

**Chapter 8  
AIR CONDITIONING SYSTEMS**

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**Introduction**

1. This Chapter contains information regarding the systems installed for the purpose of cabin air conditioning and pressurisation, suit ventilation, bomb bay heating and windscreen demisting by hot air and by silica gel. Servicing details are given and the recommended method of removal and assembly of certain components.

2. The air conditioning system installed in this aircraft enables operations to be carried out in comfort at extreme altitudes and under varying conditions of flight, the air in the crew's compartment being maintained at reasonable temperatures and pressures over the

whole range of conditions likely to be encountered. A similar conditioning plant to that used for cabin supply is included in the main air-ventilated suit system and maintains a flow of warm dry air through supply lines to individual suits at crew stations. An auxiliary air ventilated suit and rear crew face blower system provides cooling air during high cabin temperature conditions.

▶ **NOTE...**

*Locally manufactured plates, introduced by STI/VULCAN/417, blank off redundant fin de-icing, bomb bay heating, and Blue Steel refrigeration systems.* ◀

**PRESSURISATION AND AIR CONDITIONING****DESCRIPTION****General**

3. Air from the engine compressors is used to pressurise the cabin, the flow of air being automatically maintained by pressure-regulating valves and by flow controllers. Pressure in the cabin is maintained by pressure-controllers connected to a combined valve unit, the controllers regulating the amount of air allowed to pass to atmosphere through the duplicated discharge valves of the valve unit. Air release valves, which may be operated either manually or by solenoids, are connected in the pressure line between the controllers and the discharge valves to provide for rapid depressurisation of

the cabin in an emergency. The pressure controllers are normally set to maintain a cabin pressure equivalent to 8 000 ft. altitude up to a maximum differential pressure of approximately 9 lb/in<sup>2</sup> (CRUISE conditions) but can be set, when required, to maintain 8 000 ft. conditions up to a maximum differential of 4 lb/in<sup>2</sup> (COMBAT conditions).

4. A reasonable temperature is maintained in the cabin by air conditioning equipment installed in the nose-wheel bay, which controls the temperature of the air entering the cabin. A temperature

control valve, operated electrically by temperature sensitive elements in the cabin, governs the path of the air through the conditioning equipment, and enables any temperature between -5 deg C and +33 deg C to be maintained on selection.

5. Provision is made for ventilation during non-pressurised flight. A ram air intake, situated on the port side of the aircraft between the fuselage wall and the engine intake boundary layer fence, feeds the cabin through an actuator-operated flap-type valve, this valve is closed during pressurised flight. The same ram air intake also feeds cooling air to the air-to-air cooler in the conditioning apparatus and an identical intake on the starboard side feeds cooling air to various electrical components in the nose-wheel bay.

6. A five-inch ground conditioning connection is fitted in the pressure cabin and one in the bomb door structure to enable cabin and bomb bay conditioning to be carried out by a ground conditioning truck while the aircraft is on the ground. Pressure test connections are also provided for ground pressure testing of the cabin and ducts.

7. A list of the main components in the pressurisation system is given in Table 1, together with their location in the aircraft and references to Air Publications which cover the components listed. The system installation is shown in fig.3.

#### COCKPIT CONTROLS AND INDICATORS

8. A pressurisation control panel on the starboard console in the pilots' compartment, houses most of the controlling switches and indicators for the air conditioning system. An ABANDON AIRCRAFT and an EMERGENCY DE-COMPRESS switch are fitted on a panel mounted on the port console. Mod.2358 introduces an additional ABANDON

AIRCRAFT switch on the starboard console. The switches and indicators are illustrated in fig.1 and the associated key gives a brief description of them. Reference must be made to Sect.6, Chap.12 of this Book for details of the electrical functions of the controlling switches.

9. A control lever, mounted in the cabin roof, above the crew's table, provides for manual operation of the cabin pressure release valves to effect decompression of the cabin.

#### AIR SUPPLY

##### Ducting

10. Air for cabin pressurisation is tapped from each engine compressor. The aircraft services air pipe, fitted as part of the engine change unit, incorporates a non-return valve and is positioned at approximately 45 deg up from the horizontal on the starboard side of each engine. Each engine change unit air pipe is connected via a combined on/off pressure-regulating valve to an aircraft services duct at the forward end of the engine bay. The aircraft services duct from each adjacent engine runs forward to connect to a common duct which runs inboard and divides into two branches at the bomb bay rib. The hot air is ducted rearward for bomb bay heating and fin de-icing (see Note, para.2) and forward for cabin conditioning and main plane leading edge de-icing. As the ducting on each side of the aircraft approaches the front spar, it descends so that it passes through the spar just below the engine intakes. Immediately afterwards the duct divides into two branches, one going to the cabin conditioning unit and the other to the main plane de-icing system. The ducting to this point is 4.5 in dia stainless steel.

11. The branches leading to the cabin conditioning unit are of 3 in dia stainless steel and converge at a three-duct feed assembly just forward of the rear bulkhead in the nose-wheel

bay. The two outer ducts, in each of which is fitted an auto-flow controller and shut-off valve, are joined by a breeches pipe to a 4 in dia duct and form a Y-shaped feed into the conditioning unit. Between the two outer ducts and isolated from them by two 3 in non-return valves, is the flood flow duct which connects to the conditioning unit through the flood flow control valve. Upstream of the flood flow control valve is a branch duct for a supply of air to the ventilated suit system. (Mod.2410 removes the flood flow control valve and blanks off the adjoining ducts). A Y-shaped duct assembly connects the two outlets from the air conditioning unit to a non-return valve on the rear pressure bulkhead of the cabin.

##### Engine isolation cocks

12. A combined electrically-operated on/off valve and pressure regulating valve is fitted in the supply duct from each engine. Each on/off valve is controlled by an independent switch on the pressurisation panel to admit or isolate the air supply as required. The pressure regulator admits the air into the system at approximately 100 lb/in<sup>2</sup> to ensure that the ducts are not damaged by excess pressure. It must be noted that these valves also control the air supply to the de-icing system (Sect.3, Chap.9) and to the engines when air starting (Sect.4, Chap.1).

##### Automatic flow-control system

###### General

13. The airflow from the on/off pressure regulating valve (para.12) to the air conditioning unit and the cabin is regulated by fully automatic flow control units. These units, installed one in each branch of the Y-shaped delivery duct to the conditioning unit, regulate the supply to the cold air unit to ensure efficient operation and to prevent the unit over-speeding. An electrically-operated shut-off valve is included in the duct directly downstream

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## KEY TO FIG.1

### CONTROLS, AIR CONDITIONING SYSTEM

1. ABANDON AIRCRAFT SWITCH  
Marked:- 'NORMAL' - energises the PRESSURE SELECTOR SWITCH.  
'EMER'Y' - energises the air-release valves and lights the abandon aircraft lamps.
2. EMERGENCY DECOMPRESSION SWITCH  
Marked:- 'NORMAL' - energises the PRESSURE SELECTOR SWITCH.  
'EMER'Y' - energises the air-release valves and lights the three loss-of-pressure warning lamps on the rear crew's panel.
3. CREW'S DECOMPRESSION HANDLE  
- provides for manual operation of the air release valves.
4. TEMP. SELECTOR, AUTO CONTROL  
- selects the required cabin temperature when the CABIN TEMPERATURE CONTROL SWITCH is in the AUTO position by appropriate movement of the temperature control valve.  
Marked:- 'COOL-NORMAL-WARM'
5. TEMP. CONTROL VALVE INDICATOR - shows setting of temperature control valve.  
Marked:- 'HOT-COLD' with intermediate positions.
6. PRESSURE SELECTOR SWITCH  
Marked:- 'CRUISE' - sets motorised cabin pressure controller at CRUISE  
'COMBAT' - sets motorised cabin pressure controller at COMBAT  
'NO PRESS' - depressurises the cabin by operating the air-release valves
7. ENGINE AIR SWITCHES - control the engine air-supply cocks (isolation cocks)  
Marked:- 'OPEN-SHUT'
8. CABIN AIR SWITCHES - control the shut-off valves upstream of the air conditioning unit, port and starboard.  
Marked:- 'OPEN-SHUT'
9. RAM AIR VALVE SWITCH - controls the ram air valve situated aft of the rear pressure bulkhead. Spring-loaded to the central off position.  
Marked:- 'SHUT-OPEN'
10. A.A.P.P. Bleed valve indicator.
11. A.A.P.P. BLEED SWITCH - controls the shut-off valve situated at the A.A.P.P. Used for ground operation of main air ventilated suit system.  
Marked:- 'SHUT-OPEN'.
12. Additional ABANDON AIRCRAFT SWITCH. Marking and function similar to item 1.
13. FLOOD FLOW SWITCH - controls the flood flow valve situated in the branch line which by-passes the 'Y' shaped duct upstream of the air conditioning unit. Spring-loaded to the off position and used to close the valve after automatic opening (This valve, which is inoperative, is removed from the aircraft by Mod.2410).  
Marked:- 'RESET'.
14. U.V. LIGHTING SELECTOR  
Marked:- 'DIM-BRIGHT'.
15. RAM AIR VALVE INDICATOR - shows setting of the ram air valve.  
Marked:- 'SHUT-OPEN'.
16. COLD AIR UNIT OVERSPEED WARNING - a doll's eye indicator which warns when the speed of the cold air unit becomes excessive.
17. CABIN TEMPERATURE CONTROL SWITCH - governs the temperature control valve. Spring-loaded to the central off position from manual positions.  
Marked:- 'AUTO' - places the temperature control valve under automatic control.  
'MANUAL HOT' - moves the temperature control valve to a hotter setting.  
'MANUAL COLD' - moves the temperature control valve to a colder setting.

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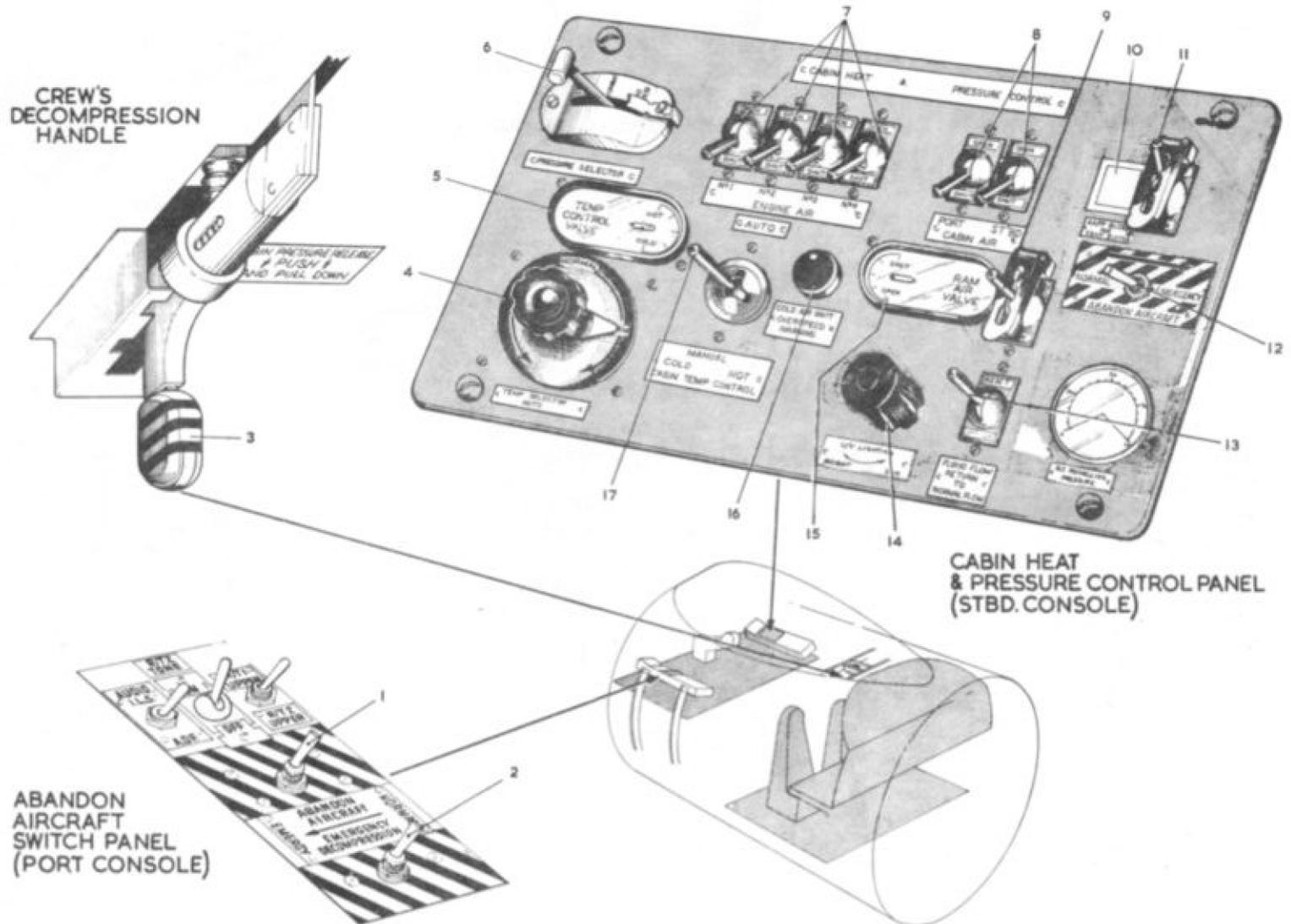


Fig. 1 Controls, air conditioning system

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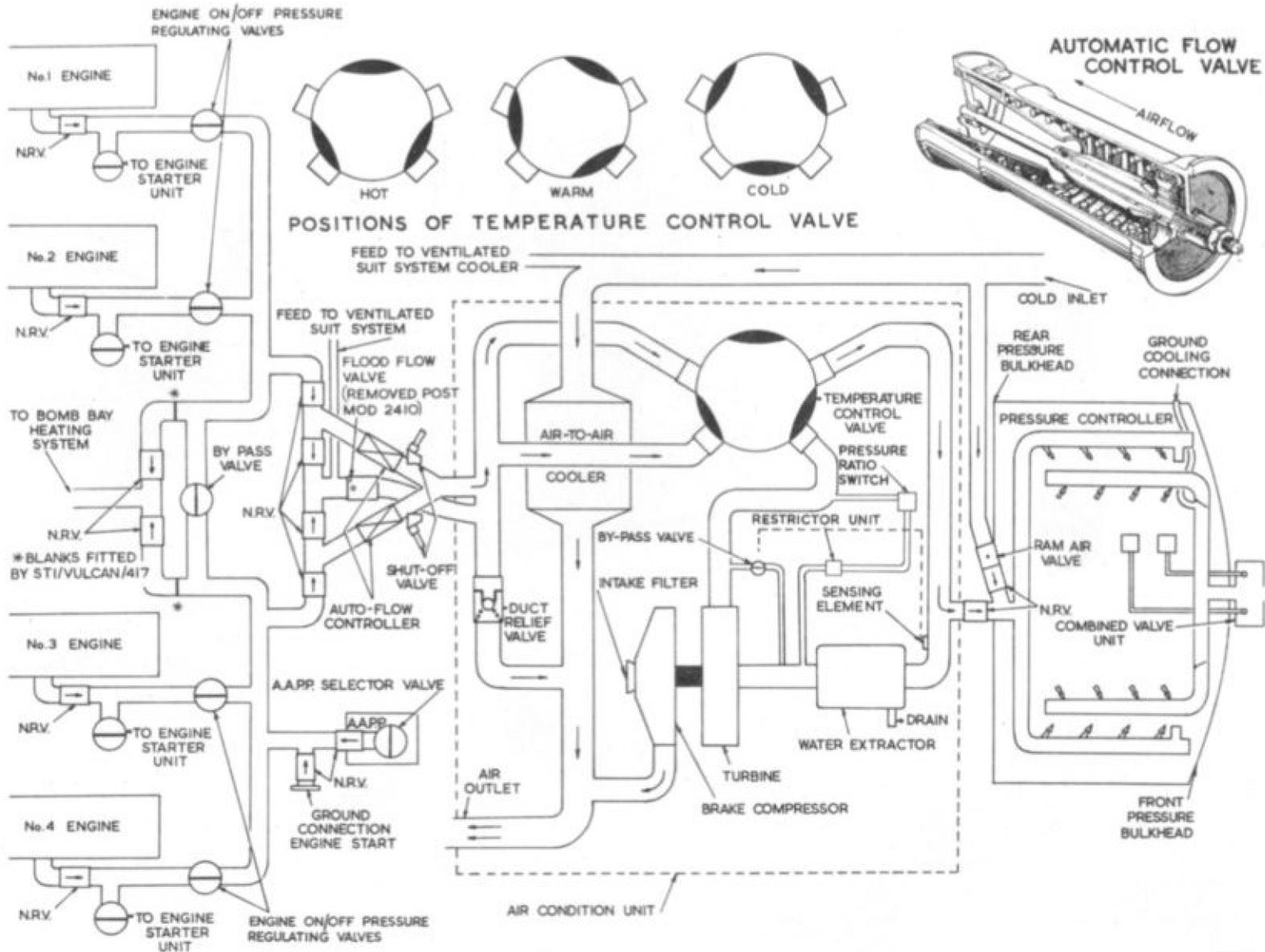


Fig. 2 Air conditioning system diagram

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of each controller. These allow the airflow to the cabin to be partially or totally cut-off by operation of one or both CABIN AIR switches on the pressurisation control panel.

#### Operation

14. The controller consists basically of a cylindrical body containing a spring-loaded tapered cone and a fixed orifice. The pressure of the charge air tends to force the tapered cone into the orifice but since the cone is restrained by the spring it takes up an intermediate position. Variations in charge air pressure, or changes in pressure drop across the controller, vary the position of the cone in relation to the fixed orifice, increasing or decreasing the effective area of the latter and thus maintaining the flow at the correct rate.

#### Flood flow control system

##### General

15. A flood flow system is provided which will operate automatically should the cabin be punctured, e.g., by enemy action, when the aircraft is flying at an altitude of 32 000 ft or more. The system consists of a 3 in dia. duct which by-passes the auto-flow controllers and contains an electrically-actuated butterfly valve which, when opened, allows air from supply to pass direct to the air conditioning unit.

##### Operation

16. If the pressure in the cabin falls to the equivalent of 29 000 ft a cabin pressure switch is operated which, if the aircraft is above 32 000 ft, will open the butterfly valve in the flood flow duct.

17. The altitudes below which the flood flow system cannot operate is governed by the ambient altitude switch, set at 32 000 ft and fitted in series with the cabin pressure switch.

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#### Control

18. If the flood flow is beyond requirements it can be controlled by the engine air switches, and when no longer required can be switched off by resetting the butterfly valve in the flood flow duct. Switches for these operations are located on the pressurisation control panel in the starboard console.

#### NOTE...

*The flood flow valve is removed from the aircraft by Mod.2410 and the adjoining ducts blanked off.*

### AIR CONDITIONING UNIT

#### General

19. The conditioning unit, in the nose-wheel bay, controls the temperature of air entering the cabin to maintain a reasonable cabin temperature throughout the widely varied conditions encountered in flight. The unit, mounted on the port side of the nose-wheel bay illustrated in fig.5, is easily removed for servicing or renewal. The principal components of the unit are as follows:-

- (1) Air-to-air cooler.
- (2) Temperature control valve.
- (3) Cold air unit, consisting of an air expanding turbine driving a brake in the form of a compressor.
- (4) Water extractor.
- (5) By-pass valve.
- (6) Underheat temperature controller.
- (7) Overheat switch.
- (8) Pressure ratio switch.
- (9) Temperature control valve centralising switch.

- (10) Follow-up resistors, one for the temperature control valve and one for the by-pass valve.
- (11) Indicator transmitter for the temperature control valve.
- (12) Duct relief valve.
- (13) Restrictor valve.

A small ram air intake, on the port side between the fuselage and the engine intake boundary layer fence, feeds cooling air to the air-to-air cooler and ram air valve. The cooler exhaust duct terminates in a rearward facing slot under the conditioning unit. For information concerning the electrical components and electrical control of the conditioning system reference must be made to Sect.6, Chap.12 of this Publication. A diagram of the air conditioning system is shown in fig.2.

