Chapter 8 AIR CONDITIONING SYSTEM

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DESCRIPTION AND OPERATION

General

1. For high altitude flying, the cabin may be pressurised with air from the engine diffuser casing. The supply and temperature of the air is regulated by a control valve assembly, which is secured to the port engine mounting and operated from a hand wheel on the port side of the cabin. The cabin pressure is controlled by a Normalair pressure control valve unit mounted on the starboard front face of bulkhead No. 1. The hatch seal, which consists of an inflatable rubber tube, is automatically inflated by air pressure from the pneumatic system when the hatch handle is moved to the *locked* position (*Sect.* 3, *Chap.* 7).

Air supply (*fig.* 1 *to* 4)

2. The cabin pressurising air supply is ducted from a tapping on the port front face of the engine diffuser casing to the control valve assembly; this assembly houses two spring-loaded poppet valves and a shaft bearing two cams. Rotation of the hand wheel in the cabin causes the valves to be opened or closed, via a Teleflex control system, so allowing them to perform the function of a combined ON/OFF valve and temperature regulator. Operation of the poppet valves admits to the cabin hot air direct from the diffuser casing, cold air via a cooling system in the port main plane or any desired mixture of the two. Hot air passes into a perforated cabin ducting, which serves as a de-misting system for the windscreen and canopy; ◄ a cold air unit supplies air through a separate duct on the port side of the cabin. ►

Air temperature control

3. The hand wheel, which controls the temperature and rate of the air supply into the cabin, has five settings (reading clockwise around the wheel periphery), i.e., OFF, COLD, MIX, HOT and REDUCE; a lug formed on one of the wheel spokes contacts a stop on the side of the control box casing to indicate each full travel position. The REDUCE setting allows the

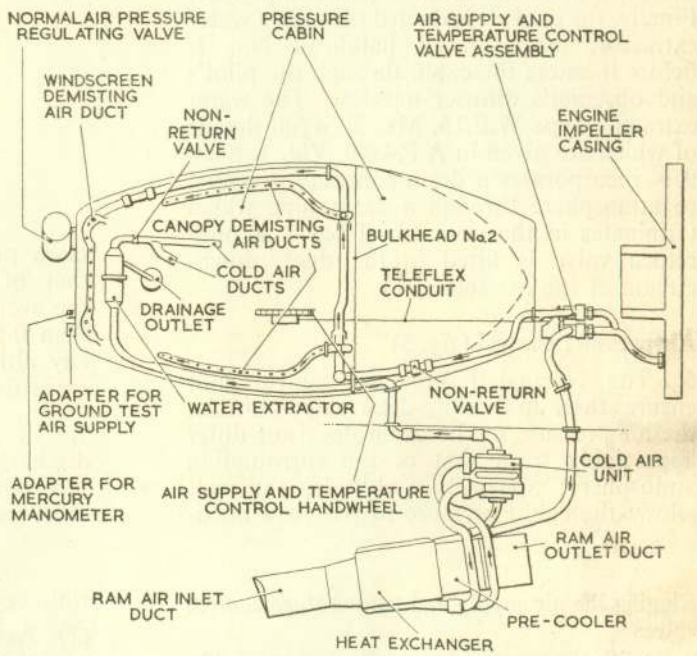


Fig. 1. Air conditioning system diagram

pilot a quicker selection of cooler air than that obtained by turning the control wheel to COLD.

Refrigeration (*fig.* 2 *and* 3)

4. The air cooling system in the inboard section of the port wing comprises a heat exchanger, a pre-cooler and a mechanical cold air unit, type A.C.R.E.9; full details of these components will be found in A.P.4340, Vol. 1. ► ◄

5. The hot air supply from the engine diffuser casing is initially ducted to the pre-cooler where it is partially cooled. From thence it passes to the cold air unit compressor where the temperature of the air is raised again as a result of its compression. On leaving the cold air unit, the air is cooled once more by passing through the heat exchanger; the effect of which is enhanced by the previous air temperature increase. From the heat exchanger, the air flows to the turbine impeller of the cold air unit where its heat and pressure is converted to kinetic energy to drive the cold air unit compressor. Finally, the cool air is ducted through a water extractor, fitted aft of bulkhead No. 1, before it enters the cabin through the pilot's and observer's diffuser nozzles. The water extractor, type W.E.15, Mk. 3, ◄ full details of which are given in A.P.4340, Vol. 1, Sect. 9, ► incorporates a drain connection vented to atmosphere through a drain pipe which terminates in the nose wheel bay. A non-return valve is fitted in the duct, downstream of the extractor.

