Group 9

WARNING AND EMERGENCY EQUIPMENT

(Completely revised)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. This group contains descriptive and servicing information for the electrical controls and equipment employed on the fire extinguisher system and canopy and door entrance warning controls. A general location illustration is given in fig.1, and theoretical circuit diagrams for the various installations will be found adjacent to the text concerned.

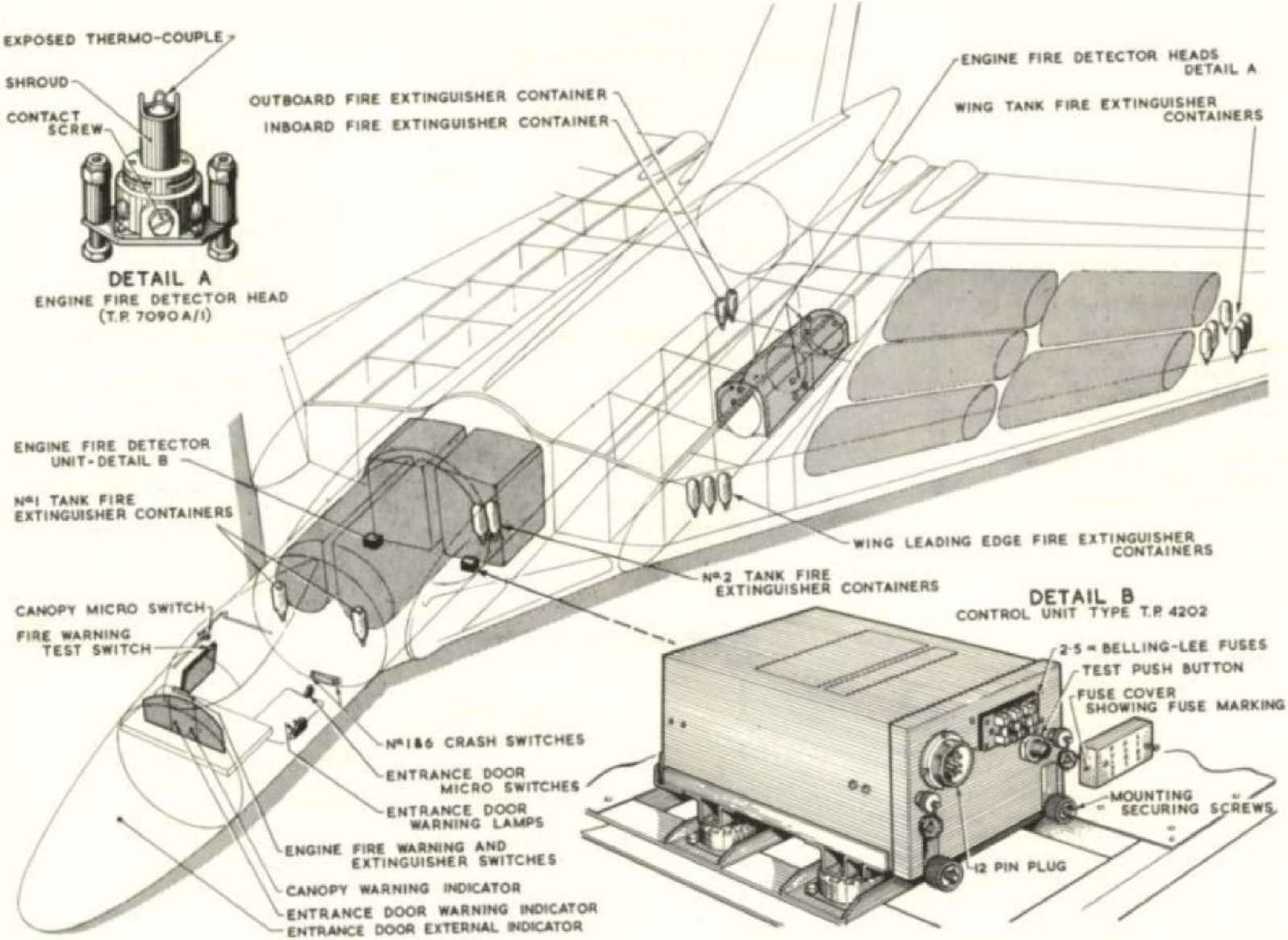

Fig. 1 Location of components

DESCRIPTION AND OPERATION

FIRE EXTINGUISHER CONTROLS

General

2. Three main circuits are employed, one for engine fire detection, one for engine fire extinguishers, and one for fuel tanks and wing leading edge duct fire extinguishers.

3. Engine fire detection and warning is fully automatic, and is operative immediately when an engine fire or rapid rise in temperature occurs. The engine fire extinguishers can be brought into operation manually by depressing the push-switches, labelled ENGINE FIRE EXTINGUISHER, on the coaming above the pilots' instrument panel. In the event of crash landing, the extinguishers will be operated automatically by the action of two inertia switches (No.1 and No.6) situated on the lower forward face of the cabin rear pressure bulkhead.

4. The fuel tank and leading edge duct fire extinguisher circuits are operated only by the action of the two inertia switches on crash landing.

5. All the fire extinguisher control circuits, including fire detection and warning, come under the heading of essential services, and all are fed from the 28-volt emergency fuses in panels 3P, 4P, and 16P. When the inertia or crash switches are tripped by the impact of a crash landing, the normal electrical services will be isolated by the action of the 24-volt and 96-volt isolation circuit breakers; battery supply will, however, still be available to those services connected to the emergency bus-bar. (Group 2A). On Mk.1A aircraft, an additional function performed by the operation of No.1 and 6 crash switches is described in Group 14.

Engine fire extinguishers

6. The engine fire extinguisher installation employs four single head methyl-bromide containers installed in the bomb bay. Each container is connected by piping to the appropriate engine bay. Four single head containers installed in the nose-wheel bay are connected by spray piping to the fire zones of the No.1 and No.2 (port and starboard) fuselage tanks. Six single head containers are installed, three in each wing leading edge and connected by spray piping to the fire zones in the leading edge ducting. Twelve dual head containers are installed, six in each wing, and are connected by spray piping to positions above the inboard tank bays.

Fire extinguisher cartridges

7. All the fire extinguishers employed are fitted with Mk.1 cartridges, Ref.No. 12K/1248. With the introduction of Mod.1118, however, the Mk.1 cartridges are replaced by Mk.3 cartridges, Ref.No. 12K/1316, in the engine fire extinguishers only. Larger size cables connecting the engine extinguishers are also introduced in order to eliminate volts drop. Pre and post mod. circuit conditions are shown in fig.9 and 9A respectively.

Engine fire detection

8. A combined fire detection and warning circuit, employing thermo-couple fire detectors, is provided for each engine. Twelve fire detectors, connected in series to form an unbroken thermo-couple 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 situated in the nose wheel bay.

9. A warning lamp is fitted in the knob of each engine fire extinguisher push-switch. The four push-switches are located on the coaming above the pilots' centre instrument panel. The warning lamps are controlled by relays in the control units. Each lamp will give a continuous red light when any of its associated thermo-couples detects a fire or a rapid rise of temperature. Three test switches are provided, one on each control unit, the other on the starboard fuse and relay panel. 4P. A theoretical wiring diagram of the detectors and warning circuit for one pair of engines is contained in fig.2.

Engine fire detector heads

10. Each detector head consists of two thermo-couples connected in series but of opposite polarity. One of the couples is shrouded from flame and rapid temperature variations, whilst the other, being exposed, is more rapidly affected by temperature variation. All fire detector heads are mounted with the exposed couple facing the flame expectant area.

11. When the combined temperature of the exposed thermo-couples exceeds that of the shrouded thermo-couples by 185 deg.C., a voltage of 7·5mV. will be developed in the chain and fed to a moving coil relay in the respective control unit. This action will light the red warning lamp previously mentioned, thus giving fire warning for the bay concerned.

12. It can be seen that the action of the thermo-couple fire detectors will give a very rapid warning in the event of a fire, and no false warning will be given during engine ground running periods, as the rate of temperature rise is too slow to give the shrouded thermo-couples sufficient voltage lead over the unshrouded thermo-couples.

