Chapter 3A

ENGINE STARTING AND PROPELLER FEATHERING

LIST OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

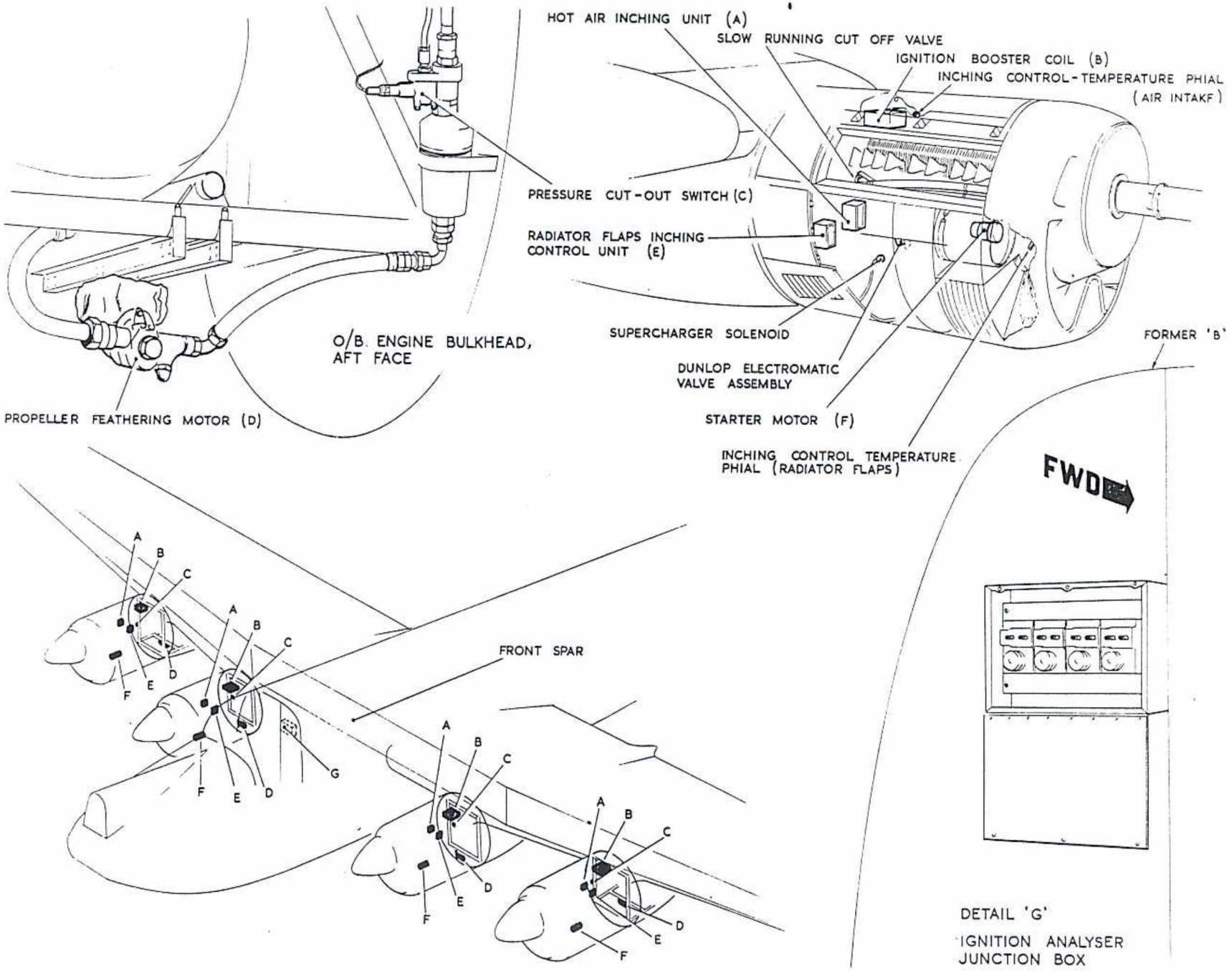


Fig. 1 Location of equipment

Introduction

1. This chapter contains the descriptive and servicing information for the electrical controls of the engine services and systems. These systems include:-

(1) Engine starting

(2) Propeller feathering

(3) Ignition system

(4) Slow running cut-off

(5) Oil dilution

(6) Supercharger

(7) Radiator flaps

(8) Charge temperature control

(9) Air cleaner

Theoretical circuit diagrams for the engine circuits described in this chapter will be found adjacent to the text concerned. Location illustrations are also included.

◀2. With this Amendment the changes for both Pre. and Post Mod.1426 conditions are included. ▶

DESCRIPTION AND OPERATION

General

3. The power plant circuits are wired on the common negative principle and all such circuits are connected to the negative bus-bars in their associated harness. Connection from the bus-bars to the aircraft structure is made, via the negative pole of the engine starter heavy duty bulkhead connector block to the appropriate earth point on the main plane front spar.

4. A description of the power plant harness, location of the electrical components forward of the engine bulkhead and a wiring diagram of the power plant electrical system will be found in A.P. ◀102B-0357-1 and 102B-0358-1. ▶

5. Engine electrical instrument services such as temperature gauges, fuel flow-meters and other services where the instrument tradesman is responsible for their operation and servicing will be found in Book 3, Sect.7 of this publication.

ENGINE STARTING AND PROPELLER FEATHERING

Master relays

6. Two heavy duty relays, Type LDA. 400-FORM B3, located on the main power panel in the cabin, control the heavy duty supply circuits to the engine starting and propeller feathering relays. Acting as master relays they are brought into operation by closing the master switch fitted on the engineer's main panel. One relay (No.259) controls the starboard starting and feathering circuits. No.260 relay controls the port.

Starter relays

7. Four heavy duty relays, Type LDA. 400-FORM B4, control the heavy duty supply to the starter motors via the master relays. Each relay is energised when the appropriate engine starting switch, on the engineer's main panel is operated. The relays are No.261 for the No.1 engine, No.262 for the No.2 engine, No.263 for the No.3 engine and No.264 for the No.4 engine (fig.2 and 3).

Feathering relays

8. Four heavy duty relays, Type LDA. 200-FORM B4, control the supply to the feathering pump motors via the master relays. Each relay is energised from its appropriate feathering switch on the pilots' instrument panel. The relays are No.265 for the No.1 pump unit, No.266 for the No.2 pump unit, No.267 for the No.3 pump unit and No.268 for the No.4 pump unit. It should be noted that the master relays described in para.6 can also be energised by operation of the feathering switches without the master switch being closed, i.e., No.1 or No.2 feathering switches will energise relay No.260, No.3 or 4 feathering switches will energise relay No.259.

CIRCUIT OPERATION

Engine starting

9. Only the starting circuit for the No.1 engine is described, the remaining engine circuits being similar (fig.4). With the master switch operated, 28-volt, d.c. from fuse PP9 will energize relay No.260 via the normally closed relay contacts 260/1. The heavy duty contacts 260/2 close to connect the starboard bus-bar to terminal 2 of relay contacts 261/2. Contacts 260/1 open to insert the additional resistance of relay coil No.260 into its energizing circuit. Relay 260 is also used for Viper engine starting (Chap.3Q).

10. Operation of the No.1 engine starting switch to START will feed the 28-volt d.c. supply from fuse PP9 (via the master switch) to energize relay No.261, via the normally closed relay contacts 261/1. Relay contacts 261/2 close to connect the starboard bus-bar to the No.1 starter motor. Contacts 261/1 open to insert the additional resistance of relay coil 261 into its energizing circuit. Descriptive and servicing information for the starter motors, Rotax Type C.3304, will be found in A.P.4343D, Vol.1, Sect.1.

