Group 8A

HEATING AND VENTILATION (POST MOD.176, 177 AND 751)

(Completely revised)

LIST OF CONTENTS

*To be issued later

LIST OF ILLUSTRATIONS

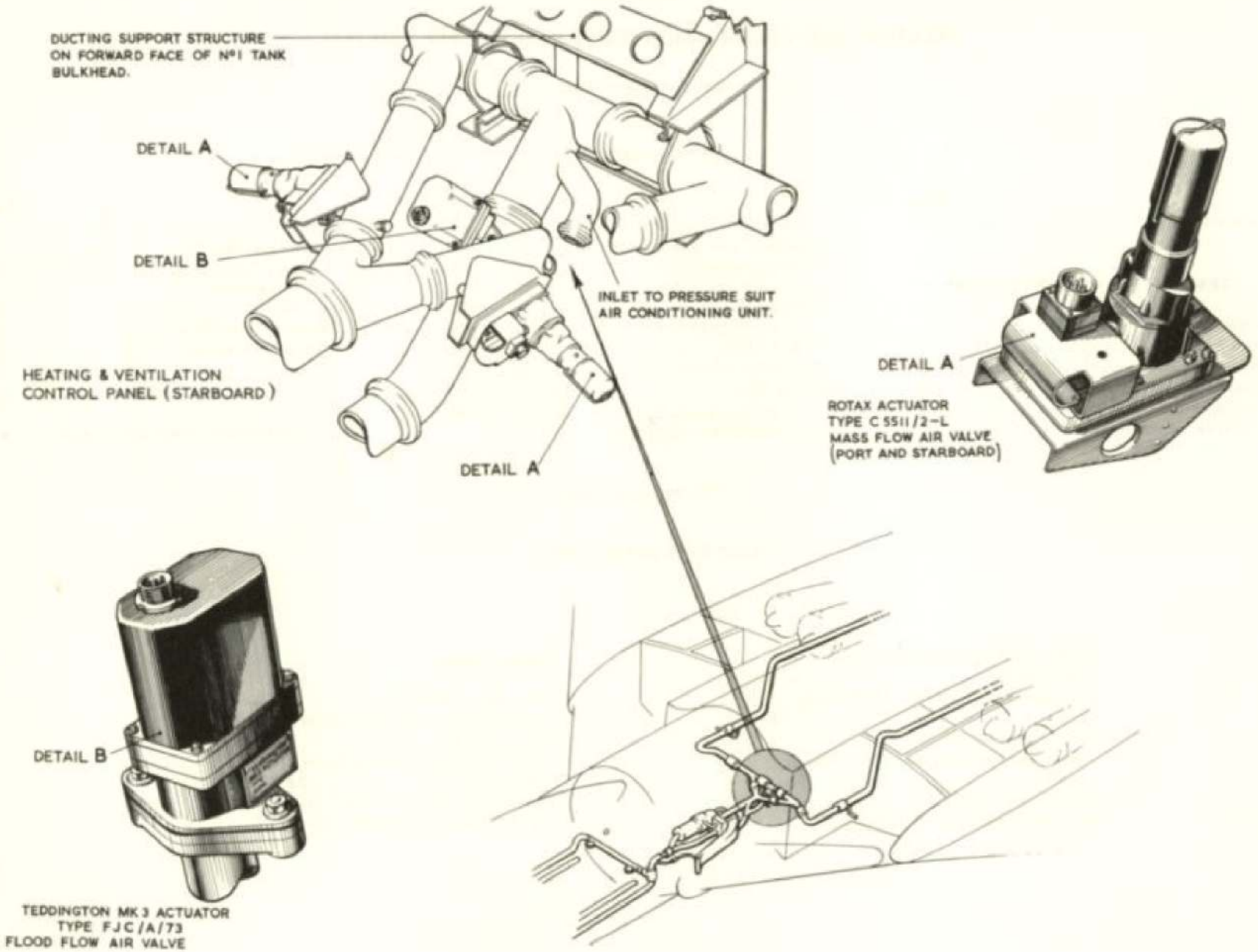

Fig.1 Mass and flood flow actuator installation

Introduction

1. This group contains descriptive and servicing information for the electrical controls and circuits for the modified heating and ventilation systems. It should be noted that the main distribution fuse tables are contained in Group 1. Theoretical circuit diagrams and location illustrations are provided. The following modifications to the heating and ventilation circuits are included in this group:-

Mod.176 - To improve flow control system.

Mod.177 - To provide a suitable form of air supply for use of air ventilated suits by the crew members.

Mod.751 - To prevent inadvertent feed to flood flow.

DESCRIPTION AND OPERATION

AIR CONDITIONING

General

2. A complete system of pressurization and cabin heating is fitted to the aircraft, and is operated by compressed air obtained from the four engines.

3. A suitable ducting, connected from each pair of engines, provides hot air for cabin air conditioning. A triangular duct arrangement in the nose wheel bay provides branch connections to the system as indicated in fig.1. Hot air for the wing anti-icing is tapped from the ducting at connections aft of the nose wheel bay. Two automatic flow controllers are mounted in two adjacent sides of the triangular ducting, whilst the base of the triangle is a by-pass leading to a flood flow valve passing between and underneath the controllers.

4. Suit ventilation is tapped from the main cabin pressurization system, just before the flood flow control valve, thus by-passing the automatic flow controllers. The air is passed through separate air conditioning equipment and is fed to each crew member's ventilated suit.

5. All the air conditioning components are contained in the air conditioning crate on the port side of the nose-wheel bay (fig.2) and include:-

(1) Air-to-air cooler, Type 27UA/487.

(2) Temperature control valve, Type FKH/A/5050.

(3) Turbine refrigeration unit, 27UA/493.

(4) Underheat temperature controller, Type FLW/A/6.

(5) By-pass control valve, Type FKH/A/5040.

(6) Water extractor, Type WE.60, Mk. 3.

(7) Overheat switch, Type FHO/A/87.

(8) Follow up resistor, Type FLJ/A/8.

6. The air flow through the crate is variable according to the position of the temperature control valve as follows:-

(1) HOT - straight through.

(2) INTERMEDIATE - some air straight through, remainder through the air-to-air cooler.

(3) WARM - all air through the air-to-air cooler.

(4) INTERMEDIATE - all air through the cooler, some air through the turbine unit.

(5) COLD - all air through the cooler and turbine unit.

Pressure control

7. The pressure in the cabin is controlled by restriction in the air discharge system. The restriction is effected by discharge valves which are controlled by two pressure controllers.

Discharge valves

8. Two bellows-operated discharge valves and a spring-loaded relief valve, are contained in the combined valve unit, Type Normalair 20/65, on the forward face of the front pressure bulkhead. Each discharge valve is controlled by a pressure controller which applies air pressure to the valve bellows. The area of the bellows is greater than the valve seat area and the control pressure is slightly lower than the cabin pressure. The discharge unit is enclosed by a shroud, and a duct feeds the discharge air into the nose section to provide cooling for the radar equipment.

