Group 4 ENGINE STARTING AND IGNITION

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. This group contains descriptive and servicing information for the electrical controls in the engine starting and high energy ignition systems. Component location is contained in fig. 1, and a theoretical circuit diagram of the system will be found in fig. 2 and 3. The following modifications are included in this group:—

Mod. 340. To improve the protection of main feeders and emergency services.

Mod. 621. To introduce load ammeters in the generators, rotary transformers and battery services.

Mod. 677. Electric Starter Panel, Rotax U2602 to introduce Type F1711/1 by conversion of F1711.

Mod. 697. To improve 112-volt generator system.

DESCRIPTION AND OPERATION

GENERAL

2. A four-stage starting system is employed, and the time cycle is automatically controlled by relays and a time delay switch. The control relays and time switch are contained in a starter panel, Rotax Type U2602, fitted to the aft face of the rear spar, adjacent to 26P in the main power compartment.

3. Under normal conditions, 112-volt ground supply will be used for engine starting, but should emergency starting be required, provision is made to enable No. 1 engine to be started from the aircraft batteries. Facilities for relighting in the air are provided by four push-switches mounted one on each engine control lever in the throttle box.

4. Each engine is started in turn, and switching of the starting control circuits to the engine concerned is effected by a 4-way selector switch on the port console 6P, at the pilot's station. A mechanical interlock between the selector switch and the engine starter push-switch ensures that the selector switch is retained in the position selected until the starting cycle for that particular engine is completed. Type Q3 relays are employed in the relighting circuit to isolate the starting control circuits when relighting is employed.

5. Heavy duty ground supply at 112-volts is fed to the Type U2602 Rotax 4-stage starter panel in the aft power compartment. Supplies for the high energy ignition circuits and for the engine starting control circuits are obtained from the 28-volt bus-bar, via their associated fuses in panels 3P and 26P. The relighting circuits are also fed from the 28-volt supply in 3P.

