

Chapter 8

AIR CONDITIONING SYSTEM

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DESCRIPTION AND OPERATION

Introduction

1. The Hunter F Mk. 4 aircraft is provided with a pressurized cockpit, pressure air being obtained from a restricted tapping on the engine compressor. A switch in the cockpit is provided to select pressurization, the OFF position enabling ram air, obtained from an air scoop in the nose of the aircraft, to be used in lieu of engine air pressure if desired and automatically under certain conditions of flight. Temperature control is effected by means of a temperature control switch, which is gated for HOT or COLD air selection in manual with intermediate positions. A fourth position provides for control in auto. The cockpit hood is provided with a rubber seal

which, with the engine running, is automatically inflated when the hood is closed and deflated automatically when HOOD OPEN is selected, partial deflation occurring before the hood actuation gear operates.

Engine air pressure system (fig. 8)

2. Air supply for cockpit pressurization is taken from a restricted tapping on the final stage of the engine compressor. From this tapping the air passes to a pre-cooler D.119/4A (A.P.4340, Vol. 1, Sect. 8, Chap. 1, App. 5) situated on the starboard side of the fuselage between frames 34 and 37. A by-pass valve (para. 12) piped to the air supply and pre-cooler permits the air to by-pass the pre-

cooler under certain conditions of flight. From the pre-cooler, which reduces the temperature of the air to a permissible value, the air passes to a motorized air supply valve (para. 11) for normal air supply, or, under certain conditions, for flood (para. 4). For normal (or main) feed, the air leaves this valve to continue to a variable orifice type mass flow controller which has two outlets, one conveying the hot air to the cockpit through the temperature control valve (para. 10) and the other passing the hot air to a cold air unit. This unit, A.C.R.E. 9, Mk. 6W (A.P.4340, Vol. 1, Sect. 2, Chap. 4), consists of a free-running compressor and turbine on one shaft with a ducted inter-cooler, D.119/3A (A.P.4340, Vol. 1, Sect. 8, Chap. 1, App. 4), in between. When air supply valve ON is selected, the air passes to the compressor and thence via the inter-cooler to the turbine. The output from the turbine is piped to the cockpit. The hot and cold airstreams rejoin at a mixing chamber downstream of the cold air unit, and the combined flow is delivered via a water extractor, type W.E.15 (A.P.4340, Vol. 1, Sect. 9, Chap. 3), situated between frames 14 and 16, and then through a non-return valve to the cockpit ventilation galleries. These galleries feed sprays at the windscreens, quarter lights and at the sides of the hood.

3. Spent ventilation air is expelled from the cockpit through a cabin air discharge valve, mounted on the forward face of frame 6. The outlet from this valve is shrouded. Piping in the nose of the aircraft, downstream of this shroud, permits the waste air to circulate in jackets around the radar equipment for cooling purposes before it is finally discharged to atmosphere in the nose of the aircraft.

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4. Flood air from the motorized supply valve is fed into the refrigerator outlet duct. The feed is controlled by an altitude switch (Sect. 5, Chap. 1, *Pocket D.6*) which automatically opens the air supply valve to the FLOOD position whenever the cockpit altitude exceeds 38,000 ft., thus preventing a low cockpit pressure occurring at this altitude.

5. A "Type A" cabin pressure controller, which operates the cabin air discharge valve, commences pressurization at 10,000 ft., and the full $3\frac{1}{2}$ lb. per sq. in. differential is built up at 25,000 ft. and above. For a description of the pressure controller, reference should be made to A.P.1275A, Vol. 1, Sect. 10, Chap. 13.

Ram air supply

6. An alternative air supply for emergency cabin air ventilation is provided from a forward facing air scoop situated in the camera vision cone in the nose of the aircraft. From the scoop, the air passes through a pneumatically-operated ram air shut-off valve mounted on frame 6 and thence into the cabin. In circumstances which entail positive isolation of the engine air pressurization supply, ram air induction is further assisted by a pneumatically-operated extractor valve, mounted on the forward face of frame 14, which operates in conjunction with the ram air shut-off valve and directs outflow of spent air to a region of low pressure. This condition is obtained by operating the "Cabin Pressure" on/off switch, thus causing the air supply valve to close and the extractor valve to open. The hood seal is kept inflated to prevent the noise of air leakage at the joints.

Temperature control

7. On this aircraft, cockpit temperature can be automatically controlled to within $\pm 2\frac{1}{2}$ deg. C. at any selection in the range of +5 deg. C. to +30 deg. C. This is effected by means of the type FLM/A/1 electronic cabin temperature controller, which is described in A.P.1275A, Vol. 1.

Hood seal (fig. 6 and 8)

8. A pneumatic rubber seal is provided around the perimeter of the cockpit hood joint. A common supply for the seal and extractor valve is taken from a tapping just downstream of the pre-cooler. A combination of reducing valve and non-return valve, with a safety blow-off, maintains the feed pressure to the seal at a pressure of 8 lb. per. sq. in. above the cockpit datum pressure. The supply branches off via solenoid valves to the hood seal and extractor. On deflation, the exhaust is bled to atmosphere. The closing of the main pressure air supply valve does not affect the seal. The hood seal solenoid valve, which is provided with a mechanical override, ensures that the hood seal is inflated when the hood is closed and remains inflated if the electrical power fails. The hood seal solenoid and hood winding motor are activated from a common control switch. The seal is inflated when the solenoid is de-energized. The circuit incorporates a time-delay to achieve deflation of the hood seal before the hood commences to open. The solenoid also incorporates a mechanical override, which, operating in conjunction with the hood jettison gear, provides for hood seal deflation prior to jettisoning the hood.

Cabin air extraction valve (fig. 1)

9. The cabin air extraction valve is fitted on frame 14. It is operated pneumatically

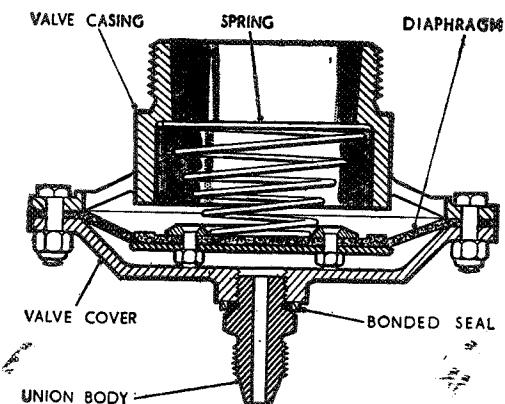


Fig. 1. Air extraction valve

via a solenoid from the main engine pressure supply and is automatically opened when the main air supply valve is closed. If the electrical power fails, the extraction valve remains closed. The valve operates in conjunction with the ram air shut-off valve (para. 6).