Inward relief valves

9. A separate inward relief valve is fitted on the front pressure bulkhead. Two further inward relief valves are fitted, one to a pressure controller, Type 510350, and one to a pressure controller, Type 510740, to limit the magnitude of negative differential pressure which can arise under certain conditions during descent. During normal operation the air supplied to the cabin is sufficient to prevent a reversal of pressure, but, in special circumstances, such as rapid descent following engine or air supply failure, these inward relief valves prevent the cabin pressure falling

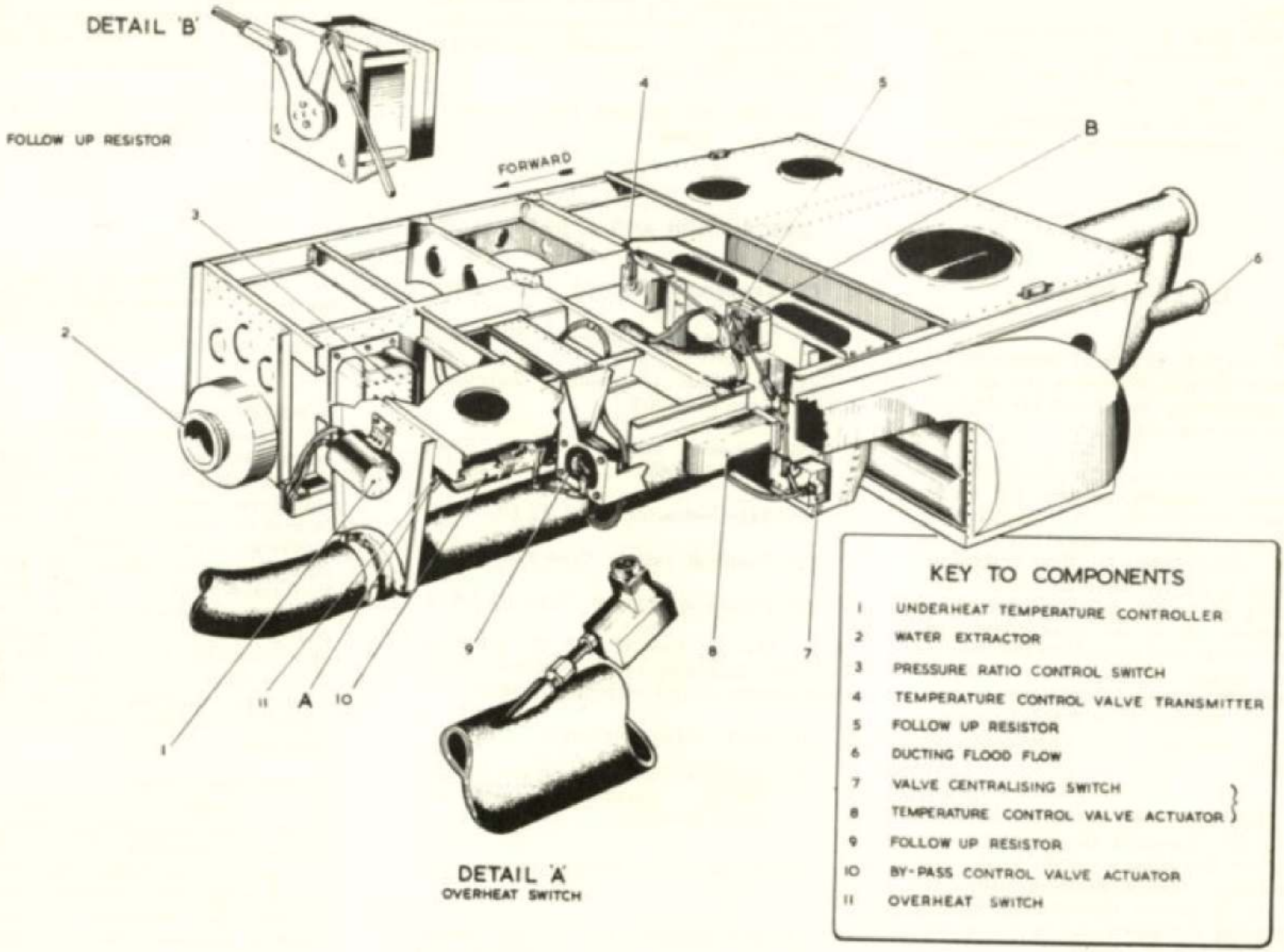

Fig. 2 Air conditioning crate (post mod. 176)

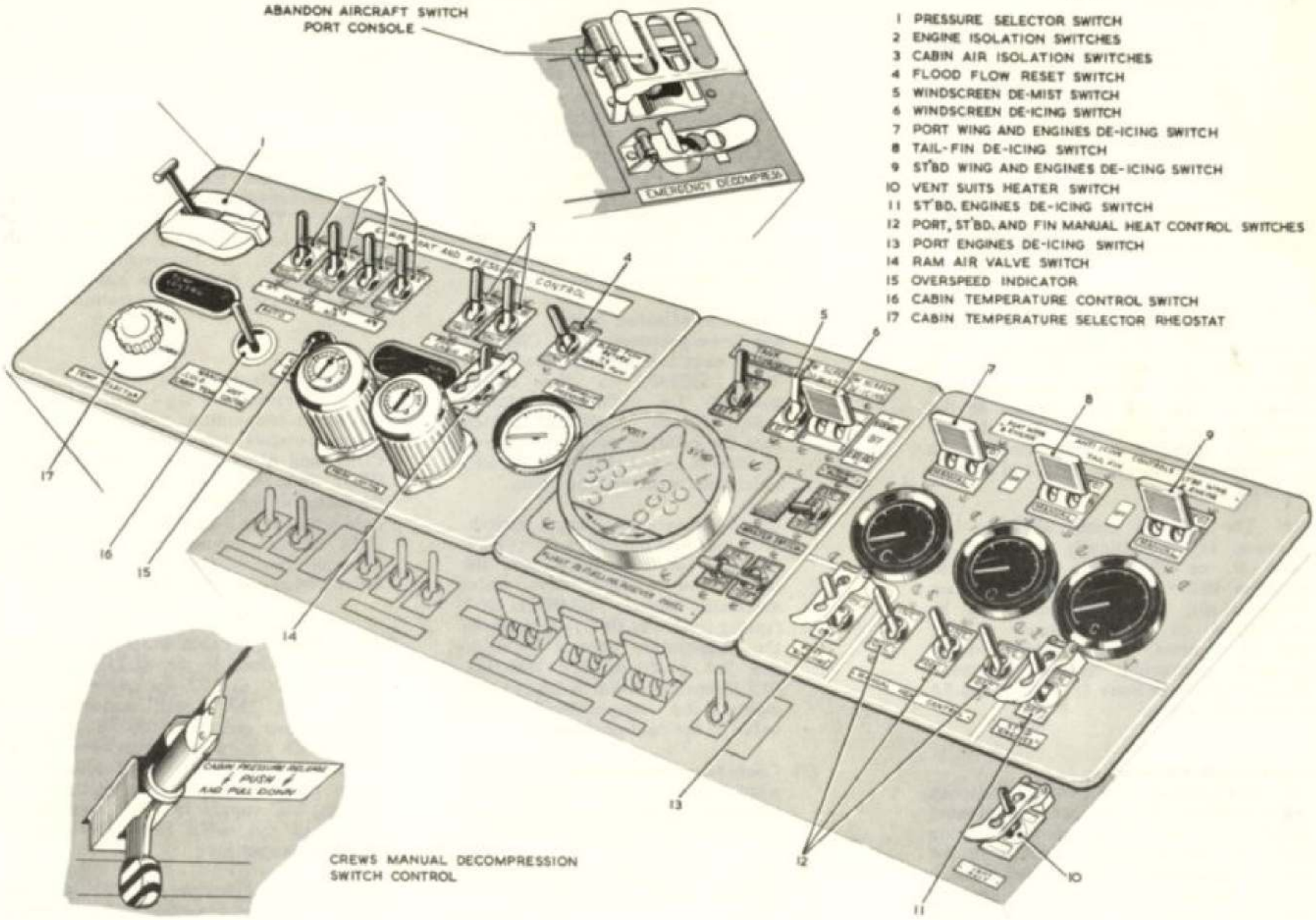

Fig. 3 Air control panel

below the pressure of the ambient atmosphere by more than a prescribed amount.

Pressure controllers

10. The two pressure controllers are used to maintain cabin pressure by controlling the operation of the discharge valves (para.8), and are mounted, one above the other, under the 2nd pilot's floor. The upper controller, Type 510740, is electrically operated (see Group 8, fig.8 and 8A) and is normally in full control of the pressure. Should failure of this unit occur, however, the controller, Type 510350, will take over to control the system at a slightly higher pressure.

Decompression valves

11. A decompression valve is connected to each control line to the discharge valve. Both valves are controlled either electrically or manually. When the decompression valves are operated the pressure in the discharge valve bellows is released through a static vent, thus allowing the discharge valve to open fully and release the cabin pressure.

