INTRODUCTION

This manual has been prepared and distributed by Airflow Performance Inc. It is intended to be used by personnel responsible for the installation, adjustment, and maintenance of Fuel Injection Systems.

Periodic revisions will be made to this manual to incorporate the latest information and procedures. If the reader finds any information or procedures omitted, please direct your comments and suggestions to Airflow Performance. An effort will be made to include this information in future revisions.

NOTE

> Airflow Performance products are not approved for use on certified aircraft. It is the users responsibility for using aircraft approved installation methods and materials to insure correct and safe operation of the engine and aircraft. Information in this manual <u>DOES NOT</u> supersede any published airframe/engine manufacture publication. Conflicting information should be directed to Airflow Performance.

This manual is compiled with special thanks and dedicated to:
Elmer Haase
Jim Kirwin
R.G. Moore
of the Bendix Energy Controls Division
South Bend, Indiana

RECORD OF REVISION

DATE	DESCRIPTION
July 2000	Manual Revision A
May 2001	Manual Revision B Section 3 and Appendix D
August 2001	Manual Revision C Section 4, page 35
June 2004	Manual Revision D Section 3, pages 14, 16, 19, 26, 32 Section 4, page 34 Section 5, pages, 37, 42, 44, 45 Section 6, pages 53, 65 Appendix C Revision B, page C-1 Appendix I Revision B ,page I-1
June 2006	Manual Revision E Section 1, pages 4, 5 Section 2, page 11 Section 3,pages 15, 17, 18, 21, 29, 35 Section 4 page 39 Section 5 pages 41, 48, 49 Appendix B Revision B, pages B-6, B-7, B-8 Appendix C Revision C, page C-7 Appendix F Revision B, page F-3 Appendix I Revision C, pages I-1, I-4, I-5
September 2008	Manual Revision F Section 1, page 8 Section 2, page 11 Section 3, pages 16, 17, 19, 22-25, 24, 25, 28, 30, 31 Section 4, page 38 Section 6, pages 52, 67, 68 Section 8, page 74 Appendix A Revision C, page A-24 Appendix B Revision C, pages B-9, B-10 Appendix C Revision D, page C-8 Appendix E Revision B, page E-2 Appendix F Revision C, page F-4 Appendix I Revision D, pages I-5, I-6
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RECORD OF REVISION

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November 2010	Manual Revision G Appendix C Revision E, page C-8, C-9 Appendix F Revision D, page F-5, F-6-
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May 2017	Manual Revision I Table of Contents Revision I page iv Installation of Pipe Threade and O-Ring Fittings, page 14 Section 3, pages 32, 33 Section 5, page 48 Section 8, pages 75, 76 Appendix K Rev. A, pages K 1, K 6, K 9

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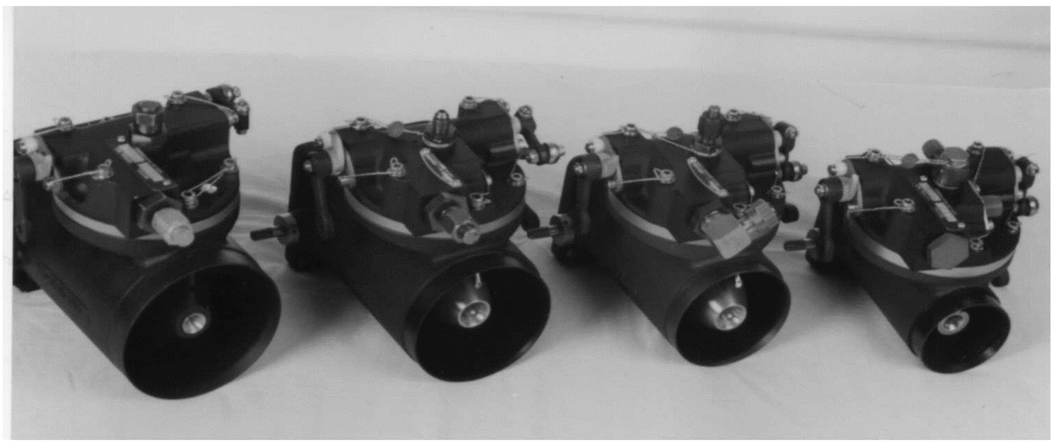
SECTION ONE

DESCRIPTION AND PRINCIPLES OF OPERATION

GENERAL

1-1. The FM-series fuel injection system uses the proven principle of mass airflow metering to proportion the fuel flow to the engine. Since the system requires the inlet fuel to be under pressure, installation position and external g-forces during operation do not effect its metering performance. All models of the FM injector operate on the same principle.

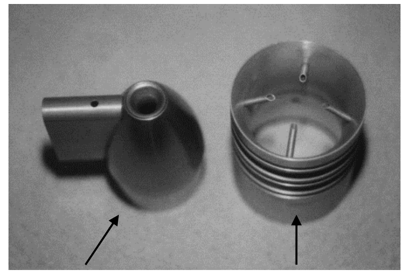


Only the throttle bore varies in size depending upon the horsepower application for which it is used. This system has successfully been used on two stroke, four stroke and rotary type internal combustion engines. Models of this injection system are capable of running naturally aspirated engines of 65 to 800 horsepower. Higher horsepower would be attainable using the same size unit by turbo or supercharging. Multiple units can be used when required.

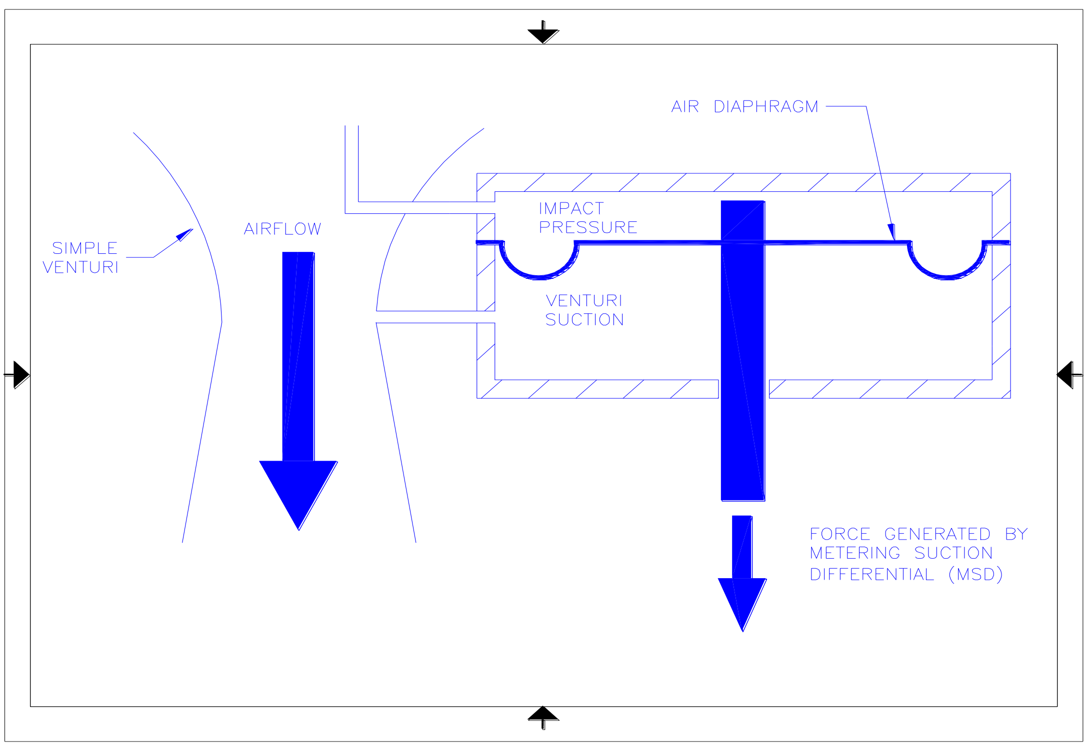
SYSTEM DESCRIPTION

1-2. The FM-series system is a mass airflow device employing a venturi to generate a signal corresponding to the mass airflow, depending upon engine requirements. Metered fuel is constant flow (Refer to the attached schematic).

AIR SECTION

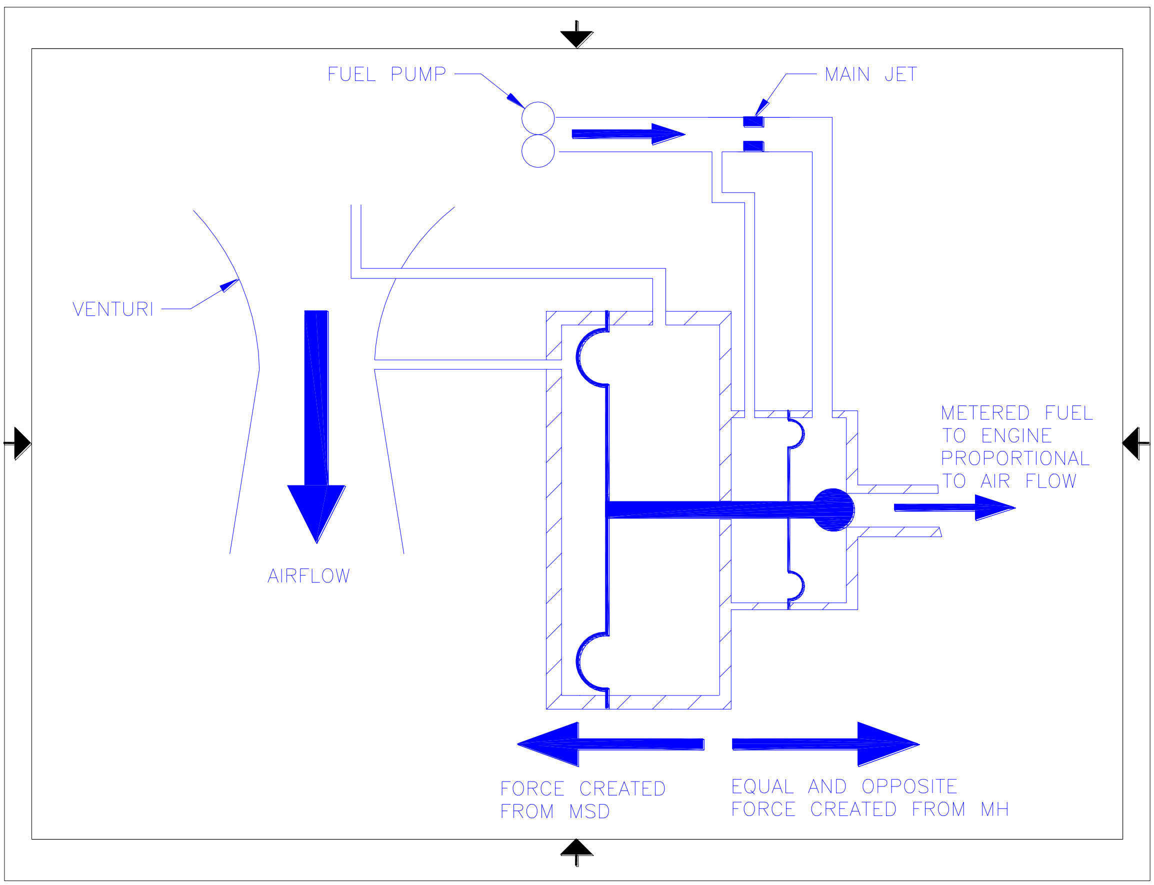


1-3. The air section consists of a throttle body containing the air control throttle valve and necessary linkage, the regulator mounting pad and a center mounted bullet type venturi with a boost venturi. By employing this type of venturi, a venturi signal can be generated at low air flows while maintaining a low pressure loss across the venturi at higher air flows. This signal to loss ratio is called gain. Typically a venturi of this type has a gain of five while a side wall or conventional type venturi has a gain of two. A measure of the air flow consumption of the engine is accomplished by sensing inlet air pressure and venturi throat pressure in the throttle body. These pressures are vented to two sides of the air diaphragm. This pressure signal is called metering suction differential (MSD). By movement of the throttle valve, a change in the engine air consumption occurs that will change the velocity of the air through the venturi, which will reflect an immediate change in the MSD.



FUEL REGULATOR SECTION

1-4. The fuel section consists of the regulator and jetting systems. The regulator consists of an air diaphragm and a fuel diaphragm connected by a solid regulator valve stem. The MSD is applied across the air diaphragm to produce a force to open the fuel regulator ball valve. The fuel flowing through the metering jet takes a pressure drop (metering head, MH) and this pressure differential is applied across the fuel diaphragm to produce an equal and opposite force across the fuel diaphragm, which tends to close the regulator ball valve. The regulator will thus find an equilibrium condition from these forces. Since the laws of flow apply to both air and fuel systems, the fuel flow generated by the regulator is proportional to air flow. Fuel air ratio is varied by changing the area of the metering jet. Response time of the regulator for a change in airflow will give a resulting change in fuel flow within 0.05 seconds. This quick response time, together with the injector nozzles located near the intake valves, eliminates the need for an acceleration pump.

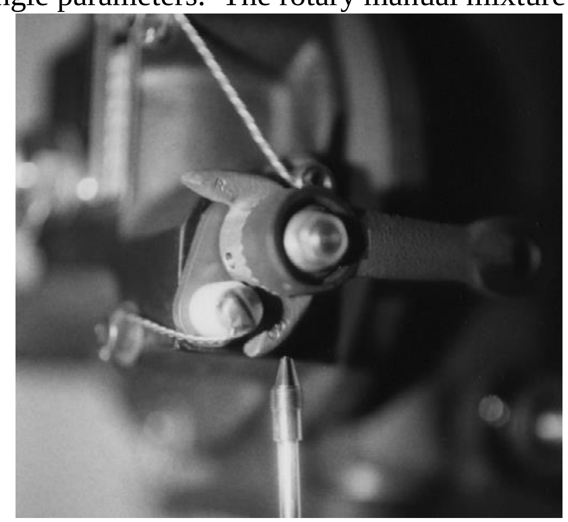


IDLE SYSTEM

1-5. Fuel flow is controlled below 20% power by a rotary idle valve linked to the throttle valve. In the idle regime, the venturi signal is negligible and the MSD generated is not sufficient to accurately operate the regulator. To create a positive MH, a constant effort spring is used to generate the required force. Engine idle air flow requirements are controlled by an idle speed adjustment screw located on the throttle stop lever. Idle mixture is set by use of an adjustable idle linkage. Off idle fuel mixture is controlled by the idle valve slot contour.

MANUAL MIXTURE CONTROL

1-6. The full rich setting incorporated in the fuel controller satisfies the engine requirements for sea level operation. As air density decreases, the velocity of air increases through the fuel controller throttle body to maintain the same weight of air into the engine. This will increase the air metering forces and in turn increase the fuel metering forces resulting in a richer fuel air ratio as altitude increases. The actual change in fuel air ratio varies as the square root of the change in ambient air density. Variation in fuel flow for this type of system with changes in air density is approximately 1/2 the change of a fuel system using RPM and throttle angle parameters. The rotary manual mixture control valve produces a full rich condition when the lever side stamped "R" (rich) is against the stop. A progressively leaner mixture is attained as the lever is moved toward the idle cut off ("ICO") position. While the ICO position will normally shut the engine down it does not provide zero leak ICO. With mixture control lever side stamped "ICO" against the stop, there is approximately 1.0 to 3.0 pound per hour (PPH) leakage across the mixture control valve.



Mixture control shown in idle cut off (ICO) position

FLOW DIVIDER

1-7. Metered fuel is delivered from the fuel controller to the flow divider. It's purpose is to divide the metered fuel equally to each injection nozzle at idle regardless of their height between each other. At idle, nozzle back pressure is typically 1-5 inches of gas pressure, if there is a difference in height between the nozzles then idle flow will tend to flow out the lowest nozzles. Metered fuel pressure enters the flow divider through a channel that permits fuel to pass through the I.D. of the flow divider spool valve. At idle the fuel pressure from the fuel controller must build up to overcome the spring force applied to the diaphragm and spool valve. This moves the spool valve upward to allow fuel to pass through the calibrated slots in the bottom of the flow divider bushing. Since the fuel controller meters and delivers a fixed amount of fuel to the flow divider, the spool valve will only open as far as necessary to pass the amount of fuel to the nozzles. Since it takes approximately 1.75-3 PSI pressure to open the spool valve, the fuel will accurately be divided between the nozzles if there is a difference in height between them of 70 inches. At idle the nozzle discharge pressure is negligible, the opening of the spool valve to the slots is very small, and thus the fuel is divided for the individual cylinders at this point by the flow divider. The flow divider also keeps the metered fuel under pressure and shuts off the individual nozzle ports when the fuel controller is placed in "idle cutoff".

DISTRIBUTION BLOCK

1-8. For installation where the engine and or injector nozzles are mounted in a horizontal plane, a distribution block can be used. This device has a common manifold that all the nozzle lines are connected to. The block incorporates a pressurizing valve to provide back pressure on the fuel controller regulator. This keeps the metered fuel hose from draining when the engine is shut off. The distribution block must be mounted below the injector nozzles to keep the nozzle lines from draining and give good idle performance to the engine. Distribution blocks are manufactured in 4, 6, and 8 cylinder designs.

INJECTOR NOZZLES

1-9. Fuel injection nozzles for each cylinder are of the air bled type. This type of nozzle uses the pressure differential between ambient and manifold pressure to draw air into the nozzle mixing chamber and spray an atomized fuel-air charge at the intake valve. Each nozzle incorporates a calibrated fuel restrictor (jet), the size of which is determined by; 1) the fuel pressure available at maximum horse power, 2) the total fuel flow required at maximum horsepower, and 3) the number of injector nozzles used on the engine. The fuel restrictors are calibrated to flow alike within plus or minus 1%. The nozzles are interchangeable between engine and cylinders, assuming the restrictors are the same size. There are four standard sizes of restrictors. .015 designated by three bands machined on the restrctor, .022; designated by one machined band on the restrictor, .028, designated by no (smooth) band on the restrictor and .032, designated by two bands machined on the restrictor. Special restrictors are made to tune individual cylinder EGT. These are designated by the size of the restrictor or a + % or - % showing the amount the restrictor is rich or lean from the standard calibration.


