Group 2—D.C. SYSTEM

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WARNING . . .

Voltages in excess of 100 volts either a.c. or d.c. can be dangerous under certain circumstances. Personnel should therefore ensure that the electrical system is electrically safe before any servicing is attempted. Where it is essential that tests or adjustments are to be made with the electrical power switched on, the utmost care must be exercised.

112-VOLT SYSTEM

◀**Note . . .**

If a generator comes off line, for whatever reason, no attempt must be made to reset it until it has been determined whether the field thermal relay has operated or not, this can be checked by observing the generator voltage.

If the generator volts are approximately zero, the field thermal relay may have operated and no attempt should be made to re-engage the generator or move the switch to RESET. It is quite safe to leave the switch at ON.

If the generator output is approximately 110-*volts, the field thermal relay has not operated and the generator may be re-set and re-engaged.*▶

Outline of system (*fig.* 1)

3. The four 22½kW generators are driven one by each engine, the full output being obtainable at all engine speeds between idling and maximum take off.

Introduction

1. This Group contains descriptive and servicing information on the d.c. system of the aircraft. Reference should be made to the relevant Air Publications for the detailed information on the operation and servicing of the items of equipment used in the system.

2. A description of the general modifications applicable to all types of Valiant aircraft can be found in the General Information group contained in Book 2 immediately after Section 5 marker card. Subsequent to March 1962, modifications affecting this group will be covered by appendices which will be periodically incorporated into the group. Information on the layout and interpretation of the schematic diagrams is given in the General Information group.

DESCRIPTION AND OPERATION

4. The output of each generator is maintained at 110-volts by a carbon pile regulator and all generators are connected in parallel, load balancing between the generators being achieved by an equalizing line connected to an equalizing coil in the regulator. A control switch with three positions, ON, RESET OR OFF and TRIM (pre-Mod. 2301) or ON, RESET and TRIM OR OFF (post Mod. 2301) is used to isolate the generator from the line, for re-setting after an overload and for setting up the voltage regulators.

Note . . .

In order to avoid confusion between pre and post Mod. 2301 *switch markings, the switch positions will be referred to as* ON, RESET *and* TRIM *in the following paragraphs.*

5. The generator control system includes reverse-current protection, under-voltage protection, thermal overload protection in both the main and field lines, and a power failure warning indicator. Post Mods. 2259 and 2680 protection is provided in case of very heavy or crash landings by tripping the generators off-line automatically.

6. Radio interference is minimized by suppressors built into the generators, with the exception of the equalizing, or balancing, line from the generator where a separate single-leg 5-amp. suppressor is fitted.

Voltage regulation (*fig.* 1 *and* 2)

7. The carbon pile of the regulator is connected in the generator field circuit and is controlled by the regulator voltage coil. An additional winding known as the equalizing coil, and carrying the equalizing line current, operates to buck or boost the

voltage according to whether the current is high or low. This winding is connected across a portion of the series field of the generator, on the negative side of the armature. Should any generator take an unequal share of the load, the voltage drop across its series field will be greater than that across the others, and a current will flow through the regulator equalizing coil in such a sense as to reduce the generator field current and lower its output. A potentiometer (ballast resistance) in the equalizing line of each generator has its slider set to the mechanical mid-position of the resistance and this effectively compensates for any differences in the resistance of the generator windings and for variations in the cable resistance of different machines. The generators are manufactured to such close tolerances that the slider need never be moved from the mechanical mid-position of the potentiometer.

Note . . .

The regulator ballast resistance is 1·25 *ohms of which* 0·625 *ohms are required in the equalizing circuit; this corresponds to the slider being in the mechanical mid position of the resistance.*

8. It should be noted that the equalizing circuit is automatically interrupted when the main circuit-breaker R2 trips, thus preventing a feed back through the regulator when any generator is off the line.

9. The regulators are fitted with external trimmers, but these may only be adjusted when the generator is not on load, a condition that is obtained by moving the generator control switch to the TRIM position. The purpose of this switch is, firstly to de-energize the circuit breaker interlock relay R1 and open (R1/1) the main circuit breaker R2, thereby allowing the generator to operate on no load, and secondly to close (R1/2) the line between the regulator ballast resistance and the external trimming resistance, as this circuit is broken by the main circuit-breaker (R2/6) when it is de-energized. The remote trimmer circuit contacts of the circuit-breaker interlock relay (R1/2), which is operated by the control switch, are in parallel with those of the main circuit breaker (R2/6) and so close the circuit to the remote trimmer resistance when the control switch is selected to TRIM.

Normal operation (*fig.* 1 *and* 2)

10. With the generator control switch selected to ON, a supply from panel G, is connected to the generator circuit-breaker interlock relay R1. This relay operates to close a pair of contacts (R1/1) in the generator main circuit-breaker (R2) line, to make ready the circuit for the operation of the main circuit-breaker when the differential relay operates. At the same time contacts (R1/2) open in the regulator trimmer circuit to enable the generator output voltage to rise in excess of the bus-bar voltage. When an engine is started, the generator output voltage will increase and at a value between 70 and 75 volts, the under-voltage relay coil R25 will be energized. The under voltage relay operates, to connect (R25/2) a supply from the generator to the differential relay voltage coil R23A and contacts (R25/3) open to insert an economy resistance in series with the under-voltage relay coil As the generator speed increases the output voltage will increase (sine the voltage regulator trimmer circuit is open-circuited (R1/2) until the generator main circuit-breaker R2 is energized) and when the generator output voltage exceeds the bus-bar voltage the differential relay voltage coil R23A will be energized. (The bus-bar voltage will be 96-volts, maintained by the 96-volt battery, until at least one generator is on-line when it will be regulated at 110 volts).

11. The differential relay operates (R23A/1) to connect a supply, from panel G, through the control switch to the generator main circuit-breaker R2 via the generator field thermal relay (R3/1) and the generator circuit-breaker interlock relay (R1/1). The main circuit breaker operates:—

(1) To connect (R2/5) the generator to the bus-bar via the differential relay current coil R23 and the reverse current H.R.C. fuse.

(2) To common the equalizing lines to one point via the auxiliary contacts (R2/4).

(3) To disconnect (R2/3) the supply to the generator failure warning lamp.

(4) To connect (R2/1) a supply to an economy hold-in coil for the main circuit breaker.

(5) To close (R2/6) the circuit between the regulator ballast resistance and remote trimmer thereby introducing voltage regulation.

12. The reason for the remote trimmer circuit of the voltage regulator being kept open-circuited, until the main circuit-breaker connects the generator to the bus-bar, is to reduce the current in, and hence the voltage across, the regulator voltage coil. This allows the carbon pile to be fully compressed, so reducing the resistance in the generator shunt field circuit. This results in the generator output voltage being rapidly built up above the normal regulated voltage so operating the differential relay. Once the generator is connected to the bus-bar, voltage regulation is immediately introduced, since the main circuit-breaker will close both the regulator voltage and equalizing circuits. The generator may be switched "off-line" by moving the generator control switch to OFF.

Trimming (*fig.* 1 *and* 2)

13. The control switch at TRIM breaks the circuit to the coil of the circuit-breaker interlock relay R1 (also known as the trimmer relay), so interrupting (R1/1) the positive feed to the main circuit-breaker coil R2 and making the connection (R1/2) between the regulator ballast connection and the remote trimmer resistance. This enables the voltage regulation to continue although the main circuit-breaker contacts (R2/6) in the remote trimmer circuit have been opened.

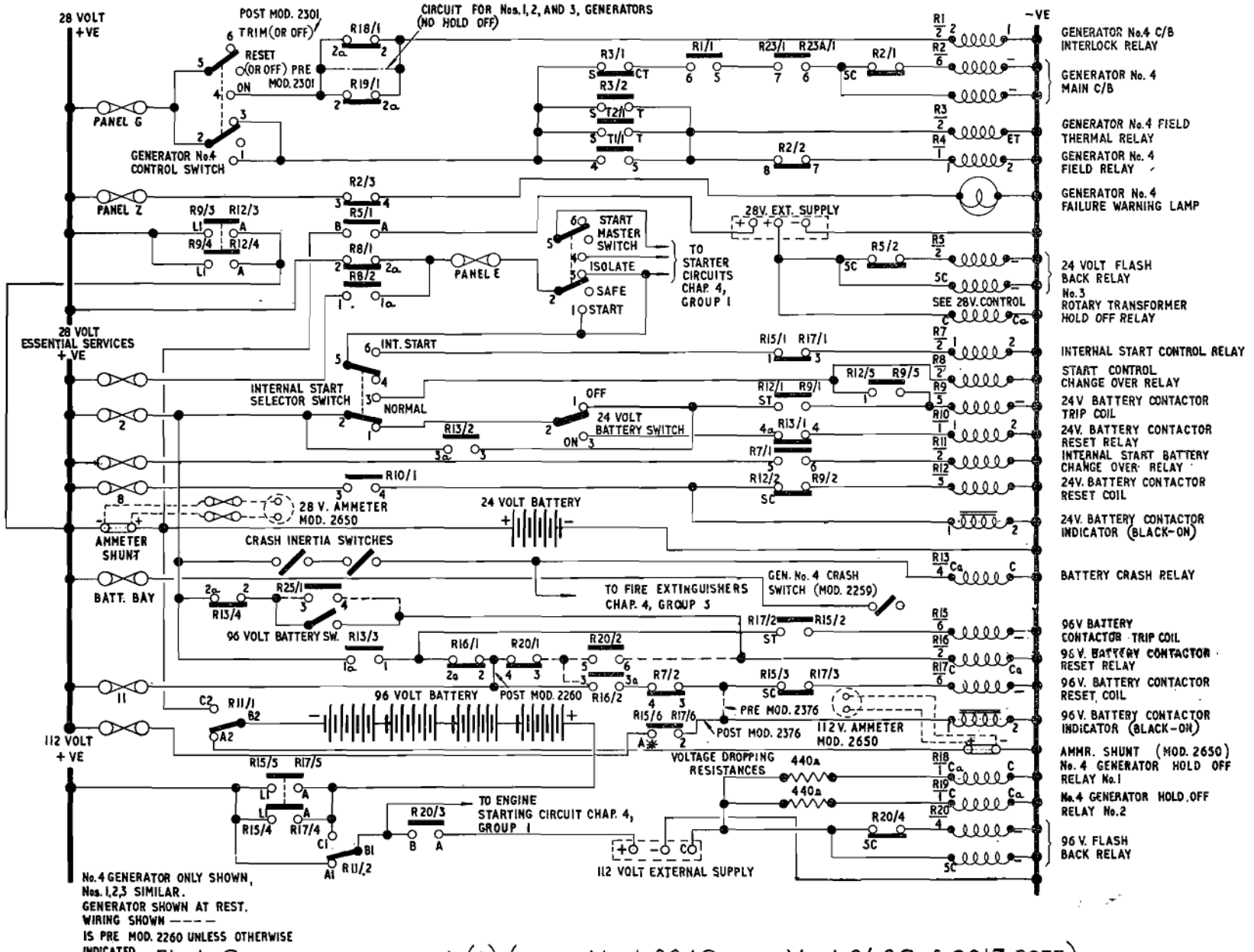

Fig. I. Generator control (1) (post Mod 2240, pre Mod 2680 & 2817, 2933)

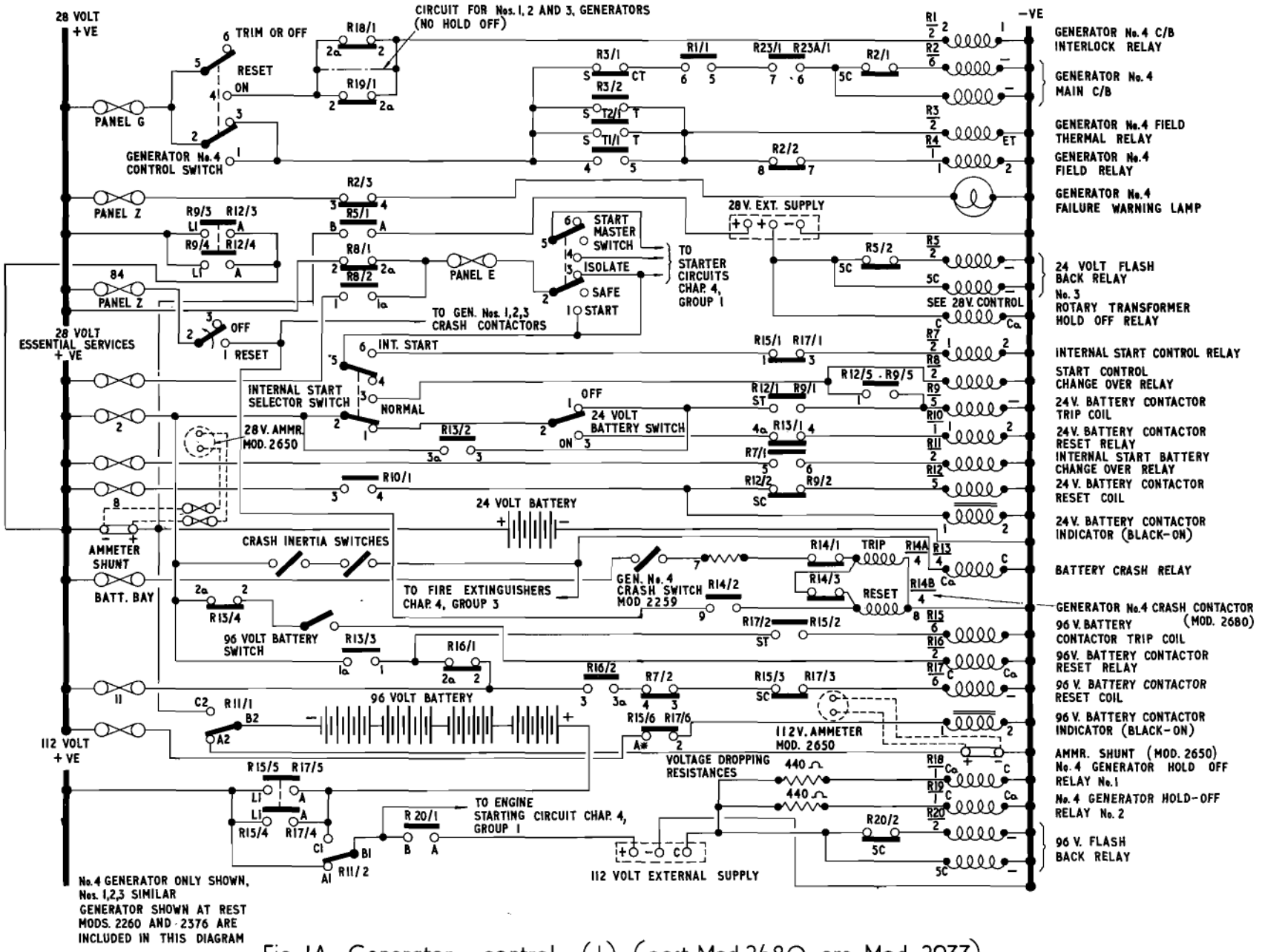

Fig. 1A. Generator control (1) (post Mod 2680, pre Mod 2933)

RESTRICTED

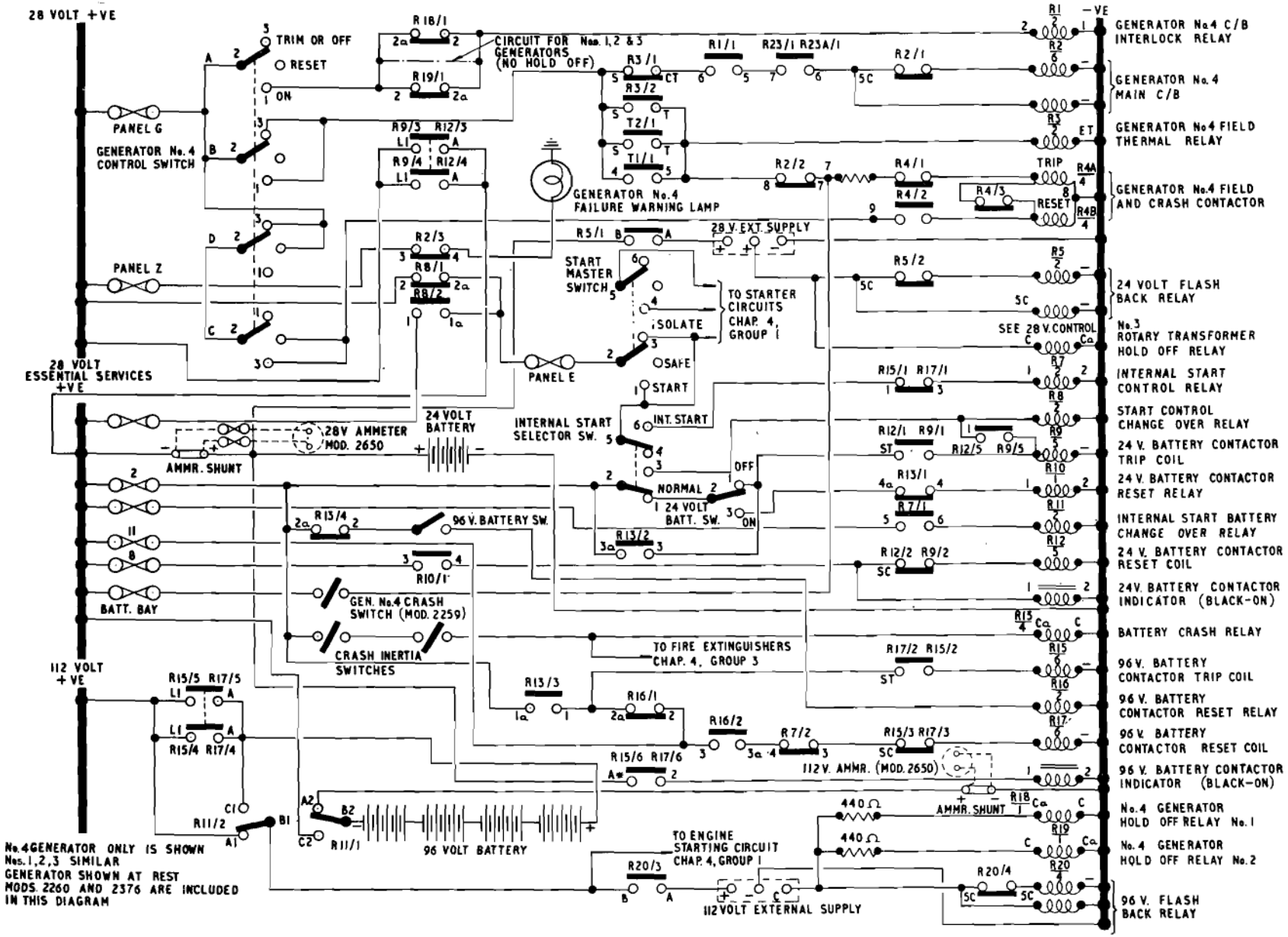

Fig. 1B Generator control (1) (post Mod. 2817 pre. Mod. 2933)

RESTRICTED

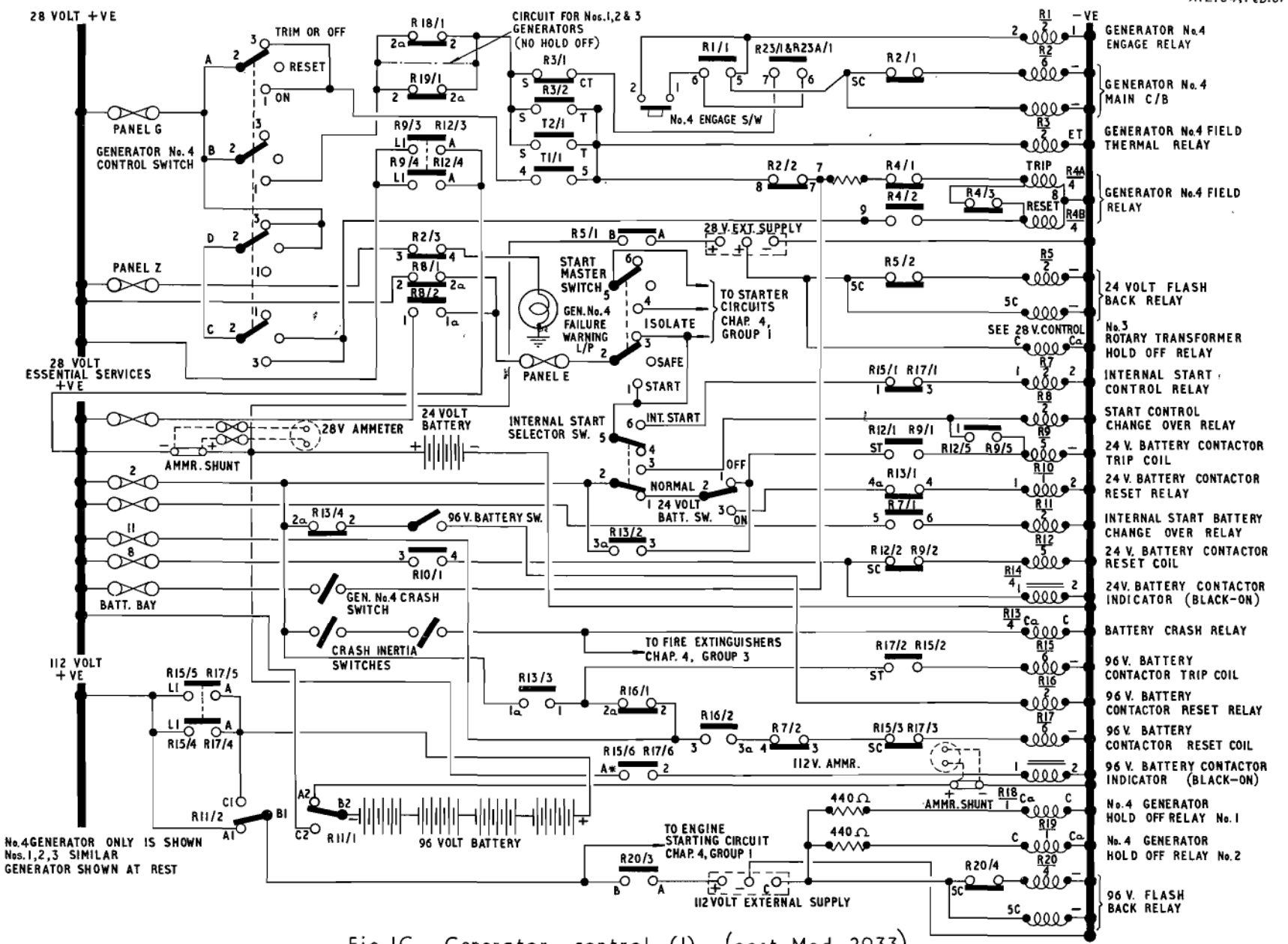

Fig. IC Generator control (1) (post Mod. 2933)

RESTRICTED

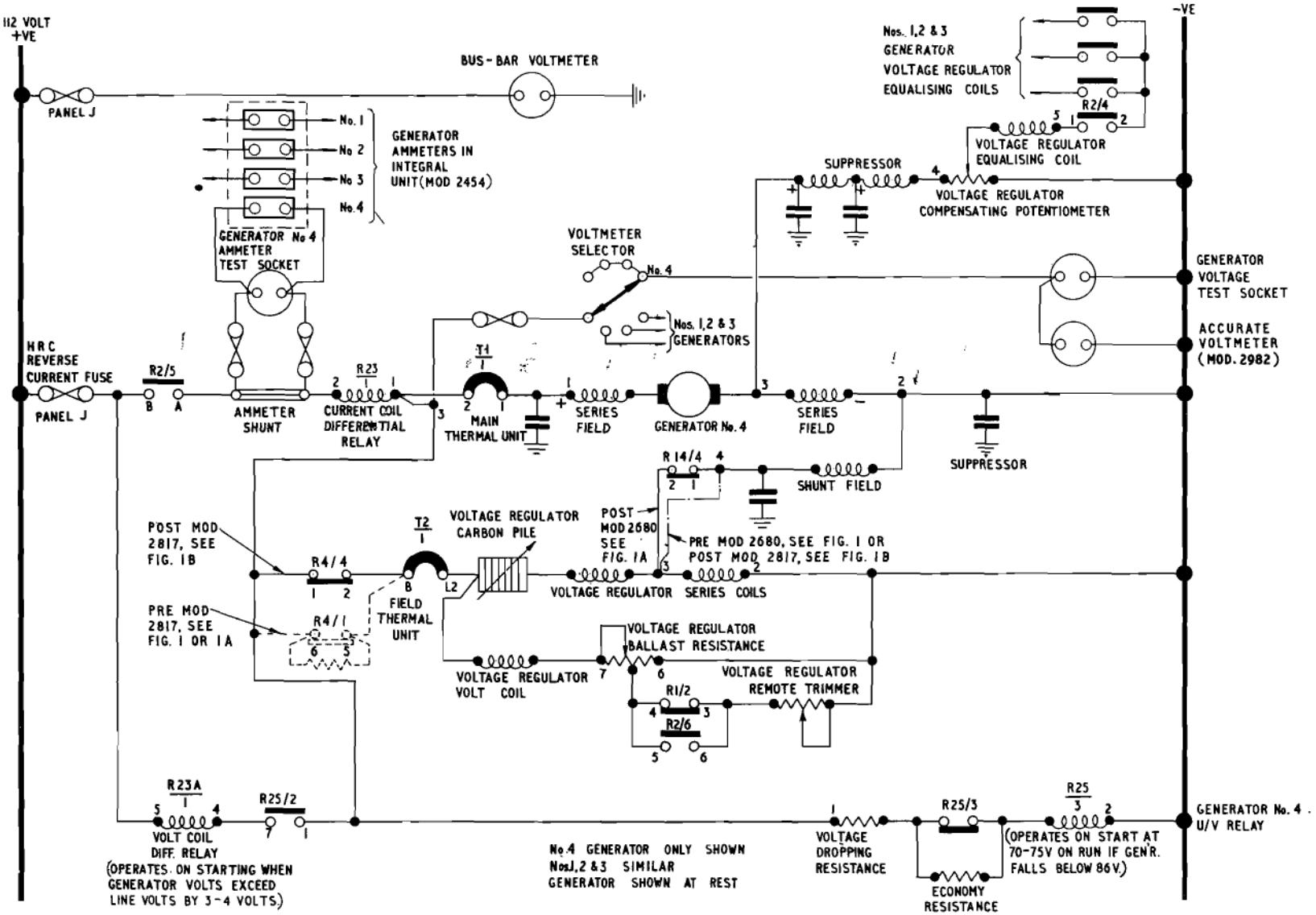

Fig. 2. Generator control system (2)(post Mod 2240 pre. Mod 2933)

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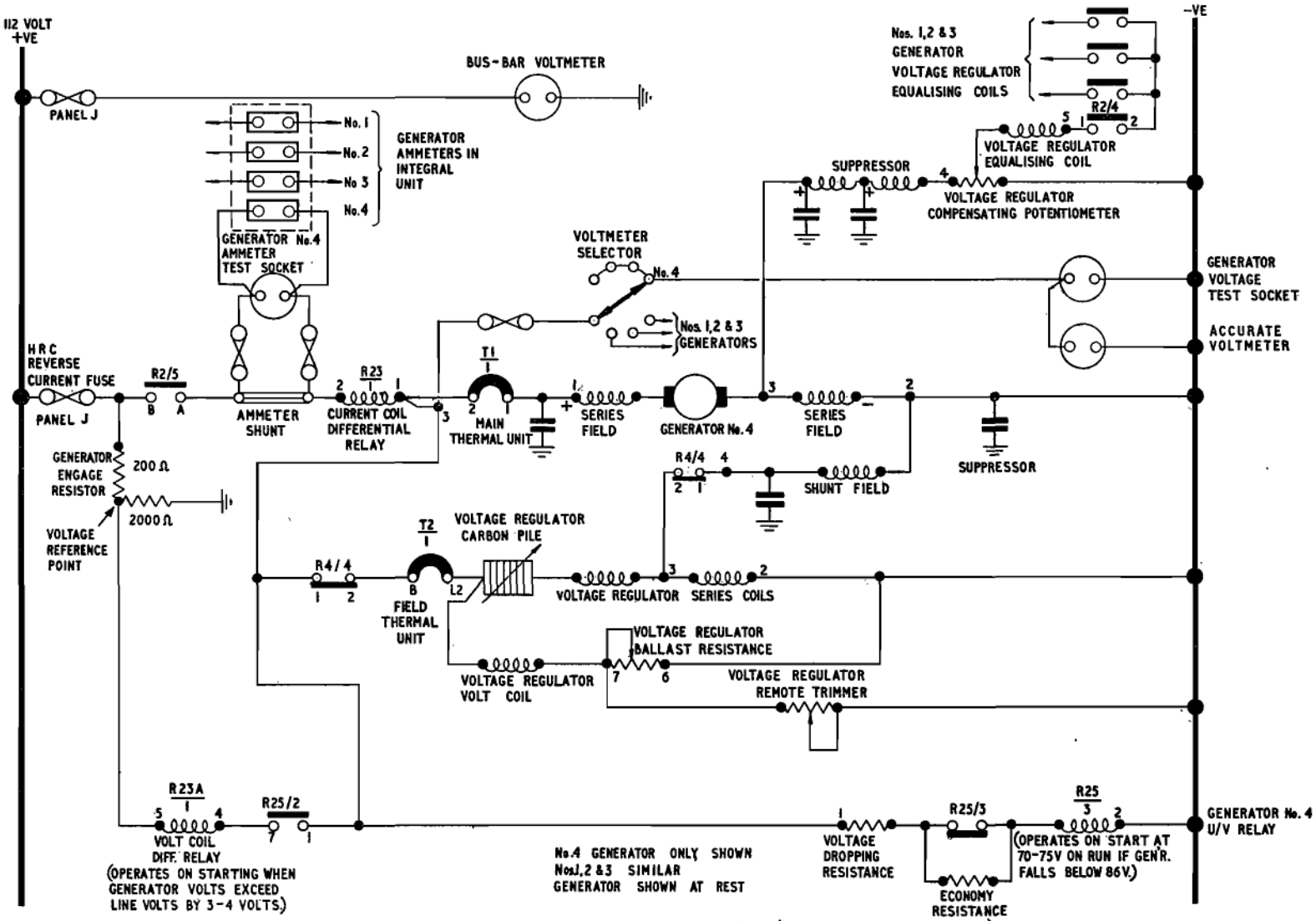

Fig. 2A Generator control (2)(post Mod 2933)

Overload conditions (*fig.* 1 *and* 2) (*pre-Mod.* 2817)

14. In the event of a sustained overload on the generator output, the main thermal unit T1 flexes and closes its contacts (T1/1), thereby applying a positive feed, via the control switch, to the coil of the field thermal unit relay R3. This unit, which is then magnetically operated, 'holds-on' and breaks the supply (R3/1) to the main circuit-breaker. The generator is thus disconnected (R2/5) from the bus-bar. The tripping of the main circuit-breaker connects (R2/2) a positive supply, via the main thermal unit contacts (T1/1), to the field relay R4. This relay operates to insert a resistance in the generator field circuit, thus reducing the output voltage. This prevents a too rapid collapse of the field with an associated surge in generator volts, which would occur if the field circuit had been open-circuited.

15. The resetting of the main thermal unit T1 will not bring the generator back on to line until the coil circuit of the field thermal relay unit R3 has been broken by moving the generator control switch to RESET. This breaks the 28-volt supply to all control relays, so collapsing the solenoid of the field thermal unit R3 and allowing it to reset. The generator field relay R4 will also be reset.

16. Provided the overload has been eliminated, the generator will be brought on load in the normal way immediately the generator control switch is moved from RESET to ON.

17. When the generator control switch is at TRIM (i.e., the generator not connected to the bus-bar), when trimming the regulators, the thermal overload protection, described above, is maintained. This affords protection to the generator in the event of a short-circuit developing in the generator output line, between the thermal unit and the circuit breaker.

Overload conditions (*figs.* 1*B and* 2) **post Mod. 2817**

18. In the event of a sustained overload on the generator output, the main thermal unit T1 flexes and closes its contacts (T1/1), thereby applying a positive feed, via the control switch, to the coil R3 of the field thermal relay. This unit, which is then magnetically operated, 'holds-in' (by its contacts R3/2) and breaks (R3/1) the supply to the main circuit-breaker. The generator is thus disconnected (R2/5) from the bus-bar. The tripping of the main circuit-breaker connects (R2/2) a positive supply from the control switch (via the main thermal unit contacts (T1/1) or contact R3/2 of the field thermal relay) to the trip coil R4A of the generator field and crash contactor via its auxiliary contact R4/1.

Note . . .

