Group B.1

GENERATORS AND BATTERIES (CODE GA)

◀ (Including Mod.1381) ▶

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Introduction

1. This group contains the description and operation of the generators and batteries, circuit, with information on the servicing required to maintain the equipment in an efficient condition. Routeing and theoretical circuit diagrams are also included. For a description of the aircraft electrical system reference should be made to Groups A.1, A.2 and A.3 of this chapter. Detailed information on the standard items of equipment used in this circuit will be found in the Air Publications listed in Table 1.

DESCRIPTION

Generators and batteries

2. Two d.c. generators, mounted on and driven by the engine accessories gearbox, supply the power for all the electrical services. The generators are connected in parallel and charge two batteries, also connected in parallel, mounted on a platofrm in the radio bay. The generator negative supplies are earthed to the aircraft structure at earth point 10 and 16, adjacent to the generators.

3. The generator controls are mounted on a panel, in the radio bay, which is hinged to the top starboard longeron and anchored to the supply panel by four Dzus fasteners. Each generator has its own set of control equipment. This comprises a voltage regulator, with external trimmer, a differential cut-out, and circuit breakers for the generator main output line and the generator field. There is, in addition, a reset switch, control relays, a power failure magnetic indicator and test equipment. Two eight-way fuse blocks, containing the control fuses, are also mounted on this control panel together with a ten-way terminal block which is used to link all the earth leads of the control equipment.

4. A battery master switch is fitted to the leg panel in the cabin. When placed in the OFF position, the switch isolates the aircraft batteries from all the electrical services, with the exception of the essential load line and fire extinguisher circuit. The generator power failure warning lamps, which light when-ever a failure of the supply circuit occurs, are also on the leg panel. An external supply socket is provided on the battery support structure. It is most important that an external supply is used whenever an electrical supply is required for servicing, thus preventing discharge of the aircraft batteries.

