LIST OF ILLUSTRATIONS

Introduction

1. This chapter contains descriptive and servicing information for the electrical controls and circuits of the heating and ventilating system. Theoretical circuit diagrams and location illustrations are provided, along with the associated routing charts. Table 1 lists the items of major equipment together with the publication references. For full details of the mechanical aspect of the system, reference should be made to Sect.3, Chap.8 of this publication. The following modifications are included:-

Mod.624 - To operate the emergency escape door opening from a selector switch at the navigator's station.

Mod.819 - To prevent inadvertent feed of flood flow.

Mod.1092 - To introduce additional switches to enable independent operation of the engine anti-icing system.

Mod.1696 - Cabin conditioning system. To introduce a resistor unit and revised wiring to the temperature control valve and pressure ratio switch to prevent the cold air unit from over-speeding.

Mod.2047 - To provide independent fuzing for safety purposes.

Mod.2275 - To introduce an auxiliary air ventilated suit system to the five crew stations and individual face blowers at the three rear crew positions to give improved cooling during high cabin temperature conditions.

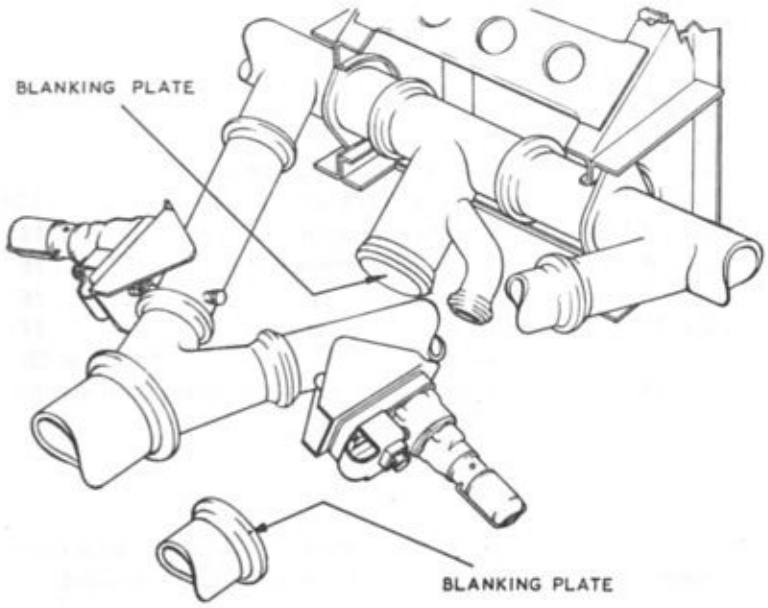
Mod.2295 - To provide an additional emergency door opening switch which, in certain circumstances can be more easily operated.

Mod.2331 - To introduce pressure ratio switch FLY/A/10 in lieu of pressure ration switch FLY/A/4 to improve the serviceability of the switch.

Mod.2333 - To reposition the cabin pressure warning horn isolation switch (command Mod. Vulcan/0234/STC).

Mod.2358 - To provide an additional abandon aircraft and decompression switch at the second pilots position (command Mod. Vulcan/0239/STC).

Mod.2410 - To remove the flood flow valve and actuator, and fit a blanking plate (command Mod. Vulcan/0284/STC).



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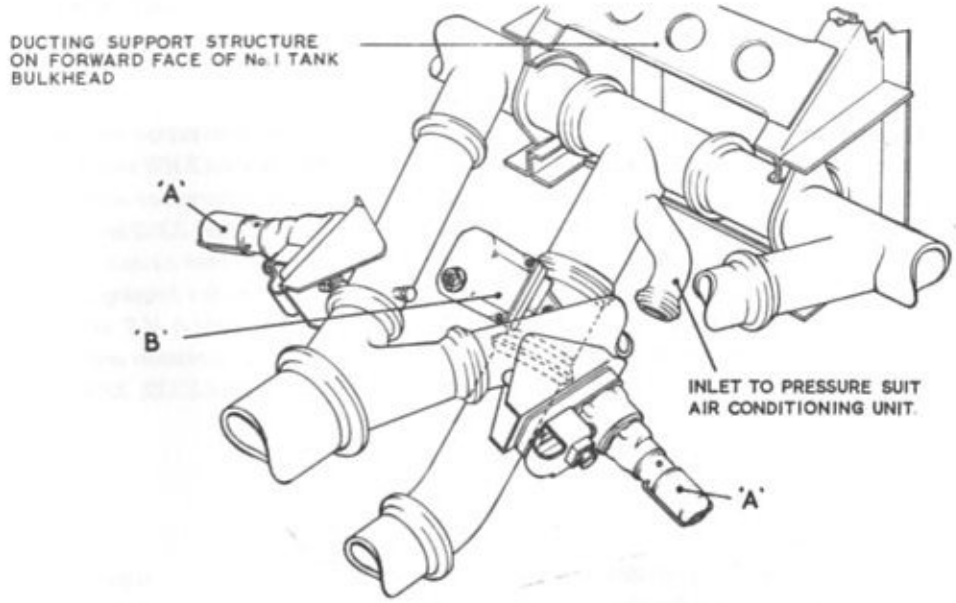

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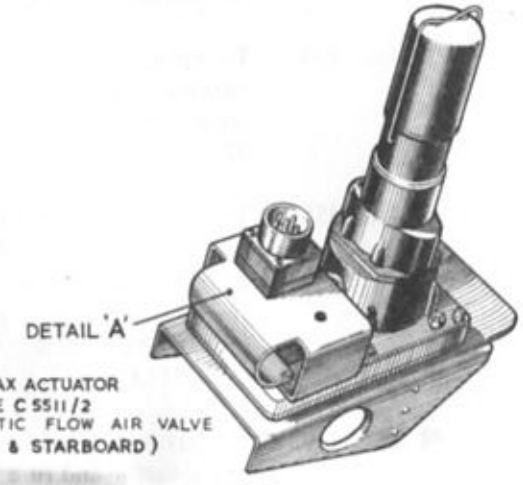

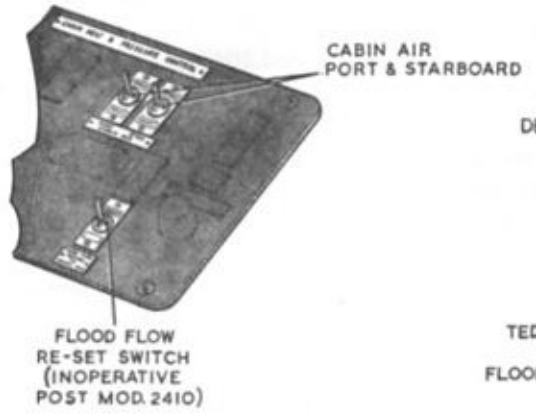

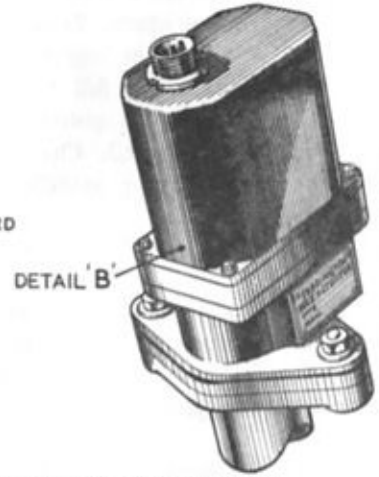

Fig. 2 Automatic and flood flow actuator installation
◀ (*Incorporating Mod. 2410*) ▶

AIR CONDITIONING

2. A complete system of pressurization, cabin and bomb bay heating is fitted in the aircraft and is operated by compressed air from the four engines. The flow of air from the engine compressors is controlled by electrically operated isolation cocks, located one in each engine bay. These cocks also control the ground air supply for engine starting (Chap.8).

3. The air ducting is connected from each pair of engines to form two main lines, which run forward to supply the wing de-icing, cabin and radome, and aft to supply the bomb bay heating and fin de-icing. A connection to the A.A.P.P. is made from the ducting between No.3 and 4 engines.

4. The main lines to the cabin link up in a triangular duct arrangement located at the rear port side of the nose wheel bay (fig.2). Two automatic flow controllers (mechanical) and two automatic flow valves (electrical) are fitted in the two forward sides of the triangular ducting, whilst at the base of the triangle is a flood flow by-pass connected to a flood flow valve (electrical). The flood flow line is provided to maintain pressure conditions in the cabin should the cabin be punctured, e.g., by enemy action, when the aircraft is flying at an altitude of 32 000 ft. or more.

5. Air for suit ventilation is tapped from the pressurization system in the by-pass line before the flood flow valve, and passes through air conditioning equipment separate from the cabin equipment (para.73). During ground servicing periods, a source of bleed air from the A.A.P.P. can be used for conditioning the cabin or for engine starting (para.86).

DESCRIPTION AND OPERATION

Air conditioning unit

6. The majority of components used in the cabin air conditioning system are contained in a crate which is installed on the port side of the nose wheel bay. These components are as follows:-

(1) Air-to-air cooler.

(2) Cold air unit.

(3) Water extractor.

(4) Temperature control valve and actuator.

(5) By-pass valve and actuator.

(6) Underheat temperature controller.

(7) Pressure ratio switch.

(8) Overheat switch.

(9) Valve centralizing switch.

(10) Follow-up resistors (2).

(11) Indicator transmitter (for temperature control valve).

The electrical items of equipment are shown in fig.3. For details of the main items, reference should be made to Sect.3, Chap.8 of this publication.

7. The air flow through the air conditioning unit is variable according to the position of the temperature control valve as follows:-

HOT - Straight through.

INTERMEDIATE - Some air straight through, remainder through the air-to-air cooler.

WARM - All air through the air-to-air cooler.

INTERMEDIATE - All air through the cooler, some air through the turbine unit.

COLD - All air through the cooler and turbine unit.

Pressure control

Discharge valve

8. The pressure in the cabin is controlled by restriction in the air discharge system which is effected by two bellows-operated discharge valves. The two discharge valves and an inward relief valve are contained in a combined valve unit fitted on the forward face of the front pressure bulkhead. Each discharge valve is controlled by a pressure controller (para.10-11), which applies air pressure to the valve bellows. Discharge air from the valve unit is fed into the radome to provide cooling for the H2S scanner unit (Sect.7, Chap.5).

Relief valves

9. Two relief valves are mounted on the front pressure bulkhead. One, the inward relief valve (port side), limits to a safe value any negative differential pressure which may occur in certain circumstances, such as rapid descent following engine failure, or cabin supply failure. The other, the outward relief valve

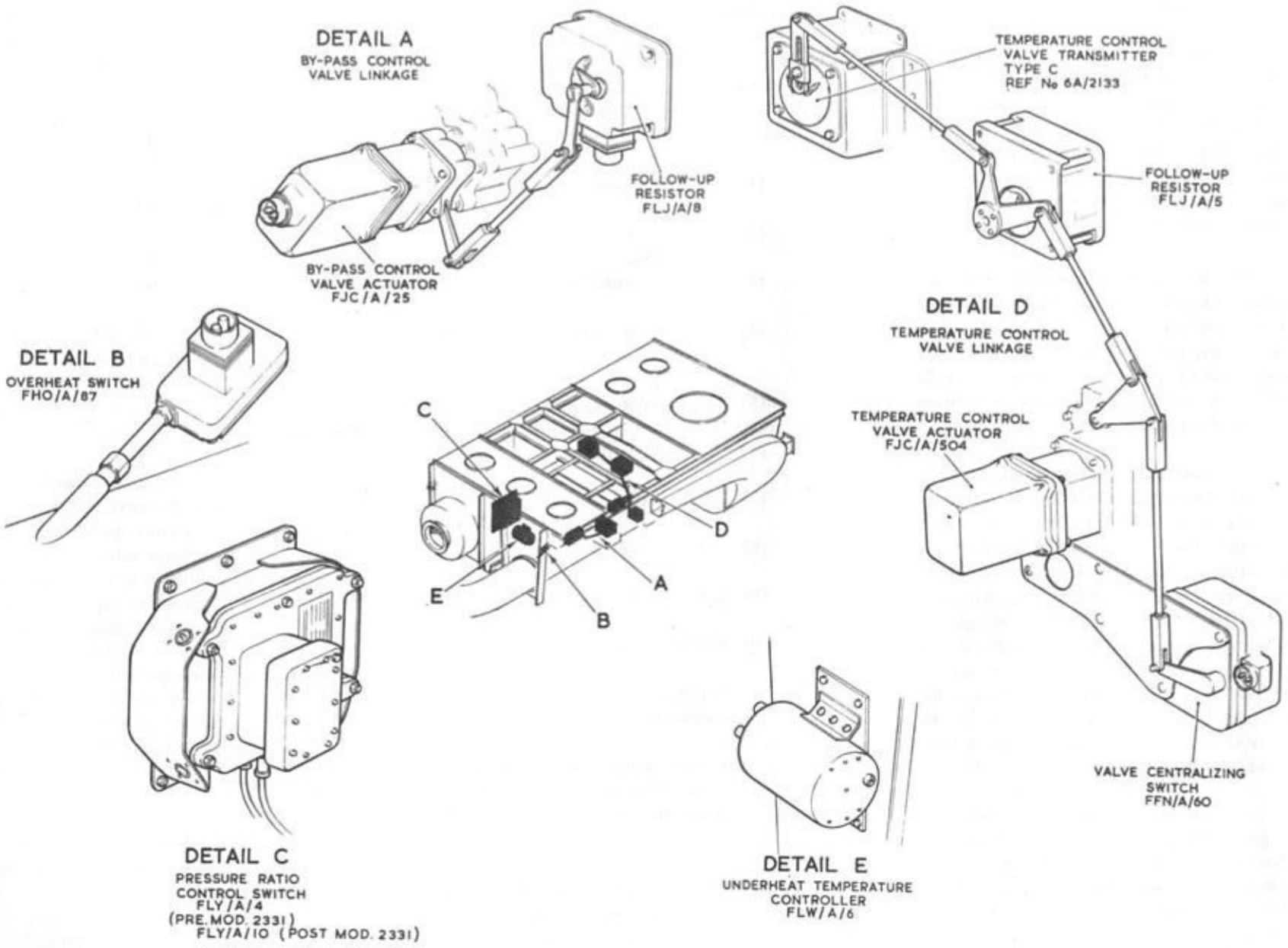

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Fig. 3 Air conditioning crate
Details clarified