Temperature control valve (fig. 2)

10. The temperature control valve consists of a valve body (A) housing a spindle which carries the operating levers (C) which in turn engage with the split sleeve (D). The sleeve contains a specially shaped port which gives a progressive opening of the valve. The actuator (B) is arranged to engage with the valve spindle for operation of the valve. A pinion on the valve spindle engages with a separately mounted quadrant which in turn operates, through a linkage, a follow-up resistor which is part of the temperature control.

Air supply valve (fig. 3)

11. This valve is similar in construction to the temperature control valve (para. 10), except that an additional outlet port is provided for flood air. It is operated by an actuator which is itself operated by the pilot's control in the cockpit for PRESSURE ON or PRESSURE OFF and by an altitude switch for flood air. A manual switch in the cabin enables the pilot to select flood air as desired.

Pre-cooler by-pass valve (fig. 4)

12. This valve consists of a body (A) which contains a spring-loaded sliding valve (D). The valve body contains two inlet ports, one of which (port B) is connected to a pipe from the pre-cooler and the other (port C) to a pipe which by-passes the pre-cooler. There is a common outlet port (E). According to the position of the sliding valve (D), the pressure air is fed directly into the system or passed through the pre-cooler. The position of the valve is dependent on the pressure difference at the two ends of the valve body, one end being connected to the hot air by-pass pipe from the variable orifice valve (para. 13) and the other to the cold air outlet from the cold air unit. When the temperature control valve is closed, the pressure in the hot air by-pass is high and hence the by-pass valve passes air through the pre-cooler.

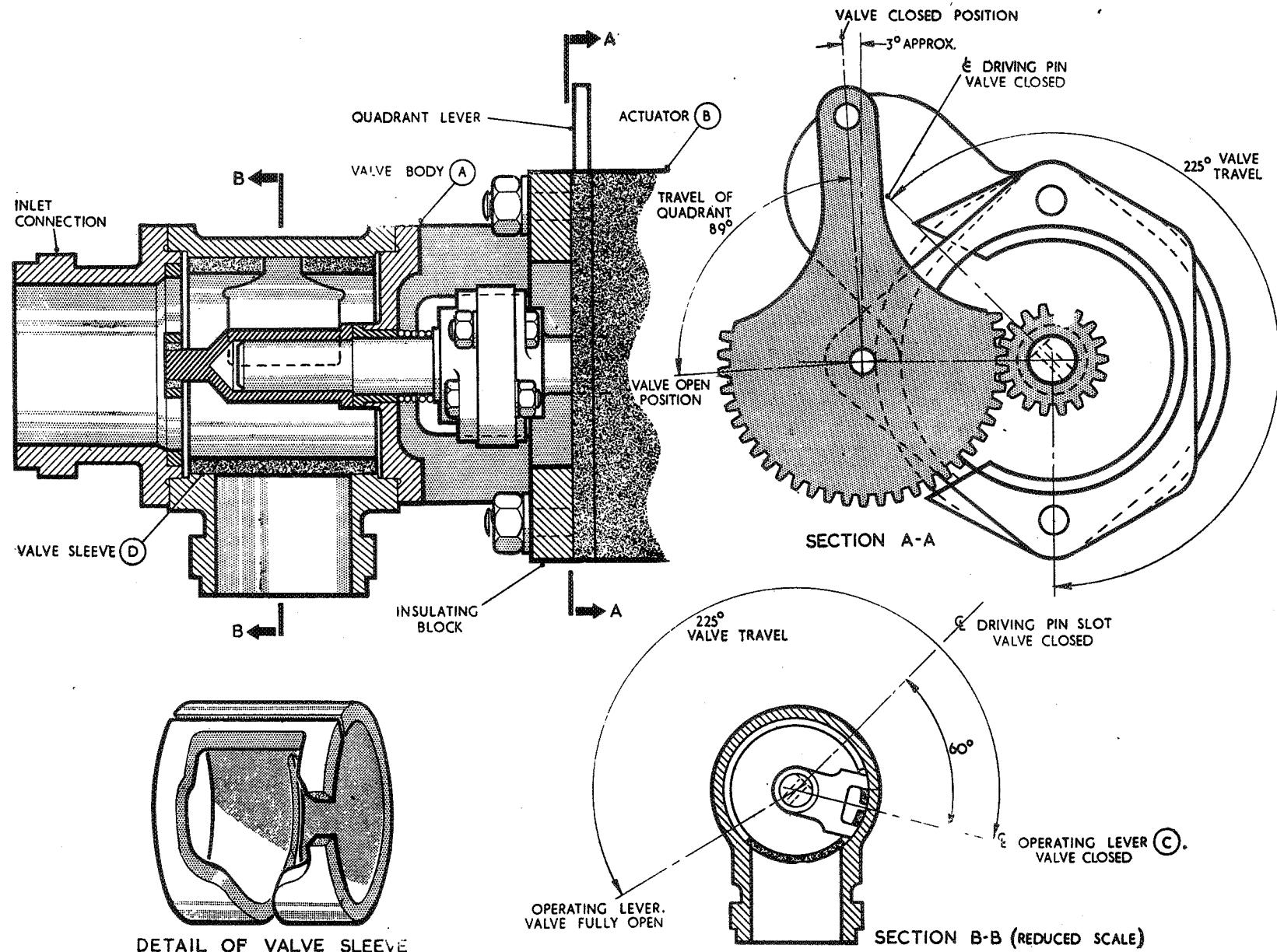


Fig. 2. Temperature control valve

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Variable orifice valve (fig. 5)

13. The variable orifice valve consists of a body (A) which contains a sliding spring-loaded valve (C). Its purpose is to control the flow of air to the cold air unit or to the

cockpit through the hot air by-pass. Movement of the valve is effected by the pressure difference across it, the profile of the valve being forced into a circular orifice in order to provide the required flow. The inlet port

(D) is in connection with the normal outlet port of the air supply valve, the outlet port (E) with the hot air by-pass and the outlet port (B) with the inlet of the cold air unit.