12. The relative cabin altitude, i.e. pressure, is automatically controlled at 5,000 ft. or 25,000 ft. according to selection which can be made at any time during flight, and the cabin may be pressurized or de-pressurized at any time as required. For details of the complete mechanical system, reference should be made to Book 1, Sect.3, Chap.8A of this publication.

Controls and indicators

13. The majority of the control switches and indicators for the air conditioning system are fitted to the air conditioning panel on the starboard console in the pilot's compartment (fig.3). An abandon aircraft switch and an emergency decompression switch are fitted to the port console, details of which are given in Group 8.

14. The control switches on the starboard console consists of the following:-

(1) Four engine air isolation switches, each labelled OPEN - SHUT. These control the air supply from each engine via the engine isolation cocks.

(2) Two cabin air switches, one port and one starboard, labelled OPEN - SHUT. When the switches are placed to OPEN, the associated mass flow control valves are opened to the automatic flow controllers (para.3). When the switches are placed to SHUT, the mass flow valves are closed to the system.

(3) Pressure selector switch. This has three positions, viz:- CRUISE, which sets the pressure controller, Type 510740, to the cruise position, i.e. 5,000 ft. relative cabin altitude; COMBAT, which sets the relative cabin pressure at 25,000 ft., and NO PRESSURE, which depressurises the cabin.

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

(5) Cabin temperature selector rheostat, which selects the required cabin temperature when the cabin temperature control switch is at AUTO.

(6) Ram air valve switch, labelled OFF (central), SHUT and OPEN.

(7) Reset switch, which when placed to RESET, returns the system to normal operation should flood flow no longer be required.

In addition two Desynn indicators are provided, one for the temperature control valve and one for the ram air valve. A magnetic indicator, Ref.5CZ/5073, gives visual warning of overspeeding in the turbine unit (para.32).

Cabin temperature

15. The cabin temperature is controlled by the movement of the temperature control valve. This valve is operated by an electrical actuator which is automatically controlled by a temperature sensitive bridge circuit, or may be manually controlled by the cabin temperature control switch.

Circuit operation

16. Reference to fig.4 will show that the cabin temperature control switch has three operative positions, namely HOT, COLD and AUTO, and is spring-loaded to OFF, from the hot or cold positions. Operation of the switch to either the hot or cold position will energize the appropriate field of the temperature control valve actuator from C.B.77 via the normally closed relay contacts 107/1 and 117/2.

17. When the cabin temperature control switch is moved to the AUTO position, a supply from C.B.77 via relay contacts 107/1 and 117/2 will energize relay 103 to close contacts 103/1 and connect a 115-volt a.c. supply from fuse No.266 and earth to the a.c. input plug of the cabin temperature control amplifier. A 28-volt d.c. supply is also connected to pin A of the cabin temperature control amplifier output plug.

18. The temperature control amplifier, Type FLM/A/14 embodies a balanced resistance bridge network and a transductor. A change in temperature of the

sensing units unbalances the bridge to pass a current through the central winding of the transductor. This triggers off the transductor, the output of which is applied to one of two relays, one controlling a supply to the hot field of the temperature control valve actuator and the other to the cold field. The actuator moves to open or close the valve, and at the same time, to adjust the follow up resistor until balanced conditions are obtained in the resistance network.

19. The cabin temperature selector is manually-operated to select the desired cabin temperature. When the selector is moved to a new setting, the alteration causes the bridge network to lose equilibrium and pass a signal to the heat control actuator. As a result of this movement a new balance is struck at the temperature selected, measured at the cabin temperature sensing elements.

Flood flow

20. The object of flood flow is to increase the mass flow to the maximum that can be obtained at a reasonable temperature and in as short a time as possible. The increased flow is required to overcome serious leakage or combat damage in the crew's compartment.

21. Flood flow starts up automatically and the main actions are to open the flood flow valve fully and to move the temperature control valve to the mid position. These valve movements are accomplished at full actuator speed.

Circuit operation

22. Reference to fig.4 will show that flood flow is brought into operation by the action of two altitude switches. One altitude switch (ambient) is connected to a static vent and is set to 30,000 ft. whilst the other is open to cabin pressure and is set to 29,000 ft.

23. If the aircraft is above 30,000 ft. and the relative cabin altitude rises to 29,000 ft. the two switches, which are connected in series, will close to energize relay 117 from C.B.78 via the normally closed contacts 108/1, and the reset switch. Contacts 117/1 then close to to hold in relay 117. The following circuit operation will now take place:-

(1) Contacts 117/2 open to isolate the cabin temperature control switch from the d.c. supply.

(2) Contacts 117/6 open so that, in the event of the overheat relay No.107 being energized by the closing of the overheat switch, no supply would be fed to the cold field of the temperature control valve actuator.

(3) Contacts 117/3 close to direct a supply from C.B.No.77 to the open field of the flood flow valve actuator to open this valve to the fully open position. Contacts 117/4 open to isolate the close field.

(4) Contacts 117/5 close to connect a supply also from C.B.No.77 to the centralizing switch of the temperature control valve actuator, which will connect a supply to either the hot or cold fields.

(5) Contacts 117/8 open and 117/7 close to open the clutch coil circuit and move the temperature control valve actuator at full speed to the central position.

24. Returning the system to normal operation when flood is no longer required, is by operation of the reset switch to de-energize relay No.117. If, however, conditions are such that both altitude switches are still closed, flood flow will restart as soon as the switch is released.

25. The supply to the flood flow system passes through the contacts of relay No.108, the coil of which is connected in parallel with the decompression valves so that the flood flow circuit supplies are broken when DECOMPRESSION is selected, (fig.8 and 8A, Group 8 of this chapter).

Mod.751

26. With the introduction of Mod.751, the possibility of an inadvertent feed energizing the flood flow system is eliminated. This is achieved by utilising the second pair of contacts in the cabin and ambient altitude switches to earth the positive side of the coil of relay 117 when the switches are in the normally open position. The switch contacts are also linked to provide double-contact switching as shown in fig.8A. No difference is made to the circuit operation described in the preceding paragraphs.

Overheat circuit

27. An overheat switch, Type FHO/A/87, is fitted in the outlet duct of the air conditioning crate and is set to close at 175 deg.C. Should the temperature of the air flow rise to this figure the switch contacts will close to energize relay 107 from fuse 341. Contacts 107/1 will then open to isolate the cabin temperature control switch from the supply (fig.4).

28. At the same time, contacts 107/2 will close to connect a supply from C.B.77 and the normally closed contacts 117/6 direct to the cold field of the temperature control valve actuator, which will operate to reduce the air temperature in the duct.

29. When the air temperature has fallen by approximately 25 deg.C. the overheat switch contacts will re-open and the system will revert to normal control.

