GROUP C1

ENGINE STARTING (CODE SA)

CONTENTS

Introduction

1. This group contains the description and operation, of the engine starting circuit installed in this aircraft, together with the information on servicing required to maintain the equipment in an efficient condition. Routeing and theoretical circuit diagrams are also included. For a general description of the aircraft electrical system, reference should be made to Groups A 1, A 2 and A 3 of this chapter. Detailed information on the standard items of equipment used will be found in the Air Publications listed in Table 1.

Equipment details

2. The engine is started by 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 the engine master switch mounted on the leg panel in the cabin. In addition to controlling the engine starting circuit, the engine master switch 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 a starter selector switch located on the leg panel.

3. Two high-energy ignition units, which supply 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 relight push-switch located on the leg panel and high-pressure fuel cock handle, respectively. The ignition switch is provided with a guard and is normally locked in the ON position.

Operation

4. With the engine master switch and the ignition switch both set to the ON position, the starting cycle may be initiated by pressing the push-button of the starter selector switch. Operation of the push-button rotates a pair of ganged rotary

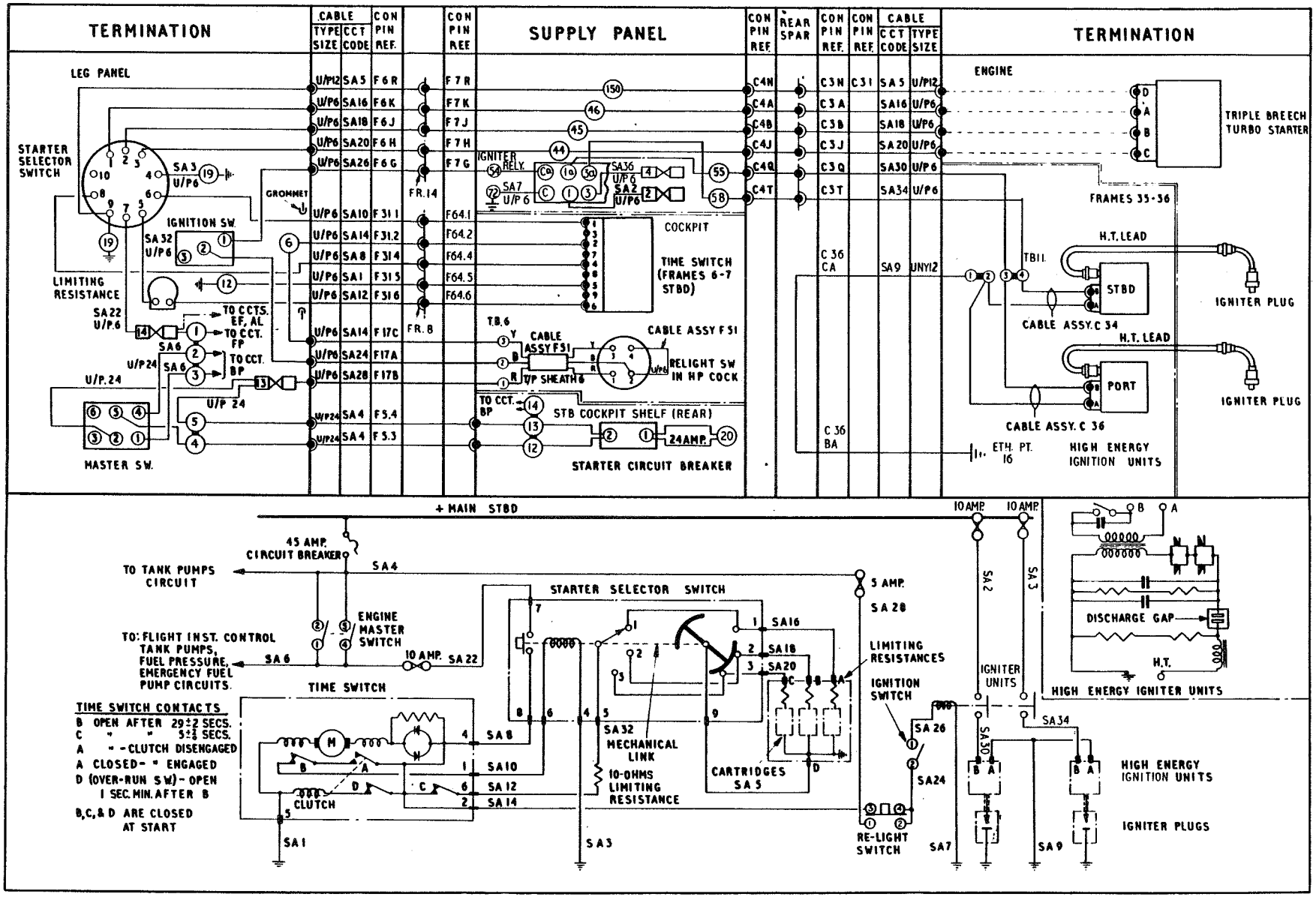
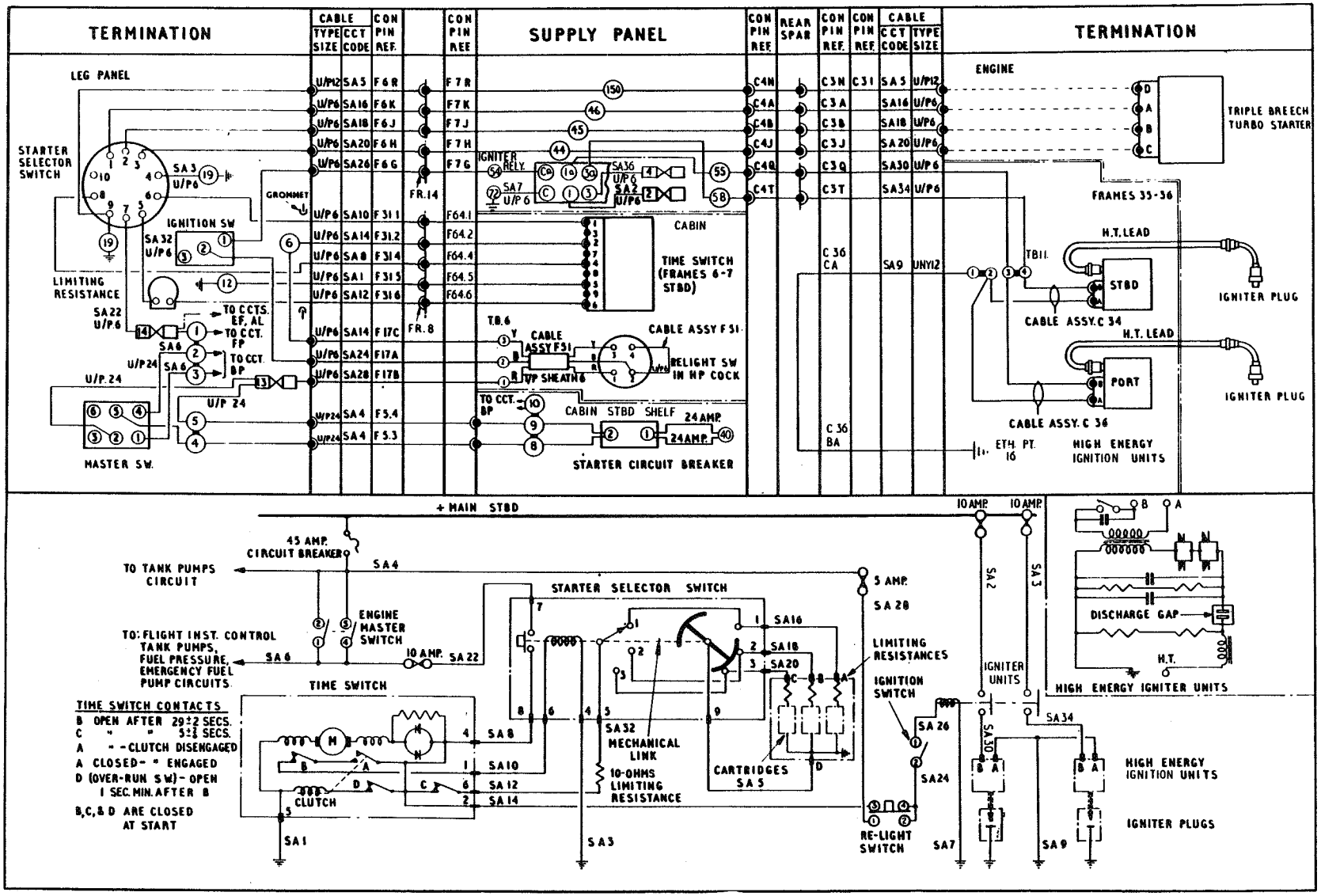


