

**GROUP C.I ENGINE STARTING**

(CODE SA)

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**Equipment employed**

1. The major components employed in the engine starting circuit are listed below, together with the relevant Air Publications

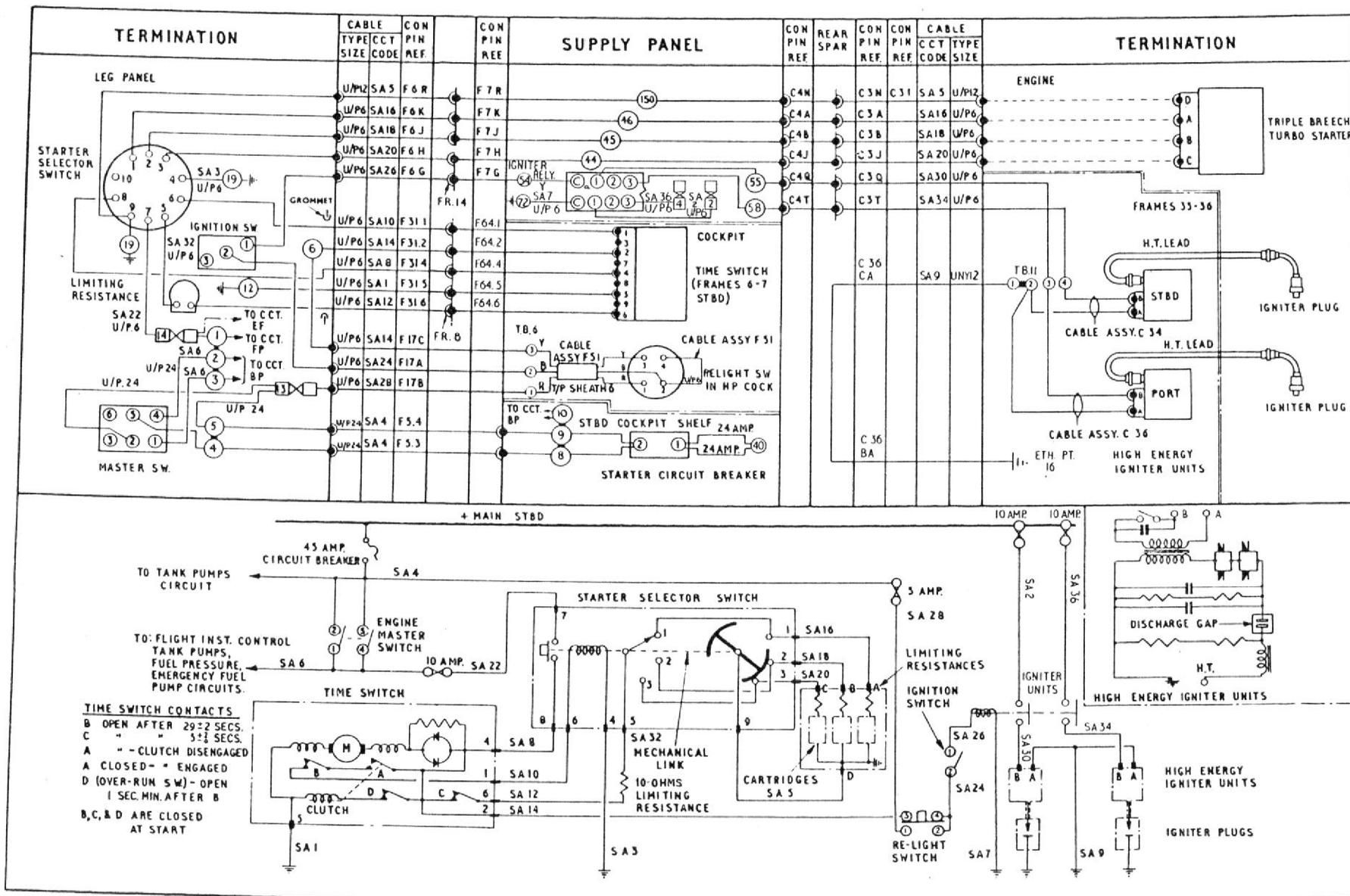
Triple breech turbo starter, Rolls Royce, Type T.B.S.720, Mk. 1 ... ..	A.P.1181, Vols. 1 and 6, Part 1, Sect. 3
Time switch, Type FHM/A/25 ... ..	} A.P.4343C, Vol. 1, Book 2, Sect. 3
Starter selector switch, Type FJB/A/5 or A/3 ... ..	
Circuit breaker, 45A, Type A6 ... ..	A.P.4343B, Vol. 1, Book 2, Sect. 10
High energy igniter units, Type C10.T.S./2 or /1 ... ..	A.P.1374G, Vol. 1, Sect. 4
Relight switch, Dowty, Type C.5162Y, Mk. 2 ... ..	} A.P.4343C, Vol. 1, Book 1, Sect. 1
Tumbler switch, S.P./ON-OFF (ignition), Type XD.779/3 ... ..	
Tumbler switch, D.P./ON-OFF (engine master), Type XD.783/3 ... ..	
Limiting resistance, 10 ohm, Type FKX/A/1 ... ..	
Relay, Type S, No. 3 (for igniters) ... ..	A.P.4343C, Vol. 1, Book 2, Sect. 3

