GROUP E.1 - A.C. SUPPLIES AND CONTROL

(CODE RO, BO, WO AND CH)

(Completely revised)

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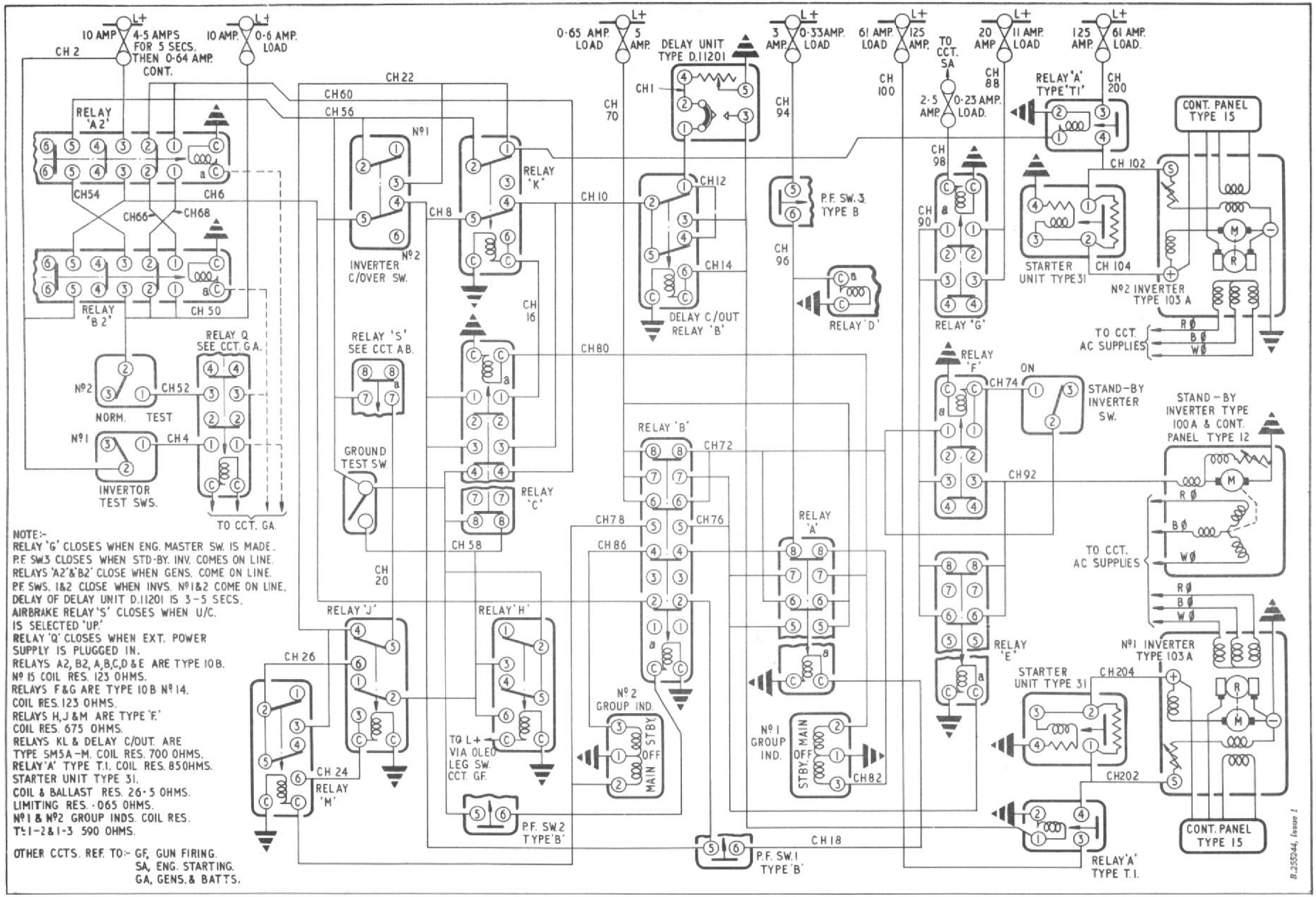

Fig.1 A.C. supplies control (theoretical)

RESTRICTED

TABLE 1

Equipment type and Air Publication reference

Equipment Type	Air Publication
Inverter, Type 103A *(Main)*	A.P.113D–0106-16
Inverter, Type 100A *(Standby)*	A.P.113D-0104-16
Power failure switches, Type B	A.P.113D–1384–1
Test switches, single pole change-over *(Spring return centre on)* single throw No. 3 Ground test switch, S.P. Type 152 Standby inverter switch, single Pole ON/OFF *(Spring return to off)* Inverter change-over switch, double pole change-over *(no centre position)*	A.P.113D-1100 series
Delay unit, Type D.11201	A.P.113D-1400 series
Starter unit, Type 31	A.P.113D-1300 series
Relays, Type 10B No. 13, 10B No. 14F, SM5 A–M, T.1	A.P.113D-1309-1
Indicator units, Plessey Type 7CZ.93135/55	A.P.113F-0610-1

Introduction

1. This Group contains the description of the aircraft's a.c. supplies and control circuit, and information on the servicing required to maintain the equipment in a state of efficiency. The circuit is controlled by the generators and batteries circuit *(Group B.1)*, and is conditioned for airborne operation by interconnections with the armament supplies circuit *(Group G.1)*, and the air brake control circuit *(Group D.7)*. Detailed descriptive and servicing information on the standard items of equipment used in the a.c. supplies and control circuit will be found in the Air Publications listed in Table 1.

DESCRIPTION

A.C. supplies and control

General

2. The a.c. supply is 115 volts, 3-phase, 400 c/s. provided by two main and one standby inverter: the main inverters comprising No. 1 and No. 2 groups respectively. The group components are mounted aft of frame 14, and No. 1 group, on the port side, includes No. 1 inverter with its control panel, starter unit, starter relay 'A', with a delay unit, and a delay cut-out relay, 'B', No. 2 group, on the starboard side, includes No. 2 inverter with its control panel, starter unit, and starter relay 'A'. The standby inverter is mounted on the cabin floor behind the starboard seat. To indicate which inverters are operating, two two-way indicators are mounted on the centre console.

3. The control circuit is so arranged that when the engine master switch is put to ON, prior to flight, the standby inverter commences operation to supply the essential a.c. loads. When the engine is started, and the d.c. generators are running, No. 2 inverter operates, and takes over all the a.c. load; while the standby inverter runs down. After a delay of 3 to 5 seconds, No. 1 inverter operates and supplies the a.c. loads; No. 2 inverter being switched off. This automatic sequence of operations prior to flight provides a check on the functioning of the system.

