APPENDIX K

Supplemental Instructions for Airflow Performance

FM-100A

FM-150

FM-150L

FM-200A

FM-300B

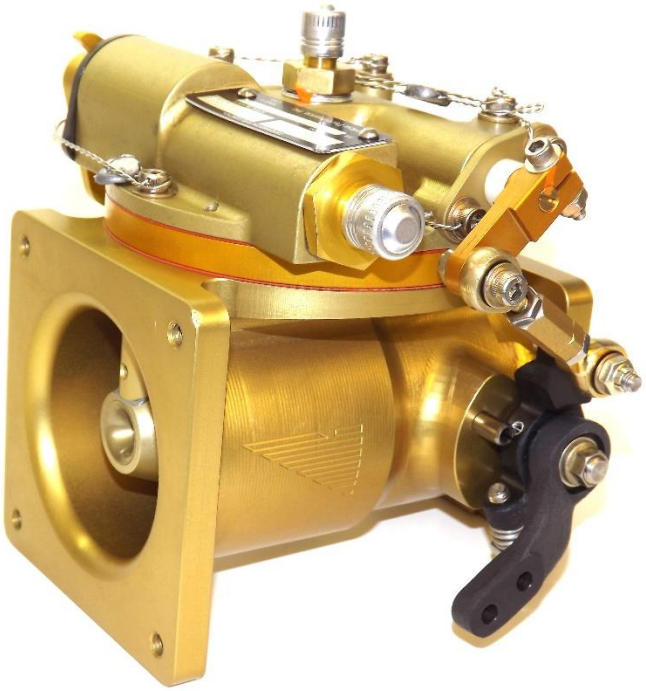
FM-R Series

Experimental Fuel Control Units

INTRODUCTION

The following fuel control units operate on the same principle as all FM-series fuel control units. The fundamental difference these units have is the incorporation of a different designed mixture control valve. This mixture control gives very low leakage in ICO (0.0 to 8 cc/min) by effectively shutting both the metered and unmetered fuel passage to the fuel regulator section. A stainless steel plate valve running against a hard coated aluminum port bushing is used to accomplish this.

The FM-150 throttle body has the same mounting flange interface, and overall length as the Bendix RSA-5 or Precision Silver Hawk servos. The FM-150 fuel control can run engines from 150 to 260 HP.

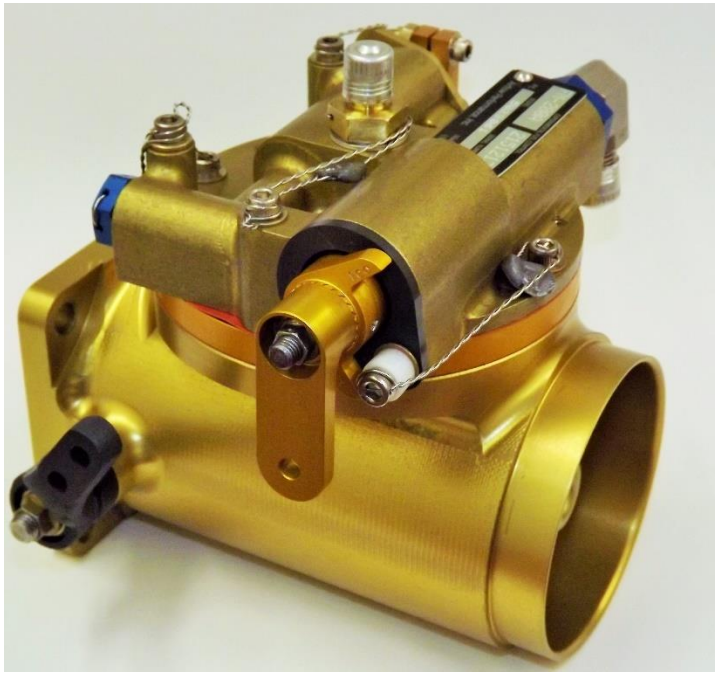


FM-150 Fuel Control

FM-150L Fuel Control

The FM-150L is a light weight version of the FM-150. This throttle body incorporates a round flange inlet with the throttle body being approximately 0.25" shorter than the FM-150. It weighs 4.1 lbs., approximately 1 lb. lighter than the Precision Silver Hawk servo. The FM-150L fuel control can run engines from 150 to 260 HP.

INTRODUCTION



The FM-100A, FM200A and FM-300B incorporates the standard FM 100, 200 and 300 throttle body assembly while using the FM-150 regulator.

