Chapter 13

ELECTRICAL HEATING

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LIST OF ILLUSTRATIONS

Introduction

1. This chapter contains descriptive and servicing information on the electrical heating circuits for aircraft equipment. These circuits are as follows:-

(1) Pilots' windscreen de-misting.

(2) Crew's ration heaters.

(3) Periscopic sextant head heaters.

(4) Rearward viewing periscope heating.

(5) Pitot head heaters.

(6) Ventilated suits heating.

(7) Gold film windscreen.

2. Location illustrations and theoretical circuit diagrams are provided where required, and routing charts will be found at the end of the text. With this amendment the following modifications are included:-

Mod.1696 – Introduction of crew's swivel seats (port and starboard) and sliding seat (centre).

Mod.1901 – Introduction of improved gold film windscreens.

Mod.1942 – To modify control circuits for gold film windscreens.

Mod.2077 – To reduce normal and overheat control temperatures of gold film windscreen by change of controllers.

Mod.2143 – To introduce resistors Type LW6, 5 ohms in the outer sensors of the gold film windscreens to prevent overheating.

Mod.2156 – To make provision for and introduce Rosemount Pitot head, Part No.15/Z9723 in lieu of existing Avimo Mk.8 Pitot head.

Mod.2294 – To reposition the gold film windscreen isolation switches to improve access to them to meet QRA requirements and to introduce a terminal block to facilitate servicing.

Mod.2330 – To introduce Rosemount pitot head Part No.16/Z9723 in lieu of Rosemount pitot head Part No.15/Z9723.

Mod.2365 – Introduction of acrylic windscreen at 2nd pilots' position:

Mod.2402 – Introduction of acrylic windscreens at 1st pilots' and centre positions.

Mod.2442 – Introduction of Rosemount pitot head Part No.23/Z9723 in lieu of Part No.16/Z9723.

▶ Mod.2455 – Introduction of manually operated controls for the independent operation of the port and starboard fire extinguishers in lieu of the automatic function. ◀

DESCRIPTION AND OPERATION

WINDSCREEN DE-MISTING

General

3. A system of warm air is used for de-misting the pilots' windscreens. The air is directed on to the windscreens via spray pipe assemblies, and is supplied from a combined heater and blower unit fitted in the air ducting under the 2nd pilots' floor. Further details of the system's ducting and piping are given in Sect.3, Chap.8.

Control switch

4. The system is controlled from a single-pole switch, labelled WINDSCREEN DE-MIST, on the 2nd pilots' instrument panel. When the switch is on, relays 301 and 302 will be energized to connect the appropriate supplies to the heater-blower unit.

Heater – blower unit

5. The heater-blower unit, Plannair Type 3PL/182/254H, incorporates two 500-watt heaters and a fan motor, which are operated on 200-volt, 3-phase ac. In addition, an overheat switch is provided in the assembly, which will open to switch off the supply to the heater should the temperature in the duct reach 70 deg.C. When the temperature falls to 60 deg.C., the overheat switch will close to reconnect the heater supply.

Circuit operation

6. When the control switch is placed to ON (fig.3), relays 301 and 302 will be energized from fuse 654. Supplies of 200-volt, 3-phase ac from fuses 194 R, Y, B will then be made to the fan motor and heater simultaneously via the respective contacts of the relays. Note that the heater relay 302 is energized via the overheat switch.

Overheat conditions

7. Should conditions of overheat arise when the air temperature in the duct reaches 70 deg.C., the overheat switch will open to de-energize relay 302 and the heater supply will be switched off. The fan motor, however, will continue to run to reduce the air temperature. When the temperature falls to 60 deg.C., the overheat switch contacts will close

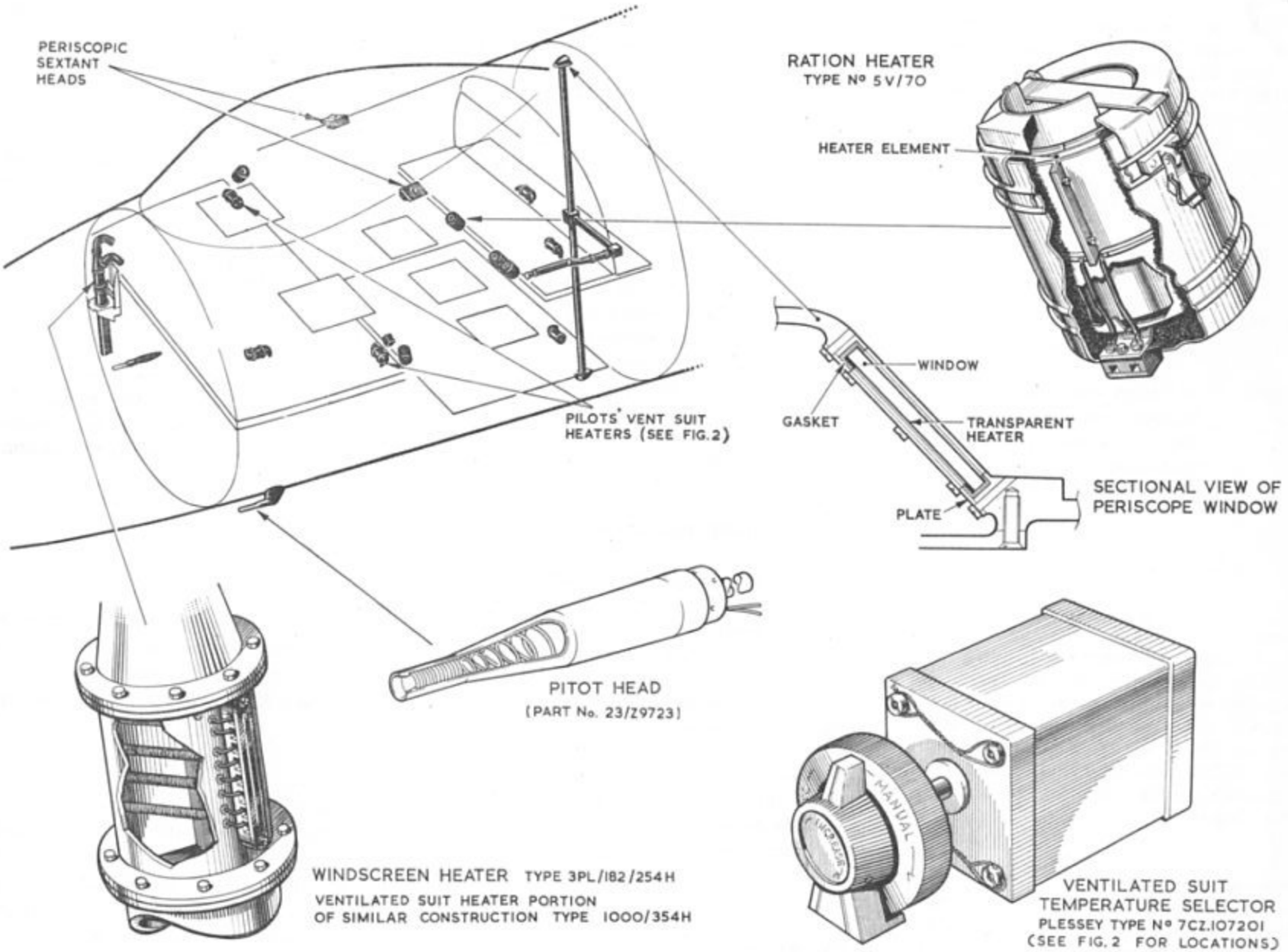


Fig. 1 Location of components

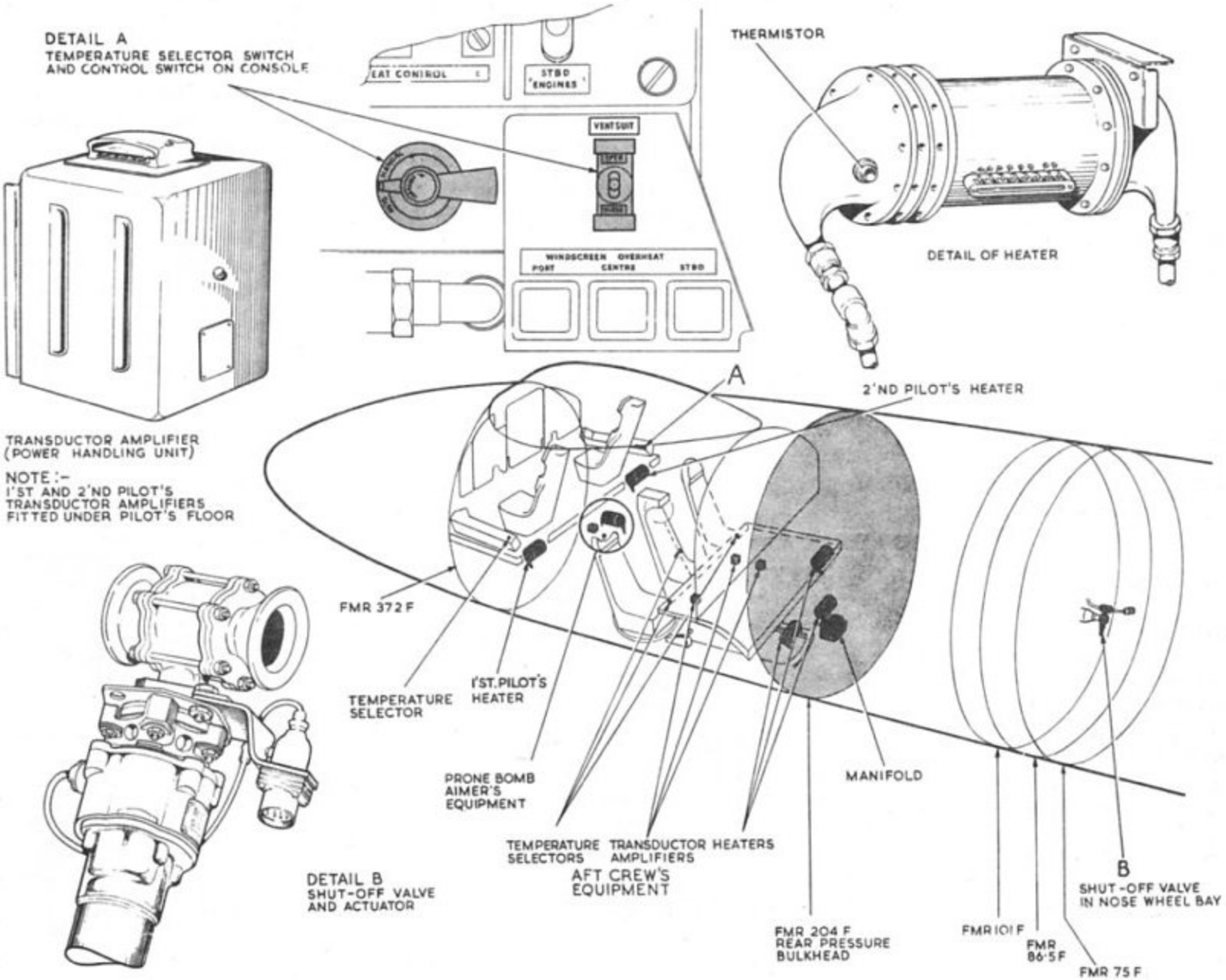


Fig. 2 Ventilated suits system

to re-energize relay 302 and restore supplies to the heater.

RATION HEATERS

General

8. Five ration heaters, designed for heating tinned rations during flight, are fitted, one adjacent to each crew member's seat. The heaters, Ref.No. 5V/70, are of 75-watt rating and are fed from the 28-volt d.c. supply. A full description of the heaters is given in A.P.113F-0003-1

Control switches

9. The heaters are controlled from two single-pole switches on 50P (fig.10). One switch, fed from fuse 710, controls the two pilots' heaters, the other switch, fed from fuse 711, controls the three rear crew's heaters.

PERISCOPIC SEXTANT HEAD HEATERS

General

10. Two periscopic sextants, Mk.2, are provided, one at each side of the cabin as described in Sect.7, Chap.4. Each sextant head (mounting) incorporates a heater, which is controlled from a single-pole switch on 3P for the port head, and a similar switch on 4P for the starboard head. Supplies are fed from 28-volt d.c. fuses 637 and 541 as shown in the routing chart, fig.12.

REARWARD VIEWING PERISCOPE HEATING

General

11. A Kelvin Hughes periscope, Type KPG-0401, is installed in the cabin near the pressure bulkhead for the use of the navigator as described in Sect.7, Chap.4.

12. The viewing heads of the periscope are mounted one above and one below the fuselage, at the top and bottom of the periscope tube. For de-misting and de-icing purposes, the window of each viewing head is heated by an electrical element in the form of a transparent conducting medium coated on the glass. The heaters are connected in series, and supplied at 115-volt, 1 600 Hz a.c. from fuse 338, via a single-pole control switch on the port side of the navigator's panel. Total heater consumption is between 40 and 80 watts.

PITOT HEAD HEATERS

General

13. Two electrically-heated pitot heads, Part No.16/Z9723 Pre Mod.2442 or 23/Z9723 Post Mod.2442 are fitted on the fuselage under the cabin at former 358. The heating elements of the pitot heads are controlled by two mechanically-linked single-pole switches on the starboard console. Each switch controls a relay, 819 (port) and 820 (starboard), which when energized completes the 115V a.c. supply from fuse 203Y to the port heater and fuse 738Y to the starboard heater (fig.14). A magnetic indicator, Ref.No. 5CZ/5074, on the pilot's centre instrument panel, will be energized to show black when the pitot heads are switched on.

14. The pitot head switches also control

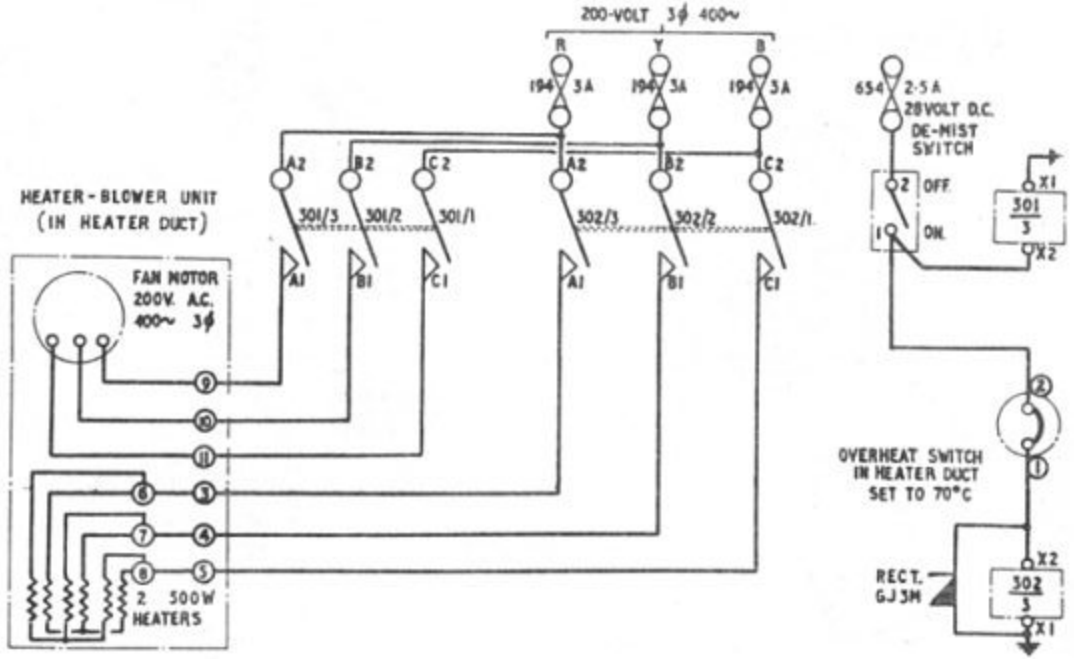


Fig.3 Windscreen demisting circuit

supplies to the following:-

Hydraulic power pack circuit (Chap.19).

Outside air temp. probe heater (Mod.2020) (Sect.7, Chap.4).

A.R.I.5959 junction box (Mod.2057) (Sect.9, Chap.7).

For information on the pitot-static system, reference should be made to Sect.7, Chap.1. The pitot heads are described in A.P. 112G-0102-1.

