



**RESTRICTED**

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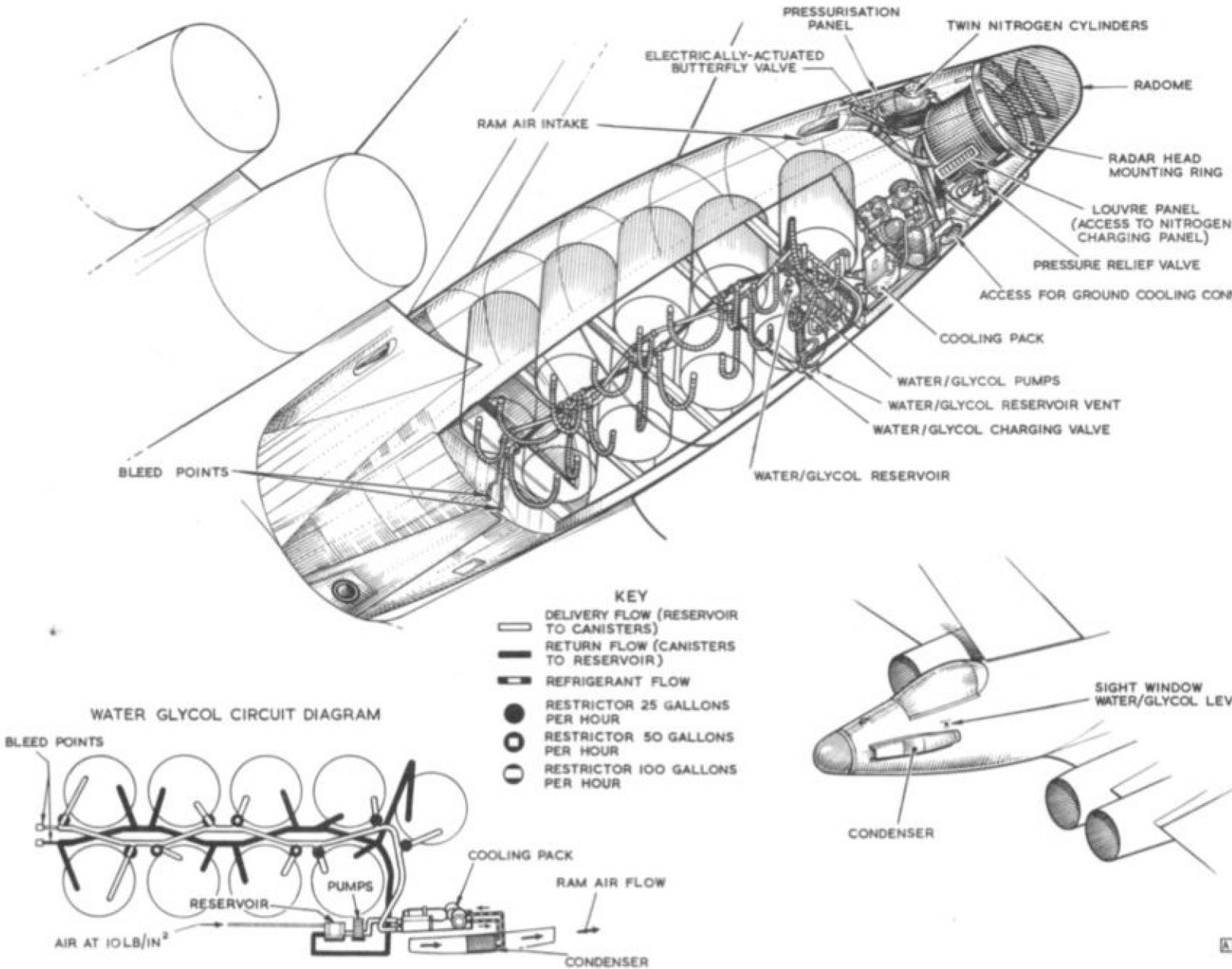


Fig.1 Cooling system (pre Mod. 2024)

**Introduction**

1. This chapter describes the water/glycol and vapour cycle systems used to control the operating temperature of the E.C.M. equipment in the rear fuselage, together with the procedure for servicing and removal of various units. Information is also given on the cooling and pressurisation systems associated with the radar head. For detailed information on the vapour cycle cooling pack refer to A.P. 4787A, Vol.1. The E.C.M. trainer installed only on certain aircraft, consists of an electronic simulator unit in a cylindrical case, mounted in the rear fuselage and electrically connected to indicators in the cabin. Electrical details of the trainer installation will be included in S.D.789.

1A. Mod.2024 and 2017 S.O.O. to 26 aircraft replaces A.R.I.18074 with A.R.I. 18146 and A.R.I.5919 with A.R.I.5952 respectively, Mod 2024 replaces the A.R.I.18074 canister with an A.R.I. 18146 power unit and introduces a transmitter canister, receiver, discriminator and a radar aerial. Mod 2193 introduces a continuous nitrogen pressurisation system for the waveguides, transmitter receiver, discriminator and radar aerial. Mod 2193 also provides for the continuous pressurisation of the Aerial Tuning Unit and the aerials in the counterpoise plates. An extension to the water/glycol system is also provided to cater for the additional transmitter, and additional pump is installed in the system and the size of the galley pipe restrictors is changed. Electrical details of the system will be found in Section 6 Chapter 22.

**COOLINGSYSTEM****General**

2. The system is designed to control the temperature, at which the E.C.M. units operate, under all aircraft operating conditions. This is achieved by circulating a mixture of water and ethylene glycol

**DESCRIPTION**

through the heat exchangers inside the canisters containing the E.C.M. equipment and controlling the temperature of the mixture by a Godfrey cooling pack. All units of the system are located in the rear of the aircraft. Cockpit controls consist of on and off push switches, a three position temperature indicator and a temperature gauge. For full details of these controls refer to Sect.6, Chap.22.

**Water/glycol circuit (pre Mod.2024)**

3. The water/glycol coolant (Ref.No. 34B/1407) is circulated by two pumps, arranged in parallel, which receive the fluid from a reservoir. The fluid is delivered from each pump, via non-return valves which prevent by-passing of the fluid back to the reservoir in the event of a failed pump, to the evaporator unit of the cooling pack and thence to the canisters. The circuit is normally pressurised from the aircraft pneumatic system to 10 p.s.i.g., to prevent evaporation of the coolant and cavitation of the pumps at high altitude. A pressure switch, connected to the delivery line from the pumps, switches off the pumps when the fluid viscosity is high and the delivery pressure reaches  $30^{+2}_{-1}$  p.s.i.g. In this way the pumps are safeguarded should they be started when the system is at a very low temperature. In consequence of the pressure drop when the pumps 'cut out', the switch will remake, resulting in a further operation of the pumps and a further pressure rise. Thus the pumps will be intermittent in operation until such time as an input of heat reduces the viscosity of the water/glycol to normal.

4. The connections to the inlet and outlet of the evaporator are made by 1 in. Avery couplings and flexible pipes. The fluid is carried in a gallery of rigid pipes run between the two rows of canisters. Each canister is connected to the gallery by a pair of flexible hoses with stainless steel quick release  $\frac{3}{4}$  in. Avery bayonet couplings, (AVX 3520 and AVX 3522, inlet

and outlet respectively). After circulating through the canisters, the fluid is returned to the gallery and thence to the reservoir. Two bleed screws are provided on the evaporator and two on the aft face of former 487.5 in.A.

5. As the maximum heat load from each canister is different, restrictors are fitted in the flexible delivery pipes to ensure that the flow of water/glycol is proportional to the heat load in the canister. The system can be operated with one or more canisters not fitted in the aircraft as the flow through the remaining canisters will be maintained.

6. A thermostat unit is positioned in the circuit. This unit operates the three position indicator at the A.E.O's station to read LOW when the temperature of the coolant reaches  $34^{\circ}\text{F} \pm 1.8^{\circ}\text{F}$ . The canister should not be operated whilst the water/glycol temperature is below  $32^{\circ}\text{F}$  and so the indicator provides the operator with a warning to this effect. When the cooling pack and the water/glycol pumps are switched on, the low temperature indication is maintained until the water/glycol temperature rises  $3^{\circ}\text{F}$  above the low temperature setting of the thermostat. This causes the indicator to change to ON. With the pack inoperative the indication becomes OFF. The temperature of the coolant is also constantly monitored by a gauge positioned adjacent to the three position indicator. This gauge, calibrated from  $-80^{\circ}\text{C}$  to  $+80^{\circ}\text{C}$ , is operated by a sensing bulb fitted in the pipe-elbow, immediately downstream of the evaporator.

7. The system is charged through a combined charging and overflow valve (Dowty Part No.C7335Y.A.14). The charging connection is fed into the main pipe between the canisters and the reservoir and the overflow is piped from the side of the reservoir. The total capacity of the system is approximately 7.5 gallons.

**Reservoir**

8. The fluid reservoir (Dowty Part No.100467.001) has a fluid capacity of 7½ pints and an air space of approximately 1½ pints. A sight glass, mounted in the rear face of the reservoir for observation of the fluid level, is viewed through a small Perspex window in the rear fuselage skinning, just aft of station 71.25 in. A, starboard side. A lamp, to illuminate the sight glass, is fitted to the reservoir mounting bracket. The reservoir is pressurised through a combined non-return air inlet and pressure relief valve. This valve operates at 15-18 p.s.i.g. with a minimum reseal pressure of 7 p.s.i.g. A pipe, connected to the vent outlet, vents to atmosphere at a point adjacent to the coolant charging valve.

**Pumps**

9. The two electrically driven pumps (Part No. SPE.16291) together deliver 520 gallons/hour  $\pm$  5 per cent at 20°C. The pumps have common inlet and outlet pipe lines, with non-return valves in the pump outlets. In the event of failure of one pump the other will circulate fluid at approximately 90 per cent of the normal rate.

**Reservoir pressurisation**

10. Air is tapped from the pneumatic feed to the inflatable seal at the rear end of the bomb bay to pressurise the coolant system to 10 p.s.i.g. From a tee-piece in the feed line to the seal, at a point just before the unimatic valve, the coolant system pressurisation pipe is led across to the starboard roof structure, from where it runs directly aft to the air inlet connection on the reservoir.

**Water/glycol circuit post Mod.2024 (fig.1A)**

10A. On aircraft with Mod. 2024 embodied the water/glycol delivery and return pipes extend forward to connect to the transmitter canister mounted in the compartment under the power compartment floor. To augment the flow, made necessary by the increase of the circuit, an additional elec-

trically-operated pump (Part No. S.P.E. 14703) is interposed in the delivery line from the two original pumps, downstream of the pressure switch connection (para.3). The restrictors fitted in the gallery delivery pipes are reduced in size to restrict the flow to the individual canisters as shown in fig.1A. The additional pipes and transmitter heat exchanger increase the capacity of the system to approximately 8 gallons.

**COOLING PACK****General**

11. The vapour cycle cooling pack (Godfrey, Type V.C.P. 1, Mk.1) is introduced to control the temperature of the coolant circulating through the heat exchangers of the E.C.M. canisters. The primary function of the pack is to absorb heat from the coolant at a low temperature level and then reject it to atmosphere at a higher level. This is achieved by using the heat removed by the coolant to evaporate the refrigerant at a low pressure and temperature, and then compressing the vapour to a higher temperature so that this heat, and the heat of compression, is transferred to a flow of ram air which condenses the refrigerant. This liquid, which is at condensing pressures and temperatures, is then cooled by expanding it through a valve between the condenser and evaporator.

12. The secondary function of the pack is to put heat into the coolant when the aircraft is operating in cold ambient temperature conditions and the temperature of the coolant is below, or tends to fall below the level necessary for maintaining the fixed evaporating temperature of the refrigerant. This is approximately 15°C.

13. The transformation of the pack into a heater automatically occurs when the compressor can no longer maintain its normal delivery pressure to the condenser. This is due to the fact that, with the pack operating in cold conditions, with no heat load to remove from the coolant, the

evaporating pressure will fall, while the condenser will become overcooled and absorb the compressor output at an excessive rate.

14. The effect of the reduced pressure is to allow a pressure-maintaining valve to close and so prevent further delivery to the condenser. This valve operates in conjunction with a by-pass circuit, which opens on reduction of the evaporating pressure and allows the hot compressed vapour to be returned directly to the evaporator. In this way, the heat of compression is used to restore and maintain the temperature of the coolant.

15. In operation, the compressor is protected by high pressure and high temperature switches, while a time delay device guards against a restart being made during run down.

16. The cooling pack consists of the following main components which are contained on a panel secured to the starboard structure of the rear fuselage by quick release Pip-pins:-

- (1) Compressor.
- (2) Vapour oil separator.
- (3) Liquid receiver (with level indicator).
- (4) Filter drier.
- (5) Manual shut-off valves A, B, C and L.
- (6) Manual servicing valves X and Y and condenser servicing valve.
- (7) Expansion valve.
- (8) Evaporator.
- (9) Pressure-maintaining valve.
- (10) Vapour control valve.



The circuit, after evacuation of all air, is charged with 12lb.  $\pm$  ½ lb. of this refrigerant. In the circuit the refrigerant will be in both the liquid and vapour state, the vapour pressure depending on the system temperature. The vapour pressure is increased by a small charge of nitrogen introduced into the system to act as a datum pressure. Although lowering the efficiency of the pack as a cooler, the nitrogen charge assists the recovery of the pack, when, in cold ambient temperature, it reverts to a cooler after a period of operation as a heater. While the pack is acting as a heater, the nitrogen prevents the pressure in the condenser falling to a very low value. An excessively low condenser pressure could so reduce the effect of the hot compressed vapour released when the pressure-maintaining valve opens, that the flow from the expansion valve would not be induced in sufficient time to counteract the heat load coming on the evaporator. This could result in a high temperature cut-out.

18. The compressor is lubricated with 350 c.c. of dehydrated Aeroshell Turbine 300 oil. The correct quantity for one charge is supplied in a sealed container (Ref.No. 34B/1430) which can be screwed into the filler orifice in the vapour oil separator. This enables a measured quantity to be squeezed into the separator without spillage. Drain plugs are provided in the base of the oil container, liquid receiver and evaporator.

18A. The handwheels of the manually operated valves, with the exception of the condenser servicing valve, are engraved with a letter to assist in identification, as follows:-

- A Shut-off valve at vapour oil separator outlet.
- B Shut-off valve at liquid receiver inlet.
- C Shut-off valve upstream of expansion valve.

- L Shut-off valve upstream of compressor liquid injection control valve.
- X Servicing valve at the vapour oil separator.
- Y Servicing valve at the liquid receiver.

#### Condenser and ram air intake

19. The Marston condenser (Part No. D1177/2A) is positioned in the ram air intake on the starboard side of the rear fuselage at former 120·251A. The intake is constructed in three sections, the front and rear sections being riveted to the fuselage skin. The centre section, attached by screws and anchor nuts, is removable to give access to the condenser which is secured to three fuselage brackets by shackle pins. The fore and aft ends of the condenser butt against the front and rear sections of the intake, where the joints are made by P-section rubber seals. Short inlet and outlet pipes integral with the condenser, pass through two holes in the fuselage skin to connect with the refrigerant return and delivery hoses. The nose portion of the ram air intake is removable and embodies an electrically-heated anti-icer which is operated in conjunction with the aircraft anti-icing system. Provision is made for checking the anti-icer by a push switch on relay panel 44P in the E.C.M. bay. The switch is labelled, DE-ICING TEST SWITCH FOR FREON COOLING INTAKE. MAX. TIME 'ON' 60 SECS.

#### Cooling operation

20. The cooling pack operates on the principle of vapour cycle refrigeration, that is, compression, cooling, expansion and heating. Heated, vapourised refrigerant at low pressure is drawn from the evaporator into the compressor where it is raised to condensation pressure. In the process of compression it also gains

further heat. Oil for lubrication of the compressor rotor and bearings is also drawn through the compressor from the oil container. The oil is discharged from the compressor with the refrigerant and both are passed into the vapour oil separator. The separated oil is piped back to the oil container for recirculation. The vapour is passed to the condenser mounted in the air flow. The cooling action of the ram air extracts the heat of evaporation and compression and the refrigerant vapour is converted to a liquid which, at condensing pressures and temperatures, is piped back to the liquid receiver mounted on the pack. The liquid refrigerant is then passed through the filter drier and shut-off valve C to the expansion valve and also via shut-off valve L and the liquid injection control valve to the inlet side of the compressor. On passing through the expansion valve the refrigerant drops in pressure and temperature and changes to a wet vapour. The expansion valve controls the rate of refrigerant flow to the evaporator where, under conditions of superheat, complete vaporisation takes place, the latent heat of vaporisation being given up to the refrigerant by the hot coolant from the E.C.M. canisters. The heated gas at low pressure now passes from the evaporator and the cycle is repeated.

#### Control

21. Operating control of the cooling pack is carried out by the following components, all of which are contained on the pack:-

- (1) Expansion valve.
- (2) Liquid injection control valve.
- (3) Pressure-maintaining valve.
- (4) Vapour control valve and vapour pressure sensing unit (V.P.S.U.).
- (5) High temperature switch.

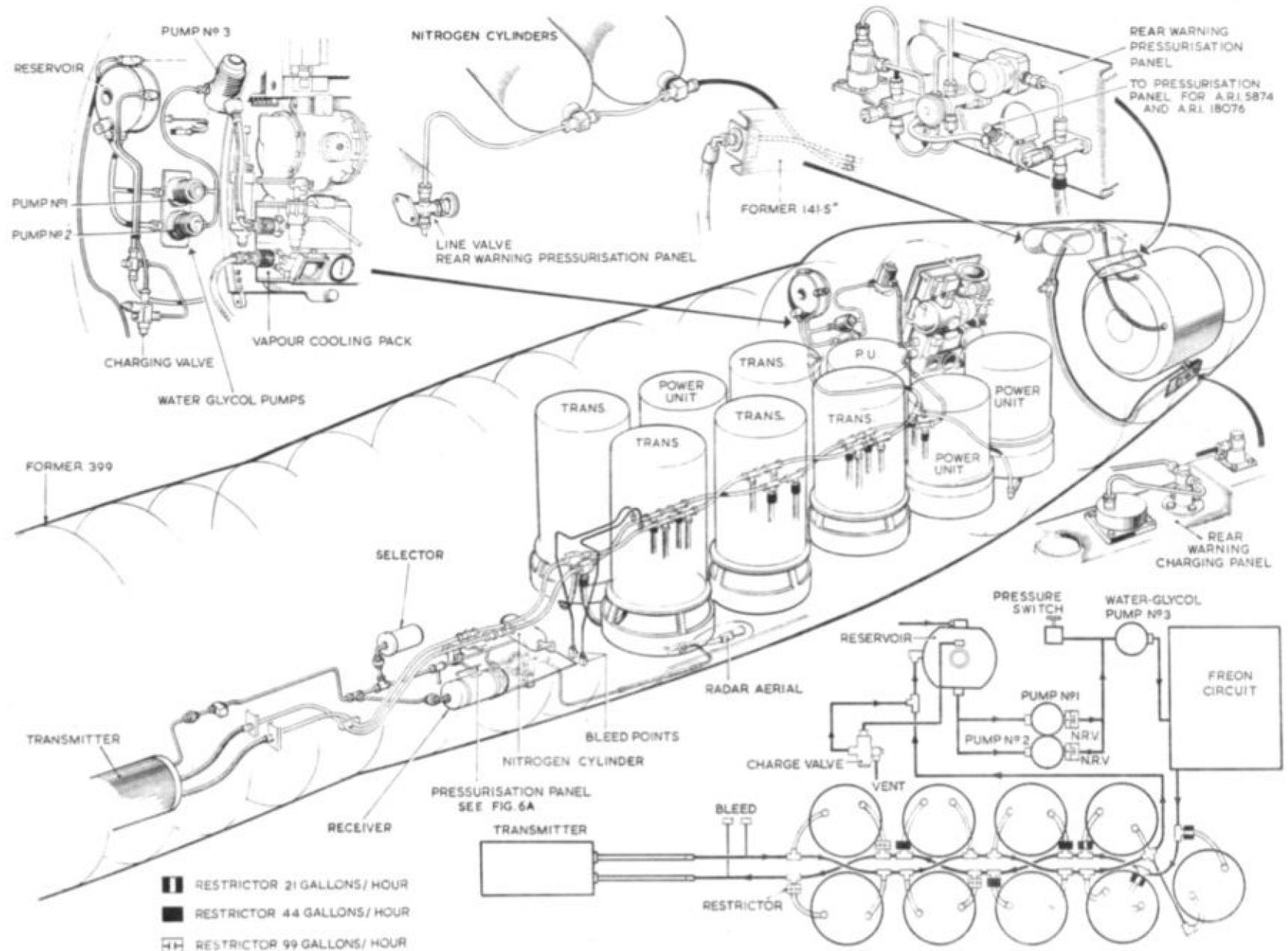


Fig. 2A Cooling system (post Mod. 2024 and 2193)