Unless otherwise noted in this Appendix refer to the main manual for all installation, adjustments, troubleshooting and maintenance.

NOTE

ALL PICTURES ARE FOR REFERENCE ONLY

SECTION 1

DESCRIPTION AND PRINCIPLES OF OPERATION

1.1. GENERAL

The FM-series fuel injection system is comprised of three basic components, a fuel metering servo, a flow divider and fuel nozzles (a nozzle in each cylinder intake port). This fuel metering system operates on a proven principle of delivering fuel in proportion to the amount of air consumed by the engine.

Figure 1.1 FM-150 Fuel System

1.2. SYSTEM DESCRIPTION

Refer to Section 1 of the manual.

1.3 MANUAL MIXTURE CONTROL

The manual mixture control valve produces a full rich condition when the lever is against the full rich (R) stop. A progressively leaner mixture is attained as the lever is moved to the "ICO" (idle cut-off) position. Moving the mixture control lever to the ICO position will effectively shut off fuel flow and stop the engine. However, the manual mixture control is not an absolute fuel shut off valve. Three to eight cc/min "leakage" is typical in the idle cut off position.

SECTION 2

INSTALLATION

2.1. FUEL PRESSURE

Typical fuel inlet pressure requirements for normal operation are 20-40 PSI. The fuel control is capable to operate at fuel pressure in the 20-80 PSI range. Maximum inlet pressure is 90 PSI.

2.2. FUEL PRESSURE GAUGE

Fuel pump output pressure is an important parameter to monitor. There are no provisions on the fuel control to pick up inlet fuel pressure. On most installations inlet fuel pressure can be measured at the outlet of the engine driven fuel pump.

2.3. FUEL FILTRATION

These fuel controls incorporate a 70 to 75 micron nominal rated composite fuel filter which can be removed for cleaning by removing the inlet fitting. This is a-relieving filter. The inlet filter fitting can be either a straight (shown) or 90-degree fitting. Cleaning the filter element is best performed in a sonic cleaner with soap and water. Blow dry with compressed air.

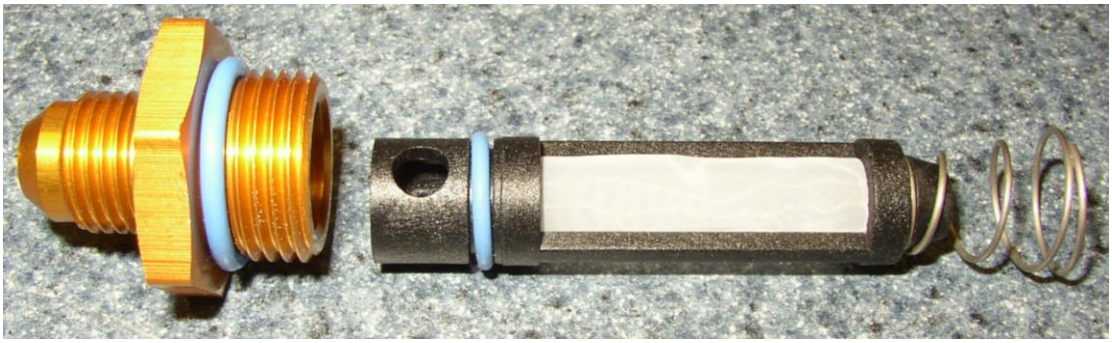


Figure 2.2 Fuel Inlet Filter

2.4. FUEL INLET FITTING

Fuel inlet fittings are –6 AN.

Figure 2.3
Fuel Inlet Fitting

Fuel Inlet Fitting
#6 Hose Connection
Torque hose connection
to 30-40 in.-lbs.

2.5. METERED FUEL OUTLET FITTING

The metered fuel outlet is –4 AN type fitting. It has been lock wired and sealed. This is a calibration adjustment and part of the fuel regulator. DO NOT REMOVE THE FITTING as this will effect calibration and proper operation of the fuel injection unit.