Air pressure control (*fig.* 5)

6. The Normalair pressure control unit ensures that, up to a pre-determined altitude, the air pressure in the cabin does not differ appreciably from that of the surrounding atmosphere; above this altitude, the unit allows the cabin pressure to rise to a maximum pressure differential of 3 p.s.i. above that of the surrounding atmosphere. In the event of the cabin pressure falling more than 0·5 p.s.i. below the normal setting for any altitude, the Normalair unit will cause a warning lamp in the cabin to be illuminated.

7. In addition to a pressure regulating discharge diaphragm, the Normalair unit incorporates an outward and an inward relief valve. The outward relief valve acts as a safety valve in the event of the regulating diaphragm failing to operate at the correct pressure and the inward relief valve admits atmospheric pressure into the cabin under conditions of rapid descent, to supplement the air supply from the cabin air system, which would otherwise be inadequate for the maintenance of the required cabin pressure conditions. Further details of the Normalair valve, are to be found in A.P.1275A, Vol. 1.

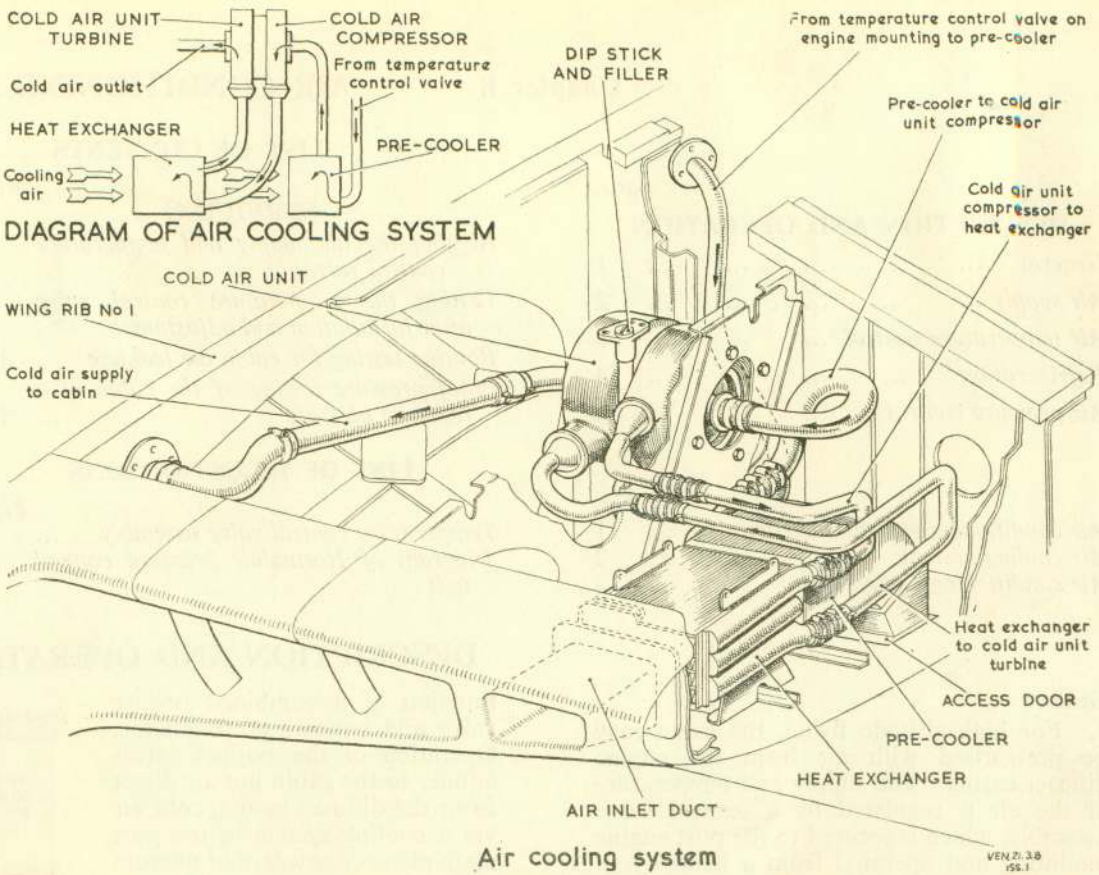


Fig. 2. Air cooling system

SERVICING

Rigging the air supply and temperature control valves

8. With the control hand wheel in the cabin in the OFF position, the procedure is as follows:—

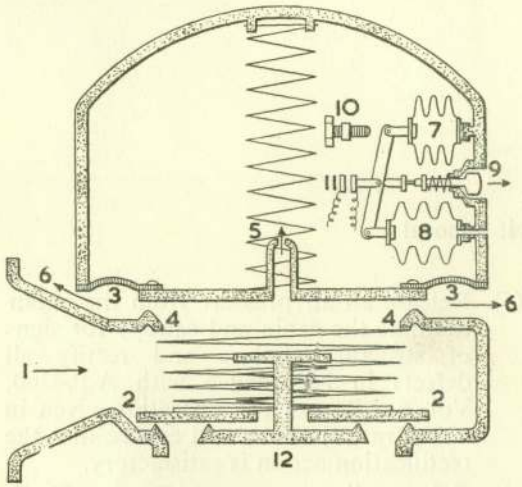
(1) Assemble the *hot* air cam on its splined shaft of the control valve assembly, so that the face bearing the heavily scribed line is on the outside and the line itself coincides with the centre-line of the *hot* valve stem. Refit, tighten and split pin the cam retaining nut.

