

Chapter 8A

AIR CONDITIONING SYSTEMS

Including bomb bay heating, windscreen demisting and air ventilated suit system.

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DESCRIPTION

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## PRESSURISATION AND AIR CONDITIONING (post Mod. 176)

### DESCRIPTION

#### Introduction

1. 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.

2. Air from the engine compressors is used to pressurise the cabin, the flow of air being automatically maintained 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 unit. Air release valves, which are operated manually or by solenoids, are connected in the pressure lines 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 p.s.i. (CRUISE condition), but can be set when required to maintain 25,000 ft. conditions up to a maximum differential of 3.5 p.s.i. (COMBAT condition) at 50,000 ft.

3. 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 cabin temperature between - 5 deg.C. and + 33 deg.C. to be maintained on selection.

### KEY TO FIG.1

1. TEMP. SELECTOR AUTO control - selects the required cabin temperature when the CABIN TEMP. CONTROL switch is in the AUTO position.  
COOL - NORMAL - WARM.
2. TEMP. CONTROL VALVE indicator - gives position of temperature control valve.
3. PRESSURE SELECTOR switch - has three positions:-  
CRUISE - sets cabin pressure controller for CRUISE conditions  
COMBAT - sets cabin pressure controller for COMBAT conditions.  
NO PRESSURE - depressurises the cabin.
4. ENGINE AIR switches (4) - control the engine air supply cocks, (isolation cocks).  
OPEN - SHUT
5. CABIN AIR switches (2) - each has two positions:-  
OPEN - opens the shut-off valves of the combined automatic flow controller and shut-off valve.  
SHUT - closes the shut-off valve.
5. Inoperative at present.
7. RAM AIR VALVE switch (guarded) has three positions:-  
Central off position.  
SHUT - closes the ram air valve.  
OPEN - opens the ram air valve.
8. RAM AIR VALVE indicator - gives position of ram air valve.
9. OVERSPEED INDICATOR - indicates conditions which may lead to the overspeeding of the air conditioning turbine unit.
10. CABIN TEMP. CONTROL switch - has four positions:-  
Central off position.  
AUTO - places the temperature control valve under automatic control.  
MANUAL HOT - spring-loaded to off - moves the temperature control valve to the hot position.  
MANUAL COLD - spring-loaded to off - moves the temperature control valve to the cold position.
11. EMERGENCY DECOMPRESS switch (guarded) has two positions:-  
Forward - energises the PRESSURE SELECTOR switch.  
Rearward - switch energises the air release valves and lights the three loss-of-pressure warning lamps on the rear crew's panel.
12. ABANDON AIRCRAFT switch  
Forward - energises the PRESSURE SELECTOR switch.  
Rearward - energises the air release valves and lights the abandon aircraft sign and the loss-of-pressure warning lamps on the rear crew's panel.
13. CREW'S DECOMPRESSION HANDLE - provides for manual operation of air release valves.

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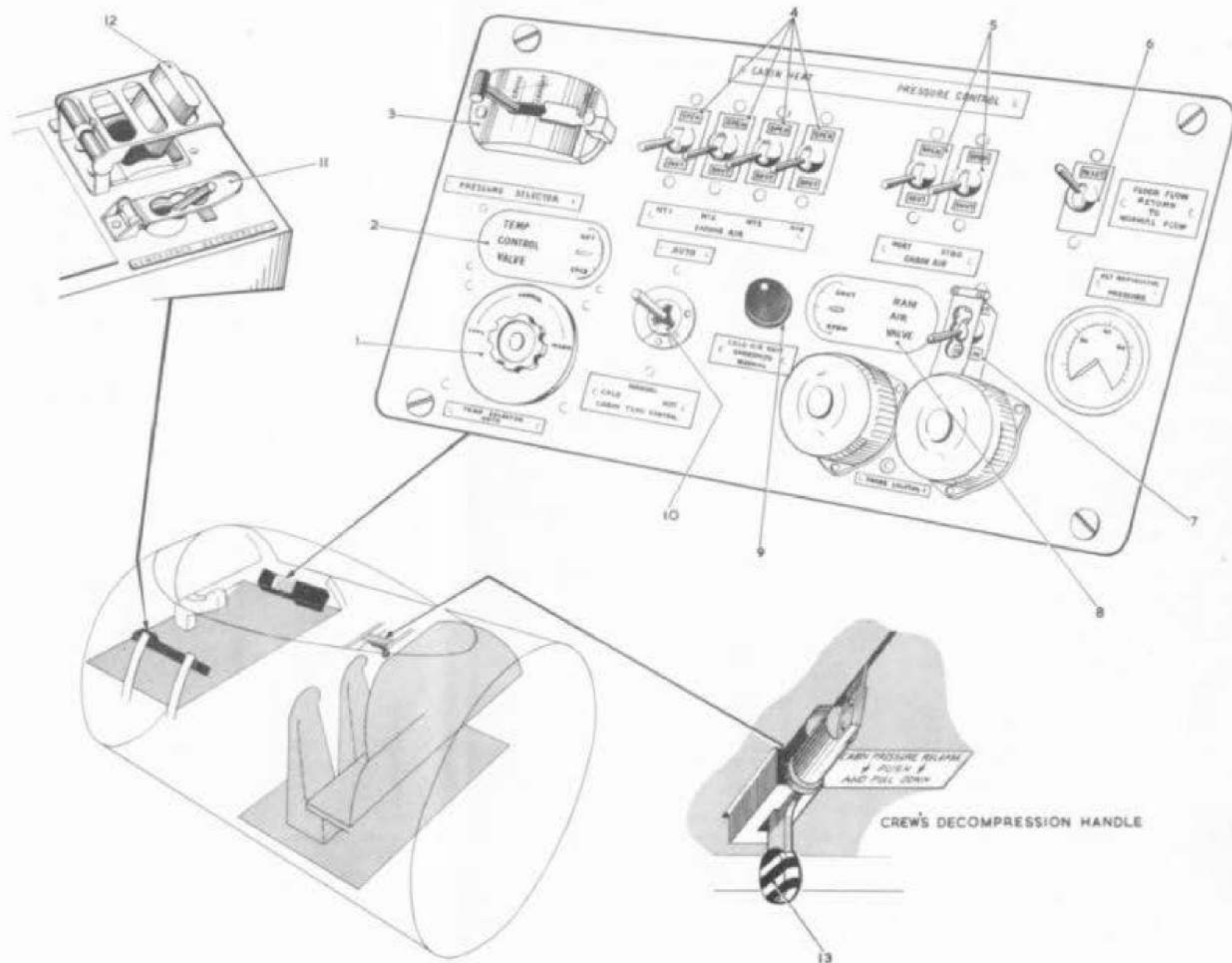


Fig. 1. Controls - air conditioning system

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**TABLE 1**  
**Cabin pressure system**

| Component  | Part No.    | Ref.No.   | No. off | A.P.Ref. | Location   |
|--|-------------|-----------|---------|----------|--|
| Pressure controller, Type B (motorised)                              | 510740      | 27KD/620  | 1       | 1275A    | } Pressure cabin, starboard side, under pilot's floor. |
| Pressure controller, Type B  | 510350      | 27KD/592  | 1       | 1275A    |  |
| Combined valve unit, Type 20/65                                      | 503640      | 27KD/37   | 1       | 1275A    |  |
| Relay valve  | 510540      | 27KD/625  | 1       | 1275A    | } Pressure cabin, starboard side.                      |
| Air release valve  | C5748Y.Mk.A |           | 2       |          |  |
| Inward relief valve, 6.1 in.   | 509180      | 27KD/626  | 1       | 4340     | } Forward pressure bulkhead.                           |
| Pressure relief valve  | 510660      | 27KD/624  | 1       | 4340     |  |
| Ground pressure test point 1½ in. (Pre-Mod.79)                       | 504600      | 27KD/10   | 1       | 4340     | } Rear pressure bulkhead.                              |
| Ground pressure test point 1.13/16 in. (Post-Mod.79)                 | 505570      | 27KD/623  | 1       | 4340     |  |
| Ground conditioning connection 5 in.                                 | 502910      | 27KD/47   | 1       | 4340     |  |
| Radar cooling coupling, 2 in.  | 504300      | 27KD/12   | 1       | 4340     | Forward end of cabin in starboard side - external      |
| Water extractor, Type W.E.60 Mk.3                                    | -           | 27UA/481  | 1       | 4340     | } Forward end of cabin in port side - external         |
| Turbine refrigeration unit   | -           | 27UA/493  | 1       | 4340     |  |
| Air-to-air cooler, Type D.150-4.A.                                   | -           | 27UA/487  | 1       | 4340     | } Nose wheel bay                                       |
| Hot air valve, 1½ in. (By-pass valve)                                | FKH/A/5040  |           | 4       |          |  |
| Temperature control valve  | FKH/A/5050  |           | 1       |          |  |
| Duct relief valve  | 505170      | 27KD/474  | 1       | 4340     |  |
| Combined automatic flow controller and shut-off valve (Post-Mod.176) | 512180      | 27KD/636  | 2       | 4340     |  |
| Combined automatic flow controller and shut-off valve (Post-Mod.835) | 518410      | 27KD/1505 | 2       | 4340     |  |
| Three-in. butterfly valve-flood flow control (Post-Mod.176)          | EMP/AS      | -         | 1       |          |  |
| Non-return valve, 3 in. (Post-Mod.176)                               | 517760      | -         | 4       |          |  |
| Non-return valve, 3 in. (Post-Mod.193)                               | 512330      | -         | 1       | 4340     |  |
| Non-return valve, 4.1 in. (Pre-Mod.263)                              | 505190      | 27KD/466  | 1       | 4340     |  |
| Non-return valve, 4.25 in. (Post-Mod.263)                            | 513600      | 27KD/483  | 1       | 4340     | } Rear pressure bulkhead                               |
| Emergency ram air valve  | 503400      | 27KD/475  | 1       | 4340     |  |

4. Provision is made for ventilation during non-pressurised flight. A ram air intake, situated on the port side between the fuselage wall and the engine intake boundary layer fence, feeds the cabin through an actuator-operated flap-type valve, this valve is held closed during flight. The same ram air intake

also feeds cooling air to the air-to-air cooler in the conditioning unit. An identical intake on the starboard side feeds cooling air to various electrical components in the starboard side of the nose-wheel bay.

5. Five-inch diameter ground con-

ditioning connections are fitted in the starboard side of the pressure cabin and in the bomb door structure, to which a hose from a ground conditioning trolley is connected to enable air conditioning of the cabin and bomb bay to be carried out while the aircraft is on the ground. A pressure test connection is provided on

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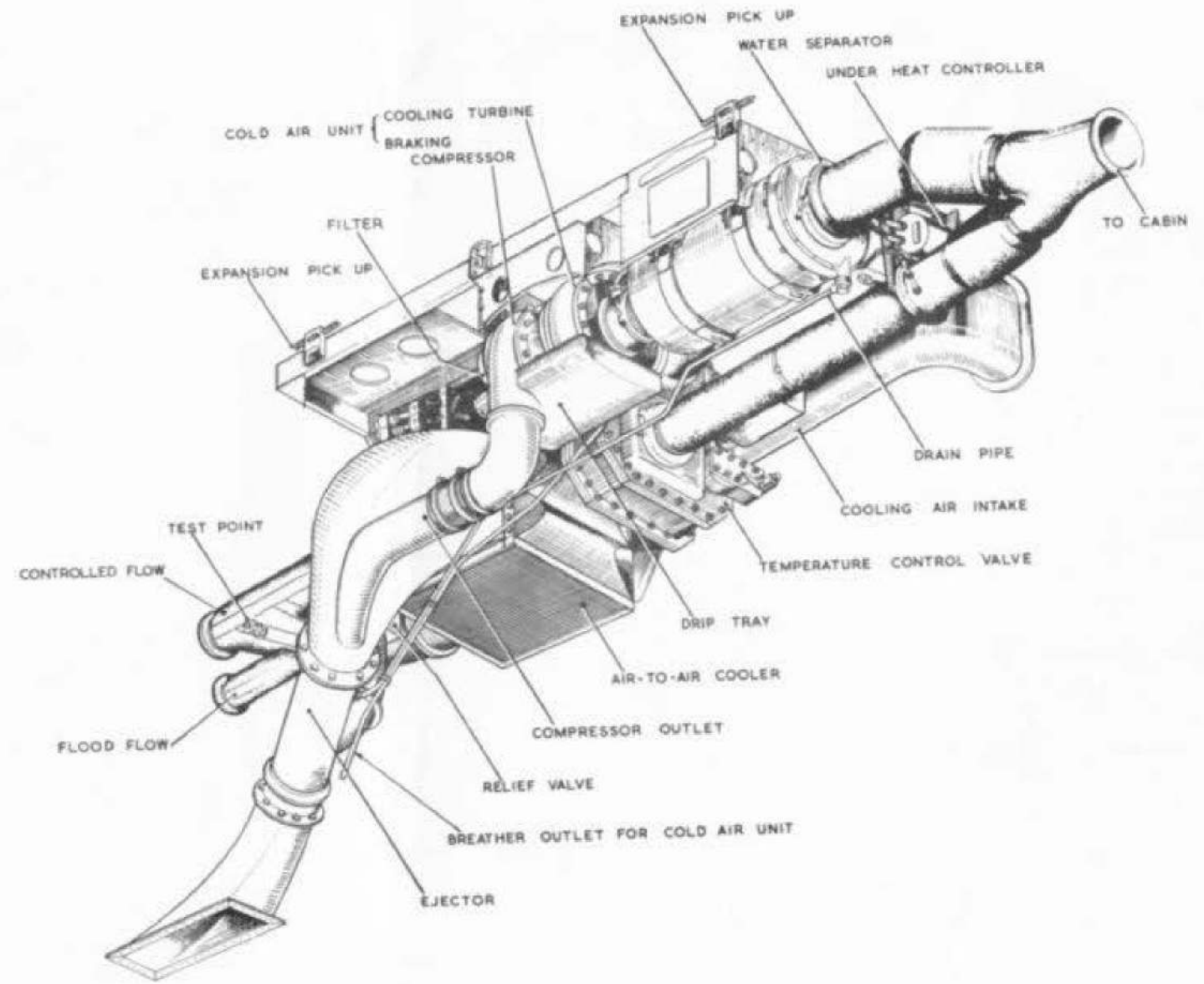


