OPERATOR'S MANUAL

FUEL INJECTION

PIPER
AIRCRAFT CORPORATION
Lock Haven, Pennsylvania

OPERATORS MANUAL

for

PA-23-250 (Six Place)

AZTEC "B"

PA-24-250

FUEL INJECTION

Piper Aircraft Corporation
Lock Haven, Pa.
U. S. A.

Additional copies of this manual may be purchased by writing to the SERVICE SPARES DEPARTMENT, PIPER AIRCRAFT CORPORATION, Lock Haven, Pennsylvania, 17745, U.S.A.

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FOREWORD

This Operators Manual has been prepared by Piper Aircraft Corporation for operation of the RSA Series Fuel Injection System, manufactured by Bendix Products Aerospace Division of The Bendix Corporation. This manual is provided as a guide to familiarize operators of this fuel injection system, with the proper procedure for operating, etc.

The RSA Fuel Injection System installed in Piper airplanes has been designed and manufactured to provide the minimum in complexity and service. Therefore, proper operation of the system is essential if trouble free service is to be achieved.

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SECTION I

DESCRIPTION

The Bendix RSA Fuel Injection System, which is installed on the Lycoming IO-540-C1B5 engine, consists of four main units: Servo Regulator, Flow Divider, Airbleed Nozzles and Fuel Flow Indicator. Each of these units have additional components which are necessary for their operation.

The Servo Regulator is the unit which is used in place of the carburetor. This unit is a combination of three components in one: Airflow Sensing System, Fuel Control and Servo Regulator.

The Flow Divider is a small cylinder type unit located on top of the engine. The unit has eight ports, one for the fuel supply coming from the Servo Regulator, one for the connection of the Fuel Flow Indicator, and six to which fuel lines for each cylinder are connected.

Airbleed Nozzles, of which there are six, are located in the cylinder head. The nozzles are small cylindrical units and are used for injecting the fuel into the intake port of the cylinders.

The Fuel Flow Indicator, which is a standard size instrument, has been designed to indicate percentage of cruise power, fuel flow in gal. per hour, and the proper leaned mixture for take-off at different altitudes.

The miscellaneous items which complete the system are assortments of flexible hoses, stainless steel tubes, clamps, etc.

• PRINCIPLES OF OPERATION

The RSA Type Fuel Injection System is based on the principle of measuring airflow and using the airflow signals to operate a servo valve. The accurately regulated fuel pressure established by the servo valve, when applied across a fuel control (jetting system), makes fuel flow proportional to airflow.

Fuel pressure regulation, by means of a servo valve, necessitates only a minimum fuel pressure drop through the entire metering system. This makes it possible to maintain metering pressure above vapor forming conditions, and at the same time does not require a high inlet fuel pressure, therefore eliminating the need for an expensive pressure pump. An inherent feature of the Servo System is self-purging, which eliminates any possibility of vapor lock and the associated problem of difficult starting.

The Airflow Sensing System, which is incorporated in the Servo Regulator, consists of the throttle body containing the throttle valve and venturi. The differential pressure between the entrance and the throat of the venturi is a measurement of air entering the engine. These pressures are applied to an air diaphragm in the Servo Regulator to create a force across the diaphragm. A change in power will change the airflow to the engine which in turn will change the force across the air diaphragm in the Servo Regulator.

The air diaphragm in the Servo Regulator converts the airflow measuring signals into an air metering force. Fuel inlet pressure is applied to one side of the fuel diaphragm and the pressure of the fuel, after it passes through the fuel control (metered fuel pressure), is applied to the other side of the diaphragm. This creates a force across the diaphragm which is referred to as fuel metering force. Relatively low airflow signals develop high fuel metering forces by virtue of the diaphragm areas selected. The requirement for low airflow signals makes possible the use of a relatively large venturi which keeps engine induction system air losses to a minimum. During idle operation when air intake is too small to create pressure differential required for operation of the diaphragm, a constant head idle spring is used to operate the diaphragm and supply the required fuel for idle.

The fuel control system which is also incorporated in the Servo Regulator consists of an inlet fuel screen, a rotary idle valve and a rotary mixture control valve. The idle valve is adjustable to obtain good idling characteristics without effecting metering at higher power settings. The mixture control valve gives full rich mixture on one stop and a progressively leaner mixture as it is moved toward the idle cut-off stop. The setting incorporated in the fuel control system is worked out to meet the engine requirement for all power settings without compromise. The full rich stop defines sea level requirements, and the mixture control provides altitude leaning.

