Group 5 FUEL SYSTEM CONTROLS (PRE MOD.38 AND 274)

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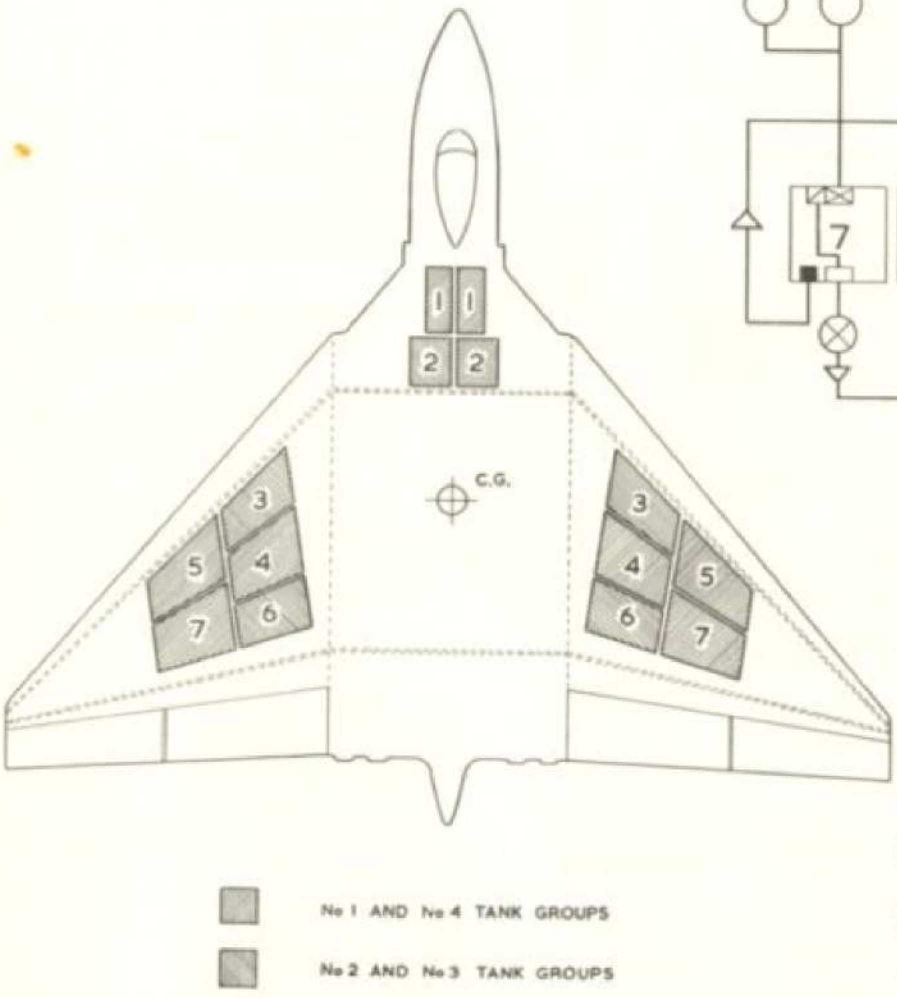
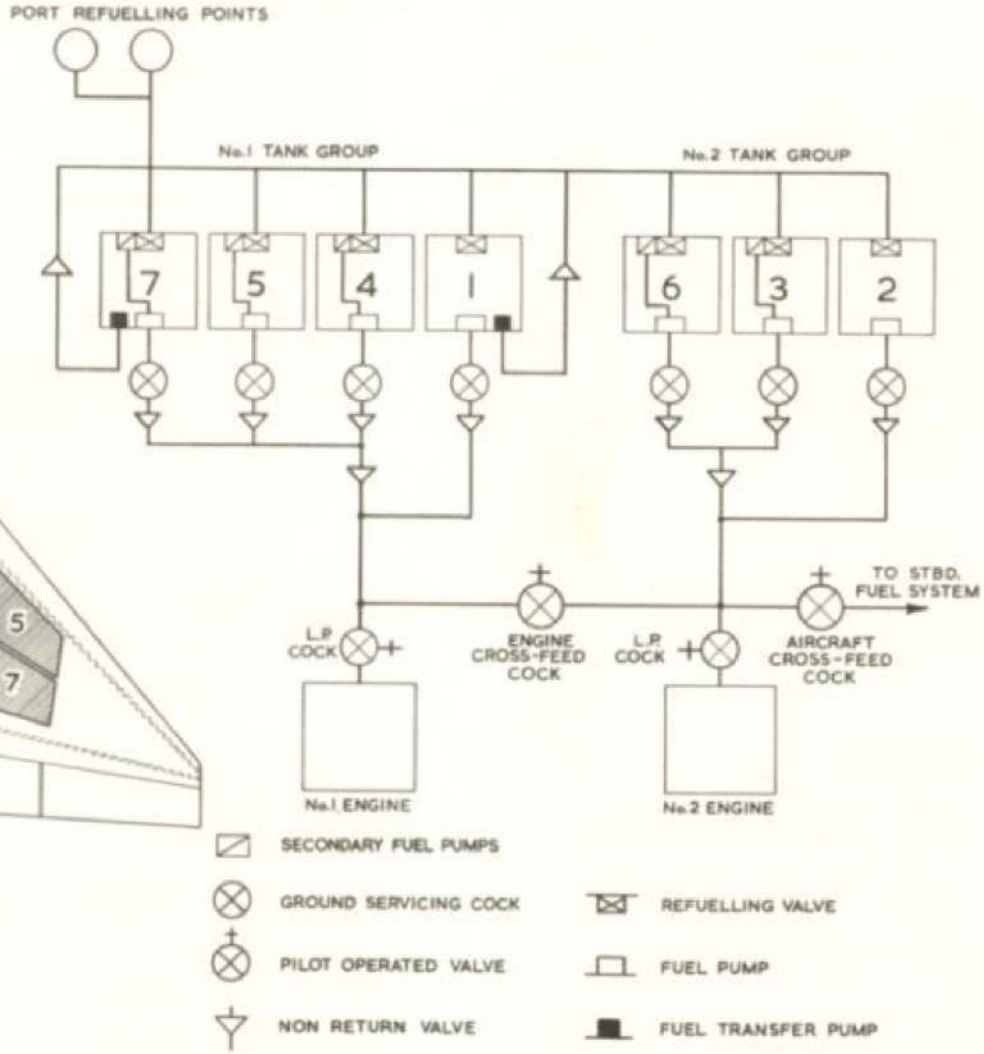


ARRANGEMENT OF TANKS



PORT FUEL SYSTEM DIAGRAM

Fig. 1 Fuel system (Q)

Introduction

1. This group contains descriptive and servicing information for the electrical equipment and controls employed in the fuel system on those aircraft where Mods. 38 and 274 are not embodied. Circuit operation is given for the more complex controls, and reference should be made to Book 1, Sect.4, Chap.2 of this publication for information on the complete fuel system.

2. Component location illustrations are provided, and theoretical circuit diagrams will be found adjacent to the text dealing with circuit function.

NOTE...
The circuit operation for aircraft embodied with Mod.38 and 274 will be found in Group 5A.

DESCRIPTION AND OPERATION

GENERAL DESCRIPTION

3. Engine fuel is stored in fourteen fuel tanks; these are installed seven on each side of the aircraft. The tanks are divided into four groups, No.1 group comprising of port tanks No.1, 4, 5 and 7, No.2 group consisting of port tanks No.2, 3 and 6, groups 3 and 4 consist of the corresponding tanks on the starboard side of the aircraft.

4. Normally, each group of tanks feed fuel to one particular engine, but cross-feed cocks fitted between each group, and between port and starboard sides of the aircraft, enable all engines to be fed from any tank group. A tank location diagram is contained in fig.1.

5. Each fuel tank is equipped with an electrically driven main fuel pump, Type S.P.E.808. In addition, the wing tanks (No.3, 4, 5, 6 and 7) are each fitted with a secondary or auxiliary fuel pump, Type S.P.E.106 Mk.1, which delivers fuel from the forward section of the tank to the well surrounding the main pump, No.1 and 7 tanks are also equipped with fuel transfer pumps.

6. To enable the fuel pump motor currents to be checked, a ten-turn coil is introduced in the supply line to each motor. The test coils are mounted on the top of panels 19 and 20P on the aft face of the front spar in the bomb-bay (fig.14). A special prong-type ammeter is provided for testing, details of which will be found under the heading 'Servicing'.

7. Electrically-operated engine low pressure fuel cocks are installed in each engine fuel line and flowmeters are provided to record the amount of fuel consumed and the rate of fuel consumption. Four fuel contents gauges provide indication of tank group contents, and they can be switched to indicate individual tank contents. Electrically-operated refuelling valves are installed in each wing.

8. Due to the shape of the aircraft, the fuel tanks are dispersed a considerable distance fore and aft of the aircraft centre of gravity. It is essential therefore that when fuel is being consumed, and during refuelling periods, the correct distribution of fuel is maintained to keep the C.G. within design limits. Automatic controls are employed for this purpose and they ensure that:-

(1) The fuel is drawn from each tank in small amounts proportional to the tank capacities.

(2) Each tank is filled to the same percentage of its capacity during refuelling operations.

CONTROLS AND INDICATORS

9. The bulk of the fuel system controlling equipment is fitted to the retractable centre console panel, 5P, in the pilots' compartment. The control panel is laid out to represent a plan view of the aircraft, so that the operator may see at a glance how to control the system manually. The controls consist of:-

Fuel pump switches	14
Individual tank contents switches	14
Cross-feed cock switches	3
Cross-feed cock indicators	3
Fuel flowmeter switches	4
Manual/auto control switches	4

10. The low-pressure fuel cock control switches are mounted on the pilots' coaming; the indicators are on the instrument panel - 2P above the retractable console, and the navigator's gauges are fitted to the plotter's panel. The controls are illustrated in fig.3.

FUEL BOOSTER PUMPS

11. The main fuel pumps Type S.P.E. 808 Mk.2, are driven by compound wound motors. The motors are fed from the 112-volt bus-bar, via their respective control relays. A resistance unit, connected in the armature circuit of each pump motor, enables the pumps to be operated at a reduced speed. This circuit is auto-

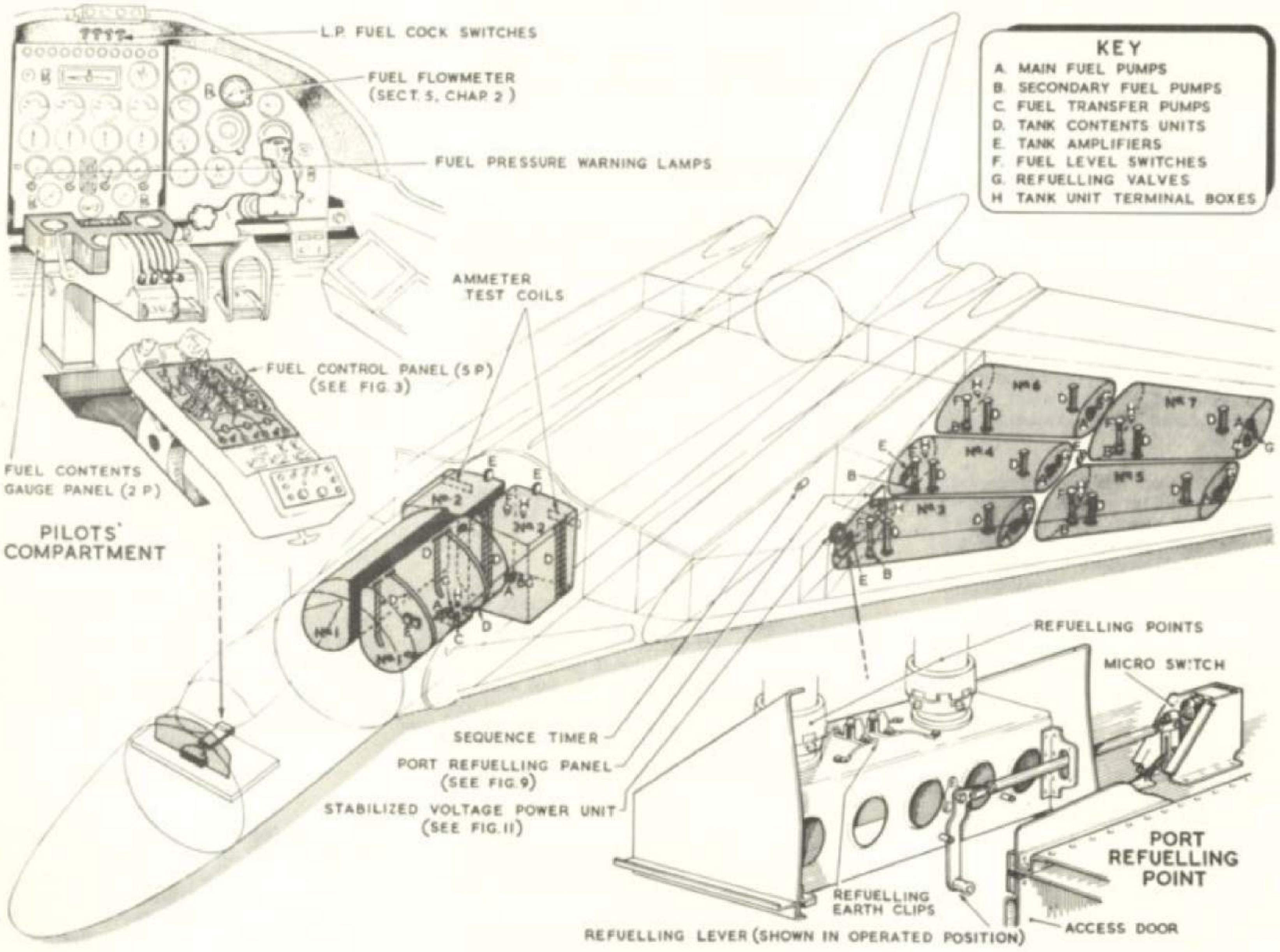


Fig. 2. Location of components.

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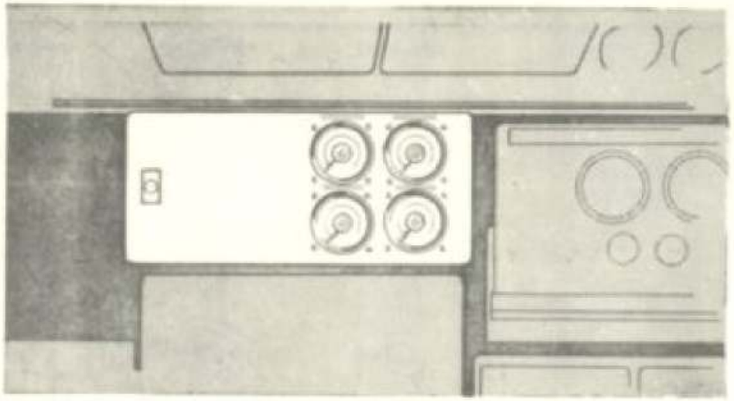
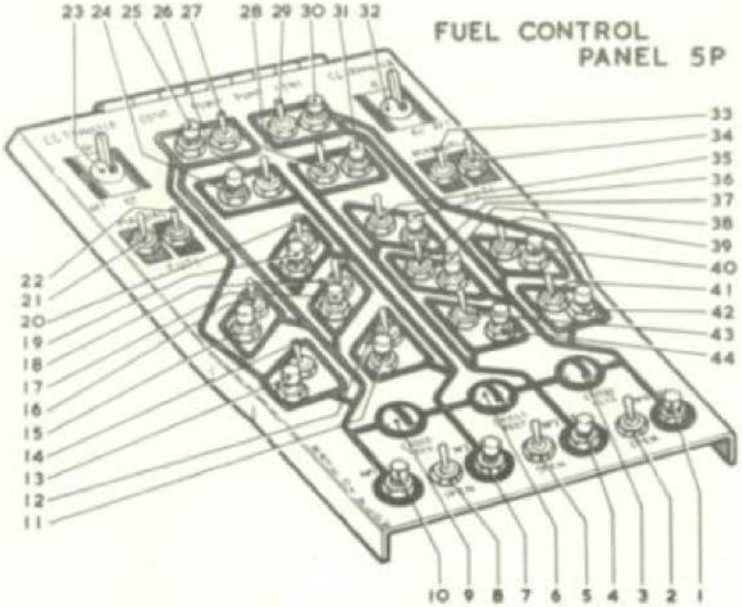


FUEL GAUGES AT CREW'S STATION (PORT)

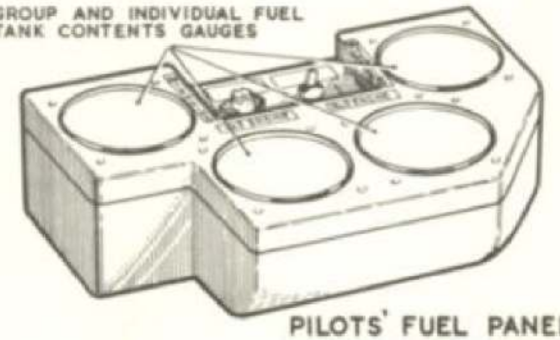


FUEL CONTROL PANEL 5P

KEY TO CONTROLS ON 5P

1. NO.4 ENGINE RATE-OF-FLOW PUSH-SWITCH
2. STARBOARD CROSS-FEED FUEL COCK SWITCH
3. STARBOARD CROSS-FEED FUEL COCK INDICATOR
4. NO.3 ENGINE RATE-OF-FLOW PUSH-SWITCH
5. AIRCRAFT CROSS-FEED FUEL COCK SWITCH
6. AIRCRAFT CROSS-FEED FUEL COCK INDICATOR
7. NO.2 ENGINE RATE-OF-FLOW PUSH-SWITCH
8. PORT CROSS-FEED FUEL COCK SWITCH
9. PORT CROSS-FEED FUEL COCK INDICATOR
10. NO.1 ENGINE RATE-OF-FLOW PUSH-SWITCH
11. NO.6 PORT TANK CONTENTS PUSH-SWITCH
12. NO.6 PORT TANK FUEL PUMP SWITCH
13. NO.7 PORT TANK CONTENTS PUSH-SWITCH
14. NO.7 PORT TANK FUEL PUMP SWITCH
15. NO.5 PORT TANK CONTENTS PUSH-SWITCH
16. NO.5 PORT TANK FUEL PUMP SWITCH
17. NO.4 PORT TANK CONTENTS PUSH-SWITCH
18. NO.4 PORT TANK FUEL PUMP SWITCH
19. NO.3 PORT TANK CONTENTS PUSH-SWITCH
20. NO.3 PORT TANK FUEL PUMP SWITCH
21. NO.2 GROUP AUTO/MANUAL CONTROL SWITCH
22. NO.1 GROUP AUTO/MANUAL CONTROL SWITCH
23. PORT FUEL TRANSFER PUMP SWITCH
24. NO.2 PORT TANK CONTENTS PUSH SWITCH
25. NO.1 PORT TANK CONTENTS PUSH-SWITCH
26. NO.2 PORT TANK FUEL PUMP SWITCH
27. NO.1 PORT TANK FUEL PUMP SWITCH
28. NO.2 STARBOARD TANK FUEL PUMP SWITCH
29. NO.1 STARBOARD TANK FUEL PUMP SWITCH
30. NO.1 STARBOARD TANK CONTENTS PUSH-SWITCH
31. NO.2 STARBOARD TANK CONTENTS PUSH-SWITCH
32. STARBOARD FUEL TRANSFER PUMP SWITCH
33. NO.3 GROUP AUTO/MANUAL CONTROL SWITCH
34. NO.4 GROUP AUTO/MANUAL CONTROL SWITCH
35. NO.3 STARBOARD TANK FUEL PUMP SWITCH
36. NO.3 STARBOARD TANK CONTENTS PUSH-SWITCH
37. NO.4 STARBOARD TANK FUEL PUMP SWITCH
38. NO.4 STARBOARD TANK CONTENTS PUSH-SWITCH
39. NO.5 STARBOARD TANK FUEL PUMP SWITCH
40. NO.5 STARBOARD TANK CONTENTS PUSH-SWITCH
41. NO.7 STARBOARD TANK FUEL PUMP SWITCH
42. NO.7 STARBOARD TANK CONTENTS PUSH-SWITCH
43. NO.6 STARBOARD TANK FUEL PUMP SWITCH
44. NO.6 STARBOARD TANK CONTENTS PUSH-SWITCH

GROUP AND INDIVIDUAL FUEL TANK CONTENTS GAUGES



PILOTS' FUEL PANEL 2P

Fig. 3 Pilots' controls and indicators

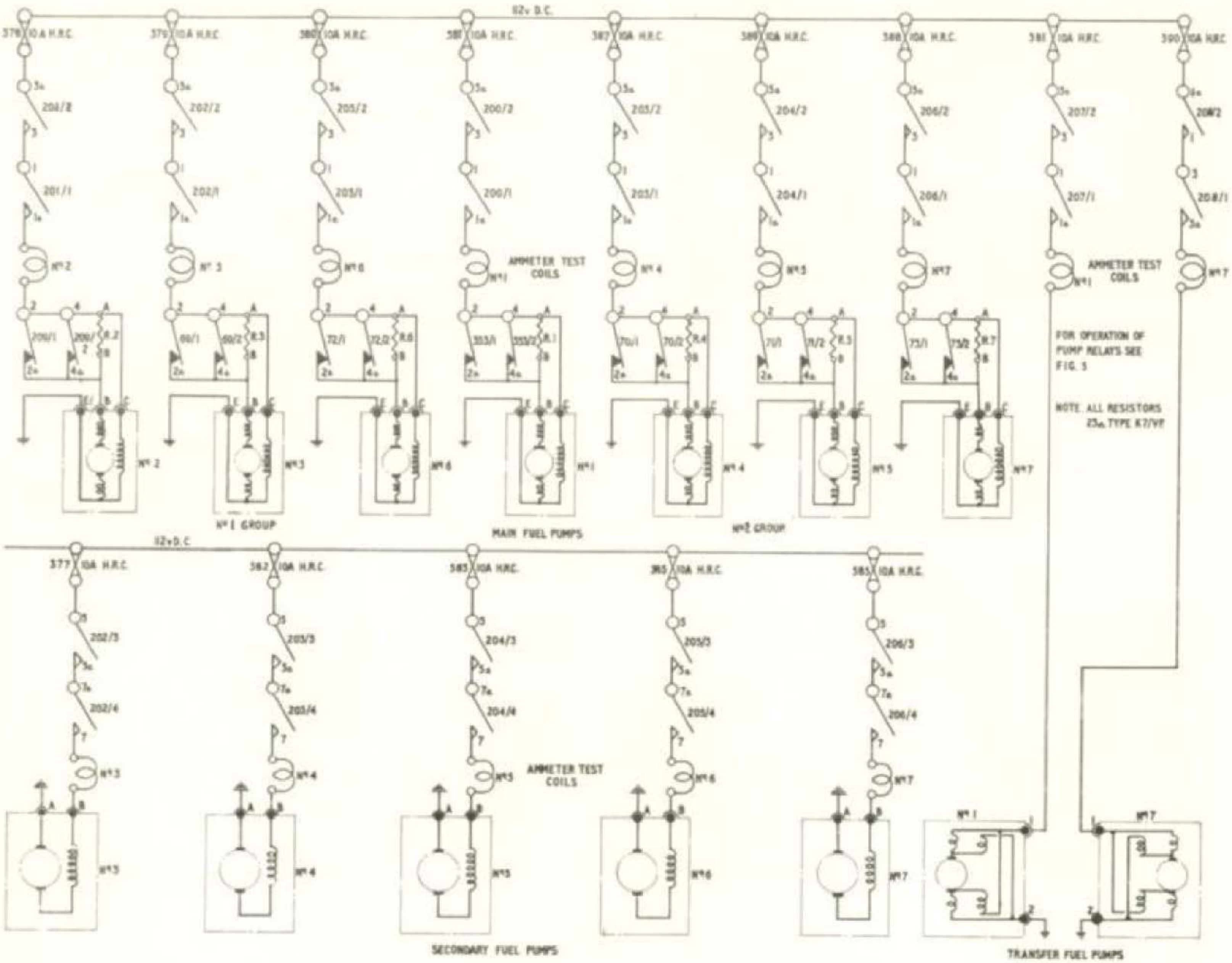


Fig. 4. Main, secondary and transfer fuel pumps (port).

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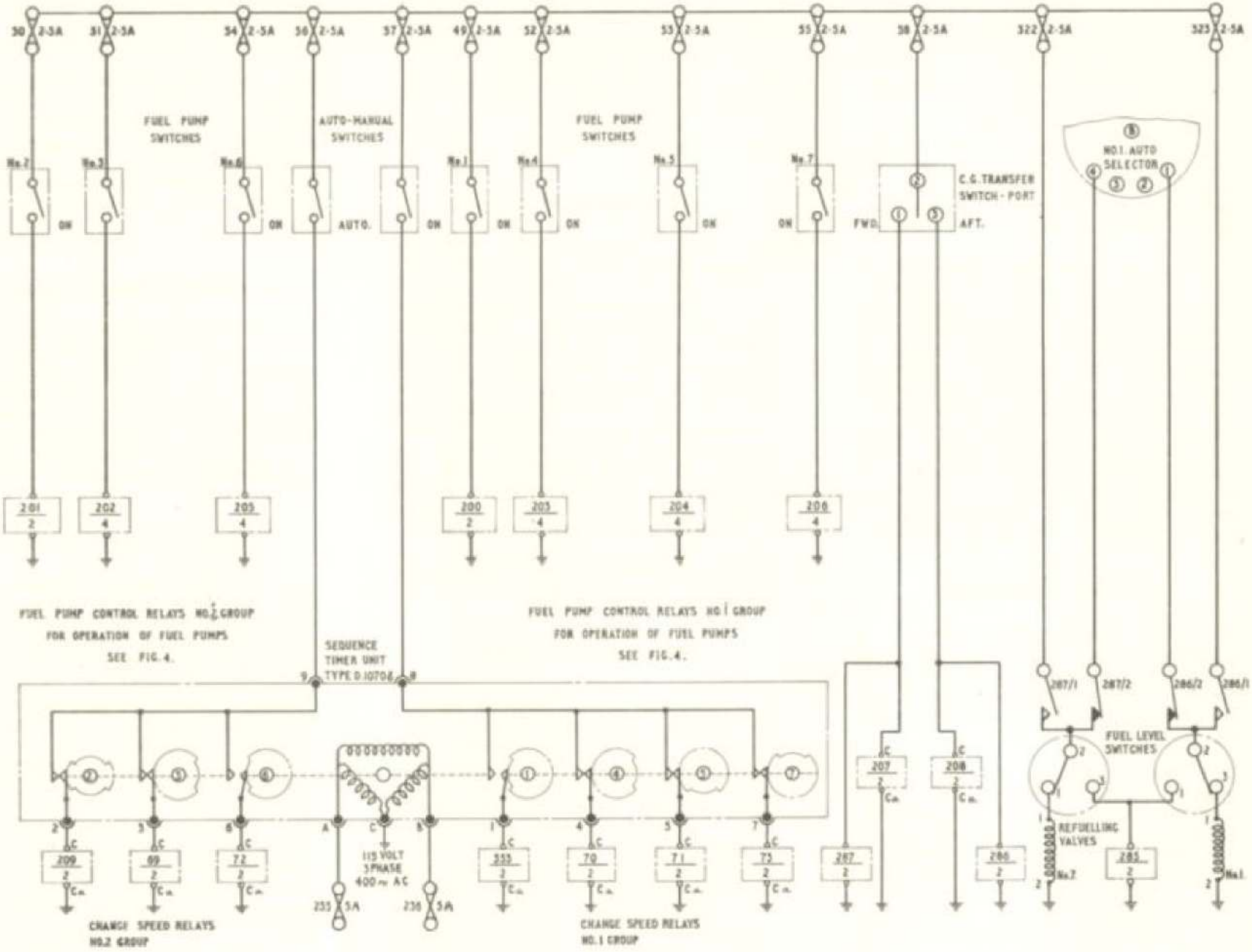


Fig.5. Sequence timer and fuel transfer - port.

matically controlled by change-speed relays and sequence timer units. When the resistance is shorted out by the relay contacts, the motor will run at full speed, to deliver fuel at 10 p.s.i. When the resistance is in series with the armature, the motor will run at reduced speed. The full speed pump will supply the engine whilst the low speed pumps stand by at a lower pressure. The secondary fuel pumps Type S.P.E. 106 Mk.1, run at a constant speed, and continue running all the time the main pumps are switched on.

12. Four switches, two on each side of the control panel, enable the pilot to select automatic or manual control for each group of tanks. When automatic control is selected, a positive supply is connected to the appropriate sequence timer, which will automatically select each pump in turn to run at full speed, whilst the remaining pumps in the group will continue to run at low speed. When manual control is selected, the supply to the sequence timer is cut off, the change-speed relays are de-energised, and all pumps switched on will run at full speed.

SEQUENCE TIMER UNITS

13. Two sequence timer units, Type D.10706, are installed one in each main wheel bay, adjacent to the refuelling panels. Each sequence timer deals with the automatic control for one side of the aircraft fuel system.

14. They contain a number of cam-operated contacts, each of which controls its associated fuel pump change-speed relay. The cams are so arranged that each tank pump will be at full speed for a time proportional to the size of the tank. No.2 tank is approximately twice the size of the other tanks, and its pump will be operated at full speed for two periods in each time cycle. A diagrammatic illustration of the time cycle and cam profile angles is given in fig.6.

15. Each camshaft is driven at a speed of 0·2 r.p.m. through a reduction gear by a squirrel cage motor. The three-phase supply for each sequence timer is provided by a 115-volt 400 cycle inverter unit, and is distributed through the appropriate a.c. supply fuses dealt with in Group 3. The internal connections of the sequence timer are contained in fig.5.

FUEL TRANSFER PUMPS

16. Two three-position switches, labelled FUEL TRIM FWD. AND AFT, control the fuel transfer pumps B.P.8 Mk.4. The switches are spring loaded to the centre OFF position. When either switch is held to the FWD. position, the associated fuel transfer pump in No.7 tank will be switched on; at the same time, the No.1 tank refuelling valve will be energised to open. The fuel transfer pump will now deliver fuel into the refuelling pipe line, and through the refuelling valve into No.1 tank. A fuel level or float switch prevents overfilling of the tank by de-energising the refuelling valve when the tank is full. A theoretical circuit diagram of the transfer pumps is contained in fig.4.

FUEL COCK CONTROLS

17. Seven electrically operated Vickers fuel cocks are employed in the fuel system. They consist of three cross-feed cocks, and four low pressure fuel cocks. Each assembly contains a motor driven actuator of the split field series type. Descriptive details for the actuators will be found in A.P.4343D, Vol.1, Sect.16. Indication that the cross-feed cocks are switched on is provided by three electro-magnetic indicators on the centre console 5P. The indicator circuits are completed through the appropriate Type Q3 relays. The cross-feed cocks are controlled by three single-pole switches on the centre console, each switch controlling a Q3 relay, the contacts of which are in the main supply lines to the actuator open or close fields.

18. The low pressure cocks are controlled by four two-way double-pole switches on the coaming above the pilots' instrument panel. No relays are employed for these circuits. The supplies for all actuators are obtained from the 28-volt bus-bars, via fuses in panels 3P and 4P.

FUEL PRESSURE WARNING INDICATORS

19. Four fuel pressure warning indicators fitted to the pilots' panel, are connected to a fuel pressure switch, Type TP5202, one on each engine. If the fuel pressure in any one engine falls below 5 p.s.i., the contacts of the switch will close, and the appropriate warning indicator will be energised.