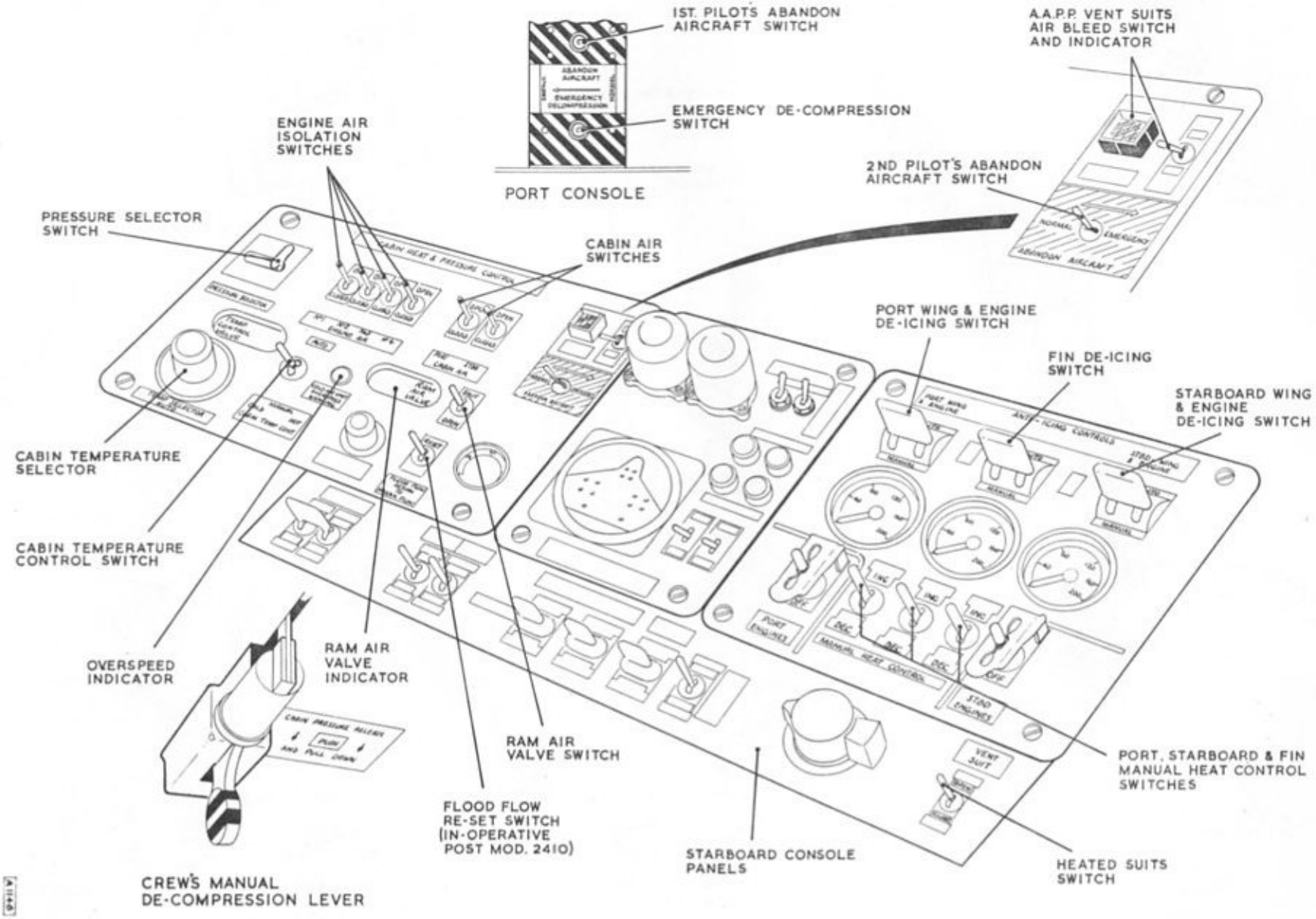


Fig. 4 Air conditioning controls

► *Detail changes* ◄

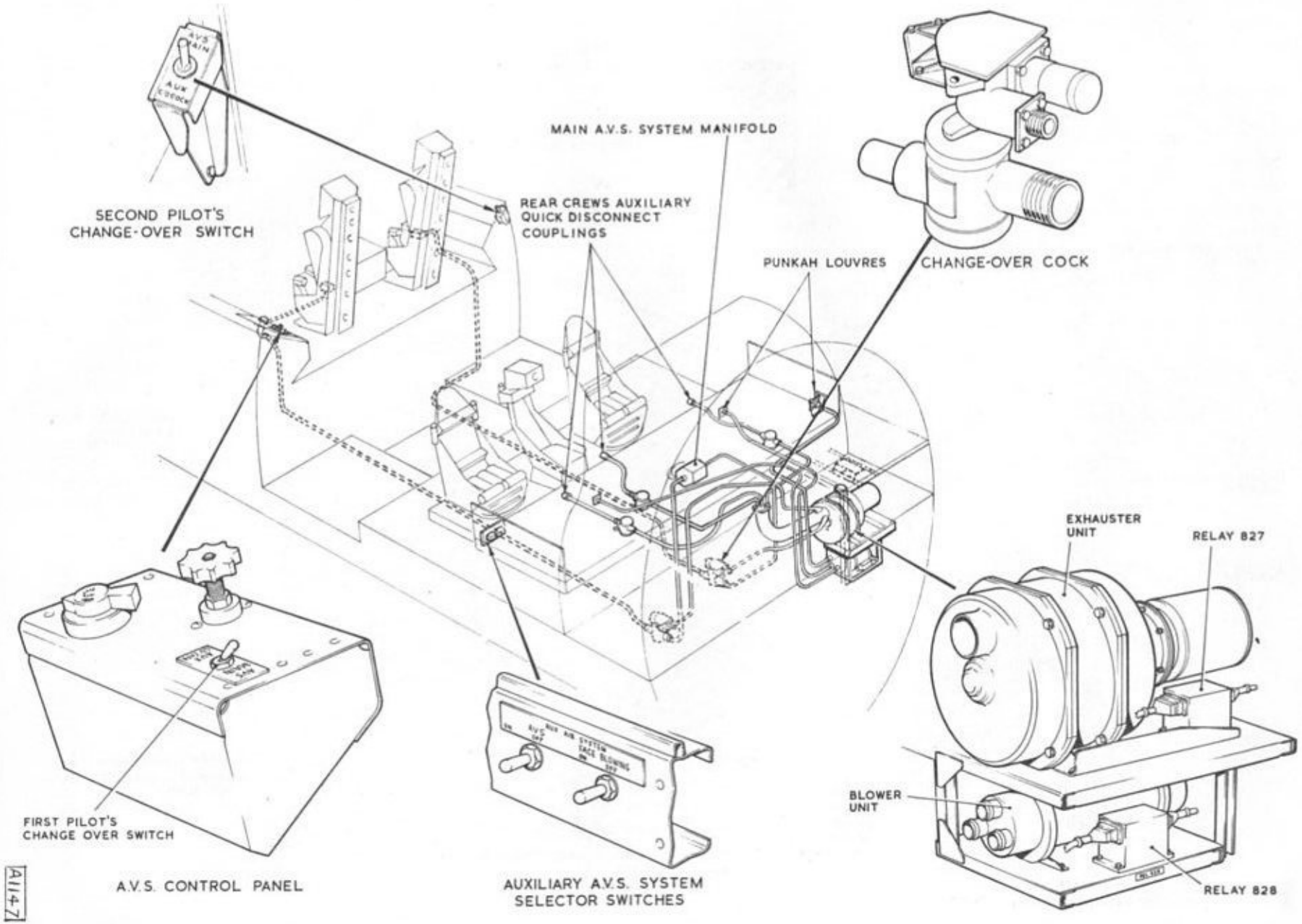


Fig. 5 Auxiliary A.V.S. and face blower equipment and controls

prevents excessive pressures in the cabin in the event of failure of the pressure controllers.

Pressure controllers

10. The two pressure controllers are installed on the starboard side of the cabin, and control the function of the discharge valves in the combined valve unit to maintain a cabin pressure greater than atmospheric at aircraft altitudes over 8 000 ft. The main controller, Type F509320, includes a small actuator which governs cabin pressure at either 9 p.s.i. differential (cruise conditions) or 4 p.s.i. (combat conditions). In addition to this function, the controller will operate a warning horn in the event of loss of cabin pressure.

11. The second controller, Type F511930, is set to maintain 9 p.s.i. and provides duplication of control in case of failure of the other. This controller does not contain an actuator, and is not electrically connected.

Air release valves

12. Two air release (decompression) valves are connected to the pressure line between the pressure controllers and the discharge valves. These valves are operated electrically (para.38-42) and can also be operated mechanically by a decompression lever at the crew's position. When the valves are operated, the pressure in the discharge bellows is released through two static vents, thus allowing the discharge valves to open fully and release the cabin pressure.

13. The relative cabin altitude, i.e., pressure, is automatically controlled at predetermined heights according to selection, which can be made at any time during flight, and the cabin may be pressurized or depressurized at any time when required. For further details reference should be made to Sect.3, Chap.8.

Ram air

14. Provision is made for ventilation during unpressurized flight by ram air which is fed from an intake on the port side of the aircraft. Control of the ram air is by means of an electrically operated valve fitted on the aft face of the rear pressure bulkhead (para.54-56).

Controls and indicators

15. The majority of the control switches and indicators for the air conditioning system are fitted to a panel on the starboard console (fig.4). An abandon aircraft switch and an emergency decompression switch are fitted on the port console. Abandon aircraft and decompression warning lamps are located on the navigator's panel.

16. The controls on the starboard console consist of the following:-

(1) Four engine air isolation cock switches. These control the engine air supply on-off cocks.

(2) Two cabin air switches. Each has two positions:- OPEN operates the automatic flow valve actuators to open, and SHUT operates the actuators to close.

(3) Pressure slector switch. This has three positions:- CRUISE sets the main pressure controller to maintain conditions in the cabin at 8 000 ft. up to a maximum differential pressure of 9 p.s.i. COMBAT sets the main pressure controller to maintain cabin conditions at 8 000 ft. up to a maximum differential pressure of 4 p.s.i., and NO PRESS. depressurizes the cabin.

(4) Cabin temperature control switch. This has four positions:- central OFF position, AUTO position, which puts the temperature control valve under automatic control: MANUAL HOT spring loaded to OFF moves the temperature control valve to the hot position: MANUAL COLD spring loaded to OFF, moves the temperature control valve to the cold position.

(5) Cabin temperature selector. Selects the cabin temperature to COOL, NORMAL or WARM as required when the cabin temperature control switch is in the AUTO position.

(6) Ram air valve switch. This has three positions:- SHUT closes ram air valve; OPEN opens ram air valve.

(7) Reset switch (flood flow). This switch is now redundant see para.30.

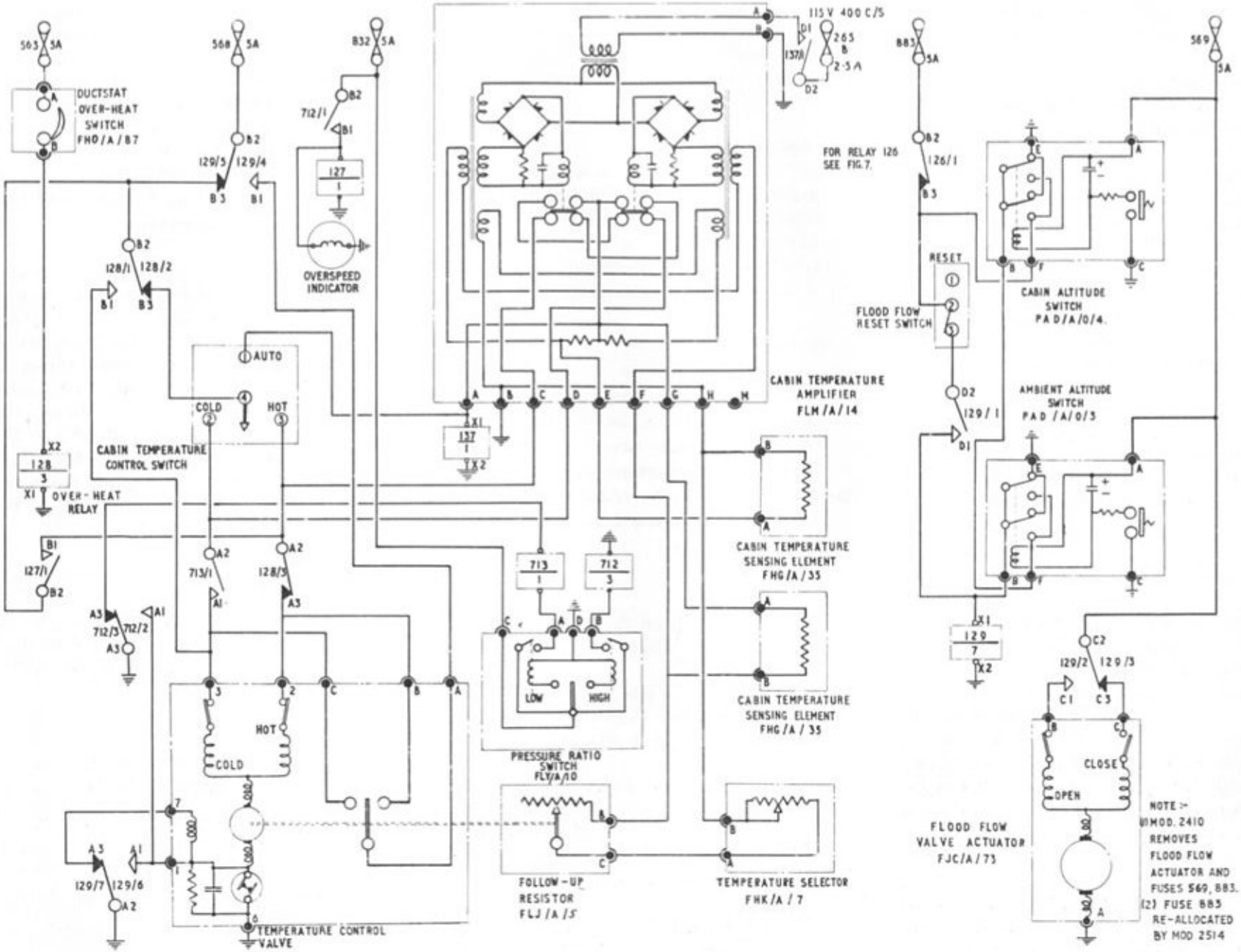


Fig.6. Cabin temperature and flood flow control

▶ *Addition to note* ◀

(8) An ABANDON AIRCRAFT switch with two positions NORMAL and EMERGENCY, to provide abandon aircraft and decompression switching facilities for the second pilot.

(9) Magnetic indicator, Ref.No. 5CZ/5073 is energized to show white when the turbine in the cold air unit overspeeds.

(10) Desynn indicators (2) show position of temperature control valve and ram air valve.

Cabin temperature

17. The cabin temperature is controlled by the movement of the temperature control valve. This valve is operated by an electrical actuator, Type FJC/A/504, which is automatically controlled by a temperature sensitive bridge circuit, or manually controlled by the cabin temperature control switch. The actuator contains a clutch coil, which is connected in series with the armature on the earth side, and enables the actuator to run at normal or high speed. For normal running speed, the coil is energized by the armature current. In high speed conditions, an alternative path to earth is provided for the armature current, and the coil is de-energized. Indication of valve position is given by a Desynn indicator on the starboard console (para.16), which is described in Sect.7, Chap.4.

