

GROUP C1 ENGINE STARTING (CODE SA)

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Introduction

1. This group contains a brief description, including the method of operation, of the engine starting circuit installed in this aircraft, together with the necessary servicing information required to maintain the equipment in an efficient condition. A routing and theoretical diagram of the circuit is also included. For a description of the electrical system of the aircraft as a whole, including system wiring details, referencing of components and general servicing, together with the location and removal of the major equipment, reference should be made to Groups A1, A2 and A3 of this chapter. Detailed information on the standard components used will be found in the appropriate volumes of A.P.4343 series.

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DESCRIPTION**ENGINE STARTING**

2. The engine is started by a Rolls-Royce T.B.S.720 Mk. 1 cartridge-fired triple-breech turbo-starter mounted on the forward end of the engine, and the starting cycle is automatically controlled by an FHM/A/25 time switch located between frames 6 and 7 on the starboard side of the cockpit. All the engine services are protected by a 45-amp. circuit breaker located on the cockpit starboard shelf and are also provided with their own fuses. The supply from this circuit breaker to the starting circuit is controlled by the engine master switch mounted on the leg panel in the cockpit. Apart from controlling the engine starting circuit, the engine master switch also controls the supply to the fuel tank booster pumps, the fuel pressure indicator, the emergency fuel pump solenoid and the A.C. supplies circuit. The cartridges are selected and the time switch energized by an FJB/A/5 or /3 starter selector switch located on the leg panel.

◀ 3. Two Type C.10-TS/2 or /3 high-energy igniter units supplying the igniter plugs in the engine combustion chambers are mounted, on the starboard side of the centre fuselage, between frames 34 and 36. The supply to these units is controlled by a relay, which is mounted on the supply panel and energized by the ignition switch and re-light push-switch, located on the leg panel and high-pressure fuel cock handle, respectively. The ignition switch is provided with a guard to retain it in the ON position.

Operation

4. The following text traces through the sequence of operations which takes place when the engine is started. It should be

noted that the starter circuit breaker must be closed and the engine master and ignition switches closed before a start may be made. The ignition switch is normally locked ON.

5. At the commencement of the starting cycle, contacts B, C and D of the time switch (fig. 1) are all made, but the clutch is disengaged and contacts A are open. When the starter selector switch push-button is depressed, the firing circuit to one of the three cartridges in the turbo-starter is selected by a rotary selector switch, which is mechanically interlocked with the push-button. As a safeguard against short-circuits between the cartridge firing circuits, the remaining two cartridges are short-circuited to earth by a rotary shorting contact which is also mechanically interlocked with the push-button. As the push-button contacts are made, a supply is fed to the firing circuit of the selected cartridge via contacts C of the time switch and the cartridge is detonated, thus revolving the starter, which, in turn, revolves the engine. At the same time, a supply is made to the time switch motor and to the igniter relay. The high-energy igniter units are thus energized, to supply the igniter plugs, by the closing of the igniter relay. Also, the time switch motor commences to run. The time switch clutch is energized by the contacts D, and as the clutch comes into engagement contacts A are made and a supply fed via contacts B to the selector switch hold-in solenoid. This solenoid causes the push-button to remain depressed, thus preventing a second cartridge from being fired until sufficient time has elapsed to ensure that no damage will be suffered by the engine, due to overspeeding.

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6. All these operations take place instantaneously and the starting cycle is now independent of outside control, with the exception of the starter circuit breaker, engine master switch and ignition switch, which may be used to stop the cycle in an emergency. This is not recommended, however, unless absolutely necessary.