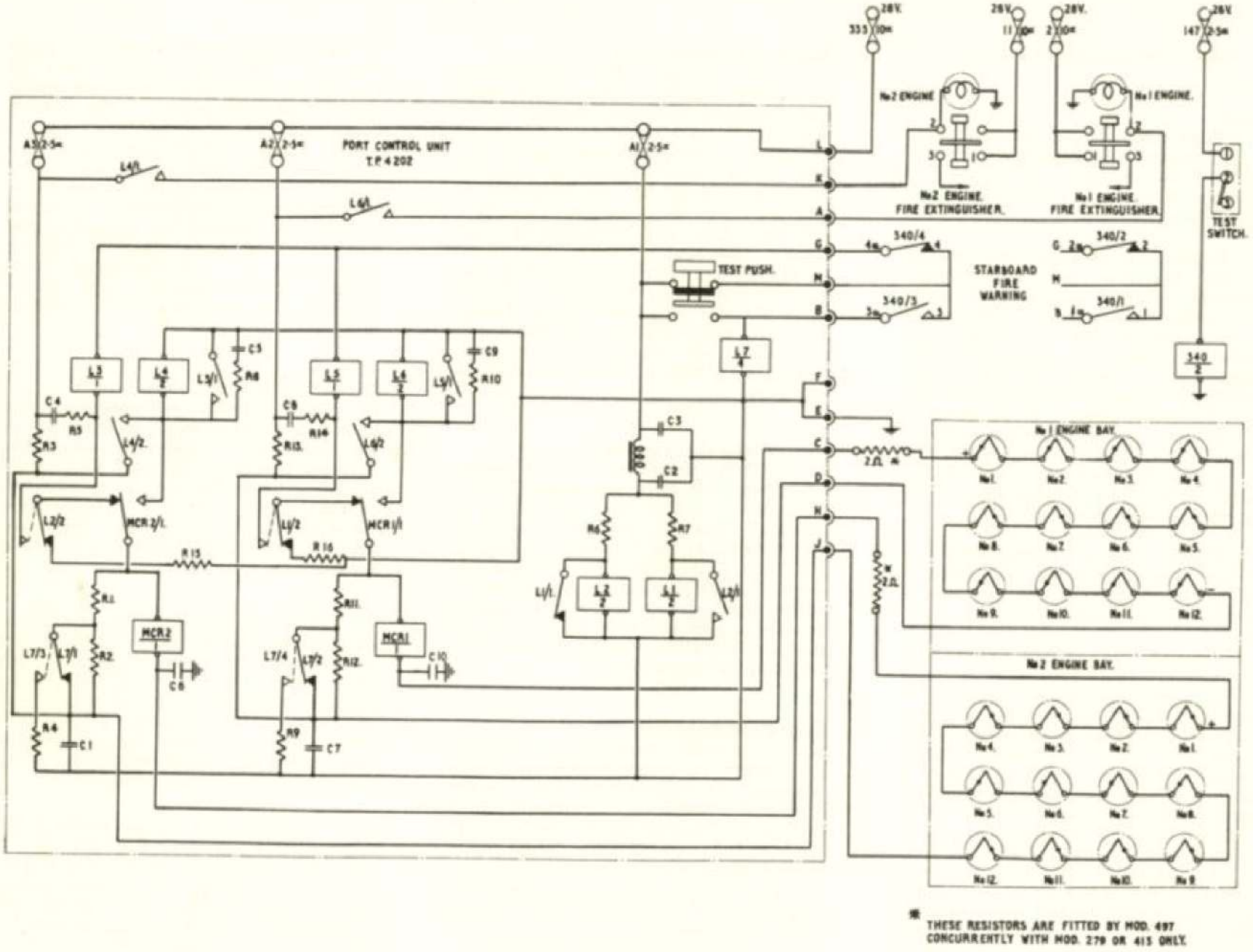

Fig.2 Engine fire warning (port)

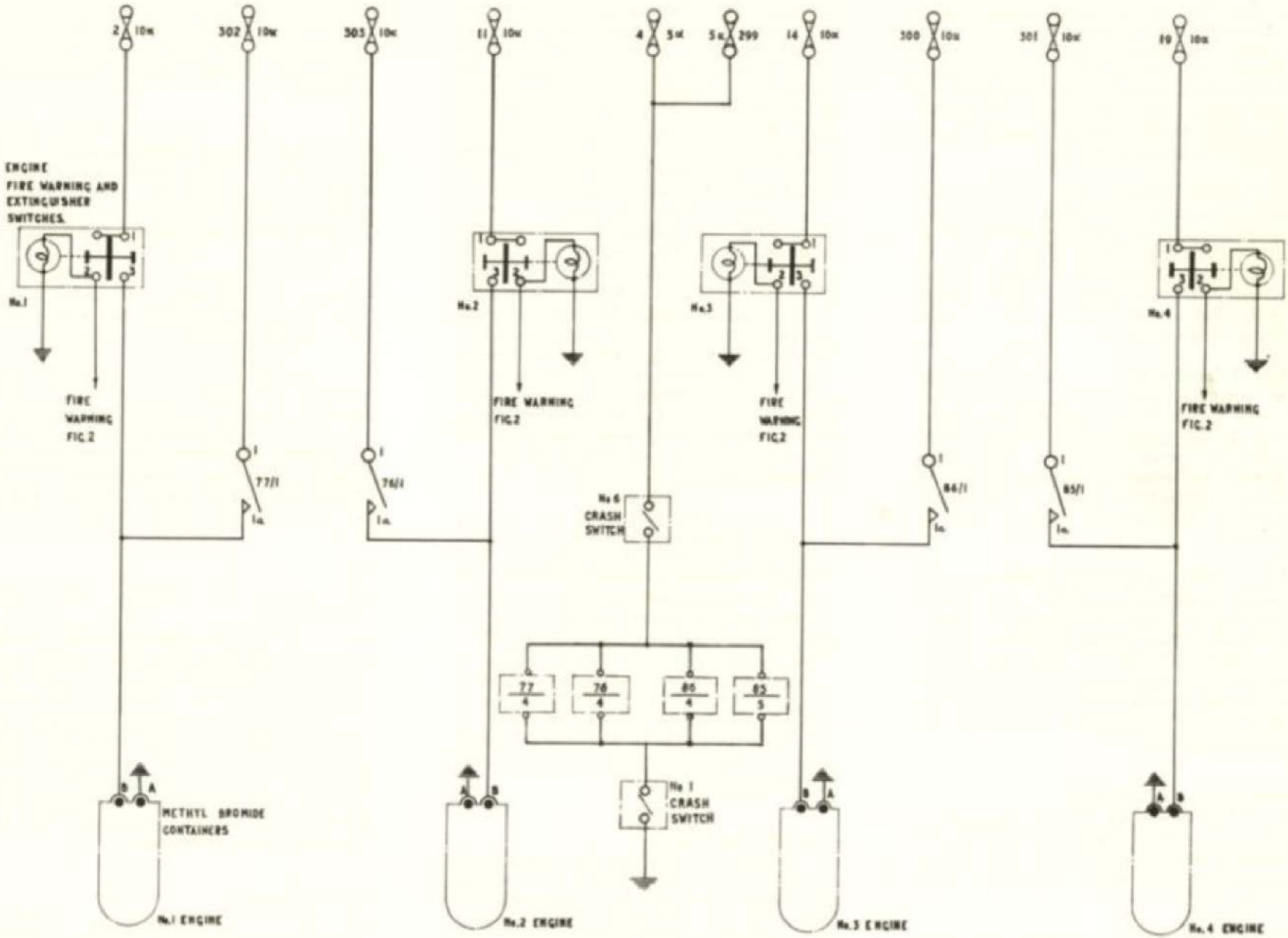

Fig.3 Engine fire extinguisher controls

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Control units

13. Two control units, Type TP.4202, are installed in the nose wheel bay as indicated in fig.1. The port control unit controls the No.1 and 2 engine fire detector circuits; the starboard unit controls the No.3 and 4 engine circuits. A later version of control unit, Type TP.4502, differs only in the kind of lubrication used for the internal components.

14. Each control unit contains two sensitive moving coil relays, one for each engine circuit. The moving coil relays are operated by the 7·5mV. output from the thermo-couple detectors. Each moving coil relay controls two Post Office relays, one for the warning circuit, the other for the cancellation circuit.

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

16. A P.O. relay Type 4184D, is used for the test circuit. This relay is 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, and tests the control unit for sensitivity and correct operation.

Detector circuit operation

17. The following circuit operation is given for the No.1 engine fire detector and warning circuit, and should be read in conjunction with the theoretical circuit diagram fig.2.

18. A 28-volt, d.c. supply from fuse 335 is fed to the control unit pulsing circuit via fuse A1. This supply is connected via a suppressor unit to two resistances (R6 and R7) and two relays (L1 and L2). This branch of the circuit is connected in such a way that, according to the position of contacts L1/1 and L2/1, either relay L1 or L2 will be energised. Contacts L1/2 therefore will constantly interrupt a 28-volt d.c. supply from fuse A2, via contacts L7/2 and resistance R11, to the moving coil relay MCR1. This pulsing circuit will continue all the time the power is switched on.

19. When a voltage of 7·5 mV. is generated by the No.1 engine bay detector chain, the voltage will be fed to one side of the moving coil relay MCR1 and returned to the negative side of the detector chain via resistance R11 and contacts L7/2. Relay MCR1 will be energised to change-over contacts MCR1/1. When the pulse contacts L1/2 change-over, a supply from fuse A2 will be fed through resistance R13, contacts L7/2, resistance R11 and the changed-over contacts MCR/1 to energise relay L6.

20. As the detector chain and moving coil relay are in parallel with this circuit, a certain proportion of current will flow through the detector chain and moving coil relay, to supplement the small operating current and so ensure a firm contact on the lightly tensioned contacts MCR1/1. This current will only flow momentarily through the contacts, due to the closing of L6/1 and L6/2. Contacts L6/2 form a 'hold-in' circuit for the coil of relay L6 and contacts L6/1 feed the fire warning lamp in the switch knob of the No.1 engine fire extinguisher switch.

Warning cancellation

21. When the engine bay temperature returns to a normal level, the voltage generated in the detector chain will fall until the coil of relay MCR1 becomes de-energised. The 28-volt supply from fuse A1 will now be fed via the test button and relay contacts 340/4, to energise relay L5. Contacts L5/1 will close to short-circuit relay L6 and contacts L6/1 and L6/2 will open. The opening of contacts L6/1 will break the feed to the warning lamp. The circuit is now reset and ready to transmit any further temperature rise.

Engine fire extinguishers operation

22. When manual control is employed, a 28-volt supply will be directed to the methyl-bromide containers as soon as the push-switches on the pilots' coaming panel are depressed. The warning lamp contained within each push-switch may be tested by pulling the switch knob. The knob, which is spring-loaded, will return to its original position when released.

23. In the event of a crash landing causing the operation of both crash switches, relays 76, 77, 85 and 86 will be energised. A 28-volt supply will then be fed through the contacts of these relays to operate the fire extinguishers. A theoretical circuit diagram for the engine fire extinguisher circuit is contained in fig.3.

Fuel tanks and leading edge fire extinguishers

24. The extinguishers provided for the fuselage tank, wing tank and leading edge areas, are operated only when the two inertia switches are tripped in the event of a crash landing. When this occurs, the operating supplies to these containers also are fed via the contacts of relays 76, 77, 85 and 86. Thus, in the event of a crash landing, all electrically operated fire extinguishers on the aeroplane will be discharged simultaneously.

Fuselage tanks

25. Four methyl-bromide containers, Type 13A, are employed for fire protection for the port and starboard No.1 and 2 fuel tanks. The containers are mounted two

on the rear pressure bulkhead for the forward tank area, and two on the bulkhead between the tanks for the aft tank area.

Wing tanks

26. Twelve methyl bromide dual head extinguisher containers, Type 14A, are provided for fire protection of the wing tank areas. They are installed six on each wing immediately outboard of the tanks. Only one discharge head of each container is used, this is provided with a 3-pin electrical connector to avoid cross connection to the one not in use. The heads in use are connected by a spray pipe system to positions above the inboard tanks. Operation of these heads therefore cause complete discharge of their containers into that area only.

Leading edge areas

27. Six Type 13A methyl-bromide containers are installed three in each wing forward of the main undercarriage bays. They are connected to spray piping systems installed in the leading edge duct of each main plane. When operated, these systems provide fire suppression in an area forward of the wing fuel tanks.

