GROUP C.1

ENGINE STARTING AND CONTROL (CODE S AND SA)

LIST OF CONTENTS

Equipment employed

1. The major components employed in the engine starting and control circuits are quoted below, together with the appropriate Air Publications to which reference should be made for a detailed description and the necessary servicing required to maintain them in an efficient condition.

Liquid fuel starter system, Plessey Type LTS.A 150 Mk.2	A.P.1181B, Vol.1, Sect.3, Chap.1 and 2.
Pump motor circuit breaker Type B.4	A.P.4343B, Vol.1, Sect.10, Chap.7.
Starter push switch Type B	A.P.4343C, Vol.1, Sect.1, Chap.3.
Engine master switch Type D.5504	A.P.4343C, Vol.1, Sect.1, Chap.28.
Ignition isolation switch Type D.5404	A.P.4343C, Vol.1, Sect.1, Chap.28.
Re-light switch Rotax Type D.5407..	A.P.4343C, Vol.1, Sect.1, Chap.28.
Main circuit breaker Type A6	A.P.4343B, Vol.1, Sect.10, Chap.6.
Main ignition units Type C.10TS/2 or C.10TS/3	A.P.1374G, Vol.1, Sect.4, Chap.2.
Ignition relay, Type S1	A.P.4343B, Vol.1, Sect.22, Chap.13
Time delay switch, Type FHM/A/24	A.P.4343C, Vol.1, Sect.3, Chap.-

DESCRIPTION

General

2. The engine is started through the medium of a liquid fuel starter mounted on the forward end of the engine and the starting cycle automatically controlled by a Mk.26 time switch unit located on the starter access door. An electrically driven blower and fuel pump Type DIV.1446 supplies the combustion chamber of the starter and is mounted vertically below and forward of this component. The blower feeds air drawn through a filter directly from the atmosphere and the pump supplies iso propyl nitrate from the starter fuel tank fitted above the pump on the port side of the fuselage. The flow of starter fuel is controlled by a Type IK.11954 solenoid valve attached to the aft face of the main spar on the starboard side. The starter Mk.8 HF 1 ignition box, mounted together with the time switch control unit on the starter access door, is energized by a Type IK.11952 pressure switch fitted to frame 26 and de- energized by another pressure switch, incorporated in the solenoid valve unit.

3. All the engine services except the main ignition, which is independently fused, are protected by a 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. The starting cycle is commenced by depressing the starter push switch, also mounted on the leg panel. Apart from controlling the engine starting circuit, the engine master switch supplies current to the fuel tank booster pumps, the fuel pressure indicator and the A.C. supplies circuit.

4. Two high energy ignition units, supplying the ignitor plugs in the engine combustion chambers, are mounted one on each side of the fuselage between frames 35 and 36. The supply to these units is controlled by a relay positioned on the supply panel. This relay is energized by the ignition switch situated above the starter push switch, via the normally closed contacts of a time delay switch mounted under the cabin port shelf.

Operation

5. To understand the function of the engine starting circuit, it is necessary to trace the sequence of operations which occur when the starter push switch is depressed. It should be noted that the starter circuit breaker, the engine master switch and the ignition isolation switch must all be closed before a start may be made. The ignition isolation switch is normally locked ON. As the theoretical diagram given in fig.1 shows, contacts B, D and F of the control unit, contacts A to B of both the high and ignition pressure switches and the contacts of the overspeed cut-out, are all made at the commencement of the starting cycle.

6. When the starter push switch is depressed, current flows through contacts B to energize the time switch motor and through contacts D to energize the relay in the combined fuel and air pump circuit breaker, thus causing the pump and blower unit to commence operation. At the same time the slug relay is energized via the high pressure and ignition switches, which are also supplied from contacts D. When the time switch clutch engages, contacts A are made and maintain the circuit supply independently of the starter push switch, making it unnecessary to depress this switch for longer than about 1/8 seconds to commence the starting cycle. Air from the blower enters the combustion chamber to scavanage any fumes from a previous start and to provide clean air for combustion, while fuel from the pump is returned to its tank via the two way solenoid valve. The slug relay closes its contacts after it has been energized for 1/8 seconds, thus energizing the overspeed relay, via contacts F and the overspeed cut-out. The making of the overspeed relay contacts,