Fig.1 Engine starting (routeing and theoretical)

▶ (Mod 1429 added) ◀



▶ Fig.1A Engine starting (routeing and theoretical) – pre-Mod 1429 ◀

TABLE 1
Equipment type and Air Publication reference

Equipment	Air Publication
Triple breech turbo starter, Rolls Royce Type T.B.S.720 Mk.1	A.P.1181, Vols.1 and 6, Part 1, Sect. 3.
Relay, Type S, No.3 (for igniters)	
Starter selector switch, Type FJB/A/5 or A/3	A.P.4343C, Vol.1, Book 2, Sect.3.
Time switch, Type FHM/A/25	
Circuit breaker, Type A6. 45 amp.	A.P.4343B, Vol.1, Book 2, Sect.10.
High energy igniter units, Type C10.T.S./2 or /3	A.P.1374G, Vol.1, Sect.4.
Relight switch, Dowty Type C.5162Y, Mk.2	
Tumbler switch, S.P./ON-OFF (Ignition) Type XD779/3	A.P.4343C, Vol.1, Book 1, Sect.1
Tumbler switch, D.P./ON-OFF (Engine master) Type XD783/3	
Limiting resistance, 10 ohm. Type FKX/A/1	Not published

switches, one of which selects the cartridge to be fired, while the other shorts the remaining two cartridges to earth as a safeguard against inadvertent firing of more than one cartridge during a starting cycle. Operation of the push-button also connects a supply to terminal 4 of the time switch.

5. In the time switch, the contacts B, C and D are initially closed. When the supply is connected to terminal 4, the selected cartridge is fired via contacts C while the ignition relay is energized via terminal 2, the relight switch and the ignition switch. The ignition relay then connects a supply to the high energy ignition units. At the same time, the supply connected to terminal 4 of the time switch starts the time switch motor and, via contacts D, energizes and closes the clutch to start the time switch mechanism. The clutch, in closing, makes the contacts A and a supply is then fed via contacts B to the hold-in solenoid of the starter selector switch push-button. The hold-in solenoid keeps the push-button depressed until the starting cycle period, measured by the time switch, is completed. This ensures that only one cartridge can be fired during each starting cycle. The operation of the triple-breech turbo starter is explained in detail in the Air Publication given in Table 1.

6. The operations described 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 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 ignition 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 relight push-switch, when depressed, energizes the igniter relay independently of the normal starting circuit, and is used to energize the high-energy ignition units when it is required to relight the engine in flight.

SERVICING

General

9. For servicing information relating to the aircraft electrical system, reference should be made to Group [illegible] 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

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 19 on the leg panel, at terminal 9. Using a Type D testmeter (*Stores 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 Air Ministry bonding tester (*Stores 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 ± 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 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 retumed 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

11. 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 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.