The Flow Divider, which is mounted on top of the engine, is provided as a fuel distributor point. Six individual lines are connected to the flow divider, then routed to the cylinders. The Flow Divider contains a spring loaded positive shut-off valve and is ported to accurately divide fuel flow to the nozzle lines.

Located in each cylinder are the airbleed nozzles. The continuous flow airbleed nozzles incorporate provisions to eliminate the adverse effect of low manifold pressure at idle. Through this, lines can be maintained full of fuel to provide good distribution and acceleration characteristics. Actual fuel metering is provided by the Servo Regulator, not the nozzles, which permits leaner operation for economy and longer engine life due to uniform cylinder head temperatures.

Installed in the instrument panel is the Fuel Flow Indicator. This instrument is connected to the Flow Divider and is designed to give an accurate indication of fuel flow in gal. per hour, percentage of cruise power, and the proper leaned mixture for take-offs at different altitudes.

SECTION II

OPERATING INSTRUCTIONS

Operating the Bendix RSA Fuel Injection System, installed on the IO-540-C1B5 Lycoming engine, will differ very little from the carburetor system with the exception of starting. The following information is provided as a guide for proper operation of the system.

STARTING ENGINE WHEN COLD

1. Open throttle approximately 1/2 inch.
2. Turn on master switch and electric auxiliary fuel pump.
3. Move mixture control to full rich until an indication on the fuel flow meter. (Engine is primed.)
4. Move mixture control to idle cut-off.
5. Ignition switches on and engage starter.
6. When engine fires advance mixture control to full rich. If engine does not fire within 5-10 seconds, disengage starter and reprime.

STARTING ENGINE WHEN HOT

1. Throttle open approximately 1/2 inch.
2. Mixture in idle cut-off.
3. Electric auxiliary fuel pump off.
4. Engage starter. When engine fires advance mixture.

STARTING ENGINE WHEN FLOODED

1. Throttle full open.
2. Mixture in idle cut-off.
3. Electric auxiliary fuel pump off.
4. Engage starter. When engine begins to fire, advance mixture and retard throttle.

Electric fuel pump on for take-off.

Starter manufacturers recommend that cranking periods be limited to ten to twelve seconds with a five minute rest between cranking periods. Longer cranking periods will shorten the life of the starter.

ALTERNATE AIR SYSTEM

Alternate air sources are incorporated on both the PA-24-250 and PA-23-250 (six place) to provide air flow to the engine in case the normal flow of air through the filters is restricted. The alternate air doors in both installations are spring loaded, and will remain closed during normal operation. In case of normal air flow restriction the suction from the engine will open the doors. On the PA-23-250 (six place) a mechanical linkage, operated by push-pull controls located on the control pedestal are provided to manually open the alternate air doors.

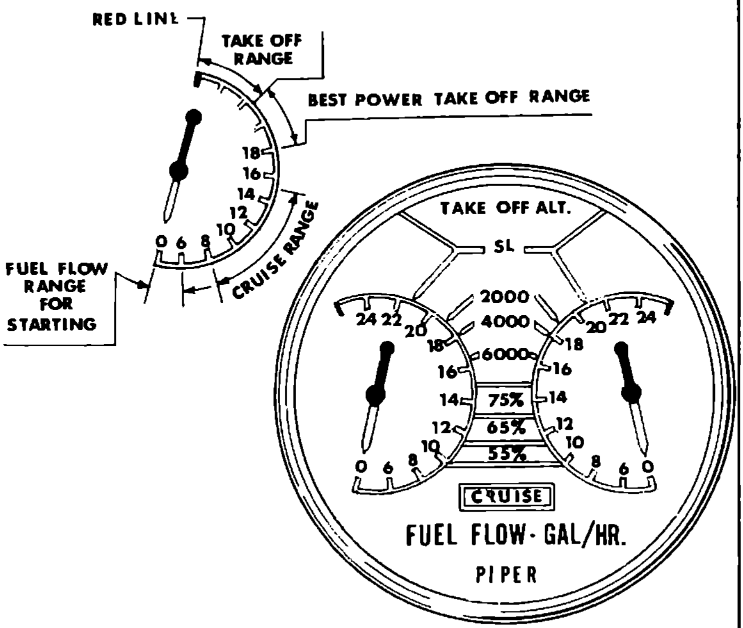
TAKE-OFF

During the pre-take-off check turn the auxiliary pump off and check that the engine driven pump is operating by noting if fuel flow is maintained.*Switch the auxiliary pump on for take-off.