VENTILATED SUITS HEATING

General

15. A ventilation system provides a flow of dry air for crew members' suits at the five crew stations and the prone bomber's position. The system uses air from the engine compressors, which is passed through an air conditioning unit in the nose wheel bay similar to that used for cabin conditioning (Chap.12). After conditioning, the air flows to a multi-outlet manifold, which distributes the air, via electrical heaters, to the crew's vent suit connections. Two further connections for vent suits, provided at the port and starboard periscopic sextant positions, are tapped off the supply lines to the A.E.O. and nav./bomber respectively. Full details of the mechanical aspect of the system are given in Sect.3, Chap.8.

16. The electrical heaters are fitted in the air supply ducts adjacent to each crew station and prone bomber's position (fig.2), and are supplied by 200-volt, 3-phase, 400 Hz a.c. Transductor amplifiers, also situated locally control current to the heaters for varying temperature selections, and also operate automatically in conjunction with thermistors fitted in the ducts near the heaters. An actuator-operated shut-off valve in the air conditioning unit controls the flow of air to the system.

Control switch

17. The system is controlled by a 2-position single pole switch, labelled OPEN-CLOSE, on the starboard console. When the switch is placed to OPEN, the shut-off valve will be opened and the control circuit energized; when the switch is placed to CLOSE, the shut-off valve will be closed and the control circuit de-energized.

Temperature control

18. Temperature selectors, consisting of an auto-manual switch and a setting potentiometer are provided at each crew station and prone bomber's position. These enable the crew to select the temperature of the air supply to individual requirements, or allow the temperature to be controlled automatically by the thermistors and associated transductor amplifiers.

Overheat control

19. Overheat control for the system is provided by an overheat switch fitted in the manifold. Should a fault in the system cause the temperature of the air from the conditioning unit (normally controlled at 15 deg.C.) to exceed 70 deg.C., the switch contacts will close and the shut-off valve will close. At the same time, all heaters will be switched off. The circuit is arranged so that when the overheat condition has ceased to

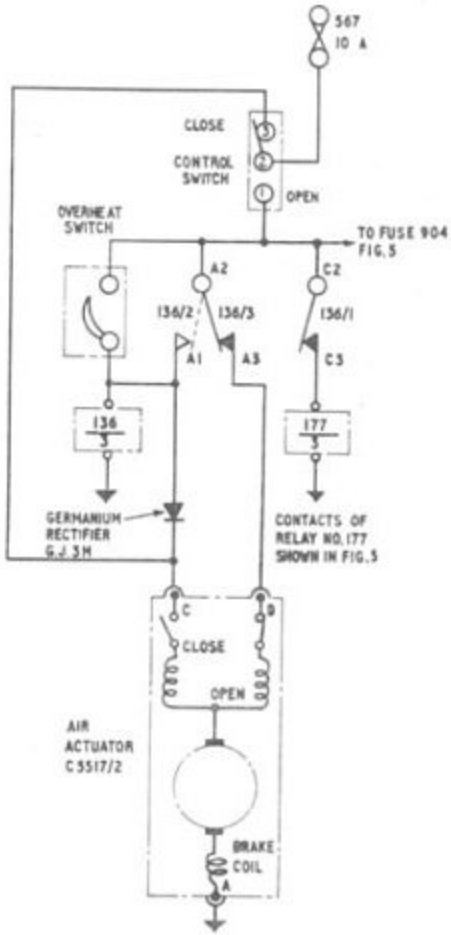


Fig.4 Ventilated suits air control

exist and the overheat switch has re-opened, the system will remain inoperative until the control switch is selected to CLOSE and then returned to OPEN. However, should overheat conditions continue, the control switch should be placed to CLOSE until the fault can be rectified.

20. An overheat switch is also provided within each heater, which gives overheat control on crew's individual air supplies. Should overheat conditions arise in any one heater, the overheat switch will open to break the supply to the control winding of transductor XDR2 (fig.5) in the associated transductor amplifier, thus causing a high impedance in the circuit, and blocking the heater supply current.

21. An overheat control valve, which responds to the pressure reaction of a sensing element in the manifold, provides a further method of overheat control. This is fully described in Sect.3, Chap.8.

Circuit operation

2. Reference to fig.4 will show that with the control switch placed to OPEN, a 28-volt d.c. supply from fuse 567 will be fed via contacts 2-1 of the switch and normally closed relay contacts 136/3 to the 'open' field of the shut-off valve actuator. The valve will open to allow conditioned air to flow to the manifold for distribution to the vent suit connections.

23. This supply will also be made to the crew's temperature selectors and transductor amplifiers via fuses 900 to 904, and at the same time relay 177 will be energized. A supply of 200-volt, 3-phase, 400 Hz a.c. to the

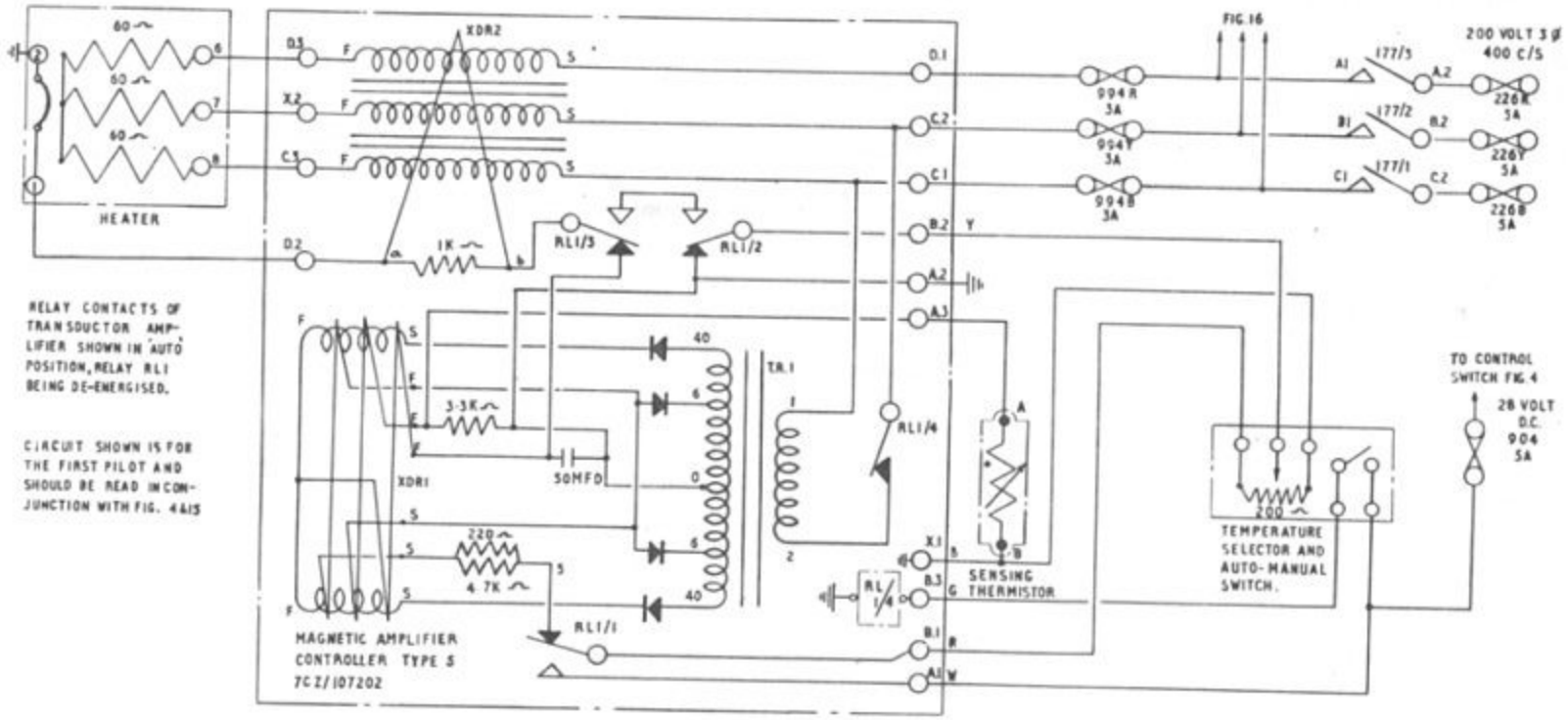


Fig.5 Ventilated suits heating circuit – 1st pilot

crew's heaters will now be fed from fuses 226R, Y, B via contacts 177/3, 177/2 and 177/1, the respective distribution fuses and transductor amplifiers (fig.5).

Manual heat control

24. When the auto-manual switch on any temperature selector is selected to MANUAL, relay RL1 in the associated transductor amplifier will be energized to change over contacts RL1/1, RL1/2, RL1/3, and open contacts RL1/4. In the case of the 1st pilot's circuit (fig.5), the supply at fuse 904 will energize relay RL1 and will be fed via contacts RL1/1, the temperature selector, and contacts RL1/2 and RL1/3 to the control winding of tranductor XDR2. The circuit to earth is completed via the overheat switch in the heater.

25. Movement of the temperature selector to INCREASE or DECREASE will vary the d.c. current flowing through the control winding of transducer XDR2. The resultant variation in the inductance of XDR2 will regulate the heater current to meet the temperature requirements of the operator.

Automatic heat control

26. Automatic heat control is provided by the thermistor and transductor XDR1, which is supplied from the rectified output of transformer TR1. With the automanual switch selected to AUTO, the switch contacts will be open and relay RL1 will be de-energized. The relay contacts will be as shown in fig.5, and the input to transformer TR1 will be fed via contacts RL1/4. Variation of air temperature in the duct will be sensed by the thermistor, which will cause a corresponding change in the current flowing in the control winding of XDR1. The control winding of XDR2 will then be fed by a corresponding amplified current from the output side of XDR1, thus maintaining automatic control of the heater current.

GOLD FILM WINDSCREEN

General

27. De-icing of the pilots' port, centre and starboard windscreens is effected by a layer of gold film deposited on the inner face of the outer glass ply of the window. The gold film is divided into three heating elements which are electrically connected via opaque silver busbars. To control temperature and conditions of overheat, two sensing elements are embedded in a layer of vinyl over the gold film. Two further sensing elements, provided as spares, can be connected into the circuit should failure of the normal sensing elements occur. A choice of three heat levels is available, the selection of which is under control of the 2nd pilot.

28. The gold film heating elements are connected in star configuration and supplied by 3-phase a.c., the connections to both heating and sensing elements being made from terminal blocks mounted at the top corners of each windscreen. The supply to the heating elements is fed from a 3-phase auro-transformer with appropriate voltage tappings for the three heat levels. Control of the windscreen temperature and protection from overheat are provided by three transductor-operated controllers, which operate in conjunction with the sensing elements. The components of the system are shown located in fig.6 (Pre Mod.2294), fig.7 (Post Mod.2294) and fig.7A (Post Mod.2365 and 2402). Tables 1 and 2 (Pre Mod.2365 and 2402) and Tables 3 and 4 (Post Mod.2365 and 2402) provide the power and resistance values of the windscreen.

Control switches

29. The circuit is controlled by a 3-position switch, Ref.No. 5CW/6430, labelled WINDSCREEN DE-ICE, LOW - MED. - HIGH. on the 2nd pilots' instrument panel. In addition, three isolation switches, labelled ON - OFF, on panel 100P Pre Mod.2294 (para.31) are used to isolate the windscreens under fault conditions, or when the aircraft is on the ground and the circuit is not in use. On aircraft where Mod.2294 has been embodied, the three isolation switches are fitted to a small panel at the aft end of panel 4P. A test terminal block, enabling the supply from fuses 199 R, Y, B, to be checked, is fitted on the side of 100P in the space previously occupied by the three isolation switches.

Indicators

30. Indication of overheat conditions for any one windscreen is given by a press-to-test amber warning lamp, Page Type C500/C/7, fitted on the 2nd pilots' instrument panel. Also, indication of normal or overheat conditions is given by three magnetic indicators, Dowty Type C5175Y, Mk.55, fitted on a bracket at the aft end of the starboard console. The indicators show NORM. or O/H when energized, and crosshatch when de-energized.

Panel 100P

31. Panel 100P contains the remote control equipment for the system and is situated under the 2nd pilots' floor. The equipment in the panel is as follows:-

Auto-transformer, 3-phase, Plessey Type 407/1/90113.

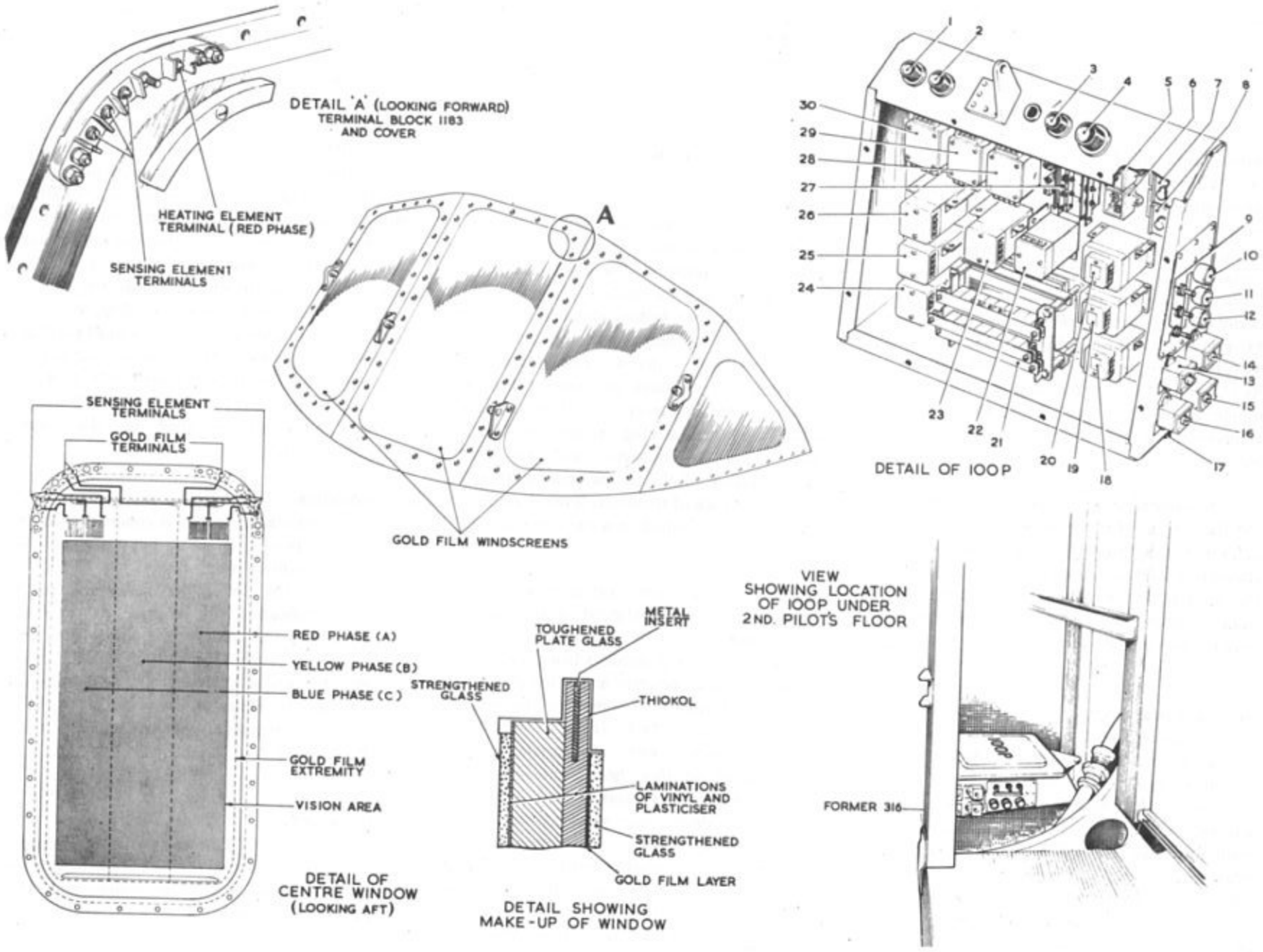


Fig.6 Gold film windscreen installation - Pre Mod.2294

KEY TO FIG.6

GOLD FILM WINDSCREEN INSTALLATION

◀ **Pre Mod.2294** ▶

1. *PLUG BREAK NO.1031*
2. *PLUG BREAK NO.1030*
3. *PLUG BREAK NO.1032*
4. *PLUG BREAK NO.1029*
5. *T.B. NO.1169*
6. *T.B. NO.1175*
7. *T.B. NO.1171*
8. *T.B. NO.1170*
9. *WINDSCREEN ISOLATION SWITCHES*
10. *FUSE NO.1378*
11. *FUSE NO.1377*
12. *FUSE NO.1376*
13. *T.B. NO.1174*
14. *T.B. NO.1187*
15. *T.B. NO.1173*
16. *T.B. NO.1172*
17. *PLUG BREAK NO.1033*
18. *PORT CONTROLLER*
19. *CENTRE CONTROLLER*
20. *STARBOARD CONTROLLER*
21. *AUTO-TRANSFORMER*
22. *RELAY NO.711*
23. *RELAY NO.712*
24. *RELAY NO.714*
25. *RELAY NO.715*
26. *RELAY NO.713*
27. *RECTIFIERS NO.1-9*
28. *RELAY NO.718*
29. *RELAY NO.717*
30. *RELAY NO.716*

Controllers (3), Plessey Type 4, Mk.1, Part No. 7CZ/106800/9,

Changeover relays (5), Plessey Part No. 7CZ/105411/1.