Mod. 2304

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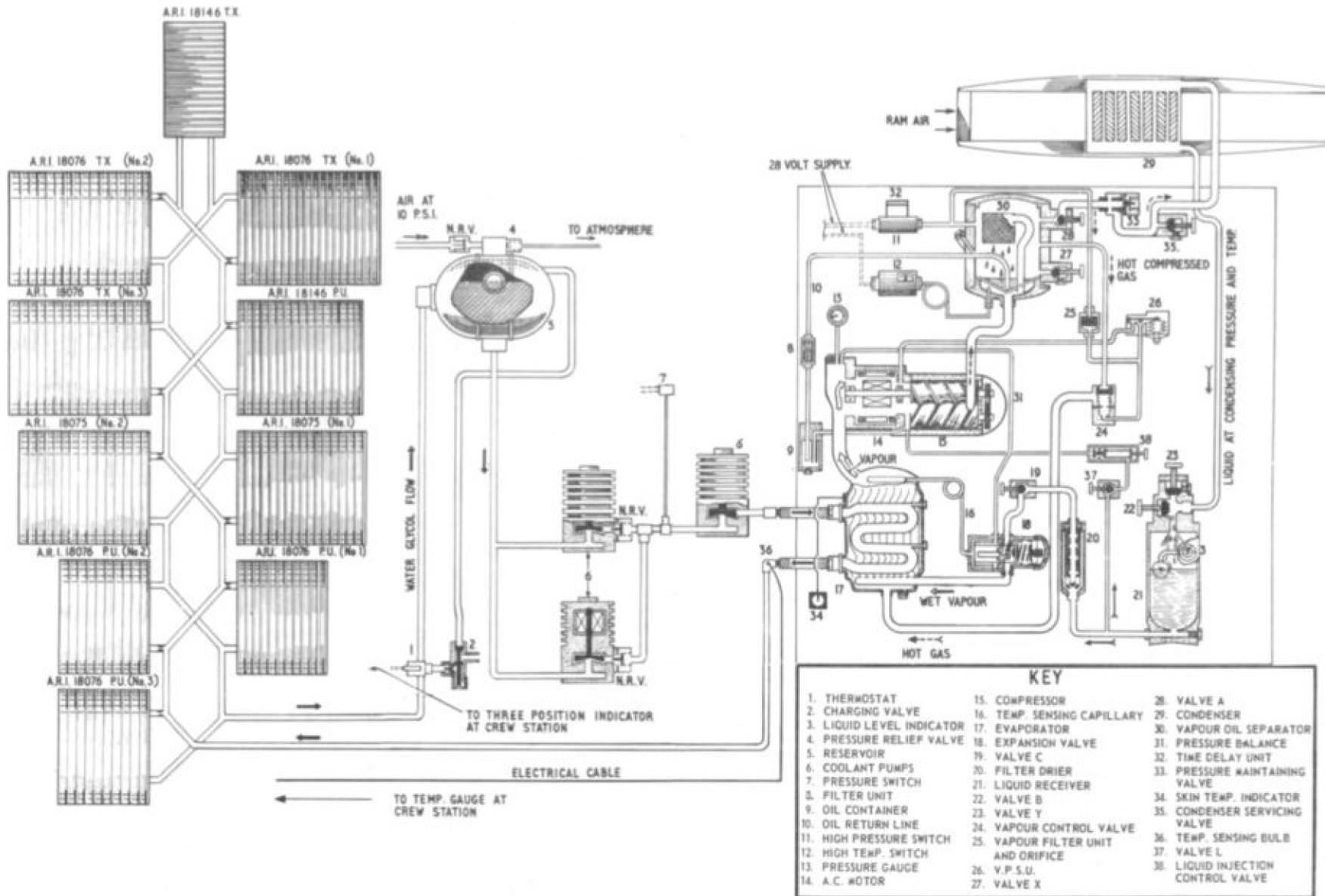
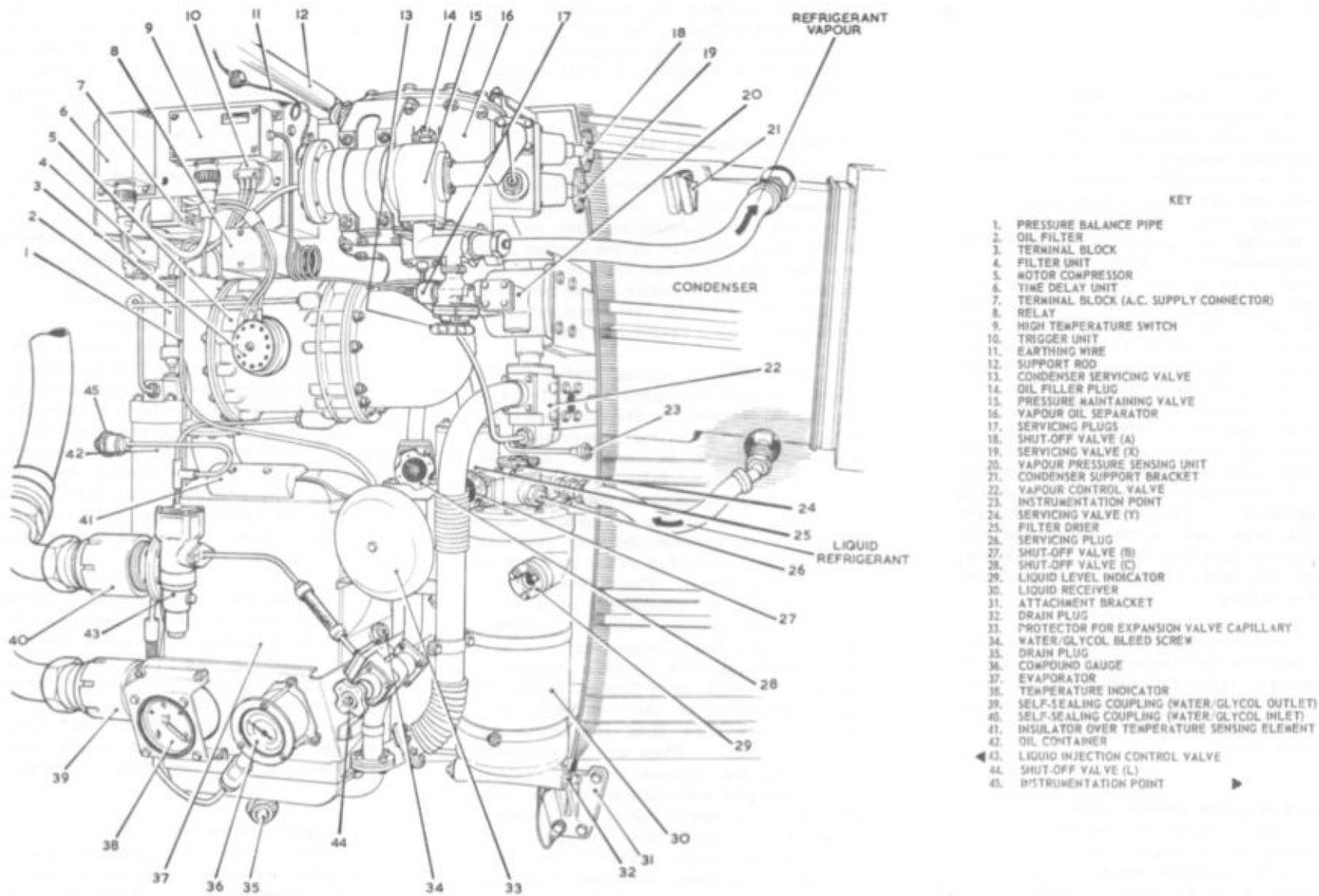


Fig.2B Cooling system diagram (post Mod. 2024)

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- KEY
1. PRESSURE BALANCE PIPE
  2. OIL FILTER
  3. TERMINAL BLOCK
  4. FILTER UNIT
  5. MOTOR COMPRESSOR
  6. TIME DELAY UNIT
  7. TERMINAL BLOCK (A.C. SUPPLY CONNECTOR)
  8. RELAY
  9. HIGH TEMPERATURE SWITCH
  10. TRIGGER UNIT
  11. EARTHING WIRE
  12. SUPPORT ROD
  13. CONDENSER SERVICING VALVE
  14. OIL FILLER PLUG
  15. PRESSURE MAINTAINING VALVE
  16. VAPOUR OIL SEPARATOR
  17. SERVICING PLUGS
  18. SHUT-OFF VALVE (A)
  19. SERVICING VALVE (X)
  20. VAPOUR PRESSURE SENSING UNIT
  21. CONDENSER SUPPORT BRACKET
  22. VAPOUR CONTROL VALVE
  23. INSTRUMENTATION POINT
  24. SERVICING VALVE (Y)
  25. FILTER DRIER
  26. SERVICING PLUG
  27. SHUT-OFF VALVE (B)
  28. SHUT-OFF VALVE (C)
  29. LIQUID LEVEL INDICATOR
  30. LIQUID RECEIVER
  31. ATTACHMENT BRACKET
  32. DRAIN PLUG
  33. PROTECTOR FOR EXPANSION VALVE CAPILLARY
  34. WATER/GLYCOL BLEED SCREW
  35. DRAIN PLUG
  36. COMPOUND GAUGE
  37. EVAPORATOR
  38. TEMPERATURE INDICATOR
  39. SELF-SEALING COUPLING (WATER/GLYCOL OUTLET)
  40. SELF-SEALING COUPLING (WATER/GLYCOL INLET)
  41. INSULATOR OVER TEMPERATURE SENSING ELEMENT
  42. OIL CONTAINER
  43. LIQUID INJECTION CONTROL VALVE
  44. SHUT-OFF VALVE (L)
  45. INSTRUMENTATION POINT

NOTE:  
LAGGING WHICH NORMALLY ENCLOSES ITEMS 15, 16, 20 AND 22  
HAS BEEN OMITTED IN ORDER TO SHOW COMPONENT DETAIL

Fig. 3. Cooling pack installation  
(Mod. 1972)  
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◀ (6) High pressure switch.

(7) Time delay unit. ▶

#### Expansion valve

22. The expansion valve, by controlling the rate of flow of the wet vapour available to the evaporator, determines the evaporating temperature. This is effected by a mechanism regulating the flow through the expansion valve orifice, the mechanism being controlled by a temperature sensing device mounted at the outlet of the evaporator. If the amount of refrigerant passing through the evaporator is not sufficient to deal with the heat given up by the circulating coolant, then the consequent rise in temperature at the evaporator outlet will cause the fluid in the sensing device to expand. This will open the expansion valve orifice to pass a greater quantity of refrigerant. The expansion valve will eventually stabilise itself to hold the evaporator outlet temperature at the required constant evaporating temperature. Conversely, any reduction of the heat load in the evaporator will reduce the flow from the expansion valve, which will again stabilise at the reduced orifice setting.

23. A pressure balance pipe is connected between the compressor inlet and the expansion valve to counteract the influence of the variable pressure drop across the evaporator on the action of the expansion valve.

#### Liquid injection control valve

◀ 24. This valve is sensitive to the pressure at its outlet and will open if the outlet pressure drops. Liquid refrigerant is tapped from the outlet of the liquid receiver and is piped through the shut-off valve L and the liquid injection control valve to the inlet side of the compressor. Appropriate to the pack operating conditions, a decrease in pressure at the compressor inlet allows

the injection control valve to meter a quantity of refrigerant direct to the compressor, by-passing the expansion valve and the evaporator. The valve reduces the system operating temperature and improves pack stability in cold running conditions. ▶

#### Pressure maintaining valve

25. This valve, positioned in the delivery line to the condenser, maintains a compressor delivery pressure that will, in low ambient temperatures when no heat load is being given up by the coolant, ensure that the pack operates to heat the coolant. The maintenance of the pressure is also necessary for the rapid recovery of the pack, from a heater to a cooler.

26. The valve is spring loaded to the closed position and opens when its bellows is compressed by delivery pressure. When the pack is cooling, the compressor delivery pressure is normal, and the valve is maintained fully open, allowing the hot vapour to pass to the condenser. If the heat load at the evaporator is reduced the compressor delivery pressure will fall and allow the valve to move to the closed position. The delivery pressure will then be maintained at a value equal to the spring loading. At this pressure, the hot compressed gas will be diverted into the by-pass system to operate the pack as a heater, while the vapour pressure in the condenser will fall and any flow from the expansion valve will stop. When the pack reverts to a cooler, the pressure build-up against the pressure-maintaining valve will, when the valve opens, result in a pressure surge of hot vapour into the condenser. This pressure surge, aided by the nitrogen datum pressure, will counteract the extreme cooling effect of the condenser and start a flow through the expansion valve.

#### Vapour control valve and V.P.S.U.

◀ 27. As the coolant heat load decreases,

the refrigerant flow from the valve approaches the minimum and the rate of heat extraction from the coolant is correspondingly reduced. When the coolant can no longer supply the heat necessary to maintain the evaporating temperature, the pressure will also fall. This pressure drop is sensed by the V.P.S.U. which, in turn, opens the vapour control valve.

28. The V.P.S.U. releases the pressure which normally holds the vapour control valve in the closed position. Hot compressed vapour from the compressor now passes through the vapour control valve, by-passing the condenser, and returns directly to the evaporator to restore the evaporating pressure. In conditions where the condenser is subjected to excessive cooling, the flow to the condenser is stopped by the pressure maintaining valve closing. In this case, the full flow from the compressor will be diverted into the by-pass system and the evaporator will become flooded with hot vapour. The setting of the V.P.S.U. is such that the vapour control valve will be fully closed when the coolant temperature rises to 25°C.

29. A pipe line, incorporating a vapour filter unit and orifice, is led from the vapour oil separator to join the sensing pipe connecting the V.P.S.U. to the vapour control valve. This orifice bleeds hot compressed gas to pressurise the vapour control valve bellows and maintain the valve on its seat at all times when the pack is not operating on by-pass.

#### High temperature switch

30. The system is guarded against excessive temperature by an automatic switch incorporating a temperature indicator. The switch is mounted on a panel adjacent to the vapour oil separator to which it is connected by a sensing line. When the temperature in the vapour oil separator increases beyond the specified maximum, the switch is operated to ▶

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break the 'hold on' circuit and stop the compressor. At the same time the indicator at the A.E.O.'s station will be de-energised to OFF and the action of the time delay unit will be started. Thus in order to make a re-start, three conditions must be satisfied, the temperature in the pack must drop below the specified minimum to allow the temperature switch to remake, the time delay period of one to two minutes must have elapsed and the ON push switch, at the A.E.O.'s station, must be pressed.

#### High pressure switch

31. If the pressure in the vapour oil separator rises above the specified maximum, a spring-loaded plunger in the switch is operated by a sensing line connected to the separator. The plunger operates a micro switch, with the same effect as the high temperature switch, and breaks the circuit to stop the compressor. When the pressure drops below the minimum level, the switch will remake and, provided the time delay period has elapsed a re-start can be made by pressing the ON switch.

#### Time delay unit

32. This unit ensures that when the compressor motor is switched off, either from the A.E.O.'s station or by the operation of the high temperature or high pressure switches, a restart cannot be made until a period of one to two minutes has elapsed. The compressor runs down in reverse, therefore if a restart were achieved during run down, severe overloading of the motor and compressor would occur. Thus the time delay protects the compressor until its rotation in reverse has ceased. The reverse run down is caused by the pressure differential between the vapour oil separator and the evaporator.

#### Condenser servicing valve

33. This valve, introduced by Mod. 1461, is fitted to the outlet of the pressure maintaining valve to enable any moisture that may have entered the condenser when disconnected from the pack to be drawn off by a vacuum pump, before opening valves A and B.

#### Cooling pack mounting and hoists

34. The cooling pack, mounted between the formers at 95.75A and 120.25A, is attached at its base by two lugs secured by Pip-pins to brackets on the starboard longeron. At the top of the pack is a single lug, to which is bolted a short rod, the other end of which is attached by a Pip-pin to a bracket on the underside of the brake parachute compartment. A slot and socket cut into the top lug, provides for the attachment of a minilift hoist cable when removing or installing the pack. The minilift hoist is attached to the roller on the underside of the cross beam at former 95.75A and the cable passed upwards through a hole in the cross beam, through a cable guide and over a pulley assembly. From the rear pulley of this assembly the cable is taken to the top of the pack.

#### CANISTER MOUNTINGS (pre Mod.2024)

##### General

35. The nine canisters, mounted in the rear fuselage, consist of six transmitter units grouped in two rows forward and three power units grouped at the rear. For a diagrammatic arrangement of the units refer to fig.1.

36. All the units are mounted upside down, with the coolant bleed plugs at the bottom. For this reason the canister heat exchanger must be filled and bled before fitment. On no account should the bleed plugs be slackened once the units are mounted in the aircraft, as they

will act as drains and allow air to enter the system.

37. To provide access to the equipment in the rear fuselage, three doors are positioned on the underside, between formers 487.5A and 120.25A (for former positions refer to Sect.3, Chap.1, Fig.1).

38. The canisters are supported at their bases by cross beams mounted on the two main longerons and at their tops to intercostals attached between the formers. On the top of each canister is a spider mounting, the arms of which are attached to three studs mounted on the end of the canister. Bolted to the centre of each spider is an anti-vibration mounting carrying an eyebolt and a cap-shaped spigot which locates in a cylindrical housing in the respective intercostal.

39. A mounting ring is bolted to the base of each canister and two plates are attached to the periphery of the ring by an anti-vibration mounting. Screw pins, carried in brackets on the cross beams, engage with holes in lugs on the plates to secure the whole assembly to the beams. Tufnol blocks, fixed to the base of the mounting rings, provide a stable support for the canisters during bay servicing and transportation and also prevent damage to the rings, when the canisters are being moved along a rough surface.

40. The screw pins have hinged thumb plates for tightening and locking purposes. After tightening, the thumb plates are folded so that their edges butt against the faces of the respective cross beams. The thumb plates are spring-loaded to the folded (locked) position. In the case of the screw pins at formers 487.5A and 120.25A the locking arrangement varies, in that the plates are folded to engage with a peg protruding from the flange of the screw pin bracket.

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### Canister hoist

41. Each canister has its own hoisting system, comprising pulleys and cables, incorporated in the aircraft structure. The system is used in conjunction with a mini-lift hoist. A typical arrangement consists of two single pulleys in the intercostal above the canister and a double pulley wheel mounted on an axle in a bracket attached to the cross beam. This bracket also contains the screw pins securing the base mounting of the canister.

42. The nipple end of the cable assembly is fitted into a recess in one of the outer flanges of the double pulley. The cable passes around the wheel and up to the pulleys in the intercostal, and thence down to the eye-bolt at the centre of the canister top mounting spider. The cable assemblies for hoisting the canisters between formers 22.25 and 46.75 pass through guides riveted to the rear face of former 46.75 before passing around the pulleys in the intercostal. A further recess, cut into the other outer flange of the double pulley wheel, accommodates the nipple end of a mini-hoist cable, when the hoist is secured by a special adapter to the attachment roller at the base of the double pulley wheel bracket. A Pip-pin which passes transversely through the pulley and bracket, locks the pulley against rotation after the canister has been installed.

43. On removal and assembly of a canister the mini-hoist is hooked into position on the roller and the cable nipple-end inserted into the slot of the double pulley. The Pip-pin is removed from the pulley and the mini-hoist cable tensioned to take the weight of the canister through the aircraft cable. The canister may now be released by removing the screw pins securing the base, then lowered. During lowering, the cable of the mini-hoist winds on to the wheel to which it is attached, whilst the aircraft cable unwinds to lower the canister.

44. During hoisting of the canister the action is a reversal of the above. When the canister is in

position and secured by the screw pins, the mini-hoist is unhooked and its cable disconnected. The Pip-pin is then inserted through the bracket and pulley wheel to lock the wheel against rotation. The wheel should be locked to take up as much cable slack as possible.

### Socket plates and ballast

45. Canisters are listed with the various items of 'service fit' equipment. Aircraft which are to become airborne without 'service fit' equipment require three ballast weights to be installed in the E.C.M. compartment. The three weights, together with stowage facilities for the air cooling pipes of the rear warning radar installation and for the E.C.M. water/glycol hoses and electrical cables in the rear fuselage, are installed in accordance with Part A of Mod.949. To meet the ballast requirements of aircraft which are to become airborne without the canisters, but with all other 'service fit' equipment present, six additional weights are to be installed in the E.C.M. compartment in accordance with Part B of Mod.949.

