Group E.1

A.C. SUPPLIES (CODE CH)

(Completely revised)

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LIST OF ILLUSTRATIONS

TABLE

Equipment employed

1. The major components employed in the a.c. supplies circuit are quoted below, together with the appropriate Air Publications to which reference should be made for a detailed description and the necessary servicing required to maintain them in an efficient condition.

DESCRIPTION

A.C. supplies

Introduction

2. The a.c. supply is 115 volts, 400 cycles per second, 3-phase, obtained from four inverters mounted on the cabin floor behind the seats. The inverters are automatically controlled by torque switches and relays contained within the a.c. junction box situated on the starboard side of the cabin and are operated in two separate groups, each consisting of a main and standby inverter. The inverters are each supplied via a separate circuit breaker mounted on a panel adjacent to the a.c.

junction box and are also provided with magnetic indicators to show which inverters are operating.

Circuit principles

3. The principle of the circuit is that the standby inverters commence operation to supply the a.c. loads immediately the engine master switch is closed. When the engine is started and the generators come on the line, the main inverters commence operation and supply two torque switches, which when the inverter output is sufficient, close their contacts to cut-out the standby inverters and allow the main inverters to supply the loads. Once the main inverters are on the line, a portion of the control circuit is locked and cannot be operated again unless resetting action is taken. Failure of a main inverter releases its associated torque switch and automatically brings the standby inverter into use.

No.1 group

4. Inverters No.1 *(main)* and No.4 *(standby)* and their control equipment form No.1 group. This group normally supplies the gyro compass installation and the magnetic amplifiers of the cabin temperature, autostabilizer and engine top temperature control circuits via No.1 inverter.

TABLE 1

Equipment Type and Air Publication reference

Equipment Type	Air Publication
Inverters, Type 100A	A.P.4343B, Vol.1, Book 3, Sect.16
Torque switches, Type B.1, E.A.P.2312	A.P.4343B, Vol.1, Book 2, Sect.22
Circuit breakers, Type A.3...	A.P.4343B, Vol.1, Book 2, Sect.10
Test switches, single-pole change over centre off (Stores Ref.5CW/7539) Standby and reset selector switches, single-pole, change over, no off position (Stores Ref.5CW/5823)	A.P.4343C, Vol.1, Book 1, Sect. 1
Relays, Type S.1, S.3 and S.M.5, A.N.25	A.P.4343C, Vol.1, Book 2, Sect. 3
Port artificial horizon magnetic indicator, Type B.2 Magnetic indicators, Plessey Type 7CZ.93135/55	A.P.4343E, Vol.1, Book 4, Sect.18

No.2 group

5. Inverters No.2 *(main)* and No.3 *(standby)* and their control equipment form No.2 group. This group supplies the artificial horizons, Mk.28 altimeter and oil pressure gauge from No.2 inverter with No.3 invertor acting as a standby.

Indicators

6. A pair of two-way magnetic indicators, which show the words MAIN, OFF and STANDBY are mounted on the centre console to give visual indication of which inverter of each pair is operating. A further magnetic indicator situated adjacent to the pupil's artificial horizon is provided to indicate when this instrument is being operated by the standby inverter.

Test switch

7. The operation of each pair of inverters and the automatic change-over circuit may be tested on the ground by the use of a test switch, which is used in conjunction with two standby and reset selector switches. The test switch is marked NORMAL - TEST GP-1 and TEST GP.2 and is mounted at the bottom of the generator control panel. The reset selector switches marked NORMAL and STANDBY are located on the centre console.

Operation

Starting up on standby inverters (fig.1 and 2)

8. When the engine master switch is placed in the ON position and before the engine is running, a battery supply through the engine starter circuit breaker will

energize relays B and F via the closed contacts 4-4a of relays D and H. With relays B and F energized, contacts 1-1a will be made and a supply fed to No.3 and 4 inverters via their circuit breakers, and these inverters will both commence operation and feed the phase bus-bars in the a.c. junction box via contacts 6-6a and 8-8a of relays D and H. The compass installation, Mk.28 altimeter and artificial horizons, together with the magnetic amplifiers and the oil pressure gauge will thus commence operation. The supply to the oil pressure gauge and Mk.28 altimeter is, however, taken through auto-transformers, which reduces the voltage to the value required by these instruments as described in Sect.5, Chap.2.

