GROUP B.1.

GENERATORS AND BATTERIES (CODE GA)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Equipment employed

1. The major components employed in the generators and batteries circuit of this aircraft are quoted below, together with the appropriate Air Publications to which reference should be made for a detailed description and the necessary servicing required for the components concerned.

Generators, Type 517, 24-volt, 6 kilowatt	A.P.4343A,Vol.1, Sect.3, Chap.16
Batteries, Type C, 12-volt, 25-amp...	A.P.4343A,Vol.1, Sect.11,Chap.1
Voltage regulators, Type 94..	A.P.4343B,Vol.1, Sect.1, Chap.31
Differential cut-outs, Type A. Mk.1..	A.P.4343B,Vol.1, Sect.10,Chap.5
Main circuit breakers, Type D, 200 amp...	A.P.4343B,Vol.1, Sect.10,Chap.8
Field circuit breakers, Type A. 3 12 15 amp.	A.P.4343B,Vol.1, Sect.10,Chap.6
Remote voltage trimmers, Type 3, 5 ohm...	A.P.4343B,Vol.1, Sect.1, Chap.31
Battery relay, Type R	A.P.4343B,Vol.1, Sect.22,Chap.12
Hold-off and crash relays, Type S, No.3	A.P.4343B,Vol.1, Sect.22,Chap.13
Regulator relays, Type 9.B, No.1	A.P.4343C,Vol.1, Sect.3, Chap. -
Reset switches, Rotax Type D.5506	A.P.4343C,Vol.1, Sect.1, Chap. -
Power failure warning lamps, Type B..	A.P.4343E,Vol.1, Sect.18,Chap.8
Power failure warning indicators, Dowty Type C. 5165Y, Mk.1 or Type A2. ...	A.P.4343E,Vol.1, Sect.18,Chap. -

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 of this aircraft. The generators are connected in parrallel and charge two batteries which are connected in series and mounted on a platform in the radio bay. To enable earth return equipment to be employed, the generator negative supplies are earthed to the aircraft structure at earth points 10 and 16 located adjacent to the generators.

3. The generator controls are mounted on a panel, located in the radio bay, which is hinged to the top starboard longeron and anchored to the supply panel by four Dzus fasteners. Each generator is provided with 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 windings, respectively. There is, in addition, a re-set switch, control relays, a power failure magnetic indicator and testing 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 located on 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 whenever a failure of the supply circuit occurs, are also located on the leg panel. An external supply socket is provided on the battery support structure to enable an external supply to be connected to the aircraft services. It is most important than an external supply is used whenever an electrical supply is required for servicing, thus preventing the aircraft batteries being discharged.

Operation

5. When two generators are operating in parrallel 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 characteristic when correctly regulated and aligned, it will tend to operate in conjunction with the other generator to a common factor. 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 electromotive 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.13). Additionally, contacts 3 and 4 of the relay serve to complete the load balancing line when the relay is closed (para.6). 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.

6. 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 2) of the generator crash relay (para.9) 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 current passing through 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 breaker are opened, thus inserting the hold-in coil into the circuit and breaking the circuit to the power failure warning lamp and magnetic indicator. As the circuit breaker main contacts close, a supply is fed to energize the regulator relay, thus removing the regulator voltage boost (para.5) and completing the circuit of the load balancing coil in the voltage regulator, the coil being supplied from the generator interpole windings.

7. 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 current drain and thus maintain the voltage constant throughout the range of operating speed and output. The function of the load balancing coil is such that it acts 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.

8. 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. The contacts feeding the power failure warning lamp and magnetic indicator are made when the main contacts beak 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 the batteries isolated, the armature of the cut-out is biased in the open position by the polarizing magnets.

9. 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. 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.

10. 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 from 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.

11. 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.13.

SERVICING

General

12. 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.

Parallelling of generators.

13. The generating circuit should always be parallelled 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 circuit and also when a check indicates that adjustment is necessary. The procedure, after the units have been adjusted on the bench as described in the relevant Air Publications, is as follows:-

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

(1) Start the engine in accordance with the instructions contained in A.P.4347F - G.H.N. (Ground Handling Notes) and in A.P.4282, Vol.1, using the aircraft's batteries.

(2) Connect the test leads of a 0-30 volt voltmeter to No.1 generator voltmeter test socket.