Circuit operation

28. Theoretical circuit diagrams are provided as follows:- No.1 and 2 tank bays at fig.4, wing tank and leading edge ducting at fig.5. Referring to fig.4, it will be seen that on operation of the two inertia switches the following action takes place:-

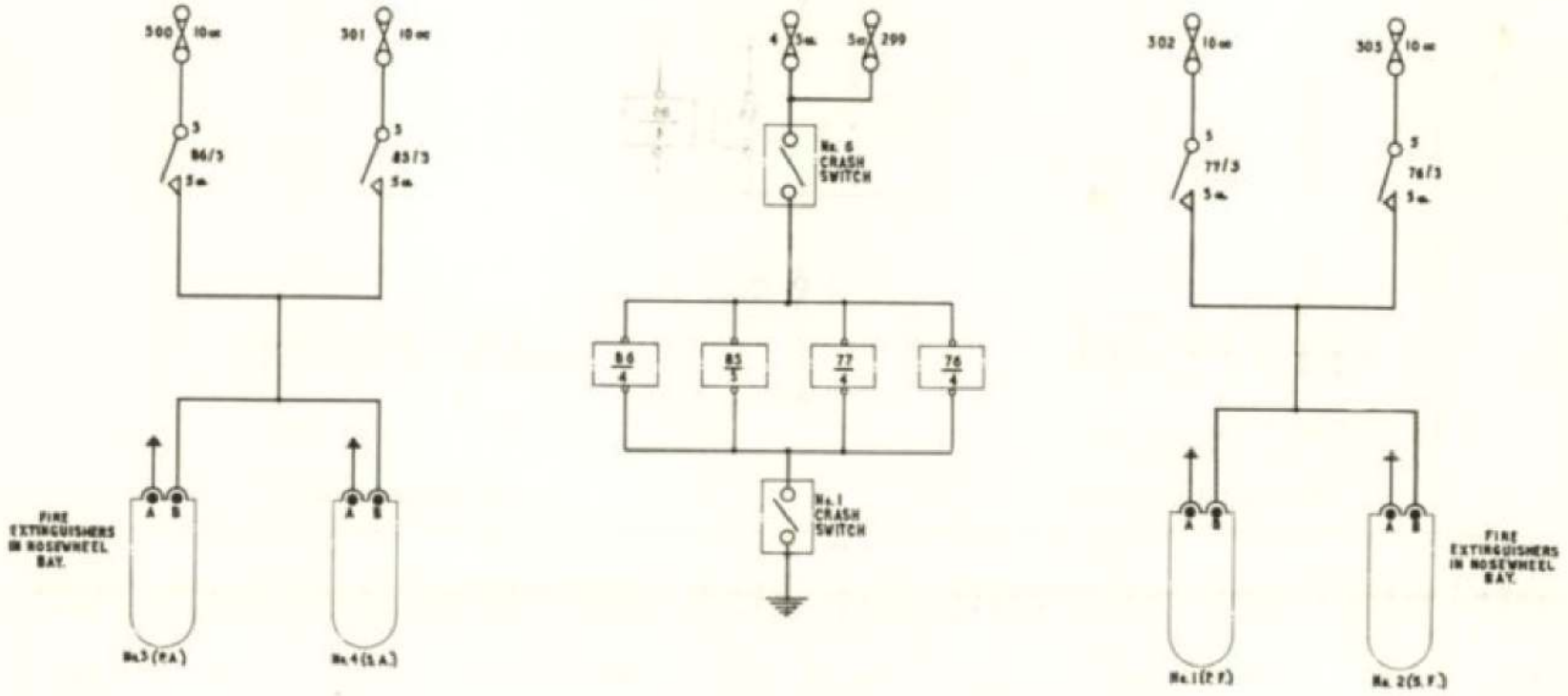


Fig.4 No.1 and 2 tank bay fire extinguishers

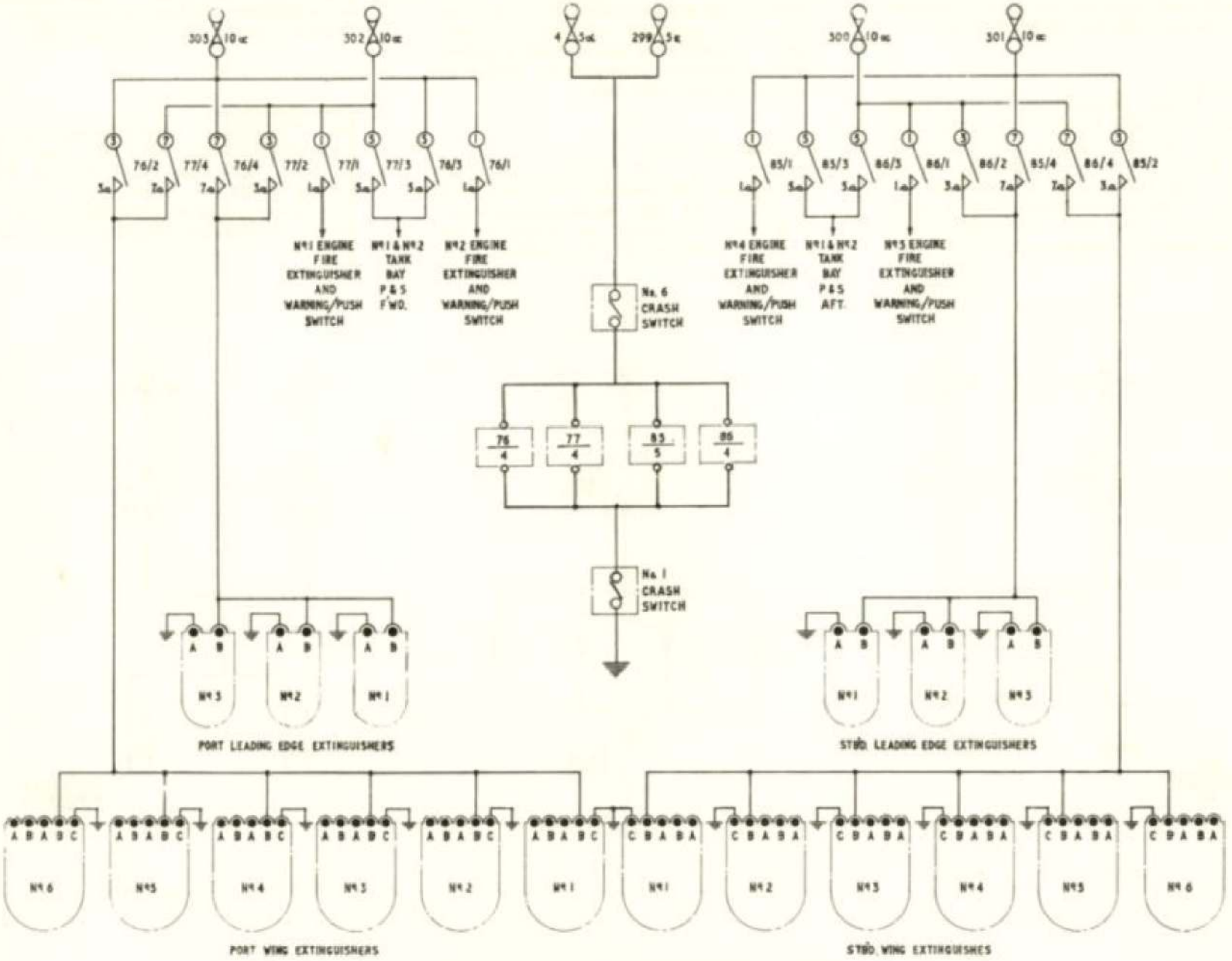


Fig.5 Wing tanks and leading edge fire extinguishers

(1) A 28-volt d.c. energising supply is connected from fuse 4 and/or 299 to the coils of Relays Nos.76, 77, 85 and 86.

(2) Closing of the contacts of these relays, completes supplies to the containers as follows:-

(a) No.1 (port forward) and No.2 (stbd. forward), from fuses 302 and/or 303 on panel 16P via relay contacts 77/3 and 76/3 respectively.

(b) No.3 (port aft) and No.4 (stbd. aft), from fuses 300 and/or 301 on 16P, via relay contacts 86/3 and 85/3 respectively.

29. Referring now to fig.5 it will be seen that on operation of the two inertia switches the following action also takes place:-

(1) A 28-volt energising supply is connected from fuse 4 and/or 299 to the coils of relays, 76, 77, 85 and 86.

(2) Closing of the contacts of these relays complete supplies to the containers as follows:-

(a) Port leading edge.
From fuses 303 and/or 302 via relay contacts 76/4 and 77/2 respectively.

(b) Stbd. leading edge.
From fuse 300 and/or 301 via relay contacts 86/2 and 85/4 respectively.

(c) Port wing tanks.
From fuse 303 and/or 302 via relay contacts 76/2 and 77/4 respectively.

(d) Stbd. wing tanks.
From fuse 300 and/or 301 via relay contacts 86/4 and 85/2 respectively.

CANOPY AND ENTRANCE DOOR INDICATION

Canopy indication

30. A magnetic indicator, Ref.No. 5CZ/5074, to the pilots' panel 1P, provides indication for canopy locking. The supply to this indicator is controlled by a micro switch actuated by the canopy release lever mechanism. When the canopy is locked in the closed position, the indicator is energised to show black. When the canopy is open the indicator is de-energised and shows white.

Entrance door indication

31. Two warning lamps, one Type A (red) and one, Type B (green), and a magnetic indicator, Ref.No. 5CZ/5074, are provided for entrance door warning internally. The two lamps are mounted on the door control box, which is located at the port forward end of the entrance aperture, and the indicator is fitted on the pilots' panel.

32. With the embodiment of Mod.208 and 209, a magnetic indicator, Ref.No.5CZ/5073, is provided for entrance door warning externally. Mod.208 introduces the wiring for the indicator, and Mod.209 installs the indicator and a double-pole switch, which are used in conjunction with ground servicing of the cabin pressurization system. Both indicator and switch are mounted on a panel at the forward starboard side of the nose wheel bay.