9. The supply to the inverters also energizes, via contacts 2-2a of relays D and H, one coil of each of the two-way magnetic indicators, which when energized in this way, show STBY to indicate that the standby inverters are operating. The d.c. bias supply for compass correction is also taken from contacts 2-2a of relay H via the closed contacts 2-2a of the de-energized relay J. The port artificial horizon's standby magnetic indicator will be de-energized under this condition and show white to indicate that this instrument is being operated by the standby inverter.

Change over to main inverters

10. When the engine is started and the output from each electrical generator is sufficient to close the main circuit breakers *(Group B.1)*, relays A.2 and B.2 *(fig.1)* are energized by a supply from terminal 8 of these circuit breakers and close their contacts. Contacts 1-1a and 3-3a of relay A.2 and B.2 complete the supply from the circuit fuses to terminal 2 of the two standby and reset switches No.1 and No.2, which when in the NORMAL position energize relays A and E via the closed contacts 2-2a of the de-energized relays C and G. At the same time, a supply is also made to contacts 1 of relays C and G, contacts 4 of the torque switches, contacts 2 of relays N and P and to contacts 1 and 3 of relays D and H in preparation for supplying the hold-on control circuits for No.1 and 2 inverters.

11. With relays A and E energized, contacts 1 and 1a will be made and a supply fed to No.1 and 2 inverters via their circuit breakers, and these inverters will both commence operation to feed the torque switches and contacts 5a and 7a of relays D and H. The supply to No.1 inverter also feeds contact 1 of relay J to maintain the d.c. bias for compass correction when this relay is energized. When the inverter output reaches 100 volts, the torque switches will close their contacts and energize relays N and P from the supply fed to their contacts 4 *(para.10)*. When relays N and P are energized, contacts 2 and 3 make and conduct the supply fed to contacts 2 *(para.10)* to the coils of relays D, H and J, together with one of the solenoid coils of each two-way magnetic indicator and the coil of the port artificial horizon's magnetic indicator.

12. With relays D and H energized, contacts 1-1a, 3-3a, 5-5a and 7-7a are all made and the remaining contacts 2-2a, 4-4a, 6-6a and 8-8a are all broken. Contacts 3-3a supply the coils of relays C and G, which are thus energized and break contacts 2-2a and make contacts 1-1a. Relays A and E will not, however, be de-energized as the supply to their coils is maintained from the closed contacts 1-1a of relays D and H. Contacts 1-1a of relays C and G form a hold-on circuit to maintain these relays in the energized state.

13. Should the output of No.1 or 2 inverters fail *(para.16)*, relays A, D, E and H will be de-energized. Relays A and E cannot, however, be re-energized by the feed via contacts 2-2a of relays C and G and restart the inverters, due to the fact that relays C and G are still self maintained in the energized state. If relays A and E were capable of being energized under failure conditions, the main inverters would operate and attempt to come on to the line again, which may result in hunting of the torque switches and relays.

14. Contacts 5-5a and 7-7a of relays D and H, when made, feed the output of No.1 and 2 inverters to the phase bus-bars, which have been isolated by the opening of contacts 6-6a and 8-8a of relays D and H, thus the equipment originally supplied by No.3 and 4 inverters will