(7) The above tests having been achieved, switch off the engine, remove the blank from the outlet valve of the Normalair unit and refit the cap.

Routine testing for cabin air leakage (*fig.* 6)

10. Referring to the Note preceding para. 9, the following procedure for routine testing the cabin and Normalair pressure control unit for leaks must be adhered to strictly:—

(1) Ensure that the aircraft pneumatic system is adequately charged for the inflation of the hatch seal, then close and fasten the hatch securely.



1 CABIN AIR
2 INWARDS RELIEF VALVE
3 DISCHARGE VALVE DIAPHRAGM
4 DISCHARGE VALVE SEATING
5 ORIFICE
6 DISCHARGE AIR
7 ABSOLUTE CAPSULE
8 ATMOSPHERIC CAPSULE
9 OUTLET VALVE
10 BEAM STOP
11 WARNING LIGHT CONTACTS
12 OUTWARDS RELIEF VALVE

Fig. 5. Diagram of Normalair pressure control unit

(2) Remove the blanking cap from the large circular adapter on the port front face of bulkhead No. 1, and connect up the air line from a test rig (*Sect.* 2, *Chap*, 1, *Table* 1, *item* H1) or suitable alternative source of supply.

Note . . .

Where the test rig to be used does not incorporate a non-return valve and a pressure gauge, it will be necessary to fit a suitable valve in the rig delivery line and to connect a mercury manometer to the small adapter on the port front face of bulkhead No. 1.

(3) Remove the cap from the outlet valve (9 *in fig.* 5), manually or mechanically blank off the valve orifice securely and pressurise the cabin to 3·1 to 3·2 p.s.i.