18. The temperature control amplifier, Type FLM/A/14 provides automatic control of the aircraft heating system. It embodies a balanced resistance bridge network connected to two transductor circuits. External sensing elements, follow-up resistor and a temperature selector are coupled into the bridge circuit. Any change in their values will cause a state of unbalance resulting in a very small d.c. flow across the bridge in either one direction or the other, depending upon the way the sensing element has been affected. The control field windings of the two transductors are connected in series across the bridge output, and any changes in the current flowing through them will appear amplified in the transductor output.

19. Each transductor has its own output circuit, which is d.c. fed from the a.c. field winding via a bridge-connected selenium rectifier unit. Connected into this circuit is the coil of a relay, and in series with it is the transductor feedback winding which increases gain and sensitivity and makes the transductor directional. When the output of either one of the transductors rises to a predetermined value its associated relay will be energized and its contacts close to connect a supply to the appropriate close or open field of the temperature control valve actuator. The two relays are so interconnected that there is no possibility of the amplifier attempting to drive the actuator in opposite directions at the same time should a condition arise whereby both relays are energized simultaneously.

20. A transformer, which steps down the a.c. supply from 115-volt, to 14.5-volt, supplies the transductors at a frequency of 400 Hz. The bridge and bias windings are supplied from the aircraft 28-volt d.c. supply.

Pressure ratio switch

21. The pressure ratio switch, Type FLY/A/10, is used to prevent overspeeding of the cold air unit turbine. The switch contains two chambers, one high pressure, and one low pressure, which are pneumatically connected across the cold air unit. Changeover pressure contacts (low and high) within the switch control the operation of two relays (low and high) depending upon the ratio of pressures existing at the inlet and outlet ports of the cold air unit. The relays, in turn, control the aircraft circuit to restrict the supply of air to the cold air unit in the event of an increase in the pressure ratio.

22. The pressure ratio switch is connected to the temperature control valve circuit (fig.6). Pressure contacts within the switch operate the circuit as follows:-

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

(2) When the high pressure contacts close, the temperature control valve is moved towards the hot position until the pressure ratio across the cold air unit drops to a suitable value.

Circuit operation

23. Considering the low pressure contacts in the pressure ratio switch to be closed (fig.6), a supply from fuse 832 will be fed via the switch contacts to energize the low relay. The low relay contacts will then close to energize relay 713, the earth return for the coil being made via relay contacts 712/3. The closing of contacts 713/1 will prepare the circuit to the

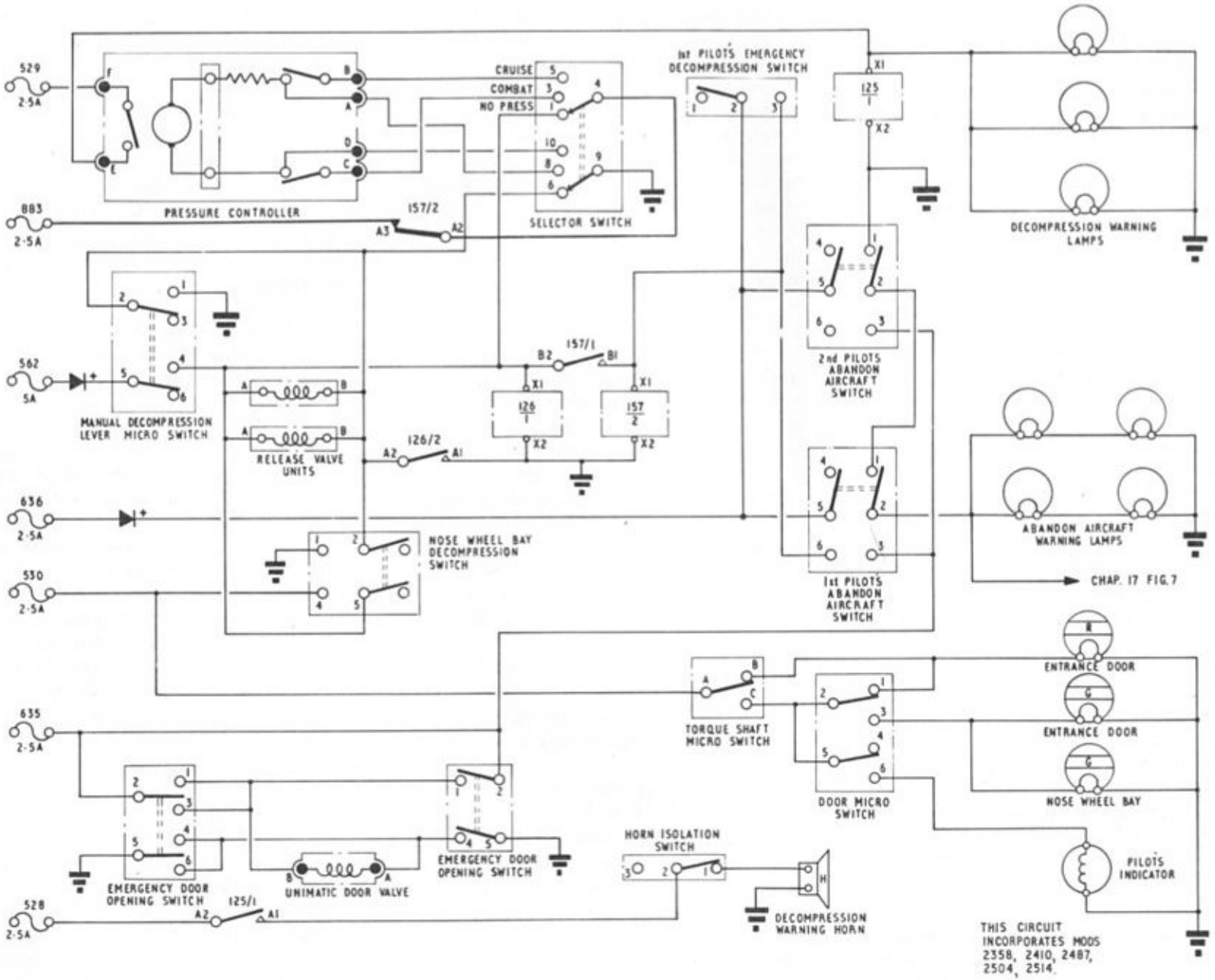


Fig 7 Decompression and warning controls

▶Title change and mod state clarified◀

'cold' field of the temperature control valve actuator.

24. When the cabin temperature control switch is selected to HOT or COLD, the appropriate field of the temperature control valve actuator will be energized from fuse 568, via the normally closed relay contacts 129/5 and 128/2, then via contacts 128/3 to the 'hot' field or 713/1 to the 'cold' field. The armature current returns to earth via the clutch coil and contacts 129/7.

25. When the switch is selected to AUTO, the 28-volt d.c. supply from fuse 568 will be connected to the amplifier, and at the same time will energize relay 137. Contacts 137/1 will then close to connect a supply of 115-volt, 400 Hz single-phase a.c. from fuse 265B to the amplifier transformer. The amplifier will automatically control the movement of the temperature control valve to the hot or cold position in conjunction with the sensing elements and cabin temperature selector, the resulting adjustment of the follow-up resistor maintaining the balance in the amplifier bridge network.

26. When the cabin temperature selector is moved to a new setting, the amplifier bridge network will be unbalanced, and the temperature control valve will be moved towards the hot or cold positions accordingly, until a new balance is struck at the temperature selected.

27. Should the low pressure contacts in the pressure ratio switch open due to a rise in the pressure ratio, the low relay will be de-energized to open its contacts and de-energize relay 713. Contacts 713/1 will then open to isolate the 'cold' field of the temperature control valve actuator from the cabin temperature control switch and the amplifier. This action will prevent further movement of the actuator towards the cold position, thus limiting the supply of cold air to the cold air unit turbine.

28. Should the high pressure contacts in the pressure ratio switch close due to a further rise in the pressure ratio, the high relay will be energized by a supply from fuse 832. The high relay contacts will now close to energize relay 712 and provide the following circuit action:-

(1) Contacts 712/1 will close to energize relay 127 from fuse 832. The overspeed indicator will also be energized to show white.

(2) Contacts 712/2 will close to provide a direct path to earth for the temperature control valve actuator, thus shorting out the clutch coil to enable the actuator to run at high speed.

(3) Contacts 712/3 will open to isolate the coil of relay 713 from earth, thus ensuring that the actuator 'cold' field cannot be energized under automatic or manual control.

(4) Contacts 127/1 will close to connect the 'hot' field of the actuator to the cabin temperature control switch and amplifier.

When the pressure ratio drops to a suitable value, the circuit will return to normal operation as in para.23-24.

Overheat circuit

29. An overheat switch, Type FHO/A/87, is fitted in the outlet of the air conditioning unit and is designed to close at 175 deg.C. Should the temperature of the air rise to this figure, the switch contacts will close to energize relay 128 from fuse 563. Contacts 128/2 will then open to isolate the cabin temperature control switch, and contacts 128/1 will close to energize the 'cold' field of the temperature control valve actuator, thus allowing cold air to flow through the system. When the temperature of the air has fallen by approximately 25 deg.C., the switch contacts will open and the system will return to normal control.

Flood flow

▶ 30. The flood flow system has been rendered inoperative by embodiment of Mod.2410, which removed the flood flow valve and actuator, blanked the associated pipelines, and removed fuses 569 and 883. Reference to flood flow operation in this chapter is retained for information only, and the wiring diagrams for identification purposes only. Fuse 883 has been re-allocated to the cabin pressurization control circuit by Mod.2514. ◀

Circuit operation

31. Reference to fig.6 will show that flood flow is brought into operation by two altitude switches. One altitude switch, Type PAD/A/0/3, is connected to a static vent and is set at 32 000 ft., the other altitude switch, Type PAD/A/0/4 is open to cabin pressure and is set at 29 000 ft. To return the system to normal flow, a switch labelled FLOOD FLOW RETURN TO NORMAL FLOW – RESET is fitted at the starboard console (fig.4).

32. If the aircraft is above 32 000 ft., and the relative cabin altitude rises to 29 000 ft., the two altitude switch relays (whose contacts are connected in series) will be energized from fuse 569 via the contacts of the pressure switches, which will be closed. A supply from fuse 883 will then be made via normally closed relay contacts 126/1 and the contacts of the altitude switch relays in series, to energize relay 129. The following circuit action will now take place:-

(1) Contacts 129/1 will close to provide a hold-in circuit for relay 129 via terminals 2-3 of the reset switch.

(2) Contacts 129/3 will open and 129/2 will close to energize the 'open' field of the flood flow actuator from fuse 569 and open the valve.

(3) Contacts 129/5 will open and 129/4 will close to connect a supply from fuse 568 to the centralizing switch of the temperature control valve actuator, which will energize either the 'hot' or 'cold' field depending upon the position of the valve.

(4) Contacts 129/7 will open and 129/6 will close to isolate the clutch coil of the temperature control valve actuator and provide a direct path to earth for the actuator, which will run at high speed.

33. When flood flow is no longer required, the system is returned to normal flow by pressing the reset switch to RESET, which will de-energize relay 129. However, if conditions are such that the altitude pressure switches are still closed, flood flow will restart when the switch is released. Note that operation of the decompression or abandon aircraft control switches (fig.7) will isolate the flood flow circuit from the supply, by energizing relay 126 to open contacts 126/1.

Automatic flow

34. Automatic flow is controlled by the automatic flow air valve actuators, Type C5511/2-L, which are selected to open or close by the two cabin air switches on the starboard console (fig.4).

Circuit operation

35. Reference to fig.11 will show that selection of the port and starboard cabin air switches to OPEN or CLOSE will energize the appropriate actuator fields from fuses 626 and 536 respectively.

Cabin pressure control operation

36. The actuator in the main pressure controller (para.10) will operate in either direction to control the cabin pressure for CRUISE or COMBAT as selected on a pressure switch fitted on the starboard console (fig.4). Reference to fig.7 will show that the supply to the pressure selector switch is fed from fuse 883, via contacts A_3-A_2 of relay 157. The selector switch setting can be overridden by operation of the first or second pilot's abandon aircraft switch or the first pilot's emergency de-compression switch. The sequence of operations is described in para.42.

37. Should serious loss of cabin pressure occur, a switch within the pressure controller will close to energize relay 125 from fuse 529, and at the same time the three decompression warning lamps on the navigator's panel will light (one for each rear crew member). Contacts 125/1 will close and a supply from fuse 528 will operate the warning horn under the starboard console. The warning horn tone can be cancelled by operating the horn isolation switch located at the aft end of panel 4P.

Decompression and abandon aircraft

38. The cabin is decompressed when the release valves (para.12) are energized by selection of the appropriate control switches. In normal conditions the valves will be energized when the pressure selector switch on the starboard console is selected to NO PRESS. For ground servicing purposes, a double-pole switch is provided in the nose wheel bay, which will energize the valves when selected to DECOMPRESS.

39. In emergency conditions, the cabin can be decompressed by the individual operation of the following switches:-

(1) A single-pole switch Ref. No. 5C/4179 labelled EMERGENCY DECOMPRESSION fitted on the port console.

(2) A double-pole switch Ref. No.

labelled ABANDON AIRCRAFT fitted on the port console.

(3) A double-pole switch labelled ABANDON AIRCRAFT fitted on the starboard console.

The release valves will be energized when either of the above switches are selected from NORMAL to EMERGENCY. Indication that the first pilot's or second pilot's abandon aircraft switch, has been operated, is given by the abandon aircraft sign being illuminated by four lamps at the navigator's panel (centre).

40. The valves will also be energized when the crew's manual decompression lever at the navigator's station is operated. This action will operate a micro switch to complete the energizing circuit at the same time as mechanically opening the valves. Note that operation of any of the control switches, including the crew's decompression lever, will also isolate the flood flow circuit. (See para.30).

Circuit operation

41. When the pressure selector switch is in the NO PRESS position (fig.7) the release valves will be energized from fuse 883, via contacts A_1-A_2 of relay 157 and contacts 4-1 of the pressure selector switch, with the earth return being made via contacts 6-9 of the pressure selector switch. Relay 126 is also energized by this supply and its contacts A_2-A_1 completes a parallel earth path. When the nose wheel bay decompression switch is selected to DECOMPRESS, the release valves and relay 126 will be energized from fuse 530 via switch contacts 4-5, with earth returns provided by switch contacts 2-1 and relay 126 contacts A_2-A_1.