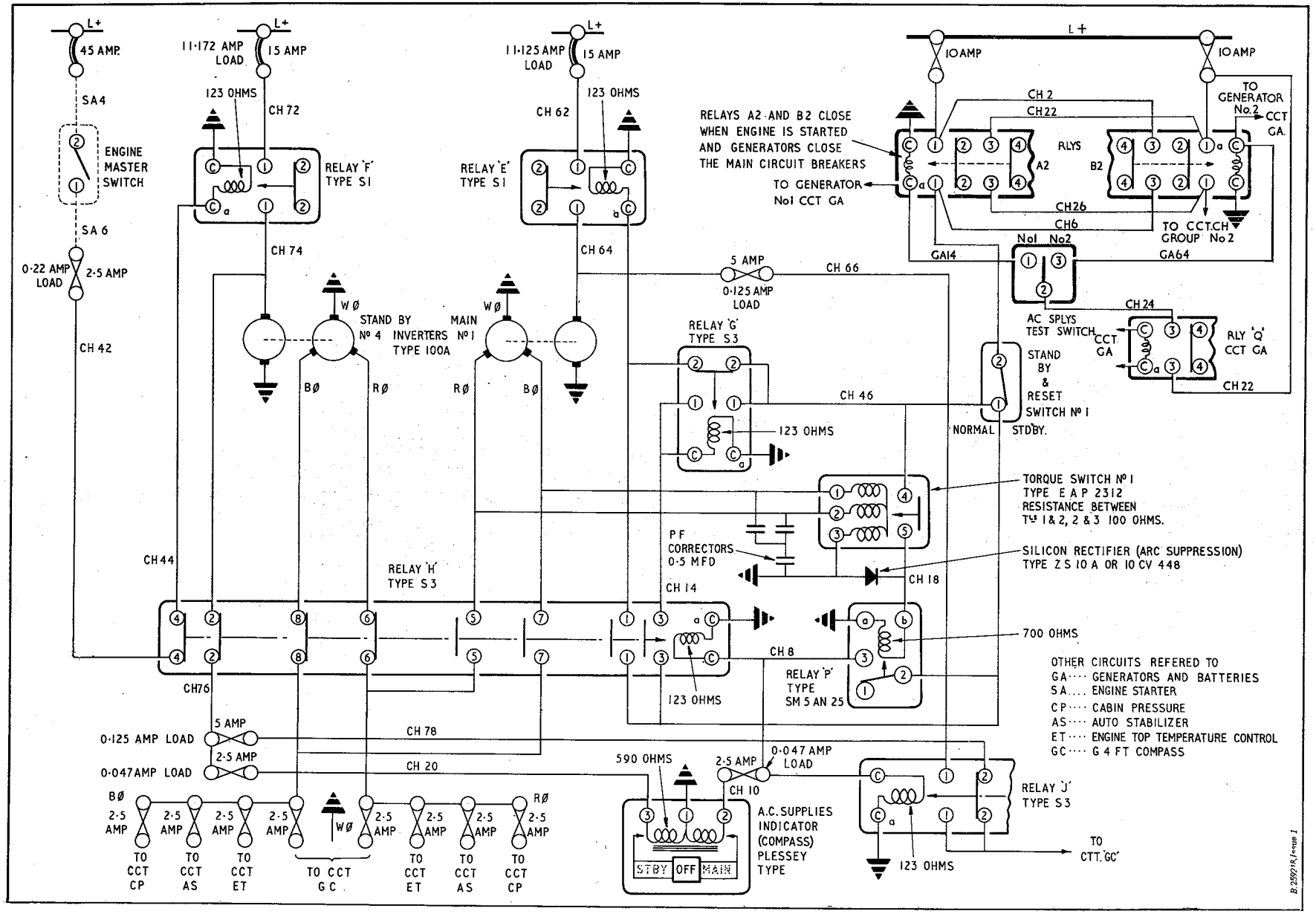

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Fig. 1. A.C. supplies No. 1 group (theoretical)

