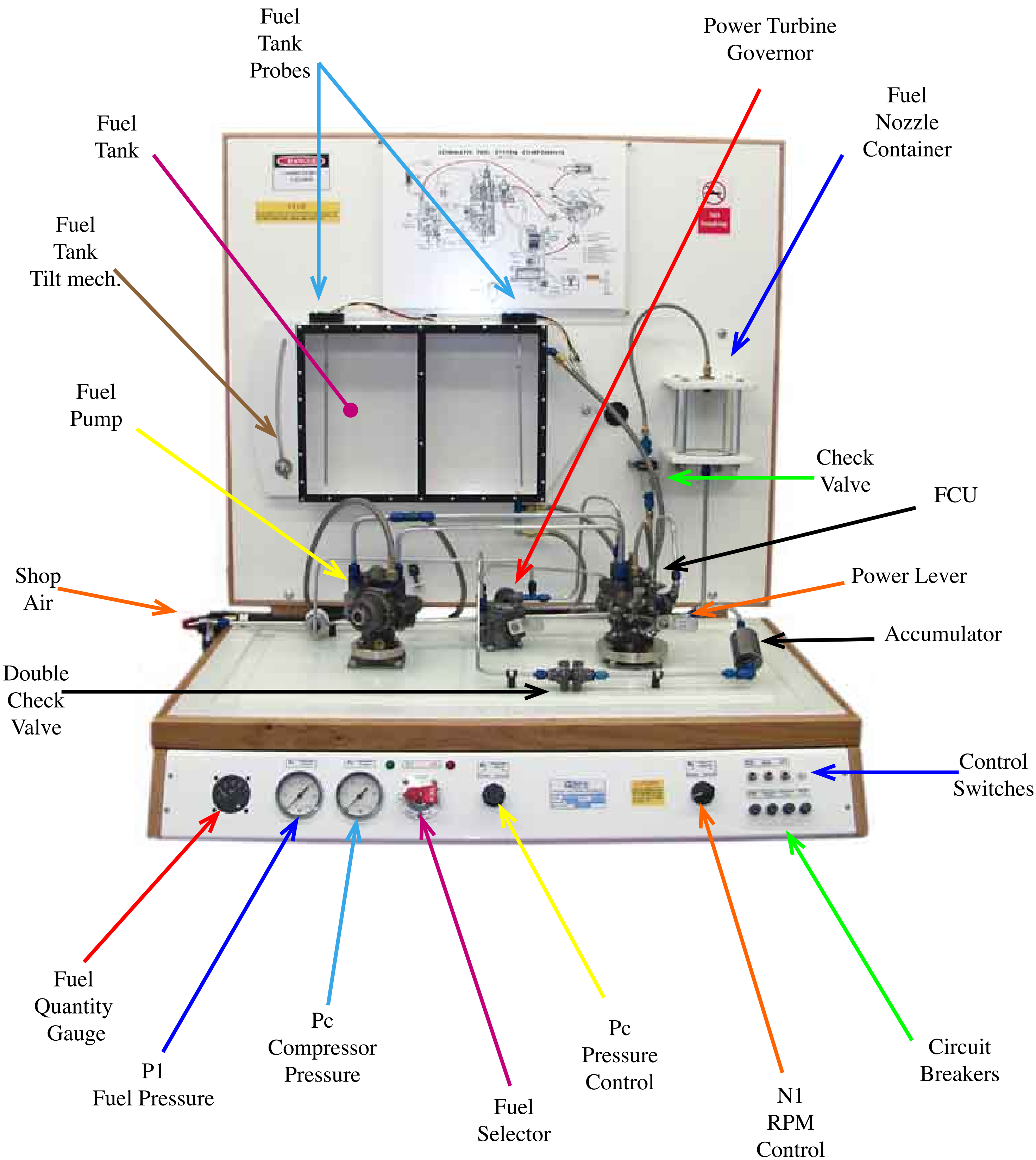
Cautions and labels



Description and operation
Fuel Nozzle

The fuel nozzle is a single entry dual orifice type nozzle. It threads into the combustion outer case and extends into the aft end of the combustion liner. The gas producer fuel control delivers fuel to the nozzle which atomizes and injects fuel into the combustion liner. Air is mixed with fuel, and the fuel air mixture is burned.

The fuel nozzle must properly atomize and inject the fuel in all ranges of fuel flow from initial “fire-up” to maximum power. This is accomplished by means of a dual orifice nozzle design. The primary orifice has fuel delivered to it whenever the engine is in operation, but the secondary orifice receives fuel only when the fuel pressure to the fuel nozzle exceeds 150 psi.

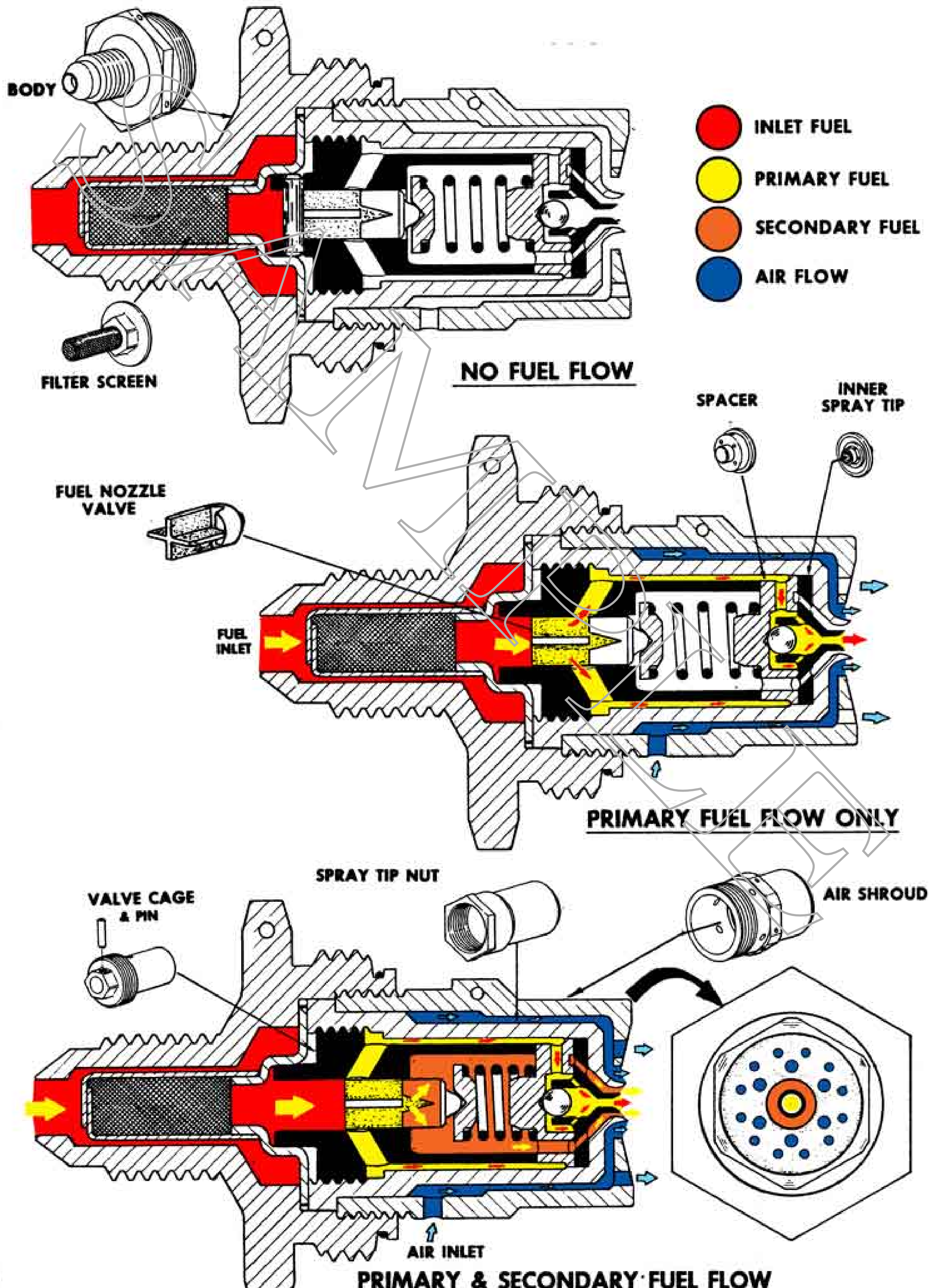
All fuel, delivered to the primary and secondary orifices, must pass through a multi layer screen filter. The filter prevents any contamination of the fuel passages within the nozzle. After the fuel is filtered, it is delivered to the metering valve. The fuel nozzle metering valve has three positions which result in (1) no fuel flow, (2) primary fuel flow, and (3) primary and secondary fuel flow. The position of the metering valve is determined by fuel pressure acting to open the valve and a spring acting to close the valve. The metering valve must move from no fuel flow position to a primary fuel flow condition by 30 psi. The metering valve moves from a primary fuel flow position to a primary and secondary fuel flow position when the fuel pressure exceeds 150 psi. Thus, from 30 psi to 150 psi fuel flows through the metering valve and two holes in the valve cage into the primary fuel passages. When pressure is greater than 150 psi, fuel continues to flow into the primary fuel passages and through two holes in the valve cage into the secondary fuel passages.