Momentarily, the reset coil R4B is energized simultaneously with the trip coil R4A via the auxiliary contact R4/3; this allows spring pressure to be relieved from the latch whilst the latch is withdrawn, as the latch is withdrawn contact R4/3 is opened. (Contact R4/3 is part of a switchette built into the contactor and does not operate directly with the main contacts).

19. Operation of the generator field and crash contactor open circuits (R4/4—*fig.* 3) the generator field circuit thereby reducing the generator volts to a minimum.

Note . . .

Although pre-Mod. 2817 *a resistance was inserted in the field circuit upon operation of the field relay, it has now been decided that it is unnecessary and that there will be no appreciable surge in voltage as the field is collapsed.*

20. Resetting the main thermal unit T1 will not bring the generator back on to line until the generator field and crash contactor has been reset by moving the generator control switch to RESET. Segments A and B of the switch break the supply to the coil of the field thermal relay R3 allowing it to reset and segments C and D of the switch connect a supply to the reset coil R4B of the field and crash contactor via the auxiliary contact R4/2. Provided the overload has been eliminated, the generator will be brought on load in the normal way immediately the generator control switch is moved from RESET to ON.

21. When the generator control switch is at TRIM (i.e. the generator is not connected to the bus-bar), the thermal overload protection is maintained—this affords protection to the generator in the event of a short-circuit developing in the generator circuit between the thermal unit and the main circuit-breaker.

Generator field overload conditions (*figs.* 1 *and* 2) pre-Mod. 2817

22. Should the overload occur in the generator field line, instead of the generator output line, the field thermal unit T2 will operate, closing its associated contacts (T2/1) to energize the field thermal relay R3. The field thermal relay operates (R3/1) to disconnect the supply to the main circuit-breaker coil R2 contacts R2/2 of which are closed allowing the field relay R4 to be energized to open its contacts (R4/1) and insert a resistance into the field circuit of the generator.

22A. The field thermal unit T2 is not self-resetting, and before the generator can be brought on-line again the field thermal relay coil R3 must be de-energized by selecting the generator control switch to RESET and again to ON.

Generator field overload conditions (*figs.* 1*B and* 2) *post Mod.* 2817

23. Should the overload occur in the generator field line, instead of the output line, the field thermal unit T2 will operate, closing its associated contacts (T2/1) to energize the field thermal relay R3. The field thermal relay operates as described in paras. 17A and 17B to trip the main circuit-breaker and the field and crash contactor thereby taking the generator off-line and open-circuiting its field circuit.

24. The field thermal unit T2 is not self-resetting and before the generator can be brought on-line again, the field thermal relay R3 and field and crash contactor R4 must be reset by moving the generator control switch to RESET as described in paras. 17C and 17D. Moving the control switch back to ON will bring the generator back on-line in the normal way provided that the overload has been eliminated.

Generator failure conditions (*fig.* 1 *and* 2)

25. Should the output voltage of the generator fall, a reverse current will flow from the battery to the generator. As soon as this reaches 15 amps. the series coil of the differential relay R23, will be de-energized allowing the contacts (R23/1) to open and disconnect the supply to the generator main circuit breaker R2. The main circuit-breaker will operate:—

(1) (R2/5) to disconnect the generator from the bus-bar.

(2) (R2/3) to connect a supply to the generator failure warning lamp.

(3) (R2/4) to open circuit the regulator equalizing line.

(4) (R2/6) to open circuit the regulator remote trimmer line.

In addition, to the differential relay, there is a 200 amp. fuse for reverse-current protection connected between the main circuit-breaker and the bus-bar, which on fuzing, disconnects the generator from the line.

26. The purpose of the under-voltage relay R25 is to disconnect, automatically, any generator which is not producing full output voltage, otherwise with the equalizing system of regulation, there would be a danger of the line voltage falling below 96 volts, and of the generators, though not necessarily the faulty one, being tripped by the reverse-current passing through the differential relay.

Power failure warning (*fig.* 1)

27. A power failure warning lamp is supplied through the contacts (R2/3) of the main circuit breaker and will light up whenever the main circuit breaker is tripped. The main circuit-breaker can be tripped directly, by selecting the generator control switch to TRIM or RESET, or by the operation of the main or field thermal units, thereby disconnecting the supply to the circuit-breaker coil R2. It may also be tripped indirectly when the differential relay operates so opening the contacts (R23/1 and R23A/1) in the main circuit-breaker operating coil circuit.

Hold-off relays (*fig.* 1)

28. The two hold-off relays R18 and R19 are energized via dropping resistances when the 112-volt external supply is plugged in. Contacts R18/1 and R19/1, in parallel, prevent the interlock relay R1 of generator No. 4 only from being energized as No. 4 engine runs up with the generator switch at ON. If No. 4 generator is running on line when the 112-volt supply is connected, then the interlock relay will be de-energized by the hold-off relays and hence the main circuit-breaker will be tripped. THIS CONDITION DOES NOT APPLY TO Nos. 1, 2 and 3 generators. When starting the engines, Nos. 1, 2, and 3 generator switches MUST BE AT OFF otherwise the generators will try to parallel with the external supply; when the engines are running No. 4 generator switch should be selected to ON prior to removing the external supply so that when the external supply is disconnected, the generator will immediately come on line and maintain the supplies in the aircraft. Nos. 1, 2 and 3 generators can then be switched to ON.

Crash relays (Mods. 2259 and 2680) (*fig.* 1*A*)

29. Mod. 2259 introduces an inertia switch, and Mod. 2680 introduces a crash contactor (Latched contactor B.T.H. LDA 50-A4), in the shunt field line of each generator. The four inertia switches are mounted in the nosewheel bay and operate independently to connect supplies from the essential services fuses to the trip coils R14A of the crash contactors via their ballast resistances and contacts R14/1. The contactors operate to break R14/A (*fig.* 2) the shunt field circuits of their associated generators. The generator volts are thereby reduced and in consequence the undervolt relays will trip them off-line. The auxiliary contacts R14/2 close to prepare the reset coil line. Once the contactors have been operated, they remain latched and keep the generators off-line until the reset switch on panel J has been selected reset. IT IS IMPORTANT THAT THE RESET SWITCH IS SELECTED RESET BEFORE THE NEXT FLIGHT AND AFTER ROUTINE SERVICING. When selected RESET the switch connects a supply from panel Z to all four crash contactor reset coils R14B via their auxiliary contacts R14/2. The contactors then latch in the reset position, contacts R14/A completing the generator field circuits and contacts R14/1 preparing the trip coil circuit.

Note . . .

Contact R4/3 apparently allows both reset R4B and trip R4A coils to be energized simultaneously on tripping the contactor. This is in fact so only momentarily; R4/3 allows spring pressure to be relieved from the latch by the reset coil thus allowing the latch to be withdrawn. As the latch is withdrawn contact R4/3 is re-opened (contact R4/3 is part of a switchette built into the contactor and does not operate directly with the main contacts).

Crash relays (post Mod. 2817) (*fig.* 1*B*)

30. The system is basically similar in operation to pre-Mod. 2817 except that the contactors now combine the function of the field relays with that of the crash relays and that the resetting is carried out from the generator control switches in lieu of the reset switch on panel J. The four inertia switches operate independently to connect supplies from the essential services bus-bar to the trip coil R4A of the crash contactors via their ballast resistances and auxiliary contacts R4/1 (*see note to para.* 24). The contactors operate to open-circuit R4/4 (*fig.* 2) the shunt field circuits of their respective generators thereby allowing the voltage to fall to a minimum and in consequence the undervolt relays will trip them off-line.

31. When the generator control switches are selected to RESET, segments C and D of the switches connect supplies from panel G

to the reset coils R4B via the auxiliary contacts R4/2 and the contactors are reset.

Note . . .

Mod. 2259 *adds an extra essential services fuse block, containing fuses* 13-24, *in the battery bay. If amendment* 661 *is incorporated, the fuse block is mounted on the* 24*-volt battery control panel, but if amendment* 661 *is not incorporated, the fuse block is mounted on the bomb bay forward bulkhead, to starboard of the* 24*-volt battery control panel.*

Voltmeter and ammeter (*fig.* 2)

32. The output voltage of any generator may be checked on a voltmeter plugged into the socket provided on the trimmer panel after selecting the appropriate position on the voltmeter selector switch. The voltage of the high voltage bus-bar is measured continuously on a voltmeter provided on the trimmer panel. Four separate sockets are provided for ammeters to enable the current in each generator line to be measured. 200 A, 100 mV. shunts are permanently connected in the generator circuits.

Accurate voltmeter (*fig.* 2) (*Mod.* **2982**)

33. An accurate 0-160 volt voltmeter is fitted to the a.c. manual change-over switch box (introduced by Mod. 2982, *see Group* 3) which is secured to the radio crate table at the A.E.O.'s position. The meter is connected in parallel with the voltmeter test socket and can therefore be switched to read accurately the off-line voltage of any generator after the relative generator control switch has been selected to TRIM.

Ammeters (post Mod. 2454)

34. This modification introduces an ammeter unit, containing four vertical scale ammeters, fitted to the radio crate at the Air Electronics Officer's position. The connections to each ammeter are made in parallel with the ammeter test sockets on the voltage trimmer panel and are consequently fed from the ammeter shunts on panel J. These instruments MUST NOT be used for setting-up the generators and are provided for in-flight checking of the generators by the flight crew.

112-VOLT SYSTEM (POST MOD. 2933)

Outline of the system (*figs.* 1*C and* 2*A*)

Note . . .

In flight NO ATTEMPT SHOULD BE MADE TO RE-ENGAGE a generator should it disconnect itself from the bus-bar (power failure lamp on). Instructions to the contrary given in this description of the installation are intended for ground maintenance only.

35. Four 22½-KW generators are driven one by each engine, with full output being obtainable at all engine speeds between idling and maximum. The output of each generator is maintained at 110-volts by a carbon pile regulator and all generators are connected in parallel, load balancing between the generators being achieved by an equalizing line connected to an equalizing coil in the regulator. A control switch having three positions; ON, RESET and TRIM OR OFF is used, together with an ENGAGE push switch operating a magnetic relay, to connect the generator to the 112-volts bus-bar. The control switch is used additionally to isolate the generator from the line, for adjusting the voltage regulator and resetting after an overload.

36. The generator control system includes reverse-current protection, under-voltage protection, thermal overload protection in both the main and field lines, and a power failure warning indicator. Protection is provided in cases of very heavy or crash landings by tripping the generators off-line automatically.

37. Radio interference is minimized by suppressors built in to the generators, with the exception of the equalizing, or balancing, line from the generator where a separate single-leg 5-amp. suppressor is fitted.

Voltage regulation (*figs.* 1*C and* 2*A*)

38. The carbon pile of the regulator is connected in the generator field circuit and is controlled by the regulator voltage coil. An additional winding known as the equalizing coil, and carrying the equalizing line current, operates to buck or boost the voltage coil according to whether the current is high or low. This winding is connected across a portion of the series field of the generator, on the negative side of the armature. Should any generator take an unequal share of the load, the voltage drop across its series field will be greater than that across the others, and a current will flow through the regulator equalizing coil in such a sense as to reduce the generator field current and lower its output. A potentiometer (ballast resistance) in the equalizing line of each generator has its slider set to the mechanical mid-position of the resistance and this effectively compensates for any differences in the resistance of the generator windings and for variations in the cable resistance of different machines. The generators are manufactured to such close tolerances that the slider need never be moved from the mechanical mid-position of the potentiometer.

Note . . .

The regulator ballast resistance is 1·25 *ohms of which* 0·625 *ohms are required in the equalizing circuit; this corresponds to the slider being in the mechanical mid-position of the resistance.*

39. It should be noted that the equalizing circuit is automatically interrupted when the main circuit-breaker R2 trips, thus preventing a feed back through the regulator when any generator is off the line.

40. A remote trimmer resistance is provided for adjustment of the voltage regulator volts coil.

Note . . .

The generator control switch should be selected to TRIM *or* OFF *before any attempt is made to adjust the trimmer.*

Generator engage resistor

41. The resistor is comprised of a resistance network so arranged to give a voltage reference point between the differential relay volts coil and the 112-volts bus-bar. This prevents an initially high differential between generator output and line voltage when the differential relay operates.

Normal operation (*figs.* 1*C and* 2*A*)

42. With the generator control switch ON, a supply from a fuse at panel G is connected to the open contacts, R23A/1, of the differen-

tial relay via the normally closed contacts of the field thermal relay (R3), to prepare the circuit for operation of the engage switch when the differential relay operates. The generator output voltage increases with engine speed until a value of between 70 and 75 volts is reached when the under-voltage relay coil (R25) is energized. Operation of the under-voltage relay closes contacts R25/2, to connect a supply from the generator to the differential relay volts coil R23A, and opens contacts R25/3 to insert an economy resistance in series with the under-voltage relay coil. The generator output voltage continues to increase until it exceeds the engage resistor reference voltage by 3·5 to 4 volts when the differential relay will operate.

Note . . .

Generator output should be established at approximately 110*-volts BEFORE ANY ATTEMPT IS MADE TO ENGAGE THE GENERATOR, since the differential relay does not ensure that the generator is above line voltage before paralleling.*

43. With the generator engage switch depressed the supply from G panel is connected via the now closed contacts (R23A/1) of the differential relay, to energize the engage relay coil. Operation of the relay closes contacts R1/1 to complete a circuit to the generator main circuit-breaker. Additionally contacts R1/1 complete a hold-in circuit for the engage relay allowing the engage switch to be released. Operation of the main circuit-breaker opens contacts R2/1 to allow the circuit-breaker to be held in by an economy coil, and contacts R2/3 to disconnect the supply to the generator failure warning lamp whilst contacts R2/4 close to common the equalizing lines. The main contacts R2/5 are closed to connect the generator to the bus-bar via the differential relay current coil R23 and the reverse current H.R.C. fuse.

44. The bus-bar voltage will be 96 volts, maintained by the 96-volt battery until the generator is on line when it will be regulated at 110 volts. The generator may be switched "off-line" by setting the generator control switch to OFF.

Trimming (*figs.* 1*C and* 2*A*)

45. The control switch at TRIM breaks the circuit to the coil of the engage relay R1/2. With the relay de-energized contacts R1/1 open, to interrupt the supply to the main circuit-breaker coil R2, and disconnect the generator from the 112 volts bus-bar. Voltage regulator adjustment may now be made via the remote trimming resistance.

Overload conditions (*figs.* 1*C and* 2*A*)

46. In the event of a sustained overload on the generator output the main thermal unit T1 flexes to close contacts T1/1, which energises the coil of the field thermal relay R3 from a supply via the control switch. Operation of the relay closes contacts R3/2, to complete a coil hold-in circuit, and opens contacts R3/1 to break the supply to the main circuit-breaker. The tripping of the main circuit-breaker disconnects the generator from the bus-bar and connects a supply, via the main thermal unit contacts T1/1, to the trip coil of the field relay R4A. With the generator field relay tripped the generator field circuit is broken, by contacts R4/4 opening, to reduce the generator output voltage to a minimum.

Note . . .

Momentarily, the reset coil R4B is energized simultaneously with the trip coil R4A via the auxiliary contact R4/3*; this allows spring pressure to be relieved from the latch whilst the latch is withdrawn, as the latch is withdrawn contact R4/3 is opened. (Contact R4/3 is part of a switchette built into the contactor and does not operate directly with the main contacts).*

47. Resetting the main thermal unit T1 will not bring the generator back on to line until the generator field and crash contactor has been reset by moving the generator control switch to RESET. Segments A and B of the switch break the supply to the coil of the field thermal relay R3 allowing it to reset, and segments C and D of the switch connect a supply to the reset coil R4B of the field and crash contactor via the auxiliary contact R4/2. Provided the overload has been eliminated, the generator will be brought on load in the normal way immediately the generator control switch is moved from RESET to ON, and the engage switch is depressed.

48. When the generator control switch is at TRIM (i.e. the generator is not connected to the bus-bar), the thermal overload protection is maintained—this affords protection to the generator in the event of a short-circuit developing in the generator circuit between the thermal unit and the main circuit-breaker.

Generator field overload conditions

49. Should the overload occur in the generator field line, instead of the output line, the field thermal unit T2 will operate, closing its associated contacts (T2/1) to energize the field thermal relay R3. The field thermal relay operates as described in para. 46, to trip the main circuit-breaker and the field and crash contactor, thereby taking the generator off-line and open circuiting its field.

50. The field thermal unit T2 is not self-resetting and before the generator can be brought on-line again, the field thermal relay R3 and field and crash contactor R4 must be reset by moving the generator control switch to RESET as described in para. 47. Moving the control switch back to ON and depressing the engage switch will bring the generator back on-line in the normal way provided that the overload has been eliminated.

Generator failure conditions

51. Should the output voltage of the generator fall, a reverse current will flow from the battery to the generator. As soon as this reaches 15 amps. the series coil of the differential relay R23 will be de-energized allowing the contacts (R23/1) to open and disconnect the supply to the generator main circuit breaker R2. The main circuit breaker will operate:—

(1) (R2/5) to disconnect the generator from the bus-bar.

(2) (R2/3) to connect a supply to the generator failure warning lamp.

(3) (R2/4) to open circuit the regulator equalizing line.

In addition to the differential relay there is a 200 amp. fuse for reverse-current protection, connected between the main circuit-breaker and the bus-bar, which on rupturing disconnects the generator from the line.

52. The under-voltage relay R25 automatically disconnects a generator should its output fall below 86 volts, since with the equalizing system of regulation there would otherwise be a danger of the line voltage falling below 96 volts and of the remaining generators being tripped by the reverse-current passing through the differential relays.

Power failure warning (*fig.* 1)

53. A power failure warning lamp is supplied through the contacts (R2/3) of the main circuit breaker and will light up whenever the main circuit-breaker is tripped. The main circuit-breaker can be tripped directly, by selecting the generator control switch to TRIM or RESET, or by the operation of the main or field thermal units, thereby disconnecting the supply to the circuit breaker coil R2. It may also be tripped indirectly when the differential relay operates, so opening the contacts (R23/1) and (R23A/1) in the main circuit-breaker operating coil circuit.

Hold-off relays (*fig.* 1*C*)

54. The two hold-off relays R18 and R19 are energised, via dropping resistances, when the 112 volts external supply is connected. Contacts R18/1 and R19/1, in parallel, prevent the engage relay R1 of generator No. 4 from being energised by its engage switch. Should No. 4 generator be on-line when the 112 volts external supply is connected, the engage relay will be de-energised by the hold-off relays and the main circuit breaker will trip to disconnect the generator from the bus-bar. When starting the engines, Nos. 1, 2 and 3 generator control switches MUST BE AT OFF to prevent operation of the engage relays by the engage switches, otherwise the generators will attempt to parallel with the external supply. With the engines running, No. 4 generator control switch should be selected to ON prior to removing the external supply, so that when the supply is disconnected the generator will, immediately the engage switch is pressed, come on line to maintain supplies in the aircraft. Nos. 1, 2 and 3 generator control switches may then be set to ON and the engage switches pressed.

Crash conditions (*fig.* 1*C*)

55. The four generator crash switches operate independently to connect supplies, from the essential services bus-bar, to the trip coil R4A of the field relays via their ballast resistances and auxiliary contacts R4/1. The field relays operate to open circuit (R4/4 *fig.* 2*A*) the shunt field of their respective generators thereby allowing the output voltage to fall, and consequently the undervolt relays to trip them off-line.

56. With the crash switches reset, the generator control switches may be selected to RESET when C and D segments of the switches will connect supplies from panel G to the reset coils R4B, via the auxiliary contacts R4/2, and the field relays are reset.

Note . . .

Contact R4/3 apparently allows both reset R4B and trip R4A coils to be energized simultaneously on tripping the relay. This is in fact so only momentarily; R4/3 allows spring pressure to be relieved from the latch by the reset coil allowing the latch to be withdrawn. As the latch is withdrawn contact R4/3 is re-opened (contact R4/3 is part of a switchette built into the relay and does not operate directly with the main contacts).

Voltmeters (*fig.* 2*A*)

57. The output voltage of any generator may be checked on a voltmeter plugged into the socket provided on the trimmer panel, after selecting the appropriate position on the voltmeter selector switch at the generator control panel. An accurate 0–160-volt voltmeter, fitted to the generator control panel, is connected in parallel with the voltmeter test socket and can therefore be switched to read accurately the off-line voltage of any generator after the relative generator control switch has been selected to TRIM. Bus-bar voltage is measured continuously on a voltmeter provided at the voltage trimmer panel.

Ammeters (*fig.* 2*A*)

58. Four 200 amps. 50 mV shunts, mounted on panel J, are permanently connected in the generator circuits. Separate sockets, connected in parallel with the shunts, are provided at the voltage trimmer panel to enable the current in each line to be checked with accurate ammeters. Four vertical scale ammeters, contained in one unit, are provided at the A.E.O.'s position on the radio crate and connected in parallel with the ammeter sockets. These instruments are provided for in-flight checking of the generators by the flight crew and SHOULD NOT be used for adjustments to the system.

28-VOLT SYSTEM

Outline of system (*fig.* 3 *and* 4)

59. The control lines for the instruments and power services are operated by a 28-volt supply obtained from three rotary transformers driven by the 112-volt supply. The design of the rotary transformers is such that the two armatures, connected in tandem rotate within a common magnetic field.

Note . . .

(1) *Mod.* 2439 *introduces rotary transformers Type* 1050*A in lieu of Type* 1050.

(2) *Mod.* 2934 *introduces a* 125 *amp. H.R.C. fuse in the output line of each rotary transformer.*

60. On pre-Mod. 733 aircraft the starting relay R1 for the rotary transformer is energized through a voltage dropping resistance as soon as the 112-volt supply is switched on to the main bus-bar. The auxiliary contacts (R1/1) of this relay open to insert an economy resistance in series with the coil R1 and contacts (R1/2) close to make ready the circuit to the main contactor. When the control switch is selected to ON, a supply is connected, from a fuse panel G, to the main contactor R4, Type D.6102, via (R3/2) the thermal unit and (R7/1 and R7A/1 in parallel) the hold-off relays. Mod. 733 deletes the starting relays.

61. Contactor R4 on closing connects a 112-volt supply (R4/2), via the thermal unit T1, and the starting resistance, in the starter unit, to the rotary transformer, which commences to rotate. As the rotary transformer speeds up, the back e.m.f. increases and applies a potential across the starter unit relay R8. The relay operates (R8/1) to short-circuit the starting resistance, so connecting the rotary transformer directly to the 112-volt supply. When the rotary transformer output reaches 16 to 18 volts, the under-voltage relay R10 operates, contacts R10/1 open and insert an economy resistance in series with the coil R10 and contacts R10/2 close to complete the circuit to the voltage coil R9A of the combined differential relay and circuit-breaker. The differential relay is polarized and when the rotary transformer output voltage has risen to about ½-volt above that of the 24-volt aircraft battery the relay closes. Contacts R9A/1 and R9/1 connect the supply, from panel G, via the control switch and the thermal unit and the interlock relay contacts (R3/2 and R2/1) to the circuit-breaker coil R5, of the combined differential relay and circuit-breaker (pre-Mod. 733 the starter relay contacts R1/2 are in series with the circuit breaker coil R5). The circuit breaker relay operates to connect the rotary transformer to the 28-volt bus-bar (R5/1). At the same time R6, the auxiliary relay closes, contacts R6/2 complete the circuit between the voltage regulator ballast resistance and remote trimmer, and contacts R6/3 complete the voltage regulator equalizing line. At the same time contacts R6/1 open to disconnect the supply, to the rotary transformer failure warning lamp.

62. Before any rotary transformer can be connected to the 28-volt bus-bar the output voltage must be about ½-volt in excess of the bus-bar voltage. When the control switch is selected to ON, the interlock relay R2 operates contact R2/2 breaks and isolates the remote trimmer thus allowing the transformer output voltage to build-up in excess of the bus-bar voltage. Voltage regulation is introduced when the differential relay voltage R9A operates and the remote trimmer is re-connected by contact R6/2.

63. If the remote trimmer was not disconnected at this stage, after the first transformer had been connected to the bus-bar the remaining two would be prevented from doing so. The bus-bar voltage would now be 27·5 volts, regulated from the first transformer and as the other two would be regulated at the same voltage the output of either would not build up to the excess of ½-volt required to operate the differential voltage relay R9A.

Equalizing system (*fig.* 4)

64. Equal output voltage and hence equal load sharing between the rotary transformers, is achieved by the provision of an equalizing line, the circuit being so arranged that the loads taken by any of the rotary transformers are equal within ± 10 per cent of the full load current. This is done by equating the voltage drop on resistances connected in the main low-voltage line from each rotary transformer to the bus-bar, and passing the balancing or circulating current between the rotary transformers through coils in their associated voltage regulators. The regulators then control the output according to the amount and direction of the circulating current.

65. This is a similar system to that used for the generator circuits, except that the latter employ part of the series field in place of an external resistance. The equalizing line is taken from each rotary transformer resistance, through a special equalizing winding in the voltage regulator and contacts (R6/3) in the auxiliary relay to the equalizing bus-bar.

66. If the load taken by any rotary transformer is greater than that taken by the others, the voltage drop across the resistance associated with that machine is also greater. This will cause a current to flow in the equalizing line and so induce the voltage regulator to reduce the output from this rotary transformer until a state of balance is achieved.

Trimming (*fig.* 3 *and* 4)

67. To compensate for manufacturing differences in the transformer windings and resistances, trimmer resistances are connected in the shunt field circuits of both input and output armatures. These trimmers are pre-set and should not be adjusted.

68. To facilitate the voltage setting of the rotary transformer output, the voltage regulator remote trimmer resistances are mounted on a panel in the cabin, this must be carried out with the rotary transformers off load. To set the voltage, the control switch must be selected to TRIM, breaking the supply to the interlock relay R2 and the circuit-breaker coil R5 (R2/1), thus disconnecting the rotary transformer from the main 28-volt bus-bar (R5/1). At the same time contacts R2/2 close to complete the circuit between the regulator ballast resistance and remote trimmer, the output voltage can now be set by the remote trimmer.

High voltage fault condition

69. Should a fault occur in the 112-volt line on pre-Mod. 733 aircraft, the three starter coils R1 are de-energized, thus disconnecting (R1/2) the low voltage supplies to the main contactors R4, the differential relays circuit breaker coil R5 and the auxiliary relay coil R6. The circuit-breaker operates (R5/1) to disconnect the rotary transformer from the main 28-volt bus-bar, while the auxiliary relay operates, (R6/3) to open the equalizing coil circuit and connect (R6/1) a supply to the warning lamp.

70. Should a fault occur in the 112-volt line on post Mod. 733 aircraft, the rotary transformers will run down. When the transformer output voltage falls below the battery voltage, a reverse current will flow through the differential relay series coil R9. The differential relay operates (R9/1) to disconnect the supply to the circuit-breaker

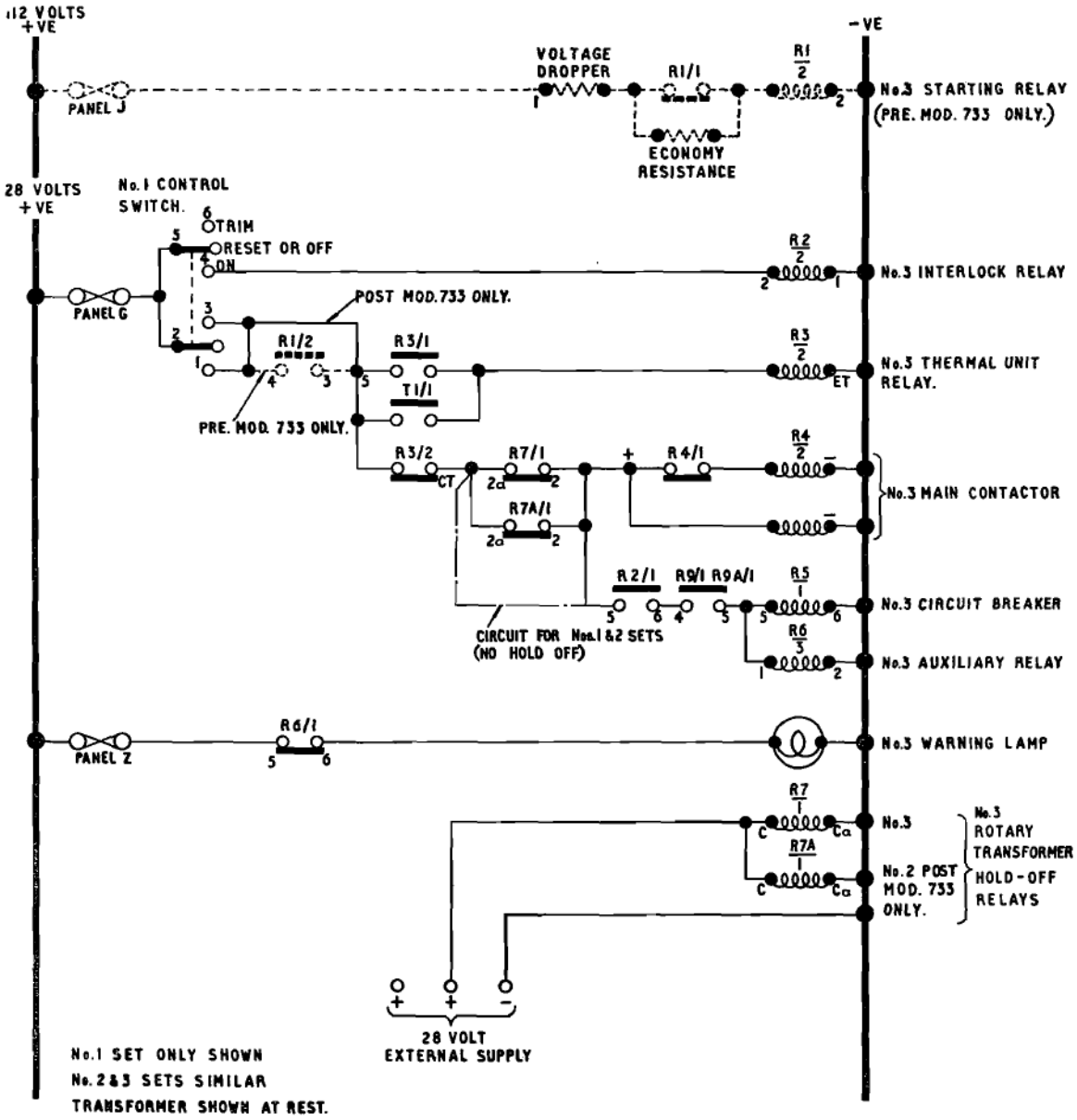

Fig. 3. Rotary transformer control (1) (post Mod. 2240)

coil R5 and auxiliary relay coil R6. The circuit-breaker will operate (R5/1) to disconnect the rotary transformer from the main 28-volt bus-bar, while the auxiliary relay operates, (R6/1) to connect a 28-volt supply to the warning lamp, (R6/3) to open the equalizing coil circuit and (R6/2) to open the remote trimmer circuit.

High voltage overload condition (*fig.* 3 *and* 4)

71. In the event of an overload occurring in the 112-volt line to the rotary transformer, heating takes place in the bi-metal strip in the thermal unit T1. This closes the associated switch contacts (T1/1), so completing the circuit to the thermal unit relay R3 and breaking (R3/2) the supply to the coils of the 112-volt contactor R4, the differential relay circuit breaker R5 and the auxiliary relay R6. The thermal unit relay R3 also closes a set of hold-in contacts (R3/1) thus maintaining the circuit in the tripped condition, irrespective of the cooling of the thermal element. The rotary transformer is therefore held off the line until the control switch is placed to RESET, so breaking the thermal unit relay circuit and allowing the unit to reset itself. Once the thermal unit has cooled down and the overload ceased to exist, the replacing of the control switch to ON will bring the circuit back to normal. There is, of course, independent thermal overload protection for each rotary transformer.

