

## Chapter 10

### REHEAT FUEL CONTROL UNIT, TYPE BA 41949

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#### Note . . .

Throughout this chapter the following symbols are used:—

$P_2$  = The pressure at the compressor outlet

$P_4$  = The pressure in the exhaust unit

$P_2/P_4$  ratio = That which exists at maximum r.p.m. reheat 'ON' and the j.p.t. normal.

does so by automatically regulating the supply of compressor delivery air ( $P_2$ ) which drives the turbine powering the reheat fuel pump, thus indirectly controlling the supply of fuel to the main reheat burner.

#### INTRODUCTION

1. Reheat is used to augment the normal maximum thrust of the engine when extra power is required for short periods. This is achieved by burning extra fuel in the gas stream as it passes through the jet pipe. The resulting higher temperature increases the gas velocity and hence the thrust of the engine. To permit the passage of the increased volume of gas at the original pressure a two position final nozzle is fitted to the jet pipe which increases the exit area when reheat is used.

2. Owing to the high fuel consumption when reheat is in use, the main reheat burner fuel system is remote from that of the normal engine system. The supply has to be accurately controlled to ensure that normal engine conditions are restored and maintained when reheat is used. The reheat fuel control unit is designed to perform this function and

3. The control unit consists basically of an air throttle actuated by a piston responsive to a servo pressure, which is derived from the engine H.P. fuel supply. A diaphragm operated bleed, sensitive to changes in the  $P_2/P_4$  ratio, automatically, alters the servo pressure and hence the air throttle setting, thus enabling the unit to compensate for variations in jet pipe conditions.

4. Three solenoids are fitted to the unit:—

(1) A pilot shut-off cock solenoid, controlling the supply of fuel to the reheat pilot burner.

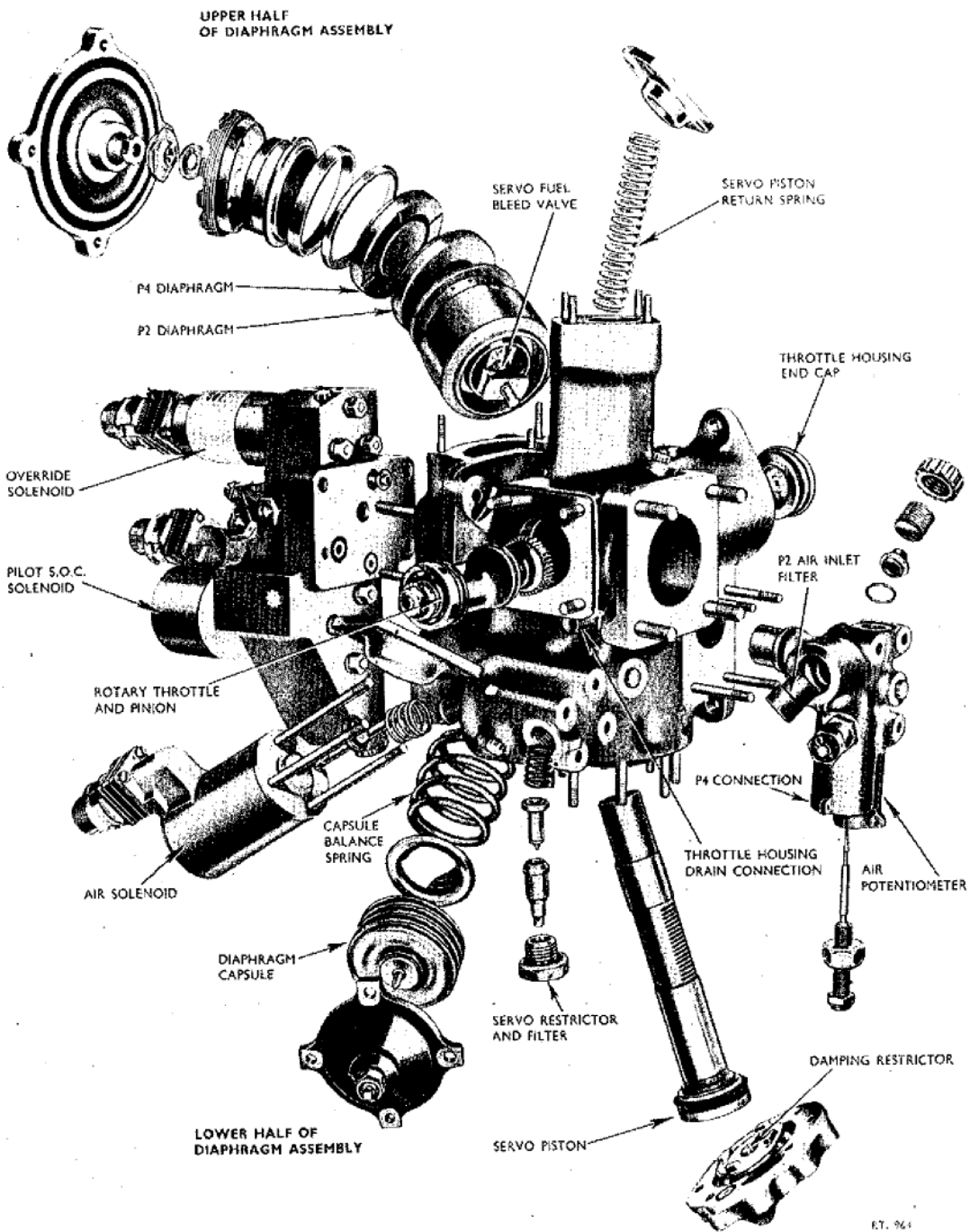
(2) A solenoid which shuts off the servo fuel bleed and thus causes a build up of servo pressure for opening the air throttle.