(3) With the engine running at the normal cruising speed (7,800 R.P.M.) and No.1 generator re-set switch set to RE-SET (generator off-load, power failure magnetic indicators indicating white and warning lamps illuminated) adjust the external voltage regulator trimmer resistance until 28 ± 0.25 volts is indicated on the voltmeter.

(4) Increase and decrease the engine speed from ground idling (2,500 R.P.M.) to the full engine speed (7,900 R.P.M.) at least three times and then check the voltage again at the original R.P.M. to ensure that it is still at 28 ± 0.25 volts.

(5) With the engine running at approximately 6,000 R.P.M., check the load balancing coil of connecting a voltage of 0.25 volts across terminals 2 and 6 of No.1 generator voltage regulator, terminal 2 being connected to the positive side of the supply. The regulated voltage should be reduced by 2 to 2.5 volts.

(6) Ensure that both re-set switches are set to RE-SET and connect a ground supply socket to the external supply plug in order to energize the hold-off relays.

(7) With the engine still running at 6,000 R.P.M., check that the controlled voltage is increased by 1± 0.25 volts whenever the re-set switch is set to NORMAL.

(8) Disconnect the ground supply socket from the external supply plug, remove the voltmeter test socket and connect it to No.2 generator voltmeter test socket.

(9) Adjust the voltage regulator for No.2 generator by repeating operations (3), (4), (5), (6) and (7) with No.2 generator re-set switch set to RE-SET.

(10) Ensure that both re-set switches are set to RE-SET and disconnect the ground supply socket from the external supply plug.

(11) Decrease the engine speed to ground idling (2,500 R.P.M.) switch both re-set switches to NORMAL and check:-

(a) That both the power failure magnetic indicators indicate black.

(b) That both warning lamps are extinguished without flickering.

(c) That there is no tendency for the cut-outs and main circuit breakers to chatter.

(12) Should the warning lamps flicker or the cut-outs and main circuit breakers chatter, it is essential that the cut-outs and/or circuit breakers are disconnected from the equipment on the generator control panel and re-adjusted as described in the relevant Air Publications. After adjustment and reconnection operations (11) must be repeated to ensure that the equipment is now operating correctly.

(13) With voltmeters in both voltmeter test sockets, increase engine speed gradually to the full engine speed (7,900 R.P.M.) and check that the voltage indicated on both instruments is 28± 0.25 volts at all speeds.

(14) Remove the voltmeters from the test sockets and connect ammeters to both ammeter test sockets.

WARNING

Before inserting the ammeters, it is important to ensure that the voltmeter is not in circuit, as damage may be caused to an ammeter should its shunt be isolated due to the non fitment or failure of its fuse while both instruments are in circuit.

(15) Switch off the engine and during the run-down time, check by reference to the power failure warning lamps and magnetic indicators, that the cut-out contacts open at a speed of approximately 1,800 R.P.M. Also during this time check that the reverse current recorded on the ammeters is not below 15 amps. minimum or above 25 amps. maximum.

(16) If the cut-out contacts do not open at a speed of approximately 1,800 R.P.M. or the reverse current is above the top limit of 25 amp., the cut-outs must be disconnected from the equipment of the panel and the reverse current setting re-adjusted as described in the relevant Air Publication. After adjustment and reconnection, operation (15) must be repeated to ensure that the cut-outs are now operating correctly.

(17) If adjustments are made, it is important that the adjusting screws are sealed with shellac varnish and the top covers refitted.

NOTE...

<u>The covers should not remain off longer than necessary.</u>

(18) Both generators are now correctly regulated and are ready for parallelling.

(19) Place both re-set switches to the NORMAL position and re-start the engine as in operation (1).

(20) During the starting period, check that at approximately 2,000 R.P.M. the power failure magnetic indicators on the generator control panel change from white to black and that the warning lamps in the cabin are extinguished.

(21) With the engine running at ground idling speed, insert a voltmeter into one of the voltmeter test sockets. Increase engine speed gradually to the full engine speed (7,900 R.P.M.) and check that the voltage indicated is 28 $\pm$ 0.25 volts at all speeds.

(22) Slow down the engine to idling speed and remove the voltmeter. Insert ammeters into both ammeter test sockets and increase engine speed gradually to the full engine speed. Check that the current indicated on both instruments is approximately equal at all speeds.

(23) The above conditions should be obtained if the foregoing instructions have been carried out correctly.