The inner spray tip receives fuel from the primary and secondary flow passages. The primary fuel is directed through four small holes in the inner spray tip into a cavity which feeds the primary orifice. Secondary fuel is directed through six small holes in the inner spray tip to the annular shaped secondary orifice. The amount of fuel, which will flow through the fuel nozzle, is a function of the pressure differential across the fuel nozzle. The combination of the primary and secondary orifices provides excellent fuel atomization at all rates of delivery.

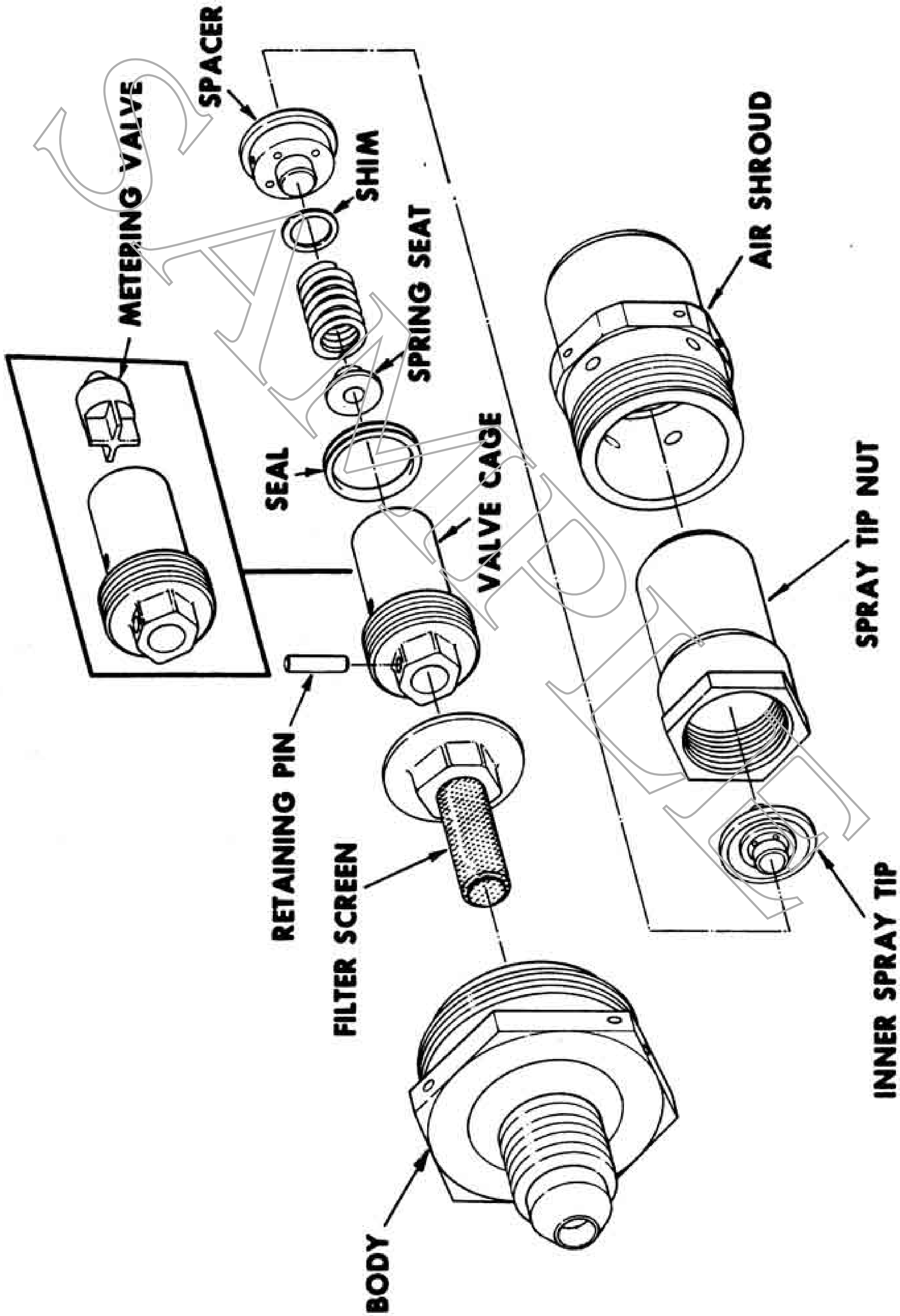
An air shroud, secured to the fuel nozzle body, collects air and directs it to numerous holes in the face of the air shroud where it exits into the combustion liner. Air flow through these holes reduces the possibility of a carbon build-up on or around the primary and secondary orifices and the air shroud.

When an engine is shut down, the spring moves the metering valve to the no fuel flow position. This feature has the following advantages: (1) clean shutoff; (2) fast light-off; (3) no afterfires; (4) no dripping; and (5) no coking.

Description and operation



Description and operation



Description and operation

GAS PRODUCER FUEL CONTROL

The gas producer fuel control and power turbine governor provide speed governing of the power turbine rotor and overspeed protection for the gas producer rotor system. The fuel control system is pneumatic-mechanical and senses N1 and N2 speeds, compressor discharge air pressure (Pc), and power lever position to regulate and maintain fuel flow within established limits.

Fuel flow is a function of Pc as sensed in the gas producer fuel control. Variations in fuel flow schedules are obtained by modulating the Pc pressure to Px and Py, pressures in the gas producer fuel control through the bleed-down circuit actuated by the governors sensing N1 RPM and N2 RPM. The design of the fuel control system is based upon controlling the engine power output by controlling N1 RPM. With the power lever in ground idle, N1 RPM is controlled by the gas producer fuel control. With the power lever in full open and N2 RPM at the setting of the power turbine governor, N1 is established by power turbine governor action upon the gas producer fuel control.

The gas producer fuel control is mounted on the accessory gearbox. The gas producer fuel control is driven by the gas producer gear train at a speed proportional to gas producer (N1) RPM.