Rotary transformer failure condition (*fig.* 4)

72. If the output voltage from any one of the rotary transformers should fall below that of the line, a reverse current will flow through the series coil R9 of the differential relay, causing the relay contacts (R9/1) to open, breaking the coil circuit of the differential relay circuit breaker R5. The coil circuit of the auxiliary relay R6 is broken at the same time, thereby interrupting (R6/3) the equalizing line and closing (R6/1) the circuit to the power failure warning lamp. As the output from the rotary transformer continues to fall, the voltage across the differential relay voltage coil R9A increases, and to limit the wattage dissipated in this coil a protection relay R11 is incorporated to introduce (R11/1)

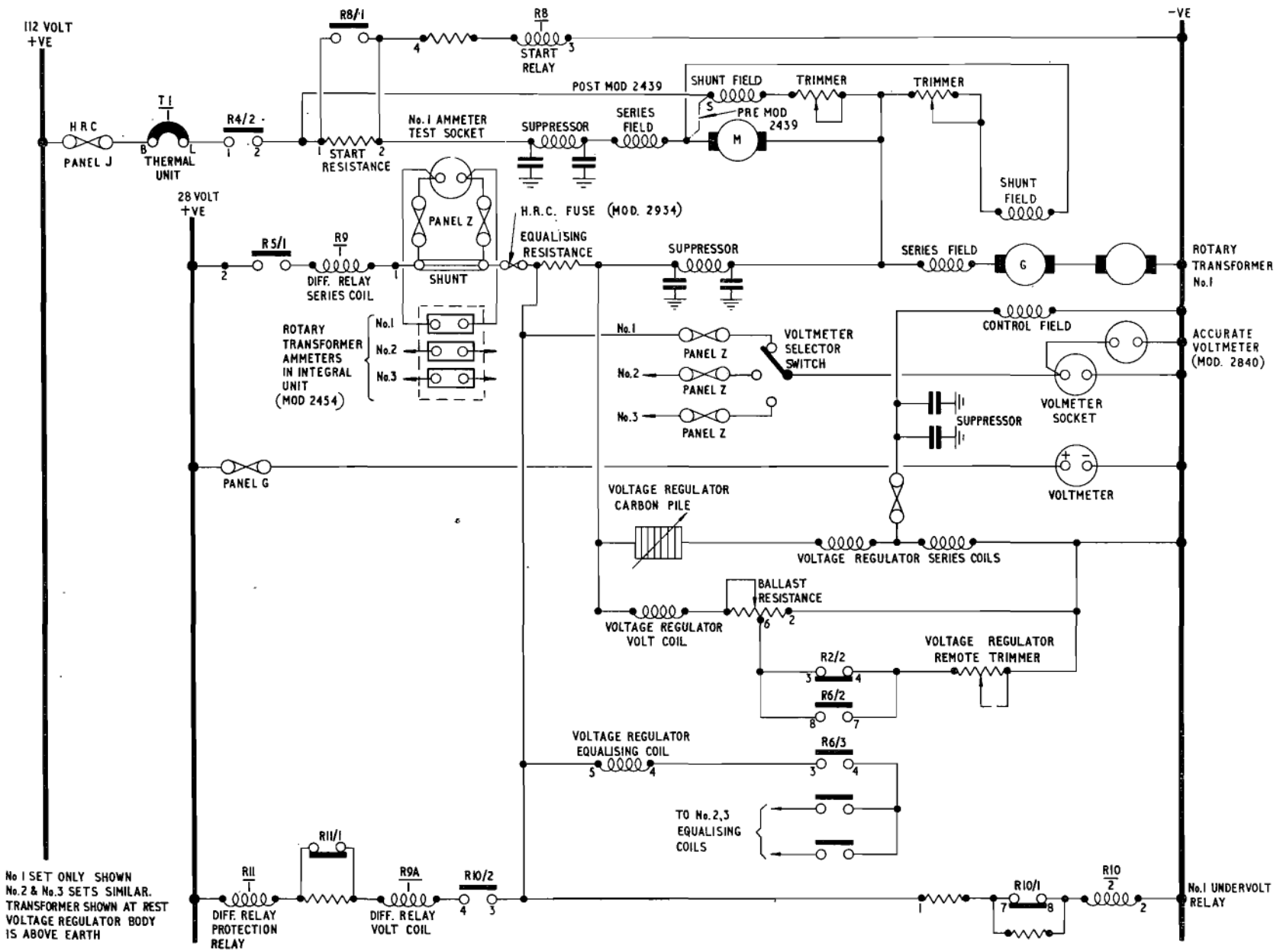

Fig. 4. 26-volt rotary transformer control (2)

a resistance in the circuit when the voltage drop increases beyond a predetermined level. When the output voltage from the rotary transformer falls to approximately 13 volts the under-voltage relay R10 opens, and isolates (R10/2) the differential relay coil circuit completely, thus preventing the continued flow of current from the bus-bar through the voltage coil R9A of the differential relay when the rotary transformer is not running.

73. A 100-amp. high-rupturing-capacity fuse is included in the 112-volt input to the rotary transformer to guard against failure of the thermal overload unit and contactor.

Voltmeter and ammeter

74. A voltmeter is fitted to the voltage trimmer panel to give a continuous indication of the 28-volt main bus-bar voltage. The output voltage of any rotary transformer may be checked on a voltmeter plugged into the socket provided on the trimmer panel, after selecting the appropriate position on the voltmeter selector switch located at the generator control panel. Pre. Mod. 2933 the selector switch is fitted to the voltage trimmer panel.

Accurate voltmeter (*fig.* 4) *Mod.* 2982

75. An accurate 0–40-volt voltmeter, introduced by Mod. 2982 (*see Group* 3), is fitted to the generator control panel. The meter is connected in parallel with the voltmeter test socket and can therefore be switched to read accurately the off-line voltage of any rotary transformer after the relative rotary transformer control switch has been selected to TRIM. Pre. mod. 2933 the voltmeter is located on the A.C. manual changeover switch box introduced by mod. 2982 (*see Group* 3).

Ammeters (*post Mod.* 2454)

76. An ammeter unit, containing three vertical scale ammeters, is fitted to the radio crate at the Air Electronics Officer's position. The connections to each ammeter are made in parallel with the ammeter test sockets on the voltage trimmer panel and are consequently fed from the ammeter shunts on panel Z. These instruments MUST NOT be used for setting-up rotary transformers and are provided for in-flight checking of the rotary transformers by the flight crew.

Hold-off relays (*fig.* 3)

77. The two hold-off relays (there is only one pre-Mod. 733) R7 and R7A are energized when a 28-volt external supply is connected. Contacts R7/1 and R7A/1, in parallel, prevent the main contactor R4 and circuit breaker R5 of the rotary transformer No. 3 only from being energized when the 112-volt system is made 'live' with No. 3 switch at ON. No. 3 rotary transformer will be tripped by the hold-off relays, if it is running when the 28-volt external supply is connected. THIS CONDITION DOES NOT APPLY TO Nos. 1 and 2 ROTARY TRANSFORMERS. Nos. 1 and 2 rotary transformers MUST BE switched OFF before the 28-volt external supply is connected, otherwise they will try to parallel the external supply; No. 3 rotary transformer must be switched ON prior to disconnecting the external supply so that when the external supply is removed, the transformer will immediately come on-line to maintain the supplies in the aircraft (if the high voltage system is 'live'). Nos. 1 and 2 rotary transformers can then be switched ON.

BATTERIES

Outline of system (*fig.* 1)

78. There are two main batteries in the aircraft, one of 96-volts, consisting of four 24-volt Type H battieries in series, used for the power services and one of 24-volts, Type H, used for instrument and control supplies. Under normal operating conditions, the engine driven generators charge the 96-volt battery through the 96-volt battery contactor and the rotary transformers charge the 24-volt battery through the 24-volt battery contactor. These contactors are used to connect or isolate the batteries from their bus-bar and are fitted with both trip and reset coils.

79. For internal starting, the 96-volt and 24-volt batteries are connected in series to give 120-volts, the connections to the 112-volt bus-bar being broken. The connections are made by the internal start battery changeover relay when the INTERNAL START switch is selected INTERNAL START.

80. The 24-volt battery is controlled by an ON/OFF switch on the port console and has a magnetic indicator to show when the battery is connected to the bus-bar. Pre-Mod. 2260 the 96-volt battery is controlled by the generator under-volt relays, the battery being connected to the bus-bar when the generator output reaches 70 to 75 volts or in an emergency (in case of generator failure) by a NORMAL/EMERGENCY switch on the port console. A magnetic indicator is provided to show when the battery is connected to the bus-bar. Post Mod. 2260, the 96-volt battery is controlled by an ON/OFF switch on the port console (replacing the NORMAL / EMERGENCY switch), and the magnetic indicator is retained.

81. The 24-volt battery is charged from the 28-volt external supply whenever the external supply is connected. The 24-volt flash-back relay prevents the battery from feeding back if a fault develops in the external supply truck.

82. Pre-Mod. 2260, the 96-volt battery is charged from the 112-volt external supply whenever the external supply is connected to the aircraft. Post Mod. 2260, the 96-volt battery can be charged from the 112-volt external supply by selecting the 96-VOLT BATTERY switch to ON after the external supply is connected. In both cases the 96-volt flash-back relay prevents the battery from feeding back if a fault develops in the external supply truck.

83. Both batteries are disconnected from their bus-bars by the battery crash relay in the event of a crash landing, the crash relay, in turn, being operated by the inertia switches.

96-volt battery (*fig.* 1 *and* 2)

Operation (*pre-Mod.* 2260)

84. When the output of the generator of the first engine to be started reaches 70 to 75 volts the undervolt relay contact R25/1

closes to connect a supply from the essential services fuse block via normally closed contacts R13/3 of the battery crash relay to the 96-volt battery contactor reset relay (R16).

85. The reset relay contact R16/1 opens to isolate the feed to the battery contactor trip coil R15 and contacts R16/2 close to connect a supply from the essential services fuse block through the normally closed contacts R7/2 of the internal start control relay to energize the 96-volt battery contactor reset coil R17 via the auxiliary contact R17/3.

86. The contactor has five sets of contacts which operate as follows:—

(1) R17/1 breaks the circuit to the internal start control relay R7 thus preventing the selection of the internal start condition.

(2) R17/2 (auxiliary) closes to make the trip coil R15 circuit thus setting the circuit for tripping the contactor when the crash relay operates or when the engines are shut down.

(3) R17/3 (auxiliary) breaks the circuit to the reset coils thus preventing simultaneous energizing of both trip and reset coils when the trip coil is energized.

(4) R17/4, in parallel with R17/5, connects the positive terminal of the battery to the 112-volt bus-bar.

87. The battery will remain connected to the bus-bar as long as at least one generator is supplying more than 86 volts (drop out value of the undervolt relays) whether or not that generator is connected to the bus-bar, until the engines are shut-down or, in the event of a crash landing, when the inertia switches energize the battery crash relay R13 (*para.* 85).

88. When the generator voltage falls below 86 volts the undervolt relay is de-energized and contacts R25/1 (four in parallel) open. When the output of the last generator falls below 86 volts the circuit to the 96-volt battery contractor reset relay R16 is broken. A supply from the essential services fuse block to the 96-volt battery contactor trip coil R15 is now connected via the normally closed contact R20/1 of the 96-volt flash back relay, contact R16/1 and contact R15/2. Simultaneously the battery contactor reset coil R17 is open circuited by contact R6/2.

89. The 96-volt battery contactor operates as follows:—

(1) R15/1 closes in the circuit to the internal start control relay.

(2) R15/2 (auxiliary) opens in the trip coil circuit thus preventing simultaneous energizing of both trip and reset coils when the reset coil is energized.

(3) R15/3 (auxiliary) closes in the reset coil R17 circuit thus setting the circuit for resetting the contactor when the engines are started or when the external supply plug is connected.

(4) R15/4 and R15/5, in parallel, disconnect the battery from the 112-volt bus-bar.

90. If, whilst the engines are running, a total failure of all four generators should occur (i.e., all four generator voltages fall below 86 volts), the battery will be tripped off-line (*para.* 55 *and* 56). The battery may be reconnected by selecting the 96-VOLT BATTERY switch to EMERGENCY. This switch is in parallel with contacts R25/1 of the generator undervolt relays and the circuit will operate otherwise as described in paras. 51 to 53. The battery will remain connected to the 112-volt bus-bar until the switch is returned to NORMAL.

Operation (*post Mod.* 2260)

Note . . .

Mod. 2260 *supersedes Mod.* 2088 *and all aircraft that were fitted with Mod.* 2088 *have been fitted with Mod.* 2260.

91. The battery is connected to the bus-bar only when the 96-VOLT BATTERY switch is selected ON. A supply from the essential services fuse block via the normally closed contacts R13/4 of the battery crash relay is then connected to the coil R16 of the 96-volt battery reset relay. The reset relay operates and contacts R16/1 open to isolate the feed to the battery contactor trip coil R15 and contact R16/2 closes to connect a further supply from the essential services fuse block through the normally closed contacts R7/2 of the internal start control relay to energize the 96-volt battery contactor reset coil R17 via its auxiliary contact R17/3. The contactor has five sets of contacts which operate as described in para. 53.

92. The battery will remain connected to the bus-bar until the switch is selected OFF or unless the crash relay operates.

Note . . .

The battery switch must not be selected OFF after flight or engine run until all engines have been shut off.

93. When the battery switch is selected OFF, the circuit to the 96-volt battery contactor reset relay R16 is broken. Contact R16/1 of this relay closes to connect a supply from the essential services fuse block to the contactor trip coil R15 through its auxiliary contact R15/2. Contact R16/2 of the reset relay opens simultaneously to open-circuit the contactor reset coil R17 line. The contactor trip coil operates the contactor to trip the battery off-line (*para.* 56).

Indicator (*pre-Mod.* 2376)

94. The magnetic indicator is mounted on the port console adjacent to the battery switch and shows BLACK when the battery is selected ON. When the generator undervolt relay operates or the battery switch is selected EMERGENCY (pre-Mod. 2260) or the battery switch is selected ON (post Mod. 2260) the indicator is energized in parallel with the battery contactor reset coil R17 from the essential services fuse block as soon as the contacts R16/2 of the reset relay close.

95. When the battery is switched OFF, contacts R16/2 of the reset relay open to break the supply to the indicator which now changes from BLACK to WHITE.

Indicator (*post Mod.* 2376)

96. In order to achieve an indication that the battery is actually connected to the bus-bar the battery contactor has been changed. Contactor 5CZ/NIV is now fitted in lieu of contactor 5CZ/4390. This contactor incorporates an extra set of auxiliary contacts which are used to control the magnetic indicator. When the contactor reset coil R17 is energized, auxiliary contact R17/6 closes to connect an independent supply from the essential services fuse block to the magnetic indicator which now changes from WHITE to BLACK.

97. When the contactor trip coil R15 is energized the auxiliary contacts are opened, thus de-energizing the magnetic indicator. The indicator now shows white.

24-volt battery

Operation (*fig.* 1)

98. The 24-volt battery is always connected to the essential services fuse blocks via the heavy duty connector blocks mounted in the battery bay above the 24-volt battery control panel.

99. The battery is connected to the main aircraft 28-volt bus-bar on panel Z by the 24-volt battery contactor which is, in turn, controlled by the 24-VOLT BATTERY switch on the port console. When the switch is selected ON, a supply from the essential services bus-bar, via the INTERNAL START switch at NORMAL (terminals 2—1), is connected through the normally closed contact R13/1 of the battery crash relay to the coil R10 of the 24-volt battery contactor reset relay.

100. Contact R10/1 of the reset relay closes to connect a separate supply from the essential services fuse block to the battery contactor reset coil R12 via its auxiliary contact R12/2. The battery contactor has five sets of contacts which operate as follows :—

(1) R12/1 (auxiliary) closes in the circuit to the contactor trip coil R9 thus setting the circuit for tripping the contactor when OFF is selected or the crash relay operates.

(2) R12/2 (auxiliary) opens in the circuit to the contactor reset coil R12 thus preventing simultaneous energizing of both trip and reset coils.

(3) R12/3 and R12/4, in parallel, connects the positive terminal of the battery to the main 28-volt bus-bar.

(4) R12/5 closes in the circuit between the internal start selector switch and the contactor trip coil R9 so that when internal start is selected the battery is disconnected from the bus-bar.

101. The battery will remain connected to the bus-bar until the battery switch is selected OFF, internal start is selected or the crash relay operates.

102. When OFF is selected, the supply to the coil R10 of the reset relay is broken and the battery switch supply is connected to the battery contactor trip coil R9 via its auxiliary contact R9/1. The reset relay contact R10/1 breaks the circuit to the battery contactor reset coil. The battery contactor trip coil operates the contactor contacts as follows:—

(1) R9/1 open in the trip coil circuit thus preventing simultaneous operation of both trip and reset coils when ON is selected.

(2) R9/2 closes in the reset coil R12 circuit, thus setting the circuit for resetting the contactor.

(3) R9/3 and R9/4, in parallel, open to disconnect the battery from the bus-bar.

(4) R9/5 opens in the circuit between the internal start switch and the contactor trip coil.

Indicator (*fig.* 1)

103. When the battery switch is selected ON the indicator, mounted on the port console adjacent to the battery switch is energized. It is connected in parallel with the reset coil R12 of the battery contactor from the essential services fuse block as soon as contact R10/1 of the battery reset relay closes.

104. When the battery is switched OFF, contact R10/1 of the reset relay opens to break the supply to the indicator which now changes from black to white.

Indicator positions:—

BLACK—battery on—energized
WHITE—battery off—unenergized

Internal start connections (*fig.* 1)

105. When internal start is selected the 96-volt battery is connected in series with the 24-volt battery, both batteries being disconnected from their respective bus-bars. The INTERNAL START switch is recessed in the rear face of the port console and is guarded by a spring loaded flap. Before these connections can be made, the START MASTER switch must be selected ISOLATE or START.

106. When the INTERNAL START switch is selected INTERNAL START, a supply via the START MASTER switch at ISOLATE or START is connected via the 96-volt battery contactor auxiliary contact R15/1, R17/1 to the internal start control relay coil R7. These contacts of the 96-volt battery contactor are closed only if the contactor trip coil is energized, if the battery is on-line when internal start is selected, the internal start control relay cannot be energized and the internal start connections cannot be made.

107. A second supply, from the essential services fuse block, is connected by terminals 2 to 3 of the internal start switch to the coil R8 of the start control changeover-relay and via auxiliary contacts R9/5, R12/5 of the 24-volt battery contactor to the trip coil R9 of the 24-volt battery contactor. These contacts of the 24-volt battery contactor are closed only when the 24-volt battery is on-line, thus when internal start is selected, the battery will be automatically tripped.

108. The internal start control relay closes, contact R7/1 connect a supply from the essential services fuse block to the coil R11 of the internal start battery change-over

relay and contacts R7/2 open the circuit to the 96-volt battery contactor reset coil R17, to prevent the 96-volt battery being connected to the bus-bar whilst internal start is selected. The start control change-over relay contacts R8/1 and R8/2 change the supply to the engine start control circuits from the 28-volt bus-bar to the essential services fuse block.

109. The internal start battery change-over relay operates as follows :—

(1) R11/1 disconnects the negative terminals of 96-volt battery from the earth return and connects them to the positive side of the 24-volt battery.

(2) R11/2 disconnects the external supply circuit to the 112-volt bus-bar and connects it to the positive side of the 112-volt battery. The engine starter supply circuit is tapped into this circuit and is fed via a 200 amp. H.R.C. fuse in the battery bay (*Chapter* 4).

The two batteries are now connected in series and both are disconnected from their bus-bars. The essential services fuse blocks are still connected to the 24-volt battery.

110. When the INTERNAL START switch is selected to NORMAL, relays R7, R8 and R11 are de-energized and the battery connections are reveted back to the condition they were in before internal start was selected:- 96-volt battery off-line, 24-volt battery either on-or off-line as selected.

Charging (*fig.* 1)

111. In flight, the 96-volt and 24-volt batteries are charged from the generators and rotary transformers respectively. On the ground, the batteries can be charged from the external supply truck.

96-*volt* (*pre-Mod.* 2260) (*fig.* 1)

112. *Pre-Mod.* 2260, the 96-volt battery is charged as soon as the 112-volt external supply is plugged in. Pin C of the external supply socket feeds a 112-volt supply to the coils R20 of the 96-volt flash back relay and via dropping resistance to the coils R18 and R19 of the two generator hold-off relays.

113. The 96-volt flash-back relay operates as follows :—

(1) R20/1 open to prevent simultaneous energizing of the 96-volt battery contactor reset and trip coils when the reset coil is energized by the operation of R20/2.

(2) R20/2 closes to connect a supply from the essential services fuse block to the 96-volt battery contactor reset coil R17 via its auxiliary contact R17/3.

(3) R20/3 closes in the circuit between the external supply socket pin + and the 112-volt bus-bar and the engine starter circuit.

(4) R20/4 opens its contact in the pull-in coil of the flash-back relay, leaving the relay held-in by the economy coil only.

The 96-volt battery contactor operates as described in para. 53 and the battery is charged via the 112-volt bus-bar from the external supply. The negative return is carried back to the supply truck via pin—ve of the supply socket.

114. If a failure occurs in the external supply truck such that the battery tends to feed into the fault in the truck, the flash-back relay will drop-out to disconnect (R20/3) the battery from the bus-bar and the bus-bar from the external supply socket (relays R20, R15 and R17).

96-*volt* (*post Mod.* 2260) (*fig.* 1)

115. Post Mod. 2260, the operation of the 96-volt flash-back relay connects R20/3 (R20/1 *fig.* 1*A*) the external supply to the 112-volt bus-bar and disconnects R20/4 (R20/2 *fig.* 1*A*) its pull-in coil as before. It does not, however, bring the 96-volt battery on-line; this has to be done by switching the 96-volt battery to ON. Protection is still retained as before by the flash-back relay to cater for failure of the ground truck.

24-*volt* (*fig.* 1)

116. When the 28-volt external supply is connected, a 28-volt supply is fed via pin C of the socket to the coils R5 of the 24-volt flash-back relay and to the coils of the rotary transformer hold-off relays. The 24-volt flash-back relay closes its contact R5/1 to connect the external supply, via pin + of the socket, to the essential services heavy duty connector and then to the 24-volt battery. Contact R5/2 opens to disconnect the pull-in coil leaving the relay held-in by the economy coil only.

117. If a failure occurs in the external supply truck such that the battery tends to feed into the fault on the truck, the flash-back relay drops out to disconnect (R5/1) the external supply from the battery.

Note . . .

In order to connect the 28-volt external supply to the main 28-volt bus-bar on panel Z, the 24-volt battery switch must be selected ON.

Crash relays (*fig.* 1)

118. In the event of a very heavy or crash landing, the inertia switches on the pilots' floor beam will operate (at 3g decelleration) to connect a supply from the essential services fuse block to the fire extinguisher control relays and to the battery crash relay R13. The contacts of this relay operate as follows:–

(1) R13/1 opens to break the circuit to the 24-volt battery reset relay.

(2) R13/2 closes to connect a supply from the essential services bus-bar to the 24-volt battery contactor trip coil R9. The 24-volt battery is then disconnected from the bus-bar.

(3) R13/3 opens to break the circuit to the 96-volt battery reset relay.

(4) R13/4 closes to connect a supply from the essential services bus-bar to the 96-volt battery contactor trip coil R15. The 96-volt battery is thus disconnected from the bus-bar.

Emergency batteries

119. Two emergency batteries are fitted, one, consisting of three alkaline batteries (Ref. No. 6140/101806) in parallel, for the cockpit emergency lamps is mounted on the rear face of the port console and the other, consisting of two 12-volt batteries (Ref. No. 5J/3307) in series, is mounted in a box attached to the cabin roof above the radio crate and is for the hood detonation system.

Battery ammeters—Mod. 2650 (*fig.* 1, 1*A or* 1*B*)

120. Modification 2650 introduces charge/discharge ammeters at the A.E.O.'s position on the radio crate for both 28 and 112-volt systems. A 100A, 50 MV shunt, fitted in the battery bay to the positive line of the 24-volt battery between the battery and the essential service (battery) bus-bar, is connected to a 60–0–100A ammeter for the 28-volt system. For the 112-volt system a 200A, 50 MV shunt is fitted in the battery bay in the negative line to earth from the 96-volt battery and is connected to a 130–0–200A. ammeter.

121. The ammeters will indicate either charge or discharge currents for their respective batteries and provide the only indication that the batteries are taking the aircraft load in the event of a total generator failure under conditions when the generator warning lamps do not indicate such failure. It should be noted that neither ammeter will be in circuit when carrying out an internal battery start with the batteries in series.

SERVICING

WARNING . . .

Voltages in excess of 100 volts either a.c. or d.c. can be dangerous under certain circumstances. Personnel should therefore ensure that the electrical system is electrically safe before any servicing is attempted. Where it is essential that tests or adjustments are to be made with the electrical power switched on, the greatest care must be exercised.

Introduction

122. Detailed descriptions of the general tests to be applied to all aircraft circuits, are given in the General Information group contained in this Book immediately after Section 5 marker card. Reference should be made to the relevant Air Publication for detailed information on the servicing of the items of equipment used in the system.

112-VOLT SYSTEM

Generator Checks

Note . . .

If a generator has operated at the emergency rating (i.e., 135 amps. maximum for a period not exceeding 5 hours) it must be inspected, immediately after flight, for damage to the brush gear, commutator and other internal parts.

123. During routine maintenance on the aircraft, insulation and brush gear checks should be carried out on the generators.

Insulation reading—100,000 ohms MINIMUM
Brush length—0·68 inches MINIMUM

During routine maintenance on the aircraft, the generator main circuit-breaker economy coil contacts should be inspected for damage or malalignment. Such damage can prevent a generator being re-selected on-line after a check of the off-line voltage or the switch has otherwise been selected from ON. Pre-Mod. 2933 attention should also be paid to the contacts of the main circuit-breaker in the trimmer circuit and to the trimmer circuit contacts of the interlock (or trimmer) relay. High contact resistance will give very high generator voltages. Contact resistances giving a voltage drop of no greater than 150 mv. at a current of 10 amps. should be obtained.

Hold-off relay running checks

124. (1) With the engines running switch OFF Nos. 1, 2 and 3 generators.

(2) Switch ON No. 4 generator.

(3) Plug in the external 112-volt supply and check that No. 4 generator comes off-line.

(4) Momentarily switch ON Nos. 1 2, and 3 generators in turn and check that they come on-line. This should only be done for a brief period to ensure that the aircraft generator output is not fed into the external supply.

(5) Shut down the engines and remove the external supply.

(6) Remove the 80 amp. H.R.C. fuse in the navigator's feeder line, located on panel Z.

(7) Connect the 112-volt external supply and start the engines.

(8) Check that Nos. 1 and 2 generators only will come on-line and that Nos. 3 and 4 generators cannot come on-line.

(9) Shut down the engines and remove the external supply.

(10) Replace the 80 amp. H.R.C. fuse in the navigator's feeder line.

(11) Carry out another engine run to ensure that the circuit operates satisfactorily after fuse replacement.

(12) Repeat items 5 to 12 for the 80 amp. H.R.C. fuse on panel Z in the wireless operator's No. 1 feeder line, checking that Nos. 3 and 4 generators only can come on-line.

(13) Shut down the engines and remove the external supply.

112-volt generator setting-up (*pre-Mod.* 2933)

125. The following checks are to be made on engine run. Attention must be paid to the engine running limitations and engines should be run for no longer than the time required for setting-up the generators.

Note . . .

The generators run at a higher speed than the engines, the ratio being 1·191 *to* 1.

(1) Run the engines at 4,500 r.p.m. (max. J.P.T.565 °C) for 20 mins. with the generators off-line (switches at RESET or OFF) and the external supply connected, to warm up the regulators. The regulators warm up quicker with the generators unloaded as a greater voltage is applied to the regulators.

(2) Switch ON No. 4 generator.

(3) Disconnect the external supplies.

(4) Switch ON Nos. 1, 2 and 3 generators.

(5) Switch No. 1 generator to TRIM.

(6) Connect a suitable 1st grade voltmeter on the ground test rig 26SR/95295 into the generator voltage test socket, on the trimmer panel in the cabin.

(7) Select to No. 1 the voltage test selector switch.

(8) Adjust No. 1 trimmer on the trimmer panel to give a reading of 110·0 volts on the meter.

(9) Check the voltage reading for stability over the full generator speed range, 4,500 to 8,000 engine r.p.m. ATTENTION MUST BE PAID TO ENGINE LIMITATIONS. Max. J.P.T. 600±50° C at 8,000 r.p.m.

(10) Switch No. 1 generator to ON.

(11) Repeat items 2 to 10 for generators Nos. 2 to 4 in turn.

112-volt generator setting-up (post Mod. 2933)

126. The following checks are to be made on engine run. Attention must be paid to the engine running limitations and engines should be run for no longer than the time required for setting-up the generators.

Note . . .

The generators run at a higher speed than the engines, the ratio being 1·191 *to* 1.

(1) Run the engines at 4,500 r.p.m. (max. J.P.T.565 ° C.) for 20 mins. with the generators off-line (switches at RESET or OFF) and the external supply connected, to warm up the regulators. The regulators warm up quicker with the generators unloaded as a greater voltage is applied to the regulators.

(2) Select No. 4 generator control switch to ON.

(3) With the voltmeter selector switch set to No. 4, check that the 112-volt voltmeter reading is approximately 110-volts (if necessary trim to 110-volts).

(4) Disconnect the external supply.

(5) Depress No. 4 generator engage switch.

(6) Select Nos. 1, 2, and 3 generator control switches to ON.

(7) Set the voltmeter selector switch to Nos. 1, 2 and 3 in turn and check that readings of 110-volts are obtained (trim if necessary).

(8) Depress Nos. 1, 2, and 3 generator engage switches.

(9) Select No. 4 generator control switch to TRIM.

(10) Connect the voltmeter on the ground test rig 26SR/95295 into the generator voltage test socket, on the trimmer panel in the cabin.

(11) Select to No. 1 the voltage test selector switch.

(12) Adjust No. 1 trimmer on the trimmer panel to give a reading of 110·0 volts on the meter.

(13) Check the voltage reading for stability over the full generator speed range 4,500—8,000 engine r.p.m. ATTENTION MUST BE PAID TO ENGINE LIMITATIONS. Max. J.P.T. 600±50 °C. at 8,000 r.p.m.

(14) Select No. 1 generator control switch to ON and depress No. 1 generator engage switch.

(15) Repeat items 9—14 for generators Nos. 2—4 in turn.

112-volt generator load sharing

Note . . .

Load sharing checks must be carried out as detailed below whenever voltage setting-up is carried out. Although load sharing should be satisfactory when all generators are set to 110 *volts, a check must be carried out; merely setting each generator to* 110·0 *volts is not sufficient, for example an incorrect tapping or rating of a ballast resistance will give bad load sharing even though the voltages are correct.*

127. The voltage regulators have their ballast resistances (equalizing potentiometers) set to the mechanical mid position before fitting to the aircraft, and with the generators, which are constructed to close tolerances, the same equalizing voltages are obtained at the regulator equalizing coils. If, therefore, it is found necessary to replace any of these items, no adjustments should be necessary other than to check that the ballast resistances in the regulators are at the mid position, and to set the remote trimmer. It has been found from experience that if, when carrying out load sharing checks, one machine appears outside the permissible limits, a re-check on the regulated voltage has shown a voltage swing due to creep of the regulator. Using the trimmer to recorrect the regulated voltage will bring the load sharing within the permissible limits.

Note . . .

The ballast resistances are 1·25 *ohms and setting the slide to the mid position introduces the required* 0·625 *ohms into the equalizing circuit.*

128. As the equalizing voltage is affected by the temperature of the generator series field winding, it is important that running conditions between the four generators have not varied appreciably immediately before the checks are made. It is also important that

the load should not be altered whilst the load sharing checks are in progress. Ground test rig Ref. No. 26SR/95295 provides suitable meters and switches required for load sharing and output checks and is provided with plugs which are to be fitted to the sockets on the trimmer panel.

129. Load sharing checks should be made as follows :—

(1) Switch on line all four generators (switches to ON).

(2) Connect sufficient services to apply a load of at least 150 amps.

(3) To check that the generators are load sharing correctly, take ammeter readings (using the test sockets on the trimmer panel) with all combinations of the four generators on-line. The ground tests rig Ref. No. 26SR/95295 provides a suitable ammeter for the test purposes.

(4) Load sharing between all four generators should be such that there is very little difference between the ammeter readings obtained from each generator at all loads up to full load throughout the generator speed range (4,500 to 8,000 engine r.p.m.). Out-of-balance readings of less than 5 amps. should be easily obtained. If difficulty is encountered, the maximum allowable out-of-balance between all four generators is ±20 amps. ATTENTION MUST BE PAID TO ENGINE LIMITATIONS.

(5) Switch all generators off-line (switches to RESET or OFF) and shut down engines.

28-VOLT SYSTEM

Rotary transformer checks

Note . . .

Frequent checks must be made to check that there is adequate clearance between the bus-bar link and the control box casing.

130. During routine maintenance in the aircraft, brush gear checks should be carried out on the rotary transformers. Brush lengths are as follows:—

112-volt end—0·46 inches MINIMUM
28-volt end—0·64 inches MINIMUM

Hold-off relay running checks

131. (1) Connect a 112-volt supply to the aircraft external connection.

(2) Select Nos. 1 and 2 rotary transformer switches to OFF.

(3) Select No. 3 rotary transformer switch to ON.

(4) Plug in the 28-volt external supply and check that No. 3 rotary transformer comes off-line.