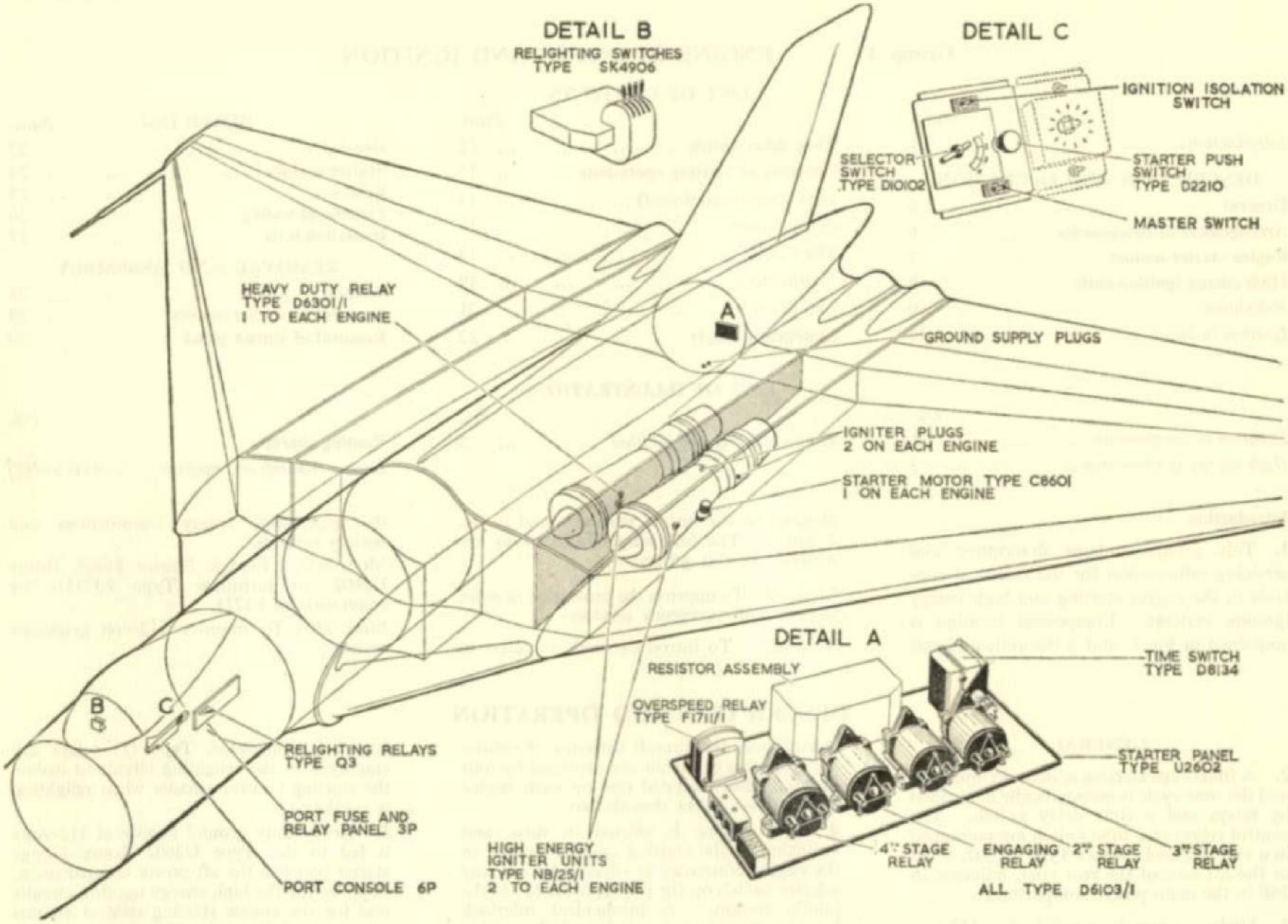

Fig. 1. Location of components (J and K)

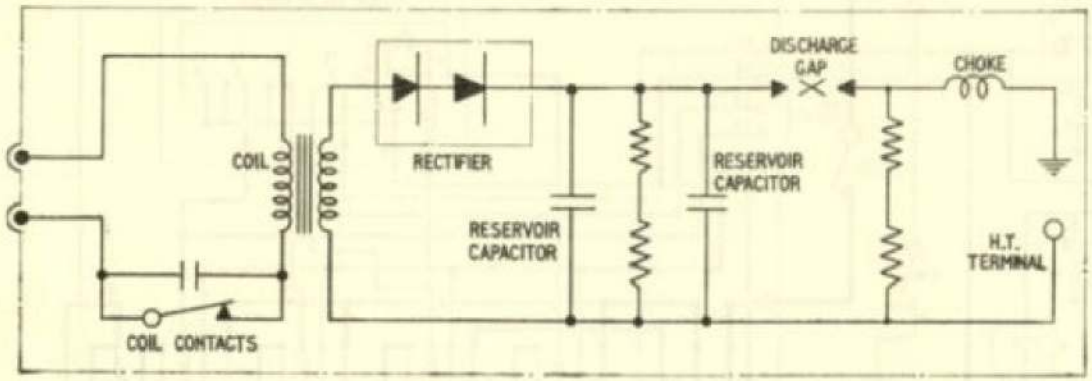

Fig. 2. High energy ignition unit

ARRANGEMENT OF COMPONENTS

6. Details of the components used in the starting and ignition systems are as follows:—

Starter motors Rotax C8601 – one on each engine.

Starter relays Rotax D6103 – one on each engine bulkhead.

High energy ignition units Rotax NB/25/1-L – two to each engine.

Starting panel Rotax U2602 – aft power compartment.

Time delay switch Rotax D8134 – fitted in starting panel.

Overspeed relay Rotax F1711/1 – fitted in starting panel.

Engaging relay Rotax 6103/1 – fitted in starting panel.

2nd stage relay Rotax 6103/1 – fitted in starting panel.

3rd stage relay Rotax 6103/1 – fitted in starting panel.

4th stage relay Rotax 6103/1 – fitted in starting panel.

Resistor assembly Rotax N113256 – fitted in starting panel.