FUEL CONTENTS GAUGES

20. A fuel contents system of the Smith Waymouth type is installed, using integral tank units and separate amplifiers, Type F.C.A. to each tank. The tank units are connected by co-axial cables to the amplifiers, the outputs of which are fed to the fuel gauges on the pilots' fuel panel 2P. Descriptive and servicing information for the Smith Waymouth system is contained in A.P.1275A, Vol.1, Sect.3.

21. The four fuel gauges on the pilot's fuel panel 2P, provide indication of tank group contents, but individual tank contents may be obtained by operating the appropriate push-switch on the centre console 5P. The associated indicator will then register the contents of the selected tank. A further four contents gauges are installed on the plotter's

panel at the navigation station. These gauges will register only tank group contents, and are unaffected by the operation of the pilots' individual tank contents push-switches. The contents gauge type numbers are as follows:-

No.1 group (pilots')	-	Type A.O.10
No.1 group (crew's)	-	Type A.G.14
No.2 group (pilots')	-	Type A.O.12
No.2 group (crew's)	-	Type A.G.15
No.3 group (pilots')	-	Type A.O.12
No.3 group (crew's)	-	Type A.G.15
No.4 group (pilots')	-	Type A.O.10
No.4 group (crew's)	-	Type A.G.14

Tank group contents

22. The fuel gauges are calibrated in thousands of pounds of fuel. The inner scale registering the total fuel in the tank group, and the outer, more readable scale showing the individual tank contents of the tank selected. The output of each tank amplifier varies linearly with the fuel contents between 2 and 7 milliamps, and at a figure proportional to the ratio of the fuel capacities of the tanks (fig.7). The outputs of the amplifiers are connected together via the operating contacts of selector relays, and directed to the group contents indicator which is a sensitive milliameter. Since full scale deflection of the indicator is obtained when a current of 7 mA. is flowing, a shunt resistance is connected across the indicator through the contacts of the shunt relay so that full-scale deflection is obtained when all the tanks are full.

Individual tank contents

23. The contents of an individual tank in any group may be ascertained by operating the individual tank push-switch on 5P. Referring to fig.8, assume that No.3 individual tank push-switch is operated.

24. It will be seen that sequence relay 299 will be energised via the push-switch

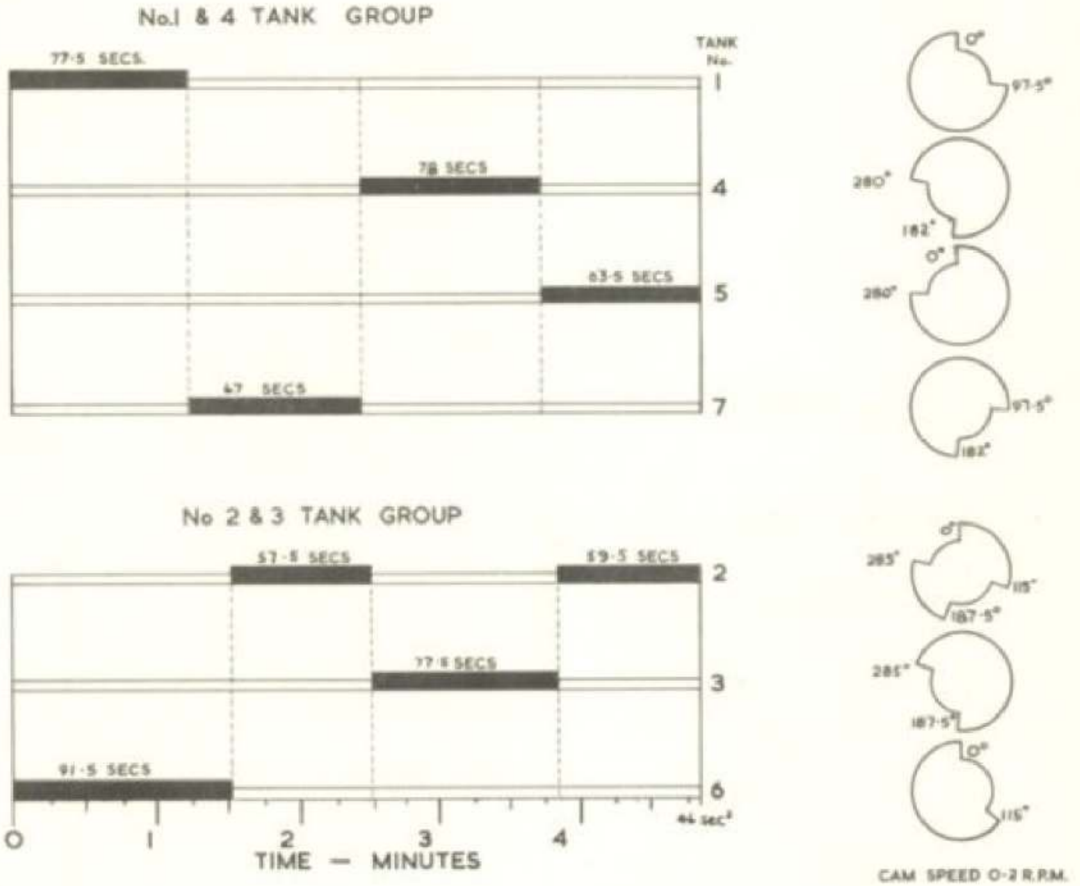
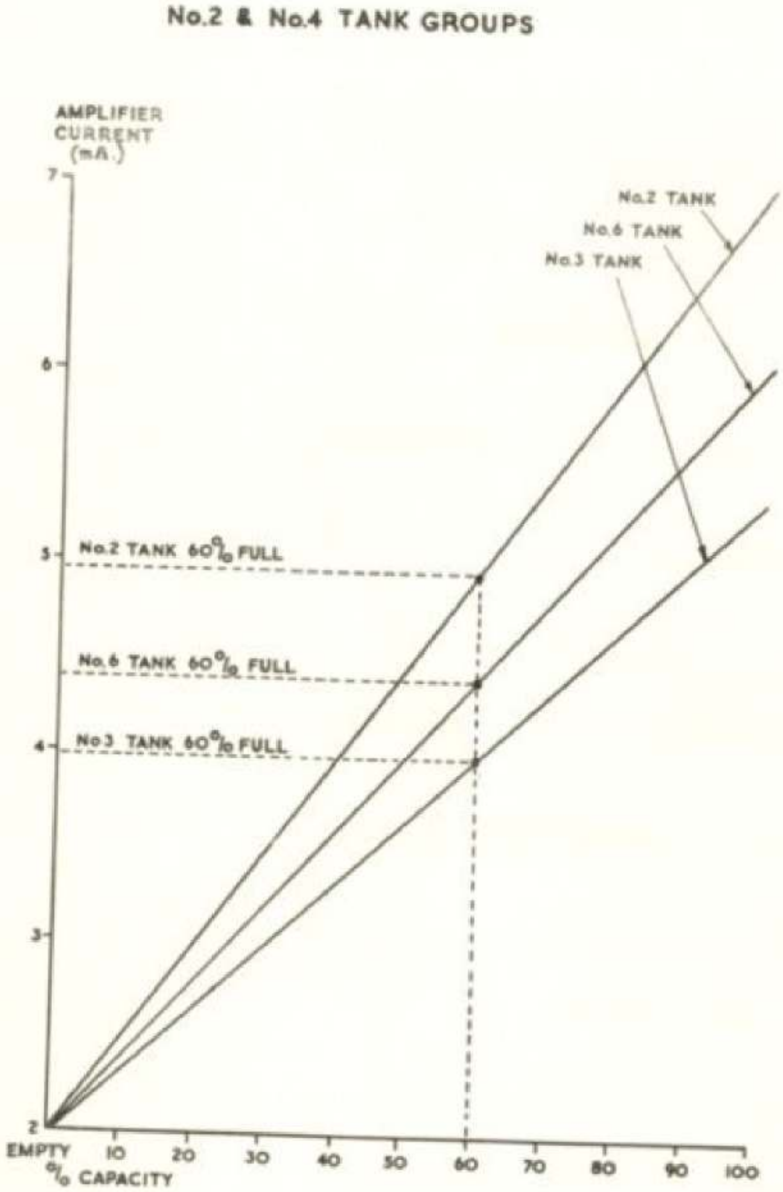


Fig. 6 Tank sequence diagram



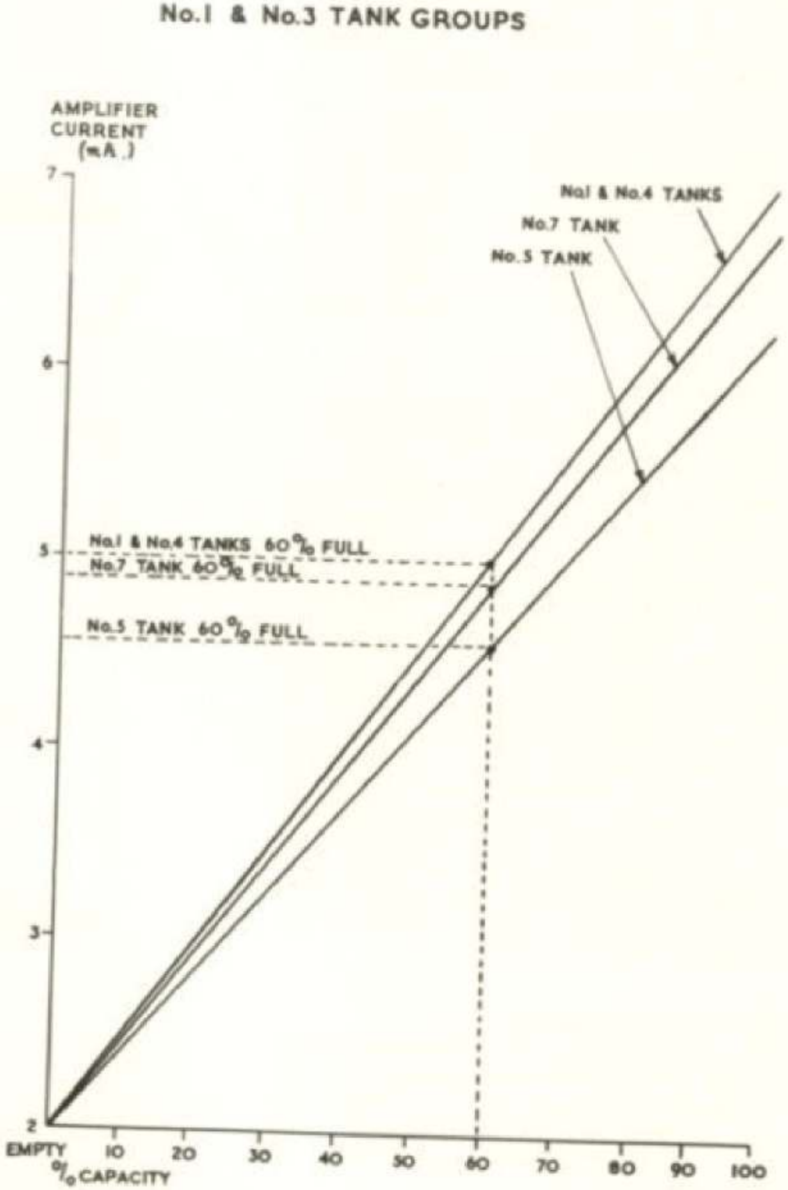


Fig.7. Ratio of fuel contents to amplifier current.

and fuse 59. Closing of contacts 299/2 will energise the shunt relay 301 via fuse 353. Operation of contacts 301/3 will disconnect all the amplifiers from the contents indicator, but No.3 tank amplifier will remain connected to the indicator via contacts 299/3, the moving coil relay MC(A) and contacts 301/2. Contacts 301/1 will maintain the positive supply to tank amplifiers 2 and 6, to prevent violent movement of their mechanisms, and contacts 301/4 will disconnect the shunt from the indicator.

25. The largest tank in the group will give full scale deflection when full, and the remaining tanks in the groups give a deflection proportional to their capacities.

WARNING...
The indicator may be damaged if two push-switches are operated simultaneously, since the two amplifier outputs will be applied to the indicator with the shunt resistance disconnected.

REFUELLING

26. During ground refuelling of the aircraft, each tank is filled to the same percentage of its capacity to maintain a correct C.G. position. Refuelling is commenced with the forward tank of each group to prevent the aircraft tilting nose up and the refuelling system is automatically switched off when refuelling has been completed.

27. Only one tank is filled at a time, automatic change-over to the next tank being made by a moving coil relay, through a resistance network refuelling circuit, to make the relay operate at any tank contents from empty to full.

Refuelling control and resistance network

28. Each moving coil relay has two windings, one connected in series with the group fuel contents indicator, the other connected to the resistance network. The resistance network obtains its supply from a variable voltage power unit which is switched on by a micro switch mechanically connected to an operating handle adjacent to the port refuelling point. The stabilised voltage supply from the power unit can be varied between 0 and 50 volts by an integral refuelling selector control which is graduated from 0 to 100 per cent. When a tank is selected for refuelling, the relevant selector relay will connect the coil of the moving coil relay to the stabilised supply through a fixed and trimmer resistance. Theoretical circuit diagrams of the resistance network and the stabilised voltage supply unit are illustrated in fig.10 and 12 respectively.

29. The current in the control coil of the moving coil relay MC(B) is dependent on the voltage selected at the stabilised power unit, and the total resistance of each arm in the resistance network. The current for the largest tank in the group is 7 mA. according to the setting of the refuelling selector from 0-50 volts, the total resistance of this branch being 11.6K.ohm. Smaller tanks have a larger total resistance, and therefore a small maximum current. The two coils of the moving coil relay are in opposition, and when the current in MC(A) rises to 2 mA. above the current in the control coil, the contacts MC/2 will operate to 'close', this action will energise an auto-selector through a relay, which will shut off the selected tank.

Stabilized voltage power unit

30. Installed in the port main wheel bay, adjacent to the refuelling panel 36P, is the stabilised voltage power unit. This unit supplies a voltage which can be set to any pre-determined value between 0 and 50 volts. Adjustment is made by operating the selector potentiometer which is calibrated 0-100 per cent. A location illustration of the power unit is contained in fig.9.

31. The output voltage of the unit, is stable to less than 0·5 volts over an aircraft supply variation between 22 and and 29 volts. Referring to fig.12, the input d.c. supply is fed to a synchronous self-rectifying vibrator and transformer operating at a frequency of 110 cycles per second. The output from the vibrator transformer, after passing through a low-pass filter, is 400 volts d.c., and is used for the H.T. supply. A 6·3 volt winding supplies the valve heaters.

32. The unit consists of two similar series valve stabiliser circuits, both adjusted to give 180 volts d.c. output with the selector set at 0 per cent. One series circuit remains fixed at 180 volts d.c., and is used to "back-off" the second which has a variable output between 180 and 230 volts d.c., the difference between the two outputs being variable between 0 - 50 volts.

33. The fixed output of 180 volts is connected to earth giving the difference taken from terminal 2 varying positively 0 to 50 volts above earth. When the two outputs are differenced in this way, a path to negative H.T. must be available to both outputs, as current flowing into the load on terminal 2 cannot return to negative H.T. through V1: R10 is included to load the fixed output in excess of any external current.

34. Two safety relays are included. Relay SR, which is "slugged" to give a time delay in the switching out of R1, which is a current limiting resistance to protect the vibrator contacts during its starting period; and relay IR, which is connected in series with R10. This relay will operate when the valves have warmed up, and its contacts connect a 28-volt supply to an indicator lamp on each refuelling panel to indicate that refuelling may commence.

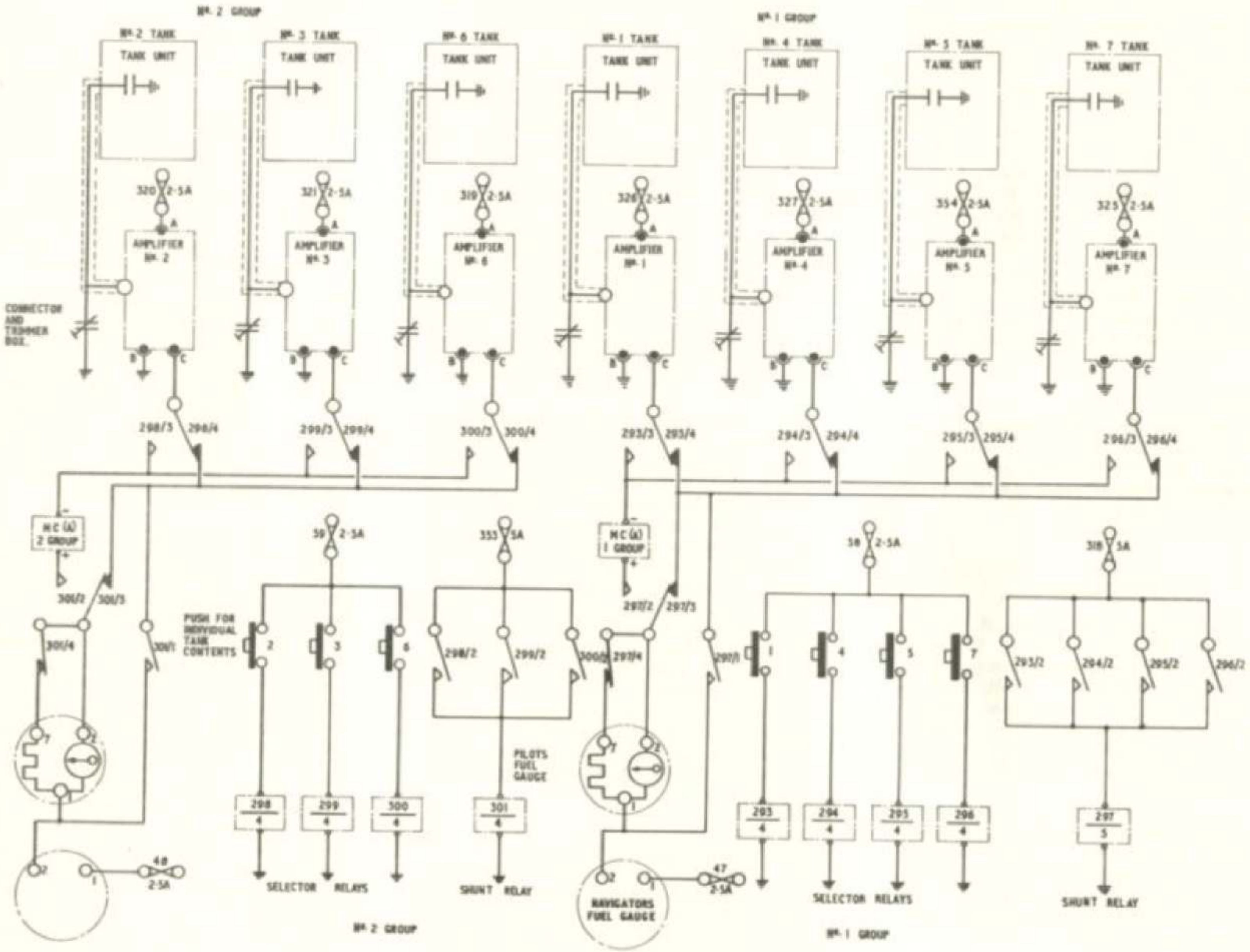


Fig.8. Fuel contents gauging-port.

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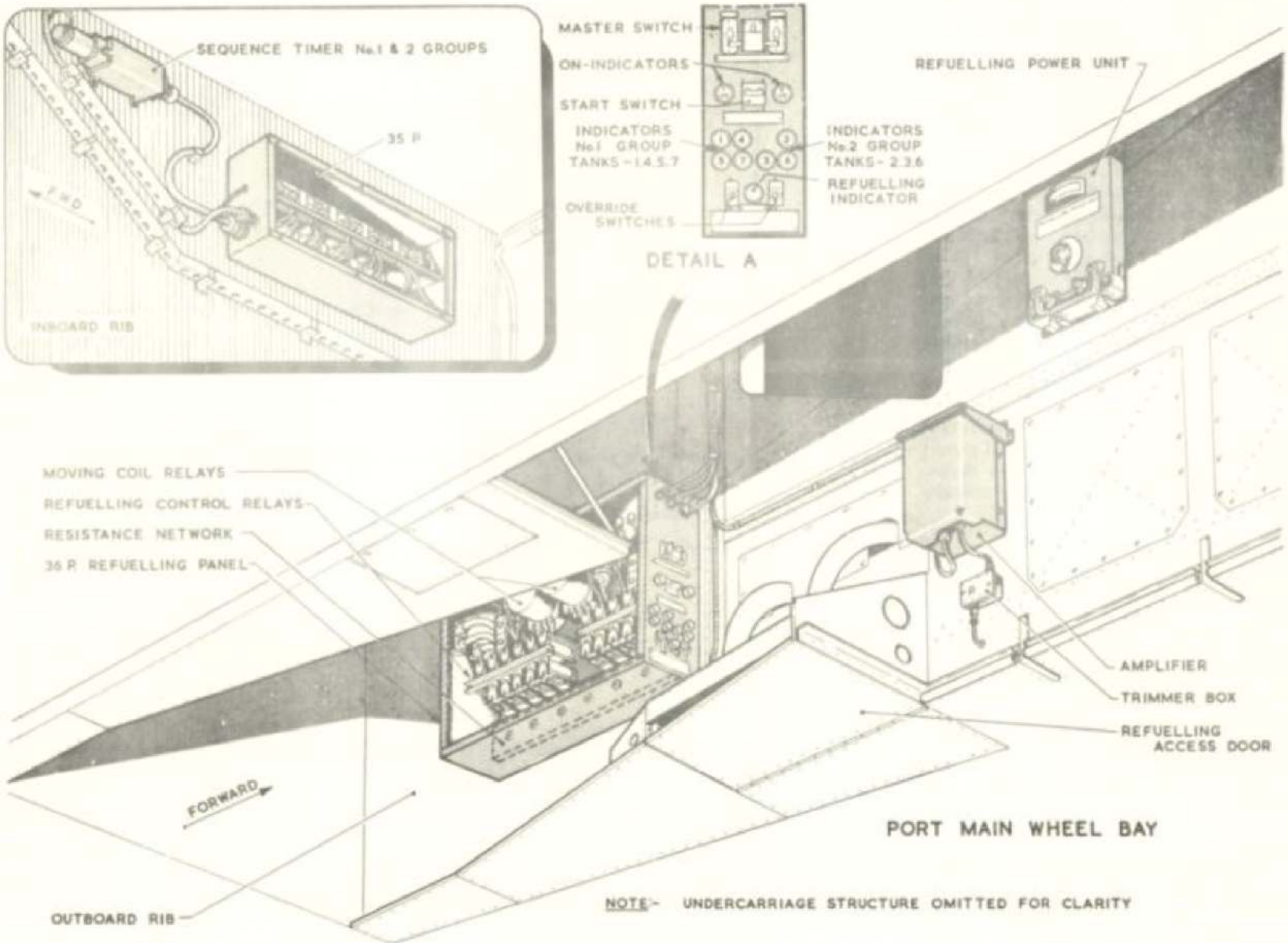

Fig.9. Refuelling controls.

Refuelling selector circuit

35. A double-bank rotary selector controls the refuelling valves and tank selector relays in each group of tanks. Each auto-selector is operated by the MC/2 contacts of the respective moving coil relay by an operating relay. A solenoid master switch connects a positive supply to each group refuelling circuit, and a START switch is used to operate the auto-selector to the correct starting position.

36. When the last tank in the group is refuelled, the auto-selector steps to the next contact, and shorts the hold-on solenoid of the master switch, thus sw[illegible]hing off the refuelling circuit of the group. When the port refuelling hoses are removed from the refuelling point, the micro switch contacts are opened by the operation of the handle adjacent to the hose connection point, and the supply to the stabilised voltage unit is cut off. Fuel level switches in series with the refuelling valves prevent accidental over-filling and possible damage to the tanks should a failure of the refuelling circuit occur.

OPERATION OF THE REFUELLING CIRCUIT

37. The refuelling operation of the port three-tank group (No.2 group) is described in the following paragraphs, and should be read in conjunction with fig.13. The operation of the No.1, 3 and 4 groups is similar, except that in the four tank groups an extra refuelling valve and extra contact in the auto-selector are included.

Starting

38. When the refuelling hose is connected to the port wing refuelling point, operation of the handle adjacent to the hose connector will cause the micro switch to make contacts 2 - 3, and connect a supply to the stabilised voltage power

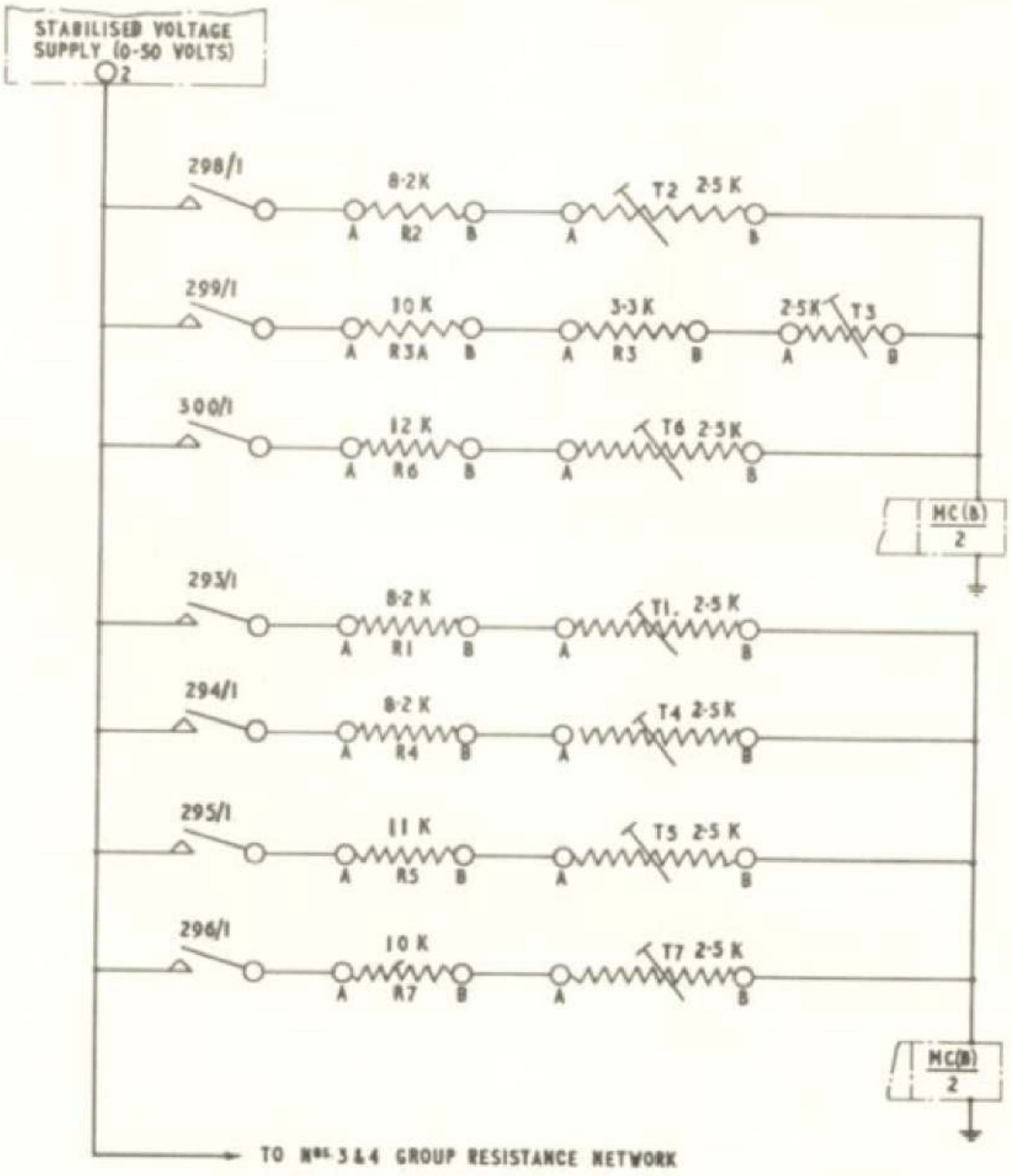

Fig.10 Port resistance network

unit. An indicator lamp on each refuelling panel will be illuminated when the valves in the power unit have warmed up.

39. When the refuelling percentage selector has been set to the desired percentage, the output voltage must be checked by observing the sensitive voltmeter on the power unit. The percentage indicated on the voltmeter should be equal to the selected percentage on the refuelling selector. It should be noted that if the reading on the check voltmeter is not within ± 2% of the selected percentage, the power unit must be adjusted in accordance with the instructions laid down in para. 95.

40. Referring to fig.13 when the group refuelling master switch is placed to ON, it will be held in via its own contacts, which will also connect a supply to the 'A' bank of the auto-selector, and to the START switch, via the normally closed contacts 291/3. Repeated operation of the start switch will operate the auto-selector switch until it reaches contacts A1 and B1, As soon as the auto-selector reaches this position, the start relay 292 will be energised.

41. Contacts 292/2 will energise the master relay 291, which will lock in via its own contacts 291/1, and also connect a supply to the "B" bank of the auto-selector, the No.2 group ON indicator, and the moving coil relay contacts. Contacts 291/3 isolate the start switch to prevent the auto-selector being operated past the starting position.

42. No.2 tank selector relay 298 will be energised via contacts A1 and relay contacts 292/1, the following circuit action will then take place:-

(1) The shunt relay 301 will be energised via contacts 298/2.

(2) All amplifiers will be disconnected from the contents gauge by contacts 301/3.

(3) The No.2 tank amplifier will be reconnected to the contents gauge via contacts 298/3, the moving coil relay MC(A) and contacts 301/3.

(4) A positive supply will be maintained on the remaining amplifiers (No.3 and 6) by contacts 301/1.

(5) The shunt will be disconnected by contacts 301/4.

(6) The moving coil relay will be connected to the stabilised voltage unit via contacts 298/1 and the resistance branch R2.

43. The output of No.2 tank amplifier passes through the moving coil relay MC(A) and the contents gauge, which will continually register the contents of the tank during refuelling. The No.2 tank refuelling valve is energised via terminal B1 of the auto-selector; the indicator lamp is illuminated to indicate that the refuelling valve is energised, and the refuelling may commence.

44. The group contents gauge will register the contents of the tank being refuelled in each group. If more than one individual tank contents push-switch is operated, the output of more than one amplifier will pass through the group contents gauge and moving coil relay. The increase in current may cause the relay to operate before the tank has been refuelled to its selected percentage. The auto-selector will select the next tank, and incorrect refuelling will result.

Shut-off and re-selection

45. When the current in the moving coil relay MC (A) rises to 2ma. above the current in moving coil relay MC (B), the relay will operate. The relief relay No.289 will be energised by contacts MC/2, and the parallel contacts 289/1 and 289/2 will close to energise the override relay 290. Contacts 290/1 will close to energise the auto-selector relay, which will step to contacts A2 or B2, thus de-energising the No.2 refuelling valve and the selector relay and energising the No.3 tank refuelling valve and selector relay 299. At the same time, contacts 290/2 will short-circuit moving coil relay MC (A), contacts MC/2 will open, relay 289 will be de-energised in preparation for the next cycle of operations. This cycle of operations is repeated for No.3 and No.6 tanks in turn.