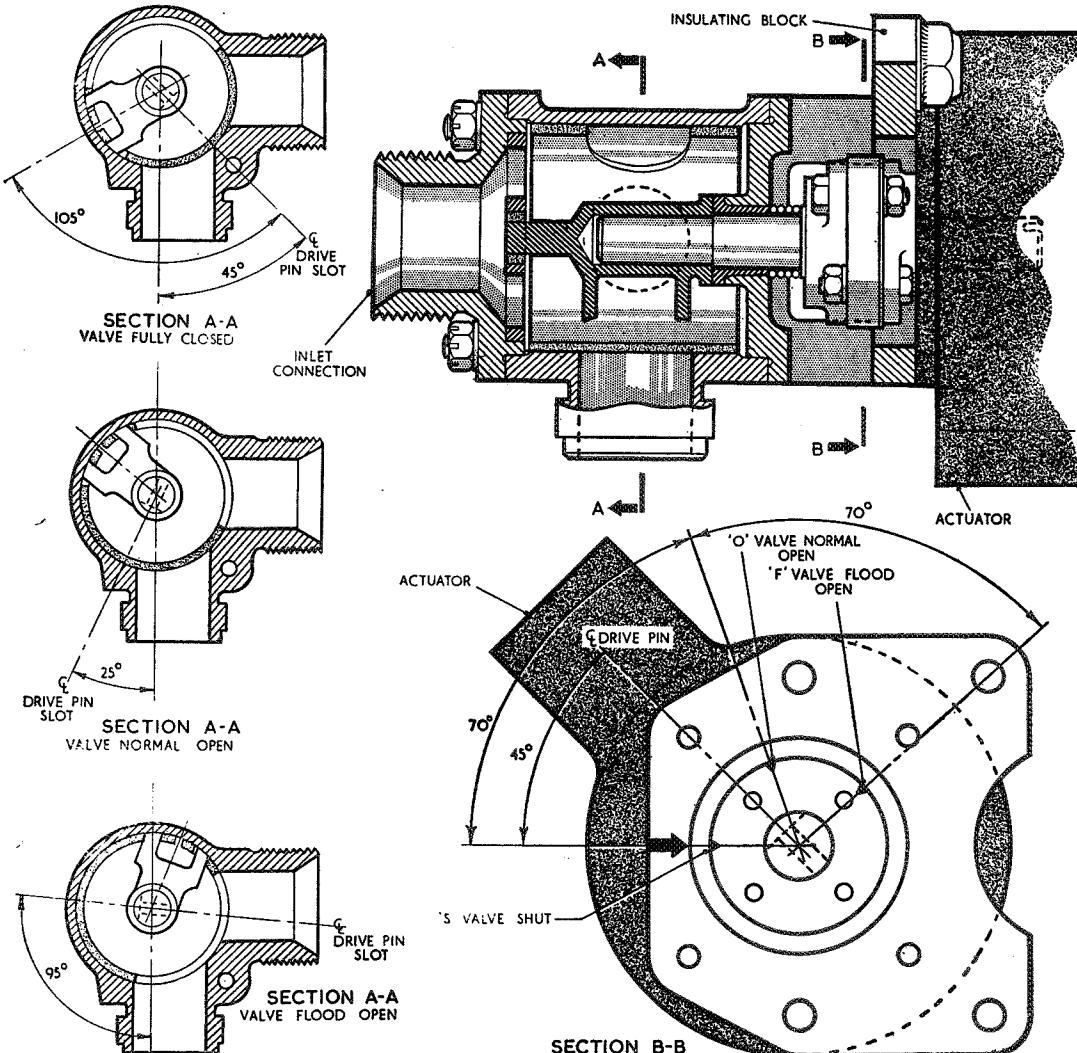


Fig. 3. Air supply valve

◀ **Auxiliary cabin air discharge valve**

13A. The auxiliary cabin air discharge valve is in the hood fairing. With the cabin pressure ON, the rear discharge valve is normally shut by venting its control chamber through the solenoid valve to the cabin. Selection of flood air manually for demisting connects the control chamber through the solenoid valve to the Type A controller. Front and rear discharge valves then operate in parallel to dispose of cabin air.

Controls

14. Cockpit pressurization is controlled from an ON/OFF pressurization control switch which is situated on the rear of the cockpit port shelf. An auto/manual temperature control switch, mounted adjacent to the pressure control switch, is marked AUTO, COLD and HOT. The pressurization control switch controls the air supply valve actuator located on frame 33, the air extractor valve solenoid situated on frame 14 and the temperature control valve actuator in the hood fairing. The intermediate positions of the temperature control switch are used to maintain the temperature control valve in any chosen condition. When the temperature control switch is placed at AUTO, temperature is selected by means of a temperature selector mounted on the cockpit port shelf. The selected temperature is then automatically maintained by the type FLM/A/1 electronic cabin temperature controller, the magnetic amplifier and cabin element of which are located in the cockpit and the follow-up resistor in the hood fairing adjacent to the temperature control valve actuator. Provision is made for overriding the pressurization control switch to close the air supply valve and energize the air extractor valve solenoid to open the valve when HOOD OPEN is selected. At the same time the hot air by-pass is closed. For further information on the operation, electrical interconnection, relays, etc., reference should be made to Sect. 5, Chap. 1, Pocket D.6.

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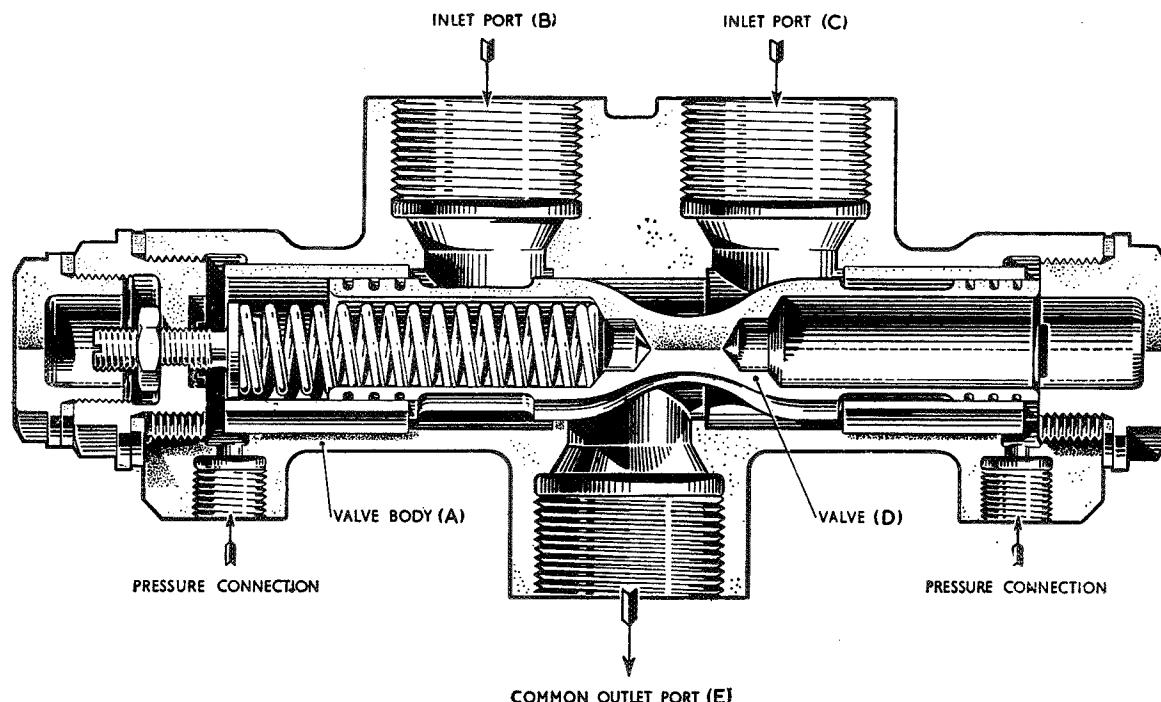


Fig. 4. Pre-cooler by-pass valve

Visual warning of loss of cabin pressure

15. Warning of loss of cabin pressure is given visually by means of a warning lamp located on the starboard instrument panel in the cockpit. The warning lamp is operated

on contacting of the switch in the type A controller mounted on the rear face of frame 6 whenever cabin pressure differential falls by $\frac{1}{2}$ —1 lb. per sq. in. below nominal datum. ◀▶

WARNING

The detachable hood fairing (item 4 of fig. 2, Sect. 2, Chap. 4) must be fitted at all times when ground pressurization tests are being carried out.

