

Chapter 9 D.C. POWER SUPPLY SYSTEM

(completely revised)

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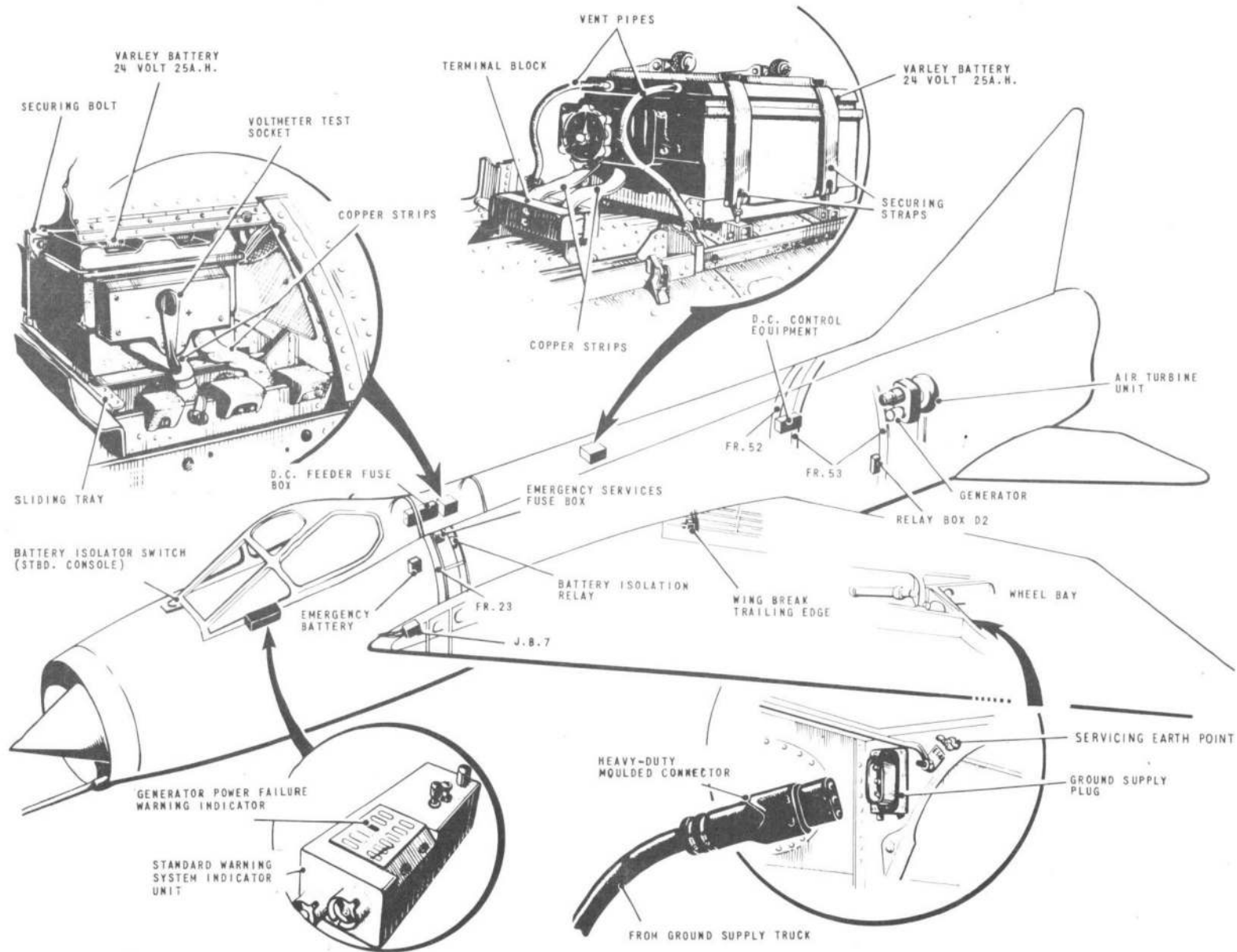


FIG. 1. D.C. POWER SUPPLY EQUIPMENT

DESCRIPTION

This chapter now includes the following modifications:-

- Mod. 4572 To introduce control and protection units Type AE 7023/2, Ref.No.5UC/9764 in lieu of control and protection unit Type AE 7023, Mk.1, Ref.No.5UC/4396014.
- Mod.4586 To effect standardization of the wiring of the d.c. generator test socket.

General

1. The d.c. power supply is provided by a brushless generator driven by an air turbine, housed in the rear fuselage between frames 53 and 55. The turbine operates from an automatically-controlled air supply fed from the engine compressors. In addition to the generator, the main components comprising the installation are a control and protection unit, a field isolating relay, a current sensing unit, and a generator reset switch. Most of the control equipment, and also a generator test socket, are located in the d.c. compartment between frames 52 and 53 at the starboard side in the rear fuselage. Two 24-volt main batteries, connected in parallel, are maintained in a charged condition by the generator and provide a stand-by supply should the generator system fail. If both generator and battery supply fail, an emergency battery of small capacity can be switched into circuit to operate emergency lighting.