Contactor relays (3), Ref.No. 5CW/6182.

H.R.C. fuses, 1 amp. (3), Brush Part No. Z590109.

Single-pole switches (3), Ref.No. 5CW/9245.

Rectifiers (9), Type GJ5-M.

Resistors (6), Type LW6, 5 ohms.

On aircraft where Mod.2294 has been embodied, the single-pole switches (3) Ref.No. 5CW/9245 are replaced by a test T.B., Type V.6560, labelled GOLD FILM W/S TEST T.B.

Auto-transformer

32. The auto-transformer provides the supplies for the three windscreens and is equipped with suitable voltage tappings for the different heat levels. Supplies to the transformer are fed direct from fuses 199 R, Y, B, the output voltages being switched through the changeover relays according to the heat selection made on the pilot's control switch. ◀ Note that all voltage figures shown in fig.8 are line voltages. (Both line and phase voltages are given inTables 1 and 3). ▶

Controllers

33. The controllers operate in conjunction with the windscreen sensing elements to maintain a constant windscreen temperature. This is achieved by operating the associated contactor relay to switch the windscreen supplies on or off according to the variation in temperature detected by the sensing elements.

34. The controller circuit consists of three main parts:-

(1) A control circuit of three transductors, control sensing element and control relay RL1.

(2) An overheat circuit of one transductor, overheat sensing element and overheat relay RL2.

(3) A single-phase transformer which supplies the control and overheat circuits.

Supplies to the transformers are fed at 115-volt a.c. (phase-to-earth) from fuses 199 R, Y, B, the transductors providing the necessary output current to energize the contactor relays and connect the supplies to the windscreens. A ◀ circuit diagram is provided in fig.9. The controllers are described in A.P.107C-0404-16. ▶

Heat levels

35. The three heat levels of the windscreens are obtained by selecting the appropriate output voltages of the auto-transformer as ◀ shown in fig.8. Medium heat is automatically ▶ selected when the isolation switches are on and the pilot's control switch is in the medium (centrally off) position. Low heat and high heat are obtained by selecting the pilot's control switch to energize relay 712 for low heat or relay 714 for high heat, the action of which changes over the voltages applied to the windscreen.

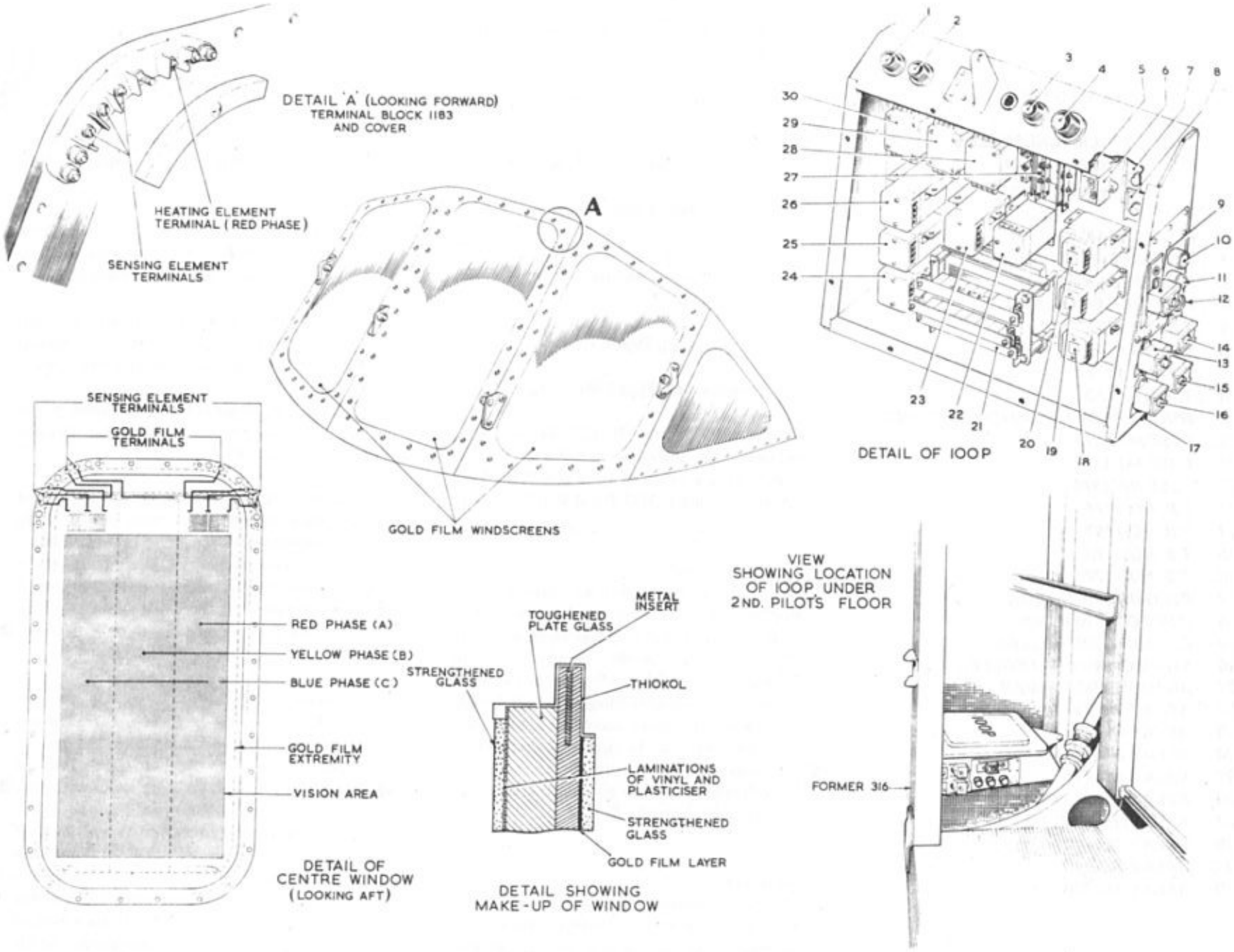


Fig. 7 Gold film windscreen installation-Post Mod. 2294

KEY TO FIG.7

GOLD FILM WINDSCREEN INSTALLATION
Post Mod.2294

1. *PLUG BREAK NO.1031*
2. *PLUG BREAK NO.1030*
3. *PLUG BREAK NO.1032*
4. *PLUG BREAK NO.1029*
5. *T.B. NO.1169*
6. *T.B. NO.1175*
7. *T.B. NO.1171*
8. *T.B. NO.1170*
9. *GOLD FILM W/S TEST T.B.*
10. *FUSE NO.1378*
11. *FUSE NO.1377*
12. *FUSE NO.1376*
13. *T.B. NO.1174*
14. *T.B. NO.1187*
15. *T.B. NO.1173*
16. *T.B. NO.1172*
17. *PLUG BREAK NO.1033*
18. *PORT CONTROLLER*
19. *CENTRE CONTROLLER*
20. *STARBOARD CONTROLLER*
21. *AUTO-TRANSFORMER*
22. *RELAY NO.711*
23. *RELAY NO.712*
24. *RELAY NO.714*
25. *RELAY NO.715*
26. *RELAY NO.713*
27. *RECTIFIER NO.1-9*
28. *RELAY NO.718*
29. *RELAY NO.717*
30. *RELAY NO.716*

36. Reference to fig.8 will show that in the side windscreens, the A phase receives a slightly lower voltage than the B and C phases. This is necessary because the vision area requires the same overall current density per sq.in., and since the vision section of the A phase is less than the B or C phase due to the window contour, the A phase is therefore of lower resistance and requires a lower voltage. Reference to Table 1 will show the values of applied volts and power in watts for all phases.

Load shedding

37. In emergency conditions when load shedding takes place, the windscreens will be automatically switched to low heat (para.43).

Circuit operation

38. With supplies of 115-volt, single-phase a.c. from fuses 199 R, Y, B, connected to terminals A3 and X1 of the controllers, the internal relays RL1 will be energized to close contacts D3-C3 (fig.8). When the isolation switches are placed to ON, the associated control relays are energized via the controllers to connect 3-phase supplies to the windscreens as selected on the pilot's control switch.

Medium heat

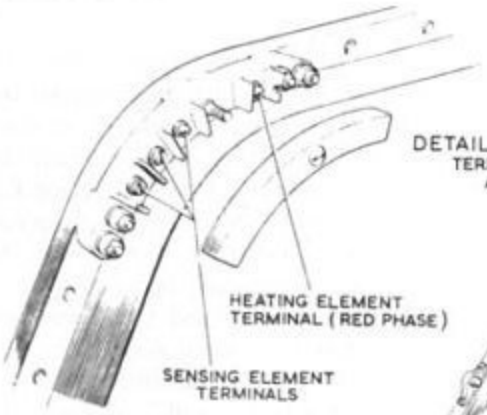
39. With the pilot's control switch selected to MED., 3-phase supplies to provide medium heat will be automatically applied to the windscreens as follows:-

Centre windscreen

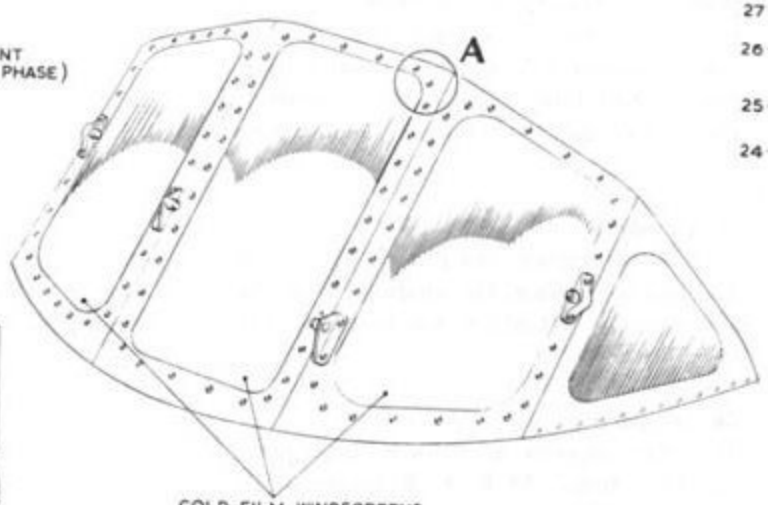
(1) A 28-volt d.c. supply from fuse 688 will be fed via the centre isolation switch and contacts D1-C2 of relay RL2 in the centre controller, to energize relay 715, and at the same time, energize the centre magnetic indicator to show NORM. Also relay 716 will be energized via contacts D3 and C3. A supply of 200-volt 3-phase a.c. will then be fed from the auto-transformer to the windscreen phases A, B and C via normally closed contacts 6, 4 and 2 of relays 714 and 712, and the now closed contacts 3, 2 and 1 of relays 715 and 716.

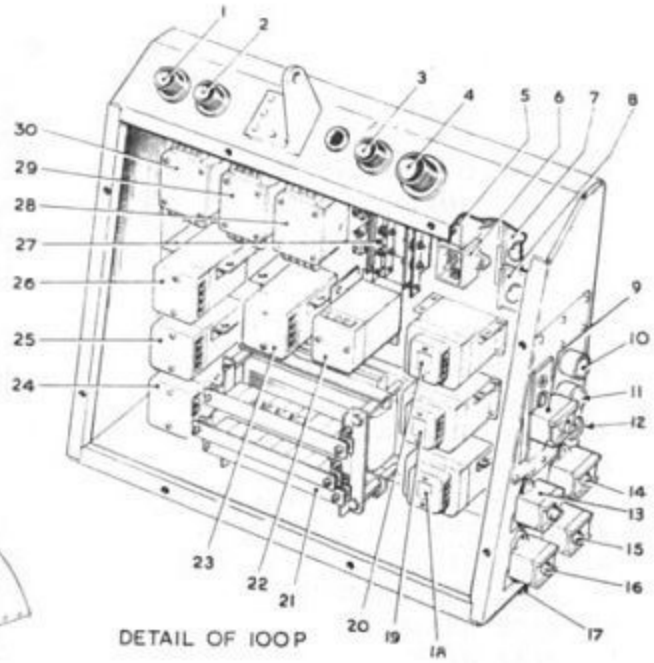
Side windscreens

(2) In the manner described for the centre windscreen, the supplies from fuses 692 and 720 will be fed via the port and starboard isolation switches to energize relays 713 and 717 via the port controller and relays 711 and 718 via the starboard controller. At the same time, the port and starboard magnetic indicators will be energized to show NORM. A 3-phase a.c. supply will then be fed to the side windscreens thus:- Phase A, 187-volt via contacts 714/8 and 712/8, through contacts 713/3 and 717/3 to the port windscreen, and through contacts 711/3 and 718/3 to the starboard windscreen: Phases B and C, 200-volt via contacts 4 and 2 of relays 714 and 712, through contacts 2 and 1 of relays 713 and 717 to the port windscreen, and through contacts 2 and 1 of relays 711 and 718 to the starboard windscreen.

