. The oil cooler system includes a Vernatherm control valve to automatically regulate oil temperature within specified limits. When the oil temperature becomes high enough to require cooling, the Vernatherm valve expands and blocks the by-pass opening so that oil flows through the cooler.

Engine oil is introduced to the propeller governor through a passage in the engine crankshaft, and is returned to the sump through passages in the crankcase.

### 4. Induction System

The air induction system used on the IO-520 Series Engines consists of intake tubes, a balance tube, connecting hoses, clamp assemblies and a combination air throttle and fuel metering control. The air throttle assembly may be located at the rear of the engine supported by brackets, or below the oil sump supported by an inverted manifold assembly or bolted to a cast aluminum oil sump. The air throttle on the IO-520-M is airframe mounted and connected to the riser by a flexible duct. The intake manifold and balance tube are mounted below the cylinders. The intake air duct and filter are provided by the aircraft manufacturer.

### 5. Ignition System

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

Torque from the engine crankshaft is transmitted through the camshaft gear to the magneto drive coupling. The magneto coupling incorporates an impulse coupling. As the rubber bushings in the drive gear turns the coupling drive lugs, counterweighted latch pawls, inside coupling cover, engage pin on the magneto case and hold back the latch plate until forced inward by the coupling cover. When the latch plate is released, the coupling spring spins the magnet shaft through its neutral position and the breaker opens to produce a high voltage surge in the secondary coil. The spring action permits the latch plate, magnet and breaker to be delayed through a lag angle of 30 degrees of drive gear rotation during the engine cranking period. Two stop pins in the case and two lobes on the breaker cam produce two sparks per revolution of the drive shaft. After engine is started, counterweights hold the latch pawls clear of the stop pins and the magnet shaft is driven at full advance.

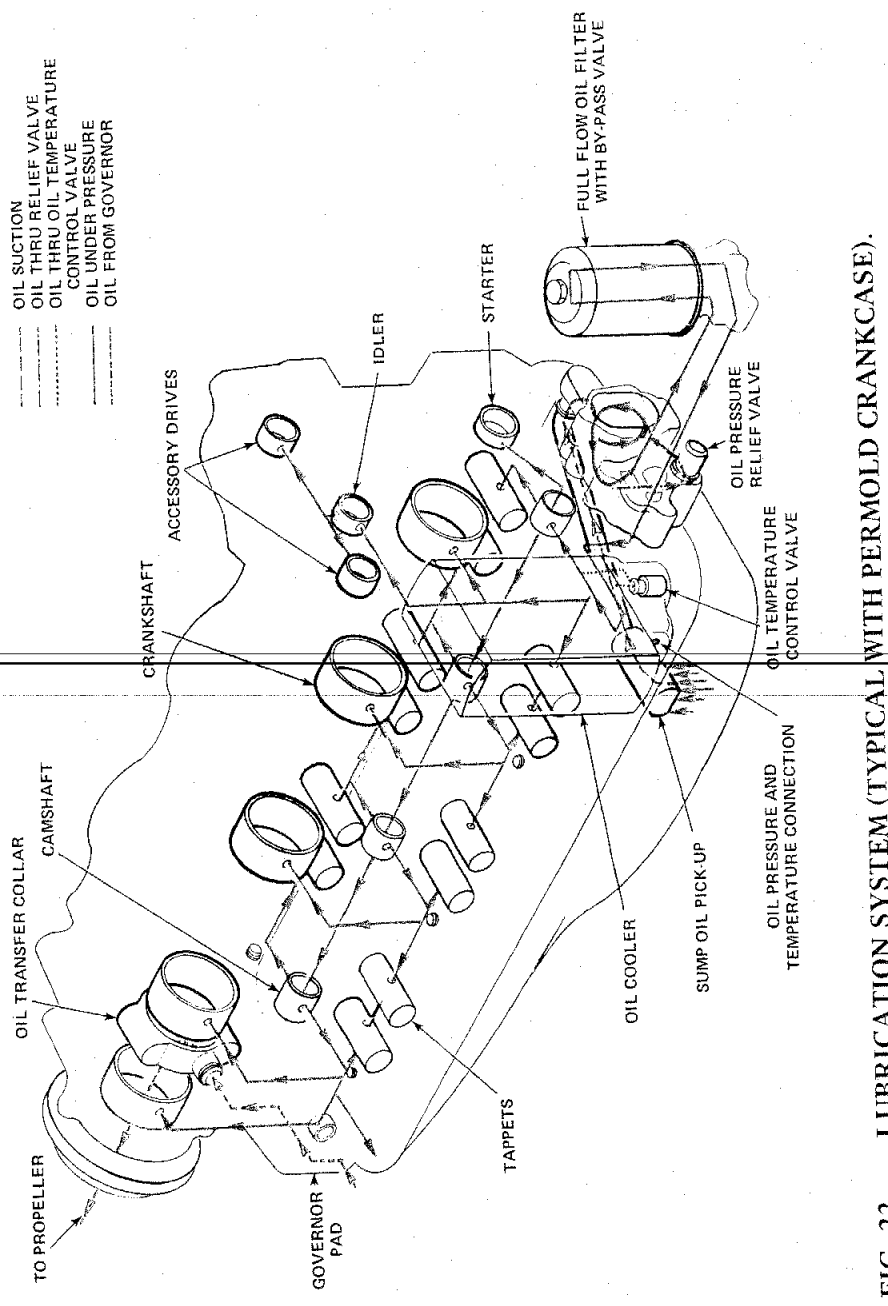


FIG. 22. LUBRICATION SYSTEM (TYPICAL WITH PERMOLD CRANKCASE).