(5) Momentarily switch ON Nos. 1 and 2 rotary transformers in turn and check that they come on-line. This should only be done for a brief period to ensure that the 28-volt output is not fed into the external supply.

(6) Disconnect the external supplies.

(7) Remove the 80-amp. H.R.C. fuse in the navigator's feeder line located on panel Z.

(8) Reconnect the 112-volt external supply and check that No. 3 transformer only will come on-line, and that Nos. 1 and 2 transformers cannot come on-line.

(9) Remove the external supply and replace the 80-amp. H.R.C. fuse.

(10) Connect up the 112-volt external supply and ensure that all transformers will come on-line after fuse replacement.

(11) Repeat items 6 to 10 for the 80-amp. H.R.C. fuse in the wireless operator's No. 1 feeder line, checking that Nos. 1 and 2 transformers only will come on line.

(12) Remove the external supply and shut down.

28-volt rotary transformers—setting up

132. The following checks are to be made with the 112-volt external supply only connected. There is no need to run the engines. The 24-volt battery switch should be at ON

(1) Check that the main supply to the rotary transformers is 112-volts.

(2) Run the rotary transformers for 20 minutes on no load (switches to TRIM) to allow the regulators to warm up. The regulators warm up quicker with the rotary transformers unloaded as a greater voltage is applied to the regulator.

(3) Using a suitable 1st grade voltmeter plugged into the rotary transformer voltage test socket, on the trimmer panel in the cabin, select No. 1 on the voltage test selector switch.

(4) Adjust No. 1 rotary transformer trimmer, on the trimmer panel, to give a reading of 27·5 volts on the meter.

(5) Repeat items 3 and 4 for Nos. 2 and 3 rotary transformers.

28-volt rotary transformers—load sharing

133. As the equalizing voltage is affected by the temperature of the rotary transformer output armature, field and equalizing resistance, it is important that running conditions between the three machines should not have varied appreciably immediately before the checks are made. It is also important that the load should not be altered whilst the load sharing checks are in progress.

134. Load sharing checks should be carried out as follows :—

(1) Switch on-line No. 1 rotary transformer (switch to ON).

(2) Select the instrument master switch to ON.

(3) Switch on sufficient 28-volt services to load the transformer to normal full load (100 amps. approx.).

(4) To check that the transformers are load sharing correctly, take ammeter readings (using the test sockets provided on the trimmer panel) with all combinations of the three transformers on-line.

(5) Load sharing between any two transformers should be within ± 10 amps. at all loads up to full load.

(6) If the load sharing is not within the permissible limits, recheck the regulated voltage and trim if necessary. If load sharing is still unsatisfactory, wiring checks will have to be made for high resistance joints, especially in the equalizing circuits.

(7) Once satisfactory load sharing has been established switch off all loads.

(8) Switch all transformers off-line (switches to RESET or OFF).

(9) Disconnect the 112-volt external supply.

BATTERIES

96-volt

Pre-Mod. 2260

135. With all switches at OFF and external supplies disconnected, short-circuit terminals 3 to 4 of the generator undervolt relays on panel J in turn and check that when short-circuited the 96-volt battery contactor operates. The 112-volt bus-bar voltmeter on the voltage trimmer panel should read 96-volts and the magnetic indicator shows black. Ensure that all shorting links are removed after this test.

136. Select the 96-volt battery switch to EMERGENCY and check that the battery contactor operates and the magnetic indicator shows black. Select the switch to NORMAL, the indicator should show white and the contactor should trip.

137. Check that when the 112-volt external supply is connected, the battery contactor operates and the indicator shows black. Remove the external supply, the indicator should now show white.

Post Mod. 2260

138. Select the 96-VOLT BATTERY switch to ON and check that the battery contactor operates (the 112-volt to bus-bar voltmeter in the voltage trimmer panel reads 96-volts) and the magnetic indicator shows black. Switch OFF, the voltmeter should now read zero and the indicator should show white.

139. Ensure that the battery does not come on-line when the 112-volt external supply is connected until the 96-VOLT BATTERY switch is selected ON. With the switch at ON, disconnect the external supply and check that the 112-volt bus-bar voltmeter falls to 96-volts. Check with an avometer that there is no feed back voltage between the external supply socket pins + to —. Select the battery switch to OFF.

24-volt battery

140. Always ensure that there is a good connection, mechanically and electrically between the 24-volt battery and the essential services fuse block(s) via the heavy duty connectors above the battery control panel.

141. Select the 24-VOLT BATTERY switch to ON and check that the battery contactor operates (the 28-volt bus-bar voltmeter on the voltage trimmer panel reads 24-volts) that the 24-volt battery magnetic indicator shows black. Switch OFF, the voltmeter should now read zero, and the indicator should show white.

Internal start connections

142. Check that the external supplies are disconnected, select the 24-VOLT BATTERY switch to ON, and the 96-VOLT BATTERY switch to OFF (or NORMAL pre-Mod. 2260). Select the INTERNAL START switch to INTERNAL start and check that the 24-volt battery goes off-line, indicator white.

143. With an avometer, measure the voltage at terminal + of the engine starter panel in the servicing bay above the nosewheel; the voltage should be 120-volts approx. Return the INTERNAL START switch to NORMAL and the 24-VOLT BATTERY switch to OFF.

INERTIA SWITCH CIRCUITS

Generator crash switches (Mods. 2259 and 2680)

144. Periodic checks should be made as follows to ensure the satisfactory functioning of the crash switches and crash contactors:—

(1) Connect up external supplies, select battery switches to ON.

(2) With the engines running select all generator switches to ON.

(3) Connect sufficient services to apply a load of 150 amps. approximately.

(4) Connect a voltmeter to the test socket of the voltage trimmer panel.

(5) Select the volts selector switch to No. 1.

(6) Concuss No. 1 crash switch in the nosewheel bay, the generator failure warning lamp should come on and the generator voltage should fall to about 10 volts.

(7) Select the volts selector switch to No. 2, No. 3 and No. 4 in turn and repeat item 5 for the relative crash switch.

(8) Switch off all loads.

(9) Reset all four crash switches.

(10) Select the crash contactor reset switch on panel J to RESET momentarily. Check that all four generator failure warning lamps go out.

Battery crash relay

145. This test should be carried out in conjunction with tests on the fire extinguishers as described in Chapter 4, otherwise the fire extinguisher crash relay coils will have to be disconnected to avoid discharging the fire extinguisher bottles.

146. Disconnect all the fire extinguisher bottles and switch both batteries on. Short-circuit the two crash inertia switches on the pilots' floor beam with short lengths of wire Check that both batteries come off-line, their indicators show white and the bus-bar voltmeters read zero.

147. Switch both batteries off and remove the shorting links from the crash switches. Reconnect all fire extinguisher bottles.

MISCELLANEOUS

Emergency batteries

148. Periodically inspect the emergency batteries for the cockpit lighting and hood detonation for corrosion and state of charge. These batteries should always be kept in good condition.

Fuse testers (Mod. 2294)

149. Fuse test probes and lamps have been fitted to all the fuse panels on the aircraft. These probes are to be used for testing the fuses on these panels during routine servicing in order that fuses need not be removed. The 112-volt test probe on panel J has a series volt-dropping resistance which should be periodically inspected.

Note . . .

The fuse test probe on panel D must not be used for fuses 122-125 *as these are* 115-*volt a.c. and the test lamp has* 28-*volt filament.*

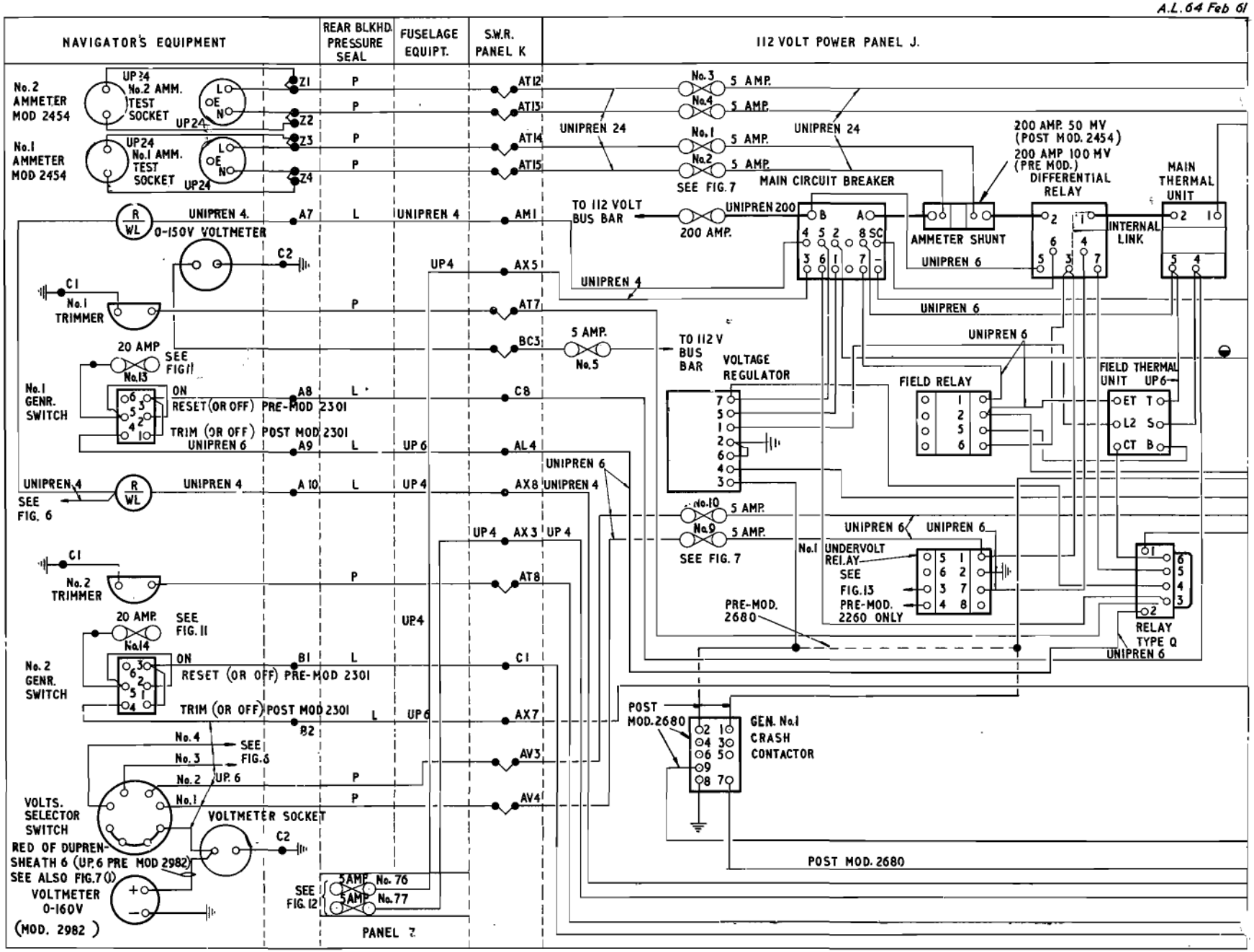

Fig. 5 (1) 112-Volt generators No. 1 and No. 2 sets (post Mod 2240 & pre Mod 2817, 2933)

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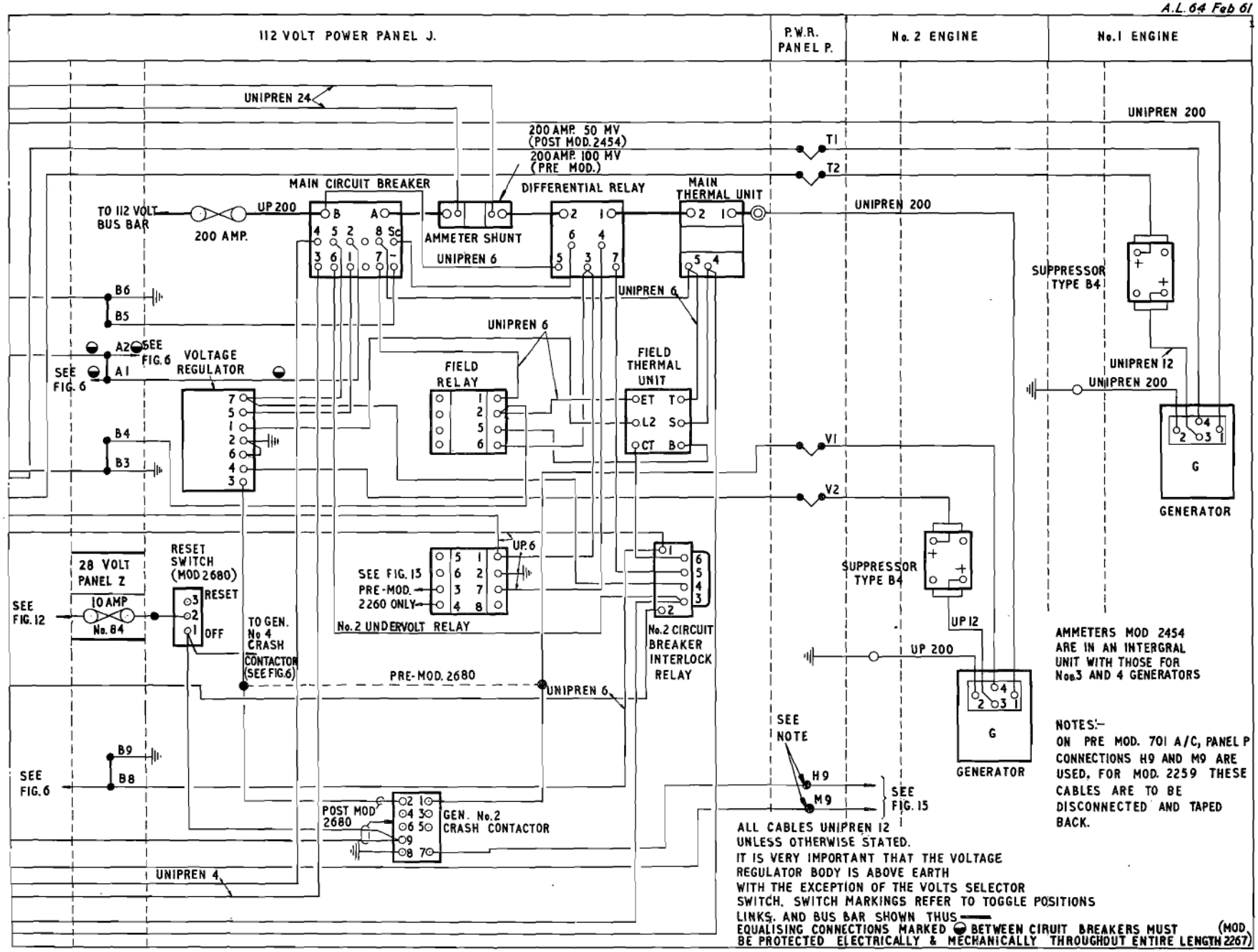

Fig. 5 (2) 112-Volt generators No.1 and No. 2 sets (post Mod 2240 & pre Mod 2817, 2933)

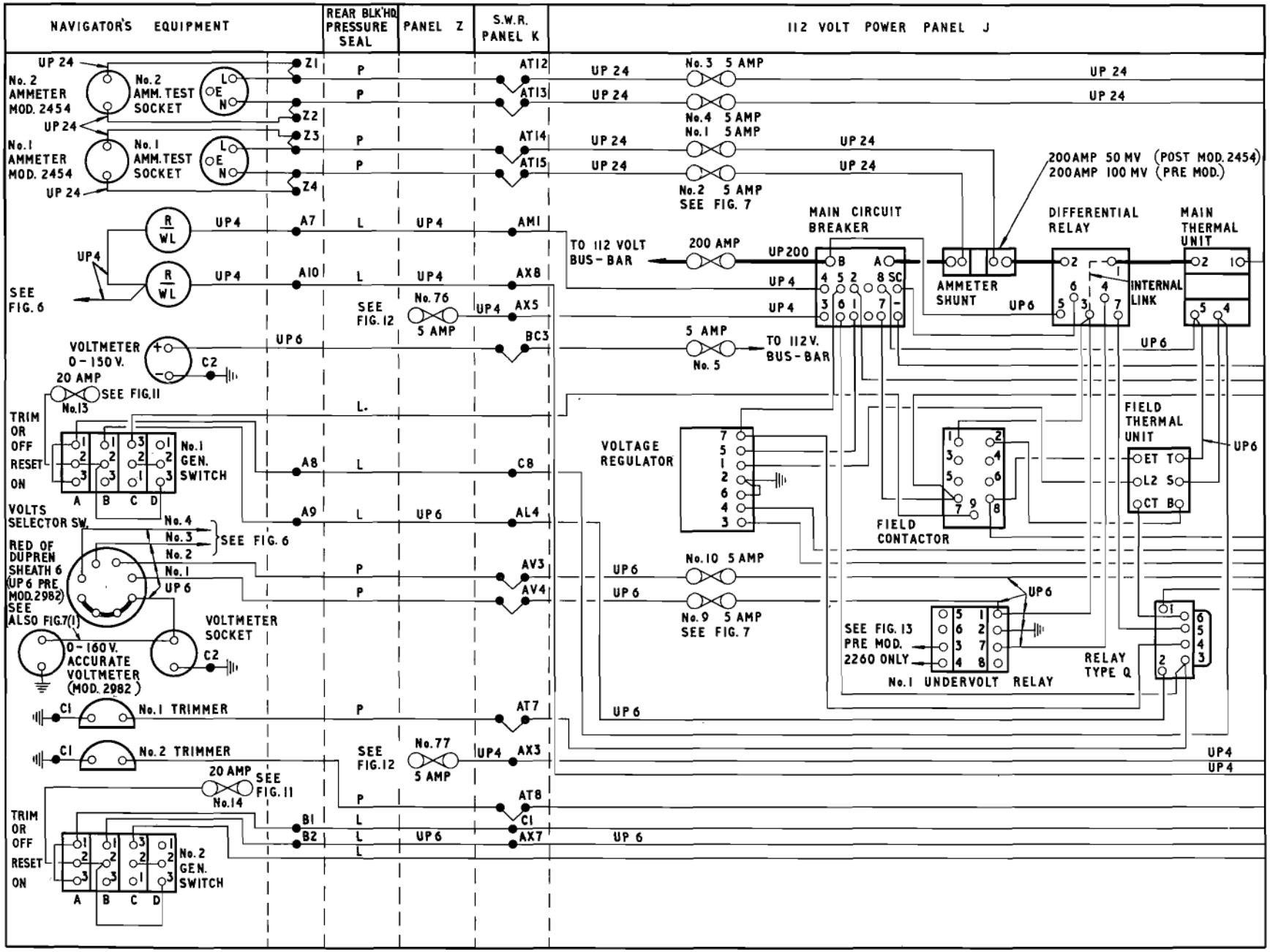

Fig. 5A (1) 112-Volt generators, No.1 and No.2 sets (post Mod 2817 pre Mod. 2933)

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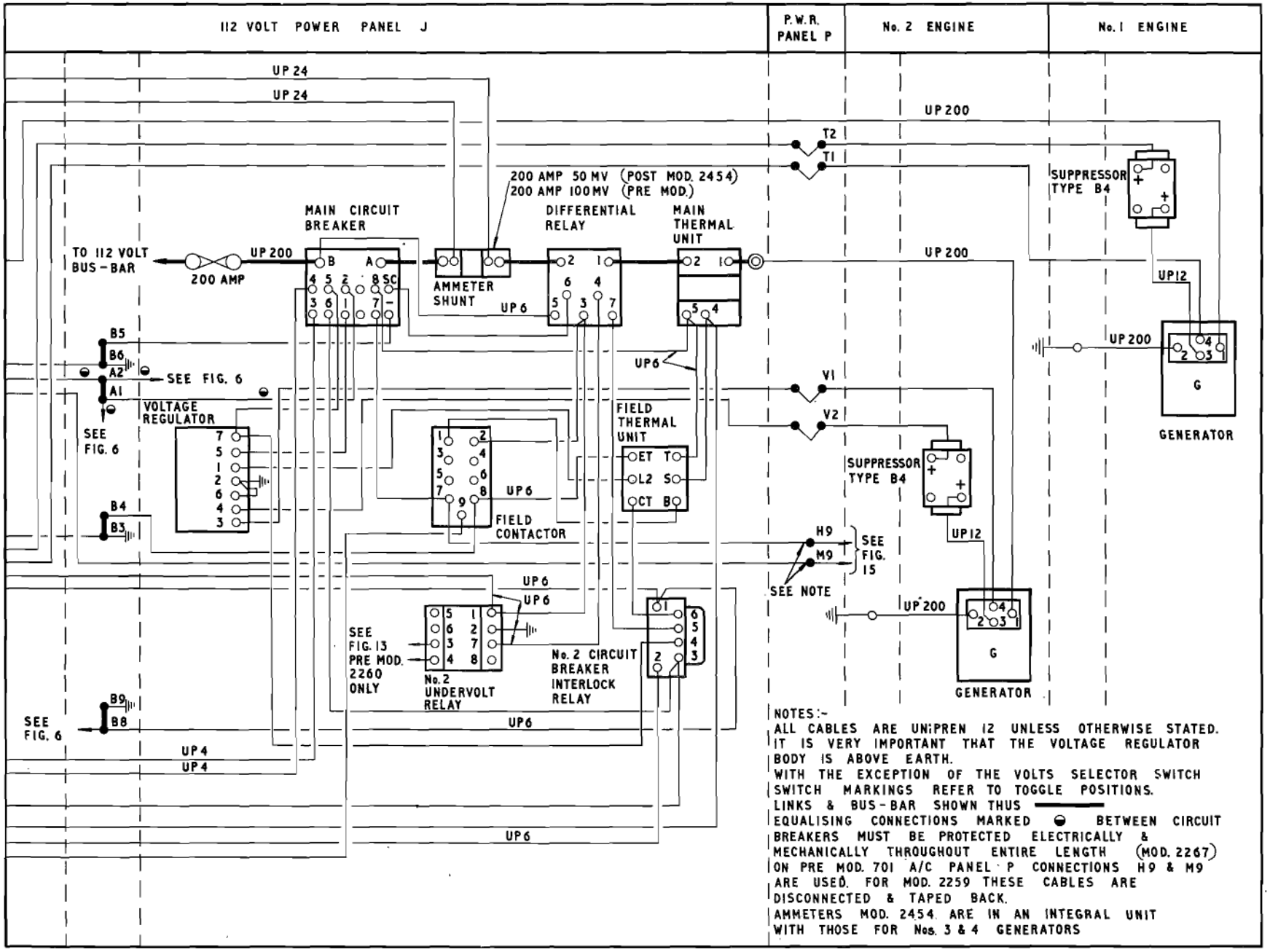

Fig. 5A (2) 112-Volt generators, No.1 and No.2 sets (post Mod 2817 pre Mod 2933)

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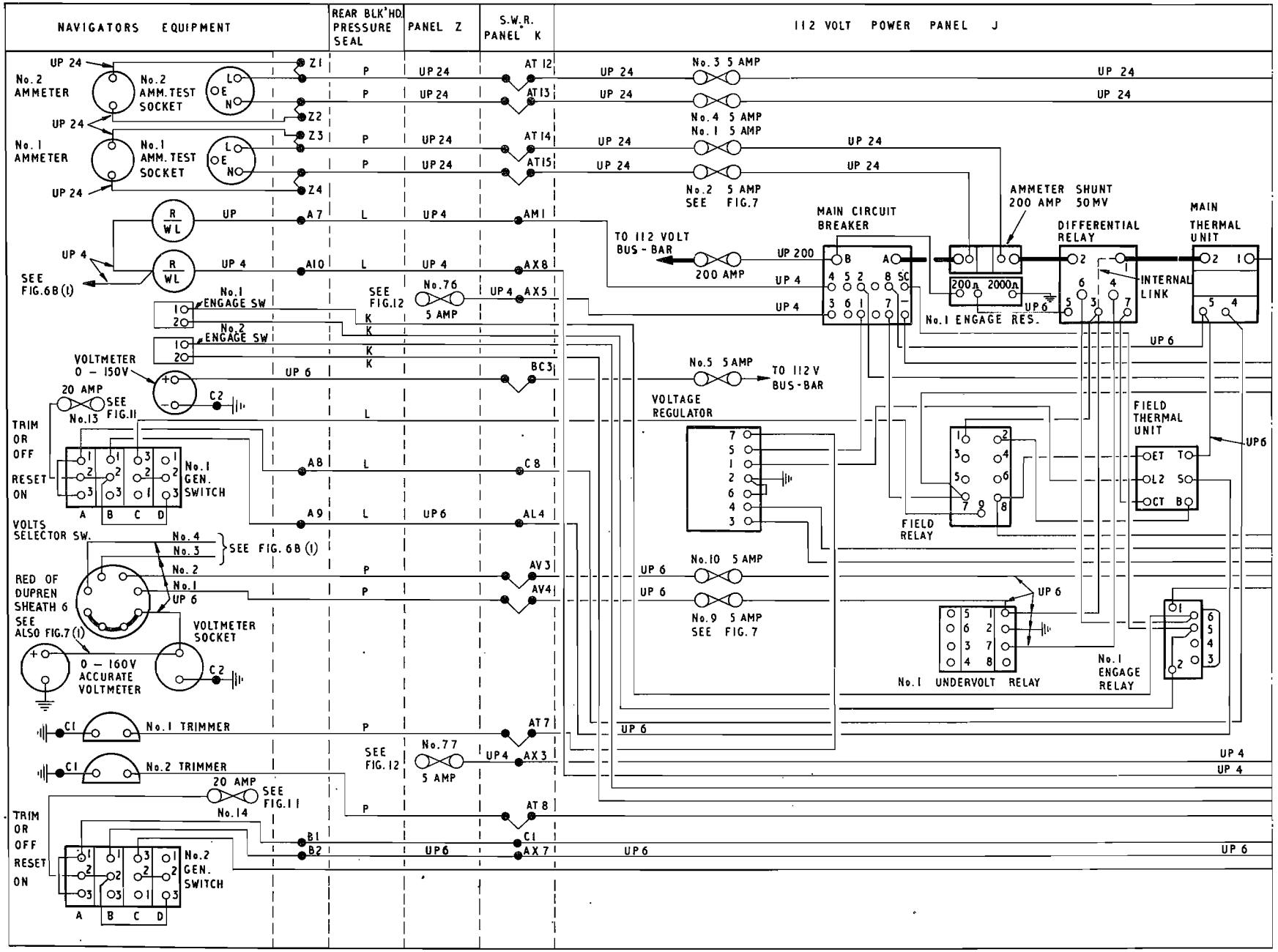

Fig 5B (1) 112 Volt generators, No.1 and No.2 sets (post Mod. 2933)

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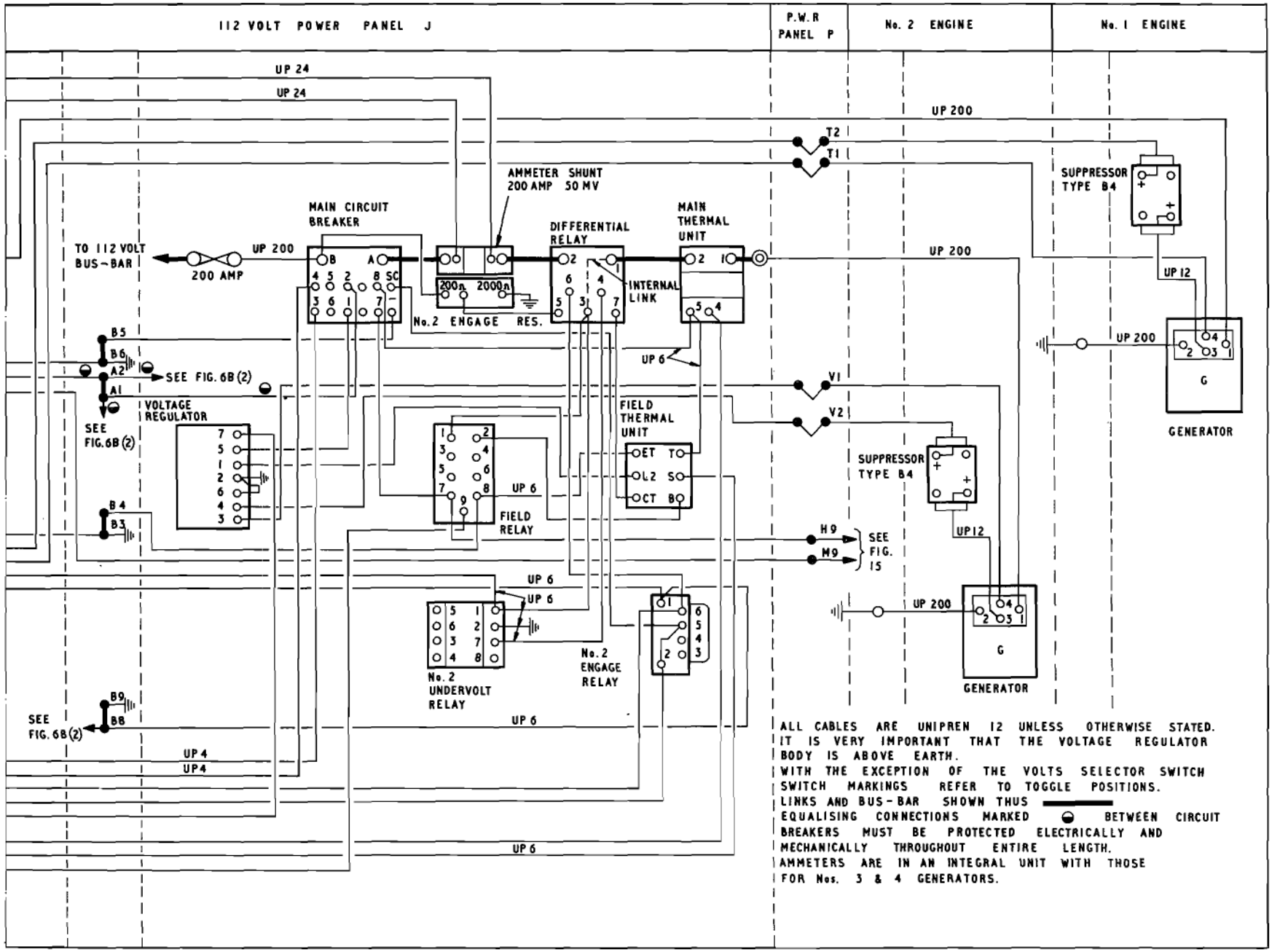

Fig 5B (2) 112 Volt generators No. 1 and No. 2 sets (post Mod 2933)

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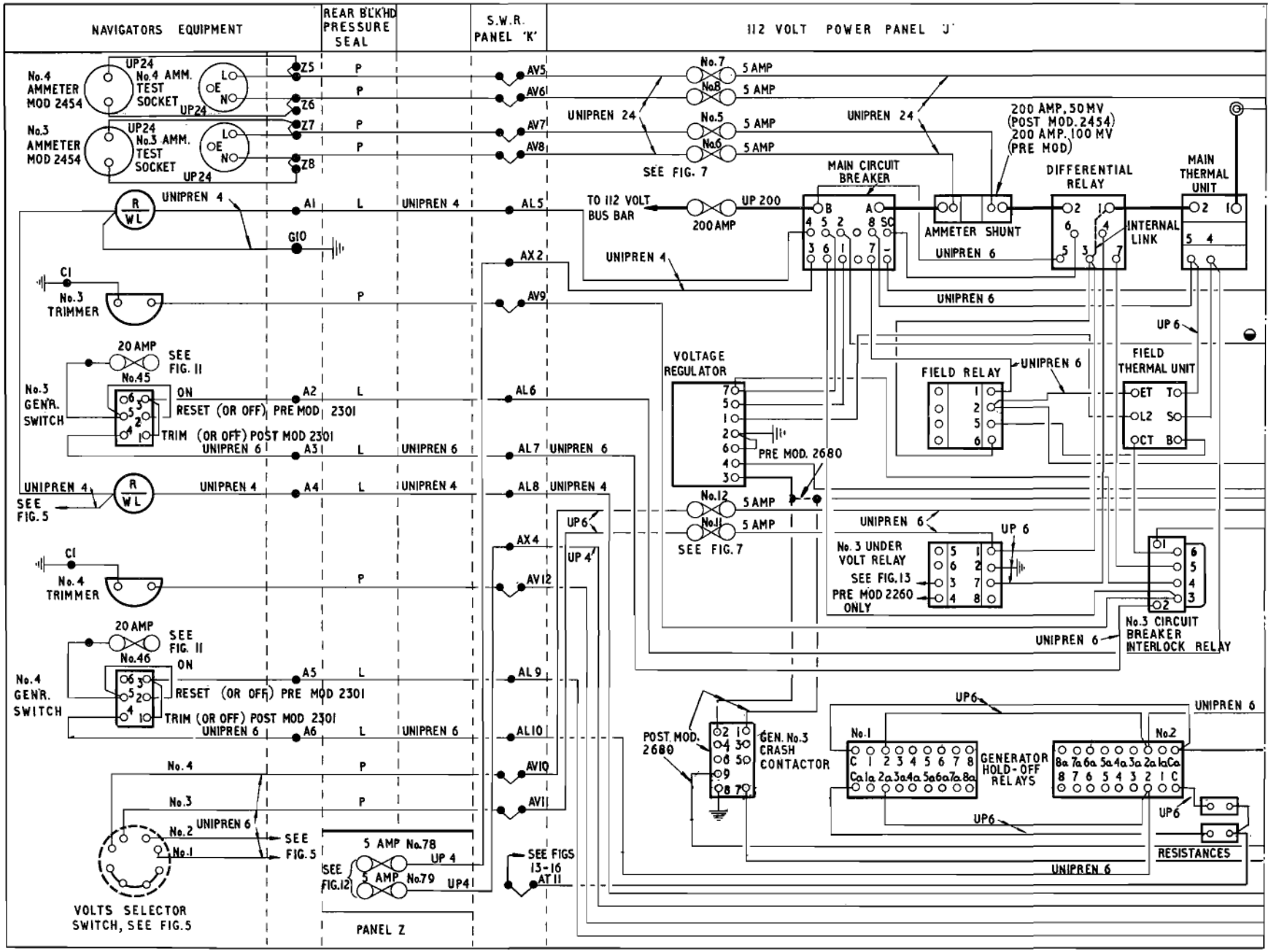

