Chapter 15

WARNING AND EMERGENCY EQUIPMENT

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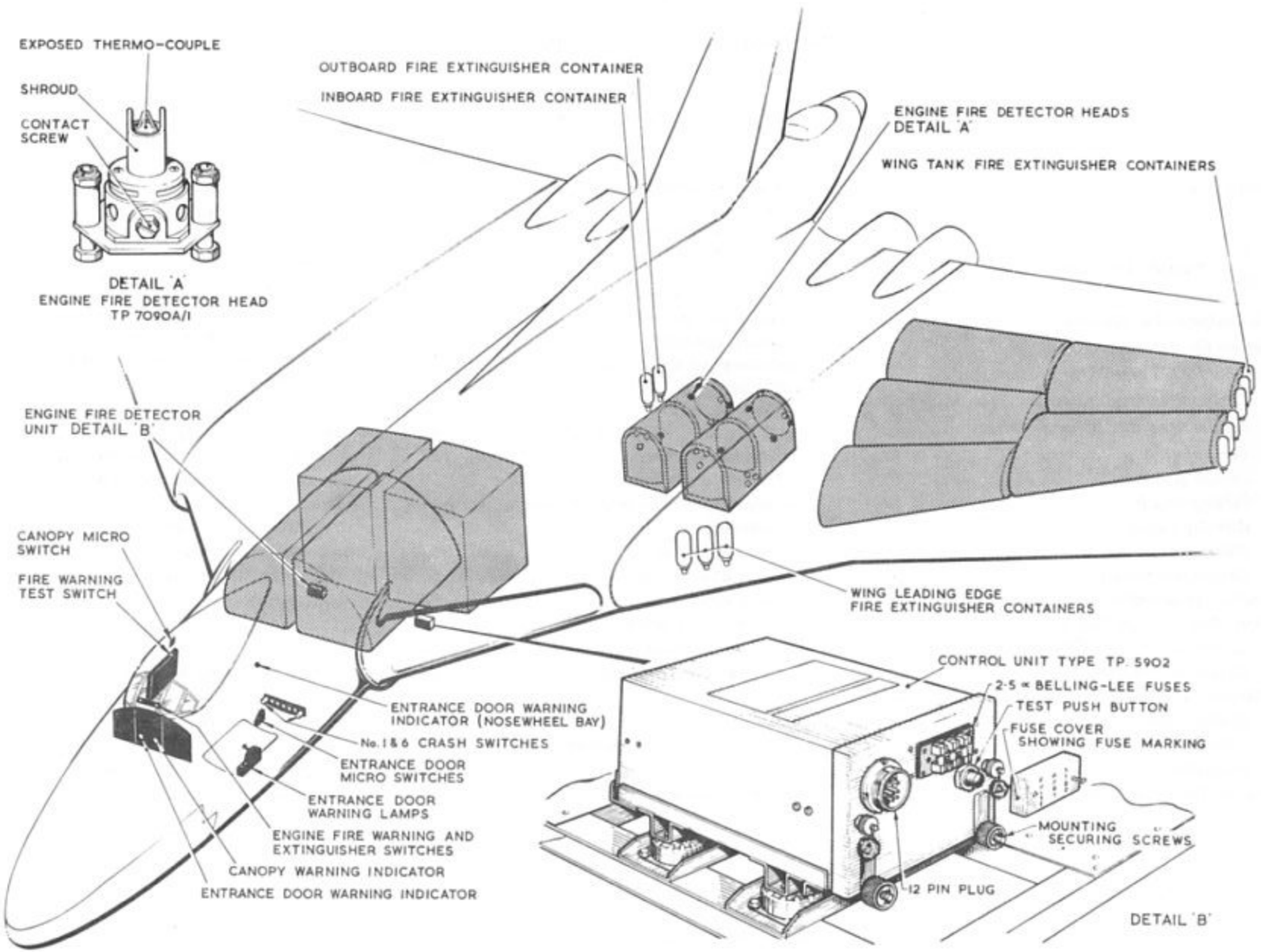

Fig. 1 Location of components pre Mod. 2271 and 2416

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Introduction

1. This chapter contains descriptive and servicing information for the electrical controls and equipment employed in the fire extinguisher systems, canopy and entrance door controls and the tail to ground warning. General locations of equipment are shown in fig.1 and fig.10 and theoretical circuit diagrams will be found adjacent to the text concerned. The mechanical aspect of the fire extinguisher systems is described in Book 1, Sect.4, Chap.5 and that for the remaining circuits in Book 1, Sect.3, Chap.11 of this publication. The following modifications are incorporated:-

Mod.526 – To introduce fixed fittings for long range fuel tanks.

Mod.624 – To introduce a selector switch at the navigator's station for emergency door opening.

Mod.774 – To introduce improved cartridge Type Graviner A716 in lieu of Graviner A216 and Graviner A717 in lieu of Graviner A217.

Mod.1346 – Introduction of Mk.3 cartridges in lieu of Mk 2.

Mod.1469 – Introduction of detector head, Type TP7700.

Mod.1583 – Introduction of tail to ground warning system.

Mod.1842 – Introduction of detector control unit, Type 162D.

Mod.2009 – Introduction of indicator fuses-bomb bay tanks fire extinguisher system.

Mod.2067 – Introduction of control units, Type TP5902 and alteration in wiring to allow control of either the inner or outer pair of engines.

Mod.2118 – Introduction of hold-off relay to prevent inadvertent operation of fire bottles.

Mod.2235 – To introduce a relay to render the engine fire warning systems inoperative with aircraft in stand-by configuration.

Mod.2271 – To introduce fire detector control units, Type TP77020 in lieu of fire detector control units Type TP5902, in engine fire warning systems to give improved functioning of detector system.

Mod.2295 – To provide an additional emergency door opening switch, which in certain circumstances can be more easily operated.

Mod.2367 – To introduce fire detector control units, Part No. TP77051 or TP77052 in lieu of fire detector control units, Part No. TP77020.

Mod.2416 – To introduce fire detector control units, Part No.TP77056 in lieu of fire detector control units Part No.TP77051 and TP77052.

Mod.2455 – To make provision for manual operation of the fire extinguishers in the fuselage tank, leading edge and wing tank areas. The Graviner firewire detection and automatic extinguisher operation in these areas are made inoperative.

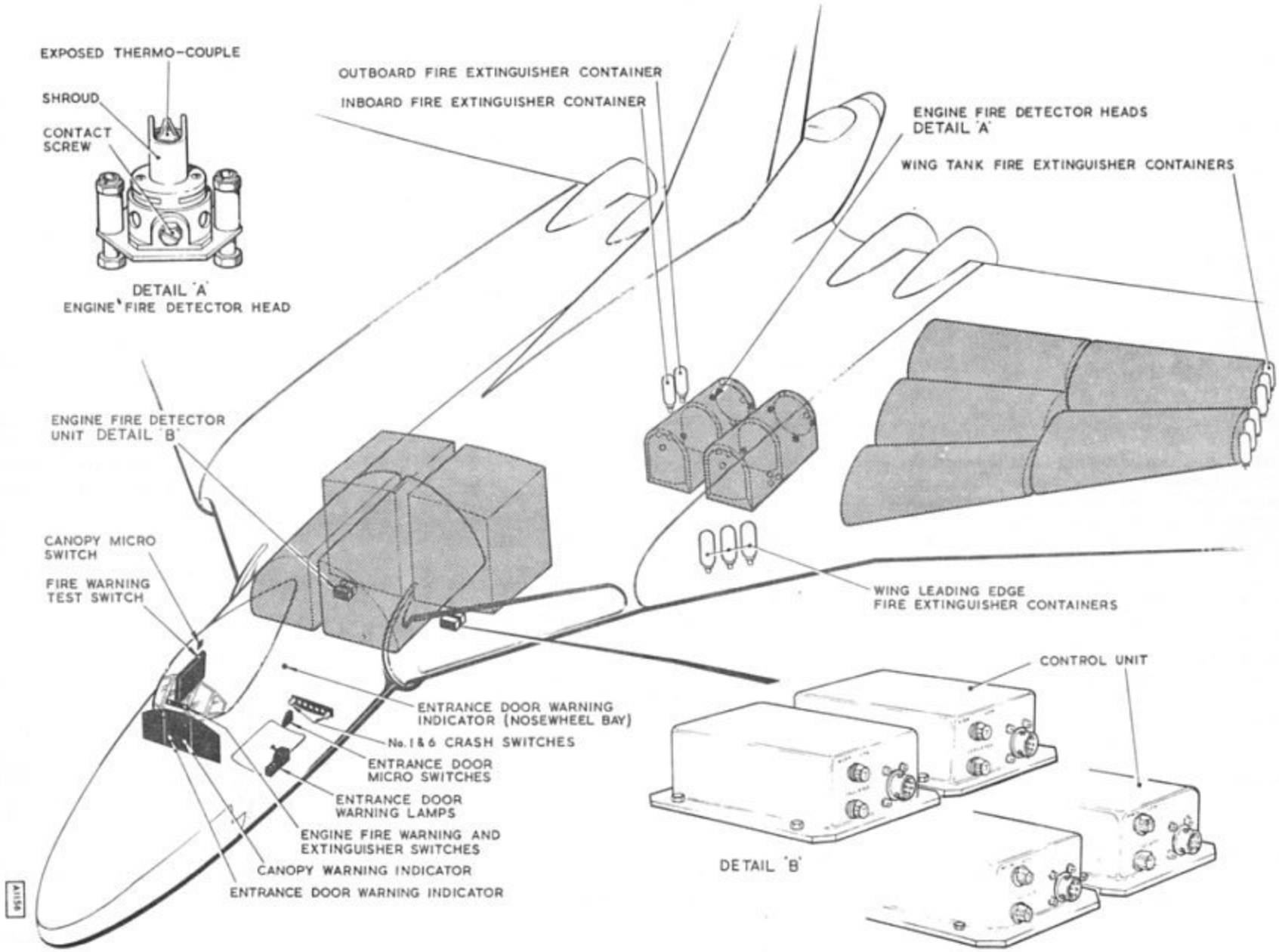

Fig. 2 Location of components : post Mod. 2271, 2367 and 2416

DESCRIPTION AND OPERATION

FIRE EXTINGUISHER SYSTEMS

2. Four main fire extinguisher control systems are employed, viz:-

(1) Engine fire warning.

(2) Engine fire extinguishers.

(3) Fuel tank and wing leading edge fire extinguishers.

(4) Bomb bay fire extinguishers.

3. Engine fire detection and warning is fully automatic and is operative immediately an engine fire or rapid rise in temperature occurs. The engine fire extinguishers are brought into operation manually by depressing the push-switches labelled ENGINE FIRE EXTINGUISHER on the coaming above the pilot's instrument panel (fig.6). The extinguishers will be operated automatically on crash landing by the action of two inertia switches situated on the lower forward face of the cabin rear pressure bulkhead.

4. Pre Mod.2455; the fuel tank, leading edge and bomb bay tank fire extinguisher circuits are operated automatically by action of the Graviner firewire sensing elements installed around the tank bays and leading edge ducts. Post Mod.2455; the fuel tank and leading edge sensing elements are isolated, Type 162D relays are removed, push-buttons are provided for manual operation of the fire extinguishers in these areas. In the event of a crash landing, all fire extinguishers will be operated if the impact is sufficient to trip the two inertia switches mentioned in the previous paragraph.

5. All the fire extinguisher control circuits, including fire detection and warning, come under the heading of vital services and all are fed from the vital services busbar via supply fuses in panels 3P, 4P and 19P. Controlling relays are fitted in panels 34P and 35P.

6. The engine fire extinguisher installation employs four single-headed methylbromide containers, Type 13A. These containers are fitted with 2-pin Mk 3 cartridges, and are installed in the bomb bay. Four identical containers installed in the nosewheel bay, are connected by spray piping to the fire zones in the No.1 and No.2 (port and starboard) fuselage tanks. Six similar containers, three in each leading edge, are connected by spray piping to the fire zones in the leading edge ducting. Another eight of these containers, in two groups of four, are installed on either side of the bomb bay and connected to spray piping positioned at vulnerable points. Twelve dual-headed containers, Type 14A, each fitted with 2-pin and 3-pin Mk 3 cartridges, are installed six in each wing. These containers are connected to spray piping situated in the fire zones around No.3, 4, 5, 6, and 7 tank bays.

Engine fire detection (pre Mod.2271 and 2416)

7. A combined fire detection and warning circuit employing thermocouple fire detection is provided for each engine. Eleven fire detectors, connected in series to form an unbroken thermocouple chain, are installed at possible fire danger points in each engine bay. Each detector circuit or chain is connected to the appropriate relay in one of two control units fitted in the nose-wheel bay.

8. A warning lamp is fitted in the knob of each engine fire extinguisher push-switch. The warning lamps are controlled by relays within the control units. Each lamp will show a continuous red light when any of its associated thermocouples detects a fire or a rapid rise in temperature. Three test switches are provided, one on each control unit, the other on the starboard fuse and relay panel 4P. A theoretical circuit diagram of the detectors and warning circuit for one pair of engines is contained in fig.3.

Engine fire detector heads

9. The detector heads used are Type T.P.7700. Each detector head consists of two thermocouples connected in series but of opposite polarity. One of the thermocouples is shrouded from flame and rapid temperature variations whilst the other is not shrouded. The latter, being exposed, is more rapidly affected by temperature variations. All fire detector heads are mounted with the exposed thermocouple facing the flame expectant area.

10. When the combined temperature of the exposed thermocouples exceeds that of the shrouded ones by 185 deg.C., a voltage of 7.5 millivolts will be developed in the detector chain and fed to a moving coil relay inside the associated control unit. This action will light the red warning lamp (para 8) thus giving a fire warning for the engine bay concerned. The action of the thermocouple fire detectors will give a rapid warning in the event of fire. No false warning will be given during engine ground running periods, as the rate of temperature rise is too slow to give the unshrouded thermocouples sufficient voltage lead over the shrouded thermocouples.

Engine fire extinguisher switches

11. The four fire extinguisher push-switches, one for each engine, are 3-position Rotax, Type H4302.

CAUTION . . .
For testing the lamp filament the head of the

push switch must be pulled out and not pushed in, as this would result in the methylbromide container being discharged.

In the normal, or centre position, the circuit is prepared for a warning signal from the control unit to pass to the warning lamp, situated in the head of the push switch. When the head is pulled out a supply is fed to the lamp filament to test its serviceability. When the head of the push switch is depressed a supply is fed via the push switch contacts to detonate the cartridge in the head of the associated methylbromide container.

Control units

12. Two control units, Type T.P.5902, Ref. No. 5CZ/6910, are installed in the nosewheel bay. The port unit controls the No.2 and No.3 engine fire detector circuits and the starboard unit, No.1 and No.4 engine fire detector circuits. Prior to Mod.2067 the control units were either Type TP4102 or Type TP4402. The port unit controlled No.1 and No.2 engine fire detector circuits and the starboard unit No.3 and No.4 engine fire detector circuits.

13. Each control unit contains two sensitive moving coil relays, one for each engine circuit. The moving coil relays are operated from the 7.5mV. output from the thermocouple detectors. Each moving coil relay controls two Post Office relays, one for the warning circuit, the other for the cancellation circuit.

14. A further two P.O. relays, Type 600, are arranged to give a pulse circuit. This circuit interrupts the main supply voltage to the moving coil relay contacts at regular intervals. This action prevents an incorrect warning should the lightly tensioned moving coil relay contacts inadvertently close due to vibration.

15. A P.O. relay, Type 418D, is used for the test circuit, the relay being controlled by the test button on the face of the control unit, or by operation of the test switch on 4P. The test circuit injects a voltage into the fire detector circuit to simulate fire conditions, thus forming a test on the control unit for correct operation.

Circuit operation

16. The following circuit operation is given for No.3 engine fire detector and warning circuit, and should be read in conjunction with the theoretical circuit diagram contained in fig.3 (other engine circuit operations are similar). A 28-volt d.c. supply from fuse 819 is fed into the control unit at pole L, via relay contacts 826/2, and from there to three fuses, A1, A2 and A3. Relays 826 and 319 are energized when the rapid engine starting gyro hold-off switch is pressed (Chap.8, App.1).

Pulsing circuit

17. A pulsing circuit is used to create vibrations in the control unit chassis to prevent any lag in the operation of a sensitive moving coil relay MCR1. Reference to fig.3 will show that a supply from fuse A1 is fed through a suppressor circuit formed by choke S1 and capacitors C2 and C3, and via resisters R7 and R6 to the energizing coils of relays L1 and L2 respectively. Prior to the supply being available at pole L of the unit, relay L2 is shorted out by contacts L1/1. When the supply is available, relay L1 is energized and contacts L1/1 open allowing relay L2 to be energized. Contacts L2/1 close, and short out the coil of relay L1, resulting in L1 being de-energized and contacts L1/1 closing to short out relay L2. This action results in both relays being constantly energized and de-energized to create the necessary chassis vibrations.

18. Contacts L1/2 and L1/3 are used in another pulsing circuit, the object of which is to prevent foreign matter creating a high resistance connection at the moving relay contacts MCR1/1. The supply from fuse A2 is fed via resistor R13 to contacts MCR/1 as follows:-

(1) Via contacts L7/3 and resistor R11

(2) Via the detector chain and the coil of MCR1.

The path through contacts MCR1/1 will depend on the position of pulsing contacts L1/2 and L1/3, i.e. when contacts L1/2 close, the circuit will be completed via R16 to earth.

19. As soon as contacts L1/2 close, the supply from fuse A2 is fed via resistor R13, contacts L7/3, R11, contacts MCR1/1, contacts L1/2 and R16 to earth. The current flowing through the parallel path of the detector chain to the coil of relay MCR1 is sufficient to energize the relay and open contacts MCR1/1, but before contacts MCR1/2 can close, the pulsing action of relay L1 opens contacts L1/2 and so interrupts the circuit to the coil of MCR1. This results in contacts MCR1/1 closing again under the tension of the relay spring. This action is repeated as contacts L1/2 close and open again. The consequent oscillation of contacts MCR1/1 at the same frequency of the pulsing relay contacts ensures that a good low resistance is obtained.

Warning circuit

20. When a fire or high temperature generates a voltage of 7.5 mV in the detector chain, this voltage is fed across the coil of relay MCR1 and back to the other side of the detector chain via resistor R11 and contacts L7/3. Relay MCR1 is energized, opening contacts MCR1/1 and closing contacts MCR1/2. As previously described in para.19, a portion of the current flowing from fuse A2 is fed via the detector chain and the moving coil

FS/4

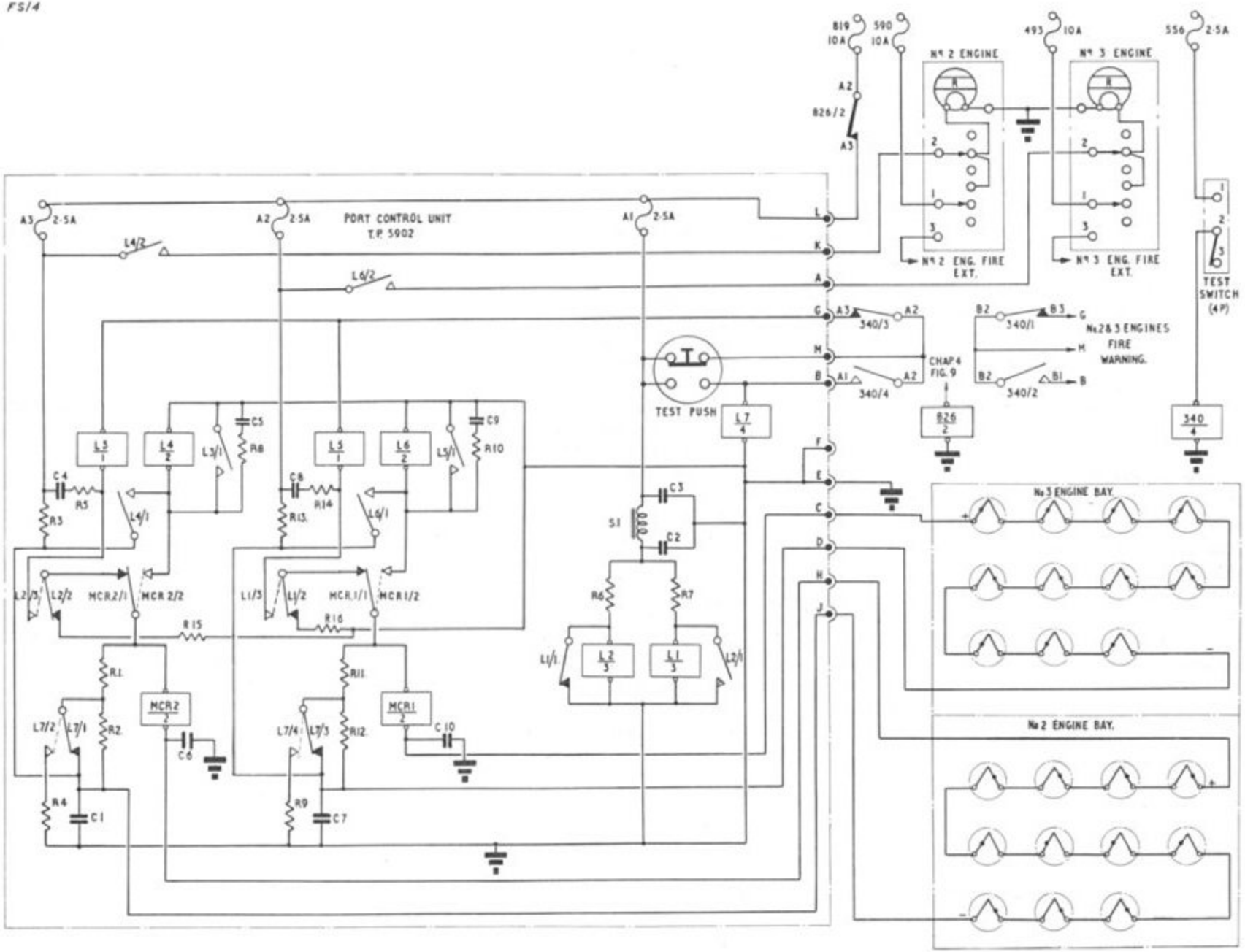

Fig. 3 Nº2 and 3 engines fire warning circuit – pre Mod. 2271 and 2416

▶ *Relay contacts 826/2 now shown closed* ◀

in such a direction as to assist the closing of contacts MCR1/2 to ensure a good connection. With contacts MCR1/2 closed, master relay L6 is energized, resulting in the following circuit operations:-

(1) Contacts L6/1 close to provide a hold-in circuit for relay L6, the supply being fed from fuse A2 via resistor R13.