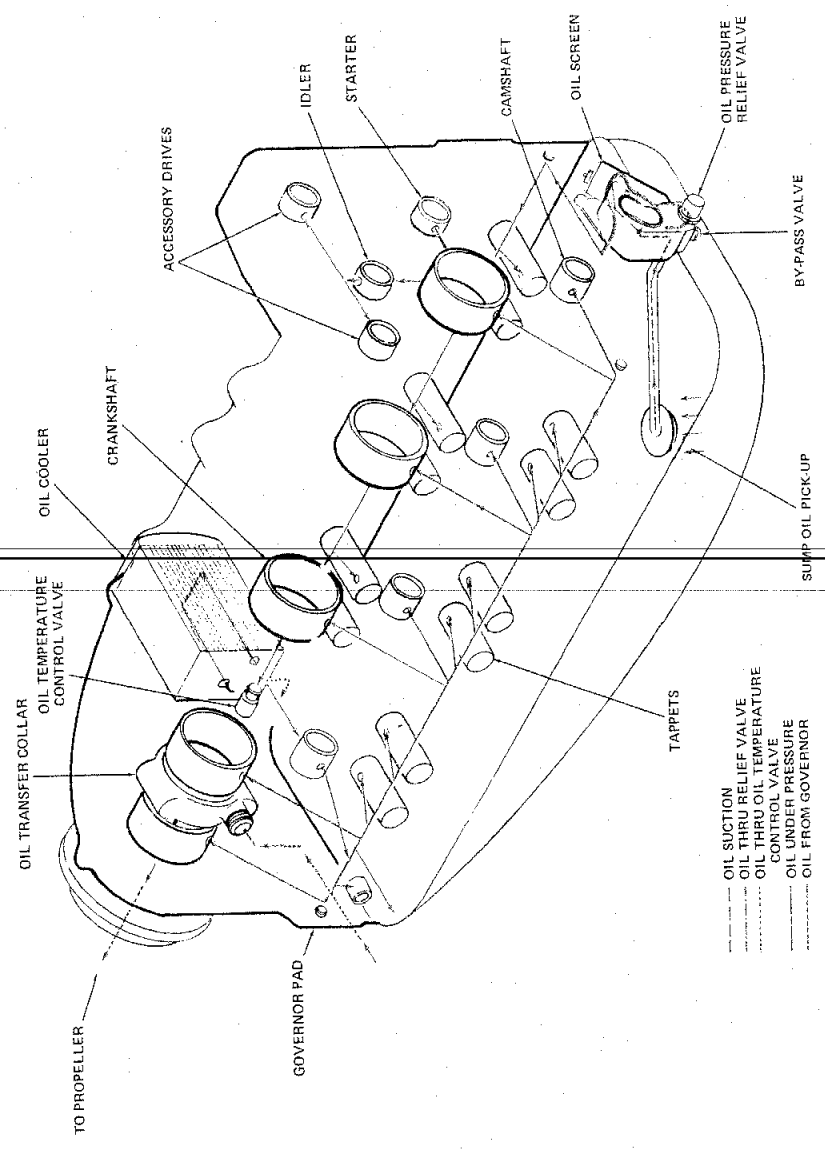


FIG. 23. LUBRICATION SYSTEM (TYPICAL WITH SANDCAST CRANKCASE).

## 6. Fuel System

The fuel injection system is of a 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 relation 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 solid fuel by swirling action. Vapor is returned to the fuel tank. The fuel injector pump forces solid 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 air

throttle valve lever. The mixture control valve is linked to the cockpit mixture control. The fuel control also by-passes excess fuel back to the fuel injector pump inlet port.

The fuel manifold valve contains a diaphragm chamber and necessary outlet ports which connect to the fuel injector lines. The spring-loaded diaphragm works with a ported plunger which distributes the precise amount of fuel, through fuel injector lines, to the fuel injector nozzles in the cylinders. Ambient air is used to vent the nozzles.