Completion of refuelling

46. When No.6 tank has been filled to the selected percentage of its capacity, the auto-selector will be stepped to contacts A4 and B4. The master switch coil will be de-energised, and the master switch contacts will break the supply to the refuelling circuits. No.6 tank selector relay (300) and subsequently the shunt relay (301) will be de-energised and the contents gauge will return to its normal purpose of summating the tank group fuel contents. Supply to the stabilised power unit will remain on until the refuelling hoses have been removed and the micro-switch operating handle has been returned to its normal horizontal position. This action will switch off the power pack, and the warning lamp will be extinguished.

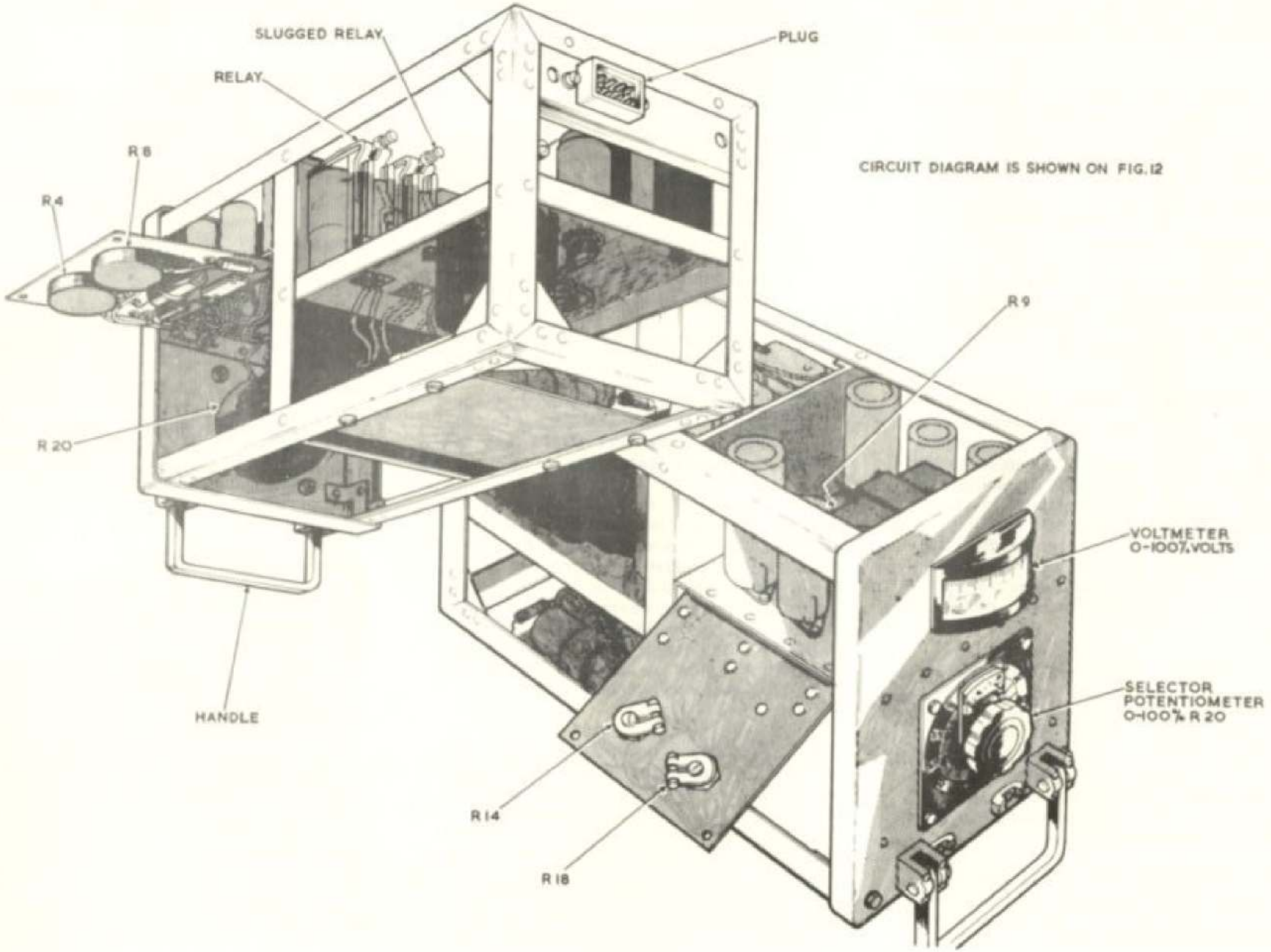

Fig.11. Stabilized voltage power unit.

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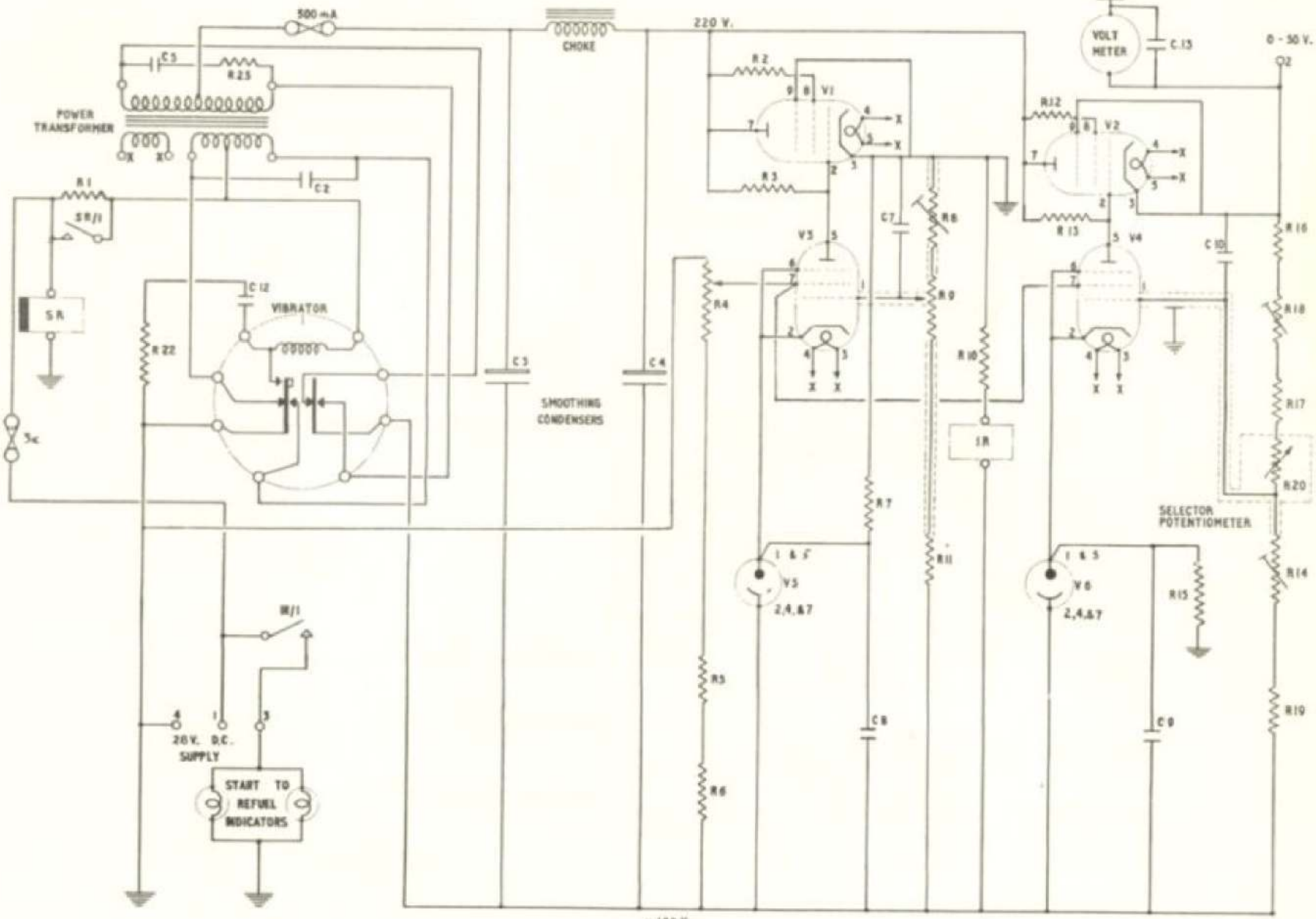

Fig. 12. Stabilized voltage power unit circuit.

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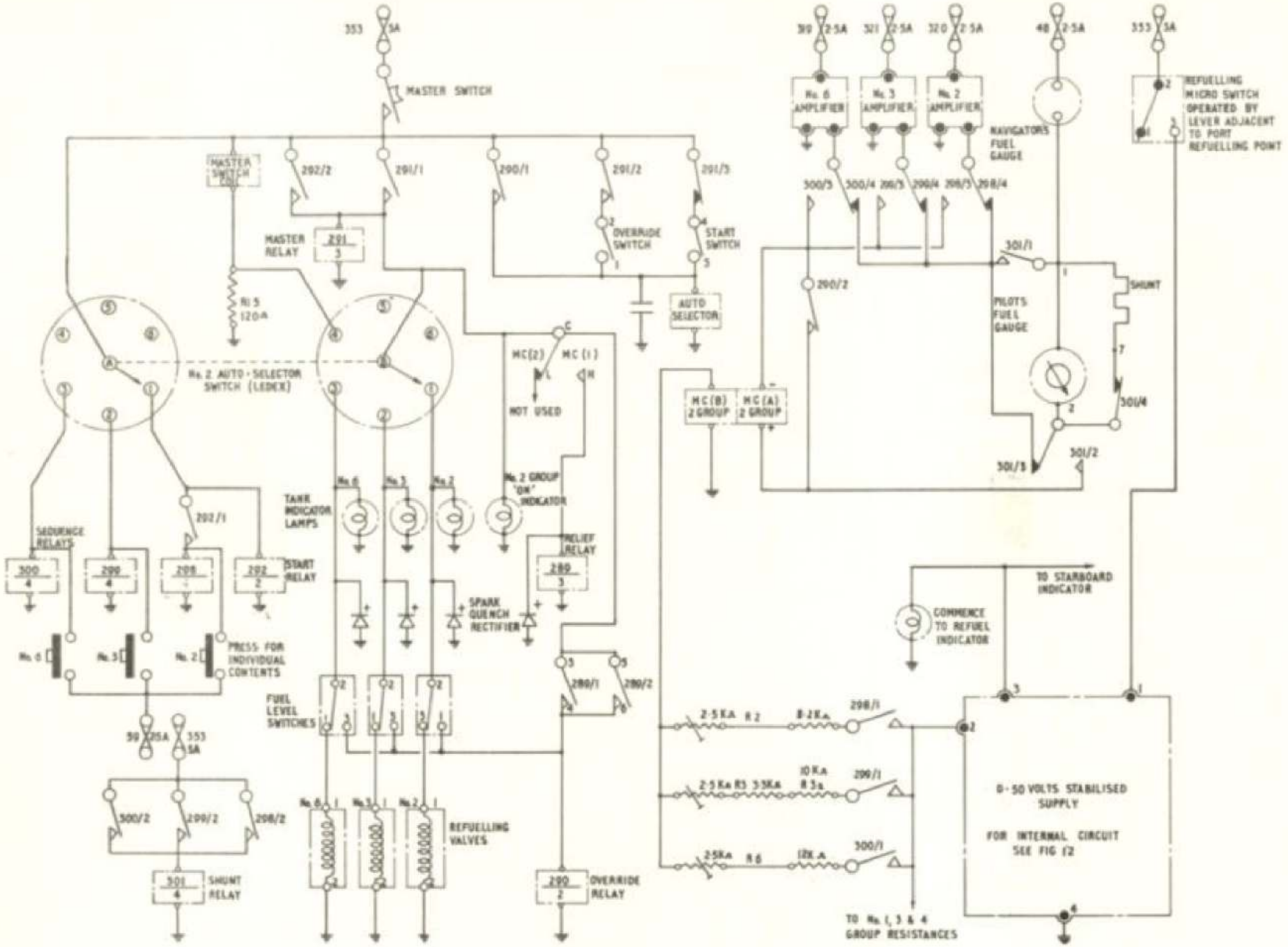

Fig.13. Nº 2 group refuelling circuit.

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Fuel level switches

47. Should any tank become overfilled during the refuelling operation, the appropriate fuel level switch will operate to de-energise the refuelling valve. Relay 290 will be energised to close contacts 290/1 and the auto-selector will operate to step to the next tank. A selector override switch is employed as a means of operating the auto-selector for servicing purposes. The master switch must be ON, and the auto-selector switch operated to START before the selector switch is operative. Each operation of the override switch will operate the auto-selector in the normal refuelling sequence and the final operation will trip the master switch. It should be noted that the override switch must NOT be operated during refuelling or the auto-selector will step to the next tank before the selected tank is filled to the correct percentage capacity.

SERVICING

General

48. Due to the operation of the electrical and mechanical controls of the fuel system being so closely allied it is essential that co-operation of the highest order is maintained between the airframe, electrical and instrument trades. This will ensure that a high degree of serviceability is maintained, and also obviate unnecessary repetition of function tests etc., during inspection periods.

49. Servicing and test functioning of the electrical components of the system is dealt with in the following paragraphs; servicing for the mechanical portion of the fuel system is contained in Book 1, Sect.4, Chap.2 of this publication.

FUEL BOOSTER PUMPS

50. Servicing information for the fuel booster pumps, Type S.P.E.808 Mk.2 is contained in 4343D, Vol.1, Sect.8, to which reference should be made for details of power consumption, pressure, rate of delivery and testing precautions.

51. As stated in para.6 of this Group, ammeter test coils are provided to enable the current consumption of each fuel booster pump to be checked. The test coils are located in the bomb bay on the aft face of the front spar. The current consumption of each pump motor should be checked periodically, using a tong-type ammeter, (Ref.No.5Q 38), at the 0-50 amp. range. The reading on the ammeter must be divided by 10 to give the current consumption of the fuel pump motor under test.

52. Pump calibration and feed line checks will be found in Book 1, Sect.4, Chap.2. Although these checks are almost wholly mechanical they call for use of the sequence timer test box, Ref.No.26DC/-95250. and the electrical tradesman will be required to connect the box and give any other necessary assistance.

53. A description of the sequence timer test box is given in A.P.4343V, Vol.1, Sect.4, Chap.4. With this item it is possible to check the sequence timers for correct operation of the cam switches during normal functioning of the aircraft fuel system. A.P.4343V, Vol.1, Sect.4, Chap.4 gives the recommended test procedure, together with the open-contact period times for the sequence timers. Servicing instructions for the sequence timers are given in A.P.4343D, Vol.1, Book 4.

CONTENTS GAUGING SYSTEM

54. Apart from a routine check on the cleanliness and security of all the wiring and connections of the electrical components employed in the electrical portion of the fuel system, little servicing is required. The co-axial cables connecting the tank units to the amplifiers should be checked periodically for ingress of moisture, abrasion of the outer insulation, and general security. Panel covers should not be removed for longer than necessary, and replaced securely after inspection of the components.

55. It will be realised from the nature of the fuel contents gauging system, that its accuracy depends on:-

(1) Equalities in system manufacture

(2) The physical properties of the fuel being used

(3) A reasonably stable voltage supply.

Any small inaccuracies which may exist will usually stem from these three sources.

Functioning check

56. Whenever the aircraft is to be refuelled check the readings of the fuel contents gauges before refuelling begins. At the completion of refuelling note that the new readings are equivalent to the quantity of fuel delivered by the bowser.

Calibration of the gauging system

57. At the periods laid down in A.P. 4505A, Vol.4, or whenever any major unit of the contents gauging system has been changed, carry out the following check. This check ensures that the contents gauges read zero when the tank units are wet, with the tanks emptied down to unusable fuel without draining the refuelling galleries. The calibration is based on a kerosene fuel having a permittivity of 2.10 and a specific gravity of 0.779 at a temperature of 20 deg.C.

58. Connect to the aircraft a ground supply capable of being set to supply 28 volts ± 1 volt. Switch the power supply on at least 45 minutes before beginning

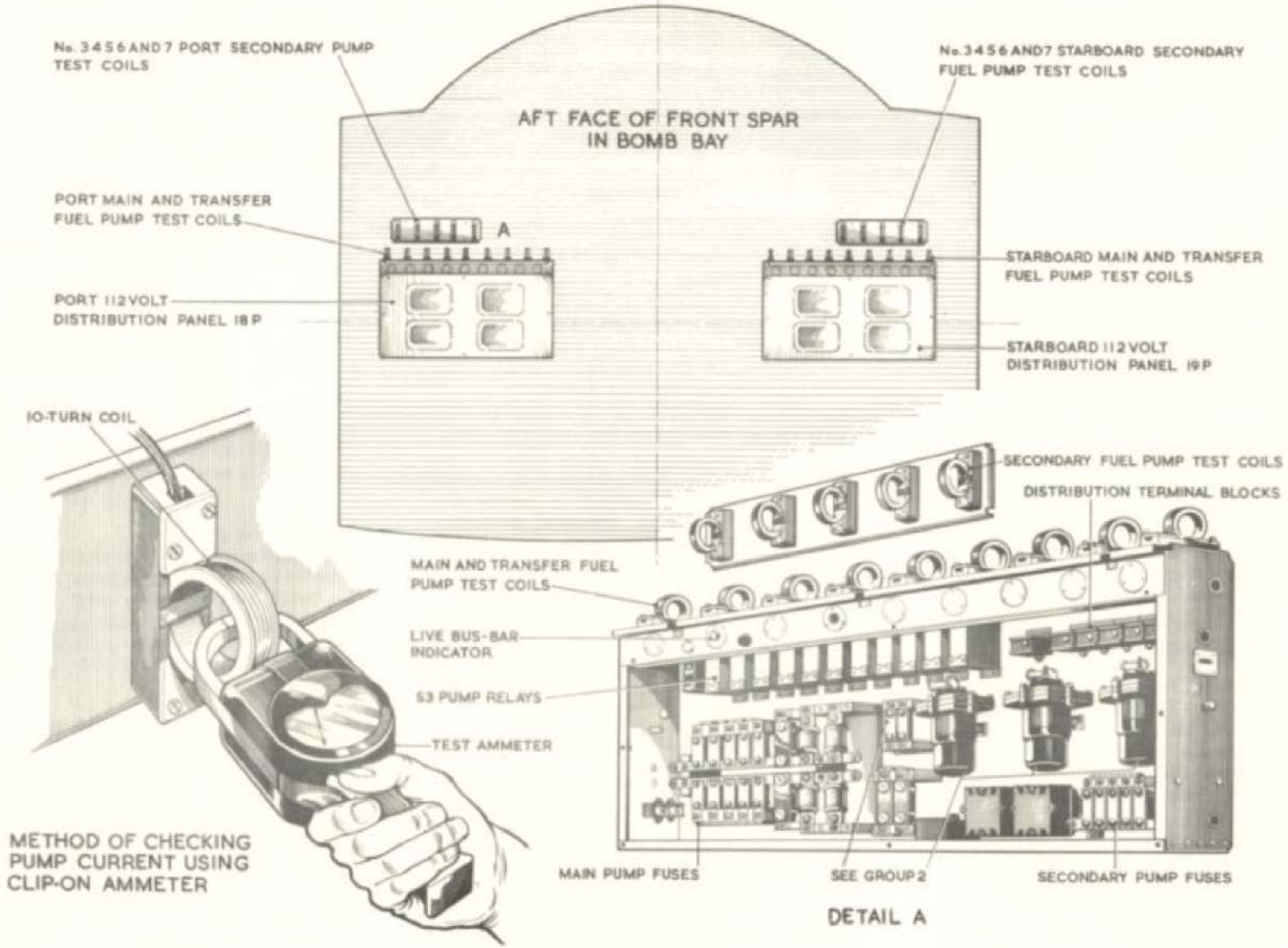

Fig. 14 Fuel pump test coils (Q)

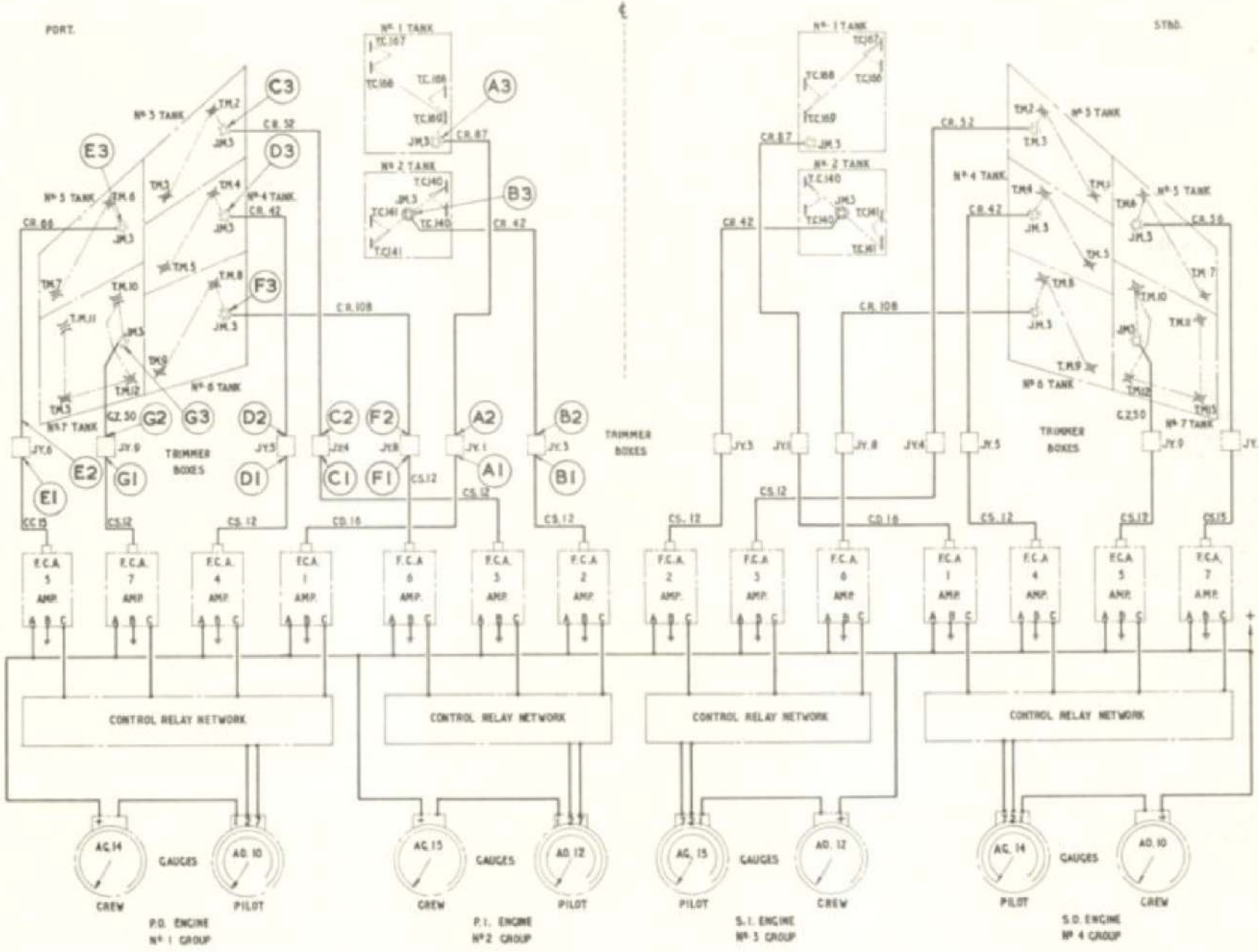

Fig. 14A Tanks cabling diagram (Q)

RESTRICTED

the checks. This will ensure that the amplifier output is stable when the checks are made.

59. With the tanks drained to unusable fuel, but with fuel still in the refuelling galleries and the tank units wet, press each individual tank selection push switch in turn. Check that the gauges read zero. Any gauge which fails to read zero should be adjusted by means of the variable capacitor in the trimmer box. Note that on no account must any fuel gauge be set to read above zero. Any slight tolerance should be below the zero mark.

60. Access to the trimmer is gained by removing the screwed sealing plug fitted in the trimmer box lid, thereby exposing the slotted top of the trimmer. By inserting a screwdriver, engaging the trimmer and turning either way, the capacitance of the tank circuit is alternatively increased or decreased and the amplifier circuit to the indicator varied. Should the indicator fail to give a zero contents reading after maximum adjustment of the trimmer the fault location checks outlined in para.61 should be applied.

Fault location checks

61. A Smith Waymouth test set, Ref. No.6C/864, is available for checking the system and a description of the test set and a general approach to the test procedure is contained in A.P.1275T, Vol.1, Sect.5, Chap.2.

Capacitance check on amplifier and indicator

62. The first part of a fault location check is carried out by connecting the test set between the amplifier and the power supply as shown in fig.3B of A.P.1275T, Vol.1, Sect.5, Chap.2. The selector switch on the test set is then moved to position 1, and then position 2, thereby checking the power supply voltage and current respectively into the amplifier, by noting the reading on the test set meter.

63. To test the circuit between the amplifier and indicator, turn the test set selector switch to position 3. As the output of the FCA amplifier varies between 2 and 7mA over the range 'tanks empty' to 'tanks full', it follows that the test set meter reading should lie between these two limits, depending on the amount of fuel in the tank.

64. If a satisfactory reading is not obtained, the fault could lie either with the amplifier and its associated tank circuit or with the indicator. To check which of these two is at fault, move the test set selector switch to position 4. This will cut-out the circuit to the indicator, and if a satisfactory reading is still not obtained the fault must lie in the amplifier or tank circuit. If a satisfactory reading is obtained, the fault lies in the indicator circuit.

65. The foregoing procedure is explained at greater length in A.P.1275T, Vol.1, Sect.5, Chap.2, and is summarised in a table on the lid panel of the test set.

66. Now disconnect the tank circuit co-axial cable from the amplifier, and substitute the co-axial cable supplied with the test set, connecting the other end of the cable to either of the two co-axial sockets on the test set. This arrangement is shown in fig.3C of A.P.1275T, Vol.1, Sect.5, Chap.2. As the test set's co-axial cable has a capacitance of 150pf, if the variable capacitor on the test set is adjusted to 1350pf, a capacitance of 1500pf will be fed into the amplifier. Thus if the selector switch is placed at position 3 or 4, the test set meter should read about 2mA. This procedure should be repeated for each of the settings given in Table 5, and the amplifier checked for approximate accordance with the values given. Note that the method of checking each amplifier and indicator is identical.

Check on tank circuits

67. It will be seen from fig.14A, that every connection or test point is numbered, starting at the trimmer box and working to the tanks. The numbers will be found in Table 7 together with the capacitance that must be connected at each point to give an indication of approximately 2mA. on the test set meter, and therefore a reading of zero contents on the indicator. Note that when testing beyond point 3 it is essential that the tanks are drained of all normally usable fuel.

68. If the amplifier has proved serviceable, reconnect the aircraft tank co-axial cable to the amplifier and disconnect it at point 1. The test set co-axial cable must now be connected to the aircraft cable as shown in A.P.1275T, Vol.1, Sect.5, Chap.2, fig.3E using the double socket clipped to the inside of the test set lid.

69. The variable capacitor should then be set to 1500pf less the capacitance of the co-axial cable connecting the amplifier to its trimmer box, the test set cable and the adaptor. If the cable connecting the amplifier to its trimmer box is serviceable, the aircraft indicator should now read zero contents and the test set meter 2mA. This procedure, using the relevant capacitance values should be followed at each of the remaining check points throughout the system until the faulty unit(s) is found.

70. Table 7 gives both the theoretical values to connect in at each point, and also the capacitance at each point when using the test co-axial cable and the various adaptors necessary. This has been done for clarity, but the capacitance of the adaptors which are necessary are as follows:-

Double Pye co-axial cable, Type CR4-10 ± 2pf

Pye Waymouth adaptor, Type CC1-8 ± 2pf

Double Waymouth co-axial cable, Type CA4-10 ± 2pf

It should be noted however that the test set co-axial cable should be used whenever possible, as its inductance has been taken into consideration in the design of the test set. The standard items of equipment supplied with the test set and their capacitance values are as follows:-

6-core cable with plug and socket, Type CG114 - Not applicable

Co-axial cable with plugs, Type CE150-150 ± 3pf

Double Waymouth adaptor, Type CC3-4 ± 2pf

71. The capacitance values given in Table 7 have the total tolerance at each particular point quoted alongside. The desired meter reading of 2mA., therefore, should be obtained with the variable capacitor setting within these limits, provided that the system trimmers are correctly adjusted. On no account should the trimmer box settings be altered, these settings should only be adjusted during a functional check.

72. Referring to Table 7, the values quoted in column A are the true capacitances to be connected at each point, whilst those in column 'B' are the true capacitances less the capacitance of connecting cables and/or socket, i.e., the 'B' values are the actual test set variable capacitor settings, and the 'A' values are the theoretical values. Both are given so that the operator may make allowances accordingly, should he use a different method of connection.

73. The test set is not intended to serve as a standard for calibrating purposes, but rather as an aid to fault finding. However the test set can be used for testing individual units, providing an additional tolerance of 3 per cent is allowed on the test figures quoted in Table 1 to 7.

Individual unit checks

Tank units

74. The capacity and range of the tank units are given in Table 1. An insulation resistance of at least 20 megohms, using an insulation resistance tester, Type C, should be obtained for a new or replacement tank unit before installation, and at least 3 megohms for a single unit and 1 megohm for two or more units when tested in situ.

Tank terminal units

75. The capacitance of the tank terminal units, Type JM3, should be 21.1 ± 3pf. The terminal units should have an insulation resistance of not less than 20 megohms.

Complete tanks

76. The insulation resistance of each complete fuel tank, measured from the tank terminal unit should be at least 3 megohms. Note that the tanks should be completely drained of all fuel before attempting this test.

77. The capacitance values of each tank should be in accordance with the following figures:-

No. 1 tanks (port and starboard)

Capacitance installed, empty and dry - 1236 ± 35pf.

Capacitance installed with unusable fuel - 1242 ± 35pf.

Unusable fuel - 3 gallons.

No. 2 tanks (port and starboard)

Capacitance installed, empty and dry - 1194 ± 35pf.

Capacitance installed, with unusable fuel - 1194 ± 35pf.

Unusable fuel - 3 gallons.

No.3 tanks (port and starboard)

Capacitance installed, empty and dry - 781 ± 20pf.

Capacitance installed, with unusable fuel - 793 ± 20pf.

Unusable fuel - 5 gallons.

No.4 tanks (port and starboard)

Capacitance installed, empty and dry - 1074 ± 20pf.

Capacitance installed, with unusable fuel - 1080 ± 20pf.

Unusable fuel - 5 gallons.

No.5 tanks (port and starboard)

Capacitance installed, empty and dry - 917 ± 20pf.

Capacitance installed, with unusable fuel - 917 ± 20pf.

Unusable fuel - 2 gallons.

No.6 tanks (port and starboard)

Capacitance installed, empty and dry - 890 ± 20pf.

Capacitance installed, with unusable fuel - 899 ± 20pf.

Unusable fuel - 10 gallons.

No.7 tanks (port and starboard)

Capacitance installed, empty and dry - 1072 ± 35pf.

Capacitance installed with unusable fuel - 1092 ± 35pf.

Unusable fuel - 10 gallons.

Co-axial cables

78. The co-axial cables connecting between the tank terminal units, trimmer boxes and amplifiers should have an insulation resistance of at least 20 megohms whether new or installed. The capacitance values for these cables are given in Table 2.