Restrictor marked with size

> **NOTE**
> Airflow Performance injector nozzle restrictors are described above. Bendix / Precision restrictors are similar but their restrictor has one band on the restrictor body and are made from stainless steel. This is a .028 restrictor.

SYSTEM REQUIREMENTS

1-10. The minimum fuel pressure requirement for system operation is dependent upon the injector nozzle drop, intake manifold pressure and the pressure requirement for regulator operation. The control is insensitive to inlet fuel pressure variation. Norman operating fuel inlet pressures are typically 20-90 PSIG. The control is compatible for use with all types of gasoline, alcohol and alcohol based fuels. When using alcohol the control system should be flushed with gasoline or equivalent to prevent gummy deposits and corrosion (common when using methanol) on internal parts. This should be done when the injector will be out of service for more than one week. Satisfactory operation of the fuel injection system depends on the fuel being relatively free of contamination. Fuel filtration before entering the control should be at least 125 microns.

PERFORMANCE

1-11. Response time of the regulator for a change in airflow will give a resulting change in fuel flow within 0.05 seconds. This quick response time, together with the fuel nozzles located near the intake or reed valves, eliminates the need for an acceleration pump. The injector is a non-compensated unit and therefore its fuel metering will be affected by changes in air density. This change in fuel air ratio varies as the square root of the change in ambient air density. Variation in fuel flow for this system with changes in air density is approximately 1/2 the change of a fuel system using RPM and throttle angle parameters.

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GETTING STARTED

CHECKING YOUR SYSTEM

2-1. Unpack your shipment and check all parts against the packing list. If any parts or components are damaged or missing contact Airflow Performance immediately. Fuel controllers and components have been configured for a specific installation. Even so, specific installations may differ. If you are unsure of your specific installation, please call our engineers at the factory if you require a different configuration for your components to fit correctly.

OPERATION OF THE INSTALLED SYSTEM

2-2. There are many factors affecting satisfactory fuel injection operation in service, which cannot be addressed regarding the design of the fuel controller alone. A recognition of these requirements regarding fuel tanks, fuel lines, fuel pumps, fuel pressure requirements, controls, air induction inlet, intake manifold design, and the operation and maneuvers the aircraft will be subjected to, must be evaluated if the fuel injection system is to function successfully in the airplane.

WARNING

It is up to the owner/installer to use proper and approved aircraft installation and fabrication techniques. Airflow Performance recommends using AC-4313-2B as a guide for approved methods and techniques for installing components on aircraft installations. Incorrect installation or modification of the supplied parts can result in poor engine operation or

USING THIS MANUAL

2-3. This manual is intended as a guide to installing your fuel injection system. There are many different installation possibilities**. There are some important details to pay attention to, and these items are discussed in the following sections**. We have attempted to show some of the combinations for installing the system and the related components. You may encounter a different situation than is explained in this manual. If you are unsure of the procedure or correct components to use in your particular situation, call our engineers at the factory to discuss the installation situation you have encountered.

INSTALLATION OF PIPE THREAD AND O-RING FITTINGS

The torque values listed are recommended values, these DO NOT supersede any published airframe/engine manufacture publication.

PIPE THREAD FITTINGS

- DO NOT under any circumstance use Teflon tape.
- Approved sealants are Permatex Thread Sealant #14 or Loctite 565 PST.

Recommended Pipe Thread Torque Values

- Torque 1/8" NPT fittings to 45 – 65 inch pounds.
- Torque 1/4" NPT fittings to 70 – 110 inch pounds.
- Torque 3/8" NPT fittings to 95 – 135 inch pounds.
- Torque 1/2" NPT fittings to 110 – 140 inch pounds.

O-RING FITTINGS and AN FITTINGS

- DO NOT under any circumstance use pipe thread sealant, "Gas Tite", "Fuel Lube" or Teflon tape on O-ring fittings. No sealant of any kind is required on flared fittings or B-Nuts.
- Apply a film of motor oil to the O-ring before installing the fitting.

Recommended O-Ring and Flared Fitting Torque Values

- #4 Plugs 20–25 in-lbs., #4 Hose B-Nut 25-35 in-lbs., #4 Bulkhead Nut 45-50 in-lbs.
- #6 Plugs 30–35 in-lbs., #6 Hose B-Nut 30-40 in-lbs., #6 Bulkhead Nut 90-100 in-lbs.
- #8 Plugs 45–50 in-lbs., #8 Hose B-Nut 60-80 in-lbs., #8 Bulkhead Nut 150-250 in-lbs.
- #10 Plugs 60–65 in-lbs., #10 Hose B-Nut 100-150 in-lbs., #10 Bulkhead Nut 200-350 in-lbs

- If the fitting leaks around the O-ring seat, replace the O-ring, inspect the O-ring port for scratches or nicks.

- If fitting leaks around flare fittings inspect the flare for scratches, or improper flare. Inspect the AN fitting for nicks or dents on the taper of the fitting where the flare seats.

- When installing bulkhead fittings. Insure that the O-ring is on the smooth part of the fitting when the bulkhead nut is tightened.

INSTALLING STUDS

When installing studs measure the complete stack-up of the parts to be clamped plus the lock nut and washer. Provide an additional 1 ½ threads to be exposed above the lock nut, this is the exposed measured distance. Installation on the stud into the casting is minimum 1 1/2 diameters of the stud OD thread (5/16" stud = .47 engagement of the threads minimum). Use Loctite 620 to install the stud in the casting to the measured exposed distance.

SECTION THREE

INSTALLATION

Refer to Appendix 'A' for fuel system schematics and fuel pump installations.

FUEL TANKS

3-1. Fuel tanks must be located and designed to provide unobstructed fuel flow to the fuel system. Tank outlets should have finger screens on the fuel outlets to protect the fuel pumps in the system. Fuel pick-ups in the tank should be designed so that no air can be picked up with the fuel. Insure that fuel can be picked up when the aircraft is in unusual attitudes. Sumps located at the fuel pick-up and baffles should be incorporated in the tank design to provide non-aerated fuel pick-up. If fuel return ports are installed in the tank, their location should be such that it does not influence the fuel pick-up, or aerate the fuel in the tank. Inverted fuel systems must provide unobstructed fuel pick-up in all attitudes. Insure the design of the flop tube and mechanism is free to swing and will not introduce air into the fuel. Fuel tank venting is very important. Insure that the vent system is adequate for the fuel flow requirements. What may seem to be a good scheme for venting the tanks on the ground may actually pull a vacuum on the tanks in flight. It is wise to have positive or ram air pressure on the venting system in flight. Fuel outlets must be sized correctly for the fuel flow requirements of the system. This is affected by the type of fuel pumping system used. A returning type or loop system will require larger feed ports than a non returning system since the total fuel flow will be greater than the engine requirements. There must be no restriction to the fuel flow exiting the tank. Consult Airflow Performance if you are unsure of the fuel outlet ports in your fuel tanks for your application.

AIRFRAME FUEL SYSTEM PLUMBING

3-2. Typically all plumbing in the airframe is done in aluminum tubing. This saves weight, provides a smooth flow path and makes for a sanitary installation. Insure that the tubing is the correct size for the fuel system. A common practice is to use 3/8" diameter tubing (.375 dia.) for aircraft having engines up to 325 HP. For installations where the engine will produce over 325 HP, 1/2" diameter tubing (.500 dia.) should be used. Consideration for the type of fuel system (returning or non-returning) and the length of the tubing required, will also be a factor in determining the size of the fuel feed tubing in the airframe. Using tube flaring tools with serrated jaws are not acceptable. Use only aircraft grade flaring equipment.

FUEL VALVE

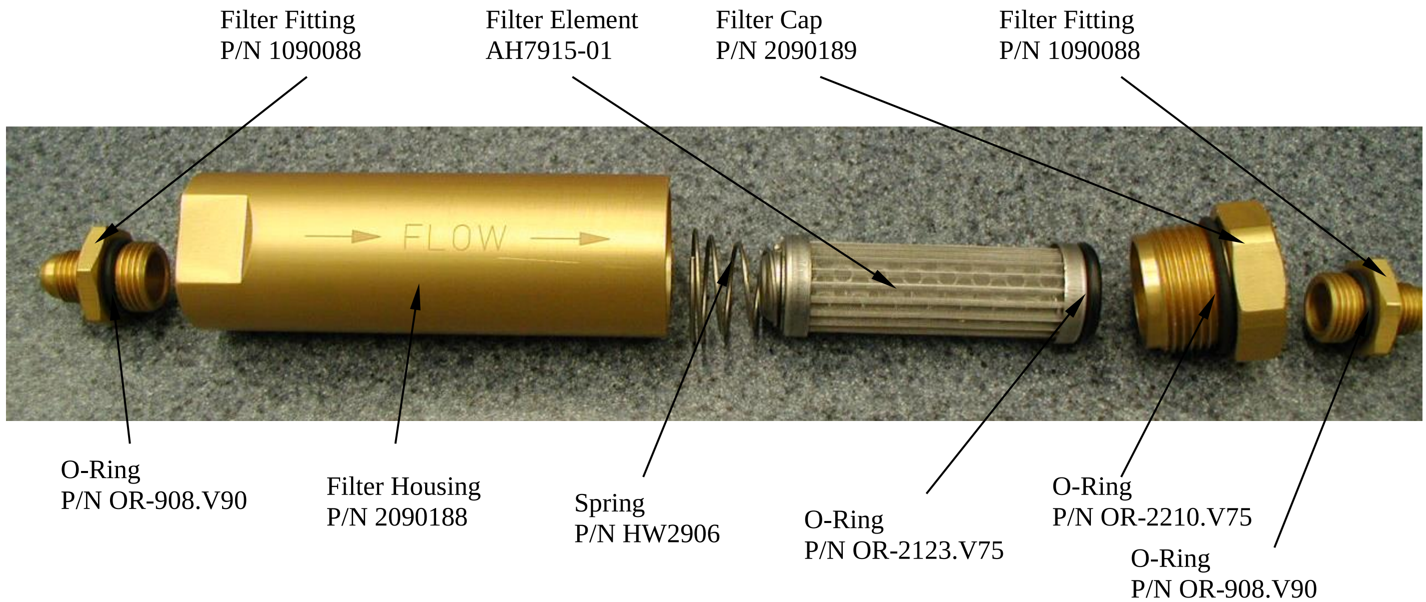
3-3. A fuel shut-off valve should be installed in the airframe fuel system plumbing. This valve usually incorporates the fuel selector valve if multiple fuel tanks are used. The valve should provide free flow to the fuel with no restriction and give zero leak in the off position. This feature is needed to allow service to the components of the fuel system. A high quality ball type valve is desirable for this use. If a fuel return is used in the system, the fuel selector valve should switch the return fuel to the tank from which the fuel is drawn. There are other methods for simple fuel management. A small sump or surge tank can be used to feed the main tanks into via the selector valve. The return fuel can be put into this tank thus eliminating the need to return the fuel to the selected tank. As per section 3-1 insure that the surge tank will provide adequate flow to the pump system, will not air lock and that the main tanks will maintain adequate feed rate to keep the surge tank full under all conditions of power and aircraft attitude.

FUEL FILTERS

3-4. A fuel filter should be installed in the system before the fuel boost pump, and after the selector valve. The filter may also incorporate a gascolator. If this type of device is used, then the gascolator should be installed at the lowest point in the fuel system. Gascolators are not required for proper operation of the fuel injection system but if used, should not be installed on the engine side of the firewall. Airflow Performance **does not** approve the use of **any** paper element type fuel filter as the primary filter in the aircraft. Paper element filters will restrict the inlet of the fuel pumps due to their fine filtration and their susceptibility to clogging from picking up water. If the inlet of the fuel pumps are restricted, the pressure on the inlet becomes depressed, this will cause the fuel to boil and the vapor will flow into the fuel controller causing it to malfunction. This problem is not as evident when float carburetors are used, since the float chamber will allow the fuel vapor and bubbles to escape. A screen type filter should be used. The filter size must be based on the total fuel flow through it, not just the engine fuel consumption. This again depends upon the type of fuel system in the aircraft, returning or non-returning. The filter Airflow Performance recommends for this application is P/N 1090079. This a maintainable filter incorporating a 125 micron pleated stainless steel filter element with a anodized aluminum housing. The filter should be in stalled in the aircraft so that periodic cleaning can be performed. It can be clamped by using -26 Adel clamps around the filter body to support it securely to the airframe structure. It is recommended that the filter be installed on the cool side of the firewall. No other filters are necessary in the system. In certain applications specifically with aircraft with composite or fiberglass fuel tanks, additional filtration may be required. In these applications it is recommended that a filter of 10-25 microns be installed after the boost pump to filter out composite debris. The filter must be of adequate size to prevent clogging and is placed down stream of the boost pump so that the boost pump can force fuel through it.

P/N 1090079 Maintainable Fuel Filter

INSTALLATION



The filter can be cleaned periodically by removing the filter from the fuel system, un-screwing the end cap of the filter assembly with a 1 ½" wrench while holding the other side of the housing with a 1 3/8" wrench or vise. The filter should be inspected after 5-10 hours of operation on new installations and then typically every year at the condition inspection after that. Inspect more frequently if known fuel conditions are questionable. The filter element can be removed from the filter cap and cleaned in mineral spirits then blown dry with compressed air. Inspect the seal O-rings. These may be re-used if in satisfactory condition. Re-assemble the filter using some engine oil on the O-rings. Make sure the conical spring is installed as per the picture and the filter assembly is installed back in the fuel system in the correct flow direction as designated by the arrows on the filter housing.

Standard Fuel Inlet

90 Deg. Fuel Inlet

Side Mount Fuel Inlet

The fuel controller incorporates a 75 micron filter in the fuel inlet fitting. If you are unsure of the type of fuel filtration to use for your application, contact Airflow Performance. This is a very important component of the fuel system and will effect the correct operation of the fuel injection system if sized incorrectly. All Airflow Performance fuel filters are non-relieving type.

FUEL BOOST PUMP

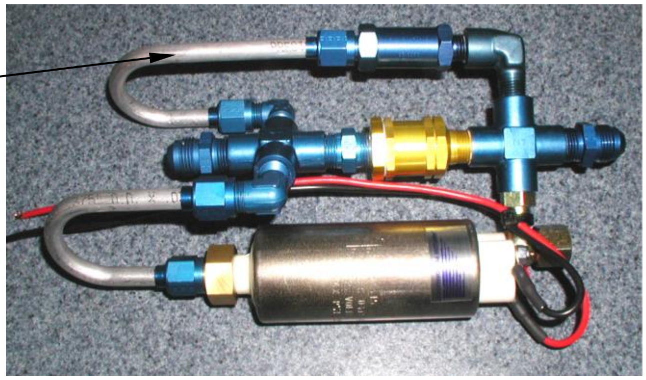
3-5. A fuel boost pump is required for engine starting and as an emergency back-up to the engine driven pump. The pump must produce the pressure and flow required to support the engine fuel requirements at maximum HP in the event of an engine driven pump failure. Weldon and Dukes pumps (these are common boost pumps used on certified aircraft) can be installed in line since these pumps incorporate integral bypass and relief valves. The relief valve on the boost pump should be set a few PSI higher than the engine driven pump operates at to verify that the boost is running when it is turned on. Ideally the boost pump should be installed in the system so that under normal flight attitudes the pump inlet will be gravity fed from the fuel supply. If this condition can not be satisfied, check with the manufacture of the boost pump to determine the dry suction lift capability of the pump. Making the pump draw fuel will increase the possibility of getting fuel vapor or bubbles in the fuel system, causing malfunction of the fuel controller, and can cause premature failure of the boost pump.

3-6. It is recommended that the boost pump is mounted in the aircraft behind the firewall. This will keep the pump in a cooler environment and will tend to keep vapor lock and hot operation problems to a minimum. In installations where the boost pump must be mounted on the firewall, it advisable to enclose the pump package in a box and flow blast air through the box. This will keep cooling air flowing through the box in flight and minimize heat soak during shut down. If the gascolator is located on the firewall it should also be installed in the box.

3-7. The Airflow Performance auxiliary pump, P/N 2090255 uses a high pressure roller vane type fuel pump. This pump package incorporates an intergral relief / bypass valve. This provides a simple in and out connection to the pump. The relief valve allows circulation of fuel through the pump to keep the pump motor cool and sets the pressure to the system at 25-32 PSI. A bypass check valve is incorporated so that when the aux. pump is not running, fuel will bypass the boost pump and flow directly to the engine driven fuel pump without restriction. This pump package will draw 5 amps at 12 VDC. The pump should be protected by a 7 to 10 amp circuit breaker. Electrical wiring to the pump should be a minimum of 16 gauge stranded wire. The pump is supplied with 14 gauge wire. The red wire is connected to +12 VDC the black wire is connected to airframe ground. Mount the pump package by using MS21919WDG29(cushion clamps) clamps around the pump body and or the relief valve housing to support it securely to the airframe structure. If two clamps are placed around the pump body, it may be necessary to trim the rubber on the outside of the clamp to provide clearance between the pump motor and the bypass valve.

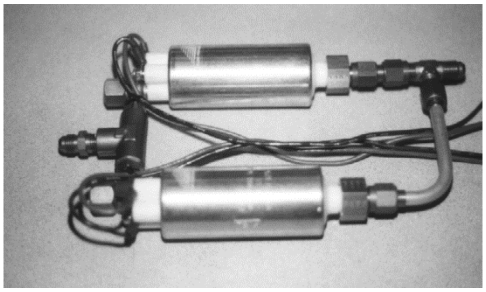
All Airflow Performance pumps are continuous duty. The maximum dry suction lift of this pump is 2 feet. It is recommended that the pump be mounted as low as possible to the fuel supply to insure quick priming and minimize vapor problems. A flooded inlet is preferred.