(3) An override solenoid which initially opens an air bleed from the diaphragm assembly to delay its controlling action until the two position nozzle is fully opened.

The operation of these solenoids is controlled by a relay system which is energized when the cockpit throttle lever is moved into the reheat position.

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### AIR THROTTLE

5. The air throttle is housed in the main body of the unit and consists of a rotary valve actuated by the servo piston through rack and pinion gearing; the pinion is mounted on one end of the valve spindle and the rack is machined in the extended shaft of the servo piston. Piston ring type seals are fitted inboard of the bearings supporting the valve to prevent air leaking past the ends of the spindle into the unit. The shaft of the servo piston is lubricated by L.P. fuel fed through annuli machined in the housing, any fuel or air leaking past these components passes to atmosphere through a drain at the pinion end of the throttle valve housing. The servo piston is subject to servo fuel pressure on the large effective area of the crown and H.P. fuel on the small effective area of the shaft side. A fuel damping restrictor located in the base of the servo chamber steadies the response rate of the piston. A spring located in the shaft of the servo piston ensures that the throttle returns to the closed position in the event of failure of the H.P. fuel supply.

### SERVO PRESSURE CONTROL

6. As mentioned in paragraph 3 the servo pressure is controlled by a diaphragm operated bleed. The diaphragm assembly and the half-ball cage housing are mounted in tandem and are supported by an evacuated capsule. The loading imposed on the diaphragms by the capsule is counteracted by a balance spring located in the base of the half-ball cage housing. In actual operation the diaphragms are continuously moving but their areas are such that when the engine is running normally with reheat 'ON' the corresponding  $P_2/P_4$  pressure ratio retains them in equilibrium and allows a small spill of servo fuel to flow through the bleed, back to the L.P. return. The fuel spill submerges both the capsule and the underside of the  $P_2$  diaphragm but as they are of equal effective areas any effect of fuel pressure on this assembly is thereby cancelled.

### AIR POTENTIOMETER

7. The air potentiometer, sometimes referred to as the splitter, is mounted on one end of the control unit by a bobbin type spigot. It has two main functions, one to provide an adjustment for matching the control unit to the working pressure of the individual jet pipe and the other to supply

cool  $P_4$  air for sensitizing the  $P_4$  diaphragm and, therefore, prevent contact with the high temperature exhaust gases. By referring to the flow diagram (*fig. 2*) it can be seen that  $P_2$  air passes direct to the  $P_3$  diaphragm. A tapping is taken from this supply and directed through a fixed orifice which is calibrated to reduce the pressure to a value slightly higher than the  $P_4$  exhaust pressure. This pressure is applied to the  $P_4$  diaphragm but is further governed by the  $P_4$  pressure from the exhaust unit. In the  $P_4$  pressure line a variable orifice consisting of a tapered needle fixed to an adjusting screw, provides a means of pressure adjustment between the unit and the exhaust tapping, thus enabling a limited alteration to be made in the  $P_2/P_4$  pressure ratio to suit individual combinations of jet pipes and control units.