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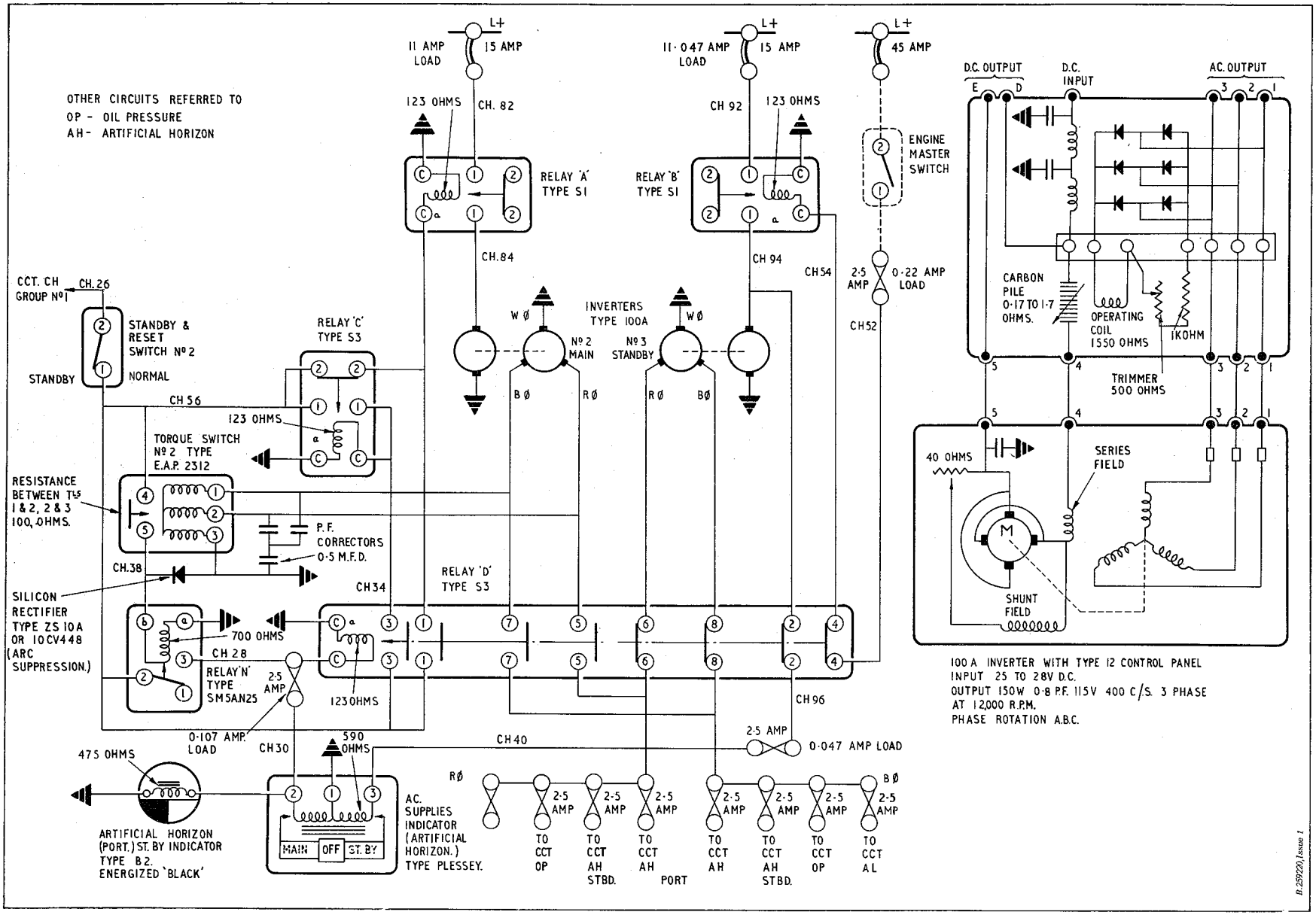

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Fig. 2. A.C. supplies No. 2 group (theoretical)

cease operation when contacts 4-4a of relays D and H open and de-energize relays B and F. The original supply for compass correction and that to the two-way magnetic indicators is also isolated by the opening of contacts 2-2a of relays D and H and by the de-energizing of relays B and F.

15. With relay J energized, contacts 1-1a are made and complete the d.c. bias supply for compass correction *(para.11)*. The supply from contact 3 of relays N and P *(para.11)*, also feeds one solenoid coil of each two-way magnetic indicator and the port artificial horizon's magnetic indicator. When the two-way indicators are energized in this way, they both show the word MAIN to indicate that the main inverters are operating and when the artificial horizon's indicator is energized it shows black to give the same information.