Some pump packages are available with an integral relief return line plumbed to the inlet of the pump. The example shown is an assembly for the M-14P radial engine. It has –8 AN fittings for the inlet and out let.



P/N 3090098-5 M-14 Pump Package

3-8. There are some installations where no engine driven fuel pump is used. In this case a dual electric pump package should be used. The pumps should be connected to separate electrical supplies to provide a redundant pump in case of a primary electrical system failure. The pumps incorporate internal check valves to prevent fuel from flowing backward through the inactive pump. The pump package can be mounted using 3 MS21919WDG29 (cushion clamps). Secure two clamps to one pump motor and one clamp to the other pump motor.



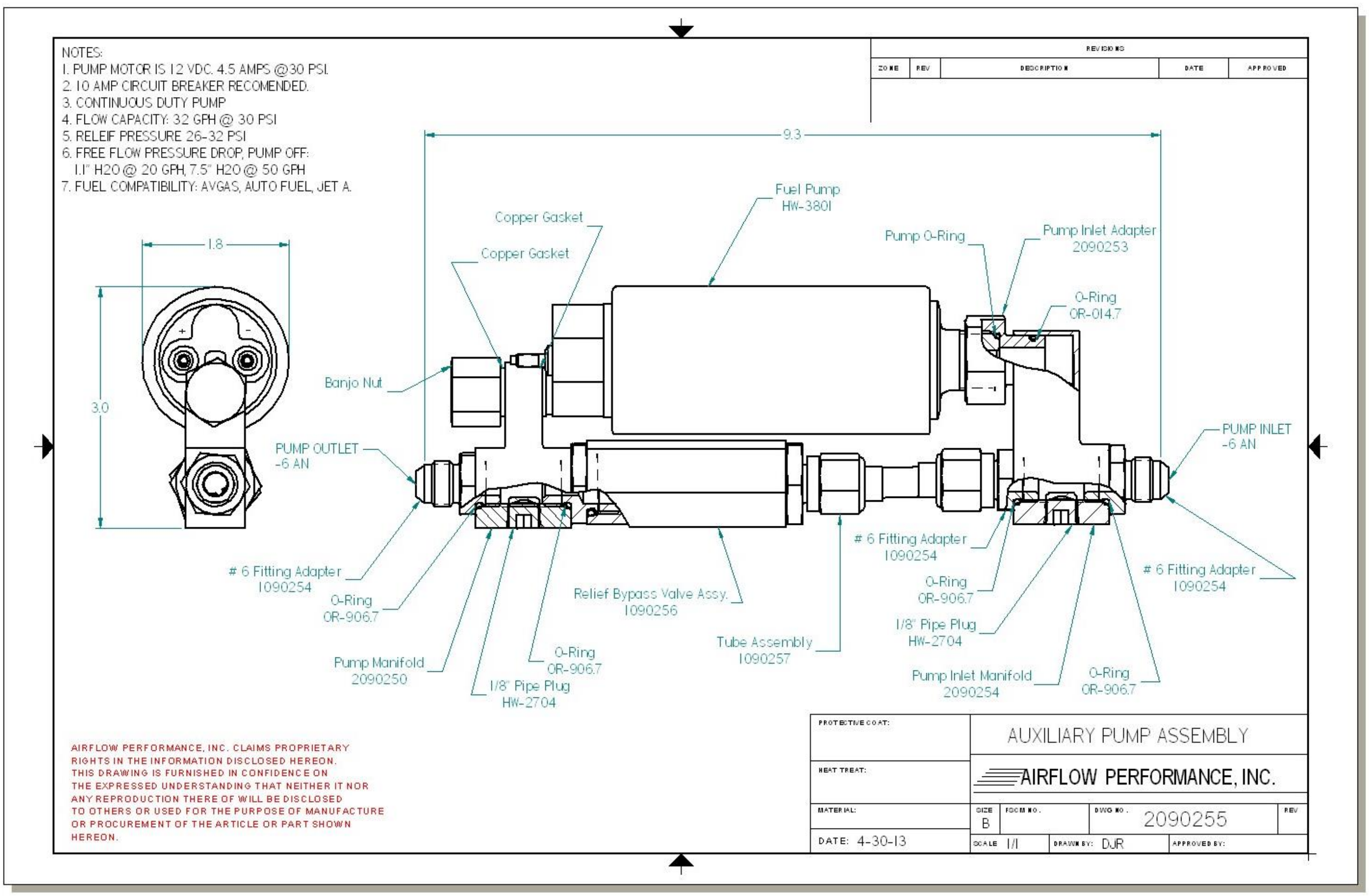
NOTE:

To insure a quick prime of fuel to the electric pump, on initial start, disconnect the outlet end of the pump and attach a suitable piece of hose. Put the hose in a container to catch the fuel. Energize the pump. This will allow the pump to free flow. Let it run to pass ½ to 1 gallon of fuel. De-energize the pump, and re-connect the standard aircraft plumbing.

WARRANTY OF PUMP PACKAGES

All pump packages are tested in house to insure proper operation of the pump motor; correct pressure out put, correct flow out put and the assembly has been tested for external leakage.

- There will be no warranty on the pump motor P/N HW-3801.
    - Do not run this pump without fuel.
    - Water contamination will ruin the pump.
- Removing the supplied electrical wires will void the warranty.
- Removing or changing the supplied pump package fittings will void the warranty.
- If the supplied pump inlet or outlet fittings do not fit your installation, please contact Airflow Performance, Inc.



CHECK LIST FOR BOOST PUMP INSTALLATION

1. Flush airframe fuel system plumbing before connecting the high-pressure boost pump.

   Use an inexpensive low-pressure fuel pump and filters to flush the fuel tanks and plumbing in composite aircraft before connecting the high-pressure electric pump to the system. Insure all plumbing, hoses, and installed fittings are free from debris. DO NOT USE TEFLON TAPE ON FUEL FITTINGS

2. Free-flow the boost pump to insure pick-up of fuel on initial run of boost pump.

   Disconnect the fuel system plumbing before the engine driven fuel pump. Install a fuel hose into a suitable container. Upon initial start of the electric fuel pump, pump should pick up fuel within 5-15 seconds. If it does not, insure that the pump is wired correctly, the plumbing to the pump is correct, there is adequate fuel in the fuel system, and there are no air leaks on the suction side of the electric fuel pump. Flow ½ to 1 gallon of fuel into the container before shutting off the electric fuel pump and re-connecting the fuel system.

WARNING

Airflow Performance and Bendix/Precision fuel injection systems are non-returning systems. In the event that a tank is run dry in flight, an air lock will be formed on the outlet of the pumps. It is possible that the boost pump will not pick up fuel, as the boost pump cannot create enough air pressure to over come the flow divider opening pressure, thus displacing the air and resume pumping fuel. It is not recommended to run a fuel tank dry in flight without adequate testing and proper documentation of the procedure for this operation.

3-9. If an electrical system is not installed on the aircraft, a manual wobble type boost pump may also be used. These pumps are generally used for starting, but do not afford the safety of an electric boost pump. Keep in mind that if the engine driven pump were to fail during take off, it would be highly unlikely that the engine could be restarted or caught before it quit by working the wobble pump to generate the necessary fuel pressure to run the engine in the time available. These pumps are generally heavier than the electric boost pumps.

ENGINE DRIVEN FUEL PUMP

3-10. Engines can be equipped with an engine driven fuel pump to supply the necessary fuel flow and pressure to the fuel controller. When the engine is equipped with magnetos for the ignition, this combination with an engine driven fuel pump, will allow the engine to operate with no electrical power on board. The minimum fuel pressure requirement for the system is dependent upon the engine output, system type, and installation. The engine driven fuel pump must be capable of supplying the required flow and pressure. Typically the pump output should be at least 1.5 times the engine requirements. If you are unsure of the pressure and flow requirements for your installation contact Airflow Performance to determine the correct pump output.

3-11. Lycoming engines usually use a high pressure diaphragm type engine driven fuel pump on their fuel injected models. This pump (LW-15473) generates 20-25 PSI while the engine is running. This is an acceptable pump to use with Airflow Performance fuel injection also. Some model engines use a vane type engine driven fuel pump. Romec or Lear are common names for these vane pumps. A common part number used is RG 17980 or RG 9080. This pump is usually required for use with turbo charged engines, due to the higher fuel pressure requirements. Make sure the pump relief pressure is set correctly for your application. Different engines may use other types of engine driven fuel pump. Consult the engine manufacture for pump compatibility.

FUEL PUMP COOLING

3-12. It is recommended to install a blast air shroud with associated ducting or duct blast air to the engine driven pump. This especially important where high ambient conditions or tight cowls are present.

FUEL PRESSURE GAUGE

3-13. Fuel pump output pressure is an important parameter to monitor. This can be picked up at the pump discharge port or fitting. The outlet fitting can be tapped to install a gauge fitting. The gauge fitting must have a restrictor installed. The restrictor should be .013-.020 inch dia. This will damp the pressure fluctuations to the gauge, and prevent dumping the fuel pressure if there is a gauge or gauge line failure. A number three or four hose is usually used to supply pressure to the gauge or pressure sender. In all cases the hose volume should be kept to a minimum. Make sure your gauge has sufficient range for your application. Selecting a gauge that has a 15 to 20 PSI higher range than the normal operating pressure is recommended. A 0-60 PSI gauge is a typical range for most installations.

FUEL LINE CONNECTION

3-14. Use fire sleeved hose for all plumbing on the inlet and outlet of the engine driven fuel pump. Typically the outlet side of the pump is plumbed with #6 (3/8) hose. The inlet hose to the fuel pump is sized based on the fuel system flow requirements. The metered fuel hose is connected to the fuel controller metered fuel outlet fitting and the flow divider or distribution block. This is typically #4 and should also be fire sleeved. Route all hoses away from heat sources and make the runs as short as possible. Use only aircraft quality fittings and aircraft grade hose recommended for fuel use. Teflon, fire sleeved hose is recommended for all hoses carrying fuel in the engine compartment.

MOUNTING THE FUEL CONTROLLER

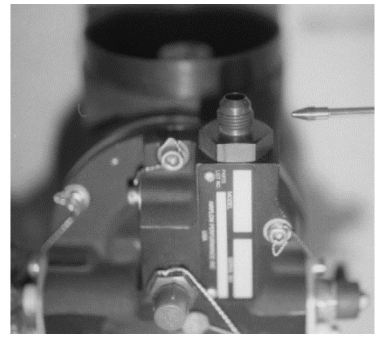
3-15. The fuel controller can be mounted to the engine intake manifold flange at any attitude to facilitate the installation requirements. Airflow Performance has a variety of elbows and adapters to fit most applications. The fuel controller can be remote mounted to the engine. Keep in mind that the ducting or required piping must be able to with stand engine vacuum and intake pulsations. 5/16" studs are required to attach all fuel controllers to the manifold or adapters. Use self locking nuts with washers on the stud to secure the fuel controller to the manifold. If the fuel controller is remote mounted, make sure that the brackets and mounts supporting the fuel controller are strong enough to with stand "G" loads encountered in flight.

FUEL INLET CONFIGURATION

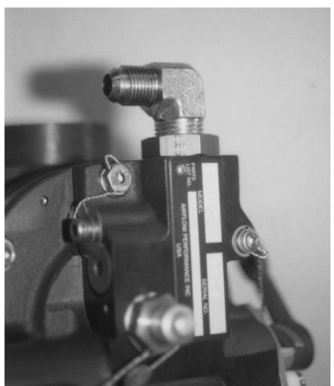
3-16. Your fuel controller has been configured for a specific application. There are three different fuel inlet configurations.

1.) Standard; the fuel inlet is in line with the air inlet and located near the air inlet.

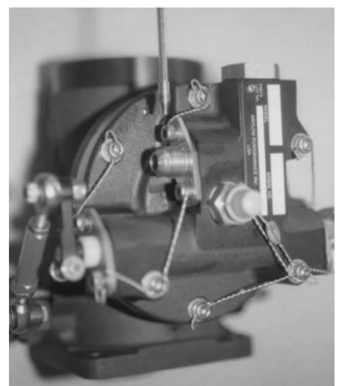
Torque the AN-6 hose connection to 30-40 in-lbs.



Standard Fuel Inlet



90 Deg. Fuel Inlet



Side Mount Fuel Inlet

2.) 90 degree; the fuel inlet is a bulkhead 90 deg. type fitting which can be rotated and locked in any position, and is near the air inlet. The bulkhead nut is torqued to 150-160 in-lbs. Torque the hose connection 30-40-in-lbs.

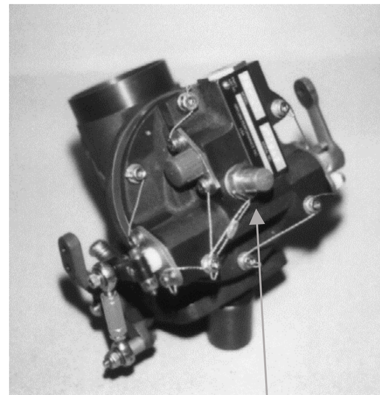
3.) Side mount; the fuel inlet is located below the air inlet and is perpendicular to the air inlet. The side mount inlet will require the use of an angled hose fitting on the fuel inlet hose to permit clearance for the idle lever at wide open throttle. Most fuel inlet fittings are -6 AN (there are some high flow applications that are -8 AN, in standard configuration only).

4.) All inlet fittings incorporate a 74 micron non-removable inlet filter screen.

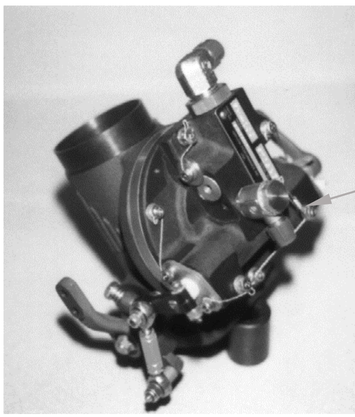
METERED FUEL OUTLET CONFIGURATION

3-17 There are three different types of fuel outlet.

1.) Standard; the outlet is a -4 AN fitting located at the center of the fuel controller regulator perpendicular to the throttle body bore.



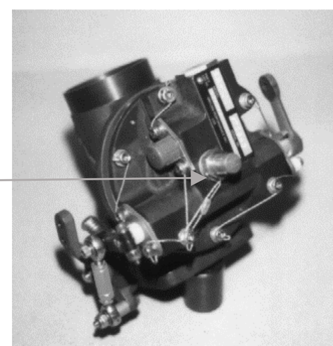
STD. Fuel Outlet #4



90 deg. Fuel Outlet #4

2.) 90 degree; the fuel outlet is a -4 AN banjo type fitting. This fitting is positioned and locked during calibration, as the banjo bolt is part of the fuel regulator seat and is shimmed and torqued at the factory. It's position should have been noted when you filled out your option sheet when you ordered your system.

Straight Fuel Outlet #6

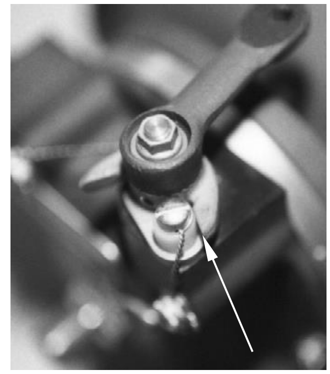


3.) -6 AN; this outlet is used for high fuel flow applications on engines running alcohol over 500 HP or engines developing over 800 HP on gasoline using a single fuel controller.

Torque the AN-4 hose connection to 25-35 in-lbs.

MANUAL MIXTURE CONTROL

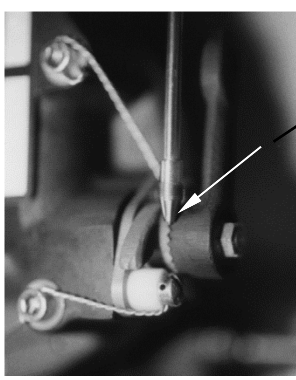
3-18. If your fuel controller is fitted with the manual mixture control option you will find the manual mixture control installed opposite the idle lever. The mixture control can be clockwise or counter clockwise rotation. This designates the rotation of the valve to the full rich position. In the full 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.



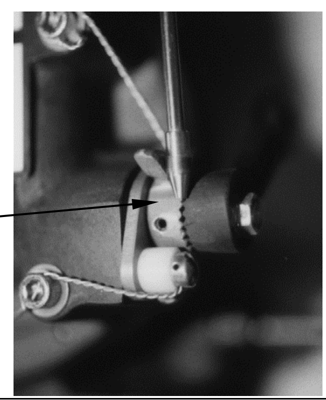
Mixture control in Rich position

Mixture control in ICO position

When "ICO" is against the plastic stop, the fuel flow is shut off to the engine. There is approximately 1.0 to 3.0 PPH leakage in this position. The mixture control lever can be indexed to any position to facilitate the linkage hook up. The mixture control lever meshes with the clutch teeth on the mixture control stop lever. This gives 15 degree increments of lever adjustment. Make sure that the teeth on the two levers mesh correctly before tightening the lock nut. Use a 5/16" socket to loosen and tighten the 1/4-28 lock nut. . Make sure that the teeth on the two levers mesh correctly before tightening the lock nut. Torque the lock nut to 45-50 in.-lbs.