### OPERATION

8. When reheat is selected or cancelled the response of the reheat fuel control unit is very rapid, the following paragraphs describe the variations in internal fuel and airflow within the unit. For purposes of description the sequence of operation is divided into the following phases:—

Reheat OFF  
Starting cycle  
Reheat ON  
Reheat cancelled

#### Reheat OFF

When reheat is off the air throttle is retained in the closed position by engine H.P. pump fuel pressure. The flow of fuel and controlling air (*fig. 2*) is as follows:—

H.P. delivery fuel from the engine pump flows into the unit to the under side of the servo piston and from here passes through the fixed orifice of the servo restrictor to the damping restrictor below the servo piston. Between these two restrictors are two passages, one leading to the half-ball valve of the air solenoid and the other to the half-ball valve operated by the diaphragm. In the REHEAT OFF setting the air solenoid is de-energized and the valve is held open by a compression spring, allowing the servo fuel to flow direct to the L.P. return without any build up of pressure occurring in the servo chamber. The pressure of the H.P. fuel acting on the shaft side of the servo piston is therefore unopposed and retains the throttle in the closed position.

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### *Starting cycle*

When reheat is selected, the control unit, in response to the energizing of the solenoids, supplies H.P. fuel to the reheat pilot burner and  $P_2$  air to the turbine of the reheat fuel pump. This is effected in the following sequence:—

An electrical relay, remotely controlled by the cockpit lever, energizes the pilot shut-off cock solenoid, opens the half-ball valve and allows H.P. fuel from the engine pump to flow direct to the reheat pilot burner. At the same time the air solenoid (described in the previous paragraph) is energized and shuts off the servo fuel bleed, causing a rapid increase in servo pressure which overcomes the pressure of the H.P. fuel on the shaft side of the piston resulting in the opening of the air throttle. When the reheat pilot burner lights up an initial  $P_4$  pressure increase is caused, which, if sensed by the diaphragm assembly would result in the immediate shutting off of the air throttle, causing the cancellation of reheat. To avoid this, the override or datum solenoid is energized allowing the  $P_4$  chamber pressure to bleed off to atmosphere, temporarily cutting out the controlling action of the diaphragm. When the fuel flow from the reheat fuel pump attains a predetermined pressure, a pressure switch causes the override solenoid to become de-energized, shutting off the  $P_4$  bleed and thus restoring the control of the unit to the diaphragm assembly. The duration of this phase is normally three seconds.

### *Reheat ON*

Under normal reheat conditions the prevailing  $P_2/P_4$  ratio retains the diaphragms in a state of equilibrium. The reaction of the diaphragms to any change in this ratio indirectly effects the flow of fuel to the reheat

burner and restores normal running conditions in the following manner:—

If the normal reheat j.p.t. is exceeded due to overfuelling a proportional rise in  $P_4$  pressure will occur, this will restrict the flow of  $P_4$  chamber pressure from the air potentiometer and cause a corresponding build-up in the  $P_4$  chamber. The increased  $P_4$  pressure acting on the top diaphragm overcomes the opposing  $P_2$  pressure and opens the servo bleed. The resulting decrease in servo pressure reduces the air throttle opening and slows down the turbo pump, thus reducing the fuel supply to the burner and therefore the  $P_4$  pressure, until normal conditions are restored. Should a low  $P_4$  pressure result, due to underfuelling, the  $P_2$  pressure acting on the lower diaphragm will hold the servo bleed closed until the  $P_2/P_4$  balance is restored.

### *Reheat cancelled*

When reheat is cancelled the pilot shut-off cock solenoid and the air solenoid are de-energized. This instantaneously cuts off the fuel supply to the pilot burner and opens the servo fuel bleed, collapsing the servo pressure and shutting the air throttle. The unit is thus returned to the conditions as described under the heading 'REHEAT OFF'.

### **INSTALLING AND ADJUSTING**

9. Full instructions covering the removal, replacement and adjustment of the reheat control unit are contained in Vol. 6, Part 1, Sect. 2, of the relevant E.C.U. Air Publication. A technical explanation of the adjustment is given in para. 7, of this chapter.