(2) Contacts L6/2 close connecting the supply from fuse A2 via pole A of the control unit and the centre contacts of the appropriate push-switch to light the warning lamp within the push-switch.

Warning cancellation

21. When the temperature at the fire detector chain falls to a safe level, the output from the chain is no longer able to maintain contacts MCR1/2 in the closed position and contacts MCR1/1 close under the action of the moving coil relay spring. As soon as the pulsing relay contacts L1/3 close again, relay L5 will be energized as follows:-

(1) A 28-volt supply from fuse A1 is fed via the unit test push-switch and the normally closed contacts 340/3, to the coil of relay L5.

(2) The closing of contacts L1/3 provides an earth return for relay L5, via contacts MCR1/1 resistor R11, contacts L7/3 hold-in contacts L6/1, the coil of relay L6 and pole E of the control unit to earth, resulting in relay L5 being energized.

22. Immediately relay L5 is energized, contacts L5/1 close to short out the coil of relay L6. Relay L6 is de-energized, opening contacts L6/1 to break the hold-in circuit, and opening contacts L6/2 to break the supply from fuse A2 to the pilots' warning lamp. By this time, pulsing contacts L1/3 will have changed to position L1/2 with the result that relay L5 is de-energized and the unit reset.

Circuit test facility

23. In addition to the filament test facility already mentioned in para.11, the engine fire warning circuit can be tested from either the test switch situated on 4P (for all four engines) or the test push-switch at each control unit (two engines at a time). In the case of No.3 engines circuit (fig.3), when the test switch on 4P is held pressed, relay 340 will be energized. Contacts 340/3 open to isolate the supply from fuse A1 to the release relay L5, and contacts 340/4 close to energize relay L7. This action will open contacts L7/3 and close contacts L7/4 to bring resistors R12 and R9 into circuit. Current from fuse A2 will now flow through R13, and the parallel path, comprising the detector chain, the coil of relay MCR1 resistors R11 and R12, via contacts L7/4 and R9 to earth.

24. Relay MCR1 will be energized to close contacts MCR1/2 and energize relay L6 in series. The pilots' warning lamp will then light (para.20). When the test switch is released, relays L7 and MCR1 will be de-energized, and when pulsing relay contacts L1/3 close again, relay L5 will be energized, which in turn will de-energize relay L6 (para.22) thus resetting the circuit. When the test push-switch on either control unit is pressed, the test circuit will function in a similar manner to that already described, but relay 340 will not be energized.

Engine fire detection (post Mod.2271 and 2416)

25. On aircraft where Mod.2271 and 2416 have been embodied, individual control units, Type TP77056 are fitted, one for each engine detector chain. The units are located in the nose wheel bay (fig.2) the No.2 and 3 engine units are fitted on the port side between frames 86.5 and 101 above panel 73P, and the No.1 and 4 engine units on the starboard side between frames 130 and 115.5 on the bottom shelf of the radio and radar crate.

Control unit Type TP77056

26. The control units, Type TP77056 are fitted with two rotary test switches labelled HIGH/LOW and ISOLATED. Each control unit is of an encapsulated modular construction, housed in a hermetically sealed case comprising:-

(1) Chopper/amplifier.

(2) D.C. level detector.

(3) Oscillator.

Inbuilt test, fault analysis and calibration checking facilities are also included. The two rotary switches fitted on the front face of the unit are used for detector chain testing and calibration of the system. Electrical connections to the unit are made via a hermetically sealed Hellerman Deutsch connector, Type DTK-02H-10-6P.

Circuit description

27. The chopper circuit within each control unit is employed for converting the low level d.c. voltage obtained from the detector chain, into a.c. This has two main advantages in that the resulting a.c. signal is more easily amplified

and, transformer coupling between the input chopper circuit and the amplifier proper gives d.c. isolation of the detector chain from the 28V d.c. supply. Having amplified the a.c. signal, the ground level is then restored, resulting in a pulsating d.c. on to which is superimposed a variable d.c. bias voltage. It is this total signal level that is detected, and, on reaching this, a warning is obtained. The circuit also includes over-voltage protection on the millivolt input up to 35 volt d.c. and an input polarity discriminator to guard against triggering on negative inputs. Each control unit is set to operate its appropriate warning lamp in the fire extinguisher push-switch knob, when 15 ± 0.5mV is produced by the detector chain and to reset when this level falls to 5 ± 0.5mV.

Test and calibration facilities

28. In addition to the filament test facility already mentioned in para.11, the engine fire warning circuit can be tested by using the test switch situated on panel 4P. When the switch is held to TEST, a 28 volt d.c. supply from fuse 557 is fed via pole A on each of the four control units, to inject a millivoltage at the input terminal of each amplifier, via the detector chains. The associated warning lamp filaments will light to establish the continuity of the detector chain circuit and the functioning of the control units.

Isolated test

29. A further warning filament test can be carried out from each control unit by turning the rotary switch to ISOLATED. This injects a millivoltage from an isolated source into the detector chain, to light the appropriate warning lamp filament.

High-low calibration check

30. The control unit calibration check is effected by injecting, at the amplifier input a millivoltage just above (HIGH) or just below (LOW) the control unit nominal operating millivolt setting, using the rotary switch labelled HIGH-LOW. With HIGH selected, the warning lamp should light. With LOW selected the warning lamp should not light.

Fault diagnosis

31. If on testing the fire warning filaments by operating the test switch on panel 4P, (para.28) a warning is not obtained it can be assumed that the fault is due to:-

(1) Detector chain shorted to earth.

(2) Detector chain open circuit.

(3) Control unit failure.

32. If the ISOLATED test (para.29) is now carried out and a warning obtained, the fault analysis has revealed a chain-to-earth condition, which does not render the system unserviceable but indicates maintenance is required at the next convenient opportunity. If a warning is not obtained using the ISOLATED test, the condition outlined in para.31 (1) has been eliminated. Calibration HIGH test should now be functioned, and if a warning is obtained the detector chain may be assumed to be open circuit (para.31 (2)), if not a control unit failure may be assumed.

Engine fire extinguisher operation

33. The engine fire extinguishers will be discharged when the pilot's push-switches are pressed. This action will connect a 28-volt d.c. supply direct to the methylbromide containers, via the appropriate push-switch contacts 1-3 (fig.5). In the event of a crash landing, causing the operation of both inertia switches, relays 76, 77, 85 and 86 will be energized by a supply from fuse 593 and contacts 76/1, 77/1, 85/1 and 86/1 will close to connect a supply directly to the extinguishers.

▶ Fuselage tanks system – pre Mod.2455 ◀

34. The four methylbromide containers employed for the fire protection of No.1 and No.2 tank bays are situated, two on the rear pressure bulkhead and two on the bulkhead between the tanks, respectively. The fire extinguisher operation is fully automatic and is controlled by Graviner firewire sensing elements. The elements, which are routed around the tank bays and consist of flexible sensing elements, coupling units and bulkhead fittings, are connected to two control relay units. The flexible sensing elements consist of stainless steel capillaries and are provided with integral means of interconnection and a co-axial centre conductor. The central electrode is separated from the walls of the capillary by a filling material whose electrical properties differ with temperature (para.36). The system is designed to give high speed detection of fire and high temperature conditions.

Control relay units

▶ 35. The control relay units, Type 162D, used in conjunction with the firewire sensing ◀ elements, are each fitted to a base unit, Type D2240. Each control relay unit contains a transformer, two relays, diodes, resistors, capacitors and a choke. One of the relays is used for test purposes and is utilised only in the case of the bomb bay tank fire extinguisher system.

36. The operation of the (Triple F.D. Firewire) system uses the total impedance of the sensing element, whereas the earlier control relay units (prior to Mod.1842) depended solely upon the resistance of the firewire filling medium. A positive charge is produced on the capillary and a negative charge on the centre

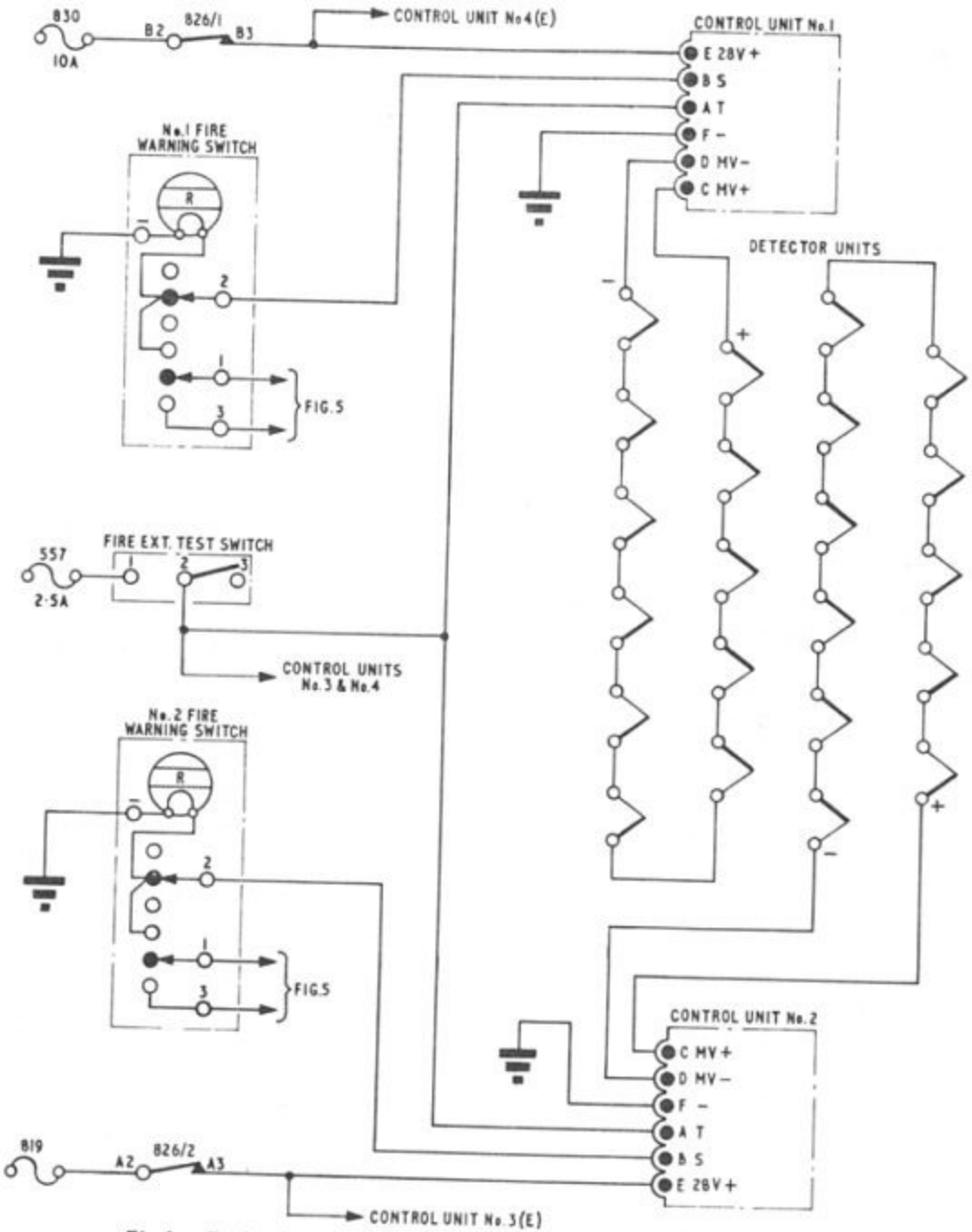

Fig.4 Engine fire warning circuit -- post Mod.2271 and 2416)

electrode. The characteristic of the sensing element is such that an increase in temperature creates an increase in the charge between the capillary and centre electrode and a decrease in resistance. During standby conditions, the high impedance of the sensing elements limits the charging current flowing through the circuit. When a fire or high temperature exists, the stored charge in the sensing element increases sufficiently to operate a silicon control rectifier, which in turn energizes a relay to complete the external fire warning and extinguisher operating circuit.

Circuit operation

37. The circuit for the No.1 and No.2 tank systems is shown in fig.7, a wiring diagram of the control relay unit is contained in fig.11. To assist in the understanding of the circuit, the internal circuit of the control relay unit is divided into the following sub-circuits:-

(1) The charging circuit
From winding S1 during the positive half-cycle through MR1, R3, the capillary, centre electrode and back to winding S1 via R1.

(2) The signal circuit
From winding S2 through R4, choke L1, the capillary, centre electrode and back to winding S1 via R1.

(3) The warning circuit
From winding S3 during the positive half-cycle through R4, MR6, R5, MR5 and back to winding S3.

During standby, the sensing element is only charged to a limited extent, due to the high impedance. The high impedance of the choke L1 in the signal circuit prevents this part of the circuit from contributing to the charging

circuit. The output of winding S1 establishes the bias for the SCR and also charges C3, during the positive half-cycle. During the negative half-cycle, C3 discharges through R4 to maintain the bias on the SCR.

Warning

38. When warning conditions exist, the charge stored in the sensing element at each positive cycle is increased. This causes the signal circuit to drive R4 more positive until the bias is removed from the SCR, which then conducts. When the SCR conducts, current flows during the negative half-cycle from winding S3 through MR2 and R2 to energize relay A, and also to charge C2. At the next positive half-cycle the relay is maintained in the energized condition by the discharge from C2. The energizing or relay A causes the following circuit action:-

(1) Contacts A/1 close to short circuit R3 and, by doing so, increase the charge current to the sensing element at the next positive half-cycle. This results in a gain in potential at the gate of the SCR to supplement the original signal.

(2) Taking the port control relay unit, contacts A/2 close to connect a 28-volt d.c. supply from fuse 807 to energize relay 358 (fig.7). Contacts 358/1 close connecting the supply from fuse 807 to the No.1 and No.3 extinguishers, and contacts 358/3, close connecting the supply to the extinguishers fired indicator.

39. In the event of a crash landing, inertia switches No.1 and No.6 will trip to energize relay 357. Contacts 357/2 will close to feed the 28-volt, d.c. supply, via fuse 807 and the normally closed contacts 358/2, direct to the No.1 and No.3 fire extinguishers (fig.7).

Wing tanks and leading edge system -- pre Mod.2455

40. Twelve methylbromide dual-head fire extinguisher containers, Type 14A, are mounted six in each wing, outboard of No.5 and 7 tanks. To avoid cross-connection, the forward containers are mounted with the 3-pole socket (head A) forward and the aft containers with the 3-pole socket (head A) aft. Operation of either head will discharge the contents of the fire extinguishers.

41. A further six, Type 13A, methylbromide containers are mounted, three in each wing bay, forward of the main wheel bays. These containers are connected by spray piping to the forward wing tank area along the leading edge duct of each main plane.

42. The operation of all wing tank and leading edge fire extinguishers is fully automatic, being controlled by a series of Graviner firewire sensing elements routed around the tank bays in both wings, similar to the ones for No.1 and No.2 tanks (para 34). The location of extinguisher containers and Graviner firewire sensing elements is shown in Fig.8.

Circuit operation

43. Referring to fig.9 it will be seen that should the firewire sensing element, fitted around the port tank bays No.3, No.4 and No.6, become heated and so operate the control relay unit, the following circuit action will take place. A supply from fuse 842 is fed via control relay unit contacts A/2 to energize relay 74. Contacts 74/1 and 74/2 close connecting the supply from fuse 842 to the 3-pole heads of the port fire extinguishers. Contacts 74/3 close connecting a supply from fuse 844 to the three fire extinguishers for the port wing leading edge and contacts 74/4 close connecting the same supply to the extinguishers fired indicator on the pilot's panel.

44. Should the firewire sensing element around the No.5 and No.7 port tank bays function, control unit relay contacts A/2 will close connecting a supply from fuse 843 to the energizing coil of relay 75. Contacts 75/1 and 75/2 close connecting the supply from fuse 843 to the 2-pole heads of the port wing fire extinguishers. Contacts 75/3 close connecting a supply from fuse 844 to the three fire extinguishers for the port wing leading edge, and contacts 75/4 close connecting the same supply to the extinguisher fired indicator.

45. In the event of a crash landing where both the No.1 and No.6 inertia switches have been tripped, the operation of the port fire extinguishers will be as follows. A 28-volt dc supply is fed from fuse 593 via the now closed inertia switch contacts to energize relays 76 and 77. Contacts 77/2 close to connect a supply from fuse 841 to energize relay 74. Contacts 74/1 and 74/2 close to connect a supply from fuse 842 to the 3-pole head of the port wing extinguishers, resulting in their containers being discharged in the inboard tank area. Contacts 74/3 close connecting a supply from fuse 844 to the leading edge extinguishers. Contacts 76/1 and 77/1 close connecting the supply from fuse 841 to the port engine fire extinguishers (fig.5).

46. The starboard system is similar in operation to the port wing system, except that should the inertia switches trip relays 85 and 86 are energized. Contacts 86/2 close to trip the battery isolation contactor (Chap.6) and contacts 85/2 close to operate the fire extinguisher system for the A.A.P.P. (Chap.5).

Fuel tanks and leading edge system -- Post Mod.2455

46A. Mod.2455 renders the firewire detection system and automatic fire extinguisher function inoperative in the fuselage tanks, leading edges and wing tanks areas by disconnection and removal of the Type 162D relays. The associated cables are insulated and stowed in the wiring looms. Circuit changes provide for manual discharge of the fire extinguishers under control of the second pilot, one push-switch controlling all

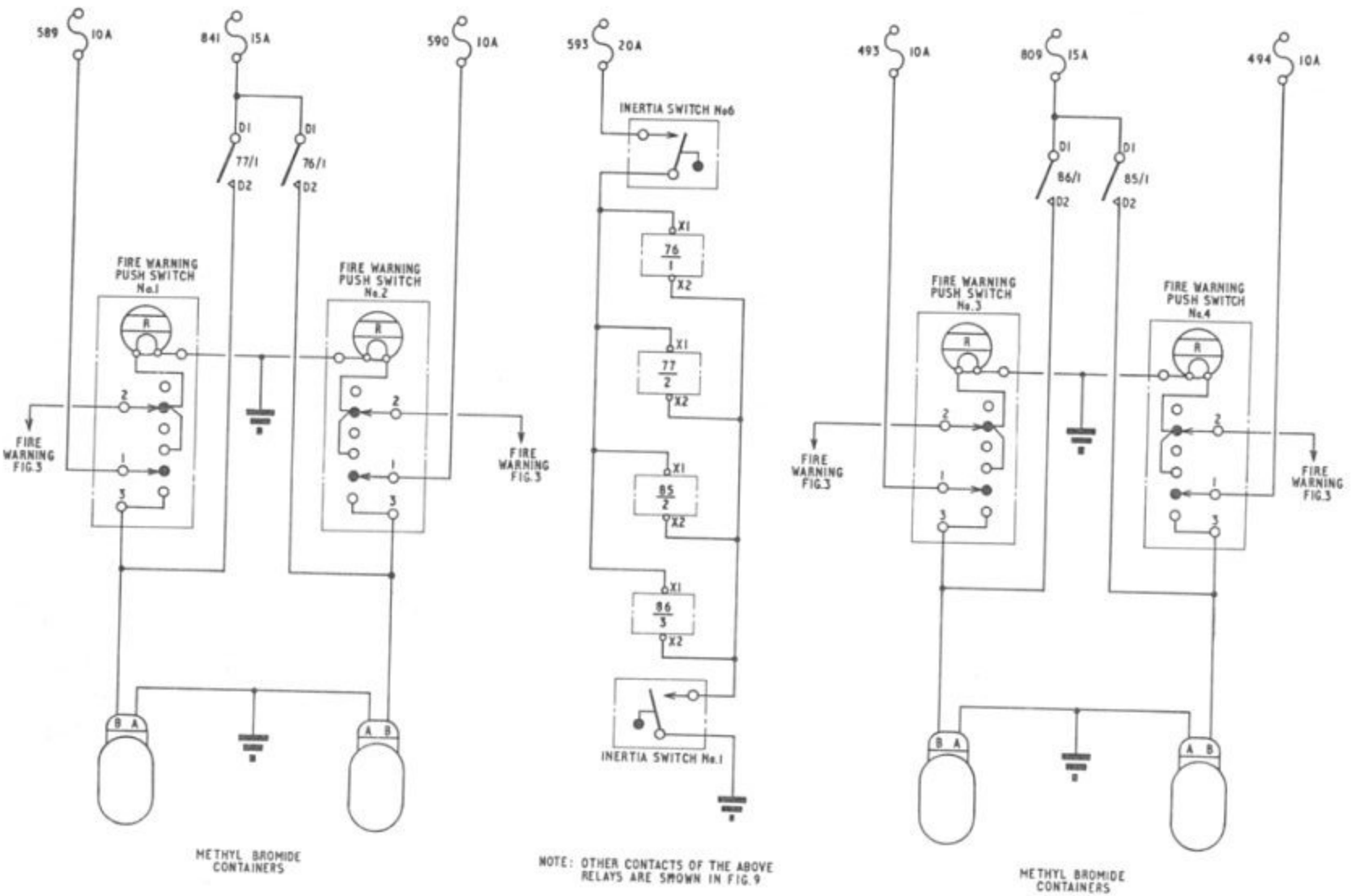

Fig. 5 Engine fire extinguisher circuit

▶ bottles in the port fuselage and wing, another controlling the starboard bottles. The extinguishers fired warning indicator for these systems is removed. The modification also disconnects and stows the 2-pin plugs from the dual headed fire bottles in each wing resulting in the extinguishant from these bottles being discharged into the inner wing tank area only.

Circuit operation

46B. Reference to fig.9A will show that operation of the port fire extinguisher push-switch will energize relays 74 and 358 from fuse 645. Contacts 74/1 and 74/2 close, completing the circuit from fuse 842 to the port wing tank fire extinguisher bottles. Contacts 74/3 close to supply the leading edge extinguishers from fuse 844, whilst the port fuselage tank bottles are fed from fuse 807 via contacts 358/1.

46C. In the event of operation of both No's 1 and 6 inertial switches, relays 76, 77 and 357 are energized from fuse 593. Contacts 357/1 close to operate the fuselage tanks fire bottles from fuse 807, and contacts 77/2 close, energizing relays 74 and 358 resulting in the circuit action described in paragraph 46B. Contacts 76/1 and 77/1 close to connect the engine fire bottles to fuse 841.