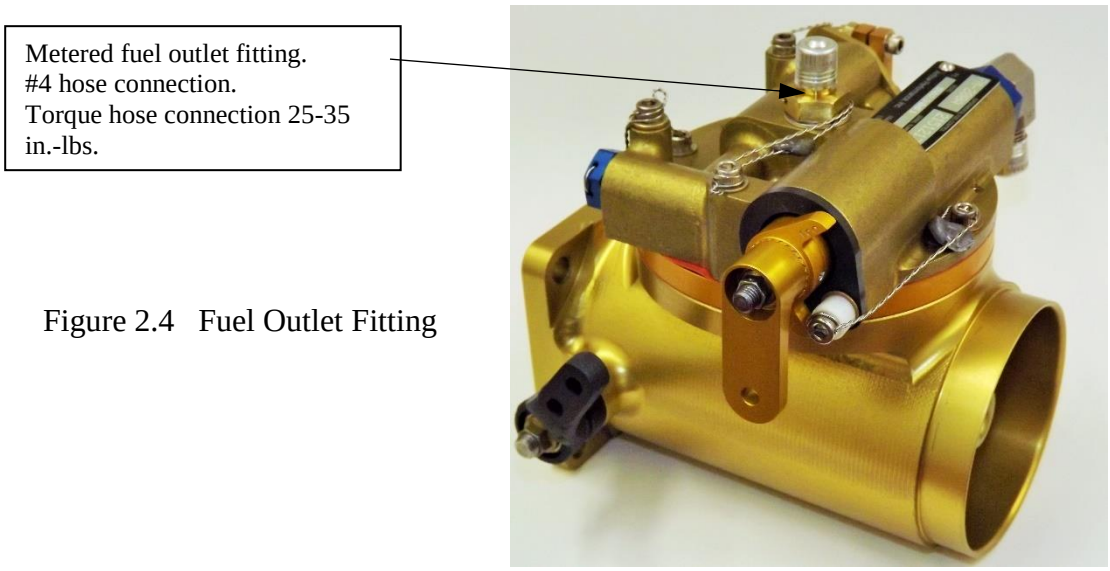
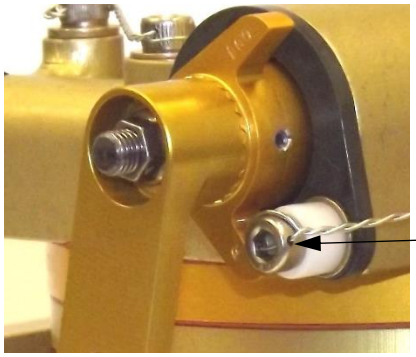


Figure 2.4 Fuel Outlet Fitting

If the supplied metered fuel outlet will not fit in your installation contact Airflow Performance for alternate solutions for a metered fuel outlet fitting.

2.6. MANUAL MIXTURE CONTROL

The fuel control is fitted with a manual mixture control. Mixture controls can be supplied in either CW or CCW rotation to full rich. In the full rich position, the "R" stamped on the mixture control stop lever is against the plastic stop. Rotating the control to the "ICO" position will lean the mixture. "ICO" is stamped on the opposite side of the mixture control stop lever. When "ICO" is against the plastic stop, the fuel flow is shut off to the engine. There is approximately 3-8 cc/min. leakage in this position. The mixture control lever can be indexed in 15 degree increments to facilitate the linkage hook up. Make sure that the teeth on the two levers mesh correctly before tightening the lock nut. Use a 5/16 inch socket to loosen and tighten the ¼-28 lock nut. Torque the lock nut to 50-60 in.-lbs.



WARNING

Mixture control stop screw must be lockwired.
Failure to do so will result in sudden engine stoppage if the screw backs out.