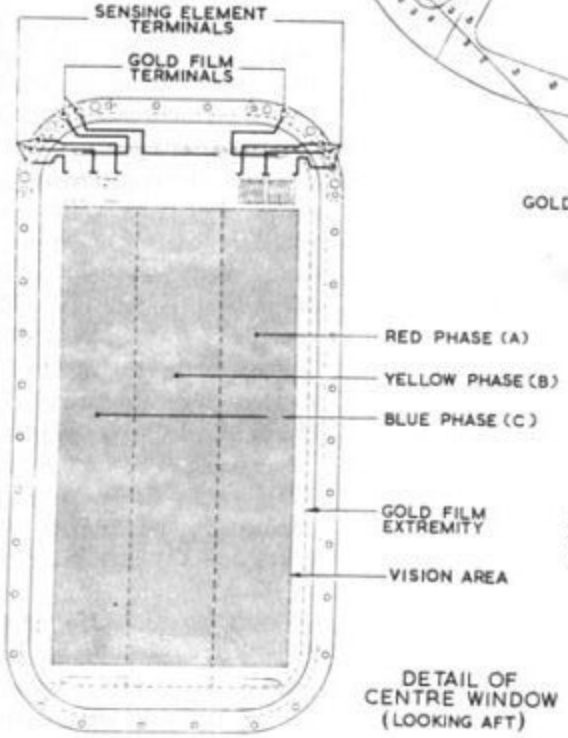


DETAIL 'A' (LOOKING FORWARD) TERMINAL BLOCK 1183 AND COVER

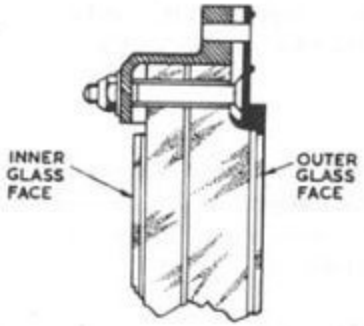




DETAIL OF IOOP



DETAIL OF CENTRE WINDOW (LOOKING AFT)



MAKE-UP OF WINDOW MOD. 2365 AND 2402

VIEW SHOWING LOCATION OF IOOP UNDER 2ND. PILOT'S FLOOR

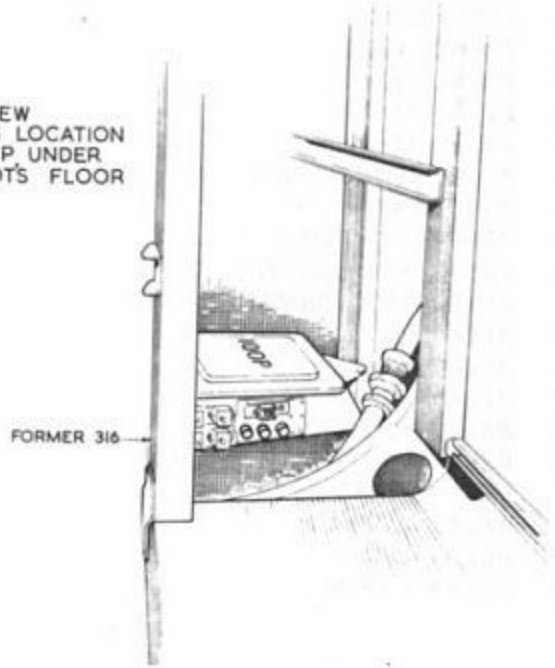


Fig 7A Gold film windscreen installation - Post Mod 2365 and 2402

KEY TO FIG.7A

GOLD FILM WINDSCREEN INSTALLATION

Post Mod.2365 and 2402

1. *PLUG BREAK NO.1031*
2. *PLUG BREAK NO.1030*
3. *PLUG BREAK NO.1032*
4. *PLUG BREAK NO.1029*
5. *T.B. NO.1169*
6. *T.B. NO.1175*
7. *T.B. NO.1171*
8. *T.B. NO.1170*
9. *GOLD FILM W/S TEST T.B.*
10. *FUSE NO.1378*
11. *FUSE NO.1377*
12. *FUSE NO.1376*
13. *T.B. NO.1174*
14. *T.B. NO.1187*
15. *T.B. NO.1173*
16. *T.B. NO.1172*
17. *PLUG BREAK NO.1033*
18. *PORT CONTROLLER*
19. *CENTRE CONTROLLER*
20. *STARBOARD CONTROLLER*
21. *AUTO-TRANSFORMER*
22. *RELAY NO.711*
23. *RELAY NO.712*
24. *RELAY NO.714*
25. *RELAY NO.715*
26. *RELAY NO.713*
27. *RECTIFIER NO.1-9*
28. *RELAY NO.718*
29. *RELAY NO.717*
30. *RELAY NO.716*

Low heat

40. With the pilots' control switch selected to LOW, a supply from fuse 515 will energize relay 712 and change over supplies as follows:-

Centre windscreen

(1) Relay 712 contacts 6, 4 and 2 will open and 5, 3 and 1 will close to connect a 140-volt, 3-phase supply to phases A, B and C of the centre windscreen.

Side windscreens

(2) Relay contacts 712/8 will open and 712/7 will close to supply phase A of the windscreens with 132-volt a.c. while phases B and C will be supplied with 140-volt a.c. via contacts 712/3 and 712/1.

High heat

41. With the pilots' control switch selected to HIGH, a supply from fuse 515 will energize relay 714. Since relay 712 will be de-energized, supplies will be connected as follows:-

Centre windscreen

(1) Relay 714 contacts 6, 4 and 2 will open and 5, 3 and 1 will close to connect a 242-volt, 3-phase supply to phases A, B and C of the centre windscreen.

Side windscreens

(1) Relay contacts 714/8 will open and 714/7 will close to supply phase A of the windscreens with 229-volt a.c., while phases B and C will be supplied with 242-volt a.c. via contacts 714/3 and 714/1.

Overheat conditions

42. Should overheat conditions occur on any windscreen, the associated controller overheat relay RL2 will operate to open contacts D1-C2 and close contacts D1 and C1 (fig.9). This will result in the control relays being de-energized to isolate the windscreen from the supply. At the same time the magnetic indicator will be energized to show O/H and the pilots' overheat warning lamp will light.

Load shedding

43. In the event of load shedding operations taking place, relay 559 will be de-energized (Chap.6). A supply will then be made from fuse 846 (vital) via contacts 559/2 to energize relay 712 and connect the windscreens to the low heat supply irrespective of previous selection.

Controller circuit

44. Variation in windscreen temperature will produce a corresponding variation in sensing element resistance. This in turn will operate the transductor circuits within the controller to control the windscreen temperature at 40 ± 1 deg.C normal, with overheat protection at 55 ± 5 deg.C. The circuit operation is as follows:-

Normal temperature control

(1) Reference to fig.9 will show that a bridge network is formed by sensing element S1, resistor R3 and the control windings on transductors XDR1 and XDR2, which are connected in push-pull. When the bridge is balanced, the effective input to the bi-stable transductor XDR3 is zero, and under this condition there will be no output from XDR3 to energize relay RL1.

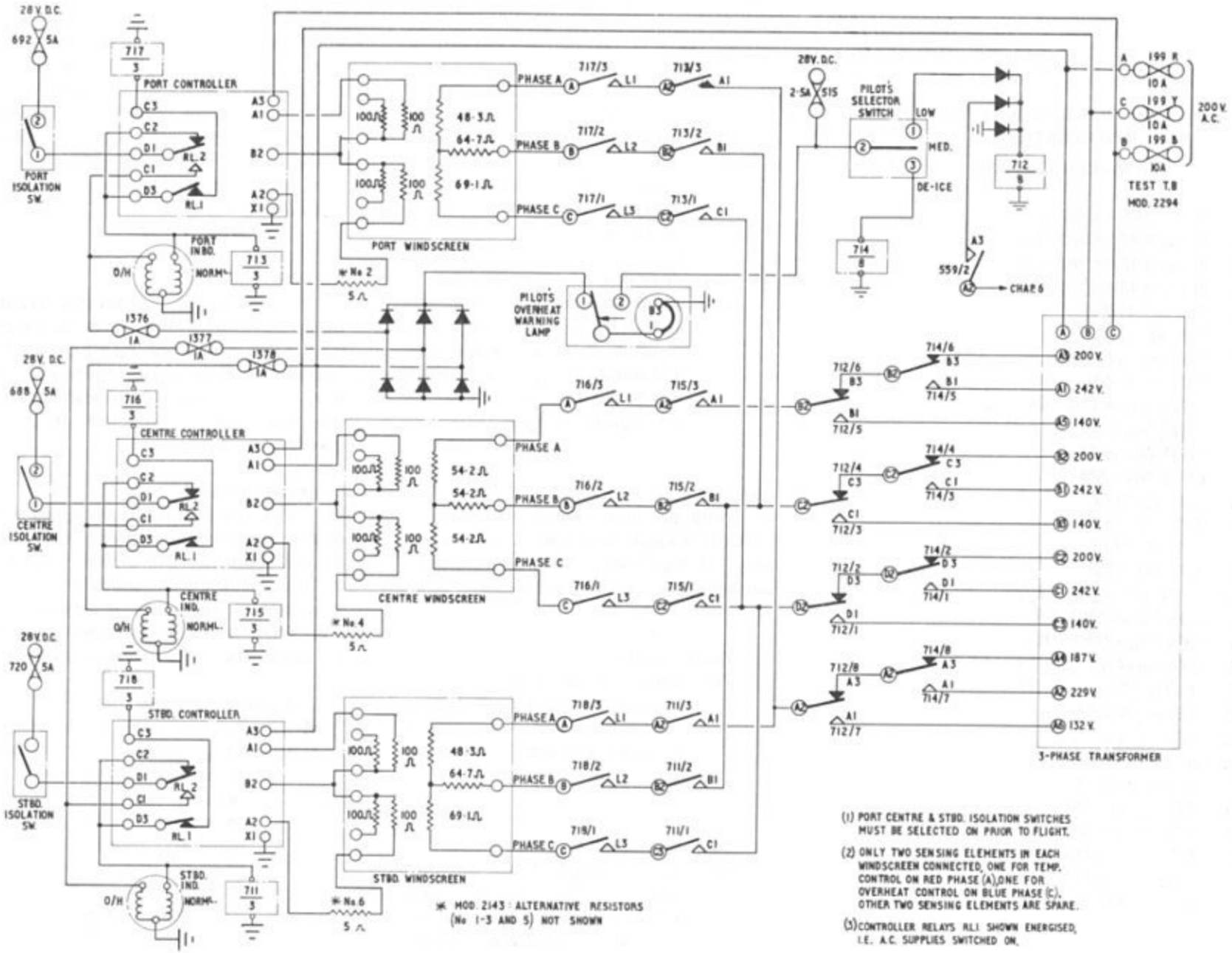


Fig. 8 Gold film windscreen circuit (Pre. Mod 2365 and 2402)

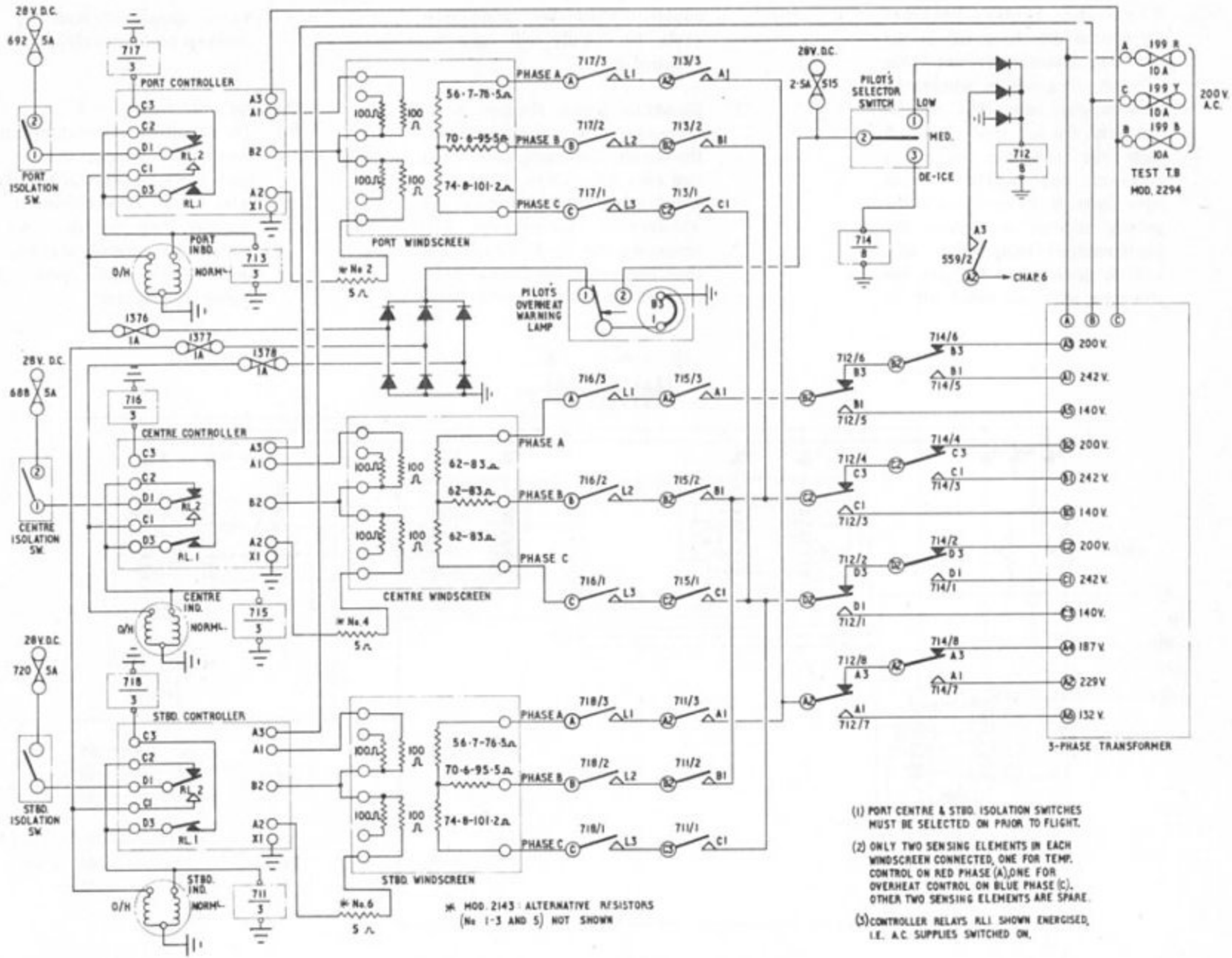


Fig. 8A Gold film windscreen circuit (Post Mod. 2365 and 2402)

(2) When the bridge becomes unbalanced due to a fall in the resistance of sensing element S1 (as a result of a fall in windscreen temperature), relay RL1 will be energized, the action of which will close the contactor relay and connect the supply to the windscreen. If the resistance of the sensing element rises above the predetermined value, relay RL1 will be de-energized to open the contactor relay and switch off the supply. When the windscreen cools, the supply will again be switched on.

(3) Should the sensing element fail by becoming open or short circuited, the circuit characteristics are such that relay RL1 will be energized to switch the supply on to the windscreen continuously. The temperature of the windscreen will then rise above the normal level, but will be prevented from rising to a dangerous level by the overheat protection circuit.

Overheat protection

(4) The circuit for overheat protection consists of sensing element S2, resistor R4, transductor XDR4 and relay RL2. This circuit is less sensitive than that described for normal temperature control, but operates in a similar manner at a higher temperature.

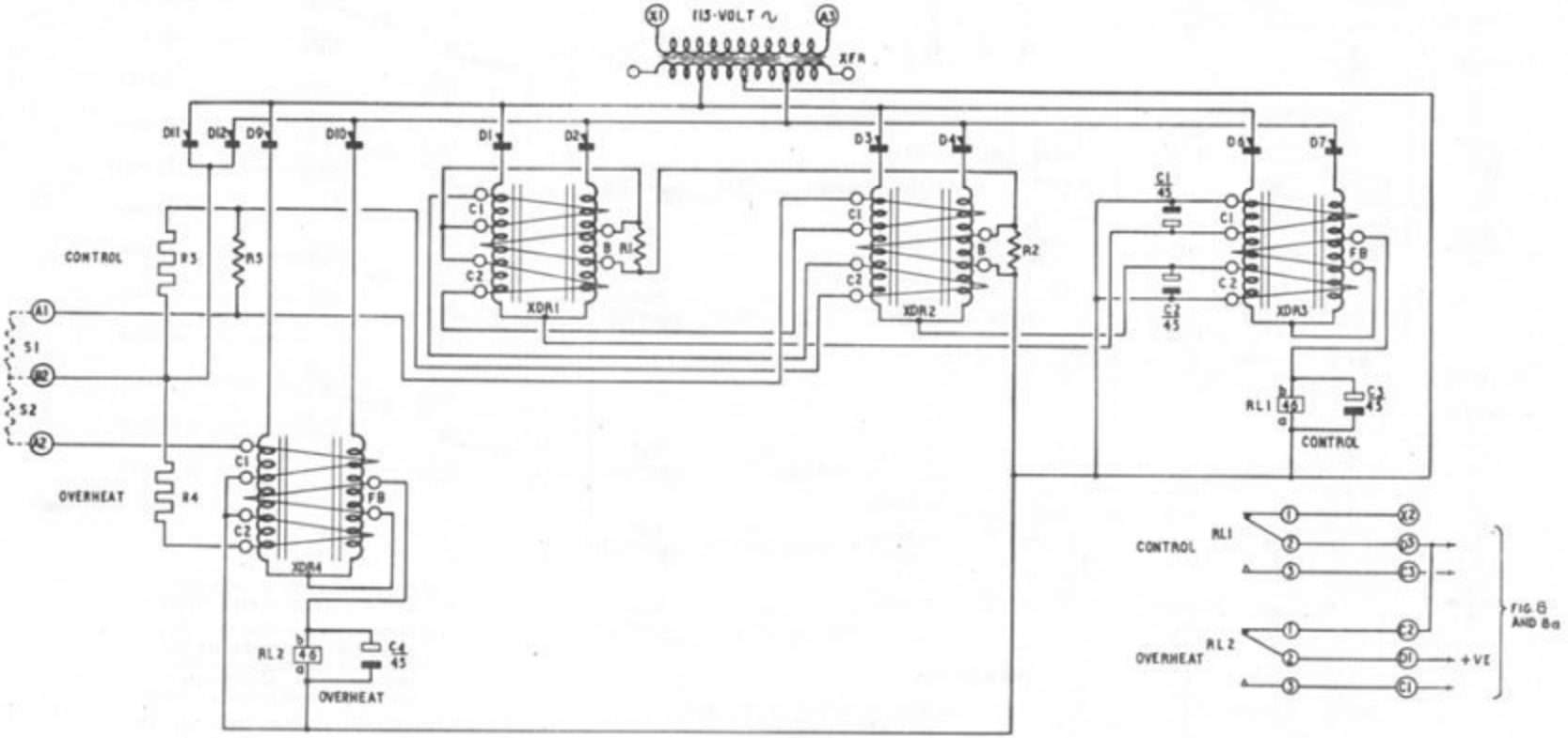


Fig.9 Gold film windscreen controller circuit

(5) Normally made contacts D1-C2 of relay RL2 are in series with the coil of the contactor relay. If the windscreen temperature becomes excessive, relay RL2 will be energized from transductor XDR4 to open contacts D1-C2 and de-energize the contactor relay, thus switching off the windscreen supply.