46D. The starboard system functions in a similar manner, with the addition that inertia switch operation results in the AAPP fire extinguisher being fired by closure of contacts 85/2, and the battery isolation contactor is tripped via contacts 86/2.

Bomb bay tank fire extinguishers

47. On aircraft where Mod.526 has been embodied, a fire extinguisher system employing the Graviner firewire method of detection is installed in the bomb bay. This system is provided to afford protection for the bomb bay fuel tanks when these are fitted during special stores roles.

48. Eight methylbromide containers, Type 13A, are used in the bomb bay system: these are fitted in two groups of four. One group is located on the port side of the bay between bomb arches 64.6 in. and 95.6 in. the other group is located in a similar position on the starboard side of the bomb bay. Each group of containers is connected to its own length of spray piping, routed along each side of the bomb bay.

49. The firewire element is routed around the bomb bay in a continuous loop, running along both sides of the bomb bay, and across bomb arch 321.9 in. At the front spar, each end of the firewire loop is connected to a control relay unit, Type 162D, located in the nose-wheel bay, on the starboard radio crate.

50. An indicator lamp with a built-in filament test facility is located on the second pilot's instrument panel in the cabin. (fig.1 or 2). This indicator lamp will light when the fire

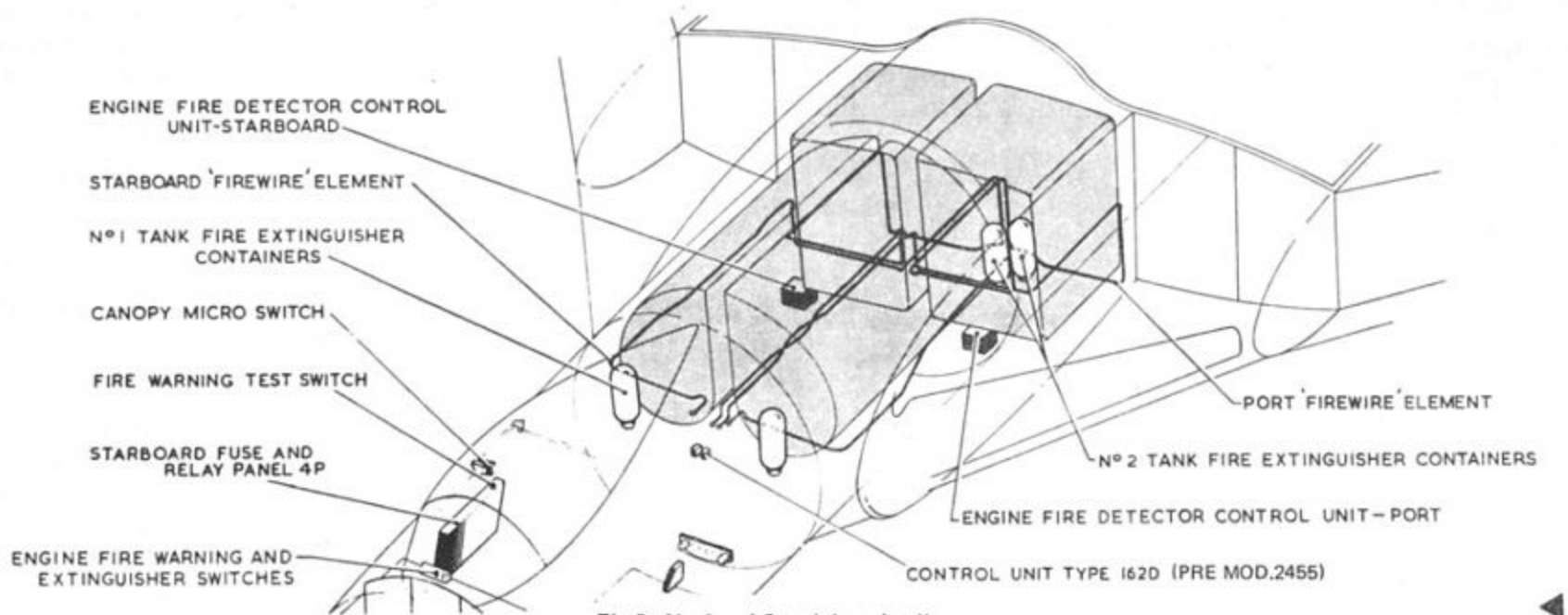

Fig.6 No.1 and 2 tank bay details
▶ (Ref. to Mod.2455 added) ◀

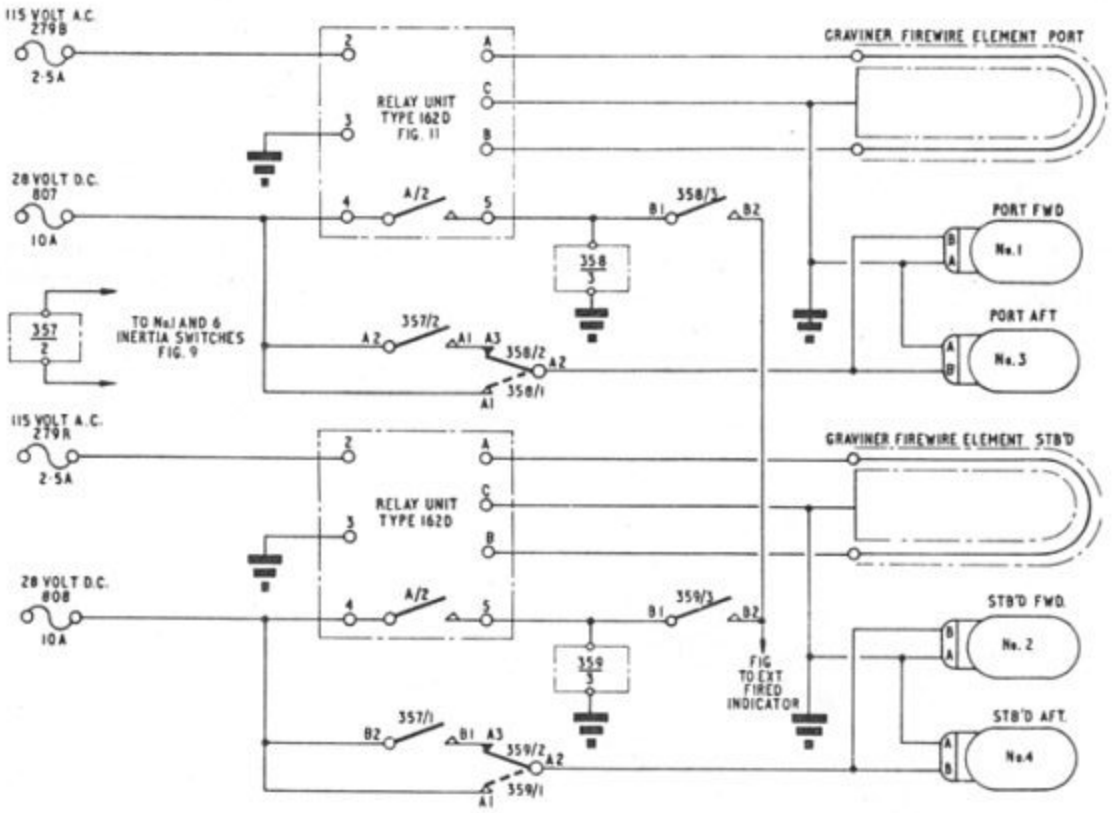

Fig.7 No.1 and 2 tank bay circuit - pre Mod.2455

▶ *Title amended* ◀

extinguisher containers have operated. A further test switch and indicator is fitted to a small panel on the radio crate structure at the starboard side of the nosewheel bay. This test switch is provided to enable the ground servicing personnel to check that the firewire detector loop is operating correctly. Because of the difficulty of checking the extinguisher cartridges when the bomb bay tanks are fitted, two indicator fuses, Type A984, Ref. No. 27N/317 have been introduced by Mod.2009. The glass fronts of the indicator fuses, which are situated at the bottom of the front spar, port side, become coloured red when the internal fuse has blown. The circuit position of these indicators is such that a blown indicator fuse denotes also a discharged container.

51. A relay panel, designated 78P is installed in the bomb bay, and contains the operating relays (505 and 506) for the extinguisher system (D.C. supplies to the system are all fed from the 28-volt vital supplies panel 19P, and the 115-volt, 400 Hz supply to the control relay unit is fed from fuse 297R in 28P.

Circuit operation

52. Referring to the circuit diagram contained in Fig.11, it will be seen that:-

(1) To afford full circuit protection, the contacts of relays 505 and 506 are interposed in both the positive and negative lines to the extinguisher containers, thus completly isolating the containers from the electrical supplies. ◀

(2) Relay 505 when energized, will cause all containers to operate, and relay 506, which is controlled by both the No.1 and No.5 inertia switches, will operate all the containers during crash conditions.

(3) The energizing of either relay will operate the two indicator fuses.

53. Should the firewire sensing element become heated, the control relay unit will operate and close contacts A/2. The closing of these contacts will connect a 28-volt dc supply from fuse 814 to energize relay 505 via the normally closed contacts 818/3. Operation of contacts 505/1, 505/2, 505/3 and 505/4 will connect all eight container heads to the appropriate supply fuses, causing the containers to discharge their contents in the bomb bay. Fuse 814 will also be connected to the EXTINGUISHERS FIRED indicator lamp, thus informing the pilot that the containers have been operated. A press to test facility is incorporated in the lamp to check the serviceability of the lamp filament, the supply being fed via fuse 531 and the 2nd pilot's windscreen wiper switch (Chap.18).

54. In the event of a crash landing when both the No.1 and No.6 inertia switches have been tripped, relay 506 will be energized. Contacts 506/1, 2, 3 and 4 close connecting all eight container heads to the appropriate supply fuses, and the containers contents will be discharged into the bomb bay.

Test switch/indicator

55. As stated in para.50, a test switch and indicator is provided in the nosewheel bay to enable the detector circuit to be ground checked. On pressing the front face of the indicator, a supply is fed from fuse 814 to energize relay 818. Contacts 818/3 open isolating relay 505, and contacts 818/1 close

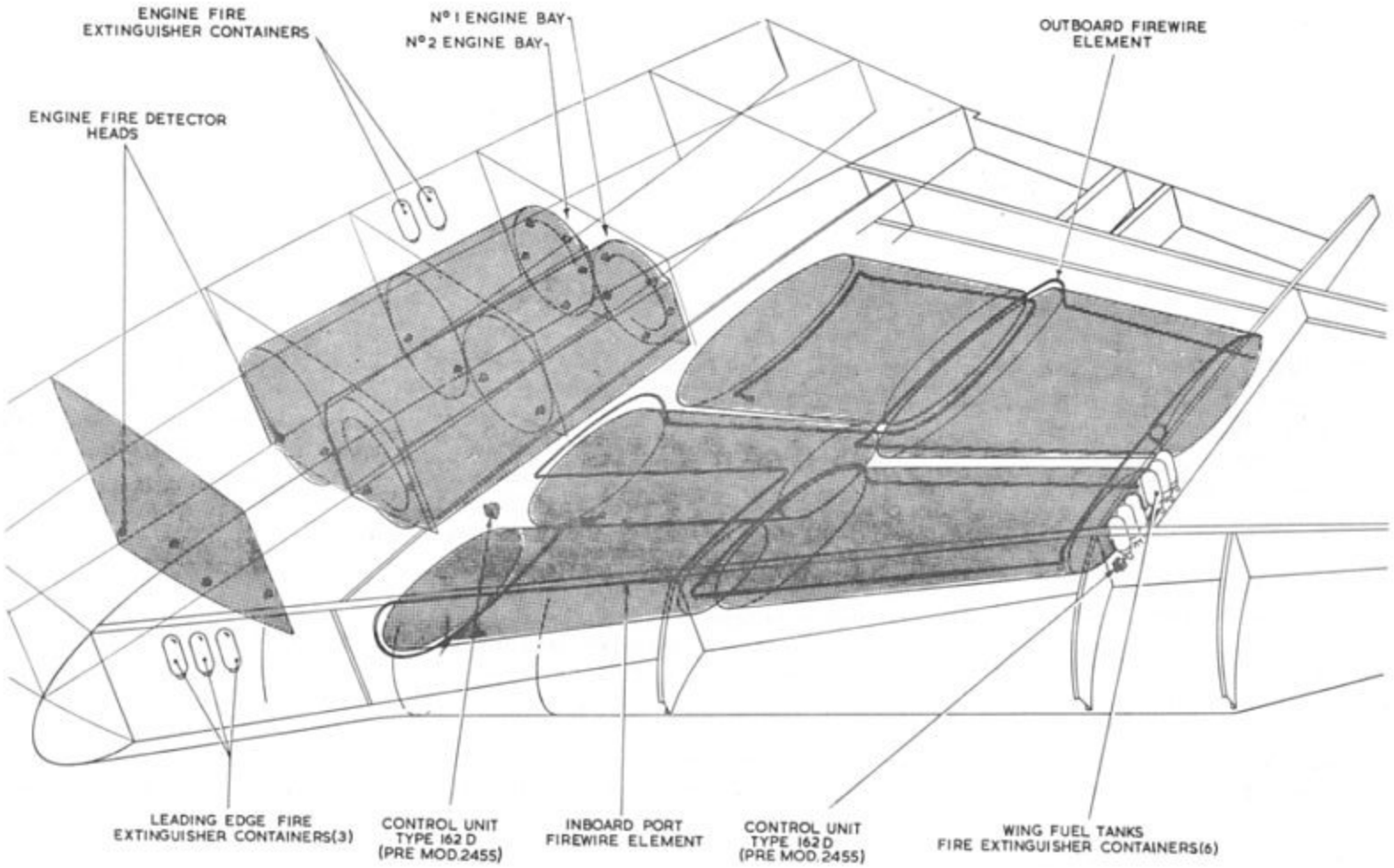

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Fig. 8 Engine bay and wing tanks fire extinguisher details

► *Ref. to Mod. 2455 added* ◄

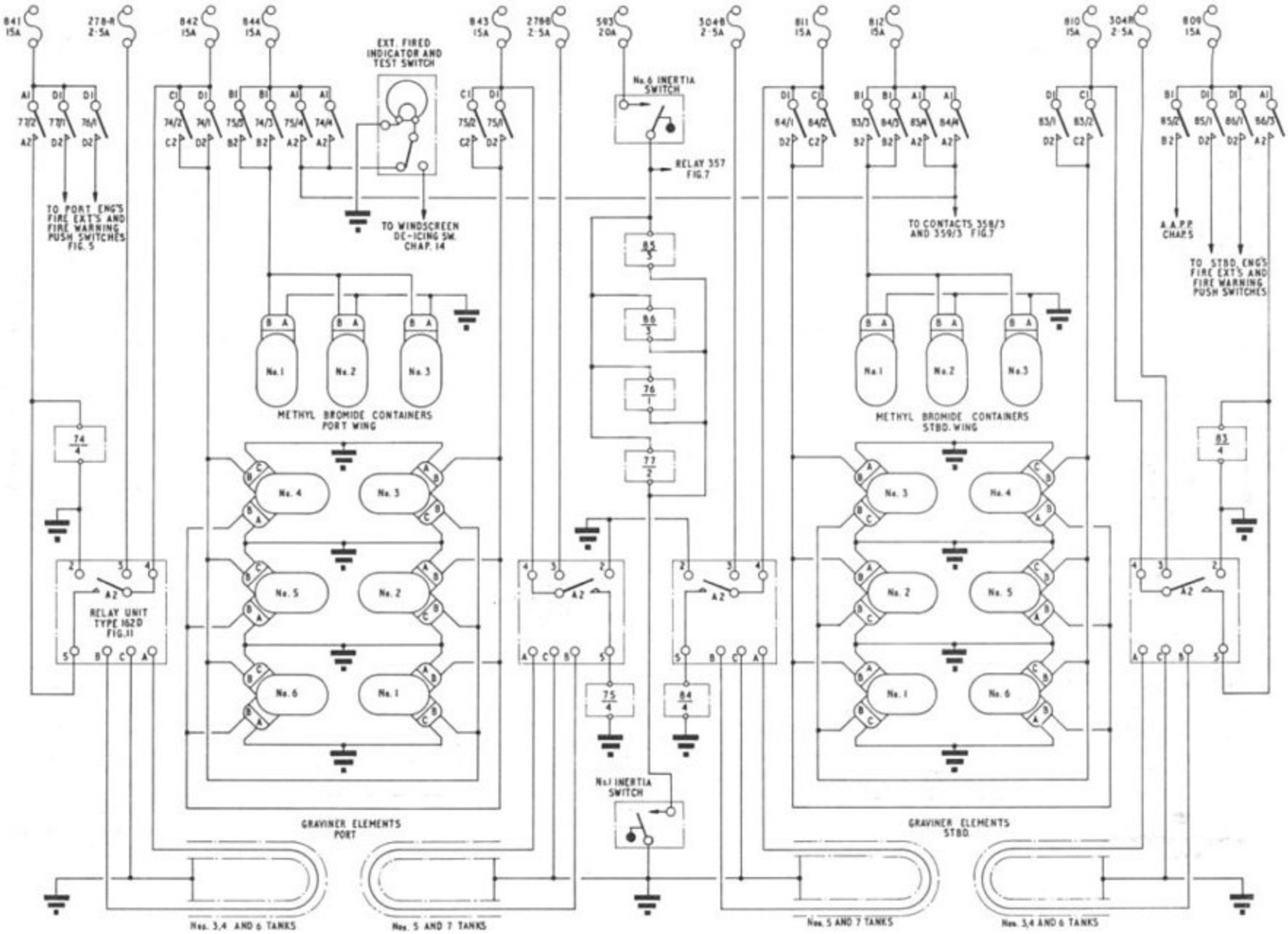

Fig. 9 Wing tanks and leading edge circuits - (Pre Mod 2455)

► *Title amended* ◄

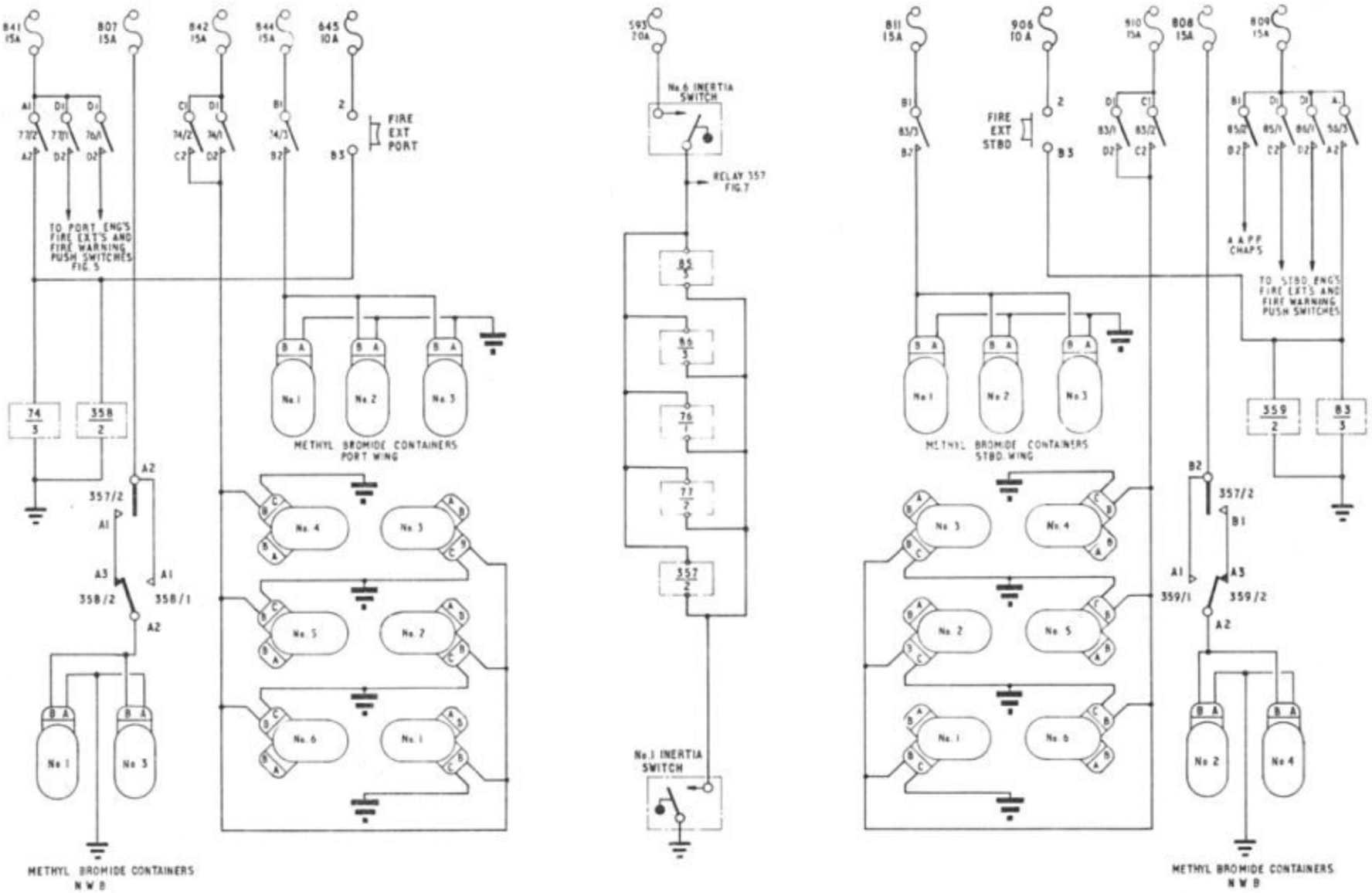

Fig 9A Fuselage tanks, leading edge and wing tanks circuits - Post Mod 2455

connecting the supply from fuse 814 to energize relay RLB within the firewire control relay unit. Test relay contacts B/1, in the control relay unit, will change over and connect capacitor C1 in series with the centre electrode of the sensing element. This action increases the charge potential across the sensing element and so initiates the circuit action described in para.38 and 39. The warning circuit will light the indicator which will remain lit until the test switch is released, thus proving the control relay unit circuit.

56. Mod.2118 introduces into the extinguisher test switch circuit relay No.818. This relay utilizes the inherent delay in the relay unit, Type 162D, and ensures that when the test switch is released the containers are not inadvertently operated.

CANOPY AND ENTRANCE DOOR CONTROL AND INDICATION

Canopy indication

57. A magnetic warning indicator, Ref. No. 5CZ/7054 fitted to the pilots' instrument panel 1P, provides indication for canopy locking. When the canopy is locked the indicator will be energized to show black via a micro switch operated by the canopy locking and release mechanism. Opening of the canopy causes the indicator to be de-energized to show white.

