Chapter 8 AIR CONDITIONING SYSTEM

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

DESCRIPTION AND OPERATION

General

1. The cabin may be pressurised for high altitude flying by air supplied from the impeller casing of the engine. The supply and temperature of the air is regulated by a single handwheel on the port side of the cockpit and the pressure is automatically controlled by a Normalair valve. The pressurised cabin is enclosed at the front and rear by fuselage bulkheads Nos. 1 and 2 respectively, at the top by the sliding canopy and windscreen and at the bottom by the cabin decking. The installation of the equipment is shown in fig. 2.

Air supply

2. The air supply, which is derived from a single tapping on the forward face of the engine impeller casing, is controlled by a pair of poppet valves. These valves are operated by a Teleflex control from the left-hand side of the cockpit. It will be seen from fig. 1 that the air may flow either directly to the cabin when one valve is open, or through the cooling system in the port wing when the other valve is open. The control wheel, therefore, serves as an ON-OFF valve and as a temperature regulator. The air is finally admitted to the cabin, either through a punkah louvre, or through the perforated gallery pipe which serves as a windscreen and canopy de-mister.

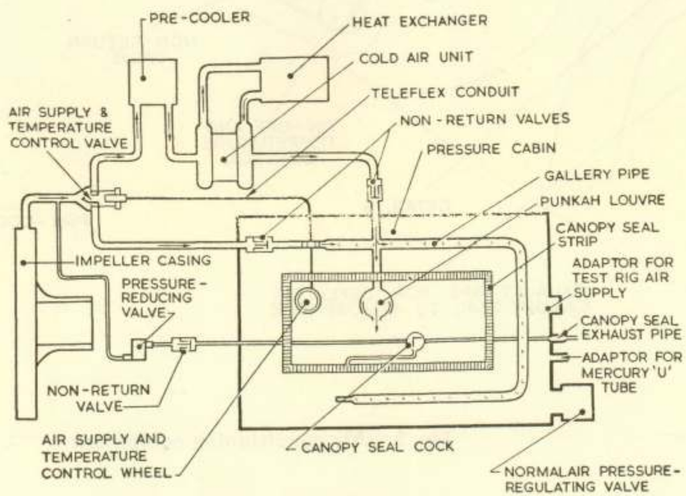

Fig. 1. Air conditioning system diagram

Air temperature control

3. By varying the proportion of air flow through each of the valves mentioned in the preceding paragraph, the temperature of the air entering the cockpit may be regulated. Cold air is admitted to the cabin when the control wheel is initially turned in a clockwise direction from its OFF position. The air temperature will progressively change to hot as the control wheel is further turned in a clockwise direction.

Refrigeration

4. The air cooling arrangement in the stub of the port wing comprises a pre-cooler or primary heat exchanger, a main heat exchanger and an ACRE 8 Type 1A (Stores Ref. 27U/272) mechanical cold air unit. The cold air unit consists of a centrifugal compressor and a turbine impeller which are directly connected to each other and rotate on a common shaft. The cooling medium for