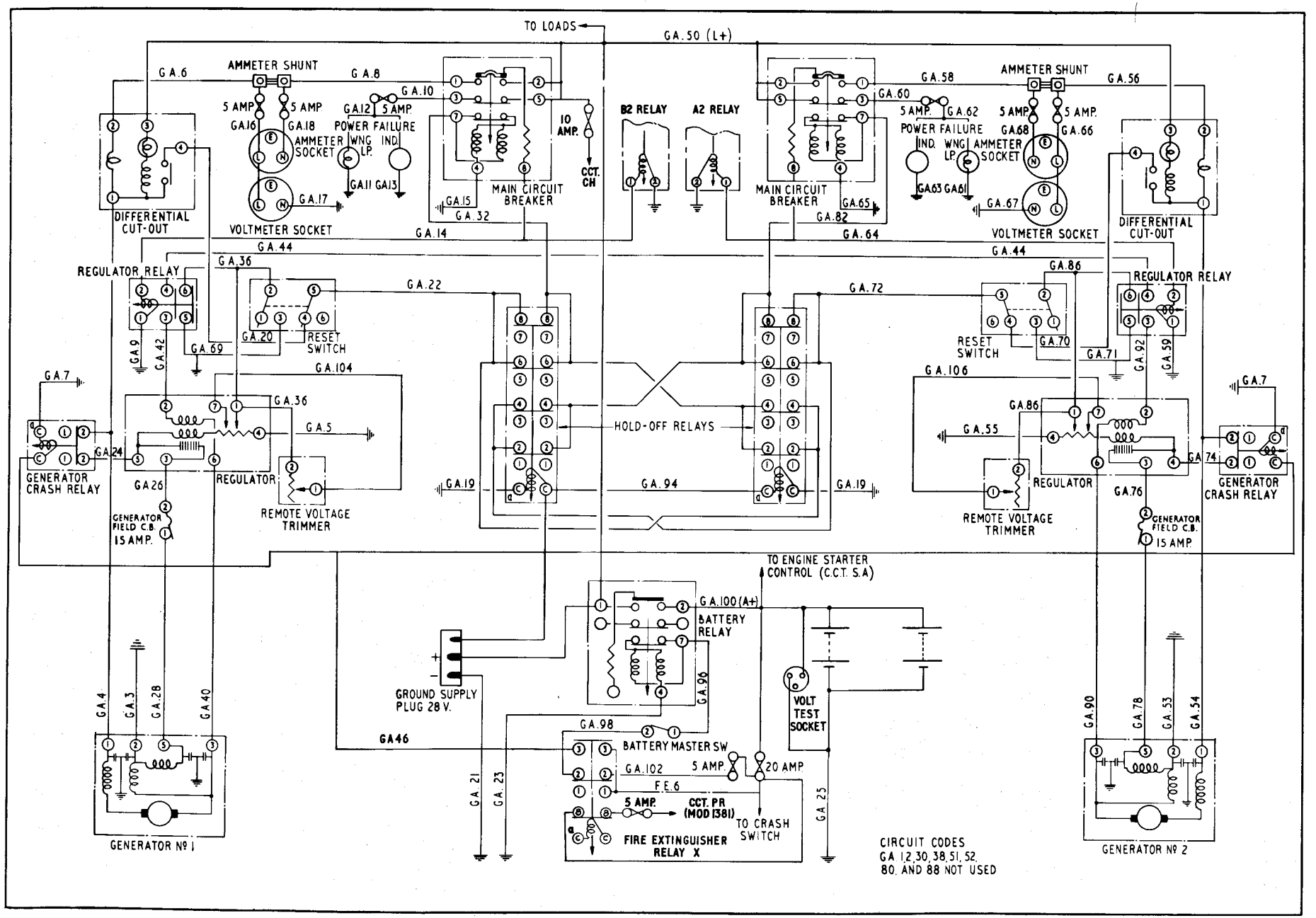

Fig. 1 Generators and batteries (theoretical)

◀ (Battery connections corrected) ▶

5. The standby batteries are carried in a battery box mounted on the starboard side of frame 16 in the radio bay, and are a pair of 12 volt. 4 amp. hour batteries connected in series. They provide a 24 volt standby supply for certain services in this aircraft should the main power supply fail, namely, the turn and slip indicator *(Chap. 2, Group 3. B)*, power controls *(Group D.2)* and cabin emergency lighting *(Group F.1)*.

Operation

6. When two generators are operating in parallel it is essential that they are regulated and aligned so that their outputs are as near equal as possible, under all operating conditions, to ensure equal load sharing and stable operation. Each generator is, therefore, provided with its own control equipment and although it operates as an independent unit, having its own characteristics when correctly regulated and aligned, it will tend to operate in conjunction with the other generator to a common factor.

7. To bring a generator into operation on a line to which another generator is already connected, it is necessary to momentarily boost the regulator controlled voltage of the additional generator so as to overcome the higher electro-motive force of the first generator, which tends to oppose the current flow from the additional generator. This boost is obtained by increasing the resistance in series with the operating coil of the voltage regulator and consequently reducing the resistance in series with the generator field windings. This operation is effected by a 3-ohm trimmer resistance in the voltage regulator, which, prior to operation of the generator, is in circuit. During normal operation of the generator, contacts 5 and 6 of the regulator relay, which are closed when the relay is energized, automatically short-circuit the trimmer, while during alignment of the generators, the trimmer may be short-circuited by use of the re-set switch *(para.20)* Additionally, contacts 3 and 4 of the relay complete the load balancing line when the relay is closed *(para.9)* As each generator control circuit is duplicated, it is only necessary to follow the operation of one generator and its control equipment to fully understand the circuit.

8. When a generator commences to rotate, an increasing voltage is developed across the output terminals, due to the residual magnetism in the field. This output is fed to the differential coil of the cut-out, the operating coil of the voltage regulator, via the normally closed contacts *(2 and 2a)* of the generator crash relay *(para.13)* and to the generator field windings, via the carbon-pile resistance in the voltage regulator. The generator field windings receive extra energization by this current which permits the output voltage to rise rapidly and this voltage builds up in opposition to the battery voltage applied to the differential coil windings and ballast lamp in the cut-out. The differential coil windings are such that, when the generator output rises to a figure of 0·35 to 0·75 volts above that of the batteries the current in the coil polarizes the armature sufficiently to cause it to move over and so close the contacts. This action energizes the closing coil of the main circuit breaker, via the re-set switch and hold-off relays, thus closing the main contacts so that the differential coil and ballast lamp are shorted out. The current now flows from the generator, through the series coil which holds the armature in the contacts-closed position and in this position the polarizing magnets also bias the armature in this direction. At the same time, the auxiliary contacts of the circuit breakers are opened, thus inserting the hold-in coil into the circuit and breaking the circuit to the power failure warning lamp and magnetic indicator.

9. As the circuit breaker main contacts close, a supply is fed to energize the regulator relay, thus removing the regulator voltage boost *(para. 7)* and completing the circuit of the load balancing coil in the voltage regulator, the coil being supplied from the generator interpole windings. Relay A.2 or B.2 is also energized to provide a supply for the a.c. supplies control circuit as described in Group E.1.