Entrance door indication

58. Two warning lamps one red and one green, are fitted on the entrance door quadrant (fig.1 or 2) to provide indication of entrance door locking. In addition a magnetic indicator, Ref. No. 5CZ/5074 is fitted on the pilots' panel. A further green warning lamp is fitted at the starboard side of the nosewheel bay for ground checks.

59. The indicator circuit is controlled by two micro switches mounted on a bracket secured to the structure at the aft end of the entrance door. The micro switches are operated by the torque tube of the door locking mechanism and by the inner surface of the door when it closes.

Circuit operation

60. When the door is closed and locked a supply is fed from fuse 530 via the torque shaft micro switch contacts A-C and the door micro switch, contacts 2-3, to light the green entrance door warning lamp, and the green nosewheel bay lamp. The same supply is fed via contacts 5-6 of the door micro switch to energize the pilots' indicator, to show black. When the door is opened or unlocked a supply is fed from fuse 530 via the torque shaft micro switch contacts A-B to light the red entrance door warning lamp. The pilots' indicator will be de-energized to show white, and the green warning lamps at the entrance door and nosewheel bay will go out.

Emergency door opening

61. In an emergency, the doors can be opened by the operation of the DOOR OPEN EMERGENCY switches one fitted at the navigator's panel (centre) and one at the navigator's table. Reference to fig.13 will show that when either switch is operated, a supply from fuse 635 is fed via the closed switch contacts to energize the unimatic door valve which opens the door. The entrance door warning lamp will light as described in para.60. Further details of the emergency door opening circuit are given in Chap.12.

TAIL TO GROUND WARNING

62. Mod.1583 introduces a warning system which alerts the pilot if the tail of the aircraft is in close proximity to the runway during landing. A pivoting bumper arm extends downwards and rearwards below the tail fuselage (fig.14). When the angle of the aircraft during 'touch down' is sufficiently acute to bring the tail near the ground, the arm will come into contact with the runway. This action will pivot the arm upwards to operate two micro switches, which will cause two warning lamps at the 1st pilot's position to light.

Components and location

63. The pivot bumper arm normally depresses the plungers of two micro switches protruding through the lower skin of the tail fuselage, the bumper arm being held in this position by a spring under tension. The micro switches which are Dowty, Type C1831Y Mk.101C, Ref. No. 5CW/6976, have their contacts open when depressed by the bumper arm. When the arm pivots due to contact with the runway, the micro switch plungers are released, thus closing their internal contacts. Individual 28-volt d.c. supplies from fuses 458 and 460 in 26P are fed via the closed micro switch contacts to light the pilots' two indicator lamps. The indicator lamps are Rotax, Type H2702 (fitted with a red glass), Ref. No. 5CX/1069, and are situated on the rectangular demister pipe mounted on the 1st pilot's windscreen. The location of the components is illustrated in fig.14, and a routing chart is contained in fig.24.

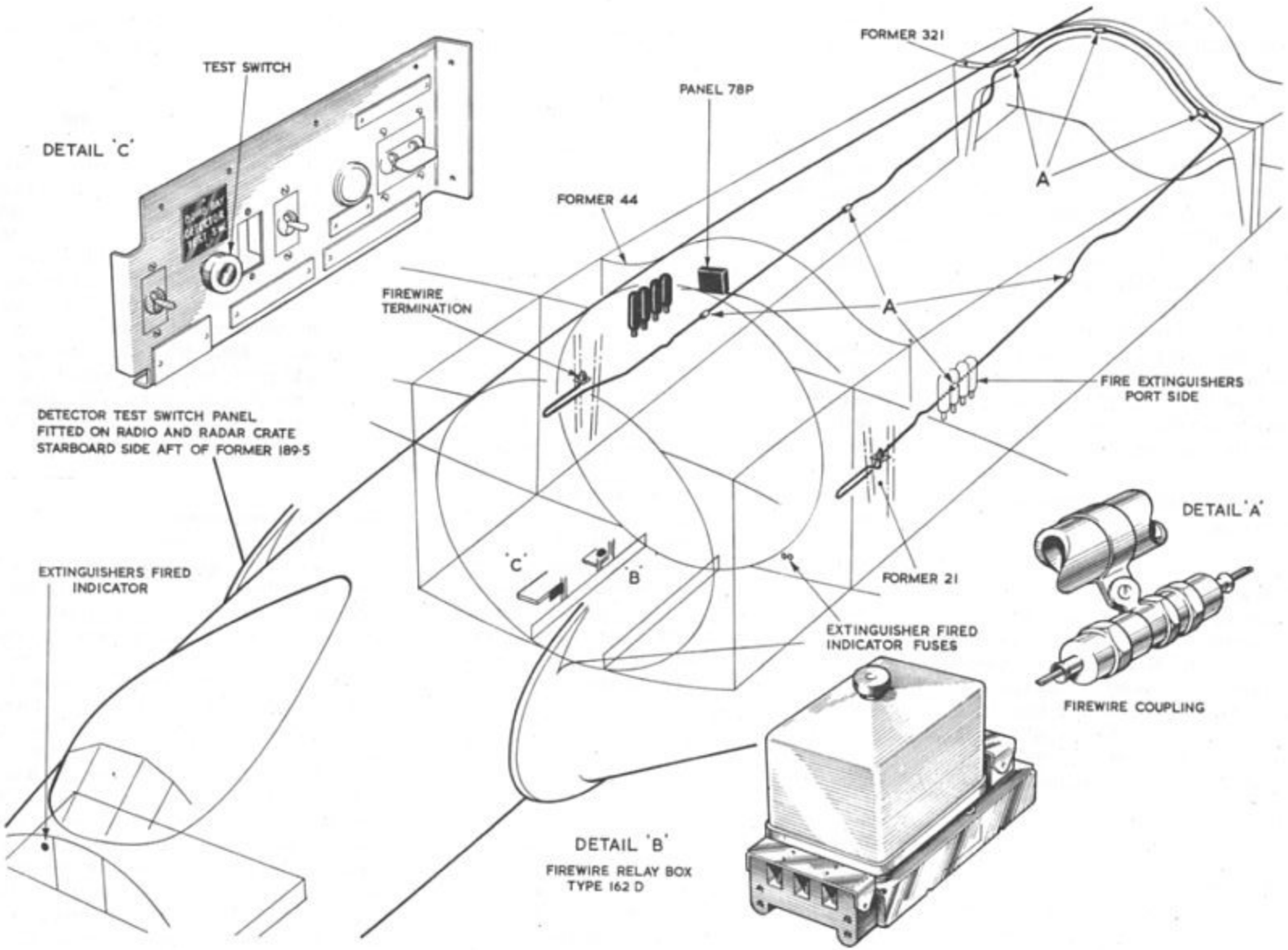

Fig.10 Bomb bay fire extinguisher system

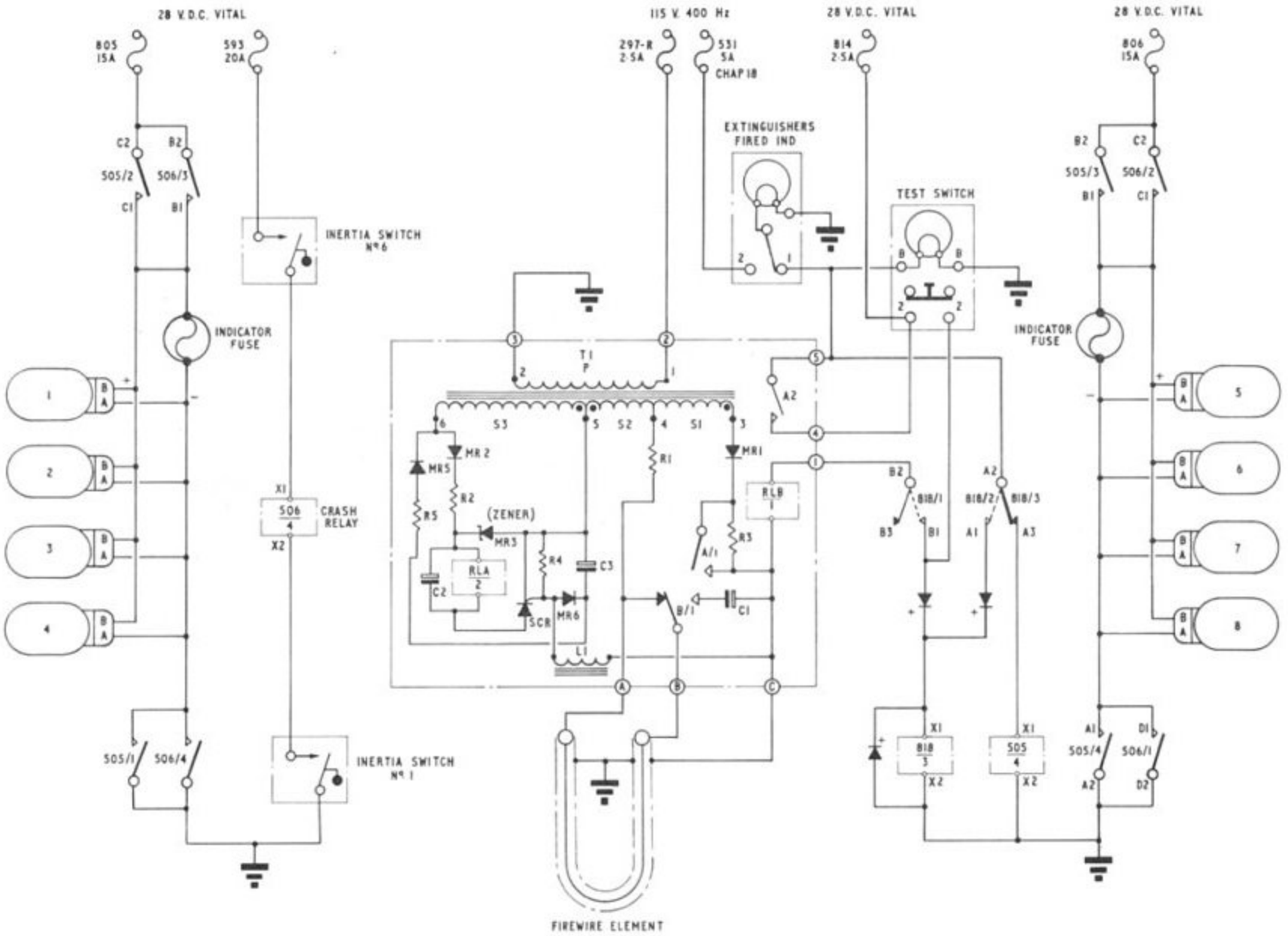

Fig.11 Bomb bay fire extinguisher control

▶ *Contact nos. on relays 505, 506 and B18 corrected* ◀

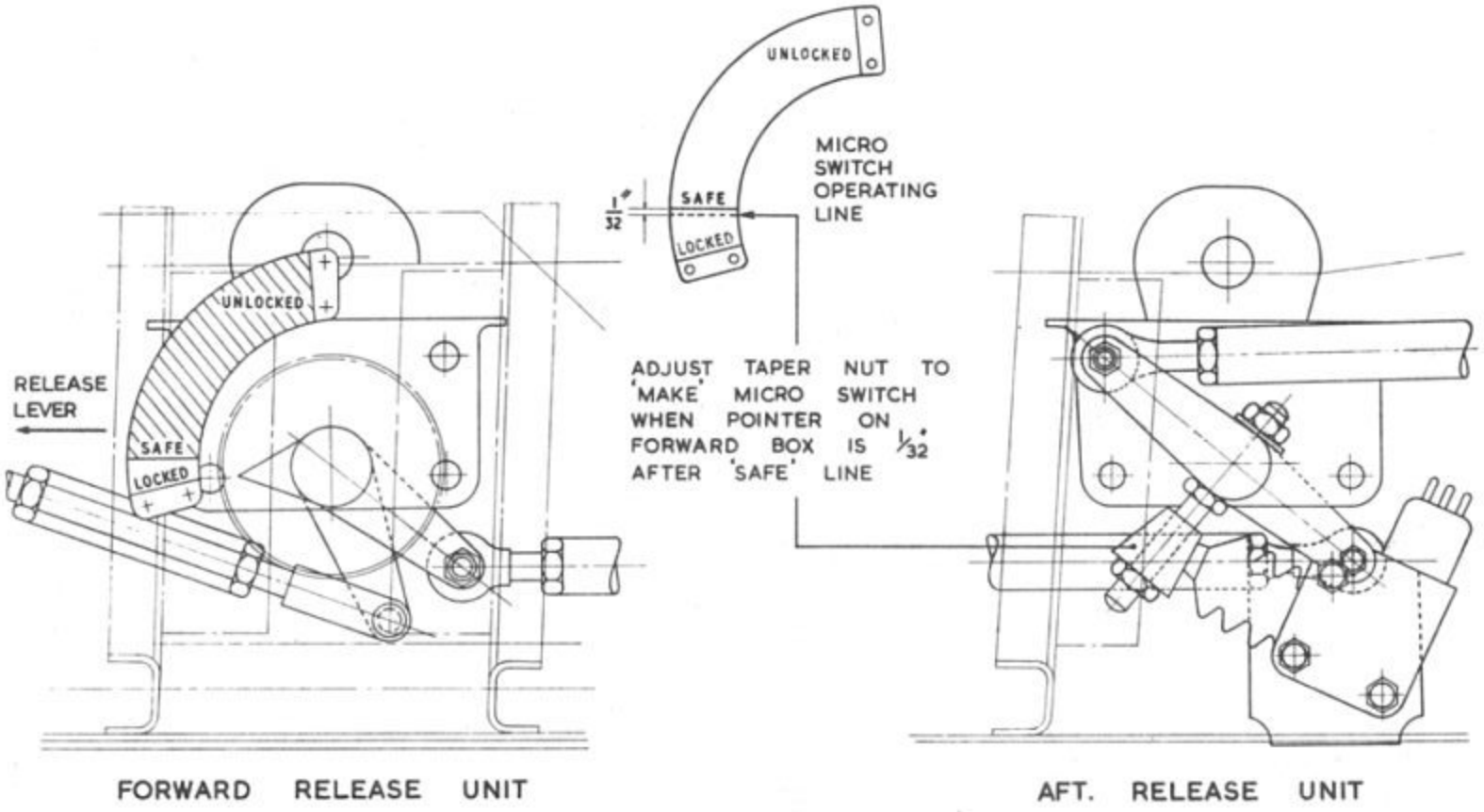

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Fig. 12 Setting of canopy micro switches

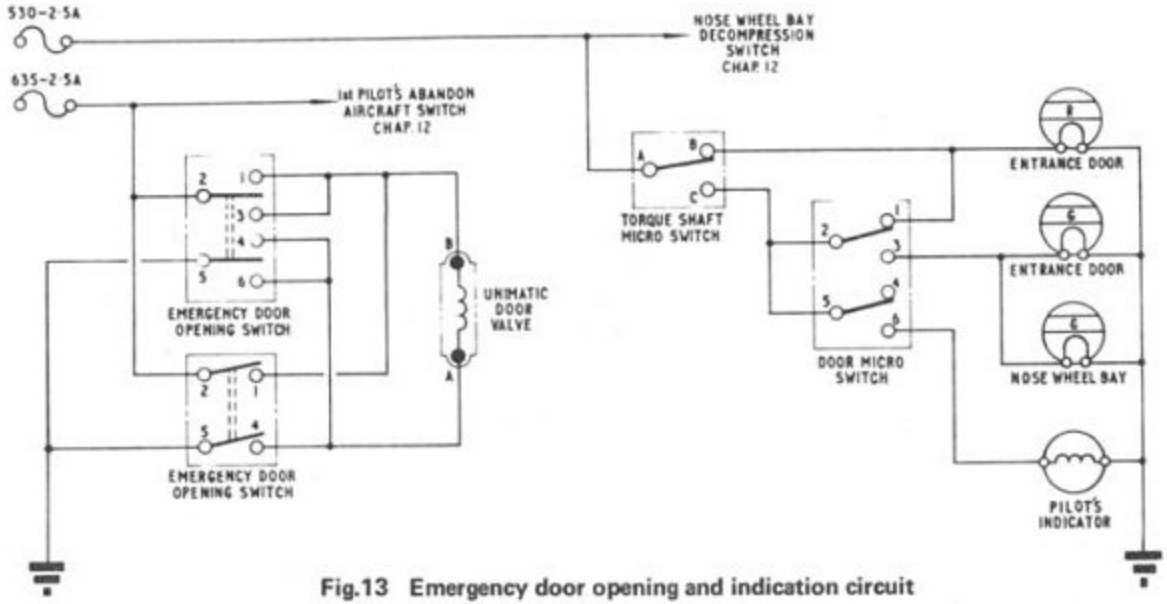


Fig.13 Emergency door opening and indication circuit

SERVICING

WARNING . . .
Methylbromide is an odourless non-irritant vapour, highly poisonous. The effects may not be apparent at once and may be fatal if a large amount is inhaled.

FIRE EXTINGUISHER CONTROLS

64. It is important that the fire extinguisher circuits be tested regularly in accordance with A.P.101B-1902-4. Inadvertent operation of the push-buttons and inertia switches must be avoided. The methylbromide container supply cables must be disconnected, protected and stowed before any servicing of the system is attempted.

Engine fire warning

65. The warning lamps in the knob of each engine fire extinguisher push-switch may be tested by pulling the knob outwards. A faulty lamp filament should be replaced by a serviceable filament of the correct type.

66. The engine fire warning circuit and thermocouple chain may be test functioned from two positions namely:-

(1) By operating the test switch on 4P, which will test all four engine circuits.

(2) By operation of the test switches on each control unit in the nosewheel bay.

For details of the circuit action during test refer to para.23 (pre Mod.2271 and 2416) or para.29 (post Mod.2271 and 2416).

Thermocouple detector heads

67. The loop resistance of each detector head chain should be checked periodically, when the total resistance should not exceed 2 ohms. Care should be taken when remaking any of the detector head connections, and the instructions laid down in the relevant section of A.P.113A must be followed at all times. Further details of the detector heads, Type TP7700 can be found in the associated A.P. listed in Table 1.

68. The correct polarity and operation of each detector head and also the function of the system as a whole can be checked by means of a Test Set, Fire Detector, Ref. No. 5G/3294. Full details of this Test Set including instructions for its operation will be found in the associated A.P. listed in Table 1.

Control units (pre Mod.2271 and 2416)

69. The control units, Type TP5902, may be checked by listening for a regular periodic tick when power is switched on. If the pulse circuit is not working (indicated by the absence of the ticking sound) examine the pulse fuse, and fit a new one if necessary. Further details of servicing checks on the control units will be found in the associated A.P. listed in Table 1.

Control units, (post Mod.2271 and 2416)

70. On aircraft where Mod.2271 and 2416 have been embodied, the control units, Type TP77056 should be checked for external corrosion, deterioration of protective treatment, damage and distortion. The electrical connection of the hermetically sealed connector should be examined for security. Thermocouple plug breaks should be periodically cleaned to reduce the effects of high resistance contacts due to oxidisation of pin and socket surfaces. For further details reference should be made to the associated A.P. listed in Table 1.

Detector polarity check

71. Detector polarity may be checked by applying heat to each detector in turn and ensuring that the resultant millivoltage measured at the detector loop terminals is of the correct polarity, (fig.16(2)).

NOTE . . .

A test set, Type 3701, comprising heat probe, polarity test meter and control unit to power plant interconnecting cable is available for this purpose.

Detector loop resistance to earth

72. The detector resistance to earth should not be less than 50K ohms.

CAUTION . . .

On no account should the detector loop resistance or insulation be tested using a high voltage tester with the control unit connected, failure to disconnect the control unit may result in damage to the internal transistorised circuitry.

73. On completion of the tests contained in para.71 and 72, the warning system should be re-checked by carrying out the following tests:-

(1) Hold the FIRE EXTINGUISHER TEST SWITCH on 4P to the TEST position and ensure that all four engine fire warning lamps light.

(2) Check each of the four control units calibration using the HIGH – LOW calibration facility.

(a) Operate the HIGH switching facility, check that the appropriate fire warning lamp lights.

(b) Release the switch and the fire warning lamp should cancel.

(c) Operate each LOW switching facility, check that the appropriate warning lamp does not light.

Fire detector systems

74. General servicing of all systems protecting the tank bays consists of periodic examination of the components for freedom from damage or deterioration. Refer to the A.P.s listed in Table 1 before carrying out any further servicing or dismantling.

Firewire test set

75. A Graviner test set, Type T1580-02, is available for locating the position of faults in the elements of a firewire sensing loop. The test set is equipped with special extension and adapter leads, which enable the test set to be connected into the firewire loop at the termination or most accessible coupling points. The coupling locations for the firewire loops are shown in fig.14A, 14B and 14C.

76. Operating instructions are provided inside the lid of the test set, which is fully described in A.P.120F-0402-1.

Fire extinguisher checks

77. To facilitate test functioning of the engine fuel tank, and bomb bay fire extinguisher circuits, a test console, Ref.No.26DC/95294 together with an operating schedule is available. Details of this test set will be found in the associated A.P. listed in Table 1.

78. Before carrying out any tests it is important that ALL fire extinguisher container cables should be disconnected, protected and stowed.

Fire extinguisher containers

79. The methylbromide fire extinguishers, Type 13A and 14A, are operated by detachable firing units. These detachable units should be tested with a safety ohmmeter, Ref.No. 5Q/25001, the resistance should read between 7 ohms and 11 ohms. The insulation resistance should be tested by a resistance tester, Type D, the reading should be at least 20 megohm. Note that on aircraft where Mod.774 has been embodied, a new type of cartridge head is fitted which has a resistance of 5-6 ohms.

80. When the cartridge firing units are tested, they must be removed from the extinguishers and mounted on a suitable rig fitted with a shield to mask the charge end of the cartridge unit, in case the cartridge is fired inadvertently; the shield must not restrict the charge end of the cartridge unit. Full details for servicing and testing the cartridges used in the firing unit will be found in the associated A.P. listed in Table 1.

CANOPY AND ENTRANCE DOOR TESTS

81. Testing of the canopy and entrance door indicators and warning lamps should be carried out during ground servicing periods, or in the case of the canopy, whenever it is removed and refitted. The microswitch setting details for the two warning circuits are given in the following paragraphs.

Canopy microswitch

82. The canopy locking mechanism and microswitch should be adjusted in accordance with Sect.3, Chapters 1 and 11 and reference should also be made to fig.12 of this chapter. The magnetic indicator on the pilot's panel should be energized to show black when the microswitch is operated.