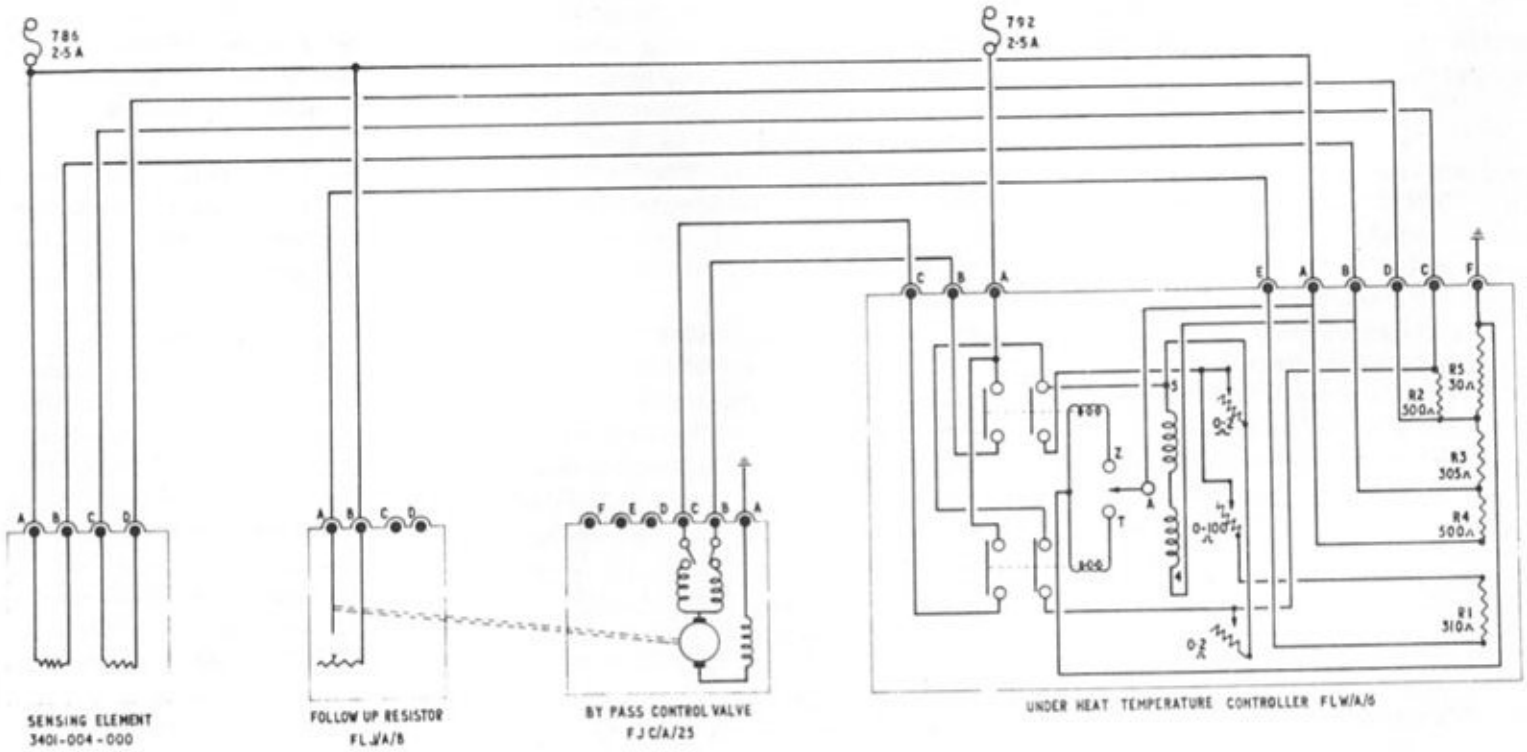


Fig.8. Underheat circuit

42. Selection of the emergency decompression switch to EMERGENCY will energize relay 157 from fuse 636. Contacts 157/2 will open to isolate the cabin pressurization selector switch. Contacts 157/1 will close, energizing relay 126 and the release valves, the earth return for the valves being completed via contacts A_2-A_1 of relay 126. This sequence of operations is the same when either the first or second pilot's abandon aircraft switch is selected to EMERGENCY, but in addition, the abandon aircraft sign will be illuminated by a supply from fuse 635 fed via the abandon aircraft switch contacts 3-2, to the warning lamps.

43. When the crew's manual decompression lever is operated, contacts 5-4 of the micro switch will close to energize the release valves and relay 126, the earth return being made via contacts 2-1 of the micro switch.

Emergency door opening

44. Two DOOR OPEN EMERGENCY switches are provided, one a double-pole, two-position switch at the navigator's panel (centre) and one a double-pole three-position switch at the navigator's table. Reference to fig.7 or 7A will show that when either switch is operated a supply from fuse 635 via the closed switch contacts energizes the unimatic valve which opens the emergency door. The valve is located near the entrance door handle. The entrance door indication circuit is described in Chap.15. The mechanical aspects of the system are given in Sect.3, Chap.7.

Underheat

45. If the outlet temperature of the turbine is allowed to fall below freezing point, the moisture in the air would freeze and block the water separator. This is prevented by the action of an underheat valve controlled by an electrically operated actuator being in turn controlled by the action of an underheat controller, Type FLW/A/6, and a ductstat. Warm air is bled from the turbine inlet via the underheat valve to the turbine outlet.

46. The system is part of the air conditioning crate situated in the nosewheel bay and is entirely automatic in operation, no manual override being provided.

Underheat controller

47. The underheat controller, Type FLW/A/6, is a sensitive relay controller which embodies a Wheatstone bridge network. The out-of-balance signals are arranged to operate directionally a sensitive relay, so that a second relay is energized to close the circuit between the supply and either the 'close' or 'open' field windings, of the underheat valve actuator.

Underheat ductstat

48. A temperature-sensitive double ductstat is fitted into the branch duct leading to the air conditioning crate (fig.3), and is linked into two opposing arms of the controller bridge network, each on a parallel circuit with a fixed resistor R2 and R4. Referring to fig.8, one of the ductstats is connected across poles A and B the other across poles C and D. The d.c. supply is connected across poles A and F. The remainder of the bridge circuit consists of two fixed resistors R1 and R3, a follow-up resistor across poles E and A, which is operated by a linkage connected to the underheat valve, and three potentiometers. The resistor R5 connected between poles D and F serves to drop some of the voltage across the bridge.

49. The circuit across the bridge is wired through the two opposing coils of the sensitive relay, so that, dependent upon the direction of an out-of-balance potential, the relay closes one or other of its set of contacts.

50. Should the air temperature fall, the ductstat sensing element resistance will increase to unbalance the bridge in the opposite direction. The sensitive relay is energized and the second relay becomes energized and closes the circuit between the supply and the 'open' field of the by-pass valve actuator. The movement of the valve also operates the follow-up resistance which will alter in value and so cancel the out-of-balance signal from the ductstat.

51. On rising temperature the opposite occurs and the valve will move to the close position. A routing chart for the system is contained in fig.14.

Engine air isolation cocks

52. The flow of compressed air from the engines for cabin conditioning is controlled by four solenoid operated valves (isolation cocks) fitted, one in each engine bay. The isolation cocks are individually controlled by four single-pole switches, labelled ENGINE AIR, on the starboard console (fig.4). Selection of the switches to OPEN will energize the solenoids and open the cocks; selection of the switches to SHUT will cut off the supply to close the cocks. A routing chart of the circuit is contained in fig.15.

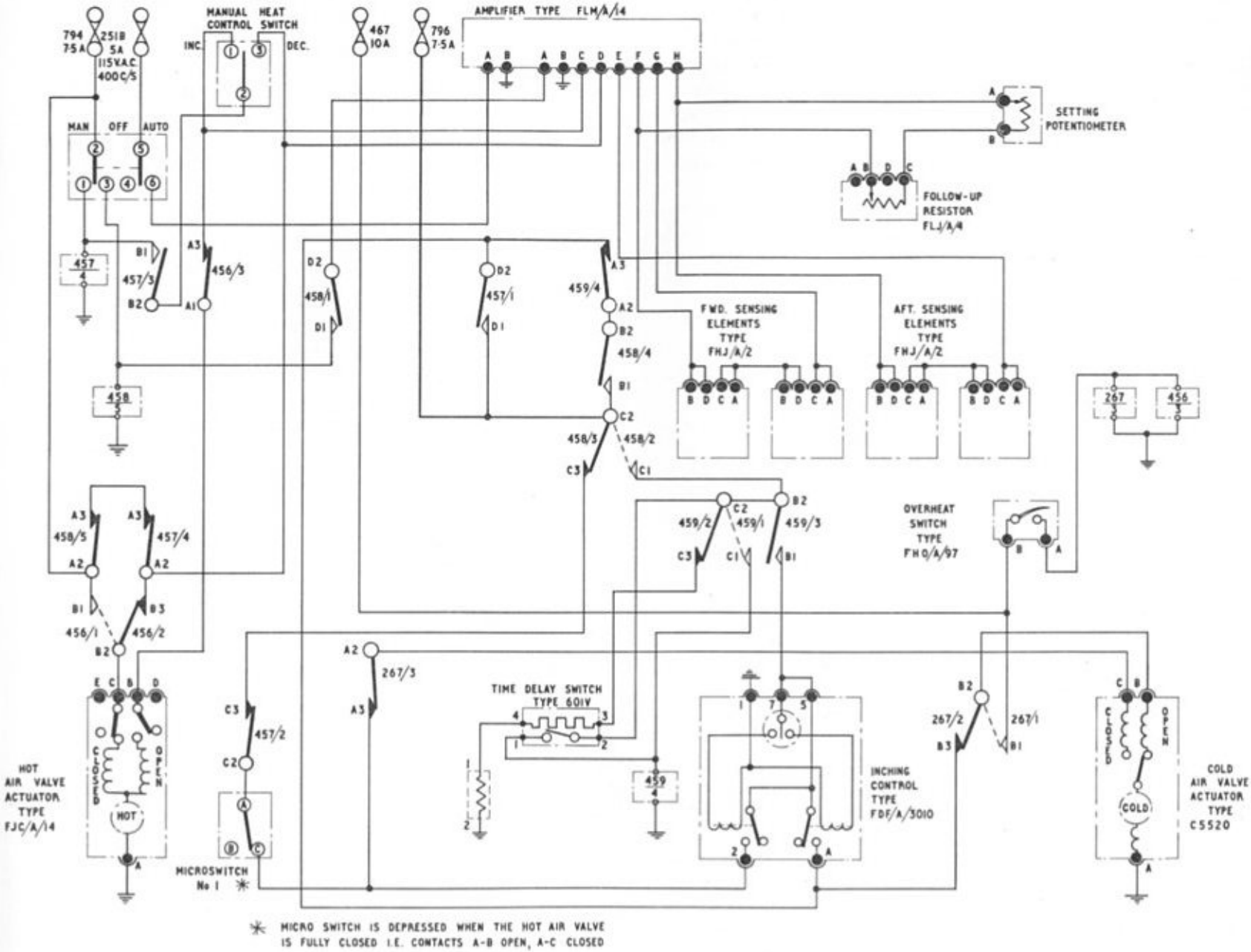


Fig.9. Bomb bay heating circuit

53. The ground air supply for starting the engines passes through the same ducting and is also controlled by the isolation cocks, which must be open for this operation. Non-return valves at the engines, however, block this opposite flow of air to the engine compressors.

Ram air valve

54. When the aircraft is flying unpressurized, ventilating air for the cabin is supplied from a forward facing air intake. Control of ram air is by means of an actuator operated valve fitted on the aft face of the rear pressure bulkhead. The actuator which controls the valve may be operated by means of a switch labelled RAM AIR – OPEN – SHUT on the starboard console (fig.3).

55. Coupled to the actuator is a Desynn transmitter which, operating in conjunction with an indicator fitted on the starboard console, serves to give visual indication of valve position.

56. A routing chart combining ram air control and position indicator is shown in fig.16.

Bomb bay heating

57. The bomb bay is heated to maintain the bomb gear and other equipment at a temperature a few degrees above freezing point. The system is situated entirely within the bomb bay and is similar to the de-icing systems (Chap.14) except that it operates continuously when switched on.

58. A branch of the engine hot air feed to the de-icing system passes through a hot air valve to the nozzle of an injector, and a branch of the cold air feed to the fin de-icing system passes through the cold air valve to the body of the injector. All these items are situated adjacent to the fin de-icing injector in the bomb bay arch.

59. The outlet from the injector system is connected to two distribution ducts running forward and aft in the bomb bay, with branch pipes to distribute the heated air at regular positions throughout the bomb bay. An outlet louvre in the port bomb bay door provides an exhaust vent for the heated air. Full details of the hot air systems will be found in Sect.3, Chap.8.

Controls and indicators

60. Two control switches and a temperature indicator are positioned on the starboard side of the navigator's panel. These are as follows:-

(1) Main control switch, labelled AUTO-OFF-MANUAL.

(2) Bomb bay heating switch, labelled INC-OFF-DEC, spring-loaded to OFF.

(3) Bomb bay temperature selector.

(4) Bomb bay temperature indicator (Sect.7, Chap.4).

In addition, the following equipment is fitted for the automatic control of the heating system:- Amplifier unit, Type FLM/A/14, Hot air valve actuator, Type FJC/A/14, Cold air valve actuator, Type C5520, Inching control, Type FDF/A/3010, Follow-up resistor, Type FLJ/A/4, Sensing elements (4), Type FHJ/A/2.

61. Before the bomb bay heating system can function, the engine air switches must be placed to ON. It is also assumed for the purpose of the following circuit description that the appropriate a.c. and d.c. supplies are switched on.

Circuit operation

62. Reference to fig.9 will show that when the AUTO-MANUAL switch is placed to AUTO, a 28-volt d.c. supply from fuse 794 will be fed via terminals 2-3 of the switch to energize relay 458. Contacts 458/1 will close to connect this supply to the amplifier input pole A. Simultaneously a 115-volt 400 Hz a.c. supply from fuse 251B will be fed via terminals 5-6 of the switch to the amplifier.

63. The cold air valve actuator 'open' field coil is energized from fuse 796 via contacts 458/4, 459/4 and 267/2 allowing the valve to move to the fully open position. The 'open' field coil of the hot air valve actuator is under automatic control via the normally closed contacts 456/3.

64. After a delay of approximately ten seconds the delay switch will operate and relay 459 will be energized. Contacts 459/1 will close to provide a hold-in supply for relay 459, and contacts 459/3 will close to complete the supply to the inching control. At the same time contacts 459/2 and 459/4 will open to isolate the delay switch and the 'open' field of the cold air valve actuator respectively.

65. At this stage the control of the hot air valve actuator will be taken over by the amplifier unit in conjunction with the bomb bay sensing elements and the setting of the temperature selector on the navigator's panel. The cold air valve will be under the control of the inching controller.

66. The system functions in a similar manner to the de-icing systems described in Chap.14. Note, therefore, that the action of the hot air valve micro switch ensures that the cold air valve will not be closed until the hot air valve is fully closed.

Manual control

67. When manual control of the bomb bay heating system is required, the auto-manual switch is selected to MANUAL. The following sequence of operations will then take place.

68. A 28-volt supply from fuse 794 via terminals 2-1 of the auto-manual switch will energize relay 457. Supplies to the amplifier unit and inching controller will be disconnected and automatic control will cease. Contacts 457/1 will close to connect the supply from fuse 796 and contacts 267/2 to the 'open' field of the cold air valve actuator, and contacts 457/3 will close to connect the supply to terminal 2 of the manual heat control switch. Simultaneously contacts 457/2 open and remove the supply to terminal 2 of the inching controller and also to remove the supply from the normally closed contacts 267/3. Contacts 457/4 will open to isolate the "close" field of the hot air valve actuator.