During a normal take-off with full power at 2575 RPM and full rich mixture the pointer on the fuel flow meter will stabilize between the sea level mark and the red line. This setting gives a slightly rich mixture to aid in fuel cooling the engine and is recommended for all normal take-offs at sea level.

When taking off from a high altitude field, (example 4,000 feet), the mixture should be leaned to obtain maximum power. This is done during the pre-take-off check. Apply full throttle, then move mixture control towards the lean position until the fuel flow pointer has stabilized at the 4,000 foot mark, located between the 18-1/2 and 19 gallon marks. Leave the mixture in this position and proceed with the take-off. This same procedure can be used at sea level to obtain maximum power except the fuel flow pointer must be stabilized at the sea level mark. Caution should be used when operating at sea level with the mixture leaned so that the engine is not overheated.

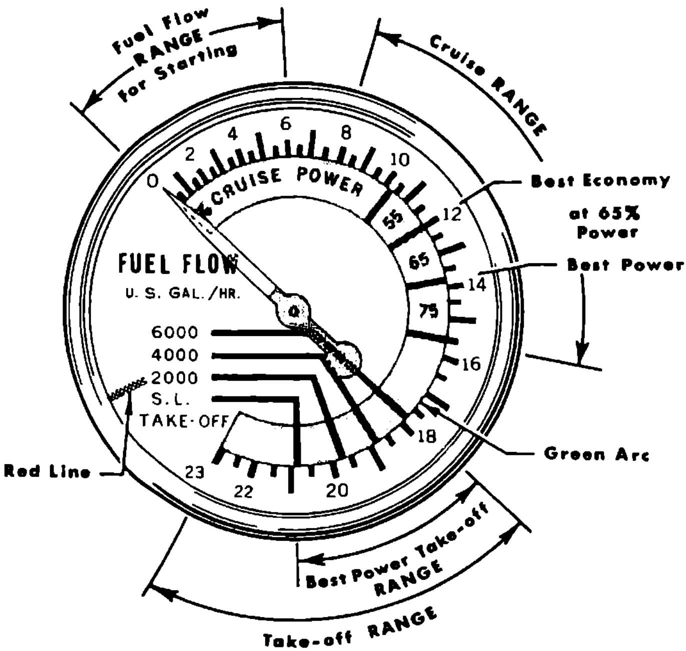
*When desired altitude is reached, auxiliary fuel pump(s) may be turned off.