#### Temperature control valve

20. This component is a four-way, actuator-operated, control valve controlled either manually or automatically. Manual operation is by selection on the CABIN TEMP. CONTROL switch located on the pressurisation control panel. Automatic control is by temperature sensitive elements in the cabin when the CABIN TEMP. CONTROL switch is selected AUTO and the desired cabin temperature is selected on the TEMP. SELECTOR AUTO control. When full heat is required, the hot air from the engines passes directly through the temperature control valve to the cabin, by-passing the air-to-air cooler and the cold air unit. If cooling is then required, selection of the TEMP. SELECTOR to NORMAL moves the temperature control valve to allow an increasing flow of air from the air-to-air cooler to pass through the control valve to the cabin until the whole flow is passing through the air-to-air cooler and by-passing the cold air unit. Selection of

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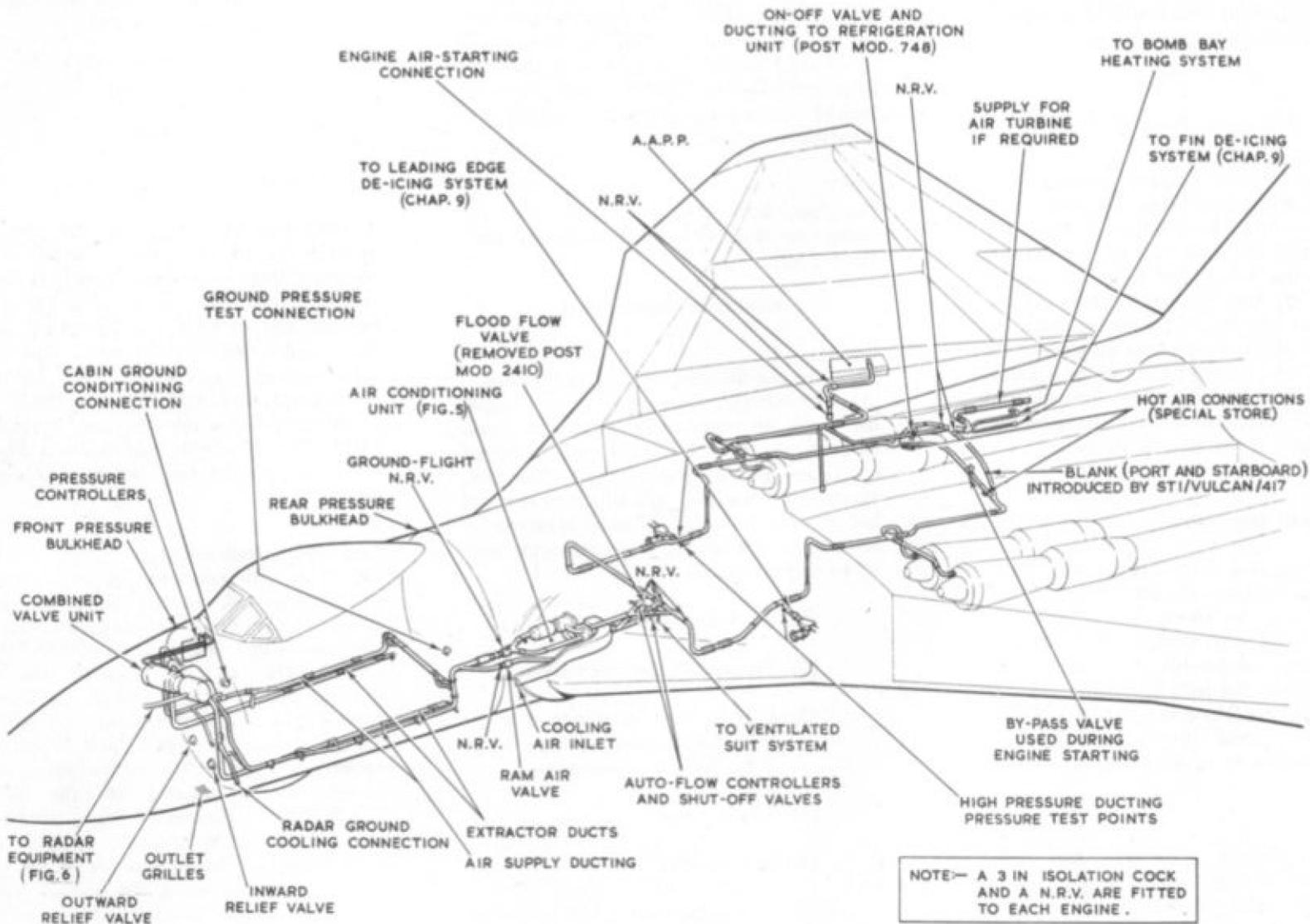


Fig. 3 Air conditioning system installation

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TABLE 1

## Components contained in the cabin conditioning system

| Components  | Part No.        | Ref. No.  | No. off | A.P. Ref. | Location   |
|---|-----------------|-----------|---------|-----------|--|
| Pressure controller, Type F (motorised)                 | 509320          | 27KD/1371 | 1       | 1275A )   |  |
| Pressure controller, Type F                             | 511930          | 27KD/1384 | 1       | 1275A )   | Cabin, stbd. side under pilots' floor                  |
| Water trap  | 26Z7741         | 26DC/2549 | 4       | - )       |  |
| Air release valve                                       | C5748Y Mk.A     | 27Q/1310  | 2       | - )       | Cabin, below pilots' floor                             |
| Ground conditioning connection 5 in                     | 502910          | 27KD/47   | 1       | 4340      | Cabin, forward, stbd. side                             |
| Radar cooling coupling 2 in.                            | 504300          | -         | 1       | 4340      | Cabin, forward, port side                              |
| Combined valve unit, Type 20/65-2                       | 510680          | 27KD/1402 | 1       | 1275A )   |  |
| Inward relief valve 6.1 in                              | 509180          | 27KD/626  | 1       | 4340 )    | Front face, front pressure bulkhead                    |
| Pressure relief valve, Type D                           | 510660          | 27KD/624  | 1       | 4340 )    |  |
| Non-return valve 3 in                                   | 512330 DEV.1    | 27KD/705  | 1       | 4340      | Front face, rear pressure bulkhead,<br>in ram air duct |
| Emergency ram air valve                                 | 503400          | 27KD/475  | 1       | 4340 )    |  |
| Non-return valve 4.25 in                                | 513600          | 27KD/483  | 1       | 4340 )    | Rear face, rear pressure bulkhead                      |
| Ground pressure test point 1.13/16 in                   | 505570          | 27KD/623  | 1       | 4340      |  |
| Water extractor, Type W.E.60 Mk.3                       | 22583           | 27UA/481  | 1       | 4340 )    |  |
| Cold air unit, Type B.T.15 Mk.2A                        | 24308           | 27UA/493  | 1       | 4340 )    |  |
| Air-to-air cooler, Type D150-4A                         | -               | 27UA/487  | 1       | 4340 )    |  |
| Hot air valve 1½ in                                     | FKH/A/40        | 27V/5070  | 1       | 4303E )   | Cabin air conditioning unit, nose-wheel bay            |
| Hot air actuator  | -               | 5W/434    | 1       | - )       |  |
| Temperature control valve                               | FKH/A/50        | 27V/5069  | 1       | 4303E )   |  |
| Temperature control actuator                            | -               | 5W/1035   | 1       | - )       |  |
| Duct relief valve, Type 55                              | 505170          | 27KD/474  | 1       | 4340 )    |  |
| Auto-flow controller and shut-off valve (Pre-Mod.835)   | 512180          | 26KD/636  | 1       | 4340 )    |  |
| Auto-flow controller and shut-off valve (Post Mod.835)  | 518410          | -         | 1       | 4340 )    | Nose-wheel bay, rear of cabin air conditioning unit    |
| ◀ Flood flow control valve 3 in (removed post mod.2410) | F.M.P./A/5028   | -         | 1       | 4303E )   |  |
| Non-return valve 3 in                                   | 517760 Mod.15AP | 27KD/-    | 4       | 4340 )    |  |
| By-pass valve 3 in                                      | F.M.P. A5022    | -         | 1       | 4303E     | Bomb bay, by-pass duct                                 |
| Pressure ratio switch                                   | FLY/A/10        | 5CW/-     | 1       | 1275A )   | Cabin air conditioning unit,                           |
| Restrictor  | 00 A.201711     | -         | 1       | - )       | nose-wheel bay   |

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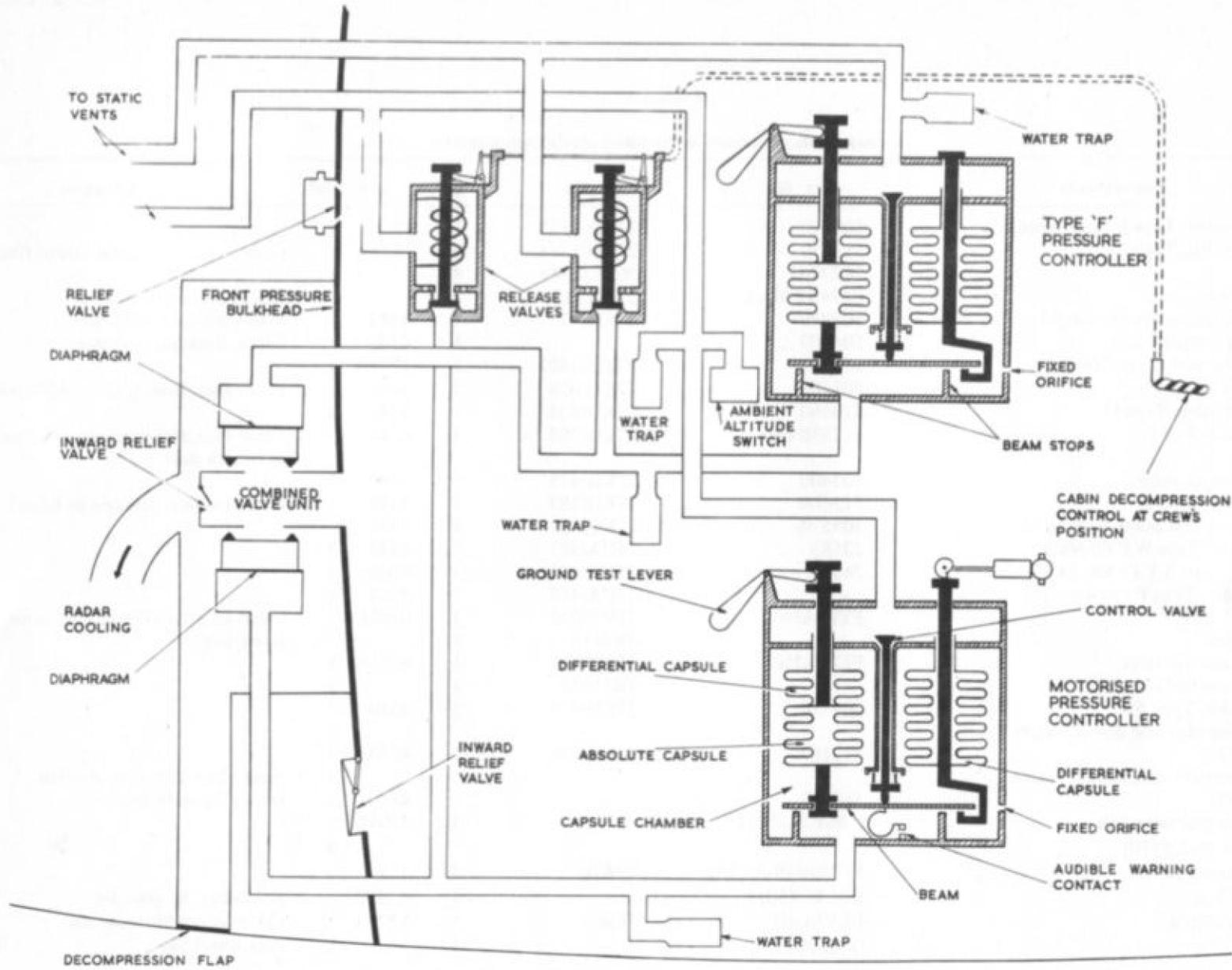


Fig. 4 Cabin pressure control diagram

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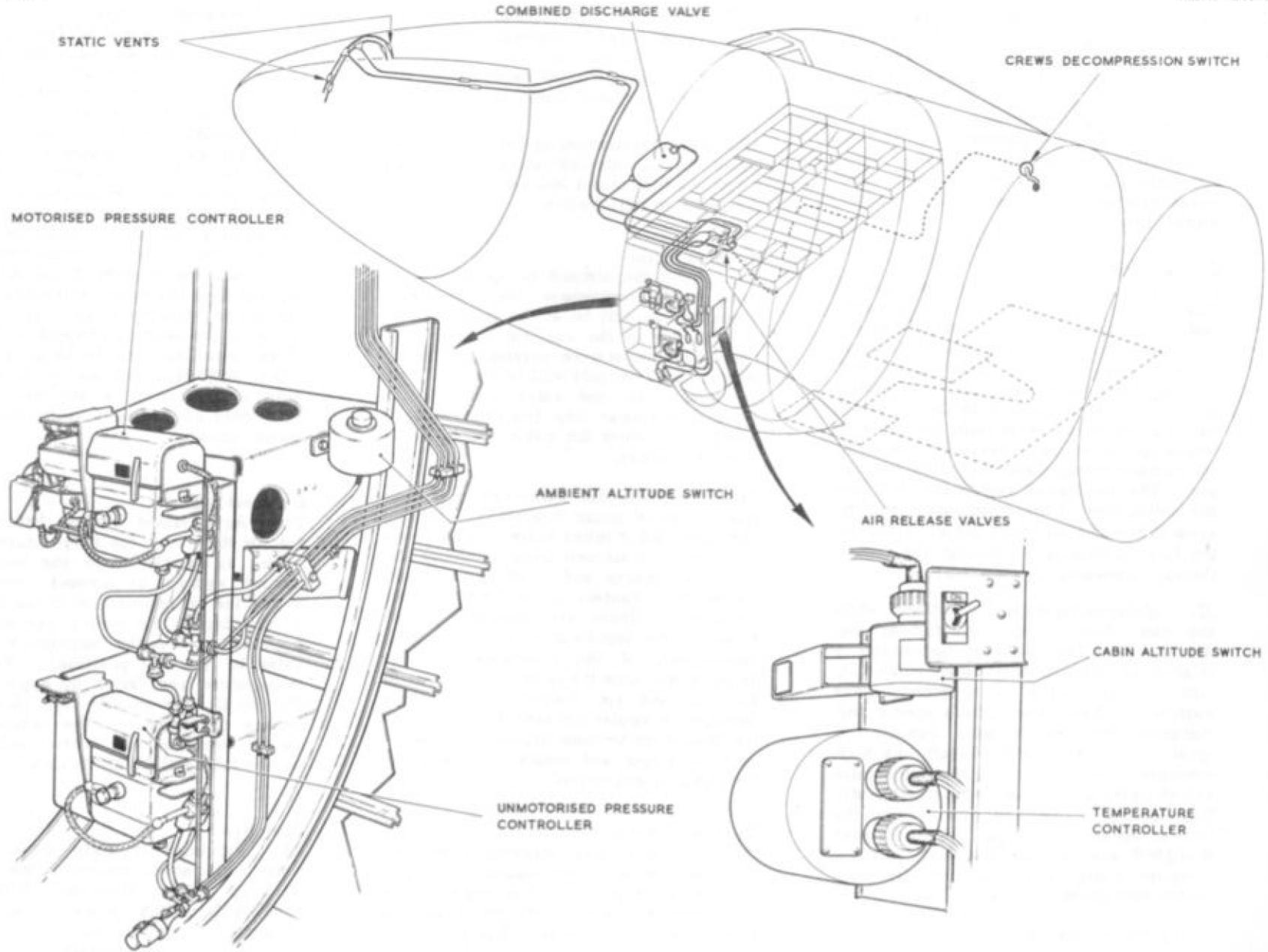


Fig.4A. Cabin pressure control installation

Mod. 2333

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the TEMP. SELECTOR towards COOL moves the temperature control valve to direct an increasing flow of air through the cold air unit turbine and water extractor to the cabin until the whole flow is passing through the air-to-air cooler and the cold air unit. A pressure ratio switch connected to the cold air unit turbine inlet and outlet ducts also controls the temperature control valve on post Mod.1969 aircraft (para.22).

#### Cold air unit

21. This unit consists of a small inward flow turbine directly coupled to a small braking compressor. The turbine inlet is connected via the temperature control valve to the air-to-air cooler outlet, the turbine outlet discharges into the ducting to a water extractor. Both the inlet and outlet ports of the centrifugal compressor, which functions as a brake in absorbing the turbine energy, are ducted to ambient air. The ejection of compressed air from the outlet side of the compressor into the exhaust from the air-to-air cooler increases the flow of cooling air through the cooler thereby increasing its efficiency.

22. Under refrigerating conditions, when the mass flow is high, the turbine may overspeed. The speed of the turbine is related to the pressure ratio across it, this ratio is applied to a pressure ratio switch. Should the turbine speed, and therefore the pressure ratio, become too great on pre-Mod.1969 aircraft, the high pressure contacts of the pressure ratio switch operate to close the port automatic flow control valve and thus reduce the flow of air to the cold air unit. On post Mod.1969 aircraft both the high and low pressure contacts in the pressure ratio switch operate as follows:-

- (1) When the low-pressure contacts open, the temperature control valve can no longer be moved towards the cold position under automatic or manual control.

- (2) When the high pressure contacts close, the temperature control valve moves to the hot position until the pressure ratio across the cold air unit drops to a suitable level.

As a further protection against overspeeding of the cold air unit turbine a restrictor valve is fitted in the low pressure pipe to the pressure ratio switch.

#### Water extractor

23. When the aircraft is operating in a warm humid atmosphere, the temperature control valve will be at the cold position in response to the call for cooling from the cabin temperature system. The air from the cold air unit will be cooled below the dew point, and water vapour in the air will condense into droplets which, if permitted to enter the cabin, would cause crew discomfort.

24. Basically the water extractor comprises a metal gauze coalescer, a tubular separator, and a relief valve. Charge air from the cold air unit passes through the coalescer gauzes and in doing so, loses its moisture content in the form of water droplets. These are deposited on the tubes of the separator, which is directly downstream of the coalescer. The droplets run down the tubes to the base of the unit and are drained to atmosphere through the cooler exhaust duct. Should the coalescer become blocked, the relief valve will open and ensure that airflow to the cabin is maintained.

#### Duct relief valve

25. A relief valve, situated in the feed duct to the air-to-air cooler, is set to relieve at 55 p.s.i. The exhaust from this valve is ducted to join the cooling air from the air-to-air cooler. The purpose of this valve is to control the maximum pressure in the feed duct to assist in preventing overspeeding of the cold air unit turbine.

#### Underheat by-pass valve

26. Under refrigerating conditions the temperature of the air efflux from the cold air unit turbine could fall below freezing point. This would mean that moisture in the air would be present in the form of frozen particles, which would be difficult to isolate and could cause a blockage in the system. A by-pass duct incorporating a hot air valve is connected across the cold air unit, the hot air valve is controlled by an underheat controller situated at the front of the air conditioning unit, and a sensing element fitted in the duct leading from the water extractor. If the air leaving the water extractor is below 2 deg.C. the sensing element and temperature controller open the by-pass valve to allow sufficient hot air to by-pass the cold air unit turbine and mix with the fully cold air before passing through the water extractor.

#### Overheat system

27. An overheat switch, fitted in the hot air duct from the temperature control valve, is coupled into the temperature control system to prevent overheating. Should the air temperature in the duct rise to 175 deg.C. the switch operates automatically to move the temperature control valve to the cool position. When the temperature has fallen by approximately 25 deg.C. the switch and the system returns to normal. The action of the switch overrides any control action that may be taking place at the time.