46. When incorporating Part A, three ballasted socket plates, containing lead and steel discs and each weighing approximately 245 lb are hoisted up in the same way as the canisters, and installed at the positions normally occupied by the three rear canisters. In addition, six socket plates, manufactured from Jabroc and weighing approximately 9 lb. each, are installed at the positions normally occupied by the six forward canisters. Part A also introduces a transportation panel for fitting in lieu of the rear warning radar unit. For details of the transportation panel refer to para.66.

47. The socket and ballast plates are similar to the canister base mountings in size, shape and means of attachment. At the centre of each plate is an eye-bolt to which the canister hoist

cable is attached for stowage or hoisting purposes. Cables attached to installed plates for stowage purposes, are made taut and the double pulleys locked against rotation. All the plates introduced by Part A incorporate stowage sockets and stowage couplings for the hoses and cables normally connected to the canisters. The couplings on each plate are linked by a bridge pipe so that the water/glycol circuit will be complete and ready to function at all times.

48. When incorporating Part B, six 245 lb. ballast plates are to be installed at the six forward positions; the three rear positions are to be occupied by the ballasted socket plates installed in accordance with Part A. There are no stowage facilities on the six ballast plates and so, the electrical cables are taped to suitable members, the fuses applicable to the cables are removed, the water/glycol system drained and the flexible hoses at the six forward positions are disconnected from the gallery. With the exception of one, the hoses are removed to store. The retained hose, (Pt.No.123/Q2111), is used to link the gallery feed and return pipes at the forward end; all other open pipe connections on the gallery are blanked. The circuit is inhibited by filling with water/glycol in accordance with para.76 (2) to (11). During the filling operation, the pumps will circulate the fluid via the link hose and the bridge pipes of the ballasted socket plates, to all parts of the piping. After the filling operation the fuses protecting the water/glycol pumps are removed. Periodic operation of the pumps, however, will prevent sludging of the water/glycol.

### Access doors

49. Each rear fuselage access door, which is of honeycomb construction and curved to conform with the fuselage con-

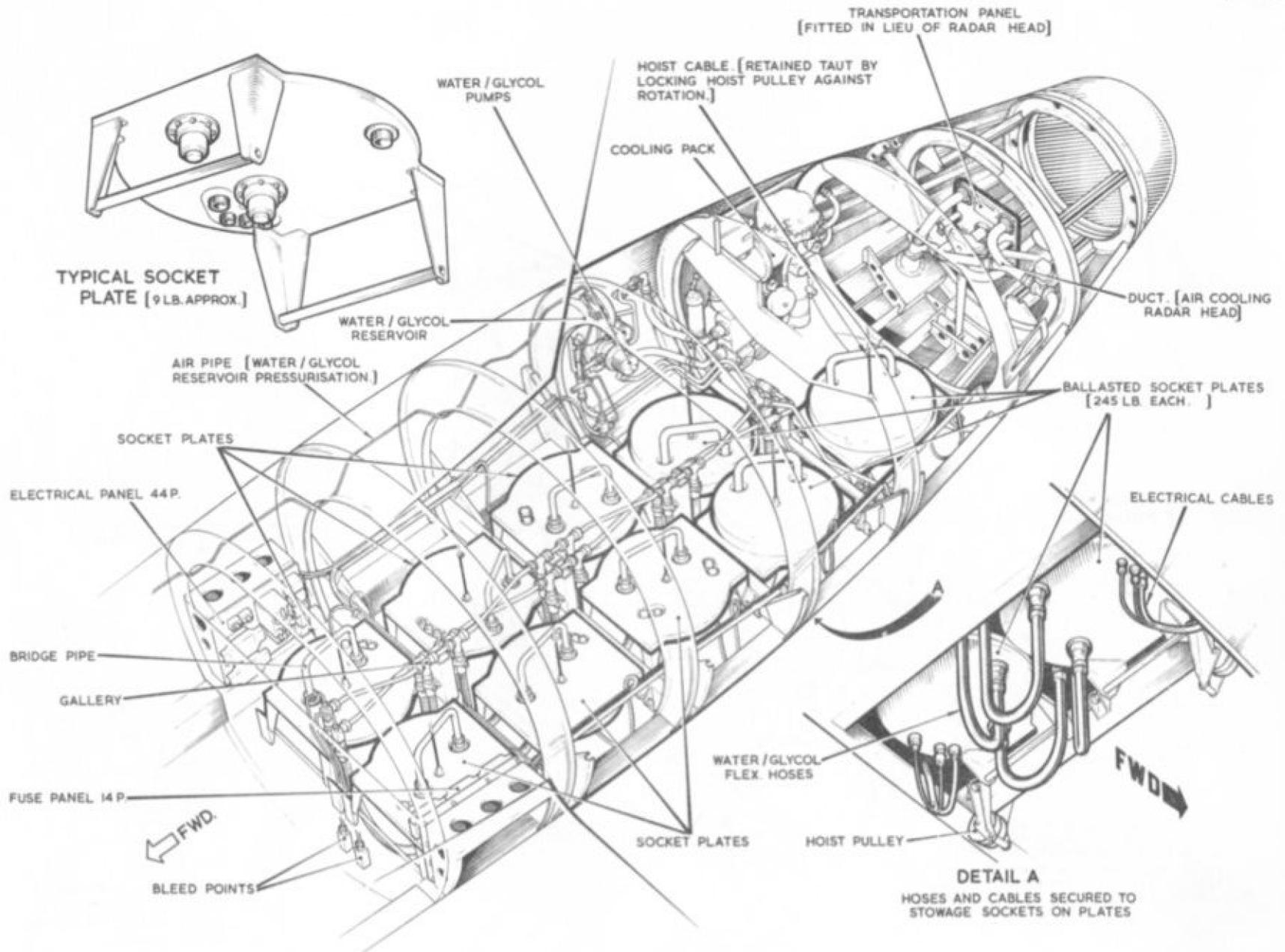


Fig. 4. E.C.M. ballast and stowage - Part A. Mod. 949

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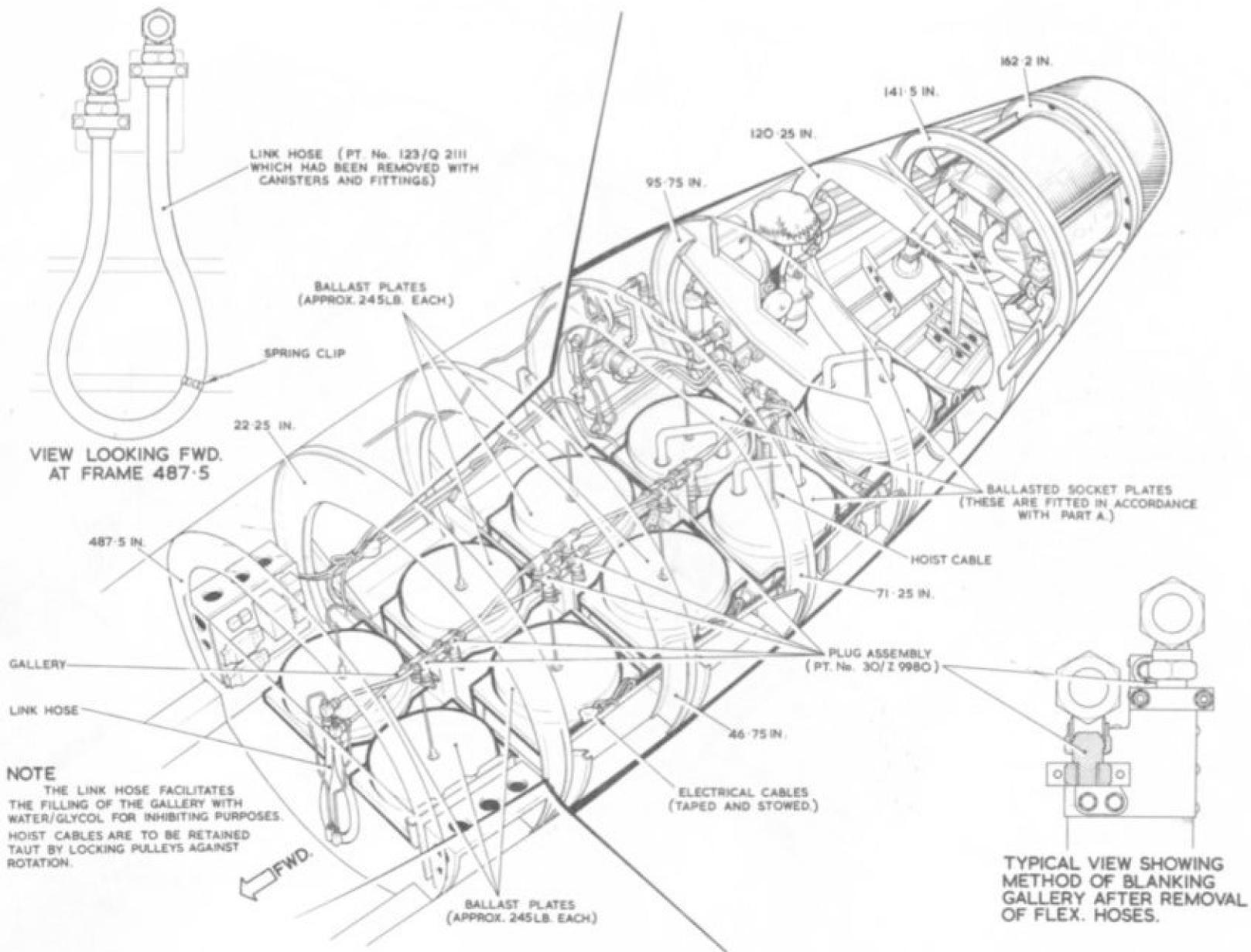
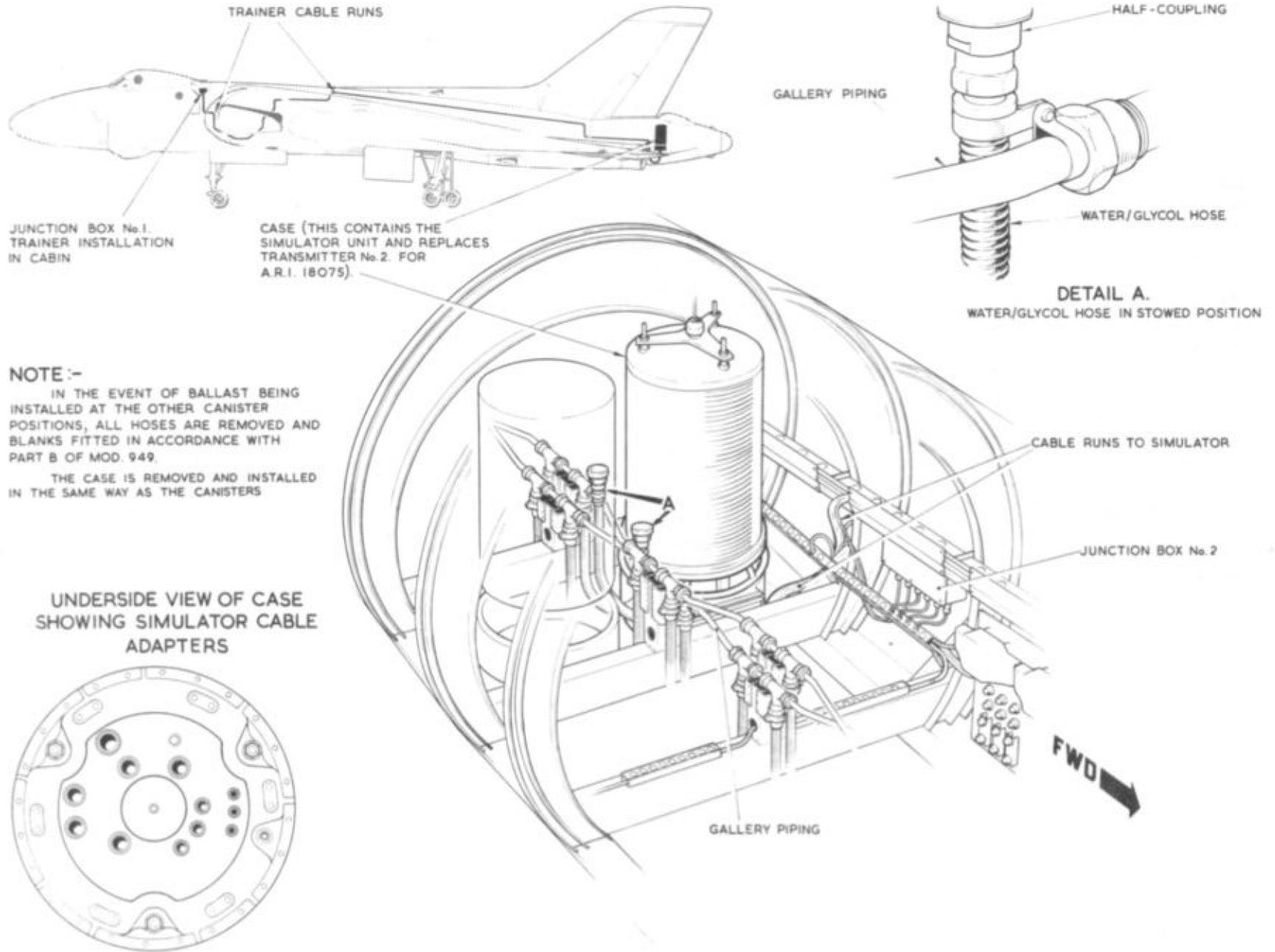


Fig. 5. E. C. M. ballast and stowage—Part B. Mod. 949

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**NOTE:-**  
 IN THE EVENT OF BALLAST BEING INSTALLED AT THE OTHER CANISTER POSITIONS, ALL HOSES ARE REMOVED AND BLANKS FITTED IN ACCORDANCE WITH PART B OF MOD. 949.  
 THE CASE IS REMOVED AND INSTALLED IN THE SAME WAY AS THE CANISTERS

UNDERSIDE VIEW OF CASE SHOWING SIMULATOR CABLE ADAPTERS

Fig. 6 E.C.M. trainer installation

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tours, opens downward on two arm type hinges let into the port longeron. The doors are fitted with press-to-release type fasteners, which engage with brackets recessed into the starboard longeron.

50. The doors, when closed, overlap from rear to front and must be opened in sequence commencing from the rear and closed in the reverse order. An access panel, in the centre of the forward door, provides access to a connection for a ground heater which is used, when necessary, for pre-heating the equipment in the rear fuselage. Ground lighting is provided by a lamp fitted to the inner face of each door.

51. A latch beam on the centre door and a support strut on the front and rear door, make provision for securing the doors in the open position. The struts brace the front and rear doors to the fuselage and the centre door is held when the latch is hinged over and secured with a Pip-pin to a bracket on the rear door. The struts and latch are stowed on the inner face of the doors prior to closing.

### EQUIPMENT INSTALLATION (Post Mod.2024)

#### Transmitter canister

51A. The transmitter canister is mounted in a cradle beneath the power compartment floor, between formers 370.0A and 428.0A, with its major axis parallel to the aircraft longitudinal axis and with its bleed plug at the rear. An access panel in the undersurface of the fuselage gives access to the transmitter. The cradle, which is installed and removed with the canister, has four attachment points which are secured with Pip-pins to eyebolts secured to anti-vibration mountings attached to the compartment side beams. A hoisting socket on top of the cradle provides for the attachment

of a mini-hoist cable ball end during removal and installation.

51B. An attachment bracket on the starboard lower side of former 384.5A in the power compartment, is provided for the attachment of the mini-hoist during removal and installation of the canister. Access to the bracket is through the power compartment access door. The mini-hoist cable passes inboard, over a pulley mounted on the power compartment floor and through a hole in the floor to engage with the hoisting socket on the canister cradle.

#### Receiver and discriminator

51C. The receiver and discriminator are secured with straps in cradles located between formers 461.5A and 472.5A in the rudder power flying control unit bay. The receiver is on the port side and the discriminator on the starboard. Both units can be manually removed from the cradles when all electrical cables and waveguides are disconnected and the securing straps undone.

#### Radar aerial

51D. The radar aerial is mounted at the front of the forward access door in the undersurface of the rear fuselage. A waveguide, connected to the aerial, must be disconnected prior to opening the door, access to the waveguide joint is through two circular access panels in the access door. Both circular panels are stencilled ACCESS TO WAVEGUIDE and a notice DISCONNECT WAVEGUIDE BEFORE OPENING THIS DOOR is stencilled adjacent to the two access panels. As the waveguide is pressurised, a manually-operated valve on the pressurisation panel (para.51E) must be closed before the waveguide is disconnected. A flexible hose incorporated in the waveguide

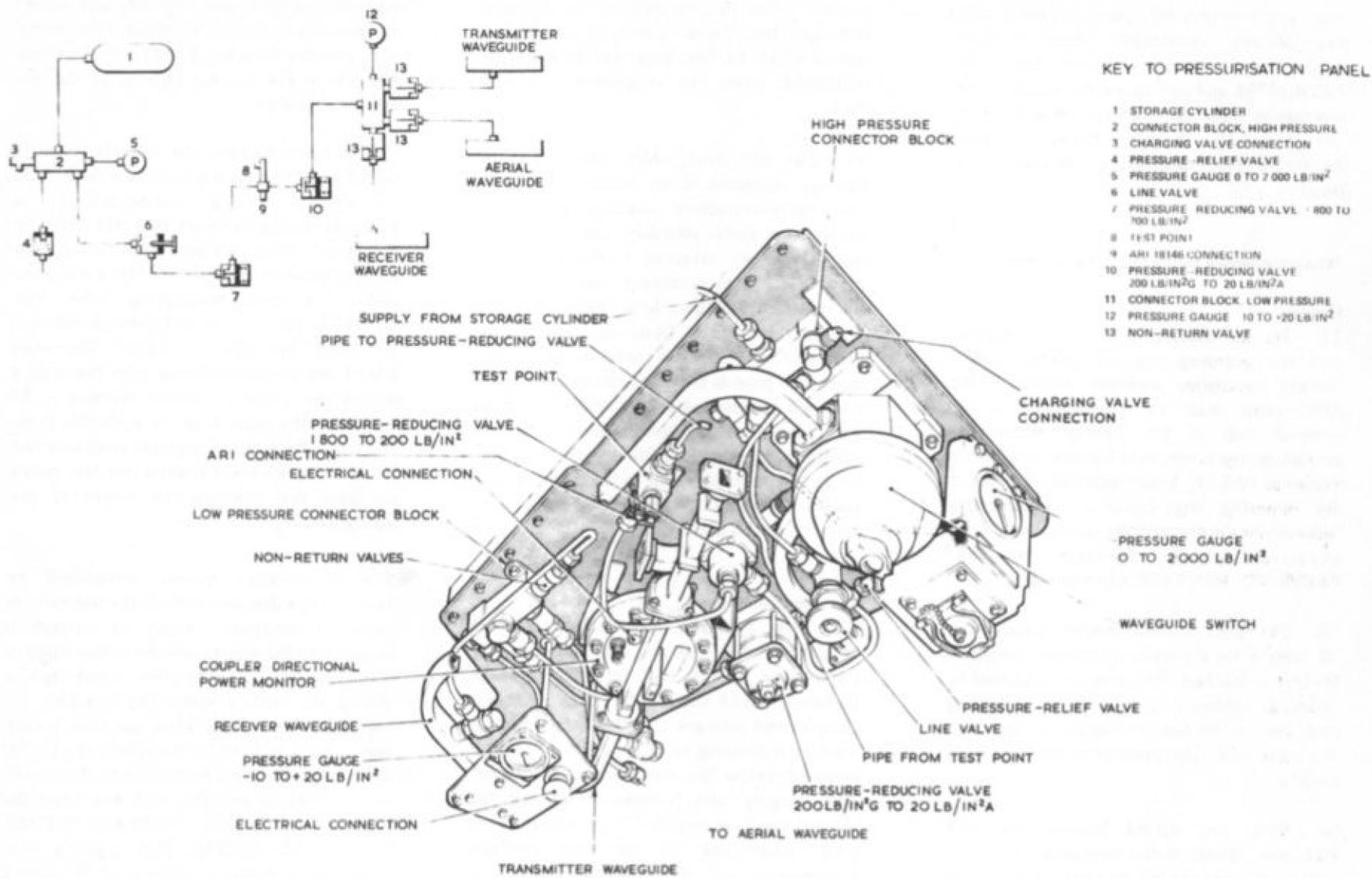
pressurisation pipe permits door opening without disconnecting the pipe.

#### Waveguide and A.R.I.18146 pressurisation

51E. The waveguides and A.R.I.18146 equipment are pressurised with nitrogen to 20 p.s.i.a. The nitrogen storage cylinder and pressurisation panel are located in the rear fuselage between formers 461.5A and 487.5A. The cylinder is installed in a cradle on the starboard side of the compartment and the panel under the centre floor, facing downward. Access to the panel is through a detachable panel in the undersurface of the rear fuselage.