Mass flow

30. Mass flow is controlled manually by

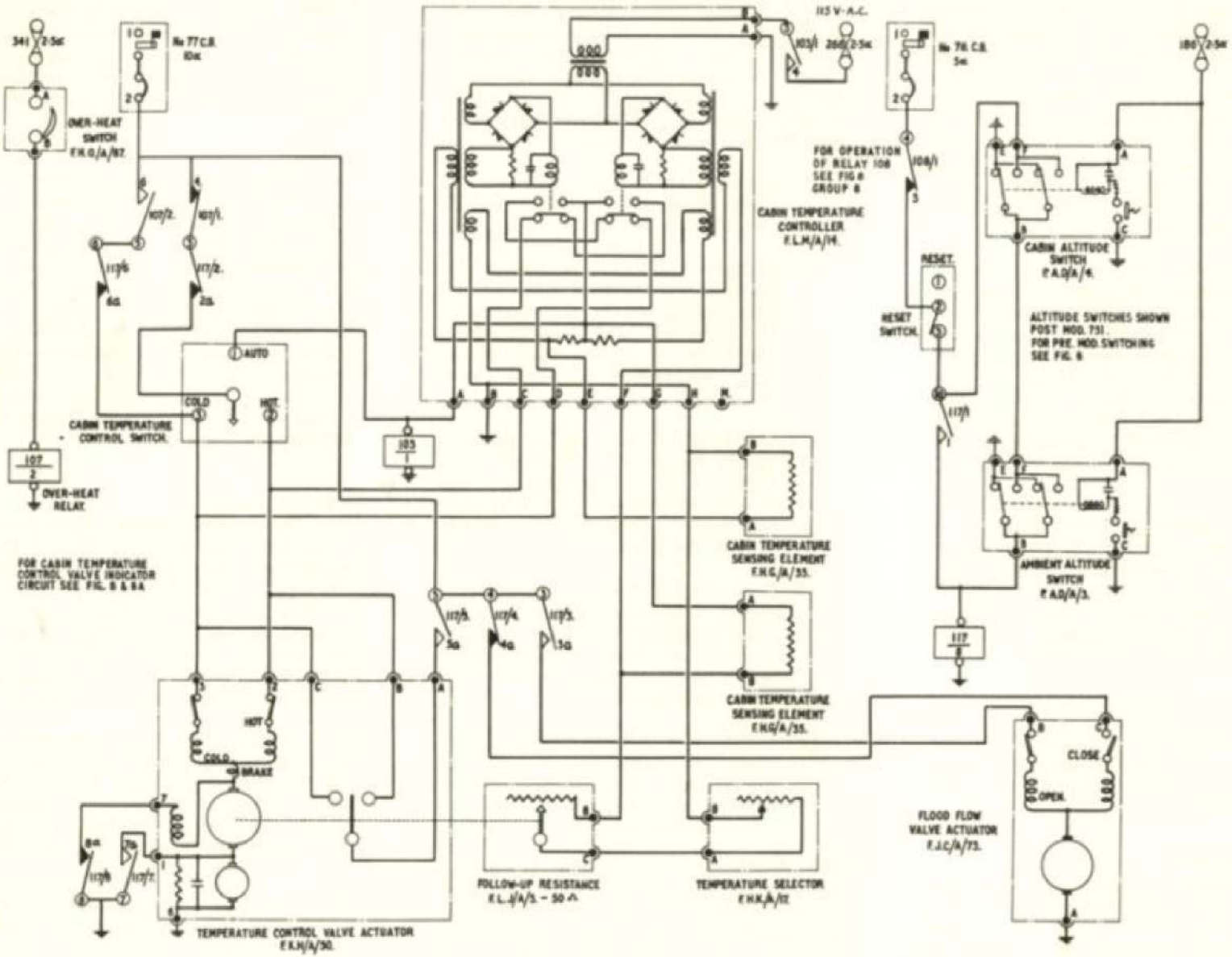

Fig. 4 Cabin temperature and flood flow control.

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operation of either or both cabin air isolation switches. Provision has been made to close automatically the port mass flow valve actuator in the event of overspeeding of the turbine unit. The mass flow and flood flow valve actuator assemblies are illustrated in fig.1.

31. The speed of the turbine unit is proportional to the pressure ratio across it. The pressure ratio is applied across a pressure ratio switch which is set to a ratio equivalent to the maximum speed of the turbine. When the pressure ratio is reached a pair of contacts will close to energize relay No.105 via fuse No.316.

Circuit operation

32. Reference to fig.5 will show that the following action will occur:- Relay contacts 105/1 will open to isolate the open field of the port mass flow valve actuator from the supply and contacts 105/2 will close to connect the supply to the close field of the mass flow valve actuator. At the same time, indication of overspeeding will be shown to the pilot by the operation of a magnetic indicator on the starboard console, which will change from black to white. If overspeeding still persists, the pilot can, by means of the starboard manual control switch, reduce the opening of the starboard mass flow valve.

33. When overspeeding is reduced, the pressure ratio control switch contacts will open and the system will return to normal control.

SUIT VENTILATION SYSTEM (POST MOD.177)

General

34. The air for suit ventilation is tapped from the main cabin pressurization system upstream of the automatic flow controllers. After conditioning, the air is supplied to a manifold which feeds the suit supply lines. The system can be operated when the cabin is not pressurized and when taxying. Ground conditioning from a trolley supplying conditioned air may be achieved through a connection provided on the undersurface of the port wing close to the nosewheel bay.

Air temperature

35. The inlet air temperature to individual suits may be varied by manually controlled 112-volt electric heaters fitted in each supply line, and accessible to each crew member.