READING THE

FUEL FLOW INDICATOR

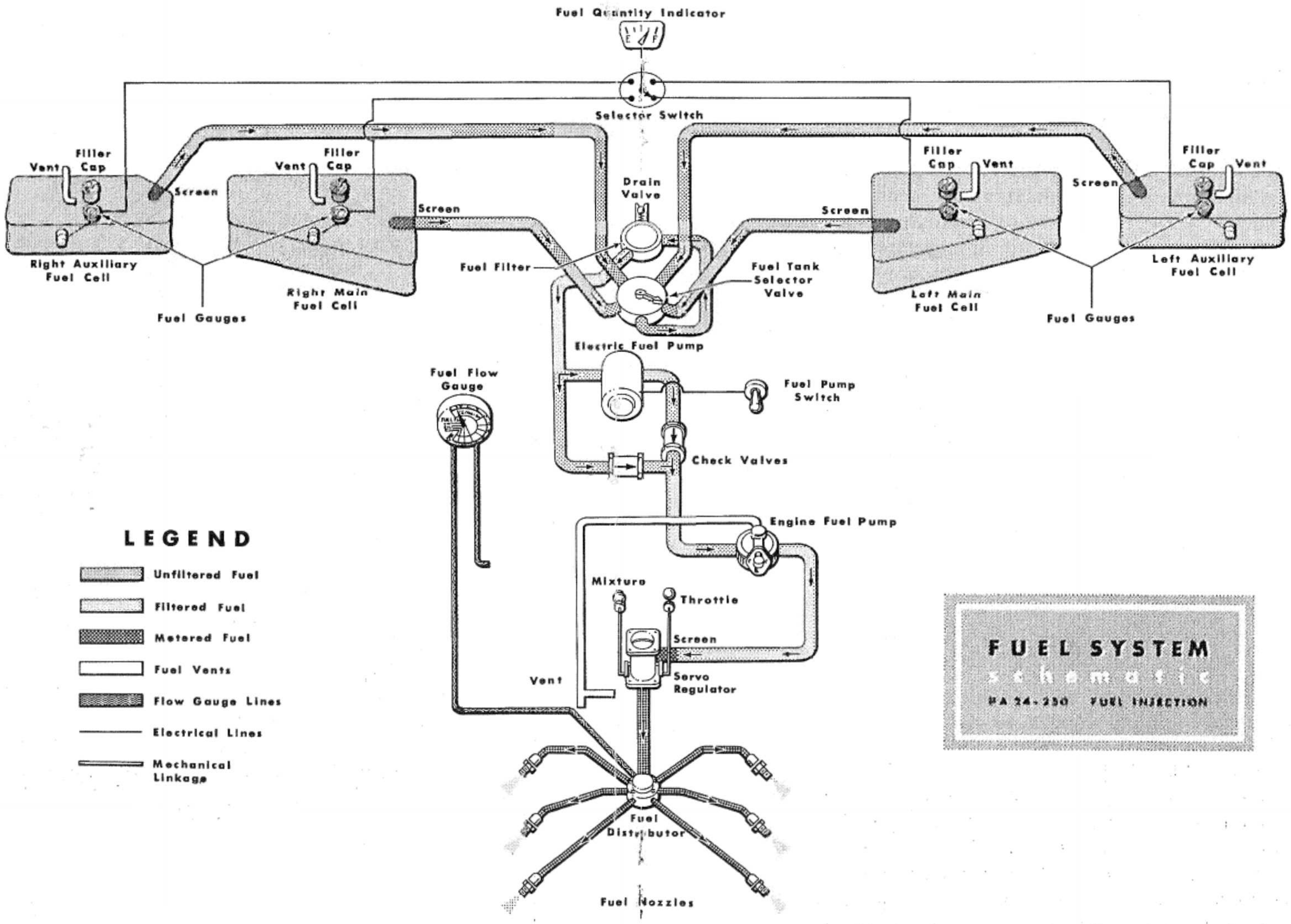
PA-23-250 (Six Place) AZTEC "B"



Reading the

FUEL FLOW INDICATOR

PA-24-250


Fuel Quantity Indicator
Selector Switch
Filler Cap
Vent
Screen
Right Auxiliary Fuel Cell
Right Main Fuel Cell
Fuel Gauges
Drain Valve
Fuel Filter
Fuel Tank Selector Valve
Left Main Fuel Cell
Left Auxiliary Fuel Cell
Electric Fuel Pump
Fuel Flow Gauge
Fuel Pump Switch
Check Valves
Engine Fuel Pump
Mixture
Throttle
Screen
Servo Regulator
Vent
Fuel Distributor
Fuel Nozzles
LEGEND
Unfiltered Fuel
Filtered Fuel
Metered Fuel
Fuel Vents
Flow Gauge Lines
Electrical Lines
Mechanical Linkage
FUEL SYSTEM
schematic
PA 24-250 FUEL INJECTION

POWER SETTINGS

Incorporated in this manual are power charts from which power settings may be derived for varying altitudes and temperatures.

To obtain the desired power set the manifold pressure and RPM according to the power setting table in this manual. After the desired power settings have been set up, adjust the mixture control for corresponding best power setting as indicated by the fuel flow meter. The low side of the power setting as shown on the fuel flow meter, indicates best economy for that percent of power while the high side indicates best power.