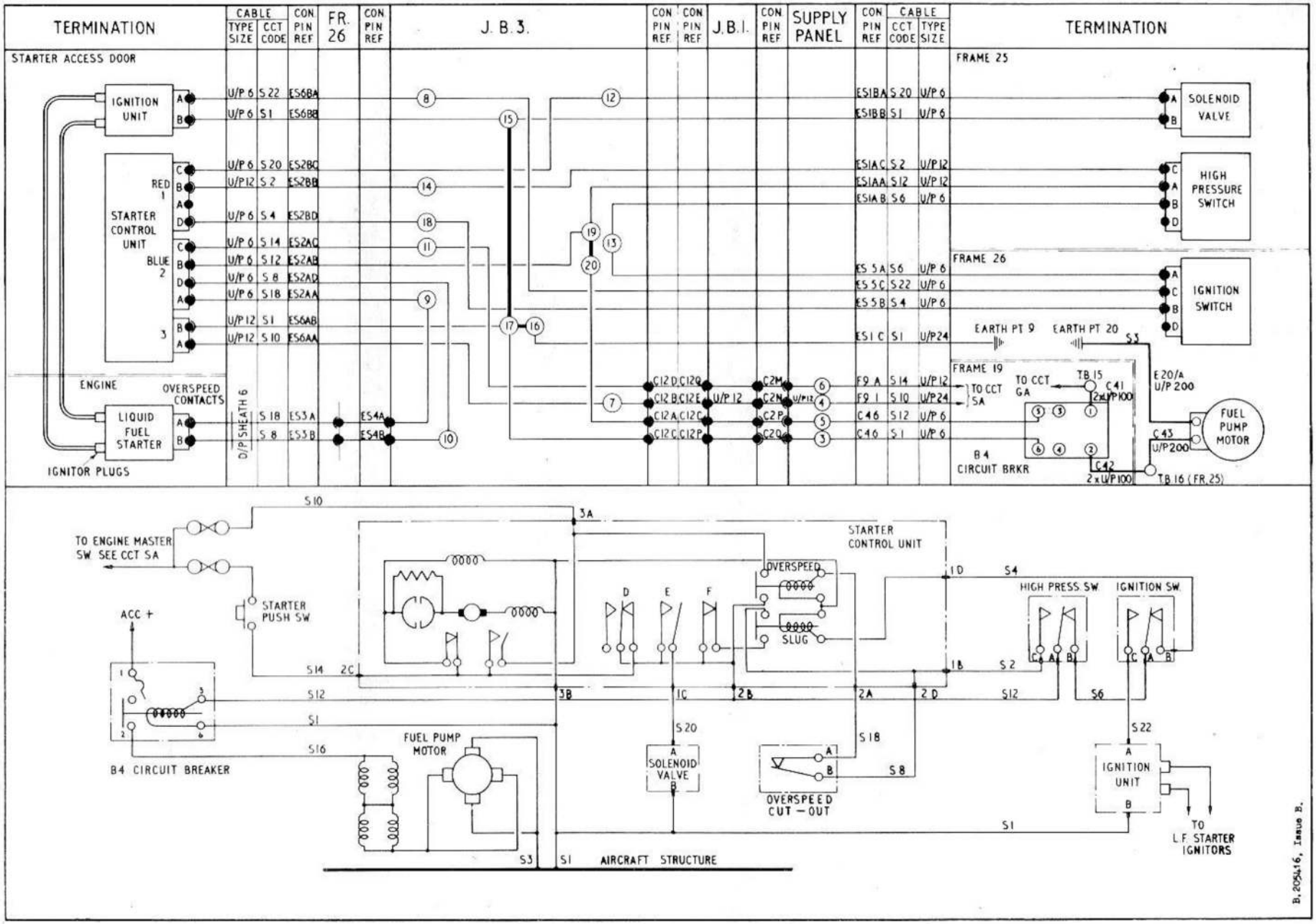

FIG. 1 ENGINE STARTING

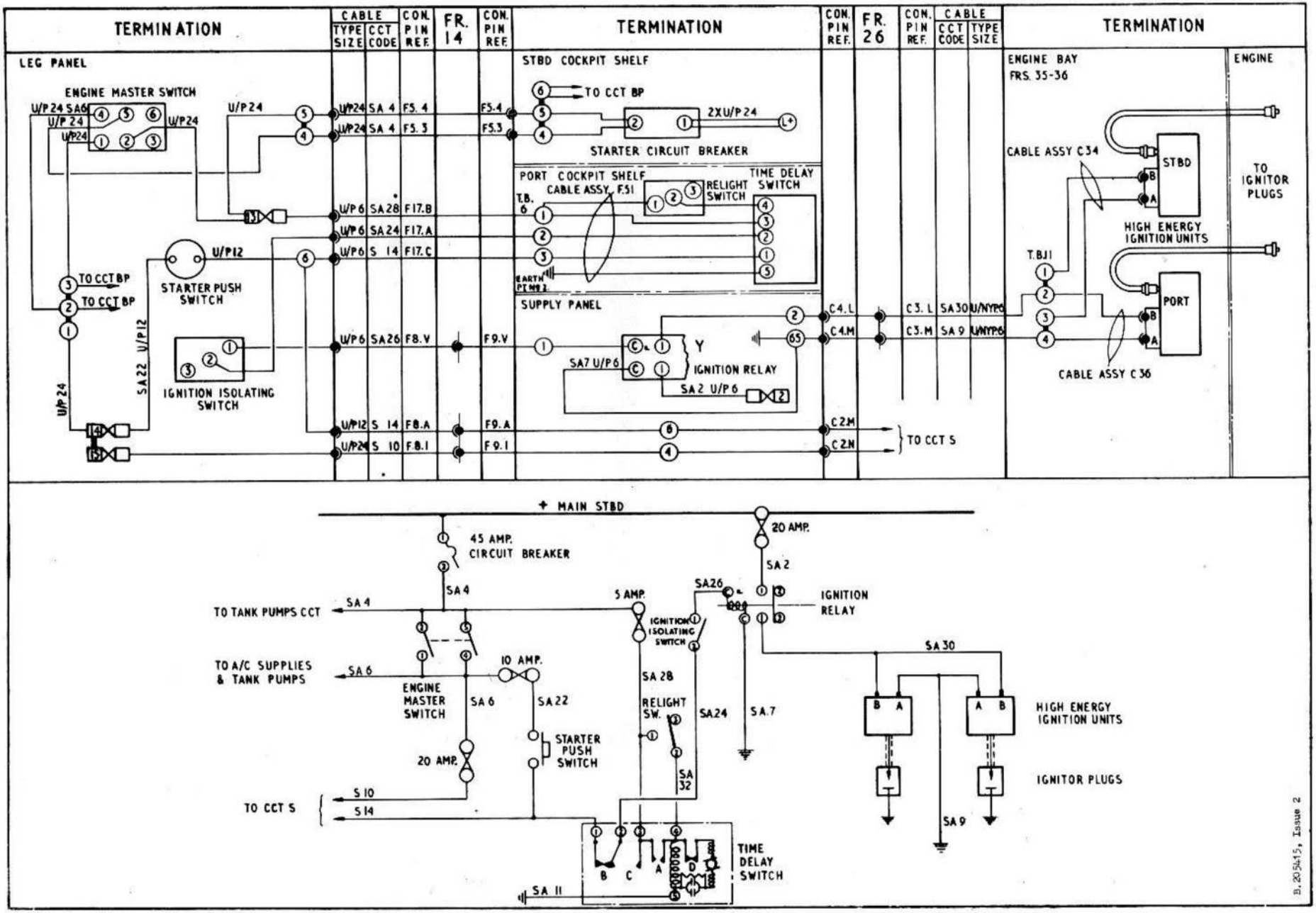

FIG. 2 ENGINE STARTER CONTROL

duplicates the supply to the pump motor circuit breaker, via contacts F, and to the slug relay, via the high pressure and ignition switches.