Additional sensing parameters required by the gas producer fuel control to properly schedule fuel flow are:

1. Gas Producer Fuel Control Lever Position, controlled by power lever position.

2. Pump Discharge Pressure (P1) supplied by fuel pump.

3. Compressor Discharge Air Pressure (Pa) sensed off diffuser scroll.

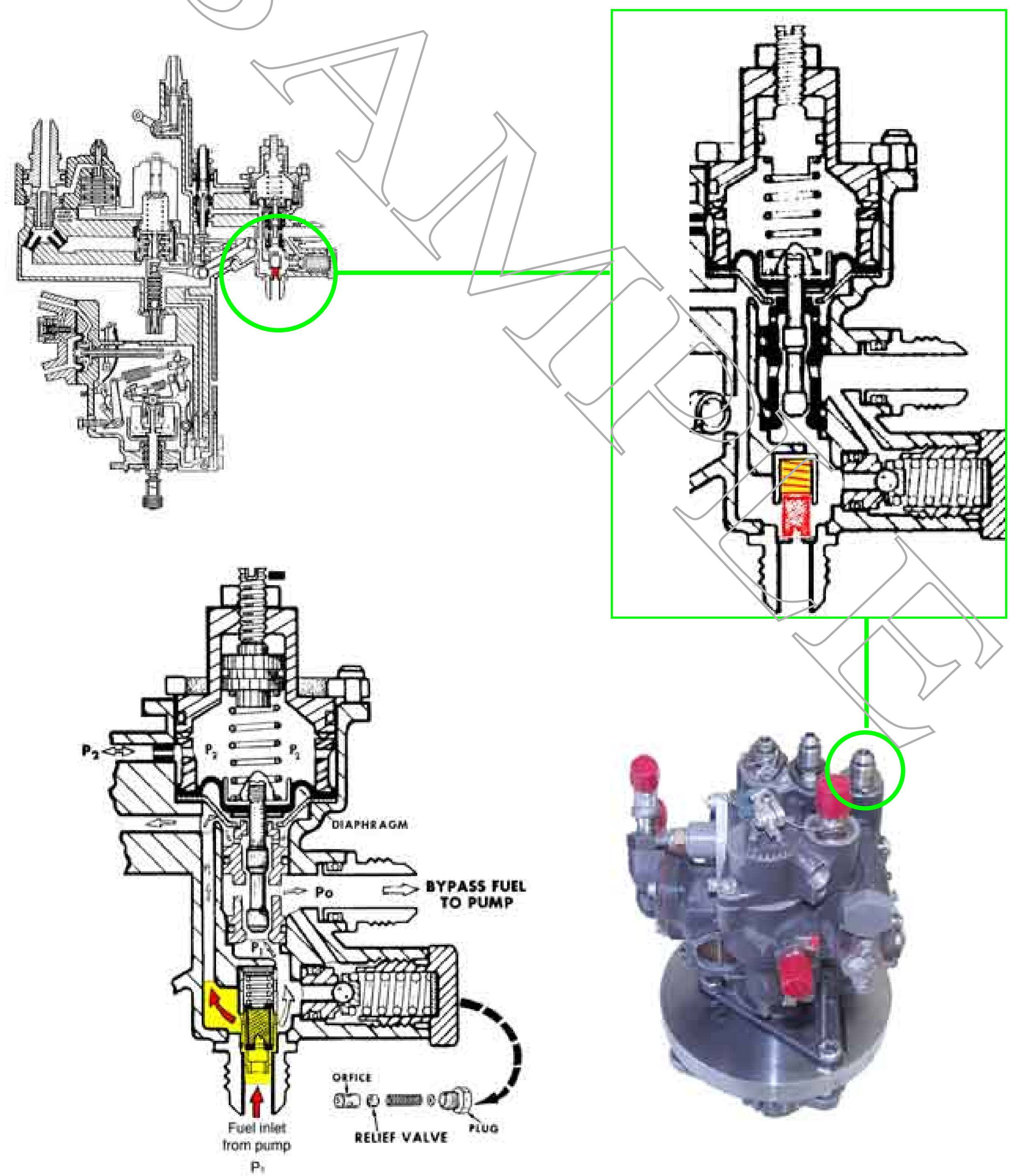
4. Regulated Air Pressure (Pr) supplied by power turbine governor.

5. Governor Reset Pressure (Pg) supplied by power turbine governor

Description and operation

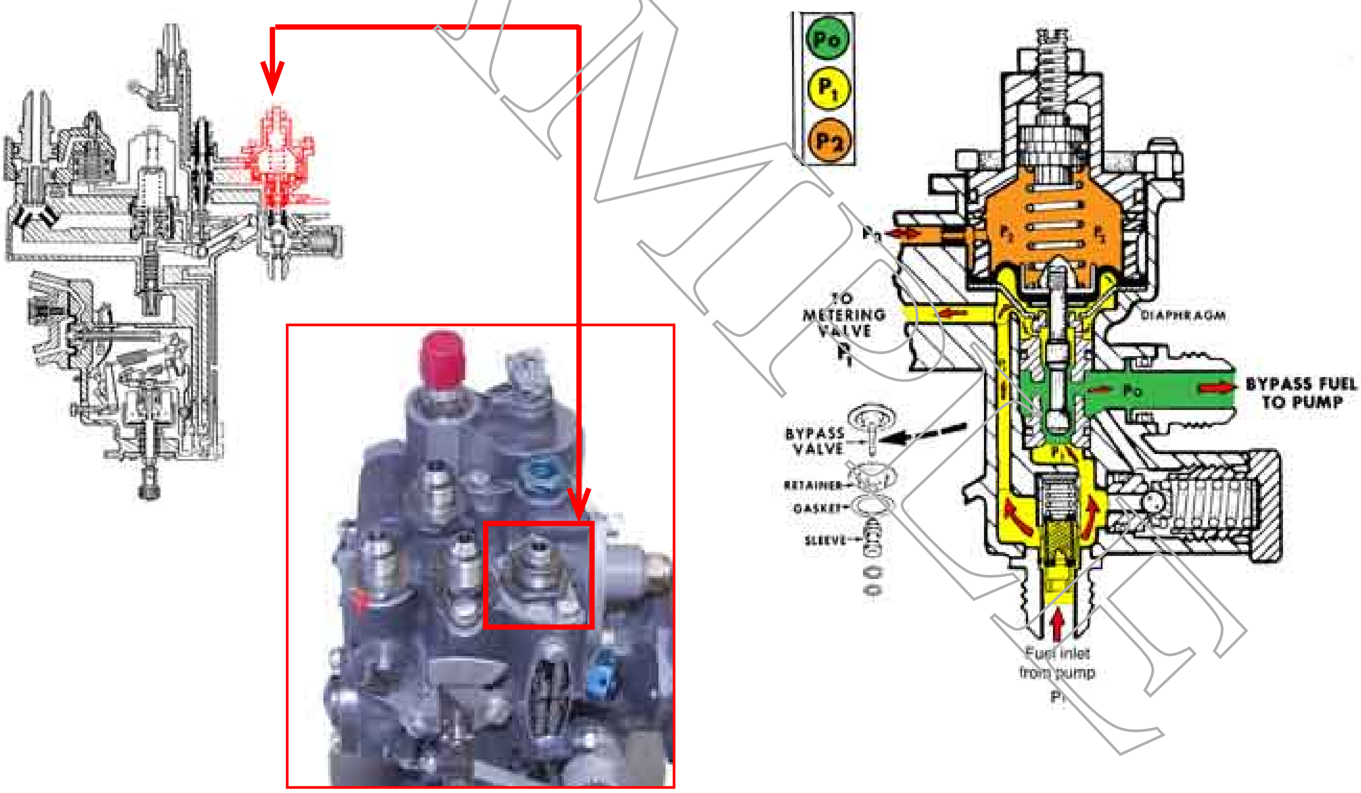
FCU fuel section

The fuel section of the FCU incorporates a fuel inlet filter and relief valve. The fuel inlet filter assembly incorporates a finger type strainer which is spring-loaded in position. Normally, all fuel delivered to the inlet port flows through the strainer. In the event of abnormal contamination, the pressure differential acting on the strainer overcomes the spring, and the strainer moves to a position in which inlet fuel no longer must flow through the strainer.