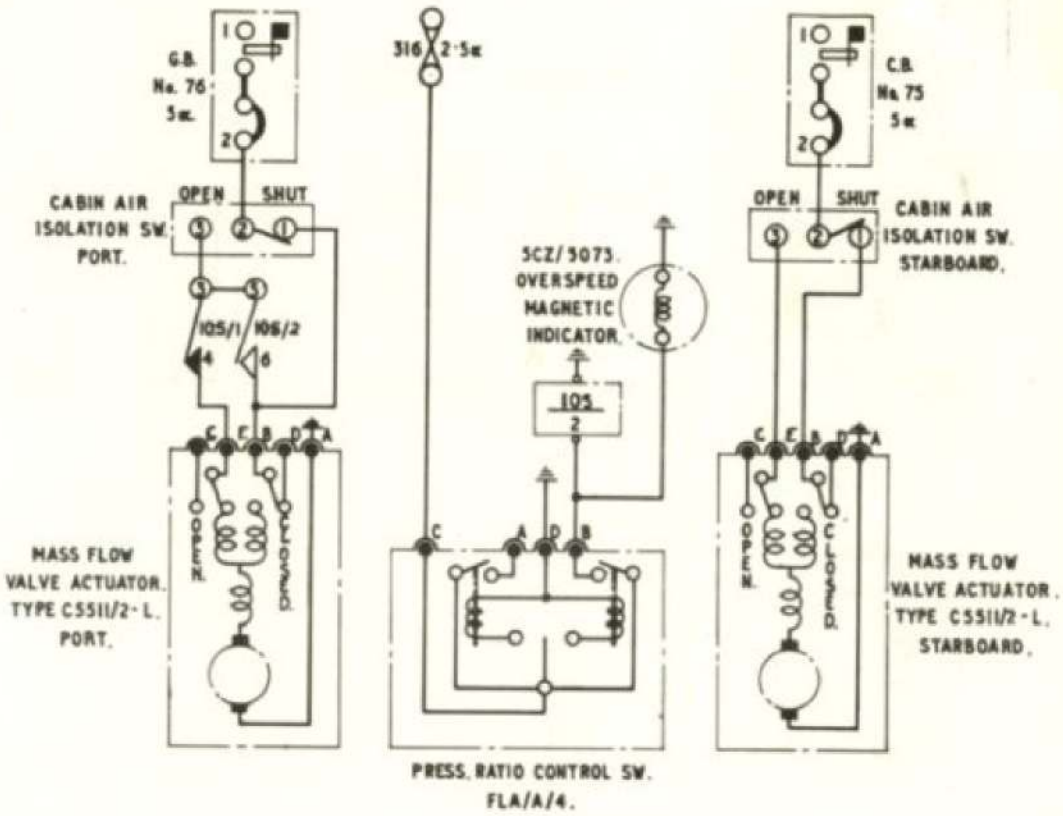

Fig.5 Mass flow control

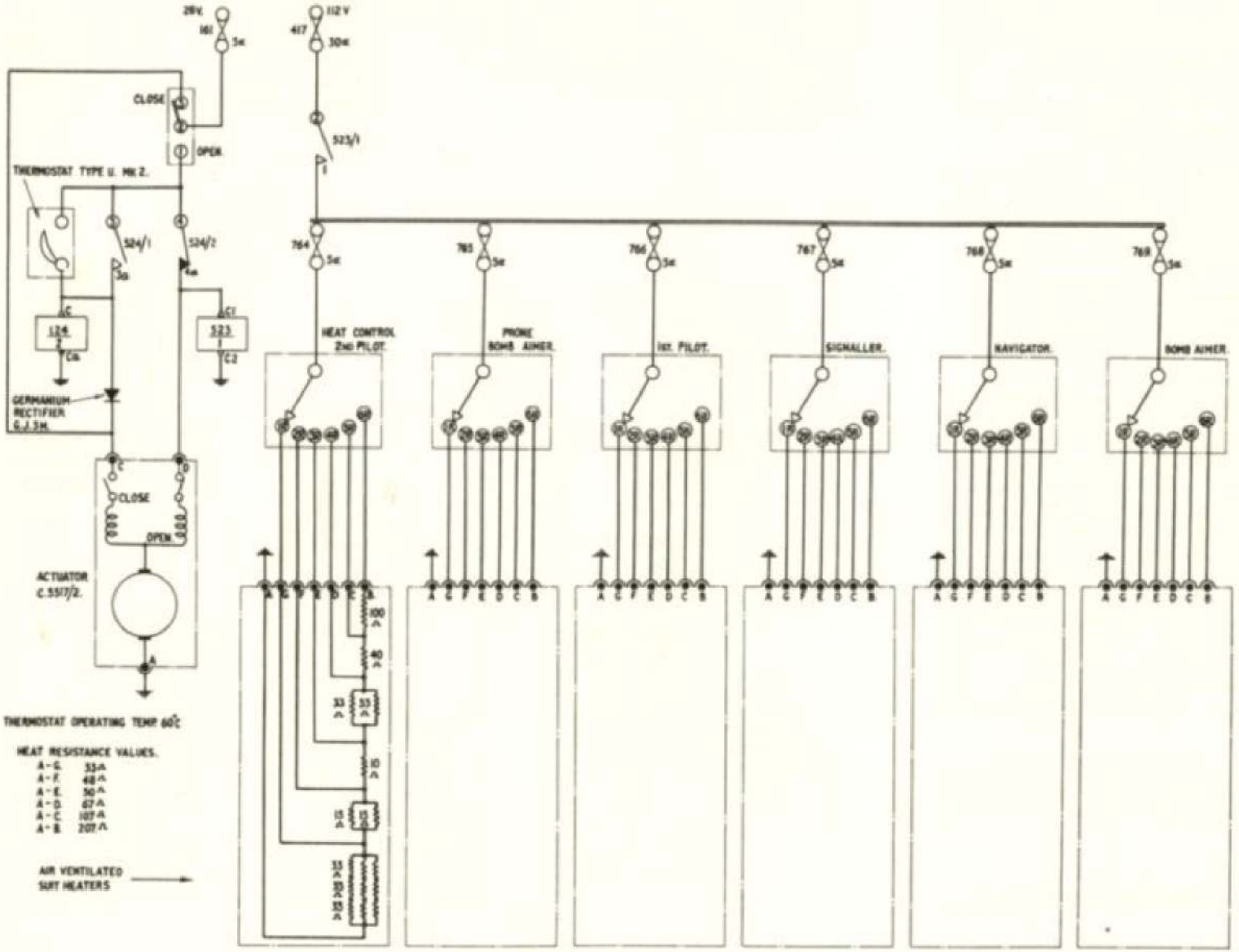

Fig. 6 Air ventilated suit system

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36. After exhausting through individual suits the air is expelled from the cabin, with the main pressurization air, through the cabin discharge valve.

Air supply control

37. The ventilated suit can be shut off completely by a remotely controlled ON-OFF cock. To prevent overheating, an overheat switch is provided which operates the shut-off valve.

Circuit operation

Air supply

38. Reference to fig.6 will show that when the master switch is placed to OPEN (see also para.40), a 28-volt d.c. supply from fuse 161 will be fed via the switch and the normally closed relay contacts 124/2 to the open field of the air cock actuator. The cock will then open to allow conditioned air to flow into the ducting leading to the distribution manifold. With the switch in the close position, the supply will be fed direct to the close field of the actuator and the cock will close.

Overheat condition

39. Should a condition of overheating arise, the thermostat (normally open) will close to energize relay 124 Contacts 124/2 will then open to isolate the open field of the actuator and contacts 124/1 will close to energize the close field. Note that contacts 124/1 also complete a hold-in circuit for the coil of relay 124 so that when the overheat condition no longer exists, the relay will remain energized until the master switch is moved to CLOSE.

Electrical heating

40. When the master switch is placed to OPEN (para.38) relay 523 will also be energized via contacts 124/2 to close contacts 523/1. This will complete a 112-volt d.c. supply from fuse 417 to distribution fuses 764-769, which in turn supply the temperature selectors for the vent suit electrical heaters.