TABLE 1

Equipment type and Air Publication reference

Equipment Type	Air Publication
Generators, Type 517, 24 volt, 6 kilowatt	A.P.113B-0200 series
Main batteries, Type J, 24 volt, 25 amp. hr.	
Standby batteries, 12 volt, 4 amp. hr.	A.P.113C-0200 series
Voltage regulators, Type 94	A.P.113D-0700 series
Differential cut-outs, Type A, Mk. 2	A.P.113D-0800 series
Main circuit breakers, Type D, 200 amp.	
Field circuit breakers, Type A.3, 15 amp.	A.P.113D-0900 series
Remote voltage trimmers, Type 3, 5 ohm	A.P.113D-0700 series
Battery relay, Type R	A.P.113D-1300 series
Hold-off and crash relays, Type S, No. 3	A.P.113D-1309-1
Regulator relays, Type 9B, No. 1	A.P.113D-1328-1
Relays A.2 and B.2, Type 9B	A.P.113D-1328-1
Re-set switches, Rotax Type D.5506	
Battery master switch, C.W.C., Type XD.799, No. 4	A.P.113D-1100 series
Power failure warning lamps, Type B	A.P.113F-0600 series
Power failure warning indicators,	
Type C.5165Y, Mk. 1 or Type A.2	A.P.113F-0615-1

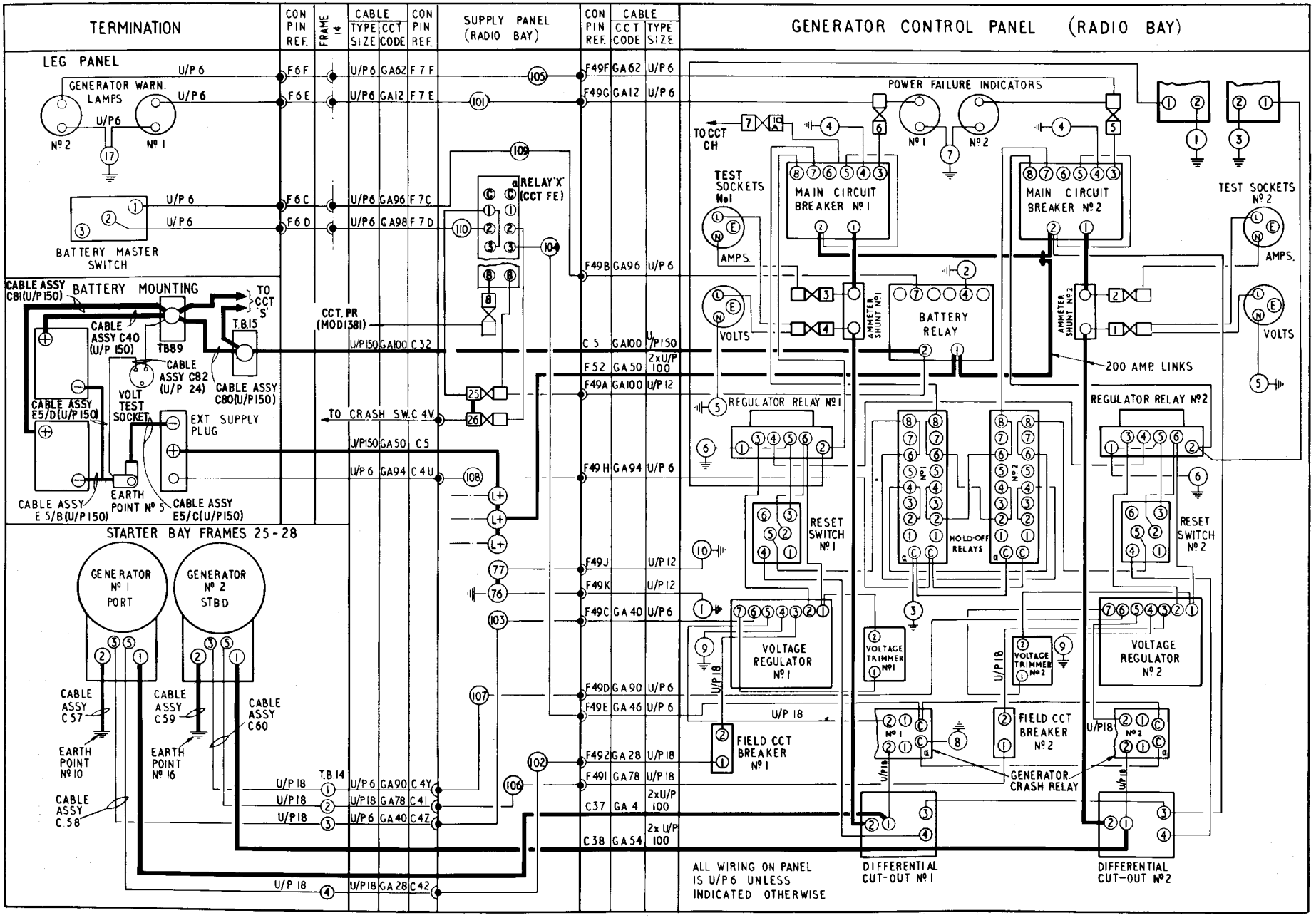

Fig. 2 Generators and batteries (routeing)