Description and operation

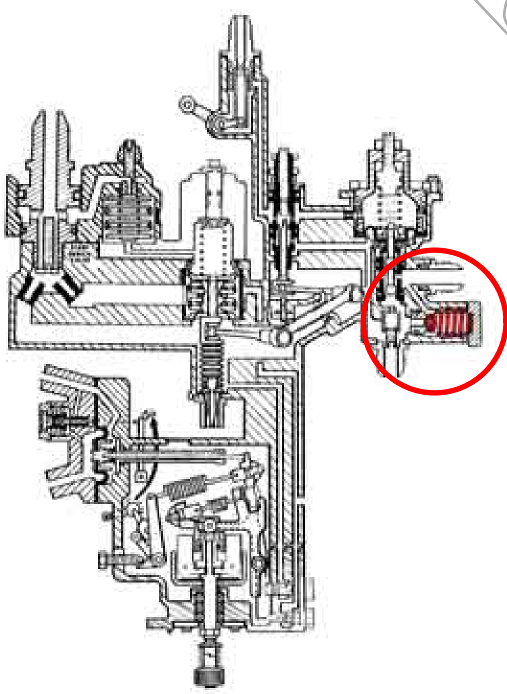
The bypass valve assembly consists of the bypass valve, bypass valve sleeve, flexible diaphragm, spring, and bypass cover, The bypass valve bypasses the excess fuel delivered to the gas producer fuel control and establishes a pressure differential of pump discharge pressure (P1) minus metered fuel pressure (P2) across the metering valve. This differential (Pl-P2) will remain practically constant during all operation. The bypass valve is double ported and designed such that flow through the valve will not tend to move the valve. The position of the bypass valve is determined by the differential forces acting on the valve's flexible diaphragm. When the bypass valve is stabilized, the opening force of P1 equals the closing force of P2 plus spring force. Therefore, (P1 - P2) = spring force. The length of the spring is a function of bypass valve position, and spring force is a function of spring length. Thus, when the bypass valve moves to assume a new position, the spring length will vary, causing the spring force to change slightly.

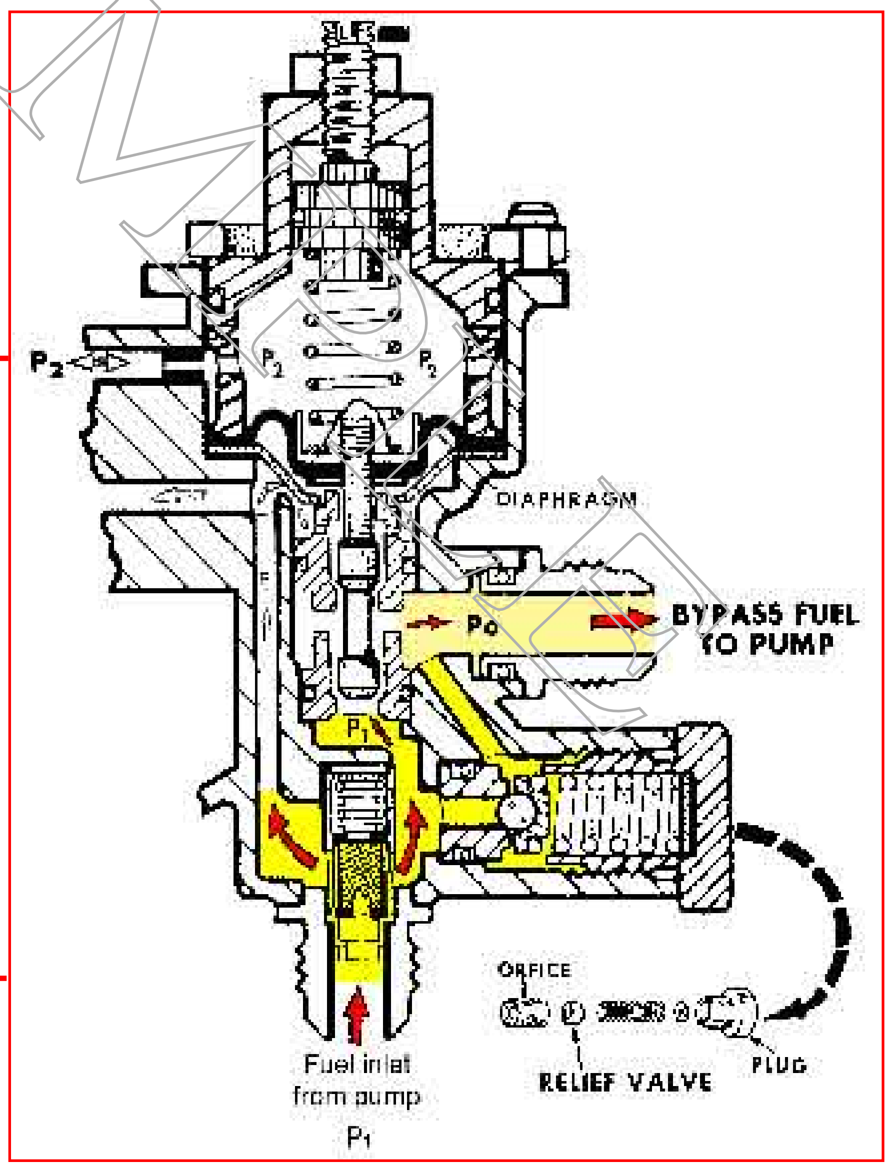


Let us assume that the bypass valve is stabilized, and then P2 pressure increases. This upsets the balance of forces acting on the bypass valve diaphragm such that the bypass valve moves toward a closed position. When this occurs, P1 will increase because of the greater restriction to flow of fuel to the bypass port. When Pl has increased by the same amount of the P2 increase, the bypass valve stabilizes in a new position where P1 and P2 are both higher than they were, but the P1-P2 differential is about the same. The opposite is also true, a decrease in P2 results in a decrease in P1 with the Pl-P2 differential remaining about the same. The P1-P2 pressure differential is established by the head adjustment when the gas producer fuel control is calibrated on a flow bench.

Description and operation

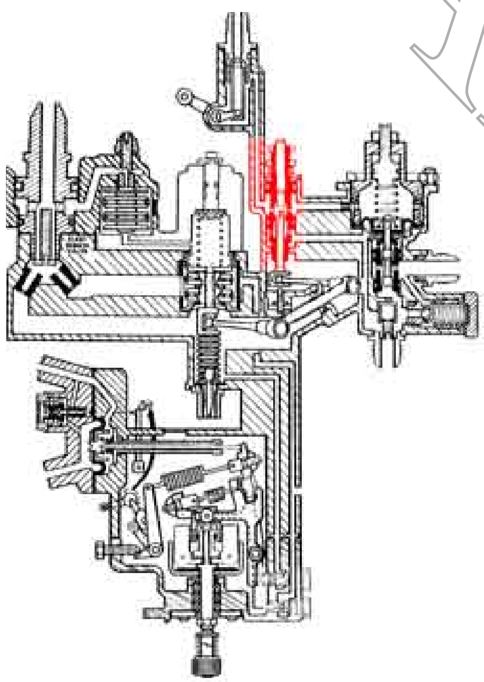
The fuel section of the FCU also incorporates a relief valve, the relief valve assembly consists of an orifice, relief valve, spring, shim, and plug. The relief valve is a ball that is spring-loaded on the orifice. The spring force acting on the ball is established by a shim located between the spring and the plug. If the pump discharge pressure (P1) exceeds approximately 700 psi, the relief valve ball moves away from the orifice and fuel flows to the bypass fuel port. During normal operation, the relief valve is closed. The relief valve protects the fuel system from damaging excessive pressures.