Starter master switch Rotax D5404 – port console 6P.

Starter push switch Rotax D2210 – port console 6P.

Isolation switch Rotax D5404 – port console 6P.

Selector switch Rotax D10102 – port console 6P.

Ignition relight switches SK4906 one on each engine control lever.

Relight relays Q3 – on port relay panel 3P.

ENGINE STARTER MOTORS

7. Four Rotax starter motors, Type C8601, designed for operation on 112-volt constant voltage supply, are fitted one to each engine. These starter motors are series wound, with a small shunt field to prevent overspeeding on no load conditions. The heavy duty supply circuit to the starter motors is fed through the various relays on the starting panel in the aft compartment, and from this common point each motor is supplied in turn through its associated relay, (Rotax, Type D6103) on the inboard side of each engine bay. The negative return from each motor is connected to the aircraft metal structure. Descriptive information for the starter motors will be found in A.P.4343D, Vol. 1, Book 1, Sect. 4, and information for the relays is contained in A.P.4343C, Vol. 1, Book 2, Sect. 4.

HIGH ENERGY IGNITION UNITS

8. Eight high energy ignition units, (Rotax Type NB25/1), are installed, two in each engine bay. Low tension supply to each pair of units is obtained from the 28-volt bus-bar in panel 3P, and is fed (a) through the engine starter selector switch, or (b) when relighting is employed, via the contacts of a Q3 relay on panel 3P. The action of this relay is described under the heading "Relighting".

9. Each high energy ingition unit consists essentially of an induction coil and trembler mechanism, high voltage selenium rectifier, a high capacity reservoir condenser, and a hermetically sealed discharge spark gap. Protective resistors, connected across the output circuit, limit the value to which the reservoir condenser voltage would rise in the event of an open circuit occurring in the high tension circuit. The internal wiring of the ignition unit is illustrated in fig. 2.

Relighting

10. Four single-pole push-switches, fitted in each engine control lever at the pilot's station, control the ignition relighting circuits. Each push-switch controls a Type Q3 relay fitted to the port fuse and relay panel 3P. Supply to the ignition units from the engine starting selector switch is fed through the normally closed contacts of the relay, but when any relighting push-switch is depressed, the relay is energized. This isolates the ignition feed from the selector switch and puts a separate supply via a second pair of contacts in the relay on to the ignition units.

Ignition isolation

11. A single-pole toggle switch, labelled IGNITION ISOLATION, is fitted adjacent to the starting selector switch on the port console 6P. This switch is provided for ignition isolation when it is desired to turn the engine for inhibiting purposes etc., during ground servicing periods.

TIME DELAY SWITCH

12. Fitted in the starting panel in the aft power compartment is a time delay switch, Type D8134. This switch automatically controls the time sequence for the four stage starting. A theoretical circuit diagram of the switch is shown in fig. 3. Contacts A, B,