Propeller feathering

11. In the event of engine failure in

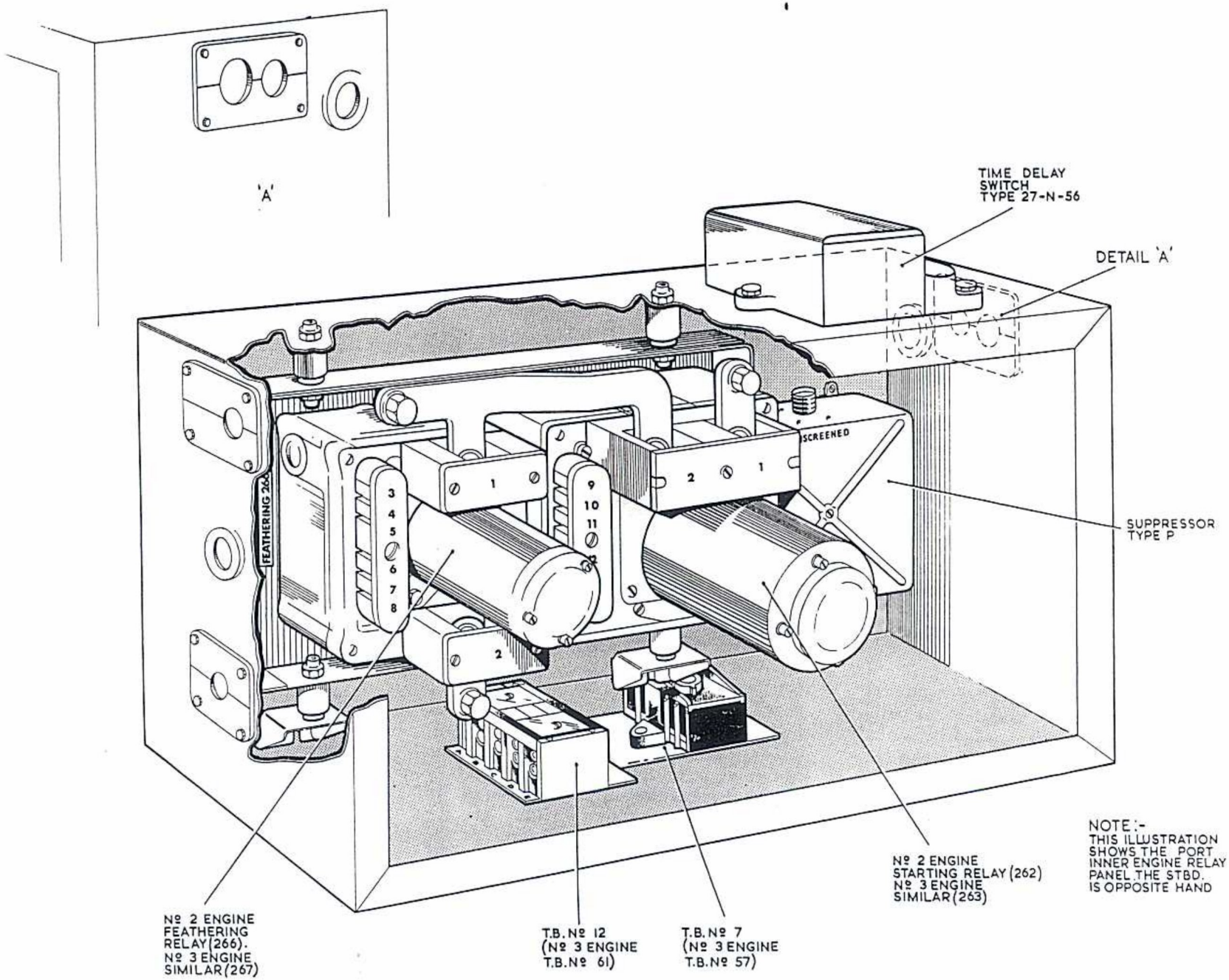


Fig. 2 Inboard engine relay panel

flight, its associated propeller will be feathered, or the propeller may be feathered on the ground during engine checks. The motors which operate the feathering pumps are controlled in a similar manner to the engine starter motors in that the heavy duty circuits to the feathering relays are fed through the master relays. The circuits are completed by pressing the appropriate push-switches on the pilots' instrument panel. This action will close:-

(1) The circuit of the feathering switch solenoid which will retain the push-button in the depressed or 'on' position.

(2) The appropriate master relay coil circuit.

(3) The coil circuit of the feathering relay concerned (No.265, 266, 267 or 268).

It should be appreciated, however, that for normal feathering operation the necessary preliminaries given in the Pilots' Notes have to be observed before closing the feathering switch.

12. When a propeller reaches the fully feathered position, a pressure cut-out switch, fitted in the high pressure line between the feathering pump and the constant speed unit, will open the feathering push-switch solenoid circuit. The push-button will then be returned to the 'off' position by spring pressure, the relays will be de-energised and the pump motor will stop running. As the oil pressure in the feathering lines falls, the pressure switch will revert to its normally closed position. A description of the feathering push-switch will be found in A.P.4343C, Vol.1. The pressure cut-out switch is described in A.P.1275A, Vol.1.

13. The sequence of circuit operations for unfeathering a stationary engine in flight is the same as that given for feathering except that the feathering push-button will be released when the engine has started and attained minimum r.p.m. A full description of the propeller and its controls is contained in A.P.1538K, Vol.1. The feathering pumps motors, Rotax Type C2801, are described in A.P.4343D, Vol.1, Book 4, Sect.20.

Master relays (Post Mod.1195)

13A. The revised routing chart (fig.8A) for the Griffon engine starting and propeller feathering services shows that the pull-in circuits for the master relays, 259 and 260 have been altered. Although the relays can now be energised when starting the Viper engines, the function of the Griffon starting and feathering services is not changed.

IGNITION CONTROLS

14. The ignition circuit is completely independent of the aircraft electrical supply except for the booster coil circuit on starting. The ignition ON-OFF switches are installed on the pilot's canopy panel. For information on the magnetoes, Rotax Type NT.12D/1, reference should be made to A.P.1374C, Vol.1, Sect.7. The wiring circuit is shown on the relevant routing chart.

Ignition booster coils

15. Each power plant is equipped with a low tension booster coil and suppressor to form a combined unit. The booster coils provide current for the low tension circuits of the appropriate magneto when starting the engines. They are energised by operating the boost switches to BOOST COIL. The booster coils, Rotax Type NB14, are described in A.P.1374E, Vol.1, Sect.2.

SLOW RUNNING CUT-OFF

16. Four electrically operated slow running cut-off valves are installed, one on each engine supercharger intake elbow. The valves are controlled from the combined S.R.C.O. and oil dilution switches fitted on the engineer's main panel. When the switches are moved to the S.R.C.O. position the solenoids are energised and the fuel cut-off valves move from the 'running' to the 'cut-off' position, thus cutting off the fuel supply to the engines. Post Mod.1426, the S.R.C.O. and boost switches are one unit and the oil dilution switches are separate. Descriptive information in respect of this type of valve will be found in A.P.4303C, Vol.1, Sect.5.

OIL DILUTION VALVES

17. Four electrically operated oil dilution valves, Type FAW/A/330, are installed, one on the port side of each engine. Each valve solenoid is controlled from the combined S.R.C.O. and oil dilution switches mentioned in para.16 (Pre.Mod.1426). Post Mod.1426 the oil dilution switches are separate. A master switch controls the 28 volt d.c. supply to the oil dilution valves. A description of the solenoid valve will be found in A.P.4343E, Vol.1, Book 1, Sect.1.

SUPERCHARGER CONTROLS

18. The gear change from M.S. (low gear) to F.S. (high gear) on the two-speed supercharger is accomplished by the action of a heavy duty solenoid unit, one fitted to each engine. These units are controlled by relays in the main power panel trough. The supercharger switch is mechanically linked to the water-methanol control switch (Chap.3B). Indication that the superchargers are in the F.S. position is shown by four magnetic indicators fitted to the engineer'a main panel.

19. When the control switch is placed

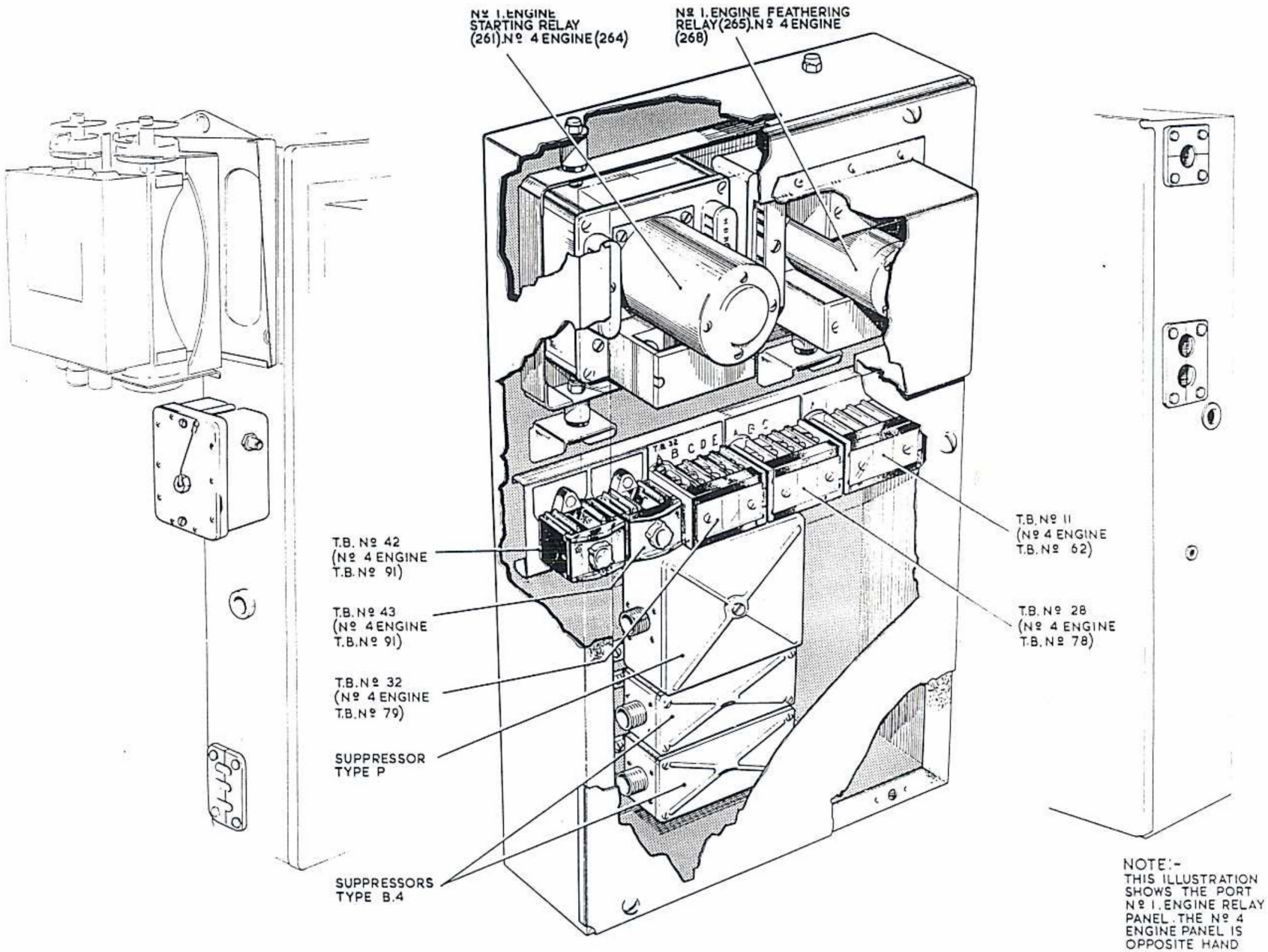
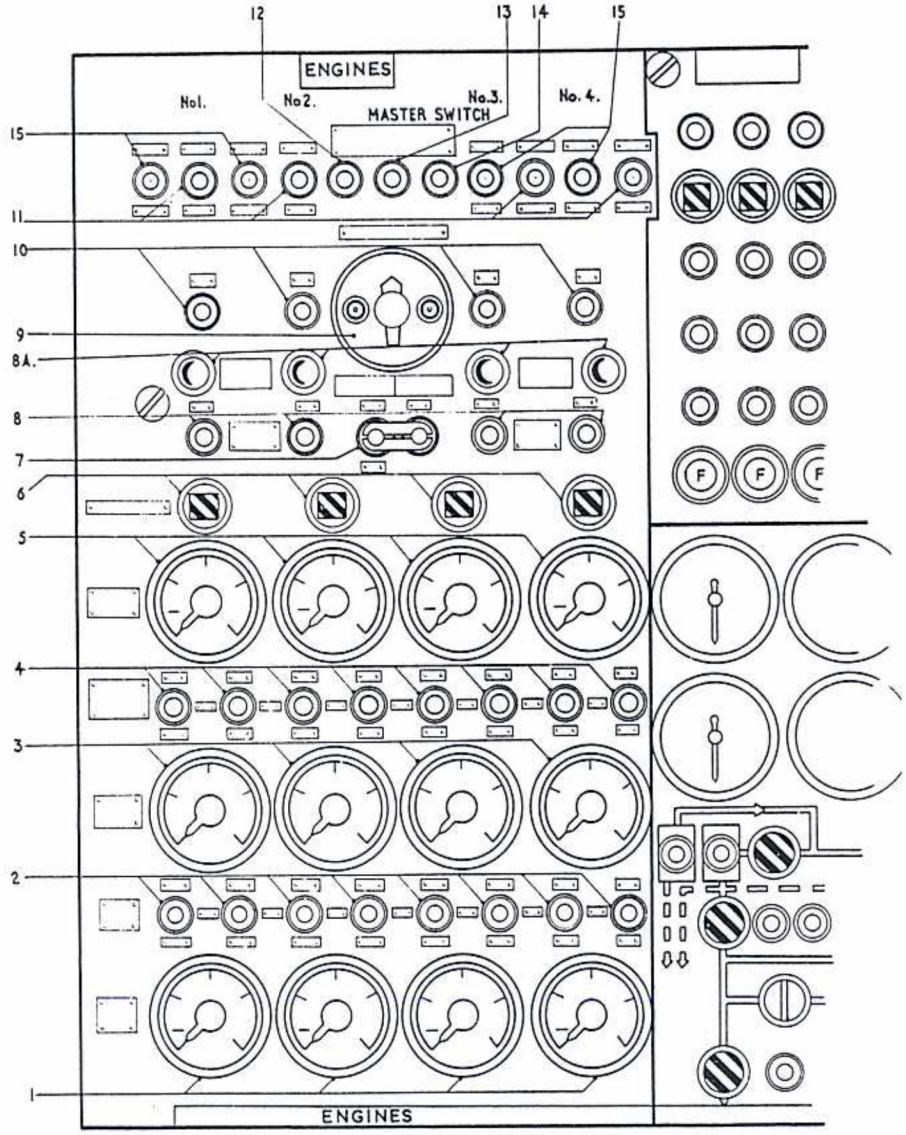