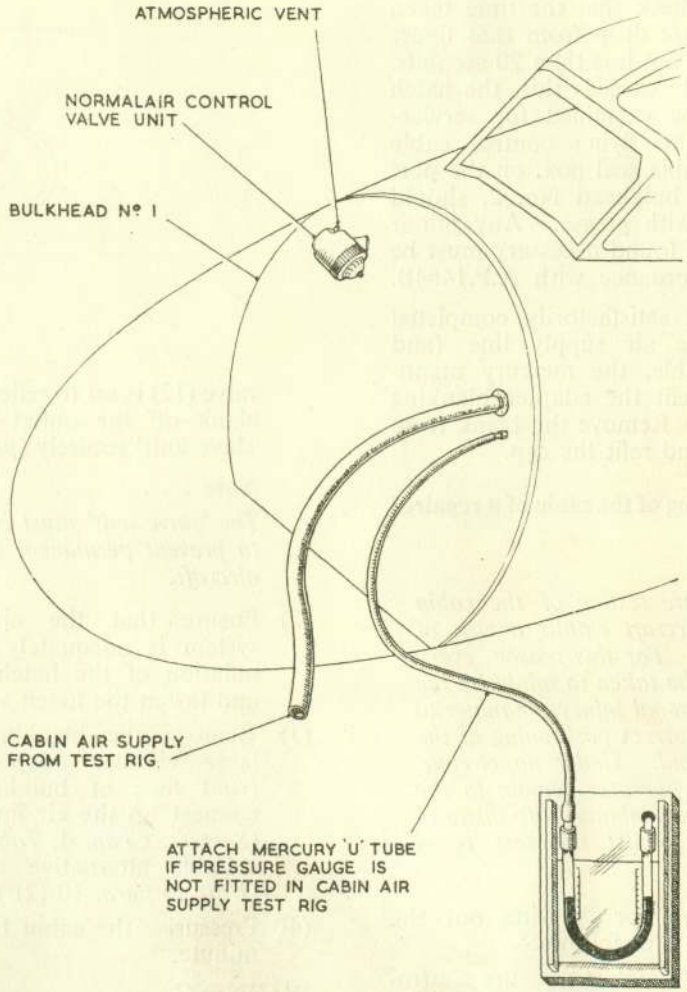


Fig. 6. Test connections

Ensure that the outwards relief valve (12) relieves within these limits. Increase the airflow to 15 lb. per minute and ensure that the cabin pressure does not exceed 3·6 p.s.i.

(4) Reduce the air supply to maintain a steady pressure of 3 p.s.i. and manually check that there is no sign of leakage from the discharge diaphragm (3) or the relief valve. Check also, that the reading on the cabin pressure gauge agrees with that of the rig gauge or manometer.

(5) At 3 p.s.i. cut off the air supply completely, and check that the time taken for the pressure drop from that figure to 1·5 p.s.i. is not less than 20 seconds. If the leak rate exceeds this, the hatch seal should be examined for serviceability and the flying control cable seals in the cable seal box, on the port front face of bulkhead No. 2, should be repacked with grease. Any minor sealing repairs found necessary must be made in accordance with A.P.1464B.

(6) With the test satisfactorily completed disconnect the air supply line (and where applicable, the mercury manometer), and refit the adapter blanking caps securely. Remove the blank from outlet valve and refit the cap.

Proof pressure testing of the cabin of a repaired aircraft

WARNING

The proof pressure testing of the cabin of a repaired aircraft entails a risk of explosive failure. For this reason, every precaution must be taken to minimise the possibility of personal injury, or material damage, by the correct positioning of the aircraft beforehand. Under no circumstances must an operator remain in the cabin, or within a minimum safe distance of the aircraft, whilst the test is in progress.

11. The procedure for carrying out the proof pressure test is as follows:—

(1) Replace the Normalair pressure control unit fitted to the aircraft by a spare 'slave unit' so modified that the relief valve (12) is set to relieve at 4 p.s.i., then blank off the outlet valve (9) of the 'slave unit' securely (*para.* 9 (2)).

Note . . .

The 'slave unit' must be suitably marked to prevent permanent installation on the aircraft.

(2) Ensure that the aircraft pneumatic system is adequately charged for the inflation of the hatch seal, then close and fasten the hatch securely.

(3) Remove the blanking cap from the large circular adapter on the port front face of bulkhead No. 1, and connect up the air line from a test rig (*Sect.* 2, *Chap.* 4, *Table* 1, *Item* H1) or suitable alternative source of supply (*Note to para.* 10 (2)).

(4) Pressurise the cabin to 4 p.s.i. for one minute.

WARNING

This pressure must NOT be exceeded.

(5) Release all air pressure from the cabin examine the cabin and canopy for signs of structural failure and rectify all defects in accordance with A.P.4360, Vol. 6. Repeat the operation given in sub-para. (4) above and ensure that the rectification action is satisfactory.

(6) Release all pressure once more, refit the original Normalair unit to the aircraft and carry out all operations listed in para. 10.

