SECTION 4

ENGINE FUEL SYSTEM

4.1 GENERAL DESCRIPTION

4.2 FUEL SYSTEM SERVICING AND ADJUSTMENTS

4.3 SETTING THROTTLE CONTROLS AFTER INSTALLATION

4.4 REMOVAL AND REPLACEMENT OF THE CHASSIS MOUNTED FUEL SYSTEM

4.5 FUEL DRAIN SYSTEM

4. 1 GENERAL DESCRIPTION

The engine fuel system consists of the following :-

1. The fuel filter, low pressure warning switch, fuel cooled oil cooler and flow distributor mounting.
2. The Chassis Mounted Fuel System comprising, in order of flow :-

   H.P. and L.P. driven Fuel Pumps

   Throttle and Potentiometer Valve

   Full Range Flow Control (F.R.F.C.)

   Air Fuel Ratio Control (A.F.R.C.)

   P1/P3 Switch

   Electro Pressure Control.
3. The Elliott H.P. Fuel Flowmeter

Fuel Filter, Oil Cooler & Flow Distributor Mounting

This mounting is siturted under the H.P. compressor casing, and the description of each unit will be in order of fuel flow.

Fuel Filter

The low pressure Vokes filter element which is of the non-by-passable type, is housed in a metal container attached to the Oil Cooler housing by two bolts. A Smiths type L.P. fuel warning switch is fitted to indicate when the fuel pressure falls below a given value. A bleed valve is fitted to the forward face of the filter housing.

The Unit Fuel System

Fuel Pumps

The pumps - Top one driven by the L.P. and the lower one by the H.P. compressor rotors, each consist of a rotor supported by a cylindrical carbon bearing, and having formed in it seven inclined cylinders which accommodate the hardened steel pumping pistons. The pistons are located by the auxiliary camplate which is mounted on a universal thrust ball on the pump drive shaft. The ends of the

pistons which ......

pistons which project from the cylinder bores, butt against a camplate which is mounted on a trunnion ring fixed axially by two trunnion pins.

The angle of the camplate can be varied from (zero piston stroke) 90°, to a position inclined at an angle of 104° maximum piston stroke.

The cylinder bores in the rotor are stepped in diameter and the small ends terminate as seven ports in the flat face of the rotor, which engages on two kidney shaped ports (inlet and outlet).

The rotor is pressed against the port face by the seven piston return springs, and also by the fuel pressure acting on the annulus formed by the step in each cylinder bore, thus giving a sealing force between the rotor and ports.

Servo Control System

The servo control system in both pumps consists of a piston operating in a cylinder against the action of two springs. The piston is connected to the trunnion ring by a link and piston rod, and controls the angularity of the camplate, the springs tend to turn the trunnion ring to the position of maximum angularity (Maximum piston stroke). Fuel at pump delivery pressure is taken across one side of the piston, and through a restrictor to the other side, and is then connected through passageways to the F.R.F.C., and A.F.R.C. and governor half balls, the equilibrium is established when the fuel pressure on one side of the piston equals the reduced pressure plus the spring on the other side.

Operation

Fuel from the tank is delivered via booster pumps through the low pressure cock and fuel filter to each of the main fuel pump inlets, then from the pistons through kidney shaped ports to the main pump outlets each having a non-return valve. From this passage fuel is taken by an internal drilling to the servo pistons which are controlled by orifices responsive to any pump output conditions.

When the control ......

When the control orifices are all closed the pressure on both sides of the pistons becomes equalised and the springs move the pistons in the direction to increase fuel delivery.

The opening of any of the control orifices allows fuel to escape from the spring side of the pistons, and allow the fuel on the other side of the pistons to overcome the spring and reduce the stroke and delivery of both pumps.

Hydro Mechanical Max. R.P.M. Governor

This device is used to control the engine max. R.P.M. and depends solely on R.P.M. for its operation. The design is such that governed speed is unaffected by changes in S.G. of the fuel.

The max. R.P.M. governor is contained within the L.P. fuel pump unit, and comprises a diaphragm which is subjected to restricted pump delivery pressure on the one side, and pump inlet pressure on the other. The diaphragm is loaded by a spring in tension, and carries a button at its centre which is contact with one end of a pivoted rocker, the other end of this rocker carries a half ball which controls the bleed from the spring side of the servo pistons, a spring beneath the rocker controls the stall pressure of the system.

Relief Valve (Fuel Pumps Servo Half Ball Valves)

The governor half ball valves act in a secondary capacity as stall valves so that in the event of servo line blockage the maximum pump delivery pressure will be controlled at 2,500 p.s.i.

A passageway from the fuel pump outlet is connected via a rate re-set valve to the spring side of the governor diaphragm, and a continuation of this passageway connects to the chamber in which the governor rotor is housed.

Rotor

The rotor comprises a shallow cylinder which is surrounded by fuel at governor pressure on its outside

while its ......

while its bore is connected to pump suction, the bore being sealed against chamber pressure by a carbon seal face plate at one end, and by a diaphragm at the other, an orifice in the latter end permits the flow of fuel from the chamber into the rotor bore at a controlled rate.

A weighted lever, which acts in the capacity of a valve, is connected at one end to the rotor by a leaf hinge, and at its centre this lever is connected to the diaphragm.

Rate Re-set Valve

The hydromechanical rotor chambers of both the L.P. driven and H.P. driven pumps are supplied with fuel at pump delivery pressure through a variable orifice.

This orifice area is controlled by a suitably shaped metering plunger, operated by fuel delivery pressure, and provides maximum restriction at maximum fuel delivery pressure As pump delivery pressure falls with increasing altitude the re-set valve moves and enlarges the flow area (permitting an increase in flow) to the rotor chamber. This increase in pressure influences the weighted lever diaphragm, allowing an increase in flow through the rotor with a slight increase in governor operating pressure although the rotor speed remains constant. Automatic correction is thus applied to counter the affects of governor creep during alterations in altitude conditions and pump pressure fluctuation.

Governor Operation

Fuel at pump delivery pressure is taken via the rate re-set valve to the governor diaphragm chamber, and so to the rotor chamber, from here it is delivered through the restricting orifice to the rotor bore which is in communication with the fuel pump inlet

Centrifugal force acting on the weight mass will

Cause a movement ......

cause a movement of the beam toward the restricting orifice, this movement is opposed by the force created due to the pressure difference on the diaphragm so that at any R.P.M. equilibrium is established, and the flow through the restrictor is controlled on a r.p.m. basis.

As R.P.M. is increased this flow will be reduced progressively, with a consequent rise in rotor chamber, and governor diaphragm chamber pressure, until at max r.p.m. the force on the governor diaphragm is sufficient to unseat the half ball, which allows a bleed from the spring chamber of the pump servo piston, so limiting the pump stroke, which in turn limits the fuel supplied to the engine and therefore the engine R.P.M.

The H.P. driven pump governor is set at 3% above MAX. H.P. R.P.M. and will therefore be inoperative under normal running conditions.

Double Datum Governing

The L.P. driven pump accommodates a double datum selector to control max and cruise L.P. R.P.M. and is operated by a pilots selector switch.

When selecting cruise R.P.M. the energising of a solenoid opens a half ball valve thus reducing the pressure on one side of the governor servo piston. The lowering of this pressure will cause the piston to move the control linkage and reduce the spring force attached to the main governor diaphragm. The reduced spring force will permit the governor to control at a lower R.P.M.

Combined Throttle Valve, Potentiometer Valve and High Pressure Cock

This unit is provided to give control over the engine by limiting the fuel flow to meet a required set of conditions. It also provides a means of stopping the engine.

Throttle Valve

Is supplied with fuel from the pumps, and comprises a rotary fluted valve operating in the bore

of a bronze ......

of a bronze sleeve in which are a series of Ports. Operation of the pilots throttle lever causes rotation of the valve so that fuel flows through the Ports in the sleeve to an annular space around it, the flow is continued to F.R.F.C. The number of Ports exposed and therefore the flow, depends on the amount of movement of the valve.

Idling Trim

An adjustable by-pass flow is provided for idling trim adjustment. When the throttle valve is in the idling position two ports only in the bronze sleeve are opened and permits a fuel flow from the throttle valve via an adjustable jet which is used to adjust idling R.P.M. and synchronisation of engines with the throttles at the idling stops.

Potentiometer Valve

A port at the base of the throttle valve subjected to pump delivery pressure accommodates the potentiometer valve. This valve consists of a bronze tapered plunger retained in position by an adjustable stop.

The rotary movement of the throttle will open or close the port thus varying its outlet pressure. This pressure is registered on the pressure control piston within the F.R.F.C.

H.P. Cock

When the pilots throttle lever is moved through the gated position to H.P. cock shut, all ports in the sleeve are closed, thus preventing any further fuel flow.

Operation of Throttle and Potentiometer Valve

Mechanically the potentiometer valve operates in opposition to the main throttle valve i.e. it is arranged to close progressively as the main throttle valve opens, thereby increasing the overall pressure drop, it is contoured to operate over the cruising to maximum flow range; the valve has virtually no effect on the pressure drop at the low throttle openings.

To increase the ......

To increase the compressor r.p.m. the throttle lever is moved forward opening the throttle valve and partly closing the potentiometer valve which reduces the pressure in the potentiometer line and increases the pressure difference across a restrictor in the pressure control servo piston. This increases pressure difference across the servo piston will move the piston to close the servo half ball valve, thus increasing the fuel pump pressure until a state of balance across the piston is regained. For any fixed throttle position, the pressure difference across the servo piston restrictor will remain at fixed value.

The Full Range Flow Control

The control unit consists of a metering plunger servo piston, bellows and capsule assembly and half ball servo control.

The metering plunger is located in a flanged guide, the flange which forms a seal between the cylinder beneath the servo piston. The plunger is integral with the servo piston which is balanced by throttle delivery pressure on the underside and a sensing spring assisted by metering plunger servo pressure on the upper side.

The half ball valve controls the units internal servo pressure through the medium of a cantilever which is influenced by the sensing spring balanced against the pressure capsule and bellows.

The pressure drop across the pressure control piston is related to throttle lever movement, since the throttle moves around the stationary Potentiometer Valve increasing the pressure drop progressively from cruise to take-off position

Operation

Under normal steady running conditions the altitude metering plunger will be partly withdrawn from its seating under the influence of throttle valve delivery pressure. This pressure applies to a

corresponding load......

corresponding load through the push rod to the sensing spring and so loads the cantilever, tending to close the servo valve. The applied load is restricted by the striker pin attached to the ram pressure capsule.

The resistance load of the capsule against the applied fuel pressure loading is a measurement of ram pressure, which is a function of ambient barometric pressure and aircraft forward speed. The two opposing loads, ram pressure and fuel pressure, are focussed on the servo valve which maintains a spill through the orifice equal to the small flow through the restricting orifice in the servo piston, so balancing the piston, and thereby the plunger, to provide a steady fuel flow through the orifice in accordance with the air mass flow.

Changes in ram pressure at a given throttle setting are sensed immediately by the capsule. If the ram pressure increases the capsule will expand and the striker pin will increase its loading on the end of the cantilever. This will unbalance the forces acting on the servo valve, permitting this to lift and increase the spill from the orifice. The forces across the piston will be unbalanced, causing the piston to lift and withdraw the flow plunger further from its seating to provide an increase fuel flow.

The increase in flow will result in a rise in pressure which will be sensed by the pressure control servo piston. The piston becomes unbalanced and will move to tilt the rocker arm and so reduce the spill past the servo half ball valve. This will cause an increase in the fuel pump servo pressure resulting in a movement of the pump stroke control servo piston to increase the pump delivery and restore the pressure drop across the flow control.

Air Fuel Ratio Control

The A.F.R.C. is part of the unit fuel system

During acceleration ......

During acceleration conditions it meters the fuel supply from the full range flow control to the flow distributor.

It has two basic requirements. It must allow the engine to accelerate in the shortest possible time, and must make it impossible for the pilot to overfuel the engine and stall the compressor.

The primary purpose of this control unit is to evaluate the compressor delivery pressure by measuring the compression ratio, and relate the value obtained to a variable orifice controlling the fuel delivery to the burners. The mass flow of air through the compressor for all practical purposes can be taken as being directly proportional to compressor delivery pressure so that a value of delivery pressure can be used to control the fuel flow.