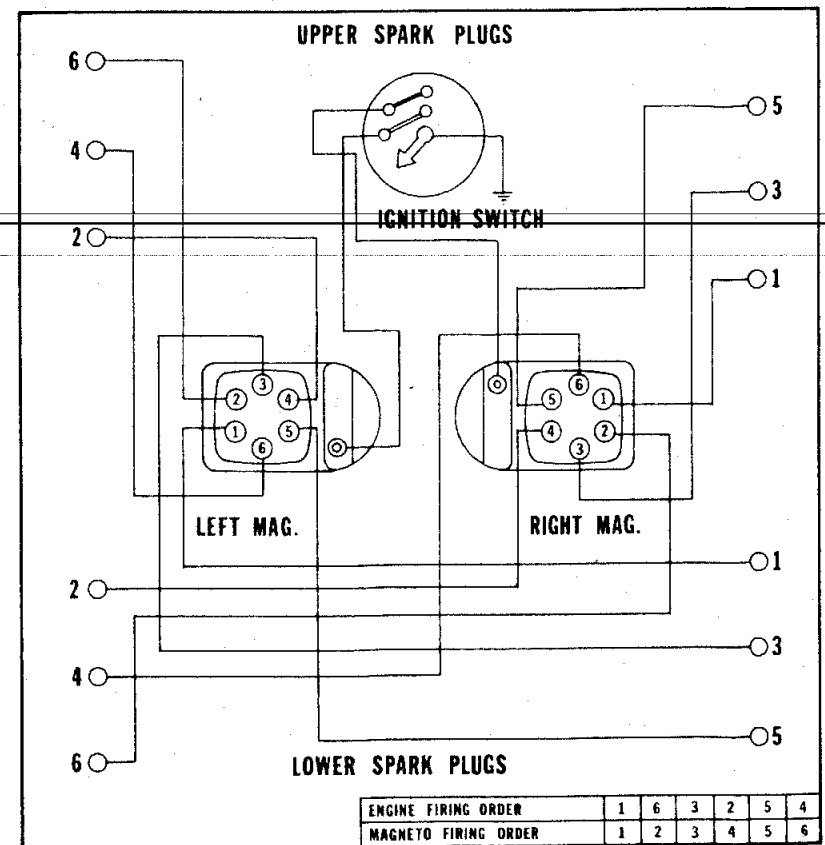


FIG. 24. WIRING DIAGRAM.

## B. OPERATING INSTRUCTIONS

### 1. Before Starting

- a. Perform the daily inspection, page 48.
- b. Make sure that mixture control is in "IDLE CUT-OFF" position and ignition switch is in "OFF" position.
- c. Before starting engine in cold weather, it is recommended that the propeller be rotated by hand to loosen congealed oil surfaces and provide channels in the oil.
- d. Place propeller governor control at limit of "INCREASED RPM" movement.
- e. Open cowling flaps, if any.

### 2. Starting

- a. Open fuel supply line valve to fuel tank (or as instructed by aircraft manufacturer).
- b. Set mixture control to "FULL RICH" position.
- c. Open throttle slightly (See Note 1).
- d. Turn master switch "ON".
- e. Turn ignition switch to "BOTH".
- f. Set auxiliary pump switch "ON" (or as instructed by aircraft manufacturer).

*CAUTION . . . If engine is hot, press starter button first, then turn auxiliary fuel pump switch "ON" (or as instructed by the aircraft manufacturer).*

- g. When fuel pressure gauge shows normal idle pressure (2 to 2.5 psi), engage starter.

*CAUTION . . . Release starter switch as soon as engine fires. Never engage the starter while the propeller is turning. If the starter has been engaged for 30 seconds, and the engine has not started, release the starter switch and allow the starter motor to cool 3 to 5 minutes before another starting attempt is made. Turn auxiliary fuel pump off during cooling period.*

**NOTE 1 . . .** The auxiliary pump delivers a continuous flow of fuel in proportion to the amount of throttle opening and length of time before engaging starter. If the engine is flooded, follow this sequence:

- (1) Turn auxiliary pump "OFF".
- (2) Turn ignition switch "OFF".
- (3) Set throttle "FULL OPEN".
- (4) Set mixture control to "IDLE CUT-OFF".
- (5) ~~Engage starter and crank engine for about 10 seconds to clear cylinders of excess fuel.~~
- (6) Repeat normal engine starting procedure.

- h. After engine is running smoothly, turn auxiliary pump "OFF" (or as instructed by aircraft manufacturer).

- i. Check oil pressure frequently. Oil pressure indication should be noted within 30 seconds in normal weather, and 60 seconds in cold weather. If no pressure is noted within the specified time, stop the engine and investigate the cause.

### 3. Warm Up

- a. 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 pressure oil pump, and to assure adequate lubrication.

- b. 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 take-off position. The minimum allowable oil temperature before take-off run-up speed is 75°F.

*CAUTION . . . Do not run engine at the run-up speed unless oil temperature is 75°F.*

c. Perform all ground operation with cowl flaps, if any, wide open, with mixture control in "FULL RICH" position and propeller governor set for maximum RPM (except for brief testing of mixture and governor controls).

d. Restrict ground operation to the time necessary for warm-up and testing.

e. Increase engine speed to 1700 RPM only long enough to perform the following checks:

(1) Check Magnetos. Due to design changes in today's higher output engines, the comparison of single magneto operation versus both magnetos is no longer a sound criteria for evaluation of magneto performance. Therefore, all magneto checks should be performed on a comparative basis between Right and Left magneto performance.

Move the ignition switch first to "R" position and note engine RPM, then move switch back to "BOTH" position to clear the other set of spark plugs. Then move the switch to "L" position and note RPM. The difference between the two magnetos operated singly should not differ more than 50 RPM.

If no drop in speed is observed when operating on either magneto alone, switch circuit should be inspected for loose connections.

(2) Check throttle and engine tachometer.

(a) Slowly move propeller governor control toward low RPM position and observe effect on tachometer reading. Engine speed should decrease. Return governor control to high speed position.

*CAUTION . . . Do not operate the engine at a speed in excess of 1500 RPM longer than necessary to test operation and observe engine instruments. Proper cooling of engine depends upon forward speed of the aircraft. Discontinue testing whenever temperature or pressure limits are approached.*

(3) Check engine operation. If engine accelerates smoothly, and the oil temperature is above 75°F., with the oil pressure holding steady at some value between 30 and 60 psi, the engine is warm enough for take-off.

#### f. Instrument Indications

(1) Oil Pressure: The oil pressure relief valve will maintain pressure within 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 dirty oil passing the valve.