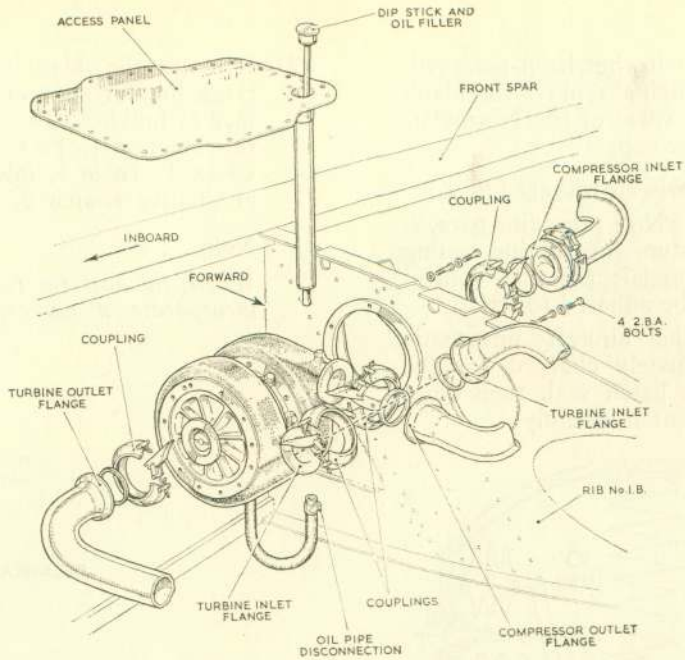


Fig. 7. Cold air unit removal

Cold air unit and Normalair pressure control unit

12. Before dismantling either the cold air or Normalair units, reference must be made to A.P.4340, Vol. 1, Sect. 2 and to A.P.1275A, Vol. 1, Sect. 20, respectively. The breather hole in the uppermost of the cold air side unit oil tank filler neck must always be kept clear.