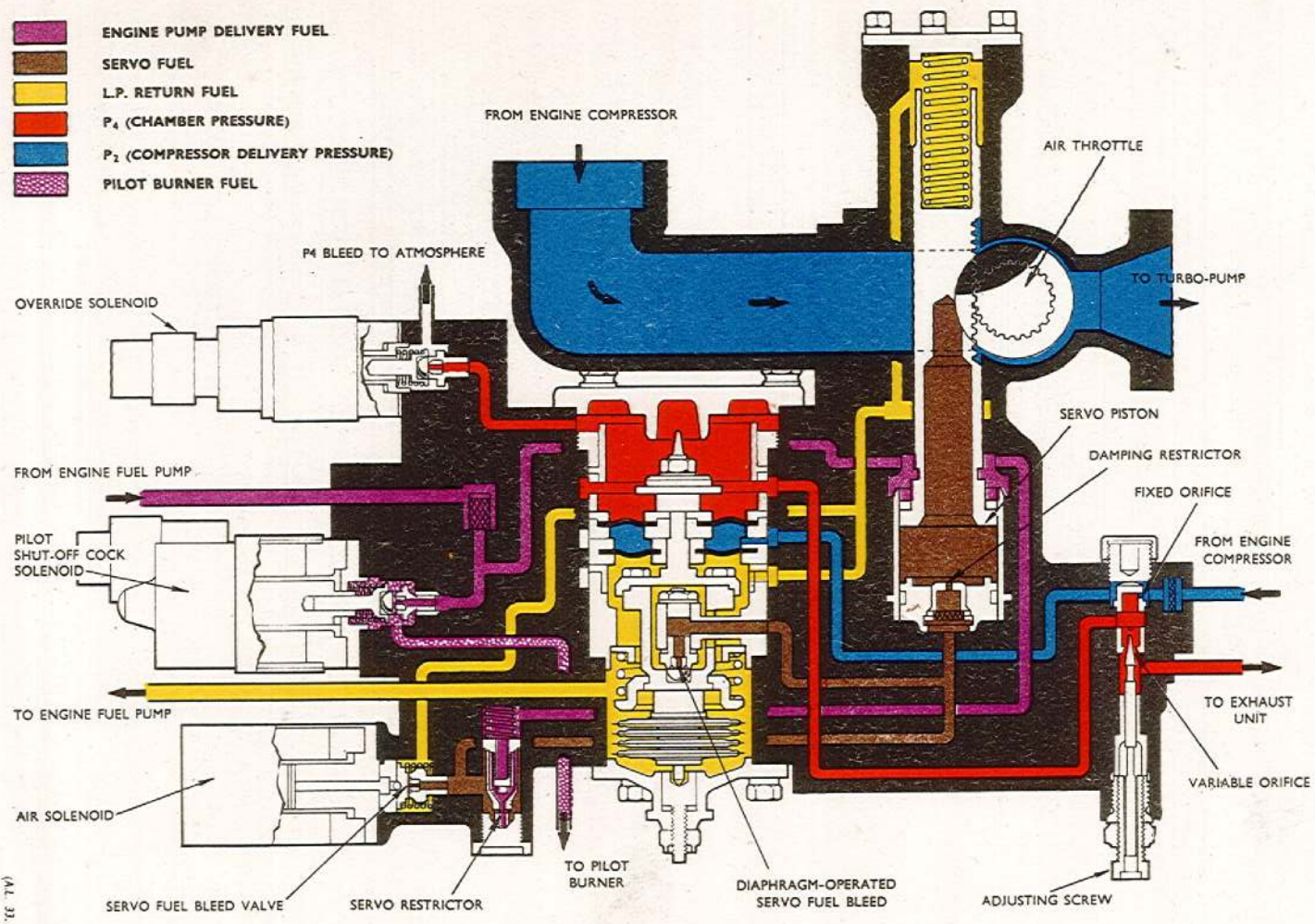
### **Warning**

*On no account must the locknut of the capsule adjusting screw be disturbed as this will necessitate the unit being recalibrated and rig tested.*

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- ENGINE PUMP DELIVERY FUEL
- SERVO FUEL
- L.P. RETURN FUEL
- P<sub>4</sub> (CHAMBER PRESSURE)
- P<sub>2</sub> (COMPRESSOR DELIVERY PRESSURE)
- PILOT BURNER FUEL



(AL 33, Dec. 54)

Fig. 2 Reheat control unit (flow diagram)

A.P. 4392, Vol. 1, Sect 7, Chap. 10 (AL 33)

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