(2) Oil Temperatures: The oil cooler and vernatherm control valve will maintain oil temperature within the specified range unless the cooler oil passages or air channels are obstructed, or the vernatherm valve is held open by solid particles in the engine oil. Oil temperature above the prescribed limit may cause a drop in oil pressure, leading to rapid wear of moving parts in the engine.

(3) Cylinder Head Temperature: Any temperature in excess of the specified limit may cause cylinder or piston damage. 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 so as to force air between the cylinder fins. Proper cooling also depends on operation practices. Fuel and air mixture ratio also affects cylinder temperature. Excessively lean mixture causes overheating, even when the cooling system is in good condition. Long climbs at low speed, or any low speed flight operation, may cause overheating by reducing the cooling air flow. The engine depends upon the air ram developed by the forward motion of the aircraft for proper cooling.

(4) Battery Charging: The ammeter should indicate a positive charging rate until the power used for starting has been replaced by the battery charging circuit, unless the electrical load on the generator or alternator is heavy enough to require its full output, in which event the ammeter reading should return to the positive side as soon as the load is reduced. A low charging rate is normal after the initial recharging of the battery. A zero reading or negative reading with no battery load indicates leak or malfunction in the generator, alternator or regulator system.

#### 4. Take-Off and Climb

##### a. Take-Off

(1) Set mixture to "FULL RICH" setting (See Note 2.) Where installed, cowl flaps should be in the full open position.

(2) Slowly advance throttle to the full throttle position. The recommended maximum power setting (RPM and manifold pressure) should not be exceeded (5 minute maximum for the IO-520-D, E, F & K).

(3) Set auxiliary pump switch as instructed by aircraft manufacturer (See Note 3).

NOTE 2 . . . For operation from fields at higher altitudes, operation should be conducted with the mixture control leaned for maximum performance as defined by charts in the aircraft manual, or by an appropriately marked fuel pressure gauge. The leaner mixture is required to eliminate engine roughness.

NOTE 3 . . . With high ambient temperature at ground level, a very low fluctuation in metered fuel pressure may appear in the early flight stages, which is caused by excess vapor. Momentary operation of the auxiliary pump will generally eliminate excess vapor.

##### b. Climb

(1) All high power climb, except when operating from high altitude fields, must be done at "FULL RICH" mixture setting with cowl flaps, if provided, in the full open position.

(2) During climb (immediately after take-off), observe manifold pressure, and retard throttle to stay below the 28.8 inch maximum manifold pressure setting (red line).

(3) At reduction from take-off power for climb, follow aircraft manufacturer's recommendation for fuel pressure at power setting used.

#### 5. Cruise

a. Set manifold pressure and RPM for cruise power selected. ~~Reset mixture control for "Best Power Setting".~~

b. After engine temperature has stabilized at cruise condition (usually 5 to 15 minutes of operation), the mixture control may be reset for a "Normal Lean".

NOTE 4 . . . An excessively lean mixture can lead to high cylinder temperatures and detonation which will result in burned pistons, scored cylinders and broken or stuck piston rings.

c. When an economy setting (step b. above) is in use, and a change in power setting is to be made, it is recommended that the mixture control be returned by gauge to approximately "Best Power Setting" before changing the throttle or propeller settings.

d. If it is necessary to retard the throttles at altitudes above 10,000 ft., leaning of the fuel mixture may also be necessary to maintain satisfactory engine operation. The mixture must be returned to the richer setting before the throttle is returned to the high power position.

## 6. Descending and Landing

- a. Set mixture control at "Best Power Setting", or richer, before reducing power for descent.
- b. The mixture control must be set in "FULL RICH" position before entering the airport traffic pattern.
- c. Operate the auxiliary pump as instructed by aircraft manufacturer.

## 7. Stopping Engine

- a. If auxiliary pump has been on in landing, turn "OFF".
- b. Place mixture control in "IDLE CUT-OFF"
- c. Then turn all switches "OFF"

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*CAUTION . . . Do not turn the propeller while the ignition switch is in the "BOTH", "LEFT" or "RIGHT" position, because this could start the engine and cause injury. Do not turn the propeller of a hot engine, even though the ignition switch is in the "OFF" position, because the engine could "kick" as the result of auto-ignition of a small amount of fuel remaining in the engine.*

## C. TROUBLE SHOOTING

The trouble shooting chart which follows discusses symptoms which can be diagnosed and interprets the results in terms of probably causes, and the appropriate corrective action to be taken.

For additional information on more specific trouble shooting procedures, refer to the Maintenance and Overhaul Manual.

All maintenance should be performed by a qualified mechanic. Any attempt by unqualified personnel to adjust, repair or replace any parts may result in damage to the engine.

**WARNING . . .** Operation of a defective engine without a preliminary examination can cause further damage to a disabled component and possible injury to personnel. By careful inspection and trouble shooting such damage and injury can be avoided and, in addition, the causes of faulty operation can often be determined without extensive disassembly.



This trouble shooting chart is provided as a guide. Review all probably causes given, check other listings of trouble with similar symptoms. Items are presented in sequence of the approximate ease of checking, not necessarily in order of probability.

### TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
1. Engine will not start	a. No fuel gauge pressure - No fuel to engine	Check fuel control for proper position, auxiliary pump "ON" and operating, feed valves open. Fuel filters open, and tank fuel level.
	b. Have gauge pressure - engine flooded	Turn off auxiliary pump and ignition switch, set throttle to "FULL OPEN" and fuel control to "IDLE CUT-OFF", and crank engine to clear cylinders of excess fuel. Repeat starting procedure.
	c. Have gauge pressure - No fuel to engine	Check for bent or loose fuel lines. Loosen one line at fuel nozzle. If no fuel shows replace fuel manifold valve.
2. Engine starts but fails to keep running	a. Inadequate fuel to fuel to manifold valve	Set fuel control in "FULL RICH" position, turn auxiliary pump "ON", check to be sure feed lines and filters are not restricted. Clean or replace defective components.
<b>TROUBLE PROBABLE CAUSE CORRECTIVE ACTION</b>		
2. Continued	b. Defective ignition system	Check accessible ignition cables and connections. Tighten loose connections. Replace defective spark plugs.
	3. Engine runs rough at idle	a. Improper idle mixture adjustment b. Fouled spark plugs
4. Engine has poor acceleration	a. Idle mixture too lean	Readjust idle mixture as described in 3-a.
	b. Incorrect fuel-air mixture worn control linkage, or restricted air cleaner	Tighten loose connections, replace worn elements of linkage. Service air cleaner.
	c. Defective ignition system	Check accessible cables and connections. Replace defective spark plugs.
5. Engine runs rough at speeds above idle	a. 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 defective.

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
5. Continued	<p>b. Restricted Fuel Nozzle</p> <p>c. Ignition system and spark plugs defective</p>	<p>Remove and clean all nozzles.</p> <p>Clean and regap spark plugs. Check ignition cables for defects. Replace defective components.</p>
6. Engine lacks power, reduction in maximum manifold pressure or critical altitude	<p>a. Incorrectly adjusted throttle control, "sticky" linkage or dirty air cleaner</p> <p>b. Defective ignition system</p>	<p>Check movement of linkage by moving control from idle to full throttle. Make proper adjustments and replace worn components. Service air cleaner.</p>
	<p>c. Loose or damaged intake manifolding</p>	<p>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.</p>
	<p>d. Fuel nozzles defective</p>	<p>Inspect entire manifold system for possible leakage at connections. Replace damaged components, tighten all connections and clamps.</p> <p>Check for restricted nozzles and lines and clean or replace as necessary.</p>

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
7. Low fuel pressure	<p>a. Restricted flow to fuel metering valve</p> <p>b. Fuel control lever interference</p> <p>c. Incorrect fuel injector pump adjustment and operation</p> <p>d. Defective fuel injector pump relief valve</p>	<p>Check mixture control for full travel. Check for restrictions in fuel filters and lines. adjust control and clean filters. Replace damaged parts.</p> <p>Check operation of throttle control and for possible contact with cooling shroud. Adjust as required to obtain correct operation.</p> <p>Check and adjust using appropriate equipment. Replace defective pumps.</p> <p>Replace pump.</p>
8. High Fuel Pressure	<p>a. Restricted flow beyond fuel control assembly</p> <p>b. Defective relief valve operation in fuel injector</p> <p>c. Restricted re-circulation passage in fuel injector pump</p>	<p>Check for restricted fuel nozzles or fuel manifold valve. Clean or replace nozzles. Replace defective fuel manifold valve.</p> <p>Replace fuel injector pump.</p> <p>Replace pump.</p>

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
9. Fluctuating Fuel Pressure	<ul style="list-style-type: none"> <li>a. Vapor in fuel system, excess fuel temperature</li> <li>b. Fuel gauge line leak or air in gauge line</li> <li>c. Restriction in vapor separator vent</li> </ul>	<p>Normally, operating the auxiliary pump will clear system. Operate auxiliary pump and purge system.</p> <p>Drain gauge line and tighten connections.</p> <p>Check for restriction in ejector jet of vapor separator cover. Clean jet with solvent (only). <b>Do Not Use Wire As Probe.</b> Replace defective parts.</p>
10. Low oil pressure on engine gauge	<ul style="list-style-type: none"> <li>a. Insufficient oil in oil sump, a. oil dilution or using improper grade oil for prevailing ambient temperature.</li> <li>b. High oil temperature</li> <li>c. Leaking, damaged or loose oil line connections - Restricted screen or filter</li> </ul>	<p>Add oil, or change oil to proper viscosity.</p> <p>Defective vernatherm valve in oil cooler; oil cooler restriction. Replace valve or clean oil cooler.</p> <p>Check for restricted lines and loose connections, and for partially plugged oil filter or screens. Clean parts, tighten connections, and replace defective parts.</p>

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
11. Poor engine idle cut-off	<ul style="list-style-type: none"> <li>a. Engine getting fuel</li> </ul>	<p>Check fuel control for being in full "IDLE CUT-OFF" position. Check auxiliary pump for being "OFF". Check for leaking fuel manifold valve. Replace defective components.</p>

## D. INSPECTION AND MAINTENANCE

### 1. General

The following procedures and schedules are recommended for engines which are subjected to normal operation. If the aircraft is exposed to severe conditions, such as training, extreme weather, or infrequent operation, inspections should be more comprehensive and the hourly intervals decreased.

### 2. Daily Inspection

As a precautionary measure, it is advisable to inspect the engine's instruments and control connections before the first flight of each day in order to detect any damage, looseness or other unsafe condition which may have developed during operation, or any condition arising from incomplete maintenance or repair work. This inspection should precede warm-up and ground test, and should be considered a part of the routine job of determining engine condition.