Main inverter failure

16. Should either No.1 or 2 inverter fail, No.3 or 4 inverter will automatically re-commence operation to act as a standby supply to maintain operation of the a.c. equipment. As an example of the automatic change-over circuit, take the case in which No.1 inverter fails. As the output from No.1 inverter falls to less than 100 volts, the contacts of No.1 torque switch will open, thus isolating the supply to relay P, which will be de-energized. With relay P de-energized, its contacts 2 and 3 will open, thus isolating the supply from the coil of relay H, the coil of relay J and the two-way magnetic indicator, which are, therefore, all de-energized. With relay H de-energized, contacts 1-1a, 3-3a, 5-5a and 7-7a are all broken, while contacts 2-2a, 4-4a, 6-6a and 8-8a are all made and with relay J de-energized contacts 1-1a are broken and contacts 2-2a made to maintain the d.c. bias supply for compass correction from another source.

17. As contacts 1-1a of relay H open, relay E is de-energized to open circuit the supply to No.1 inverter and at the same time the output of the inverter is isolated from the phase bus-bars by the opening of contacts 5-5a and 7-7a. The opening of contacts 3-3a will have no effect on relay G as this relay is self maintained in the energized state by the hold-on circuit *(para.12)*. The closed contacts 4-4a of relay H will complete the supply from the engine master switch to energize relay F and in turn will complete the supply from the circuit breaker to No,4 inverter, which will commence operation and feed the phase bus-bars, via the closed contacts 6-6a and 8-8a of relay H.

18. The supply to the inverter also feeds via the closed contacts 2-2a of relay H, one coil of the two-way magnetic indicator, which when energized in this way, shows STBY to indicate that the standby inverter is operating. The d.c. bias for compass correction is also taken from this source to contacts 2-2a of relay J. The whole change-over operation takes place automatically and the only indication of failure is given by the magnetic indicator. A similar change-over sequence takes place between No.2 and 3 inverters if No.2 inverter fails and will also occur should the supply to No.1 or 2 inverter fail due to a fuse failure or open circuit.

Generator failure

19. If one or the other of the electrical generators fail and opens the contacts of its main circuit breaker, either relay A.2 or B.2 will be de-energized and open its contacts, but the supply to the inverter control relays will be maintained via the contacts of the other relay, since these relays are wired to duplicate the supply from the circuit fuses. When the engine master switch is placed in the OFF position, to stop the engine, and the contacts of both generator main circuit breakers open, relays A.2 and B.2 are both de-energized and open their contacts, thus isolating the supply to the inverter control relays and magnetic indicators, which are all de-energized. No.1 and 2 inverters will cease operation as contacts 1-1a of relays A and E open and the magnetic indicators will each show the word OFF when de-energized. The de-energizing of relays D and H, will not cause No.3 and 4 inverters to re-commence operation as the supply to relays B and F is isolated at the 'open' engine master switch.

Ground testing

20. To test inverters No.1 and No.2 when the aircraft is on the ground with the

engine stopped, an external supply must be connected to the aircraft, a supply is then available at terminal 2 of the inverter test switch via contacts 3-3a of relay Q *(Group B.1)*. Placing the test switch to the TEST GP.1 position energizes relay A.2 via contacts 1-2 of the test switch thus operating inverter No.1. Placing the test switch in the TEST GP.2 position energizes relay B.2 via contacts 2-3 of the test switch thus operating inverter No.2. The inverters operate in a similar manner to that described in para.10 to 15. The operation of the Tacan test switch is described in Group H.1.

Flight testing

21. When the standby and reset selector switches are placed in the STANDBY position the hold-on circuits of relays C and G are released and relays A, D, E and H are all de-energized so allowing the standby inverters to function as during the circuit starting operations described in paragraph 8. The switches are used, in flight after failure of a main inverter, to reset the circuit and allow the main inverter to come back on the line if its failure was of a temporary nature. The switches may also be used, on the ground, to simulate failure of the main inverters while relays A.2 and B.2 are energized so that the standby inverters and change-over circuits may be tested while the engine is running.