#### Operation

28. Provision is made for both automatic and manual control of the air conditioning system. When the CABIN TEMP. CONTROL switch is set to AUTO. the temperature control valve will function automatically and maintain cabin temperature according to the selection made on TEMP. SELECTOR. When manual control is used, the temperature control valve may

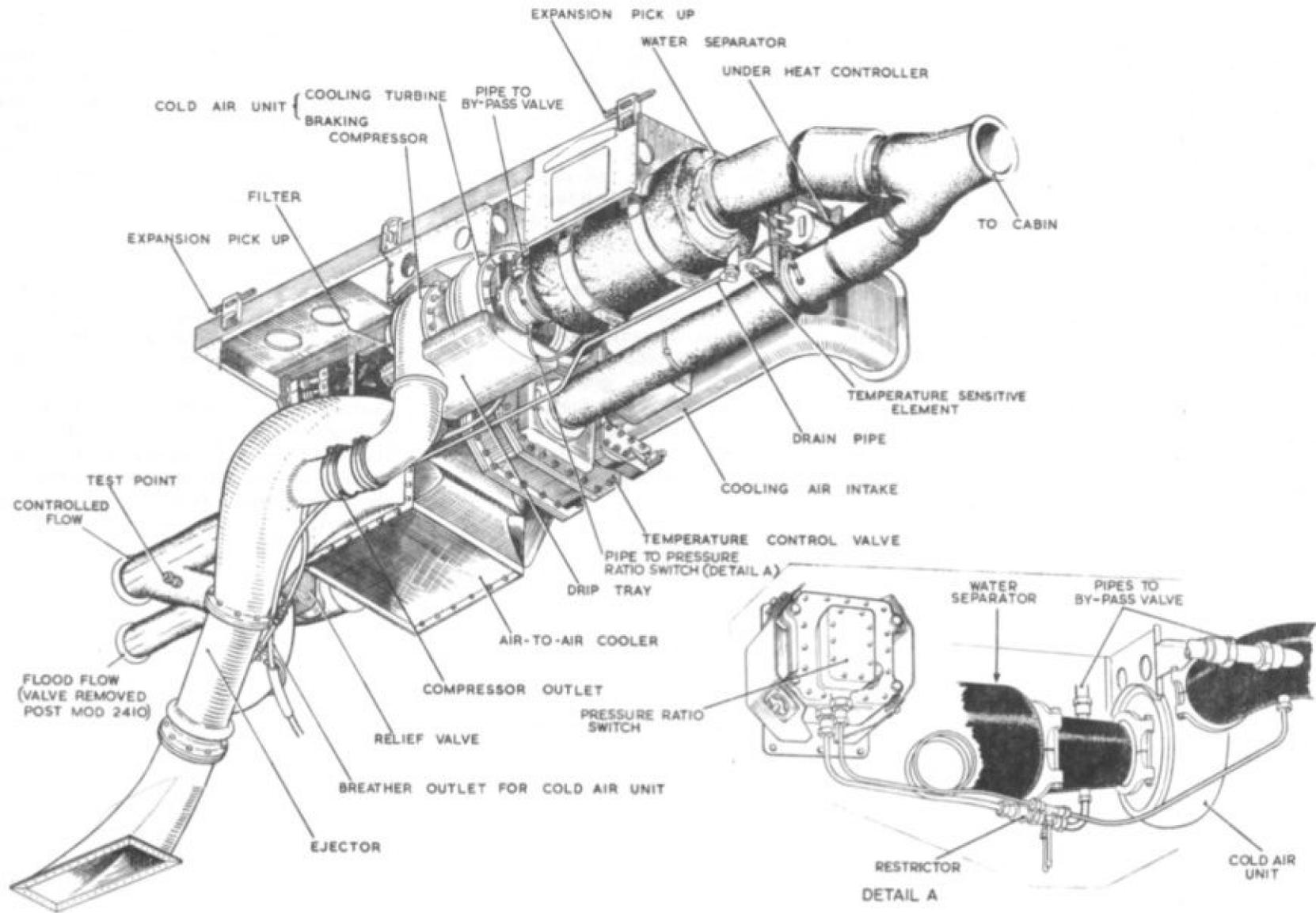


Fig. 5. Air conditioning unit (cabin conditioning)

◀ Mod. 241Q ▶

be set to any position by setting the CABIN TEMP. CONTROL switch to either the HOT or COLD position, reference being made to the TEMP. CONTROL VALVE position indicator. Details of the electrical operations involved are given in Sect.6, Chap.12 of this Publication.

#### CABIN PRESSURISATION SYSTEM

##### Cabin ducting

29. After entering the cabin through the 4.25 in dia. non-return valve, the air supply ducting divides and runs forward under the crew's floor each side of the main entrance door. Small stub pipes feed air into the wall ducts formed by the spaces between the trimming panels and the fibreglass sheet between adjacent formers, louvres at floor level allowing air into the cabin. The diameter of each duct is reduced, in stages, from the rear

pressure bulkhead to its termination at the forward edge of the pilots' floor. Small branch pipes feed air on to the air bomber's window to prevent misting.

30. Two extractor ducts run forward, adjacent to the feed ducts, and short stub pipes, interposed between the wall feed pipes, connect them to the wall ducts. The used air in the cabin is collected through louvres and the fuselage former ducts and fed to a common discharge point in the front pressure bulkhead. It is then passed through a combined valve unit, and blown over the radar equipment in the nose as cooling air. Finally, the air passes overboard through outlet grills on the undersurface of the nose radome. Incorporated in the vertical section of ducting, just aft of the front pressure bulkhead, are two flow-operated flap valves which are held in the open position

by the flow of air from the cabin. The valve in the port side assembly covers the duct aperture of the radar ground cooling connection during cabin pressurisation and, alternatively, during ground functioning of the nose radar equipment, will close the cabin outlet and prevent cooling air from a ground source being lost into the cabin.

##### Discharge valves

31. A combined valve unit, containing two bellows-operated discharge valves, is mounted on the forward face of the front pressure bulkhead. The unit's function is to regulate cabin pressure by offering restriction to the discharge of air from the cabin. Each valve is governed by a pressure controller, the controlling pressures supplied by the capsule chamber of the latter regulate the pressure in the discharge valve bellows.

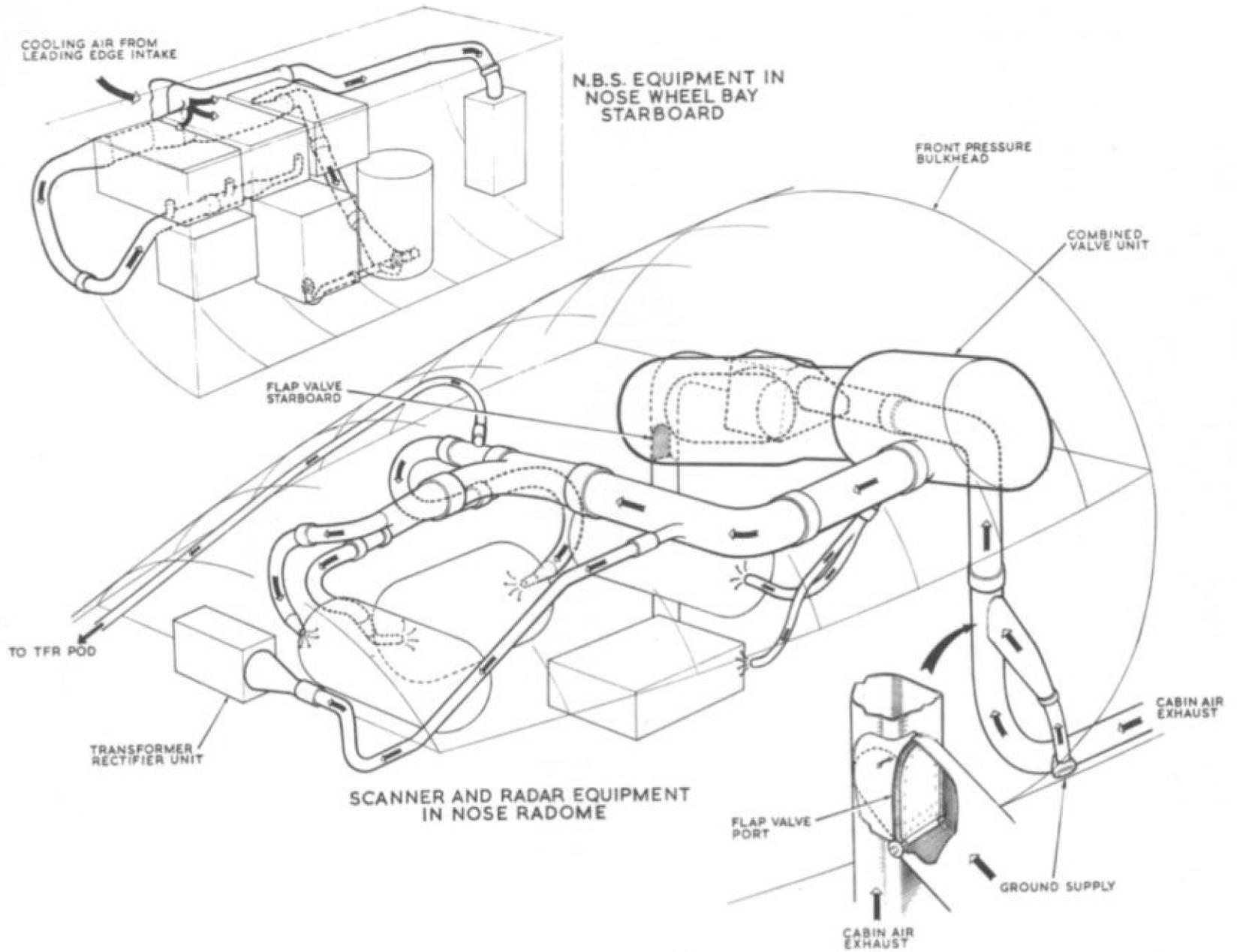


Fig. 6. Radar equipment cooling

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The consequent restriction imposed by the valve bellows on the discharged air determines the cabin pressure. The combined valve unit is enclosed by a shroud, to which is attached a duct to lead discharge air to the radar equipment in the nose. A decompression flap allows discharge air to pass directly to atmosphere during cabin decompression.

### Pressure controllers

#### General

32. Two Type F pressure controllers, each controlling one discharge valve, are mounted in the crew's cabin, their function being to maintain a cabin pressure greater than atmospheric at aircraft altitudes over 8,000 ft. One of the pressure controllers includes a small rotary actuator which allows that particular controller to govern cabin pressure at either 9 p.s.i. differential (cruise conditions) or 4 p.s.i. differential (combat conditions). The other controller is set to maintain 9 p.s.i. providing duplication in case of failure, both units normally sharing the duty of controlling cabin pressure. A diagram of the system is given in fig.4.

33. Each controller consists basically of three pressure sensitive capsules, two of which are combined to form one unit, operating a needle control valve by a simple beam mechanism, the interior of the capsule chamber being open to cabin air through a small fixed orifice. The double capsule unit, consisting of an absolute capsule evacuated and sealed with a small differential capsule attached, is sensitive to absolute pressure, while the other, its interior connected to static ambient pressure, responds to changes in differential pressure. The pressure in the capsule chamber is regulated by the

setting of the control valve, which is piped to atmosphere, in relation to the fixed orifice. Since the capsule chamber is connected to the bellows of the discharge valve, the pressure in the capsule chamber governs the position of the discharge valve and therefore the passage of air from the cabin.

#### Operation

34. At take-off the differential capsule is at its nominal length and the absolute capsule is compressed to a minimum, consequently the beam mechanism opens the valve to such an extent that pressure cannot build up in the discharge valve and little resistance is offered to the flow of air from the cabin. The cabin pressure, therefore, is for all practical purposes the same as atmospheric pressure. As the aircraft climbs, the absolute capsule expands causing the control valve to close progressively. At 8,000 ft. the valve has closed and enough pressure can build up in the capsule chamber and the discharge valves for the bellows to function and restrict the flow of air from the cabin. The restriction causes the cabin pressure, and therefore the differential pressure, to increase. As the aircraft continues to climb, the cabin altitude is maintained at 8,000 ft. and the differential pressure increases, progressively, causing continued expansion of the absolute capsule and contraction of the differential capsule until at approximately 47,000 ft. the differential pressure becomes 9 p.s.i. At this altitude the absolute capsule becomes non-effective as that end of the beam comes against its stop. The differential capsule, the compressive movement of which so far has not affected the control valve but merely taken up the gap between its end fitting and the beam, now takes over, and any tendency for the 9 p.s.i. differential to be increased is

offset by further contraction of the differential capsule to cause the opening of the control valve to increase. The 9 p.s.i. differential is maintained throughout any further aircraft climb.

#### Cabin altitude selection

35. In one of the pressure controllers the differential capsule can be reset by a rotary actuator controlled by the PRESSURE SELECTOR switch on the pressurisation control panel. If this switch is placed to the COMBAT position, the rotary mechanism is put in motion and raises the differential capsule so that it takes over control from the absolute capsule when a differential of 4 p.s.i. is attained; this occurs at approximately 19,500 ft. and is maintained throughout any further increase in aircraft altitude. In this condition the cabin pressure is governed by one discharge valve under the influence of the motorised controller, whilst the other discharge valve remains closed due to the attempt of its controller to increase cabin pressure to the cruise setting. If COMBAT is selected from the CRUISE position, the differential capsule is reset to give a rate of reduction of cabin pressure of 12 p.s.i. per min; if CRUISE is selected from COMBAT, the capsule is reset to give a rate of increase of cabin pressure of 1 p.s.i. per min. This differential rate of resetting, which is necessary for physiological reasons, is accomplished by the two-speed gear box, which transfers the drive from the motor to the camshaft in the motorised controller at different ratios according to the direction of rotation.

#### Safety precautions

36. Should failure of the air supply system, or damage to the cabin structure, cause loss of pressure whilst the cabin is pressurised, the simultaneous expansion of absolute and differential capsules in the motorised pressure controller will cause contacts to close in the warning

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device circuit. This circuit operates three loss-of-pressure warning lamps on the rear crew's panel and a warning horn located below the pilots' floor. The horn can be isolated for ground servicing purposes by a manually-operated switch mounted at the rear of panel 4P.

37. An inward relief valve is mounted on the front pressure bulkhead, to limit to a safe value any negative differential pressure which may arise. Normally the air supplied to the cabin is sufficient to prevent any reversal of pressure, but in certain circumstances such as very rapid descent following engine failure or cabin supply failure, the external pressure could exceed cabin pressure. In such a case the inwards relief valve opens to allow air to enter the cabin, and as soon as cabin and atmospheric pressures are approximately the same, the valve closes.

38. A relief valve is fitted to the front pressure bulkhead to prevent excessive pressure in the cabin. In the event of failure of the

#### General

40. Servicing the air conditioning system consists of making the routine checks at the periods stipulated in the relevant Servicing Schedule. Where details of these checks are required, they are given in the following paragraphs.

40A. If a duct joint is disconnected during servicing, a new seal must be fitted on assembly. The half clamps are to be fitted as matched pairs with their identifying numbers adjacent to each other. To ensure correct seating of the half clamps, it is permissible to gently tap the crown of the clamps using a hammer of 8 oz maximum weight. Care must be observed to avoid damaging the clamps. The securing bolts of half-clamps fitted to 2 and 2.5 in diameter ducts are to be torque loaded

pressure controllers or associated equipment, it is possible that the differential pressure may exceed the maximum value permitted. As soon as the differential pressure reaches 9.5 lb/in<sup>2</sup> the valve will start relieving and will maintain the cabin at a maximum differential pressure of 10.25 lb/in<sup>2</sup>.

#### NOTE . . .

*It is not permitted to raise the cabin pressure to 9.5 lb/in<sup>2</sup> for the purpose of testing the valve; it should be removed from the aircraft for servicing and setting the correct blow-off pressure.*

#### Decompression

39. Air release valves, which may be operated either electrically or manually are connected in the pressure lines between the controllers and discharge valves. Operation of these release valves allows the pressure in the lines to be exhausted to atmosphere, thus effectively breaking the connection between each controller and its discharge valve. This

#### SERVICING

to 5 lb ft, on ducts of a larger size the securing bolts must be tightened evenly. On completion of assembly, a leakage test as detailed in para.56 must be carried out and after the first engine run, all clamp bolts must be checked for correct torque loading and tightness. Should a persistent leak from a duct joint be found during leakage tests, disconnect a number of joint clamps and brackets in the same pipe run. Check alignment of the ducts, correct as necessary, fit new seals and tighten the clamps and brackets progressively.

#### COMPONENT CHECKS

41. Static checks with engines stopped can be performed to test the functioning of certain components which have both switches and indicators on the pressurisation control panel. These are:—

causes the bellows of the discharge valves to collapse, allowing the maximum area for outlet flow of air from the cabin, i.e., rapidly depressurising the cabin. The airflow from the cabin during this decompression does not flow through the normal collection ducting, but passes directly into the combined valve unit through a lightly loaded spring flap at the junction of port and starboard collection ducts; this ensures that the required rate of decompression is achieved, and avoids very large pressure drops in the ducting. Electrical operation of the release valves is obtained by moving the PRESSURE SELECTOR, on the pressure control panel, to the NO PRESS position, or by operation of the ABANDON AIRCRAFT switch (Mod.2358) on the same panel or by operation of the ABANDON AIRCRAFT or EMERGENCY DECOMPRESSION switches situated on the port console. A mechanical means of operating the valves is provided by a Teleflex linkage, attached to a lever in the cabin roof above the rear crew's seats, within easy reach of the three rear crew members.

- (1) Emergency ram air valve - check by reference to the indicator that the valve opens and closes correctly.
- (2) Temperature control valve - indicator should follow hot/cold switch selection.
- (3) Temperature selector - temperature control valve indicator should follow hot/cold selection of temperature selector when selection switch is at AUTO.
- (4) Inward relief valve, on front pressure bulkhead - check manually for freedom of operation.

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- (5) Following replacement of the Y pipe, connecting the air conditioning unit to the non-return valve on the rear pressure bulkhead, the GROUND/FLIGHT lever on the valve must be operated to ensure unrestricted movement of the valve.

42. With at least one engine at each side running, functioning of most components can be checked by their effect on the air delivery to the cabin. Checks are as follows:-

- (1) Cold air unit - by noting slight vibration of the unit, or by low cabin inlet temperature.
- (2) Pressure Inflation to controllers maximum differential for both COMBAT and CRUISE by use of valve unit ground test levers.
- (3) Combined CRUISE by use of ground test levers.
- (4) Air release valves - with NO PRESS selected pressure cannot be built up.

### COLD AIR UNIT

43. The lubrication system for the bearings of the cold air unit will not prime with oil until a rotational speed corresponding to an air flow of at least 10 lb/min through the turbine has been reached. Conditions under which non-lubrication may occur are when the unit is started, during ground idling, taxiing, descent in flight or at any time when the temperature control valve routes less than 1/5 of the total cabin air flow through the turbine. Once the lubrication system is primed at high speed the speed of the unit can be reduced to below the critical value and the unit will only require repriming after remaining stationary for over one hour.

### Priming of rotor bearings

44. To ensure that the rotor bearings are primed with oil proceed as follows. With at least one engine on each side of the aircraft running at more than 80 per cent of maximum rev/min, with ENGINE AIR and CABIN AIR switches on the pressurisation control panel at OPEN, move the cabin temperature control to the MANUAL COLD position and hold in this position until the temperature control valve indicator shows that the valve is in the fully cold position. Keep this selection for at least one minute and then select the required temperature in either AUTO or MANUAL.

### CABIN PRESSURE AND LEAKAGE TESTS

#### General

45. The following paragraphs describe the various tests which may be required when it is suspected that the system is not functioning properly or that air leaks are occurring. The tests should also be effected at the servicing periods stipulated in the Servicing Schedule applicable to this aircraft.

#### Safety precautions

46. The safety precautions contained in A.P.3158, Vol.2, Leaflet H36, relating to cabin pressure testing, must be strictly complied with.

#### Cabin pressure tests with engines running

47.

#### WARNING . . .

When cabin pressure leakage points are being located the cabin pressure differential must not exceed 3 lb/in<sup>2</sup>.

- (1) Blank off, at the forward pressure bulkhead, the relief pipeline from the cabin to the H2S scanner regulator. Ensure that the static pipeline is connected to the

calculator Type 3, Mk.2 in the N.B.S. Mk.1A.

- (2) An accurate boost gauge and rate of climb indicator should be taken into the cabin and the initial pressure on the boost gauge noted.

#### NOTE . . .

*It is advisable to have the 200 volt a.c. ground supply plugged in to maintain the electrical supplies.*

- (3) Prime the bearings of the cold air unit in accordance with instructions given in para.44 and then reduce the engines to ground idling rev/min.
- (4) Move the ground test lever on both pressure controllers to the ground test position.
- (5) Shut the ram air valve and lock the switch with the locking guard.
- (6) Ensure that the canopy is locked, the main entrance door is closed and locked, pressure seals are inflated and the clear vision windows are closed and secured. Check also that the signal pistol is in position and locked, and that the front pressure bulkhead door is secure.
- (7) Check that all anti-icing and bomb bay heating switches are OFF.
- (8) The operation of the pressure controllers can be checked at this stage. Disconnect the piping between the unmotorised controller and the combined valve unit at the controller end. The piping should be left open and NOT blanked off.