4. At take-off, No. 2 inverter automatically commences operation to supply the Tacan load, and also functions as a standby to No. 1. If No. 1 fails, or if No. 2 inverter is manually selected *(para. 7)*, the latter takes over the loads of No. 1 and continues to supply these until after the aircraft has landed. In normal conditions *(i.e., with No. 1 inverter serviceable)*, No. 2 inverter ceases to run when the aircraft touches down. If either d.c. generator fails, No. 2 inverter is automatically switched off, but, if No. 1 had previously failed, No. 2 continues to run, supplying all the a.c. loads except that of the Tacan installation. Should both the d.c. generators fail, the main inverters cease to run, and the standby inverter comes on to supply the essential loads.

D.C. supplies

5. The main inverters are supplied with d.c. via two 125 amp, fuses mounted on the generator control panel, and the supply to each inverter is controlled by its respective starter relay 'A' *(para. 2)*, which is energized by operation of the automatic switching equipment in A.C. junction box No. 1. The supplies to the switching equipment are derived via two 10 amp. fuses on the generator control panel and are controlled by two relays on the panel, 'A.2' and 'B.2', which are energized when the generators are on the line *(Group B.1)*. These relays provide duplicate supplies to the switching relays that control No. 1 inverter, so that if either 'A.2' or 'B.2' is de-energized, supplies to No. 1 inverter will be maintained. The standby inverter is supplied via a 20 amp. fuse which is mounted on the front of A.C. J.B.1. The supply to the inverter is controlled by a relay 'G', which is energized via a fuse in the main fuse box when the engine master switch is on, *Group C.1.*

A.C. J.B.1

6. A.C. J.B.1, which is mounted on the starboard side of the cabin, contains the switching relays 'A' to 'M' inclusive *(fig. 1)*,

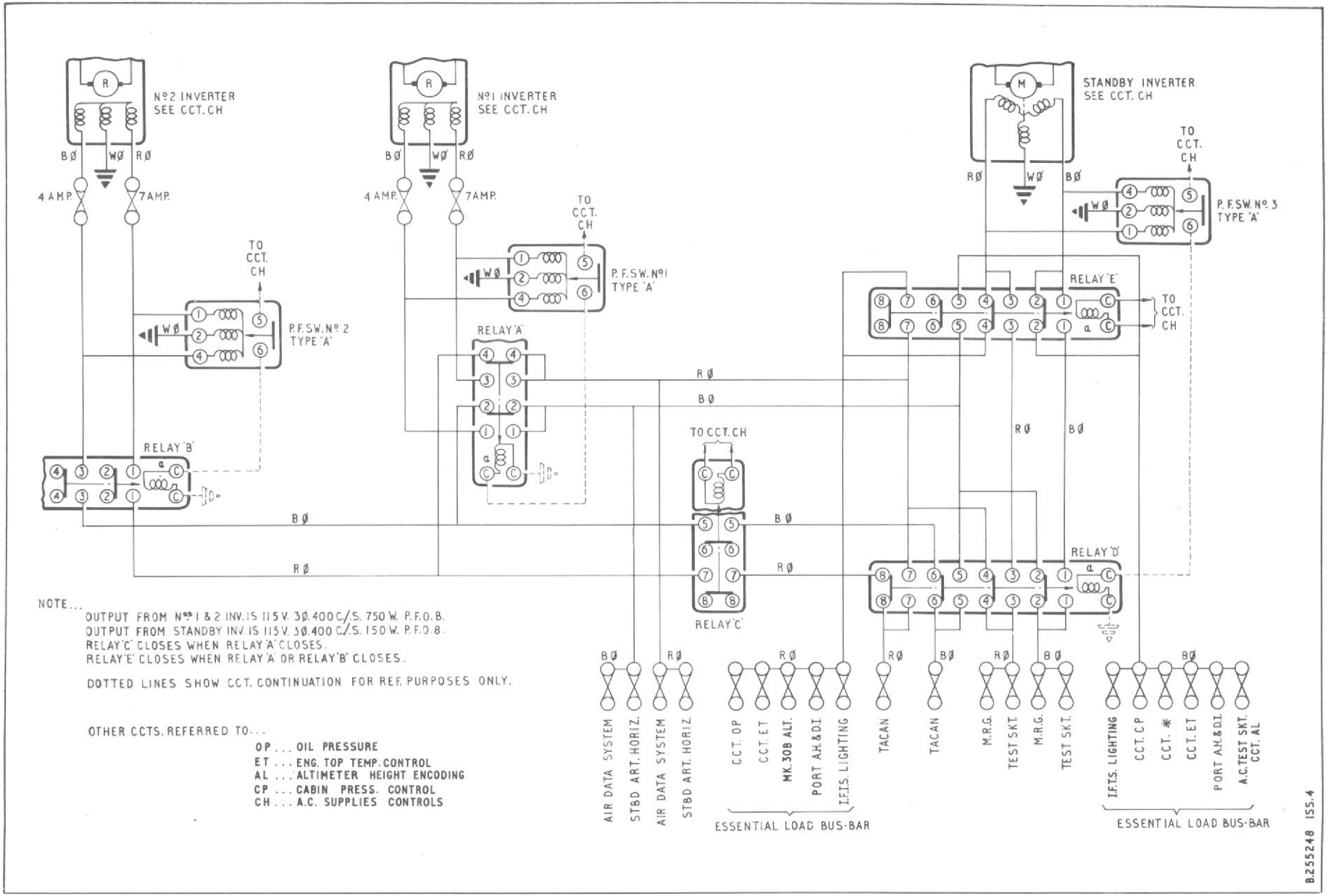

Fig. 2 A.C. supplies (theoretical)