SERVICING

General

22. For general servicing of the electrical system as a whole, reference should be made to Group A.1. Apart from keeping all the components clean and carrying out the standard routine tests of security and serviceability as described in the appropriate Air Publications listed in Table 1, the only other servicing is the testing of the main and standby inverters as described in the following paragraph.

Testing main and standby inverters

23. During daily servicing and before each flight, the operation of the main and standby inverters, together with the automatic change-over circuit must be tested for correct functioning by use of the test and selector switches, as follows:-

(1) Ensure that the hood is open and that an external supply is connected to the aircraft's external supply plug *(Group A.1)*. Check that the altimeter power supply switch *(post mod.1378)* is set to NORMAL.

(2) Switch on the engine master switch and check that the inverter changeover indicators show that both the STANDBY inverters are operating and thus supplying the compasses, the artificial horizons, oil pressure gauge and Mk.28 altimeter *(pre-mod.1378)*. For post mod.1378 aircraft check that the Type F.I.45E inverter and altimeters function as described in Chap. 2, Group 3A, App.1.

(3) Place the test switch on the generator control panel to the TEST GP.1 position, check that the compass group indicator shows that the MAIN *(No.1)* inverter is operating and thus supplying the instruments originally supplied by the STANDBY *(No.4)* inverter. Check the operation of the No.1 selector switch, i.e. selecting STANDBY causes the compass group indicator to show STANDBY.

(4) Trip the No.1 main inverter circuit circuit breaker, thus simulating a failure of the compass group main inverter. Check that the compasses continue to function however as these are now supplied by standby inverter No.4. The compass group indicator will now show STANDBY.

(5) Reset the No.1 *(compass group)* main inverter's circuit breaker and note that there is no resulting change in the operating of the inverters. Momentarily switch the compass group selector switch *(i.e. No.1)* to STANDBY and back to NORMAL again. Check that the change-over indicator then shows MAIN.

(6) Place the test switch on the generator control panel to the TEST GP.2 position, check that the artificial horizon group indicator shows that the MAIN *(No.2)* inverter is operating and thus supplying the instruments originally supplied by the STANDBY *(No.3)* inverter. Check the operation of the No.2 selector switch, i.e., selecting STANDBY causes the artificial horizon group indicator to show STANDBY and the artificial horizon indicator WHITE.