The basic unit comprises, a fuel flow metering plunger varying the area of an orifice in the fuel supply to the flow distributor, the position of the plunger, and consequently the flow of fuel, is controlled by the pressure drop across the plunger, balanced against the influence of a capsule sensing compressor delivery pressure. A servo piston attached to the metering plunger is moved by a change in servo pressure balance, which is modified by the control capsule through a rocker lever carrying a Kinetic valve, whilst the pressure drop across the plunger orifice is sensed by a pressure control piston. The piston acts upon a rocker lever and half ball valve which varies the pump servo pressure and so regulates the delivery from the pumps to the value required for any given air mass flow.

<u>Operation</u>

During normal operation, compressor delivery pressure is applied to the control capsule thereby influencing the position of the rocker lever. The rocker lever is balanced against the control spring which senses the position of the

metering plunger...

metering plunger according to the fuel flow, dependent upon the pressure balance across the plunger servo piston. It will be seen therefore, that the ratio of the lever balance between the control capsule influence and the control spring influence, proportions the fuel flow in accordance with compressor pressure, the adjustment between the two being effected by the degree of spill from the Kinetic valve, controlling the position of the plunger, and consequently the flow area through the orifice.

On acceleration the throttle is opened to provide an increased fuel flow to the engine; this demand is passed by the air/fuel ratio control up to the maximum permitted by the metering plunger setting for the prevailing compressor delivery pressure.

As the engine R.P.M. and delivery pressure increases the control capsule is compressed and causes the rocker lever to unbalance the Kinetic valve and so increase the leak from the metering plunger servo cylinder. This will effect the pressure balance across the metering plunger piston causing it to move and increase the flow through the orifice. At the same time this will increase the tension in the control spring, and consequently the load on the rocker lever, causing the Kinetic valve to be restored to the balanced position, therefore re-establishing the pressure balance across the metering plunger piston. The piston will now become stabilised in its new position as determined by the increased compressor delivery pressure.

During acceleration fuel delivery tends to rise above the flow limit set by the compressor delivery pressure, and causes an increased pressure drop across the unit which would result in overfuelling. This increased pressure drop however, is sensed by the pressure balance piston controlling the bleed from the fuel

pump servo line. ..

pump servo line. In this case the piston moves against its spring loading and allows the rocker lever half-ball valve to open and increase the bleed from the servo cylinders of the fuel pumps, thereby causing the pump servo pistons to move and reduce the pump delivery until the pressure drop across the control unit is restored to its desired value and the fuel flow to the proportion demanded by the air mass flow.

P1/P3 Switch

This device operates in conjunction with the A.F.R.C., and is designed to impart a step to the operating line of this unit, thus ensuring that the A.F.R.C. retains its functions as an acceleration control, without imposing a limitation on the engine performance at altitude.

The unit comprises a chamber, which forms a housing for two capsules in tandem which are connected by a valve, the bore of one of these capsules is connected to engine bay pressure whilst the other capsule is exhausted; two passageways are connected to compressor delivery pressure at their outer ends and to the intake via the bore of the large capsule at their inner ends. Each passage containes two restrictors and tappings taken from between the restrictors are connected to the A.F.R.C. and to the switch unit capsule chamber respectively.

Operation

When the engine is running at low compression ratios the valve is open and the supply of air from the compressor delivery pressure flows through the passage-ways, with a consequent pressure drop, this reduced pressure is applied from one of the passageways to the A.F.R.C. capsule chamber. As the engine speed increases the P1/P3 switch capsule chamber pressure will rise, to the value necessary to close the valve, when this happens the flow in the passageway which is connected to

the A.F.R.C. ...

the A.F.R.C. will be full delivery pressure, thus bringing about a shift in the operating line.

Elliott Fuel Flow Meter

The Mk.3 Elliott Flow Meter is situated on the lower port side of the engine to the rear face of the front bulkhead, and provides the following information on two gauges in the cockpit :-

1. The indication of the rate of flow to each engine when the relevant switch is selected.
2. The indication of the rate of flow and total fuel consumed when the relevant switch is selected.

Operation

The transmitter is of the variable area orifice type, in which a measuring vane moves in a spirally cut chamber against a calibrated spring to positions corresponding to fuel flow rates. The spiral chamber is so proportioned as to provide sensitive indication over an expanded scale from 7-100 lbs/min. in the first 130° of vane rotation, with the remaining range 100 - 400 lbs/min. compressed into the last 48° of vane rotation. When the vane is at zero position adjustment is made on the screw at the bottom of the unit. No attempt should be made in service to adjust this screw.

The Serck Fuel Cooled Oil Cooler

Receives fuel at burner pressure passing this through tubes to the flow distributor. Baffles in the cooler casing ensure adequate cooling of hot oil, however when cold and of sufficiently high pressure the oil is by-passed by the unseating of a spring loaded valve.

Flow Distributor and Dump Valve

Flow Distributor

The flow distributor is located on the oil cooler mounting and is designed to distribute the fuel under all conditions to each burner. It also ensures that the main burners are closed

up to a ...

up to a certain fuel pressure.

The unit consists of a casting in which is housed the flow distributor valve operating in a closely fitting cylinder. In the base of the cylinder metering slots are accurately shaped to terminate in drillings in the walls of the cylinder, the drillings radiating through the casting to their appropriate burner connections spaced around the outside of the unit.

Operation

With the engine stationary, the valve is held in the closed position by the spring, the metering slots being completely blanked off.

On the engine starting, fuel by-passes the flow distributor valve and is fed to the primary manifold and burners. When sufficient pressure is built up the valve moves to uncover the metering slots, and allows fuel to pass to the main burners.

Both primary and main burners now being in operation.

Dump Valve

The fuel dump valve is formed integral with the casting of the distributor and consists of a spring loaded piston type valve.

Operation

During engine running the fuel pressure on the top of the piston is opposing the spring keeping the valve closed. On engine shut down the valve opens allowing fuel to drain from the primary burner manifold, thus preventing a possibility of a hot start.

Burners

The "duplex" burners are secured to their locations in the delivery casing by tabwashered set bolts.

The stem of each burner passes through the flanged connection of the combustion chamber nose cone unit. The burner being located in the bore of the swirler fitted in the flare.

This type of burner ...

This type of burner employs two sets of fuel inlet passages each having its own swirl and orifice plates. Fuel is supplied to one or both of these passages, according to the fuel requirements of the engine, by means of the flow distributor unit. Thus low flows will be fed through the primary passage, while additional fuel requirements for normal operations are passed through the main passage, both passages then working together.

A wire wound filter is fitted in the primary drilling of the burner.

The atomiser assembly is contained in a flanged cylindrical sleeve being located by a shroud, which screws on to the burner adaptor. The assembly consists of a distributor block, pilot swirl plate, rear orifice plate. The shroud which is locked on the burner adaptor by means of a tabwasher contains a series of holes which admit a stream of air to an annulus between the shroud and the sleeve and then via tangential slots across the outlet orifice of the burner. In this way, the formation of a carbon-deposit-is-prevented.

Thermocouples

Thermocouples of Chromel and Alumel are situated in the main gas stream in the jet nozzle unit.

Around the outside of this unit are situated 4 terminal boxes, each connecting two thermocouples and one junction box which receives connections from both the Chromel and Alumel side of all thermocouples. Output from this junction box is fed into an amplifier unit to limit jet pipe temperature and also for jet pipe temperature indication in the cockpit.

Jet Pipe Temperature Limitation

The datum selector switch limits the jet pipe temperature at the take-off and operation necessity (TAKE-OFF) and maximum continuous (CRUISE) settings by reducing r.p.m. below the governor settings.

This is ...

This is achieved by an eight thermocouple assembly in the jet pipe connected to a magnetic amplifier (jet pipe temperature limiter) in the aircraft, which in turn actuates a solenoid controlled half-ball valve in the electro pressure control of the engine fuel system.

This control is effective at take-off and operational necessity (TAKE-OFF) and at the maximum continuous (CRUISE) setting and limits the jet pipe temperature to the maximum permitted for either condition. As the temperature in the jet pipe approaches the maximum permissible for the relevant setting, the increasing current output from the thermocouples actuates the magnetic amplifier which then passes a current to the electro pressure control operating solenoid. The push rod of the solenoid opens a half ball valve. This causes a state of unbalance of the pressure control piston in the full range control and is followed by a reduction in delivery from the pumps.

4.2 FUEL SYSTEM SERVICING AND ADJUSTMENTS

Fuel Filter

The fuel filter element should only need servicing at the engine reconditioning period. Should, however, it be found necessary to carry out servicing at an earlier period, proceed as follows:-

Check that the throttle levers are in the H.P. COCK SHUT position.

Check that the L.P. fuel COCKS are at OFF.

The fuel tank booster pumps are switched OFF.

Lift the two spring-loaded sliding bolts clear of the locking pegs.

Note.

Unscrew each sliding bolt clear of the filter casing; remove the casing.

Withdraw the filter element.

Notes.

The filter is secured in position with a circlip.

Discard the '0' seal from the filter top end cap and the casing flange.

Make sure that the filter casing is perfectly clean, then fit a new element assembly.

Fit a new '0' Seal to the filter cap top spigot, and to the filter casing flange.

When the sliding head bolts are tight locate the lower slots over the locating pegs.

Bleed the fuel system.

BLEEDING THE FUEL SYSTEM

General

Under the circumstances listed below it is essential that the fuel system is bled to ensure the removal of all air. It is essential that no air remains in the fuel system.

Before starting the engine after installation.

When de-inhibiting the engine.

When a fuel system defect is suspected.

After any part of the fuel system has been "broken down".

When the L.P. ...

When the L.P. fuel cocks have been inadvertently closed prior to the engine ceasing to rotate.

Following the draining and the subsequent filling of the aircraft fuel tanks.

Before bleeding the system, carry out the following:-

Turn the aircraft appropriate tank booster pump to ON.

Make sure the throttle lever is in the H.P. COCK SHUT position.

Gain access to the fuel system. Make provision to collect the drainage from the fuel system bleed points as described subsequently.

<u>Engine L.P. Fuel Filter Bleed Point</u>

Bleed the engine fuel filter as follows:-

Attach a suitable hose to the bleed valve and locate its free end in the container.

Notes ...

Cut the securing lock-wire.

This bleed valve is located at the forward end of the filter.

Screw out the bleed valve one complete turn.

When bubble-free fuel emerges from the hose, retighten the bleed valve.

Note ...

<u>L.P. and H.P. Compressor Driven Fuel Pump Remote Bleed Valves</u>

Bleed each remote bleed valve in a similar manner to that described for the engine L.P. fuel filter. Before bleeding the fuel pumps remove the gear covers and fit the tool kit keys. Rotate both the L.P. and H.P. compressors while bleeding the pumps.

Note ...

At the conclusion of the operation, replace the gear covers and wire-lock the bleed valves.

<u>RATE reset bleed valves</u>

Bleed the RATE reset valves in a similar manner to that described for the engine fuel pumps.

Notes ...

Little or no fuel will come from these bleed valves.

Turn the tank booster pump to OFF.

If instability of the engine is experienced during any subsequent ground run bleed, the fuel pump governors with the engine running at IDLING rev/min.

Caution ...

Caution ...

Do not open the engine to TAKE-OFF while the governors are being bled.

L.P. and H.P. fuel pumps - dry running conditions

In the event of an engine failure in flight, the engine, and consequently the fuel pumps, would be subjected to wind-milling. The pilot will have selected L.P. fuel COCK OFF and, therefore there will be no fuel flow through the system. Similarly, in the event of booster pumps failure (electrical fault) the engine speed will drop, simulating conditions of engine failure; the pumps will then run under conditions of aeration. Replacement of the fuel system will not be necessary unless the permitted maximum of one hour running under these conditions has been exceeded in any one flight.

Fuel pump governor adjustment

Caution ...

The engine overspeed governor is located on the h.p. compressor driven fuel pump. This governor is rig set and must not be adjusted.

The L.P. fuel pump governor acts as the cruise and take-off datum governor for the L.P. compressor; both datum points may be adjusted under the following circumstances.

On a newly-installed engine.

When the take-off rev/min does not conform to the limit quoted in the ground setting of the Operating Limitations (provided J.P.T. limiter is not restricting max. rev/min) and, an investigation proves the governor setting to be low.

When a replacement fuel system has been fitted.

When the cruise of the L.P. fuel pump has been disturbed.

Note ...