Fig. 2 Air conditioning unit (cabin conditioning)

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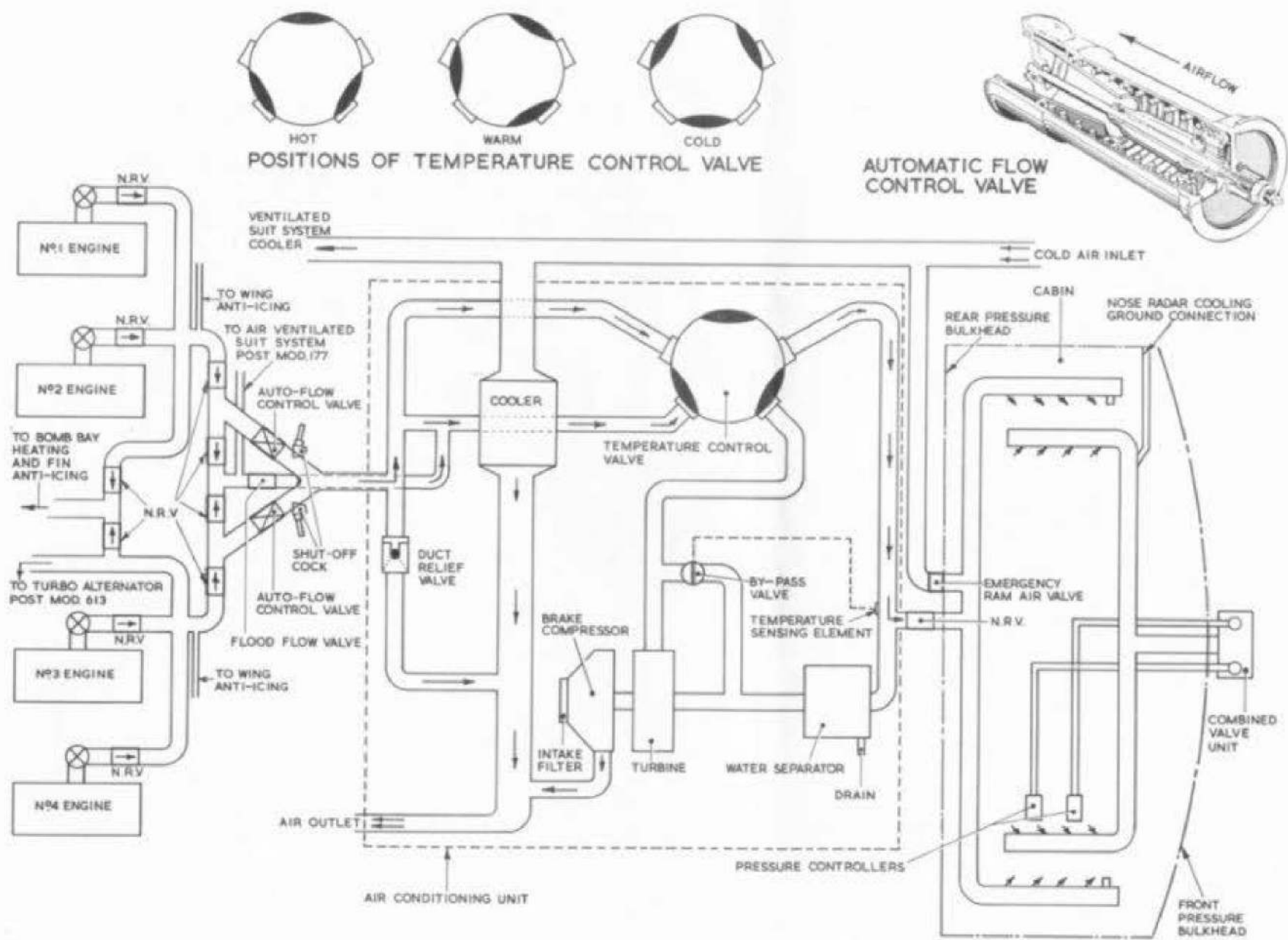


Fig.3 Air conditioning system diagram

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the rear pressure bulkhead for ground pressure testing of the cabin.

6. A list of main components in the pressurising and air conditioning system is given in Table 1, together with their location in the aircraft and references to Air Publications which cover the components listed or similar equipment.

#### COCKPIT CONTROLS AND INDICATORS

7. A 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 switch and an emergency decompression switch are fitted on the side panel of the port console. The switches and indicators are illustrated in fig.1 and the associated key gives a brief description of them. Reference should be made to Sect.5, Chap.1, of Book 2 of this publication for details of the electrical functions of the controlling switches.

8. A controlling 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

9. Air is tapped from each engine compressor for cabin pressurisation and airframe anti-icing. None of the engines is handed, each having a three-inch diameter isolation cock and non-return valve fitted as part of the engine installation unit, positioned at about 45 degrees to the horizontal through the engine and on the port side in each case. The same tapping connection is used for both cabin air and anti-icing air, the duct for both systems being common until just forward of the front spar. The ducting from adjacent engines is common downstream of the non-return valves and runs forward above

the engines close to the bomb bay rib. As the ducting on each side 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 and the other to the wing anti-icing system. The ducting to this point is of 4.5 in. dia. stainless steel.

10. The three-in. dia. stainless steel branches leading to the cabin join just forward of the rear bulkhead in the nose-wheel bay to form, on the port side, the base of a triangular ducting assembly that connects through a short length of four-in. dia. duct to the air conditioning unit. In the base of the assembly, on both sides of the joints made with the ducts that form the sides of the triangle, are three-in. dia. non-return valves, and in each of the side ducts a combined automatic flow controller and shut off valve.

11. Tapped into the base of the triangular ducting assembly between the inner pair of non-return valves is a three-in. dia. stainless steel duct that leads through an electrically-actuated flood flow control valve to the feed pipe of the air-to-air cooler in the air conditioning unit. On aircraft with Mod.177 embodied, the air supply for the ventilated suit system is tapped from this duct, upstream of the flood flow control valve.

12. A breeches piece connects the air conditioning unit to a non-return valve on the rear pressure bulkhead.

#### ENGINE ISOLATION COCKS

13. Each engine is provided with an electrically-operated ON-OFF cock, controlled by switches on the starboard console, to admit or isolate the air supplies as required. It should be noted that these cocks also control the supply of air to the airframe thermal anti-icing

system (Sect.3, Chap.9 of this Book.).

#### MASS FLOW CONTROL SYSTEM

14. The mass flow control system consists of the three-in. dia. non-return valves and the combined automatic flow controllers and shut-off valves in the triangular ducting assembly at the rear of the nose-wheel bay.

15. Each flow controller, which automatically maintains the mass flow to the conditioning unit within the required limits, consists of a cylindrical body in which a spring-loaded valve moves in an orifice of fixed diameter (fig.3). Variations in the pressure of the air supply combined with the pressure drop across the controller, adjusts the position of the spring-loaded valve in the orifice, and the valve, which is shaped such that its increasing or decreasing diameter varies the area of the air outlet through the orifice, decreases or increases the air supply to maintain the required mass flow. The mass flow, which varies with altitude, decreases slowly and smoothly from 50-60 lb. per min. at sea level to 13-15 lb. per min. at 50,000 ft. A detailed description of the combined automatic flow controller and shut-off valve, together with its operation and servicing, can be obtained by reference to A.P.4340, Vol.1, Book 2, Sect.5.

16. The electrically-actuated shut-off valves are normally opened or closed by manual selection of the cabin air switches on the air conditioning panel in the starboard console. If a certain pressure ratio is reached and the turbine in the conditioning unit overspeeds, the port shut-off valve is automatically closed and an indicator on the conditioning panel is energised by an electrical circuit, controlled by a pressure ratio switch (para.24).

17. Non-return valves in the base of

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the assembly, isolate the port and starboard air supplies, to the conditioning unit, from each other to prevent complete loss of air if one side of the system is damaged, but permit either side to feed air to the flood flow control valve, and, if Mod.177 is embodied, to the air ventilated suit system. Since the non-return valves isolate the port and starboard air supplies and each automatic flow controller can be isolated by closing its shut-off valve, each controller can be tested independently with its respective pair of engines.

#### FLOOD FLOW CONTROL SYSTEM



18. If a serious leak develops in the crew's cabin at altitudes above 30,000 ft., two altitude switches automatically open the flood flow control valve and move the temperature control valve to mid-position when the relative cabin altitude reaches 29,000 ft., producing an increase in mass flow to maximum in the shortest possible time and maintaining a reasonable cabin temperature. At the same time the cabin temperature control switch and the over-heat switch are isolated from their electrical supplies. A detailed description of the flood flow electrical circuits can be obtained from Vol.1, Book 2, of this Air Publication.

19. Flood flow can be stopped and the temperature control system returned to normal operation by holding a spring-loaded reset switch, on the air conditioning control panel, in the RESET position. If, however, conditions are such that both altitude switches are still closed, flood flow will restart as soon as the switch is released.

20. Flood flow is automatically stopped when the cabin is decompressed.

#### AIR CONDITIONING

21. The conditioning unit, in the nose-wheel bay, controls the temperature of the 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, is easily removed for servicing or renewal. The principal components of the unit are as follows:-

- (1) An air-to-air cooler.
- (2) A four-in. dia. cooler by-pass duct.
- (3) Temperature control valve.
- (4) A cold air unit, consisting of an expanding turbine driving a brake in the form of a compressor.
- (5) Water separator, fitted downstream of the cold air unit.
- (6) A four-in. dia. cold air unit by-pass duct.

A small ram air intake, on the port side between the fuselage wall 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 electrical control of the conditioning system, reference must be made to Vol.1, Book 2, Sect.5, Chap.1, of this Air Publication.

#### Temperature control valve

22. This component of the air conditioning system is a four-way actuator-operated hot air valve, which responds to temperature-sensitive elements in the cabin and governs the path of air through the conditioning equipment. Operation

can be automatic in conjunction with a selector on the starboard console, or the valve can be controlled manually by a temperature control switch. When full heat is required, the hot air from the engine passes directly through the air conditioning unit to the cabin, by-passing the cooler and refrigerator units. If cooling is then required and the valve moved towards the 'NORMAL' position, an increasing proportion of the air is routed by the valve through the air-to-air cooler until the whole flow is passing through the cooler and by-passing the refrigerator. If valve movement is continued towards the 'COOL' position, an increasing proportion of the air is directed through the turbine refrigerating unit until the whole flow is passing through the cooler and also through the refrigerating unit. Any further cooling required is attained by an increase in mass flow, the temperature control valve being retained in the 'COOL' position.

#### Turbine refrigeration unit

23. This unit consists of a small inward flow turbine directly coupled to a small centrifugal braking compressor. The turbine inlet is connected through the temperature control valve to the cooler outlet; the turbine outlet discharges into the ducting to a water separator. Air is taken into the centrifugal compressor, which functions as a brake in absorbing the turbine energy, through a No.8, 24 s.w.g. brass wire filter and is discharged from it into the ejector. The ejection of compressed air from the outlet side of the compressor into the air-to-air cooler exhaust tends to increase the cooling air flow through the cooler, thereby increasing the reduction of temperature in the cooler.

24. 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 being applied to a pressure ratio switch. Should the pres-