For servicing, a ground supply may be connected through a socket in the port wheel well.

D.C. generator

2. The Type AE.2519 brushless generator is basically a three-stage a.c. unit incorporating integral rectifiers, and which provides a controlled rectified d.c. output of 200 amp at 28 volts (nominal). The generator is cooled by blast air from an intake at the base of the fin.

3. The voltage developed in the generator first stage by a permanent magnet exciter, circuit P1-P2-P3, is fed into the power supply module and the voltage regulator in the control and protection unit. The resultant output is fed back into the field circuit M1-M2 to excite the second-stage three-phase rotor. The output from the latter is then rectified by rectifiers integral with the rotor, and the outgoing d.c. supply energizes the third-stage rotating field used to excite the final five-phase stator. The five output phases are connected to a full-wave rectifier bridge and associated smoothing capacitors installed in the generator unit. The resultant d.c. output negative is earthed to the airframe whilst the positive is fed, via the current sensing unit coil and the main fuse, to busbar PL.

Control and protection unit

4. Voltage control and circuit protection of the d.c. power supply is provided by a Type AE 7023/2 control and

protection unit in which voltage regulation, under and overvoltage sensing and other functions are carried out by separate circuit modules embodied in the unit. The generator output is normally controlled at 28-volts \pm 0.5 volt. The overvoltage circuit will cause the generator to shut down if its output rises above 30.5-volts \pm 0.5-volt, whilst the undervoltage circuit will cause generator shut-down should the output fall below 25.5-volts \pm 0.5-volt at normal turbine speed.

Field isolating relay

5. The connection between the generator secondary field circuit M1-M2 and the control and protection unit is through the normally-closed contacts of a relay, Ref.No.7CZ/107791, housed in the D2 relay box. Should the relay operate and open the field circuit, the generator will close down immediately. The relay is energized by undervolting at normal speed or overvolting of the system at any speed, both of which will cause the control unit overvoltage latch relay to close, or by closing of the crash relay by operation of the inertia switches if they should be tripped in a heavy landing.

Current sensing unit

6. Indication of main generator failure is controlled initially by a Type F8101 current sensing unit in the d.c. compartment. The unit consists mainly of a heavy current coil and contacts which are opened and closed by the amount of current passing through the coil, which is connected in the main generator

positive line. The contacts of the relay open when the current through the coil rises to between 15 and 25 amp and close when the flow falls to between 10 and 5 amp.

Generator reset switch

7. In the event of the generator going off-line as a result of under or over-volting conditions which may be transient, it may be possible to bring the generator back on line by pressing the generator reset switch fitted above the standard warning panel at the port side of the cockpit.

Generator test socket

8. A three-pin socket for use when making checks on the main generator system is located on the aft face of frame 52 in the d.c. compartment. The voltage measured at the socket is that which appears at terminal R5 (voltage-sensing terminal) of the voltage regulator in the control and protection unit.

Ground supply

9. The ground supply connection to the aircraft is provided via a plug located in the port wheel well. The circuit includes a Type T100B relay, fitted in the port side of the main equipment compartment. Connection of a ground supply socket energizes the relay, thus feeding the main busbar. The relay opens when the socket is removed. During alighting gear retraction tests the normal ground supply socket cannot be used, therefore an alternative method for connecting the ground supply is

provided by an extension cable (*Chap. 1*) which connects to the aircraft main battery connector. Use of this cable avoids the necessity of frequent replacement of discharged aircraft batteries during prolonged alighting gear tests and adjustments.

Main batteries

10. Two 24-volt, 25Ah Varley batteries are mounted in trays, one in the forward spine compartment and the other at the port side of No.2 engine hatch. Each battery is vented to atmosphere through pipelines which terminate at the fuselage skin. Electrical connection to each battery is made through a plug and socket assembly on the side of the

battery, the forward battery connector having a built in test socket for checking battery voltage during servicing. An alternative method for checking battery voltage is provided by connecting the battery test extension cable, Ref.No.10HG/2143 (*fig.5*), to the telebriefing socket, in the starboard wheel well, and connecting a voltmeter to the terminal ends. The batteries are connected to the main busbar PL through a Type R relay controlled by the BATTERY isolation switch. In the event of a crash landing and the subsequent operation of the inertia switches, the relay will open and isolate the batteries from all circuits except the fire extinguishers, canopy control, and certain armament releases. The battery