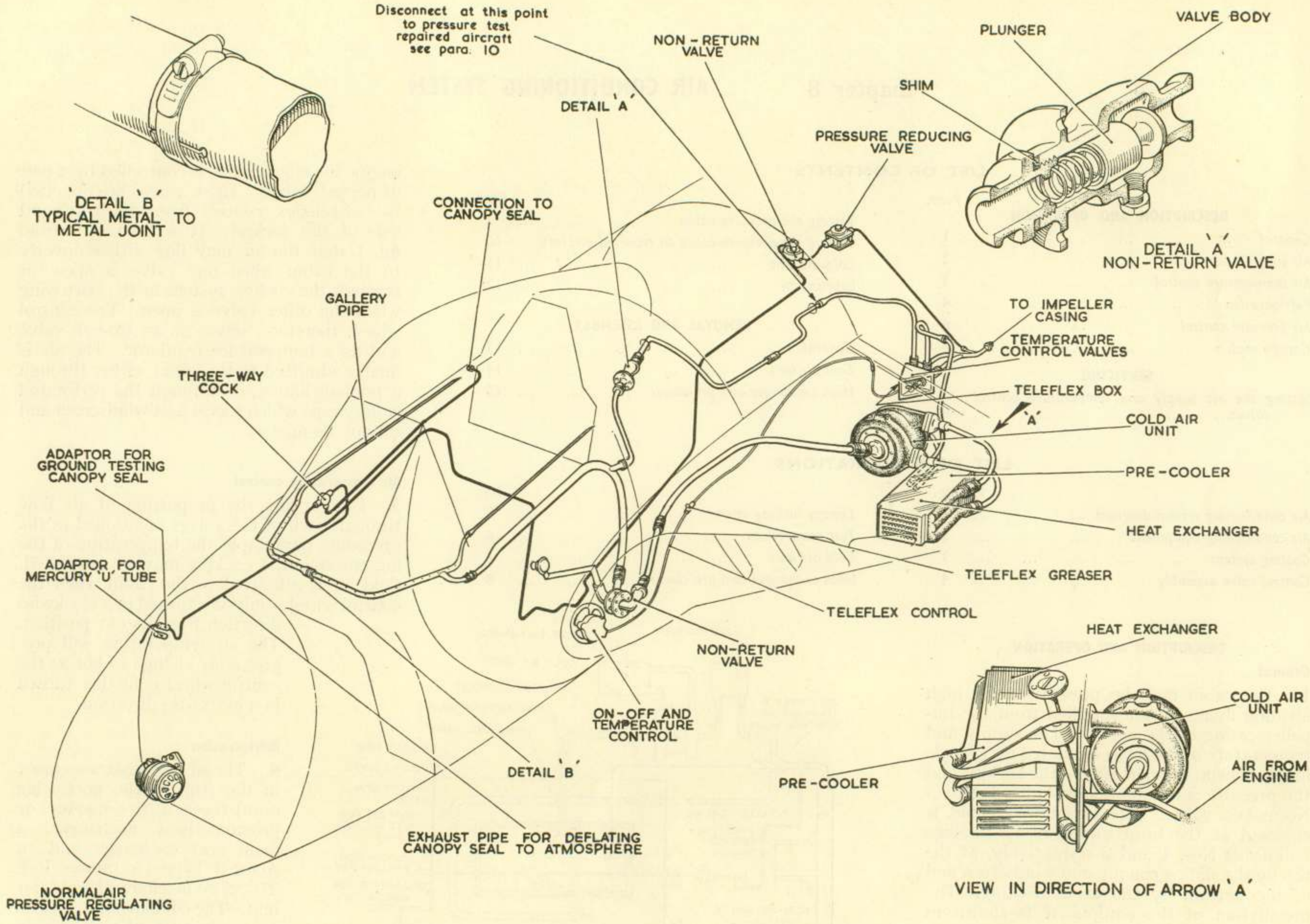

Fig. 2. Air conditioning equipment

the pre-cooler and heat exchanger is provided by ram air admitted through an inlet duct in the leading edge of the wing. Details of the functioning and mechanism of the cold air unit will be found in A.P.4340, Vol. 1, Sect. 2.

5. The hot air supply from the engine first receives a preliminary cooling in the pre-cooler from which it is ducted to the eye of the cold air unit compressor. From the outlet of the compressor, the air flow, which has again

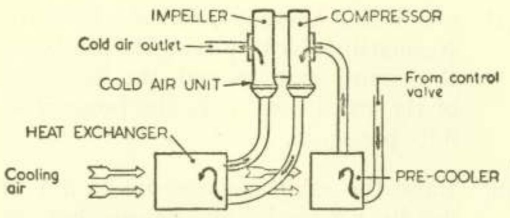

DIAGRAM OF AIR COOLING SYSTEM

risen in temperature resulting from the compression, is ducted to the main heat exchanger for the second stage of cooling. The efficiency of the heat exchanger is enhanced by this slight increase in temperature of the air flow. On leaving the heat exchanger, the flow is fed back to the cold air unit where it impinges upon the blades of the turbine wheel. The air rapidly expands as it passes through the turbine and the heat which is taken out is converted into kinetic energy and used to drive the compression stage of the unit. The resultant cold air supply emerges from the eye of the turbine and is ducted to the cabin.