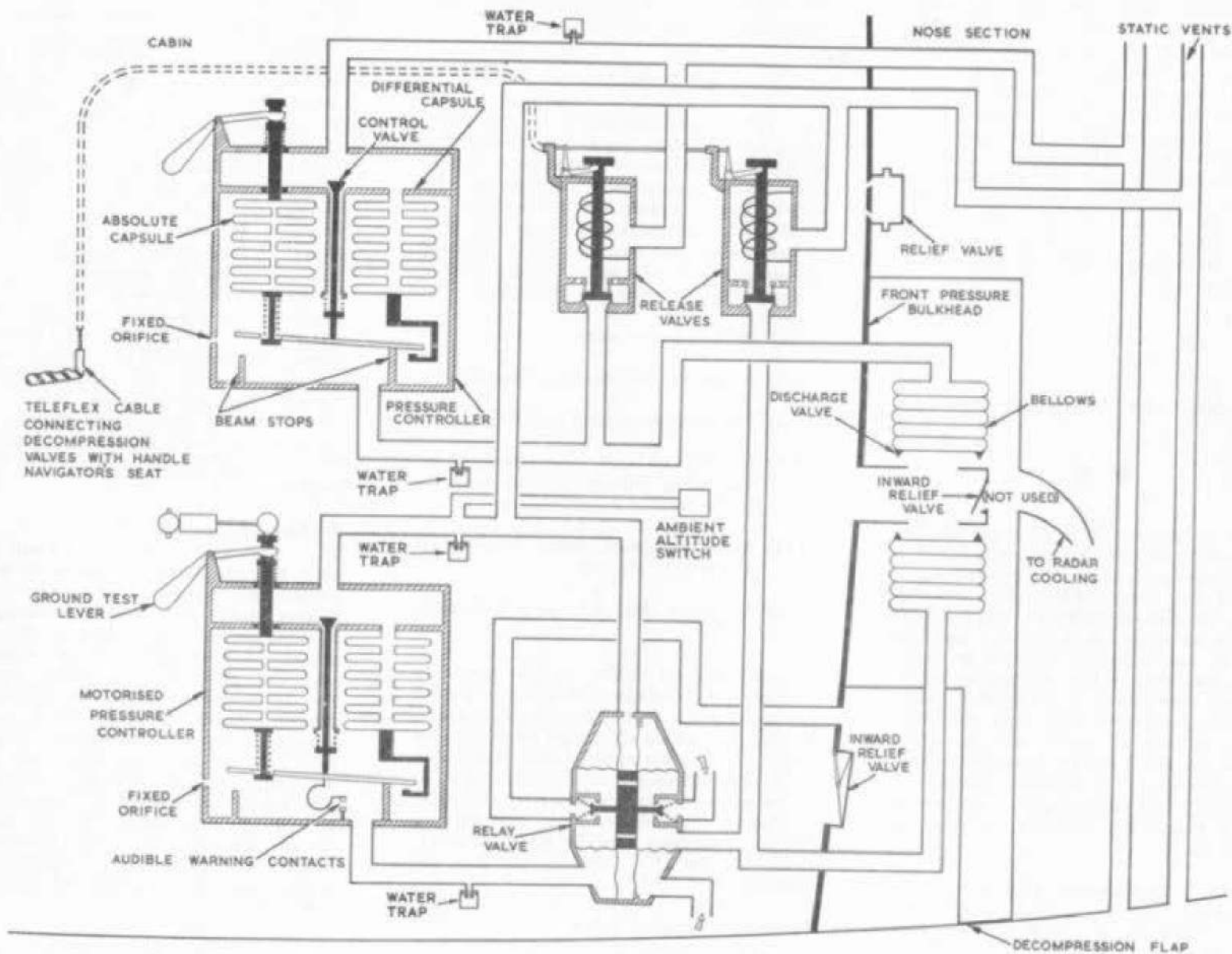


Fig. 5. Cabin pressure control diagram

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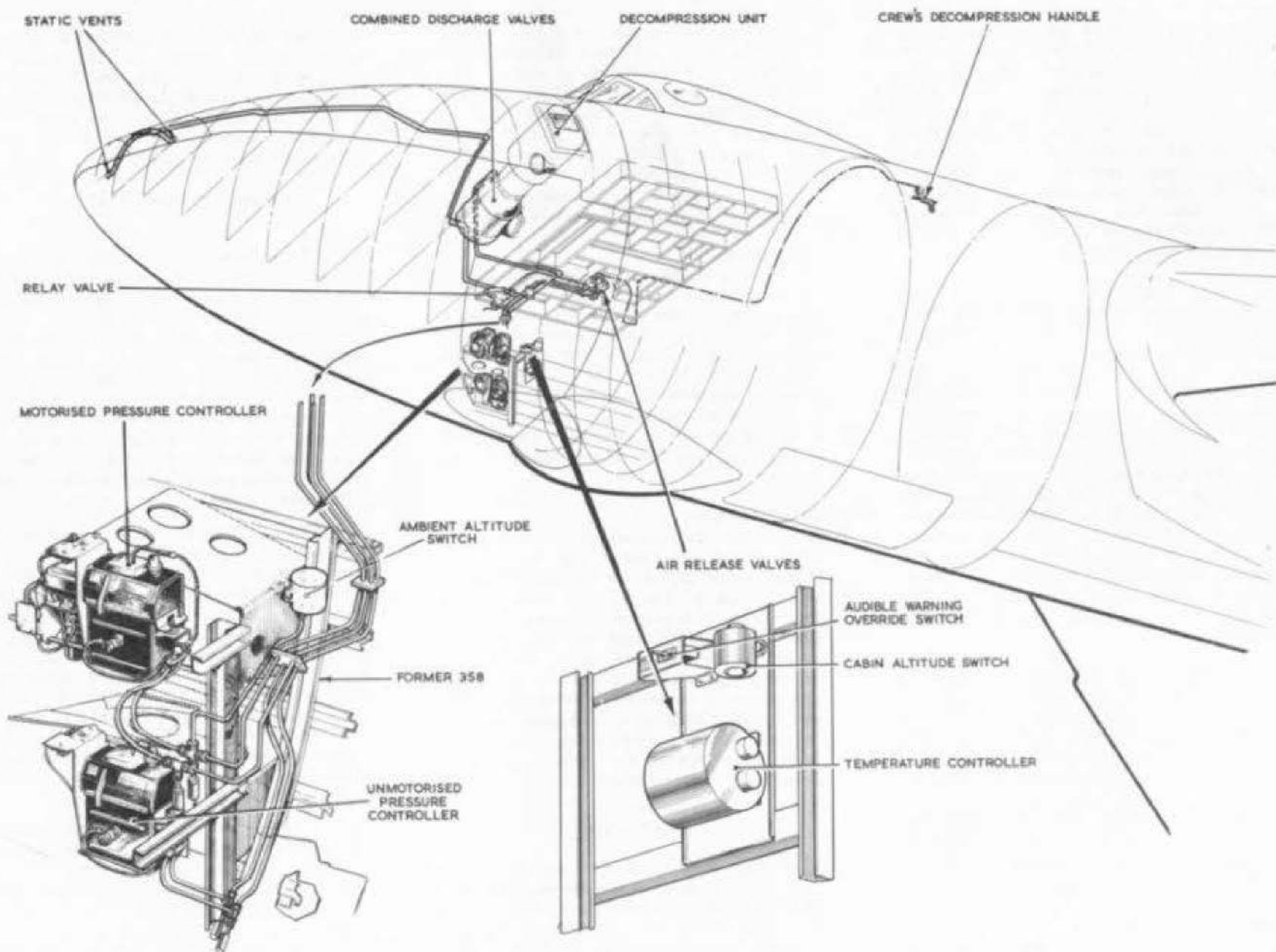


Fig. 6. Cabin pressure control installation

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sure ratio become too great, the switch operates an electrical circuit that closes the shut-off valve of the port combined automatic flow controller and shut-off valve and changes the magnetic overspeed indicator on the air conditioning panel from black to white. When the pressure ratio has decreased, the port shut-off valve will open and the indicator return to black. If overspeeding persists after the port shut-off valve has been automatically closed, mass flow through the starboard flow controller can be reduced by partly closing the shut-off valve.

25. The lubrication system for the bearings of the turbine refrigerating unit will not prime with oil until a rotational speed corresponding to an air flow of at least 10 lb. per minute 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 has been primed at high speed the speed of the unit can be reduced to below the critical value and the unit will only need repriming after being stationary for over one hour. To reprime the unit proceed as follows:-

With No.1 and 4 engines running at more than 80 per cent of maximum r.p.m., with both ENGINE AIR and CABIN AIR switches OPEN, and with the temperature control in MANUAL, move the temperature control valve to COLD. Keep this selection for at least one minute and then select the required position of the temperature control system in either AUTO or MANUAL.

#### Underheat by-pass valve

26. Under refrigerating conditions the temperature of the air efflux from the cold air unit 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 would cause difficulty with blockages. A small hot air valve, controlled by a temperature sensitive element set at 2 deg.C. operates when the air leaving the turbine is below this temperature, and allows sufficient hot air to bypass the turbine and mix with the fully cold air to keep at above freezing point, before passing through the water separator

#### Overheat switch

27. An overheat switch is coupled into the temperature control system to prevent overheating. Should the air temperature rise to 175 deg.C the switch operates automatically to move the temperature control valve towards the cool position. When the temperature has fallen to 165 deg.C. the switch returns to normal. The action of the switch overrides any control action that may be taking place at the time.

#### Water separator

28. 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 sensing 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 misting and fogging troubles and add to crew discomfort. A small drain pipe drains the water overboard through the cooler exhaust duct.

### OPERATION

29. Provision is made for both automatic and manual control of the air conditioning. When the cabin temperature control switch is moved to the AUTO position, the temperature control valve functions automatically to maintain the cabin temperature according to the selection made on the

temperature selector. When manual control is used, the temperature control valve may be set to any position by use of the temperature control switch, reference being made to the temperature control valve position indicator. Reference should be made to Sect.5, Chap.1 of Book 2 of this publication for details of the electrical operations involved.

### CABIN PRESSURE SYSTEM

#### Ducting

30. After entering the cabin through a 4.1 in. (pre.Mod.263) or 4.25 in. (post. Mod.263) 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 wall ducts formed by the spaces between the trimming panels and the fibreglass sheet between adjacent formers. Louvres at floor level allow air in to the cabin, and small branch pipes feed air to the air bomber's pannier and to the window to prevent misting.

31. Two extractor ducts run forward, adjacent to the feed ducts, short stub pipes connecting them to wall ducts similar to, and interposed between, the wall feed ducts. The used air in the cabin is collected through louvres and the fuselage former ducts, and led through the extractor ducts to a common discharge point on the front pressure bulkhead. It is there passed through a combined valve unit, ducted to the radar equipment in the nose for cooling purposes finally passing overboard through outlet grilles on the under surface of the aircraft nose.

32. Cooling air, during ground running of the radar equipment, is provided for by a cooling air trolley connection on the port side of the cabin connected by a duct to the port extraction duct. Flap valves, fitted in the port and starboard extraction ducts, operated by the airflow, prevents the cooling air entering the cabin through the extraction ducts.

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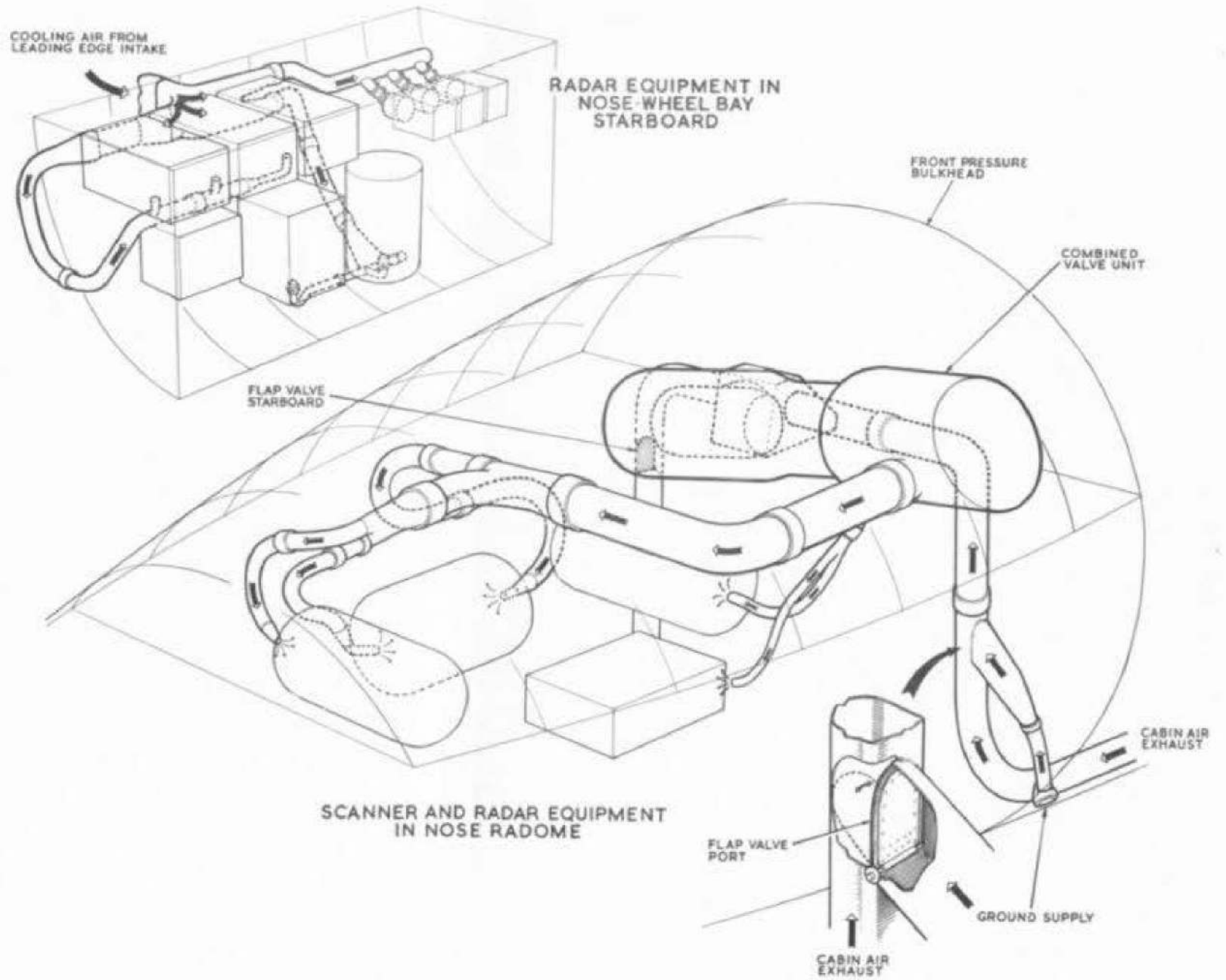


Fig. 7 Radar equipment cooling  
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#### Discharge valves

33. A combined valve unit, Type 20/65, containing two bellows-operated discharge valves, is mounted on the forward face of the front pressure bulkhead, its function being to regulate cabin pressure by offering resistance to the discharge of air from the cabin. Each valve is controlled by a pressure controller and controlling pressures supplied by the capsule chambers of the latter, regulate the pressure in the discharge valve bellows. In the case of the motorised controller (para.34), this is done by way of a relay valve which operates the discharge valve bellows rapidly enough to prevent lag when there is any surge or sudden fluctuation in cabin pressure. The consequent restriction imposed by the bellows on the discharged air determines the cabin pressure. The discharge valve unit is enclosed by a shroud and a duct feeds the discharge air into the nose section to provide cooling for the radar equipment.

#### Pressure controllers

34. Two Type-B pressure controllers, each controlling one discharge valve, are mounted in the pressurised compartment, their function being to maintain a cabin pressure greater than atmosphere at aircraft altitudes over 8,000 ft. The motorised controller is set to control up to a maximum differential pressure of 8.9 p.s.i., and the unmotorised controller to 9.36 p.s.i. The reason for this difference is to ensure that there will be no interference between the two controllers. If both had the same setting they would attempt to control to the same pressure at the same time, and since only the motorised controller is in series with a relay valve the sensitivity of the system to flow variation would be lost. The motorised controller should be in full control at all times, except in emergency and in case of failure of the controller. If such a failure occurs, the unmotorised unit will take over control at the slightly higher pressure given by its setting.

35. Each controller consists basically of two pressure-sensitive capsules operating a needle control valve by way of a simple beam mechanism, the interior of the capsule being open to cabin air through a small fixed orifice. One capsule is evacuated and sealed, and so, is sensitive to changes in absolute pressure, while the other, its interior being connected with 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 discharge valve bellows, the action of the capsules and the setting of the control valve govern the restriction offered by the discharge bellows to the passage of air from the cabin.