Fig. 3 Outboard engine relay panel



KEY

1. OIL TEMPERATURE INDICATORS
2. RADIATOR FLAP CONTROL SWITCHES
3. RADIATOR TEMPERATURE INDICATORS
4. CHARGE TEMPERATURE CONTROL SWITCHES
5. CHARGE TEMPERATURE INDICATORS
6. SUPERCHARGER INDICATORS
7. SUPERCHARGER/WATER METHANOL LINKED CONTROL SWITCHES
8. WATER METHANOL TEST SWITCH
8A. CRANKCASE PRESSURE INDICATORS (POST MOD. 1461)
9. ENGINE PRIMING CONTROL SWITCH
10. OIL DILUTION / SLOW RUNNING CUT-OFF CONTROL SWITCHES
11. STARTING SWITCHES
12. AIR CLEANER CONTROL SWITCH
13. OIL DILUTION MASTER CONTROL SWITCH
14. STARTING MASTER CONTROL SWITCH
15. BOOST SWITCHES

Fig. 3A Controls at engineer's station

◂ *Mod 1461 incorporated* ▸

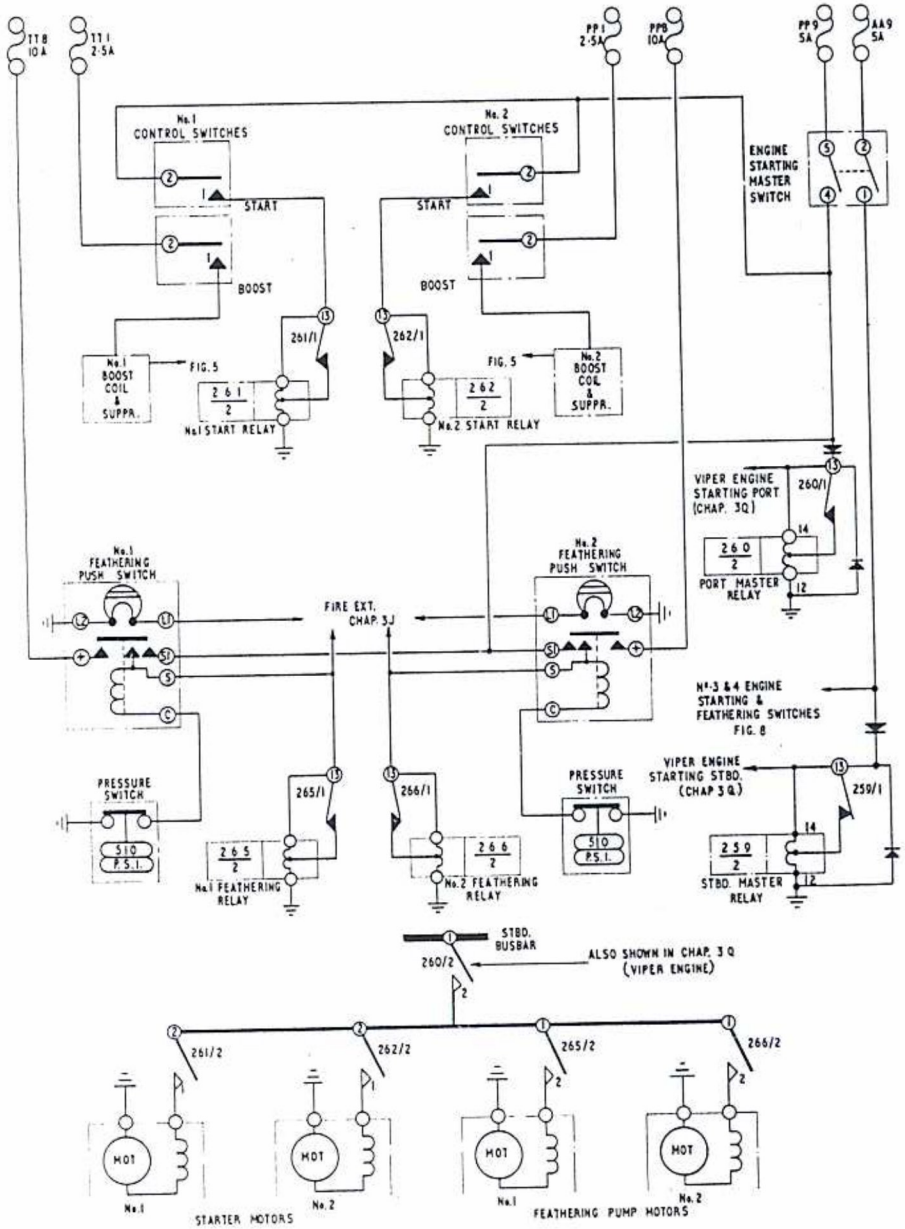


Fig.4 Engine starting and propeller feathering

to HIGH, the relays will close, and the supercharger solenoids will be energised. This operation will actuate a hydraulic change-over valve in each case and the superchargers will change from M.S. to to F.S. When the switch is placed to LOW the solenoids will be de-energised and the change-over valves will return to the M.S. position. Details of the action of the hydraulic change-over valve will be found in A.P.2243E, Vol.1, Sect.4.

20. Each supercharger solenoid contains 'pull - in' and 'retaining' coils, which are centre-tapped to earth via two normally closed primary contacts within the solenoid. These normally closed contacts short circuit the retaining coil thus providing for the initial 'pull' necessary for quick operation. As soon as the solenoid is energised the movement of the plunger opens the primary contacts and the retaining coil comes into circuit. At the same time, a second pair of contacts within the solenoid close the circuit to the associated indicator on the engineer's main panel.

ENGINE ELECTRO-PNEUMATIC CONTROLS

21. Operation of the radiator flaps, hot air intake flaps and air cleaner shutters is effected by pneumatic rams, the movement of which is controlled by electrically-operated valves. These valves are contained in a Dunlop electromatic valve assembly, one of which is installed on each engine mounting frame. Each assembly provides five pneumatic outlets, two to the radiator flap ram (open and close), two to the hot air flaps ram (open and close) and one to the air cleaner ram.