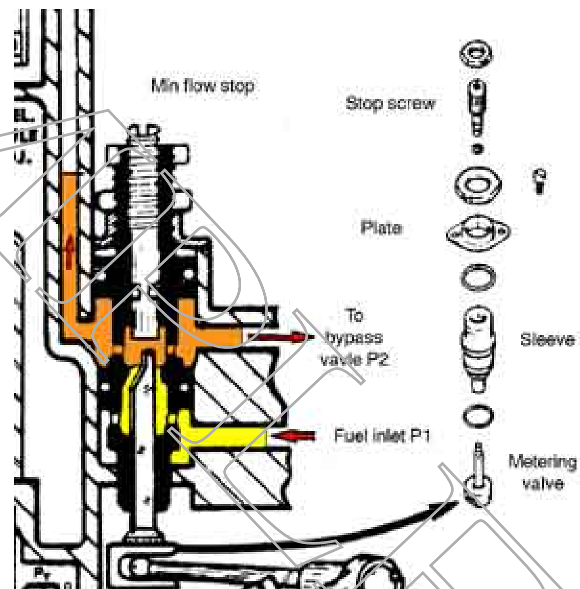


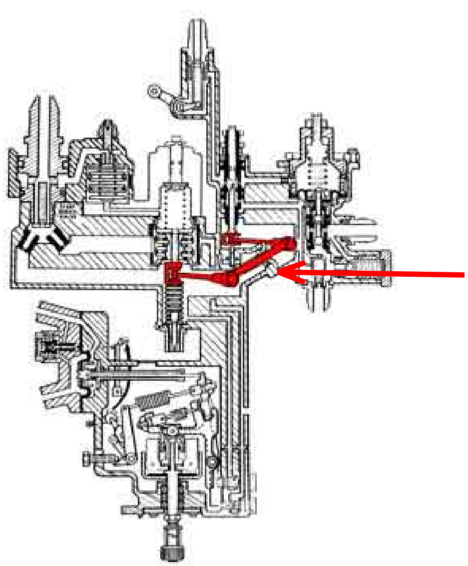


Description and operation

The metering valve assembly consists of a metering valve, a sleeve, a minimum flow stop, a maximum flow stop, and a torque tube assembly. Since the bypass valve establishes the Pl-P2 pressure differential across the metering valve, the volume flow through the metering valve is a function of the metering valve orifice size. The tip of the metering valve is tapered such that the orifice through which the fuel is metered varies as the valve is moved within the sleeve. The minimum flow stop establishes a minimum flow by limiting the travel of the valve into the sleeve. The maximum flow stop establishes a maximum flow by limiting the travel of the valve out of the sleeve. The position of the metering valve within the sleeve is established by the torque tube assembly. The torque tube assembly consists of a torque tube and two levers. The levers are firmly attached to the torque tube. One lever fits into the metering valve, and the other lever fits into the bellows assembly.



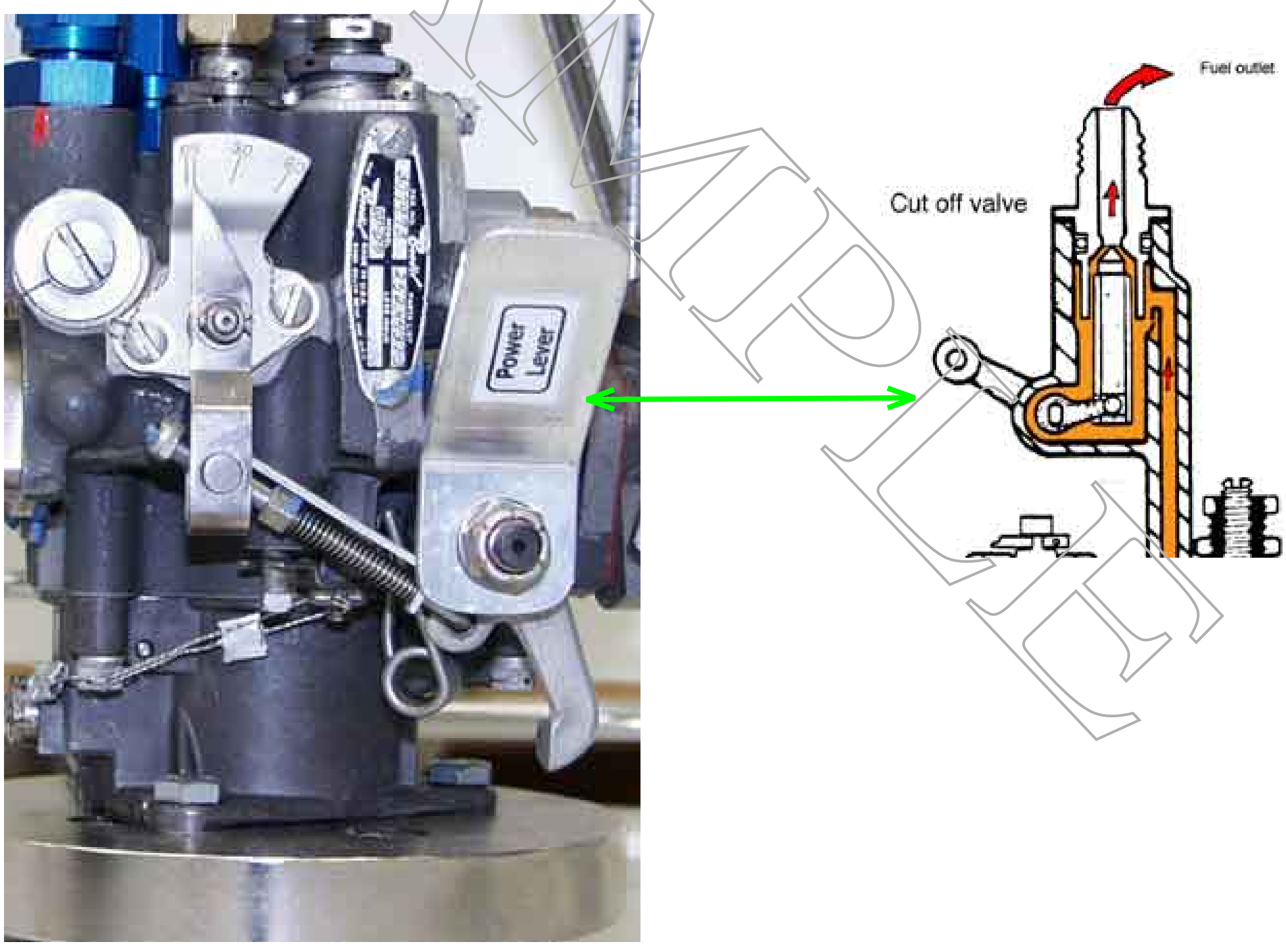




The torque tube does not pivot, it only rotates. Linear movement of the bellows assembly moves one lever to rotate the torque tube and as the torque tube rotates, the other lever moves the metering valve. Thus, the position of the metering valve within its sleeve and, consequently, the fuel metered by the metering valve is established by the bellows assembly which is a part of the scheduling section of the gas producer fuel control.

