Chapter 6 HEATING - DE-ICING - RAIN DISPERSAL - AIR CONDITIONING

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LIST OF ILLUSTRATIONS

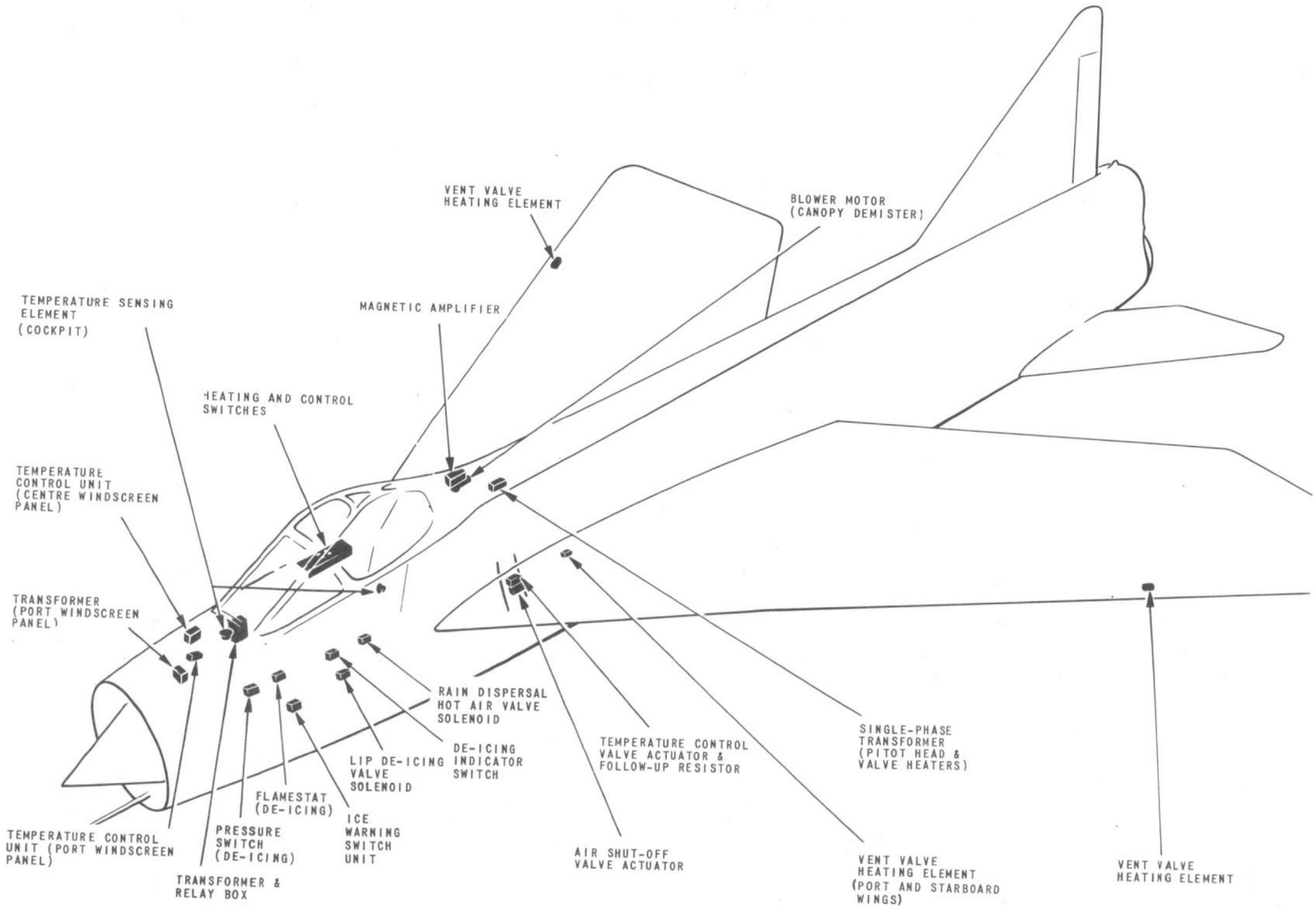

FIG. 1. HEATING – DE-ICING – AIR CONDITIONING

DESCRIPTION

General

1. This chapter, which now includes the modifications listed below, contains information on fuel vent valve, pressure head and windscreen heating, cockpit heating and pressurization, rain dispersal, canopy de-misting and engine de-icing.

◀ Mod.4090 To introduce wiring for vent valve heater on ventral tank.

Mod.4148 To introduce magnetic amplifier Type FLM/A/36 in lieu of Type FLM/A/14.

Mod.4398 To introduce 165 knot pressure switch Pt.No.T.P.30187 in lieu and by conversion of 150 knot pressure switch Pt.No.T.P.5694.

HEATING

Fuel vent valves and pitot head

General

2. The vent valves and the pitot head are electrically heated by integral elements normally fed with single-phase a.c. from a 200/28-volt transformer in the forward equipment compartment. Both services are controlled by the PITOT HEAD switch on the starboard console.

Operation

3. The control switch has three positions, ON-OFF-STANDBY, and operates in conjunction with a Type S1 relay in the a.c. fuse and relay box. With the switch selected to ON the relay is energized and the pitot head, main plane and ventral tank valve heaters operate from the a.c. supply circuit XK1. When STANDBY is selected the relay is de-energized and the pitot head heater only, is then fed with d.c. from busbar PF2.

Port windscreen panel

General

4. The port windscreen panel is heated by a laminar element which is supplied from the a.c. system via a transformer. The heater circuit is primarily-controlled through one pole of the double-pole SIDE WINDSCREEN switch (the other controls the de-mister circuit) fitted on the starboard console. Automatic temperature regulation is effected by a heat controller in conjunction with temperature sensing elements incorporated in the laminae of the panel. The heat controller, power supply transformer and a Type 20B relay which controls the power supply from the a.c. busbar to the transformer, are installed in the forward equipment compartment. ▶

Heat controller

5. The Type 4, Mk.4 heat controller, incorporates four transductors, a number of rectifiers and capacitors, a control relay and an overheat relay. It operates from an integral single-phase transformer which is supplied from the a.c. system.

Operation

6. The controller operates in response to temperature-change signals fed from the panel sensing elements. The latter have a resistance of 315 ohms at 75 deg F. When the resistance of the sensing elements drops due to a reduction in temperature, the control relay closes to energize the Type 20B relay which, in turn, closes to complete the a.c. supply to the panel heater element. Conversely, when the panel temperature rises, the sense element signal causes the overheat relay to open. This breaks the energizing circuit of the Type 20B relay, which opens and switches off the heater supply.

7. As this type of panel cannot be made to fine electrical limits the resistance of individual heater elements may vary considerably. For this reason each panel is identified with a letter and number symbol which signifies its heater resistance value. Symbols will also be found opposite the output terminals of the supply transformer. If the panel is renewed, the resistance symbol on the replacement panel must agree with the symbol on the output connections on its supply transformer.