This applies only when the take-off governor is to be adjusted.

Prepare for adjustment as follows :-

Drain the door tanks, then open the engine bay doors and secure them.

Ensure that the governor setting has been checked.

Maximum rev/min (take-off)

Adjust the take-off governor as follows :-

Release the capnut and, using the tool kit

square headed key ...

square headed key, turn the adjuster anti-clockwise to increase the rev/min and vice versa.

Note ...

The capnut is secured with lock-wire.

One quarter of a turn or one flat of the key equals 50 rev/min approximately.

Note ...

Tighten the capnut and wire-lock to secure.

If the engine is running when the adjustment is made, select CRUISE on the R.P.M. GOVERNOR/J.P.T. LIMITER switch to ease the load on the stop.

On later engines when Mod. Olympus 931 is incorporated, adjust the maximum rev/min by the "clicker".

Each "click" represents 13 rev/min.

Note ...

Turn the adjuster clockwise to increase the rev/min and vice versa.

Run the engine to check that the TAKE-OFF rev/min are satisfactory.

Maximum continuous rev/min (cruise)

Adjust the cruise governor as follows :-

Push the hexagonal shaped fine adjuster in an upwards direction and rotate it clockwise to increase the rev/min and vice versa.

Notes ...

When setting CRUISE rev/min, use only the fine adjustment. Do not use the coarse adjustment.

One whole turn of the fine adjuster equals 25 rev/min approximately.

Pull the adjuster downwards to engage the serration and lock the adjustment.

After adjusting the cruise governor re-adjust the take-off governor.

Caution ...

Do not on any account disturb the two rate reset adjustments.

Run the engine ...

Run the engine to check that CRUISE and TAKE-OFF rev/min are satisfactory.

Idling by-pass ...

Adjust the idling by-pass as follows :-

Make sure that the IDLING setting is as quoted in the ground setting of the Operating Limitations.

Note ...

When running make sure the alternator is loaded.

Release the capnut and, using the tool kit square headed key, turn the adjuster anti-clockwise to increase the rev/min and vice versa.

Notes ...

The capnut is secured with lock-wire.

The resultant rev/min will be slow in re-acting, therefore, allow the engine to settle before carrying out further adjustment.

At the completion of the setting, tighten the capnut and secure with lock-wire.

Stop the engine and close the engine bay doors.

4.3 SETTING THROTTLE CONTROLS AFTER INSTALLATION

Throttle angle

To correct or set the throttle angle, carry out the following:-

Position the appropriate throttle lever to IDLING.

Check that the f.r.f.c. pointer is at 22° from the H.P. COCK SHUT position.

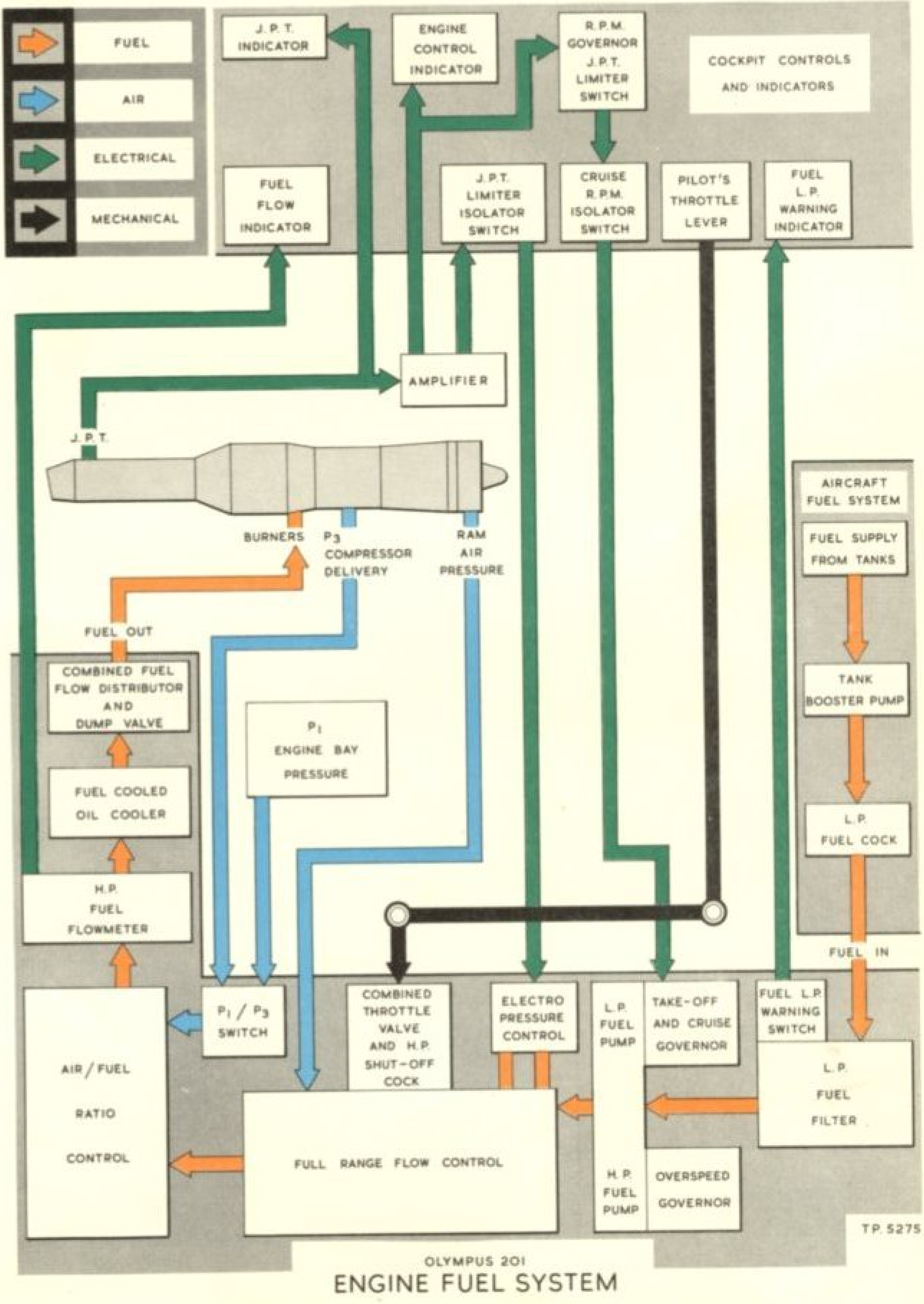
Note: The setting limit is 18° to 26° but 22° is desirable.

Position the throttle lever to OPEN; the f.r.f.c. pointer should then be at 90°.

Again position the throttle lever to the H.P. COCK SHUT position; the f.r.f.c. pointer should then be at 0°.

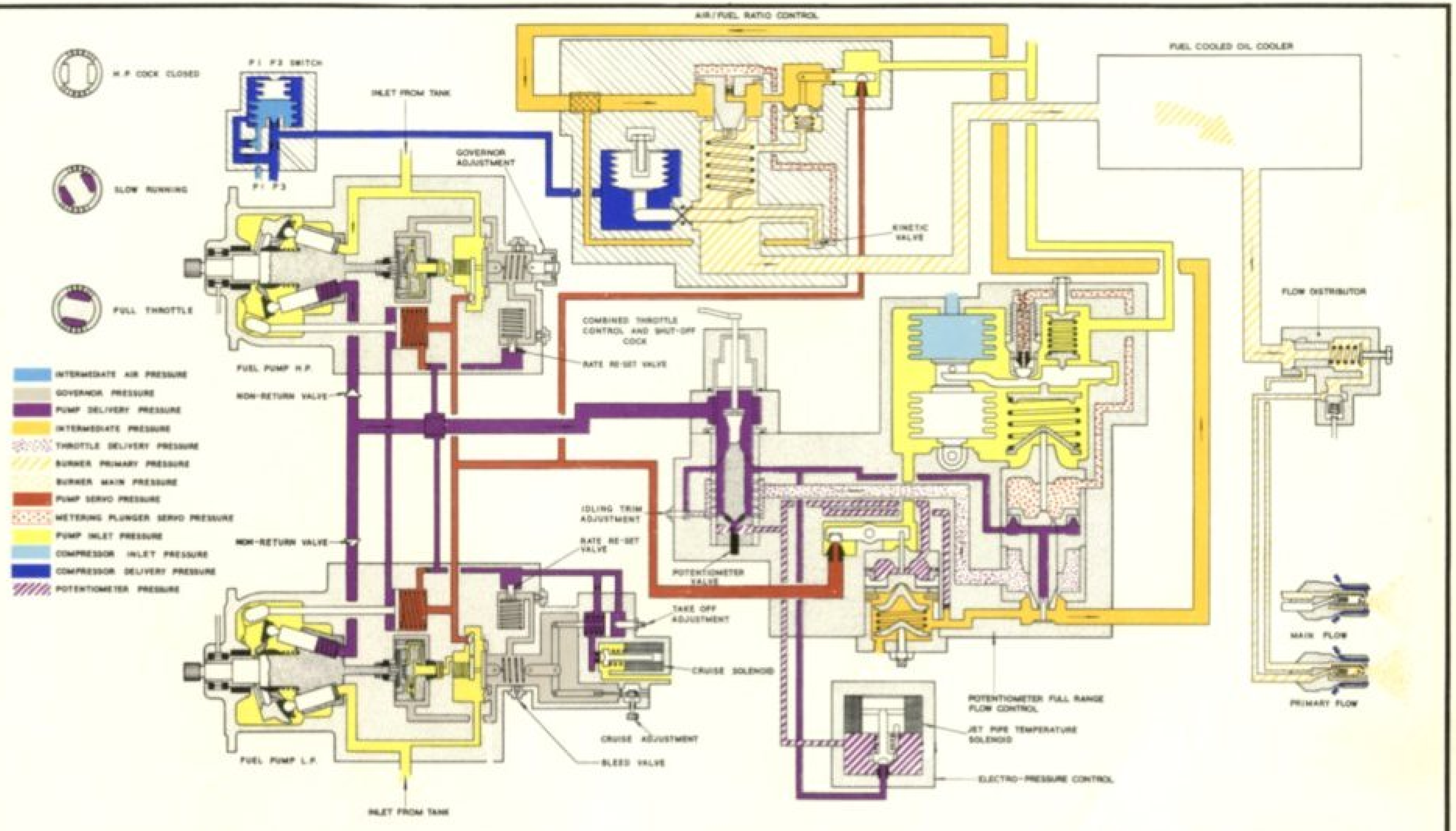
Note: Make sure that the throttle lever has an additional 1/4 in. spring movement, at H.P. COCK SHUT and take off positions.

If the foregoing conditions are not obtained adjustment must be made on the aircraft controls.