Air pressure control

6. The pressure in the cabin is automatically regulated by a Normalair control valve mounted on the forward face of bulkhead No. 1. This valve ensures that the air pressure inside the cabin does not differ appreciably from the surrounding atmospheric pressure until the pressurising height is attained. At this predetermined height, the action of the valve progressively increases the pressure in the cabin, in relation to the surrounding atmosphere, up to a maximum differential of 3 lb. per sq. in. The unit incorporates a switch to operate a warning lamp should the cabin pressure drop more than ½ lb. per sq. in. below the normal for any altitude. Two more valves are included in the unit ; one, an outward relief valve (set to 3½ lb. per sq. in.) which acts as a safety valve should the regulating valve fail to operate at the correct pressure, and the other, an inward relief valve which operates when the ambient atmospheric pressure exceeds the pressure in the cabin as would occur during a rapid descent. Details of the construction and mechanism of the Normalair valve will be found in A.P.1275A, Vol. 1, Sect. 10.

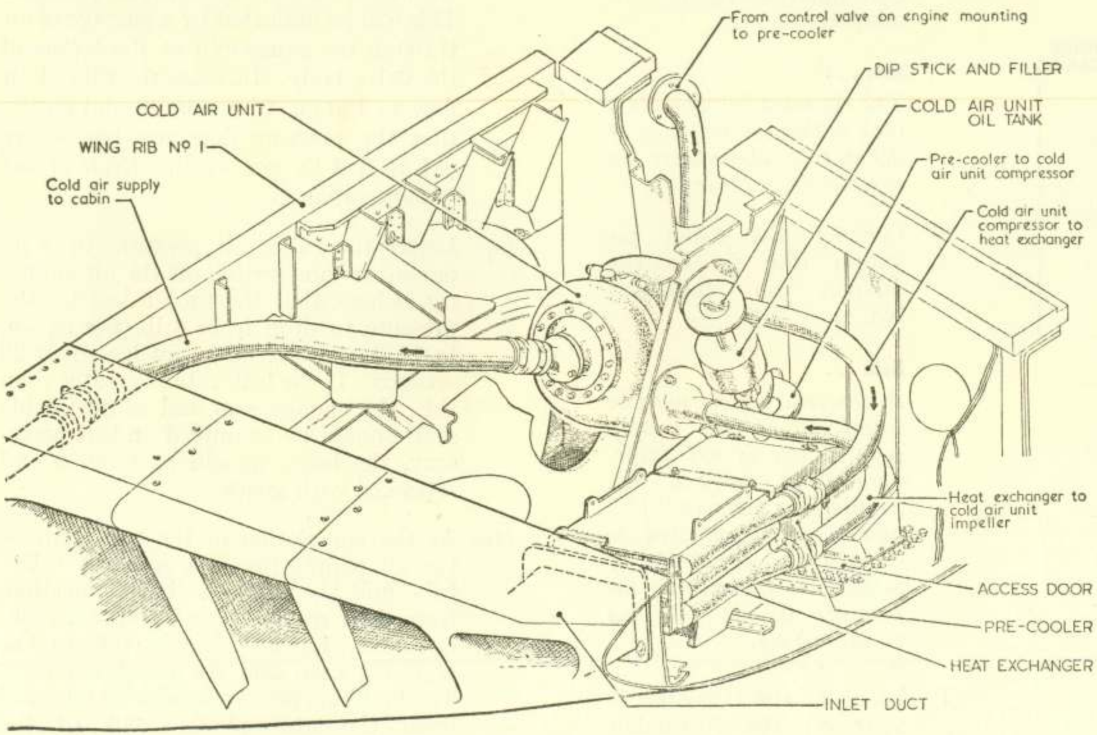

Fig. 3. Cooling system

Canopy seal

7. When the canopy is closed, it must be sealed to the windscreen frame and to the adjacent fuselage structure by the inflatable rubber seal before pressurising the cabin. A tapping, from the cabin air supply line at the engine impeller casing, provides the air pressure which, after passing through a reducing-valve and non-return valve, inflates the seal. A three-way cock, on the starboard side of the cockpit, either inflates or deflates the seal according to its position ON or OFF, the pressure in the seal being exhausted to atmosphere when the cock is turned to OFF. The cock lever is arranged so that, when it is turned ON with the canopy closed, the initial movement of the canopy winding handle will strike the cock lever thus reminding the operator of the necessity to deflate the seal before opening the canopy.