69. The cold air valve will open. Operation of the hot air valve will be controlled by the auto-manual switch, i.e. selection of the switch to INCREASE will energize the "open" field of the valve via contacts 456/3, and selection of the switch to DECREASE will energize the "close" field of the valve via contacts 456/2.

Overheat switch

70. Should the temperature of the heated air exceed 135 deg.C., a thermal overheat switch in the bomb bay air ducting will close, and this action will result in the closing of the hot air valve. When the temperature of the air drops to 125 deg.C., the overheat switch will open and the circuit will return to normal.

71. Should the switch close, due to the specified rise in temperature, a supply from fuse 467 via the switch contacts will energize relays 267 and 456. Contacts 456/3 will then open to isolate the " open" field of the hot air valve actuator while 456/1 will close to energize the "close" field of the actuator, direct from fuse 794. Contacts 267/3 open to isolate the "close" field of the cold air valve actuator while the supply from fuse 467 is also fed across the closed contacts 267/1 which completes the circuit to the "open" field of the cold air valve actuator allowing cold air to enter the system. Opening of the switch will de-energize relays 267 and 456, isolating the "open" field of the cold air valve actuator when contacts 267/1 opens contacts and completing the circuit to the "open" field of the hot air valve actuator when contacts 456/3 close. Contacts 456/1 open to isolate the "close" field of the hot air valve actuator, and contacts 267/3 close completing the circuit to the "close" field of the cold air actuator.

Suit ventilation system

72. A flow of dried air required for suit ventilation is tapped from the pressurisation system upstream of the flood flow valve and fed to the vent suit connection at each crew position (Chap.13).

73. A separate air conditioning unit installed at the aft end of the nose wheel bay is used for suit ventilation.

74. Exhaust air from the suits is exhausted with the cabin pressurisation air through the cabin discharge valves.

Air temperature

75. The inlet air temperature to individual suits may be varied by manually controlled electrical heaters. This heating system is described in Chap.13.

Air flow control

76. The air flow for the ventilated suit system is controlled by an actuator-operated on-off cock in the nosewheel bay. Selection of the cock to open or close is made by means of a change-over switch on the starboard console. To prevent overheating, an overheat switch is provided which completes the circuit to close the cock in the event of high temperature. The associated routing charts are contained in Chap.13.

77. The system can be operated when the cabin is not pressurized and when the aircraft is taxying, provided the engine air switches are selected to open. Ground conditioning from a trolley supplying conditioned air can be provided via a connection in the port wing root. Full details of the mechanical aspect of the system are contained in Sect.3, Chap.8 of this publication.

Auxiliary air ventilated suit and face blower system

78. An auxiliary air ventilated suit (A.V.S.) system is provided for each of the five crew stations, along with individual face blowers (punkah louvres) at the three rear crew positions. This system provides extra cooling facilities during taxying and low level flight in hot climatic conditions.

79. The auxiliary A.V.S. system comprises mainly, an exhauster unit with feeder pipelines to each rear crew member and electrically operated change-over cocks, introduced into the first and second pilots existing A.V.S. system. The existing A.V.S. system will be used when heating is required and the auxiliary A.V.S. system when cooling is required. The ▶ electrical items of equipment are dealt with ◀ in this chapter. The mechanical aspects of the system are dealt with in Sect.3, Chap.8 of this Publication.

Exhauster unit

80. The exhauster unit, Part No. 1/Z12379, mounted in a crate under the navigator's table (fig.5) houses a fan driven by a 200-volt a.c. motor and a control relay (827). The supply to the motor is controlled by a switch labelled A.V.S. ON-OFF mounted at the A.E.O.'s station on the navigator's panel (fig.5).

81. With the A.V.S. switch selected to ON (fig.12) a 28-volt d.c. supply is fed from fuse 976 in panel 3P, via switch contacts 2-1, to energize relay 827. Contacts A-L1, B-L2 and C-L3 of relay 827 close connecting a 200-volt 3-phase a.c. supply from fuses 733 R, Y and B on panel 75P to the A.V.S. exhauster motor. With the exhauster motor running, air is extracted from the cabin and drawn through the crews ventilated suits to provide cooling.

Change-over cocks

82. The two electrically operated change-over cocks, for the first and second pilots systems, are mounted below the navigator's table. The cocks are operated by d.c. rotary actuators, the supply to the actuator motors being fed from fuse 652 in panel 3P (first pilot) and fuse 583 in panel 4P (second pilot). Each change-over cock is controlled by a switch labelled A.V.S. c/o COCK with two switch positions labelled MAIN/AUX. The switches are located at the rear aft end of the first and second pilots' consoles 6P and 7P respectively.

83. Reference to fig.12 will show that, with either switch set to MAIN or AUX a.d.c. supply is fed to the appropriate actuator motor which will operate the change-over cock to connect the pilot's suits to either the main or auxiliary A.V.S. system as selected.

Face blower unit

84. A face blower unit, H.S.A. Part No. 1/Z12380, is connected via flexible pipelines to punkah louvres fitted at each of the three rear crew positions to provide additional cooling. The blower unit mounted below the exhauster unit under the navigator's table houses a fan, driven by a 200-volt a.c. motor and a control relay (828). The supply to the motor is controlled by a switch labelled FACE BLOWING ON-OFF, mounted adjacent to the A.V.S. ON-OFF switch at the A.E.O.'s panel.

85. With the FACE BLOWING switch operated to ON, a 28-volt d.c. supply fed from fuse 546 on panel 4P via switch contacts 2-1 to energize relay 828. Contacts A-L1, B-L2 and C-L3 of relay 828 close connecting a 200-volt, 3 phase a.c. supply from fuse 741 R, Y and B to the blower motor. With the motor running, the unit delivers air through the flexible pipelines to the punkah louvres, which may be positioned as required by the rear crew members.

A.A.P.P. bleed air

86. Bleed air can be obtained from the A.A.P.P. (Chap.5) for cabin conditioning when the aircraft is on the ground only, or for emergency engine starting. This circuit is part of the engine start and ignition routing chart and is described in Chap.8.

87. With the introduction of Mod.1320 – Rapid engine start (Chap.8, App.1), the bleed air from the A.A.P.P. when required, is used for cabin conditioning only, and has no connection with engine starting. In this case, therefore, a separate routing chart for the bleed air control circuit is provided and is contained in fig.19 of this chapter.

88. When the control switch, labelled ▶ A.A.P.P. – BLEED FOR VENT. SUITS, on ◀ the starboard console is placed to ON, the circuit operation is the same as that described in Chap.8, except that the control relay 189 is now relay 634.

N.B.C. AND H2S AIR VALVES

89. A pressurised dry air supply is provided for the N.B.C. and H2S installations. This air is supplied from two storage cylinders in the nose of the aircraft. Both cylinders are charged from a charging point located behind a panel on the port side of the nose of the aircraft (Sect.7, Chap.5).

90. Two electromatic taps, one for each system, are fitted in the lines between the bottles and the equipment concerned. Each tap is controlled by a single-pole switch fitted at the navigator's station (fig.17).

SERVICING

General

91. The heating and ventilation systems should be tested in accordance with the procedures laid down in the Servicing Schedule. Close co-operation between all trades concerned will avoid unnecessary repetition of tests and ensure a high standard of serviceability. Components should be examined periodically for cleanliness and security, and suspected faulty items should be replaced. Full information can be found in the publications listed in Table 1.

92. Continuity tests on any of the circuits can be made by disconnecting the system components and connecting suitable test lamps to the respective cable plugs or sockets. The circuit wiring and operation of controlling relays can then be tested by operating the appropriate control switches and observing the test lamp indications.

Pressure controller

93. Servicing details and tests for the controller, Type F509320, are contained in the publication listed in Table 1.

94. Operation of the switch within the controller to test the decompression warning horn circuit can be effected by raising the ground test lever on the controller to the GROUND TEST position, when the warning horn will sound. The lever must be returned to the FLIGHT position after test.

Sensing elements

95. The sensing elements, Type FHG/A/35 (cabin temperature), Part No.3401-004-000 (underheat) and Type FHJ/A/2 (bomb bay heating) should be checked for insulation resistance and temperature resistance in accordance with the values specified in the publication listed in Table 1.

Overheat switches (flamestats)

96. Servicing instructions for the overheat switches, Type FHO/A/87 and FHO/A/97, used in the cabin temperature and bomb bay heating systems respectively, are contained in the publication listed in Table 1.

Amplifiers

97. The amplifiers, Type FLM/A/14, used in the cabin temperature and bomb bay heating systems, should be serviced in accordance with the instructions outlined in the publication listed in Table 1.

Cabin temperature and flood flow

Temperature control valve

98. Servicing information on the temperature control valve, Type FKH/A/5050, and the actuator, Type FJC/A/504, which is part of the valve assembly are dealt with in the publications listed in Table 1.

Follow-up resistor linkage setting

99. The linkage between the follow-up resistor, Type FLJ/A/5 and the temperature control valve should be set in accordance with the instructions outlined in Sect.3, Chap.8 of this publication.

Pressure ratio switch

100. The pressure ratio switch, Type FLY/A/10, should be tested in accordance with the Standard Serviceability Test outlined in the publication listed in Table 1.

Cabin altitude switches

101. The cabin altitude switches, Type PAD/A/0/3 and PAD/A/0/4, should be tested in accordance with the Standard Serviceability Test outlined in the publication listed in Table 1.

Temperature selector

102. The cabin temperature selector, Type FHK/A/7, should be serviced in accordance with the instructions contained in the publication listed in Table 1.

Flood flow valve actuator

103. Servicing details for the flood flow valve actuator, Type FJC/A/73, are given in the publication listed in Table 1.

Automatic flow valve actuators

104. Servicing details for the automatic flow valve actuators, Type C5511/2, are given in the publication listed in Table 1.

Underheat controls

By-pass control valve actuator

105. Servicing details for the by-pass control valve actuator, Type FJC/A/25, are given in the publication listed in Table 1.

Follow-up resistor linkage setting

106. The linkage between the follow-up

resistor, Type FLJ/A/8 and the by-pass control valve should be set in accordance with the instructions outlined in Sect.3, Chap.8 of this publication.

Underheat controller

107. Servicing information on the underheat controller, Type FLW/A/6, is contained in the publication listed in Table 1.

Ram air valve actuator

108. Servicing details for the ram air valve actuator, Type C5511/2, are given in the publication listed in Table 1.

Bomb bay heating

Hot air valve actuator

109. Servicing details for the bomb bay hot air valve actuator, Type FJC/A/14, are given in the publication listed in Table 1.

Hot air valve micro switch setting

110. Instructions for setting the bomb bay hot air valve micro switch will be found in Sect.3, Chap.8 of this publication.

Follow-up resistor linkage setting

111. The linkage between the follow-up resistor, Type FLJ/A/4, and the bomb bay hot air valve should be set in accordance with the instructions outlined in Sect.3, Chap. 8 of this publication.

Cold air valve actuator

112. Servicing details for the bomb bay cold air actuator, Type C5520, are given in the publication listed in Table 1.

Inching control

113. Servicing information and Standard Serviceability Tests for the inching control, Type FDF/A/3010, are contained in the publication listed in Table 1.

Sunvic time delay switch

114. The Sunvic time delay switch and its series resistance are matched in manufacture, and should either item fail, both must be replaced by a matched set. Details of the switch are contained in the publication listed in Table 1.

Auxiliary A.V.S. system

115. Functional tests of the auxiliary A.V.S. system can be found in Sect.3, Chap.8 of this publication.

Face blowers

116. A functional test of the face blower system can be found in Sect.3, Chap.8 of this publication.

REMOVAL AND INSTALLATION

General

117. Most of the electrical components in the heating ventilation systems are readily accessible and no detailed removal instructions are necessary. Information on removing the air conditioning unit in the nose wheel bay is provided in Sect.3, Chap.8, of this publication.

TABLE 1
Major items of equipment

Equipment	Type	A.P. Reference
Pressure controller	F509320	1275A, Vol.1, Sect.20, Chap.28, App.4
Sensing element (cabin temperature)	FHG/A/35	107B-0216-1
Sensing element (bomb bay heating)	FHJ/A/2	107B-0227-1
Overheat switch	FHO/A/87	112G-1122-1
Overheat switch	FHO/A/97	112G-1122-1
Amplifier	FLM/A/14	107B-0207-16
Temperature control valve	FKH/A/5050	4303E, Vo.1, Sect.2, Chap.12
Temperature control valve actuator	FJC/A/504	113E-0203-16
Follow-up resistor	FLJ/A/5	–
Pressure ratio switch	FLY/A/10	112G-1124-1
Cabin altitude switch	PAD/A/0/3	112G-1128-1
Cabin altitude switch	PAD/A/0/4	112G-1128-1
Temperature	FHK/A/7	107B-0214-16
◀ Flood flow valve actuator (Removed Post Mod.2410) ▶	FJC/A/73	4343D, Vol.1, Book 5, Sect.16, Chap.40
Automatic flow valve actuators	C5511/2	113E-0218-16
By-pass control valve actuator	FJC/A/25	4343D, Vol.1, Book 5, Sect.16, Chap.40
Underheat controller	FLW/A/6	107B-0215-16
Ram air valve actuator	C5511/2	113E-0218-16
Hot air valve actuator (bomb bay)	FJC/A/14	4343D, Vol.1, Book 5, Sect.16, Chap.40
Cold air valve actuator	C5520	113E-0218-16
Inching controller	FDF/A/3010	112G-1129-1
Sunvic time delay switch	601/V	4343C, Vol.!, Book 2, Sect.3, Chap.46
Exhauster unit	H.S.A. Part No.1/Z12379	–
Blower unit	H.S.A. Part No.1/Z12380	–