◀ (Battery connections corrected) ▶

10. The action of the operating coil in the voltage regulator is to adjust the resistance of the carbon-pile, in series with the generator field windings, relative to the load on the generator and thus maintain the voltage constant throughout the range of generator speed and output. The function of the load balancing coil is to act on the carbon-pile to reduce the voltage of the generator when it is overloaded in relation to the other generator and to increase the voltage when it is underloaded, thus the output is varied according to the load imposed and the load is shared more or less equally between the two generators.

Power failure

11. Power failure is indicated by one warning lamp and one magnetic indicator for each generator. When the generator voltage falls below that of the batteries, a reverse current flows in the series coil of the cut-out and this reverses the polarity of the armature and opens the contacts. This action de-energizes the holding coil of the circuit breaker and breaks the main contacts, thus disconnecting the generator from the batteries and de-energizing either relay A.2 or B.2 (*Group E.1*). The contacts feeding the power failure warning lamp and magnetic indicator are made when the main contacts break and the lamp and indicator operate to indicate failure. At the same time, the regulator relay is de-energized to break the load balancing line and connect into circuit the 3-ohm trimmer in the voltage regulator, thus providing voltage boost, which, if the fault was of a temporary nature, will enable the generator to re-commence operation in the normal manner. When the generator is shut down, i.e., engine stopped and batteries isolated, the armature of the cut-out is biased in the open position by the polarizing magnets.

Batteries

12. The batteries are connected to the positive bus-bars via the battery relay which is energized from the battery essential load line and controlled by the fire extinguisher relay and battery master switch. Placing the master switch in the ON position, with the fire extinguisher relay de-energized, i.e., in its normal condition, energizes the closing coil of the battery relay and causes the main contacts to close and the auxiliary contacts to open. The batteries are thus connected to the bus-bars through the main contacts while the hold-on coil of the battery relay is energized by the breaking of the auxiliary contacts.

Off-loading

13. In the event of a crash landing the inertia switches in the fire extinguisher circuit (*Group C.2 of this chapter*) will operate and energize the fire extinguisher relay which, apart from operating the fire extinguisher, will also break the supply to the battery master switch and battery relay, thus opening the main contacts of the battery relay and isolating the batteries from all but the essential load line and fire extinguisher circuit. At the same time, the fire extinguisher relay makes the supply to the generator crash relays, which become energized and break the supply to the voltage regulator operating coils, thus off-loading the generators.

External supply

14. When an external supply is connected to the external plug for testing the aircraft electrical equipment, the coils of the hold-off relays are fed from the external supply, via a "loose" positive link, before the main positive connection is made. The hold-off relays are thus energized and break the feeds to the generator circuit breakers, the main contacts of which open to isolate the generators so preventing the external supply attempting to "motor" the generators. It is also advisable to place the battery master switch to OFF when the external supply is connected, to prevent the batteries being discharged should the external supply voltage fall below that of the batteries.

Test sockets

15. Voltmeter and ammeter test-sockets, together with an ammeter shunt, are provided for each generator for use when adjusting the circuit as described in para. 20.

Standby supply

16. The operation of the standby supply circuit (B+) will be obvious when reference is made to fig. 3 of this group and to the routeing and theoretical diagrams contained in Group F.1 of this chapter. For information regarding the turn and slip indicator, reference should be made to Chapter 2, Group 3 of this section.

SERVICING

General

17. For general servicing of the circuit as a whole, reference should be made to Group A.1 of this chapter. Absolute cleanliness of all parts, particularly the generator brush gear and commutator, together with the immediate remedy of any defects, however small, is essential for the reliable operation of the circuit. The contacts of the cut-outs, circuit breakers and relays must be kept clean and the terminals of all components must be kept tight and free from corrosion. For functional tests and detailed servicing of the standard components used, reference should be made to the appropriate Air Publications quoted in para. 1.

Servicing main batteries

18. The state of charge of the main batteries installed in this aircraft is determined by voltage, as no check of specific gravity is possible. A small three-pole test socket is located adjacent to the batteries for this purpose. When using this socket, it is essential to check one battery at a time and this may be accomplished by removing the Cannon plug from one of the batteries while checking the other and vice versa. After test, ensure that both Cannon plugs are reconnected to the batteries.