33. Supplies to the lamps and the indicators are controlled by the operation of a double-pole and a single-pole micro switch. Both switches are mounted on a bracket which is secured to the aft internal edge of the entrance aperture. The single-pole switch is actuated by the door locking mechanism and the double-pole switch by the interior surface of the door when it closes. The red lamp is illuminated when the door is open or unlocked, the green lamp is illuminated when the door is closed and locked. The internal indicator is energised to show black and the external indicator to show white when the door is closed and locked. Routing charts showing these circuits are given in fig.12 and in Group 8, fig.26 and 27.

SERVICING

FIRE EXTINGUISHER CONTROLS

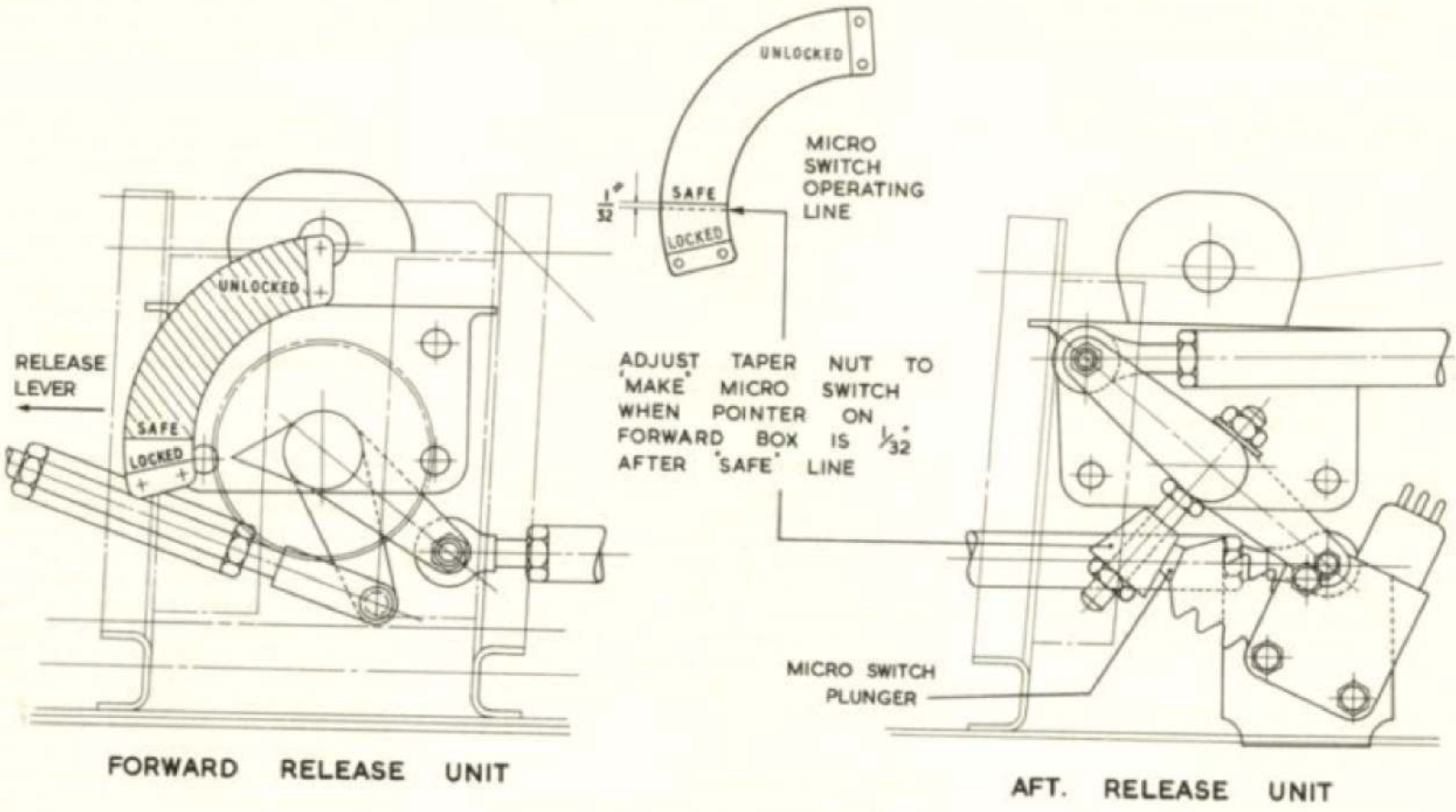
34. It is important that the fire extinguisher circuits be tested regularly, and inadvertent operation of the push-buttons and inertia switches must be avoided. The

WARNING . . .
Methyl bromide. Odourless non-irritant vapour, highly poisonous. The effects may not be apparent at once and may be fatal if a large amount is inhaled before signs develop.

methyl-bromide container supply cables must be disconnected before any servicing of the system is attempted.

Engine fire warning

35. The warning lamps in the knob of



STARBOARD CANOPY RELEASE MECHANISM

Fig.6 Setting of canopy micro switch

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. On aircraft with Mod.497 embodied, resistors are added in series with the thermo-couple chains. This is done to adapt the existing heads for correct operation where engines of a higher working temperature are fitted, i.e. on embodiment of Mod.279 or 413.

36. The engine fire warning circuit and thermo-couple chain may be test-functioned from two positions:-

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

(2) By operation of the push-button test switch, one on each control unit in the nose wheel bay. Each control unit serves a pair of engines.

37. When the test button on the port control unit is depressed, the 28-volt supply from fuse A1, which normally feeds relay L5 via contacts 340/4, will be directed to relay L7. Operation of relay L7 will cause contacts L7/1 and L7/2 to open, and contacts L7/3, and L7/4 to close. Opening of contacts L7/2 will remove the short circuit from resistance R12. The circuit will now be from fuse A2, resistance R13, to the two parallel paths:-

(a) Via R12, contacts L7/4, R9, to earth.

(b) Pin D, detector head chain MCR1, R11, contacts L7/4, R9 and earth.

38. A current will now flow in the same direction and of the same magnitude as that produced by the detector chain for a fire warning. This current will energise the moving coil relay MCR1, causing contacts MCR1/1 to close. Current will now flow from fuse A2, via resistances R12, R11, contacts MCR1/1 and relay L6 to earth; also through the parallel paths, the detector chain, moving coil relay MCR1, contacts MCR1/1 and relay L6 to earth.

39. Relay L6 will be energised, closing contacts L6/1 and L6/2. Supply from fuse A2 will be fed via L6/1 to the warning lamp in the engine fire extinguisher push-switch knob, and the lamp will light.

40. It will be seen (fig.2) that the same circuit operation will take place for the No.2 engine circuit, thus both No.1 and 2 warning lamps will be lit.

41. When the test push-button is released, the supply from A1 will be removed from relay L7 causing the contacts to revert to their normal position. Relays L3 and L5 will be energised, by the circuit operation outlined in para.21 for warning cancellation.

42. When the test switch on 4P is held to the TEST position, a supply from fuse 147 will energise the test relay 340. Contacts 340/1 and 340/3 will operate to close. It will be seen that this has the same effect as operating the push-switches on both control units. All four engine detector circuits will be tested simultaneously, and the four warning lamps will light. When the test switch is released, the same sequence of circuit operations will take place as outlined for warning cancellation in para.21.

Thermo-couple detector heads

43. The loop resistance of each detector head chain should be checked periodically; the total resistance must not exceed 2 ohms. Care should be taken when remaking any of the detector head connections, and the instructions laid down in A.P.4343, Vol.1, Sect.22, Chap.1, should be followed at all times. Further details of the detector heads, Type TP7090A/1, are contained in A.P.4343E, Vol.1, Sect.14, Chap.8.

44. 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 A.P.4343S, Vol.1, Sect.17, Chap.3.

Control units

45. The control units, Type TP4202 or TP4502, 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 are contained in A.P.4343, Vol.1, Sect.22, Chap.1, and A.P.4343E, Vol.1, Sect.14, Chap.7.

Inertia switches

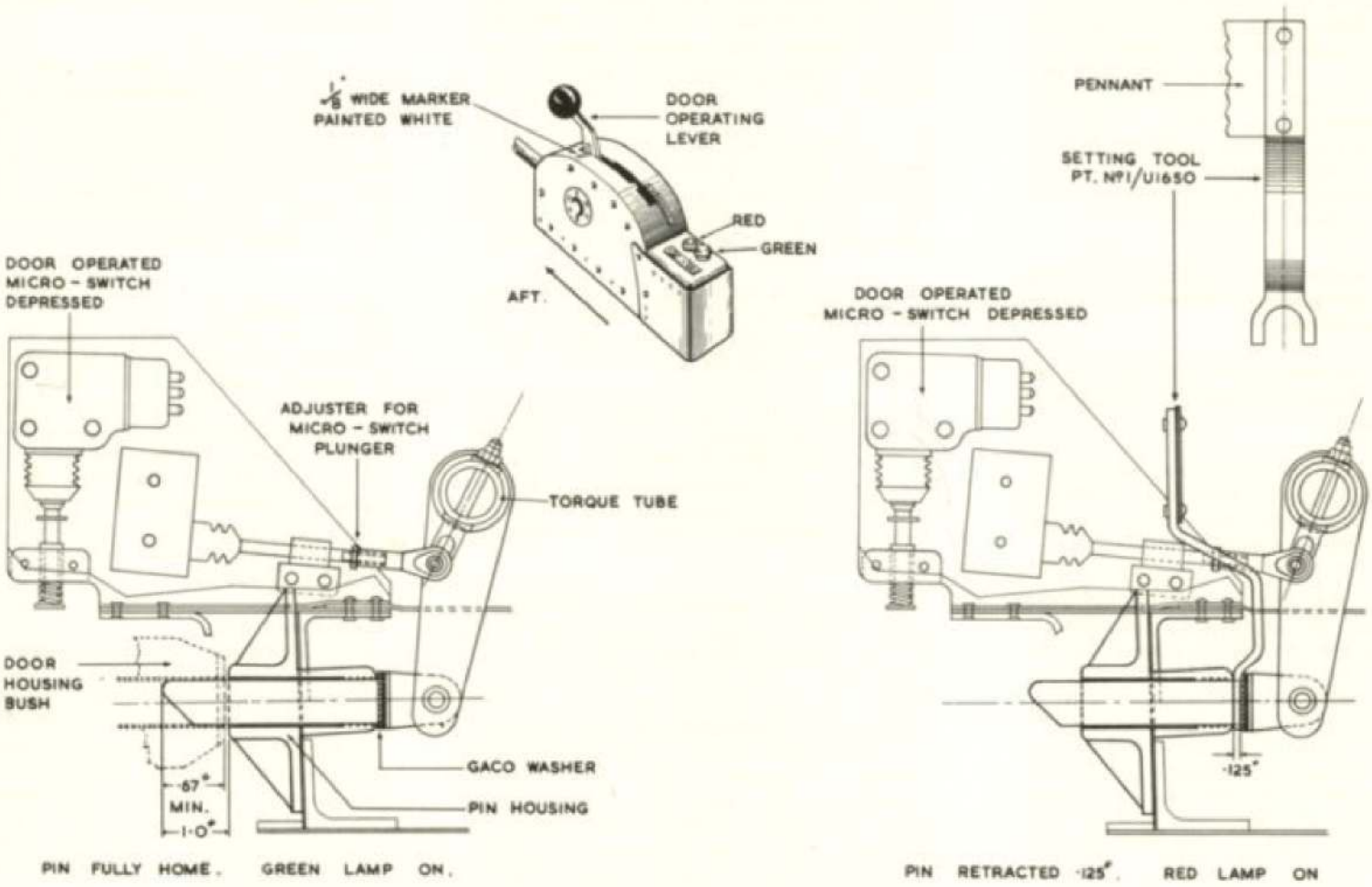
46. The crash or inertia switches Mk.2, Type 10C, should be checked periodically for security and cleanliness of connections. It is possible to observe the inside of the switch through the transparent case, and if observation reveals any of the parts to be damaged, or moisture to be present, the switch should be replaced by a serviceable one. Descriptive and servicing information for the switches is contained in A.P.4343C, Vol.1, Sect.3.