◀ Mod. 1382 added ▶

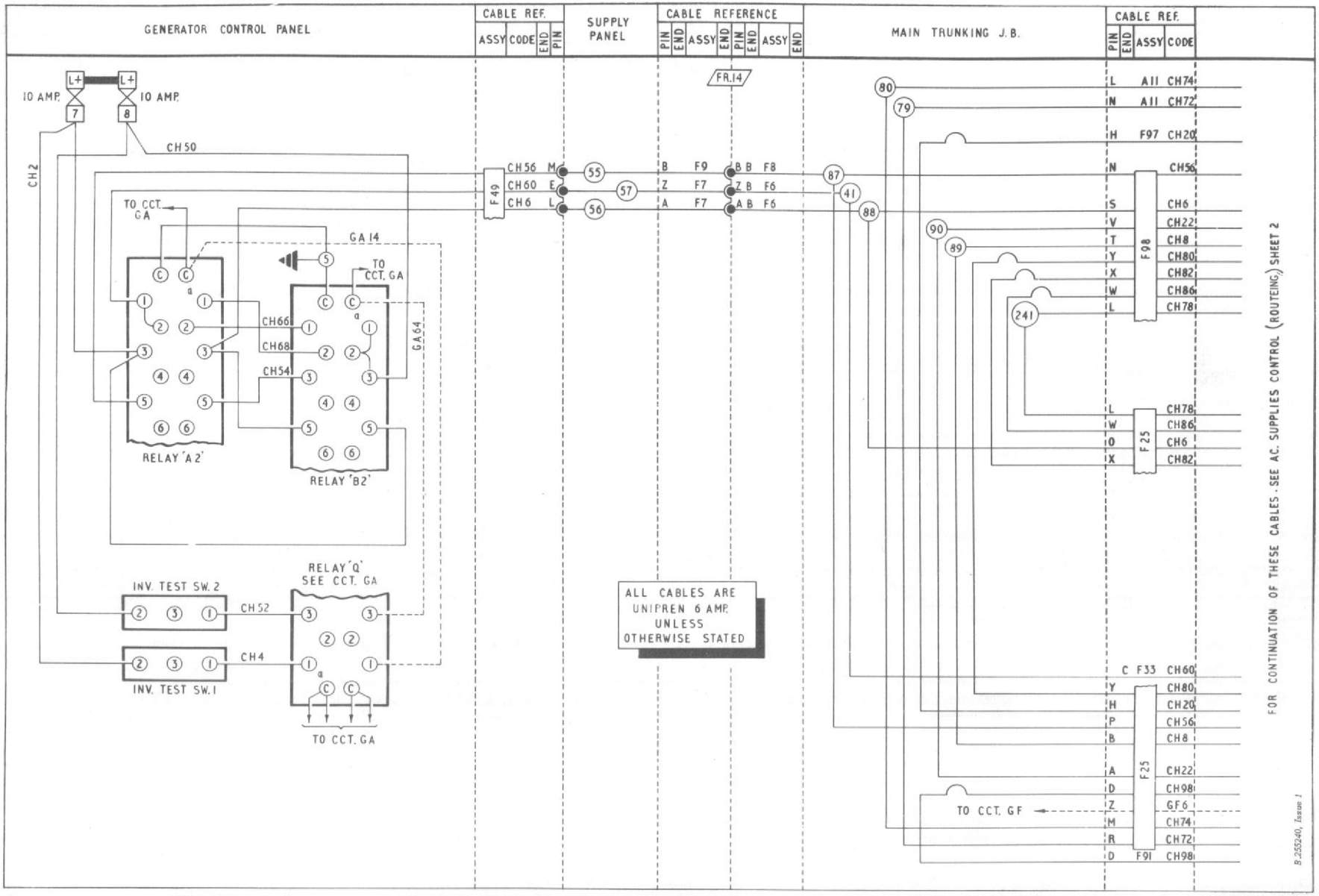

Fig.3 A.C. supplies control (routeing sheet 1)

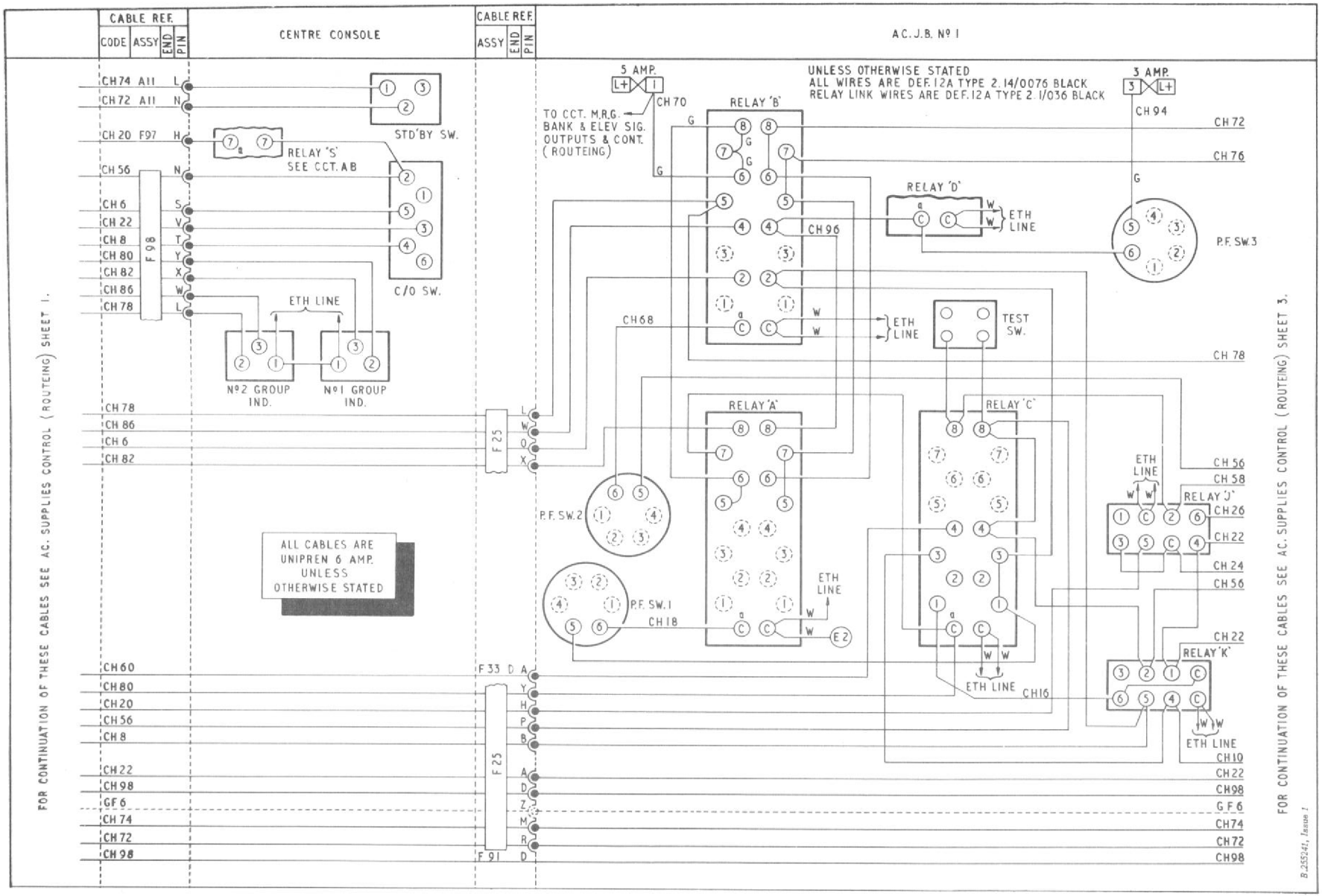

Fig.4 A.C. supplies control (routeing sheet 2)