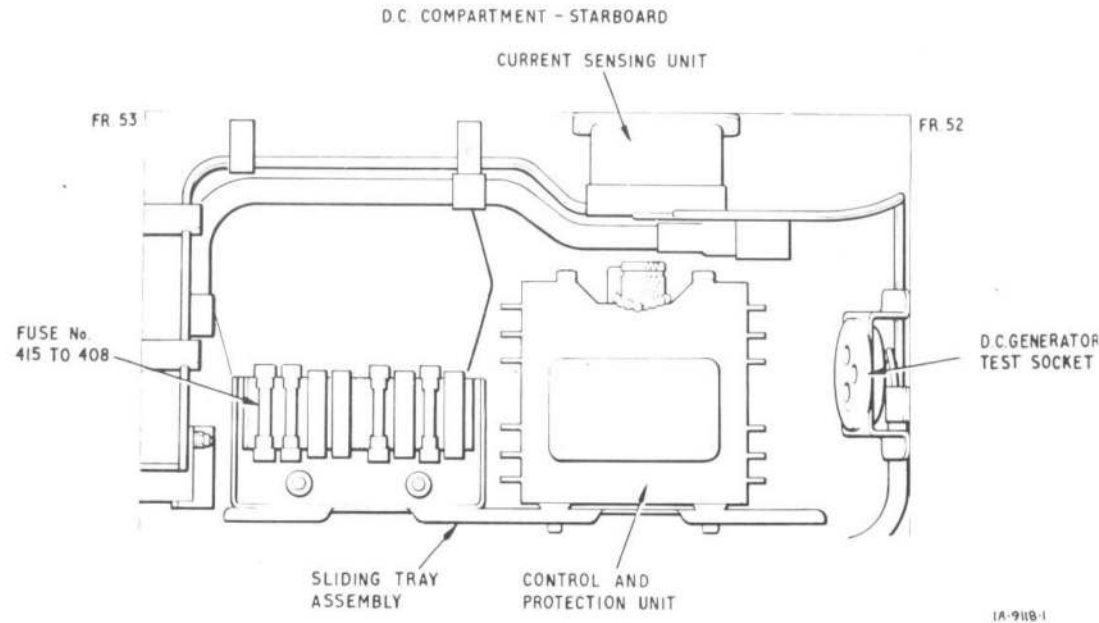


Fig. 2. D.C. control equipment

isolation switch is located at the aft end of the starboard console.

Note...

When the aircraft is on the ground with the engines at rest, to prevent discharge of the batteries by circuits permanently connected to the d.c. busbar, the battery isolator switch should be set to OFF.

Emergency battery

11. A 24-volt, 7Ah alkaline battery is secured in a tray mounted on the port aft upper gun cover in the main equipment compartment. The emergency lighting distribution circuits which it supplies are controlled by a switch on the main instrument panel.

Voltmeter

12. Indication of d.c. busbar voltage is provided by a voltmeter having coloured sectors and a range of 0 to 35 volts. The meter is installed on the starboard shroud above and forward of the starboard console. The meter is connected to the busbar via the fuse, in the d.c. feeder fusebox, which supplies the port fuel gauge.

Distribution

13. The primary supplies are fed to the aircraft busbar PL in the d.c. feeder fusebox, located in the front fuselage spine. The supply is then distributed through protective fuses to the port fusebox via feeders PF1 and PF3, to the starboard fusebox via feeders PF2 and PF4, and to auxiliary busbars KA6 and KA7 in the rear fuselage spine. These latter circuits are protected by

two 160-amp H.R.C. fuses on the d.c. feeder fuse panel and provide power for the engine starting equipment. Earth connections in the rear fuselage spine are made to a negative busbar which is linked to the battery earth E9. An emergency services fusebox in the main equipment compartment (port) distributes a supply from the battery busbar PE to circuits associated with canopy control and crash-landing services. These are normally fed via the closed contacts of the battery isolator relay but when the relay opens, are supplied direct from the service batteries.

Test socket

14. A voltmeter test socket is mounted adjacent to the d.c. control equipment behind access panel 104S (fig.2).

Power failure warning

15. Indication of the failure of the generator is given by the GEN warning light on the standard warning panel at the port side in the cockpit. The light comes on when the current sensing unit coil becomes de-energized and its auxiliary contacts (PW1-PW11) close, or when the contacts connected to terminals L1 and R1 of the control and protection unit close.

OPERATION

Generating system

16. When the engines are started and the air turbine is running up to speed, the generator pilot exciter voltage builds up and the generator positive is connected to the main d.c. busbar via the current sensing unit coil and the

main fuse. The operation of the current sensing unit contacts break circuit PW1-PW11 to the GEN warning on the standard warning panel. At this stage the GEN warning will not go out as circuit PW1-PW11 is also connected to terminals L1-R1 of the undervoltage and time delay module in the control and protection unit.

17. When the generator voltage reaches approximately 25-volts, the undervoltage and time delay module will operate to break circuit PW1-PW11 and the GEN warning on the standard warning panel will then go out.

18. Should the speed of the turbine fall sufficiently to operate the under-speed relay (Chap.13), circuit PJ53 and PJ54 to the control and protection unit will be broken and cause shut-down of the generator when undervoltage occurs.

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.

General

19. Routine checks should be made on the complete generator installation for the security and serviceability of the cables and equipment. System checks are described in the functioning test procedures which follow.