Trimmer boxes

79. The trimmer boxes, Type JY3, JY4 and JY5, should have an insulation resistance of not less than 20 megohms, whether in situ or bench tested. Trimmer boxes, Type JY1, JY2, JY6, JY8 and JY9 each contain a coil which is connected to earth, therefore no insulation resistance test is possible on these units. These trimmer boxes may be considered serviceable provided that they conform to the capacitance figures given in Tables 3 and 4.

80. The capacitance of the trimmer boxes should be checked in accordance with the procedure laid down in Sect.5, Chap.2, Vol.1, of A.P.1275T, and the figures given in Tables 3 and 4. Note that before checking a trimmer box in accordance with the values in Table 4, the trimmers must be adjusted to their nominal value (mid-setting). Range into, and out of the box is the increase in capacitance above 2mA.

81. As no 'range' value is applicable to boxes JY3, JY4 and JY5, they may be considered serviceable if they conform to the input socket values given in Table 3. It will be seen from Table 3 that the 'capacitance out of box' figure is the 'tanks empty' capacitance of the amplifier less the capacitance of the connecting cable.

Amplifiers

82. As the amplifier, Type FCA, contains a 150-volt working condenser, which would be damaged by the higher insulation tester voltage, an insulation resistance test on these units must not be attempted. The amplifiers may be considered serviceable if they conform to the capacitance/indicator current test figure given in Table 5, using the test procedure outlined in A.P.1275T, Vol.1, Sect.5, Chap.2.

Contents indicators

83. An insulation resistance test must not be attempted on these units. They may be considered serviceable if they conform with the figures laid down in Table 6, using the test procedure outlined in A.P.1275T, Vol.1, Sect.5, Chap.2.

REFUELLING SYSTEM

84. Apart from the usual checks on the components of the refuelling panels 36P and 37P, and a check on the wiring for damage, security and cleanliness, little servicing is necessary to maintain the ground refuelling portion of the fuel system in a serviceable condition. It is important that the panel covers should not be removed for longer than is necessary, and replaced securely after inspection periods.

85. The ground refuelling system is

Table 1

Tank unit capacitance values

Tank unit	Initial capacitance (pf)	Range (pf)	Location
TC 166	285 ± 3	273 ± 3	No.1 tank (p & s)
TC167	258 ± 3	249 ± 3	No.1 tank (p & s)
TC168	280 ± 3	271 ± 3	No.1 tank (p & s)
TC169	256 ± 3	247 ± 3	No.1 tank (p & s)
TC140	268 ± 5	278 ± 3	No.2 tank (p & s)
TC141	245 ± 5	251 ± 3	No.2 tank (p & s)
TM2	400 ± 3	401 ± 3	No.3 tank (p & s)
TM3	293 ± 3	291 ± 3	No.3 tank (p & s)
TM4	580 ± 3	593 ± 3	No.4 tank (p & s)
TM5	408 ± 3	418 ± 3	No.4 tank (p & s)
TM6	491 ± 3	499 ± 3	No.5 tank (p & s)
TM7	332 ± 3	331 ± 3	No.5 tank (p & s)
TM8	491 ± 3	505 ± 3	No.6 tank (p & s)
TM9	324 ± 3	329 ± 3	No.6 tank (p & s)
TM10	297 ± 3	298 ± 3	No.7 tank (p & s)
TM11	195 ± 3	194 ± 3	No.7 tank (p & s)
TM12	278 ± 3	280 ± 3	No.7 tank (p & s)
TM13	191 ± 3	193 ± 3	No.7 tank (p & s)

calibrated and set up along with the contents gauging system at the contractors works during flight trials, and under normal circumstances, no further calibrations or adjustments will be necessary. Should fault conditions develop however, or any major component be replaced or renewed for any reason, the tank or group of tanks affected should be re-calibrated. The calibration and setting up procedure must be carried out in conjunction with the airframe and engine tradesmen responsible for the aircraft, observing all the precautions for handling the fuel system laid down in A.P.4505A & C, Vol.1, Book 1.

Setting up the refuelling system

86. The following calibration and setting up procedure is given on the assumption that a fuel tank or tanks replacement has been necessary, but the same principle will apply for any major component change. The number of tanks to be refuelled and defuelled will be determined by:-

(1) The number of tanks being newly installed.

(2) Maintenance of the aircraft C of G.

(3) The necessity to refuel the tank preceding the installed tank so that the system is primed.

87. To calibrate the ground refuelling system both the 112-volt and 28-volt external supplies must be connected, the ground refuelling tender connected to the refuelling connections and the stabilized voltage power pack switched on. Then proceed as follows:-

(1) Ensure that the aircraft is at approximately 5° wing incidence.

(2) Disconnect the fuel feed piping to the appropriate engine, upstream of the King coupling, and fit a length of flexible hose with a manually operated ON-OFF cock at the outlet end. The hose should be of sufficient length to reach a 50 gallon drum calibrated in 10 gallon divisions.

(3) It is now necessary to ensure proper wetting of the tank unit prior to setting the contents gauges to zero. Select 100% on the stabilised voltage power pack, set the bowser 'gallons gone' to zero, and commence refuelling of tanks in the group. Each tank should be filled to 90-95% capacity and the fuel allowed to soak for approximately ten minutes. When a particular tank has been filled to the required capacity the override switch on the refuelling panel should be employed to select the next tank in the group requiring fuel. Record the quantity of fuel delivered to each tank. Note that any pipes which have been disconnected should be checked for leaks when the pressure at the refuelling connection is approximately 50 p.s.i. This pressure must not be exceeded.

(4) The fuel in the tanks now requires to be emptied down to unusable fuel but without draining the refuelling galleries. To do this close all the ground servicing cocks except that of the new tank. Open the defuelling cock and with the assistance of the booster pump defuel from the newly installed tank the quantity of fuel delivered to the tank (3) less 20 gallons. Note that it may be necessary at this stage to defuel from other tanks to maintain the aircraft C of G. As each tank is defuelled only the ground service cock of that tank must be open.

(5) After completion of the de-fuelling, close the de-fuelling cock and open all the ground servicing cocks. Open the L.P. cock for the tank group, and, with the aid of the booster pump, drain the fuel remaining in the newly installed tank via the pipe fitted upstream of the King coupling. As the flow from the tank is reduced to a very low flow of pencil thickness, the pump should be switched off. Repeat the operation for any other tanks refuelled in (3). Alternatively in cases where it is inconvenient to break down the engine feed pipe, fuel may be pumped out to a bowser via the defuelling cock. The booster pumps only should be used, and NO suction from the bowser should be introduced. Pumping should be continued until flow ceases, as indicated on the bowser "gallons gone" indicator.

(6) Set the contents gauge for the newly installed tank to zero as outlined in para.59. Note that the gauge unit must never be set to give a reading above zero; any slight tolerance should be below the zero mark. It is important also that the gauge be set to read zero immediately after draining, while the tanks are still wet.

(7) Disconnect the cable attached to terminal H on the group moving coil relay. This action will isolate the relief relay, thus making percentage refuelling selection inoperative to permit fuel to reach the level of the fuel float switches in the tanks.

(8) Connect a suitable 24-volt low wattage test lamp between the fuel level switch and earth. Note that the test lamp will indicate when the fuel switch has operated to

close, but the next tank will not be selected; this will assist in the accurate assessment of the quantity of fuel delivered into the tanks.

(9) Refuel the necessary tanks (para.86) to the limit provided by the fuel level switches. As the fuel reaches the level switch, the rate of refuelling should be reduced to avoid possible overfilling and subsequent damage to the system. When the test lamp has illuminated, stop refuelling, and record the amount of fuel delivered to the tank. (Gallons gone indicator on the refuelling tender). It will be necessary to operate the manual override switch on the refuelling panel to select the next tank.

(10) Drain 10 gallons of fuel from the newly installed tank, via the on/off cock in the drain, and reconnect the cable to terminal H on the moving coil relay (sub-para.7).

88. Due to variations in specific gravity of fuels that can be used in the aircraft, table 8 has been compiled to provide a setting for the refuelling stabilized voltage power unit with respect to the S.G. of the fuel used at the time of calibration.

NOTE...

The results obtained in Table 8 are derived from the formula:-

Refuelling Power Unit Setting in %

$$= \frac{100 \times \text{S.G. of fuel used}}{0{\cdot}8}$$

89. The next step in the calibration procedure is to check the current differential of the tank group moving coil relay, and then set the newly installed tank circuit to this value. The most convenient tank to check for the differential, which may be checked on any tank within the group, is the No.4 tank for groups 1 and 4 and the No.3 tank for groups 2 and 3. For a clearer understanding of the calibration technique used, the No.2 tank group will be considered, therefore, the No.3 tank will be used to check the differential and the No.6 tank will be considered as being the newly installed tank. In the event of other tank groups requiring calibration, the appropriate tank identification number must be substituted into the following procedure:-

(1) Disconnect the co-axial cable from the tank terminal unit of tank No.3.

(2) Check and record the S.G. of the fuel drained in para.87 (10).

(3) Connect the Q.A.A. test set Ref.No.6C/864 to the disconnected co-axial cable (1).

(4) Adjust the stabilized voltage unit to a percentage setting in accordance with table 8 and (2).

(5) Select tank No.3 by repeated operation of the override switch on the associated refuelling panel. Slowly increase the capacitance on the Q.A.A. test set until the moving coil relay operates to select the next tank, in this case, No.6 tank. At this point decrease the test set capacitance by 20 pF.

(6) Re-select tank No.3 as in (5) and then increase the capacitance of the test set very, very slowly until the moving coil relay just trips again.

(7) Disconnect terminal H on the moving coil relay and then again re-select No.3 tank as in (5).

(8) Measure the current differential between colis A and B using a high grade 0-10 milliammeter in the following way:-

(a) Connect the milliammeter in series between the positive terminal of moving coil B and the cable disconnected from it, the reading should be carefully noted.

(b) Re-connect the normal connections to coil B and then connect the milliammeter in series with coil A, just as with coil B. Measure the current passing through coil A, and carefully note the reading.

(9) The differential can now be determined by subtracting the figure noted in 8(a) from the figure noted in 8(b). The differential should be 2mA ± 80 micro-amps, and the exact value noted.

(10) With the milliammeter still connected in series with the A coil, disconnect the co-axial cable from the Q.A.A. test set and re-connect the cable to the No.3 tank terminal unit. Check the exact current flowing in coil A, then subtract from this the differential obtained in (9). Note the figure obtained and set coil B to this figure via the associated resistance trimmer. Re-connect the milliameter in series with coil A.

(11) With the newly installed tank No.6 refuelled in accordance with para.87, select the new tank on the refuelling panel. Check the current passing through the 'A' coil then subtract from this figure the differential found in (9).

(12) Set coil B to the figure derived in (11) via the associated resistance trimmer. Lock the trimmer and

check that the current value is still correct.

(13) The same procedure outlined in (11) and (12) should be carried out on the remaining tanks within the group to ensure correct operation of the auto-selector at the chosen percentage setting.

(14) Disconnect the milliammeter and reconnect the cables to the moving coil relay and terminal H. Remove the test lamps and refuelling equipment fitted in para.87 and reconnect the fuel level switches.

Table 2

Co-axial cable details

Cable	Length (inches)	Capacitance (pf)
CS12	12	22 ± 3
CC15	15	28 ± 3
CD16	16	30 ± 3
CD24	24	43 ± 3
CR42	42	76 ± 3
CZ50	50	90 ± 3
CR52	52	94 ± 3
CR57	57	103 ± 3
CR66	66	119 ± 3
CR87	87	156 ± 3
CR108	108	194 ± 5

90. With the refuelling selector set as in para.89; and wiring to terminal H on the moving coil relay reconnected. Select the first tank in the group on the refuelling panel. If the trimmers are set correctly the auto-selector should operate and each tank should trip in turn.

91. De-fuel the tanks as in para.87; note that it may be necessary to de-fuel other tanks to maintain the aircraft C of G; then check that the contents gauges read zero.

92. Re-fuel the new tank to 20, 40, 60. 80, and 100% selection. Record the quantities of fuel indicated on the refuelling tender flowmeter , subject to condition imposed in the next paragraph, and the aircraft contents gauges at each percentage level.

93. As stated in para.57, the gauging system is calibrated to give maximum accuracy with a Kerosene fuel having a permittivity of 2·10 and a specific gravity of 0·779 at a temperature of 20 deg.C. Due to the variations in the fuel used, it will be necessary therefore to correct the refuelling tender flowmeter readings before comparing them with the aircraft contents gauge readings. To do this, measure the S.G. of the fuel being used, and correct as follows:-

Gallons gone x S.G. x 10 = fuel in lbs.
Record the final fuel figures.

At 100% selection the bowser gallons should be within ± 10 gallons of the theoretical 100% figures given in Table 9. At all percentage selections the gauge readings should agree with the calculated weight of fuel within ± 6% of the 100% value. The gauge tolerance at any selection is found as follows:-

$$\pm \frac{\text{calculated weight of 100\% fuel} \times 6}{100}$$

The group contents should be noted at each percentage filling and the gauge error should not be more than ± 4% of the group 100% calculated weight.

Panels 36P and 37P

94. A test panel Ref.No.26DC/95206 is available for checking panels 36P and 37P throughout their full working range. The panel is not designed for "in situ" testing and will normally be used in a suitably equipped test house. A full description of the panel and its method of use will be found in A.P.4343V, Vol.1, Sect.4.

Stabilized voltage power unit

95. Should it become necessary at any time to adjust the power unit, it must be removed from the aircraft, and set up in the following manner:-

(1) Connect the power unit to a d.c. supply variable between 22 and 29 volts, allowing sufficient time for warm up and stable operation.

(2) Using a testmeter Type D set to the 400 volt d.c. range, measure the -180-volt line with respect to earth, and set to -180 volts by adjustment of R8 and R9.

(3) Check that a range of 0-50 volts can be obtained at the output terminals when the selector potentiometer (R20) is adjusted, also that the voltage range is proportionately read in conjunction with the built in voltmeter calibrated 0-100%. If the range 0-50 volts or 100% cannot be obtained, adjust R14 and R18 in the following manner:-

(a) If the selector potentiometer is at the end of its travel and a reading of less than 50 volts or 100% is obtained, correction can be achieved by setting the selector potentiometer to 50%, adjust R14 so that 55% indication occurs on the built-in voltmeter, then adjust R18 to restore the reading on the built-in voltmeter to 50%. For optimum setting the procedure for R14 and R18 should be done several times. Check that readings for 50 volts or 100% can now be obtained.

(b) If the output voltage exceeds the required voltage at the output terminals, the procedure is to set the selector potentiometer to 50%, adjust R14 to read 45% in the built-in voltmeter, and then restore the reading to 50% by adjustment of R18. Check that readings for 50 volts or 100% can now be obtained, slight adjustment of R14 and R18 may also be necessary for optimum setting of 50 volts or 100% output.

(4) To obtain optimum regulation, potentiometer R4 may be adjusted. In the event of regulation falling off as the selector potentiometer is positioned towards 100% output, the -180 volt line must be reduced by a small amount by R8 and R9. The potentiometer R14 and R18 must then be reset to allow the selector potentiometer to control the correct range of the output. Once R8 and R9 have been set for optimum regulation they must not be altered. Any subsequent adjustments must be made via R14 and R18 only. To check for optimum setting, vary the input voltage from 22 to 29 volts and note the change in output. The output should be maintained within 0·5 volt of the original output setting.

NOTE...

When a defective valve is to be replaced, it must be replaced with one of the exact type specified, and under no circumstances should a valve of near similar characteristics be used.

96. A test panel Ref.No.26DC/95205 is available as a means of checking the on-load output voltage characteristic of the stabilized voltage power unit. The unit is fully described in A.P.4343V, Vol.1, Sect.4. The appropriate test procedure will be found in the same chapter.

REMOVAL AND INSTALLATION

General

97. The removal and installation of the major components in the various systems is straightforward and no special instructions are required. The safety precautions in Group 9A must be carried out before entering any tank to remove or refit internal units.

TABLE 3

Trimmer box details

Trimmer box type	Tanks empty capacitance into box at input socket: Trimmer at min. not less than	Tanks empty capacitance into box at input socket: Box input nominal value	Tanks empty capacitance into box at input socket: Trimmer at max. not more than	'Tanks empty' capacitance out of box
JY1	1433pf	1388pf	1343pf	1470pf
JY2	1380pf	1335pf	1290pf	1457pf
JY3	270pf	1268pf	150pf	1478pf
JY4	649pf	874pf	559pf	1478pf
JY5	369pf	1154pf	279pf	1478pf
JY6	1081pf	1036pf	991pf	1472pf
JY8	1132pf	1087pf	1042pf	1478pf
JY9	1224pf	1179pf	1134pf	1478pf

TABLE 4

Trimmer box ranges

Trimmer box type	Range out of box	Range into box
JY1	1000pf	1055pf
JY2	1000pf	1055pf
JY6	850pf	884pf
JY8	790pf	824pf
JY9	890.5pf	1024pf

Range into box ± 1%

TABLE 5

Amplifier details

Type FCA
Power supply
Nominal voltage 28 volts
Current at 28 volts 0·7 amp.

Capacitance -
Initial input at tanks empty - 1500pf
Tanks full input - 2500pf
Range - 1000pf

Relationship between indicator current and capacitance with a power supply of 28 volts:-

Capacitance (pf)	*Indicator current (Ma.)*
1500	2·0 ± ·03
1700	3·0 ± ·05
1900	4·0 ± ·05
2100	5·0 ± ·05
2300	6·0 ± ·05
2500	7·0 ± ·05

TABLE 6

Fuel contents indicator details

Indicator Type A.O.10

Indication inner scale (lbs. x 1000)	Indicator current (Ma.)	Indication outer scale (lbs. x 1000)	Indicator current (Ma.)
0	8·00	0	2·00
1	8·60	0·2	2·12
2	9·39	0·4	2·26
3	10·49	0·6	2·45
4	11·51	0·8	2·67
5	12·57	1·0	2·87
6	13·63	1·2	3·09
7	14·70	1·4	3·30
8	15·78	1·6	3·51
9	16·86	1·8	3·73
10	17·94	2·0	3·94
11	19·03	2·2	4·16
12	20·14	2·4	4·38
13	21·16	2·6	4·59
14	22·25	2·8	4·81
15	23·30	3·0	5·02
16	24·33	3·2	5·25
17	25·38	3·4	5·46
18	26·42	3·6	5·67
18,224(F)	26·70	3·8	5·89
		4·0	6·10
		4·2	6·30
		4·4	6·51
		4·6	6·72
		4·8	6·92
		5·0	7·11

TABLE 6 - contd.

Indicator Type A.O.12

Indication inner scale (lbs. x 1000)	Indicator current (Ma.)	Indication outer scale (lbs. x 1000)	Indicator current (Ma.)
0	6·00	0	2·00
1	6·53	0·2	2·09
2	7·16	0·4	2·21
3	7·87	0·6	2·34
4	8·55	0·8	2·48
5	9·26	1·0	2·62
6	9·99	1·2	2·76
7	10·71	1·4	2·90
8	11·42	1·6	3·05
9	12·16	1·8	3·20
10	12·89	2·0	3·33
11	13·64	2·2	3·48
12	14·38	2·4	3·63
13	15·11	2·6	3·77
14	15·83	2·8	3·91
15	16·55	3·0	4·06
16	17·22	3·2	4·21
17	17·85	3·4	4·35
17,964(F)	18·67	3·6	4·49

TABLE 6 - contd.

Indicator Type A.O.12

Indication inner scale (lbs. x 1000)	Indicator current (Ma.)	Indication outer scale (lbs. x 1000)	Indicator current (Ma.)
		3·8	4·65
		4·0	4·79
		4·2	4·94
		4·4	5·09
		4·6	5·22
		4·8	5·37
		5·0	5·50
		5·2	5·65
		5·4	5·80
		5·6	5·95
		5·8	6·09
		6·0	6·24
		6·2	6·40
		6·4	6·54
		6·6	6·66
		6·8	6·80
		7·0	6·93
		7·2	7·08
		7·4	7·22

TABLE 6 - contd.

Indicator Type A.G.14 Indicator Type A.G.15

Indication (lbs. x 1000)	Indicator current (Ma.)	Indication (lbs. x 1000)	Indicator current (Ma.)
0	8·00	0	6·00
1	8·60	1	6·53
2	9·39	2	7·16
3	10·49	3	7·87
4	11·51	4	8·55
5	12·57	5	9·26
6	13·63	6	9·99
7	14·70	7	10·71
8	15·78	8	11·42
9	16·86	9	12·16
10	17·94	10	12·89
11	19·03	11	13·64
12	20·14	12	14·38
13	21·16	13	15·11
14	22·25	14	15·83
15	23·30	15	16·55
16	24·33	16	17·22
17	25·38	17	17·85
18	26·42	17,964(F)	18·67
18,224(F)	27·70		

TABLE 7

Tank circuit testing values

Tank No.	Test point	Test capacitance 'A' (pF)	Test capacitance 'B' (pF)	Adaptors and cables used	Approximate reading on: Aircraft indicator	Approximate reading on: Test set meter
1 Port	A1	1470 ± 3	1312 ± 8	CE150-CC1	Zero contents	2mA
	A2	1398 ± 38	1230 ± 45	CE150-CC1-CR4	Zero contents	2mA
	A3	1242 ± 35	1084 ± 40	CE150-CC1	Zero contents	2mA
1 Stbd.	A1	1457 ± 3	1299 ± 8	CE150-CC1	Zero contents	2mA
	A2	1445 ± 38	1277 ± 45	CE150-CC1-CR4	Zero contents	2mA
	A3	1242 ± 35	1084 ± 40	CE150-CC1	Zero contents	2mA
2 Port and Stbd.	B1	1478 ± 3	1320 ± 8	CE150-CC1	Zero contents	2mA
	B2	1270 ± 38	1102 ± 45	CE150-CC1-CR4	Zero contents	2mA
	B3	1194 ± 35	1036 ± 40	CE150-CC1	Zero contents	2mA
3 Port and Stbd.	C1	1478 ± 3	1320 ± 8	CE150-CC1	Zero contents	2mA
	C2	887 ± 23	719 ± 30	CE150-CC1-CR4	Zero contents	2mA
	C3	793 ± 20	635 ± 25	CE150-CC1	Zero contents	2mA
4 Port and Stbd.	D1	1478 ± 3	1320 ± 8	CE150-CC1	Zero contents	2mA
	D2	1156 ± 23	988 ± 30	CE150-CC1-CR4	Zero contents	2mA
	D3	1080 ± 20	922 ± 25	CE150-CC1	Zero contents	2mA
5 Port and Stbd.	E1	1472 ± 3	1314 ± 8	CE150-CC1	Zero contents	2mA
	E2	1036 ± 23	868 ± 30	CE150-CC1-CR4	Zero contents	2mA
	E3	917 ± 20	759 ± 25	CE150-CC1	Zero contents	2mA
6 Port and Stbd.	F1	1478 ± 3	1320 ± 8	CE150-CC1	Zero contents	2mA
	F2	1093 ± 25	925 ± 32	CE150-CC1-CR4	Zero contents	2mA
	F3	899 ± 20	741 ± 25	CE150-CC1	Zero contents	2mA
7 Port and Stbd.	G1	1478 ± 3	1320 ± 8	CE150-CC1	Zero contents	2mA
	G2	1182 ± 38	1014 ± 35	CE150-CC1-CR4	Zero contents	2mA
	G3	1092 ± 35	934 ± 40	CE150-CC1-CR4	Zero contents	2mA

TABLE 8

Power Unit Selection - Fuel S.G.

S.G. of Fuel Used	Refuelling Power Unit Selection, for 'B' Coil Trimming
0·8	100%
0·79	98·75%
0·78	97·5%
0·77	96·25%
0·76	95·0%
0·75	93·75%

TABLE 9

Fuel tank capacities

Tanks	Gals. fuel S.G. 0·8	LB. fuel S.G. 0·8	Gals. fuel S.G. 0·78 0·75	Fuel S.G. 0·78	LB. Fuel S.G. 0·77	LB. Fuel S.G. 0·76	LB. Fuel S.G. 0·75
1	2 x 625	2 x 5,000	2 x 635	2 x 4,953	2 x 4,890	2 x 4,826	2 x 4,763
2	2 x 945	2 x 7,560	2 x 955	2 x 7,449	2 x 7,353	2 x 7,258	2 x 7,163
3	2 x 630	2 x 5,040	2 x 640	2 x 4,992	2 x 4,928	2 x 4,864	2 x 4,800
4	2 x 620	2 x 4,960	2 x 630	2 x 4,914	2 x 4,851	2 x 4,788	2 x 4,725
5	2 x 510	2 x 4,080	2 x 520	2 x 4,056	2 x 4,004	2 x 3,952	2 x 3,900
6	2 x 735	2 x 5,880	2 x 745	2 x 5,811	2 x 5,736	2 x 5,662	2 x 5,587
7	2 x 550	2 x 4,400	2 x 560	2 x 4,368	2 x 4,312	2 x 4,256	2 x 4,200
TOTAL	9,230	73,840	9,370	73,086	72,148	71,212	70,276