7. Five seconds after the commencement of the starting cycle, contacts C open to break the supply to the cartridge firing circuit, and after 29 seconds, contacts B open to break the supply to the selector switch hold-in solenoid. The push-button contacts open to break the supply to the time switch motor and igniter relay, thus stopping the time switch and de-energizing the high-energy igniter units. As the clutch in the time switch disengages, contacts A open and the remaining contacts re-set in preparation for the next start. It should be noted that contacts D of the time switch act as an over-run safety limit switch, which comes into operation when the unit is being tested on the bench without being connected to a starter selector switch. Under this condition, should the motor be supplied inadvertently for more than 29 seconds, contacts D will open one second after contacts B to allow the unit to re-set and commence another cycle.

8. The re-light switch, when depressed, energizes the igniter relay independently of the normal starting circuit, and is used to energize the high-energy igniter units when it is required to re-light the engine in flight.

SERVICING

General

9. For servicing information relating to the electrical system as a whole, reference should be made to Group A1 of this chapter. All the components should be kept clean and the contacts of the switches, relays, etc., inspected for signs of pitting, which, if found, must be removed. The brushes of the time switch motor should also be examined to ensure that they are in good condition. Apart from

the standard bench testing and servicing of the components as described in the appropriate Air Publications, no further servicing should be necessary.

Testing engine starter circuit

10. To ensure that a high resistance to earth does not exist in the engine starting circuit wiring, the following tests must be made. They are important as a high resistance earth may result in the firing of two cartridges simultaneously with consequent damage to the aircraft and injury to personnel.

- (1) Check that terminal 9 of the starter selector switch is connected to earth and that the resistance to earth does not exceed 1.0 ohm.
- (2) Ensure that the starter body is earthed to the airframe, by using a bonding tester (*Stores Ref.* 5G/2126). The resistance should not exceed 0.025 ohm.
- (3) Disconnect cable assembly C.3 from the plug on the engine and cable assembly F.31 from the time switch. Check that two of the three pins A, B or J of the socket of cable assembly C.3 are connected to pin 1. Test the remaining pin with a 250-volt insulation resistance tester to ensure that it is not connected to earth.
- (4) Press the starter selector switch button ONCE and repeat operation (3). Repeat this test four times.
- (5) Test, with a wheatstone bridge, to ensure that the resistance of each of the three cartridge leads is less than 1.0 ohms. Two of the leads may be tested between pins A, B or J and pin 1 at the socket on cable assembly C.3 and the third lead tested from the remaining pin after depression of the engine starter selector switch button.
- (6) Reconnect cable assembly F.31 to the time switch plug. Connect three 24-volt lamps between pins A, B and J of the plug of cable assembly C.3 and an earth

(negative). Energize the complete circuit and press the starter selector switch button once. Note which lamp lights. *Only one lamp should light during any one cycle.* Wait 30 seconds until the selector switch button returns to its normal position and then press it again. Repeat this test at least six times and ensure that the lamps light in their correct sequence.

- (7) When the tests are completed, remove the three lamps and reconnect cable assembly C.3 to the plug on the engine.