Radiator temperature control

22. Automatic and manual controlled

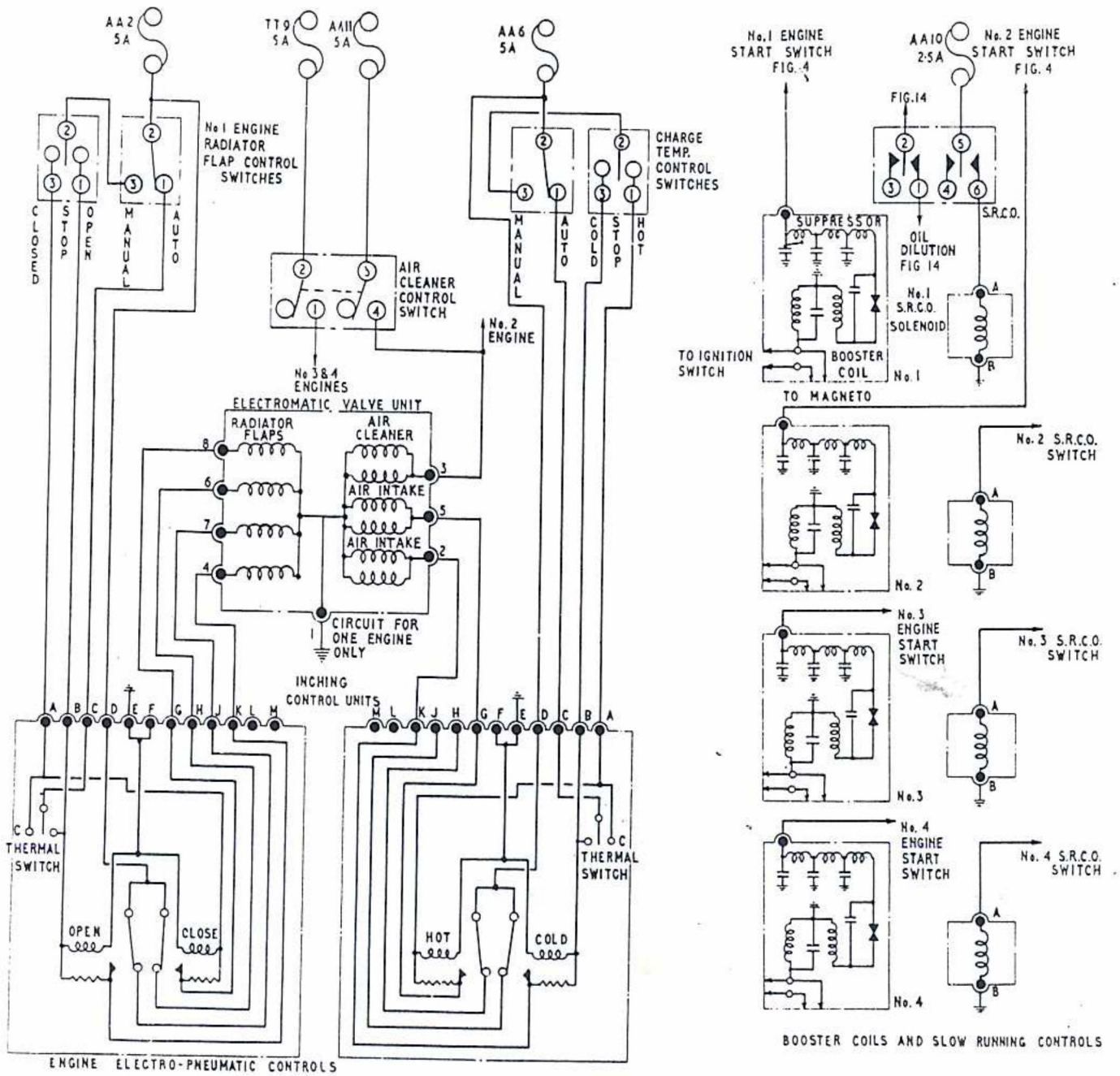


Fig. 5. Engine control circuits

'HOT' and 'COLD' positions at control switch reversed

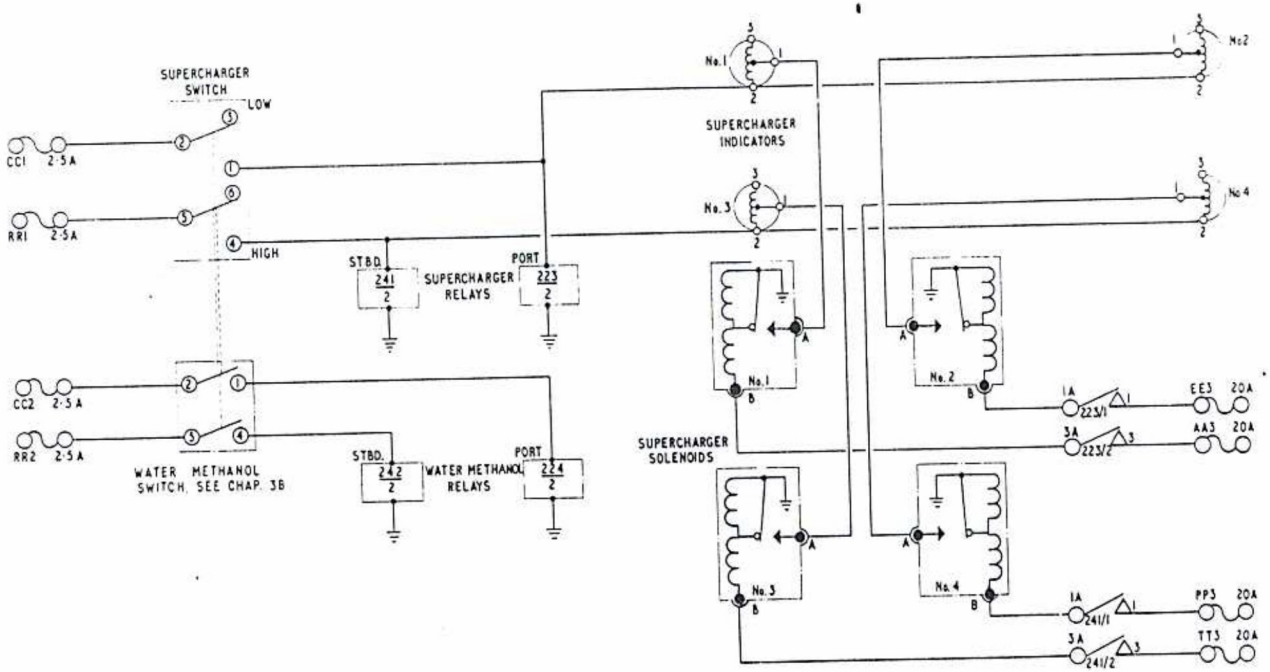


Fig.6 Supercharger circuit

switching is provided for the radiator and hot air intake flaps, selection of the appropriate valve solenoids being made via relays incorporated within the associated inching control units fitted in the vicinity of the electromatic valve units. Manual control only is provided for the valve solenoids of the air cleaner shutter rams. Descriptive and functioning details of these systems will be found in A.P.4275A, Vol.1, Sect.3. A description of the electromatic valve assembly, Type AC.1031, is given in A.P.4304B, Vol.1, Sect.5. The inching control units, FDF/A series, are dealt with in A.P.1275A, Vol.1, Sect.11.

23. The bottom row of eight switches on the engineer's main panel control the selection of the automatic or manual circuits. Four switches are labelled AUTO-MAN. and the remaining four switches are labelled OPEN-STOP-CLOSE. When the four AUTO-MAN. switches are placed to AUTO, the position of the flaps is controlled automatically by the action of a 2-position switch in each inching control unit. Movement of the switch is effected by bellows which are linked by a capillary to a temperature-sensitive phial in the starboard outlet pipe from the coolant header tank. The 2-position switch completes the coil circuits of the 'open' or 'close' relays in the inching control unit according to the temperature of the radiator coolant. The relay concerned will then select the appropriate valve solenoid in the electromatic valve assembly. The temperature range of the inching control unit, Type FDF/A/1490 is 100-125 deg.C with a differential of 3 to 4·5 deg.

24. When the AUTO-MAN. switches are set to MAN. and the four OPEN-STOP-CLOSE switches are operated to the OPEN or CLOSE position the automatic switching is by-passed, direct connection being made to the 'open' or 'close' relay control in the inching control unit. The flaps can be stopped and retained in any position. In the event of an electrical failure, both sides of the pneumatic ram will be open to atmosphere. If such a failure should occur during flight, the flaps will trail so that an adequate airflow will be maintained through the radiator and overheating of the engine avoided.

Charge temperature control

25. Engine charge temperature control is effected by two small flaps in the side of the air intake duct which admit hot air from behind the radiator. The pneumatic rams which actuate these flaps are controlled automatically during flight by their associated inching control units, Type FDF/A/2180, one at the starboard side of each mounting frame. The temperature range of this type of control unit is 41 to 51 deg.C with a differential of 1°75 to 2°5 deg. Movement of the 2-position switch in the control unit is determined by the capillary action transmitted by a temperature sensitive phial or bulb in the engine induction manifold.

26. Apart from a slight difference in the connections to the valve solenoids in the electromatic valve assembly, circuit operation is similar to that for the radiator flaps. The eight control switches on the engineer's main panel under the charge temperature indicators control the automatic and manual circuits. Four switches are labelled AUTO-MAN, and the remaining four switches HOT-STOP-COLD.

27. In the event of an electrical failure the hot air flaps will remain in the position in which they were at the time of failure.

Air cleaner control

28. The admission of clean filtered air to each engine is achieved by the action of a pneumatic ram. Movement of the ram is controlled by an electrically operated valve in the electromatic valve assembly at the starboard side of the engine mounting frame. When filtered air is required the valve solenoid is energized by placing the air cleaner switch, at the top of the engineer's main panel, to CLEAN. The valve will then open the pneumatic line to the ram and the normal air duct will be closed by a sealing flap. Filtered air will then be drawn through the air cleaner elements and the air shutters at the aft end of the air intake duct.

29. When the air cleaner switch is returned to the OFF position, the valve solenoid will be de-energized, the pneumatic line will be closed, and the sealing flap returned to the open position by the spring return action of the ram. No pneumatic control is provided. In the event of an electrical failure, the sealing flap will return to the normal open position. Mechanically linked to the sealing flap is a sand extractor flap. The linkage is so arranged that this flap is in the open position when the sealing flap is closed and vice-versa.