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- (9) Switch all ENGINE AIR switches to OPEN. During the test these should be tested individually to see if there is still flow into the cabin.
- (10) Move one CABIN AIR switch to OPEN and check that cabin pressure builds up. Place this switch to SHUT and then move the other CABIN AIR switch to OPEN.
- (11) Select COMBAT on the pressure selector switch.
- (12) Adjust engine r.p.m. to increase cabin pressure at a comfortable rate not exceeding 1,000 ft. per min.
- (13) Check that the cabin pressure stabilises at 3.6 to 4.2 p.s.i. after allowing for the initial reading on the boost gauge.
- (14) Select CRUISE on the pressure selector switch.
- (15) Check that after several minutes the cabin pressure stabilises at 8.6 to 9.2 p.s.i. after allowing for the initial reading on the boost gauge.
- (16) Switch the CABIN AIR and ENGINE AIR switches to SHUT and reduce engine r.p.m. to ground idling.
- (17) Carry out a leakage test if required (para.51).
- (18) Release the pressure in the cabin by opening the ram air valve fully. When the cabin pressure has fallen to atmospheric reconnect the piping to the unmotorised controller.
- (19) Disconnect the piping to the motorised controller as in (8). Close the ram air valve.
- (20) Switch one CABIN AIR and all ENGINE AIR switches to OPEN.
- (21) Adjust engine r.p.m. to increase cabin pressure at a comfortable rate not exceeding 1,000 ft. per min.
- (22) Check that the cabin pressure stabilises at 8.6 to 9.2 p.s.i. after allowing for the initial reading on the boost gauge.
- (23) Switch the CABIN AIR and ENGINE AIR switches to SHUT and reduce engine r.p.m. to ground idling. Open the ram air valve fully to release the pressure from the cabin.
- (24) Reconnect the pipe to the motorised controller and reset the ground test levers on the pressure controllers to the flight position.
- (25) Reconnect, at the forward pressure bulkhead, the relief pipe line from the cabin to the H2S scanner regulator.
- (26) Close the ram air valve and lock the switch with the locking guard.

## NOTE...

*A 3 in. diameter non-return valve (Part No.512339) is fitted on the cabin side of the ram air valve on the rear pressure bulkhead. This valve permits the use of the ram air valve to depressurise the cabin after ground pressure tests, so that a rate of cabin pressure reduction larger than that obtainable by natural leakage may be employed. The non-return valve is so designed that the resulting leakage rate, when the cabin is pressurised and the ram air valve is opened fully, gives a safe rate of pressure reduction.*

During one of the above pressure tests while the pressure is above 8 p.s.i. and the engines are running, functioning of the temperature control valve and cold air unit may be checked by selection of various temperatures on the TEMPERATURE SELECTOR and also by manual selection of temperature.

**Cabin pressure test with ground test rig 48.** For this test a ground testing trolley Mk.2 (Ref.No.4F/2013) should be used. If this is not available, testing trolley (Ref.No.4F/1869) may be used as an alternative.

## ◀ WARNING... ▶

*When cabin pressure leakage points are being located the cabin pressure differential must not exceed 3 p.s.i.*

- (1) Blank off, at the forward pressure bulkhead, the relief pipeline from the cabin to the H2S scanner regulator. Ensure that the static pipeline is connected to the calculator Type 3 Mk.2, in the N.B.S Mk.1A.
- (2) Connect the ground test trolley to the 1.13/16 in. ground pressure test point on the rear pressure bulkhead.
- (3) Connect an accurate boost gauge or manometer to the adapter adjacent to the test point.
- (4) Check that the ram air valve is shut and its switch locked.
- (5) Operate the ground test levers of both pressure controllers to the GROUND TEST position.
- (6) Disconnect the piping between the motorised controller and the combined valve unit at the controller end. The piping should be left open and NOT blanked off.

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- (7) Check that the canopy is locked and the clear vision windows are closed and secured. Check also that the signal pistol is in position and locked, and that the front pressure bulkhead door is locked. Deflate common seal and door closing air storage bottle. Ensure that all personnel leave the cabin and manually close and secure the main entrance door. Check that the indicator on the test switch panel at the starboard side of the nosewheel bay is energized WHITE to ensure that the door is locked.
- NOTE...**  
*The decompression switch on this panel is NOT to be used to decompress the cabin during cabin pressure tests.*
- (8) Connect a foot pump to any convenient charging point and inflate the seals on the main entrance door and canopy from outside the aircraft.
- (9) Check that the relief valve on the ground test trolley is set to 10 p.s.i. Start the trolley and pressurise the cabin.
- (10) When pressure in the cabin has stabilised at 8.6 to 9.2 p.s.i. shut off the trolley.
- (11) Carry out a leakage test if required (para.51).
- (12) When the pressure in the cabin has fallen to atmospheric enter the aircraft and reconnect the pipe to the motorised controller disconnected at (6).
- (13) The motorised controller may now be checked for correct functioning by disconnecting the piping to the unmotorised controller as in item(6).
- (14) Repeat items (7) to (10). With

COMBAT selected on the pressure selector cabin pressure should stabilise at 3.6 to 4.2 p.s.i. With CRUISE selected on the pressure selector cabin pressure should stabilise at 8.6 to 9.2 p.s.i.

- (15) When the pressure in the cabin has fallen to atmospheric enter the aircraft and reconnect the pipe to the unmotorised controller disconnected in item (13). Remove the ground test trolley and the boost gauge or manometer.
- (16) Reset the ground test levers on the pressure controllers to the flight position.
- (17) Reconnect, at the forward pressure bulkhead, the relief pipe from the pipe from the cabin to the H2S scanner regulator.

### Leak test of controller installation

49. Following a cabin pressure test, or whenever a component of the controller installation has been disconnected or renewed, the following leak test should be carried out:-

- (1) Remove the filter nut from the cabin air inlet connection on the front face of both pressure controllers.
- (2) Connect a source of clean, low pressure air to the cabin air inlet connection on the front face of the motorised controller, i.e., the 3/8 in. B.S.P. union revealed when the filter nut is removed.

### NOTE...

*Ensure that the air supply can be carefully controlled, and has provision for a pressure gauge between a stop cock and the pressure controller inlet. The stop cock should be as close to the controller inlet as possible.*

- (3) Blank off the cabin air inlet to the unmotorised controller.
- (4) Ensure the ground test levers on the pressure controllers are in the down or normal position.
- (5) Disconnect and blank off the static pipelines to the pressure release valves at a point outside the pressure cabin.
- (6) Open the pressure release valves manually or electrically.
- (7) Disconnect and blank off the static pipeline to the ambient altitude switch.
- (8) Apply air pressure slowly to 8 p.s.i. allow time for the pressure to stabilise and then close the stop cock on the supply line.
- (9) Check the pressure drop over a period of 2 minutes. The pressure should not fall below 7 p.s.i.
- (10) Remove one of the blanks from the static pipelines and ensure that pressure drops rapidly to zero. Replace the blank.
- (11) Repeat item (8).
- (12) Remove the blank from the other static pipeline and ensure that pressure drops rapidly to zero.
- (13) Remove blanks and reconnect static pipelines. Refit the filter nuts to the pressure controllers. Close the pressure release valves.
- (14) Remove the blank and reconnect the static pipeline to the ambient altitude switch.

### Leakage test

51. When leak testing, the pressure cabin inflation should be by means of the 1.13/16 in. dia. ground test connection on

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the rear pressure bulkhead. The pressure should be read by means of a manometer connected to the adapter on the rear pressure bulkhead. The minimum time intervals for the pressure to fall in the cabin are given at the end of this paragraph. It is important that each interval be cleared separately, the total time from 9 to 1 lb/in<sup>2</sup> is NOT a valid check.

**NOTE...**

The 4.25 in non-return valve must be left in the FLIGHT position for cabin leakage rate checks and is to perform as a non-return valve. A check must be made to ensure that the static vents for the pressure controllers are not blanked off.

| Cabin pressure<br>(lb/in <sup>2</sup> ) | MAJOR<br>Time<br>(min & sec) | ROUTINE<br>Time<br>(min & sec) |
|---|------------------------------|--------------------------------|
| 9 - 8                                   | 0 - 43                       | 0 - 30                         |
| 8 - 7                                   | 1 - 07                       | 0 - 43                         |
| 7 - 6                                   | 1 - 27                       | 0 - 58                         |
| 6 - 5                                   | 1 - 38                       | 1 - 04                         |
| 5 - 4                                   | 1 - 50                       | 1 - 17                         |
| 4 - 3                                   | 2 - 15                       | 1 - 28                         |
| 3 - 2                                   | 2 - 49                       | 1 - 45                         |
| 2 - 1                                   | 3 - 11                       | 2 - 15                         |
|   | Total time<br>15 min         | Total time<br>10 min           |

**DUCT PRESSURE AND LEAKAGE TESTS****General**

52. The high pressure air trolley Pt. No. GM 9079, used as a source of pressure supply for these tests, is connected, as required, to the two 7/8 in pressure test connections, one in each branch duct leading to the wing anti-icing hot air valves for port and starboard high-pressure ducting, and to the test connections on the air conditioning unit for the low-pressure ducting. To register the

test pressures, a pressure gauge must be fitted in the delivery line from the H.P. trolley as near to the test connection as possible. The air trolley regulator valve must be set to 500 lb/in<sup>2</sup> and the air delivery to the ducts controlled by the trolley delivery valves.

53. During the leakage testing of the system it should be noted, where possible, whether leaks occur at duct joints or from valves and other items of equipment. Duct joints should not leak noticeably. Leakage from the cold air unit, cooler or temperature control valve is more serious than leakage from the water extractor, since the working pressure of the latter item is far below the test pressure. If a high pressure air supply is employed for the tests, it is necessary to use suitable reducing valves to ensure that the correct test pressures are not exceeded. It is also advisable to check the output pressure from the air supply before connecting to the test connections in the ducting.

54. In cases where high pressure ducting is tested whilst disconnected from the power unit and blanked off, the portion of the ducting which is normally connected to the engine must be firmly supported to prevent movement when pressure is applied. When repairs or renewals are made in the ducting, the complete section of duct in which the repair or renewal has been made is to be tested.

**High pressure ducting tests**

55. Port or starboard high-pressure ducting is pressure tested as follows:-

**Note...**

The blanks introduced by STI/VULCAN/417 between bomb arches 171.842 and 182.967, port and starboard, may affect the pressure ducting tests.

- (1) On Free Fall Role aircraft close the following; the cabin air shut-off valves, the flood flow valve (pre mod 2410), the anti-icing hot air valves for wings and fin, the bomb bay heating hot-air valve, the shut-off valve in bomb bay cross-feed duct, and the air ventilated suit shut-off valve.
- (2) On Blue Steel Role aircraft close the following; the cabin air shut-off valves, the flood flow valve (pre mod 2410), the air ventilated suit shut-off valve, the anti-icing hot air valves for wings and fin, the shut-off valve in the bomb bay cross-feed duct, and the hot air control valve in the duct to the Blue Steel.
- (3) Close the combined on/off pressure-regulating valve at each engine.
- (4) On Blue Steel Role aircraft open the overheat shut-off valve in the duct to the Blue Steel, and the on/off valve in the duct to the Blue Steel refrigeration pack. Disconnect the A.L.S.U. hot air ducts from the bomb bay cross-feed duct and blank off the tappings in the cross-feed duct. Disconnect the downstream duct from the refrigeration pack air regulating valve and blank off the valve.
- (5) Connect the air supply, containing a pressure gauge, to the 7/8 in pressure test point in the branch duct to the wing anti-icing.
- (6) Raise the duct pressure to the proving value of 260 lb/in<sup>2</sup> and hold for 60 seconds.
- (7) The duct leakage test can be carried out at this stage as pressure is falling in the ducts. The time for the pressure to fall from 90 to 60 lb/in<sup>2</sup> must be not less than 45 sec.

## RESTRICTED

### NOTE . . .

*If this test is carried out after the system has been in use with the engines running, increased leakage may be expected due to the effect of heat on the hot air valves in the system. It is not possible to give a universal leak rate for all aircraft, but the time for the pressure to fall from 90 to 60 lb/in<sup>2</sup> must be not less than 30 seconds.*

- (8) On completion of tests disconnect the test equipment and fit the blanks to the test points. Remove all other blanks fitted for the test and connect the ducts.

### Low pressure ducting tests

56. To pressure test the low pressure ducting proceed:-

- (1) Lock the 4.25 in non-return valve, adjacent to the rear pressure bulkhead, in the GROUND or non-flow position with the lever provided.
- (2) Close the cabin air shut-off valves and the flood flow valve (Mod.2410 removes the flood flow valve and blanks off the adjoining ducting).
- (3) Remove the duct relief valve, at the rear end of the air conditioning crate, and blank off the stub pipe.
- (4) Disconnect the water drain pipe from the water extractor and fit a blank on the extractor connection.
- (5) Disconnect the oil vent pipe from the cold air unit and fit a blank on the cold air unit connection.

- (6) On aircraft with Mod.1969 embodied disconnect the low pressure pipe to the pressure ratio switch from the connection on the outlet duct from the cold air unit. Fit a blank to the connection on the duct.
- (7) Connect the air supply, containing a pressure gauge, to the 7/8 in pressure test point in the inlet duct to the air-to-air cooler.
- (8) Raise the duct pressure to 75 lb/in<sup>2</sup> and hold for 60 seconds.
- (9) The duct leakage test can be carried out at this stage, as the pressure is falling in the ducts. The time for the pressure to fall from 40 to 25 lb/in<sup>2</sup> must not be less than 32 seconds.
- (10) When the pressure in the ducts has fallen to atmospheric, return the 4.25 in non-return valve to the FLIGHT position.
- (11) Remove the blank from the stub pipe and fit the duct relief valve.
- (12) Remove the blank from the tapping on the water extractor and fit the water drain pipe.
- (13) Remove the blank from the tapping on the cold air unit and fit the oil vent pipe.
- (14) Remove the blank from the tapping on the outlet duct from the cold air unit and fit the pressure ratio switch low pressure pipe.

### SETTING TEMPERATURE CONTROL VALVE AND LEVER ASSEMBLY

57. To set the temperature control valve and its associated lever assembly refer to fig.7 and proceed as follows:-

- (1) Electrically operate the temperature control valve through its full range, as indicated by 90 deg of valve lever movement, and set the valve in its mid-travel position.
- (2) Fit the linkage rod attachment lever to the square shaft on the temperature control valve and secure with a taper pin.
- (3) Check the centralising switch for full movement as indicated by 85 deg of switch lever movement. Set the switch in the mid-travel position, remove the switch cover and check the contacts.
- (4) Adjust, if necessary, the linkage rod between the centralising switch and the temperature control valve and connect the rod to the centralising switch.
- (5) Electrically operate the temperature control valve to the extremities of its travel then check the rod length, in conjunction with the centralising switch, at the temperature control valve positions to ensure full travel of the centralising switch. Connect the rod to the temperature control valve.
- (6) Electrically operate the temperature control valve to the fully cold position, i.e., cool air inlet to the cold air unit.

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## ◀ NOTE...

When the follow-up resistor has been disturbed, a check must be made to ensure that the distance tubes on the mounting bolts have been correctly assembled, i.e., short distance tubes Part No. A.S.2806/6/130 on the bottom bolts, long distance tubes Part No. A.S.2806/6/140 on the top bolts.

- (7) Set the follow-up resistor linkage rod lever to the fully anti-clockwise position. Adjust, if necessary, and connect the linkage rod between the temperature control valve and the follow-up resistor.
- (8) Electrically operate the temperature control valve, check that no clutch slip occurs on the follow-up resistor over the full range of movement of 80 deg.
- (9) Connect the linkage rod between the follow-up resistor and the Desynn lever to agree with mechanism geometry.
- (10) Carry out a complete electrical function of the temperature

control valve to prove the mechanical setting in conjunction with the indicator on the control panel.

## SETTING THE BY-PASS VALVE

58. To set the by-pass valve and its associated follow-up resistor proceed as follows:-

- (1) Electrically operate the by-pass valve and check for full movement as indicated by 60 deg of linkage rod attachment lever movement. Set the valve in mid-travel position.
- (2) Check the follow-up resistor for full movement as indicated by 80 deg of linkage rod attachment lever movement. Set the follow-up resistor in the mid-travel position.
- (3) Adjust, if necessary, and connect the linkage rod to the by-pass valve and follow-up resistor levers.
- (4) Electrically operate the by-pass valve, check that no clutch slip occurs over the full range of follow-up resistor movement. ▶

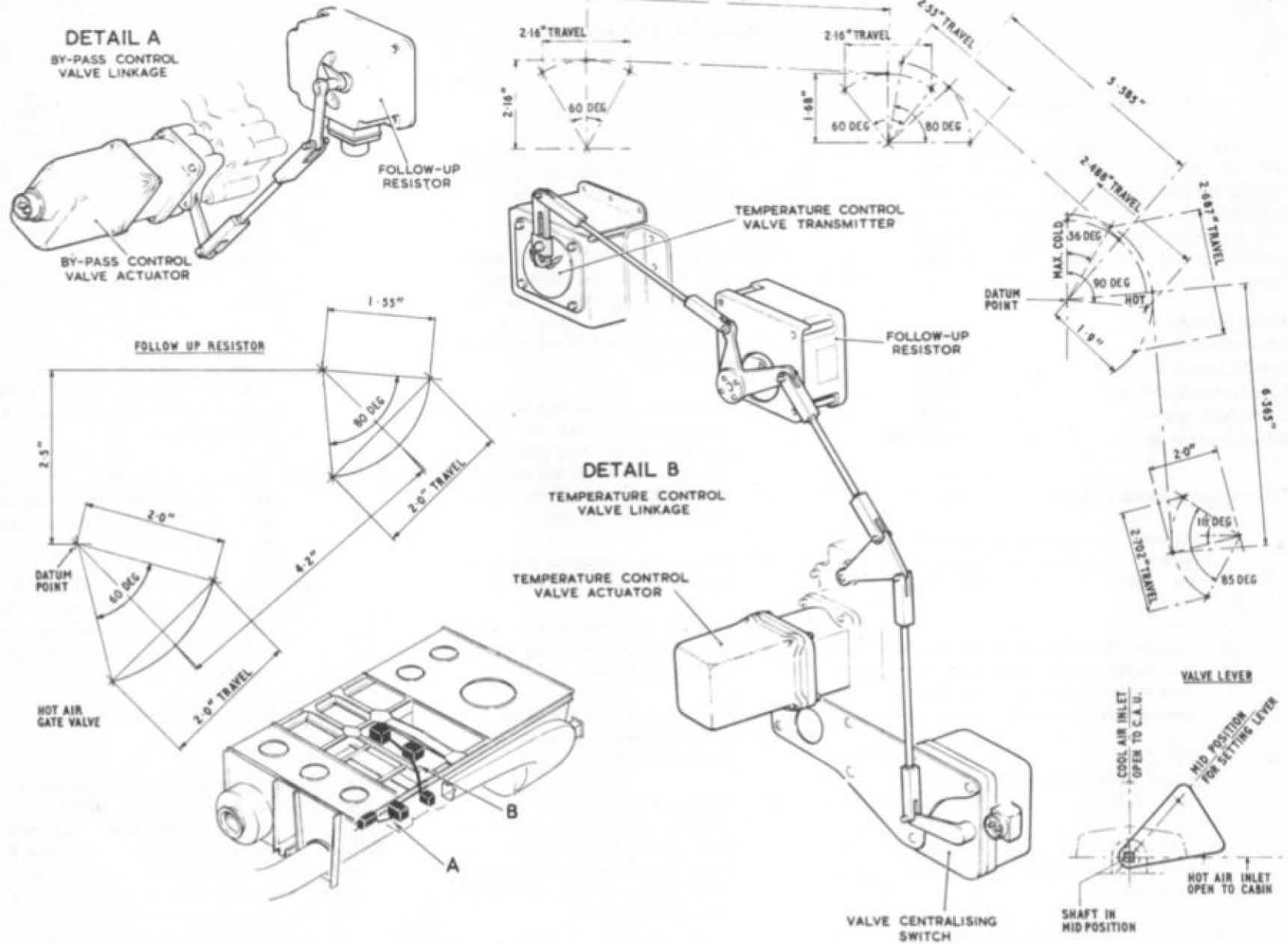


Fig.7. Linkage setting - conditioning unit

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## REMOVAL AND ASSEMBLY

### AIR CONDITIONING UNIT

59. The air conditioning equipment for the cabin air, situated in the nose-wheel bay, can be removed when required as a complete unit, together with the crate to which it is fitted. Two special hoists are required for the removal operation, each comprising the following items:-

|  |                   |
|--|-------------------|
| ◀ Winch, aircraft,<br>heavy components | Part No. A42/1    |
| Handle, winch, 9 in                    | Part No. 41/163   |
| Extension tube, 84 in                  | Part No. 41/105   |
| Top sheath, special                    | Part No. 42/50    |
| Ball-end, cable, winch                 | Part No. 41/136 ▶ |

The removal procedure (fig.8) is as follows:-

- (1) Remove the bonding at the two forward clamps on the Y-piece to the cabin and disconnect the clamps.
- (2) Remove the bonding at the two rear clamps on the ducts from the flow control valves and flood flow valve and disconnect the clamps.