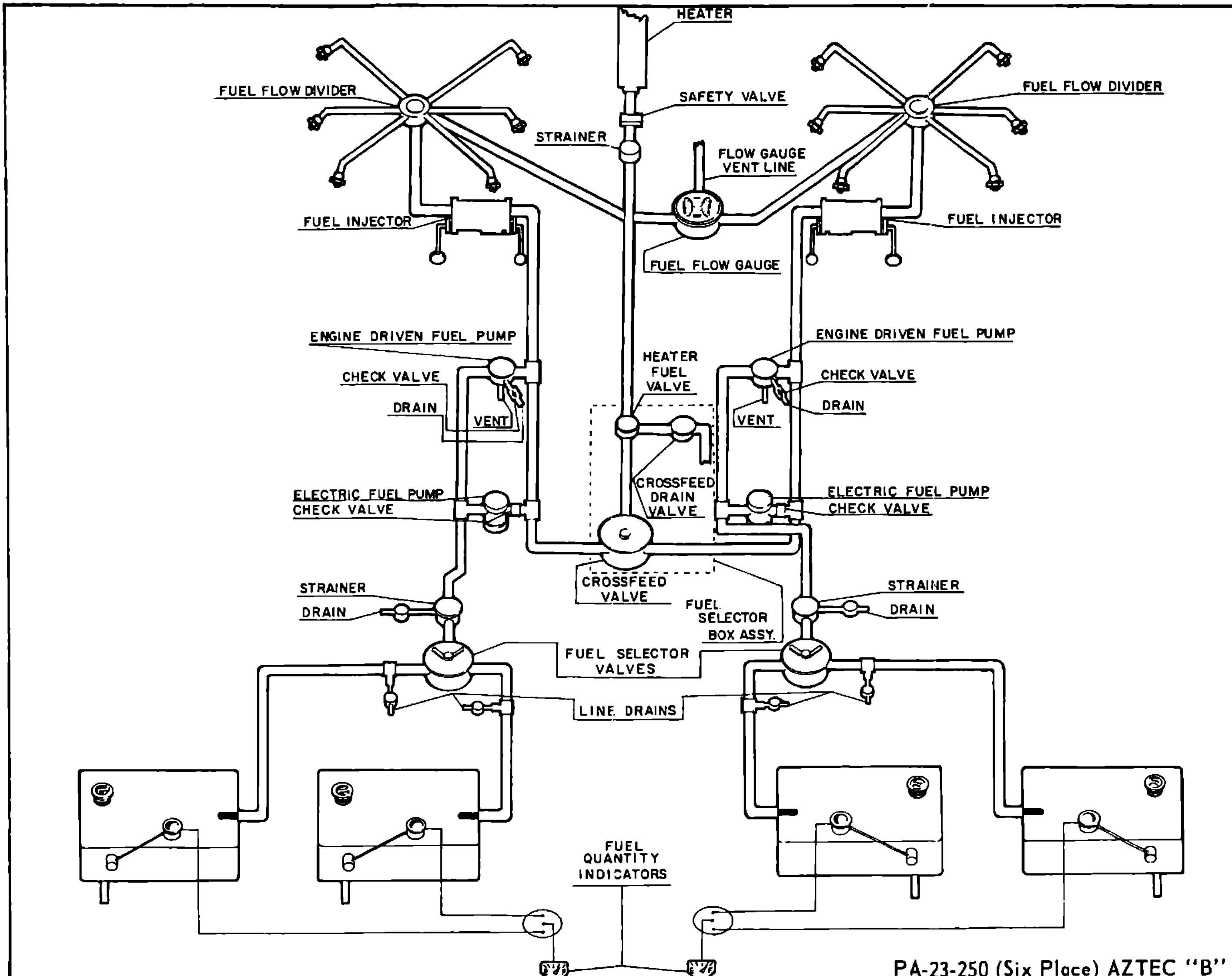
During climbing operation the servo regulator will sense the change in altitude and will automatically lean the mixture. Manual leaning with the mixture control can also be accomplished if desired.

DESCENDING AND LANDING

While descending, the mixture control setting can remain in the cruise configuration as the servo regulator will automatically richen the mixture as altitude is lost. During the prelanding check it is recommended that the mixture control be moved to the rich position.

NOTE

The servo regulator will sense altitude and temperature effects enough so that the engine will operate at 10,000 feet altitude with the mixture control full rich. If the mixture is leaned at this altitude and the aircraft is brought down to sea level, with the leaned setting, the engine will still function if full throttle is applied.