Fig.6 (1) 112-Volts generators, No.3 and No.4 sets (post Mod.2240 & pre Mod.2817, 2933)

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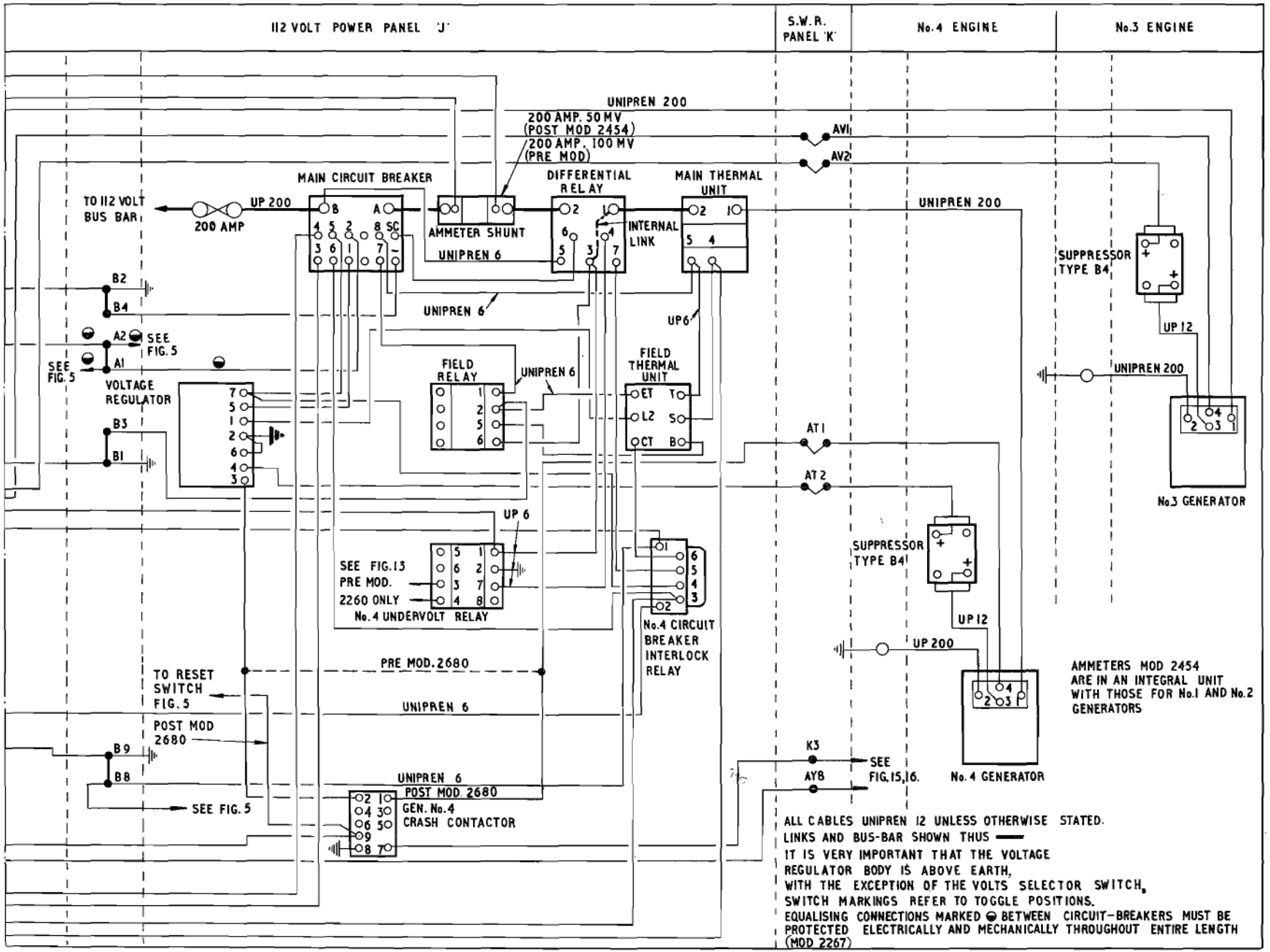

Fig. 6. (2) 112-Volt generators, No. 3 and No. 4 sets (post Mod. 2240 & pre Mod. 2817, 2933)

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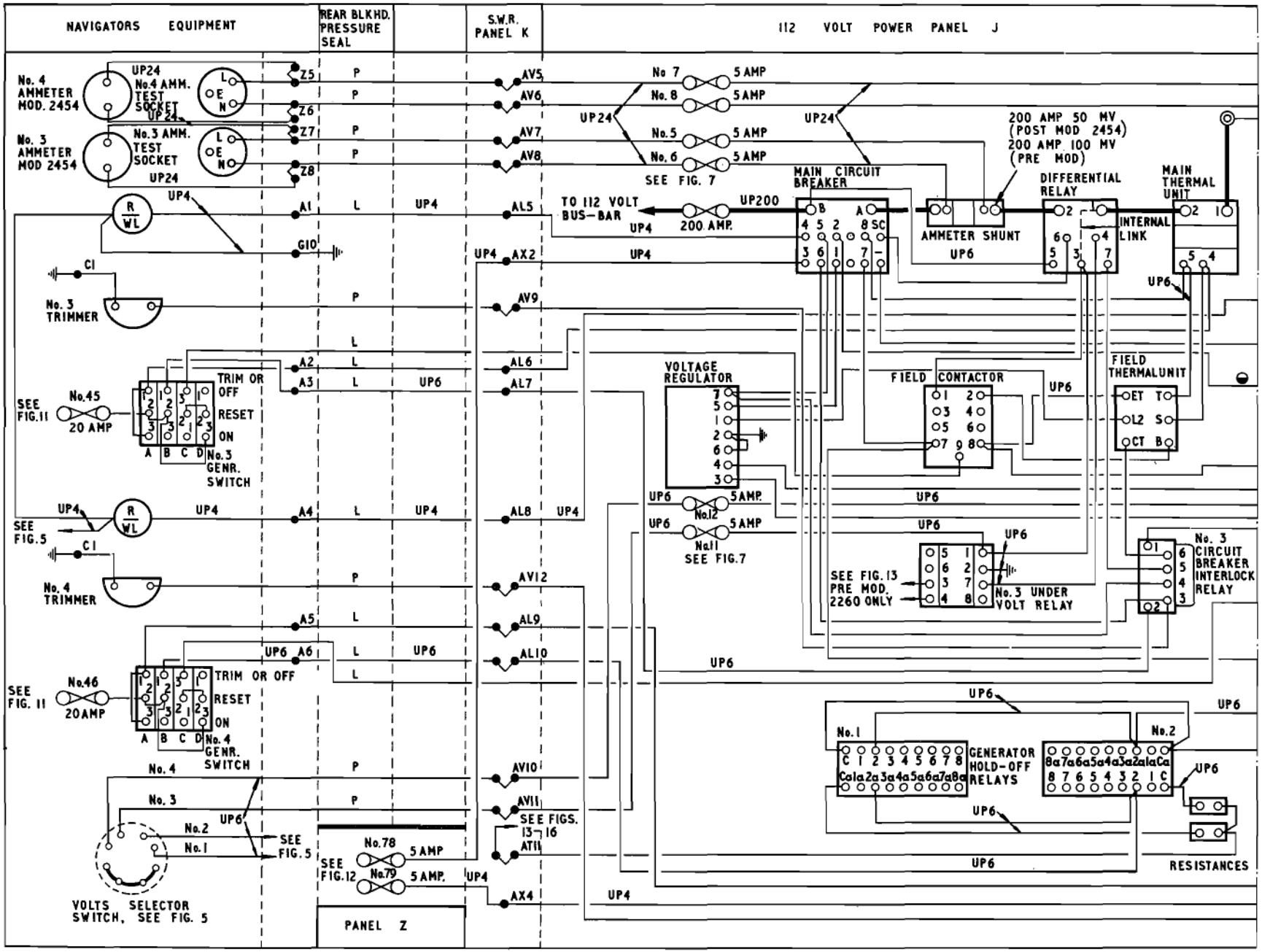

Fig. 6A (1) 112-Volt generators No. 3 and No. 4 sets (post Mod. 2817 pre Mod. 2933)

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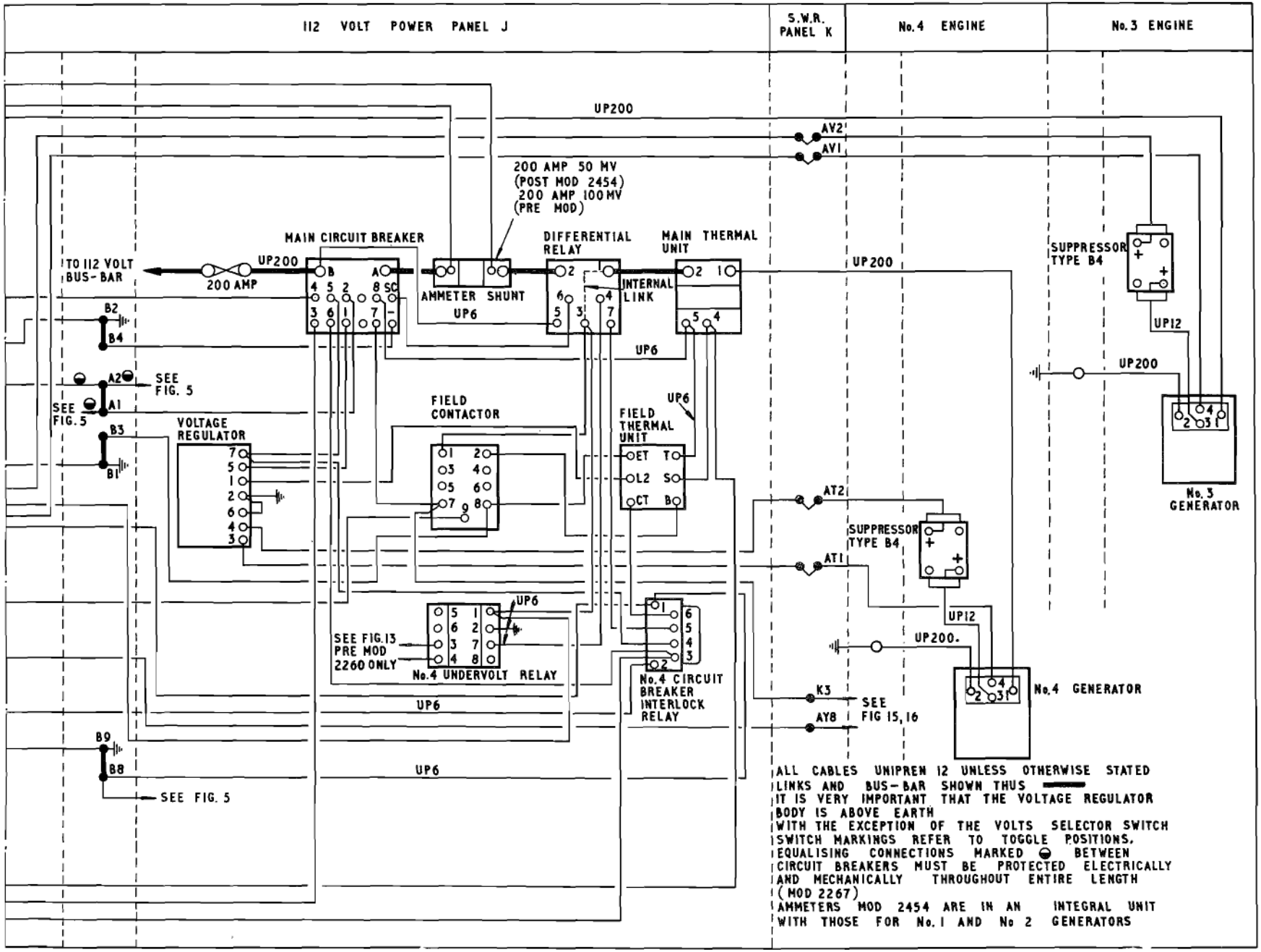

Fig. 6A (2) 112-Volt generators No. 3 and No. 4 sets (post Mod. 2817 pre Mod. 2933)

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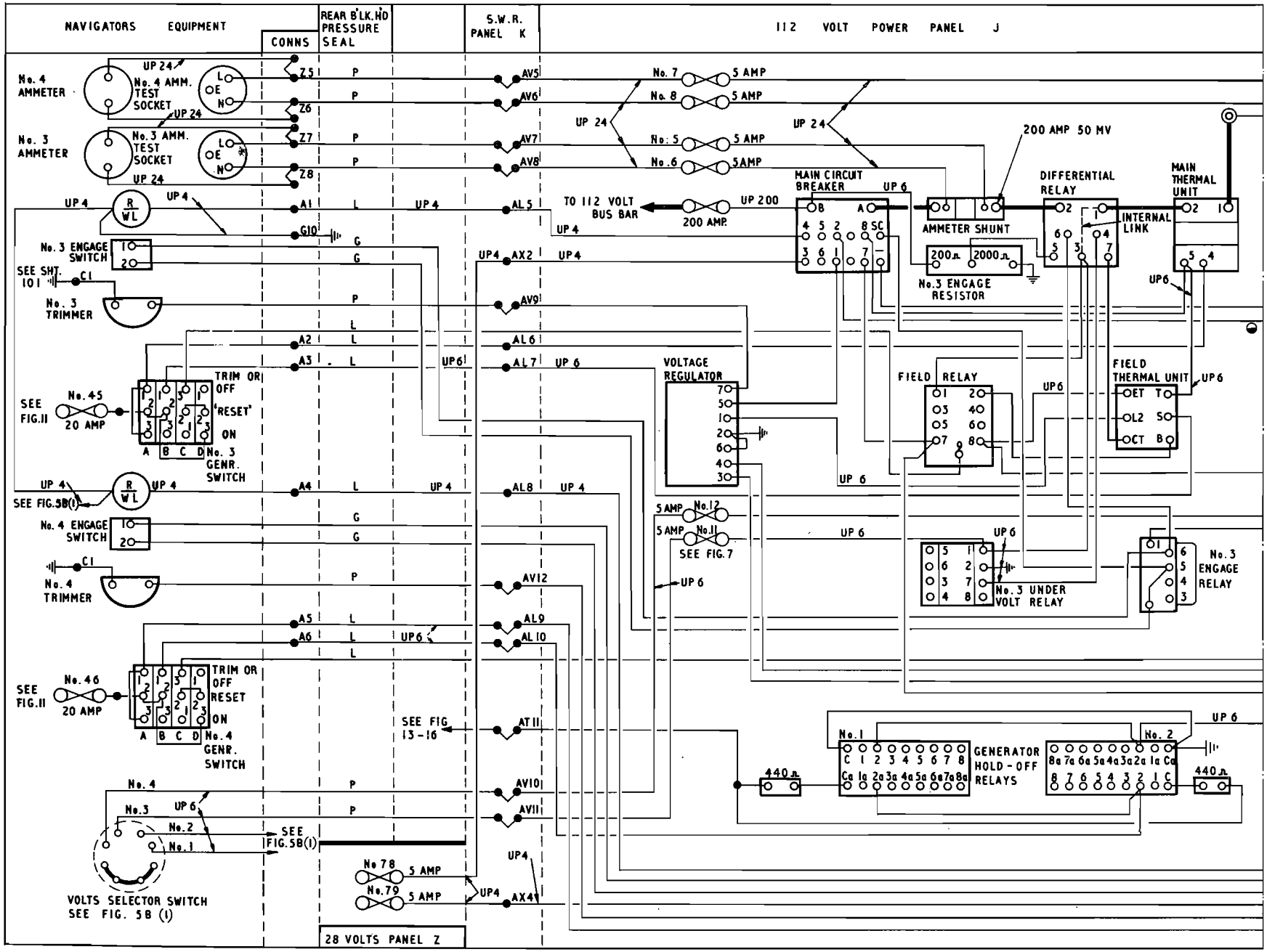

Fig. 6B (1) 112-Volt generators, No. 3 and No. 4 sets (post Mod. 2933)

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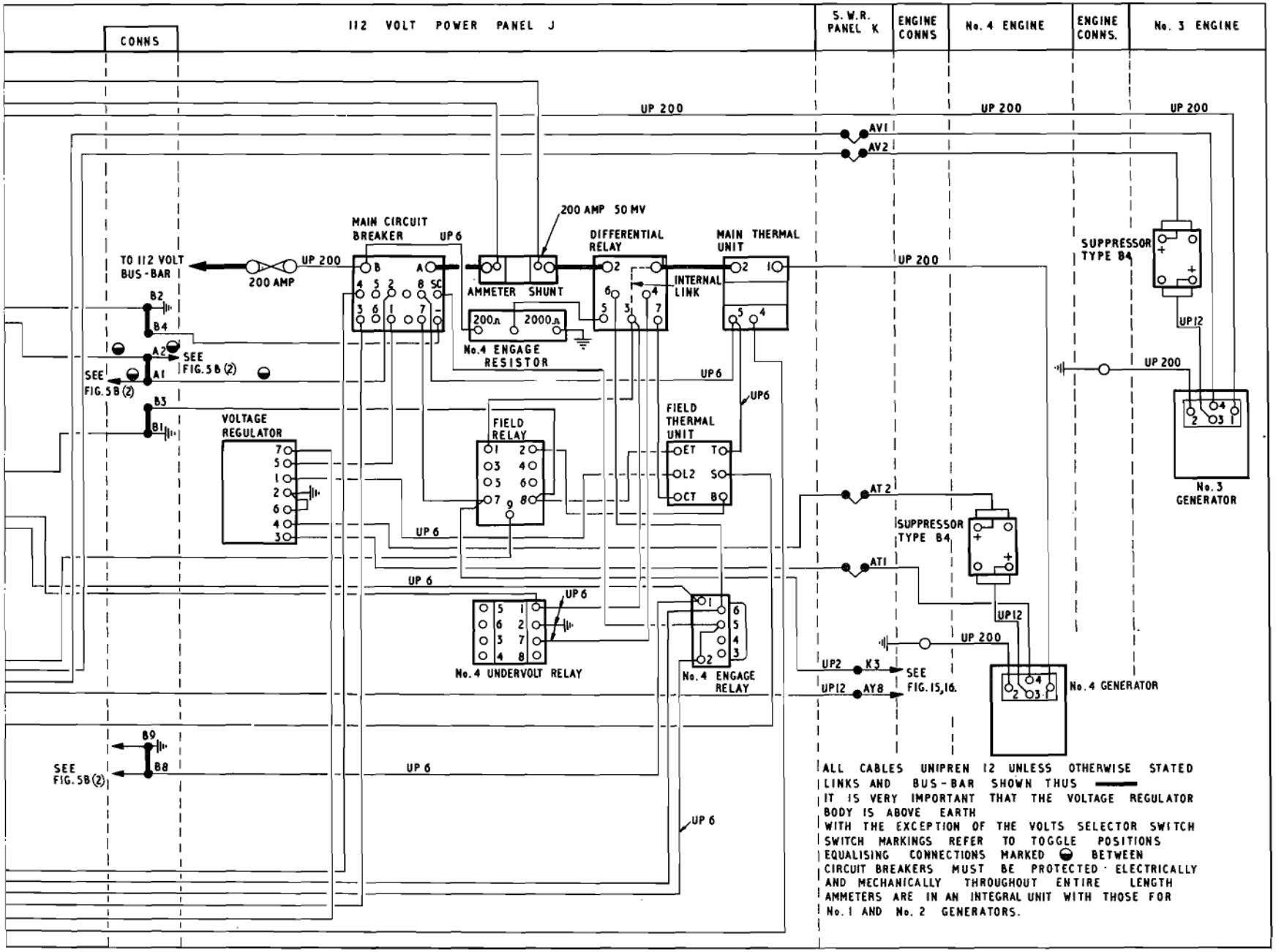


Fig. 6B (2) 112-Volt generators, No. 3 and No. 4 sets (post Mod. 2933)

RESTRICTED

75836 SHT. 185-W

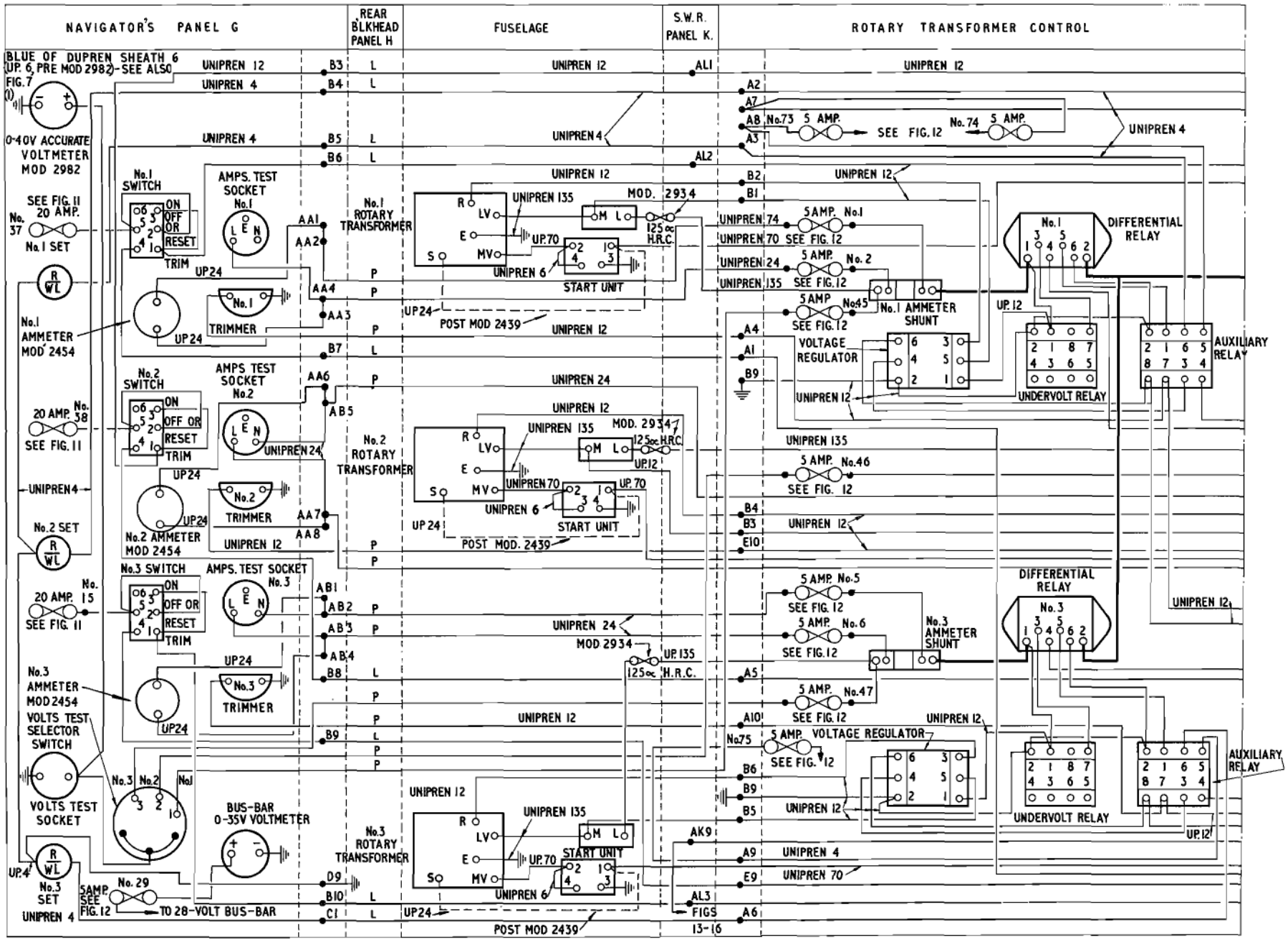


Fig. 7. (1) 28 Volt Rotary transformers (post Mod 2240)

RESTRICTED

75836 SHT. 127-S
67436 SHT. 127-AC

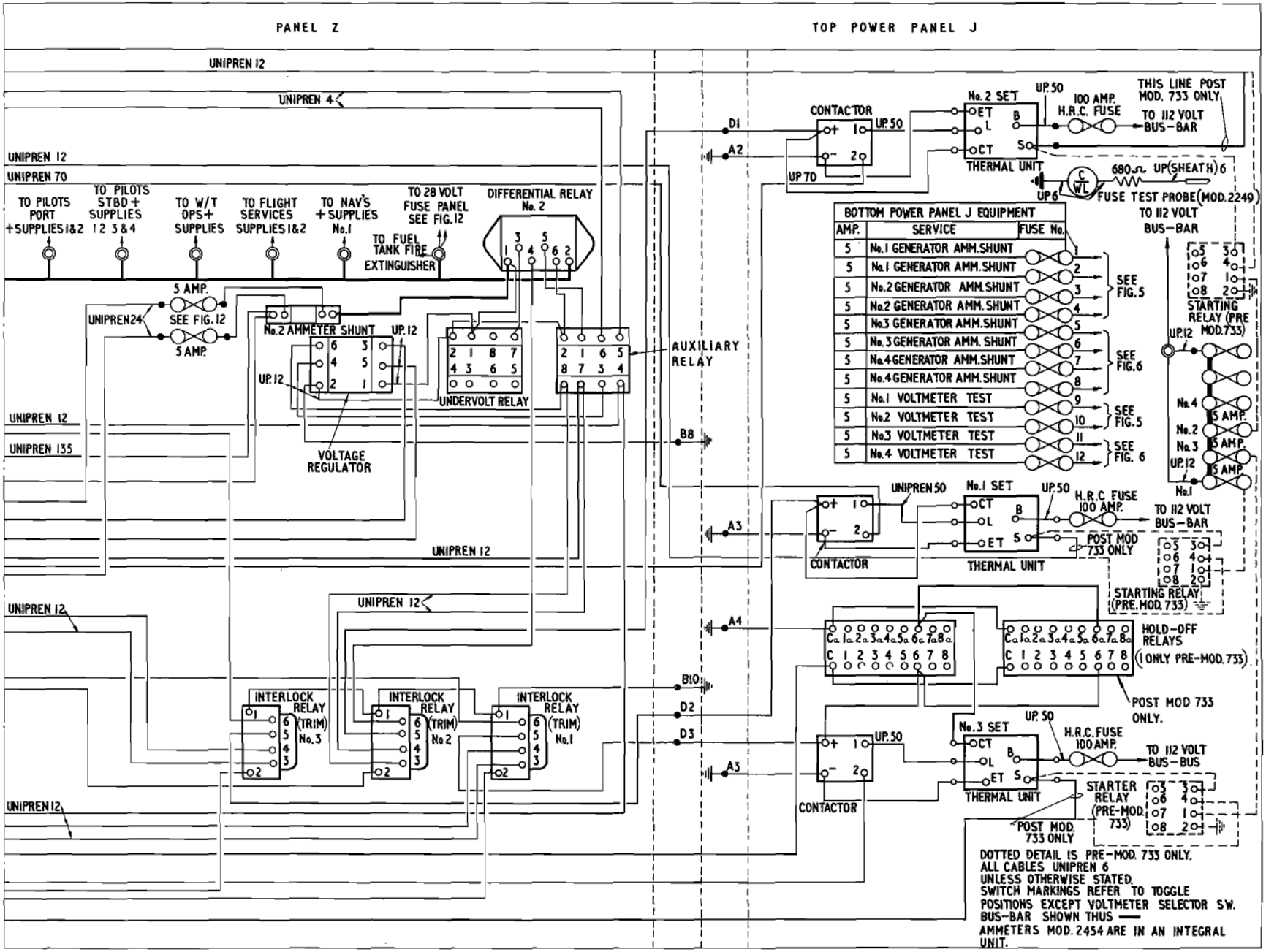


Fig. 7. (2) 28 Volt Rotary transformers (post Mod 2240)

RESTRICTED

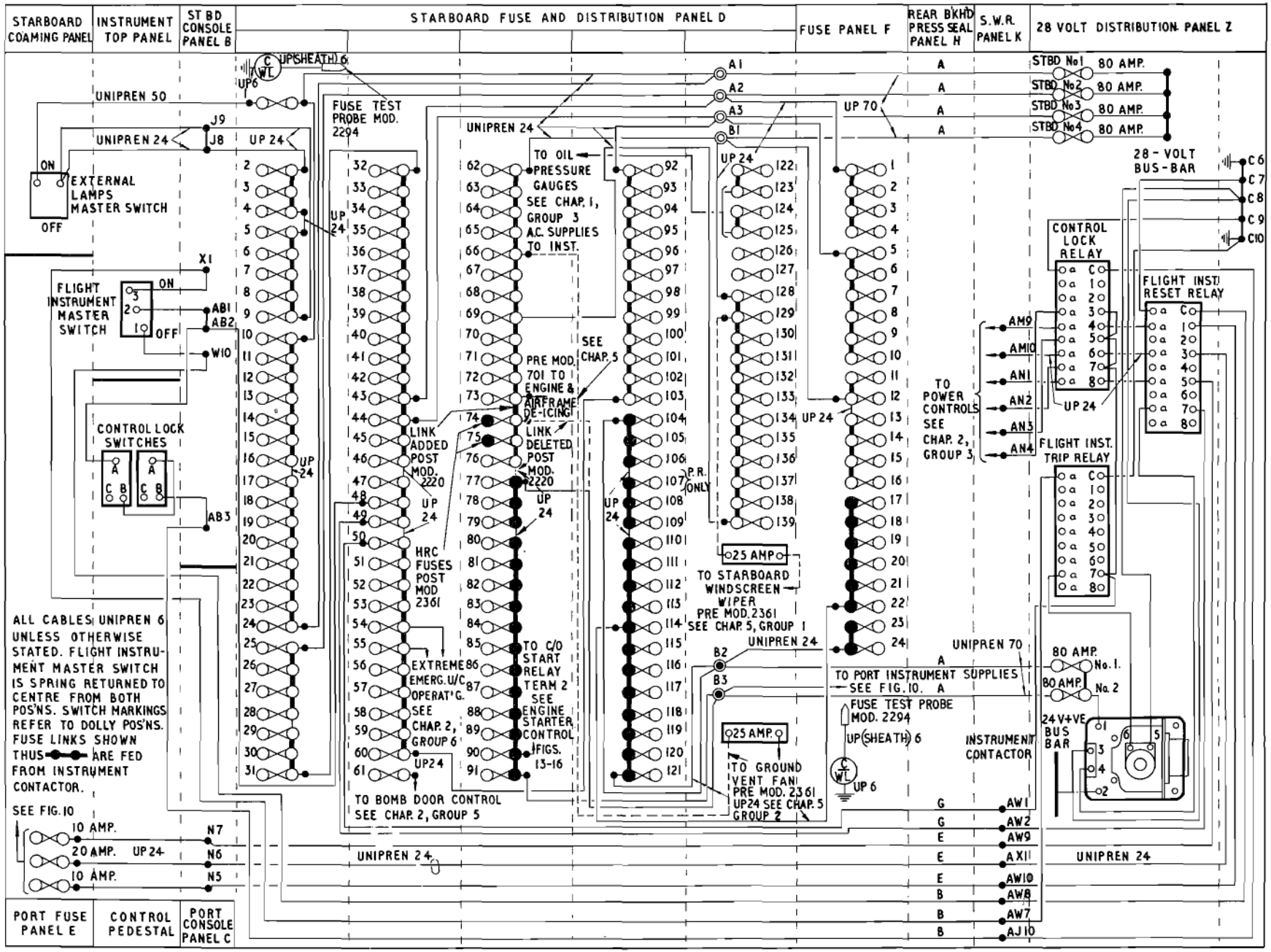


Fig. 8. Pilots starboard positive supplies (pre Mod. 2089)