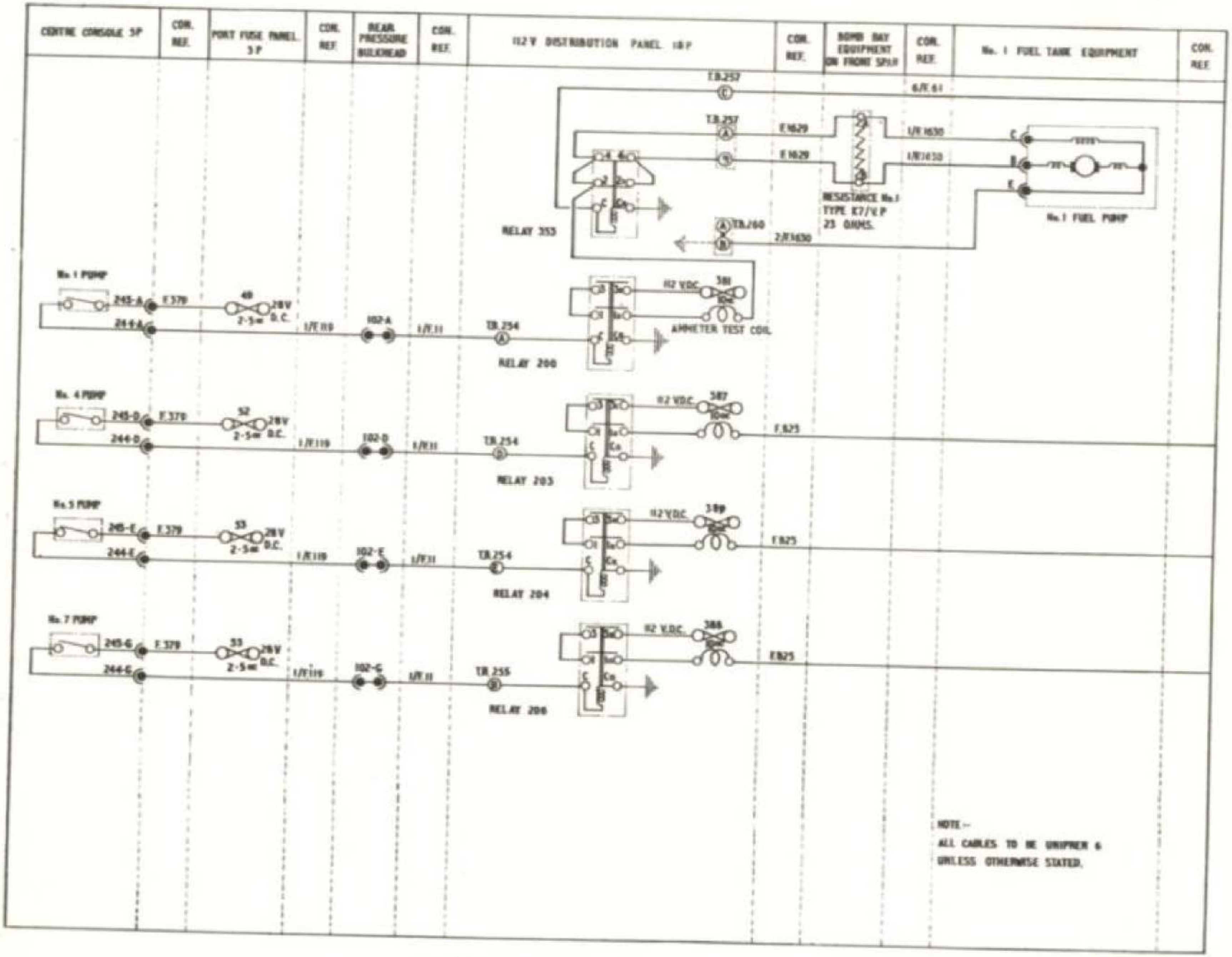

Fig 15(1) Nº 1,4,5, and 7 port fuel pumps

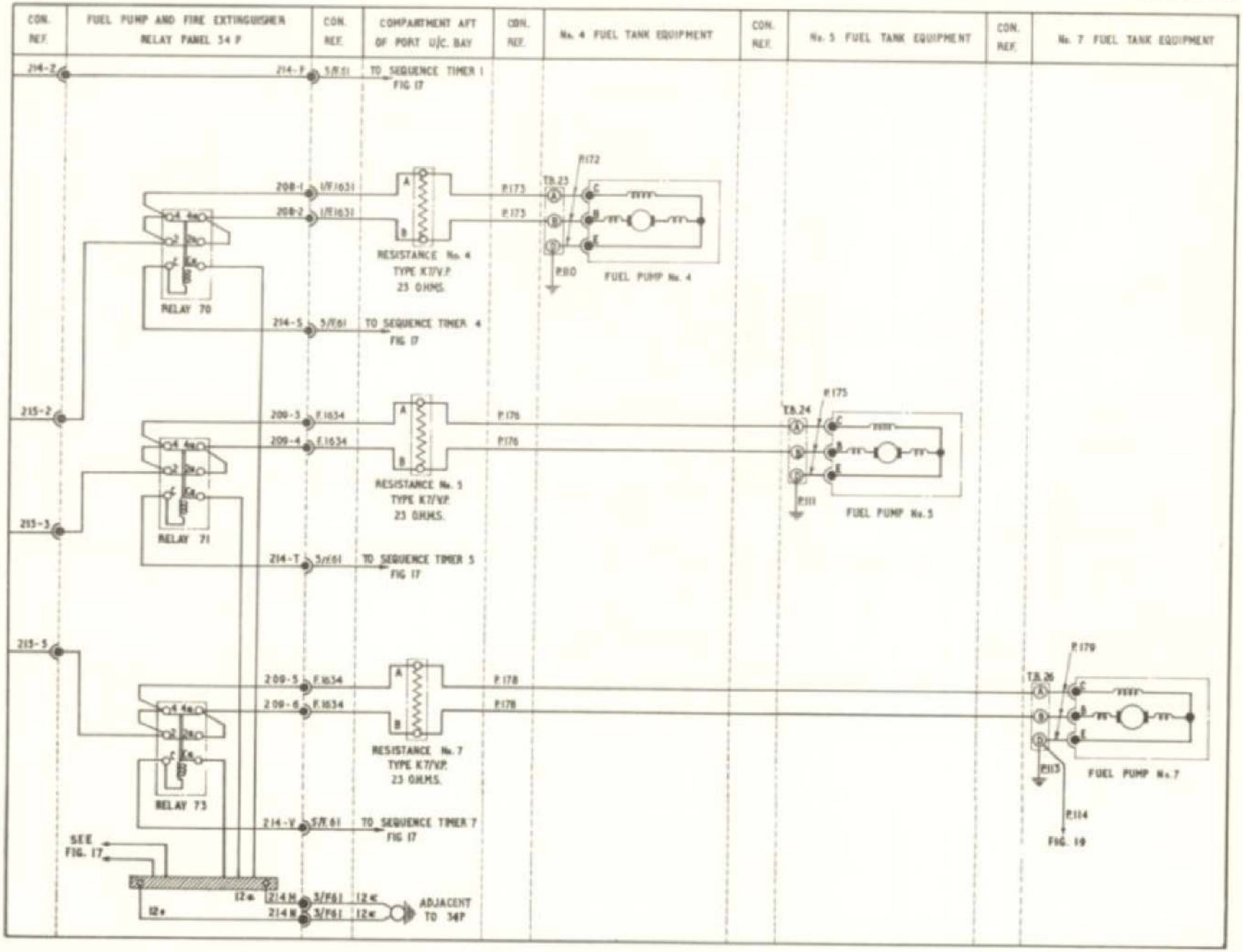

Fig. 15 (2) Nº 1, 4, 5, and 7 port fuel pumps

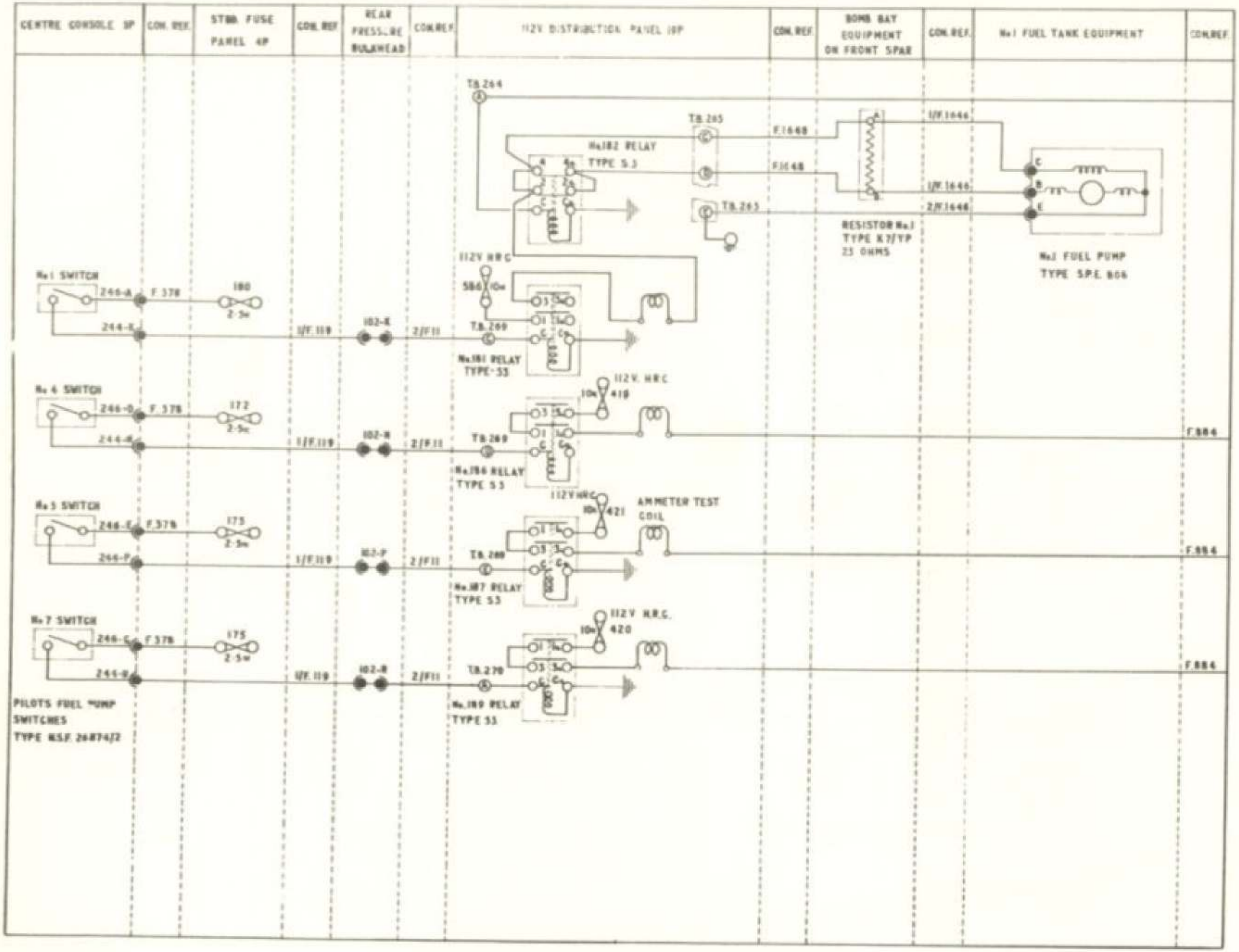

Fig.16(1) Nº 1, 4, 5 and 7 starboard fuel pumps

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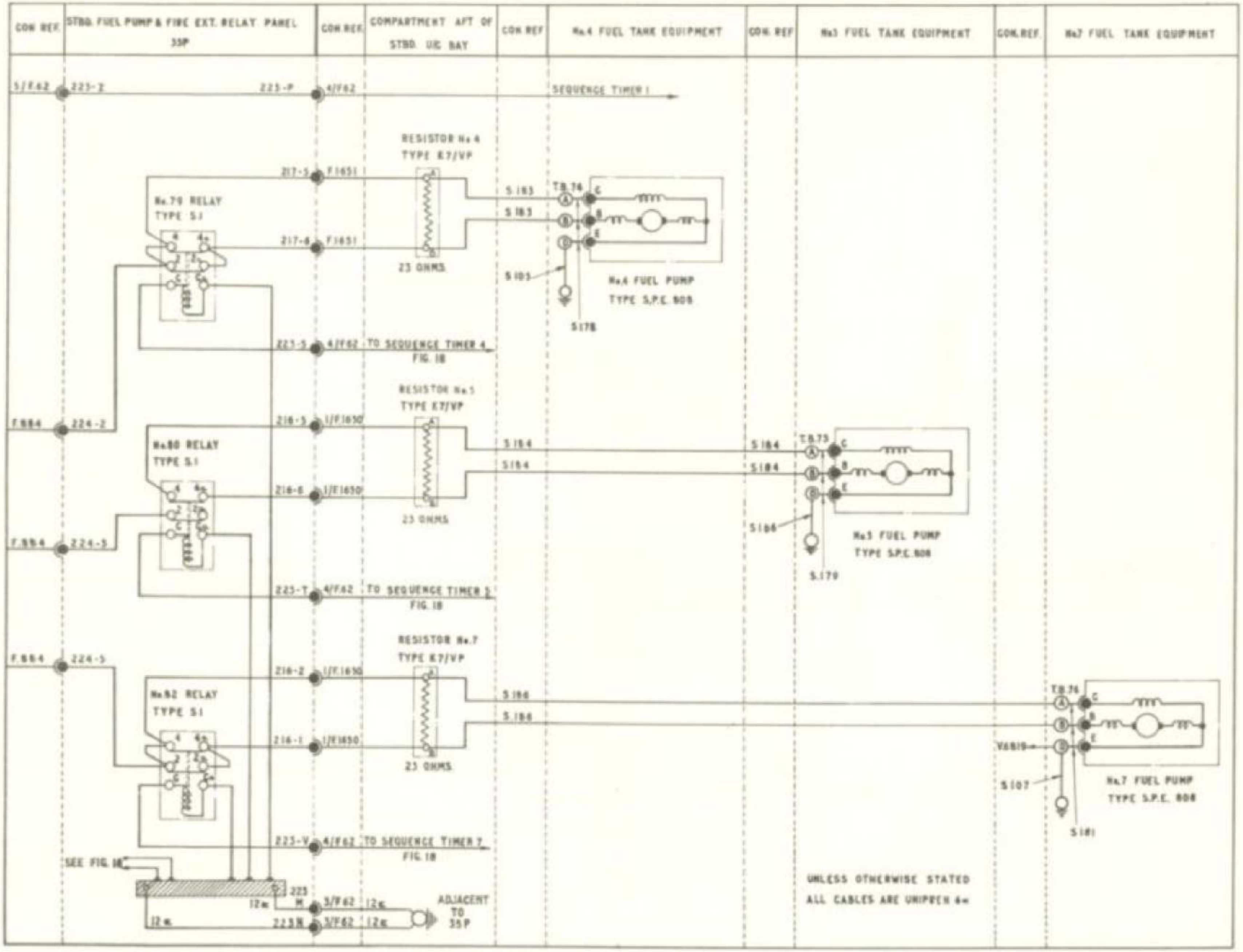

Fig. 16 (2) Nº 1, 4, 5 and 7 starboard fuel pumps

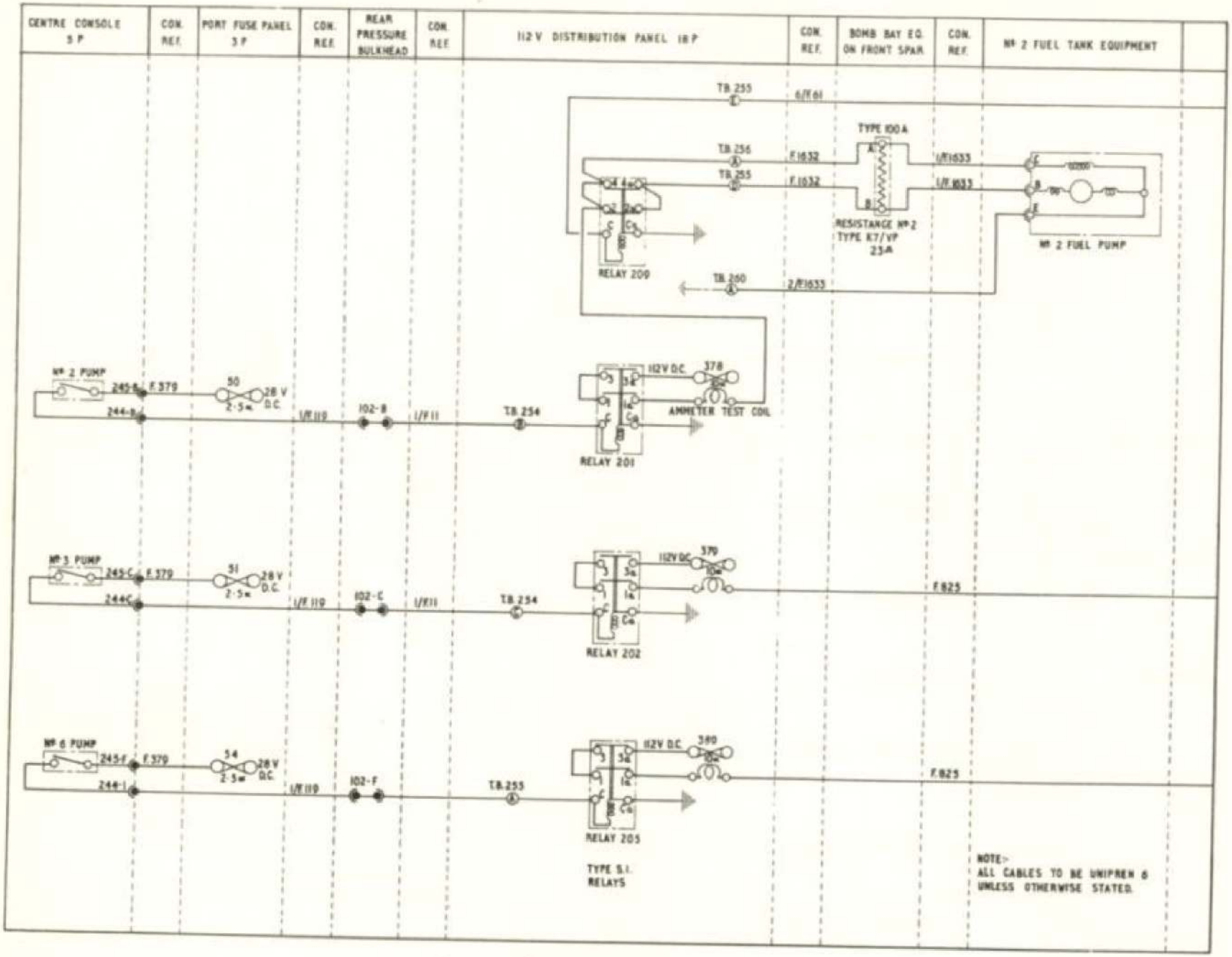

Fig 17 (1) Nº 2, 3, and 6 port fuel pumps

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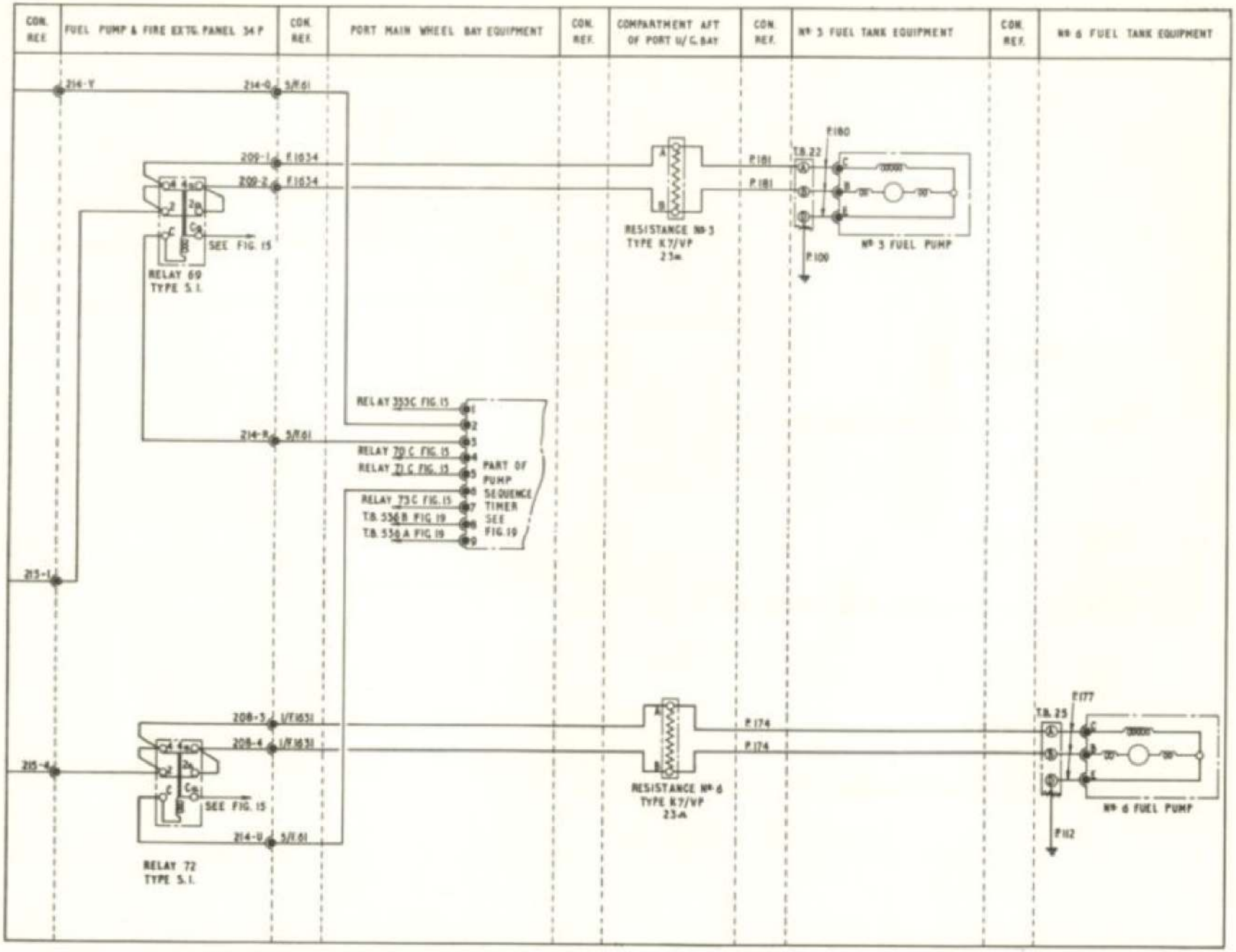

Fig. 17 (2) Nº 2, 3 and 6 port fuel pumps

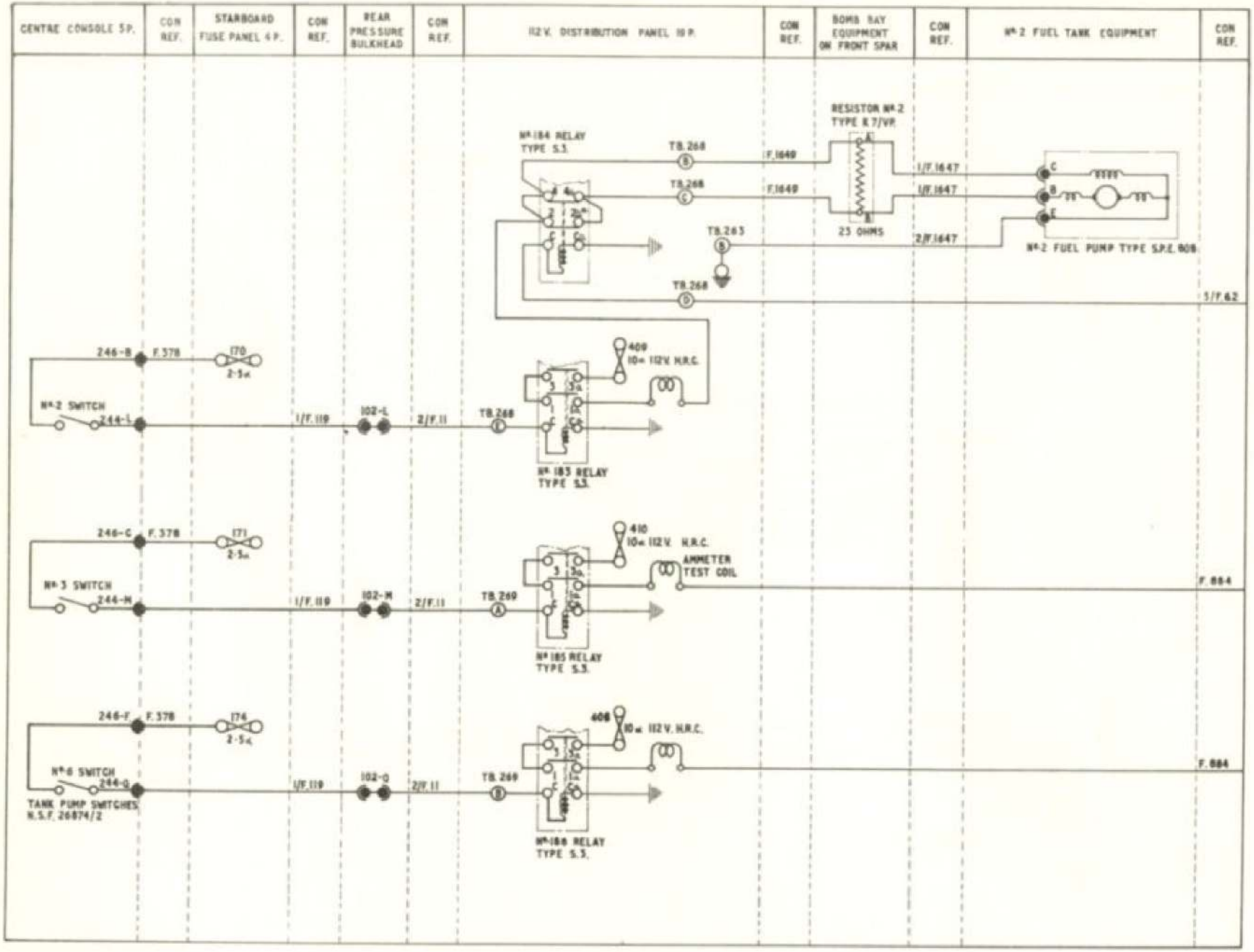

Fig. 18 (1) Nº 2, 3 and 6 starboard fuel pumps

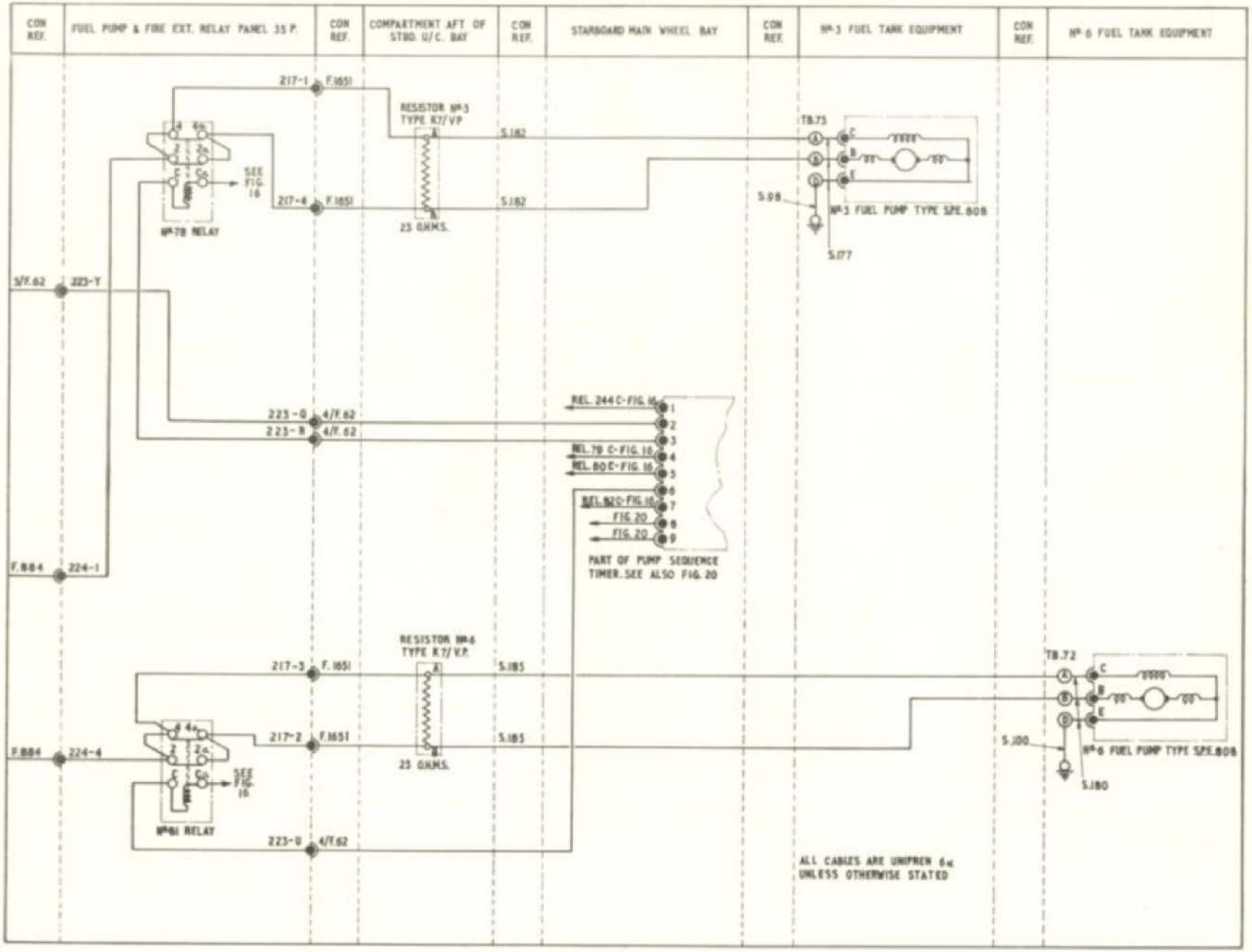

Fig 18. (2) Nº 2, 3 and 6 starboard fuel pumps

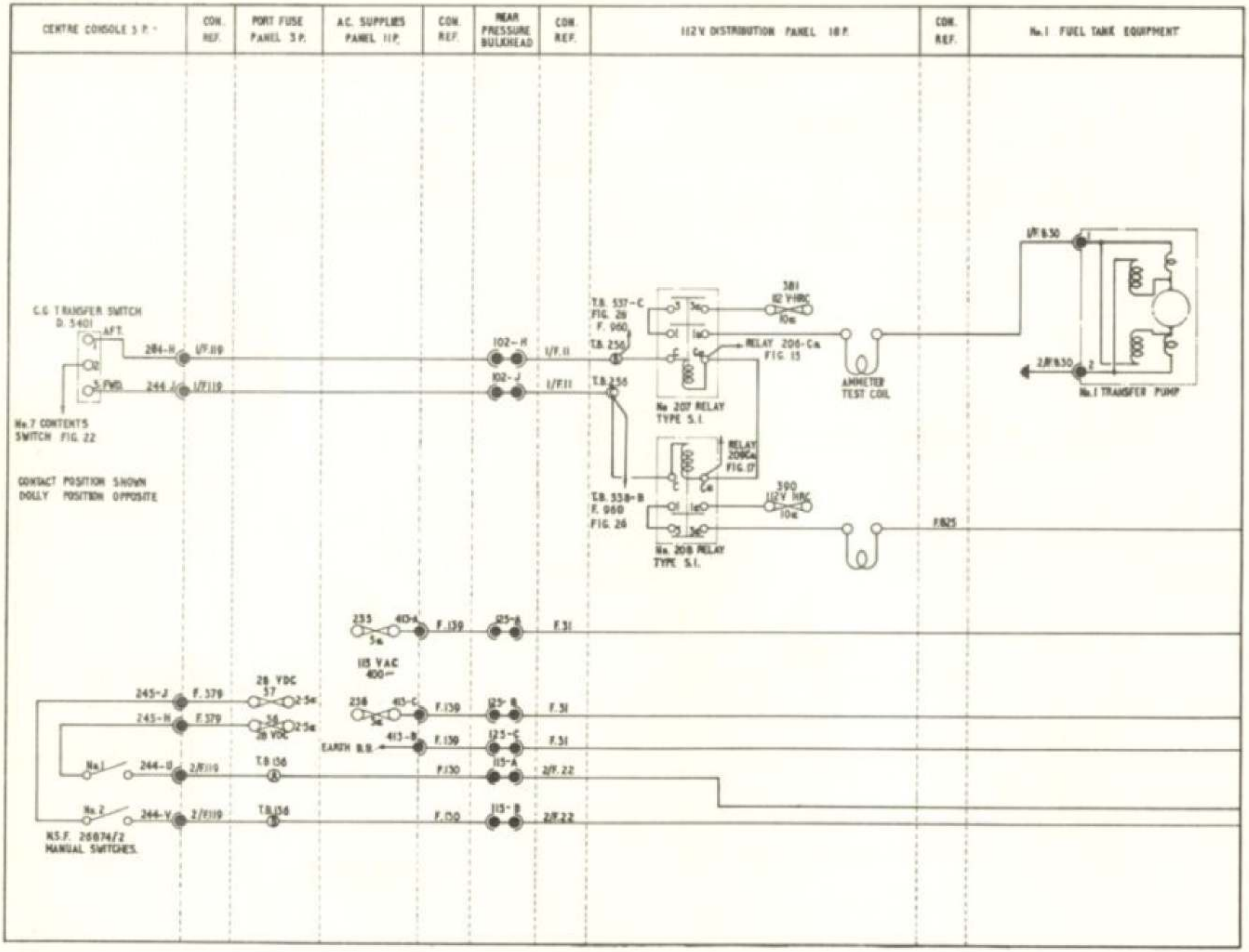

Fig 19 (1) Nº 1 and 7 port transfer fuel pumps

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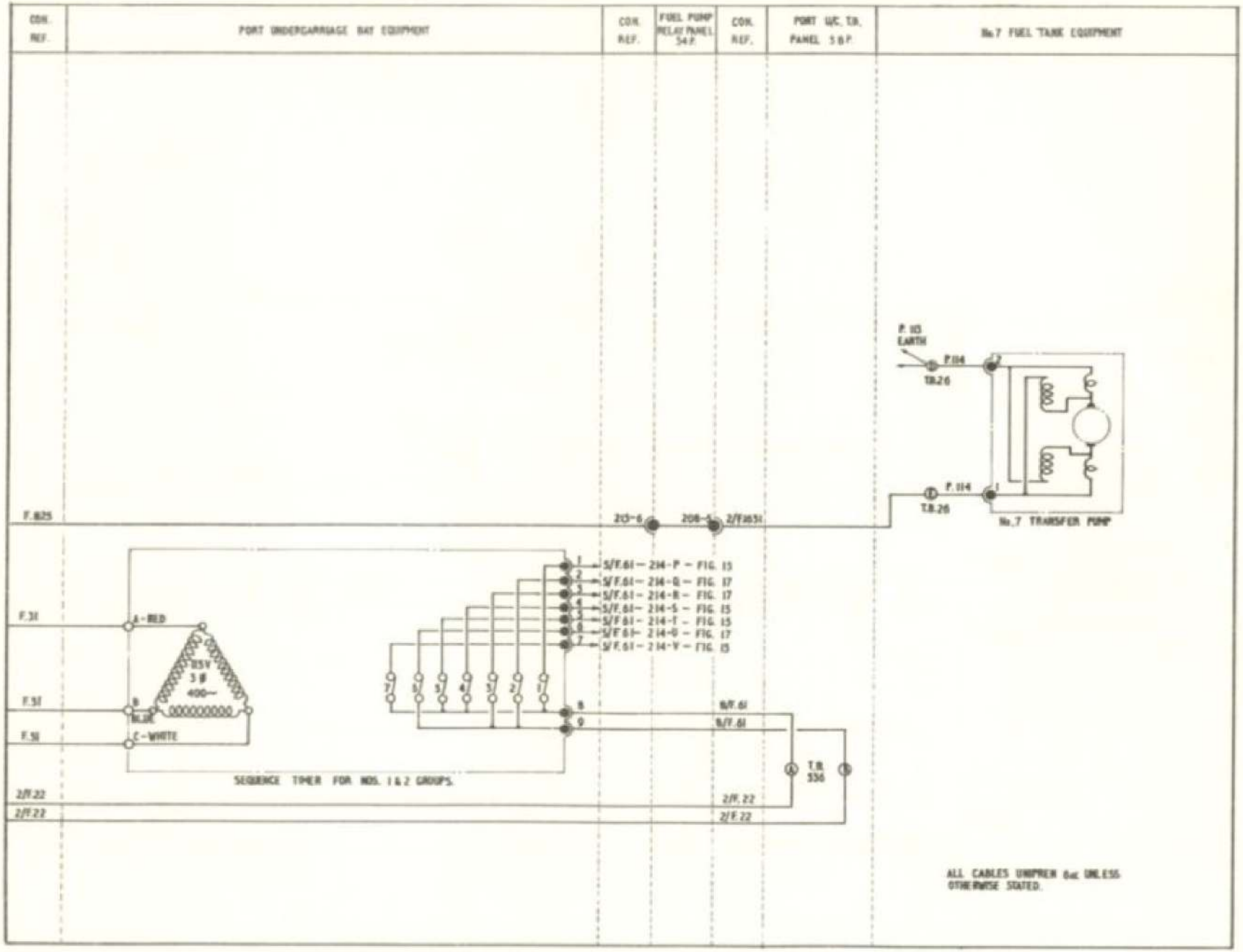