(6) Should the overheat sensing element fail by becoming open or short circuited, relay RL2 will be energized, the contactor relay opened and the supply switched off.

SERVICING

WINDSCREEN DE-MISTING

45. Little servicing is required for the windscreen de-misting installation. The electrical components and wiring of the system should be checked for security and tightness of connections. When testing the heater-blower unit in situ, the operation should be confined to the minimum time required to ascertain that the fan motor is running and the heater is functioning correctly.

RATION HEATERS

46. The ration heaters should be checked for security of attachment and correct operation. Further servicing details will be found in A.P.4343E, Vol.1, Book 2, Sect.10.

PERISCOPIC SEXTANT HEAD HEATERS

47. The sextant heads should be examined periodically for signs of damage, and the heaters tested by switching on the supplies. Further information will be found in Sect.7, Chap.4.

REARWARD VIEWING PERISCOPE HEATING

48. The viewing heads of the periscope should be checked at the appropriate inspection periods to ensure that the windows are being heated. This will require switching on the No.2 frequency changer (Chap.4) to obtain the 115-volt, 1,600 Hz a.c. supply for the heaters, before switching on the control switch.

WARNING . . .
Ground testing the heaters must be limited to the minimum required to ensure that the windows are being heated. This will prevent overheating and possible cracking of the windows in the absence of slipstream cooling.

PITOT HEAD HEATERS

49. The pitot heads and associated magnetic indicator should be checked for correct operation at the normal servicing periods. The indicator should show black when the circuit is switched on. When not in use protective covers should be placed over the pitot heads as described in Sect.7, Chap.1.

WARNING . . .
When testing the pitot head heaters, the heads must be switched off immediately the heads become too hot to hold by the naked hand, otherwise the elements may be damaged due to overheating in still air.

VENTILATED SUITS HEATING

50. The ventilated suit system should be checked for correct functioning in conjunction with the fitter tradesmen as outlined in Sect.3, Chap.8. It is important to ensure that all components in the system are regularly inspected for security of mounting and tightness of connectors.

51. Suspected faulty heaters can be continuity tested from the terminal connections. Since the elements are connected in star, the resistance across any two legs should read 120 ohms.

GOLD FILM WINDSCREEN

NOTE . . .
In order to maintain correct use of the windscreen circuits it is important to ensure that the isolation switches on panel 100P (Pre Mod.2294), or at the aft end of panel 4P (Post Mod.2294) are switched ON before flight and OFF after flight.

Testing the circuit

Resistance and voltage checks

52. Should the normal heating up of any windscreen be suspect, a check for windscreen resistance values and applied voltages can be made at the appropriate windscreen terminal blocks. Using a suitable testmeter the checks should be carried out as follows:-

Resistance check

(1) Ensure that the 200 - volt a.c. supplies are switched off.

(2) Remove the covers from the terminal blocks on the windscreen under test.

(3) Measure the resistance of the windscreen heating and sensing elements, referring to figs.17, 18 and 19 for terminal block connections and to Tables 2 and 4 for resistance values. Note that all resistance checks should be carried out at 20 deg.C ambient temperature.

Voltage check

(4) Ensure that 200 - volt a.c. and 28 - volt d.c. supplies are connected to the aircraft.

(5) Switch on the isolation switch for the windscreen under test.

(6) Measure the voltage across each two phases of the windscreen, i.e., A-B, A-C and B-C with the pilots' control switch selected to LOW, MED., and HIGH in turn. The figures obtained should agree with the line volts given in Table 1 (Pre Mod.2365 and 2402) and Table 3 (Post Mod.2365 and 2402). Note that in the case of the side windscreens, the voltage measured across phases A-B, A-C will be less than that across phase B-C.

At the conclusion of the above checks, ensure that the windscreen terminal block covers are replaced and the power supplies are switched off.

Power checks

53. Power consumption of the windscreens can be checked at the appropriate inspection periods by the use of a Ferranti clip-on type wattmeter. The wattmeter is connected, red lead to T.B. 1169-B in 100P and black lead to earth (fig.16). With the three windscreens switched on, the wattmeter is then clipped around each of the three phase wires in turn on cable assembly F3267 outside 10P. This is done at LOW, MED., and HIGH selections on the pilot's control switch, and the readings recorded. Instructions for this test are given in the Servicing Schedule, which also includes a Table in watts, against which the wattmeter readings should be compared.

Controllers

54. Tests to determine correct operation of the controllers, Type 4, Mk.1, are fully described in A.P.107C-0404-16.

Windscreen failure

55. In the event of a windscreen failing to heat up due to an open circuit of the heating elements, the windscreen must be removed and replaced by a serviceable one.

56. Should sensing element failure occur on any windscreen, either one or both spare sensing elements may be brought into circuit to replace faulty elements. This is done by reconnecting the cables from terminals A1 and A2 of the respective controller at the associated terminal block in 100P (fig.17, 18 and 19).

57. In the case of a windscreen having three failed sensing elements, replacement by a new windscreen is necessary. However, in emergency conditions, if a new windscreen is not available, the remaining sensing element of the windscreen may be connected to the overheat circuit of the controller (thus providing overheat protection) to enable the aircraft to be flown back to base for repair.

REMOVAL AND INSTALLATION

Precautions

58. Removal of the various components in the systems described in this chapter are comparatively straightforward, and removal information is given only where required. In all cases, however, the following instructions should be observed:-

(1) Before removing any item of electrical equipment, ensure that the circuit is switched off.

(2) Insulate and stow all disconnected cables.

(3) Before reconnecting cables to components, refer to the appropriate routing chart where necessary.

(4) Ensure that all bonding leads are replaced and are undamaged.

WINDSCREEN DE-MISTING

Heater-blower unit

59. This unit, which is located under the 2nd pilot's floor can be removed as follows:-

(1) Remove the hose clips securing the triangular ducting to the windscreen pipes (above floor).

(2) Remove the four bolts securing the bracket support assembly (below floor).

(3) Hold unit and turn so that terminal connector block is accessible. Remove cable connections.

(4) Slide complete assembly downwards and free of surrounding structure.

When replacing the unit, the above procedure should be reversed.

PERISCOPIC SEXTANT HEADS

60. Instructions for removing the periscopic sextant heads are given in Sect.3, Chap.1.

REARWARD VIEWING PERISCOPE HEADS

61. Instructions for removing the periscope viewing heads are given in Sect.3, Chap.1.

PITOT HEADS

62. Instructions for removing the pitot heads are given in Sect.7, Chap.1.

VENTILATED SUITS HEATING

Heaters

63. The heaters are removed by disconnecting the cables from the connector block and removing the four bolts and the clips securing the inlet and outlet pipes to the heater ducts.

Transductor-amplifiers

64. These units are secured to the structure by four screws, which can easily be removed. Connector blocks on the units provide the electrical connections.

Temperature selectors

65. Four screws, partly obscured by the operating knobs, secure the temperature selectors to their mountings. The knobs, therefore, must first be removed before releasing the screws. Electrical connections to the selectors are integral, so that the associated cables must be disconnected at the transductor amplifiers and removed with the selectors.

GOLD FILM WINDSCREEN

Panel 100P

66. Since panel 100P is located directly below the N.B.S. calculator, Type 3, Mk.2, the removal of 100P or any component within the panel will first require the removal of the calculator. This is done by disconnecting the calculator and sliding it out of the crate on to the cabin floor (Sect.7, Chap.5). The removal of 100P or its components is then straightforward.

TABLE 1
Nominal power conditions for windscreens
◀(Pre Mod.2365 and 2402)▶

	Low Heat				
	Phase	Phase Volts	Line Volts	Phase Watts	Total Watts
Centre Windscreen	A, B & C	81	140	121	363
Side Windscreens	A	71.5	132	106	302
	B	81	140	101	
	C	81	140	95	

	Medium Heat					High Heat				
	Phase	Phase Volts	Line Volts	Phase Watts	Total Watts	Phase	Phase Volts	Line Volts	Phase Watts	Total Watts
Centre Windscreen	A, B & C	115	200	244	732	A, B & C	140	242	362	1086
Side Windscreens	A	101	187	211	606	A	124	229	318	905
	B	115	200	204		B	140	242	303	
	C	115	200	191		C	140	242	284	

TABLE 2
Resistance values for windscreens
◀ (Pre Mod.2365 and 2402) ▶

	Phase	Phase Resistance in ohms	Sensing element Resistance in ohms	
Centre Windscreen	A, B & C	54.2 + 15% - 10%		
Side Windscreens	A	48.3 + 15% - 10%	100	At 20 deg.C. ambient temp.
	B	64.7 + 15% - 10%		
	C	69.1 + 15% - 10%		

TABLE 3
Power conditions for windscreens
◀ (Post Mod.2365 and 2402) ▶

	Low Heat				
	Phase	Phase Volts	Line Volts	Phase Watts	Total Watts
Centre Windscreen	A, B and C	81	140	79 – 105	228 – 315
Side Windscreens	A	71.5	132	68 – 85	202 – 255
	B	81	140	69 – 89	
	C	81	140	65 – 81	

	Medium Heat					High Heat				
	Phase	Phase Volts	Line Volts	Phase Watts	Total Watts	Phase	Phase Volts	Line Volts	Phase Watts	Total Watts
Centre Windscreen	A, B and C	115	200	101 – 161	303 – 483	A, B and C	140	242	235 – 315	705 – 945
Side Windscreens	A	101	187	133 – 178	402 – 541	A	124	229	201 – 268	598 – 807
	B	115	200	138 – 187		B	140	242	204 – 277	
	C	115	200	131 – 176		C	140	242	193 – 262	

TABLE 4
Resistance values for windscreens
◀ (Post Mod.2365 and 2402) ▶

	Phase	Phase Resistance in ohms	Sensing element Resistance in ohms	
Centre Windscreen	A, B and C	62 – 83	100	At 20 deg.C ambient temp.
Side Windscreens	A	56.7 – 76.5		
	B	70.6 – 95.5		
	C	74.8 – 101.2		