RESTRICTED

75836 SHT. 102-S (NOT INCL. E&K)
67436 SHT. 102-AZ

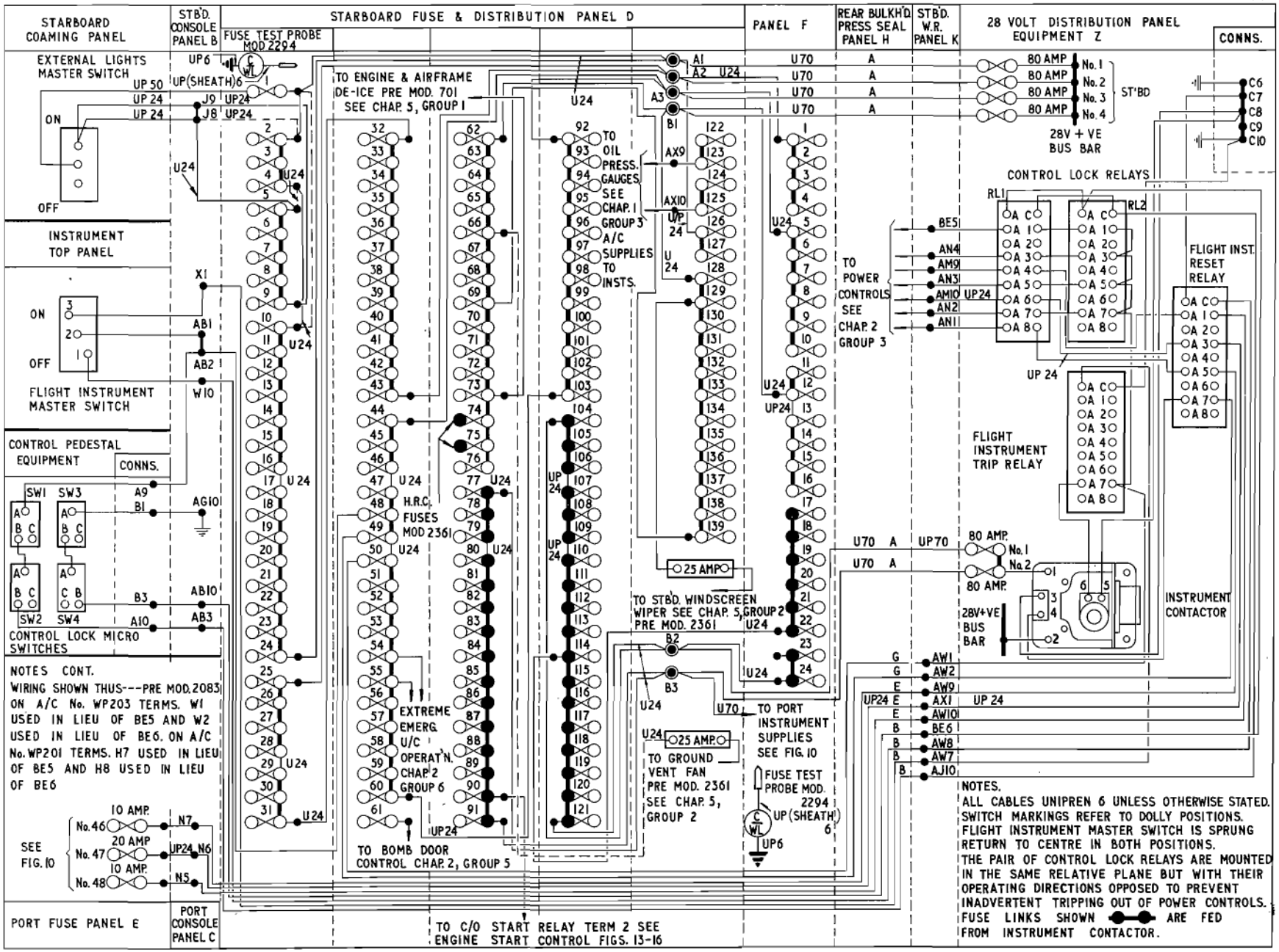


Fig. 9. Pilots starboard positive supplies (post Mod. 2089, 2083 and 2220)

75836 SHT. 102 - Y
67436 SHT. 102 - BW

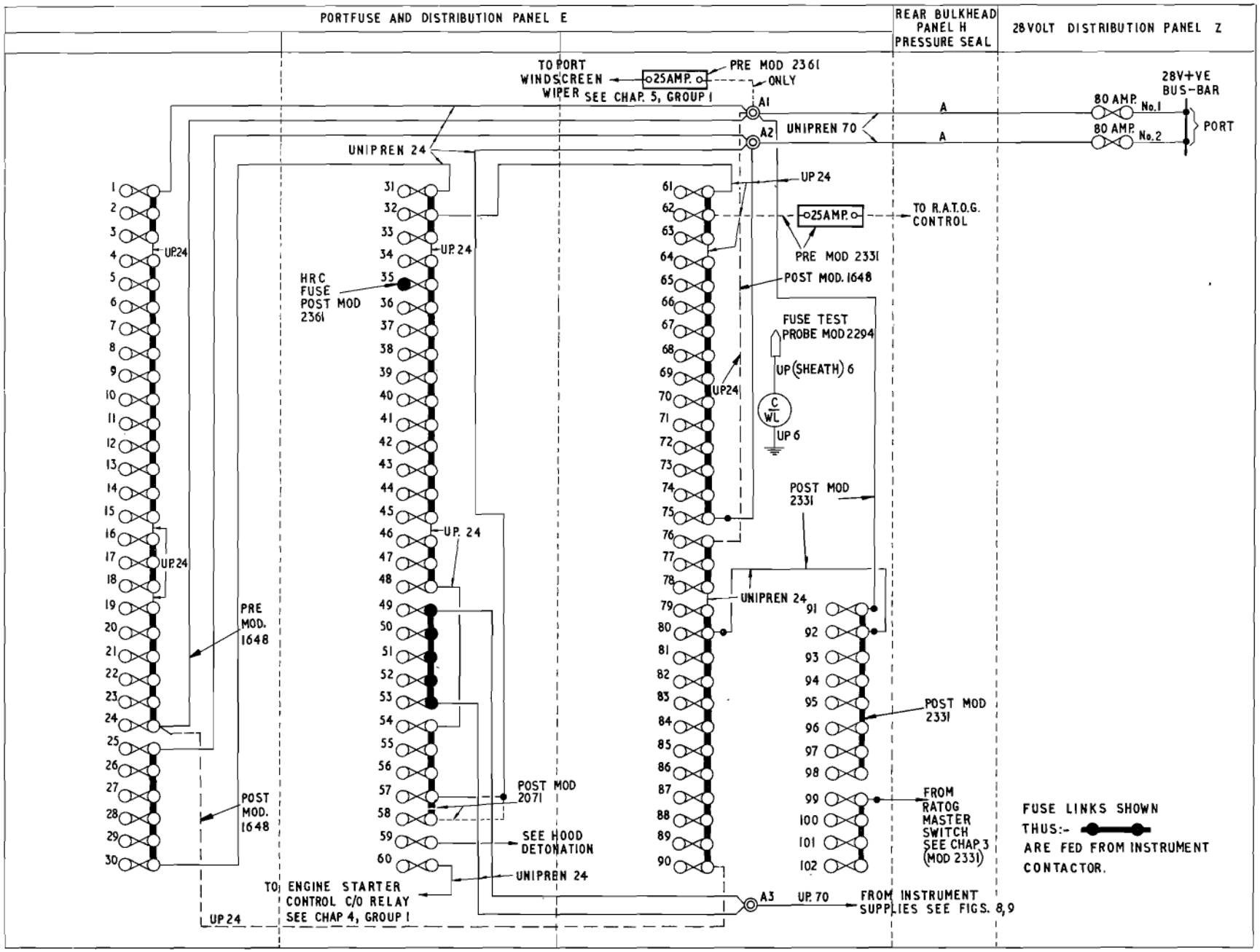
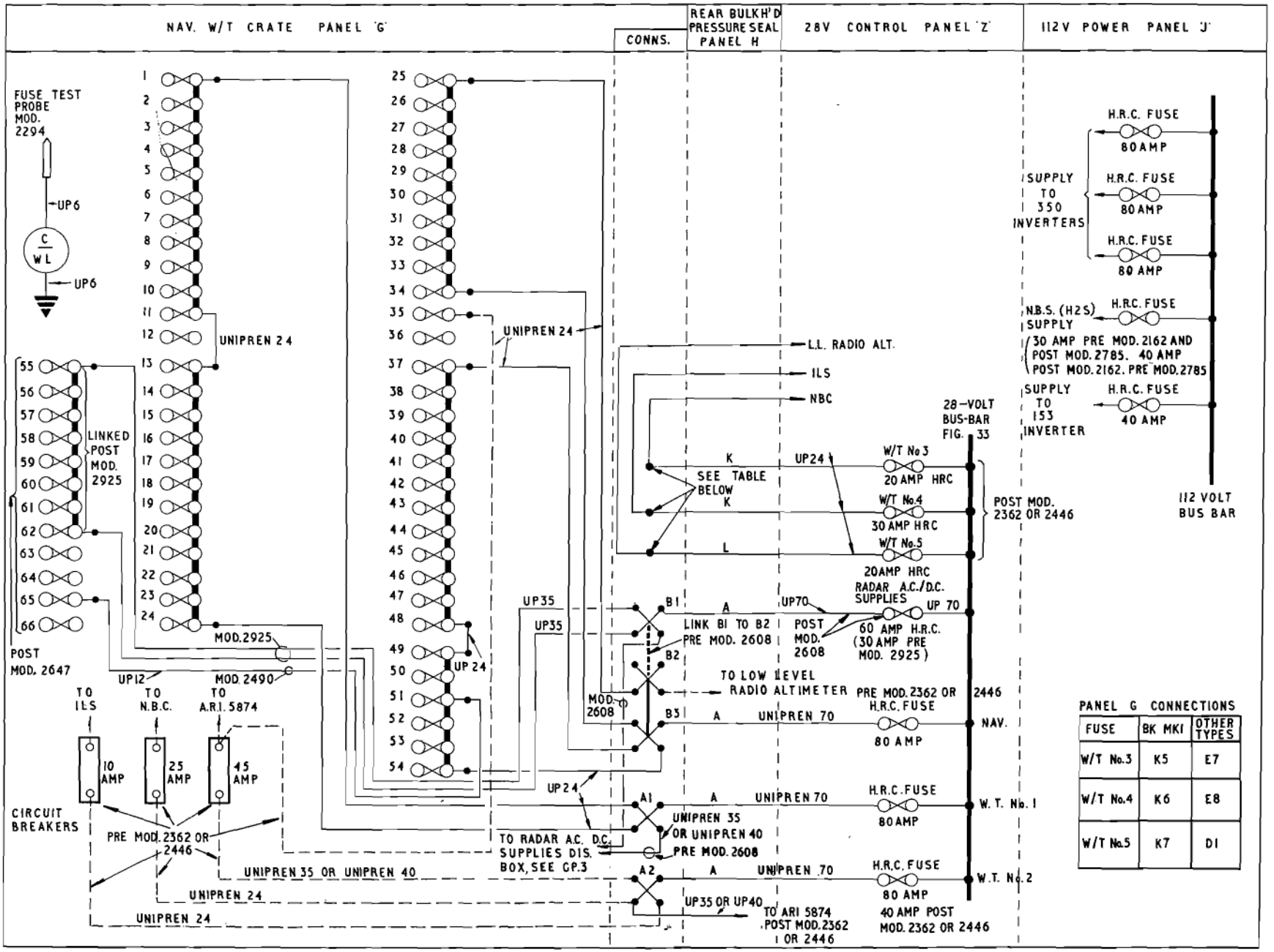


Fig. 10. Pilots port positive supplies.

RESTRICTED

(75836 SHT. 103-V EXCLUDES ISSUE M) 75836 SHT 103-V 67436 SHT.103-AU



PANEL G CONNECTIONS

FUSE	BK MKI	OTHER TYPES
W/T No.3	K5	E7
W/T No.4	K6	E8
W/T No.5	K7	D1

Fig. 11. W/T, radar and navigator's positive supplies

RESTRICTED

67436 SHT. 104-CN

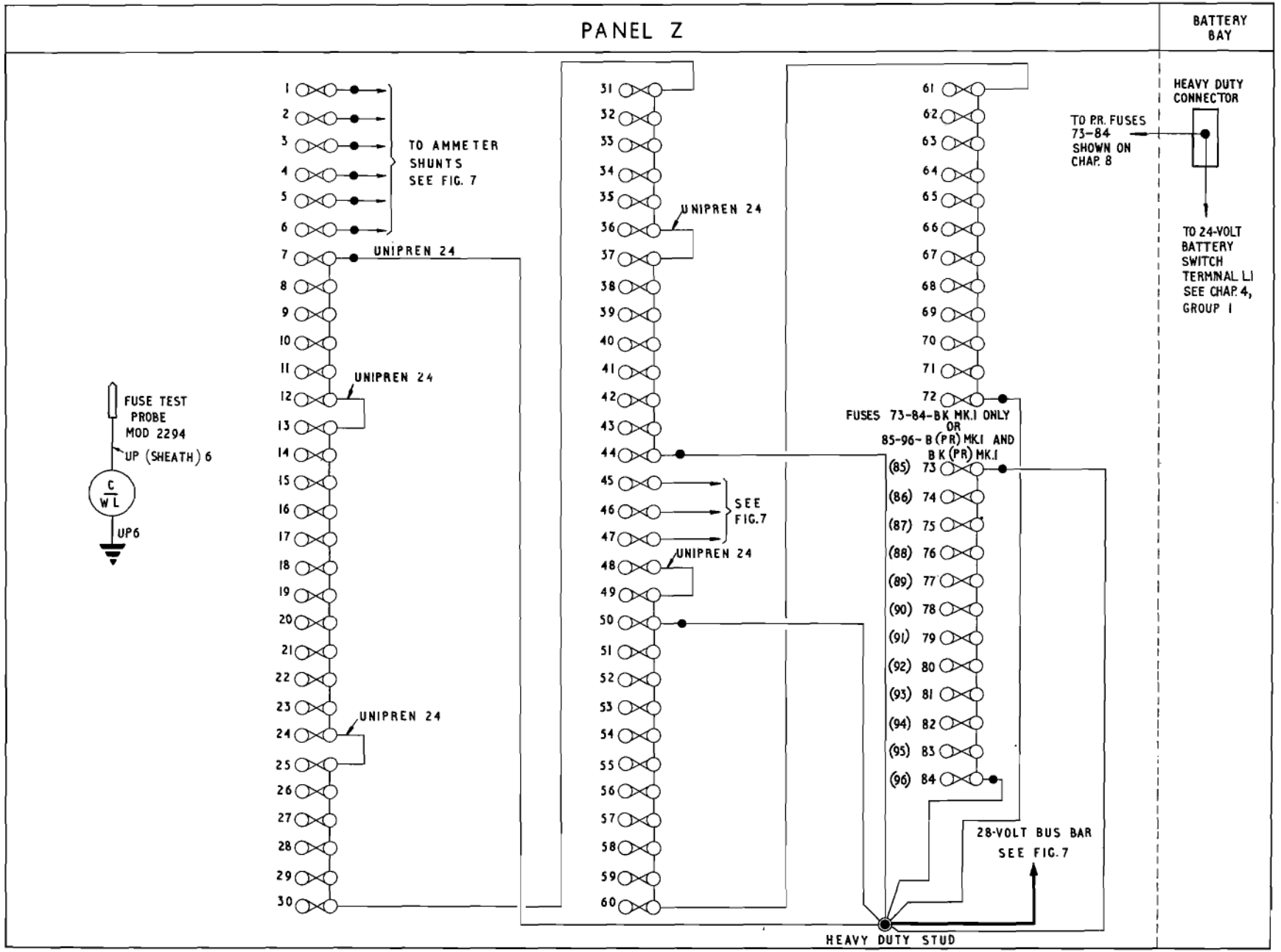


Fig. 12. Panel Z positive supplies (post Mod. 2240) 75836 SHT 195-F 67436 SHT. 195-R

RESTRICTED

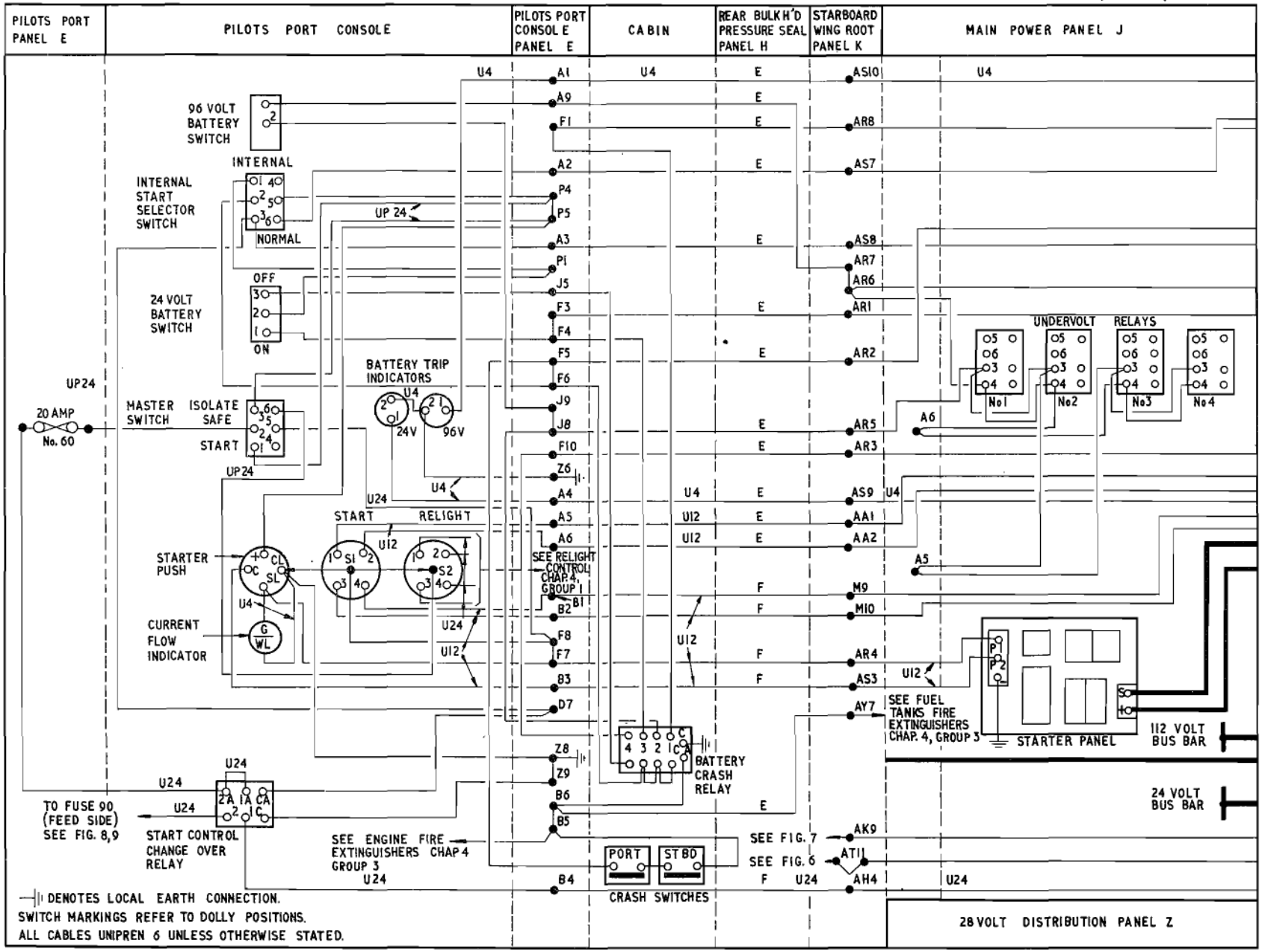


Fig. 13. (1) Battery control (post Mod 2240)

RESTRICTED

7646 446417 9/59 625 C.B.&S.LTD. GP924.

(AL 35, APR, '59).

71036 SHT 125-F, 67436 SHT 125-AL

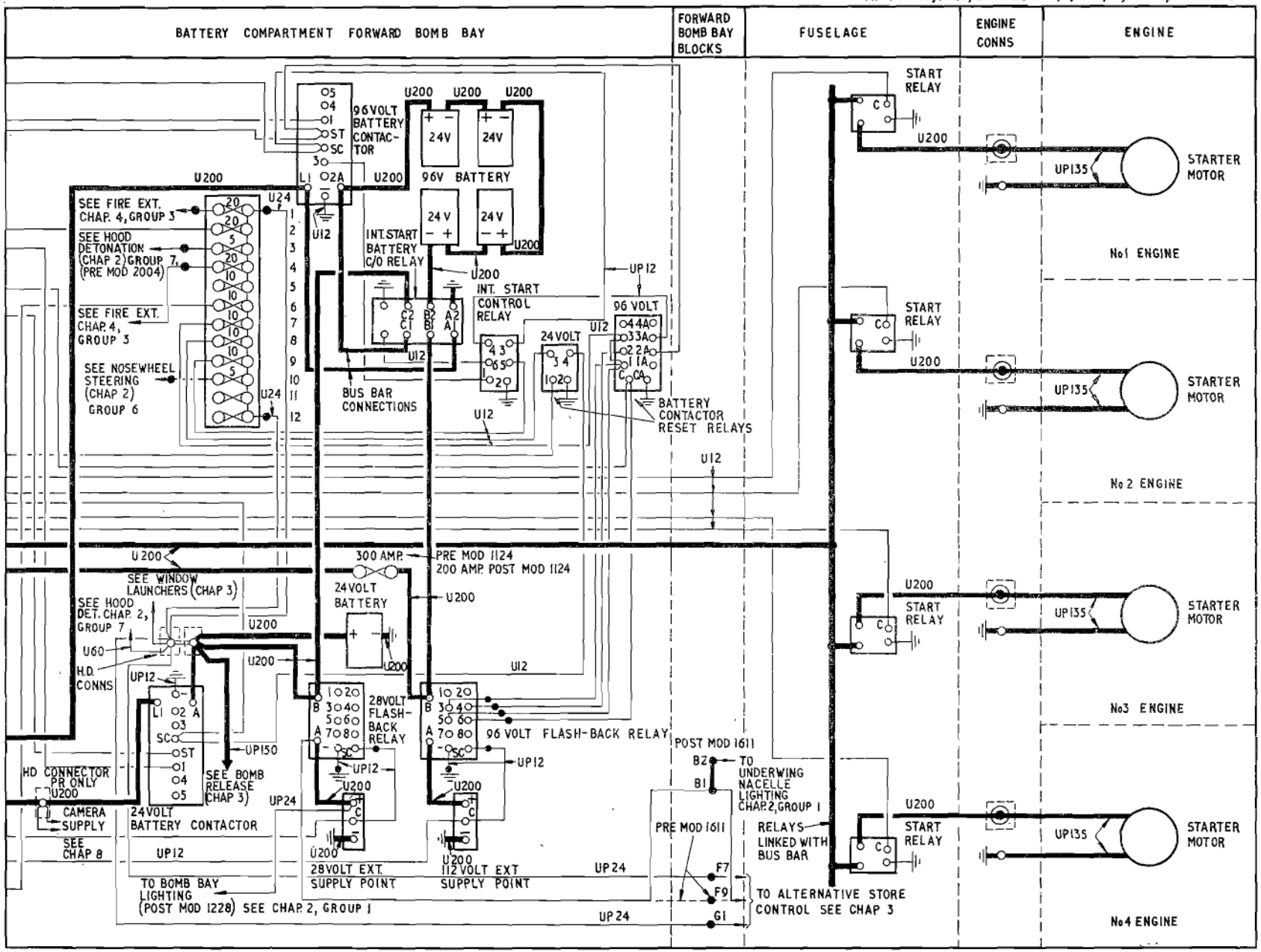


Fig. 13. (2) Battery control (post Mod 2240)

RESTRICTED

7646 446417 9/59 625 C.B.&S.L^TD. GP924.

(AL 35, APR, '59).

71036 SHT 125-F, 67436 SHT 125-AL

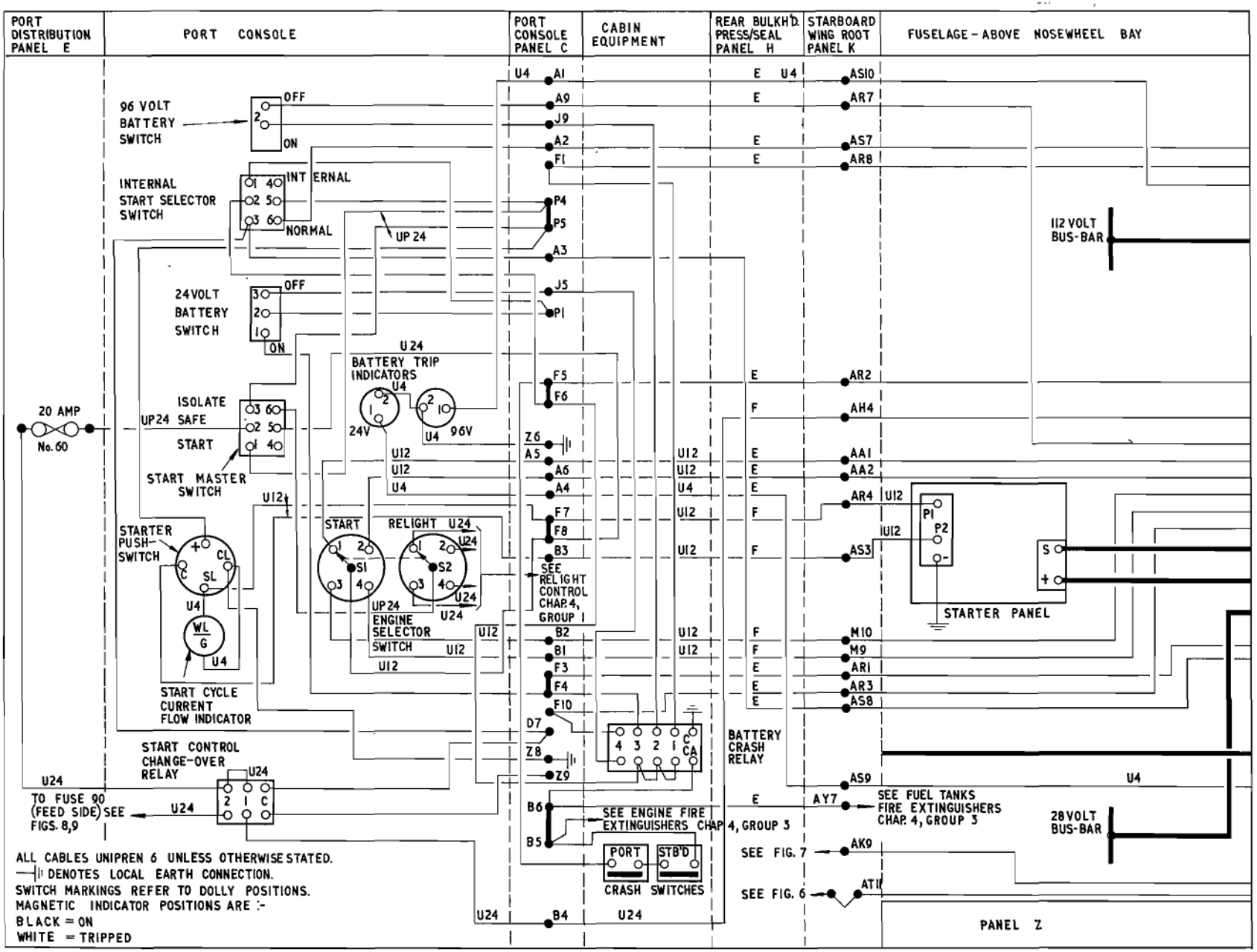


Fig. 14. (1) Battery control (post Mods 2240 & 2260)

RESTRICTED

67436 SHT 125-AN

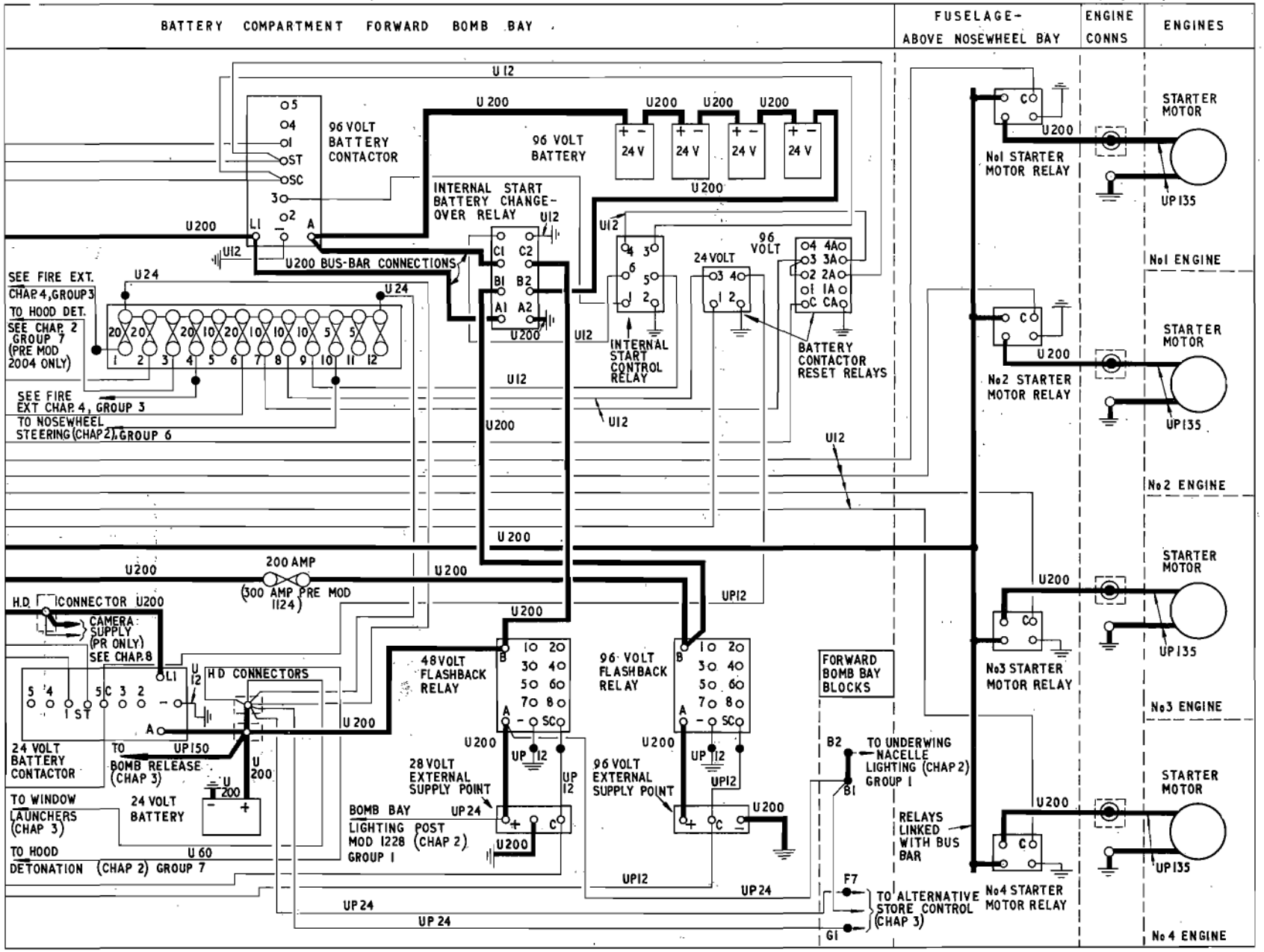


Fig. 14 (2) Battery control (post Mods 2240 & 2260)

RESTRICTED

7646 446417 9/59 625 C.B.&S.L^TD. GP924.