20. Functioning tests must be made at

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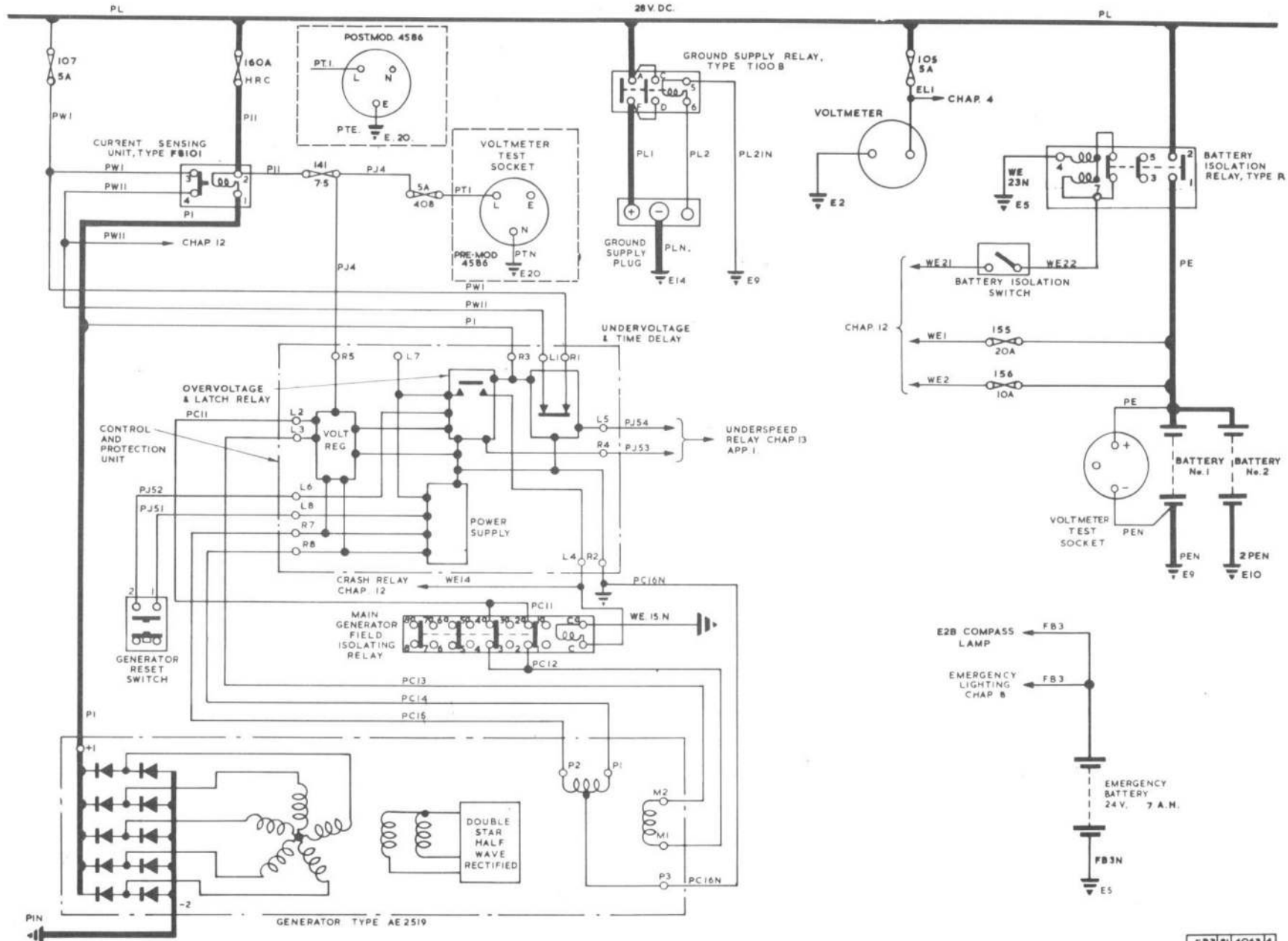


FIG. 3. DC. POWER SUPPLIES.

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the appropriate servicing period or when any major component in the installation is changed, and are carried out with the engines running.

Electrical functioning test

Equipment required

21.

1. D.C. generating system test box, B.A.C. Ref.No.AP6J11/760 (fig.4) or test box of local manufacture.
2. Voltmeter, range 0-30 volts
3. Voltmeter, range 0-50 volts
4. 28-volt test lamp
5. Intercomm set for communication between cockpit operator and ground operator.
6. Suitable d.c. ground supply

Note...

A d.c. test and meter box, Ref.No. AP6J11/816, may be used as a substitute for items 2 to 4.

Preparation

22.

- (1) Connect the d.c. test box to the test socket on the control and protection unit.
- (2) Connect the 0-30-volt voltmeter to the generator voltage test socket in the d.c. compartment.
- (3) Connect the 0-50 volt voltmeter to the terminals on the test box.
- (4) Disconnect cable PW11 from terminal

L1 on the control and protection unit and connect the 28-volt test lamp between terminals L1 and R2.