Figure 2.5 Mixture Control in Rich Position

Figure 2.6 Mixture Control in ICO Position

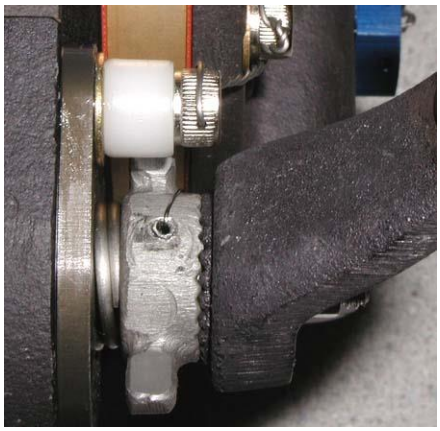


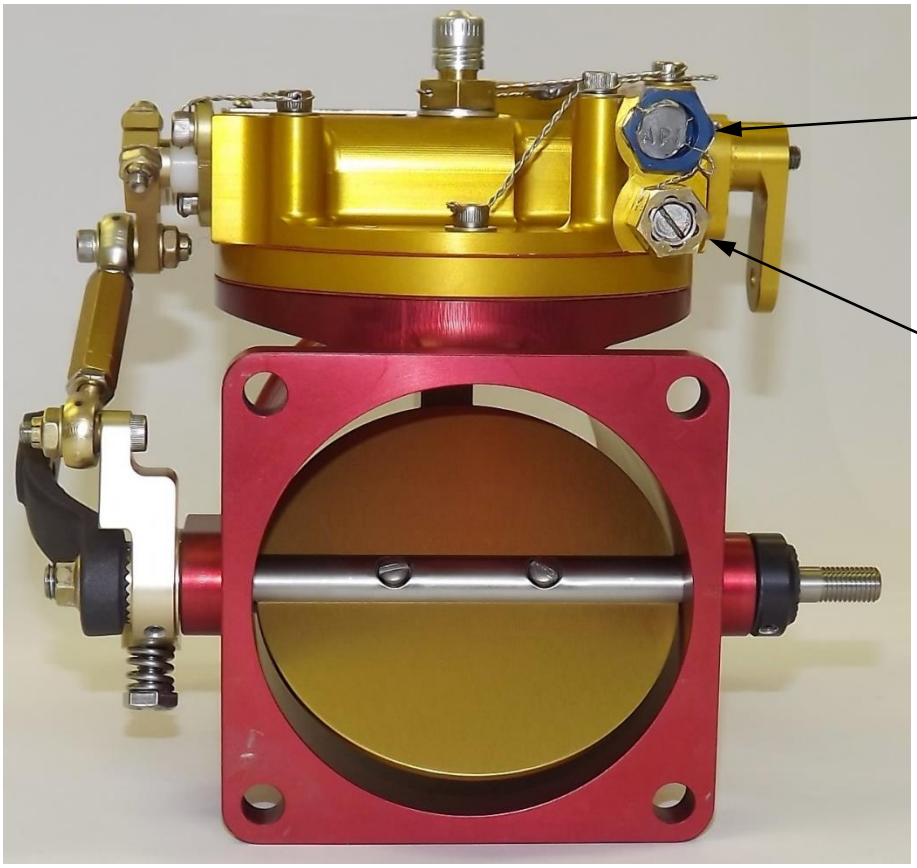
Figure 2.7 Correctly Meshed Control Lever with Clutch Teeth

NOTE:

The manual mixture control is not intended to be used as an aircraft fuel shut off valve. If the fuel supply is near or above the level of the injector nozzles, fuel may seep into the engine, or seep out the injector nozzle vents. A zero leak fuel shut off valve should be used on these installations.

2.7 R Series Fuel Controls

R series fuel controls incorporate the light weight regulator components found in the FM-150L. These units also incorporate a fuel regulator that allows for external adjustment of the main jet setting (full throttle fuel air ratio). Typical adjustments provide approximately 1% per click to the fuel air ratio. There is an effective range of 16 clicks.



SECTION 3

GENERAL OPERATING INFORMATION

3.1. GENERAL

Several phases of ground operation are adversely affected by fuel vaporization in the fuel lines. Fuel vaporization may be experienced under hot conditions of ambient and/or nacelle temperatures. Starting, idle operation, and engine shut down procedures must be modified to obtain optimum results under these conditions.

3.2. STARTING

In cold weather, the engine compartment (nacelle) temperature drops off rapidly following engine shut down and the nozzle lines stay nearly full of fuel. Cold weather starting procedures are therefore simple with highly predictable results. However, in extremely hot weather, nacelle temperatures increase rapidly following engine shut down, and the fuel in the lines vaporizes and escapes out into the manifold. Hot weather starting procedures therefore depend considerably on how soon the next start is attempted. Within the first 20-30 minutes the manifold is nicely primed and the empty nozzle lines will fill before the engine quits. After a 20 to 30 minute wait, the vaporized fuel in the manifold will have nearly disappeared and some slight priming may be required to refill the nozzle lines and keep the engine running after first firing.

3.3. STARTING PROCEDURE

The following starting procedure has proven successful.

A. Cold Starts

1. Mixture control in the IDLE CUT-OFF position.
2. Set throttle to 1/2 open position.
3. Master switch -ON-.
4. Boost pump switch -ON-.
5. Move mixture control to FULL-RICH until an indication of fuel flow is seen, then immediately return the mixture control to the cut-off position.
6. Boost pump switch -OFF-.
7. Set throttle to 1/8 open

NOTE:

On installations where a fuel flow indicator is not used, allow 4 to 5 seconds in place seeing an indication of fuel flow, or turn the boost pump on until an indication of fuel pressure is observed on the inlet fuel pressure gage (15-20 PSI), put the mixture to cut-off position, then turn the pump off.