- a. Make sure the throttle can be moved through the full range without binding, slippage or lash.
- b. Check the mixture controls for freedom through the full range.
- c. If the fuel line has a visible trap or sediment bowl, check for water or dirt. Remove and clean as necessary.
- d. Look for leaks in the fuel supply lines wherever they are visible, particularly forward of the firewall.
- e. Inspect the front side of the air filter to make sure it is not obstructed by dust or other foreign matter. The air filter should be inspected daily for:

- (1) cleanliness
- (2) condition of seals and gaskets
- (3) condition of air box and ducting
- (4) air leaks in induction system at any point that would allow unfiltered air into the engine.

The filter should be cleaned as often as it becomes dirty - every day under severe conditions. Service per airframe manufacturer's instructions.

- f. Look for oil leaks at all visible engine connections and for drippings in the lower cowling.
- g. If practical, inspect ignition cables for damage or looseness of parts, particularly at magneto and spark plug terminals. Inspect all visible attaching parts, instrument connections, plugs and electrical wiring for unsafe conditions.
- h. Check for birds nests and straw or debris on fins of cylinders.
- i. Check fuel supply for proper grade (color) and oil gauge rod for oil supply level. Make sure aircraft is in proper attitude when checking oil. Replenish if required.
- j. Check engine instruments or gauges for possible irregularities in performance at various settings. Check manifold pressure gauge, if aircraft is so equipped, for static barometric indication.

### 3. First 50 - Hour Inspection

Perform all services outlined under "Daily Inspection". The following inspections should be made in addition to the above:

- a. Change filter or clean oil screen. Change oil if full flow filter is not used. (See Service Bulletin M73-3, Rev. 1.)

b. Remove and clean air filter with fresh cleaning solvent, or service as indicated by the airframe manufacturer. Inspect for damage. Inspect air scoop and filter retaining parts for cracks and other damage. Replace damaged parts as required. Dip reusable air filter in clean engine oil and allow to drain overnight before reinstalling.

c. Make sure fuel shut-off valve is in "OFF" position. Remove fuel supply line strainer. Clean parts in solvent. Make sure strainer is not obstructed.

d. The fuel injection system normally requires no service other than cleaning the fuel filters. Any trouble will likely be associated with dirt or foreign matter in the system. Refer to Service Bulletin M73-22 for procedures for cleaning the relief valve. Refer to the overhaul manual for other service procedures. In the event that a line or fitting must be replaced, only a fuel soluble lubricant (such as engine oil) may be used on the threads. ~~Do not use any other form of thread compound. If a nozzle is damaged and must be replaced, the replacement nozzle must match the letter/number identification on the hex. It is not necessary to replace nozzles as a set.~~

e. Check all induction system connections for leakage and possible looseness of clamps and attaching hardware. Hoses must not exhibit any signs of deterioration.

f. Check exhaust system for cracks, blown gaskets or stains indicating obvious leaks.

#### 4. Periodic or 100 - Hour Inspection

Perform all services outlined under "Daily Inspection" and "First 50 - Hour Inspection." In addition, perform a more thorough inspection of the engine to detect incipient troubles due to looseness of parts, normal wear, fatigue cracks and obstruction to air flow. Any instance of improper fitting of parts of the engine and engine accessories should be corrected to assure continued

reliable performance and to prevent small troubles from becoming costly repair items.

a. Remove cowling. Clean engine compartment thoroughly before starting the inspection. Remove any dirt and oil to reduce fire hazards and more easily detect oil leakage.

b. Inspect all fuel tubes, gauge tubes and breather tube connectors and supports for security of attachment, abrasion, cracks and other possible damage. Tubes are most likely to crack near end of fittings and at intermediate supports. Check tube grommets at firewall. Repair or replace components as necessary.

c. Differential Pressure Compression Check (refer to Service Bulletin M73-19). The differential pressure tester is designed to check the compression of aircraft engines by measuring the leakage through the cylinders caused by worn or damaged components. The operation of the compression tester is based on the principle that for any given air flow through a fixed orifice, a constant pressure drop across that orifice will result.

The restrictor orifice dimensions for Continental aircraft engines should be a 0.040-inch orifice diameter, 0.250-inch long with a 60° approach angle. (See Figure 25.)

As the regulated air pressure is applied to one side of the restrictor orifice with the air valve closed, there will be no leakage on the other side of the orifice and both pressure gauges will read the same. However, when the air valve is opened and leakage through the cylinder increases, the cylinder pressure gauge will record a proportionally lower reading.

**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 used.

*CAUTION . . . Magnetos and fuel must be shut off prior to test to make certain engine cannot accidentally fire.*

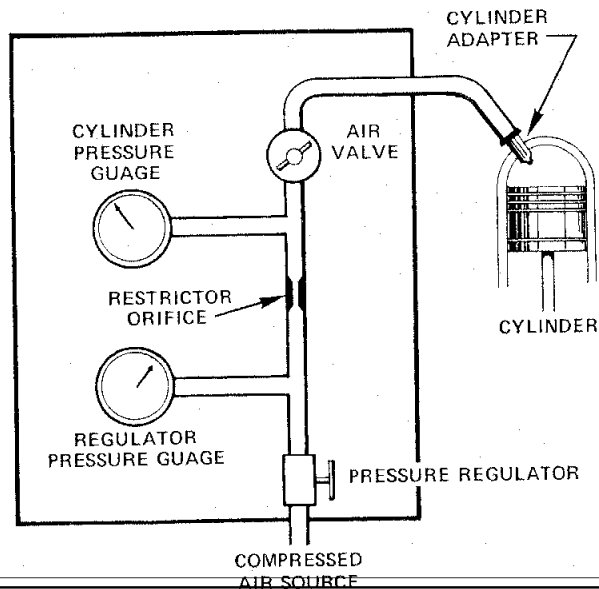


FIG. 25. SCHEMATIC OF COMPRESSION TESTER.