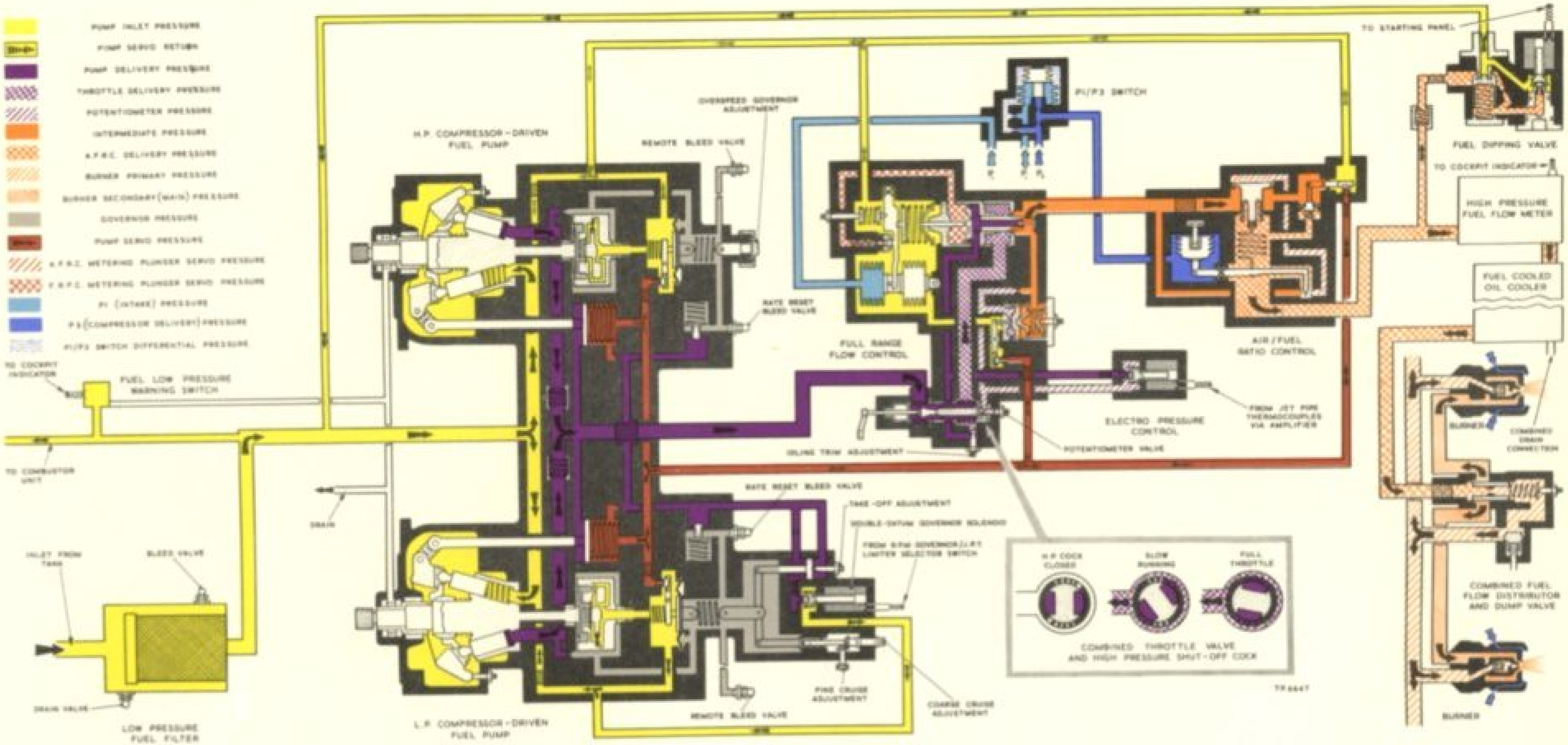
OLYMPUS 201

ENGINE FUEL SYSTEM

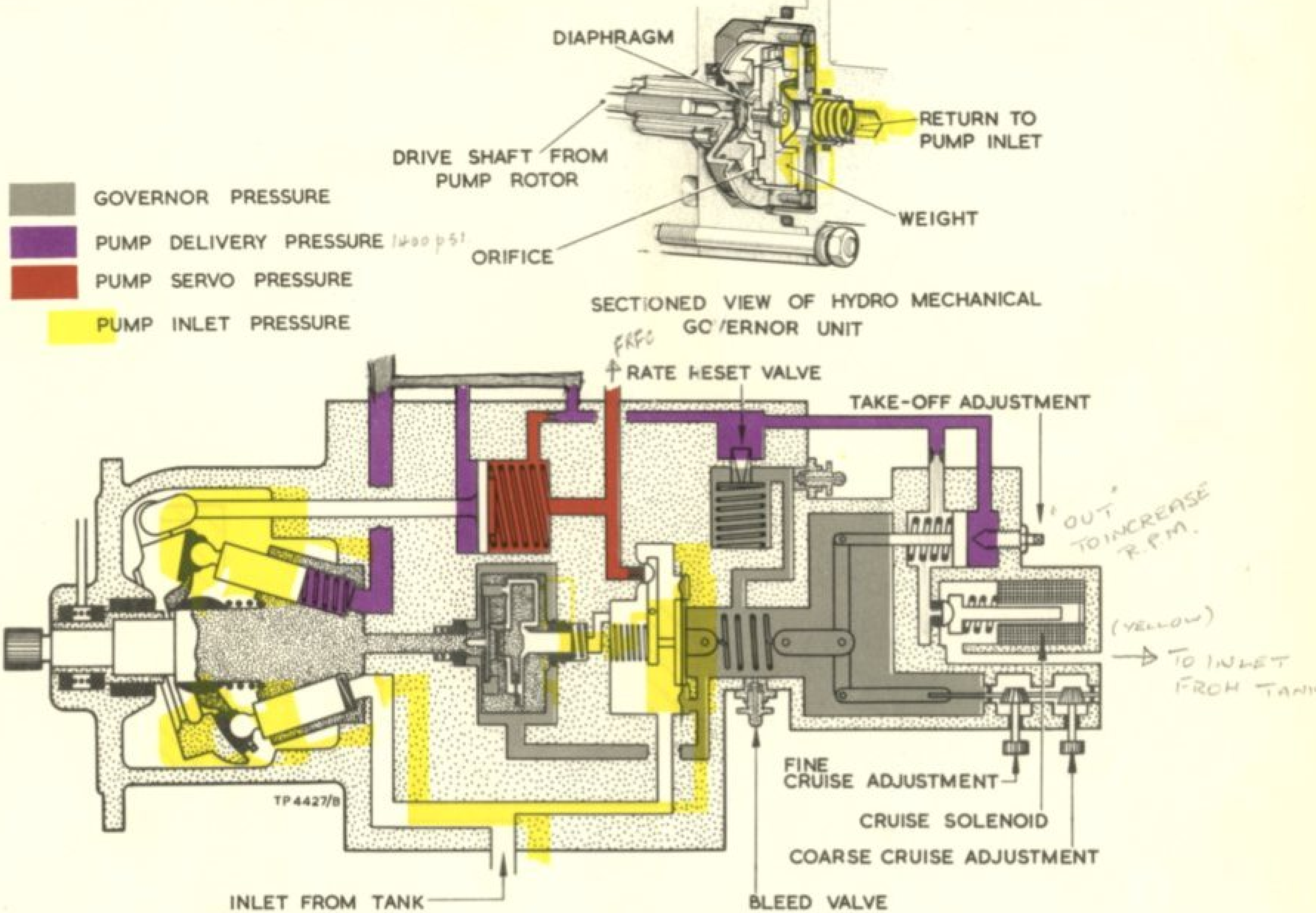


FUEL SYSTEM DIAGRAM OLYMPUS 201 TURBOJET

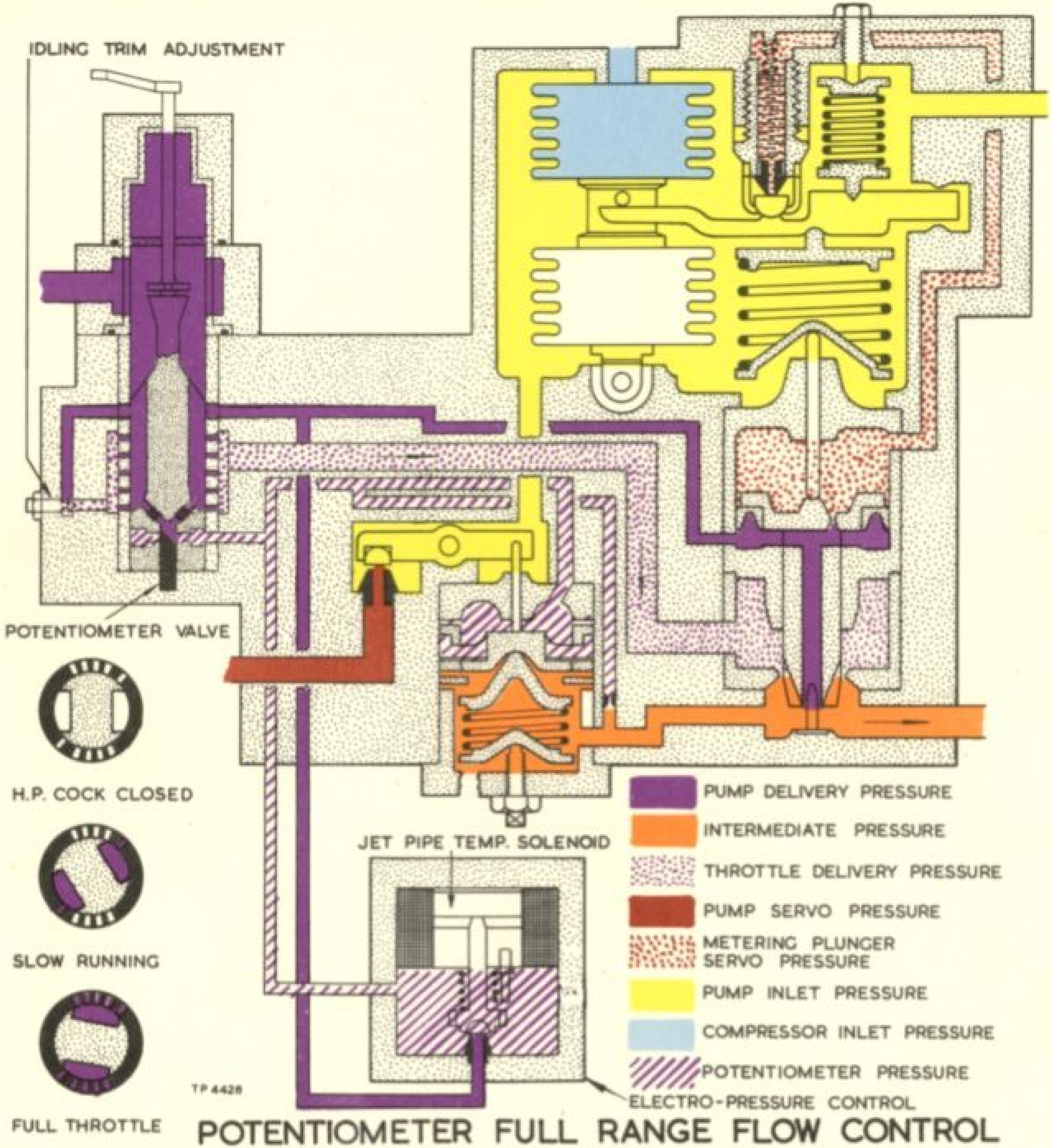
TP. 4087



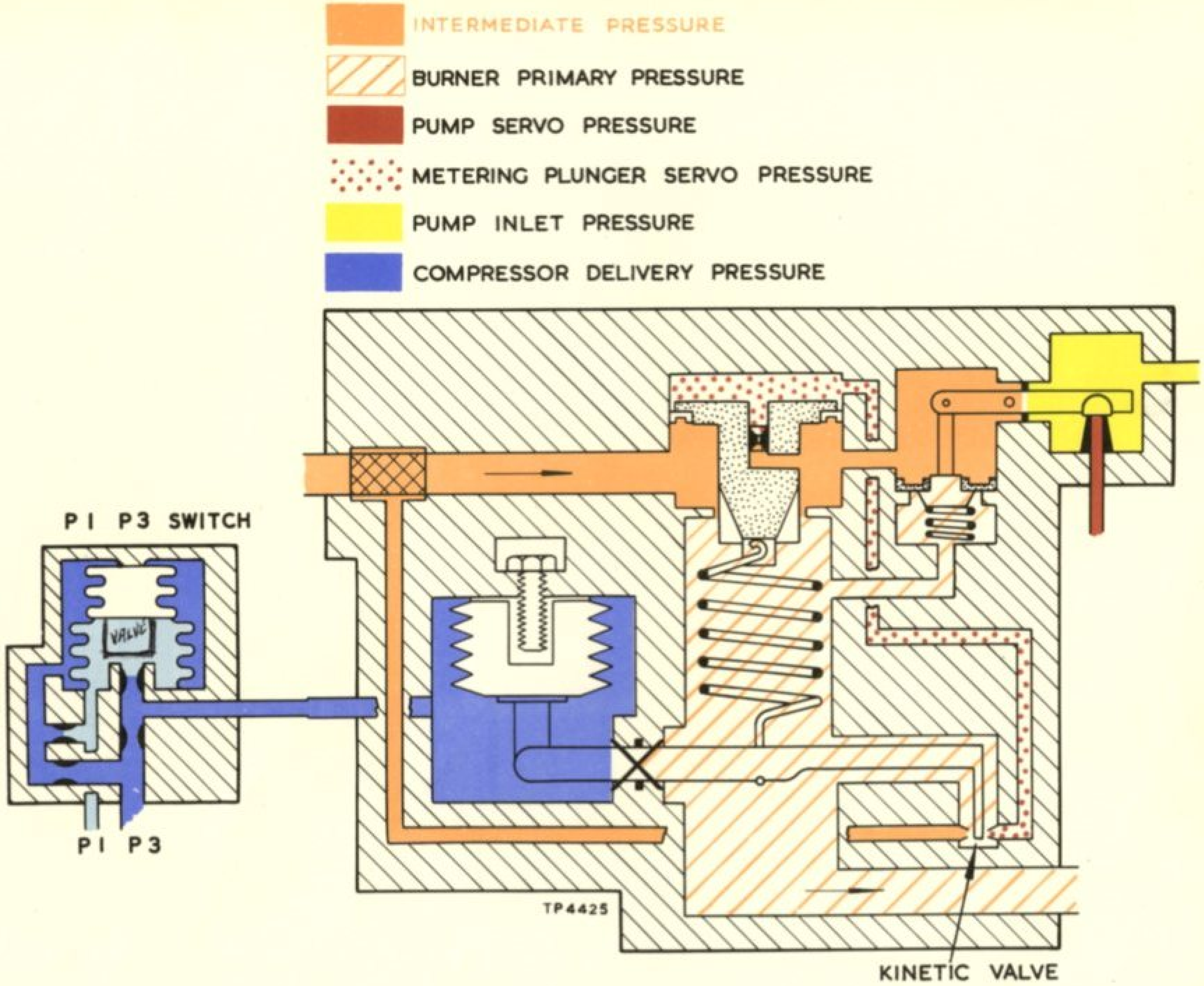
FUEL SYSTEM DIAGRAM – OLYMPUS.