Door warning indicator microswitch settings

83. The door warning indicators and microswitch settings should be checked at the periods laid down in A.P.101B-1902-4. The operating sequence and microswitch settings are detailed in Sect.3.

TABLE 1

Major items of equipment

Item	Type	Ref.No.	A.P. Reference
Thermocouple detector heads	T.P.7700	5CZ/6188	107E-0002-1
Control units (pre Mod.2271 and 2416)	T.P.5902	5CZ/6910	
Control units (post Mod.2271 and 2416)	T.P.77056	5CZ/NIV	107E-0001-1
Control relay unit	162D	5CZ/7404	107E-0104-1
Test set, fire detector	–	5G/3294	120F-0001-1, Sect.17
Test set, fire detector	T1580-02	5G/6327256	120F-0402-1
Indicator fuses	A984	27N/317	107E-0301-1
Test console	–	26DC/95294	120N-0145-1
Cartridge firing unit	–	–	110N-0703-1

TAIL TO GROUND WARNING

Microswitch checks

84. The microswitches are set to operate when the vertical dimension between the undersurface of the keel member and the top of the operating arm is 3.5 in ± 0.25 in. To achieve this setting move the arm upward by hand until the microswitches operate and the warning lamp lights. Check the dimension and, if necessary, adjust the strikers away from the switch to increase, toward the switch to decrease.

REMOVAL AND INSTALLATION

Firewire elements

85. The firewire elements for the fuselage and wing tanks are necessarily in close proximity to the tanks and are therefore not accessible until the tanks and tank skinning have been removed. In the case of the bomb bay element however, access can be gained along its length to enable speedy unclipping and removal.

Control units, Type TP5902

86. Removal of these units consists of uncoupling the 12-pole connector from the front panel, undoing the knurled securing nuts and lifting the unit clear of the rack.

▶ **Control Units, Type TP77056**

87. These transistorized control units are removed by first disconnecting the Hellerman Deutsch 6-way connector, then removing the four securing bolts.

Control relay units, Type 162D

88. In each case the relay unit is detached from its base by unscrewing the knurled screw at the top of the unit. The base is then removed by undoing the three associated securing bolts. ◀