Description and operation

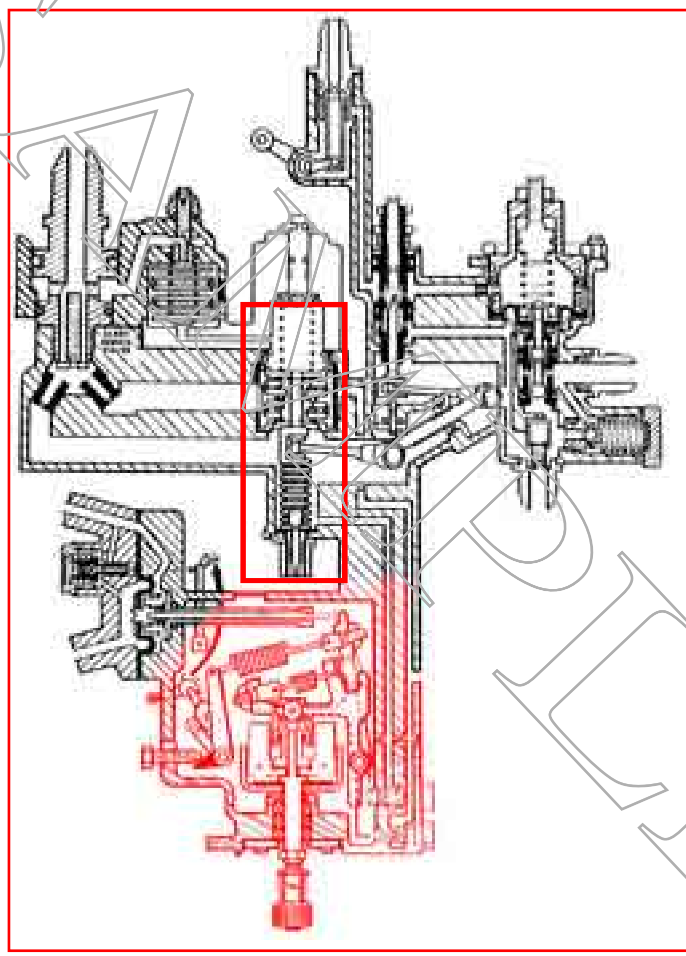
The cutoff valve assembly incorporates a cutoff valve, a valve seat, a lever and shaft assembly. The position of the cutoff valve is established by the power lever which positions the gas producer fuel control lever. The cutoff valve lever is mechanically linked to the gas producer fuel control lever. The gas producer fuel control has a quadrant and a pointer which are used to indicate the position of the twist grip. The quadrant has the following markings: 0, 5, 30, and 90. When the pointer is between 0 and 5, the cutoff valve is against the valve seat, and the cutoff valve is closed. When the power lever is moved from the cutoff position to the ground idle position, the cutoff valve opens and the pointer will indicate 30. The cutoff valve is fully open at all power lever positions between 30 and 90.



Description and operation

FCU scheduling section

The scheduling section of the gas producer fuel control consists of two bellows assemblies and a drive body assembly. The scheduling section positions the metering valve and, thus, schedules the fuel metered for all engine operations.



Description and operation

Power Turbine Governor

Governor section

(See fig # 4)

The governor section consists of a (Pr to Pg) bleed, a governor (Pg to Pa) orifice, and overspeed (Py to Pa) orifice, drive shaft assembly with two flyweights, governor lever, governor spring, overspeed lever, throttle shaft, and power turbine governor.

When the engine is not in operation, the governor spring positions the governor lever such that the Pg to Pa orifice is closed. This orifice will remain closed until power turbine (N2) RPM reaches approximately 100%. With the Pg to Pa closed, governor pressure (Pg) cannot bleed off to ambient pressure (Pa). Thus, with no Pg flow to Pa, Pg becomes equal to Pr. Pg is delivered to a check valve assembly (see fig #5) which contains two one-way check valves. One check valve allows flow from Pg to Pg', and the other check valve allows flow from Pg' to Pg. Governor reset pressure (Pg') is in the accumulator and is ported to the governor reset assembly of the gas producer fuel control. Pg' and Pg are practically the same. During operation, very small changes in Pg will not result in a Pg' pressure change because of the check valve assembly. The accumulator and check valve are incorporated to dampen surges in the Pg' pressure signal to the governor reset assembly. Since Pg' can be considered to be the same as Pg it follows that when the governor orifice is closed and Pg is equal to Pr, the Pr-Pg' differential acting on the governor reset diaphragm is very small. Thus, during starting, the power turbine governor and the governor reset assembly have very little effect upon the fuel schedule.

When the power lever is moved to full open with minimum collective pitch (minimum power demand on the turbine), the following will take place:

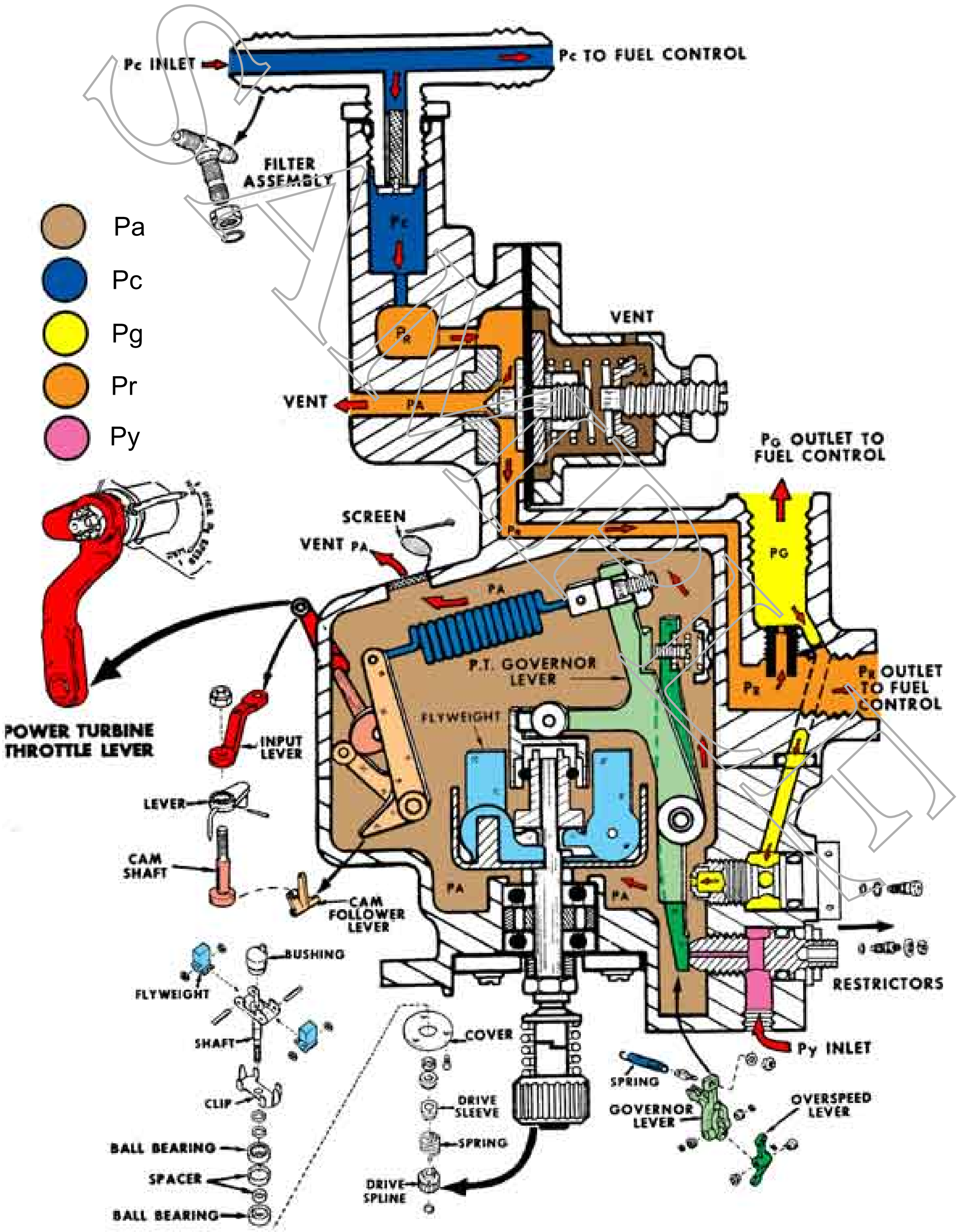
(1) Nl increases from ground idle RPM of approximately 62.6%. to an N1 of approximately 78 to 82%
(2) N2 increases to the RPM setting of the power turbine governor (approximately 100% N2)
(3) Gas producer fuel control set to limit N1 RPM to approximately 103% N1
(4) Power turbine governor via governor reset assembly schedules the fuel flow.