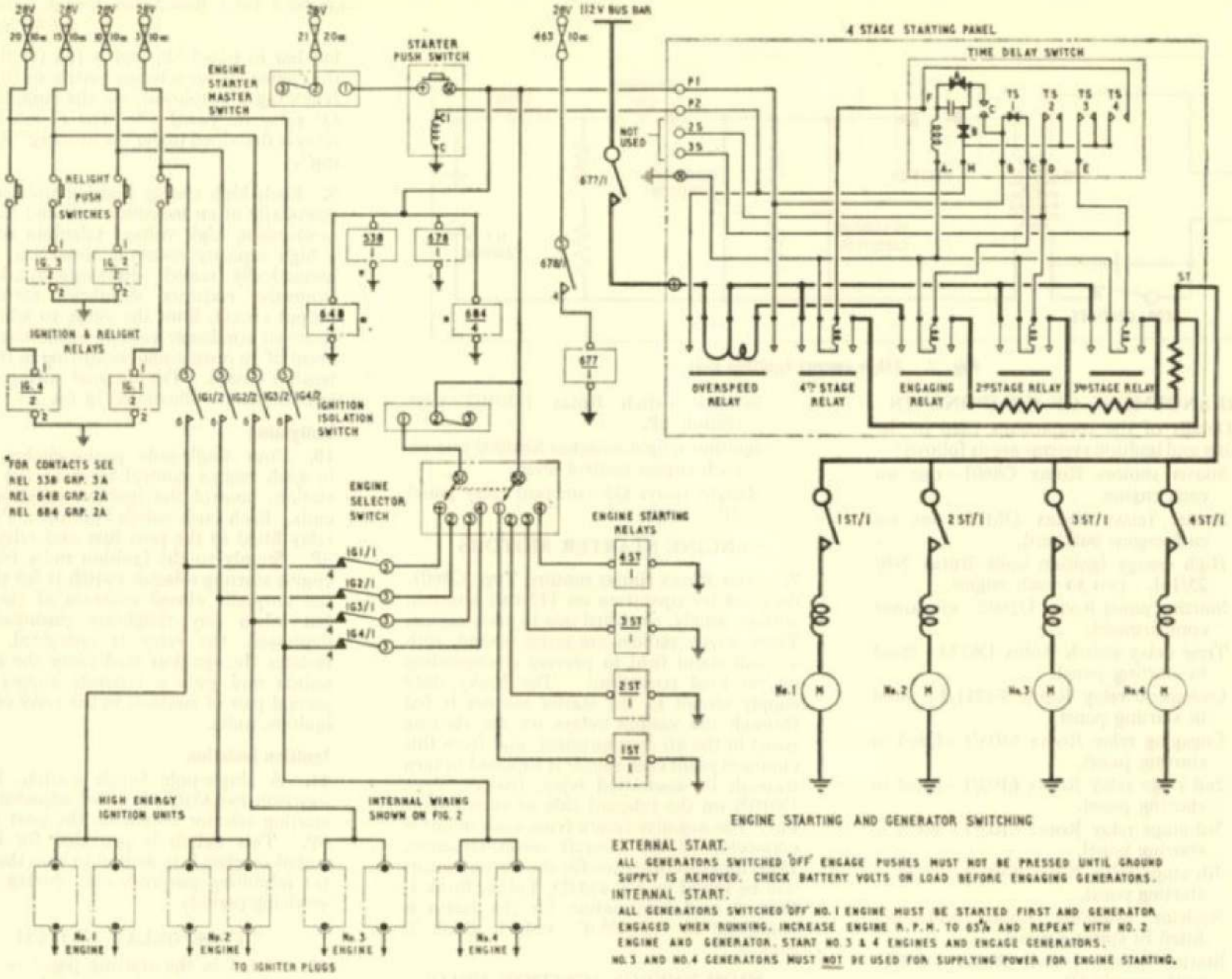

Fig. 3. Engine starting and ignition

and C of the time delay switch are concerned only with the winding of the spring. During the initial starting operation, the winding solenoid coil is energized from terminal P1, via the coil contacts A and B.

SEQUENCE OF STARTING OPERATIONS

13. In describing the sequence of all electrical operations during starting, it is assumed that all essential engine controls and fuel cocks have been positioned for starting. Ground supplies of 112 volts and 28 volts should be connected to their respective plugs in the rear fuselage. After the ignition isolation switch and engine starting master switch have been placed to ON, and the starting selector switch placed to the No. 1 position, the sequence of operations outlined in the following paragraphs will take place.

First stage (engagement)

14. Referring now to fig. 3, it will be seen that when the engine starting push-switch is depressed, a 28-volt supply is fed from fuse 21, via relay contacts IGI/1 to the No. 1 engine ignition units. The No. 1 engine starting relay 1ST will also be energized and relay contacts 1ST/1 will close to place the No. 1 engine motor circuit at readiness for starting. At the same time, the 28-volt d.c. supply will be connected to energize the coil of relay 678. Closing of relay contacts 678/1 will connect a supply from fuse 463 to energize the coil of the heavy duty relay 677. Closing of relay contacts 677/1 will connect a supply from the 112-volt d.c. bus-bar to the positive terminal of the starting panel.