REMEMBER

With the mixture control in the rich position, fuel will flow into the engine as long as the boost pump is left on.

8. Crank engine. When engine fires, put mixture to FULL-RICH and throttle to idle.

B. Warm Starts

1. Use the same procedure as for cold starts except the boost may be left "off" and step 4, 5 and 6 eliminated. PRIME MAY NOT BE NECESSARY.

NOTE

If high under cowl temperature exist, it may be necessary to turn on the boost pump after the engine has started.

C. Flooded Starts

1. Mixture to cut-off position
2. Throttle to full open
3. Crank engine
4. When engine starts, close throttle and slowly put mixture to full rich.

3.4. IDLING

During ground operation every precaution should be taken to keep nacelle temperatures from increasing to the extent that fuel will boil and vaporize in the lines. The following suggestions are aimed at minimizing this problem:

A. Keep nacelle temperature as low as possible by:

1. Avoiding excessive ground operation.
2. Keep cooling air flow up by keeping engine RPM as high as possible.
3. Place cowl flaps in the wide open position whenever practical.
4. Upon restarting of a hot engine, operate the engine at elevated RPM'S (1200-1500 RPM) several minutes to reduce the residual heat in the engine compartment.

B. Keep fuel temperature as low as possible. Higher RPM'S with the accompanying higher line pressure and flow will help to dissipate some of the heat within the lines.

1. After restarting a hot engine, turn on the boost pump. This will pressurize the engine driven fuel pump to prevent vapor lock.
2. The boost pump should be running during take-off, before letting down for landing approach, landing and aerobatics. Under high ambient conditions it may be advisable to leave the boost pump running during taxiing to parking.

C. Make an idle speed and mixture adjustment that is a compromise between the engine's requirement during the cool of the morning and the heat of the day.

1. Adjust the idle speed to provide 700-750 RPM or as high as practical. The application the engine is used in will also determine the correct idle speed. A higher idle speed is sometimes objectionable due to its effect on landing and braking characteristics, both on roll-out and during taxiing.

2. Adjust the idle mixture after the engine is to operating temperature. A slight RPM rise (10-40 RPM) may be observed when the mixture control is pulled slowly into idle cut-off.

3.5. SHUT DOWN

The idling procedure practiced just prior to engine shut down has considerable bearing on the "cleanness" or smoothness with which the engine stops. If the idling procedures above are not followed and the fuel is vaporizing and emptying the lines, the engine may continue to idle rough for a few seconds. This is despite a 100% cut-off of the fuel supply by the mixture control.

A. Make sure the electric boost pump is turned off before attempting to shut the engine off.

B. If required, opening the throttle with the mixture control in the idle cut-off position will aid in a cleaner shut off.

C. Allowing the engine to run at higher RPM after prolonged idle period (1200-1500 RPM) for 10 to 15 seconds then returning the throttle to idle and stabilizing before shut down will aid in eliminating fuel vapor in the nozzle lines and improve engine shut down.

D. Do not allow the engine to buck or "diesel" after the mixture is pulled in the ICO position. Open the throttle and turn off the mags.

3.6. SHUT DOWN PROCEDURE

1. Set propeller at minimum blade angle.

2. Idle until there is a decided decrease in cylinder head temperature.

3. Increase throttle to 1000 RPM. Maintain speed for approximately 20-30 seconds to insure adequate scavenging of the hot fuel and vapor in the nozzle lines

4. Move mixture to Idle Cut-Off.

5. When engine stops, turn ignition switch off.

SECTION 4

FIELD SERVICE

4.1. IDLE SPEED AND MIXTURE ADJUSTMENT

The following instructions deal with setting the idle mixture and speed on the engine. A preliminary idle adjustment has been set at the factory. This should be sufficient to get the engine started and running.

WARNING

THE FOLLOWING PROCEDURE IS PERFORMED WITH THE ENGINE RUNNING. THE AIRCRAFT SHOULD BE IN AN AREA THAT IS SAFE FOR RUNNING AND SECURELY TIED DOWN. USE EXTREME CAUTION WHILE WORKING AROUND RUNNING ENGINES. BE AWARE OF YOUR POSITION RELATIVE TO THE PROPELLER. IF YOU ARE UNSURE OF YOUR ABILITY TO WORK AROUND RUNNING AIRCRAFT ENGINES, DON'T ATTEMPT THIS PROCEDURE, FIND SOMEONE WHO IS QUALIFIED TO PERFORM IT FOR YOU. HAVE A QUALIFIED PERSON IN THE COCKPIT DURING THE ADJUSTMENT. DO NOT ATTEMPT THIS ADJUSTMENT ALONE. DO NOT LEAVE THE COCKPIT OR ENGINE RUNNING UNATTENDED.