SERVICING

ENGINE STARTING AND PROPELLER FEATHERING

General

30. Servicing of the engine feathering and engine starting motors is restricted, whilst installed on the aircraft, to a routine inspection of brush gear and commutator. Carbon or copper deposits should be removed by means of dry compressed air. Terminal connections should be checked to ensure that they are tight and the insulation caps should be a secure fit. The relays should be examined for pitting of contacts and security of connections. The motors should be removed and bench tested in accordance with the instructions in the Servicing Schedule.

Master relays

31. In view of the major dual function of the master relays, the necessity for regular checks to ensure security of connections and contact assembly cannot be over-emphasised.

Engine starting

32. To prove continuity, and to test the operation of the relay in each starter circuit, disconnect each starter motor at the fireproof bulkhead connector block and connect a 24-volt low wattage test lamp across each pair of starter leads. Operate each starter switch to START and the lamp connected across the selected engine starter leads should light. Remove the test lamps and re-connect the starter motor leads.

Feathering motors

33. These circuits can be tested in a similar manner to that outlined for the engine starting. Disconnect each feathering motor and connect a 24-volt low wattage test lamp across each pair of leads. Operate the feathering push-switches, ensure that they are held in the closed position by their integral solenoids, check that the test lamps light. Remove the pressure cut-out switch plugs and note that the feathering push-switches are automatically returned to the 'off' position. Remove the test lamps and re-connect the feathering motors and pressure cut-out switches.

IGNITION

34. The ignition cables from the magneto switches on the pilot's canopy panel to each engine bulkhead should be examined at regular intervals for security of

connections. Particular attention should be paid to the junction boxes situated at the wireless operator's station, to ensure that they are free from moisture and that the cable gland nuts are tight.

35. Provision is made at the signaller's station for connecting an ignition analyser into the ignition circuits. The analyser is used during ground running of the engines to diagnose engine performance faults. The signal reference and full details for operating and setting up the ignition analyser will be found in A.P. 4343S, Vol.1, Sect.21.

Booster coils

36. Care should be taken when testing booster coils while they are installed on the aircraft. Periodical checks only are necessary and reference should be made to A.P.1374E, Vol.1, Sect.2, before any adjustments are attempted.

SLOW RUNNING CUT-OFF

37. No servicing is necessary for this unit other than a periodical check for security of connections at the solenoid unit. A functional test can be carried out by closing in turn the control switches on the engineer's main panel, when operation of the selected valve will be audible at the engine concerned.

SUPERCHARGER CONTROLS

38. Before attempting to test the electrically operated gearchange valves on the engines, the water-methanol pump main fuses CC2 and RR2 must be removed as the supercharger and water-methanol switches are mechanically linked. The test may then proceed as follows:-

(1) Place the supercharger switch on the engineer's main panel to HIGH (F.S.) and ensure that each engine solenoid is energised.

(2) Check that the four magnetic indicators on each side of the control switches show HIGH.

(3) Return the control switch to LOW (M.S.), the indicators should show LOW and the solenoids should now be de-energised.

(4) At the conclusion of the test, refit fuses CC2 and RR2.

ENGINE ELECTRO-PNEUMATIC CONTROLS

39. The Dunlop electromatic valve assembly used for the operation of the radiator flaps, charge temperature control flap and air cleaner shutters is serviced by the engine fitter trades, but the electrical plug and socket connections should be checked for security and cleanliness.

Radiator flaps control

40. The operation of the radiator flaps can be verified when the aircraft is on the ground with the engines stopped as follows:-

(1) Ensure that the pressure in the penumatic system exceeds 160 p.s.i.

(2) Place each control switch in turn to the OPEN and CLOSE positions and note that the flaps move to the selected position. The AUTO-MAN. switches must be in the MAN. position.

(3) With the flaps in the mid-open position, place the AUTO-MAN. switches to AUTO., if the engine is hot, the flaps will automatically open. If the engine is cold, the flaps will close.

Thermostatic inching control

41. For servicing purposes this control unit, Type FDF/A/1490, is regarded as a sealed unit and only Standard Serviceability Tests are permitted. These tests are contained in A.P.112G–1129–1. Operational checks on the function of the thermal switches in the control unit can be carried out during test flights by observation of the associated thermometer indicator on the engineer's main panel.

Charge temperature control

42. The operation of the hot air flap valve can be checked by a procedure similar to that given for the radiator flaps (para.40). The inching control units for this installation are Type FDF/A/2180. For further information reference should be made to A.P.112G–1129–1.

Air cleaner

43. With the penumatic system charged above 160 p.s.i., ensure that the air cleaner rams on all engines operate when the control switch on the engineer's main panel is placed to CLEAN.

REMOVAL AND INSTALLATION

General

44. Instructions for the removal of all the electrical components located on the engine are provided in the power plant publication A.P.102B–0357–1 and 102B–0358–1.