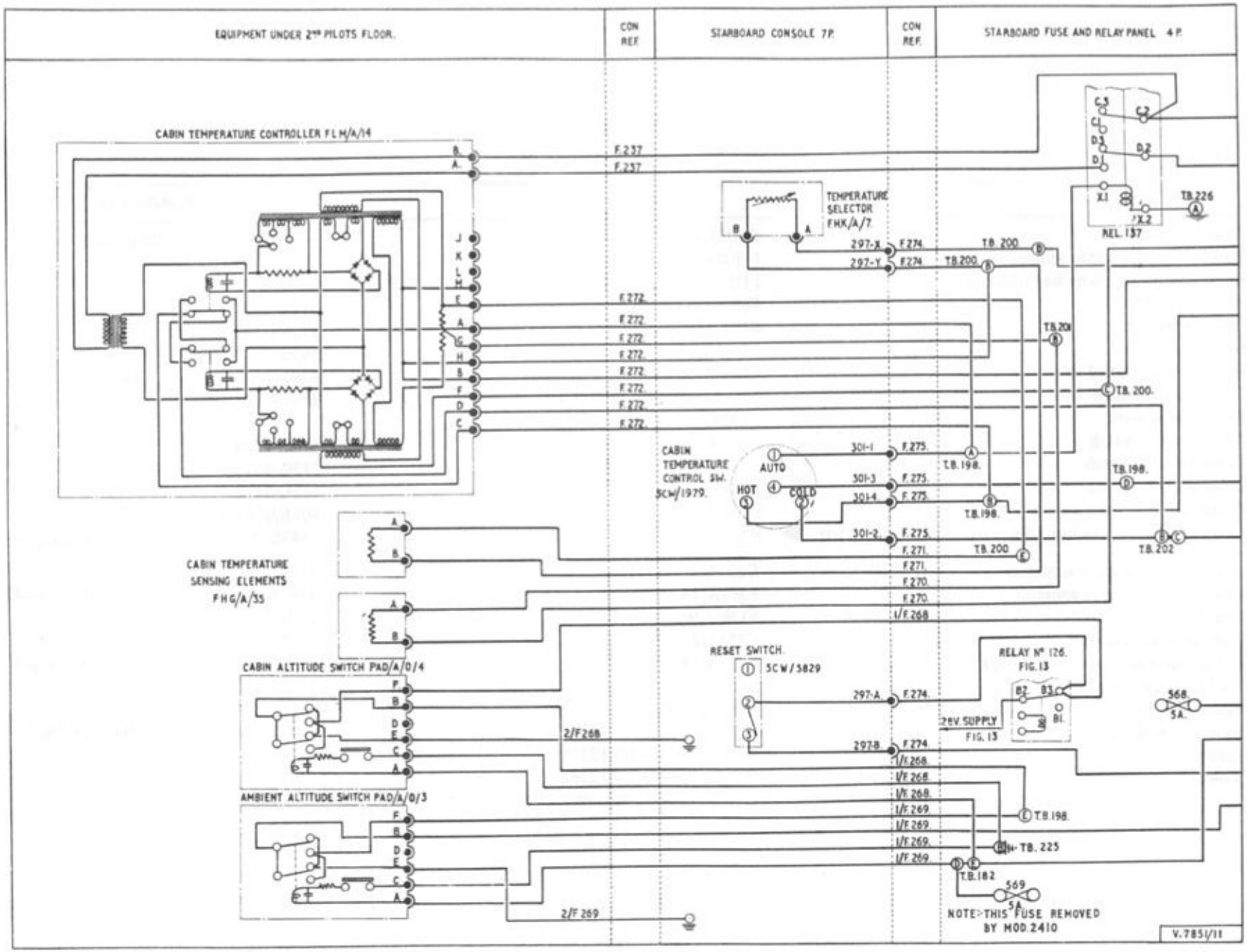


Fig. 10. (1) Cabin temperature and flood flow

◀ Mod. 2410 ▶

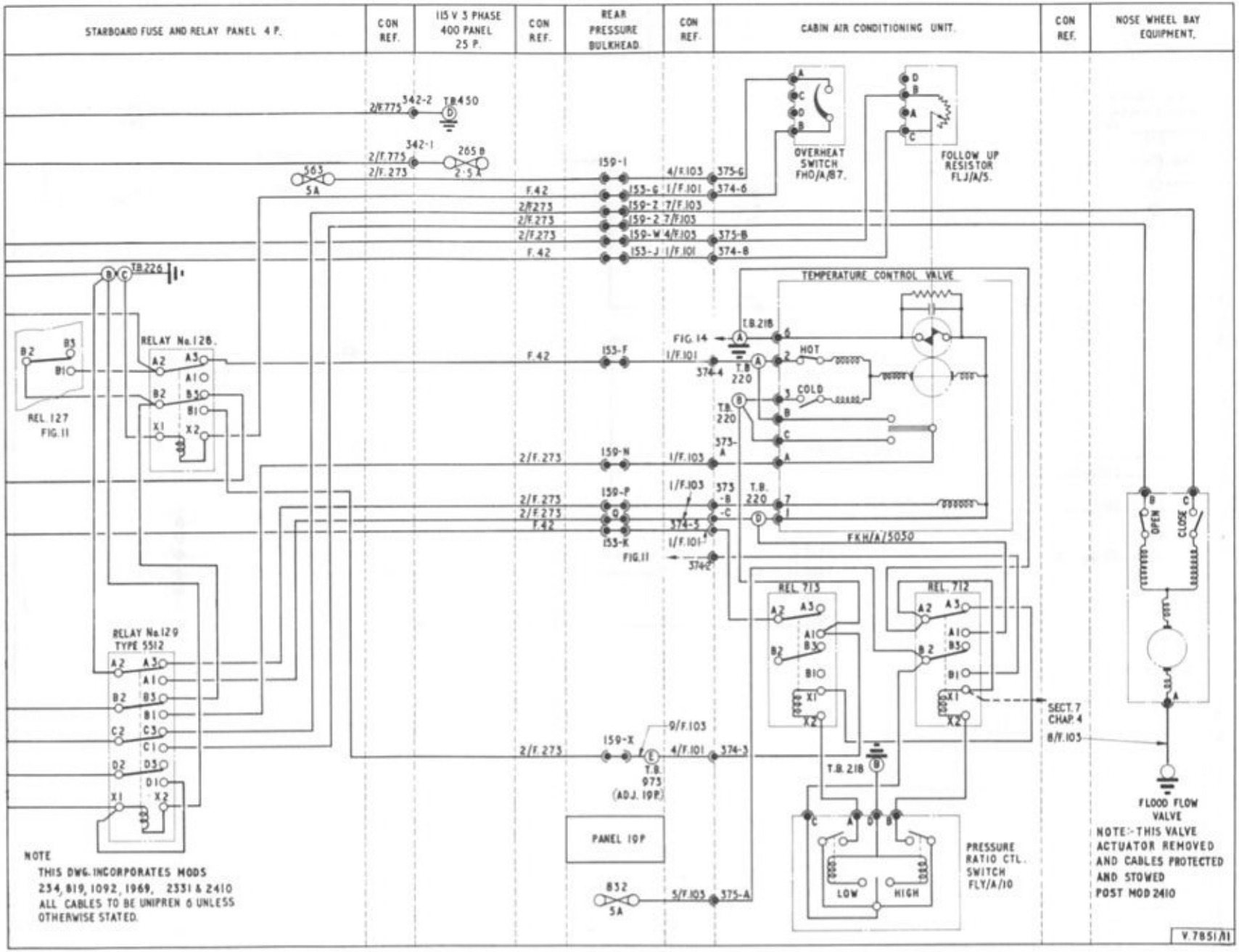


Fig. 10. (2) Cabin temperature and flood flow

◀ Mod 2410 ▶

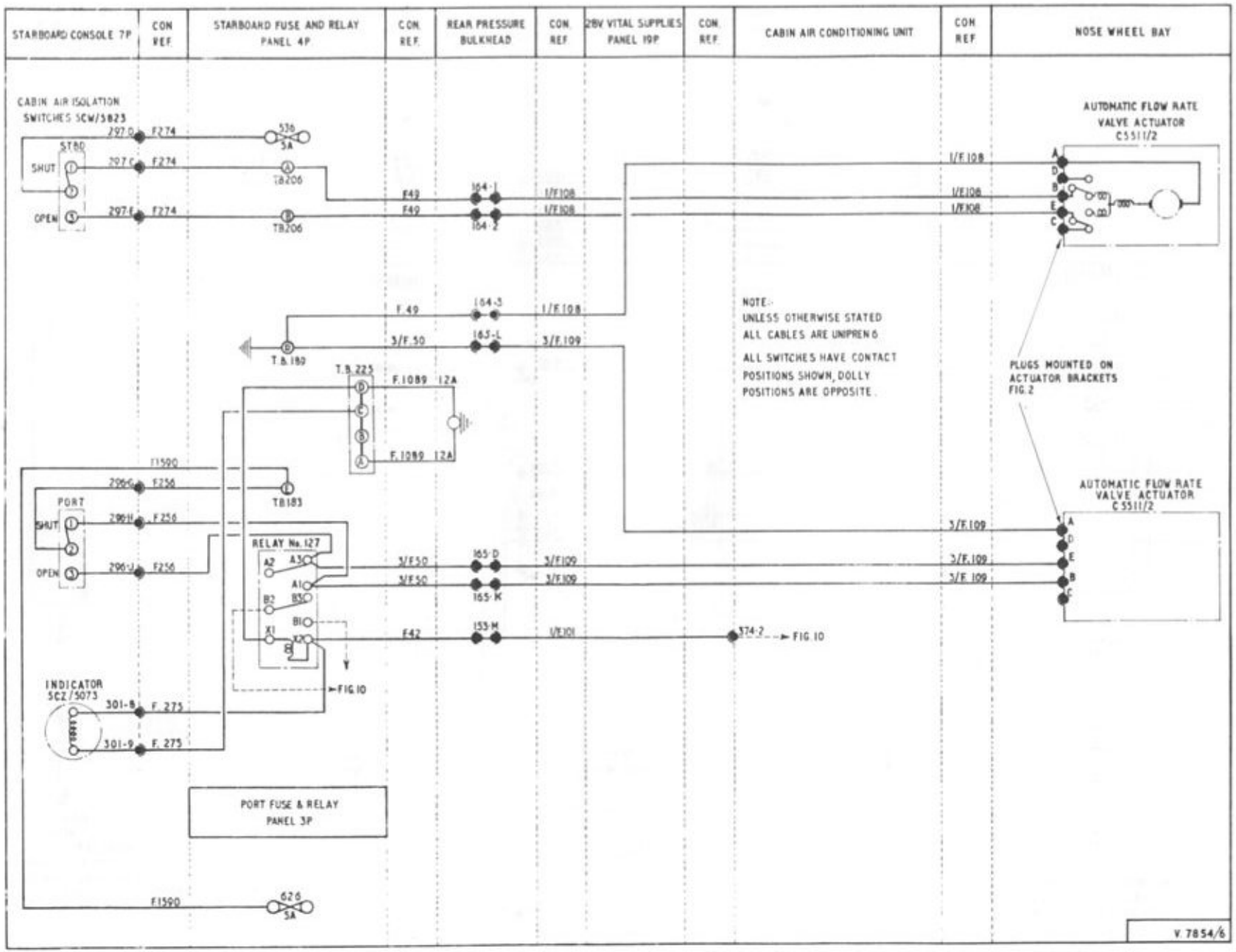


Fig. 11. Automatic flow

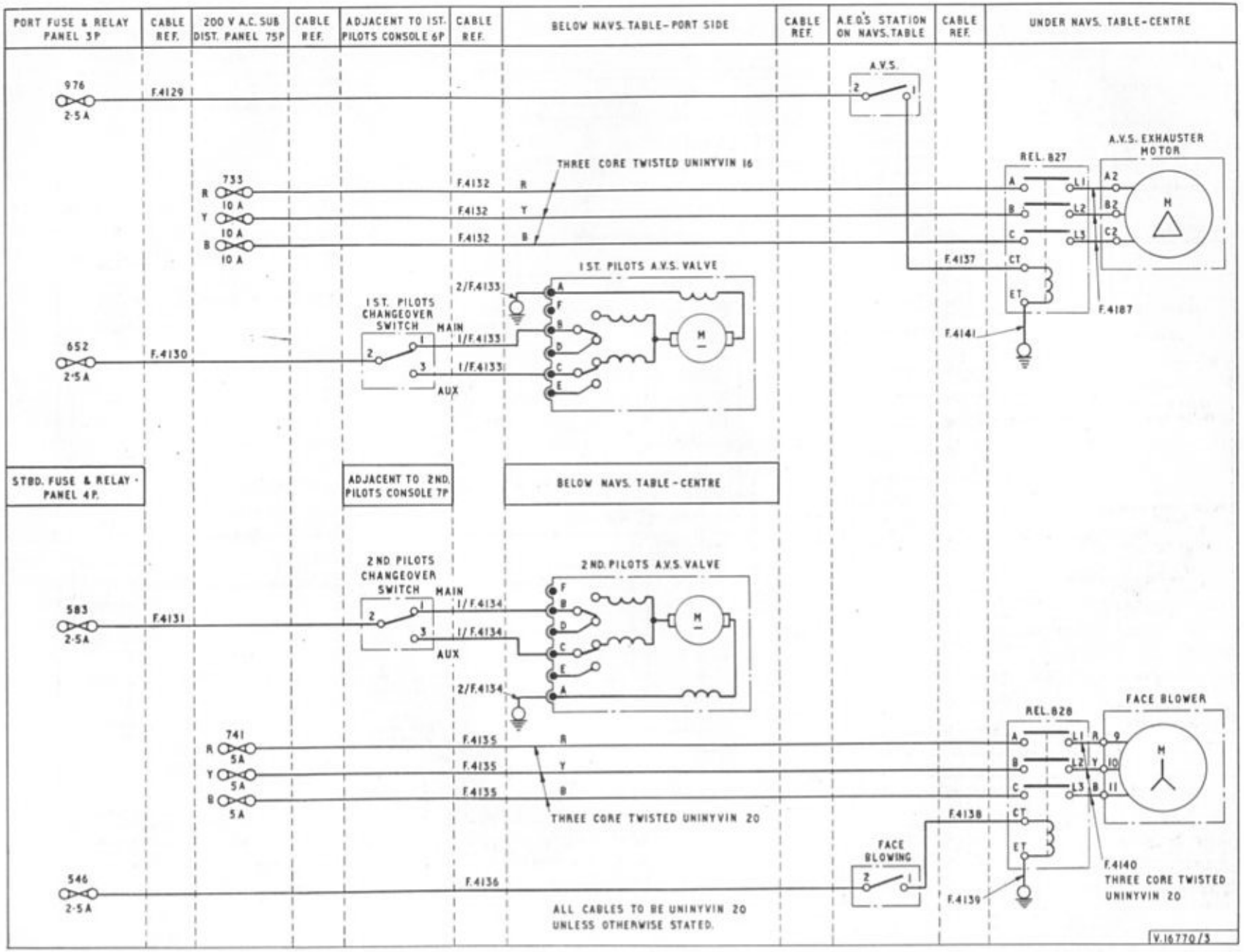


Fig. 12. Auxiliary A.V.S. and face blower