Fig 19 (2) Nº 1 and 7 port transfer fuel pumps

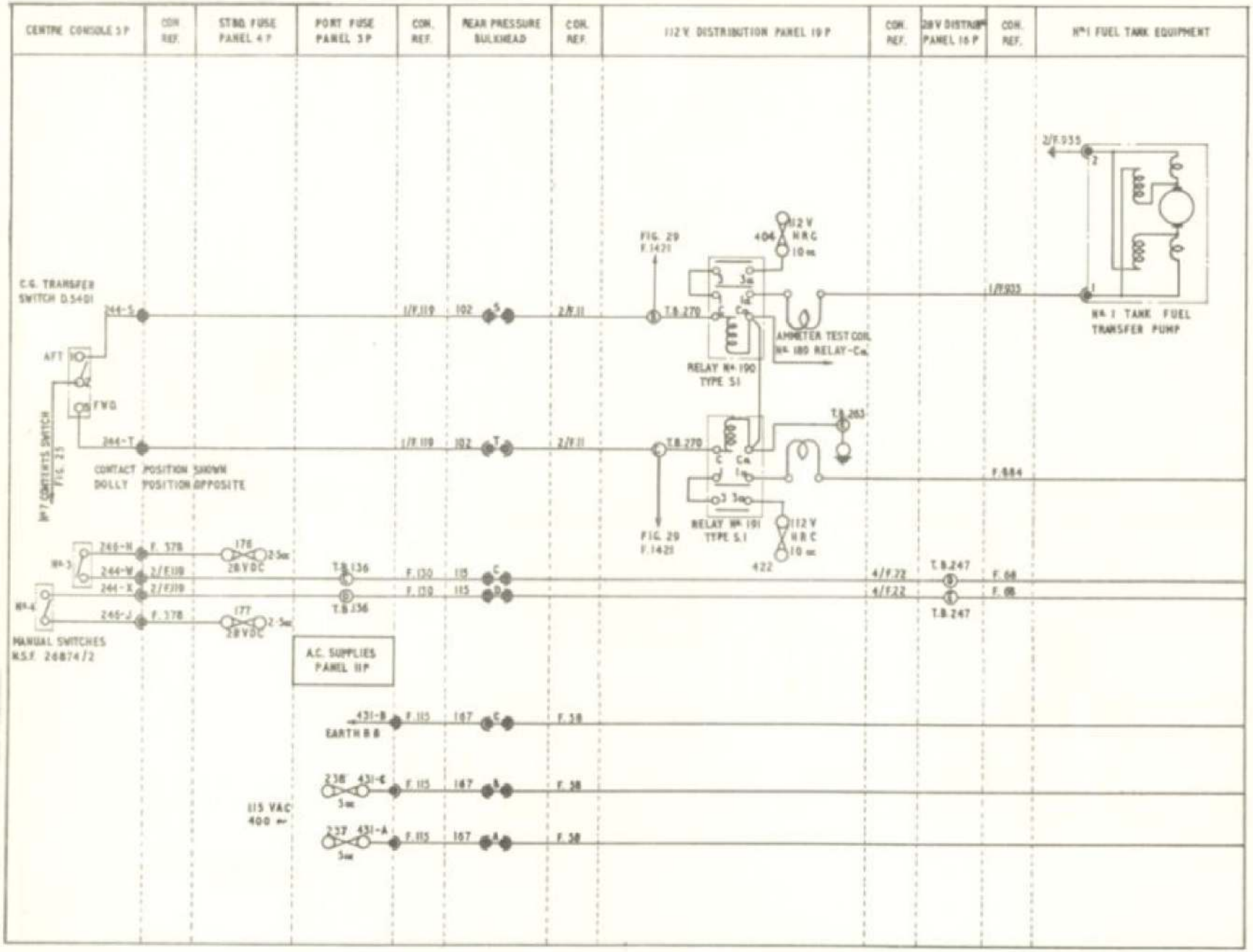

Fig 20 (1) Nº 1 and 7 starboard transfer fuel pumps

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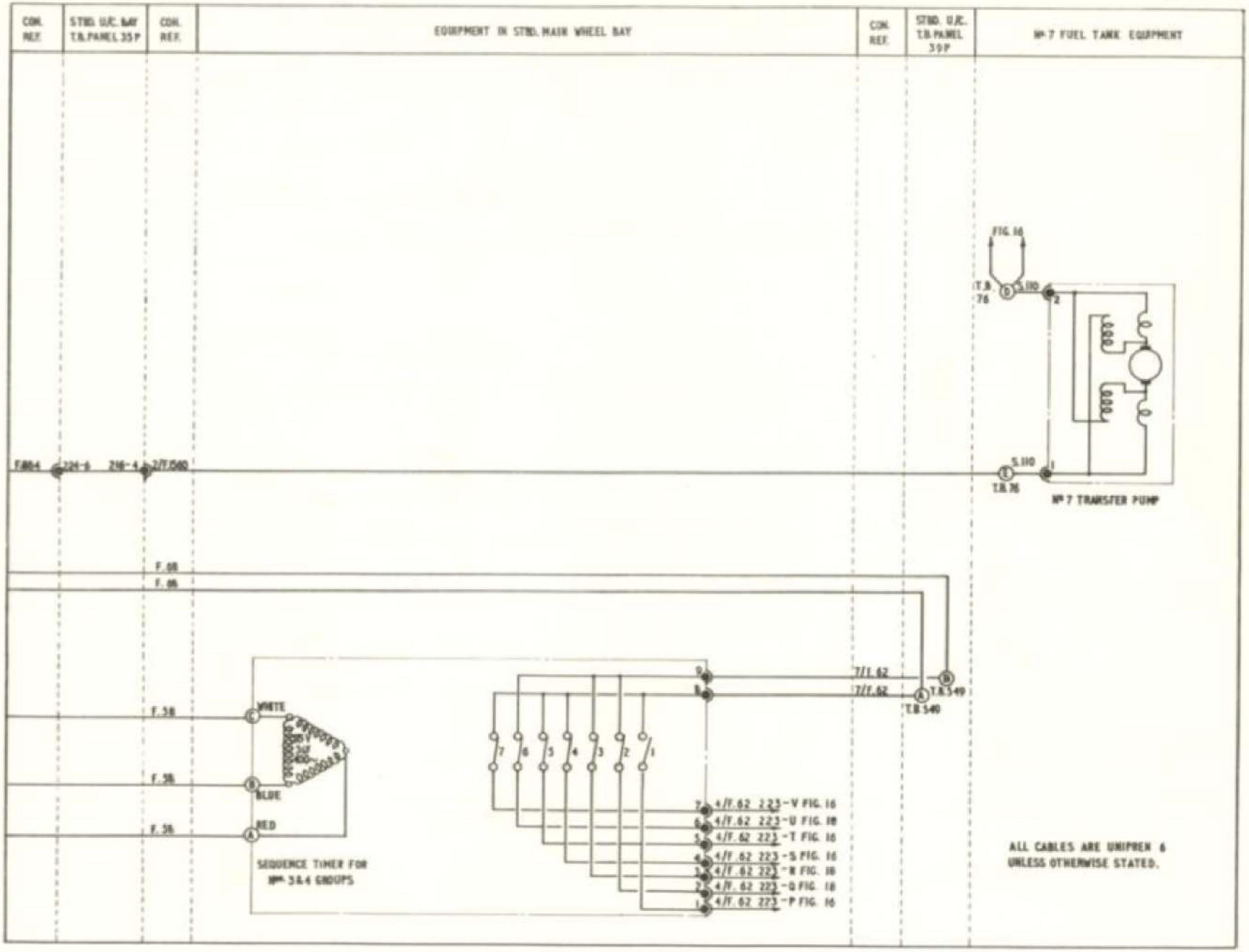

Fig. 20 (2) No. 1 and 7 starboard transfer fuel pumps

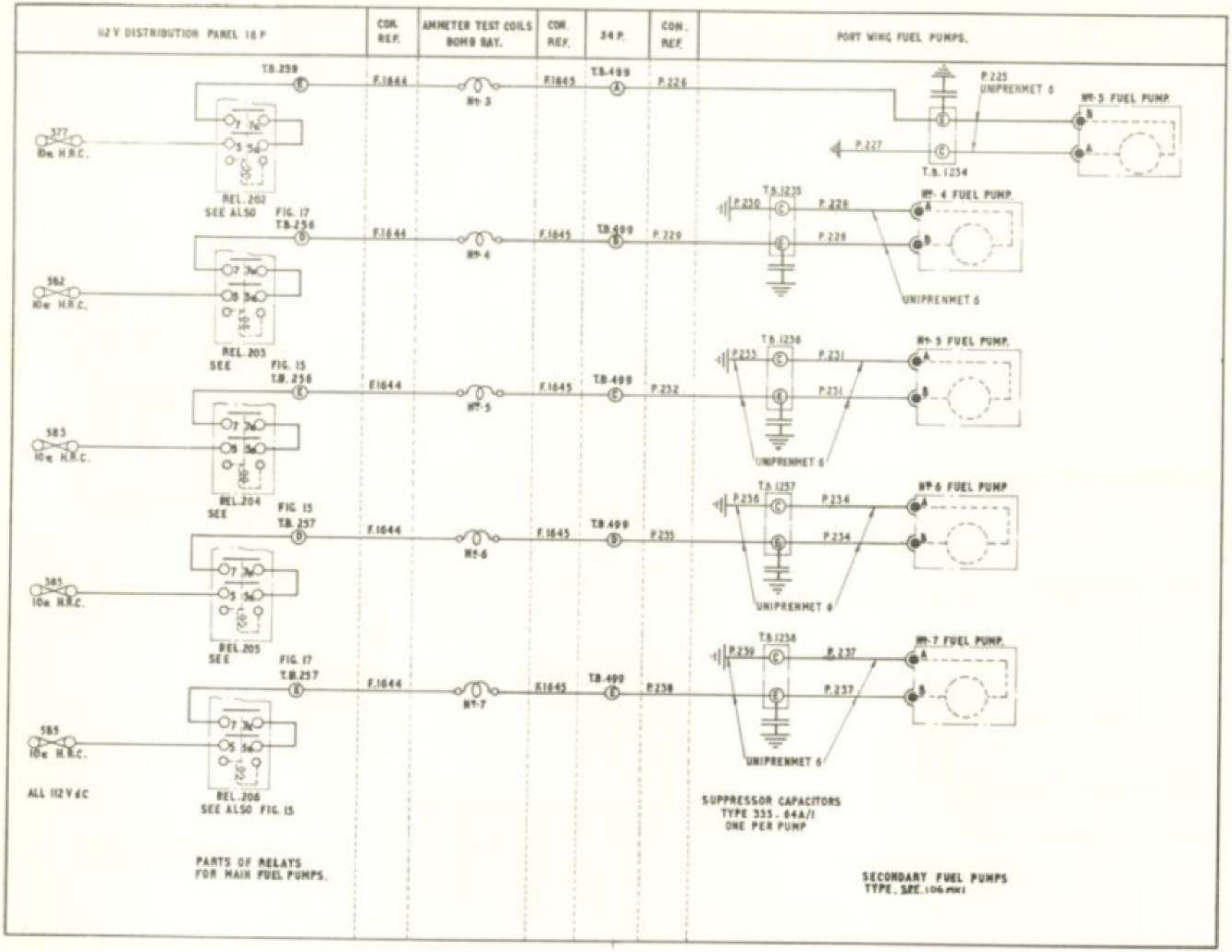

Fig. 21 (1) Secondary fuel pumps

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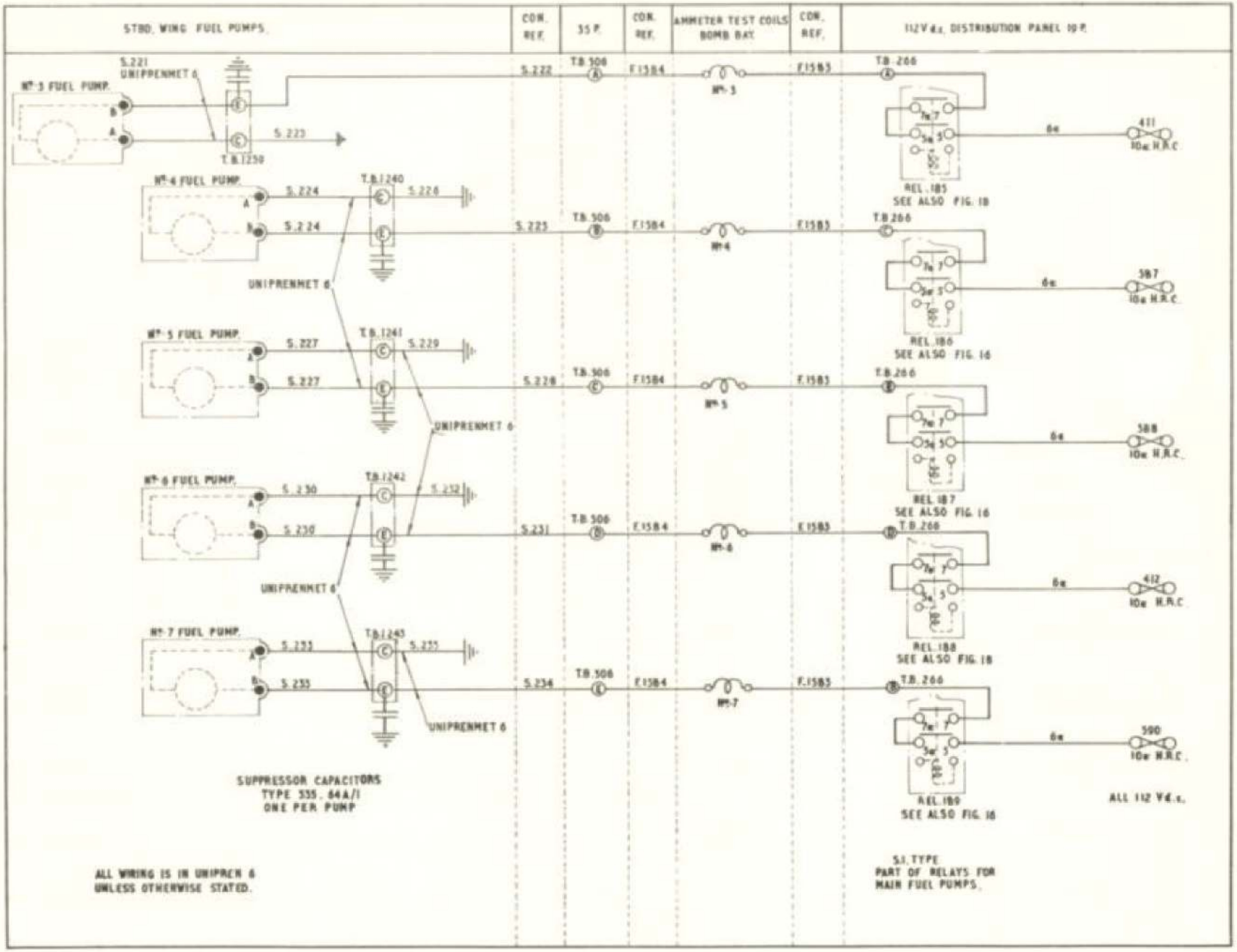

Fig. 21 (2) Secondary fuel pumps

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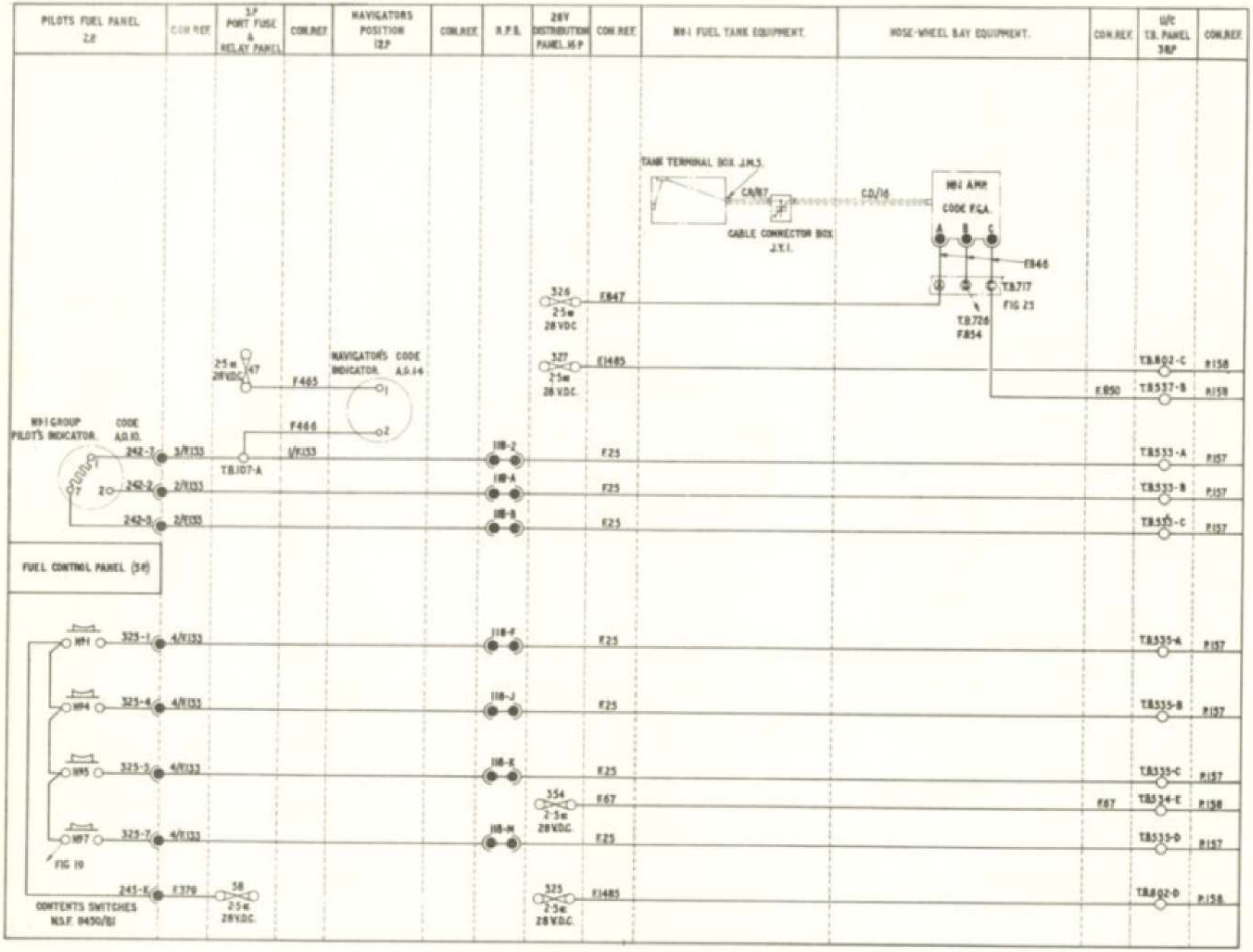

Fig.22 (1) Nº1 group-tank selection and contents

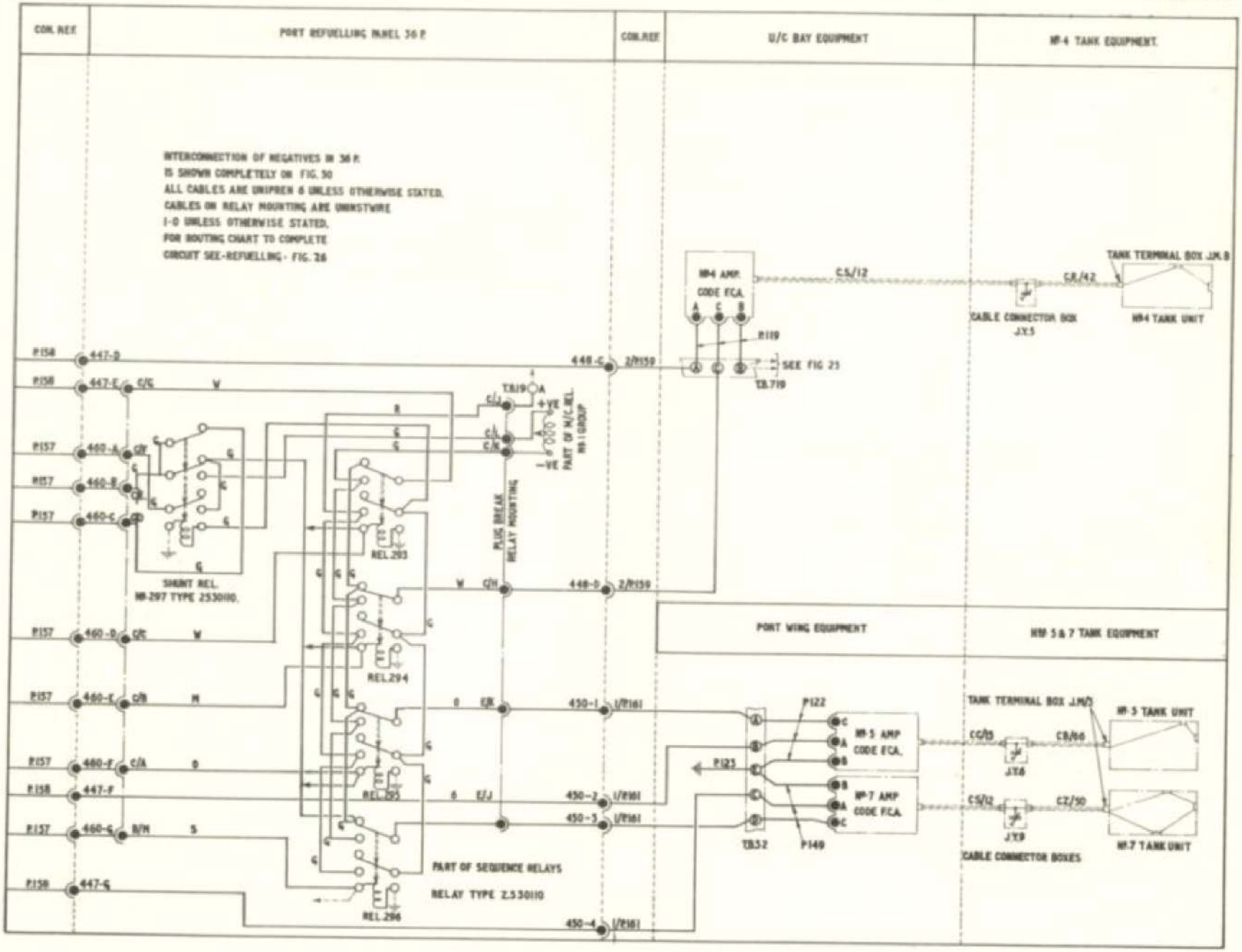

Fig. 22 (2) Nº 1 group-tank selection and contents

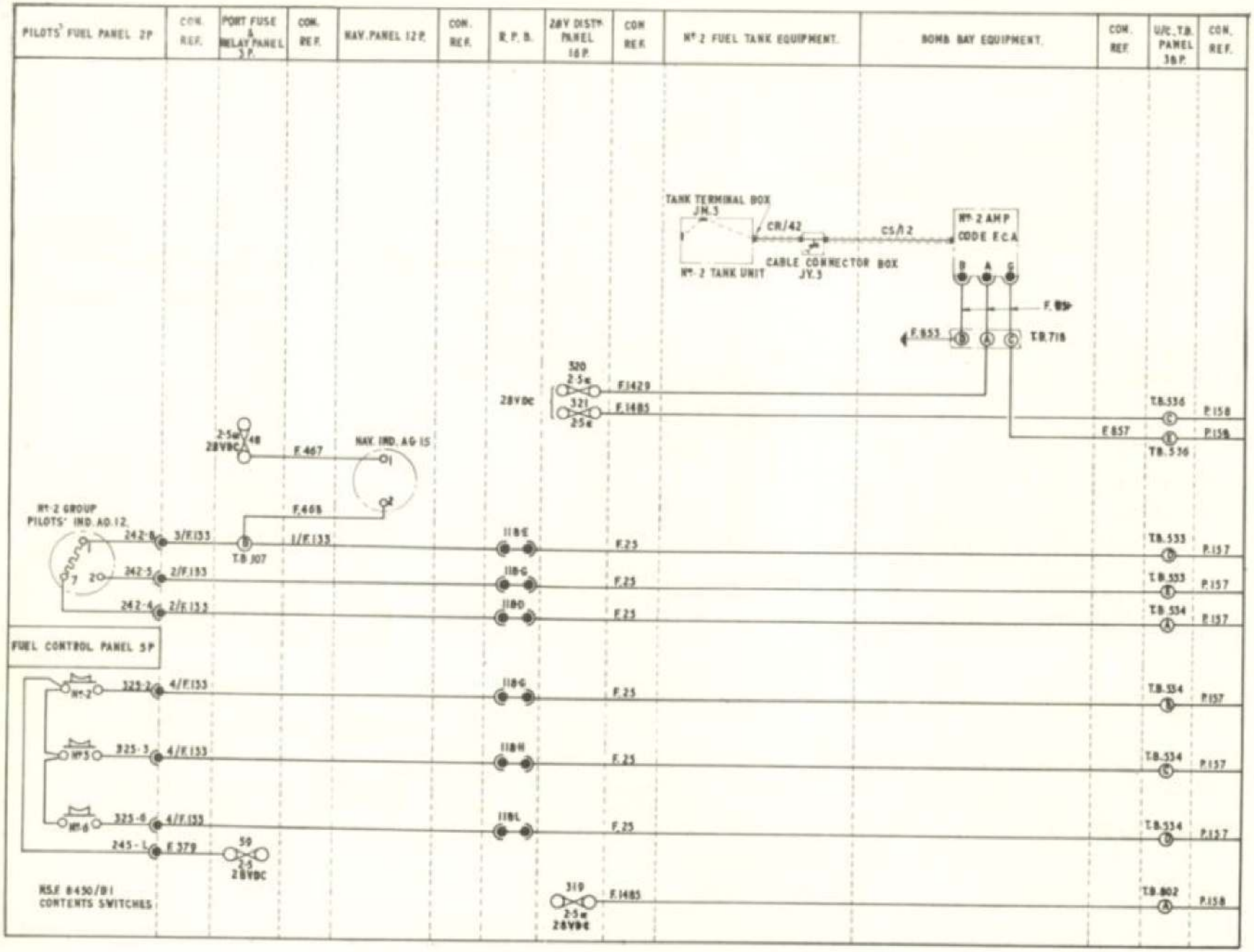

Fig. 23 (1) Nº 2 group-tank selection and contents

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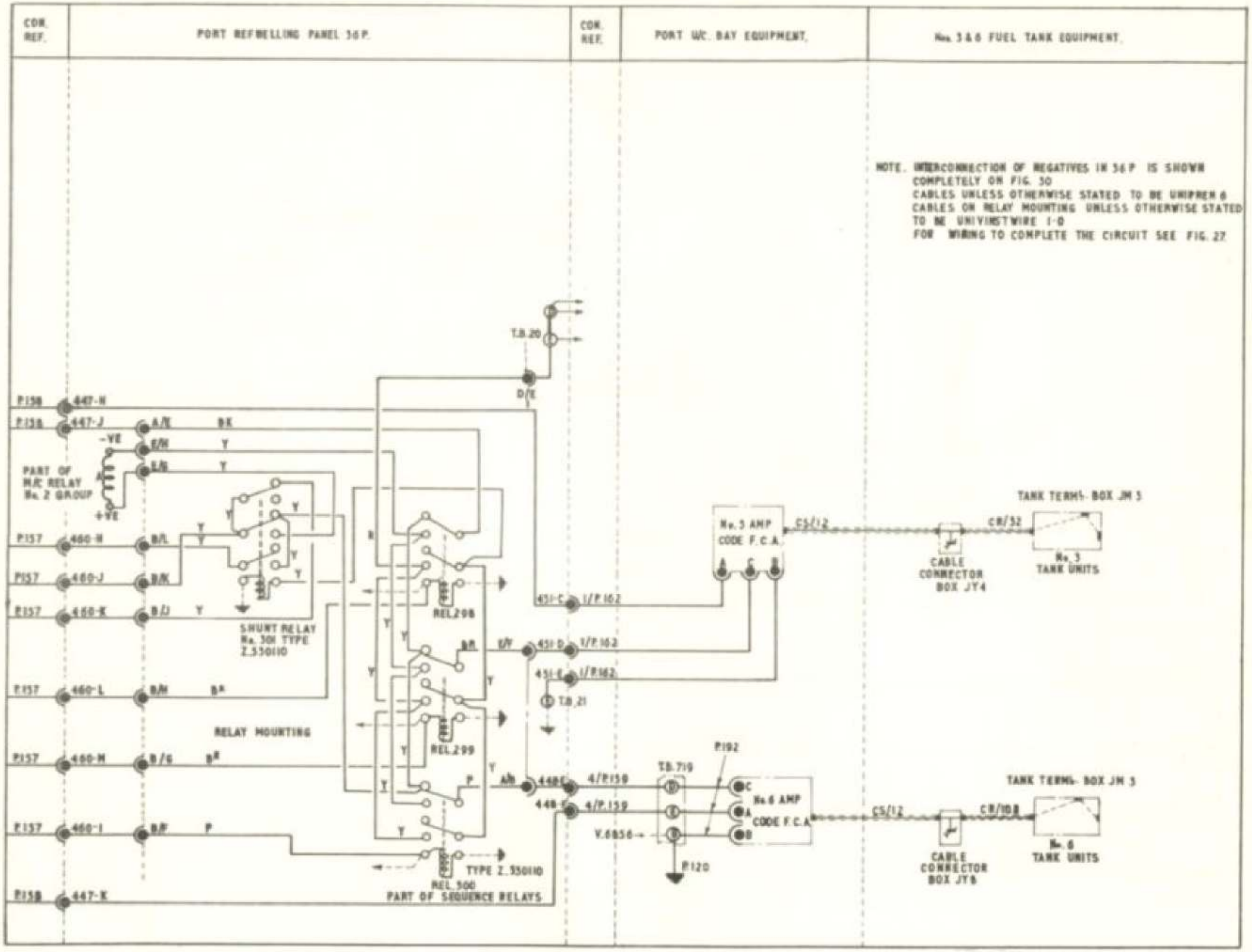