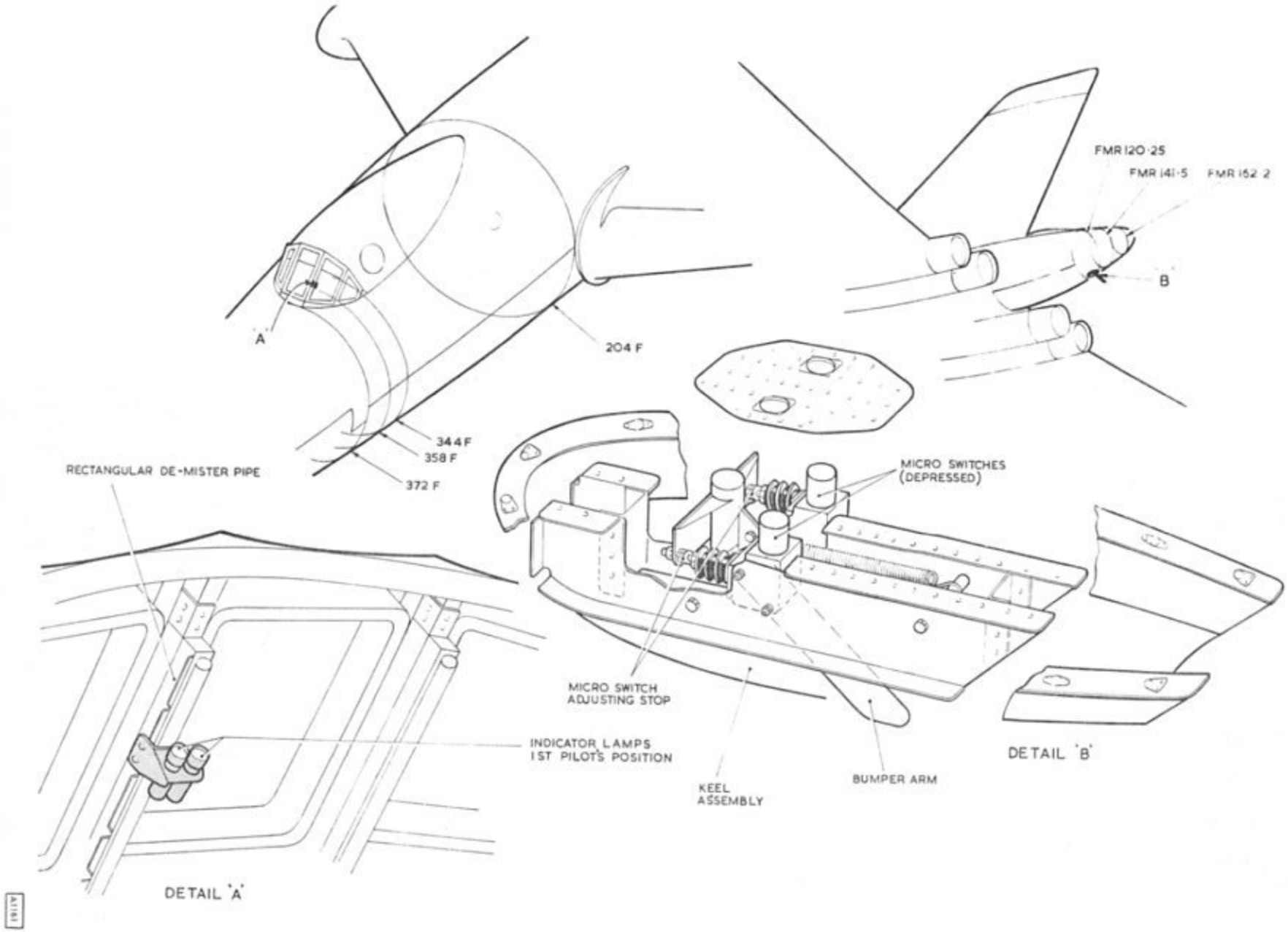


Fig.14 Tail to ground warning, location

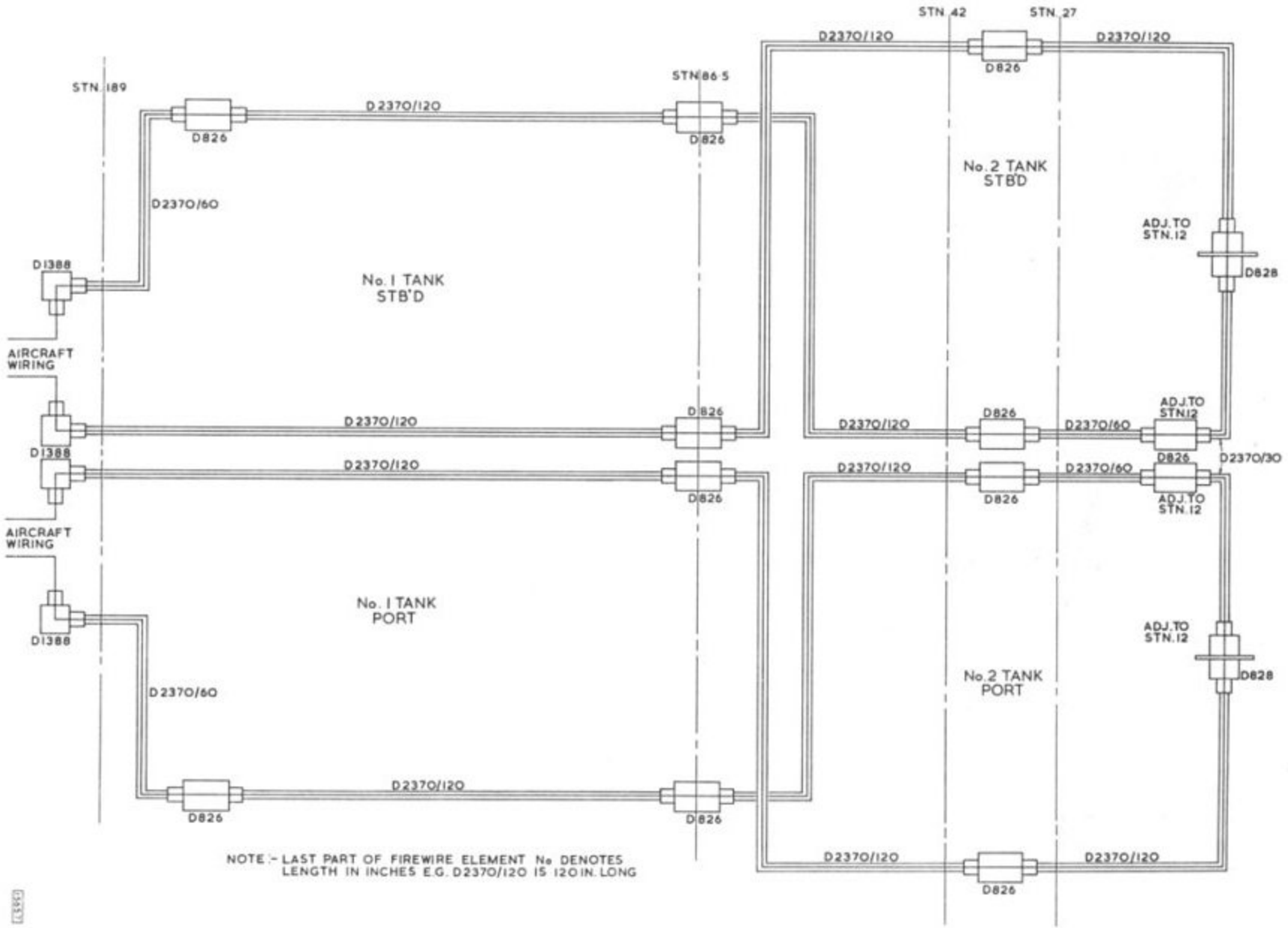


Fig. 14A No. 1 and 2 tanks firewire sensing loops

▶ *New diagram* ◀

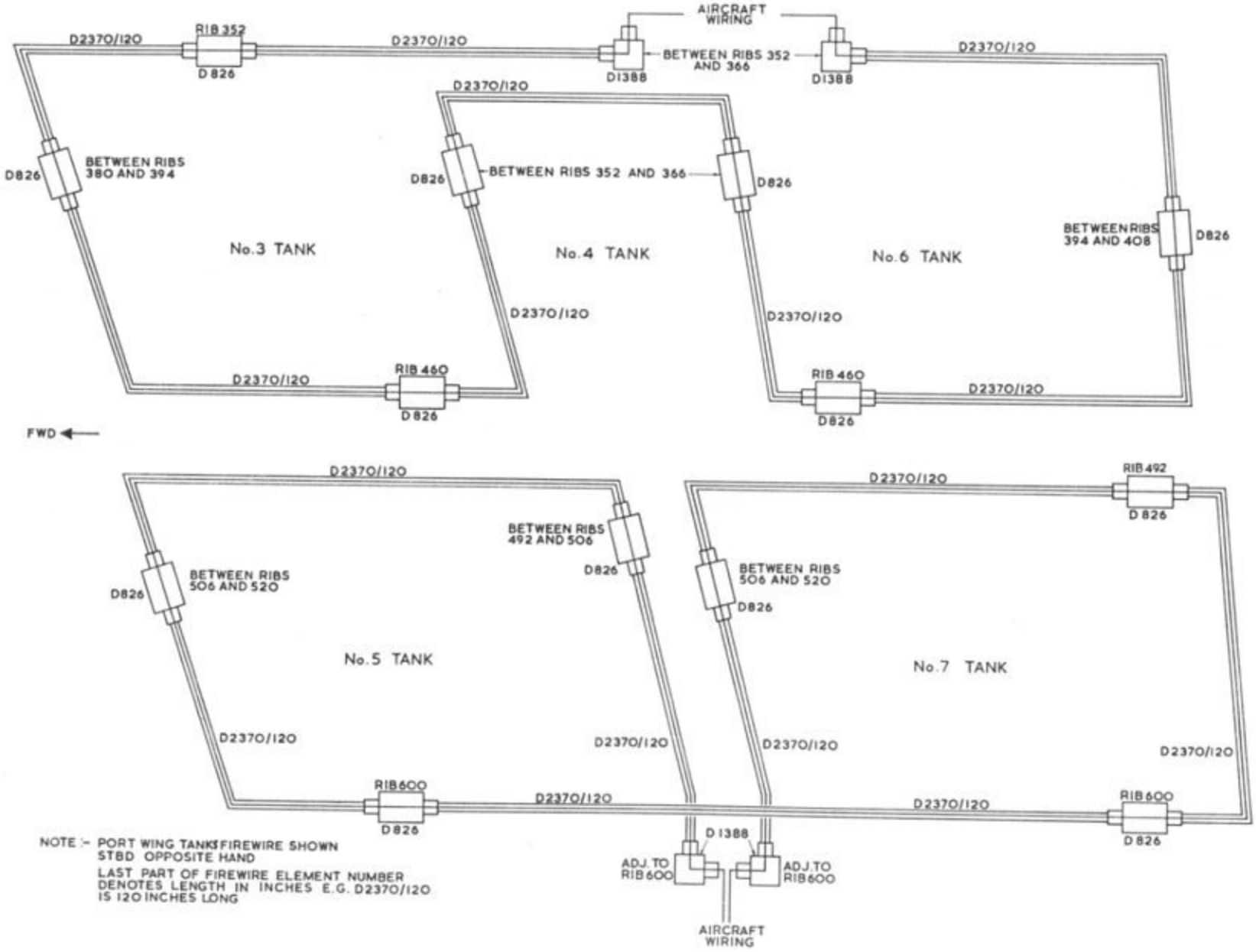


Fig. 14B Wing tanks firewire sensing loops

▶ *New diagram* ◀

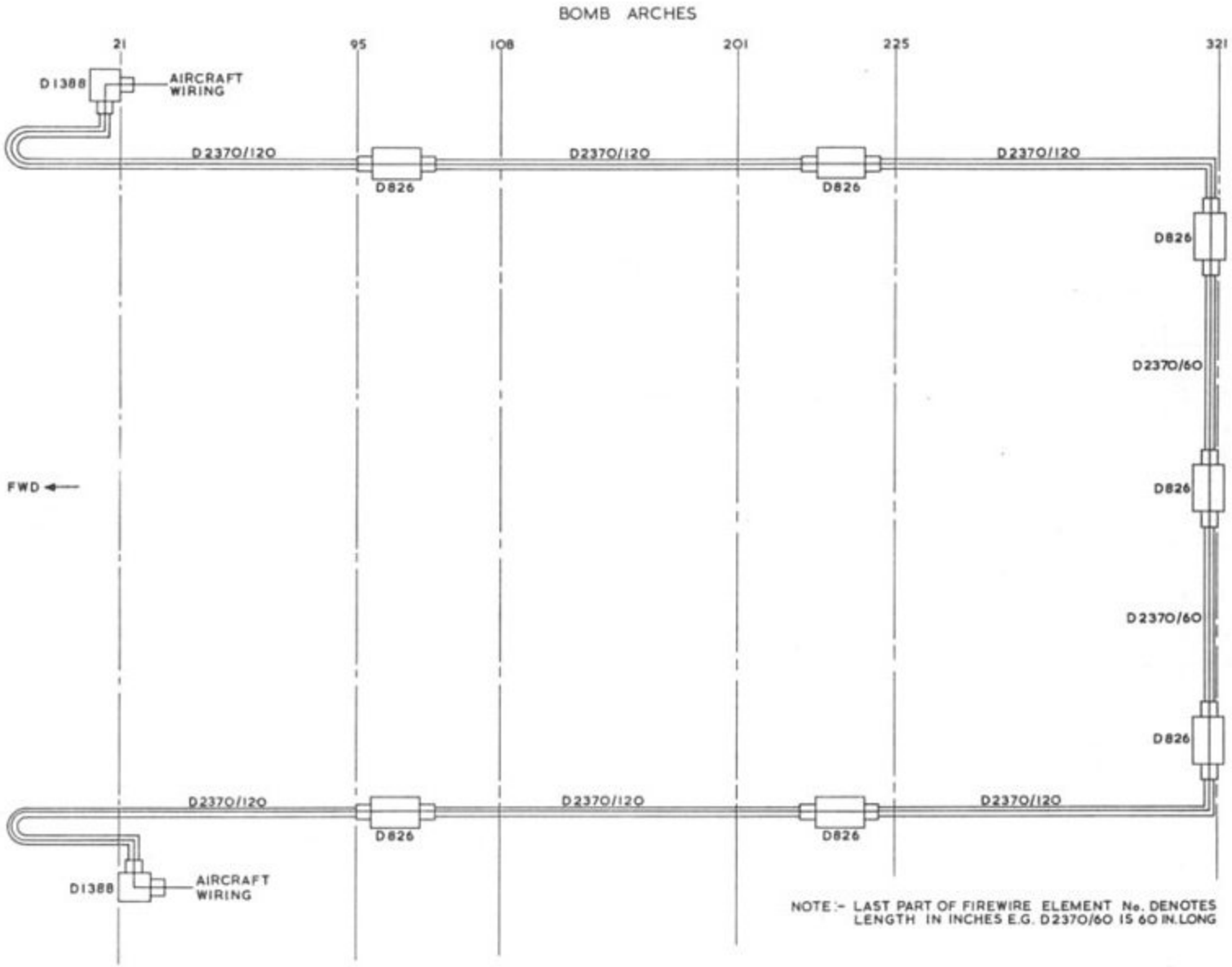


Fig. 14C Bomb bay firewire sensing loop

▶ *New diagram* ◀

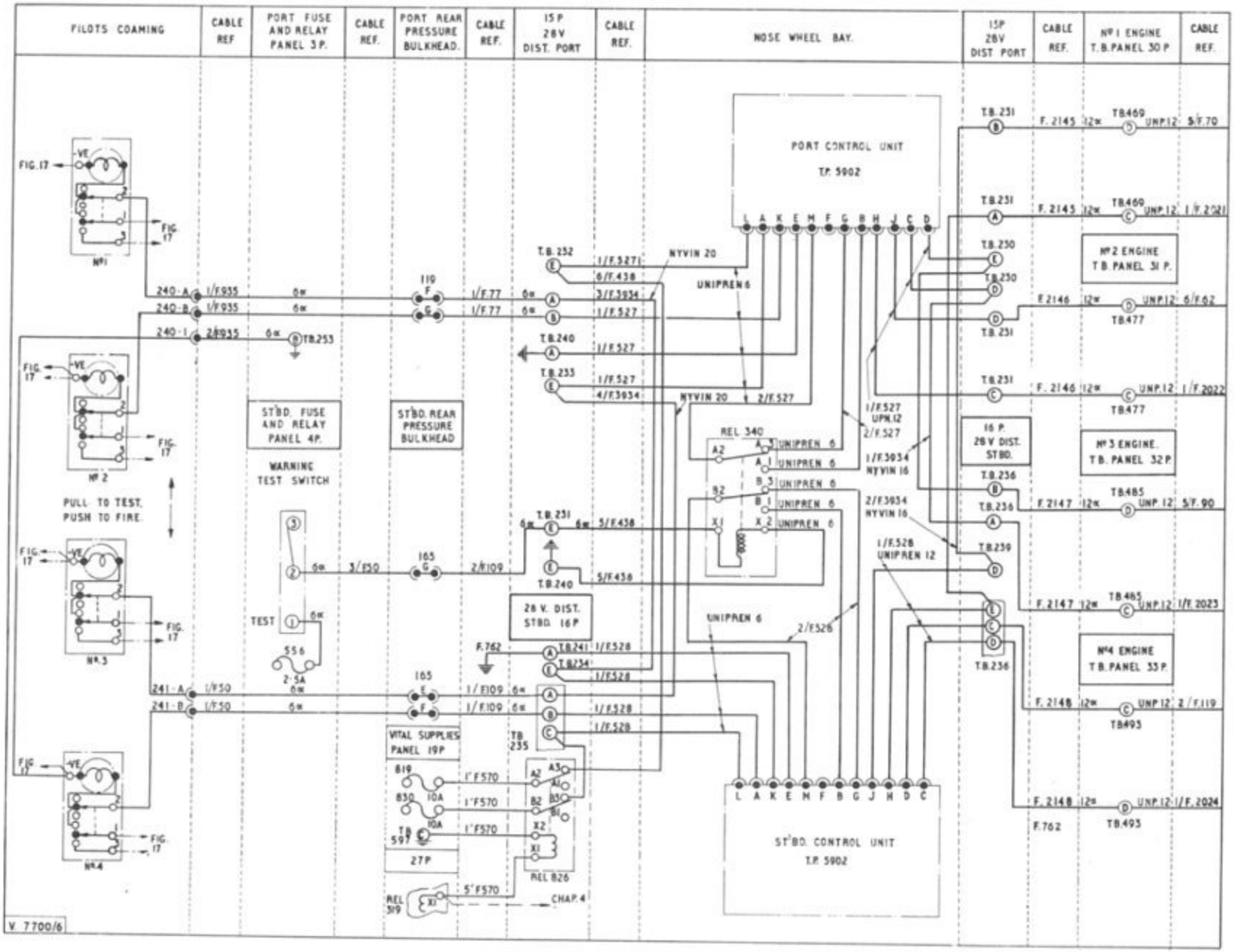


Fig.15(1) Engine fire warning control — pre Mod.2271 and 2416

▶ *Mod. state clarified* ◀

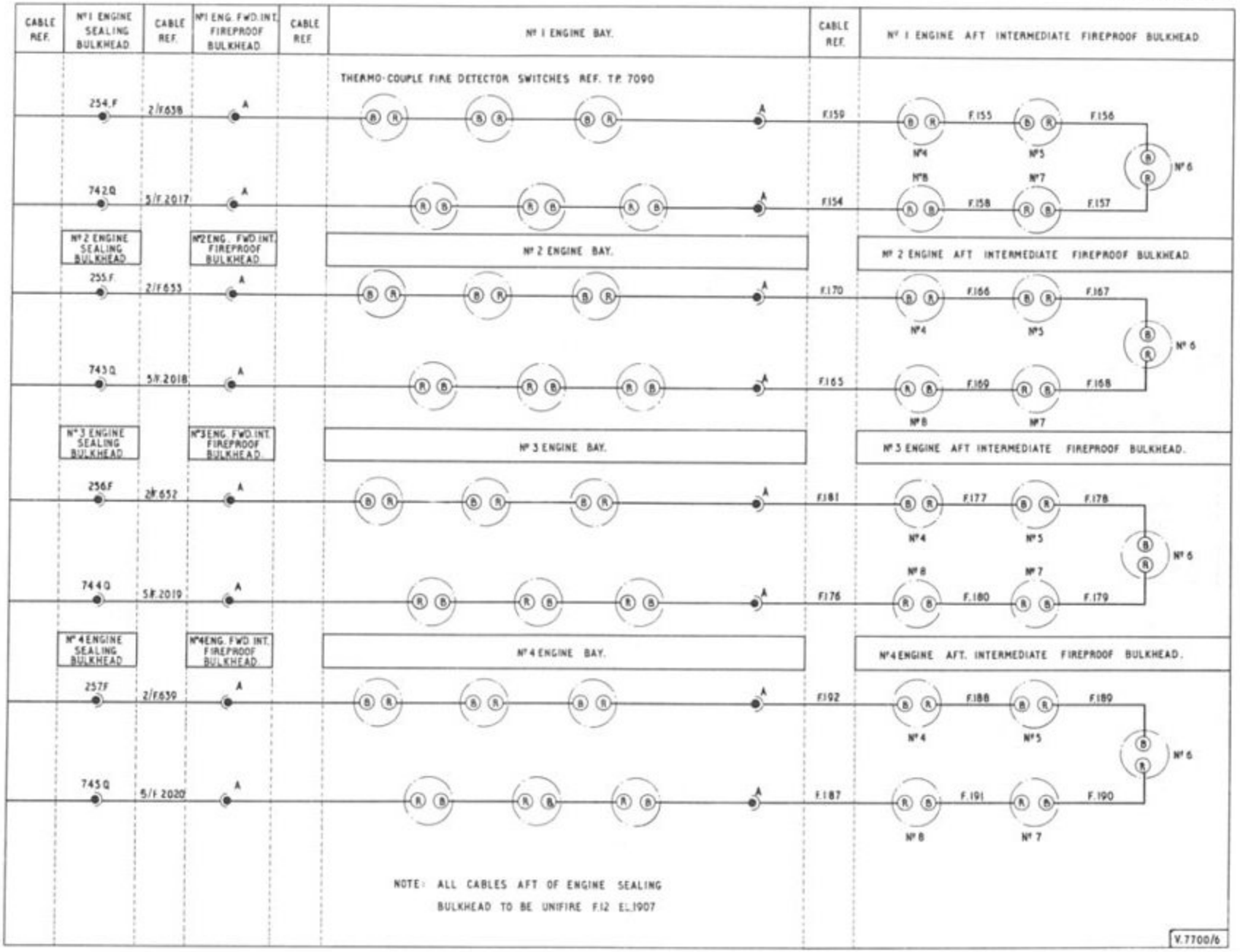


Fig.15(2) Engine fire warning control — pre Mod.2271 and 2416

▶ *Mod. state clarified* ◀

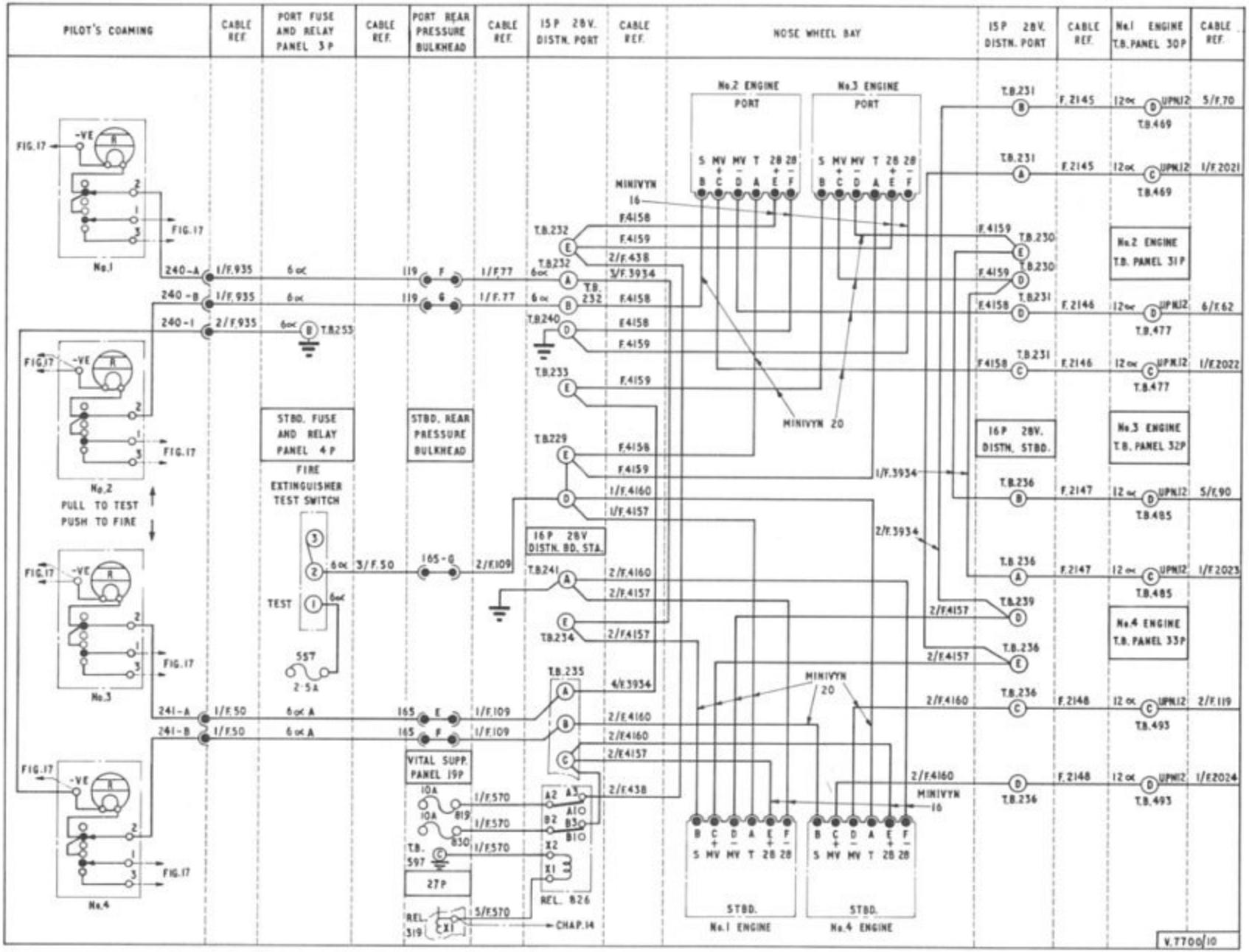


Fig.16(1) Engine fire warning control — post Mod.2271 and 2416

▶ *Mod. state clarified* ◀

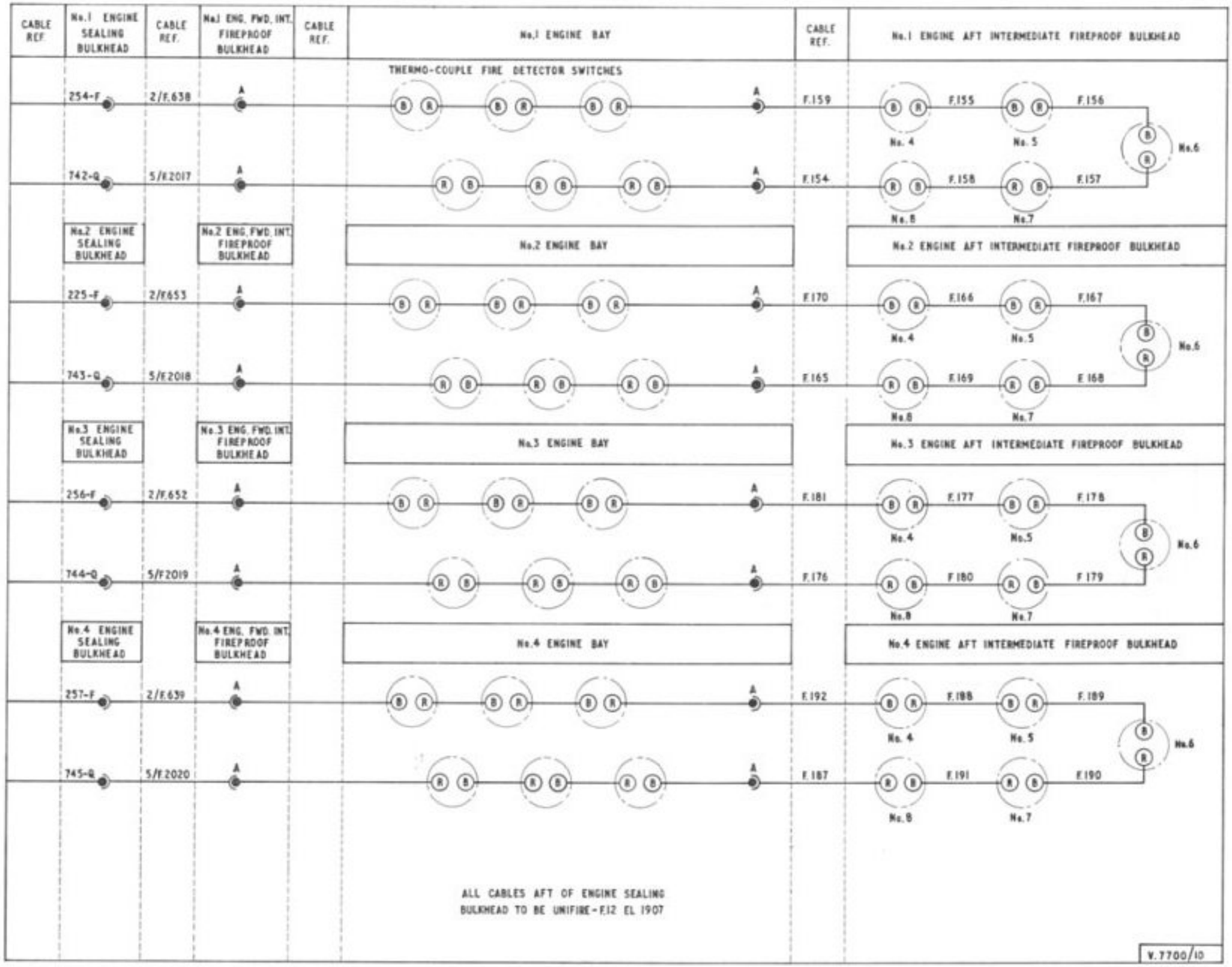


Fig.16(2) Engine fire warning control – post Mod.2271 and 2416

▶ *Mod. state clarified* ◀

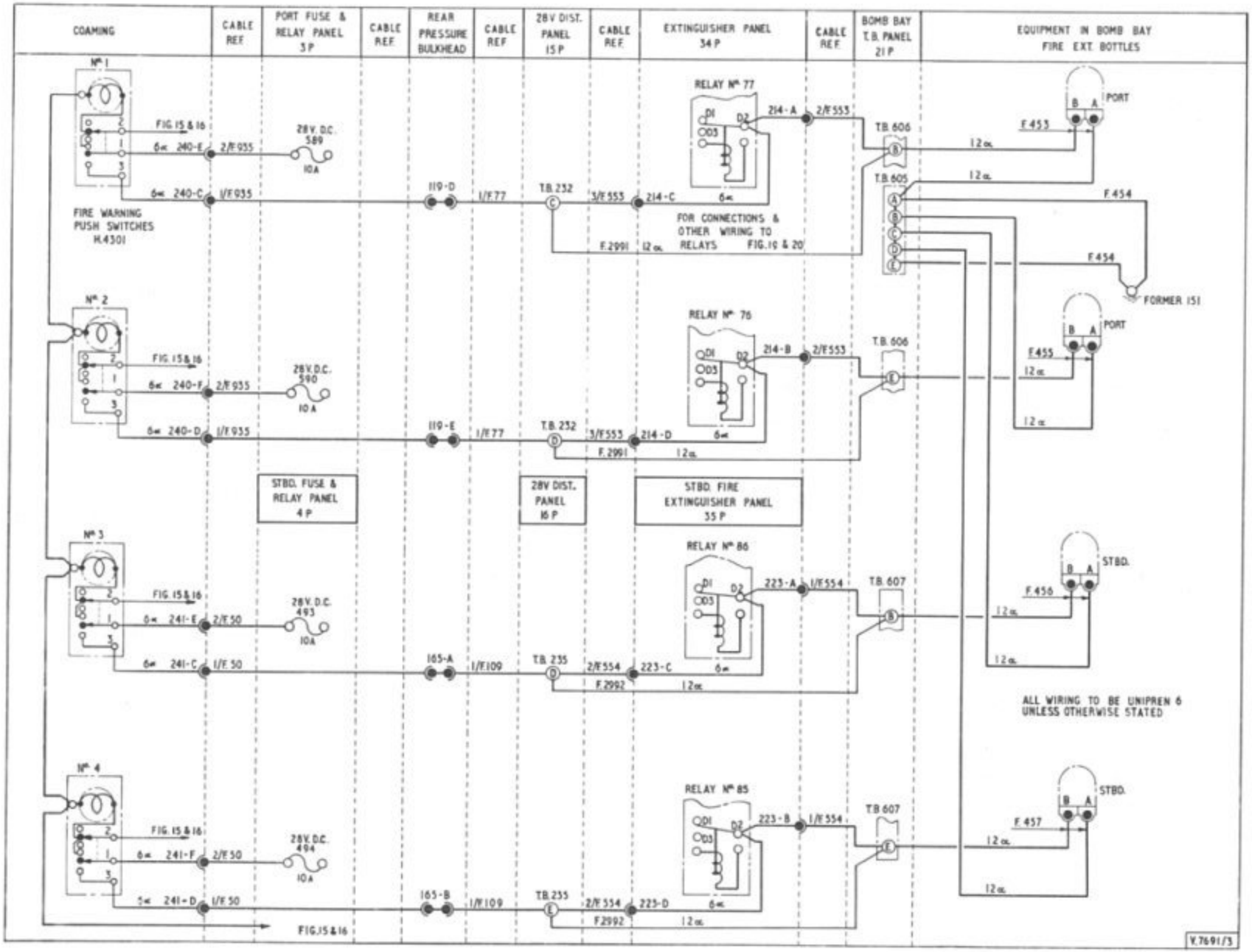


Fig. 17 Engine fire extinguishers

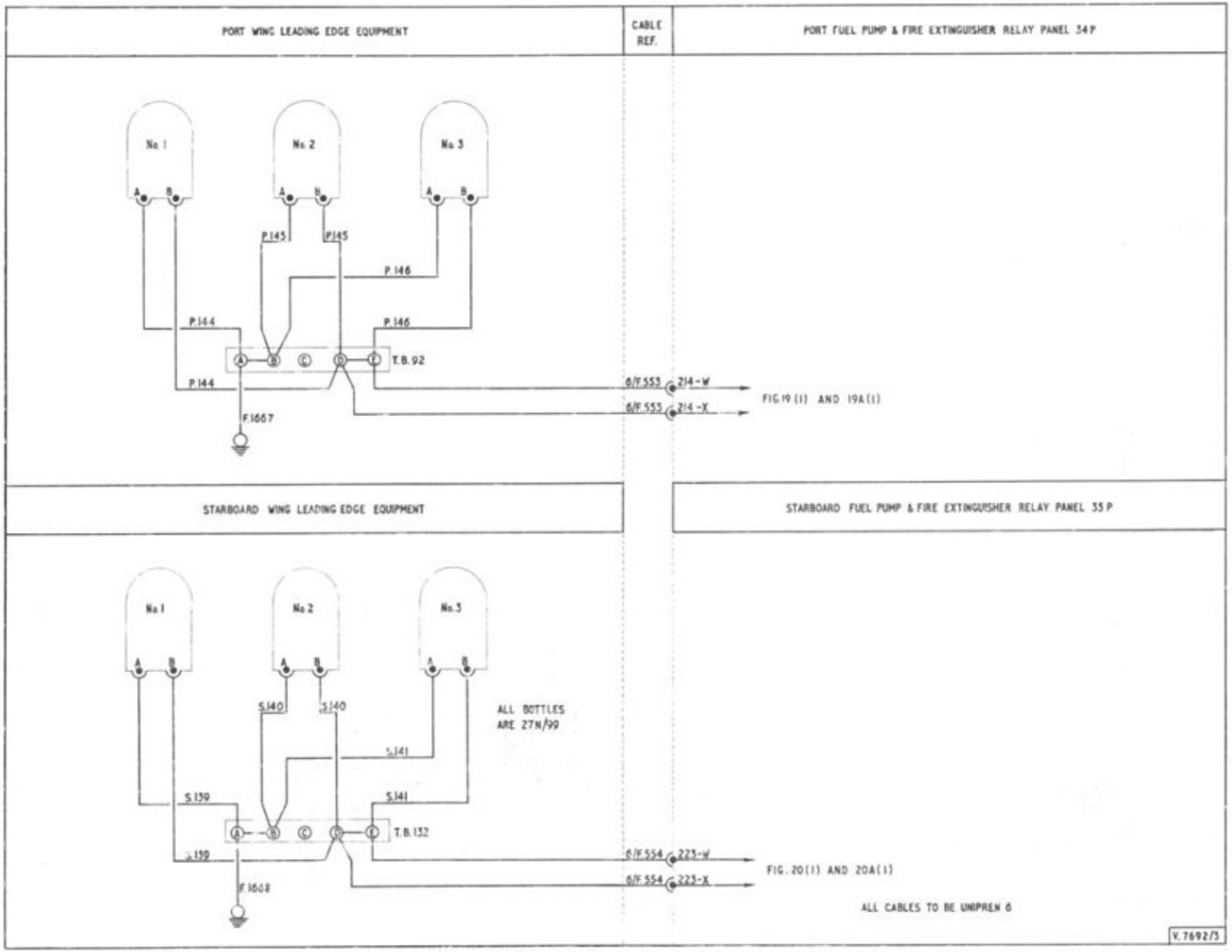
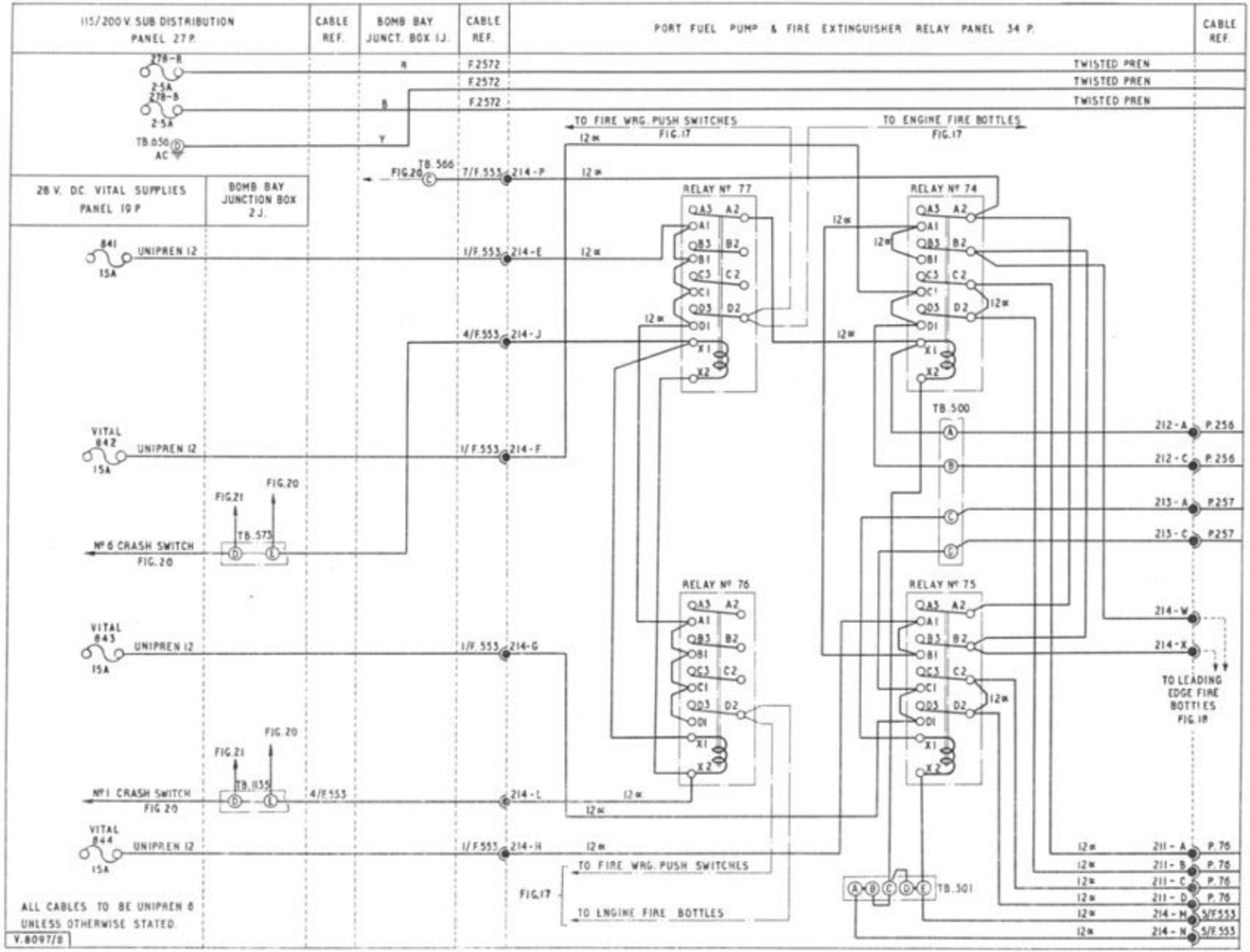