8. The three possible values of resistance of the panels and their relevant connection symbol are as follows:-

Heater resistance	Connection symbol
68-76	a2
76-84	a3
84-92	a4

Centre windscreen panel

General

9. The heating circuit for this panel

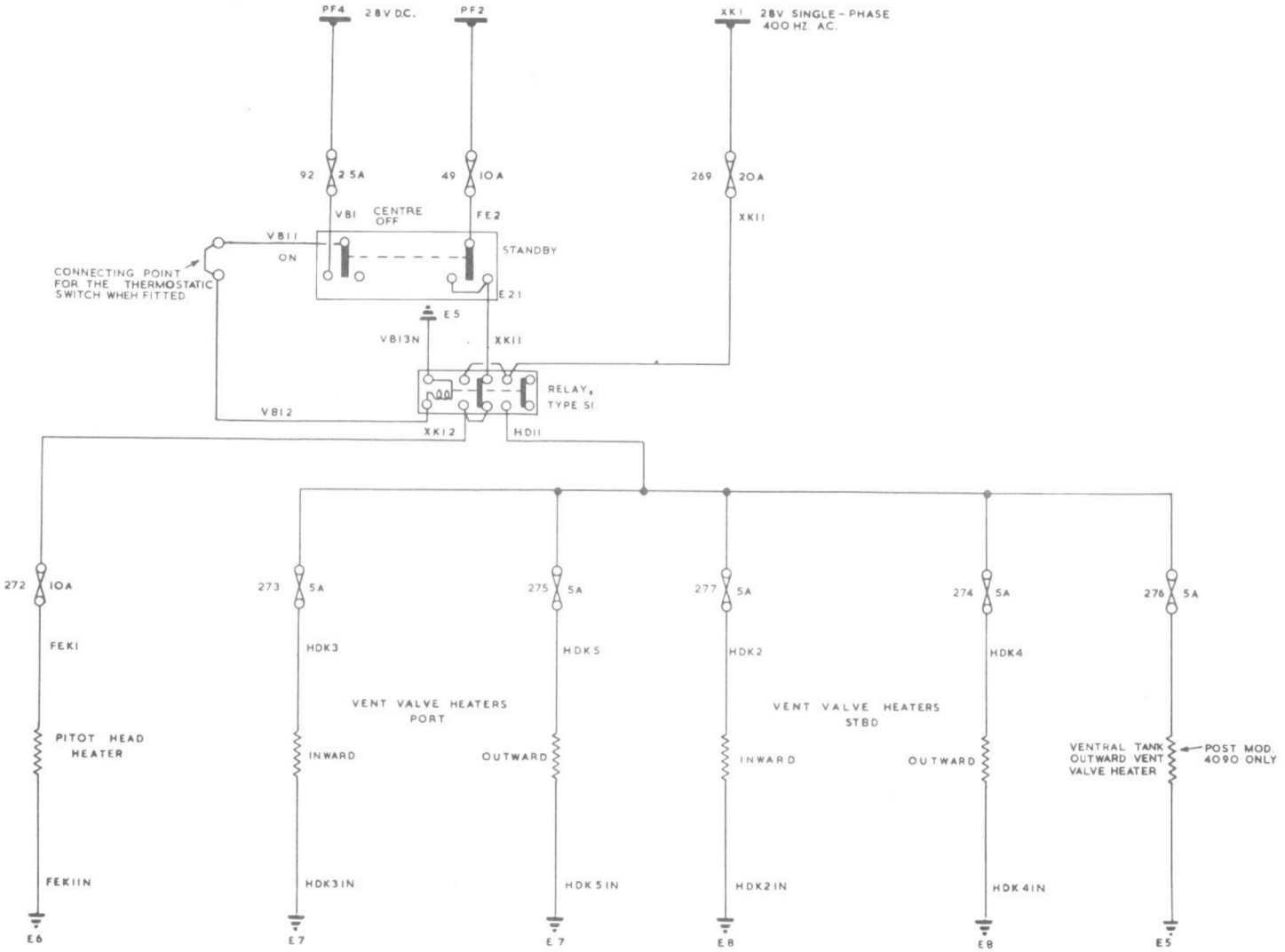

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FIG. 2. PITOT HEAD AND VENT VALVE HEATING

◀MOD. 4090 EMBODIED▶

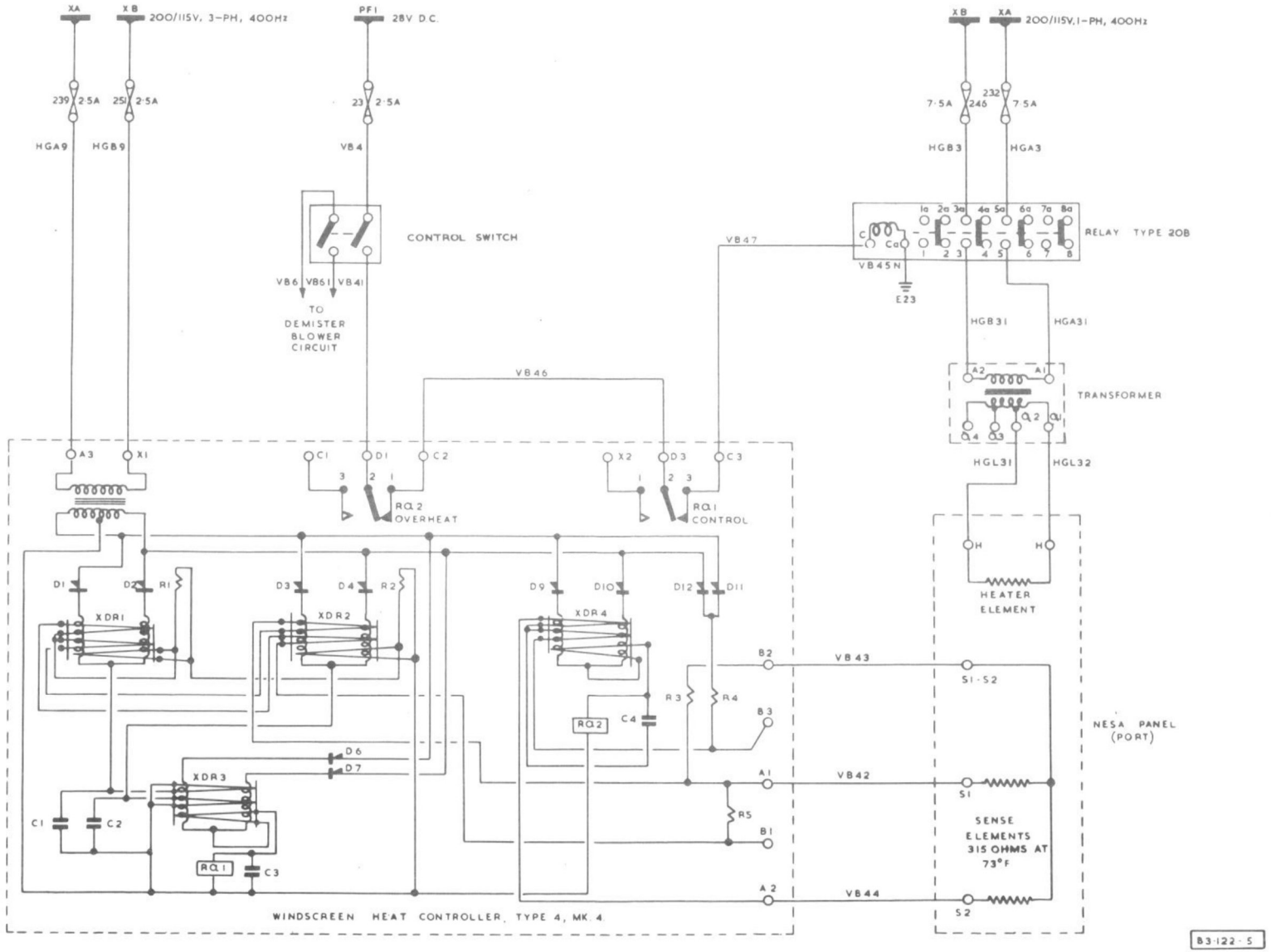

FIG. 3. PORT WINDSCREEN HEATING

◄ MINOR AMENDMENTS ►

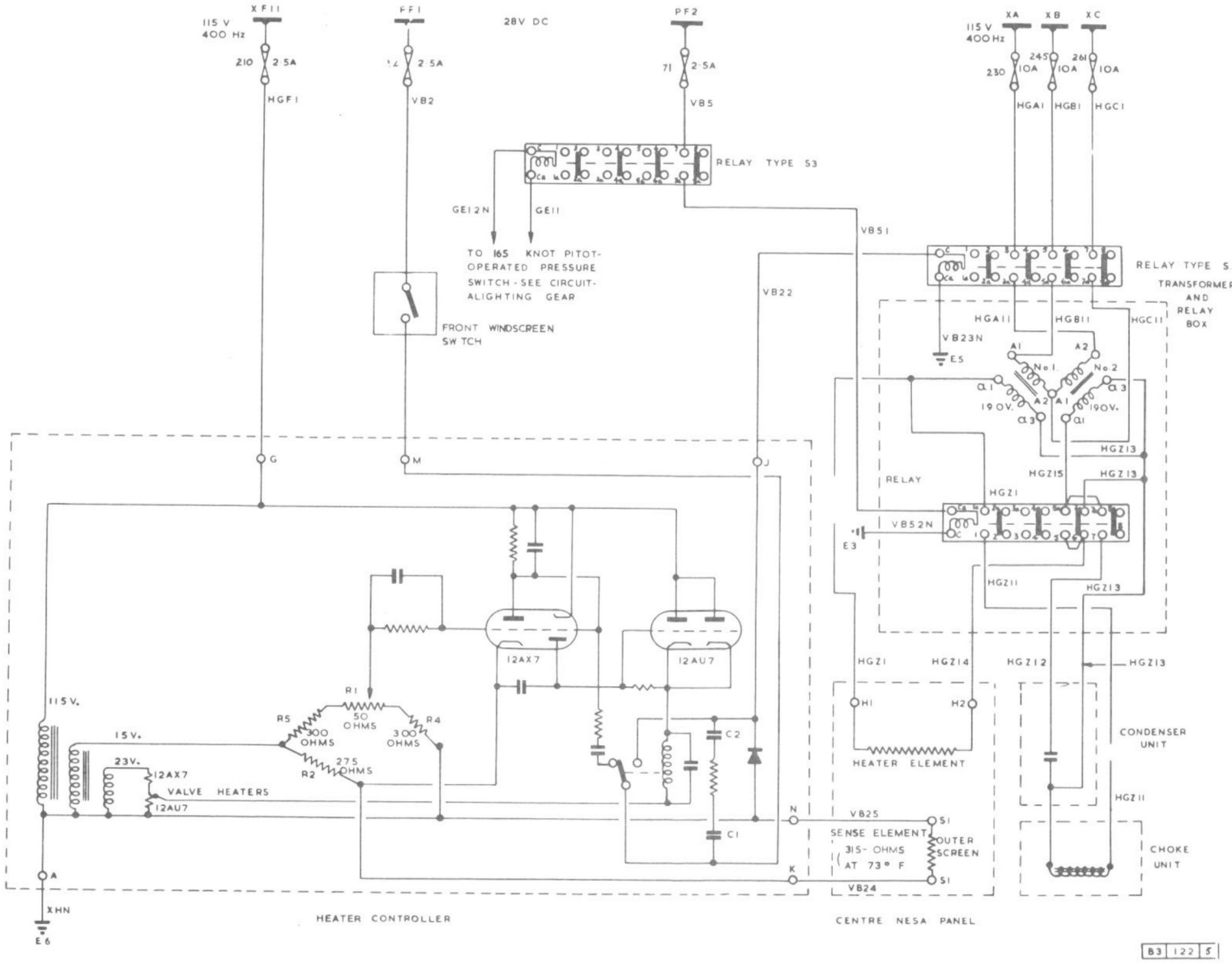

FIG. 4 CENTRE WINDSCREEN HEATING

◀ MOD. 4398 EMBODIED ▶

is primarily controlled by the FRONT WINDSCREEN switch on the starboard console. The panel incorporates a heating element which is supplied from the a.c. system. The panel temperature is automatically regulated by a Type AVE 205 control unit which operates in conjunction with a sensing element fitted between the outer laminae of the panel. To obviate the risk of damaging the panel by over-rapid heating, the control system automatically prevents the application of full voltage to the heating element when the aircraft is on the ground.