15. The supply from fuse 21 will also be connected to terminal P1 of the starting panel and thence via pin B, contacts T.S.1. and pin C of the time delay switch to energize the coil of the engaging relay. Closing of the engaging contacts further connects the 112-volt d.c. heavy duty supply from the positive terminal via the coil of the overspeed relay and the limiting resistors, to terminal ST. From terminal ST, the 112-volt supply is fed via closed contacts 1ST/1 to the motor which will commence to rotate at reduced speed. It should be noted that depressing the engine start switch also connects the 28-volt d.c. supply from fuse 21 to energize relays 538, 648 and 684. The circuit action resulting from the operation of these relays is as follows:—

Relay 538 – Starting of No. 3 inverter.

Relay 648 – Places the 24- and 96-volt d.c. battery load ammeters out of circuit.

Relay 684 – Places the No. 1 and No. 2 generator load ammeters out of circuit.

Fuller details on relay 538 will be found in Group 3A and on relays 648 and 684 in Group 2A of this chapter.

16. Current flow through the overspeed relay coils will energize this relay to close and the 28-volt supply at terminal P1 will now be fed to P2, energizing the hold-in coil of the starter push-switch, and also, via terminal M, to the time switch winding coil. It should be noted that at this stage, one side of contacts TS2, and TS3 and TS4 are now supplied with 28 volts, the starting push-switch will be held in for the duration of the cycle, and the engine selector switch will be locked in the No. 1 position for that period.

Second stage

17. The time switch will now commence to unwind, and after a period of three seconds, contacts TS2 will operate, to close the second stage relay. The action of this relay will short-circuit the second stage resistor, and a section of the overspeed relay coils. After a further two seconds, contacts TS1 will open to de-energize the engaging relay. The heavy duty supply to the starter motor will then be fed through the single-turn coil of the overspeed relay, the contacts of the second stage relay, and the two remaining starting resistors.

Third stage

18. When the time delay switch has unwound for a period of eight seconds, contacts TS3 will close, and the supply from terminal P1 will be fed through these contacts to energize and close the third stage relay. Supply to the starter motor will now be fed through the single turn overspeed relay coil, the contacts of the third stage relay and the remaining starting resistor.

Fourth stage

19. When the time delay switch has unwound for a period of thirteen seconds, contacts TS2 will open, de-energizing the coil of the second stage relay, and contacts TS4 will close, energizing the fourth stage relay. This will short-circuit the fourth stage resistor. After a further period of three seconds, contacts TS3 will open to de-energize the third stage relay. Supply to the starter motor will now be fed through the single turn overspeed relay coil. All three starting current limiting resistors will now be cut out of the circuit and full voltage will be applied to the starter motor.

20. After a total interval of thirty seconds, contacts TS4 will open to de-energize the fourth stage relay. By this time, the increasing speed of the starter motor may have reduced the current value at which the overspeed relay will open. But if this condition has not been attained, the opening of the fourth stage relay will obtain this effect.

End of cycle

21. As soon as the overspeed relay opens, the supply from terminal P1 to the coil of the engine starting push-switch will be cut off, and the push-button will return to its normal position. Finally, after a total interval of thirty-five seconds from the commencement of unwinding, the time delay switch contacts TS1, and the winding contacts B will close. The circuit will now be set for a repetition of the starting cycle when the second engine is selected.

EMERGENCY SUPPLY

22. In the absence of 112-volt ground supply, No. 1 engine only may be started, using the 96-volt aircraft battery. Emergency starting drill, including circuit operation, is contained in Group 2A, para. 159 to 165.

SERVICING

WARNING

The high energy ignition H.T. voltage is lethal, and a period of at least one minute must be allowed to elapse before any disconnection of these units is attempted.

GENERAL

23. Due to the heavy currents flowing in the engine starting circuit, it is essential that all heavy duty cable connections should be inspected periodically to ensure that they are secure and free from contamination. Particular attention should be paid to the metal braided cables connected to the high energy ignition units in the engine bays for signs of abrasion and chafing of the braiding.