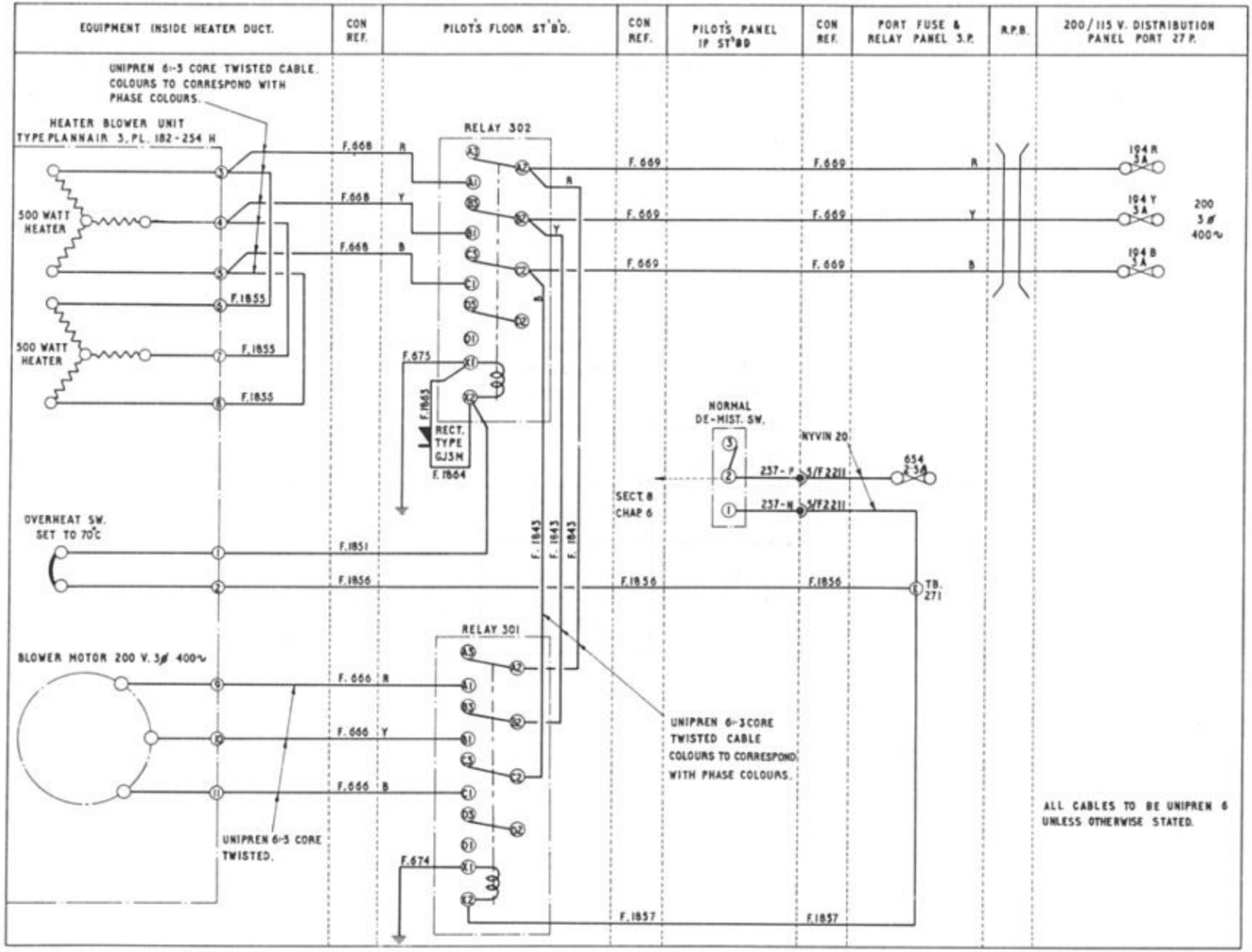


Fig.10 Windscreen de-misting

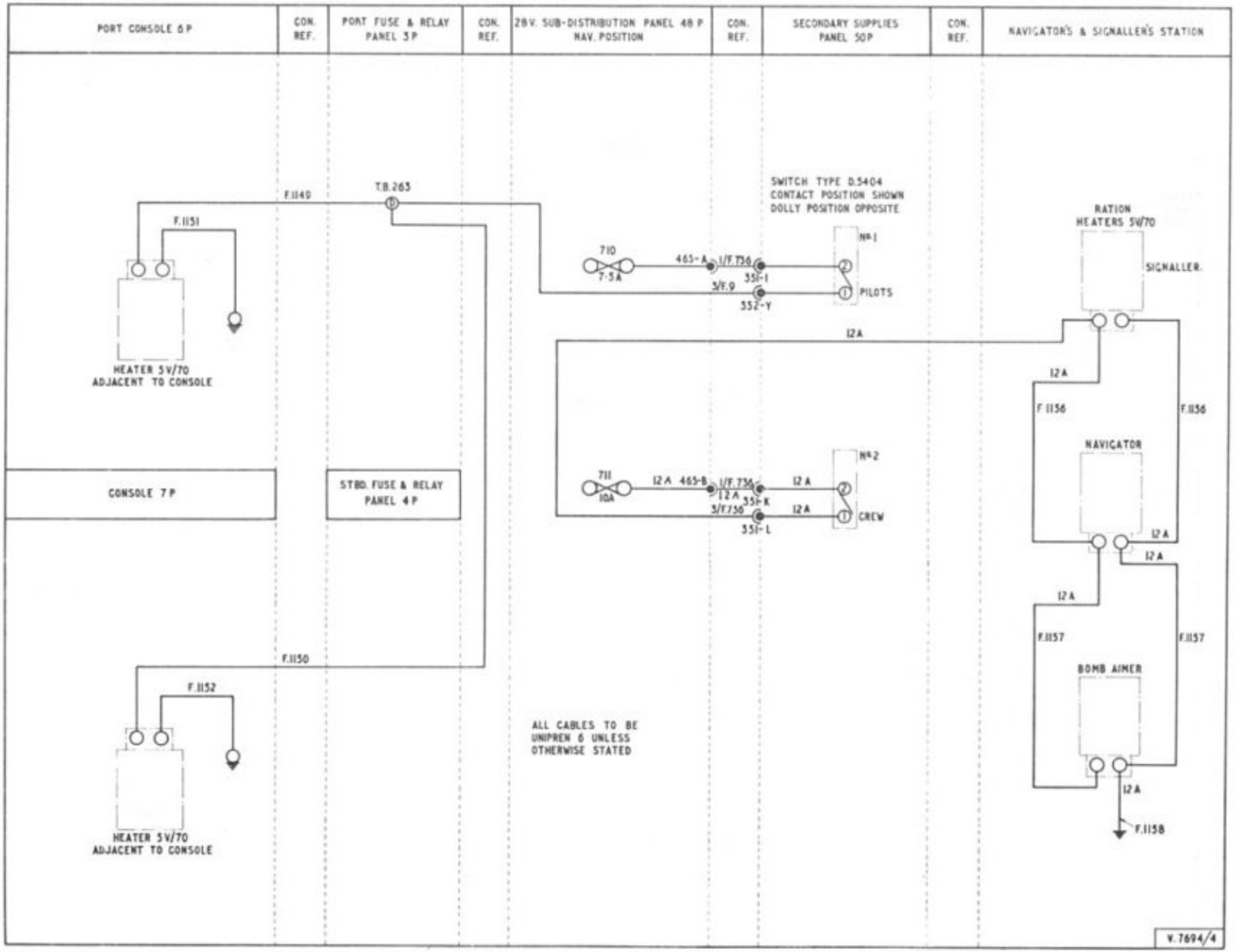


Fig.11 Crews ration heaters

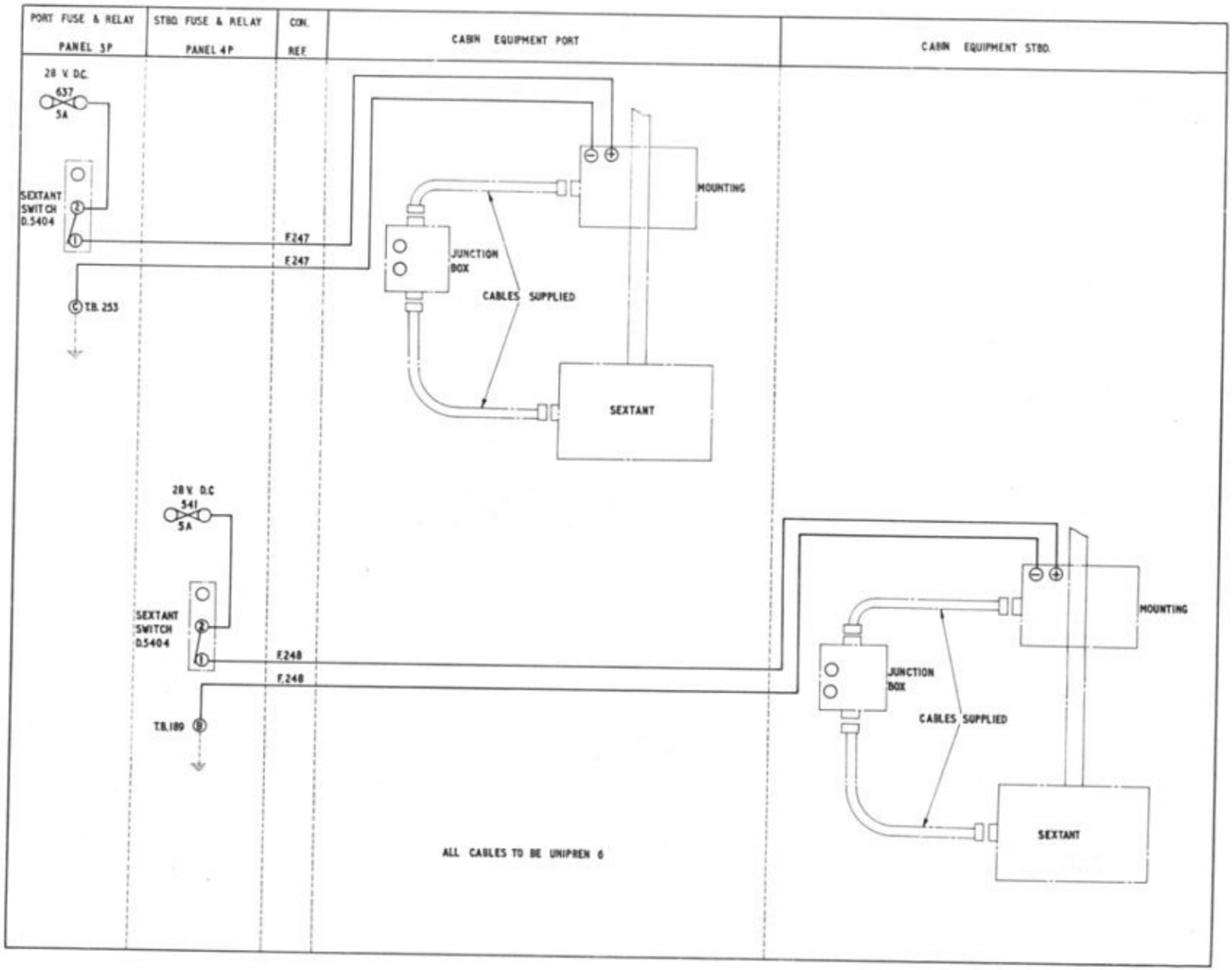


Fig.12 Periscopic sextant heaters

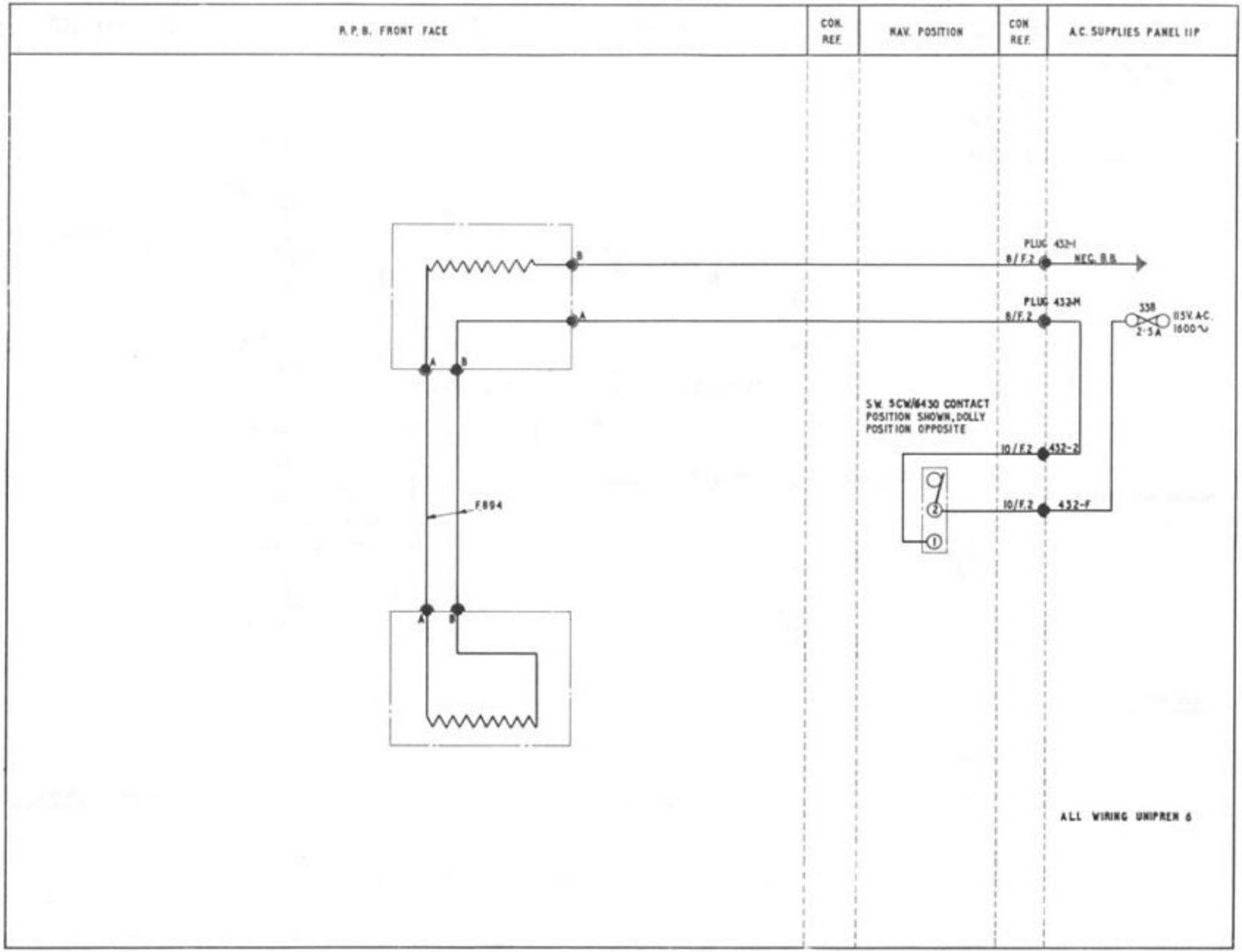


Fig. 13 Rearward viewing periscope heating

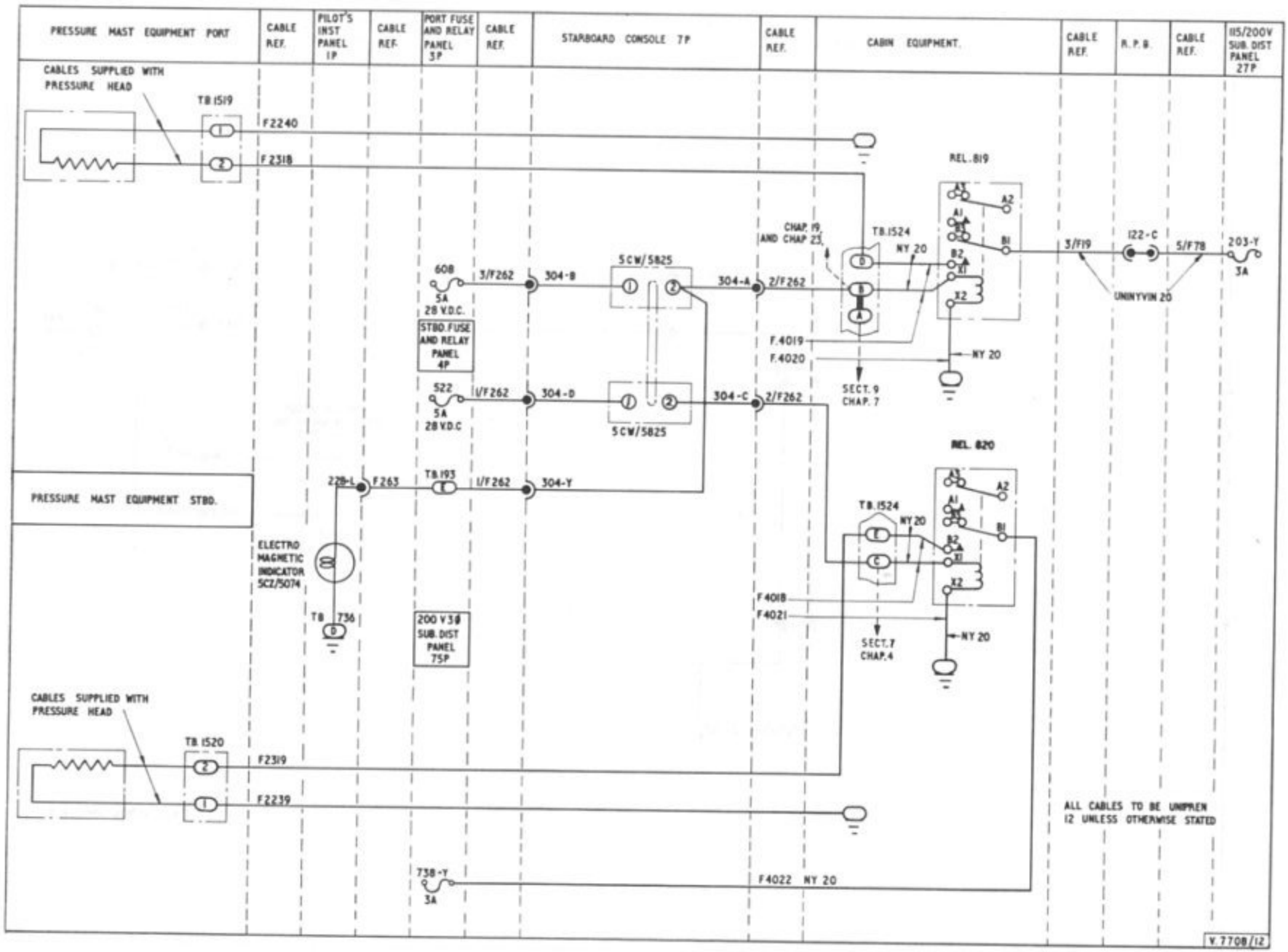


Fig. 14 Pitot head heaters

◂Cable 3/F19 and 5/F78 now uninyvin 20▸

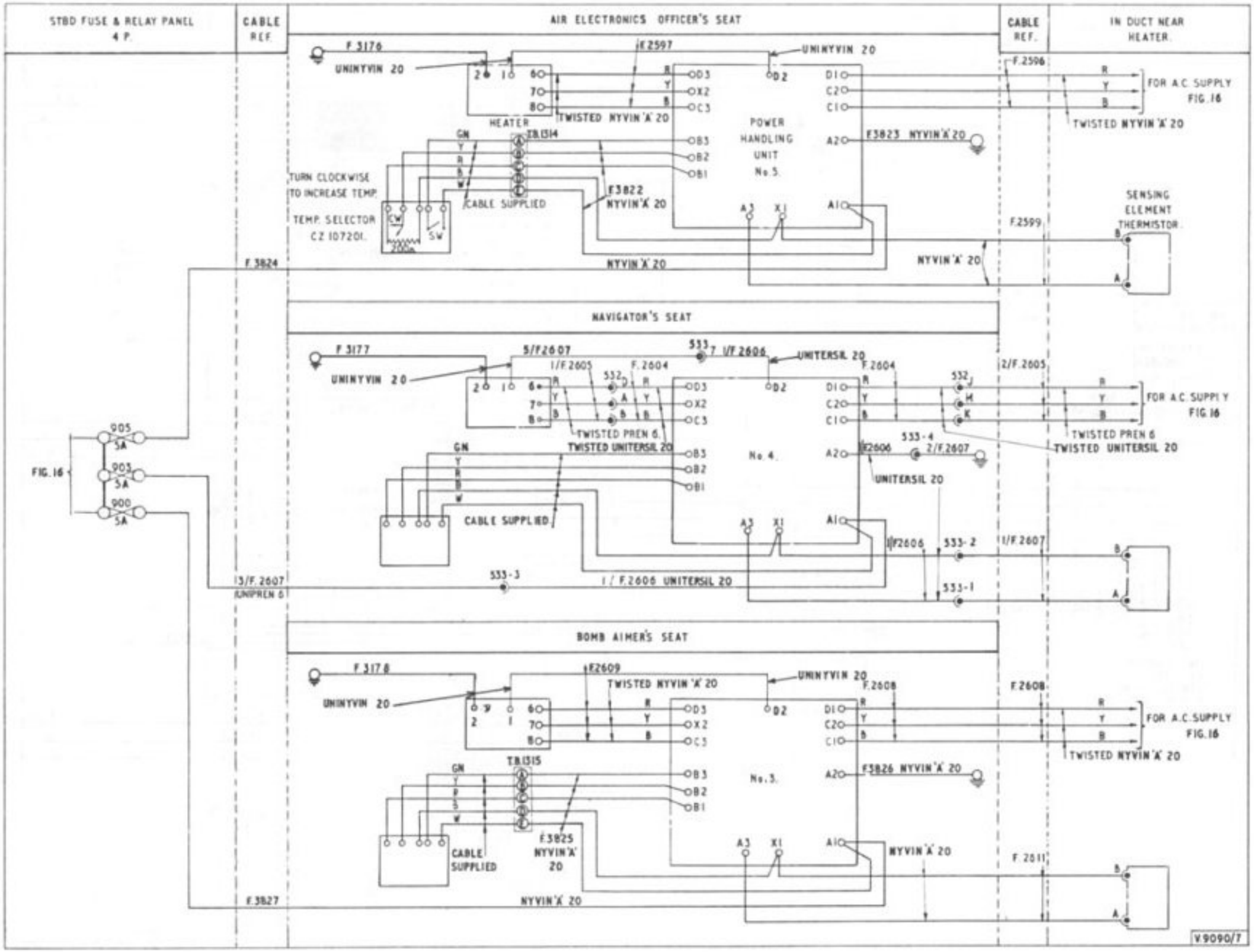