51F. The Mk.5A storage cylinder Ref.No. 6D/9429890 of 750 litre capacity is charged to 1,800 p.s.i. from an external source through a charging valve Type D.C. 24 connected to the high pressure connector block at the front of the panel. The charging valve is located behind the access panel in the tail bumper structure. The connector block is fitted with three outlet connections, the first of which is connected to a 0-200 p.s.i.g. pressure gauge Ref.No. 6A/2689 mounted at the front of the panel. To the second connection, a pressure relief valve Part No. ACM 17728 to safeguard against overcharging while the third connection supplies high pressure nitrogen to a 1,800 to 200 p.s.i.g. pressure reducing valve Part No. A.C.M.16368 via a manually operated shut-off valve Ref. No. 6D/2118. From the pressure reducing valve, medium pressure nitrogen is fed to a connector block which incorporates a test point Part No. A58 or D.C.22 and a connection for the A.R.I.18146 system. From this tapping, a supply of medium pressure nitrogen is fed to the Transmitter, Selector and the Receiver of the A.R.I.18146. The third outlet connection feeds medium pressure nitrogen to a second pressure reducing valve Part

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KEY TO PRESSURISATION PANEL

- 1 STORAGE CYLINDER
- 2 CONNECTOR BLOCK, HIGH PRESSURE
- 3 CHARGING VALVE CONNECTION
- 4 PRESSURE-RELIEF VALVE
- 5 PRESSURE GAUGE 0 TO 2 000 LB/IN<sup>2</sup>
- 6 LINE VALVE
- 7 PRESSURE-REDUCING VALVE - 800 TO 700 LB/IN<sup>2</sup>
- 8 TEST POINT
- 9 ARI 18146 CONNECTION
- 10 PRESSURE-REDUCING VALVE 200 LB/IN<sup>2</sup>G TO 20 LB/IN<sup>2</sup>A
- 11 CONNECTOR BLOCK, LOW PRESSURE
- 12 PRESSURE GAUGE 10 TO +20 LB/IN<sup>2</sup>
- 13 NON-RETURN VALVE

Fig.6A Waveguide pressurisation panel

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No.A.C.M.25138 set at 200 to 20 lb/in<sup>2</sup> and then to a low pressure connector block with four delivery connections. Three of these incorporate non-return valves Part No. A.C.M.25794 and are connected to the three waveguides while the fourth is connected to a -10 to +20 lb/in<sup>2</sup> pressure gauge Ref.No.6A/3952 mounted at the rear of the panel.

### REAR WARNING INSTALLATION (Pre.Mod.2017)

#### General

52. The tail warning radar unit and scanner with the mounting ring and radome, form a quickly detachable assembly known as the 6932 radar head. It is positioned at the extreme end of the fuselage where the mounting ring mates with the rear face of the former at 162.2A. Four spigots, on the face of the mounting ring, locate in corresponding holes in the former and the whole assembly is secured to the fuselage by four PRESS-TO-RELEASE type fasteners.

53. The radar head is normally pressurised to 20 lb/in<sup>2</sup>a by a system completely contained in the rear fuselage. This pressure is retained by inflatable rubber ring seals on the mounting ring and on the heat exchanger integral with the radar unit. The pressure in the seals is 23 lb/in<sup>2</sup>a.

54. Ram air, ducted through the heat exchanger, dissipates the heat given up to that unit by the pressurising air which is circulated inside the radar head by a built-in fan. The ram air is admitted by a butterfly valve, which is controlled by a temperature sensing switch fitted to the heat exchanger. This arrangement prevents overcooling of the radar equipment in

cold ambient conditions, the ram air being shut-off when the temperature in the heat exchanger drops below -20 deg C. The valve is opened when the heat generated by the radar equipment raises the temperature to +10 deg C.

55. The radar head, which extends into the fuselage, is braced at its forward end by an anti-vibration structure consisting of a friction damper and spider assembly. The four feet of the damper are attached to the cooling air ports of the heat exchanger, and the arms of the spider are bolted to three fuselage brackets. A spigot, protruding from the spider centre, locates in a hole in the centre of the friction damper to provide the point through which the loads are transmitted to the spider. To guide the radar head on installation or removal, radially disposed rollers, fitted to the unit, bear on Tufnol strips attached to the crown of four guide rails which are secured by brackets to formers 141.5A and 162.2A.

#### Pressurisation system

56. Twin cylinders Ref.No.64Q/2110 are secured with straps and tension rod turnbuckles to the roof structure between formers 120.25A and 141.5A. Each cylinder is charged with nitrogen to 3 000 lb/in<sup>2</sup> through a nitrogen charging valve Type D.C.22 or A 58 mounted below the rear warning radar unit. This charging valve is accessible through the louvred panel secured by Dzus fasteners to the port underside of the rear fuselage. Incorporated on the charging panel is a Mk.14LL pressure gauge together with a unit pressure test point and these are visible on removal of the louvred panel. A relief valve set to relieve at a pressure of 3 300 lb/in<sup>2</sup> and to reseat at a minimum pressure of 3 000 lb/in<sup>2</sup>

is installed in the pipe between the charging valve and the cylinders. Both cylinders deliver nitrogen to a common line which is led across to a pressure-reducing panel located on the port side of the fuselage adjacent to the two nitrogen cylinders.

57. A hand-operated line valve is mounted on the pressure-reducing panel, the outlet side of which being connected to a pressure-reducing valve set at 3 500 lb/in<sup>2</sup> to 200 lb/in<sup>2</sup>. From this pressure-reducing valve medium pressure nitrogen is fed via a test point and a pressure-maintaining valve Part No.A.C.O.1564 to a second pressure-reducing valve set at 200 lb/in<sup>2</sup> to 23 lb/in<sup>2</sup>. The outlet side of this pressure-reducing valve passes via a second test point to deliver nitrogen at 23 lb/in<sup>2</sup>a to the radar head via a flexible hose. The line valve which is normally open is closed for servicing purposes and the two test points are used for checking the output of the reducing valves.

◀ 57A. A locking plate, introduced by Mod.2321, is designed to fit to the line valve to ensure a continuous supply of nitrogen is available to the various systems before flight or engine run (fig.7A). The plate, consisting of a slotted disc with a spring clip attached, fits over the valve spindle when the valve is fully open and is secured to the valve body by the spring clip. The plate is attached to the aircraft structure by a retaining cord and bears the inscription WARNING - REPLACE BEFORE FLIGHT OR ENGINE RUN together with fitting instructions on one side of the slotted disc and REMOVE TO CLOSE VALVE on the reverse side. ▶

58. Medium pressure nitrogen is fed from the pressure-maintaining valve Part No.A.C.O.1564

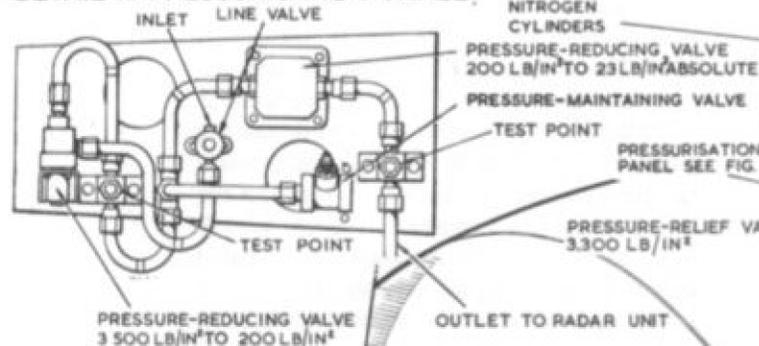
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on the pressurisation panel across the fuselage to the pressurisation panel for A.R.I.5874 and 18076. On aircraft post Mod.2321 a tapping is taken off this pipe to supply nitrogen through a pressure-reducing valve to the hydraulic reservoir and emergency power pack (Sect.3, Chap.6, para.9A). The A.R.I.5874 and 18076 pressurisation panel is located on the starboard side of the fuselage adjacent to the nitrogen cylinders. The supply pipe divides at a tee-piece on the panel, each pipe passing to a pressure-reducing valve. One valve Part No. A.C.M.25764 set at 200 to 30 lb/in<sup>2</sup> supplies low pressure nitrogen to a test point Part No. D.C.22 via a pressure-relief valve Part No. A.C.M.26758 set at 40 lb/in<sup>2</sup> and thence to the aerials on the counterpoise plates. The pipe from the other pressure-reducing valve Part No. A.C.M.21538 which is set at 200 to 20 lb/in<sup>2</sup> supplies low pressure nitrogen to a test point Part No.D.C.22 via a pressure-relief valve Part No. A.C.M.26760 set to 23 lb/in<sup>2</sup>a and thence to the Aerial Tuning Unit at the base of the fin aft of the leading edge. The test points in each pressure circuit are used to check the output of the reducing valves.

59. Within the radar head is an integral nitrogen circuit incorporating a pressure-differential valve and a non-return valve. The differential valve passes the nitrogen to inflate the seals to 23 lb/in<sup>2</sup>a and the unit to 20 lb/in<sup>2</sup>a. The non-return valve retains the pressure in the seals should the unit pressure fall due to leakage. In this way leakage past the seals is kept to a minimum. A safety valve is fitted to the casing of the radar unit to guard against excessive supply pressure. This valve is set to operate when the pressure differential between the unit pressure and the external pressure exceeds 26 lb/in<sup>2</sup>. A lamp lights on the indicator unit at the A.E.O.'s station when the radar head pressurisation is adequate and above 18.5 lb/in<sup>2</sup>a. The equipment is automatically switched off when the pressure falls below 13.5 lb/in<sup>2</sup>a. To facilitate checking the unit pressure, an extension pipe is run to a test point adjacent to the gauge and charging valve of the pressurisation system. A Schrader valve is provided on the top front face of the unit for deflating the seals. This valve is labelled DEFLATE SEALS.

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DETAIL A PRESSURISATION PANEL



TO COUNTERPOISE AERIALS (A.R.I. 18076)

SEE FIG. 7B

TO TUNING UNIT (A.R.I. 5874)

DEFLATE SEALS

PRESSURISATION PANEL SEE DETAIL 'A' SEE FIG. 7B

FLEXIBLE HOSE

BUTTERFLY VALVE

RAM AIR INTAKE

SAFETY VALVE

TEMPERATURE SENSING SWITCH

NITROGEN CHARGING PANEL SEE DETAIL 'B'

TEST POINT (UNIT PRESSURE)

THERMAL PRESSURE-RELIEF VALVE 3 300 LB/IN<sup>2</sup>

BOX STRUCTURE

FLOW DIAGRAM

SCHRADER VALVE (DEFLATE SEALS)  
PRESSURISATION PANEL SEE DETAIL 'A'  
COOLING AIR INLET MANIFOLD

DESICCATOR

GUIDE ROLLER

PRESSURE-RELIEF VALVE 3 300 LB/IN<sup>2</sup>

OUTLET TO RADAR UNIT

FRICTION DAMPER

AIR OUTLET MANIFOLD

BOX STRUCTURE AND ACCESS FOR GROUND COOLING CONNECTION

BUTTERFLY VALVE ACTUATOR

NITROGEN CHARGING PANEL SEE DETAIL 'B'

RAM AIR INTAKE

TEMP. SWITCH

LOUVRE PANEL

NITROGEN CHARGING ADAPTER

NITROGEN PRESSURE GAUGE

TEST POINT (UNIT PRESSURE)

SPIDER ASSEMBLY

LOUVRE PANEL ATTACHMENTS

DETAIL B NITROGEN CHARGING PANEL

Fig. 7 Rear warning cooling and pressurisation installation (pre Mod. 2321)

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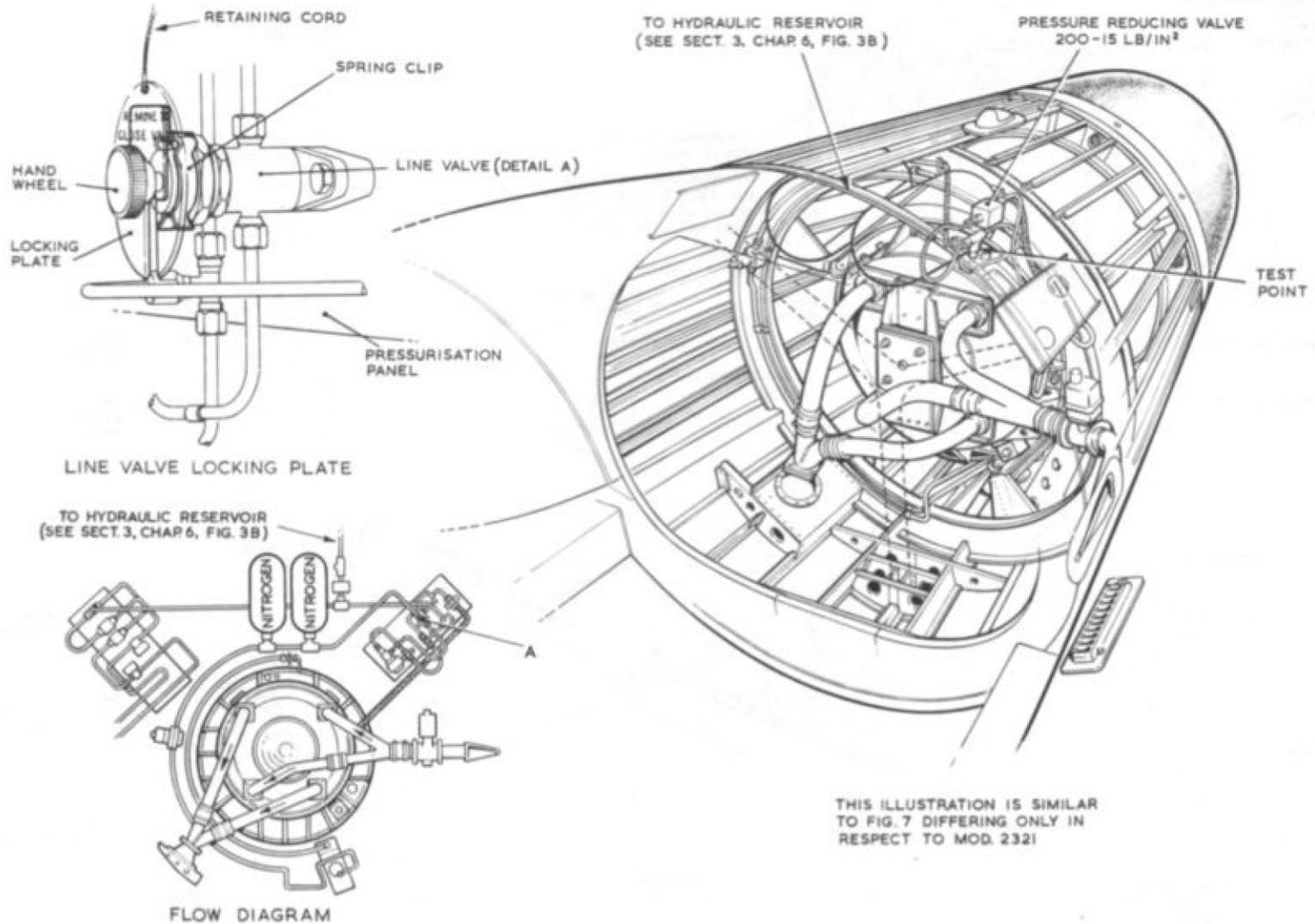
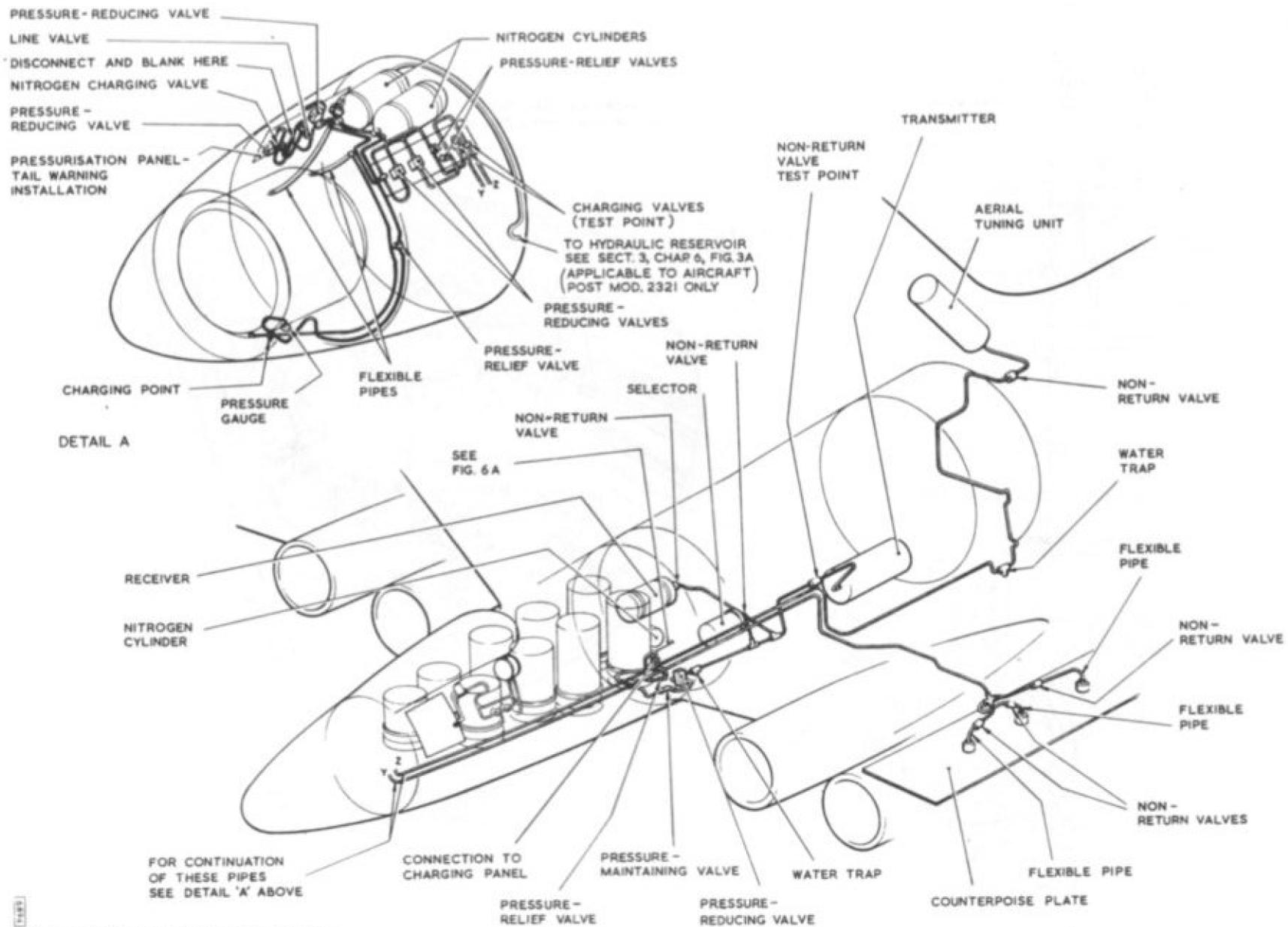


Fig. 7A Rear warning cooling and pressurisation installation (post Mod. 2321)

◀ New illustration ▶

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FOR FURTHER DETAILS SEE FIG. 2A

Fig. 7B Pressurisation of A.R.I. 18076 and 5874

◀ Mod. 2321 ▶

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- 1 AERIALS ON COUNTERPOISE PLATES
- 2 NON-RETURN VALVES
- 3 FOUR-WAY CONNECTION
- 4 BULKHEAD CONNECTION
- 5 TEST POINT
- 6 PRESSURE-RELIEF VALVE
- 7 PRESSURE-REDUCING VALVE 200-30 LB/IN<sup>2</sup>A
- 8 PRESSURE-REDUCING VALVE 200-20 LB/IN<sup>2</sup>A
- 9 TEE-PIECE
- 10 PRESSURE-MAINTAINING VALVE
- 11 TEE-PIECE
- 12 WATER TRAP
- 13 AERIAL TUNING UNIT