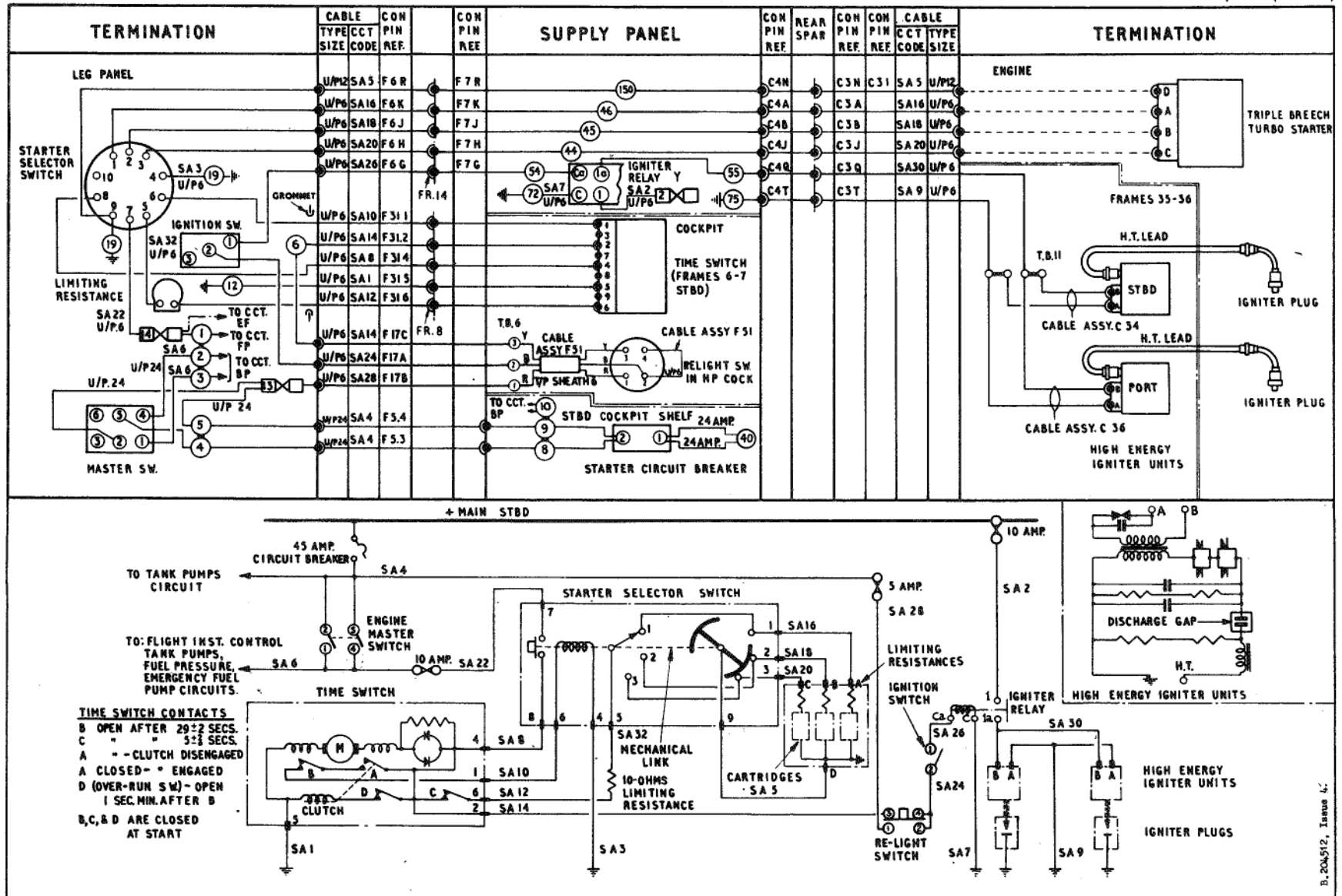
Replacement of re-light cable

11. To prevent the possibility of damage to the re-light cable under the cabin port shelf by fouling the high pressure cock Teleflex control box mounting nuts, it is considered necessary to give the following precise assembly instructions, which must be adopted whenever the cable is replaced.

The cable, under the shelf, is to be bound with Lassovic tape for a distance of 2 in. at a point on the cable where the centre of the binding is 10 in. from the grommet in the re-light switch housing. The last three turns of this tape are to pass round the high pressure cock Teleflex conduit and then six turns of waxed cord are to be bound round the taped cable and conduit at a distance of 2 in. from frame 11 to stop the cable moving. Finally, check that this method of strapping has resulted in a clean cable run without the possibility of a foul at the Teleflex control box mounting nuts.

REMOVAL AND ASSEMBLY

12. Once access has been obtained, the removal and assembly of the electrical equipment forming the engine starting circuit should present no unusual difficulties. The removal of the leg panel and supply panel, which carry certain engine starting components, is fully described in Group A2 of this chapter, while the location and access to all the components is indicated in Group A3.



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FIG. I. ENGINE STARTING
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