#### ◀ NOTE . . .

*Flood flow valve removed post Mod.2410.* ▶

- (3) Disconnect the cold air unit breather pipe at the lower rubber connection.
- (4) Remove the split pin, nut and bolt from the top and bottom of each nose-wheel door jack and tie the

jacks back out of the way.

- (5) Remove the circular access panel located beside the port jack top attachment bracket. Remove the bracket.
- (6) Remove the short length of angled duct fitted to the output side of the flow augmentor. The flow augmentor is fitted in the conditioning unit of the ventilated suit system.
- (7) Having first ensured that the power supplied are switched off, remove the three Breeze-type plugs at the rear of the unit and the small plug on the upper side of the Y-piece duct at the forward end.
- (8) Remove the cooling air intake and the clamp from the outlet duct.
- (9) Remove the knurled nuts which secure the unit and bring the unit off its locating pins.
- (10) Slide the unit on its fixed rail until it is positioned in the centre of the nose-wheel bay.
- (11) Hook the two minilift hoists in position, pull the ball end on the hoist cable 18 in out from both hoists and thread the ends over the fixed pulleys in the roof of the nose-wheel bay.
- (12) Attach the ball ends of the cables in the sockets provided at each end

of the crate. Quick-release pins are provided at these points to ensure that the ball ends do not inadvertently escape from the sockets.

- (13) Take the weight of the crate on the hoists and remove the quick-release pins attaching the crate to the slide.

#### NOTE . . .

*These pins must on no account be removed until the weight of the unit is fully and safely borne by the hoist cables.*

- ◀ (14) Position a trolley Part No. 1U/1262 under the unit, swing the support at each corner of the trolley outward. ▶
- (15) Lower the unit into the trolley, swing the support arms of the trolley inward and secure the crate with the quick-release pins supplied.
- (16) Remove the minilift hoists.

◀ The procedure for installation is the reverse of the foregoing. When installing, all pins, rollers and rails must be lubricated with grease XG-287. It is also important to note that if a duct joint is broken for any reason, the seals making the joint must be replaced by new seals, i.e., the seals must only be used once, and the joint half clamps fitted as given in para.40A. All pipes must be blanked off whilst the unit is not fitted to the aircraft. ▶

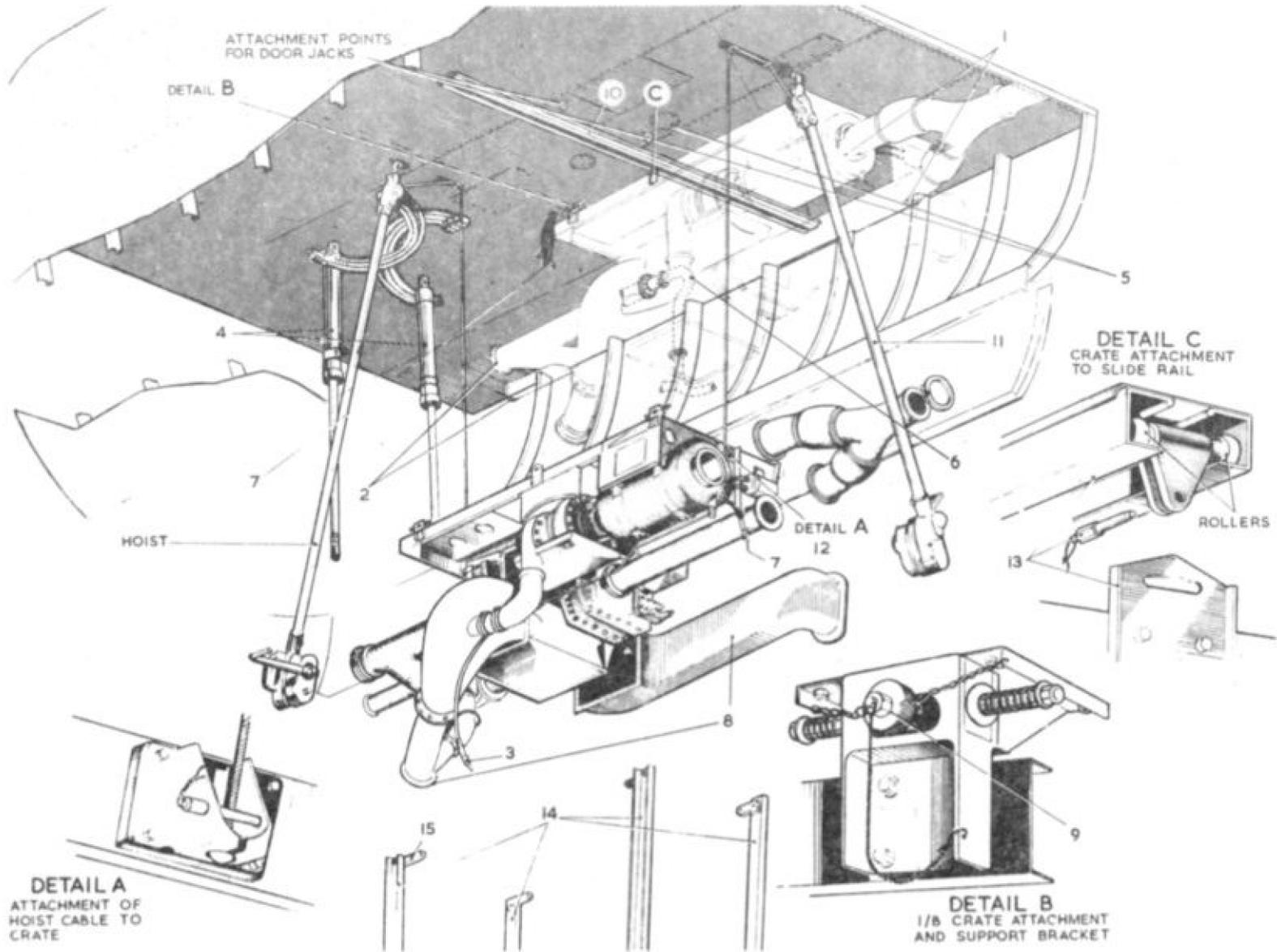


Fig.8. Air conditioning unit removal

## ◀ MAIN AIR VENTILATED SUIT SYSTEM ▶

## DESCRIPTION

**Introduction**

60. The main suit ventilation system installed in the aircraft provides a flow of dried air at moderate temperature to the personal-equipment connectors (P.E.C.) at the pilots' stations and to delivery hoses incorporating quick-disconnect couplings at the rear crew's stations, the air bomber's station and the two sextant positions.

61. Engine compressor air used for this system is passed through a series of components which form an air conditioning unit similar to that used for the main cabin pressurisation system. The conditioned air temperature and rate of flow may be varied at the suit inlets by manually-operated controls at each crew station. All heaters and the main shut-off cock are electrically operated and reference must be made to Sect.6, Chap.12 for electrical description and servicing operation. Air can, if required, be supplied by the A.A.P.P.

61A. In addition to the main system an auxiliary suit ventilation system (para.94) provides a cooling air supply to the pilots and rear crew members ventilated suits. The rear crew members are each provided with a separate supply. The pilots' supply connects via two actuator operated changeover cocks into the pipelines to the pilots' P.E.C.'s.

**General**

62. The main suit ventilation system is supplied with air from the engine compressors, a tapping being taken from the flood flow

supply duct at a point just upstream of the flood flow valve (fig.9). Charge air at high pressure and temperature passes through a duct containing an electrically-actuated shut-off cock, after which it is branched two ways. One airstream is directed to two temperature control valves, to be passed as required to a heat exchanger and a water extractor. The second airstream enters an air-to-air cooler for conditioning treatment. Components required for this function are grouped in the nose-wheel bay, aft of the main cabin pressurisation and conditioning equipment.

63. From the cooler the air passes to the turbine of a cold air unit which further reduces the temperature and pressure of the airflow. It then passes through a water extractor, where the free moisture content is removed, and into a heat exchanger where its temperature is raised to that required for maximum cooling efficiency. A duct from the heat exchanger passes air through a filter to a non-return valve on the rear pressure bulkhead. Pressure air is tapped from the duct between the cooler and the cold air unit and carried through a by-pass duct containing a flow augmentor, to be introduced into the main flow duct between the water extractor and the heat exchanger. A ground conditioning connection is branched into the duct downstream of the air conditioning unit.

64. Conditioned air from the non-return valve is fed into a manifold which regulates the temperature and pressure of the air and distributes it, through separate feed lines, to the individual suits at crew stations.

65. Inlet air temperature to individual suits may be varied by a manually-controlled electric heater fitted in each supply line from the manifold. Rate of flow can also be adjusted to individual needs by a manual control valve in the feed line to each crew position. Exhaust air from individual suits is absorbed by and expelled with the cabin pressurisation air through the cabin discharge valves.

66. The suit ventilation system can be operated when the cabin is not pressurised and when the aircraft is taxiing, provided the ENGINE AIR switches, on the pressurisation control panel, are set to OPEN. Ground conditioning, from a trolley supplying conditioned air, may be achieved through a 2 in. connection provided in the port wing root underskin. A pressure test connection is also provided in the duct to the air cooler for ground testing components and ducting.

67. A list of the main components in the suit ventilation system is given in Table 2 together with their location in the aircraft, and a reference to the Air Publications which cover the components listed or equipment of a similar type and function.

**CONTROLS**

68. The main on/off cock in the supply duct can be operated by either one of two switches, a manually-operated switch mounted at the rear of the starboard console, or a fully automatic overheat switch incorporated in the manifold.

69. Manual control valves and temperature selector controls are arranged at individual crew-stations as follows:-

◀ First and second pilot's stations

Temperature selector switch, manual control valve and main/auxiliary system selector switch are mounted on the port and starboard consoles.

Air bomber's station

Temperature selector switch and manual control valve are at the starboard side of the air bomber's station, mounted on the pilot's floor support.

Rear crew outboard stations

Manual control valve fitted under the

front edge of the table and the temperature selector switch on the front edge of the table.

Rear crew centre station

Manual control valve fitted on port side of seat and temperature selector switch on starboard side of seat.

NOTE:- 1ST. PILOTS CHANGE-OVER COCK SHOWN IN MAIN SYSTEM OPERATING POSITION.  
2ND. PILOTS CHANGE-OVER COCK SHOWN IN AUXILIARY SYSTEM OPERATING POSITION

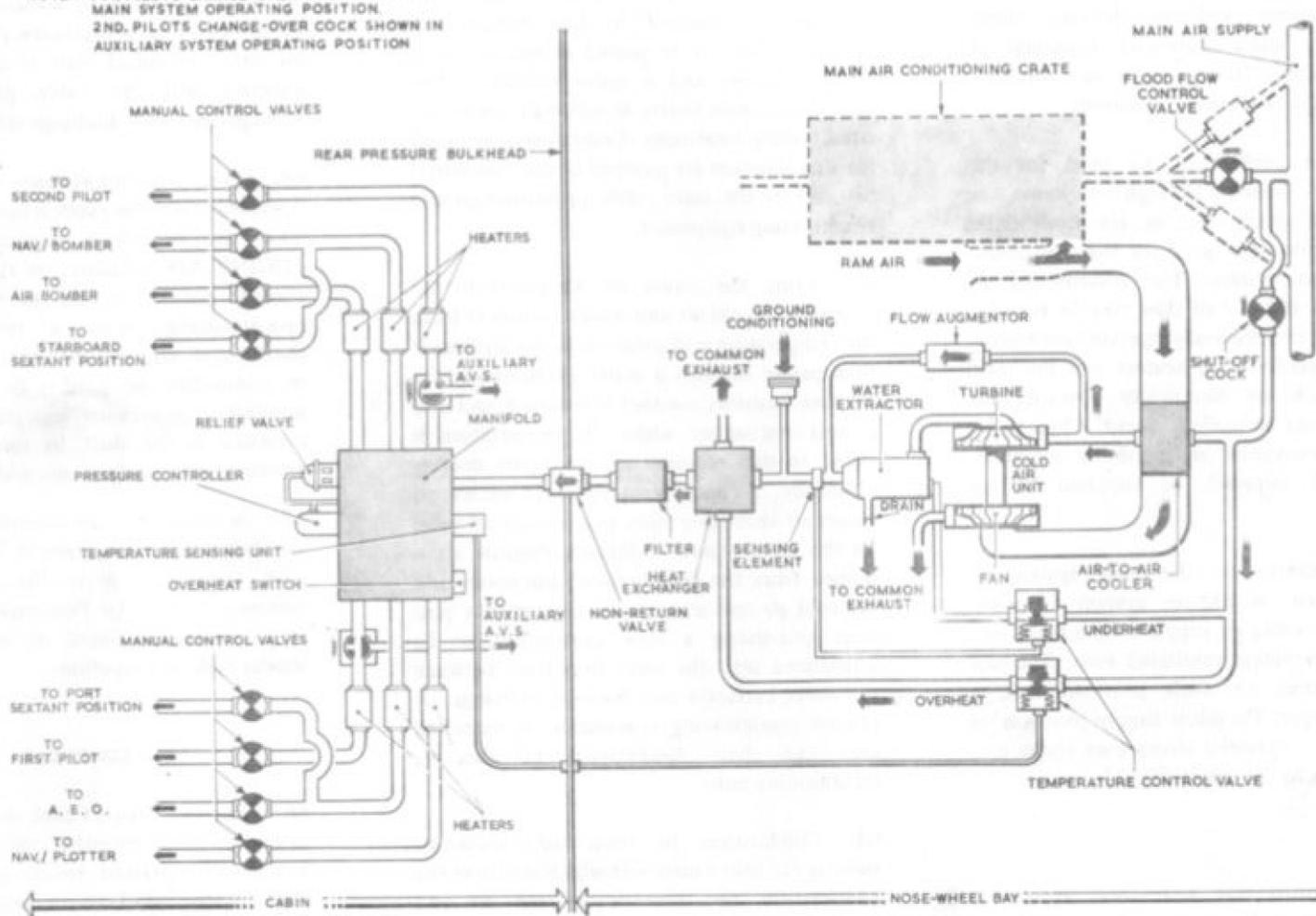


Fig.9 Air ventilated suit system diagram  
◀ Mod. 2275 ▶

**Sextant positions**

Temperature of the air supplied at these positions is governed by the selection at rear outboard crew positions, starboard by the rear starboard crew position and port by the rear port crew position. A manual control valve is located on the oxygen regulator panel at both sextant positions.

**WARNING...**

*To avoid damage to the heaters it is important that these are always switched off, by operation of the temperature selector switches, before closing the flow control valves.*

**AIR SUPPLY DUCTING**

70. From a tapping upstream of the flood flow control valve a 1.5 in. diameter stainless steel duct routes the air supply through a shut-off cock to the conditioning unit. Downstream of the shut-off cock two tappings are made, and from them 0.75 in. diameter stainless steel pipes deliver hot compressor air to the overheat and underheat control valves (para. 80 and 81). Conditioned air is delivered to the non-return valve at the rear pressure bulkhead, through a 2 in. diameter stainless steel duct.

70A. A 2 in. diameter light-alloy duct connects the non-return valve to the manifold and 1 in. diameter light-alloy pipes connect the manifold to the heaters. A 3/16 in. diameter light-alloy pipe connected to the manifold passes rearward through the rear pressure bulkhead, via an adapter, to connect to the overheat control valve. The heaters at the port and starboard rear crew's positions, the first and second pilot's, and the air bomber's positions are connected by 5/8 in. light-alloy pipes to the shut-off valves at the individual stations. At the centre rear crew member's position the heater is connected by a 5/8 in. light-alloy pipe to an adapter

in the floor adjacent to the seat. The adapter is connected to the shut-off valve, mounted on the crew member's seat, by a flexible hose.

**NOTE...**

*The supply to the A.E.O.'s position is tapped to feed the port sextant position, the starboard sextant position is fed from the nav./bomber's position.*

**AIR CONDITIONING EQUIPMENT**

71. The function of the air conditioning equipment in the system is to provide a flow of dry air at moderate temperature throughout the varying conditions encountered in flight. Equipment to carry out this function is mounted in the nose-wheel bay, aft of the main cabin system conditioning unit, and consists of the following components:-

- (1) An air-to-air cooler.
- (2) A cold air unit, consisting of a turbine and fan mounted on a common shaft.
- (3) A flow augmentor, in a duct which by-passes the cold air unit.
- (4) A water extractor, fitted just downstream of the cold air unit.
- (5) An underheat temperature control valve, in the 0.75 in. diameter branch line to the water extractor.
- (6) An overheat temperature control valve in the 0.75 in. diameter branch line to the heat exchanger.
- (7) A heat exchanger, in the 2 in. diameter duct from the water extractor.

**Air-to-air cooler**

72. A 3.5 in. square branch pipe, from the ram air supply duct to the main cabin

system cooler, feeds cold air to the suit ventilating system cooler. Cooling air is drawn through the cooler by the action of the cold air unit fan, the volute of which is connected to the exhaust side of the cooler by a short length of ducting.

**Cold air unit**

73. The cold air unit consists of a directly coupled, inward radial flow turbine and an axial flow fan enclosed in a light-alloy body. The lubrication system consists of oil impregnated felt washers which are connected by a wick and located between the two bearings. When the unit is running an air and oil mist is drawn from the wick on to the ball bearings and thence back to the felt washers.

74. Air from the engine compressors, partly cooled by its passage across the air-to-air cooler, enters the turbine inlet of the cold air unit and gives up a further quantity of its heat in the form of energy to drive the turbine. As the turbine and fan are mounted on a common shaft, the rotation of the fan accelerates the flow of ram cooling air on the downstream side of the cooler, thereby increasing the cooling efficiency.

**Flow augmentor**

75. A flow augmentor is included in the system to ensure that the pressure delivered to the manifold does not fall below the desired minimum under conditions which may occur when flying at high altitude or with the engines idling on the ground. Should the supply pressure fall, the flow augmentor allows a proportion of the air flowing from the air-to-air cooler to be delivered direct to the heat exchanger, thus by-passing the cold air unit and the water extractor.