Fig. 15 Ventilated suits heating – aft crew

◀Cross refs. corrected▶

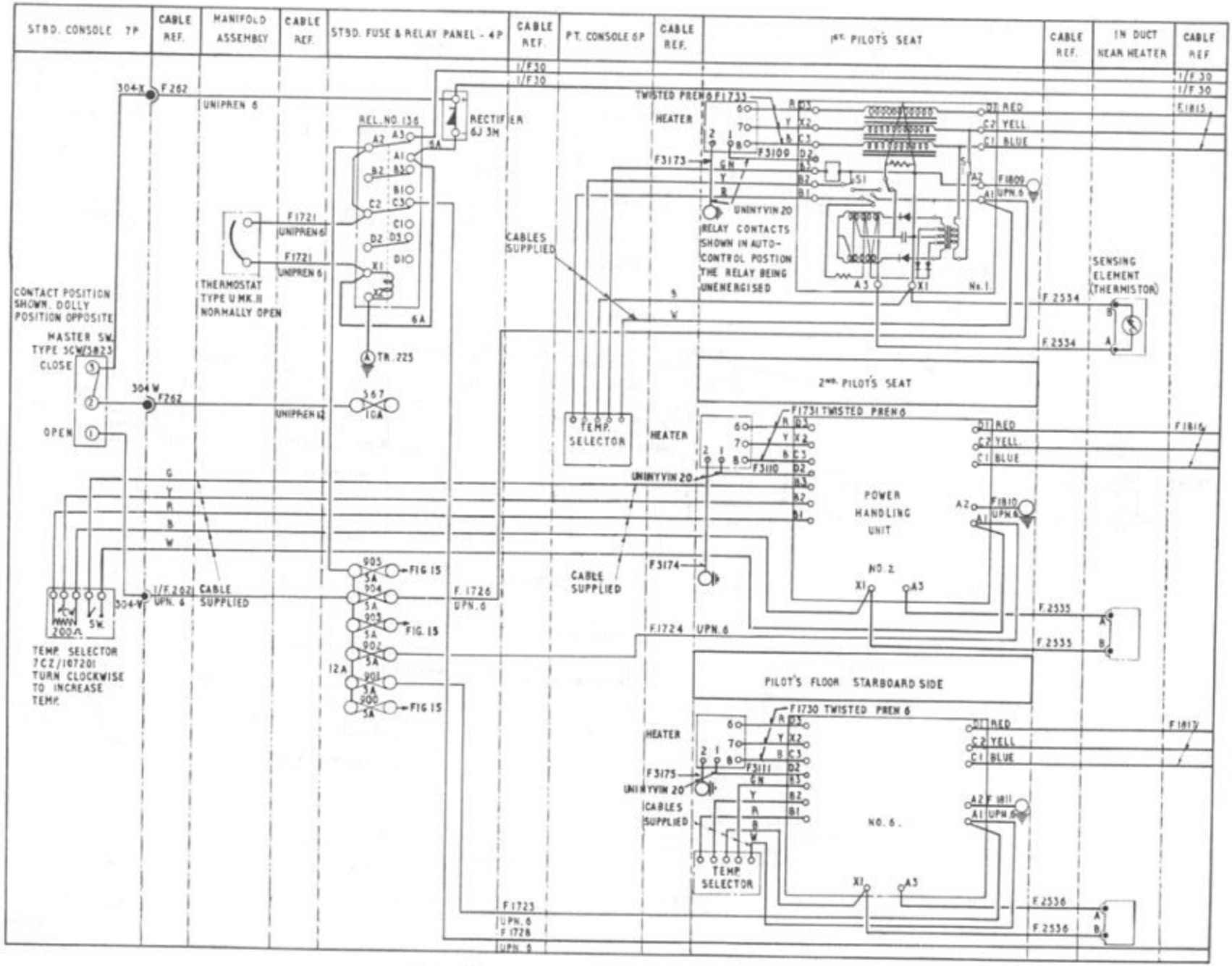


Fig. 16 (1) Ventilated suits heating – fw'd crew

Cross refs. corrected

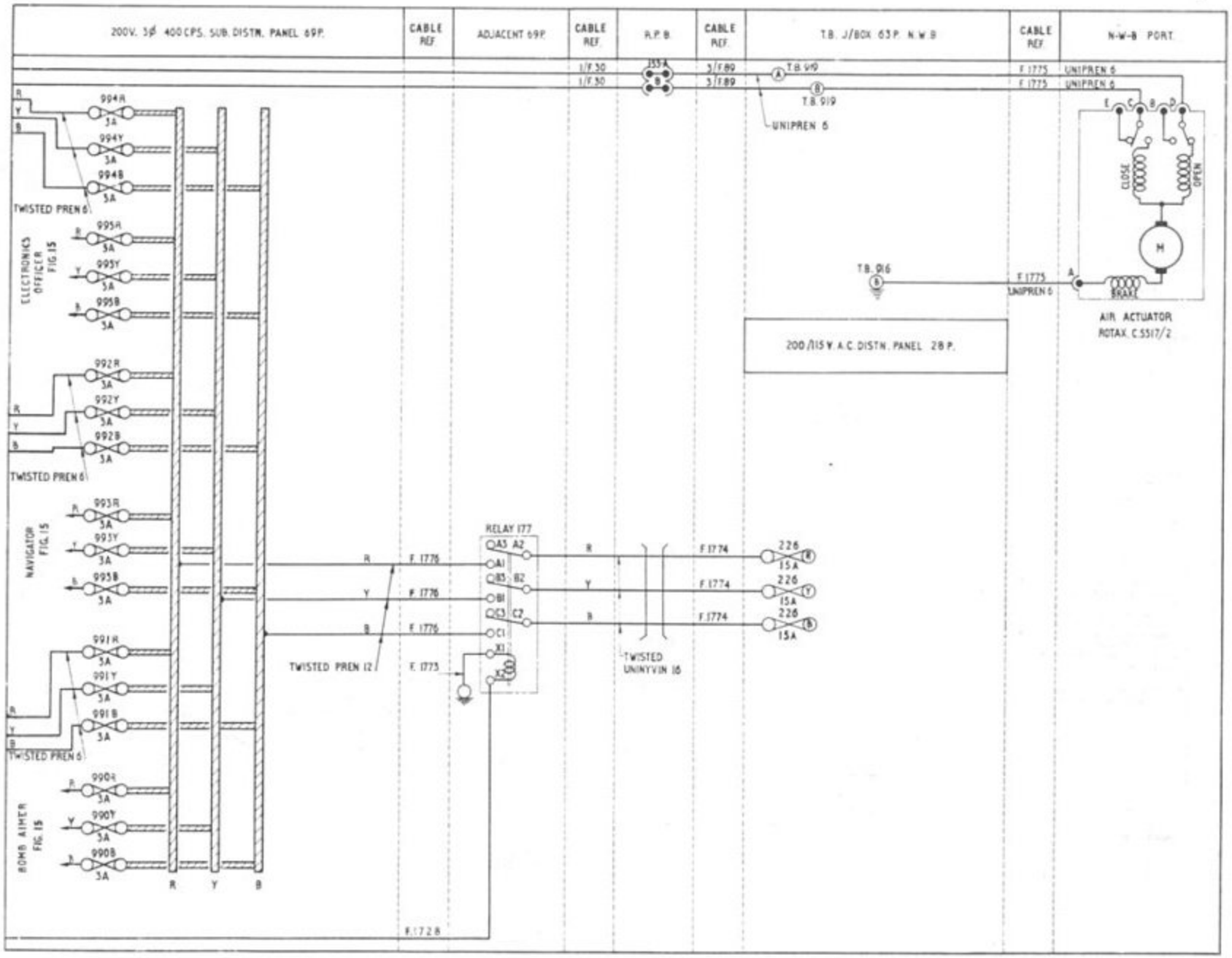


Fig. 16 (2) Ventilated suits heating - fw'd crew

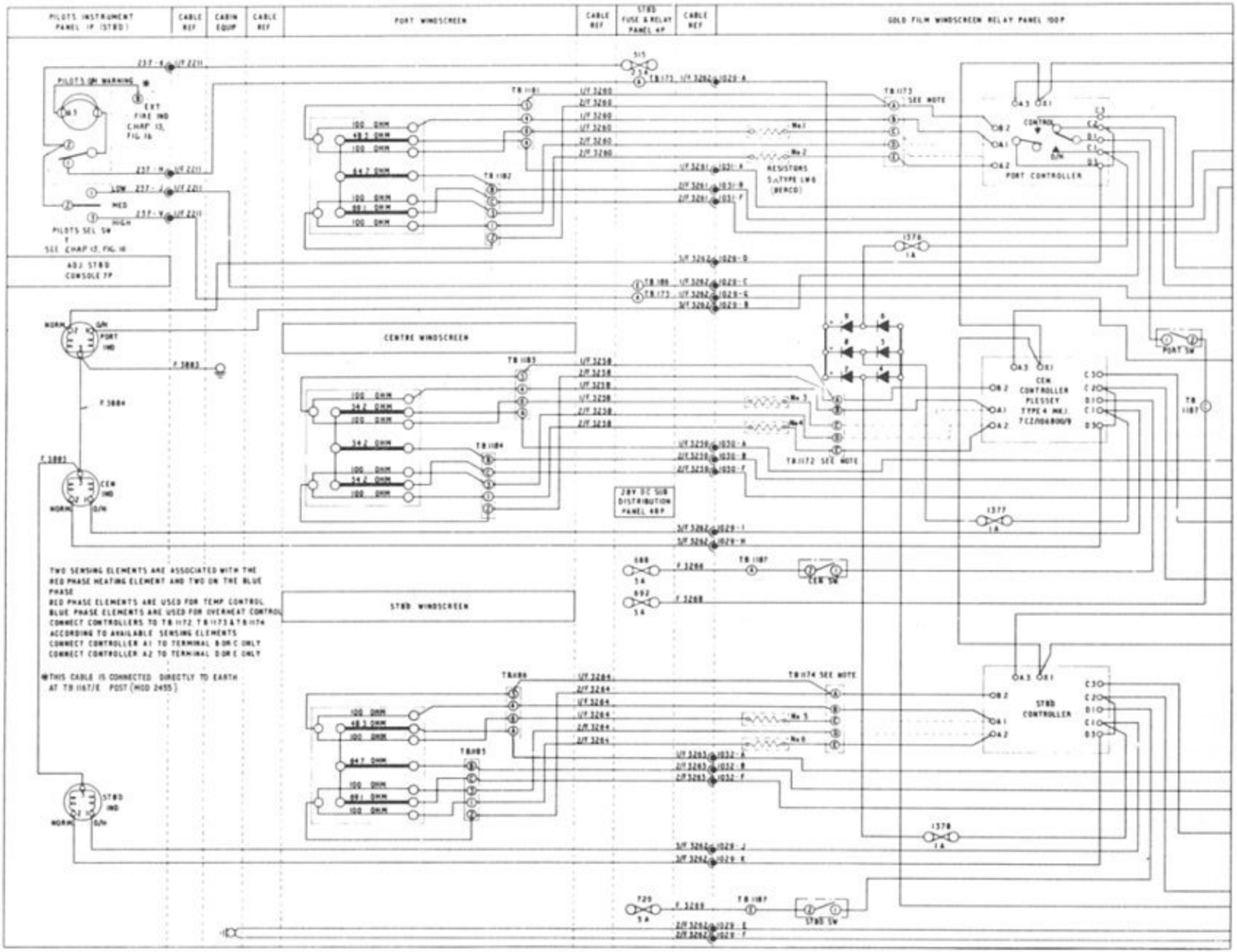


Fig.17 (1) Gold film windscreen (pre Mod.2294)

▶ *Mod 2455 (note added)* ◀

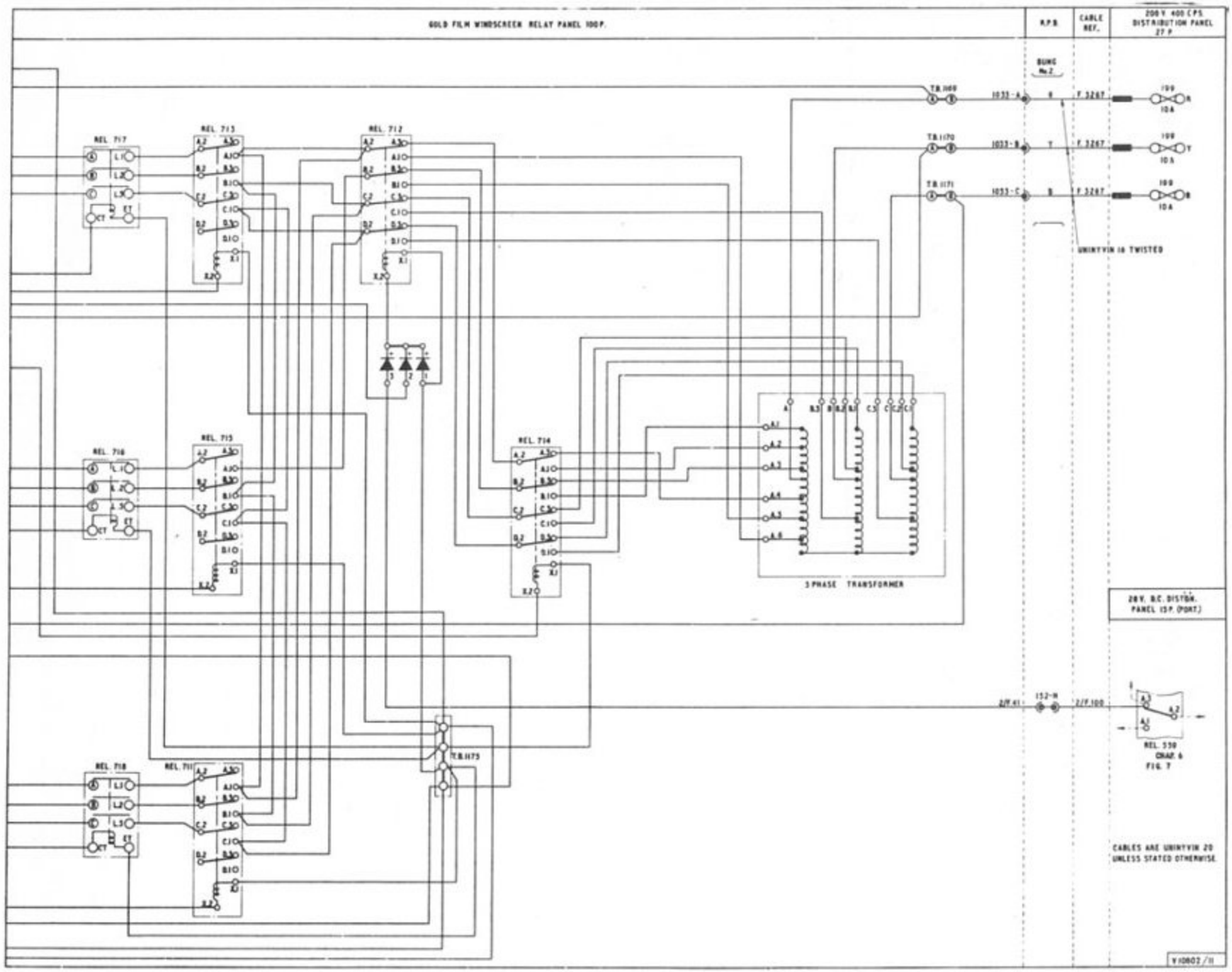


Fig.17 (2) Gold film windscreen (pre Mod.2294)