36. 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. As the aircraft climbs, the absolute capsule expands causing the control valve to close progressively. At 8,000 ft. the valve has closed to such an extent, that enough pressure can build up in the capsule chamber and the discharge valves, for the latter to begin to restrict the flow from the cabin. This 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 46,000 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

37. In one of the pressure controllers the absolute capsule can be reset by a cam and rocker gear operated by a small electric motor through a two-speed gearbox. If the pressure selector switch is placed to the COMBAT position, the cam is rotated and resets the absolute capsule so that pressurisation does not commence until the aircraft reaches an altitude of 25,000 ft., and a maximum differential of  $3\frac{1}{2}$  p.s.i. is attained at 50,000 ft. In this condition the cabin pressure is governed by the discharge valve under the control of the motorised controller, whilst the other discharge valve remains closed. If COMBAT is selected from the CRUISE position, the cam resets the absolute capsule at a rate of 12 p.s.i. per minute, if CRUISE, is selected from COMBAT, the capsule is reset at 1 p.s.i. per minute. The differential rate of resetting is accomplished by the two-speed gearbox, which transfers the drive from the motor to the camshaft at differing ratios according to the direction of rotation.

#### SAFETY PRECAUTIONS

38. The motorised pressure controller incorporates a contact mechanism which operates an audible warning device in the cabin in the event of a serious loss of

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cabin pressure. A manually-operated override switch, located under the crew's floor, is provided so that the warning horn automatic switch can be cut out during ground servicing operations.

39. An inwards 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 pressure are approximately the same the valve closes.

40. The relief valve Type D, is fitted to the front pressure bulkhead to prevent excessive pressure in the cabin. In the

#### General

42. Servicing of 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.

#### COMPONENT CHECKS

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

- (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

event of failure of 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 9.75 p.s.i., the relief valve opens to allow air to escape to atmosphere.

#### NOTE...

*It is not permitted to raise cabin pressure to 9.75 p.s.i. for the purpose of testing this valve; it should be removed from the aircraft for servicing and the setting of correct blow-off pressure.*

#### DECOMPRESSION

41. Air release valves, which may be operated either electrically or manually, are connected in the pressure lines between controllers and discharge valves. Operation of these release valves allows the pipe pressure to be connected directly to static atmosphere, thus effectively

#### SERVICING

control valve indicator should follow hot/cold selection of temperature selector when selector switch is at AUTO.

- (4) Inward relief valve - on front bulkhead; check manually for freedom of operation.
  - (5) Check cold air unit fluid level.
  - (6) If Mod.177 is fitted, check that each of the ventilated suit manual control valves operates fully over the range full closed to full open.
  - (7) 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.
44. With No.1 and 4 engines running, functioning of most components can be

breaking the connection between controller and combined valve unit. This means that the discharge valve bellows will 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 the port and starboard collection ducts; this ensures that the required rate of decompression is achieved, and avoids very high pressure drops in the ducting. Electrical operation of the release valves is obtained by moving the pilot's control switch to NO PRESSURE or by operation of the ABANDON AIRCRAFT and EMERGENCY DECOMPRESS switches. A mechanical means of operating the valves is provided by a Teleflex linkage, attached to a lever above the crews table within easy reach of the three rear crew members.

checked by their effect on the air delivery to the cabin. Checks are as follows:-

- (1) Shut-off valves - with both of the cabin air switches closed, air should not enter the cabin. Check that air flows into the cabin when each switch is operated independently of the other.
  - (2) Cold air unit - by noting slight vibration of the unit, or by low cabin inlet temperature.
  - (3) Pressure controllers
  - (4) Combined valve inlet
  - (5) Air release valves - with NO PRESSURE selected no pressure can build up.
- } by use of ground test levers to inflate to maximum differential

#### PRESSURE AND LEAKAGE TESTS

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.

#### Precautions

46. The following general precautions must be observed when routine pressure tests are being made:-

- (1) All personnel engaged inside the aircraft during pressure tests must be approved by the Medical Officer as being physically fit for the work. (A.P.1464D, Vol.1, Part 1, Leaflet No.36 refers).
- (2) The correct ground test rig (Ref. No.4F/2013) must be used and must be operated only by authorised personnel. A compressed air line must not be used and the relief valve on the test rig must never be set above 10 p.s.i.
- (3) When personnel occupy the fuselage during pressure and leakage tests, a system of communication must be arranged with personnel outside the fuselage.
- (4) When personnel occupy the fuselage during pressure and leakage tests, using the ground test rig or the engines, the rates of change of pressure should be kept at a level not exceeding the equivalent of 1,000 ft.per minute.
- (5) All pressures inside the fuselage must be measured with an accurate boost gauge or manometer. The boost gauge must be calibrated to read pressures in excess of that used for the test, so that it can be accurately checked that the cabin pressure stabilises at the correct level.

- (6) It is recommended that, during pressure tests, the aircraft be moved away from other aircraft and personnel not actively engaged in the tests.

#### Cabin pressure test with engine running 47.

- (1) Blank off at the forward pressure bulkhead the relief pipeline from the cabin to the H2S pressurisation system regulator.
- (2) Ensure, that if the N.B.S. Calculator 3, Auto Pilot, Zero Reader and T4 bombsight are not fitted, the static lines from the nose section are blanked off. Also that the pitot-static system pipes to the port and starboard pilot's panels, navigator's panel, yaw damper monitor and auto mach unit, are connected to their respective components or blanked off.
- (3) An accurate boost gauge and a rate-of-climb indicator should be taken into the cabin and the initial pressure on the boost gauge noted.
- (4) Check that the engines are at ground idling r.p.m.

#### NOTE...

*It is advisable to have the 112V ground supply plugged in to maintain electrical supplies.*

- (5) Move the ground test levers of both pressure controllers to the ground test position.
- (6) Shut the ram air valve and lock the switch with the locking guard
- (7) Check that the canopy is locked, the main entrance door is closed and locked, pressure seals are inflated, and the clear vision windows are secured. Check also

that the signal pistol is in position and locked, and that the front pressure bulkhead door is secured.

- (8) Check that the anti-icing, bomb-bay heating and ventilated suit system switches are OFF.
- (9) Disconnect the unmotorised pressure controller from the combined valve unit. The pipe should be disconnected at a convenient position WITHIN the cabin and NOT blanked off.
- (10) Switch all ENGINE AIR switches to OPEN. During the test these should be tested individually to see if there is still a flow into the cabin.
- (11) Switch one CABIN AIR switch to OPEN.
- (12) Adjust engine r.p.m. to increase cabin pressure at a comfortable rate not exceeding 1,000 ft/min.
- (13) Check that the cabin pressure stabilises at 8.46-8.9 p.s.i. after making allowances for the initial reading on the boost gauge.
- (14) Switch the CABIN AIR and ENGINE AIR to SHUT and reduce engine r.p.m. to GROUND IDLING.
- (15) Make a leakage test if required (para. 51).
- (16) When the cabin pressure has fallen to atmospheric, reconnect the controller disconnected in item (9).
- (17) Disconnect the piping from the second controller as in item (9).
- (18) Switch the CABIN AIR switch selected in item (11) to CLOSE and the other switch to OPEN.

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- (19) Repeat items (12), (13) and (14). The cabin pressure this time should stabilise at 8.82-9.36 p.s.i. due to the higher setting of the unmotorised controller.
- (20) When the cabin pressure has fallen to atmospheric, inch the ram air valve fully OPEN.
- (21) Reconnect the disconnected controller and reset the ground test levers on both controllers to the flight position.
- ◀ (22) Reconnect, at the forward pressure bulkhead, the relief pipeline from the cabin to the H2S scanner pressurisation system regulator. ▶

During one of the pressure tests already described, while the pressure is above 8 p.s.i. and the engines are running, ensure that the temperature control valve and cold air unit function by selection of various temperatures on the temperature selector and also by means of manual selection of temperature.

## NOTE...

When Mod.193 is embodied, a three-in. dia. non-return valve (Part No.512330) is fitted on the cabin side of the ram air valve on the rear pressure bulkhead. Introduction of this modification permits the use of the ram air valve to depressurise the cabin after ground pressure tests, so that a rate of cabin pressure reduction higher than that obtainable by natural leakage may be employed. The non-return valve is designed so that the leakage rate when the cabin is pressurised and the ram air valve is opened fully, gives a safe rate of reduction.

Cabin pressure test with ground test rig 48. For this test one of the ground testing trolleys listed in Table 1, Sect.2, Chap.4, should be used.

- (1) Connect the testing trolley to the 1½ in. (pre.Mod.79) or 1.13/16 in. (post-mod 79) test connection on the rear pressure bulkhead.
- (2) Connect a manometer to the adapter adjacent to the test connection.
- (3) Blank off, at the forward pressure bulkhead, the relief pipeline from the cabin to the H2S scanner pressurisation system regulator.
- ◀ (4) Ensure that, if the N.B.S. calculator 3, auto pilot, zero reader and T4 bombsight are not fitted, the static pipes from the nose section are blanked off. Also that the pitot-static system pipes to the port and starboard pilot's panels, navigator's panel, yaw damper monitor and the auto mach unit are connected to their respective components or blanked off. ▶
- (5) Shut the ram air valve and lock the switch with the locking guard.
- (6) Operate the ground test levers of both pressure controllers to the ground test position.
- (7) Disconnect the unmotorised controller from the combined valve unit. The pipe should be disconnected at a convenient point WITHIN the pressure cabin and NOT blanked off.
- (8) Check that the canopy is locked, the clear vision windows are closed and secured, the signal pistol is in position and locked and that the front pressure bulkhead door is secured. Ensure that all personnel have left the cabin and close and secure the main entrance door. An indicator on the starboard side of the

nose wheel bay, aft of the front pressure bulkhead will show that the entrance door is closed and locked.

## NOTE...

The decompression switch on this panel is NOT to be used to decompress the cabin during pressure tests.

- (9) CHECK THAT THE RELIEF VALVE ON THE TESTING TROLLEY IS SET AT 10 P.S.I.
- (10) Start the testing trolley and set the controls to pressurise the cabin.
- (11) Check that the cabin pressure stabilises at 8.46-8.9 p.s.i.
- (12) Shut off the testing trolley.
- (13) Make a leakage test if required (para.51).
- (14) When the cabin pressure has fallen to atmospheric, enter the aircraft and reconnect the unmotorised pressure controller disconnected in item (7).
- (15) Disconnect the piping from the second controller as in item (7).
- (16) Repeat items (8) to (12). This time the cabin pressure should stabilise at 8.82-9.36 p.s.i. due to the higher setting of the unmotorised controller.
- (17) When the cabin pressure has fallen to atmospheric, open the entrance door, reconnect the motorised controller and remove the ground testing trolley and the manometer.
- (18) Reset the ground test levers on the pressure controllers to the flight position and switch the ram air valve to OPEN.

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- (19) Reconnect, at the forward pressure bulkhead, the relief pipeline from the cabin to the H2S scanner regulator.

#### Leak test of complete controller installation

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

- (1) Remove the filters from the cabin air inlet connections on the front face of each pressure controller.
- (2) Interconnect the two relay valve cabin air inlet connections with a piece of rubber tubing.
- (3) Blank off the static or low pressure connection from the relay valve at the vent located on the forward pressure bulkhead.
- (4) Disconnect and blank off the static pipelines to the ambient altitude switch.
- (5) Open the release valve manually or electrically.
- (6) Ensure the ground test levers are in the down or normal position.
- (7) 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 a pressure gauge between a stop cock and the connecting union. The stop cock should be as close to the controller inlet as possible.

- (8) Blank off the cabin air inlet connection on the unmotorised controller.
- (9) Apply air pressure slowly to 8 p.s.i., allow time for the pressure to stabilise and then close the supply stop cock.
- (10) Check the pressure drop over a period of two minutes. The pressure should not fall below 7 p.s.i.
- (11) Remove the blanks from the static vent of the motorised controller and ensure that the pressure falls rapidly to zero. Replace the blanks.
- (12) Apply air pressure slowly once again to 8 p.s.i. allow time for the pressure to stabilise and then close the supply stop cock.
- (13) Remove the blanks from the static vents of the unmotorised controller and ensure the pressure falls rapidly to zero.
- (14) Remove all test equipment and blanks and reset the air release valve.

#### Proving pressure test of cabin

50. A proving pressure test involving the pressurising of the cabin to 1.33 times normal operating pressure, i.e., 12 p.s.i., will only be required when major repairs to the primary structure of the cabin have been effected. It is emphasised that this is not a routine test and the comparatively high pressure used is considered necessary to prove the strength of the repairs. In addition to the general precautions detailed in para. 46. the following special precautions must be observed:-

AS THE PRESSURE INVOLVED CONSIDERABLY EXCEEDS NORMAL

OPERATING PRESSURE, A PROVING TEST SHOULD BE MADE IN THE OPEN. SHELTERS SHOULD BE PROVIDED FOR THE OBSERVERS AT A SAFE DISTANCE FROM THE AIRCRAFT AND THE APPROACH TO THE TEST AREA SHOULD BE POLICED TO PREVENT ANYONE APPROACHING THE VICINITY OF THE CABIN UNDER TEST. WHENEVER IT IS NECESSARY FOR OBSERVERS TO APPROACH THE CABIN, THE PRESSURE MUST FIRST BE REDUCED TO 9 P.S.I.

#### NOTE...

This test must be carried out on a fully equipped cabin.

The procedure for the test is as follows:-

- (1) Blank off, at the forward pressure bulkhead, the relief pipeline from the cabin to the H2S scanner pressurisation system regulator.
- (2) Disconnect the pipes between the discharge valves and the pressure controllers. These pipes should be disconnected at a convenient point WITHIN the pressure cabin and left loose. They should not be blanked in any way.
- (3) Remove the pressure relief valve (Part No.510660) from the front pressure bulkhead and fit the blanking plate (Part No.D10232) from the flight tool kit.
- (4) Check that the canopy is locked, the clear vision windows are closed and secured, and the front pressure bulkhead door is secure. Connect the inflatable seals to any convenient charging point so that they can be inflated from outside the aircraft by a foot pump. Shut the ram air valve and lock the switch with the locking guard. Ensure that the wheel brakes have been left on. Close the entrance door, check

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that it is locked, by the indicator in the nose-wheel bay, and ensure that all personnel have left the cabin.

- (5) Connect a manometer and rate-of-climb indicator to the connection on the rear pressure bulkhead.
- (6) Connect the testing trolley (Table 1, Sect.2, Chap.4) to the ground test point on the rear cabin bulkhead.
- (7) CHECK THAT THE RELIEF VALVE ON THE TESTING TROLLEY IS SET TO 12 P.S.I.
- (8) Inflate the cabin to 12 p.s.i. as read on the manometer and hold for 60 seconds.
- (9) It is convenient at this point to hold a leakage test; this can be done while pressure in the cabin is falling naturally (para.51).
- (10) After checking the leakage rate, discontinue the test, remove the test equipment and reconnect the discharge valve pipes.
- (11) Remove the blanking plate (Part No.D10232) and refit the pressure relief valve on the front pressure bulkhead.