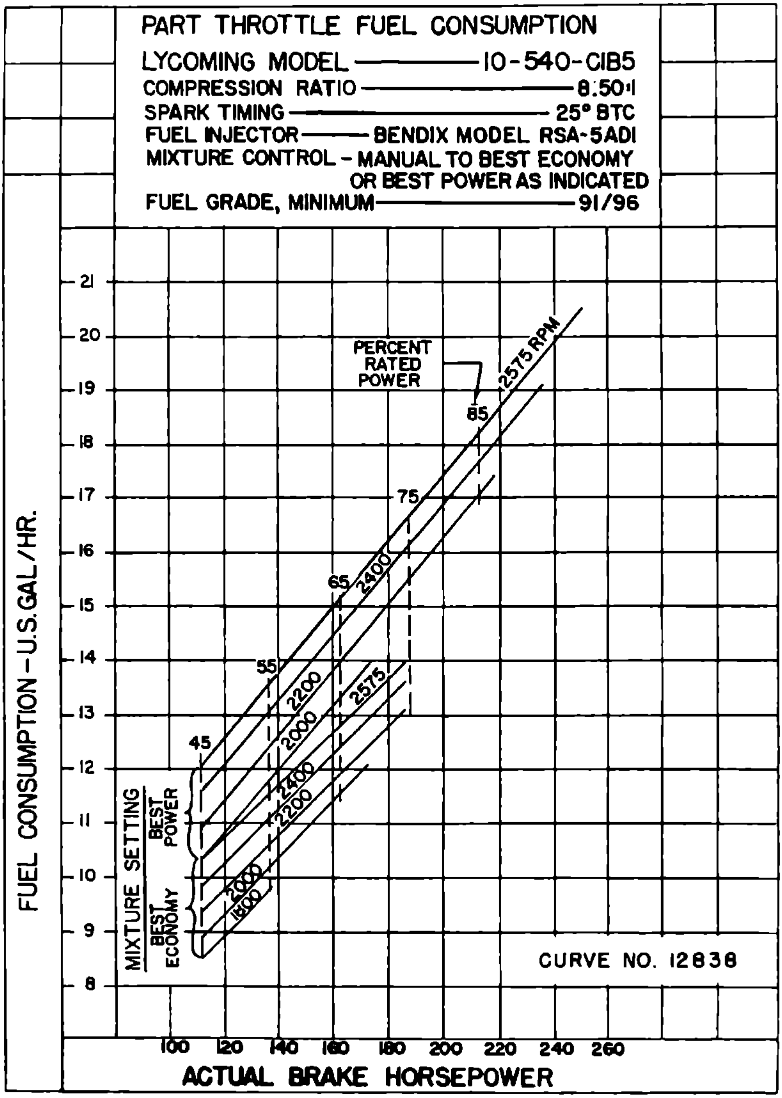


PA-23-250 (Six Place) AZTEC "B"

Power Setting Table-Lycoming Model IO-540-C1B5, 250 HP Engine

Press. Alt. 1000 Feet	Std. Alt. Temp. °F	138 HP - 55% Rated RPM AND MAN. PRESS.				163 HP - 65% Rated RPM AND MAN. PRESS.				188 HP - 75% Rated RPM AND MAN. PRESS.		
		2100	2200	2300	2400	2100	2200	2300	2400	2200	2300	2400
SL	59	21.9	21.0	20.2	19.6	24.6	23.5	22.7	22.0	26.2	25.2	24.4
1	55	21.7	20.8	20.0	19.4	24.4	23.3	22.5	21.8	25.9	25.0	24.1
2	52	21.4	20.6	19.8	19.2	24.1	23.0	22.2	21.5	25.6	24.7	23.9
3	48	21.2	20.3	19.6	19.0	23.8	22.8	22.0	21.3	25.3	24.5	23.6
4	45	20.9	20.1	19.4	18.8	23.6	22.5	21.8	21.1	25.0	24.2	23.4
5	41	20.7	19.9	19.2	18.6	23.3	22.3	21.5	20.9	FT	24.0	23.1
6	38	20.5	19.6	19.0	18.4	23.1	22.0	21.3	20.7	---	FT	22.9
7	34	20.2	19.4	18.8	18.2	22.8	21.8	21.1	20.4	---	---	FT
8	31	20.0	19.2	18.5	18.0	FT	21.5	20.8	20.2	---	---	---
9	27	19.8	18.9	18.3	17.8	---	FT	20.6	20.0			
10	23	19.5	18.7	18.1	17.6	---	---	FT	19.8			
11	19	19.3	18.5	17.9	17.4	---	---	---	FT			
12	16	FT	18.2	17.7	17.2	---	---	---	---			
13	12	---	FT	17.5	17.0							
14	9	---	---	FT	16.8							
15	5	---	---	---	FT							

To maintain constant power, correct manifold pressure approximately 0.17" Hg. for each 10° F variation in carburetor air temperature from standard altitude temperature. Add manifold pressure for air temperatures above standard; subtract for temperatures below standard.