76. The flow augmentor valve is fitted in the by-pass duct which connects the air-to-air cooler to the heat exchanger

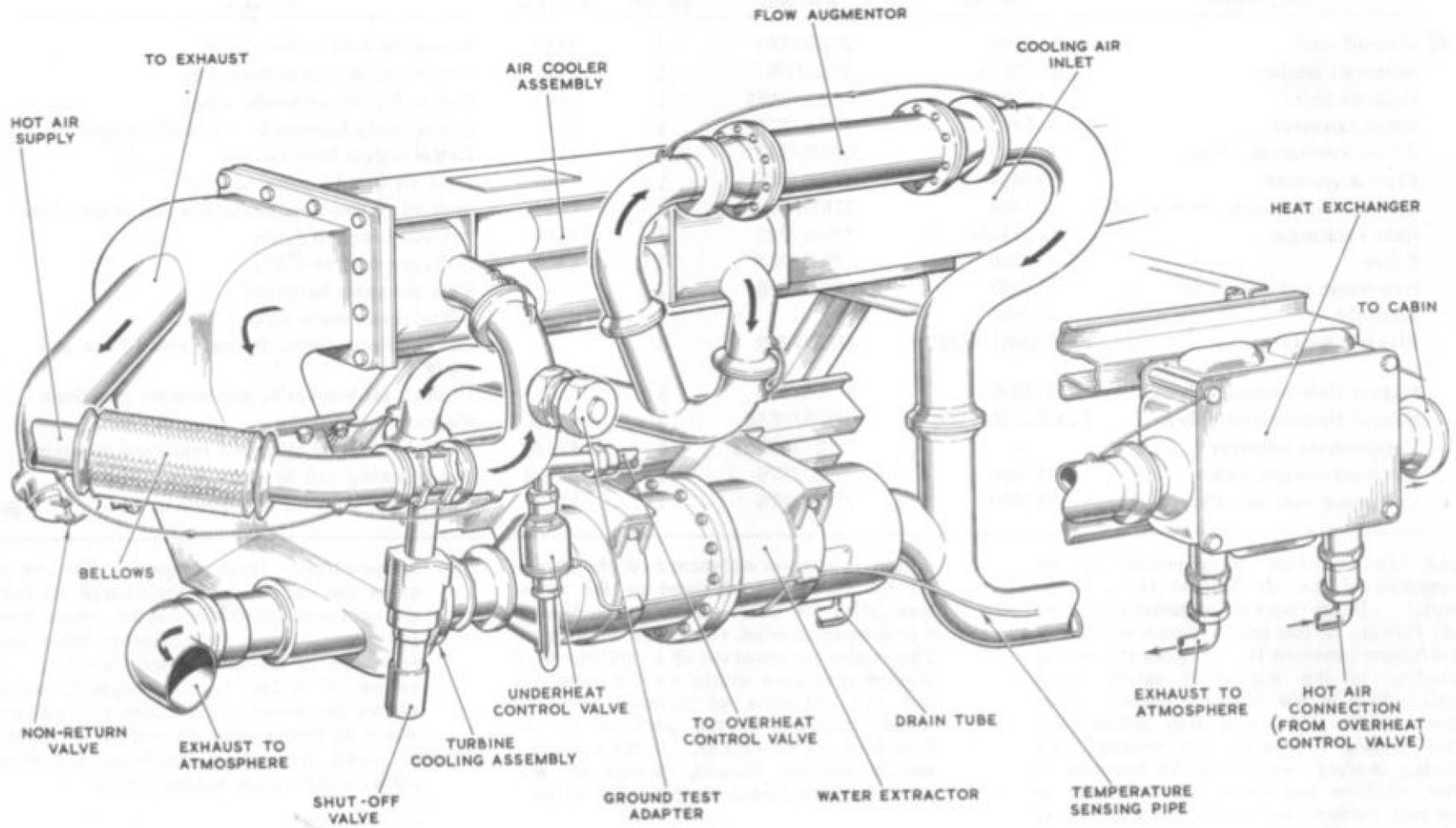


Fig.11. Air conditioning unit (suit ventilation)

**RESTRICTED**

**TABLE 2**  
**COMPONENTS CONTAINED IN THE AIR VENTILATED SUIT SYSTEM**

| Components                     | Part No.        | Ref. No.   | No. Off | A.P. Ref. | Location  |
|--------------------------------|-----------------|------------|---------|-----------|---|
| Shut-off cock                  | 512760          | 27KD/985   | 1       | 4340      | In supply duct before cooler                      |
| Air-to-air cooler              | D.721-1A        | 27UA/799   | 1       | 4340      | Port side, aft nose-wheel bay                     |
| Cold air unit                  | 11-201270       | 27UA/1195  | 1       | 4340      | Port side, aft nose-wheel bay                     |
| Water extractor                | 518490          | 27UA/1730  | 1       | 4340      | Immediately forward of the cold air unit          |
| 2.5 in. non-return valve       | 512510          | 27KD/982   | 1       | 4340      | Exhaust duct from cooler                          |
| Flow augmentor                 | 515950          | 27KD/988   | 1       | 4340      | Cold air unit by-pass duct                        |
| Ground conditioning connection | 504300          | 27KD/12    | 1       | 4340      | Inboard, forward undersurface port main plane     |
| Heat exchanger                 | D.721-2A        | 27UA/782   | 1       | 4340      | Delivery duct to cabin                            |
| Filter                         | 512930          | 27KD/977   | 1       | 4340      | Delivery duct to cabin                            |
| Non-return valve               | 512990          | 27KD/980   | 1       | -         | Rear pressure bulkhead                            |
| Manifold                       | 527660          | -          | 1       | -         | Aft of rear crew's floor                          |
| Electric heaters               | 1000-354H/MOD.1 | SUD/7359   | 6       | -         | Below pilots' floor. Below crew's floor and table |
| Manual flow-control valves     | 513390          | 27KD/989   | 5       | 4340      | Pilots', air bomber's, and sextant positions      |
| Manual flow-control valves     | F.A.C./102/006  | 27VB/5514  | 3       | 4303C     | Rear crew positions                               |
| Temperature selector           | -               | 7CZ/107201 | 6       | 4343C     | Pilots', air bomber's, and rear crew positions    |
| Overheat control valve         | 513010          | 27KD/976   | 1       | 1275A     | Conditioning unit by-pass pipe                    |
| Underheat control valve        | 513010          | 27KD/976   | 1       | 1275A     | Cooler and cold air unit by-pass pipe             |

and its operation is governed by the pressure of the air flow to the cold air unit. Under normal circumstances the air flowing to the cold air unit will be of sufficient pressure to overcome the spring loading of the augmentor valve, which will hold it in the closed position. When the aircraft is flying at high altitude and the supply pressures are reduced, the spring loading overcomes the pressure of the air flow and opens the valve by an amount proportional to the loss of supply pressure. This allows part of the supply air flow to pass through the augmentor valve thus by-passing the cold air unit and the water extractor.

**Water extractor**

77. A water extractor is installed in the

system to remove moisture from the charge air before it is delivered to the suits. Basically, the water extractor consists of a coalescer, a relief valve, and a collector. The coalescer consists of a terylene wool blanket contained within a nylon envelope, and the collector of several banks of tubes disposed in the path of the air flow from the coalescer. If the coalescer should become choked, charge air will pass to the collector via the relief valve.

78. The water extractor is installed directly downstream of the cold air unit, the two components being connected by a flanged coupling. Charge air enters the water extractor from the cold air unit and is diffused over the surface of the coalescer pack. In passing through the pack, the minute water droplets unite to form

comparatively large drops. The water drops are carried with the charge air from the coalescer to the collector, where they are deposited on the collector tubes and run down to the tube support casing. A series of holes in the support casing allows the water to pass into a sump from where it drains away through a restrictor. A small bore pipe connects the drain outlet to the cooler exhaust duct.

**Heat exchanger**

79. The heat exchanger is installed downstream of the water extractor to raise the temperature of the dry charge air to that required for maximum cooling efficiency. The exchanger is arranged for cross flow operation, with one pass of the

charge airflow, and four passes of the heating airflow. The heating airflow is supplied from a tapping upstream of the air-to-air cooler and is controlled by a valve (para.80) installed in this tapping. From the heating exchanger, used heating air is piped to the common exhaust outlet and discharged to atmosphere.

#### Overheat control valve

80. This component is a bellows-operated hot air valve, which responds to the pressure reaction of a temperature sensing element in the manifold, and controls the flow of heating air through the heat exchanger. Should the temperature in the manifold rise above a nominal 15 deg.C, an orifice in the sensing element is closed, and this allows pressure in the bellows of the control valve to build up and close the valve. When the temperature in the manifold falls, the orifice in the sensing element is opened, which allows the pressure in the bellows of the control valve to be released. This opens the valve and allows heating air to pass through the heat exchanger.

#### Underheat control valve

81. This valve is identical to the valve described in para.80 and operates in a similar manner. A temperature sensing element in the ducting between the water extractor and the heat exchanger ensures that the temperature of the air flowing

through the water extractor remains above 0 deg.C. If the temperature tends to fall towards this figure, the sensing element will open the control valve and allow a flow of hot air to pass direct to the water extractor.

#### MANIFOLD

82. The manifold assembly is situated in the pressure cabin aft of the rear crew's floor and consists of five main components i.e., sonic venturis, pressure relief valve, pressure controller, temperature sensing unit, and overheat switch. It serves as a distribution point for the supply of conditioned air to individual crew stations, the six sonic venturis ensuring that the flow of air to each suit is limited to 1 lb. per min.

83. During normal operation the flow of conditioned air to the manifold is in excess of that required for the ventilated suits. Pressure in the unit is prevented from rising above 18 p.s.i. absolute (3.3 p.s.i. at ground level) by a relief valve, which is held open to the required amount by a pressure controller.

84. A temperature sensing element projecting into the manifold is connected by a small bore pipe to the overheat control valve (para.80). The purpose of

#### SERVICING

##### General

87. Servicing the air ventilated suit system consists of making the routine checks at the periods stipulated in the relevant Servicing Schedule. Details of these checks are given in the following paragraphs.

87A. If a duct joint is disconnected during servicing, a new asbestos seal must be fitted on assembly. The half clamps are to be fitted as matched pairs with

their identifying numbers adjacent to each other. The securing bolts of half-clamps fitted to 2 in. and 2.5 in. dia. ducts are to be torque loaded to 5 lb.ft. Where difficulty is met in fitting the split pins without exceeding 5 lb.ft., it is permissible to gently tap the crown of the clamp with a hammer (8 oz. maximum weight). Do not mark the crown when hammering. A leakage test as detailed in para.93 must be carried out on completion of assembly. Should a persistent leak from a duct joint

this component is to limit the temperature of the air in the manifold to 15 deg.C. Should the temperature rise above this figure the orifice in the sensing element is closed by a bi-metal strip and this allows the overheat control valve to cut off the supply of heating air to the heat exchanger.

85. An overheat switch is located on the manifold casing directly below the temperature sensing element. This switch prevents an uncontrolled temperature rise in the event of a fault in the system. It consists of a miniature thermostat connected to a relay which operates the shut-off cock upstream of the air conditioning equipment. If temperature in the manifold rises to 70 deg.C the contacts of the thermostat 'make', which causes the shut-off cock to close, rendering the complete system inoperative. The contacts 'break' when the manifold temperature falls to 60 deg.C.

#### ELECTRIC HEATERS

86. Electric heaters are installed, one in each of the six lines downstream of the manifold. The heaters are individually controlled by a temperature selector at each crew station. Reference should be made to Book 2 of this publication for further details of this component.

be found during leakage tests, disconnect a number of joint clamps and brackets in the same pipe run. Check alignment of the ducts, correct as necessary, fit new seals and tighten the clamps and brackets progressively.

##### NOTE...

*Before the A.A.P.P. is used as the source of supply for the air ventilated suit system, the starboard cabin air valve must be 'OPEN' and the cabin temperature control selected 'COLD'.*

## RESTRICTED

### COMPONENT CHECKS

88. Static checks with the engines stopped can be performed on the following:-

- (1) Manual control valves - check that each valve operates freely over the range full CLOSED to full OPEN.
- (2) Temperature selectors - check that each selector operates freely.

### COLD AIR UNIT

89. For descriptive and servicing information on this unit reference should be made to A.P.4340, Vol.1, Book 1. The lubrication system which consists of oil (OX-14) impregnated felt washers, is self contained and can only be replenished during overhaul of the unit.

### SYSTEM FUNCTION TEST WITH ENGINE RUNNING

90. These tests are carried out with one engine running:-

- (1) Ensure that all ENGINE AIR switches are OPEN and that the CABIN AIR switches are SHUT (pressurisation control panel).
- (2) Check that the BOMB BAY HEATING main control switch is OFF (crew's panel).
- (3) Ensure that the three main control switches for wing and fin DE-ICING are OFF (anti-icing control panel).

- (4) Ensure that the lever on the non-return valve in the ventilated suit duct, at the rear pressure bulkhead, is selected and wire locked in the FLIGHT position.
- (5) Turn the six manual control valves in the cabin fully OPEN.
- ◀(6) Ensure that the A.V.S. c/o cock control switch is selected to MAIN. ▶
- (7) Select the VENT SUIT control switch on the starboard console to the OPEN position and check that, with one engine running at idling r.p.m., a flow of air issues from the P.E.C. or M.S.C. at each crew station when its flap valve is depressed.
- (8) Increase engine r.p.m. to cruise and check that the temperature of the air decreases and then remains fairly constant. Check that during this operation the relief valve on the manifold blows off.
- (9) Reduce engine r.p.m. to idling.
- (10) Turn on the electric heater for one crew station and check by depressing the flap valve in the P.E.C. or M.S.C. that the temperature of the air flow increases. Switch off the heater.
- (11) Repeat item (9) for each crew station in turn.

### DUCT PRESSURE AND LEAKAGE TESTS

#### General

91. The air for the air ventilated suit system is tapped from the high pressure section of the main system, and includes high and low pressure sections. The high pressure section extends from the main shut-off cock at the tapping from the main system to the cold air unit turbine and flow augmentor. The low pressure section extends from these units to the rear pressure bulkhead. During the leakage testing of the system it should be noted, where possible, whether leaks occur at duct joints, or from valves and other items of equipment. Duct joints should not leak noticeably. Leakage from the cold air unit, air-to-air cooler, or flow augmentor is more serious than leakage from the water extractor, since the working pressure of the latter item is far below the test pressure.

#### High pressure ducting tests

92.

- (1) Check that the VENT SUIT control switch on the starboard console is in the CLOSED position.
- (2) Disconnect the duct at the entry to the cold air unit and blank off.
- (3) Disconnect the duct at the flow augmentor outlet and blank off the flow augmentor.
- (4) Disconnect the 0.75 in. diameter pipes from the water extractor side of the underheat control valve and the heat exchanger side of the overheat control valve. Blank off the control valves.

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- (5) Connect an air supply, with pressure gauge, to the 7/8 in. bore pressure test point on the ducting leading from the shut-off cock to the air-to-air cooler.
- (6) Raise the pressure in the ducts to 260 p.s.i. and hold for 60 seconds.
- (7) If required, a duct leakage test can be carried out at this stage, as the pressure is falling in the ducts. The time for pressure to fall from 90 to 60 p.s.i. must be not less than 40 seconds.
- (8) Release the pressure in the ducts. Complete the system by removing the blanks and refitting the pipes to the cold air unit, flow augmentor and underheat and overheat control valves.

#### Low pressure ducting tests

93.

- (1) Disconnect the duct at the inlet to the flow augmentor and blank off the augmentor.

#### Introduction

94. An auxiliary air ventilated suit (A.V.S.) system, provides cooling air at the five normal crew positions. Air from the cabin is sucked through the crew's air ventilated suits by an exhaustor unit. A face blower provides a cooling air flow to punkah louvres at each rear crew station. A list of main components in the system is given in Table 3 together with their

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- (2) Ensure that the lever on the non-return valve at the rear pressure bulkhead is selected to the FLIGHT position, and that all manual control valves are closed.
- (3) Disconnect the water extractor from the cold air unit outlet and the duct from the water extractor to the underheat control valve and blank off the water extractor.
- (4) Connect an air supply, with pressure gauge, to the water extractor drain.
- (5) Disconnect the pressure controller flexible pipe, at the T-piece in the pipe connecting the manifold casing to the manifold relief valve. Connect a low pressure air supply, with pressure gauge, to the T-piece, and apply a pressure of 30 p.s.i. to hold the relief valve closed.

#### NOTE . . .

*It is essential that the pressure does not exceed 30 p.s.i.*

### AUXILIARY AIR VENTILATED SUIT AND FACE BLOWER SYSTEM

#### DESCRIPTION

location in the aircraft. Details of the electrical system is given in Sect.6, Chap.12.

#### General (fig.11A and 11B)

95. The auxiliary A.V.S. system comprises an exhaustor unit, flexible pipelines, two changeover cocks, and three manually-operated ON-OFF valves. The exhaustor unit is mounted above a face blower unit in a crate under the

- (6) Raise the pressure in the ducts to 26 p.s.i. and hold for 60 seconds.
- (7) It is convenient to carry out a leakage test at this stage, as pressure is falling in the ducts. The time for pressure to fall from 5 to 1 p.s.i. should be not less than 20 seconds.
- (8) Release the pressure on the manifold relief valve and reconnect the pressure controller flexible pipe to the T-piece.
- (9) Raise the pressure in the ducts to 3.3 p.s.i. and check that the manifold relief valve blows off.
- (10) Release the pressure in the ducts.
- (11) Complete the system by removing the blanks and refitting the pipes to the flow augmentor and water extractor and refit the water extractor to the cold air unit.

rear crew table aft of the crew's floor. Five flexible pipelines attach to the exhaustor inlet fitting.

96. Three of the pipelines pass to ventilated suit quick-release connections at each rear crew position via the manually-operated ON-OFF valves, which can be used to control the flow of air. The remaining two pipelines are

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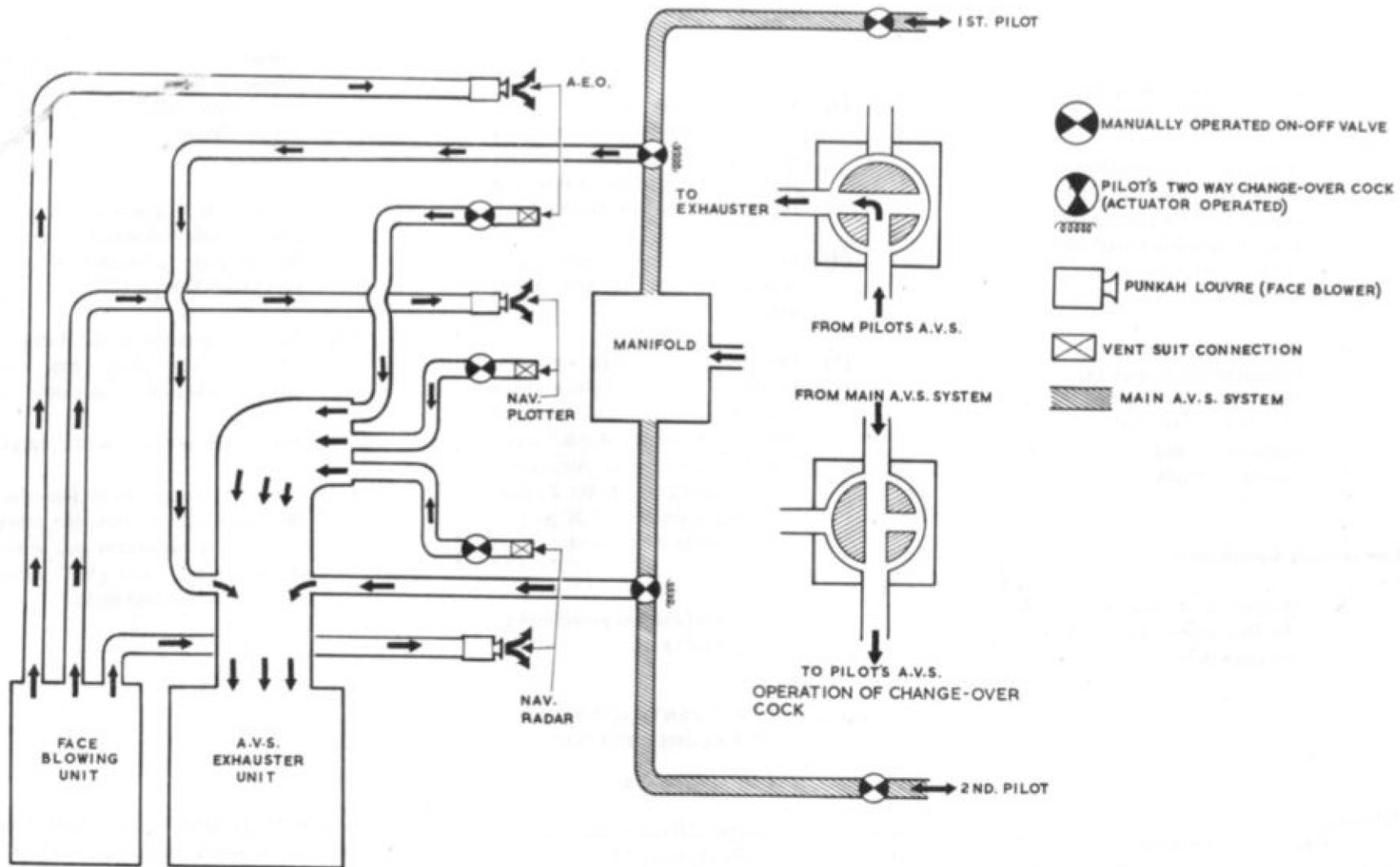