#### Leakage test

51. The leakage allowance is based on a total flow 1.5 lb/min. at altitude when the cabin differential pressure is 9 p.s.i. The time intervals for pressure to fall from each pressure to the next must not be less than the figure quoted at the end of this paragraph. Each interval must be cleared separately and total times must not be considered. The first time interval from 9 to 8 p.s.i. will not be achieved when testing from the motorised pressure controller setting, which is less than 9 p.s.i. and the next interval should

then be considered as the first. When leakage testing the cabin, inflation should be by means of the test connection on the rear pressure bulkhead and the manometer connected to the adjacent test connection on this bulkhead.

#### NOTE...

*The 4.25 in. non-return valve should not be locked "closed" for the cabin leak rate check; it is to function as a non-return valve.*

A check should be made to ensure that the static vents for the pressure controllers are not blanked off.

| CABIN PRESSURE<br>p.s.i. gauge | TIME |      |
|--------------------------------|------|------|
|                                | min. | sec. |
| 9 - 8                          | -    | 43   |
| 8 - 7                          | 1    | 07   |
| 7 - 6                          | 1    | 27   |
| 6 - 5                          | 1    | 38   |
| 5 - 4                          | 1    | 50   |
| 4 - 3                          | 2    | 15   |
| 3 - 2                          | 2    | 49   |
| 2 - 1                          | 3    | 11   |

#### SETTING TEMPERATURE CONTROL VALVE AND LEVER ASSEMBLY

52. To set the temperature control valve and its associated lever assembly on the air conditioning unit 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 by taper pin.
- (3) Check the centralising switch for full movement is 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 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.

#### 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 and long distance tubes (Part No.A.S.2806/6/140) on the top bolts.*

- (6) Electrically operate the temperature control valve to the fully cold position, i.e., cool air inlet to the cold air unit.
- (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.

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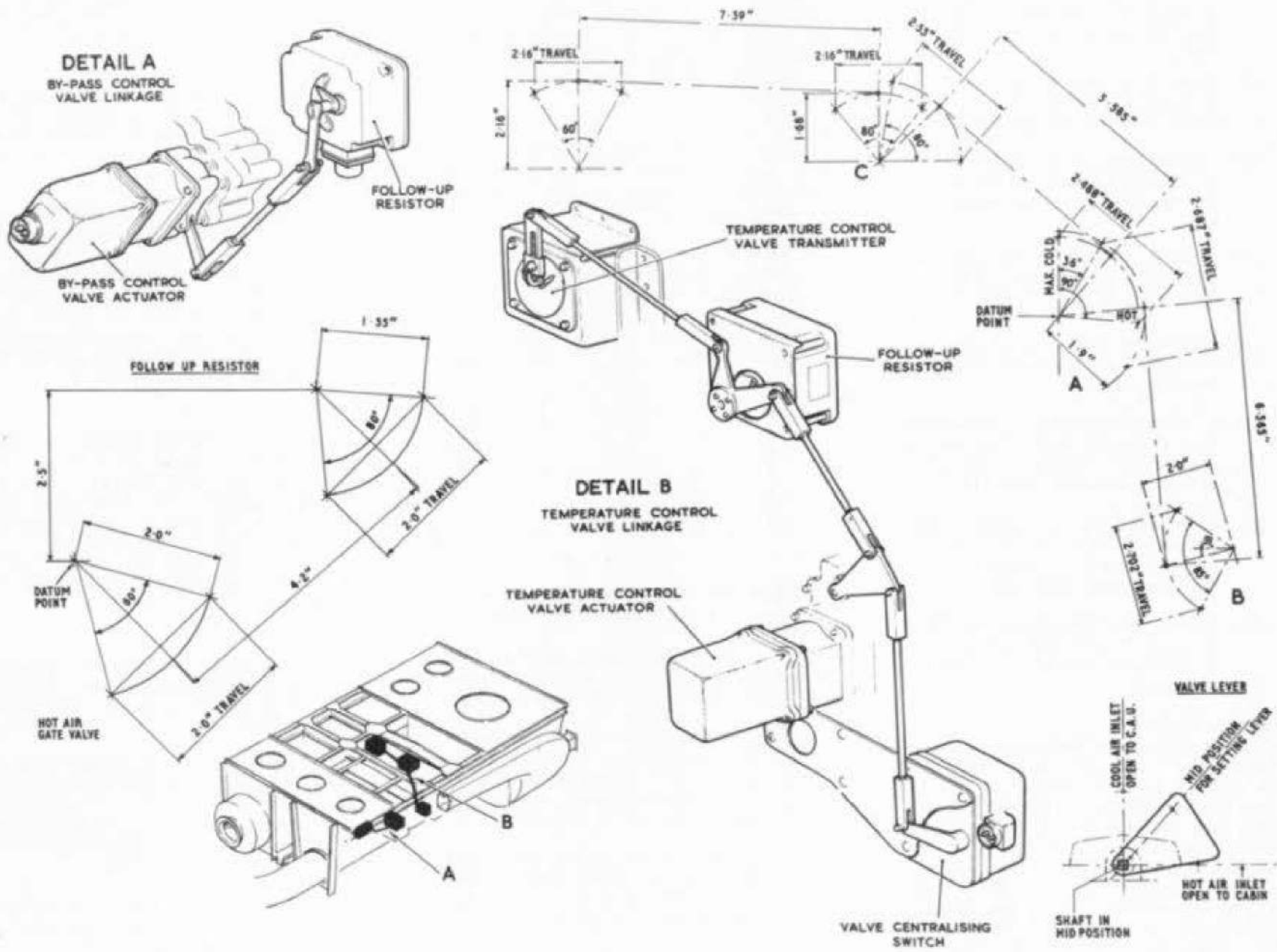


Fig.8 Linkage setting - conditioning unit  
**RESTRICTED**

- (9) Connect the linkage rod between the follow-up resistor and the Desynn transmitter. Adjust, if necessary, on the linkage rod and the Desynn lever to agree with the 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.

#### AIR CONDITIONING UNIT (fig.8)

54. The air conditioning equipment 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 heavy components | Ref.No.4GC/5425 |
| Handle winch 9 in.               | Ref.No.4GC/5426 |
| Extension tube 84 in.            | Ref.No.4GC/5452 |
| Top sheath (Type No.1) hook      | Ref.No.4GC/5700 |
| Ball-end cable winch             | Ref.No.4GC/5433 |

The procedure for removal is as follows:-

- (1) Disconnect two forward clamps on the Y-piece to the cabin, also disconnect the bonding.
- (2) Disconnect the three rear clamps from the ejector and mass flow inlet pipes, also disconnect the bonding.
- (3) Disconnect the cold air unit breather pipe at the lower rubber connection.

#### SETTING THE BY-PASS VALVE

53. To set the by-pass valve and its associated follow-up resistor on the air conditioning unit proceed as follows:-

- (1) Electrically operate the by-pass valve and check for full movement as indicated by 60 deg. movement of the linkage rod attachment lever. Set the valve in mid-travel position.
- (2) Check the follow-up resistor for

full movement as indicated by 80 deg. movement of the linkage rod attachment lever. 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.

#### REMOVAL AND ASSEMBLY

- (4) Remove the split pin, nut and bolt from the top and bottom of each nose-wheel door jack, and tie jacks back out of the way.
- (5) Having first ensured that the power supplies 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.
- (6) Remove the cooling air intake.
- (7) Remove the two knurled nuts which secure the unit and bring the unit off its locating pins.
- (8) Slide the unit on its fixed rail until it is positioned in the centre of the nose-wheel bay.
- (9) Hook the two Minilift hoists in position, pull the ball end on the hoist cable 18 in. out from both hoists and thread the cables over the fixed pulleys in the roof of the nose-wheel bay.
- (10) 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 slip from the sockets.

- (11) 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.*

- (12) Position a trolley, (Ref.No.26DC/95150) under the unit, swing the support arms, at the corners of the trolley, outward.
- (13) Lower the unit into the trolley, swing the support arms of the trolley inward and secure the crate with the quick-release pins supplied.
- (14) Remove the Minilift hoists.

55. The procedure for installation is the reverse of the foregoing. When installing, all pins, rollers and rails must be lubricated with grease XG-295.

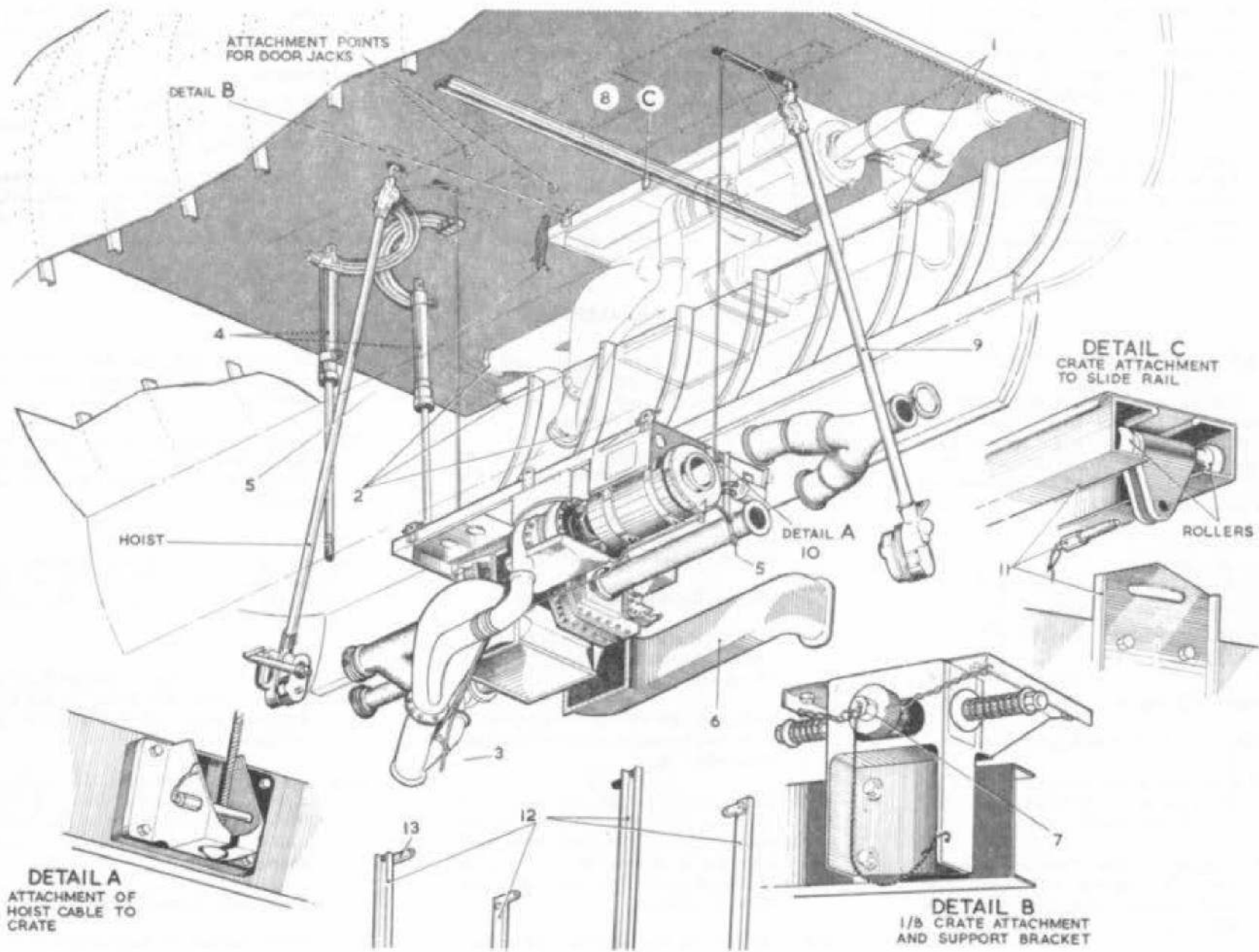


Fig. 9. Removal of air conditioning unit

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### DUCT JOINTS

55A. If a duct joint is broken for any reason, the seals making the joint must be replaced by new seals, i.e., seals must only be used once. When Mod.1965 is embodied, introducing asbestos seals at the duct joints, certain joints clamps, shown on fig.4 and 10 must be torque loaded to 5 lb.ft.

### BOMB HEATING SYSTEM

#### Introduction

56. Provision is made for heating the bomb bay as the temperature of the bomb bay must not fall below freezing point when certain stores are carried. The heating system, which may be operated under either automatic or manual control, utilises air tapped off the main engine compressors which is mixed with cold air

and circulated through the bomb bay. All controllers are electrically operated and reference must be made to Book 2, Sect.5, Chap.1 of this publication for electrical description and servicing information.

### CONTROLS AND INDICATORS

57. These are mounted on the starboard upper portion of the navigator/air bomber's panel and consist of:-

- (1) Main control switch - three positions. AUTO - OFF - MANUAL.
- (2) MANUAL HEAT CONTROL switch - loaded to the centre OFF position.
- (3) Setting potentiometer - enables the operator to set the datum temperature under automatic control.
- (4) Bomb bay temperature indicator.

### HOT AIR SYSTEM (fig.10)

58. Hot air, from the delivery side of the main engine compressors, is fed from the port and starboard pairs of engines to the hot air valves of the fin anti-icing and bomb bay heating systems. The flow of air into the bomb bay heating system is controlled by an electrically-operated hot air valve. A temperature controller opens or closes the valve, as necessary, to maintain a bomb bay temperature of 0 to 25 deg.C.