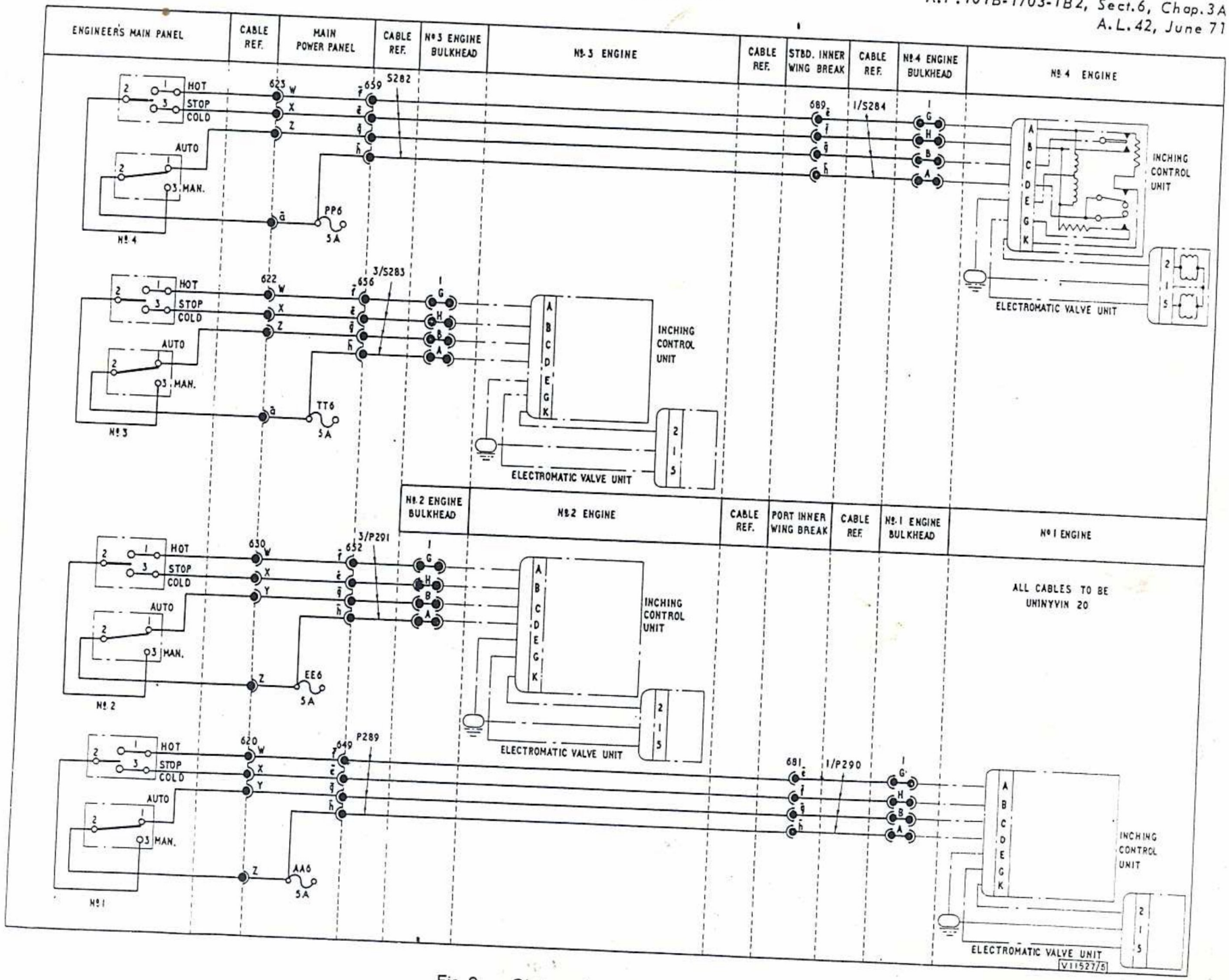


Fig. 9. Charge temperature control

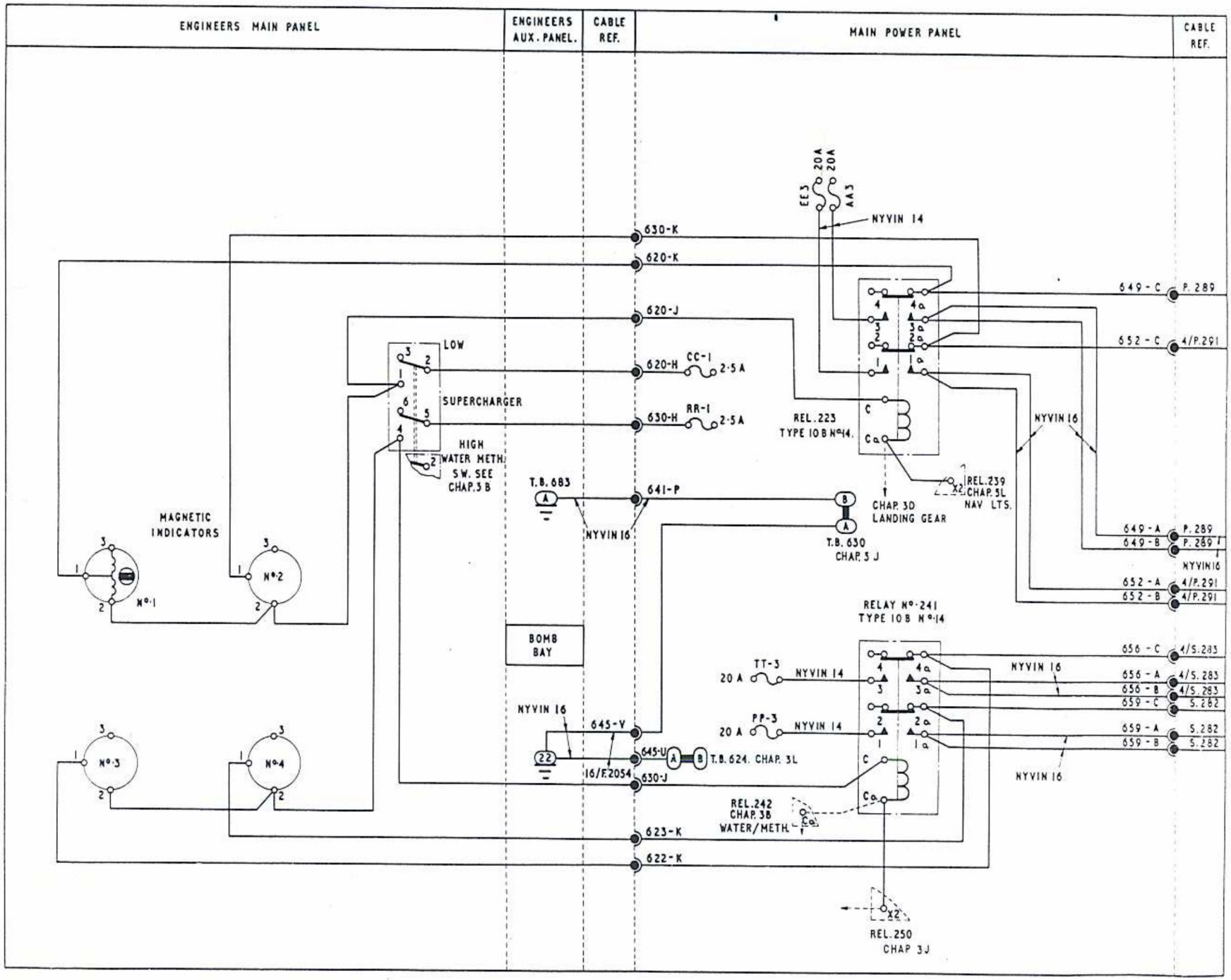


Fig. 10 (1) Supercharger

‹Nav. lights and landing gear chapter identified›