(24) Check the voltage regulators for stability by switching on a typical flight load, i.e. flight instruments, radio and radar ranging. At an engine speed of 6,000 R.P.M. switch one of these loads, i.e. flight instruments on and off at least three times. Under these conditions the regulators should respond without any tendency to hunt.

(25) The generating circuit is now aligned and the engine may be switched off and the voltmeters and ammeters removed,

REMOVAL AND ASSEMBLY

General

14. The removal of the generator control panel, which carries the majority of the equipment forming the generating circuit, is fully described in Group A.2 of this chapter, while the removal of the batteries is covered in Section 2, Chapter 2 of this publication. Once clear access has been obtained, the removal of the generators and other components of the circuit, should present no special difficulties.

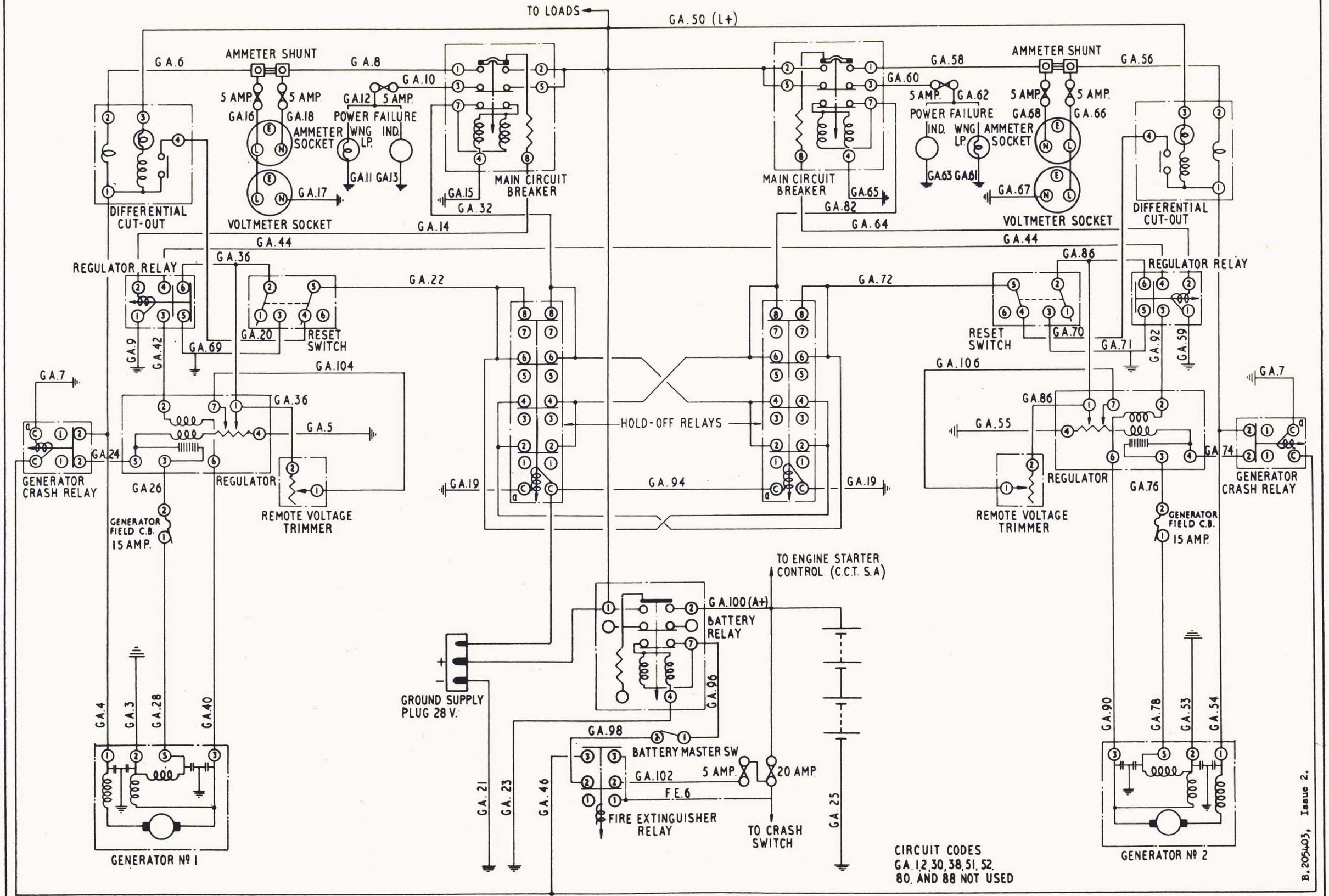

FIG. 1. GENERATORS AND BATTERIES (THEORETICAL)