When N2 RPM reaches approximately 100%, the power turbine governor flyweights overcome the governor spring force to move the governor lever such that the Pg to Pa orifice is opened. When the Pg to Pa orifice is opened, Pg can bleed off to Pa. Thus, Pg no longer can be equal to Pr and, consequently, Pr will be greater than Pg'. The resulting Pr-Pg' differential on the governor reset diaphragm (see fig #6) moves the governor reset (shaft) plunger against the gas producer fuel control governor lever. Then the governor reset assembly exerts a force on the governor and speed enrichment levers. When the combined force of the governor reset assembly and the gas producer fuel control fly weights exceeds the governor spring force, the governor and speed enrichment levers are rotated in a clockwise direction. Thus Py and Px can both bleed off to Pa. The resulting Px-Py differential acting in the bellows assembly moves the gas producer fuel control metering valve to a slightly smaller orifice. Fuel flow is then cut back to provide that required for stabilized operation at minimum collective pitch with the power lever full open.

Description and operation

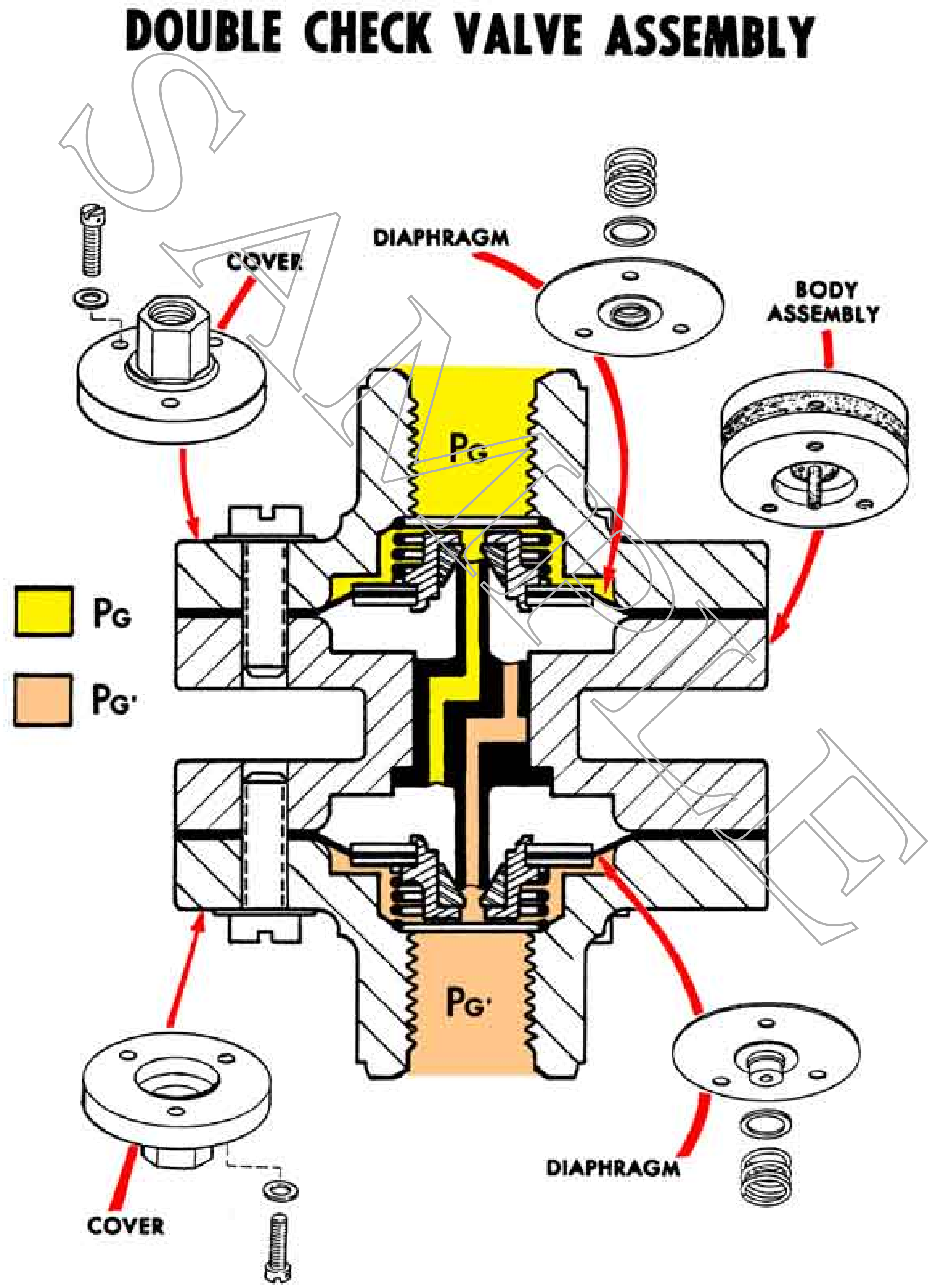
Fig #4

POWER TURBINE GOVERNOR SCHEMATIC



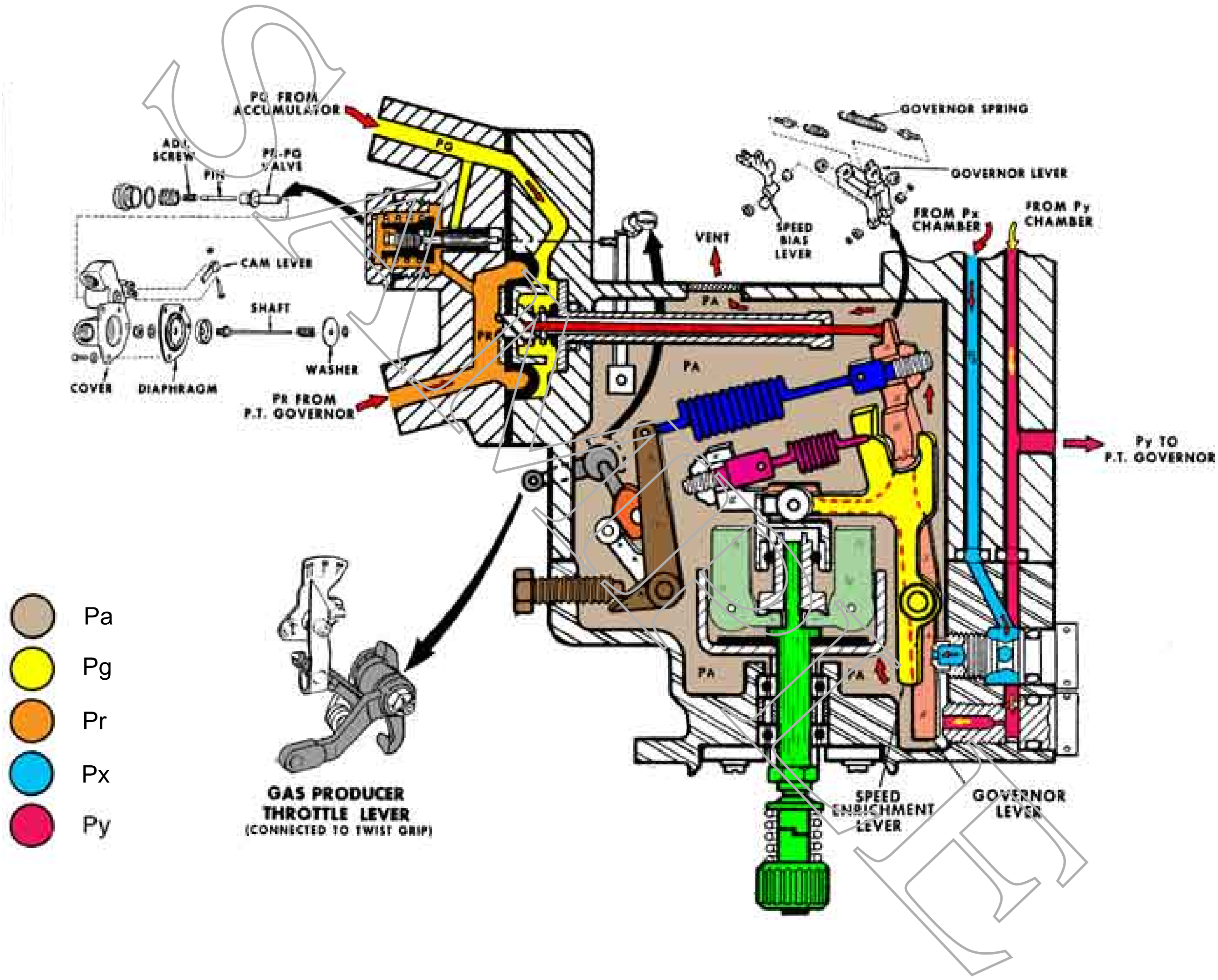
Description and operation

Fig #5



Description and operation

Fig #6



System Set Up POWER ON

Operation #1

Fuel capacitance and transfer demonstration

Never operate the trainer with no fuel as the pump is lubricated by fuel. A minimum of 2 people are required to use this trainer, one must be the instructor. Locate one person at the control panel, and place one as fire guard.

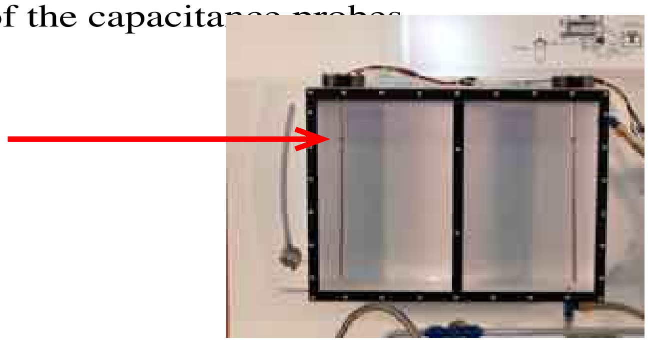
1) Verify all items in the Power off set up section have been completed. Turn the master switch on (up). Verify the vent fan at the back of the unit is running and blowing air out from the cabinet.

2) Allow cabinet to purge for 5 minutes before proce n system use.

3) Move the fuel selector to the "right" position.

4) Move the wing tank drain valve to the off position (off is visible). The drain valve is located at the top

5) Turn on the pump boost switch; note the red fuel transfer light and the green fuel pump light illuminate. Fill the upper fuel tank to the black lines near the top of the capacita



System Set Up POWER ON

Operation #1

Fuel capacitance and transfer demonstration (cont)

6) Move the selector to off and turn the pump boost off.