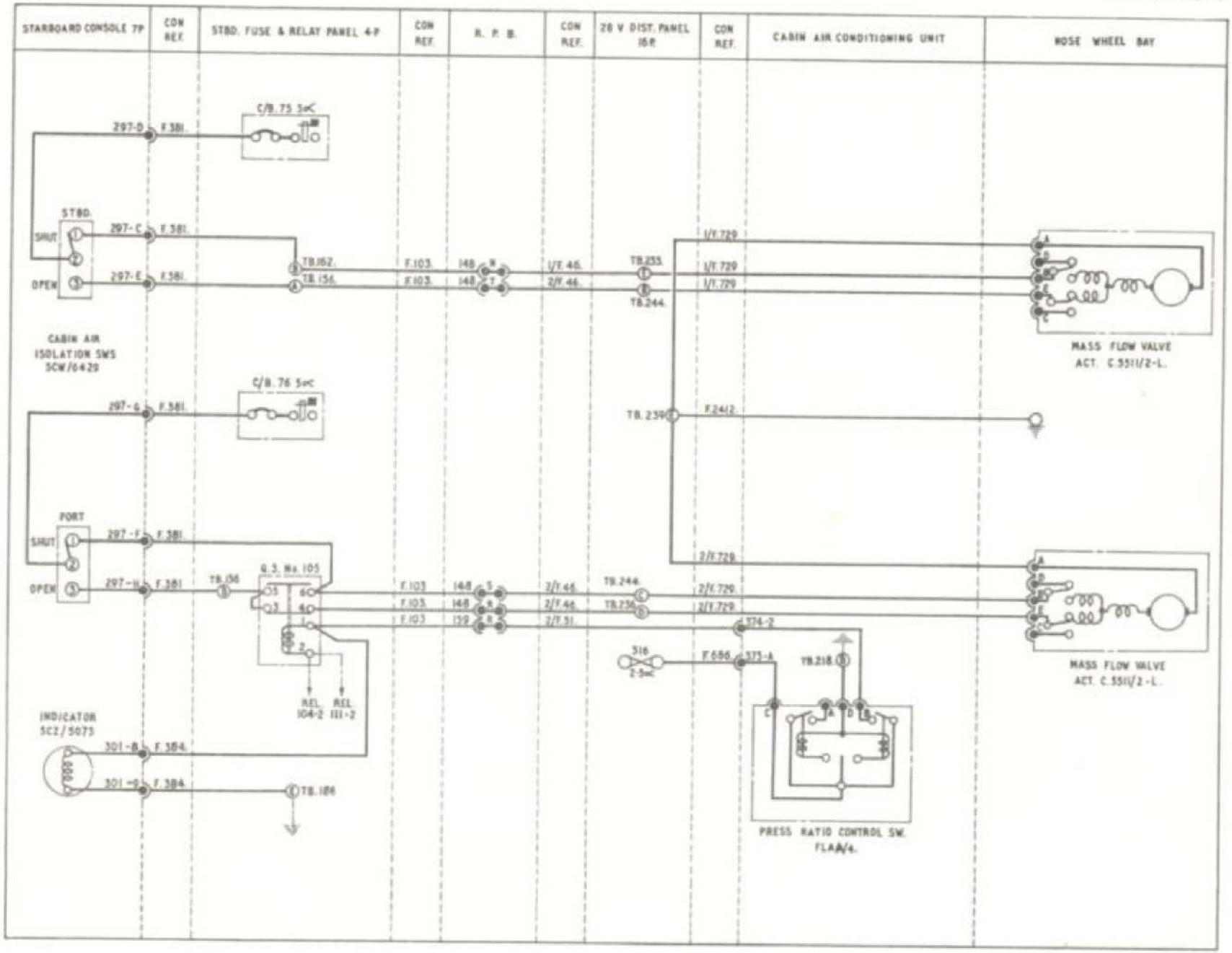

Fig.7 Mass flow control

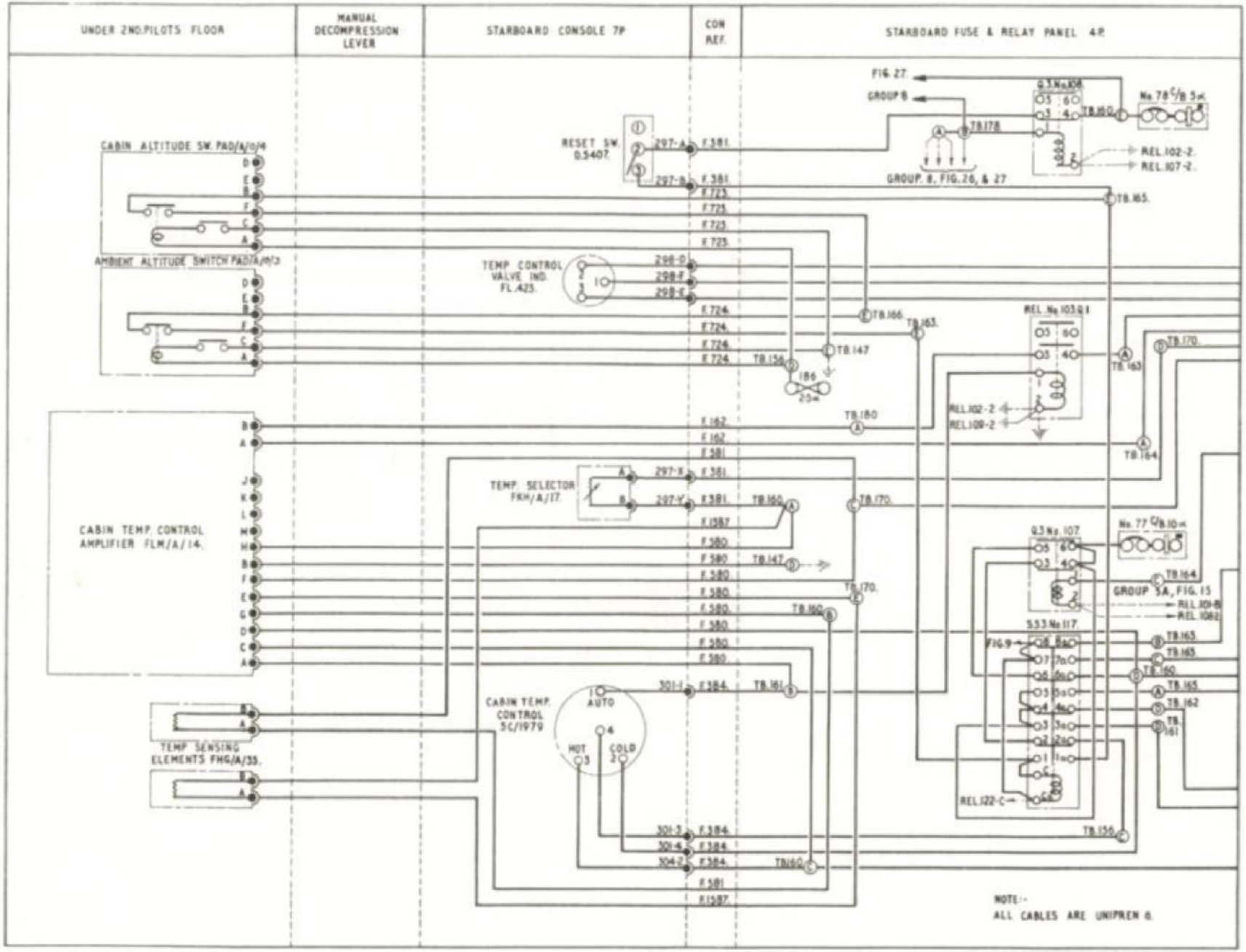

Fig.8(1) Cabin temperature and flood flow (pre mod.751)
(◄ Ref. added at relay 117 ►)

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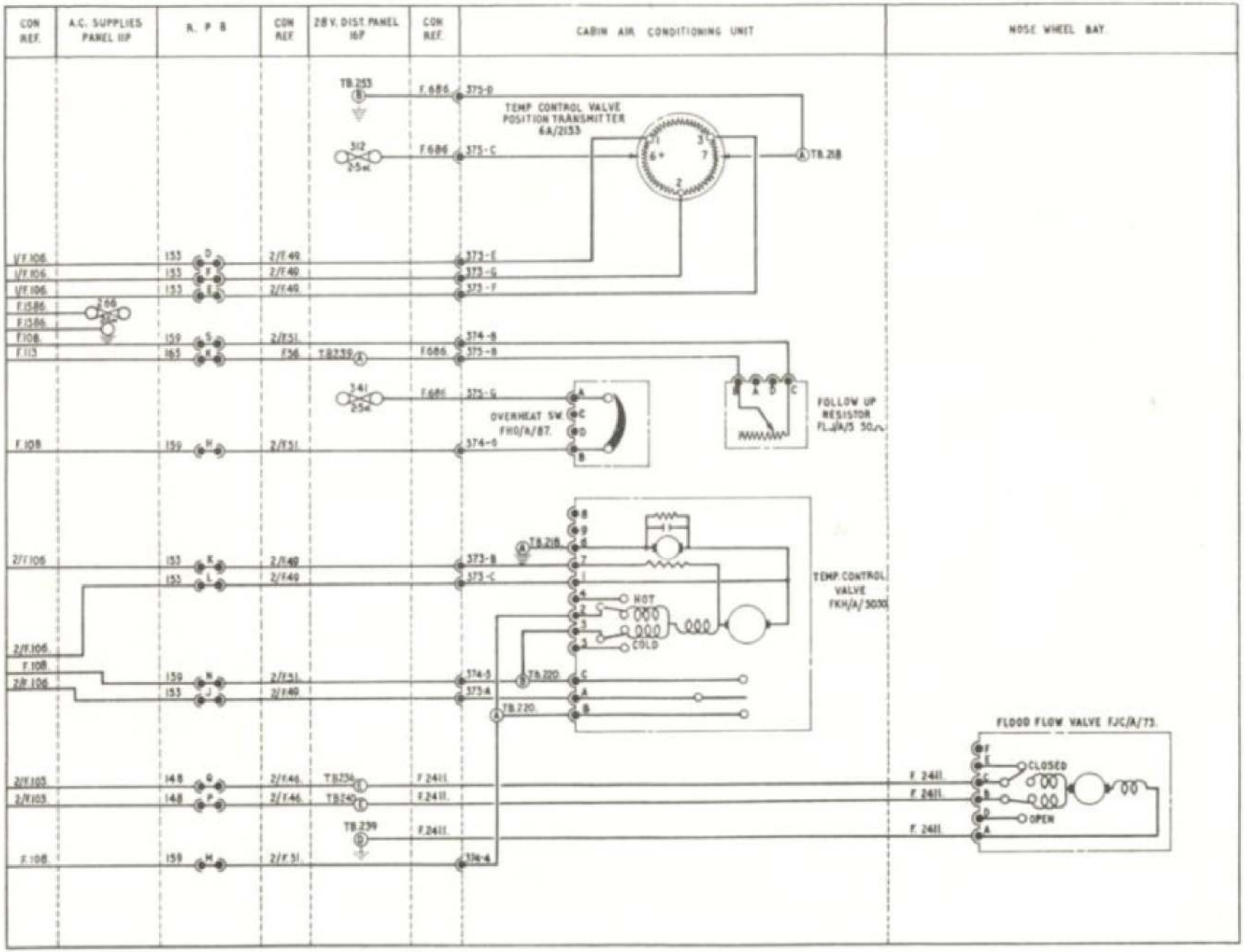