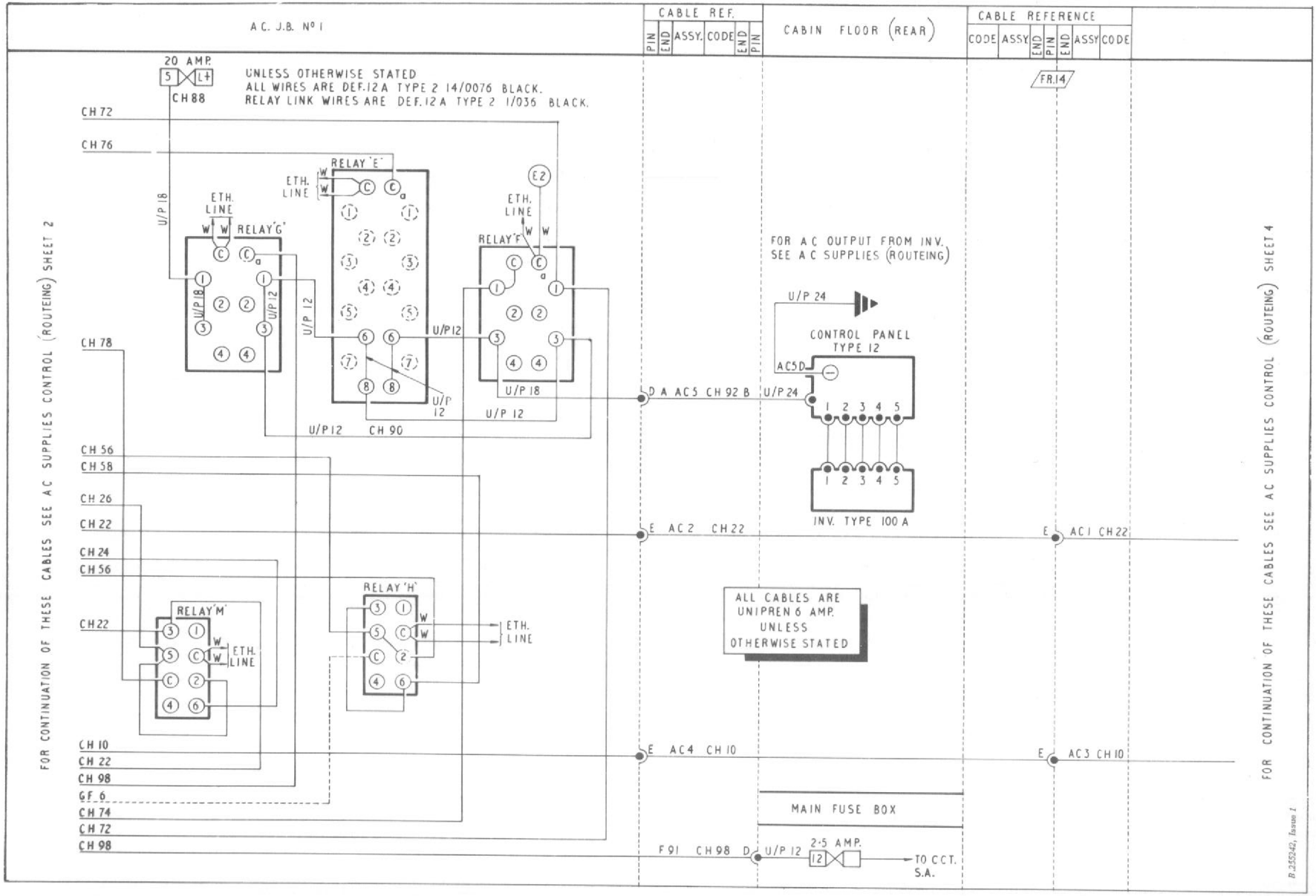

Fig.5 A.C. supplies control (routeing sheet 3)