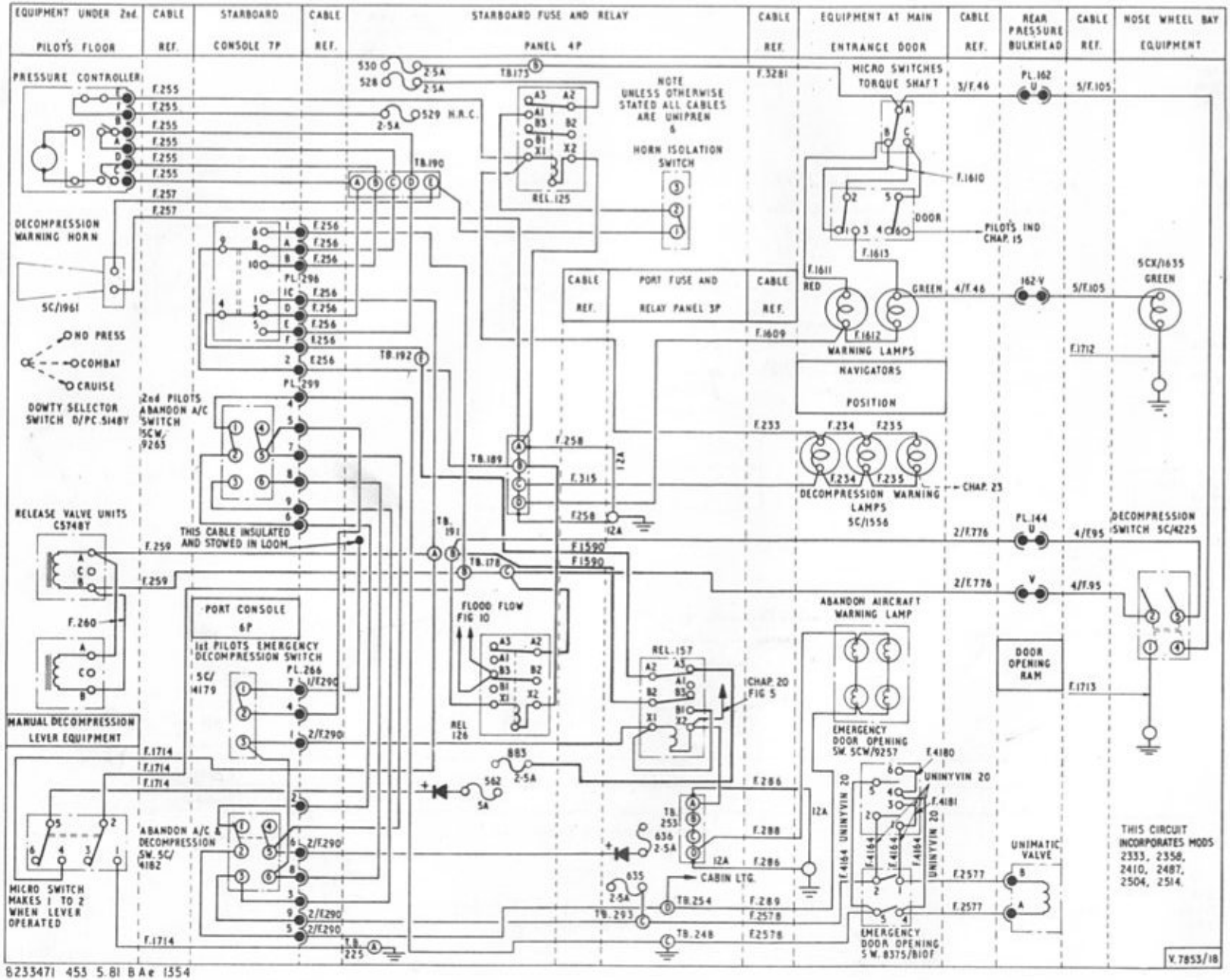


Fig. 13 Decompression and warning

Title change and mod state clarified

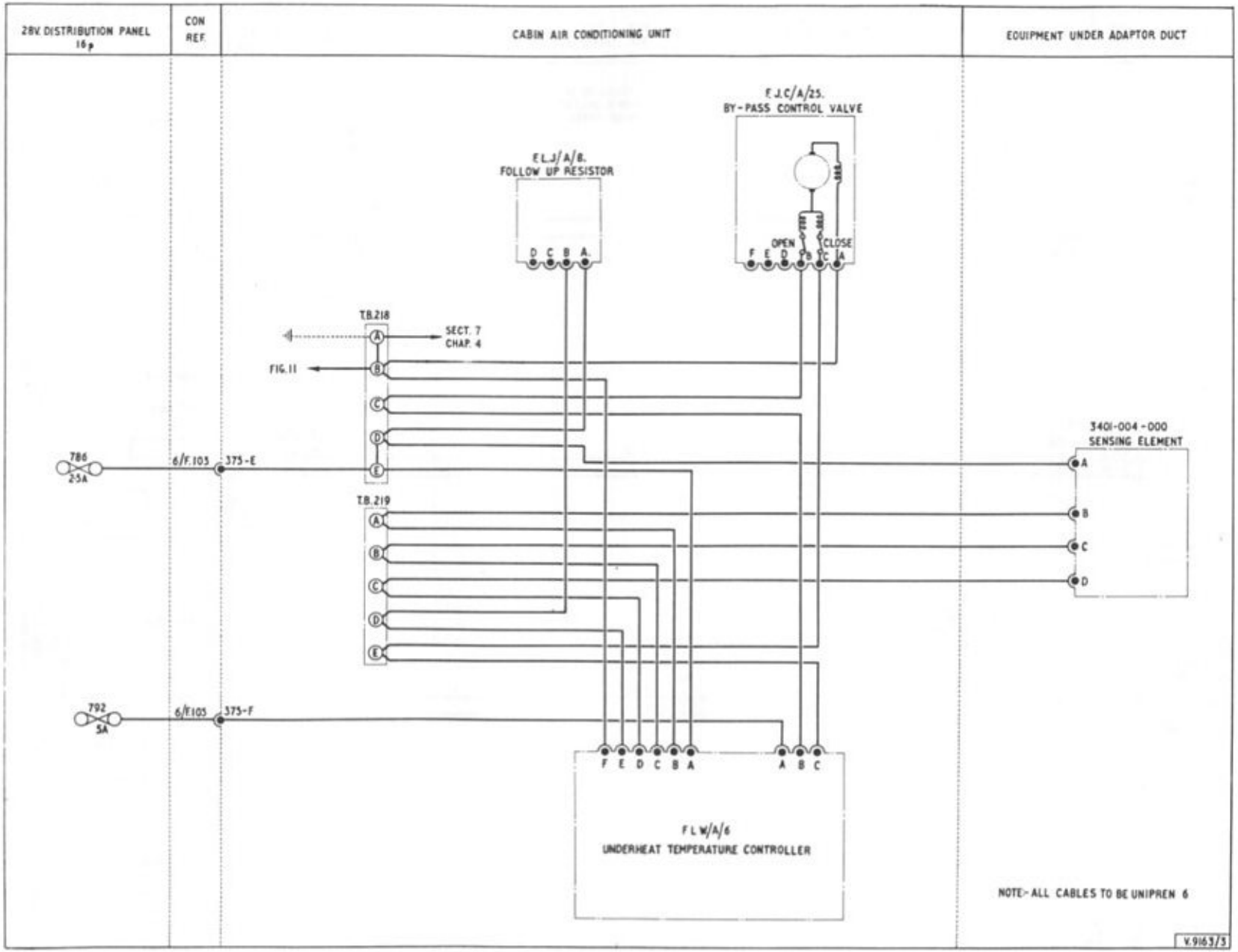


Fig. 14. Underheat controls
Col. 15p now 16p

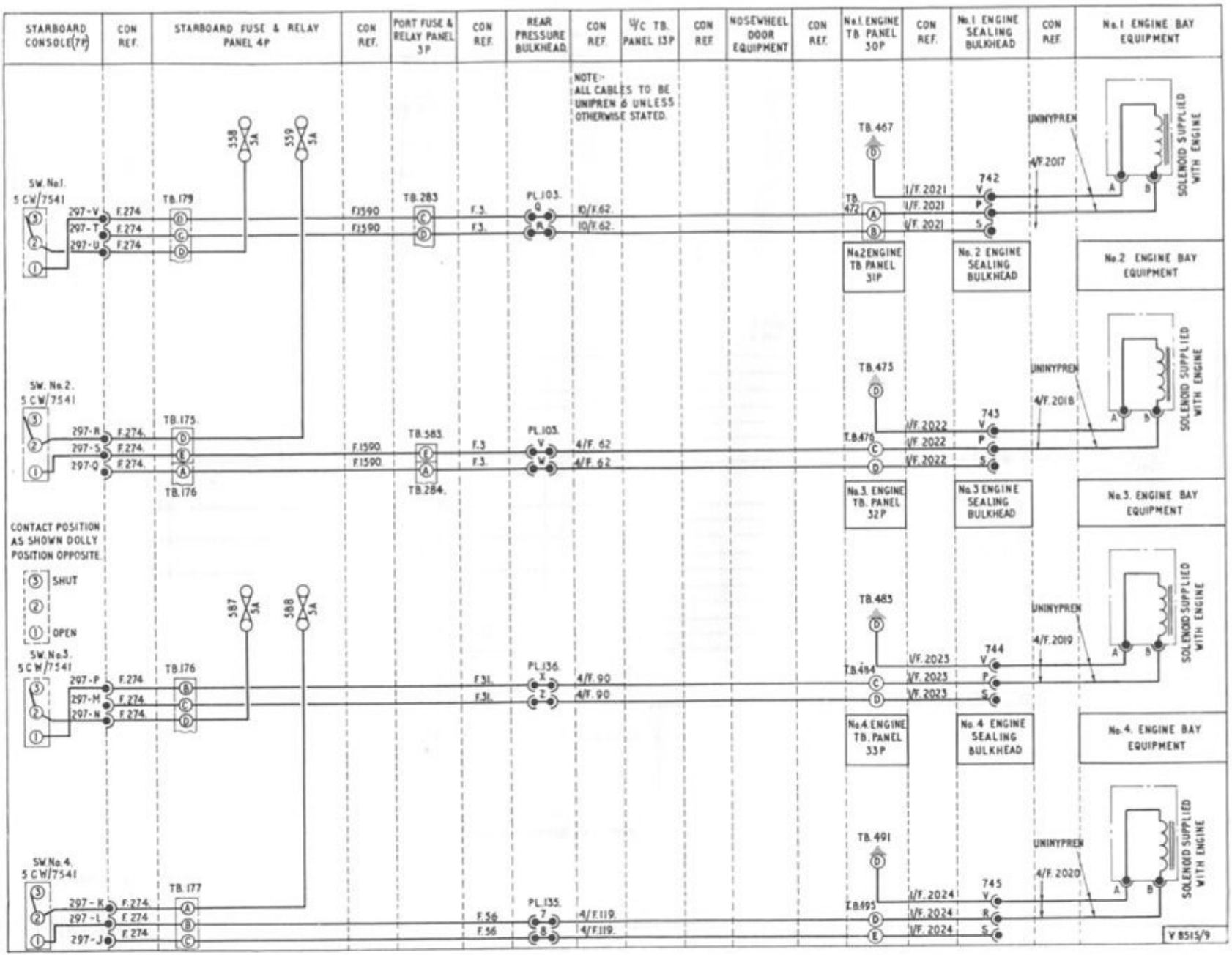


Fig.15. Engine air isolation cocks

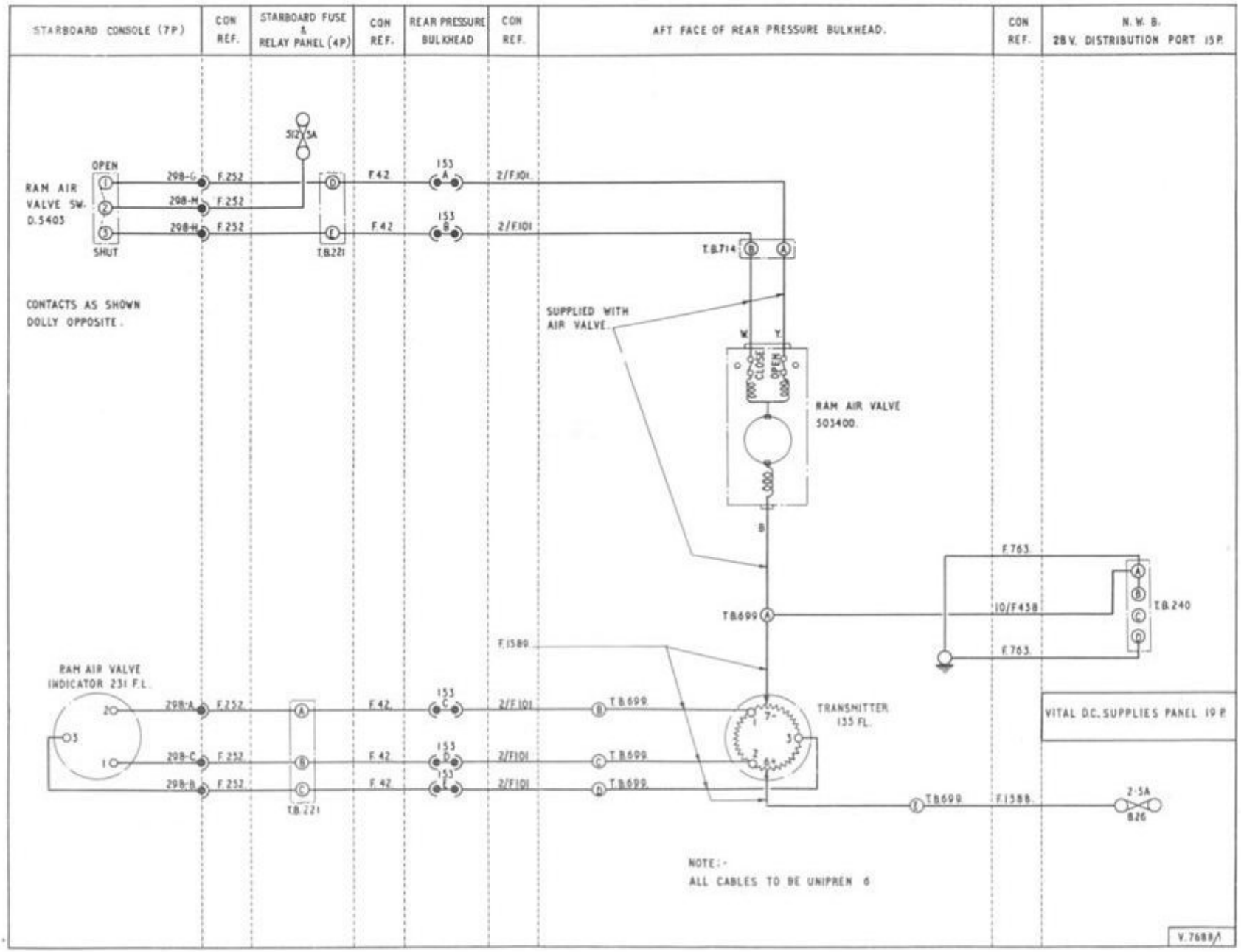


Fig. 16. Ram air valve
(◀ *Fig. No. changed* ▶)