Fig. 23 (2) No 2 group-tank selection and contents

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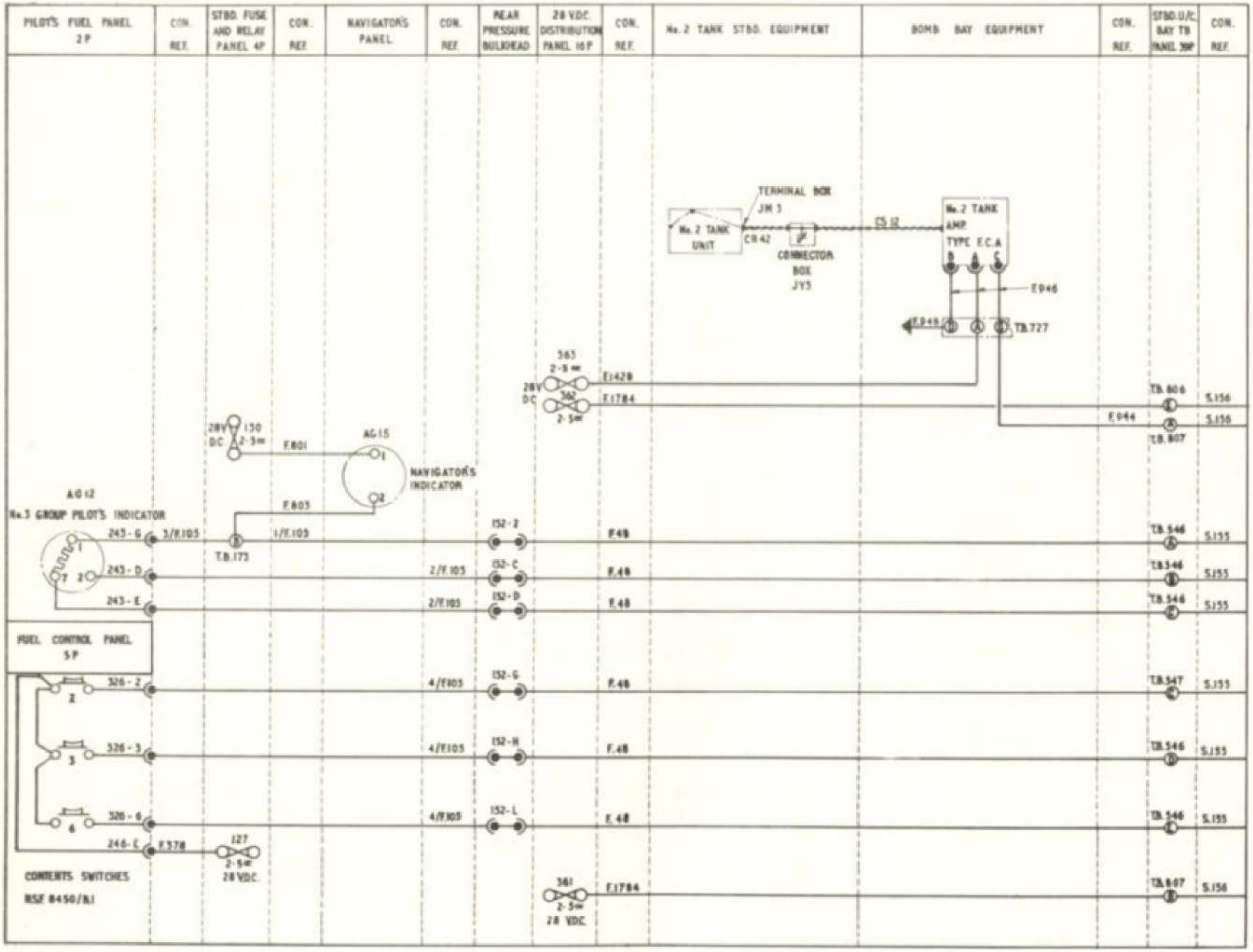

Fig. 24 (1) Nº 3 group-tank selection and contents

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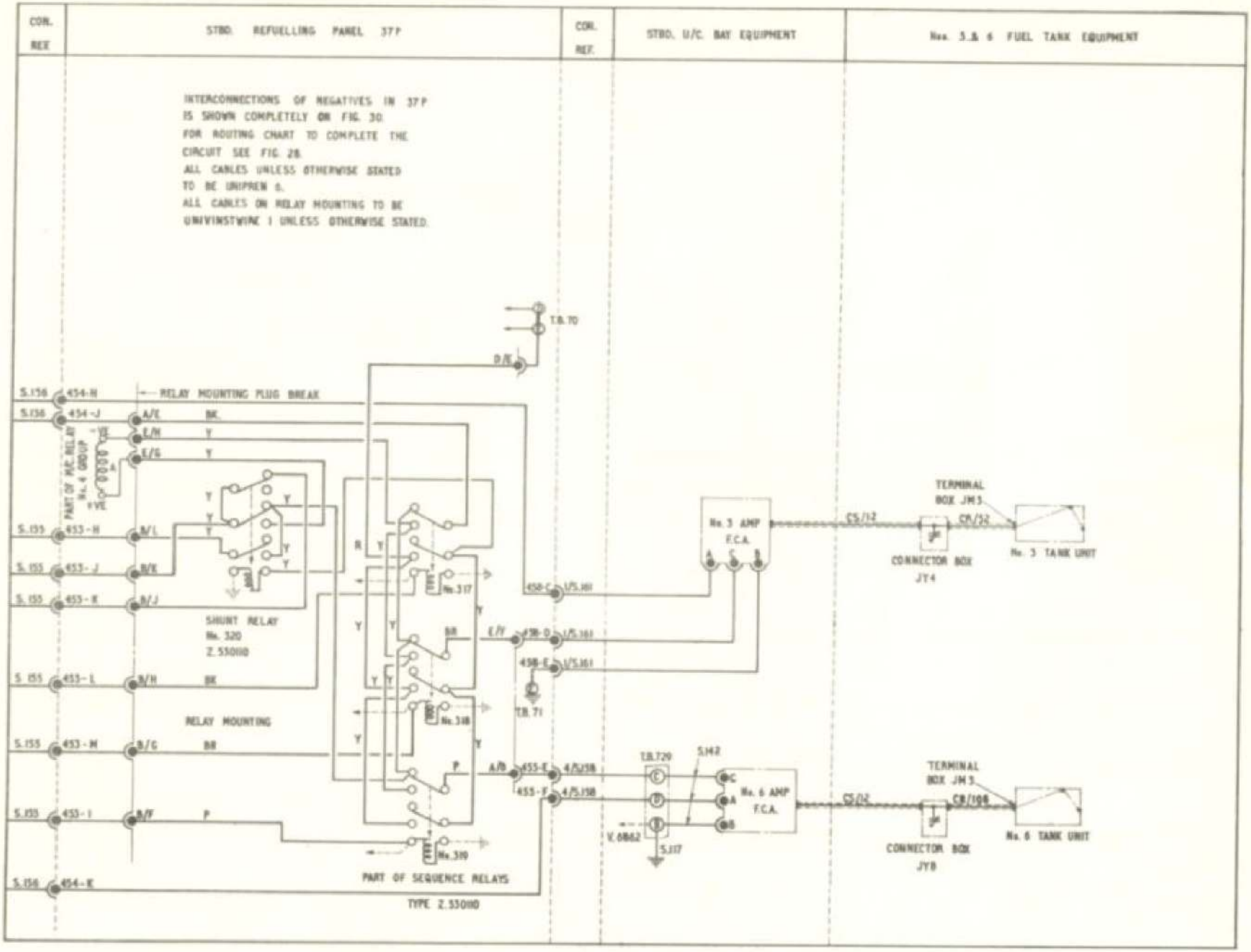

Fig. 24 (2) Nº 3 group-tank selection and contents

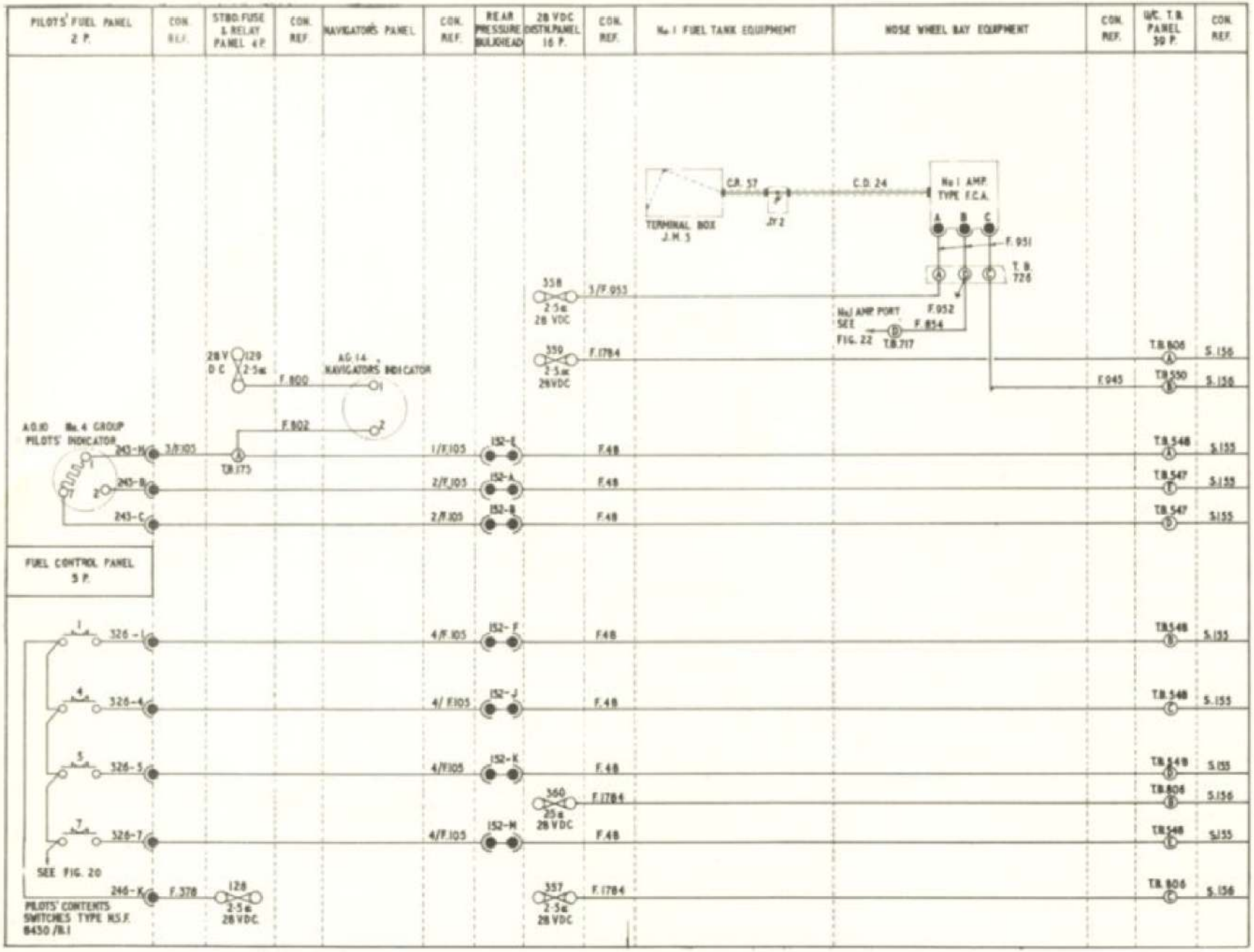

Fig. 25 (1) No 4 group-tank selection and contents

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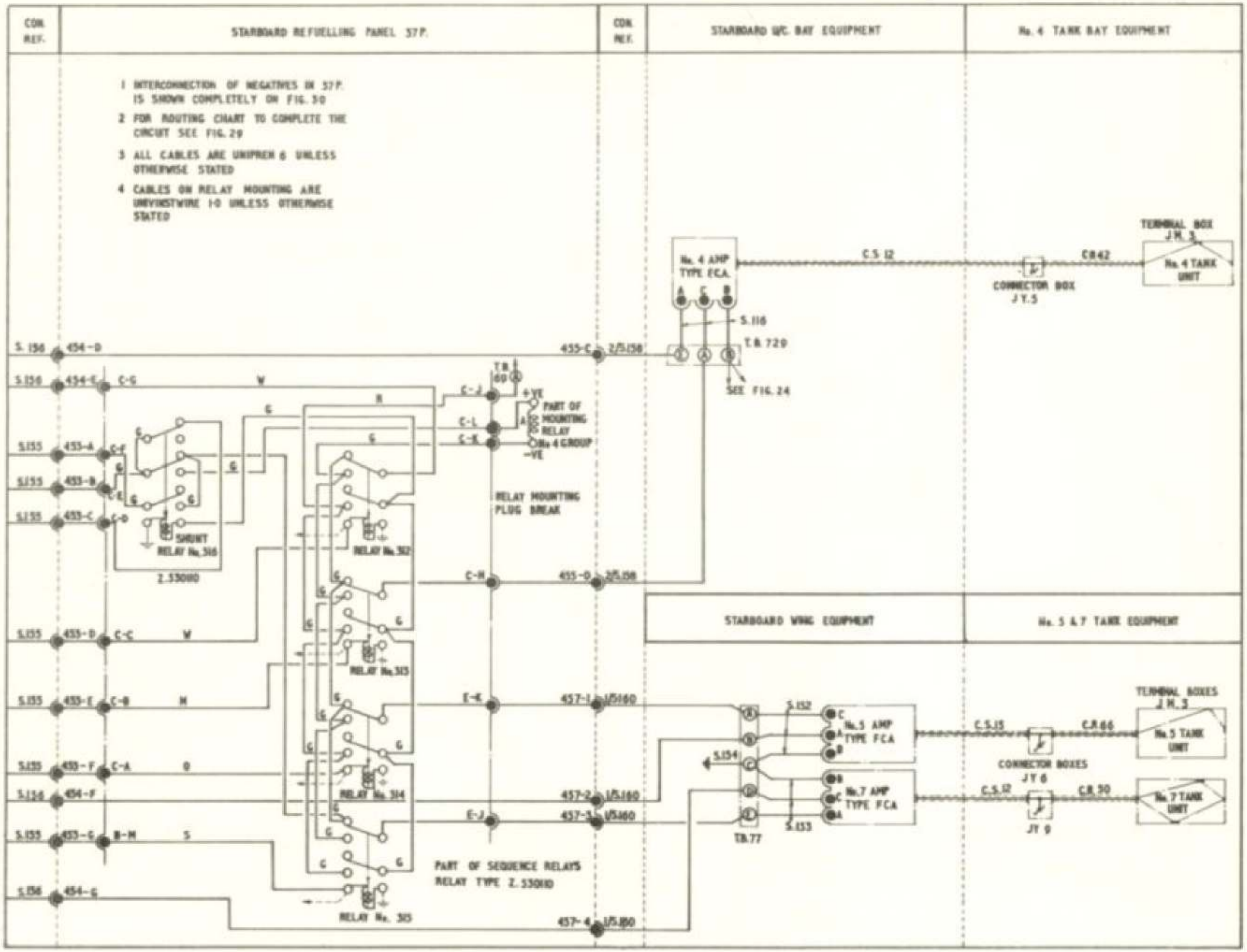

Fig. 25 (2) Nº 4 group-tank selection and contents

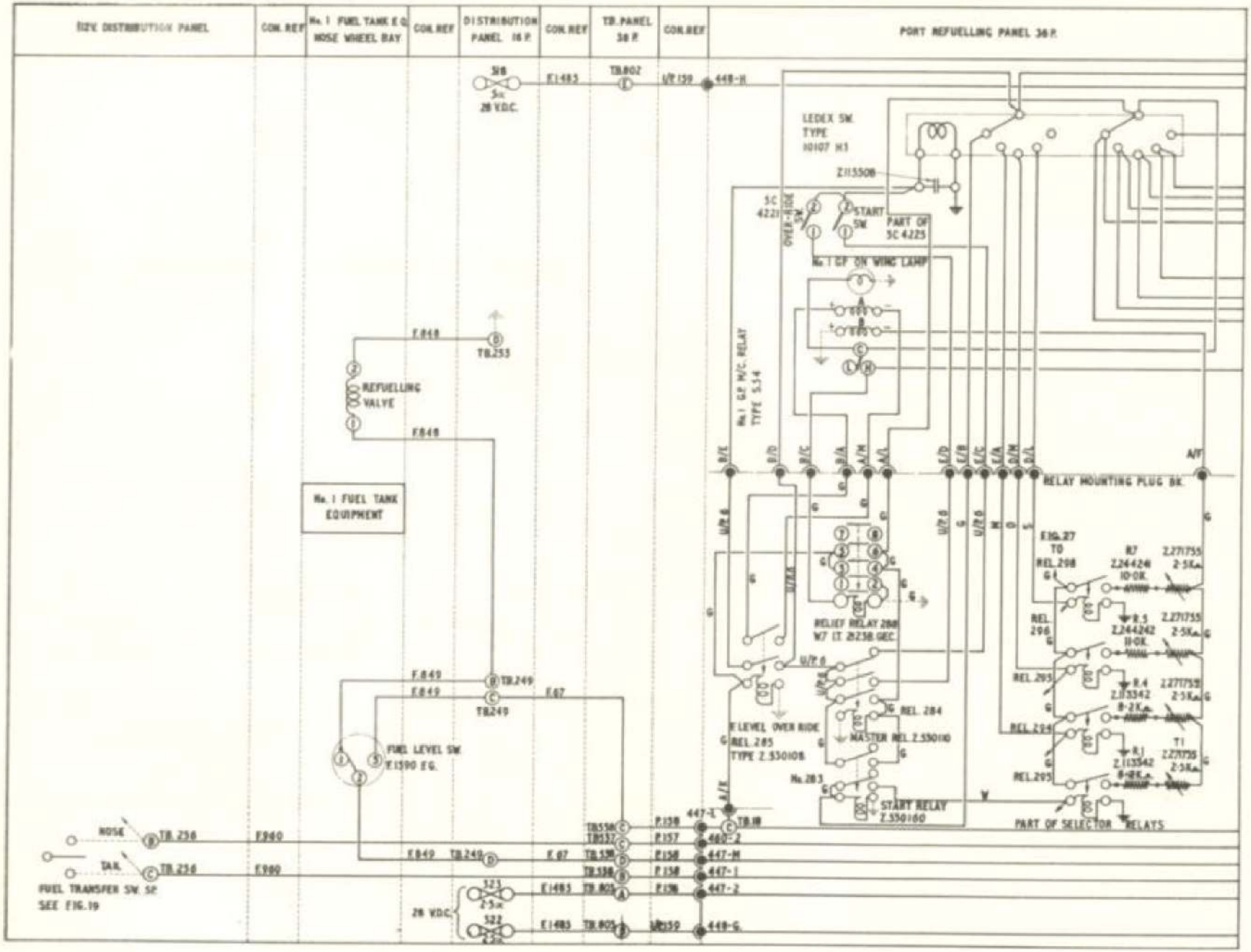

Fig.26 (I) Refuelling Nº I group

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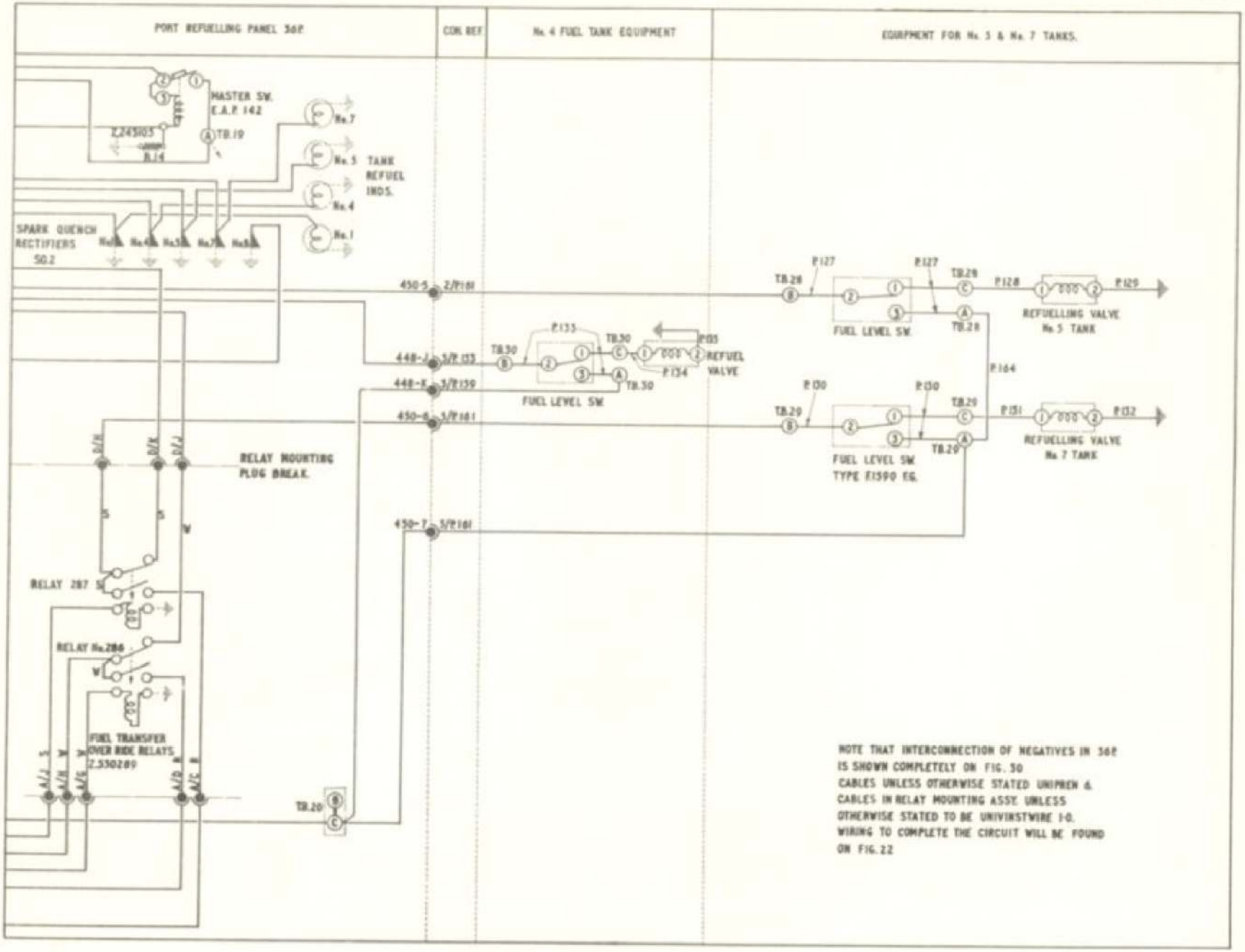

Fig. 26 (2) Refuelling - Nº 1 group

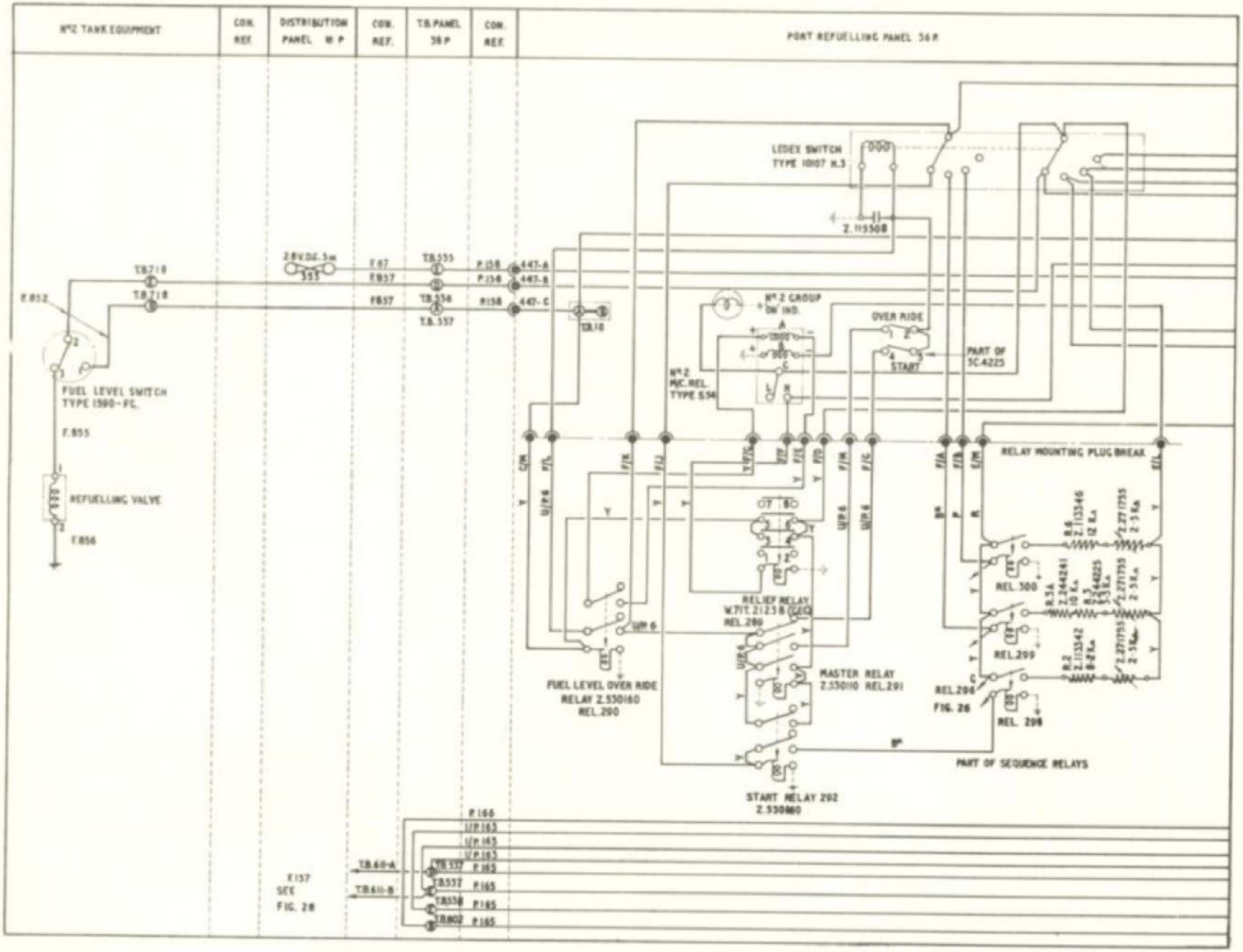

Fig 27 (1) Refuelling - Nº 2 group

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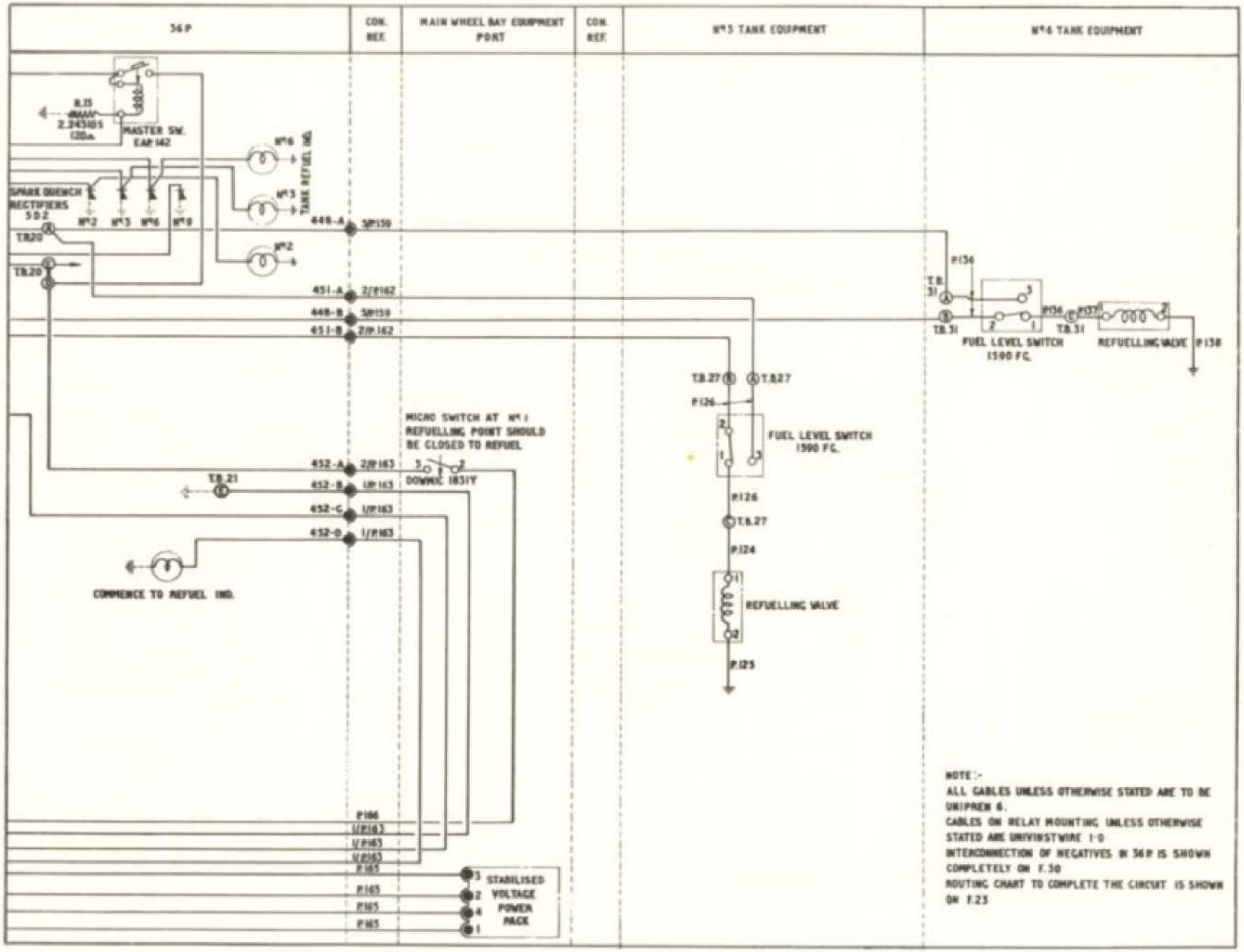

Fig 27 (2) Refuelling - Nº 2 group

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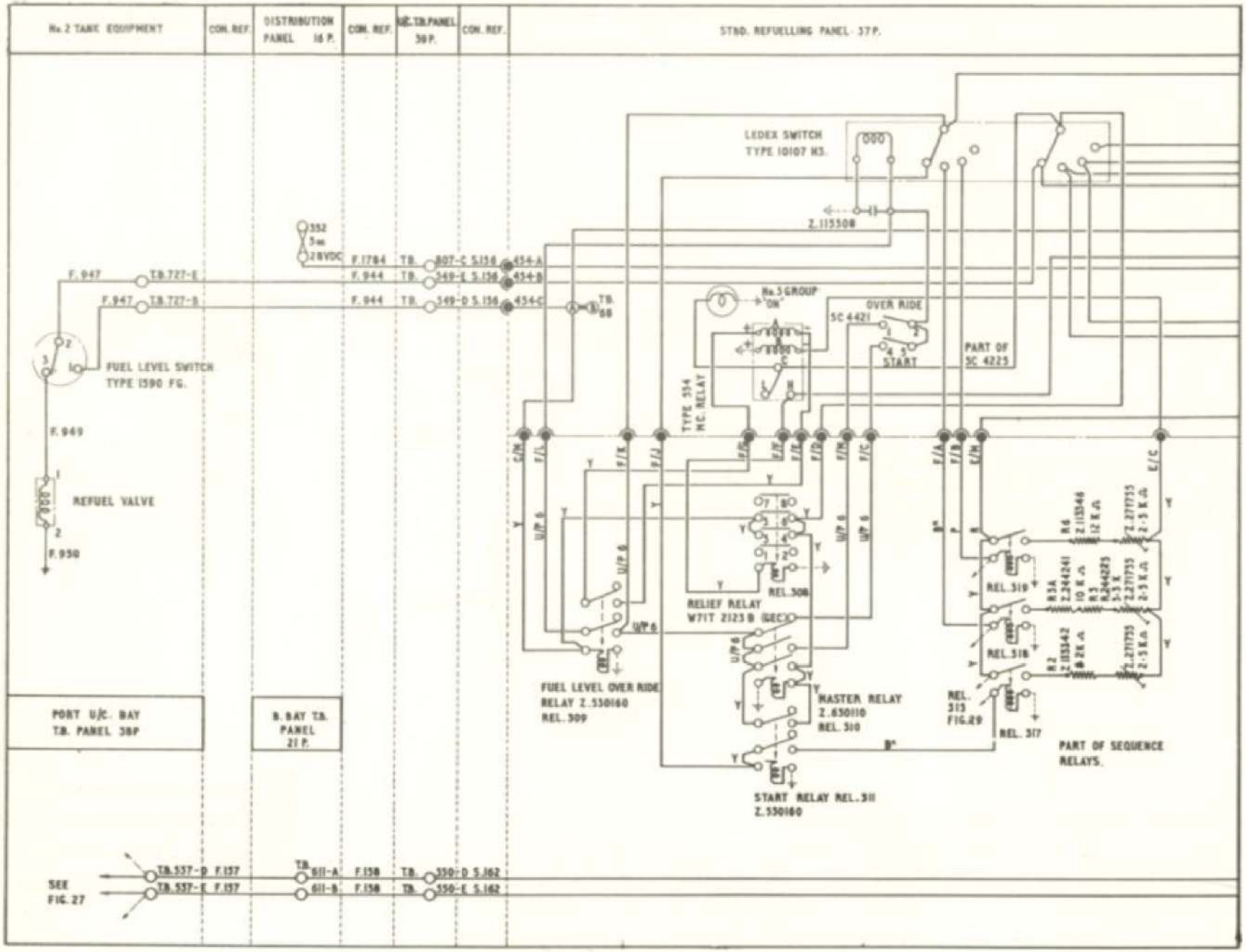