**DESCRIPTION**

**Engine starting**

2. The engine is started through the medium of a cartridge-fired triple-breech turbo-starter mounted on the forward end of the engine and the starting cycle is automatically controlled by a time switch located between frames 6 and 7 on the starboard side of the cabin. All the engine services are protected by a 45 amp. circuit breaker located on the cabin starboard shelf and are also provided with their own fuses. The supply from the circuit breaker to the starting circuit is controlled by an engine master switch on the leg panel in the cabin. Apart from controlling the starting circuit, the 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 cycle initiated by pressing the push button of the engine starter switch, located on the leg panel.

3. The igniter plugs in the engine combustion chambers are supplied from two high energy igniter units mounted on the starboard



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Fig. I. Engine starting (routing and theoretical)

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side of the centre fuselage between frames 35 and 36. The supply to these units is controlled by relay Y, which is mounted on the supply panel in the front fuselage and energized by the ignition and relight switches in series, 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 and the igniter units are independently fused.

#### Operation

4. To understand the function of the engine starting circuit, it is necessary to trace the sequence of operations which occur when the engine is started. It should be noted that the starter circuit breaker, the engine master switch and ignition switch must be 'ON' 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 closed, but the clutch is disengaged and contacts A are open. When the engine starting switch push-button is pressed, the firing circuit to one of the three cartridges in the turbo-starter is selected by a rotary selector switch, which is mechanically inter-locked 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 closed, 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 engine. At the same time a supply is made to the time switch motor and to relay Y. The high energy igniter units are then energized, to supply the igniter plugs, by the closing of the relay's contacts. Also, the time switch motor commences to run. The time switch clutch is energized via the contacts D and, as the clutch comes into engagement, contacts A are made to supply a feed, via contacts B, to the starting 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.

6. All these operations take place simultaneously 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 starting switch hold-in solenoid. The push-button contacts open to break the supply to the time switch motor and relay Y, 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 the contacts D of the time switch are provided as an over-run safety limit switch, which comes into operation when the unit is being tested on the bench without being connected to an engine starting switch. Under this condition, should the motor be supplied inadvertently for more than 29 seconds, contacts D will open 1 second after contacts B to allow the unit to re-set and commence another cycle.

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

#### SERVICING

##### General

9. For general servicing of the electrical system, reference should be made to Group A.1. 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 in the approved manner. 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 relevant Air Publications (*listed in para. 1*), 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. *This is 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) Remove all the cartridges from the starter and then remove the local earthing wire between terminal 9 on the engine starting switch and terminal 10 on the leg panel, at terminal 9. Using a Type D testmeter (*Ref. 10S/10610*) with an 0 to 1 ohm. - 0 to 10 ohm. resistance range extension unit, check that the resistance between terminal 9 on the switch and earth does not exceed 1.0 ohms.
- (2) Using a standard bonding tester (*Ref. 5G/2126*) check that the resistance to earth of the local earthing wire removed from terminal 9 of the starting switch, does not exceed 0.025 ohms.
- (3) Still using the bonding tester, ensure that the starter body is earthed to the airframe. The resistance should not exceed 0.025 ohms.
- (4) Disconnect cable assembly C.3 from the plug on the engine and cable assembly F.64 from the time switch in the cabin.

- (5) Using the Type D testmeter, 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 Megger to ensure that it is not connected to earth.
- (6) Press the starting switch once and repeat test (5). *Repeat this operation and test four times.*
- (7) Using the Type D testmeter check that the resistance between pin 1 of the socket of cable assembly F.64 and earth is  $165 \pm 12$  ohms (*i.e. continuity resistance of push-button solenoid*).
- (8) Reconnect cable assembly F.64 to the time switch plug, cable assembly C.3

to the engine plug and the local earth wire to terminal 9 of the starting switch. Insert three cartridge test units Type STD. Sch. 17 into the starter and proceed with a functional check as follows:

- (a) Close the engine master switch and press the starter switch *once*. Note which indicator light glows in the cartridge test sets. (*Only one light to be on during any one cycle.*)
- (b) Wait 30 seconds, noting that the starting switch button is held in during this time. When the starting switch button has returned to its normal position press it again, etc.

(c) Repeat this test at least *six* times and ensure that the lamps indicate in their correct sequence.

- (9) When the tests are completed, remove the cartridge test units and move the engine master switch to the 'OFF' position.

#### REMOVAL AND ASSEMBLY

##### General

II. Once access has been obtained, the removal and assembly of the electrical equipment forming the engine starting circuit should present no difficulties. The removal of the equipment panels, which carry certain engine starting components, is fully described in Group A.2 and the location and access to all the components is indicated in Group A.3.

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