19. The open circuit voltage of a fully-charged battery is 25·8 to 25·1 volts, a quarter to half discharged battery is 25·1 to 24·5 volts and a half discharged battery is 24·5 to 24·2 volts. To obtain more definite information on the state of charge, an off-load reading should be taken immediately after taking a reading with the battery

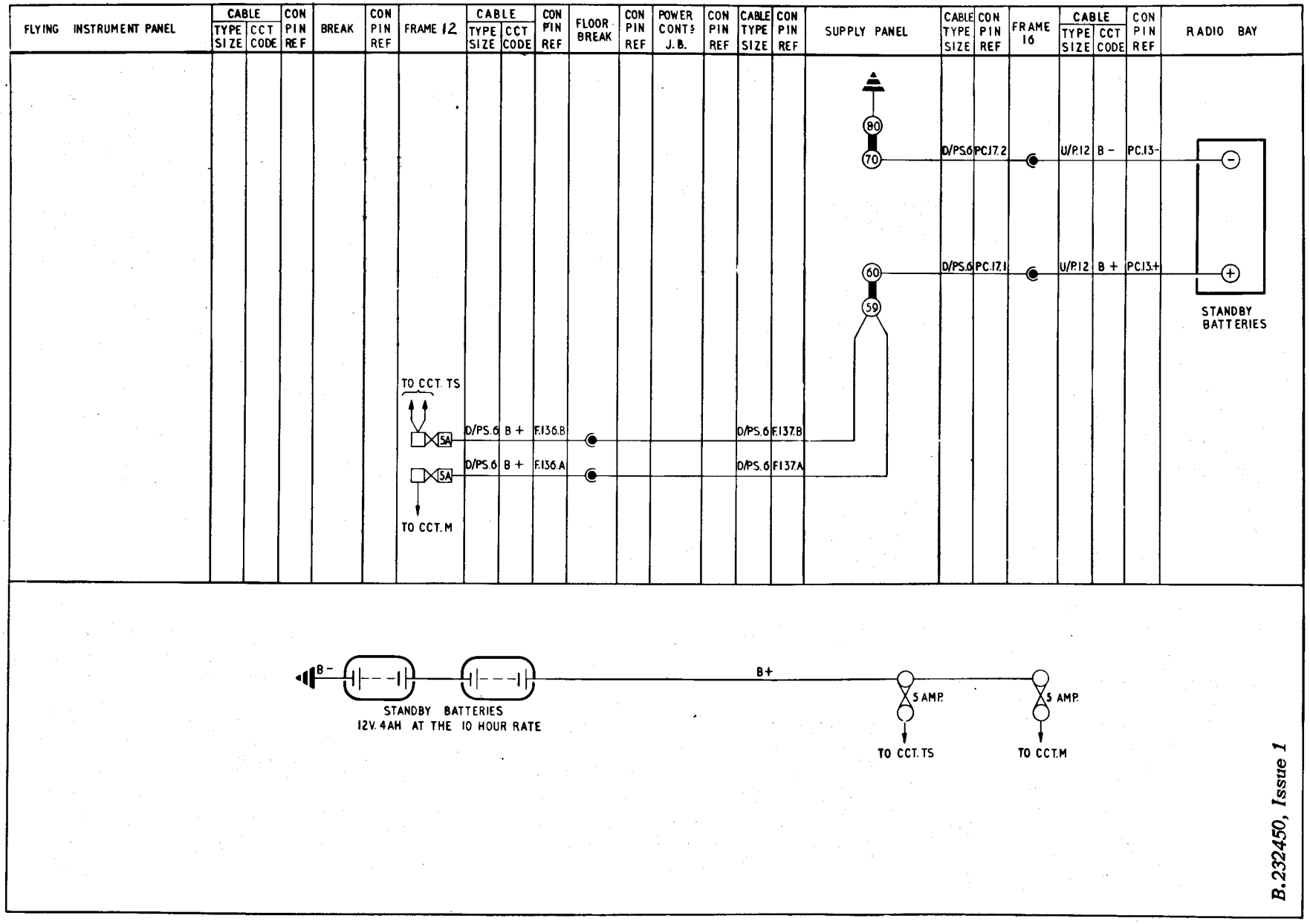

Fig. 3 B + distribution

connected to a load of approximately 20 amp for 15 seconds, i.e., radio, navigation lamps and cabin lamps switched on. The increase in reading from on load to off load should be approximately 1 volt. If the aircraft is not flown or the engine is not run-up for more than two weeks, the batteries must be removed and given a freshening charge. Under no circumstances should the batteries be left without a freshening charge for more than four weeks or serious deterioration will result. For detailed servicing of the batteries, reference should be made to the Air Publication quoted in para. 1 of this group.

Paralleling of generators

20. The generating circuits should always be ensured parallel after the fitment of a new generator, a new voltage regulator, a new cut-out or after any servicing which may have disturbed the alignment of the circuits and also when a check is indicated as being necessary. Using a Multimeter Type 12889 or similar test equipment, the procedure for checking the generator control system is as follows:-

Note . . .