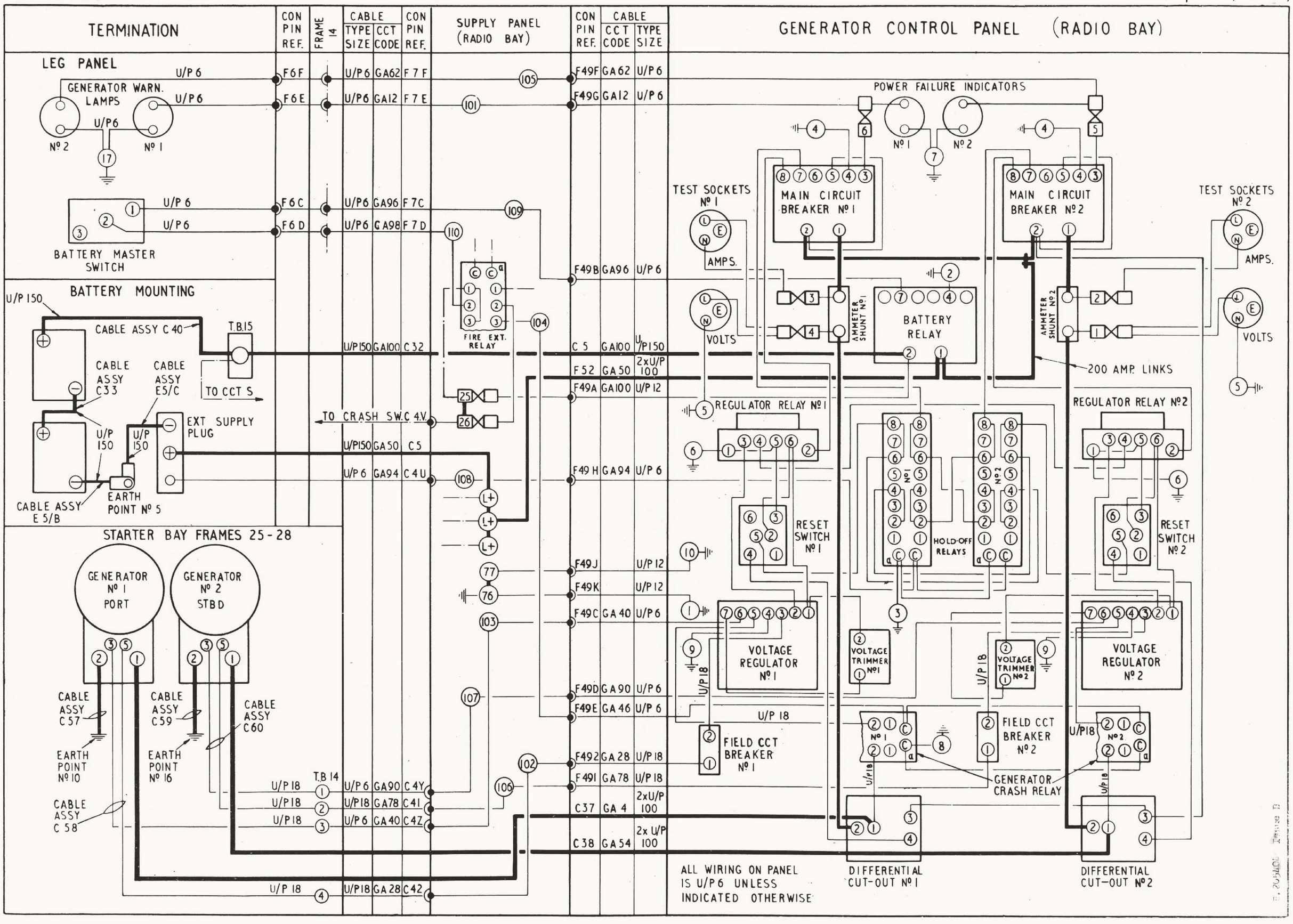

FIG. 2. GENERATORS AND BATTERIES (ROUTING)