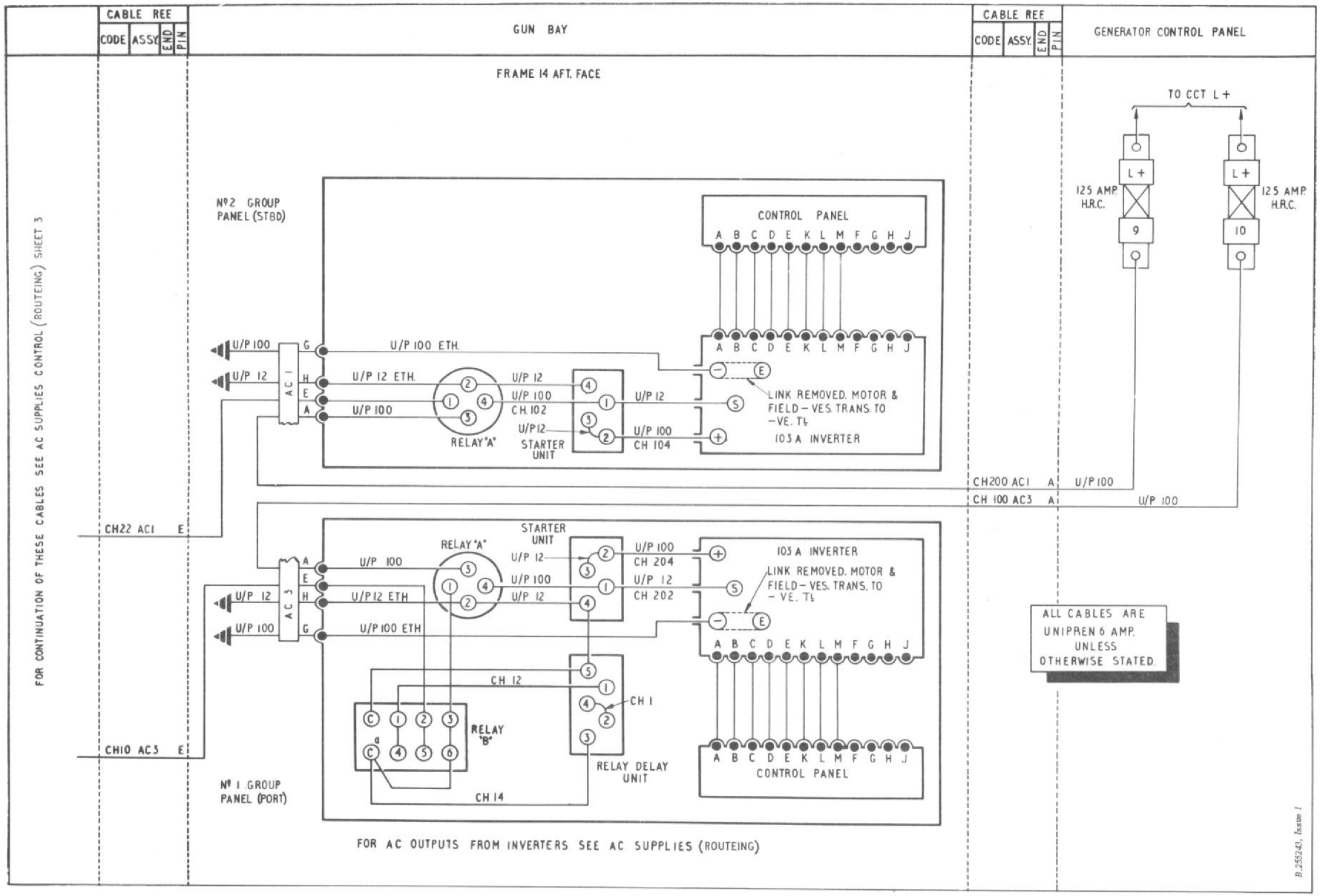

Fig.6 A.C. supplies control (routeing sheet 4)

and the power failure switches, (*P.F.Sw. 1, 2, and 3*). These are torque switches, each of which, when energized by the output of its associated inverter, operates to cause the appropriate switching relay (*'A', 'B' or 'D'*) to be energized to connect the inverter's output to the a.c. loads (*fig. 2*). A.C. J.B.1 contains the a.c. loads busbars, d.c. fuses, and a ground test switch whose contacts are closed when the lid of the box is removed (*para. 27*).

Manual control switches

7. Either main inverter can be selected by use of the inverter changeover switch, which is mounted on the centre console. The two poles of the switch are wired to the supply control relays 'A.2' and 'B.2', but derive their supplies from separate fuses. The standby inverter switch, also mounted on the centre console, is a single-pole ON/OFF type, with spring return to the OFF position.

Test switches and test socket

8. The operation of the inverters and the automatic change-over circuit can be tested on the ground by use of the No. 1 and No. 2 inverter test switches, which are mounted on the generator control panel. Each of these is a single-pole type, marked NORMAL and TEST, with spring return to the NORMAL, (*or Off position*). A test socket, which is mounted between frames 12 and 13, on the starboard side, provides a.c. and d.c. voltages, derived via A.C. J.B.1, for use with the test set used for ground testing the master reference gyro system (*Chap. 2, Group 3.A*).

Operation

Starting up on standby inverter

9. When the engine master switch is put to ON, before the engine is started relay 'G' is energized, and its contacts connect a supply from the 20 amp. fuse to the relay 'E' contacts 8–8a and 6–6a, which connect the supply to the standby inverter. When the inverter runs up, P.F.Sw. 3 closes, connecting a supply from the 3 amp. fuse to energize relay 'D', and also, passing via contacts 8–8a of relay 'A' and 4–4a of relay 'B', to energize No. 1 and No. 2 group indicators to show STANDBY. Contacts 2–2a and 4–4a on relay 'E' connect the inverter output to the essential a.c. load busbars (*fig. 2*).

Change-over to main inverter (fig. 1)

10. When the engine is running and the generator outputs have closed the main circuit breakers, (*Group B.1*), relays 'A.2' and 'B.2' are energized, and contacts 3a–3 of relay 'B.2', and 5a–5 of relay 'A.2' connect a supply from the circuit fuse to contacts 2–1 of relay 'K', by which the supply passes to No. 2 inverter's starter relay 'A'. The starter relay energizes, and its contacts connect a supply from the 125 amp. fuse to No. 2 inverter's starter unit, which causes the inverter to commence operation.

11. At the same time a supply from a further fuse, connected via contacts 3–3a of relay 'A.2', and 5a–5 of 'B.2', passes via contacts 5–4 of the inverter change-over switch, and 5–4 of relay 'K' to the delay cut-out relay, whose contacts pass the supply to the delay unit, which commences operation to delay the operation of No. 1 inverter for 3 to 5 secs.

12. In the meantime, No. 2 inverter's output energizes P.F.Sw. 2, which passes a supply derived via relays 'A.2' and 'B.2' to energize relay 'B'. Relay 'B' contacts 7a–7 connect a supply from a line fuse to energize relay 'E'. The opening of the relay 'E' contacts 8–8a and 6–6a disconnects the supply from the standby inverter, while the opening of contacts 4–4a and 2–2a (*fig. 2*), disconnect the essential load busbars from the standby inverter. When the standby inverter runs down, P.F.Sw. 3 de-energizes, and its contacts disconnect the supply from the coil of relay 'D', whose contacts change over, so that No. 2 inverter supplies all the a.c. loads except Tacan.

13. The opening of P.F.Sw. 3 (*fig. 1*) also causes the indicator STANDBY coils to be de-energized, while the operation of relay 'B' causes the MAIN coil of No. 2 group indicator, and the coil of relay 'M' to be energized. When the relay 'M' contacts close, they connect a supply derived via contact 1 of relay 'K' to the coil of relay 'J', causing relay 'J' to latch on. Contact 2 of relay 'J' is connected to the relay 'A.2' supply line via the ground test switch, hence contacts 2–3 of relay 'J' and 6–5 and 2–3 of relay 'M' in effect bridge contacts 2–1 of relay 'K', thus providing a loop supply to No. 2 inverter.

14. After the 3–5 secs. delay (*para. 11*), the delay unit contacts 1–3 close, passing the supply so that the delay cut-out relay energizes, and latches, breaking the supply to the delay unit, and making the supply via contacts 2–3 and 5–6 to No. 1 inverter's starter relay. When No. 1 inverter operates, P.F.Sw. 1 closes, connecting a supply (*derived via the change-over switch*) to energize relay 'A', whose contacts 5a–5 pass a supply from a line fuse to energize relay 'E', while contacts 7–7a connect the supply to the coil of relay 'C', and the MAIN coil of No. 1 group indicator. On relay 'E' contacts 7a–7 and 5a–5 connect the essential load busbars to No. 1 inverter.