Fig.11A Auxilliary air ventilated suit system diagram

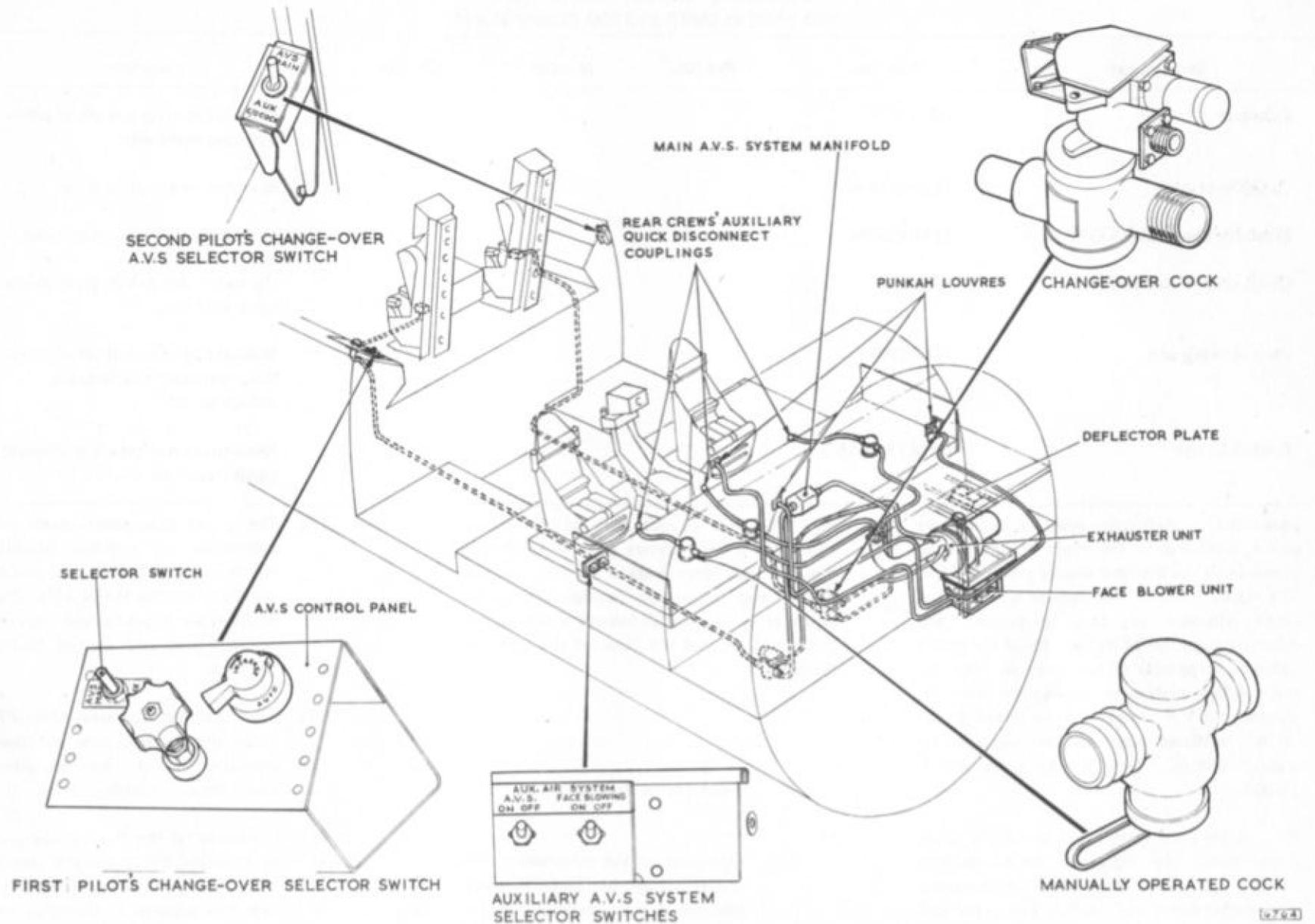


Fig. 11B Auxiliary air ventilated suit system installation

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**TABLE 3  
AUXILIARY AIR VENTILATED SUIT  
AND FACE BLOWER SYSTEM COMPONENTS**

| <b>Component</b>               | <b>Part No.</b> | <b>Ref. No.</b> | <b>No. Off</b> | <b>A.P. Ref.</b> | <b>Location</b>   |
|--------------------------------|-----------------|-----------------|----------------|------------------|---|
| Exhauster                      | 1/Z12379        |                 | 1              |                  | Mounted in crate just aft of crews floor starboard side.                        |
| Changeover cock                | 5109005000      |                 | 2              |                  | Mounted under crews floor.  |
| Manually operated ON-OFF valve | 5114002000      |                 | 3              |                  | Mounted under rear crews table  |
| Quick release connection       | AC06580         |                 | 3              |                  | On end of aux A.V.S. pipes to rear crew members.                                |
| Face blowing unit              | 1/Z12380        |                 | 1              |                  | Mounted in crate just aft of crews floor starboard side beneath exhauster unit. |
| Punkah louvre                  | CF/K1584/58/3   |                 | 3              |                  | Mounted in rear crew's instrument panel structure.                              |

connected to electrically-operated changeover cocks, mounted in the main A.V.S. system pipelines to the first and second pilot's P.E.C.s. The cocks fitted to brackets attached to the cabin structure are actuator-operated and selection is controlled by switches at the pilot's consoles to provide either warm air from the main A.V.S. system or cooling air from the auxiliary A.V.S. system. Flow through the pilots' ventilated suits may be regulated by manual control valves in the main A.V.S. system.

97. A deflector plate fitted at the top of the crate above the exhauster outlet deflects exhaust air away from electrical/electronic equipment above the outlet. The plate also prevents foreign objects from falling into the exhauster rotating assembly.

98. The face blower part of the system comprises a face blower unit, three flexible pipelines and three punkah louvres. The face blower unit delivers air through the flexible pipelines to the punkah louvres which may be positioned to cool the faces of the rear crew members.

**CONTROLS (fig. 11B)**

99.

(1) Operation of the exhauster unit is controlled by an ON-OFF switch labelled A.V.S., mounted at the forward face of the table at the A.E.O.'s position.

(2) The pilots changeover cocks are controlled by switches labelled A.V.S. c/o COCK with two switch positions labelled MAIN-AUX. The switches are located at the rear end of the first and second pilot's consoles.

(3) The manually-operated ON-OFF cocks for the rear crew positions auxiliary A.V.S. are mounted under the crews table.

(4) Operation of the face blower unit is controlled by an ON-OFF switch labelled FACE BLOWING mounted adjacent to the exhauster unit switch.

## MAIN COMPONENTS

**Exhauster unit (fig.11B)**

100. The unit bolted to a mounting base comprises an inlet manifold bolted to an impellor casing containing three single sided centrifugal impellers axially mounted on a common shaft and an outlet manifold also bolted to the impellor casing. A diffuser plate faces each impellor. The common shaft is connected to the drive shaft of a 200V a.c. electric motor through a flexible spider coupling.

101. Air drawn through the inlet manifold is accelerated through the three stages of the unit and expelled through the outlet. The acceleration of the air through the unit creates

**General**

105. To ensure efficient operation of the face blower the inlet and outlet screen grilles are to be cleaned periodically. Following installation or when the systems are disturbed to change components and at periods specified in the servicing schedule the following tests are to be carried out.

**Auxiliary A.V.S. system functional test**

106.

- (1) Shut off the three rear crew manually-operated ON-OFF cocks.
- (2) Ensure 200V a.c. and 28V d.c. electrical supplies are energized.
- (3) Select first and second pilots' c/o cock switches to MAIN.
- (4) Select AUX AIR SYSTEM A.V.S. switch at A.E.O.'s station to ON,

a vacuum at the inlet to provide the suction required to draw the air through the air ventilated suits.

**Changeover cock (fig.11A and 11B)**

102. The two-position cock is contained in a housing incorporating two inlet and one outlet pipe adapters. A 28V d.c. rotary actuator mounted on the cock housing drives the cock to the selected position.

**Face blower unit (fig.11B)**

103. The unit bolted to a mounting base comprises a fan attached to the shaft of a 200V a.c. electric motor housed in a volute casing. A cover bolted to the inlet end of the

casing incorporates screen grilles which prevent foreign matter entering the fan unit. A cover incorporating three stub pipes and a screen grille is bolted to the outlet end of the volute casing, the screen grille bleeds sufficient air from the outlet to prevent the fan stalling when the face blower punkah louvres are shut.

**Punkah louvre (fig.11B)**

104. Each punkah louvre is used to control and direct the airflow from the face blower unit. The knurled sleeve at the centre of the louvre is screwed clockwise to shut off the airflow and anti-clockwise to initiate and increase the airflow. The direction of flow can be varied by swivelling the universally mounted ball within its mounting frame.

## SERVICING

- and check for no flow at each rear crew quick release connector.
- (5) Select each rear crew members ON-OFF cock to ON in turn and check by hand for negative pressure at quick release connectors.
  - (6) Open first and second pilots' manual flow control valves and check at P.E.C. for no pressure.
  - (7) Select first pilot's c/o cock switch to AUX and check for negative pressure at P.E.C., return switch to MAIN.
  - (8) Repeat op. (7) at second pilot's P.E.C.
  - (9) Select AUX AIR SUPPLY A.V.S. switch to OFF.
  - (10) Close first and second pilot's manual flow control valves.
  - (11) On engine run switch on the main A.V.S. system.
  - (12) Open first and second pilot's manual flow control valves.
  - (13) Select first pilot's A.V.S. switch to MAIN and check for positive pressure at P.E.C. Select switch to AUX and check no pressure at P.E.C.
  - (14) Repeat op. (13) at second pilot's P.E.C.
  - (15) Switch off the main A.V.S. system.
  - (16) Close first and second pilot's manual flow control valves.

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### Face blowers - functional test

107.

- (1) Close the three punkah louvres at rear crew positions.

### General

108. When it is necessary to change an exhauster or its associated electric motor, remove the exhauster unit complete with the mounting base, place on a suitable bench and replace components as required.

### Exhauster unit

109. To remove the exhauster unit, ensure

### Introduction

#### NOTE...

*The bomb bay heating system is blanked off by STI/VULCAN/417.*

112. Provision is made for heating the bomb bay, as the temperature of the bay must not fall below freezing point when certain stores are carried. The system, which can be operated under automatic or manual control, receives hot air from the main engine compressors, mixes it with cold air from the dorsal fin cold air intake and circulates it throughout the bomb bay. For information on this system in the Blue Steel role reference must be made to Sect.2, Chap.5, and Sect.5, Chap.5 of this book. All controllers are electrically operated, and reference should be made to Book 2, Sect.6, Chap.12 of this publication for electrical description and servicing information.

### CONTROLS AND INDICATORS

113. These are mounted on the starboard

- (2) Select AUX AIR SYSTEM FACE BLOWER switch to ON.

- (3) Check each punkah louvre in turn for no pressure.

- (4) Open each punkah louvre in turn and check for positive pressure.

- (5) Select AUX AIR SYSTEM FACE BLOWER switch OFF.

### REMOVAL AND INSTALLATION

electrical power supply is switched OFF, disconnect the electrical plug at relay 827, slacken hose clip securing inlet fitting to exhauster inlet and slide fitting clear of unit, take out the four bolts securing mounting base to crate and remove the unit.

110. To install the unit reverse the procedure in para. 109.

### BOMB BAY HEATING SYSTEM

#### DESCRIPTION

upper portion of the rear crew's panel, and consist of:-

- (1) Main control switch - three positions, AUTO-OFF-MANUAL.
- (2) Manual heat control switch - three positions, INC-OFF-DEC, spring-loaded to the centre OFF position.
- (3) Temperature selector - enables the operator to set the datum temperature under automatic control.
- (4) Bomb bay temperature indicator.

#### HOT AIR VALVE

114. Hot air, tapped from the main engine

### Face blower unit

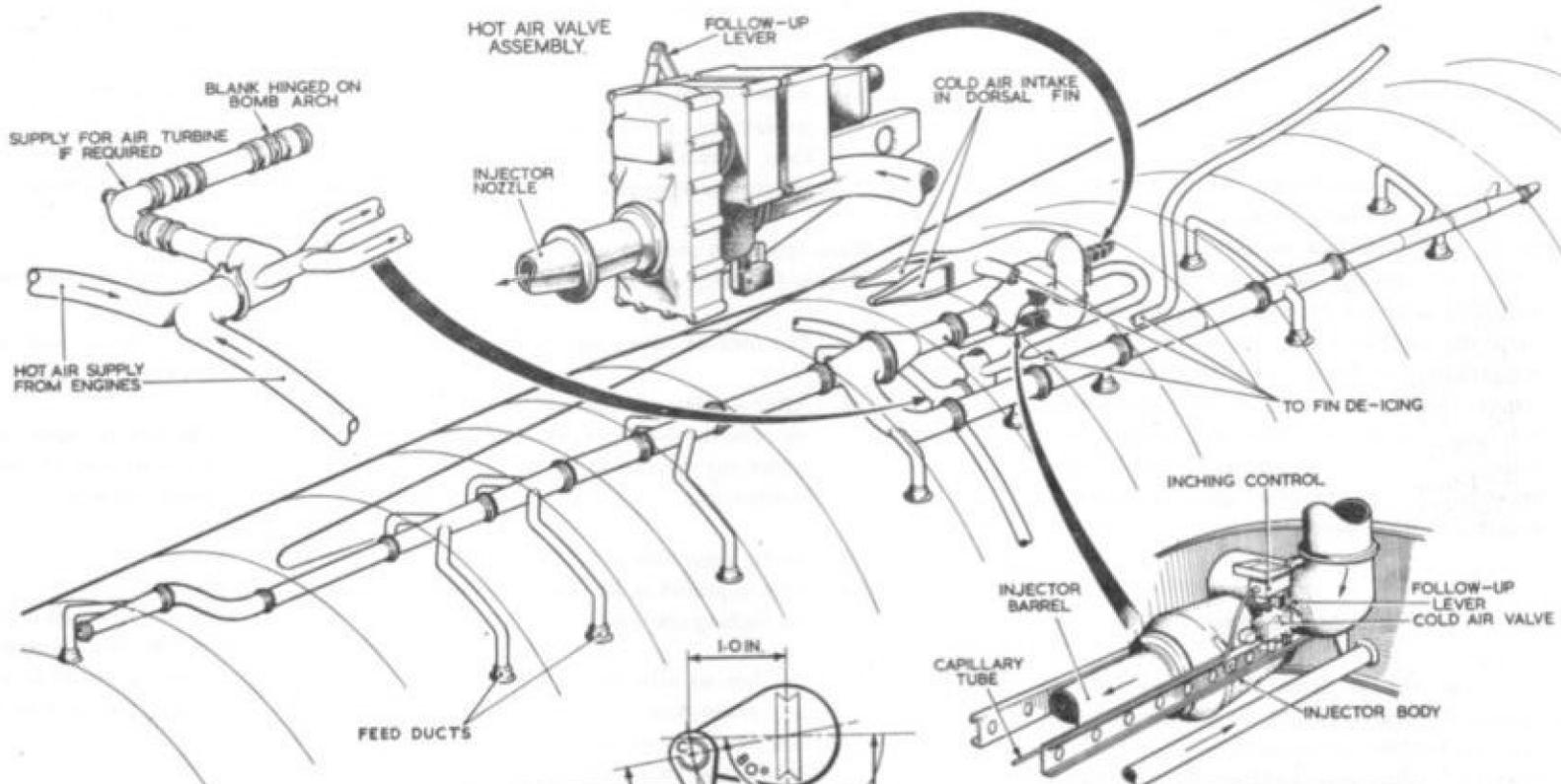
111. To change the unit ensure power supply is switched OFF, disconnect the electrical plug at relay 828, slacken hose clips securing the three pipes to outlet cover and move pipes clear. Take out the bolts securing mounting base to crate. Individual components can be changed with the unit placed on a suitable bench. To install the unit reverse the above procedure.

compressors, is fed from the port and starboard pairs of engines to the hot air valves of the fin anti-icing and bomb bay systems. The flow of air into the bomb bay heating system is controlled by an electrically-operated hot air valve which is situated, together with the cold air valve and injector, in the roof of the bomb bay between bomb arches 201.367A and 243.127A. An amplifier, wired to four temperature sensing elements dispersed in the bomb bay, causes an actuator to open or close the valve as necessary to maintain a bomb bay temperature between 0 and 25 deg.C.

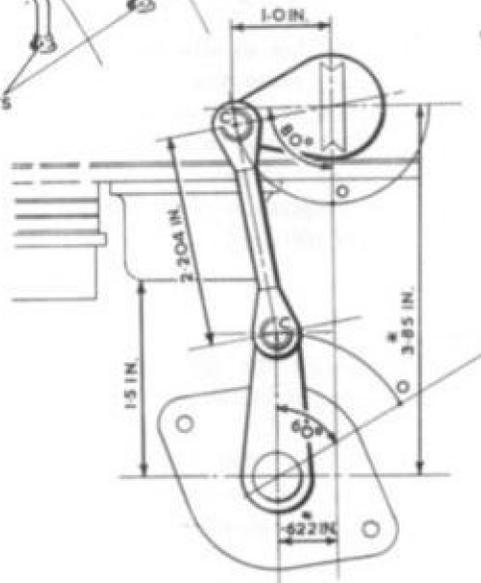
#### COLD AIR VALVE

115. Two flush-type air-intakes, back to back in the dorsal fin, supply air to the cold air valve. This valve has an inching control, the operation of which is governed by the capillary tube attached to the duct downstream of the

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COLD AIR VALVE AND INJECTOR ASSEMBLY.



COLD AIR VALVE LINKAGE SETTING (VALVE FULLY CLOSED)

NOTE:  
WHEN SETTING VALVE LINKAGE ENSURE THAT THE VALVE IS FULLY CLOSED. THE DIMENSIONS MARKED \* ARE IMPORTANT AND MUST BE MAINTAINED TO OBTAIN THE CORRECT SETTING BETWEEN THE INCHING CONTROL AND THE COLD AIR VALVE ASSEMBLY.

Fig.12 Bomb bay heating system

## RESTRICTED

injector, and maintains an air temperature of 100 deg.C at the injector outlet.

### INJECTOR

116. Hot air from the hot air valve passes to the injector, leaving through the injector nozzle at considerable velocity. It then passes down the mixing tube, mixing with and imparting some of its velocity to the cold air from the cold air valve, which enters around the periphery of the nozzle. By the time the air reaches the end of the tube complete mixing has taken place, and the final temperature depends on the proportion and initial temperatures of the hot air and cold air supplied to the injector.

### HOT AIR DUCTING

117. The hot air from the mixing tube is ducted forward and aft above the bay, through the bomb arches. Seventeen feed ducts join the main trunk duct and distribute the heating air throughout the length of the bomb bay. The exhaust air from the bomb bay passes to atmosphere through an exit louvre fitted in the port inner bomb door.

### OPERATION

#### Automatic

118. To operate the system under automatic control proceed as follows:-

- (1) Ensure that the ENGINE AIR switches are in the OPEN position (pressurisation control panel).

- (2) Place the main control switch to AUTO.
- (3) Allow the bomb bay temperature to stabilise (temperature indicator) then operate the temperature selector as required.

119. When the main control switch is placed to AUTO, the following operations take place:-

- (1) The cold air valve opens fully.
- (2) After a delay of approximately 10 seconds the hot air valve is placed under the control of the amplifier control unit.
- (3) At the same time as (2) the cold air valve is placed under the control of the inching control.
- (4) The hot air valve opens and closes to maintain a bomb bay temperature between 9 and 25 deg.C., and the cold air valve opens and closes to maintain a temperature at the injector outlet of 100 deg.C.

#### Manual

120. To operate the system under manual control proceed as follows:-

- (1) Ensure that the ENGINE AIR switches are OPEN (pressurisation control panel).
- (2) Place the main control switch to MANUAL.

- (3) Operate the manual heat control switch to INC. or DEC. to obtain the required bomb bay temperature.

121. When the main control switch is placed to MANUAL, the following operations take place:-

- (1) The cold air valve opens fully.
- (2) The manual heat control switch becomes operative.
- (3) The hot air valve is controlled by the selection of the manual heat control switch.

#### NOTE . . .

*When manually operating the system, the temperature in the bomb bay must be kept within the range - minus 5 to plus 30 deg.C.*

#### Overheat

122. If the temperature of the heating air rises above 130 deg.C., an overheat switch in the mixing tube operates and the hot air valve is disconnected from manual or automatic control and is closed. When the duct temperature falls below 120 deg.C., the switch returns to normal and the hot air valve returns to manual or automatic control.

#### Switching off

123. When the main control switch is returned to OFF, the hot air valve closes. When the hot air valve has closed the cold air valve closes.

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**General**

124. Servicing the bomb bay heating system consists of making the routine checks at the periods stipulated in the relevant Servicing Schedule. Details of these checks are given in the following paragraphs.