Heater supply

10. The heater supply circuit includes two 200/190-volt single-phase transformers which are connected to the a.c. distribution system via a Type S3 relay in the a.c. fuse and relay box. The relay is automatically controlled by the temperature control unit. The secondary windings of the transformers are connected in series to provide output voltages of 190 volts and 330 volts for half and full heating respectively. The appropriate voltage is primarily selected by a Type S3 relay, fitted in the d.c. relay box, which is controlled by the ◀ 165-knot pitot pressure switch associated with the alighting-gear circuit. The operation of the relay is arranged to control a Type 20B relay in the transformer and relay box. When the Type 20B relay is de-energized, the heating element is connected to the output of one transformer only, i.e. to the 190-volt supply. At airspeeds above 165 knots, ▶ both relays are energized and closed and the resultant output voltage from both transformers is applied to the element. Closing of the Type 20B relay also connects a choke and a capacitor unit across the respective secondary windings of the transformers. With these components in the circuit the resultant loading on the three-phase system is approximately balanced. The Type 20B relay and the transformers are fitted in a box situated forward of the instrument flying panel whilst the choke and the capacitor unit are mounted at the forward end of the starboard console.

Temperature control unit

11. The Type AVE 205 temperature control unit, installed in the forward equipment compartment, comprises a valve amplifier, a supply transformer, a sensitive relay, and an a.c. bridge circuit. A variable resistor and a number of fixed resistors form three arms of the bridge, and the temperature sensing element completes the circuit. The variable resistor provides the means of presetting the temperature level. The amplifier section of the control unit is energized from the 115-volt a.c. system while the circuit controlled by the integral relay receives a 28-volt d.c. supply via the control switch. As the windscreen temperature falls below the preset level, the resistance of the sensing element decreases and the bridge becomes unbalanced. The resulting voltage differential across the bridge causes the current through the output valve of the amplifier to increase and as the solenoid of the sensitivity relay is in the cathode circuit of this valve, the relay closes to a certain output amplitude and extends the 28-volt supply to the solenoid of the Type S3 relay. The latter, on closing, connects the 200-volt a.c. supply to the heater transformers. When the windscreen temperature rises to the pre-determined level, the sensitive relay drops out, tripping the Type S3 relay and cutting off the heater supply.

DE-ICING

Ice warning

General

12. Warning of icing in the engine air intake duct is given by an indicator lamp on the starboard console. The indicator is controlled by an ice warning switch unit, a moisture sensing head, and a thermal switch.

Ice warning switch unit

13. This is a Type PAG/A/5 unit installed near frame 5 in the forward equipment bay. Its main components are two miniature relays and a resistance network which constitutes a bridge system.

Mositure sensing head

14. The Type PBA/A/5 sensing head is mounted between frames 12 and 13 in the air intake duct. The head incorporates a number of heating elements, and two sensing elements which convert the temperature difference between moist and dry air into an electrical voltage which controls the ice warning switch unit and subsequently the ice warning lamp. Post Mod. 2140 a Type PBA/A/7 sensing head is fitted.

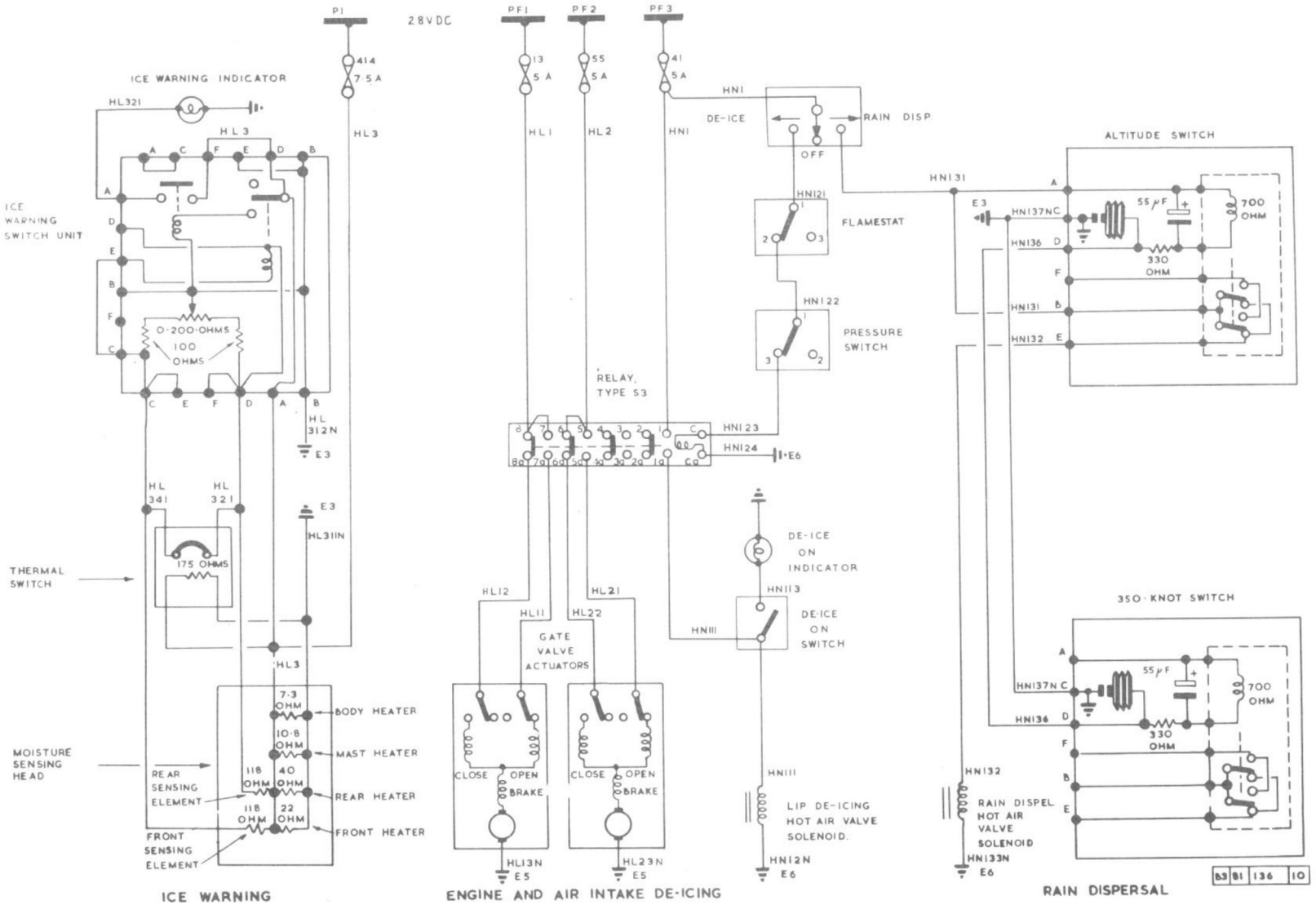

FIG. 5. DE - ICING - ICE WARNING - RAIN DISPERSAL

Thermal switch

15. This switch, a Type PBB/A/9, is fitted adjacent to the moisture sensing head in the intake duct. The switch is connected across the two sensing elements in the moisture sensing head. When the temperature in the duct is above that required to cause icing, the switch is closed and the sensing elements are shorted out, making the ice warning system inoperative. When the temperature drops in icing conditions the thermal switch opens and the moisture sensing head functions normally with the indicator circuit.

Power supply

16. The ice warning circuit operates from a d.c. supply which is not switched but fed direct from a fuse in the d.c. compartment between frames 52 and 53.

Engine and air intake de-icing

General

17. Under icing conditions the engines and the air intake duct lip are protected by a de-icing system which utilizes hot air fed from the engine compressor stages. The system is initially controlled by a three-position centre-off switch on the starboard console. The switch is marked RAIN DISP-OFF-DE-ICE and operates in conjunction with a Type S3 relay in the d.c. relay box. The other main components in the installation are two electrically-actuated gate valves fitted one on each engine, which control the hot air supply from the engine compressors, and a pressure switch near frame 5 and a flamestat near frame 6, in the front fuselage. In addition, a solenoid-operated valve which controls the hot air supply to the nose intake lip is installed near frame 7 at the port side in the fuselage.

De-icing indicator

18. Indication that the de-icing system is operating is given by a DE-ICE 'ON' indicator lamp on the starboard console. The lamp is controlled by a switch which is actuated by movement of the intake de-icing solenoid valve.

Operation

19. When the control switch is selected to DE-ICE the Type S3 relay is energized to close so that the gate valves and the solenoid valve operate to the 'open' position. Opening of the solenoid valve operates the indicator switch and the indicator lamp shows that the de-icing system is in operation. The pressure switch and the flamestat are connected in series with the control switch and the relay, and should their contacts open due to excess pressure or temperature, respectively, the relay is de-energized and the gate valves close to cut off the hot air supply.