STARTER MOTORS

24. Servicing of the engine starter motors is restricted whilst they are on the aircraft to a routine inspection of the brush-gear and commutator. Copper or carbon deposits should be removed by means of dry compressed air. General servicing details for starter motors are contained in A.P.4343, Vol. 1, Sect. 15, and servicing details particular to the Type C8601 starter motors are contained in A.P.4343D, Vol. 1, Book 1, Sect. 4.

RELAYS

25. The relays should be examined periodically for pitting of contacts and security of connections. The relays, Type D6103, should be bench-tested periodically in accordance with the instructions laid down in A.P.4343C, Vol. 1, Book 2, Sect. 4. Details for servicing of the Type Q3 relays will be found in Sect. 24 of the same publication.

FUNCTIONAL TESTING

26. Functional testing of the engine starter motors can only be carried out during actual engine starting operations, or when the motors are removed for bench testing. A functional test of the starting panel components and high energy circuits may be carried out during ground servicing periods in the following manner:—

(1) Ensure that all power supplies are OFF and the ground supply truck is NOT connected to the aircraft.
(2) Disconnect the L.T. supply sockets from each pair of high energy ignition units in the engine bays.
(3) Connect a suitable low wattage test lamp across the pins of each disconnected socket.
(4) Remove the cover from the starting panel in the aft power compartment, and using a suitable shorting link, connect terminals P1 and P2 together.
(5) Plug in the 28-volt ground supply to the appropriate ground supply plug.
(6) Place the 28-volt isolation switch on the main power panel to the ON position.
(7) Depress each relighting push-switch on the engine control levers in turn, and check that:
  (*a*) The appropriate Q3 relay operates.
  (*b*) The appropriate two test lamps in each engine bay are illuminated.
(8) Place the engine starting master switch and the ignition isolation switch to the ON position.
(9) Depress the starting push-switch, and check that the push-button is held in by the solenoid coil.
(10) The starting cycle of the time delay switch and associated relays will be repeated until the link is removed from terminals P1 and P2.
(11) During the cycling period, check that:—
  (*a*) Time from beginning of cycle to engaging period is 2·75 to 3·25 seconds.
  (*b*) Time from beginning of cycle to end of second stage is 7·5 to 8·5 seconds.
  (*c*) Time from beginning of cycle to end of third stage is 12·5 to 13·5 seconds.
  (*d*) Time from beginning of cycle to end of fourth stage is 28 to 30 seconds.
(12) At the conclusion of the above tests, ensure that all switches are OFF, the link removed from terminals P1 and P2 and all disconnected plugs and sockets are replaced and secure.

INSULATION TESTS

27. Insulation tests on the starting panel should be carried out with the panel removed from the aircraft. Using a 500-volt insulation tester, the insulation resistance between all terminals and the frame of the panel should not be less than 20 megohms with the panel at room temperature.

REMOVAL AND ASSEMBLY

GENERAL

28. The removal of most of the components used in the starting and ignition system requires no detailed instructions. It is important that all power supplies are switched OFF before any removal of components is attempted.

REMOVAL OF STARTER MOTORS

29. The closest co-operation should be maintained between the engine and electrical tradesmen during the removal of the starter motors. Detailed instructions for the removal and replacement of these units is contained in A.P.4501B, Vol. 1, to which reference should be made before any removal of the starter motors is attempted.

REMOVAL OF STARTER PANEL

30. Should it become necessary to remove this item from the aircraft, the following procedure is recommended:—

(1) Position a Safety-Raiser or other adjustable platform trestle below the entrance to the aft power compartment with the platform high enough to clear the aircraft structure.
(2) Install the special servicing platforms on the power compartment floor structure.
(3) Release the ten Dzus fasteners securing the cover of the starter panel, and remove the cover.
(4) Disconnect the light and heavy duty cables connected to the starter panel terminal blocks (port side) and insulate and stow the cables.
(5) Undo the four bolts securing the starter panel to the bulkhead, and slide the panel clear of the support frame.