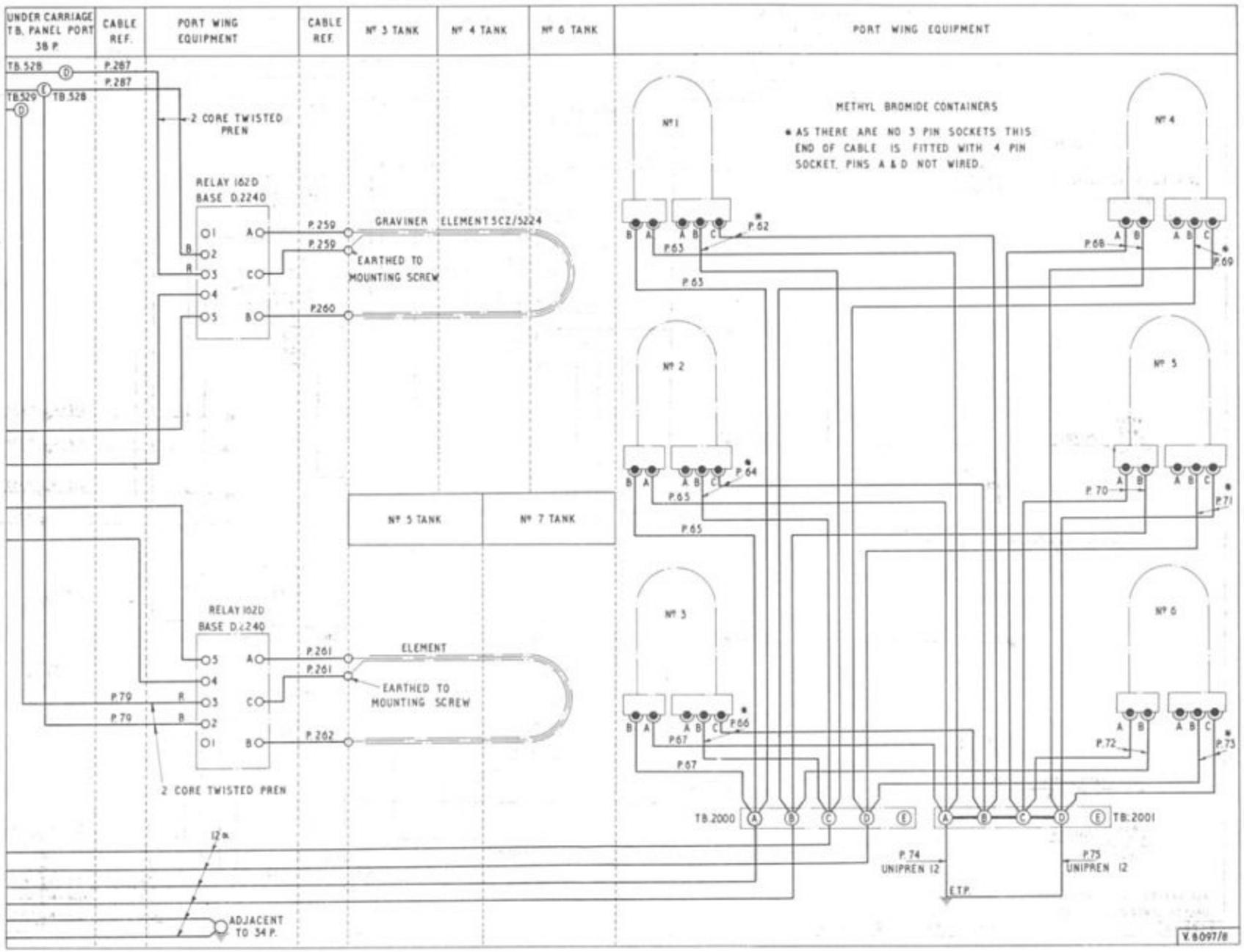
Fig. 18 Leading edge duct fire extinguishers

►*Fig. numbers cross references added*◄



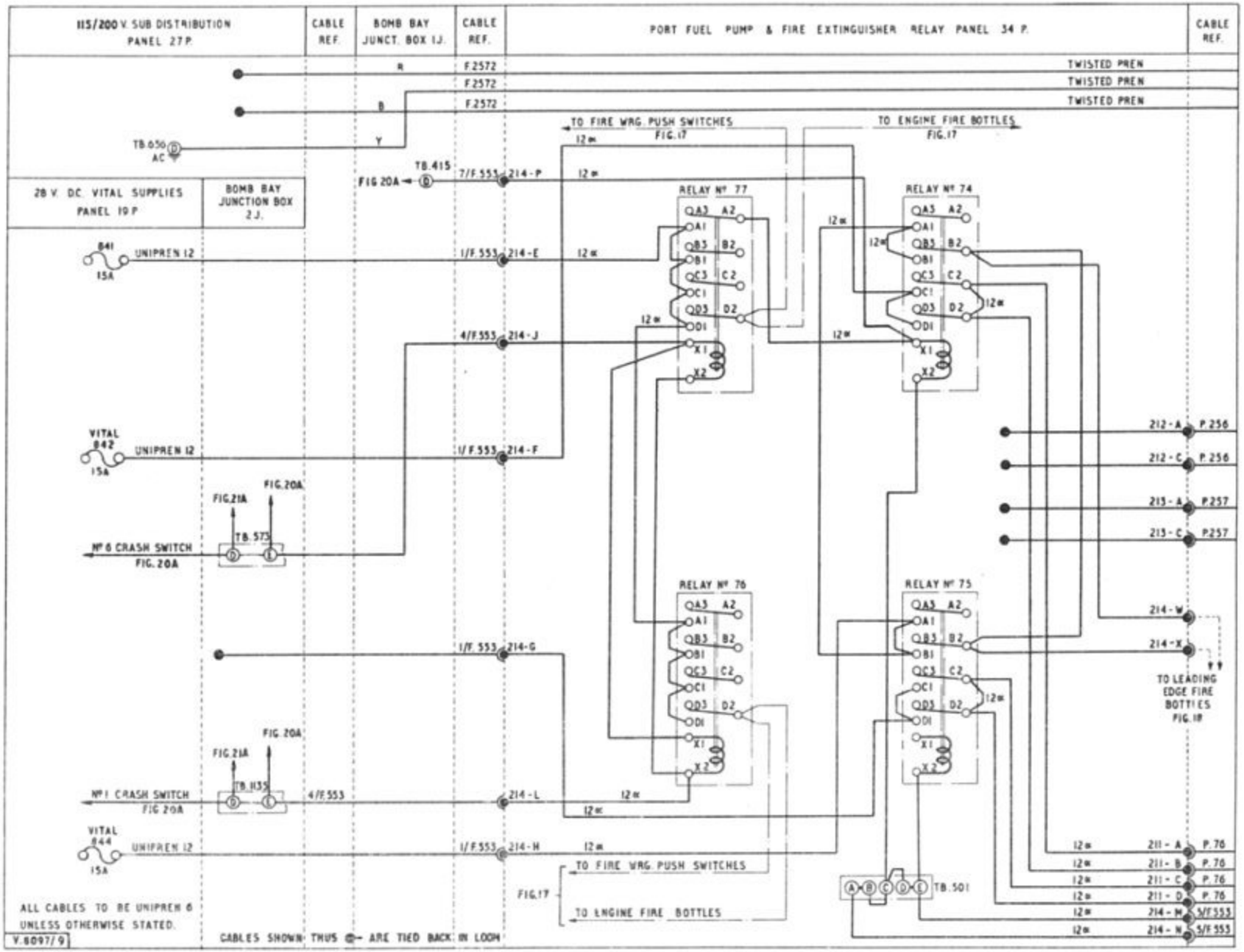
►Fig. 19 (1) Port wing tanks fire extinguishers (Pre Mod 2455) ◄

►*Title amended*◄

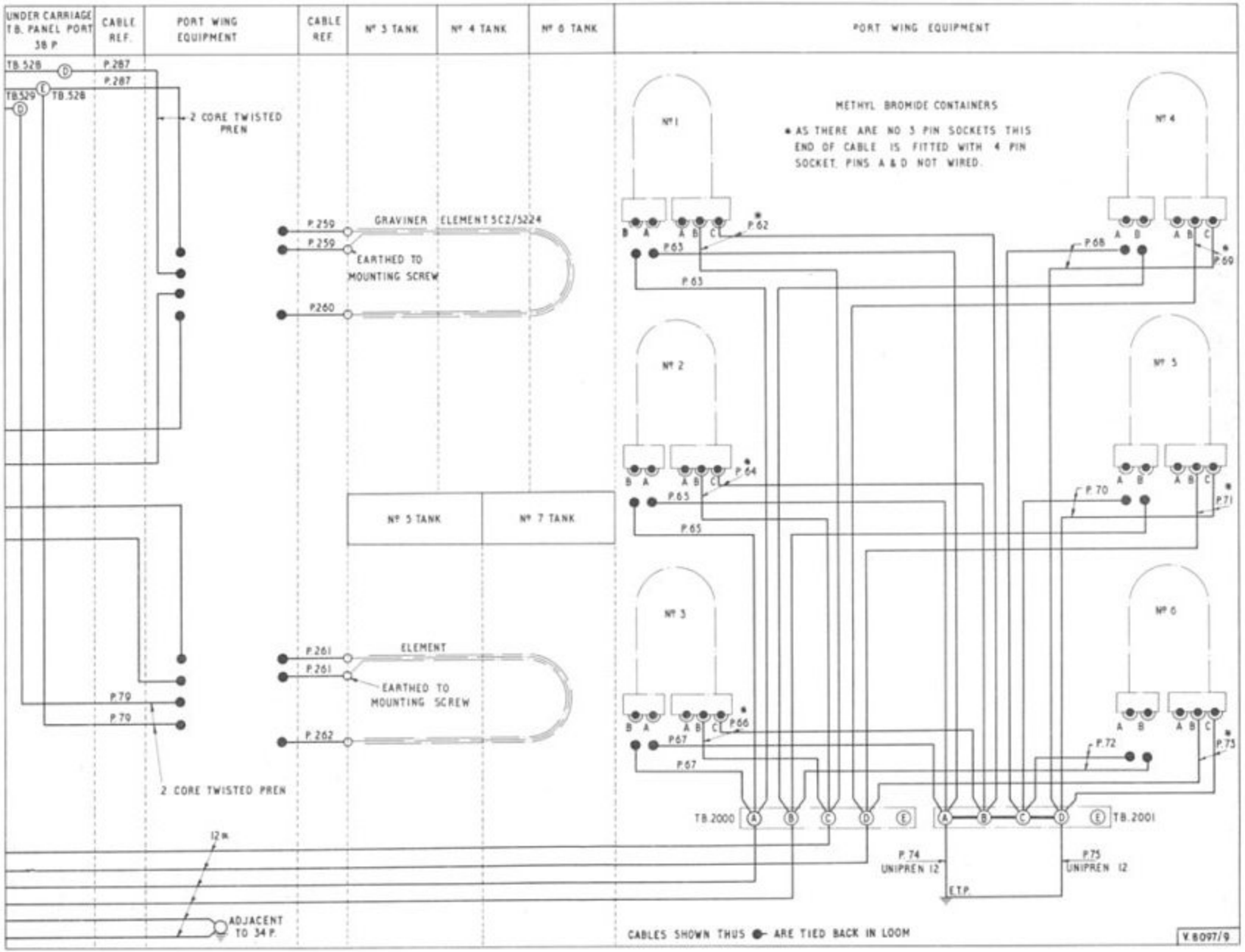


▶Fig. 19(2) Port wing tanks-fire extinguishers-(Pre Mod 2455)◀

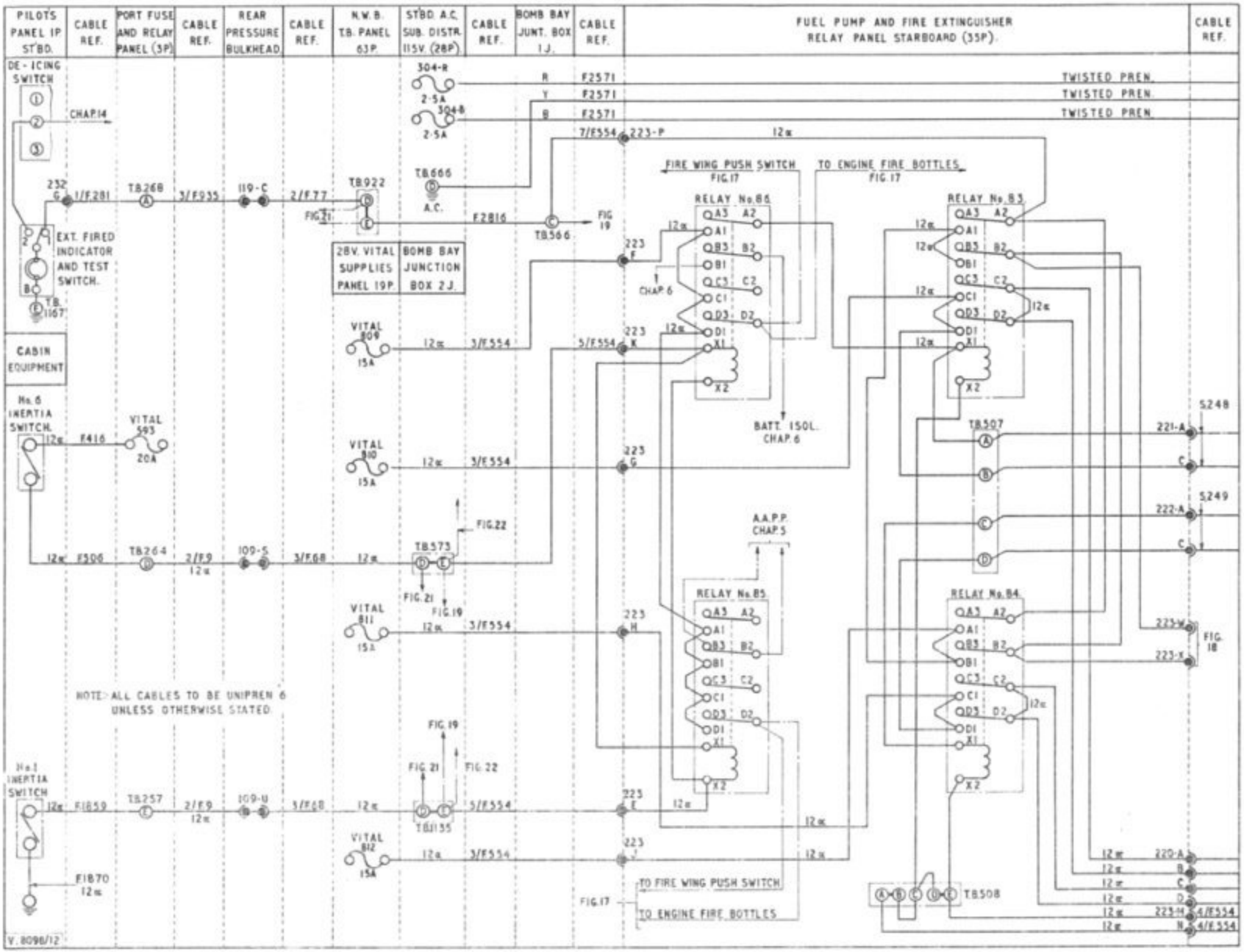
▶Title amended◀



▸ Fig 19A (1) Port wing tanks-fire extinguishers-Post Mod 2455 ◂

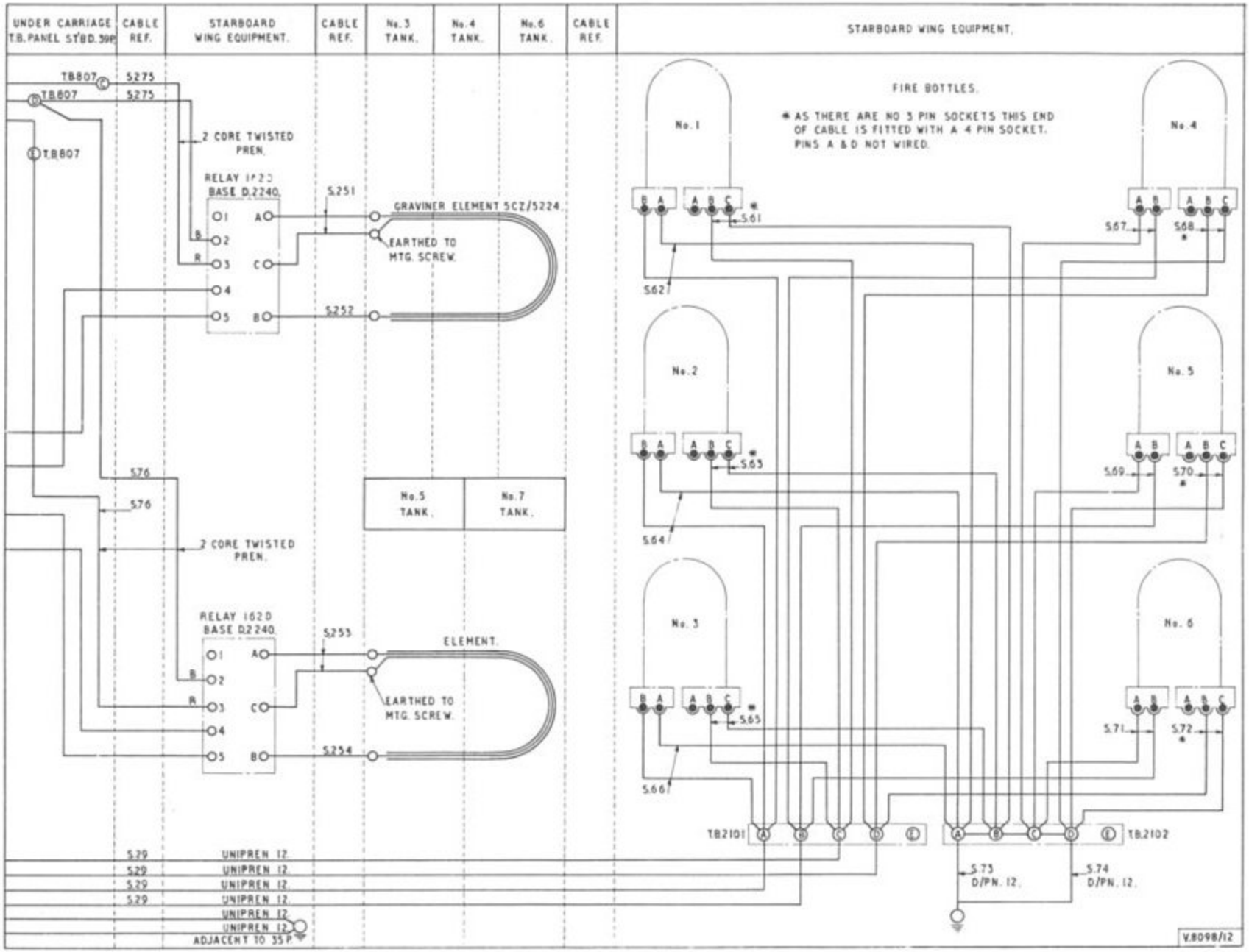


▶Fig 19A (2) Port wing tanks - fire extinguishers - Post Mod 2455◀



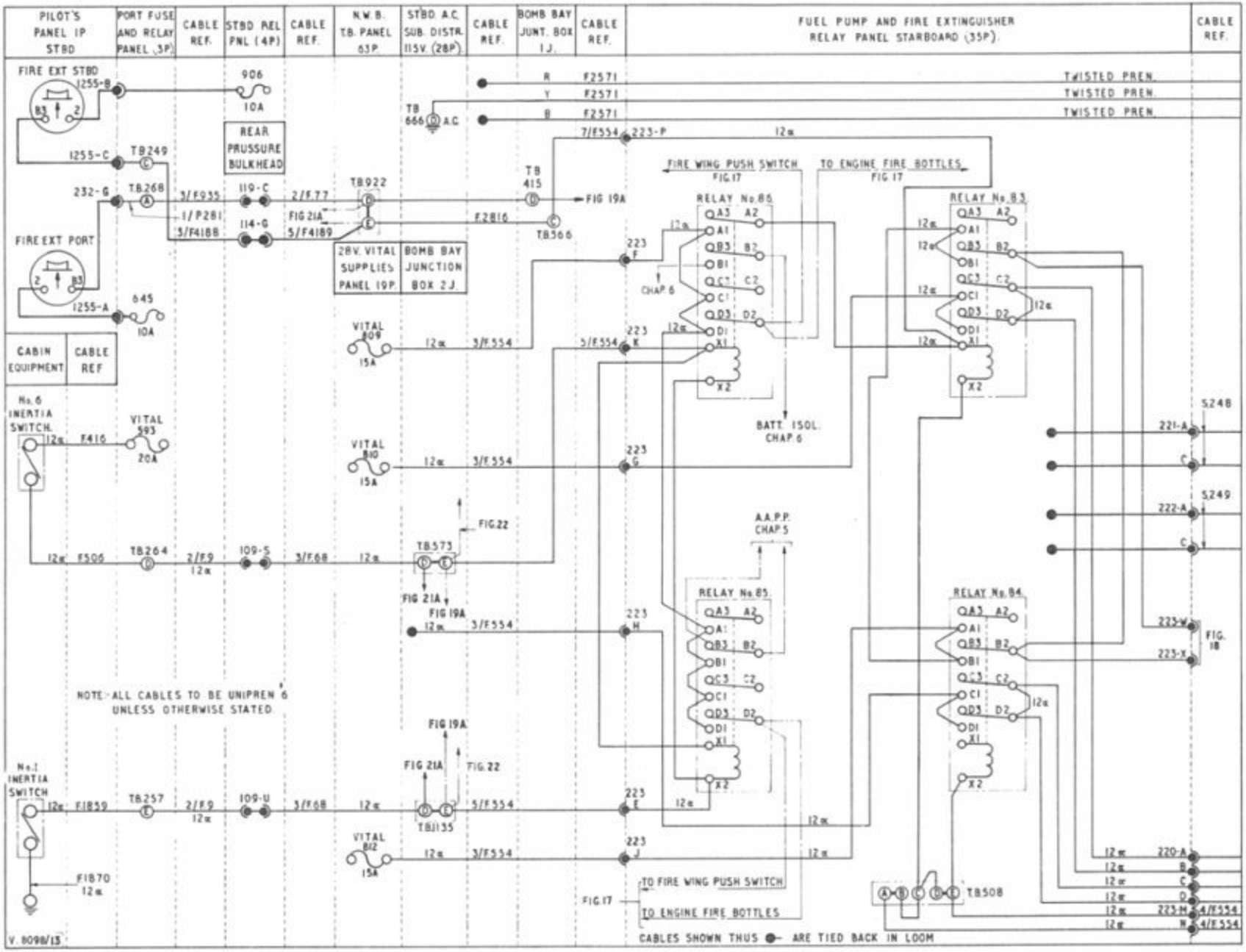
▶ Fig. 20 (1) Starboard wing tanks – fire extinguishers – (Pre Mod 2455) ◀