RAIN DISPERSAL

General

20. The rain dispersal installation ensures that the windscreen is kept clear in heavy rain during low flying or landing. The system operates by blowing hot air over the windscreen when necessary. The main items of the installation are the RAIN DISP-DE-ICE switch on the starboard console, and an altitude switch and a 350-knot pressure switch near the lower starboard gun blast panel at frame 4A. Both the altitude switch and the 350-knot switch contain a sensing element and a relay. The circuit is arranged to control a solenoid-actuated hot air valve between frames 8 and 9, port.

Operation

21. Provided that the aircraft altitude is under 10,000 ft and the airspeed below 350 knots the system is operative after selecting the control switch to RAIN DISP. At altitudes above 10,000 ft the altitude switch sense element contacts close to energize its integral relay. This breaks the supply to the solenoid of the valve which closes, cutting off the air supply. The solenoid valve will also be closed at speeds over 350 knots by operation of the 350-knots switch whose contacts are in parallel with those of the altitude switch.

▶ ◀

AIR CONDITIONING

General

22. The cockpit is pressurized and heated by air bled from the engine compressors. The air is ducted via a common pipeline to a temperature control valve, whence it passes to the cockpit directly or via a pre-cooler. The cockpit temperature varies in accordance with the apportionment of air to the two paths, and this, in turn, is determined by the setting of the valve. Pressurization of the cockpit is maintained by a pressure controller located on the side of the port console. Further details of the air conditioning system are given in Sect.3, Chap.8B.

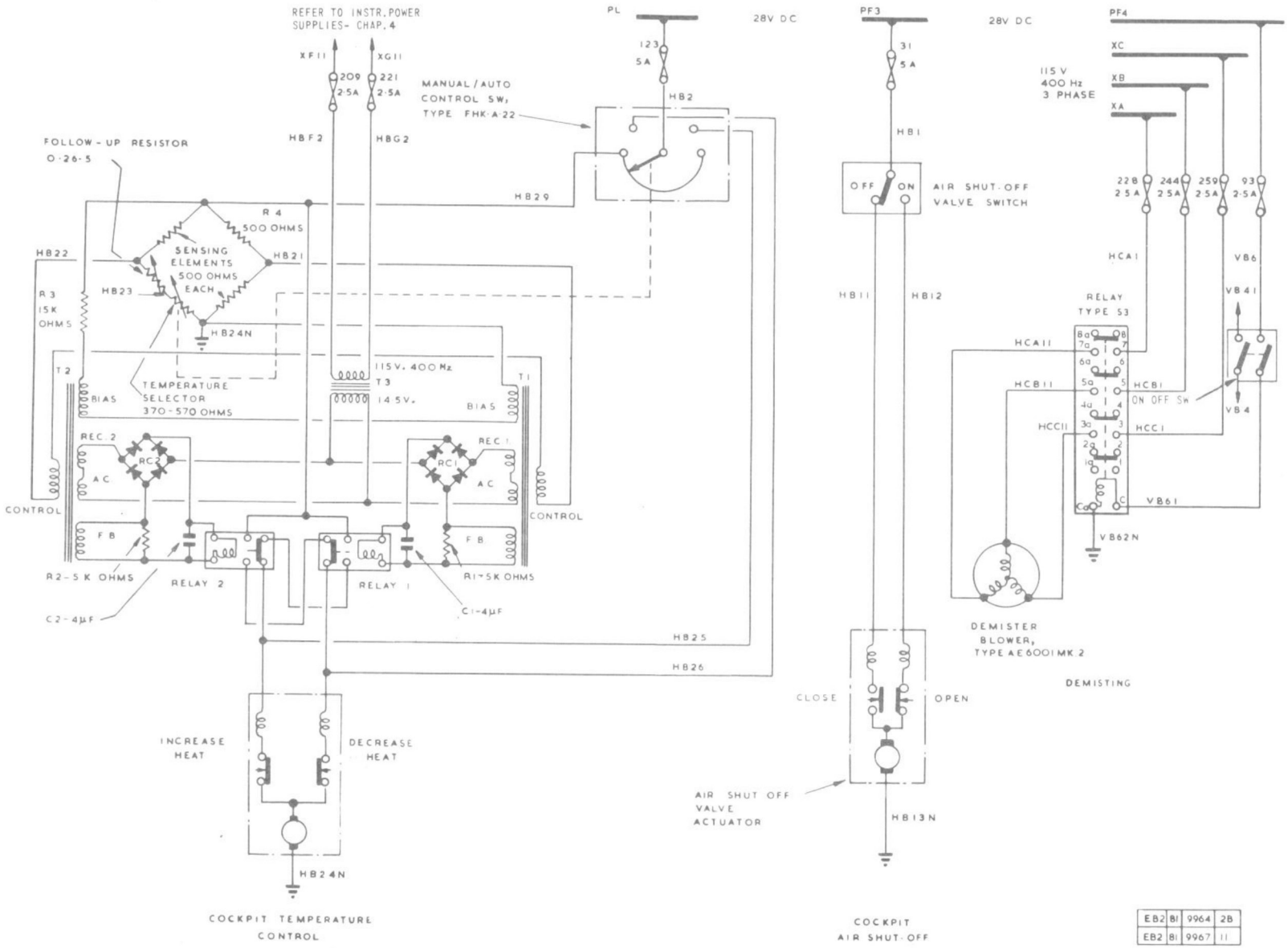

FIG.6. AIR CONDITIONING - CANOPY DE-MISTING

◀MINOR AMENDMENTS▶

Cockpit temperature control

◀ 23. The Type FOZ/A/7 temperature control valve is installed in the starboard section of the main equipment compartment. It is electrically actuated, and the associated circuit provides for both manual and automatic control. Post Mod. 2539 a Type FOZ/A/5019 temperature control valve is fitted. A Type FHK-A-22 ▶ switch unit, labelled CABIN AIR TEMP., MANUAL/AUTO, is fitted on the starboard console. This combined switch and rheostat is operated by a single control knob attached to a common drive spindle.

Manual control

24. When the control switch is operated in the MANUAL sector, its action is similar to that of a 3-position spring-loaded rotary switch. The central (off) position is labelled FIXED, and the two remaining positions are labelled WARM and COOL. respectively. Selecting either of the latter positions connects a supply direct to the relevant winding of the valve actuator; thus, by appropriate movement of the switch, the cockpit temperature may be adjusted to the required level. When the switch is released, it returns automatically to the FIXED position.

Automatic control

25. Turning the knob of the switch unit into the AUTO sector overrides the spring loading and energizes the automatic control circuit. The switch unit then functions as a rheostat and is used for adjusting the level of the temperature control datum. In this mode of operation the valve actuator is controlled by a pair of relays incorporated in a magnetic amplifier unit, situated in the main equipment compartment. The amplifier comprises two transductors, a 115/14.5-volt transformer from which the transductor output circuits are supplied, and two bridge rectifiers. A polarizing supply is fed to the bias windings of the transductors via the control switch and a 15,000-ohm resistor. The relays are operated by rectified output signals from the respective transductors, and their contacts are so connected that both windings of the valve actuator cannot be energized simultaneously. Input signals are supplied to the amplifiers from a resistance bridge circuit. Two opposite arms of the bridge are temperature-sensitive, each consisting of a Type FHG/A/35 sensing element having a nominal resistance of 500 ohms. One is fitted in the starboard air inlet pipe, the other at the end of the air outlet pipe in the forward equipment compartment. The control windings of the transductors are connected in series-opposition across the bridge, and when the latter becomes unbalanced due to a change of temperature, the resulting current flowing through the control windings has the effect of increasing the output of one transductor and suppressing that of the other, depending upon the direction of the out-of-balance current. If the temperature change is of sufficient magnitude, the relevant relay closes, and the valve actuator moves in the appropriate direction to compensate for the temperature change. A variable 'follow-up' resistor, mechanically linked to the valve, is included in the bridge circuit; and as the valve moves, the resistance is varied until the bridge is rebalanced. The actuator is then de-energized and the valve will remain stationary until a further temperature change unbalances the bridge again. Since the rheostat incorporated in the switch unit is connected in series with the follow-up resistor, adjustment of the rheostat alters the balance datum with respect to the valve position and, in consequence, varies the temperature level. To stabilize the control system and so prevent hunting of the valve about the preselected setting, each transductor is fitted with a feed-back winding which is magnetically opposed to the control winding and connected across a 5000-ohm resistor in series with the solenoid of the associated relay. The flux due to the feed-back winding is, therefore, proportional to the output current of the transductor.

Air shut-off valve

26. An actuator-operated shut-off valve, included in the hot-air supply line from the engines, is fitted on the forward face of frame 25, at the starboard side of the front fuselage. The actuator is controlled by a Type 8810/B104 switch, labelled CABIN AIR, on the starboard console.

Low pressure warning

27. In the event of a serious loss of cockpit pressure a switch in the pressure controller closes automatically and connects an energizing supply to the relevant warning circuit of the standard warning system.

Canopy de-misting

28. A motor-driven blower Type AE.6001 Mk.2 installed in the main equipment compartment maintains a constant supply of dry air between the inner and outer skins of the canopy. The motor is supplied from the 200-volt, 3-phase system via a Type S3 relay which is controlled by a double-pole switch, also associated with the control circuit for the port windscreen heater.