A. Warm the engine to obtain CHT and oil temperature within prescribed normal operating temperature.

B. Make sure operating temperatures are not exceeded while running with the engine uncowled as cooling air over the engine may be decreased during ground operation.

C. Check ignition in accordance with the instructions furnished in the aircraft or engine operational manual. If the "mag-drop" is normal, proceed with the idle adjustment.

D. Set the idle speed with the speed stop bolt (on the throttle stop lever). Set the idle speed to the airframe manufacturer's specification, or set the idle speed as high as practical. Normal idle speed for most applications is approximately 700-750 RPM. If the RPM changes appreciably after making an idle mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

E. The optimum idle setting is one that is rich enough to provide satisfactory acceleration under all conditions and lean enough to prevent spark plug fouling or rough operation.

F. The actual idle mixture adjustment is made by lengthening (rich) or shortening (lean) the linkage between the throttle stop lever and the idle lever. When it is turned out of its block, the link becomes longer and a richer idle mixture is provided. When it is turned into its block the linkage is shortened and leaner idle mixture is provided. There is a left and right hand jam nut to lock the linkage. Use two ⅜ inch wrenches to make the adjustments. The left hand thread is on the throttle stop lever end. Loosen one jam nut but leave the other jam nut just snug. This will provide a little drag on the adjustment and make the adjustment easier and more accurate. Tighten both jam nuts 10-15 in-lbs. after correct idle mixture is achieved.

NOTE

Idle adjustments will not affect the wide open throttle mixture.