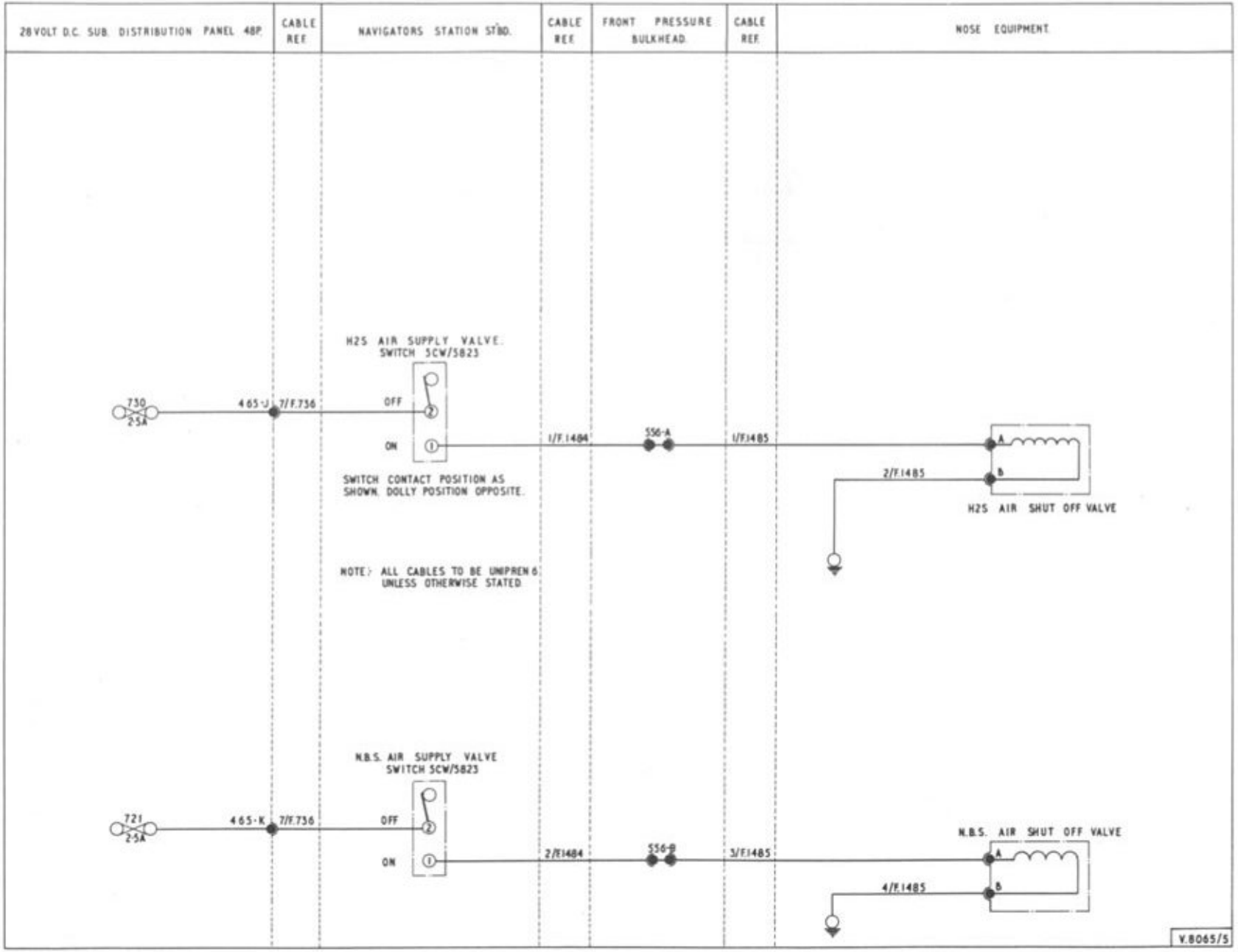


Fig.17. H2S and N.B.S. air valves

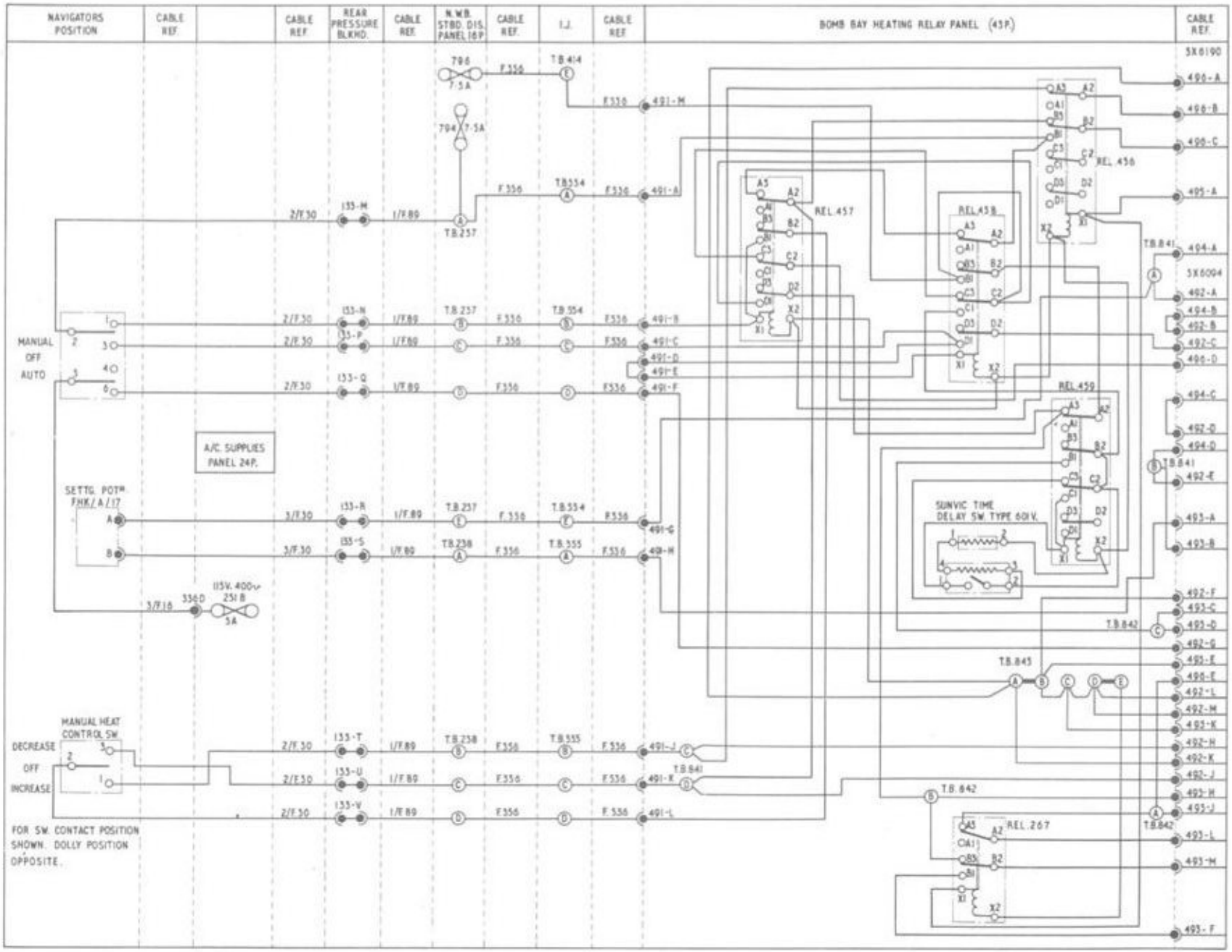


Fig.18 (1) Bomb bay heating
(◀Fig. No. changed▶)

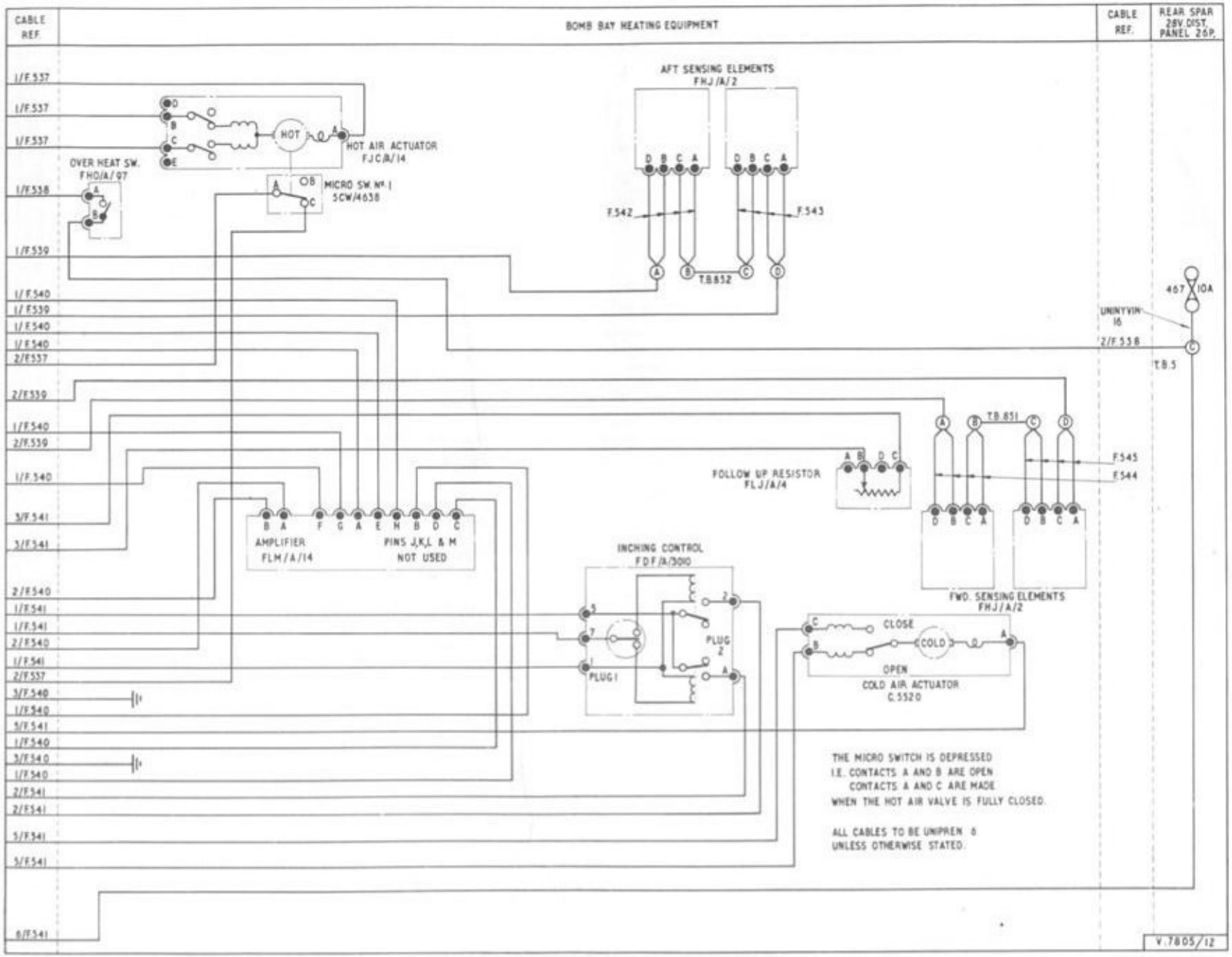
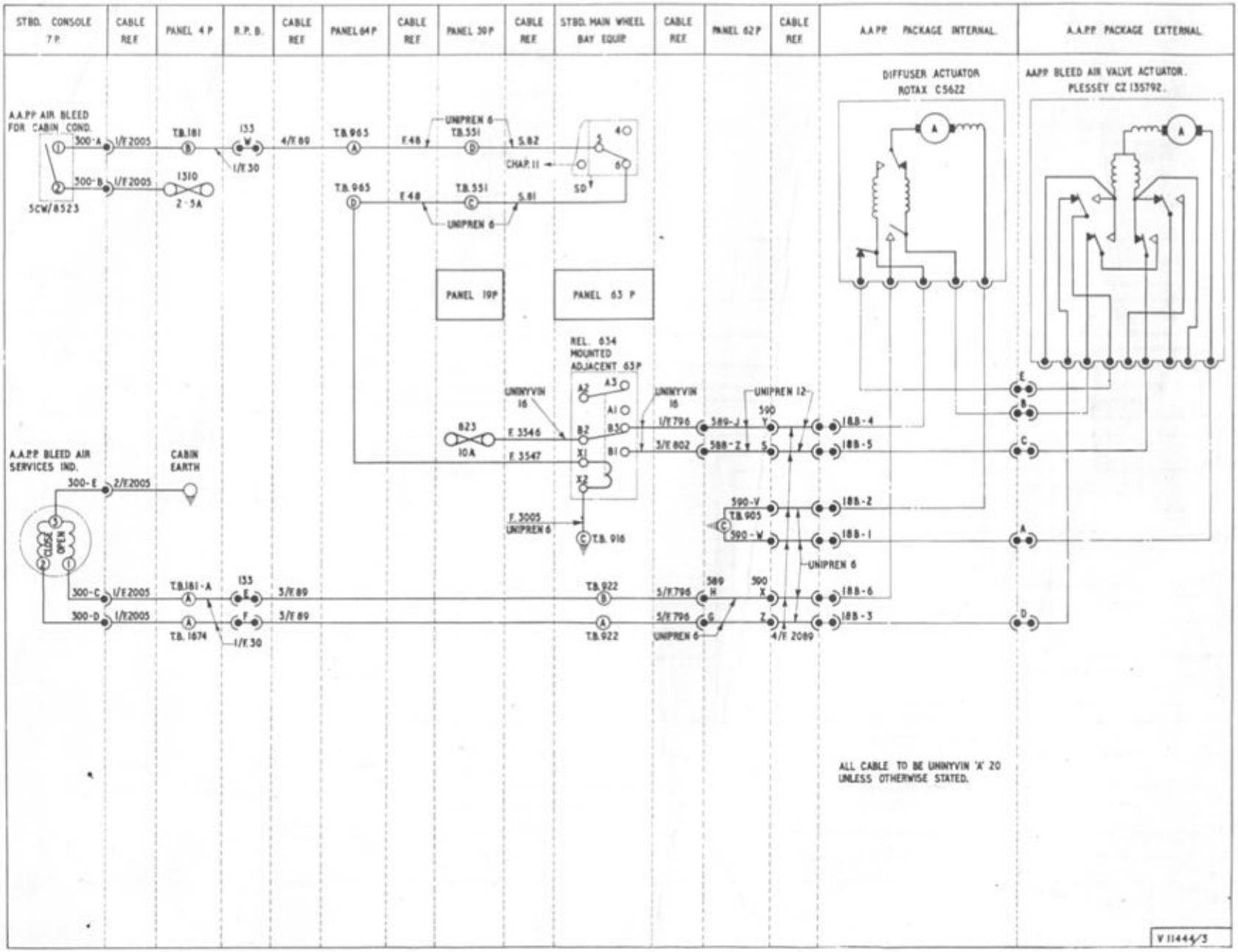


Fig.18 (2) Bomb bay heating

(◀ Fig No changed ▶)



939980 570 1,73 H.S.A.1354

Fig. 19. A.A.P.P. bleed air for cabin conditioning