15. When relay 'C' energizes, the change-over of its contacts 4a–4 and 8–8a disconnects the supplies from P.F.Sw. 2 and the contacts of relays 'J' and 'M', while the closing of the relay 'C' contacts 1a–1 connects a supply (*from contact 4 of the change-over switch*) to energize relay 'K', which latches on. From contact 4 of the change-over switch the supply to keep the cut-out relay latched is passed via contacts 3–3a of relay 'C'. By the removal of the supply from P.F.Sw. 2, relay 'B' is de-energized, and its contacts 5–5a open and cause the MAIN coil of No. 2 group indicator, and the coil of relay 'M' to be

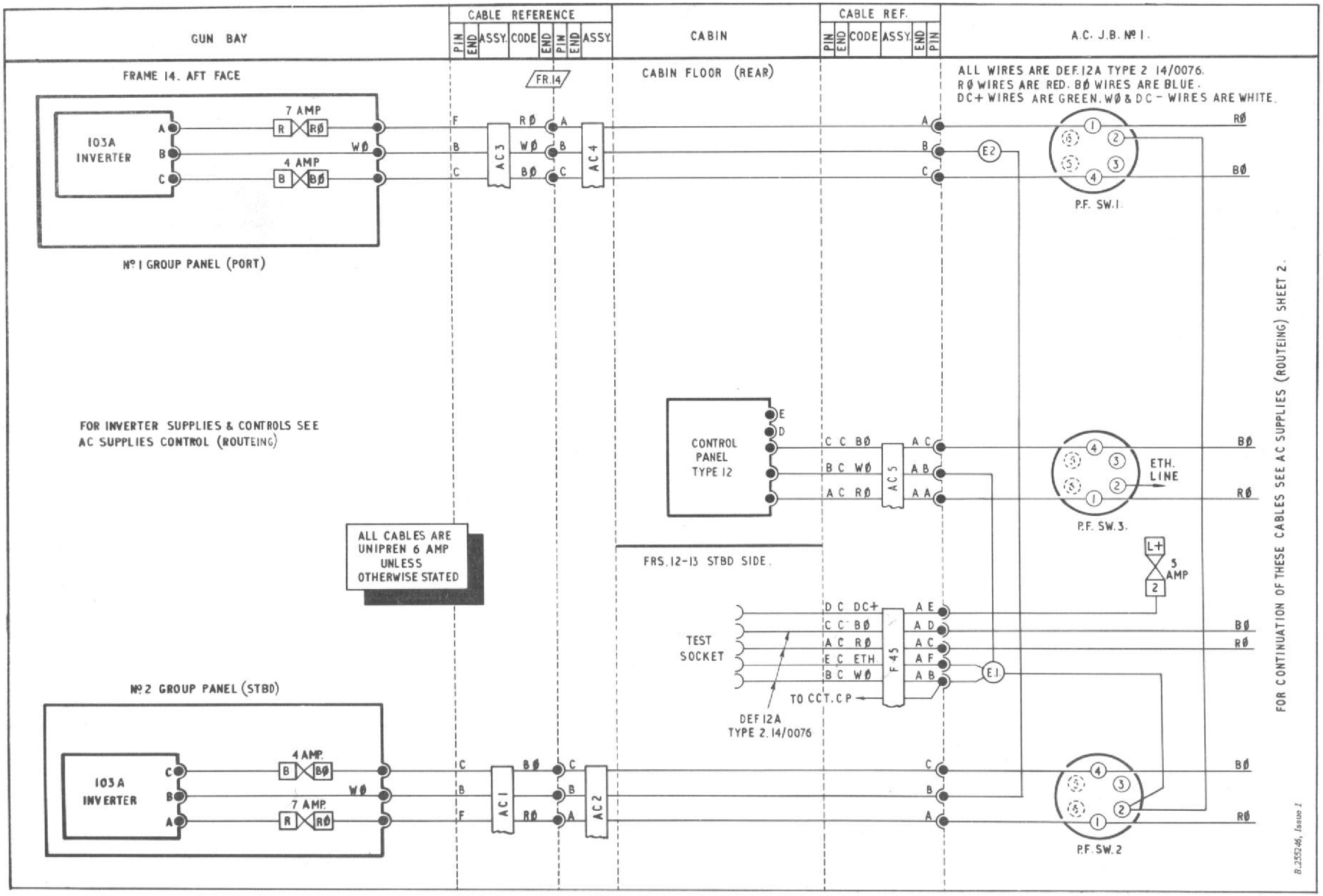

Fig.7 A.C. supplies (routeing sheet 1)