Fig.8 (2) Cabin temperature and flood flow (pre. mod. 751)

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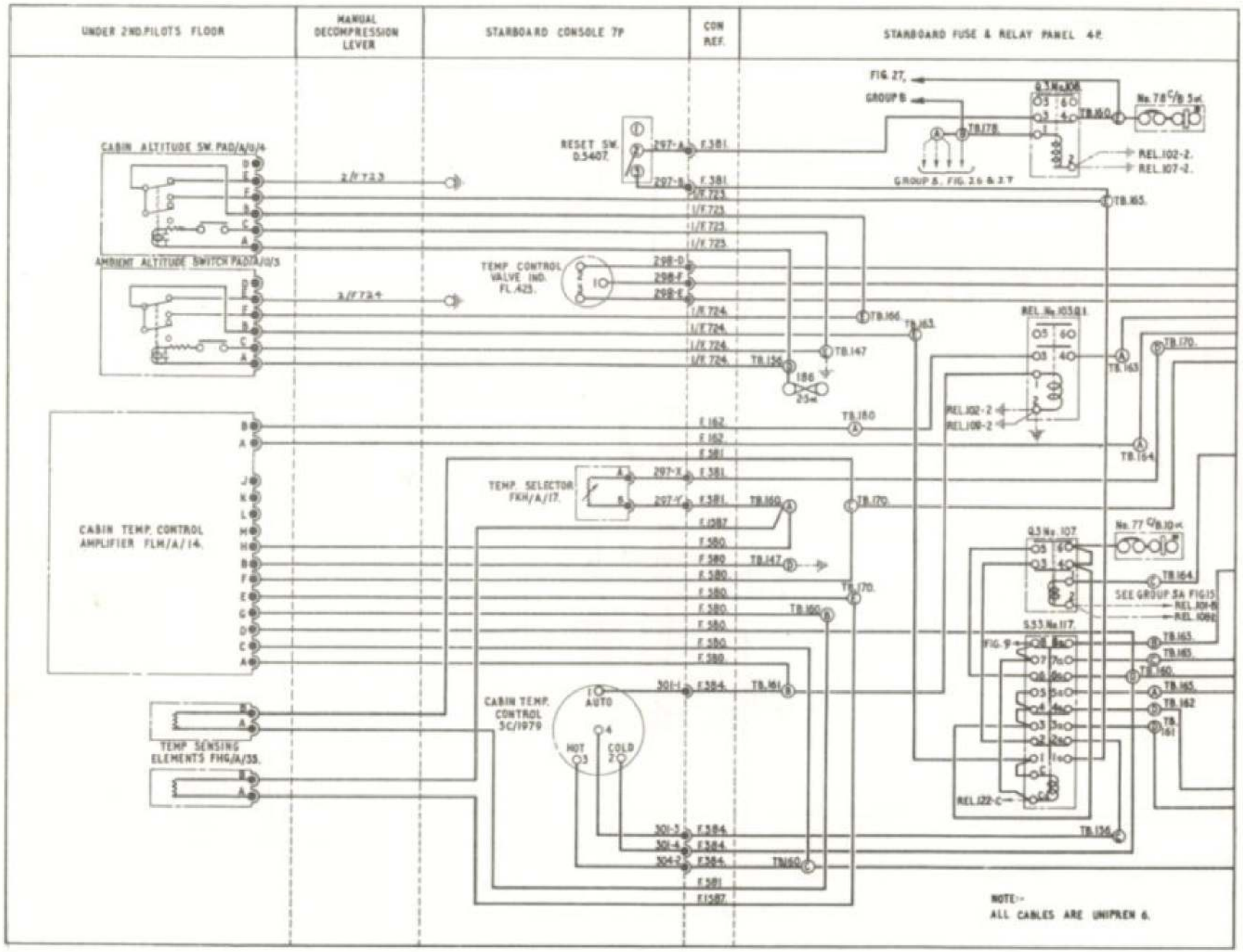

Fig.8A(1) Cabin temperature and flood flow (post mod.751)
(→Ref. added at relay 117←)

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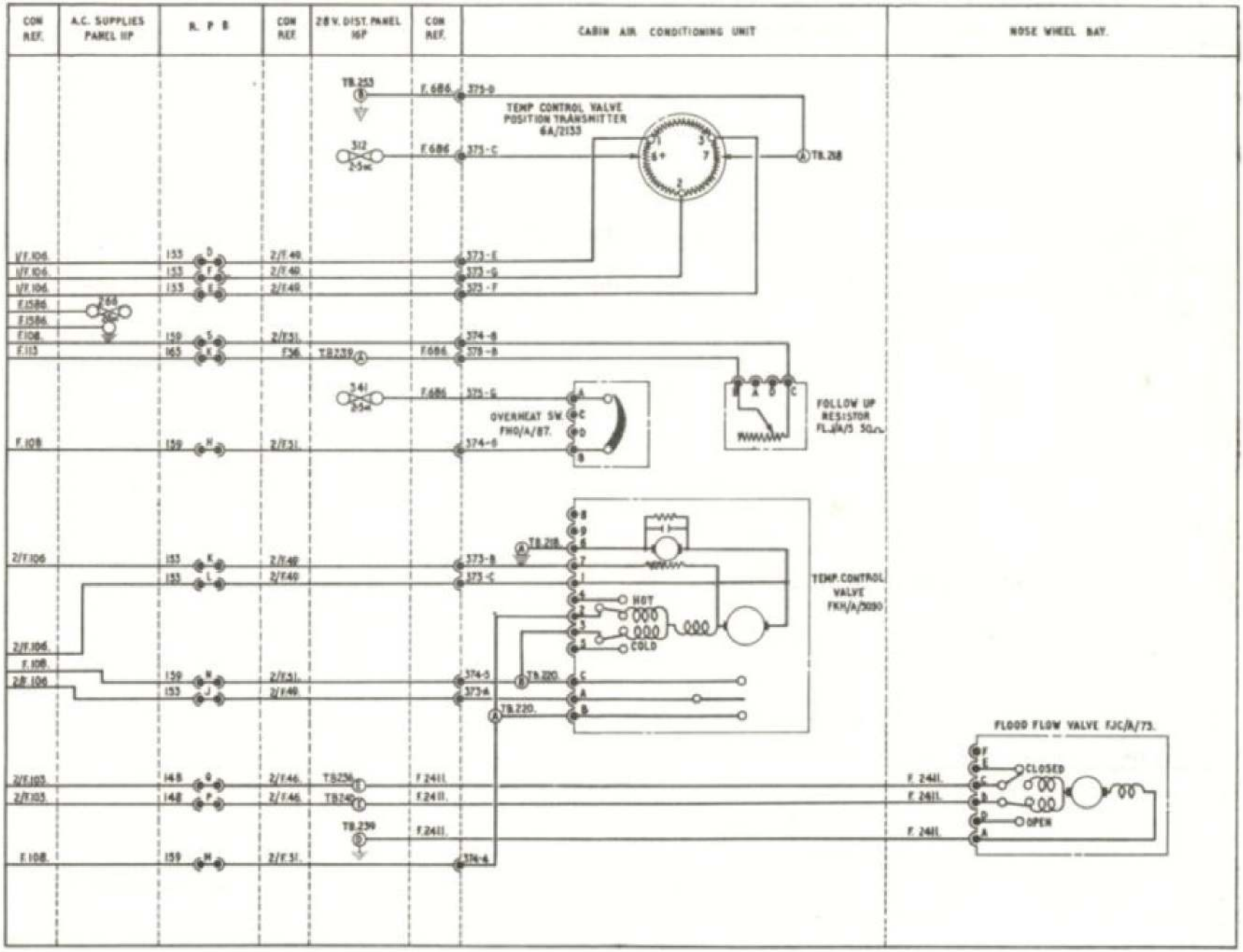