1. Perform the compression test as soon as possible after the engine has been shut down to ensure that the piston rings, cylinder walls and other engine parts are well lubricated.
2. Remove the most accessible spark plug from each cylinder.
3. With the air valve closed, apply an external source of clean air (approximately 100-120 psi) to the tester.
4. Install an adapter in the spark plug bushing and connect the compression tester to the cylinder.
5. Adjust the pressure regulator to obtain a reading of 80 psi on the regulator pressure gauge. At this time, the cylinder pressure gauge should also register 80 psi.
6. Turn the crankshaft by hand in the direction of rotation until the piston (in the cylinder being checked) is coming up on the

compression stroke. Slowly open the air valve and pressurize the cylinder to approximately 80 psi.

*CAUTION . . . Care must be exercised in opening the air 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.*

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 least one-half revolution and start over again to eliminate the affect of backlash in the valve operating mechanism and to keep piston rings seated on the lower ring lands.

7. Open the air valve completely. Check the regulated pressure and adjust, if necessary, to 80 psi.
8. Observe the pressure indication on the cylinder pressure gauges. The difference between this pressure and the pressure shown by the regulator pressure gauge is the amount of leakage through the cylinder. A loss in excess of 25 per cent of the input air pressure is cause to suspect the cylinder of being defective. Operate the engine for at least three minutes to allow for seating of the rings with oil and recheck the readings.
9. The source of air leakage can be determined by listening for the sound of flowing air at the intake, exhaust and crankcase vent.
  - a. Leakage at exhaust signifies a bad exhaust valve or foreign material under the valve face.
  - b. Leakage at intake signifies a bad intake valve or foreign material under the valve face.
  - c. Leakage at the crankcase vent signifies broken, stuck or worn piston rings.

10. If leakage is still occurring after a recheck, 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 between the valve face and seat.

NOTE . . . When correcting a low reading in this manner, rotate the propeller so that 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 engine before rechecking compression to reseat the valves in the normal manner.

d. Inspect engine cylinders and oil cooler fins for obstructions. Remove any dirt with compressed air or flush with cleaning solvent. Make sure that inter-cylinder air baffles are securely attached.

~~e. The recommended oil change interval on engines without full flow filters is every 50 hours of operation, depending on dust, humidity and engine condition, or every six months, whichever comes first. When using the recommended filter, the oil change period may be extended to 100 hours. When using the taller (5.80-inch high) filter, the filter may also be changed at the 100-hour interval. The smaller filter (4.80-inch high) must be changed at the 50-hour inspection period. Inspect and clean oil screens, if applicable, at each oil change. These fine mesh screens filter out carbon and other particles from the lubrication system. New engines frequently exhibit widely dispersed metal flakes and lint on the first few oil changes. If they persist, or if large amounts of metal are apparent on any oil change, it should be investigated thoroughly. (See Service Bulletin M73-3, Rev. 1.)~~

f. Check control connections, levers and linkage for security of attaching parts, for safetying and for wear of pins and bearings. Add a drop of engine oil on each end of the air throttle shaft and at each end of the linkage. No other lubrication is required. Repair or replace defective linkage.

g. Nozzles need only be removed every 300 hours for periodic inspection and cleaning unless a visual inspection reveals damage or green stain indicating plugging has occurred. When necessary to remove the nozzles, a standard half-inch spark plug socket is the correct tool to use. Slosh the nozzle in a cleaning solvent such as lacquer thinner, MEK or acetone. If nozzles are exceptionally varnished, soak in solvent for several hours. Blow nozzles clean with compressed air. Do not attempt to clean with wire or other similar object in an effort to dislodge plugging. If obstruction cannot be removed by soaking and blowing with compressed air, replace the nozzle.

h. Remove, clean, inspect and test all spark plugs. Note the position number as the plugs are removed. Ceramic insulator on center electrode should be slightly brown but not cracked or chipped. Check and adjust the electrode gap (see Service Bulletin M68-4). If electrodes show 50 per cent wear, replace plugs. Before installing the plugs, coat the threads with a film of BG mica thread lubricant or clean engine oil. Rotate the plugs from top to bottom and bottom to top. Install and torque to 300 to 360 inch lbs.

i. If oil pressure has been fluctuating during operation or the oil pressure reading was low, the oil pressure relief valve may be malfunctioning because of dirt. Remove the valve and clean and inspect parts. Inspect seat and plunger face for nicks and scratches and other defects which would affect operation. After reinstalling valve, adjust oil pressure to the 30-60 psi desired range by turning the adjusting screw. Turn screw clockwise to increase pressure and counterclockwise to decrease pressure. Secure adjusting screw with locknut when adjustment has been completed.

j. The spring-loaded oil temperature control valve may malfunction if it becomes contaminated with dirt or foreign particles. Remove the valve and clean in fresh solvent. Inspect seat for possible damage. No repairs or adjustment can be made to this unit. If thermal action is questionable, the travel of the valve may be checked by immersing the assembly in heated water. Valves marked 173° F. should travel a minimum of 0.16-inch as the water