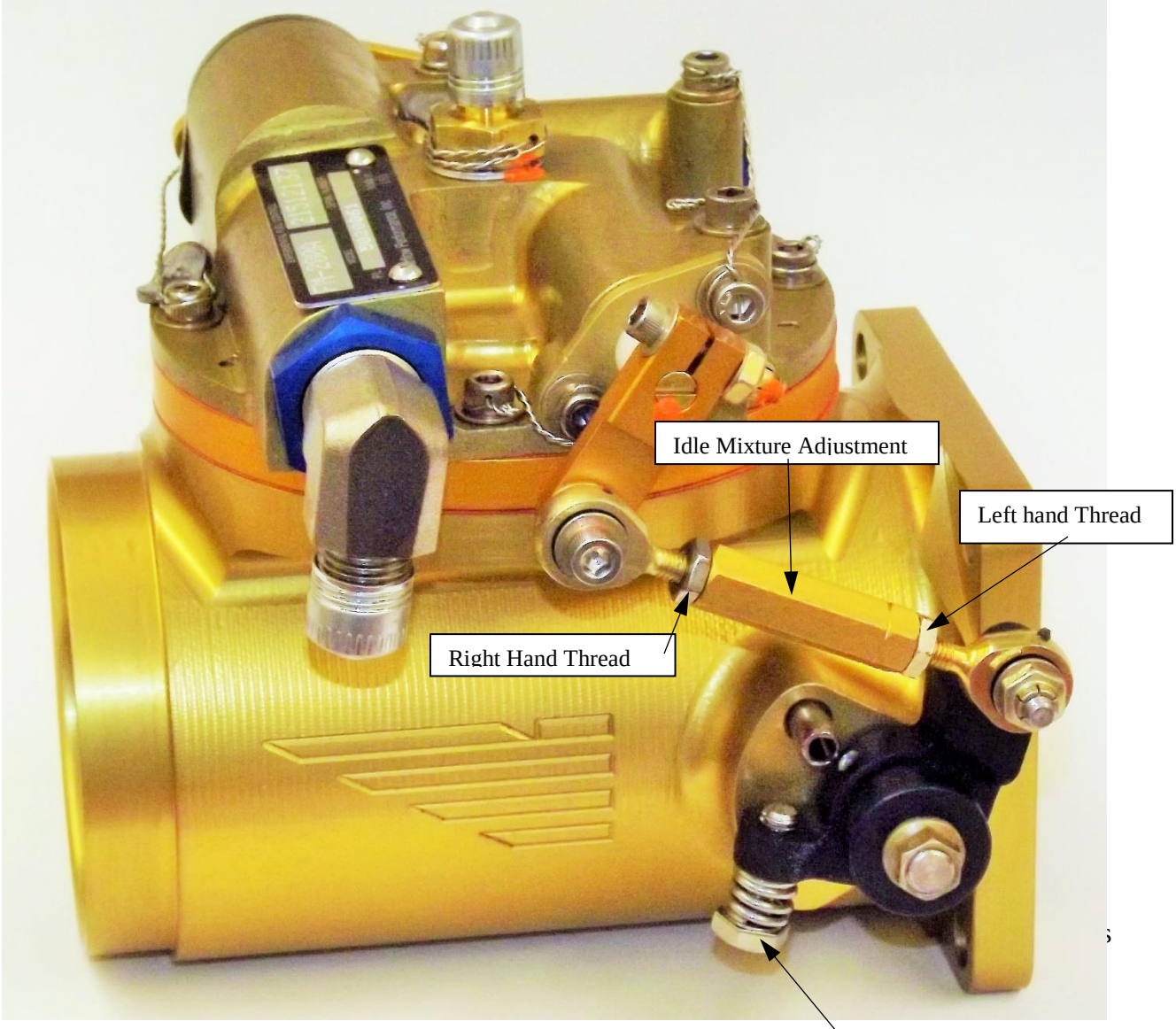


Figure 4-1

H. A method for finding correct idle mixture is to check RPM rise. When the idle speed has been stabilized, move the cockpit mixture control with a very slow, 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 in RPM while leaning out indicates the idle mixture is on the rich side of best power. An immediate decrease in RPM (if not preceded by a momentary increase) indicates that the idle mixture is on the lean side of best power. A rise of 10-40 RPM is typical with a properly adjusted mixture.

I. Another method is to use the manifold pressure gauge. This is useful in adjusting or determining if the idle mixture is set correctly. Typically, the correct idle mixture is achieved when there is only a 0.1 to 0.3 inch of mercury drop in the MAP gauge reading with the throttle at idle and the mixture control is slowly pulled toward ICO.

J. Each time an adjustment is made, clear the engine by running it up to 1/2 to 3/4 throttle then back to idle before making a mixture check.

K. Changing the idle speed will affect the idle mixture. Work between the two adjustments to get the best operation.

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

NOTE

The idle mixture adjustment is sensitive. Do not adjust more than one to two flats at a time. Normal adjustment should not require more than one full turn in either direction.

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

M. Idle speed and mixture adjustments made according to this method should require little attention except for extreme variations in temperature and altitude.

N. Erratic idle may be encountered under prolonged idle or high under cowl temperatures. Running the engine up briefly will clear the hot fuel from the nozzle lines.

O. If while adjusting the idle mixture it seems that the idle mixture is erratic or the adjustment seems to be chased, try running the boost pump, clear out the engine and continue with the idle mixture adjustment procedure with the boost pump on.

4-2. FULL THROTTLE MIXTURE ADJUSTMENT

The following instructions deal with the full throttle mixture. An EGT (exhaust gas temperature) gauge and fuel flow meter is highly advisable to determine the correct mixture strength. The fuel air ratio in your fuel control has been set at the factory for flow limits established for the engine model.

WARNING

THE FOLLOWING PROCEDURE REQUIRES THAT THE ENGINE BE OPERATED UNDER FULL POWER. THE AIRCRAFT MUST BE IN AN AREA SUITABLE FOR FULL THROTTLE RUN-UP. THE AIRCRAFT MUST BE CHOCKED AND TIED DOWN SECURELY. DO NOT RELY ON THE AIRCRAFT BRAKES TO HOLD THE AIRCRAFT DURING THIS TEST. OBSERVE ENGINE OPERATING TEMPERATURES AND OPERATION DURING FULL THROTTLE. IF ANY TEMPERATURES OR PARAMETERS ARE EXCEEDED OR ENGINE OPERATION IS NOT NORMAL OR ERRATIC, IMMEDIATELY DISCONTINUE FULL THROTTLE OPERATION.