Cold air unit—servicing prior to installation

17. At all times care must be taken to exclude dirt, oil or foreign matter from entry into this unit. Prior to installation, all connecting pipe flanges should be examined for damage and distortion, and it should be

ensured that they are clean and free from obstruction and oil. If the unit has been inoperative for an appreciable time, e.g., as in storage, it should be primed as detailed in A.P.4340, Vol. 1, Sect. 2, Chap. 4.

Cold air unit—topping up

18. When the unit is subsequently serviced on the aircraft it should be topped up to the dipstick level with oil as specified in the Leading Particulars. The oil and containers must be absolutely clean. Avoid overfilling

A test switch, located on the rear portion of the cockpit port shelf, is provided to ground test the audio, warning light and flood circuits. For further information on the warning systems, reference should be made to Sect. 5, Chap. 1, Pocket D.6.

Ground test connections

16. Provision is made for ground testing the system, using an external supply. The equipment consists of the following:

(1) A connection for ground pressurization of the cabin and a switch for external operation of the sliding hood, both of which are mounted on the forward face of frame 3. These are accessible after removing the nose-piece of the aircraft, which is secured by fasteners (Sect. 3, Chap. 1, fig. 9).

(2) A connection for hood seal inflation from an external source and a connection for a pressure gauge, both of which are on the forward face of frame 6, are accessible through the nose wheel bay.

WARNING

Only personnel certified by the station or Unit Medical Officer as fit for servicing duties inside pressure cabins are permitted inside the aircraft when tests are carried out at ground level. Personnel with colds must have further medical approval. (A.P.1464D, Vol. 2, Part 1, Leaflet refers).

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the unit as excess oil may seep past the labyrinth seals when the unit is stationary.

Drains

19. The water separator is provided with a restricted drain which terminates outside the fuselage skin between frames 14 and 15 on the port side of the aircraft. The drain should be periodically examined to ensure that it is not blocked. The pre-cooler and inter-cooler are each provided with a drain pipe, these being in the region of frame 35 and 36 and

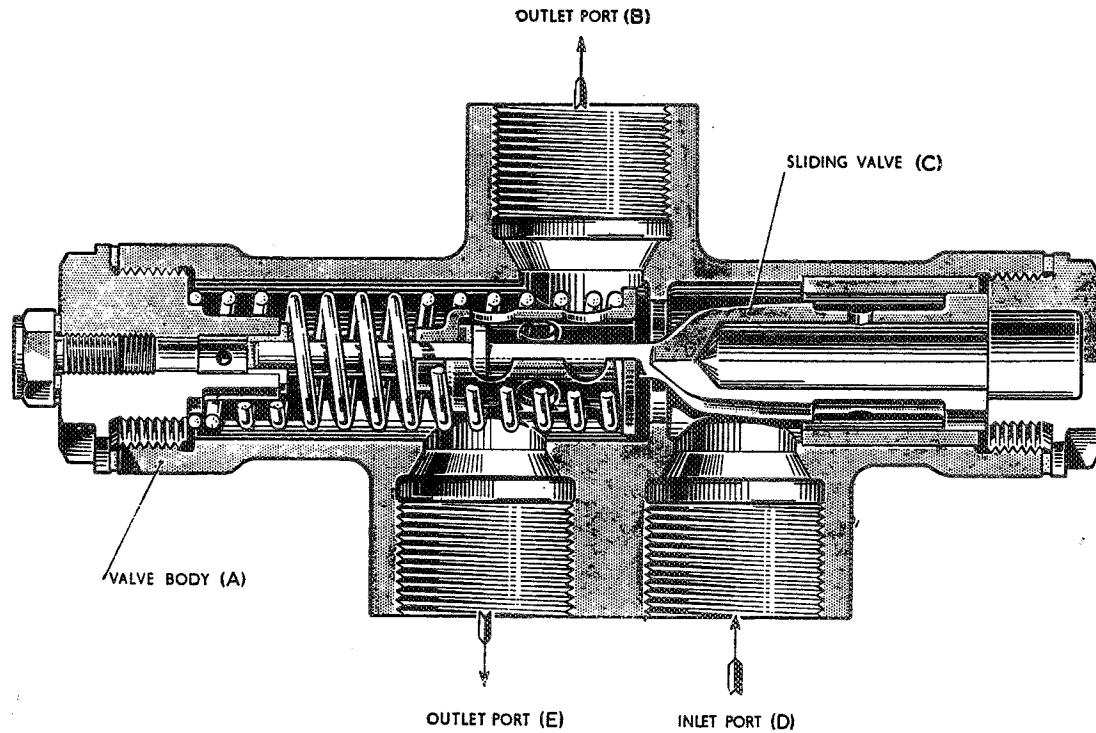


Fig. 5. Variable orifice valve

accessible through the engine access door (Sect. 2, Chap. 4, fig. 2). The plugs sealing the drain pipes should be removed periodically and any water that may have collected should be drained off.

Maintenance of cabin pressure and structural sealing

Sealing cabin structure

20. The maintenance of cabin pressure at high altitude is essential and all sources of leakage must be sealed in accordance with the instructions given in the following paragraphs, using the approved materials listed below:—

(1) Bostik pressurizing plastic No. 1751 (Stores Ref. 33C/1139). This is a liquid used as a primer and sealant. It is applied with a brush.

(2) Bostik pressurizing plastic No. 1790 (Stores Ref. 33C/1138). This is a stopper extruded from a tube, or pressure applicator, to form a bead around the edges of mating parts and for filling spaces too large for Bostik 1751.

(3) Soft rubber rectangular strip (Commercial) or Prestik pressure plastic (Stores Ref. 33C/889). This is for the preliminary filling of spaces too large for Bostik 1790.

Note . . .

As Bostik sealants are highly inflammable, the usual fire precautions for the application of inflammable materials must be observed.