(5) Remove the 160 amp main d.c. fuse from the d.c. feeder fuse panel.

(6) Check that both switches on the test box are in the OFF position and that the potentiometer is in the fully counter-clockwise position.

(7) Connect the d.c. ground supply trolley to the aircraft and ensure that its output voltage is between 27.5 and 29 volts.

Note...

If the test and meter box, Ref.No. AP 6J11/816, is used connect plug 'A' to the test socket, and the crocodile clip to terminal L1, on the control and protection unit, plug 'B' to the generator voltage test socket in the d.c. compartment and plug 'C' to the socket on the d.c. generating system test box.

Procedure

23.

Note...

During the tests which follow, a fault which energizes any of the warnings on the standard warning panel should automatically cause the attention lamps to flash and the audio warning to be heard. When the fault is removed or cancelled the warning should cease.

(1) Switch on the ground supply, operate the BATTERY isolation switch and switch

ON the ENGINE MASTER switch. Check that the A.C., TURB and GEN warnings are illuminated.

(2) Start No.2 engine, run up and maintain speed at 65 per cent rev/min. Generator should build up to 28 ± 0.5 volts as indicated on the 0-30 volt voltmeter. A.C., TURB and GEN warnings should be extinguished.

(3) Select OVER VOLT CAL on the d.c. generating system test box. Generator voltage should rise to approximately 29-30 volts.

Note...

Ensure that the OV/UV selector switch on the a.c. generating system test box (Chap.13) is selected to OFF.

(4) Slowly rotate the potentiometer until the overvoltage relay trips, indicated by the generator voltage collapsing and the GEN warning being illuminated. The relay should trip at $30.5 \pm \frac{1}{2} \%$ volts as indicated on the 0-50 volt voltmeter.

(5) Rotate the potentiometer to the fully clockwise position, depress and hold the GEN reset switch in the cockpit. The generator voltage should again build up and then collapse as the overvoltage relay operates, no cycling of the overvoltage relay should occur. GEN warning should be illuminated.

(6) Release the reset switch, select OFF on the test box and return the potentiometer to the fully counter-clockwise position; depress the GEN

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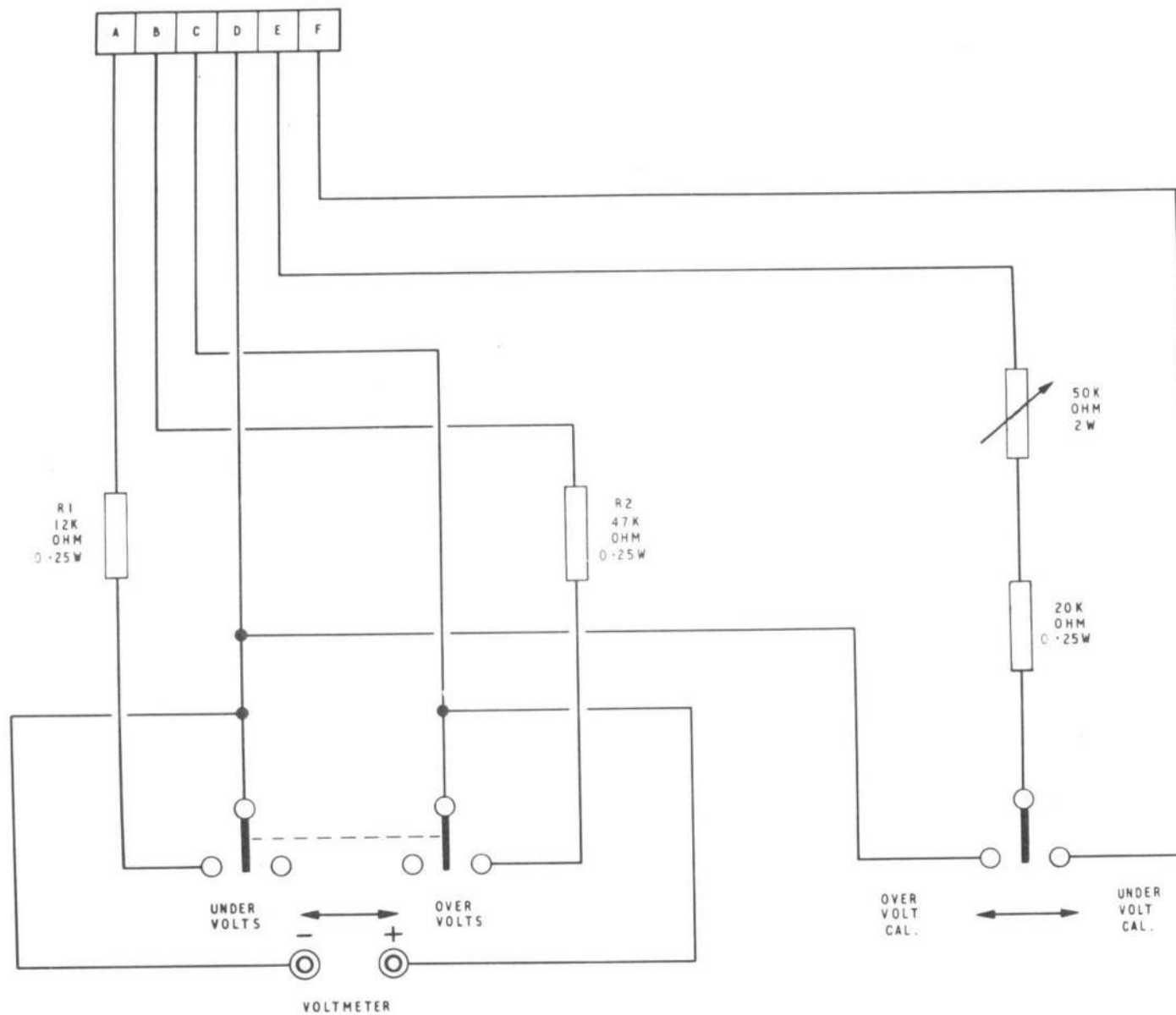