7. After $1\frac{3}{4}$ seconds, contacts D open, thus the supply to pump motor circuit breaker and the slug relay solenoid is no longer duplicated. When the air scavenge is complete one second later, contacts E make to energize the solenoid valve. This valve operates, transferring the flow of fuel to the starter combustion chamber, which it enters through atomizers and mixes with the air. The pressure created in the fuel line by the flow through the atomizers is made to operate the ignition pressure switch. The function of this two way switch is to break the supply to the coil of the slug relay and to energize, through its contacts A to C, the starter ignition unit, which in turn causes the ignition plugs in the combustion chamber to spark and ignite the mixture thus turning the starter. The increase of pressure in the fuel line which the combustion causes operates the two way high pressure switch. This stops the operation of the ignition unit by isolating the supply. Contacts A to C, of the switch, then supply the relay in the pump motor circuit breaker, which has been maintained in the energized state by the delay in the opening of the slug relay's contacts.

8. The overspeed cut-out, which operates from a governor in the starter, will open when the engine reaches idling speed. This is normally $5\frac{1}{4}$ seconds, after ignition in the starter, the engine having been lit during this period by plugs supplied from two high energy ignition units. These units are supplied from a relay which is energized throughout the starting cycle, via the normally closed contacts B of the time delay switch, by the starter push switch followed by contacts A. When the overspeed cut-out operates, the overspeed relay is de-energized and the control unit contacts return to their pre-start positions. The overspeed relay opens thus de-energizing the relay in the pump motor circuit breaker. The pump then ceases operation, releasing the pressure in the fuel line. When this occurs, both the pressure switches return to their pre-start position. After completion of the starting cycle which is normally 8 seconds from the time the starter push switch is depressed, the starter disengages from the engine, and as it slows down the overspeed cut-out returns to its closed position.

9. The re-light switch, when made, energizes the time delay switch, which after approximately 1 second, brakes contact B and makes contacts C to supply the ignition relay independently of the normal starting circuit. It is used to energize the high energy ignitor units when it is required to relight the engine in flight. Contacts C of the delay switch remain made for approximately 30 seconds after which they open and contacts B make again, to return the circuit to its normal condition.

False starts

10. If the engine reaches idling speed without igniting, the overspeed cut-out will operate as in the case of a successful start. In all other instances of false starts the time switch motor will run for 18 secs. and no further attempt to start the engine may be made until this period has elapsed. In the event of a start being attempted without any fuel in the starter tank, neither of the pressure switches will operate and contacts F will stop the pump motor when they open after $3\frac{1}{4}$ secs. If the system is operated with fuel, but the mixture fails to ignite, the high pressure switch will not operate and the pump motor will stop when the contacts of the slug relay open after just under 3 seconds from the start of the cycle. In the case of the mixture igniting initially but not maintaining combustion, the high pressure switch will operate but return to its pre-start position almost immediately and the pump motor will stop as in the previous case.

SERVICING

General

11. For general servicing of the electrical system as a whole, reference should be made to Group A 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 in the approved manner. The brushes of the motors should be examined to ensure that they are in good condition. Apart from the standard bench testing and servicing of the components described in the appropriate Air Publications quoted in Para.1 of this Group, no further servicing should be necessary.

Testing high energy igniter units

11A. The high energy units, Type C.10TS/2 employed in this circuit are to be checked as follows to ensure that they are suitable for this aircraft. All the tests are to be carried out with suitable H.T. cables and discharge plugs fitted. Care must be taken not to touch the H.T. connections of the units or plugs when the units are operating, and an operated unit must be discharged before handling, or otherwise a lethal shock can be received:-

(1) Connect a 24^{-0}_{+1} volt d.c. supply to the units input connection, observing the correct polarity and check:-

(a) That the input current measured on a d.c. moving coil instrument does not exceed 2.5 amps.

(b) That the plug discharges at not less than 60 times per minute.

(2) Connect as in operation (1), but with a 21^{-0}_{+1} volt d.c. supply and check that the time for 10 discharges at plug does not exceed 12 seconds. This test must not exceed 3 minutes.

(3) Connect as in operation (1), but with a 16^{-0}_{+1} d.c. supply and check that the input current does not exceed 4 amps. Any units which take more than 4 amps. are unsuitable for this aircraft.

NOTE...

The above checks must be made by tapping down the battery and NOT by means of a dropping resistor.

REMOVAL AND ASSEMBLY

General

12. Once access has been obtained, the removal and assembly of the equipment forming the engine starting and control circuits should present no unusual difficulties. The location and access to all the equipment employed is fully described in Group A of this chapter.