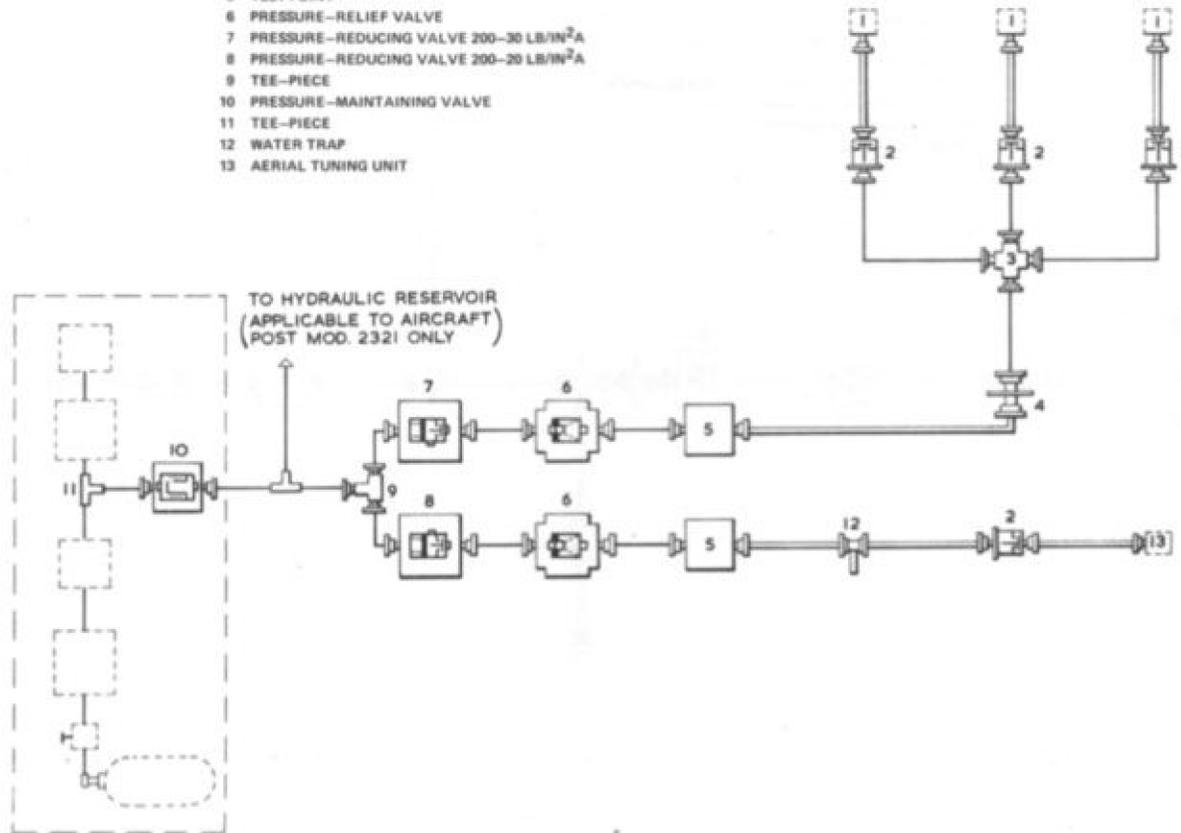


Fig.7C Pressurisation diagram A.R.I. 18076 and 5874

◀Mod. 2321▶

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- 1 RECEIVER
- 2 TRANSMITTER
- 3 CONTROL FREQUENCY SELECTOR
- 4 NON-RETURN VALVE
- 5 TEST POINT
- 6 TEE-PIECE
- 7 TEE-PIECE
- 8 NON-RETURN VALVE
- 9 WATER TRAP
- 10 PRESSURE-REDUCING VALVE 200-20 LB/IN<sup>2</sup>A
- 11 PRESSURE-MAINTAINING VALVE
- 12 BULKHEAD CONNECTION
- 13 BANJO UNION

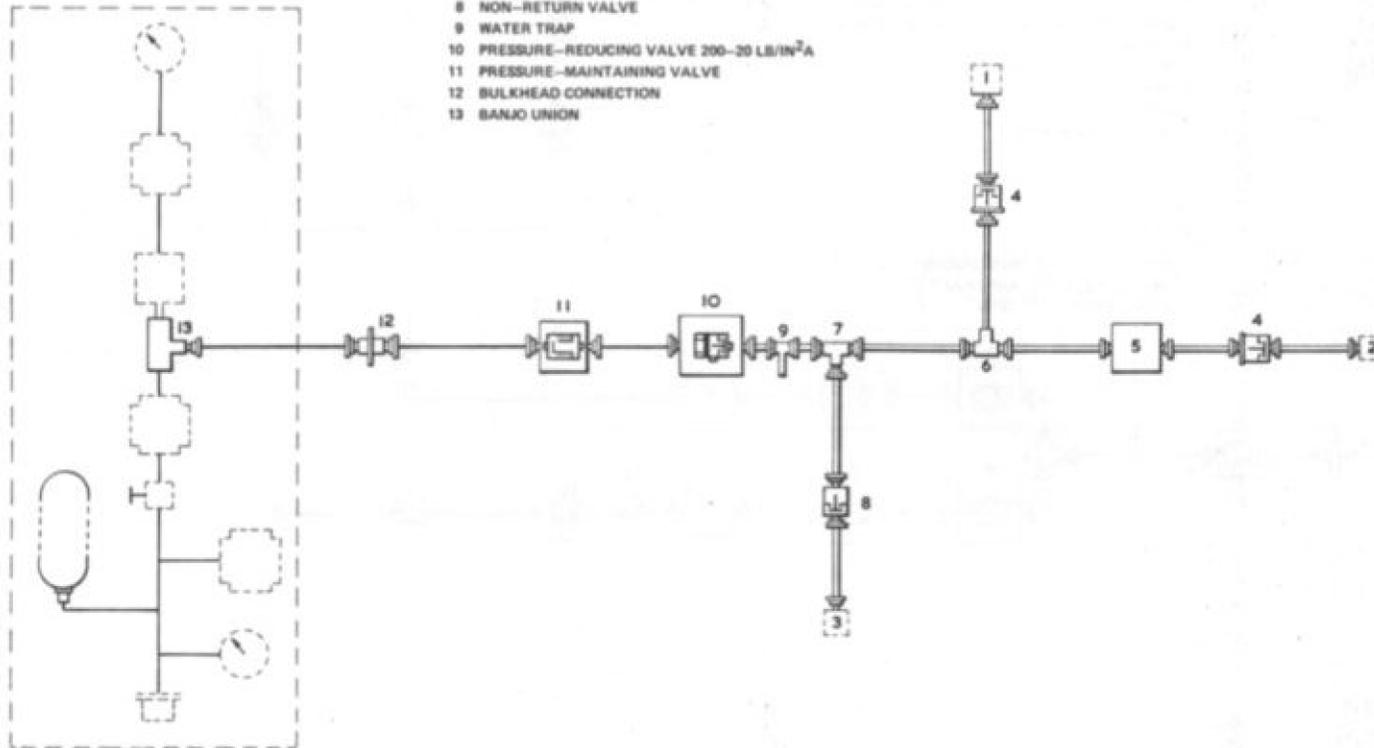


Fig. 7D Pressurisation diagram A.R.I. 18146

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**Cooling system**

60. The cooling air supply, admitted by the butterfly valve to the radar heat exchanger, is ducted from a flush intake in the port side of the rear fuselage. The butterfly valve is an electrically-actuated two-position type (Teddington Part No. P.M.P.5091) mounted inside the fuselage, with its inlet connected to the throat of the intake. The outlet side of the valve is connected to two inlet ports on the forward face of the heat exchanger, by a branched manifold assembly. With the butterfly in the open position, the cooling ram air circulates through the heat exchanger to pass from two exhaust ports into an outlet manifold.

61. The common extension of the outlet manifold leads down and connects to a box structure on the inside of the rear fuselage at the lower starboard side. The air is then dispersed from the lightening holes of the box, to circulate within the fuselage.

62. A removable round panel, let into the fuselage skin, gives access to the inside of the box structure and the connection for the delivery hose of a ground cooling trolley. Thus during ground operation of the radar unit, the cooling air flow through the heat exchanger is reversed.

**Louvre panel**

63. Ventilation of the rear fuselage is provided by the louvre panel which is removed to gain access to the nitrogen charging point

and gauge of the rear warning pressurisation installation.

**Radome and mounting ring**

64. The hemispherical radome is carried by the mounting ring to which it is attached by screws and anchor nuts. The ring is manufactured from aluminium-alloy and fitted to it are the four spigots and fasteners which locate and secure the assembly to the rear fuselage. Two inflatable seals are also fitted to the ring, one on its outer circumference and the other on its inner. The outer seal provides for sealing the radome at its base and the inner for sealing the joint between the radar unit and mounting ring.

65. The radome is made up of an expanded Hycar core overlaid with five layers of glass cloth on the outside and four layers on the inside, there being no lap joints in the scanned area. The inside surface is sealed with a Neoprene compound to D.T.D.926 and the outside finished in anti-flash white. Around the inside of the radome and concentric with the base, is an aluminium-alloy ring of continuous section and a smooth finish. The inflatable outer seal presses around the tip of this ring to make the pressure tight joint.

**Transportation panel**

66. This is provided for attaching to the anti-vibration spider in order to blank and support the air cooling pipes, if the aircraft is flown without the rear warning radar unit.

When it becomes necessary to use this panel, the line valve of the radar head pressurisation must be closed, the flexible supply hose blanked, the electrical leads taped and stowed and a radome and mounting ring fitted to act as a rear end fairing.

67. Fitted to the square Jabroc panel are three webbing straps, a positioning boss and a stowage compartment. The panel is secured to the spider arms by the straps and located to the spider spigot by the boss.

68. The panel is also fitted with nuts and bolts, these being necessary for attaching the coupling adapters which are normally fitted to the cooling air ports of the radar unit heat exchanger. When mounted on the panel, the adapters provide the attachments for the air cooling pipes. Being aircraft parts, the couplings are not supplied with the radar unit and so, when a radar unit is eventually fitted these couplings are readily available for transfer. The locking wire, washers and special bolts required for the fitting of the adapters to the radar head are contained in the stowage compartment.

**REAR WARNING INSTALLATION (Post Mod.2017)****General**

68A. Mod.2017 introduces a radar head 5841-99-954-7738 in lieu of radar head 6932. The pressurisation, cooling and mounting is identical to that given in para.52 to 68.

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## SERVICING

### WATER/GLYCOL SYSTEM

#### General

69. When servicing the water/glycol system ensure that:-

- (1) The ground equipment, for use with the system, is clean.
- (2) The coolant is not contaminated and is of correct specific gravity (A.P.1464B, Vol.1, refers).

#### NOTE...

*The coolant is a Sodium Benzoate inhibited glycol solution mixed with water in the volume ratio of 60 per cent glycol to 40 per cent water. It contains no dye.*

- (3) Disconnected pipes are blanked.
- (4) New pipes, couplings and components are cleaned and flushed before fitting.
- (5) Distilled or de-mineralised water is used for all flushing operations, (Chlorinated water must not be used).
- (6) Coolant spilled on the aircraft structure or installations, is removed immediately.

#### Draining

##### General

70. Draining of the water/glycol must be carried out bearing in mind that if the canisters are drained in-situ, they must be removed for filling and bleeding. If draining of the rest of the system is all that is required, then a lengthy servicing operation will be avoided if the quick-release self-sealing couplings are disconnected from the canisters before comm-

encing the draining operation. However, it is possible that some fluid may be lost from canisters as the couplings are being disconnected, resulting in the ingress of air. This loss is less likely to happen if the system is at a pressure of 10 p.s.i. during the disconnecting operation. To improve accessibility to the water/glycol reservoir, pumps and cooling pack, it is necessary that the rear starboard canister be removed.

#### Draining (pre Mod.2024)

71. The following procedure deals with the draining of that part of the system exclusive of the canisters:-

- (1) Disconnect the quick-release self-sealing couplings from the base of the canisters.
- (2) Attach suitable lengths of drain hose to the bleed screw nipples on former 487-5A and lead the hoses into the container. Open the bleed screws.
- (3) Obtain two fixed-half bayonet couplings (Lockheed Part No. AVX.3521 and AVX.3523) and with the valve ends of the two flexible hoses at the forward end of the gallery directed into the container, mate the two fixed-half couplings with the union-half couplings at the end of the hoses and allow the fluid to drain.
- (4) Remove the protection cap from the system charging valve and depress the piston valve. This will allow any fluid in the overflow line to drain off and also vent the reservoir.
- (5) When the fluid has ceased flowing from the two forward hoses and

bleed screws, remove the fixed-half couplings.

- (6) In turn, insert the fixed-half couplings into the ends of the remaining flexible hoses and drain the residual fluid.

#### NOTE...

*Should it be considered necessary to drain the fluid trapped because of the U-tube effect of parts of the system, then the appropriate pipe couplings will have to be disconnected.*

#### Draining (post Mod.2024)

71A. This procedure is the same as given in para.71 except that the two fixed-half bayonet couplings (Lockheed AVX.3521) and AVX.3523) are mated with union-half couplings on the hoses leading to the canister mounted beneath power compartment.

#### Flushing the system

72. The canisters are flushed (para.73) after their removal from the aircraft. The rest of the system is drained (para.71) and then filled with distilled or de-mineralised water in the same manner as for water/glycol filling (para.74). Flushing will take place during the water filling operation as this entails running the pumps for approximately 5 minutes. As soon as possible, after stopping the pumps, the water should be drained and checked for contamination. Repeat the flushing operation until no contamination can be detected.

#### Flushing the canisters and socket plates

73. To flush a canister, a quantity of distilled or de-mineralised water is poured

into the heat exchanger in the same way as for charging and bleeding (para.77). The heat exchanger is then rinsed by rocking and inverting the canister. Repeat this operation until the rinsing water is free of contamination. To flush the socket plates, open their self-sealing couplings and allow water to flow through the bridge pipes. Use appropriate hose-half couplings to open the socket plate couplings.

#### Filling and bleeding

##### General

74. In this operation it is assumed that the canisters, except for the one removed to give accessibility to the pumps, etc., are mounted in position having been filled and bled before fitment or are full from when previously isolated. The flexible hoses must not be connected to the canisters until the rest of the system has been filled and bled, and the bleed plugs in the base of the canisters must not be slackened. In order to charge and bleed the system, it is necessary to complete the circuit. To achieve this, when the flexible hoses are not connected to the canisters, each pair of flexible hoses are linked together by a coupling adapter (Ref. No. 26DC/95453) which consists of a short pipe with a fixed-half bayonet coupling (Part No. AVX.3521) fitted to one end and a similar coupling (Part No. AVX.3523) fitted to the other.

75. The system is charged by a 10 gall. fluid replenishing can (Ref.No. 4G/5378). This is pressurised with air and connected to the charging valve by an adapter (Part No. AVA.1186C) and a reducing adapter (Ref.No. 4G/5795). To prevent the pressure air entering the system during the charging operation, the can must not be allowed to become empty of fluid. This is particularly important when topping up, after the system has been bled.

#### Filling and bleeding (pre Mod.2024)

76. Ensure that the can is full of correctly mixed and tested fluid, then proceed as follows:-

- (1) Fit a coupling adapter to each pair of flexible hoses. This will complete the water/glycol circuit normally made through the heat exchangers of the canisters.
- (2) Isolate the cooling pack compressor motor from the electrical supply by disconnecting fuse No. 701 on panel 48P.
- (3) Attach lengths of rubber hose to the nipples of the bleed screws on the evaporator and the rear face of former 487-51A. Lead the hose into suitable containers and open the bleed screws.
- (4) Attach the replenishing can delivery gun to the system charging valve. This action will depress the piston valve and open the overflow to atmosphere.
- (5) Pressurize the can, open its delivery valve and operate the charging gun to allow the fluid to fill the system. Continue to fill as the fluid runs from the bleed screws. Close the bleed screws.
- (6) Switch on the water/glycol pumps and allow the coolant to circulate for about 5 minutes.
- (7) In turn, open the bleed screws. Close the bleed screws when the flow from them becomes steady and air free.
- (8) Slacken the union at the pressure switch, in order to break any airlocks in the small bore pipe. Tighten the union.

- (9) Slacken the union at the high point of the common delivery pipe from the pumps and bleed. Maintain the fluid at sight glass level to ensure a positive bleed. Tighten the union.

#### NOTE...

*Rags must be placed under the unions to absorb the bled fluid.*

- (10) Top up the fluid to sight glass level.
- (11) Pressurize the system to 35 p.s.i.g. and check for leaks (para.78 to 81). If no leaks are detected and the fluid level remains visible, the system is ready for connecting the flexible hoses to the canisters. If, however, the level is not visible and no leaks are detected, then the system is not completely bled. Release the air pressure and repeat op.(6) to (10). Again raise the system pressure to 35 p.s.i.g. and confirm that the level remains on the sight glass.
- (12) When the level check is satisfactory, reduce the pressure on the system to 10 p.s.i.g. and disconnect the coupling adapters from the flexible hoses. Lock all the bleed screws and pipe unions.
- (13) Install the rear starboard canister with its heat exchanger full of coolant.
- (14) Check that the system pressure is at 10 p.s.i.g. then couple the flexible hoses to the canisters. As each canister is connected into the system, check the reservoir fluid level. Provided the connections are made cleanly any appreciable lowering of the level will indicate air in the heat exchanger

of the particular canister. This will entail the removal of that canister for filling and bleeding.

- (15) When all canisters are satisfactorily connected, increase the pressure in the system to 35 p.s.i.g. and check the quick-release couplings for signs of coolant leaks.
- (16) Release the air pressure and remove all charging and test equipment. Ensure the removal of the blank from the pressure-relief valve vent pipe. Fit fuse No.701.

#### *Filling and bleeding (post Mod.2024)*

76A. This procedure is identical to that given in para.76 except that an additional adapter (Ref.No. 26DC/95453) is required to couple the flexible hoses leading to the canister under the power compartment.

#### **Charging and bleeding a canister**

77. A canister is filled when supported so that the heat exchanger is uppermost. To facilitate filling, two union half bayonet couplings (Part No. AVX.3520) and AVX.3522, 3 pin and 4 pin respectively) are fitted to the water/glycol inlet and outlet connection on the heat exchanger. This action will maintain the self-sealing valves in the open position. The bleed plug is removed and the unit is filled with the correct mixture of water/glycol until all air is expelled. Tilting the canister in various directions will ensure thorough bleeding. When correctly filled the bleed plug is tightened and locked, the couplings removed and the canister inverted. In this position the self-sealing valves and bleed plugs are checked for seepage. If satisfactory, the unit is ready for mounting in the aircraft.

#### **Pressure testing**

78. A full pressure test entails checking for the following:-

- (1) Fluid and air leaks.
- (2) Inadequate bleeding.
- (3) The correct operation of the high pressure switch.
- (4) The correct functioning of both valves in the reservoir combined air inlet and pressure relief assembly.
- (5) The satisfactory pressurising of the reservoir from the ancillary supplies pneumatic system.

79. With the fluid at the correct level, the test pressure is introduced through the overflow outlet of the water/glycol charging valve, with the piston valve of that unit held in the open position.

80. The items of ground equipment necessary for pressure testing are; a foot pump, a lamp and battery, a suitable means of blanking the reservoir pressure relief valve vent pipe and a test adapter (Ref.No. 26DC/95457). This consists of a connector pipe fitted with a Schrader valve, a pressure gauge and a bayonet type coupling, the latter being attached to the pipe by a short chain. The coupling is fitted to the water/glycol charging connection in order to maintain the piston valve open, and the pipe, with its gauge and valve, is attached to the overflow outlet to indicate the test pressures and act as the air charging point.

#### *NOTE...*

*To prevent flooding the test gauge the overflow line should be drained by fitting the bayonet coupling before the pipe assembly. For the same reason no attempt should be made to top up the system or operate the water/glycol pumps whilst the pipe assembly is still fitted.*

81. Remove the rear starboard canister to

give accessibility to the system, then proceed as follows:-

- (1) Withdraw the electrical connection from the pressure switch.
- (2) Connect a lamp and battery to the switch.
- (3) Fit the pressure test adapter to the water/glycol charging valve. Connect the foot pump to the Schrader valve of the adapter.
- (4) Blank the vent from the reservoir pressure-relief valve.
- (5) With the lamp and battery switch depressed (the light should be on), raise the pressure in the reservoir. When the pressure switch is operated and the light goes out, the pressure in the system should be 29 to 32 p.s.i.g. Reduce this pressure, gradually, until the light comes on. This also should occur within this pressure range.
- (6) Raise the system pressure to 35 p.s.i.g. and check the whole system for air and coolant leaks. Air leaks, as indicated by the pressure gauge, may be external from the reservoir and its overflow and pressure relief pipes, or internal to the ancillary supplies pneumatic system. An internal leak can be caused by the malseating of the non-return valve in the pressurisation air inlet on top of the reservoir. To check for an internal leak: disconnect, at the rear bomb-bay bulkhead, the line to the reservoir, and apply a soap solution to the pipe end. External leaks may also be detected with a soap solution.
- (7) If no leaks have been detected, check the fluid level in the

reservoir; this should still be visible. If it is not, the system requires bleeding. First, release the pressure on the system, then slacken the bleed screws and the union at the high point of the common outlet pipe from the pumps and release any air trapped at these points. Top up the fluid and pressurize to 35 p.s.i.g. Should this operation prove that air is elsewhere in the circuit it will be necessary to disconnect all the flexible hoses from the canisters and repeat the procedure in para.76 (6) to (16), first removing fuse No. 701 and the pressure test adapter.