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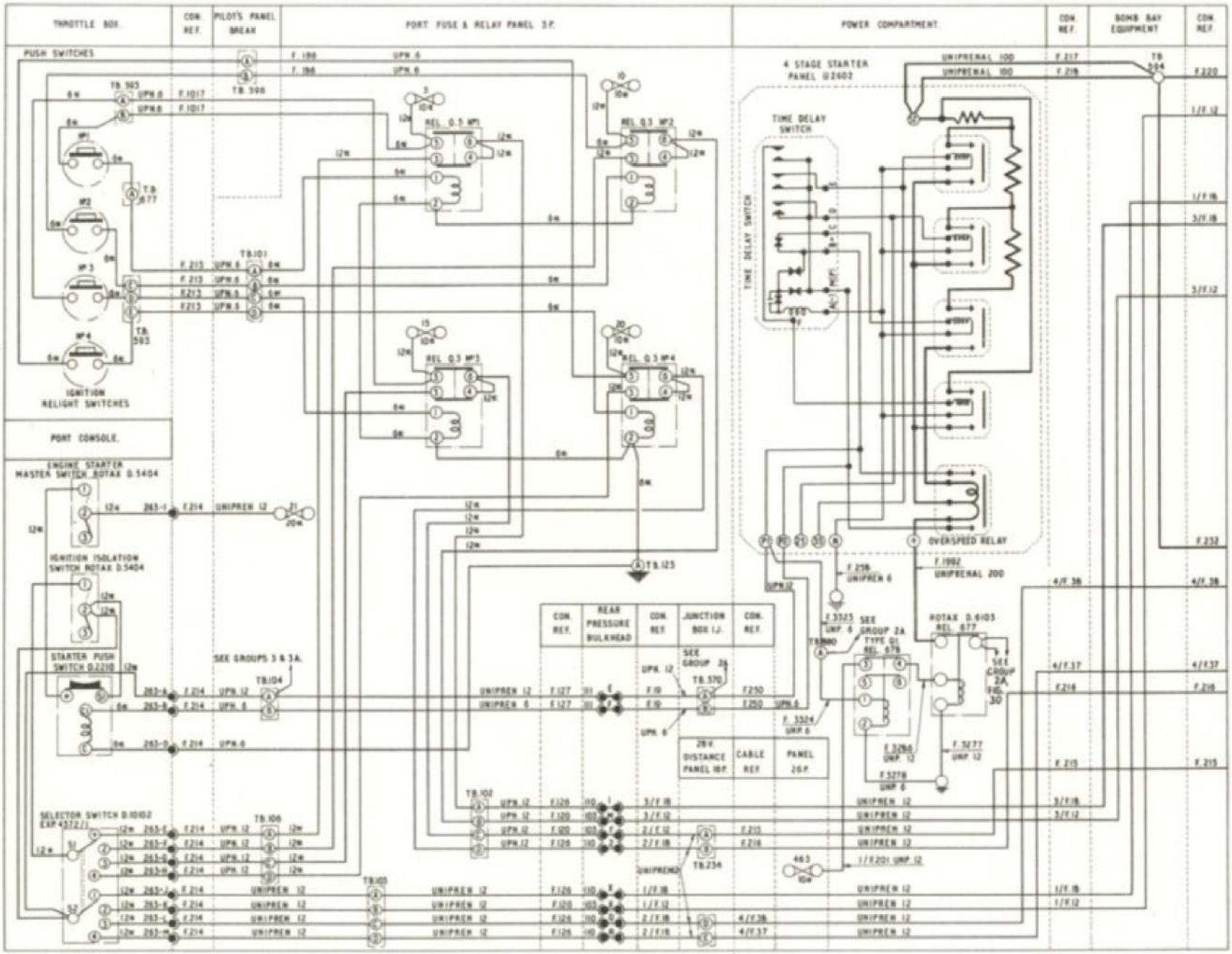

Fig 4. (1) Engine starting and ignition
(◄ Relay 677 fig. ref. added ►)