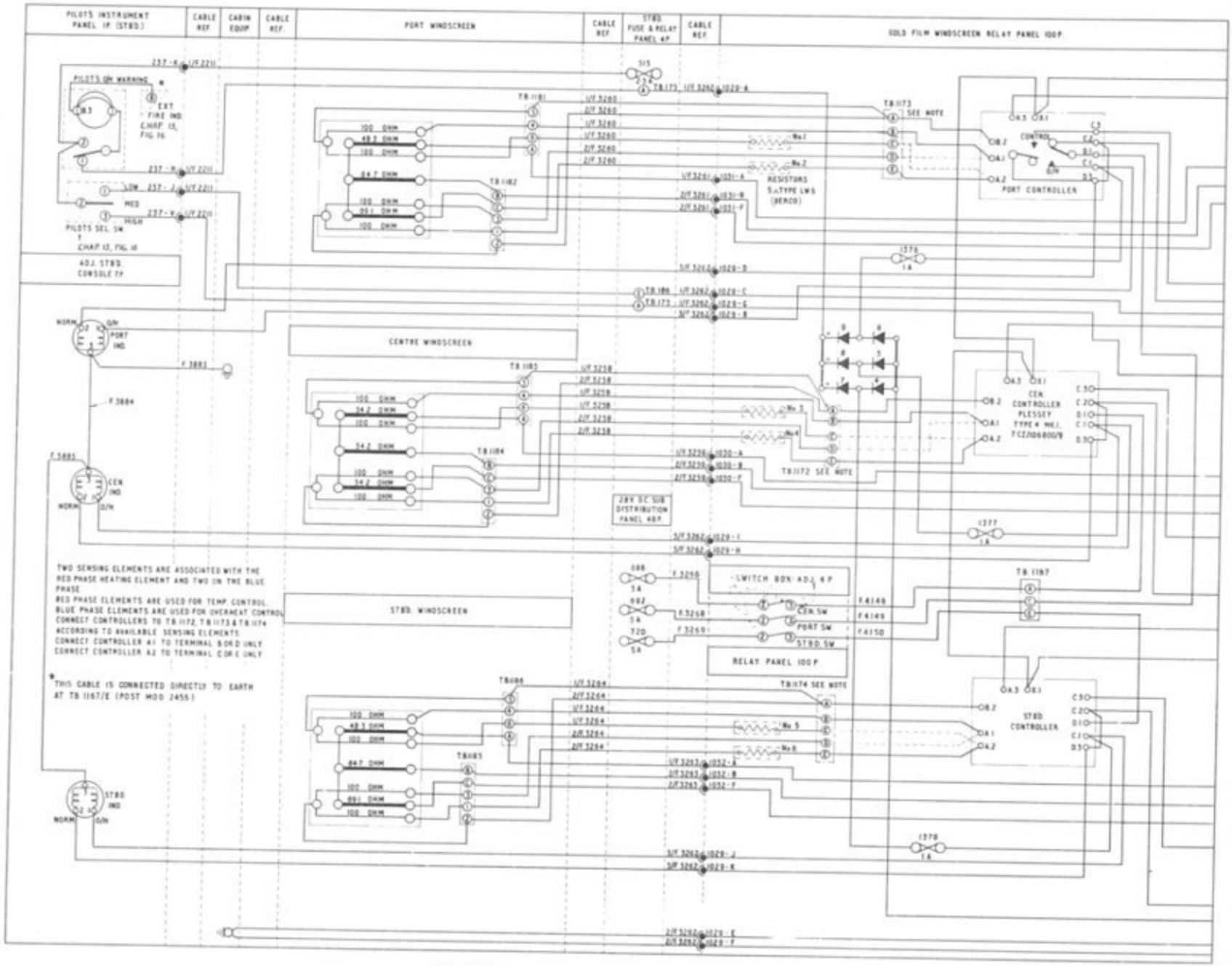
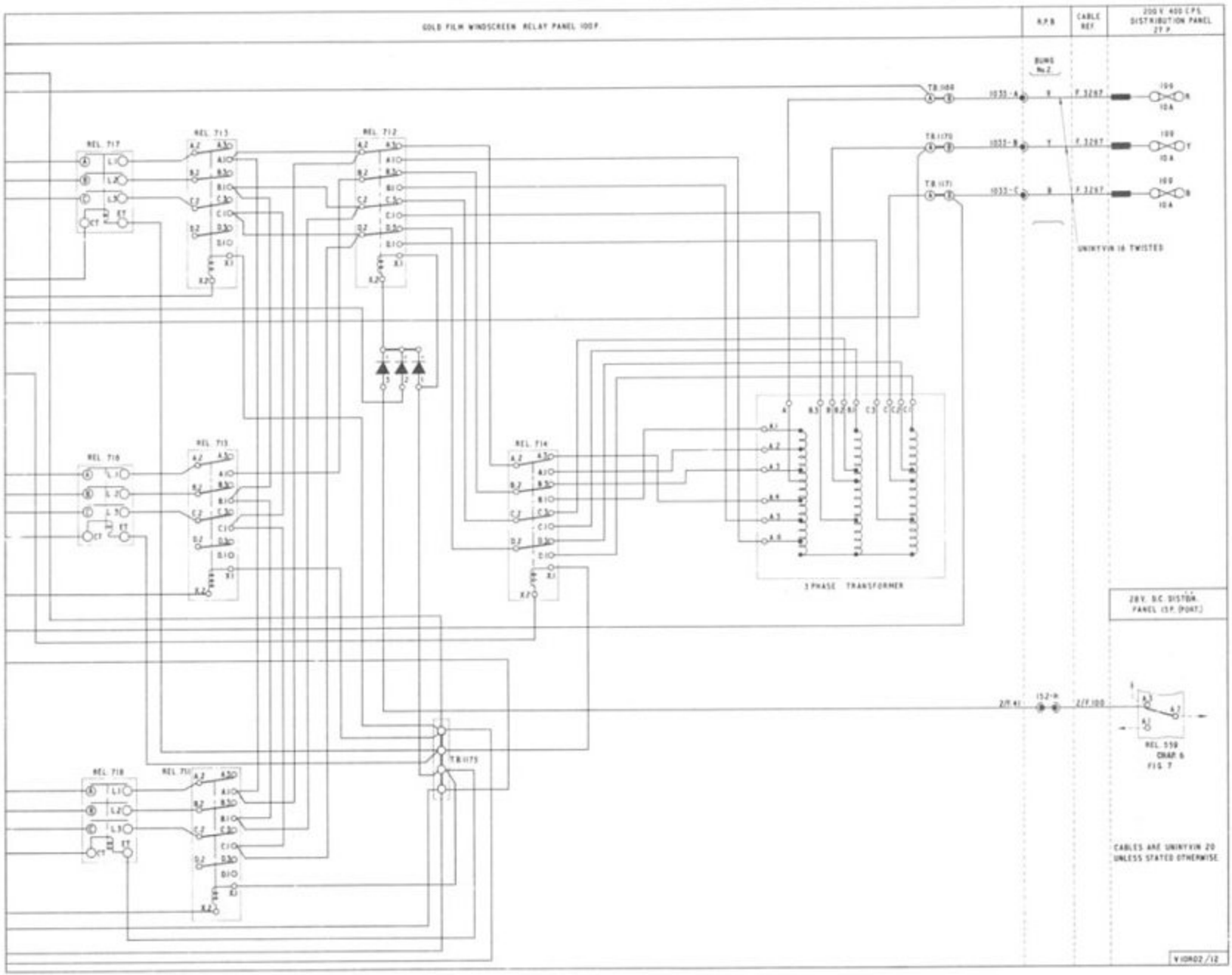


Fig.18 (1) Gold film windscreen (Post Mod. 2294)

► *Mod 2455 (note added)* ◄



◂ Fig. 18 (2) Gold film windscreen (Post Mod 2294) ▸

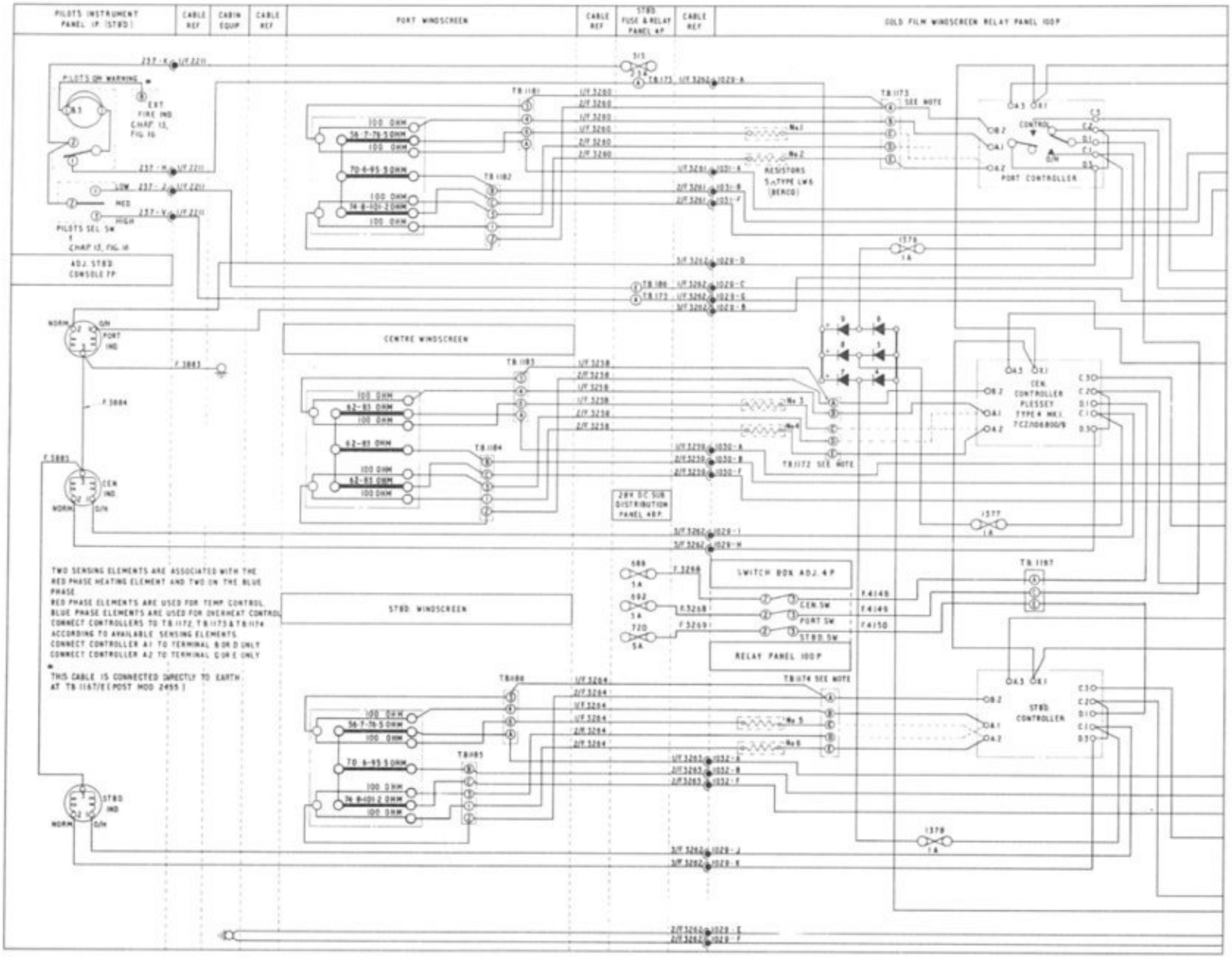


Fig. 19 (1) Gold film windscreen (Post Mod. 2365 and 2402)

► *Mod 2455 (note added)* ◄

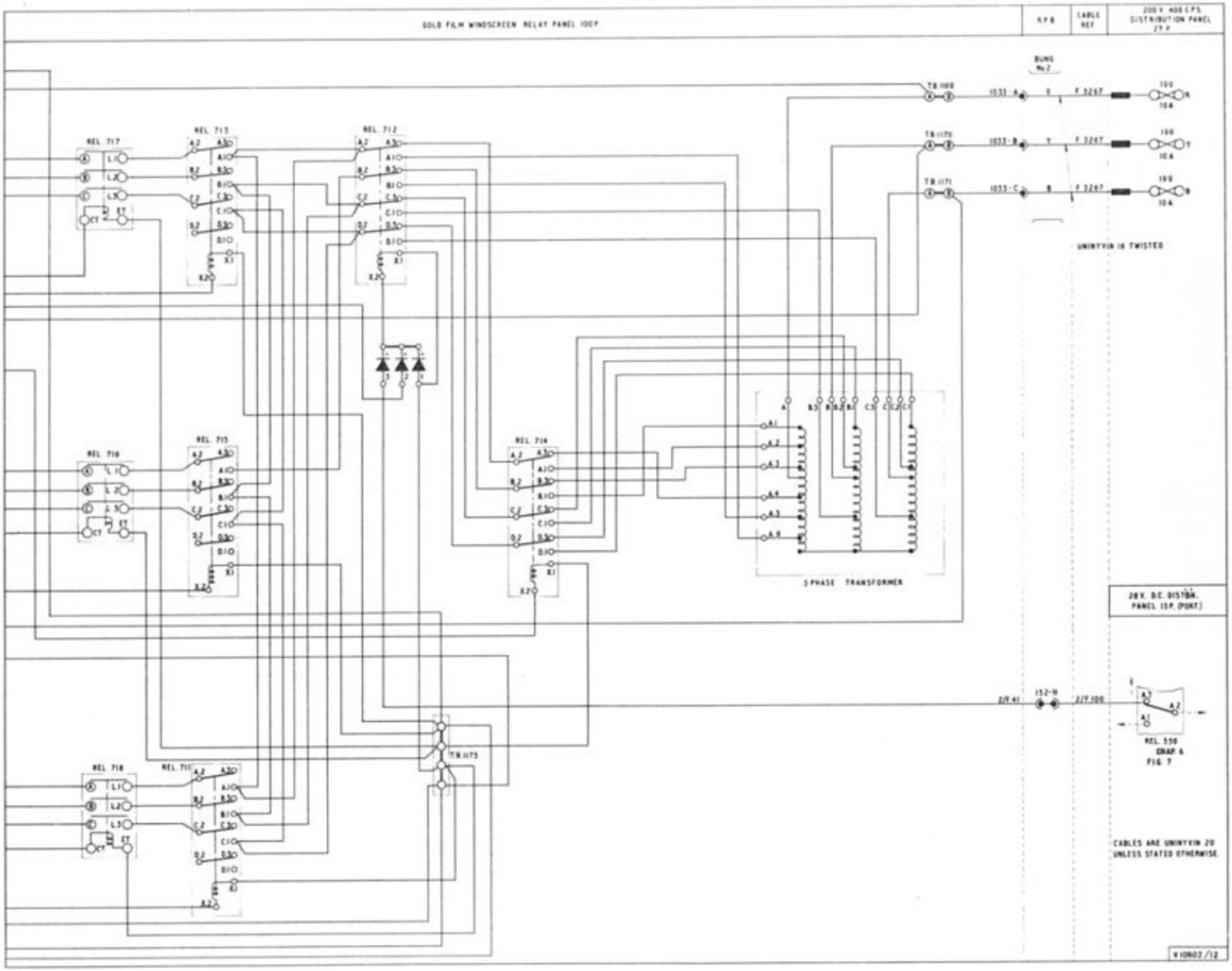


Fig 19(2) Gold film windscreen (Post Mod. 2365 and 2402)

◄ Issue number corrected ►