Before commencing operations, ensure the aircraft batteries are at least 80% charged.

(1) Start the engine in accordance with the instructions detailed in AP101B-1301/1301A-12 *(Ground handling notes).* Ensure both generator failure warning lamps extinguish at an engine speed of approximately 2 000 rev/min and that the power failure magnetic indicators operate correctly.

(2) Run the engine at the normal cruising speed of 7 800 rev/min.

(3) Select No. 1 generator re-set switch to RE-SET, *(No. 1 generator off-load warning lamp illuminated, power failure magnetic indicator indicating white),* connect the testmeter to No. 1 volts test socket and ensure a voltage of 28V d.c. ± 0.25V d.c., adjusting the external voltage trimmer as necessary to obtain this figure. Select No. 1 generator re-set switch to NORMAL, checking that the regulated voltage momentarily rises by approximately 1 volt as the generator output is boosted to enable it to come on line. Disconnect the testmeter from the test socket.

Note . . .

The voltage boost is removed immediately the main contactor closes and is therefore evident for a very short period. Some testmeters may not respond quickly enough to fully show the temporary increase.

(4) Select No. 2 generator re-set switch to RE-SET, *(No. 2 generator off-load, warning lamp illuminated, power failure magnetic indicator indicating white),* connect the testmeter to No. 2 volts test socket and ensure a voltage of 28V d.c. ± 0.25V d.c., adjusting the external voltage trimmer as necessary to obtain this figure. Select No. 2 generator re-set switch to NORMAL, checking that the regulated voltage momentarily rises by approximately 1 volt as the generator comes on line. Disconnect the testmeter from the test socket.

(5) Increase the engine speed to maximum and repeat sub-para. (3) and (4) ensuring a voltage of 28V d.c. ± 0.25V d.c. Reduce the engine speed to 2 500 rev/min.

(6) With the testmeter disconnected from the volts test sockets and both generator re-set switches selected to NORMAL, connect ammeters to the ammeter test sockets. Ensure a load of at least 50 amp, including battery charging, is imposed on the L+ bus-bar. Increase the engine speed to maximum, checking that the load current difference between No. 1 and No. 2 generators does not exceed 10 amp throughout the engine speed range.

Note . . .

If this figure is exceeded, the procedure detailed in sub-para.(2), (3) and (4) should be repeated followed by a further load sharing check.

(7) With the ammeters still connected, reduce the engine speed to idling. Shut down the engine and as the speed reduces through approximately 1 800 rev/min, ensure the cut-out contacts open, illuminating the power failure warning lamps and operating the power failure magnetic indicators. During this period, check that the reverse current reading on the ammeters is between 15 amp and 25 amp. The generating circuits are now aligned and the ammeters may be removed from the ammeter test sockets. ▶

REMOVAL AND ASSEMBLY

General

21. The removal of the generator control panel which carries the majority of the equipment forming the generating circuit, is described in Group A.2 of this chapter. The removal of the main and standby batteries is described in the following paragraphs. Once clear access has been obtained, the removal of the generators and other components of the circuit, should present no special difficulties.

Changing main batteries

22. The two main batteries are carried on platforms located on frame 19 in the radio bay and access may be gained via the radio bay access doors. The procedure for changing the batteries is as follows:-

(1) Ensure that the battery master switch is in the OFF position.

(2) Disconnect the vent pipes from each battery.

(3) Remove the Cannon plugs from each battery and place in such a position so that they will not short on the aircraft structure.

(4) Disengage the special quick release bolts securing each battery and carefully remove the batteries from their mounting platforms.

(5) Examine the replacement batteries to ensure that their voltage is within ± 0.5 volts of each other. Place the replacement batteries on the platforms and reverse the procedure in sub-para. (2) to (4).

Note . . .

Before attempting to connect the batteries, ensure that the Cannon plugs are not shorting against the aircraft structure.

Removal of standby batteries

23. These batteries are carried in a box located on the starboard side of frame 16 in the radio bay, access being gained by opening the radio bay access doors. To remove the batteries, proceed as follows:-

(1) Render the aircraft electrically safe, as described in Group A.1 of this chapter.

(2) Disconnect cable assembly P.C.13 from cable assembly P.C.17 at the plug and socket connection on the side of the battery box.

(3) Withdraw the two draw bolts at the top of the box from the mounting structure and lift the box upwards to disengage its lower mountings.

(4) Remove the box and batteries from the aircraft.

(5) The batteries may be removed from the box by opening the lid and disconnecting the leads of the cable assembly P.C.13 from the battery terminals.