SERVICING

Setting the air supply and temperature control valves

8. The following is the procedure for setting the two cams on the splined Teleflex control shaft, with the control wheel in the cabin in the fully OFF position.

(1) Assemble the hot air cam, which may be identified by its shape, on its respective splined shaft. The cam must be assembled so that the heavily scribed line appears on the outside and is in line with the centre-line of the valve stem. Replace and tighten the cam retaining nut.

(2) With the hot air cam in this position, adjust the end cap on the valve stem so that there is a clearance of 0·01 in. between the cam and the end cap. Tighten the lock-nut on the end cap after this adjustment.

(3) Assemble the cold air cam on its respective shaft so that the heavily scribed line appears on the outside and is in line with the valve stem. Replace and tighten the retaining nut.

(4) With the cold air cam in this position, adjust the end cap on the valve stem so that it just contacts the cam, then extend the end cap a ¼ turn, in which position the valve should be just open. The locknut should now be tightened on the end cap.

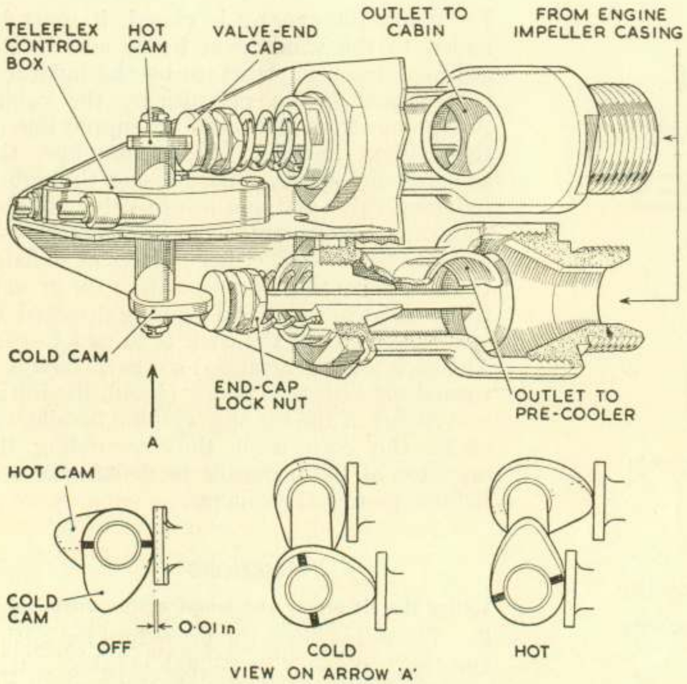

Fig. 4. Control valve assembly

Testing the pressure cabin

9. If it is desired that an operator should remain in the cabin during the pressure test, *it is essential that he be of the approved medical category*. In the test outlined below it is assumed that no such operator will be in the cabin and the procedure is as follows :—

(1) Turn the canopy seal cock to OFF. Close the canopy, insert the locking strut and extend it by unscrewing the knurled head until the canopy is held firmly against the windscreen.