SERVICING

◀ **WARNING**

The relevant safety precautions detailed on the LETHAL WARNING marker card must always be observed before entering the cockpit or performing any operations upon the aircraft. ▶

FUNCTIONAL TESTS

Windscreen temperature control systems

Note...

In addition to the normal operation tests and continuity checks, the following tests should be made at the intervals laid down in A.P.101B-1001, Vol.5, or whenever any major component in the system has been repaired or renewed.

Port windscreen panel

29. *Test procedure*

Equipment required:-

Testmeter (set to 10,000-ohm range)

Two decade boxes of at least 400-ohm internal resistance

A.C. voltmeter (0-400 volts)

(1) Measure resistance of sensing elements, using a high-impedance meter to avoid self-heating of the elements. The resistance of these should be 305-315 ohms at 68 deg F.

(2) Measure resistance of heater element and ensure that it is connected to correct terminal on supply transformer as follows:-

Heater resistance	Transformer terminal
68-76 ohms	a2
76-84 ohms	a3
84-92 ohms	a4

Terminal a1 is common to all three connections.

(3) Disconnect panel leads from windscreen heating T.B. i.e., VB42, VB43, VB44, HGL31 and HGL32.

(4) Connect voltmeter to leads HGL31 and HGL32, connect two decade boxes in place of sensing elements, one between VB42 and VB43 (No.1 decade box) and the other, (No.2 decade box) between VB43 and VB44. Set each box tc 400 ohms.

(5) With d.c. and a.c. power available select SIDE WINDSCREEN switch to ON. There should be no reading on voltmeter.

(6) Reduce the resistance of both decade boxes to 300 ohms and switch the heater on. The voltmeter should read between 275 and 320 depending on the transformer tapping used (this should be marked alongside the heater terminals on the windscreen).

(7) Slowly increase resistance of No.1 decade box until the voltmeter reading falls to zero. This should occur between 337 and 340 ohms.

(8) Decrease resistance of No.1 decade box until voltage is again indicated on voltmeter. This should occur within 4 ohms of the value obtained in test (7).

(9) Reduce value of No.1 decade box to 300 ohms.

(10) Slowly increase the resistance of No.2 decade box until the voltmeter reading falls to zero. This should occur between 350 and 370 ohms.

(11) Decrease the resistance of No.2 decade box until the voltage is again shown on the voltmeter. This should occur within 24 ohms of the value obtained in test (10).

(12) Switch off d.c. and a.c. power supplies. Remove decade boxes and reconnect panel leads VB42, VB43, VB44, HGL31 and HGL32 at terminal block. The voltmeter should be left connected to HGL31 and HGL32 and the sensing elements connected in the circuit in the normal manner.

(13) Switch on the d.c. and a.c. power

supplies. The voltmeter should read 260, 275 or 290 volts depending on whether connection a2, a3 or a4 is used on the transformer. When the panel operating temperature is reached the heater should be then controlled automatically by the controller unit.

(14) On the conclusion of the tests remove the voltmeter, disconnect all power supplies, and recheck all connections which have been broken down.

Centre windscreen panel

30. *Test procedure*

Equipment required:-

Testmeter (set to 10,000 ohms range)

Decade resistance box (0-400 ohms)

A.C. voltmeter (0-400 volts)

Thermometer (0-100 deg C)

(1) Disconnect the leads referenced VB24, VB25, HGZ1, and HGZ14 at the 10-way terminal block below the windscreen panel.

(2) Connect the decade resistance box to VB24 and VB25, and set the resistance to 300 ohms.

(3) Connect the a.c. voltmeter to HGZ1 and HGZ14.

(4) Connect d.c. and a.c. ground supplies.

(5) With the ohmeter set to the 10,000 ohms range, measure the resistance of the sensing element. This should be 310 ± 5 ohms at 20 deg C (68 deg F). If the resistance is not within the above tolerance limits, the spare sensing element (if serviceable) should be brought into use when the panel leads are reconnected at operation 10 of this schedule.

(6) Set the instrument master switch to ON; then, after 30 seconds, set the FRONT WINDSCREEN switch to ON. The voltmeter should register approximately 190 volts.

(7) Slowly increase the setting of the decade resistance box, and note the resistance value when the voltmeter pointer drops to zero. This should occur at a resistance setting between 350 and 352 ohms. Slowly decrease the setting of the decade resistance box and note the resistance value when the voltmeter again registers approximately 190 volts. The resistance-differential between 'cut out' and 'cut in' should be between 4 and 10 ohms. The operating points of the Type AVE 205 control unit can be varied by adjusting the potentiometer on the front cover of the unit. Access to this is achieved by removing an acorn nut which should be locked with new locking wire after refitting. Variation of the potentiometer setting may also effect the resistance-differential between the operating points. If the 'cut in' level and/or resistance-differential cannot be adjusted to the specified values, the control unit should be renewed.

(8) Pressurize the pitot system until the A.S.I. registers approximately 175 knots. With the decade resistance box at the cut in setting, the voltmeter should register approximately 350 volts.

(9) Set the FRONT WINDSCREEN switch and the instrument master switch to OFF.

(10) Disconnect the decade resistance box and the voltmeter, and reconnect the panel leads at the 10-way terminal block.

(11) Connect the voltmeter in parallel with the heating element, and attach a thermometer to the outside of the windscreen at the approximate centre of the heated area.

(12) Set the FRONT WINDSCREEN switch and the instrument master switch to ON.

(13) Check that the control unit automatically switches the heater supply 'on' and 'off' to control the windscreen temperature at approximately 50 deg C (122 deg F).

Note...

During the first few operational cycles, the windscreen temperature may rise above 50 deg C (122 deg F) but should not be allowed to exceed 60 deg C (140 deg F).

(14) Set the FRONT WINDSCREEN switch and the instrument master switch to OFF.

(15) Disconnect the voltmeter and remove the thermometer.

(16) Disconnect the pressure rig from the pitot system.