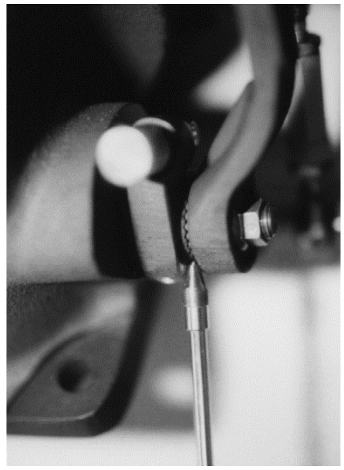
Correctly Meshed teeth



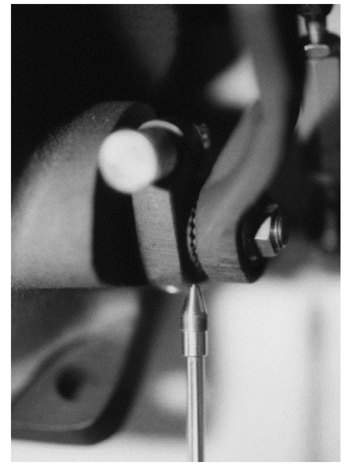
Incorrectly meshed teeth

NOTE: **The manual mixture is not intended to be used as a fuel shut valve. If the fuel supply is near or above the level of the injector nozzles fuel will seep into the engine, or seep out the injector nozzle vents. A zero leak fuel shut off valve must be used on these installations**.

THROTTLE LEVER

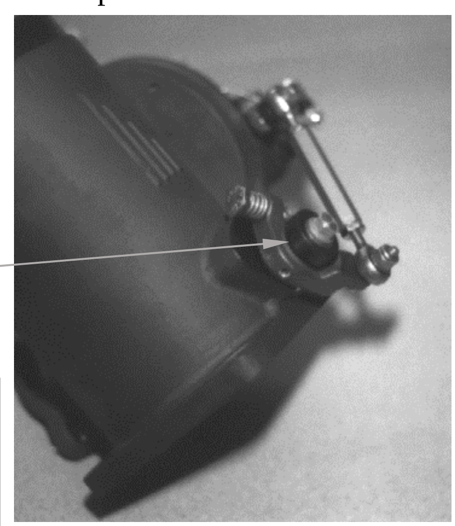


Correctly meshed Teeth



Incorrectly meshed teeth

3-19. The throttle lever can be installed on either side of the throttle shaft. It will typically be installed on the throttle stop lever side when the fuel controller is assembled. Like the mixture control lever, the throttle lever has clutch teeth that mesh with the throttle stop lever to give the throttle lever 15 degree increments of adjustment. Make sure that the teeth on the two levers mesh correctly before tightening the lock nut. Use a 3/8" socket to loosen and tighten the 5/16-24 lock nut. If you wish to install the lever on the other side of the throttle shaft, remove the lever from the throttle stop side and install on the opposite side of the throttle shaft. Mesh the lever with the teeth on the throttle shaft spacer and secure in place with a 5/16-24 lock nut. Purchase P/N 1090128 throttle shaft spacer, and install the spacer on the throttle stop lever side of the throttle shaft. Mesh the clutch teeth on the two parts and secure with a 5/16-24 lock nut. This is necessary to keep the throttle stop lever tight against the shoulder on the throttle shaft. . Make sure that the teeth on the two levers mesh correctly before tightening the lock nut. Torque the lock nut to 50-60 in.-lbs.



Throttle shaft spacer
P/N 1090128

NOTE

A mechanical stop on the aircraft throttle and mixture control should be used to set wide-open throttle (WOT) and full rich (R) mixture setting. This will eliminate premature wear of the throttle and mixture stop levers. With the throttle in the WOT position it is acceptable to have up to 1/6 inch of clearance between the stop pin (roll pin) and the throttle stop lever. The mixture control should just hit the stop pin at each end of its travel.

CONTROLS

Refer to Appendix 'B' for control and linkage installation.

3-20. The control rods and levers used to operate the throttle and mixture control should be of rugged construction so that positive operation may be obtained. The levers are drilled to accept 3/16'" bolts. Spherical bearing rod ends are recommended for attachment to the levers. The use of flimsy motorcycle type cables with return springs is not recommended. The system should be designed and built so that full movement of the fuel controller throttle and mixture levers is obtained, and the movement is in the proper direction. Insure that "G" loads encountered in flight will not change the position of the throttle or mixture control set by the pilot.

AIR INLET

Refer to Appendix 'C' for air inlet configurations.

3-21. Correct air flow into the fuel controller is necessary not only for optimum performance of the fuel controller, but to obtain peak performance from the engine as well. Cold ram air can be applied directly to the inlet of the throttle body with no adverse effects to the fuel metering capabilities of the fuel controller. It is best to have two sources of air to the fuel controller.

1.) Unfiltered cold ram air inlet.

2.) Filtered alternate air inlet from inside the cowling. The filtered air provides protection to the engine during ground operations and if flying through rain, snow or ice. The ram air inlet provides maximum air density to the engine. This is especially important at high altitudes where the air density is low.

3-22. The air inlet on the cowling should have a smooth radiused entrance to the duct leading to the fuel controller. **DO NOT** connect a straight piece of tubing to the fuel controller entrance and have this piece of tubing protruding through the cowling to pick up the air. This type of sharp edge entrance does not flow air well and causes the fuel controller to enrichen the fuel air ratio. Be sure that where the air is picked up on the cowling is a high pressure area in flight. Consult the manufacture of the airframe or instrument the aircraft to record in flight air inlet pressure to confirm this. A 5 to 15 degree included angle duct is useful in providing smooth air into the fuel controller. The duct should be at least as big in diameter as the fuel controller inlet O.D. Scat tubing is an acceptable duct as long as the lengths are kept to a minimum. If 5 times the diameter of the tube will be used for length, consider using the next larger size scat tubing. Scat tubing does not flow air well due to its corrugated design. Smooth inner wall would be better for long runs.

Insure that the ducting cannot kink or collapse under use. Be a where of flexible tubing with an inner liner. Make sure the inner liner cannot collapse or peel back during installation.

3-23. For designs where the fuel controller inlet attaches to an air box, insure the box has adequate volume so the air slows sufficiently before turning and going into the fuel controller inlet. Install a radiused inlet in the box to smooth the air flow into the fuel controller. If you are unsure of the design of the box, contact Airflow Performance for approval. **NOTE: A poorly designed air box will adversely effect the operation of the fuel controller and the engine. Running an engine with this inlet configuration or without the air box attached, will result in a poor and extremely rich running engine. If the propeller blast flows across the top of the fuel controller inlet, disruption to the air flowing into the throttle body will result. There can even be a vacuum pulled on the air inlet causing the engine to surge and run erratically**.

FLOW DIVIDER

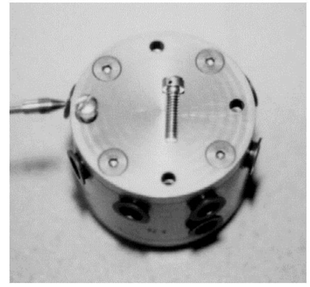
Refer to Appendix 'D' for Flow Divider installation.

3-24. If your installation requires the use of a flow divider, the location where the flow divider is mounted is dependent upon the installation. On Lycoming engines the common place to mount the flow divider is on the top of the engine. If the engine is down draft cooled, this will provide cooling air around the flow divider while the engine is operating. With the injector nozzles installed in the injector nozzle ports in the top of the cylinder heads, this also allows the installation of the shortest possible nozzle lines. It is a good idea to provide some type of vent or cowl flap to allow the heat to escape from the cowling when the engine is shut off. This will help to keep the fuel from boiling out of the flow divider and solve some of the hot start problems.

3-25. If your installation has up draft cooling or the injection nozzles are mounted in the primer ports, mount the flow divider under the engine. A common place on Lycoming engines for this installation is under the crankcase next to the starter, or mount a bracket off the oil sump attaching bolts.

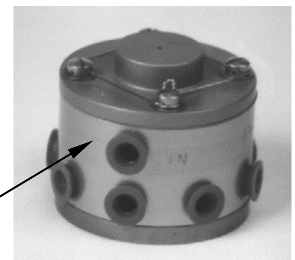
NOTE: Always install the flow divider on the cool side of the engine.

3-26. The flow divider can be mounted in any position. Provide a sturdy mount to withstand engine vibration and "G" loads encountered in flight. of the flow divider to facilitate mounting. All Airflow Performance flow dividers have eight nozzle line ports. Choose any of the ports necessary to satisfy the nozzle line requirements and give convenient routing of the nozzle lines. Install the nozzle line fittings in the appropriate port and plug the other ports with the supplied 1/8" pipe plugs. A AN 816-4D (1/8 pipe to #4 straight) or AN 822-4D (1/8 pipe to #4 90 deg.) is typically installed in the port marked "IN".



10-24 UNC mounting holes. 4 locations

3-27. Connect the flow divider port marked "IN" to the metered fuel outlet on the fuel controller. Use a flexible No. 4 fire sleeved hose to connect the two components. Route the hose away from heat sources like the exhaust pipes. Clamp or tie off the hose securely to eliminate chaffing. Airflow Performance **does not** recommend the use of hard tubing for this connection.



"IN" port

DISTRIBUTION BLOCK

Refer to Appendix 'E' for Distribution Block Installation.

3-28. If your installation uses a distribution block, it must be mounted below the injector nozzles. For Lycoming engines, fabricate a bracket to mount the distribution block under the crankcase, or off the oil sump attaching bolts. For other engines, find a suitable place which keeps the block below the injector nozzles, and keeps the injector lines as short as possible. The distribution block should be mounted horizontal if possible, although satisfactory results have been obtained by mounting it in any position. Use a flexible No. 4 fire sleeved hose to connect the distribution block to the metered fuel out on the fuel controller. Route the hose away from heat sources like the exhaust system. Clamp or tie off the hose securely to eliminate chaffing. Airflow Performance **does not** recommend the use of hard tubing for this connection.

NOTE

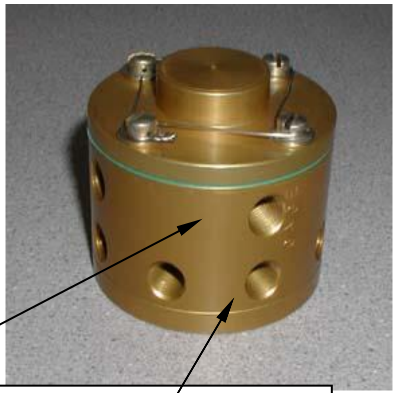
Distribution block must be mounted below the injector nozzles and on the cold side of the engine for proper engine operation. If injector nozzles are not at the same level, improper idle operation will result.

FLOW METERS

3-29. You may wish to install a fuel flow meter in your installation. There are electronic models on the market available for aircraft use. These models typically use a turbine flow meter to measure the fuel flow. Install the turbine flow meter in the No. 4 metered fuel line. This is between the fuel controller and the flow divider or distribution block. Follow the manufacture's recommendation for installation of the flow meter. Install straight fittings in the inlet and outlet of the flow meter. “Full Flow” (curved tube) 90 or 45 degree hose fittings can be used on the inlet or outlet of the flow meter connection. Refer to Appendix D.

DO NOT CONNECT TURBINE TYPE FLOW METERS ON THE INLET OF THE ENGINE DRIVEN FUEL PUMP.

3-30. It is possible to use a pressure gauge, which measures nozzle backpressure to show fuel flow. The gauge must be calibrated for a specific number, and size of injector nozzles. If a flow divider is used, install a No. 2 or No. 3 fitting in the "GAGE" port. No restrictor is required in the gage fitting as the restrictor is machined into the flow divider body. The nozzle port directly below the "gage" port must be connected to an injector nozzle for the flow reading to be accurate. Run a No. 2 or No. 3 hose from the fitting on the flow divider to the pressure gauge. Keep hose volume to a minimum.



Fuel flow gauge connection.

Nozzle must be connected to this

3-31. If a distribution block is used in your installation, install a tee in one of the ports that has a nozzle line attached, or install the No. 2 or No. 3 fitting directly in a spare port on the block. The fitting must incorporate a .013" to .016" diameter restrictor in the fitting. Connect a No. 2 or No. 3 hose from the fitting to the fuel flow gauge. Keep hose volume to a minimum.

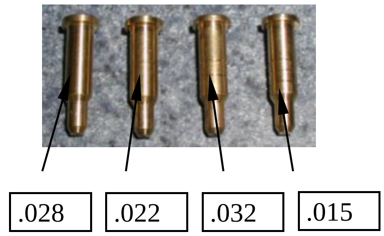
3-32. There are fuel flow gauges from certified engine installations, which may be applicable for your installation. These gauges are calibrated in GPH and have a usable range in the cruise and full throttle power area. If you want to calibrate a standard pressure gauge or use an existing fuel flow gauge, contact Airflow Performance for a gauge calibration sheet or conformation of the calibration of the fuel flow gauge you want to use.

NOTE:
Using a pressure gauge to indicate fuel flow is for reference purposes only. This method **should not** be used to determine fuel quantity on board the aircraft.

NATURALLY ASPIRATED INJECTOR NOZZLE

3-33. Naturally aspirated injector nozzles are identified by the gold anodized shield around the nozzle body. Each nozzle has a calibrated fuel restrictor that slips into the body of the nozzle. These are identified by machined bands on the body of the restrictor.

BAND	SIZE
None	.028
1	.022
2	.032
3	.015



> **NOTE**
> Airflow Performance injector nozzle restrictors are described above. Bendix / Precision restrictors are similar but their restrictor has one band on the restrictor body and are made from stainless steel. This is a .028 restrictor.

Do not mix restrictor sizes on the same engine. To install the nozzle body; remove the restrictor and

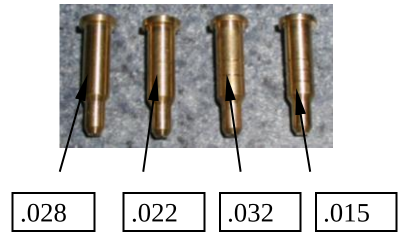
apply a **<u>small</u>** amount of anti-seize compound to the pipe threads on the body. Install the nozzle with a <u>clean</u> 1/2" deep socket (a 1/4" drive, 6 point deep socket works well) to tighten the nozzle. Make sure the hex is broached far enough into the socket so it will not damage the nozzle shield. Torque the nozzle body to 40 to 60 inch pounds. If the nozzle will be installed in any position other than vertical (discharge end down), tighten the nozzle to 40 inch pounds first then check for the position of the "A" stamped on one of the hex flats on the body of the nozzle. Continue to tighten the nozzle until the "A" points downward within a tolerance of one flat of the hex of the nozzle body. Do not exceed the maximum nozzle torque value when positioning the "A". This will position the air bleed hole in the body of the nozzle to face upward, and tend to keep fuel from dripping out the air bleed hole after engine shut down. Reinstall the fuel restrictor into the nozzle body before attaching the nozzle line.

TURBO INJECTOR NOZZLES

3-34 These nozzles are on engines using turbo or superchargers. They are also used on naturally aspirated engines where the position of the installed nozzle will be up side down (the discharge end of the nozzle is higher than the air bleed hole on the nozzle body). This is typical for Lycoming engines where the nozzles are installed in the primer ports. You may also choose to use these nozzles if the environment where the engine will be running is extremely dirty. These nozzles have a shroud, which uses two O-Rings to seal the air bleed section of the nozzle. There is a 3/16" diameter stainless steel tube brazed to the shroud for attachment of a 3/16" hose.

Each nozzle has a calibrated fuel restrictor that slips into the body of the nozzle. These are identified by machined bands on the body of the restrictor.

BAND	SIZE
None	.028
1	.022
2	.032
3	.015



NOTE

Airflow Performance injector nozzle restrictors are described above. Bendix / Precision restrictors are similar but their restrictor has one band on the restrictor body and are made from stainless steel. This is a .028 restrictor.

Do not mix restrictor sizes on the same engine. To install the nozzle body; remove the restrictor and apply a **small** amount of anti-seize compound to the pipe threads on the body. Install the nozzle body into the injector nozzle port on the engine. Use a clean 1/2" deep socket (a 1/4" drive, 6 point deep socket works well) to tighten the nozzle. Torque the nozzle body to 40 to 60 inch pounds. The B-nut of the nozzle line will hold the spring and retainers in place. Be sure the nozzle restrictor is in place before connecting the nozzle line.

Refer to Appendix 'F' for nozzle Bleed Air Rail installation.

3-35. The shrouds of all the nozzles must be connected to in a way to vent the nozzle. A bleed air rail can be constructed to connect the nozzles on one side of the engine. This is typically built using 3/8" diameter stainless tubing for the rail between the nozzles, and 3/16" stainless tubing stubs silver soldered to the rail. Connect the stubs to the shroud tubes with short pieces of 3/16" hose. Clamp securely. If the installation uses a turbo or supercharger, the bleed air rails will be connected to the bleed air shuttle valve, or the turbo discharge. If the engine is naturally aspirated, connect hoses to the bleed air rail to vent them overboard or to the air box. Air will be drawn through the air bleed system when the engine is running so protect the system from picking up dirt. Naturally aspirated engines can also vent turbo nozzles by running individual 3/16" hoses from each nozzle. Run these hoses overboard or connect all the 3/16" hoses to one 3/8" hose and run it overboard. Do not connect more than six nozzles to one 3/8" hose. After engine shut down, some fuel may drip from the bleed air hoses.

Refer to Appendix ‘G’ for Bleed Air Shuttle Valve Installation.

BLEED AIR SHUTTLE VALVE

3-36. For turbo or supercharger installations where the fuel controller is installed on the inlet side of the compressor or blower, a bleed air shuttle valve is used to vent the injector nozzles. Install the shuttle valve using two Adel (cushion clamps) clamps. Install the valve with the body horizontal or with the screen up. Connect the ports marked "BLEED AIR" to the bleed air rail with No. 6 (3/8") hose. There are two ports for this connection. If only one hose is used, cap the other port with a AN-6 pressure cap. Connect the port marked "TURBO" to the turbo charger or blower outlet before an inter cooler, or the intake manifold. Use a No. 6 (3/8") hose for this connection.

STAINLESS STEEL INJECTION NOZZLE LINES

Refer to Appendix ‘H’ for Injector Nozzle Line installation.