#### NOTE . . .

*On manual control the bomb bay temperature must be kept within the range -5 to +30 deg.C.*

### COLD AIR SYSTEM

59. Two flush-type air intakes back-to-

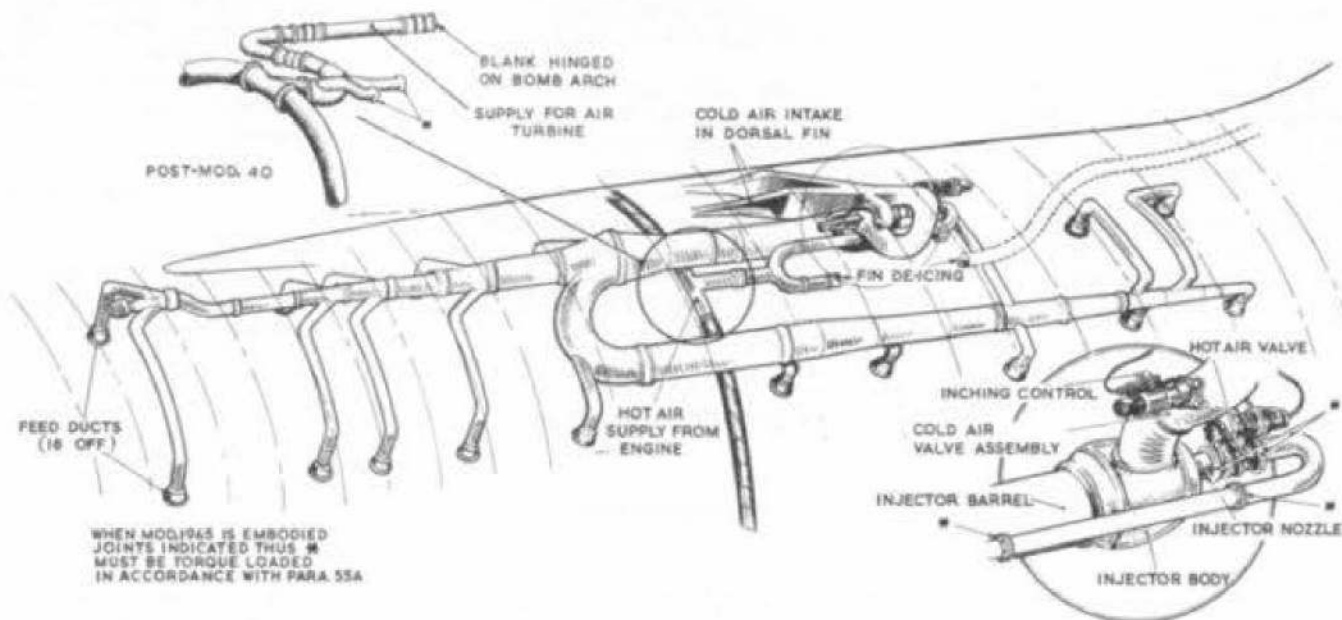


Fig. 10 Bomb bay heating  
(◀ Mod.1965 ▶)

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back in the dorsal fin, are connected to an injector through the cold air valve. The cold air valve is controlled by an inching control which opens or closes the valve to maintain a heating air temperature at the injector outlet of 100 deg.C.

#### INJECTOR

60. Hot air from the engine compressors passes through the hot air control valve to the nozzle of the injector. The air leaves the nozzle at considerable velocity and passes down the mixing tube, mixing with and imparting some of its velocity to the cold air which enters the tube around the nozzle. At the far end of the tube complete mixing has taken place, and the final temperature depends on the proportion and initial temperature of the hot air and the cold air.

#### HEATING AIR DUCTING

61. The heating air from the injector passes forward and aft along the bomb bay in two main distribution ducts which pass through the bomb arches, leaving the bay unobstructed. Feed ducts, from the main distribution ducts, supply heating air to eighteen outlet points situated in pairs along the length of the bay. The air finally passes to atmosphere through the exit louvre fitted in the port inner bomb bay door.

#### OPERATION

##### Automatic

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

- (1) Ensure that the ENGINE AIR switches are open (pressurisation panel).
- (2) Place the main control switch to AUTO.
- (3) When the bomb bay temperature has stabilised, operate the setting potentiometer as required.

63. 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 10 seconds the hot air valve is placed under the control of the temperature controller.
- (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 of 0-25 deg.C., and the cold air valve opens and closes to maintain a heating air temperature of 100 deg.C.

#### WINDSCREEN DEMISTING

##### DESCRIPTION

internal misting of the three centre sandwich type panels and a thermal system which uses heated cabin air directed, as required, on to the cabin

##### Manual

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

- (1) Check that the ENGINE AIR switches are OPEN (pressurisation panel).
- (2) Place the main control switch to MANUAL. The cold air valve opens fully and a positive supply is applied to the MANUAL HEAT CONTROL switch.
- (3) Operate the MANUAL HEAT CONTROL switch to INC. or DEC. to obtain the required bomb bay temperature within the limitations of -5 to +30 deg.C. The operation controls the hot air valve direct.

##### OVERHEAT

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

##### SWITCHING OFF

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

##### Introduction

67. The pilots' windscreen is provided with two systems to prevent misting. A silica-gel air-drying system to prevent

side of the five windscreen panels. Electrical details of the system are given in Vol.1, Book 2, Sect.5 of this publication.

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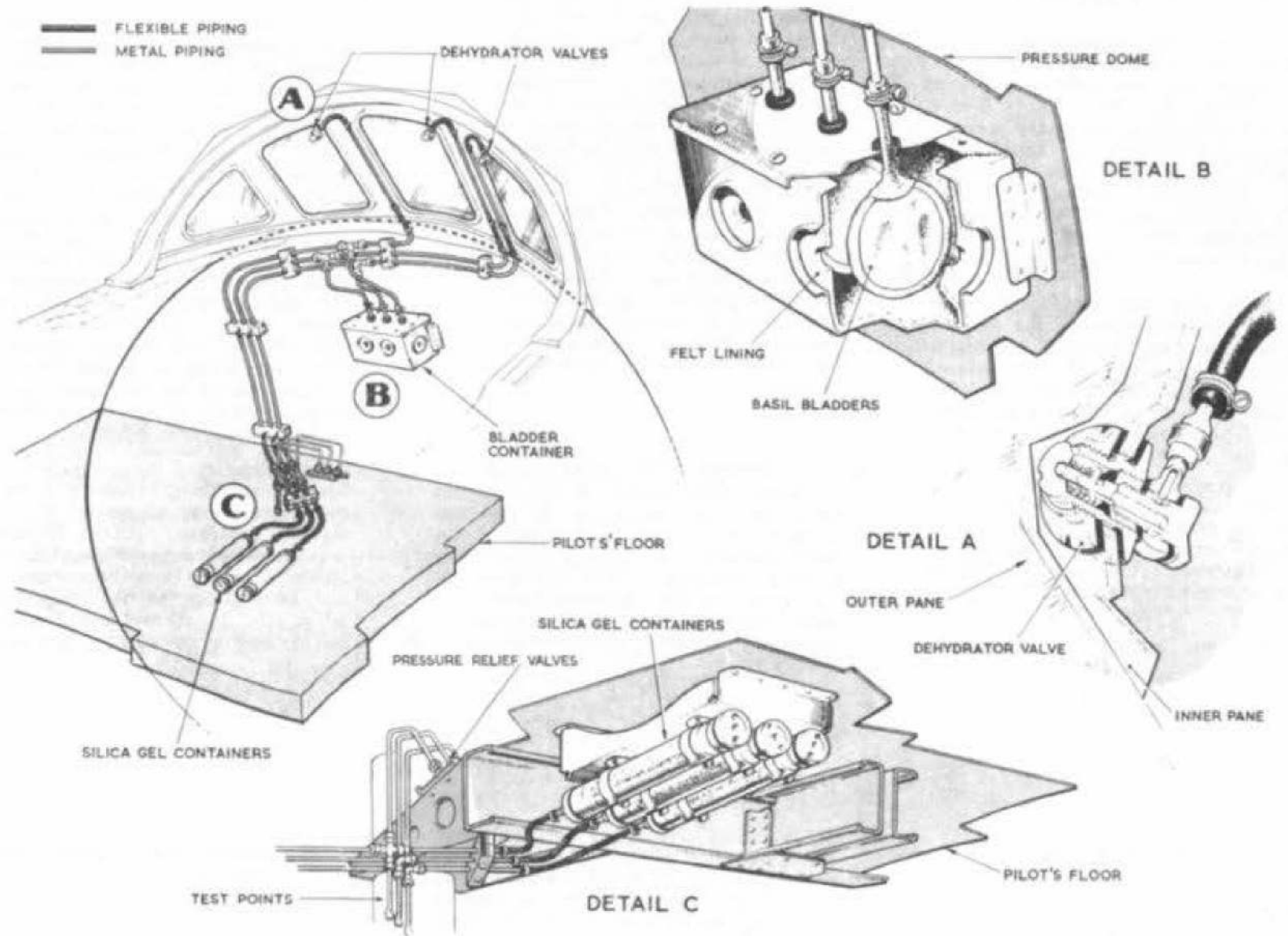


Fig. 11. Windscreen demisting - silica gel system  
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### SILICA GEL SYSTEM (fig.11)

68. Fitted in the upper portion and on the inner side of the centre three windscreen panels is a self-sealing dehydrator valve, Vickers Part No.A1971. These valves effectively seal the space between the windows until they are connected to the pipes of the system by dehydrator valve connections, Vickers Part No. A1985, which maintain the valves in the open position thus ensuring that only dried air is admitted to the interspace.

69. Pipes from each valve pass downward on the cabin side of the forward pressure dome to air-drying cartridges mounted at the forward end of the underside of the pilots' floor, on the port side. The connections at each end of the pipes are made with short lengths of flexible tubing.

70. The air-drying cartridges, Part No. A5500, are fitted with silica gel as an air-drying medium. The silica gel is blue when fresh, and slowly changes to pink as it absorbs moisture.

71. As the system is completely

contained within the pressure cabin, it follows that the air in the windscreen interspace is at the same pressure as the cabin air at all times. Should the cabin be depressurised in an emergency, it is necessary that the pressure in the windscreen interspace be reduced at approximately the same rate as the cabin pressure, in order to avoid possible damage to the screen through differential pressure. To obtain this condition three small basil bladders are connected to the system, one to each pipe, by short branch pipes. These bladders permit rapid expansion of the air and therefore rapid reduction of the pressure in the windscreen and pipes. A light-alloy box on the rear side of the forward pressure dome houses the three bladders.

72. Pressure-relief valves mounted on the pilots' floor forward of the silica gel containers are connected to the top connections of cross pieces fitted in the pipes connecting the silica gel containers to the windscreens. These valves relieve the momentary high differential pressures which inflate the basil bladders during an emergency or inadvertent decompression.

### THERMAL SYSTEM (fig.12)

73. Control of the heating supply for the windscreen is by a two-position switch marked ON-OFF, which is located on the anti-icing panel (pre Mod.38) or the flight refuelling panel (post Mod.38) on the starboard console. When the switch is moved to the ON position, current is supplied to start a motor-driven blower, which is mounted below the pilots' floor on the starboard side. Air is drawn in by the blower and passed through ducting on its outlet side to a 1 kW. heating unit. From the heater the air continues along the ducting which passes through the pilots' floor. Just above the floor the duct divides and the air passes along these twin ducts to outlets fitted on the cockpit side of the windscreen so that an adequate supply of warm air is directed on to the panels.

#### Overheating

74. Should the temperature of the air in the ducting rise above 80 deg.C., two thermal switches, located in the duct just above the pilots' floor, interrupt the electrical supply to the heater unit. When the temperature in the duct falls to 60 deg.C., the thermal switches 'remake' and the heater comes into action again.

### SERVICING

- (1) Before removing an affected cartridge, clip the flexible pipe cartridge to the windscreen pipe. This must be done to prevent ingress of moist air to the windscreen interspace.
- (2) Disconnect the cartridge from the flexible tube.

- (3) Remove the cartridge from the mounting.
- (4) Fit a new cartridge.
- (5) Reconnect the flexible tube and remove the clip.

### SILICA GEL SYSTEM

#### Air driers

75. Air drying cartridges must be replaced when the silica gel contents have changed colour from blue to pink. To do this proceed as follows:-

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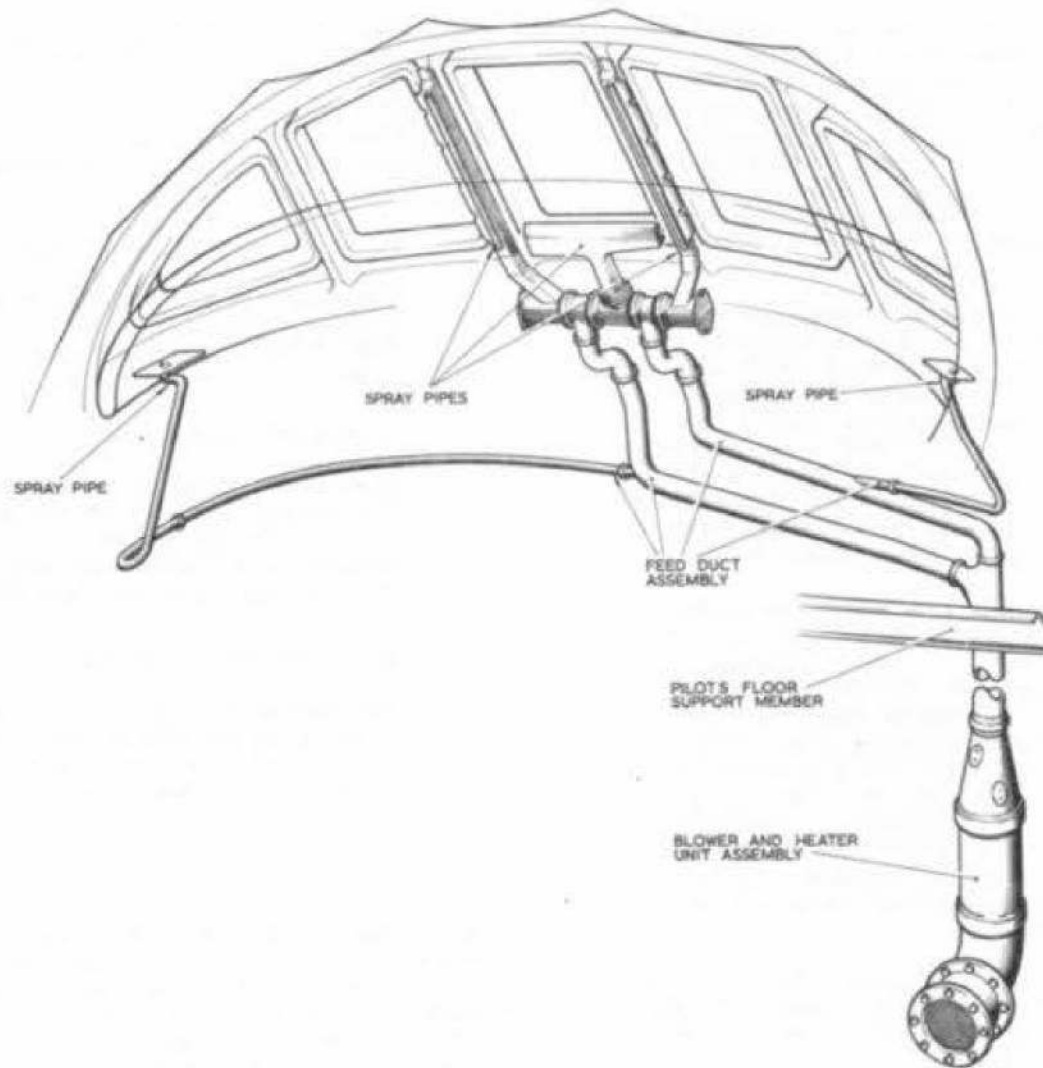