DIAPHRAGM
RETURN TO PUMP INLET
DRIVE SHAFT FROM PUMP ROTOR
WEIGHT
ORIFICE
GOVERNOR PRESSURE
PUMP DELIVERY PRESSURE
PUMP SERVO PRESSURE
PUMP INLET PRESSURE
SECTIONED VIEW OF HYDRO MECHANICAL GOVERNOR UNIT
RATE RESET VALVE
TAKE-OFF ADJUSTMENT
"OUT" TO INCREASE R.P.M.
(YELLOW)
TO INLET FROM TANK
FINE CRUISE ADJUSTMENT
CRUISE SOLENOID
COARSE CRUISE ADJUSTMENT
TP 4427/B
INLET FROM TANK
BLEED VALVE

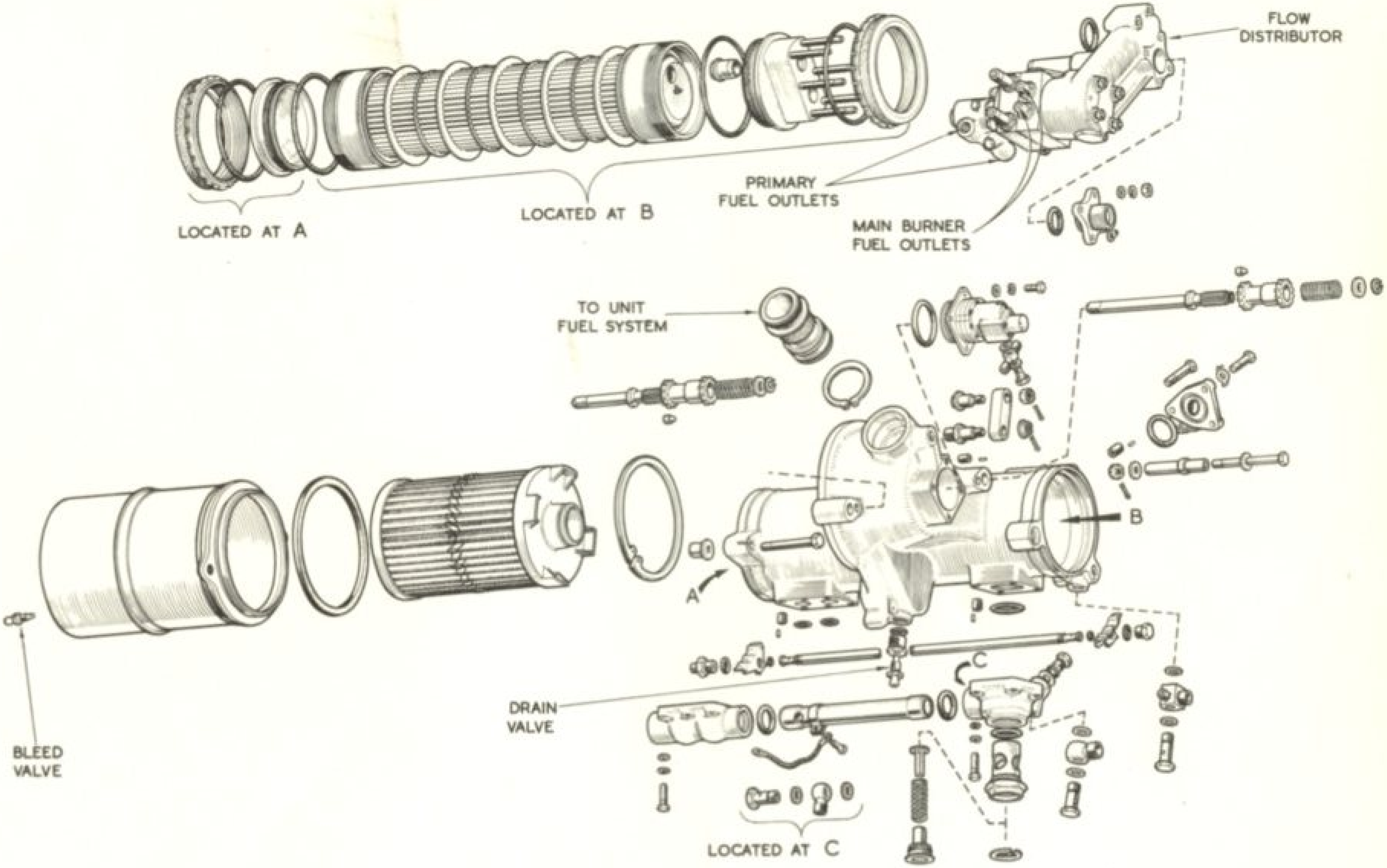
FUEL PUMP (L.P.)



POTENTIOMETER FULL RANGE FLOW CONTROL

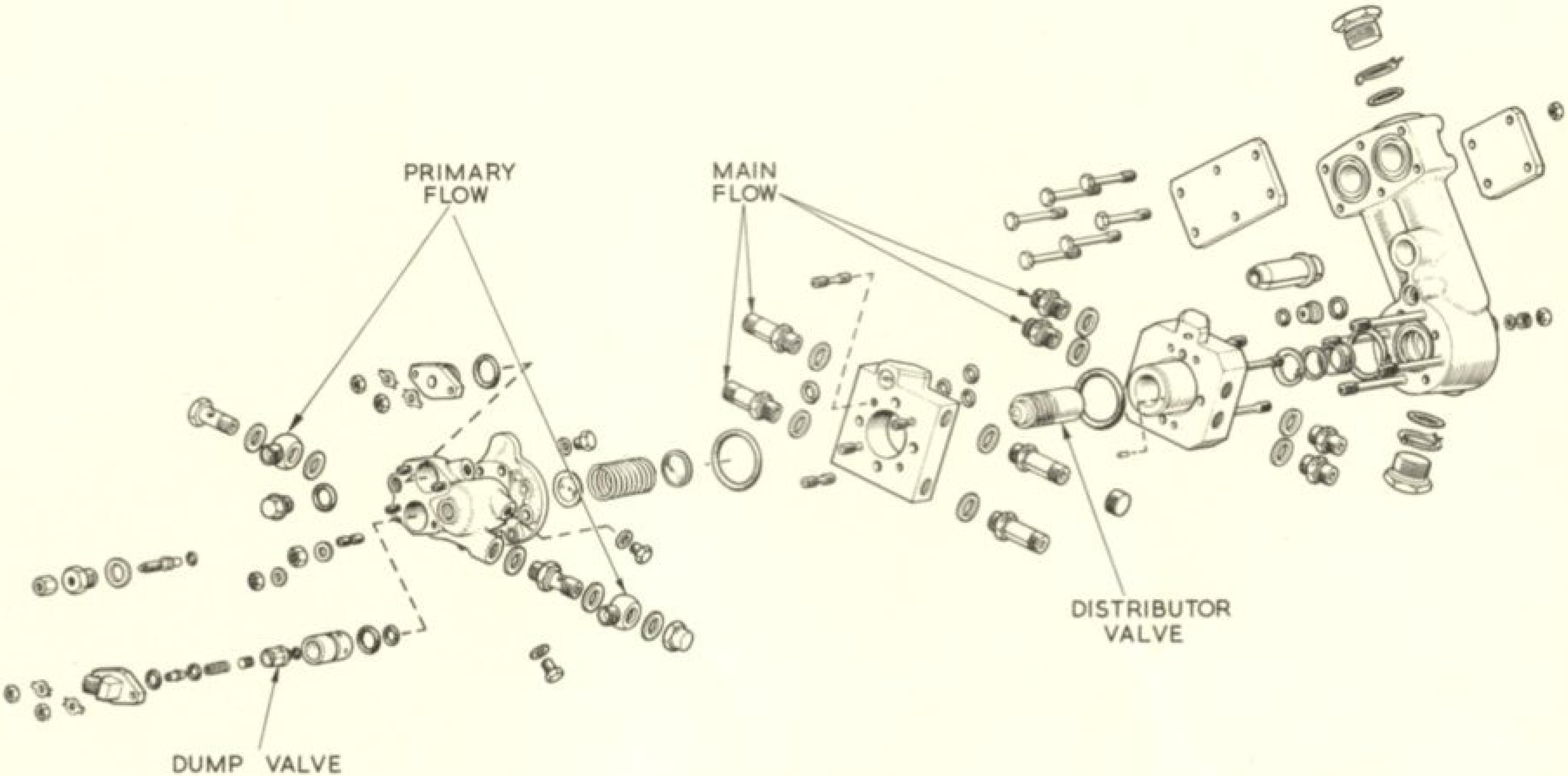


AIR/FUEL RATIO CONTROL



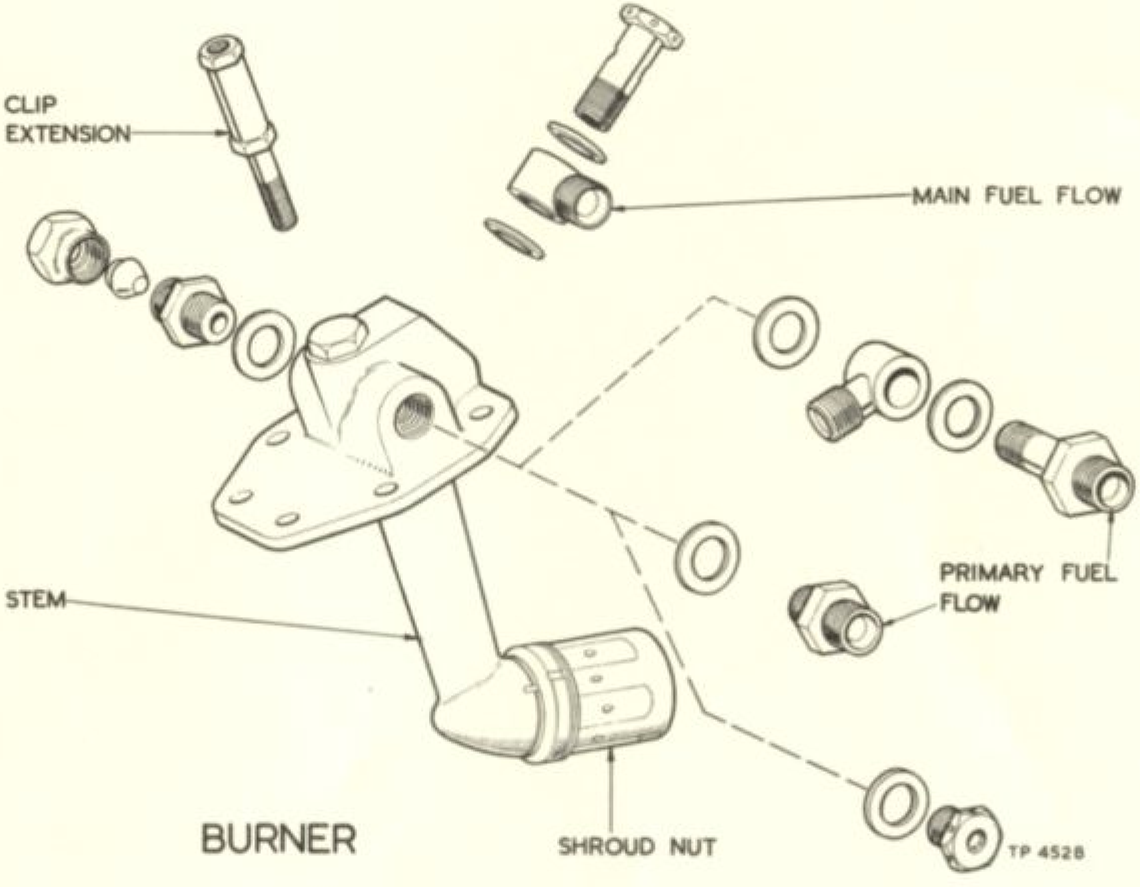
OIL COOLER. FUEL FILTER & FLOW DISTRIBUTOR MOUNTING

TP 4580



TP 4544

FLOW DISTRIBUTOR


CLIP
EXTENSION
MAIN FUEL FLOW
STEM
PRIMARY FUEL
FLOW
SHROUD NUT
TP 4528

BURNER

4.4 REMOVAL AND REPLACEMENT OF THE CHASSIS MOUNTED FUEL SYSTEM

Introduction

1. This section details the methods of removing and replacing defective fuel system components.

2. Access to the components is gained by draining zone 2B collector tanks and opening the engine bay doors. Once the doors are open, make sure that the jury struts are fitted in position.