(2) Remove the short extension pipe from the canopy seal exhaust adapter on bulkhead No. 1 and connect the seal inflation rig to this adapter.

Note . . .

The rig must incorporate a cock so that the seal may be deflated to atmosphere on completion of the test.

(3) Connect the cabin air supply test rig to the adapter on bulkhead No. 1.

Note . . .

A non-return valve must be interposed in the supply pipe if one is not incorporated in the test rig. Similarly, a mercury " U " tube must be attached to the appropriate adapter if means for determining the pressure is not provided on the test rig.

(4) Blank off the atmospheric vent on the Normalair valve.

(5) Inflate the canopy seal to 5½ lb. per sq. in. The seal cock in the cockpit must remain at OFF as previously instructed since the seal is being inflated through the normal exhaust pipe via the cock.

(6) Start the cabin air supply rig and pressurise the cabin to 3 lb. per sq. in. It will require an air flow of approximately 12 cu. ft. a minute to maintain this pressure but the air flow required will vary according to the leak rate (*sub-para.* 9).

(7) Check that there are no leaks from the Normalair valve by placing the hand over the gauze exit around the *periphery* of the valve body with the pressure at 3 lb. per sq. in.

(8) Raise the cabin air pressure to 3·1 to 3·2 lb. per sq. in. and ensure that the Normalair valve relieves at this pressure. This will be indicated by a passage of air through the gauze exit at the *bottom* of the valve body. Increase the rate of air flow to 130 cu. ft. a minute and ensure that the pressure does not rise above 3·1 to 3·2 lb. per sq. in. (*Note at end of paragraph*).

(9) Lower the cabin air pressure to 3 lb. per sq. in. and switch off the air supply rig. Check that the time taken for the pressure to drop from 3 lb. per sq. in. to 1½ lb. per sq. in. is not less than 20 seconds. If the leak rate is greater than this, the canopy seal and control cable seals should be examined and, if necessary, the latter should be cleaned and repacked with grease.

(10) At the completion of the test, remove the air supply line, the mercury " U " tube and the seal inflation connection, from their respective adapters on bulkhead No. 1, and securely replace the blanking caps and the extension pipe. The blanking plug must also be removed from the atmospheric vent of the Normalair valve.