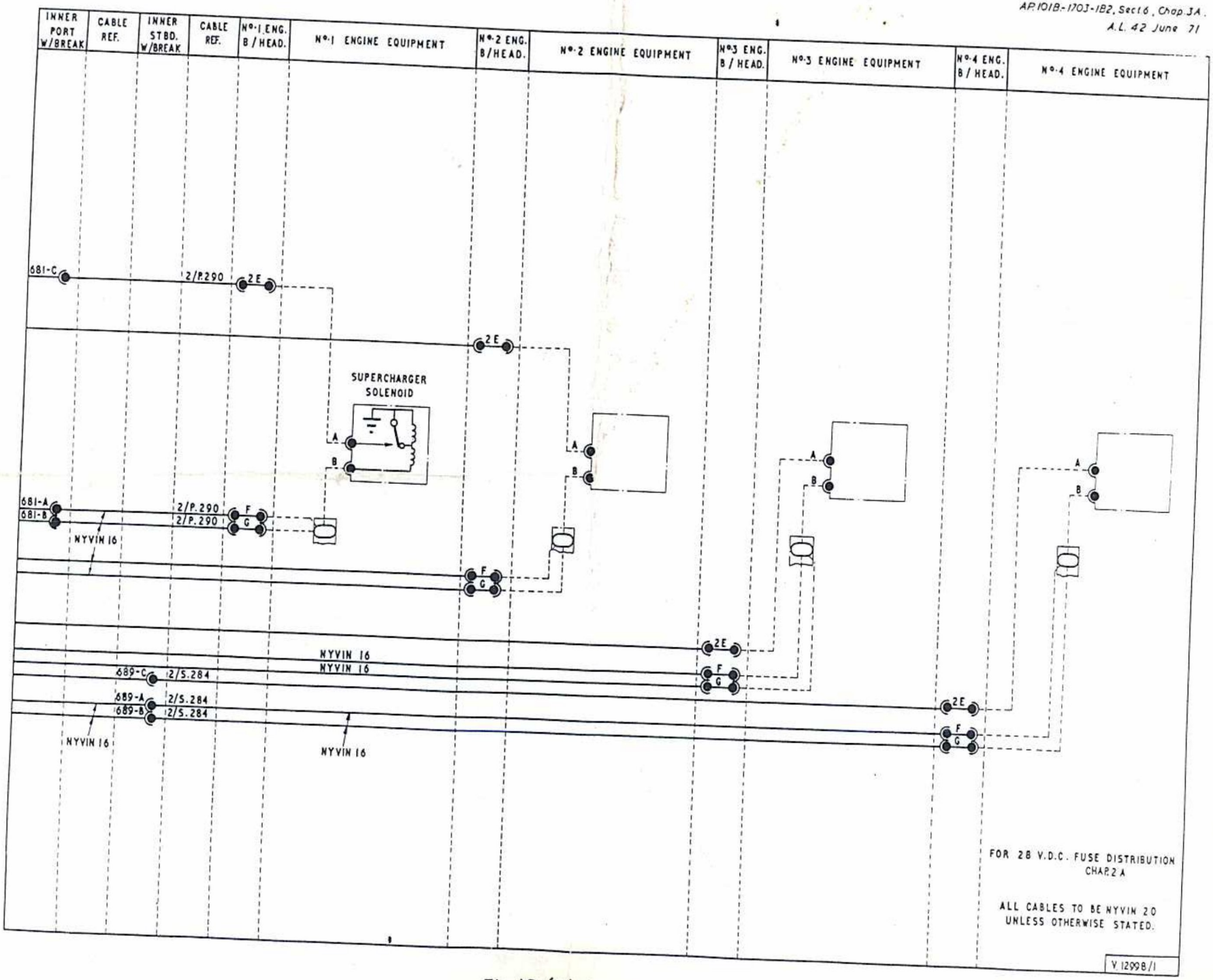


Fig. 10 (2) Supercharger

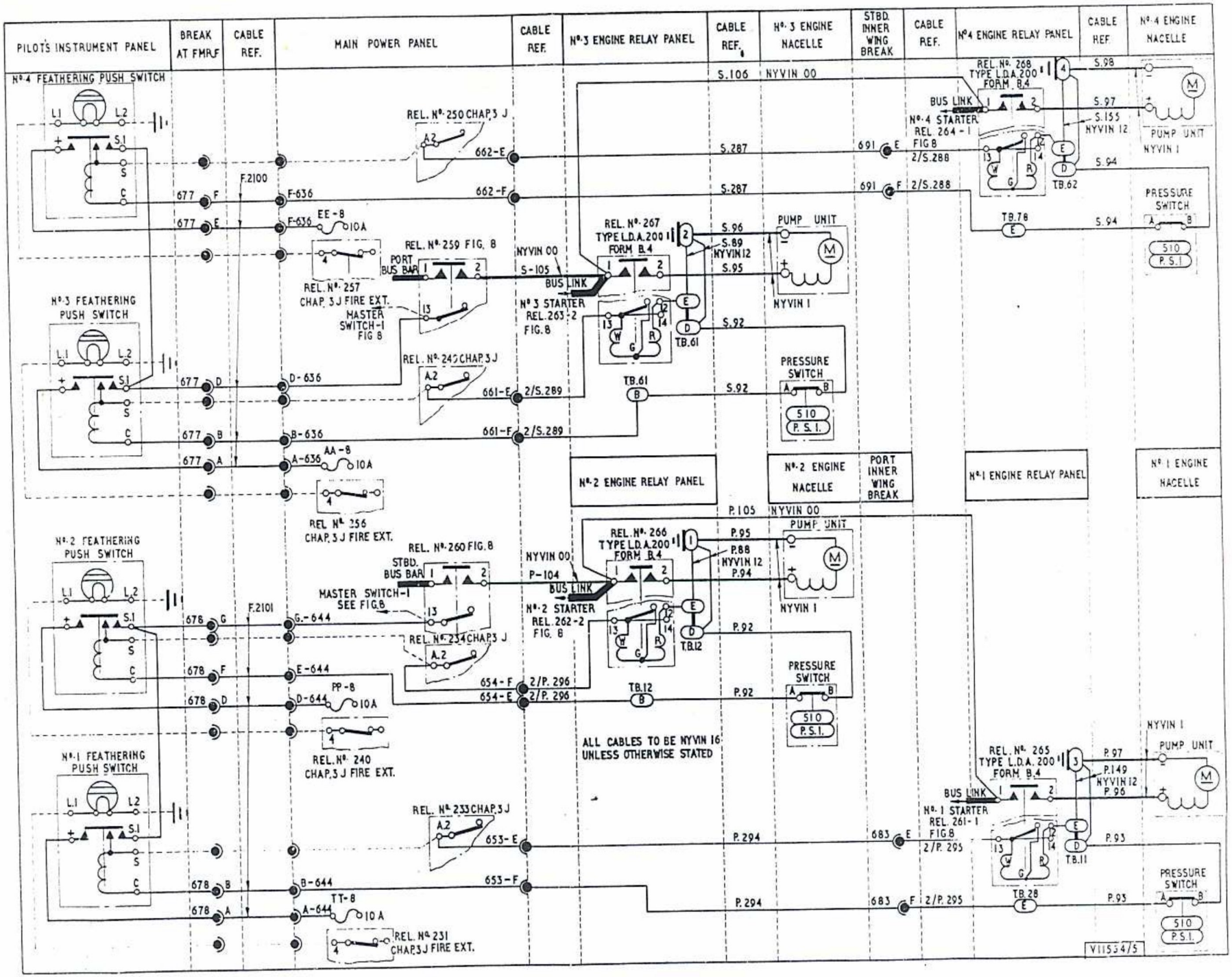


Fig. 11. Propeller feathering

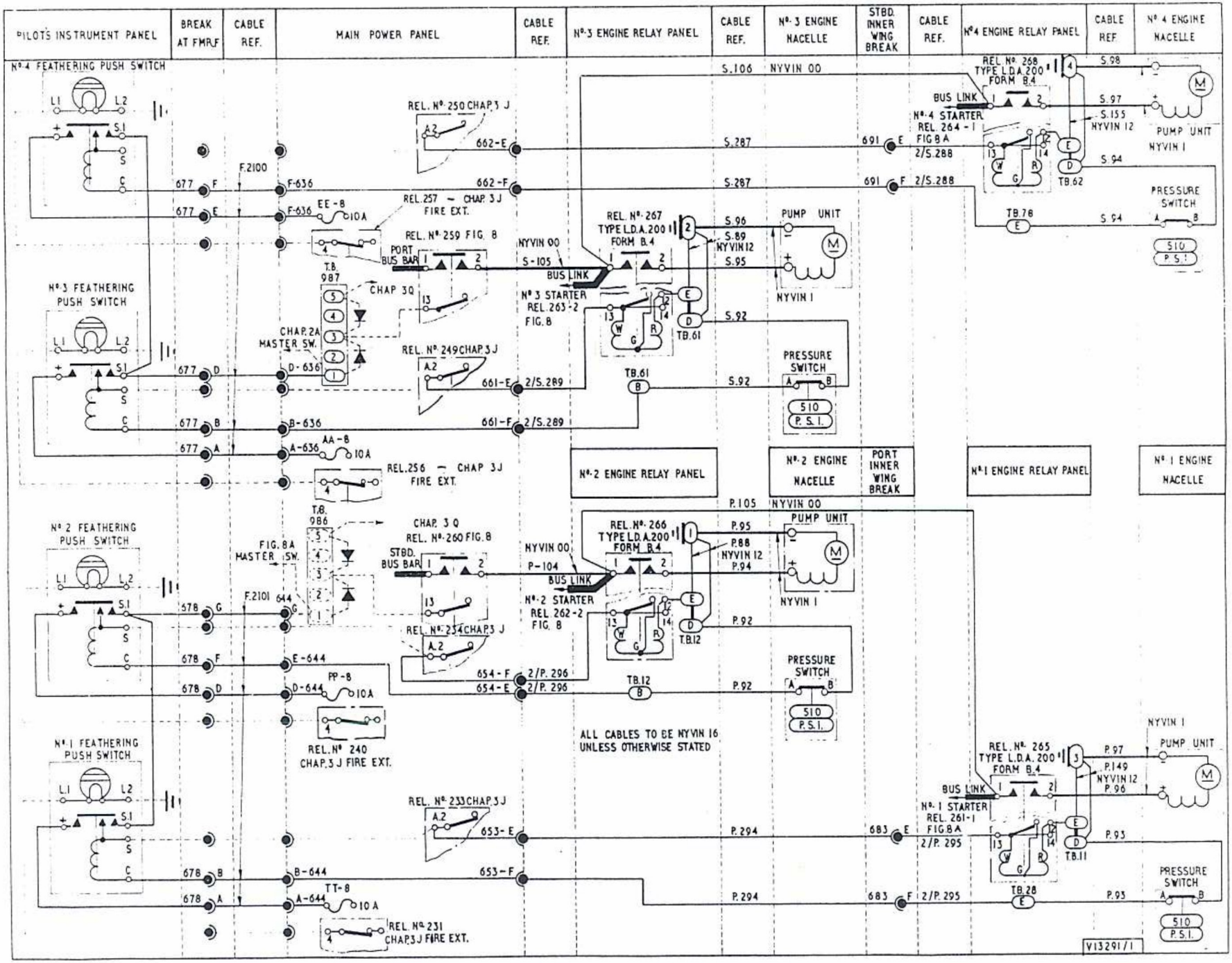


Fig. 11A. Propeller feathering (Mod. 1195)