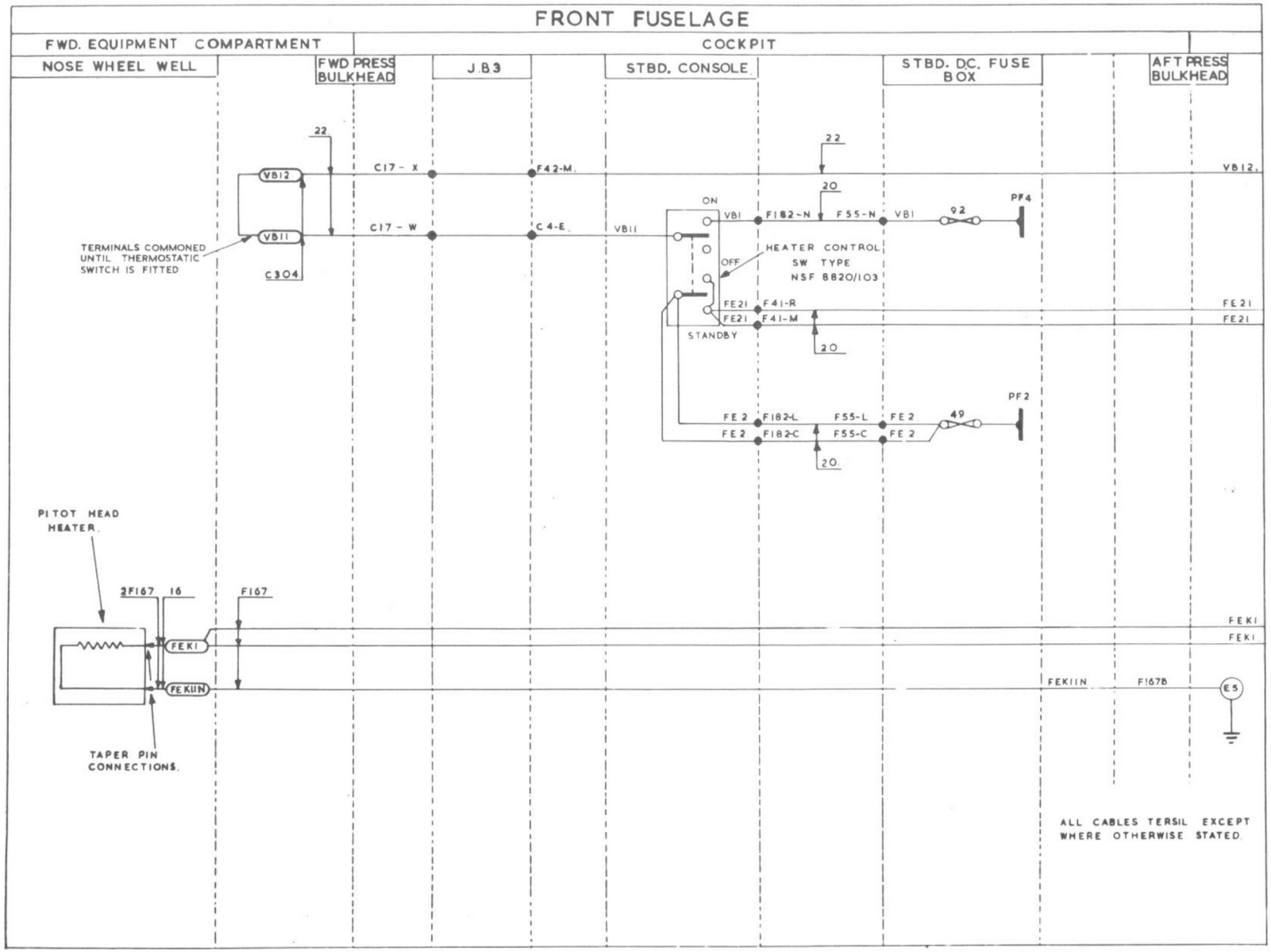

FIG. 7. PITOT HEAD AND VENT VALVE HEATING

◀ MOD. 4090 EMBODIED ▶

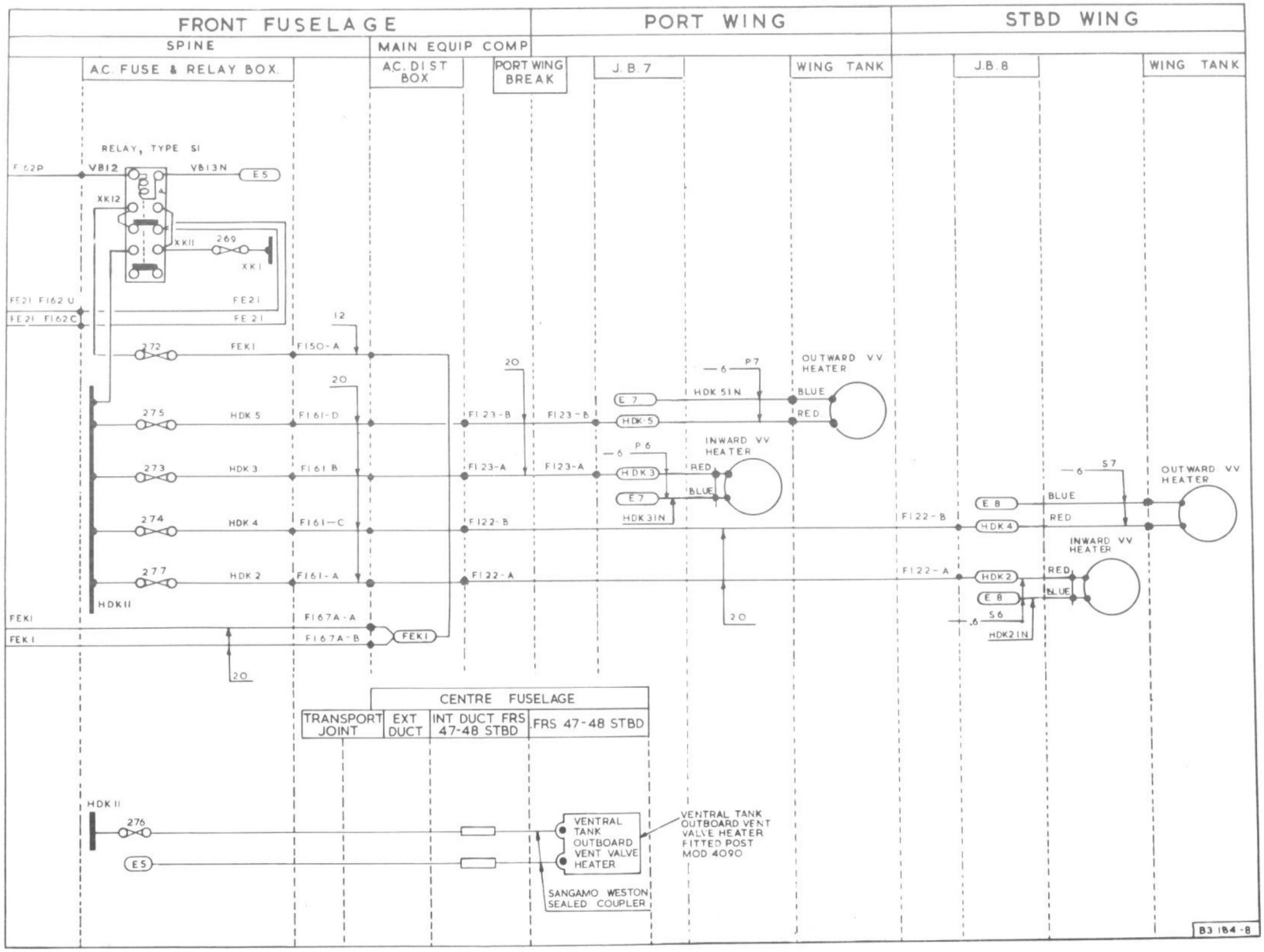

FIG. 7A. PITOT HEAD AND VENT VALVE HEATING

◀ MOD 4090 EMBODIED ▶

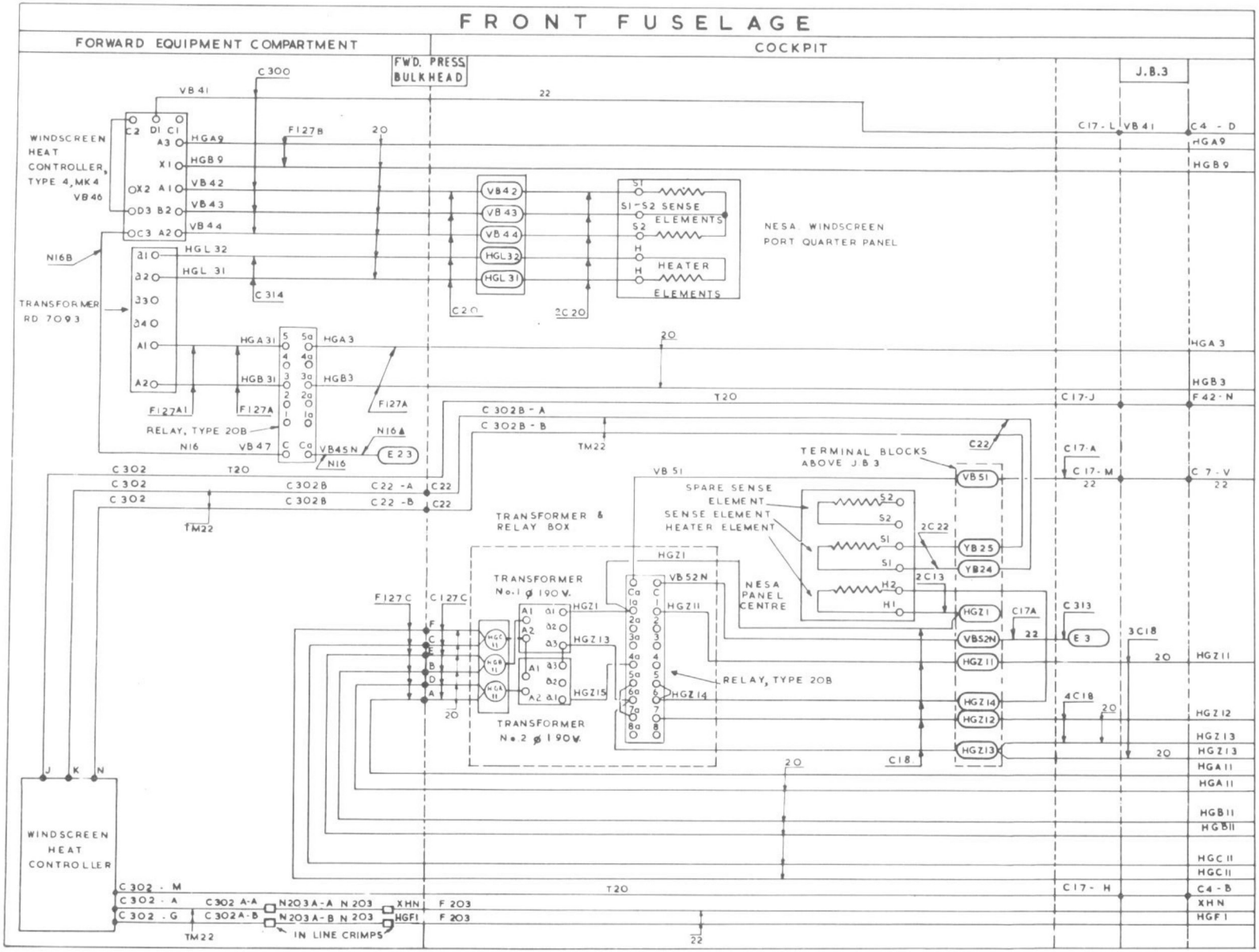

FIG.8. WINDSCREEN HEATING