LIST OF APPENDICES

Appendix 1 - MODIFICATION 1320 (S.O.O.)

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LIST OF ILLUSTRATIONS

Introduction

1. This Appendix describes the changes to the generators and batteries circuit introduced by Mod.1320 *(Tacan)* into certain Mk. 6 aircraft. Circuit operation for the A.R.I.18107 *(Tacan)* equipment is described in Sect. 5, Chap. 1, Group H.1, Appendix 2.

DESCRIPTION

General

2. On aircraft with Mod.1320 incorporated relays A.2 and B.2 Type 9B are replaced by relays Type 10B, No. 15 or Type 20B, No. 1. Contacts 1-1 and 3-3 of hold-off relay Q are wired to the invertor test switches, which are used to energize relays A.2 and B.2 when ground testing the a.c. supplies circuit as described in Group E.1. Contacts 7-7a of relays A.2 and B.2 complete a safety circuit to the regulator load balancing coil. If either regulator relay dropped out, a supply would continue to be fed to the load balancing coil in the regulator, via these relays. Contacts 5-5a of relays A.2 and B.2 also provide a duplicate supply for the re-set switch in the RE-SET position. The remaining contacts of relays A.2 and B.2 are used in the a.c. supplies control circuit *(Group E.1).*

Operation

3. The operation of the generators and batteries circuit is fully described in Sect. 5, Chap. 1, Group B.1.

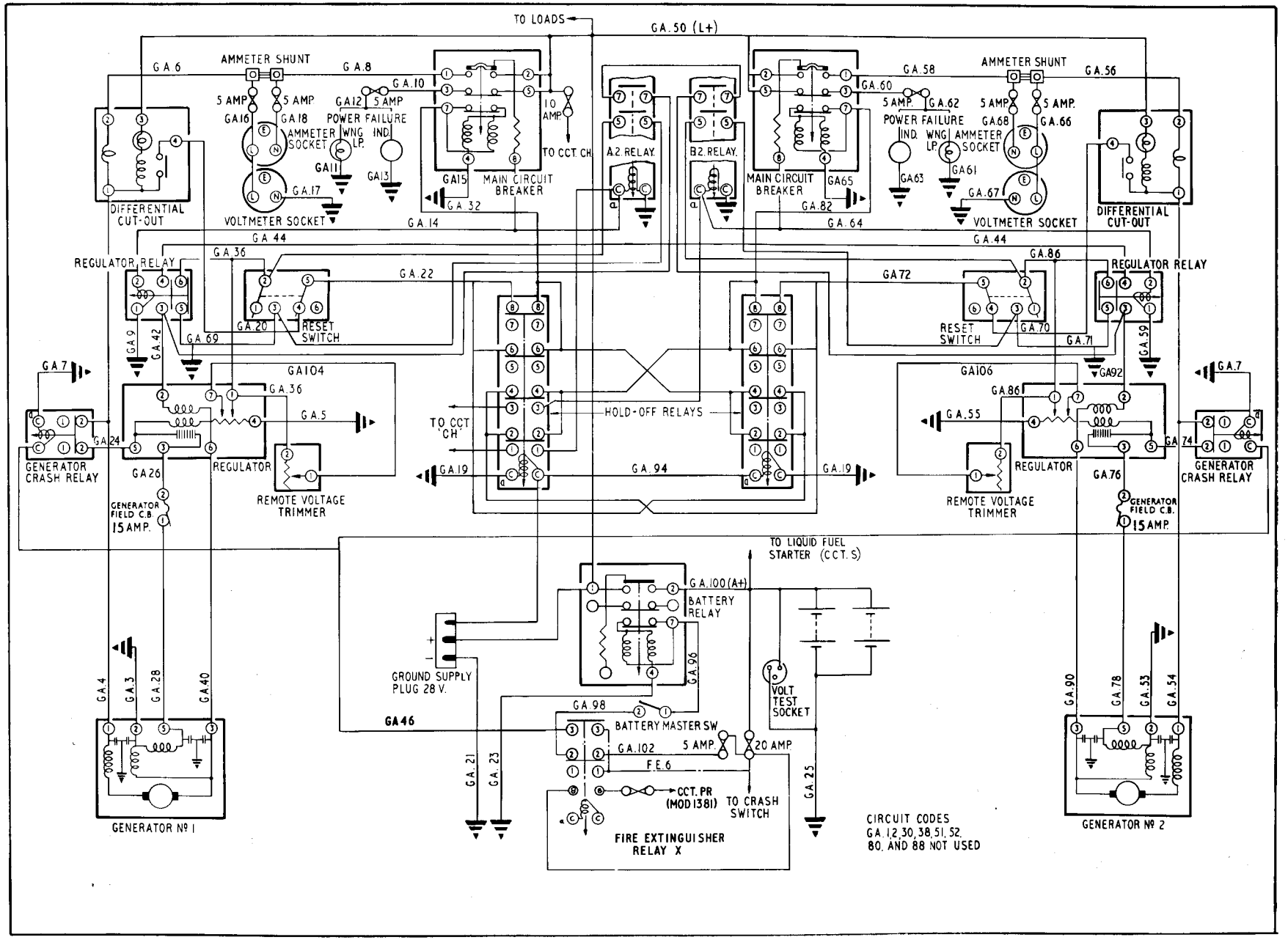

Fig. 1 Generators and batteries (theoretical)