Fig.12. Windscreen de-misting - thermal system

**System test**

76. The pipes of the system must be pressure tested at suitable intervals as specified in Vol.4 of this publication, or when any pipes have been changed. The pressure testing must be carried out using an indicator vacuum Mk.2, (Ref.No.6C/526), with the indicator reversed and the U-tube emptied of mercury and filled with water. To pressure test the system proceed as follows:-

- (1) Disconnect the pipes from the relief valve and the silica gel cartridge. Clip or blank off the open pipes.
- (2) Connect a length of light-alloy pipe to the test point and connect the water manometer to the light-alloy pipe by a length of rubber tubing.
- (3) Apply a pressure of 13.8 in. W.G. and check the system for leaks. Any drop in pressure must not exceed 0.55 in. W.G. over a period of 10 min.
- (4) Release the pressure and connect the pipe to the pressure-relief valve.
- (5) Apply a pressure to the system and check that the pressure-relief valve operates at 1.373 to 3.78 in. W.G.
- (6) Release the pressure and apply suction not exceeding -13.8 in. W.G., check that the pressure relief valve does not inward vent.
- (7) Connect the pipe to the silica gel cartridge, remove the test equipment, fit the blanking tube to the test connection and lock all unions as necessary.

**WARNING . . .**

The windscreen interspace must not be subjected to a pressure greater than 13.8 in. W.G.

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## AIR VENTILATED SUIT SYSTEM (MOD.177)

### DESCRIPTION

#### Introduction

77. Mod.117 introduces a system to supply a flow of dry air to the individual crew stations at the required temperature and flow rate. Engine compressor air used in the system is passed through a series of components which form the air conditioning unit. The conditioned air temperature and flow rate is controlled at the suit inlets, by manually operated controls in the supply line adjacent to each crew station. All heaters, temperature controls, and the main shut off valve are electrically operated; reference should be made to A.P. 4505A & C, Vol.1, Book 2, Sect.5, Chap.1 for electrical description and servicing information.

#### General

78. Charge air at high pressure and temperature is tapped from the flood flow supply duct upstream from the flood flow valve, and is passed through an electrically-operated shut-off valve to a two-way duct. One airstream is ducted to a temperature control valve to be directed as required to the heat exchanger and water extractor. The other airstream enters a primary cooler for conditioning.

79. From the cooler, pressure air is passed through a brake turbine to a water extractor, the dry air then being directed to a heat exchanger. Pressure air is tapped from the duct between the primary cooler and the cold air unit and carried through a duct incorporating a flow augmentor to be introduced into the main flow between the water extractor and the heat exchanger. Conditioned air is then passed through a filter to a non-return valve in the rear pressure bulkhead. A ground conditioning connection is tapped into the duct between the heat exchanger and the water extractor.

80. Conditioned air is passed from the non-return valve to a manifold for distribution through separate feed lines to the suits at the crew stations. Incorporated in the manifold is a sensing element and an overheat switch to govern the temperature of supply air to the feed lines. Pressure is maintained at a suitable level in the manifold by a pressure controller and a relief valve.

81. Inlet air temperature to individual suits can be varied by manually-controlled heaters fitted in each supply line. Rate of flow is adjusted to individual needs by a manually-operated control valve incorporated in the feed lines and fitted, or adjacent, to the seats at crew stations. Exhaust air from the suits is absorbed by and expelled with the cabin pressurisation air through the main cabin discharge valve.

82. 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, is achieved through the ground conditioning connection in the port wing root underskin. Ground testing of components and ducting is achieved through a pressure test connection in the duct between the shut-off valve and the primary cooler.

83. Table 2 gives a list of components used in the system together with their Air Publication reference and location in the aircraft.

### CONTROLS

84. The main on-off control valve in the supply duct is operated either by a manually operated switch mounted in the aft position

of the starboard console, or by a fully automatic overheat switch incorporated in the manifold.

85. Rate of flow and temperature selector controls are provided at crew stations as follows:-

First and second pilots' stations.

Temperature selector switch is fitted to the starboard side of each seat. Rate of flow control valve is fitted to the port side of each seat.

Air bomber's station.

Temperature selector switch and flow control valve are on the port side of the air bomber's station mounted on the radar crate support structure adjacent to the pilots' floor support.

Navigators' and A.E.O. stations

Temperature selector switches are fitted on the port side of each seat. Flow control valves are fitted to the starboard side of each seat.

### AIR SUPPLY

86. From the tapping in the flood flow supply duct a 1.5 in. dia. stainless steel duct carries the air through the shut-off valve to the conditioning unit. A stream of hot compressor air tapped from the main supply, prior to the primary cooler, is carried to the overheat control valve by 0.75 in. dia. stainless steel pipes. Conditioned air is carried from the heat exchanger to the non-return valve in the rear pressure bulkhead through a 2 in. dia. stainless steel duct.

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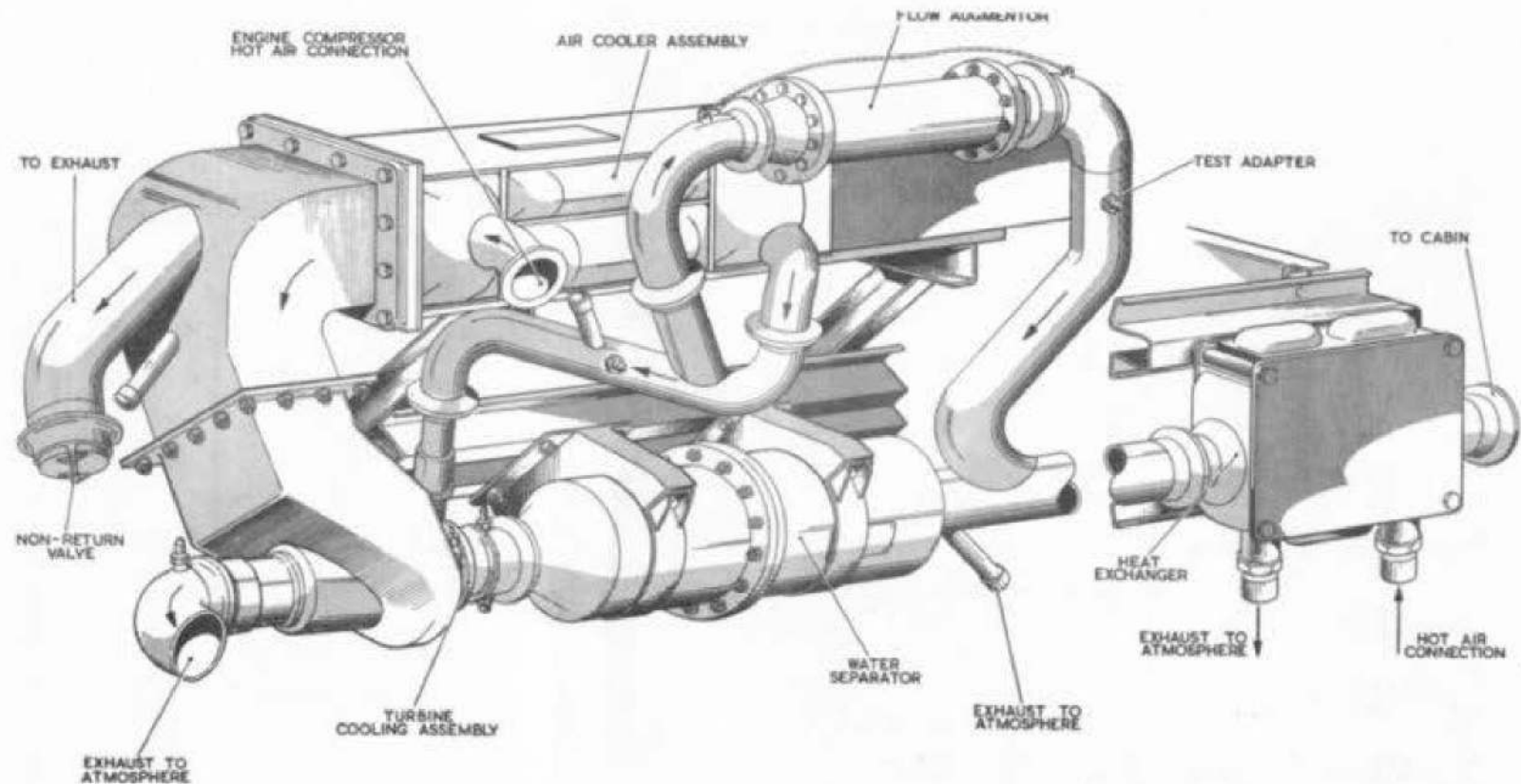


Fig.13. Air conditioning unit - suit ventilation

**AIR CONDITIONING**

87. The air conditioning system provides a supply of dry air at moderate temperatures throughout the varying conditions encountered in flight. Components which make up the system are mounted on the port side of the nose-wheel bay, aft and to port of the main cabin conditioning unit, and are as follows:-

- (1) Air-to-air primary cooler.

- (2) A cold air unit.
- (3) A flow augmentor.
- (4) A water extractor.
- (5) Heat exchanger.
- (6) Overheat control valve.

**Air-to-air primary cooler**

88. 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 cooler exhaust.

**Cold air unit**

89. The cold air unit consists of a directly coupled inward radial flow turbine and an axial flow fan. Suit ventilating system air enters the turbine inlet and

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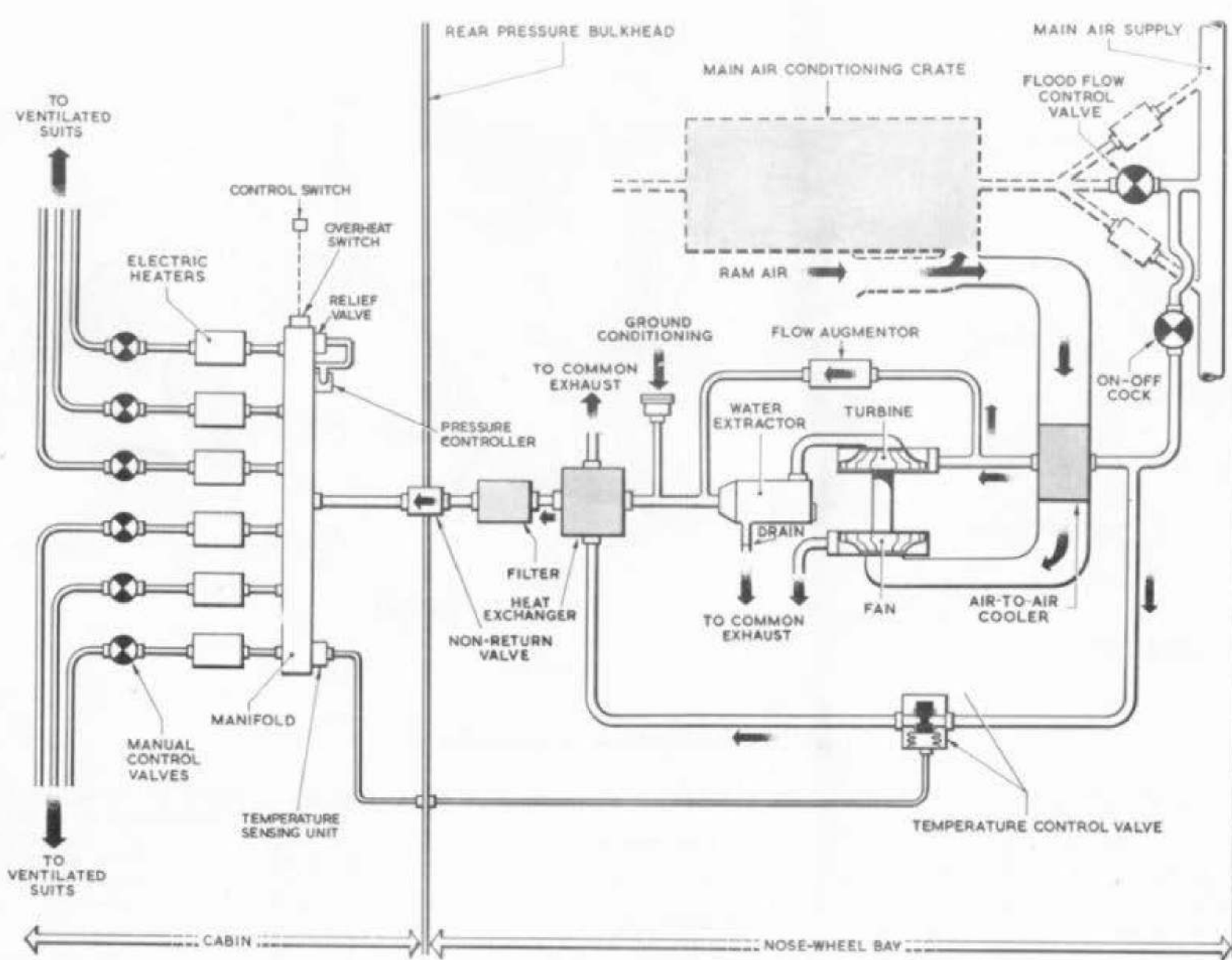