- (8) Assuming the level has remained visible, ease the blank from the pressure-relief valve vent pipe so that the pressure reduces slowly to the reset pressure of the relief valve. The pressure gauge must indicate not less than 7 p.s.i.g.
- (9) Increase the pressure until the relief valve blows. This must be between 15 and 18 p.s.i.g.
- (10) Reduce the pressure to zero.
- (11) Inflate the ancillary supplies pneumatic system (Sect.3, Chap.7) and check that the reservoir pressurizes at 10 p.s.i.g.
- (12) Remove the lamp and battery and connect the electrical lead to the

pressure switch. Ensure that all bleed screws and pipe unions are locked.

- (13) Install the rear starboard canister. Following the procedure in para.76 op.(14) to (16), connect the flexible hoses to this unit.

#### Testing the pumps

##### General

82. For the test it is necessary to ensure that the pressure switch is set to within 29 to 32 p.s.i.g. and that the canisters or socket plates are connected into the system. One pump at a time is operated. This test which enables the flow and the non-return valves to be checked simultaneously, depends on the fact that a pump operating with the correct performance will pass the required flow with a known pressure rise across the pump. The pressure rise across an operating pump is determined by increasing the reservoir pressure to an amount which is just sufficient to operate the pressure switch. The difference between the reservoir pressure and the switch setting pressure is, therefore, the pressure rise created by the pump.

83. When the pressure switch operates, the electrical supply to the pump will be interrupted, the pump delivery pressure will fall and the switch will remake. This action will be repeated with such rapidity that the pump will continue to run accompanied by a 'chattering' of the 'hold on' relay in the electrical supply circuit

to the pump. A 230 volt lamp, plugged into the lead from the other pump, will give a flickering light indication when the pressure switch operates. If the reservoir is pressurised in excess of the minimum necessary to operate the pressure switch, a false result will be obtained. Excess pressures may be introduced unless the operator is aware that the indications of the interrupting action of the switch will continue with rising pressure, up to the point where the pump finally stops.

##### Testing the pumps (pre Mod.2024)

83A. The test is as follows:-

- (1) Isolate the cooling pack compressor motor from its electrical supply by removing fuse No. 701 on panel 48P.
- (2) Disconnect the electrical lead from the pressure switch.
- (3) Check the pressure switch for correct operation (para.81 op.(2) to (5)). Note the minimum operating pressure.
- (4) Connect the electrical lead to the pressure switch.
- (5) Reduce the reservoir pressure to 10 p.s.i.g.
- (6) Disconnect the supply lead from the lower pump. Connect the lead to a 230 volt test lamp.

- (7) Run the remaining pump.
  - (8) Slowly increase the reservoir pressure until the pressure switch operates. Audible indication given by the relay in the pump electrical supply circuit; visual indication by the test lamp.
  - (9) Note the reservoir pressure. This pressure subtracted from that noted in op.(3) must give  $8.5 \pm 1$  p.s.i.
  - (10) Repeat the test for the other pump.
  - (11) Connect both pumps and remove all test equipment. Replace fuse No.701 removed in op.(1).
- NOTE...*  
*Reduced output may be due to the non-return valve of the other pump seating incorrectly.*
- Testing the pumps (post Mod.2024)*  
 83B. This test is as follows:-
- (1) Isolate the cooling pack compressor motor from its electrical supply by removing fuse No.701 on panel 48P.
  - (2) Disconnect the electrical lead from the pressure switch.
  - (3) Check the pressure switch for correct operation (para.81 op.(2) to (5)). Note the minimum operating pressure.
  - (4) Connect the electrical lead to the pressure switch.
  - (5) Reduce the reservoir pressure to 10 p.s.i.g.
  - (6) Disconnect the supply lead from pumps No.1 and 3.
  - (7) Connect the lead from No.1 pump to a 230 volt test lamp.
  - (8) Run No.2 pump.
  - (9) Slowly increase the reservoir pressure until the pressure switch operates. Audible indication given by the relay in the pump electrical supply circuit; visual indication by the test lamp.
  - (10) Note the reservoir pressure. This pressure subtracted from that noted in op.(3) must give  $8.3 \begin{smallmatrix} + 2 \\ - 1 \end{smallmatrix}$  p.s.i.
  - (11) Repeat the test for No.1 pump.
  - (12) Disconnect the electrical supply lead from No.1 pump. Connect the lead to No.3 pump, check that this pump runs when it is switched on.

- (13) Connect the supply leads to No.1 and 2 pumps. Remove all test equipment and replace fuse No. 701 removed in op.(1).

*NOTE...*

*Reduced output may be due to the non-return valves, in the delivery pipes from No.1 and 2 pumps, seating incorrectly.*

## COOLING PACK

**General**

84. The satisfactory operation of the cooling pack depends upon all air being eliminated from the system. Therefore, once the air has been evacuated, every precaution must be taken to prevent its entry, particularly during the refrigerant and nitrogen charging operation. Water vapour and dirt can also have a detrimental effect should they enter the pack, so, during servicing, blanks must always be fitted to valve ports and disconnected pipes. Charging lines must be purged with nitrogen before use.

85. The equipment necessary for charging and testing the pack whilst it is installed in the aircraft is:-

- (1) Servicing trolley (Ref.No.4G/6582). This contains a motor driven vacuum pump, plastic connecting hoses and a height gauge calibrated in inches and millimeters.

- (2) A refrigerant container fitted with a shut-off valve and charged with 12 lb.  $\pm$  1/2 lb. of Arcton 11.
- (3) A spring balance suitable for weighing the container.
- (4) A five-way charging manifold (Ref. No.4G/6634).
- (5) Ground cooling trolley (Ref. No. 4F/2584 or 4F/2396).
- (6) Adapter (Part No.U.1655) which is used to connect the hose of the ground cooling trolley to the rear end of the condenser ram air intake.
- (7) 350 c.c. of Aeroshell Turbine oil 300 in a sealed container.
- (8) A nitrogen cylinder fitted with a fine-adjusting pressure-regulator valve.
- (9) Trolley, detector, leak, refrigerant, (Ref.No.78AA/118).
- (10) Reducing unit, nitrogen (Ref.No. 6D/2184).

86. The shut-off valve on the refrigerant container will be referred to as valve G. The valves on the five-way manifold are marked as follows:-

	Marking
Vacuum pump connector valve	H
Nitrogen supply connector valve	N
Arcton 11 connector valve	R

87. The gauge on a pack is read off the outer scale, the inner scale being applicable to other refrigerants. A zero indication of the gauge denotes a pressure of one atmosphere at the compressor inlet. Below the zero, the outer scale has a calibration for depressions in

inches of mercury, down to 30 inches. Thus a gauge indicating 10 in. denotes a depression of 10 in. Hg. below one atmosphere. Above the zero, the gauge is calibrated in p.s.i.

88. On charging with refrigerant the vapour pressure will be relative to the system temperature. At 15°C the refrigerant vapour pressure is such that a depression of approximately 9 in. Hg. should be indicated by the gauge. The

nitrogen charge, which is introduced after refrigerant charging, is specified as the amount required to raise the pressure, in a system at 15°C, to 15 p.s.i. absolute (approx. zero gauge). Therefore, at 15°C, the pressure rise due to the nitrogen is 9 in. Hg. or 4 1/2 p.s.i. As the pressure/temperature relationship of nitrogen and Arcton 11 is practically the same over the temperature range that charging is likely to be carried out, the temperature factor may be ignored, and the system is correctly

TABLE 1

Pressure/temperature table of Arcton 11 plus nitrogen

Temperature indicator reading	Gauge reading in. Hg. depression		Gauge reading p.s.i.g.	
	A	B	A	B
Deg. C.				
-30	18	to 12		
-25	17	to 11		
-20	15	to 9		
-15	14	to 8		
-10	12	to 6		
- 5	10	to 4		
0	8	to 2		
5	6	to 0		
10	3	to 0	...	...
15			0	to 1
20			3	to 4
25			5	to 6
30			8	to 9
35			11	to 12
40			15	to 16
45			19	to 20
50			24	to 25
55			29	to 30
60			35	to 36

NOTE...

Select the nearest temperature reading to the temperature observed on the indicator then read off the corresponding pressure readings. The tolerances between the readings in columns A and B are permissible. Temperature readings are to be taken when temperatures throughout the system have become even.

charged when nitrogen is gradually introduced until the gauge indicates a pressure which is  $4\frac{1}{2}$  p.s.i. above the vapour

pressure indicated after refrigerant charging.

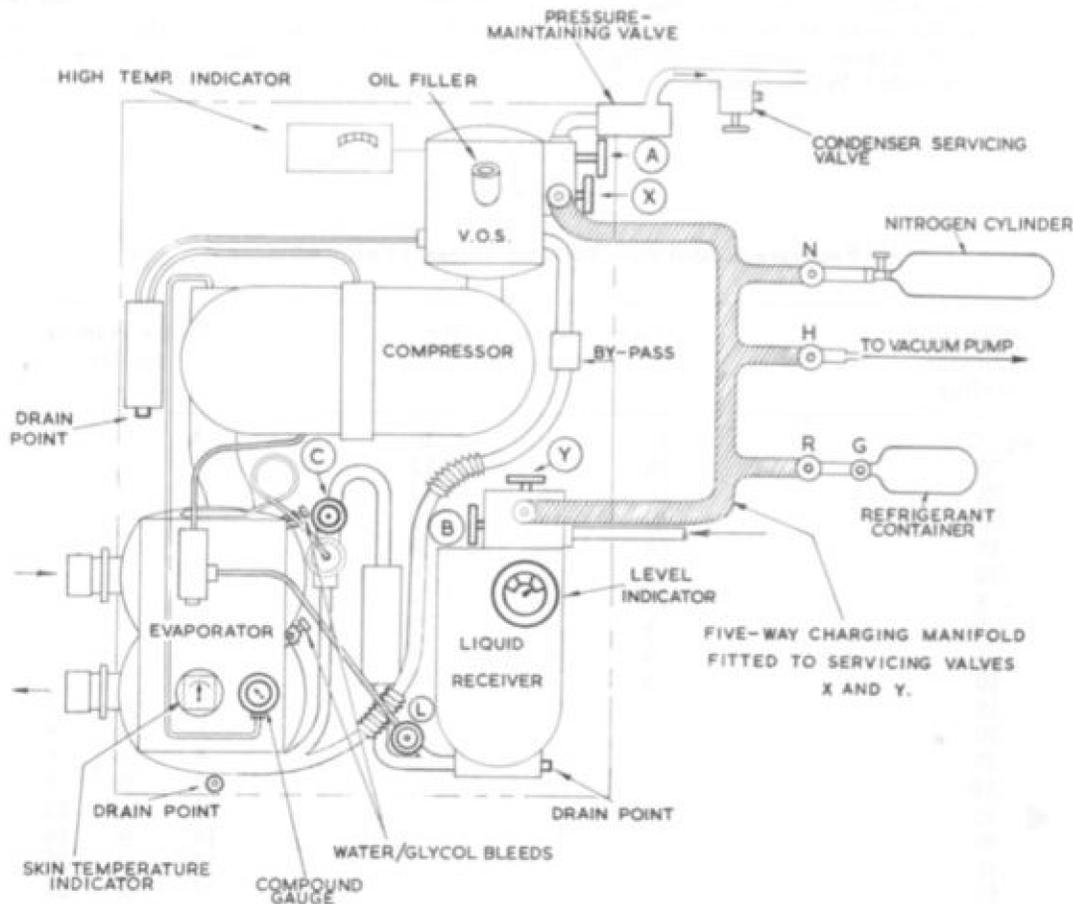


Fig. 8. Cooling pack servicing diagram  
(◀ Mod. 1972 ▶)

89. Table 1 is used in conjunction with the skin temperature indicator in order that an additional check may be carried out on a pack which has soaked to an even temperature; for instance, after an overnight standing period. Outward leaks or air contamination can be suspected if the gauge indicates a depression or pressure which, when related to the system temperature, is not within the limits given in the table.

90. The skin temperature indicator, calibrated from  $-80^{\circ}\text{C}$  to  $+80^{\circ}\text{C}$ , indicates the temperature of the system for reference in conjunction with Table 1. The indicator sensing element, in the form of a resistance bulb, is wired to the indicator which is connected to the 28-volt d.c. supply. Because the evaporator remains relatively cool at all times, the indicator will not record true system temperature until a considerable period has elapsed after a pack has ceased to operate. For this reason the use of the indicator is limited to systems at ambient temperature throughout.

91. An operating pack which develops a small leak on its pressure side will steadily lose refrigerant and nitrogen but should continue to operate satisfactorily for some considerable time. The pump down operation, (para.96) will eventually indicate this loss. If the leak is on the suction side, air will be induced and malfunctioning will rapidly ensue.

92. A standing pack, at a temperature whereby the system pressure is above ambient, will also lose refrigerant and nitrogen through a leak. Conversely, at system pressures below ambient, air could leak into the system. Inward leaks tend to zero the gauge fairly rapidly, therefore, a gauge indicating a lesser depression than that permitted in

Table 1 is an indication that a leak has occurred.

93. It must not be assumed that inward leaks have occurred if the gauge reads approximately zero when the system temperature is in the region of 15°C. At this temperature the relative system pressure is, in any case, near zero.

#### Oil charging

94. Before introducing the oil into the pack, ensure that the pack is completely drained, otherwise this oil may be additional to a previous charge. To do this, carefully unscrew the drain plug in the base of the oil container, check that no oil flows from the drain and then immediately tighten the plug. The charge of 350 c.c. of oil, in the sealed container (Ref.No.34B/1430) is introduced into the pack before charging with refrigerant. Proceed as follows:-

- (1) Remove the servicing plug adjacent to valve X, connect a nitrogen supply to the valve, open valve X and introduce nitrogen at a rate just sufficient to maintain a nominal pressure, above ambient, within the pack to prevent the ingress of air during the oil charging operation.
- (2) Unlace the small flap on the lagging gaiter enclosing the vapour oil separator to expose the oil filler plug. Unlock and remove the oil filler plug.
- (3) Break the plastic seal on the oil container but do not break the wire seal. Pull the plug from the top of the container, then screw the container nozzle into the filler plug orifice. Inject the contents of the container into the vapour oil separator by squeezing the container body. Close valve X, remove the nitrogen supply and loosely refit the servicing plug.
- (4) Unscrew the container from the

filler plug orifice, fit the oil filler plug and wire-lock the plug. Lace up the flap on the gaiter.

#### Charging with refrigerant and nitrogen.

95. This operation is carried out after the pack has been charged with oil. First ensure that all shut-off and servicing valves, except valves C and L, are closed and then proceed as follows:-

- (1) Remove the servicing plugs adjacent to valves X and Y.
- (2) Close valves R, H and N on the 5 way manifold and connect the manifold to the servicing plug holes at valves X and Y as shown in fig.8.
- (3) Check weigh the Arcton 11 cylinder to ensure that the refrigerant content is 12 lb.  $\pm$  ½ lb. Connect the charging line to the cylinder.
- (4) Position the cylinder on a servicing platform placed adjacent to the condenser ram air intake. Pass the free end of the charging line through the access hole in the ram air intake fairing and the hole through which the condenser inlet pipe enters the fuselage. Connect the charging line to valve R on the manifold.
- (5) Connect the line from the servicing trolley vacuum pump to manifold valve H.
- (6) Connect the line from the nitrogen cylinder reducing valve to manifold valve N.
- (7) Open valves X, Y, A, B, R and N.
- (8) Start the vacuum pump, then open valve H and evacuate the system until the servicing trolley vacuum gauge reads 8 mm. Hg. Leave

the pump running for a further 5 minutes after obtaining this reading, then close valve H and disconnect the vacuum pump line. Stop the vacuum pump.

#### NOTE...

*If the pump is stopped before disconnecting, the oil in the pump will be sucked into the line.*

- (9) Check that the vacuum is holding by reference to the pack gauge.
- (10) Ensure that the Arcton 11 cylinder is inverted and the charging line connecting valves G and R has a continuous downward run. Shut valve X.
- (11) Open valve G and allow the total contents of the cylinder to drain into the pack.
- (12) Close valves G and R and disconnect the cylinder. Check weigh the cylinder to ensure that the 12 lb. refrigerant charge has entered the system.
- (13) Note the reading of the pack gauge. Establish the pressure the gauge will indicate when the system pressure is increased by 4½ p.s.i. (Allow 1 p.s.i. for every 2 in. Hg.)
- (14) Open valve X, then gradually open the nitrogen supply valve until the pack gauge indicates the established pressure.
- (15) Close valves X and Y, disconnect the nitrogen line and the manifold.
- (16) Fit the servicing plugs to valves X and Y. Wire-lock all valves and servicing plugs, ensuring that valves A, B, C and L are open.
- (17) Replace the cover plate on the

access hole in the ram air intake fairing.

#### Checking the refrigerant content

96. The quantity of refrigerant in the pack is checked by the level indicator on the liquid receiver which has a dial with a green, yellow and red sector. When the pack cools after a period of operation, the refrigerant that condenses in the condenser will gravitate into the liquid receiver. If the indicator pointer moves into the yellow or green sectors then the refrigerant content of the pack may be regarded as satisfactory. If however, the pointer remains at red, an outward leak may have occurred. To ensure that the refrigerant is not in the rest of the system it will be necessary to carry out a pump down. This entails closing valves C and L and running the compressor until the refrigerant is transferred to the receiver. If this operation does not cause the indicator to move to the green sector, check the system with the leak detector as soon as possible after the compressor has stopped. Unless a leak, which entails simple rectification is detected, the pack should be removed and a replacement fitted. Leaks usually result in the loss of an unknown quantity of oil. Therefore, after rectification, the system should be drained and completely recharged.

97. It is permissible to run the compressor for a period of two minutes, from a cold start, without ground cooling for the condenser. Within this period, a satisfactory pump down can be achieved. However, if the coolant temperature is very low, the pack will operate initially with the pressure maintaining valve closed and the transfer may not be effected within the two minutes. After the pump down, lock valves C and L in the open position.

#### Periodic checks

98. At the specified servicing period, the pack is checked for leaks and correct operation. Ground cooling must be provided

for the condenser unless the check can be concluded within two minutes (para.97). During the check the pointer on the high temperature switch should remain stationary. Proceed as follows:-

- (1) Check the reading on the compound gauge and temperature indicator and then refer to Table 1 to ensure that the pressure is correct for the observed temperature. This check is only applicable if the system is at the same temperature.
- (2) Check that the level indicator is in the yellow or green sector. If it is at red then carry out the pump down procedure (para. 96).
- (3) Start the motor compressor to check for free rotation and noise level (a continuous high-pitched noise).
- (4) Check the compound gauge. This should indicate between 5.5 in. Hg. and 15.0 in. Hg.
- (5) Check, during the run, that the liquid level indicator moves towards the red sector. This will indicate that the expansion valve is operating.
- (6) Stop the compressor and check the complete system with the leak detector.

#### Draining

##### WARNING...

*The liquid refrigerant is injurious to the eyes, therefore goggles must be worn while draining the system.*

99. The system is drained as follows:-

- (1) Remove the servicing plugs from valves X and Y and open these valves gradually. This will reduce pressures to ambient.
- (2) Remove the drain plug from the liquid receiver and drain the re-

frigerant into a spare can. Replace the plug.

- (3) Remove the drain plug from the oil container and drain the oil. Refit the plug.
- (4) Remove the drain plug from the base of the evaporator and drain any liquid from this point. Replace the plug.
- (5) Fit the five-way manifold and either completely charge the system with oil and refrigerant, or, inhibit with nitrogen (para.100).

#### Inhibiting

100. Drained packs are inhibited with nitrogen as follows:-

- (1) Remove the servicing plugs from valves X and Y. Open these valves.
- (2) Fit a five-way manifold (fig.8).
- (3) Connect a vacuum pump to valve H.
- (4) Connect a nitrogen supply to valve N.
- (5) Ensure valves R and N are closed then open valve H and evacuate the system to 8mm. Hg. absolute. Close valve H and disconnect the vacuum pump. Stop the pump.
- (6) Open valve N, gradually, and allow the nitrogen to fill the system. Close valve N when the pack gauge indicates approximately 20-25 p.s.i.g.

##### WARNING...

*On no account must a pressure of 30 p.s.i.g. be exceeded, otherwise the evacuated capsule of the V.P.S.U. will be damaged.*

- (7) Close valve X and Y, and remove the equipment.
- (8) Replace the servicing plugs in valves X and Y.
- (9) Record the pack pressure, the ambient temperature and date, on a label. Attach the label to the pack.