7) Read the fuel gauge on the panel, it should be full.

6) Firmly grab the fuel tank and slowly loosen the wing nut and allow the tank to slope down at an angle. The fuel gauge should not vary.

Wing nut

Caution

Support the fuel tank before loosening the wing nut when tilting the tank!

7) Select the drain valve to open on the tank and set the fuel level to 1/2 tank and then 1/4 tank respectfully and discuss the reasons for the fuel gauge and the reason for constant fuel level indications.

8) Tip the tank back to its normal position and drain all the fluid back to the main supply tank.

System Set Up POWER ON

Operation #2

Turbine fuel system operation

1) Verify all items in the Power off set up section have been completed. Turn the master switch on (up). Verify the vent fan at the back of the unit is running and blowing air out from the cabinet.

2) Allow cabinet to purge for 5 minutes before preceding to power on system use.

3) Move the fuel selector to the "left" position.

4) Move the wing tank drain valve to the on position (on is visible)

5) Rotate the N2 knob to the full CCW (counter clock wise) position. No turbine RPM.

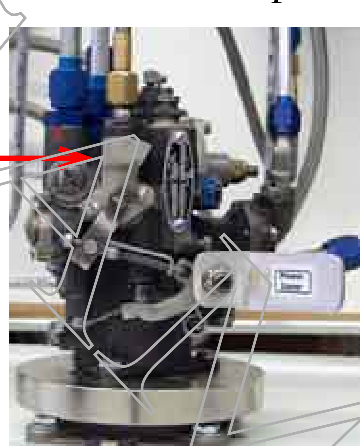
System Set Up POWER ON

Operation #2

Turbine fuel system operation (cont)

6) Position the power lever so the pointer indicates 30 degrees for turbine start.

Pointer

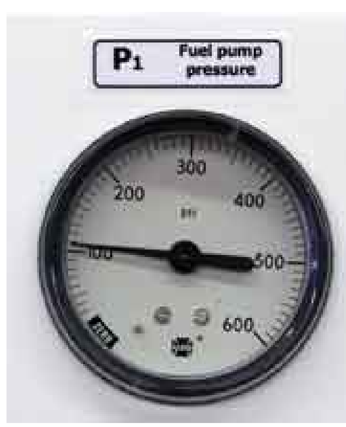


Power lever

7) Turn on the pump boost switch, note the green fuel pump light illuminates, the fuel tank will not fill.

8) Turn on the engine pump switch. (up)

9) Slowly rotate the N2 knob until the P1 (pump pressure) shows 100 PSI.



System Set Up POWER ON

Operation #2

Turbine fuel system operation (cont)

10) Note the fuel spray nozzle spray pattern.

11) Rotate the N2 knob to the full CW (clockwise) position note that with the increase in N2 RPM the pressure does not increase.

12) Turn the Pc knob clockwise so that 40 PSI is indicated, at the same time note the increase in fuel nozzle spray and also that the P2 pressure increases to 200 PSI, the nozzle is now duplexing.

Fuel cut off

13) Reduce the fuel pressure to 50 PSI by turning the N2 knob CCW. Slowly increase N2 by rotating the knob CW and increase the P1 pressure until the P1 pressure just reaches 100 PSI and stop! Slowly rotate the power lever to the fuel cut off position and note the fuel nozzle spray will stop and the pressure on P1 will increase to approximately 200 PSI.

14) Return the power lever to full power