FIG.4. D.C. GENERATING SYSTEM TEST BOX
MINOR AMENDMENTS

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reset switch. The generator voltage, should build up and control at 28 ± 0.5 volts as indicated on the 0-30 volt voltmeter and the GEN warning should be extinguished.

(7) Select OVER VOLTS on the test box. The generator voltage should collapse and the GEN warning should illuminate.

(8) Select OFF on the test box. The generator should build up and control at 28 ± 0.5 volts and the GEN warning should extinguish.

(9) Select UNDER VOLT CAL on the test box and rotate the potentiometer until the undervoltage relay trips as indicated by the generator volts collapsing. The undervoltage relay should trip at 25.5 ± 0.5 volts as indicated on the 0-50 volt voltmeter.

(10) Rotate potentiometer fully counter-

clockwise and depress the GEN reset switch. The generator should build up and control at 26-27 volts.

(11) Select TRIP on the a.c. generating system test box (Chap. 13). The A.C. and TURB warnings should illuminate.

(12) On the d.c. generating system test box rotate the potentiometer until the undervoltage relay operates, as indicated by illumination of the test lamp. The relay should operate at 25.5 ± 0.5 volts as indicated on the 0-50 volt voltmeter. No cycling of the relay should occur.

(13) Rotate the potentiometer fully clockwise and then slowly counter-clockwise until the test lamp extinguishes. This should occur at 25.5 ± 0.5 volts as indicated on the 0-50 volt voltmeter. No cycling of the relay should occur.

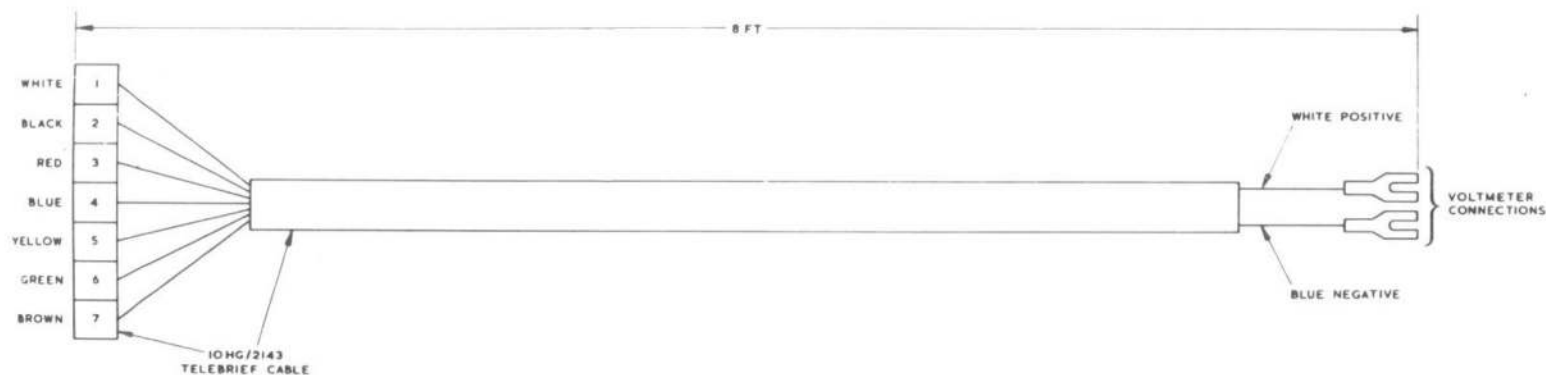
(14) Select the switches on the a.c. and d.c. generating system test boxes to OFF. The d.c. generator voltage should build up and control at 28 ± 0.5 volts and the A.C. and TURB warnings should extinguish.