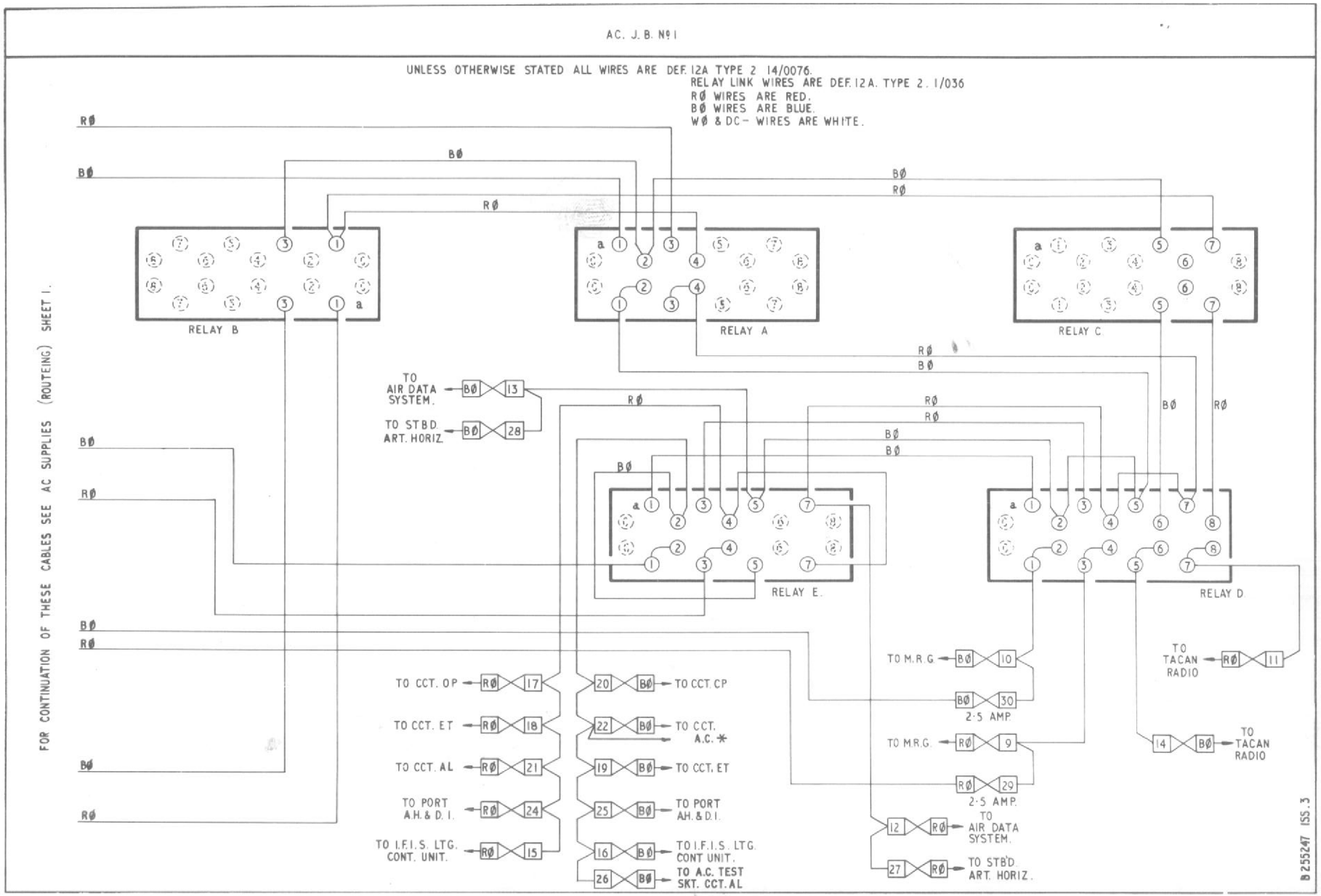

Fig. 8 A.C. supplies (routeing – sheet 2)

◀ Mod. 1382 added ▶

de-energized. With the contacts of relays 'J' and 'M' open, the loop supply to contact 1 of relay 'K' is broken, thus No. 2 inverter's starter relay de-energizes, disconnecting the supply from the inverter, which runs down. No. 1 inverter now supplies the essential loads, the 'a' loads, and the M.R.G. portion of the 'b' loads. These conditions remain unchanged until the aircraft takes off.

Airborne operation

16. When the aircraft takes off, the oleo leg switches close, and a supply from circuit GF (*Group G.1*) energizes relay 'H', whose contacts close, connecting a supply via the ground test switch (open) to contact 2 of relay 'J'. When undercarriage UP is selected, relay 'S' (*Group D.7*) is energized, and its contacts 7–7a connect the same supply to contacts 5–4 of relay 'J', by which it passes via contact 1 of relay 'K' to No. 2 inverter starter relay, which energizes, causing No. 2 inverter to be supplied.

17. When No. 2 inverter's output closes P.F.Sw. 2, the latter passes a supply to energize relay 'B', which, via its contacts 7a–7 and 5–5a passes supplies which energize the MAIN coil of No. 2 group indicator, and the coil of relay 'M'. When relay 'M' energizes, its contacts 3–2–5–6 connect the supply (*derived via 5–4 of relay 'J' and '7–7a' of relay 'S'*) to the coil and contact 3 of relay 'J', thus causing relay 'J' to latch on to the supply controlled by the relay 'S' contacts. This supply also passes via 2–3 of relay 'M' to contact 1 of relay 'K', thus keeping No. 2 inverter starter relay energized. By contacts 1a–1 and 3a–3 of relay 'B' (*fig. 2*), No. 2 inverter's output is connected via 5a–5 and 7a–7 of relay 'C' to the Tacan load.

18. When undercarriage DOWN is selected, relay 'S' de-energizes and its contacts 7–7a open, disconnecting the direct supply to relay 'M'. Relay 'J' is still energized and latched on by a supply routed via parallel contacts 2–3 and 5–6 of relay 'H' which is still held in by the oleo leg switches and contacts 6–5 and 2–3 of relay 'M'. When the aircraft lands, the oleo leg switches open, thus de-energizing relay 'H' and removing the hold-on supply from relay 'J'. This, in turn, breaks the feed to the No.2 inverter supply relay 'A'. No.2 inverter then runs down, P.F. Sw. 2 opens, de-energizing relay 'B', thus removing the supply from No.2 group MAIN indicator and the coil of relay 'M'.

Main inverter failure

19. If No. 1 inverter fails during flight, No. 2 inverter automatically accepts the loads of No. 1. When the output of No. 1 inverter fails, P.F.Sw. 1 opens, de-energizing relay 'A', the opening of whose contacts 7–7a de-energizes relay 'C', and the MAIN coil of No. 1 group indicator. By the opening of relay 'C' contacts 3–3a, the supply from contact 4 of the change-over switch is disconnected from the delay cut-out relay, which de-energizes, its contacts disconnecting No. 1 inverter starter relay, and re-connecting the delay unit. The opening of the relay 'C' contacts 5a–5 and 7a–7 (*fig. 2*) disconnects the Tacan load from No. 2 inverter, which takes over all the remaining a.c. loads.

20. If at the time of failure Tacan is essential, it can be supplied by use of the standby inverter. By selecting the standby inverter switch to ON, a supply from a line fuse, routed via contacts 6a–6 of relay 'A', energizes relay 'F', which latches; its contacts 3a–3 connecting the 20 amp. fuse supply (*routed via relay 'G'*) to the standby inverter. When the latter's output closes P.F.Sw. 3, relay 'D' energizes and its contacts 5a–5 and 7a–7 (*fig. 2*) connect the Tacan loads to No. 2 inverter, while contacts 1a–1 and 3a–3 connect the M.R.G. loads to the standby inverter.

21. To confirm that No. 1 inverter's failure was not of a transient nature, the inverter change-over switch may be selected to No. 2 position to unlock relay 'K' and the cut-out relay, thereby bringing the delay unit back into circuit. If, after 3 to 5 secs., No. 1 inverter fails to start, it must be concluded that the fault is permanent.