3-37. If your system was sent to you without the nozzle lines, the injector nozzles and flow divider must be mounted on the engine to determine the correct nozzle line length. After the injector nozzles and flow divider or distribution block is installed, the injection nozzle lines can be fitted. Use wire or welding rod to simulate the routing of the lines. Keep the lines as short as possible routing them away from heat sources (like exhaust). Provide for places to clamp the lines. Airflow Performance recommends clamping the nozzle line every 6 to 8 inches. The lines do not have to be equal length, but keep the lengths within 12 to 15 inches of each other. After you determine the required lengths, contact Airflow Performance to order your nozzle lines. The lines are custom made to your specifications. On Lycoming engines, if the flow divider is mounted on top the engine, the lines are typically routed and clamped down the push rod tubes. If the flow divider or distribution block is mounted under the engine, the lines are typically routed and clamped to the intake pipes. Keep the lines away from the exhaust pipes. If a distribution block is used in the installation, not only the block must be mounted below the nozzles, but also route the nozzle lines below the injection nozzle until right at the nozzle then run the line up and into the nozzle.

3-38. When installing the nozzle lines, bend the lines to follow the required routing. The nozzle line material is annealed 1/8" diameter stainless steel tubing and can be easily bent by hand. If a tighter radius is required use a suitable tube bender. Minimum bend radius is 0.5". Provide at least 0.5" of straight tube from each end before starting a bend. Clamp the nozzle line tubing every 6 to 8 inches. Use 1/8" Adel clamps (cushion clamps) around the nozzle line

Do not place a piece of rubber hose around the nozzle tube then clamp around the hose. Clamp the Adel clamp directly to the nozzle line. It is acceptable to fire sleeve the nozzle line tubing but is generally not required. Make sure the nozzle restrictor is installed in the nozzle body and secure the nozzle line B-nut to the nozzle body. If using turbo nozzles install the nozzle shroud, O-ring, spring and spring retainers. The B-nut holds the shroud spring and retainers in place. Torque the B-nut to 20-30 inch pounds or seat the B-nut finger tight then tighten the B-nut an additional one-half flat.

Over torquing the B-nut will fail the fuel restrictor.

TYGON NOZZLE LINES

3-39. This type of nozzle line material is normally used on two stroke engines. A plumbing kit is supplied with this type of nozzle line material. Route all lines away from heat sources. Apply some oil to the fittings to help with the installation of the tubing. Use a cable tie around each hose connection. Tie and support the lines to keep them from rubbing or laying on engine components. Make sure the nozzle restrictor is installed in the nozzle body and secure the nozzle fitting B-nut to the nozzle body. If using turbo nozzles install the nozzle shroud, O-ring, spring and spring retainers. If a distribution block is used in the installation, not only the block must be mounted below the nozzles, but also route the nozzle lines below the injection nozzle until right at the nozzle then run the line up and into the nozzle. The nozzle fitting B-nut holds the shroud spring and retainers in place. Torque the B-nut to 20-30 inch pounds or seat the B-nut finger tight then tighten the B-nut an additional one-half flat.

Over torquing the B-nut will fail the fuel restrictor.

PURGE VALVE ASSEMBLY

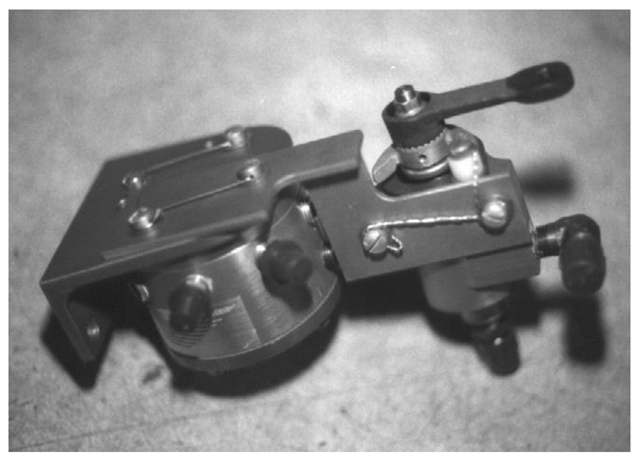
Background

3-40. Modern light aircraft fuel injection systems are of the low pressure constant flow type. Fuel is metered and is delivered to air bled nozzles, which atomize and spray the fuel at each intake valve. Airflow Performance and Bendix fuel injection systems meter fuel to the engine based on engine air consumption. The fuel regulator in both these types of injection systems do not return any fuel to the tank, therefore only the fuel that is used by the engine flows through the fuel controller. Vapor in these types of metering systems causes the fuel regulator to operate erratically and poor engine performance will result. This is usually evident during hot restarts. Hot restart problems are a typical complaint of pilots operating fuel injected engines. After engine shut down heat in the cowling and engine tends to boil the fuel in the fuel control, fuel pump and related fuel metering components.

Some of the fuel expands in the nozzle lines and gets forced through the injection nozzles and into the engine. This leaves hot fuel and fuel vapor through out the complete fuel metering system, engine driven fuel pump included. During an attempted start under this condition usually results in the engine starting for a moment then quitting. The pilot is then faced with decision of how to proceed with the start procedure. Flooding the engine then cranking the engine until it starts is usually done. This procedure is dependent upon battery life, which sometimes expires before the engine starts. Engines, which use the high pressure diaphragm fuel pump, experience another problem, which influences the ease of restarting the engine. By their design the diaphragm fuel pump acts like an accumulator when the engine is shut down. This keeps fuel pressure on the fuel controller, and leakage in the idle cut off circuit of the fuel controller will allow the fuel to bleed off into the engine. This can cause run on in idle cut off and flooding of the engine initially after shut down.

PURGE VALVE INSTALLATION

Refer to Appendix 'I' for Purge Valve plumbing installation schematics.



PURGE VALVE ASSEMBLY MOUNTED TO FLOW DIVIDER

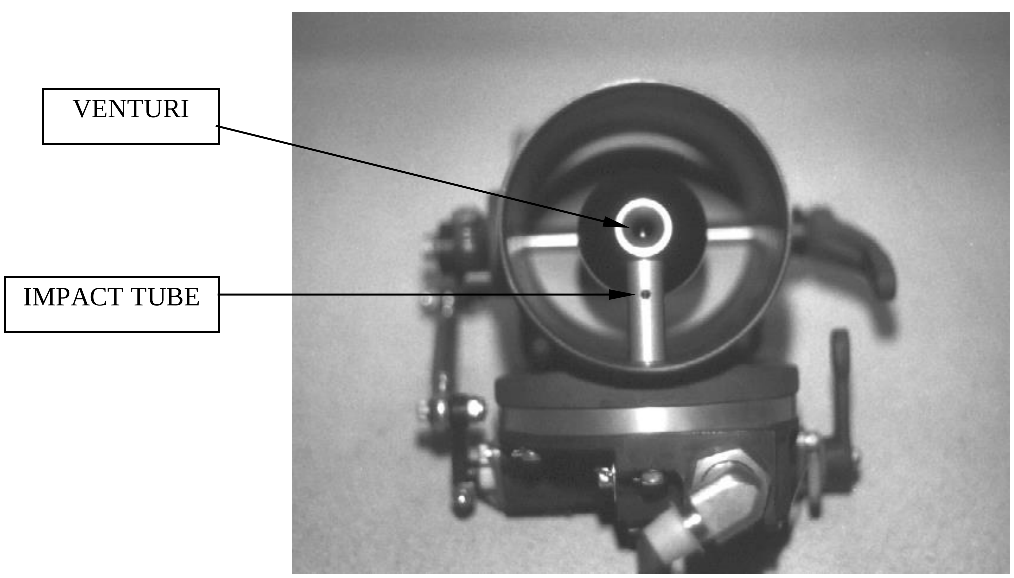
3-41. The purge valve is a manually operated device. It can be actuated by cable or linkage. It should be installed as close to the flow divider or distribution block as possible. Refer to the attached schematic for correct hook up of the purge valve assembly. The purge valve body has three 10-24 UNC threaded holes to facilitate mounting it to a bracket. All ports on the purge valve body are 1/8 NPT. The port stamped "IN" is to be connected to the fuel controller's metered fuel outlet. The port stamped "OUT" is to be connected to the flow divider or distribution block inlet. Make this connection and or hose as short as possible. Use AN-4 fittings and hose for these two connections. The port stamped "RETURN" is to be run back to any tank. This connection can be AN-2 to AN-4. Running this return hose back to the gascolator or fuel pump will reduce the effectiveness of the purge valve as the hot fuel and vapor will only be circulated through the fuel system. It may be possible to return the fuel to a low point in the vent system. Test to insure that during purge the fuel will flow back into the tank and not out the overboard vent. Make sure the actuating control moves the purge valve lever fully to its stops, both "R" and "ICO". The actuating control should be placed in the cockpit where it will not inadvertently be moved during flight. A locking control is preferred.

Make sure the actuating control will keep the purge valve in the "R" position during all flight conditions and attitudes. Leak check all the connections and plumbing before starting engine. Lock wire all hard ware. Make sure to lock wire the stop screw.

> **WARNING**
> **Failure to lock wire the stop screw holding the purge valve in the housing, will result in immediate engine stoppage if the screw backs out.**

FLUSHING THE FUEL SYSTEM

3-42. **Before running the engine, flush out the fuel system.** Before connecting the high pressure electric boost pump it is best to flush out the fuel system plumbing and tanks. Install a low pressure automotive electric pump with a throw away fuel filter on the discharge end of the pump after the selector valve. Put a discharge hose on the end of the filter and return the hose to the fuel tank the fuel is being drawn from. Run the pump circulating the fuel from the tank until 7-10 gallons has passed through the system. Shake the plane to get debri and insure fuel has sloshed all over the inside of the tank. Repeat procedure for all fuel tanks, then connect the inline filter and high pressure boost pump. Disconnect the nozzle lines from the nozzles. Place all the nozzle lines in a container. With the mixture control on the fuel controller in the full rich position, turn on the boost pump. Open the throttle wide open. Fuel should be flowing through all the lines. Increase the fuel flow rate by blowing air into the fuel controller inlet. Use an air hose to accomplish this. Hold the air hose a foot away from the fuel controller air inlet and blow at the venturi. **DO NOT BLOW AT THE IMPACT TUBE.** Flow a quart or so of fuel through the system. Return the throttle to idle and turn off the boost pump. Reconnect the nozzle lines to the injectors. **Do not** over torque the nozzle line B-nuts.



CHECK LIST FOR FUEL SYSTEM INSTALLATION

1. Check airframe plumbing for secureness.
    a. Tight connections.
    b. No kinked or chaffing plumbing.
    c. Check electrical wiring and electrical connector for boost pump.
    d. Correct circuit breaker for boost pump.
    e. Fuel system plumbing and wiring are free from interfering with full movement of all control surface controls.
2. Flush airframe fuel system plumbing before connecting high-pressure boost pump.
3. Free flow boost pump to insure pick-up of fuel on initial run of boost pump.
4. Check mounting hardware of fuel control, adapters, and brackets. Check lock nuts for correct engagement and torque. Check all screws requiring lock wire to be lock wired. Check Purge Valve stop screw for lock wire.
5. Check control cables for security to mounting brackets.
6. Check control cable rod ends for secured jam nuts and correct locking hardware on the actuating levers.
7. Check for correct engagement of the teeth on control levers.
8. Check operation of the manual mixture control. No binding. Check position to “Full Rich” and “ICO” with operation of the control in the cockpit.
9. Check operation of the throttle control. No binding. Check position to WOT to idle with operation of the control in the cockpit.
10. Check operation of the purge valve. No binding. Check position to “Full Rich” (run) and “ICO” with operation of the control in the cockpit.
11. Check security and clamping of the injector nozzle lines.
12. Check all hose connections in engine compartment. Fire sleeved hose, hoses tied off to prevent chaffing and away from exhaust system.
13. Injector nozzles installed with restrictors. Nozzle lines torqued at both ends.
14. Check air box installation. Check operation of alternate air valve if installed.
15. Pressure test fuel system. Purge valve in the ICO position.

SECTION FOUR

GENERAL OPERATING INFORMATION

GENERAL

4-1. Several phases of ground operation are adversely affected by fuel vaporization in the lines. Fuel vaporization may be experienced under extreme 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.

STARTING

4-2. 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 dies. After a 20-30 minute wait, the vaporized fuel in the manifold will have nearly disappeared and some slight priming could be required to refill the nozzle lines and keep the engine running after first firing.

IDLING

4-3. 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 temperatures 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 for Lycoming's, different engines may require RPM'S suitable for the installation)for several minutes to reduce the residual heat in the engine compartment.
5. Removal of heat from the cowling after engine shut down will aid in hot restarts.

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 taxing to parking. Due to the low power output, fuel flow is minimal. This keeps the fuel on the suction side of the engine driven pump under pressure so it does not boil. Keeping the pump on during these conditions also provides back up incase of engine driven pump failure.

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. For Lycoming and similar engines, adjust the idle speed stop to provide 700-750 RPM or as high as practical. Other types of engines will require different idle speeds. 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 taxing.
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.

SHUT DOWN

4-4. The idling procedure practiced just prior to engine shutdown 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. Opening the throttle with the mixture control in the idle cut-off position will aid in a cleaner shut off.

OPERATION USING THE PURGE VALVE

4-5. Unless requested by the customer, all aircraft installations using a engine driven fuel pump incorporate a purge valve as part of the flow divider assembly. These are fuel injection systems using the FM-100, FM-200, FM-300 and FM-300A fuel controllers. The purge valve control is used to start and stop the engine for all starting and engine shut downs. Leave the manual mixture control in the "Full Rich" position. During engine shut down the purge valve is put into the off or ICO position. This will allow the metered fuel to the engine to be shut off at the flow divider and be diverted back to the tank. This positively shuts the fuel off to the engine and allows the fuel pressure to dump in the system. The fuel controller mixture control is left in the full rich position. During a hot restart, the mixture control is left in the full rich position. Leaving the purge valve in the off position, open the throttle at least ½ open and turn the boost pump on. Fuel will then circulate through the engine driven pump, fuel controller, to the flow divider and back to the tank. This will flush the hot fuel and vapor from the system and cool the fuel injection components. A short prime may or may not be necessary for a hot start. Return the throttle to off idle, turn on the ignition and crank the engine. When it starts return the purge valve control to the run position. The engine will continue to run after it starts since the system is completely purged of vapor and the engine driven pump and fuel controller are filled with cool fuel. On a hot start it may be necessary to keep the boost pump running after the engine starts.

See Page 48 and 49 for Purge Valve Operating Procedures.

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SECTION FIVE

FIELD ADJUSTMENTS

STARTING PROCEDURE FOR INSTALLATIONS WITHOUT A PURGE VALVE

5-1. The following starting procedure has proven successful in installations using an <u>engine driven fuel pump</u> and an electric boost pump and no purge valve.

A. Cold Starts

1. Mixture control in the IDLE CUT-OFF position.
2. Set throttle to 1/8 open position.
3. Master switch -ON-.
4. Boost pump switch -ON-.
5. Move the mixture control to FULL-RICH until the fuel flow indicator reads 4 to 6 GPH then immediately return the mixture control to the cut-off position.
6. Boost pump switch -OFF-.

NOTE

On installations where a fuel flow indicator is not used, allow 4 to 5 seconds in place of reading 4 to 6 GPH on the gauge, or turn the boost pump on until an indication of fuel pressure is observed on the inlet fuel pressure gauge (5 to 10 PSI) then turn the pump off.

REMEMBER

Fuel will flow into the engine as long as the boost pump is left on.

7. 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. DO NOT PRIME.

C. Shutting Engine Off

1. Bring engine to idle.
2. Turn off boost pump.
3. Put mixture control to IDLE CUT-OFF position.
4. When engine quits, turn off ignition.

NOTE

The mixture control in the cut-off position is only intended to "Cut-Off" fuel to the engine. It is not intended as a fuel shut off valve. From 1.0 to 3.0 PPH leakage will flow through the fuel controller with the boost pump running and the mixture control in "ICO".

D. Starting Flooded Engine

1. Open throttle wide open.
2. Leave boost pump -OFF-.
3. Put mixture control in IDLE CUT-OFF.
4. Crank engine. When engine starts, bring throttle toward idle and slowly move mixture to FULL RICH as engine "cleans out".

5-2. The following starting procedure has proven successful in **installations using only electric fuel pumps**. Typically with these installations, the mixture control can be left in the FULL RICH position during starting and shut off procedures.

A. Cold Starts

1. Mixture control in the FULL RICH position.
2. Set throttle to 1/8 open position.
3. Master switch -ON-.
4. Fuel pump switch -ON-.
5. When the fuel flow indicator reads 4 to 6 GPH turn the fuel pump switch -OFF-.

NOTE

On installations where a fuel flow indicator is not used, allow 4 to 5 seconds in place of reading 4 to 6 GPH on the gauge, or turn the fuel pump on until an indication of fuel pressure is observed on the inlet fuel pressure gauge (5 to 10 PSI) then turn the pump -OFF-.

REMEMBER

If the fuel pump is left on when the engine is not running, the engine will flood and fill with fuel.

6. Crank engine. When engine starts, turn the fuel pump -ON- and bring the throttle to idle.

B. Warm Starts

1. Use the same procedure as for cold starts except eliminate step 4 and 5. DO NOT PRIME.

C. Shutting Engine Off

1. Bring engine to idle.
2. Turn off fuel pump.
3. When engine quits, turn off ignition.

D. Starting Flooded Engine

1. Open throttle wide open.
2. Leave fuel pump -OFF-.
3. Crank engine. When the engine starts, bring throttle toward idle and when the engine starts to run "clean", turn -ON- the fuel pump.

IDLE SPEED AND MIXTURE ADJUSTMENT

5-3. 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.