Fig. 14. Air ventilated suit system diagram

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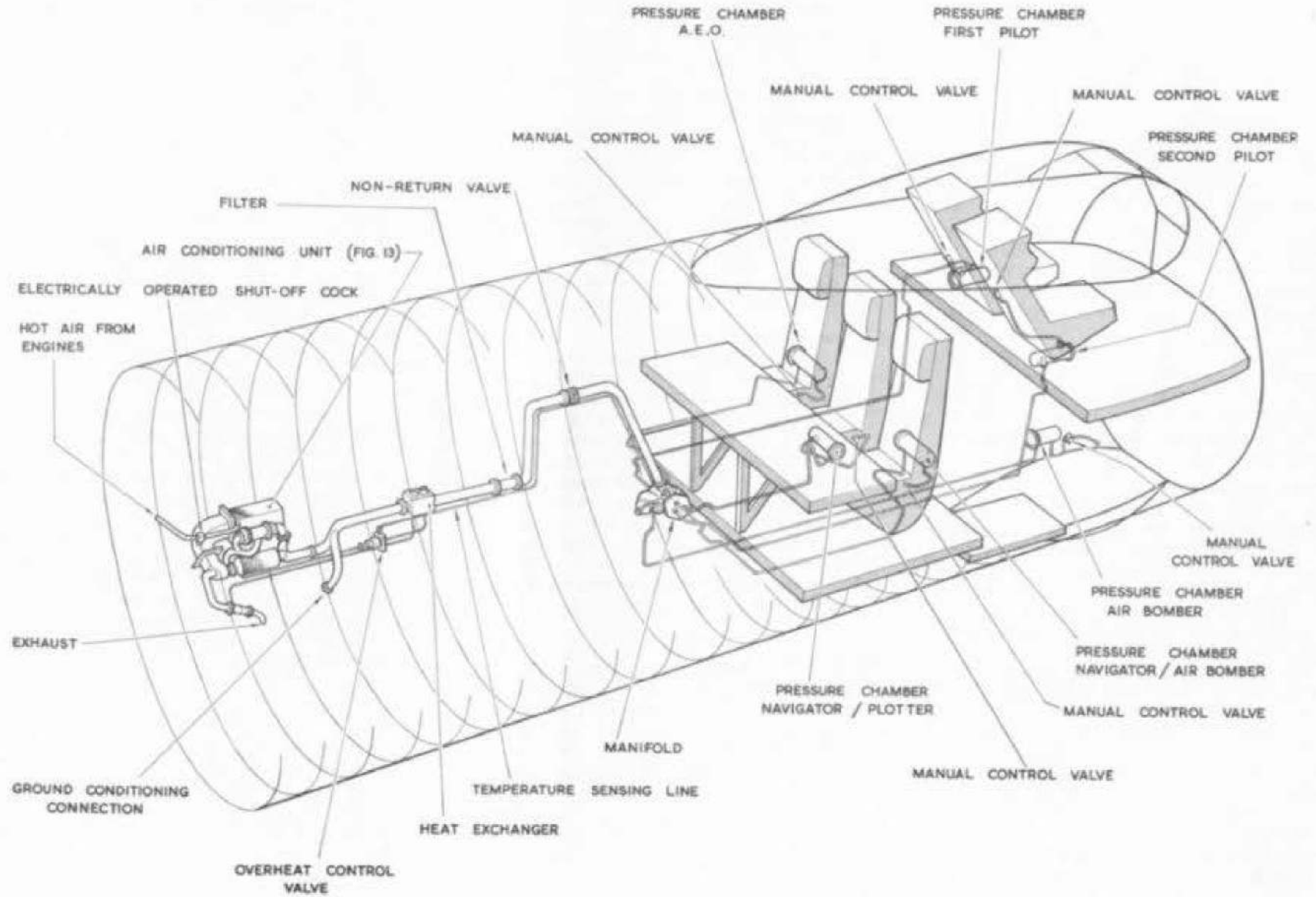


Fig. 15. Air ventilated suit system installation.

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loses a further quantity of heat in the form of energy required to drive the turbine. As a result the axial flow fan accelerates the flow of cooling air from the air-to-air primary cooler exhaust thereby increasing cooling efficiency.

#### Flow augmentor

90. The flow augmentor is fitted in the system to ensure an adequate supply of air to the ventilated suits when there is an insufficient supply of air from the cold air unit. This condition is liable to occur when the aircraft is flying at altitude or when taxiing. Under normal circumstances the pressure of air from the primary cooler is sufficient to overcome the spring loading of the valve in the flow augmentor and close it. As the supply pressure drops the spring loading opens the valve allowing the air to flow through the duct bypassing the cold air unit and water extractor to enter the main system downstream from the water extractor.

#### Water extractor

91. Since the efficient operation of the ventilated suits depends on an air supply of low humidity and containing no free water, a water extractor is fitted in the system. The water extractor consists of a coalescer, a relief valve and a collector. Air passes into the extractor and diffuses over the coalescer pack. Since direct passage of the air through the extractor is prevented by the relief valve diaphragm, the air percolates through the coalescer pack, where the minute water droplets form into large drops. These large drops are carried by the air flow into the collector where they adhere to the collector tubes. The collected moisture runs down the collector tubes to the outer casing from where it is drained by a small pipe to the cooler exhaust duct. To prevent an ex-

cessive loss of system air, a restrictor is fitted in the drain outlet.

#### Heat exchanger

92. The heat exchanger, downstream of the water extractor, is installed to raise the temperature of the dry charge air, as required, before delivery to the supply system. The heat exchanger is arranged for cross flow operation with one pass of 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 controlled by the overheat valve (para.93). The used heating airflow is piped to the air-to-air cooler exhaust and discharged to atmosphere.

#### Overheat control valve

93. The overheat control valve is bellows operated and responds to the pressure reaction of the temperature sensing unit in the system manifold. When the temperature in the manifold rises, a corresponding rise of pressure in the sensing unit is transferred to the pressure sensitive mechanism in the overheat control valve; this in turn closes the valve and restricts or stops the flow of hot air to the heat exchanger. When the temperature drops in the manifold the reverse action takes place and the flow of hot air increases.

#### MANIFOLD

94. The manifold assembly, situated in the pressure cabin to the rear of the crew's floor, consists of; a cylindrical casing provided with a conditioned air inlet and six sonic venturis, pressure relief valve, a pressure controller, a temperature sensing unit and an overheat switch. It serves as a distribution point for the supply of conditioned air to individual crew stations, the supply pipes being connected to the sonic venturis.

#### SERVICING

as directed in Vol.4 of this publication. Reference must be made to the relevant publication listed in Table 2 of this chap-

95. During normal operation the flow of conditioned air to the manifold is in excess of the demand, the pressure in the manifold being controlled at 18 p.s.i. by the action of the pressure controller in conjunction with the relief valve. At 18 p.s.i. the flow to the crew's stations is controlled at 1 lb. per minute by the pressure ratios across the sonic venturis.

96. Temperature of the conditioned air in the manifold is controlled at 15 deg.C., by the temperature sensing unit in conjunction with the overheat control valve (para. 93) to which it is connected by a small bore pipe. A bi-metal strip which, with variations in temperature, opens or closes the temperature sensing unit orifice controls the pressure to the overheat control valve bellows, thus controlling the flow of hot air to the heat exchanger.

97. The overheat switch, located on the manifold casing directly below the temperature sensing unit, 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 ventilated suit system shut-off cock. Should the manifold temperature rise to 70 deg.C the thermostat contacts "make" closing the shut-off cock and rendering the complete system inoperative. The contacts "break" when the temperature drops to 60 deg.C.

#### PRESSURE CHAMBERS

98. Pressure chambers incorporating electric heaters are fitted at each crew members station. The heaters are individually controlled by a temperature selector at each crew station. Reference should be made to Vol.1, Book 2 of this publication for details of this component.

ter for the servicing and testing of individual components and to the following paragraphs for the testing of the system.

#### General

99. The air ventilated suit system and its components must be serviced and tested

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## SYSTEM FUNCTIONING TEST

100. A functioning test of the system with an engine running may be carried out as follows:-

- ◀ (1) Ensure that the relevant ENGINE AIR switch is open and 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 wing and fin DE-ICING switches are OFF (anti-icing control panel). ▶
- (4) Ensure that the lever on the non-return valve on the rear pressure bulkhead is selected and wire-locked in the flight position.
- (5) Check that all the manual flow control valves in the cabin are OPEN.
- (6) With one engine running at idling revs., select the ventilated suit system control switch to the ON position. Check that a flow of air issues from the delivery hose at each crew position.
- (7) Increase the engine revs. to cruise and check that the temperature of the air decreases and then remains fairly constant.
- (8) Close the manual flow control valves, leaving one open, check that during this operation the relief valve on the manifold blows off and that the temperature of the air issuing from the one hose remains constant.
- (9) Reduce engine revs. to idling, open all manual flow control valves.
- (10) Switch on the electric heaters at

each crew station and check that the temperature of the delivery air increases. Switch electric heaters off.

## DUCT PRESSURE AND LEAKAGE TESTS

## ◀ General

101. The air ventilated suit system is divided into two sections, the high and low pressure sections. The high pressure section extends from the main shut-off cock to the cold air turbine and flow augmentor. The low pressure section extends from the cold air turbine and flow augmentor to the rear pressure bulkhead. During the leakage testing it must be noted, where possible, whether leaks occur at duct joints or from the air conditioning components. Duct joints must not leak noticeably. Leaks from the air-to-air cooler, cold air unit and flow augmentor are more serious than leaks from the water extractor, since the working pressure of the latter is far below the test pressure. ▶

## High pressure ducting leak test

102. To leak test the high pressure ducting of the system proceed as follows:-

- (1) Ensure that the shut-off valve is closed.
- (2) Disconnect the duct from the entry to the cold air unit and blank off the duct.
- (3) Disconnect the duct downstream of the flow augmentor and blank off the flow augmentor.
- ◀ (4) Disconnect the 0.75in. dia. pipe from the heat exchanger side of the overheat control valve and fit a blank on the valve. ▶
- (5) Connect the pressure test unit to the test point.
- (6) Raise the pressure in the ducts to 190 p.s.i. and maintain for 60 seconds.

- (7) It is convenient to carry out a duct leakage test at this stage as duct pressure falls. The time for pressure to fall from 90 to 60 p.s.i. should be not less than 40 seconds.

- (8) Release pressure completely and reconnect all ducts. Disconnect pressure test rig.

## Low pressure ducting leak test

103. To leak test the low pressure ducting of the system proceed as follows:-

- (1) Disconnect the duct upstream of the flow augmentor and blank the flow augmentor.
- (2) Ensure that the lever on the non-return valve on the rear pressure bulkhead is in the flight position.
- (3) Disconnect the six supply pipes from the manifold in the cabin and blank off the manifold.
- (4) Disconnect the water extractor from the turbine outlet and blank off the extractor. Connect the pressure test unit to the water extractor drain.
- (5) Disconnect the inlet pipe from the relief valve on the manifold and apply a pressure of 30 p.s.i. to the relief valve.

## NOTE...

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

- (6) Raise the pressure in the ducts to 26 p.s.i. and hold for 60 seconds.
- (7) Release pressure in the ducts.
- (8) Reduce pressure in the diaphragm chamber of the relief valve to 15 p.s.i.
- (9) Raise the pressure in the ducts to 15 p.s.i. and allow it to fall. The time for the pressure to drop from

10-5 p.s.i. should be not less than 35 seconds.

- (10) Connect the air supply lines to the manifold and ensure that all the manual flow control valves are closed.
- (11) Raise the pressure to 5 p.s.i. and hold for 60 seconds.

(12) It is convenient to carry out a leak test as the pressure is falling. The time for the pressure to fall from 5-1 p.s.i. should be not less than 20 seconds.

(13) Release the pressure on the manifold relief valve and reconnect the

supply line to the relief valve.

- (14) Raise the pressure in the ducts to 3.3 p.s.i. and check that the manifold relief valve blows off.
- (15) Release the pressure in the ducts. Reconnect all ducts. Remove test equipment.

TABLE 2  
Air ventilated unit system

| Component                                | Part No.   | Ref. No.  | No. off | A.P. Ref. | Location  |
|--|------------|-----------|---------|-----------|---|
| Shut-off valve                           | 512760     | 27KD/985  | 1       | 4340      | In supply duct before cooler  |
| Air-to-air cooler                        | TD/43/1A   | -         | 1       | 4340      | Port side, aft, nose-wheel bay  |
| Cold Air Unit                            | 10-201270  | 27UA/780  | 1       | 4340      | Port side, aft, nose-wheel bay  |
| Water extractor                          | 518490     | 27UA/1730 | 1       | 4340      | Immediately forward of cold air unit  |
| Non-return valve, 2.5 in.                | 512510     | 27KD/982  | 1       | 4340      | Exhaust duct from cooler  |
| Flow augmentor                           | 515950     | 27KD/988  | 1       | 4340      | Cold air unit by-pass duct  |
| Temperature control valve                | 513010     | 27KD/976  | 1       | 1275A     | In cooler by-pass pipe  |
| Heat exchanger                           | TD/721/2A  | -         | 1       | -         | In delivery duct to cabin   |
| Ground conditioning connection           | 504300     | -         | 1       | 4340      | Inboard, forward underside, port mainplane  |
| Filter                                   | 512930     | 27KD/977  | 1       | 4340      | Supply duct to cabin  |
| Non-return valve, 2 in.                  | 512990     | -         | 1       | 4340      | Rear pressure bulkhead  |
| Manifold                                 | 513090     | 27KD/972  | 1       | 1275A     | Below navigators' table   |
| Pressure chamber - pilots'               | 72/Z9148   | -         | 2       | -         | First pilot - on pilots' floor outboard of seat<br>Second pilot - below pilots' floor on supporting structure     |
| Pressure chamber - navigators and A.E.O. | 70/Z9148   | -         | 3       | -         | On crew seats   |
| Pressure chamber - air bomber            | 71/Z9148   | -         | 1       | -         | Pilots' floor support structure   |
| Flow control valves                      | 513390     | 27KD/989  | 3       | 4340      | Pilots' and air bomber's supply lines   |
| Flow control valves                      | F.C.2      | -         | 3       | 4303B     | At crew positions in supply lines   |
| Temperature selector                     | -          | 5C/2569   | 6       | -         | Pilots' - starboard side of seats<br>Crew - port side of seats<br>Air bomber - port radar crate support structure |
| Quick-release socket                     | A.C.O.6580 | -         | 2       | -         | First and second pilots' seats  |



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