#### Drying out the condenser

101. For this operation it is assumed that Mod.1461 is embodied and that valves A and B have not been opened since the condenser was connected to the pack. Proceed as follows:-

- (1) Remove the sealing plug from the condenser servicing valve.
- (2) Connect a vacuum pump to the condenser servicing valve.
- (3) Start the vacuum pump, open the condenser servicing valve and then blow warm air into the rear end of the condenser ram intake.
- (4) Evacuate the condenser to at least 8mm. Hg. absolute. Close the servicing valve approximately 15 min. after the 8mm. reading is attained and then discontinue the warm air. Disconnect the vacuum pump. Stop the vacuum pump.
- (5) Replace the sealing plug.

#### REAR WARNING INSTALLATION

##### General

102. If a radome is removed to gain access to the scanner etc., care must be taken not to damage the dome portion in any way. It is also essential to ensure that the alloy ring, inside the radome, is kept perfectly clean and not scratched. The smooth finish of the ring is essential for ensuring a pressure tight joint; minute

scratches can cause leakage.

#### WARNING...

*A damaged radome must not be used. Its reduced strength makes it a source of danger owing to the possibility of an explosive rupture. The strain imposed on a weakened radome will become greater and failure more likely to occur as the pressure difference becomes greater with increasing altitude. Before attempting to remove a radome, the pressure in the unit must be released before deflating the seals, otherwise the seals will be blown out by the unit pressure and jammed.*

103. With the line valve, on the pressure reducing panel, closed, the unit pressure is released at the test point, adjacent to the system charging valve, under the louvre panel. After releasing the unit pressure, the seal pressure is released by depressing the Schrader valve marked DEFLATE, SEALS, on the top front face of the unit.

#### Pressure test

104. Close the line valve on the tail warning panel and disconnect the pipe between the tee piece and the pressure maintaining valve and blank off the tee piece, then open the line valve and with both systems fully charged, there should be no apparent loss of pressure over a period of 30 minutes. If a pressure drop is indicated on the gauge adjacent to either of the two nitrogen charging valves the pipe joints in that circuit should be tested for leaks using a soap solution. If there is a continuous escape of nitrogen from the relief valve incorporated in the 3,000 - 200 p.s.i.g. reducing valve, it is an indication that the valve is faulty. The radar unit safety valve, the seal deflate and the pipe run to the unit test point on the nitrogen charging panel should also be checked for leaks. Nitrogen escaping from the safety valve will indicate that either the safety valve is faulty or that there is excessive output from the 200 - 23 p.s.i.

reducing valve. If no leaks are detected, close the line valve, and fit a suitable gauge to the unit test point and note the pressure. If, after half an hour, this pressure has dropped by more than 0.2 p.s.i. the radar head must be removed and a replacement fitted. The leakage rate from a serviceable system can be expected to be higher under vibrating conditions at altitude than at the ground condition, therefore re-charging the system becomes necessary when the cylinder pressure has fallen to 2000 p.s.i.g.

104A. The output of the pressure-reducing valves in the nitrogen supply system to radar head can be checked at the test points downstream of the valves. An absolute gauge should be used at the test point after the 200-23 p.s.i. absolute valve. The full tests applicable to the components in the supply system are contained in the A.P.4303 series.

#### Aerials and A.T.U. pressure test

105. After reconnecting the pipe at the tee piece, open the line valve and check for leaks at all pipe joints between the tee piece and the Aerial Tuning Unit and the counterpoise plates. If the latter pipes are connected to their stowage points these joints must be checked for leaks also. A continuous escape of pressure from either of the release valves will denote that there is excessive output from the 200 - 23 or 200 - 30 p.s.i. reducing valves. With the system fully charged and all pipe unions tight there must be no leaks over a period of 30 minutes.

#### REAR WARNING INSTALLATION (post Mod.2017)

105A. The servicing of this installation is identical to that given in para.102 to 105.

#### Waveguide and A.R.I.5874 pressurisation (Mod 2024 and 2193)

105B. There must be no apparent leaks, as indicated on the gauges on the panel, from a fully charged system over a period

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of 30 minutes. After the system is pressurised the line valve must be closed to separate the high and low pressure sections of the system. All unions on the panel, waveguides transmitter, receiver and selector circuits must be checked for leaks, using a soap solution ensuring that, after the test, all traces of the solution are removed.

### WATER/GLYCOL SYSTEM

106. No detailed instructions are necessary for the removal of any components on the water/glycol system. However, before attempting to remove a reservoir, ensure that the pressure relief valve vent pipe is disconnected at the reservoir bottom mounting bracket.

### REMOVAL OF VAPOUR COOLING PACK

107. For this operation the electrical power supplies must be isolated from the pack by removing the appropriate fuses. Refer to fig.8 and 9 and proceed as follows:-

- (1) Close valves A and B.
- (2) Disconnect the condenser refrigerant hoses at the connections on the liquid receiver and on the condenser servicing valve. Blank the open ends of the hoses and the liquid receiver and condenser servicing valve connections.
- (3) Disconnect the a.c. and d.c. supply leads from the pack.
- (4) Disconnect the coolant pipes from the evaporator. Fit the protective caps on the self-sealing couplings of the evaporator and the aircraft pipe lines.
- (5) Disconnect the pack earthing lead from the earthing lead attached to the upper attachment bracket.

### REMOVAL AND ASSEMBLY

- (6) Using the adapter head (Ref.No. 26DC/95374) attach a minilift hoist to the roller on the starboard underside of the cross beam at former 95.75A.
- (7) Pass the hoist cable nipple-end through the cable guide and pulley assembly. Engage the nipple-end in the socket in the pack top mounting lug.
- (8) Slightly tension the hoist cable and withdraw the Pip-pin from the upper attachment bracket.
- (9) Remove the Pip-pins from the lower attachment brackets and ease the pack inboard until it is clear of the starboard longeron.
- (10) Lower on the hoist and guide the pack out of the fuselage. Secure the pack bottom mounting lugs to the storage stand.
- (11) Remove the support rod from the top mounting lug. Secure the lug to the top bracket of the storage stand and detach the hoist cable.
- (12) If the pack is not to be serviced immediately it should be drained and inhibited (para.100 refers).

### INSTALLATION OF COOLING PACK

108. Before preparing a pack for installation, check it for loss of inhibitor pressure. Packs are stored pressurised with nitrogen to approximately 20 p.s.i.g. The date of the pressurising operation, together with the indicated pressure and ambient temperature at the time, is recorded on a label attached to the pack. If leakage occurs during storage, the acceptable loss is not more than 2 p.s.i.g. per month, determined by reference to the

pack gauge and the date on the label. Packs are not acceptable if the pressure has leaked to below 10 p.s.i.g.

109. Normally, packs are charged with oil and refrigerant before installation, as part of bay servicing. If a charged pack is to be installed, operations (16), (17), (25) and (26) in the following procedure for an uncharged pack will not apply:-

- (1) Attach the minilift hoist to the roller on the underside of the cross beam at former 95.75A.
- (2) Remove the protective caps from the evaporator self-sealing coupling.
- (3) Remove the blanking plate from the inlet port of the liquid receiver and fit the refrigerant hose adapter, using a new 'O' ring seal.
- (4) Bolt the support rod to the top mounting lug of the panel (Detail A, fig.9).
- (5) Position the pack below the compartment and insert the nipple-end of the hoist cable into the socket in the pack top mounting lug. Tension the hoist cable to support the pack, then detach the storage stand.
- (6) Hoist the pack into the aircraft until the bottom mounting lugs are in line with the lower attachment brackets and insert the Pip-pins.
- (7) Align the support rod with the upper attachment bracket and insert the Pip-pin.
- (8) Disconnect and remove the minilift hoist.
- (9) Connect the earthing lead from the top attachment bracket to the

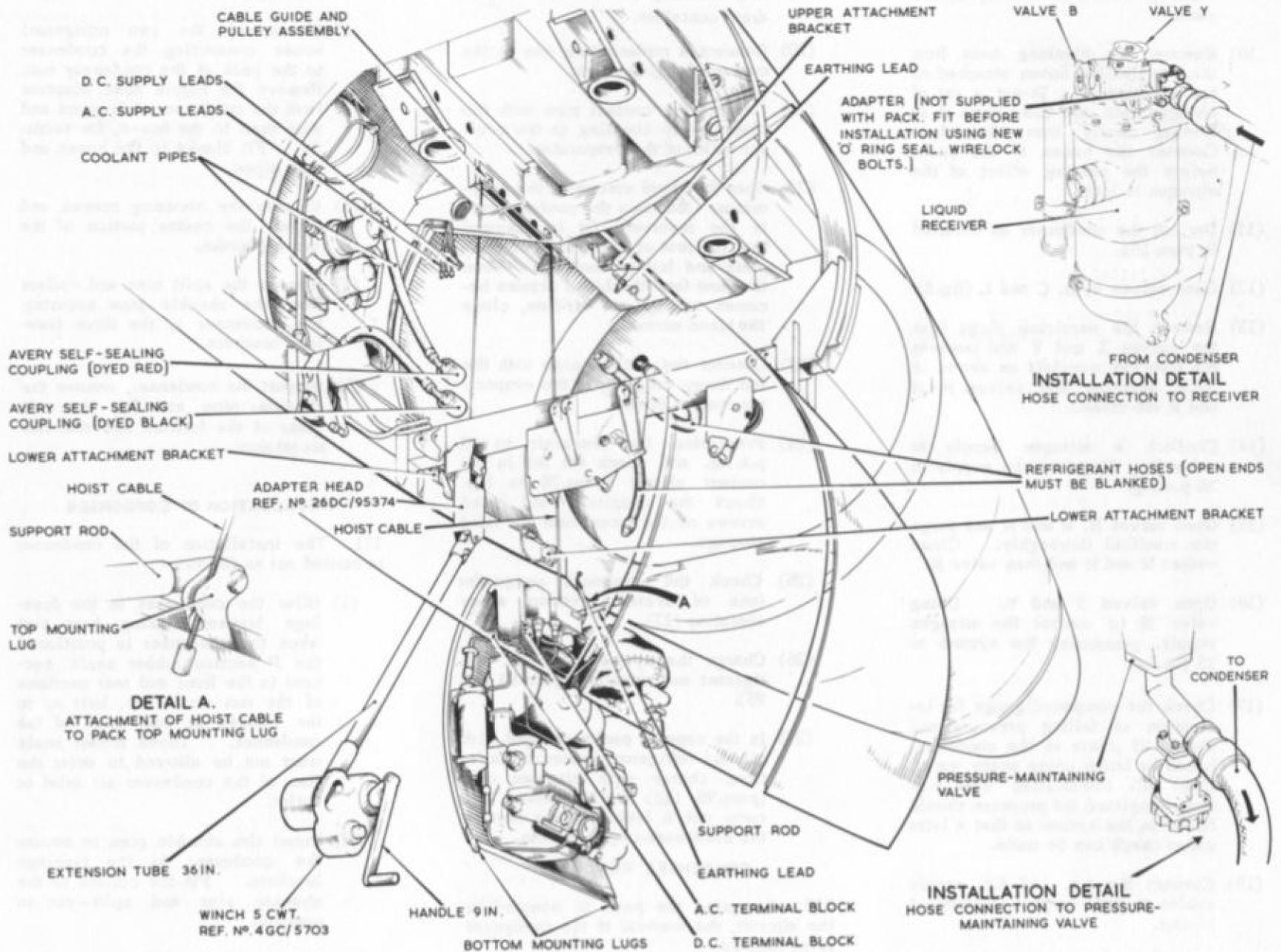


Fig. 9. Cooling pack removal.

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- earthing lead from the top of the pack.
- (10) Remove the blanking caps from the two flexible hoses attached to the condenser. Direct a jet of nitrogen into one hose until it is flowing freely from the other. Connect the hoses to the pack, before the purging effect of the nitrogen is lost.
  - (11) Dry out the condenser as detailed in para.101.
  - (12) Open valves A, B, C and L (fig.8).
  - (13) Remove the servicing plugs from the valves X and Y and connect the five-way manifold as shown in fig.8, ensuring that valves R, H and N are closed.
  - (14) Connect a nitrogen supply to valve N. Regulate the supply to 30 p.s.i.g.
  - (15) Open valves N, R and H and purge the manifold thoroughly. Close valves R and H and then valve N.
  - (16) Open valves X and Y. Using valve N to control the nitrogen supply, pressurize the system to 25 p.s.i.g.
  - (17) Check the compound gauge for indication of falling pressure and check all joints in the condenser hoses for leaks, using soapy water. Until all installation work has been completed the pressure should be left in the system so that a later gauge check can be made.
  - (18) Connect the a.c. and d.c. supply cables to their respective terminal blocks.
  - (19) Attach suitable lengths of hose to the bleed screws on the evaporator, inserting the hose ends into a drain container.
  - (20) Connect a replenishing can to the coolant charging valve.
  - (21) Connect the coolant pipe with the black Avery coupling to the coolant outlet of the evaporator.
  - (22) Open the bleed screws on the evaporator. Maintain the coolant level in the reservoir, (it is assumed that the rest of the system is complete and full of coolant). When the flow from the bleed screws becomes steady and air-free, close the bleed screws.
  - (23) Connect the coolant pipe with the red Avery coupling to the evaporator coolant inlet.
  - (24) Pressurise the reservoir to 35 p.s.i.g. and check for air in the coolant circuit (para.78 to 81). Check the couplings and bleed screws on the evaporator for fluid seepage.
  - (25) Check the compound gauge for loss of system pressure since operation (17).
  - (26) Charge the system with oil, refrigerant and nitrogen, (para.94 and 95).
  - (27) In the case of packs charged with oil and refrigerant before installation, charge with nitrogen only (para.95 (13) to (16) refers) and carry out a leak detector test on the condenser-to-pack joints.

### CONDENSER REMOVAL

110. Assuming the pack is mounted in the aircraft, the removal of the condenser is as follows:-

- (1) Close valves A and B on the

cooling pack.

- (2) Disconnect the two refrigerant hoses connecting the condenser to the pack at the condenser end. Remove the nipple hose adapters from the condenser stub pipes and wire them to the hoses, for security. Fit blanks to the hoses and stub pipes.
- (3) Remove the securing screws and detach the centre portion of the ram air intake.
- (4) Remove the split pins and collars from the shackle pins securing the condenser to the three fuselage brackets.
- (5) Support the condenser, remove the shackle pins and lift the unit clear of the forward and rear ram air intakes.

### INSTALLATION OF CONDENSER

111. The installation of the condenser is carried out as follows:-

- (1) Offer the condenser to the fuselage brackets taking care that when the condenser is positioned the P section rubber seals, secured to the front and rear sections of the ram air intake, butt up to the flanges at both ends of the condenser. These rubber seals must not be allowed to enter the line of the condenser air inlet or outlet.
- (2) Insert the shackle pins to secure the condenser to the fuselage brackets. Fit the collars to the shackle pins and split-pin in position.
- (3) Refit the centre portion of the ram air intake.

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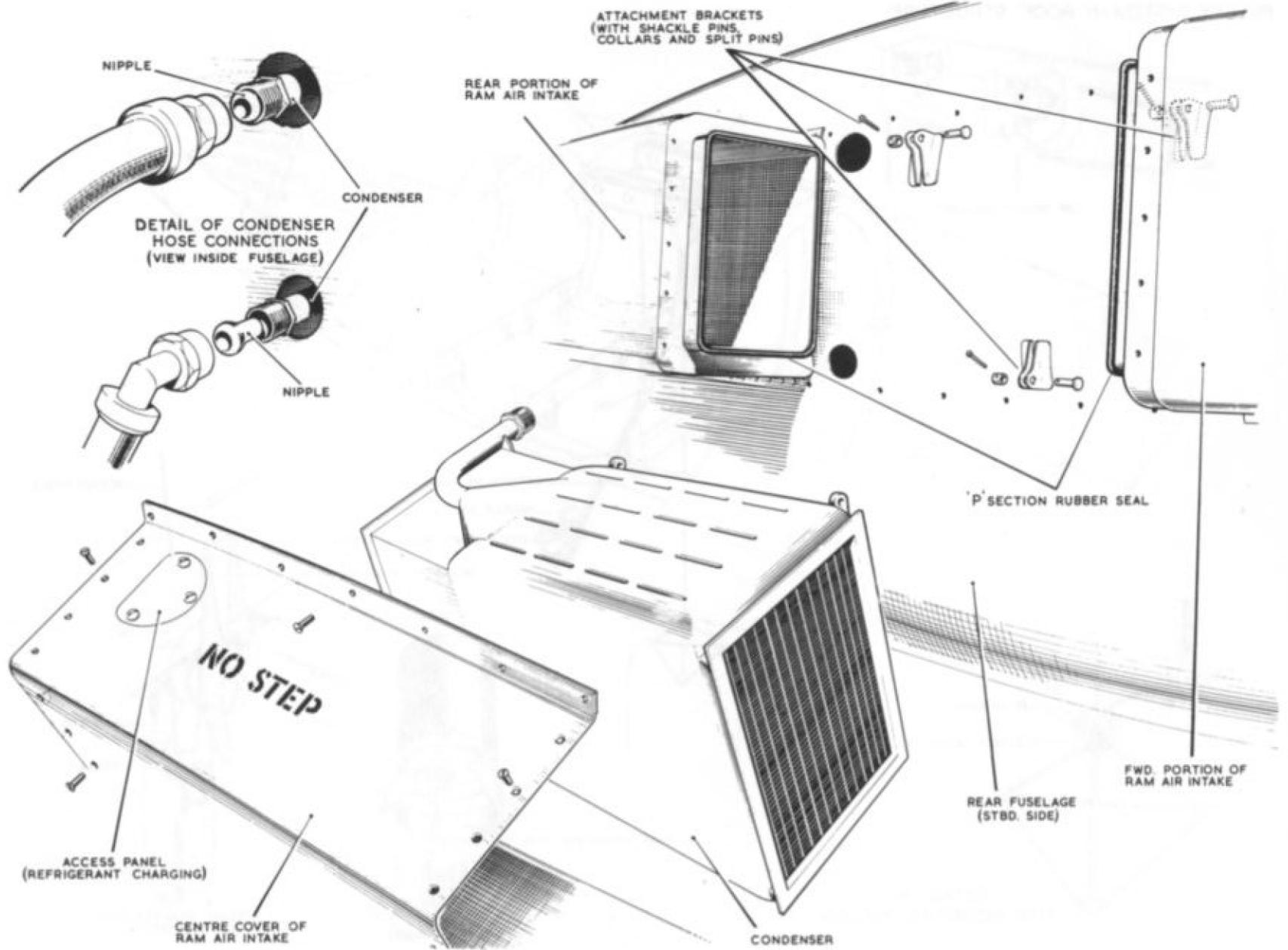
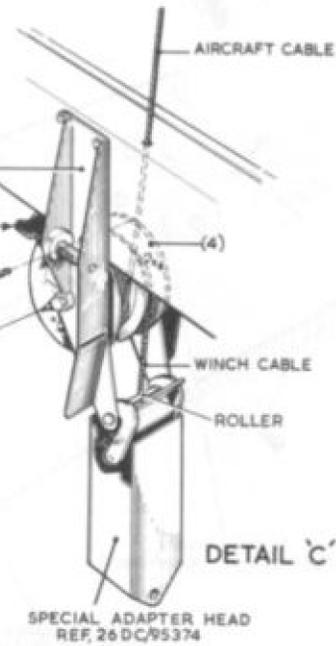
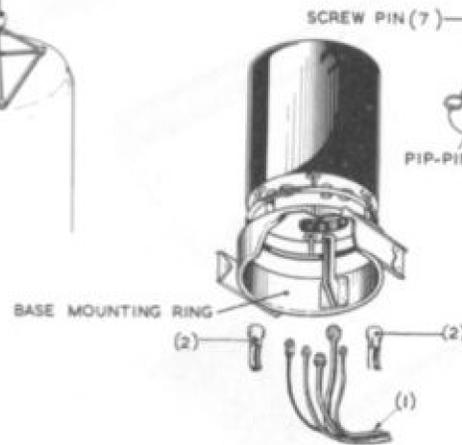
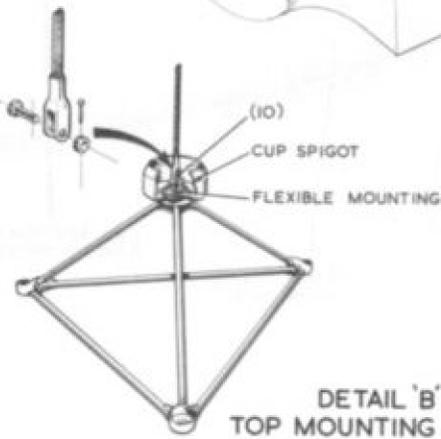
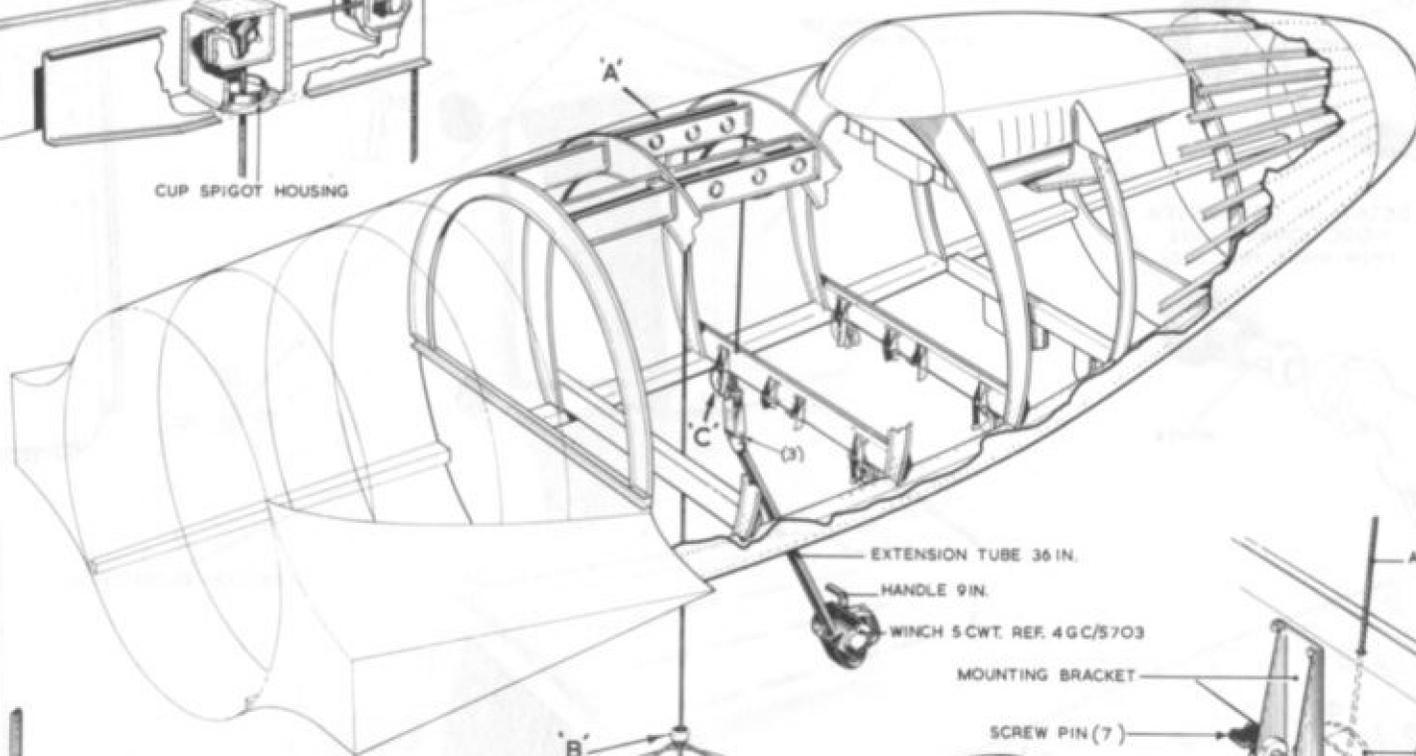
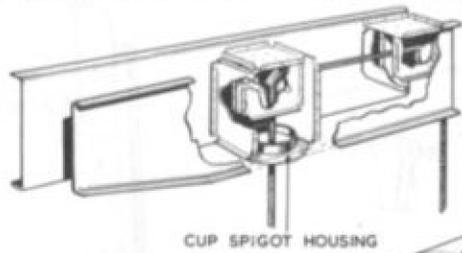