PART THROTTLE FUEL CONSUMPTION
LYCOMING MODEL ———— IO-540-CIB5
COMPRESSION RATIO ———— 8.50:1
SPARK TIMING ———— 25° BTC
FUEL INJECTOR ———— BENDIX MODEL RSA-5ADI
MIXTURE CONTROL - MANUAL TO BEST ECONOMY OR BEST POWER AS INDICATED
FUEL GRADE, MINIMUM ———— 91/96
PERCENT RATED POWER
45
55
65
75
85
2575 RPM
2400
2200
2000
2575
2400
2200
2000
1800
MIXTURE SETTING
BEST POWER
BEST ECONOMY
CURVE NO. 12838
FUEL CONSUMPTION - U.S. GAL/HR.
8
9
10
11
12
13
14
15
16
17
18
19
20
21
100
120
140
160
180
200
220
240
260
ACTUAL BRAKE HORSEPOWER

STOPPING ENGINE

To stop the engine move the mixture control to idle cut-off. Then turn off all switches after thc engine has ceased to run.

OPERATING TIPS

In operating the Fuel Injector, as in that of any other system, there are a few points of technique and information that apply particularly to this system. The following operating tips may be helpful in the operation of the fuel injection system.

1. During the starting sequence the throttle must be open 1/2" or more to get a fuel flow indication when the mixture is full rich and the auxiliary fuel pump is turned on.

2. Remember that raw fuel is injected into the engine whenever the throttle is open, the mixture is full rich, and the auxiliary fuel pump is on.

3. Check engine driven pump for operation during run-up by switching auxiliary pump off and noting fuel flow is maintained. Leave auxiliary fuel pump on for take-offs and landings.

4. In some instances on the PA-24 the pointer on the fuel flow meter will move up the scale after the airplane has set over night or a longer period of time. This is caused by the attitude of the airplane and should cause no concern.

5. As this Fuel Injection System does not require a fuel return line to the fuel cells, fuel from any cell can be used first with the exception of take-off and landing on the PA-24-250 when fuel from the mains must be used.

6. A high fuel pressure indication on the fuel flow indicator is a possible indication of restricted airbleed nozzles. (Refer to Section III for Cleaning Procedures.)

7. Variations of indicated fuel flow between engines will be normal under specific conditions. At full throttle, full rich operation tolerance of up to 14% may exist. This is due to normal tolerance of the engine, injector unit, and fuel flow gauge. Therefore the following tolerances are acceptable for indicated fuel flow between engines.

Sea level, full throttle, full rich	3 GPH
6000 feet, full throttle, full rich	2.5 GPH

SECTION III

INSPECTION

When service is required on the Bendix RSA Fuel Injection System it is recommended the aircraft be taken to an Authorized Piper Distributor or Dealer to have the maintenance accomplished.

The following information is provided as a guide for regular inspections and minor adjustments.

* INSPECTION

In general, little attention is required between injector overhauls. However, it is recommended that the following items be checked during inspections of the engine.

1. Check tightness and lockwire of all nuts and screws which fasten the injector to the engine.
2. Check all fuel lines for tightness and evidence of leakage. A slight fuel stain adjacent to the airbleed nozzles is not cause for concern.
3. Check throttle and mixture controls for tightness and safeties.
4. Remove and clean the injector fuel inlet strainer at the first 25 hour inspection and each 50 hour inspection thereafter. Damaged strainer "O" rings should be replaced.

* ADJUSTMENTS: IDLE SPEED AND MIXTURE

1. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal.
2. Check magnetos in accordance with instructions in the aircraft owners handbook. If the magneto check is normal, proceed with idle adjustment.
3. Close the throttle to idle (approximately 550 to 600