Lubrication

13. Details regarding the lubrication of the various system components will be found in ◄ Sect. 2, Chap. 4. ►

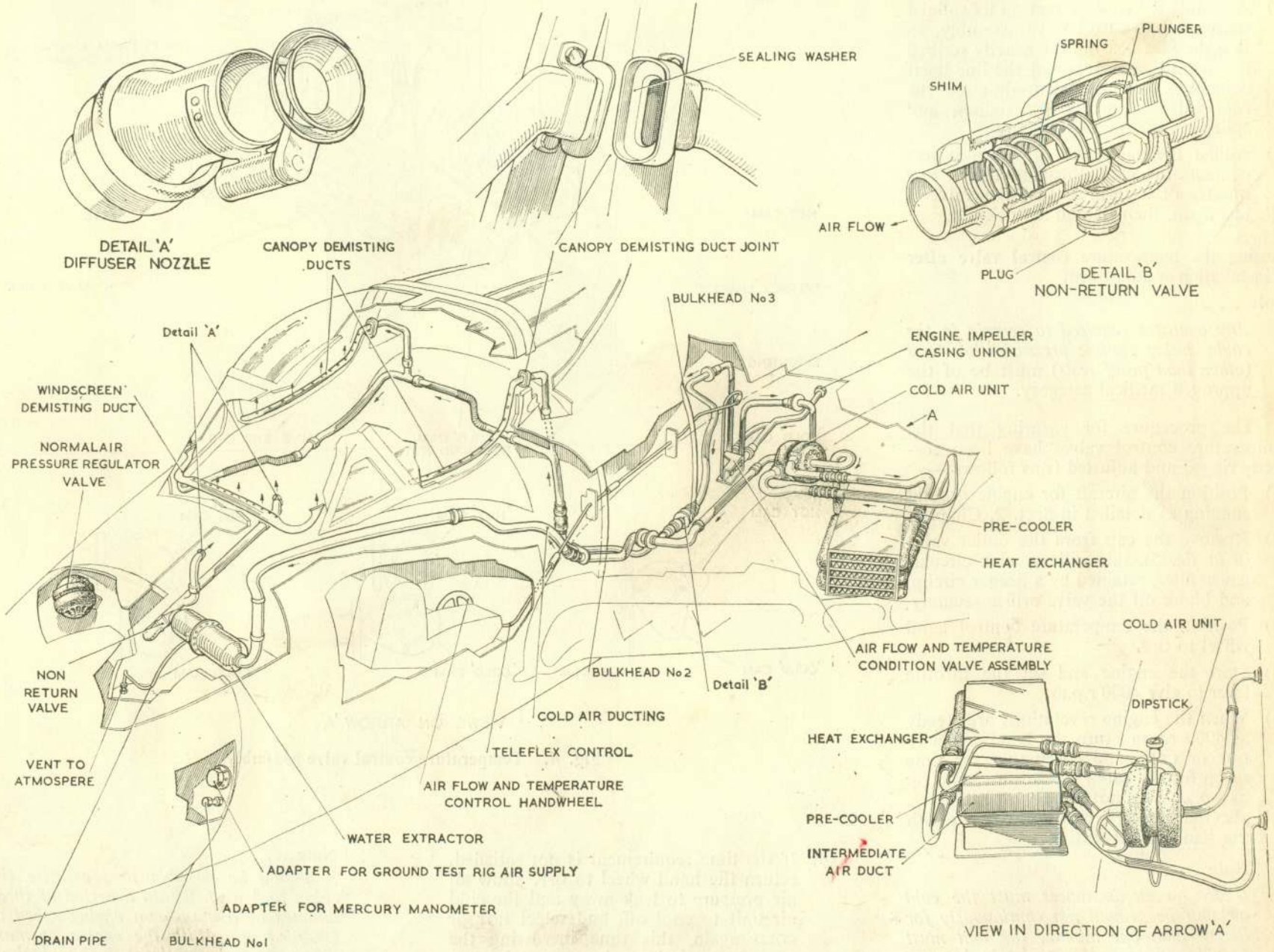


Fig. 3. Air conditioning equipment

(2) Adjust the clearance between the cam and the valve end cap to 0·01 in. and tighten the cap lock-nut.

(3) Assemble the *cold* air cam on its splined shaft of the control valve assembly, so that the face bearing the heavily scribed line is on the outside and the line itself coincides with the centre-line of the *cold* valve stem. Refit, tighten and split pin the cam retaining nut.

(4) Adjust the valve end cap until it just contacts the cam, then unscrew it one quarter of a turn, so that the valve is just open, then tighten its lock-nut.

Testing the temperature control valve after installation or adjustment

Note . . .

Any operator required to remain in the cabin during routine pressurisation tests (other than proof tests) must be of the approved medical category.

9. The procedure for ensuring that the temperature control valves have been correctly rigged and adjusted is as follows:—

(1) Position the aircraft for engine ground running as detailed in Sect. 2, Chap. 1.

(2) Remove the cap from the outlet valve (9 *in fig.* 5), this will reveal a circular gauze filter, retained by a Seegar circlip, and blank off the valve orifice securely.

(3) Position the temperature control hand wheel to OFF.

(4) Start the engine and set the throttle lever to give 4000 r.p.m.

(5) When the engine revolutions are steady at 4000 r.p.m., turn the hand wheel to HOT or COLD and check that the time taken for the cabin pressure to build up to 3 p.s.i. does not exceed three minutes, also that the air temperature agrees with the hand wheel setting.

Note . . .

Under no circumstances must the cold air unit be ground run continuously for longer than one minute; the unit must be allowed to cool completely between running periods.