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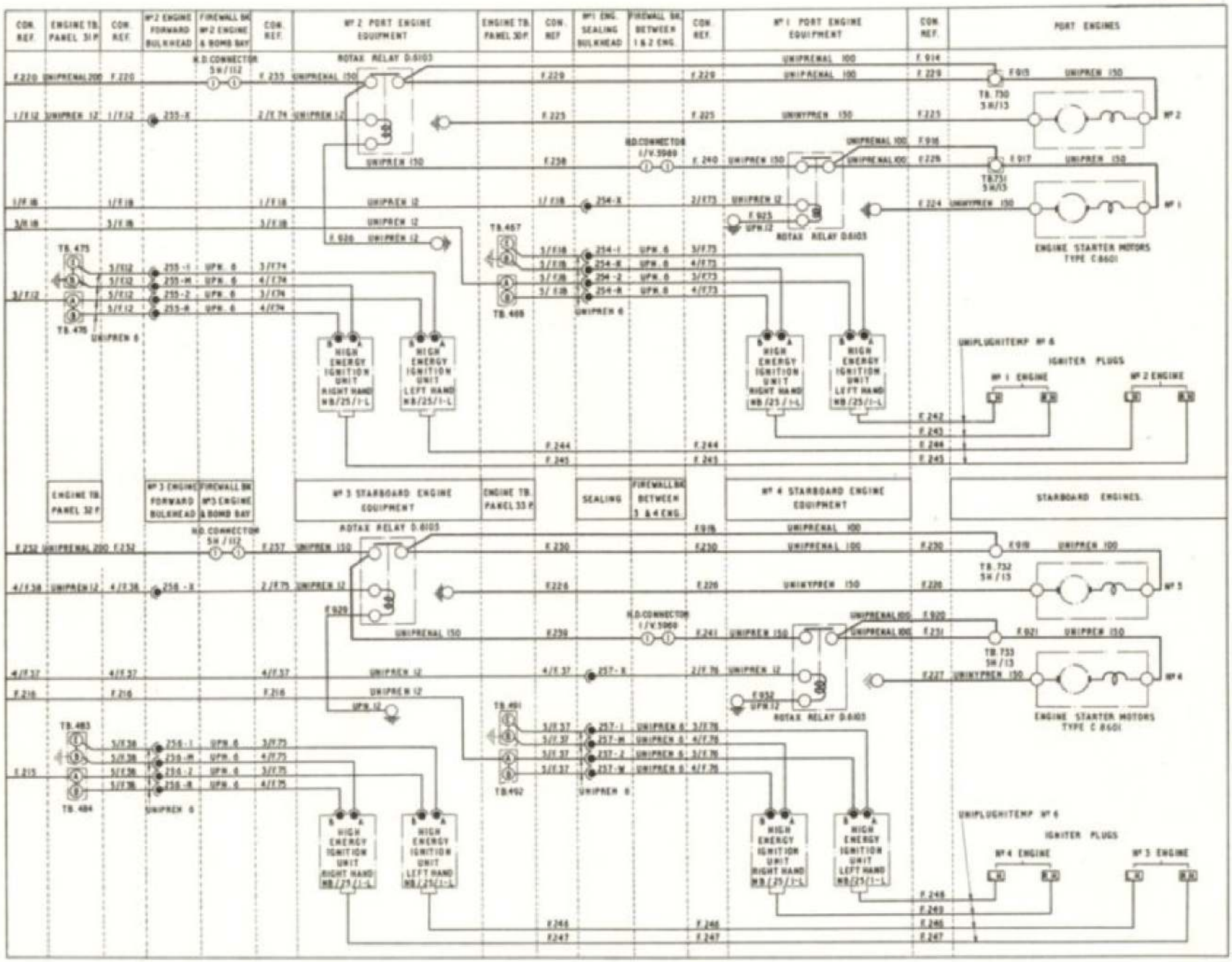

Fig.4. (2) Engine starting and ignition
(◄Starter motor Type Nos. corrected►)

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