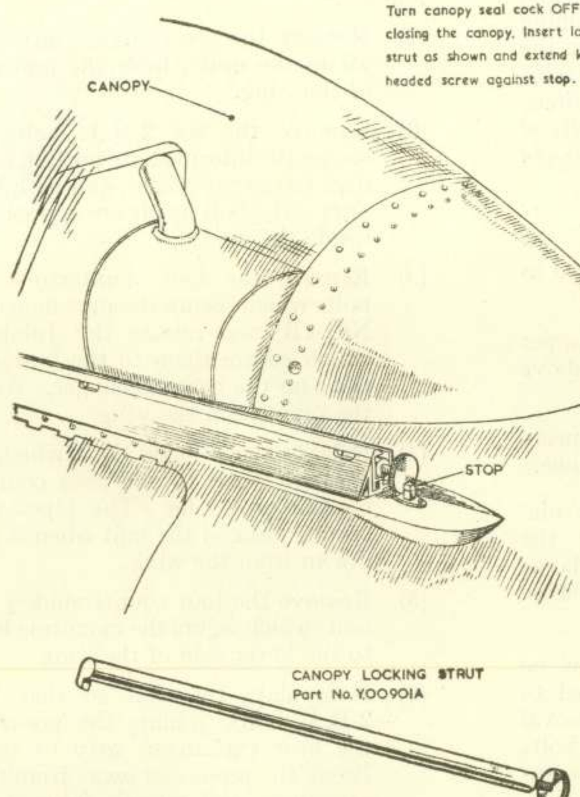

Fig. 5. Canopy locking strut

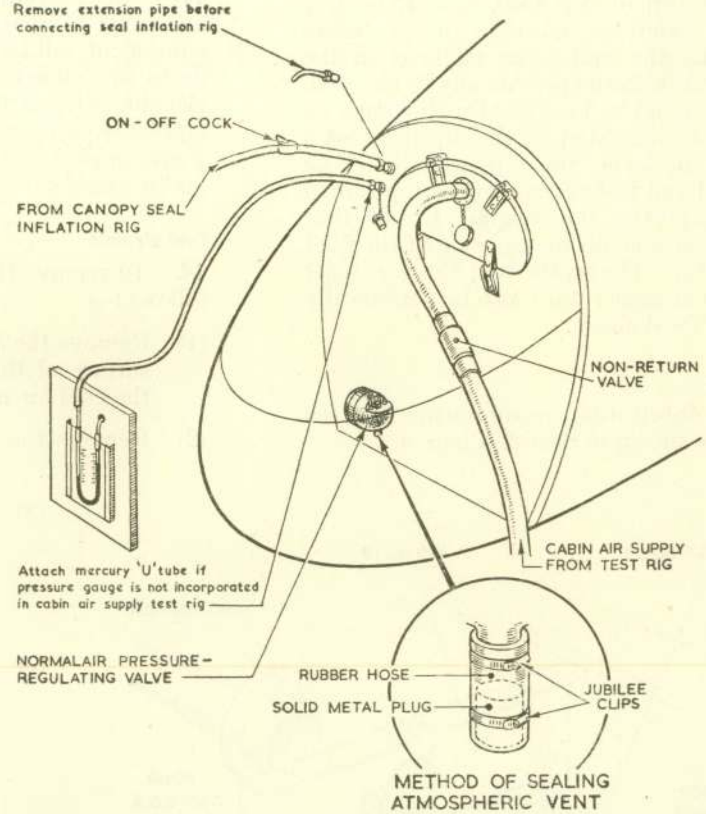

Fig. 6. Test connections

(11) Test the electrical circuit of the cabin pressure warning lamp (*para.* 6), by removing the terminal block cover from the Normalair valve, and bridge the terminals. The warning lamp should now function.

Note . . .

The maximum air flow supplied by the Ghost engine at sea level is approximately 130 *cu. ft. a minute. When testing, it is necessary to raise the rate of air flow into the cabin up to this figure* (sub-para. (8)) *in order to check that there is no build up in pressure caused by the Normalair valve failing to relieve this volume of air.*

Testing the pressure cabin on repaired aircraft

10. After any structural repairs affecting the bulkheads or walls of the pressurised cabin, the following test should be made in addition to that outlined in para. 9.

(1) Disconnect the air supply pipe at the pipe connection and connect the test rig air supply at this point. Attach the mercury " U " tube on bulkhead No. 1 if a pressure gauge is not incorporated in the test rig.

(2) Blank off the atmosphere vent of the Normalair valve and remove the circlip and gauze filter from the end of the valve body (*A.P.*1275A, *Vol.* 1, *Sect.* 10).

(3) Start the cabin air supply rig, and pressurise the cabin to 4 lb. per sq. in. by holding the relief valve of the Normalair valve down on its seating. *On no account must the pressure be allowed to rise above* 4 *lb. per sq. in.*

(4) Whilst the cabin is subjected to this pressure, examine all possible sources for leaks. The procedure to be adopted for stopping minor leaks is given in A.P.1464B.

(5) On completion of the test, replace the gauze filter and circlip in the Normalair valve and remove the blank from the atmospheric vent.