◀ MINOR AMENDMENTS ▶

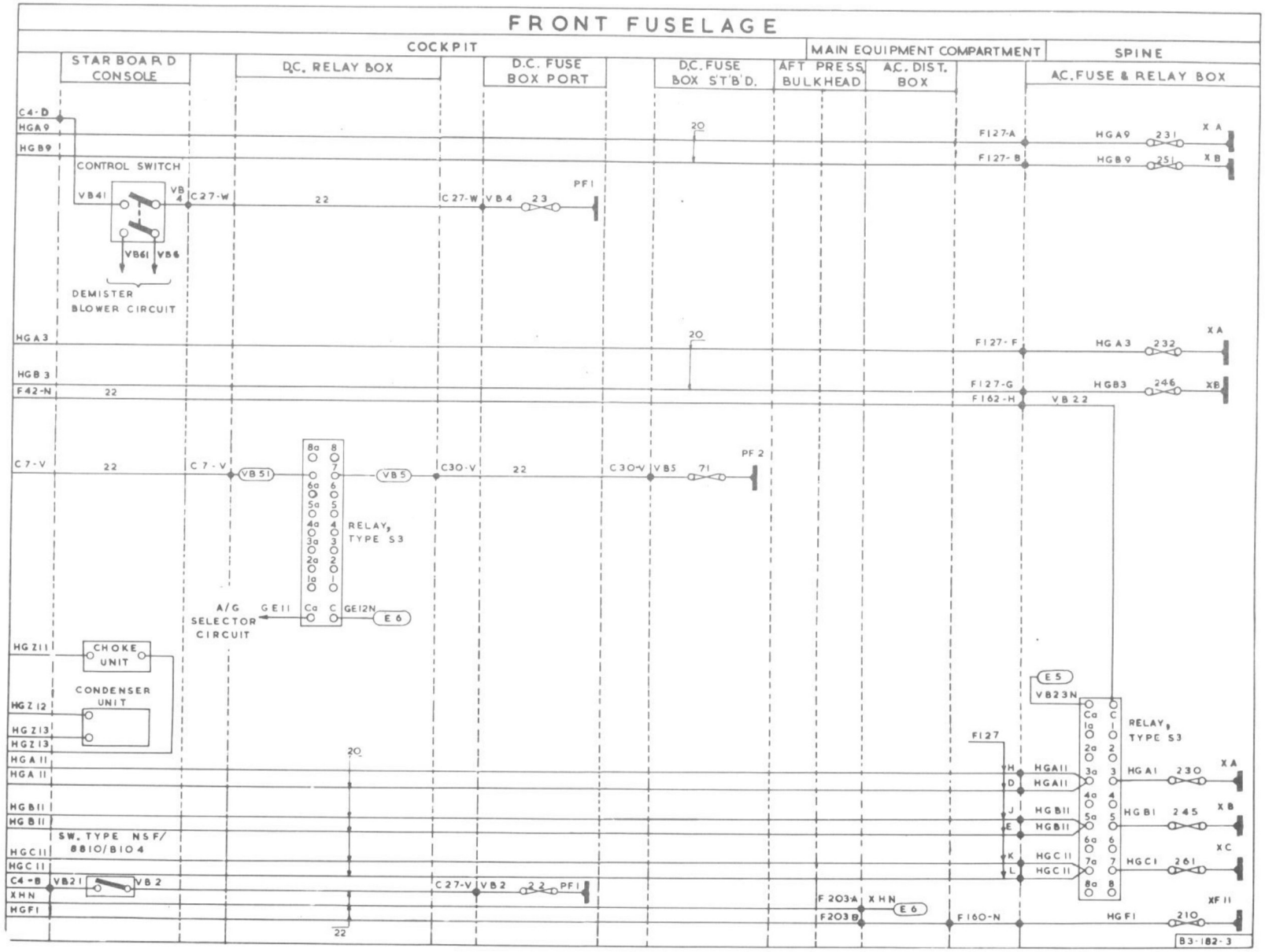

FIG.8A. WINDSCREEN HEATING

◀ MINOR AMENDMENTS ▶

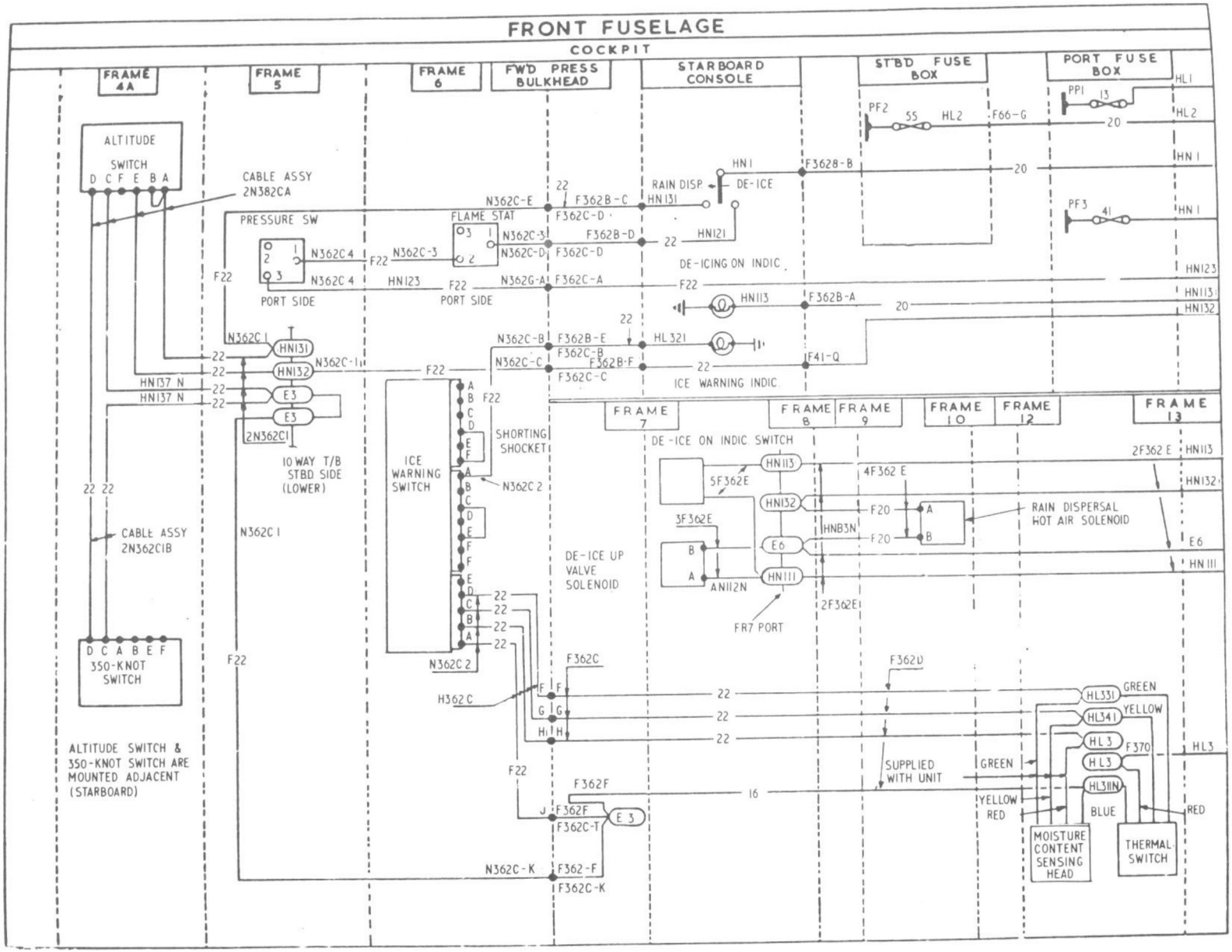

FIG. 9. DE-ICING-ICE WARNING-RAIN DISPERSAL

◀ MINOR AMENDMENTS ▶

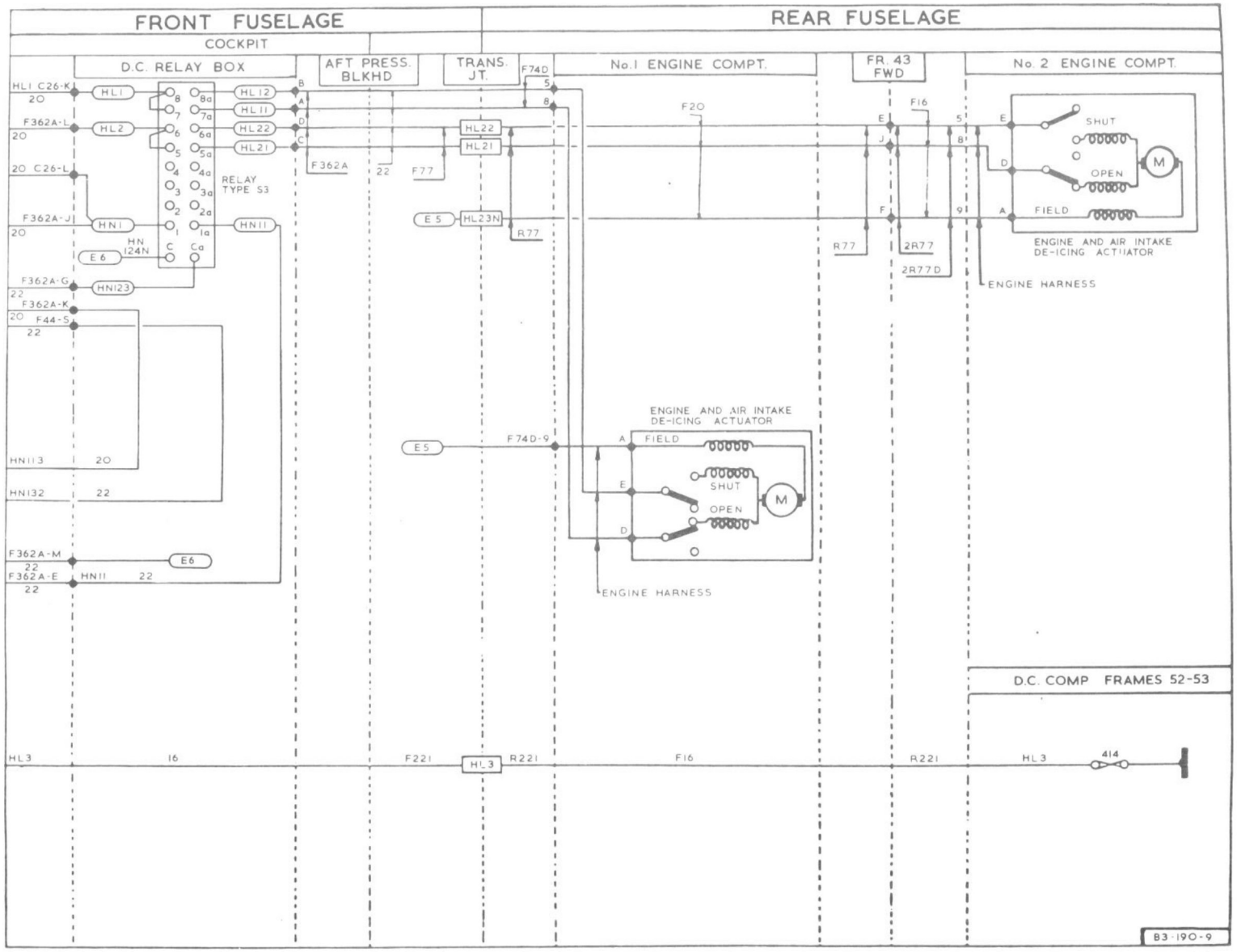