Fig. 28 (1) Refuelling - No 3 group

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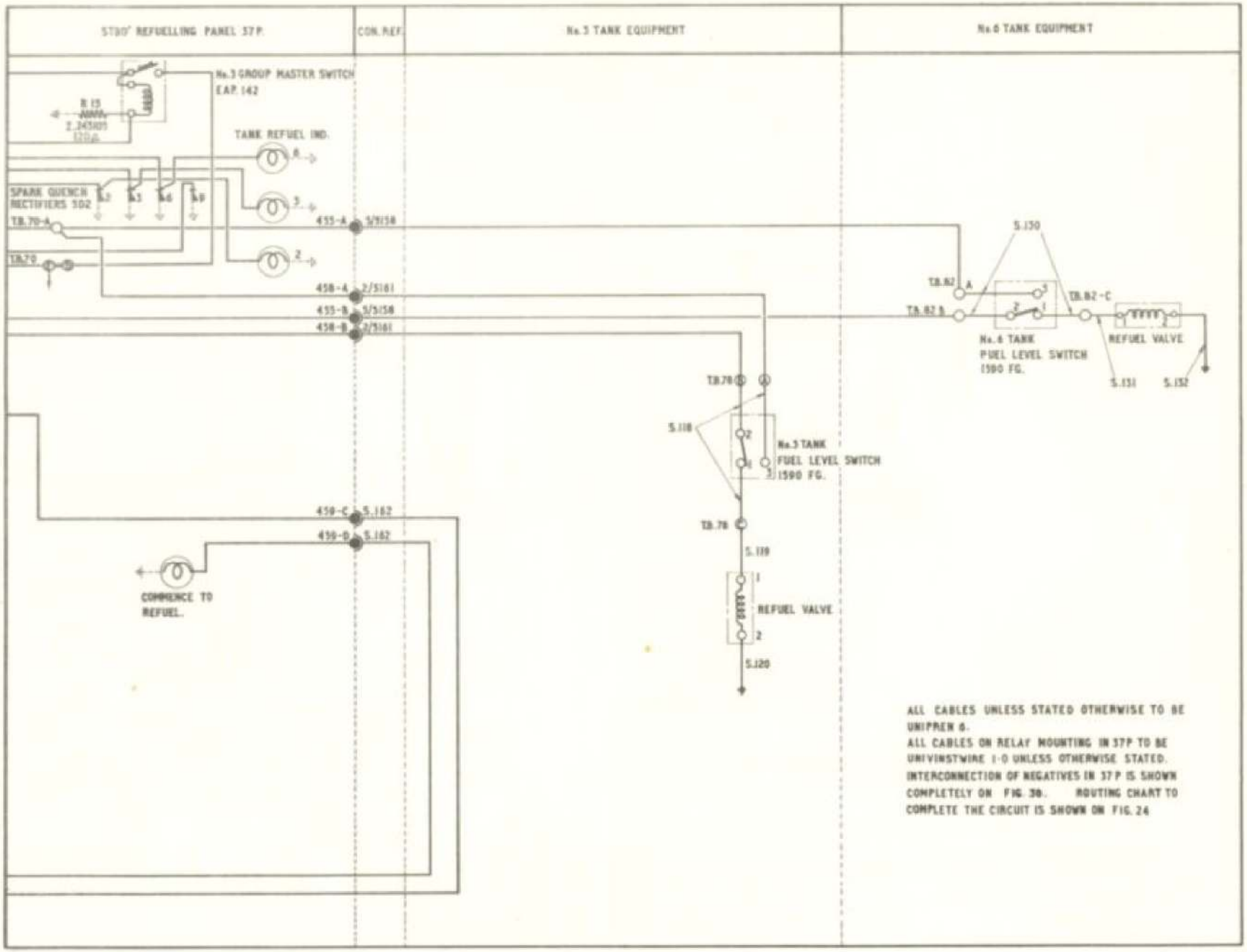

Fig 28 (2) Refuelling - No 3 group

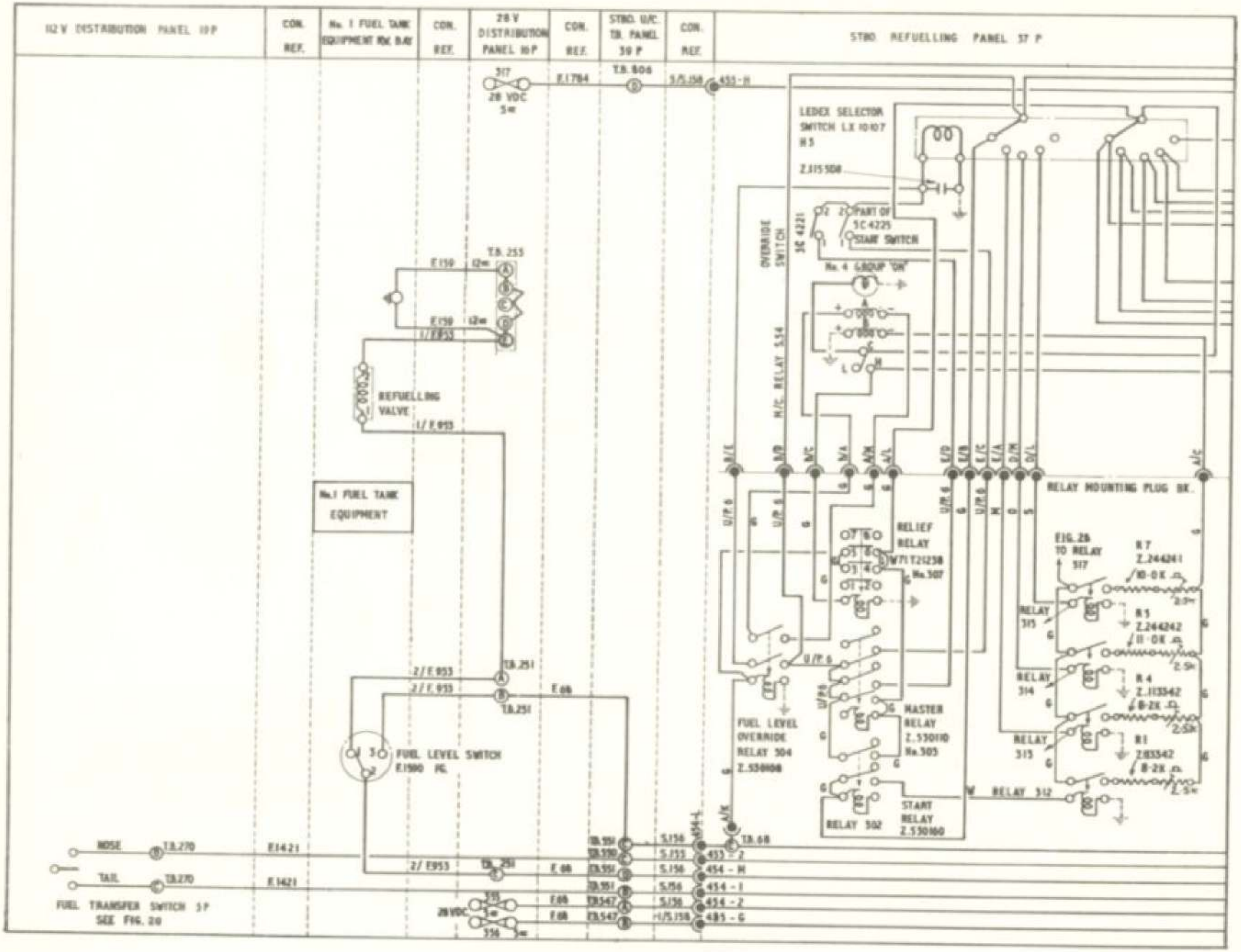

Fig 29 (1) Refuelling - Nº 4 group

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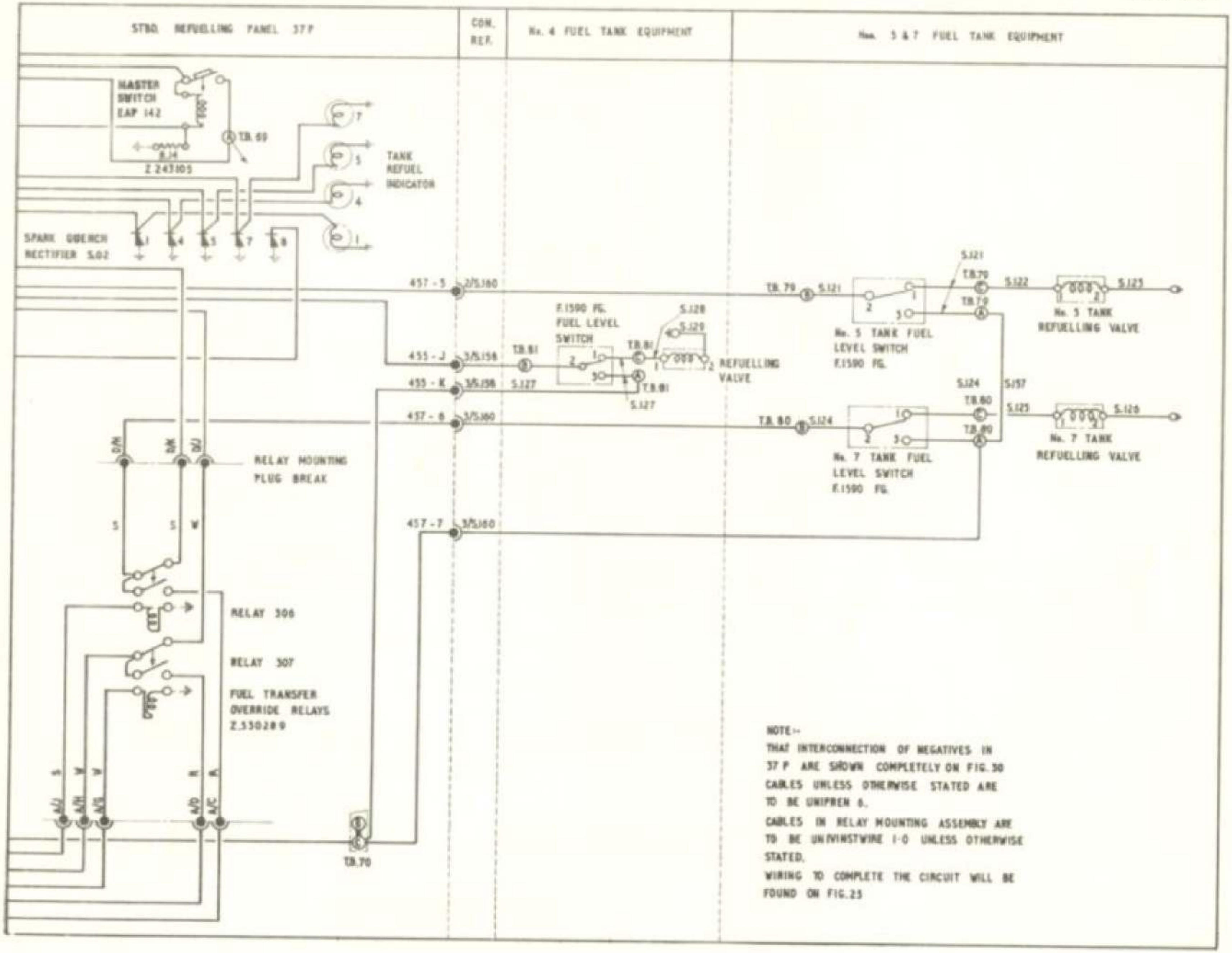

Fig 29 (2) Refuelling - No 4 group

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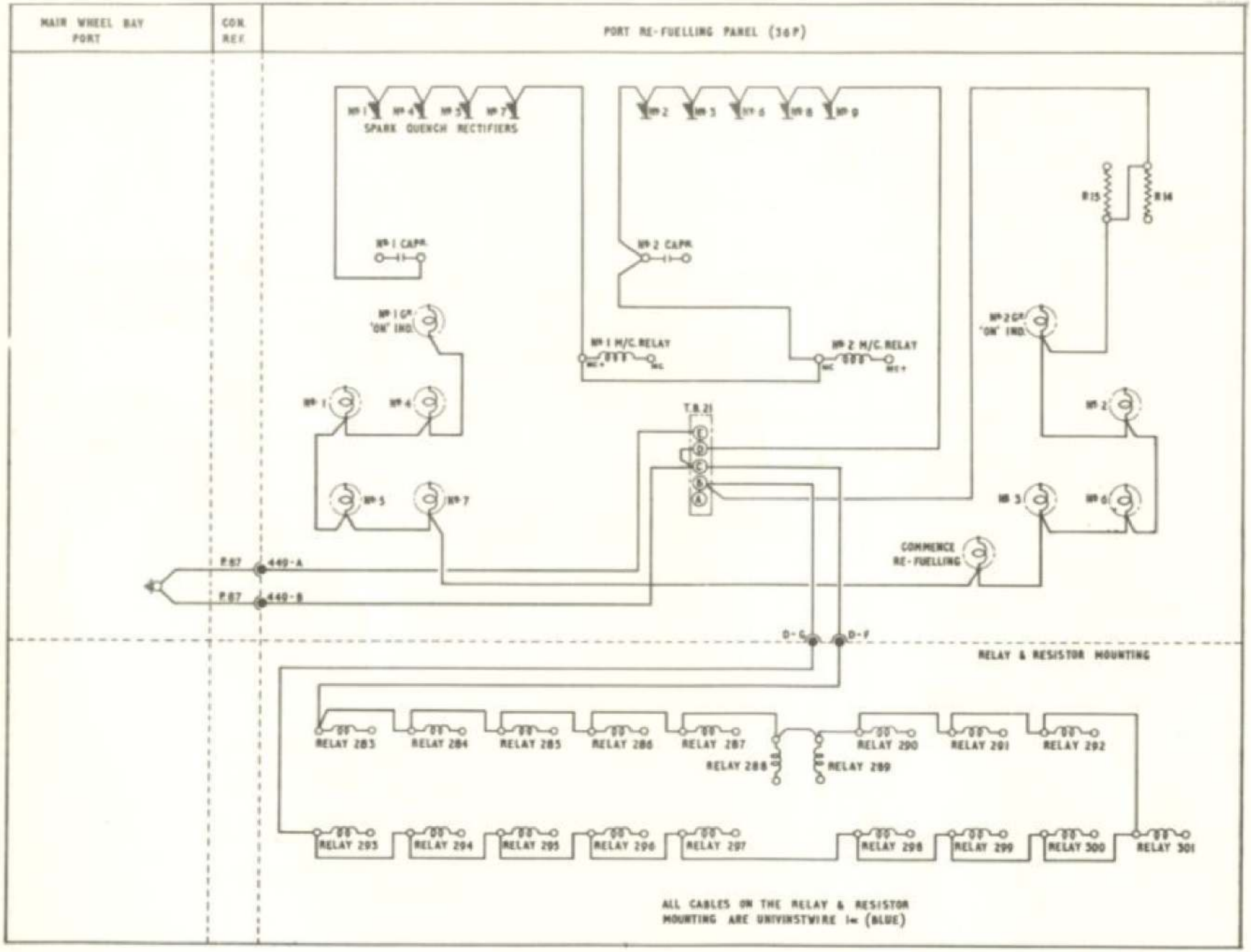

Fig. 30 (1) Negative distribution

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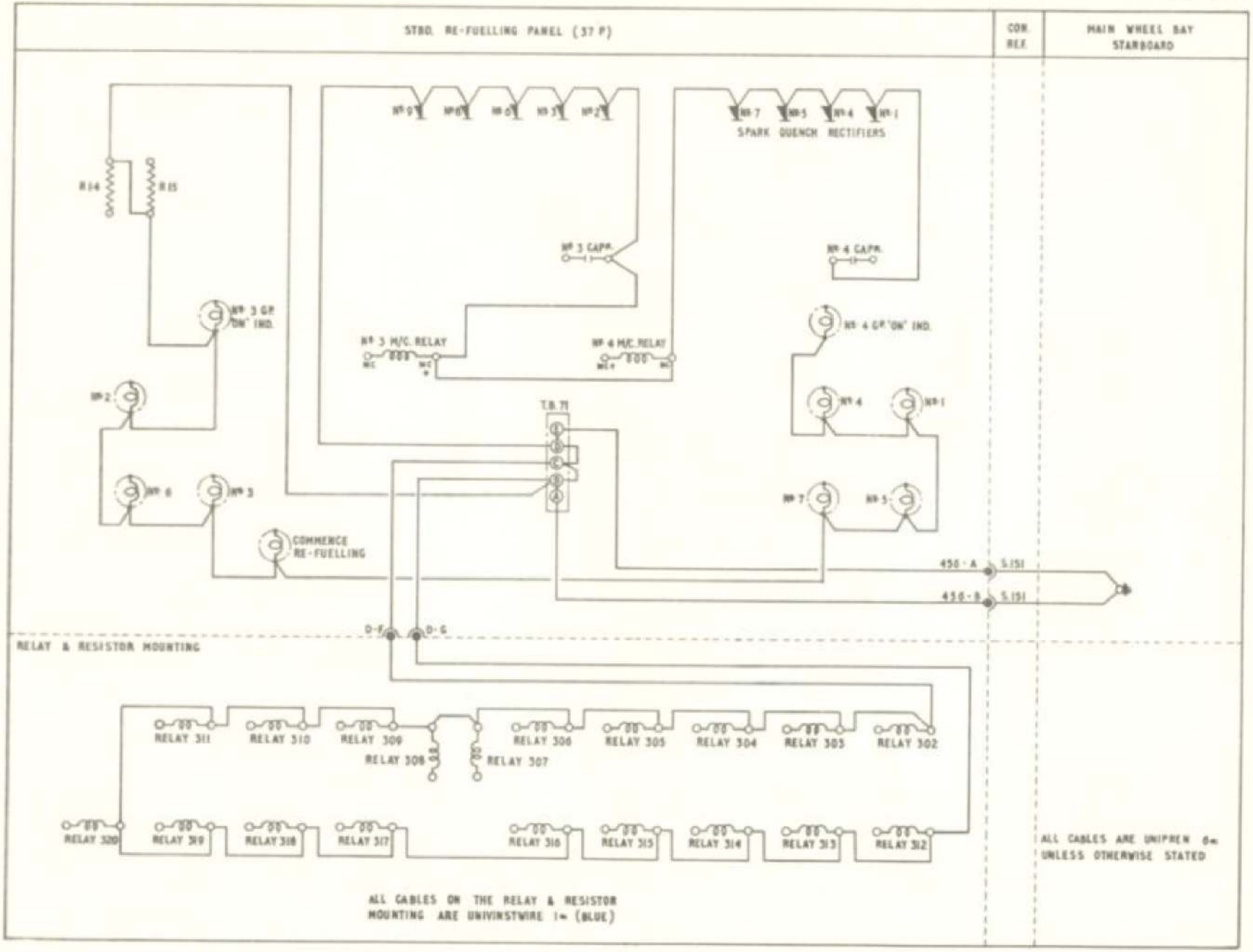

Fig 30 (2) Negative distribution

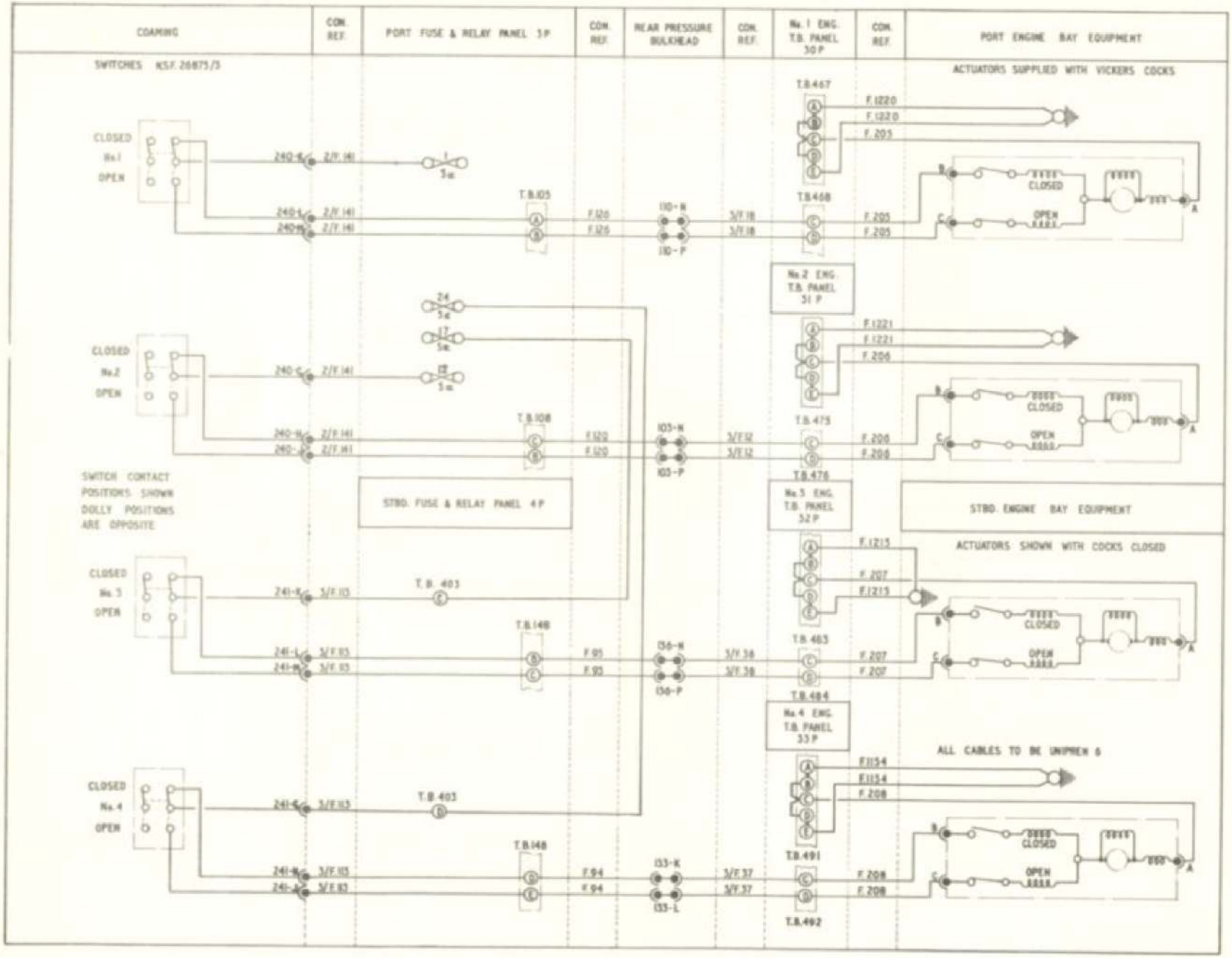

Fig. 31 L.P. fuel cock controls

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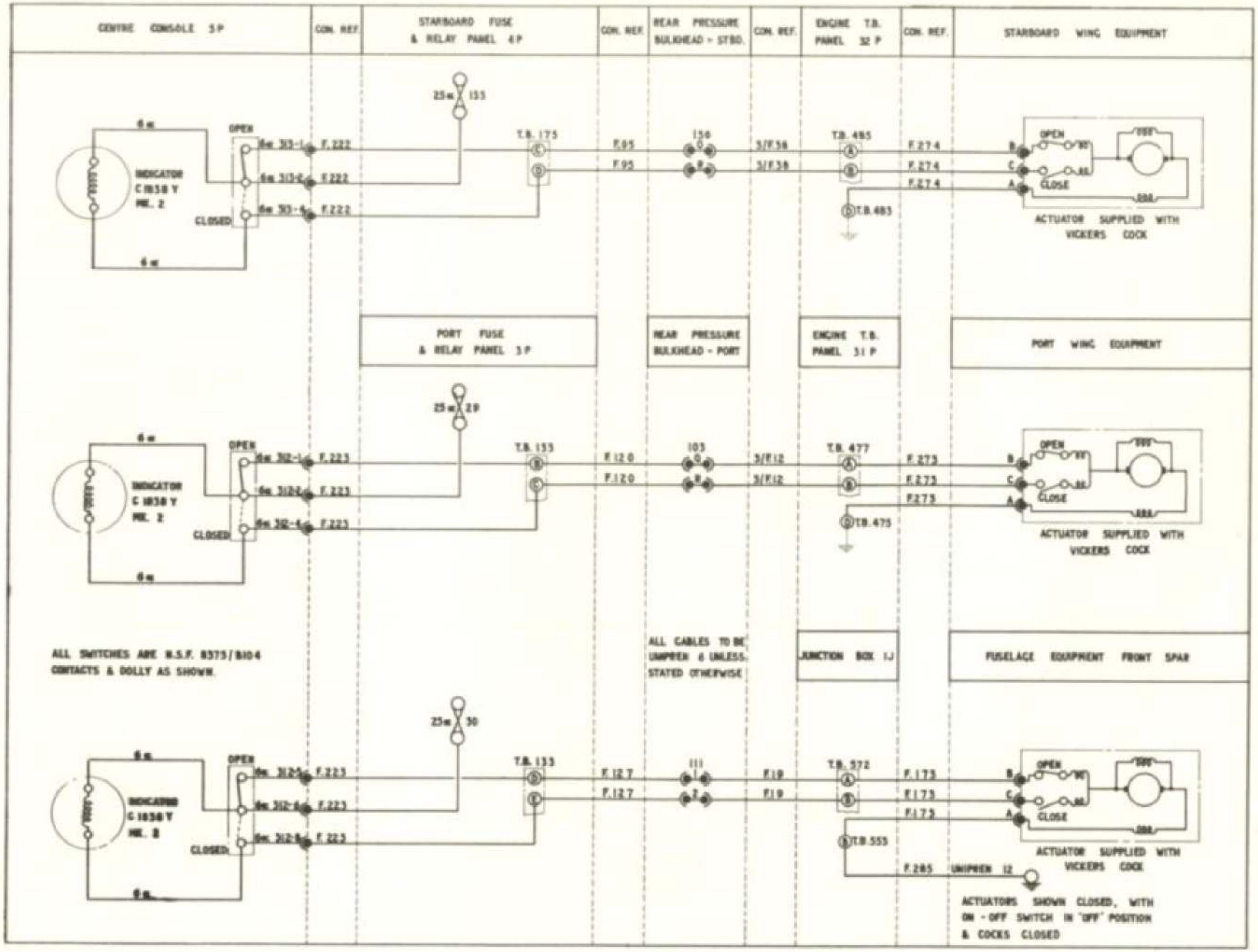

Fig. 32 Cross-feed fuel cock controls

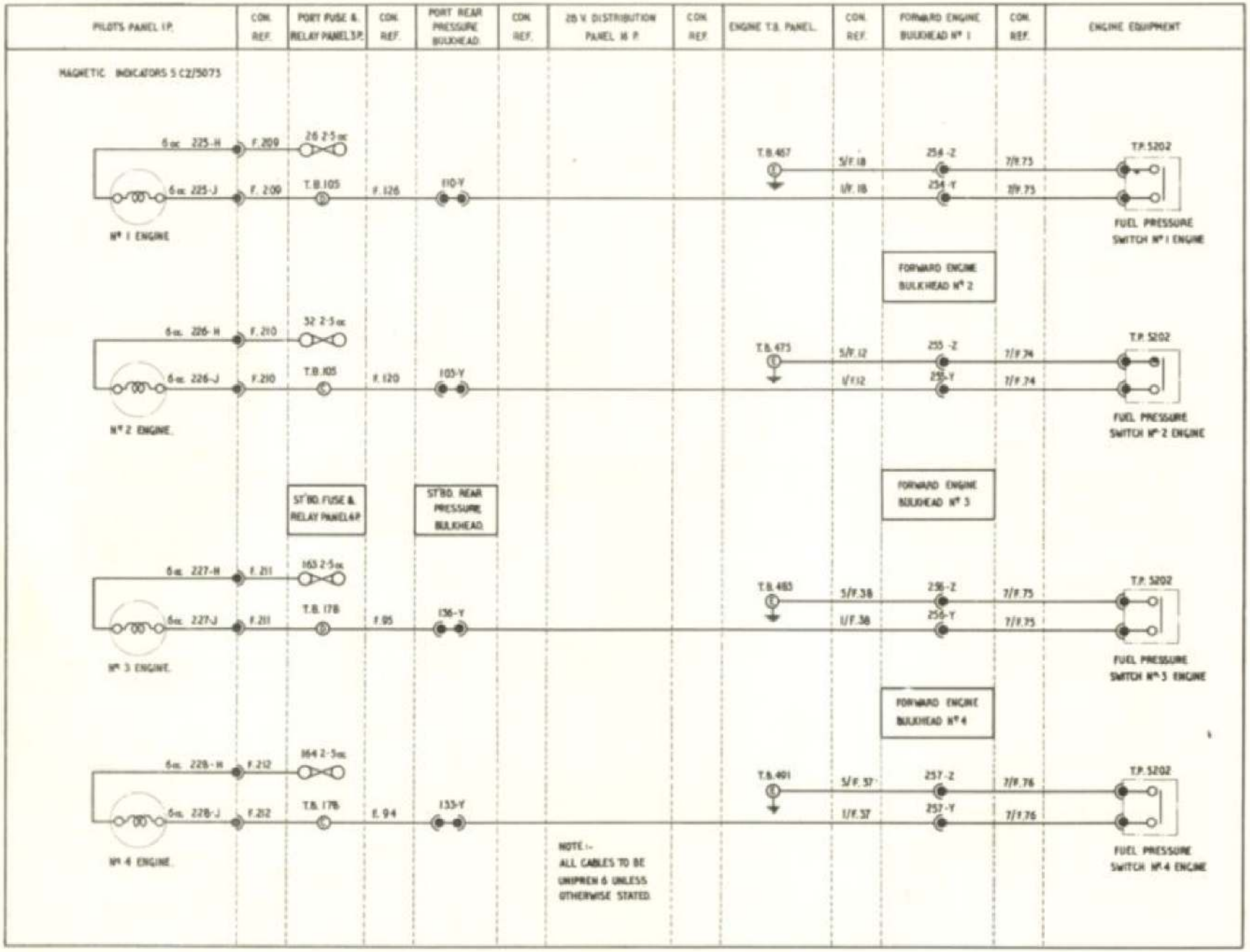

Fig. 33 Fuel pressure warning

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