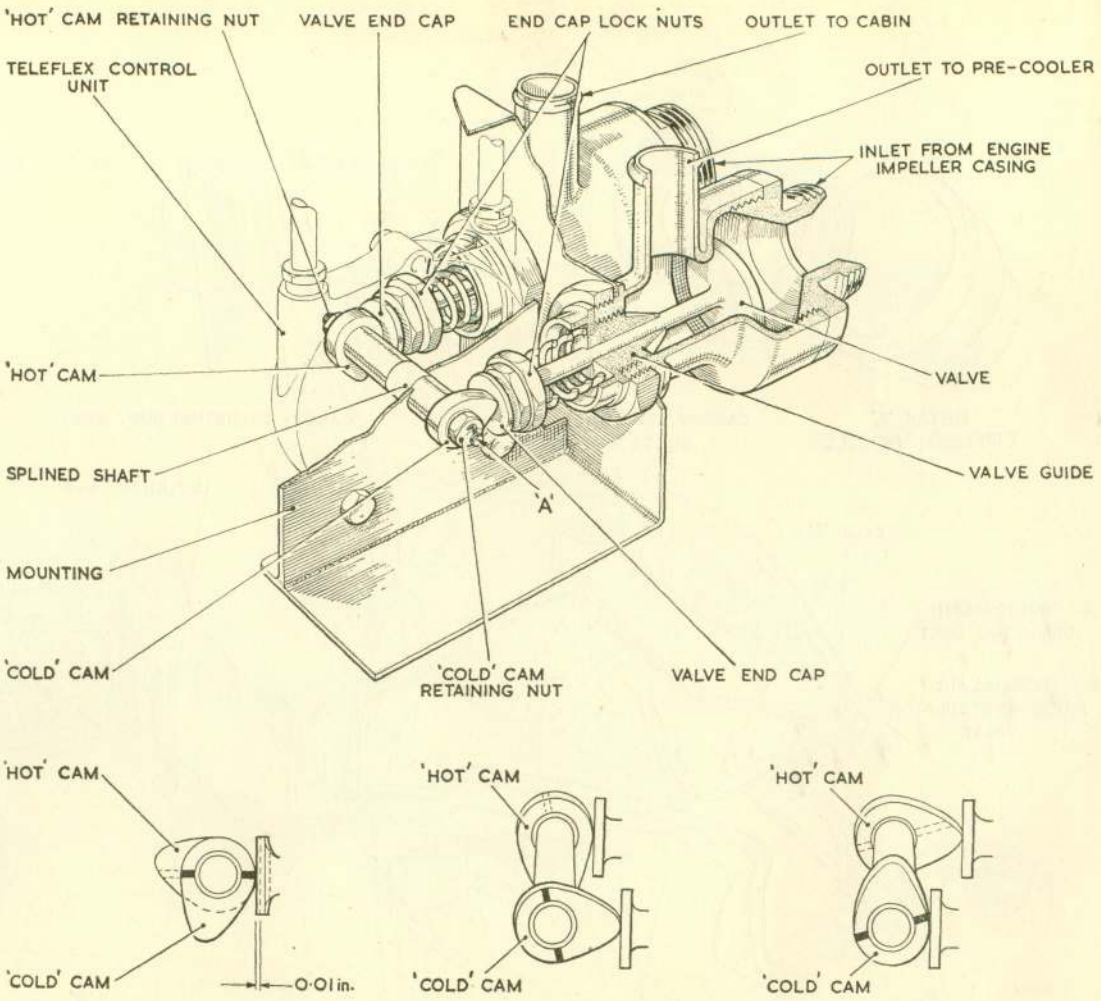


Fig. 4. Temperature control valve assembly

(6) If the time requirement is not satisfied, return the hand wheel to OFF, allow all air pressure to leak away and the cold air unit to cool off, and select HOT or COLD again, this time increasing the engine revolutions by approximately 1000 r.p.m. Repeat the time check.

Note . . .

I should be possible to pressurise the cabin to 3 p.s.i. within a period of three minutes at a maximum engine speed of 8000 r.p.m. With the engine at max. r.p.m. and the outlet valve unblanked, pressure should not exceed 1 p.s.i.

REMOVAL AND ASSEMBLY

General

14. The procedure for the removal and assembly of most of the air conditioning equipment, will be readily apparent when the components are seen on the aircraft. Extreme cleanliness is essential during these operations, especially with regard to the cold air unit, where the ingress of foreign matter may damage the turbine blades under conditions of high speed rotation.

Cold air unit (*fig.* 7)

15. The procedure for removing the cold air unit is as follows:—

(1) Remove the access panel in the port main plane immediately above the unit.

◄ (2) Remove the four couplings from the turbine and compressor inlet and outlet flanges and, finally remove the four 2 B.A. bolts securing the unit to rib No. 1B. ►

(3) Release the Jubilee clip from the oil hose at the base of the unit and carefully withdraw the hose; collecting the oil which flows from the hose and the unit sump in a suitable container.

(4) Lift out the cold air unit through the access hole above it.

Heat exchanger and pre-cooler (*fig.* 8)

16. Before attempting to remove the heat exchanger and pre-cooler, it will first be necessary to remove the cold air unit; the procedure is then as follows:—

(1) Remove the access panel positioned immediately aft of the two units in the main plane underskin.