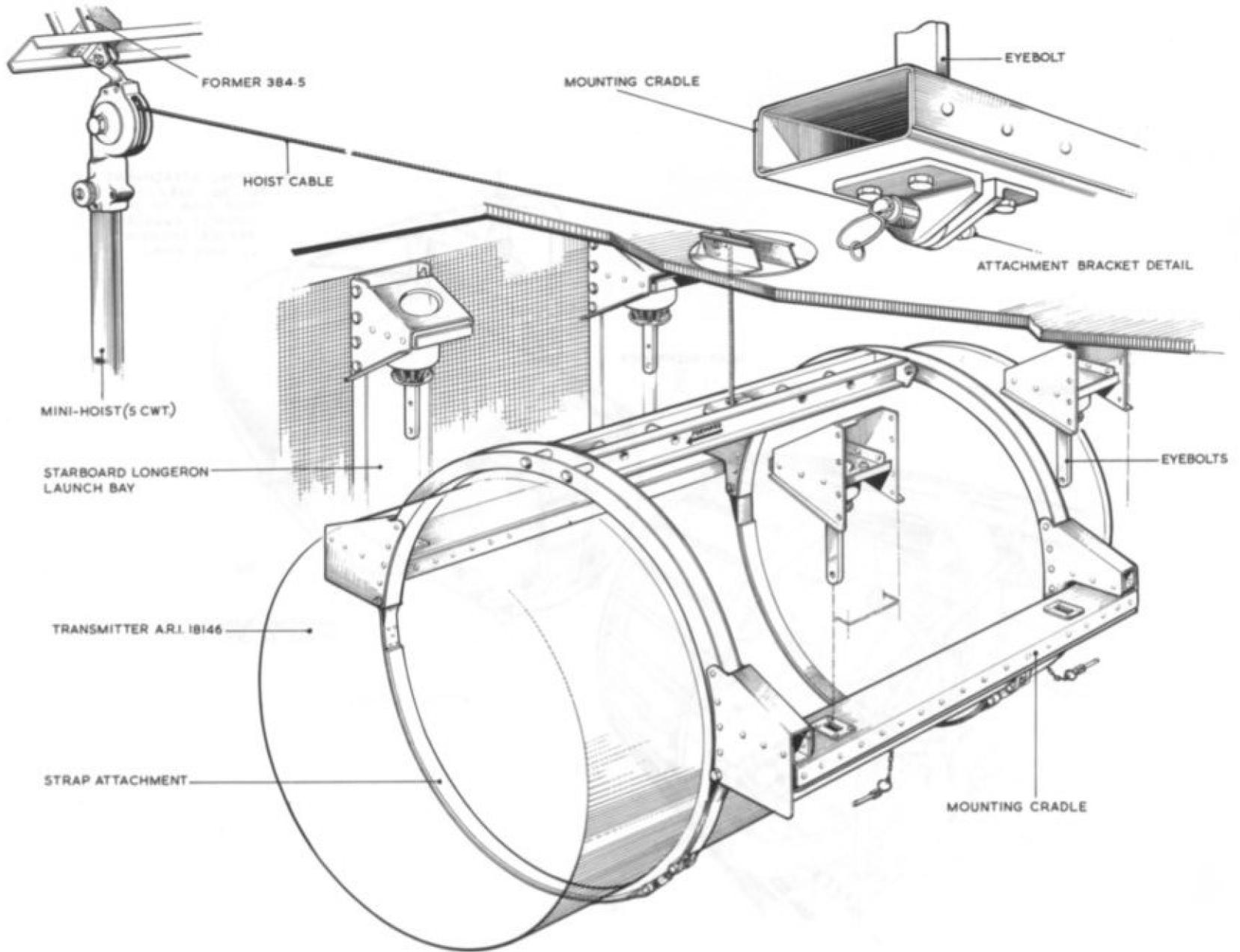
Fig. 10. Condenser removal.

DETAIL 'A'  
PULLEY SYSTEM IN ROOF STRUCTURE



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Fig. 11. Canister removal.



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Fig.IIA.Canister removal (post Mod. 2024)

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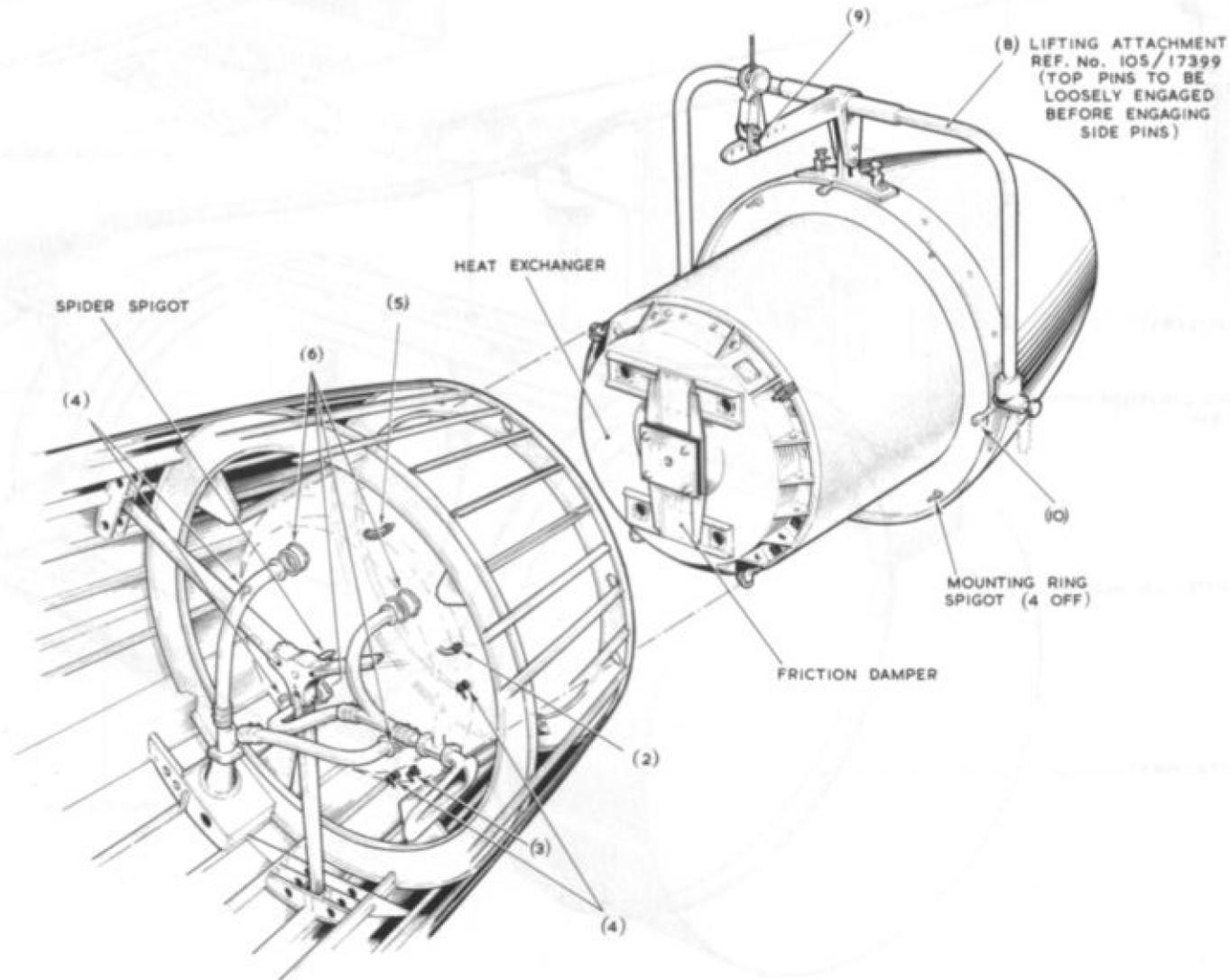


Fig. 12 Removal of radar head

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- (4) Remove the blanks from the condenser stub pipes and from the two refrigerant hoses connected to the pack.
- (5) Purge the condenser and hoses with nitrogen. Before the purging effect is lost, fit the nipple hose adapters to the condenser stub pipes and couple up the hoses. Dry out the condenser as detailed in para.101.
- (6) Open valves A and B.
- (7) Remove the servicing plugs from valves X and Y and connect a five-way manifold as shown in fig.8. Close valves, R, H and N.
- (8) Connect a nitrogen supply to valve N. Regulate the supply to 30 lb/in<sup>2</sup>.
- (9) Open valves N, R and H, and purge the manifold thoroughly. Close valves R and H and then valve N.
- (10) Open valves X and Y. Using valve N to control the nitrogen supply, pressurise the system to 25 lb/in<sup>2</sup>. If the system contains refrigerant, check the condenser joints with a leak detector, otherwise use soapy water.
- (11) Drain and recharge the system.

**CANISTER REMOVAL (pre Mod.2024)**

112. This removal method is similar for all

canisters except for the transmitter canister introduced by Mod.2024, which is given in para.114. Pressurise the reservoir to 10 lb/in<sup>2</sup>, ensure that all electrical supplies are OFF, refer to fig.11 and proceed as follows:-

- (1) Disconnect the feeder cables and electrical leads from the canister base. Release the cables from the support blocks attached to the base mounting ring.
- (2) Disconnect the water/glycol flexible hose quick-release couplings.
- (3) Using the special adapter Ref.No. 26DC/95374, hook a minihoist to the roller attachment at the base of the pulley bracket. Ensure that the roller is free to rotate.
- (4) Insert the nipple end of the minihoist cable into the recessed slot in the pulley.
- (5) Withdraw the Pip pin.
- (6) Tension the winch cable to take the weight of the canister.

**WARNING . . .**

Do not excessively tension the winch cable, otherwise the swaged joint at the canister end of the aircraft cable, will be strained. Conversely, if the cable is too slack when the screw pins are removed, the resultant snatch load, imparted to the cable may fracture its attachment assembly on the spider, allowing the canister to drop to the ground.

- (7) Disengage the screw pins (4 off)

from the canister base mountings.

- (8) Position a transportation trolley below the unit.
- (9) Lower the canister on to the trolley.
- (10) Remove the stiffnut, washer and bolt securing the aircraft cable to the lifting eye at the centre of the spider mounting.

**INSTALLATION OF CANISTER (pre Mod.2024)**

113. The procedure for installation is the reversal of that for removal but, before hoisting, check the aircraft cable and pulley system for security. During hoisting do not allow the aircraft cable to be excessively tensioned (para.112(6)). When the canister is secured in position, rotate the double pulley to take up the slack in the aircraft cable then lock the pulley with the Pip-pin. Connect the water/glycol flexible hoses to the canister following the procedure in para.76 op. (14) to (16).

**CANISTER REMOVAL (post Mod.2024)**

114. The removal procedure for the canister mounted under the power compartment floor is as follows:-

- (1) Ensure that all electrical supplies are OFF.
- (2) Remove the panels from the under-surface of the fuselage giving access to the canister and to the waveguide pressurisation panel.

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- (3) Close the line valve on the pressurisation panel and disconnect the waveguide from the canister. At the same time disconnect the pressurisation pipe at the canister, sealing off both open ends of the union.
- (4) Pressurise the water/glycol reservoir to 10 lb/in<sup>2</sup> and disconnect the water/glycol flexible hose quick-release couplings from the canister.
- (5) Disconnect the electrical cables from the canister.
- (6) Disconnect the bonding cable between the canister cradle and the aircraft.
- (7) Open the power compartment access door.
- (8) Secure a minilift, by its hook, to the attachment bracket on the starboard side of former 384.5A.
- (9) Pass the minilift cable over the pulley, mounted on the power compartment floor, through the hole in the floor and engage the cable ball end with the hoisting bracket on the canister cradle.
- (10) Tighten the minilift cable to just take the weight of the canister. Remove the four Pip-pins securing the canister cradle to the anti-vibration mountings.
- (11) Position a transportation trolley

below the unit and lower the canister on to the trolley. Disconnect the cable ball end from the cradle hoisting bracket.

### INSTALLATION OF CANISTER (post Mod.2024)

115. The procedure for installing this canister is the reverse of the removal procedure given in para.114. After installation ensure that the bonding cable is secured to the canister cradle and the aircraft. The pipe union at the canister must, on completion of installation be checked for leaks.

### WAVEGUIDE PRESSURISATION PANEL

#### Removal

116. To remove the waveguide pressurisation panel, ensure that all electrical supplies are OFF and proceed as follows:-

- (1) Remove the pressurisation panel access panel on the undersurface of the rear fuselage.
- (2) Release the pressure from the nitrogen storage cylinder, through the charging valve.
- (3) Remove the guard plate at the front of the panel.
- (4) Remove the test socket panel at the rear of the panel.
- (5) Disconnect the waveguides at the flanged joints, retain any shims fitted to the particular joints. Unclip the waveguides, remove the

guards and withdraw the waveguides clear of the panel.

- (6) Disconnect the low-pressure nitrogen pipe at the union connection on the port side beam of the compartment.
- (7) Disconnect the nitrogen feed pipe from the storage cylinder at the high-pressure connector block. Unclip the pipe and move it clear of the panel.
- (8) Disconnect the electrical cables from the panel.
- (9) Disconnect the panel bonding cable.
- (10) Support the panel and remove the bolts securing the panel to the anchor nuts on the compartment side beams. Lower the panel clear of the rear fuselage.

#### Installation

117. The procedure for installing a pressurisation panel is the reverse of the removal procedure given in para.116 but the following points must be noted:-

- (1) Ensure that the waveguides, the supporting clips and brackets are assembled without strain or distortion.
- (2) New seals must be fitted to the waveguide flange joints. The nuts and bolts securing the flange joints must be torque loaded to 15 lb/in .

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- (3) When fitting the guards over the waveguides, ensure that there is a clearance between the guards and the waveguides.
- (4) On completion of panel installation, charge the system with nitrogen and carry out a pressure test as given in para.105B.

#### RADAR HEAD PRESURISATION SYSTEM

118. No specific instructions are necessary for removing and assembling components in the pressurisation system to the radar head on both pre and post Mod.2017 aircraft. Before release of any union upstream of the line valve, the nitrogen pressure in the cylinders must be discharged by using an adapter Part No.772/B, at the charging valve. The line valve must be closed before releasing unions downstream of the valve. After replacement of components, the system should be pressurised, the pipe unions checked for leaks and the line valve locking plate (para.57A) fitted.

#### REMOVAL OF RADAR HEAD

119. The radar head, i.e., the combination of the radar unit, heat exchanger, mounting ring and radome, is removed and installed as a complete unit. Ensure that all power supplies are off, then proceed as follows:-

#### NOTE...

*This procedure is applicable to pre and post Mod.2017 aircraft.*

- (1) Remove the locking plate from the line valve on the pressurisation panel and close the valve, to shut off the supply of nitrogen to the radar head.
- (2) Disconnect the flexible supply hose at the radar head. Remove the blanking cap from the pressurisation panel outlet test point and connect the free end of the flexible hose to the exposed test point.
- (3) Open the line valve to supply pressure to the ARI 5874 and ARI 18076 pressurisation panel and, on aircraft post Mod.2321, to pressurise the hydraulic reservoir and emergency power pack. Secure the valve in the open position by fitting the locking plate (para.57A).
- (4) Disconnect the lead from the temperature sensing switch.
- (5) Disconnect the four electrical connectors from the unit.
- (6) Disconnect the flexible hose from the unit test connection, adjacent to the Schrader valve for deflating the seals.
- (7) Disconnect the four quick-release clamps which attach the cooling air manifolds to the adapters fitted to the cooling air ports of the heat exchanger.

- (8) Remove the screws indicated by the arrows stencilled on the radome.
- (9) Fit the lifting attachment Ref.No. 10S/17399.
- (10) Attach the hoisting equipment to the slinging link on the arm of the lifting attachment. Suitable equipment consists of a standard 5 cwt minilift with a 3 ft extension tube, a jib Part No. 050267 and a servicing ladder Part No. 050993. For details of the arrangement refer to A.P.1464G, Vol.1.

#### NOTE...

*The link must be fitted in the third hole from the end of the arm.*

- (11) Slightly tension the hoist, then release the four fasteners securing the radar head to the fuselage.
- (12) Manipulate the hoist and slide the unit free.
- (13) Lower the radar head and secure it to the attachment ring Ref.No. 10S/6368613 which is fitted to the servicing trolley Ref.No. 10S/17400.

#### NOTE...

*For field use, this trolley is mounted on trolley Type E Part No. TR/E783290.*

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### INSTALLATION OF RADAR HEAD

120. The installation procedure is a reversal of that detailed in para.119. As the unit is offered up to the fuselage, ensure that the rollers are aligned on the guide rails. When the four mounting ring spigots engage with the holes in the former, check that the spider spigot enters the hole in the friction damper plate. Do not use grease to effect the entry of the spigot, it will adversely affect the friction damper. Before securing the cooling air manifold to the adapters on the air ports of the heat exchanger, ensure that the ring seals are in position. When complete, ensure the line valve on the pressurisation panel is open to pressurise the radar head, and the locking plate (para.57A) is secured in position.

#### *NOTE . . .*

*Fitment of the locking plate ensures that the supply of nitrogen is available to the*  
◀ *ARI 5874, ARI 18076, and on aircraft post*  
*Mod.2321 to the hydraulic reservoir and the*  
*emergency power pack, should the rear* ▶  
*warning radar head be removed or isolated.*



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