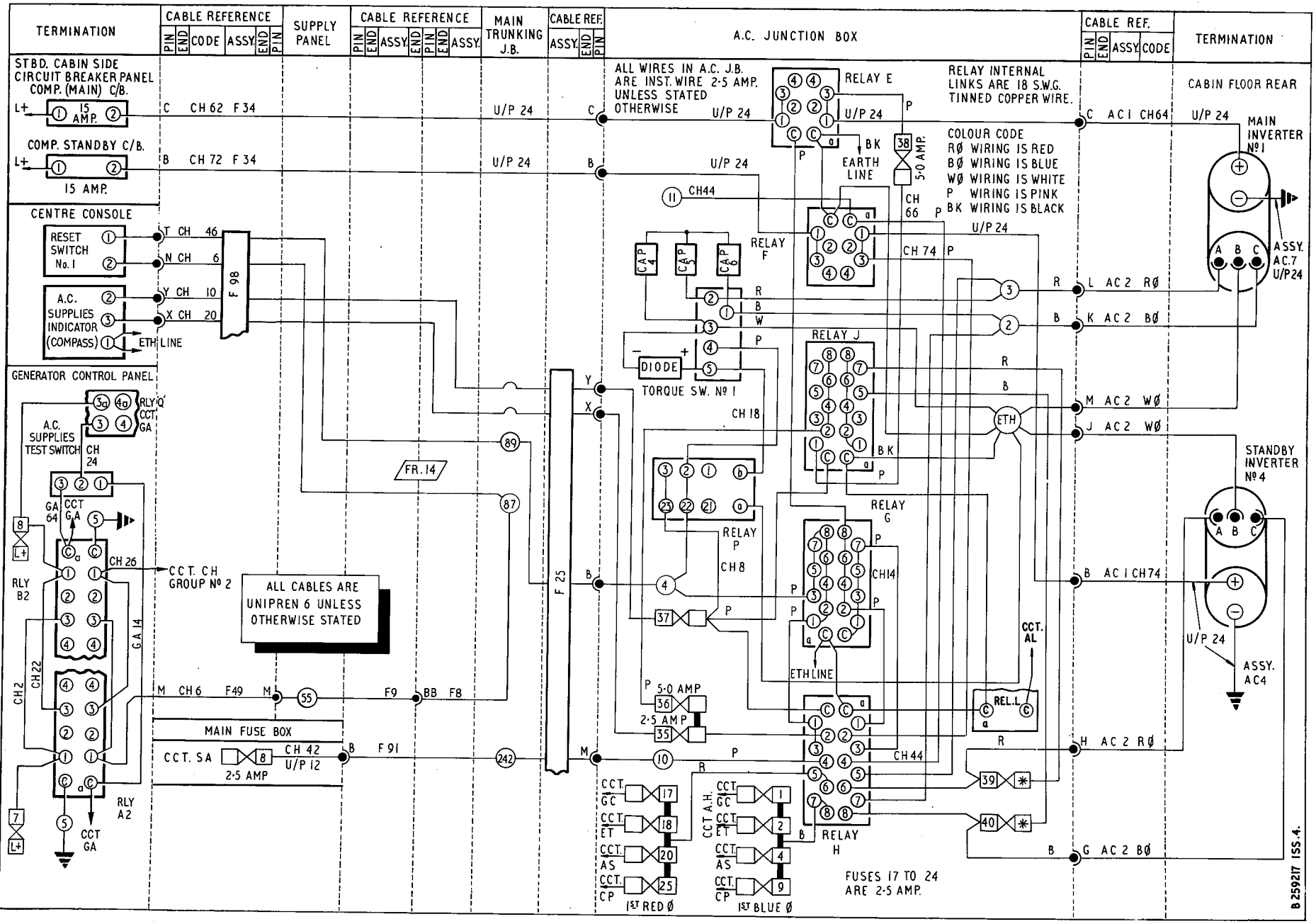

Fig.3 A.C. supplies No.1 group (routeing)