Testing the fire extinguisher circuits

47. Testing of these circuits is carried out using the miscellaneous system test console Stores Ref.26DC/95216. The checks should be made in accordance with A.P.4343V, Vol.1, Sect.4, Chap.1 and its associated schedules.

Fire extinguisher containers

48. The methyl-bromide fire extinguishers



LOCKING MECHANISM

Fig.7 Setting of entrance door micro switches

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.

49. 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 units will be found in A.P.1661F, Vol.1, Sect.5, Chap.3.

CANOPY AND ENTRANCE DOOR TESTS

50. 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 micro switch setting details for the two warning circuits are given in the following paragraphs.

Canopy micro switch

51. The canopy locking mechanism should be adjusted in accordance with the instructions contained in Book 1, Sect.3, Chap.1 and 11 of this publication. The micro switch is then adjusted in accordance with the details shown in fig.6 of this group. The magnetic indicator on the pilots' panel should be energised to show black when the micro switch is operated.

Door indicator sequence

52. The door warning indicators should be checked at the periods laid down in the Servicing Schedule. The sequence of operation is as follows:-

(1) With the door open and the operating lever at the fully aft position check that:-

(a) The white lines on the lever and box are correctly aligned.

(b) The red warning lamp on the door operating lever quadrant lights.

(c) The green warning lamp on the door operating lever quadrant is extinguished.

(d) The warning indicator on the pilots' panel is de-energised to show white.

(2) Manually depress the plunger of the door-operated micro switch and check that:-

(a) The red warning lamp is extinguished.

(b) The green warning lamp lights.

(c) The warning indicator on the pilots' panel is energised to show black.

(3) With the door-operated micro switch plunger still depressed, move the door operating lever to the forward position and check that as the white lines move out of alignment:-

(a) The green warning lamp is extinguished.

(b) The red warning lamp lights.

(c) The warning indicator on the pilots' panel is de-energised to show white.

(4) With the door-operated micro switch plunger still depressed, return the door operating lever to the aft position and check that as the white lines move into alignment:-

(a) The red warning lamp is extinguished.

(b) The green warning lamp lights.

(c) The warning indicator on the pilots' panel is energised to show black.

(5) Release the plunger of the door operated micro switch and check that:-

(a) The green warning lamp is extinguished.

(b) The red warning lamp lights.

(c) The warning indicator is de-energised to show white.

NOTE . . .
On aircraft with Mod.209 embodied the external indicator functions in identical sequence to that on the pilots' panel 1P. It should be noted however, that it shows white when energised and black when de-energised.

53. If this sequence of operation is not obtained the torque tube and door operated micro switches should be checked independently for correct functioning. The wiring to both switches can also be checked against figs.26 and 27 in Group 8.

Torque tube micro switch

54. The micro switch operated by the locking mechanism is adjusted in accordance with fig.7. The following procedure should be carried out:-

(1) With the entrance door open, remove the false floor covering the torque tube.

(2) Using a torch or other source of lighting, confirm that with the door operating lever in the fully aft

position the Gaco washers at the shoulders of both locking pins butt against the aft end of the pin housing. Check that in this position the locking pins protrude 1 inch from the forward end of the pin housing.

(3) Check that the white lines painted on the door operating lever and box are in alignment.

(4) Check the surface finish of the locking pin housing bushes on the entrance door.

(5) If the bushes are burred, clean out with a 25/32 inch reamer, ensuring that any swarf caused by the reamering is removed.

(6) Pack both the door housing bushes with anti-freeze grease (Ref.No. XG-295), and close the door, ensuring that the lines on the lever and box are aligned.

(7) Open the door and check that the penetration of the locking pins in the door housing bushes is a minimum of 0·67 inch. This dimension is measured from the face of the housing bush to the grease indentation corresponding to the end of the pin.

(8) Push on the locking pins to retract them sufficiently to insert the special setting tool Avro Part No. 1/U1650 between the Gaco washer and the aft end of either pin housing. This sets the mechanism 1/8 inch from its fully home position.

(9) With the plunger of the door operated micro switch depressed, adjust the push rod operating the torque tube micro switch so that the red warning lamp just lights.

(10) Lock the push rod adjustment and remove the setting tool.

(11) Close the door and ensure that the white lines on the door operating lever and the quadrant are in line and that the green warning lamp lights.

NOTE . . .

It is important that the torque tube micro switch should cause the appropriate switching of the red and green warning lights only as the locking pin moves through the last 1/8 inch movement of its fully home position.

55. At the completion of these checks the supply should be disconnected and the false floor replaced.

REMOVAL AND ASSEMBLY

Control units Type TP.4202

56. Removal of each unit consists of detaching the 12 pin connector from the front panel, undoing the knurled securing nuts and lifting the unit clear of the rack.