(15) On the d.c. generating system test box select UNDER VOLTS. The generator voltage should collapse and the GEN warning lamp illuminate.

(16) Select OFF on the test box. The generator voltage should build up and the GEN warning extinguish.

(17) Stop engine, operate BATTERY isolation switch to OFF and switch off the ground supply. Disconnect the test lamp from the terminals of the control and protection unit and reconnect cable PW11 to terminal L1. Replace the 160 amp main d.c. fuse in the d.c. feeder fuse panel.

(18) Switch on the ground supply and



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Fig. 5. Battery test extension cable

operate the BATTERY isolation switch. The A.C. GEN and TURB warnings should illuminate.

(19) Restart No.2 engine, run up to 65 per cent rev/min, switch off the ground supply. The generator should come on line and control at 28 ± 0.5 volts after the ground supply is switched off. The A.C., GEN and TURB warnings should extinguish.

(20) Throttle back engine until the GEN warning illuminates. The A.C. and TURB warning should also illuminate.

(21) Stop engine, switch OFF BATTERY

isolation switch and ENGINE MASTER switch and disconnect the test equipment.

Batteries

24. Battery voltage must be checked regularly and the batteries serviced in accordance with A.P.113C-0202-1, (main battery) and A.P.113C-0307-1, (emergency battery).

REMOVAL AND ASSEMBLY

Generator

25. A description of the removal and re-assembly of the generator is given in A.P.101B-1001-1A, Sect.3, Chap.8A. Before the removal of the units their

cables must be disconnected and safely stowed.

Equipment

26. The removal and reassembly of the generator control equipment in the d.c. compartment is generally straight-forward. The removal of panel 104S at the starboard side of the rear fuselage provides access to the main generator test socket and the sliding tray which carries the control and protection unit, the current sensing unit, and the associated equipment. After removing two securing screws the tray can be withdrawn sufficiently for the control equipment to be accessible.

FIG. 6. D. C. POWER SUPPLIES

(illustration overleaf)