Application of sealants

21. The method of application of the above sealants is as follows:—

- (1) Parts to be assembled or rectified for leakage should be coated with Bostik 1751 in the detail stage.
- (2) All joints in the pressure cabin must be sealed and, for an effective seal, the surfaces to be sealed must be scrupulously clean. If necessary, the surfaces to which the sealant is to be applied can be cleaned with white spirit, but the spirit must be used sparingly.
- (3) Make all joints between mating parts, e.g., skin to frames, with Bostik 1751 applied with a 1 in. medium soft bristle brush, the application to extend for $\frac{1}{8}$ in. from the joint in all directions on the pressure side of the joint. Allow between 30 and 60 minutes' drying time before bringing the joint faces together. After riveting, apply a liberal coat of Bostik 1751 over all rivet heads. Dip bolts in Bostik 1751 before assembly. Coat any large apertures (above 0.10 in. approx. dia.) in corners with Bostik 1751 and fill with Prestik coated with Bostik 1751 immediately prior to insertion. Fill tooling holes with "Chekaleke" plugs applied as above. Fill pop rivets with Bostik 1790 and coat with Bostik 1751 on the pressure side. Allow to dry for 2 hours.
- (4) Apply a fillet of Bostik 1790 as necessary along the edges of mating parts and in jointed corners. Allow to dry for 24 hours.
- (5) Apply a further coat of Bostik 1751, extending over the whole area treated in sub-para. (3) above. Allow to dry for 24 hours before pressure testing.
- (6) Pressurize the cabin in accordance with the requirements laid down in para. 23.
- (7) Stop any leaks shown in the above test with a further application of Bostik 1790 and 1751 over the pressure side of the leak. Alternatively, a mixture of half and half of each, by volume, may be applied to the leak with a brush. Allow to dry for 6 hours before re-testing.
- (8) Allow 12 hours from the last application of sealant before painting.
- (9) Re-test in accordance with the requirements laid down in para. 23.

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Note . . .

Bostik 1790 may be thinned down by thinner Bostik 6846 if required. Experience has shown that a suitable mixture of Bostik 1790 and 1751 may be satisfactorily used in the pressure applicator and also applied with a brush. After using the pressure applicator, accessories should be thoroughly cleaned with Bostik cleaner 6307 if they are likely to be out of use for a period in excess of 24 hours.

Cabin pressure test equipment

22. For this test an electrical supply is required for the hood motor, extractor valve solenoid and hood seal solenoid. Also the special cable for operating the hood externally should be plugged in. The cable is clipped to the structure near the hood operating controls on the port side of the cockpit. Other equipment needed is:—

- (1) Test trolley (Stores Ref. No. 4F/1714.) (Connection point shown on fig. 6, item 24.)
- (2) Canopy seal inflator (incorporating Schrader valve) (Stores Ref. No. 4F/1812).
- (3) Connection adapter for cabin pressure gauge, 2 off (Stores Ref. No. 4F/1810).
- (4) Canopy seal pressure gauge (Stores Ref. No. 6A/1582).
- (5) Cabin pressure gauge (Stores Ref. No. 6A/1582). (Connection point shown on fig. 6, item 32.)
- (6) Length of rubber hose to suit adapter (Stores Ref. No. 4F/1810).
- (7) Foot pump for hood seal inflation (car type).

Cabin pressure test (engine off)

23. (1) After preliminary adjustments of

the hood seal micro-switch to cut in within the limits laid down (Sect. 3, Chap. 1, fig. 13 and 14), and with the equipment listed above coupled to the aircraft, close the hood by means of the external switch, and gradually apply pressure with the foot pump to the hood seal and extractor valve. Note the pressure at which the extractor valve closes and continue pumping until the seal pressure builds up to 8 lb. per sq. in. Check for leaks in the seal and extractor valve system. (The cabin pressure switch must be in the ON position).

- (2) Blank the static vent (fig. 8, item 31) of the type "A" controller and run the test trolley with the blow off set to produce a pressure of $3\frac{1}{2}$ lb. per sq. in. in cabin. The trolley blow off setting should not be more than about 5 lb. per sq. in. Carry out checks for leakages from various points, particularly the following:—
 - (a) Cabin and ram non-return valves.
 - (b) Extractor valve.
 - (c) Cabin discharge valve.
 - (d) Access holes for flying controls, Teleflex controls, etc.
- (3) Operate the various flying controls to make sure that their movement does not increase the leakage rate. In conclusion, check the rate of fall of the cabin pressure. The required rate is for the pressure to drop from $3\frac{1}{2}$ — $1\frac{1}{2}$ lb. per sq. in. in not less than 1 min. after disconnecting the supply, with the hood seal pressure maintained at 8 lb. per sq. in. At the end of these tests, unblank the type "A" controller static vent.

- (4) With the hood closed and the cabin pressure ON build up the hood seal pressure to 8 lb. per sq. in. Disconnect the foot pump and check that the seal pressure does not fall below $6\frac{1}{2}$ lb. per sq. in. over a period of 5 minutes. At the end of these tests disconnect the ground equipment.

ASSEMBLY OF COMPONENTS**Air supply valve and temperature control valve**

24. The following points should be observed when changing either the actuator or the valve in the above assemblies.

- (1) When fitting the actuator to the valve, care should be taken to ensure that the actuator driving pin engages correctly with the valve spindle. The two components when in alignment should slide together freely. Malalignment may cause damage to the actuator and increase valve gland leakage.
- (2) With the valve closed apply air pressure at 75 lb. per sq. in. to the end inlet connection. This should be done before and after assembly to the actuator to check that gland leakage has not increased.
- (3) With a suitable breeze plug and switch, connect the actuator to a 24 volt supply. With pressure applied, open and close the valve through its full range by means of the actuator.

Cabin air extraction valve

25. When fitting a new cabin air extraction valve to frame 14, the mounting flange of the valve may be filed, locally, if necessary to enable it to clear the bend radius of the diaphragm of frame 14.