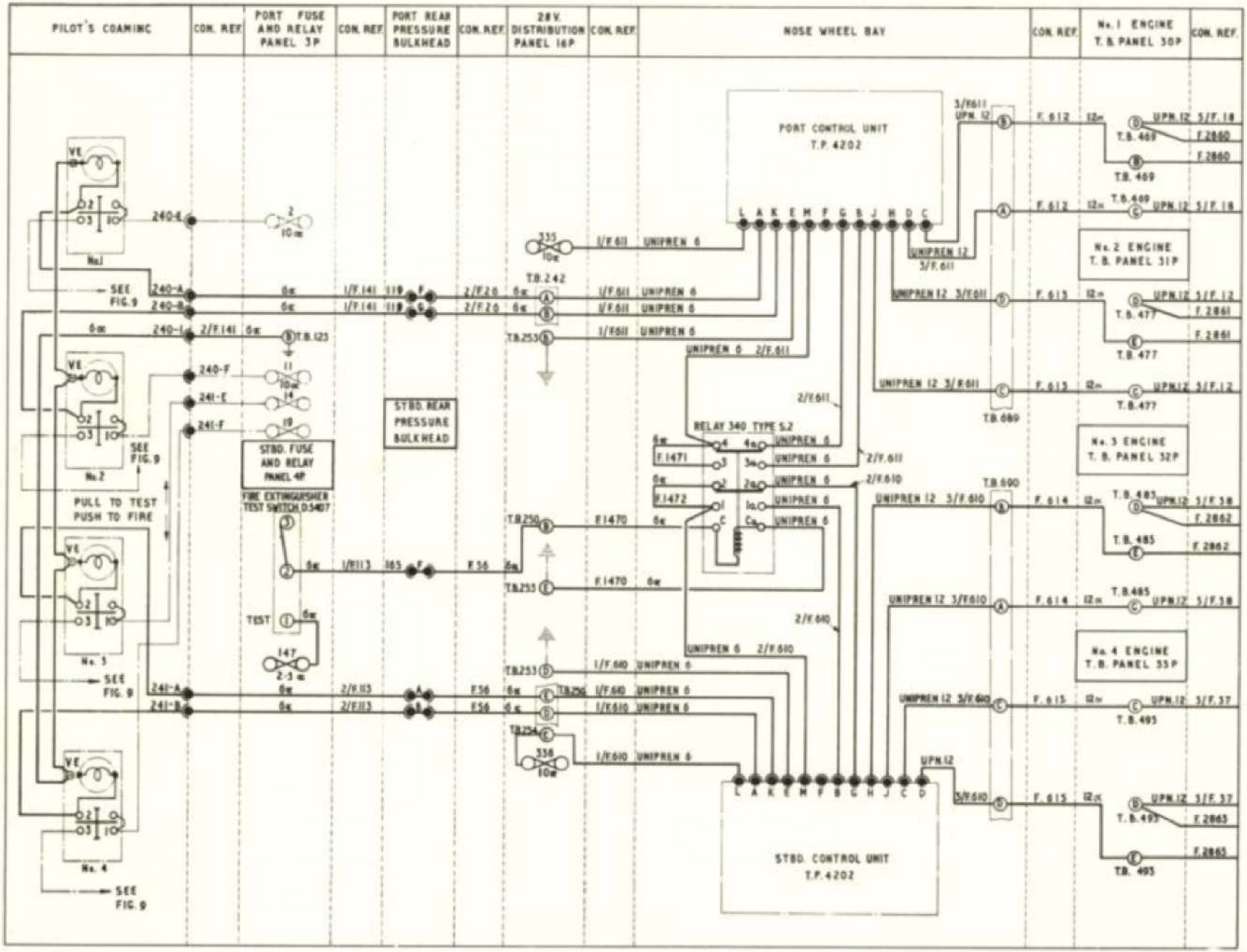


Fig.8(1) Engine fire warning control

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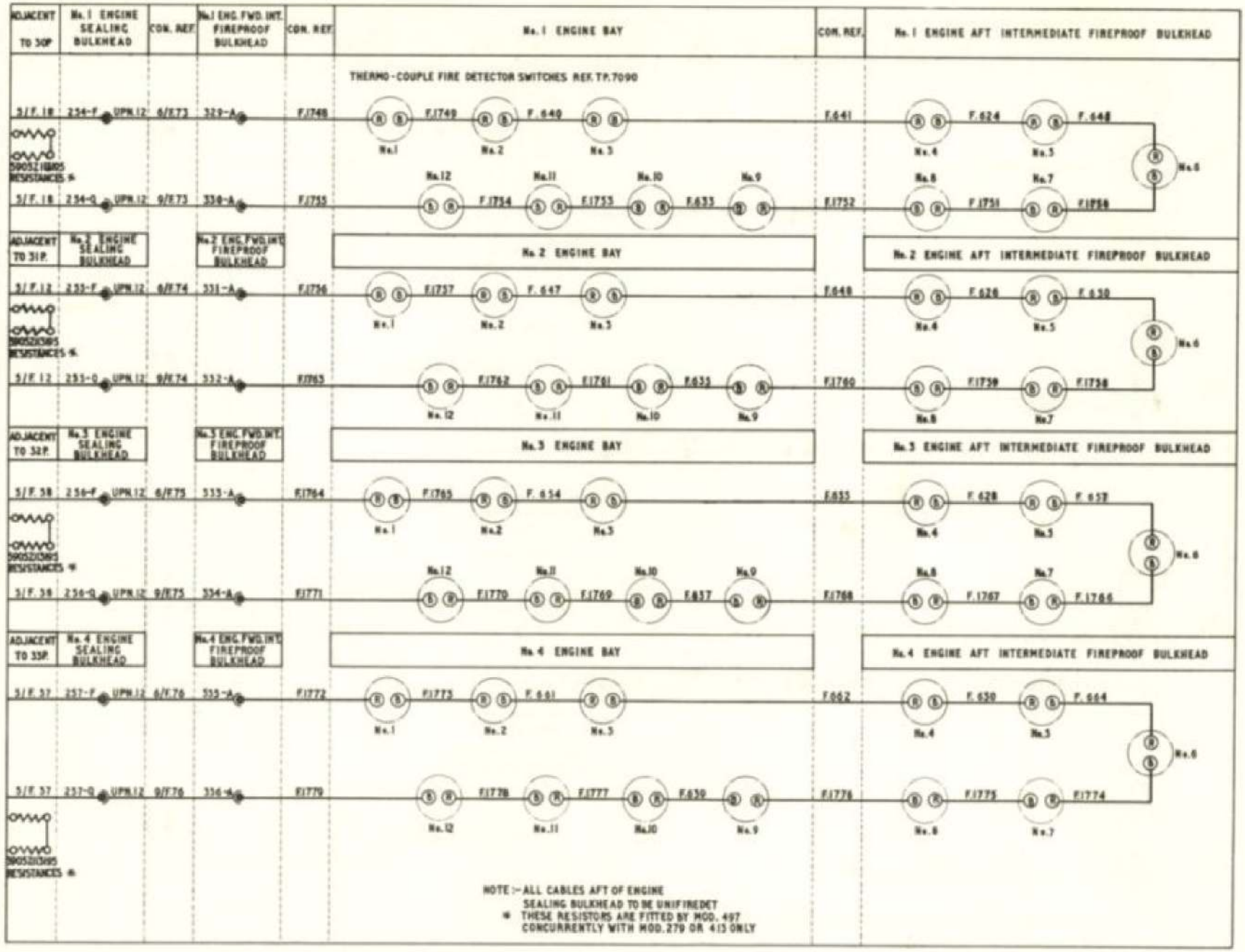

Fig.8(2) Engine fire warning control

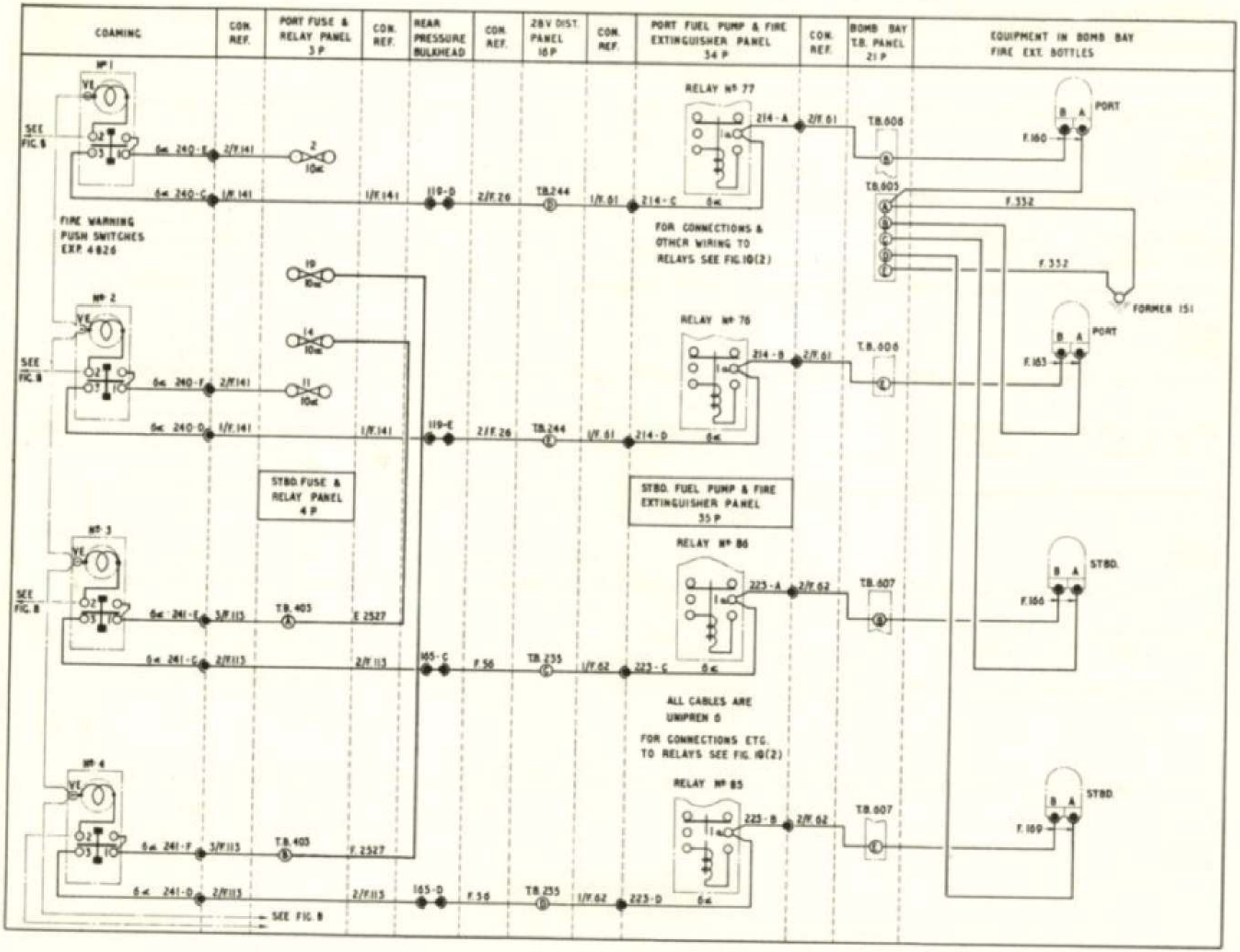

Fig. 9. Engine fire extinguishers. (pre Mod. 1118.)

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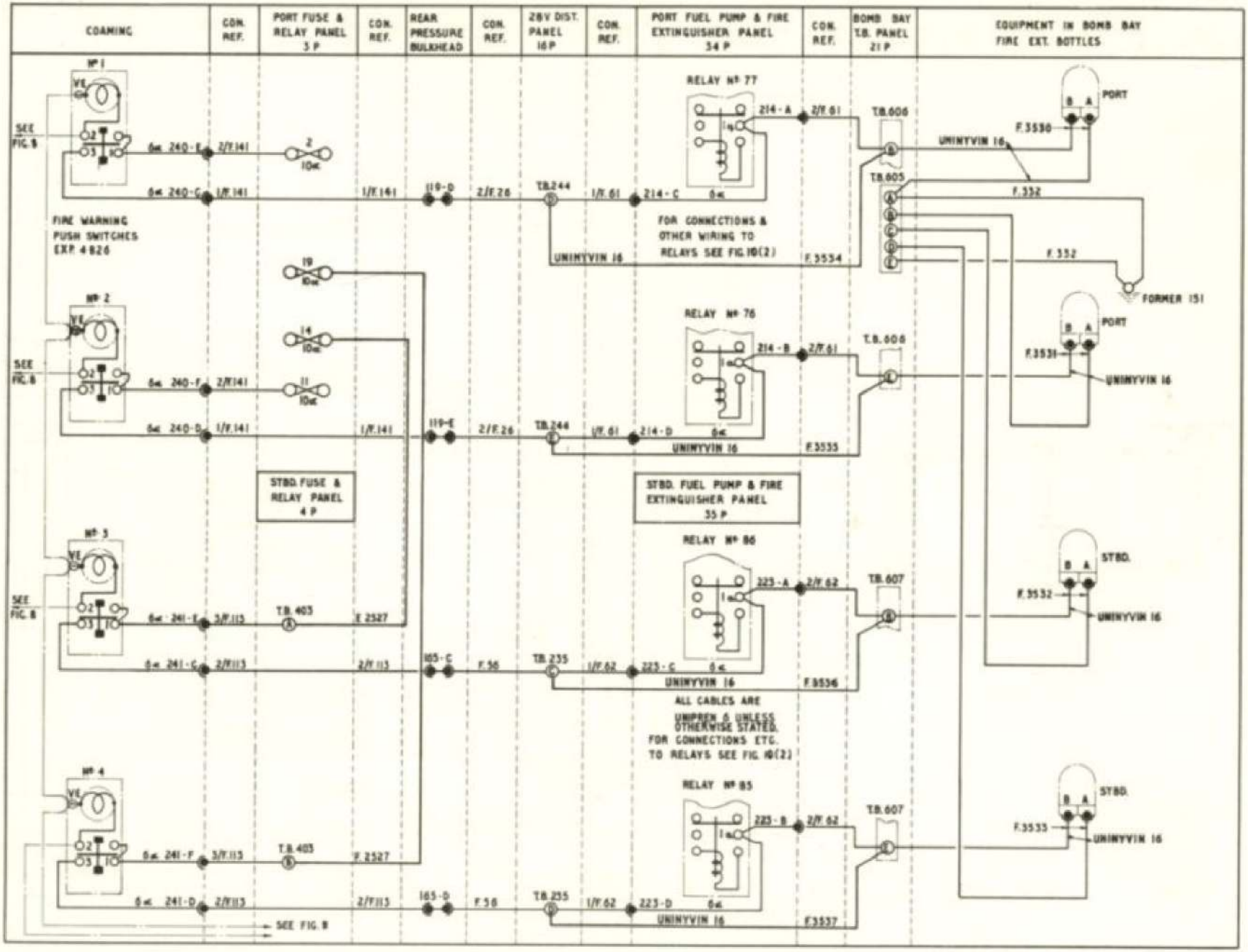

Fig. 9A. Engine fire extinguishers. (post Mod. 1118.)