Cold air unit

11. Instructions for servicing the cold air unit are given in A.P.4340, Vol. 1, Sect. 2 to which reference must be made before dismantling the unit. The oil level in the auxiliary tank should periodically be checked. The unit should be kept filled with engine oil to the mark indicated on the dipstick ; ◀to take the oil level, the dipstick should be unscrewed and just resting on the top thread of the adapter in the wing.▶ Ensure that the breather hole on the top side of the filler neck is clear. The matrices of the pre-cooler and heat exchanger must also be periodically inspected for damage.

Lubrication

12. The lubrication requirements for the system are shown in Sect. 2, Chap. 4.

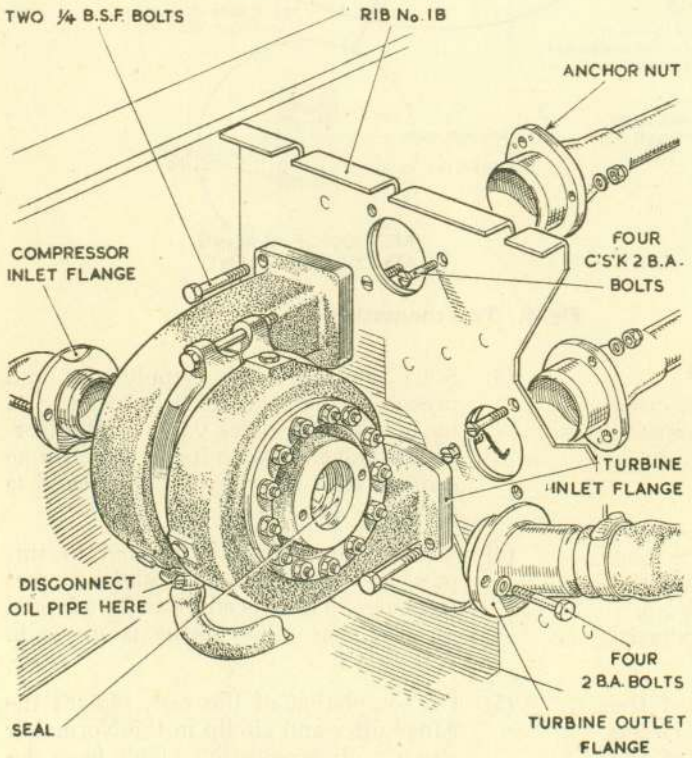

Fig. 7. Cold air unit

REMOVAL AND ASSEMBLY

General

13. The procedure for the removal and assembly of most of the air conditioning equipment will be readily apparent when the items are viewed on the aircraft. Extreme cleanliness is essential during these operations, *especially on the cold air unit which rotates at a very high speed and to which any foreign matter would cause considerable damage.*

Cold air unit

14. To remove the cold air unit, proceed as follows :—

(1) Remove the access panel from the upper surface of the wing immediately above the cold air unit.

(2) Remove the two 2-B.A. bolts securing the turbine outlet flange.

(3) Remove the two ¼ in. dia. bolts which secure the compressor outlet flange and the turbine inlet flange to rib. No. 1B.

(4) The unit should now be carefully manipulated to give access for the removal of the two 2-B.A. bolts which secure the compressor inlet flange.

(5) Release the Jubilee clip securing the oil hose to the base of the unit. Carefully withdraw the hose and collect the oil, which will flow both through the hose and from the sump of the unit, in a container.

(6) The unit is now free to be removed through the access opening in the upper surface of the wing.

Heat exchanger and pre-cooler

15. Before proceeding with the removal of the heat exchanger and pre-cooler, the cold air unit must first be removed as detailed in para. 14. The procedure is as follows :—

(1) Remove the access panel, situated just aft of the units, from the undersurface of the wing.

(2) Remove the six 2-B.A. bolts, which secure the intermediate portion of the air duct to the pre-cooler, and withdraw the duct. The bolt heads are accessible from inside the duct.

(3) Remove the four countersunk 2-B.A. bolts which secure the pipe flanges to rib No. 1B, and release the Jubilee clips which secure them to the hose connections on the heat exchanger. Withdraw the pipes from the wing.