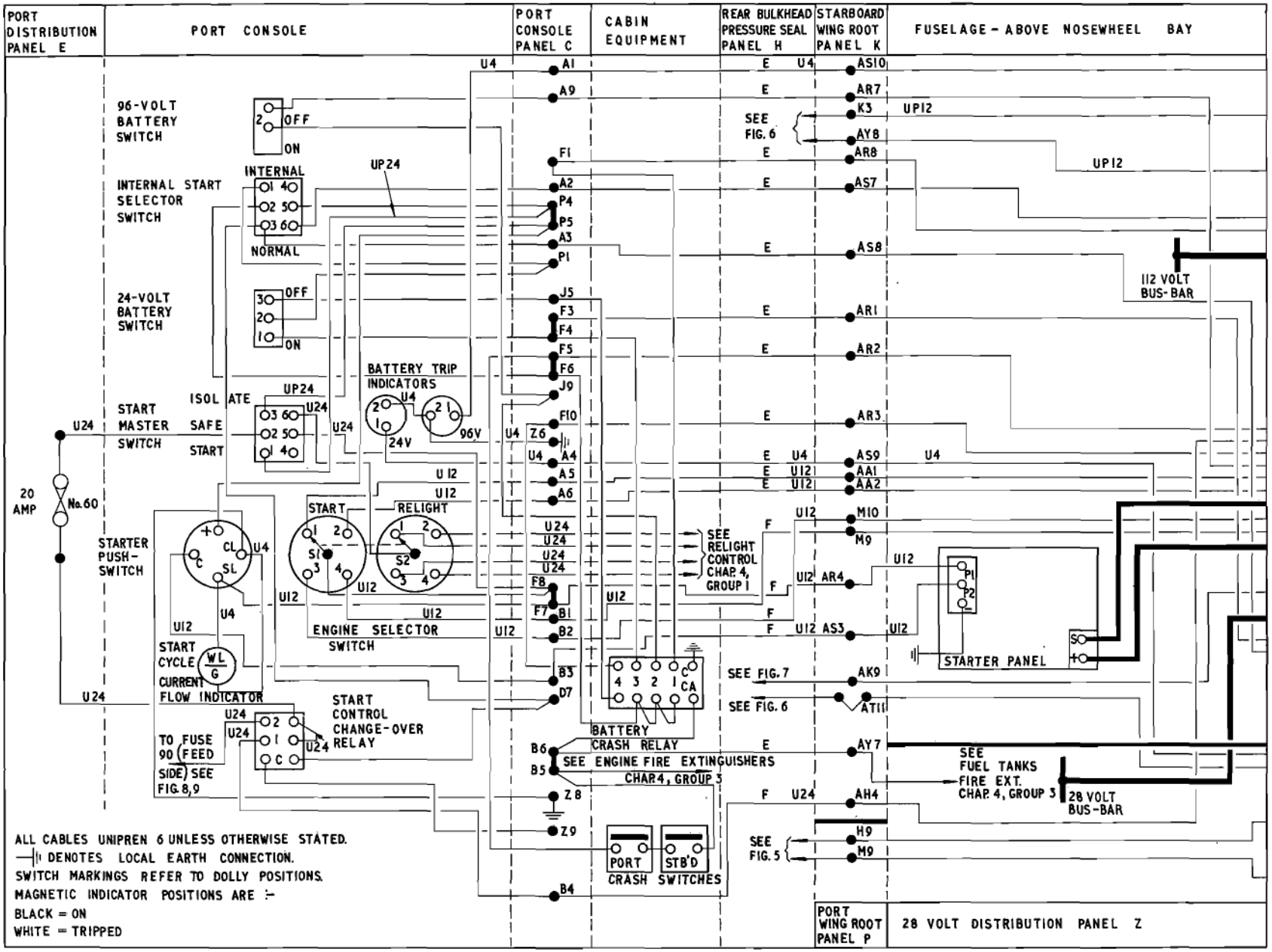


Fig. 15. (1) Battery control (post Mods 2240, 2260 & 2259)

RESTRICTED

67436 SHT. 125-AT

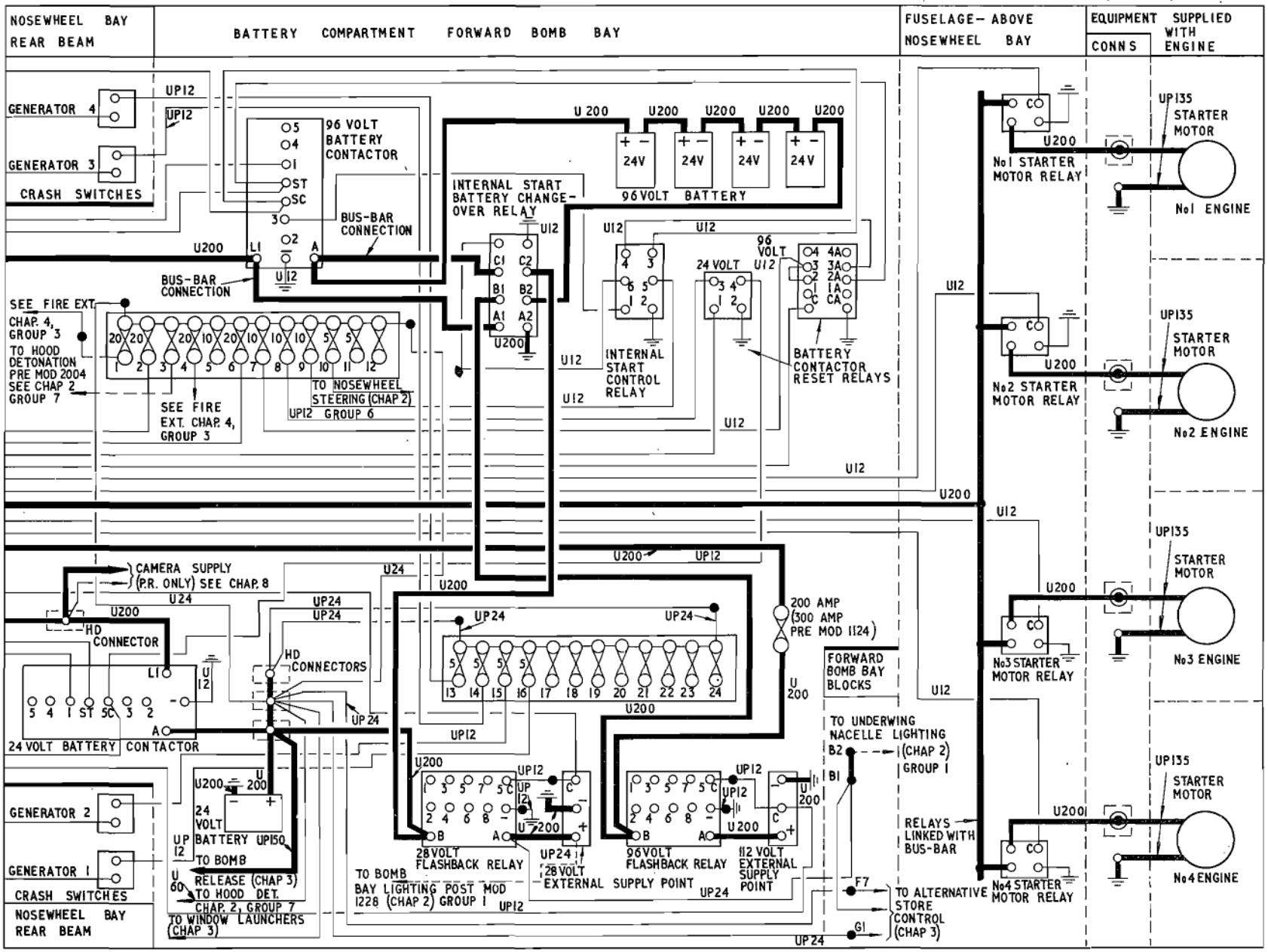


Fig. 15. (2) Battery control (post Mods 2240, 2260 & 2259)

RESTRICTED

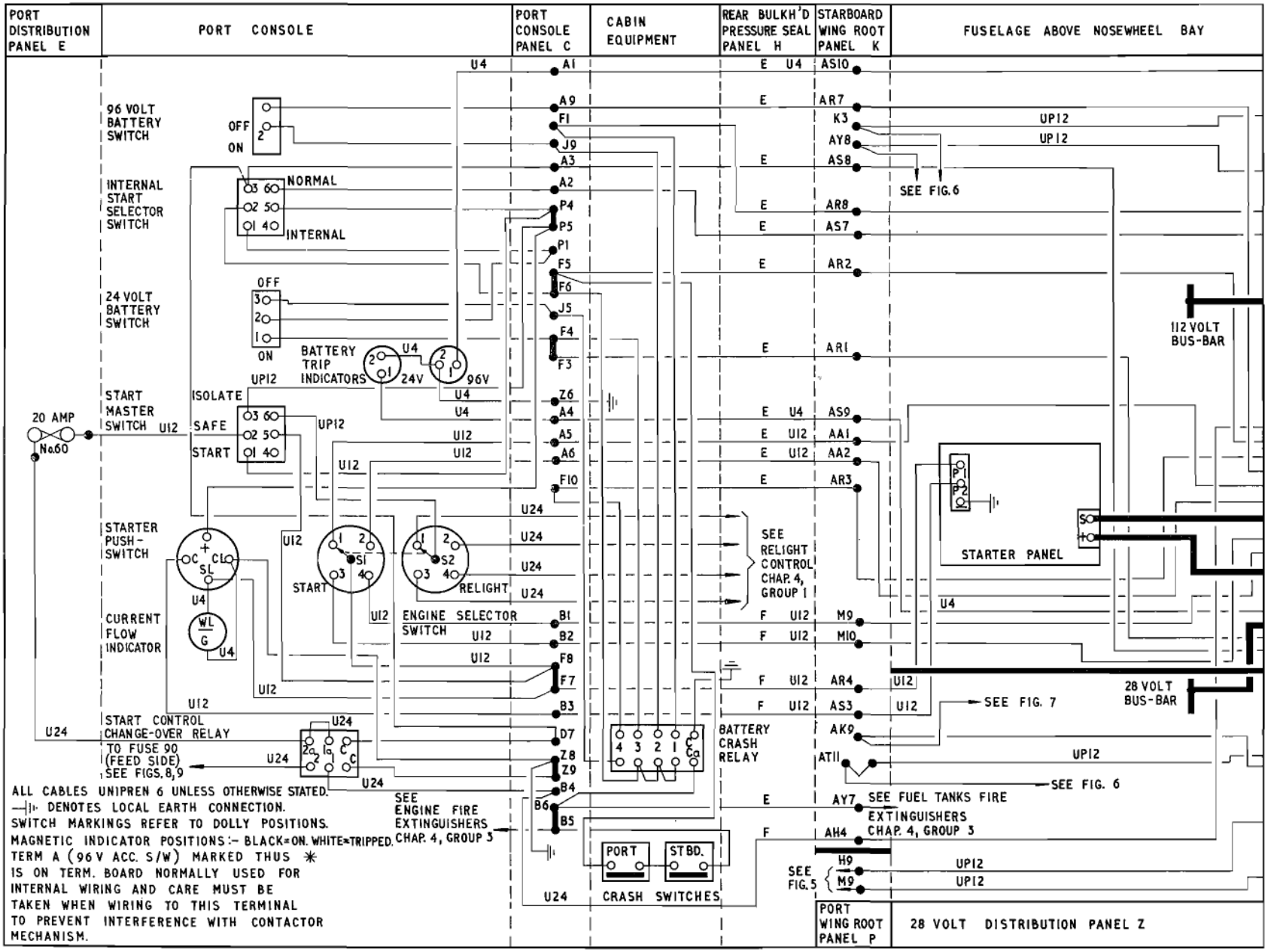


Fig. 16. (1) Battery control (post Mods 2240, 2259, 2260 & 2376)

RESTRICTED

75836 SHT 125-Q

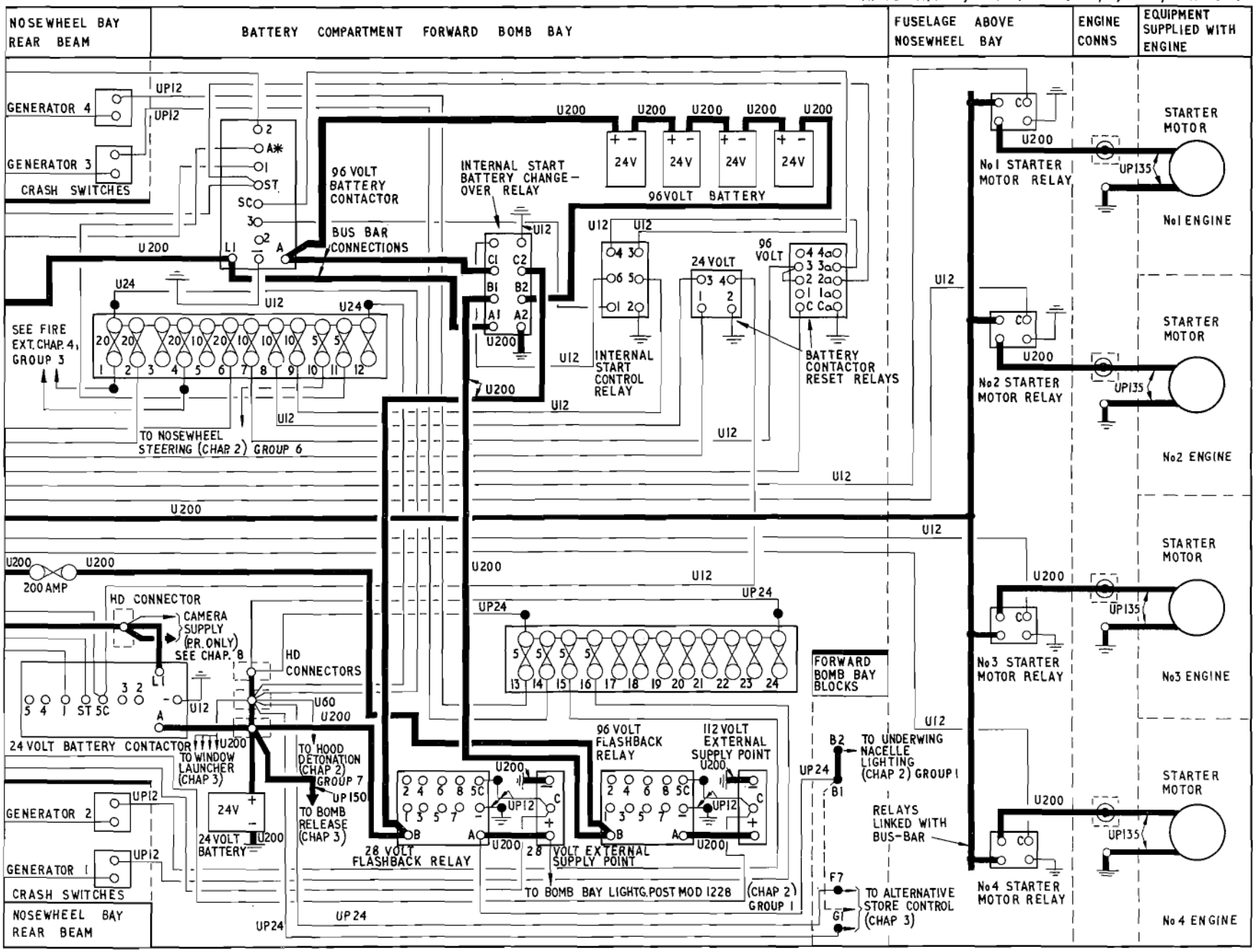


Fig. 16. (2) Battery control (post Mods 2240, 2259, 2260 & 2376)

RESTRICTED

75836SHT125-Q

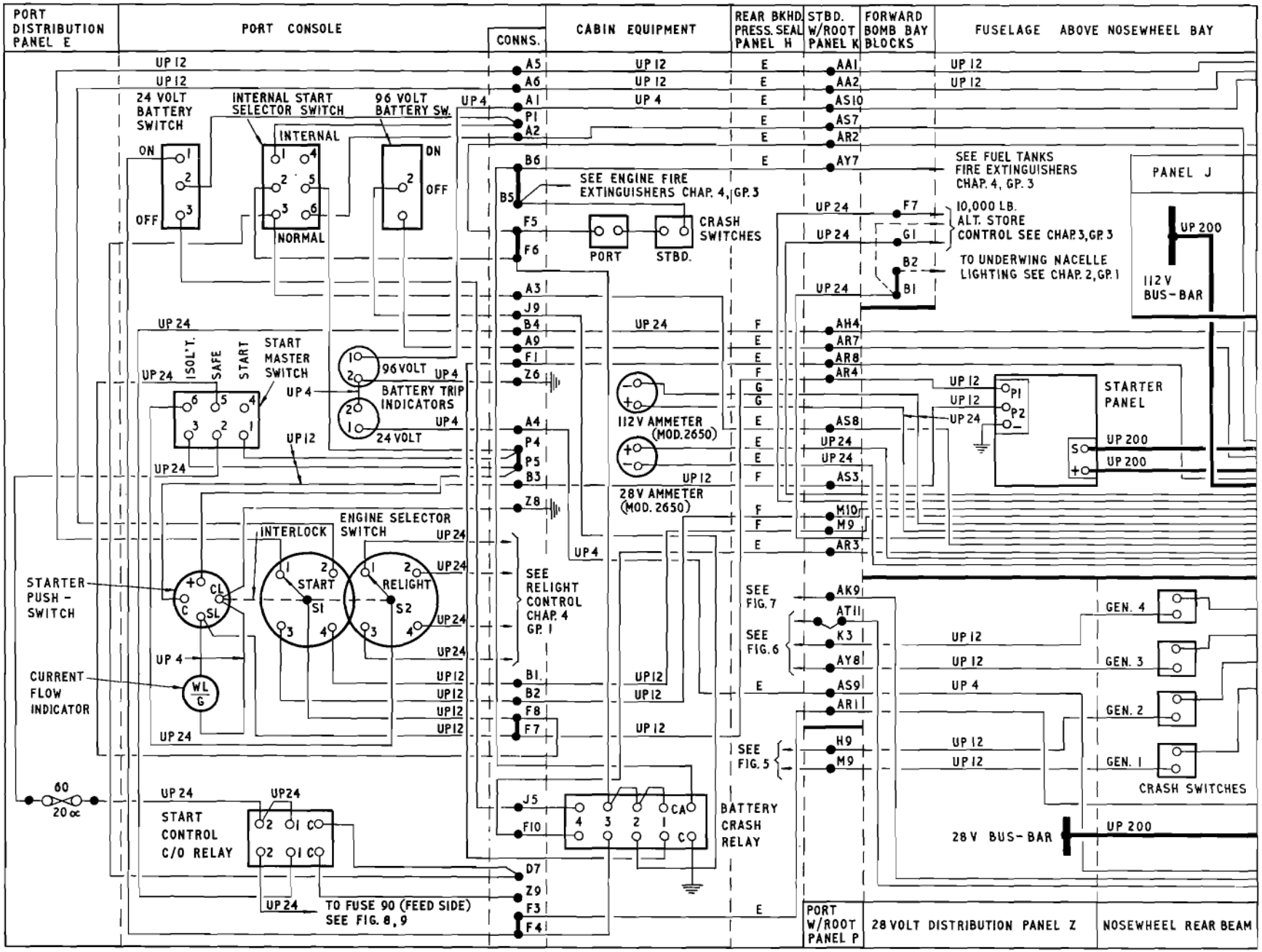


Fig. 17 (1) Battery control (post Mods. 2650, 2833 and 2945)

RESTRICTED

75836 SHT. 125-Z
71036 SHT. 125-AA
70636 SHT. 125-AA

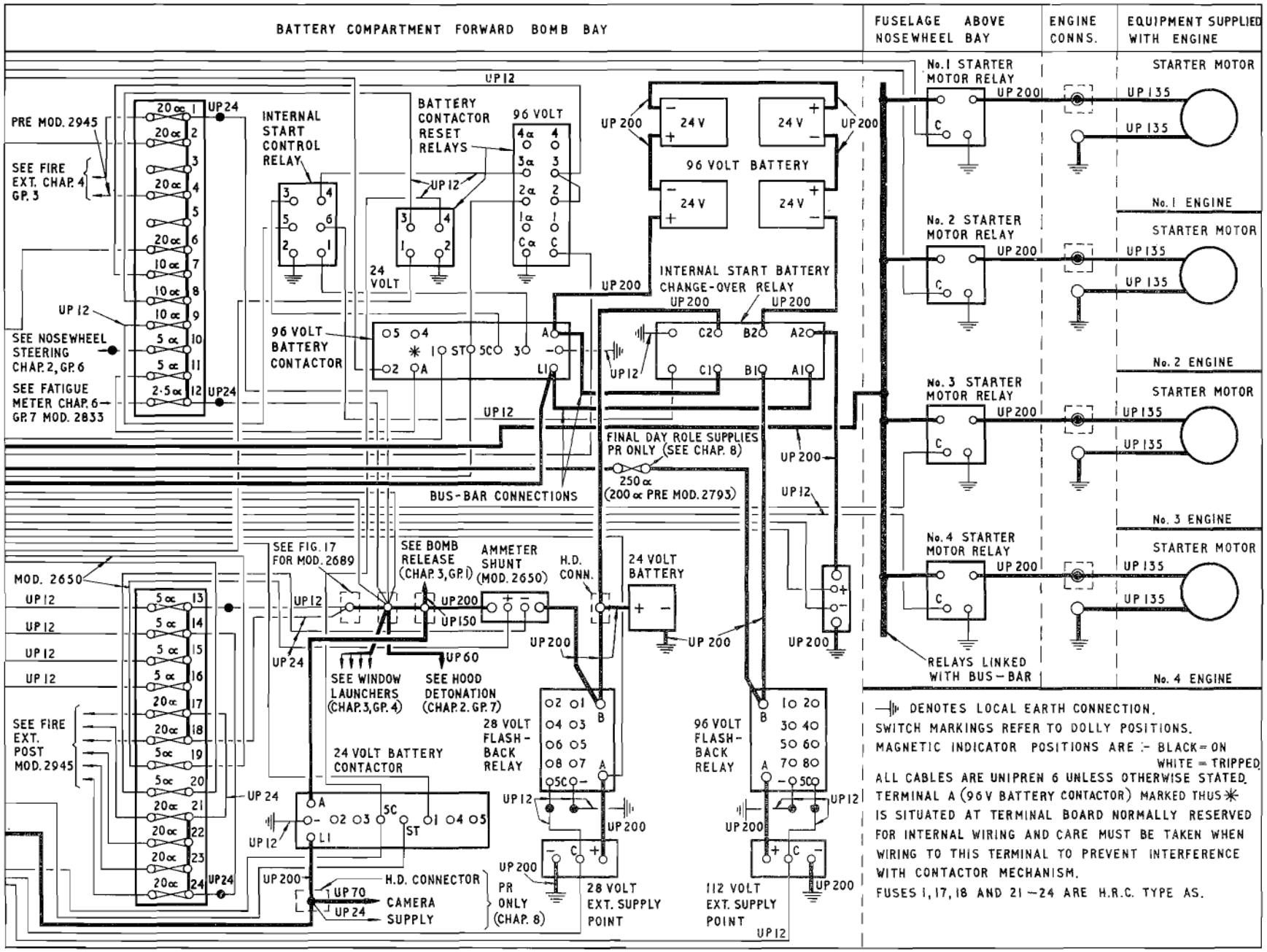


Fig. 17 (2) Battery control (post Mods. 2650, 2833 and 2945)

RESTRICTED

75836 SHT. 125-4
71036 SHT. 125-AA
70636 SHT. 125-AA

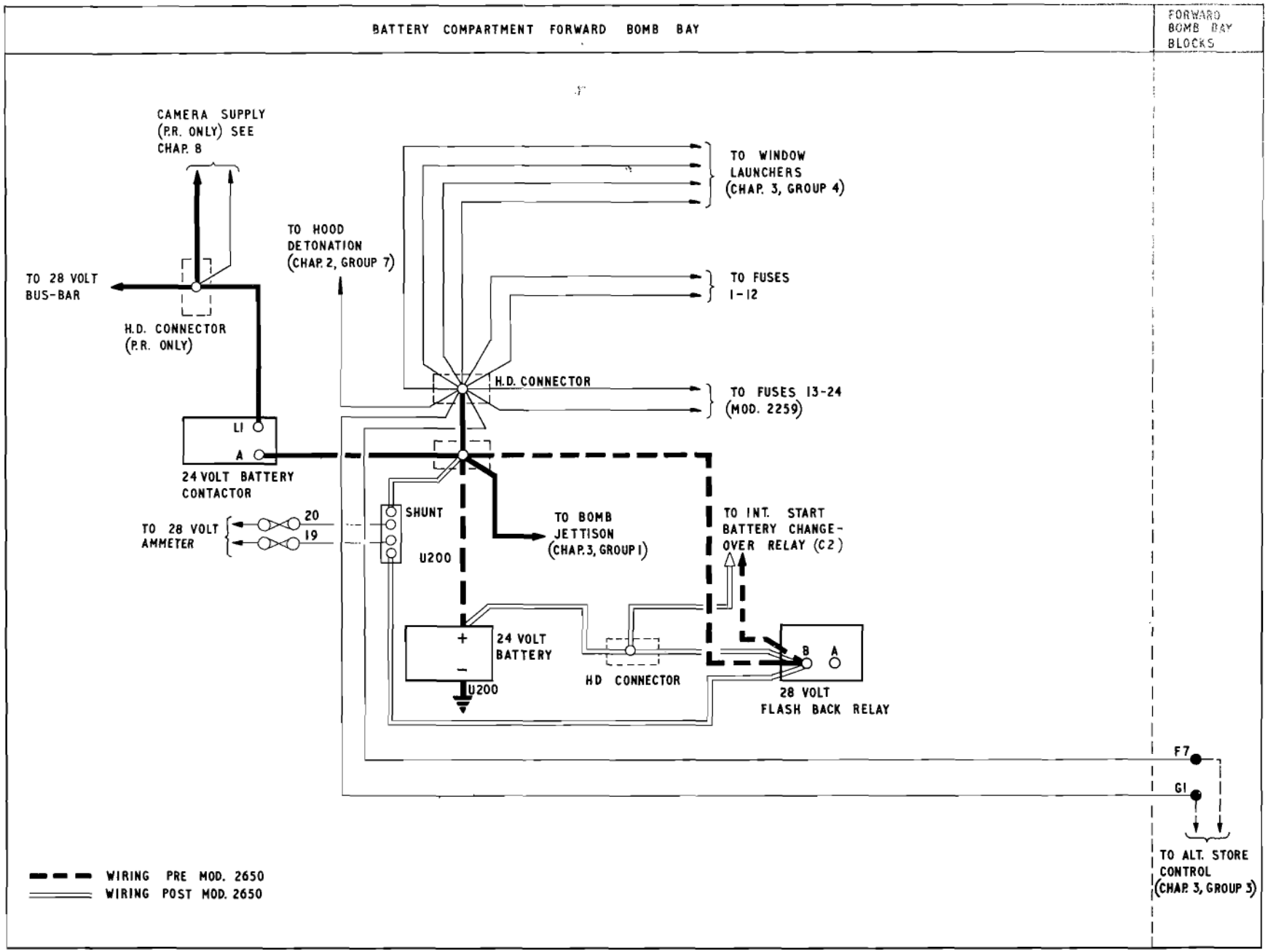


Fig. 18 Arrangement of H.D. blocks on battery bulkhead (post Mod. 2689)

RESTRICTED

LIST OF APPENDICES

Appendix 1

112-VOLT SYSTEM (post Mod. 3076)

1. Under Mod. 3076 the earth connections shown in Fig. 5, 5A, 6, 6A and 6B in the basic Group are revised as shown in Fig. 1.

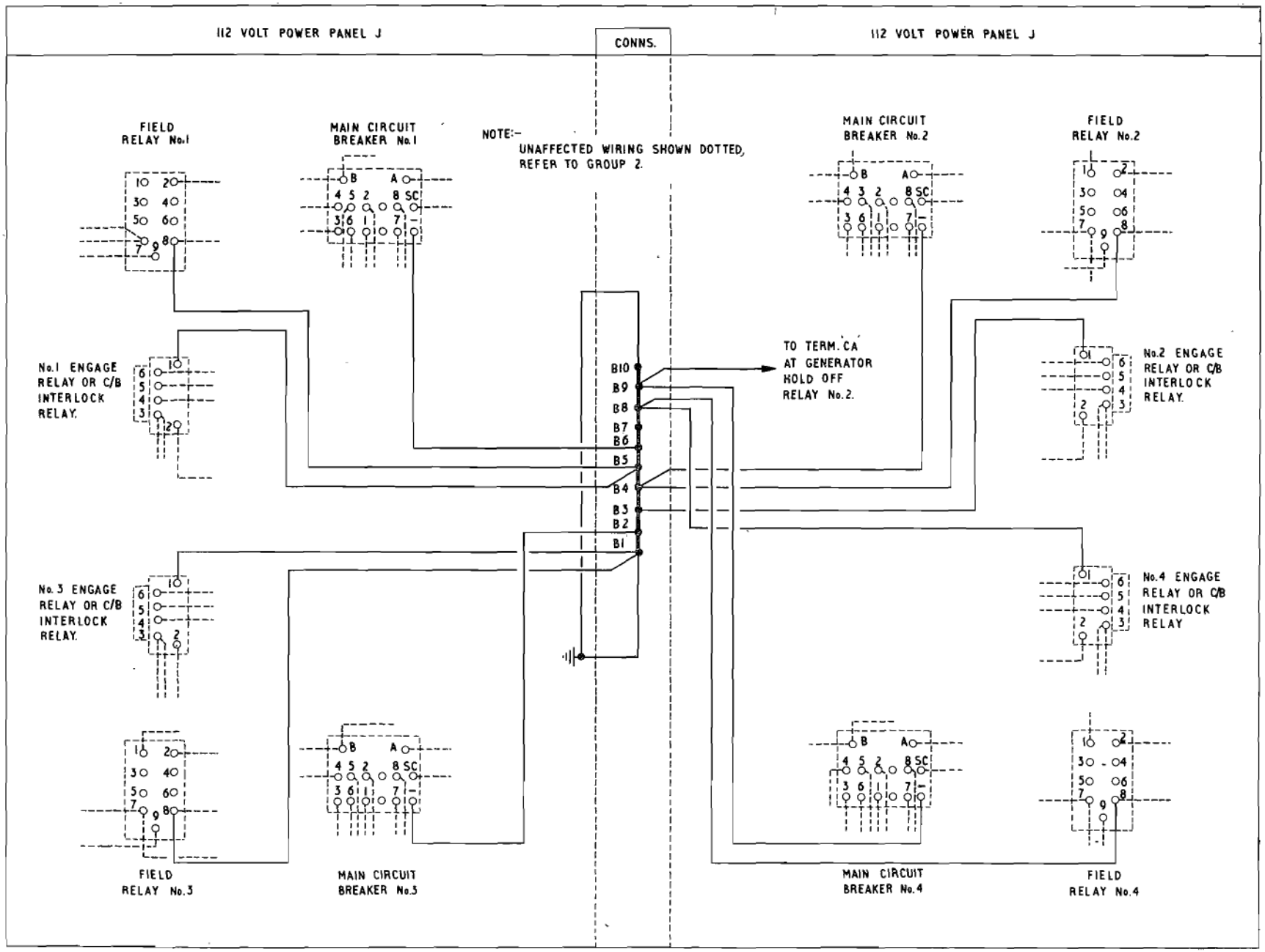


Fig. 1. Alteration to Fig. 5, 5A, 5B, 6, 6A and 6B in Group 2 (post Mod. 3076)

75836 SHT. 128 –AA
75836 SHT. 185 –X

Appendix 2

28-VOLT SYSTEM (post Mod. 3069)