A. Bring the engine up to operating temperature.

B. Put the mixture control to the FULL RICH position.

C. Advance the throttle to wide open.

D. Observe the RPM, MAP and EGT. These parameters must be within the engine model specifications.

E. If the full rich full throttle mixture is not correct, it can be made by changing the main jet

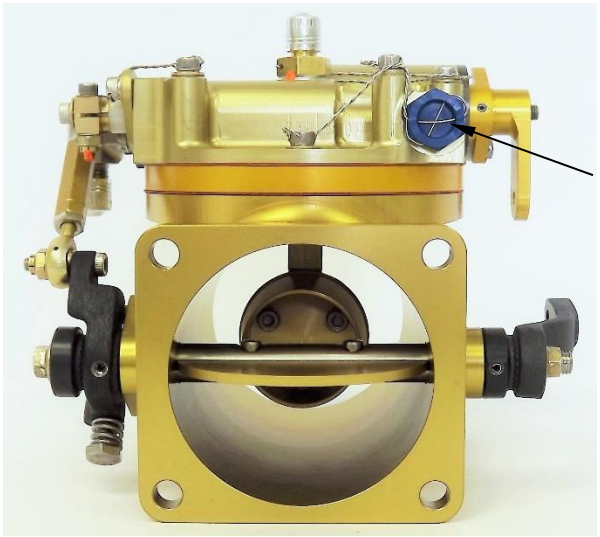


Figure 4-2.

WARNING

PROCEDURES PERFORMED WHILE THE ENGINE IS RUNNING REQUIRE EXTREME CAUTION. BE AWARE AT ALL TIMES OF YOUR POSITION RELATIVE TO THE PROPELLER. HAVE A QUALIFIED PERSON IN THE COCKPIT AT ALL TIMES WHILE THE ENGINE IS RUNNING. DO NOT LEAVE AN ENGINE RUNNING UNATTENDED.

F. Observe the RPM and EGT. These parameters must be within the engine manufactures specifications. Typical full throttle EGT for Lycoming engines is 1300 to 1375 degrees Fahrenheit. On most 4-stroke engines, correct full rich mixture is indicated by an increase of 25 to 50 RPM when the mixture is manually leaned while at full throttle and the engine is equipped with a fixed pitch propeller.

G. Typical correct fuel mixture can also be determined by the change in EGT from peak to full rich. With a power setting of 2400 RPM and 24" MAP lean the mixture until one of the cylinder's peaks in EGT. Record that number then return the mixture to full rich. When the EGT has stabilized on that cylinder, record the EGT reading. The difference in the two readings should be 185-225 degrees F. If the change is less than 185 then it indicates that the mixture is lean. Alternately a difference of more than 225 degrees indicated a rich mixture. Readings should be taken at altitudes below 4000 feet.

H. If the full rich full throttle mixture is not correct, it can be adjusted by changing the main jet located inside the fuel controller. See Figure 4-2.

I. Main jets are precision flowed parts, and can be purchased from Airflow Performance. Jets are sized like number drills (a #48 is leaner than a #46) and are also available in half sizes. Use extreme caution when removing or installation the main jet. Be careful not to chip or allow the screw driver to slip on the jet. Do not over tighten the jet when reinstalling. Apply some oil to the O-rings when reinstalling the fittings.

J. Re-lock-wire the #4 plug after changing the main jet.

K. If there is no change in fuel flow with an adjustment of the main jet, other problems exist in the fuel system. Discontinue making adjustments to this feature and refer to the trouble-shooting section of this manual.

L. The above are guidelines only. Engine full rich mixture requirements will vary from engine to engine due to engine design and air inlet configurations. Contact Airflow Performance and or the engine manufacture before making a main jet change.

SECTION 5

TROUBLE-SHOOTING

5.1. GENERAL
Refer to Section 6 of the manual

5.2. MANUAL MIXTURE CONTROL LEAKAGE TEST

The following procedure will test for correct operation of the manual mixture control. The Manual Mixture Control on FM fuel control in the idle cut-off position will only reduce the fuel flow sufficiently to stop the engine. It is not a zero leak valve. It is not intended as a fuel shut off valve.

A. Disconnect the hose that attaches to the flow divider (metered fuel hose). Leave the hose attached to the fuel control.

B. Place the hose in a suitable container.

C. Turn the boost pump on and put the mixture control to Full Rich. Open the throttle wide open.

D. Observe the fuel flowing from the metered fuel hose; now close the throttle to idle. The fuel flow should decrease to a lower level. Insure that all the air has been purged from the fuel control. There should be no air bubbles observed in the fuel stream.

E. Put the manual mixture control in Idle Cut-Off (ICO).

F. The fuel flow should decrease to a slow drip (3-8 cc's per minute).

If the fuel control does not perform as described in the above procedure, there is excessive leakage around the manual mixture control. Return the fuel control for repair.

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