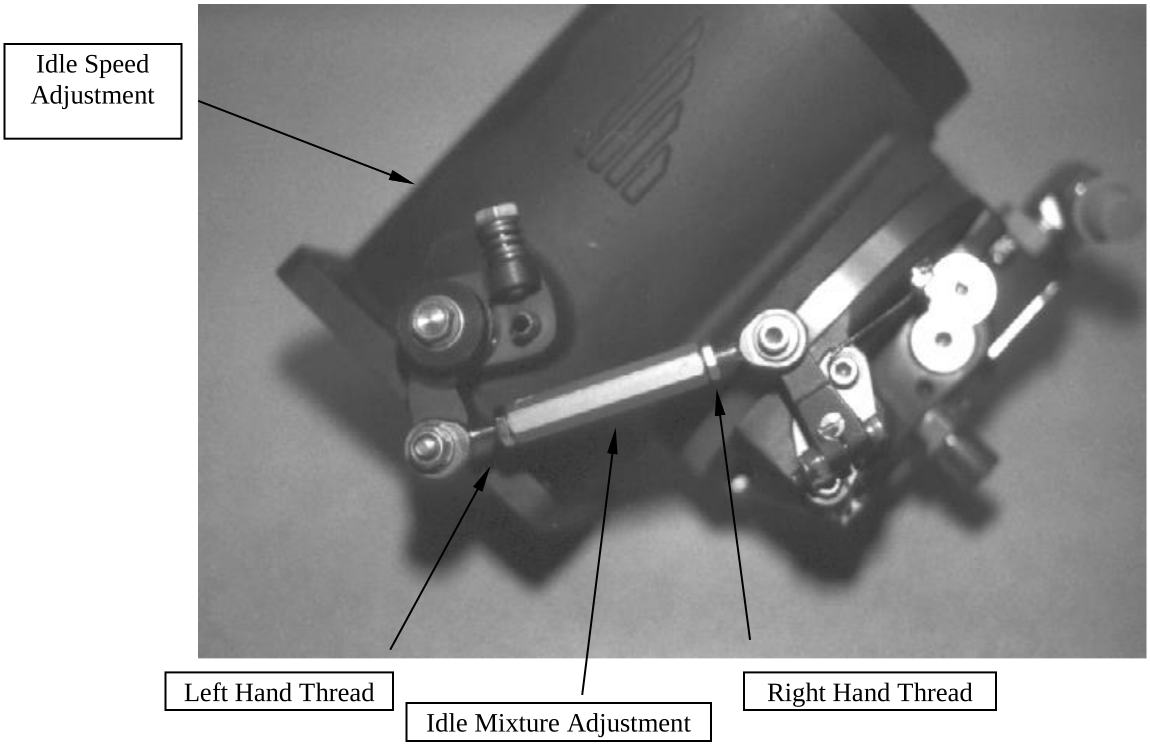
1. Warm the engine to operating temperature.

2. 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.

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

4. Set the idle speed with the speed stop bolt (on the throttle stop lever). Set the idle speed to the engine manufactures specification, or set the idle speed as high as practical. Lycoming engines are set to idle approximately 700 to 750 RPM. If the RPM changes appreciably after making an idle mixture adjustment during the succeeding steps, re-adjust the idle speed to the desired RPM.

5. 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.



6. 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 it's block, the link becomes longer and a richer idle mixture is provided. When it is turned into it's block the linkage is shortened and a leaner idle mixture is provided. There is a left and right hand jam nut to lock the linkage. . Use two 3/8" 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 after correct idle mixture is achieved.

NOTE

This adjustment will not effect the wide open throttle mixture.

7. Finding the optimal mixture is usually found by leaning the idle mixture link one flat at a time until the engine will not take the throttle while making a brisk advance of the throttle from idle. When this point is found, richen the mixture one or two flats.

8. Another 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 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.
   If a manifold pressure gauge is a cockpit instrument, it can be used to set optimal idle mixture. Lean or richen the idle mixture until the lowest manifold pressure is obtained at idle speed. Typical idle mixture for Lycomings is .3" to .5" MAP richer than the lowest reading. This will also give the best idle mixture.

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

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

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

12. 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.

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

14. 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.

FULL THROTTLE MIXTURE ADJUSTMENT

5-4. The following instructions deal with the full throttle mixture. An EGT (exhaust gas temperature) gauge is highly advisable to determine the correct mixture strength. The fuel air ratio in your fuel controller has been set at the factory for flow limits established by the engine manufacture. While these limits generally satisfy the engine requirements, modifications to the engine may require a slightly different fuel air ratio.

WARNING

The following procedure will require that the engine will 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.

1. Bring the engine up to operating temperature.

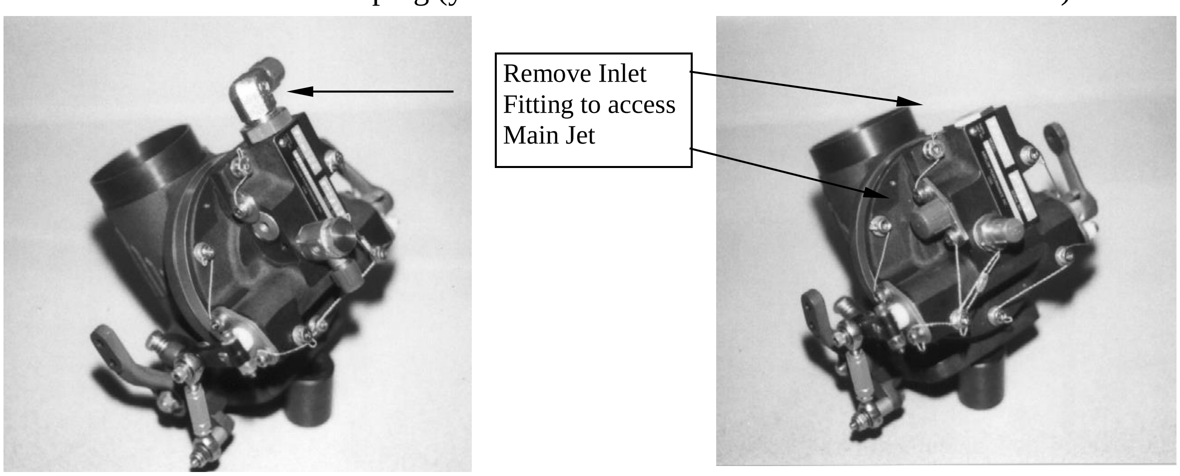
2. Put the mixture control to the FULL RICH position.

3. Advance the throttle to wide open.

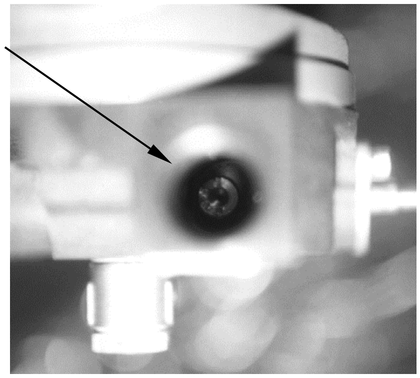
4. Observe the RPM and EGT. These parameters must be within the engine manufactures specifications. Typical full throttle EGT for Lycoming engines is 1300 to 1375 degrees Fahrenheit. On most 4-stroke engines, correct full rich mixture is indicated by an increase of 25 to 50 RPM when the mixture is manually leaned while at full throttle. This is with a fixed pitch prop. On engines with constant speed props, correct mixture can be determined by EGT change from full rich to peak EGT. To determine mixture using this method power must be set 22-24" MAP at no higher than 3500 ft. MSL. Record peak EGT on one cylinder then record full rich EGT on the same cylinder. The difference in EGT between peak and full rich should be 185 to 225 degrees F.

5. If the full rich full throttle mixture is not correct, it can be adjusted by changing the main jet located inside the fuel controller.

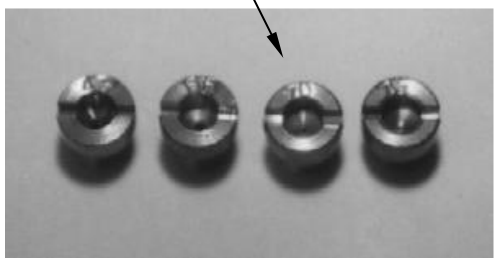
6. The main jet is located under the inlet filter fitting, the 90 degree inlet filter fitting, or for those fuel controllers with side mount inlet filter fitting it is located under the blue plug (you must remove the side mount inlet filter also).



Main Jet location inside regulator. Inlet Filter Fitting removed



Main Jet number (size) stamped on top of jet.



7. 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. <u>Use extreme caution</u> 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.

8. Re-lockwire the side mount inlet filter screws if removed.

OPERATING INSTRUCTIONS FOR USING THE PURGE VALVE

5-5. The following instructions are recommended procedures for operating engines with engine driven fuel pumps.

<u>COLD STARTS</u>

- Purge valve off (“ICO” position).
- Mixture control "FULL RICH".
- Throttle open ½ or more.
- Turn on boost pump. Run for 30-45 seconds
- Put purge valve to run (“R” position), count to five then return purge valve to off position. Actual prime time may be different from installation to installation. If the engine tends to flood, reduce the throttle to off idle then prime the engine.
- Reduce throttle to 1/8 or off idle.
- Leave the Mixture control in the full rich position.
- With mags "HOT”, crank engine, when engine fires, put the purge valve in the run position and the throttle to idle. After the engine stablizes idle, the boost pump can be shut off.

ENGINE SHUT DOWN

- Bring engine to idle speed.
- Leave mixture control "FULL RICH".
- Turn boost pump off.
- Put purge valve control to "OFF" position.
- Turn off the ignition.

HOT STARTS

- Mixture control "FULL RICH".
- Throttle ½ to wide open.
- Purge valve "OFF" position.
- Turn on boost pump and let run 30 to 45 seconds. This will purge the hot fuel and vapor from the system, and will cool and fill the fuel system components with cool fuel.
- Leave the the boost pump on.
- Set Throttle to 1/8 open.
- Give engine a short prime by putting the purge valve to "run" then back to "off".

The amount of prime required my vary from installation to installation.

- Leave Mixture control "Full Rich".
- With mags "HOT", crank engine, when engine fires, return throttle to idle and purge valve to "Run".
- Leave the boost pump on during hot, low power, operation.

Another method for starting the engine when hot is to leave the mixture "rich" after purging the system. With the purge valve in the ICO position and the throttle at idle, crank the engine while slowly moving the purge valve to the Rich position. The engine will start during this movement to the Rich position.

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SECTION SIX

TROUBLESHOOTING

6-1. Effective troubleshooting is an art that separates the professionals from the amateurs. To be able to pinpoint the problem or problems causing the malfunction is effective troubleshooting. Removing and replacing components on a trial and error basis is "shotgun" troubleshooting in its worst form. Shotgunning is expensive, time consuming, and nothing can be learned from it. To be effective, troubleshooting must be an analysis of the problem, its probable causes, and the necessary actions to correct the problem, and if possible, prevent it from happening in the future.

6-2. There are several points to keep in mind in developing an effective troubleshooting procedure for engines, their systems, and components. A complete understanding of basic engine principles and theory of operation is necessary to determine the path to follow to solve the problem. A suggested method, which, with minor changes, can be adapted to almost any engine, consists of five basic steps. These are:

1. STUDYING THE SYMPTOMS
2. ISOLATING THE SYSTEM EFFECTED
3. DETERMINING THE PROBABLE CAUSES
4. CHECKING AND REPAIRING
5. TESTING AND DOCUMENTING THE RESULTS

Possible causes are listed on the following pages in the troubleshooting charts, along with methods for determining correct operation of the individual components in the text following with out resorting to "changing the part and see if that fixes the problem".

The fuel controller in it self, is a fairly simple device. There are many engine symptoms that may mimic a fuel injection problem, but on understanding the operation of the fuel control system these symptoms can be isolated. An intermittent problem is usually not caused by the fuel controller it self do to the simple nature of its operation.

TROUBLESHOOTING CHART

PROBLEM	PROBABLE CAUSE	REMEDY
Hard starting	Technique	Refer to sections 5-1 and 5-2 also aircraft and engine manufacturers recommended starting procedure.
	Flooded	Refer to sections 5-1 and 5-2.
	Throttle valve open to far.	Open throttle to 1/8 or less. Amount may vary for given application
	Insufficient prime (usually accompanied by a backfire).	Increase amount of priming.
	Slow cranking speed Ignition timing Weak spark	Inspect starter motor, battery, associated wiring and components. Ignition may also be effected by slow cranking speed.
Rough idle	Mixture too rich or too lean.	Confirm with manual mixture control. Adjust idle mixture as per section 5-3.
	Restricted nozzle High take-off fuel flow may also be indicated on a fuel flow gauge, which measures nozzle back pressure.	Flow test and clean nozzles per instruction in section 6-7 and 6-8.
	Sheared nozzle restrictor. Caused by over torquing nozzle line B-nut.	Remove failed restrictor from nozzle body. Replace with correct restrictor size and torque nozzle line B-nut to 20-30 in-lbs.
	Restricted flow divider port. (If flow divider is used)	Flow test and clean per instruction in section 6-9
	Slight air leak into induction system through manifold drain if used.	Confirm by temporarily plugging drain valve. Repair or replace valve as necessary.
	Slight air leak into induction system through loose intake pipes or damaged seals or gaskets.	Repair as necessary.
	Incorrect ignition timing	Set to engine manufacturer's specifications.
	Incorrect valve lash Sticking valves	Set to engine manufacturer's specifications.
	Stuck flow divider valve.	Insure flow divider spool valve moves freely. See 6-10.

PROBLEM	PROBABLE CAUSE	REMEDY
Rough idle (Continued)	Injector nozzle lines draining. For installations using distribution blocks.	Mount distribution block below nozzles. Route nozzle lines below nozzles until connection to nozzle is made.
	Air in fuel supply.	Test per instructions in section 6-3.
	Fuel vaporizing in nozzle lines, distribution block, or flow divider. Encountered under high ambient temperature conditions, or following prolong operation at low RPM's.	Refer to section 4-3.
	Baffling hitting cowling.	Make sure only rubber seal strips contact cowl.
Unable to lean idle mixture.	Hung fuel controller regulator. (trash in regulator)	Test per instructions in section 6-4.
	Idle valve has excessive clearance	Test per instructions in section 6-5.
	Clogged air bleeds on injector nozzles. Restricted bleed air rail or stuck bleed air shuttle valve (turbo engines).	Inspect and repair as necessary.
Off idle stumble	Idle mixture to lean.	Reset idle mixture. Refer to section 5-3.
	Intake manifold leak.	Inspect and repair as necessary.
	Incorrect ignition timing.	Reset to engine manufacture's specifications.
	Air in fuel supply.	Test per instructions in section 6-3.
	Fuel vaporizing in nozzle lines, distribution block, or flow divider. Encountered under high ambient temperature conditions, or following prolong operation at low RPM's.	Refer to section 4-3.
Engine hangs on first acceleration of the day.	Air in fuel controller.	A brief hesitation is common on first start-up. This symptom should clear after the engine is run up.

TROUBLESHOOTING CHART (Continued)

PROBLEM	PROBABLE CAUSE	REMEDY
Engine hangs on first acceleration of the day. (Continued)	Oil or fuel contamination in the air section of the fuel controller.	Normally this is an indication of a turbo-charger seal leak. Return fuel controller for repair.
Engine hangs or is slow to transition off idle	Ignition	Make sure ignition is operating correctly and is timed to the engine manufacture's specs.
	Propeller	Incorrectly pitched prop
		Low pitch stop incorrectly set.
Engine is slow to transition mid-range to full throttle power and runs rich	Propeller	Low pitch stop incorrectly set. Possible prop governor problem.
	Turbo system	Differential pressure controller, waste gate, or waste gate control malfunction.
Low take-off fuel flow. Lean engine operation.	Insufficient inlet fuel pressure	Confirm fuel pressure requirement for maximum HP.
	Plugged inlet filter fitting or flow divider filter.	Remove filter fitting, clean and reinstall. Remove flow divider cover and diaphragm/valve assy. Back flush screen. See 6-10
	Restricted fuel supply to fuel pump. Problem can sometimes be confirmed by turning on boost pump.	Test for restriction in aircraft fuel system plumbing, filters, valves, fittings, etc. Eliminate 90 degree fittings on the inlet side of pumps.
	Stuck flow divider valve.	Flow divider valve must move freely. **DO NOT SAND OR REMOVE METAL FROM VALVE.** **Lightly** polish with 1200 wet/dry or Crocus cloth if necessary. Check for contamination and correct.
	Induction system air leaks	Inspect and repair as necessary. Pressure test induction system. (Disconnect M.A.P. gauge before performing pressure test.)

PROBLEM	PROBABLE CAUSE	REMEDY
Lean operation	Air in fuel supply.	Test per instructions in section 6-3.
Low take-off fuel flow. Lean engine. (Continued)	Incorrect full throttle fuel/air ratio. (Accompanied by high EGT)	Refer to section 5-4.
	Leaks or restrictions at nozzle lines.	Check nozzle lines for loose fittings or B-nuts. Check for kinks in line and cracks at braze joints.
	Incorrect gauge reading. (Accompanied by normal EGT)	Insure gauge is calibrated for correct number and size of nozzles. (When using nozzle back pressure gauge for flow meter)
		Insure correct K factor is installed into turbine type flow meter computer.
High take-off fuel flow. Rich engine.	Restricted nozzle. Accompanied by high fuel flow reading if pressure gauge type fuel flow gauge is used.	Remove and clean nozzles as per instructions in section 6-7 and 6-8.
	Incorrect full throttle fuel/air ratio. (Accompanied by low EGT)	Refer to section 5-4.
	Incorrect gauge reading. (Accompanied by normal EGT)	Insure gauge is calibrated for correct number and size of nozzles. (When using nozzle back pressure gauge for flow meter)
		Insure correct K factor is installed into turbine type flow meter computer.
	Restricted air inlet.	Check for clogged air filter, collapsed or obstructed duct.
	Heated air inlet.	Pulling inlet air from inside the cowl area may result in rich operation and low power output due to low air density (heated air).
	No inlet or incorrect approach on fuel controller air inlet.	Refer to section 3-21 and 3-22.