22. If No. 2 inverter fails, P.F.Sw. 2 opens, de-energizing relay 'B', which causes the MAIN coil of No. 2 group indicator and the coil of relay 'M' to de-energize. The opening of the relay 'M' contacts disconnects the supply to No. 2 inverter's starter relay (*routed via contact 1 of relay 'K'*), thus isolating No. 2 inverter from the supply. With No. 2 inverter off, the Tacan loads will not be supplied. If Tacan is required, it can be supplied by switching on the standby inverter, as described in para. 20.

23. If both main inverters fail, their associated relays are de-energized (*para. 19 to 22*), causing relay 'E' to de-energize. Contacts 6–6a and 8–8a of relay 'E' connect the 20 amp. fuse supply (*routed via the contacts of relay 'G'*), to the standby inverter. When P.F.Sw. 3 closes, relay 'D', and the STANDBY coils in the indicators are energized. The essential loads only are supplied, being connected to the inverter via contacts 2–2a and 4–4a of relay 'E'.

Suspected failure of No. 1 inverter

24. If it is suspected during flight that No. 1 inverter is not functioning correctly, No. 2 inverter can be selected by means of the inverter change-over switch. No. 1 inverter then ceases to operate, and its associated relays de-energize. To ensure that No. 1 inverter does not run down and shed its load before No. 2 inverter has run up, contacts 4 and 5 of the change-over switch are bridged via contacts 2a–2 of relay 'B' and contact 5 of P.F.Sw. 1 until P.F.Sw. 2 closes. Tacan can be supplied by switching on the standby inverter, as described (*para. 20*).

Generator failure

25. In the event of failure of either d.c. generator, either relay 'A.2' or 'B.2' is de-energized, but a supply to No. 1 inverter's control relays is maintained by the duplicate supply (*para. 5*). Under these conditions No. 2 inverter ceases to operate, since its control circuit derives its supplies via contacts of relays 'A.2' and 'B.2' that are in series. Any services being supplied at this time by No. 2

inverter can only be supplied by selecting the standby inverter.

Failure of generator if No. 1 inverter has failed

26. If either of the generators fail while No. 2 inverter is supplying the loads normally supplied by No. 1, the d.c. supply to No. 2 inverter is not interrupted. If the generator failure de-energizes relay 'A.2', the opening of the 'A.2' contacts 5a–5 will not interrupt No. 2 inverter's supply since contacts 1a–1 of 'B.2', and 2a–2 of 'A.2' pass a supply via contacts 4a–4 of relay 'C', the ground test switch connection, and contacts 2–1 of relay 'K'.

Ground testing

27. Ground testing the a.c. supplies and control circuit is carried out with the engine stopped, the battery master switch OFF, and an external supply connected by means of the external supply plug *(Group B.1)*. By use of the inverter change-over switch and the inverter test switches *(para. 8)*, the main inverters can be tested separately, or, with the engine master switch on, the automatic running sequence of all the inverters can be tested. With the ground test switch in A.C.J. B.1 closed *(para. 6)* airborne running conditions can be simulated.

28. When the external supply is connected, relay 'Q' energizes, and power is available, via the line fuses, at the contacts of relays 'A.2' and 'B.2', and the inverter test switches, and also at the engine master switch. With the inverter change-over switch selected to No. 1 position, the engine master switch to ON, and the inverter test switches held in the TEST position, relays 'A.2' and 'B.2' are energized. Relay 'G' also energizes, causing the standby inverter to run. The main inverters also run as described *(para. 9 to 15)*, except that with the lid of A.C.J. B.1 removed, the sequence will be as described in para. 16 to 18.

SERVICING

General

29. General servicing of the aircraft's electrical system is described in Group A.1, which includes a diagram of available spare wiring for the a.c. supplies and control circuit. Servicing of the circuit consists in keeping the components clean, and applying the standard tests for security and serviceability described in the relevant Air Publications *(Table 1)*, and carrying out the tests described in para. 30.

Testing main and standby inverters

30. The inverters and the control circuit must be tested during daily servicing and before each flight. The tests may be made with the hood either open or closed. If the hood is open, the hood jury strut *(Sect. 3, Chap. 1)* must be fitted, to prevent inadvertent operation. The testing procedure is as follows:–

(1) Ensure that the battery master switch is OFF, and that an external supply is connected to the ground supply plug.

(2) Put the engine master switch to ON. Check that the inverter change-over switch is in the No. 1 position, and that No. 1 and No. 2 group indicators show STBY., indicating that the standby inverter is running and supplying the essential load busbars.

(3) Hold No. 1 and No. 2 inverter test switches to the TEST position *(simulating normal run up sequence)*. Check that No. 2 inverters runs up, and that No. 2 group indicator shows MAIN, and that after 3 to 5 secs., No. 1 inverter runs up and No. 1 group indicator shows MAIN, while No. 2 inverter ceases to run, and No. 2 group indicator shows OFF. Release the test switches.

(4) Remove the lid from A.C.J. B.1, and operate and hold on No. 1 and No. 2 test switches *(to simulate normal airborne running conditions)*. Check that No. 1 and No. 2 group indicators show MAIN, indicating that both main inverters are running, and are supplying the essential loads busbars, the 'a' and 'b' loads busbars, and Tacan.

(5) Select the inverter change-over switch to No. 2 position *(simulating No. 1 inverter failure)*. Check that No. 1 inverter runs down and its indicator shows OFF, and that No. 2 group indicator still shows MAIN, indicating that No. 2 inverter is now supplying the loads shed by No. 1 inverter.

(6) Return the inverter change-over switch to No. 1 position, and check that No. 1 inverter re-starts. Release No. 1 inverter test switch *(simulating one generator failed)*, and check that No. 2 inverter runs down, No. 2 group indicator shows OFF, and No. 1 inverter continues to run, *(i.e. No. 1 group indicator shows MAIN)*.

(7) Return No. 1 test switch to the TEST position and check that No. 2 inverter runs. Select the change-over switch to No. 2 position *(to simulate failure of No. 1 inverter)*. Release No. 1 test switch *(simulating generator failure)*. No. 1 inverter should run down, and No. 2 inverter should continue to run and supply No. 1 inverter's load. No. 1 group indicator should show OFF, and No. 2 group indicator show MAIN.

(8) Release No. 2 test switch *(to simulate failure of the engine or of both generators)*. Check that both indicators show STBY., and that standby inverter oper-

ates, supplying the essential loads.

(9) Return the inverter change-over switch to OFF. Replace the lid of A.C.J. B.1. Check that both group indicators show OFF.

(10) Disconnect the ground supply.

REMOVAL AND ASSEMBLY

General

31. The recommended procedure for removing the inverters and A.C.J.B. are described in Group A.2. For removal of the remainder of the components are given in Group A.3.