FIG.9A. DE-ICING - ICE WARNING - RAIN DISPERSAL

◀ MINOR AMENDMENTS ▶

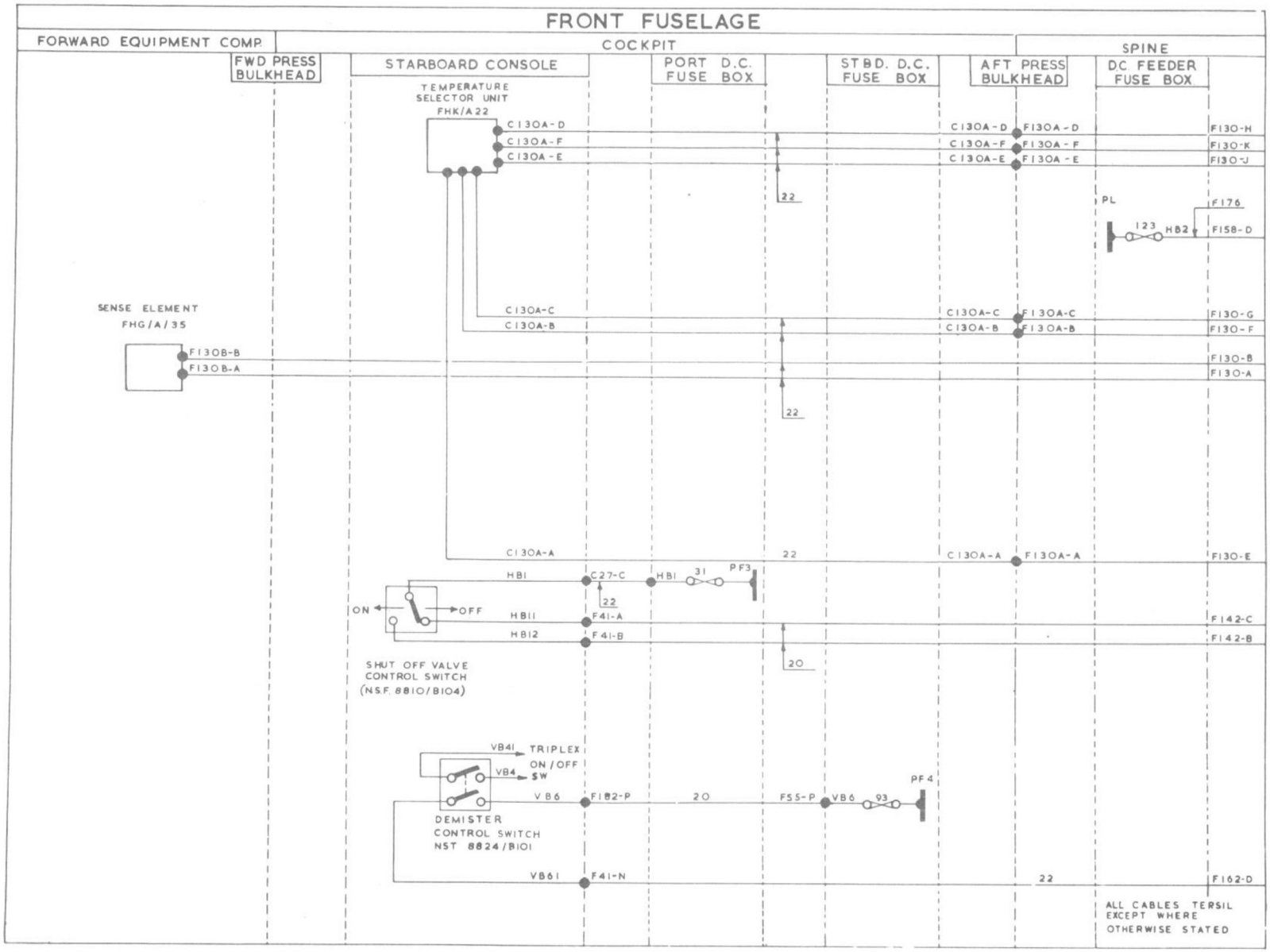

FIG.10. AIR CONDITIONING - CANOPY DE-MISTING

◀ MINOR AMENDMENTS ▶

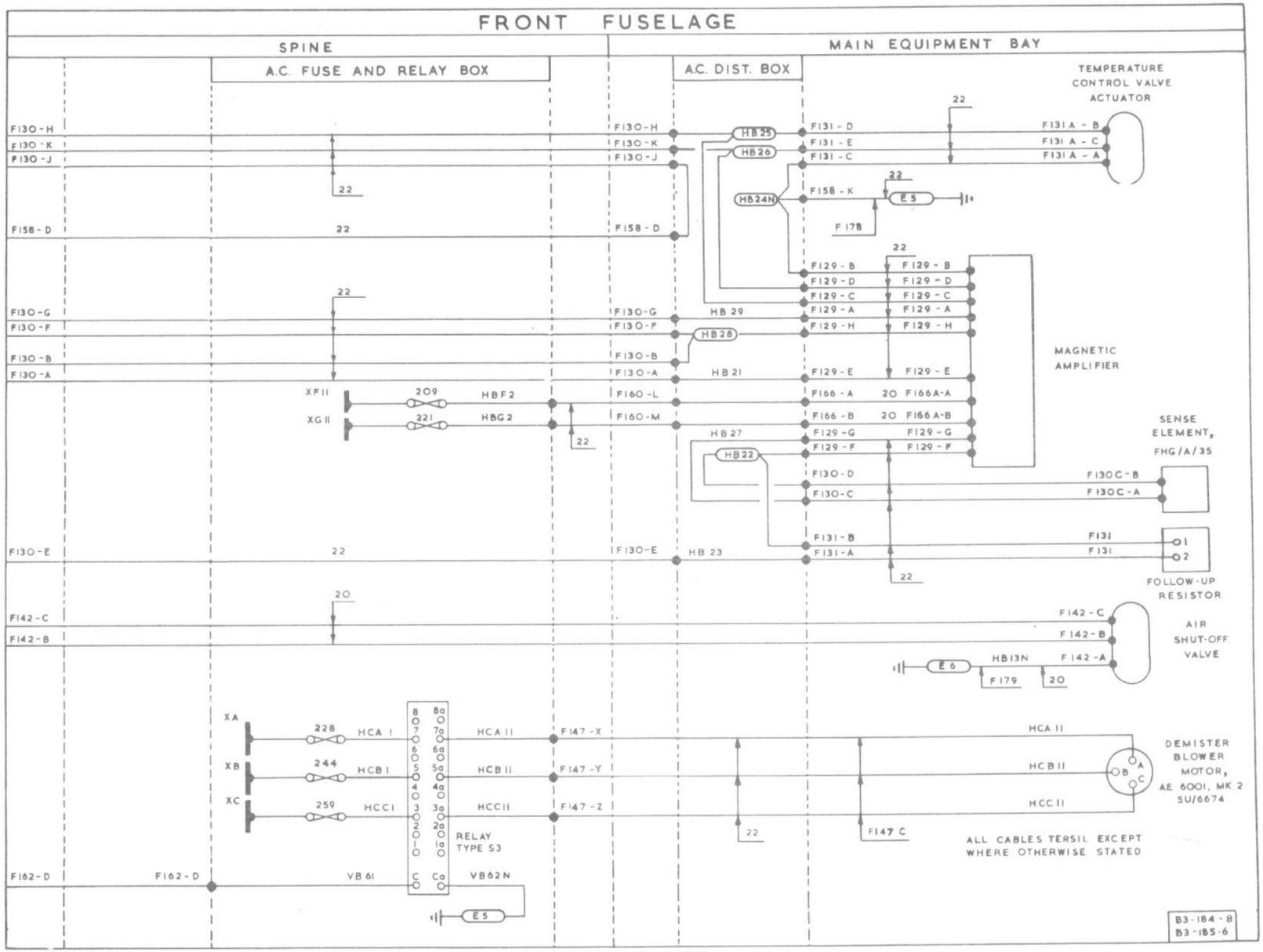

FIG.10A. AIR CONDITIONING - CANOPY DE-MISTING

◀ MINOR AMENDMENTS ▶