PROBLEM	PROBABLE CAUSE	REMEDY
Engine will not accelerate past a given RPM.	Restricted nozzle if accompanied by high fuel flow reading on pressure type fuel flow gauge.	Remove and clean injector nozzles as per instructions in section 6-7 and 6-8.
	Improper internal engine timing or ignition problem.	Correct timing problem.
	Restricted exhaust system.	Refer to engine manufacture for corrective action.
	Restricted intake manifold.	Insure correct gaskets are used and are installed correctly on intake manifold.
	Incorrectly pitched propeller.	Insure correct pitched prop.
	Throttle control not rigged properly.	Insure throttle on fuel controller opens to wide open stop when throttle control is at full throttle.
Poor cut-off.	Improper rigging of mixture control.	Adjust. ICO side of mixture control stop lever must be against plastic stop.
	Idle mixture set to rich.	Adjust idle mixture per instructions in section 5-3.
	Excessive clearance on mixture control valve. Note: 1.0 to 3.0 PPH leakage is normal for the mixture control in the ICO position. The purpose of the mixture valve is to shut the engine off in the ICO position, not to replace the aircraft fuel shut off valve.	Return fuel controller to for repair. Test for mixture control leakage as outlined in section 6-6.
	Vapor in nozzle lines.	Refer to section 4-3.
Inlet fuel pressure gauge fluctuations.	Restriction on inlet side of fuel pump.	Check for clogged filters, restricted fittings or hoses, incorrect sized fuel supply lines.
	Fuel boiling on inlet side of pump (vapor locking pump). This is common when using a vane type engine driven fuel pump with high under cowl temperatures and low RPM.	Turn on boost pump before reducing power. Leave boost pump on during idle operation.

PROBLEM	PROBABLE CAUSE	REMEDY
Inlet fuel pressure gauge fluctuations. (Continued)	Air in fuel system.	Test per instructions in section 6-3.
	No bleed or to large restrictor in gauge line.	Refer to section 3-13.
	Air in gauge line.	Purge air from line.
Engine runs rich and rough until oil temperature reaches 130-140 degrees.	The fuel injection system is not effected by oil temperature. Valve train problem, excessive oil pressure, malfunctioning hydraulic lifters, spalled lifters, incorrect valve lash.	Contact engine manufacture.
Engine looses power and fuel flow after running at maximum out put for a few minutes. After a subsequent restart full power and RPM is obtained, then after a few minutes of operation the engine looses power.	Since fuel flow is controlled by engine airflow consumption, a loss in power and fuel flow while running at WOT is indicative of an ignition problem. A possibility is changing ignition timing or bad spark plugs.	Test ignition system and spark plugs. Check valve guides for sticking valves.

TESTING FOR AIR IN THE FUEL SYSTEM

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.

6-3. The following procedure can be used to determine if air is getting into the fuel supply. After determining if air bubbles are in the fuel, work backward through the fuel system, removing components one at a time until the cause is found.

1. Connect a length of clear piece of Teflon tube between the fuel controller and the flow divider or distribution block. A 2 to 3 inch piece is all that is required to be clamped between two AN style fittings.

2. Run the engine and watch for air bubbles. Bubbles may initially be observed at start up and at idle. Run the engine up to a mid power setting. If bubbles are observed after 30 seconds or so then shut the engine down and proceed with step 3. It is common to see some air in the metered fuel lines or nozzle lines after start up and during prolonged idle. This air should clear out when the engine is run up to full power.

3. If air is observed during part and full throttle operation, proceed by disconnecting the fuel supply hose from the fuel controller. Use a valve and pressure gauge to put back pressure on the system. Set the valve to give 15 to 20 PSI with the boost pump running. Flow the fuel into a suitable container and observe the fuel stream for air. Continue testing back through the fuel system, removing one component at a time until the air source is found. Primary sources are:

   A. Heat being transferred to flow divider or distribution block.
   B. Fuel lines routed too close to exhaust system.
   C. Heat being transferred to fuel hoses under low flow conditions (idle power).
   D. Deteriorated main fuel (engine driven) fuel pump seals.
   E. Airframe boost pump shaft seal leakage.
   F. Damaged cones and flares on fuel line fittings.
   G. Flow restricting component on inlet side of fuel pump.
   H. Restricted fuel tank vent.

NOTE

Fuel fittings and lines can leak air and not fuel if the line or hose is on the suction side of the fuel pump. If having the boost pump on improves operation, then a leaky fitting or hose is possible between the boost pump and the selector valve or boost pump and the engine driven pump. You will typically see fuel leakage when this area is pressurized.

TESTING FOR CORRECT OPERATION OF THE FUEL CONTROLLER

6-4. The following procedure tests the operation of the fuel controller regulator. It is not intended to be used to determined if the fuel controller is in calibration.

A. Disconnect the hose that attaches to the flow divider or distribution block (metered fuel hose). Leave the hose attached to the fuel controller.

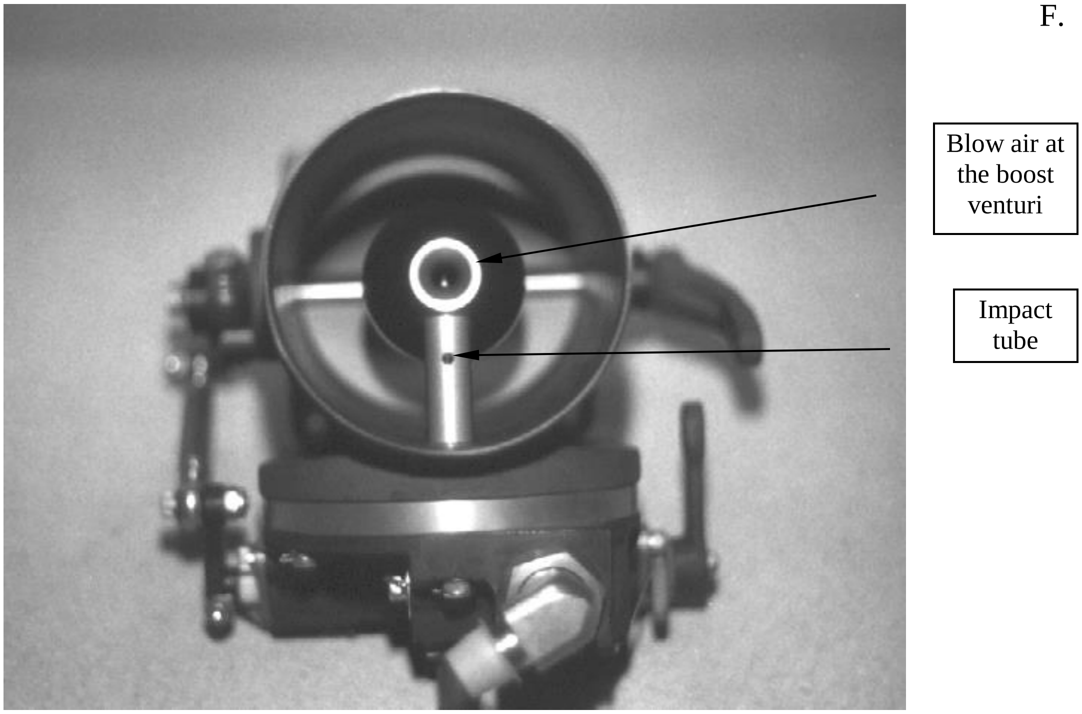
B. Place the hose in a suitable container.

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

D. Fuel should be flowing out the metered fuel hose.

E. Use an air hose to blow air at the venturi. This will simulate air flowing into the engine. Hold the air nozzle a foot or so away from the fuel controller air inlet. <u>DO NOT BLOW DIRECTLY AT THE IMPACT TUBE.</u>

F.



Observe the metered fuel flow. When blowing air at the venturi the fuel flow should increase immediately to a high rate. When the air is stopped the flow rate should immediately slow to a low rate. Do this procedure three or four times to make sure the fuel controller tracks the air flow inputs.

G. With the boost pump still running, and no air flow, return the throttle to idle. The metered fuel flow should slow to a lower rate (idle fuel flow).

H. Observe the impact tube during the test while the boost pump is running. There should be no fuel dripping or flowing from this port.

If the fuel controller does not perform as described in the above procedure, there is a malfunction or contamination in the fuel controller regulator. Continue with the following procedure:

I. With the throttle wide open, mixture full rich, boost pump on, and air blowing at the venturi, turn the boost pump off and on several times. Continue to blow air at the venturi while turning the pump off and on. This will cause the regulator to travel to its maximum limit and will tend to flush any contamination from between the regulator ball and seat.

J. Re test as described in steps "C" through "G".

If the fuel controller does not perform as described in the above procedure, there is a malfunction or contamination in the fuel controller regulator. Return the fuel controller for repair.

IDLE VALVE LEAKAGE TEST

6-5. The following procedure tests for excessive idle valve leakage. The fuel controller must pass the test in section 6-4. before proceeding with this test.

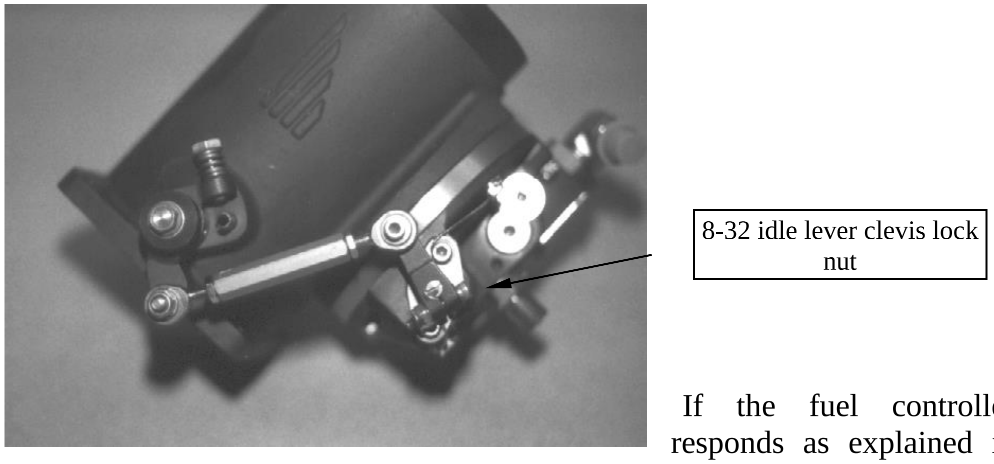
A. Disconnect the hose that attaches to the flow divider or distribution block (metered fuel hose). Leave the hose attached to the fuel controller.

B. Place the hose in a suitable container.

C. Turn the boost pump on and put the mixture control 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.

E. Disconnect the idle linkage at the idle valve lever by removing the 10-24 cap screw and lock nut. <u>Do not loosen the 8-32 clevis lock nut on the idle lever it self.</u> <u>Slowly</u> rotate the idle valve lever counter clockwise. The fuel flow should continue to slow to a fast drip (10 to 20 cc's per minute).



F. If the fuel controller responds as explained in part "D" and "E", the fuel controller is operating correctly. Reconnect the idle linkage to the idle valve lever with the 10-24 cap screw and lock nut. Make sure the idle valve rotates clockwise when the throttle is opened.

If the fuel controller does not perform as described in the above procedure, there is excessive leakage around the idle valve or contamination in the fuel controller regulator. Return the fuel controller for repair.

MANUAL MIXTURE CONTROL LEAKAGE TEST

6-6. The following procedure will test for correct operation of the manual mixture control. The Manual Mixture Control on FM fuel controllers in the idle cutoff 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. The fuel controller must pass the tests described in section 6-4 before proceeding with this test.

A. Disconnect the hose that attaches to the flow divider or distribution block (metered fuel hose). Leave the hose attached to the fuel controller.

B. Place the hose in a suitable container.

C. Turn the boost pump on and put the mixture control 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.

E. Put the manual mixture control into Idle Cutoff (ICO).

F. The fuel flow should decrease to a slow drip (1.0 to 3.0 PPH). Lightly tapping on the throttle body with the plastic handle of a screw driver may decrease the dripping rate. This is normal as the regulator ball is seating more firmly into the seat.

If the fuel controller does not perform as described in the above procedure, there is excessive leakage around the manual mixture control, contamination in the fuel controller regulator, or excessive leakage between the regulator ball and seat. Return the fuel controller for repair.

TESTING INJECTOR NOZZLES

NOTE

The following procedure is intended as a troubleshooting aid only, and should not be construed as a calibration check of the nozzle assembly. If a question exists regarding the serviceability of a given nozzle, the nozzle assembly should be returned for repair.

6-7. The following procedure tests for nozzle spray pattern and flow division between nozzle assemblies. If a flow divider is installed in the system it must be tested per the instructions in section 6-9 before proceeding with this test. If a distribution block is used in the installation make sure that all the nozzle lines route above the block and that all the nozzles are at the highest point and at the same level. Make sure that the same size restrictor is in each nozzle assembly.

A. Remove each nozzle from the engine and reattach the injector nozzle to the nozzle line.

B. Get some small containers of equal size to put each nozzle into. Baby food jars or cut off "COKE" cans work well.

C. Put the throttle wide open, mixture full rich and turn the boost pump on. Allow fuel to flow for a minute or two or until fuel is flowing from all the nozzles signifying that all the air is purged from the lines.

D. Turn the boost pump off and move the mixture to ICO. Discard the fuel in all the containers.

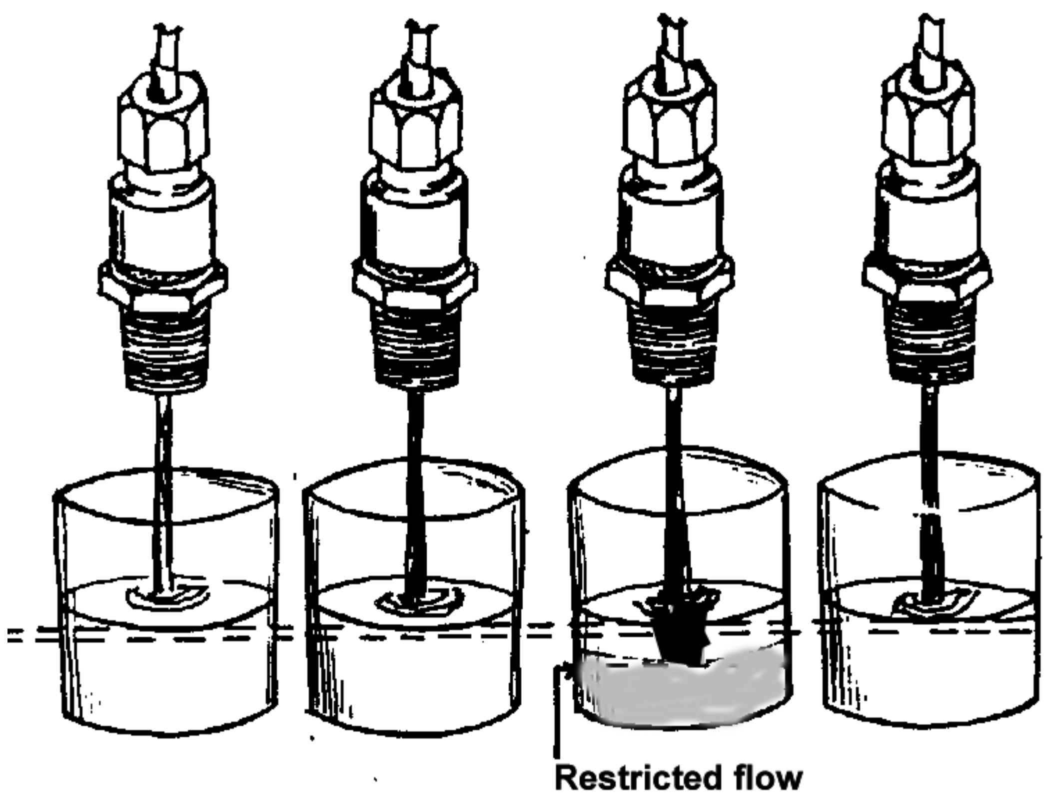
E. Insert nozzles in each container, leave the throttle open, turn the boost pump on and put the mixture to full rich. Allow the flow to run 15 to 30 seconds or fill the containers to half to three quarter full. Then return the mixture to ICO and turn off the boost pump.

F. Set the containers on a level surface and check for approximate equal volume.

G. Some variation is normal; a large variation indicates a restricted nozzle. While during the flow test, the nozzle spray pattern should be a straight pencil stream. Scattered or defused spray indicates a partially restricted or dirty nozzle.

Note: Nozzle spray pattern at idle is not always the same. Engine vacuum atomizes the fuel at idle flow conditions. Since vacuum is not present at this test, give more attention to the spray pattern of the nozzle at wide open throttle.

H. Locate and correct the source of contamination before returning the aircraft to service.



NOZZLE CLEANING INSTRUCTIONS

6-8. The following procedure is approved for cleaning Airflow Performance injector nozzles.

1. Remove the nozzle from the engine using a clean 1/2" six point 1/4" drive deep socket.

2. Remove the fuel restrictor from the injector nozzle body.

3. Submerge all the nozzle parts in non etching parts cleaner, Acetone, MEK, or Hoppes Number 9 gun cleaning fluid. Use the submersion time prescribed by the cleaner manufacture for cleaning the parts.

SOME CLEANERS WILL ETCH THE NOZZLE MATERIAL. PROLONGED SUBMERSION IN THESE TYPES OF CLEANERS WILL RUIN THE NOZZLE BODY AND FUEL RESTRICTOR.

4. Sonic cleaning is also an acceptable method of cleaning injector nozzles. Use approved solvent in the sonic cleaner. Follow the manufactures recommendations for cleaning time.

WARNING

<u>DO NOT</u> INSERT WIRE OR ANY SHARP OBJECTS INTO THE NOZZLE ORIFICES.

5. Remove from the solvent, rinse and blow dry.

6. Repeat the flow test as described in section 6-7.

7. Reinstall the injection nozzle in the engine as described in section 3-33 or 3-34.

TESTING THE FLOW DIVIDER

NOTE

The following procedure is intended as a troubleshooting aid only, and should not be construed as a calibration check of the flow divider assembly. If a question exists regarding the serviceability of the flow divider, the flow divider assembly should be returned for repair.