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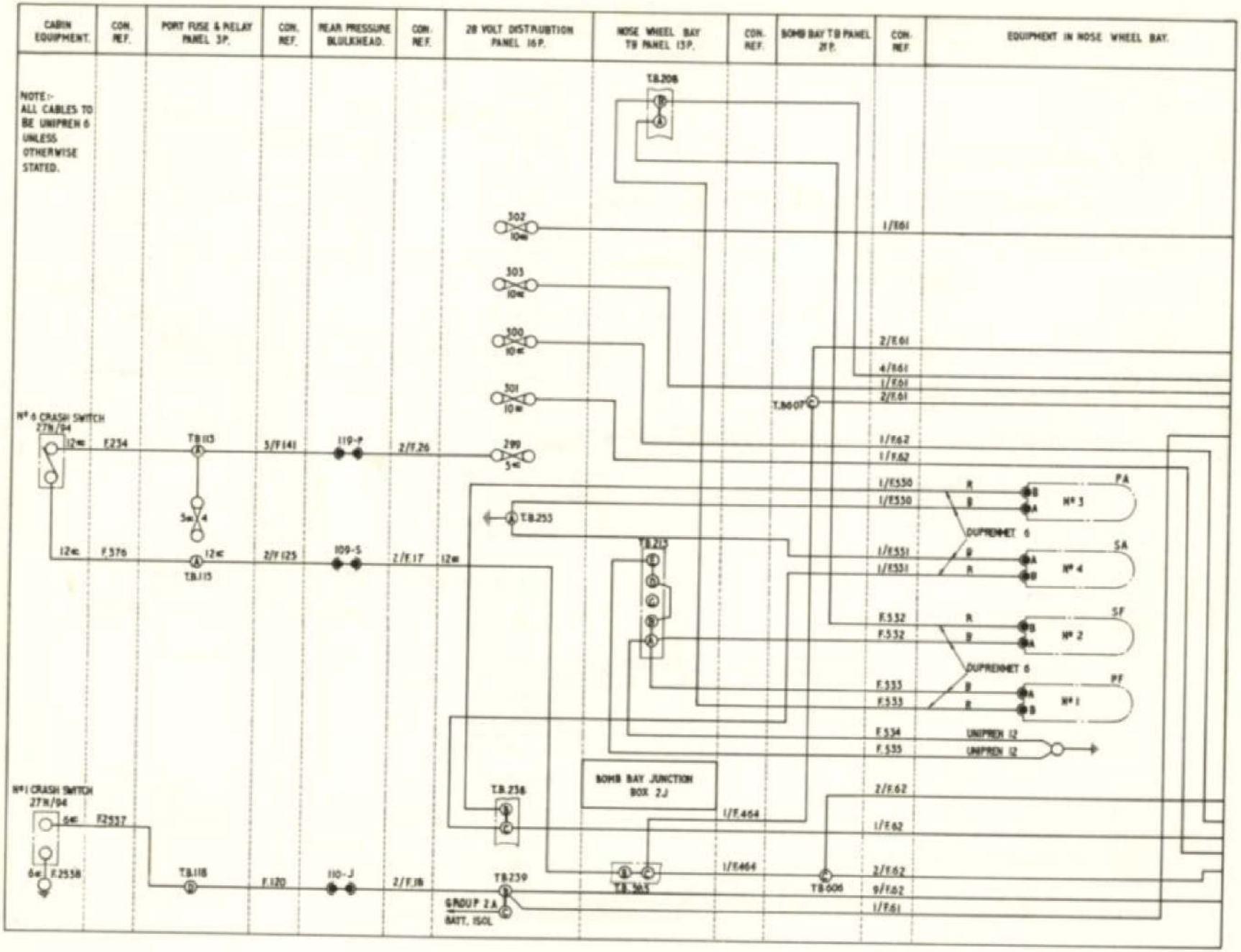

Fig.10(1) Port and stbd wing tanks and nº 1 and 2 tank bays

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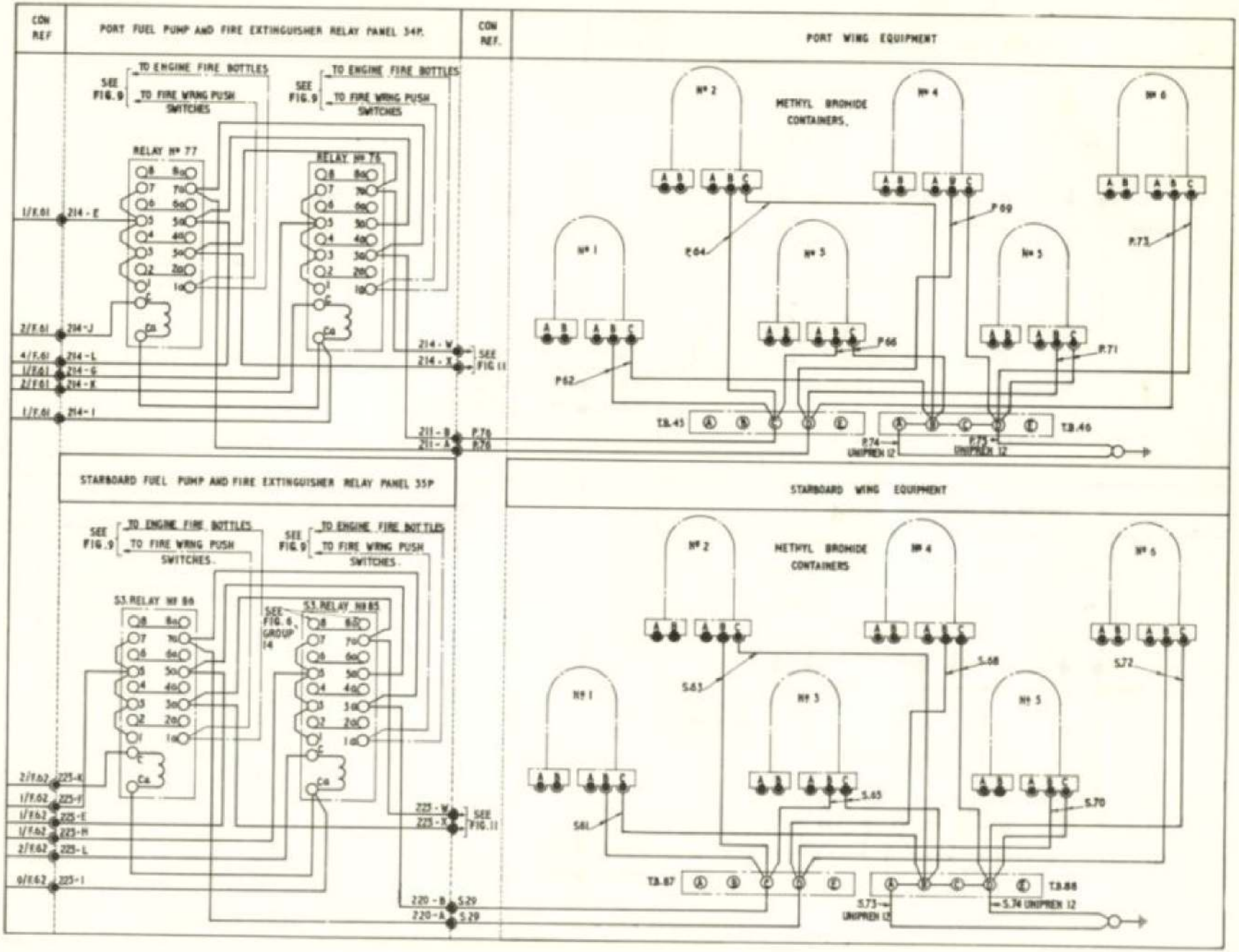