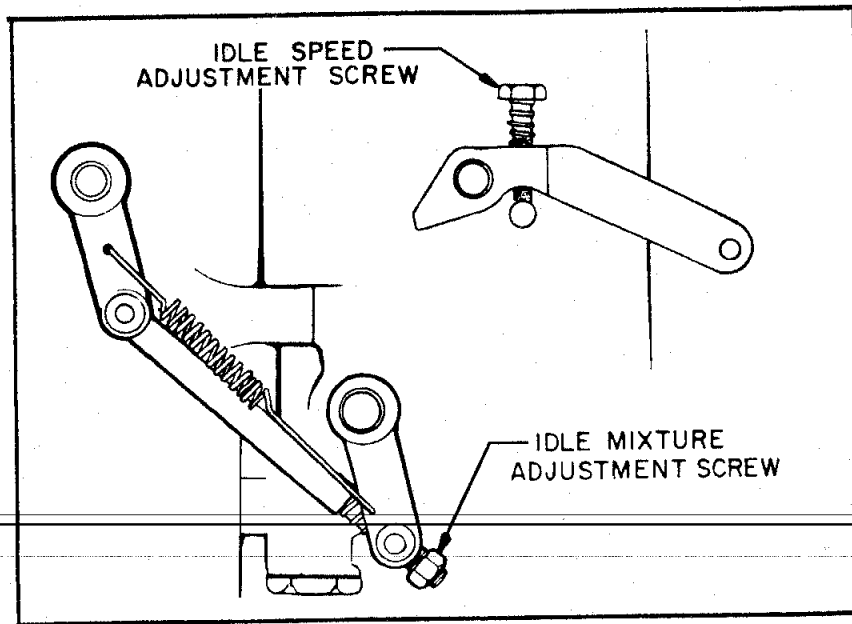


FIG. 26. IDLE ADJUSTMENT POINTS FOR IO-520-A, F, J, K & L.

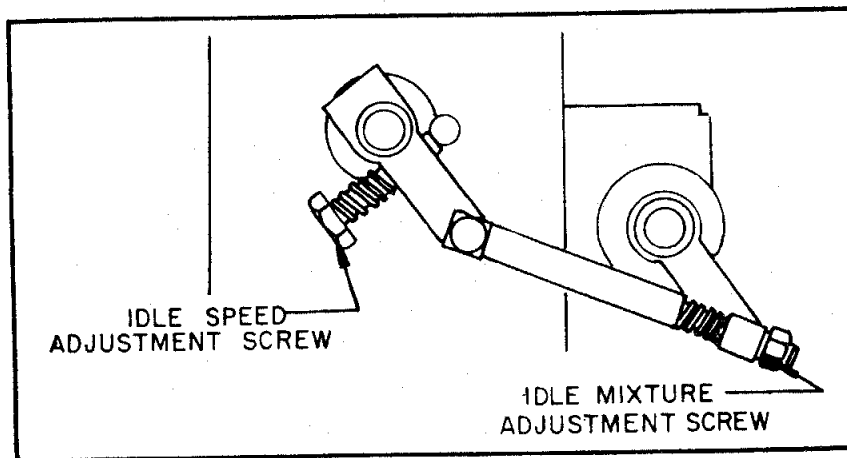


FIG. 27. IDLE ADJUSTMENT POINTS FOR IO-520-B, C, D, E & M.

temperature is raised from 135°F. to 173°F. Valves marked 77c must travel a minimum of 0.09 inch between 120°F. and 170°F. Replace valves which do not pass this test.

k. The idle speed is controlled by a spring-loaded screw located in the air throttle lever. (See Figure 26, 27.) Set to values specified in aircraft handbook by turning in to increase and out to decrease idle speed. The idle mixture is controlled by means of an adjustable link rod. Turn the adjusting nut to the right to enrich and to the left to lean. Current fuel pumps may be adjusted for both idle and full throttle fuel pressure in accordance with Service Bulletin M72-4.

l. Check starter and generator/alternator for security of attaching parts and electrical connections. Check for oil leaks which are indicative of a defective oil seal.

m. Remove rocker covers at the first 100 and each 300 hours thereafter and inspect valve mechanism for defective parts and signs of improper lubrication. All parts should be covered with oil. Apply hand pressure on valve rockers and note if lower end can be depressed, indicating that the valve is defective. Under most conditions, any lash in the valve train indicates a hydraulic tappet is not operating correctly. If, however, the engine is at rest overnight with a valve open, lifter will remain deflated, usually until the engine is operated. Clean and inspect any lifter which functions improperly. If lack of oil caused the lifter to malfunction, check and clean oil holes in pushrod. Replace pushrod housing oil seals if leakage is noted. Always use new gaskets and lockwashers when replacing rocker covers.

n. Before attaching ignition cables to spark plugs, inspect leads and cable terminal parts for cracks and deformation. Magnetos are normally inspected at each 200-hour period unless there is reason to suspect ignition malfunction. The magnetos are in a "SWITCH ON" condition when the switch lead wires are disconnected. Make sure spark plug leads are disconnected before attempting inspection of magnetos. Perform the magneto and engine timing



check as described in Service Bulletin M68-2, Rev. 1, and the applicable overhaul manual.

o. Test the generator/alternator drive belt tension by moving either side up or down. A movement of one-half inch either side of normal indicates correct belt tension. If too loose, correct by shifting the generator outward on its pivot.