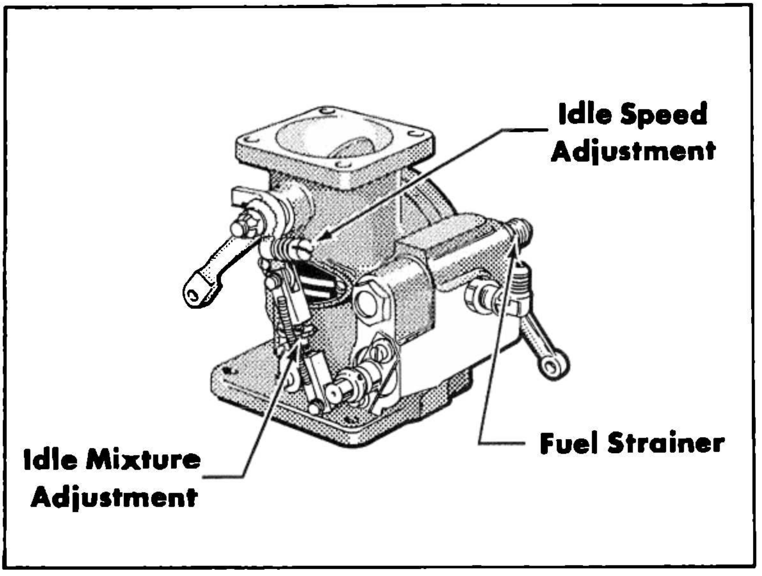
RPM). If the RPM changes appreciably after making idle mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

NOTE

The idle mixture should be set with the propeller in full low fixed pitch. Also, the auxiliary fuel pump must be operating when making the following adjustments.

4. When the idling speed has been stabilized, move the mixture control lever with a smooth, steady pull, into the "IDLE CUT-OFF" position and observe the tachometer for any change during the "leaning out" process. Caution must be exercised to return the mixture control to the "FULL RICH" position before the RPM can drop to a point where the engine cuts out. An increase of 25 RPM while "leaning out" indicates the idle mixture is to the rich side of best power. An immediate decrease in RPM (if not preceded by a momentary increase) indicates that the idle mixture is to the lean side of best power. The same indication of idle mixture is obtained by watching the manifold pressure gauge. If the manifold pressure holds steady momentarily then rises as engine speed decreases, the idle mixture is at or below best power. If the manifold pressure drops, then rises while "leaning out", the idle mixture is to the rich side of best power. The idle mixture should be adjusted as per figures in step (5). Too lean an idle mixture could cause a slight hesitation on fast acceleration.

5. If steps (3) and (4) indicate that the idle adjustment is too rich or too lean, turn the idle mixture adjustment one or two notches as indicated by arrow on mixture adjustment linkage, and check by repeating steps (3) and (4). Make additional adjustments as necessary until a check with step (3) and (4)



results in a momentary pick-up of approximately 25 RPM.

6. Each time an adjustment is changed, clear the engine by running it up to approximately 2000 RPM before making mixture check (steps (3) and (4).

7. Make the final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle.

8. If the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions upon idling adjustment. The relation of the airplane to the direction of the prevailing wind will have an effect on the propeller load and thus on its RPM; hence, it is advisable to make the idle setting with the airplane cross-wind.

9. Idle speed and mixture adjustments made according to the above method should require very little further attention except for extreme variations in temperature and altitude.

* STORAGE

If it is known that an airplane is going to be taken out of service for an extended period, it is recommended that the fuel section of the injector be completely drained of all fuel. Install drain plugs and connect on oil supply line to the fuel inlet and inject oil into the injector at 5 psi. The oil must be Grade 1010 conforming to Aeronautical Specification No. MIL-O-6081. Continue pumping oil to the injector until oil flows from the nozzles, insuring that the injector is completely filled.

If practical, the following alternate method can be used for short storage periods. Instead of oil flushing the injector, the fuel system may be pressurized every 7 to 10 days. This is accomplished by placing the mixture control in rich and moving the throttle to half open position, then momentarily operating the boost pump until fuel starts to flow from the nozzles. Return mixture control to idle cut-off and close throttle. This will insure that the injector is completely filled with fuel.

* LUBRICATION

There is very little need for lubrication of the injector in the field between regular overhauls. However, the clevis pins used in connection with the throttle and manual mixture control levers should be checked for freedom of movement and lubricated, if necessary, as directed in the owner's handbook.

Add a drop of engine grade oil on the end of the throttle shaft in such a manner that it can work into the throttle shaft bushings.

CAUTION

Extreme caution should be exercised when handling or working around the injector to prevent foreign matter from entering the injector. Fluid can easily enter the air section of the injector through the annular groove around the venturi or the impact tubes. For this reason, some protection plate should be installed on the scoop mounting flange when performing routine maintenance on the engine, such as washing down the engine and air scoop, or when injecting preservative into the engine prior to storing or shipping.

CLEANING AIRBLEED NOZZLES

To clean the airbleed nozzles remove them from the engine and immerse in any suitable cleaning solvent. Dry with compressed air. Do not use wire or other object to remove restrictions from nozzles.

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