3. Before attempting to remove any of the fuel system components, make sure that the throttle levers are in the H.P. COCK SHUT position, the L.P. COCK SWITCHES are at OFF and that the fuel tank booster pumps are switched OFF. Make provision to collect drainage as each disconnection is made and fit blanks to the pipe ends and component unions immediately; this promotes cleanliness, which is vitally important with turbo-jet fuel system components.

4. When reconnecting pipes, check that the unions, pipe nipples and nuts are scrupulously clean and undamaged, since certain pipes are subjected to high pressure and leak-free joints are essential to satisfactory engine functioning.

Note: It is essential to bleed the fuel system after any disconnection has been remade or a component has been changed.

Removing

5. Disconnect and remove from the aircraft bulkhead, the fire extinguisher horizontal spray pipe, situated adjacent to the engine fuel system metering unit.

6. Drain the fuel system.

(1) Cut the lock wire securing the drain valves, situated in the oil cooler and filter head body casting and on the filter casing.

(2) Attach a suitable hose to each valve and locate the free end of each hose in a container.

(3) Screw out .....

(3) Screw out the valves one complete turn and allow the fuel to drain.

(4) When draining is complete, tighten the valves and remove the hoses then secure the valves with lock wire.

7. Drain the oil sump as described in Section 5.

8. Disconnect the throttle linkage.

(1) Remove the blanking cover from the rear of the rear bulkhead, to gain access to the rear end of the throttle assembly.

(2) Remove the bolt securing the throttle spindle lever to the extension.

(3) Detach the throttle spindle coupling flange from the stop lever and then separate the assembly, leaving the control rod connected to the throttle spindle lever.

(4) Disconnect the control rod from the throttle torque tube lever.

9. Release the clipping securing the pipe (high pressure fuel flowmeter to fuel cooled oil cooler) to the fuel system metering unit, ram pressure air pipe and rear vent pipe elbow, then disconnect and remove the pipe.

10. Unbolt the rear vent pipe elbow from the delivery casing, release the bonding cables and pipe clip and then withdraw the elbow and pipe.

11. Disconnect and remove the following pipes:-

(1) Turbine rear bearing drain. Disconnect this pipe at the junction block and at the rigid pipe protruding through the bulkhead.

(2) Delivery casing to P1/P3 switch.

(3) H.P. fuel pump to fuel low pressure warning switch (drain).

(4) Fuel system metering unit to high pressure fuel flowmeter.

(a) Release the fuel elbow from the metering unit.

(b) Turn the pipe....

(b) Turn the pipe counter-clockwise through approximately 120° to provide withdrawal clearance for the fuel system metering unit. Do not remove the pipe.

12. Disconnect the following pipes:-

(1) Flow distributor to Nos. 6, 7 and 8 burners (secondary), from the flow distributor.

(2) Flow distributor to No.6 burner (secondary), from the burner.

(3) Burner manifold (primary) from No.5 and No.6 burners.

Note: First release the clipping securing Nos. 7 and 8 burners secondary feed pipes.

(4) Ram pressure air, from the fuel system metering unit.

13. Disconnect the two electrical leads, front bulkhead to fuel system metering unit, at the Breeze connections on the metering unit.

14. Release the fuel transfer bobbin.

(1) If modification Olympus 813 is incorporated, disconnect the halves of the bobbin.

(2) Prior to the incorporation of modification Olympus 813, release the circlip and slide the bobbin into the oil cooler and filter head body casting.

15. Assemble the mini-hoist equipment.

(1) Feed the hoist cable through the special adapter head and the Fairlead conduit, then attach the special adapter attachment to the end of the cable.

(2) Connect the adapter attachment to the fuel system metering unit mounting cover.

(3) Tighten the cable just sufficiently to take the weight of the metering unit.

16. Detach the fuel .....

16. Detach the fuel system metering unit from the rear support brackets then remove the lower bracket from the h.p. compressor casing flange.

17. Release the six bolts securing the fuel system metering unit to the drive housings on the intermediate casing.

Note: Only the two outboard bolts can be removed. The two lower bolts on the inboard side cannot be fully released until the unit has been moved rearwards while the two remaining bolts form part of the unit and are trapped in the unit casting. Segregate the pipe clip bracket.

18. Carefully ease the unit rearwards until the two inboard securing bolts can be released from the drive casing, then draw the unit clear of the drive housings.

Note: Take care to maintain the unit in a level position until the drives are clear of their housings, otherwise damage to the housings and/or unit may result.

19. When clear of the engine, lower the unit carefully on to a suitable support stand and disconnect the hoist.

20. Disconnect the electrical connections from the electro-pressure control and from the double datum governor solenoid on the l.p. fuel pump.

21. Release the Breeze connection mounting plate from its bracket on the metering unit.

Note: Do not remove the Breeze connection mounting brackets (B.153282 and B.153283), as this will affect the setting of the metering unit.

22. Release the half clamp, securing the electrical conduits to the metering unit, and detach both conduits.

23. Remove the mounting cover from the metering unit.

Note: Do not remove the half clamp bracket (B.158200) or the pipe bracket (B.158023). These items are fitted by Messrs. Lucas.

24. If modification Olympus 813 is incorporated, remove the half of the fuel transfer bobbin remaining in the metering unit.

25. If the metering unit is to be despatched for repair, it must be inhibited.

Inspection .....

Inspection

26. Remove the transportation and storage blanks from the replacement metering unit, allow the inhibiting fluid to drain and then inspect the unit generally for damage paying particular attention to the fuel pump drive shafts and the Breeze electrical connections.

27. Examine the fuel pump drive casing, on the intermediate casing, for damage.

Preparation for refitting

28. Prepare the replacement unit for fitment to the engine in the following manner:-

(1) Fit a new "O" seal to the mounting cover spigot and then fit the cover to the unit. Secure with setbolts.

(2) Fit the electrical conduits.

(a) Connect the Breeze electrical connections to the electro-pressure control and to the double datum governor solenoid on the l.p. fuel pump.

(b) Secure the breeze connection mounting plate to its bracket on the metering unit with bolts, plain washers and slotted nuts. Lock the nuts with split pins.

(c) Secure the conduits to the unit with the half clamps, a spring washer and nut.

(d) Wire-lock the electrical connections.

(e) Fit new "O" seal to each of the unit drive spigots.

(3) Remove the storage blanks from the unit and allow the inhibiting fluid to drain from the ports and unions.

(4) When draining is complete, refit the union blanks.

(5) Fit new "O" seals .....

(5) Fit new "O" seals to the fuel transfer bobbin. If modification Olympus 813 is incorporated, fit half of the bobbin to the oil cooler and filter head body casting and the other half to the metering unit. If the unmodified fuel transfer bobbin is being refitted, insert the bobbin fully into the oil cooler and filter head body casting.

(6) Inspect the unit to ensure that it is undamaged.

29. Attach the mini-hoist adapter attachment to the unit mounting cover.

Refitting

30. Using the mini-hoist equipment as described previously, hoist the unit and offer it into position. Start the two lower inboard securing bolts in the drive casing before easing the unit fully home.

Note: Take care to maintain the unit in a level position when entering the drives into their housings, otherwise damage to the housings and/or unit may result. If necessary, remove the covers from the l.p. and h.p. compressor hand turning gears and rotate the compressors to facilitate fitment of the unit.

31. Fit the lower rear support bracket to the h.p. compressor casing flange and secure it with new tabwashers and nuts. Lock the nuts with the tabwashers.

32. Bolt the unit to the drive casing fitting distance pieces and spring washers to the two outboard bolts and the pipe clip bracket to the lower of the two outboard bolts.

33. Secure the unit to the upper rear support bracket with a bolt and plain washer, passing through the bracket and into the trapped nut in the mounting cover.

34. Secure the unit to the lower rear support bracket with a bolt, plain washer and stiffnut.

35. Check tighten all the unit securing bolts.

36. Release the adapter attachment from the unit

and dismantle the .....

and dismantle the mini-hoist equipment.

37. If modification Olympus 813 is incorporated, bolt the halves of the fuel transfer bobbin together with bolts, tabwashers and nuts; lock the nuts with tabwashers. If the unmodified fuel transfer bobbin is fitted, slide it into engagement with the location in the metering unit and secure it with its circlip.

38. Connect the two electrical leads (front bulkhead to metering unit) to the Breeze connections on the metering unit. Wire-lock the connections.

Note: Ensure that these leads are reconnected to the correct Breeze connections.

39. Connect, tighten and wire-lock the following pipes:-

(1) Ram pressure air, at the fuel system metering unit.

(2) Burner manifold (primary) at Nos. 5 and 6 burners.

(3) Flow distributor to No.6 burner (secondary) at the burner.

(4) Flow distributor to Nos. 6, 7 and 8 burners (secondary) at the flow distributor.

40. Clip Nos. 7 and 8 burners secondary feed pipes to the pillar bolt on No.6 burner.

41. Clip together Nos. 7 and 8 burners secondary feed pipes, No.5 to No.6 burners primary pipe and the flow distributor to No.6 burner primary pipe, with the Duco hose clip.

42. Fit, tighten and wire-lock the following pipes:-

(1) Scavenge oil return.

(2) Delivery casing to P1/P3 switch. Clip this pipe to the bracket on the metering unit using a bolt and stiffnut.

(3) H.P. fuel pump to fuel low pressure warning switch (drain).

(4) Clip together the pipes (2) and (3) using a bolt and stiffnut.

43. Refit the fuel .....

43. Refit the fuel elbow to the fuel system metering unit.

(1) Fit new "O" seals to the rear end of the fuel flowmeter rigid pipe and to the fuel elbow then fit the elbow on the pipe.

(2) Turn the pipe carefully until the fuel elbow at the rear end of the pipe aligns with its aperture in the fuel system metering unit.

(3) Secure the elbow to the metering unit with bolts, spring washers and plain washers.

44. Fit the rear vent pipe and elbow.

(1) Fit a new "O" seal to the forward end of the pipe.

(2) Offer the pipe and elbow into position.

(3) Secure the elbow to the delivery casing with nuts and spring washers.

(4) Connect the bonding cables at the forward and rear ends of the pipe.

45. Fit the high pressure fuel flowmeter to fuel cooled oil cooler pipe. Secure the pipe clip to the bracket on the fuel system metering unit with a stiffnut and secure the pipe bracket to the rear vent pipe elbow with bolts, spring washers and the nut plate.

46. <u>Connect the throttle linkage</u>

(1) Insert the throttle spindle into the throttle spindle coupling flange, engaging the serrations.

(2) Fit the coupling over the throttle spindle extension and then assemble this unit to the throttle spindle lever.

(3) Offer the whole assembly to the stop lever of the fuel system metering unit and to the throttle spindle extension bracket.

(4) Bolt the throttle .....

(4) Bolt the throttle spindle coupling flange to the stop lever with bolts, tabwashers and nuts. Lock the nuts with the tabwasher.