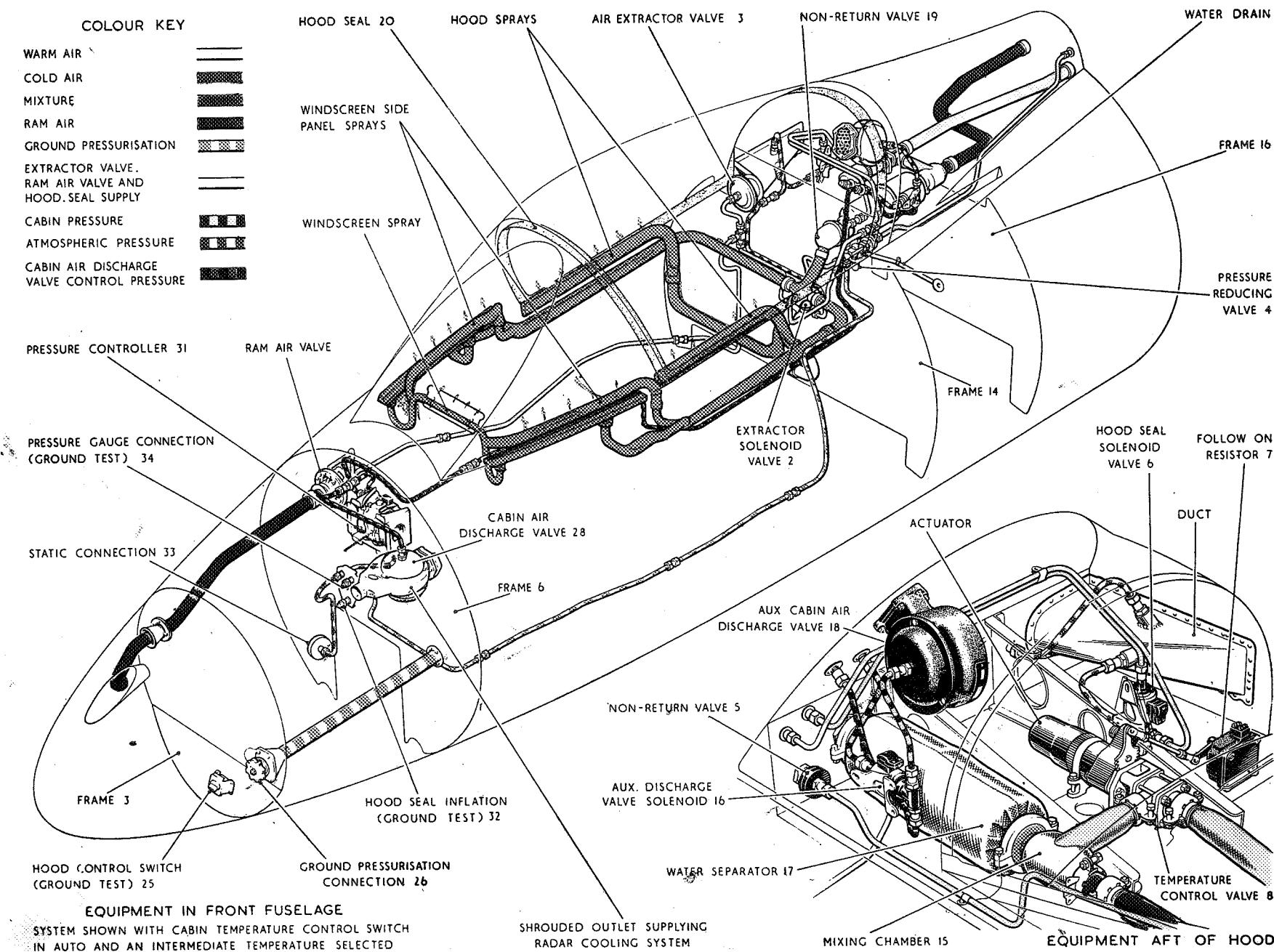
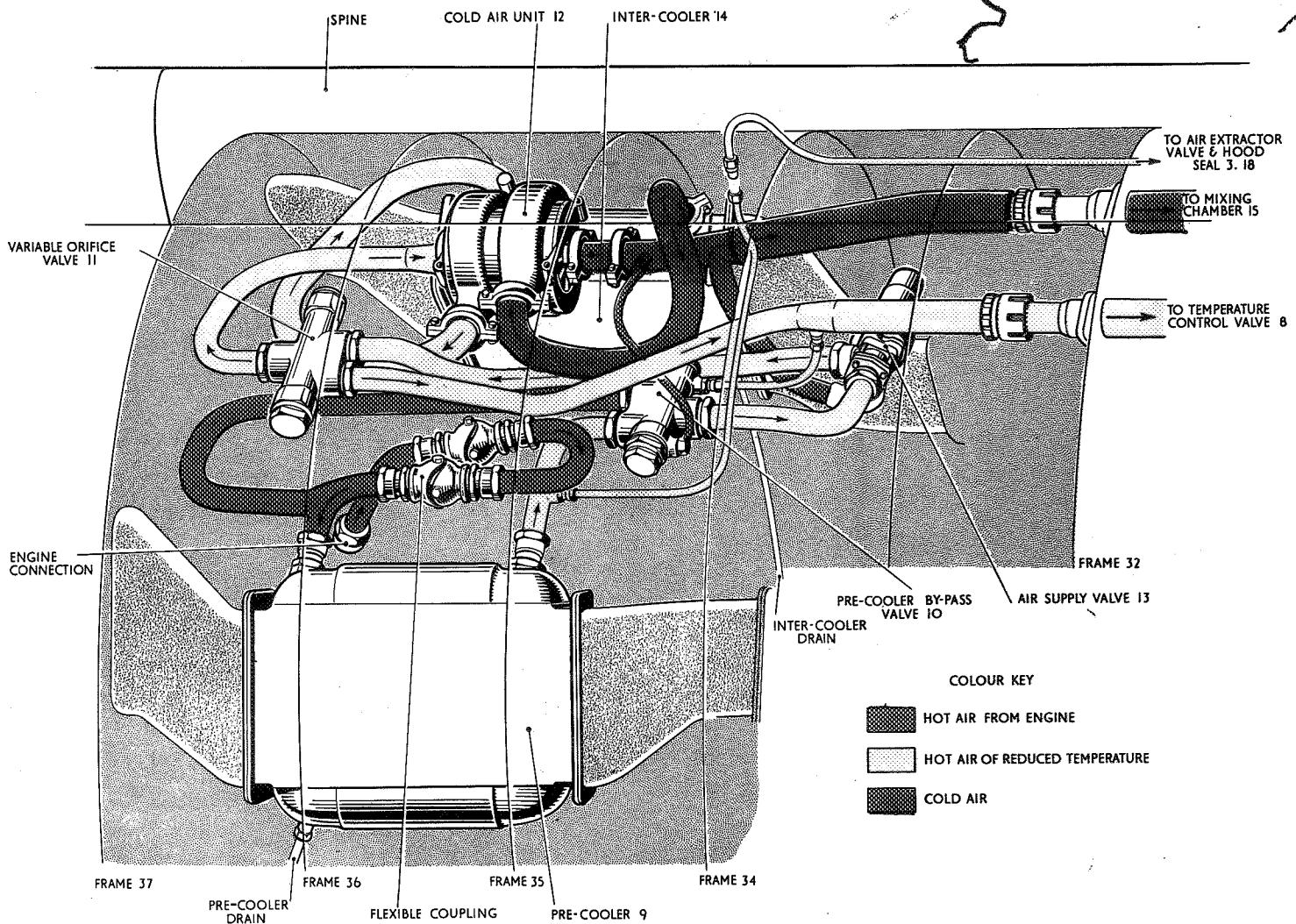