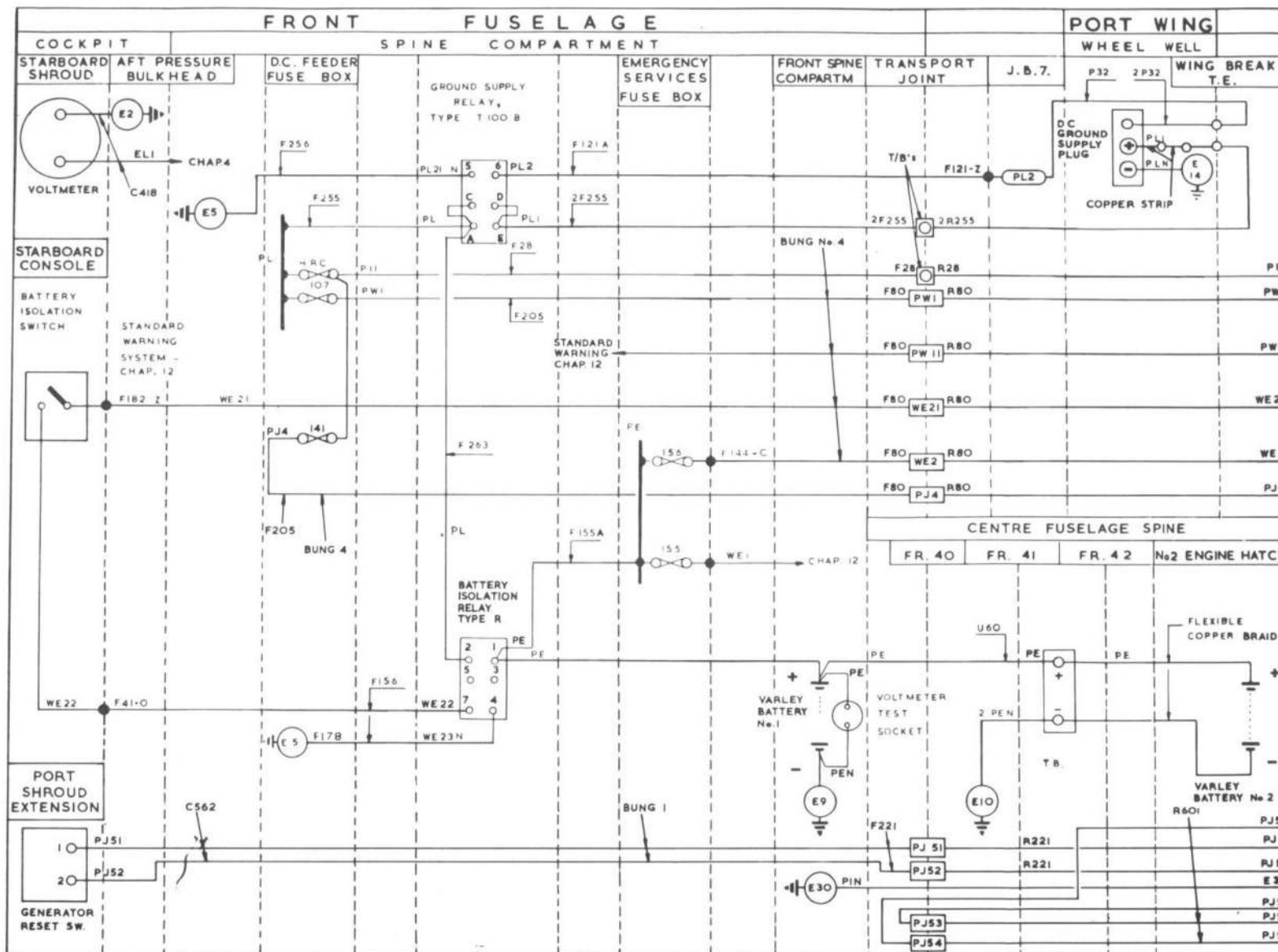


FIG.6. D.C. POWER SUPPLIES

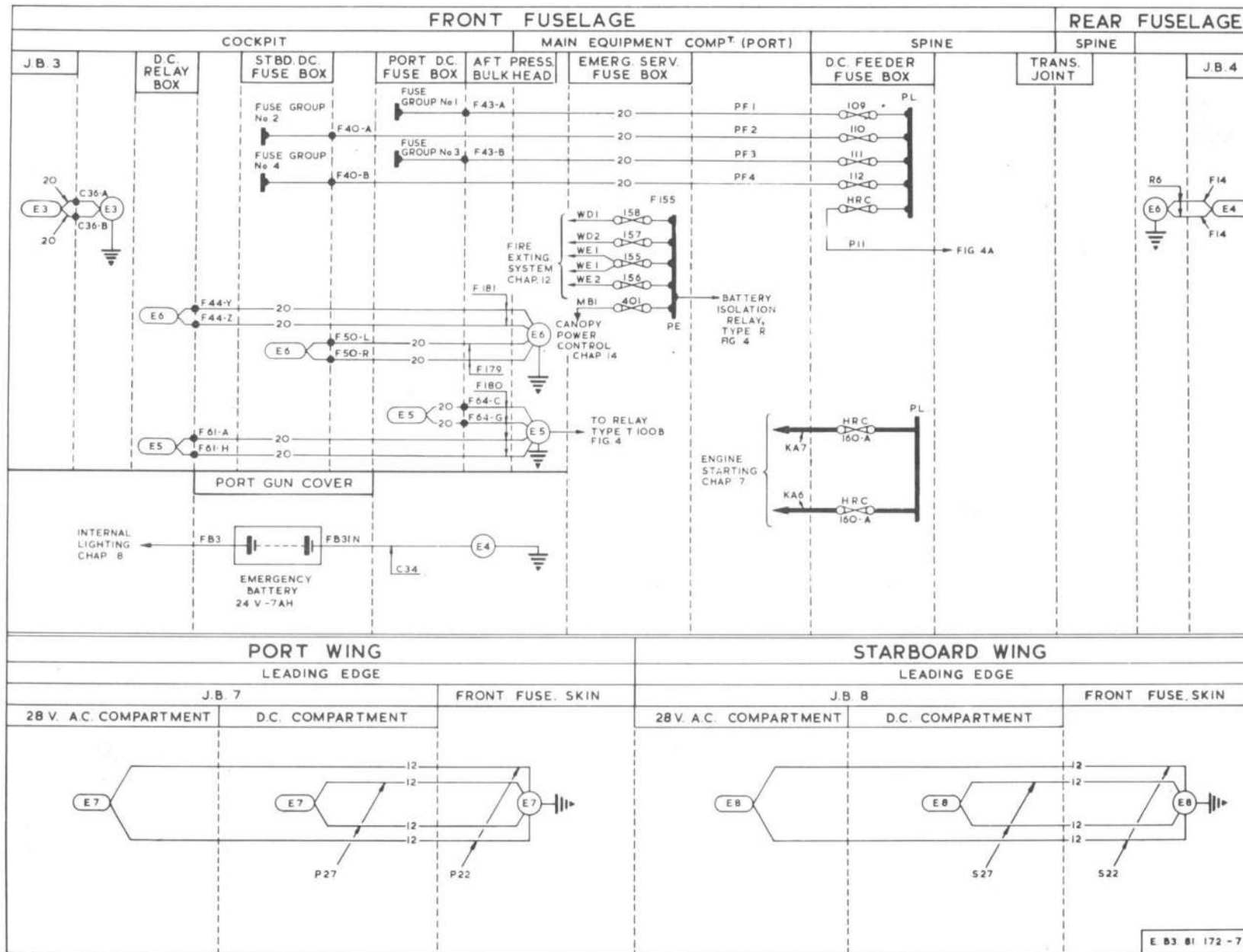


FIG. 7. D.C. POWER SUPPLY DISTRIBUTION
MINOR AMENDMENTS

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