(4) Release the Jubilee clips which secure the two pipes to the hose connections on the pre-cooler. The pipes may be sprung clear of the unit when it is withdrawn from the wing.

(5) Remove the four countersunk ¼ in. dia. bolts which secure the mounting brackets to the lower skin of the wing.

(6) Manipulate the unit so that the six 2-B.A. bolts, joining the pre-cooler to the heat exchanger, may be removed. Break the pre-cooler away from the heat exchanger and remove from the wing.

(7) Remove the two mounting brackets from the base of the heat exchanger and withdraw the latter from the wing.

16. When installing the heat exchanger, it is *important* to ensure that its forward end enters into the leading edge duct. The subsequent procedure for the assembly of the heat exchanger, pre-cooler and cold air unit is a reversal of that outlined in the preceding paragraphs. Ensure that the annular rubber seals, in the inlet and outlet connections of the cold air unit, are correctly positioned and are in good condition before installing the unit. Sealing compounds must NOT be used in the vicinity of the connecting pipe flange joints during installation of the cold air unit.

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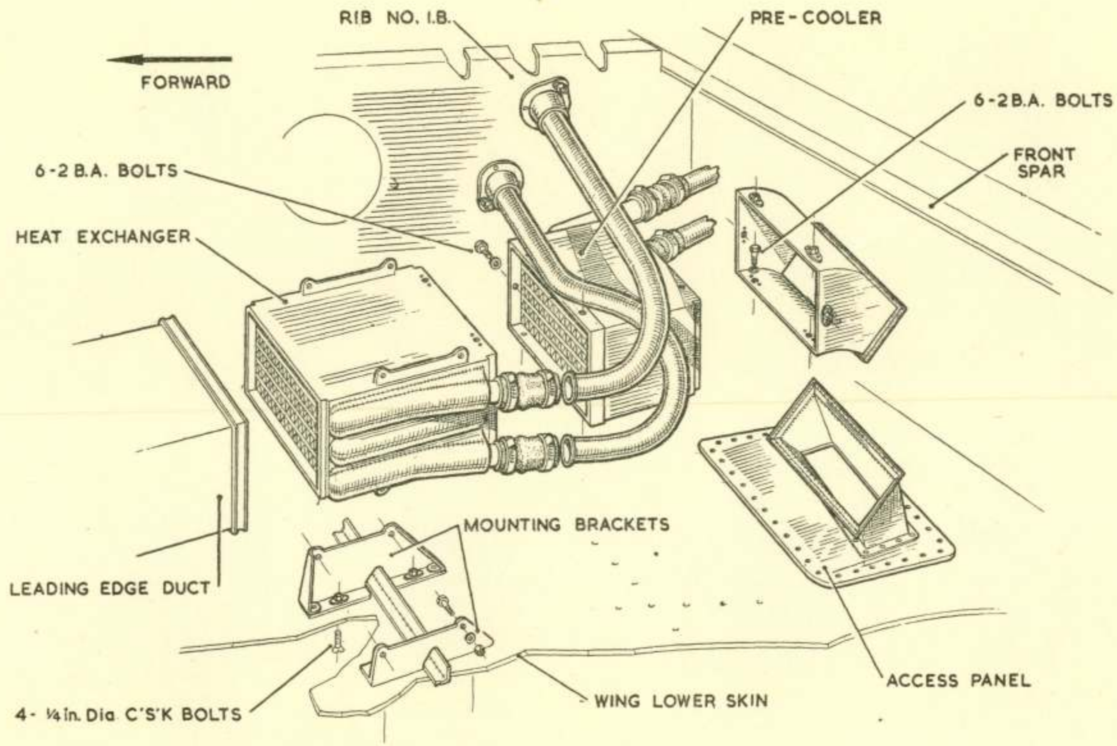

Fig. 8. Heat exchanger and pre-cooler (port main plane)


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ENTRANCE OTHER SIDE