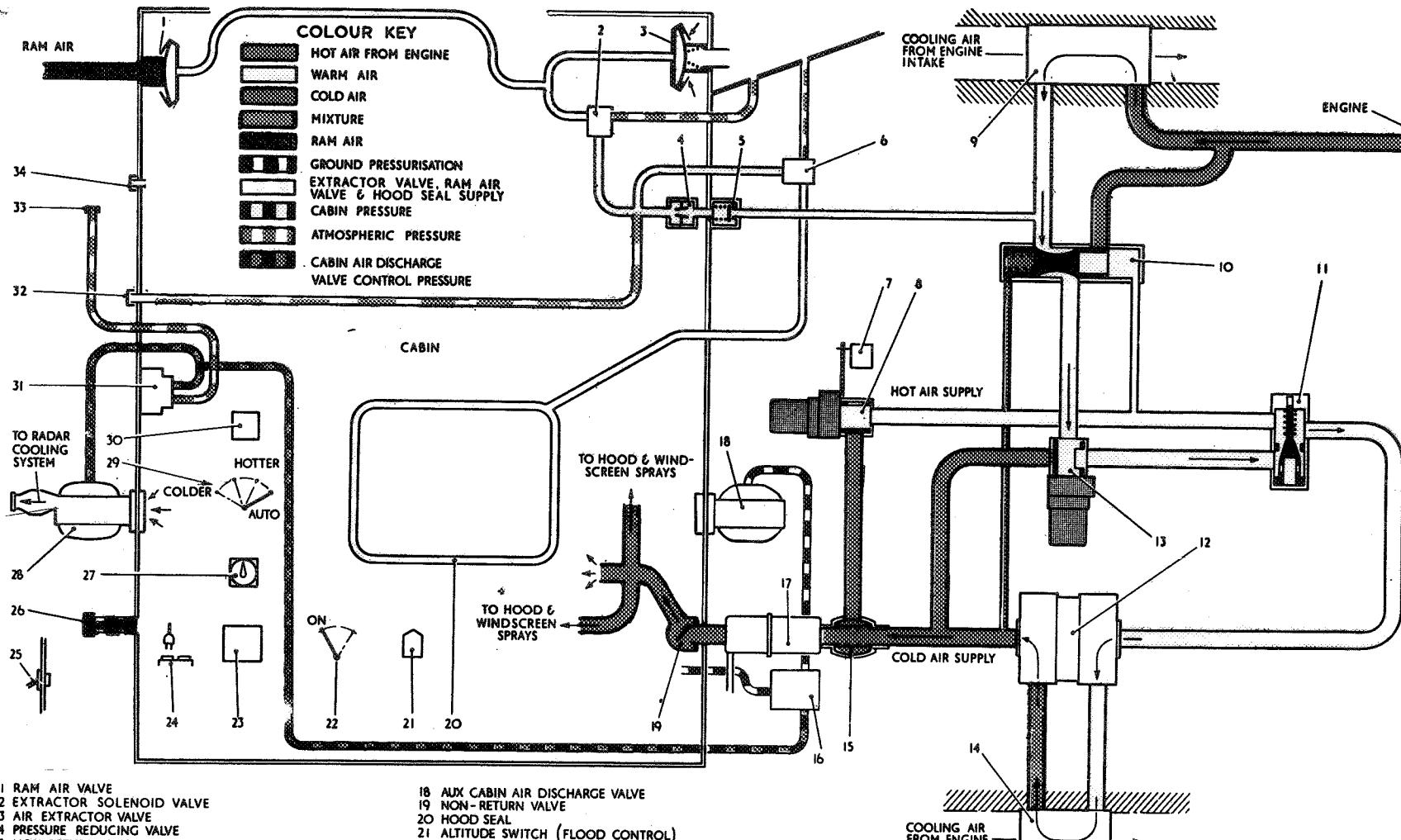
Fig. 6. Air conditioning system installation (1)

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COMPONENTS IN CENTRE FUSELAGE (VIEW FROM STARBOARD SIDE)
SYSTEM FUNCTIONING AS SHOWN IN DIAGRAM FOR
INTERMEDIATE TEMPERATURES, SEE FIG. 9

FIG. 7 AIR CONDITIONING SYSTEM INSTALLATION (2)
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1 RAM AIR VALVE
 2 EXTRACTOR SOLENOID VALVE
 3 AIR EXTRACTOR VALVE
 4 PRESSURE REDUCING VALVE
 5 NON-RETURN VALVE
 6 HOOD SEAL SOLENOID VALVE
 7 FOLLOW-ON RESISTOR
 8 TEMPERATURE CONTROL VALVE
 9 PRE-COOLER
 10 PRE-COOLER BY-PASS VALVE
 11 VARIABLE ORIFICE VALVE
 12 COLD AIR UNIT
 13 AIR SUPPLY VALVE
 14 INTER-COOLER
 15 MIXING CHAMBER
 16 AUX DISCHARGE VALVE SOLENOID
 17 WATER SEPARATOR
 18 AUX CABIN AIR DISCHARGE VALVE
 19 NON-RETURN VALVE
 20 HOOD SEAL
 21 ALTITUDE SWITCH (FLOOD CONTROL)
 22 CABIN PRESSURE CONTROL SWITCH
 23 AMPLIFIER
 24 PLUG AND SOCKET (HOOD CONTROL)
 25 SWITCH (HOOD CONTROL)
 26 GROUND PRESSURISATION CONNECTION
 27 TEMPERATURE SELECTOR
 28 CABIN AIR DISCHARGE VALVE
 29 CABIN TEMPERATURE CONTROL SWITCH
 30 CABIN ELEMENT
 31 PRESSURE CONTROLLER
 32 HOOD SEAL INFLATION (EXTERNAL SUPPLY)
 33 STATIC CONNECTION
 34 PRESSURE GAUGE CONNECTION (EXTERNAL)

DIAGRAM FOR 'FULLY COLD' DELIVERY (ALL AIR THROUGH COLD AIR UNIT)
 CABIN TEMPERATURE CONTROL SWITCH 29 IN AUTO. & TEMPERATURE SELECTOR 27
 SET TO PROVIDE LOW TEMPERATURE AIR
 ALTERNATIVELY FOR MANUAL SETTING 'COLDER' ON SWITCH 29

FIG. 8 AIR CONDITIONING SYSTEM DIAGRAM (II)

(A.L.28, Feb. 56)