6-9. The following procedure will test the fuel flow division capabilities of the flow divider assembly.

A. Remove each nozzle line from the injector nozzle.

B. Get some small containers of equal size to put each nozzle line into. Baby food jars or cut off "COKE" cans work well.

C. Put the throttle wide open, mixture full rich and turn the boost pump on. Allow fuel to flow for a minute or two or until fuel is flowing from all the nozzle lines signifying that all the air is purged from the lines.

D. Turn the boost pump off and move the mixture to ICO. Discard the fuel in all the containers.

E. Insert the nozzle lines in each container, put the throttle to idle, turn the boost pump on and put the mixture to full rich. Allow the flow to run 30 to 60 seconds or fill the containers to half to three quarter full. Then return the mixture to ICO and turn off the boost pump.

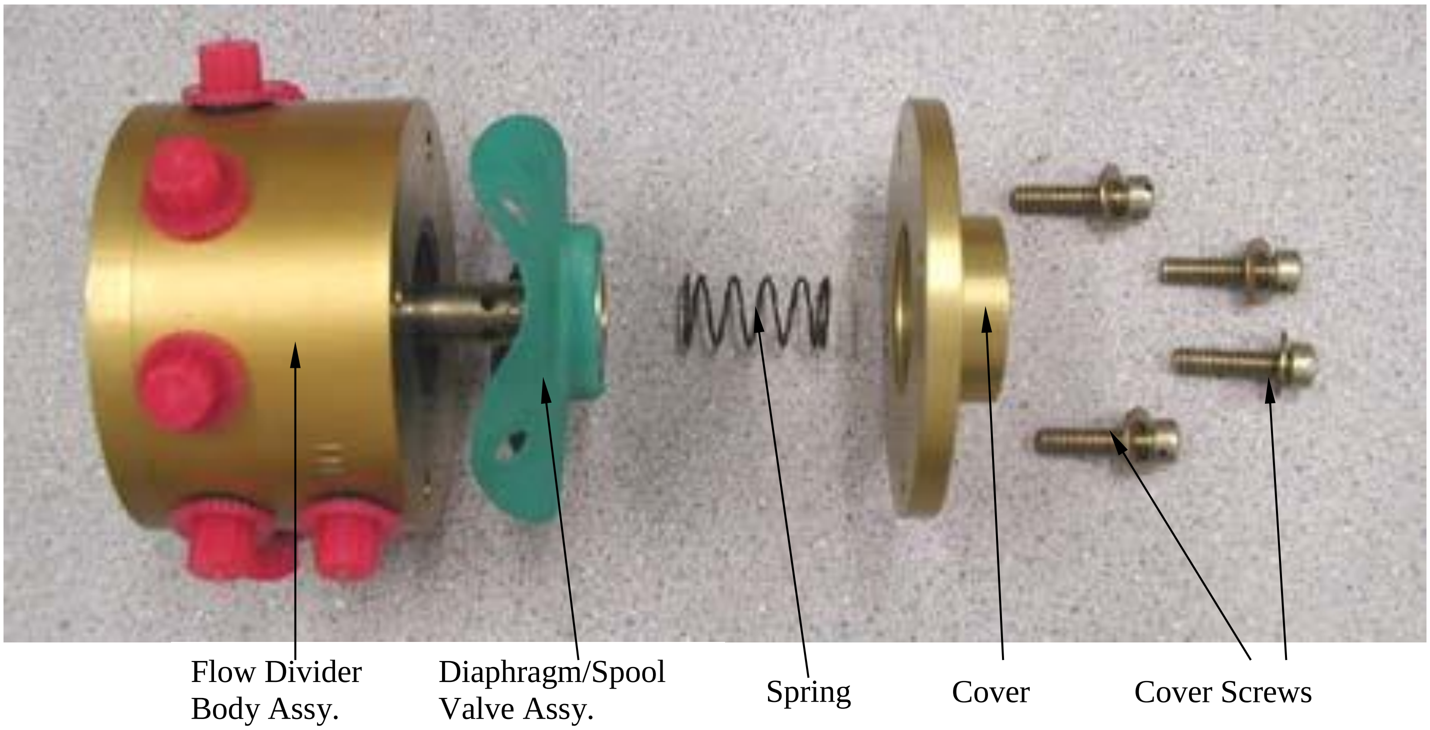
F. Set the containers on a level surface and check for approximate equal volume.

G. A small variation is normal; a large variation indicates a restricted flow divider port. A restricted or kinked nozzle line is also possible.

H. Locate and correct the source of contamination or restriction before returning the aircraft to service.

FLOW DIVIDER CLEANING INSTRUCTIONS

6-10. The following procedure is approved for cleaning the flow divider in the field. Should a malfunction in the flow test occur after cleaning, the flow divider should be returned for repair.



1. Remove the flow divider from the engine.

2. Remove the four 10-24 screws from the cover, and remove the cover. There is a spring under the cover. Remove the flow divider spool valve and diaphragm as one assembly. Do not remove the diaphragm from the spool valve.

3. Remove the four 10-24 flat head screws from the base of the flow divider. Remove the base noting the position of the base relative to the flow divider body. The bottom of the flow divider body and base are lapped surfaces. <u>DO NOT</u> nick or scratch these surfaces. Remove the O-ring from the base.

4. Clean the flow divider body in non etching parts cleaner, Acetone or MEK. Do not submerge the spool and diaphragm in any cleaner. Wash the spool valve and diaphragm with Stoddard solvent. Blow off all parts with compressed air. Sonic cleaning is also an approved method for cleaning the flow divider body.

5. Insure that all the flow divider port slots are clean. A .006" feeler gauge is useful for this task.

6. Reassemble the flow divider in the reverse order. Replace the flow divider base O-ring if damaged. O-Ring P/N OR-027.7.

7. Repeat the flow test as described in section 6-9.

8. Reinstall the flow divider on the engine as described in section 3-26 and 3-27.

INTERMITTENT POWER LOSS

6-11. The most aggravating problem for a mechanic is trying to find the reason(s)for an intermittent power loss. Generally, this is not caused by the fuel controller. Many times it is caused by the interruption of either the fuel or air supply to the fuel controller. This may be due to such things as air in the fuel supply, dropping fuel pressure or a restricted induction air duct.

NOTE

The words power loss here refer to engine stoppage and the subsequent ability to restart the engine and obtain full power.

The fuel controller will not cause an intermittent/inconsistent power loss, even momentarily. If the fuel controller would be responsible for an engine stoppage, the cause of the stoppage (internal regulator failure) would remain and be readily apparent during the flow test and tear-down inspection.

If a power loss is accompanied by high fuel flow (measured by pressure gauge type flow meter), check the injector nozzles, nozzle lines, and flow divider for indications of a contamination problem. Check for water or moisture in the fuel. Given the right situation, this can form ice crystals in the fuel, temporarily blocking the injector nozzles. Once the engine has stopped, the ice will melt, and the fuel supply will be restored. High fuel flow (normally a pegged gauge) will accompany this situation. Ice could also block other fuel lines and not melt until after the aircraft has landed. If water is suspect in the fuel, drain and flush the entire fuel system.

Check the intake system, especially double wall ducting, for integrity. Also insure correct air flow into the fuel controller inlet. Refer to sections 3-21 through 3-23.

Check air filter for condition, particularly after operating in rain or wet conditions. Also test the alternate air door for proper operation.

Check the fuel filters for contamination (REMOVE ALL PAPER ELEMENT FILTERS FROM THE FUEL SYSTEM) such as water, salt, sand, fiberglass hairs, etc. Also ensure the filter housing is installed properly to eliminate any possibility of air entering the fuel supply.

Check the fuel hoses for deterioration or a flap of rubber near the fitting ends.

Check ignition and ignition components. Many times failure of these components symptomize a fuel system problem to the extent that leaning the mixture improves engine operation.

Check for valve train problems, loose valve guides, insufficient valve lash, stuck valves, tight valve guides.

Check exhaust system, muffler baffles, cracks, restrictions, deterioration.

Insure correct oil pressure especially during aerobatics and unusual attitudes. Loss of oil pressure can cause constant speed propeller operation to go to maximum pitch, causing the engine to load up and loose power.

Check for air in the fuel system, especially if the power loss is associated with a particular aircraft attitude.

Check for fuel vent pressure if power loss is associated with an increase in airspeed.

Insure that alternate air doors are in the full closed (alternate air) or full opened (ram air) position. Partial position of the alternate air valve will upset airflow into the fuel control causing surging and poor engine operation.

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SECTION SEVEN

INJECTION SYSTEM NOTES

INDUCTION SYSTEM ICING

7-1. There two types of icing conditions, which are of considerable concern to the operator of any aircraft. The first is ice formation due to fuel vaporization, and the second is impact or atmospheric icing. The conditions that bring about these two ice formations are considerably different in their origin and, therefore, will be discussed separately.

VAPORIZATION ICING

7-2. Ice formation within carburetors due to fuel vaporization or refrigeration, is a result of a temperature drop at the point of fuel entering the air stream. The rapid vaporization of gasoline at the point of discharge can result in a 40 to 70 degree F drop in temperature. As moisture is always present in engine intake air, ice will form in the immediate area downstream from the discharge nozzle. In a carburetor this ice will usually form on the venturi and throttle shaft, and if permitted to accumulate will restrict the induction system to such an extent as to cause complete engine failure.

7-3. One of the main advantages of the FM series of fuel injection system is its "non-icing" characteristics. As fuel is discharged under pressure directly into the valve port of the intake manifold, the heat on the valve face completely eliminates the possibility of ice formation. Ice will not form in the venturi area of the fuel controller as no fuel is discharged in this area and the acceleration of the air across the venturi will not lower the temperature enough to cause ice to form.

ATMOSPHERIC ICING

7-4. Atmospheric (rime or impact) ice will usually form when flying through heavy rain, freezing rain, snow, or ice when the temperature is in the vicinity of 32 degrees F. This type of ice not only collects on the wing and propeller surfaces of the aircraft, but may completely restrict the inlet air scoop. Since this ice cannot be removed by application of heated air (carb heat), continued flight must be made on protected alternate air.

ICE AND SNOW

7-5. Power loss resulting from induction system restriction is often encountered when operating under these conditions. The restriction can form in the air inlet. Flight under there conditions must be continued by using protected alternate air.

FLIGHT DURING ADVERSE WEATHER CONDITIONS

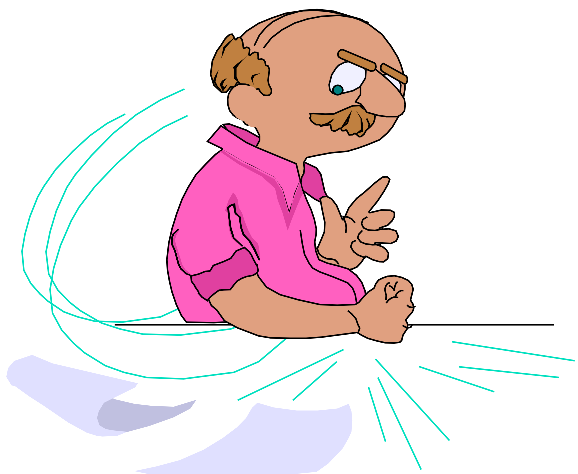
7-6. Flight under certain weather conditions can result in the accumulation of ice in the air induction system. Observing normal pilot precautionary and corrective measures, as well as the airframe manufacturer's prescribed procedures, such as use of protected alternate air, should be adhered to whenever flying in icing conditions.

SECTION EIGHT

MAINTENANCE, LUBRICATION, AND STORAGE

MAINTENANCE

8-1. In general, very little attention is required between fuel controller overhauls (2000 hours). It is recommended that the following items be checked during 100 hour inspections and or annual inspections of the engine and airframe. More frequent removal of components and or hoses is discouraged since there is more chance of contamination getting into the system.



"IF IT AIN'T BROKE, DON'T FIX IT!!"

A. After the first 3 to 5 hours of engine operation after installing the fuel controller on a new installation, remove and clean all fuel filters and strainers in the aircraft fuel system. Repeat after 10 hours of operation, 25 hours of operation and every 50 hours of operation there after. Fuel control inlet filter should be inspected and cleaned (sonic cleaner recommended) at condition inspection.

B. Check all fuel lines for tightness and evidence of leakage. A slight fuel stain adjacent to the injection nozzles is normal and not cause for concern.

C. Check tightness and lockwiring of all nuts, screws, and fasteners on the fuel controller and attaching hardware to the engine.

D. Check the throttle and mixture control rod ends and levers for wear and tightness. Also inspect the idle linkage jam nuts for tightness and rod ends for wear.

E. Clean injection nozzles every 100 hours of engine operation. More frequent cleaning may be necessary if operating under sever dirty conditions. Do not clean nozzles more often than every 50 hours. It is not necessary to remove the nozzle body from engine. Remove the fuel restrictor from the body and clean as described in section 6-8. If the nozzle body requires cleaning follow the instructions in section 6-8.

F. If a slight degradation in full throttle fuel flow is seen over time, inspect the venturi for contamination. If the venturi is coated with oil and dirt, spray off the venturi and boost venturi with “Brake Kleen” or equivalent. Clean the boost venturi with a “Q-Tip” wetted with solvent. Do not insert sharp instruments or scratch the boost venturi. Wipe dry with a clean soft cloth.

8-2. Gasoline becomes stale due to prolonged storage. This stale oxidized gasoline acquires a very distinctive odor similar to varnish. This forms a gummy deposit on internal metal parts. This condition will not occur during normal operation of the engine as fresh fuel will be circulating through the fuel controller. Installations in aircraft running auto fuel should start, take off and land using avgas. This will flush auto fuel from the metering system keeping varnish from fouling components.

8-3. If the aircraft will not be used or run for more than three months, the fuel controller should be drained of fuel and filled with a good grade of No. 10 non detergent oil. If this procedure is not followed then the engine should be run a minimum of 10 minutes every three months.

LUBRICATION

8-4. There is very little need for lubrication of the injector in the field. Place a drop or two of engine oil on each end of the throttle shaft so that it will work into the throttle shaft bushings. Recommended lubrication of these bushings is every 50 hours.

8-5. Follow the aircraft manufacture's, or air cleaner manufacture's instructions for cleaning and oiling the filter element. A filter element replaced with an excessive amount of oil on it can cause fuel metering difficulties as the excess oil will be drawn into the fuel controller inlet and into the venturi. This can greatly effect the metering characteristics of the fuel controller.

PREPARATION FOR STORAGE

8-6. Units taken out of service for more than three months should be removed from the engine and preserved. Use the following procedure for preserving the fuel controller.

A. Remove the fuel controller from the engine. Drain all residual fuel from the fuel controller.

B. Introduce 10 weight oil by gravity into the fuel inlet on the fuel controller. Use only clean filtered (10 weight, 10 micron filtration). Add oil until the oil runs out the outlet fitting. Exercise caution when adding oil to keep oil from entering the air section through the venturi. Although no damage will result to the parts in the regulator exposure to oil may effect the air signals from the venturi. This effect will be more noticeable in extremely cold environments.

C. Drain the excess oil from the fuel controller. A film of oil on the internal parts of the fuel section is sufficient to preserve the controller.

D. Replace caps on the fuel inlet and outlet.

E. Pack the fuel controller in a dust proof container.

F. If the fuel controller is to be stored or shipped over salt water, the following should be observed:

    1. Spray the external surfaces of the fuel controller with clean preserving oil. Do not spray oil in the venturi or impact tube.

    2. Pack the fuel controller in a clean dust-proof packing, wrap the packing with moisture-proof material and seal. Pack the fuel controller in a suitable shipping case.

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SECTION NINE

OVERHAUL PERIOD

Airflow Performance fuel controllers are not field repairable. There are no rebuild kits available and specialized test equipment is required for re calibration of the fuel controller. With the exception of the field maintenance and troubleshooting described in the previous sections, the fuel controller and components must be returned to Airflow Performance for overhaul and or re calibration.

TIME BETWEEN OVERHAUL

9-1. The time between overhaul (TBO) for all fuel controllers and fuel system components is the same as the recommended TBO for the engine, not to exceed 2000 hours. Time between overhaul is also dependent upon the type of service and the installation the fuel controller is subjected to. An installation subjected to hard aerobatics may not complete the full TBO due to higher vibration levels that are encountered in this type of service.

9-2. Regardless of time in service, overhaul is recommended based on an accumulated calendar time of 12 years for fuel control units and 8 years for flow dividers. This is from the date of manufacture or last overhaul date.

9-3. A complete overhaul is required regardless of accumulated time in use when the fuel controller or fuel system component has been subjected to severe environment such as but not limited to:

1. Engine fire, external or prolonged air intake manifold fire, accident, or when service history of the fuel controller is unknown.

2. Contaminated fuel such as water, sand, rust, etc.

3. Fuel that does not meet the engine manufacturer's requirement may be detrimental to engine operation. If a non-specified fuel is inadvertently pumped into the aircraft fuel system and drained, fuel controller overhaul is not required.

4. If uncertain that the fuel controller or components requires service or overhaul, contact Airflow Performance for consultation.

PREPARATION FOR SHIPMENT

CAUTION: FEDERAL REGULATIONS CONCERNING SHIPMENT OF FUEL UNITS REQUIRE THAT THE FUEL SECTION BE SEALED WITH CAPS CAPABLE OF KEEPING FUEL FROM LEAKING. DO NOT USE MASKING TAPE OR OTHER NON APPROVED MATERIALS FOR THIS PURPOSE.

9-4. Install caps or AN style pressure caps to the fuel inlet and outlet.

9-5. Place the fuel controller in a clean plastic bag to protect the air section from packaging materials. Do not use tape for this purpose.

9-6. Place the sealed fuel controller in a suitable container with sufficient packaging materials to prevent damage during shipment.