1. Under Mod. 3069 the earth connections shown in Fig. 7 in the basic Group are revised as shown in Fig. 1.

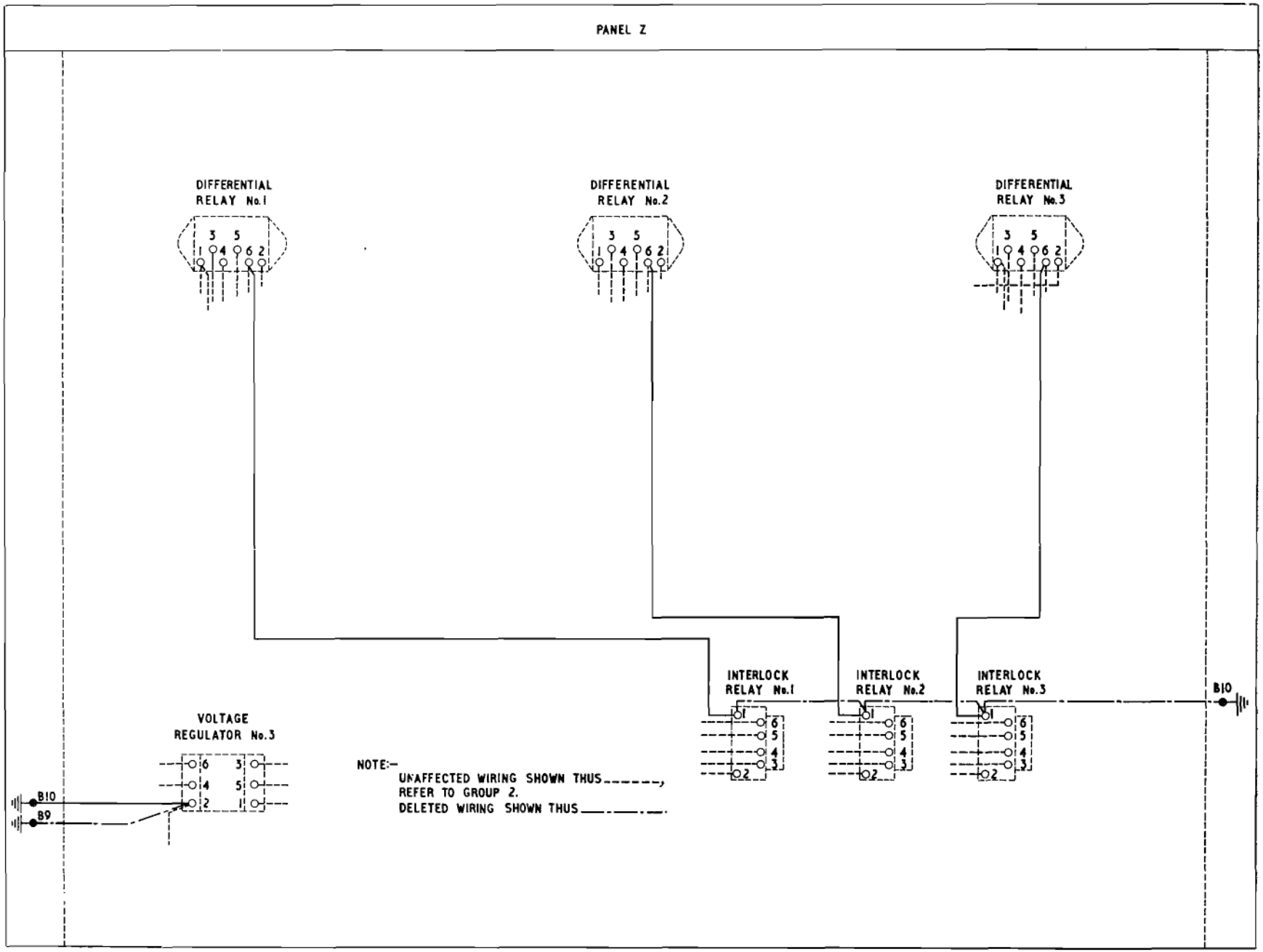


Fig. 1. Alteration to Fig. 7 in Group 2 (post Mod. 3069)

Appendix 3 W/T, RADAR AND NAVIGATORS' POSITIVE SUPPLIES (post Mod. 2796)

1. The supplies are revised by Mod. 2796 as shown in Fig. 1.

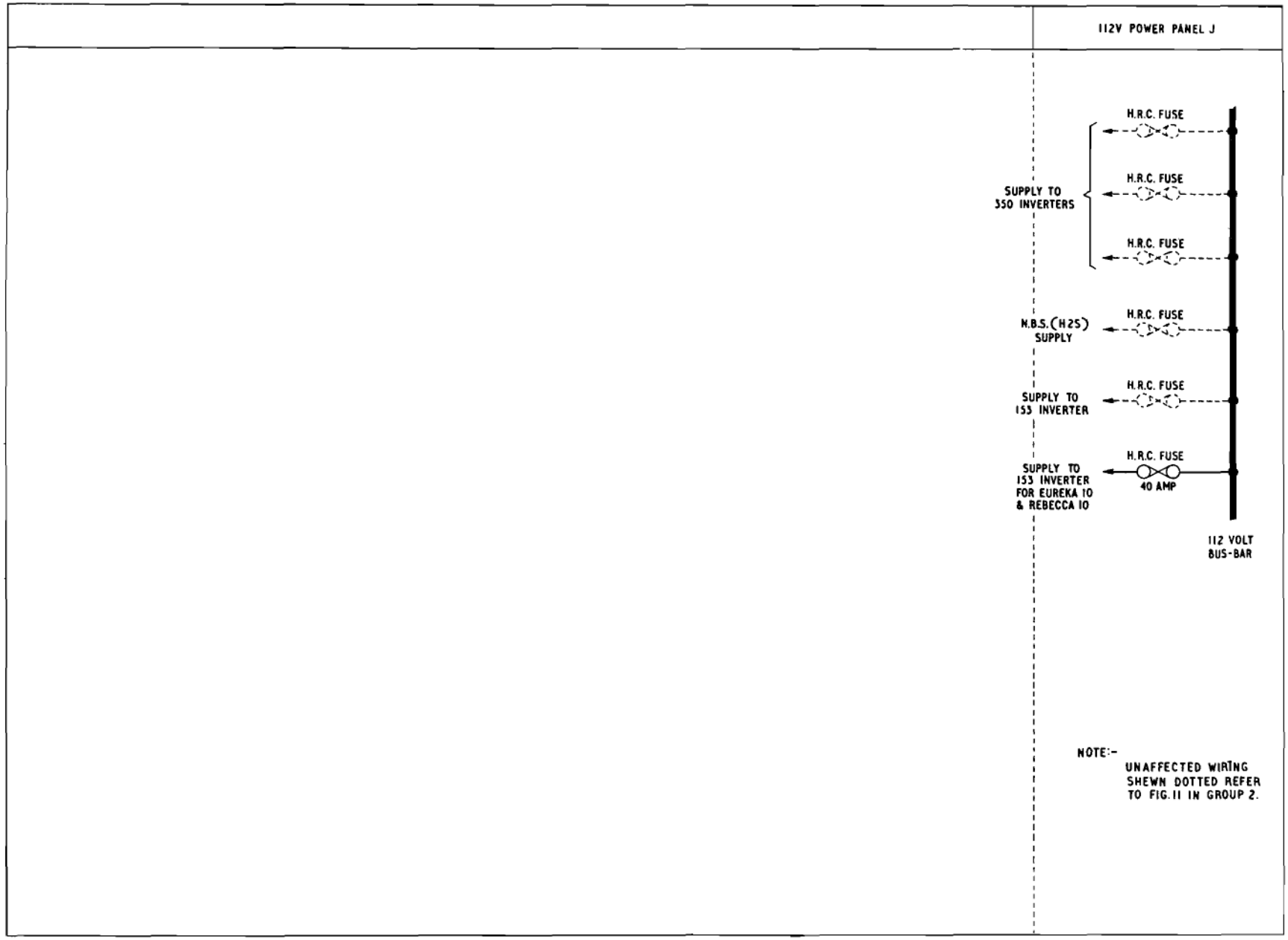


Fig. 1. Alterations to Fig. 11 in Group 2 (post Mod. 2796)

Appendix 4

BATTERIES (post Mod. 2650)

Introduction

1. This appendix describes the battery ammeter installation introduced by Mod. 2650 (*Group* 2, *para.* 86*A*) and altered by later issues of the Mod. Schematic and routeing diagrams are included in this appendix to show circuit changes, and the position of equipment is shown in the Group 4 location diagrams.

DESCRIPTION AND OPERATION

Battery ammeters (*fig.* 1)

2. External shunt ammeters are used to indicate charge or discharge current flow at the 96-volt and 24-volt batteries. The ammeters provide an indication of loads being taken by the batteries, and thus facilitates load shedding in the event of generator failures. The circuits are arranged to automatically disconnect the meters during engine start procedures.

3. For the 112-volt system, a 130-0-200A ammeter is connected across a 50mV, 200A shunt fitted in the negative line of the 96-volt battery. The 28-volt system uses a 60-0-100A ammeter connected across a 50mV, 100A shunt fitted in the negative line of the 24-volt battery. The ammeters are mounted together on the radio crate at the A.E.O.'s position, and the shunts are located in the battery bay.

4. The ammeters are connected to their shunts via the normally made contacts of a relay, Type S, controlled by the ENGINE START master switch and mounted on panel H. With the master switch selected to START or ISOLATE, the relay is operated to open circuit the ammeters.

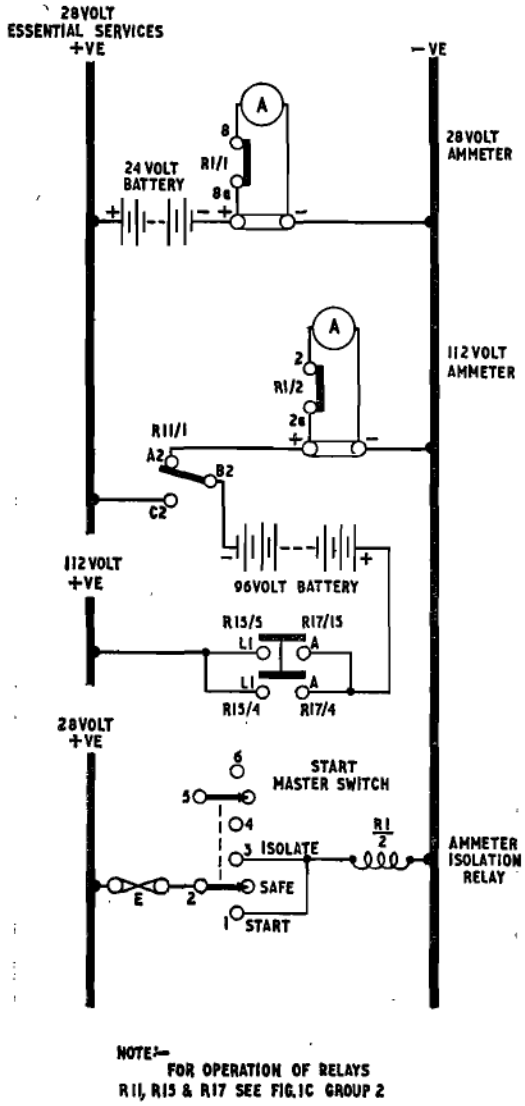
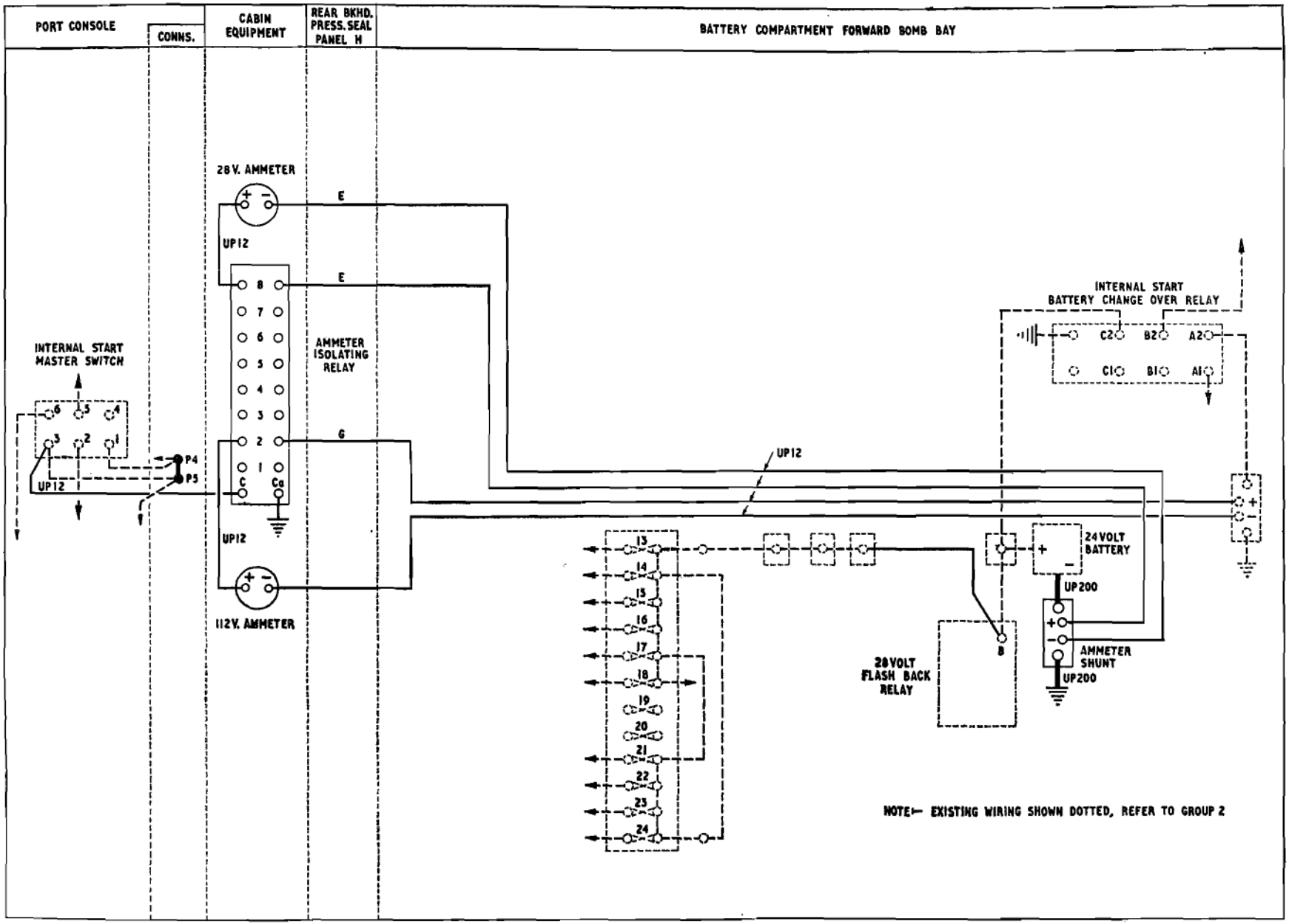


Fig. 1. Battery ammeters (post Mod. 2650)



67436 SHT.125-BJ
71036 SHT.125-AD
75836 SHT.125-AC

Fig. 2. Alterations to Fig. 17 in Group 2 (post Mod. 2650)

Appendix 5

28-VOLT STANDBY SERVICES SUPPLY (Mod. 3088)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. This appendix describes the standby services installation introduced by Mod. 3088. The modification introduces a three-pin NATO plug located in the nosewheel bay starboard side, a Type 1A, No. 1 relay in the upper servicing bay, and a 100 amp H.R.C. Fuse on control panel Z. A routeing diagram is included in this appendix, and the position of the equipment is shown in Group 4 location diagrams.

Note . . .

The fire warning and fire extinguisher systems are connected to the essential services section of the aircraft supply and are therefore available at all times.

DESCRIPTION AND OPERATION

General

2. The 28-volt d.c. standby service NATO plug feeds the control panel Z bus-bar, the bus-bar supplying the essential services for rapid take-off (fig. 1) thus preventing drain on the aircraft battery during stand-by periods. The NATO plug is mounted in a metal box with a spring-loaded lid, the box being inclined at an angle to facilitate the disconnection of the NATO socket on rapid take-off.

3. The 28-volt NATO three-pin plug located in the nosewheel bay has two large (heavy duty) pins and one small one; the positive heavy-duty pin is connected to control panel Z bus-bar, via normally-open contacts A and B of the magnetic switch Type 1A, No. 1, and a 100 amp H.R.C. fuse.

4. The magnetic switch is energized by a 28-volt supply from the small positive pin of the NATO plug, via the normally-closed contacts 4 and 4A of the battery contact re-set relay (Sect. 5, Chap. 1, Group 2, Fig. 14-17).

5. The heavy duty negative pin is earthed via a cable to the rear wall at the starboard servicing bay. Flashback at the plug is prevented by the action of the magnetic relay which opens contacts A and B when the NATO socket is removed.

Operation

6. When an external 28-volt d.c. supply is connected to the aircraft, via the three pin plug, the following services are available:—

(1) Bomb bay temperature indication.
(2) Taxi lights.
(3) Navigation lights.
(4) Windscreen de-icing (check reservoir contents).
(5) Windscreen wipers.
(6) Feel unit heaters.
(7) Pressure head heating; this can be used to prevent the pressure head cover freezing to the pressure head.
(8) Firewire; this will necessitate a 115-volt, 400 cycle A.C. supply.

SERVICING

General

7. After every rapid take-off ensure that no damage is sustained by the NATO plug.

8. The general tests to be applied are contained in the General Information group, contained in this book immediately after Section 5, marker card.

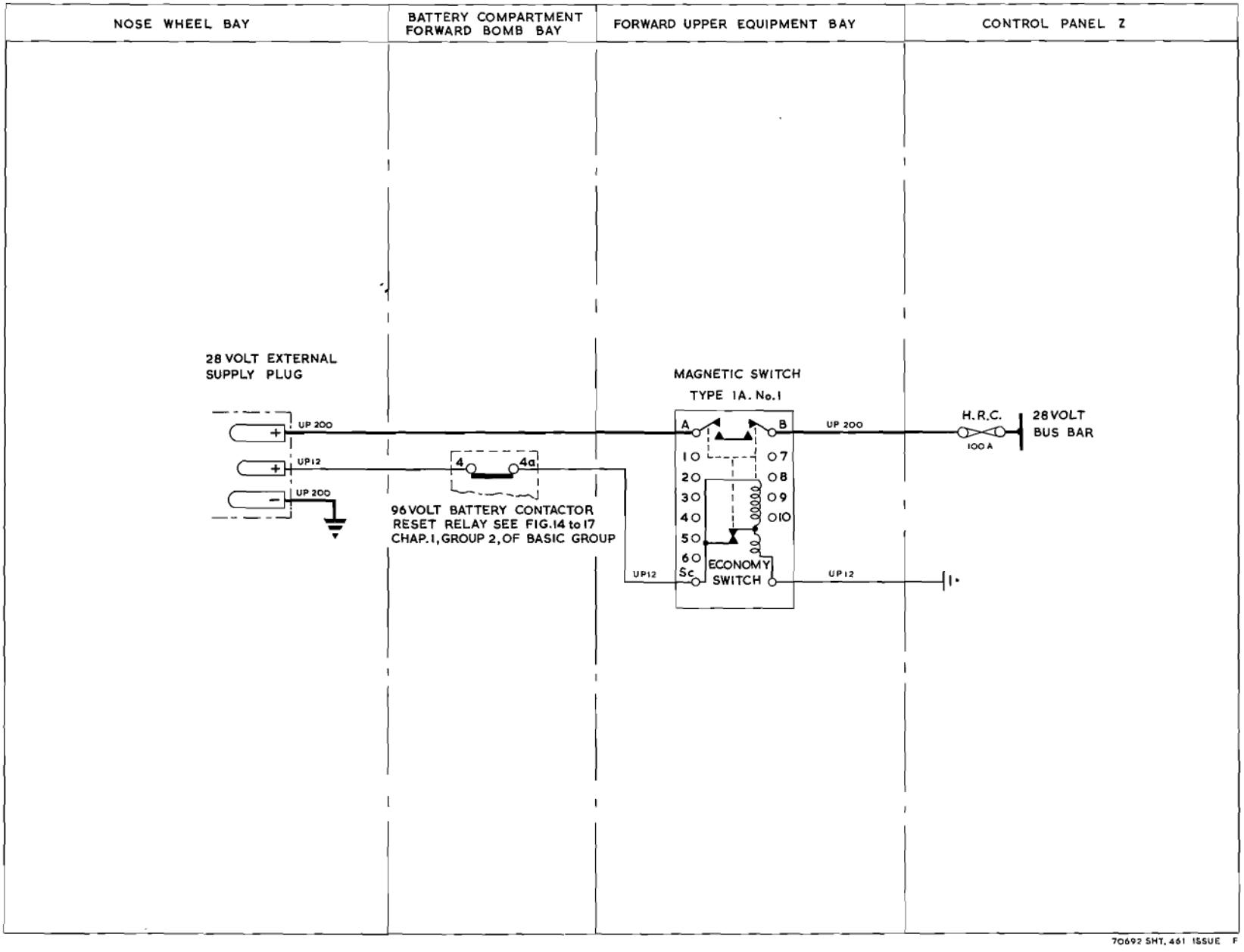


Fig.1 28-Volts Standby services supply (Mod. 3088)

RESTRICTED

2553 281983 625 7/63 P.P. 925-2

Appendix 6

W/T, RADAR AND NAVIGATOR'S POSITIVE SUPPLIES (post Mod. 3089 and 3129)

Mod. 3089

1. Under Mod. 3089 Fuses No. 63 and 64 are linked to fuse No. 65 by mod. 3089 as shown in fig. 1.

Mod. 3129

2. Under mod. 3129, Type S.10 relays replace Type S.4 in the pilot's starboard positive supplies.

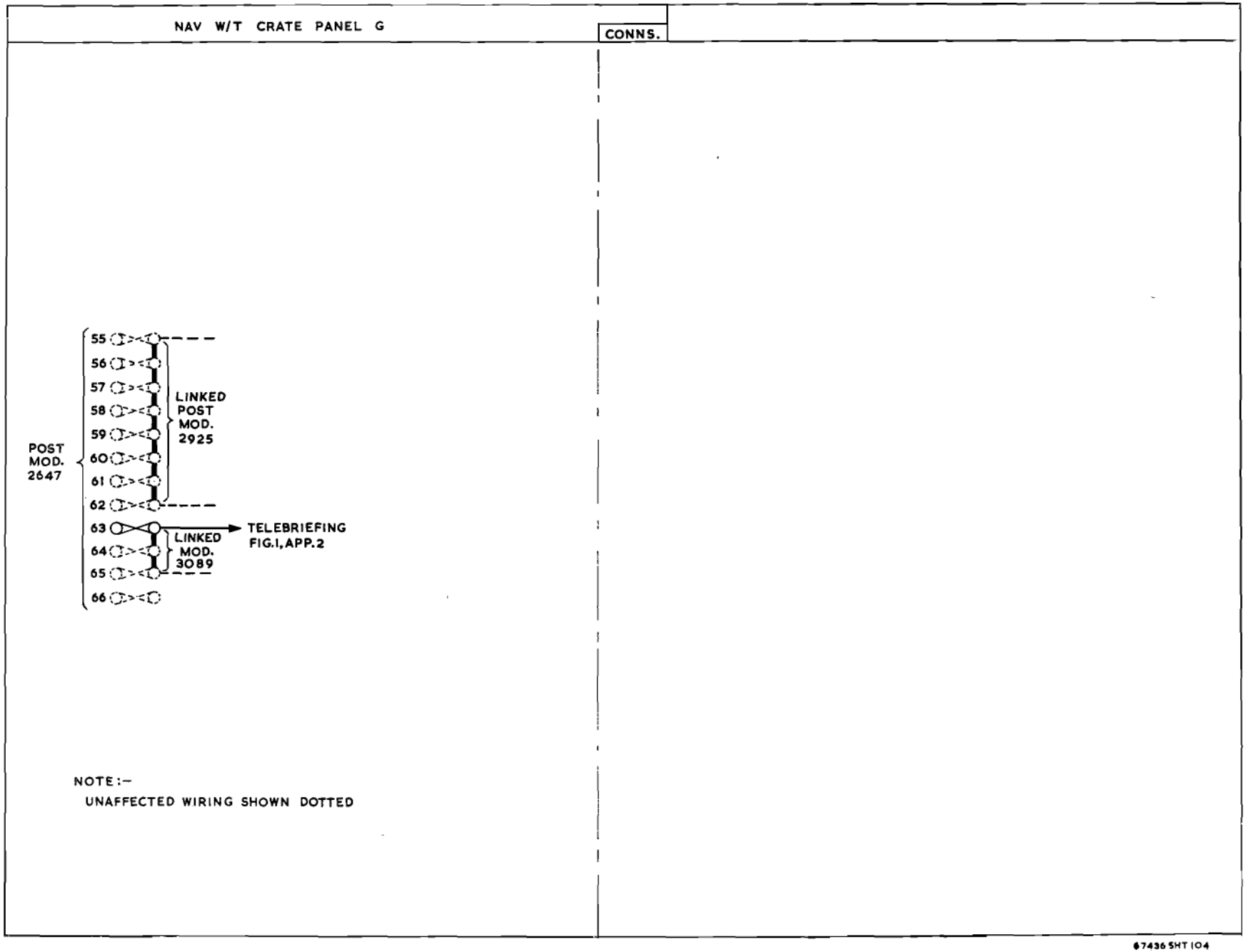


Fig. 1. Alterations to W.T. radar and navigators positive supplies (Mod. 3089)

Appendix 7

PILOTS PORT POSITIVE SUPPLIES (post Mod. 3058)

1. Under Mod. 3058, the Pilots port positive supplies are revised as shown in fig. 1 of this appendix.

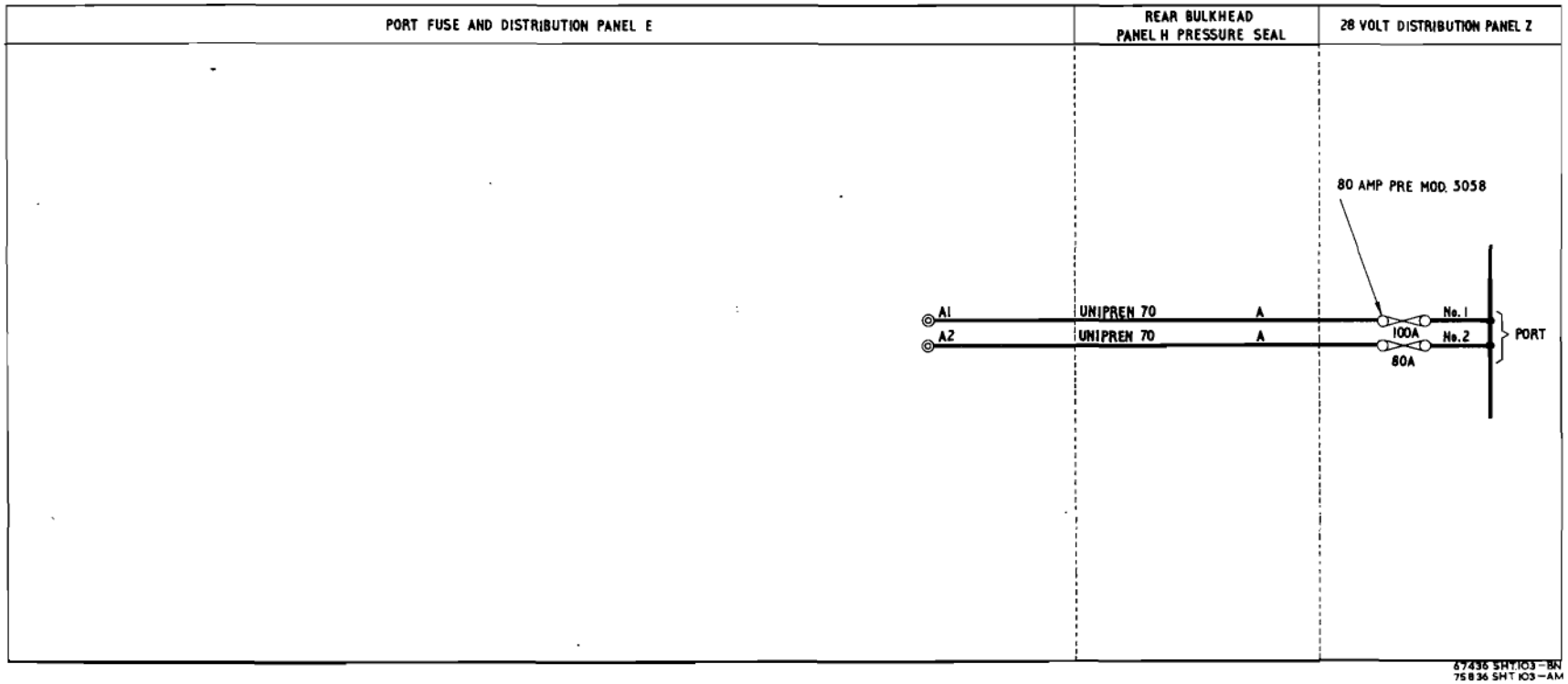


Fig. 1. Alteration to Fig. 10 (post Mod. 3058)

Appendix 8

RADIO TEST SOCKET (Mod. 3144)

Introduction

1. Mod.3144 introduces a 28-volt d.c. supply socket on the A.E.O.'s voltage trimmer panel to provide a source of supply for portable radio test equipment.

2. The socket is mounted on the blanking plate fitted under Mod.2933 in the position formerly occupied by the generator voltmeter selector switch, the fuse being fitted in panel G. A schematic diagram of the socket is included in this appendix and illustrated on fig. 15 in Group 4.

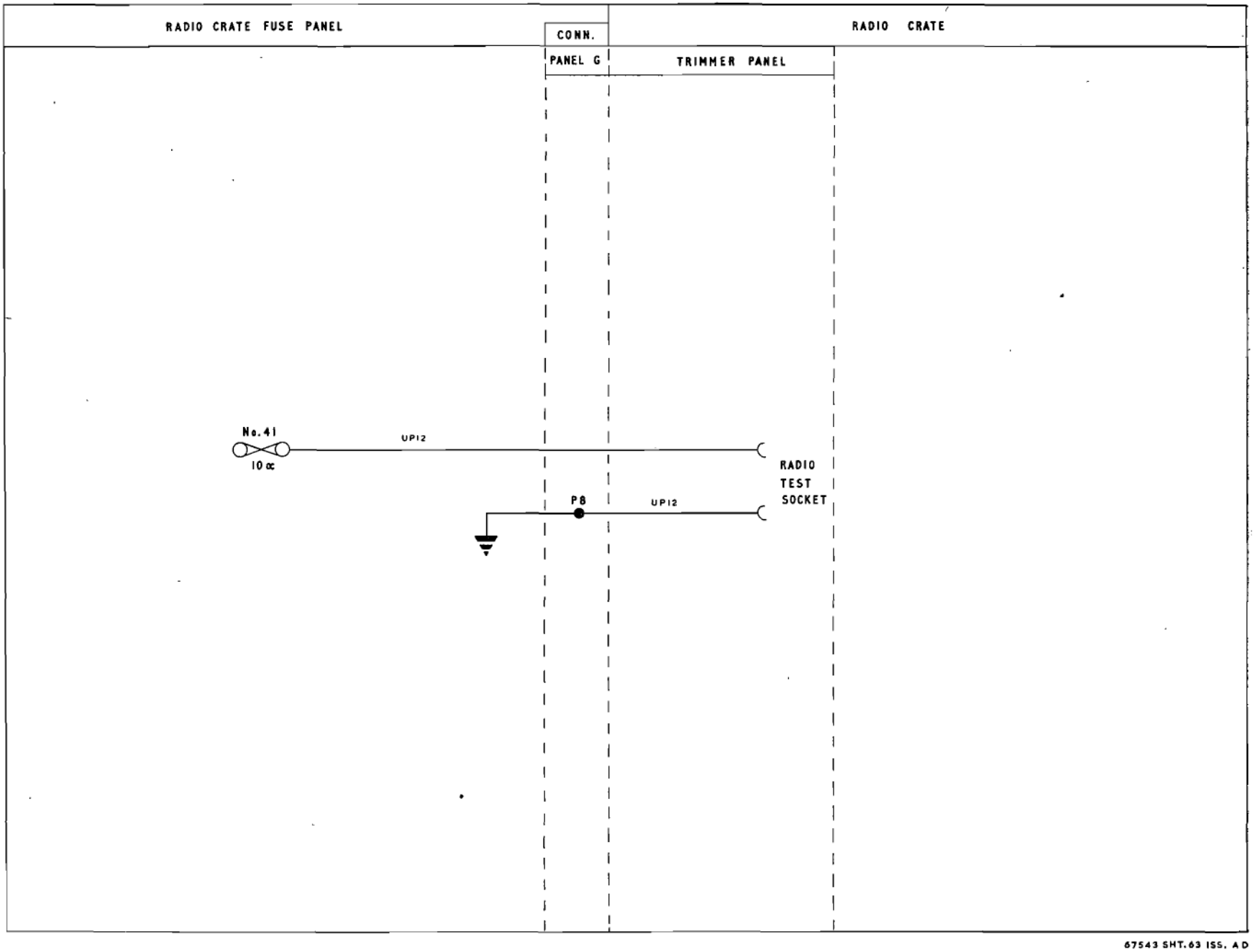


Fig. 1. Schematic diagram, radio test socket (Mod. 3144)

Appendix 9

BATTERY INSULATION (Mod. 3212)

Introduction

1. Mod.3212 improves the insulation between battery containers and airframe, and battery to battery, by fitting the following items at the 96 volts battery tray:—

(1) An insulating cap is fitted to each battery tray spigot.

(2) An insulating bush and washer to each eye-bolt.

(3) An insulating mat under each battery.