**NOTE . . .**

*If a duct joint is disconnected, a new asbestos seal must be fitted on re-assembly. The half-clamps are to be fitted as matched pairs with their identifying numbers adjacent to each other. The securing bolts of half-clamps fitted to 2 in. and 2.5 in. dia. ducts are to be torque loaded to 5 lb.ft. Where difficulty is experienced in fitting the split pins without exceeding 5 lb.ft., it is permissible to gently tap the crown of the clamp with a light hammer, (8 oz. maximum weight). Do not mark the crown when hammering. Care must be taken to reconnect any bonding which has been disconnected. All locking wire must be 22 s.w.g. stainless steel to spec. D.T.D. 189A or D.T.D. 161. Should a persistent leak from a duct joint be found during leakage tests, disconnect a number of joint clamps and brackets in the same pipe run. Check alignment of the ducts, correct as necessary, fit new seals and tighten the clamps and brackets progressively.*

**COMPONENT CHECKS**

125. Static checks, with the engines stopped, can be performed to test the functioning of the cold air valve and the hot air valve by operation of switches on the rear crew's panel. Proceed as follows:-

**SERVICING**

- (1) With the temperature selector at its minimum setting, select AUTO on the main control switch.
- (2) As soon as this selection is made check that the cold air valve, below the cold air intake in the dorsal fin, opens fully and then closes. This can be done by observing the movement of its follow-up lever.
- (3) With the temperature selector at its maximum setting check, by observing the movement of its follow-up lever, that the hot air valve opens.
- (4) Switch the main control switch to OFF and check that the hot air valve closes and the cold air valve remains closed.
- (5) Select MANUAL on the main control switch.
- (6) As soon as this selection is made check that the cold air valve opens fully and remains in that position by observing the movement of its follow-up lever.
- (7) Hold the manual control switch in the INCREASE position and check that the hot air valve opens.
- (8) Hold the manual control switch in the DECREASE position and check that the hot air valve closes.
- (9) Return the main control switch to

OFF and check that the cold air valve closes.

**SYSTEM FUNCTION TESTS WITH ENGINE RUNNING**

126. Since personnel have to occupy the bomb bay for these checks, one outboard engine only should be used for supplying air. The tests are as follows:-

- (1) Run one outboard engine at idling r.p.m.
- (2) Check that the appropriate engine air switch is ON and that the cabin air switches are OFF (pressurisation control panel).
- (3) With the temperature selector at its minimum setting, select AUTO on the main control switch.
- (4) Check by feel that warm air issues from the distribution ducting in the bomb bay. On a cold day it may be necessary to increase the setting of the temperature selector in order to obtain a noticeable warm air flow.
- (5) Increase the setting of the temperature and check that the flow of warm air increases.
- (6) Select OFF on the main control switch and check that the airflow ceases.

## RESTRICTED

- (7) Select **MANUAL** on the main control switch.
- (8) Hold the manual control switch to **INCREASE** and check that air flow from the distribution ducting commences.
- (9) Hold the manual control switch to **DECREASE** and check that the airflow ceases.
- (10) Select **OFF** on the main control switch.

### DUCT PRESSURE TEST

127. The low pressure ducting from the hot air valve to the outlet points in the bomb bay has to withstand pressures of less than 1 p.s.i. and no pressure test is necessary. The high pressure duct from the hot air supply from the engines to the hot air valve is tested as stated in para.55.

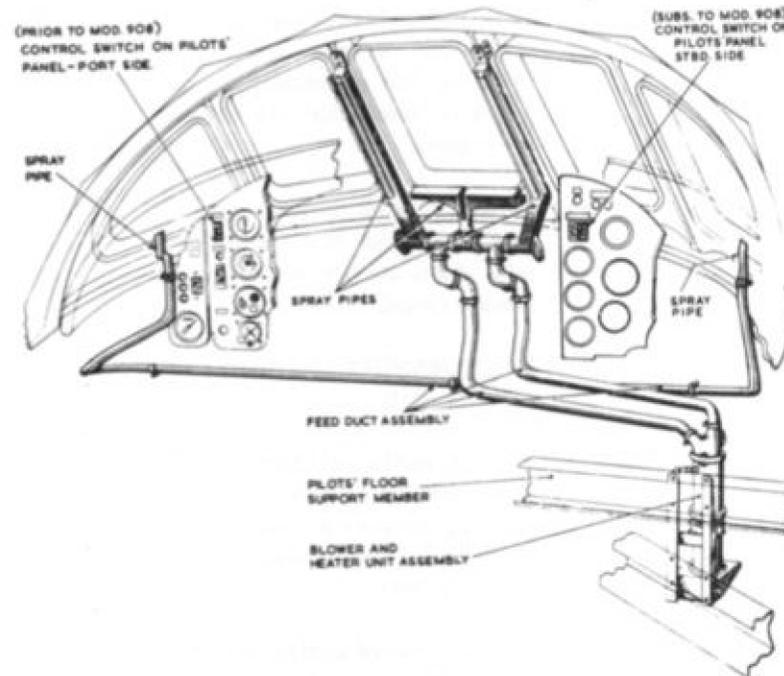


Fig.13 Windscreen demisting - thermal system

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## WINDSCREEN DE-MISTING

**Introduction**

128. Subsequent to Mod.969, the three dry air sandwich type centre panels are removed from the windscreen and replaced by three electrically heated (Gold Film) panels, consequently, the windscreen silica gel system is deleted. The thermal de-misting system, which blows hot air over the inside surfaces of

the windscreen panels, is retained and is described in the following paragraphs. Small individual silica gel units are provided to prevent internal misting of the direct vision windows, at each side of the windscreen, and at the circular windows on each side of the canopy and crews' compartment. Silica gel units are attached directly to the Perspex inner

panel of the D.V. windows and connect to the air space via small drillings in the panel. The units at the circular windows, mounted on the adjacent frame, connect to the air space via short lengths of flexible tube. For information on the function of the thermal system electrical components reference should be made to Sect.6, Chap.13 of this publication.

## THERMAL SYSTEM

129. Warm air is supplied to the windscreen from a combined blower and heater unit, mounted vertically on the starboard side forward support member of the pilots' floor. Two feed ducts, from the breeches piece at the blower, pass air to a spray assembly attached to the lower portion of the centre windscreen frame; spray pipes from this assembly direct a flow of air over the three centre screens. Two smaller ducts, from tappings in the main supply ducts, deliver air over the two outer panels of the windscreen (fig.13).

## THERMAL SYSTEM

133. The satisfactory performance of this system depends on the areas of the slots in the spray pipes being maintained at their correct values, therefore, when a windscreen or spray pipe has been renewed, the condition of these slots must be checked. The correct width of the slots in the pipe for the centre windscreen

## DESCRIPTION

**Control**

130. Prior to the embodiment of Mod.908, control of air supply to the windscreen is by a two-position switch located on the port side of the first pilot's instrument panel. Subsequent to Mod.908, the switch is located on the inboard side of the second pilot's instrument panel. When the switch is moved to the 'ON' position, current is supplied to drive the motor and energise the 1 k.w. heater, air is drawn from the cabin by the blower and passes directly over the heater and into the distribution ducts.

## SERVICING

is 0.12 in. The slots for the side windscreen should reduce from 0.12 in. wide at the bottom slot to approximately 0.03 in. wide at the lower end of the top slot.

**Function test**

134. To carry out a function test of the system, move the control switch to the 'ON' position and check, by feel, that warm air

**Overheat**

131. Should the temperature of the air in the ducting reach 70 deg.C., a thermal switch, located in the blower/heater unit, interrupts the electrical supply to the heater. When the temperature in the duct falls to 60 deg.C. the thermal switch 'makes' and the heater comes into operation again.

## SILICA GEL UNITS

132. In the individual units, the air-drying silica gel crystals are contained in nylon tubular bags (Part No. 44.D.8625) which are easily removed and replaced as the crystals become discoloured.

issues from each spray pipe.

## SILICA GEL UNIT

135. Silica gel crystals containers must be removed when the crystals change from blue to pink. Containers are easily changed when the end cap or plug is removed from the unit.

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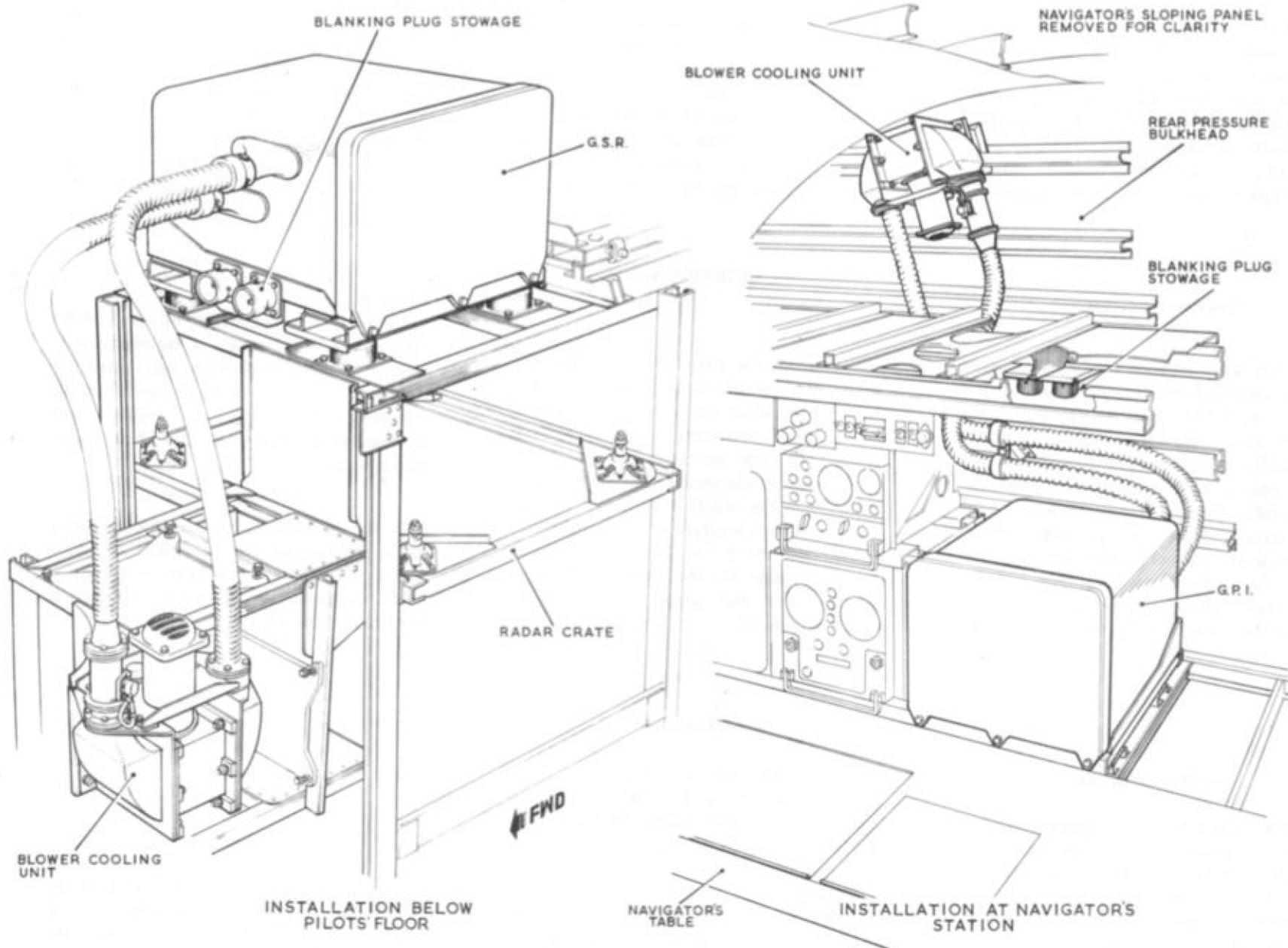


Fig.14. Instrument cooling

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**Introduction**

136. Self-contained cooling systems are provided to maintain the G.P.I. (Mk.4 or, when available Mk.6) and the G.S.R. units at reasonable temperatures during the operating periods. These systems are installed in two stages; the first stage introduces the mounting structure for the cooler and provides stowage facilities for the inlet and outlet pipes, the second stage includes the cooler and associated wiring. The equipment is installed (depending on the type of store to be carried) by modification action in the following manner:-

- (1) Embodiment of Mod.1220 Part A provides inlet and outlet pipe stowages and the mounting structure for a cooler at the G.P.I. Mk.6 position at the navigators

**INSTRUMENT COOLING**

station. Part B of the modification (embodied by Special Order Only) introduces a 115-volt cooler and associated 115-volt wiring.

- (2) Similarly, Mod.1221 Part A introduces stowages and a mounting structure for a cooler at the G.S.R. position, below the pilots floor, and Part B introduces the 115-volt cooler and associated wiring, again when the 'S.O.O.' authority is given.
- (3) The introduction of Mod.1434 provides 200-volt coolers and associated wiring at both instrument positions. This equipment may be installed when

Part A of Mod.1220 and/or 1221 is embodied.

**NOTE...**

*The G.P.I. Mk.4 was introduced as a temporary measure, by Mod.1038, until the G.P.I. Mk.6 becomes more generally available.*

137. When installed, the coolers are controlled from a single switch labelled G.P.I. COOLING situated on the secondary supplies panel (12P) on the starboard side of the fuselage above the navigators table. When the cooler is not fitted, inlet and outlet pipes are engaged in blanking plug stowage brackets secured to the adjacent structure. Both installations are shown in fig.15. For information on electrical systems and components reference must be made to Sect.6, Chap.12 of this A.P.

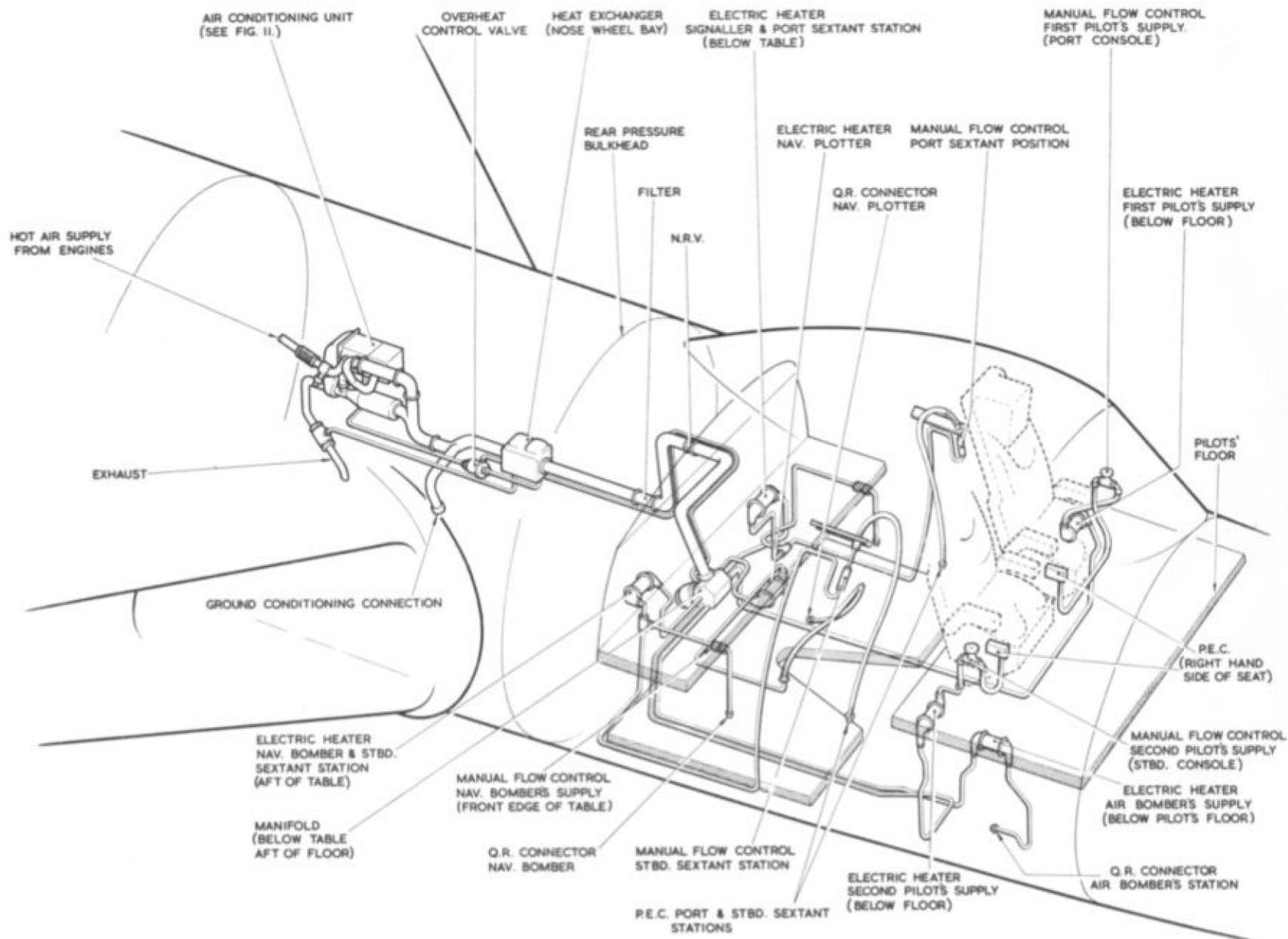
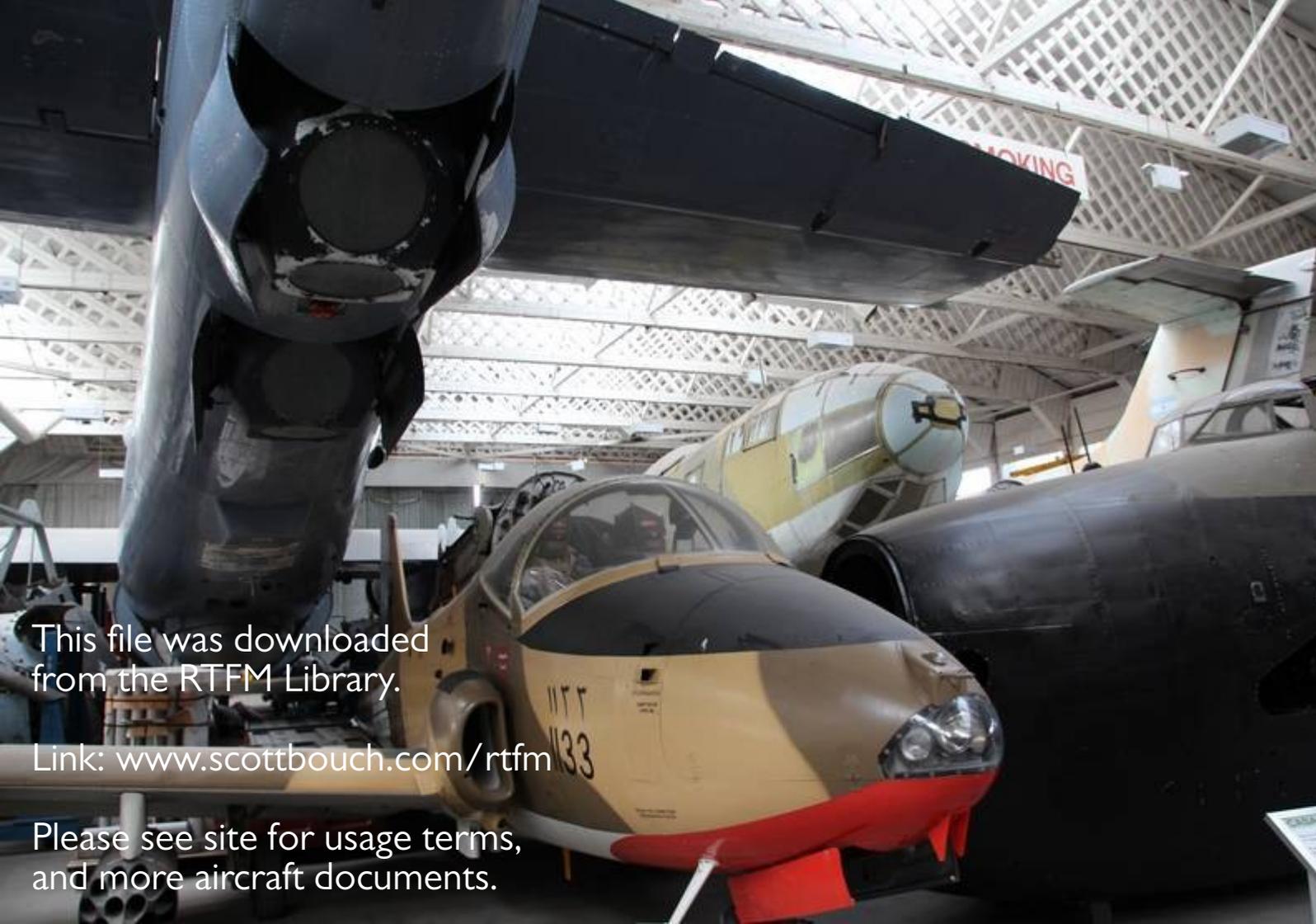


Fig.15. Air ventilated suit system installation (Post-Mod. 1696.)

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