◀ Mod.1378 added ▶

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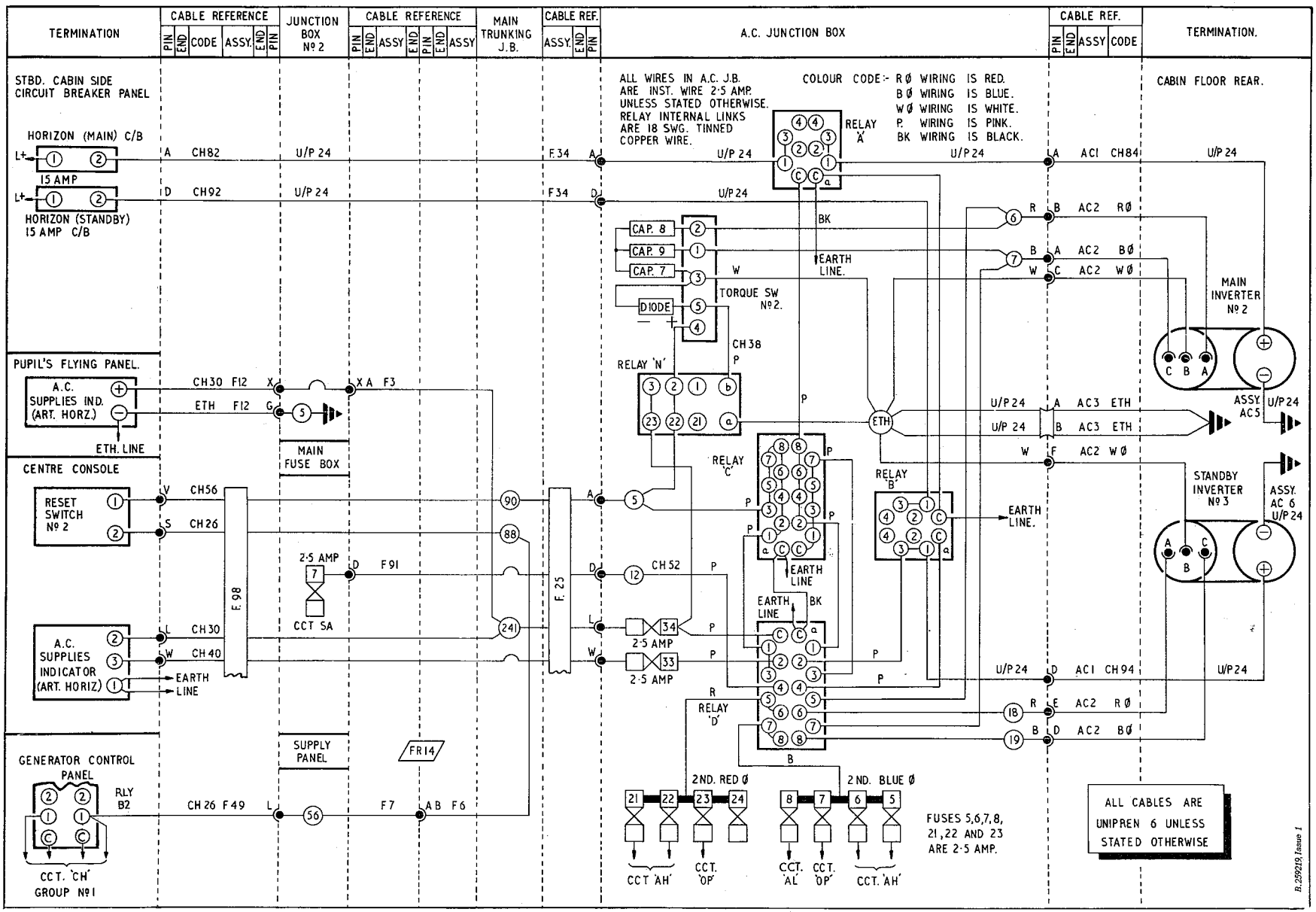

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Fig.4. A.C. supplies No.2 group (routeing)

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(7) Trip the artificial horizon group Main inverter's circuit breaker, thus simulating a failure of the artificial horizon group main inverter. Check that the artificial horizons continue operation, being supplied from the corresponding standby inverter. The artificial horizon group indicator will show STANDBY and the artificial horizon indicator WHITE.

(8) Trip the artificial horizon group standby inverter's circuit breaker. Check that the artificial horizons cease to function, and that the artificial horizon group indicator shows OFF. Reset the circuit breaker and note that there is a reversion to the condition of (7) above.

(9) Reset the artificial horizon group main inverter's circuit breaker and note that there is no change in the operation of the inverters. Momentarily switch the artificial horizon group selector switch *(i.e. switch No.2)* to STANDBY and back to NORMAL again. Check that the change-over indicator then shows MAIN and the artificial horizon indicator BLACK.

(10) Place the test switch on the generator control panel to the NORMAL position. *(This simulates failure of the engine or generators)*. Check that both change-over indicators show STANDBY and the artificial horizon indicator WHITE.

(11) Return all switches to the OFF or NORMAL position and, finally check that the change-over indicators both show OFF.

(12) Return the battery master switch to the OFF position and disconnect the external supply.

REMOVAL AND ASSEMBLY

General

24. Once access has been obtained, the removal and assembly of the components forming the a.c. supplies circuit should present no unusual difficulties. The removal of a.c. junction box No. 1, which carries the majority of the control circuit components is described in Group A.2, while the location and access to all the components is indicated in Group A.3.