Fig.8 A(2) Cabin temperature and flood flow (post mod.751)

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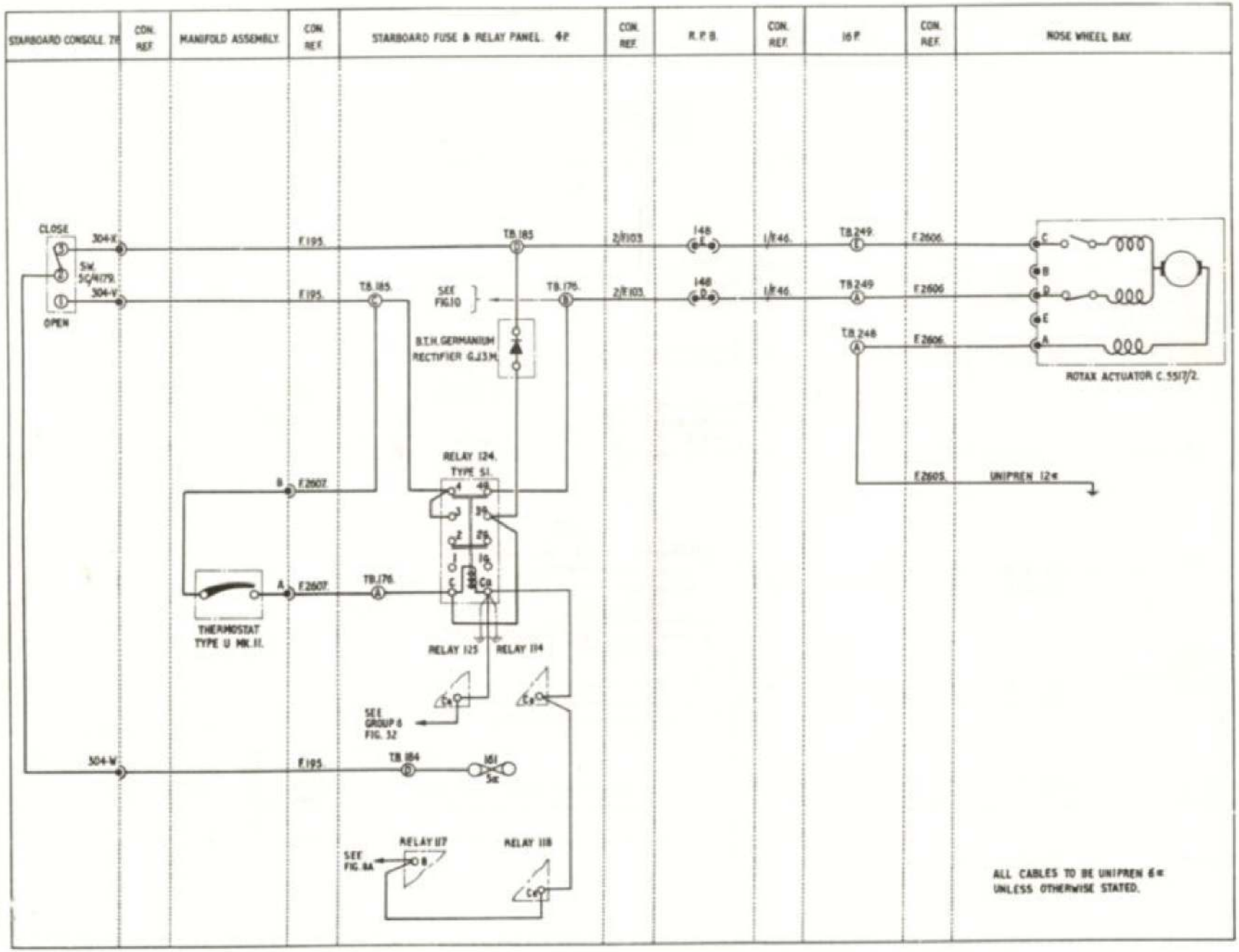

Fig.9 Air supply for ventilated suits

(◄ Relay earths added ►)

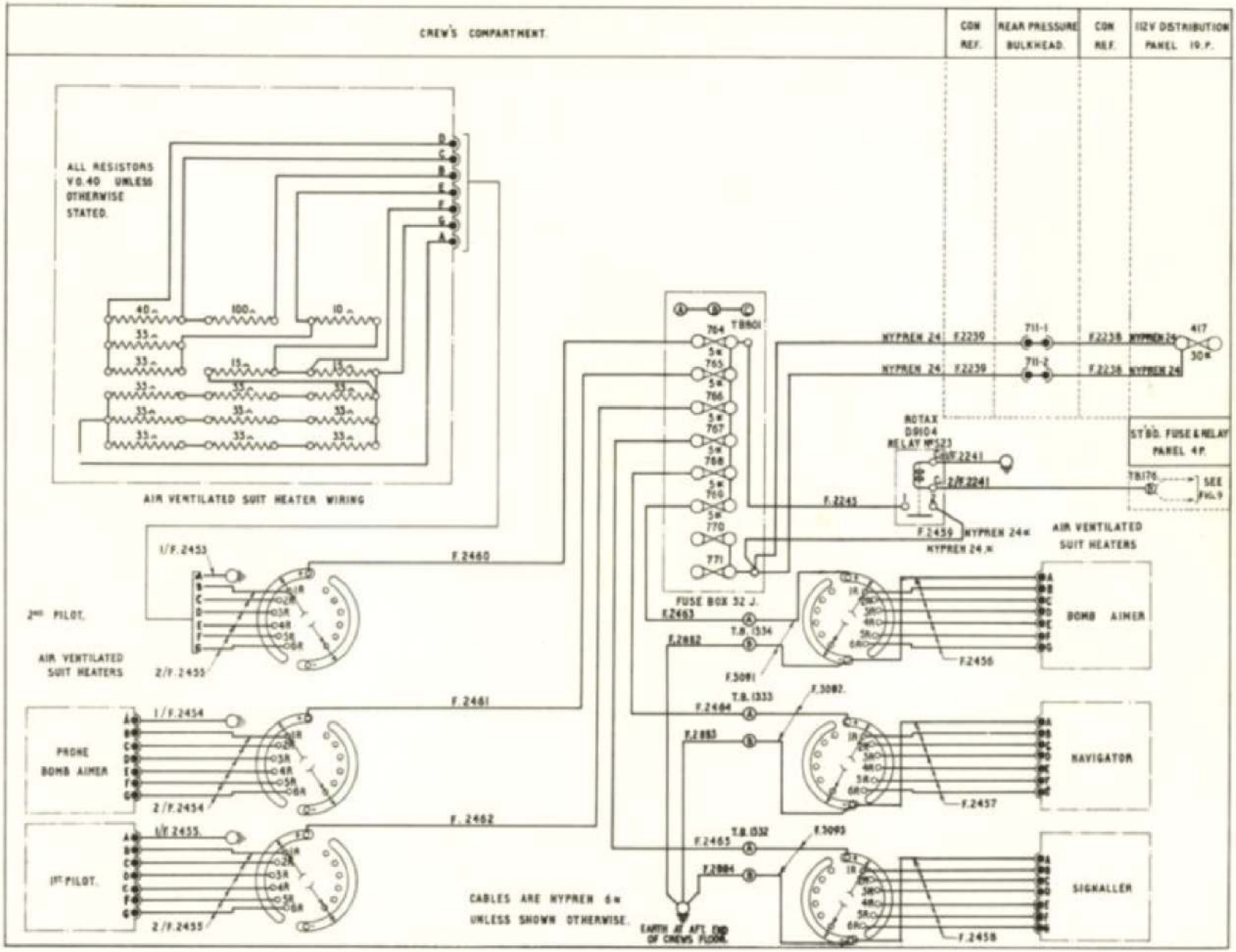

Fig.10 Ventilated suits heater control

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