(2) Take out the six 2 B.A. bolts securing the intermediate air duct to the pre-cooler and remove the duct. Access to the heads of the two top and two side attachment bolts is gained from the inside of the duct.

◄ (3) Release the Jubilee clips securing the compressor outlet and turbine inlet pipe flanges at rib No. 1B ► and the heat exchanger hose connections and withdraw the pipes through the access hole in the main plane underskin.

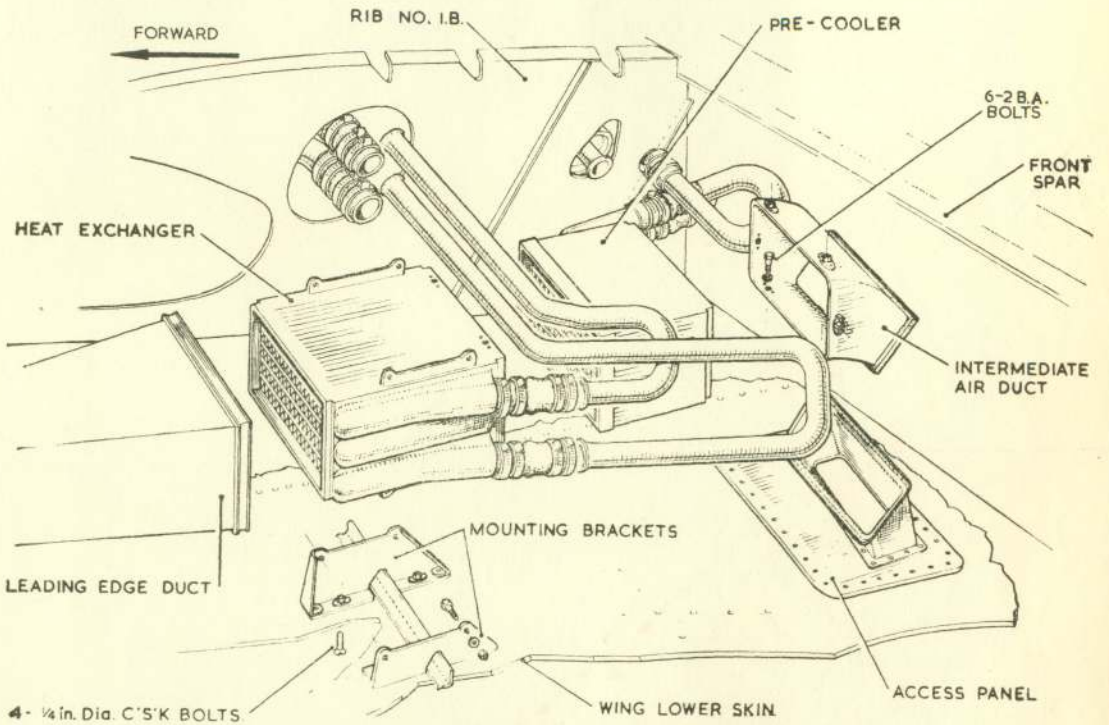


Fig. 8. Heat exchanger and pre-cooler removal

(4) Release the Jubilee clips securing the two pipes to the pre-cooler hose connections and ◄ the coupling of the upper pipe from the cold air unit flange then withdraw this pipe through the access hole in the main plane underskin. ►

(5) Take out the four ¼ in. dia. countersunk bolts from this main plane underskin, immediately forward of the exchange and cooler access hole to release the mounting brackets.

(6) Manipulate the heat exchanger until the six 2 B.A. bolts attaching it to the pre-cooler can be removed and take out the pre-cooler.

(7) Detach the heat exchanger from the two mounting brackets and withdraw it from the wing.

17. The re-assembly of the heat exchanger, pre-cooler and cold air unit entails only the reversal of the removal procedure. Care must be taken however, that the *forward* end of the heat exchanger enters into the leading edge duct, and that the annular rubber seals in the inlet and outlet connections of the cold air unit are serviceable and correctly positioned before the unit itself is installed. Sealing compounds must NOT be used in the vicinity of the cold air unit connecting pipe flange joints.

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