◀ (Mod.1381 added) ▶

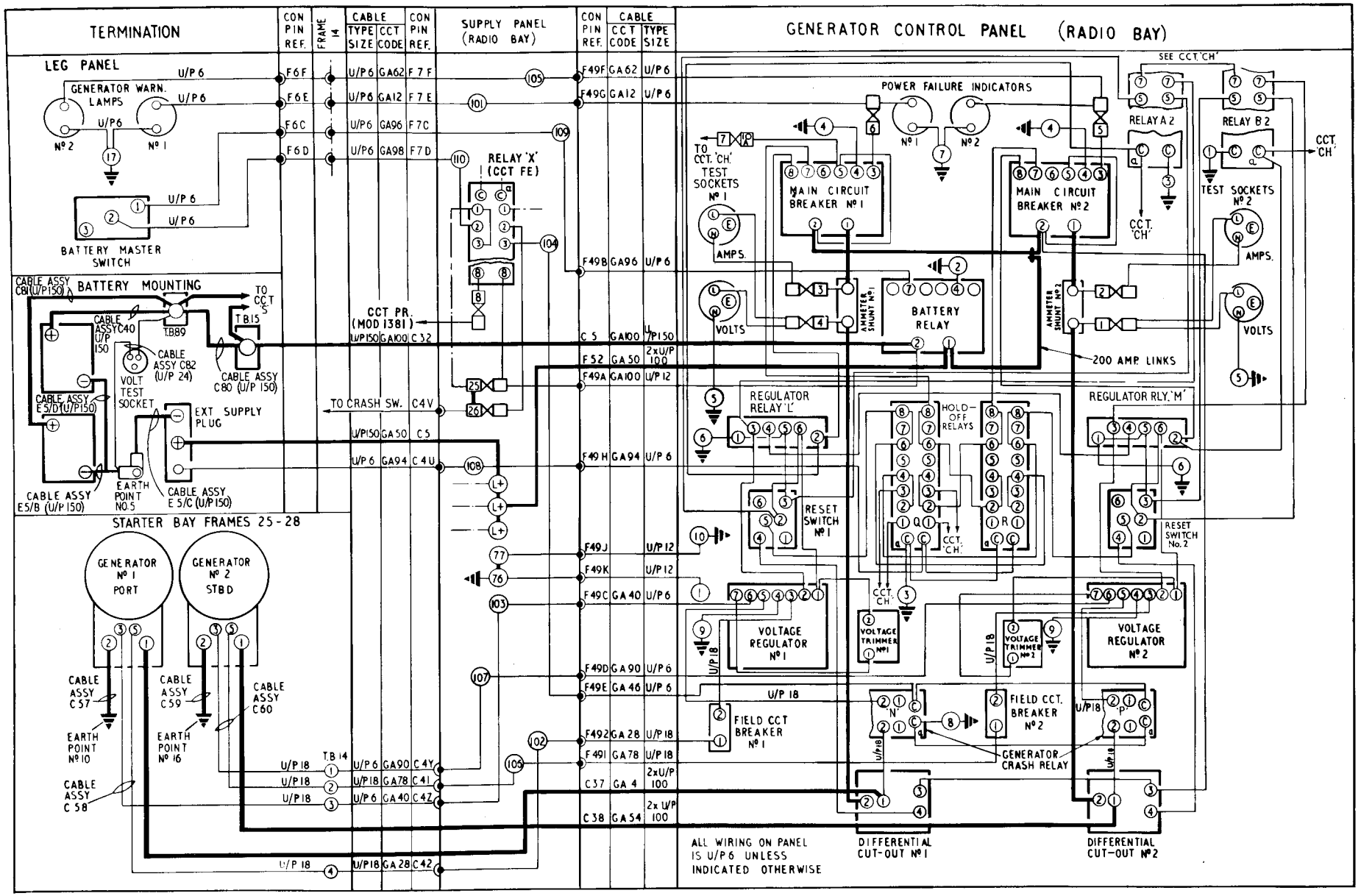

Fig. 2 Generators and batteries (routeing)

◀ (Mod.1381 added) ▶

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