Setting and Checking the Throttle Control Linkage

(1) Rotate the fuel chassis throttle valve to the H.P. cock closed position, this will give a reading of approx. 0°.

(2) Set the E.C.U. linkage so that the pointer at the front of the rear bulkhead degree plate is lined up with the 45° mark at the cut off positions.

(3) Using the vernier coupling mate up the throttle connections.

(4) Rotate the throttle valve to the take-off position, this will give a reading of approx. 90°. The pointer at the rear bulkhead should now align with the 45° mark at the take off position.

(5) Should there be a plus or minus discrepancy at take-off, this discrepancy should be equalised at both ends i.e. H.P. cock closed and take-off positions.

(6) A final check can be carried out by setting the throttle valve to 45° when the pointer at the rear bulkhead should align with the central position.

47. Fit, tighten and wire-lock the fire extinguisher spray pipe to the 'T' junction on the aircraft bulkhead adjacent to the fuel system metering unit. Clip this pipe to the brackets on the aircraft bulkhead.

48. Check the contents of the engine oil tank to make sure that there is sufficient oil in the tank to perform a dry motoring cycle. If necessary, replenish the oil tank as described Sect. 5.

49. Perform a dry motoring cycle as described and then fill the oil tank.

50. Bleed the engine .....

50. Bleed the engine fuel system as described in Sect. 4.

51. Subsequent to replacing a fuel system metering unit start the engine and carry out the necessary ground running checks.

High Pressure Fuel Flowmeter

Removing

52. Release the clipping securing the high pressure fuel flowmeter to fuel cooled oil cooler pipe to the fuel system metering unit and to the ram pressure air pipe, then disconnect the pipe from the flowmeter.

53. Release the fuel elbow from the fuel system metering unit.

54. Disconnect the Breeze connection of the flowmeter electrical cable from the bulkhead.

55. Detach the flowmeter mounting plate from the front bulkhead securing bolts.

56. Withdraw the flowmeter from its recess in the front bulkhead.

57. Unscrew the fuel inlet pipe, complete with fuel elbow, from the flowmeter inlet connection.

58. Remove the mounting bracket from the flowmeter.

59. Remove the inlet and outlet union connections and the electrical lead from the flowmeter.

60. If the unit is to be despatched for repair, it must be inhibited.

Inspection

61. Remove the transportation and storage blanks from the replacement flowmeter, allow the inhibiting fluid to drain and then inspect the unit generally for damage paying particular attention to the Breeze electrical connection.

Preparation for refitting

62. Prepare the unit for fitment to tne engine in the following manner:-

(1) Fit the mounting .....

(1) Fit the mounting bracket to the flowmeter. Secure with bolts, plain washers and slotted nuts; lock the nuts with split pins.

(2) Fit new "O" seals to the inlet and outlet union connections then fit the connections to the flowmeter.

(3) Fit the electrical lead to the unit.

(4) Fit the fuel system metering unit to high pressure fuel flowmeter pipe.

(a) Fit new "O" seals to the forward end of the pipe.

(b) Apply a light coating of Acheson's Dag 1126 compound to the threads at the forward end of the pipe.

(c) Screw the pipe carefully into the inlet union of the flowmeter.

(d) Trial fit the flowmeter in position and check that the fuel elbow at the rear of the pipe alignswith its aperture in the fuel system metering unit.

<u>Refitting</u>

63. Fit the flowmeter to the engine.

(1) Fit the unit into position in its recess in the bulkhead.

(2) Secure the mounting plate to the front bulkhead securing bolts with nuts, spring washers and plain washers.

64. Connect the pipe (high pressure fuel flowmeter to fuel cooled oil cooler) to the flowmeter outlet union connection. Wire-lock the pipe connection. Clip this pipe to the fuel system metering unit bracket and secure with a stiffnut, then clip the ram pressure air pipe to the pipe securing the clip with bolt, spring washer and nut. Connect the electrical lead to its bulkhead connection and secure with lock wire.

65. Fit a new .....

65. Fit a new "O" seal to the elbow of the rigid pipe and secure the elbow to the metering unit with bolts, spring washers and plain washers.

66. Bleed the engine fuel system.

67. Subsequent to replacing a high pressure fuel flowmeter, carry out the necessary ground running checks.

Combined Fuel Flow Distributor and Dump Valve

Removing

68. Disconnect the following pipes:-

(1) Dump valve to burners (primary) at the dump valve.

(2) Flow distributor to burners (secondary) at the flow distributor.

(3) High pressure fuel flowmeter to fuel cooled oil cooler at the cooler.

(4) Dump valve to by-pass valve drain connection at the dump valve.

(5) Fuel low pressure warning switch to the fuel cooled oil cooler bypass valve drain connection at the cooler.

69. Release the clipping securing the high pressure fuel flowmeter to fuel cooled oil cooler pipe to the rear vent pipe elbow. This pipe may then be moved to provide clearance.

70. Remove the oil cooler fuel inlet union fitting from the flow distributor mounting.

71. Detach the flow distributor mounting (complete with flow distributor and dump valve) from the fuel cooled oil cooler.

Note: Before the retaining nuts are released, draw the unit rearwards to clear its mounting studs and then ease the unit clear of the engine.

72. If the unit is to be despatched for repair, inhibit in accordance with the instructions.

Inspection .....

Inspection

73. Remove the transportation and storage blanks from the replacement unit and allow the inhibiting fluid to drain. When drainage is complete, refit the blanks and inspect the unit generally for damage.

Refitting

74. Fit the combined fuel flow distributor and dump valve to the fuel cooled oil cooler. Do not secure at this stage.

Note: Fit new "O" seals to the distributor mounting and two new "O" seals to the distributor mounting steady.

75. Fit a new "O" seal to the spigot of the oil cooler fuel inlet union fitting and then fit it to the studs protruding through the distributor mounting. Secure the distributor mounting and the inlet union with plain washers, spring washers and nuts.

Note: Fit a locking washer under one of the inlet union securing nuts.

76. Connect, tighten and wire-lock the following pipes to the flow distributor and dump valve.

(1) Dump valve to by-pass valve drain connection.

(2) High pressure fuel flowmeter to fuel cooled oil cooler.

(3) Flow distributor to burners (secondary).

(4) Dump valve to burners (primary).

(5) Connect, tighten and wire-lock the fuel low pressure warning switch to fuel cooled oil cooler pipe, to the by-pass valve drain connection on the cooler.

77. Clip the high pressure fuel flowmeter to fuel cooled oil cooler pipe to the rear vent pipe elbow bracket, with bolts, spring washers and the nut plate.

78. Bleed the engine fuel system.

79. Subsequent to .....

79. Subsequent to replacing a combined fuel flow distributor and dump valve, carry out the necessary ground running checks.

Fuel Low Pressure Warning Switch

Removing

80. Disconnect the following pipes from the switch banjo connection.

(1) H.P. fuel pump gland drain to fuel low pressure warning switch (drain).

(2) Fuel low pressure warning switch to drain connection on fuel cooled oil cooler.

81. Disconnect the electrical Breeze connection.

82. Remove the switch from the oil cooler and filter header body casting.

83. Remove the banjo and banjo bolt from the switch.

84. Blank off all the connections.

Inspection

85. Remove the transportation and storage blanks from the replacement switch and inspect the switch generally paying particular attention to the Breeze electrical connection.

86. Test the operation of the switch before assembly to the e.c.u. to ensure that it operates at the correct pressure.

Preparation for refitting

87. Fit the banjo and banjo bolt to the switch, interposing new bonded sealing washers.

88. Fit a new "O" seal to the spigot of the switch.

Refitting

89. Fit the switch to the oil cooler and filter header body casting. Secure with bolts, plain washers and spring washers.

90. Connect, tighten and wire-lock the following pipes to the switch banjo:-

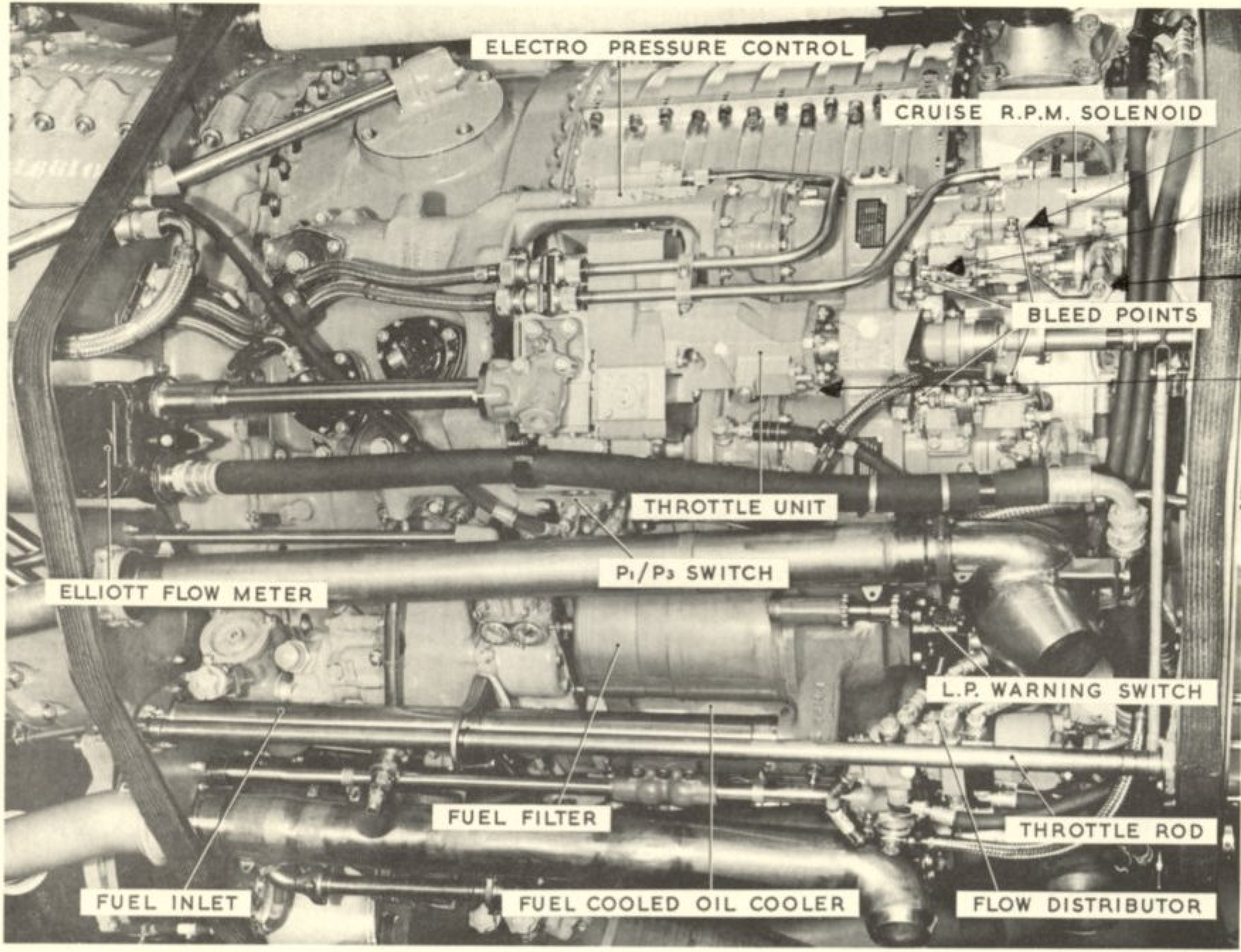
(1) Fuel low pressure warning switch to drain connection on the fuel cooled oil cooler.

(2) H.P. fuel pump .....

(2) H.P. fuel pump to fuel low pressure warning switch (drain). Connect the Breeze electrical connection to the switch.