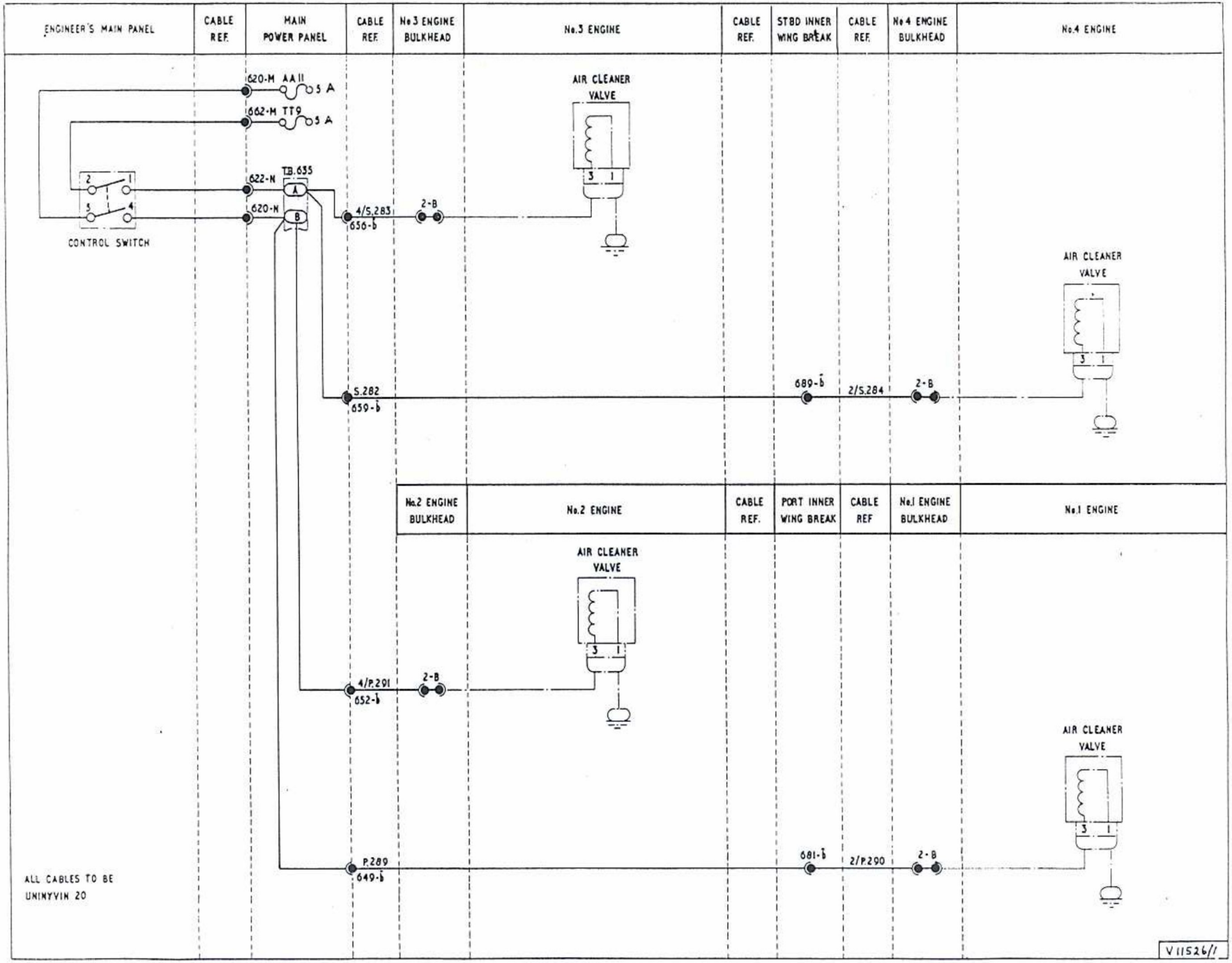


Fig. 12 Air cleaner

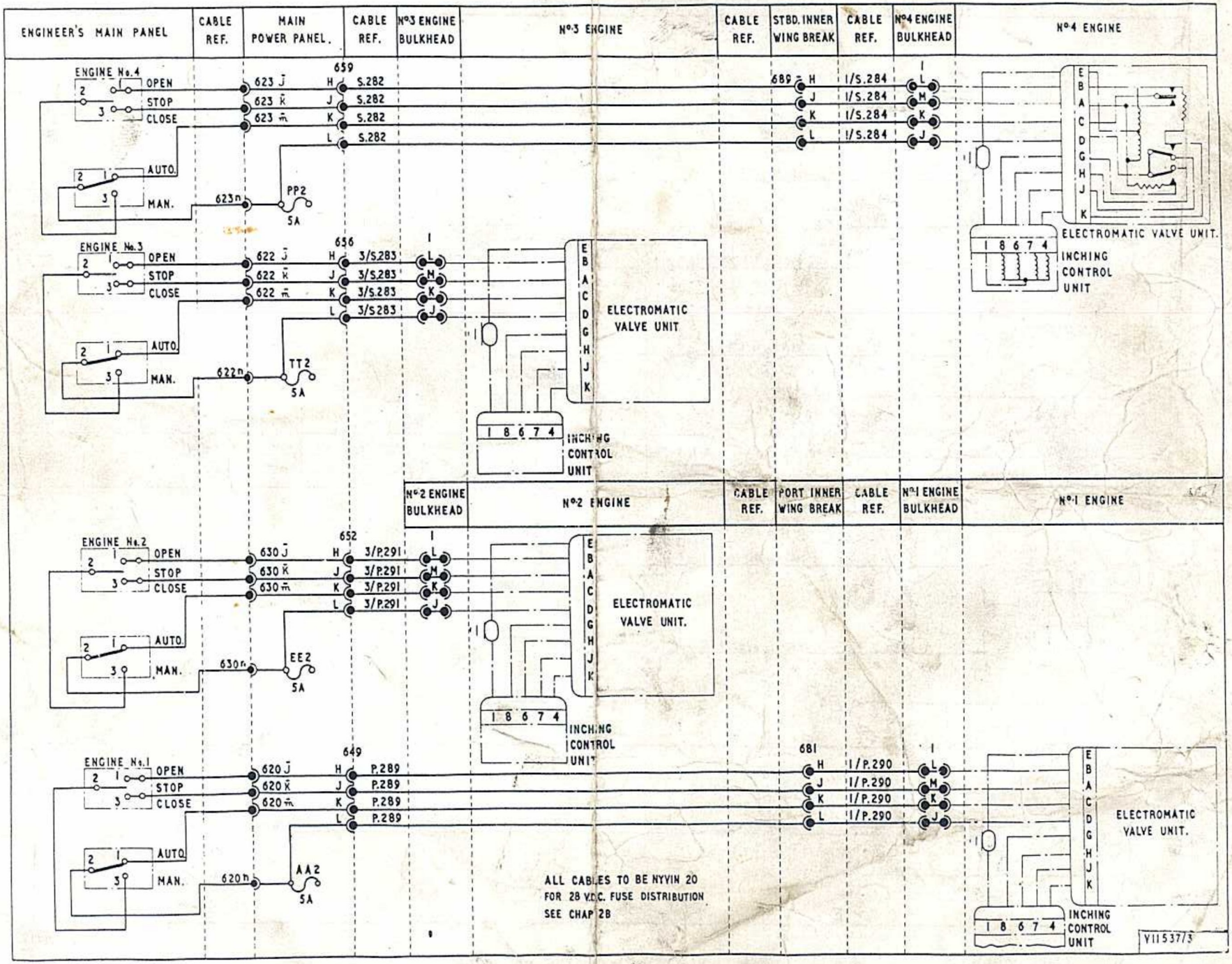


Fig. 13 Radiator flap control

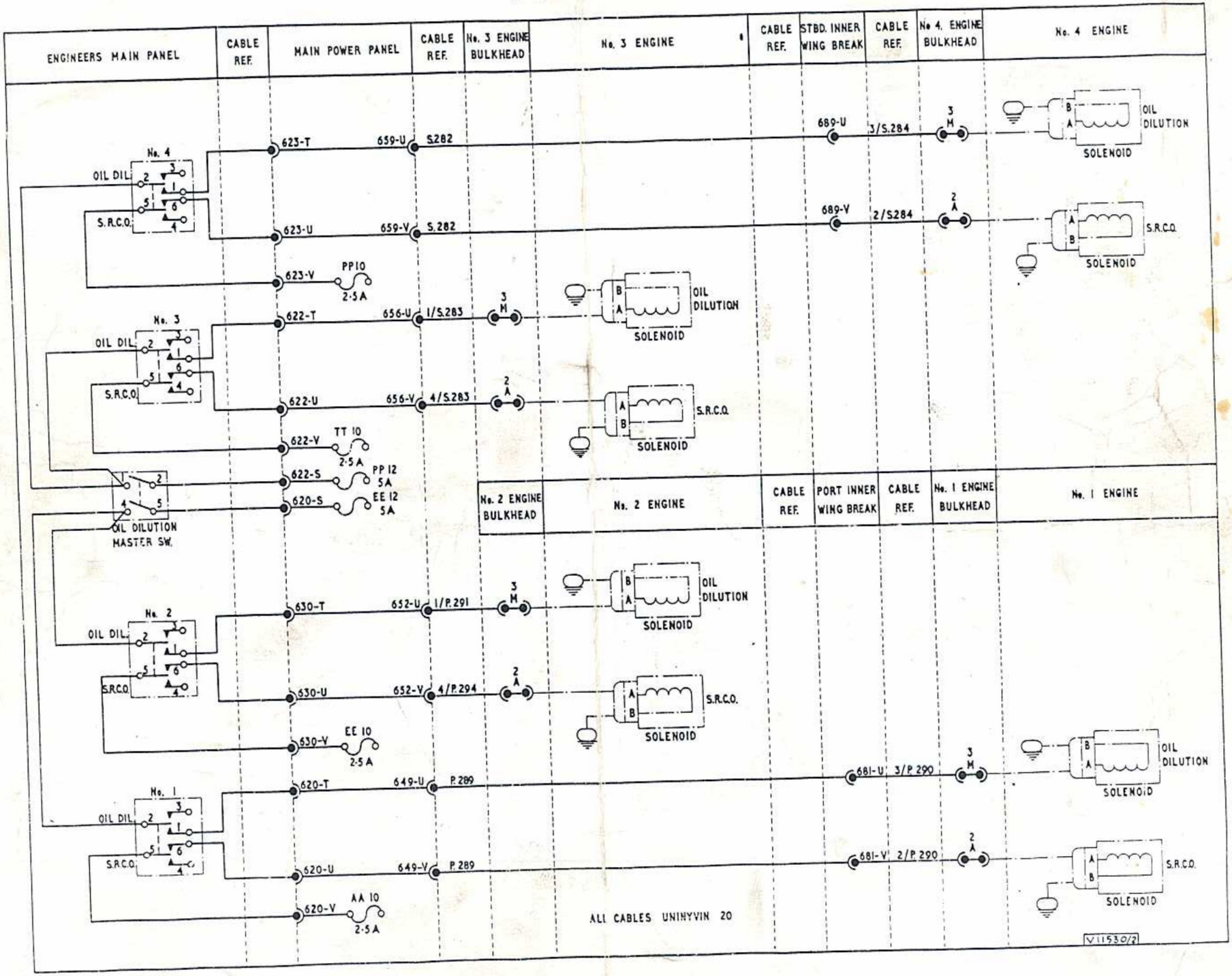


Fig. 14. Slow running cut-off and oil dilution (Pre. Mod. 1426)

Pre. Mod. 1426 added to title

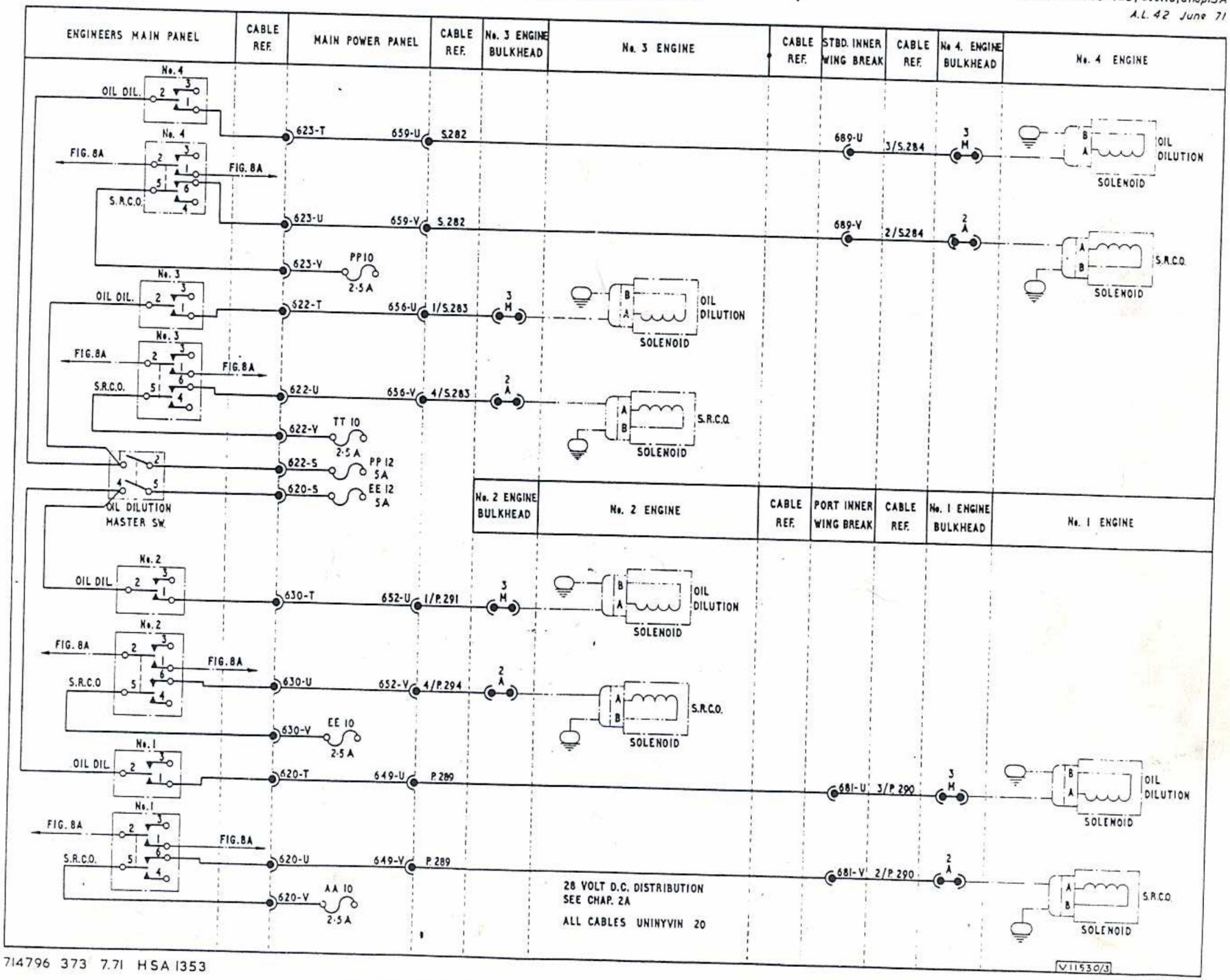


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Fig. 15. Slow running cut-off and oil dilution (Post Mod. 1426)