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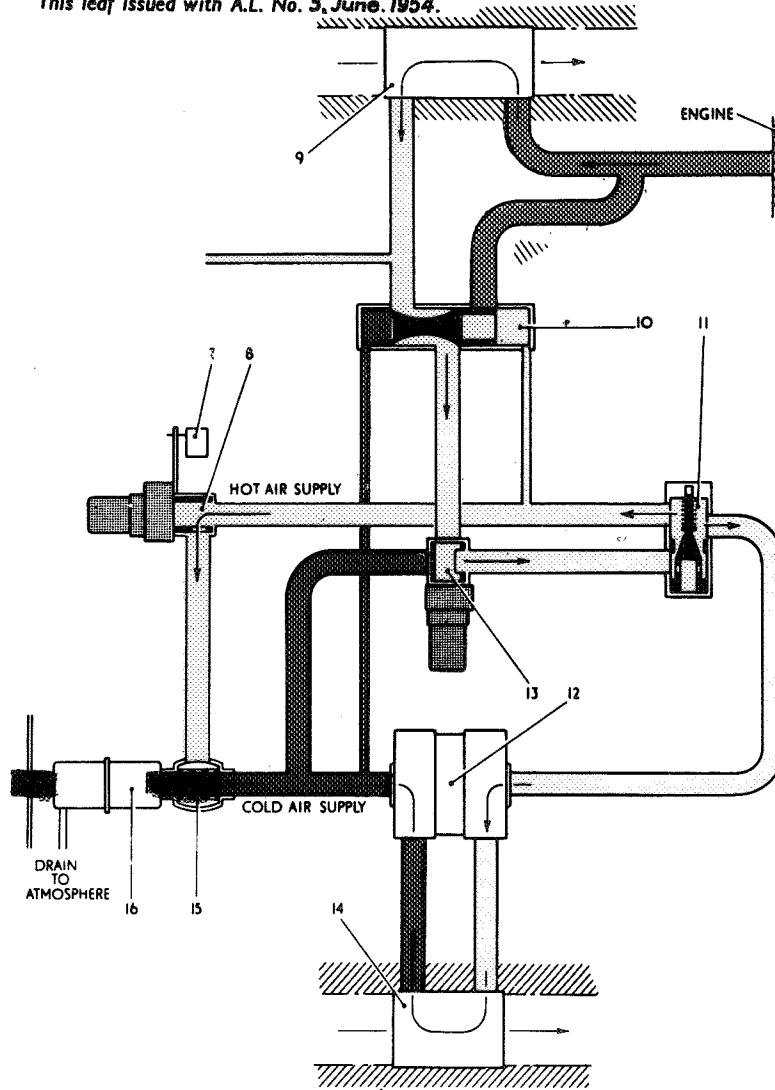


DIAGRAM FOR INTERMEDIATE TEMPERATURES (MIXTURE OF HOT & COLD AIR)
CABIN TEMPERATURE CONTROL SWITCH 27 IN AUTO. & TEMPERATURE SELECTOR 25 SET
TO PROVIDE REQUIRED TEMPERATURE OF AIR

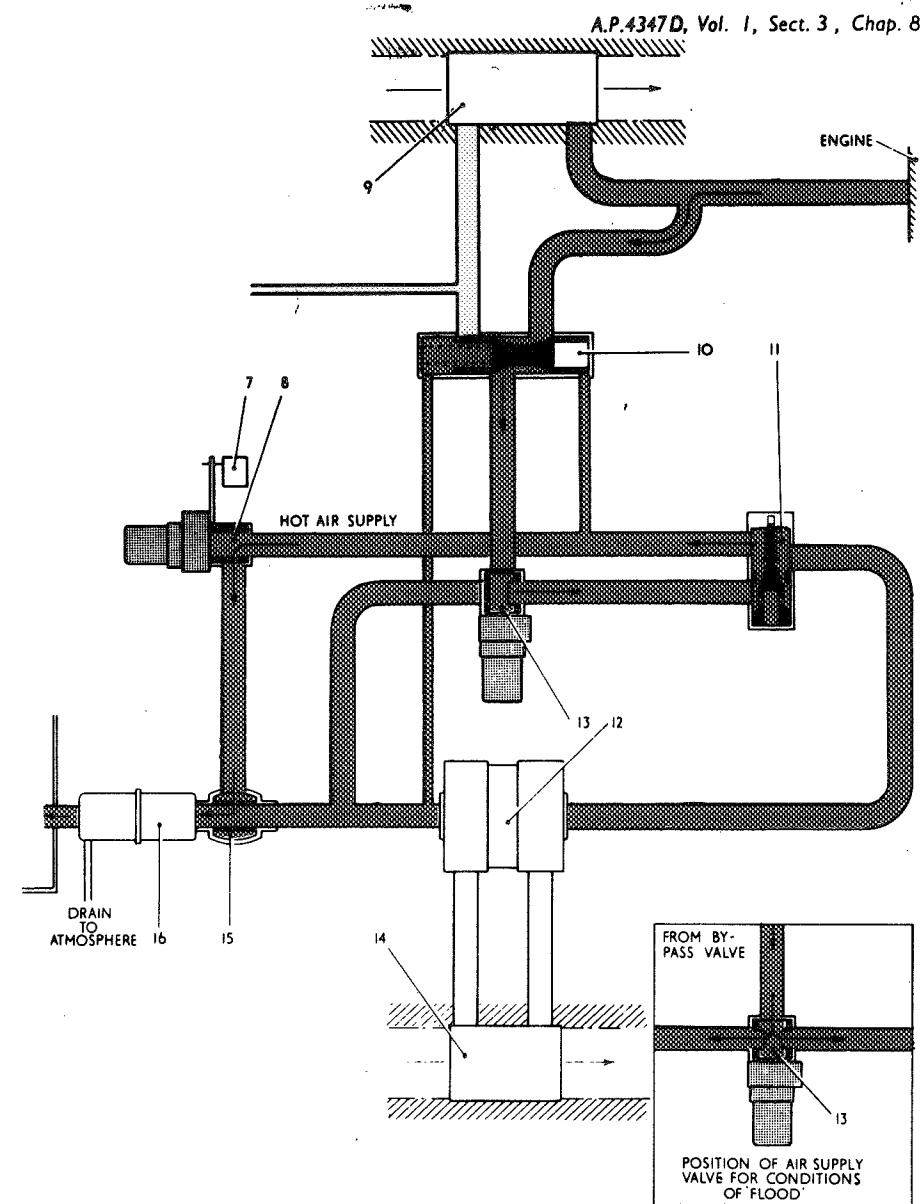


DIAGRAM FOR 'FULLY HOT' DELIVERY (COLD AIR UNIT BY-PASSED)
CABIN TEMPERATURE CONTROL SWITCH 27 IN AUTO. & TEMPERATURE
SELECTOR 25 SET TO PROVIDE HIGH TEMPERATURE AIR
ALTERNATIVELY FOR MANUAL SETTING 'HOTTER' ON SWITCH 27

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