▶ *Title amended* ◀

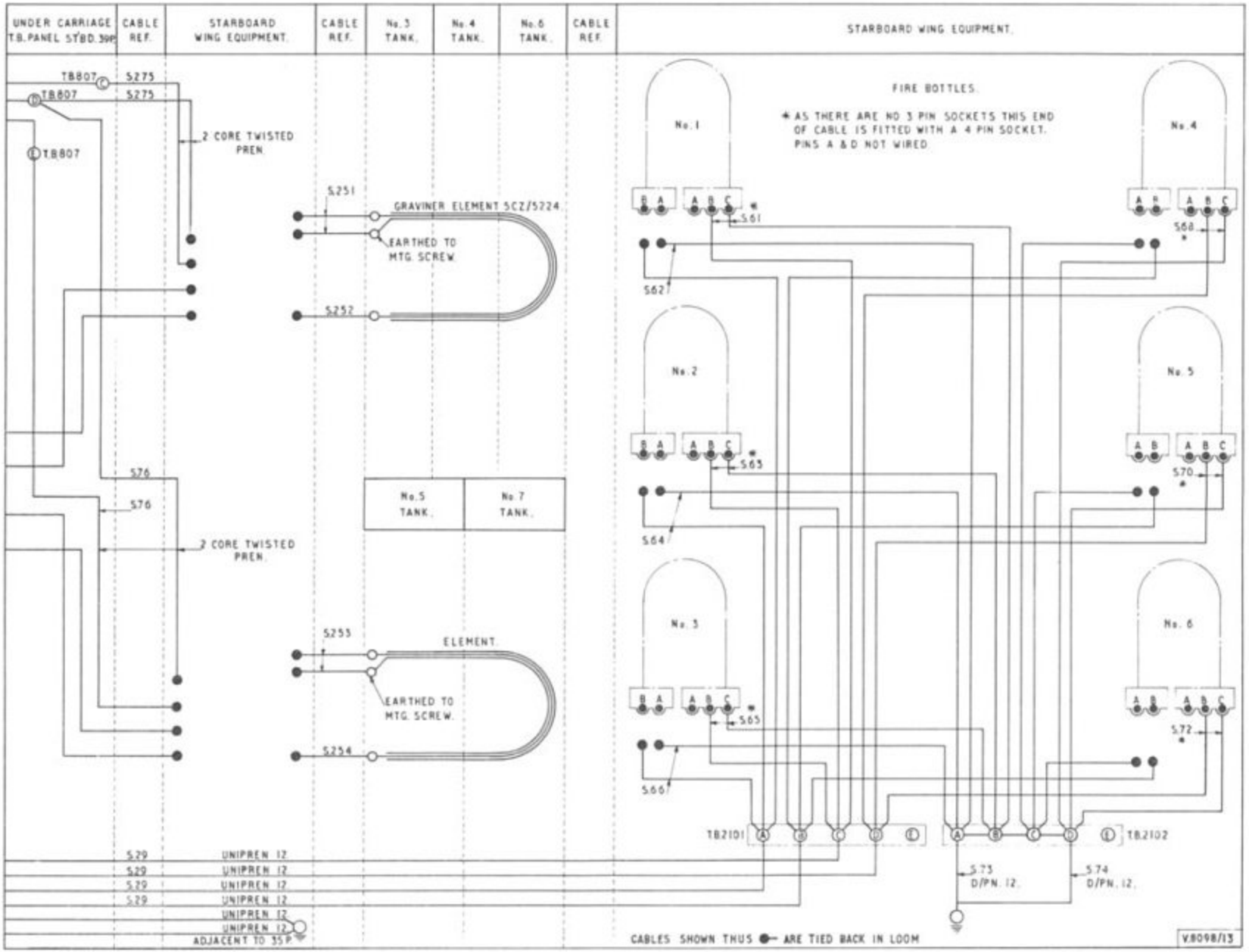


►Fig 20 (2) Starboard wing tanks-fire extinguishers-(Pre Mod 2455)◄

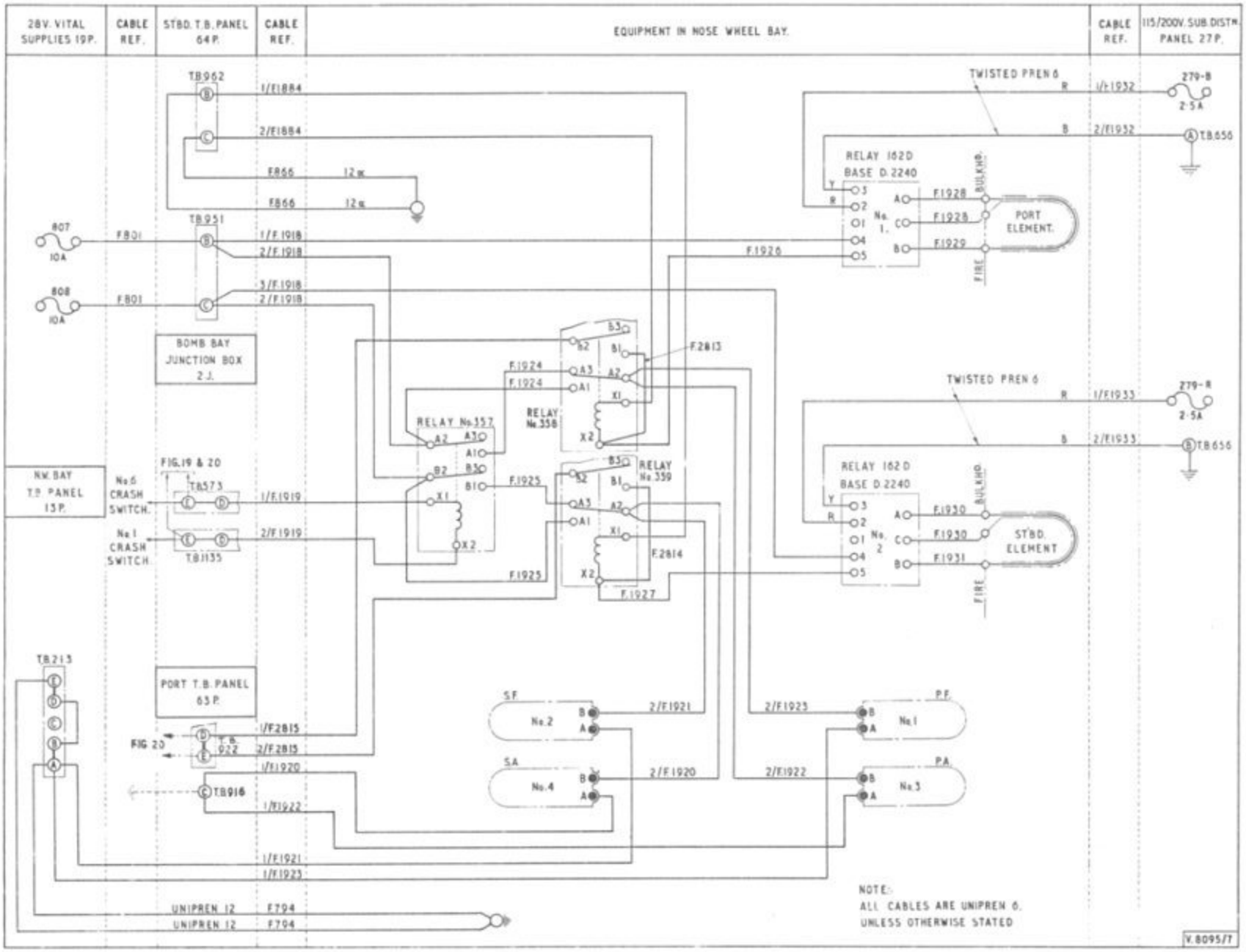
►*Title amended*◄



▶ Fig 20A (1) Starboard wing tanks - fire extinguishers - Post Mod 2455 ◀

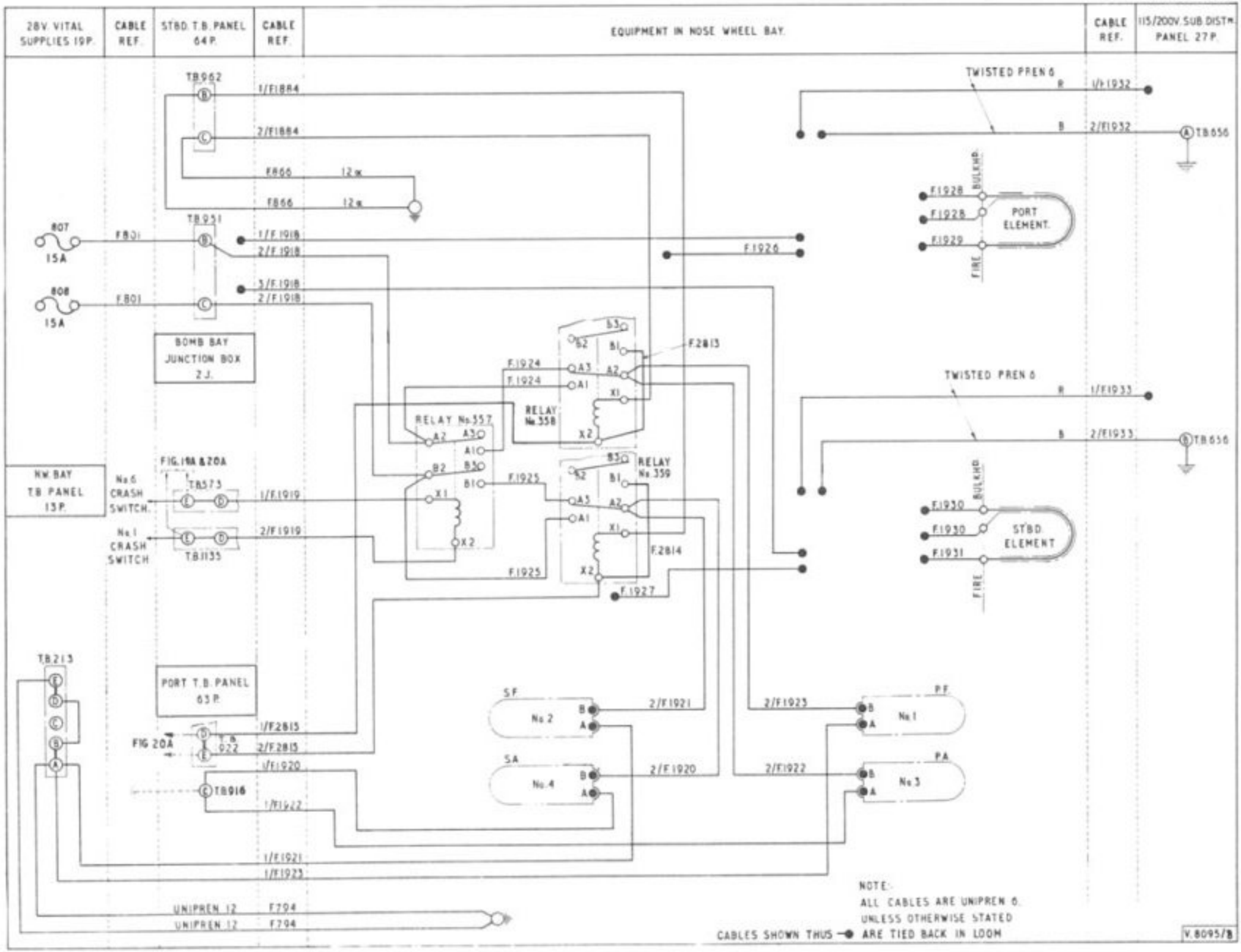


▶Fig 20A(2) Starboard wing tanks - fire extinguishers - Post Mod 2455◀



▶Fig 21 No 1 and No 2 tank bay fire extinguishers - Pre Mod 2455◀

▶*Title amended*◀



▶Fig 21A No 1 and No 2 tank bay fire extinguishers - Post Mod 2455◀

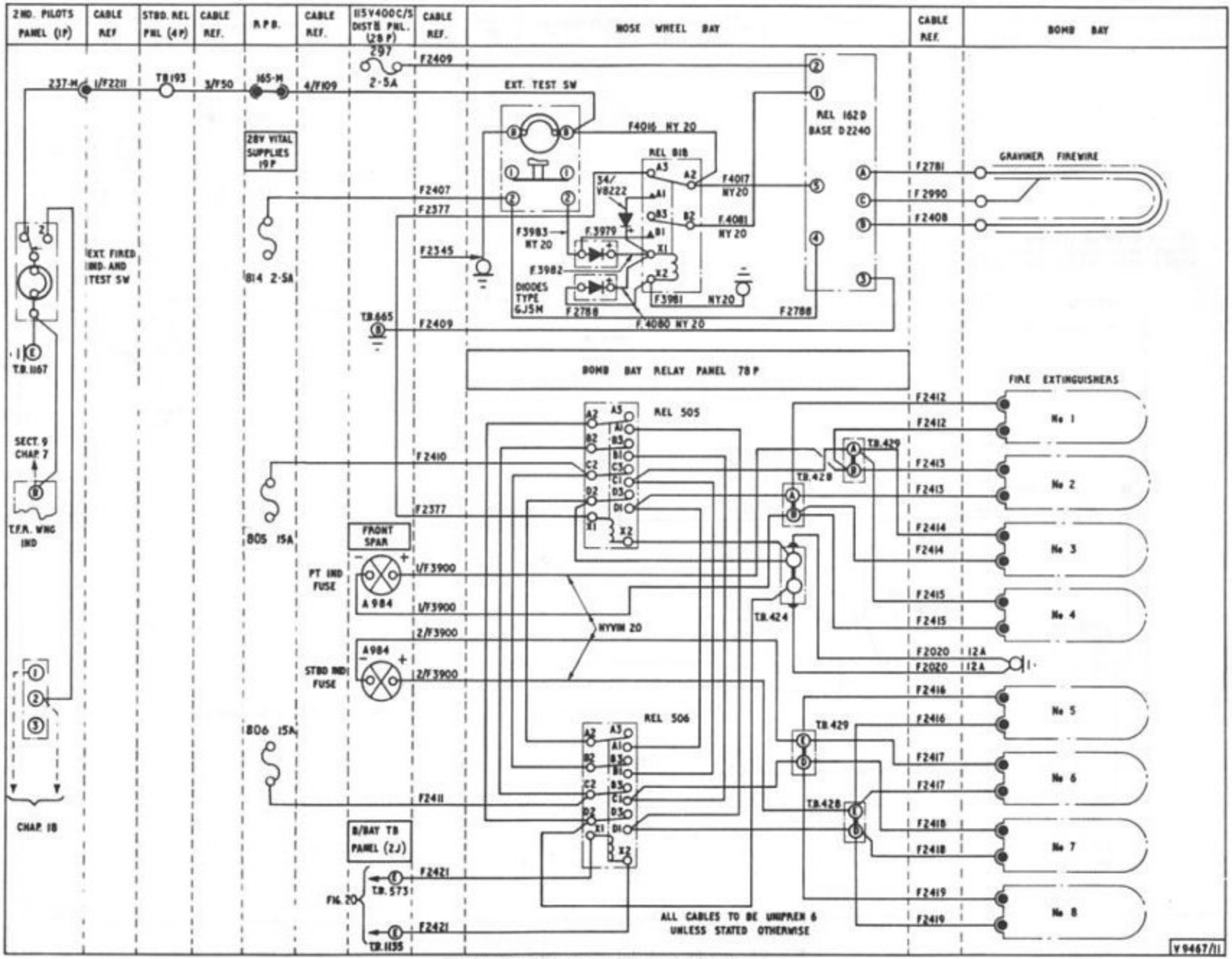


Fig. 22 Bomb bay fire extinguishers

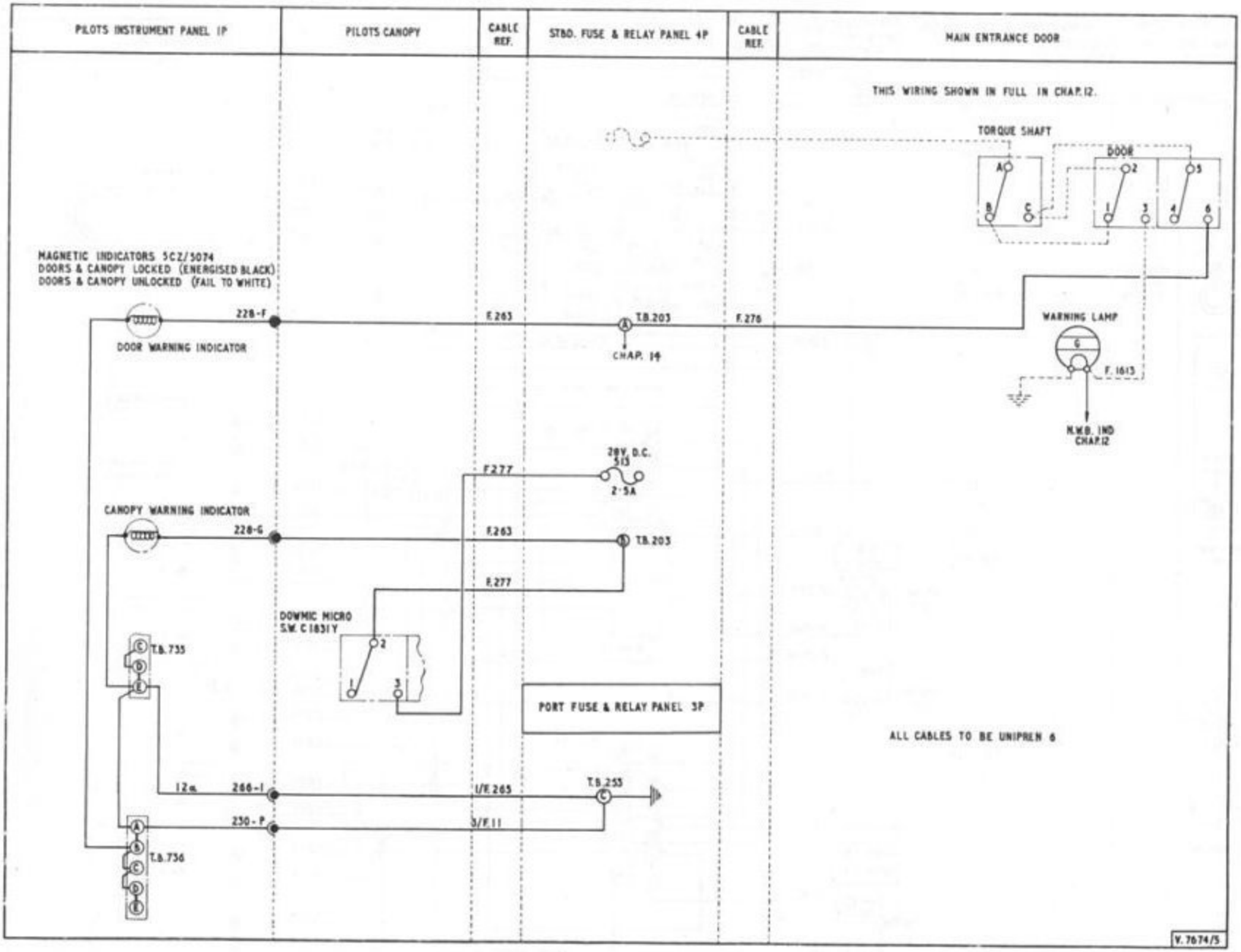


Fig. 23 Canopy and entrance door indication

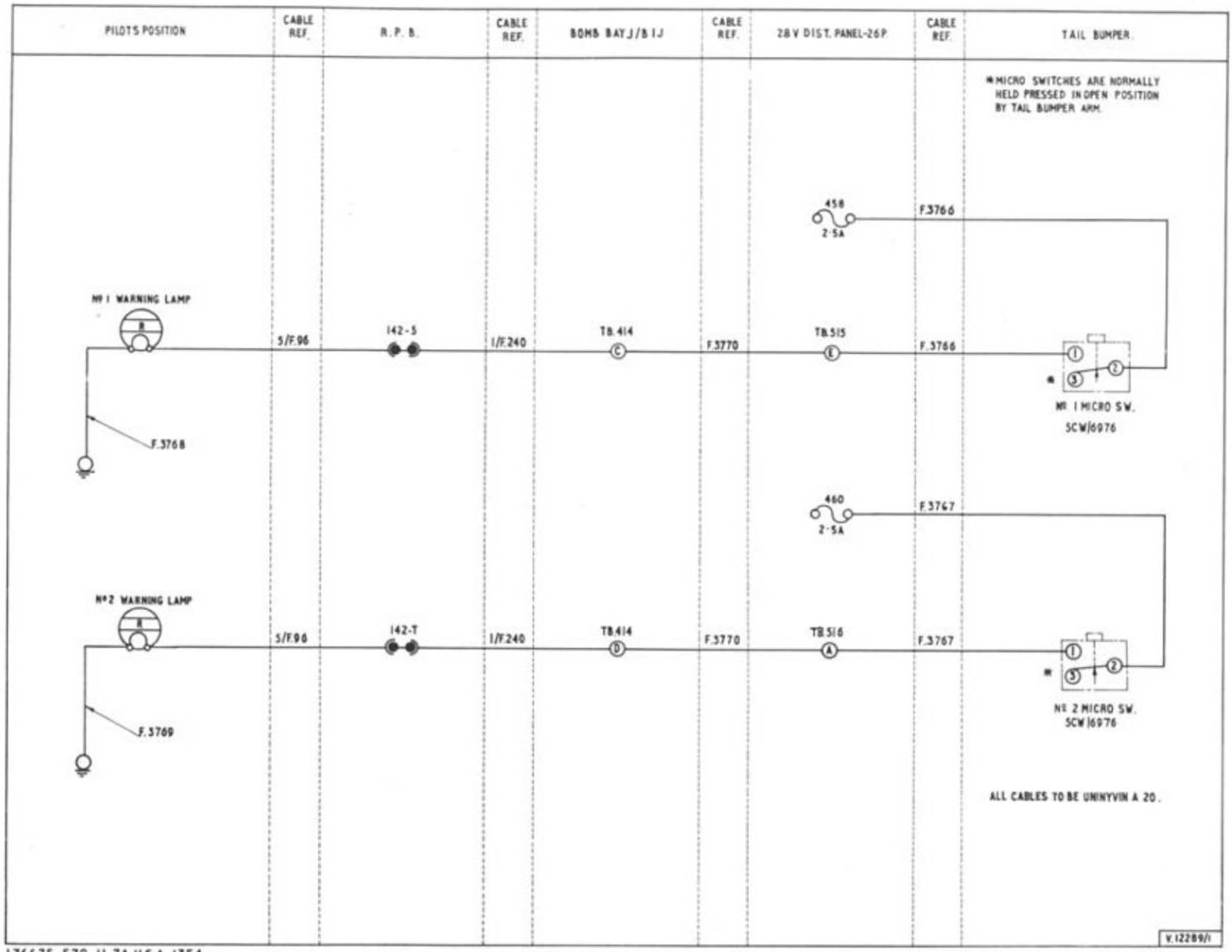


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Fig.24 Tail to ground warning