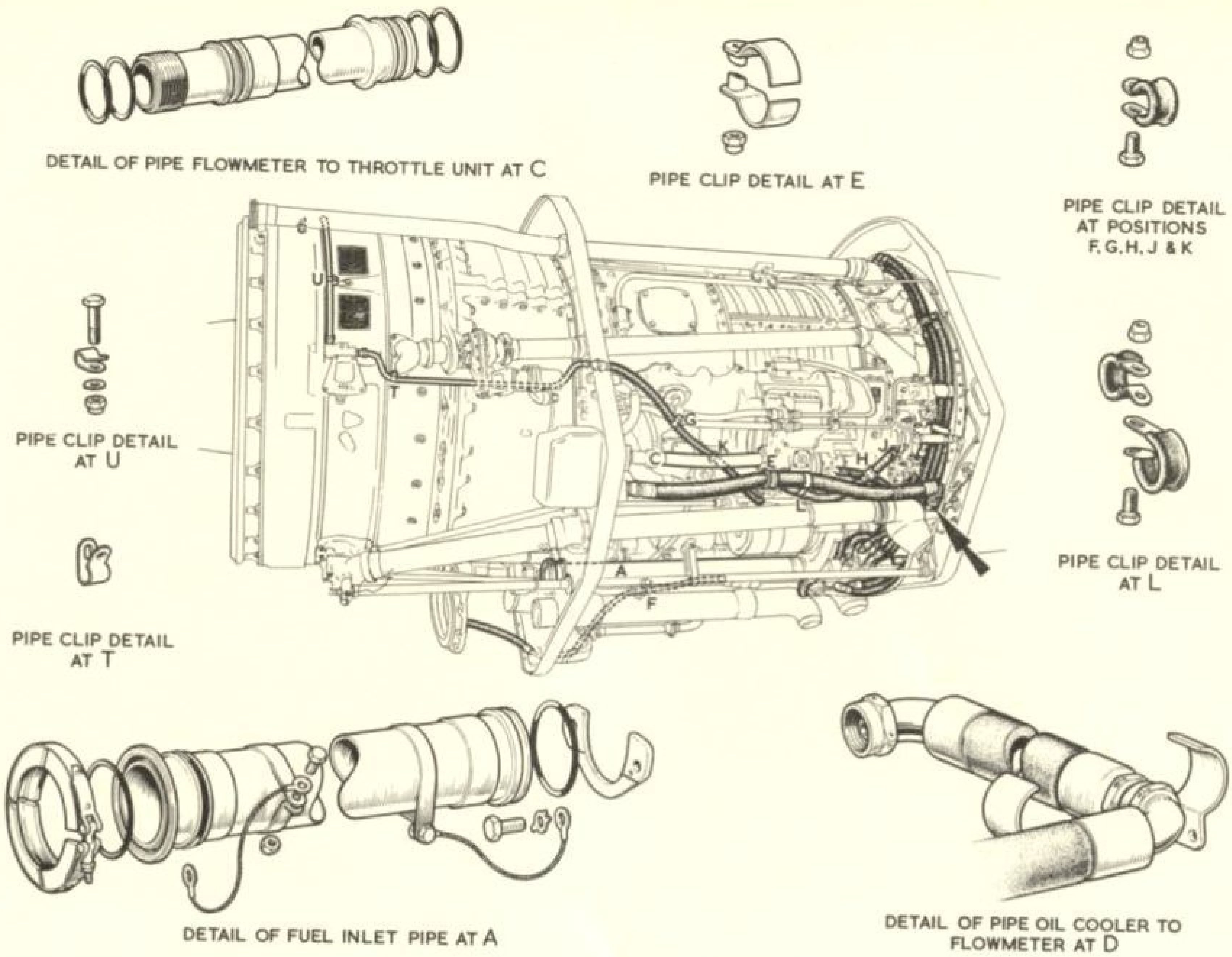
91. Bleed the engine fuel system.

92. Subsequent to replacing a fuel low pressure warning switch, carry out the necessary ground running checks.



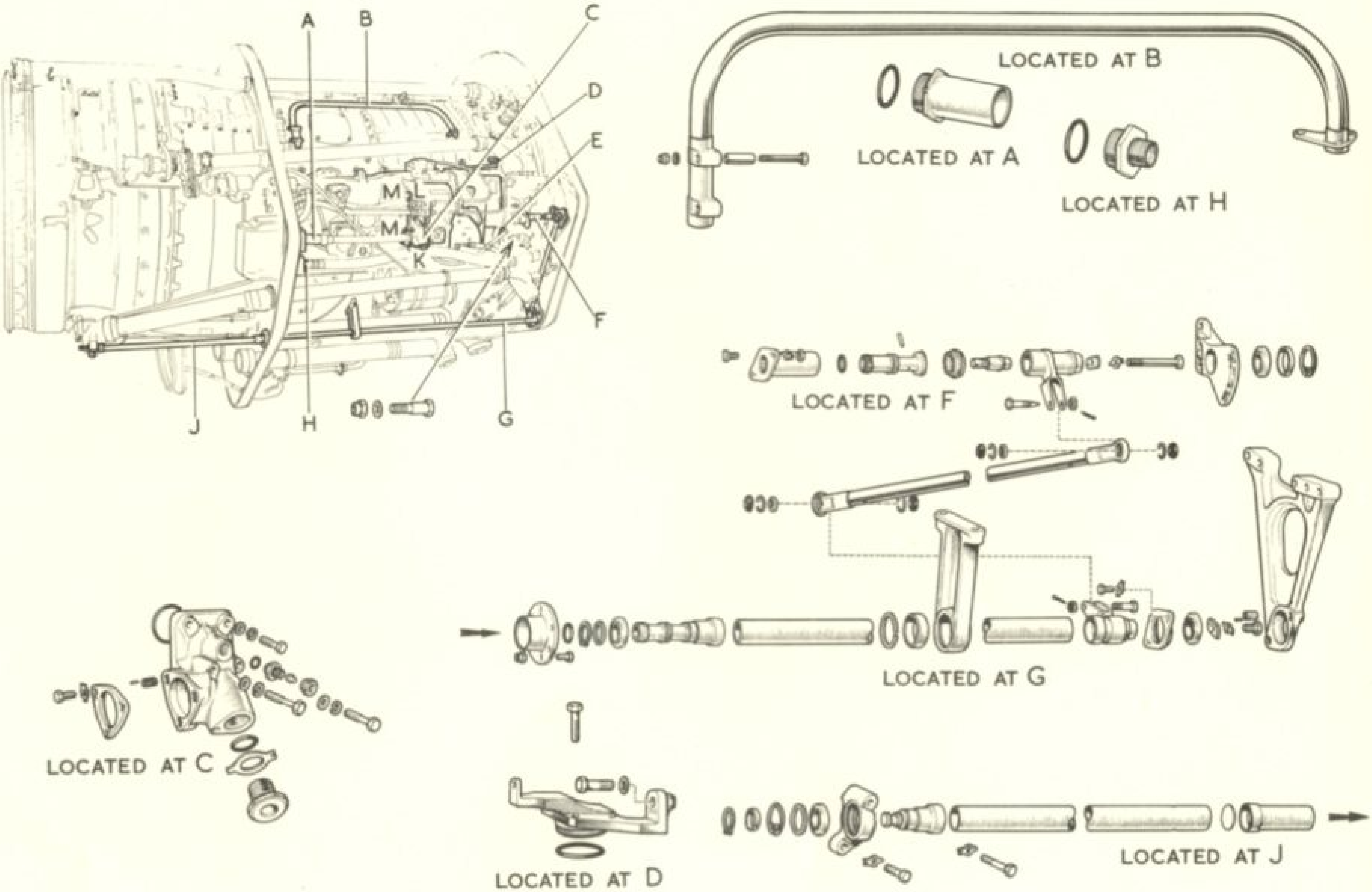
T.P. 4397

OLYMPUS 201 FUEL SYSTEM



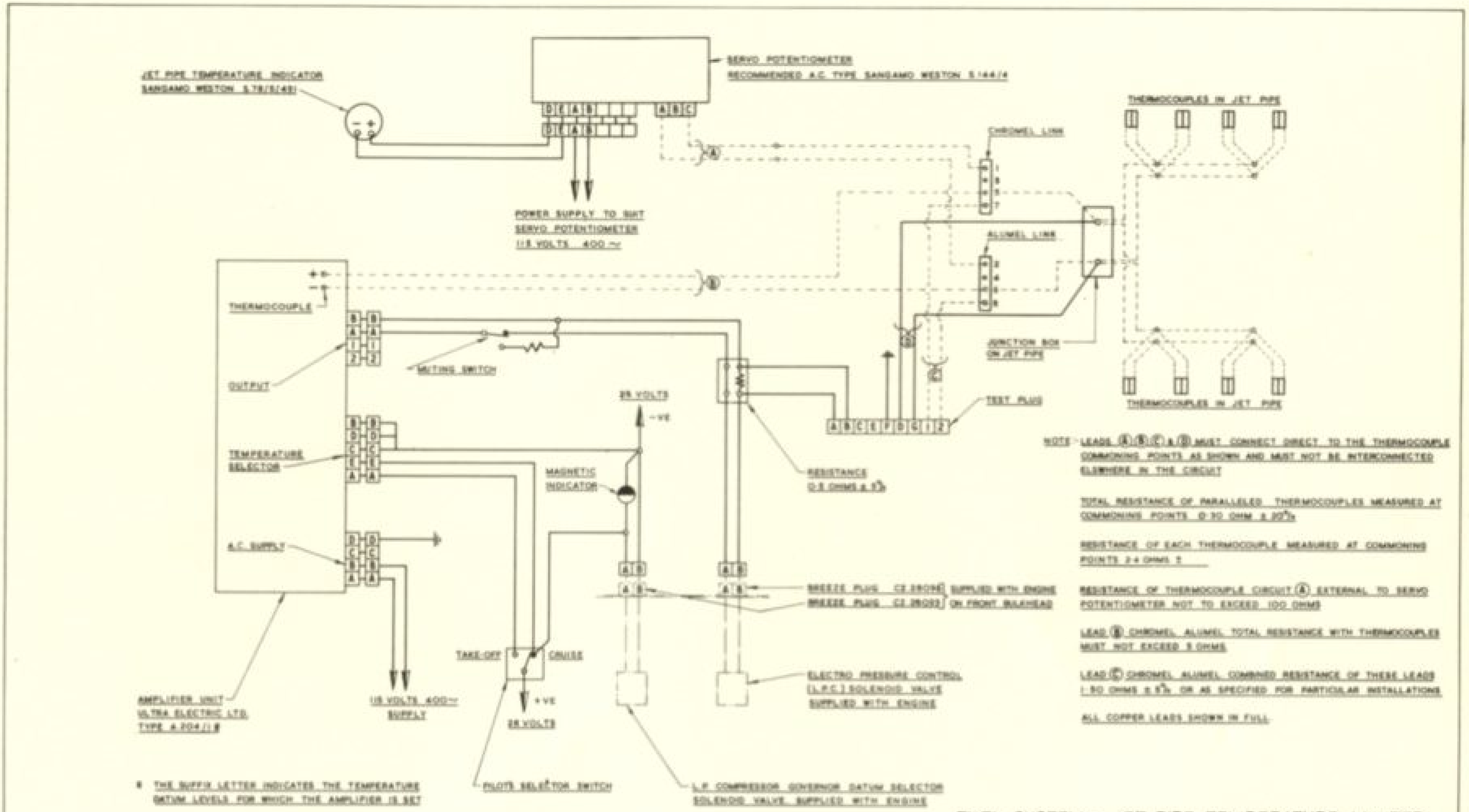
FUEL SYSTEM PIPES

TP 4664/1



TP. 4665

FUEL SYSTEM CONTROLS



FUEL SYSTEM - JET PIPE TEMPERATURE LIMITER

B.163922.B.

4.5. FUEL DRAIN STSTEM

Drain System.

To minimise the risk of fire in the engine bays, all drains are brought to the outside skin of the aircraft through the engine bay doors in Zone 2B.

Zone 2B door is of fabricated construction having and inner and outer skin. The door is stressed so that when it is in the closed position it forms an integral part of the aircraft structure. Between the inner and outer skins of the door a collector drains tank is fitted, which is designed with two compartments, the right one known as tank A is the smaller of the two, and collects gland drainage from the oil cooler, C.S.U. and unit fuel system. The second and larger compartment known as tank B, collects fuel drainage from the dump valve. On the outer skin of Zone 2B door will be found the collector drains tank selector pipe, the purpose of which is to enable the contents of either tank A or tank B to be checked by means of hand operated drain valves.

Each compartment of the collector drains tank is vented to atmosphere through a common pipe.

Tank B is designed to be self emptying in flight by extractor action, the outlet pipe being positioned to the rear of Zone 2B door.


ROLLS-ROYCE
ENGINE INHIBITED
-
DO NOT TURN PROP