Fig.10(2) Port and st'bd' wing tanks and nº 1 and 2 tank bays

RESTRICTED

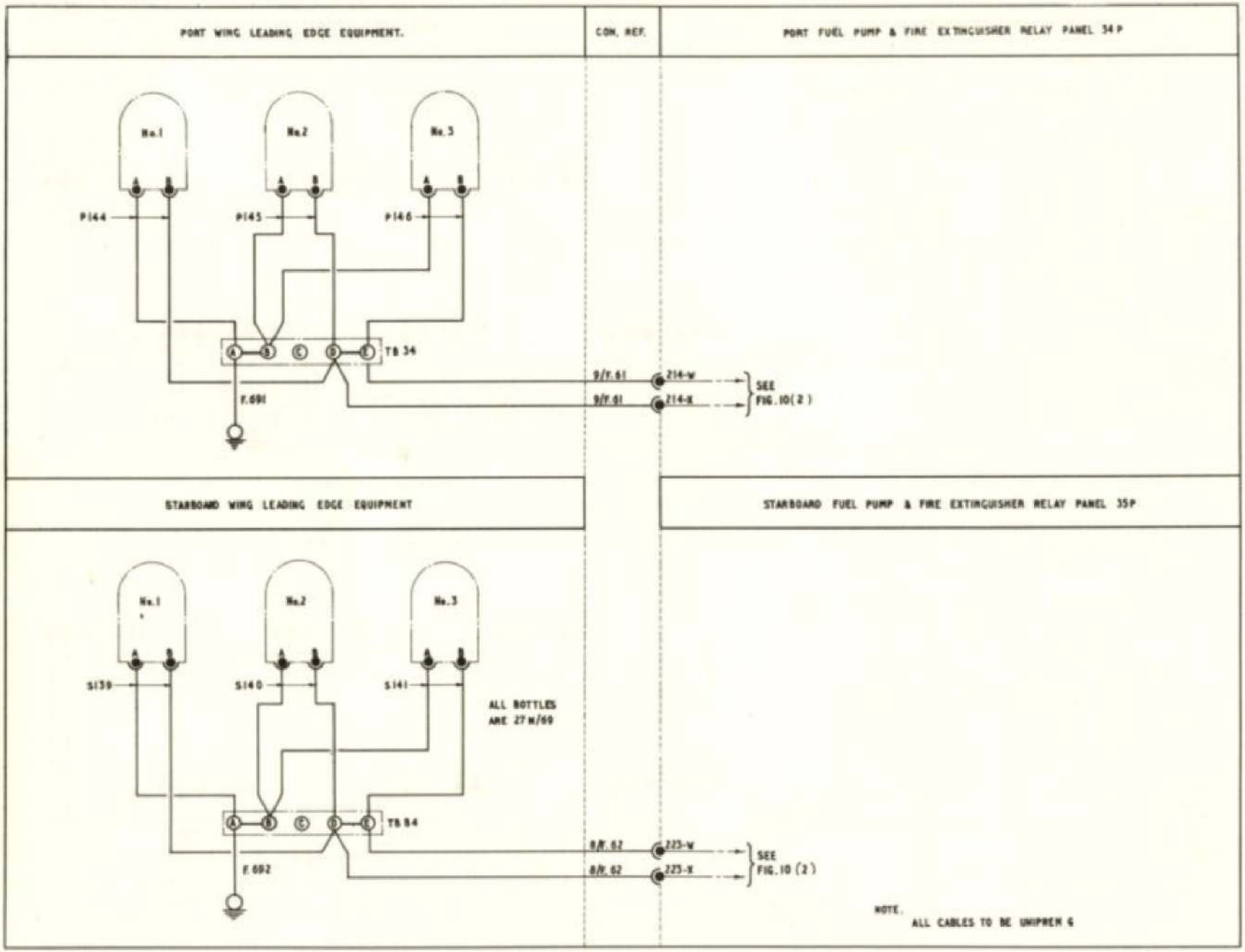

Fig.11 Leading edge duct fire extinguishers

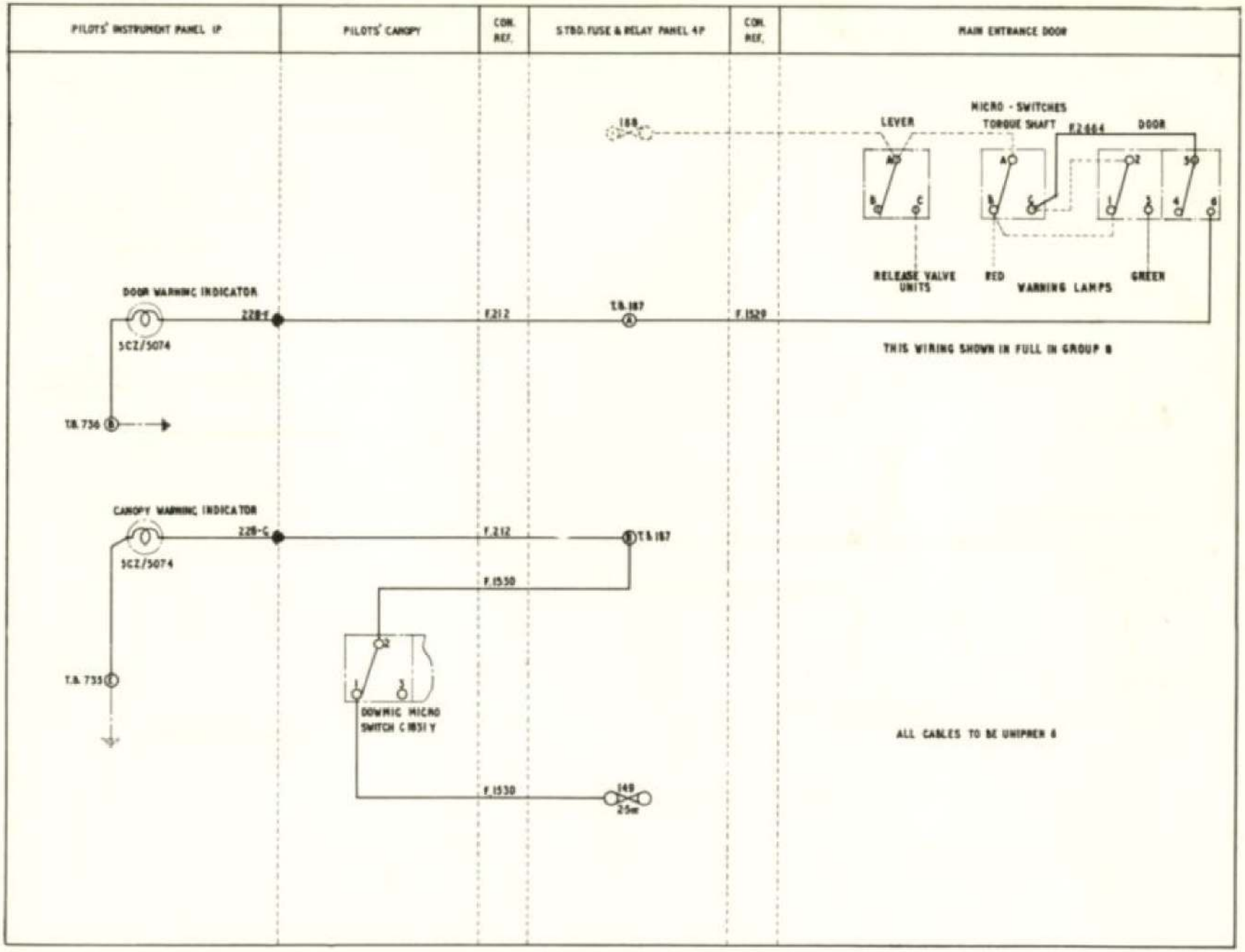

Fig.12 Canopy and entrance door indication (pre mod. 209)

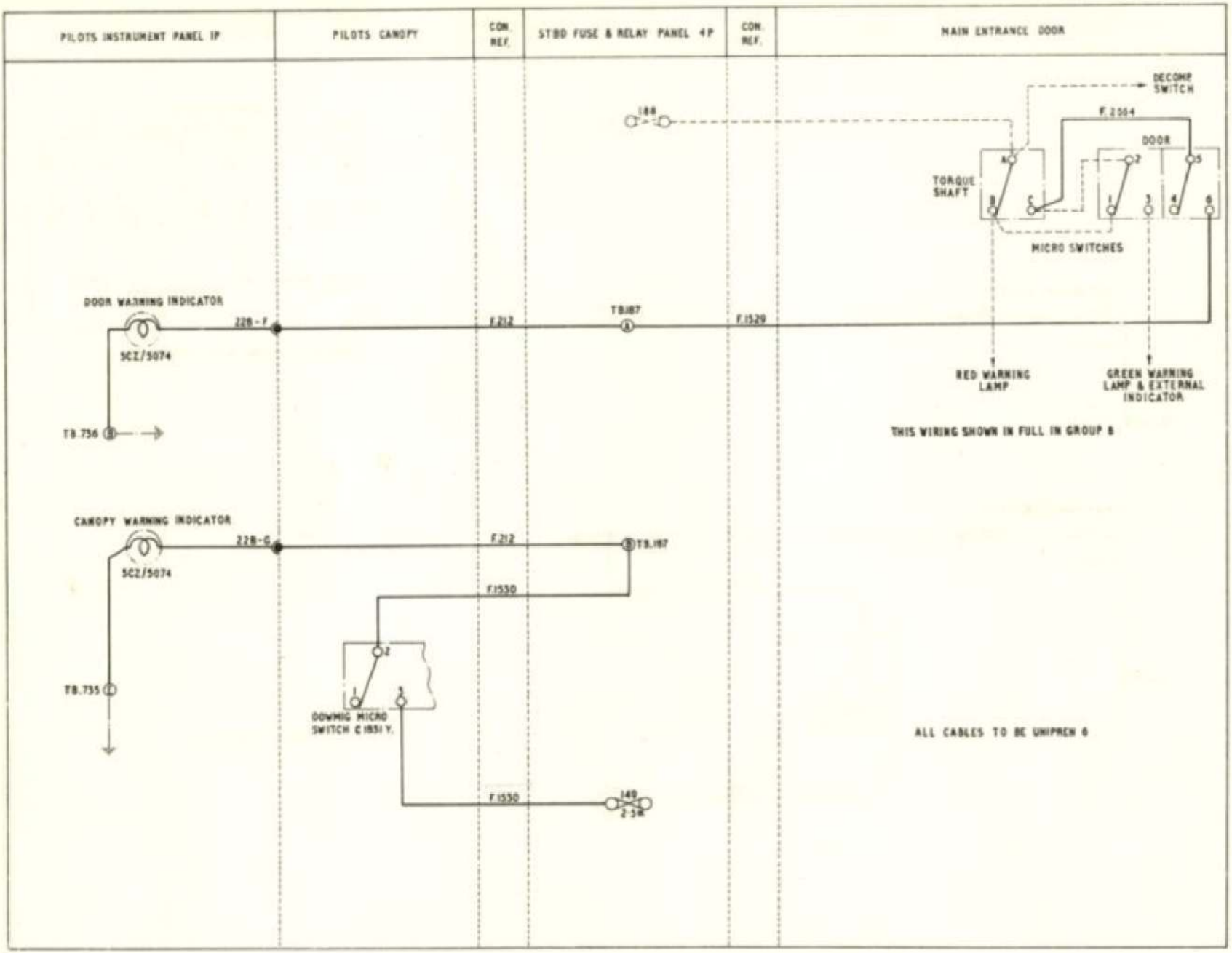

Fig.12A. Canopy and entrance door indication (post mod.209)